

May 27, 2026

**VIA ELECTRONIC MAIL:**

Dear :

**Re: Request for Access to Records – Response**  
***Freedom of Information and Protection of Privacy Act (FOIPPA)***

I am writing further regarding your request received by the BC Energy Regulator (BCER) for access to records relating to the Flaring Management Report referred to in the LNG Canada facility permit amendment.

Please see the attached records located in response to your request. Some information has been withheld pursuant to section 22 (Disclosure harmful to personal privacy) of FOIPPA. A complete copy of FOIPPA is available online at: [Freedom of Information and Protection of Privacy Act \(gov.bc.ca\)](https://www.oipc.bc.ca).

Please note, a copy of these records will be published on the BCER's website within seven business days after release. To find out more about proactive disclosure of requests, please visit the BCER website: [Proactive-Disclosure-of-FOI-Requests-Guide.pdf](#). Your file is now closed. Pursuant to section 52 of the FOIPPA, you may ask the Office of the Information and Privacy Commissioner (OIPC) to review any decision, act, or failure to act with regard to your request under FOIPPA within 30 business days by writing to:

*Information and Privacy Commissioner*  
*PO Box 9038 Stn Prov Govt*  
*4<sup>th</sup> Floor, 947 Fort Street*  
*Victoria BC V8W 9A4*  
*Phone: 250.387.5629 Fax: 250.387.1696*  
*Email: [info@oipc.bc.ca](mailto:info@oipc.bc.ca)*

If you request a review, please provide the OIPC with a copy of your original request, a copy of the BCER's response, and the reasons or grounds upon which you are requesting the review. Further information on the complaint and review process can be found on the OIPC website: <https://www.oipc.bc.ca>. Please write [FOIIntake@bc-er.ca](mailto:FOIIntake@bc-er.ca), if you have any questions regarding your request or require any further clarification.

Sincerely,

***D. Keough***  
BC Energy Regulator

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Wednesday, February 28, 2024 1:52 PM  
**To:** Mathews, Suzanne  
**Cc:** permitting@Ingcana.ca; LNGC JVD PERMITTING; scot.mackillop@Ingcana.ca; Ben Ashton; erin.furlong@Ingcana.ca; Lyndsey.Hunter@Ingcana.ca; Ariyawansa, Sarangi; Whitehouse, Mike; Post Permit Requests; Cameron.McCormick@Ingcana.ca  
**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report  
**Attachments:** L001-06200-OA-5880-0001\_R0.pdf

Afternoon,

Please see the attached Flaring Management Report (Rev 0). There is no change to the content of this Report (Rev 0) from Revision H, rather the status has been updated from “Issued for Review” to “Approved for Use”.

Regards

Janine

**Janine Forrest** | **JGC Fluor BC LNG JV** | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | Ms22  
[www.jfvkitimat.com](http://www.jfvkitimat.com)

---

**From:** Janine Forrest  
**Sent:** Thursday, December 21, 2023 1:30 PM  
**To:** Mathews, Suzanne <Suzanne.Mathews@bc-er.ca>  
**Cc:** permitting@Ingcana.ca; LNGC JVD PERMITTING <LNGC.JVD.PERMITTING@fluor.com>; scot.mackillop@Ingcana.ca; Ben Ashton <Ben.Ashton@fluor.com>; erin.furlong@Ingcana.ca; Lyndsey.Hunter@Ingcana.ca; James Frith <James.Frith@fluor.com>; Cameron.McCormick@Ingcana.ca; Ariyawansa, Sarangi <Sarangi.Ariyawansa@bc-er.ca>; Whitehouse, Mike <Mike.Whitehouse@bc-er.ca>; Post Permit Requests <postpermitrequests@bc-er.ca>  
**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report

Afternoon,

Please see the revised Flaring Management Report (Rev H) along with the responses to BCERs clarification questions on Rev. G (provided Dec. 07). The only changes made to the Report were to address the BCER questions (the line on the right side of the page indicates all the sections that have been changed/updated).

I'll share these documents with Haisla this afternoon also.

Please let Lyndsey or I know if you have any questions on this submission,

Once the BCER review has been satisfied, the intent is to update this document to be Revision 0, Approved for Use.

Happy Holidays (again),

Janine

**Janine Forrest** | **JGC Fluor BC LNG JV** | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | Ms22  
[www.jfvkitimat.com](http://www.jfvkitimat.com)

---

**From:** Mathews, Suzanne <[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)>  
**Sent:** Thursday, December 7, 2023 4:33 PM  
**To:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; [Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca); Ariyawansa, Sarangi <[Sarangi.Ariyawansa@bc-er.ca](mailto:Sarangi.Ariyawansa@bc-er.ca)>; Whitehouse, Mike <[Mike.Whitehouse@bc-er.ca](mailto:Mike.Whitehouse@bc-er.ca)>; Post Permit Requests <[postpermitrequests@bc-er.ca](mailto:postpermitrequests@bc-er.ca)>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,  
Thank you for this submission. Please see attached for some clarification questions.

Regards,



---

**Suzanne Mathews**, P.Eng.  
Supervisor, LNG & Research  
[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)

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s22

We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal traditions and relationships. We also acknowledge the Métis and Inuit people living across B.C.

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**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Friday, November 10, 2023 2:30 PM  
**To:** Ariyawansa, Sarangi <[Sarangi.Ariyawansa@bc-er.ca](mailto:Sarangi.Ariyawansa@bc-er.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)>; Whitehouse, Mike <[Mike.Whitehouse@bc-er.ca](mailto:Mike.Whitehouse@bc-er.ca)>; Post Permit Requests <[postpermitrequests@bc-er.ca](mailto:postpermitrequests@bc-er.ca)>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; [Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca)  
**Subject:** RE: LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached updated Flaring Management Report (L001-06200-OA-5880-0001\_RG.pdf) along with the responses to BCERs clarification questions on Rev. F ("LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.pdf"), on behalf of LNG Canada.

As previously discussed, this Report has been significantly updated since Revision F, therefore I have not included the version that shows all the tracked changes (i.e., with different colored font / strike through text that has been removed) as it is very difficult to follow - the line on the right side of the page indicates all the sections that have been changed/updated.

I'll share these documents with Haisla this afternoon also.

Let Lyndsey or I know if you have any questions on this submission,

Regards

Janine

**Janine Forrest** | **JGC Fluor BC LNG JV** | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M  
s22  
[www.jfvkitimat.com](http://www.jfvkitimat.com)

---

**From:** Ariyawansa, Sarangi <[Sarangi.Ariyawansa@bcogc.ca](mailto:Sarangi.Ariyawansa@bcogc.ca)>  
**Sent:** Thursday, September 15, 2022 3:58 PM  
**To:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; Whitehouse, Mike <[Mike.Whitehouse@BCOGC.ca](mailto:Mike.Whitehouse@BCOGC.ca)>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,

Thank you for this submission. Please see the attached for a comment about FMR and some follow-up and additional review questions.

Thanks,  
Sarangi



**Sarangi Ariyawansa** EIT  
Engineer, Facilities  
[Sarangi.Ariyawansa@bcogc.ca](mailto:Sarangi.Ariyawansa@bcogc.ca)

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We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal traditions and relationships. We also acknowledge the Métis and Inuit people living across B.C.

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---

**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Tuesday, August 2, 2022 8:53 AM  
**To:** Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING



<[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; 'scot.mackillop@Ingcana.ca' <[scot.mackillop@Ingcana.ca](mailto:scot.mackillop@Ingcana.ca)>;  
'Neven.Dimic@Ingcana.ca' <[Neven.Dimic@Ingcana.ca](mailto:Neven.Dimic@Ingcana.ca)>; Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>;  
[erin.furlong@Ingcana.ca](mailto:erin.furlong@Ingcana.ca); 'Lyndsey.Hunter@Ingcana.ca' <[Lyndsey.Hunter@Ingcana.ca](mailto:Lyndsey.Hunter@Ingcana.ca)>; James Frith  
<[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; Hassan, Umair <[Umair.Hassan@bcogc.ca](mailto:Umair.Hassan@bcogc.ca)>

**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated Flaring Management Report for the LNG Canada Project: L001-06200-OA-5880-0001\_RF (2022JUL26)\_TRACKED.pdf. The tracked changes are shown in red (additions).

I will also share this Report with Haisla Nation this morning.

Let me know if you have any further questions / clarifications for this Report. The intent is to issue the "final" version as Rev. 0 (Approved for Use) after we have closed out the OGC / Haisla review.

Regards

Janine

---

**From:** Janine Forrest

**Sent:** Friday, June 3, 2022 10:17 AM

**To:** Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>

**Cc:** 'permitting@Ingcana.ca' <[permitting@Ingcana.ca](mailto:permitting@Ingcana.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@Ingcana.ca](mailto:scot.mackillop@Ingcana.ca); [Neven.Dimic@Ingcana.ca](mailto:Neven.Dimic@Ingcana.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@Ingcana.ca](mailto:erin.furlong@Ingcana.ca); 'Lyndsey.Hunter@Ingcana.ca' <[Lyndsey.Hunter@Ingcana.ca](mailto:Lyndsey.Hunter@Ingcana.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; Hassan, Umair <[Umair.Hassan@bcogc.ca](mailto:Umair.Hassan@bcogc.ca)>

**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>

**Sent:** Thursday, April 14, 2022 2:38 PM

**To:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>; Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>

**Cc:** 'permitting@Ingcana.ca' <[permitting@Ingcana.ca](mailto:permitting@Ingcana.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@Ingcana.ca](mailto:scot.mackillop@Ingcana.ca); [Neven.Dimic@Ingcana.ca](mailto:Neven.Dimic@Ingcana.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@Ingcana.ca](mailto:erin.furlong@Ingcana.ca); 'Lyndsey.Hunter@Ingcana.ca' <[Lyndsey.Hunter@Ingcana.ca](mailto:Lyndsey.Hunter@Ingcana.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>; Hassan, Umair <[Umair.Hassan@bcogc.ca](mailto:Umair.Hassan@bcogc.ca)>

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



**Suzanne Mathews**, P.Eng.  
Supervisor, Engineering Strategic & Technical  
Services  
[Suzanne.Mathews@BCOGC.ca](mailto:Suzanne.Mathews@BCOGC.ca)

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**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Tuesday, March 8, 2022 12:25 PM  
**To:** Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>  
**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/Ing canada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua <[Joshua.Porter@bcogc.ca](mailto:Joshua.Porter@bcogc.ca)>  
**Sent:** Friday, November 19, 2021 12:09 PM  
**To:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>; Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca)>

<[Lyndsey.Hunter@Ingcana.ca](mailto:Lyndsey.Hunter@Ingcana.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.



**Joshua Porter** P.Eng.  
Engineer, LNG Facilities  
[Joshua.Porter@BCOGC.ca](mailto:Joshua.Porter@BCOGC.ca)

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**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>

**Sent:** Friday, October 1, 2021 3:14 PM

**To:** Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Porter, Joshua <[Joshua.Porter@bcogc.ca](mailto:Joshua.Porter@bcogc.ca)>

**Cc:** 'permitting@Ingcana.ca' <[permitting@Ingcana.ca](mailto:permitting@Ingcana.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@Ingcana.ca](mailto:scot.mackillop@Ingcana.ca); [Neven.Dimic@Ingcana.ca](mailto:Neven.Dimic@Ingcana.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@Ingcana.ca](mailto:erin.furlong@Ingcana.ca); 'Lyndsey.Hunter@Ingcana.ca' <[Lyndsey.Hunter@Ingcana.ca](mailto:Lyndsey.Hunter@Ingcana.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>

**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

**Janine Forrest** | **JGC Fluor BC LNG JV** | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M s22  
[www.jrvkitimat.com](http://www.jrvkitimat.com)



Controlled Document

## Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | 0                                            |
| Document Status          | Approved for Use                             |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 26-Feb-2024                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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# REVISION CONTROL PAGE

| Revision Status |             |                   |                            | Approving Organization                                                                       |                            |             |
|-----------------|-------------|-------------------|----------------------------|----------------------------------------------------------------------------------------------|----------------------------|-------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                     | Approver                   | Review Code |
| A               | 08-Jun-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 | N/A         |
| B               | 12-Oct-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 |             |
| C               | 09-Apr-2021 | Issued for Review | C. McCormick               |                                                                                              |                            |             |
| D               | 01-Oct-2021 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>R. Kabgarian<br>S. MacKillop<br>N. Dimic                                        | B. Ashton<br>R. Dronamraju |             |
| E               | 08-Mar-2022 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>N. Dimic<br>C. Sharwood<br>A. Betts                                             | B. Ashton<br>R. Dronamraju |             |
| F               | 26-Jul-2022 | Issued for Review | J. Forrest                 | N. Dimic<br>C. McCormick<br>J. Keim                                                          | B. Ashton<br>R. Dronamraju |             |
| G               | 10-Nov-2023 | Issued for Review | J. Forrest                 | L. Hunter<br>C. McCormick<br>S. MacKillop                                                    | B. Ashton                  |             |

|   |             |                   |                                                                                                 |                                                                                                 |                                                                                                  |  |
|---|-------------|-------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--|
| H | 21-Dec-2023 | Issued for Review | J. Forrest                                                                                      | L. Hunter<br>C. McCormick<br>S. MacKillop                                                       | B. Ashton                                                                                        |  |
| 0 | 26-Feb-2024 | Approved for Use  | J. Forrest<br> | B. Ashton<br> | B. Ashton<br> |  |

# TABLE OF CONTENTS

|        |                                                                           |    |
|--------|---------------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                              | 5  |
| 1.1.   | Project Background                                                        | 5  |
| 1.2.   | Purpose and Objectives                                                    | 5  |
| 1.3.   | Project Flaring and Overview                                              | 5  |
| 1.3.1. | Project Overview                                                          | 5  |
| 1.3.2. | Process Description Overview                                              | 5  |
| 1.3.3. | Flaring Overview                                                          | 7  |
| 1.3.4. | Flaring Event Classification                                              | 10 |
| 1.4.   | Environmental Considerations                                              | 11 |
| 1.4.1. | LNG Canada Commitments                                                    | 11 |
| 1.4.2. | Potential Environmental Effects                                           | 12 |
| 1.5.   | Roles and Responsibilities                                                | 12 |
| 1.6.   | Abbreviations and Definitions                                             | 13 |
| 2.     | REGULATORY FRAMEWORK                                                      | 18 |
| 2.1.   | Project Approvals and Conditions                                          | 18 |
| 2.1.1. | Facility Permit                                                           | 18 |
| 2.1.2. | Waste Discharge Authorization                                             | 21 |
| 2.1.3. | Environmental Assessment Certificate                                      | 21 |
| 2.1.4. | Decision Statement                                                        | 22 |
| 2.2.   | Acts, Regulations, and Guidelines                                         | 22 |
| 2.2.1. | Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation | 23 |
| 2.2.2. | BCER Flaring and Venting Reduction Guideline                              | 24 |
| 2.2.3. | BC Noise Control Best Practices Guideline                                 | 24 |
| 2.2.4. | BCER Light Control Best Practices Guideline                               | 25 |
| 2.2.5. | Ambient Air Quality Objectives                                            | 25 |
| 3.     | MITIGATION MEASURES                                                       | 26 |
| 3.1.   | Design                                                                    | 26 |
| 3.1.1. | Air Emissions, GHG Emissions, Visible Emissions                           | 26 |
| 3.1.2. | Thermal Radiation                                                         | 27 |
| 3.1.3. | Noise                                                                     | 28 |
| 3.2.   | Construction                                                              | 28 |
| 3.3.   | Operations                                                                | 28 |
| 3.3.1. | Air Emissions and GHG Emissions                                           | 29 |
| 3.3.2. | Visible Emissions                                                         | 29 |
| 3.3.3. | Light and Wildlife                                                        | 29 |
| 3.3.4. | Noise                                                                     | 29 |
| 4.     | CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                               | 30 |
| 4.1.   | HSSE Management System                                                    | 30 |
| 4.2.   | Tracking of Flare Losses                                                  | 30 |
| 5.     | REPORT REVIEW AND UPDATES                                                 | 31 |
| 6.     | REFERENCES                                                                | 32 |
|        | APPENDIX A LIST OF ATTACHMENTS                                            | 33 |

# 1. Introduction

## 1.1. Project Background

LNG Canada Development Inc. (LNG Canada) is building a liquefied natural gas (LNG) export facility in Kitimat, British Columbia (BC), Canada, in the traditional territory of the Haisla Nation. LNG Canada is a joint venture comprised of Shell Canada Energy (Shell), North Montney LNG Limited Partnership, PetroChina Kitimat LNG Partnership (CNPC), Diamond LNG Canada Partnership (Diamond), and KOGAS Canada LNG Partnership (KOGAS).

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project, including permitting.

A list of acronyms is provided in Section 1.6.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning, in conformance with the LNG Canada Facility Permit issued by the BC Energy Regulator (BCER) (formerly known as the BC Oil and Gas Commission (OGC)).

This document does not cover the feed gas pipeline that is under Coastal GasLink (CGL) control.

## 1.3. Project Flaring and Overview

### 1.3.1. Project Overview

The Project includes, but is not limited to, the following LNG processing and storage systems:

- Natural gas inlet station
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities
- Up to two full containment storage LNG tanks
- Up to two condensate storage tanks
- Flare systems, including a total of up to two flare derricks.

There are two parallel LNG loading lines, up to two vapour return lines, and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier and a material offloading facility.

The Project is being constructed in two phases, with each phase having two processing units and associated utilities, one LNG storage tank and one LNG carrier berth. The flare system has been designed to accommodate both phases.

### 1.3.2. Process Description Overview

The Project receives dry pressurized natural gas from the CGL pipeline. The feed gas stream is primarily methane with some ethane, propane, butane, and a small heavy tail with some impurities. The raw, warm gas is cleaned of its impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, and heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to Figure 1).



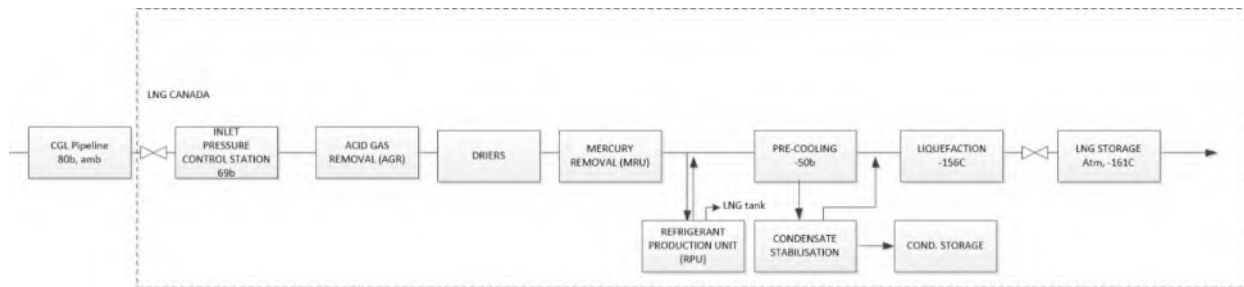


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown, as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses Pre-cool Mixed Refrigerant (“PMR”) cooling from ambient temperatures to -50°C
- Deeper liquefaction cycle: uses Mixed Refrigerant (“MR”) cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE).

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called “String A” and “String B” (refer to Figure 2). Each string can handle approximately half the production rate. The gas turbines are semi-aero derivative type with low torque requirement at start. This means there is no need to depressurize inventory to allow restart.

Methane, ethane and propane are the components used as refrigerants in the liquefaction process. They are available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).

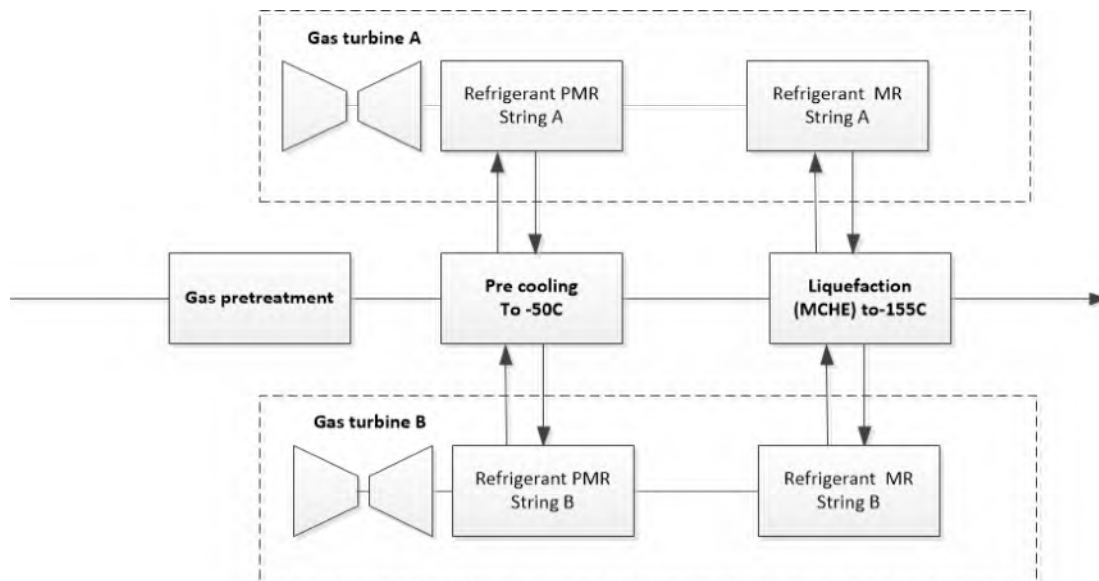


**Figure 2 Liquefaction Overview Schematic (High Level)**

### 1.3.3. Flaring Overview

During Normal Operations, natural gas and other hydrocarbons flow continuously through an LNG facility. When there is a disruption to the expected operation of the LNG facility, the constant flow of natural gas is interrupted. Large scale LNG facility designs incorporate flare systems to safely combust excess hydrocarbons when necessary. There are various events that will result in flaring at the LNG Canada facility, refer to Section 1.3.4.

At the LNG Canada facility, there are four vapour flares and nine liquid burners on two derrick structures. Table 1 contains further information on each vapour flare and the liquid burners. Figure 3 and Figure 4 illustrate the location of the flare systems, and Figure 5 illustrates the flare derrick structures that support the design height requirements of the flare release points.

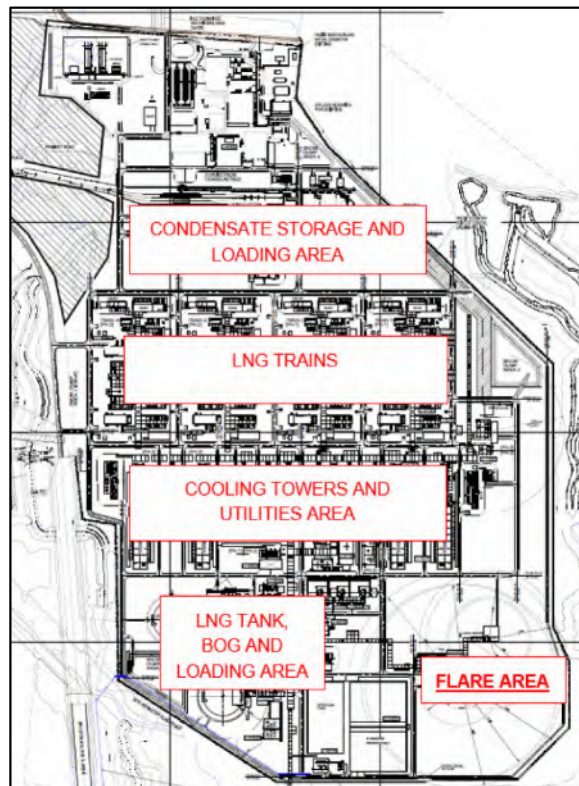
The flares are equipped with a flare pilot; a continuous source of fuel gas to ignite gas sent to the flare, enabling the hydrocarbons to burn safely and efficiently under all conditions without escaping into the atmosphere. The LNG facility has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers) for operational reasons.

The flare pilot is a small, smokeless flame. When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be large, noisy, and/or create visible smoke emissions. During Commissioning and the early stages of Normal Operations, it is expected that flare volumes and visibility will be higher compared to when “steady state” Normal Operations is achieved. The flaring activity will reduce over time as the facility moves into “steady state” Normal Operations.

**Table 1 Flare Derrick Structures and System**

| Item                 |                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour Flare Derrick | Warm/Wet Process Flare (F-WW) | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"><li>• Inlet Facilities</li><li>• Acid Gas Removal Unit</li><li>• Dehydration Unit</li><li>• Mercury Removal Unit</li><li>• Liquefaction Unit</li><li>• Incinerator Unit</li><li>• Condensate Stabilisation Unit</li><li>• Heat Transfer Fluid System</li><li>• Tempered Cooling Water System Unit</li><li>• Fuel Gas System</li><li>• Defrost Gas System</li></ul> |

| Item                  |                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | Cold/Dry Process Flare (F-CD)                 | <p>For cryogenic hydrocarbon vapours that will not contain water. This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                             |
|                       | Low Pressure Storage and Loading Flare (F-LP) | <p>For low pressure LNG vapours from the LNG storage tank(s) and/or LNG carrier loading, in the event of BOG compressor failure. Compressor seal vents and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p> <p>Includes a velocity seal to minimize purge gas requirements.</p> <p>A mixture of methane and CO<sub>2</sub> or nitrogen will be released to the F-LP flare during LNG carrier de-inerting. Additional fuel gas will be added at the flare to maintain the minimum required heating value.</p> |
|                       | Spare flare                                   | <p>Used in place of one of the other flares when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare (F-WW) with a minimum design temperature to release the cold/dry vapours.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Liquid Burner Derrick | Liquid burners                                | For either warm/wet or cold/dry liquids.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



### Figure 3 Flare Location Overview

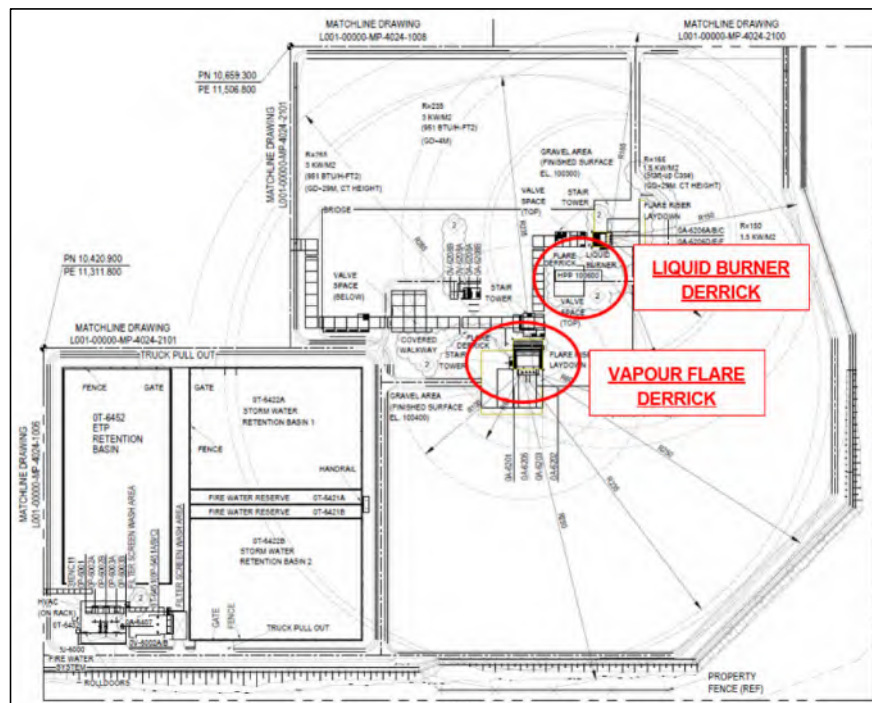


**Figure 4 Flare Plot Plan (L001-00000-MP-4024-1011\_R2)**

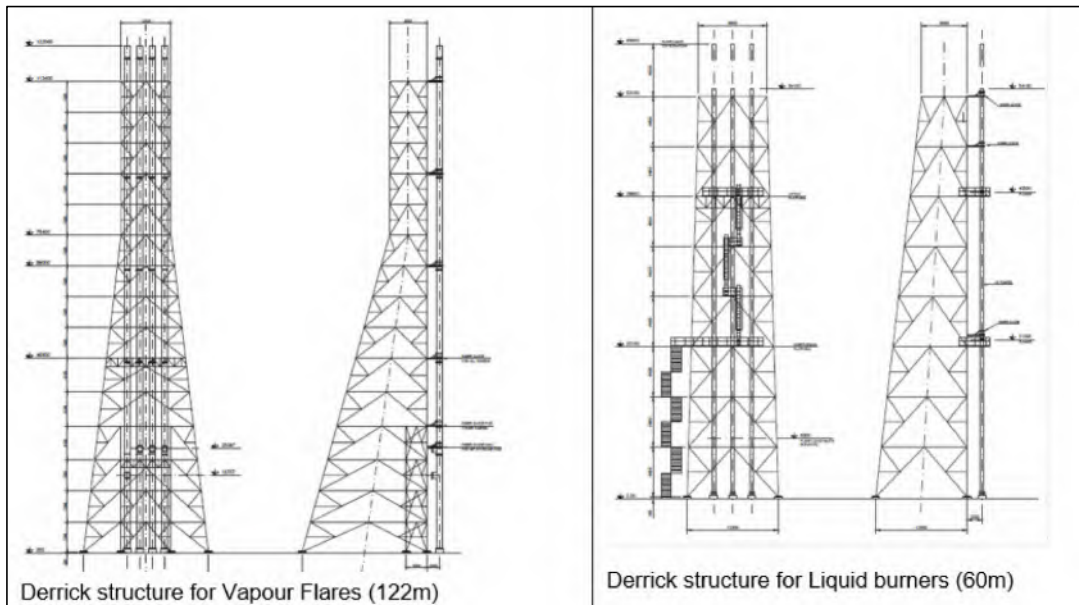


**Figure 5 Derrick Structure**

#### 1.3.4. Flaring Event Classification

LNG Canada will endeavor to accurately classify flaring events aligned with the types and examples shown in Table 2. The flaring event types are based on the LNG Facility Regulation (refer to Section 2.2.1) and the permissions in the LNG Canada Facility Permit (refer to Section 2.1.1).

**Table 2 Flaring Event Classification**

| Regulation / Authorization | Type of Flaring | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LNG Facility Regulation    | Emergency       | <p>Safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure. Examples include:</p> <ul style="list-style-type: none"> <li>• Activation of an Instrumented Protective Function (IPF) safeguard</li> <li>• Relief valve operation</li> <li>• Operator activation of Emergency de-pressuring system</li> <li>• Manual de-pressuring by operations technicians.</li> </ul> |
|                            | Maintenance     | <p>Flaring related to maintenance or turnaround activities to remove hydrocarbon from equipment where equipment requires maintenance to maintain integrity or inspect/repair defects.</p>                                                                                                                                                                                                                                                                                                              |
| Facility Permit            | Flare pilots    | <p>Small continuous sources of process gas sent to the warm wet flare and low-pressure storage and loading flare including the primary seal gas from the compressors, and analyzer sample gas.</p>                                                                                                                                                                                                                                                                                                     |

| Regulation / Authorization | Type of Flaring             | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | Flare system purge          | There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                            | De-inerting of LNG carriers | <p>Routine/planned de-inerting of LNG carriers.</p> <p>The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with inert gas prior to loading. These tanks need to be purged and cooled down with LNG from the facility. During the purging and cooldown process, the vapour return is sent to the low pressure flare until confirmation that required CO<sub>2</sub> specifications have been met based on laboratory sampling. Upon confirmation, the vapour is then routed to the storage tank and BOG compressors. There are no requirements to vent from the inerted LNG carrier.</p>                                                                                                                                                                                             |
|                            | Process upsets              | <p>Deviations that require the operator to take measures that prevent safety or production loss and preempt activation of safety systems (i.e., flaring occurs to prevent an emergency event from developing and prevent safety or production loss). Examples include:</p> <ul style="list-style-type: none"> <li>• Console operator takes action to de-pressure a vessel to prevent activation of IPF</li> <li>• Routing of process gas to flare due to off-spec condition to prevent damage to downstream unit (i.e., amine foaming, high dewpoint, high C5+, offspec product)</li> <li>• Flaring due to internal leaks within equipment (MCHE internal leaks)</li> <li>• Flaring to de-pressure rotating equipment to facilitate restart</li> <li>• Evacuation of remaining hydrocarbon from systems after an Emergency state once event is downgraded from Emergency (i.e., risk of injury or property loss is mitigated).</li> </ul> |
|                            | Commissioning               | Flaring in the period of time commencing when operations begin in accordance with section 11 of the LNGFR and ending when the first cargo of LNG is shipped from the LNG train.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 1.4. Environmental Considerations

### 1.4.1. LNG Canada Commitments

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment (HSSE) and Social Performance (SP) focuses on ways to avoid and minimize negative environmental and social impacts resulting from their operations and enhance the positive impacts in a systematic manner.

Further information the HSSE & SP Framework and Environmental Management System (EMS) is provided in Section 4.

#### 1.4.2. Potential Environmental Effects

The act of flaring can cause potential effects to the environment due to the characteristics of the chemical, noise and thermal emissions. Potential environmental effects from flaring and associated emissions of greenhouse gases, criteria air contaminants, light, smoke (from incomplete combustion), noise and heat were considered in the Environmental Assessment Certificate (EAC) process (refer to Section 2.1.3 for further information on the EAC and applicable conditions).

A summary of these potential effects from flaring is provided herein for information.

- **Greenhouse Gas Emissions (GHG):** Emissions of primary GHGs from the flare system include CO<sub>2</sub>, methane (CH<sub>4</sub>) and nitrous oxide, from the combustion of hydrocarbons. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane.
- **Air Emissions:** Emissions of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), carbon monoxide (CO), particulate matter (PM) and volatile organic compounds (VOCs) from the combustion of hydrocarbons.
- **Light:** Some elevated light emissions are anticipated during Commissioning and the early stages of Normal Operations; however, this is a standard part of starting up an LNG facility and will reduce as the facility approaches a “steady state” of Normal Operations. Flaring events may be seen from the community depending on the resulting size of the flare size. Also refer to potential effects to wildlife below.
- **Visual Emissions – Smoke:** Incomplete combustion of the gases or liquids being flared has the potential to producing coarse and fine PM emissions that can be visible. Even if the PM emissions do not result in an air quality effect, the visibility of flaring emissions is undesirable and a potential nuisance to the community within an observation distance. Visibility of emissions is often measured in terms of opacity or the density of the emission and its ability to block light. As opacity of the emission increases, it results in a plume of visible smoke that can be described as moving from a light gray (20% opacity) to ultimately a complete black smoke (100% opacity). A Ringelmann scale (0 to 5; 0% to 100% opacity) is often used to describe a human observation of the opacity of a flare event, where the objective of the flare design is to perform at Ringelmann 0 or “R0” as often as achievable.
- **Noise:** The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential effects from noise are assessed within the Project site (occupational) and offsite (nuisance).
- **Thermal Heat:** When combustion occurs in the flare system, a large amount of heat is released. This heat can pose a safety risk to personnel and the environment.
- **Wildlife:** Increased noise, light and vibration levels can potentially cause sensory disturbance (e.g., attract and disorient birds, nest abandonment, displace wildlife from preferred foraging or breeding habitat). Nighttime lighting can disrupt the foraging patterns of nocturnal wildlife.

#### 1.5. Roles and Responsibilities

There are various roles and responsibilities related to the design, construction, and operations of the flare system. JFJV, as LNG Canada’s EPC contractor, is responsible for managing the design, fabrication, construction, pre-commissioning, and Commissioning of the facility, up to “ready for start-up” (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing Commissioning activities that cannot be physically done prior to RFSU and Normal Operations after RFSU and handover of each LNG train, with support from JFJV to execute post-



RFSU activities in the early stages of Normal Operations. Commissioning, ramp-up, and the early stages of Normal Operations shall be executed by a joint team of staff from LNG Canada and JFJV. A basic principle of the Project is that compliance with the FMR, applicable laws and regulations is a line management responsibility.

## 1.6. Abbreviations and Definitions

Table 3 and Table 4 contain a list of abbreviations and definitions used within this document.

**Table 3 Abbreviations**

| Abbreviation    | Definition                                                                                            |
|-----------------|-------------------------------------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                                                 |
| AQO             | Ambient Air Quality Objective                                                                         |
| BC              | British Columbia                                                                                      |
| BCER            | BC Energy Regulator (formerly known as BC OGC)                                                        |
| BOG             | Boil Off Gas                                                                                          |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                                                  |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e., heavier hydrocarbons)                            |
| CAAQS           | Canadian Ambient Air Quality Standards                                                                |
| CAC             | Criteria Air Contaminants                                                                             |
| CAS             | Climate Action Secretariat                                                                            |
| CGL             | Coastal GasLink                                                                                       |
| CH <sub>4</sub> | Methane                                                                                               |
| CIE             | Commission Internationale de l'Eclairage                                                              |
| CO              | Carbon Monoxide                                                                                       |
| CO <sub>2</sub> | Carbon Dioxide                                                                                        |
| CSA Z276        | Canadian Standards Association, Liquefied Natural Gas (LNG) – Production, Storage and Handling (Code) |
| dBA             | A-weighted decibel (unit of noise measurement)                                                        |
| dB(C)           | C-weighted decibel (unit of noise measurement)                                                        |
| DRE             | Destruction Removal Efficiency                                                                        |
| EAC             | Environmental Assessment Certificate                                                                  |
| EAO             | BC Environmental Assessment Office                                                                    |



| Abbreviation      | Definition                                                                        |
|-------------------|-----------------------------------------------------------------------------------|
| ECCC              | Environment and Climate Change Canada                                             |
| EMLI              | BC Ministry of Energy, Mines, and Low Carbon Innovation                           |
| EMS               | Environmental Management System                                                   |
| ENV               | BC Ministry of Environment and Climate Change Strategy                            |
| EPA               | United States Environmental Protection Agency                                     |
| EPC               | Engineering, Procurement, and Construction                                        |
| F-CD              | Cold Dry Vapour Flare                                                             |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                     |
| F-WW              | Warm Wet Vapour Flare                                                             |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development |
| FVRG              | Flaring and Venting Reduction Guideline                                           |
| GHG               | Greenhouse Gas                                                                    |
| GWP               | Global Warming Potential                                                          |
| hr                | Hour (unit of time)                                                               |
| HSSE              | Health, Safety, Security and Environment                                          |
| IAAC              | Impact Assessment Agency of Canada                                                |
| IPF               | Instrumented Protective Function                                                  |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                    |
| KAG               | Kitimat Airshed Group                                                             |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                         |
| LNG               | Liquefied Natural Gas                                                             |
| LNG Canada        | LNG Canada Development Inc.                                                       |
| LNGFR             | LNG Facility Regulation                                                           |
| m                 | Meter (unit of length)                                                            |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                      |
| MCHE              | Main Cryogenic Heat Exchanger                                                     |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| MJ                | Mega joules (unit of energy)                                                             |
| MOH               | BC Ministry of Health                                                                    |
| MR                | Mixed Refrigerant                                                                        |
| NO <sub>x</sub>   | Nitrogen Oxides                                                                          |
| OGC               | BC Oil & Gas Commission                                                                  |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of "0"                                                          |
| RAM               | Risk Assessment Matrix                                                                   |
| RFSU              | Ready for Start-Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| SP                | Social Performance                                                                       |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |

**Table 4 Definitions**

| Term        | Definition                                                                                                                                                                  |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assist Gas  | The assist gas enhances smokeless flaring through the assist gas ring at the outside of the flare tip.                                                                      |
| Black Smoke | When Visible Smoke Emissions, defined by United States Environmental Protection Agency (EPA) Method 22, have met or exceeded a threshold (i.e., smoke index) <sup>1</sup> . |

| Term                                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Commissioning                        | <p>Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.</p> <p>In the Facility Permit, it is defined as the “<i>period of time commencing when operations begin in accordance with section 11 of the OGC [BCER] Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i>”.</p> |
| De-Inventorization                   | Disposal of hydrocarbon inventory within a process unit or equipment.                                                                                                                                                                                                                                                                                                                                                               |
| Dilution Gas                         | Typically, fuel gas is used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as flare gas.                                                                                                                                                                                                       |
| Destruction Removal Efficiency (DRE) | A percentage that represents the number of molecules of a compound removed or destroyed relative to the number of molecules that entered the system.                                                                                                                                                                                                                                                                                |
| Emergency                            | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire, or catastrophic equipment failure (per the Facility Permit).                                                                                                      |
| First Cargo                          | <p>First LNG carrier shipment of 138,000 m<sup>3</sup> to 217,000 m<sup>3</sup> LNG volume (based on LNG cargo / LNG carrier capacity) from each LNG train.</p> <p>LNG Canada will advise BCER of the expected First Cargo volume based on cargo nominations up to 1 month prior to expected commissioning of each LNG Train.</p>                                                                                                   |
| Fuel Gas                             | <p>A gas that is combusted and the released energy is used in upstream oil and gas operations.</p> <p>For this LNG facility, the gas burned in the gas turbine and process vessel burners are considered fuel gas.</p>                                                                                                                                                                                                              |
| Flared Gas                           | <p>A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).</p> <p>For LNG Canada facility, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided.</p>                                                                      |
| Flaring                              | <p>Disposal by combustion of natural gas or gas derived from petroleum.</p> <p>Typically, through an elevated stack and burner tip (not used to provide energy for facility operations).</p>                                                                                                                                                                                                                                        |

| Term                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Definition                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Continuous Flaring                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                         |
| Fugitive emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment or tanks have not been properly closed or tightened. |
| Greenhouse Gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Gases in the atmosphere that absorb and emit thermal radiation. In the context of GHG and Energy Management for an LNG facility, these are CO <sub>2</sub> , CH <sub>4</sub> , nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.                                       |
| Natural gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non-hydrocarbon impurities such as nitrogen, carbon dioxide, and hydrogen sulfide.<br><br>Feed gas as supplied by the CGL pipeline.                                     |
| Normal Operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Excludes Emergency conditions and Commissioning (per the Facility Permit), sometimes also referred to commonly as “routine operations”                                                                                                                                                              |
| Process upset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                                                     |
| Venting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | The intentional controlled release of uncombusted gases directly to the atmosphere.                                                                                                                                                                                                                 |
| Visible Smoke Emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission (per EPA Method 22).                                                                        |
| <p>Notes:</p> <ol style="list-style-type: none"> <li>1. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. Subject to BCER inspection and audit, for assessment of Facility Permit Condition 38 compliance and reporting.</li> </ol> <p>Sources:</p> <ul style="list-style-type: none"> <li>• LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023 (BCER 2023a)</li> <li>• Oil and Gas Glossary and Definitions, Version 1.13, December 2021 (BC OGC 2021c)</li> <li>• LNG Canada Project Facility Permit AD# 100083612 (as amended)</li> <li>• United States Environmental Protection Agency (EPA), Method 22 Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019 (EPA 2019)</li> </ul> |                                                                                                                                                                                                                                                                                                     |

## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to the design, construction and operation of the LNG facility to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In BC, LNG facilities are regulated by the Liquefied Natural Gas Facility Regulation (LNGFR) (B.C. Reg 146/2014), under the *Energy Resource Activities Act (ERAA)* (formerly the *Oil and Gas Activities Act*). The BCER has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operation of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate”, which authorizes commissioning and operations (LNGFR, Section 4).

The BCER issued a Facility Permit (Legacy File No. 9709124; Application Determination #100083612) to LNG Canada on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BCER issued amendments to the Facility Permit on January 7, 2021, January 31, 2022, and October 20, 2023, which included re-numbered conditions (references to condition numbers herein are based on the amended Facility Permit). A summary of the permit conditions applicable to the flare system are provided in Table 5. This Flaring Management Report was developed to satisfy Facility Permit conditions 39 and 40. The other related conditions shown in Table 5 are provided for information. Refer to the Facility Permit for the full list of conditions, including those related to noise management.

A “Leave to Construct” for the LNG facility construction activities associated with LNG trains 1 and 2, including the flare systems, was issued by the BCER on July 30, 2020. There were no specific conditions in this Leave to Construct, as it was based on the Facility Permit and LNGFR. A “Leave to Operate” will be required from the BCER prior to Commissioning the flare systems.

**Table 5 Facility Permit Conditions**

| Permission / Condition |               | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31                     | Flare systems | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |

| Permission / Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34                     | LNG carrier               | The Permit Holder must notify the Commission via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , at least 24 hours before de-inerting a LNG carrier at the LNG facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 35                     | Flaring Notification Plan | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius of 1.0 km for residents.</li> </ul> |
| 36                     | Flaring Notification Plan | The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m <sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.                                                                                                                                                                                                                                                                                                                    |
| 37                     | Emissions                 | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 38                     | Black smoke               | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |

| Permission / Condition |                                 | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 39                     | Flaring Management Report (FMR) | The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 40                     | FMR submission timing           | The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 41                     | FMR implementation              | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 47                     | Noise                           | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA and dBC comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> <li>d) Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</li> </ul> |
| 50                     | Noise                           | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the "British Columbia Noise Control Best Practices Guideline." Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 52                     | Light                           | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l'Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities, and operations. The BCER has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for criteria air contaminants (CACs) emitted by the LNG Canada facility.

The WDA application for air emissions, which includes those from the flare systems, was submitted to BCER on June 29, 2023, and is currently under review at the date of issuance of this report. Engagement with the BCER commenced on November 13, 2020, when the WDA preliminary application was submitted.

## 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued an EAC (#E15-01) for the Project to LNG Canada on June 17, 2015, with subsequent amendments issued in 2016, 2019, and 2021. Certificate conditions applicable to the flare system are provided in Table 6 for information. Refer to Schedule B of EAC #E15-01 for the full list of conditions.

**Table 6 Environmental Assessment Certificate #E15-01 Conditions**

| Condition  |                                   | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A | Certified Project Description     | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Schedule B | Table of Conditions – Condition 1 | <p><b>Air Quality</b></p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC (<i>now BCER</i>), and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC (<i>now BCER</i>).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details.</i></p> |
| Schedule B | Table of Conditions – Condition 2 | <p><b>Acoustics</b></p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                             |



| Condition   |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule B  | Table of Conditions – Condition 3  | <p>Greenhouse Gas Emissions</p> <p>The Holder must develop a GHG emissions management plan in consultation with the BC Ministry of Energy, Mines, and Low Carbon Innovation (EMLI) and the Climate Action Secretariat (CAS) that sets out the means by which the GHG management mitigation measures related to Operations in the [EAC application] Mitigation Table under the heading “GHG management” (section 5.3) will be implemented.</p>                                                                                                                                                                                                          |
| Schedule B  | Table of Conditions – Condition 12 | <p>Wildlife</p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>now BC Ministry of Water, Land and Resource Stewardship</i>) and OGC (<i>BCER</i>). The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p> |
| Application | Mitigation Measure 5.3-9           | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued a Decision Statement for the Project to LNG Canada on June 17, 2015, with a subsequent amendment issued in April 2021. The Decision Statement conditions applicable to the flare system are associated with migratory birds.

Condition 5.2 states that “*The Proponent shall:*

- 5.2.1 *restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;*
- 5.2.2 *minimize flaring during night-time and during periods of bird vulnerability;*
- 5.2.3 *adjust operational lighting to avoid attracting migratory birds.”*

This information is provided for context only.

## 2.2. Acts, Regulations, and Guidelines

As outlined in Section 2.1, there are several acts, regulations and guidelines that inform the design, construction, and operation of the flare system. A summary of applicable acts, regulations and guidelines is provided herein. Refer to the acts, regulations and guidelines for full details.

## 2.2.1. Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation

As outlined in Section 2.1.1, the LNGFR is a key regulation for LNG facilities in BC. Sections of the LNGFR that are applicable to the flare system are summarised in Table 7.

The BCER developed the “Liquefied Natural Gas Facility Permit Application and Operations Manual” (BCER 2023a) to provide a reference document for applicants that wish to construct and operate an LNG facility in BC, as regulated by the LNGFR. The manual provides further guidance on the operational standards and practices related to flaring, notification and reporting, noise and light control.

**Table 7 LNG Facility Regulation Sections**

| Section |                                            | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4       | Engineering Design and LNG Facility Siting | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p> |
| 15      | Noise and Light Control                    | An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 17      | Venting                                    | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p>                                                                                                                                                                                                                                |

| Section |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18      | Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ol style="list-style-type: none"> <li>flaring is required for maintenance purposes, or</li> <li>permission to flare is included in the LNG facility permit.</li> </ol> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                  |
| 19      | Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p> |

### 2.2.2. BCER Flaring and Venting Reduction Guideline

The “Flaring and Venting Reduction Guidelines” (FVRG, BC OGC 2022) will inform, where applicable, all stages of the Project to eliminate routine flaring and reduce non-routine events. Key chapters include:

- Chapter 3: Natural Gas Facility Flaring and Venting, includes a decision tree that will be used where appropriate, when considering alternatives to flaring and venting.
- Chapter 5: Notification Requirements
- Chapter 6: Performance Requirements, includes requirements for black smoke, noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance, and dispersion modelling.
- Chapter 7: Venting and Fugitive Emissions Management Requirements
- Chapter 10: Measurement and Reporting
  - All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting, and record retention.
  - Permit holders are also required to maintain a log of flaring and venting events, and respond to public complaints. Logs must be signed and kept for a minimum of 12 months, and be available to BCER upon request (refer to Table 7 for the flaring log requirements under the LNGFR).

### 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline (BC OGC 2021b) outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BCER.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to be met by the LNG facility noise emissions, including those from the flare system.

#### 2.2.4. BCER Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline (BC OGC 2021a) outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BCER.

A facility flare is an example of a “sky glow” source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light with reference to CIE 2003 (also refer Facility Permit condition 52, Table 5).

#### 2.2.5. Ambient Air Quality Objectives

In BC, ambient air quality criteria that have been developed provincially and nationally for air contaminants over various averaging periods are used to inform decisions in the management of air contaminants. These include provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e., not legally binding), unless referenced directly in a regulation or authorization and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts
- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories.

Limits on air emissions from operations at the LNG Canada facility will be prescribed in the WDA (refer to Section 2.1.2) and are not further addressed in this report.

### 3. Mitigation Measures

There is a range of measures applicable to design, construction and operations of the LNG facility that minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during Commissioning.

As illustrated in Figure 6, mitigation measures were identified during the design phase of the LNG facility to minimize flaring, and then quality procedures were implemented during the procurement, fabrication, and construction of the flare system. Operational procedures will be followed during operations to ensure that the system is being operated as per the design intent; with regular maintenance and turnaround activities to ensure the long-term integrity of the system.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process (refer to Section 4).

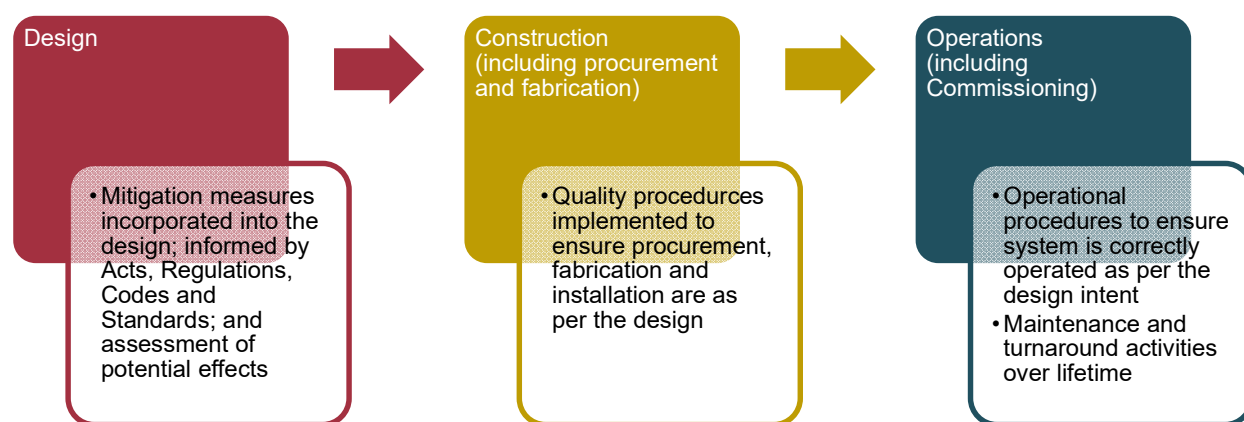


**Figure 6** Timeline for Addressing Mitigation Measures to Minimize Flaring

#### 3.1. Design

Key design measures that will minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 1. The design includes mitigations to reduce flare load during unplanned upsets.

The selection of flare technology used to meet the design basis was a key component. The Project contracted Zeeco to design and fabricate the vapour and liquid flare systems. Some parameters of the front-end engineering design (FEED) basis were adjusted during detailed design with the vendor.

Further information on design measures identified to address potential environmental effects is outlined herein.

##### 3.1.1. Air Emissions, GHG Emissions, Visible Emissions

A key design measure related to air quality and GHG emissions is the Destruction Removal Efficiency (DRE), which relates to the effectiveness of the combustion process. Typically, flare technology has a DRE of approximately 98%; however, for this Project, the chosen flare technology has a DRE of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that byproducts of incomplete combustion, such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and VOCs are released at extremely low quantities. The trade-off for this improved DRE is that GHG emissions will be slightly increased when assist gas is used in the flare; however, these emissions are relatively minor. The Project is developing a GHG Emissions Management Plan, in conformance

with EAC #E15-01, which will outline how the mitigation measures in the EAC application for managing the GHG emissions will be implemented.

As part of the EAC application (refer to Section 2.1.3) and WDA application (refer to Section 2.1.2), air dispersion modeling was undertaken, which includes emissions from the flare system. The modelling included routine/normal operations, as well as various non-routine scenarios for four CACs, which included two upset flaring cases (high sulphur case and high NO<sub>x</sub> and PM<sub>2.5</sub> case). Refer to the WDA application for further information.

### 3.1.2. Thermal Radiation

To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing, which could pose a fire hazard. A flare thermal radiation design basis was implemented in the design (refer to Table 8).

The issue of exposure of personnel to flare thermal radiation during work on or near the liquid burner derrick structure was assessed. This is not a significant concern as personnel can be evacuated from the liquid burner structure prior to a flaring event. The assessment also reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75-metre covered walkway were needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn.

In addition, operational controls will be in place; any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure if a flaring event occurs while personnel are in the area and would be covered through LNG Canada's Permit to Work practice.

**Table 8 Flare Thermal Radiation Design Basis**

| Heat Radiation Limit (kW/m <sup>2</sup> ) | Location                                                                               | Basis                                                                                                                                                                                                                                                           |
|-------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | Outside the facility fence line for normal operation, including start-up and shut down | Project requirement (Flare Equipment Data Requisition Sheet).<br>LNGFR maximum requirement for outside the boundary with normal flow rates is 3 kW/m <sup>2</sup> in remote areas.                                                                              |
| 3.0                                       | Outside the facility fence line for emergency conditions                               | Project requirement (Flare Equipment Data Requisition Sheet)<br>LNGFR maximum requirement for outside the boundary with accidental flow rates is 5 kW/m <sup>2</sup> in remote areas.                                                                           |
| 5.0                                       | At the boundary of sterile area for emergency conditions                               | LNGFR prescribed limit for outer edges of sterile area is 5 kW/m <sup>2</sup> for accidental flow rate.<br><br>This is significantly below the 25-30 kW/m <sup>2</sup> general guideline for spontaneous ignition of wood (which could result in forest fires). |

### 3.1.3. Noise

The flare design includes requirements to meet the following noise limits from the Project's design criteria:

- Emergency Cases: 115 dBA at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops.
- Normal operation including start-up/shutdown: 85dBA at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system and associated mitigation measures to be implemented in the design. This report was submitted to the BCER in accordance with the Facility Permit (refer to Table 5).

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA, with one multi-jet liquid burner to observe smokeless capability and noise measurement. Both results were satisfactory and correlated noise for nine burners was estimated at 85dB at 250 metres.

The flare system complies with Project's design criteria based on the noise data sheets issued by the vendor. However, due to the unpredictable nature of emergency events, additional operational controls will be in place. Whenever personnel are accessing the sterile area of the flare, double hearing protection will be required under the Permit to Work system and safety signage will be in place.

## 3.2. Construction

Key measures undertaken in construction that will allow the facility to minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 2. In this phase, it is critical to implement quality programs to verify that the mitigation measures identified in the design, have been procured, fabricated, and adequately installed and tested prior to operations.

## 3.3. Operations

There are a range of measures that are implemented during Commissioning and Operations that will allow the facility to minimize the flaring of gas and liquids and associated emissions (refer to Appendix A, Attachment 3). During operations, it is critical that the systems are operated as per the design intent; with supporting maintenance programs implemented. LNG Canada plans to operate within the design window for equipment, however in cases where flaring still occurs, further operational mitigations will be assessed to reduce emissions.

The amount of flaring during Commissioning is anticipated to be higher than "steady state", as bringing the process to specification can require additional testing, and additional time stopping or reversing the start-up process due to undetected flaws from construction and fabrication. During these early stages of Normal Operations (typically up to two years), there will be increased trips and a higher likelihood of unplanned outages to correct any operational issues. This period is characterized by a higher unreliability rate of equipment and more intensive facility organizational learning to resolve challenges. These events lead to flaring during the restart of the facility and any purging of equipment for maintenance.

There is also higher potential for smoke generation during Commissioning, extending into the early stages of Normal Operations. Flows and compositions outside the design window of the flare, leftover material from construction, or dust and rust may enter the flare network and inadvertently impact flare performance by altering combustion properties of the hydrocarbons.

Further information on measures to address the potential environmental effects during operations is outlined herein.

### 3.3.1. Air Emissions and GHG Emissions

LNG Canada will be required to meet the conditions of the WDA, which will include air emissions discharge limits, monitoring and reporting requirements (refer to Section 2.1.2), as well as implement the Air Quality Management and Monitoring Plan, developed in accordance with EAC Condition 1 (refer to Table 6).

LNG Canada will undertake GHG monitoring and reporting, in accordance with regulatory requirements, and implement the mitigation measures in accordance with the EAC Condition 3 (refer to Table 6).

LNG Canada also participates in the Kitimat Airshed Group (KAG), a multi-disciplinary group that is focused on air quality monitoring and public outreach, that BCER also participates in.

### 3.3.2. Visible Emissions

As per the BCER FVRG, the inspection to determine if black smoke is present or not, is to be performed using United States EPA [Method 22 - Visual Determination of Fugitive Emissions](#) (EPA 2019).

LNG Canada is investigating the implementation of technology to complement or replace visual observation from EPA Method 22. Advanced monitoring systems with optical sensors and cameras can accurately measure and record smoke characteristics (i.e., smoke index, destruction efficiency) in real-time, enabling operators to take more immediate action to mitigate potential risks. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. Once the measure surpasses the pre-determined smoke threshold, the monitoring system would trigger an alert or notification. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. LNG Canada acknowledges that BCER will maintain authority to conduct assessment using EPA Method 22 or other methods they determine most appropriate.

### 3.3.3. Light and Wildlife

Where possible, considering a number of factors, including safety, production requirements, and feasibility, flaring activities will be scheduled to occur during the daytime. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible. LNG Canada will also consider the following as appropriate:

- Seasonal migrations
- Cloud ceiling height
- Weather conditions.

The Flaring Notification Plan (L001-06200-AA-6048-4440) outlines the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts.

LNG Canada will also implement the Wildlife Management Plan, developed in accordance with the EAC Condition 12 (refer to Table 6).

### 3.3.4. Noise

The Project has a separate Noise Management Program, as required by the Facility Permit (refer to Table 5) that includes the noise mitigations, measurement and monitoring, and process for addressing complaints and noise concerns).

As noted in Section 3.1.3, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the Permit to Work system and safety signage will be in place.



## 4. Continuous Improvement, Review and Auditing

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process. Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
- Follow-up on flare key performance indicators
- Review of flaring incidents and progress of corrective actions
- Management of Change process for hardware change impacting flaring
- Review of operations/maintenance practices and procedures.

### 4.1. HSSE Management System

LNG Canada's HSSE Management System includes an HSSE & SP Control Framework with several elements related to flaring:

- **Flaring and Venting Manual** – Requires development of a Flaring and Venting Management Plan for facilities that are flaring and/or venting >1% by mass and combined flaring and venting exceeds 10,000 tonnes per annum of CO<sub>2e</sub>. It also requires that flaring risks are reviewed with a Subject Matter Expert if exceeding greater than 1% by mass.
- **Risk Assessment Matrix (RAM) Manual** – Environmental and community impacts are considered as part of the risk ranking process. This approach would be used to evaluate flaring events during an incident investigation. Escalation of events would occur due to factors such as the presence of black smoke over an extended period, complaints from the community, and/or AQO exceedances

LNG Canada will maintain an EMS in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy, and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Regular internal audits of the EMS will be conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

### 4.2. Tracking of Flare Losses

The flare losses are included as part of the facility mass balance reconciliation, which is monitored weekly with flare losses reported monthly to Petrinex as part of Volumetric reporting.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after Commissioning and early stages of Normal Operations. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

In addition to the monthly Petrinex submission, an annual Monitoring Report will be prepared by LNG Canada's Environmental Team and submitted to the BCER. The flow meters on the flare header will be utilized in determining the daily and monthly volumes. Flare header meters are designed and installed to meet the requirement outlined in the BC Measurement Guideline.

## 5. Report Review and Updates

This FMR is intended to be reviewed and updated:

- After Commissioning LNG trains 1 and 2 to incorporate lessons learned for Commissioning of Phase 2 (LNG trains 3 and 4)
- Annually to incorporate any identified changes from
  - Process/Procedural changes impacting Report
  - Facility changes impacting Report
  - Continuous improvement cycles.
- Between review cycles if there are changes identified through ongoing engagements with Indigenous groups, BCER, or other stakeholders.

Should any required revisions be identified, the following update process will be initiated:

- Administrative/minor changes only: FMR will be updated and re-issued to the BCER for awareness, with a summary of the changes provided. The updated FMR will be effective for implementation.
- Significant change (i.e., change to the fundamentals of the management approach): BCER will be consulted on the proposed change(s). After the consultation activities are completed, the FMR will be updated and re-issued to the BCER with a summary of the changes provided. The updated FMR will then be effective for implementation.

## 6. References

- BC Energy Regulator (BCER). 2023a. LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023.
- BCER. 2023b. BC Measurement Guideline, Version 2.4, October 2023.
- BC Oil and Gas Commission (BC OGC). 2022. Flaring and Venting Reduction Guideline, Version 5.3, September 2022.
- BC OGC. 2021a. BC Light Control Best Practice Guideline, Version 1.0, March 2021.
- BC OGC. 2021b. BC Noise Control Best Practice Guideline, Version 2.2, July 2021.
- BC OGC. 2021c. Oil and Gas Glossary and Definitions, Version 1.13, December 2021.
- Commission Internationale de l'Eclairage (CIE). 2003. Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 150:2003.
- United States Environmental Protection Agency (EPA). 2019. Method 22 - Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019.

## Appendix A

## List of Attachments

| Number | Title                                                                                 |
|--------|---------------------------------------------------------------------------------------|
| 1      | Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions       |
| 2      | Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions |
| 3      | Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions  |

**Attachment 1      Design Measures to Minimize Flaring of  
Gas and Liquids and Associated  
Emissions**

## Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect           | Reduction/<br>Mitigation Measure                  | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Pilot System                | Consistent Ignition Source                        | The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system. If the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ✓                                                          |                             |
| Pilot System                | Redundant Pilots                                  | The vapour flares have redundant pilots. In the unlikely case that all four pilots are lost, they will continue to operate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Flare System                | Sonic Flare Management                            | Selection of a sonic flares as well as associated flare rate and flame height, promotes mixing which is expected to help manage flare performance, minimize smoke potential and improve the destruction removal efficiency (DRE).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Vapour Flare Systems        | Nitrogen Purge                                    | All flare headers are continuously purged with nitrogen instead of fuel gas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Vapour Flare Systems        | Assist Gas for DRE                                | Assist Gas is available for DRE on the Warm Wet Flare ("F-WW"), Cold Dry ("F-CD") Flare, and Spare Flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          | ✓                           |
| Liquid Burners              | Assist Gas                                        | The liquid burners are equipped with assist gas to promote air entrainment into the flame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquid Burners              | Cooldown                                          | Automated advanced cooldown to reduce flaring time at the cold liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                                          |                             |
| Flare Knock Out Drums       | Liquid Management                                 | Installation of flare knock out (KO) drums; which are protected from liquid overflow through a combination of design liquid retention volume, as well as the use of two independent radar level measurements. These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners. The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system, the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck. |                                                            | ✓                           |
| Control Valves              | Continuous Passing Valves / Leaking Specification | All control valves connected to the flare system conform to a minimum America National Standards Institute (ANSI) Class IV leakage specification. Emergency depressuring valves and other control valves that have been specified as "tight shut-off" (TSO), meet ANSI Class V leakage specification, as per Project standards. This ensures that the amount of hydrocarbon lost to the flare is minimized.                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Manual Valves               | Blinding                                          | Manual valves connected to the flare system, which are used for maintenance purposes, are blinded to ensure that the leakage is eliminated. These locations must be de-blinded to purge equipment to flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Liquefaction Train          | Quench Line                                       | Each compressor string is equipped with a quench line for start-up to allow quick equalization with cold running string to reduce flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Compressors                           | The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) Refrigerant qualities can be adjusted by recycling their vapours to the condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Recycling                             | Pre-cooling PMR cycle can circulate MR, on full recycle via an MR "start-up recycle line", to provide pre-cooling load, to facilitate pre-cooling system start-up and decouple with MCHE final cool down.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |
| Refrigerant Production Unit | Vapour Routed to LNG Tank                         | Vapour from the spheres is normally routed to the LNG tank and is mixed with boil off gas (BOG) to prevent flaring of propane or ethane.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Refrigerant - Insulation / Temperature Controlled | The ethane refrigerant sphere is insulated and chilled to -11°C to minimize vapour losses from the sphere.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Refrigerant Production Unit | Refrigerant - Pressure Controlled                 | Refrigerant spheres are pressure controlled to the LNG tank vapour space.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |

| Location / Aspect           | Reduction/<br>Mitigation Measure     | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Refrigerant Production Unit | Operating Pressure of Propane Sphere | Propane sphere design and normal operating pressures are above vapour pressure; therefore excess propane vapor generation is not expected during holding mode eliminating the need to continuously send propane vapours to flare.                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Start-up Lines                       | Installation of start-up lines to reduce flaring during Refrigerant Production Unit (RPU) start-up:<br>- De-ethanizer column ethane vapour import from refrigerant storage<br>- De-ethanizer reflux ethane liquid import from refrigerant storage<br>- De-propanizer column propane vapour import from refrigerant storage<br>- De-propanizer reflux propane liquid import from refrigerant storage                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Recycling Lines                      | Installation of recycling lines to reduce flaring during RPU operation:<br>- Gas overheads from de-ethanizer and de-propanizer are recycled to the LNG tank<br>- De-propanizer bottoms liquids are always recycled to natural gas stream<br>- Gas overheads from de-methanizer are recycled to natural gas stream                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| BOG Compressors             | Capturing Excess BOG                 | Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          |                             |
| Condensate Tank             | Temperature Controlled               | The condensate tank vapours are chilled to -10°C to reduce hydrocarbon directed to the incinerator, which minimizes venting (and associated emissions).                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Metering                    | Metering                             | Installation of full metering capability on the flare headers (including density measurement) to help identify abnormal flaring earlier. Flaring is metered via Ultrasonic (US) flowmeters on each common flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have a measurement turndown of 1:1000 and an accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy. | ✓                                                          |                             |
| Waste                       | Disposal of warm wet waste streams   | Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |

## **Attachment 2**

### **Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**



## Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect         | Reduction/<br>Mitigation Measure  | Details                                                                                                                                                                                                                                                                                                                                                                                                                          | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|---------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Liquid Burners            | Testing on LNG                    | During design the liquid burners were tested with LNG to confirm burner performance.                                                                                                                                                                                                                                                                                                                                             |                                                            | ✓                           |
| Pilot System              | Testing                           | Ensures the flare system is fully tested before introduction of natural gas to prevent uncombusted gas from being vented (using liquid petroleum gas (LPG) bottles).                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Overall - Quality Program | Contractor Prequalifications      | Implement the contractor prequalification process; for the screening, prequalification and evaluation of contractors.                                                                                                                                                                                                                                                                                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Quality Management Plans          | Development and implementation Project quality management plans address how the quality objectives will be managed for the duration of construction (including design, procurement, fabrication, and commissioning), plus the flow down to the contractors' and subcontractors' quality plans.                                                                                                                                   | ✓                                                          | ✓                           |
| Overall - Quality Program | Flawless Project Delivery Program | Development and implementation of a Flawless Project Delivery (FPD) program (L001-00000-OA-5876-1001). The FPD program identifies flaws (including lessons learnt from all stakeholders that have occurred on previous projects) and identifies and implements mitigations to reduce and/or eliminate the potential risk [Applicable from design through commissioning and start up].                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Plans         | Development and implementation of inspection and test plans (ITPs), which contain the key inspection activities and identification of the interface points for reviewing, witnessing and holding by the subcontractor, sub-subcontractor (where applicable), JFJV and LNG Canada.                                                                                                                                                | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Records       | Inspections and tests will be formally reported through inspection and test records (ITRs). Records generated by self-perform and subcontractors (including module fabricators) will be progressively filed into appropriately labelled records files in readiness for handing over to LNG Canada.                                                                                                                               | ✓                                                          | ✓                           |
| Overall - Quality Program | Surveillance                      | Surveillance is performed by JFJV; where observations are raised with either recommendations or corrective and/or preventative actions.                                                                                                                                                                                                                                                                                          | ✓                                                          | ✓                           |
| Overall - Quality Program | Change Management                 | Development and implementation of the comprehensive change management program ensures that the correct level of professional engineering engagement and oversight will be maintained during all stages of the project and that all deviations, changes and revisions will be identified, documented and actioned at the appropriate level of review.                                                                             | ✓                                                          | ✓                           |
| Overall - Quality Program | Technical Integrity Verification  | Development and implementation of the Technical Integrity Verification (TIV) Plan, that is the clear demonstration that all safety critical elements meet the agreed performance standards for design, procurement and testing; with handover of detailed deliverables with sufficient granularity to allow the future asset to maintain safety critical equipment and perform safety critical tasks to their required standard. | ✓                                                          | ✓                           |

### **Attachment 3**

### **Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**

### Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Applicable Phase         | Location / Aspect                              | Reduction/ Mitigation Measure                                                                       | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|--------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Commissioning / Start Up | LNG Train 1 Start-Up                           | Quality Programs                                                                                    | During the Commissioning of LNG Train 1, it is expected that material left over from construction and pre-commissioning may become trapped in temporary strainers and will need to be removed during start-up or shortly after production is achieved. Measures to minimize left over material is addressed in the construction quality program noted herein.                                                                                                                                                                                                                                                                                   | ✓                                              | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit                    | Import refrigerants (ethane and propane) to storage and cooldown of associated piping and equipment | Refrigerant grade liquid ethane and propane will be imported into the facility for commissioning; to avoid the need to initially produce the refrigerant prior to LNG production, eliminating weeks of flaring from the facility.                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              | ✓                     |
| Commissioning / Start Up | LNG Storage                                    | Import LNG to storage and cooldown of associated piping and equipment                               | LNG will be imported to cooldown of the LNG circuits and LNG storage tank, which reduces the expected flaring by due to the avoidance of using LNG from Train 1 to cooldown the piping and LNG storage tank.                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              | ✓                     |
| Commissioning / Start Up | Acid Gas Removal (AGR) Unit Start-up           | Absorber Turndown                                                                                   | Turndown the feed rates (below the design minimum) will be evaluated during the actual start-up. It will depend on the system's ability to maintain treated gas on specification for carbon dioxide (CO2) and benzene, toluene, ethylbenzene and xylene (BTEX).                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Commissioning / Start Up | Mercury Bed Drying and Cold End Defrost        | Use of defrost gas                                                                                  | At the completion of dry out of the mercury bed, defrost gas will be available to begin dryout of the cold end without jeopardizing the integrity of the aluminum components. Some of the flow currently routed to the warm-wet flare will be instead routed to the cold-dry flare. Although the same amount of gas is flared, the overall height may be reduced at times due to this diversion.                                                                                                                                                                                                                                                | ✓                                              |                       |
| Commissioning / Start Up | Cold End Cooldown and Condensate Stabilization | Dilution with natural gas                                                                           | During start up and surge testing of overhead compressors, the overhead gas is flared until all testing is complete. Natural gas added to the steam from overhead gas for dilution, to reduce risk of black smoke from the heavier composition of the stream.                                                                                                                                                                                                                                                                                                                                                                                   |                                                | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit (RPU)              | Recycle to LNG Tank                                                                                 | Once the refrigerant is on-specification, it will be routed to the storage spheres and any gas overheads from the de-ethanizer and de-propanizer are recycled to the LNG tank to avoid flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              | ✓                     |
| Commissioning / Start Up | Train 2                                        | Use of defrost gas                                                                                  | For Train 2 startup, defrost gas from Train 1 will be used to defrost the equipment eliminating the need for excess flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations               | Flare Management                               | Dilution Gas                                                                                        | Dilution gas is added to lower the concentration of combustible components in the flare gas, improving the combustion efficiency and reducing emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Monitoring & Optimization                                                                           | Pro-actively monitor flaring and associated characteristics to allow the operator to adjust the flare operation to minimize emissions. Methods for detecting and monitoring flaring include:<br>- Closed circuit television (CCTV) in the control room for 24 hours a day, 7 days a week, monitoring of flare performance<br>- Equipment trips<br>- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions<br>- An alarm on some controlled streams flared (valve not closed status)<br>- Proactive Technical Monitoring set-up for the flaring system to monitor abnormalities in the flare system | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Flare Checks                                                                                        | Procedures/processes in place for Operations to identify if there is an unknown passing valve to the flare system. This will include systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by Operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves. Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.                                                          | ✓                                              |                       |

| Applicable Phase | Location / Aspect                    | Reduction/Mitigation Measure                         | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|--------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | Flare Management                     | Unplanned Flaring Procedures                         | Procedures/processes in place for Operations to respond to an unplanned flaring event. This will include Operations first undertaking any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service, if it is safe to do so.<br>If the equipment cannot be readily returned to service, the Operations Shift Team will coordinate with LNG Canada Production Scheduling department to undertake actions to reduce facility throughput to minimum turndown, if required to reduce flaring. The facility has a design minimum turndown of 50% for the equipment and this will limit the turndown to 50% of the design rate to prevent potential equipment damage.<br>Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair, LNG Canada Production Scheduling will optimize the production plan and LNG carrier arrival within any pre-existing limits to minimize flaring and economic loss. | ✓                                              |                       |
| Operations       | Flare Management                     | Flaring Event Investigations                         | Procedures/processes in place for Operations to investigate a flaring event. For flaring events greater than 10,000 m3, Operations will use the incident reporting system and correct causes of repeated non-routine flaring, incinerating, or venting as part of continuous improvement. The investigation reports would be available to the regulator upon request.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                              |                       |
| Operations       | Overall                              | Quality                                              | Implementation of the quality management system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              |                       |
| Operations       | Flare Management                     | Visible Emissions - Training                         | Training/processes in place for Operations to visually observe smoke in alignment with United States Environmental Protection Agency (USEPA) Method 22.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                | ✓                     |
| Operations       | Overall                              | Measurement Data: Analyze Data & Reporting           | Procedures/processes in place for Operations to maintain diligence in the management of flaring and associated emission. Will include analysis of measurement data in the context of monitoring data to further the learning of predicted against actualized outcomes. This learning will be systematically captured, such that the management approach can be adapted towards improving both predicting and reducing flaring events and associated emissions.<br>The Project will use the BC Measurement Guideline for measurement of flared volumes and associated fuel gas volumes through Petrinex reporting system monthly.<br>maintain the log of air flaring that occurs, in accordance with LNG Facility Regulation; and regularly review as part of the continuous approval process.                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Operations       | Overall                              | Flaring Log                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Corrective Maintenance Program   | Procedures/processes in place for Operations to address corrective maintenance when a mismeasurement is observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer. The evidence or manifest of mismeasurement could be as follows:<br>- Observed during calibration, part of preventive maintenance activities<br>- Difference in reading observed by the Operation referring to other process parameters<br>- Determined by the Technology Team during the daily mass balance activity<br>- Self-diagnosis by the smartness of the device and manifested as alert or fault<br>Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error within the accuracy using the Project test equipment that is certified by a Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.                                          | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Preventative Maintenance Program | All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centered Maintenance (RCM), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventative maintenance task within stipulated time frame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Relief Valve                         | Inspection and Overhaul - Spares                     | Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                                              |                       |
| Operations       | Adjustment of PMR and MR composition | Recycling                                            | Procedures/processes in place for Operations to adjust Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) qualities by recycling their vapours to the condensate stabilizer unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              | ✓                     |

| Applicable Phase | Location / Aspect           | Reduction/ Mitigation Measure                    | Details                                                                                                                                                                                                                                                                                                                                                   | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|-----------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | LNG Carrier Loading Mode    | Slower cooldown                                  | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess boil off gas (BOG) generated.                                                                                                                                     | ✓                                              |                       |
| Operations       | Gas Turbines                | Turn around - Parallel Strings                   | With parallel 50% strings, boroscoping of each aeroderivative gas turbine during turnaround can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring.                                                                                                                                | ✓                                              |                       |
| Operations       | Refrigerant Production Unit | Turn around - De-inventory PMR Circuit           | In preparation of turnaround the PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train.                                                                                                                                                                         | ✓                                              | ✓                     |
| Operations       | Fuel Gas                    | Turnaround - MP Fuel gas during Nitrogen Purging | Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, MP fuel gas will be added to ensure the minimum heating value is maintained.                                           | ✓                                              |                       |
| Operations       | De-Inerting LNG Carriers    | MP Fuel Gas during De-Inerting                   | MP Fuel gas, supplied from a dedicated fuel gas line at the bottom of the Storage and Loading Flaring, is added to the flare to ensure the minimum heating value of 20 MJ/m3 is maintained.                                                                                                                                                               | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Assist Gas during Acid Gas Thermal Oxidizer Trip | The overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere. Fuel gas is added to the flare from the fuel gas controller at the Warm Flare Knock-out drum, to ensure the minimum heating value is maintained.                                                | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Re-routing to other LNG Train                    | The control scheme makes use of last known values of flow indication and Lower Heating Content from the analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.                                                                                                | ✓                                              |                       |
| Operations       | Liquefaction Train          | Main Cryogenic Heat Exchanger (MCHE) Trip        | LNG production is immediately stopped and the gas flow to the facility is automatically reduced at the inlet station. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.                                                                                                                            | ✓                                              |                       |
| Operations       | Residue Vapour Compressor   | Residue Vapour Compressor Trip - Duration        | If the compressor is unable to be started within four hours, the Refrigerant Production Unit (RPU) would be shut down to stop flaring.                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Assist Gas     | Assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.                                                                                                                                                                                                                               |                                                | ✓                     |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Duration       | If operations are unable to bring the condensate stabilization unit back to specification to stop flaring the overall production would be reduced until the stream meets specification, or the LNG train would be shutdown.                                                                                                                               | ✓                                              | ✓                     |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Holding Mode        | During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. To reduce the amount of BOG generated during this mode of operation, and therefore reduce flaring, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank to reduce the volume of BOG generated. | ✓                                              |                       |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Loading Mode        | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess BOG generated.                                                                                                                                                    | ✓                                              |                       |

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Friday, 12 Jan 2024 10:52 AM  
**To:** "Mathews, Suzanne" <Suzanne.Mathews@bc-er.ca>  
**CC:** "permitting@lngcanada.ca" <permitting@lngcanada.ca>; LNGC JVD PERMITTING <LNGC.JVD.PERMITTING@fluor.com>; "scot.mackillop@lngcanada.ca" <scot.mackillop@lngcanada.ca>; Ben Ashton <Ben.Ashton@fluor.com>; "erin.furlong@lngcanada.ca" <erin.furlong@lngcanada.ca>; "Lyndsey.Hunter@lngcanada.ca" <Lyndsey.Hunter@lngcanada.ca>; James Frith <James.Frith@fluor.com>; "Cameron.McCormick@lngcanada.ca" <Cameron.McCormick@lngcanada.ca>; "Ariyawansa, Sarangi" <Sarangi.Ariyawansa@bc-er.ca>; "Whitehouse, Mike" <Mike.Whitehouse@bc-er.ca>; Post Permit Requests <postpermitrequests@bc-er.ca>  
**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report

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Morning,

Please see the attached additional response to BCERs clarification question on Rev. G for the Flaring Management Report, which addresses BCER's feedback from December 21 (refer to below email).

I'll share this document with Haisla this afternoon also.

Please let Lyndsey or I know if you have any questions on this submission,

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M s22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

---

**From:** Mathews, Suzanne

**Sent:** Thursday, December 21, 2023 4:30 PM

**To:** Janine Forrest

**Cc:** permitting@lngcanada.ca; LNGC JVD PERMITTING ; scot.mackillop@lngcanada.ca; Ben Ashton ; erin.furlong@lngcanada.ca; Lyndsey.Hunter@lngcanada.ca; James Frith ; Cameron.McCormick@lngcanada.ca; Ariyawansa, Sarangi ; Whitehouse, Mike ; Post Permit Requests

**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for your responses, it is under review.

Please note that the response to our question about the probability of BOG compressor failure was not fully addressed. Also, if there are mitigations measures to reduce the duration of a BOG compressor trip (e.g., availability of spare parts) that would be helpful context.

Regards,



Suzanne Mathews , P.Eng.  
Supervisor, LNG & Research  
[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)

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T. 250 419-4409  
F. 250-419-4403  
s22

We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal and Inuit people living across B.C.

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Thursday, December 21, 2023 12:30 PM  
**To:** Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bc-er.ca">Suzanne.Mathews@bc-er.ca>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;  
[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);  
[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>;  
[Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca); Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bc-er.ca">Sarangi.Ariyawansa@bc-er.ca>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@bc-er.ca">Mike.Whitehouse@bc-er.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca>  
**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report

Afternoon,

Please see the revised Flaring Management Report (Rev H) along with the responses to BCERs clarification questions on Rev. G (provided Dec. 07). The only changes made to the Report were to address the BCER questions (the line on the right side of the page indicates all the sections that have been changed/updated).

I'll share these documents with Haisla this afternoon also.

Please let Lyndsey or I know if you have any questions on this submission,

Once the BCER review has been satisfied, the intent is to update this document to be Revision 0, Approved for Use.

Happy Holidays (again),

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | Ms22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

---

**From:** Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bc-er.ca">Suzanne.Mathews@bc-er.ca>  
**Sent:** Thursday, December 7, 2023 4:33 PM  
**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;  
[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);  
[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>;  
[Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca); Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bc-er.ca">Sarangi.Ariyawansa@bc-er.ca>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@bc-er.ca">Mike.Whitehouse@bc-er.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for this submission. Please see attached for some clarification questions.

Regards,



**Suzanne Mathews**, P.Eng.  
Supervisor, LNG & Research  
[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)

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s22

We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal and Inuit people living across B.C.

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**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>

**Sent:** Friday, November 10, 2023 2:30 PM

**To:** Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bc-er.ca">Sarangi.Ariyawansa@bc-er.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bc-er.ca">Suzanne.Mathews@bc-er.ca>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@bc-er.ca">Mike.Whitehouse@bc-er.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca>

**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; [Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca)

**Subject:** RE: LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached updated Flaring Management Report (L001-06200-OA-5880-0001\_RG.pdf) along with the responses to BCERs clarification questions on Rev. F ("LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.pdf"), on behalf of LNG Canada.

As previously discussed, this Report has been significantly updated since Revision F, therefore I have not included the version that shows all the tracked changes (i.e., with different colored font / strike through text that has been removed) as it is very difficult to follow - the line on the right side of the page indicates all the sections that have been changed/updated.

