National Fire Protection Association

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M E M O R A N D U M

TO: NFPA Technical Committee on Liquefied Natural Gas

FROM: Elena Carroll, Administrator, Technical Projects

DATE: May 9, 2011

SUBJECT: NFPA 59A ROC TC Letter Ballot (F2011)

The ROC letter ballot for NFPA 59A is attached. The ballot is for formally voting on whether or not you concur with the committee's actions on the comments. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible but no later than **Friday, May 27, 2011.** As noted on the ballot form, please return the ballot to Elena Carroll either via e-mail to ecarroll@nfpa.org or via fax to 617-984-7110. You may also mail your ballot to the attention of Elena Carroll at NFPA, 1 Batterymarch Park, Quincy, MA 02169.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachments: Comments
Letter Ballot

59A-1 Log #35 Final Action: Hold

(3.3.x Fire Protection (New))

Submitter: Andrew Kohout, Staff of Federal Energy Regulatory Commission (FERC)

Comment on Proposal No: 59A-15

Recommendation: Revise text to read as follows:

Revise to read, "Fire protection for the purposes of this code shall be defined in the broad sense to include ~~fire~~ the prevention, ~~fire~~ detection, protection, control, ~~and~~ suppression, and response to fire and flammable hazards."

Substantiation: Fire Protection should not be limited to those above. The NFPA 550 Fire Safety Concepts would be a good and appropriate reference for what fire protection entails. It may also be beneficial to include guidance in the appendix on what the fire protection evaluation methodology should entail, which is not uncommon. NFPA 101 provides design scenarios within the body of the test. The Annex of NFPA 30 and Annex of NFPA 72 also provide guidance on structure and may be used as a basis for guidance in the 59A annex. The ISA provides technical guidance on the placement/location of Fire and Gas Detectors. The fire protection evaluations we have seen vary greatly in quality and would benefit from guidance. A committee should be formed and this should be worked on.

Committee Meeting Action: Hold

Committee Statement: The committee placed the comment on hold to allow time for a task group to review other NFPA documents and identify appropriate revisions to the ROP definition and annex material.

59A-2 Log #36 Final Action: Reject

(3.3.x Safe Area (New))

Submitter: Andrew Kohout, Staff of Federal Energy Regulatory Commission (FERC)

Comment on Proposal No: 59A-18

Recommendation: Revise text to read as followed:

Revise to read, "A safe area is a location within a LNG facility ~~or marine berth where the presence of a flammable gas~~ that minimizes ~~the hazard~~ hazards to the public, personnel, and other equipment."

Substantiation: There have been a number of recent incidents involving the venting of natural gas in an unsafe manner (e.g. Kleen Energy, ConAgra Foods, etc). Those incidents resulted in a series of recommendations by the US Chemical Safety Board to OSHA, NFPA, AGA, and other stakeholders, including a more clear definition of venting to a safe area for NFPA 54, Fuel Gas Piping. NFPA 54 enacted a TIA that better defines safety criteria for venting outdoors. In addition, in response to these tragic events, NFPA created a new Technical Committee to develop a comprehensive standard for gas process safety.

The definition has been revised from the original proposed definition. Hazards are not limited to flammable gas, but could be due to cryogenic temperatures. In addition, marine berth was stricken since a LNG facility would seem to include marine berth, therefore it did not seem necessary to explicitly include marine berth.

Committee Meeting Action: Reject

Committee Statement: The committee reaffirmed its ROP action and notes that the wording of the proposed definition is not appropriate to the context in which "safe area" is used in the document.

59A-3 Log #37 Final Action: Reject

(3.3.x Sources of Ignition (New))

Submitter: Andrew Kohout, Staff of Federal Energy Regulatory Commission (FERC)

Comment on Proposal No: 59A-19

Recommendation: Revise text to read as follows:

Revise definition similar to original proposed definition, "Sources of Ignition. Devices or equipment, or activities that, because of their intended modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable gas-air mixtures.

Substantiation: The original definition included ignition sources due to activities such as hot work, and would also encompass static ignition. The accepted definition only attributes ignition to devices or equipment.

Committee Meeting Action: Reject

Committee Statement: The committee rejected the comment because the addition of "activities" makes the usage within the document confusing in some sections.

59A-4 Log #29 Final Action: Accept in Principle

(3.3.12 G and A.3.3.12 (New))

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 59A-25

Recommendation: Revise text to read as follows:

3.3.12* G. The normal or standard constant of gravity ~~, with a value of 32.17405 ft/s^2 (9.80665 m/s^2)~~ .

A.3.3.12 G. At sea level, G equals 32.17405 ft/s^2 (9.80665 m/s^2).

Substantiation: The definition should simply contain the concept and the value should be retained in the annex. It makes sense to correct the value as proposed by the proponent.

Committee Meeting Action: Accept in Principle

~~3.3.12* G. The normal or standard constant of gravity~~ ~~, with a value of 32.17405 ft/s^2 (9.80665 m/s^2)~~ .

Committee Statement: The committee accepts the comment in principle and deletes the definition in its entirety because the only paragraph where it was used has been removed as a result of action on ROP 59A-57.

59A-5 Log #30 Final Action: Hold

(3.3.19 Noncombustible Material and 4.6)

Submitter: Marcelo M. Hirschler, GBH International

Comment on Proposal No: 59A-26

Recommendation: Revise text to read as follows:

3.3.29 Noncombustible (Material). See 4.6. [101, 2012] ~~A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. Materials that are reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, shall be considered noncombustible materials. [*101,* 2009]~~ [101, 3.3.160.3, 2012]

4.6* Noncombustible Material.

4.6.1* A material that complies with any of the following shall be considered a noncombustible material. [101, 4.6.14.1, 2012]

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. [101, 4.6.14.1(1), 2012]

(2) A material that is reported as passing ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C, shall be considered a noncombustible material. [101, 4.6.14.1(2), 2012]

(3) A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C, shall be considered a noncombustible material. [101, 4.6.14.1(3) , 2012]

A.4.6 The provisions of 4.7 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [101, A.4.6.14, 2012]

A.4.6.1(1) Examples of such materials include steel, concrete, masonry and glass. [101, A.4.6.14.1 (1), 2012]

Also add ASTM E 2652, Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C [2009] to section 2.3.4 on ASTM publications.

Substantiation: The definition in the ROP for NFPA 59A is being extracted from NFPA 220. In the new edition of NFPA 101 the committee made a change to do two things: (a) comply with the NFPA Manual of Style and ensure there are no requirements in the definition and that the definition is in a single sentence and (b) to include two ways of testing for non combustibility, namely by using ASTM E 136 or by using ASTM E 2652. The proposal recommends that the text still be extracted from NFPA 101 but that the additional text that NFPA 101 placed in section states that definitions need to be in single sentences. The second sentence in the present text is really clarification and is best placed in the annex, although it could also be placed somewhere in the body of the standard, outside of the definitions Sections 4.6.14.1 and 4.6.14.2 also be extracted.

The action, at the ROP, from the NFPA 101 committee on fundamentals can be found in the NFPA ROP for proposals 101-54a and 101-64.

The details of the NFPA 101 action at the ROP stage follow:

NFPA 101-54a Accept:

3.3.160.3* ~~3.3.160.3~~ Noncombustible (Material). A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. ~~Materials that are reported as passing ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C, shall be considered noncombustible materials.~~

~~A.3.3.160.3 See 4.6.14 for additional information on noncombustible material.~~

Substantiation: The action taken on Proposal 101-64 adds text on Noncombustible Material as a new 4.6.14 so as to permit the definition of Noncombustible Material to be simplified - removing requirements from the definition.

NFPA 101-64 Accept in Principle:

Add new text to read as follows:

4.6.14 Noncombustible Material.

4.6.14.1 A material that is reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, shall be considered a noncombustible material.

4.6.14.2 A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*, shall be considered a noncombustible material.

4.6.14.3 Where the term limited-combustible is used in this *Code*, it shall also include noncombustible.

Add ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow*

Stabilizer, at 750 Degrees C, into Chapter 2, on referenced standards.

