APPENDIX G MAINLINE BLOCK VALVE SPACING: SUPPORT FOR SPECIAL PERMIT APPLICATION

Main Line Block Valve

Technical Support

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1. Purpose and Introduction

This purpose of this attachment is to provide additional information in support of the Alaska LNG Project Special Permit Application, which is pursuing an increase in Main Line Block Valve (MLBV) spacing only in Class 1 locations that would be greater than the limits of 49 CFR §192.179, which states:

> *(a) Each transmission line, other than offshore segments, must have sectionalizing block valves spaced as follows, unless in a particular case the Administrator finds that alternative spacing would provide an equivalent level of safety:*
>
> > *(4) Each point on the pipeline in a Class 1 location must be within 10 miles (16 kilometers) of a valve.*

This attachment complements the Special Permit Application, Environmental Information, and Special Permit Conditions related to MLBV spacing. It summarizes the technical, legal and historical case to support the Administrator finding "that alternative spacing would provide an equivalent level of safety."

This attachment is divided into three Sections, described below:

> I. Development of Transmission Line Valve Spacing in Part 192, Including Historical Connection to ASME B31.8, and International Design Codes. This section provides a summary of the rulemaking associated with §192.179. It also provides background on the origin of the Class 1 MLBV Spacing requirement, which is based on the 1968 edition of ASME B31.8.[1, 2] This section also highlights that multiple internationally recognized pipeline design codes, including ASME B31.8 (2014)[3], no longer require a prescriptive block valve spacing in remote (e.g. Class 1) locations.[4]
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> II. Safety Considerations Relevant to Block Valve Spacing. The modern pipeline design code is based upon studies that have evaluated the role of main line block valves in a rupture and concluded that block valve spacing has no effect on reducing consequence in remote locations. These studies will be summarized in this attachment, along with the Project's own engineering analysis into the thermal radiation impact that would result from a very unlikely rupture and its consequences to personnel, wood structures, bridges, and the Trans Alaska Pipeline System

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[1] 61 Fed. Reg. 28770 (June 6, 1996), which can be accessed on-line at: https://www.gpo.gov/fdsys/pkg/FR-1996-06-06/pdf/96-13787.pdf

[2] 2008 Michael Baker Jr., Inc. report entitled "Comparison of US and Canadian Transmission Pipeline Consensus Standards". This report can be accessed at PHMSA's on-line document database at the following location: https://primis.phmsa.dot.gov/gasimp/docs/FinalReport_TransborderStandards.pdf

[3] ASME B31.8 (2014) "Gas Transmission and Distribution Piping Systems", 846.1 Required Spacing of Valves

[4] More than 99% of the Mainline Pipeline is within a Class 1 location. CFR § 192.179 block valve spacing will be followed for other than Class 1 locations.

(TAPS).[5] The Project's rupture analysis concluded that "these results indicate that increased valve spacing could be implemented in remote, low population density areas without affecting safety."[6] This attachment will not only address ways to reduce consequence, which is one way to reduce risk, but also to reduce probability of a rupture, which includes robust line pipe and welding and enhanced integrity management practices. It will also discuss ways to address public perception of pipeline safety, namely ways to reduce valve closure times,[7] by using enhanced valve monitoring and closure set-points based on engineering analysis.

III. Air Quality and Emissions: This section will summarize the gas outflow analysis. In the very unlikely event of a rupture, methane from the pipeline would either be released to the atmosphere, or combusted. Conversely, a reduction in the number of MLBVs, through the use of Special Permit conditions, will result in a reduction in greenhouse gas emissions in the event of a rupture, which will be detailed in this attachment.

Before detailing the above information, it is first important to define "safety", particularly given the requirement in 49 CFR §192.179 to demonstrate to the Administrator "that alternative spacing would provide an equivalent level of safety". Although Part 192 does not define "safety", or the evaluation performed to determine an "equivalent level of safety", insight into how PHMSA defines safety can be derived from their 2012-2016 Strategic Plan,[8] which contains the following statements:

"Our mission is to protect people and the environment from the risks of hazardous materials transportation."

"Pipeline Safety—We identify and evaluate safety risks."

"We reduce risk in two ways—by preventing failures wherever possible, and by reducing the consequences of failures that do occur."

Based on these statements, PHMSA has related safety to risk. More specifically, a reduction in risk would constitute an increase in safety. Also, risk consists of both probability (preventing failures) and

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[5] These studies will address the ASME B31.8, 846.1 requirement to assess "the impact in the area of gas release (e.g., nuisance and any hazard resulting from prolonged blowdowns)". The Project has performed a separate study that addressed the economic related assessments in 846.1. This study, which accounted for both capital and operating expenses, found block valve spacing up to 50 miles resulted in a more cost effective design, which is a benefit to the public.

[6] Rothwell, B., Dessein, T. and Collard, A. 2016. Effect of Block Valve and Crack Arrestor Spacing on Thermal Radiation Hazards Associated with Ignited Rupture Incidents for Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC2016-64604. September.

[7] Studies that have examined pipeline incidents have failed to find a correlation between valve closure time and consequence in Class 1 locations, which will be discussed in this attachment. However, PHMSA has requested the Project address valve closure time based on past public feedback.

[8] http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/PHMSA%20Strategic%20Plan%20Final%208%203%2012.pdf

consequence (effects of a failure). Risk is reduced, and safety is enhanced, by a reduction of probability and/or consequence. This is consistent with a common industry definition of risk, which is:

Risk = Probability x Consequence.

This attachment will demonstrate that 1) the consequence of increasing MLBV spacing beyond 20 miles in Class 1 locations does not increase the consequence of a rupture and 2) the probability of a rupture of the Alaska LNG Project's Mainline Pipeline based on historical data is extremely low. The remoteness of the Mainline acts to reduce both the probability and consequence of rupture. The probability is reduced because there will be less likelihood for third-party damage, while the consequence is decreased because of the lower density of people, buildings intended for human occupancy, and other infrastructure. The risk of rupture is even further reduced by the layers of in-line inspection (ILI), and integrity management that are proposed for use, to include:

1. Alternative MAOP (§ 192.620), to include in line inspection for general wall loss and dents using High Resolution Magnetic Flux Leakage technology and caliper tools;
2. Integrity Management Plan for High Consequence Areas (Part 192 Subpart O);[9]
3. ILI for crack like features using Electromagnetic Acoustic Transducer (EMAT) technology;[10] and
4. ILI to determine bending strain and pipeline location using Geospatial Pipeline Mapping technology.[11]

[9] This includes both HCAs as defined by § 192.903, but also treating all Strain Based Design (SBD) segments as "covered segments", per the requirements of the SBD Special Permit.

[10] A Condition of the Three Layer Polyethylene Special Permit is to inspect all Alternative MAOP pipeline segments utilizing EMAT.

[11] Use of the mapping ILI tool is a Condition of the SBD Special Permit.

2. Development of Transmission Line Valve Spacing in Part 192, Including Historical Connection to ASME B31.8, and Comparison to Modern International Design Codes

Existing Section 192.179 was derived from ASME B31.8 (1968), which contained specific standards for spacing and location of transmission line valves.[12] In the original proposed rulemaking notice, US DOT explained it was basing the proposed rules on State standards, which were based on ASME B31.8, with certain differences requiring additional analysis and public comment.[13] Under ASME B31.8 (1968), sectionalizing block valves on transmission lines were required to be installed 20 miles apart in Class 1 Locations, 15 miles in Class 2 Locations, 8 miles in Class 3 Locations, and 5 miles in Class 4 locations.[14] During the rulemaking process for the federal standards, US DOT's proposed spacing requirements for transmission system valves mirrored ASME B31.8 exactly without discussion.[15]

When the federal minimum standards were finalized, they articulated spacing requirements differently than in ASME B31.8 in order to maintain the same intent, but to clarify the requirements for valves at transitions between class locations. The Final Rule specified the current requirements for sectionalizing block valve spacing by reference to the proximity of valves to "each point on [a] pipeline," rather than the distances between the valves themselves.[16] The Final Rule adopted the current regulatory language, providing that "each point on the pipeline" must be within 2 ½ miles of a valve in Class 4 locations, 4 miles in Class 3 Locations, 7 ½ miles in Class 2 Locations, and 10 miles in Class 1 Locations.[17] US DOT stated the reason for the change in wording as "[t]he provisions on spacing of transmission line valves have been rewritten to more clearly express the intended result."[18] Thus, these spacing requirements essentially incorporated the intent of the 1968 ASME standard without any analysis of necessity from a safety standpoint.

Since the original Part 192 standards were promulgated in 1970, there have been three subsequent rules modifying Section 192.179, only one of which resulted in a substantive change to the spacing requirements.[19] In 1996, in response to a pipeline company request, the agency amended the rule to provide for alternative spacing of sectionalizing block valves upon a determination that alternative

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[12] 35 Fed. Reg. 5713 (April 8, 1970) proposing, among other Part 192 subparts, Subpart D Component Design, including valve spacing

[13] 34 Fed. Reg. at 18556-18557

[14] ASME B31.8 (1968), Section 846.11

[15] 35 Fed. Reg. at 5721

[16] 35 Fed. Reg. 13248, 13263 (Aug. 19, 1970)

[17] Ibid

[18] Ibid at 13252

[19] The other two revisions (1) provided that offshore segments of transmission lines must be equipped with valves or other components to shut off the flow of gas to an offshore platform in an emergency, 41 Fed. Reg. 13248 (Aug. 16, 1976); and (2) provided metric equivalents for the distances set forth in the rule, 63 Fed. Reg. 37500 (July 13, 1998).

spacing would provide an equivalent level of safety.[20] In the notice of proposed rulemaking, the agency explained a pipeline company had requested that operators themselves be allowed to determine valve spacing, asserting that the fixed valve spacing requirements were not necessary for safety, given that damage from a pipeline failure would occur in a very short period of time.[21] The agency rejected the specific request but agreed to propose language to allow the Administrator to approve alternative spacing upon a demonstration of "equivalent level of pipeline safety."[22]

Based on the foregoing, it is apparent that the development of Section 192.179 was not grounded in specific agency analysis of the need for, or impacts on safety from, prescriptive spacing of sectionalizing block valves. Studies, including 2008 Michael Baker Jr., Inc. report entitled "Comparison of US and Canadian Transmission Pipeline Consensus Standards"[23] (Baker Report), which was prepared for PHMSA, have found that safety was not the driver for the original fixed spacing requirements. Those requirements, rather, were a function of industry practices, common in the 1950s when the standards were created, which were largely unrelated to safety concerns. The Baker Report explained:[24]

> *Operating convenience, economics, and the need to limit adverse publicity during an incident were the primary motivations for establishing valve spacing recommendations. Although it is often perceived that valve spacing is based on minimizing the consequences of a pipeline incident, in actuality, the majority of damage from a pipeline rupture occurs in the first few minutes (Sparks, 1995; Sparks, 1998). If the gas is ignited, being able to close the valve quickly has no effect on safety but may minimize negative public perception. Timely valve closure may not significantly reduce the amount of gas released to the atmosphere (Sparks, 1995, 1998). Safety is best addressed in the Code by ensuring that the valve is accessible, and unexpected gas losses are minimized.*
>
> *The [ASME B31.8] Code Committee surveyed industry practice in 1955 and suggested a requirement for valve spacing as a function of class location. Specific intervals were designated to satisfy concerns of potential litigation associated with specifying valve spacing based on engineering judgment. The Code Committee intended the valve spacing recommendations to be used as guidelines, but for pipeline operators to also consider local conditions. For example, a valve located near a roadway is more readily accessible than one located in the middle of a pasture, cornfield, or swamp. These spacing intervals reflected the current practices of the*

[20] 61 Fed. Reg. 28770 (June 6, 1996)

[21] 57 Fed. Reg. at 39575

[22] Ibid.

[23] 2008 Michael Baker Jr report entitled "Comparison of US and Canadian Transmission Pipeline Consensus Standards FINAL REPORT" This report can be accessed at PHMSA's on-line document database at the following location: https://primis.phmsa.dot.gov/gasimp/docs/FinalReport_TransborderStandards.pdf

[24] Baker Report at Appendix A, p. 15

majority of pipeline operators in 1955, while also responding to governmental and public pressure for more valves in higher population areas.

The valve spacing requirements in 49 CFR 192 were based on recommendations in the original ASME B31.8 Code, but were rewritten to more clearly express the intended result (Docket OPS-3). The Technical Pipeline Safety Standards Committee (TPSSC) believed that valve placement was primarily an economic matter rather than a safety consideration. The increased number of valves required for higher population areas was based on minimizing the volume of gas released during maintenance activities and was not a decision based on public safety.

This history leads naturally to the recent improvements to ASME B31.8 (2014) to allow valve spacing determinations based on an engineering assessment.[25] Insofar as studies have determined that the prescribed valve spacing requirements are unnecessary for safety, this change is not inconsistent with pipeline safety.

This change in ASME B31.8 from a prescriptive sectionalization valve spacing requirement in Class 1 locations (20 miles) to a performance-based evaluation to determine block valve spacing is in keeping with other internationally recognized pipeline design codes, and studies that have evaluated pipeline incident databases, and incident investigations.

In Canada, the predominant pipeline design code is CSA Z662 (2015)[26], which requires that "the company shall perform an engineering assessment that gives consideration to relevant factors…" such as nature and amount of fluid released due to maintenance, leaks or ruptures, the effect on inhabitants in the area of blowdown gas release and continuity of service. CSA Z662 changed from a prescriptive valve spacing requirement in Class 1 locations to an engineering assessment based spacing methodology in 2003.[27]

In Europe, the normative pipeline design standard, ISO 13623,[28] does not have a prescriptive requirement for block valve spacing in Class 1 locations. Rather, when determining valve placement it requires the following factors be accounted for: "pressure relief, security and proximity to occupied buildings".

[25] ASME B31.8 (2014) "Gas Transmission and Distribution Piping Systems", Section 846.1 "Required Spacing of Valves"

[26] CSA Z662-15 "Oil and gas pipeline systems - Seventh Edition", Section 4.4 "Valve Location and Spacing"

[27] Z662.1-03 "Commentary on CSA Standard Z662-03, Oil and Gas Pipeline Systems"

[28] ISO 13623 "Petroleum and Natural Gas Industries - Pipeline Transportation Systems - Second Edition", Section 6.11 "Section isolation valves"

AS 2885.1 is the predominant gas transmission pipeline design code in Australia. It defines class locations in an analogous method as Part 192, but with different designations. For example, rural (R1) is the AS 2885.1 analog to Class 1 in CFR § 192.5. R1 is defined as:[29]

> *Land that is unused, undeveloped or is used for rural activities such as grazing, agriculture and horticulture. Rural applies where the population is distributed in isolated dwellings. Rural includes areas of land with public infrastructure serving the rural use; roads, railways, canals, utility easements.*

There is no recommended maximum spacing of valves in R1 location class, rather, "An assessment shall be carried out and the following factors shall be considered", such as consequences of fluid release, the ability to detect events which might require isolation, and the response time to events.[30]

In summary, a prescriptive requirement for valve spacing in Class 1 locations is not consistent with modern pipeline design codes from around the world. Instead, the prescriptive 20 miles spacing was based on historical pipeline design practices from prior to 1968 that were not predicated on engineering assessments, such as those required by present day design codes and undertaken in support of this Special Permit Application.

The performance based criteria in the aforementioned pipeline design codes are consistent with the research that has been published in multiple studies that have examined pipeline incidents. These will be reviewed in the next section.