I'll share these documents with Haisla this afternoon also.

Let Lyndsey or I know if you have any questions on this submission,

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M s22

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---

**From:** Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bcogc.ca">Sarangi.Ariyawansa@bcogc.ca>  
**Sent:** Thursday, September 15, 2022 3:58 PM  
**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@BCOGC.ca">Mike.Whitehouse@BCOGC.ca>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,  
Thank you for this submission. Please see the attached for a comment about FMR and some follow-up and additional review questions.  
Thanks,  
Sarangi



**Sarangi Ariyawansa** EIT  
Engineer, Facilities  
[Sarangi.Ariyawansa@bcogc.ca](mailto:Sarangi.Ariyawansa@bcogc.ca)

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[BCOGC Web Site](#) F. 250 980-6053



We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal Inuit people living across B.C.

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Tuesday, August 2, 2022 8:53 AM  
**To:** Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; 'scot.mackillop@lngcanada.ca' <<a href="mailto:scot.mackillop@lngcanada.ca">scot.mackillop@lngcanada.ca>

href="mailto:scot.mackillop@lngcanada.ca">scot.mackillop@lngcanada.ca>;  
'Neven.Dimic@lngcanada.ca' <<a  
href="mailto:Neven.Dimic@lngcanada.ca">Neven.Dimic@lngcanada.ca>; Ben Ashton <<a  
href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);  
'Lyndsey.Hunter@lngcanada.ca' <<a  
href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a  
href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a  
href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>

**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated Flaring Management Report for the LNG Canada Project: L001-06200-OA-5880-0001\_RF (2022JUL26)\_TRACKED.pdf. The tracked changes are shown in red (additions).

I will also share this Report with Haisla Nation this morning.

Let me know if you have any further questions / clarifications for this Report. The intent is to issue the "final" version as Rev. 0 (Approved for Use) after we have closed out the OGC / Haisla review.

Regards

Janine

---

**From:** Janine Forrest

**Sent:** Friday, June 3, 2022 10:17 AM

**To:** Mathews, Suzanne <<a

href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

'Lyndsey.Hunter@lngcanada.ca' <<a

href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a

href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a

href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>

**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne <<a

href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>

**Sent:** Thursday, April 14, 2022 2:38 PM

**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>;

Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



**Suzanne Mathews**, P.Eng.  
Supervisor, Engineering Strategic &  
Technical Services  
[Suzanne.Mathews@BCOGC.ca](mailto:Suzanne.Mathews@BCOGC.ca)

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**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Tuesday, March 8, 2022 12:25 PM  
**To:** Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>  
**Subject:** RE: LNG Canada Project Flaring Management Report  
Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/Ingcanada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>

**Sent:** Friday, November 19, 2021 12:09 PM

**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

'Lyndsey.Hunter@lngcanada.ca' <<a

href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a

href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.



**Joshua Porter** P.Eng.  
Engineer, LNG Facilities  
[Joshua.Porter@BCOGC.ca](mailto:Joshua.Porter@BCOGC.ca)

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>

**Sent:** Friday, October 1, 2021 3:14 PM

**To:** Post Permit Requests <<a

href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne

<<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

'Lyndsey.Hunter@lngcanada.ca' <<a

href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a

href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>

**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M  
s22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

-----  
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| LNG Canada Flaring Management Report BCER Information Request |                  |
|---------------------------------------------------------------|------------------|
| Project                                                       | LNG Canada       |
| OGC File #                                                    | 1000836125       |
| Date                                                          | December 7, 2023 |

December 21, 2023: The LNG Canada responses to the BCER questions are indicated in blue font herein.

Additional information was provided to BCER on January 12, 2024, in relation to the question for Table 1.

**Reference Documents:**

1. L001-06200-OA-5880-0001\_RG.pdf, Flaring Management Review, Revision G. Revision Date 10-Nov-2023.
2. LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.

**Information Request:**

Follow-up 40-1: no further questions

Follow-up 43-1: no further questions

Question 46: no further questions

Question 47: Thank you for the submission of revision G. Please see below for review comments and questions.

| Section | Relevant excerpt                                                                                                                                      | BCER Review Comment                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.4.2   | "Potential environmental effects from flaring... were considered in the Environmental Assessment Certificate (EAC) process (refer to Section 2.1.2)." | <p>The reference is not clear. (Is it referring to this report? Is it referring to an EAO submission? Other?) Please include sufficient details for the reader to find section 2.1.2.</p> <p>Project Response (Dec-21): This section should refer to Section 2.1.3 of the Flaring Management Report, for further information on the EAC and applicable conditions. This has been updated in the revised Flaring Management Report (Rev H).</p> |

|                      |                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.4.2                | <p>“Visible Emissions – Light: ...</p> <p>Visual Emissions – Smoke: ...”</p>                                                                                        | <p>With the exception of section 1.4.2, the report uses ‘visible emissions’ to refer to smoke (e.g., section 3.3.2 Visible Emissions relates to black smoke). The use of visual emissions for smoke and visible emissions for light in section 1.4.2 is confusing. It is recommended that consistent terminology be used.</p> <p><b>Project Response (Dec-21):</b> Removed the language “visible emissions” for light in Section 1.4.2 of the revised Flaring Management Report (Rev H). This language is now consistent with Section 3.3.3 of the Flaring Management Report, where “Light” is referenced.</p>                                                                                                                                                                                                                                                                                |
| 1.3.2 and Appendix A | <p>“The gas turbines are semi-aero derivative type with a high torque requirement at start.”</p> <p>“The semi aeroderivatives have low torque demand at start.”</p> | <p>Please verify the description of the turbine torque requirements.</p> <p><b>Project Response (Dec-21):</b> It is “low torque” therefore the language has been updated in Section 1.3.2 of the revised Flaring Management Report (Rev H).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Table 1              | <p>“In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.”</p>                  | <p>What is the probability of BOG compressor failure with no back-up?</p> <p><b>Project Response (Dec-21):</b> In Phase 1, there is no backup capacity for the BOG compressors. No change to the language in the Flaring Management Report.</p> <p><b>Further Project Information (Jan-12):</b> Industry benchmarking suggests the BOG Compressors may experience a major trip (duration approximately 1 week) every approximate 11 years and a minor trip (duration of a few hours) every approximate 2 years.</p> <p>To sustain their high reliability, the BOG Compressors will be maintained by performing overhauls during scheduled plant turnarounds and by performing regular condition monitoring to anticipate failures before they occur to allow for planned intervention.</p> <p>To minimize trip duration a stock of spare parts is maintained, and preplanning is done for</p> |

|         |                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                                                                                                                                                                                                                                                                  | anticipated work scopes. A contract is in place with the OEM to support maintenance.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Table 4 | First Cargo                                                                                                                                                                                                                                                      | <p>As per the Basis of Design – Marine Structures (001-07000-CX-8380-1917). Vessel capacity varies from 138,000 m3 to 217,000 m3. Please modify the definition to align with the lower end of the LNG carrier capacity.</p> <p>Project Response (Dec-21): The definition for “First Cargo” has been updated in Table 4 of the revised Flaring Management Report (Rev H).</p>                                                                                                                                                                    |
| Table 4 | Dilution Gas<br><br>Fuel Gas                                                                                                                                                                                                                                     | <p>The definitions of dilution gas and fuel gas are not consistent with the FVRG. Please note that gas that is combusted in a flare or incinerator is considered to be flare gas.</p> <p>Project Response (Dec-21): The definitions for “Dilution Gas” and “Fuel Gas” have been updated in Table 4 of the revised Flaring Management Report (Rev H).</p>                                                                                                                                                                                        |
| 4.2     | “Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after Commissioning and early stages of Normal Operations.” | <p>Please note, that the LNG Facility Regulation requires that “the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized”. This target should be periodically evaluated to ensure that quantity of gas flared is minimized.</p> <p>Project Response (Dec-21): Noted. LNG Canada will evaluate against the internal target; however, it should be clarified that the 0.3 wt% is an internal target and should not be a compliance point. No change to the language in the Flaring Management Report.</p> |



**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Thursday, 21 Dec 2023 01:29 PM  
**To:** "Mathews, Suzanne" <Suzanne.Mathews@bc-er.ca>  
**CC:** "permitting@lngcanada.ca" <permitting@lngcanada.ca>; LNGC JVD PERMITTING <LNGC.JVD.PERMITTING@fluor.com>; "scot.mackillop@lngcanada.ca" <scot.mackillop@lngcanada.ca>; Ben Ashton <Ben.Ashton@fluor.com>; "erin.furlong@lngcanada.ca" <erin.furlong@lngcanada.ca>; "Lyndsey.Hunter@lngcanada.ca" <Lyndsey.Hunter@lngcanada.ca>; James Frith <James.Frith@fluor.com>; "Cameron.McCormick@lngcanada.ca" <Cameron.McCormick@lngcanada.ca>; "Ariyawansa, Sarangi" <Sarangi.Ariyawansa@bc-er.ca>; "Whitehouse, Mike" <Mike.Whitehouse@bc-er.ca>; Post Permit Requests <postpermitrequests@bc-er.ca>  
**Subject:** RE: [External] RE: LNG Canada Project Flaring Management Report

---

Afternoon,

Please see the revised Flaring Management Report (Rev H) along with the responses to BCERs clarification questions on Rev. G (provided Dec. 07). The only changes made to the Report were to address the BCER questions (the line on the right side of the page indicates all the sections that have been changed/updated).

I'll share these documents with Haisla this afternoon also.

Please let Lyndsey or I know if you have any questions on this submission,

Once the BCER review has been satisfied, the intent is to update this document to be Revision 0, Approved for Use.

Happy Holidays (again),

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | Ms22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

---

**From:** Mathews, Suzanne

**Sent:** Thursday, December 7, 2023 4:33 PM

**To:** Janine Forrest

**Cc:** permitting@lngcanada.ca; LNGC JVD PERMITTING ; scot.mackillop@lngcanada.ca; Ben Ashton ; erin.furlong@lngcanada.ca; Lyndsey.Hunter@lngcanada.ca; James Frith ;

Cameron.McCormick@lngcanada.ca; Ariyawansa, Sarangi ; Whitehouse, Mike ; Post Permit Requests

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for this submission. Please see attached for some clarification questions.

Regards,



Suzanne Mathews , P.Eng.  
Supervisor, LNG & Research  
[Suzanne.Mathews@bc-er.ca](mailto:Suzanne.Mathews@bc-er.ca)

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s22

We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal and Inuit people living across B.C.

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Friday, November 10, 2023 2:30 PM  
**To:** Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bc-er.ca">Sarangi.Ariyawansa@bc-er.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bc-er.ca">Suzanne.Mathews@bc-er.ca>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@bc-er.ca">Mike.Whitehouse@bc-er.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; [Cameron.McCormick@lngcanada.ca](mailto:Cameron.McCormick@lngcanada.ca)  
**Subject:** RE: LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached updated Flaring Management Report (L001-06200-OA-5880-0001\_RG.pdf) along with the responses to BCERs clarification questions on Rev. F ("LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.pdf"), on behalf of LNG Canada.

As previously discussed, this Report has been significantly updated since Revision F, therefore I have not included the version that shows all the tracked changes (i.e., with different colored font / strike through text that has been removed) as it is very difficult to follow - the line on the right side of the page indicates all the sections that have been changed/updated.

I'll share these documents with Haisla this afternoon also.

Let Lyndsey or I know if you have any questions on this submission,

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | Ms22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

---

**From:** Ariyawansa, Sarangi <<a href="mailto:Sarangi.Ariyawansa@bcogc.ca">Sarangi.Ariyawansa@bcogc.ca>  
**Sent:** Thursday, September 15, 2022 3:58 PM  
**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Cc:** [permitting@lngcanada.ca](mailto:permitting@lngcanada.ca); LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); [Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca); James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Whitehouse, Mike <<a href="mailto:Mike.Whitehouse@BCOGC.ca">Mike.Whitehouse@BCOGC.ca>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine,

Thank you for this submission. Please see the attached for a comment about FMR and some follow-up and additional review questions.

Thanks,

Sarangi



**Sarangi Ariyawansa** EIT  
Engineer, Facilities  
[Sarangi.Ariyawansa@bcogc.ca](mailto:Sarangi.Ariyawansa@bcogc.ca)

Kelowna  
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We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal Inuit people living across B.C.

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Tuesday, August 2, 2022 8:53 AM  
**To:** Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; 'scot.mackillop@lngcanada.ca' <<a href="mailto:scot.mackillop@lngcanada.ca">scot.mackillop@lngcanada.ca>; 'Neven.Dimic@lngcanada.ca' <<a href="mailto:Neven.Dimic@lngcanada.ca">Neven.Dimic@lngcanada.ca>; Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>  
**Subject:** RE: LNG Canada Project Flaring Management Report  
Suzanne,  
Please see the attached updated Flaring Management Report for the LNG Canada Project: L001-06200-OA-5880-0001\_RF (2022JUL26)\_TRACKED.pdf. The tracked changes are shown in red (additions).

I will also share this Report with Haisla Nation this morning.

Let me know if you have any further questions / clarifications for this Report. The intent is to issue the "final" version as Rev. 0 (Approved for Use) after we have closed out the OGC / Haisla review.

Regards

Janine

---

**From:** Janine Forrest

**Sent:** Friday, June 3, 2022 10:17 AM

**To:** Mathews, Suzanne <<a

href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

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**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne <<a

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**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,

Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



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**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/lngcanada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>  
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**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.



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**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

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## Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | H                                            |
| Document Status          | Issued for Review                            |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 21-Dec-2023                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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|-----------------|-------------|-------------------|----------------------------|----------------------------------------------------------------------------------------------|----------------------------|-------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                     | Approver                   | Review Code |
| A               | 08-Jun-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 | N/A         |
| B               | 12-Oct-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 |             |
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| E               | 08-Mar-2022 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>N. Dimic<br>C. Sharwood<br>A. Betts                                             | B. Ashton<br>R. Dronamraju |             |
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| G               | 10-Nov-2023 | Issued for Review | J. Forrest                 | L. Hunter<br>C. McCormick<br>S. MacKillop                                                    | B. Ashton                  |             |

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| H | 21-Dec-2023 | Issued for Review | J. Forrest | L. Hunter<br>C. McCormick<br>S. MacKillop | B. Ashton |  |
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# TABLE OF CONTENTS

|        |                                                                           |    |
|--------|---------------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                              | 5  |
| 1.1.   | Project Background                                                        | 5  |
| 1.2.   | Purpose and Objectives                                                    | 5  |
| 1.3.   | Project Flaring and Overview                                              | 5  |
| 1.3.1. | Project Overview                                                          | 5  |
| 1.3.2. | Process Description Overview                                              | 5  |
| 1.3.3. | Flaring Overview                                                          | 7  |
| 1.3.4. | Flaring Event Classification                                              | 10 |
| 1.4.   | Environmental Considerations                                              | 11 |
| 1.4.1. | LNG Canada Commitments                                                    | 11 |
| 1.4.2. | Potential Environmental Effects                                           | 12 |
| 1.5.   | Roles and Responsibilities                                                | 12 |
| 1.6.   | Abbreviations and Definitions                                             | 13 |
| 2.     | REGULATORY FRAMEWORK                                                      | 18 |
| 2.1.   | Project Approvals and Conditions                                          | 18 |
| 2.1.1. | Facility Permit                                                           | 18 |
| 2.1.2. | Waste Discharge Authorization                                             | 21 |
| 2.1.3. | Environmental Assessment Certificate                                      | 21 |
| 2.1.4. | Decision Statement                                                        | 22 |
| 2.2.   | Acts, Regulations, and Guidelines                                         | 22 |
| 2.2.1. | Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation | 23 |
| 2.2.2. | BCER Flaring and Venting Reduction Guideline                              | 24 |
| 2.2.3. | BC Noise Control Best Practices Guideline                                 | 24 |
| 2.2.4. | BCER Light Control Best Practices Guideline                               | 25 |
| 2.2.5. | Ambient Air Quality Objectives                                            | 25 |
| 3.     | MITIGATION MEASURES                                                       | 26 |
| 3.1.   | Design                                                                    | 26 |
| 3.1.1. | Air Emissions, GHG Emissions, Visible Emissions                           | 26 |
| 3.1.2. | Thermal Radiation                                                         | 27 |
| 3.1.3. | Noise                                                                     | 28 |
| 3.2.   | Construction                                                              | 28 |
| 3.3.   | Operations                                                                | 28 |
| 3.3.1. | Air Emissions and GHG Emissions                                           | 29 |
| 3.3.2. | Visible Emissions                                                         | 29 |
| 3.3.3. | Light and Wildlife                                                        | 29 |
| 3.3.4. | Noise                                                                     | 29 |
| 4.     | CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                               | 30 |
| 4.1.   | HSSE Management System                                                    | 30 |
| 4.2.   | Tracking of Flare Losses                                                  | 30 |
| 5.     | REPORT REVIEW AND UPDATES                                                 | 31 |
| 6.     | REFERENCES                                                                | 32 |
|        | APPENDIX A LIST OF ATTACHMENTS                                            | 33 |

# 1. Introduction

## 1.1. Project Background

LNG Canada Development Inc. (LNG Canada) is building a liquefied natural gas (LNG) export facility in Kitimat, British Columbia (BC), Canada, in the traditional territory of the Haisla Nation. LNG Canada is a joint venture comprised of Shell Canada Energy (Shell), North Montney LNG Limited Partnership, PetroChina Kitimat LNG Partnership (CNPC), Diamond LNG Canada Partnership (Diamond), and KOGAS Canada LNG Partnership (KOGAS).

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project, including permitting.

A list of acronyms is provided in Section 1.6.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning, in conformance with the LNG Canada Facility Permit issued by the BC Energy Regulator (BCER) (formerly known as the BC Oil and Gas Commission (OGC)).

This document does not cover the feed gas pipeline that is under Coastal GasLink (CGL) control.

## 1.3. Project Flaring and Overview

### 1.3.1. Project Overview

The Project includes, but is not limited to, the following LNG processing and storage systems:

- Natural gas inlet station
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities
- Up to two full containment storage LNG tanks
- Up to two condensate storage tanks
- Flare systems, including a total of up to two flare derricks.

There are two parallel LNG loading lines, up to two vapour return lines, and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier and a material offloading facility.

The Project is being constructed in two phases, with each phase having two processing units and associated utilities, one LNG storage tank and one LNG carrier berth. The flare system has been designed to accommodate both phases.

### 1.3.2. Process Description Overview

The Project receives dry pressurized natural gas from the CGL pipeline. The feed gas stream is primarily methane with some ethane, propane, butane, and a small heavy tail with some impurities. The raw, warm gas is cleaned of its impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, and heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to Figure 1).

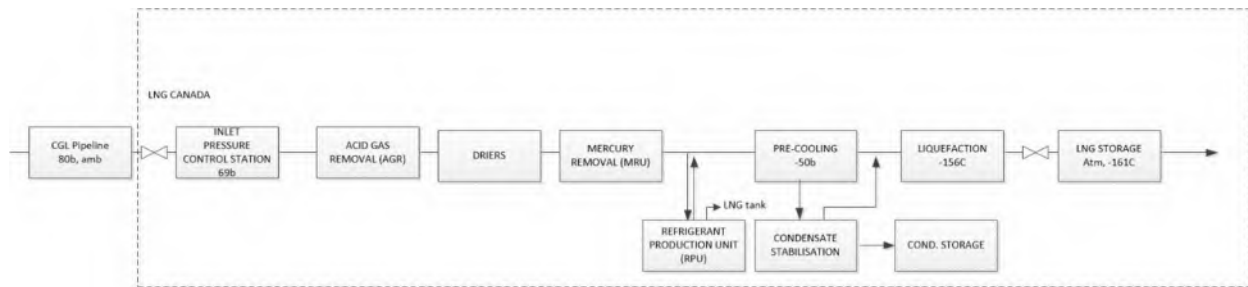


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown, as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses Pre-cool Mixed Refrigerant ("PMR") cooling from ambient temperatures to -50°C
- Deeper liquefaction cycle: uses Mixed Refrigerant ("MR") cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE).

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called "String A" and "String B" (refer to Figure 2). Each string can handle approximately half the production rate. The gas turbines are semi-aero derivative type with low torque requirement at start. This means there is no need to depressurize inventory to allow restart.

Methane, ethane and propane are the components used as refrigerants in the liquefaction process. They are available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).

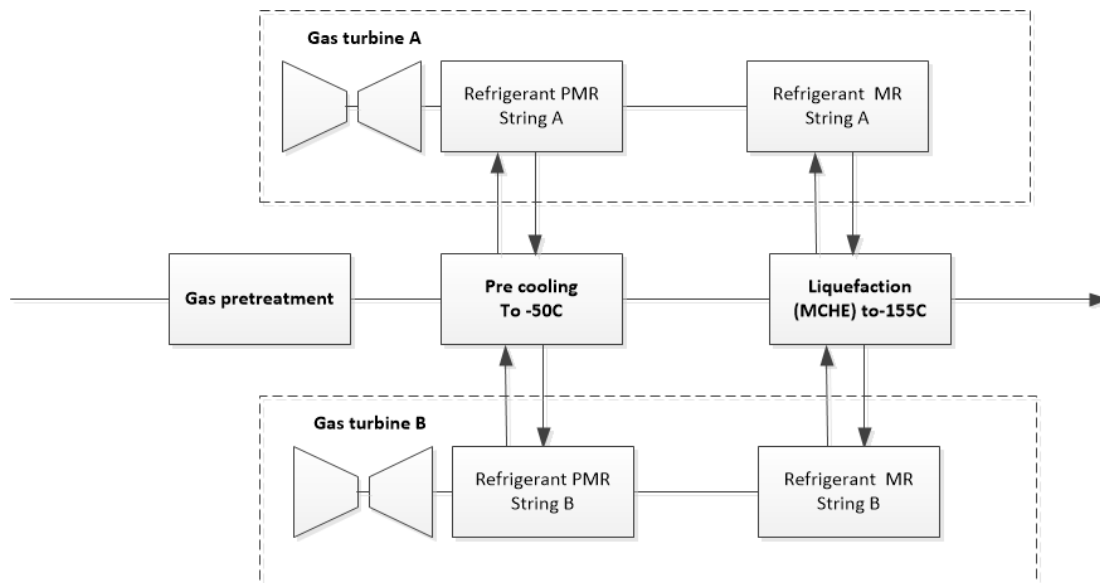


**Figure 2 Liquefaction Overview Schematic (High Level)**

### 1.3.3. Flaring Overview

During Normal Operations, natural gas and other hydrocarbons flow continuously through an LNG facility. When there is a disruption to the expected operation of the LNG facility, the constant flow of natural gas is interrupted. Large scale LNG facility designs incorporate flare systems to safely combust excess hydrocarbons when necessary. There are various events that will result in flaring at the LNG Canada facility, refer to Section 1.3.4.

At the LNG Canada facility, there are four vapour flares and nine liquid burners on two derrick structures. Table 1 contains further information on each vapour flare and the liquid burners. Figure 3 and Figure 4 illustrate the location of the flare systems, and Figure 5 illustrates the flare derrick structures that support the design height requirements of the flare release points.

The flares are equipped with a flare pilot; a continuous source of fuel gas to ignite gas sent to the flare, enabling the hydrocarbons to burn safely and efficiently under all conditions without escaping into the atmosphere. The LNG facility has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers) for operational reasons.

The flare pilot is a small, smokeless flame. When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be large, noisy, and/or create visible smoke emissions. During Commissioning and the early stages of Normal Operations, it is expected that flare volumes and visibility will be higher compared to when “steady state” Normal Operations is achieved. The flaring activity will reduce over time as the facility moves into “steady state” Normal Operations.

**Table 1 Flare Derrick Structures and System**

| Item                 |                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour Flare Derrick | Warm/Wet Process Flare (F-WW) | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"><li>• Inlet Facilities</li><li>• Acid Gas Removal Unit</li><li>• Dehydration Unit</li><li>• Mercury Removal Unit</li><li>• Liquefaction Unit</li><li>• Incinerator Unit</li><li>• Condensate Stabilisation Unit</li><li>• Heat Transfer Fluid System</li><li>• Tempered Cooling Water System Unit</li><li>• Fuel Gas System</li><li>• Defrost Gas System</li></ul> |

| Item                  |                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | Cold/Dry Process Flare (F-CD)                 | <p>For cryogenic hydrocarbon vapours that will not contain water. This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                             |
|                       | Low Pressure Storage and Loading Flare (F-LP) | <p>For low pressure LNG vapours from the LNG storage tank(s) and/or LNG carrier loading, in the event of BOG compressor failure. Compressor seal vents and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p> <p>Includes a velocity seal to minimize purge gas requirements.</p> <p>A mixture of methane and CO<sub>2</sub> or nitrogen will be released to the F-LP flare during LNG carrier de-inerting. Additional fuel gas will be added at the flare to maintain the minimum required heating value.</p> |
|                       | Spare flare                                   | Used in place of one of the other flares when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare (F-WW) with a minimum design temperature to release the cold/dry vapours.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Liquid Burner Derrick | Liquid burners                                | For either warm/wet or cold/dry liquids.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

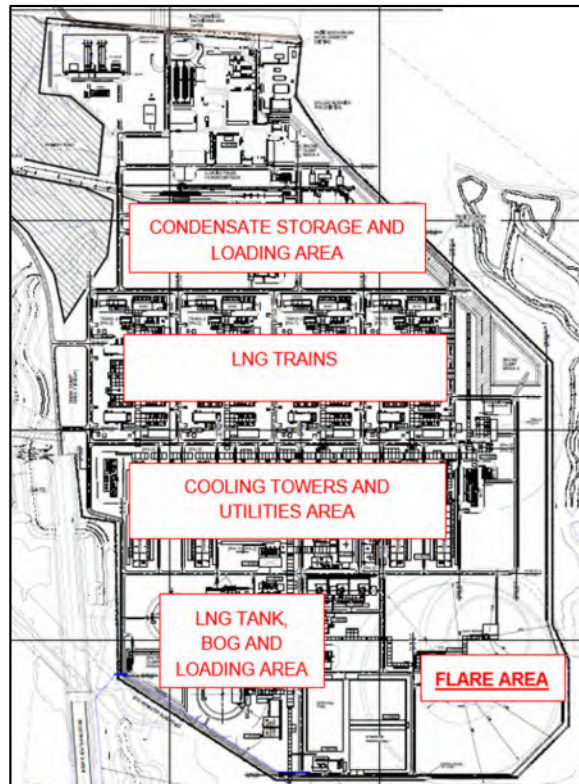


Figure 3 Flare Location Overview

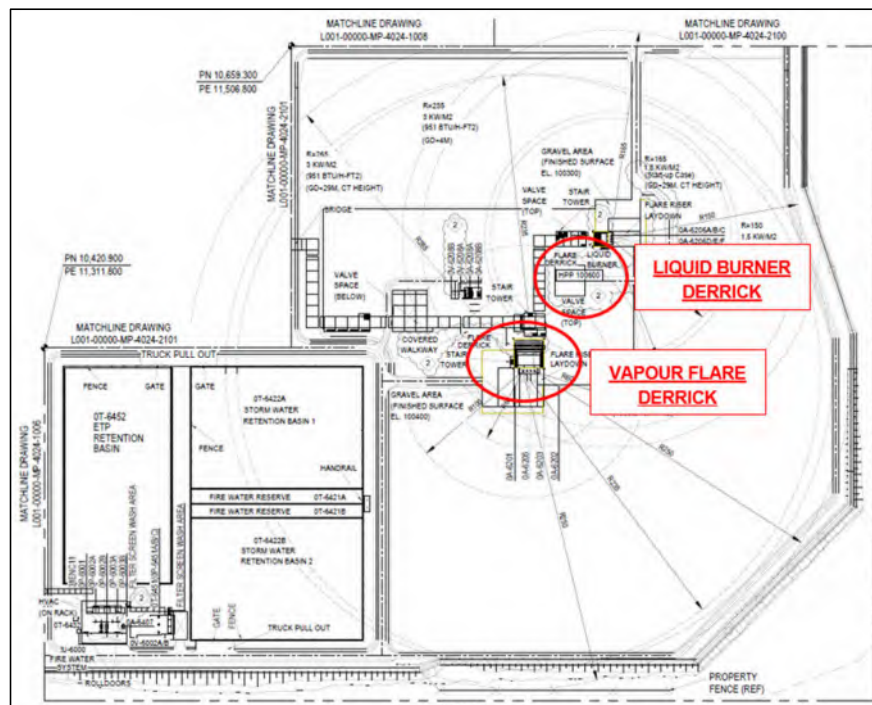


Figure 4 Flare Plot Plan (L001-00000-MP-4024-1011\_R2)



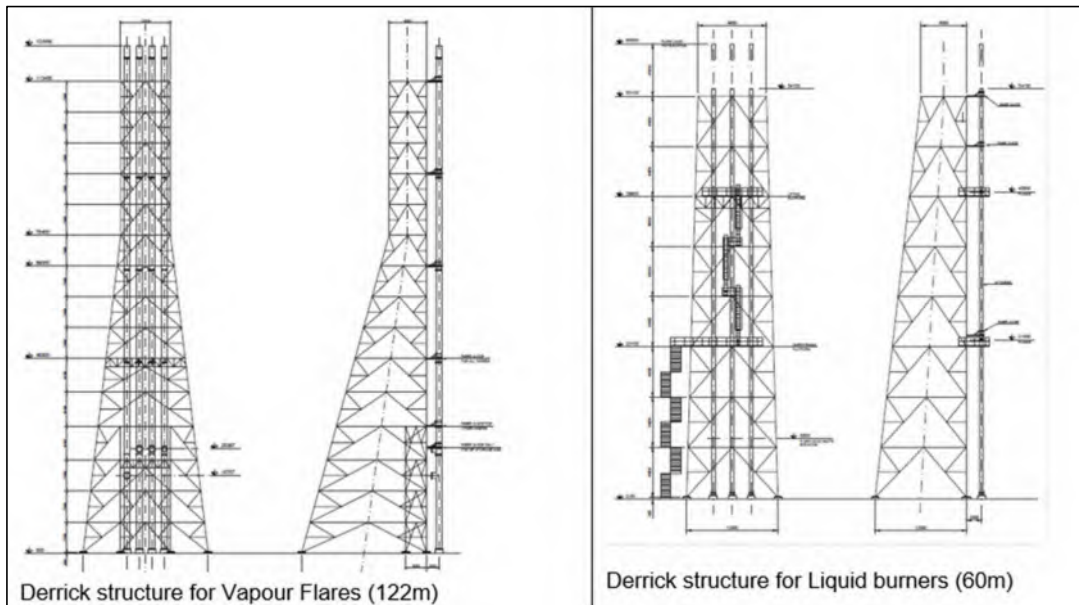


**Figure 5 Derrick Structure**

#### 1.3.4. Flaring Event Classification

LNG Canada will endeavor to accurately classify flaring events aligned with the types and examples shown in Table 2. The flaring event types are based on the LNG Facility Regulation (refer to Section 2.2.1) and the permissions in the LNG Canada Facility Permit (refer to Section 2.1.1).

**Table 2 Flaring Event Classification**

| Regulation / Authorization | Type of Flaring | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LNG Facility Regulation    | Emergency       | <p>Safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure. Examples include:</p> <ul style="list-style-type: none"> <li>• Activation of an Instrumented Protective Function (IPF) safeguard</li> <li>• Relief valve operation</li> <li>• Operator activation of Emergency de-pressuring system</li> <li>• Manual de-pressuring by operations technicians.</li> </ul> |
|                            | Maintenance     | <p>Flaring related to maintenance or turnaround activities to remove hydrocarbon from equipment where equipment requires maintenance to maintain integrity or inspect/repair defects.</p>                                                                                                                                                                                                                                                                                                              |
| Facility Permit            | Flare pilots    | <p>Small continuous sources of process gas sent to the warm wet flare and low-pressure storage and loading flare including the primary seal gas from the compressors, and analyzer sample gas.</p>                                                                                                                                                                                                                                                                                                     |

| Regulation / Authorization | Type of Flaring             | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | Flare system purge          | There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                            | De-inerting of LNG carriers | <p>Routine/planned de-inerting of LNG carriers.</p> <p>The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with inert gas prior to loading. These tanks need to be purged and cooled down with LNG from the facility. During the purging and cooldown process, the vapour return is sent to the low pressure flare until confirmation that required CO<sub>2</sub> specifications have been met based on laboratory sampling. Upon confirmation, the vapour is then routed to the storage tank and BOG compressors. There are no requirements to vent from the inerted LNG carrier.</p>                                                                                                                                                                                             |
|                            | Process upsets              | <p>Deviations that require the operator to take measures that prevent safety or production loss and preempt activation of safety systems (i.e., flaring occurs to prevent an emergency event from developing and prevent safety or production loss). Examples include:</p> <ul style="list-style-type: none"> <li>• Console operator takes action to de-pressure a vessel to prevent activation of IPF</li> <li>• Routing of process gas to flare due to off-spec condition to prevent damage to downstream unit (i.e., amine foaming, high dewpoint, high C5+, offspec product)</li> <li>• Flaring due to internal leaks within equipment (MCHE internal leaks)</li> <li>• Flaring to de-pressure rotating equipment to facilitate restart</li> <li>• Evacuation of remaining hydrocarbon from systems after an Emergency state once event is downgraded from Emergency (i.e., risk of injury or property loss is mitigated).</li> </ul> |
|                            | Commissioning               | Flaring in the period of time commencing when operations begin in accordance with section 11 of the LNGFR and ending when the first cargo of LNG is shipped from the LNG train.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 1.4. Environmental Considerations

### 1.4.1. LNG Canada Commitments

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment (HSSE) and Social Performance (SP) focuses on ways to avoid and minimize negative environmental and social impacts resulting from their operations and enhance the positive impacts in a systematic manner.

Further information the HSSE & SP Framework and Environmental Management System (EMS) is provided in Section 4.

#### 1.4.2. Potential Environmental Effects

The act of flaring can cause potential effects to the environment due to the characteristics of the chemical, noise and thermal emissions. Potential environmental effects from flaring and associated emissions of greenhouse gases, criteria air contaminants, light, smoke (from incomplete combustion), noise and heat were considered in the Environmental Assessment Certificate (EAC) process (refer to Section 2.1.3 for further information on the EAC and applicable conditions).

A summary of these potential effects from flaring is provided herein for information.

- **Greenhouse Gas Emissions (GHG):** Emissions of primary GHGs from the flare system include CO<sub>2</sub>, methane (CH<sub>4</sub>) and nitrous oxide, from the combustion of hydrocarbons. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane.
- **Air Emissions:** Emissions of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), carbon monoxide (CO), particulate matter (PM) and volatile organic compounds (VOCs) from the combustion of hydrocarbons.
- **Light:** Some elevated light emissions are anticipated during Commissioning and the early stages of Normal Operations; however, this is a standard part of starting up an LNG facility and will reduce as the facility approaches a “steady state” of Normal Operations. Flaring events may be seen from the community depending on the resulting size of the flare size. Also refer to potential effects to wildlife below.
- **Visual Emissions – Smoke:** Incomplete combustion of the gases or liquids being flared has the potential to producing coarse and fine PM emissions that can be visible. Even if the PM emissions do not result in an air quality effect, the visibility of flaring emissions is undesirable and a potential nuisance to the community within an observation distance. Visibility of emissions is often measured in terms of opacity or the density of the emission and its ability to block light. As opacity of the emission increases, it results in a plume of visible smoke that can be described as moving from a light gray (20% opacity) to ultimately a complete black smoke (100% opacity). A Ringelmann scale (0 to 5; 0% to 100% opacity) is often used to describe a human observation of the opacity of a flare event, where the objective of the flare design is to perform at Ringelmann 0 or “R0” as often as achievable.
- **Noise:** The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential effects from noise are assessed within the Project site (occupational) and offsite (nuisance).
- **Thermal Heat:** When combustion occurs in the flare system, a large amount of heat is released. This heat can pose a safety risk to personnel and the environment.
- **Wildlife:** Increased noise, light and vibration levels can potentially cause sensory disturbance (e.g., attract and disorient birds, nest abandonment, displace wildlife from preferred foraging or breeding habitat). Nighttime lighting can disrupt the foraging patterns of nocturnal wildlife.

#### 1.5. Roles and Responsibilities

There are various roles and responsibilities related to the design, construction, and operations of the flare system. JFJV, as LNG Canada’s EPC contractor, is responsible for managing the design, fabrication, construction, pre-commissioning, and Commissioning of the facility, up to “ready for start-up” (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing Commissioning activities that cannot be physically done prior to RFSU and Normal Operations after RFSU and handover of each LNG train, with support from JFJV to execute post-

RFSU activities in the early stages of Normal Operations. Commissioning, ramp-up, and the early stages of Normal Operations shall be executed by a joint team of staff from LNG Canada and JFJV. A basic principle of the Project is that compliance with the FMR, applicable laws and regulations is a line management responsibility.

## 1.6. Abbreviations and Definitions

Table 3 and Table 4 contain a list of abbreviations and definitions used within this document.

**Table 3 Abbreviations**

| Abbreviation    | Definition                                                                                            |
|-----------------|-------------------------------------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                                                 |
| AQO             | Ambient Air Quality Objective                                                                         |
| BC              | British Columbia                                                                                      |
| BCER            | BC Energy Regulator (formerly known as BC OGC)                                                        |
| BOG             | Boil Off Gas                                                                                          |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                                                  |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e., heavier hydrocarbons)                            |
| CAAQS           | Canadian Ambient Air Quality Standards                                                                |
| CAC             | Criteria Air Contaminants                                                                             |
| CAS             | Climate Action Secretariat                                                                            |
| CGL             | Coastal GasLink                                                                                       |
| CH <sub>4</sub> | Methane                                                                                               |
| CIE             | Commission Internationale de l'Eclairage                                                              |
| CO              | Carbon Monoxide                                                                                       |
| CO <sub>2</sub> | Carbon Dioxide                                                                                        |
| CSA Z276        | Canadian Standards Association, Liquefied Natural Gas (LNG) – Production, Storage and Handling (Code) |
| dBA             | A-weighted decibel (unit of noise measurement)                                                        |
| dB(C)           | C-weighted decibel (unit of noise measurement)                                                        |
| DRE             | Destruction Removal Efficiency                                                                        |
| EAC             | Environmental Assessment Certificate                                                                  |
| EAO             | BC Environmental Assessment Office                                                                    |

| Abbreviation      | Definition                                                                        |
|-------------------|-----------------------------------------------------------------------------------|
| ECCC              | Environment and Climate Change Canada                                             |
| EMLI              | BC Ministry of Energy, Mines, and Low Carbon Innovation                           |
| EMS               | Environmental Management System                                                   |
| ENV               | BC Ministry of Environment and Climate Change Strategy                            |
| EPA               | United States Environmental Protection Agency                                     |
| EPC               | Engineering, Procurement, and Construction                                        |
| F-CD              | Cold Dry Vapour Flare                                                             |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                     |
| F-WW              | Warm Wet Vapour Flare                                                             |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development |
| FVRG              | Flaring and Venting Reduction Guideline                                           |
| GHG               | Greenhouse Gas                                                                    |
| GWP               | Global Warming Potential                                                          |
| hr                | Hour (unit of time)                                                               |
| HSSE              | Health, Safety, Security and Environment                                          |
| IAAC              | Impact Assessment Agency of Canada                                                |
| IPF               | Instrumented Protective Function                                                  |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                    |
| KAG               | Kitimat Airshed Group                                                             |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                         |
| LNG               | Liquefied Natural Gas                                                             |
| LNG Canada        | LNG Canada Development Inc.                                                       |
| LNGFR             | LNG Facility Regulation                                                           |
| m                 | Meter (unit of length)                                                            |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                      |
| MCHE              | Main Cryogenic Heat Exchanger                                                     |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| MJ                | Mega joules (unit of energy)                                                             |
| MOH               | BC Ministry of Health                                                                    |
| MR                | Mixed Refrigerant                                                                        |
| NO <sub>x</sub>   | Nitrogen Oxides                                                                          |
| OGC               | BC Oil & Gas Commission                                                                  |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of "0"                                                          |
| RAM               | Risk Assessment Matrix                                                                   |
| RFSU              | Ready for Start-Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| SP                | Social Performance                                                                       |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |

**Table 4 Definitions**

| Term        | Definition                                                                                                                                                                  |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assist Gas  | The assist gas enhances smokeless flaring through the assist gas ring at the outside of the flare tip.                                                                      |
| Black Smoke | When Visible Smoke Emissions, defined by United States Environmental Protection Agency (EPA) Method 22, have met or exceeded a threshold (i.e., smoke index) <sup>1</sup> . |

| Term                                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Commissioning                        | <p>Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.</p> <p>In the Facility Permit, it is defined as the “<i>period of time commencing when operations begin in accordance with section 11 of the OGC [BCER] Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i>”.</p> |
| De-Inventorization                   | Disposal of hydrocarbon inventory within a process unit or equipment.                                                                                                                                                                                                                                                                                                                                                               |
| Dilution Gas                         | Typically, fuel gas is used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as flare gas.                                                                                                                                                                                                       |
| Destruction Removal Efficiency (DRE) | A percentage that represents the number of molecules of a compound removed or destroyed relative to the number of molecules that entered the system.                                                                                                                                                                                                                                                                                |
| Emergency                            | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire, or catastrophic equipment failure (per the Facility Permit).                                                                                                      |
| First Cargo                          | <p>First LNG carrier shipment of 138,000 m<sup>3</sup> to 217,000 m<sup>3</sup> LNG volume (based on LNG cargo / LNG carrier capacity) from each LNG train.</p> <p>LNG Canada will advise BCER of the expected First Cargo volume based on cargo nominations up to 1 month prior to expected commissioning of each LNG Train.</p>                                                                                                   |
| Fuel Gas                             | <p>A gas that is combusted and the released energy is used in upstream oil and gas operations.</p> <p>For this LNG facility, the gas burned in the gas turbine and process vessel burners are considered fuel gas.</p>                                                                                                                                                                                                              |
| Flared Gas                           | <p>A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).</p> <p>For LNG Canada facility, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided.</p>                                                                      |
| Flaring                              | <p>Disposal by combustion of natural gas or gas derived from petroleum.</p> <p>Typically, through an elevated stack and burner tip (not used to provide energy for facility operations).</p>                                                                                                                                                                                                                                        |

| Term                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Definition                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Continuous Flaring                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                         |
| Fugitive emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment or tanks have not been properly closed or tightened. |
| Greenhouse Gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Gases in the atmosphere that absorb and emit thermal radiation. In the context of GHG and Energy Management for an LNG facility, these are CO <sub>2</sub> , CH <sub>4</sub> , nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.                                       |
| Natural gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non-hydrocarbon impurities such as nitrogen, carbon dioxide, and hydrogen sulfide.<br><br>Feed gas as supplied by the CGL pipeline.                                     |
| Normal Operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Excludes Emergency conditions and Commissioning (per the Facility Permit), sometimes also referred to commonly as “routine operations”                                                                                                                                                              |
| Process upset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                                                     |
| Venting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | The intentional controlled release of uncombusted gases directly to the atmosphere.                                                                                                                                                                                                                 |
| Visible Smoke Emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission (per EPA Method 22).                                                                        |
| <p>Notes:</p> <ol style="list-style-type: none"> <li>1. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. Subject to BCER inspection and audit, for assessment of Facility Permit Condition 38 compliance and reporting.</li> </ol> <p>Sources:</p> <ul style="list-style-type: none"> <li>• LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023 (BCER 2023a)</li> <li>• Oil and Gas Glossary and Definitions, Version 1.13, December 2021 (BC OGC 2021c)</li> <li>• LNG Canada Project Facility Permit AD# 100083612 (as amended)</li> <li>• United States Environmental Protection Agency (EPA), Method 22 Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019 (EPA 2019)</li> </ul> |                                                                                                                                                                                                                                                                                                     |



## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to the design, construction and operation of the LNG facility to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In BC, LNG facilities are regulated by the Liquefied Natural Gas Facility Regulation (LNGFR) (B.C. Reg 146/2014), under the *Energy Resource Activities Act (ERAA)* (formerly the *Oil and Gas Activities Act*). The BCER has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operation of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate”, which authorizes commissioning and operations (LNGFR, Section 4).

The BCER issued a Facility Permit (Legacy File No. 9709124; Application Determination #100083612) to LNG Canada on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BCER issued amendments to the Facility Permit on January 7, 2021, January 31, 2022, and October 20, 2023, which included re-numbered conditions (references to condition numbers herein are based on the amended Facility Permit). A summary of the permit conditions applicable to the flare system are provided in Table 5. This Flaring Management Report was developed to satisfy Facility Permit conditions 39 and 40. The other related conditions shown in Table 5 are provided for information. Refer to the Facility Permit for the full list of conditions, including those related to noise management.

A “Leave to Construct” for the LNG facility construction activities associated with LNG trains 1 and 2, including the flare systems, was issued by the BCER on July 30, 2020. There were no specific conditions in this Leave to Construct, as it was based on the Facility Permit and LNGFR. A “Leave to Operate” will be required from the BCER prior to Commissioning the flare systems.

**Table 5 Facility Permit Conditions**

| Permission / Condition |               | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31                     | Flare systems | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |

| Permission / Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34                     | LNG carrier               | The Permit Holder must notify the Commission via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , at least 24 hours before de-inerting a LNG carrier at the LNG facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 35                     | Flaring Notification Plan | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius of 1.0 km for residents.</li> </ul> |
| 36                     | Flaring Notification Plan | The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m <sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.                                                                                                                                                                                                                                                                                                                    |
| 37                     | Emissions                 | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 38                     | Black smoke               | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |

| Permission / Condition |                                 | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 39                     | Flaring Management Report (FMR) | The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 40                     | FMR submission timing           | The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 41                     | FMR implementation              | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 47                     | Noise                           | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA and dBC comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> <li>d) Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</li> </ul> |
| 50                     | Noise                           | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the "British Columbia Noise Control Best Practices Guideline." Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 52                     | Light                           | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l'Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities, and operations. The BCER has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for criteria air contaminants (CACs) emitted by the LNG Canada facility.

The WDA application for air emissions, which includes those from the flare systems, was submitted to BCER on June 29, 2023, and is currently under review at the date of issuance of this report. Engagement with the BCER commenced on November 13, 2020, when the WDA preliminary application was submitted.

## 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued an EAC (#E15-01) for the Project to LNG Canada on June 17, 2015, with subsequent amendments issued in 2016, 2019, and 2021. Certificate conditions applicable to the flare system are provided in Table 6 for information. Refer to Schedule B of EAC #E15-01 for the full list of conditions.

**Table 6 Environmental Assessment Certificate #E15-01 Conditions**

| Condition  |                                   | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A | Certified Project Description     | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Schedule B | Table of Conditions – Condition 1 | <p><b>Air Quality</b></p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC (<i>now BCER</i>), and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC (<i>now BCER</i>).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details.</i></p> |
| Schedule B | Table of Conditions – Condition 2 | <p><b>Acoustics</b></p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Condition   |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule B  | Table of Conditions – Condition 3  | <p>Greenhouse Gas Emissions</p> <p>The Holder must develop a GHG emissions management plan in consultation with the BC Ministry of Energy, Mines, and Low Carbon Innovation (EMLI) and the Climate Action Secretariat (CAS) that sets out the means by which the GHG management mitigation measures related to Operations in the [EAC application] Mitigation Table under the heading “GHG management” (section 5.3) will be implemented.</p>                                                                                                                                                                                                          |
| Schedule B  | Table of Conditions – Condition 12 | <p>Wildlife</p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>now BC Ministry of Water, Land and Resource Stewardship</i>) and OGC (<i>BCER</i>). The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p> |
| Application | Mitigation Measure 5.3-9           | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued a Decision Statement for the Project to LNG Canada on June 17, 2015, with a subsequent amendment issued in April 2021. The Decision Statement conditions applicable to the flare system are associated with migratory birds.

Condition 5.2 states that “*The Proponent shall:*

- 5.2.1 *restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;*
- 5.2.2 *minimize flaring during night-time and during periods of bird vulnerability;*
- 5.2.3 *adjust operational lighting to avoid attracting migratory birds.”*

This information is provided for context only.

## 2.2. Acts, Regulations, and Guidelines

As outlined in Section 2.1, there are several acts, regulations and guidelines that inform the design, construction, and operation of the flare system. A summary of applicable acts, regulations and guidelines is provided herein. Refer to the acts, regulations and guidelines for full details.

## 2.2.1. Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation

As outlined in Section 2.1.1, the LNGFR is a key regulation for LNG facilities in BC. Sections of the LNGFR that are applicable to the flare system are summarised in Table 7.

The BCER developed the “Liquefied Natural Gas Facility Permit Application and Operations Manual” (BCER 2023a) to provide a reference document for applicants that wish to construct and operate an LNG facility in BC, as regulated by the LNGFR. The manual provides further guidance on the operational standards and practices related to flaring, notification and reporting, noise and light control.

**Table 7 LNG Facility Regulation Sections**

| Section |                                            | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4       | Engineering Design and LNG Facility Siting | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p> |
| 15      | Noise and Light Control                    | An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 17      | Venting                                    | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p>                                                                                                                                                                                                                                |

| Section |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18      | Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ol style="list-style-type: none"> <li>flaring is required for maintenance purposes, or</li> <li>permission to flare is included in the LNG facility permit.</li> </ol> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                  |
| 19      | Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p> |

### 2.2.2. BCER Flaring and Venting Reduction Guideline

The “Flaring and Venting Reduction Guidelines” (FVRG, BC OGC 2022) will inform, where applicable, all stages of the Project to eliminate routine flaring and reduce non-routine events. Key chapters include:

- Chapter 3: Natural Gas Facility Flaring and Venting, includes a decision tree that will be used where appropriate, when considering alternatives to flaring and venting.
- Chapter 5: Notification Requirements
- Chapter 6: Performance Requirements, includes requirements for black smoke, noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance, and dispersion modelling.
- Chapter 7: Venting and Fugitive Emissions Management Requirements
- Chapter 10: Measurement and Reporting
  - All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting, and record retention.
  - Permit holders are also required to maintain a log of flaring and venting events, and respond to public complaints. Logs must be signed and kept for a minimum of 12 months, and be available to BCER upon request (refer to Table 7 for the flaring log requirements under the LNGFR).

### 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline (BC OGC 2021b) outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BCER.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to be met by the LNG facility noise emissions, including those from the flare system.

#### 2.2.4. BCER Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline (BC OGC 2021a) outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BCER.

A facility flare is an example of a “sky glow” source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light with reference to CIE 2003 (also refer Facility Permit condition 52, Table 5).

#### 2.2.5. Ambient Air Quality Objectives

In BC, ambient air quality criteria that have been developed provincially and nationally for air contaminants over various averaging periods are used to inform decisions in the management of air contaminants. These include provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e., not legally binding), unless referenced directly in a regulation or authorization and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts
- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories.

Limits on air emissions from operations at the LNG Canada facility will be prescribed in the WDA (refer to Section 2.1.2) and are not further addressed in this report.



### 3. Mitigation Measures

There is a range of measures applicable to design, construction and operations of the LNG facility that minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during Commissioning.

As illustrated in Figure 6, mitigation measures were identified during the design phase of the LNG facility to minimize flaring, and then quality procedures were implemented during the procurement, fabrication, and construction of the flare system. Operational procedures will be followed during operations to ensure that the system is being operated as per the design intent; with regular maintenance and turnaround activities to ensure the long-term integrity of the system.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process (refer to Section 4).

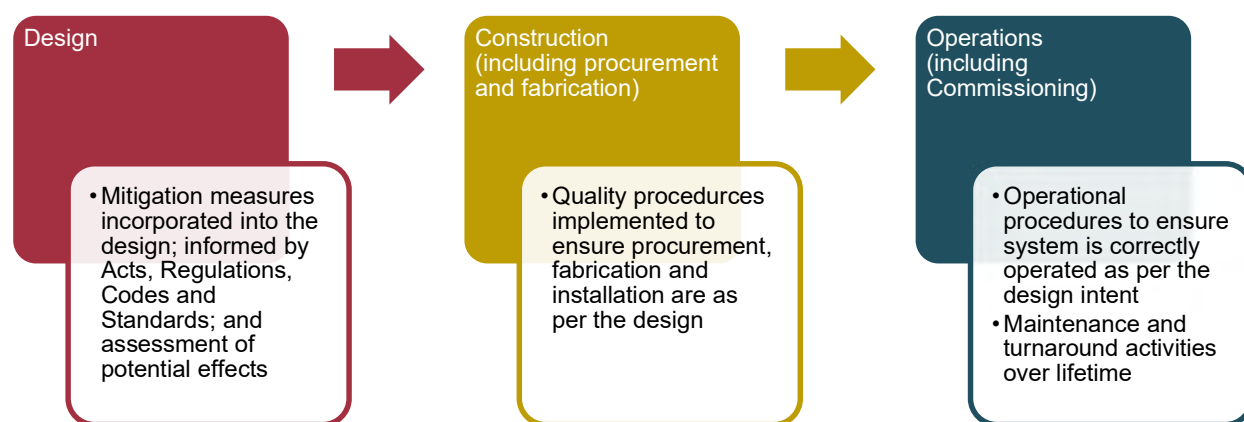


**Figure 6** Timeline for Addressing Mitigation Measures to Minimize Flaring

#### 3.1. Design

Key design measures that will minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 1. The design includes mitigations to reduce flare load during unplanned upsets.

The selection of flare technology used to meet the design basis was a key component. The Project contracted Zeeco to design and fabricate the vapour and liquid flare systems. Some parameters of the front-end engineering design (FEED) basis were adjusted during detailed design with the vendor.

Further information on design measures identified to address potential environmental effects is outlined herein.

##### 3.1.1. Air Emissions, GHG Emissions, Visible Emissions

A key design measure related to air quality and GHG emissions is the Destruction Removal Efficiency (DRE), which relates to the effectiveness of the combustion process. Typically, flare technology has a DRE of approximately 98%; however, for this Project, the chosen flare technology has a DRE of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that byproducts of incomplete combustion, such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and VOCs are released at extremely low quantities. The trade-off for this improved DRE is that GHG emissions will be slightly increased when assist gas is used in the flare; however, these emissions are relatively minor. The Project is developing a GHG Emissions Management Plan, in conformance

with EAC #E15-01, which will outline how the mitigation measures in the EAC application for managing the GHG emissions will be implemented.

As part of the EAC application (refer to Section 2.1.3) and WDA application (refer to Section 2.1.2), air dispersion modeling was undertaken, which includes emissions from the flare system. The modelling included routine/normal operations, as well as various non-routine scenarios for four CACs, which included two upset flaring cases (high sulphur case and high NO<sub>x</sub> and PM<sub>2.5</sub> case). Refer to the WDA application for further information.

### 3.1.2. Thermal Radiation

To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing, which could pose a fire hazard. A flare thermal radiation design basis was implemented in the design (refer to Table 8).

The issue of exposure of personnel to flare thermal radiation during work on or near the liquid burner derrick structure was assessed. This is not a significant concern as personnel can be evacuated from the liquid burner structure prior to a flaring event. The assessment also reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75-metre covered walkway were needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn.

In addition, operational controls will be in place; any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure if a flaring event occurs while personnel are in the area and would be covered through LNG Canada's Permit to Work practice.

**Table 8 Flare Thermal Radiation Design Basis**

| Heat Radiation Limit (kW/m <sup>2</sup> ) | Location                                                                               | Basis                                                                                                                                                                                                                                                           |
|-------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | Outside the facility fence line for normal operation, including start-up and shut down | Project requirement (Flare Equipment Data Requisition Sheet).<br>LNGFR maximum requirement for outside the boundary with normal flow rates is 3 kW/m <sup>2</sup> in remote areas.                                                                              |
| 3.0                                       | Outside the facility fence line for emergency conditions                               | Project requirement (Flare Equipment Data Requisition Sheet)<br>LNGFR maximum requirement for outside the boundary with accidental flow rates is 5 kW/m <sup>2</sup> in remote areas.                                                                           |
| 5.0                                       | At the boundary of sterile area for emergency conditions                               | LNGFR prescribed limit for outer edges of sterile area is 5 kW/m <sup>2</sup> for accidental flow rate.<br><br>This is significantly below the 25-30 kW/m <sup>2</sup> general guideline for spontaneous ignition of wood (which could result in forest fires). |

### 3.1.3. Noise

The flare design includes requirements to meet the following noise limits from the Project's design criteria:

- Emergency Cases: 115 dBa at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops.
- Normal operation including start-up/shutdown: 85dBa at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system and associated mitigation measures to be implemented in the design. This report was submitted to the BCER in accordance with the Facility Permit (refer to Table 5).

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA, with one multi-jet liquid burner to observe smokeless capability and noise measurement. Both results were satisfactory and correlated noise for nine burners was estimated at 85dB at 250 metres.

The flare system complies with Project's design criteria based on the noise data sheets issued by the vendor. However, due to the unpredictable nature of emergency events, additional operational controls will be in place. Whenever personnel are accessing the sterile area of the flare, double hearing protection will be required under the Permit to Work system and safety signage will be in place.

## 3.2. Construction

Key measures undertaken in construction that will allow the facility to minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 2. In this phase, it is critical to implement quality programs to verify that the mitigation measures identified in the design, have been procured, fabricated, and adequately installed and tested prior to operations.

## 3.3. Operations

There are a range of measures that are implemented during Commissioning and Operations that will allow the facility to minimize the flaring of gas and liquids and associated emissions (refer to Appendix A, Attachment 3). During operations, it is critical that the systems are operated as per the design intent; with supporting maintenance programs implemented. LNG Canada plans to operate within the design window for equipment, however in cases where flaring still occurs, further operational mitigations will be assessed to reduce emissions.

The amount of flaring during Commissioning is anticipated to be higher than "steady state", as bringing the process to specification can require additional testing, and additional time stopping or reversing the start-up process due to undetected flaws from construction and fabrication. During these early stages of Normal Operations (typically up to two years), there will be increased trips and a higher likelihood of unplanned outages to correct any operational issues. This period is characterized by a higher unreliability rate of equipment and more intensive facility organizational learning to resolve challenges. These events lead to flaring during the restart of the facility and any purging of equipment for maintenance.

There is also higher potential for smoke generation during Commissioning, extending into the early stages of Normal Operations. Flows and compositions outside the design window of the flare, leftover material from construction, or dust and rust may enter the flare network and inadvertently impact flare performance by altering combustion properties of the hydrocarbons.

Further information on measures to address the potential environmental effects during operations is outlined herein.

### 3.3.1. Air Emissions and GHG Emissions

LNG Canada will be required to meet the conditions of the WDA, which will include air emissions discharge limits, monitoring and reporting requirements (refer to Section 2.1.2), as well as implement the Air Quality Management and Monitoring Plan, developed in accordance with EAC Condition 1 (refer to Table 6).

LNG Canada will undertake GHG monitoring and reporting, in accordance with regulatory requirements, and implement the mitigation measures in accordance with the EAC Condition 3 (refer to Table 6).

LNG Canada also participates in the Kitimat Airshed Group (KAG), a multi-disciplinary group that is focused on air quality monitoring and public outreach, that BCER also participates in.

### 3.3.2. Visible Emissions

As per the BCER FVRG, the inspection to determine if black smoke is present or not, is to be performed using United States EPA [Method 22 - Visual Determination of Fugitive Emissions](#) (EPA 2019).

LNG Canada is investigating the implementation of technology to complement or replace visual observation from EPA Method 22. Advanced monitoring systems with optical sensors and cameras can accurately measure and record smoke characteristics (i.e., smoke index, destruction efficiency) in real-time, enabling operators to take more immediate action to mitigate potential risks. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. Once the measure surpasses the pre-determined smoke threshold, the monitoring system would trigger an alert or notification. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. LNG Canada acknowledges that BCER will maintain authority to conduct assessment using EPA Method 22 or other methods they determine most appropriate.

### 3.3.3. Light and Wildlife

Where possible, considering a number of factors, including safety, production requirements, and feasibility, flaring activities will be scheduled to occur during the daytime. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible. LNG Canada will also consider the following as appropriate:

- Seasonal migrations
- Cloud ceiling height
- Weather conditions.

The Flaring Notification Plan (L001-06200-AA-6048-4440) outlines the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts.

LNG Canada will also implement the Wildlife Management Plan, developed in accordance with the EAC Condition 12 (refer to Table 6).

### 3.3.4. Noise

The Project has a separate Noise Management Program, as required by the Facility Permit (refer to Table 5) that includes the noise mitigations, measurement and monitoring, and process for addressing complaints and noise concerns).

As noted in Section 3.1.3, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the Permit to Work system and safety signage will be in place.

## 4. Continuous Improvement, Review and Auditing

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process. Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
- Follow-up on flare key performance indicators
- Review of flaring incidents and progress of corrective actions
- Management of Change process for hardware change impacting flaring
- Review of operations/maintenance practices and procedures.

### 4.1. HSSE Management System

LNG Canada's HSSE Management System includes an HSSE & SP Control Framework with several elements related to flaring:

- **Flaring and Venting Manual** – Requires development of a Flaring and Venting Management Plan for facilities that are flaring and/or venting >1% by mass and combined flaring and venting exceeds 10,000 tonnes per annum of CO<sub>2e</sub>. It also requires that flaring risks are reviewed with a Subject Matter Expert if exceeding greater than 1% by mass.
- **Risk Assessment Matrix (RAM) Manual** – Environmental and community impacts are considered as part of the risk ranking process. This approach would be used to evaluate flaring events during an incident investigation. Escalation of events would occur due to factors such as the presence of black smoke over an extended period, complaints from the community, and/or AQO exceedances

LNG Canada will maintain an EMS in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy, and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Regular internal audits of the EMS will be conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

### 4.2. Tracking of Flare Losses

The flare losses are included as part of the facility mass balance reconciliation, which is monitored weekly with flare losses reported monthly to Petrinex as part of Volumetric reporting.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after Commissioning and early stages of Normal Operations. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

In addition to the monthly Petrinex submission, an annual Monitoring Report will be prepared by LNG Canada's Environmental Team and submitted to the BCER. The flow meters on the flare header will be utilized in determining the daily and monthly volumes. Flare header meters are designed and installed to meet the requirement outlined in the BC Measurement Guideline.

## 5. Report Review and Updates

This FMR is intended to be reviewed and updated:

- After Commissioning LNG trains 1 and 2 to incorporate lessons learned for Commissioning of Phase 2 (LNG trains 3 and 4)
- Annually to incorporate any identified changes from
  - Process/Procedural changes impacting Report
  - Facility changes impacting Report
  - Continuous improvement cycles.
- Between review cycles if there are changes identified through ongoing engagements with Indigenous groups, BCER, or other stakeholders.

Should any required revisions be identified, the following update process will be initiated:

- Administrative/minor changes only: FMR will be updated and re-issued to the BCER for awareness, with a summary of the changes provided. The updated FMR will be effective for implementation.
- Significant change (i.e., change to the fundamentals of the management approach): BCER will be consulted on the proposed change(s). After the consultation activities are completed, the FMR will be updated and re-issued to the BCER with a summary of the changes provided. The updated FMR will then be effective for implementation.

## 6. References

- BC Energy Regulator (BCER). 2023a. LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023.
- BCER. 2023b. BC Measurement Guideline, Version 2.4, October 2023.
- BC Oil and Gas Commission (BC OGC). 2022. Flaring and Venting Reduction Guideline, Version 5.3, September 2022.
- BC OGC. 2021a. BC Light Control Best Practice Guideline, Version 1.0, March 2021.
- BC OGC. 2021b. BC Noise Control Best Practice Guideline, Version 2.2, July 2021.
- BC OGC. 2021c. Oil and Gas Glossary and Definitions, Version 1.13, December 2021.
- Commission Internationale de l'Eclairage (CIE). 2003. Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 150:2003.
- United States Environmental Protection Agency (EPA). 2019. Method 22 - Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019.

## Appendix A

## List of Attachments

| Number | Title                                                                                 |
|--------|---------------------------------------------------------------------------------------|
| 1      | Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions       |
| 2      | Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions |
| 3      | Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions  |



**Attachment 1      Design Measures to Minimize Flaring of  
Gas and Liquids and Associated  
Emissions**

## Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect           | Reduction/<br>Mitigation Measure                  | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Pilot System                | Consistent Ignition Source                        | The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system. If the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ✓                                                          |                             |
| Pilot System                | Redundant Pilots                                  | The vapour flares have redundant pilots. In the unlikely case that all four pilots are lost, they will continue to operate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Flare System                | Sonic Flare Management                            | Selection of a sonic flares as well as associated flare rate and flame height, promotes mixing which is expected to help manage flare performance, minimize smoke potential and improve the destruction removal efficiency (DRE).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Vapour Flare Systems        | Nitrogen Purge                                    | All flare headers are continuously purged with nitrogen instead of fuel gas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Vapour Flare Systems        | Assist Gas for DRE                                | Assist Gas is available for DRE on the Warm Wet Flare ("F-WW"), Cold Dry ("F-CD") Flare, and Spare Flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          | ✓                           |
| Liquid Burners              | Assist Gas                                        | The liquid burners are equipped with assist gas to promote air entrainment into the flame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquid Burners              | Cooldown                                          | Automated advanced cooldown to reduce flaring time at the cold liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                                          |                             |
| Flare Knock Out Drums       | Liquid Management                                 | Installation of flare knock out (KO) drums; which are protected from liquid overflow through a combination of design liquid retention volume, as well as the use of two independent radar level measurements. These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners. The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system, the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck. |                                                            | ✓                           |
| Control Valves              | Continuous Passing Valves / Leaking Specification | All control valves connected to the flare system conform to a minimum America National Standards Institute (ANSI) Class IV leakage specification. Emergency depressuring valves and other control valves that have been specified as "tight shut-off" (TSO), meet ANSI Class V leakage specification, as per Project standards. This ensures that the amount of hydrocarbon lost to the flare is minimized.                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Manual Valves               | Blinding                                          | Manual valves connected to the flare system, which are used for maintenance purposes, are blinded to ensure that the leakage is eliminated. These locations must be de-blinded to purge equipment to flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Liquefaction Train          | Quench Line                                       | Each compressor string is equipped with a quench line for start-up to allow quick equalization with cold running string to reduce flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Compressors                           | The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) Refrigerant qualities can be adjusted by recycling their vapours to the condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Recycling                             | Pre-cooling PMR cycle can circulate MR, on full recycle via an MR "start-up recycle line", to provide pre-cooling load, to facilitate pre-cooling system start-up and decouple with MCHE final cool down.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |
| Refrigerant Production Unit | Vapour Routed to LNG Tank                         | Vapour from the spheres is normally routed to the LNG tank and is mixed with boil off gas (BOG) to prevent flaring of propane or ethane.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Refrigerant - Insulation / Temperature Controlled | The ethane refrigerant sphere is insulated and chilled to -11°C to minimize vapour losses from the sphere.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Refrigerant Production Unit | Refrigerant - Pressure Controlled                 | Refrigerant spheres are pressure controlled to the LNG tank vapour space.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |

| Location / Aspect           | Reduction/<br>Mitigation Measure     | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Refrigerant Production Unit | Operating Pressure of Propane Sphere | Propane sphere design and normal operating pressures are above vapour pressure; therefore excess propane vapor generation is not expected during holding mode eliminating the need to continuously send propane vapours to flare.                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Start-up Lines                       | Installation of start-up lines to reduce flaring during Refrigerant Production Unit (RPU) start-up:<br>- De-ethanizer column ethane vapour import from refrigerant storage<br>- De-ethanizer reflux ethane liquid import from refrigerant storage<br>- De-propanizer column propane vapour import from refrigerant storage<br>- De-propanizer reflux propane liquid import from refrigerant storage                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Recycling Lines                      | Installation of recycling lines to reduce flaring during RPU operation:<br>- Gas overheads from de-ethanizer and de-propanizer are recycled to the LNG tank<br>- De-propanizer bottoms liquids are always recycled to natural gas stream<br>- Gas overheads from de-methanizer are recycled to natural gas stream                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| BOG Compressors             | Capturing Excess BOG                 | Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          |                             |
| Condensate Tank             | Temperature Controlled               | The condensate tank vapours are chilled to -10°C to reduce hydrocarbon directed to the incinerator, which minimizes venting (and associated emissions).                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Metering                    | Metering                             | Installation of full metering capability on the flare headers (including density measurement) to help identify abnormal flaring earlier. Flaring is metered via Ultrasonic (US) flowmeters on each common flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have a measurement turndown of 1:1000 and an accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy. | ✓                                                          |                             |
| Waste                       | Disposal of warm wet waste streams   | Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |

## **Attachment 2**

### **Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**

## Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect         | Reduction/<br>Mitigation Measure  | Details                                                                                                                                                                                                                                                                                                                                                                                                                          | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|---------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Liquid Burners            | Testing on LNG                    | During design the liquid burners were tested with LNG to confirm burner performance.                                                                                                                                                                                                                                                                                                                                             |                                                            | ✓                           |
| Pilot System              | Testing                           | Ensures the flare system is fully tested before introduction of natural gas to prevent uncombusted gas from being vented (using liquid petroleum gas (LPG) bottles).                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Overall - Quality Program | Contractor Prequalifications      | Implement the contractor prequalification process; for the screening, prequalification and evaluation of contractors.                                                                                                                                                                                                                                                                                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Quality Management Plans          | Development and implementation Project quality management plans address how the quality objectives will be managed for the duration of construction (including design, procurement, fabrication, and commissioning), plus the flow down to the contractors' and subcontractors' quality plans.                                                                                                                                   | ✓                                                          | ✓                           |
| Overall - Quality Program | Flawless Project Delivery Program | Development and implementation of a Flawless Project Delivery (FPD) program (L001-00000-OA-5876-1001). The FPD program identifies flaws (including lessons learnt from all stakeholders that have occurred on previous projects) and identifies and implements mitigations to reduce and/or eliminate the potential risk [Applicable from design through commissioning and start up].                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Plans         | Development and implementation of inspection and test plans (ITPs), which contain the key inspection activities and identification of the interface points for reviewing, witnessing and holding by the subcontractor, sub-subcontractor (where applicable), JFJV and LNG Canada.                                                                                                                                                | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Records       | Inspections and tests will be formally reported through inspection and test records (ITRs). Records generated by self-perform and subcontractors (including module fabricators) will be progressively filed into appropriately labelled records files in readiness for handing over to LNG Canada.                                                                                                                               | ✓                                                          | ✓                           |
| Overall - Quality Program | Surveillance                      | Surveillance is performed by JFJV; where observations are raised with either recommendations or corrective and/or preventative actions.                                                                                                                                                                                                                                                                                          | ✓                                                          | ✓                           |
| Overall - Quality Program | Change Management                 | Development and implementation of the comprehensive change management program ensures that the correct level of professional engineering engagement and oversight will be maintained during all stages of the project and that all deviations, changes and revisions will be identified, documented and actioned at the appropriate level of review.                                                                             | ✓                                                          | ✓                           |
| Overall - Quality Program | Technical Integrity Verification  | Development and implementation of the Technical Integrity Verification (TIV) Plan, that is the clear demonstration that all safety critical elements meet the agreed performance standards for design, procurement and testing; with handover of detailed deliverables with sufficient granularity to allow the future asset to maintain safety critical equipment and perform safety critical tasks to their required standard. | ✓                                                          | ✓                           |

### **Attachment 3**

### **Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**

## Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Applicable Phase         | Location / Aspect                              | Reduction/ Mitigation Measure                                                                       | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|--------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Commissioning / Start Up | LNG Train 1 Start-Up                           | Quality Programs                                                                                    | During the Commissioning of LNG Train 1, it is expected that material left over from construction and pre-commissioning may become trapped in temporary strainers and will need to be removed during start-up or shortly after production is achieved. Measures to minimize left over material is addressed in the construction quality program noted herein.                                                                                                                                                                                                                                                                                   | ✓                                              | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit                    | Import refrigerants (ethane and propane) to storage and cooldown of associated piping and equipment | Refrigerant grade liquid ethane and propane will be imported into the facility for commissioning; to avoid the need to initially produce the refrigerant prior to LNG production, eliminating weeks of flaring from the facility.                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              | ✓                     |
| Commissioning / Start Up | LNG Storage                                    | Import LNG to storage and cooldown of associated piping and equipment                               | LNG will be imported to cooldown of the LNG circuits and LNG storage tank, which reduces the expected flaring by due to the avoidance of using LNG from Train 1 to cooldown the piping and LNG storage tank.                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              | ✓                     |
| Commissioning / Start Up | Acid Gas Removal (AGR) Unit Start-up           | Absorber Turndown                                                                                   | Turndown the feed rates (below the design minimum) will be evaluated during the actual start-up. It will depend on the system's ability to maintain treated gas on specification for carbon dioxide (CO2) and benzene, toluene, ethylbenzene and xylene (BTEX).                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Commissioning / Start Up | Mercury Bed Drying and Cold End Defrost        | Use of defrost gas                                                                                  | At the completion of dry out of the mercury bed, defrost gas will be available to begin dryout of the cold end without jeopardizing the integrity of the aluminum components. Some of the flow currently routed to the warm-wet flare will be instead routed to the cold-dry flare. Although the same amount of gas is flared, the overall height may be reduced at times due to this diversion.                                                                                                                                                                                                                                                | ✓                                              |                       |
| Commissioning / Start Up | Cold End Cooldown and Condensate Stabilization | Dilution with natural gas                                                                           | During start up and surge testing of overhead compressors, the overhead gas is flared until all testing is complete. Natural gas added to the steam from overhead gas for dilution, to reduce risk of black smoke from the heavier composition of the stream.                                                                                                                                                                                                                                                                                                                                                                                   |                                                | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit (RPU)              | Recycle to LNG Tank                                                                                 | Once the refrigerant is on-specification, it will be routed to the storage spheres and any gas overheads from the de-ethanizer and de-propanizer are recycled to the LNG tank to avoid flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              | ✓                     |
| Commissioning / Start Up | Train 2                                        | Use of defrost gas                                                                                  | For Train 2 startup, defrost gas from Train 1 will be used to defrost the equipment eliminating the need for excess flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations               | Flare Management                               | Dilution Gas                                                                                        | Dilution gas is added to lower the concentration of combustible components in the flare gas, improving the combustion efficiency and reducing emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Monitoring & Optimization                                                                           | Pro-actively monitor flaring and associated characteristics to allow the operator to adjust the flare operation to minimize emissions. Methods for detecting and monitoring flaring include:<br>- Closed circuit television (CCTV) in the control room for 24 hours a day, 7 days a week, monitoring of flare performance<br>- Equipment trips<br>- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions<br>- An alarm on some controlled streams flared (valve not closed status)<br>- Proactive Technical Monitoring set-up for the flaring system to monitor abnormalities in the flare system | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Flare Checks                                                                                        | Procedures/processes in place for Operations to identify if there is an unknown passing valve to the flare system. This will include systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by Operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves. Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.                                                          | ✓                                              |                       |

| Applicable Phase | Location / Aspect                    | Reduction/ Mitigation Measure                        | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|--------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | Flare Management                     | Unplanned Flaring Procedures                         | Procedures/processes in place for Operations to respond to an unplanned flaring event. This will include Operations first undertaking any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service, if it is safe to do so.<br>If the equipment cannot be readily returned to service, the Operations Shift Team will coordinate with LNG Canada Production Scheduling department to undertake actions to reduce facility throughput to minimum turndown, if required to reduce flaring. The facility has a design minimum turndown of 50% for the equipment and this will limit the turndown to 50% of the design rate to prevent potential equipment damage.<br>Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair, LNG Canada Production Scheduling will optimize the production plan and LNG carrier arrival within any pre-existing limits to minimize flaring and economic loss. | ✓                                              |                       |
| Operations       | Flare Management                     | Flaring Event Investigations                         | Procedures/processes in place for Operations to investigate a flaring event. For flaring events greater than 10,000 m3, Operations will use the incident reporting system and correct causes of repeated non-routine flaring, incinerating, or venting as part of continuous improvement. The investigation reports would be available to the regulator upon request.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                              |                       |
| Operations       | Overall                              | Quality                                              | Implementation of the quality management system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              |                       |
| Operations       | Flare Management                     | Visible Emissions - Training                         | Training/processes in place for Operations to visually observe smoke in alignment with United States Environmental Protection Agency (USEPA) Method 22.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                | ✓                     |
| Operations       | Overall                              | Measurement Data: Analyze Data & Reporting           | Procedures/processes in place for Operations to maintain diligence in the management of flaring and associated emission. Will include analysis of measurement data in the context of monitoring data to further the learning of predicted against actualized outcomes. This learning will be systematically captured, such that the management approach can be adapted towards improving both predicting and reducing flaring events and associated emissions.<br>The Project will use the BC Measurement Guideline for measurement of flared volumes and associated fuel gas volumes through Petrinex reporting system monthly.<br>maintain the log of air flaring that occurs, in accordance with LNG Facility Regulation; and regularly review as part of the continuous approval process.                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Operations       | Overall                              | Flaring Log                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Corrective Maintenance Program   | Procedures/processes in place for Operations to address corrective maintenance when a mismeasurement is observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer. The evidence or manifest of mismeasurement could be as follows:<br>- Observed during calibration, part of preventive maintenance activities<br>- Difference in reading observed by the Operation referring to other process parameters<br>- Determined by the Technology Team during the daily mass balance activity<br>- Self-diagnosis by the smartness of the device and manifested as alert or fault<br>Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error within the accuracy using the Project test equipment that is certified by a Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.                                          | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Preventative Maintenance Program | All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centered Maintenance (RCM), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventative maintenance task within stipulated time frame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Relief Valve                         | Inspection and Overhaul - Spares                     | Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                                              |                       |
| Operations       | Adjustment of PMR and MR composition | Recycling                                            | Procedures/processes in place for Operations to adjust Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) qualities by recycling their vapours to the condensate stabilizer unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              | ✓                     |



| Applicable Phase | Location / Aspect           | Reduction/ Mitigation Measure                    | Details                                                                                                                                                                                                                                                                                                                                                   | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|-----------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | LNG Carrier Loading Mode    | Slower cooldown                                  | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess boil off gas (BOG) generated.                                                                                                                                     | ✓                                              |                       |
| Operations       | Gas Turbines                | Turn around - Parallel Strings                   | With parallel 50% strings, boroscoping of each aeroderivative gas turbine during turnaround can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring.                                                                                                                                | ✓                                              |                       |
| Operations       | Refrigerant Production Unit | Turn around - De-inventory PMR Circuit           | In preparation of turnaround the PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train.                                                                                                                                                                         | ✓                                              | ✓                     |
| Operations       | Fuel Gas                    | Turnaround - MP Fuel gas during Nitrogen Purging | Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, MP fuel gas will be added to ensure the minimum heating value is maintained.                                           | ✓                                              |                       |
| Operations       | De-Inerting LNG Carriers    | MP Fuel Gas during De-Inerting                   | MP Fuel gas, supplied from a dedicated fuel gas line at the bottom of the Storage and Loading Flaring, is added to the flare to ensure the minimum heating value of 20 MJ/m3 is maintained.                                                                                                                                                               | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Assist Gas during Acid Gas Thermal Oxidizer Trip | The overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere. Fuel gas is added to the flare from the fuel gas controller at the Warm Flare Knock-out drum, to ensure the minimum heating value is maintained.                                                | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Re-routing to other LNG Train                    | The control scheme makes use of last known values of flow indication and Lower Heating Content from the analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.                                                                                                | ✓                                              |                       |
| Operations       | Liquefaction Train          | Main Cryogenic Heat Exchanger (MCHE) Trip        | LNG production is immediately stopped and the gas flow to the facility is automatically reduced at the inlet station. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.                                                                                                                            | ✓                                              |                       |
| Operations       | Residue Vapour Compressor   | Residue Vapour Compressor Trip - Duration        | If the compressor is unable to be started within four hours, the Refrigerant Production Unit (RPU) would be shut down to stop flaring.                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Assist Gas     | Assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.                                                                                                                                                                                                                               |                                                | ✓                     |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Duration       | If operations are unable to bring the condensate stabilization unit back to specification to stop flaring the overall production would be reduced until the stream meets specification, or the LNG train would be shutdown.                                                                                                                               | ✓                                              | ✓                     |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Holding Mode        | During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. To reduce the amount of BOG generated during this mode of operation, and therefore reduce flaring, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank to reduce the volume of BOG generated. | ✓                                              |                       |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Loading Mode        | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess BOG generated.                                                                                                                                                    | ✓                                              |                       |

| LNG Canada Flaring Management Report BCER Information Request |                  |
|---------------------------------------------------------------|------------------|
| Project                                                       | LNG Canada       |
| OGC File #                                                    | 1000836125       |
| Date                                                          | December 7, 2023 |

December 21, 2023: The LNG Canada responses to the BCER questions are indicated in blue font herein.

#### Reference Documents:

1. L001-06200-OA-5880-0001\_RG.pdf, Flaring Management Review, Revision G. Revision Date 10-Nov-2023.
2. LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.

#### Information Request:

Follow-up 40-1: no further questions

Follow-up 43-1: no further questions

Question 46: no further questions

Question 47: Thank you for the submission of revision G. Please see below for review comments and questions.

| Section | Relevant excerpt                                                                                                                                      | BCER Review Comment                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.4.2   | "Potential environmental effects from flaring... were considered in the Environmental Assessment Certificate (EAC) process (refer to Section 2.1.2)." | <p>The reference is not clear. (Is it referring to this report? Is it referring to an EAO submission? Other?) Please include sufficient details for the reader to find section 2.1.2.</p> <p><b>Project Response (Dec-21):</b> This section should refer to Section 2.1.3 of the Flaring Management Report, for further information on the EAC and applicable conditions. This has been updated in the revised Flaring Management Report (Rev H).</p> |
| 1.4.2   | "Visible Emissions – Light: ...<br>Visual Emissions – Smoke: ..."                                                                                     | <p>With the exception of section 1.4.2, the report uses 'visible emissions' to refer to smoke (e.g., section 3.3.2 Visible Emissions relates to black smoke). The use of visual emissions for smoke and visible emissions for light in section 1.4.2 is confusing. It is recommended that consistent terminology be used.</p>                                                                                                                         |

|                      |                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      |                                                                                                                                                                     | <p>Project Response (Dec-21): Removed the language “visible emissions” for light in Section 1.4.2 of the revised Flaring Management Report (Rev H). This language is now consistent with Section 3.3.3 of the Flaring Management Report, where “Light” is referenced.</p>                                                                                                    |
| 1.3.2 and Appendix A | <p>“The gas turbines are semi-aero derivative type with a high torque requirement at start.”</p> <p>“The semi aeroderivatives have low torque demand at start.”</p> | <p>Please verify the description of the turbine torque requirements.</p> <p>Project Response (Dec-21): It is “low torque” therefore the language has been updated in Section 1.3.2 of the revised Flaring Management Report (Rev H).</p>                                                                                                                                     |
| Table 1              | <p>“In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.”</p>                  | <p>What is the probability of BOG compressor failure with no back-up?</p> <p>Project Response (Dec-21): In Phase 1, there is no backup capacity for the BOG compressors. No change to the language in the Flaring Management Report.</p>                                                                                                                                     |
| Table 4              | First Cargo                                                                                                                                                         | <p>As per the Basis of Design – Marine Structures (001-07000-CX-8380-1917). Vessel capacity varies from 138,000 m3 to 217,000 m3. Please modify the definition to align with the lower end of the LNG carrier capacity.</p> <p>Project Response (Dec-21): The definition for “First Cargo” has been updated in Table 4 of the revised Flaring Management Report (Rev H).</p> |
| Table 4              | <p>Dilution Gas</p> <p>Fuel Gas</p>                                                                                                                                 | <p>The definitions of dilution gas and fuel gas are not consistent with the FVRG. Please note that gas that is combusted in a flare or incinerator is considered to be flare gas.</p> <p>Project Response (Dec-21): The definitions for “Dilution Gas” and “Fuel Gas” have been updated in Table 4 of the revised Flaring Management Report (Rev H).</p>                     |

|     |                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.2 | <p>“Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after Commissioning and early stages of Normal Operations.”</p> | <p>Please note, that the LNG Facility Regulation requires that “the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized”. This target should be periodically evaluated to ensure that quantity of gas flared in minimized.</p> <p><a href="#">Project Response (Dec-21):</a> Noted. LNG Canada will evaluate against the internal target; however, it should be clarified that the 0.3 wt% is an internal target and should not be a compliance point. No change to the language in the Flaring Management Report.</p> |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Friday, 10 Nov 2023 03:29 PM  
**To:** "Ariyawansa, Sarangi" <Sarangi.Ariyawansa@bc-er.ca>; "Mathews, Suzanne" <Suzanne.Mathews@bc-er.ca>; "Whitehouse, Mike" <mike.whitehouse@bc-er.ca>; Post Permit Requests <postpermitrequests@bc-er.ca>  
**CC:** "permitting@lngcanada.ca" <permitting@lngcanada.ca>; LNGC JVD PERMITTING <LNGC.JVD.PERMITTING@fluor.com>; "scot.mackillop@lngcanada.ca" <scot.mackillop@lngcanada.ca>; Ben Ashton <Ben.Ashton@fluor.com>; "erin.furlong@lngcanada.ca" <erin.furlong@lngcanada.ca>; "Lyndsey.Hunter@lngcanada.ca" <Lyndsey.Hunter@lngcanada.ca>; James Frith <James.Frith@fluor.com>; "Cameron.McCormick@lngcanada.ca" <Cameron.McCormick@lngcanada.ca>  
**Subject:** RE: LNG Canada Project Flaring Management Report

---

Afternoon,

Please see the attached updated Flaring Management Report (L001-06200-OA-5880-0001\_RG.pdf) along with the responses to BCERs clarification questions on Rev. F ("LNGC FMR\_OGC Clarifications R3 (Sep 15 2022)\_Response (NOV 2023)\_R0.pdf"), on behalf of LNG Canada.