Committee Statement: The Committee Meeting Action does what the submitter requested but rewords the title from "Combustibility" to "Noncombustible Material" as the added text speaks specifically to noncombustible materials.

At the ROC stage, NFPA 101 acted as follows (NFPA 101-31):

Replace the text of 4.6.14 as proposed by the action at the ROP Proposal 101-64 with the following:

4.6.14* Noncombustible Material.

4.6.14.1 A material that complies with any of the following shall be considered a noncombustible material:

(1)* A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat.

(2) A material that is reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C.*

(3) A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*, shall be considered a noncombustible material.

4.6.14.2 Where the term limited-combustible is used in this *Code*, it shall also include noncombustible.

A.4.6.14 The provisions of 4.6.14 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials.

A.4.6.14.1 (1) Examples of such materials include steel, concrete, masonry and glass.

3.3.xx Noncombustible Material. See 4.6.14.

The complete NFPA 101 action also includes information on a term, limited combustible, not used in NFPA 59A, and that portion is not proposed to be extracted from NFPA 101.

Committee Meeting Action: Hold

Committee Statement: The committee placed the comment on hold to allow time for further study of the NFPA 101 revision and to determine the applicability of ASTM 2652 to materials in NFPA 59A.

59A-6 Log #31 **Final Action: Accept in Principle**

(5.2.3.6)

Submitter: Frank A. Licari, Burke, VA

Comment on Proposal No: 59A-33

Recommendation: Reverse the Committee Meeting's Action to increase the lower flammability limit from 50 to 100 LFL in paragraph 5.2.3.6 in the upcoming edition of NFPA 59A.

Paragraph 5.2.3.6 shall be revised to state "The spacing of an LNG tank impoundment to the property line that can be built upon shall be such that, in the event of an LNG spill as specified in 5.2.3.7, and average concentration of methane in air of 50 percent of ~~up to~~ the lower flammability limit (LFL) does not extend beyond the property line that can be built upon, in accordance with a model that is acceptable for use."

Substantiation: There is a body of safety knowledge, data, and research that refutes the Committee Meeting's Action to allow flammable gas vapors at 100 percent LFL to reach the property line of an LNG facility. Research by Havens [1], Hanna [2], and Carissimo [3] independently concluded that theoretical vapor dispersion models underpredict test measurements of gas concentrations, as illustrated in Tables 1, 36, and 37. More recently, the Journal of Loss Prevention in the Process Industries published the paper, "Performance metrics For Evaluating LNG Vapor Dispersion Models," that statistically confirmed the likelihood of a vapor dispersion model underpredicting test measurements of gas concentrations. Increasing the flammable gas concentration that reaches an LNG facility property line from 50 to 100 percent, as adopted by the Committee, effectively eliminates the safety buffer that protects the public, property, and the environment from the hazards of a flash fire.

The above data and research provide a sharp contrast to the theoretical assertions that substantiate Proposal 59A-33 (Log #140) and the committee's actions. Claiming that a vapor fire "always burns like a flash fire" provides little comfort or margin of safety for the public, if NFPA 59A allows flammable vapors to extend to or inadvertently beyond, a property line and ignite. Furthermore, comparing the temporary hazards of LNG carrier shipments (as described in Sandia National Laboratories December 2004 report) to the permanent hazard of storing LNG too close to the public (as proposed by the Committee's Action is inappropriate and misleading.

Note: Supporting material is available for review at NFPA Headquarters.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on 59A-7 (Log #38).

59A-7 Log #38 Final Action: Accept in Principle
(5.2.3.6)

Submitter: Andrew Kohout, Staff of Federal Energy Regulatory Commission (FERC)
Comment on Proposal No: 59A-33
Recommendation: Revise text to read as follows:

Revise. "The spacing of an LNG tank impoundment to the property line that can be built upon shall be such that, in the event of an LNG spill ~~as specified in 5.2.3.7~~, the ~~average~~ predicted concentration of methane in air ~~up to the~~ of 50 percent of the lower flammability limit (LFL) shall not extend beyond the property line that can be built upon."

Substantiation: The revised definition places the focus that the $^{1}/_{2}$ LFL is due to model predictions and not the physics of igniting a flammable substance below the lower flammability limit. There is no definitive statement that clarifies how the output of a model should be adjusted to take into the account of the model uncertainty.

Specifying that only the LFL needs to be considered would be inconsistent with the acceptance criteria defined in the Model Evaluation Protocol (MEP), which is adopted by NFPA 59A for the acceptance of a dispersion model.

The MEP provides quantitative acceptance criteria for the evaluation of a model. The acceptance criteria requires that a dispersion model predicts within a factor of 2 for more than 50% of the validation data.

Requiring that model predictions are made to 1/2 LFL would make the requirements consistent with the MEP acceptance criteria.

Committee Meeting Action: Accept in Principle

5.3.3.6 The spacing of an LNG ~~tank~~ impoundment to the property line that can be built upon shall be such that, in the event of an LNG spill as specified in 5.3.3.7, a~~n average~~ predicted concentration of methane in air of 50 percent of the lower flammability limit (LFL) does not extend beyond the property line that can be built upon, in accordance with a model that is acceptable for use by the authority having jurisdiction that has been evaluated by an independent body using the Model Evaluation Protocol facilities published by the NFPA Research Foundation report Evaluating Vapor Dispersion Models for Safety Analysis of LNG.

Committee Statement: The committee modifies action on the proposals previously accepted to return to previous (TIA) edition text, with the only modifications being striking "tank" and changing "average" to "predicted". After much discussion, the committee determined that the existing language clearly describes the need for a model and for that model to be approved. The committee agrees with the submitter's substantiation that the 50% LFL level reflects the uncertainty associated with current modeling programs.

59A-8 Log #7 Final Action: Accept
(5.3.2.10)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-41
Recommendation: Revise text to read as follows:

5.3.2.10 The dike or impounding wall height and the distance from containers operating at 15 psi (~~100~~ 103 kPa) or less shall be determined in accordance with Figure 5.3.2.10.

Substantiation: The original proposed 103.5 kPa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 kPa listed in the standard and the committee proposed 105 kPa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 kPa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 5.3.2.10 but references the proposal for 7.7.5 on outer tanks in error.

Committee Meeting Action: Accept

59A-9 Log #39 Final Action: Reject
(5.3.3.x (New))

Submitter: Andrew Kohout, Staff of Federal Energy Regulatory Commission (FERC)
Comment on Proposal No: 59A-50
Recommendation: Add new paragraph before 5.3.3.7. "Provisions shall be made to minimize the potential of a flammable mixture of vapors from a design spill specified in 5.3.3.7 reaching a property line that can be built upon and that would result in a distinct hazard."
Substantiation: LNG facilities with liquefaction and NGL stripping will have flammable substances other than LNG, such as ethylene, propane, ethane, and other hydrocarbons that can pose a higher risk than LNG. The other codes referenced in NFPA 59A do not have similar siting provisions to address these risks. The philosophy of siting an LNG facility based solely on LNG releases is an inconsistent safety approach and a public safety concern.
Committee Meeting Action: Reject
Committee Statement: The committee reaffirmed its ROP action. The wording as presented was rejected because the subject is adequately addressed in 5.3.3.6. The proposed wording does not address other flammable substances because it refers to the design spill, which by definition is LNG only. In addition, sections 5.3.1.2 and 5.3.1.3 require some method of confining flammable liquids and refrigerants, such as impoundment.

59A-10 Log #32 Final Action: Accept in Principle
(5.3.3.6)

Submitter: Frank A. Licari, Burke, VA
Comment on Proposal No: 59A-46
Recommendation: Reverse the Committee Meeting's Action to increase the lower flammability limit from 50 to 100 LFL in paragraph 5.3.3.6 in the upcoming edition of NFPA 59A.
Reinstate original wording in the 2009 edition of NFPA 59A paragraph 5.3.3.6 by revising the Committee Meeting's Action to state "The spacing of an LNG tank impoundment to the property line that can be built upon shall be such that, in the event of an LNG spill as specified in 5.3.3.7, an average concentration of methane in air of 50 percent of ~~up to~~ the lower flammability limit (LFL) does not extend beyond the property line that can be built upon. The output of the model shall be adjusted by the tolerance of the model used." [The remainder of paragraph 5.3.3.6 is unchanged.]
Substantiation: See the substantiation in my Comment to Proposal 59A-33 (Log #140).
Committee Meeting Action: Accept in Principle
Committee Statement: Refer to Committee Action on 59A-7 (Log #38).