[29] AS 2885.1-2012 "Pipelines—Gas and liquid petroleum Part 1: Design and construction", Section 4.3.4 "Primary Class Location"

[30] Ibid. Section 4.6.4 "Isolation Valves"

3. Safety Considerations Relevant to Block Valve Spacing

This section consists of several parts. First, the literature relevant to block valve spacing and pipeline incident databases will be reviewed. This literature demonstrates that in remote, Class 1 locations block valve spacing does not affect probability or consequence of a pipeline rupture. In the next part, estimates of the probability of rupture in remote Class 1 locations will be discussed. This will demonstrate that even using historical approaches to pipeline design, operations, and integrity management, the probability of rupture of the Alaska LNG Project Mainline Pipeline is extremely low compared to the historical performance of gas pipelines in undeveloped areas equivalent to class location 1. The literature suggests that the probability of rupture can be further lowered by using modern day integrity management practices, like high resolution in-line inspection tools that are capable of detecting not only general corrosion wall loss, but crack-like features as well. Lastly, in the very unlikely event of a rupture, the consequences to key Alaskan infrastructure will be discussed, along with ways to mitigate the risk of rupture.

3.1 Relevant Block Valve Spacing and Pipeline Incident Literature

There have been several published papers that examined what, if any role, block valve spacing played in pipeline incidents. Several of these reports will be highlighted below.

As early as 1999, the US DOT Research and Special Programs Administration found that "virtually all fatalities and injuries occurred at, or very near (within three minutes), the time of initial rupture, long before the ruptured pipe section would be isolated, even with RCVs installed."[31] This conclusion was based upon evaluation of 81 incidents from 1972 to 1997. This report also concluded that "the value of gas saved because of RCV closure is the only measureable benefit that can be derived from the SwRI study."[32] This is consistent with the performance language in most international pipeline design codes that require some analysis of economic impacts due to gas loss in the engineering analysis for valve placement.

Another study that was published in 2000 was based on a review of the U.S. DOT/OPS incident database from 1985 through mid-1997 that evaluated 655 pipeline incidents.[33] This work found that "there are more incidents, injuries and fatalities in more populated areas (Class 3 and 4 locations) in comparison to the less populated areas (Class 1 and 2 locations)." On a per 1,000 mile-year basis, this analysis demonstrated that the likelihood of an injury in a Class 1 location is 9.6 times less than in a Class 3 or 4 location, and the likelihood of a fatality occurring in a Class 1 location is 6.5 times less than in Class 3 or

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[31] "Remotely Controlled Valves on Interstate Natural Gas Pipelines" This report can be accessed at the following location: http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/rcv_rpt.fnl.pdf

[32] The "SwRI study" refers to two reports produced by Southwest Research Institute in 1995 and 1998 for the Gas Research Institute. These reports were entitled "Remote and Automatic Main Line Valve Technology Assessment" and "Cost Benefit Study of Remote Controlled Main Line Valves", respectively.

[33] Eiber, R., McGehee, W., Hopkins, P., Smith, T., Diggory, I., Goodfellow, G., Baldwin, T. R. and McHugh, D. 2000. Valve Spacing Basis for Gas Transmission Pipelines. Pipeline Research Council International, PRCI Report PR 249 9728. January.

4. This is particularly significant given that the Part 192 valve spacing in Class 4 is four (4) times less than in Class 1, and in Class 3 the spacing is 2.5 times less than in Class 1. This work demonstrates that pipeline incidents and the consequence of those incidents is correlated with population density, as quantified by class location, and not with block valve spacing.

In 2007, US DOT PHMSA contracted Oak Ridge National Laboratory (ORNL) to "assist PHMSA in assessing the safety impact of system valve spacing."[34] This work evaluated a number of pipeline configurations, including a 36" diameter, 2,100 psi MAOP pipeline design. This pipeline design is quite similar to that proposed for the majority of the Alaska LNG Project's Mainline Pipeline, which is 42" diameter with 2,075 psi MAOP. ORNL concluded:

- *"Using an adaptation of the Stephens hazard radius criteria[35], valve spacing has a negligible influence on natural gas pipeline safety for the pipeline diameter, pressure range, and valve spacings considered in this study.*
- *Over the first 30 s of the transient, pipeline pressure has a far greater effect on the hazard radius calculated with the Stephens criteria than any variations in the transient flow decay profile and the average discharge rate."*

In 2008, Michael Baker Jr. published a report for PHMSA that compared differences between US and Canadian Standards.[23] As already noted in Section 2 above, CSA Z662 does not have a prescriptive requirement for valve spacing in Class 1 locations. This Michael Baker report also notes that "valves do not prevent the occurrence of pipeline failure incidents" based upon separate work published in 2000. In other words, they do not reduce the probability of an incident. Furthermore, the Michael Baker report continues by saying "valve spacing plays no significant role in reducing the risk of the initial release of gas and ignition". This is significant because "although it is often perceived that valve spacing is based on minimizing the consequences of a pipeline incident, in actuality, the majority of damage from a pipeline rupture occurs in the first few minutes." This Michael Baker report is published on PHMSA's "Gas Transmission Integrity Management: Technical Reports" website,[36] which has the following stated purpose:

> *"The following reports are intended to serve as a technical resource for OPS and State pipeline safety inspectors evaluating operators' integrity management (IM) programs. Inspectors consider information from a number of sources in determining the adequacy of each IM*

[34] 2007 Oak Ridge National Laboratory report entitled "Scoping Study on the Safety Impact of Valve Spacing in Natural Gas Pipelines" This report can be accessed at the following location: http://info.ornl.gov/sites/publications/files/Pub3603.pdf

[35] This criteria was originally published in Gas Research Institute (GRI)-00/0189: http://pstrust.org/docs/C-FERstudy.pdf The results of this work were later adopted into section 192.903 to define the Potential Impact Radius, which is "the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property."

[36] https://primis.phmsa.dot.gov/gasimp/techreports.htm

> *program. Development of these reports was funded via a Congressional appropriation specifically designated for implementation of IM oversight. These and other similar reports are separate and distinct from the work products associated with and funded via OPS's R&D Program."*

In 2011, the most recent work evaluating the safety implications of block valve spacing was published.[37] This study included consideration of relevant published work along with a review of the PHMSA incident database from 2002 to 2009 and thirteen gas transmission pipeline incident reports published by the NTSB from 1969 to 2009. The summary of its findings is as follows:

> *"This review found that all of the prior research studies, the examination of the PHMSA incident database, and examination of NTSB gas transmission pipeline incidents indicate that main line block valve spacing on natural gas transmission pipelines is not related to public safety. Valves are useful for maintenance and line modification but they do not control or affect public safety as the injuries and fatalities on gas transmission pipelines generally occur during the first 30 seconds after gas has been released from a pipeline. The NTSB incidents reviewed indicated that it took at least an hour after the rupture occurred for the natural gas to decompress and exhaust from the pipeline. This exists because a natural gas pipeline is not like a water pipe in a building where when the valve is closed the incompressible water stops flowing out of the pipe no matter how far the valve is from the pipe opening. Natural gas is compressed to about 70 to 100 atmospheres for a cross country transmission pipelines and it takes time for the decompression to occur."*

As can be seen from the literature that has reviewed pipeline incident data, including work either performed or sponsored by the Office of Pipeline Safety (PHMSA), block valve spacing does not affect consequence or probability in remote Class 1 locations.

3.2 Probability of Rupture

Several historical incident databases were reviewed to provide insight in the probability of rupture for the Mainline pipeline[38]. This analysis, which was performed by the Project, is summarized below. It included data from the US DOT, the European Gas Pipeline Incident Data Group, and internal data from TransCanada, found that third-party mechanical damage is the primary cause of rupture for gas transmission pipelines. Based on this observation, several factors contribute to a low rupture probability for the Mainline pipeline compared to historical performance in areas equivalent to class location 1. These factors are briefly described in the following.

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[37] Robert J. Eiber Consultant Inc, Kiefner and Associates: "Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing", ASME STP-PT-046, 2011.

[38] The predominant mode of installation of gas pipelines is below ground. As such, the probability of rupture discussion in the section is predicated on a below ground design, which is the selected installation mode for the Mainline pipeline. FERC Resource Report 10 contains additional information on the safety benefits of a below ground design.

- Based on past studies[33], the probability of incidents due to third-party interference is directly related to the population level with a much lower frequency in class location 1 compared to the higher class locations. Approximately 800.98 miles, corresponding to 99.3% of the entire Mainline route, are located in class location 1. In addition to that, more than 700 miles of the route are located in areas with no inhabited dwellings within the Class Location corridor of 220 yards on either side of the pipeline centerline[39], which further reduces the probability of experiencing mechanical damage or rupture in those regions. This is seen in Table A at the end of this attachment, which is a list of structures, residences, and identified sites[40] in Class 1 locations along the Mainline pipeline. These buildings were identified using visual imagery. This is consistent with the level of engineering detail for the Project at this time and will be further refined prior to installation and subsequent operation of the Mainline pipeline.
- Previous studies have used the analysis of historical occurrences and fault tree modeling to calculate the hit frequency rate for undeveloped areas representative of a typical class 1 location.[41,42] This was found to be equal to 6.4×10^{-3} per mile-year. The remoteness and route conditions of the Alaska LNG project would likely reduce this rate even further for the Mainline.
- In the case of a pipeline hit occurring on the Mainline, the Alaska LNG Project's fracture control plan ensures a robust design against fracture initiation. To put that in perspective, a through-wall thickness longitudinal defect larger than 5 inches would be required to initiate a rupture event. It is possible to show that the force required to achieve that type of damage is in excess of 200,000 lbs, a force that can only be generated by very large excavators, such as some of those used in the mining industry.
- From analysis of the incident databases, it was found that the probability of rupture due to third-party mechanical damage is much lower for pipelines with wall thickness greater than 0.59 in. The minimum wall thickness of the Mainline is 0.677", which occurs for X80 pipe segments following Alternative Maximum Allowable Operating Pressure (AMAOP) requirements in Class 1 locations.
- The requirement for monthly flyovers of the line due to the use of the AMAOP and the high public profile of the Alaska LNG Project further reduce the probability of third-party interference.
- Finally, it should be noted that even in the unlikely case of a rupture, the probability of gas ignition is estimated to be only 33% for pipeline diameters larger than 16".[43]

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[39] Definition of Class Location is provided in CFR §192.5

[40] Definition of Identified Site is provided in CFR § 192.903

[41] Q. Chen and M. Nessim, "Reliability-Based Prevention of Mechanical Damage to Pipelines," *Proceedings from the EPRG/PRCI 12th Biennial Joint Technical Meeting on Pipeline Research,* 1999.

[42] R. Doctor and N. a. S. N. Dunker, "Third-Party Damage Prevention Systems," Nicor Technologies Inc., GRI-95/0316, Gas Research Institute, Chicago, 1995.

[43] EGIG, Gas Pipeline Incidents, 8th Report of the European Gas Pipeline Data Group, 2011.

3.3 Methods to further reduce probability of rupture with design, materials and operation

As the previous part demonstrated, the probability of rupture for the remote, Class 1 Alaska LNG Mainline is extremely low based on historical databases. However, this probability may be lowered even further by applying modern day materials, and integrity management technologies.

In the aforementioned Eiber 2011 study[37], particular attention was placed on incidents from 2002 to 2009 because "[This data] represents the impact of the Integrity Management Plans developed after the implementation in Subpart O "Gas Transmission Pipeline Integrity Management" in Part 192. Review of this post IMP data found that there were no injuries or fatalities in areas that followed Subpart O regardless of Location class. It was found that use of in line inspection tools was integral in reducing risk by enabling the identification of defects before they result in an incident.

In recognition of this finding, additional integrity management requirements have been included in the Special Permit Conditions for increased MLBV spacing. Additionally, it should be noted that enhanced integrity management requirements are also included in the other Special Permits that would be sought concurrently from PHMSA, to include Strain Based Design, Multi-Layer Coating, and Crack Arrestor spacing. Additional details on these Special Permits can be found in Appendices of FERC Resource Report 11. The Conditions for each of these Special Permits include many supplemental measures above the requirements of Part 192. If PHMSA were to grant the Special Permits, the Project would implement these Conditions, further reducing the probability of rupture. The following is an overview of some of these Conditions.

The Alaska LNG Project would comply with AMAOP requirements in § 192.602 (d)(10), which includes conducting periodic assessments of integrity as if the AMAOP segments were covered by Part 192 Subpart O – Gas Transmission Pipeline Integrity Management. This includes performing internal inspections using a high resolution magnetic flux tool at intervals not to exceed seven (7) years [c.f. § 192.939(a)]. The use of these tools was identified as a contributing factor in the lack of injuries or fatalities in High Consequence Areas [HCAs are covered by Subpart O] between 2002 and 2009.[37] Additionally, the following Condition would be included as part of a Special Permit application for the use of Multi-Layer Coatings:

> *An Electromagnetic Acoustic Transducer (EMAT) in-line inspection tool must be run not later than fourteen (14) years after Pipeline Start-Up and once every seven (7) years thereafter. An alternate EMAT ILI schedule can be proposed to PHMSA Director or Project Designee for "no objection".*[44]

The use of in-line inspection tools would further reduce the risk of rupture by enabling the detection of both crack like defects using EMAT, and general wall loss corrosion defects using a high resolution MFL.

[44] Three Layer Polyethylene Coating, Main Line Block Valve and Crack Arrestor Spacing Special Permit CONDITIONS, Alaska LNG Project FERC Resource Report 11, Appendix E

This use of advances in technology is not only consistent with recommended practices based on the pipeline incident data, but it is also consistent with the PHMSA Strategic Vision, which states that:

> *"advances in technology—particularly in materials, construction, and defect detection technologies—offer the potential for reducing risk."*[8]

PHMSA has requested a list of structures and identified sites within the Potential Impact Radius[45] (PIR) of the Mainline pipeline, which is contained in Table B at the end of this attachment. This table also provides stop and start mile posts of HCAs, Strain-Based Design Segments, along with MLBV location and type. Given the importance integrity management actions have on reducing the probability of rupture, there are several columns that provide detail on the integrity actions that will be taken along the route with respect to each building within the PIR. The detailed Operations and Maintenance requirements of Alternative MAOP[46] will apply to the entire onshore Mainline pipeline. As part of these requirements, the Project would be required to "conduct internal inspections using a high resolution magnetic flux tool on the frequency determined" by Part 192 Subpart O. High resolution magnetic flux leakage (HR MFL) tools are capable of detecting general corrosion wall loss and dents. The HR MFL inspection requirement is complemented by three other integrity management practices. First, EMAT is capable of detecting crack like features. While such features are unlikely to form on the Mainline, they can be difficult for HR MFL to detect. Similar to the HR MFL, the entire onshore Mainline would be inspected using the EMAT tool.[47] Second, in-line inspection sections[48] that contain SBD segments would be inspected with a geospatial mapping ILI tool (ILI-IMU) that is capable of detecting pipe movement, and any accumulated bending strain. Lastly, the totality of the Integrity Management Program detailed in Part 192 Subpart O will be complied with in HCAs, which are also shown in the Table B.

The resistance to fracture of the pipeline would also be enhanced by procuring all line pipe to a Project Specification that requires API 5L PSL 2 pipe with additional destructive testing requirements including DWTT, and toughness testing over a range of temperatures. At a minimum, those testing requirements would comply with §192.328 for AMAOP segments, and would also comply with the Strain Based Design Conditions (see Attachment 1 of the Strain-Based Design Special Permit Application) for the SBD segments. Girth welding would be performed in accordance with a Project Specification that meets or exceeds the requirements of Part 192 and API 1104. All of the pipe would be joined together using welding procedures qualified in accordance with API 1104 that would include both destructive and non-destructive testing as part of the qualification process. During construction, 100% of the girth welds

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45 Definition of Potential Impact Radius is provided in CFR § 192.903. For the Mainline pipeline the PIR has been calculated to be 1,466 ft.