As previously discussed, this Report has been significantly updated since Revision F, therefore I have not included the version that shows all the tracked changes (i.e., with different colored font / strike through text that has been removed) as it is very difficult to follow - the line on the right side of the page indicates all the sections that have been changed/updated.

I'll share these documents with Haisla this afternoon also.

Let Lyndsey or I know if you have any questions on this submission,

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M

s22

[www.jfvkitimat.com](http://www.jfvkitimat.com)

---

**From:** Ariyawansa, Sarangi

**Sent:** Thursday, September 15, 2022 3:58 PM

**To:** Janine Forrest

**Cc:** permitting@lngcanada.ca; LNGC JVD PERMITTING ; Mathews, Suzanne ; scot.mackillop@lngcanada.ca; Neven.Dimic@lngcanada.ca; Ben Ashton ; erin.furlong@lngcanada.ca; Lyndsey.Hunter@lngcanada.ca; James Frith ; Whitehouse, Mike

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,

Thank you for this submission. Please see the attached for a comment about FMR and some follow-up and additional review questions.

Thanks,

Sarangi



**Sarangi Ariyawansa** EIT  
Engineer, Facilities  
[Sarangi.Ariyawansa@bcogc.ca](mailto:Sarangi.Ariyawansa@bcogc.ca)

Kelowna  
[Office Address Directory](#) T. 250 980-6055  
[BCOGC Web Site](#) F. 250 980-6053



We acknowledge and respect the many Indigenous Territories and Treaty areas, each with unique cultures, languages, legal Inuit people living across B.C.

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---

**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Tuesday, August 2, 2022 8:53 AM  
**To:** Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; 'scot.mackillop@lngcanada.ca' <<a href="mailto:scot.mackillop@lngcanada.ca">scot.mackillop@lngcanada.ca>; 'Neven.Dimic@lngcanada.ca' <<a href="mailto:Neven.Dimic@lngcanada.ca">Neven.Dimic@lngcanada.ca>; Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>  
**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated Flaring Management Report for the LNG Canada Project: L001-06200-OA-5880-0001\_RF (2022JUL26)\_TRACKED.pdf. The tracked changes are shown in red (additions).

I will also share this Report with Haisla Nation this morning.

Let me know if you have any further questions / clarifications for this Report. The intent is to issue the "final" version as Rev. 0 (Approved for Use) after we have closed out the OGC / Haisla review.

Regards

Janine

---

**From:** Janine Forrest

**Sent:** Friday, June 3, 2022 10:17 AM

**To:** Mathews, Suzanne <<a

href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

'Lyndsey.Hunter@lngcanada.ca' <<a

href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a

href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a

href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>

**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne <<a

href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>

**Sent:** Thursday, April 14, 2022 2:38 PM

**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>;

[scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a

href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca);

'Lyndsey.Hunter@lngcanada.ca' <<a

href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a

href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>; Hassan, Umair <<a

href="mailto:Umair.Hassan@bcogc.ca">Umair.Hassan@bcogc.ca>

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,

Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



**Suzanne Mathews**, P.Eng.  
Supervisor, Engineering Strategic &  
Technical Services  
[Suzanne.Mathews@BCOGC.ca](mailto:Suzanne.Mathews@BCOGC.ca)

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**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>  
**Sent:** Tuesday, March 8, 2022 12:25 PM  
**To:** Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>  
**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/lngcanada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>  
**Sent:** Friday, November 19, 2021 12:09 PM  
**To:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>; Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Friedrich, Hardy <<a href="mailto:Hardy.Friedrich@bcogc.ca">Hardy.Friedrich@bcogc.ca>  
**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>



href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>

**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.



**Joshua Porter** P.Eng.  
Engineer, LNG Facilities  
[Joshua.Porter@BCOGC.ca](mailto:Joshua.Porter@BCOGC.ca)

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**From:** Janine Forrest <<a href="mailto:Janine.Forrest@fluor.com">Janine.Forrest@fluor.com>

**Sent:** Friday, October 1, 2021 3:14 PM

**To:** Post Permit Requests <<a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>

href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca>; Mathews, Suzanne <<a href="mailto:Suzanne.Mathews@bcogc.ca">Suzanne.Mathews@bcogc.ca>; Porter, Joshua <<a href="mailto:Joshua.Porter@bcogc.ca">Joshua.Porter@bcogc.ca>

**Cc:** 'permitting@lngcanada.ca' <<a href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>

href="mailto:permitting@lngcanada.ca">permitting@lngcanada.ca>; LNGC JVD PERMITTING <<a href="mailto:LNGC.JVD.PERMITTING@fluor.com">LNGC.JVD.PERMITTING@fluor.com>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <<a href="mailto:Ben.Ashton@fluor.com">Ben.Ashton@fluor.com>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <<a href="mailto:Lyndsey.Hunter@lngcanada.ca">Lyndsey.Hunter@lngcanada.ca>; James Frith <<a href="mailto:James.Frith@fluor.com">James.Frith@fluor.com>

**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250 | M  
S22

[www.jfjvkitimat.com](http://www.jfjvkitimat.com)

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| LNG Canada Flaring Management Report BCOGC Information Request |                    |
|----------------------------------------------------------------|--------------------|
| Project                                                        | LNG Canada         |
| OGC File #                                                     | 1000836125         |
| Date                                                           | September 15, 2022 |

#### **Reference Documents:**

1. L001-06200-OA-5880-0001\_RF (2022JUL26) TRACKED.
2. LNGC FMR BCOGC RFI 2 April 14, 2022\_Response (2022JUN03) \_R0

Thank you for submitting the comprehensive flare information; this was helpful for our review.

Permit condition 39 requires that:

The Permit Holder must not undertake commissioning of the LNG facility until it has submitted via email to [postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca), to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.

For the purpose of this permit condition, we request LNG Canada to limit the document to outline the mitigation measures to minimize the flaring and remove the supplemental information from the report.

[Response \(Nov-10\): The Flaring Management Report \(Revision G\) has been updated to remove supplemental information and submitted to the BC Energy Regulator \(BCER\) on Nov 10, 2023.](#)

#### **Information Request:**

40. **Follow-Up 40-1:** The Commission reviewers will revisit this question once Q2/Q3 2022 flaring estimate update is available

[Response \(Nov-10\): An updated flaring estimate has been completed based on a deterministic 42-day start-up schedule for LNG Train 1 and 35-day start-up schedule for LNG Train 2; approximately 0.6 million tonnes of gas is estimated to be flared during the start-up of LNG Trains 1 and 2. This is approximately 1.6 times higher than the flared gas volume estimated shared in 2015 for the start-up of the two trains \(previous volume estimate was approximately 0.365 million tonnes\). Both of these estimates did not include early stages of normal operations. The increase in the estimated volume is due to several reasons as outlined below, with the first two reasons having the most impact:](#)

- [change in assumed duration of start-up related to each train \(especially start-up of warm end\);](#)
- [correction of assumptions accounting for the need for the LNG facility to be at minimum turndown for startup of compressors and stabilization unit; and,](#)
- [inclusion of flaring occurring prior to commissioning of LNG trains \(i.e., pipeline](#)

and inlet facility).

However, if the LNG facility experiences a longer start-up period due to unexpected events, the emissions would be higher and this aligns with the conservative scenario presented to BCER in the Flare Management Report REV F, which projected 1.4 million tonnes of flared gas for the start-up period not including early stages of normal operations. Flaring profiles were removed in the updated draft Flaring Management Report Rev G.

43. **Follow-Up 43-1:** The additional commentary in the definition of “normal operations” should be removed, it is not part of the definition.

Response (Nov-10): The additional commentary proposed in the definition of normal operations has been removed from the updated Flaring Management Report Rev G.

46. The most recent revision includes a definition of “Black Smoke” that is not consistent with the method used by the Commission to determine compliance with this requirement. If a definition is required, it should reference EPA Method 22, not opacity. Also, it is noted that section 6.1 includes commentary on the use of opacity to define “Black Smoke”. This section is not consistent with how the Commission determines compliance with regulatory requirements related to black smoke (i.e., EPA Method 22).

Response (Nov-10): As discussed with BCER Staff on September 22, 2023, LNG Canada has included the revisions to the definition of “Black Smoke” in the updated Flaring Management Report Rev G. LNG Canada acknowledges that BCER will maintain authority to conduct assessment using EPA Method 22 or other methods they determine most appropriate.



## Controlled Document

# Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | G                                            |
| Document Status          | Issued for Review                            |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 10-Nov-2023                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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# REVISION CONTROL PAGE

| Revision Status |             |                   |                            | Approving Organization                                                                       |                            |                 |
|-----------------|-------------|-------------------|----------------------------|----------------------------------------------------------------------------------------------|----------------------------|-----------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                     | Approver                   | Review Code     |
| A               | 08-Jun-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 | Choose an item. |
| B               | 12-Oct-2019 | Issued for Review | C. Fischer                 | S. MacKillop<br>M. Lampp<br>N. Dimic<br>C. McCormick<br>J. Willem<br>Trapman<br>T. Kok-Leong | C. Fischer                 |                 |
| C               | 09-Apr-2021 | Issued for Review | C. McCormick               |                                                                                              |                            |                 |
| D               | 01-Oct-2021 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>R. Kabganian<br>S. MacKillop<br>N. Dimic                                        | B. Ashton<br>R. Dronamraju |                 |
| E               | 08-Mar-2022 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>N. Dimic<br>C. Sharwood<br>A. Betts                                             | B. Ashton<br>R. Dronamraju |                 |
| F               | 26-Jul-2022 | Issued for Review | J. Forrest                 | N. Dimic<br>C. McCormick<br>J. Keim                                                          | B. Ashton<br>R. Dronamraju |                 |
| G               | 10-Nov-2023 | Issued for Review | J. Forrest                 | L. Hunter<br>C. McCormick<br>S. MacKillop                                                    | B. Ashton                  |                 |

# TABLE OF CONTENTS

|        |                                                                           |    |
|--------|---------------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                              | 4  |
| 1.1.   | Project Background                                                        | 4  |
| 1.2.   | Purpose and Objectives                                                    | 4  |
| 1.3.   | Project Flaring and Overview                                              | 4  |
| 1.3.1. | Project Overview                                                          | 4  |
| 1.3.2. | Process Description Overview                                              | 4  |
| 1.3.3. | Flaring Overview                                                          | 6  |
| 1.3.4. | Flaring Event Classification                                              | 9  |
| 1.4.   | Environmental Considerations                                              | 11 |
| 1.4.1. | LNG Canada Commitments                                                    | 11 |
| 1.4.2. | Potential Environmental Effects                                           | 11 |
| 1.5.   | Roles and Responsibilities                                                | 12 |
| 1.6.   | Abbreviations and Definitions                                             | 12 |
| 2.     | REGULATORY FRAMEWORK                                                      | 17 |
| 2.1.   | Project Approvals and Conditions                                          | 17 |
| 2.1.1. | Facility Permit                                                           | 17 |
| 2.1.2. | Waste Discharge Authorization                                             | 19 |
| 2.1.3. | Environmental Assessment Certificate                                      | 19 |
| 2.1.4. | Decision Statement                                                        | 21 |
| 2.2.   | Acts, Regulations, and Guidelines                                         | 21 |
| 2.2.1. | Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation | 21 |
| 2.2.2. | BCER Flaring and Venting Reduction Guideline                              | 23 |
| 2.2.3. | BC Noise Control Best Practices Guideline                                 | 23 |
| 2.2.4. | BCER Light Control Best Practices Guideline                               | 23 |
| 2.2.5. | Ambient Air Quality Objectives                                            | 23 |
| 3.     | MITIGATION MEASURES                                                       | 25 |
| 3.1.   | Design                                                                    | 25 |
| 3.1.1. | Air Emissions, GHG Emissions, Visible Emissions                           | 25 |
| 3.1.2. | Thermal Radiation                                                         | 26 |
| 3.1.3. | Noise                                                                     | 26 |
| 3.2.   | Construction                                                              | 27 |
| 3.3.   | Operations                                                                | 27 |
| 3.3.1. | Air Emissions and GHG Emissions                                           | 27 |
| 3.3.2. | Visible Emissions                                                         | 28 |
| 3.3.3. | Light and Wildlife                                                        | 28 |
| 3.3.4. | Noise                                                                     | 28 |
| 4.     | CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                               | 29 |
| 4.1.   | HSSE Management System                                                    | 29 |
| 4.2.   | Tracking of Flare Losses                                                  | 29 |
| 5.     | REPORT REVIEW AND UPDATES                                                 | 30 |
| 6.     | REFERENCES                                                                | 31 |
|        | APPENDIX A LIST OF ATTACHMENTS                                            | 32 |

# 1. Introduction

## 1.1. Project Background

LNG Canada Development Inc. (LNG Canada) is building a liquefied natural gas (LNG) export facility in Kitimat, British Columbia (BC), Canada, in the traditional territory of the Haisla Nation. LNG Canada is a joint venture comprised of Shell Canada Energy (Shell), North Montney LNG Limited Partnership, PetroChina Kitimat LNG Partnership (CNPC), Diamond LNG Canada Partnership (Diamond), and KOGAS Canada LNG Partnership (KOGAS).

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project, including permitting.

A list of acronyms is provided in Section 1.6.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning, in conformance with the LNG Canada Facility Permit issued by the BC Energy Regulator (BCER) (formerly known as the BC Oil and Gas Commission (OGC)).

This document does not cover the feed gas pipeline that is under Coastal GasLink (CGL) control.

## 1.3. Project Flaring and Overview

### 1.3.1. Project Overview

The Project includes, but is not limited to, the following LNG processing and storage systems:

- Natural gas inlet station
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities
- Up to two full containment storage LNG tanks
- Up to two condensate storage tanks
- Flare systems, including a total of up to two flare derricks.

There are two parallel LNG loading lines, up to two vapour return lines, and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier and a material offloading facility.

The Project is being constructed in two phases, with each phase having two processing units and associated utilities, one LNG storage tank and one LNG carrier berth. The flare system has been designed to accommodate both phases.

### 1.3.2. Process Description Overview

The Project receives dry pressurized natural gas from the CGL pipeline. The feed gas stream is primarily methane with some ethane, propane, butane, and a small heavy tail with some impurities. The raw, warm gas is cleaned of its impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, and heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to Figure 1).



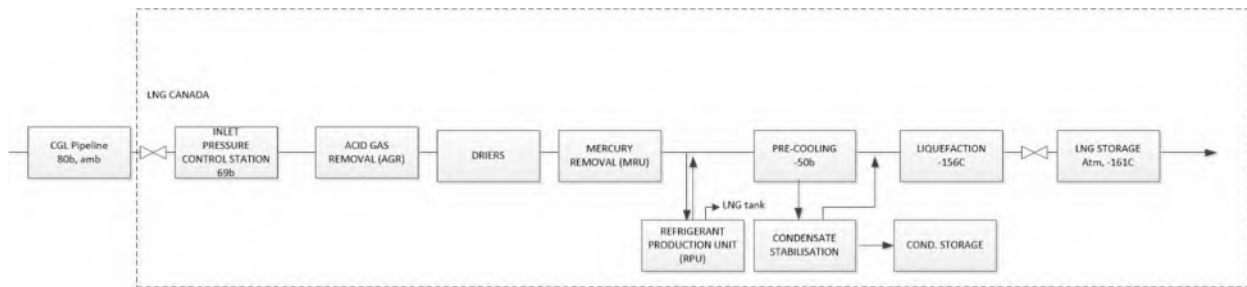


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown, as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses Pre-cool Mixed Refrigerant ("PMR") cooling from ambient temperatures to -50°C
- Deeper liquefaction cycle: uses Mixed Refrigerant ("MR") cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE).

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called "String A" and "String B" (refer to Figure 2). Each string can handle approximately half the production rate. The gas turbines are semi-aero derivative type with high torque requirement at start. This means there is no need to depressurize inventory to allow restart.

Methane, ethane and propane are the components used as refrigerants in the liquefaction process. They are available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).

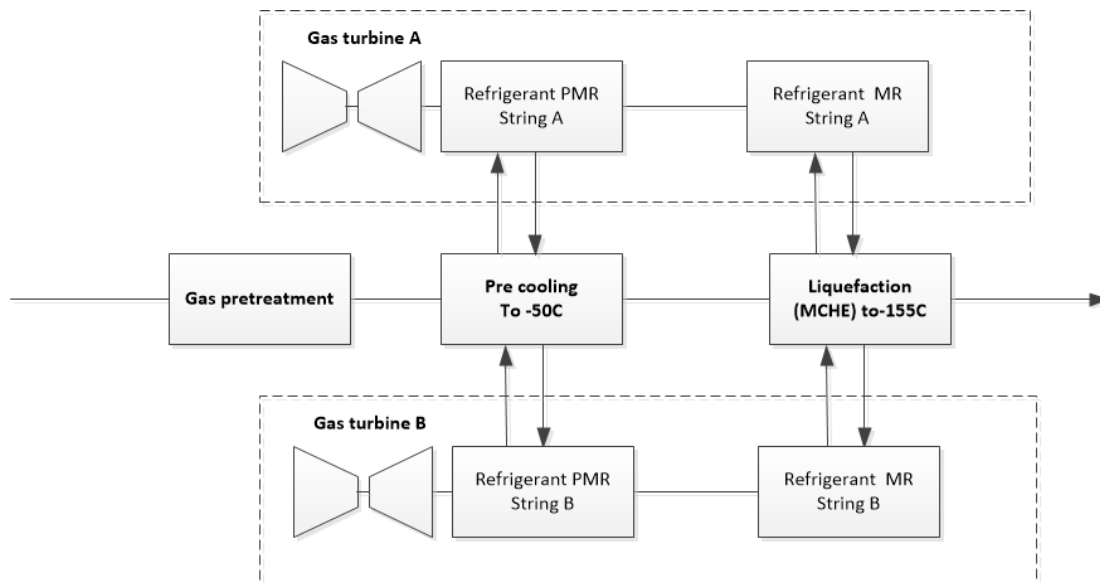


**Figure 2 Liquefaction Overview Schematic (High Level)**

### 1.3.3. Flaring Overview

During Normal Operations, natural gas and other hydrocarbons flow continuously through an LNG facility. When there is a disruption to the expected operation of the LNG facility, the constant flow of natural gas is interrupted. Large scale LNG facility designs incorporate flare systems to safely combust excess hydrocarbons when necessary. There are various events that will result in flaring at the LNG Canada facility, refer to Section 1.3.4.

At the LNG Canada facility, there are four vapour flares and nine liquid burners on two derrick structures. Table 1 contains further information on each vapour flare and the liquid burners. Figure 3 and Figure 4 illustrate the location of the flare systems, and Figure 5 illustrates the flare derrick structures that support the design height requirements of the flare release points.

The flares are equipped with a flare pilot; a continuous source of fuel gas to ignite gas sent to the flare, enabling the hydrocarbons to burn safely and efficiently under all conditions without escaping into the atmosphere. The LNG facility has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers) for operational reasons.

The flare pilot is a small, smokeless flame. When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be large, noisy, and/or create visible smoke emissions. During Commissioning and the early stages of Normal Operations, it is expected that flare volumes and visibility will be higher compared to when “steady state” Normal Operations is achieved. The flaring activity will reduce over time as the facility moves into “steady state” Normal Operations.

**Table 1 Flare Derrick Structures and System**

| Item                 |                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour Flare Derrick | Warm/Wet Process Flare (F-WW) | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"><li>• Inlet Facilities</li><li>• Acid Gas Removal Unit</li><li>• Dehydration Unit</li><li>• Mercury Removal Unit</li><li>• Liquefaction Unit</li><li>• Incinerator Unit</li><li>• Condensate Stabilisation Unit</li><li>• Heat Transfer Fluid System</li><li>• Tempered Cooling Water System Unit</li><li>• Fuel Gas System</li><li>• Defrost Gas System</li></ul> |

| Item                  |                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | Cold/Dry Process Flare (F-CD)                 | <p>For cryogenic hydrocarbon vapours that will not contain water. This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                             |
|                       | Low Pressure Storage and Loading Flare (F-LP) | <p>For low pressure LNG vapours from the LNG storage tank(s) and/or LNG carrier loading, in the event of BOG compressor failure. Compressor seal vents and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p> <p>Includes a velocity seal to minimize purge gas requirements.</p> <p>A mixture of methane and CO<sub>2</sub> or nitrogen will be released to the F-LP flare during LNG carrier de-inerting. Additional fuel gas will be added at the flare to maintain the minimum required heating value.</p> |
|                       | Spare flare                                   | <p>Used in place of one of the other flares when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare (F-WW) with a minimum design temperature to release the cold/dry vapours.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Liquid Burner Derrick | Liquid burners                                | <p>For either warm/wet or cold/dry liquids.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

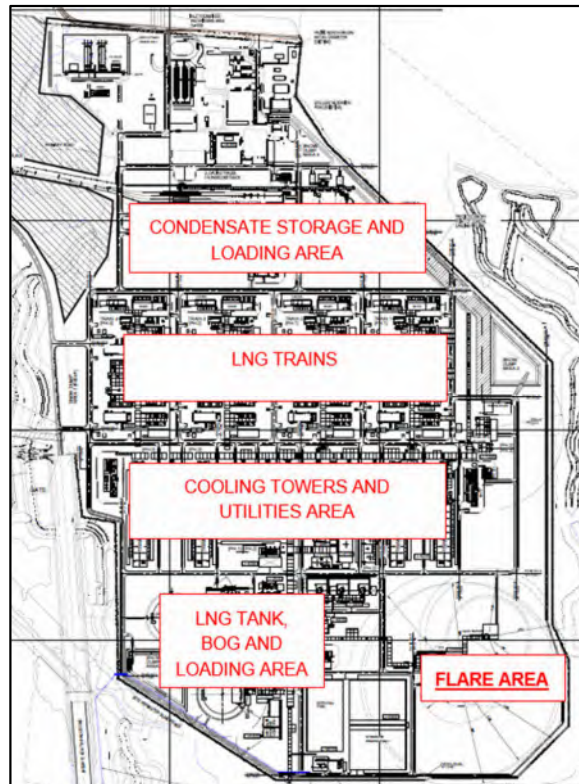


Figure 3 Flare Location Overview

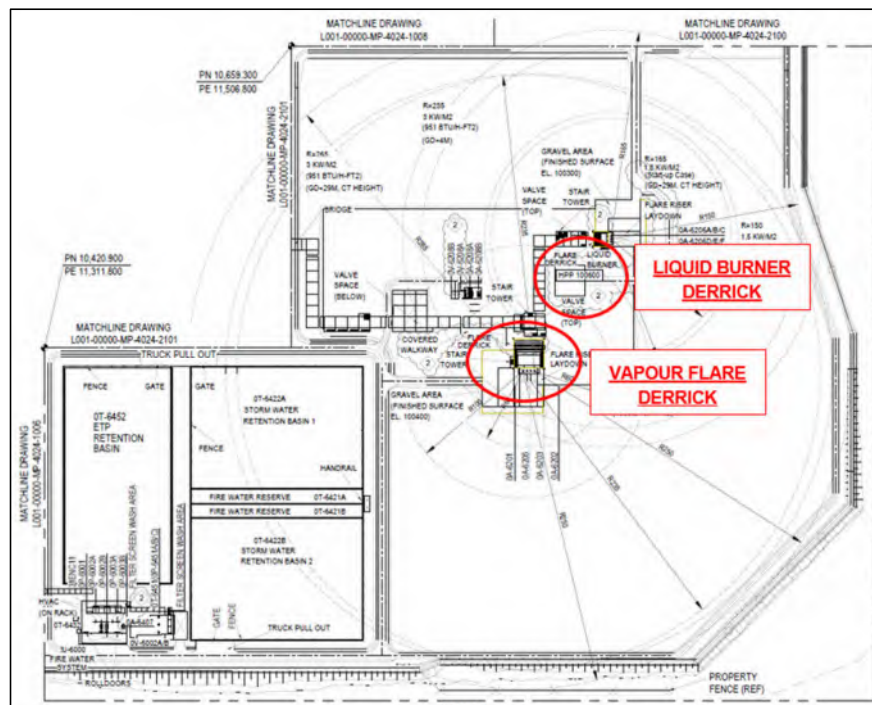


Figure 4 Flare Plot Plan (L001-00000-MP-4024-1011\_R2)

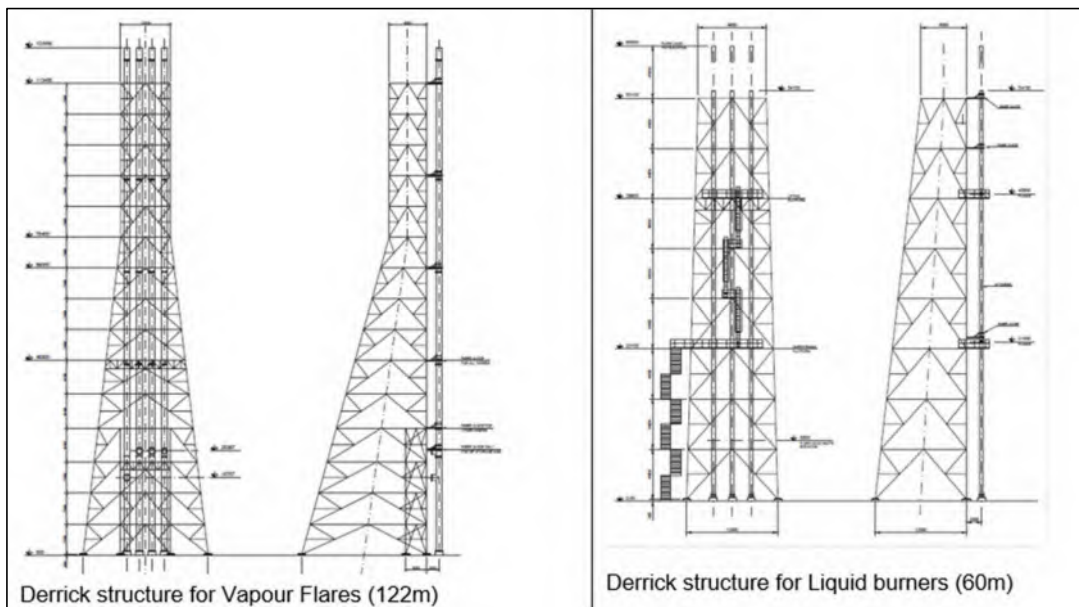


**Figure 5 Derrick Structure**

#### 1.3.4. Flaring Event Classification

LNG Canada will endeavor to accurately classify flaring events aligned with the types and examples shown in Table 2. The flaring event types are based on the LNG Facility Regulation (refer to Section 2.2.1) and the permissions in the LNG Canada Facility Permit (refer to Section 2.1.1).

**Table 2 Flaring Event Classification**

| Regulation / Authorization | Type of Flaring | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LNG Facility Regulation    | Emergency       | <p>Safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure. Examples include:</p> <ul style="list-style-type: none"> <li>• Activation of an Instrumented Protective Function (IPF) safeguard</li> <li>• Relief valve operation</li> <li>• Operator activation of Emergency de-pressuring system</li> <li>• Manual de-pressuring by operations technicians.</li> </ul> |
|                            | Maintenance     | <p>Flaring related to maintenance or turnaround activities to remove hydrocarbon from equipment where equipment requires maintenance to maintain integrity or inspect/repair defects.</p>                                                                                                                                                                                                                                                                                                              |

| Regulation / Authorization | Type of Flaring             | Examples                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Facility Permit            | Flare pilots                | Small continuous sources of process gas sent to the warm wet flare and low-pressure storage and loading flare including the primary seal gas from the compressors, and analyzer sample gas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                            | Flare system purge          | There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                            | De-inerting of LNG carriers | <p>Routine/planned de-inerting of LNG carriers.</p> <p>The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with inert gas prior to loading. These tanks need to be purged and cooled down with LNG from the facility. During the purging and cooldown process, the vapour return is sent to the low pressure flare until confirmation that required CO<sub>2</sub> specifications have been met based on laboratory sampling. Upon confirmation, the vapour is then routed to the storage tank and BOG compressors. There are no requirements to vent from the inerted LNG carrier.</p>                                                                                                                                                                                             |
|                            | Process upsets              | <p>Deviations that require the operator to take measures that prevent safety or production loss and preempt activation of safety systems (i.e., flaring occurs to prevent an emergency event from developing and prevent safety or production loss). Examples include:</p> <ul style="list-style-type: none"> <li>• Console operator takes action to de-pressure a vessel to prevent activation of IPF</li> <li>• Routing of process gas to flare due to off-spec condition to prevent damage to downstream unit (i.e., amine foaming, high dewpoint, high C5+, offspec product)</li> <li>• Flaring due to internal leaks within equipment (MCHE internal leaks)</li> <li>• Flaring to de-pressure rotating equipment to facilitate restart</li> <li>• Evacuation of remaining hydrocarbon from systems after an Emergency state once event is downgraded from Emergency (i.e., risk of injury or property loss is mitigated).</li> </ul> |
|                            | Commissioning               | Flaring in the period of time commencing when operations begin in accordance with section 11 of the LNGFR and ending when the first cargo of LNG is shipped from the LNG train.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 1.4. Environmental Considerations

### 1.4.1. LNG Canada Commitments

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment (HSSE) and Social Performance (SP) focuses on ways to avoid and minimize negative environmental and social impacts resulting from their operations and enhance the positive impacts in a systematic manner.

Further information the HSSE & SP Framework and Environmental Management System (EMS) is provided in Section 4.

### 1.4.2. Potential Environmental Effects

The act of flaring can cause potential effects to the environment due to the characteristics of the chemical, noise and thermal emissions. Potential environmental effects from flaring and associated emissions of greenhouse gases, criteria air contaminants, light, smoke (from incomplete combustion), noise and heat were considered in the Environmental Assessment Certificate (EAC) process (refer to Section 2.1.2).

A summary of these potential effects from flaring is provided herein for information.

- **Greenhouse Gas Emissions (GHG):** Emissions of primary GHGs from the flare system include CO<sub>2</sub>, methane (CH<sub>4</sub>) and nitrous oxide, from the combustion of hydrocarbons. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane.
- **Air Emissions:** Emissions of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), carbon monoxide (CO), particulate matter (PM) and volatile organic compounds (VOCs) from the combustion of hydrocarbons.
- **Visible Emissions – Light:** Some elevated light emissions are anticipated during Commissioning and the early stages of Normal Operations; however, this is a standard part of starting up an LNG facility and will reduce as the facility approaches a “steady state” of Normal Operations. Flaring events may be seen from the community depending on the resulting size of the flare size. Also refer to potential effects to wildlife below.
- **Visual Emissions – Smoke:** Incomplete combustion of the gases or liquids being flared has the potential to producing coarse and fine PM emissions that can be visible. Even if the PM emissions do not result in an air quality effect, the visibility of flaring emissions is undesirable and a potential nuisance to the community within an observation distance. Visibility of emissions is often measured in terms of opacity or the density of the emission and its ability to block light. As opacity of the emission increases, it results in a plume of visible smoke that can be described as moving from a light gray (20% opacity) to ultimately a complete black smoke (100% opacity). A Ringelmann scale (0 to 5; 0% to 100% opacity) is often used to describe a human observation of the opacity of a flare event, where the objective of the flare design is to perform at Ringelmann 0 or “R0” as often as achievable.
- **Noise:** The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential effects from noise are assessed within the Project site (occupational) and offsite (nuisance).
- **Thermal Heat:** When combustion occurs in the flare system, a large amount of heat is released. This heat can pose a safety risk to personnel and the environment.
- **Wildlife:** Increased noise, light and vibration levels can potentially cause sensory disturbance (e.g., attract and disorient birds, nest abandonment, displace wildlife from preferred foraging or breeding habitat). Nighttime lighting can disrupt the foraging patterns of nocturnal wildlife.

## 1.5. Roles and Responsibilities

There are various roles and responsibilities related to the design, construction, and operations of the flare system. JFJV, as LNG Canada's EPC contractor, is responsible for managing the design, fabrication, construction, pre-commissioning, and Commissioning of the facility, up to "ready for start-up" (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing Commissioning activities that cannot be physically done prior to RFSU and Normal Operations after RFSU and handover of each LNG train, with support from JFJV to execute post-RFSU activities in the early stages of Normal Operations. Commissioning, ramp-up, and the early stages of Normal Operations shall be executed by a joint team of staff from LNG Canada and JFJV. A basic principle of the Project is that compliance with the FMR, applicable laws and regulations is a line management responsibility.

## 1.6. Abbreviations and Definitions

Table 3 and Table 4 contain a list of abbreviations and definitions used within this document.

**Table 3     Abbreviations**

| Abbreviation    | Definition                                                                                            |
|-----------------|-------------------------------------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                                                 |
| AQO             | Ambient Air Quality Objective                                                                         |
| BC              | British Columbia                                                                                      |
| BCER            | BC Energy Regulator (formerly known as BC OGC)                                                        |
| BOG             | Boil Off Gas                                                                                          |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                                                  |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e., heavier hydrocarbons)                            |
| CAAQS           | Canadian Ambient Air Quality Standards                                                                |
| CAC             | Criteria Air Contaminants                                                                             |
| CAS             | Climate Action Secretariat                                                                            |
| CGL             | Coastal GasLink                                                                                       |
| CH <sub>4</sub> | Methane                                                                                               |
| CIE             | Commission Internationale de l'Eclairage                                                              |
| CO              | Carbon Monoxide                                                                                       |
| CO <sub>2</sub> | Carbon Dioxide                                                                                        |
| CSA Z276        | Canadian Standards Association, Liquefied Natural Gas (LNG) – Production, Storage and Handling (Code) |
| dBA             | A-weighted decibel (unit of noise measurement)                                                        |
| dBc             | C-weighted decibel (unit of noise measurement)                                                        |
| DRE             | Destruction Removal Efficiency                                                                        |
| EAC             | Environmental Assessment Certificate                                                                  |



| Abbreviation      | Definition                                                                        |
|-------------------|-----------------------------------------------------------------------------------|
| EAO               | BC Environmental Assessment Office                                                |
| ECCC              | Environment and Climate Change Canada                                             |
| EMLI              | BC Ministry of Energy, Mines, and Low Carbon Innovation                           |
| EMS               | Environmental Management System                                                   |
| ENV               | BC Ministry of Environment and Climate Change Strategy                            |
| EPA               | United States Environmental Protection Agency                                     |
| EPC               | Engineering, Procurement, and Construction                                        |
| F-CD              | Cold Dry Vapour Flare                                                             |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                     |
| F-WW              | Warm Wet Vapour Flare                                                             |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development |
| FVRG              | Flaring and Venting Reduction Guideline                                           |
| GHG               | Greenhouse Gas                                                                    |
| GWP               | Global Warming Potential                                                          |
| hr                | Hour (unit of time)                                                               |
| HSSE              | Health, Safety, Security and Environment                                          |
| IAAC              | Impact Assessment Agency of Canada                                                |
| IPF               | Instrumented Protective Function                                                  |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                    |
| KAG               | Kitimat Airshed Group                                                             |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                         |
| LNG               | Liquefied Natural Gas                                                             |
| LNG Canada        | LNG Canada Development Inc.                                                       |
| LNGFR             | LNG Facility Regulation                                                           |
| m                 | Meter (unit of length)                                                            |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                      |
| MCHE              | Main Cryogenic Heat Exchanger                                                     |
| MJ                | Mega joules (unit of energy)                                                      |
| MOH               | BC Ministry of Health                                                             |
| MR                | Mixed Refrigerant                                                                 |
| NOx               | Nitrogen Oxides                                                                   |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| OGC               | BC Oil & Gas Commission                                                                  |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of "0"                                                          |
| RAM               | Risk Assessment Matrix                                                                   |
| RFSU              | Ready for Start-Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| SP                | Social Performance                                                                       |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |

**Table 4 Definitions**

| Term               | Definition                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assist Gas         | The assist gas enhances smokeless flaring through the assist gas ring at the outside of the flare tip.                                                                                                                                                                                                                                                                                                                         |
| Black Smoke        | When Visible Smoke Emissions, defined by United States Environmental Protection Agency (EPA) Method 22, have met or exceeded a threshold (i.e., smoke index) <sup>1</sup> .                                                                                                                                                                                                                                                    |
| Commissioning      | Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.<br><br>In the Facility Permit, it is defined as the " <i>period of time commencing when operations begin in accordance with section 11 of the OGC [BCER] Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i> ". |
| De-Inventorization | Disposal of hydrocarbon inventory within a process unit or equipment.                                                                                                                                                                                                                                                                                                                                                          |

| Term                                 | Definition                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dilution Gas                         | Typically, fuel gas is used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as fuel gas instead of flared gas.                                                                                                      |
| Destruction Removal Efficiency (DRE) | A percentage that represents the number of molecules of a compound removed or destroyed relative to the number of molecules that entered the system.                                                                                                                                                                                                    |
| Emergency                            | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire, or catastrophic equipment failure (per the Facility Permit).                          |
| First Cargo                          | First LNG carrier shipment of 174,000 m <sup>3</sup> LNG volume (estimated average LNG cargo / LNG carrier capacity) from each LNG train.                                                                                                                                                                                                               |
| Fuel Gas                             | A process stream that is used in providing energy for facility operations.<br><br>For this LNG facility, this is gas burned in the gas turbine and incinerator as fuel gas or added to the flare to improve heating value of the flared gas.                                                                                                            |
| Flared Gas                           | A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).<br><br>For LNG Canada facility, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided. |
| Flaring                              | Disposal by combustion of natural gas or gas derived from petroleum.<br><br>Typically, through an elevated stack and burner tip (not used to provide energy for facility operations).                                                                                                                                                                   |
| Continuous Flaring                   | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                                                                             |
| Fugitive emissions                   | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment or tanks have not been properly closed or tightened.                                                     |

| Term                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                              | Definition                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Greenhouse Gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                              | Gases in the atmosphere that absorb and emit thermal radiation. In the context of GHG and Energy Management for an LNG facility, these are CO <sub>2</sub> , CH <sub>4</sub> , nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.   |
| Natural gas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                              | Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non-hydrocarbon impurities such as nitrogen, carbon dioxide, and hydrogen sulfide.<br><br>Feed gas as supplied by the CGL pipeline. |
| Normal Operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                              | Excludes Emergency conditions and Commissioning (per the Facility Permit), sometimes also referred to commonly as “routine operations”                                                                                                                          |
| Process upset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                              | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                 |
| Venting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                              | The intentional controlled release of uncombusted gases directly to the atmosphere.                                                                                                                                                                             |
| Visible Smoke Emissions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | A pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission (per EPA Method 22). |                                                                                                                                                                                                                                                                 |
| Notes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                 |
| 1. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. Subject to BCER inspection and audit, for assessment of Facility Permit Condition 38 compliance and reporting.                                                                                                        |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                 |
| Sources:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"><li>LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023 (BCER 2023a)</li><li>Oil and Gas Glossary and Definitions, Version 1.13, December 2021 (BC OGC 2021c)</li><li>LNG Canada Project Facility Permit AD# 100083612 (as amended)</li><li>United States Environmental Protection Agency (EPA), Method 22 Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019 (EPA 2019)</li></ul> |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                 |

## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to the design, construction and operation of the LNG facility to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In BC, LNG facilities are regulated by the Liquefied Natural Gas Facility Regulation (LNGFR) (B.C. Reg 146/2014), under the *Energy Resource Activities Act (ERAA)* (formerly the *Oil and Gas Activities Act*). The BCER has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operation of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate”, which authorizes commissioning and operations (LNGFR, Section 4).

The BCER issued a Facility Permit (Legacy File No. 9709124; Application Determination #100083612) to LNG Canada on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BCER issued amendments to the Facility Permit on January 7, 2021, January 31, 2022, and October 20, 2023, which included re-numbered conditions (references to condition numbers herein are based on the amended Facility Permit). A summary of the permit conditions applicable to the flare system are provided in Table 5. This Flaring Management Report was developed to satisfy Facility Permit conditions 39 and 40. The other related conditions shown in Table 5 are provided for information. Refer to the Facility Permit for the full list of conditions, including those related to noise management.

A “Leave to Construct” for the LNG facility construction activities associated with LNG trains 1 and 2, including the flare systems, was issued by the BCER on July 30, 2020. There were no specific conditions in this Leave to Construct, as it was based on the Facility Permit and LNGFR. A “Leave to Operate” will be required from the BCER prior to Commissioning the flare systems.

**Table 5 Facility Permit Conditions**

| Permission / Condition |               | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31                     | Flare systems | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |

| Permission / Condition |                                 | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34                     | LNG carrier                     | The Permit Holder must notify the Commission via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , at least 24 hours before de-inerting a LNG carrier at the LNG facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 35                     | Flaring Notification Plan       | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius of 1.0 km for residents.</li> </ul> |
| 36                     | Flaring Notification Plan       | The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m <sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.                                                                                                                                                                                                                                                                                                                    |
| 37                     | Emissions                       | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 38                     | Black smoke                     | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |
| 39                     | Flaring Management Report (FMR) | The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> , to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.                                                                                                                                                                                                                                                                                                                                          |
| 40                     | FMR submission timing           | The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Permission / Condition |                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 41                     | FMR implementation | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 47                     | Noise              | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA and dBC comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> <li>d) Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</li> </ul> |
| 50                     | Noise              | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the "British Columbia Noise Control Best Practices Guideline." Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bc-er.ca">postpermitrequests@bc-er.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 52                     | Light              | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l'Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

### 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities, and operations. The BCER has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for criteria air contaminants (CACs) emitted by the LNG Canada facility.

The WDA application for air emissions, which includes those from the flare systems, was submitted to BCER on June 29, 2023, and is currently under review at the date of issuance of this report. Engagement with the BCER commenced on November 13, 2020, when the WDA preliminary application was submitted.

### 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued an EAC (#E15-01) for the Project to LNG Canada on June 17, 2015, with subsequent amendments issued in 2016, 2019, and 2021. Certificate conditions applicable to the flare system are provided in Table 6 for information. Refer to Schedule B of EAC #E15-01 for the full list of conditions.

**Table 6 Environmental Assessment Certificate #E15-01 Conditions**

| Condition  |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A | Certified Project Description      | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Schedule B | Table of Conditions – Condition 1  | <p><b>Air Quality</b></p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC (<i>now BCER</i>), and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC (<i>now BCER</i>).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details.</i></p> |
| Schedule B | Table of Conditions – Condition 2  | <p><b>Acoustics</b></p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009).</p> <p><i>Note, there is further detail in the condition that is not provided herein. Refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Schedule B | Table of Conditions – Condition 3  | <p><b>Greenhouse Gas Emissions</b></p> <p>The Holder must develop a GHG emissions management plan in consultation with the BC Ministry of Energy, Mines, and Low Carbon Innovation (EMLI) and the Climate Action Secretariat (CAS) that sets out the means by which the GHG management mitigation measures related to Operations in the [EAC application] Mitigation Table under the heading “GHG management” (section 5.3) will be implemented.</p>                                                                                                                                                                                                                                                                                                                                                                                   |
| Schedule B | Table of Conditions – Condition 12 | <p><b>Wildlife</b></p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>now BC Ministry of Water, Land and Resource Stewardship</i>) and OGC (<i>BCER</i>). The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p>                                                                                                                                                                          |



| Condition   |                          | Requirement                                                                                                                                                    |
|-------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Application | Mitigation Measure 5.3-9 | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start-up. |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued a Decision Statement for the Project to LNG Canada on June 17, 2015, with a subsequent amendment issued in April 2021. The Decision Statement conditions applicable to the flare system are associated with migratory birds.

Condition 5.2 states that *“The Proponent shall:*

- 5.2.1 *restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;*
- 5.2.2 *minimize flaring during night-time and during periods of bird vulnerability;*
- 5.2.3 *adjust operational lighting to avoid attracting migratory birds.”*

This information is provided for context only.

## 2.2. Acts, Regulations, and Guidelines

As outlined in Section 2.1, there are several acts, regulations and guidelines that inform the design, construction, and operation of the flare system. A summary of applicable acts, regulations and guidelines is provided herein. Refer to the acts, regulations and guidelines for full details.

### 2.2.1. Energy Resource Activities Act, Liquefied Natural Gas Facility Regulation

As outlined in Section 2.1.1, the LNGFR is a key regulation for LNG facilities in BC. Sections of the LNGFR that are applicable to the flare system are summarised in Table 7.

The BCER developed the “Liquified Natural Gas Facility Permit Application and Operations Manual” (BCER 2023a) to provide a reference document for applicants that wish to construct and operate an LNG facility in BC, as regulated by the LNGFR. The manual provides further guidance on the operational standards and practices related to flaring, notification and reporting, noise and light control.

**Table 7 LNG Facility Regulation Sections**

| Section |                                            | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4       | Engineering Design and LNG Facility Siting | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> |

| Section |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                                    | <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p>                                                                                                                                                                                                                                                                                                                               |
| 15      | Noise and Light Control            | An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 17      | Venting                            | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p> |
| 18      | Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ul style="list-style-type: none"> <li>a) flaring is required for maintenance purposes, or</li> <li>b) permission to flare is included in the LNG facility permit.</li> </ul> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                                                                                                                              |
| 19      | Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p>                                                                                                                   |

## 2.2.2. BCER Flaring and Venting Reduction Guideline

The “Flaring and Venting Reduction Guidelines” (FVRG, BC OGC 2022) will inform, where applicable, all stages of the Project to eliminate routine flaring and reduce non-routine events. Key chapters include:

- Chapter 3: Natural Gas Facility Flaring and Venting, includes a decision tree that will be used where appropriate, when considering alternatives to flaring and venting.
- Chapter 5: Notification Requirements
- Chapter 6: Performance Requirements, includes requirements for black smoke, noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance, and dispersion modelling.
- Chapter 7: Venting and Fugitive Emissions Management Requirements
- Chapter 10: Measurement and Reporting
  - All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting, and record retention.
  - Permit holders are also required to maintain a log of flaring and venting events, and respond to public complaints. Logs must be signed and kept for a minimum of 12 months, and be available to BCER upon request (refer to Table 7 for the flaring log requirements under the LNGFR).

## 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline (BC OGC 2021b) outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BCER.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to be met by the LNG facility noise emissions, including those from the flare system.

## 2.2.4. BCER Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline (BC OGC 2021a) outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BCER.

A facility flare is an example of a “sky glow” source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light with reference to CIE 2003 (also refer Facility Permit condition 52, Table 5).

## 2.2.5. Ambient Air Quality Objectives

In BC, ambient air quality criteria that have been developed provincially and nationally for air contaminants over various averaging periods are used to inform decisions in the management of air contaminants. These include provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e., not legally binding), unless referenced directly in a regulation or authorization and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts

- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories.

Limits on air emissions from operations at the LNG Canada facility will be prescribed in the WDA (refer to Section 2.1.2) and are not further addressed in this report.

### 3. Mitigation Measures

There is a range of measures applicable to design, construction and operations of the LNG facility that minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during Commissioning.

As illustrated in Figure 6, mitigation measures were identified during the design phase of the LNG facility to minimize flaring, and then quality procedures were implemented during the procurement, fabrication, and construction of the flare system. Operational procedures will be followed during operations to ensure that the system is being operated as per the design intent; with regular maintenance and turnaround activities to ensure the long-term integrity of the system.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process (refer to Section 4).

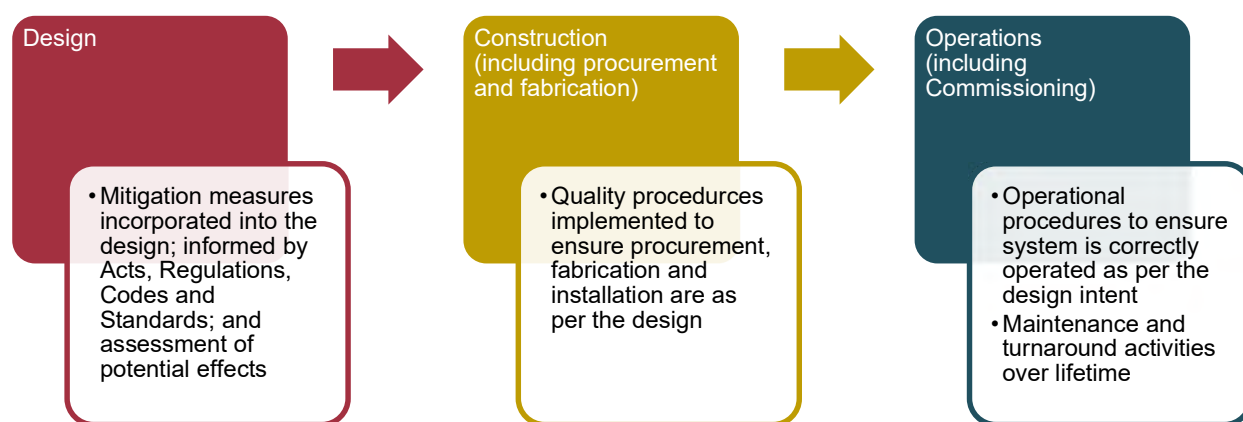


**Figure 6** Timeline for Addressing Mitigation Measures to Minimize Flaring

#### 3.1. Design

Key design measures that will minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 1. The design includes mitigations to reduce flare load during unplanned upsets.

The selection of flare technology used to meet the design basis was a key component. The Project contracted Zeeco to design and fabricate the vapour and liquid flare systems. Some parameters of the front-end engineering design (FEED) basis were adjusted during detailed design with the vendor.

Further information on design measures identified to address potential environmental effects is outlined herein.

##### 3.1.1. Air Emissions, GHG Emissions, Visible Emissions

A key design measure related to air quality and GHG emissions is the Destruction Removal Efficiency (DRE), which relates to the effectiveness of the combustion process. Typically, flare technology has a DRE of approximately 98%; however, for this Project, the chosen flare technology has a DRE of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that byproducts of incomplete combustion, such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and VOCs are released at extremely low quantities. The trade-off for this improved DRE is that GHG emissions will be slightly increased when assist gas is used in the flare; however, these emissions are relatively minor. The Project is developing a GHG Emissions Management Plan, in conformance

with EAC #E15-01, which will outline how the mitigation measures in the EAC application for managing the GHG emissions will be implemented.

As part of the EAC application (refer to Section 2.1.3) and WDA application (refer to Section 2.1.2), air dispersion modeling was undertaken, which includes emissions from the flare system. The modelling included routine/normal operations, as well as various non-routine scenarios for four CACs, which included two upset flaring cases (high sulphur case and high NO<sub>x</sub> and PM<sub>2.5</sub> case). Refer to the WDA application for further information.

### 3.1.2. Thermal Radiation

To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing, which could pose a fire hazard. A flare thermal radiation design basis was implemented in the design (refer to Table 8).

The issue of exposure of personnel to flare thermal radiation during work on or near the liquid burner derrick structure was assessed. This is not a significant concern as personnel can be evacuated from the liquid burner structure prior to a flaring event. The assessment also reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75-metre covered walkway were needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn.

In addition, operational controls will be in place; any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure if a flaring event occurs while personnel are in the area and would be covered through LNG Canada's Permit to Work practice.

**Table 8 Flare Thermal Radiation Design Basis**

| Heat Radiation limit (kW/m <sup>2</sup> ) | Location                                                                               | Basis                                                                                                                                                                                                                                                           |
|-------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | Outside the facility fence line for normal operation, including start-up and shut down | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR maximum requirement for outside the boundary with normal flow rates is 3 kW/m <sup>2</sup> in remote areas.                                                                           |
| 3.0                                       | Outside the facility fence line for emergency conditions                               | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR maximum requirement for outside the boundary with accidental flow rates is 5 kW/m <sup>2</sup> in remote areas.                                                                       |
| 5.0                                       | At the boundary of sterile area for emergency conditions                               | LNGFR prescribed limit for outer edges of sterile area is 5 kW/m <sup>2</sup> for accidental flow rate.<br><br>This is significantly below the 25-30 kW/m <sup>2</sup> general guideline for spontaneous ignition of wood (which could result in forest fires). |

### 3.1.3. Noise

The flare design includes requirements to meet the following noise limits from the Project's design criteria:

- Emergency Cases: 115 dBA at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops.
- Normal operation including start-up/shutdown: 85dBA at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system and associated mitigation measures to be implemented in the design. This report was submitted to the BCER in accordance with the Facility Permit (refer to Table 5).

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA, with one multi-jet liquid burner to observe smokeless capability and noise measurement. Both results were satisfactory and correlated noise for nine burners was estimated at 85dB at 250 metres.

The flare system complies with Project's design criteria based on the noise data sheets issued by the vendor. However, due to the unpredictable nature of emergency events, additional operational controls will be in place. Whenever personnel are accessing the sterile area of the flare, double hearing protection will be required under the Permit to Work system and safety signage will be in place.

### **3.2. Construction**

Key measures undertaken in construction that will allow the facility to minimize the flaring of gas and liquids and associated emissions are provided in Appendix A, Attachment 2. In this phase, it is critical to implement quality programs to verify that the mitigation measures identified in the design, have been procured, fabricated, and adequately installed and tested prior to operations.

### **3.3. Operations**

There are a range of measures that are implemented during Commissioning and Operations that will allow the facility to minimize the flaring of gas and liquids and associated emissions (refer to Appendix A, Attachment 3). During operations, it is critical that the systems are operated as per the design intent; with supporting maintenance programs implemented. LNG Canada plans to operate within the design window for equipment, however in cases where flaring still occurs, further operational mitigations will be assessed to reduce emissions.

The amount of flaring during Commissioning is anticipated to be higher than "steady state", as bringing the process to specification can require additional testing, and additional time stopping or reversing the start-up process due to undetected flaws from construction and fabrication. During these early stages of Normal Operations (typically up to two years), there will be increased trips and a higher likelihood of unplanned outages to correct any operational issues. This period is characterized by a higher unreliability rate of equipment and more intensive facility organizational learning to resolve challenges. These events lead to flaring during the restart of the facility and any purging of equipment for maintenance.

There is also higher potential for smoke generation during Commissioning, extending into the early stages of Normal Operations. Flows and compositions outside the design window of the flare, leftover material from construction, or dust and rust may enter the flare network and inadvertently impact flare performance by altering combustion properties of the hydrocarbons.

Further information on measures to address the potential environmental effects during operations is outlined herein.

#### **3.3.1. Air Emissions and GHG Emissions**

LNG Canada will be required to meet the conditions of the WDA, which will include air emissions discharge limits, monitoring and reporting requirements (refer to Section 2.1.2), as well as implement the Air Quality Management and Monitoring Plan, developed in accordance with EAC Condition 1 (refer to Table 6).

LNG Canada will undertake GHG monitoring and reporting, in accordance with regulatory requirements, and implement the mitigation measures in accordance with the EAC Condition 3 (refer to Table 6).

LNG Canada also participates in the Kitimat Airshed Group (KAG), a multi-disciplinary group that is focused on air quality monitoring and public outreach, that BCER also participates in.

### 3.3.2. Visible Emissions

As per the BCER FVRG, the inspection to determine if black smoke is present or not, is to be performed using United States EPA [Method 22 - Visual Determination of Fugitive Emissions](#) (EPA 2019).

LNG Canada is investigating the implementation of technology to complement or replace visual observation from EPA Method 22. Advanced monitoring systems with optical sensors and cameras can accurately measure and record smoke characteristics (i.e., smoke index, destruction efficiency) in real-time, enabling operators to take more immediate action to mitigate potential risks. A threshold would be set to indicate the presence of smoke by establishing a specific quantitative measure (i.e., smoke index) for the facility. Once the measure surpasses the pre-determined smoke threshold, the monitoring system would trigger an alert or notification. A threshold would also be set to indicate when the smoke is reportable under Facility Permit Condition 38 for assessment of compliance. LNG Canada acknowledges that BCER will maintain authority to conduct assessment using EPA Method 22 or other methods they determine most appropriate.

### 3.3.3. Light and Wildlife

Where possible, considering a number of factors, including safety, production requirements, and feasibility, flaring activities will be scheduled to occur during the daytime. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible. LNG Canada will also consider the following as appropriate:

- Seasonal migrations
- Cloud ceiling height
- Weather conditions.

The Flaring Notification Plan (L001-06200-AA-6048-4440) outlines the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts.

LNG Canada will also implement the Wildlife Management Plan, developed in accordance with the EAC Condition 12 (refer to Table 6).

### 3.3.4. Noise

The Project has a separate Noise Management Program, as required by the Facility Permit (refer to Table 5) that includes the noise mitigations, measurement and monitoring, and process for addressing complaints and noise concerns).

As noted in Section 3.1.3, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the Permit to Work system and safety signage will be in place.



## 4. Continuous Improvement, Review and Auditing

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part of their continual improvement process. Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
- Follow-up on flare key performance indicators
- Review of flaring incidents and progress of corrective actions
- Management of Change process for hardware change impacting flaring
- Review of operations/maintenance practices and procedures.

### 4.1. HSSE Management System

LNG Canada's HSSE Management System includes an HSSE & SP Control Framework with several elements related to flaring:

- **Flaring and Venting Manual** – Requires development of a Flaring and Venting Management Plan for facilities that are flaring and/or venting >1% by mass and combined flaring and venting exceeds 10,000 tonnes per annum of CO<sub>2e</sub>. It also requires that flaring risks are reviewed with a Subject Matter Expert if exceeding greater than 1% by mass.
- **Risk Assessment Matrix (RAM) Manual** – Environmental and community impacts are considered as part of the risk ranking process. This approach would be used to evaluate flaring events during an incident investigation. Escalation of events would occur due to factors such as the presence of black smoke over an extended period, complaints from the community, and/or AQO exceedances

LNG Canada will maintain an EMS in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy, and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Regular internal audits of the EMS will be conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

### 4.2. Tracking of Flare Losses

The flare losses are included as part of the facility mass balance reconciliation, which is monitored weekly with flare losses reported monthly to Petrinex as part of Volumetric reporting.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after Commissioning and early stages of Normal Operations. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

In addition to the monthly Petrinex submission, an annual Monitoring Report will be prepared by LNG Canada's Environmental Team and submitted to the BCER. The flow meters on the flare header will be utilized in determining the daily and monthly volumes. Flare header meters are designed and installed to meet the requirement outlined in the BC Measurement Guideline.

## 5. Report Review and Updates

This FMR is intended to be reviewed and updated:

- After Commissioning LNG trains 1 and 2 to incorporate lessons learned for Commissioning of Phase 2 (LNG trains 3 and 4)
- Annually to incorporate any identified changes from
  - Process/Procedural changes impacting Report
  - Facility changes impacting Report
  - Continuous improvement cycles.
- Between review cycles if there are changes identified through ongoing engagements with Indigenous groups, BCER, or other stakeholders.

Should any required revisions be identified, the following update process will be initiated:

- Administrative/minor changes only: FMR will be updated and re-issued to the BCER for awareness, with a summary of the changes provided. The updated FMR will be effective for implementation.
- Significant change (i.e., change to the fundamentals of the management approach): BCER will be consulted on the proposed change(s). After the consultation activities are completed, the FMR will be updated and re-issued to the BCER with a summary of the changes provided. The updated FMR will then be effective for implementation.

## 6. References

- BC Energy Regulator (BCER). 2023a. LNG Facility Permit Application and Operations Manual, Version 1.8, October 2023.
- BCER. 2023b. BC Measurement Guideline, Version 2.4, October 2023.
- BC Oil and Gas Commission (BC OGC). 2022. Flaring and Venting Reduction Guideline, Version 5.3, September 2022.
- BC OGC. 2021a. BC Light Control Best Practice Guideline, Version 1.0, March 2021.
- BC OGC. 2021b. BC Noise Control Best Practice Guideline, Version 2.2, July 2021.
- BC OGC. 2021c. Oil and Gas Glossary and Definitions, Version 1.13, December 2021.
- Commission Internationale de l'Eclairage (CIE). 2003. Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 150:2003.
- United States Environmental Protection Agency (EPA). 2019. Method 22 - Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, January 14, 2019.

## Appendix A

## List of Attachments

| Number | Title                                                                                 |
|--------|---------------------------------------------------------------------------------------|
| 1      | Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions       |
| 2      | Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions |
| 3      | Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions  |

## **Attachment 1**

## **Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**

## Design Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect           | Reduction/<br>Mitigation Measure                  | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Pilot System                | Consistent Ignition Source                        | The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system. If the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ✓                                                          |                             |
| Pilot System                | Redundant Pilots                                  | The vapour flares have redundant pilots. In the unlikely case that all four pilots are lost, they will continue to operate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Flare System                | Sonic Flare Management                            | Selection of a sonic flares as well as associated flare rate and flame height, promotes mixing which is expected to help manage flare performance, minimize smoke potential and improve the destruction removal efficiency (DRE).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Vapour Flare Systems        | Nitrogen Purge                                    | All flare headers are continuously purged with nitrogen instead of fuel gas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Vapour Flare Systems        | Assist Gas for DRE                                | Assist Gas is available for DRE on the Warm Wet Flare ("F-WW"), Cold Dry ("F-CD") Flare, and Spare Flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          | ✓                           |
| Liquid Burners              | Assist Gas                                        | The liquid burners are equipped with assist gas to promote air entrainment into the flame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquid Burners              | Cooldown                                          | Automated advanced cooldown to reduce flaring time at the cold liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                                          |                             |
| Flare Knock Out Drums       | Liquid Management                                 | Installation of flare knock out (KO) drums; which are protected from liquid overflow through a combination of design liquid retention volume, as well as the use of two independent radar level measurements. These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners. The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system, the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck. |                                                            | ✓                           |
| Control Valves              | Continuous Passing Valves / Leaking Specification | All control valves connected to the flare system conform to a minimum America National Standards Institute (ANSI) Class IV leakage specification. Emergency depressuring valves and other control valves that have been specified as "tight shut-off" (TSO), meet ANSI Class V leakage specification, as per Project standards. This ensures that the amount of hydrocarbon lost to the flare is minimized.                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Manual Valves               | Blinding                                          | Manual valves connected to the flare system, which are used for maintenance purposes, are blinded to ensure that the leakage is eliminated. These locations must be de-blinded to purge equipment to flare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ✓                                                          |                             |
| Liquefaction Train          | Quench Line                                       | Each compressor string is equipped with a quench line for start-up to allow quick equalization with cold running string to reduce flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Compressors                           | The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ✓                                                          |                             |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) Refrigerant qualities can be adjusted by recycling their vapours to the condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Vapour Recycling                      | MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ✓                                                          | ✓                           |
| Liquefaction Train          | Refrigerant Recycling                             | Pre-cooling PMR cycle can circulate MR, on full recycle via an MR "start-up recycle line", to provide pre-cooling load, to facilitate pre-cooling system start-up and decouple with MCHE final cool down.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |
| Refrigerant Production Unit | Vapour Routed to LNG Tank                         | Vapour from the spheres is normally routed to the LNG tank and is mixed with boil off gas (BOG) to prevent flaring of propane or ethane.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Refrigerant - Insulation / Temperature Controlled | The ethane refrigerant sphere is insulated and chilled to -11°C to minimize vapour losses from the sphere.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Refrigerant Production Unit | Refrigerant - Pressure Controlled                 | Refrigerant spheres are pressure controlled to the LNG tank vapour space.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                                          |                             |

| Location / Aspect           | Reduction/<br>Mitigation Measure     | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|-----------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Refrigerant Production Unit | Operating Pressure of Propane Sphere | Propane sphere design and normal operating pressures are above vapour pressure; therefore excess propane vapor generation is not expected during holding mode eliminating the need to continuously send propane vapours to flare.                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Start-up Lines                       | Installation of start-up lines to reduce flaring during Refrigerant Production Unit (RPU) start-up:<br>- De-ethanizer column ethane vapour import from refrigerant storage<br>- De-ethanizer reflux ethane liquid import from refrigerant storage<br>- De-propanizer column propane vapour import from refrigerant storage<br>- De-propanizer reflux propane liquid import from refrigerant storage                                                                                                                                                                                                                               | ✓                                                          | ✓                           |
| Refrigerant Production Unit | Recycling Lines                      | Installation of recycling lines to reduce flaring during RPU operation:<br>- Gas overheads from de-ethanizer and de-propanizer are recycled to the LNG tank<br>- De-propanizer bottoms liquids are always recycled to natural gas stream<br>- Gas overheads from de-methanizer are recycled to natural gas stream                                                                                                                                                                                                                                                                                                                 | ✓                                                          | ✓                           |
| BOG Compressors             | Capturing Excess BOG                 | Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                                          |                             |
| Condensate Tank             | Temperature Controlled               | The condensate tank vapours are chilled to -10°C to reduce hydrocarbon directed to the incinerator, which minimizes venting (and associated emissions).                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ✓                                                          |                             |
| Metering                    | Metering                             | Installation of full metering capability on the flare headers (including density measurement) to help identify abnormal flaring earlier. Flaring is metered via Ultrasonic (US) flowmeters on each common flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have a measurement turndown of 1:1000 and an accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy. | ✓                                                          |                             |
| Waste                       | Disposal of warm wet waste streams   | Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ✓                                                          | ✓                           |

## **Attachment 2**

## **Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**



## Construction Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Location / Aspect         | Reduction/<br>Mitigation Measure  | Details                                                                                                                                                                                                                                                                                                                                                                                                                          | Outcome:<br>Reduce<br>Flaring &<br>Associated<br>Emissions | Outcome:<br>Reduce<br>Smoke |
|---------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------|
| Liquid Burners            | Testing on LNG                    | During design the liquid burners were tested with LNG to confirm burner performance.                                                                                                                                                                                                                                                                                                                                             |                                                            | ✓                           |
| Pilot System              | Testing                           | Ensures the flare system is fully tested before introduction of natural gas to prevent uncombusted gas from being vented (using liquid petroleum gas (LPG) bottles).                                                                                                                                                                                                                                                             | ✓                                                          |                             |
| Overall - Quality Program | Contractor Prequalifications      | Implement the contractor prequalification process; for the screening, prequalification and evaluation of contractors.                                                                                                                                                                                                                                                                                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Quality Management Plans          | Development and implementation Project quality management plans address how the quality objectives will be managed for the duration of construction (including design, procurement, fabrication, and commissioning), plus the flow down to the contractors' and subcontractors' quality plans.                                                                                                                                   | ✓                                                          | ✓                           |
| Overall - Quality Program | Flawless Project Delivery Program | Development and implementation of a Flawless Project Delivery (FPD) program (L001-00000-OA-5876-1001). The FPD program identifies flaws (including lessons learnt from all stakeholders that have occurred on previous projects) and identifies and implements mitigations to reduce and/or eliminate the potential risk [Applicable from design through commissioning and start up].                                            | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Plans         | Development and implementation of inspection and test plans (ITPs), which contain the key inspection activities and identification of the interface points for reviewing, witnessing and holding by the subcontractor, sub-subcontractor (where applicable), JFJV and LNG Canada.                                                                                                                                                | ✓                                                          | ✓                           |
| Overall - Quality Program | Inspection and Test Records       | Inspections and tests will be formally reported through inspection and test records (ITRs). Records generated by self-perform and subcontractors (including module fabricators) will be progressively filed into appropriately labelled records files in readiness for handing over to LNG Canada.                                                                                                                               | ✓                                                          | ✓                           |
| Overall - Quality Program | Surveillance                      | Surveillance is performed by JFJV; where observations are raised with either recommendations or corrective and/or preventative actions.                                                                                                                                                                                                                                                                                          | ✓                                                          | ✓                           |
| Overall - Quality Program | Change Management                 | Development and implementation of the comprehensive change management program ensures that the correct level of professional engineering engagement and oversight will be maintained during all stages of the project and that all deviations, changes and revisions will be identified, documented and actioned at the appropriate level of review.                                                                             | ✓                                                          | ✓                           |
| Overall - Quality Program | Technical Integrity Verification  | Development and implementation of the Technical Integrity Verification (TIV) Plan, that is the clear demonstration that all safety critical elements meet the agreed performance standards for design, procurement and testing; with handover of detailed deliverables with sufficient granularity to allow the future asset to maintain safety critical equipment and perform safety critical tasks to their required standard. | ✓                                                          | ✓                           |

## **Attachment 3**

## **Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions**

### Operational Measures to Minimize Flaring of Gas and Liquids and Associated Emissions

| Applicable Phase         | Location / Aspect                              | Reduction/ Mitigation Measure                                                                       | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|--------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Commissioning / Start Up | LNG Train 1 Start-Up                           | Quality Programs                                                                                    | During the Commissioning of LNG Train 1, it is expected that material left over from construction and pre-commissioning may become trapped in temporary strainers and will need to be removed during start-up or shortly after production is achieved. Measures to minimize left over material is addressed in the construction quality program noted herein.                                                                                                                                                                                                                                                                                   | ✓                                              | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit                    | Import refrigerants (ethane and propane) to storage and cooldown of associated piping and equipment | Refrigerant grade liquid ethane and propane will be imported into the facility for commissioning; to avoid the need to initially produce the refrigerant prior to LNG production, eliminating weeks of flaring from the facility.                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              | ✓                     |
| Commissioning / Start Up | LNG Storage                                    | Import LNG to storage and cooldown of associated piping and equipment                               | LNG will be imported to cooldown of the LNG circuits and LNG storage tank, which reduces the expected flaring by due to the avoidance of using LNG from Train 1 to cooldown the piping and LNG storage tank.                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              | ✓                     |
| Commissioning / Start Up | Acid Gas Removal (AGR) Unit Start-up           | Absorber Turndown                                                                                   | Turndown the feed rates (below the design minimum) will be evaluated during the actual start-up. It will depend on the system's ability to maintain treated gas on specification for carbon dioxide (CO2) and benzene, toluene, ethylbenzene and xylene (BTEX).                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Commissioning / Start Up | Mercury Bed Drying and Cold End Defrost        | Use of defrost gas                                                                                  | At the completion of dry out of the mercury bed, defrost gas will be available to begin dryout of the cold end without jeopardizing the integrity of the aluminum components. Some of the flow currently routed to the warm-wet flare will be instead routed to the cold-dry flare. Although the same amount of gas is flared, the overall height may be reduced at times due to this diversion.                                                                                                                                                                                                                                                | ✓                                              |                       |
| Commissioning / Start Up | Cold End Cooldown and Condensate Stabilization | Dilution with natural gas                                                                           | During start up and surge testing of overhead compressors, the overhead gas is flared until all testing is complete. Natural gas added to the steam from overhead gas for dilution, to reduce risk of black smoke from the heavier composition of the stream.                                                                                                                                                                                                                                                                                                                                                                                   |                                                | ✓                     |
| Commissioning / Start Up | Refrigerant Production Unit (RPU)              | Recycle to LNG Tank                                                                                 | Once the refrigerant is on-specification, it will be routed to the storage spheres and any gas overheads from the de-ethanizer and de-propanizer are recycled to the LNG tank to avoid flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ✓                                              | ✓                     |
| Commissioning / Start Up | Train 2                                        | Use of defrost gas                                                                                  | For Train 2 startup, defrost gas from Train 1 will be used to defrost the equipment eliminating the need for excess flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations               | Flare Management                               | Dilution Gas                                                                                        | Dilution gas is added to lower the concentration of combustible components in the flare gas, improving the combustion efficiency and reducing emissions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Monitoring & Optimization                                                                           | Pro-actively monitor flaring and associated characteristics to allow the operator to adjust the flare operation to minimize emissions. Methods for detecting and monitoring flaring include:<br>- Closed circuit television (CCTV) in the control room for 24 hours a day, 7 days a week, monitoring of flare performance<br>- Equipment trips<br>- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions<br>- An alarm on some controlled streams flared (valve not closed status)<br>- Proactive Technical Monitoring set-up for the flaring system to monitor abnormalities in the flare system | ✓                                              |                       |
| Operations               | Flare Monitoring and Control Systems           | Flare Checks                                                                                        | Procedures/processes in place for Operations to identify if there is an unknown passing valve to the flare system. This will include systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by Operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves. Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.                                                          | ✓                                              |                       |

| Applicable Phase | Location / Aspect                    | Reduction/ Mitigation Measure                        | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|--------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | Flare Management                     | Unplanned Flaring Procedures                         | Procedures/processes in place for Operations to respond to an unplanned flaring event. This will include Operations first undertaking any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service, if it is safe to do so.<br>If the equipment cannot be readily returned to service, the Operations Shift Team will coordinate with LNG Canada Production Scheduling department to undertake actions to reduce facility throughput to minimum turndown, if required to reduce flaring. The facility has a design minimum turndown of 50% for the equipment and this will limit the turndown to 50% of the design rate to prevent potential equipment damage.<br>Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair, LNG Canada Production Scheduling will optimize the production plan and LNG carrier arrival within any pre-existing limits to minimize flaring and economic loss. | ✓                                              |                       |
| Operations       | Flare Management                     | Flaring Event Investigations                         | Procedures/processes in place for Operations to investigate a flaring event. For flaring events greater than 10,000 m3, Operations will use the incident reporting system and correct causes of repeated non-routine flaring, incinerating, or venting as part of continuous improvement. The investigation reports would be available to the regulator upon request.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ✓                                              |                       |
| Operations       | Overall                              | Quality                                              | Implementation of the quality management system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              |                       |
| Operations       | Flare Management                     | Visible Emissions - Training                         | Training/processes in place for Operations to visually observe smoke in alignment with United States Environmental Protection Agency (USEPA) Method 22.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                | ✓                     |
| Operations       | Overall                              | Measurement Data: Analyze Data & Reporting           | Procedures/processes in place for Operations to maintain diligence in the management of flaring and associated emission. Will include analysis of measurement data in the context of monitoring data to further the learning of predicted against actualized outcomes. This learning will be systematically captured, such that the management approach can be adapted towards improving both predicting and reducing flaring events and associated emissions.<br>The Project will use the BC Measurement Guideline for measurement of flared volumes and associated fuel gas volumes through Petrinex reporting system monthly.<br>maintain the log of air flaring that occurs, in accordance with LNG Facility Regulation; and regularly review as part of the continuous approval process.                                                                                                                                                                                                                                                                                                                                                 | ✓                                              |                       |
| Operations       | Overall                              | Flaring Log                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Corrective Maintenance Program   | Procedures/processes in place for Operations to address corrective maintenance when a mismeasurement is observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer. The evidence or manifest of mismeasurement could be as follows:<br>- Observed during calibration, part of preventive maintenance activities<br>- Difference in reading observed by the Operation referring to other process parameters<br>- Determined by the Technology Team during the daily mass balance activity<br>- Self-diagnosis by the smartness of the device and manifested as alert or fault<br>Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error within the accuracy using the Project test equipment that is certified by a Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.                                          | ✓                                              |                       |
| Operations       | Overall                              | Measurement System: Preventative Maintenance Program | All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centered Maintenance (RCM), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventative maintenance task within stipulated time frame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ✓                                              |                       |
| Operations       | Relief Valve                         | Inspection and Overhaul - Spares                     | Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ✓                                              |                       |
| Operations       | Adjustment of PMR and MR composition | Recycling                                            | Procedures/processes in place for Operations to adjust Pre-cooled Mixed Refrigerant (PMR) and Mixed Refrigerant (MR) qualities by recycling their vapours to the condensate stabilizer unit rather than flaring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ✓                                              | ✓                     |

| Applicable Phase | Location / Aspect           | Reduction/ Mitigation Measure                    | Details                                                                                                                                                                                                                                                                                                                                                   | Outcome: Reduce Flaring & Associated Emissions | Outcome: Reduce Smoke |
|------------------|-----------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------|
| Operations       | LNG Carrier Loading Mode    | Slower cooldown                                  | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess boil off gas (BOG) generated.                                                                                                                                     | ✓                                              |                       |
| Operations       | Gas Turbines                | Turn around - Parallel Strings                   | With parallel 50% strings, boroscoping of each aeroderivative gas turbine during turnaround can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring.                                                                                                                                | ✓                                              |                       |
| Operations       | Refrigerant Production Unit | Turn around - De-inventory PMR Circuit           | In preparation of turnaround the PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train.                                                                                                                                                                         | ✓                                              | ✓                     |
| Operations       | Fuel Gas                    | Turnaround - MP Fuel gas during Nitrogen Purging | Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, MP fuel gas will be added to ensure the minimum heating value is maintained.                                           | ✓                                              |                       |
| Operations       | De-Inerting LNG Carriers    | MP Fuel Gas during De-Inerting                   | MP Fuel gas, supplied from a dedicated fuel gas line at the bottom of the Storage and Loading Flaring, is added to the flare to ensure the minimum heating value of 20 MJ/m3 is maintained.                                                                                                                                                               | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Assist Gas during Acid Gas Thermal Oxidizer Trip | The overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere. Fuel gas is added to the flare from the fuel gas controller at the Warm Flare Knock-out drum, to ensure the minimum heating value is maintained.                                                | ✓                                              |                       |
| Operations       | Acid Gas Removal (AGR) Unit | Re-routing to other LNG Train                    | The control scheme makes use of last known values of flow indication and Lower Heating Content from the analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.                                                                                                | ✓                                              |                       |
| Operations       | Liquefaction Train          | Main Cryogenic Heat Exchanger (MCHE) Trip        | LNG production is immediately stopped and the gas flow to the facility is automatically reduced at the inlet station. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.                                                                                                                            | ✓                                              |                       |
| Operations       | Residue Vapour Compressor   | Residue Vapour Compressor Trip - Duration        | If the compressor is unable to be started within four hours, the Refrigerant Production Unit (RPU) would be shut down to stop flaring.                                                                                                                                                                                                                    | ✓                                              |                       |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Assist Gas     | Assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.                                                                                                                                                                                                                               |                                                | ✓                     |
| Operations       | Condensate Stabilizer Unit  | Condensate Stabilizer Unit Trip - Duration       | If operations are unable to bring the condensate stabilization unit back to specification to stop flaring the overall production would be reduced until the stream meets specification, or the LNG train would be shutdown.                                                                                                                               | ✓                                              | ✓                     |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Holding Mode        | During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. To reduce the amount of BOG generated during this mode of operation, and therefore reduce flaring, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank to reduce the volume of BOG generated. | ✓                                              |                       |
| Operations       | Boil-off Gas Compressor     | Boil-off Gas Compressor Trip-Loading Mode        | During LNG Carrier loading, the carrier is initially cooled down leading to an increase in BOG generation and subsequent flaring. Cooldown can be slowed to reduce the amount of excess BOG generated.                                                                                                                                                    | ✓                                              |                       |

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Tuesday, August 2, 2022 8:53 AM  
**To:** Mathews, Suzanne; Post Permit Requests; Friedrich, Hardy  
**Cc:** 'permitting@Ingcana.ca'; LNGC JVD PERMITTING; 'scot.mackillop@Ingcana.ca'; 'Neven.Dimic@Ingcana.ca'; Ben Ashton; erin.furlong@Ingcana.ca; 'Lyndsey.Hunter@Ingcana.ca'; James Frith; Hassan, Umair  
**Subject:** RE: LNG Canada Project Flaring Management Report  
**Attachments:** L001-06200-OA-5880-0001\_RF (2022JUL26) TRACKED.pdf

Suzanne,

Please see the attached updated Flaring Management Report for the LNG Canada Project: L001-06200-OA-5880-0001\_RF (2022JUL26)\_TRACKED.pdf. The tracked changes are shown in red (additions).

I will also share this Report with Haisla Nation this morning.

Let me know if you have any further questions / clarifications for this Report. The intent is to issue the "final" version as Rev. 0 (Approved for Use) after we have closed out the OGC / Haisla review.

Regards

Janine

---

**From:** Janine Forrest  
**Sent:** Friday, June 3, 2022 10:17 AM  
**To:** Mathews, Suzanne ; Post Permit Requests ; Friedrich, Hardy  
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**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>  
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**Subject:** [External] RE: LNG Canada Project Flaring Management Report

Hi Janine,  
Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



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**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/Ing canada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

**From:** Porter, Joshua <[Joshua.Porter@bcogc.ca](mailto:Joshua.Porter@bcogc.ca)>

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**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.



**Joshua Porter** P.Eng.  
Engineer, LNG Facilities  
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**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.



Note, that this has also been shared with Haisla Nation.