59A-11 Log #34 Final Action: Accept in Principle in Part
(5.3.3.6 and A.5.3.3.6)

Submitter: Glenn Mahnken, FM Global
Comment on Proposal No: 59A-33
Recommendation: Revise text to read as follows:

5.3.3.6* [Retain the same wording as in the 2009 edition (i.e. retain the ½ LFL limit for the determination of the exclusion zone for vapor cloud fires).]

Add new text in Annex A.5.3.3.6 as follows:

A.5.3.3.6

The LFL extent of a large vapor cloud represents a potential for harm. The American Institute of Chemical Engineers and the Center for Chemical Process Safety explain the potential for harm to personnel at the LFL distance as follows:

"*The cloud border to the Lower Flammability Limit defines a hazard zone for personnel safety; i.e. any person within the cloud LFL contour is likely to be in danger. Additionally, fuel-air clouds are often non-homogeneous in concentration and pockets of higher than average concentration can ignite outside the border as estimated by a dispersion model using a prescribed averaging time.*" ["Guidelines for Vapor Cloud Explosion, Pressure Vessel Burst, BLEVE and Flash Fire Hazards", Center for Chemical Process Safety, 2nd edition, 2010, page 80.]

This statement presumes that the cloud ignites or is likely to ignite in the presence of an ignition source at some undefined location and time where the cloud concentration is within the flammable range. The presumption of a defined accidental release and ignition of that release is characteristic of deterministic separation distances for flammable gases, even though in actuality the cloud might not ignite. In the case of vapor cloud fires, loss experience has also demonstrated that "a flammable cloud can pass over several ignition sources before igniting because not all of the cloud is in the flammable range and not all ignition sources have an immediate effect." (from *Estimating the Flammable mass of a Vapor Cloud* , by J.L. Woodward, AIChE, CCPS, 1998, page 14].

Dispersion models are only approximations of actual cloud behavior and may under-predict the LFL extent for a given design spill. The actual cloud concentration for a given design spill could be flammable outside the property line even though a dispersion model might predict the LFL extent to be at or inside the property line. If the error and uncertainty associated with model LFL predictions could be scientifically quantified as a performance metric, then an exclusion zone could be specified based on the distance where the LFL concentration has say a 95% confidence of not being exceeded. Until a performance metric is adopted by this standard, the distance to the ½ LFL has been established to provide a margin of safety to protect off site targets against engulfment in a vapor cloud fire. The ½ LFL criterion has also been reviewed in depth and supported for similar reasons by the Health and Safety Laboratory (D. Weber, "On Defining a Safety Criterion for Flammable Clouds", HSL 2007/30).

Substantiation: The ½ LFL criterion needs to be improved upon, but adopting the LFL amounts to throwing out the baby with the bathwater. The proposed adoption of the LFL as criteria for vapor cloud exclusion zone will potentially expose personnel, emergency responders and the public outside the property line to harm from vapor cloud fires associated with the design spill. The new Annex material above provides a rationale for the ½ LFL criteria. If the TC in its wisdom decides in favor of the LFL, I hope the proponents will provide a supporting rationale in the form of an Annex statement to explain to 59A users why the new LFL criteria is deemed to be safe for the purposes of the standard.
A performance metric for dispersion model predictions has recently been proposed (F. Licari, "A performance metric for evaluating liquefied natural gas, vapor dispersion models," Journal of Loss Prevention in the Process Industries 23 (2010) 745e752. We should consider using this metric as a more scientific alternative to the ½ LFL.

Committee Meeting Action: Accept in Principle in Part

A.5.3.3.6 The 50% LFL level reflects the uncertainty associated with current modeling programs. One model that has been used to calculate methane concentrations in air is described in GRI Report 0242, "LNG Vapor Dispersion Prediction with the DEGADIS Dense Gas Dispersion Model."

Committee Statement: The committee agrees that further information on the selection of the 50% LFL level is useful to the user of the document. However, the committee does not see the need for the level of detail provided by the submitter.

59A-12 Log #6 Final Action: Hold
(5.3.4.2)

Submitter: Takashi Niwa, JGC Corporation
Comment on Proposal No: N/A
Recommendation: Revise text to read as follows:

5.3.4.2 Full and double construction LNG storage containers of greater than 70,000 gal (265 m3) water capacity shall be separated from adjoining LNG storage containers such that a fire in one container or impoundment will not cause loss of containment from adjacent containers. This shall be accomplished by ensuring that no part of the adjacent storage container roof, walls, or its impoundment structure reaches a temperature at which the strength of the material of the container roof, wall, or its impoundment is reduced to a level where the LNG tank, roof, or impoundment loses its structural integrity.

The application of engineering analyses shall be used to determine this temperature by including the following conditions in the analyses:

(1) The analyses shall be performed for the following:

(a) A fire involving the complete loss of containment of a container to an impoundment area that complies with the requirements of 5.3.2.1

(b) A fire over the whole surface of the liquid contained in the tank, assuming the roof is completely lost. The whole liquid surface fire for the full containment tank made of concrete (both wall and roof) is considered only if specifically required, i.e., very low probability.

(C) Pressure relief valve tail fire

(2) The analyses shall account for the following:

(a) The duration of the fire, the radiant heat emission characteristics of the fire, and the physical attributes of the fire under the anticipated atmospheric conditions

(b) The atmospheric conditions producing the maximum separation distances shall be used except for conditions that occur less than 5 percent of the time based on recorded data for the area and using a LNG fire model in accordance with 5.3.3.4

(c) Active or passive systems to reduce thermal heat flux incident on the surface or to limit the surface temperature

(d) The materials, design, and methods of construction of the target LNG tank being analyzed.

Substantiation: For full and double containment container, an analysis is required to ensure that no part of adjacent tank is damaged by thermal radiation by a fire in the container. For this analysis, the section specifies a fire over the whole surface of the liquid contained in the tank assuming the roof is completely collapsed.
As per the definition of full containment container in Chapter 3, full containment container includes containers with secondary container wall and roof made of steel or concrete. However, we believe that this requirement is based on steel roof tank only. The scenario of whole liquid surface fire for the full containment container, which wall and roof is made of concrete, is too conservative scenario and It will result in excessively large spacing between tanks.

EN1473 (Installation and equipment for liquefied natural gas - Design of onshore installation) specifies the difference of the credible scenario between steel and concrete. Especially for the full containment tank made of concrete (both wall and roof), the whole liquid surface fire is considered only if specifically required, i.e., very low probability.
The deterministic scenario of whole liquid surface fire by collapse of roof does not reflect the actual industry experience and it makes the selection of full containment concrete roof and wall tank not technically justified. Full containment tanks with concrete roof and wall are selected for safety reasons based on LNG industry common practices and as demonstrated by historical data.

Committee Meeting Action: Hold
Committee Statement: The comment is put on hold because it is new material and would benefit from public review in the next full revision cycle. The committee recognizes the need to differentiate the susceptibility of failure between concrete and steel roofs in the next full revision cycle.

59A-13 Log #CC1 Final Action: Accept
(5.4.1, 5.4.2, and A.5.4.1(1))

Submitter: Technical Committee on Liquefied Natural Gas,
Comment on Proposal No: 59A-52
Recommendation: Revise 5.4 to read:

5.4.1 Buildings and Structures Design Category. Buildings and structures shall be classified in accordance with the following:

(1)* Classification I. Buildings and structures as defined in 7.3.2.5(1) and 7.3.2.5(2).
~~Included would be control rooms, tank system foundations, structures supported by the storage tank, structures supporting piping on the storage tank and structures supporting piping up to the tank isolation valve.~~

(2) Classification II. Buildings and structures supporting or enclosing equipment and piping that contain flammable or toxic materials.