46 CFR § 192.620

47 This is subject to PHMSA's approval of the Multi-Layer Coating Special Permit.

48 Because inspection tools must be launched and received at purpose-built facilities, which are identified on Table B, each inspection section may contain multiple segments of interest, such as an HCA, or SBD. The result is that a much larger portion of the total pipeline length is often inspected using ILI tools than the segment of interest. For example, while there are only 34 miles of total SBD segments, the ILI-IMU tool will inspect a total of 361 miles, representing 45% of the total pipeline length.

would be non-destructively inspected. Welds that do not pass this inspection would either be repaired and reinspected, or cut-out and rewelded. Lastly, a fracture control plan would be developed that would define minimum toughness requirements for both the line pipe and girth weld to allow the pipeline to withstand, at a minimum, a 5" through wall thickness defect without rupturing.

3.4 Consequence of rupture in Class 1 Locations

3.4.1 Thermal radiation study

To determine the number and placement of MLBVs for the Mainline pipeline, an engineering analysis in accordance with ASME B31.8 (2014)[3] was performed. This analysis included a thermal radiation study to determine whether increasing MLBV spacing in Class 1 locations beyond the 49 CFR § 192.179(a)(4) limits would result in an equivalent level of safety for the remote locations of the pipeline. A summary of the study results has been published.[6]

The study concluded "that increased valve spacing could be implemented in remote, low population density areas without affecting safety". The results of this work for the Project are consistent with previous studies detailed above that examined the results of NTSB and PHMSA incident databases and concluded the risk to the public is independent of valve spacing.

In the very unlikely event of an ignited full-bore rupture, this engineering study found that the effective consequence is the same for MLBV spacing of 20 and 50 miles. This can be seen in the following figures from this study. In Figure 1, the mass outflow from a full bore rupture is plotted as a function of time for four different valve spacings: 20, 30, 40 and 50 mile. It is important to note that the mass outflow at 17.5 minutes has decreased to approximately one-third the outflow rate experienced in the minutes following the rupture. Secondly, the mass outflow is exactly the same for all valve spacing until approximately 17.5 minutes, which is when the outflow is affected by valve activation for case of 20 mile MLBV spacing.

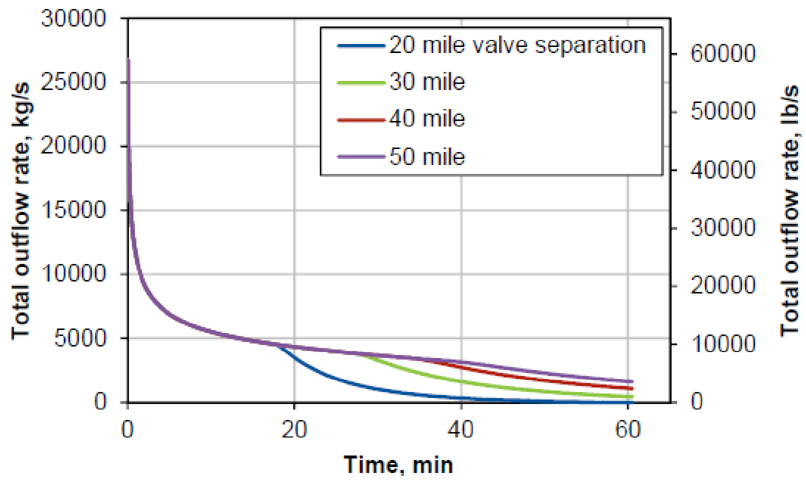

Figure 1: Mass outflow rate due to a rupture as a function of time and MLBV spacing [from Figure 1 in footnote 49]

Based on Figure 1 the resulting consequence is expected to be exactly the same for the first 17.5 minutes, regardless of MLBV spacing greater than 20 miles. This was demonstrated by performing cumulative thermal dosage calculations, which is a measure of thermal radiation that a receptor (person or structure) is exposed to in a given time. The results are shown in Figure 2, which is a plot of affected area as a function of cumulative thermal dosage for humans that is a function of both radiation intensity (I) and time (t). Cumulative radiation dosage enables the comparison of consequences associated with thermal radiation and varying MLBV spacing. At 16 minutes, which is soon before the effects of valve activation are observed for the 20 mile MLBV spacing, the thermal radiation dosage is exactly the same for all four MLBV spacings. To put this 16 minute time in perspective, the exposure time used for personnel safety in previous key studies is 30 seconds[49,50] and a review of the literature and incident databases concluded that "injuries and fatalities that occur in connection with pipeline ruptures mainly occur in the first 30 seconds after the rupture and are associated with the initial release of gas and ignition, if it occurs."[4] This is the case for the remote, Class 1 segments that are the subject of this Special Permit given the absence of other buildings intended for human occupancy that would potentially be involved in a fire as a result of a pipeline rupture. For personnel, there is no difference in consequence between 20 and 50 mile MLBV spacing.

For fixed structures, a threshold radiation intensity (I_{th}) is included in the calculation of cumulative thermal radiation dosage. For wood, the threshold radiation intensity below which ignition will not occur is 14.7 $(kW/m^2)^{4/3}s$.[51] Figure 3 shows the results of these calculations for dosages accumulated over 60.5 minutes for ignition of wood. As can be seen from this figure, for wooden structures, there is no difference in consequence between 20 and 50 mile MLBV spacing for up to 60.5 minutes.

[49] Stephens, M., Leewis, K. and Moore, D. 2002. A Model for Sizing High Consequence Areas Associated with Natural Gas Pipelines. Proceedings of the International Pipeline Conference, ASME International, New York, NY. Paper IPC02-27073. September.

[50] These results[49] produced the equation for Potential Impact Radius that Part 192 later adopted in §192.903 that defines "the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property."

[51] The concepts of threshold dosage can be observed at any camp fire. Logs must be placed within a certain proximity (thermal radiation intensity) of the fire for them to begin burning (ignition). Logs that are too far away from the fire to ignite may absorb a large amount of thermal radiation over time, but they will never burn.

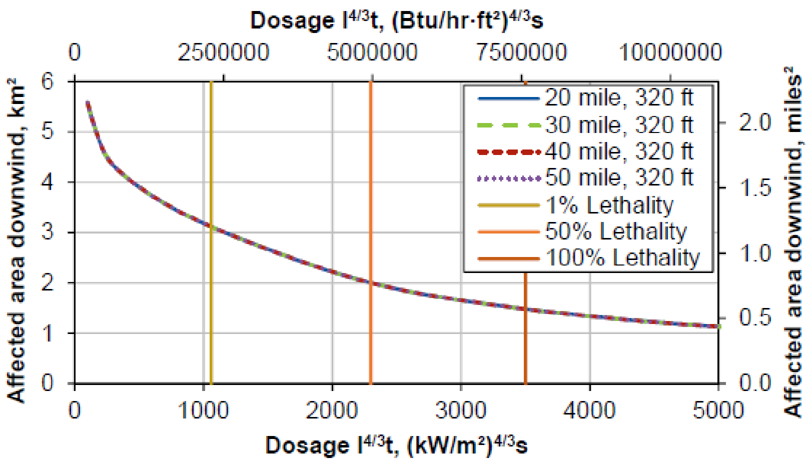

Figure 2: Affected area as a function of thermal radiation dosage for humans as a function of valve spacing at 16 minutes after rupture [from Figure 5(a) in footnote 49]

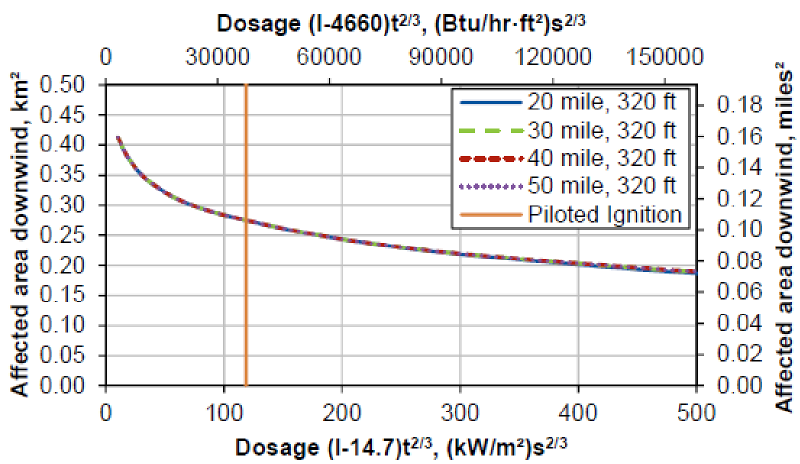

Figure 3: Variation of affected area with thermal radiation dosage for wooden structures and valve spacing [from Figure 6 in footnote 49]

3.4.2 TAPS Thermal Radiation Impact Study

The Mainline pipeline route is proposed to approximately parallel TAPS from the TAPS Pump Station 1 on the North Slope to near the town of Livengood, north of Fairbanks. In the very unlikely, remote scenario of an ignited rupture of the Mainline pipeline, thermal radiation from the resulting jet fires could potentially pose a threat to the integrity of TAPS. Therefore, a study was undertaken to evaluate the potential effects of this thermal field on TAPS, which is summarized below. This study was designed to identify the distance at which a rupture of the Mainline could have an effect on TAPS. However, the results of this study also provide insight into the potential effects of crack arrestor spacing on the consequences to TAPS.

Methodology

The analysis methodology comprised multiple steps. A brief description of each analysis step and their connection is provided in the following.

- First, rupture simulations were used to calculate the thermal radiation field caused by an ignited pipeline rupture of the Mainline. These results were then employed to calculate thermal loads as input to the heat transfer analysis of the TAPS pipeline.
- A first heat transfer analysis was conducted to calculate the extent of the damaged insulation on TAPS. Based on this result, thermal loads were recalculated to account for the higher emissivity of bare steel compared to the aluminum jacket enclosing the insulation.
- A second heat transfer analysis with removed insulation was carried out to determine the temperature of the pipeline steel, Vertical Support Member (VSM) steel and flowing oil.
- The calculated temperature distribution was finally used in a structural analysis to determine pipeline stresses, displacement and reaction forces at VSMs and reaction forces at anchor locations.

Additional detail on assumptions, models and input for each analysis step is given in the following sections.

Rupture Simulations

The rupture simulations were conducted by C-FER Technologies using the PIPESAFE™ software, which is a well-established industry tool developed to conduct quantitative risk assessments of natural gas pipelines[52]. These simulations allow calculation of the thermal radiation field produced by an ignited rupture of the Mainline pipeline for different values of the rupture length and valve spacing. Rupture lengths ranging from 320 ft to 3,200 ft and valve spacing from 20 to 50 miles were investigated.

Figure 4 shows a comparison of thermal radiation fields between a rupture length of 320 ft and 1,600 ft for 20 miles valve spacing at 24.5 minutes after the initial rupture event. It may be noted that the two thermal fields have very distinct features. In the case of 320 ft, the jet fires at the two ends of the rupture impinge against each other forming a single area of high thermal radiation (red contour circle in Figure 4). For the 1,600 ft case, the two jet fires do not impinge against each other and form separate

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[52] M. Acton, T. Baldwin and E. Jager, "Recent developments in the design and application of the PIPESAFE risk assessment package for gas transmission pipelines," Proceedings IPC 2002, p. 831, 2002.

high radiation regions at the rupture ends. An important consideration is that impingement of the two jet fires increases the horizontal component of the flames causing thermal radiation levels to be experienced at longer distances from the pipeline. This feature can be seen in Figure 4 with the 1,600 ft radiation field being more elongated along the direction of the pipeline, especially at radiation levels equal or greater than 5,000 BTU/ft^2-hr.

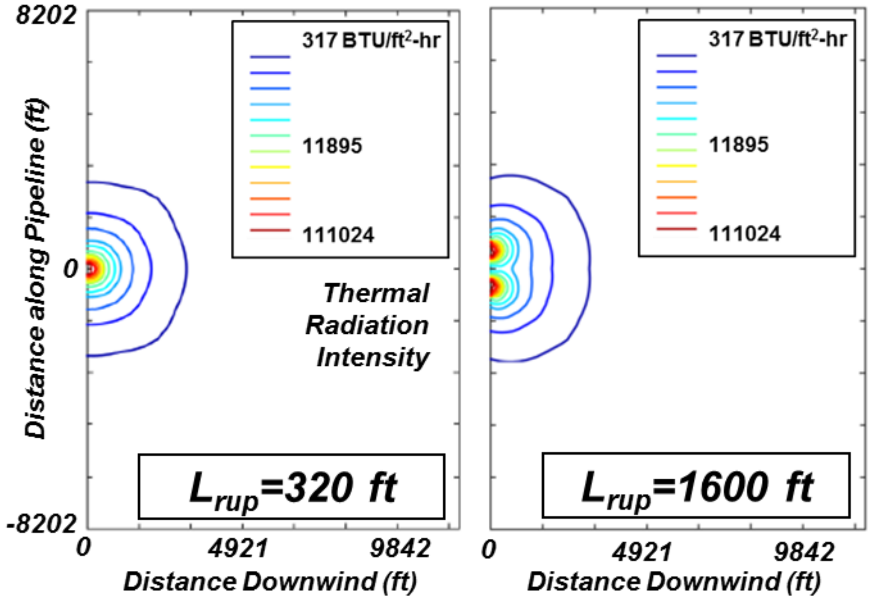

Figure 4: Comparison of thermal radiation fields for 320 ft and 1,600 ft rupture lengths for 20 mile valve spacing 24.5 minutes after the rupture event

Heat Transfer Analysis

Both the heat transfer and the structural analysis were carried out by SC Solutions using the commercial Finite Element (FE) software ADINA™. This is one of many software packages available for these types of analysis, and was selected due to its use in a previous study and a relatively user-friendly interface. The heat transfer and structural analyses were decoupled since displacements and deformations do not affect significantly the heat transfer solution.

The thermal radiation fields from the rupture simulations were used as input to the heat transfer analysis, which taken into consideration the following components:

- Radiative heat transfer to the outer surface of the insulation-pipeline system;
- Convection from the outer surface to the surrounding air;
- Conduction from the insulation to the steel pipeline;
- Convection from the steel pipeline to the flowing oil.

It is important to note that calculation of thermal loads from radiation needs to account for the specific heat transfer scenario and the emissivity of the outer material. For instance, if the flame directly impinges on the system, the emissivity is set to 1.0 to simulate heat transfer through chemical contact. In the case of no direct impingement, the material emissivity reduces the effective heat transfer and is set to 0.1 for the aluminum jacket surrounding the insulation and 0.8 for the bare pipeline steel.

In addition to that, damage to the insulation has to be captured by the analysis process. Therefore, a first heat transfer analysis it is run to determine the extent of insulation damage. As previously mentioned the outer jacket surrounding the insulation is made of aluminum. Aluminum melts at approximately 1100°F and its strength is severely deteriorated at 930°F. Therefore, it was assumed that all the regions with temperatures above 930°F in the first heat transfer analysis would experience insulation damage. A second analysis was then run with insulation removed and bare pipeline steel exposed in those regions.

The analyses were run as transient simulations for a time period equal to one hour since it was determined that the gas outflow and the resulting fire would be significantly reduced at that point in time. A rupture length of 1,600 ft was assumed, which is consistent with the crack arrestor spacing that the Project is currently proposing. The thermal radiation field corresponding to a time approximately 16 minutes after the initial rupture event was conservatively assumed to remain constant for the remaining duration of the simulation. This assumption is conservative for the purposes of determining the distance at which a rupture could impact TAPS because, as it will be shown, flame impingement is the critical factor that would impact TAPS. The greatest potential for flame impingement occurs within the first few minutes after a rupture when the gas outflows are highest. This is well before the any difference in block valve spacing would be observed given the rupture simulations results that demonstrated there is no influence of valve spacing approximately for the first 17 minutes after the rupture[6]. This conservative assumption caused the temperature of the system to keep increasing throughout the entire 1 hour of simulation time, regardless of valve spacing. The final peak temperature distribution was then used as input to the structural analysis.