Regards

Janine

**Janine Forrest** | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250

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Controlled Document

## Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | F                                            |
| Document Status          | Issued for Review                            |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 26-Jul-2022                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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| Revision Status |             |                   |                            | Approving Organization                                                                                                                                                 |                            |                 |
|-----------------|-------------|-------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                                                                                               | Approver                   | Review Code     |
| A               | 08-Jun-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong                                                            | Christian Fischer          | Choose an item. |
| B               | 12-Oct-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong<br>Rik van der Ploeg<br>Bart Buhre<br>Schom-Moffatt, Patti | Christian Fischer          |                 |
| C               | 09-Apr-2021 | Issued for Review | Cameron McCormick          |                                                                                                                                                                        |                            |                 |
| D               | 01-Oct-2021 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>R. Kabganian<br>S. MacKillop<br>N. Dimic                                                                                                                  | B. Ashton<br>R. Dronamraju |                 |

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| E | 08-Mar-2022 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>N. Dimic<br>C. Sharwood<br>A. Betts | B. Ashton<br>R. Dronamraju |  |
| F | 26-Jul-2022 | Issued for Review | J. Forrest                 | N. Dimic<br>C. McCormick<br>J. Keim              | B. Ashton<br>R. Dronamraju |  |

# TABLE OF CONTENTS

|        |                                                                       |    |
|--------|-----------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                          | 7  |
| 1.1.   | Project Background                                                    | 7  |
| 1.2.   | Purpose and Objectives                                                | 7  |
| 1.3.   | Project Overview                                                      | 8  |
| 1.4.   | Abbreviations and Definitions                                         | 8  |
| 2.     | REGULATORY FRAMEWORK                                                  | 13 |
| 2.1.   | Project Approvals and Conditions                                      | 13 |
| 2.1.1. | Facility Permit                                                       | 13 |
| 2.1.2. | Waste Discharge Authorization                                         | 15 |
| 2.1.3. | Environmental Assessment Certificate                                  | 15 |
| 2.1.4. | Decision Statement                                                    | 16 |
| 2.2.   | Acts, Regulations and Guidelines                                      | 17 |
| 2.2.1. | Oil and Gas Activities Act; Liquefied Natural Gas Facility Regulation | 17 |
| 2.2.2. | BC OGC Flaring and Venting Guideline Reduction Guidelines             | 18 |
| 2.2.3. | BC Noise Control Best Practices Guideline                             | 19 |
| 2.2.4. | BC OGC Light Control Best Practices Guideline                         | 19 |
| 2.2.5. | Ambient Air Quality Objectives                                        | 19 |
| 2.3.   | Environmental Commitments                                             | 19 |
| 3.     | ROLES AND RESPONSIBILITIES                                            | 21 |
| 4.     | FLARE SYSTEMS OVERVIEW                                                | 22 |
| 4.1.   | General                                                               | 22 |
| 4.2.   | Process Description Overview                                          | 22 |
| 5.     | FLARE DESIGN BASIS, TECHNOLOGY SELECTION AND MEASURES                 | 28 |
| 5.1.   | Design Basis                                                          | 28 |
| 5.1.1. | Flare Systems                                                         | 28 |
| 5.1.2. | Flare Radiation                                                       | 28 |
| 5.1.3. | Flare Knockout Drums                                                  | 29 |
| 5.2.   | Flare Technology                                                      | 30 |
| 5.2.1. | Pilot System                                                          | 30 |
| 5.2.2. | Vapour Flare Systems                                                  | 30 |
| 5.2.3. | Liquid Burners System                                                 | 31 |
| 5.2.4. | Derrick Structures                                                    | 32 |
| 5.3.   | Flaring and Venting Mitigation Measures in Design                     | 33 |
| 6.     | ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES                         | 34 |
| 6.1.   | Smoke                                                                 | 34 |
| 6.2.   | Air Contaminant & GHG Emissions                                       | 35 |
| 6.3.   | Thermal Heat                                                          | 36 |
| 6.4.   | Noise                                                                 | 36 |
| 6.4.1. | Impact to Personnel on Site                                           | 36 |
| 6.4.2. | Offsite Impact                                                        | 37 |
| 6.5.   | Light                                                                 | 37 |
| 6.6.   | Wildlife                                                              | 37 |
| 7.     | CONTINUOUS VENTING EMISSIONS                                          | 38 |
| 7.1.   | Continuous Vent Emissions to Atmosphere                               | 38 |

|                                                                         |    |  |
|-------------------------------------------------------------------------|----|--|
| 7.2. Unplanned Vent Emissions to Atmosphere                             | 38 |  |
| 8. CONTINUOUS FLARING EMISSIONS                                         | 40 |  |
| 8.1. Flare Pilot                                                        | 40 |  |
| 8.2. Compressor Seal Gas                                                | 40 |  |
| 8.3. Analyzer Sample Returns                                            | 40 |  |
| 8.4. Continuous Passing Valves                                          | 41 |  |
| 8.5. Flare Purges                                                       | 41 |  |
| 8.6. Continuous Incinerator Emissions                                   | 41 |  |
| 9. COMMISSIONING FLARING ACTIVITIES                                     | 42 |  |
| 9.1. Commissioning Overview                                             | 42 |  |
| 9.2. Commissioning Flaring Overview                                     | 42 |  |
| 9.2.1. Pipeline and Inlet Facility Start-up                             | 43 |  |
| 9.2.2. Refrigerant Import                                               | 44 |  |
| 9.2.3. LNG Import                                                       | 45 |  |
| 9.2.4. LNG Train 1 Start-Up                                             | 46 |  |
| 9.2.5. Acid Gas Removal Unit Start-up and Molesieve Regeneration Period | 47 |  |
| 9.2.6. Mercury Bed Drying and Cold End Defrost                          | 48 |  |
| 9.2.7. Cold End Cooldown and Condensate Stabilization Start-up          | 48 |  |
| 9.2.8. Emergency Shut Down Test                                         | 49 |  |
| 9.3. Subsequent LNG Train Start-Up                                      | 49 |  |
| 9.4. Refrigerant Production Unit (RPU) Start-Up                         | 50 |  |
| 10. EARLY STAGES OF NORMAL OPERATIONS FLARING ACTIVITIES                | 52 |  |
| 11. PLANNED FLARING ACTIVITIES DURING NORMAL OPERATION AND TURNAROUND   | 55 |  |
| 11.1. LNG Train Turnaround                                              | 55 |  |
| 11.1.1. Restart from Turnaround                                         | 55 |  |
| 11.2. De-inerting of LNG Carriers                                       | 56 |  |
| 11.3. Adjustment of PMR Composition at PMR Reclaimer                    | 56 |  |
| 11.4. Adjustment of MR composition at HP MR Separation Vessel           | 57 |  |
| 11.5. Refrigerant Production Unit (RPU) Turnaround                      | 57 |  |
| 11.6. Relief Valve Inspection and Overhaul                              | 57 |  |
| 11.7. Routine Maintenance Activities                                    | 58 |  |
| 12. UNPLANNED FLARING ACTIVITIES                                        | 59 |  |
| 12.1. Unplanned equipment failure or repair                             | 59 |  |
| 12.2. Flash Gas Compressor Trip                                         | 59 |  |
| 12.3. Acid Gas Thermal Oxidizer Trip                                    | 59 |  |
| 12.4. Regeneration Gas Compressor Trip                                  | 60 |  |
| 12.5. Gas Turbine Compressor Trips                                      | 60 |  |
| 12.6. Main Cryogenic Heat Exchanger (MCHE) Trip                         | 60 |  |
| 12.7. Condensate Stabilizer Overheads Compressor Trip                   | 61 |  |
| 12.8. Residue Vapour Compressor Trip                                    | 61 |  |
| 12.9. Condensate Storage Tank Vapour Recovery Unit Trip                 | 61 |  |
| 12.10. Boil-off Gas Compressor Trips                                    | 61 |  |
| 12.10.1. Holding Mode                                                   | 62 |  |
| 12.10.2. Loading Mode                                                   | 62 |  |
| 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate           | 62 |  |
| 12.12. Flaring Due to Off-Spec Products                                 | 62 |  |
| 13. EMERGENCIES                                                         | 63 |  |

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| 13.1. Emergency Depressurization                                      | 63 |
| 13.2. Extended Electrical Black Out                                   | 63 |
| 14. MEASUREMENT, MONITORING, NOTIFICATION, AND REPORTING              | 64 |
| 14.1. Flaring Measurement                                             | 64 |
| 14.2. Flow Meter Maintenance and Calibration                          | 64 |
| 14.2.1. Corrective Maintenance                                        | 64 |
| 14.2.2. Preventive Maintenance                                        | 64 |
| 14.3. Monitoring                                                      | 65 |
| 14.4. Flare Checks                                                    | 65 |
| 14.5. Internal Reporting                                              | 65 |
| 14.6. Response to Public Concern Related to Flaring                   | 66 |
| 14.7. External Notification and Reporting                             | 66 |
| 14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting | 66 |
| 15. CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                       | 67 |
| 16. REFERENCES                                                        | 68 |

# 1. Introduction

## 1.1. Project Background

Shell Canada Energy (“Shell”), North Montney LNG Limited Partnership, KOGAS Canada LNG Partnership (“KOGAS”), Diamond LNG Canada Partnership (“Diamond”), and PetroChina Kitimat LNG Partnership (“CNPC”), together the Joint Venture Participants referred to as LNG Canada Development Inc. (LNG Canada), are jointly developing a liquefied natural gas (LNG) export facility near Kitimat, British Columbia (B.C.), Canada, on the Traditional Territory of the Haisla Nation.

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project.

A list of acronyms and definitions is provided in Section 1.4.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, Commissioning and Operation of the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke, in conformance with the Project Facility Permit, issued by the BC Oil and Gas Commission (OGC).

This report provides an overview of the following aspects for routine and non-routine flaring during Commissioning and Operations:

- Regulatory Framework – Section 2
- Roles and Responsibilities – Section 3
- Flare System Overview – Section 4
- Flare System Design Basis, Technology Selection and Mitigation Measures – Section 5
- Environmental Impacts and Mitigation Measures – Section 6
- Inventory of Flaring Activities, including anticipated flare characteristics:
  - Continuous Venting – Section 7
  - Continuous Flaring – Section 8
  - Commissioning – Section 9
  - Early Stages of Normal Operations – Section 10
  - Normal Operations and Turn Around – Section 11
  - Unplanned Flaring – Section 12
  - Emergency Flaring – Section 13
- Measurement, Monitoring, Notifications and Reporting – Section 14
- Continuous Improvement – Section 15

This document does not:

- Include the feed gas pipeline that is under Coastal GasLink (CGL) control.



This document is intended to be reviewed and updated:

- Within three months after Commissioning LNG Train 1 to incorporate lessons learned that need to be applied to Commissioning of LNG Train 2
- As required to capture continuous improvement cycles

### 1.3. Project Overview

The Project includes the following LNG processing and storage systems (but not limited to):

- Natural gas inlet station
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities
- Up to two full containment storage LNG tanks
- Up to two condensate storage tanks
- Flare systems, including a total of up to two flare derricks

There are two parallel LNG loading lines, up to two vapour return lines, and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier and a material offloading facility.

The Project is being constructed in two phases, with each phase having two processing units and associated utilities, one LNG Storage Tank and one LNG Carrier Berth. The flare system has been designed to accommodate both phases, with the Commissioning and early stages of Normal Operations information focused on the first phase herein.

### 1.4. Abbreviations and Definitions

Table 1 and Table 2 contain a list of abbreviations and definitions used within this document.

**Table 1: Abbreviations**

| Abbreviation    | Definition                                                                |
|-----------------|---------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                     |
| AGR             | Acid Gas Removal                                                          |
| AQO             | Ambient Air Quality Objective                                             |
| BTEX            | Benzene, Toluene, Ethylbenzene and Xylene                                 |
| B.C.            | British Columbia                                                          |
| BOG             | Boil Off Gas                                                              |
| CAAQS           | Canadian Ambient Air Quality Standards                                    |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                      |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e. heavier hydrocarbons) |
| CCTV            | Closed Circuit Television                                                 |
| CGL             | Coastal GasLink                                                           |
| CIE             | Commission Internationale de l'Eclairage                                  |

| Abbreviation      | Definition                                                                                            |
|-------------------|-------------------------------------------------------------------------------------------------------|
| CO <sub>2</sub>   | Carbon Dioxide                                                                                        |
| CSA Z276          | Canadian Standards Association, Liquefied Natural Gas (LNG) – Production, Storage and Handling (Code) |
| dBA               | A-weighted decibel (unit of noise measurement)                                                        |
| dB(C)             | C-weighted decibel (unit of noise measurement)                                                        |
| DRE               | Destruction Removal Efficiency                                                                        |
| EAC               | Environmental Assessment Certificate                                                                  |
| EAO               | BC Environmental Assessment Office                                                                    |
| ECCC              | Environment and Climate Change Canada                                                                 |
| EMS               | Environmental Management System                                                                       |
| ENV               | BC Ministry of Environment and Climate Change Strategy                                                |
| EPC               | Engineering, Procurement, and Construction                                                            |
| F-CD              | Cold Dry Vapour Flare                                                                                 |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                                         |
| F-WW              | Warm Wet Vapour Flare                                                                                 |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development                     |
| FVRG              | Flaring and Venting Reduction Guideline                                                               |
| GHG               | Greenhouse Gas                                                                                        |
| GWP               | Global Warming Potential                                                                              |
| H <sub>2</sub> S  | Hydrogen Sulphide                                                                                     |
| HP                | high pressure                                                                                         |
| hr                | Hour (unit of time)                                                                                   |
| HSSE              | Health, Safety, Security and Environment                                                              |
| IAAC              | Impact Assessment Agency of Canada                                                                    |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                                        |
| KAG               | Kitimat Airshed Group                                                                                 |
| Kg                | Kilogram (unit of weight)                                                                             |
| KO                | Knockout                                                                                              |
| kPa               | Kilopascal (unit of pressure)                                                                         |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                                             |
| LNG               | Liquefied Natural Gas                                                                                 |
| LNG Canada        | LNG Canada Development Inc.                                                                           |
| LNGFR             | LNG Facility Regulation                                                                               |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| LPG               | Liquid Petroleum Gas                                                                     |
| m                 | Meter (unit of length)                                                                   |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                             |
| MCHE              | Main Cryogenic Heat Exchanger                                                            |
| MJ                | Mega joules (unit of energy)                                                             |
| MOH               | BC Ministry of Health                                                                    |
| MR                | Mixed Refrigerant                                                                        |
| Nm <sup>3</sup>   | Normal metre cubed (unit of volume)                                                      |
| NOx               | Nitrogen Oxides                                                                          |
| OGAA              | Oil and Gas Activities Act                                                               |
| BC OGC            | BC Oil and Gas Commission                                                                |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| ppm               | Parts per million                                                                        |
| ppmv              | Parts per million volume                                                                 |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of “0”                                                          |
| RAM               | Risk Assessment Matrix                                                                   |
| RCM               | Reliability Centred Maintenance                                                          |
| RFSU              | Ready for Start-Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| Sm <sup>3</sup>   | Standard metre cubed (unit of volume)                                                    |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| SP                | Social Performance                                                                       |
| t/h               | Tonnes per Hour                                                                          |
| Te                | Metric Tonnes (unit of weight)                                                           |
| US                | Ultra-sonic (flow meter)                                                                 |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |

**Table 2: Definitions**

| Term                                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Black Smoke                          | Visible suspension of carbon, or other particles in air, having an opacity greater than 40%.                                                                                                                                                                                                                                                                                                                    |
| Commissioning                        | Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.<br>In the Facility Permit, it is defined as “ <i>Period of time commencing when operations begin in accordance with Section 11 of the OGC Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i> ”. |
| De-Inventorization                   | Disposal of hydrocarbon inventory within a process unit or equipment.                                                                                                                                                                                                                                                                                                                                           |
| Dilution Gas                         | Typically, fuel gas used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as fuel gas instead of flared gas.                                                                                                                                                                 |
| Destruction Removal Efficiency (DRE) | A percentage that represents the number of molecules of a compound removed or destroyed relative to the number of molecules that entered the system.                                                                                                                                                                                                                                                            |
| Emergency                            | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire, or catastrophic equipment failure (per the Facility Permit).                                                                                  |
| Fuel Gas                             | A process stream that is used in providing energy for facility operations.<br>For this Project, this is gas burned in the gas turbine and incinerator as fuel gas or added to the flare to improve heating value of the flared gas.                                                                                                                                                                             |
| Flared Gas                           | A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).<br>For this Project, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided.                                                                    |
| Flaring                              | Disposal by combustion of natural gas or gas derived from petroleum.<br>Typically through an elevated stack and burner tip (not used to provide energy for facility operations).                                                                                                                                                                                                                                |
| Continuous Flaring                   | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                                                                                                                                     |
| Fugitive emissions                   | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment of tanks have not been properly closed or tightened.                                                                                                             |
| Greenhouse Gas                       | Gases in the atmosphere that absorb and emit thermal radiation. In the context of Greenhouse Gas (GHG) and Energy Management for an LNG project, these are carbon                                                                                                                                                                                                                                               |

| Term                        | Definition                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Natural gas                 | dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.<br><br>Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non-hydrocarbon impurities such as nitrogen, carbon dioxide, and hydrogen sulfide.<br>Feed gas as supplied by Coastal GasLink. |
| Normal (routine) Operations | Excludes Emergency conditions and Commissioning (per the Facility Permit).<br>In the first two years of Normal Operations, occurring immediately after completion of Commissioning, the facility reliability is anticipated to be relatively lower, resulting in increased flaring. This period of time is referenced as “early stages of Normal Operations”.      |
| Process upset               | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                                                                                                                    |
| Throughput                  | Fraction of the daily capacity (flow rate) of one train                                                                                                                                                                                                                                                                                                            |
| Turnaround                  | Planned full inspection of a liquefaction train.                                                                                                                                                                                                                                                                                                                   |
| Venting                     | The intentional controlled release of uncombusted gases directly to the atmosphere.                                                                                                                                                                                                                                                                                |

Sources:

- BC OGC (2018), LNG Facility Permit Application and Operations Manual, Version 1.6, August
- BC OGC (2020), Oil and Gas Glossary and Definitions, Version 1.11, December
- LNG Canada Project Facility Permit AD# 100083612, January 31, 2022 (Amended)

## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to design, Commissioning, and/or Normal Operations to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In B.C., LNG facilities are regulated by the *Liquefied Natural Gas Facility Regulation* (LNGFR) (B.C. Reg 146/2014), under the *Oil and Gas Activities Act* (OGAA). The BC OGC has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operations of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate” application, which authorizes commissioning and operations (LNGFR, Section 4).

The Project received the Facility Permit (Legacy File No. 9709124; Application Determination #100083612) on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BC OGC issued an amendment to the Facility Permit on January 7, 2021, and January 31, 2022, which re-numbered conditions (references to conditions herein are based on the amendment). Permit conditions applicable to the flare system are provided in Table 3 (refer to the permit for the full list of conditions; including additional conditions related to noise management). Note, LNG Canada is the “permit holder” for all permits issued by the BC OGC. This report was developed to satisfy Condition 39 and 40, and the other related conditions are provided for context only.

A “Leave to Construct” for the LNG Facility construction activities associated with Trains 1 and 2, within the bund wall (including the flare systems), was issued by the BC OGC on July 30, 2020. There were no specific conditions in this issued leave, as it’s based on the Facility Permit and LNGFR. A “Leave to Operate” will be required prior to Commissioning the flare system.

**Table 3: Facility Permit Conditions**

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31        | Flare Systems             | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |
| 35        | Flaring Notification Plan | The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a> , to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                           | <p>satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius for residents as defined below:</li> </ul> <p>H<sub>2</sub>S Content &amp; Notification Radius:</p> <ul style="list-style-type: none"> <li>&lt; 1%: 1.0km</li> <li>≥ 1% and &lt; 5%: 1.5km</li> <li>≥ 5%: 3.0 km</li> </ul> |
| 36        | Flaring Notification Plan | <p>The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m<sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.</p>                                                                                                                                                                                                                                                                                        |
| 37        | HSSE                      | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 38        | Smoke                     | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                                                                             |
| 39        | Flaring Management Report | <p>The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.</p>                                                                                                                                                                                                                                                                                                              |
| 40        | Flaring Management Report | <p>The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 41        | Flaring Management Report | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 47        | Noise                     | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA and dBC comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> </ul> <p>Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</p> |
| 50        | Noise                     | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the “British Columbia Noise Control Best Practices Guideline.” Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 52        | Light                     | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l’Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities, and operations. The BC OGC has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for emissions.

At this time of document issuance, the WDA application for air emissions that includes the flare system is under development. Engagement with the BC OGC commenced on **November 13, 2020**, via submission of the WDA pre-application.

### 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued the Environmental Assessment Certificate (EAC) for the Project on June 17, 2015 (#E15-01) with subsequent amendments issued in 2016, 2019, and 2021. LNG Canada is the “Holder” for the EAC. Permit conditions applicable to the flare system are provided in Table 4 (refer to the permit for the full list of conditions) for context only.



**Table 4: Environmental Assessment Certificate #E15-01 Conditions**

| Condition   |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A  | Certified Project Description      | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Schedule B  | Table of Conditions – Condition 1  | <p><b>Air Quality</b></p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC, and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC.</p> <p><i>Note, there is further detail in the condition that is not provided hererin. Refer to the EAC for further details.</i></p> |
| Schedule B  | Table of Conditions – Condition 2  | <p><b>Acoustics</b></p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009).</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                          |
| Schedule B  | Table of Conditions – Condition 12 | <p><b>Wildlife</b></p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>Ministry of Forests, Lands, Natural Resources and Rural Development</i>) and OGC. The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p>                                                                                                                                         |
| Application | Mitigation Measure 5.3-9           | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued the Decision Statement for the Project on June 17, 2015, with a subsequent amendment issued in April 2021. LNG Canada is the “Proponent” for the Decision Statement. Permit

conditions applicable to the flare system are associated with migratory birds. Condition 5.2 states that “*The Proponent shall:*

- 5.2.1 restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;
- 5.2.2 minimize flaring during night-time and during periods of bird vulnerability;
- 5.2.3 adjust operational lighting to avoid attracting migratory birds.”

This information is provided for context only.

## 2.2. Acts, Regulations and Guidelines

As outlined in Section 2.1, there are several regulatory acts, regulations and guidelines that inform the design, construction, and operation of the flare system. Further details on key acts, regulations, and guidelines are provided herein, please refer to the full act, regulation, and guideline for further information.

### 2.2.1. Oil and Gas Activities Act; Liquified Natural Gas Facility Regulation

As outlined in Section 2.1.1, the OGAA, LNGFR is a key regulation for LNG facilities. Key sections conditions applicable to the flare system are provided in Table 5 (refer to the regulation for further details).

The BC OGC developed the “Liquified Natural Gas Facility Permit Application and Operations Manual”, which provides further guidance on flaring and references various guidelines. The manual is available online through the BC OGC.

**Table 5: LNGFR Sections**

| Section |                                            | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4       | Engineering Design and LNG Facility Siting | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p> |
| 15      | Noise and Light Control                    | An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Section                               | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17 Venting                            | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p> |
| 18 Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ul style="list-style-type: none"> <li>a) flaring is required for maintenance purposes, or</li> <li>b) permission to flare is included in the LNG facility permit.</li> </ul> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                                                                                                                              |
| 19 Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p>                                                                                                                   |

### 2.2.2.BC OGC Flaring and Venting Guideline Reduction Guidelines

The BC OGC *Flaring and Venting Reduction Guidelines* (FVRG) will inform where applicable, all stages of the Project to eliminate routine flaring and reduce non-routine events. The FVRG is available online through the BC OGC. Key chapters include:

- Chapter 3 – Natural Gas Facility Flaring and Venting: Includes a decision tree that will be used where appropriate, when considering alternatives to flaring and venting.
- Chapter 5 – Notification Requirements.
- Chapter 6 – Performance Requirements: Includes requirements for noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance, and dispersion modelling.

- Chapter 7 – Venting and Fugitive Emissions Management Requirements.
- Chapter 10 – Measurement and Reporting: All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting, and record retention.

### 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC, with the latest version issued in July 2021.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to account for the flare system.

The Project is developing a separate Noise Management Program, as required by Project permits (refer to Section 2.1 herein) that will include the applicable measures to mitigate noise.

### 2.2.4. BC OGC Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC.

A facility flare is an example of a “sky glow” source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light, with reference to the CIE guide (which is also Project Facility Permit Condition 52, refer to Table 3). Some elevated light emissions are anticipated during Commissioning and the early stages of Normal Operations; however, this is a standard part of startup of LNG facilities and will reduce as the plant approaches a “steady state” of Normal Operations.

### 2.2.5. Ambient Air Quality Objectives

The province of B.C. uses a suite of ambient air quality criteria that have been developed provincially and nationally to inform decisions in the management of air contaminants. Ambient air quality objectives applied in B.C., include provincial and national objectives and standards developed for a number of contaminants over various averaging periods. These include Provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e., not legally binding), unless referenced directly in a regulation or authorization and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts
- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories

Limits on air emissions for the Project will be defined in the WDA (refer to Section 2.1.2) and not further addressed in this plan. The AQOs are available online.

## 2.3. Environmental Commitments

During Normal Operations, the Facility will operate without routine flaring or venting, with minor continuous sources e.g., flare pilot. Furthermore, non-routine flaring will be minimized, and the design will include flare mitigation to reduce flare load during unplanned upsets.

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment (HSSE) and Social Performance (SP) focuses on ways to avoid and minimize negative environmental and social impacts resulting from our operations and enhance the positive impacts in a systematic manner, which were addressed as part of the flare system design.

LNG Canada's HSSE Management System includes an HSSE & SP Control Framework with several elements related to flaring:

- **Flaring and Venting Manual** – Requires development of a Flaring and Venting Management Plan for facilities that are flaring and/or venting >1% by mass **and** combined flaring and venting exceeds 10,000 tonnes per annum of CO<sub>2</sub>e. It also requires that flaring risks are reviewed with a Subject Matter Expert if exceeding greater than 1% by mass.
- **Risk Assessment Matrix (RAM) Manual** – Environmental and community impacts are considered as part of the risk ranking process. This approach would be used to evaluate flaring events during an incident investigation. Escalation of events would occur due to factors such as the presence of black smoke over an extended period, complaints from the community, and/or AQO exceedances.

### 3. Roles and Responsibilities

There are various roles and responsibilities applicable to the design, construction, and operations of the flare system. JFJV, as LNG Canada's EPC, is responsible for managing the design, fabrication, construction, pre-commissioning, and Commissioning activities, up to "ready for start-up" (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing Commissioning activities that cannot be physically done prior to RFSU and Normal Operations after RFSU of the LNG Train (i.e., handover), with support from JFJV to execute post-RFSU activities in the early stages of Normal Operations. Commissioning, ramp-up, and the early stages of Normal Operations shall be executed by a joint, team of staff from LNG Canada and JFJV.

## 4. Flare Systems Overview

### 4.1. General

During Normal Operations, natural gas and other hydrocarbons flow continuously through an LNG facility. When there is a disruption to the expected operation of the LNG facility, such as an equipment or power outage, the constant flow of natural gas is interrupted. Large-scale LNG plant designs incorporate flare systems to safely combust excess hydrocarbons when necessary. For scenarios including start up, process upsets or emergency conditions, the hydrocarbons are ignited via a small continuous “flare pilot” flame to burn gases safely and efficiently under all conditions without escaping into the atmosphere. For this Project, the flare pilot, which is supplied by fuel gas and is a small, smokeless flame, provides a continuous ignition source, such that any gas sent to the flare as a result of upset conditions is immediately combusted.

When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be large, noisy, and/or create smoke.

The Project is designed to minimize continuous flaring and venting during normal operations and minimize flaring during maintenance and other normal non-routine events during operations. Flaring is kept to occasions when it is needed as a safety measure during start-up and shut down events to prevent equipment damage and maintain safety and facility reliability.

As stated in Section 2.3, during Normal Operations, the Project will operate with limited continuous sources (i.e., pilot flares and other safety features), and will not carry out routine flaring or venting (refer to Section 7 and 8 for information on the limited continuous sources). The flare system will facilitate purging of the plant during the following activities:

- Routine maintenance activities
- Planned maintenance (turnarounds)
- Trips and unplanned shutdown to repair defects
- Commissioning
- Emergency Situations

The Project has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers to flare used for operational reasons).

The EAC application had estimated that “a default factor of 0.3 weight percent of each train’s LNG output is assumed to best represent flaring volumes occurring during Normal Operation and during maintenance events”, which is still a representative estimate based on industry benchmarking.

As flares radiate heat, the height of the flare stacks is designed with safety in mind. A specially designed and secure exclusion zone exists surrounding the base of the flare to control access to the flare area to protect the public and workers at the LNG facility.

During Commissioning and the early stages of Normal Operations, it is expected that flare volumes and visibility will be higher compared to when “steady state” Normal Operations is achieved. The flaring activity will reduce over time as the facility moves into steady state Normal Operations (as discussed in more detail later in this report, refer to Section 11).

### 4.2. Process Description Overview

The Project receives dry pressurized natural gas from the CGL pipeline. The feed gas stream is primarily methane with some ethane, propane, butane, and a small heavy tail with some impurities. The raw, warm gas is cleaned of its

impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, and heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to **Figure 1**).

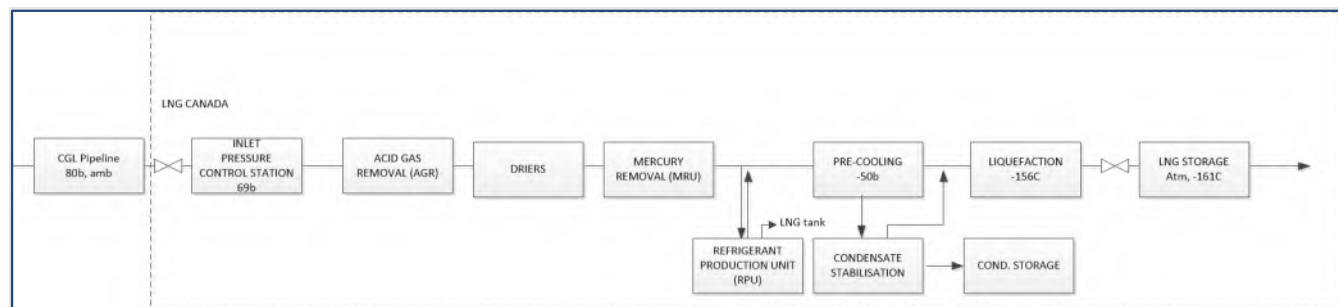


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown, as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses a Pre-cool Mixed Refrigerant ("PMR") cooling from ambient to -50°C
- Deeper liquefaction cycle: uses a Mixed Refrigerant ("MR") cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE)

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called "String A" and "String B," as shown in **Figure 2**. Each string can roughly handle half the production. The gas turbines are semi-aero, derivative-type with high torque requirement at start. This means there is no need to depressurize inventory to allow restart.

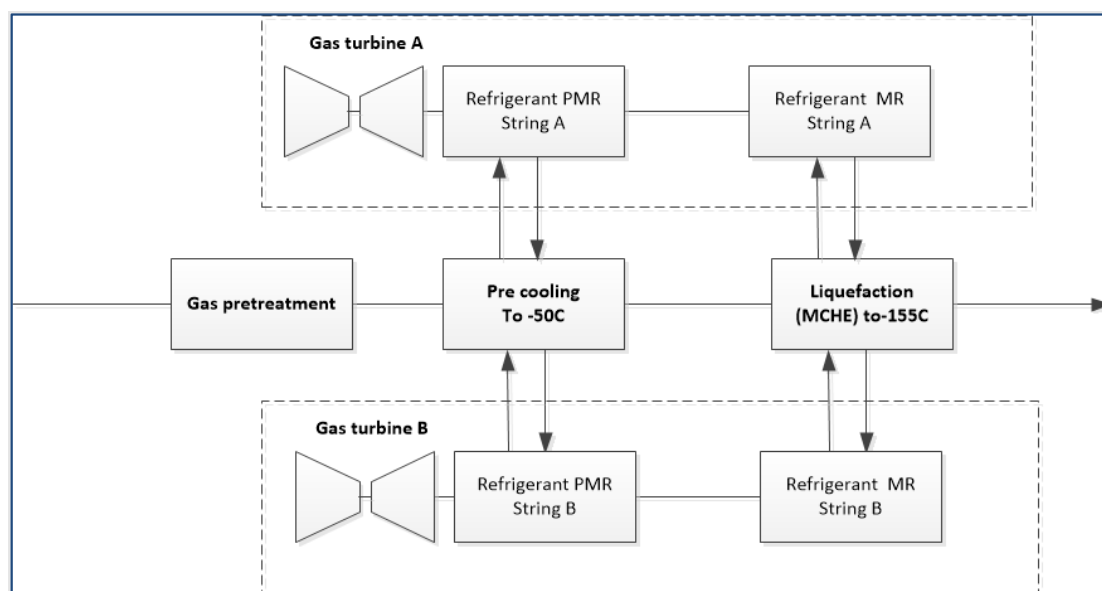


**Figure 2 Liquefaction Overview Schematic (high level)**

Methane, ethane, and propane are the components used as refrigerants in the liquefaction process. They are therefore available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).



There are four flares and nine liquid burners, which are common for both Train 1 and Train 2 (Figure 3, further details are provided in Section 5). The Project has two derrick structures to support the flares and liquid burners, as outlined in Table 6. Refer to Figure 3 and Figure 4 for the location of the structures.

There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.

**Table 6: Flare Derrick Structures and Systems**

| Item                 |                                                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour Flare Derrick | Warm/Wet Process Flare ("F-WW")                 | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"> <li>• Inlet Facilities</li> <li>• Acid Gas Removal Unit</li> <li>• Dehydration Unit</li> <li>• Mercury Removal Unit</li> <li>• Liquefaction Unit</li> <li>• Incinerator Unit</li> <li>• Condensate Stabilisation Unit</li> <li>• Heat Transfer Fluid System</li> <li>• Tempered Cooling Water System Unit</li> <li>• Fuel Gas System</li> <li>• Defrost Gas System</li> </ul> |
|                      | Cold/Dry Process Flare ("F-CD")                 | <p>For cryogenic hydrocarbon vapours (will not contain water). This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                            |
|                      | Low Pressure Storage and Loading Flare ("F-LP") | <p>For low pressure LNG vapours from the LNG Storage Tanks, in the event of BOG Compressors failure and/or carrier loading, compressor seal vents, and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p>                                                                                                                                                  |

| Item                        |                | Description                                                                                                                                                                                                                                                        |
|-----------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Liquid<br>Burner<br>Derrick |                | Includes a velocity seal to minimize purge gas requirements.<br><br>CO <sub>2</sub> or nitrogen containing gases released during de-inerting of LNG carriers route to the F-LP as well. Sufficient fuel gas shall be supplied for continuous burning of the flame. |
|                             | Spare flare    | Used in place of the individual flare systems when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare stack, with minimum design temperature dictated by the cold/dry process flare design.                     |
|                             | Liquid burners | For either warm/wet or cold/dry liquids.                                                                                                                                                                                                                           |

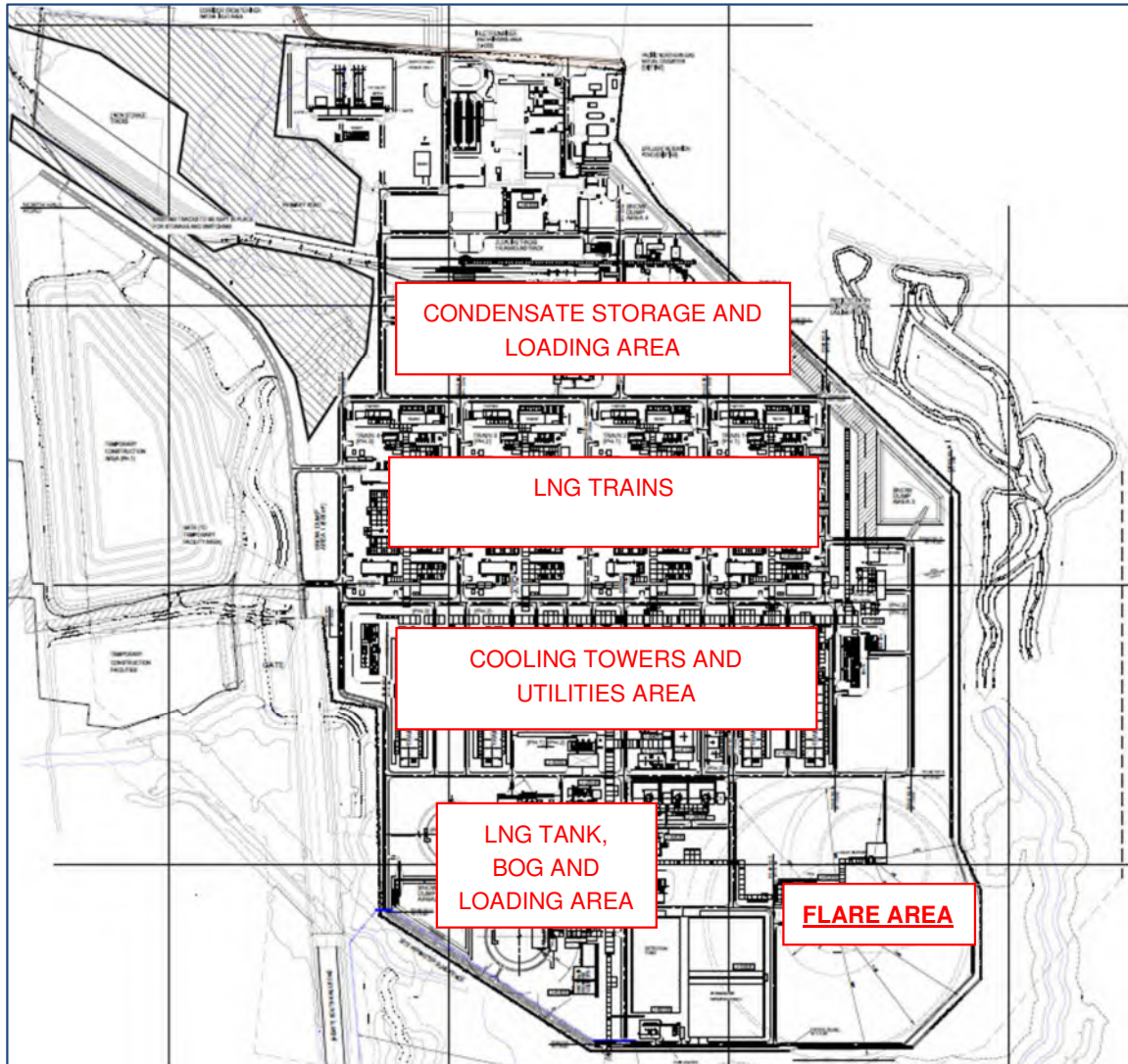


Figure 3 Flare Location Overview

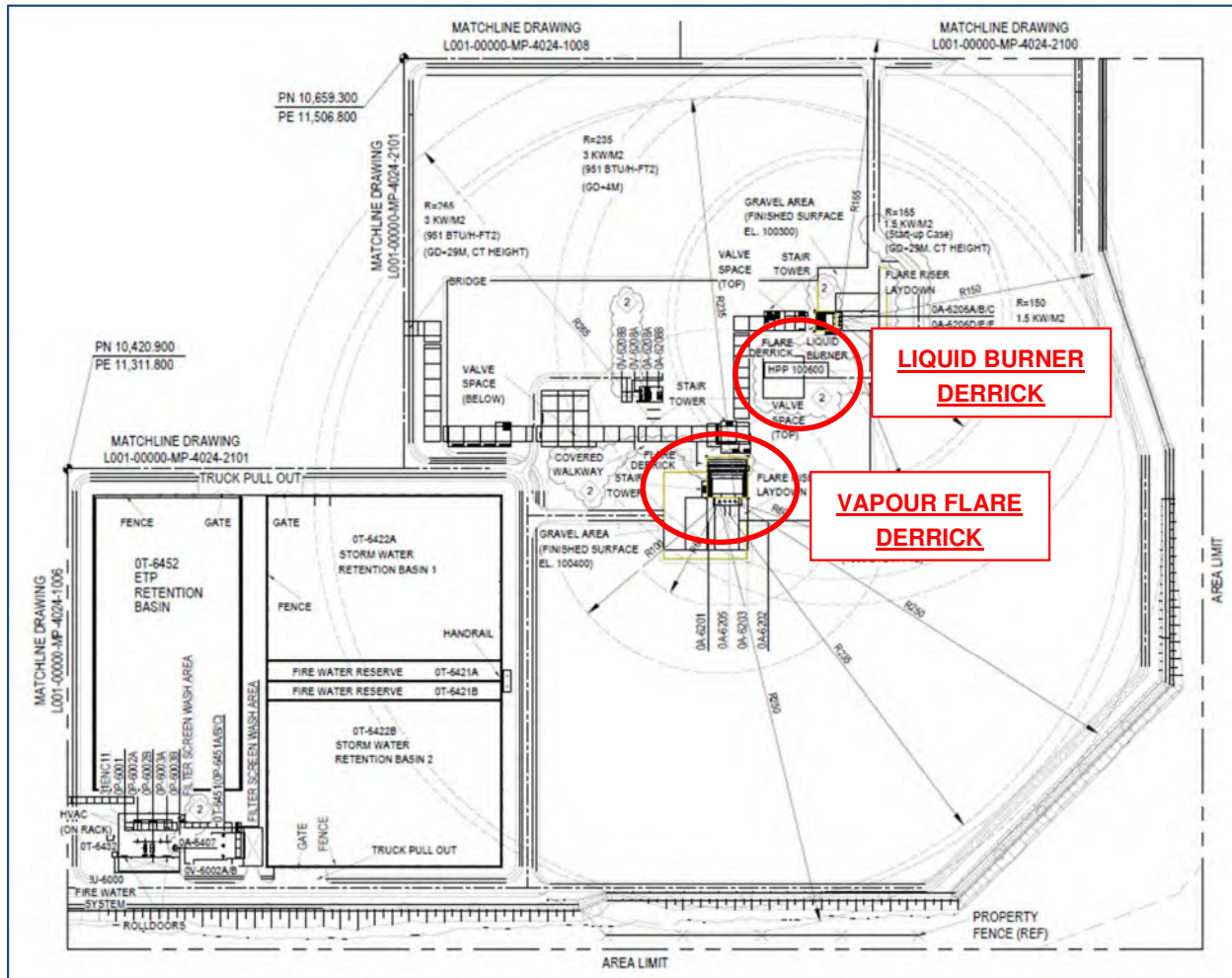


Figure 4 Flare Plot Plan (L001-00000-MP-4024-1011\_R2)

## 5. Flare Design Basis, Technology Selection and Measures

### 5.1. Design Basis

The design basis for key components of the flare systems is provided below. Some parameters of the design basis were adjusted during detailed design with the vendor (refer to Section 5.2 for further information).

#### 5.1.1. Flare Systems

The design flow rate for each flare, and associated design case are provided in Table 7 and Table 8, which are consistent with the permissions in the Facility Permit. The flares are designed to achieve 99.53% destruction removal efficiency (DRE).

**Table 7: Vapour Flares Design Basis**

| Flare                      | Diameter (inch) | Height (m) | Design flow (t/h) | Case                                          |
|----------------------------|-----------------|------------|-------------------|-----------------------------------------------|
| Warm Wet ("F-WW")          | 56              | 122        | 2195              | Blocked outlet liquefaction                   |
| Cold Dry ("F-CD")          | 48              | 122        | 1717              | Refrigerant compressor blocked outlet         |
| Storage & Loading ("F-LP") | 56              | 122        | 299               | Loss of all BOG compressors (4 trains)        |
| Spare                      | 56              | 122        | 2195              | Blocked outlet liquefaction as governing case |

**Table 8: Liquid burners Design Basis**

| Flare                                                                                                | Number of Flare Tips | Flare Tip Diameter (inch) | Height (m) | Design flow (t/h) | Case                                                     |
|------------------------------------------------------------------------------------------------------|----------------------|---------------------------|------------|-------------------|----------------------------------------------------------|
| Liquid burner-warm case                                                                              | 3                    | 3                         | 60         | 32                | Hydrocarbons (C <sub>3</sub> ), Condensate disposal      |
| Liquid burner-Cold case                                                                              | 9                    | 3 with 3"<br>6 with 6"    | 60         | 310               | LNG restart following outage (30% production of 1 train) |
| Note: The three 3" burners that have a dual function for both warm and cold liquids are 0A6206A/D/G. |                      |                           |            |                   |                                                          |

#### 5.1.2. Flare Radiation

The design complies with the following requirements for thermal radiation outlined in Table 9.

**Table 9: Flare Thermal Radiation Design Basis**

| Heat Radiation limit (kW/m <sup>2</sup> ) | Location                                                                               | Basis                                                                                                                                                                                     |
|-------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | Outside the facility fence line for normal operation, including start-up and shut down | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR maximum requirement for outside the boundary with normal flow rates is 3 kW/m <sup>2</sup> in remote areas.     |
| 3.0                                       | Outside the facility fence line for emergency conditions                               | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR maximum requirement for outside the boundary with accidental flow rates is 5 kW/m <sup>2</sup> in remote areas. |
| 5.0                                       | At the boundary of sterile area for emergency conditions                               | LNGFR prescribed limit for outer edges of sterile area is 5 kW/m <sup>2</sup> for accidental flow rate.                                                                                   |

### 5.1.3. Flare Knockout Drums

The design basis for the flare knockout (KO) drums is provided in Table 10. The flare KO drums are protected from liquid overflow through a combination of design liquid retention volume, as well as the use of two independent radar level measurements (one alarm is initiated through the distributed control system and the second through the safety system). These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners.

The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system, the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck.

**Table 10: Flare Knock Out Drums Design Basis**

| Flare Knockout Drum | Liquid Sizing Criteria                                                                                                                                                                                                                                                                                                                                         |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm-Wet            | To handle maximum vapour relief. The maximum liquid inventory is 180 m <sup>3</sup> , based on the amine liquid relief scenario.                                                                                                                                                                                                                               |
| Cold-Dry            | Assuming that the blowcase operation does not occur for 20 minutes after the emergency depressurizing of the LNG train liquification unit starts. This scenario equates to 140 m <sup>3</sup> of liquid accumulation in the flare KO drum, which is based on the depressuring from PMR accumulator prior to start of the blowcase sequence and liquid burners. |
| Spare               | To meet the most stringent design criteria of both the WW and CD systems, this KO drum has been sized to retain 180 m <sup>3</sup> of liquid carryover from the amine flash drum, without operation of the flare KO drum pump, as this has been identified as the largest relief load.                                                                         |

## 5.2. Flare Technology

The selection of flare technology used to meet the design basis is a key component to ensure efficient operations, including minimizing associated emissions. The Project contracted Zeeco to design and fabricate the vapor and liquid flare systems.

### 5.2.1. Pilot System

The vapour flares are equipped with four pilots each, and the liquid burners are equipped with an individual pilot.

The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system. If the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.

Each flare pilot is equipped with a redundant thermocouple to detect a flameout. On detection of a pilot flame out, an alarm will be initiated to the panel operator and the system will automatically attempt to relight the pilot with a high energy ignition system. If the high energy ignition system fails to relight the pilot, field operations will attempt to relight the pilot with a flame front generator.

The vapour flares have redundant pilots, and the flares are the final barrier to a process safety incident; therefore, in the unlikely case that all four pilots are lost, they will continue to operate. To account for the scenario that all pilots have been extinguished, a flame out scenario has been modelled for these flares and the unburned hydrocarbon from the flare does not pose a hazard to people. If the pilots are unable to be relit, the impacted flare will be taken out of service and switched to the spare flare, if available, until repaired.

For the liquid burners, as this equipment is only required for start-up and liquid disposal, a loss of the pilot will result in the individual burner tripping to prevent liquid rainout.

### 5.2.2. Vapour Flare Systems

Details on the selected vapour flare technology is provided in Table 11 and supporting images provided in Figure 5 and Figure 6.

**Table 11: Vapour Flare Summary**

| Flare                                                                                                                 | Type                | Smoke Index <sup>1</sup> | Assist Gas for DRE |
|-----------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------|--------------------|
| Warm Wet ("F-WW")                                                                                                     | Multi-Jet MJ-56     | R0                       | Yes                |
| Cold Dry ("F-CD")                                                                                                     | VariJet VJ-48       | R0                       | No                 |
| Storage & Loading ("F-LP")                                                                                            | Utility Flare UF-56 | R0                       | Yes                |
| Spare                                                                                                                 | Multi Jet MJ-56     |                          | Yes                |
| Notes:                                                                                                                |                     |                          |                    |
| 1. Further information on smoke performance is provided in Section 6.1 R0 = estimated Ringelmann scale measure of "0" |                     |                          |                    |





**Figure 5: Example of a Warm Flare – Multi Jet (MJ) (Vendor – Zeeco)**



**Figure 6: Example of a Low pressure Flare – Utility Flare (Vendor – Zeeco)**

### 5.2.3. Liquid Burners System

Details on the selected liquid burner technology is provided in Table 12. The liquid burners system consists of nine burners, three of which will be used in the warm case and all nine used for the cold case.

**Table 12: Liquid Burner Summary**

| Flare                     | Type       | Comments                                          |
|---------------------------|------------|---------------------------------------------------|
| Liquid burner - warm case | MJ3        | 1 Spider burner per riser, 3 risers               |
| Liquid burner - Cold case | MJ6<br>MJ3 | 3 Spider burners (2x6", 1x3") per riser; 3 risers |

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA, with one multi-jet liquid burner to observe smokeless capability and noise measurement.

Both results were satisfactory and correlated noise for nine burners was estimated at 85dB at 250 metres. Images from the testing are shown Figure 7.



## Liquid burner: Multi-Jet from Zeeco



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81

Figure 7 Liquid Burners (Star Shape) from Zeeco for LNG Canada

### 5.2.4. Derrick Structures

The derrick structure for the flares and liquid burners is shown in Figure 8.

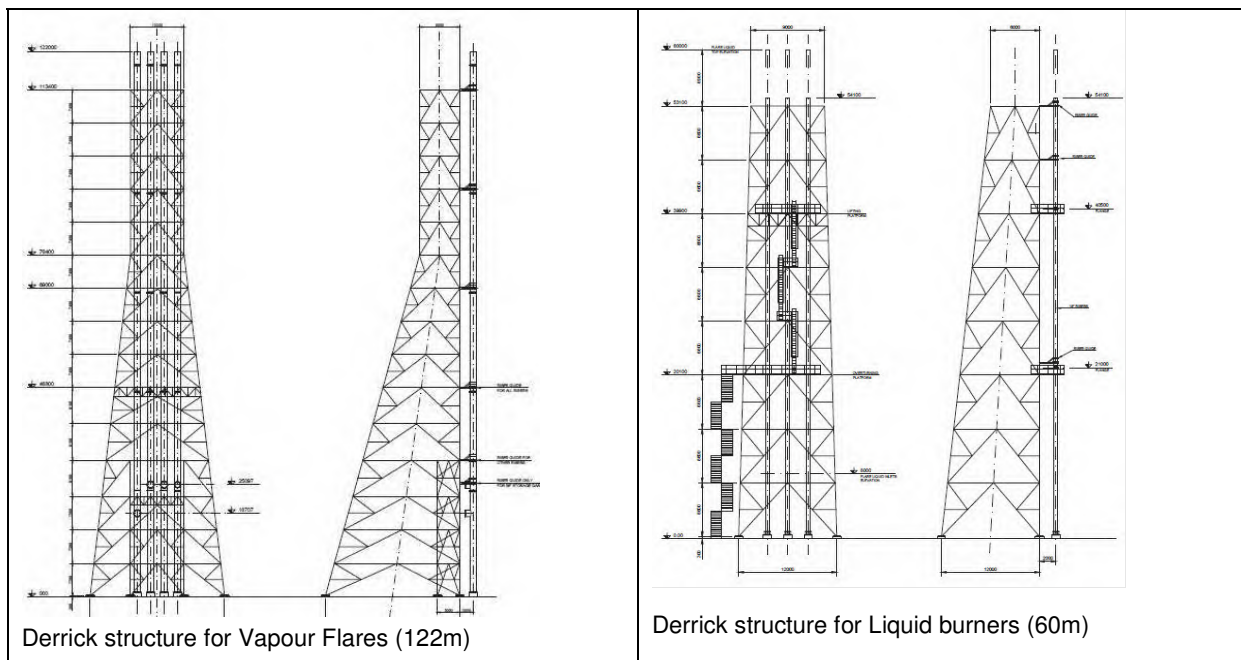


Figure 8 Derrick Structure

### 5.3. Flaring and Venting Mitigation Measures in Design

Several prospective flare reduction technologies were considered for implementation, including the recovery of start-up gas through the BOG compressor and the review of split range pressure controllers to ensure that they do not prematurely open to flare.

Elements of the Project design that will support minimizing flaring and venting include:

1. The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.
2. There are two parallel strings for each liquefaction train. A trip or outage of one string does not interrupt LNG production, it reduces production by 50%, so there is no flaring impact.
3. Each compressor string is equipped with a quench line for start-up to allow quick equalization with cold running string to reduce flaring.
4. The ethane refrigerant sphere is insulated and chilled to -11°C to minimize vapour losses from the sphere.
5. PMR and MR Refrigerant qualities can be adjusted by recycling their vapours to the condensate unit rather than flaring.
6. MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring.
7. PMR refrigerant liquid can be drained and recycled to the PMR storage sphere in preparation of turnaround, reducing amount to flare.
8. Refrigerant spheres are pressure controlled to the LNG tank vapour space.
9. Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.
10. The RPU overheads and bottoms are fully recycled back to the LNG train.
11. Pre-cooling PMR cycle can circulate MR, on full recycle via an MR “start-up recycle line”, to provide pre-cooling load, to facilitate pre-cooling system start-up and decouple with MCHE final cool down.
12. The condensate tank vapours are chilled to -10°C to reduce hydrocarbon directed to the incinerator.
13. Upon thermal oxidiser trip, the acid gas stream is sent to the warm flare instead of being vented.
14. Automated advanced cooldown to reduce flaring time at the cold liquid burners.
15. Purging of flare headers by nitrogen instead of fuel gas.
16. Full metering capability on the flare headers including density measurement, which can help identify abnormal flaring earlier.
17. Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part continual improvement.

## 6. Environmental Impacts and Mitigation Measures

The act of flaring can cause a potential impact to the environment due to smoke, air emissions, heat, noise, and light. Potential environmental effects from flaring were addressed in the EAC process. The following section outline how each of these elements has been minimized through design.

### 6.1. Smoke

The Project Facility Permit stipulates that the permit holder must design, maintain, and operate flares and incinerators so that flaring, other than for emergencies, does not result in black smoke or emission of black smoke during upsets that exceeds 15 minutes in any two-hour period (and is completely eliminated during Normal Operations) (refer to Table 3).

The Ringelmann scale is the scale used by industry for measuring the apparent density of smoke opacity (refer to Figure 9).

During the detailed engineering phase, JFJV worked with two reputable flare manufacturers with experience in the LNG industry and in Canada. Each vendor provided two designs: the first compliant with Ringelmann 1 performance, which has been utilized at other sites for start-up; and a second design with Ringelmann 0 performance for start-up.

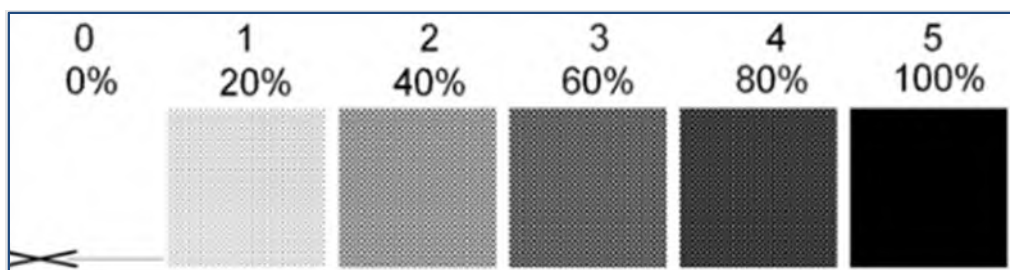


Figure 9 Ringelmann Chart

After evaluation, LNG Canada chose an improved design that reduces noise generation as well as smoke. According to the manufacturer, Ringelmann “0” or “R0” performance is likely in most situations. However, this is not a guarantee for all conceivable operating scenarios. Smoke may occur in certain scenarios, including during Commissioning and early stages of Normal Operations. Table 13 summarizes the design improvements.

Table 13 Summary of Flare Design Changes

| Flare riser               | Original design                                                           | New Design                                                                                                                                                                                          |
|---------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm Flare                | Single tip sonic pressurized                                              | Multi-tip fixed slot sonic type; fixed orifice size                                                                                                                                                 |
| Cold Flare                | Single tip sonic pressurized                                              | Multi-tip variable slot sonic type                                                                                                                                                                  |
| Storage and Loading Flare | General gas assisted flare                                                | No change possible due to requirement for low back pressure constraints                                                                                                                             |
| Spare Flare               | Single tip sonic pressurized                                              | Multi-tip fixed slot sonic type; fixed orifice size                                                                                                                                                 |
| Liquid Burners            | Four burners with atomizing gas to combust heavier liquids as well as LNG | Three risers with three burners each: <ul style="list-style-type: none"> <li>Six burners to burn smokeless LNG at start-up</li> <li>Three burners to burn heavier liquids as well as LNG</li> </ul> |

The Facility Permit does not specifically define black smoke; however, LNG Canada proposes that “black smoke” be defined as a visible suspension of carbon, or other particles in air, having an opacity greater than 40% (>R2), which is similar to definitions in other jurisdictions (e.g., Alberta (Directive 60), Australia, United Kingdom). This definition would reduce ambiguity and focus facility compliance on events that have the greatest potential for visual impacts. While Sections 9 and 10 provide more details on potential flaring events during Commissioning and early stages of Normal Operations and their relative likelihood of black smoke, LNG Canada has more specifically estimated the rate, duration, frequency, and opacity of potential events during this period (see Table 14 below).

During Normal Operations, the facility is designed for zero flaring; however, during stable normal operation, process upsets and emergencies could occur that can lead to the emission of black smoke. Given the unpredictable nature of these types of events, it is not possible to give a frequency of them occurring although an estimate is provided below in Table 14 for up to 200 cargos (R200).

**Table 14: Characteristics of Potential Black Smoke Events**

| <b>Event</b>                                          | <b>Rate</b>    | <b>Estimated duration of black smoke</b> | <b>Frequency of Scenario (before R200)</b>   | <b>Ringelmann estimate</b> |
|-------------------------------------------------------|----------------|------------------------------------------|----------------------------------------------|----------------------------|
| Dryer Regen Compressor failure                        | Medium         | 5 to 15 days                             | 4 to 6 times in first year                   | R1 / R2                    |
| MCHE NG tube leaks                                    | Low            | 90 to 180 days                           | 2 to 4 times per year before R200            | R1 / R2                    |
| Emergency depressurization (response to fire / upset) | Extremely High | 15 minutes to an hour                    | 1 to 3 times per year before R200            | R2 / R3                    |
| Ethane Refrigerant Import                             | Low            | 3 to 10 days                             | Potentially 1 to 3 times after Commissioning | R2                         |
| Propane Refrigerant Import                            | Low            | 3 to 10 days                             | Potentially 1 to 3 times after Commissioning | R2                         |

LNG Canada will operate within the design window for equipment to reduce the risk of black smoke formation, but in cases where it still occurs, assist gas will be added to induce air flow into the flame and aid combustion. Additionally, natural gas can be added to the flare header to dilute the heavier components and further increase the velocity.

## 6.2. Air Contaminant & GHG Emissions

The Project is committed to the health and safety of the public, which is aligned with Facility Permit condition related to ensuring that emissions from flares and incinerators does not create a hazard to public health or safety, result in off-lease odours, or result in injury to vegetation or wildlife (refer to Table 3).

Normally, flare technology has a DRE of approximately 98%; however, for this Project, the chosen flare technology has a DRE of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that byproducts of incomplete combustion, such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and Volatile Organic Compounds (VOCs) are released at extremely low quantities. The trade-off for this improved DRE is that GHG emissions will be slightly increased when assist gas is used in the flare; however, these emissions are relatively minor.

The combustion products of hydrocarbons also contribute to GHG emissions. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane. Other by-products of combustion that will be released from the flare include nitrogen oxides (NO<sub>x</sub>), and sulphur dioxide (SO<sub>2</sub>), when flaring feed gas or acid gas from the amine units.

To ensure that the project has a negligible impact on the environment and human health, comprehensive air dispersion modeling was completed as part of the EAC application, which confirmed that the B.C. AQOs would not be exceeded as a result of the LNG Canada facility for normal and emergency conditions. Further air emissions modelling is being undertaken as part of the WDA application, which includes the worst-case emergency flare scenarios (as it relates to air quality) (refer to Section 2.1.2).

LNG Canada participates in the Kitimat Airshed Group (KAG), a multi-disciplinary group that is focused on air quality monitoring and public outreach. At the time this document was drafted, the group is in the process of completing a third-party review to define the airshed boundaries and identify any gaps in continuous ambient air quality monitoring. Once any identified gaps have been closed, LNG Canada will rely on the monitoring network throughout its operations and verify results from air dispersion modelling with monitoring data.

### 6.3. Thermal Heat

When combustion occurs in the flare system, a large amount of heat is released. This heat can pose a safety risk to personnel and the environment. To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing, which could pose a fire hazard.

The height of the flare system will comply with the following thermal radiation limits provided in Table 9.

As the Project site is surrounded by trees, a potential concern that has been assessed is high thermal radiation leading to a forest fire. A maximum radiation level of 6.3 kW/m<sup>2</sup> is allowed at the boundary of the sterile zone in emergency conditions, which is significantly below the 25-30 kW/m<sup>2</sup> general guideline for spontaneous ignition of wood.

The issue of exposure of personnel to high flare radiation during work on the derrick structure was assessed (for the liquid burners). This is not a significant concern as personnel can be evacuated from the liquid burner structure prior to flaring event). The assessment also reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75-metre covered walkway is needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn. Any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure, if a flaring event occurs while personnel are in the area, and would be covered through LNG Canada's Permit to Work practice.

### 6.4. Noise

The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential impacts from noise are assessed within the Project site (occupational) and offsite (nuisance).

#### 6.4.1. Impact to Personnel on Site

The flare design includes requirements to meet the following noise limits from the Project design criteria:

- Emergency Cases: 115 dBA at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops.
- Normal operation including start-up/shutdown: 85dBA at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

The current flare system complies with both of the above criteria, based on the noise data sheets issued by the vendor; however, due to the unpredictable nature of emergency events, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the permit to work system as well as safety signage.

#### 6.4.2. Offsite Impact

Management of the impact of noise to the public is addressed through the BC OGC Noise Control Best Practice Guidelines. A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system.

### 6.5. Light

Flaring from the Project will likely result in potential light impacts to the community, particularly during Commissioning and **early stages of Normal** Operations (a "sky glow"), prior to reaching steady state operations. This potential impact has been mitigated through the design of the flare system by incorporating minimal operational flaring. The **separate** Flaring Notification Plan will outline the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts. Where possible, taking into account a number of factors, including safety, production requirements, economic impacts, and feasibility, flaring activities will be scheduled to occur during the **daytime**. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible.

### 6.6. Wildlife

The Wildlife Management Plan for operations will be developed in conformance with the EAC, and will outline the mitigation measures, including **for** migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during operations, as feasible from a technical and safety perspective (refer to Table 4). Per the EAC Condition 12, the plan will be developed in consultation with **Environment and Climate Change Canada** (ECCC), **Forests, Lands and Natural Resource Operations** (FLNRO), and the **BC OGC** as well as with Haisla Nation.



## 7. Continuous Venting Emissions

Details on the several of the streams associated with continuous venting will be provided in the waste discharge authorization application to the BC OGC. An overview is provided herein.

### 7.1. Continuous Vent Emissions to Atmosphere

Hydrocarbon (methane) vapours have a much higher GWP than CO<sub>2</sub>. LNG Canada design has incorporated measures to minimize the venting of hydrocarbons to atmosphere. Small quantities from the following sources outlined in this section from the process system are vented to atmosphere.

#### Process Analyzers

To maintain control of the process and ensure product quality requirements are met, a number of streams are equipped with continuous analyzers. There are two main emission streams from the analyzers: a stream from the sample conditioning system and the exhaust stream from the analyzer itself. In some cases, the direct vents to atmosphere are equipped with catalytic oxidizer systems (TRACErase) to convert the residual hydrocarbon to CO<sub>2</sub> and water. In other cases, the stream is directly vented to the atmosphere.

For example, approximately 3 Sm<sup>3</sup>/hr of incinerator flue gas will be vented to the atmosphere, through the TRACErase.

#### Atmospheric Storage Tanks without Vapour Conservation Facilities

As it is not practical to connect storage tanks to the flare system, storage tanks in the Project will vent directly to atmosphere during filling or during thermal outbreathing.

- Diesel, heat transfer fluid, amine, demineralized water storage tank venting to atmosphere during filling or thermal breathing. Due to the low vapour pressure of the liquids, this vapour stream will primarily be nitrogen.
- Water storage tanks including wastewater will vent directly to atmosphere. This vapour stream will be air and water vapour.

#### Secondary Compressor Seal Vents

Compressor secondary seal vents are routed to atmosphere due to the low operating pressure. During normal operation this stream is nitrogen.

- Secondary seal gas to atmosphere (all main centrifugal compressors): during Normal Operation, this will be nitrogen. In the case of a failure of the secondary seal, hydrocarbons will be vented to atmosphere until the compressor is shut down and depressurized.

### 7.2. Unplanned Vent Emissions to Atmosphere

The following are unplanned sources of hydrocarbon that could vent to atmosphere:

- Any LNG tank relief valve lifting (pressure relief valves or reserve capacity relief valves, which are on top of the LNG tank (refer to Figure 10 and Figure 11).
- Loss of both condensate tank vapour recovery blowers or vapour recovery chiller package. Due to inability to direct this stream elsewhere, the vapours from the tank will be vented to atmosphere via the pressure control valve. Note that as the condensate is stabilized, it's not expected to vent to atmosphere.
- Pressure relieve valve lifting on condensate system (main tank, vapour recovery).
- Fugitive emissions on valve gland packings, flanges, instrument connections, and relief valves routed to atmosphere. These sources will be monitored as part of LNG Canada's fugitive emission monitoring program

(A Fugitive Emissions Management Plan will be developed for the Project in conformance with LNGFR, Section 8(1)(c)).

- Depressurizing of equipment to atmosphere. Generally, the equipment is purged to the flare with nitrogen to displace any hydrocarbons; however, a small residual amount would exist that is depressurized to atmosphere as part of the isolation process.



Figure 10 Example of LNG Tank Pressure Relief Valve



Figure 11 Example of LNG Tank Reserve Capacity Valve



## 8. Continuous Flaring Emissions

Details on the specific streams associated with continuous flaring will be provided in the waste discharge authorization application to the BC OGC. An overview is provided herein (the pre-application package submitted to the BC OGC, in November 2020, included the maximum discharge rates for Normal Operations for each flare and the liquid burners).

### 8.1. Flare Pilot

During Normal Operations, fuel gas is combusted in the flare pilots as pilot gas. The pilots are designed to provide a continuous ignition source, such that any gas sent to the flare, as a result of upset conditions, is immediately combusted. The pilot flare is a small, smokeless flame, which emits minor quantities of carbon dioxide, nitrogen oxides, and water vapour.

The flame is typically about 30 cm (refer to Figure 12 for example). Generally, the flame from the pilots is difficult to see but may be visible during nighttime. During daytime, the flame is difficult to see at any distance.



Figure 12 Example of Flame Pilot Light

There are four pilots per vapour flare and a dedicated pilot per liquid burner. The design volume of pilot gas used per pilot is 2.17 Nm<sup>3</sup>/hr; and the full system this is 54.25 Nm<sup>3</sup>/hr.

As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#), section 4.4.9.1-5, pilot gas is considered as flared gas, not fuel gas.

### 8.2. Compressor Seal Gas

A small amount of process gas mixed with nitrogen is always sent to the flare through the centrifugal compressor primary seal vents as part of the seal design to contain the process gas. For example, approximately 18 Sm<sup>3</sup>/hr of seal gas is expected from PMR compressor string A.

The centrifugal compressors for the Project also have a secondary seal containing nitrogen, which is vented to atmosphere. If the primary seal fails in the compressor, this will be detected by the increased flow, then the compressor will trip and depressurize automatically to minimize any release of process gas to atmosphere.

### 8.3. Analyzer Sample Returns

Process monitoring is conducted via online analyzers, with a number of the analyzer sample conditioning systems venting excess hydrocarbon to the flare system.

For example, approximately 0.02 m<sup>3</sup>/hr of gas between from the PMR compressor to the PMR desuperheater will be vented to the cold flare.

## 8.4. Continuous Passing Valves

All control valves connected to the flare system conform to a minimum **America National Standards Institute (ANSI)** Class IV leakage specification. Emergency depressuring valves and other control valves that have been specified as “tight shut-off” (TSO), meet ANSI Class V leakage specification, as per Project standards. This ensures that the amount of hydrocarbon lost to the flare is minimized. Manual valves connected to the flare system, which are used for maintenance purposes, are blinded to ensure that the leakage is eliminated. These locations must be de-blinded to purge equipment to flare.

## 8.5. Flare Purges

The vapour flares are continuously purged to avoid air ingress in the system and potential deflagration inside the flare system. As the liquid burners do not have any continuous sources, these burners are only purged immediately after combustion to remove any residual liquid in the system.

In older facilities, fuel gas was used for flare purges, which had a GHG impact. For this Project to reduce GHG emissions, all flare headers are continuously purged with nitrogen instead of fuel gas. For example, the warm flare nitrogen purge is approximately 50 Sm<sup>3</sup>/hr. In the event of an outage, or shortage of nitrogen in the facility, fuel gas will be used for purge as a backup. The amount of fuel gas purge is approximately 280 Sm<sup>3</sup>/hr. Also, the normal operating cases for the warm flare and cold flare are greater than 12 MJ/m<sup>3</sup>; fuel gas will only be added to the minimum nitrogen purging for the storage and loading flare to increase the minimum heating value to 12 MJ/m<sup>3</sup>. Utilizing nitrogen will save approximately 5,500 kNm<sup>3</sup>/year of continuous flaring. During periods where nitrogen may not be available to purge the flare headers, alternative fuel gas connections are available to ensure a purge is always available.

The required purge volume is set either to maintain a velocity through the flare header when fouling is possible or to maintain a minimum purge volume to the flare tip to prevent ingress of air. For the Project, as there is no fouling fluids, the flare header purge is set to satisfy the required purge from the flare vendor. Each purge gas has its own differential orifice plate flow meter with accuracy typically better than 5%.

## 8.6. Continuous Incinerator Emissions

The acid gas thermal oxidizer is used primarily to incinerate acid gas from the amine regenerator. This acid gas stream contains primarily CO<sub>2</sub> (approximately 90%), hydrogen sulphide (H<sub>2</sub>S) (approximately 0.2%), and hydrocarbons (including BTEX) (approximately 7%) with the balance as water vapour. The acid gas incinerators in LNG Train 1 and 2 will also receive non-condensable gas from the condensate storage tanks when the tank vapour recovery unit is in operation; this stream is primarily nitrogen (approximately 89%) with the balance being hydrocarbons. These streams do not have sufficient heating value to sustain combustion. As such, fuel gas is used in the incinerator to generate sufficient heat for oxidization of these streams prior to release to atmosphere. With the high operating temperature and residence time of the incinerator, a DRE of 99.99% for BTEX components is expected.

In case of a thermal oxidizer trip, the overheads are routed to the warm flare, and fuel gas is added to the flare to meet the 20 MJ/sm<sup>3</sup> heat content minimum requirement.

**Note:** As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#) section 1.7.2.5, fuel gas added to the incinerator or the flare due to the low heating value of the stream is considered fuel gas and not flared gas.

## 9. Commissioning Flaring Activities

The flaring profile during the Commissioning, Start-up and early stages of Normal Operations of an LNG facility is different from the “steady state” Normal Operations of the facility.

Meticulous adherence to safety and equipment testing protocols is required to ensure a safe Start-up, but there will be a flaring profile unique to this phase. The following section outlines the Commissioning and Start-up phases. Refer to Section 10 for further information related to the early stages of Normal Operations.

### 9.1. Commissioning Overview

Commissioning of the LNG Canada facility follows these general steps:

- Flare pilot start-up and testing on liquid petroleum gas (LPG) bottles
- Pipeline Commissioning to the plant, including plant inlet de-inerting and pressurization
- Flare purge Start-up
- Gas turbine testing
- Refrigerants (ethane and propane) import to storage and cooldown of associated piping and equipment
- LNG import to storage and cooldown of associated piping and equipment
- Start-up of Acid Gas Removal (AGR) unit with feed gas to meet acid gas specification of natural gas
- Initial regeneration of mole sieve driers downstream of the AGR unit to meet moisture specification in natural gas
- Mercury bed drying to meet moisture specification in natural gas and long term mercury bed performance
- Cryogenic circuits drying with dry gas (natural gas, refrigerant, LPG)
- Compressor circuit testing
- Start-up of pre-cooling section to -50°C to meet heavy hydrocarbon specification in natural gas to liquefaction circuit
- Cooldown and Start-up of condensate stabilization unit to produce on-specification stabilized condensate product
- Final cooling of MCHE to -155°C at plant to produce on-specification LNG product

### 9.2. Commissioning Flaring Overview

The amount of flaring during Commissioning will be higher compared to the planned and unplanned flaring activities during Normal Operations. This is due to the additional testing of equipment and additional time to bring the process to specification due to Start-up of new equipment.

Another potential source of increased flaring during Commissioning could come from having to stop or reverse the Start-up process due to undetected flaws from construction and fabrication. During the construction and fabrication phase, the Project utilizes a Flawless Project Delivery program to incorporate lessons learned from previous projects to minimize the risk of an undetected flaw that could lead to delays or an early shutdown of the facility. While this is done on best effort basis, it is normal for some residual flaws to materialize during the Commissioning period.

During future start-ups of the LNG train (e.g., subsequent start-ups after the initial one), the level of additional testing is minimized, construction debris reduced, and lessons learned are incorporated to reduce the start-up duration and impacts.

There is also higher potential for black smoke generation during Commissioning and extending into the early stages of Normal Operations period due to unplanned process streams, with flows and compositions outside the design window of the flare, entering the flare and leftover material from construction inadvertently impacting flare performance. There is also potential for dust and rust to enter the flare network, which could impact the combustion properties of the hydrocarbon.

The following categories identify the potential of black smoke occurring. This has been based on prior start-up experience and the commodity being flared:

- High-potential would be a heavier hydrocarbon stream that has generated smoke at other LNG facilities.
- Low-potential would be a lighter hydrocarbon stream that does not have a history of generating significant smoke at other facilities.

The following section describes the Project Commissioning plan and the strategies to reduce the amount flared at initial start-up. There are various activities that occur during this period; outlined in the section below.

### 9.2.1. Pipeline and Inlet Facility Start-up

Prior to Start-up of the LNG facility, the feedstock pipeline will be commissioned.

A portion of the CGL pipeline will be purged through the Project flare system. The CGL pipeline will be preserved and dried after mechanical completion and the pipeline up to the Kitimat Metering Station will be filled with on-specification natural gas.

The section from the Kitimat Metering Station to the Project site will be preserved with nitrogen until the facility is ready to start using gas.

Once the flare pilots have been lit on LPG bottles, natural gas will be introduced at the Kitimat Metering Station and the nitrogen displaced to the flare system through the Start-up fuel gas heater. Once the nitrogen has been displaced and the LP fuel gas header has been inventoried, the flare pilots will be switched to LP fuel gas. The required minimum flow to operate the Start-up fuel gas heater is approximately 1,000 te/d. Any gas not utilized in the facility as fuel gas will be flared until the Start-up gas heater is no longer required.

Once warm heat transfer fluid is available, the remainder of the inlet facility will be pressurized shortly before the Start-up of the LNG Train 1.

It is expected that up to six months will elapse between Commissioning of the pipeline and LNG Train 1 Commissioning. During this period, the pipeline will initially be used to:

- Supply the flare pilots
- Supply common fuel gas headers
- Supply fuel gas to the gas turbines for early testing (solo run, N<sub>2</sub> run)
- Supply vacuum protection for LNG storage tank after LNG import

During this time period, the performance of the flare is expected to be smokeless with a height of approximately 20% of the flare stack length (approximately 24 metres).

### 9.2.2. Refrigerant Import

Refrigerant grade liquid ethane and propane will be imported into the facility to avoid the need to initially produce the refrigerant prior to LNG production. The decision to import the refrigerant will save approximately two weeks of flaring from the facility with the LNG train at minimum turnaround.

For ethane and propane import, hydrocarbon vapour is introduced into the refrigerant storage spheres to displace the nitrogen to prevent auto-refrigeration. Introduction of vapours is also done at a controlled rate to stay within the differential temperature limits, between various sections of the piping and storage tanks, and avoid any resultant mechanical stresses due to rapid cooldown. This cooldown step results in approximately 43 tonnes of both ethane and propane lost to the flare. This will be flared through the cold dry flare.

During the displacement of nitrogen to the flare, there is higher potential for black smoke generation, due to the heavier composition of the gas and the low flow rate to the flare limiting mixing at the flare tip. The expected duration of flaring is approximately 6 to 12 hours, per sphere, with two spheres being purged initially, and the third sphere being purged after LNG train Start-up (refer to Figure 13).

As the import would occur after the pipeline and inlet facility have been commissioned, there is the option to open the fuel gas purge to the flare header, to help increase mixing at the flare tip, while diluting the ethane and propane with methane from the pipeline.



**Figure 13 Potential Flaring profile during refrigerant import**

Once started up, it is not expected that ethane or propane sphere will contribute to flaring for the following reasons as the:

- Vapour from the spheres is normally routed to the LNG tank and is mixed with BOG
- Propane sphere design and normal operating pressures are above vapour pressure; therefore, excess propane vapor generation is not expected during holding mode
- Ethane sphere is insulated and includes a chiller package to prevent ethane loss

### 9.2.3.LNG Import

LNG will be imported from an LNG carrier to allow for cooldown of the LNG circuits and LNG storage tank.

This will avoid using LNG produced from LNG Train 1 to cool down these circuits and reduce the amount of LNG flared during the Commissioning period, as the LNG can be fully directed to the storage tank, once it meets specification, instead of flaring a portion of the LNG produced by the train, as the remainder is used to cool the rundown piping and tank.

Import of LNG reduces the expected flaring by approximately 51,800 Te, due to the avoidance of using LNG from Train 1 to cooldown the piping and LNG storage tank.

At start of cooldown, LNG vapour from an LNG carrier will displace nitrogen to flare, approximately 36 Te over 10 hours (refer to Figure 14). During the cooldown of the piping and LNG tank, a large amount of LNG is vapourized to bring the components to cryogenic conditions. Vapours will also be introduced at a controlled rate to stay within the differential temperature limits between various sections of the piping and storage tanks to avoid any resultant mechanical stresses due to rapid cooldown. This results in flaring of approximately 7776 Te over 72 hours.

Once the cooldown is complete, the remaining LNG will be transferred from the LNG carrier to the storage tank over 40 hours, leading to approximately 7920 Te of flaring during the transfer. Once the LNG has been imported, the system will be in holding mode until LNG Train 1 start-up.

Due to heat leak into the system, BOG will be produced and disposed of to the flare until the BOG compressors are able to be started and recycle the BOG into the fuel gas system. This is not expected to happen until close to LNG Train 1 Commissioning, when there is a demand for high pressure (HP) fuel gas and the BOG flow is sufficient to allow a compressor to operate in recycle with quench. Until this time, it is expected that approximately 18 Te/hr of BOG will be directed to the flare.



**Figure 14 Examples of an LNG Import Flare size during day and night**

The potential flare profile for the LNG import is shown below. Flaring will occur from the low-pressure (shipping and loading) flare, which is designed as a utility flare and has a lower exit velocity than the sonic flares. Once the BOG compressor is online, this gas stream will be redirected to the cold-dry sonic flare until there is sufficient demand for the gas in the fuel gas system or as part of Train 1 Commissioning.

The flame is expected to be smokeless due to the composition of the gas and will occur from the period where LNG is imported until Train 1 is started.

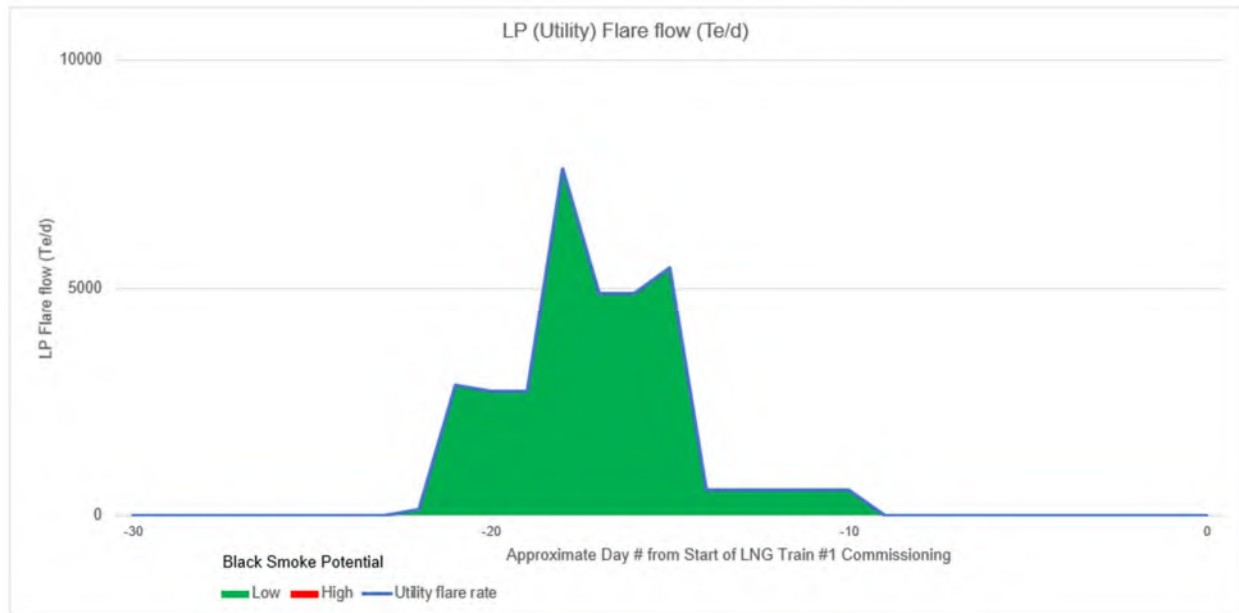


**Figure 15 Potential Flaring profile during LNG import prior to LNG Train 1 Commissioning**

#### 9.2.4.LNG Train 1 Start-Up

The Commissioning of the first LNG train is expected to lead to additional flaring compared to future LNG train Commissioning due to the lack of defrost gas to allow dry out of the cold end to occur concurrently with the dry out of the mercury bed which, in subsequent start-ups, is not a problem as dry defrost gas is available from another running train.

In addition, during the Commissioning of LNG Train 1, it is expected that material left over from construction and pre-commissioning may become trapped in temporary strainers and will need to be removed during start-up or shortly after production is achieved, thus requiring multiple starts and stops. The material may include pipe scale, general fouling, as well as foreign material, such as PPE and welding rods, left by craft. Mitigation measures to minimize left over material includes inspections and implementation of the cleanliness/preservation specifications. During the initial start-up of the LNG train, the bulk of the flaring will occur through the sonic flare (Warm-wet and Cold-Dry) and will consist of a similar composition to natural gas.

Black smoke generation can occur during the start-up of the condensate stabilization unit overhead compressors. However, during the initial start-up, it is expected that this step will occur concurrently with flaring from the rest of the LNG train reducing the potential for smoke generation.

At the peak flaring rate, the flame height is expected to be approximately 50% of the length of the flare derrick (approximately 60 metres). The total duration of the Start-up period will depend on equipment performance. A preliminary flare profile for the vapour flares and liquid flares are provided in the below figures.



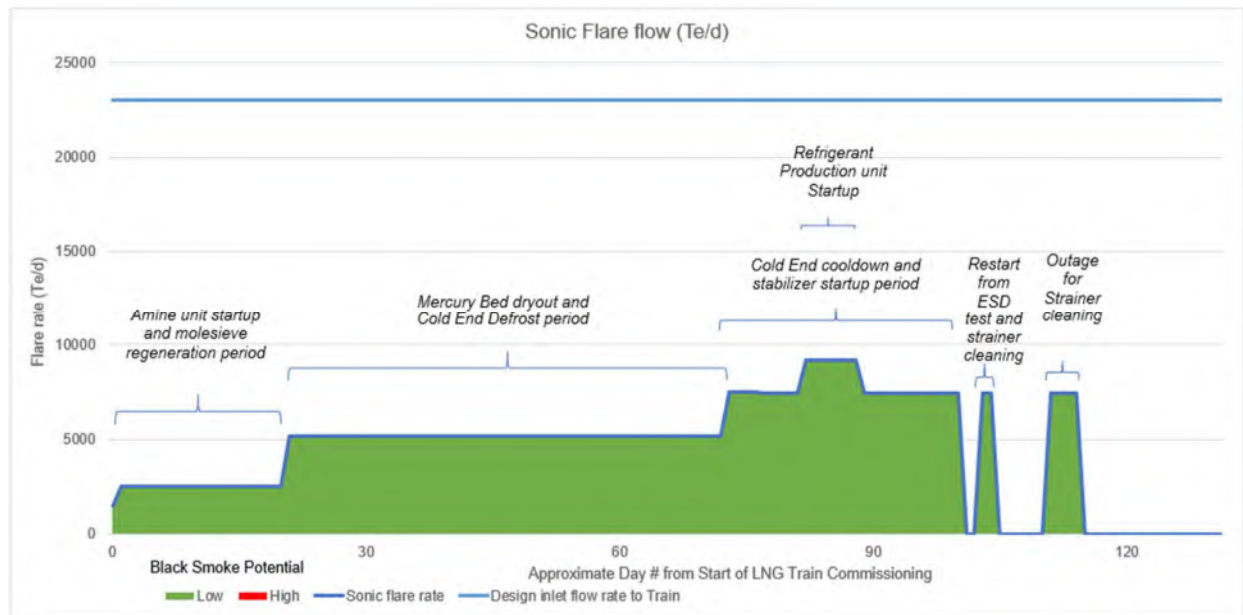


**Figure 16 Potential Flaring profile during LNG Train 1 Start-up – Vapour Flares**

The liquid burners will be used to dispose of condensate and LNG from the train. Based on experience from other LNG start-ups, there is high potential for black smoke generation during condensate combustion due to the composition of the stream. The liquid burners are equipped with assist gas to promote air entrainment into the flame and early start-up of the condensate stabilizer, reducing the time required to meet specification before running down to the condensate storage tank.