(3) Classification III. All other Buildings and structures

5.4.2 Buildings and structures design. Buildings and structures shall be designed for seismic, wind, ice and snow in accordance with ~~the following~~ 5.2.4.1 through 5.2.4.3.:

5.2.4.1. **Classification I.** Seismic design shall use the OBE and SSE ground motions as defined in ~~clause~~ 7.3.2 for determination of loads to be used per ASCE-7~~:~~, wind, ice, and snow design shall use an occupancy category of IV per ~~the~~ ASCE-7.

5.2.4.2. **Classification II.** Seismic, wind, ice, and snow design shall use an occupancy category of III per the ASCE-7.

5.2.4.3. **Classification III.** Seismic, wind, ice, and snow design shall use an occupancy category of II per the ASCE-7.

2. Add a new A.5.4.1 to read:

A.5.4.1 (1). Examples of buildings and structures included in Classification I are control rooms, tank system foundations, structures supported by the storage tank, structures supporting piping on the storage tank, and structures supporting piping up to the tank isolation valve.

Substantiation: Editorial revisions to comply with the NFPA Manual of Style.
Committee Meeting Action: Accept

59A-14 Log #8 Final Action: Reject
(7.3.2.1(1))

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-61
Recommendation: Revise text to read as follows:

7.3.2.1(l) The deterministic limit on MCE ground motion shall be taken as the response spectrum determined in accordance with the provisions of ASCE 7, Minimum Design Loads for Buildings and Other Structures, with the value of SS (mapped MCE spectral response acceleration at short periods) taken as 1.5 ~~G~~ g, the value of S1 (mapped MCE spectral response acceleration at 1 second) taken as 0.6 ~~G~~ g, and the values of Fa (short-period site coefficient at 0.2 second) and Fv (long-period site coefficient at 1 second) selected for the site class most representative of the subsurface conditions where the LNG facility is located.

Substantiation: The current notation in NFPA 59A 7.3.2.1 “G” (which ASCE 7 defines as the average shear modulus for soils beneath the foundation at large strain levels (units are pounds per square foot or Pascal’s)) is inappropriate for use in 7.3.2.1, and should be replaced with “g” which ASCE-7 defines as a unit of acceleration (feet per second squared ft/s2).
Committee Meeting Action: Reject
Committee Statement: The comment is rejected because this paragraph was removed during the proposal stage in ROP 59A-57.

59A-15 Log #9 Final Action: Accept
(7.3.6)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-62
Recommendation: Revise text to read as follows:
7.3.6 Filling Volume.
Containers designed to operate at a pressure in excess of 15 psi (~~100~~ 103 kPa) shall be equipped with a device(s) that prevents the container from becoming liquid full or from covering the inlet of the relief device(s) with liquid when the pressure in the container reaches the set pressure of the
relieving device(s) under all conditions.
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.3.6 but references the proposal for 7.7.5 on outer tanks in error.
Committee Meeting Action: Accept

59A-16 Log #10 Final Action: Accept
(7.4.1)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-63
Recommendation: Revise text to read as follows:
7.4.1 Containers Designed for Operation at 15 psi (~~100~~ 103 kPa) and Less.

Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.4.1 but references the proposal for 7.7.5 on outer tanks in error.
Committee Meeting Action: Accept

59A-17 Log #11 Final Action: Accept
(7.4.1.1)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-64
Recommendation: Revise text to read as follows:
7.4.1.1 Welded containers designed for not more than 15 psi (~~100~~ 103 kPa) shall comply with API 620, Design and Construction of Large, Welded, Low-Pressure Storage Tanks.
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.4.1.1 but references the proposal for 7.7.5 on outer tanks in error.
Committee Meeting Action: Accept

59A-18 Log #12 **Final Action: Accept**
(7.4.2)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-65
Recommendation: Revise text to read as follows:
7.4.2 Containers Designed for Operation at More Than 15 psi (~~100~~ 103 kPa).
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.4.2 but references the proposal for 7.7.5 on outer tanks in error.
Committee Meeting Action: Accept

59A-19 Log #13 **Final Action: Accept**
(7.4.2.4(B)(1))

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-68
Recommendation: Revise text to read as follows:
7.4.2.4(B)(1) The ASME Boiler and Pressure Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of not less than 15 psi (~~100~~ 103 kPa).
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.4.2.4(B)(1) but references the proposal for 7.7.5 on outer tanks.
Committee Meeting Action: Accept

59A-20 Log #14 **Final Action: Accept**
(7.4.2.4(C))

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-69
Recommendation: Revise text to read as follows:
7.4.2.4(C) Heads and spherical outer tanks that are formed in segments and assembled by welding shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of 15 psi (~~100~~ 103 kPa).
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 100 Kpa listed in the standard and the committee proposed 105 Kpa are both inaccurate. To align with the new API 625 and current Canadian LNG standard, a value of 103 Kpa should be considered. Furthermore, the committee meeting action is not related to the proposal effecting 7.4.2.4(C) but references the proposal for 7.7.5 on outer tanks in error.
Committee Meeting Action: Accept

59A-21 Log #15 **Final Action: Accept**
(7.7.3)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-73
Recommendation: Revise text to read as follows:
7.7.3 Shop-fabricated containers designed for pressures in excess of 15 psi [103 kPa(g)] shall be pressure tested by the manufacturer prior to shipment to the installation site.
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates. Furthermore, the committee meeting action text is not related to the proposal effecting 7.7.3 but references the proposal for 7.7.5 in error.
Committee Meeting Action: Accept

59A-22 Log #16 **Final Action: Accept**
(7.7.4)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-74
Recommendation: Revise text to read as follows:
7.7.4 The inner tank of field-fabricated containers designed for pressures in excess of 15 psi [103 kPa(g)] shall be tested in accordance with the ASME Boiler and Pressure Vessel Code or CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates. Furthermore, the committee meeting action is not related to the proposal effecting 7.7.4 on inner tanks but references the proposal for 7.7.5 on outer tanks.
Committee Meeting Action: Accept

59A-23 Log #17 **Final Action: Accept**
(7.7.5)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-75
Recommendation: Revise text to read as follows:
7.7.5 The outer tank of field-fabricated containers designed for pressures in excess of 15 psi [~~105~~ 103 kPa(g)] shall be tested in accordance with Section 9.7.
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates.
Committee Meeting Action: Accept

59A-24 Log #18 Final Action: Accept in Principle
(9.4.2.9)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-92
Recommendation: Revise text to read as follows:
9.4.2.9 Where power-operated isolation valves are installed, the closure time shall not produce a hydraulic shock capable of causing pipe stresses that can result in pipe ~~line~~ or equipment failure.
Substantiation: The original proposed text was not captured as indicated in the Committee Action on 59A-85, Log 170, (piping chapter re-write). Original proposed text should be considered and acted on separately from the committee indicated 59A-85 Log 170. This proposed text is important to retain as it was deleted in proposal 59A-93 Log 58 (accepted by the TC) based on its relocation in the original 9.4.2.9 proposal.
Committee Meeting Action: Accept in Principle
9.4.2.9 Where power-operated ~~isolation~~ valves are installed, the closure time shall not produce a hydraulic shock capable of causing stresses that can result in piping ~~line~~ or equipment failure.
Committee Statement: The committee deleted the reference to isolation valves because other power-operated valves, that are not categorized as isolation valves, should have the same requirement. The committee changed the "pipe" to "piping" to reflect that the concern is failure of any part of the piping system, not just the pipe itself.