Structural Analysis

The structural analysis used pipe beam elements, which are capable of capturing the effect of internal pressure, elbow configurations and applied curvature. The temperature distribution from the previous heat transfer analysis was used as input and assigned to the different nodes of the FE model. The temperature was assumed to be uniform throughout the cross-section of each element for a particular nodal location.

The TAPS pipeline possesses a characteristic zigzag configuration to allow for thermal expansion at bends due to the warm oil flowing through it. The model includes VSMs, which provide vertical support to the pipeline and longitudinal anchor points. VSMs are spaced 60 ft apart with some of them having lateral stops. The configuration adopted in the analysis is schematically shown in Figure 5. The anchors are shown as boxes, the VSMs with stops are shown as tick marks, while the ones without stops are not illustrated in this schematic.

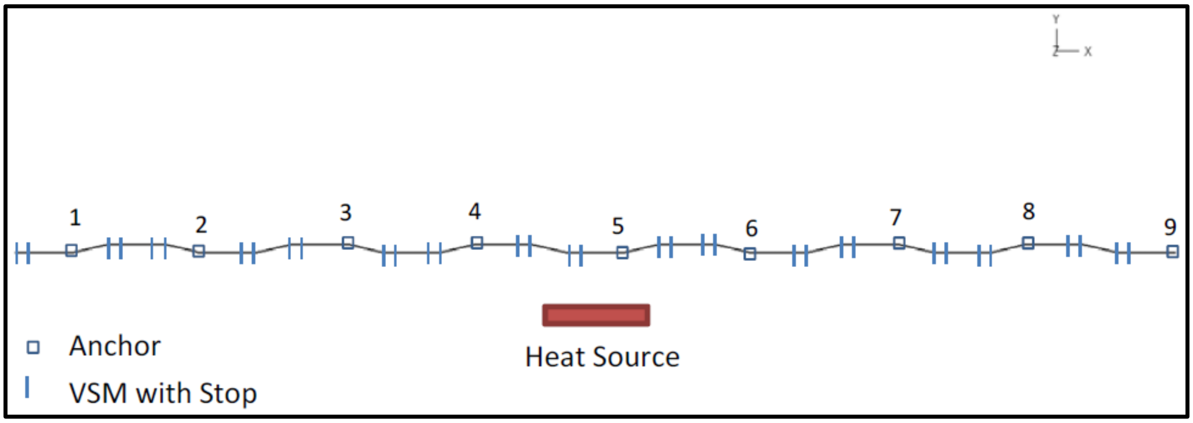

Figure 5: Schematics of pipeline configuration considered in FE study

The element size was selected to be 3 ft based on a preliminary mesh sensitivity study. A gap of 7.9 inches was assumed between the pipe and the VSM piles. The VSMs were modeled as springs with a force–displacement relationship meant to reproduce the frictional contact behavior between the pipe and the seat, the gap and the pile stiffness. The specific load response of the VSMs has been evaluated in a previous study, which considered the effect of piles length, pipeline elevation and soil conditions (frozen vs. thawed). Based on the findings of that study, VSMs were assumed to have a 15 ft length elevation and the ground was conservatively assumed to be completely frozen.

Temperature dependent material properties were used for the pipeline and the VSM steel modelled as an elastic perfectly plastic material with a temperature dependent yield strength.[53] No attempt was made to capture the temperature dependence in the plastic region since, as outlined in the next section dealing with limit states, development of plastic strains was not considered an acceptable simulation outcome.

Results

This section describes the key results of this study with the following structure: the first part presents the limit states that were employed to evaluate the effect of thermal radiation on TAPS integrity, while the second part illustrates the key results and finding of the analyses including the parametric study carried out to investigate the sensitivity to the distance between the two pipelines.

Limit States

Multiple limit states were considered to assess the effect of the thermal radiation field on the integrity of the TAPS pipeline. A brief description of each limit state is provided in the following.

- **Pipeline Temperature** – The pipeline steel temperature has to remain below a limit of 750°F, which based on the guidance in reference,[53] is assumed to correspond to a

[53] J. P. V. Franssen, "Fire Design of Steel Structures - Appendix C - Mechanical Properties of Carbon and Stainless Steel," European Convention for Structural Steelwork, 2012.

significant degradation of the material yield strength. It should be noted that the simulations are not able to capture the temperature gradient through the pipe wall thickness, but it is reasonable to not account for this given the high thermal conductivity of steel.

- **Oil Temperature** – This temperature limit is 145°F, which represents the maximum oil design temperature for TAPS.
- **VSM** – The VSM steel temperature has to be below 930°F. A higher temperature limit was selected for this steel since it is mainly subjected to a compressive stress state, while the pipe steel is mainly subjected to a tensile stress state. For VSMs without stops, no contact with the support is allowed. For VSMs with stops, the horizontal load has to remain below 53 kips, which prevents the pipe from falling off the support.
- **Anchor** – The total horizontal load at anchors will not exceed 150 kips, corresponding to their maximum design load.
- **Pipeline Stress** – Pipeline steel stress has to remain within the elastic range below the temperature dependent yield strength.

Parametric Study

A parametric study was conducted to evaluate the thermal radiation effects on TAPS integrity for different distances, d, between the pipelines. Figure 6 shows a schematic illustration of the definition of this distance d.

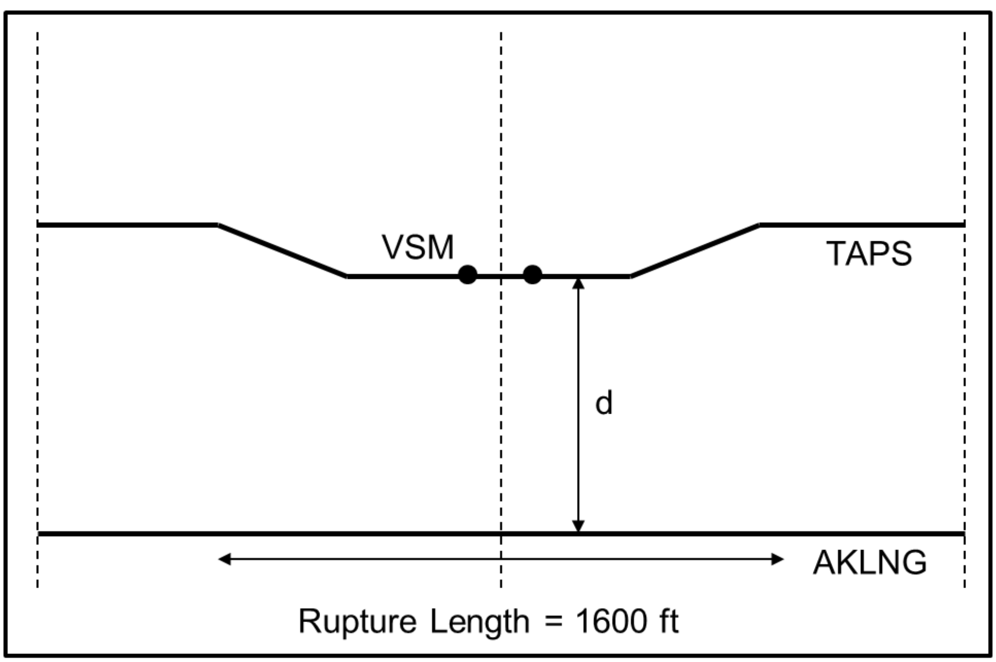

Figure 6: Schematic illustration of minimum distance d between two pipelines

For each distance d, heat transfer analyses were first carried out and the results were evaluate against the thermal limit states. The structural analysis was then conducted if all of the conditions on maximum allowable temperatures were met.

Figure 7 shows the temperature distribution along TAPS for the simulation case with d equal to 164 ft. Two hotter regions may be noticed in the central portion of the pipeline. This corresponds to two regions where the pipeline insulation was damaged due to direct impingement of the jet fires.

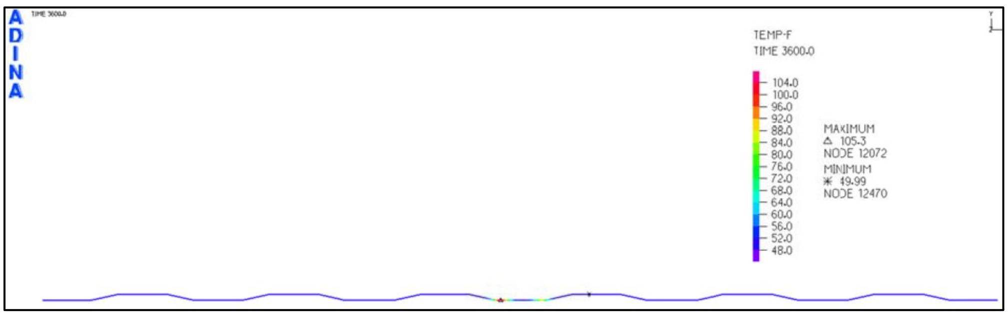

Figure 7: Temperature distribution for simulation case with 164 ft distance

The stress distribution along the TAPS pipeline for the same simulation case with d equal to 164 ft is displayed in Figure 8. Two locations of higher stress corresponding to the hotter regions may be noticed in the central portion of the pipeline (shaded area in the figure).

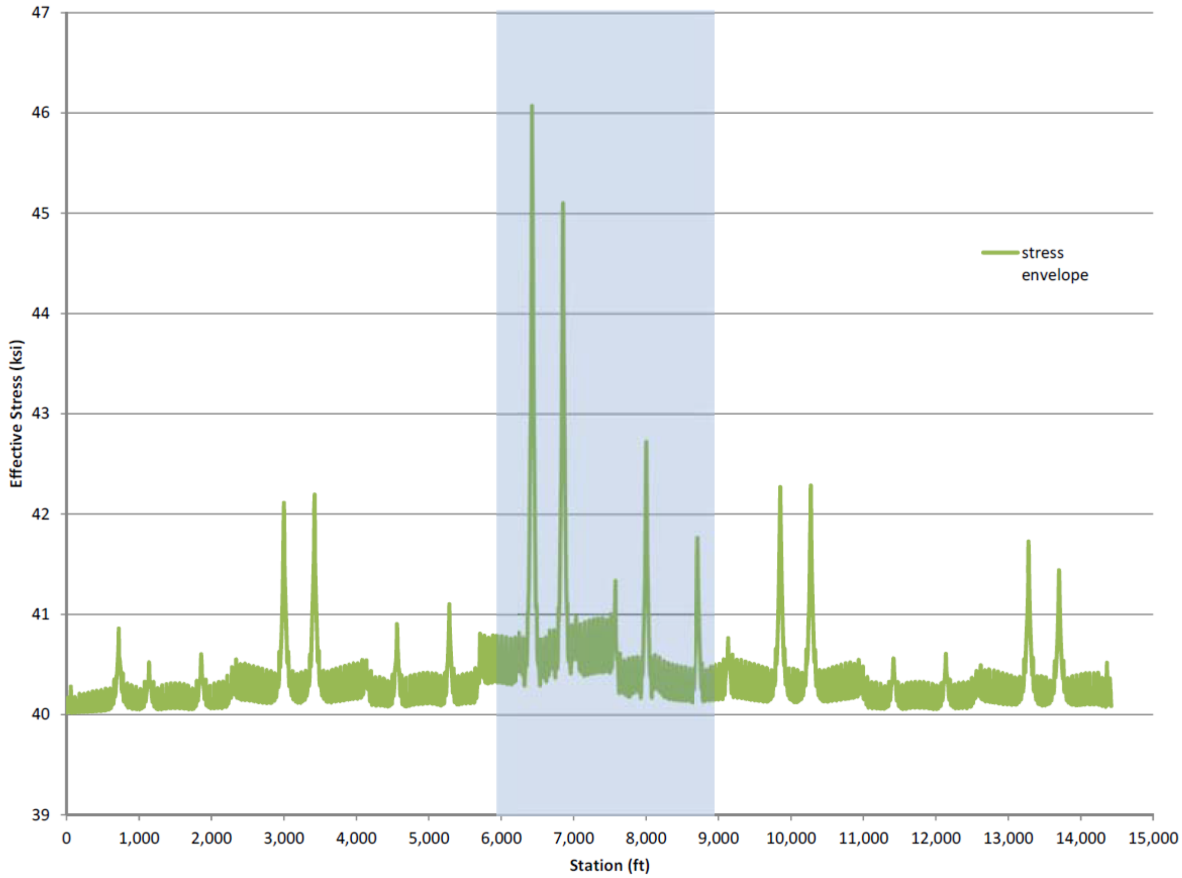

Figure 8: Stress distribution for simulation case with 164 ft distance

Results for the parametric study in terms of the limit states described in the previous section are summarized in Table 1 using a Pass/Fail commentary for each condition.

Table 1 - Summary of analyses results

Configuration	d (ft)	Pipe Temp.	Oil Temp.	VSM	Anchor	Pipeline Stress
Parallel	100	**Fail**	**Fail**	N/A	N/A	N/A
	150	**Fail**	Pass	N/A	N/A	N/A
	164	Pass	Pass	Pass	Pass	Pass
	175	Pass	Pass	Pass	Pass	Pass
	200	Pass	Pass	Pass	Pass	Pass

The shortest distance at which all the limit states condition are met is 164 ft. Although, multiple limit states are close to their limit condition at this distance and a larger safety margin can be achieved at a distance of 175 ft. A key finding of this study was that for all cases with no insulation damage there was practically no increase in the pipe steel temperature and the overall thermal radiation effects on TAPS integrity were negligible. The only situations where insulation damage was observed were the cases with direct jet fire impingement. Therefore, it may be concluded that flame engulfment is the key aspect governing the response of the TAPS pipeline in the unlikely event of an ignited rupture of the Mainline pipeline. Based on this finding and the analysis of the thermal radiation fields it can be inferred that a shorter rupture length of 320 ft with a larger horizontal component of the jet flames is likely to result in a higher potential to impact TAPS integrity. The fact that flame engulfment is the key aspect controlling the impact to TAPS also allows the effect of crack arrestor spacing to be inferred. Because the maximum extent of the flame will occur immediately after rupture, before block valve closure will impact gas outflow, MLBV spacing will not change the area subject to flame engulfment. As a result, the distance to TAPS at which a rupture will impact TAPS will not change with MLBV spacing.

Summary

A study was conducted to evaluate the potential effects on TAPS from the thermal radiation field produced in the highly unlikely scenario of an ignited rupture of the Mainline pipeline. The key findings and conclusions of the TAPS thermal radiation study:

- For distances between the two pipelines greater than 175 ft, there is no significant impact on TAPS integrity from the thermal radiation effects;
- The key aspect governing the thermal radiation effects on TAPS is the occurrence of direct jet fire impingement and the related damage of the outer insulation shell;
- Because the area of flame engulfment will not be affected by MLBV spacing, it can be inferred that MLBV spacing will have no effect on the distance at which a rupture will impact TAPS.
- This study confirmed the validity of the 200 ft separation distance that was used as routing criterion based on a previous preliminary assessment.