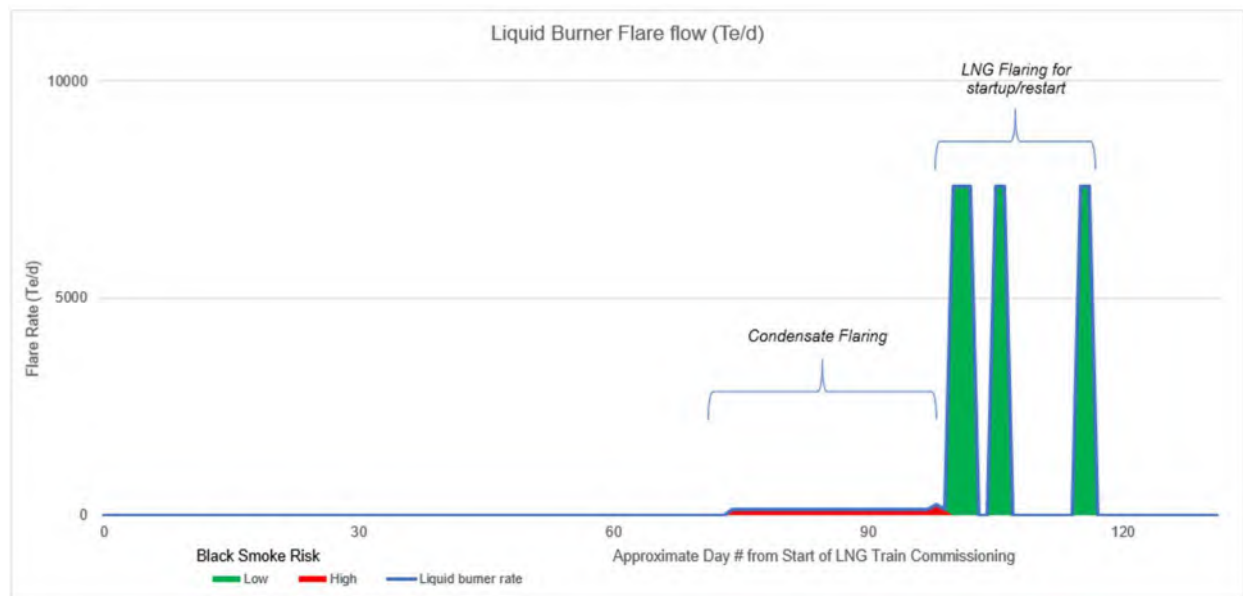


**Figure 17 Potential Flaring profile during LNG Train 1 Start-up – Liquid Burners**

#### 9.2.5. Acid Gas Removal Unit Start-up and Molesieve Regeneration Period

Depending on the level of cleanliness during pre-commissioning (chemical cleaning), the start-up of the AGRU and drier unit could be two to three weeks. During this time, the amount of flaring has been assumed at approximately 2,400 Te/d.



Further turndown below the design minimum, will be evaluated during the actual start-up but will be limited by the system's ability to maintain treated gas on specification for CO<sub>2</sub> and BTEX. It will also will depend on amine absorber internal performance.

The flare performance is expected to be smokeless during this period due to the composition and flare rate with flaring from the sonic flares with a flame height of approximately 38 metres.

From the stabilization of the amine unit, the start-up progresses to the drier unit where the molecular sieve drier beds will be regenerated to produce dry gas. At the completion of the regeneration of the drier beds, the inlet flow rate will be ramped up from approximately 2,400 Te/d to approximately 5,000 Te/d, which will be flared.

The flare is expected to remain smokeless at this point, but the flame will increase in height to approximately 53 metres.

#### 9.2.6. Mercury Bed Drying and Cold End Defrost

The mercury removal unit requires thorough dry down before introducing feed gas to the cryogenic section as any mercury in the feed gas can impact the integrity of the aluminum components. The bed will be pre-dried extensively with nitrogen; however, the effectiveness of this drying will be dependent on the ability to maintain sufficient flow through the bed.

It is assumed that potentially 18 days will be needed to dry the mercury bed at an inlet rate of 5,000 Te/d to maintain the amine unit specification during this period of time.

At the completion of dry out of the mercury bed, defrost gas will be available to begin dryout of the cold end without jeopardizing the integrity of the aluminum components. Some of the flow currently routed to the warm-wet flare will be instead routed to the cold-dry flare. Although the same amount of gas is flared, the overall height may be reduced at times due to this diversion.

During the start-up of the cold end, the inlet rate is ramped to approximately 7,400 Te/d, which is the minimum rate to maintain integrity of the coil wound heat exchangers and to provide minimum heat sink for the pre-cooling section. Initially, the various loops are dried using defrost gas from the warm end to dry the equipment. Once the equipment is dried, refrigerant is introduced to the various loops and the compressors are surge tested.

The testing of the main refrigerant compressors, followed by testing and start-up of the pre-cooling section, may take up to four weeks, after which point this section can be cooled down prior to the final cooldown of the MCHE.

Initially, the flaring will be similar to the previous steps with natural gas going to the sonic flares. As part of the cooldown process, unstabilized condensate is produced, which is routed to the liquid burners prior to the start-up of the condensate stabilization unit.

This could take up to two weeks depending on any stoppages to clean strainers. The flaring from the liquid burners may produce black smoke due to the heavy composition of the condensate.

#### 9.2.7. Cold End Cooldown and Condensate Stabilization Start-up

For the condensate stabilizer start-up, condensate is inventoried into the system and circulation is established. When the condensate from the LNG train has reached its normal operating condition, this stream can be redirected from the liquid burners to the stabilization unit. After introduction of the unstabilized condensate, any condensate produced from the stabilizer is routed to liquid burners until it is confirmed to be on specification and can be routed to the storage tank.

Once the condensate stabilizer is started, the overhead compressors are started and surge tested. During this period, the overhead gas will be flared until all testing is complete. This stream is expected to be smoke free primarily because it will be diluted with natural gas from the rest of the unit. If this stream is burned by itself, there is risk of black smoke from the flare due to the heavier composition of the stream. This would be mitigated by dilution of the stream with natural gas to the flare tip. The produced condensate would be similar to the unstabilized condensate and could produce black smoke.

The final cooldown of the MCHE is the **last** step before the production of LNG. The final cooldown must be done for integrity reasons at no less than the minimum turndown of the LNG train (approximately 7,400 Te/d) throughput, and the rate of temperature change is limited to ensure equipment integrity as the piping and exchangers cool to their operating temperatures. **This** flow has to be diverted to flare(s) until the LNG is subcooled enough to avoid potentially over pressurizing the LNG tank from hot rundown

During cooldown, the gas will be flared through the Cold Flare (F-CD) and LNG will be routed to the liquid burners. The flame of the liquid burners will be luminous, larger **in scale**, with low potential for the generation of black smoke (refer to Figure 18).



**Figure 18 Example of Liquid Burners at night in final cool down**

#### 9.2.8. Emergency Shut Down Test

**A**fter completion of the initial start-up and production of LNG, the facility may be required to be tripped to perform a final verification of the instrumented-protective functions. After this test, the LNG train will be restarted. The flare will appear similar to the final cooldown phase of the start-up.

### 9.3. Subsequent LNG Train Start-Up

The Commissioning of subsequent LNG trains is expected to be of a shorter duration due to incorporation of lessons learned from LNG Train 1 and the availability of the defrost gas from online LNG trains to allow concurrent dry out of the mercury bed and cold end. Otherwise, the start-up follows a similar sequence except for the start-up of the refrigerant production unit. The potential flare profile is presented in Figure 19 and Figure 20.

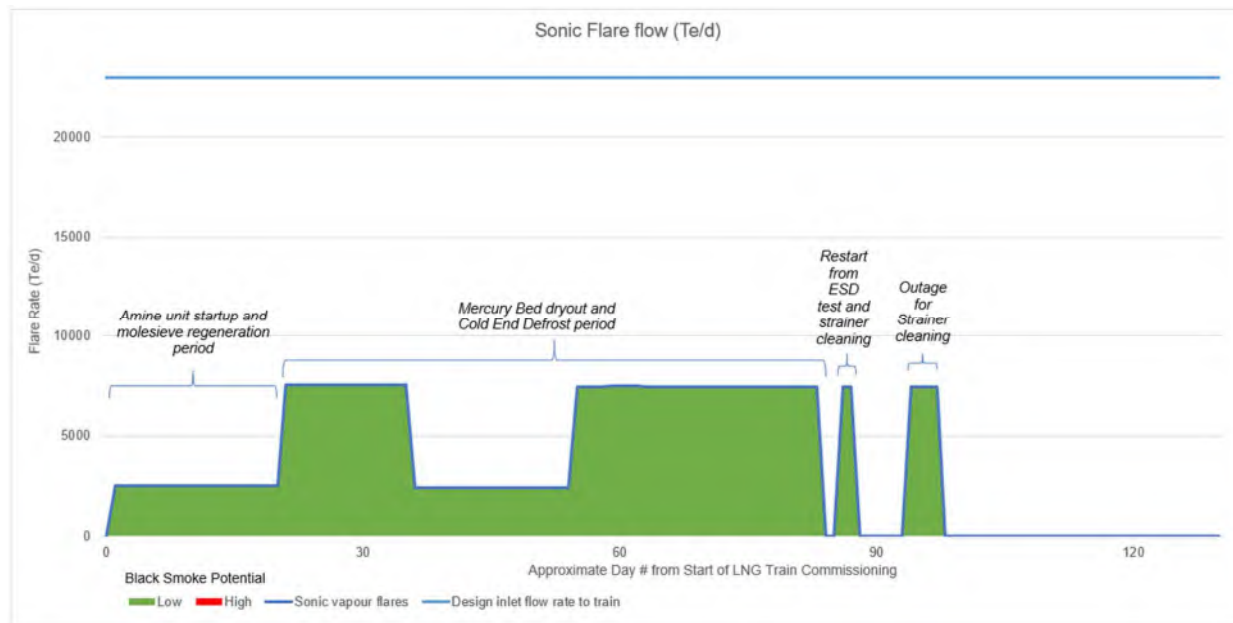


Figure 19 Potential Flaring profile during LNG Train 2 start-up – Vapour Flares

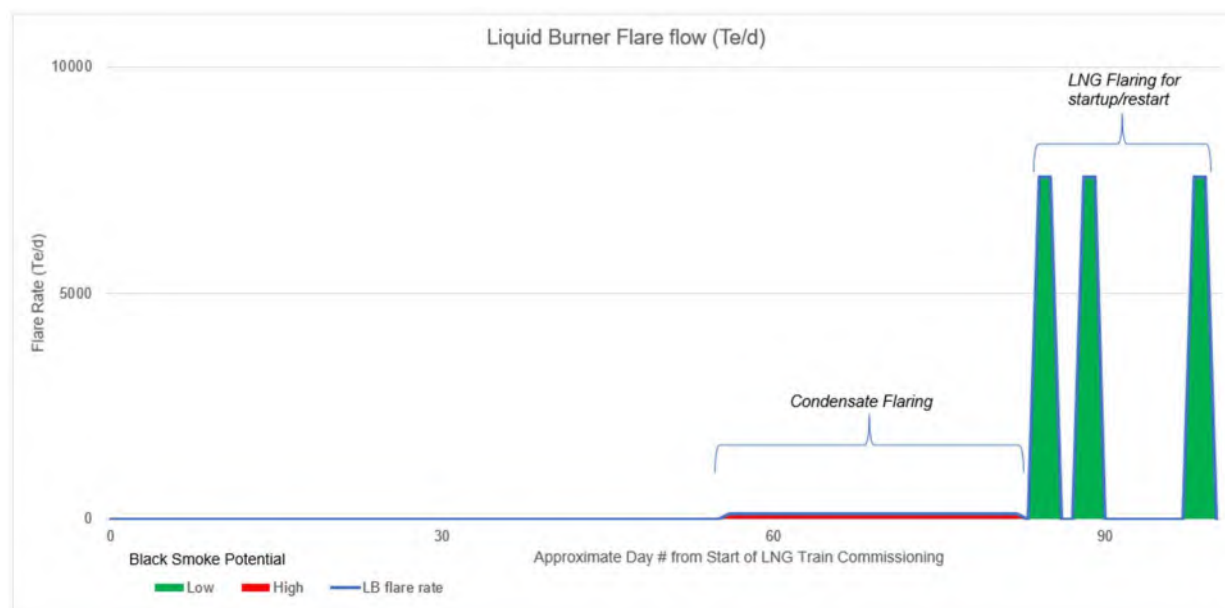


Figure 20 Potential Flaring profile during LNG Train 2 start-up – Liquid Burners

#### 9.4. Refrigerant Production Unit (RPU) Start-Up

Due to initial import of the ethane and propane refrigerant, the start-up of this unit can be done after LNG rundown occurs from LNG Train 1.

During start-up of the RPU, flaring will occur as nitrogen is displaced from the unit and will continue until the residual gas compressor can be started to return the residual hydrocarbon to the LNG train. Refrigerant from the storage spheres can be used to inventory the overhead receivers of the de-ethanizer and de-propanizer to reduce the time needed to bring the refrigerant on-specification. Once the refrigerant is on-specification, this stream will be routed to the storage

spheres and any gas overheads from the de-ethanizer and de-propanizer are recycled to the LNG tank to avoid flaring. Heavy hydrocarbons from the de-propanizer bottoms liquids are recycled to the natural gas stream through reinjection into the suction of the residual gas compressor.

The ethane and propane refrigerant are slowly and gradually lost due to compressor primary seal gas venting, maintenance of refrigerant containing equipment, refrigerant composition adjustment (MR and PMR), etc. Due to these losses, it is expected that the RPU will be operated approximately twice per year to produce ethane and propane refrigerants.

The following start-up lines are further installed to reduce flaring during RPU start-up:

- De-ethanizer column ethane vapour import from refrigerant storage
- De-ethanizer reflux ethane liquid import from refrigerant storage
- De-propanizer column propane vapour import from refrigerant storage
- De-propanizer reflux propane liquid import from refrigerant storage

During RPU operation:

- Gas overheads from de-ethanizer and de-propanizer are recycled to the LNG tank
- De-propanizer bottoms liquids are always recycled to natural gas stream
- Gas overheads from de-methanizer are recycled to natural gas stream

## 10. Early Stages of Normal Operations Flaring Activities

During the early stages of Normal Operations (typically up to two years), there will be increased trips and a higher likelihood of unplanned outages to correct any operational issues. This period is characterized by a higher unreliability rate of equipment and more intensive facility organizational learning to resolve challenges. These events lead to flaring during the restart of the facility and any purging of equipment for maintenance.

Based on industry-wide benchmarking, there will be approximately 20 trips and two unplanned outages, per LNG train, per year, during this period. After a trip, up to two days of flaring can occur depending on the time required to identify and correct the cause of the trip. This does not include any depressuring or preparation of equipment for maintenance.

In the case of an unplanned outage, it is likely that equipment will need to be opened, which will require displacement of hydrocarbon from the system to create a safe working environment as well as an extended start-up due to having to cool the equipment in the cold end of the facility. Figure 21 provides an example of the flaring profile for an unplanned outage, including a period to purge hydrocarbon from the equipment followed by a subsequent restart period. Actual profiles will depend on equipment to be opened and ability to maintain a portion of the facility on standby.

The flaring profiles in Figure 21 and Figure 22 provide an overview of what the Commissioning and early stages of Normal Operations of LNG trains 1 and 2 for the facility could look like. These graphs incorporate assumptions based on benchmarking of other similar facilities to account for unplanned outages and trips during the first two years of operation. It includes a number of trips, and two unplanned outages per train, to correct issues and also shows an improving reliability over time as early failures are corrected and reliability stabilizes.

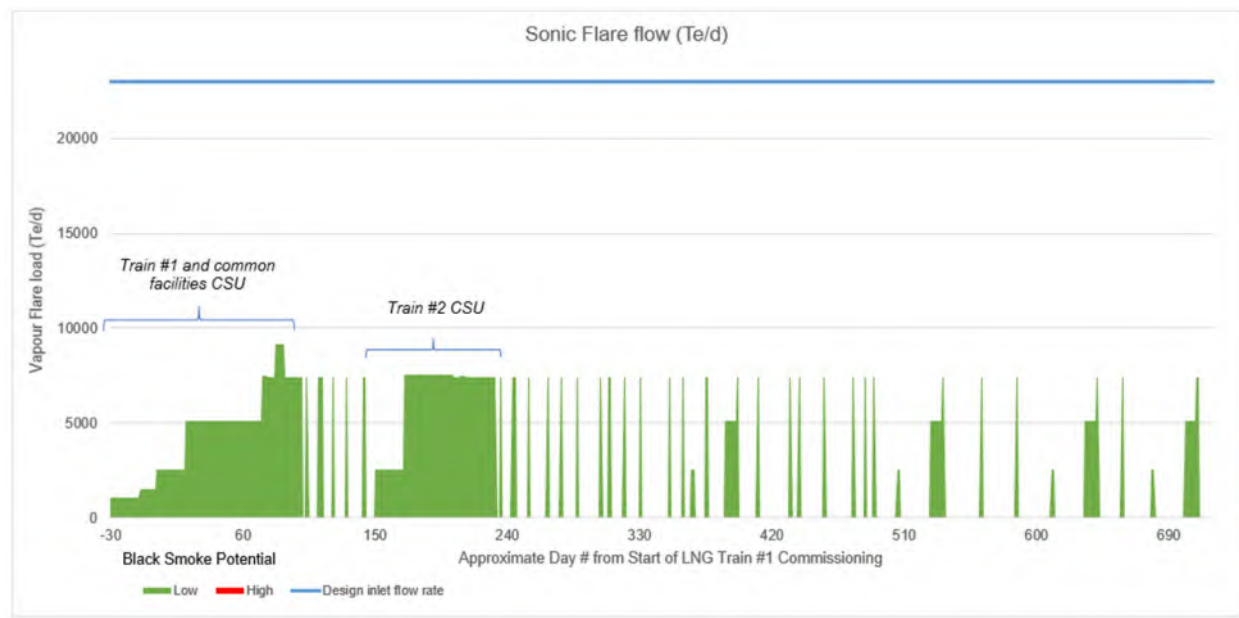


Figure 21 Vapour Flare Load Profiles – First two years of Normal Operations

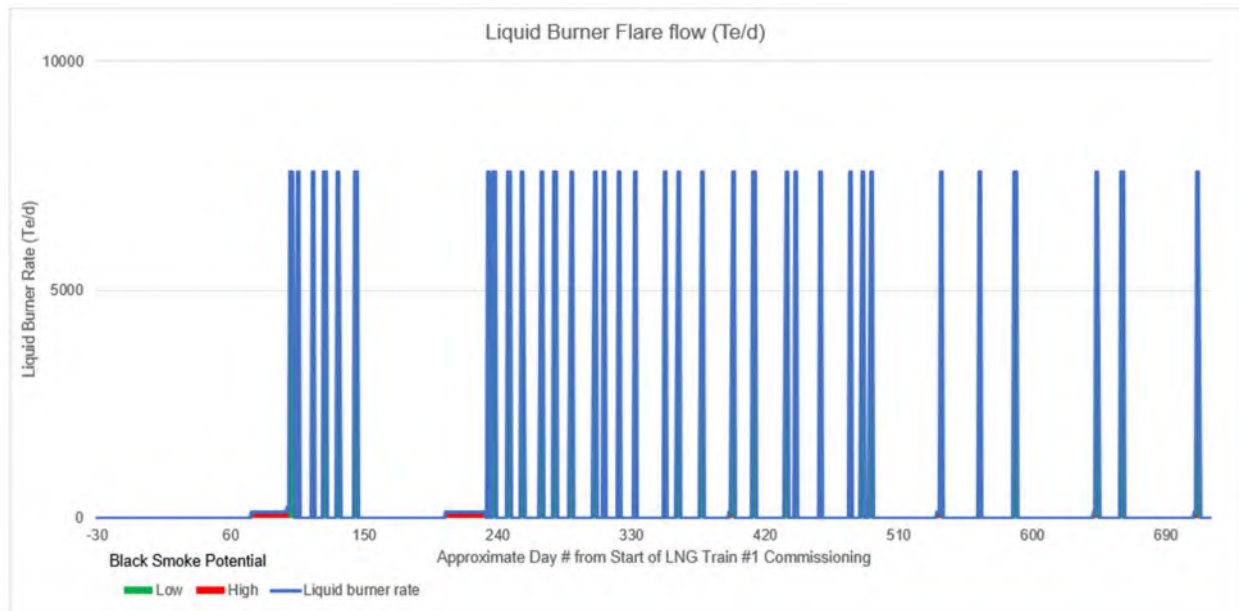


**Figure 22 Liquid Burner Profiles – First two years of Normal Operations**

When an LNG train is required to be shut down for corrective maintenance, similar to a future turnaround, flaring will occur as the hydrocarbon is removed from the equipment to create a safe working environment. Once the maintenance work is completed, the LNG train would need to be started similar to the start-up that occurred as part of Commissioning.

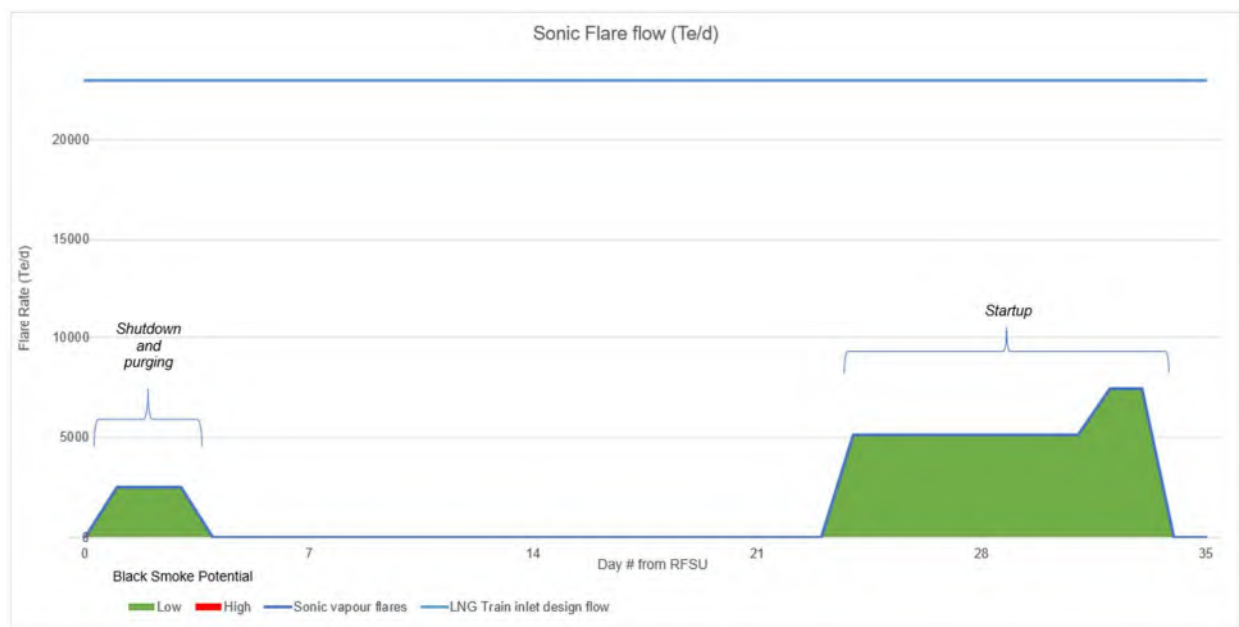


**Figure 23 Outage Flare Profile - Vapour Flare**

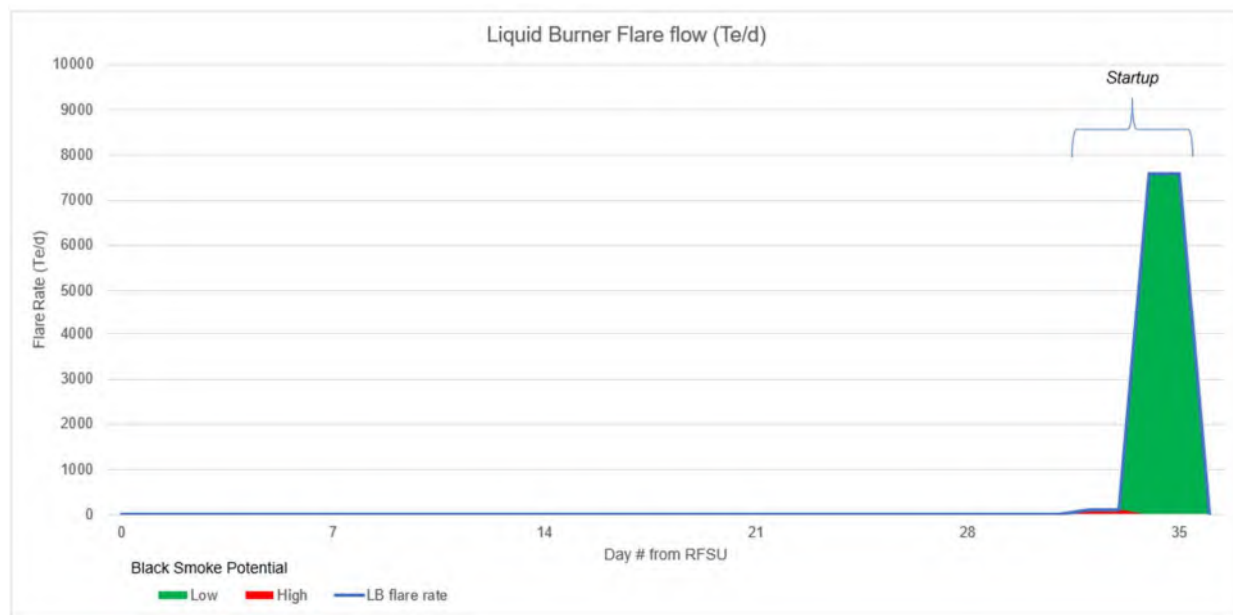


Figure 24 Outage Flare Profile - Vapour Flare

## 11. Planned Flaring Activities During Normal Operation and Turnaround

In general, due to the design of the flare system, routine flaring for maintenance or turnaround would not result in any impact to ambient air quality objectives (addressed through the permitting process); however, it may result in potential light impacts, as well as an increase in sound levels, due to the requirement to purge the equipment in the plant and to flare gas during Start-up, until the plant is performing at specification.

### 11.1. LNG Train Turnaround

There are two main types of planned shutdowns based on a 6-year turnaround cycle for the molecular sieve beds:

1. **Boroscopying of each aeroderivative gas turbine:** it is needed every year. However, with parallel 50% strings, this can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring. Nevertheless, some depressurizing and purging may be required to create a safe working environment.
2. **Planned turnarounds:** a turnaround is a major event where an entire LNG train is taken offline for equipment inspection and catalyst replacement (note, other equipment in the common facilities, such as feed gas pre-heaters, feed gas filters, etc., may also be taken offline at the same time to utilize the opportunity and will add to the de-inventory volume). Initially, a first turnaround is scheduled out of sequence to allow for any changes or repairs due to issues identified during Commissioning and Start-up. Afterward, the individual train turnarounds are scheduled every three years, alternating between a minor (approximately 14 days) or a major (approximately 20 days) turnaround.

Planned turnarounds will occur in a single LNG train at a time and will require de-energizing and de-inventorying of the hydrocarbon, in the LNG train, to allow for safe inspection by LNG Canada Maintenance. This will entail flaring for de-inventorying and purging, as well as during LNG train restart. To maximize the amount of refrigerant recovered during this activity, the ability to recover PMR has been included in the design of the facility. The PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train. Likewise, in preparation for shutdown, the MR circuit can be lowered by directing MR to the stabilization unit. The level in the stabilizer will be displaced to the storage tank via pressure in the column to minimize remaining liquids that would need to be disposed of via the liquid burners.

Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, assist gas will be added to the flares to maintain the lower heating value above 20 MJ/m<sup>3</sup>; this is expected to take between 12 to 24 hours.

#### 11.1.1. Restart from Turnaround

After a turnaround, the LNG train will first be inerted with nitrogen to remove any air from the system and partially dry the unit. At this point, the amine unit will be inventoried from tankage and natural gas will be inventoried into the train to displace the nitrogen. Once the nitrogen is displaced, dried natural gas (de-frost gas) from an online LNG train will be introduced to dry the LNG train to specification to allow inventorying of the refrigerant. This is expected to take approximately up to three days and result in approximately 1,500 Te of gas flared. After the LNG train has been dried, refrigerant will be inventoried in the liquification unit and the feed gas will be introduced into the LNG train and flared through various units until they are on-specification.

Initially, once feed gas is introduced, it will be flared via the warm wet flare from the outlet of the amine absorber until confirmed to be on-specification for CO<sub>2</sub>. This is estimated to take approximately up to 12 hours.



In the case that the molecular sieve has been replaced, it will have to be regenerated to remove atmospheric moisture. This will require approximately two additional days of flaring at the minimum design throughput. The mercury bed will also require replacement through the life of the facility and will require additional flaring to dry the bed. It is expected this replacement would occur approximately every eight to 10 years, depending on the mercury content of the feed gas to the facility.

Once the molecular sieve unit is confirmed on-spec, the gas can be introduced into the liquification unit, and the system can start cooling. Initially, it will be cooled to -50°C, where the gas off the flash vessel will be confirmed to be on-specification for heavier hydrocarbon (C5+) content after which the rest of the liquification will be cooled until on-spec for routing to the LNG tank. It is estimated to take between 24 to 36 hours from start of cooldown to LNG production.

The stabilizer column will initially be inventoried from the stabilized condensate header to tankage, which will allow this column to be warm and operating once C5+ feed is available from the flash vessel. Minor flaring from the column will occur until the stabilizer compressors are able to be started to recycle this stream back to the liquification section.

## 11.2. De-inerting of LNG Carriers

The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification of less than 50 parts per million (ppm) to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with inert gas prior to loading. These tanks need to be purged and cooled down with LNG from the facility. During the purging and cooldown process, the vapour return is sent to low pressure flare until confirmation that CO<sub>2</sub> specifications have been met (based on laboratory sampling). Upon confirmation, the vapour is then routed to the storage tank and BOG compressors. There are no requirements to vent from the inerted LNG carrier.

The ships requiring de-inerting are planned in advance as part of the yearly delivery plan. An LNG carrier requiring de-inerting requires approximately three times the LNG carrier volume to be flared (approximately 3 x 150 000 m<sup>3</sup>). During this time, assist gas is added to the flare to ensure the minimum heating value is maintained. A dedicated fuel gas line ("dilution gas") at the bottom of the Storage and Loading Flare is provided. It is metered as fuel gas at 62FI300 (Ultrasonic, P&T compensated) through an automatic hand controller (62HIC300).

De-inerting and cooldown of the ship's tanks is expected to take approximately 24 hours before normal loading can begin. It is expected that the de-inerting process is limited to six inert ships per year.

## 11.3. Adjustment of PMR Composition at PMR Reclaimer

High levels of non-condensable gases (methane/ nitrogen) in the refrigerant circuit will significantly impact plant production and efficiency due to the condensing pressure increasing. To return to normal performance, the non-condensable gas will need to be purged from the refrigerant system. This is normally done by purging the non-condensable gases through the PMR reclaimer condenser which is installed as part of the PMR accumulator. The reclaimer re-condenses the refrigerant using the cold PMR liquid flowing across the tubes, which drops back into the accumulator and any residual non-condensable are then sent to the stabilization unit for reprocessing and returned back to the natural gas stream, but during abnormal situations this stream may be sent directly to flare if required for process considerations.

In addition to light non-condensable vapors, PMR refrigerant can also be contaminated by heavy components which cannot be reclaimed or reprocessed. These small quantities will bleed to the flare to remove heavy components from the PMR inventory.

## 11.4. Adjustment of MR composition at HP MR Separation Vessel

Similar to the adjustment of the PMR composition, the MR composition must be carefully adjusted in the MR refrigerant circuit, as it can significantly impact plant production and efficiency due to the degradation of thermal approaches in the cryogenic system. The MR composition is adjusted at the HP MR separation vessel:

- Liquid from the HP MR separation vessel will be recycled to the condensate and stabilisation unit inlet with no flaring
- Vapour from HP MR separation vessel will be recycled to the top of the stabiliser overhead compressor with no flaring

In abnormal situations, adjustment of the composition may be done by directing the vapour from the drum to the flare.

## 11.5. Refrigerant Production Unit (RPU) Turnaround

The ethane and propane refrigerant are slowly and gradually lost due to compressor primary seal gas venting, maintenance of refrigerant containing equipment, refrigerant composition adjustment (MR and PMR), etc.

It is expected that the RPU will be needed to be started twice per year, for a two-to-three-week period each time, to produce ethane and propane refrigerants until storage is full before shutting down and de-inventorizing again.

The unit can be filled and then reliably started at design throughput of 73 t/h.

The following start-up lines are further installed to reduce flaring during RPU start-up:

- De-ethanizer column ethane vapour import from refrigerant storage
- De-ethanizer reflux ethane liquid import from refrigerant storage
- De-propanizer column propane vapour import from refrigerant storage
- De-propanizer reflux propane liquid import from refrigerant storage

Additionally, during RPU operation:

- Gas overheads from de-ethanizer and de-propanizer are recycled to LNG tank
- De-propanizer bottoms liquids are always recycled to natural gas stream
- Gas overheads from de-methanizer are recycled to natural gas stream.

Therefore, once the RPU is operational, the flaring will be limited to cooldown of the unit expander generator, columns, and cryogenic pumps over approximately one day. The volume sent to the flare is expected to be negligible (less than 10,000 m<sup>3</sup>), similar to what would occur from routine maintenance on similar equipment in the facility.

Each campaign will last about two to three weeks until each of the refrigerant spheres are full. When the campaign is finished, the unit will be left with hydrocarbon vapour at a low pressure until the unit is needed again. If the unit is required to be opened for maintenance, the hydrocarbon vapour will be displaced to the flare with nitrogen.

The de-inventorization for preservation involves about 130 m<sup>3</sup> of equipment with an average gas pressure of 50 kPa or, approximately 2 tonnes of gas, to be flared to the Cold Dry Flare over one to two days. Any remaining liquids will be drained to the flare system and allowed to vapourize in the flare KO drums, unless ongoing activities require the liquid to be disposed of in the liquid burners.

## 11.6. Relief Valve Inspection and Overhaul

The plant comprises of about 400 installed Relief Valves for about 300 systems. Initially, they will be inspected every 18 months; then, they may be inspected on a variable testing frequency, depending on a risk based inspection study

outcome. Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.

For example, de-inventorizing four meters of 4" diameter piping represents 20 to 30 litres with an average density of 50 kg/m<sup>3</sup>; therefore, 1 kg/relief valve. This represents overall venting of approximately 500 kg over a six-year cycle.

### **11.7. Routine Maintenance Activities**

Individual equipment requiring on-line servicing needs de-inventorization before safe maintenance can be allowed. During re-commissioning it requires gas-in and sometimes cooldown. Volume is usually small, but could exceed 10,000 m<sup>3</sup>.

## 12. Unplanned Flaring Activities

Unplanned flaring can occur at any time as a result of an upset condition in the facility. During an unplanned flaring event, operations will first undertake any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service, if it is safe to do so.

If the equipment cannot be readily returned to service within four hours, the Operations Shift Team will coordinate with LNG Canada Production Scheduling department to undertake actions to reduce facility throughput to minimum turndown, if required to reduce flaring. The facility has a design minimum turndown of 50% for the equipment and this will limit the turndown to 50% of the design rate to prevent potential equipment damage.

Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair, LNG Canada Production Scheduling will optimize the production plan and LNG carrier arrival within any pre-existing limits to minimize flaring and economic loss.

LNG Canada will investigate flaring events greater than 10,000 m<sup>3</sup> through the incident reporting system and correct causes of repeated non-routine flaring, incinerating, or venting as part of continuous improvement. The investigation reports would be available to the regulator upon request.

### 12.1. Unplanned equipment failure or repair

Not all equipment in the LNG facility has an installed spare. As such, the failure of single piece of equipment can lead to flaring while the process is stabilized and equipment is de-inventorized, before safe maintenance can be allowed. The volume is usually small, but could exceed a 10,000 m<sup>3</sup> threshold for notification, when considering nitrogen purging activities required to provide a safe working environment.

### 12.2. Flash Gas Compressor Trip

The Flash Gas Compressor is used to recover gas absorbed in HP amine absorber bottoms and let down in the amine flash vessel. This stream is normally recycled to inlet amine treating. Whenever the flash gas compressor trips, the flash gas is diverted to the Warm Wet Flare.

The duration of flaring can be variable depending on cause of incident. Flaring will take place until such time that the Flash Gas Compressor is returned to service. The expected flow is approximately 2,200 Sm<sup>3</sup>/hr and is expected to be smokeless based on the composition and volume.

Since the flash gas generated is related to the amine circulation rate, as the amine enters the flash vessel saturated with hydrocarbon, in order to reduce flare volume, the amine circulation rate needs to be reduced. Operations will reduce the amine circulation rate and associated feed gas rate until either the amine is at minimum turndown or the feed gas is at minimum turndown.

### 12.3. Acid Gas Thermal Oxidizer Trip

The acid gas thermal oxidizer is used to thermally oxidize acid gas coming from acid gas regenerator overheads. The stream consists of CO<sub>2</sub>, water vapour, some entrained hydrocarbons (approximately 54%), and a small amount of H<sub>2</sub>S (less than 0.2% typically). The incinerator may also oxidize a non-condensable stream from the condensate storage tank, which is typically approximately 89% nitrogen with the balance as light hydrocarbon. This stream is not rich enough to be combustible and is incinerated, together with assist fuel gas and sufficient excess air, to oxidize the H<sub>2</sub>S and hydrocarbons into SO<sub>x</sub> and CO<sub>2</sub>, and water while the CO<sub>2</sub> undergoes no further oxidation and is released to atmosphere.

In case of thermal oxidizer trip, the overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere, which occurs in other LNG plants. The amount

routed to flare is approximately 26,444 Nm<sup>3</sup>/hr and is expected to have smokeless combustion and depends on the CO<sub>2</sub> content of the feed gas. Fuel gas is added to the flare to meet the minimum heating value requirement via fuel gas controller at Warm Flare Knock-out drum. The control scheme makes use of last known values of flow indication and Lower Heating Content from the analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.

Reliability of thermal oxidizer is typically high after Commissioning and Start-up with planned maintenance occurring during LNG train turnarounds when the upstream amine regenerator is offline.

The duration of flaring can be variable depending on cause of incident, which may be a few hours in the case of an instrument malfunction, to longer duration in the case of refractory damage. If Operations are unable to restart the incinerator, the feed gas flow to the LNG train will be reduced to minimum turndown to minimize the amount of acid gas routed to flare.

## 12.4. Regeneration Gas Compressor Trip

The Regeneration Gas Compressor is used to recover natural gas used for regeneration of the molecular sieve drier beds, which remove water from the feed gas prior to liquification. The Regeneration Gas Compressor circulates gas through the beds to regenerate the molecular sieves for service based on a described cycle. This is a requirement prior to liquefaction.

Whenever the centrifugal regeneration gas compressor trips, gas is diverted to the Warm Wet Flare during the regeneration cycle. The expected flaring volume is 66,000 Nm<sup>3</sup>/hr during regeneration. With the flare design, this is expected to be smokeless combustion. The regeneration compressor does not have the capability to be restarted from settle out pressure but will require depressurization to suction conditions; however, this is a small volume of hydrocarbon as the pressure differential across the compressor is small.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

In case of a long-term compressor outage, as the regeneration cycle is strictly based on time, facility throughput will not be reduced as this action would have no impact on flared gas volumes.

## 12.5. Gas Turbine Compressor Trips

Gas Turbine Compressors are critical to the liquefaction process. These systems form part of the refrigerant loops which chill feed gas, leading to liquefaction. When any compressor or its driver malfunctions, they will automatically be stopped by the control system. Each LNG train has parallel compressor strings allowing approximately 50% production while one compressor train is shutdown. During the transition to minimum rates after a compressor trip minor flaring may occur to prevent the loss of a single compressor from cascading to a larger upset.

In other LNG facilities, the compressors are required to be depressurized prior to restart. For this Project, the compressors can restart from settle out pressure, which removes the requirement to depressurize the compressors prior to restart.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## 12.6. Main Cryogenic Heat Exchanger (MCHE) Trip

If the MCHE trips as a result of instrument malfunction or exceedance of the design operating window, the LNG production immediately stops, and the gas flow to the facility is automatically reduced at the inlet station with minimal flaring or over pressuring of the downstream piping. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.

After a few hours, the refrigerant in the MCHE shell and tubes will warm and pressure will increase, requiring the pressure to be relieved to the flare system to prevent overpressure of the MCHE.

Upon restart of MCHE, the cold vapour gas or LNG must be flared through the cold vapour flare and then liquid burners at approximately 35% production rate until the rundown temperature is low enough to be routed to the LNG storage tank. The equipment has a cooldown limit of approximately 30 °C per hour, which dictates the time required to route the LNG to the flare system, until it can be routed to the LNG storage tank. In the case of a short trip, it is expected that flaring will occur for one to three hours.

Flaring of this stream through both the cold flare and liquid burners is expected to be smokeless.

## 12.7. Condensate Stabilizer Overheads Compressor Trip

C5+ hydrocarbons contained in the Feed gas would freeze in MCHE and need to be extracted in C5+ flash vessel, before entering MCHE. The bottoms of the flash vessel containing LPG and the C5+ is sent to condensate stabilization unit for further processing. The overheads (light ends) are recycled back to MCHE via condensate stabilizer overhead compressors, while the stabilized condensate bottoms are sent to an atmospheric storage tank prior to being loaded into rail cars.

The concentration of C5+ material in the feed gas will dictate if both compressors are required, or if one is required for the load. In the case of lean feed gas, a single compressor trip will not result in any significant flaring as the second compressor will be available to be started and loaded. When the gas is heavier, both compressors are required to be in service and a loss of one compressor will result in some level of flaring. For the extreme rich gas case, this will result in approximately 69,000 m<sup>3</sup>/hr for a single compressor trip and approximately 138,000 m<sup>3</sup>/hr for both compressors tripping. This stream is expected to achieve smokeless combustion in the flare.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

This stream is not expected to produce black smoke with the current flare design, as it has a guarantee case for Ringlemann 0 combustion. However, to reduce flaring volume overall, throughput of the LNG train would be reduced until the available compression can manage the gas volume or the LNG train reaches minimum turndown.

## 12.8. Residue Vapour Compressor Trip

During periods of time when the RPU is online, the overhead gas from the de-methanizer column and excess refrigerant is recompressed in the residue vapour compressor and recycled back the LNG train for liquefaction. In the case of a residue vapour compressor trip, this stream will be routed to flare until such time that the compressor is restarted, or RPU is shutdown. The flaring would be approximately 100,000 m<sup>3</sup>/hr from this system. If the compressor is unable to be started within four hours, the RPU would be shut down to stop flaring. This stream is expected to achieve smokeless combustion in the flare.

In this case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## 12.9. Condensate Storage Tank Vapour Recovery Unit Trip

During Normal Operations, the non-condensable vapour from the condensate storage tank is routed to the incinerators in either LNG Train 1 or 2 for combustion. When the condensate chiller package is offline, this stream cannot be recovered and will lead to venting from the condensate storage tank until the package is repaired. A loss of a single condensate blower can also lead to intermediate venting from the condensate storage tank until it can be repaired.

This stream is generally nitrogen that is displaced while the tank is filling and evaporation of the condensate in the tank. The facility throughput will not be reduced in this case, as the stream is not expected to cause offsite concerns or environmental hazards.

## 12.10. Boil-off Gas Compressor Trips

The LNG under slight pressure runs down from the Trains to the near atmospheric LNG tank, where it flashes at -161°C. Two centrifugal BOG compressors are used to recompress the flashed gas and natural boil-off from the cryogenic LNG

tank, loading lines, and LNG carrier loading. This stream is utilized as fuel gas in the high-pressure fuel gas network. Excess gas beyond what is required for the fuel gas demand for the plant, is recycled to the inlet facility and reprocessed through the plant eliminating flaring, which would otherwise have occurred.

The duration of a compressor outage from a trip can be from one-to-three hours to multiple weeks depending on whether the compressor has suffered damage and requires repair prior to restart.

#### 12.10.1. Holding Mode

The LNG facility will be operating in holding mode approximately two thirds of the time; in this mode the LNG tank is filling from the LNG trains, and LNG carriers are not loading. During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. A loss of both compressors would lead to flaring of approximately 103,000 m<sup>3</sup>/hr while the plant is in holding mode, until the compressor can be repaired and returned to service. This stream is expected to achieve smokeless combustion in the flare.

To reduce the amount of BOG generated during this mode of operation, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank, leading to reduced production, or overall LNG production can be reduced to meet the capacity of a single compressor.

#### 12.10.2. Loading Mode

During LNG carrier loading, the carrier is initially cooled down over three hours leading to an increase in BOG generation and subsequent flaring. During this time, cooldown can be slowed to reduce the amount of excess BOG generated as part of this step. Due to the relatively short duration over which this flaring is expected to occur, LNG production would not be reduced further than is required during holding mode.

Once bulk LNG loading has commenced, a single compressor is expected to be able to handle the gas generated while the LNG carrier is loaded.

### 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate

In case of off-spec condensate, or upset in the condensate stabilization unit, there is limited buffer volume from C5+ flash vessel. This stream will be routed to the liquid burners until the plant can recover. To prevent the formation of smoke, assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.

If operations are unable to bring the condensate stabilization unit back to specification to stop flaring, the overall production would need to be reduced until the stream meets specification or the LNG train would be shutdown.

### 12.12. Flaring Due to Off-Spec Products

In general, LNG plants are not equipped to tolerate off-spec production through the normal product handling systems. In the case of LNG Canada, because both condensate and LNG are stored in one tank only for phase 1; there is no capacity to manage an off-spec final product stream.

The following potential off-spec conditions may result in short term flaring while the process is returned to normal:

- Off-spec natural gas with too much C5+
- Off-spec LNG rundown
- Off-spec sweet gas from AGR (greater than 50 parts per million volume (ppmv) CO<sub>2</sub>)
- Off-spec sweet gas from the driers (greater than 1 ppmv water)

Except for off-spec C5+ material, the current flare system is expected to achieve smokeless performance for these streams. The C5+ material performance will depend on how much C5+ material is in the stream and how much BOG is available to dilute the stream to achieve smokeless performance.

## 13. Emergencies

Emergency is defined through the BC Emergency Management Regulation. As related to LNG Canada operation, emergency will be defined as an earthquake event, malicious act, equipment failure or loss that can lead to a liquid or gas release potentially impacting personnel or the environment.

As defined in the Facility permit: *“Emergency Conditions: involve activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure”.*

### 13.1. Emergency Depressurization

During an emergency event, LNG Canada Operations will initiate the emergency shutdown functionality designed in the plant to stop process flow and sectionalize the hydrocarbon-containing equipment. If a release is occurring or likely to occur, LNG Canada Operations will depressurize the impacted equipment to the flare system.

There are blowdown valves for each train, grouped in several areas, and for Refrigerant/BOG/Inlet.

Depending on the zone affected and scenario, the depressurization could reach 1,000 to 1,700 t/h for Warm Flare and 1,350 t/h for the Cold Flare (largest peak flow rate for zone depressurizing). The flame may reach 100 meters in height. The expected duration of flaring in this scenario is one-to-three hours depending on the number of sections that require depressurizing.

### 13.2. Extended Electrical Black Out

In case of an extended electrical black-out of the LNG facility from either a loss of BC Hydro supply to site or major infrastructure damage, initially the facility will trip and minor flaring will occur from the BOG generated from the LNG storage tank, but as the plant begins to warm up, and refrigerant vapourize, the facility pressure will be managed by directing hydrocarbon to flare.

In the case of an extended power outage, where the onsite emergency power generation is not available, the plant will be proactively depressurized for safety reasons before the Uninterrupted Power Supply required to control the blowdown is depleted. Two trains will start being depressurized in a staggered way to avoid overloading the flare. Flaring flows for each flare (Warm, Cold, Storage and Loading) will typically last 90 to 120 minutes.



## 14. Measurement, Monitoring, Notification, and Reporting

### 14.1. Flaring Measurement

The Project will use the BC OGC Measurement Guideline for measurement of flared volumes and associated fuel gas volumes through Petrinex reporting system monthly.

Flaring is metered via Ultrasonic (US) flowmeters on each common flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have a measurement turndown of 1:1000 and an accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy.

Dilution gas is added during LNG carrier de-inerting and acid gas flaring to maintain 20 MJ/m<sup>3</sup> lower heating value of the flared gas to ensure DRE (refer to Table 15).

**Table 15: Flaring Measurements – Fuel Gas**

| Operation               | Flow indication            | Fluid       | type    | Location                 |
|-------------------------|----------------------------|-------------|---------|--------------------------|
| LNG carrier de-inerting | 62FI300, P & T compensated | MP Fuel Gas | US type | Warm Flare knockout drum |
| Acid gas flaring        | 62FC101, P & T compensated | MP Fuel Gas | US type | F-LP bottom              |

### 14.2. Flow Meter Maintenance and Calibration

The Central Control Room panel operator pro-actively monitors flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator.

#### 14.2.1. Corrective Maintenance

Corrective maintenance will take place when a mismeasurement is observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer.

The evidence or manifest of mismeasurement could be as follows:

- Observed during calibration, part of preventive maintenance activities
- Difference in reading observed by the Operation referring to other process parameters
- Determined by the Technology Team during the daily mass balance activity
- Self-diagnosis by the smartness of the device and manifested as alert or fault

Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error within the accuracy using the Project test equipment that is certified by a Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.

#### 14.2.2. Preventive Maintenance

All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centred Maintenance ("RCM"), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventative maintenance task within stipulated time frame.

### 14.3. Monitoring

The panel operator will proactively monitor flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator.

Flaring can be detected and monitored through:

- Closed circuit television (CCTV) in the control room for 24 hours a day, 7 days a week, monitoring of flare performance
- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions
- An alarm on some controlled streams flared (valve not closed status)
- Proactive Technical Monitoring set-up for the flaring system to monitor abnormalities in the flare system

### 14.4. Flare Checks

As described through this report, there are many connections to the flare system. The indication of an unknown passing valve to the flare system can be identified by Operations as a visible flame or as a measurable increase in flow to the flare system not related to the continuous flare header purges. Operations will begin systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by Operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves.

Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.

### 14.5. Internal Reporting

Internal Reporting of flaring activities is required and will be documented through the shift log at a minimum. For flaring related to incidents, this will occur through the Project's incident reporting system. In case of no flaring incident, the flare section of the shift log will mention "nothing to report".

LNG Canada Operations team will escalate any flaring event to the Production Team leader upon emission of black smoke, exceeding 10,000 m<sup>3</sup> or a duration of four hours to initiate the flare notification process.

Initial detection can be identified via the following means:

- Equipment trip
- Visual from outside operator
- Pro-active monitoring
- CCTV
- Some alarms in case of controllers to flare open (non-closed status)

In case of a small amount of flaring, the panel operator can quickly zoom in via CCTV, if required, on which header is the source of flaring, as each LNG train flare header has its dedicated thermal flowmeter, upstream of the common flare headers described previously.

The following information must be captured within the shift log:

- Time flaring commenced and ended
- If black smoke was observed, or if operations believe R0 performance was not achieved due to visible smoke emission

- Specific cause of flaring
- Estimated quantity and maximum flow
- Actions taken to minimize flaring or prevent similar events from reoccurring

This information will be used as part of the accounting and reporting process for flare emissions and made available to the BC OGC upon request.

## 14.6. Response to Public Concern Related to Flaring

The Project will investigate all public complaints and ensure they are responded to accordingly. Public complaints will be logged with the following information as per the FVRG.

In the event of a community complaint, or request from the BC OGC, the Project is required to undertake monitoring as specified by BC OGC, which will be coordinated by the Environment Lead.

Logs must include:

- Complaint Name and contact information
- Company representative assigned to investigate and follow up with complainant
- Commission representative contacted
- If the complaint was resolved

## 14.7. External Notification and Reporting

As outlined in the LNGFR, and Flaring Notification Plan, Haisla Nation, residents within one kilometre, Regional District of Kitimat-Stikine, and the District of Kitimat will be notified at least 24 hours prior to a planned flaring event and within 24 hours of a flaring event where the quantity of gas exceeds 10,000 m<sup>3</sup> or the duration exceeds four hours. In addition, where an LNG carrier is to be de-inerted at the facility, LNG Canada will provide at least 24 hours notice to BC OGC via email as outlined in the Facility Permit. The Flaring Notification Plan outlines the notification tiers and mechanisms for notification. Note, continuous activities, such as combustion for flare pilot lights or incinerators are excluded from the notification requirement.

Reporting on monitoring undertaken in response to complaints or specific direction of the BC OGC will be provided upon request.

Monthly reporting of flared volumes will be completed via Petrinex system.

## 14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting

The flare losses are included in the facility mass balance reconciliation, which is monitored through proactive technical monitoring and reported monthly. The flow meters will be utilized in determining the maximum uncertainty of monthly volume as outlined in the BC OGC Measurement Guideline.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly, and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after the Commissioning and early stages of Normal Operations phases. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

An annual Monitoring Report will be prepared by LNG Canada's Environmental Team and submitted to the BC OGC.

## 15. Continuous Improvement, Review and Auditing

LNG Canada will maintain an Environmental Management System (EMS) in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy, and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
- Follow-up on flare key performance indicators
- Review of flaring incidents and progress of corrective actions
- Management of Change process for hardware change impacting flaring
- Review of operations/maintenance practices and procedures

Regular internal audits of the EMS will be conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

## 16. References

- BC OGC, 2021, Flaring and Venting Reduction Guidelines, Version 5.22, April 2021.
- BC OGC, 2020, BC Measurement Guideline, Version 2.2, June 2020

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Friday, June 3, 2022 9:17 AM  
**To:** Mathews, Suzanne; Post Permit Requests; Friedrich, Hardy  
**Cc:** 'permitting@Ingcana.ca'; LNGC JVD PERMITTING; scot.mackillop@Ingcana.ca; Neven.Dimic@Ingcana.ca; Ben Ashton; erin.furlong@Ingcana.ca; 'Lyndsey.Hunter@Ingcana.ca'; James Frith; Hassan, Umair  
**Subject:** RE: LNG Canada Project Flaring Management Report  
**Attachments:** LNGC FMR BCOGC RFI 2 April 14 2022\_Response (2022JUN03)\_R0.pdf

Suzanne,

Please see the attached responses to the clarification questions on the Flaring Management Report.

We intend to share the updated Flaring Management Report later this month,

Regards

Janine

---

**From:** Mathews, Suzanne  
**Sent:** Thursday, April 14, 2022 2:38 PM  
**To:** Janine Forrest ; Post Permit Requests ; Friedrich, Hardy  
**Cc:** 'permitting@Ingcana.ca' ; LNGC JVD PERMITTING ; scot.mackillop@Ingcana.ca; Neven.Dimic@Ingcana.ca; Ben Ashton ; erin.furlong@Ingcana.ca; 'Lyndsey.Hunter@Ingcana.ca' ; James Frith ; Hassan, Umair  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine,

Thank you for this submission. Please see attached for some follow-up and additional review questions.

Regards,



**Suzanne Mathews**, P.Eng.  
Supervisor, Engineering Strategic &  
Technical Services  
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**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Tuesday, March 8, 2022 12:25 PM  
**To:** Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>  
**Subject:** RE: LNG Canada Project Flaring Management Report

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/Ing canada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua <[Joshua.Porter@bcogc.ca](mailto:Joshua.Porter@bcogc.ca)>  
**Sent:** Friday, November 19, 2021 12:09 PM  
**To:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>; Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Friedrich, Hardy <[Hardy.Friedrich@bcogc.ca](mailto:Hardy.Friedrich@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

**CAUTION:** This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Janine.

An Information Request for the Flare Management Report is attached.

Thank you, and have a good weekend.





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**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Friday, October 1, 2021 3:14 PM  
**To:** Post Permit Requests <[postpermitrequests@bcogc.ca](mailto:postpermitrequests@bcogc.ca)>; Mathews, Suzanne <[Suzanne.Mathews@bcogc.ca](mailto:Suzanne.Mathews@bcogc.ca)>; Porter, Joshua <[Joshua.Porter@bcogc.ca](mailto:Joshua.Porter@bcogc.ca)>  
**Cc:** 'permitting@lngcanada.ca' <[permitting@lngcanada.ca](mailto:permitting@lngcanada.ca)>; LNGC JVD PERMITTING <[LNGC.JVD.PERMITTING@fluor.com](mailto:LNGC.JVD.PERMITTING@fluor.com)>; [scot.mackillop@lngcanada.ca](mailto:scot.mackillop@lngcanada.ca); [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca); Ben Ashton <[Ben.Ashton@fluor.com](mailto:Ben.Ashton@fluor.com)>; [erin.furlong@lngcanada.ca](mailto:erin.furlong@lngcanada.ca); 'Lyndsey.Hunter@lngcanada.ca' <[Lyndsey.Hunter@lngcanada.ca](mailto:Lyndsey.Hunter@lngcanada.ca)>; James Frith <[James.Frith@fluor.com](mailto:James.Frith@fluor.com)>  
**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

Janine Forrest | JGC Fluor BC LNG JV | Permitting and Compliance Lead | [janine.forrest@fluor.com](mailto:janine.forrest@fluor.com) | O +1.403.538.1250  
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| LNG Canada Flaring Management Report BCOGC Information Request |                |
|----------------------------------------------------------------|----------------|
| Project                                                        | LNG Canada     |
| OGC File #                                                     | 1000836125     |
| Date                                                           | April 14, 2021 |

#### Reference Documents:

1. L001-06200-OA-5880-0001\_RD\_CLEAN.pdf, Flaring Management Review, Revision D. Revision Date October 1, 2021.
2. LNG Canada FMR BCOGC Information Request 1 Nov 19 2021\_Response (08MAR2022)\_R0.
3. L001-06200-OA-5880-0001\_RE\_TRACKED.

#### Information Request:

6. **Follow-up 6-1:** Please clarify in the report whether the EAC application estimate is still representative of the project design.

Response (Jun-03): Yes, the default factor of 0.3 is still representative estimate based on industry benchmarking.

10. **Follow-up 10-1:** In section 5.1.1 Table 8, please specify which liquid burners (A, B, C, D, E, F, G, H, and I) are specified for warm and cold cases.

Response (Jun-03): There are three sets of liquid burners, each with three burners (nine burners in total). In each set, there are two burners with 6" diameter and one with 3" diameter. The three 3" liquid burners that have a dual function for both warm and cold liquids are 0A6206A/D/G, and all nine burners are used for the cold case. This information will also be included in the next revision of the FMR.

12. **Follow-up 12-1:** Based on the information provided in Table 9, the LNGFR requirement for maximum thermal radiation flux limit for the "outer edges of the sterile area" of 5.0 kW/m<sup>2</sup> is not met. Also, please correct the description of the LNGFR requirements for "facility fence line for all cases and cooling tower" (LNGFR requirement for "normal flow rate" is not 5 kW/m<sup>2</sup>) and "at the boundary of sterile area for emergency conditions" in Table 9.

Response (Jun-03): This information will be updated in the next revision of the FMR; including further explanation for the selection of the radiation limit design basis (Project design requirements as compared to the LNG Facility Regulation (LNGFR)). The basis for the LNGFR value used will also be updated to define which Table in LNGFR Schedule 1 is being applied.

25. **Follow-up 25-1:** The Commission reviewers will revisit the question of demonstrating compliance with section 17(1) of the LNGFR [Reference: RFI-LNGC-JFJV-00054].

Response (Jun-03): Noted.

26. **Follow-up 26-1:** The Commission reviewers will revisit the question of demonstrating compliance with section 17(1) of the LNGFR [Reference: RFI-LNGC-JFJV-00054].

Response (Jun-03): Noted.

27. **Follow-up 27-1:** The Commission reviewers will revisit this question once JFJV question RFI-LNGC-JFJV-00054 is addressed.

Response (Jun-03): Noted.

31. **Follow-up 31-1:** The Commission reviewers will revisit this question once a response is provided.

Response (Jun-03): Section 8.5 of the FMR notes that “the normal operating cases for the warm flare and cold flare are greater than 12 MJ/m<sup>3</sup>; fuel gas will only be added to the minimum nitrogen purging for the storage and loading flare to increase the minimum heating value to 12 MJ/m<sup>3</sup>.”

To “help ensure that flares maintain stable operation, comply with the BC Air Quality Objectives and Standards and do not emit unburned hydrocarbons” (per the clarification question from the BC Oil and Gas Commission on September 7, 2021), the Project proposes to maintain a minimum low heating value of 12 MJ/m<sup>3</sup> for normal operations in the flare, which is consistent for stacks with stable operations per the BC Oil and Gas Commission Flaring and Venting Guideline (April 2021) and the US Environmental Protection Agency<sup>1</sup>.

Note, this applies to normal operations only (non-flaring events), as the heating value will increase during a flaring event. The FMR does identify specific applications where a low heating value of 20 MJ/m<sup>3</sup> will be applied, such as during a thermal oxidizer trip, planned turn arounds, and LNG carrier de-inerting.

33. **Follow-up 33-1:** Please include a statement, consistent with the response to #33, regarding no venting from inerted LNG carrier in the Flaring Management Report.

Response (Jun-03): Section 11.2 of the FMR will be updated in the next revision to document this statement.

40. As per the presentation from October 2015 during the application stage of the project: The presentation shows that approximately 365,000 tonnes of LNG (~350 million m<sup>3</sup>) will be flared during the commission and start up (CSU). After implementing all the mitigation strategies, provide a final estimated flaring volume for the commission and start up activities (CSU). (It is noted that Section 9 & 10 of the flaring management reports mentions all the break downs.)

Response (Jun-03): The 2015 presentation shows an “initial estimate” of 365,000 tonnes of LNG (~350 million m<sup>3</sup>) being flared “for CSU period in the LNG Canada 2-train project.” This estimate was based on the Heat and Material Balances (HMBs) that were available during the FEED stage of project development, and it was considered a P50 estimate (based on a 44-day start-up schedule). This preliminary estimate was presented as the best available at the time with the understanding that the final design would govern flaring rates and durations. Additionally, as noted in the 2015 presentation, predicted versus actual estimates have varied significantly for other projects due to flaring events that were not predicted.

LNG Canada is forecast to complete Start-up Ramp-up (SURU) Modeling in Q2 / Q3 2022,

<sup>1</sup> E:\0010 PRT\0010 241\New Fact Sheets\Revised English\Updated costs\flare-final.wpd (epa.gov)  
LNG Canada Project - Review

which will provide a range of flaring estimates (P10/P50/P90) based on the latest assumptions, as well as an understanding of volume reductions resulting from mitigations that have been adopted. It is expected that these values will differ from the 2015 estimate due to the evolution of design as well as the following elements:

- Change in assumed duration of start-up
- Inclusion of adjustments (e.g., strainer plugging/fouling)
- Correction in assumptions accounting for the need for the LNG facility to be at minimum turndown for startup of compressors and stabilization unit
- Changes in LNG import assumptions
- Inclusion of flaring occurring prior to commissioning of LNG trains (i.e., pipeline and inlet facility)

As discussed in the FMR, LNG Canada is committed to continuous improvement and will be looking at ways to reduce flaring volumes both before start-up and once operational as outlined below:

- Before Start-Up
  - A technical team within LNG Canada has identified an inventory of additional initiatives to reduce flaring volumes particularly during the start-up and ramp-up period. These initiatives include
    - a. mitigation of any risks that result in trips or prolonged start-up; and
    - b. optimization opportunities.
  - Each initiative will be tracked internally on a monthly basis for progress and impact. With optimization opportunities, each is being assessed to ensure it does not introduce additional complexities or novelties that will pose a risk to a safe start-up or inadvertently lead to a longer start-up and more flaring.
  - LNG Canada will also canvas the global expertise of its Joint Venture Participants to incorporate best practices and lessons learned from other start-ups.
- During Start-Up and Beyond
  - Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
  - Follow up on flare key performance indicators
  - Review of flaring incidents and progress of corrective actions
  - Management of Change process for hardware change impacting flaring
  - Review of operations/maintenance practices and procedures

41. Section 9.2.4 also talks about the material which will be left over from the construction and pre commissioning which will require multiple starts and stops. Can you explain what kind of material will be left over and are there any mitigation steps/procedure in place to control the number of starts and stops and decrease the flaring volume.

Response (Jun-03): The material may include pipe scale, general fouling as well as foreign material and debris left over from the construction and assembly processes such as welding rods. The mitigation measures in place include inspections and implementation of the cleanliness/preservation specifications to minimize leftover material; however, based on past

experience from start ups, it is anticipated that some material will be missed therefore has been flagged in the FMR as a potential event.

42. Automated cooldown process programs have been used to cool main cryogenic heat exchangers with minimal human interaction for a more consistent cooldown with reduced flaring. Please confirm whether an automated cooldown process to reduce flaring was considered / implemented for this facility.

Response (Jun-03): Automated Cooldown has been included as part of design but it is expected the first few cooldowns will be undertaken by an operator to aid in the tuning of the advanced control scheme.

43. The defined terms in the LNG Canada facility permit should be used as applicable. Early operations is included in the definition of normal operations (per the facility permit). If there is a desire to differentiate “early operations” the proposal should not include redefining a term from the facility permit. The following definitions in the Flaring Management Report require an update:

- a. Early Operations
- b. Normal Operations

Response (Jun-03): The definitions in the next revision of the FMR will be updated to reflect the terms within the Facility Permit (i.e. Commissioning and Normal Operations), and language updated throughout to highlight the lower reliability expectations during the early stages of Normal Operations (rather than using the previously defined “Early Operations”).

44. It is noted that the Major Flaring Event is not defined yet.

Response (Jun-03): This line item will be removed from the Definitions Table in the next revision of the FMR.

45. Section 11.2 uses the term “warm ships” in the context of de-inerting LNG carriers. “Warm ships” are different than inerted ones. In a separate section please clarify flaring activities associated with warm ships arriving at the berth.

Response (Jun-03): Section 11.2 of the FMR will be updated to replace the reference to six warm ships per year, to six inert ships per year. Warm ships are not expected to contribute flaring unless the gas does not meet the specification to return to the fuel gas system (i.e. inert components).

**From:** Janine Forrest <Janine.Forrest@fluor.com>  
**Sent:** Tuesday, March 8, 2022 1:25 PM  
**To:** Post Permit Requests; Mathews, Suzanne; Friedrich, Hardy  
**Cc:** 'permitting@lngcanada.ca'; LNGC JVD PERMITTING; scot.mackillop@lngcanada.ca; Neven.Dimic@lngcanada.ca; Ben Ashton; erin.furlong@lngcanada.ca; 'Lyndsey.Hunter@lngcanada.ca'; James Frith  
**Subject:** RE: LNG Canada Project Flaring Management Report  
**Attachments:** LNG Canada FMR BCOGC Information Request 1 Nov 19 2021\_Response (08MAR2022)\_R0.pdf; L001-06200-OA-5880-0001\_RE\_TRACKED.pdf

Suzanne,

Please see the attached updated revision of the Flaring Management Report ("L001-06200-OA-5880-0001\_RE\_TRACKED"; Issued for Review) along with a response to the clarification questions from November.

For your awareness, I will be sharing both with Haisla today also.

The two documents referenced in the clarification response have been uploaded to the FTP site "/lng canada submissions before construction/Facility Permit Conditions" and will be included in the next update to the NDA Schedule A.

Thanks

Janine

---

**From:** Porter, Joshua  
**Sent:** Friday, November 19, 2021 12:09 PM  
**To:** Janine Forrest ; Post Permit Requests ; Mathews, Suzanne ; Friedrich, Hardy  
**Cc:** 'permitting@lngcanada.ca' ; LNGC JVD PERMITTING ; scot.mackillop@lngcanada.ca; Neven.Dimic@lngcanada.ca; Ben Ashton ; erin.furlong@lngcanada.ca; 'Lyndsey.Hunter@lngcanada.ca' ; James Frith  
**Subject:** [External] RE: LNG Canada Project Flaring Management Report

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Hi Janine.

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Thank you, and have a good weekend.



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---

**From:** Janine Forrest <[Janine.Forrest@fluor.com](mailto:Janine.Forrest@fluor.com)>  
**Sent:** Friday, October 1, 2021 3:14 PM  
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**Subject:** LNG Canada Project Flaring Management Report

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

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| LNG Canada Flaring Management Report BCOGC Information Request |                   |
|----------------------------------------------------------------|-------------------|
| Project                                                        | LNG Canada        |
| OGC File #                                                     | 1000836125        |
| Date                                                           | November 19, 2021 |

#### Reference Documents:

1. **L001-06200-OA-5880-0001\_RD\_CLEAN.pdf** Flaring Management Review, Revision D. Revision Date October 1, 2021.

#### Information Request:

1. **Section 1.3** – “Within three months after commissioning LNG Train 1 to incorporate lessons learnt that need to be applied to commissioning of LNG Train; and”

Confirm lesson learnt to be applied to Train 2.

Response (Mar-08): This statement is in Section 1.2; and has been updated to include a “2” after the second LNG Train reference for clarity.

2. **Definitions**

Please define de-inventorization.

Response (Mar-08): A definition for de-inventorization has been added in Section 1.4, Table 2 (Definitions).

3. **Section 2.2.4**

Please identify the Environmental Management Plans that address light.

Response (Mar-08): Light is included in the Construction Environmental Management Plan (CEMP), but is not required in the Operations Environmental Management Plan per the Environmental Assessment Certificate conditions, therefore the third paragraph in this section has been removed to avoid confusion.

The project is designed to meet the BC Light Control Best Practice Guideline. In addition to facility lighting design considerations, a key mitigation is the minimization of continuous flaring during normal operations (only flare pilots, passing of valves, analyzers, and purge gas).

4. **Section 2.3** – “Specific to flaring, the Project will operate without routine flaring or venting, with minor continuous sources (e.g., flare pilot)”

It is unclear how venting is included in a statement that is specific to flaring. Please provide clarification.

Response (Mar-08): The statement intended to apply to both flaring and venting, therefore “specific to flaring” has been replaced with “during normal operations” to avoid confusion.

5. **Section 4.1**

Some of these general statements (all LNG plant design incorporate flare systems, for example) are not necessarily accurate. Consider revising the overview to be more specific to LNG Canada, or otherwise correcting.

Response (Mar-08): This section has been updated to ensure that it is specific to the Project; and the general reference to “all LNG plant designs” has been updated to “large scale LNG plant designs”.

Is “excess gas” the intended term? Consider revising or clarifying.

Response (Mar-08): The reference to “excess gas” has been removed in this updated section.

6. **Section 4.1** – *“During initial operation period, the EAC application had estimated that “a default factor of 0.3 weight percent of each train’s LNG output is assumed to best represent flaring volumes occurring during normal operation and during maintenance events”*

Please clarify this statement.

Response (Mar-08): “During initial operation period” has been removed, as the statement in the EAC application applied to normal operation and during maintenance events.

7. **Section 4.1** – *“As stated in Section 2.3, the Project will operate with limited continuous pilot flares and other safety features, and will not carry out routine flaring or venting”*

Please clarify. Some continuous venting sources have been identified in Section 7.

Response (Mar-08): This section has been updated to reference Section 7 and 8. The continuous venting sources identified in Section 7 are for atmospheric venting of N<sub>2</sub> from various sources such as secondary seal gas vents; the only continuous venting to flare is from the compressor primary seal gas vent (mostly nitrogen) and analyzer sample returns.

8. **Section 4.1** – *“In addition there are many manual drains (e.g., manual vents to vapor flare header, manual drain to the liquid flare headers)”*

Possible editing mistake that makes this statement unclear. Please correct and/or clarify.

Response (Mar-08): This statement has been removed from the updated Section 4.1.

9. **Section 4.2**

The F-LP is the only system that specifies equipment to minimize purge gas requirements. Do the other systems include other or similar equipment to minimize purge gas requirements?

Response (Mar-08): While a velocity seal is used to minimize purge gas requirements for F-LP, these requirements are minimized for other flares without needing a velocity seal.

10. **Section 5.1.1**

Confirm Accuracy of Table 8 and consistency with permitted liquid burner permission.

Response (Mar-08): All tables have been reviewed as part of the update and are consistent



with permissions in the Facility Permit for the liquid burner.

**11. Section 5.1.2**

Please clarify the location and flow rate for the “Property limit boundary for all cases and cooling towers” basis within Table 9.

Response (Mar-08): Table 9 has been updated to refer to the “Facility fenceline” rather than the “Property Limit boundary” for the 3.0 kW/m<sup>2</sup> line, as limit is applicable for all relief cases.

**12. Section 5.1.2**

Are there thermal radiation contour maps or plot plans with thermal rational contours that can be provided?

Response (Mar-08): The Radiation Profiles for Vapor and Liquid Flares are contained with the following attached documents:

- L001-06200-HS-8249-100206-1200: Radiation Profiles Vapor Flare System.
- L001-06200-HS-8249-100206-1201: Radiation Profiles Liquid Flare System.

Relevant sections of these reports will be shared with the OGC. Please note that these documents are confidential and subject to the Restricted Use and Confidentiality Agreement (RUCA) with LNG Canada. Updates to Schedule “A” of the RUCA are currently being executed to include these documents. Please note that while it is being executed, these documents (that are confidential in nature) are expected to be treated and handled pursuant to the terms of the RUCA, and will be managed accordingly by the OGC and its representatives.

**13. Section 5.2.1**

How will operations respond if pilot cannot be relit with a flame front generator?

Response (Mar-08): This section updated to include the following sentence: "If the pilots are unable to be relit, the impacted flare will be taken out of service and switched to the spare flare, if available, until repairs can be made."

**14. Section 5.2.1 – “As the vapour flares have redundant pilots and are the final barrier to a process safety incident, they will continue to operate. A flame out scenario has been modeled for these flares and the unburned hydrocarbon from the flare does not pose a hazard to people”**

Please clarify these statements. Do they continue to operate in the event that a pilot cannot be relit? Please provide some additional information for the flame out scenario mentioned.

Response (Mar-08): This paragraph has been updated for clarity, with further information provided.

**15. Section 5.2.2**

Table 11 includes “DRE” which was not included in the abbreviations, and the report refers to destruction efficiency and DRE. Suggest that these terms are defined, DRE is added into the

abbreviations, and a single term is used (if applicable).

Response (Mar-08): “DRE” has been added in Section 1.4, Table 2 (Definitions), and used throughout where applicable.

#### 16. Section 5.2.2

Do the vapour flare systems include features to improve combustion, such as air assist?

Response (Mar-08): Table 11 (Vapour Flare Summary) has been updated to show which flares have the option of assist gas to improve DRE.

#### 17. Section 5.2.3

Confirm Accuracy of Table 12 and consistency with permitted liquid burner permission.

Response (Mar-08): All tables have been reviewed as part of the update and are consistent with permissions in the Facility Permit for the liquid burner.

#### 18. Section 6.2 Table 13

Confirm the burners in new design.

The original design states “4 burners consuming a lot of atomizing to burn LNG-condensate range”.

Please clarify this statement.

Response (Mar-08): Table 13 (Summary of Flare Design Changes) has been updated for clarity and to accurately summarize the new design, which consists of 9 burners in total (6 for LNG and 3 for LNG/condensate).

#### 19. Section 6.2 – “Ringelmann “0” or “R0” performance is likely in most situations, but not a guarantee case from the vendor”

Are options available to operations to reduce black smoke and/or noise in the event either become problematic during abnormal conditions?

Response (Mar-08): In addition to the smokeless design specification, LNG Canada also has the option to use assist gas if needed.

#### 20. Section 6.2 – “Normally, flare technology has a combustion efficiency of approximately 98%; however, for this Project, the chosen flare technology has a combustion efficiency of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design.”

Will assist gas be included in all flare systems? What are estimated assist gas volumes? When will assist gas be added to flare systems?

Response (Mar-08): There will be an option to use assist gas only if needed to reduce black smoke by improving combustion efficiency. This assist gas is already accounted for in the flaring mass flow rate estimates that were provided in the report (given that these are estimates only, whether assist gas is used or not is accounted for within the uncertainty for this number).

21. **Section 6.2** – *“Once the Project is operational, the results from the air dispersion modeling will be verified through ambient air quality monitoring.”*

Please provide additional information related to this monitoring

Response (Mar-08): Further information has been added in relation to the LNG Canada’s role in the Kitimat Airshed Group.

22. **Section 6.3** – *“The height of the flare system will comply with the following thermal radiation limits provided in Table 11.”*

Should this be Table 9?

Response (Mar-08): Yes, this cross reference has been updated.

23. **Section 6.3**

Some previous maps of the site showed that the vegetation height to the southeast of the flares was going to be managed to meet the thermal radiation limits. If this is still the case, please include this in the document.

Response (Mar-08): Based on flare radiation modeling, it was determined that there were no exceedances of thermal radiation limits beyond the fenceline and no impacts were foreseen. Therefore, no clearing is required in this zone.

24. **Section 6.4 and 6.5**

Will there be consideration to plan flaring during daytime hours (when able) to minimize the impact of noise and light pollution?

Response (Mar-08): The following was added to Section 6.5 (Light): “Where practical to do so, considering available resources and economic considerations, flaring activities will be scheduled to occur during daytime. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible.”

25. **Section 7**

It would be useful to include some discussion on how these continuous vent emission meet section 17(1) of the LNG Facility Regulation, and why they are not tied into flare or gas conservation system.

Response (Mar-08): Further discussion will be undertaken with OGC related to this topic, through the existing RFI process.

26. **Section 7**

It would be useful to include some discussion on how these unplanned vent emission meet section 17(1) of the LNG Facility Regulation, and why they are not tied into flare or gas conservation system.

Response (Mar-08): Further discussion will be undertaken with OGC related to this topic, through the existing RFI process.

27. **Section 7**

RFI-LNGC-JFJV-00054 was submitted to the Commission to address the interpretation of the LNG Facility Regulation for irregular and unplanned venting. Please ensure these vent sources are consistent with this RFI.

Response (Mar-08): Further discussion will be undertaken with OGC related to this topic, through the existing RFI process.

28. **Section 8.5** – *“For the Project to reduce GHG emissions, all flare headers are continuously purged with nitrogen instead of fuel gas. For example, the warm flare nitrogen purge is approximately 50 Sm<sup>3</sup>/hr, where the fuel gas purge is approximately 280 Sm<sup>3</sup>/hr.”*

It is unclear what fuel gas purge is being referred to. Please provide clarification.

Response (Mar-08): In the event of nitrogen outage or shortage, backup fuel gas purge is provided; Section 8.5 has been updated to clarify. Also, the normal operating cases for the warm flare and cold flare are greater than 12 MJ/m<sup>3</sup>; fuel gas will only be added to the minimum nitrogen purging for the storage and loading flare to increase the minimum heating value to 12 MJ/m<sup>3</sup>.

29. **Section 11**

How will impacts to wildlife, noise and ambient air quality from associated flaring be considered when planning the timing of turnaround and maintenance activities?

Response (Mar-08): Potential environmental impacts have been assessed during the Environmental Assessment process. One of the resulting Environmental Assessment Certificate (EAC) conditions is to “identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.” Furthermore, ambient air quality impacts are being evaluated as part of the Waste Discharge Authorization (WDA) application, and a noise report has been submitted to the OGC as per LNG Facility Permit Condition #47.

30. **Section 11.1** – Table 14

Confirm the schedule is consistent with explanation of shutdowns for boroscoping.

Response (Mar-08): The sample schedule (Table 14) has been removed to avoid confusion.

31. **Section 11.1** – *“During this purge step, assist gas will be added to the flares to maintain the lower heating value above 20 MJ/m<sup>3</sup>; this is expected to take between 12 to 24 hours.”*

Considering the facility air emissions waste discharge authorization, is this necessarily accurate? The OGC Bi-Weekly Update Meeting (27-Oct-2021) says “Clarification was sent to the OGC on Feb. 05 related to the low heating value requirement (20MJ/m<sup>3</sup>) for nitrogen purging; with follow up in early June; OGC sent clarification question on Sep. 07 (draft response under Project review).”

Response (Mar-08): A response to this clarification will be shared with OGC, in parallel to the updates with the Flaring Management Report. The 20 MJ/m<sup>3</sup> is applicable to the incinerator

trip or deinerting scenarios only.

32. **Section 11.1.1** – *“Once the nitrogen is displaced, dried natural gas (de-frost gas) from an online LNG train will be introduced to dry the LNG train to specification to allow inventorying of the refrigerant, which is expected to take approximately one day and result in approximately 1500 Te of gas flared”*

Please include Te in Abbreviations and/or definitions.

Response (Mar-08): “Te” has been added in Section 1.4, Table 2 (Definitions).

33. **Section 11.2**

In the description of the de-inerting process, please include both the LNG that is being used to de-inert the vessel and the venting that is expected to occur from the LNG carrier prior to the vapour being sent to the flare.

Response (Mar-08): This section has been updated; there are currently no requirements to vent from carrier.

34. **Section 11.3** – *“To return to normal performance, the noncondensable gas will need to be purged from the refrigerant system. This is normally done by venting the noncondensable gases through the PMR reclaimer condenser”*

Please confirm if the noncondensable gases are venting. This section seems to say these gases are conserved or flared.

Response (Mar-08): “venting” has been updated to “purging”.

35. **Section 11.5** – *“Therefore, the flaring once the RPU is operational will be limited to cooldown of the unit expander generator, columns, and cryogenic pumps”*

What are expected flaring volumes and durations?

Response (Mar-08): This section has been updated to include volumes and durations; the volume is expected to be small due similar to routine maintenance activities and duration is approximately one day.

36. **Section 11.5** – *“The de-inventorization for preservation involves about 130 m3 of equipment with an average gas pressure of 50 kPa or approximately 2 tonnes of gas to be flared to the Cold Dry Flare. The liquid bottoms, after lowering the levels, represent less than 10 tonnes, which need to be flared to the dry Cold liquid burners mostly with the exception of the de-propanizer bottoms, which are burned via the Warm liquid burners.”*

What are expected durations?

Response (Mar-08): This section has been updated to include durations; which will be over one or two days.

37. **Section 12** – *“After the plan implementation date, the commission may take enforcement action if another exceedance of the 6-in-6 criterion occurs within 24 months.”*

Please delete. It is preferred to not have Report referring to Commission actions from a Guidance

document.

Response (Mar-08): The information related to the written exceedance report has been removed.

**38. Section 12.1**

Do sections 12.2 to 12.12 include a comprehensive list of equipment that does not have redundancy and would result in prolonged flaring if they required replacement or repair?

Response (Mar-08): Section 12.2 to 12.12 list all major equipment that will result in flaring, in the event the equipment is down for maintenance.

**39. Section 14.1** – *“The Project will use the BC OGC Measurement Guideline for measurement of flared volumes through Petrinex reporting system monthly”*

Please confirm if this will include associated fuel gas as well.