59A-25 Log #19 Final Action: Accept
(9.9.1(a) (New))

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-97
Recommendation: Add text to read as follows:
9.9.1(a) Safety relief systems (piping and valves) shall be designed, installed, and tested in accordance with ASME B31.3, ASME B31.3 322.6, and this section 9.9 in its entirety.
Substantiation: The original proposed text was accepted in principle in log 61 to be part of the rewrite, but was not captured as indicated in the Committee Action on 59A-85, Log 170. Therefore, the original proposed text should be considered and acted on separately from the committee indicated 59A-85 Log 170.
The original proposal was to add new 9.9.1 and retain, renumber original 9.9.1 through 9.9.3.2 accordingly to follow. The proposed new text provides improved identification of safety relief system requirements through specific reference to applicable standards and sections of those standards.
Committee Meeting Action: Accept

59A-26 Log #20 Final Action: Accept in Principle
(12.4.4)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-136
Recommendation: Revise text to read as follows:

12.4.4 ~~The detection systems shall be designed, installed, and maintained in accordance with NFPA 72, National Fire Alarm Code.~~ When installed as determined by the evaluation required in 12.2.1, the following detection system components shall be designed, installed, documented, tested, and maintained in accordance with NFPA 72, National Fire Alarm Code or as approved by the AHJ:

(1) Initiating devices (detectors – smoke, flame, heat, etc.),
(2) Fire system controllers and monitoring panels,
(3) Notification appliances (strobes, sirens, etc),
(4) Fire system activation devices on installed extinguishment/suppression systems (water deluge, fixed dry chemical systems, etc.),
(5) Field wiring between initiating, notification components, activation/suppression system, controllers, and monitoring panels,
(6) Power supply and backup power equipment for fire alarm system
(7) Any devices determined necessary in the evaluation required by 12.2.1 which are not already identified in 12.4.4 (1)-(6) and is covered by NFPA 72, those additional devices shall be designed, installed, documented, tested, and maintained in accordance with NFPA 72.

Substantiation: The proposed clarifies requirements in NFPA 72 for increased safety of the facilities fire system based on a set of standard requirements and gives an alternate approach via a AHJs approval.

The proposal as written is based on the experience of LNG operators installing NFPA 72 compliance systems and brings clarity as to which components must comply with NFPA 72 National Fire Alarm Code. NFPA 72 is applicable to many different types of facilities, much of which aimed at public areas of assembly such as apartment complex's and high rise buildings. The proposal aids LNG facility owner/operators in understanding the requirements applicable to an industrial process facility such as an LNG facility. To address the committee statement, 12.4.4(7) was added to ensure the proposed does not limit the coverage of NFPA 72. Finally, a similar proposal was submitted to the NFPA 59 Utility LP-Gas Code Technical Committee which has been approved for publication in the next edition of NFPA 59. Both NFPA 59A LNG and NFPA 59 Propane facilities serve similar roles in industry and present similar hazards and should be held to similar standards requirements.

Committee Meeting Action: Accept in Principle

12.4.4 The detection systems shall be designed, installed, and maintained in accordance with NFPA 72, National Fire Alarm Code.

A.12.4.4.When installed as determined by the evaluation required in 12.2.1, the following detection system components should be designed, installed, documented, tested, and maintained in accordance with NFPA 72, National Fire Alarm Code or as approved by the AHJ:

(1) Initiating devices (detectors – smoke, flame, heat, etc.),
(2) Fire system controllers and monitoring panels,
(3) Notification appliances (strobes, sirens, etc),
(4) Fire system activation devices on installed extinguishment/suppression systems (water deluge, fixed dry chemical systems, etc.),
(5) Field wiring between initiating, notification components, activation/suppression system, controllers, and monitoring panels,
(6) Power supply and backup power equipment for fire alarm system
(7) Any additional devices covered by NFPA 72 that are determined necessary in the evaluation required by 12.2.1

Committee Statement: The committee retained the mandatory text as written and added the more specific information to the annex.

59A-27 Log #21 **Final Action: Accept**
(13.3.10(1))

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-142
Recommendation: Revise text to read as follows:
13.3.10(1) The ASME Boiler and Pressure Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of not less than 15 psi (~~105~~ 103 kPa)
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates. Furthermore, the committee meeting action is not related to the proposal effecting 13.3.10(1) but references the proposal for 7.7.5.
Committee Meeting Action: Accept

59A-28 Log #22 **Final Action: Accept**
(13.3.11)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-143
Recommendation: Revise text to read as follows:
13.3.11 Heads and spherical outer tanks that are formed in segments and assembled by welding shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of 15 psi (~~100~~ 103 kPa).
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates. Furthermore, the committee meeting action is not related to the proposal effecting 13.3.11 but references the proposal for 7.7.5.
Committee Meeting Action: Accept

59A-29 Log #23 **Final Action: Accept**
(13.4)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-146
Recommendation: Revise text to read as follows:
13.4 Container Filling.
Containers designed to operate at a pressure in excess of 15 psi (~~100~~ 103 kPa) shall be equipped with a device(s) that prevents the container from becoming liquid full or the inlet of the relief device(s) from becoming covered with liquid when the pressure in the container reaches the set pressure of the relieving device(s) under all conditions.
Substantiation: The original proposed 103.5 Kpa value is precise as it relates to 15 psi, and while I agree with the TC that the value is a soft metric conversion, the current 103 Kpa listed in the standard should be retained and the committee proposed 105 Kpa should be rejected as it is inaccurate. The value of 103 Kpa should be retained and not changed to 105 as committee action indicates. Furthermore, the committee meeting action is not related to the proposal effecting 13.4 but references the proposal for 7.7.5.
Committee Meeting Action: Accept

59A-30 Log #CC5 Final Action: Accept
(13.8.4.5(C)(2) and 14.11.4(2))

Submitter: Technical Committee on Liquefied Natural Gas,
Comment on Proposal No: 59A-165
Recommendation: Revise as follows:
(2) Fire protection water systems shall be maintained in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems; NFPA 14, Standard for the Installation of Standpipe and Hose Systems; NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection; NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection; NFPA 22, Standard for Water Tanks for Private Fire Protection; ~~and~~ NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances; and NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems.
Substantiation: The committee added reference to NFPA 25 because the scope is specific to inspection, testing and maintenance of water-based fire protection systems.
Committee Meeting Action: Accept

59A-31 Log #24 Final Action: Accept
(14.6.3)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-169
Recommendation: Revise text to read as follows:
14.6.3 The terminal operator shall certify in writing that the provisions of 14.14.1.2 and 14.14.1.3~~13.18.2.6~~ are met. ~~before transfer of LNG begins.~~

Substantiation: During the revision from 2006 to 2009, the referenced paragraphs were not maintained correctly and should be restored to the references from the 2006 revision. Additionally, this requirement is similar to the requirement of 33 cfr 127.301(b) and is not required to be documented for each LNG transfer but only once to verify the qualification of the LNG transfer personnel.
Committee Meeting Action: Accept

59A-32 Log #28 Final Action: Accept
(Chapter 15)