3.4.3 Criteria for bridges

As discussed above in section 3.4.1 Thermal radiation study, for both personnel and wooden structures there was no difference in consequence between 20 and 50 mile MLBV spacing for up to 60.5 minutes. Additionally, there are several sections of Part 192 that indicate the concern of the regulation is not the impact of the pipeline on a bridge, but rather the impact of a bridge on the pipeline.[54] Furthermore, the Mainline is not placed on any road bridges in Alaska. Rather, the Project is building three separate aerial pipeline crossings at Nenana River at Moody, Fox Creek and Nenana River at Windy.

[54] See §§192.111, 192.917, and 192.935

Outside the scope of the regulation, the impact of the pipeline on a bridge may be of concern, for example, due to the remoteness of Alaska, and the importance of road bridges in the logistics infrastructure and personal mobility. As such, PHMSA and ADOT&PF requested the Alaska LNG Project consider additional measures to protect key bridges.

Based on conversations with ADOT&PF and PHMSA, the following were identified as key bridges. This determination was based upon several factors, including distance between the bridge and the pipeline, the type of bridge and its susceptibility to damage, the length and style of the bridge, volume and type of traffic (e.g. commerce), and the type and length of an emergency detail should the bridge require repair.

- Dietrich River (1337)[55]
- Nenana River at Moody (1143)
- Nenana River at Windy (1243)
- Iceworm Gulch (1146)
- Antler Creek (1141)

In the highly unlikely event of an ignited pipeline rupture, the resultant thermal radiation may negatively impact the functionality of the bridge. However, there is no guidance in the regulations or other identified documents that establishes a thermal radiation threshold, or separation criteria between bridges and pipelines.

Housing and Urban Development has developed an "acceptable separation distance of a proposed HUD-assisted project from a hazard" where the "projects shall be located so that the allowable thermal radiation flux level at the building shall not exceed 10,000 BTU/ft^2/hr".[56] The same thermal radiation flux is used to define a "thermal exclusion zone" in Title 49 CFR §193.2057, which references NFPA 59A (2001), 2.2.3.2(a)(4).

Since the peak gas outflow and peak thermal radiation flux will occur immediately after an ignited rupture, before valve closure affects gas outflow, there will be no impact of MLBV spacing on the area subject to a radiation flux of 10,000 BTU/ft^2/hr.

3.4.4 Valve monitoring and closure

As shown above, comprehensive reviews of pipeline incident databases have not shown any correlation between improved public safety and valve closure time in remote, Class 1 locations. However, the public may perceive a greater level of safety with reduced valve closure. This dichotomy is reflected in the following statement from the PHMSA-sponsored Michael Baker Jr report:[2]

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[55] Numbers in parentheses are bridge numbers from "Alaska 2013 Bridge Inventory Report": http://www.dot.alaska.gov/stwddes/desbridge/assets/pdf/2013bridgeinventory.pdf

[56] Title 24 CFR §51.203 Safety standards, which can be accessed at http://www.ecfr.gov/cgi-bin/text-idx?SID=2e55921ee92291a1e8d0661a9e4df5b9&mc=true&node=pt24.1.51&rgn=div5#se24.1.51_1203

If the gas is ignited, being able to close the valve quickly has no effect on safety but may minimize negative public perception.

PHMSA has also acknowledged the role of public perception in their 1999 report,[31] which stated in its summary "Proposal" section:

We have also found that there may be a public perception that RCVs will improve safety and reduce the risk from a ruptured gas pipeline.

To address PHMSA's concerns related to public perception of safety, and minimize gas losses in an unlikely loss of containment event, the Project's proposed design, subject to PHMSA Special Permit conditions, employs the use of a combination of Automatic Shut-off Valves (ASV) and Remote Controlled Valves (RCV), with both types of valves equipped with pressure set points that would initiate automatic closure. As part of the Special Permit, RCVs would be located at all powered locations (i.e. compressor and heater stations), while ASVs would be located at all stand-alone locations. The RCVs would be capable of remote operation (closure and opening) along with pressure monitoring, both upstream and downstream of the valve, which is reported to a Pipeline Control Center. The use of ASVs and RCVs in non-AMAOP, non-HCA segments exceeds the requirements of Part 192.

While Part 192 is prescriptive in its placement of block valves based on Class location (CFR § 192.179), it is silent on the set point that would initiate valve closure. Similarly, the type of valve that must be used, whether it be manual, ASV, or RCV, is not specified with the exception of AMAOP segments that contain an HCA (§ 192.620 (d)(3)), which requires an RCV or ASV, but does not specify the closure set point.

The Project team has compared the valve closure time of designs compliant with the minimum requirements of Part 192 to the proposed approach for the AKLNG Mainline, with varying spacing scenarios (Table 2). Engineering estimates for the manual valve closure time were used. Given the remote Alaskan environment, two hours is considered a best case scenario estimate for maintenance crew response time to a manual valve. Given the size of the valve, it would likely take in excess of 20-30 minutes for a maintenance crew to close the valve.

For an ASV, an industry best practice activation set point of 40% MAOP was used. Hydraulic calculations were performed to estimate the time required to reach the set point for a rupture midway between valves. Based on discussions with valve and valve actuator vendors, 42 seconds (0.7 minutes) was adopted as a conservative valve closure time.

These two cases represent Part 192 compliant design scenarios. These are compared to several variations of valve spacing, and actuation set points that are included in the MLBV Special Permit Conditions. Based upon conversations with PHMSA, a 60% maximum operating pressure (MOP) set point will be used for the ASVs and RCVs, while RCVs will also have a pressure rate of change set point of X% reduction in pressure in 10 minutes (-ΔP% / 10 minutes). The "X" reduction in pressure would ensure that a pipeline rupture would cause valve closure, while not resulting in inadvertent closures, and subsequent denial of supply, during normal operation and expected maintenance activities. Based on hydraulic calculations performed to date this value of X would be 8.75% for 50 mile valve spacing and activation of all RCVs would occur 10 minutes after a pipeline rupture, irrespective of valve spacing.

Table 2 – Valve Activation and Closure Time

<table>
<tr><th>Compliance with</th><th>Case</th><th>Valve Type</th><th>Time to valve activation (minutes)</th><th>Valve closure time once activated (minutes)</th><th>Total time for valve closure (minutes)</th></tr>
<tr><td rowspan="2">Part 192: Class 1</td><td>1) 20 miles spacing, non AMAOP</td><td>Manual</td><td>120</td><td>30 minutes</td><td>150</td></tr>
<tr><td>2) 20 mile spacing, AMAOP segment containing HCA</td><td>ASV</td><td>35.8 (40% MAOP set-point)</td><td rowspan="4">0.7 minutes</td><td>36.5</td></tr>
<tr><td rowspan="3">Special Permit: Class 1</td><td>3) 50 mile spacing</td><td>ASV</td><td>35.3 (60% MOP set-point)</td><td>36.0</td></tr>
<tr><td>4) 30 mile spacing</td><td>ASV</td><td>25 (60% MOP set-point)</td><td>25.7</td></tr>
<tr><td>5) 50, 40, or 30 mile spacing</td><td>RCV</td><td>10 (-XΔP% / 10 minutes set-point)</td><td>10.7</td></tr>
</table>

As can be seen in Table 2, all proposed Special Permit cases result in a faster valve closure time than the Part 192 compliant cases. To further quantify the difference in the various cases PHMSA has requested that a rupture gas outflow analysis be performed to calculate the amount of gas released for various pipeline design cases in the very unlikely event of a pipeline rupture. This is addressed in Section 4.

4. Air Quality and Emissions

The purpose of this work is to support the regulatory filing of PHMSA Special Permits by generating a comparison between the greenhouse gas emissions possible with the base Part 192 MLBV spacing, and the MLBV spacing that would be requested in a Special Permit from PHMSA.

Analysis Cases

The gas outflow following a rupture of the 42" Mainline pipeline was modeled with the rupture located at the mid-point of a section that was bounded by either a manual valve, a remote control valve (RCV) or an automatic shut-off valve (ASV) on either side. The model assumed full bore rupture and treated the pipeline as a closed bottle with a total length of 100 miles, which is representative of the maximum distance between compressor stations north of Fairbanks. Schematics of the systems and conditions that were modeled are shown in Figures 9 through 11.

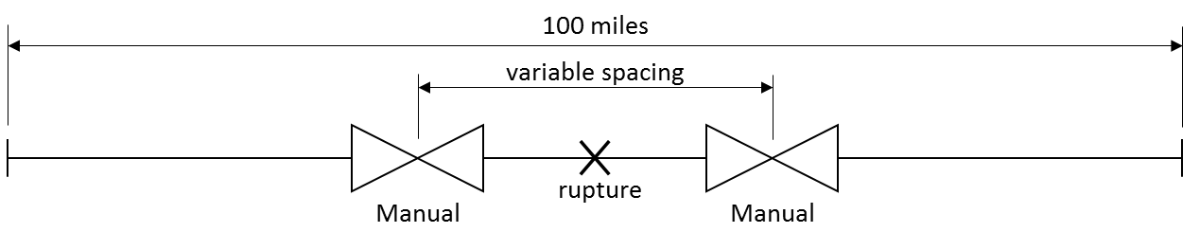

Figure 9: Model Schematic - Case 1

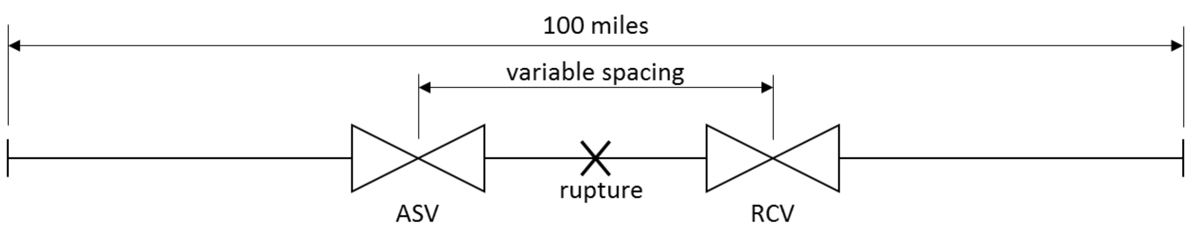

Figure 10: Model Schematic - Cases 3 and 4

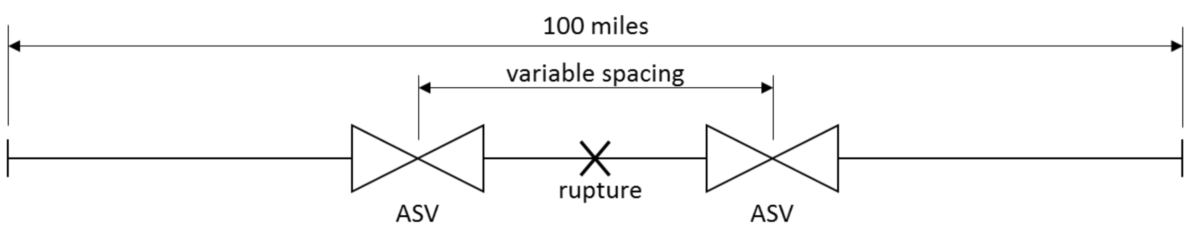

Figure 11: Model Schematic - Cases 2 and 5

The analysis included six (6) cases as laid out in Table 3. The first two cases represented compliance to Part 192 (Case 1), and the AMAOP requirements in section 192.620. Cases 3 through 5 were variations of possible pipeline design scenarios based on Special Permit Conditions. Details for each case are provided below.

Table 3: Analysis Cases

Compliance with	Case	Valve Arrangement for Model	Valve Closure Time
Part 192: Class 1	1) 20 miles spacing, non AMAOP	Manual to Manual	2 hours
	2) 20 mile spacing, AMAOP segment containing HCA	ASV to ASV	40.9 minutes for ASV (40% MAOP set-point)
Special Permit: Class 1	3) 50 mile spacing	ASV to RCV	35.3 minutes for ASV (60% MOP set-point) 10.7 minutes for RCV
	4) 30 mile spacing	ASV to RCV	25.2 minutes for ASV (60% MOP set-point) 10.7 minutes for RCV
	5) 30 mile spacing	ASV to ASV	25.2 minutes for ASV (60% MOP set-point)

For Case 1, a 2 hour valve closure time of a manual valve was selected given the remoteness of the pipeline. This represents a case that strictly complies with the code while using reasonable engineering approximations for the amount of time it would take to access the valve, a parameter that is not described, nor prescribed, in Part 192.

For AMAOP segments, there are valve closure regulatory requirements for valves on either side of a high consequence area. These requirements are defined in § 192.620(d)(3), which is excerpted below:

> *(ii) If personnel response time to mainline valves on either side of the high consequence area exceeds one hour (under normal driving conditions and speed limits) from the time the event is identified in the control room, provide remote valve control through a supervisory control and data acquisition (SCADA) system, other leak detection system, or an alternative method of control.*
>
> *(iv) A line break valve control system using differential pressure, rate of pressure drop or other widely-accepted method is an acceptable alternative to remote valve control.*

Assuming a §192.179 and § 192.620(d)(3) compliant block valve spacing and valve control, there are approximately nine (9) HCA containing segments in Class 1 locations. Case 2 models this scenario.

Because Part 192 does not provide guidance on the valve closure set-point for the requirements in (iv), an industry best practice set-point of 40% MAOP was adopted for this case.

Cases 3 through 5 are all variations of possible block valve spacing and type that would require a Special Permit. Based on conversations with PHMSA, the actuation set-points are 60% of MOP for ASVs and a decrease in operating pressure in ten (10) minutes is greater than 8.75% (∆Pressure/10min > 8.75%) for RCVs.

The gas outflow simulations were run by C-FER Technologies and DNV GL using the PIPESAFE™ software.[52] DNV GL removed the standard outflow time limit of 60.5 in PIPESAFE™ so that the simulations would run until the outflow reached 0.

Summary of Results

The gas outflow summary of results for the above five cases are shown in Figure 12 and Table 4. Case 1, which is compliant with section 192.179, resulted in the largest gas outflow and had the highest gas outflow of all five cases at any given time (Figure 13). The outflow was 35% greater than when using the proposed Special Permit spacing of up to 50 miles that includes use of SP Conditions like RCV and ASV. As can be seen in Figure 14 the use of these valve types, which are stipulated in the Special Permit Conditions, results in more rapid valve closure.

The difference in total gas outflow is even greater when comparing the Part 192 compliant Case 1 to both of the Special Permit 30 mile cases. Even when ASVs are used to comply with the Alternative MAOP HCA requirements, the Part 192 compliant Case 2 results in greater gas release than the proposed Special Permit 30 mile spacing with ASV closure set-points included in the Special Permit Conditions (60% MOP).

While it is informative to compare the individual cases, the safety of the overall pipeline system, which can consist of multiple individual Cases above, needs to be considered. In a Part 192 compliant Mainline pipeline design, 67% of the pipeline segments would correspond to the greatest gas outflow (Case 1). Conversely, using the Special Permit to design the pipeline system, only 40% of the pipeline segments would correspond to Case 3, and, as noted above, each of these segments would result in 35% less gas outflow than the Part 192 compliant Case 1 segments. Under the Special Permit, the remaining Class 1 segments would be represented by Case 4 and 5, which have the lowest gas outflows. As a result, it is apparent that the Special Permit will result in a lower total gas outflow than a Part 192 compliant pipeline comprised of Cases 1 and 2.

To further consider the system as a whole, the number of Class 1 segments was tallied for both a Part 192 and SP compliant design. This is shown in Tables 5 and 6. Because the MLBV spacing Special Permit is only for Class 1 locations, only Class 1 segments were considered in this system analysis. This allows for a comparison of the Special Permit Conditions on pipeline system outflow with compliance to Part 192.