Response (Mar-08): Yes, therefore this sentence has been updated to reference the fuel gas volumes also.



Controlled Document

## Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | E                                            |
| Document Status          | Issued for Review                            |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 08-Mar-2022                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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# REVISION CONTROL PAGE

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|-----------------|-------------|-------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                                                                                               | Approver                   | Review Code     |
| A               | 08-Jun-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong                                                            | Christian Fischer          | Choose an item. |
| B               | 12-Oct-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong<br>Rik van der Ploeg<br>Bart Buhre<br>Schom-Moffatt, Patti | Christian Fischer          |                 |
| C               | 09-Apr-2021 | Issued for Review | Cameron McCormick          |                                                                                                                                                                        |                            |                 |
| D               | 01-Oct-2021 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>R. Kabganian<br>S. MacKillop<br>N. Dimic                                                                                                                  | B. Ashton<br>R. Dronamraju |                 |



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|---|-------------|-------------------|----------------------------|--------------------------------------------------|----------------------------|--|
| E | 08-Mar-2022 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>N. Dimic<br>C. Sharwood<br>A. Betts | B. Ashton<br>R. Dronamraju |  |
|---|-------------|-------------------|----------------------------|--------------------------------------------------|----------------------------|--|

# TABLE OF CONTENTS

|        |                                                                       |    |
|--------|-----------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                          | 7  |
| 1.1.   | Project Background                                                    | 7  |
| 1.2.   | Purpose and Objectives                                                | 7  |
| 1.3.   | Project Overview                                                      | 8  |
| 1.4.   | Abbreviations and Definitions                                         | 8  |
| 2.     | REGULATORY FRAMEWORK                                                  | 13 |
| 2.1.   | Project Approvals and Conditions                                      | 13 |
| 2.1.1. | Facility Permit                                                       | 13 |
| 2.1.2. | Waste Discharge Authorization                                         | 15 |
| 2.1.3. | Environmental Assessment Certificate                                  | 15 |
| 2.1.4. | Decision Statement                                                    | 16 |
| 2.2.   | Acts, Regulations and Guidelines                                      | 17 |
| 2.2.1. | Oil and Gas Activities Act; Liquified Natural Gas Facility Regulation | 17 |
| 2.2.2. | BC OGC Flaring and Venting Guideline Reduction Guidelines             | 18 |
| 2.2.3. | BC Noise Control Best Practices Guideline                             | 19 |
| 2.2.4. | BC OGC Light Control Best Practices Guideline                         | 19 |
| 2.2.5. | Ambient Air Quality Objectives                                        | 19 |
| 2.3.   | Environmental Commitments                                             | 20 |
| 3.     | ROLES AND RESPONSIBILITIES                                            | 21 |
| 4.     | FLARE SYSTEMS OVERVIEW                                                | 22 |
| 4.1.   | General                                                               | 22 |
| 4.2.   | Process Description Overview                                          | 22 |
| 5.     | FLARE DESIGN BASIS, TECHNOLOGY SELECTION AND MEASURES                 | 27 |
| 5.1.   | Design Basis                                                          | 27 |
| 5.1.1. | Flare Systems                                                         | 27 |
| 5.1.2. | Flare Radiation                                                       | 27 |
| 5.1.3. | Flare Knockout Drums                                                  | 28 |
| 5.2.   | Flare Technology Used                                                 | 28 |
| 5.2.1. | Pilot System                                                          | 28 |
| 5.2.2. | Vapour Flare Systems                                                  | 29 |
| 5.2.3. | Liquid Burners System                                                 | 30 |
| 5.2.4. | Derrick Structures                                                    | 31 |
| 5.3.   | Flaring & Venting Mitigation Measures in Design                       | 32 |
| 6.     | ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES                         | 33 |
| 6.1.   | Smoke                                                                 | 33 |
| 6.2.   | Air Contaminant & GHG Emissions                                       | 34 |
| 6.3.   | Thermal Heat                                                          | 34 |
| 6.4.   | Noise                                                                 | 35 |
| 6.4.1. | Impact to Personnel on Site                                           | 35 |
| 6.4.2. | Offsite Impact                                                        | 35 |
| 6.5.   | Light                                                                 | 35 |
| 6.6.   | Wildlife                                                              | 35 |
| 7.     | CONTINUOUS VENTING EMISSIONS                                          | 36 |
| 7.1.   | Continuous Vent Emissions to Atmosphere                               | 36 |

|                                                                         |    |
|-------------------------------------------------------------------------|----|
| 7.2. Unplanned Vent Emissions to Atmosphere                             | 36 |
| 8. CONTINUOUS FLARING EMISSIONS                                         | 38 |
| 8.1. Flare Pilot                                                        | 38 |
| 8.2. Compressor Seal Gas                                                | 38 |
| 8.3. Analyzer Sample Returns                                            | 38 |
| 8.4. Continuous Passing Valves                                          | 39 |
| 8.5. Flare Purges                                                       | 39 |
| 8.6. Continuous Incinerator Emissions                                   | 39 |
| 9. COMMISSIONING FLARING ACTIVITIES                                     | 40 |
| 9.1. Commissioning Overview                                             | 40 |
| 9.2. Commissioning Flaring Overview                                     | 40 |
| 9.2.1. Pipeline and Inlet Facility Start-up                             | 41 |
| 9.2.2. Refrigerant Import                                               | 41 |
| 9.2.3. LNG Import                                                       | 42 |
| 9.2.4. LNG Train 1 Start-Up                                             | 44 |
| 9.2.5. Acid Gas Removal Unit Start-up and Molesieve Regeneration Period | 45 |
| 9.2.6. Mercury Bed Drying and Cold End Defrost                          | 46 |
| 9.2.7. Cold End Cooldown and Condensate Stabilization Start-up          | 46 |
| 9.2.8. Emergency Shut Down Test                                         | 47 |
| 9.3. Subsequent LNG Train Start-Up                                      | 47 |
| 9.4. Refrigerant Production Unit (RPU) Start-Up                         | 48 |
| 10. EARLY OPERATIONS FLARING ACTIVITIES                                 | 50 |
| 11. PLANNED FLARING ACTIVITIES DURING NORMAL OPERATION AND TURNAROUND   | 53 |
| 11.1. LNG Train Turnaround                                              | 53 |
| 11.1.1. Restart from Turnaround                                         | 53 |
| 11.2. De-inerting of LNG Carriers                                       | 54 |
| 11.3. Adjustment of PMR Composition at PMR Reclaimer                    | 54 |
| 11.4. Adjustment of MR composition at HP MR Separation Vessel           | 54 |
| 11.5. Refrigerant Production Unit (RPU) Turnaround                      | 55 |
| 11.6. Relief Valve Inspection and Overhaul                              | 55 |
| 11.7. Routine Maintenance Activities                                    | 56 |
| 12. UNPLANNED FLARING ACTIVITIES                                        | 57 |
| 12.1. Unplanned equipment failure or repair                             | 57 |
| 12.2. Flash Gas Compressor Trip                                         | 57 |
| 12.3. Acid Gas Thermal Oxidizer Trip                                    | 57 |
| 12.4. Regeneration Gas Compressor Trip                                  | 58 |
| 12.5. Gas Turbine Compressor Trips                                      | 58 |
| 12.6. Main Cryogenic Heat Exchanger (MCHE) Trip                         | 58 |
| 12.7. Condensate Stabilizer Overheads Compressor Trip                   | 59 |
| 12.8. Residue Vapour Compressor Trip                                    | 59 |
| 12.9. Condensate Storage Tank Vapour Recovery Unit Trip                 | 59 |
| 12.10. Boil-off Gas Compressor Trips                                    | 59 |
| 12.10.1. Holding Mode                                                   | 60 |
| 12.10.2. Loading Mode                                                   | 60 |
| 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate           | 60 |
| 12.12. Flaring Due to Off-Spec Products                                 | 60 |

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| 13. EMERGENCIES                                                       | 61 |
| 13.1. Emergency Depressurization                                      | 61 |
| 13.2. Extended Electrical Black Out                                   | 61 |
| 14. MEASUREMENT, MONITORING, NOTIFICATION AND REPORTING               | 62 |
| 14.1. Flaring Measurement                                             | 62 |
| 14.2. Flow Meter Maintenance and Calibration                          | 62 |
| 14.2.1. Corrective Maintenance                                        | 62 |
| 14.2.2. Preventive Maintenance                                        | 62 |
| 14.3. Monitoring                                                      | 63 |
| 14.4. Flare Checks                                                    | 63 |
| 14.5. Internal Reporting                                              | 63 |
| 14.6. Response to Public Concern Related to Flaring                   | 64 |
| 14.7. External Notification and Reporting                             | 64 |
| 14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting | 64 |
| 15. CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                       | 65 |
| 16. REFERENCES                                                        | 66 |

# 1. Introduction

## 1.1. Project Background

Shell Canada Energy (“Shell”), North Montney LNG Limited Partnership, KOGAS Canada LNG Partnership (“KOGAS”), Diamond LNG Canada Partnership (“Diamond”), and PetroChina Kitimat LNG Partnership (“CNPC”), together the Joint Venture Participants referred to as LNG Canada Development Inc. (LNG Canada), are jointly developing a liquefied natural gas (LNG) export facility near Kitimat, British Columbia (B.C.), Canada, on the Traditional Territory of the Haisla Nation.

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project.

A list of acronyms and definitions is provided in Section 1.4.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, Commissioning and Operation of the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke, in conformance with the Project Facility Permit, issued by the BC Oil and Gas Commission (OGC).

This report provides an overview of the following aspects for routine and non-routine flaring during commissioning and operations:

- Regulatory Framework – Section 2
- Roles and Responsibilities – Section 3
- Flare System Overview – Section 4
- Flare System Design Basis, Technology Selection and Mitigation Measures – Section 5
- Environmental Impacts and Mitigation Measures – Section 6
- Inventory of Flaring Activities, including anticipated flare characteristics:
  - Continuous Venting – Section 7
  - Continuous Flaring – Section 8
  - Commissioning – Section 9
  - Early Operations – Section 10
  - Normal Operations and Turn Around – Section 11
  - Unplanned – Section 12
  - Emergencies – Section 13
- Measurement, Monitoring, Notifications and Reporting – Section 14
- Continuous Improvement – Section 15

This document does not:

- Include the feed gas pipeline that is under Coastal GasLink (CGL) control.

This document is intended to be reviewed and updated:

- Within three months after Commissioning LNG Train 1 to incorporate lessons learnt that need to be applied to Commissioning of LNG Train 2; and
- As required to capture continuous improvement cycles.

### 1.3. Project Overview

The Project includes the following LNG processing and storage systems (but not limited to):

- Natural gas inlet station;
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities;
- Up to two full containment storage LNG tanks;
- Up to two condensate storage tanks; and
- Flare systems, including a total of up to two flare derricks.

There are two parallel LNG loading lines; up to two vapour return lines; and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier; and a materials offloading facility.

The Project is being constructed in two Phases; with each Phase having two processing units and associated utilities, one LNG Storage Tank and one LNG carrier Berth. The flare system has been designed to accommodate both phases, with the Commissioning and Early Operations information herein focused on the first phase.

### 1.4. Abbreviations and Definitions

Table 1 and Table 2 contain a list of abbreviations and definitions used within this document.

**Table 1: Abbreviations**

| Abbreviation    | Definition                                                                |
|-----------------|---------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                     |
| AGR             | Acid Gas Removal                                                          |
| AQO             | Ambient Air Quality Objective                                             |
| BTEX            | Benzene, Toluene, Ethylbenzene and Xylene                                 |
| B.C.            | British Columbia                                                          |
| BOG             | Boil Off Gas                                                              |
| CAAQS           | Canadian Ambient Air Quality Standards                                    |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                      |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e. heavier hydrocarbons) |
| CGL             | Coastal GasLink                                                           |
| CIE             | Commission Internationale de l'Eclairage                                  |

| Abbreviation      | Definition                                                                                            |
|-------------------|-------------------------------------------------------------------------------------------------------|
| CO <sub>2</sub>   | Carbon Dioxide                                                                                        |
| CSA Z276          | Canadian Standards Association, Liquefied Natural Gas (LNG) – Production, Storage and Handling (Code) |
| dBA               | A-weighted decibel (unit of noise measurement)                                                        |
| dB(C)             | C-weighted decibel (unit of noise measurement)                                                        |
| DRE               | Destruction Removal Efficiency                                                                        |
| EAC               | Environmental Assessment Certificate                                                                  |
| EAO               | BC Environmental Assessment Office                                                                    |
| ECCC              | Environment and Climate Change Canada                                                                 |
| EMS               | Environmental Management System                                                                       |
| ENV               | BC Ministry of Environment and Climate Change Strategy                                                |
| EPC               | Engineering, Procurement, and Construction                                                            |
| F-CD              | Cold Dry Vapour Flare                                                                                 |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                                         |
| F-WW              | Warm Wet Vapour Flare                                                                                 |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development                     |
| FVRG              | Flaring and Venting Reduction Guideline                                                               |
| GHG               | Greenhouse Gas                                                                                        |
| GWP               | Global Warming Potential                                                                              |
| H <sub>2</sub> S  | Hydrogen Sulphide                                                                                     |
| HP                | high pressure                                                                                         |
| hr                | Hour (unit of time)                                                                                   |
| IAAC              | Impact Assessment Agency of Canada                                                                    |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                                        |
| KAG               | Kitimat Airshed Group                                                                                 |
| Kg                | Kilogram (unit of weight)                                                                             |
| KO                | Knockout                                                                                              |
| kPa               | Kilopascal (unit of pressure)                                                                         |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                                             |
| LNG               | Liquefied Natural Gas                                                                                 |
| LNG Canada        | LNG Canada Development Inc.                                                                           |
| LNGFR             | LNG Facility Regulation                                                                               |
| LPG               | Liquid Petroleum Gas                                                                                  |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| m                 | Meter (unit of length)                                                                   |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                             |
| MCHE              | Main Cryogenic Heat Exchanger                                                            |
| MJ                | Mega joules (unit of energy)                                                             |
| MOH               | BC Ministry of Health                                                                    |
| MR                | Mixed Refrigerant                                                                        |
| Nm <sup>3</sup>   | Normal metre cubed (unit of volume)                                                      |
| NOx               | Nitrogen Oxides                                                                          |
| OGAA              | Oil and Gas Activities Act                                                               |
| OGC               | Oil and Gas Commission                                                                   |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| ppm               | Parts per million                                                                        |
| ppmv              | Parts per million volume                                                                 |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of "0"                                                          |
| RCM               | Reliability Centred Maintenance                                                          |
| RFSU              | Ready for Start-Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| Sm <sup>3</sup>   | Standard metre cubed (unit of volume)                                                    |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| t/h               | Tonnes per Hour                                                                          |
| Te                | Metric Tonnes (unit of weight)                                                           |
| US                | Ultra-sonic (flow meter)                                                                 |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |



**Table 2: Definitions**

| Term                                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Commissioning                        | Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.<br>In the Facility Permit, it is defined as “ <i>Period of time commencing when operations begin in accordance with Section 11 of the OGC Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i> ”. |
| De-Inventorization                   | Disposal of hydrocarbon inventory within a process unit or equipment.                                                                                                                                                                                                                                                                                                                                           |
| Dilution Gas                         | Typically, fuel gas used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as fuel gas instead of flared gas.                                                                                                                                                                 |
| Destruction Removal Efficiency (DRE) | A percentage that represents the number of molecules of a compound removed or destroyed relative to the number of molecules that entered the system.                                                                                                                                                                                                                                                            |
| Early Operations                     | Period of operations prior to the facility commencing Normal Operations, occurring immediately after completion of Commissioning and may extend for up to two years where facility reliability is relatively lower, resulting in increased flaring.                                                                                                                                                             |
| Emergency                            | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure (per the Facility Permit).                                                                                   |
| Fuel Gas                             | A process stream that is used in providing energy for facility operations.<br>For this Project, this is gas burned in the gas turbine and incinerator as fuel gas or added to the flare to improve heating value of the flared gas.                                                                                                                                                                             |
| Flared Gas                           | A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).<br>For this Project, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided.                                                                    |
| Flaring                              | Disposal by combustion of natural gas or gas derived from petroleum.<br>Typically through an elevated stack and burner tip (not used to provide energy for facility operations).                                                                                                                                                                                                                                |
| Continuous Flaring                   | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                                                                                                                                     |
| Fugitive emissions                   | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment of tanks have not been properly closed or tightened.                                                                                                             |

| Term                        | Definition                                                                                                                                                                                                                                                        |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Greenhouse Gas              | Gases in the atmosphere that absorb and emit thermal radiation. In the context of Greenhouse Gas (GHG) and Energy Management for an LNG project, these are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. |
| Major Flaring Event         | PLACEHOLDER; to be defined in consultation with the BC OGC.                                                                                                                                                                                                       |
| Natural gas                 | Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non- hydrocarbon impurities such as nitrogen, carbon dioxide and hydrogen sulfide.<br>Feed gas as supplied by Coastal GasLink.        |
| Normal (routine) Operations | Excludes Emergency conditions and Commissioning (per the Facility Permit), occurring after Early Operations has concluded.                                                                                                                                        |
| Process upset               | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                   |
| Throughput                  | Fraction of the daily capacity (flow rate) of 1 train                                                                                                                                                                                                             |
| Turnaround                  | Planned full inspection of a liquefaction train.                                                                                                                                                                                                                  |
| Venting                     | The intentional controlled release of un-combusted gases directly to the atmosphere.                                                                                                                                                                              |

Sources:

- BC OGC (2018), LNG Facility Permit Application and Operations Manual, Version 1.6, August
- BC OGC (2020), Oil and Gas Glossary and Definitions, Version 1.11, December
- LNG Canada Project Facility Permit AD# 100083612, January 7, 2021 (Amended)

## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to design, Commissioning, Early Operations, and/or Normal Operations to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In B.C., LNG facilities are regulated by the *Liquefied Natural Gas Facility Regulation* (LNGFR) (B.C. Reg 146/2014), under the *Oil and Gas Activities Act* (OGAA). The BC OGC has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operations of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate” application, which authorizes commissioning and operations (LNGFR, Section 4).

The Project received the Facility Permit (Legacy File No. 9709124; Application Determination #100083612) on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BC OGC issued an amendment to the Facility Permit on January 7, 2021 and January 31, 2022, which re-numbered conditions (references to conditions herein are based on the amendment). Permit conditions applicable to the flare system are provided in Table 3 (refer to the permit for the full list of conditions; including additional conditions related to noise management). Note, LNG Canada is the “permit holder” for all permits issued by the BC OGC. This report was developed to satisfy Condition 39 and 40, and the other related conditions are provided for context only.

A “Leave to Construct” for the LNG Facility construction activities associated with Trains 1 and 2 within the bund wall (including the flare systems) was issued by the BC OGC on July 30, 2020. There were no specific conditions in this issued leave, as it’s based on the Facility Permit and LNGFR. A “Leave to Operate” will be required prior to Commissioning the flare system.

**Table 3: Facility Permit Conditions**

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31        | Flare Systems             | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |
| 35        | Flaring Notification Plan | The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a> , to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                           | <p>satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius for residents as defined below:</li> </ul> <p>H<sub>2</sub>S Content &amp; Notification Radius:</p> <p>&lt; 1%: 1.0km</p> <p>≥ 1% and &lt; 5%: 1.5km</p> <p>≥ 5%: 3.0 km</p> |
| 36        | Flaring Notification Plan | <p>The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m<sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.</p>                                                                                                                                                                                                                                         |
| 37        | HSSE                      | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 38        | Smoke                     | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                              |
| 39        | Flaring Management Report | <p>The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.</p>                                                                                                                                                                                                                                                               |
| 40        | Flaring Management Report | <p>The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 41        | Flaring Management Report | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 47        | Noise                     | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA and dBC comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> </ul> <p>Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</p> |
| 50        | Noise                     | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the "British Columbia Noise Control Best Practices Guideline." Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 52        | Light                     | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l'Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities and operations. The BC OGC has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for emissions.

At this time of document issuance, the WDA application for air emissions that includes the flare system, is under development. Engagement with the BC OGC has commenced via submission of the WDA pre-application on 13 November 2020.

### 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued the Environmental Assessment Certificate (EAC) for the Project on June 17, 2015 (#E15-01) with subsequent amendments issued 2016, 2019 and 2021. Note, LNG Canada is the "Holder" for the EAC. Permit conditions applicable to the flare system are provided in Table 4 (refer to the permit for the full list of conditions) for context only.

**Table 4: Environmental Assessment Certificate #E15-01 Conditions**

| Condition   |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A  | Certified Project Description      | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Schedule B  | Table of Conditions – Condition 1  | <p>Air Quality.</p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC, and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction, and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC.</p> <p><i>Note, there is further detail in the condition that is not provided hererin. Refer to the EAC for further details.</i></p> |
| Schedule B  | Table of Conditions – Condition 2  | <p>Acoustics</p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009)</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                             |
| Schedule B  | Table of Conditions – Condition 12 | <p>Wildlife</p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>Ministry of Forests, Lands, Natural Resources and Rural Development</i>) and OGC. The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p>                                                                                                                                           |
| Application | Mitigation Measure 5.3-9           | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start-up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued the Decision Statement for the Project on June 17, 2015 with a subsequent amendment issued in April 2021. Note, LNG Canada is the “Proponent” for the Decision Statement.

Permit conditions applicable to the flare system are associated with migratory birds; Condition 5.2 states that “*The Proponent shall:*

*5.2.1 restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;*

*5.2.2 minimize flaring during night time and during periods of bird vulnerability;*

*5.2.3 adjust operational lighting to avoid attracting migratory birds.”*

Note, this information is provided for context only.

## 2.2. Acts, Regulations and Guidelines

As outlined in Section 2.1, there are several regulatory acts, regulations and guidelines that inform the design, construction and operation of the flare system. Further details on key acts, regulations and guidelines are provided herein, please refer to the full act, regulation and guideline for further information.

### 2.2.1. Oil and Gas Activities Act; Liquified Natural Gas Facility Regulation

As outlined in Section 2.1.1, the OGAA, LNGFR is a key regulation for LNG Facilities. Key sections conditions applicable to the flare system are provided in Table 5 (refer to the regulation for further details).

The BC OGC developed the “Liquified Natural Gas Facility Permit Application and Operations Manual” which provides further guidance on flaring and references various guidelines; the manual is available online through the BC OGC.

**Table 5: LNGFR Sections**

| Section                                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>4</p> <p>Engineering Design and LNG Facility Siting</p> | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p> |
| <p>15</p> <p>Noise and Light Control</p>                   | <p>An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Section |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17      | Venting                            | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p> |
| 18      | Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ul style="list-style-type: none"> <li>a) flaring is required for maintenance purposes, or</li> <li>b) permission to flare is included in the LNG facility permit.</li> </ul> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                                                                                                                              |
| 19      | Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p>                                                                                                                   |

### 2.2.2. BC OGC Flaring and Venting Guideline Reduction Guidelines

The BC OGC *Flaring and Venting Reduction Guidelines* (FVRG) will **inform where applicable**, all stages of the Project to eliminate routine flaring and reduce non-routine events. The FVRG is available online through the BC OGC. Key chapters include:

- Chapter 3 – Natural Gas Facility Flaring and Venting: Includes a decision tree that **will** be used **where appropriate**, when considering alternatives to flaring and venting.
- Chapter 5 – Notification Requirements.
- Chapter 6 – Performance Requirements: Includes requirements for noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance and dispersion modelling.



- Chapter 7 – Venting and Fugitive Emissions Management Requirements.
- Chapter 10 – Measurement and Reporting: All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting and record retention.

### 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC, with the latest version issued in July 2021.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to account for the flare system.

Note, the Project is developing a separate Noise Management Program, as required by Project permits (refer to Section 2.1 herein) that will include the applicable measures to mitigate noise.

### 2.2.4. BC OGC Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC.

A facility flare is an example of a “sky glow” source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light, with reference to the CIE guide (which is also Project Facility Permit Condition 52, refer to Table 3). **Some elevated light emissions are anticipated during Commissioning and Early Operations; however, this is a standard part of startup of LNG Facilities and will reduce as the plant approaches Normal Operations.**

### 2.2.5. Ambient Air Quality Objectives

The province of B.C. uses a suite of ambient air quality criteria that have been developed provincially and nationally to inform decisions in the management of air contaminants. Ambient air quality objectives applied in B.C. include provincial and national objectives and standards developed for a number of contaminants over various averaging periods. These include Provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e., not legally binding), unless referenced directly in a regulation or authorization; and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts
- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories

Limits on air emissions for the Project will be defined in the WDA (refer to Section 2.1.2) and not further addressed herein. The AQOs are available online.

## 2.3. Environmental Commitments

During Normal Operations, the Project will operate without routine flaring or venting, with minor continuous sources (e.g., flare pilot). Furthermore, non-routine flaring will be minimized, and the design will include flare mitigation to reduce flare load during unplanned upsets.

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment and Social Performance focuses on ways to avoid and minimize negative environmental and social impacts resulting from our operations and enhance the positive impacts in a systematic manner, which were addressed as part of the flare system design.

### 3. Roles and Responsibilities

There are various roles and responsibilities applicable to the design, construction and operations of the flare system. JFJV, as LNG Canada's EPC, is responsible for managing the design, fabrication, construction, pre-commissioning and **Commissioning** activities up to "ready for start-up" (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing **Commissioning** activities that **cannot** be physically done prior to RFSU and **Early Operations** after RFSU of the LNG Train (i.e., handover), with support from JFJV to execute post-RFSU activities. Commissioning, ramp-up and **Early Operations** shall be executed by a joint, competent team of staff from LNG Canada and JFJV.

## 4. Flare Systems Overview

### 4.1. General

During Normal Operations, natural gas and other hydrocarbons flow continuously through an LNG Facility. When there is a disruption to the expected operation of the LNG Facility, such as an equipment or power outage, the constant flow of natural gas is interrupted. Largescale LNG plant designs incorporate flare systems to safely combust excess hydrocarbons when necessary. For scenarios including start up, process upsets or Emergency conditions, the hydrocarbons are ignited via a small continuous “flare pilot” flame to burn gases safely and efficiently under all conditions without escaping into the atmosphere. For this Project, the flare pilot, which is supplied by fuel gas and is a small, smokeless flame, provides a continuous ignition source, such that any gas sent to the flare as a result of upset conditions is immediately combusted.

When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be quite large, noisy or create smoke.

The Project is designed to minimize continuous flaring and venting during normal operations and minimize flaring during maintenance and other normal non-routine events during operations. Flaring is kept to those occasions when it is needed as a safety measure during start-up and shut down events, to prevent equipment damage and maintain safety and facility reliability.

As stated in Section 2.3, during Normal Operations, the Project will operate with limited continuous sources (i.e., pilot flares and other safety features), and will not carry out routine flaring or venting (refer to Section 7 and 8 for information on the limited continuous sources). The flare system will facilitate purging of the plant during the following activities:

- Routine maintenance activities
- Planned maintenance (turnarounds)
- Trips and unplanned shutdown to repair defects
- Commissioning
- Emergency Situations

The Project has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers to flare used for operational reasons).

The EAC application had estimated that “a default factor of 0.3 weight percent of each train’s LNG output is assumed to best represent flaring volumes occurring during Normal Operation and during maintenance events”.

As flares radiate heat, the height of the flare stacks is designed with safety in mind. A specially designed and secure exclusion zone exists surrounding the base of the flare to control access to the flare area to protect the general public and workers at the LNG facility.

During Commissioning and Early Operations, it is expected that flare volumes and visibility will be higher compared to Normal Operations. The flaring activity will reduce over time as the facility moves into Normal Operations (as discussed in more detail later in this report, refer to Section 11).

### 4.2. Process Description Overview

The Project receives dry pressurized Natural Gas from the CGL pipeline. The feed gas stream is primarily methane with some ethane, propane, butane and a small heavy tail with some impurities. The raw, warm gas is cleaned of its impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to Figure 1).

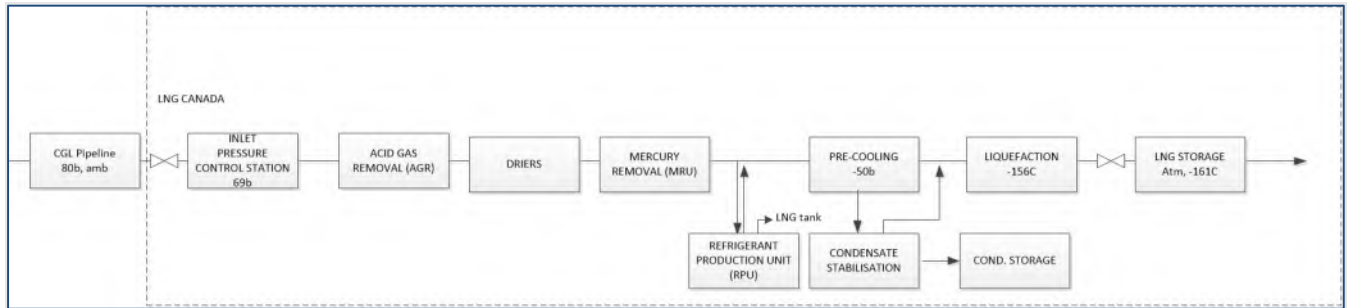


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses a Pre-cool Mixed Refrigerant (“PMR”) cooling from ambient to -50°C; and
- Deeper liquefaction cycle: uses a Mixed Refrigerant (“MR”) cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE).

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called “String A” and “String B,” as shown in **Figure 2**. Each string can roughly handle half the production. The gas turbines are semi-aero derivative type with low torque requirement at start (meaning there is no need to depressurize inventory to allow restart).

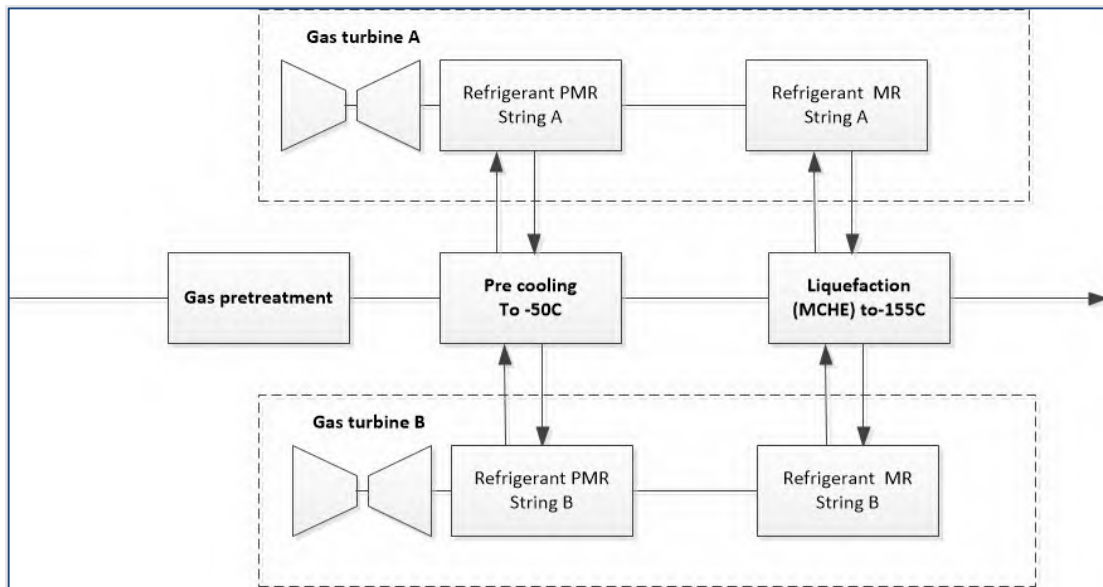


**Figure 2 Liquefaction Overview Schematic (high level)**

Methane, ethane and propane are the components used as refrigerants in the liquefaction process. They are therefore available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).

There are four flares and nine liquid burners, which are common for both Train 1 and Train 2 (**Figure 3**, further details are provided in Section 5). The Project has two derrick structures to support the flares and liquid burners, as outlined in Table 6. Refer to **Figure 3** and **Figure 4** for the location of the structures.

There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.

**Table 6: Flare Derrick Structures and Systems**

| Item                       |                                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour<br>Flare<br>Derrick | Warm/Wet Process<br>Flare ("F-WW")                    | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and / or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"> <li>• Inlet Facilities</li> <li>• Acid Gas Removal Unit</li> <li>• Dehydration Unit</li> <li>• Mercury Removal Unit</li> <li>• Liquefaction Unit</li> <li>• Incinerator Unit</li> <li>• Condensate Stabilisation Unit</li> <li>• Heat Transfer Fluid System</li> <li>• Tempered Cooling Water System Unit</li> <li>• Fuel Gas System</li> <li>• Defrost Gas System</li> </ul> |
|                            | Cold/Dry Process<br>Flare ("F-CD")                    | <p>For cryogenic hydrocarbon vapours (will not contain water). This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                              |
|                            | Low Pressure<br>Storage and<br>Loading Flare ("F-LP") | <p>For low pressure LNG vapours from the LNG Storage Tanks in the event of BOG Compressors failure and / or carrier loading; compressor seal vents and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p> <p>Includes a velocity seal to minimize purge gas requirements.</p>                                                                                |

| Item                  | Description    |                                                                                                                                                                                                                                                |
|-----------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                | CO <sub>2</sub> or nitrogen containing gases released during de-inerting of LNG carriers route to the F-LP also. Sufficient fuel gas shall be supplied for continuous burning of the flame.                                                    |
|                       | Spare flare    | Used in place of the individual flare systems when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare stack, with minimum design temperature dictated by the cold/dry process flare design. |
| Liquid Burner Derrick | Liquid burners | For either warm/wet or cold/dry liquids.                                                                                                                                                                                                       |

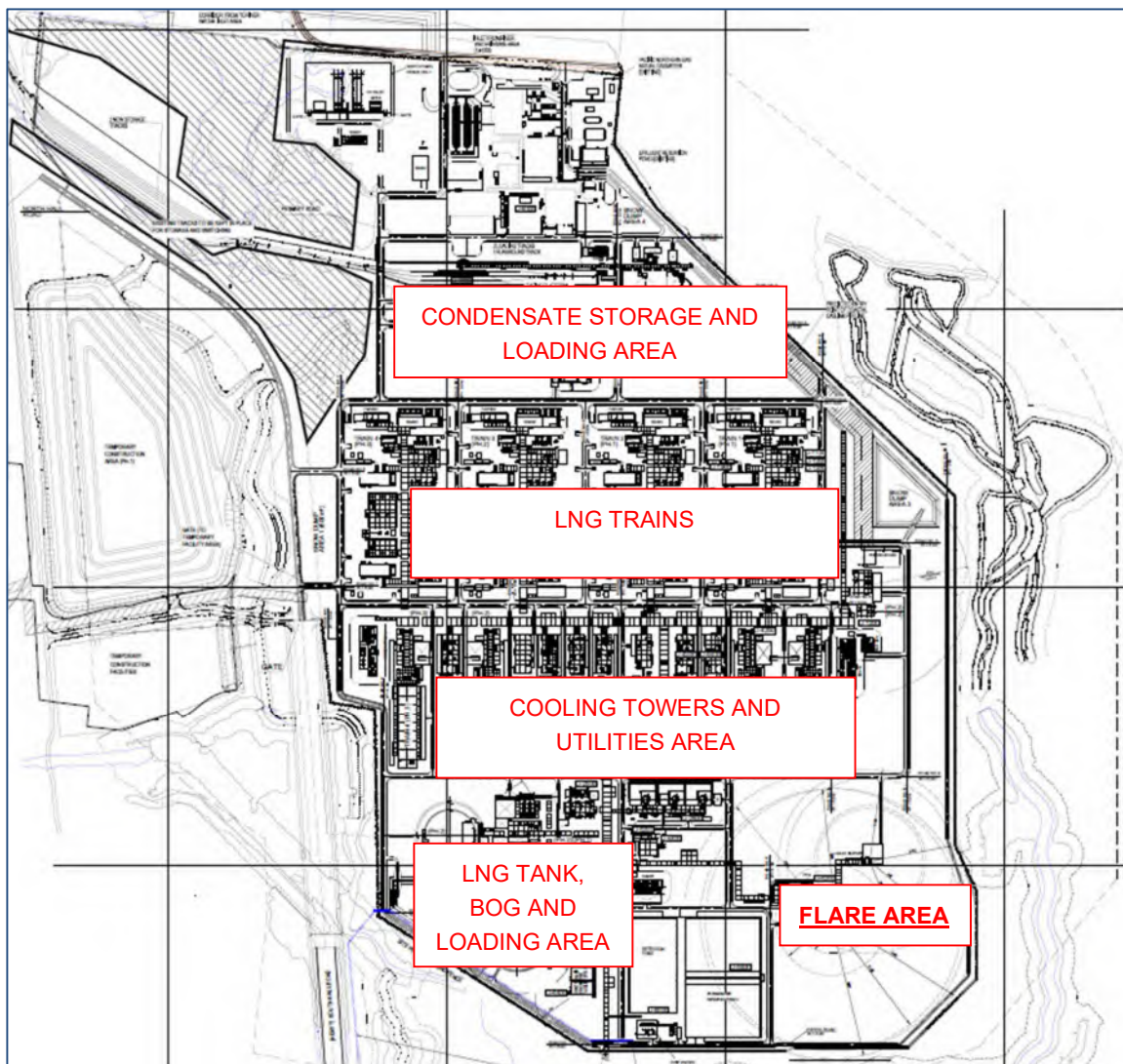


Figure 3 Flare Location Overview







## 5. Flare Design Basis, Technology Selection and Measures

### 5.1. Design Basis

The design basis for key components of the flare systems is provided below. Some parameters of the design basis were adjusted during detailed design with the vendor (refer to Section 5.2 for further information).

#### 5.1.1. Flare Systems

The design flow rate for each flare, and associated design case are provided in Table 7 and Table 8, which are consistent with the permissions in the Facility Permit. The flares are designed to achieve 99.53% destruction removal efficiency (DRE).

**Table 7: Vapour Flares Design Basis**

| Flare                      | Diameter (inch) | Height (m) | Design flow (t/h) | Case                                          |
|----------------------------|-----------------|------------|-------------------|-----------------------------------------------|
| Warm Wet ("F-WW")          | 56              | 122        | 2195              | Blocked outlet liquefaction                   |
| Cold Dry ("F-CD")          | 48              | 122        | 1717              | Refrigerant compressor blocked outlet         |
| Storage & Loading ("F-LP") | 56              | 122        | 299               | Loss of all BOG compressors (4 trains)        |
| Spare                      | 56              | 122        | 2195              | Blocked outlet liquefaction as governing case |

**Table 8: Liquid burners Design Basis**

| Flare                   | Number of Flare Tips | Flare Tip Diameter (inch) | Height (m) | Design flow (t/h) | Case                                                     |
|-------------------------|----------------------|---------------------------|------------|-------------------|----------------------------------------------------------|
| Liquid burner-warm case | 3                    | 3                         | 60         | 32                | Hydrocarbons (C3), Condensate disposal                   |
| Liquid burner-Cold case | 9                    | 3 with 3"<br>6 with 6"    | 60         | 310               | LNG restart following outage (30% production of 1 train) |

#### 5.1.2. Flare Radiation

The design complies with the following requirements for thermal radiation outlined in Table 9.

**Table 9: Flare Thermal Radiation Design Basis**

| Heat Radiation limit (kW/m <sup>2</sup> ) | Location                                                                              | Basis                                                                                                                   |
|-------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | At the boundary of sterile area for normal operation including start-up and shut down | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR requirement is maximum of 5 kW/m <sup>2</sup> |

| Heat Radiation limit (kW/m <sup>2</sup> ) | Location                                                 | Basis                                                                                                                   |
|-------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 3.0                                       | Facility fence line for all cases and cooling towers     | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR requirement is maximum of 5 kW/m <sup>2</sup> |
| 6.3                                       | At the boundary of sterile area for emergency conditions | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR requirement is maximum of 9 kW/m <sup>2</sup> |

### 5.1.3. Flare Knockout Drums

The design basis for the flare knockout (KO) drums is provided in Table 10. The flare KO drums are protected from liquid overflow through a combination of design liquid retention volume as well as the use of two independent radar level measurements (one alarm is initiated through the distributed control system and the second through the safety system). These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners.

The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck.

**Table 10: Flare Knock Out Drums Design Basis**

| Flare Knockout Drum | Liquid Sizing Criteria                                                                                                                                                                                                                                                                                                                                        |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm-Wet            | To handle maximum vapour relief. The maximum liquid inventory is 180 m <sup>3</sup> , based on the amine liquid relief scenario.                                                                                                                                                                                                                              |
| Cold-Dry            | Assuming that the blowcase operation does not occur for 20 minutes after the emergency depressurizing of the LNG train liquification unit starts. This scenario equates to 140 m <sup>3</sup> of liquid accumulation in the flare KO drum which is based on the depressuring from PMR accumulator prior to start of the blowcase sequence and liquid burners. |
| Spare               | To meet the most stringent design criteria of both the WW and CD systems, this KO drum has been sized to retain 180 m <sup>3</sup> of liquid carryover from the amine flash drum without operation of the flare KO drum pump as this has been identified as the largest relief load.                                                                          |

## 5.2. Flare Technology Used

The selection of flare technology used to meet the design basis is a key component to ensure efficient operations, including minimizing associated emissions. The Project contracted Zeeco to design and fabricate the vapor and liquid flare systems.

### 5.2.1. Pilot System

The vapour flares are equipped with four pilots each, and the liquid burners are equipped with an individual pilot.

The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system; if the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.

Each flare pilot is equipped with a redundant thermocouple to detect a flameout. On detection of a pilot flame out, an alarm will be initiated to the panel operator and the system will automatically attempt to relight the pilot with a high energy ignition system. If the high energy ignition system fails to relight the pilot, field operations will attempt to relight the pilot with a flame front generator.

The vapour flares have redundant pilots and the flares are the final barrier to a process safety incident; therefore, in the unlikely case that all four pilots are lost, they will continue to operate. To account for the scenario that all pilots have been extinguished, a flame out scenario has been modeled for these flares and the unburned hydrocarbon from the flare does not pose a hazard to people. If the pilots are unable to be relit, the impacted flare will be taken out of service and switched to the spare flare, if available, until repairs can be made.

For the liquid burners, as this equipment is only required for start-up and liquid disposal, a loss of the pilot will result in the individual burner tripping to prevent liquid rainout.

### 5.2.2. Vapour Flare Systems

Details on the selected vapour flare technology is provided in Table 11; and supporting images provided in Figure 5 and Figure 6.

**Table 11: Vapour Flare Summary**

| Flare                                                                                                                 | Type                | Smoke Index <sup>1</sup> | Assist Gas for DRE |
|-----------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------|--------------------|
| Warm Wet ("F-WW")                                                                                                     | Multi-Jet MJ-56     | R0                       | Yes                |
| Cold Dry ("F-CD")                                                                                                     | VariJet VJ-48       | R0                       | No                 |
| Storage & Loading ("F-LP")                                                                                            | Utility Flare UF-56 | R0                       | Yes                |
| Spare                                                                                                                 | Multi Jet MJ-56     |                          | Yes                |
| Notes:                                                                                                                |                     |                          |                    |
| 1. Further information on smoke performance is provided in Section 6.1 R0 = estimated Ringelmann scale measure of "0" |                     |                          |                    |



**Figure 5: Example of a Warm Flare – Multi Jet (MJ) (Vendor – Zeeco)**



**Figure 6: Example of a Low pressure Flare – Utility Flare (Vendor – Zeeco)**

### 5.2.3. Liquid Burners System

Details on the selected liquid burner technology is provided in Table 12. The liquid burners system consist of nine burners, three of which will be used in the warm case, with all nine used for the cold case.

**Table 12: Liquid Burner Summary**

| Flare                    | Type       | Comments                                          |
|--------------------------|------------|---------------------------------------------------|
| Liquid burner- warm case | MJ3        | 1 Spider burner per riser, 3 risers               |
| Liquid burner- Cold case | MJ6<br>MJ3 | 3 Spider burners (2x6", 1x3") per riser; 3 risers |

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA with one multi-jet liquid burner to observe:

- Smokeless capability; and
- Noise measurement.

Both results were satisfactory; correlated noise for nine burners was estimated at 85dB at 250 metres. Images from the testing are shown Figure 7.

## Liquid burner: Multi-Jet from Zeeco



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81

Figure 7 Liquid Burners (Star Shape) from Zeeco for LNGC

### 5.2.4. Derrick Structures

The derrick structure for the flares and liquid burners is shown in Figure 8.

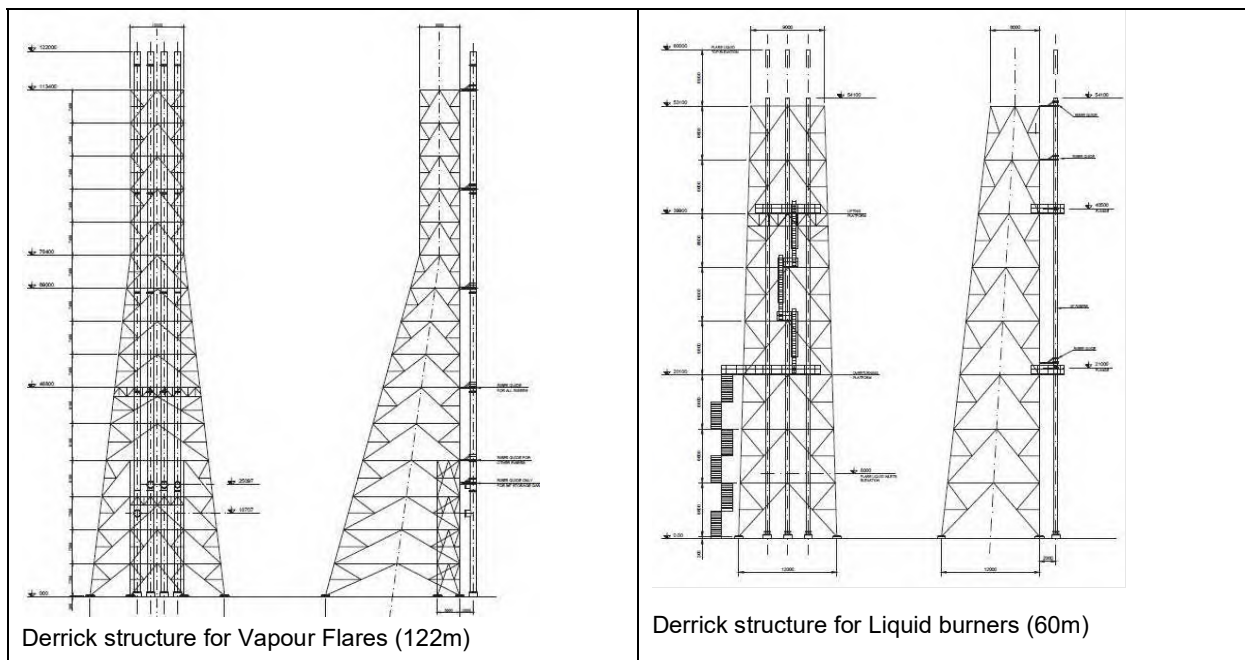


Figure 8 Derrick Structure

### 5.3. Flaring & Venting Mitigation Measures in Design

Several prospective flare reduction technologies were considered for implementation including the recovery of start-up gas through the BOG compressor and the review of split range pressure controllers to ensure that they do not prematurely open to flare.

Elements of the Project design that will support minimizing flaring and venting include:

1. The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.
2. There are two parallel strings for each liquefaction train; a trip or outage of one string does not interrupt LNG production; it only cuts it in half, so there is no flaring impact.
3. Each compressor string is equipped with its quench line for start-up to allow quick equalization with cold running string to reduce flaring.
4. The ethane refrigerant sphere is insulated and chilled to  $-11^{\circ}\text{C}$  to minimize vapour losses from the sphere.
5. PMR and MR Refrigerant qualities can be adjusted by recycling their vapours to condensate unit rather than flaring them.
6. MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring it.
7. PMR refrigerant liquid can be drained and recycled to PMR storage sphere in preparation of turnaround, reducing amount to flare.
8. Refrigerant spheres are pressure controlled to the LNG tank vapour space.
9. Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.
10. The RPU overheads and bottoms are fully recycled back to the LNG Train.
11. Pre-cooling PMR cycle can circulate MR on full recycle via an MR "start-up recycle line" to provide pre-cooling load, to facilitate pre-cooling system start-up and decouple with MCHE final cool down.
12. The condensate tank vapours are chilled to  $-10^{\circ}\text{C}$  to reduce hydrocarbon directed to the incinerator.
13. Upon thermal oxidiser trip, the acid gas stream is sent to the Warm flare instead of being vented.
14. Automated advanced cooldown to reduce flaring time at the cold liquid burners.
15. Purging of flare headers by nitrogen instead of fuel gas.
16. Full metering capability on the flare headers including density measurement which can help identify abnormal flaring earlier.
17. Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part continual improvement.



## 6. Environmental Impacts and Mitigation Measures

The act of flaring can cause a potential impact to the environment due to smoke, air emissions, heat, noise and light. Potential environmental effects from flaring were addressed in the EAC process. The following section outlines how each of these elements has been minimized through design.

### 6.1. Smoke

The Project Facility Permit stipulates that the permit holder must design, maintain, and operate flares and incinerators so that flaring, other than for emergencies, does not result in black smoke or emission of black smoke during upsets that exceeds 15 minutes in any two-hour period (and is completely eliminated during Normal Operations) (refer to Table 3).

The Ringelmann scale is the scale used by industry for measuring the apparent density of opacity of smoke (refer to Figure 9).

During the detailed engineering phase, JFJV worked with two reputable flare manufacturers with experience in the LNG industry and in Canada; each vendor provided two designs: the first compliant with Ringelmann 1 performance, which has been utilized at other sites for start-up; and a second design with Ringelmann 0 performance for start-up.

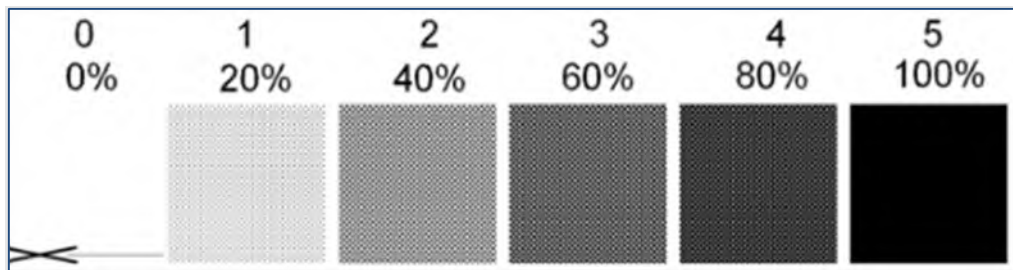


Figure 9 Ringelmann Chart

After evaluation, LNG Canada chose an improved design that reduces noise generation as well as smoke. According to the manufacturer, Ringelmann “0” or “R0” performance is likely in most situations. However, this is not a guarantee for all conceivable operating scenarios. Smoke may occur in certain scenarios, including Commissioning and Early Operations (refer to Sections 9 and 10). Table 13 summarizes the design improvements.

Table 13 Summary of Flare Design Changes

| Flare riser               | Original design                                                        | New Design                                                                                                                                                                                   |
|---------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm Flare                | Single tip sonic pressurized                                           | Multi tip fixed slot sonic type; fixed orifice size                                                                                                                                          |
| Cold Flare                | Single tip sonic pressurized                                           | Multi tip variable slot sonic type                                                                                                                                                           |
| Storage and Loading Flare | General gas assisted flare                                             | No change possible due to requirement for low back pressure constraints                                                                                                                      |
| Spare Flare               | Single tip sonic pressurized                                           | Multi tip fixed slot sonic type; fixed orifice size                                                                                                                                          |
| Liquid Burners            | 4 burners with atomizing gas to combust heavier liquids as well as LNG | 3 risers with 3 burners each: <ul style="list-style-type: none"> <li>6x burners to burn smokeless LNG at start-up; and</li> <li>3x burners to burn heavier liquids as well as LNG</li> </ul> |

## 6.2. Air Contaminant & GHG Emissions

The Project is committed to the health and safety of the public, which is aligned with Facility Permit condition related to ensuring that emissions from flares and incinerators does not create a hazard to public health or safety, result in off-lease odours or result in injury to vegetation or wildlife (refer to Table 3).

Normally, flare technology has a **DRE** of approximately 98%; however, for this Project, the chosen flare technology has a **DRE** of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that by-products of incomplete combustion such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and Volatile Organic Compounds (VOCs) are released at extremely low quantities. The trade-off for this improved **DRE** is that GHG emissions **will be slightly increased** when assist gas is used in the flare; however, these emissions are relatively minor.

The combustion products of hydrocarbons also contribute to GHG emissions. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane. Other by-products of combustion that will be released from the flare include nitrogen oxides (NO<sub>x</sub>), and sulphur dioxide (SO<sub>2</sub>) when flaring feed gas or acid gas from the amine units.

To ensure that the project has a negligible impact on the environment and human health, comprehensive air dispersion modeling was completed as part of the EAC application, which confirmed that the B.C. AQOs would not be exceeded as a result of the LNG Canada facility for normal and emergency conditions. Further air emissions modelling is being undertaken as part of the WDA application, which includes the worst-case emergency flare scenarios (as it relates to air quality) (refer to Section 2.1.2).

LNG Canada participates in the Kitimat Airshed Group (KAG), a multi-disciplinary group that is focused on air quality monitoring and public outreach. The group is currently in the process of completing a third party review to define the airshed boundaries and identify any gaps in continuous ambient air quality monitoring. Once any identified gaps have been closed, LNG Canada will rely on the monitoring network throughout its operations and verify results from air dispersion modelling with monitoring data.

## 6.3. Thermal Heat

When combustion occurs in the flare system, a large amount of heat is released; this heat can pose a safety risk to personnel and the environment. To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing in the area, which could pose a fire hazard.

The height of the flare system will comply with the following thermal radiation limits provided in Table 9.

As the Project site is surrounded by trees, a potential concern that has been assessed is high thermal radiation leading to a forest fire. A maximum radiation level of 6.3 kW/m<sup>2</sup> is allowed at the boundary of the sterile zone, which is significantly below the 25-30 kW/m<sup>2</sup> general guideline for spontaneous ignition of wood".

The issue of exposure of personnel to high flare radiation during work on the derrick structure was assessed (for the liquid burners). This is not a significant concern as personnel can be evacuated from the liquid burner structure prior to flaring event). The assessment also reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75 metre covered walkway is needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn. However, any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure if a flaring event occurs while personnel are in the area and would be covered through LNG Canada's Permit to work practice.



## 6.4. Noise

The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential impacts from noise are assessed within the Project site (occupational) and offsite (nuisance).

### 6.4.1. Impact to Personnel on Site

The flare design includes requirements to meet the following noise limits from the Project design criteria:

- Emergency Cases: 115 dBA at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops
- Normal operation including start-up/shutdown: 85 dBA at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

The current flare system complies with both of the above criteria, based on the noise data sheets issued by the vendor; however, due to the unpredictable nature of emergency events, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the permit to work system as well as safety signage.

### 6.4.2. Offsite Impact

Management of the impact of noise to the public is addressed through the BC OGC Noise Control Best Practice Guidelines. A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system.

## 6.5. Light

Flaring from the Project will likely result in potential light impacts to the community, particularly during **Commissioning** and **Early Operations** (a “sky glow”), prior to reaching steady state operations. This potential impact has been mitigated through the design of the flare system by incorporating minimal operational flaring. The Flaring Notification Plan will outline the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts. **Where possible, taking into account a number of factors including safety, production requirements, economic impacts and feasibility, flaring activities will be scheduled to occur during the day time. Due to the longer duration of certain flaring activities, scheduling of flaring activities to only occur during daylight hours is not possible.**

## 6.6. Wildlife

The Wildlife Management Plan for operations will be developed in conformance with the EAC, and will outline the mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during operations, as feasible from a technical and safety perspective (refer to Table 4). Per the EAC Condition 12, the plan will be developed in consultation with ECCC, FLNR and the OGC; and engagement with Haisla Nation.

## 7. Continuous Venting Emissions

Details on the several of the streams associated with continuous venting will be provided in the waste discharge authorization application to the BC OGC; however an overview is provided herein.

### 7.1. Continuous Vent Emissions to Atmosphere

Hydrocarbon (methane) vapours have a much higher GWP than CO<sub>2</sub>. LNG Canada design has incorporated measures to minimize the venting of hydrocarbons to atmosphere. Small quantities from the following sources outlined in this Section from the process system, are vented to atmosphere.

#### Process Analyzers

To maintain control of the process and ensure product quality requirements are met, a number of streams are equipped with continuous analyzers. There are two main emission streams from the analyzers: a stream from the sample conditioning system and the exhaust stream from the analyzer itself. In some cases, the direct vents to atmosphere are equipped with catalytic oxidizer systems (TRACErase) to convert the residual hydrocarbon to CO<sub>2</sub> and water. In other cases, the stream is directly vented to the atmosphere.

For example, approximately 3 Sm<sup>3</sup>/hr of incinerator flue gas will be vented to the atmosphere, through the TRACErase.

#### Atmospheric Storage Tanks without vapour conservation facilities

As it is not practical to connect storage tanks to the flare system, storage tanks in the Project will vent directly to atmosphere during filling or during thermal outbreathing.

- Diesel, heat transfer fluid, amine, demineralized water storage tank venting to atmosphere during filling or thermal breathing: due to the low vapour pressure of the liquids, this vapour stream will primarily be nitrogen.
- Water storage tanks including wastewater will vent directly to atmosphere. This vapour stream will be air and water vapour.

#### Secondary Compressor Seal Vents

Compressor secondary seal vents are routed to atmosphere due to the low operating pressure; during normal operation this stream is nitrogen.

- Secondary seal gas to atmosphere (all main centrifugal compressors): during **Normal Operation**, this will be nitrogen; in the case of a failure of the secondary seal, hydrocarbons will be vented to atmosphere until the compressor is shut down and depressurized.

### 7.2. Unplanned Vent Emissions to Atmosphere

The following are unplanned sources of hydrocarbon that could vent to atmosphere:

- Any LNG tank relief valve lifting (pressure relief valves or reserve capacity relief valves, which are on top of the LNG tank (refer to **Figure 10** and **Figure 11**).
- Loss of both condensate tank vapour recovery blowers or vapour recovery chiller package. Due to inability to direct this stream elsewhere, the vapours from the tank will be vented to atmosphere via the pressure control valve. Note, that as the condensate is stabilized, not expected to vent to atmosphere.
- Pressure relieve valve lifting on condensate system (main tank, vapour recovery).
- Fugitive emissions on valve gland packings, flanges, instrument connections and relief valves routed to atmosphere; these sources would be monitored as part of LNG Canada's fugitive emission monitoring program

(note, a Fugitive Emissions Management Plan will be developed for the Project in conformance with LNGFR, Section 8(1)(c)).

- Depressurizing of equipment to atmosphere; generally, the equipment is purged to the flare with nitrogen to displace any hydrocarbons; however, a small residual amount would exist that is depressurized to atmosphere as part of the isolation process.



**Figure 10 Example of LNG Tank Pressure Relief Valve**



**Figure 11 Example of LNG Tank Reserve Capacity Valve**

## 8. Continuous Flaring Emissions

Details on the specific streams associated with continuous flaring will be provided in the waste discharge authorization application to the BC OGC; however an overview is provided herein (the pre-application package submitted to the OGC in November 2020 included the maximum discharge rates for **Normal Operations** for each flare and the liquid burners).

### 8.1. Flare Pilot

During **Normal Operations**, fuel gas is combusted in the flare pilots as pilot gas. The pilots are designed to provide a continuous ignition source, such that any gas sent to the flare as a result of upset conditions is immediately combusted. The pilot flare is a small, smokeless flame, which emits minor quantities of carbon dioxide, nitrogen oxides and water vapour.

The flame is typically about 30 cm long (refer to Figure 12 for example). Generally, the flame from the pilots is difficult to see but may be visible during nighttime. During daytime, the flame is difficult to see at any distance.



**Figure 12 Example of Flame Pilot Light**

There are four pilots per vapour flare and a dedicated pilot per liquid burner. The design volume of pilot gas used per pilot is 2.17 Nm<sup>3</sup>/hr; for the full system this is 54.25 Nm<sup>3</sup>/hr.

Note: As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#) section 4.4.9.1-5, pilot gas is considered as flared gas, not fuel gas.

### 8.2. Compressor Seal Gas

A small amount of process gas mixed with nitrogen is always sent to the flare through the centrifugal compressor primary seal vents as part of the seal design to contain the process gas. For example, approximately 18 Sm<sup>3</sup>/hr of seal gas is expected from PMR compressor string A.

The centrifugal compressors for the Project also have a secondary seal containing nitrogen, which is vented to atmosphere. If the primary seal fails in the compressor, this will be detected by the increased flow and the compressor will trip and depressurize automatically to minimize any release of process gas to atmosphere.

### 8.3. Analyzer Sample Returns

Process monitoring is conducted via online analyzers, with a number of the analyzer sample conditioning systems venting excess hydrocarbon to the flare system.

For example, approximately 0.02 m<sup>3</sup>/hr of gas between from the PMR compressor to the PMR Desuperheater will be vented to the cold flare.

#### 8.4. Continuous Passing Valves

All control valves connected to the flare system conform to a minimum ANSI Class IV leakage specification. Emergency Depressuring valves and other control valves that have been specified as “tight shut-off” (TSO), meet ANSI Class V leakage specification as per Project standards. This ensures that the amount of hydrocarbon lost to the flare is minimized. Manual valves connected to the flare system, which are used for maintenance purposes, are blinded to ensure that the leakage is eliminated. These locations must be de-blinded to purge equipment to flare.

#### 8.5. Flare Purges

The vapour flares are continuously purged to avoid air ingress in the system and potential deflagration inside the flare system. As the liquid burners do not have any continuous sources, these burners are only purged immediately after combustion to remove any residual liquid in the system.

In older facilities, fuel gas was used for flare purges, which had a GHG impact. For the Project to reduce GHG emissions, all flare headers are continuously purged with nitrogen instead of fuel gas. For example, for the warm flare nitrogen purge is approximately 50 Sm<sup>3</sup>/hr. In the event of outage or shortage of nitrogen in the facility fuel gas will be used for purge as a backup. The amount of fuel gas purge is approximately 280 Sm<sup>3</sup>/hr. Also, the normal operating cases for the warm flare and cold flare are greater than 12 MJ/m<sup>3</sup>; fuel gas will only be added to the minimum nitrogen purging for the storage and loading flare to increase the minimum heating value to 12 MJ/m<sup>3</sup>. Utilizing nitrogen will save approximately 5,500 kNm<sup>3</sup>/year of continuous flaring. During periods where nitrogen may not be available to purge the flare headers, alternative fuel gas connections are available to ensure a purge is always available.

The required purge volume is set either to maintain a velocity through the flare header when fouling is possible or to maintain a minimum purge volume to the flare tip to prevent ingress of air. For the Project, as there is no fouling fluids, the flare header purge is set to satisfy the required purge from the flare vendor. Each purge gas has its own differential orifice plate flow meter with accuracy typically better than 5%.

#### 8.6. Continuous Incinerator Emissions

The acid gas thermal oxidizer is used primarily to incinerate acid gas from the amine regenerator; this acid gas stream contains primarily CO<sub>2</sub> (approximately 90%), hydrogen sulphide (H<sub>2</sub>S) (approximately 0.2%) and hydrocarbons (including BTEX) (approximately 7%) with the balance as water vapour. The acid gas incinerators in LNG Train 1 and 2 will also receive non-condensable gas from the condensate storage tanks when the tank vapour recovery unit is in operation; this stream is primarily nitrogen (approximately 89%) with the balance being hydrocarbons. These streams do not have sufficient heating value to sustain combustion; as such, fuel gas is used in the incinerator to generate sufficient heat for oxidization of these streams prior to release to atmosphere. With the high operating temperature and residence time of the incinerator, a DRE of 99.99% for BTEX components is expected.

In case of a thermal oxidizer trip, the overheads are routed instead to the warm flare, and fuel gas is added to the flare to meet the 20 MJ/sm<sup>3</sup> heat content minimum requirement.

**Note:** As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#) section 1.7.2.5, fuel gas added to the incinerator or the flare due to the low heating value of the stream is considered fuel gas and not flared gas.

## 9. Commissioning Flaring Activities

The flaring profile during the Commissioning, start-up and Early Operations of an LNG facility is different from the Normal Operations of the facility.

Meticulous adherence to safety and equipment testing protocols is required to ensure a safe start-up, but there will be a flaring profile unique to this phase. The following section will contain details of the outlines the Commissioning and start-up phase. Refer to Section 10 for further information related to the Early Operations phase.

### 9.1. Commissioning Overview

Commissioning of the LNG Canada facility follows these general steps:

- Flare pilot start-up and testing on liquid petroleum gas (LPG) bottles;
- Pipeline Commissioning to the plant including Plant inlet de-inerting and pressurization;
- Flare purge start-up;
- Gas turbine testing;
- Refrigerants (ethane and propane) import to storage and cooldown of associated piping and equipment;
- LNG import to storage and cooldown of associated piping and equipment;
- Start-up of Acid Gas Removal (AGR) unit with feed gas to meet acid gas specification in natural gas;
- Initial regeneration of mole sieve driers downstream the AGR unit to meet moisture specification in natural gas;
- Mercury bed drying to meet moisture specification in natural gas and long term mercury bed performance;
- Cryogenic circuits drying with dry gas (natural gas, refrigerant, LPG);
- Compressor circuit testing;
- Start-up of pre-cooling section to -50°C to meet heavy hydrocarbon spec in natural gas to liquefaction circuit;
- Cooldown and start-up of condensate stabilization unit to produce on-specification stabilized condensate product; and
- Final cooling of MCHE to -155°C at plant to produce on-specification LNG product.

### 9.2. Commissioning Flaring Overview

The amount of flaring during Commissioning will be higher compared to the planned and unplanned flaring activities during Normal Operations. This is due to the additional testing of equipment, and additional time to bring the process to specification due to start-up of new equipment.

Another potential source of increased flaring during Commissioning could come from having to stop or reverse the start-up process due to undetected flaws from construction and fabrication. During the construction and fabrication phase, the Project utilizes a Flawless Project Delivery program to incorporate lessons learned from previous projects to minimize the risk of an undetected flaw that could lead to delays or an early shutdown of the facility. While this is done on best effort basis, it is normal for some residual flaws to materialize during the Commissioning period.

During future start-ups of the LNG train (e.g., subsequent start-ups after the initial one), the level of additional testing is minimized, construction debris reduced, and lessons learned are incorporated to reduce the start-up duration and impacts.

There is also higher potential for black smoke generation during Commissioning and extending into the Early Operations period due to unplanned process streams, with flows and compositions outside the design window of the flare, entering the flare and leftover material from construction inadvertently impacting flare performance. There is also potential for dust and rust to enter the flare network, which could impact the combustion properties of the hydrocarbon.

The following categories identify the potential of black smoke occurring. This has been based on prior start-up experience and the commodity being flared:

- High-potential would be a heavier hydrocarbon stream that has generated smoke at other LNG facilities.
- Low-potential would be a lighter hydrocarbon stream that does not have a history of generating significant smoke at other facilities.

The following section describes the Project Commissioning plan and the strategies to reduce the amount flared at initial start-up. There are various activities that occur during this period; outlined in the section below.

### 9.2.1. Pipeline and Inlet Facility Start-up

Prior to start-up of the LNG facility, the feedstock pipeline will be commissioned.

A portion of the CGL pipeline will be purged through the Project flare system. The CGL pipeline will be preserved and dried after mechanical completion and the pipeline up to the Kitimat Metering Station will be filled with on-specification natural gas.

The section from the Kitimat metering station to the Project site will be preserved with nitrogen until the facility is ready to start using gas.

Once the flare pilots have been lit on LPG bottles, natural gas will be introduced at the Kitimat metering station and the nitrogen displaced to the flare system through the start-up fuel gas heater. Once the nitrogen has been displaced and the LP fuel gas header has been inventoried, the flare pilots will be switched to LP fuel gas. The required minimum flow to operate the start-up fuel gas heater is approximately 1,000 te/d. Any gas not utilized in the facility as fuel gas will be flared until start-up gas heater is no longer required.

Once warm heat transfer fluid is available, the remainder of the inlet facility will be pressurized shortly before the start-up of the LNG Train 1.

It is expected that up to six months will elapse between Commissioning of the pipeline and LNG Train 1 Commissioning. During this period, the pipeline will initially be used to:

- Supply the flare pilots;
- Supply common fuel gas headers;
- Supply fuel gas to the gas turbines for early testing (solo run, N<sub>2</sub> run); and
- Supply vacuum protection for LNG storage tank after LNG import.

During this time period, the performance of the flare is expected to be smokeless with a height of approximately 20% of the flare stack length (approximately 24 metres).

### 9.2.2. Refrigerant Import

Refrigerant grade liquid ethane and propane will be imported into the facility to avoid the need to initially produce the refrigerant prior to LNG production. The decision to import the refrigerant will save approximately two weeks of flaring from the facility with the LNG train at minimum turndown.

For ethane and propane import, hydrocarbon vapour is introduced into the refrigerant storage spheres to displace the nitrogen to prevent auto-refrigeration. Introduction of vapours is also done at a controlled rate to stay within the differential temperature limits between various sections of the piping and storage tanks and avoid any resultant



mechanical stresses due to rapid cooldown. This cooldown step results in approximately 43 tonnes of both ethane and propane lost to the flare. This will be flared through the cold dry flare.

During the displacement of nitrogen to the flare, there is higher potential for black smoke generation from the flare due to the heavier composition of the gas and the low flow rate to the flare limiting mixing at the flare tip. The expected duration of flaring is approximately 6 to 12 hours per sphere with two spheres being purged initially and the third sphere being purged after LNG train start-up (refer to Figure 13).

As the import would occur after the pipeline and inlet facility have been commissioned, there is the option to open the fuel gas purge to the flare header to help increase mixing at the flare tip while diluting the ethane and propane with methane from the pipeline.



**Figure 13 Potential Flaring profile during refrigerant import**

Once started up, it is not expected that ethane or propane sphere will contribute to flaring for the following reasons:

- Vapour from the spheres is normally routed to the LNG tank and is mixed with BOG;
- Propane sphere design and normal operating pressures are above vapour pressure therefore excess propane vapor generation is not expected during holding mode; and
- Ethane sphere is insulated and includes a chiller package to prevent ethane loss.

### 9.2.3.LNG Import

LNG will be imported from an LNG carrier to allow for cooldown of the LNG circuits and LNG Storage tank.

This will avoid having to use LNG produced from LNG Train 1 to cool down these circuits and reduce the amount of LNG flared during the Commissioning period as the LNG can be fully directed to the storage tank once it meets specification instead of flaring a portion of the LNG produced by the train as the remainder is used to cool the rundown piping and tank.

Import of LNG reduces the expected flaring by approximately 51,800 Te due to the avoidance of having to having to use the LNG from Train 1 to cooldown the piping and LNG storage tank.



At start of cooldown, LNG vapour from an LNG carrier will displace nitrogen to flare, approximately 36 Te over 10 hours (refer to Figure 14). During the cooldown of the piping and LNG tank, a large amount of LNG is vapourized to bring the components to cryogenic conditions. Vapours will also be introduced at a controlled rate to stay within the differential temperature limits between various sections of the piping and storage tanks and avoid any resultant mechanical stresses due to rapid cooldown. This results in flaring of approximately 7776 Te over 72 hours.

Once the cooldown is complete, the remaining LNG will be transferred from the LNG carrier to the storage tank over 40 hours leading to approximately 7920 Te of flaring during the transfer. Once the LNG has been imported, the system will be in holding mode until LNG Train 1 start-up.

Due to heat leak into the system, BOG will be produced and disposed of to the flare until the BOG compressors are able to be started and recycle the BOG into the fuel gas system; this is not expected to happen until close to LNG Train 1 Commissioning when there is a demand for high pressure (HP) fuel gas and the BOG flow is sufficient to allow a compressor to operate in recycle with quench. Until this time, it is expected that approximately 18 Te/hr of BOG will be directed to the flare.



**Figure 14 Examples of an LNG Import Flare size during day and night**

The potential flare profile for the LNG import is shown below, the flaring will occur from the low-pressure (shipping and loading) flare, which is designed as a utility flare and has a lower exit velocity than the sonic flares. Once the BOG compressor is online, this gas stream will be redirected to the cold-dry sonic flare until there is sufficient demand for the gas in the fuel gas system or as part of Train 1 Commissioning.

The flame is expected to be smokeless due to the composition of the gas and will occur from the period where LNG is imported until Train 1 is started.

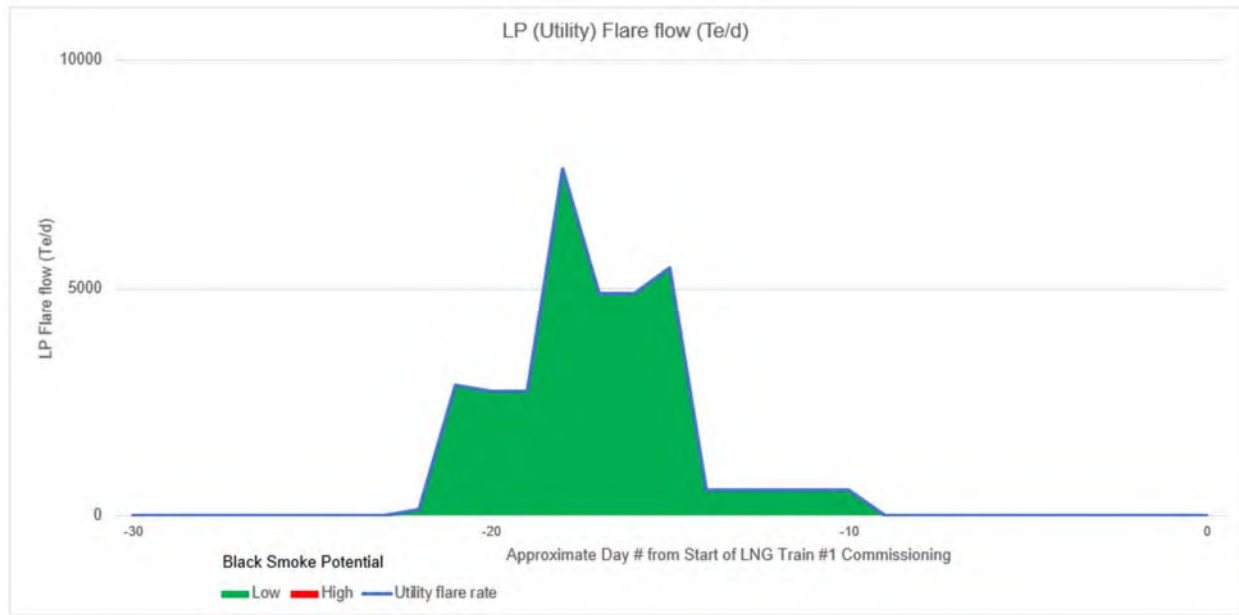


**Figure 15 Potential Flaring profile during LNG import prior to LNG Train 1 Commissioning**

#### 9.2.4. LNG Train 1 Start-Up

The Commissioning of the first LNG train is expected to lead to additional flaring compared to future LNG train Commissioning due to the lack of defrost gas to allow dry out of the cold end to occur concurrently with the dry out of the mercury bed which, in subsequent start-ups, is not a problem as dry defrost gas is available from another running train.

In addition, during the Commissioning of LNG Train 1, it is expected that material left over from construction and pre-commissioning may become trapped in temporary strainers and will need to be removed during start-up or shortly after production is achieved, thus requiring multiple starts and stops.

During the initial start-up of the LNG train, the bulk of the flaring will occur through the sonic flare (Warm-wet and Cold-Dry) and will consist of a similar composition to natural gas.

Black smoke generation can occur during the start-up of the condensate stabilization unit overhead compressors. However, during the initial start-up, it is expected that this step will occur concurrently with flaring from the rest of the LNG train reducing the potential for smoke generation.

At the peak flaring rate, the flame height is expected to be approximately 50% of the length of the flare derrick (approximately 60 metres); the total duration of the start-up period will depend on equipment performance. A preliminary flare profile for the vapour flares and liquid flares are provided in the below figures.

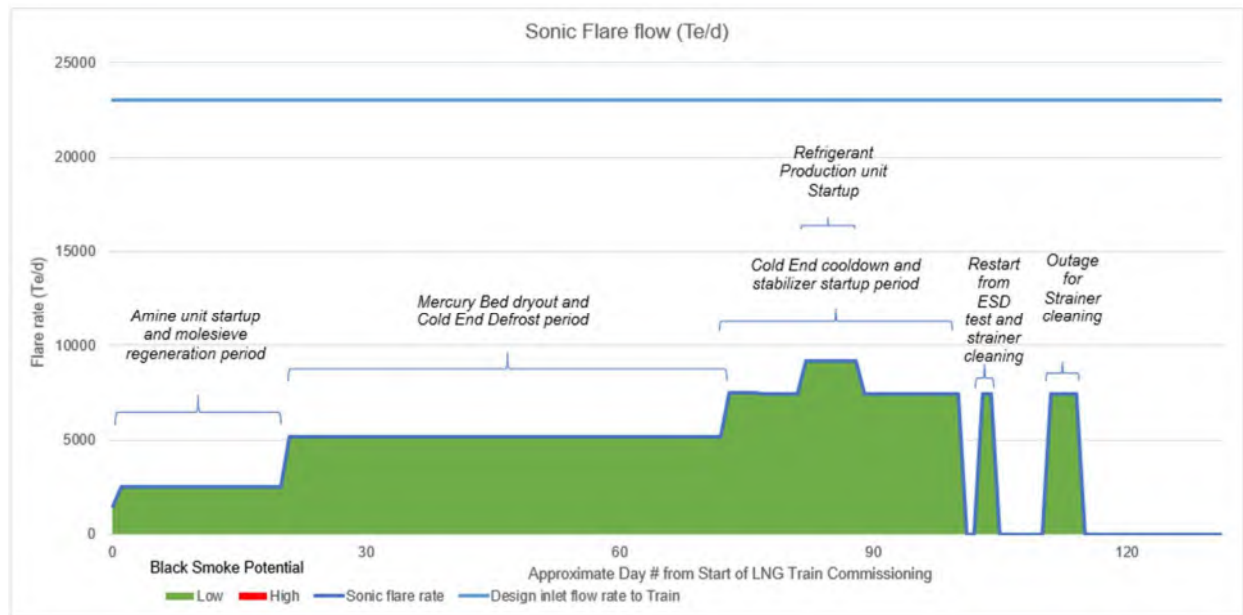


**Figure 16 Potential Flaring profile during LNG Train 1 start-up – Vapour Flares**

The liquid burners will be used to dispose of condensate and LNG from the train. Based on experience from other LNG start-ups, there is high potential for black smoke generation during condensate combustion due to the composition of the stream. The liquid burners are equipped with assist gas to promote air entrainment into the flame and early start-up of the condensate stabilizer, reducing the time required to meet specification before running down to the condensate storage tank.

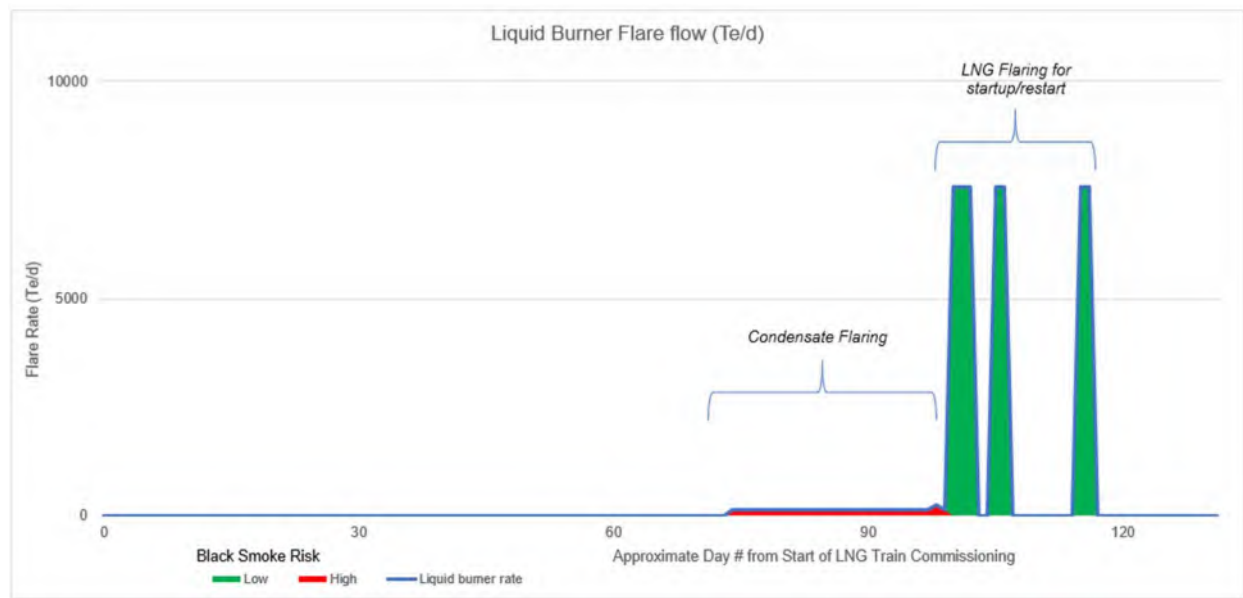


**Figure 17 Potential Flaring profile during LNG Train 1 start-up – Liquid Burners**

#### 9.2.5. Acid Gas Removal Unit Start-up and Molesieve Regeneration Period

Depending on the level of cleanliness during pre-commissioning (chemical cleaning), the start-up of the AGRU and drier unit could be two to three weeks. During this time, the amount of flaring has been assumed at approximately 2,400 Te/d.

Further turndown below the design minimum will be evaluated during the actual start-up but will be limited by the system's ability to maintain treated gas on specification for CO<sub>2</sub> and BTEX and will depend on amine absorber internal performance.

The flare performance is expected to be smokeless during this period due to the composition and flare rate with flaring from the sonic flares with a flame height of approximately 38 metres.

From the stabilization of the amine unit, the start-up progresses to the drier unit where the molecular sieve drier beds will be regenerated to produce dry gas. At the completion of the regeneration of the drier beds, the inlet flow rate will be ramped up from approximately 2,400 Te/d to approximately 5,000 Te/d, which will be flared.

The flare is expected to remain smokeless at this point, but the flame will increase in height to approximately 53 metres.

#### 9.2.6. Mercury Bed Drying and Cold End Defrost

The mercury removal unit requires thorough drying down before introducing feed gas to the cryogenic section as any mercury in the feed gas can impact the integrity of the aluminum components. The bed will be pre-dried extensively with nitrogen; however, the effectiveness of this drying will be dependent on the ability to maintain sufficient flow through the bed.

It is assumed that potentially 18 days will be needed to dry the mercury bed at an inlet rate of 5,000 Te/d to maintain the amine unit on-specification during this period of time.

At the completion of dry out of the mercury bed, defrost gas will be available to begin dryout of the cold end without jeopardizing the integrity of the aluminum components. Some of the flow currently routed to the warm-wet flare will be instead routed to the cold-dry flare. Although the same amount of gas is flared, the overall height may be reduced at times due to this diversion.

During the start-up of the cold end, the inlet rate is ramped to approximately 7,400 Te/d, which is the minimum rate to maintain integrity of the coil wound heat exchangers and to provide minimum heat sink for the pre-cooling section. Initially, the various loops are dried using defrost gas from the warm end to dry the equipment. Once the equipment is dried, refrigerant is introduced to the various loops and the compressors are surge tested.