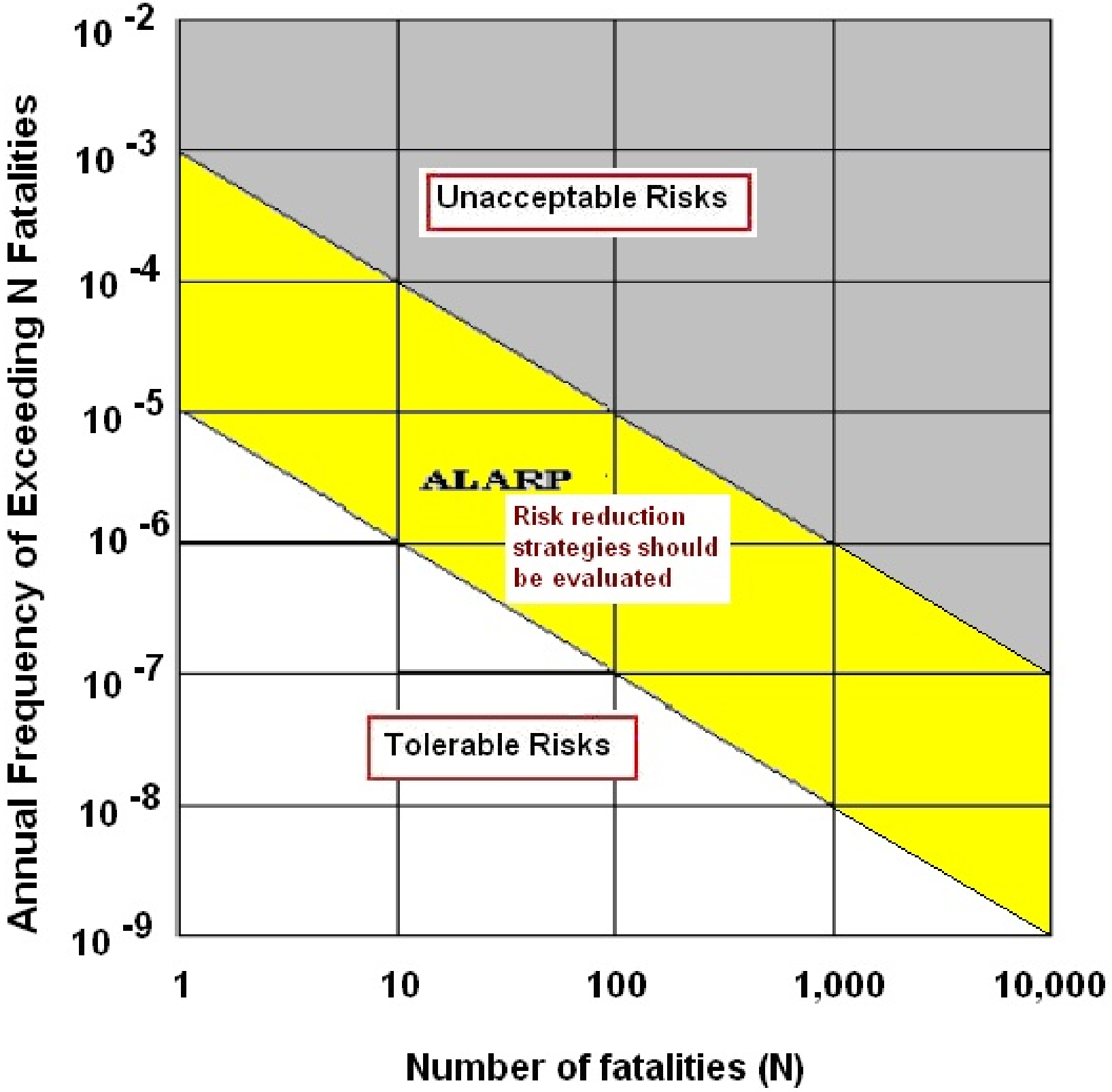
Submitter: Francis J. Katulak, Distrigas of Massachusetts, LLC
Comment on Proposal No: 59A-181
Recommendation: In support of the proposal, use of risk-based regulations for siting LNG facilities exist in a large majority of jurisdictions outside the U.S. Non-U.S. jurisdictions that require risk-based analysis who use NFPA 59A require operators to use both the prescriptive NFPA 59A with another risk-based code, usually European. This leads to difficulty for both regulators and project proponents. The lack of a mandatory risk-based standard inhibits the objective of NFPA to develop globally applicable standards.
Substantiation: None given.
Committee Meeting Action: Accept

59A-33 Log #41 Final Action: Accept in Principle
(Chapter 15)

Submitter: Phani K. Raj, Technology & Management Systems, Inc.
Comment on Proposal No: 59A-181
Recommendation: Add new text to read as follows:
The task force on Risk Analysis had submitted to the committee draft language for inclusion in a new chapter 15. As a part of this draft several definitions were proposed. The Committee accepted the task force proposal and said:
3 Add to Chapter 3, the following definitions associated with the requirements in the new Chapter 15, to read:
The RoP has omitted the inclusion of these definitions in Chapter 3. These definitions should be added to chapter 3.
Substantiation: The omission of the definition of terms (occurring in Chapter 15) should be corrected.
Committee Meeting Action: Accept in Principle
15.3 Definitions. The following definitions shall apply only to usage in Chapter 15. (renumber subsequent)
15.3.1* As Low as Reasonably Practicable (ALARP). The level of risk that represents the point, objectively assessed, at which the time, difficulty and cost of further reduction measures become unreasonably disproportionate to the additional risk reduction obtained.
A.15.3.1 Refer to United Kingdom Health and Safety Executive publication "Reducing Risks, Protecting People" available for free download from http://www.hse.gov.uk/risk/theory/r2p2.pdf.
15.3.2 Event. The combination of successive outcomes of LNG, flammable fluids, flammable refrigerants or toxic material release and its subsequent hazard to persons exposed.
15.3.3* Individual Risk. The frequency, expressed in number of realizations per year, at which an individual, with continuous potential exposure, may be expected to sustain a serious or fatal injury.
A.15.3.3 A serious injury is any detrimental outcome of an event to a person exposed to or affected by the LNG or other in-plant hazardous material release, which results in the person requiring first-aid (to preserve life) or being treated and kept in a medical facility for at least 24 hours.
15.3.4 Societal Risk. The cumulative risk exposure by all persons sustaining serious or fatal injury from an event in the LNG plant.
15.8.2.2* The societal risk values shall be presented in the form of cumulative annual frequency of exceedance of a specified number of fatalities vs. number of ~~casualties~~ (~~fatalities~~).
Change column 1 title in Table 15.9.1 as follows: Criterion Annual ~~Probability~~ Frequency
Change the title of Table 15.9.2 as follows: Table 15.9.2: Criteria for tolerability of Societal (~~injury~~fatalities) Risks.
Change column 1 title in Table 15.9.2 as follows: Criterion Annual ~~Probability~~ Frequency
Change note to Table 15.9.2 as follows: (F= Annual probability of experiencing N or more ~~injuries~~ fatalities)
Modify Figure 15.9.2 as shown:

Insert Fig 15_9_2 LOG 41_Here

A.15.8.2.2 The fatalities alluded to in this section are only those caused as a direct consequence of, and occurring within a short period of time after exposure to hazards associated with LNG or other hazardous materials released from a LNG plant.
Committee Statement: The committee reviewed and revised the proposed definitions that were overlooked in the publishing of the ROP. The definitions were placed in a section in chapter 15 to insure that some terms that are used elsewhere in the standard, such as "event", could be defined specifically for the context of chapter 15. The definitions were revised to reflect input from multiple sources on risk assessment. The figure was revised to extend the ALARP region at the same slope because limiting the ALARP region would unnecessarily restrict the siting of plants where additional mitigation measures could be taken. Annex material was added to several paragraphs to provide additional guidance and background for users.


Annual Frequency of Exceeding N Fatalities
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
10 -9
Unacceptable Risks
ALARP
Risk reduction strategies should be evaluated
Tolerable Risks
1
10
100
1,000
10,000
Number of fatalities (N)

59A-34 Log #CC2 Final Action: Accept
(Chapter 15)

Submitter: Technical Committee on Liquefied Natural Gas,
Comment on Proposal No: 59A-181
Recommendation: Reverse committee action on ROP 59A-180 and reaffirm ROP action on 59A-181 to delete Annex E in its entirety.
Substantiation: The purpose of the committee comment is to clarify the intent of the committee to delete Annex E and accept the new chapter 15 as published in the Report on Proposals. The task group reports that the the committee action in ROP 59A-181 incorporated the substance of the modifications made in ROP 59A-180 into the new chapter 15.
Committee Meeting Action: Accept

59A-35 Log #CC3 Final Action: Accept
(Chapter 15)

Submitter: Technical Committee on Liquefied Natural Gas,
Comment on Proposal No: 59A-181
Recommendation: A.15.5.1 Some additional references for failure rate data of equipment items are listed below:
• OREDA: Contains data for use in reliability, availability and maintainability studies - failure rates, failure mode distribution and repair times for equipment (Reference: OREDA, Offshore Reliability Data Handbook 4th Edition, SINTEF, 2002)
• Reliability Data for Control and Safety Systems, 1998, SINTEF Industrial Management, Trondheim, Norway
• CCPS Process Equipment Reliability Database. The database is only open to CCPS members but some data are available in the book Guidelines for Process Equipment Reliability Data (CCPS 1989). Guidelines for Process Equipment Reliability Data, CCPS, 1989
• FMD-97, Failure mode / Mechanism Distributions, 1997, Reliability Analysis Center, Rome, NY
• NPRD-95, Nonelectronic Parts Reliability Data, 1995, Reliability Analysis Center, Rome, NY
• IEEE Std. 500, IEEE Guide To The Collection and Presentation Of Electrical, Electronic, Sensing Component, And Mechanical Equipment Reliability Data For Nuclear-Power Generating Stations, 1984, IEEE, New York, NY
• Johnson, E.M. and Welker, J. R., “Development of an Improved LNG Plant Failure Rate Data Base”, GRI-80/0093, Gas Research Institute, Chicago, IL, USA, 1980.