The segments in Tables 5 and 6 assume the maximum allowable length per segment, which was also the segment lengths used in the gas outflow analysis: 20 miles per CFR § 192.179, and either 30 miles or 50 miles for the SP case.[57] A gas outflow value is then calculated for each type of segment based on its percentage of total line length. Based on the gas outflow value for each type of segment and the number of segments of each type, a weighted average gas outflow is calculated for the entire pipeline system. The result is that the weighted average for the Part 192 case is 22,196 tons per segment, compared to 15,249 tons per segment for the Special Permit case. This demonstrates that using the Special Permit conditions, there is 31% less average gas outflow for the system per segment than compliance with Part 192. This result highlights the importance of evaluating gas outflow indicators on a system wide basis, where it is evident that more responsive valve functionality (RCV and ACV) due to Special Permit conditions, positively offsets larger pipeline segments due to longer valve spacing.

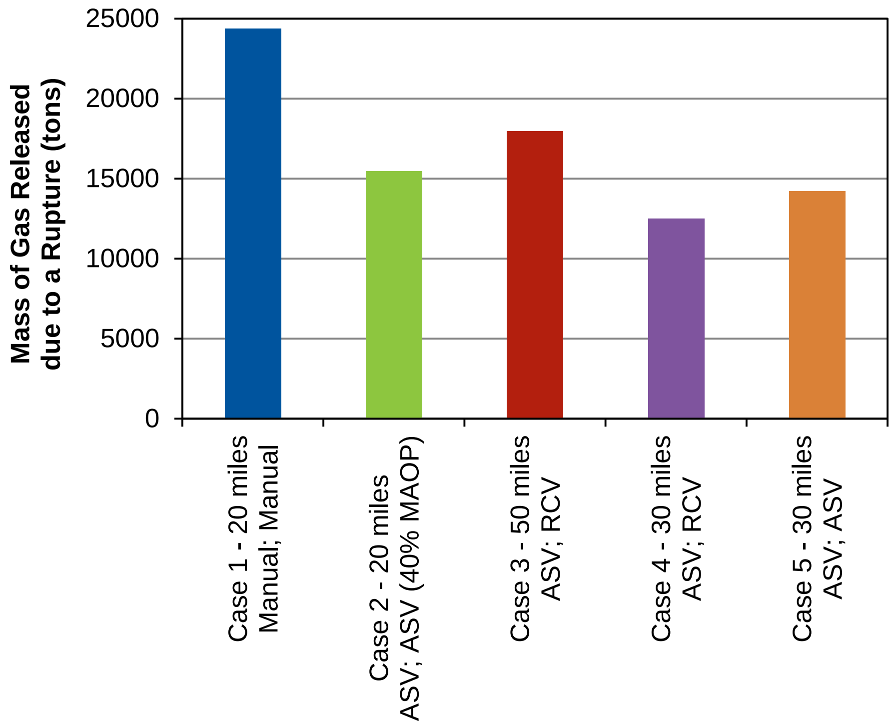

Figure 12: Total Gas Outflow

Table 4: Total Gas Outflow

[57] While the Special Permit Conditions request Class 1 MLBV spacing up to 50 miles north of Fairbanks, and 30 miles spacing south of Fairbanks, the average MLBV spacing is 42.17 miles north of Fairbanks and 24.1 miles south of Fairbanks.

Compliance with	Case	Valve Arrangement for Model	Mass of Gas Released (tons)
Part 192: Class 1	1) 20 miles spacing, non AMAOP	Manual to Manual	24,376
	2) 20 mile spacing, AMAOP segment containing HCA	ASV to ASV	15,475
Special Permit: Class 1	3) 50 mile spacing	ASV to RCV	17,984
	4) 30 mile spacing	ASV to RCV	12,526
	5) 30 mile spacing	ASV to ASV	17,256

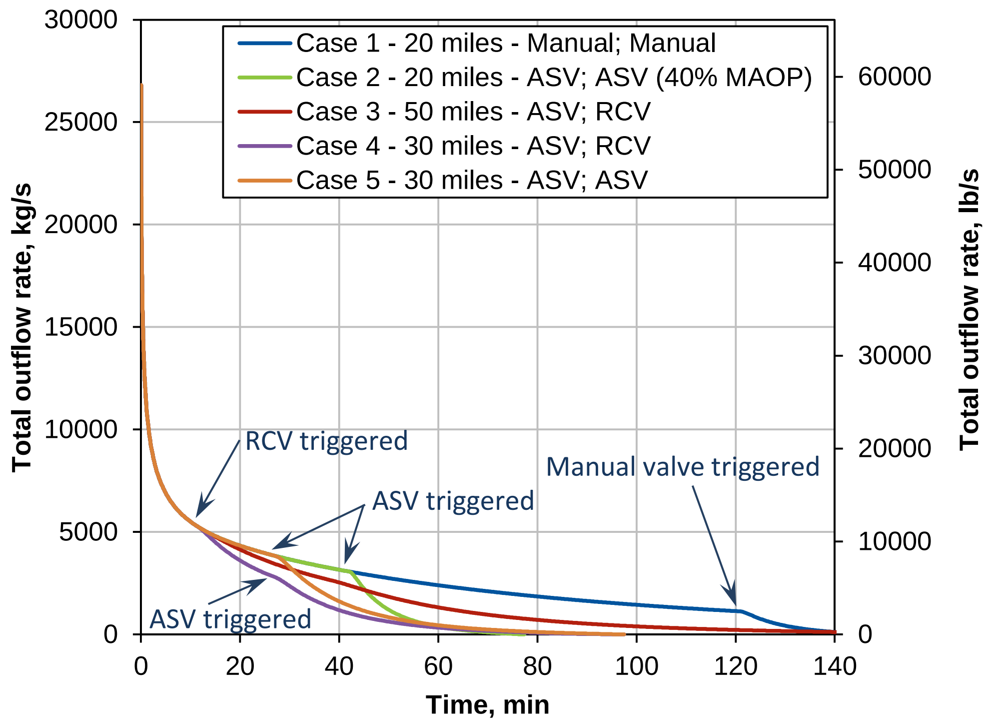

Figure 13: Gas Outflow as a Function of Time

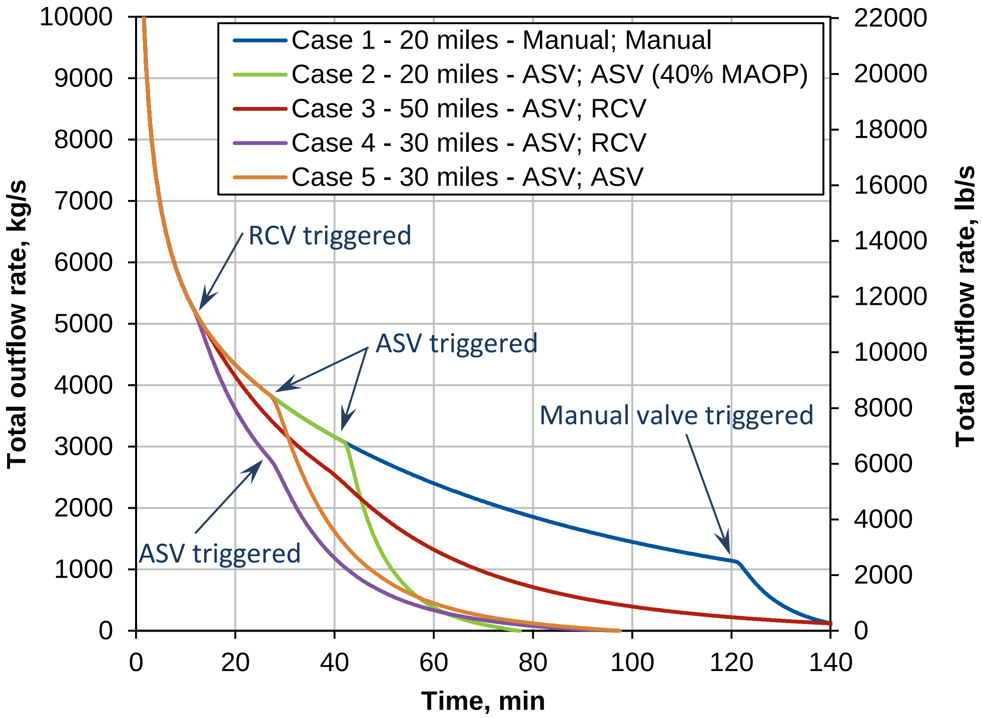

Figure 14: Gas Outflow as a Function of Time (expanded y-axis)

Table 5: Gas Outflow for Part 192 Pipeline System in Class 1 Locations

Valve Combination in Segment	# of Segments	% of Total Segments	Gas Outflow Per Segment (tons)
Manual – Manual	33	67.3	24,376
Manual – ASV[58]	8	16.3	19,925
ASV – ASV	8	16.3	15,475
		Weighted Average	**22,196**

Table 6: Gas Outflow for Pipeline System under Special Permit in Class 1 Locations

Valve Combination in Segment	# of Segments	% of Total Segments	Gas Outflow Per Segment (tons)
RCV – ASV (50 miles)	11	40.7	17,984
RCV – ASV (30 miles)	8	29.6	12,526
ASV – ASV (30 miles)	8	29.6	14,210
		Weighted Average	**15,249**

[58] The gas outflow for this valve combination is the average of Case 1 and Case 2: Manual – Manual and ASV – ASV, 20 mile Part 192 cases.

Table A: Structures, residences, and identified sites within the Class Location Buffer in Class 1 Locations along the Mainline

Mile Post	Offset (ft.)	Direction	Type	Comments
0.00				**Class 1 Start**
174.78	363	Left	Structure	DOT/PF Garage
174.85	288	Left	Structure	
174.86	296	Left	Structure	
174.86	335	Left	Structure	
174.87	542	Left	Structure	
175.12	571	Left	Structure	
236.12	494	Left	Structure	
236.12	542	Left	Structure	
236.13	547	Left	Structure	
352.79	603	Left	Associated Structure to Identified Site	Hotspot Cafe
352.80	638	Left	Identified Site	Hotspot Cafe
358.41	619	Right	Structure	
438.83	215	Left	Structure	
439.20	514	Left	Structure	
439.26	607	Left	Structure	
469.64	589	Left	Structure	
470.71	302	Right	Structure	
470.71	412	Right	Structure	
471.86	75	Left	Structure	
471.95	352	Right	Structure	
471.96	252	Left	Structure	
471.97	418	Left	Structure	
471.97	399	Right	Structure	
471.97	208	Left	Structure	
471.98	242	Left	Structure	
472.04	535	Right	Structure	
472.33	564	Right	Structure	
472.34	651	Right	Structure	
472.35	577	Right	Structure	
472.37	597	Right	Structure	
504.87	269	Left	Structure	
513.06	307	Left	Structure	
513.09	366	Left	Structure	
523.45	585	Right	Structure	
526.82	359	Left	Structure	
529.54	497	Right	Structure	

Table A: Structures, residences, and identified sites within the Class Location Buffer in Class 1 Locations along the Mainline

Mile Post	Offset (ft.)	Direction	Type	Comments
535.99				**Class 1 Stop**
536.49				**Class 1 Start**
556.31	542	Right	Structure	
556.46	587	Right	Structure	
556.48	332	Right	Structure	
556.51	177	Right	Structure	
560.07	554	Right	Structure	Denali Fly Fishing Guides
566.35	607	Right	Identified Site	DOT/PF Cantwell Station
566.47	651	Right	Structure	
566.49	511	Left	Structure	
566.50	473	Right	Structure	
566.69	394	Right	Structure	
566.69	604	Right	Structure	
566.74	654	Right	Structure	
588.74	660	Right	Structure	
588.78	337	Right	Structure	
608.64	345	Left	Structure	
608.67	212	Right	Structure	
608.69	126	Left	Structure	
634.17	523	Right	Structure	
658.27	533	Left	Structure	
664.68	581	Left	Structure	
664.78	385	Right	Structure	
665.03	476	Right	Structure	
727.78	171	Right	Structure	
764.94	648	Left	Structure	
797.13	487	Left	Structure	
797.20	204	Right	Structure	
798.65	**-**	**-**	**-**	**Class 1 stop**
801.27	**-**	**-**	**-**	**Class 1 start**
803.78	**-**	**-**	**-**	**Class 1 stop**
806.25	**-**	**-**	**-**	**Class 1 start**
806.57	**-**	**-**	**-**	**Class 1 stop**