The testing of the main refrigerant compressors, followed by testing and start-up of the pre-cooling section, may take up to four weeks, after which point this section can be cooled down prior to the final cooldown of the MCHE.

Initially, the flaring will be similar to the previous steps with natural gas going to the sonic flares. As part of the cooldown process, unstabilized condensate is produced, which is routed to the liquid burners prior to the start-up of the condensate stabilization unit.

This could take up to two weeks depending on any stoppages to clean strainers. The flaring from the liquid burners may produce black smoke due to the heavy composition of the condensate.

#### 9.2.7. Cold End Cooldown and Condensate Stabilization Start-up

For the condensate stabilizer start-up, condensate is inventoried into the system and circulation is established. When the condensate from the LNG train has reached its normal operating condition, this stream can be redirected from the liquid burners to the stabilization unit. After introduction of the unstabilized condensate, any condensate produced from the stabilizer is routed to liquid burners until it is confirmed to be on specification and can be routed to the storage tank.

Once the condensate stabilizer is started, the overhead compressors are started and surge tested; during this period, the overhead gas will be flared until all testing is completed. This stream is expected to be smoke free primarily because it will be diluted with natural gas from the rest of the unit. If this stream is burned by itself, there is risk of black smoke from the flare due to the heavier composition of the stream. This would be mitigated by dilution of the stream with natural gas to the flare tip. The produced condensate would be similar to the unstabilized condensate and could produce black smoke.

The final cooldown of the MCHE is the final step before the production of LNG. The final cooldown between must be done for integrity reasons at no less than the minimum turndown of the LNG train (approximately 7,400 Te/d) throughput, and the rate of temperature change is limited to ensure equipment integrity as the piping and exchangers cool to their operating temperatures; this flow has to be diverted to flare(s) until the LNG is subcooled enough to avoid potentially over pressurizing the LNG tank from hot rundown

During cooldown, the gas will be flared through the Cold Flare (F-CD) and LNG will be routed to the liquid burners. The flame of the liquid burners will be very luminous, large, with low potential for the generation of black smoke (refer to Figure 18).



**Figure 18 Example of Liquid Burners at night in final cool down**

### 9.2.8. Emergency Shut Down Test

The after completion of the initial start-up and production of LNG, the facility may be required to be tripped to perform a final verification of the instrumented protective functions. After this test, the LNG train will be restarted. The flare will appear similar to the final cooldown phase of the start-up.

## 9.3. Subsequent LNG Train Start-Up

The Commissioning of subsequent LNG trains is expected to be of a shorter duration due to incorporation of lessons learned from LNG Train 1 and the availability of the defrost gas from online LNG trains to allow concurrent dry out of the mercury bed and cold end. Otherwise, the start-up follows a similar sequence except for the start-up of the refrigerant production unit. The potential flare profile is presented in Figure 19 and Figure 20.

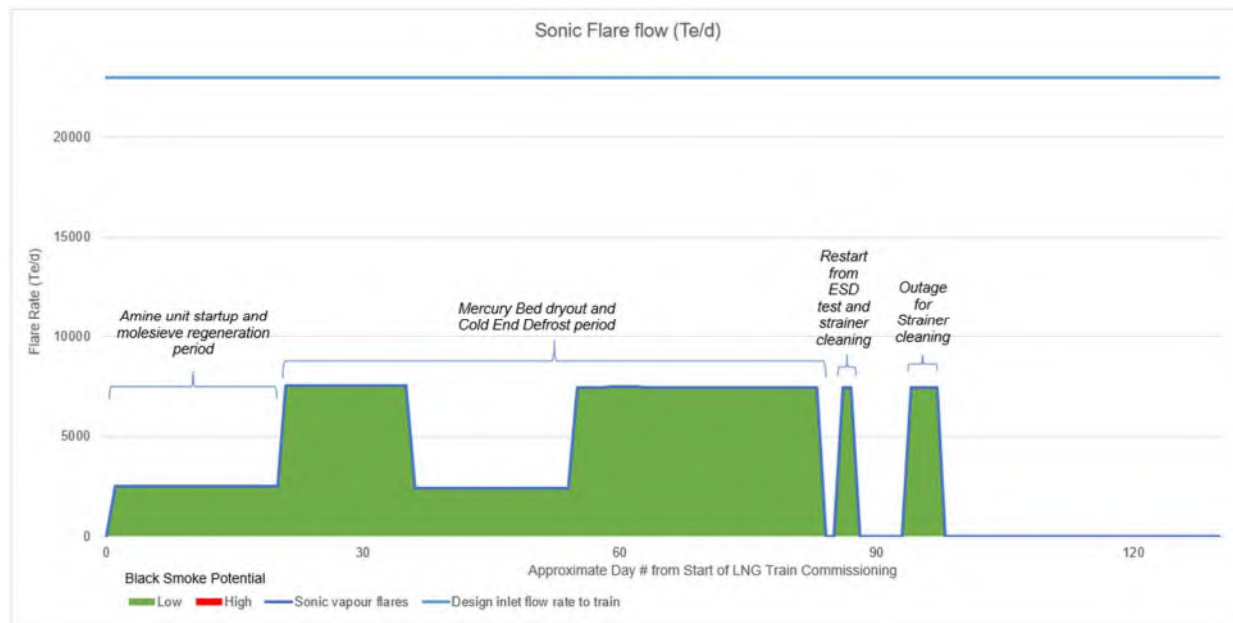


**Figure 19 Potential Flaring profile during LNG Train 2 start-up – Vapour Flares**

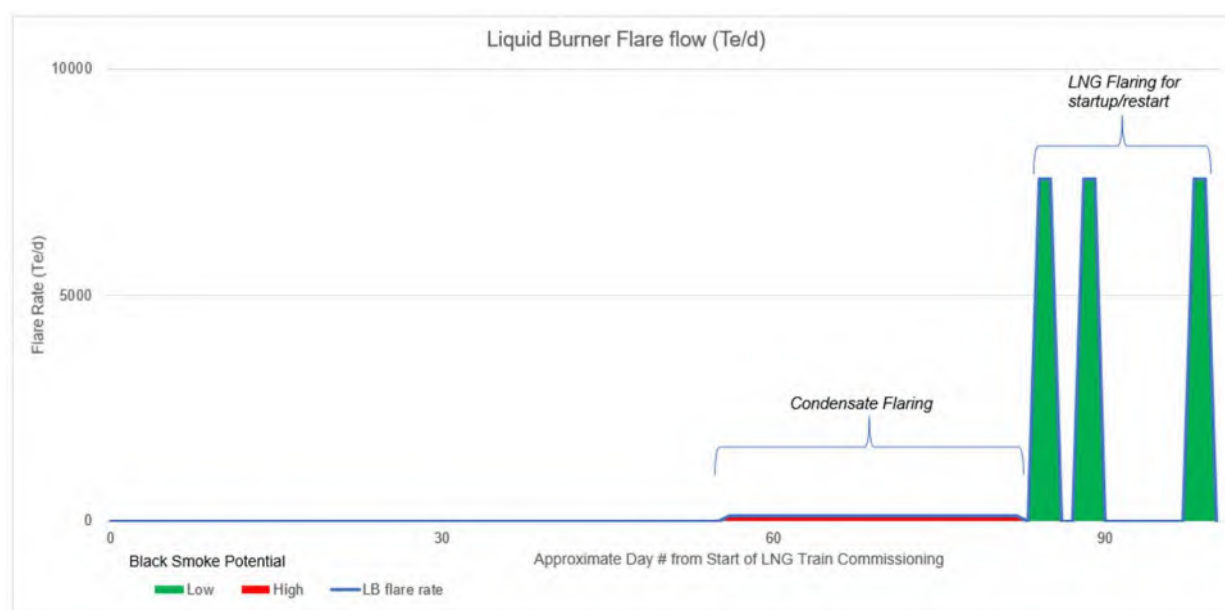


**Figure 20 Potential Flaring profile during LNG Train 2 start-up – Liquid Burners**

#### 9.4. Refrigerant Production Unit (RPU) Start-Up

Due to initial import of the ethane and propane refrigerant, the start-up of this unit can be done after LNG rundown occurs from LNG Train 1.

During start-up of the RPU, flaring will occur as nitrogen is displaced from the unit and will continue until the residual gas compressor can be started to return the residual hydrocarbon to the LNG Train. Refrigerant from the storage spheres can be used to inventory the overhead receivers of the de-ethanizer and de-propanizer to reduce the time needed to bring the refrigerant on-specification. Once the refrigerant is on-specification, this stream will be routed to

the storage spheres and any gas overheads from de-ethanizer and de-propanizer are recycled to LNG Tank to avoid flaring. Heavy hydrocarbons from the de-propanizer bottoms liquids are recycled to the natural gas stream through reinjection into the suction of the residual gas compressor.

The ethane and propane refrigerant are slowly and gradually lost due to compressor primary seal gas venting, maintenance of refrigerant containing equipment, refrigerant composition adjustment (MR and PMR), etc. Due to these losses, it is expected that the RPU will be operated approximately twice per year to produce ethane and propane refrigerants.

The following start-up lines are further installed to reduce flaring during RPU start-up:

- De-ethanizer column ethane vapour import from refrigerant storage;
- De-ethanizer reflux ethane liquid import from refrigerant storage;
- De-propanizer column propane vapour import from refrigerant storage; and
- De-propanizer reflux propane liquid import from refrigerant storage.

During RPU operation:

- Gas overheads from de-ethanizer and de-propanizer are recycled to LNG Tank;
- De-propanizer bottoms liquids are always recycled to natural gas stream; and
- Gas overheads from de-methanizer are recycled to natural gas stream.



## 10. Early Operations Flaring Activities

The Early Operation phase, which can take up to two years, will have increased trips and a higher likelihood of unplanned outages to correct any concerns. This period is characterized by a higher failure rate of equipment and more intensive facility organizational learning to resolve reliability challenges. These events lead to flaring during the restart of the facility and any purging of equipment for maintenance.

Based on industry wide benchmarking there will be approximately 20 trips and two unplanned outages per LNG train per year during this period. After a trip, up to two days of flaring can occur depending on the time required to identify and correct the cause of the trip; this does not include any depressuring or preparation of equipment for maintenance.

In the case of an unplanned outage, it is likely that equipment will need to be opened, which will require displacement of hydrocarbon from the system to create a safe working environment as well as an extended start-up due to having to cool the equipment in the cold end. Figure 21 provides an example of the flaring profile for an unplanned outage including a period to purge hydrocarbon from the equipment followed by a subsequent restart period. Actual profiles will depend on equipment to be opened and ability to maintain portion of the facility on standby.

The flaring profiles in Figure 21 and Figure 22 provide an overview of what the Commissioning and Early Operations of LNG trains 1 and 2 for the facility could look like. These graphs incorporate assumptions based on benchmarking of other similar facilities to account for unplanned outages and trips during the first two years of Operation. It includes a number of trips and two unplanned outages per train to correct issues and also shows an improving reliability over time as early failures are corrected and reliability stabilizes.

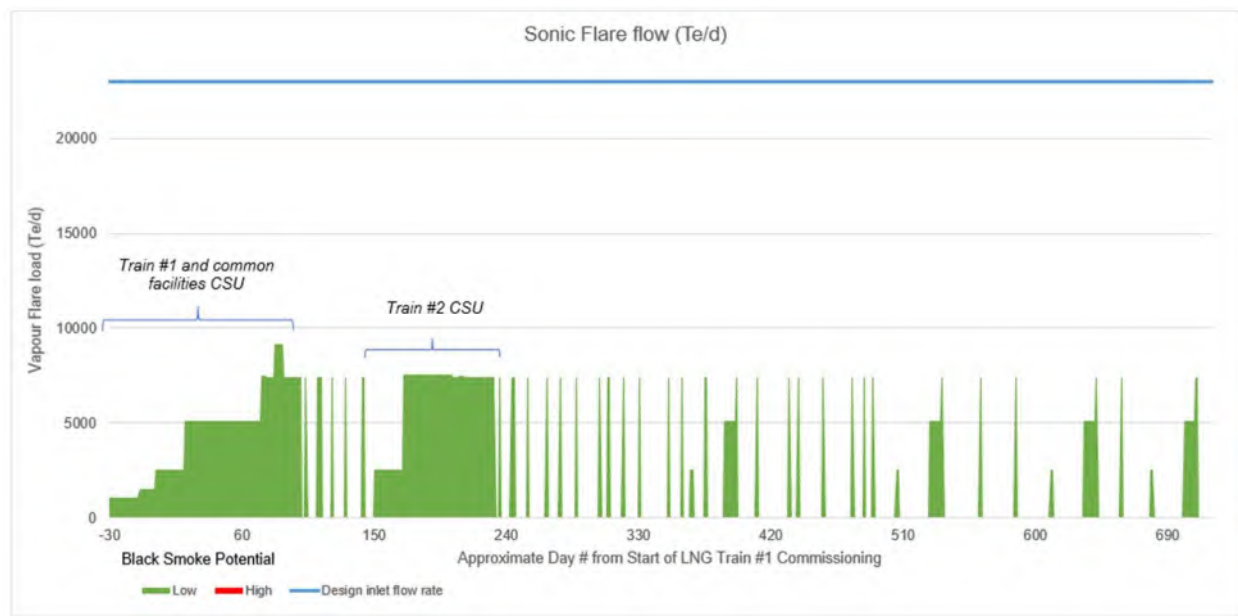


Figure 21 Vapour Flare Load Profiles – First two years



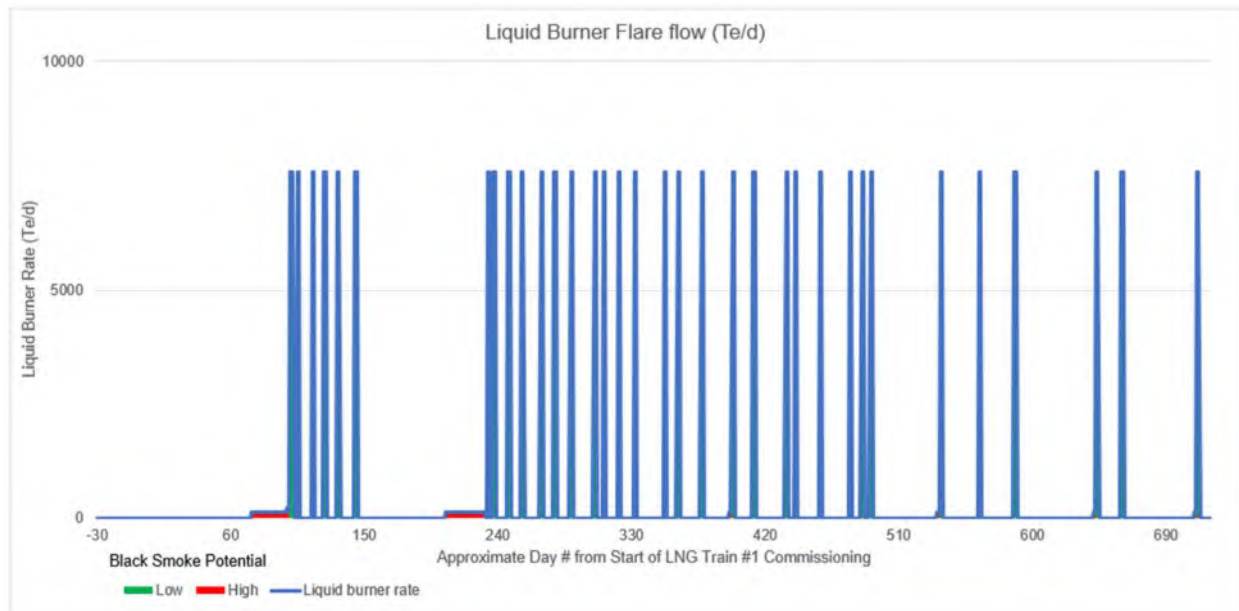


**Figure 22 Liquid Burner Profiles – First two years**

When an LNG train is required to be shut down for corrective maintenance, similar to a future turnaround, flaring will occur as the hydrocarbon is removed from the equipment to create a safe working environment. Once the maintenance work is completed, the LNG train would need to be started similar to the start-up that occurred as part of Commissioning.

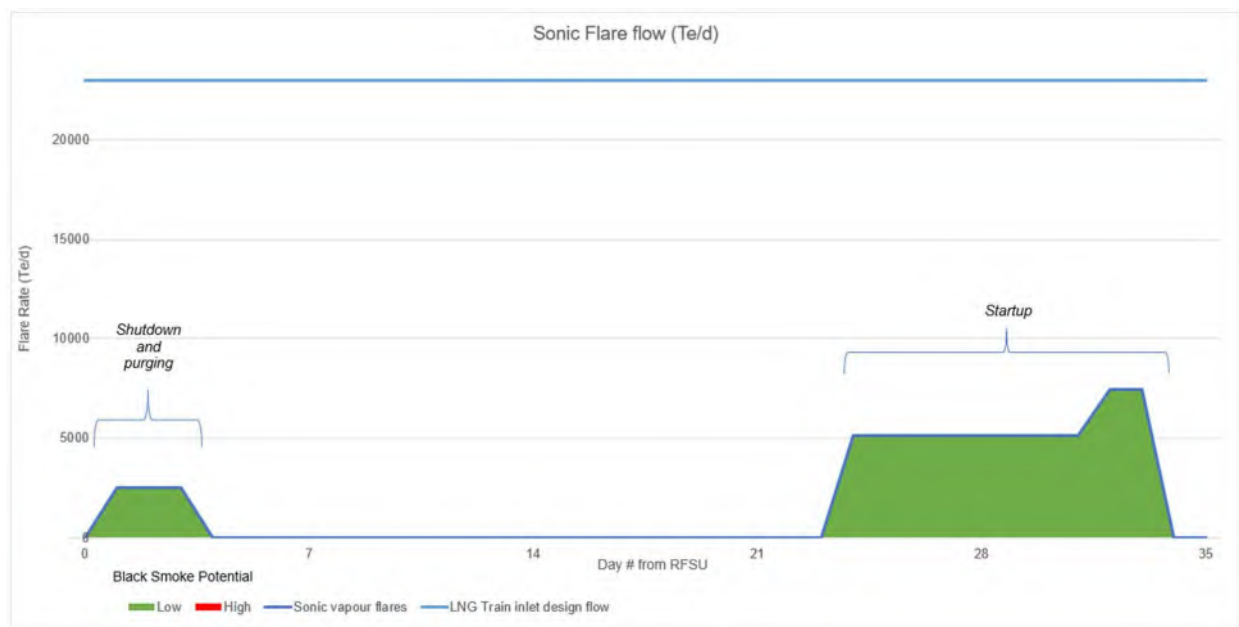


**Figure 23 Outage Flare Profile - Vapour Flare**

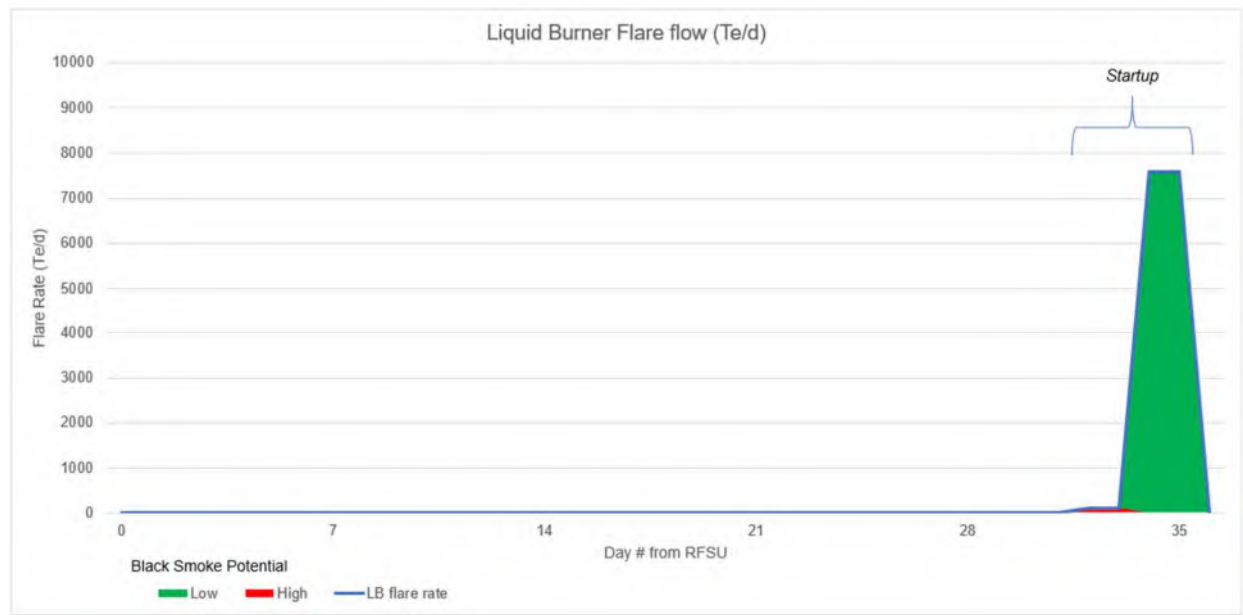


Figure 24 Outage Flare Profile - Vapour Flare

## 11. Planned Flaring Activities During Normal Operation and Turnaround

In general, due to the design of the flare system, routine flaring for maintenance or turnaround would not result in any impact to ambient air quality objectives (addressed through the permitting process); however, it may result in potential light impacts as well as an increase in sound levels due to the requirement to purge the equipment in the plant and to flare gas during start-up until the plant is performing at specification.

### 11.1. LNG Train Turnaround

There are two main types of planned shutdowns based on a 6-year turnaround cycle for the molecular sieve beds:

1. **Boroscopying of each aeroderivative gas turbine:** it is needed every year. However, with parallel 50% strings, this can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring. Nevertheless, some depressurizing and purging may be required to create a safe working environment.
2. **Planned turnarounds:** a turnaround is a major event where an entire LNG train is taken offline for equipment inspection and catalyst replacement (note, other equipment in the common facilities such as feed gas pre-heaters, feed gas filters etc. may also be taken offline at the same time to utilize the opportunity and will add to the de-inventory volume). Initially, a first turnaround is scheduled out of sequence to allow for any changes or repairs due to issues identified during Commissioning and start-up. Afterwards, the individual train turnarounds are scheduled every 3 years alternating between a minor (approximately 14 days) or a major (approximately 20 days) turnaround.

Planned Turnarounds will occur in a single LNG train at a time and will require de-energizing and de-inventorying of the hydrocarbon in the LNG train to allow for safe inspection by LNG Canada Maintenance. This will entail flaring for de-inventorying and purging, as well as during LNG Train restart. To maximize the amount of refrigerant recovered during this activity, the ability to recover PMR has been included in the design of the facility. The PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train. Likewise, in preparation for shutdown, the MR circuit can be lowered by directing MR to the stabilization unit. The level in the stabilizer will be displaced to the storage tank via pressure in the column to minimize remaining liquids that would need to be disposed of via the liquid burners.

Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, assist gas will be added to the flares to maintain the lower heating value above 20 MJ/m<sup>3</sup>; this is expected to take between 12 to 24 hours.

#### 11.1.1. Restart from Turnaround

After a turnaround, the LNG train will first be inerted with nitrogen to remove any air from the system and partially dry out the unit. At this point, the amine unit will be inventoried from tankage and natural gas will be inventoried into the train to displace the nitrogen. Once the nitrogen is displaced, dried natural gas (de-frost gas) from an online LNG train will be introduced to dry the LNG train to specification to allow inventorying of the refrigerant, which is expected to take approximately up to three days and result in approximately 1500 Te of gas flared. After the LNG train has been dried, refrigerant will be inventoried in the liquification unit and the feed gas will be introduced into the LNG train and flared through the various units until they are on specification.

Initially, once feed gas is introduced, it will be flared via the warm wet flare from the outlet of the amine absorber until confirmed to be on-specification for CO<sub>2</sub>. This is estimated to take approximately up to 12 hours.

In the case that the molecular sieve has been replaced, it **will have** to be regenerated to remove atmospheric moisture; this will require approximately two additional days of flaring at the minimum design throughput. The mercury bed will also require replacement through the life of the facility and will require additional flaring to dry the bed out. It is expected this replacement would occur approximately every 8 to 10 years depending on the mercury content of the feed gas to the facility.

Once the molecular sieve unit is confirmed on-spec, the gas can be introduced into the liquification unit and the system can start cooling down. Initially, it will be cooled to -50°C, where the gas off the flash vessel will be confirmed to be on-specification for heavier hydrocarbon (C5+) content after which the rest of the liquification will be cooled down until on spec for routing to the LNG tank. It is estimated to take between 24 to 36 hours from start of cooldown to LNG production.

The stabilizer column will initially be inventoried from the stabilized condensate header to tankage, which will allow this column to be warm and operating once C5+ feed is available from the flash vessel. Minor flaring from the column will occur until the stabilizer compressors are able to be started to recycle this stream back to the liquification section.

## 11.2. De-inerting of LNG Carriers

The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification of less than 50 parts per million (ppm) CO<sub>2</sub> to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with **inert gas**; prior to loading, these tanks need to be **purged** and cooled down **with LNG from the facility**. During the **purging and cooldown** process, the vapour return is sent to low pressure flare until confirmation that CO<sub>2</sub> specifications have been met (**based on laboratory sampling**). Upon confirmation, the vapour is then routed to the storage tank and BOG compressors.

The ships requiring de-inerting are planned in advance as part of the yearly delivery plan. An LNG carrier requiring de-inerting requires approximately **three** times the LNG carrier volume to be flared (approximately 3 x 150 000 m<sup>3</sup>). During this time, assist gas is added to the flare to ensure the minimum heating value is maintained. A dedicated fuel gas line ("dilution gas") at the bottom of the Storage and Loading Flare is provided. It is metered as fuel gas at 62FI300 (Ultrasonic, P&T compensated) through an automatic hand controller (62HIC300).

De-inerting and cooldown of the ships tanks is expected to take approximately 24 hours before normal loading can begin. **It is expected that the de-inerting process is limited to six warm ships per year.**

## 11.3. Adjustment of PMR Composition at PMR Reclaimer

High levels of non-condensable gases (methane/ nitrogen) in the refrigerant circuit will significantly impact plant production and efficiency due to the condensing pressure increasing. To return to normal performance, the non-condensable gas will need to be purged from the refrigerant system. This is normally done by **purging** the non-condensable gases through the PMR reclaimer condenser **which is installed as part of the PMR accumulator**. The reclaimer re-condenses the refrigerant **using the cold of PMR liquid flowing across the tubes which drops back into the accumulator and any residual** non-condensable are then sent to the stabilization unit for reprocessing **and returned back to the natural gas stream**, but during abnormal situations this stream may be sent directly to flare if required for process considerations.

In addition to light non-condensable vapors, PMR refrigerant can also be contaminated by heavy components which cannot be reclaimed or reprocessed. This small quantities will be bleed to flare to remove the heavy components from the PMR inventory.

## 11.4. Adjustment of MR composition at HP MR Separation Vessel

Similar to the adjustment of the PMR composition, the MR composition must be carefully adjusted in the MR refrigerant circuit as it can significantly impact plant production and efficiency due to the degradation of thermal approaches in the cryogenic system. The MR composition is adjusted at the HP MR separation vessel:

- Liquid from the HP MR separation vessel will be recycled to the condensate and stabilisation unit inlet with no flaring; and
- Vapour from HP MR separation vessel will be recycled to top of the stabiliser overhead compressor with no flaring.

In abnormal situations, adjustment of the composition may be done by directing the vapour from the drum to flare.

## 11.5. Refrigerant Production Unit (RPU) Turnaround

The ethane and propane refrigerant are slowly and gradually lost due to compressor primary seal gas venting, maintenance of refrigerant containing equipment, refrigerant composition adjustment (MR and PMR), etc.

It is expected that the RPU will be needed to be started twice per year for a two to three week period each time to produce ethane and propane refrigerants until storage is full before shutting down and de-inventorizing again.

The unit can be filled and then reliably started at design throughput of 73 t/h.

The following start-up lines are further installed to reduce flaring during RPU start-up:

- De-ethanizer column ethane vapour import from refrigerant storage
- De-ethanizer reflux ethane liquid import from refrigerant storage
- De-propanizer column propane vapour import from refrigerant storage
- De-propanizer reflux propane liquid import from refrigerant storage

Additionally, during RPU operation:

- Gas overheads from de-ethanizer and de-propanizer are recycled to LNG Tank
- De-propanizer bottoms liquids are always recycled to natural gas stream
- Gas overheads from de-methanizer are recycled to natural gas stream.

Therefore, the flaring once the RPU is operational will be limited to cooldown of the unit expander generator, columns, and cryogenic pumps over approximately one day. The volume sent to the flare is expected to be negligible (less than 10,000 m<sup>3</sup>), similar to what would occur from routine maintenance on similar equipment in the facility.

Each campaign will last about two to three weeks until each of the refrigerant spheres are full. When the campaign is finished, the unit will be left with hydrocarbon vapour at a low pressure until the unit is needed again. If the unit is required to be opened for maintenance, the hydrocarbon vapour will be displaced to the flare with nitrogen.

The de-inventorization for preservation involves about 130 m<sup>3</sup> of equipment with an average gas pressure of 50 kPa or approximately 2 tonnes of gas to be flared to the Cold Dry Flare over one to two days. Any remaining liquids will be drained to the flare system and allowed to vapourize in the flare KO drums unless ongoing activities require the liquid to be disposed of in the liquid burners.

## 11.6. Relief Valve Inspection and Overhaul

The plant comprises about 400 installed Relief Valves for about 300 systems. Initially, they will be inspected every 18 months. Then, they may be inspected on a variable testing frequency, depending on Risk Based Inspection study outcome. Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.

For example, de-inventorizing four meters of 4" diameter piping represents 20 to 30 litres with an average density of 50 kg/m<sup>3</sup> therefore 1 kg/relief valve. This represents overall venting of approximately 500 kg over a six year cycle.

## 11.7. Routine Maintenance Activities

Individual equipment requiring on-line servicing needs de-inventorization before safe maintenance can be allowed. During re-commissioning it requires gas-in and sometimes cooldown. Volume is usually small but could exceed 10,000 m<sup>3</sup>.

## 12. Unplanned Flaring Activities

Unplanned flaring can occur at any time as a result of an upset condition in the facility. During an unplanned flaring event, operations will first undertake any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service if it is safe to do so.

If the equipment cannot be readily returned to service within 4 hours, the Operations Shift Team will coordinate with LNG Canada Production Scheduling department to undertake actions to reduce facility throughput to minimum turndown, if required to reduce flaring. The facility has a design minimum turndown of 50% for the equipment in the facility and this will limit the facility turndown to 50% of the design rate to prevent potential equipment damage.

Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair; LNG Canada Production scheduling will optimize the production plan and LNG Carrier arrival within any pre-existing limits to minimize flaring while minimizing economic loss.

LNG Canada will investigate major flaring events through the incident reporting system and correct causes of repeated non-routine flaring, incinerating or venting as part of continuous improvement. The investigation reports would be available to the regulator for review upon request.

### 12.1. Unplanned equipment failure or repair

Not all equipment in the LNG facility has an installed spare, as such the failure of single piece of equipment can lead to flaring while the process is stabilized, and equipment will need to be de-inventorized before safe maintenance can be allowed. The volume is usually small but could exceed 10,000 m<sup>3</sup> threshold for notification when considering nitrogen purging activities required to provide a safe working environment.

### 12.2. Flash Gas Compressor Trip

The Flash Gas Compressor is used to recover gas absorbed in HP amine absorber bottoms and let down in the amine flash vessel. This stream is normally recycled to inlet amine treating. Whenever the flash gas compressor trips, the flash gas is diverted to the Warm Wet Flare.

The duration of flaring can be variable depending on cause of incident. Flaring will take place until such time that the Flash gas compressor is returned to service; the expected flow is approximately 2,200 Sm<sup>3</sup>/hr and is expected to be smokeless based on the composition and volume.

Since the flash gas generated is related to the amine circulation rate, as the amine enters the flash vessel saturated with hydrocarbon, in order to reduce flare volume, the amine circulation rate needs to be reduced. Operations will reduce the amine circulation rate and associated feed gas rate until either the amine is at minimum turndown or the feed gas is at minimum turndown.

### 12.3. Acid Gas Thermal Oxidizer Trip

The acid gas thermal oxidizer is used to thermally oxidize acid gas coming from acid gas regenerator overheads. The stream consists of CO<sub>2</sub>, water vapour, some entrained hydrocarbons (approximately 54%) and a small amount of H<sub>2</sub>S (less than 0.2% typically). The incinerator may also oxidize a non-condensable stream from the condensate storage tank which is typically approximately 89% nitrogen with the balance as light hydrocarbon. This stream is not rich enough to be combustible and is incinerated together with assist fuel gas and sufficient excess air to oxidize the H<sub>2</sub>S and hydrocarbons into SO<sub>x</sub> and CO<sub>2</sub>, and water while the CO<sub>2</sub> undergoes no further oxidation and is released to atmosphere.

In case of thermal oxidizer trip, the overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere, which occurs in other LNG plants. The amount

routed to flare is approximately 26,444 Nm<sup>3</sup>/hr and is expected to have smokeless combustion and depends on the CO<sub>2</sub> content of the feed gas. Fuel gas is added to the flare to meet the minimum heating value requirement via fuel gas controller at Warm Flare Knock-out drum. The control scheme makes use of last known values of flow indication and Lower Heating Content from analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.

Reliability of thermal oxidizer is typically high after Commissioning and start-up with planned maintenance occurring during LNG train turnarounds when the upstream amine regenerator is offline.

The duration of flaring can be variable depending on cause of incident, which may be a few hours in the case of an instrument malfunction to longer duration in the case of refractory damage. If operations are unable to restart the incinerator, the feed gas flow the LNG train will be reduced to minimum turndown to minimize the amount of acid gas routed to flare.

## 12.4. Regeneration Gas Compressor Trip

The Regeneration Gas Compressor is used to recover natural gas used for regeneration of the molecular sieve drier beds which remove water from the feed gas prior to liquefaction. The Regeneration gas compressor circulates gas through the beds to regenerate the molecular sieves for service based on a described cycle. This is a requirement prior to liquefaction.

Whenever the centrifugal regeneration gas compressor trips, gas is diverted to the Warm Wet Flare during the regeneration cycle. The expected flaring volume is 66,000 Nm<sup>3</sup>/hr during regeneration, with the flare design this is expected to be smokeless combustion. The regeneration compressor does not have the capability to be restarted from settle out pressure but will require depressurization to suction conditions; however, this is a small volume of hydrocarbon as the pressure differential across the compressor is small.

In this case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

In case of a long-term compressor outage, as the regeneration cycle is strictly based on time, facility throughput will not be reduced as this action would have no impact on flared gas volumes.

## 12.5. Gas Turbine Compressor Trips

Gas Turbine Compressors are critical to the liquefaction process. These systems form part of the refrigerant loops which chill feed gas, leading to liquefaction. When any compressor or its driver malfunctions, they will automatically be stopped by the control system. Each LNG train has parallel compressor strings allowing approximately 50% production while one compressor train is shutdown. During the transition to minimum rates after a compressor trip minor flaring may occur to prevent the loss of a single compressor from cascading to a larger upset.

In other LNG facilities, the compressors will require to be depressurized prior to restart; in the case of this Project, the compressors can restart from settle out pressure, which removes the requirement to depressurize the compressors prior to restart.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## 12.6. Main Cryogenic Heat Exchanger (MCHE) Trip

In case that the MCHE trips as a result of instrument malfunction or exceedance of the design operating window, the LNG production immediately stops, and the gas flow to the facility is automatically reduced at the inlet station with minimal flaring or over pressuring of the downstream piping. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.

After a few hours, the refrigerant present in the MCHE shell and tubes will start warming up and pressure will increase requiring the pressure to be relieved to the flare system to prevent overpressure of the MCHE.



Upon restart of MCHE, the cold vapour gas or LNG must be flared through the cold vapour flare and then liquid burners at approximately 35% production rate until the rundown temperature is low enough to be routed to the LNG storage tank. The equipment has a cooldown limit of approximately 30 °C per hour, which dictates the time required to route the LNG to the flare system until it can be routed to the LNG storage tank. In the case of a short trip, it is expected that flaring will occur for one to three hours.

Flaring of this stream through both the cold flare and liquid burners is expected to be smokeless.

## 12.7. Condensate Stabilizer Overheads Compressor Trip

C5+ contained in the Feed gas would freeze in MCHE and need to be extracted in C5+ flash vessel before entering MCHE. The bottoms of the flash vessel containing LPG and the C5+ is sent to condensate stabilization unit for further processing. The overheads (light ends) are recycled back to MCHE via condensate stabilizer overhead compressors while the stabilized condensate bottoms are sent to an atmospheric storage tank prior to being loaded into rail cars.

The concentration of C5+ material in the feed gas will dictate if both compressors are required or if one is required for the load. In the case of lean feed gas, a single compressor trip will not result in any significant flaring as the second compressor will be available to be started and loaded. When the gas is heavier, both compressors are required to be in service and a loss of one compressor will result in some level of flaring. For the extreme rich gas case, this will result in approximately 69,000 m<sup>3</sup>/hr for a single compressor trip and approximately 138,000 m<sup>3</sup>/hr for both compressors tripping. This stream is expected to achieve smokeless combustion in the flare.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

This stream is not expected to produce black smoke with the current flare design as it has a guarantee case for Ringlemann 0 combustion. However, to reduce flaring volume overall, throughput of the LNG train would be reduced until the available compression can manage the gas volume or the LNG train reaches minimum turndown.

## 12.8. Residue Vapour Compressor Trip

During periods of time when the RPU is online, the overhead gas from the de-methanizer column and excess refrigerant is recompressed in the residue vapour compressor and recycled back the LNG train for liquefaction. In the case of a residue vapour compressor trip, this stream will be routed to flare until such time that the compressor is restarted, or RPU is shutdown. The flaring would be approximately 100,000 m<sup>3</sup>/hr from this system. If the compressor is unable to be started within four hours, the RPU would be shut down to stop flaring. This stream is expected to achieve smokeless combustion in the flare.

In this case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## 12.9. Condensate Storage Tank Vapour Recovery Unit Trip

During Normal Operations, the non-condensable vapour from the condensate storage tank is routed to the incinerators in either LNG Train 1 or 2 for combustion. When the condensate chiller package is offline, this stream cannot be recovered and will lead to venting from the condensate storage tank until the package is repaired. A loss of a single condensate blower can also lead to intermediate venting from the condensate storage tank until it can be repaired.

This stream is generally nitrogen that is displaced while the tank is filling and evaporation of the condensate in the tank. The facility throughput will not be reduced in this case as the stream is not expected to cause offsite concerns or environmental hazards.

## 12.10. Boil-off Gas Compressor Trips

The LNG under slight pressure runs down from the Trains to the near atmospheric LNG Tank where it flashes at -161°C. Two centrifugal BOG compressors are used to recompress the flashed gas and natural boil off from cryogenic LNG tank, loading lines and LNG carrier loading. This stream is utilized as fuel gas in the high-pressure fuel gas

network. Excess gas beyond what is required for the fuel gas demand for the plant is recycled to the inlet facility and reprocessed through the plant eliminating flaring which would otherwise have occurred.

The duration of a compressor outage from a trip can be from one to three hours to multiple weeks depending on whether the compressor has suffered damage and requires repair prior to restart.

#### 12.10.1. Holding Mode

The LNG facility will be operating in holding mode approximately two thirds of the time; in this mode the LNG tank is filling from the LNG trains, and LNG carriers are not loading. During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. A loss of both compressors would lead to flaring of approximately 103,000 m<sup>3</sup>/hr while the plant is in holding mode until the compressor can be repaired and returned to service. This stream is expected to achieve smokeless combustion in the flare.

To reduce the amount of BOG generated during this mode of operation, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank leading to reduced production or overall LNG production can be reduced to meet the capacity of a single compressor.

#### 12.10.2. Loading Mode

During LNG carrier loading, the carrier is initially cooled down over three hours leading to an increase in BOG generation and subsequent flaring. During this time, cooldown can be slowed to reduce the amount of excess BOG generated as part of this step. Due to the relatively short duration over which this flaring is expected to occur, LNG production would not be reduced further than is required during holding mode.

Once bulk LNG loading has commenced, a single compressor is expected to be able to handle the gas generated while the LNG carrier is loaded.

### 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate

In case of off-spec condensate, or upset in the condensate stabilization unit, there is limited buffer volume from C5+ flash vessel. This stream will be routed to the liquid burners until the plant can recover. To prevent the formation of smoke, assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.

If operations are unable to bring the condensate stabilization unit back to specification to stop flaring, the overall production would need to be reduced until the stream is meeting specification or the LNG train would be shutdown.

### 12.12. Flaring Due to Off-Spec Products

In general, LNG plants are not equipped to tolerate off-spec production through the normal product handling systems; in the case of LNG Canada, because both condensate and LNG are stored in one tank only for phase 1 there is no capacity to manage an off-spec final product stream.

The following potential off-spec conditions may result in short term flaring while the process is returned to normal:

- Off-spec natural gas with too much C5+;
- Off-spec LNG rundown;
- Off-spec sweet gas from AGR (greater than 50 parts per million volume (ppmv) CO<sub>2</sub>); and
- Off-spec sweet gas from the driers (greater than 1 ppmv water).

Except for off-spec C5+ material, the current flare system is expected to achieve smokeless performance for these streams. The C5+ material performance will depend on how much C5+ material is in the stream and how much BOG is available to dilute the stream to achieve smokeless performance.

## 13. Emergencies

“Emergency” is defined through the BC Emergency Management Regulation. As related to LNG Canada operation, emergency will be defined as an earthquake event, malicious act, equipment failure or loss that can lead to a liquid or gas release potentially impacting personnel or the environment.

As defined in the Facility permit: *“Emergency Conditions: involve activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure”.*

### 13.1. Emergency Depressurization

During an emergency event, LNG Canada operations will initiate the emergency shutdown functionality designed in the plant to stop process flow and sectionalize the hydrocarbon containing equipment. If a release is occurring or likely to occur, LNG Canada operations will depressurize the impacted equipment to the flare system.

There are blowdown valves for per train, grouped in several areas, and for Refrigerant/BOG/Inlet.

Depending on the zone affected and scenario, the depressurization could reach 1000 to 1700 t/h for Warm Flare and 1350 t/h for the Cold Flare (largest peak flow rate for zone depressurizing). The flame may reach 100 meters in height. The expected duration of flaring in this scenario is one to three hours depending on the number of sections that require depressurizing.

### 13.2. Extended Electrical Black Out

In case of an extended electrical black-out of the LNG facility from either a loss of BC Hydro supply to site or major infrastructure damage, initially the facility will trip and minor flaring will occur from the BOG generated from the LNG storage tank, but as the plant begins to warm up and refrigerant vapourize, the facility pressure will be managed by directing hydrocarbon to flare.

In the case of an extended power outage where the onsite emergency power generation is not available, the plant will be proactively depressurized for safety reasons before the Uninterrupted Power Supply required to control the blowdown is depleted. Two trains will start being depressurized in a staggered way to avoid overloading the flare. Flaring flows for each flare (Warm, Cold, Storage and Loading) will typically last 90 to 120 minutes.

## 14. Measurement, Monitoring, Notification and Reporting

### 14.1. Flaring Measurement

The Project will use the BC OGC Measurement Guideline for measurement of flared volumes and associated fuel gas volumes through Petrinex reporting system monthly.

Flaring is metered via Ultrasonic (US) flowmeters on each common Flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have measurement turndown of 1:1000 and accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy.

Dilution gas is added during LNG carrier de-inerting and acid gas flaring to maintain 20 MJ/m<sup>3</sup> lower heating value of the flared gas to ensure DRE (refer to Table 14).

**Table 14: Flaring Measurements – Fuel Gas**

| Operation               | Flow indication            | Fluid       | type    | Location                 |
|-------------------------|----------------------------|-------------|---------|--------------------------|
| LNG carrier de-inerting | 62FI300, P & T compensated | MP Fuel Gas | US type | Warm Flare knockout drum |
| Acid gas flaring        | 62FC101, P & T compensated | MP Fuel Gas | US type | F-LP bottom              |

### 14.2. Flow Meter Maintenance and Calibration

The Central Control Room panel operator pro-actively monitors flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator.

#### 14.2.1. Corrective Maintenance

Corrective maintenance will take place when a mismeasurement happened to be observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer.

The evidence or manifest of mismeasurement could be as follows:

- Observed during the calibration, part of preventive maintenance activities;
- Difference in reading observed by the Operation referring to other process parameters;
- Determined by the Technology Team during the daily mass balance activity; or
- Self-diagnosis by the smartness of the device and manifested as alert or fault.

Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error with-in the accuracy using the Project test equipment that is certified by Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.

#### 14.2.2. Preventive Maintenance

All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centred Maintenance ("RCM"), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventive maintenance task within stipulated time frame.

### 14.3. Monitoring

The panel operator will proactively monitor flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator

Flaring can be detected and monitored through:

- Closed circuit TV in the control room for 24 hours a day, 7 days a week monitoring of flare performance;
- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions;
- Alarm on some controlled streams to flared (valve not closed status); and
- Proactive Technical Monitoring set-up for the flaring system to monitor the any abnormalities in the flare system.

### 14.4. Flare Checks

As described through this report, there are many connections to the flare system. The indication of an unknown passing valve to the flare system can be identified by operations as a visible flame or as a measurable increase in flow to the flare system not related to the continuous flare header purges. Operations will begin systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves.

Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.

### 14.5. Internal Reporting

Internal Reporting of flaring activities is required and will be documented through the shift log at a minimum. For flaring related to incidents, this will occur through the Project's incident reporting system. In case of no flaring incident, the flare section of the shift log will mention "nothing to report."

LNG Canada operations team will escalate any flaring event to the **Production Team leader** upon emission of black smoke, exceeding 10,000 m<sup>3</sup> or a duration of four hours to initiate the flare notification process.

Initial detection can be identified via the following means:

- Equipment trip;
- Visual from outside operator;
- Pro-active monitoring;
- Closed circuit TV; and
- Some alarms in case of controllers to flare open (non-closed status).

In case of a small amount of flaring, the panel operator can quickly zoom in, if required, on which header is the source of flaring, as each LNG Train flare header has its dedicated thermal flowmeter, upstream of the common flare headers described previously.

The following information must be captured within the shift log:

- Time flaring commenced and ended;
- If black smoke was observed or if operations believe R0 performance was not achieved due to visible smoke emission;

- Specific cause of flaring;
- Estimated quantity and maximum flow; and
- Actions taken to minimize flaring or prevent similar events from reoccurring.

This information will be used as part of the accounting and reporting process for flare emissions and made available to BC OGC upon request.

## 14.6. Response to Public Concern Related to Flaring

The Project will investigate all public complaints and ensure they are responded to accordingly. Public complaints will be logged with the following information as per the FVRG.

In the event of a community complaint or request from the BC OGC, the Project is required to undertake monitoring as specified by BC OGC, which will be coordinated by the Environment Lead.

Logs must include:

- Complaint Name and contact information;
- Company representative assigned to investigate and follow up with complainant;
- Commission representative contacted; and
- If the complaint was resolved.

## 14.7. External Notification and Reporting

As outlined in the LNGFR and Flaring Notification Plan, Haisla Nation, residents within one kilometer, Regional District of Kitimat-Stikine, the District of Kitimat will be notified at least 24 hours prior to a planned flaring event and within 24 hours of a flaring event where the quantity of gas exceeds 10,000 m<sup>3</sup> or the duration exceeds four hours. In addition, where an LNG Carrier is to be de-inerted at the facility, LNG Canada will provide at least 24 hours of notice to BC OGC via email as outlined in the Facility Permit. **The Flaring Notification Plan outlines the notification tiers and mechanisms for notification.** Note, continuous activities, such as combustion for flare pilot lights or incinerators are excluded from the notification requirement.

Reporting on monitoring undertaken in response to complaints or specific direction of the BC OGC will be provided upon request.

Monthly reporting of flared volumes will be completed via Petrinex system.

## 14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting

The flare losses are included in the facility mass balance reconciliation which is monitored through proactive technical monitoring and reported monthly. The flow meters will be utilized in determining the maximum uncertainty of monthly volume as outlined in the BC OGC Measurement Guideline.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after the **Commissioning and Early Operations** phases. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

An annual Monitoring Report will be prepared by LNG Canada Environmental Team and submitted to the BC OGC.

## 15. Continuous Improvement, Review and Auditing

LNG Canada will maintain an Environmental Management System (EMS) in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department;
- Follow up on flare key performance indicators;
- Review of flaring incidents and progress of corrective actions;
- Management of Change process for hardware change impacting flaring; and
- Review of operations/maintenance practices and procedures.

Regular internal audits of the EMS are conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

## 16. References

- BC OGC, 2021, Flaring and Venting Reduction Guidelines, Version 5.22, April 2021.
- BC OGC, 2020, BC Measurement Guideline, Version 2.2, June 2020



**From:** Janine Forrest <Janine.Forrest@fluor.com>  
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**Subject:** LNG Canada Project Flaring Management Report  
**Attachments:** L001-06200-OA-5880-0001\_RD\_CLEAN.pdf

**Follow Up Flag:** Follow up  
**Flag Status:** Completed

Afternoon,

Please see the attached "Flaring Management Report", required under the LNG Canada Project Facility Permit (AD# 100083612) Condition 39.

We look forward to feedback on this submission, in parallel to the resolution of the hold items.

Note, that this has also been shared with Haisla Nation.

Regards

Janine

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## Controlled Document

# Flaring Management Report

|                          |                                              |
|--------------------------|----------------------------------------------|
| Document Number          | L001-06200-OA-5880-0001                      |
| DCAF Control ID          | N/A                                          |
| Document Revision        | D                                            |
| Document Status          | Issued for Review                            |
| Discipline Document Type | OA5880 – Other Plan                          |
| Author Organization      | JFJV                                         |
| Revision Date            | 01-Oct-2021                                  |
| Export Control           | Not Controlled – No Disclosure of Technology |
| Security Classification  | Restricted                                   |
| Approving Organization   | JFJV                                         |

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# REVISION CONTROL PAGE

| Revision Status |             |                   |                            | Approving Organization                                                                                                                                                 |                            |                 |
|-----------------|-------------|-------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------|
| Rev             | Date        | Document Status   | Author                     | Reviewer                                                                                                                                                               | Approver                   | Review Code     |
| A               | 08-Jun-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong                                                            | Christian Fischer          | Choose an item. |
| B               | 12-Oct-2019 | Issued for Review | Christian Fischer          | Scot MacKillop<br>Michael Lampp<br>Neven Dimic<br>Cameron McCormick<br>Jan Willem Trapman<br>Toh, Kok-Leong<br>Rik van der Ploeg<br>Bart Buhre<br>Schom-Moffatt, Patti | Christian Fischer          |                 |
| C               | 09-Apr-2021 | Issued for Review | Cameron McCormick          |                                                                                                                                                                        |                            |                 |
| D               | 01-Oct-2021 | Issued for Review | J. Forrest<br>C. McCormick | J. Solman<br>R. Kabgianian<br>S. MacKillop<br>N. Dimic                                                                                                                 | B. Ashton<br>R. Dronamraju |                 |
|                 |             |                   |                            |                                                                                                                                                                        |                            |                 |

# TABLE OF CONTENTS

|        |                                                                       |    |
|--------|-----------------------------------------------------------------------|----|
| 1.     | INTRODUCTION                                                          | 6  |
| 1.1.   | Project Background                                                    | 6  |
| 1.2.   | Purpose and Objectives                                                | 6  |
| 1.3.   | Project Overview                                                      | 7  |
| 1.4.   | Abbreviations and Definitions                                         | 7  |
| 2.     | REGULATORY FRAMEWORK                                                  | 12 |
| 2.1.   | Project Approvals and Conditions                                      | 12 |
| 2.1.1. | Facility Permit                                                       | 12 |
| 2.1.2. | Waste Discharge Authorization                                         | 14 |
| 2.1.3. | Environmental Assessment Certificate                                  | 14 |
| 2.1.4. | Decision Statement                                                    | 15 |
| 2.2.   | Acts, Regulations and Guidelines                                      | 16 |
| 2.2.1. | Oil and Gas Activities Act; Liquified Natural Gas Facility Regulation | 16 |
| 2.2.2. | BC OGC Flaring and Venting Guideline Reduction Guidelines             | 17 |
| 2.2.3. | BC Noise Control Best Practices Guideline                             | 18 |
| 2.2.4. | BC OGC Light Control Best Practices Guideline                         | 18 |
| 2.2.5. | Ambient Air Quality Objectives                                        | 18 |
| 2.3.   | Project Environmental Commitments                                     | 19 |
| 3.     | ROLES AND RESPONSIBILITIES                                            | 20 |
| 4.     | FLARE SYSTEMS OVERVIEW                                                | 21 |
| 4.1.   | General                                                               | 21 |
| 4.2.   | Process Description Overview                                          | 21 |
| 5.     | FLARE DESIGN BASIS, TECHNOLOGY SELECTION AND MEASURES                 | 26 |
| 5.1.   | Design Basis                                                          | 26 |
| 5.1.1. | Flare Systems                                                         | 26 |
| 5.1.2. | Flare Radiation                                                       | 26 |
| 5.1.3. | Flare Knockout Drums                                                  | 27 |
| 5.2.   | Flare Technology Used                                                 | 27 |
| 5.2.1. | Pilot System                                                          | 27 |
| 5.2.2. | Vapour Flare Systems                                                  | 28 |
| 5.2.3. | Liquid Burners System                                                 | 29 |
| 5.2.4. | Derrick Structures                                                    | 30 |
| 5.3.   | Flaring & Venting Mitigation Measures in Design                       | 31 |
| 6.     | ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES                         | 32 |
| 6.1.   | Smokeless Performance                                                 | 32 |
| 6.2.   | Air Contaminant & GHG Emissions                                       | 33 |
| 6.3.   | Thermal Heat                                                          | 33 |
| 6.4.   | Noise                                                                 | 33 |
| 6.4.1. | Impact to Personnel on Site                                           | 34 |
| 6.4.2. | Offsite Impact                                                        | 34 |
| 6.5.   | Light                                                                 | 34 |
| 6.6.   | Wildlife                                                              | 34 |
| 7.     | CONTINUOUS VENTING EMISSIONS                                          | 35 |
| 7.1.   | Continuous Vent Emissions to Atmosphere                               | 35 |

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| 7.2. Unplanned Vent Emissions to Atmosphere                           | 35 |
| 8. CONTINUOUS FLARING EMISSIONS                                       | 37 |
| 8.1. Flare Pilot                                                      | 37 |
| 8.2. Compressor Seal Gas                                              | 37 |
| 8.3. Analyzer Sample Returns                                          | 37 |
| 8.4. Continuous passing valves                                        | 38 |
| 8.5. Flare Purges                                                     | 38 |
| 8.6. Continuous Incinerator Emissions                                 | 38 |
| 9. COMMISSIONING FLARING ACTIVITIES                                   | 39 |
| 10. EARLY OPERATIONS FLARING ACTIVITIES                               | 40 |
| 11. PLANNED FLARING ACTIVITIES DURING NORMAL OPERATION AND TURNAROUND | 41 |
| 11.1. LNG Train Turnaround                                            | 41 |
| 11.1.1. Restart from Turnaround                                       | 42 |
| 11.2. De-inerting of LNG Carriers                                     | 42 |
| 11.3. Adjustment of PMR Composition at PMR Reclaimer                  | 42 |
| 11.4. Adjustment of MR composition at HP MR Separation Vessel         | 43 |
| 11.5. Refrigerant Production Unit (RPU) Turnaround                    | 43 |
| 11.6. Relief Valve Inspection and Overhaul                            | 44 |
| 11.7. Routine Maintenance Activities                                  | 44 |
| 12. UNPLANNED FLARING ACTIVITIES                                      | 45 |
| 12.1. Unplanned equipment failure or repair                           | 45 |
| 12.2. Flash Gas Compressor Trip                                       | 46 |
| 12.3. Acid Gas Thermal Oxidizer Trip                                  | 46 |
| 12.4. Regeneration Gas Compressor Trip                                | 46 |
| 12.5. Gas Turbine Compressor Trips                                    | 47 |
| 12.6. Main Cryogenic Heat Exchanger (MCHE) Trip                       | 47 |
| 12.7. Condensate Stabilizer Overheads Compressor Trip                 | 47 |
| 12.8. Residue Vapour Compressor Trip                                  | 48 |
| 12.9. Condensate Storage Tank Vapour Recovery Unit Trip               | 48 |
| 12.10. Boil-off Gas Compressor Trips                                  | 48 |
| 12.10.1. Holding Mode                                                 | 48 |
| 12.10.2. Loading Mode                                                 | 48 |
| 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate         | 49 |
| 12.12. Flaring Due to Off-Spec Products                               | 49 |
| 13. EMERGENCIES                                                       | 50 |
| 13.1. Emergency Depressurization                                      | 50 |
| 13.2. Extended Electrical Black Out                                   | 50 |
| 14. MEASUREMENT, MONITORING, NOTIFICATION AND REPORTING               | 51 |
| 14.1. Flaring Measurement                                             | 51 |
| 14.2. Flow Meter Maintenance and Calibration                          | 51 |
| 14.2.1. Corrective Maintenance                                        | 51 |
| 14.2.2. Preventive Maintenance                                        | 51 |
| 14.3. Monitoring                                                      | 52 |
| 14.4. Flare Checks                                                    | 52 |
| 14.5. Internal Reporting                                              | 52 |
| 14.6. Response to Public Concern Related to Flaring                   | 53 |

|                                                                       |    |
|-----------------------------------------------------------------------|----|
| 14.7. External Notification and Reporting                             | 53 |
| 14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting | 53 |
| 15. CONTINUOUS IMPROVEMENT, REVIEW AND AUDITING                       | 54 |
| 16. REFERENCES                                                        | 55 |

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# 1. Introduction

## 1.1. Project Background

Shell Canada Limited (Shell), North Montney LNG Limited Partnership, KOGAS Canada LNG Partnership (“KOGAS”), Diamond LNG Canada Partnership (“Diamond”), and PetroChina Kitimat LNG Partnership (“CNPC”), together the Joint Venture Participants referred to as LNG Canada Development Inc. (LNG Canada), are jointly developing a liquefied natural gas (LNG) export facility near Kitimat, British Columbia (BC), Canada, on the Traditional Territory of the Haisla Nation.

The LNG Canada Project (the Project) includes the design, construction, and operation of a natural gas liquefaction plant and facilities for the storage and export of LNG, including marine off-loading and shipping facilities.

JGC Fluor BC LNG Joint Venture (JFJV) is providing Engineering, Procurement, and Construction (EPC) services to the Project.

A list of acronyms and definitions is provided in Section 1.4.

## 1.2. Purpose and Objectives

The purpose of this document is to outline the measures applied to design, commissioning and operation the LNG facility to minimize flaring of gas and liquids and associated emissions, in conformance with the Project Facility Permit, issued by the BC Oil and Gas Commission (OGC).

This report provides an overview of the following aspects for routine and non-routine flaring during commissioning and operations:

- Regulatory Framework – Section 2
- Roles and Responsibilities – Section 3
- Flare System Overview – Section 4
- Flare System Design Basis, Technology Selection and Mitigation Measures – Section 5
- Environmental Impacts and Mitigation Measures – Section 6
- Inventory of Flaring Activities, include anticipated flare characteristics:
  - Continuous Venting – Section 7
  - Continuous Flaring – Section 8
  - Commissioning – Section 9
  - Early Operations – Section 10
  - Normal Operations and Turn Around – Section 11
  - Unplanned – Section 12
  - Emergencies – Section 13
- Measurement, Monitoring, Notifications and Reporting – Section 13
- Continuous Improvement – Section 14

This document does not:

- Include the feed gas pipeline that is under Coastal GasLink (CGL) control.

This document is intended to be reviewed and updated:

- Within three months after commissioning LNG Train 1 to incorporate lessons learnt that need to be applied to commissioning of LNG Train; and
- As required to capture continuous improvement cycles.

### 1.3. Project Overview

The Project includes the following LNG processing and storage systems (but not limited to):

- Natural gas inlet station;
- Up to four natural gas liquefaction trains (processing units), comprised of gas treatment and liquefaction facilities;
- Up to two full containment storage LNG tanks;
- Up to two condensate storage tanks; and
- Flare systems, including a total of up to two flare derricks.

There are two parallel LNG loading lines; up to two vapour return lines; and supporting utility lines located on an elevated trestle structure, to transport LNG from the processing and storage area to the marine terminal. The marine terminal has up to two LNG carrier berths, each able to accommodate one LNG carrier; and a materials offloading facility.

The Project is being constructed in two Phases; with each Phase having two processing units and associated utilities, one LNG Storage Tank and one LNG carrier Berth. The flare system has been designed to accommodate both phases, with the commissioning information herein focused on the first phase.

### 1.4. Abbreviations and Definitions

Table 1 and Table 2 contain a list of abbreviations and definitions used within this document.

**Table 1: Abbreviations**

| Abbreviation    | Definition                                                                                            |
|-----------------|-------------------------------------------------------------------------------------------------------|
| °C              | Degrees Celsius (unit of temperature)                                                                 |
| AQO             | Ambient Air Quality Objective                                                                         |
| BTEX            | Benzene, Toluene, Ethylbenzene and Xylene                                                             |
| BC              | British Columbia                                                                                      |
| BOG             | Boil Off Gas                                                                                          |
| CAAQS           | Canadian Ambient Air Quality Standards                                                                |
| C3 Hydrocarbons | Hydrocarbons with three carbon atoms (e.g., propane)                                                  |
| C5+             | Hydrocarbons with more than five carbon atoms (i.e. heavier hydrocarbons)                             |
| CGL             | Coastal GasLink                                                                                       |
| CO <sub>2</sub> | Carbon Dioxide                                                                                        |
| CSA Z276        | Canadian Standards Association, Liquified Natural Gas (LNG) – Production, Storage and Handling (Code) |



| Abbreviation      | Definition                                                                        |
|-------------------|-----------------------------------------------------------------------------------|
| dBA               | A-weighted decibel (unit of noise measurement)                                    |
| dB(C)             | C-weighted decibel (unit of noise measurement)                                    |
| EAC               | Environmental Assessment Certificate                                              |
| EAO               | BC Environmental Assessment Office                                                |
| ECCC              | Environment and Climate Change Canada                                             |
| EMS               | Environmental Management System                                                   |
| ENV               | BC Ministry of Environment and Climate Change Strategy                            |
| EPC               | Engineering, Procurement, and Construction                                        |
| F-CD              | Cold Dry Vapour Flare                                                             |
| F-LP              | Storage and Loading Low Pressure Vapour Flare                                     |
| F-WW              | Warm Wet Vapour Flare                                                             |
| FLNR              | BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development |
| FVRG              | Flaring and Venting Reduction Guideline                                           |
| GHG               | Greenhouse Gas                                                                    |
| GWP               | Global Warming Potential                                                          |
| H <sub>2</sub> S  | Hydrogen Sulphide                                                                 |
| HP                | high pressure                                                                     |
| hr                | Hour (unit of time)                                                               |
| IAAC              | Impact Assessment Agency of Canada                                                |
| JFJV              | JGC Fluor BC LNG Joint Venture                                                    |
| Kg                | Kilogram (unit of weight)                                                         |
| KO                | Knockout                                                                          |
| kPa               | Kilopascal (unit of pressure)                                                     |
| kW/m <sup>2</sup> | Kilowatt per square meter                                                         |
| LNG               | Liquefied Natural Gas                                                             |
| LNG Canada        | LNG Canada Development Inc.                                                       |
| LNGFR             | LNG Facility Regulation                                                           |
| m                 | Meter (unit of length)                                                            |
| m <sup>3</sup>    | Cubic Meter (unit of volume)                                                      |
| MCHE              | Main Cryogenic Heat Exchanger                                                     |
| MJ                | Mega joules (unit of energy)                                                      |
| MOH               | BC Ministry of Health                                                             |

| Abbreviation      | Definition                                                                               |
|-------------------|------------------------------------------------------------------------------------------|
| MR                | Mixed Refrigerant                                                                        |
| Nm <sup>3</sup>   | Normal metre cubed (unit of volume)                                                      |
| NOx               | Nitrogen Oxides                                                                          |
| OGAA              | Oil and Gas Activities Act                                                               |
| OGC               | Oil and Gas Commission                                                                   |
| PM <sub>10</sub>  | Particulate Matter with a diameter of 10 micrometres or less (coarse particulate matter) |
| PM <sub>2.5</sub> | Fine Particulate Matter having a diameter of 2.5 micrometres or less                     |
| PMR               | Pre-cooled Mixed Refrigerant                                                             |
| PPE               | Personal Protective Equipment                                                            |
| ppm               | Parts per million                                                                        |
| ppmv              | Parts per million volume                                                                 |
| Project           | LNG Canada Project                                                                       |
| PSL               | Permissible Sound Level                                                                  |
| R0                | Ringelmann scale measure of '0'                                                          |
| RCM               | Reliability Centred Maintenance                                                          |
| RFSU              | Ready for Start Up                                                                       |
| RPU               | Refrigerant Production Unit                                                              |
| Sm <sup>3</sup>   | Standard metre cubed (unit of volume)                                                    |
| SO <sub>2</sub>   | Sulphur Dioxide                                                                          |
| t                 | Tonnes (unit of weight)                                                                  |
| US                | Ultra-sonic (flow meter)                                                                 |
| VOC               | Volatile Organic Compounds                                                               |
| WDA               | Waste Discharge Authorization                                                            |

**Table 2: Definitions**

| Term          | Definition                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Commissioning | Commissioning is the stage following mechanical completion, where individual equipment and systems are being put into trial operations.<br>In the Facility Permit, it is defined as " <i>Period of time commencing when operations begin in accordance with Section 11 of the OGC Liquefied Natural Gas Facility Regulation (LNGFR) and ending when the first cargo of LNG is shipped from the LNG train</i> ". |
| Dilution Gas  | Typically, fuel gas used to provide adequate fuel for incineration or flaring of acid gas. Dilution gas is used to maintain a minimum heating value of the flared or incinerated gas, which must be reported as fuel gas instead of flared gas.                                                                                                                                                                 |

| Term                        | Definition                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Emergency                   | Activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure (per the Facility Permit).                |
| Fuel Gas                    | A process stream that is used in providing energy for facility operations.<br>For this Project, this is gas burned in the gas turbine and incinerator as fuel gas or added to the flare to improve heating value of the flared gas.                                                                                                          |
| Flared Gas                  | A combustible process stream routed to flare or incinerator (when incineration is used in place of flare).<br>For this Project, this includes pilot gas, fuel gas used as purge gas, and hydrocarbon sources to the flare system. Acid gas sent to the incinerator or flare will be considered as shrinkage as per the definitions provided. |
| Flaring                     | Disposal by combustion of natural gas or gas derived from petroleum.<br>Typically through an elevated stack and burner tip (not used to provide energy for facility operations).                                                                                                                                                             |
| Continuous Flaring          | Uninterrupted flared volumes with a constant and visible flame under routine operations and includes fuel gas being burned to maintain a pilot and/or continuous purge in the flare header.                                                                                                                                                  |
| Fugitive emissions          | Unintentional releases of gas or fumes resulting from production, processing, transmission, storage, and delivery of gas. This may occur from breaks or small cracks in seals, tubing, valves and pipelines, or when lids or caps on equipment of tanks have not been properly closed or tightened.                                          |
| Greenhouse Gas              | Gases in the atmosphere that absorb and emit thermal radiation. In the context of Greenhouse Gas (GHG) and Energy Management for an LNG project, these are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.                                                                            |
| Natural gas                 | Gaseous forms of hydrocarbons, principally methane, with minor amounts of ethane, butanes, pentanes, and hexanes along with non- hydrocarbon impurities such as nitrogen, carbon dioxide and hydrogen sulfide.<br>Feed gas as supplied by Coastal GasLink.                                                                                   |
| Normal (routine) operations | Excludes emergency conditions and commissioning (per the Facility Permit).                                                                                                                                                                                                                                                                   |
| Process upset               | Deviations that require operator to take measures that prevent safety or production loss and pre-empt activation of safety systems. Process upset excludes safety systems activation (per the Facility Permit).                                                                                                                              |
| Throughput                  | Fraction of the daily capacity (flow rate) of 1 train                                                                                                                                                                                                                                                                                        |
| Turnaround                  | Planned full inspection of a liquefaction train.                                                                                                                                                                                                                                                                                             |

| Term    | Definition                                                                           |
|---------|--------------------------------------------------------------------------------------|
| Venting | The intentional controlled release of un-combusted gases directly to the atmosphere. |

Sources:

- BC OGC (2018), LNG Facility Permit Application and Operations Manual, Version 1.6, August
- BC OGC (2020), Oil and Gas Glossary and Definitions, Version 1.11, December
- LNG Canada Project Facility Permit AD# 100083612, January 7, 2021 (Amended)

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## 2. Regulatory Framework

The following sections outline the various applicable regulations and permit conditions that inform the mitigation measures applied to design, commissioning and/or operations to minimize flaring and associated emissions.

### 2.1. Project Approvals and Conditions

#### 2.1.1. Facility Permit

In BC, LNG facilities are regulated by the *Liquefied Natural Gas Facility Regulation* (LNGFR) (B.C. Reg 146/2014), under the *Oil and Gas Activities Act* (OGAA). The BC OGC has the jurisdiction to issue permits associated with oil and gas activities, including LNG facilities. The LNGFR uses a phased permitting approach to authorize the siting, construction, and operations of LNG facilities. The proposed proponents are required to apply for a Facility Permit (LNGFR, Section 2); then submit documentation to support a “Leave to Construct”, which authorizes construction activities associated with the LNG Facility (LNGFR, Section 3); then submit documentation to support a “Leave to Operate” application, which authorizes commissioning and operations (LNGFR, Section 4).

The Project received the Facility Permit (Legacy File No. 9709124; Application Determination #100083612) on December 22, 2015 (refer to L001-09800-AA-5753-3053). The BC OGC issued an amendment to the Facility Permit on January 7, 2021, which re-numbered conditions (references to conditions herein are based on the amendment). Permit conditions applicable to the flare system are provided in Table 3 (refer to the permit for the full list of conditions; including additional conditions related to noise management). Note, LNG Canada is the “permit holder” for all permits issued by the BC OGC. This report was developed to satisfy Condition 39 and 40, and the other related conditions are provided for context only.

A “Leave to Construct” for the LNG Facility construction activities associated with Trains 1 and 2 within the bund wall (including the flare systems) was issued by the BC OGC on July 30, 2020. There were no specific conditions in this issued leave, as it’s based on the Facility Permit and LNGFR. A “Leave to Operate” will be required prior to commissioning of the flare system, which is forecast for 2023.

**Table 3: Facility Permit Conditions**

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31        | Flare Systems             | <p>The permit holder may flare gas from the four flares and nine liquid burners, identified as “warm wet”, “cold dry”, “spare”, “storage &amp; loading”, “liquid burner A”, “liquid burner B”, “liquid burner C”, “liquid burner D”, “liquid burner E”, “liquid burner F”, “liquid burner G”, “liquid burner H”, and “liquid burner I” in L001-06200-PX-2366-1002, rev H, Process Flow Diagram Unit 6200 Pressure Relief and Liquid Disposal System Sheet 2, 7 April 2020 for the following purposes:</p> <ul style="list-style-type: none"> <li>a) Flare pilots;</li> <li>b) Flare system purge;</li> <li>c) De-inerting of LNG carriers;</li> <li>d) Process upsets; and</li> <li>e) Commissioning.</li> </ul> |
| 35        | Flaring Notification Plan | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                           | <p>satisfaction of the Commission, a Flaring Notification Plan. The Flaring Notification Plan will include:</p> <ul style="list-style-type: none"> <li>a) notification processes specific to <ul style="list-style-type: none"> <li>(i) flaring during commissioning; and</li> <li>(ii) flaring during operations; and</li> </ul> </li> <li>b) notification to residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation regarding flaring events. The Flaring Notification Plan must include the notification radius for residents as defined below:</li> </ul> <p>Hydrogen Sulphide (H<sub>2</sub>S) Content &amp; Notification Radius:</p> <ul style="list-style-type: none"> <li>&lt; 1%: 1.0km</li> <li>≥ 1% and &lt; 5%: 1.5km</li> <li>≥ 5%: 3.0 km</li> </ul> |
| 36        | Flaring Notification Plan | <p>The permit holder must notify residents, the Regional District of Kitimat-Stikine, the District of Kitimat and the Haisla Nation at least 24 hours before a planned flaring event or within 24 hours of the start of an unplanned flaring event if the quantity of gas exceeds 10,000 m<sup>3</sup> per event or the duration exceeds 4 hours. This notification must be conducted in accordance with the relevant detail in the Flaring Notification Plan referenced in condition 35 above.</p>                                                                                                                                                                                                                                                                                                            |
| 37        | HSSE                      | <p>The permit holder must ensure that emissions from flares and incinerators do not:</p> <ul style="list-style-type: none"> <li>a) create a hazard to public health or safety;</li> <li>b) result in off-lease odours; or</li> <li>c) result in injury to vegetation or wildlife.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 38        | Smoke                     | <p>Subject to section 18(3) of the LNGFR, the permit holder must design, maintain and operate flares and incinerators so that flaring, other than flaring for emergency purposes, does not result in:</p> <ul style="list-style-type: none"> <li>a) the emission of black smoke during normal operations; or</li> <li>b) the emission of black smoke during process upsets that exceed a period or periods aggregating more than 15 minutes in any two-hour period.</li> </ul>                                                                                                                                                                                                                                                                                                                                 |
| 39        | Flaring Management Report | <p>The permit holder must not undertake commissioning of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a Flaring Management Report that documents measures to design, construct and operate the LNG facility to minimize flaring of gas and liquids and associated emissions including, but not limited to, black smoke during commissioning.</p>                                                                                                                                                                                                                                                                                                                                  |
| 40        | Flaring Management Report | <p>The Flaring Management Report must be submitted to the Commission at least 18 months prior to commencement of commissioning, subject to any applicable written exemptions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



| Condition |                           | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 41        | Flaring Management Report | The permit holder must implement the measures set out in the Flaring Management Report.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 47        | Noise                     | <p>The permit holder must not undertake commissioning, or operation of the LNG facility until it has submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a>, to the satisfaction of the Commission, a detailed noise impact assessment including:</p> <ul style="list-style-type: none"> <li>a) The sound power levels of the dominant noise sources and the basis of the sound power level;</li> <li>b) Details of noise mitigations applied;</li> <li>c) Results showing the predicted dBA (A-weighted decibel) and dBC (C-weighted decibel) comprehensive sound levels at far-field (1.5km) locations and residents 1-4 under representative weather conditions (<i>note, Condition 46 contains a table of locations for residents 1-4</i>).</li> </ul> <p>Noise contours that demonstrate that the LNG facility does not direct significantly more noise in any particular direction under representative weather conditions.</p> |
| 50        | Noise                     | The permit holder must not undertake commissioning, or operation of the LNG facility until it has implemented a documented Noise Management Program that complies with the applicable requirements set out in the "British Columbia Noise Control Best Practices Guideline." Prior to being implemented, the Noise Management Program must be submitted via email to <a href="mailto:postpermitrequests@bcogc.ca">postpermitrequests@bcogc.ca</a> and be to the satisfaction of the Commission.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 52        | Light                     | The Permit Holder must select, install and maintain a lighting design that conforms to the Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, Commission Internationale de l'Eclairage (CNC/CIE) 150:2003, as amended from time to time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

### 2.1.2. Waste Discharge Authorization

A Waste Discharge Authorization (WDA) is also required under the *BC Environmental Management Act* (SBC 2003), for the discharge of air emissions from various industries, activities and operations. The BC OGC has the jurisdiction to issue WDAs associated with oil and gas activities. The WDA will contain specific limits for emissions.

At this time of document issuance, the WDA application for air emissions that includes the flare system, is under development. Engagement with the BC OGC has commenced via submission of the WDA pre-application on 13 November 2020.

### 2.1.3. Environmental Assessment Certificate

The BC Environmental Assessment Office (EAO) issued the Environmental Assessment Certificate (EAC) for the Project on June 17, 2015 (#E15-01) with a subsequent amendments issued 2016, 2019 and 2021. Note, LNG Canada is the "Holder" for the EAC. Permit conditions applicable to the flare system are provided in Table 4 (refer to the permit for the full list of conditions) for context only.

**Table 4: Environmental Assessment Certificate #E15-01 Conditions**

| Condition   |                                    | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schedule A  | Certified Project Description      | <p>The components related to the LNG progressing and storage site are:</p> <ul style="list-style-type: none"> <li>Flare systems, including a total of up to two flare derricks of no greater than 135 m in height each.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Schedule B  | Table of Conditions – Condition 1  | <p>Air Quality.</p> <p>The Holder must develop, in consultation with MOE (<i>now ENV; Ministry of Environment and Climate Change Strategy</i>), MOH (<i>Ministry of Health</i>) and OGC, and implement an air quality management plan which specifies mitigation measures to reduce air emissions during Construction, and sets out the means by which the mitigation measures in the Mitigation Table under the heading “air quality” related to Construction will be implemented.</p> <p>Prior to commencing Operations, the Holder must develop an air quality management and monitoring plan, in consultation with MOE (<i>now ENV</i>), MOH and OGC.</p> <p><i>Note, there is further detail in the condition that is not provided hererin. Refer to the EAC for further details.</i></p> |
| Schedule B  | Table of Conditions – Condition 2  | <p>Acoustics</p> <p>During Operations the Holder must be designed to comply with the OGC Noise Control Best Practices Guidelines (2009)</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details. There is also a more recent version of the Guidelines referenced, as detailed in Section 2.2.3 herein.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                             |
| Schedule B  | Table of Conditions – Condition 12 | <p>Wildlife</p> <p>The Holder must develop a wildlife management plan for Operations in consultation with EC (<i>now Environment and Climate Change Canada, ECCC</i>), FLNR (<i>Ministry of Forests, Lands, Natural Resources and Rural Development</i>) and OGC. The plan must identify mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during Operations, as feasible from a technical and safety perspective.</p> <p><i>Note, there is further detail in the condition that is not provided herein; refer to the EAC for further details.</i></p>                                                                                                                                           |
| Application | Mitigation Measure 5.3-9           | Adhere to the OGC Flaring and Venting Reduction Guideline. Minimize flaring or venting, except as required to maintain safe operations and LNG train start up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

#### 2.1.4. Decision Statement

The Impact Assessment Agency of Canada (IAAC) issued the Decision Statement for the Project on June 17, 2015 with a subsequent amendment issued in April 2021. Note, LNG Canada is the “Proponent” for the Decision Statement.



Permit conditions applicable to the flare system are associated with migratory birds; Condition 5.2 states that “*The Proponent shall:*

*5.2.1 restrict flaring of vented emissions to the minimum required for maintenance activities or to manage emergencies;*

*5.2.2 minimize flaring during night time and during periods of bird vulnerability;*

*5.2.3 adjust operational lighting to avoid attracting migratory birds.”*

Note, this information is provided for context only.

## 2.2. Acts, Regulations and Guidelines

As outlined in Section 2.1, there are several regulatory acts, regulations and guidelines that inform the design, construction and operation of the flare system. Further details on key acts, regulations and guidelines are provided herein, please refer to the full act, regulation and guideline for further information.

### 2.2.1. Oil and Gas Activities Act; Liquified Natural Gas Facility Regulation

As outlined in Section 2.1.1, the OGAA, LNGFR is a key regulation for LNG Facilities. Key sections conditions applicable to the flare system are provided in Table 5 (refer to the regulation for further details).

The BC OGC developed the “Liquified Natural Gas Facility Permit Application and Operations Manual” which provides further guidance on flaring and references various guidelines; the manual is available online through the BC OGC.

**Table 5: LNGFR Sections**

| Section |                                            | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4       | Engineering Design and LNG Facility Siting | <p>(1) An LNG facility permit holder must, subject to anything in the LNG facility permit, ensure that the engineering design and siting for an LNG facility:</p> <ul style="list-style-type: none"> <li>a) subject to subsections (4) and (5), is completed in accordance with CSA Z276,</li> <li>c) is based on a consideration of the effects of noise associated with the normal operation of the LNG facility, and</li> <li>e) is based on a consideration of the effects of light associated with the normal operation of the LNG facility.</li> </ul> <p>(3) Subject to subsections (4) and (5), an LNG facility permit holder must ensure a flare or ignited vent stack is sited so that the thermal radiation flux at the targets identified in column 1 of Schedule 1 do not exceed the maximum radiation flux identified in column 2.</p> <p><i>Note, there is further detail in this section that is not provided herein. Refer to the LNGFR for further details.</i></p> |
| 15      | Noise and Light Control                    | An LNG facility permit holder must ensure that the construction of and normal operations at the LNG facility do not cause excessive noise or excessive emanation of light.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Section                               | Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17 Venting                            | <p>(1) An LNG facility permit holder must not vent gas from an LNG facility unless the gas heating value, volume or flow rate is insufficient to support stable combustion and all of the following apply:</p> <ul style="list-style-type: none"> <li>a) the venting is conducted in a manner that does not constitute a safety hazard;</li> <li>b) the venting does not cause off-site odours;</li> <li>c) the quantity of vented gas is minimized;</li> <li>d) the duration of venting is minimized.</li> </ul> <p>(2) An LNG facility permit holder may use gas containing hydrogen sulphide for pneumatic instrumentation or to provide motive force to pumps only if the gas contains no more than 20 parts per million of hydrogen sulphide.</p> |
| 18 Flaring Limits                     | <p>(1) Subject to subsection (2), an LNG facility permit holder must not flare gas from the LNG facility unless flaring is required for emergency purposes.</p> <p>(2) An LNG facility permit holder may flare gas from the LNG facility if</p> <ul style="list-style-type: none"> <li>a) flaring is required for maintenance purposes, or</li> <li>b) permission to flare is included in the LNG facility permit.</li> </ul> <p>(3) An LNG facility permit holder must ensure that the duration of flaring and the quantity of gas that is flared from an LNG facility is minimized.</p>                                                                                                                                                              |
| 19 Flaring Notification and Reporting | <p>(1) An LNG facility permit holder must notify the commission at least 24 hours before a planned flaring event from the LNG facility if the quantity of gas to be flared exceeds 10 000 m<sup>3</sup>.</p> <p>(2) If an unplanned flaring event occurs at the LNG facility and the quantity of flared gas exceeds 10 000 m<sup>3</sup>, the LNG facility permit holder must notify the commission within 24 hours after the flaring event begins.</p> <p>(3) An LNG facility permit holder must maintain a log of all flaring that occurs at the LNG facility and submit flaring information to the commission on its request.</p>                                                                                                                   |

### 2.2.2. BC OGC Flaring and Venting Guideline Reduction Guidelines

The BC OGC *Flaring and Venting Reduction Guidelines* (FVRG) will be followed during all stages of the Project to eliminate routine flaring and reduce non-routine events. The FVRG is available online through the BC OGC. Key chapters include:

- Chapter 3 – Natural Gas Facility Flaring and Venting: Includes a decision tree that must be used when considering alternatives to flaring and venting; and self disclosure process if there are six or more major flaring events within a six-month rolling period.
- Chapter 5 – Notification Requirements.

- Chapter 6 – Performance Requirements: Includes requirements for noise, conversion efficiency, spacing, stack design, ignition, liquid separation, backflash control, flare maintenance and dispersion modelling.
- Chapter 7 – Venting and Fugitive Emissions Management Requirements.
- Chapter 10 – Measurement and Reporting: All monthly flared, incinerated, and vented volumes must be reported monthly through the Ministry of Finance; therefore includes requirements for metering, reporting and record retention.

### 2.2.3. BC Noise Control Best Practices Guideline

The BC Noise Control Best Practice Guideline outlines the recommended best practices for noise control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC, with the latest version issued in July 2021.

While there are no specific references to flaring or flare systems within this guideline, it provides the basis for undertaking noise assessments and determining the Permissible Sound Levels (PSLs) that will need to account for the flare system.