Some references for leak frequency data are listed below:
• Hydrocarbon Releases (HCR) Database, UK Health and Safety Executive, with the following associated documents:
o Offshore hydrocarbon releases statistics and analysis, 2002, HID statistics report, HSR 2002 002, February 2003, HSE
o Revised guidance on reporting of offshore hydrocarbon releases, OTO 96 956, November 1996, HSE
o Supplementary Guidance for Reporting Hydrocarbon Releases, September 2002, UKOOA
• MHIDAS (Major Hazard Incident Data Service): database maintained by AEA Technology, Warrington
• Purple Book, Guidelines for quantitative risk assessment – CPR 18E, RVIM, 1999
• E&P Forum Hydrocarbon Leak Database (Reference: Quantitative risk assessment datasheet directory, E&P Forum Report N0 11.8/250, October 1996)
• Lees "Loss Prevention in the Process Industry”. Loss Prevention in the Process Industry, Frank P Lees, 2nd edition, 1996, ISBN 0750615478 (Note 3rd edition published 2005)
Substantiation: The committee added references to assist users in finding data.
Committee Meeting Action: Accept

59A-36 Log #40 Final Action: Accept in Principle
(15.2.2)

Submitter: Phani K. Raj, Technology & Management Systems, Inc.
Comment on Proposal No: 59A-181
Recommendation: Modify the text as indicated
15.2.2 The requirements of this chapter shall be used to assess the level of risks to surrounding population to ensure that the individual risk to a person located ~~near~~ in areas surrounding the plant and the societal risk do not exceed tolerable levels
Substantiation: The word “near” is very nebulous and implies only close to the plant. The risk can, potentially, extend to larger distances than that can be considered as “near.” Hence the suggested change.
Committee Meeting Action: Accept in Principle
15.2.2 The requirements of this chapter shall be used to assess the level of risks to surrounding population to ensure that the individual risk ~~to a person located near the plant~~ and the societal risk do not exceed tolerable levels in accordance with section 15.9.
Committee Statement: The committee modified the wording by taking out the vague reference to "near" and referring to the section where risk levels are established.

59A-37 Log #42 Final Action: Accept in Principle
(15.3.1)

Submitter: Phani K. Raj, Technology & Management Systems, Inc.
Comment on Proposal No: 59A-181
Recommendation: Add new text to read as follows:
Add an additional sub item to section 15.3.1 as follows:
(5) Other QRA methods that are recognized in risk analysis literature
Substantiation: The identified methodologies for QRA in section 15.3.1 do not constitute the universe of QRA procedures indicated in the risk analysis literature. In any case the procedure to be used has to be approved by an AHJ (see 15.3.2)
Committee Meeting Action: Accept in Principle
A.15.3.1 The list of methodologies here is not intended to override the Equivalency clause of 1.3. Users, with sufficient documentation and approval of the Authority Having Jurisdiction, should be permitted to use alternate methodologies.
Committee Statement: The Committee rejected the comment text because it is redundant to the Equivalency clause of 1.3 and added a reference to the Annex to further direct users to the Equivalency clause.

59A-38 Log #CC4 Final Action: Accept
(A.1.5)

Submitter: Technical Committee on Liquefied Natural Gas,
Comment on Proposal No: 59A-5
Recommendation: Revise as follows:
A.1.5 If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value should be regarded as the requirement. A given equivalent value should be considered to be approximate.
Substantiation: The committee added the annex note to clarify the use of SI conversions throughout the document.
Committee Meeting Action: Accept

59A-39 Log #25 Final Action: Accept
(Annex B)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-179
Recommendation: Revise text to read as follows:
Replace existing Annex B with that identified in the ROC Explanation of Negative statement by B. Eisentrout.
Substantiation: AGA supports the proposed Annex text offered by B. Eisentrout shown in the ROC Explanation of Negative statement. The update of this appendix is necessary as the seismic design criteria changed and the standard is planned for revision to include changes.
Committee Meeting Action: Accept
Annex B Seismic Design of LNG Plants
This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.
B.1 Introduction. The purpose of Annex B is to provide information on the selection and use of operating basis earthquake (OBE), safe shutdown earthquake (SSE) and Aftershock level Earthquake (ALE) seismic levels. These three seismic levels form part of the requirements of this standard for the design of LNG containers, system components required to isolate the container and maintain it in a safe shutdown condition, and any structures or systems the failure of which could affect the integrity of the aforementioned.

B.2 Operating Basis Earthquake (OBE). The OBE is a probable earthquake to which a facility can be subjected during its design life. All elements of the facility defined in 7.3.2.5 are designed to withstand this event in accordance with conventional engineering procedures and criteria, and, therefore, the facility is expected to remain in operation. The OBE is defined as ground motion having a 10 percent probability of exceedance within a 50-year period (mean return interval of 475 years). For design, this motion is typically represented by design response spectra covering the appropriate ranges of natural period and damping ratio. The OBE design response spectrum is not adjusted by an importance factor. Following any event with a magnitude greater than OBE, the facility is expected to be evaluated for permanent damage and repaired as necessary.

B.3 Safe Shutdown Earthquake (SSE).
B.3.1 The SSE ground motion is the "risk-adjusted maximum considered earthquake (MCE_R) ground motion," per the definition in ASCE 7, Minimum Design Loads for Buildings and Other Structures. For most locations, except possibly those near active faults, the MCE_R is determined by adjustment from ground motion that has a 2 percent probability of exceedance in a 50-year period, to ground motion that achieves targeted risk requirements. The ASCE 7 adjustment establishes a uniform probability of failure criteria (1% chance of collapse in 50 years) for structures designed in accordance with the seismic provisions of ASCE 7-10. In this standard, the LNG facility is designed to contain the LNG and prevent catastrophic failure of critical facilities under an SSE event. This more onerous performance criteria is achieved through design requirements of API 625, API 620 Appx L and ACI 376 which have established response reduction factors to prevent collapse at the design level ground motion.

ASCE 7 requires the base design level earthquake to be 2/3 of MCE_R. Setting the importance factor, I, equal to 1.5 (corresponding to structures containing extra hazardous materials) results in a design level equal to MCER Thus SSE = MCE_R, as required by this standard is consistent with ASCE 7-10 provisions for the design level ground motion. Design of critical facilities to this standard exceeds the design performance requirements of ASCE 7.
The facility is not required to remain operational following the SSE event.

B.3.2 The objective of the selection and use of the SSE is to provide a minimum level of public safety in the event of a very low probability seismic event. It is recognized that the required probability level to achieve acceptable public safety varies from project to project, depending on such factors as location and population density. It is desirable to allow the owner flexibility in achieving the required level of public safety.

B.3.3 The SSE level of seismic loading is to be used for a limit state check on the specified components. The specified SSE is the minimum level of ground motion that must be used for the analysis. The actual level must be specified by the owner, and when used in conjunction with other considerations, such as location, siting, type of impounding system, hazard control, local climatic conditions, and physical features, it must be sufficient to ensure adequate public safety to the satisfaction of the regulatory authorities. A risk analysis study is recommended. At the SSE level of seismic loading,

primary components of the LNG container are permitted to reach the stress limits specified in 7.4.4.8 An LNG container subjected to this level of loading must be capable of continuing to contain a full volume of LNG.

B.3.4 The impounding system must, as a minimum, be designed to withstand the SSE level of loading while empty and the ALE level of loading while holding the volume, V, as specified in 7.4.4.7. The rationale is that should the LNG container fail following an SSE, the impounding system must remain intact and be able to contain the contents of the LNG container when subjected to an aftershock.

B.3.5 Systems or components, the failure of which could affect the integrity of the LNG container, the impounding system, or the system components required to isolate the LNG container and maintain it in a safe shutdown condition, must be designed to withstand an SSE.