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Feature	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
0.000	-	-	**MLBV 1 / ILI**	**RCV and ILI Launcher at GTP Meter Station**	YES	HR MFL	YES	NO
36.740			**MLBV 2**	**ASV**	YES	HR MFL	YES	NO
75.970			**MLBV 3 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	NO
80.660	693.413	Left	Structure		YES	HR MFL	YES	NO
112.040			**MLBV 4**	**ASV**	YES	HR MFL	YES	NO
148.510			**MLBV 5 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
174.781	362.934	Left	Structure	DOT/PF Garage	YES	HR MFL	YES	YES
174.851	288.344	Left	Structure		YES	HR MFL	YES	YES
174.861	295.888	Left	Structure		YES	HR MFL	YES	YES
174.861	334.869	Left	Structure		YES	HR MFL	YES	YES
174.871	542.128	Left	Structure		YES	HR MFL	YES	YES
174.901	452.343	Left	Structure		YES	HR MFL	YES	YES
175.121	570.639	Left	Structure		YES	HR MFL	YES	YES
194.000	-	-	-	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
194.090			**MLBV 6**	**ASV**	YES	YES - IMP	YES	YES
196.000	-	-	-	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
227.000	-	-	-	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
230.000	-	-	-	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
236.080	-	-	-	**HCA start**	YES	YES - IMP	YES	YES
236.115	1450.414	Left	Structure		YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	**Offset Distance**	**Direction**	**Type**	**Comments**	**Alternative MAOP § 192.620**	**HCA Subpart O**	**EMAT 3LPE SP**	**ILI-IMU (SBD-SP)**
236.115	493.732	Left	Structure		YES	YES - IMP	YES	YES
236.115	541.570	Left	Structure		YES	YES - IMP	YES	YES
236.125	547.490	Left	Structure		YES	YES - IMP	YES	YES
236.685	866.501	Left	Identified Site	Marion Creek Campground	YES	YES - IMP	YES	YES
237.330	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	YES
240.100	**-**	**-**	**MLBV 7 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
241.055	1364.489	Right	Structure		YES	HR MFL	YES	YES
257.000	**-**	**-**	**-**	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
262.000	**-**	**-**	**-**	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
270.000	**-**	**-**	**-**	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
276.000	**-**	**-**	**-**	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
286.050	**-**	**-**	**MLBV 8**	**ASV**	YES	HR MFL	YES	YES
310.409	759.874	Right	Structure		YES	HR MFL	YES	YES
310.419	820.965	Right	Structure		YES	HR MFL	YES	YES
332.640	**-**	**-**	**MLBV 9 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
352.210	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	NO
352.788	603.155	Left	Associated Structure to Identified Site	Hotspot Cafe	YES	YES - IMP	YES	NO
352.798	637.751	Left	Identified Site	Hotspot Cafe	YES	YES - IMP	YES	NO
353.350	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	NO
358.406	618.931	Right	Structure		YES	HR MFL	YES	NO
377.950	**-**	**-**	**MLBV 10**	**ASV**	YES	HR MFL	YES	NO
421.560	**-**	**-**	**MLBV 11 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
429.000	**-**	**-**	**-**	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
438.829	215.130	Left	Structure		YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
438.959	1323.801	Left	Structure		YES	YES - IMP	YES	YES
438.979	966.308	Left	Structure		YES	YES - IMP	YES	YES
439.139	937.929	Left	Structure		YES	YES - IMP	YES	YES
439.199	514.342	Left	Structure		YES	YES - IMP	YES	YES
439.199	871.954	Left	Structure		YES	YES - IMP	YES	YES
439.209	1190.731	Left	Structure		YES	YES - IMP	YES	YES
439.259	606.836	Left	Structure		YES	YES - IMP	YES	YES
439.269	1202.846	Left	Structure		YES	YES - IMP	YES	YES
439.309	970.598	Left	Structure		YES	YES - IMP	YES	YES
440.000	**-**	**-**	**-**	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
444.900	**-**	**-**	**MLBV 12**	**ASV**	YES	HR MFL	YES	YES
467.100	**-**	**-**	**MLBV 13**	**ASV**	YES	HR MFL	YES	YES
469.638	589.315	Left	Structure		YES	HR MFL	YES	YES
469.688	983.268	Left	Structure		YES	HR MFL	YES	YES
469.698	1013.879	Left	Structure		YES	HR MFL	YES	YES
469.698	927.060	Left	Structure		YES	HR MFL	YES	YES
470.688	1194.297	Right	Structure		YES	HR MFL	YES	YES
470.688	833.487	Right	Structure		YES	HR MFL	YES	YES
470.688	750.056	Right	Structure		YES	HR MFL	YES	YES
470.708	302.110	Right	Structure		YES	HR MFL	YES	YES
470.708	412.291	Right	Structure		YES	HR MFL	YES	YES
471.398	1025.061	Right	Structure		YES	HR MFL	YES	YES
471.418	701.099	Right	Structure		YES	HR MFL	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
471.858	74.750	Left	Structure		YES	HR MFL	YES	YES
471.948	351.510	Right	Structure		YES	HR MFL	YES	YES
471.958	252.314	Left	Structure		YES	HR MFL	YES	YES
471.968	662.240	Right	Structure		YES	HR MFL	YES	YES
471.968	418.049	Left	Structure		YES	HR MFL	YES	YES
471.968	399.308	Right	Structure		YES	HR MFL	YES	YES
471.968	208.456	Left	Structure		YES	HR MFL	YES	YES
471.978	242.020	Left	Structure		YES	HR MFL	YES	YES
472.038	534.520	Right	Structure		YES	HR MFL	YES	YES
472.278	753.517	Right	Structure		YES	HR MFL	YES	YES
472.328	564.065	Right	Structure		YES	HR MFL	YES	YES
472.338	650.627	Right	Structure		YES	HR MFL	YES	YES
472.348	576.589	Right	Structure		YES	HR MFL	YES	YES
472.368	597.213	Right	Structure		YES	HR MFL	YES	YES
472.378	709.757	Right	Structure		YES	HR MFL	YES	YES
492.960	**-**	**-**	**MLBV 14**	**ASV**	YES	HR MFL	YES	YES
497.827	1395.593	Right	Structure		YES	HR MFL	YES	YES
497.837	1209.974	Right	Structure		YES	HR MFL	YES	YES
497.877	1447.302	Right	Structure		YES	HR MFL	YES	YES
498.756	1156.715	Right	Structure		YES	HR MFL	YES	YES
501.372	940.710	Right	Structure		YES	HR MFL	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
502.730	1385.177	Right	Structure		YES	HR MFL	YES	YES
504.236	1395.646	Right	Structure		YES	HR MFL	YES	YES
504.866	268.975	Left	Structure		YES	HR MFL	YES	YES
505.026	1379.321	Left	Structure		YES	HR MFL	YES	YES
506.026	1338.158	Right	Structure		YES	HR MFL	YES	YES
511.071	1191.118	Right	Structure		YES	HR MFL	YES	YES
511.861	758.422	Right	Structure		YES	HR MFL	YES	YES
511.861	938.854	Right	Structure		YES	HR MFL	YES	YES
512.891	1057.428	Right	Structure		YES	HR MFL	YES	YES
513.051	759.934	Left	Structure		YES	HR MFL	YES	YES
513.061	1065.076	Left	Structure		YES	HR MFL	YES	YES
513.061	307.145	Left	Structure		YES	HR MFL	YES	YES
513.091	366.456	Left	Structure		YES	HR MFL	YES	YES
513.091	962.824	Left	Structure		YES	HR MFL	YES	YES
513.091	857.000	Left	Structure		YES	HR MFL	YES	YES
513.101	1310.699	Left	Structure		YES	HR MFL	YES	YES
513.161	1160.707	Left	Structure		YES	HR MFL	YES	YES
513.171	682.131	Left	Structure		YES	HR MFL	YES	YES
513.231	1071.053	Left	Structure		YES	HR MFL	YES	YES
514.791	1038.822	Left	Structure		YES	HR MFL	YES	YES
514.821	1232.404	Left	Structure		YES	HR MFL	YES	YES
517.620	**-**	**-**	**MLBV 15 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
523.449	584.857	Right	Structure		YES	HR MFL	YES	YES
526.821	358.843	Left	Structure		YES	HR MFL	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
529.210	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	YES
529.545	497.180	Right	Structure		YES	YES - IMP	YES	YES
529.795	933.862	Left	Identified Site	Denali RV Park and Motel	YES	YES - IMP	YES	YES
530.440	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	YES
534.790	**-**	**-**	**MLBV 16**	**ASV**	YES	HR MFL	YES	YES
535.540	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	YES
536.121	1364.558	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1367.271	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	958.285	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1266.327	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1161.797	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1423.318	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1399.269	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1340.024	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1261.126	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1311.464	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1316.986	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	702.626	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	618.503	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	559.975	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	492.383	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	424.511	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	368.043	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	313.273	Right	Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	681.205	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.121	641.979	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	611.248	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	567.412	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	466.072	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	416.674	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	470.524	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	228.138	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	735.903	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	604.075	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1101.094	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1116.019	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1126.897	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.121	1137.525	Right	Associated Structure to Identified Site	McKinley Chalet Resort / hotel	YES	YES - IMP	YES	YES
536.141	1448.972	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.141	1409.778	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.151	1434.334	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.151	1368.162	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.151	1331.527	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.151	1466.000	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.151	1398.690	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.161	1347.068	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.161	1424.684	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.161	1372.175	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.161	1384.070	Right	Structure	Cabin	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.184	1448.756	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.184	1408.043	Right	Structure	Cabin	YES	YES - IMP	YES	YES
536.184	169.516	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.184	1063.011	Right	Identified Site	Hotel	YES	YES - IMP	YES	YES
536.191	1434.237	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.191	1456.534	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.198	289.922	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.198	214.944	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.198	318.865	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.206	1341.376	Right	Associated Structure to Identified Site	Hotel	YES	YES - IMP	YES	YES
536.206	338.086	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.206	358.375	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.213	399.590	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.260	923.608	Right	Associated Structure to Identified Site	Restaurant	YES	YES - IMP	YES	YES
536.260	308.290	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.260	1095.224	Right	Structure		YES	YES - IMP	YES	YES
536.260	1176.856	Right	Structure		YES	YES - IMP	YES	YES
536.260	1035.478	Right	Structure	Clinic	YES	YES - IMP	YES	YES
536.267	1245.048	Right	Identified Site	Restaurant	YES	YES - IMP	YES	YES
536.267	356.687	Right	Associated Structure to Identified Site	Gift Shop. Tourist Attraction	YES	YES - IMP	YES	YES
536.267	979.955	Right	Associated Structure to Identified Site	Gift Shop. Tourist Attraction	YES	YES - IMP	YES	YES
536.267	1364.954	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1465.704	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.267	1440.872	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1354.821	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1242.287	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1160.787	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1096.962	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1259.654	Right	Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1397.150	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	1394.614	Right	Associated Structure to Identified Site	Denali Princess Wilderness Lodge	YES	YES - IMP	YES	YES
536.267	576.614	Right	Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	568.226	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	692.268	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	738.593	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	641.177	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	785.877	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	817.517	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	843.535	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	863.284	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	886.539	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	906.864	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	928.709	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	943.072	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	965.823	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	983.437	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.267	1001.947	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.277	1026.850	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.277	1041.755	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.287	1065.089	Right	Associated Structure to Identified Site	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.287	302.807	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.287	331.914	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.297	457.169	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.297	1105.870	Right	Structure	Gas Station	YES	YES - IMP	YES	YES
536.307	1171.193	Right	Structure	Gift Shop/ Tourist Attraction	YES	YES - IMP	YES	YES
536.307	1018.303	Right	Structure	Gas Station	YES	YES - IMP	YES	YES
536.317	1144.467	Right	Structure	Gas Station	YES	YES - IMP	YES	YES
536.337	707.586	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.337	725.239	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.337	739.682	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.337	756.585	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.337	691.699	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	779.222	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	708.888	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	796.220	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	725.695	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	814.584	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	743.157	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.347	832.429	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.357	768.551	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.357	1366.527	Right	Identified Site	Denali Gift Co	YES	YES - IMP	YES	YES
536.357	786.300	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.357	610.027	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.357	898.695	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.357	805.838	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.357	822.126	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.367	833.948	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.367	672.249	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.377	1403.333	Right	Identified Site	Salmon Bake	YES	YES - IMP	YES	YES
536.377	921.415	Right	Identified Site	Denali Crow's Nest Cabins - Lodge	YES	YES - IMP	YES	YES
536.387	755.317	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.387	775.973	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	NO	YES
536.387	888.769	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	NO	YES
536.387	796.934	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.387	907.026	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.387	924.979	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.387	939.521	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.387	823.568	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	953.406	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	840.265	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	885.176	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	851.979	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.397	970.444	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	1258.540	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.397	869.735	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	1336.175	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.397	889.178	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	1378.565	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.397	1230.213	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.397	826.175	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.397	1091.295	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.406	844.598	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	1145.766	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.406	940.558	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	955.943	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	863.539	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	974.569	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	881.327	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	1147.592	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.406	896.095	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.406	1293.300	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.416	911.151	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.416	1348.382	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.416	945.821	Right	Structure	Denali Crow's Nest Cabins - Single cabin	YES	YES - IMP	YES	YES
536.436	1242.579	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.659	1456.622	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
536.659	1465.001	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.659	1419.561	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.659	1345.136	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.659	1346.337	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.659	1408.607	Right	Structure	Denali Salmon Bake Cabins - Single cabin	YES	YES - IMP	YES	YES
536.676	1409.169	Right	Identified Site	Alpine Glow Restaurant	YES	YES - IMP	YES	YES
536.695	1015.662	Right	Structure		YES	YES - IMP	YES	YES
536.705	1348.884	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.705	1359.224	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.716	1266.304	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.716	1377.643	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.716	1287.570	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.726	1393.375	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.726	1312.934	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.726	1400.970	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.736	1422.442	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.745	1437.362	Right	Structure	Denali Bluffs Hotel - Single cabin	YES	YES - IMP	YES	YES
536.805	1099.113	Right	Identified Site	Grand Denali Lodge	YES	YES - IMP	YES	YES
536.805	992.741	Right	Associated Structure to Identified Site	Grand Denali Lodge	YES	YES - IMP	YES	YES
536.845	1170.828	Right	Associated Structure to Identified Site	Grand Denali Lodge	YES	YES - IMP	YES	YES
537.104	1437.401	Right	Structure		YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
537.311	1344.033	Right	Associated Structure to Identified Site	ERA Helicopters	YES	YES - IMP	YES	YES
537.319	1312.154	Right	Identified Site	ERA Helicopters	YES	YES - IMP	YES	YES
537.740	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	YES
538.790	**-**	**-**	**MLBV 17**	**ASV**	YES	HR MFL	YES	YES
541.000	**-**	**-**	**-**	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
544.000	**-**	**-**	**-**	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
546.500	**-**	**-**	**MLBV 18**	**ASV**	YES	HR MFL	YES	YES
551.319	1223.680	Right	Structure		YES	HR MFL	YES	YES
551.339	1457.263	Right	Structure		YES	HR MFL	YES	YES
551.340	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	YES
551.389	1202.942	Right	Structure		YES	YES - IMP	YES	YES
551.429	1357.000	Right	Structure		YES	YES - IMP	YES	YES
551.649	1376.361	Right	Identified Site	McKinley Creekside Cabins	YES	YES - IMP	YES	YES
551.649	1442.031	Right	Associated Structure to Identified Site	McKinley Creekside Cabins	YES	YES - IMP	YES	YES
551.649	1258.442	Right	Associated Structure to Identified Site	McKinley Creekside Cabins	YES	YES - IMP	YES	YES
551.649	1434.773	Right	Associated Structure to Identified Site	McKinley Creekside Cabins	YES	YES - IMP	YES	YES
551.649	957.257	Right	Associated Structure to Identified Site	McKinley Creekside Cabins	YES	YES - IMP	YES	YES
551.659	1403.543	Right	Associated Structure to Identified Site	Denali Perch Resort	YES	YES - IMP	YES	YES
551.659	1430.050	Right	Associated Structure to Identified Site	Denali Perch Resort	YES	YES - IMP	YES	YES
551.659	1459.098	Right	Associated Structure to Identified Site	Denali Perch Resort	YES	YES - IMP	YES	YES
551.859	1335.104	Right	Associated Structure to Identified Site	Denali Perch Resort	YES	YES - IMP	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
551.869	1024.641	Right	Associated Structure to Identified Site	Denali Perch Resort	YES	YES - IMP	YES	YES
552.270	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	YES
556.306	541.792	Right	Structure		YES	HR MFL	YES	YES
556.456	586.520	Right	Structure		YES	HR MFL	YES	YES
556.476	332.494	Right	Structure		YES	HR MFL	YES	YES
556.506	176.928	Right	Structure		YES	HR MFL	YES	YES
559.000	**-**	**-**	**-**	**SBD start - treat as HCA**	YES	YES - IMP	YES	YES
559.847	1379.765	Left	Structure	PowerPlant	YES	YES - IMP	YES	YES
560.067	553.748	Right	Structure	Denali Fly Fishing Guides	YES	YES - IMP	YES	YES
560.152	844.721	Left	Structure		YES	YES - IMP	YES	YES
563.000	**-**	**-**	**-**	**SBD stop - treat as HCA**	YES	YES - IMP	YES	YES
564.834	808.684	Right	Structure		YES	HR MFL	YES	YES
565.370	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	YES
566.334	1417.305	Right	Identified Site	Local Gov't building	YES	YES - IMP	YES	YES
566.354	607.089	Right	Identified Site	DOT/PF Cantwell Station	YES	YES - IMP	YES	YES
566.475	651.460	Right	Structure		YES	YES - IMP	YES	YES
566.495	511.108	Left	Structure		YES	YES - IMP	YES	YES
566.505	473.169	Right	Structure		YES	YES - IMP	YES	YES
566.694	393.787	Right	Structure		YES	YES - IMP	YES	YES
566.694	604.136	Right	Structure		YES	YES - IMP	YES	YES
566.744	654.293	Right	Structure		YES	YES - IMP	YES	YES
566.794	1042.790	Right	Structure		YES	YES - IMP	YES	YES
566.794	1361.404	Right	Structure		YES	YES - IMP	YES	YES
566.794	1017.402	Right	Structure		YES	YES - IMP	YES	YES
567.230	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	YES
572.230	**-**	**-**	**MLBV 19**	**ASV**	YES	HR MFL	YES	YES
588.741	659.675	Right	Structure		YES	HR MFL	YES	YES