Note, the Project is developing a separate Noise Management Program, as required by Project permits (refer to Section 2.1 herein) that will include the applicable measures to mitigate noise.

### 2.2.4. BC OGC Light Control Best Practices Guideline

The BC Light Control Best Practice Guideline outlines the recommended best practices for light control of operations associated with wells and facilities under the jurisdiction of the BC OGC. This guideline is available online through the BC OGC.

A facility flare is an example of a "sky glow" source, and the guideline provides mitigation measures that should be considered to not cause excessive emanation of light, with reference to the CIE guide (which is also Project Facility Permit Condition 52, refer to Table 3).

Note, the Project addresses light through the Environment Management Plans, submitted to the EAO, as required by the Project permits (refer to Section 2.1 herein).

### 2.2.5. Ambient Air Quality Objectives

The province of BC uses a suite of ambient air quality criteria that have been developed provincially and nationally to inform decisions in the management of air contaminants. Ambient air quality objectives applied in BC include provincial and national objectives and standards developed for a number of contaminants over various averaging periods. These include Provincial Ambient Air Quality Objectives (AQOs), and Canadian Ambient Air Quality Standards (CAAQS). AQOs are non-statutory limits (i.e. not legally binding), unless referenced directly in a regulation or authorization; and are used by regulators to:

- Gauge current and historical air quality
- Guide decisions on environmental impact assessments and authorizations
- Guide airshed planning efforts
- Inform regulatory development
- Develop and apply episode management strategies such as air quality advisories

Limits on air emissions for the Project will be defined in the WDA (refer to Section 2.1.2) and not further addressed herein. The AQOs are available online.

### **2.3. Project Environmental Commitments**

Specific to flaring, the Project will operate without routine flaring or venting, with minor continuous sources (e.g., flare pilot). Furthermore, non-routine flaring will be minimized, and the design will include flare mitigation to reduce flare load during unplanned upsets.

LNG Canada's Commitment and Policy on Health, Safety, Security, Environment and Social Performance focuses on ways to avoid and minimize negative environmental and social impacts resulting from our operations and enhance the positive impacts in a systematic manner, which were addressed as part of the flare system design.

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### **3. Roles and Responsibilities**

There are various roles and responsibilities applicable to the design, construction and operations of the flare system. JFJV, as LNG Canada's EPC, is responsible for managing the design, fabrication, construction, pre-commissioning and commissioning activities up to "ready for startup" (RFSU), with support from LNG Canada. LNG Canada is responsible for managing and performing commissioning activities that can not be physically done prior to RFSU and operations after RFSU of the LNG Train (i.e. handover), with support from JFJV to execute post-RFSU activities. Commissioning, ramp-up and early operations shall be executed by a joint, competent team of staff, from LNG Canada and JFJV.

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## 4. Flare Systems Overview

### 4.1. General

During normal operations, natural gas and other hydrocarbons flow continuously through an LNG Facility. Whenever there is a disruption to the expected operation of the LNG Facility, such as an equipment or power outage, the constant flow of natural gas is interrupted and any excess hydrocarbons are sent to the flare to be safely ignited via a small continuous pilot flame. Hence, all LNG plant designs incorporate flare systems to safely evacuate gas when necessary, which are designed to burn gases safely and efficiently under all conditions. In all conditions, excess gas may need to be burned off safely and efficiently without escaping into the atmosphere. The continuous “flare pilot” is supplied by fuel gas, and is a small, smokeless flame. The flare pilot provides a continuous ignition source, such that any gas sent to the flare as a result of upset conditions is immediately combusted.

When a flaring event occurs, the flame at the top of the flare stack safely grows larger, and in some cases, can be quite large, noisy or create smoke.

During initial operation period, the EAC application had estimated that “a default factor of 0.3 weight percent of each train’s LNG output is assumed to best represent flaring volumes occurring during normal operation and during maintenance events”.

A modern LNG facility is designed to minimize continuous flaring and venting during normal operations and minimize flaring during maintenance and other normal non-routine events during operations. In this way, flaring is kept to those occasions when it is needed as a safety measure during start-up and shut down events, to prevent equipment damage and maintain safety and facility reliability.

As stated in Section 2.3, the Project will operate with limited continuous pilot flares and other safety features, and will not carry out routine flaring or venting. The flare system will facilitate purging of the plant during the following activities:

- Routine maintenance activities
- Planned maintenance (turnarounds)
- Trips and unplanned shutdown to repair defects
- Commissioning
- Emergency Situations

The Project has many safety valves and manual isolation valves routed to flare (e.g., relief valves, blowdown valves, pressure or hand controllers to flare used for operational reasons). In addition there are many manual drains (e.g., manual vents to vapor flare header, manual drain to the liquid flare headers).

During early operation period, it is expected that flare volumes and visibility will be higher compared to normal operations, which is common to the start-up of all LNG facilities. This flaring activity will reduce over time as the facility moves into normal operations.

As flares radiate heat, the height of the flare stacks is designed with safety in mind. A specially designed and secure exclusion zone exists surrounding the base of the flare to control access to the flare area to protect the general public and workers at the LNG facility.

### 4.2. Process Description Overview

The Project receives dry pressurized Natural Gas from CGL. The feed gas stream is primarily methane with some ethane, propane, butane and a small heavy tail with some impurities. The raw, warm gas is cleaned of its impurities (carbon dioxide (CO<sub>2</sub>), water, trace mercury, heavier hydrocarbons) before liquefying it in two stages, into LNG at -161°C and near atmospheric pressure (refer to **Figure 1**).

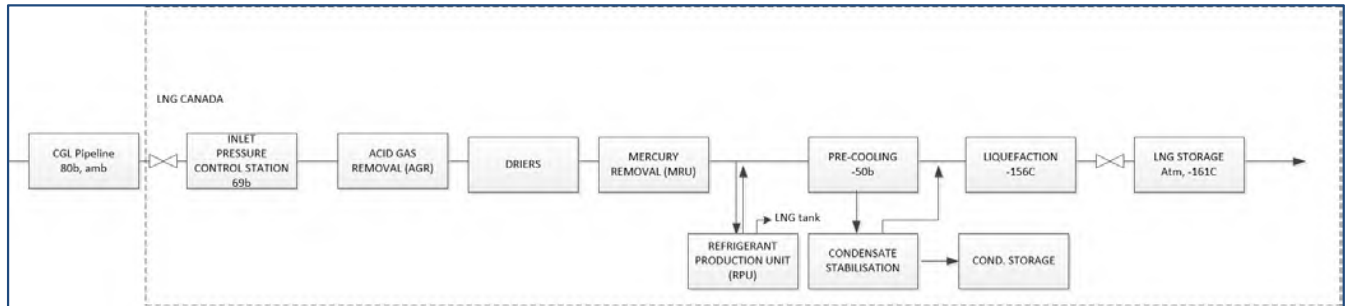


**Figure 1 Overall Process Overview Schematic**

The liquefaction process has two refrigerant cycles in series involving compressing, condensing, and letdown as outlined below. The compressors are driven by gas turbines.

- Pre-cool cycle: uses a Pre-cool Mixed Refrigerant ("PMR") cooling from ambient to -50°C; and
- Deeper liquefaction cycle: uses a Mixed Refrigerant ("MR") cooling from -50°C to -155°C in the Main Cryogenic Heat Exchanger (MCHE).

It is important to note for the purpose of this report, that there are two refrigerant systems in parallel per LNG train called "String A" and "String B," as shown in **Figure 2**. Each string can roughly handle half the production. The gas turbines are semi-aero derivative type with low torque requirement at start (meaning there is no need to depressurize inventory to allow restart).

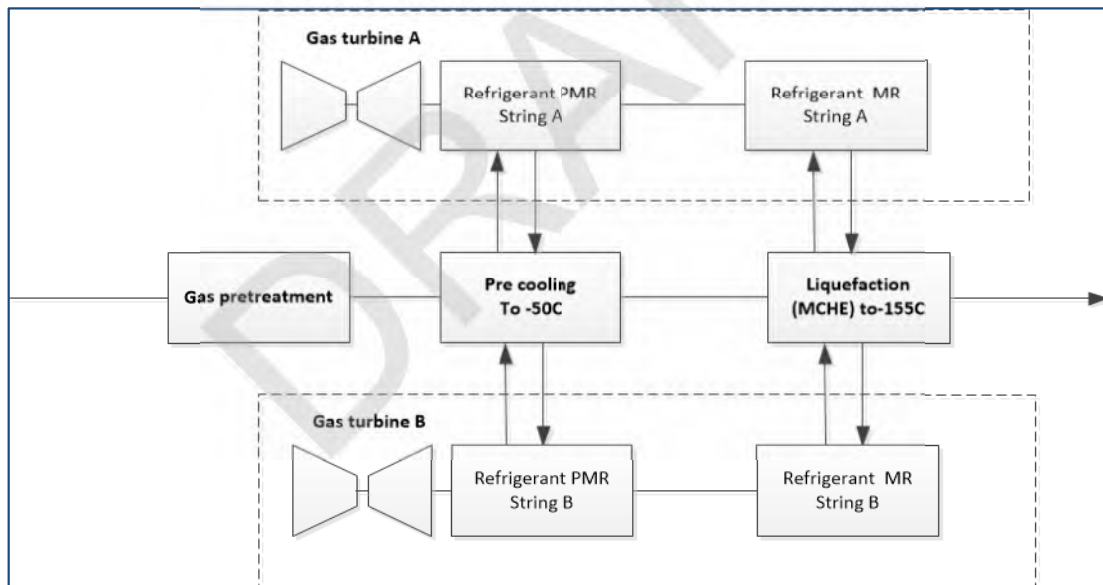


**Figure 2 Liquefaction Overview Schematic (high level)**

Methane, ethane and propane are the components used as refrigerants in the liquefaction process. They are therefore available within the feed gas and do not require regular import. Ethane and propane can be extracted and purified in the refrigerant production unit (RPU).

There are four flares and nine liquid burners, which are common for both Train 1 and Train 2 (further details are provided in Section 5.3). The Project has two derrick structures to support the flares and liquid burners, as outlined in Table 6. Refer to Figure 3 and Figure 4 for the location of the structures.

There are networks of flare headers collecting gases that are continuously purged with nitrogen to avoid air ingress into the flare stacks. Fuel gas purge would only be used as a back-up, should the nitrogen supply be depleted.

**Table 6: Flare Derrick Structures and Systems**

| Item                       |                                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vapour<br>Flare<br>Derrick | Warm/Wet Process<br>Flare ("F-WW")                    | <p>For warm hydrocarbon vapour streams that may be saturated with water vapour and / or contain free liquid hydrocarbons and water.</p> <p>The system collects releases from:</p> <ul style="list-style-type: none"> <li>• Inlet Facilities</li> <li>• Acid Gas Removal Unit</li> <li>• Dehydration Unit</li> <li>• Mercury Removal Unit</li> <li>• Liquefaction Unit</li> <li>• Incinerator Unit</li> <li>• Condensate Stabilisation Unit</li> <li>• Heat Transfer Fluid System</li> <li>• Tempered Cooling Water System Unit</li> <li>• Fuel Gas System</li> <li>• Defrost Gas System</li> </ul> |
|                            | Cold/Dry Process<br>Flare ("F-CD")                    | <p>For cryogenic hydrocarbon vapours (will not contain water). This system collects releases from:</p> <ul style="list-style-type: none"> <li>• Liquefaction Unit (except defrost)</li> <li>• Condensate Stabilisation Unit</li> <li>• RPU</li> <li>• Refrigerant Storage System</li> <li>• LNG Storage and Boil Off Gas (BOG) Compression</li> </ul>                                                                                                                                                                                                                                              |
|                            | Low Pressure<br>Storage and<br>Loading Flare ("F-LP") | <p>For low pressure LNG vapours from the LNG Storage Tanks in the event of BOG Compressors failure and / or carrier loading; compressor seal vents and analyzer exhausts are routed to this flare as well. These vapours cannot be directed to the F-CD due to the low pressure of these streams. In case of a long duration trip of one of the BOG compressors, the LNG production rate will be reduced to decrease the amount of flaring.</p> <p>Includes a velocity seal to minimize purge gas requirements.</p>                                                                                |



| Item                  | Description    |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | Spare flare    | CO <sub>2</sub> or nitrogen containing gases released during de-inerting of LNG carriers route to the F-LP also. Sufficient fuel gas shall be supplied for continuous burning of the flame.<br><br>Used in place of the individual flare systems when a flare needs to come out of service for maintenance. This flare is a duplicate of the warm/wet flare stack, with minimum design temperature dictated by the cold/dry process flare design. |
| Liquid Burner Derrick | Liquid burners | For either warm/wet or cold/dry liquids.                                                                                                                                                                                                                                                                                                                                                                                                          |

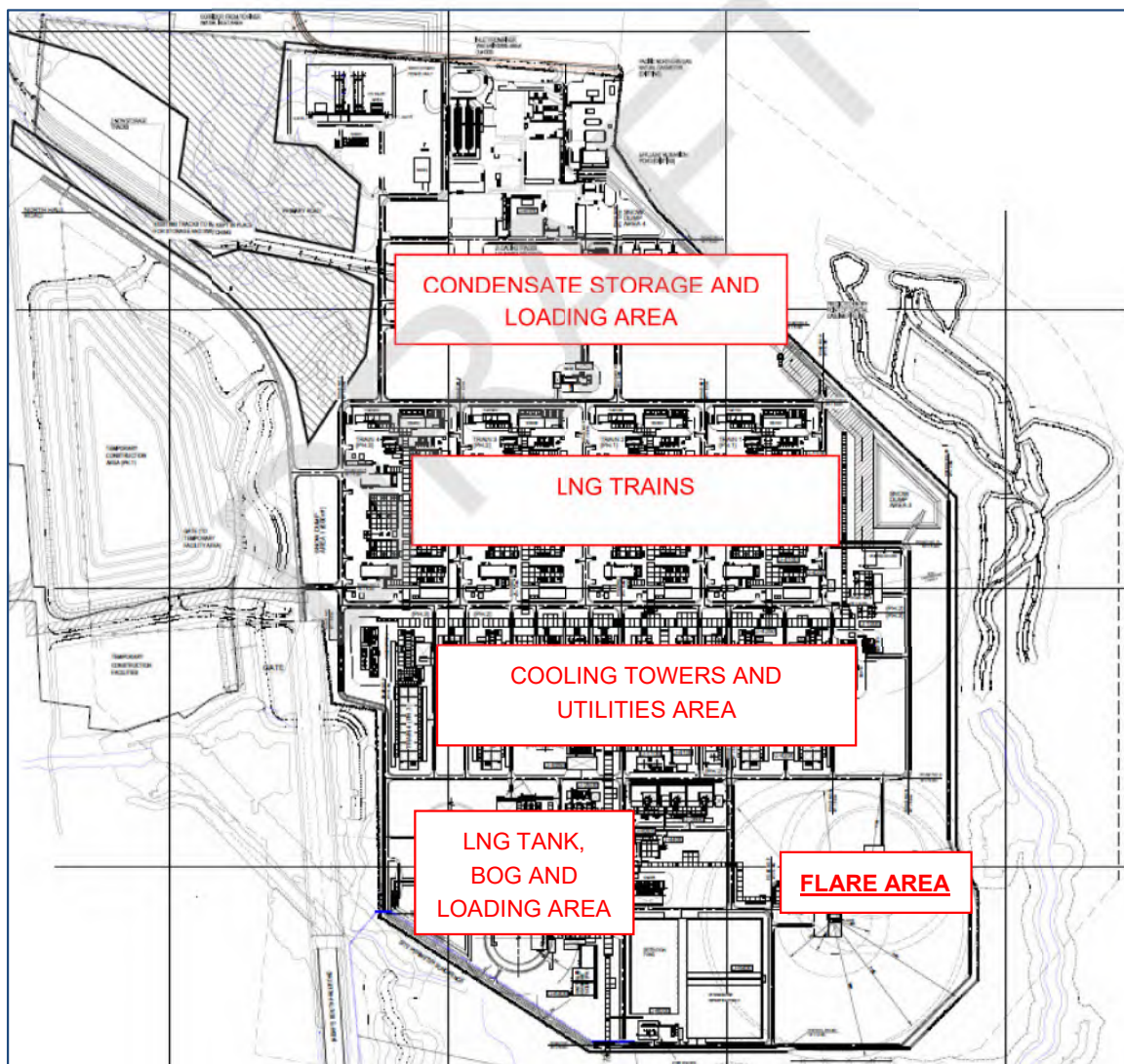


Figure 3 Flare Location Overview



## 5. Flare Design Basis, Technology Selection and Measures

### 5.1. Design Basis

The design basis for key components of the flare systems is provided below. Some parameters of the design basis were adjusted during detailed design with the vendor (refer to Section 6.2 for further information).

#### 5.1.1. Flare Systems

The design flow rate for each flare, and associated design case are provided in Table 7 and Table 8. The flares are designed to achieve 99.53% destruction efficiency.

**Table 7: Vapour Flares Design Basis**

| Flare                      | Diameter (inch) | Height (m) | Design flow (t/h) | Case                                          |
|----------------------------|-----------------|------------|-------------------|-----------------------------------------------|
| Warm Wet ("F-WW")          | 56              | 122        | 2195              | Blocked outlet liquefaction                   |
| Cold Dry ("F-CD")          | 48              | 122        | 1717              | Refrigerant compressor blocked outlet         |
| Storage & Loading ("F-LP") | 56              | 122        | 299               | Loss of all BOG compressors (4 trains)        |
| Spare                      | 56              | 122        | 2195              | Blocked outlet liquefaction as governing case |

**Table 8: Liquid burners Design Basis**

| Flare                   | Number of Flare Tips | Flare Tip Diameter (inch) | Height (m) | Design flow (t/h) | Case                                                     |
|-------------------------|----------------------|---------------------------|------------|-------------------|----------------------------------------------------------|
| Liquid burner-warm case | 3                    | 3                         | 60         | 32                | Hydrocarbons (C3), Condensate disposal                   |
| Liquid burner-Cold case | 9                    | 3 with 3"<br>6 with 6"    | 60         | 310               | LNG restart following outage (30% production of 1 train) |

#### 5.1.2. Flare Radiation

The design complies with the following requirements for thermal radiation outlined in Table 9.

**Table 9: Flare Thermal Radiation Design Basis**

| Heat Radiation limit (kW/m <sup>2</sup> ) | Location                                                                              | Basis                                                                                                               |
|-------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| 1.5                                       | At the boundary of sterile area for normal operation including start up and shut down | Project requirement (Flare Equipment Data Requisition Sheet)<br>LNGFR requirement is maximum of 5 kW/m <sup>2</sup> |
| 3.0                                       | Property limit boundary for all cases and cooling towers                              | Project requirement (Flare Equipment Data Requisition Sheet)<br>LNGFR requirement is maximum of 5 kW/m <sup>2</sup> |



| Heat Radiation limit<br>(kW/m <sup>2</sup> ) | Location                                                 | Basis                                                                                                                   |
|----------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 5.0                                          | At the boundary of sterile area for emergency conditions | Project requirement (Flare Equipment Data Requisition Sheet)<br><br>LNGFR requirement is maximum of 9 kW/m <sup>2</sup> |

### 5.1.3. Flare Knockout Drums

The design basis for the flare knockout (KO) drums is provided in Table 10. The flare KO drums are protected from liquid overflow through a combination of design liquid retention volume as well as the use of two independent radar level measurements (one alarm is initiated through the distributed control system and the second through the safety system). These measurements provide independent alarms for operator response to initiate removal of accumulated liquids to the liquid burners.

The storage and loading flare system is not expected to ever accumulate liquid through normal operation. However, in the unlikely event that liquids enter this system the flare header has a liquid boot to collect any liquids with two independent level measurements and a single level alarm. Once liquids have accumulated, these will need to be removed and disposed of via vacuum truck.

**Table 10: Flare Knock Out Drums Design Basis**

| Flare Knockout Drum | Liquid Sizing Criteria                                                                                                                                                                                                                                                                                                                                        |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm-Wet            | To handle maximum vapour relief. The maximum liquid inventory is 180 m <sup>3</sup> , based on the amine liquid relief scenario.                                                                                                                                                                                                                              |
| Cold-Dry            | Assuming that the blowcase operation does not occur for 20 minutes after the emergency depressurizing of the LNG train liquification unit starts. This scenario equates to 140 m <sup>3</sup> of liquid accumulation in the flare KO drum which is based on the depressuring from PMR accumulator prior to start of the blowcase sequence and liquid burners. |
| Spare               | To meet the most stringent design criteria of both the WW and CD systems, this KO drum has been sized to retain 180 m <sup>3</sup> of liquid carryover from the amine flash drum without operation of the flare KO drum pump as this has been identified as the largest relief load.                                                                          |

## 5.2. Flare Technology Used

The selection of flare technology used to meet the design basis is a key component to ensure efficient operations, including minimizing associated emissions. The Project contracted Zeeco to design and fabricate the vapor and liquid flare systems.

### 5.2.1. Pilot System

The vapour flares are equipped with four pilots each, and the liquid burners are equipped with an individual pilot.

The pilots for the flare are continuously lit with fuel gas supplied from the plant fuel gas system; if the plant fuel gas is not available, a backup supply of liquified petroleum gas is available to supply the pilots for a short period of time.

Each flare pilot is equipped with a redundant thermocouple to detect a flameout. On detection of a pilot flame out, an alarm will be initiated to the panel operator and the system will automatically attempt to relight the pilot with a high energy ignition system. If the high energy ignition system fails to relight the pilot, field operations will attempt to relight the pilot with a flame front generator.

As the vapour flares have redundant pilots and are the final barrier to a process safety incident, they will continue to operate. A flame out scenario has been modeled for these flares and the unburned hydrocarbon from the flare does not pose a hazard to people.

For the liquid burners, as this equipment is only required for start-up and liquid disposal, a loss of the pilot will result in the individual burner tripping to prevent liquid rainout.

## 5.2.2. Vapour Flare Systems

Details on the selected vapour flare technology is provided in Table 11; and supporting images provided in Figure 5 and Figure 6.

**Table 11: Vapour Flare Summary**

| Flare                                                                                                                 | Type                | Smoke Index <sup>1</sup> | Comments                                                                |
|-----------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------|-------------------------------------------------------------------------|
| Warm Wet ("F-WW")                                                                                                     | Multi-Jet MJ-56     | R0                       | Multi tip fixed slot sonic type. Assist gas for DRE/99.5%.<br>4 Pilots. |
| Cold Dry ("F-CD")                                                                                                     | VariJet VJ-48       | R0                       | Multi tip variable slot sonic. Assist gas for DRE/99.5%.<br>4 Pilots.   |
| Storage & Loading ("F-LP")                                                                                            | Utility Flare UF-56 | R0                       | General gas assisted.<br>4 Pilots.                                      |
| Spare                                                                                                                 | Multi Jet MJ-56     |                          | Multi tip fixed slot sonic type; replace sonic single tip.<br>4 Pilots. |
| Notes:                                                                                                                |                     |                          |                                                                         |
| 1. Further information on smoke performance is provided in Section 7.1 R0 = estimated Ringelmann scale measure of "0" |                     |                          |                                                                         |



**Figure 5: Example of a Warm Flare – Multi Jet (MJ) (Vendor – Zeeco)**



**Figure 6: Example of a Low pressure flare – Utility Flare (Vendor – Zeeco)**

### 5.2.3. Liquid Burners System

Details on the selected liquid burner technology is provided in Table 12.

**Table 12: Liquid Burner Summary**

| Flare                    | Type       | Comments                                          |
|--------------------------|------------|---------------------------------------------------|
| Liquid burner- warm case | MJ3        | 1 Spider burner                                   |
| Liquid burner- Cold case | MJ6<br>MJ3 | 3 Spider burners (2x6", 1x3") per riser; 3 risers |

In September 2019, Zeeco performed a test on LNG flaring at their facility in Tulsa, Oklahoma, USA with one multi-jet liquid burner to observe:

- Smokeless capability; and
- Noise measurement.

Both results were satisfactory; correlated noise for nine burners was estimated at 85dB at 250 metres. Images from the testing are shown Figure 7.

## Liquid burner: Multi-Jet from Zeeco



Figure 7 Liquid Burners (Star Shape) from Zeeco for LNGC

### 5.2.4. Derrick Structures

The derrick structure for the flares and liquid burners is shown in Figure 8.

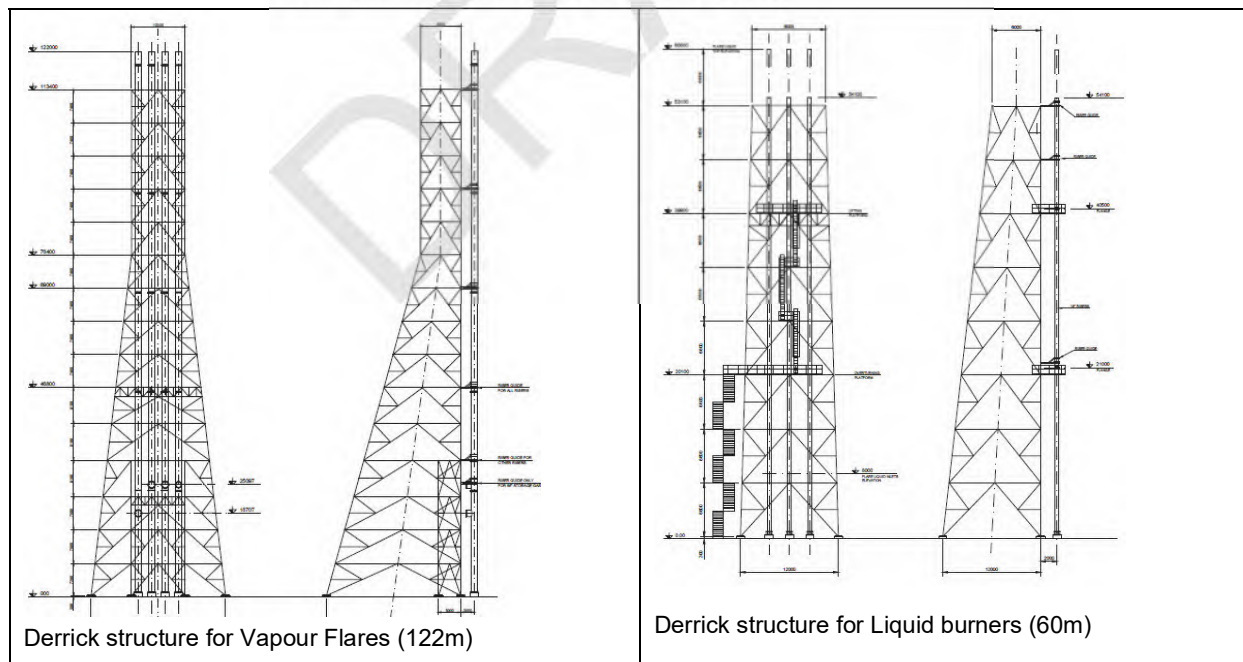


Figure 8 Derrick Structure

### 5.3. Flaring & Venting Mitigation Measures in Design

Several prospective flare reduction technologies were considered for implementation, as part of a Best Available Technologies assessment, including the recovery of start-up gas through the BOG compressor and the review of split range pressure controllers to ensure that they do not prematurely open to flare.

Elements of the Project design that will support minimizing flaring and venting include:

1. The large refrigerant compressors do not need de-inventory for restart after an outage or a trip as the semi aeroderivatives have low torque demand at start.
2. There are two parallel strings for each liquefaction train; a trip or outage of one string does not interrupt LNG production; it only cuts it in half, so there is no flaring impact.
3. Each compressor string is equipped with its quench line for start up to allow quick equalization with cold running string to reduce flaring.
4. The ethane refrigerant sphere is insulated and chilled to -11°C to minimize vapour losses from the sphere.
5. PMR and MR Refrigerant qualities can be adjusted by recycling their vapours to condensate unit rather than flaring them.
6. MR Refrigerant quality can be adjusted by recycling the heavy Liquid H-MR to condensate unit rather than flaring it.
7. PMR refrigerant liquid can be drained and recycled to PMR storage sphere in preparation of turnaround, reducing amount to flare.
8. Refrigerant spheres are pressure controlled to the LNG tank vapour space.
9. Excess BOG from tank and LNG carrier is recycled to inlet facilities through the BOG compressors.
10. The RPU overheads and bottoms are fully recycled back to the LNG Train.
11. Pre-cooling PMR cycle can circulate MR on full recycle via an MR "start-up recycle line" to provide pre-cooling load, to facilitate pre-cooling system start up and decouple with MCHE final cool down.
12. The condensate tank vapours are chilled to -10°C to reduce hydrocarbon directed to the incinerator.
13. Upon thermal oxidiser trip, the acid gas stream is sent to the Warm flare instead of being vented.
14. Automated advanced cooldown to reduce flaring time at the cold liquid burners.
15. Purging of flare headers by nitrogen instead of fuel gas.
16. Full metering capability on the flare headers including density measurement which can help identify abnormal flaring earlier.
17. Capability to load warm wet waste stream (hydrocarbons, water, sulfinol) to truck disposal instead of liquid burners.

LNG Canada will continue to assess flaring and potential improvements in technology, maintenance, and operations, as part continual improvement.



## 6. Environmental Impacts and Mitigation Measures

The act of flaring can cause a potential impact to the environment due to smoke, air emissions, heat, noise and light. Potential environmental effects from flaring were addressed in the EAC process. The following section outlines how each of these elements has been minimized through design.

### 6.1. Smokeless Performance

The Project Facility Permit stipulates that the permit holder must design, maintain, and operate flares and incinerators so that flaring, other than for emergencies, does not result in black smoke or emission of black smoke during upsets that exceeds 15 minutes in any two-hour period (and is completely eliminated during normal operations) (refer to Table 3).

The Ringelmann scale is the scale used by industry for measuring the apparent density of opacity of smoke (refer to Figure 9).

During the Detailed engineering phase, JFJV worked with two reputable flare manufacturers with experience in the LNG industry and in Canada; each vendor provided two designs, the first compliant with the base design and a second design aligned with improved smokeless performance as represented by the Ringelmann scale.

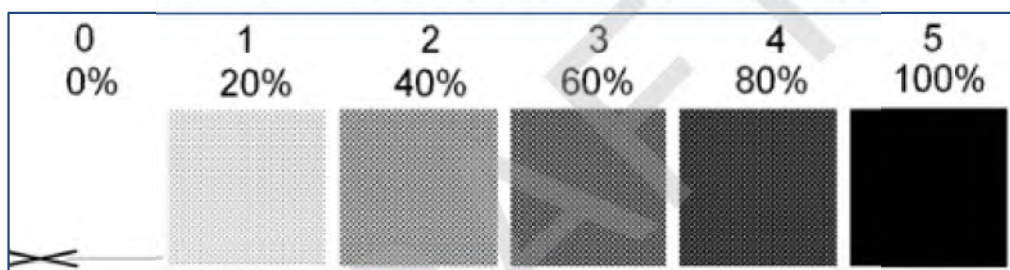


Figure 9 Ringelmann Chart

After evaluation, an improved design was selected that reduces noise generation as well as smoke. Ringelmann “0” or “R0” performance is likely in most situations, but not a guarantee case from the vendor (smoke may occur in certain scenarios, refer to Section 9). Table 13 summarizes the design improvements.

Table 13 Summary of Flare Design Changes

| Flare riser               | Original design                                                     | New Design                                                                                                                                                                                   |
|---------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warm Flare                | Single tip sonic pressurized                                        | Multi tip fixed slot sonic type; fixed orifice size                                                                                                                                          |
| Cold Flare                | Single tip sonic pressurized                                        | Multi tip variable slot sonic type                                                                                                                                                           |
| Storage and Loading Flare | General gas assisted flare                                          | No change possible due to requirement for low back pressure constraints                                                                                                                      |
| Spare Flare               | Single tip sonic pressurized                                        | Multi tip fixed slot sonic type; fixed orifice size                                                                                                                                          |
| Liquid Burners            | 4 burners consuming a lot of atomizing to burn LNG-condensate range | 3 risers with 3 burners each: <ul style="list-style-type: none"> <li>9x LNG burners to burn smokeless LNG at start up; and</li> <li>3x condensate burners to burn heavier liquids</li> </ul> |

## 6.2. Air Contaminant & GHG Emissions

The Project is committed to the health and safety of the public, which is aligned with Facility Permit condition related to ensuring that emissions from flares and incinerators does not create a hazard to public health or safety, result in off-lease odours or result in injury to vegetation or wildlife (refer to Table 3).

Normally, flare technology has a combustion efficiency of approximately 98%; however, for this Project, the chosen flare technology has a combustion efficiency of at least 99.53%, which is achieved by using assist gas in the flare system and flare tip design. This design criteria ensures that by-products of incomplete combustion such as coarse and fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>) and Volatile Organic Compounds (VOCs) are released at extremely low quantities. The trade-off for this improved combustion efficiency is increased GHG emissions when assist gas is used in the flare; however, note these emissions are relatively minor GHG emissions.

The combustion products of hydrocarbons also contribute to GHG emissions. The main GHG released by flaring is CO<sub>2</sub>, which has a much lower Global Warming Potential (GWP) compared to methane. Other by-products of combustion that will be released from the flare include nitrogen oxides (NO<sub>x</sub>), and sulphur dioxide (SO<sub>2</sub>) when flaring feed gas or acid gas from the amine units.

To ensure that the project has a negligible impact on the environment and human health, comprehensive air dispersion modeling was completed as part of the EAC application, which confirmed that the BC AQOs would not be exceeded as a result of the LNG Canada facility for normal and emergency conditions. Further air emissions modelling is being undertaken as part of the WDA application, which includes the worst-case emergency flare scenarios (as it relates to air quality) (refer to Section 2.1.2).

Once the Project is operational, the results from the air dispersion modeling will be verified through ambient air quality monitoring.

## 6.3. Thermal Heat

As a result of the combustion in the flare system, a large amount of heat is released; this heat can pose a safety risk to personnel and the environment. To manage exposure to high temperatures for personnel, the area immediately surrounding the flare stack is considered a 'sterile' area, where the surface is gravel to prevent vegetation from growing in the area, which could pose a fire hazard.

The height of the flare system will comply with the following thermal radiation limits provided in Table 11.

As the site is surrounded by trees, a potential concern that has been evaluated is high thermal radiation leading to a forest fire. A maximum radiation level of 5.0 kW/m<sup>2</sup> is allowed at the boundary of the sterile zone, which is significantly below the 25-30 kW/m<sup>2</sup> general guideline for spontaneous ignition of wood".

The issue of exposure of personnel to high flare radiation during work on the derrick structure was assessed (for the liquid burners, this is not a significant concern as personnel can be evacuated from the liquid burner structure prior to flaring event). The assessment reviewed expected maintenance activities and validated if the original heat shields were suitable to ensure personnel can conduct a safe escape from the flare area. It was determined that to ensure a safe escape is possible, a heat shield and a 75 metre covered walkway is needed. These were included as part of the design to ensure that the effective radiation does not result in a second-degree burn. However, any work in the flare sterile area will require additional personal protective equipment (PPE) to protect skin from thermal exposure if a flaring event occurs while personnel are in the area and would be covered through LNG Canada's Permit to work practice.

## 6.4. Noise

The operation of the flare can generate significant levels of noise as a result of the combustion process. Potential impacts from noise are assessed within the Project site (occupational) and offsite (nuisance).

#### 6.4.1. Impact to Personnel on Site

The flare design includes requirements to meet the following noise limits from the Project design criteria:

- Emergency Cases: 115 dBa at the working platform to limit exposure to personnel who may be in the area when an emergency scenario develops
- Normal operation including start-up/shutdown: 85 dBa at the edge of the sterile zone as personnel are not expected to be inside the sterile zone for planned activities such as start-up or shutdowns.

The current flare system complies with both of the above criteria, based on the noise data sheets issued by the vendor; however, due to the unpredictable nature of emergency events, whenever personnel are accessing the sterile area of the flare, double hearing protection will be required through the permit to work system as well as safety signage.

#### 6.4.2. Offsite Impact

Management of the impact of noise to the public is addressed through the BC OGC Noise Control Best Practice Guidelines. A Noise Study Report (L001-00000-HX-7180-2100) has been developed for the Project, where various operating scenarios were considered to determine the impact on key receptors in the Kitimat area, including noise generated from the flare system.

### 6.5. Light

Flaring from the Project will likely result in potential light impacts to the community, particularly during commissioning and early operations (a “sky glow”), prior to reaching steady state operations. This potential impact has been mitigated through the design of the flare system by incorporating minimal operational flaring. The Flaring Notification Plan will outline the requirements for providing notification to the community at least 24 hours before a planned flaring event, so they are aware of the upcoming potential light impacts.

### 6.6. Wildlife

The Wildlife Management Plan for operations will be developed in conformance with the EAC, and will outline the mitigation measures, including migratory bird timing windows, to reduce the risk of mortality and injury to birds during planned flaring events during operations, as feasible from a technical and safety perspective (refer to Table 4). Per the EAC Condition 12, the plan will be developed in consultation with ECCC, FLNR and the OGC; and engagement with Haisla Nation.

## 7. Continuous Venting Emissions

Details on the several of the streams associated with continuous venting will be provided in the waste discharge authorization application to the BC OGC; however an overview is provided herein.

### 7.1. Continuous Vent Emissions to Atmosphere

Hydrocarbon (methane) vapours have a much higher GWP than CO<sub>2</sub>. LNG Canada design has incorporated measures to minimize the venting of hydrocarbons to atmosphere. Small quantities from the following sources outlined in this Section from the process system, are vented to atmosphere.

#### Process Analyzers

To maintain control of the process and ensure product quality requirements are met, a number of streams are equipped with continuous analyzers. There are two main emission streams from the analyzers: a stream from the sample conditioning system and the exhaust stream from the analyzer itself. In some cases, the direct vents to atmosphere are equipped with catalytic oxidizer systems (TRACErase) to convert the residual hydrocarbon to CO<sub>2</sub> and water. In other cases, the stream is directly vented to the atmosphere.

For example, approximately 3 Sm<sup>3</sup>/hr of incinerator flue gas will be vented to the atmosphere, through the TRACErase.

#### Atmospheric Storage Tanks without vapour conservation facilities

As it is not practical to connect storage tanks to the flare system, storage tanks in the Project will vent directly to atmosphere during filling or during thermal outbreathing.

- Diesel, heat transfer fluid, amine, demineralized water storage tank venting to atmosphere during filling or thermal breathing: due to the low vapour pressure of the liquids, this vapour stream will primarily be nitrogen.
- Water storage tanks including wastewater will vent directly to atmosphere. This vapour stream will be air and water vapour.

#### Secondary Compressor Seal Vents

Compressor secondary seal vents are routed to atmosphere due to the low operating pressure; during normal operation this stream is nitrogen.

- Secondary seal gas to atmosphere (all main centrifugal compressors): during normal operation, this will be nitrogen; in the case of a failure of the secondary seal, hydrocarbons will be vented to atmosphere until the compressor is shut down and depressurized.

### 7.2. Unplanned Vent Emissions to Atmosphere

The following are unplanned sources of hydrocarbon that could vent to atmosphere:

- Any LNG tank relief valve lifting (pressure relief valves or reserve capacity relief valves, which are on top of the LNG tank (refer to Figure 10 and Figure 11).
- Loss of both condensate tank vapour recovery blowers or vapour recovery chiller package. Due to inability to direct this stream elsewhere, the vapours from the tank will be vented to atmosphere via the pressure control valve. Note, that as the condensate is stabilized, not expected to vent to atmosphere.
- Pressure relieve valve lifting on condensate system (main tank, vapour recovery).
- Fugitive emissions on valve gland packings, flanges, instrument connections and relief valves routed to atmosphere; these sources would be monitored as part of LNG Canada's fugitive emission monitoring program

(note, a Fugitive Emissions Management Plan will be developed for the Project in conformance with LNGFR, Section 8(1)(c)).

- Depressurizing of equipment to atmosphere; generally, the equipment is purged to the flare with nitrogen to displace any hydrocarbons; however, a small residual amount would exist that is depressurized to atmosphere as part of the isolation process.



**Figure 10 Example of LNG Tank Pressure Relief Valve**



**Figure 11 Example of LNG Tank Reserve Capacity Valve**

## 8. Continuous Flaring Emissions

Details on the specific streams associated with continuous flaring will be provided in the waste discharge authorization application to the BC OGC; however an overview is provided herein (the pre-application package submitted to the OGC in November 2020 included the maximum discharge rates for normal operations for each flare and the liquid burners).

### 8.1. Flare Pilot

During normal operations, fuel gas is combusted in the flare pilots as pilot gas. The pilots are designed to provide a continuous ignition source, such that any gas sent to the flare as a result of upset conditions is immediately combusted. The pilot flare is a small, smokeless flame, which emits minor quantities of carbon dioxide, nitrogen oxides and water vapour.

The flame is typically about 30 cm long (refer to Figure 12 for example). Generally, the flame from the pilots is difficult to see but may be visible during nighttime. During daytime, the flame is difficult to see at any distance.



Figure 12 Example of Flame Pilot Light

There are four pilots per vapour flare and a dedicated pilot per liquid burner. The design volume of pilot gas used per pilot is 2.17 Nm<sup>3</sup>/hr; for the full system this is 54.25 Nm<sup>3</sup>/hr.

Note: As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#) section 4.4.9.1-5), pilot gas is considered as flared gas, not fuel gas.

### 8.2. Compressor Seal Gas

A small amount of process gas mixed with nitrogen is always sent to the flare through the centrifugal compressor primary seal vents as part of the seal design to contain the process gas. For example, approximately 18 Sm<sup>3</sup>/hr of seal gas is expected from PMR compressor string A.

The centrifugal compressors for the Project also have a secondary seal containing nitrogen, which is vented to atmosphere. If the primary seal fails in the compressor, this will be detected by the increased flow and the compressor will trip and depressurize automatically to minimize any release of process gas to atmosphere.

### 8.3. Analyzer Sample Returns

Process monitoring is conducted via online analyzers, with a number of the analyzer sample conditioning systems venting excess hydrocarbon to the flare system.



For example, approximately 0.02 m<sup>3</sup>/hr of gas between from the PMR compressor to the PMR Desuperheater will be vented to the cold flare.

#### 8.4. Continuous passing valves

All valves have acceptable leakage rates when in the closed position. Due to the number of valves connected to the system this will lead a small continuous flow of hydrocarbon to flare. The overall flow has been reduced due to incorporating closed isolation blinds in the piping.

#### 8.5. Flare Purges

The vapour flares are continuously purged to avoid air ingress in the system and potential deflagration inside the flare system. As the liquid burners do not have any continuous sources, these burners are only purged immediately after combustion to remove any residual liquid in the system.

In older facilities, fuel gas was used for flare purges, which had a GHG impact. For the Project to reduce GHG emissions, all flare headers are continuously purged with nitrogen instead of fuel gas. For example, the warm flare nitrogen purge is approximately 50 Sm<sup>3</sup>/hr, where the fuel gas purge is approximately 280 Sm<sup>3</sup>/hr. Utilizing nitrogen will save approximately 5,500 km<sup>3</sup>/year of continuous flaring. During periods where nitrogen may not be available to purge the flare headers, alternative fuel gas connections are available to ensure a purge is always available.

The required purge volume is set either to maintain a velocity through the flare header when fouling is possible or to maintain a minimum purge volume to the flare tip to prevent ingress of air. For the Project, as there is no fouling fluids, the flare header purge is set to satisfy the required purge from the flare vendor. Each purge gas has its own differential orifice plate flow meter with accuracy typically better than 5%.

#### 8.6. Continuous Incinerator Emissions

The acid gas thermal oxidizer is used primarily to incinerate acid gas from the amine regenerator; this acid gas stream contains primarily CO<sub>2</sub> (approximately 90%), H<sub>2</sub>S (approximately 0.2%) and hydrocarbons (including BTEX) (approximately 7%) with the balance as water vapour. The acid gas incinerators in LNG Train 1 and 2 will also receive non-condensable gas from the condensate storage tanks when the tank vapour recovery unit is in operation; this stream is primarily nitrogen (approximately 89%) with the balance being hydrocarbons. These streams do not have sufficient heating value to sustain combustion; as such, fuel gas is used in the incinerator to generate sufficient heat for oxidation of these streams prior to release to atmosphere. With the high operating temperature and residence time of the incinerator, a combustion efficiency of 99.99% for BTEX components is expected.

In case of a thermal oxidizer trip, the overheads are routed instead to the warm flare, and fuel gas is added to the flare to meet the 20 MJ/sm<sup>3</sup> heat content minimum requirement.

**Note:** As part of [OGC Measurement Guideline for Upstream Oil and Gas Operations](#) section 1.7.2.5, fuel gas added to the incinerator or the flare due to the low heating value of the stream is considered fuel gas and not flared gas.

## 9. Commissioning Flaring Activities

*PLACEHOLDER - This section will contain details of the flaring activities during Commissioning. This will include the general steps for Commissioning activities (that relate to flaring activities) including anticipated volumes, timelines and assumptions.*

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## 10. Early Operations Flaring Activities

*PLACEHOLDER - This section will contain details of the flaring activities during Early Operations. This will include the general steps for Early Operations activities (that relate to flaring activities) including anticipated volumes, timelines and assumptions.*

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# 11. Planned Flaring Activities During Normal Operation and Turnaround

In general, due to the design of the flare system, routine flaring for maintenance or turnaround would not result in any impact to ambient air quality objectives (addressed through the permitting process); however, it may result in potential light impacts as well as an increase in sound levels due to the requirement to purge the equipment in the plant and to flare gas during start-up until the plant is performing at specification.

## 11.1. LNG Train Turnaround

There are two main types of planned shutdowns based on a 6-year turnaround cycle for the molecular sieve beds (refer to Table 14 for example of schedule):

1. **Boroscopying of each aeroderivative gas turbine:** it is needed every year. However, with parallel 50% strings, this can be performed with the LNG train operating at reduced rates preventing any continuous flaring or start-up/shutdown flaring. Nevertheless, some de-pressurizing and purging may be required to create a safe working environment.
2. **Planned turnarounds:** a turnaround is a major event where an entire LNG train is taken offline for equipment inspection and catalyst replacement (note, other equipment in the common facilities such as feed gas pre-heaters, feed gas filters etc. may also be taken offline at the same time to utilize the opportunity and will add to the de-inventory volume). Initially, a first turnaround is scheduled out of sequence to allow for any changes or repairs due to issues identified during commissioning and start-up. Afterwards, the individual train turnarounds are scheduled every 3 years alternating between a minor (approximately 14 days) or a major (approximately 20 days) turnaround. A sample schedule is shown in Table 14.

**Table 14: Example Turnaround Schedule – Days Outage (6 year cycle)**

| Shutdown Activity | Yr 0 | Yr 1 | Yr 2 | Yr 3 | Yr 4 | Yr 5 | Yr 6 |
|-------------------|------|------|------|------|------|------|------|
| String Boroscope  |      |      | 4    |      | 4    | 4    |      |
| Turnaround        |      | 14   |      | 14   |      |      | 20   |

Planned Turnarounds will occur in a single LNG train at a time and will require de-energizing and de-inventorying of the hydrocarbon in the LNG train to allow for safe inspection by LNG Canada Maintenance. This will entail flaring for de-inventorying and purging, as well as during LNG Train restart. To maximize the amount of refrigerant recovered during this activity, the ability to recover PMR has been included in the design of the facility. The PMR circuit can be de-inventoried to the PMR Storage Tank to reduce the flare volume as well as reduce the time required to start the LNG train. Likewise, in preparation for shutdown, the MR circuit can be lowered by directing MR to the stabilization unit. The level in the stabilizer will be displaced to the storage tank via pressure in the column to minimize remaining liquids that would need to be disposed of via the liquid burners.

Once the LNG train is depressurized to flare, the remaining hydrocarbons will be displaced with nitrogen to achieve a safe working environment to allow installation of blinds and equipment to be opened. During this purge step, assist gas will be added to the flares to maintain the lower heating value above 20 MJ/m<sup>3</sup>; this is expected to take between 12 to 24 hours.

#### 11.1.1. Restart from Turnaround

After a turnaround, the LNG train will first be inerted with nitrogen to remove any air from the system and partially dry out the unit. At this point, the amine unit will be inventoried from tankage and natural gas will be inventoried into the train to displace the nitrogen. Once the nitrogen is displaced, dried natural gas (de-frost gas) from an online LNG train will be introduced to dry the LNG train to specification to allow inventorying of the refrigerant, which is expected to take approximately one day and result in approximately 1500 Te of gas flared. After the LNG train has been dried, refrigerant will be inventoried in the liquification unit and the feed gas will be introduced into the LNG train and flared through the various units until they are on specification.

Initially, once feed gas is introduced, it will be flared via the warm wet flare from the outlet of the amine absorber until confirmed to be on-specification for CO<sub>2</sub>. This is estimated to take approximately up to 12 hours.

In the case that the molecular sieve has been replaced, it has to be regenerated to remove atmospheric moisture; this will require approximately two additional days of flaring at the minimum design throughput. The mercury bed will also require replacement through the life of the facility and will require additional flaring to dry the bed out. It is expected this replacement would occur approximately every 8 to 10 years depending on the mercury content of the feed gas to the facility.

Once the molecular sieve unit is confirmed on-spec, the gas can be introduced into the liquification unit and the system can start cooling down. Initially, it will be cooled to -50°C, where the gas off the flash vessel will be confirmed to be on-specification for heavier hydrocarbon (C<sub>5</sub>+) content after which the rest of the liquification will be cooled down until on spec for routing to the LNG tank. It is estimated to take between 24 to 36 hours from start of cooldown to LNG production.

The stabilizer column will initially be inventoried from the stabilized condensate header to tankage, which will allow this column to be warm and operating once C<sub>5</sub>+ feed is available from the flash vessel. Minor flaring from the column will occur until the stabilizer compressors are able to be started to recycle this stream back to the liquification section.

### 11.2. De-inerting of LNG Carriers

The vapour returned to the LNG storage tanks has a CO<sub>2</sub> specification of less than 50 parts per million (ppm) CO<sub>2</sub> to prevent hydrate formation in the system. When LNG carriers arrive from dry dock, the storage tanks are usually inerted with CO<sub>2</sub> or Nitrogen; prior to loading, these tanks need to be de-inerted and cooled down. During the de-inerting process, the vapour return is sent to low pressure flare until confirmation that CO<sub>2</sub> specifications have been met. Upon confirmation, the vapour is then routed to the storage tank and BOG compressors.

The ships requiring de-inerting are planned in advance as part of the yearly delivery plan. A LNG carrier requiring de-inerting requires approximately 3 times the LNG carrier volume to be flared (approximately 3 x 150 000 m<sup>3</sup>). During this time, assist gas is added to the flare to ensure the minimum heating value is maintained. A dedicated fuel gas line ("dilution gas") at the bottom of the Storage and Loading Flare is provided. It is metered as fuel gas at 62FI300 (Ultrasonic, P&T compensated) through an automatic hand controller (62HIC300).

De-inerting and cooldown of the ships tanks is expected to take approximately 24 hours before normal loading can begin.

### 11.3. Adjustment of PMR Composition at PMR Reclaimer

High levels of non-condensable gases (methane/ nitrogen) in the refrigerant circuit will significantly impact plant production and efficiency due to the condensing pressure increasing. To return to normal performance, the non-condensable gas will need to be purged from the refrigerant system. This is normally done by venting the non-condensable gases through the PMR reclaimer condenser. The reclaimer re-condenses the refrigerant and recycles light ends mostly to high pressure (HP) MR accumulator. The non-condensable are then sent to the stabilization unit

for reprocessing within the process, but during abnormal situations this stream may be sent directly to flare if required for process considerations.

#### **11.4. Adjustment of MR composition at HP MR Separation Vessel**

Similar to the adjustment of the PMR composition, the MR composition must be carefully adjusted in the MR refrigerant circuit as it can significantly impact plant production and efficiency due to the degradation of thermal approaches in the cryogenic system. The MR composition is adjusted at the HP MR separation vessel.

- Liquid purge from the HP MR separation vessel will be recycled to the condensate and stabilisation unit inlet with no flaring
- Vapour purge from HP MR separation vessel will be recycled to top of the stabiliser overhead compressor with no flaring

In abnormal situations, adjustment of the composition may be done by directing the vapour from the drum to flare.

#### **11.5. Refrigerant Production Unit (RPU) Turnaround**

The ethane and propane refrigerant are slowly and gradually lost due to compressor primary seal gas venting, maintenance of refrigerant containing equipment, refrigerant composition adjustment (MR and PMR), etc.

It is expected that the RPU will be needed to be started twice per year for a two to three week period each time to produce ethane and propane refrigerants until storage is full before shutting down and de-inventorizing again.

The unit can be filled and then reliably started at design throughput of 73 t/h.

The following start-up lines are further installed to reduce flaring during RPU start-up:

- De-ethanizer column ethane vapour import from refrigerant storage
- De-ethanizer reflux ethane liquid import from refrigerant storage
- De-propanizer column propane vapour import from refrigerant storage
- De-propanizer reflux propane liquid import from refrigerant storage

Additionally, during RPU operation:

- Gas overheads from de-ethanizer and de-propanizer are recycled to LNG Tank
- De-propanizer bottoms liquids are always recycled to natural gas stream
- Gas overheads from de-methanizer are recycled to natural gas stream.

Therefore, the flaring once the RPU is operational will be limited to cooldown of the unit expander generator, columns, and cryogenic pumps.

Each campaign will last about two to three weeks until each spheres are full. When the campaign is finished, it is planned to de-inventorize the unit and to preserve it under nitrogen. This may be changed to full recycle at full build out (four trains running).

The de-inventorization for preservation involves about 130 m<sup>3</sup> of equipment with an average gas pressure of 50 kPa or approximately 2 tonnes of gas to be flared to the Cold Dry Flare. The liquid bottoms, after lowering the levels, represent less than 10 tonnes, which need to be flared to the dry Cold liquid burners mostly with the exception of the de-propanizer bottoms, which are burned via the Warm liquid burners.

## **11.6. Relief Valve Inspection and Overhaul**

The plant comprises about 400 installed Relief Valves for about 300 systems. Initially, they will be inspected every 18 months. Then, they may be inspected on a variable testing frequency, depending on Risk Based Inspection study outcome. Most have spare positions or even an installed spare allowing for inspection while the train and the equipment are running.

For example, de-inventorizing four meters of 4" diameter piping represents 20 to 30 litres with an average density of 50 kg/m<sup>3</sup> therefore 1 kg/relief valve. This represents overall venting of approximately 500 kg over a six year cycle.

## **11.7. Routine Maintenance Activities**

Individual equipment requiring on-line servicing needs de-inventorization before safe maintenance can be allowed. During re-commissioning it requires gas-in and sometimes cooldown. Volume is usually small but could exceed the 10,000 m<sup>3</sup> threshold.

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## 12. Unplanned Flaring Activities

Unplanned flaring can occur at any time as a result of an upset condition in the facility. During an unplanned flaring event, operations will first undertake any actions to stabilize the plant operation, which could include slowing down production or shutting down the facility. After the facility is stable, operations will undertake troubleshooting or steps to return the equipment back to service if it is safe to do so.

As per the FVRG, if the equipment cannot be readily returned to service within 4 hours operations will undertake actions to reduce facility throughput to minimum turndown if required to reduce flaring. The guideline directs to reduce the throughput by 75% of the average daily volume over the preceding 30 days; however, Project equipment has a design minimum turndown of 50% for the equipment in the facility and this will limit the facility turndown to 50% as allowed by the guideline.

Once the return to service date has been determined by engineering and/or maintenance for equipment requiring repair; LNG Canada Production scheduling will optimize the production plan and LNG Carrier arrival within any pre-existing limits to minimize flaring while minimizing economic loss.

LNG Canada will investigate and correct causes of repeated non-routine flaring, incinerating or venting as part of continuous improvement.

As required by 3.6 of the FVRG, a written exceedance report must be submitted to BC OGC when a 6 or more major flaring event occurs within a rolling six-month period (6-in-6).

- For LNG Canada a major flaring event will be a flared volume of 100,000 m<sup>3</sup> or more. Each day that the threshold is exceeded will be considered an event (i.e. greater than 100,000 m<sup>3</sup> per day flared for three days will be considered three events).
- When the daily flared volume is less than 100,000 m<sup>3</sup>/d but the event leads to continuous flaring over multiple days it will be considered a major event when it exceeds 100,000 m<sup>3</sup> (i.e. flaring for four days at 25,000 m<sup>3</sup> per day will be considered a major flaring event after four days).

The written exceedance report will contain at minimum:

- The report must provide data on all flaring events (volume and duration) for the consecutive (rolling) six-month period in question and their possible causes
- The report must also propose a plan and corresponding timeline for implementing corrective actions to ensure that frequent major non-routine flaring does not recur
- Permit holders must expedite schedules for implementing the corrective actions
- After the plan implementation date, the commission may take enforcement action if another exceedance of the 6-in-6 criterion occurs within 24 months.

Major causes of unplanned flaring events are outlined the below section.

### 12.1. Unplanned equipment failure or repair

Not all equipment in the LNG facility has an installed spare, as such the failure of single piece of equipment can lead to flaring while the process is stabilized, and equipment will need to be de-inventorized before safe maintenance can be allowed. The volume is usually small but could exceed 10,000 m<sup>3</sup> threshold for notification when considering nitrogen purging activities required to provide a safe working environment.

## 12.2. Flash Gas Compressor Trip

The Flash Gas Compressor is used to recover gas absorbed in high pressure amine absorber bottoms and let down in the amine flash vessel. This stream is normally recycled to inlet amine treating. Whenever the flash gas compressor trips, the flash gas is diverted to the Warm Wet Flare.

The duration of flaring can be variable depending on cause of incident. Flaring will take place until such time that the Flash gas compressor is returned to service; the expected flow is approximately 2,200 Sm<sup>3</sup>/hr and is expected to be smokeless based on the composition and volume.

Since the flash gas generated is related to the amine circulation rate, as the amine enters the flash vessel saturated with hydrocarbon, in order to reduce flare volume, the amine circulation rate needs to be reduced. Operations will reduce the amine circulation rate and associated feed gas rate until either the amine is at minimum turndown or the feed gas is at minimum turndown.

## 12.3. Acid Gas Thermal Oxidizer Trip

The acid gas thermal oxidizer is used to thermally oxidize acid gas coming from acid gas regenerator overheads. The stream consists of CO<sub>2</sub>, water vapour, some entrained hydrocarbons (approximately 54%) and a small amount of H<sub>2</sub>S (less than 0.2% typically). The incinerator may also oxidize a non-condensable stream from the condensate storage tank which is typically approximately 89% nitrogen with the balance as light hydrocarbon. This stream is not rich enough to be combustible and is incinerated together with assist fuel gas and sufficient excess air to oxidize the H<sub>2</sub>S and hydrocarbons into SO<sub>x</sub> and CO<sub>2</sub>, and water while the CO<sub>2</sub> undergoes no further oxidation and is released to atmosphere.

In case of thermal oxidizer trip, the overheads from the amine regenerator and the condensate storage tank will be routed to the Warm Flare instead of being vented directly to atmosphere, which occurs in other LNG plants. The amount routed to flare is approximately 26,444 Nm<sup>3</sup>/hr and is expected to have smokeless combustion and depends on the CO<sub>2</sub> content of the feed gas. Fuel gas is added to the flare to meet the minimum heating value requirement via fuel gas controller at Warm Flare Knock-out drum. The control scheme makes use of last known values of flow indication and Lower Heating Content from analyzer before the incinerator trip. During this time the non-condensable stream has the option to be routed to the other LNG train if available.

Reliability of thermal oxidizer is typically high after commissioning and start-up with planned maintenance occurring during LNG train turnarounds when the upstream amine regenerator is offline.

The duration of flaring can be variable depending on cause of incident, which may be a few hours in the case of an instrument malfunction to longer duration in the case of refractory damage. If operations are unable to restart the incinerator, the feed gas flow the LNG train will be reduced to minimum turndown to minimize the amount of acid gas routed to flare.

## 12.4. Regeneration Gas Compressor Trip

The Regeneration Gas Compressor is used to recover natural gas used for regeneration of the molecular sieve drier beds which remove water from the feed gas prior to liquification. The Regeneration gas compressor circulates gas through the beds to regenerate the molecular sieves for service based on a described cycle. This is a requirement prior to liquefaction.

Whenever the centrifugal regeneration gas compressor trips, gas is diverted to the Warm Wet Flare during the regeneration cycle. The expected flaring volume is 66,000 Nm<sup>3</sup>/hr during regeneration, with the flare design this is expected to be smokeless combustion. The regeneration compressor does not have the capability to be restarted from settle out pressure but will require depressurization to suction conditions; however, this is a small volume of hydrocarbon as the pressure differential across the compressor is small.

In this case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

In case of a long-term compressor outage, as the regeneration cycle is strictly based on time, facility throughput will not be reduced as this action would have no impact on flared gas volumes.

## **12.5. Gas Turbine Compressor Trips**

Gas Turbine Compressors are critical to the liquefaction process. These systems form part of the refrigerant loops which chill feed gas, leading to liquefaction. When any compressor or its driver malfunctions, they will automatically be stopped by the control system. Each LNG train has parallel compressor strings allowing approximately 50% production while one compressor train is shutdown. During the transition to minimum rates after a compressor trip minor flaring may occur to prevent the loss of a single compressor from cascading to a larger upset.

In other LNG facilities, the compressors will require to be depressurized prior to restart; in the case of this Project, the compressors can restart from settle out pressure, which removes the requirement to depressurize the compressors prior to restart.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## **12.6. Main Cryogenic Heat Exchanger (MCHE) Trip**

In case that the MCHE trips as a result of instrument malfunction or exceedance of the design operating window, the LNG production immediately stops, and the gas flow to the facility is automatically reduced at the inlet station with minimal flaring or over pressuring of the downstream piping. The refrigerant compressors will remain in operation under full recycle until the MCHE can be restarted.

After a few hours, the refrigerant present in the MCHE shell and tubes will start warming up and pressure will increase requiring the pressure to be relieved to the flare system to prevent overpressure of the MCHE.

Upon restart of MCHE, the cold vapour gas or LNG must be flared through the cold vapour flare and then liquid burners at approximately 35% production rate until the rundown temperature is low enough to be routed to the LNG storage tank. The equipment has a cooldown limit of approximately 30 °C per hour, which dictates the time required to route the LNG to the flare system until it can be routed to the LNG storage tank. In the case of a short trip, it is expected that flaring will occur for one to three hours.

Flaring of this stream through both the cold flare and liquid burners is expected to be smokeless.

## **12.7. Condensate Stabilizer Overheads Compressor Trip**

C5+ contained in the Feed gas would freeze in MCHE and need to be extracted in C5+ flash vessel before entering MCHE. The bottoms of the flash vessel containing LPG and the C5+ is sent to condensate stabilization unit for further processing. The overheads (light ends) are recycled back to MCHE via condensate stabilizer overhead compressors while the stabilized condensate bottoms are sent to an atmospheric storage tank prior to being loaded into rail cars.

The concentration of C5+ material in the feed gas will dictate if both compressors are required or if one is required for the load. In the case of lean feed gas, a single compressor trip will not result in any significant flaring as the second compressor will be available to be started and loaded. When the gas is heavier, both compressors are required to be in service and a loss of one compressor will result in some level of flaring. For the extreme rich gas case, this will result in approximately 69,000 m<sup>3</sup>/hr for a single compressor trip and approximately 138,000 m<sup>3</sup>/hr for both compressors tripping. This stream is expected to achieve smokeless combustion in the flare.

In the case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

This stream is not expected to produce black smoke with the current flare design as it is a guarantee case for Ringlemann 0 combustion. However, to reduce flaring volume overall, throughput of the LNG train would be reduced until the available compression can manage the gas volume or the LNG train reaches minimum turndown.



## 12.8. Residue Vapour Compressor Trip

During periods of time when the RPU is online, the overhead gas from the de-methanizer column and excess refrigerant is recompressed in the residue vapour compressor and recycled back the LNG train for liquefaction. In the case of a residue vapour compressor trip, this stream will be routed to flare until such time that the compressor is restarted, or RPU is shutdown. The flaring would be approximately 100,000 m<sup>3</sup>/hr from this system. If the compressor is unable to be started within four hours, the RPU would be shut down to stop flaring. This stream is expected to achieve smokeless combustion in the flare.

In this case of a leak or seal damage, the compressor will be depressurized to flare to minimize the risk to personnel.

## 12.9. Condensate Storage Tank Vapour Recovery Unit Trip

During normal operations, the non-condensable vapour from the condensate storage tank is routed to the incinerators in either LNG Train 1 or 2 for combustion. When the condensate chiller package is offline, this stream cannot be recovered and will lead to venting from the condensate storage tank until the package is repaired. A loss of a single condensate blower can also lead to intermediate venting from the condensate storage tank until it can be repaired.

This stream is generally nitrogen that is displaced while the tank is filling and evaporation of the condensate in the tank. The facility throughput will not be reduced in this case as the stream is not expected to cause offsite concerns or environmental hazards.

## 12.10. Boil-off Gas Compressor Trips

The LNG under slight pressure runs down from the Trains to the near atmospheric LNG Tank where it flashes at -161°C. Two centrifugal BOG compressors are used to recompress the flashed gas and natural boil off from cryogenic LNG tank, loading lines and LNG carrier loading. This stream is utilized as fuel gas in the high-pressure fuel gas network. Excess gas beyond what is required for the fuel gas demand for the plant is recycled to the inlet facility and reprocessed through the plant eliminating flaring which would otherwise have occurred.

The duration of a compressor outage from a trip can be from one to three hours to multiple weeks depending on whether the compressor has suffered damage and requires repair prior to restart.

### 12.10.1. Holding Mode

The LNG facility will be operating in holding mode approximately two thirds of the time; in this mode the LNG tank is filling from the LNG trains, and LNG carriers are not loading. During this time, a single BOG compressor can handle approximately 80% of the gas generated from the tank. A loss of both compressors would lead to flaring of approximately 103,000 m<sup>3</sup>/hr while the plant is in holding mode until the compressor can be repaired and returned to service. This stream is expected to achieve smokeless combustion in the flare.

To reduce the amount of BOG generated during this mode of operation, the liquefaction unit operating mode can be adjusted to further sub-cool the LNG rundown to the tank leading to reduced production or overall LNG production can be reduced to meet the capacity of a single compressor.

### 12.10.2. Loading Mode

During LNG carrier loading, the carrier is initially cooled down over three hours leading to an increase in BOG generation and subsequent flaring. During this time, cooldown can be slowed to reduce the amount of excess BOG generated as part of this step. Due to the relatively short duration over which this flaring is expected to occur, LNG production would not be reduced further than is required during holding mode.

Once bulk LNG loading has commenced, a single compressor is expected to be able to handle the gas generated while the LNG carrier is loaded.

## 12.11. Condensate Stabilizer Unit Trip or Off-Spec Condensate

In case of off-spec condensate, or upset in the condensate stabilization unit, there is limited buffer volume from C5+ flash vessel. This stream will be routed to the liquid burners until the plant can recover. To prevent the formation of smoke, assist gas will be used to help entrain additional air into the atomized condensate stream to promote smokeless combustion.

If operations are unable to bring the condensate stabilization unit back to specification to stop flaring, the overall production would need to be reduced until the stream is meeting specification or the LNG train would be shutdown.

## 12.12. Flaring Due to Off-Spec Products

In general, LNG plants are not equipped to tolerate off-spec production through the normal product handling systems; in the case of LNG Canada, because both condensate and LNG are stored in one tank only for phase 1 there is no capacity to manage an off-spec final product stream.

The following potential off-spec conditions may result in short term flaring while the process is returned to normal:

- Off-spec natural gas with too much C5+
- Off-spec LNG rundown
- Off-spec sweet gas from AGR (greater than 50 parts per million volume (ppmv) CO<sub>2</sub>)
- Off-spec sweet gas from the driers (greater than 1 ppmv water)

Except for off-spec C5+ material, the current flare system is expected to achieve smokeless performance for these streams. The C5+ material performance will depend on how much C5+ material is in the stream and how much BOG is available to dilute the stream to achieve smokeless performance.

## 13. Emergencies

"Emergency" is defined through the BC Emergency Management Regulation. As related to LNG Canada operation, emergency will be defined as an earthquake event, malicious act, equipment failure or loss that can lead to a liquid or gas release potentially impacting personnel or the environment.

As defined in the Facility permit: *"Emergency Conditions: involve activation of facility safety systems that could lead to emergency flaring. Emergency flaring occurs when safety controls within the LNG facility are enacted to depressurize equipment to avoid possible injury or property loss resulting from explosion, fire or catastrophic equipment failure"*.

### 13.1. Emergency Depressurization

During an emergency event, LNG Canada operations will initiate the emergency shutdown functionality designed in the plant to stop process flow and sectionalize the hydrocarbon containing equipment. If a release is occurring or likely to occur, LNG Canada operations will depressurize the impacted equipment to the flare system.

There are blowdown valves for per train, grouped in several areas, and for Refrigerant/BOG/Inlet.

Depending on the zone affected and scenario, the depressurization could reach 1000 to 1700 t/h for Warm Flare and 1350 t/h for the Cold Flare (largest peak flow rate for zone depressurizing). The flame may reach 100 meters in height. The expected duration of flaring in this scenario is one to three hours depending on the number of sections that require depressurizing.

### 13.2. Extended Electrical Black Out

In case of an extended electrical black-out of the LNG facility from either a loss of BC Hydro supply to site or major infrastructure damage, initially the facility will trip and minor flaring will occur from the BOG generated from the LNG storage tank, but as the plant begins to warm up and refrigerant vapourize, the facility pressure will be managed by directing hydrocarbon to flare.

In the case of an extended power outage where the onsite emergency power generation is not available, the plant will be proactively depressurized for safety reasons before the Uninterrupted Power Supply required to control the blowdown is depleted. Two trains will start being depressurized in a staggered way to avoid overloading the flare. Flaring flows for each flare (Warm, Cold, Storage and Loading) will typically last 90 to 120 minutes.

## 14. Measurement, Monitoring, Notification and Reporting

### 14.1. Flaring Measurement

The Project will use the BC OGC Measurement Guideline for measurement of flared volumes through Petrinex reporting system monthly.

Flaring is metered via Ultrasonic (US) flowmeters on each common Flare header (F-WW, F-CD, F-LP, Liquid dry, liquid burner warm and cold) and on each individual train flare header to allow swift identification and proper accounting of flared gases. Ultrasonic flowmeters have measurement turndown of 1:1000 and accuracy of 6%. Furthermore, for LNG Canada, the range chosen is 0 to 30% of the maximum flow rate, which captures 99.9% of the flaring for better accuracy.

Dilution gas is added during LNG carrier de-inerting and acid gas flaring to maintain 20 MJ/m<sup>3</sup> lower heating value of the flared gas to ensure combustion efficiency (refer to Table 15).

**Table 15: Flaring Measurements – Fuel Gas**

| Operation               | Flow indication            | Fluid       | type    | Location                 |
|-------------------------|----------------------------|-------------|---------|--------------------------|
| LNG carrier de-inerting | 62FI300, P & T compensated | MP Fuel Gas | US type | Warm Flare knockout drum |
| Acid gas flaring        | 62FC101, P & T compensated | MP Fuel Gas | US type | F-LP bottom              |

### 14.2. Flow Meter Maintenance and Calibration

The Central Control Room panel operator pro-actively monitors flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator.

#### 14.2.1. Corrective Maintenance

Corrective maintenance will take place when a mismeasurement happened to be observed. A mismeasurement is defined as an inaccurate or incorrect measurement that is more than the accuracy of the device stipulated by the manufacturer.

The evidence or manifest of mismeasurement could be as follows:

- Observed during the calibration, part of preventive maintenance activities;
- Difference in reading observed by the Operation referring to other process parameters;
- Determined by the Technology Team during the daily mass balance activity; or
- Self-diagnosis by the smartness of the device and manifested as alert or fault.

Once the mismeasurement is observed or notified, immediate corrective action will be taken within 24 hours. The device(s) shall be calibrated to bring the error with-in the accuracy using the Project test equipment that is certified by Measurement Canada accredited laboratory. All the Project test equipment will be calibrated and recertified each year by the Measurement Canada accredited laboratory.

#### 14.2.2. Preventive Maintenance

All the measuring devices shall go through the process of a risk-based approach of evaluation called Reliability Centred Maintenance ("RCM"), which include the regulatory requirements. The outcome of the RCM study will dictate the test frequency and method of test to meet requirements. Based on the RCM study, automated maintenance notice/workorders are generated and Maintenance Team shall complete the preventive maintenance task within stipulated time frame.

### 14.3. Monitoring

The panel operator will proactively monitor flaring as part of panel routine screening and proactive communications between Utility and the LNG trains panel operator

Flaring can be detected and monitored through:

- Closed circuit TV in the control room for 24 hours a day, 7 days a week monitoring of flare performance
- Proactive monitoring target sheets, which capture all streams to flare for any abnormal conditions
- Alarm on some controlled streams to flared (valve not closed status)
- Proactive Technical Monitoring set-up for the flaring system to monitor the any abnormalities in the flare system

### 14.4. Flare Checks

As described through this report, there are many connections to the flare system. The indication of an unknown passing valve to the flare system can be identified by operations as a visible flame or as a measurable increase in flow to the flare system not related to the continuous flare header purges. Operations will begin systematic flare checks throughout the facility to identify the passing valves to the flare system. In situations where the flow is small and unable to be detected readily by operations, additional resources may be used to check for passing valves utilizing ultrasonic flow measurement across valves.

Once a passing valve has been identified, a maintenance notification will be raised, and the valve repaired at the next opportunity.

### 14.5. Internal Reporting

Internal Reporting of flaring activities is required and will be documented through the shift log at a minimum. For flaring related to incidents, this will occur through the Project's incident reporting system. In case of no flaring incident, the flare section of the shift log will mention "nothing to report."

LNG Canada operations team will escalate any flaring event to the Shift superintendent upon emission of black smoke, exceeding 10,000 m<sup>3</sup> or a duration of four hours to initiate the flare notification process.

Initial detection can be identified via the following means:

- Equipment trip
- Visual from outside operator
- Pro-active monitoring
- Closed circuit TV
- Some alarms in case of controllers to flare open (non-closed status)

In case of a small amount of flaring, the panel operator can quickly zoom in, if required, on which header is the source of flaring, as each LNG Train flare header has its dedicated thermal flowmeter, upstream of the common flare headers described previously.

The following information must be captured within the shift log:

- Time flaring commenced and ended
- If black smoke was observed or if operations believe R0 performance was not achieved due to visible smoke emission

- Specific cause of flaring
- Estimated quantity and maximum flow
- Actions taken to minimize flaring or prevent similar events from reoccurring

This information will be used as part of the accounting and reporting process for flare emissions and made available to BC OGC upon request.

## **14.6. Response to Public Concern Related to Flaring**

The Project will investigate all public complaints and ensure they are responded to accordingly. Public complaints will be logged with the following information as per the FVRG.

In the event of a community complaint or request from the BC OGC, the Project is required to undertake monitoring as specified by BC OGC, which will be coordinated by the Environment Lead.

Logs must include:

- Complaint Name and contact information
- Company representative assigned to investigate and follow up with complainant
- Commission representative contacted
- If the complaint was resolved

## **14.7. External Notification and Reporting**

As outlined in the LNGFP and Flaring Notification Plan, Haisla Nation, residents within one kilometer, Regional District of Kitimat-Stikine, the District of Kitimat will be notified at least 24 hours prior to a planned flaring event and within 24 hours of a flaring event where the quantity of gas exceeds 10,000 m<sup>3</sup> or the duration exceeds four hours. In addition, where an LNG Carrier is to be de-inerted at the facility, LNG Canada will provide at least 24 hours of notice to BC OGC via email as outlined in the Facility Permit. Note, continuous activities, such as combustion for flare pilot lights or incinerators are excluded from the notification requirement.

Reporting on monitoring undertaken in response to complaints or specific direction of the BC OGC will be provided upon request.

Monthly reporting of flared volumes will be completed via Petrinex system.

## **14.8. Daily Plant Mass Balancing Reconciliation and Monthly Reporting**

The flare losses are included in the facility mass balance reconciliation which is monitored through proactive technical monitoring and reported monthly. The flow meters will be utilized in determining the maximum uncertainty of monthly volume as outlined in the BC OGC Measurement Guideline.

Flare losses are tracked as part of proactive monitoring to track weekly, monthly and yearly performance. The target for LNG Canada is 0.3 wt.% flare losses of the total feed gas to the facility after the initial commissioning phase. This exercise allows LNG Canada to prepare the activity of monthly reporting as required by the regulation.

An annual Monitoring Report will be prepared by LNG Canada Environmental Team and submitted to the BC OGC.

## 15. Continuous Improvement, Review and Auditing

LNG Canada will maintain an Environmental Management System (EMS) in accordance with the international standard ISO 14001, which will include auditing of the facility flaring. The EMS must be regularly audited to ensure its continuing suitability, adequacy and effectiveness, as well as to meet LNG Canada's commitment to continual improvement.

Strategies for continuous improvement may include the following aspects:

- Flare performance reported as part of proactive technical monitoring performed by the LNG Canada Technology department
- Follow up on flare key performance indicators
- Review of flaring incidents and progress of corrective actions
- Management of Change process for hardware change impacting flaring
- Review of operations/maintenance practices and procedures

Regular internal audits of the EMS are conducted, covering all activities within the scope of the LNG Canada EMS. LNG Canada will also ensure that a qualified third-party auditor undertakes compliance monitoring against the Project conditions every three years.

## 16. References

- BC OGC, 2018, Flaring and Venting Reduction Guidelines, Version 5.2, April 2021.
- BC OGC, 2020, BC Measurement Guideline, Version 2.2, June 2020

DRAFT



**From:** Neven.Dimic@lngcanada.ca  
**Sent:** Tuesday, 1 Oct 2019 03:45 PM  
**To:** Suzanne.Mathews@BCOGC.ca  
**CC:** Hardy.Friedrich@bcogc.ca; scot.mackillop@lngcanada.ca  
**Subject:** Flare Management Report Table of Contents

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Hi Suzanne,

As discussed during the biweekly meetings, LNG Canada has prepared an annotated table of contents to outline the proposed format/organization and contents of our Flare Management Report (as per LNG Facility Permit Condition # 9). Please let us know if you have any questions on the attached document.

Thanks,



Neven Dimic, P.Eng., M.Eng.  
Regulatory Advisor, LNG Canada

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Email: [Neven.Dimic@lngcanada.ca](mailto:Neven.Dimic@lngcanada.ca)  
Skype: s22



To conserve resources, please don't print this e-mail unless it's necessary, and delete it when you no longer require it.

# LNG Canada Flare Management Report– Annotated Table of Contents (Draft – 10/01/19)



**LNG CANADA**  
Opportunity for British Columbia. Energy for the world

Joint venture companies



## 1. Abbreviations & Definitions

- Overview of acronyms and terms used throughout report
- Definitions from LNG Canada's LNG Facility Permit (LNGFP) included for commissioning, normal operations, emergency conditions, and process upset

## 2. Purpose, Scope, Validity, and Regulatory Context

- Description of regulatory framework including relevant sections of OGC LNG Facility Regulation (LNGFR), LNGFP application and permit conditions, BC Environmental Assessment Office (EAO) Environmental Assessment Certificate (EAC) conditions, OGC Noise Control Best Practice Guideline, and OGC Flaring and Venting Reduction Guideline

## 3. LNG Canada Environmental Commitment

- Overview of LNG Canada commitment to safety and environment and its relation to flare management

## 4. Summary of Responsibilities

- Table of responsibilities for personnel undertaking activities covered by the document – including Asset Manager; Operations Manager; Panel Operator; Shift Supervisor; Shift Superintendent; Trainer; Maintenance Manager; Social Performance Advisor; Technology Department; HSSE Manager; Environment and Compliance Team Lead; Compliance Advisor; Environmental Advisor; and Communications, Consultation & Community Relations Manager

## 5. Flare Systems Overview

- Description of the use of flare systems as a means to safely evacuate gas during routine maintenance activities, planned train maintenance (turnarounds), trips and unplanned shutdowns to repair defects, rare emergency situations, and initial start-up (no continuous flaring)
- Overview of the LNG Canada process in general and a description of 4 LNG Canada facility flares (Warm/Wet, Cold/Dry, Low Pressure Storage and Loading, and Spare), and liquid burners; description of purge gas usage
- Design basis for flares and liquid burners – including diameter, height, and design flow rate



## 6. Description of the Flare Technology Used

- Summary of vendor choice and the ability of the vendor to achieve smokeless flaring and noise performance requirements
- Final design for vapour flares and liquid burners (diameter, height, type, and flare tip information)

## 7. Flaring Environmental Impacts

- Description of combustion efficiency, role of flares in reducing methane emissions, and overview of residual air pollutants and greenhouse gas emissions
- Radiation plots and summary of noise impacts

## 8. Flaring Mitigation Measures

- List of flaring mitigations already included in design (expanding on list provided as part of LNGFP application)

## 9. Inventory of LNG Canada Venting Emissions

- Although the design is based on no continuous venting, this section describes situations where temporary venting may occur

## 10. Inventory of LNG Canada Continuous Flare Emissions

- Description of smaller continuous flaring emissions (flare pilot, flare purges)

## 11. Inventory of Commissioning and Start-up (CSU) Flaring Activities

- Description of typical quantities of flaring during initial start-up along with a list of typical activities that contribute to this
- Overall CSU flaring assumptions for LNG Canada
- Propane and ethane import to avoid the need to flare Refrigerant Production Unit during start-up
- LNG import for initial cool down
- Description of CSU flaring activities related to equipment pre-drying, acid gas removal unit start-up, mole sieve bed and regeneration compressor start-up, mercury bed drying, pre-cooler start-up, final cooldown, and refrigerant production unit (RPU) start-up

## 12. Inventory of Planned Flaring Activities During Normal Operations and Turnaround

- Description of planned shutdowns: boroscoping of each aeroderivative gas turbine (every year – no flaring impact); planned turnarounds (every 3 years, 14-20 days)
- Overview of restart from turnaround, ex-dry dock ship gassing up activities, RPU campaign, and relief valve inspection/ overhaul

### 13. Inventory of Unplanned Flaring Activities

- Description of flaring during routine maintenance (including list of equipment that might be applicable)
- Overview of adjustment of Parallel Mixed Refrigerant (PMR) or Mixed Refrigerant (MR) composition

### 14. Inventory of Upsets

- Overview of flaring due to off-spec products (definition of specifications and description of controllers)

### 15. Inventory of Emergencies

- Definition of emergency flaring
- Description of specific emergency incidents related to trips in the following equipment: flash gas compressor, acid gas thermal oxidiser, regeneration gas compressor, gas turbine compressor, main cryogenic heat exchanger, condensate overheads compressor, BOG compressor, and other liquid phase condensate unit (or offspec condensate)

### 16. Measurement, Monitoring, Notification, and Reporting

- Description of LNG Canada's compliance with BC OGC Measurement Guideline for Upstream Oil and Gas Operations
- Summary of flow meter specifications including rangeability, accuracy and density compensation method
- Overview of applicability to flares, liquid burners, ship de-inerting, and acid gas flaring
- Description of proactive monitoring by panel operator (use of CCTV and alarm), flare checks, as well as internal/external reporting and notification requirements

### 17. Continuous Improvement, Review, and Auditing

- Overview of LNG Canada Environmental Management System as per ISO 14001
- Description of strategy for continuous improvement and table of flaring related KPIs to be tracked monthly
- Summary of benchmarking information for percentage of feed gas volume flared

### 18. Appendix A: Facility Permit 9709124

- Link to LNG Canada's LNGFP

### 19. Appendix B: Feed Gas Composition

- Expected feed gas composition (lean, average and rich cases)

## 20. Appendix C: Flare Notification and Reporting Plan

- Further details on LNG Canada's plan to meet LNGFP Conditions #5 and #6

## 21. References

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