B.3.6 The operator is required to install instrumentation capable of measuring ground motion at the plant site. Following an earthquake that produces ground motion equal to or greater than the design OBE ground motion, it is advisable that the operator of the facility either take the LNG container out of service and have it inspected or prove that the LNG container components have not been subjected to loading in excess of the container's OBE stress level and design criteria. For instance, if the LNG container was partially full during the seismic event, calculations can prove that the container OBE stress levels were not exceeded.

B.4 Aftershock Level earthquake
The aftershock level earthquake (ALE) ground motion is defined as 50% of the SSE ground motion.

B.5 Design Response Spectra. Using the OBE and SSE ground motions as defined in Section B.2 and B.3.1, respectively, vertical and horizontal design response spectra must be constructed that cover the entire range of anticipated damping ratios and natural periods of vibration, including the fundamental period and damping ratio for the sloshing (convective) mode of vibration of the contained LNG.

B.6 Other Seismic Loads.
B.6.1 Small LNG plants consisting of shop-built LNG containers and limiting processing equipment should be designed for seismic loading using the ground motion specified by ASCE 7, Minimum Design Loads for Buildings and Other Structures. Either a structural response analysis should be performed or an amplification factor of 0.60 should be applied to the maximum design spectral acceleration (SDS), as defined in 7.5.2.1 to determine the loads on the vessels or piping.

B.6.2 All other structures, buildings and process equipment must be designed for the seismic loading as determined by the classification and occupancy category in accordance with 5.4.1 and 5.4.2 and ASCE 7, Minimum Design Loads for Buildings and other Structures.

Committee Statement: The result of the comment is to strike existing Annex B and replace with the text from B. Eisentrout's negative ballot as shown here.

59A-40 Log #26 Final Action: Reject
(Annex E)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-180
Recommendation: No text.
Substantiation: AGA supports the proposed edits to Annex "E" as it relates to development of "Risk-Based Alternative Plant Siting" requirements if the text remains in Annex E (non-mandatory) at this time.
Committee Meeting Action: Reject
Committee Statement: The committee reaffirmed its ROP action and refers to action on Log #43. It is important to permit a performance-based alternative in the Standard. The Fire Protection Research Foundation is in the process of pursuing a guidance document for the industry and authorities having jurisdiction. It is also important to note that use of the performance-based alternative still requires approval of the authority having jurisdiction. The Committee also intends to request a modification or an additional Research Foundation project to develop and analyze scenarios using the performance-based alternative.

59A-41 Log #27 Final Action: Reject
(Annex E)

Submitter: Nneka Assing, American Gas Association
Comment on Proposal No: 59A-181
Recommendation: No text.
Substantiation: AGA is opposed to the relocation of annex E to a new mandatory Chapter 15. While AGA is supportive of the development of alternative risk based siting criteria and its inclusion in the non-mandatory annex "E", AGA does not believe the climate is appropriate to list risk based siting criteria in the mandatory chapter of NFPA 59A. AGA would reconsider our support in the future if after the new risk based siting requirements from Annex "E" were applied in an actual siting of a new LNG facility. This would validate the process and its acceptance with AHJ's and the public. AGA supports the proposed edits to Annex "E" as it relates to development of "Risk-Based Alternative Plant Siting" requirements if the text remains in Annex E (non-mandatory) at this time.
Committee Meeting Action: Reject
Committee Statement: See Committee Action on 59A-43 (Log #43). The committee reaffirmed its ROP action. It is important to permit a performance-based alternative in the Standard. The Fire Protection Research Foundation is in the process of pursuing a guidance document for the industry and authorities having jurisdiction. It is also important to note that use of the performance-based alternative still requires approval of the authority having jurisdiction. The Committee also intends to request a modification or an additional Research Foundation project to develop and analyze scenarios using the performance-based alternative.

59A-42 Log #33 Final Action: Reject
(Annex E)

Submitter: Frank A. Licari, Burke, VA
Comment on Proposal No: 59A-181
Recommendation: Reverse the Committee Meeting's Action to:
1) delete the entire Annex E, "Performance based Alternative Standard for Plant Siting," in the current (2008 edition of NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG); and
2) add a new "Chapter 15 - Performance (Risk Assessment) Based LNG Plant Siting."
Implement all corrections adopted by the Committee Meeting's Action for Annex E in Proposal 59A-180 (Log #141).
Incorporate into Annex E all new and revised text that was adopted by the Committee Meeting's Action for Chapter 15.
Convert all statements within Annex E to non-mandatory language for consistency.
Substantiation: Among those who explained their ballots, a uniform consensus exists that Proposal 59A-181 (Log #142) "is good but needs significant modification" to obtain stakeholder acceptance. Practitioners of societal risk analyses realize that the language and methodology for risk-based plant siting must be prescriptive and rigorous to obtain consistent and credible results. Although the current committee proposal is an improvement, it still fails to :

- quantify the likelihood of human error and its consequences,
- evaluate how action and passive safety systems may degrade over time,
- consider the plausibility of cascading failures,
- delineate how risk values for releases and related consequences and combined properly, and
- ensure construction practices meet performance standards and achieve annual failure probabilities.

For these reasons, the language, performance standards, and acceptance criteria adopted in Proposals 59A-180 (Log #141) and 59A-181 (Log #142) shall continue as a non-mandatory standards.
Contrary to the assertion in the Substantiation and Committee Statement for Proposal 59A-181 (Log #142), the language, performance standards, and acceptance criteria for this proposal are unproven and unexplained to many stakeholders. Until an independent panel of risk management experts with direct experience in quantifying societal risk and related consequences vet Annex E thoroughly, it should remain a non-mandatory standard.
Committee Meeting Action: Reject
Committee Statement: Refer to Committee Action on 59A-43 (Log #43). The committee reaffirmed its ROP action. It is important to permit a performance-based alternative in the Standard. The Fire Protection Research Foundation is in the process of pursuing a guidance document for the industry and authorities having jurisdiction. It is also important to note that use of the performance-based alternative still requires approval of the authority having jurisdiction. The Committee also intends to request a modification or an additional Research Foundation project to develop and analyze scenarios using the performance-based alternative.

59A-43 Log #43 Final Action: Reject
(Annex E)

Submitter: Terry L. Turpin, Federal Energy Regulatory Commission
Comment on Proposal No: 59A-181
Recommendation: Delete text to read as follows:
Make the entire contents of Annex E "Performance-based Alternative Standard for Plant Siting" an annex to the 59A standard and not a new Chapter 15 in the mandatory part of the 59A standard.
Substantiation: An acceptable risk-based siting methodology must produce consistent results by different parties for the same scenario. Establishing specific assumptions/databases/models on which to base the risk methodology is critically important in ensuring that results are consistent from analyst to analyst and between jurisdictions. Until "reproducibility" is demonstrated for the method in Annex E, the approach should remain as an annex.
This is further supported by the October 2008 Request for Proposals for the "Development of a Quantitative Risk Assessment Methodology Protocol for LNG Facilities Siting" by the Fire Protection Research Foundation (FPRF). According to the FPRF, user guidance is needed for the Annex E risk based approach under consideration by the 59A technical Committee for use as an alternative siting method.
As stated by the FPRF, "there are many QRA methodologies suggested in the industry such as those reported in the US AICHE's Center of Chemical Process Safety (CCPS), the Dutch TNO Purple Book, and the UK HSE Safety Case Guidelines. Consequently, there is no consistency in the application of QRA due to the following reasons: failure rate data used are different for each method and there is no methodology available to adjust failure data for alternative sites; consequence models used are different for each method; and assumptions used in developing hazard scenarios and different for each method."
As a result the FPRF was seeking assistance in developing a step by step QRA methodology in a form suitable to apply in NFPA 59A for siting an LNG facility and in creating user guidance including worked examples to illustrate the application of the method. These issues need to be addressed before Annex E should be moved to a new Chapter 15 within the mandatory part of the 59A standard.
Committee Meeting Action: Reject
Committee Statement: The committee reaffirmed its ROP action. It is important to permit a performance-based alternative in the Standard. The Fire Protection Research Foundation is in the process of pursuing a guidance document for the industry and authorities having jurisdiction. It is also important to note that use of the performance-based alternative still requires approval of the authority having jurisdiction. The Committee also intends to request a modification or an additional Research Foundation project to develop and analyze scenarios using the performance-based alternative.