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
588.741	809.900	Right	Structure		YES	HR MFL	YES	YES
588.751	754.682	Right	Structure		YES	HR MFL	YES	YES
588.771	910.265	Right	Structure		YES	HR MFL	YES	YES
588.781	337.005	Right	Structure		YES	HR MFL	YES	YES
597.350	**-**	**-**	**MLBV 20 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	YES
608.378	1389.187	Left	Structure		YES	HR MFL	YES	NO
608.388	1370.945	Left	Structure		YES	HR MFL	YES	NO
608.388	1435.223	Left	Structure		YES	HR MFL	YES	NO
608.449	1356.761	Left	Structure		YES	HR MFL	YES	NO
608.639	344.633	Left	Structure		YES	HR MFL	YES	NO
608.669	212.367	Right	Structure		YES	HR MFL	YES	NO
608.689	126.426	Left	Structure		YES	HR MFL	YES	NO
615.434	885.926	Left	Structure		YES	HR MFL	YES	NO
615.444	956.450	Left	Structure		YES	HR MFL	YES	NO
625.830	**-**	**-**	**MLBV 21**	**ASV**	YES	HR MFL	YES	NO
629.750	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	NO
630.417	1125.420	Left	Identified Site	Byers Lake Campground (73 units)	YES	YES - IMP	YES	NO
631.350	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	NO
633.750	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	NO
634.108	1448.662	Right	Identified Site	Trapper Creek Pizza Pub	YES	YES - IMP	YES	NO
634.128	1430.086	Right	Associated Structure to Identified Site	Trapper Creek Pizza Pub	YES	YES - IMP	YES	NO
634.138	729.489	Right	Structure		YES	YES - IMP	YES	NO
634.168	523.448	Right	Structure		YES	YES - IMP	YES	NO
634.500	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	NO
636.197	1244.456	Left	Structure		YES	HR MFL	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
648.160	**-**	**-**	**MLBV 22**	**ASV**	YES	HR MFL	YES	NO
650.391	1131.503	Right	Structure		YES	HR MFL	YES	NO
650.412	1379.435	Left	Structure		YES	HR MFL	YES	NO
657.690	982.432	Left	Structure		YES	HR MFL	YES	NO
658.269	532.657	Left	Structure		YES	HR MFL	YES	NO
662.527	1387.862	Left	Structure		YES	HR MFL	YES	NO
664.347	1281.851	Left	Structure		YES	HR MFL	YES	NO
664.657	1344.830	Left	Structure		YES	HR MFL	YES	NO
664.667	1007.813	Left	Structure		YES	HR MFL	YES	NO
664.677	580.700	Left	Structure		YES	HR MFL	YES	NO
664.737	1015.969	Right	Structure		YES	HR MFL	YES	NO
664.777	384.960	Right	Structure		YES	HR MFL	YES	NO
664.827	979.389	Right	Structure		YES	HR MFL	YES	NO
665.027	476.074	Right	Structure		YES	HR MFL	YES	NO
665.617	980.571	Left	Structure		YES	HR MFL	YES	NO
665.697	1431.606	Left	Structure		YES	HR MFL	YES	NO
665.697	1318.418	Left	Structure		YES	HR MFL	YES	NO
665.697	1239.486	Left	Structure		YES	HR MFL	YES	NO
665.697	767.422	Left	Structure		YES	HR MFL	YES	NO
665.697	1055.347	Left	Structure		YES	HR MFL	YES	NO
665.707	1445.577	Left	Structure		YES	HR MFL	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
665.707	725.575	Left	Structure		YES	HR MFL	YES	NO
665.807	1342.227	Left	Structure		YES	HR MFL	YES	NO
665.877	1061.861	Left	Structure		YES	HR MFL	YES	NO
675.240	**-**	**-**	**MLBV 23 / ILI**	**RCV and ILI Receiver & Launcher at Compressor Station**	YES	HR MFL	YES	NO
703.670	**-**	**-**	**MLBV 24**	**ASV**	YES	HR MFL	YES	NO
725.930	**-**	**-**	**MLBV 25**	**ASV**	YES	HR MFL	YES	NO
727.780	170.870	Right	Structure		YES	HR MFL	YES	NO
749.110	**-**	**-**	**MLBV 26**	**RCV at Heater Station**	YES	HR MFL	YES	NO
764.533	1206.066	Right	Structure		YES	HR MFL	YES	NO
764.543	1312.575	Right	Structure		YES	HR MFL	YES	NO
764.623	869.535	Left	Structure		YES	HR MFL	YES	NO
764.763	935.468	Left	Structure		YES	HR MFL	YES	NO
764.913	1411.841	Left	Structure		YES	HR MFL	YES	NO
764.923	1245.312	Left	Structure		YES	HR MFL	YES	NO
764.943	647.997	Left	Structure		YES	HR MFL	YES	NO
765.033	711.668	Left	Structure		YES	HR MFL	YES	NO
766.010	**-**	**-**	**MLBV 27**	**ASV - Cook Inlet Crossing**	**NO - OFFSHORE**	HR MFL	**YES**	NO
793.340	**-**	**-**	**MLBV 28**	**ASV - Cook Inlet Crossing**	**NO - OFFSHORE**	HR MFL	**YES**	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
797.118	1253.836	Left	Structure		YES	HR MFL	YES	NO
797.126	487.297	Left	Structure		YES	HR MFL	YES	NO
797.142	1092.068	Left	Structure		YES	HR MFL	YES	NO
797.202	203.904	Right	Structure		YES	HR MFL	YES	NO
797.570	812.135	Left	Structure		YES	HR MFL	YES	NO
797.710	**-**	**-**	**-**	**HCA start**	YES	YES - IMP	YES	NO
798.296	1245.942	Right	Associated Structure to Identified Site	Nikiski Ship Repair	YES	YES - IMP	YES	NO
798.326	1278.893	Right	Associated Structure to Identified Site	Nikiski Ship Repair	YES	YES - IMP	YES	NO
798.336	1149.639	Right	Identified Site	Nikiski Ship Repair	YES	YES - IMP	YES	NO
798.536	1447.235	Left	Identified Site	Commercial Building	YES	YES - IMP	YES	NO
798.676	722.628	Right	Identified Site	Kenai Heliport	YES	YES - IMP	YES	NO
798.696	731.606	Right	Identified Site	Kenai Heliport	YES	YES - IMP	YES	NO
799.280	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	NO
799.376	688.206	Left	Structure		YES	HR MFL	YES	NO
799.376	644.556	Left	Structure		YES	HR MFL	YES	NO
799.621	460.678	Right	Structure		YES	HR MFL	YES	NO
799.723	127.909	Right	Structure		YES	HR MFL	YES	NO
799.850	**-**	**-**	**MLBV 29**	**ASV**	YES	HR MFL	YES	NO
799.863	763.940	Left	Structure		YES	HR MFL	YES	NO
800.059	246.580	Right	Structure		YES	HR MFL	YES	NO
800.059	325.264	Right	Structure		YES	HR MFL	YES	NO
800.096	317.519	Right	Structure		YES	HR MFL	YES	NO
800.106	390.818	Right	Structure		YES	HR MFL	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
800.116	602.890	Right	Structure		YES	HR MFL	YES	NO
800.126	694.062	Right	Structure		YES	HR MFL	YES	NO
800.132	610.361	Right	Structure		YES	HR MFL	YES	NO
800.148	820.006	Right	Structure		YES	HR MFL	YES	NO
800.148	763.046	Right	Structure		YES	HR MFL	YES	NO
800.148	677.743	Right	Structure		YES	HR MFL	YES	NO
800.157	819.797	Right	Structure		YES	HR MFL	YES	NO
800.161	1042.956	Right	Structure		YES	HR MFL	YES	NO
800.303	897.006	Right	Structure		YES	HR MFL	YES	NO
800.303	1216.659	Right	Structure		YES	HR MFL	YES	NO
800.303	811.611	Right	Structure		YES	HR MFL	YES	NO
800.335	1175.533	Right	Structure		YES	HR MFL	YES	NO
800.360	818.531	Right	Structure		YES	HR MFL	YES	NO
800.369	282.554	Right	Structure		YES	HR MFL	YES	NO
800.385	1022.958	Right	Structure		YES	HR MFL	YES	NO
800.393	989.050	Right	Structure		YES	HR MFL	YES	NO
800.393	769.356	Right	Structure		YES	HR MFL	YES	NO
800.401	916.796	Left	Structure		YES	HR MFL	YES	NO
800.426	964.354	Right	Structure		YES	HR MFL	YES	NO
800.434	730.158	Right	Structure		YES	HR MFL	YES	NO
800.523	226.446	Left	Structure		YES	HR MFL	YES	NO
800.771	862.361	Left	Structure		YES	HR MFL	YES	NO
800.771	824.217	Left	Structure		YES	HR MFL	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
800.781	1038.818	Left	Structure		YES	HR MFL	YES	NO
800.811	1093.799	Left	Structure		YES	HR MFL	YES	NO
800.851	627.269	Left	Structure		YES	HR MFL	YES	NO
800.951	568.039	Left	Structure		YES	HR MFL	YES	NO
800.971	1144.506	Left	Structure		YES	HR MFL	YES	NO
801.031	1328.986	Left	Structure		YES	HR MFL	YES	NO
801.031	747.027	Left	Structure		YES	HR MFL	YES	NO
801.091	879.317	Left	Structure		YES	HR MFL	YES	NO
801.121	1440.705	Left	Structure		YES	HR MFL	YES	NO
801.141	1236.793	Left	Structure		YES	HR MFL	YES	NO
801.151	1349.082	Left	Structure		YES	HR MFL	YES	NO
801.151	763.963	Left	Structure		YES	HR MFL	YES	NO
801.191	830.241	Left	Structure		YES	HR MFL	YES	NO
801.231	696.622	Left	Structure		YES	HR MFL	YES	NO
801.261	1097.269	Left	Structure		YES	HR MFL	YES	NO
801.271	767.218	Left	Structure		YES	HR MFL	YES	NO
801.311	1351.982	Left	Structure		YES	HR MFL	YES	NO
803.390	-	-	-	**HCA start**	YES	YES - IMP	YES	NO
803.581	966.416	Left	Structure		YES	YES - IMP	YES	NO
803.601	1038.168	Left	Structure		YES	YES - IMP	YES	NO
803.621	1134.947	Left	Structure		YES	YES - IMP	YES	NO
803.890	738.224	Left	Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.890	647.575	Left	Associated Structure to Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.890	607.687	Left	Identified Site	Church	YES	YES - IMP	YES	NO
803.890	1014.752	Left	Associated Structure to Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.890	1127.155	Left	Structure		YES	YES - IMP	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
803.890	1253.988	Left	Structure		YES	YES - IMP	YES	NO
803.890	1386.302	Left	Structure		YES	YES - IMP	YES	NO
803.890	320.366	Left	Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.930	304.535	Left	Associated Structure to Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.940	692.333	Left	Associated Structure to Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.940	382.269	Left	Associated Structure to Identified Site	Commercial Building	YES	YES - IMP	YES	NO
803.980	990.758	Left	Structure		YES	YES - IMP	YES	NO
804.020	868.562	Left	Structure		YES	YES - IMP	YES	NO
804.030	595.514	Left	Structure		YES	YES - IMP	YES	NO
804.090	325.029	Left	Identified Site	Schlumberger Oilfield Services	YES	YES - IMP	YES	NO
804.130	1129.739	Left	Structure		YES	YES - IMP	YES	NO
804.180	862.664	Left	Structure		YES	YES - IMP	YES	NO
804.180	1189.416	Left	Structure		YES	YES - IMP	YES	NO
804.210	297.178	Left	Structure		YES	YES - IMP	YES	NO
804.210	450.214	Left	Structure		YES	YES - IMP	YES	NO
804.290	275.476	Left	Associated Structure to Identified Site	Baker Hughes Office	YES	YES - IMP	YES	NO
804.290	923.649	Right	Identified Site	Power Company Office	YES	YES - IMP	YES	NO
804.300	287.441	Left	Associated Structure to Identified Site	Baker Hughes Office	YES	YES - IMP	YES	NO
804.320	908.285	Right	Structure		YES	YES - IMP	YES	NO
804.330	317.062	Left	Associated Structure to Identified Site	Baker Hughes Office	YES	YES - IMP	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	**Offset Distance**	**Direction**	**Type**	**Comments**	**Alternative MAOP § 192.620**	**HCA Subpart O**	**EMAT 3LPE SP**	**ILI-IMU (SBD-SP)**
804.360	326.062	Left	Identified Site	Baker Hughes Office	YES	YES - IMP	YES	NO
804.581	590.963	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	379.925	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	522.156	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	387.165	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	665.392	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	655.891	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	595.283	Right	Associated Structure to Identified Site	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	650.479	Right	Identified Site	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	609.588	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	1370.385	Right	Structure	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	584.434	Right	Associated Structure to Identified Site	Conoco Phillips Property	YES	YES - IMP	YES	NO
804.586	164.298	Right	Structure		YES	YES - IMP	YES	NO
804.613	127.210	Right	Structure		YES	YES - IMP	YES	NO
804.613	202.059	Right	Structure		YES	YES - IMP	YES	NO
804.878	385.761	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.889	607.553	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.889	690.329	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.917	1109.260	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.917	442.449	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management			
					Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
804.917	984.216	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.917	761.901	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.936	593.779	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.936	1357.726	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.946	453.227	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.946	762.264	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.946	977.501	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.956	588.213	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.995	444.692	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.995	760.672	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
804.995	597.373	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.005	954.742	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.014	1366.509	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.014	1137.251	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.024	445.060	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.063	1090.873	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.073	443.165	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.073	634.101	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.073	1402.169	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.073	373.776	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	Offset Distance	Direction	Type	Comments	Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
805.073	190.550	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	861.045	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	663.031	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	384.161	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	1401.667	Right	Associated Structure to Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	446.794	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	151.458	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	374.393	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	153.191	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	1171.710	Right	Associated Structure to Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	1414.586	Right	Associated Structure to Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	450.933	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	447.913	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	502.589	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	868.255	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	983.806	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	1416.833	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.092	1187.820	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.098	540.389	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.306	492.350	Right	Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

Mile Post	Offset Distance	Direction	Type	Comments	Integrity Management: Alternative MAOP § 192.620	HCA Subpart O	EMAT 3LPE SP	ILI-IMU (SBD-SP)
805.306	768.252	Right	Associated Structure to Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.326	550.061	Right	Associated Structure to Identified Site	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.435	515.092	Left	Structure		YES	YES - IMP	YES	NO
805.435	1251.195	Left	Structure		YES	YES - IMP	YES	NO
805.511	726.756	Left	Structure		YES	YES - IMP	YES	NO
805.742	774.894	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.761	769.393	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.761	267.377	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.805	528.781	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.815	899.625	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.815	1107.940	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.824	579.467	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.853	893.228	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.853	1111.866	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.919	1019.961	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
805.919	492.045	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
806.039	1009.210	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
806.039	484.394	Right	Structure	Tesoro Kenai Refinery	YES	YES - IMP	YES	NO
806.050	**-**	**-**	**-**	**HCA stop**	YES	YES - IMP	YES	NO
806.119	1441.191	Left	Structure		YES	HR MFL	YES	NO
806.119	1027.524	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO

Table B: Structures, residences, and identified sites within the PIR in Class 1 Locations along the Mainline

					Integrity Management			
Mile Post	**Offset Distance**	**Direction**	**Type**	**Comments**	**Alternative MAOP § 192.620**	**HCA Subpart O**	**EMAT 3LPE SP**	**ILI-IMU (SBD-SP)**
806.119	485.627	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.129	1237.323	Left	Structure		YES	HR MFL	YES	NO
806.322	1030.197	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.322	894.746	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.322	1120.373	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.322	1075.192	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.322	661.942	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.322	616.761	Right	Structure	Tesoro Kenai Refinery	YES	HR MFL	YES	NO
806.332	1444.220	Left	Structure		YES	HR MFL	YES	NO
806.570		**-**	**MLBV 30 / ILI**	**RCV and ILI Receiver at LNG Meter Station**	YES	HR MFL	YES	NO