DEPARTMENT OF TRANSPORTATION

Materials Transportation Bureau

[49 CFR Part 193]

[Docket No. OPSO-46; Notice 4]

LNG FACILITIES; FEDERAL SAFETY STANDARDS

Development of New Standards

AGENCY: Materials Transportation Bureau, DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: This notice proposes establishment of a set of comprehensive safety standards governing the design (including site selection) and construction of liquefied natural gas (LNG) facilities used in the transportation of natural gas by pipeline in or affecting interstate or foreign commerce. Present safety standards are considered inadequate in light of the grave consequence that could result from a major accident at a facility. The new standards would provide safety through a combination of engineering features and sufficient area around a facility to protect the nearby population.

DATE: Comments must be received by May 9, 1979.

ADDRESS: Send comments to the Docket Branch, Room 6500, Materials Transportation Bureau, Trans Point Building; 2100 Second Street, S.W., Washington, D.C. 20590. Comments should identify the docket and notice number and be submitted in triplicate. They will be available to the public for review at the above location.

FOR FURTHER INFORMATION CONTACT:

Walt Dennis, 202-426-2082.

SUPPLEMENTARY INFORMATION: The Materials Transportation Bureau (MTB) believes that a new comprehensive set of safety standards is needed for LNG facilities. LNG is natural gas (mostly methane) that has been cooled to about minus 260°F, where it is a liquid. As a liquid, natural gas is 1/600th of its original volume, making it economically feasible to transport by vehicle or vessel and store in large quantities. The hazards of LNG derive from its cold temperature, flammability, and characteristics upon release. LNG can cause severe freeze burns and immediate cracking of certain metals such as carbon steel. Upon exposure to ground temperatures, LNG vaporizes rapidly and returns to a gaseous state. The vapor may remain close to the ground and travel in the form of a plume or cloud dispersed into the atmosphere. While the vapor is not poisonous, it can cause asphyxiation, and it is flammable in a concentration in air between 5 and 15 percent.

The standards proposed by this notice concerns the design (including site selection) and construction of facilities used to liquefy natural gas or to transfer, store, or vaporize LNG in conjunction with the pipeline transportation of natural gas. If adopted, they would be published in a new Part 193 of Title 49 of the Code of Federal Regulations. Standards for the operation, including security, and maintenance of LNG facilities will be the subject of a notice of proposed rulemaking to be issued in March 1979. These standards also would be included in Part 193.

The intent of the new Part 193 would be to prescribe an acceptable level of public safety with regard to LNG facilities in consideration of the hazards of LNG and the potential causes and consequences of accidents and the steps that may be taken to safeguard against them. In most cases, Part 193 would provide for employee safety only to the extent that it is affected by measures required for public safety.

Each of the proposed standards relates to a potential accident cause. For example, weak structures, faulty construction, installation defects, fires or spills of LNG near components, and environmental forces (high winds, earthquakes) can cause accidents or worsen an existing hazardous condition resulting from some other cause. The proposed standards would prescribe actions needed to minimize or prevent (1) the occurrence of accidents due to controllable causes (e.g., faulty construction) or uncontrollable causes (e.g., earthquakes) and (2) the potentially damaging effects of accidents that may occur. Some standards would require redundant or back-up measures for extra protection, as in the case of manual and automatic shut-off valves. Because of the severity of potential consequences, even more special precautions would have to be taken to prevent accidents which could result in failure of an LNG storage tank.

If an accident were to result in a spill of LNG, under the proposed Subpart E a second level of protection would be provided by impounding systems that are designed to hold LNG and prvent it from endangering other components, entering neighboring property, or rapidly turning to gas. Since there is a threat of ignition once LNG is released, Part 193 also would provide a final level of safety through safe distances around a facility. (§§ 193.107 and 193.109) These distances would protect persons who live or work near the facility site by providing enough room for flammable gas to dissipate or enough separation from the heat of burning LNG at the site.

The need for comprehensive new Federal LNG facility safety standards arises because of the seriousness of potential hazards from LNG facilities coupled with the anticipated increase of LNG facility construction to meet the nation's energy needs, and the developing variations in the design of facilities near population centers, or areas of greatest energy demand. Congressional committees, the General Accounting Office, the Federal Energy Regulatory Commission and other Federal, State, and Local agencies; nongovernment organization; representatives of industry; and the public in general have expressed concern over the adequacy of present standards to provide for public safety.

A report issued on July 31, 1978, by the General Accounting Office titled "Liquefied Energy Gases" (EMD 78-28) shows some of the safety concerns in the transportation and storage of LNG. Foremost among these are: (1) protection of persons and property near an LNG facility from thermal radiation (heat) caused by ignition of a major spill of LNG, (2) protection of persons and property near an LNG facility from dispersion and delayed ignition of a natural gas cloud arising from a major spill of LNG, and (3) reduction of the potential for a catastrophic spill of LNG.

The existing Federal safety standards governing LNG facilities used in the transportation of natural gas by pipeline are contained in 49 CFR Part 192. These standards were adopted by Amendment 192-10, issued on Oceober 10, 1972 (37 FR 21638). The Amendment added § 192.12, adopting as the Federal LNG safety standards the National Fire Protection Association (NFPA) Standard 59A (1971 edition), as well as the other applicable requirements of Part 192. Subsequently, the 1972 edition of NFPA 59A was adopted (41 FR 13590).

In the preamble of Amendment 192-10, it was stated that the NFPA standard was adopted only as an interim measure while permanent Federally developed regulations specifically applicable to LNG facilities were being developed. MTB believes that there is a need for Federally developed regulations for LNG facilities because the present referenced standards are not written in enforceable terms and do not adequately cover all safety problems respecting an LNG facility.

In 1974, the Department's Office of Pipeline Safety contracted for a study by Arthur D. Little, Inc. (ADL) to provide safety information on LNG facilities (NTIS No. PB-241048). The study included a comparative analysis of national, state, local, industrial, and professional society codes, standards, practices, and regulations relating to LNG facilities. The ADL report, made in December 1974, is titled "Technology and Current Practices for Processing, Transferring, and Storing Liquefied Natural Gas." Copies of the report (NTIS No. PB-241048) are available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151, telephone (703) 557-4650, in paper for $7.75 and in microfiche for $3.00. A copy is also available for review in the docket.

The ADL study provides useful information in developing safety standards for LNG facilities. The study identified and analyzed many areas of public concern about the operation of LNG facilities. It also addressed many practices and functions where special precautions are needed to protect persons and property. MTB believes that the results of the ADL study are consistent with current information obtained from other sources. Therefore, MTB has adopted the ADL report as a basis for this regulatory action.

The ADL report found that NFPA 59A was the basis for practically all national, state and local codes for LNG facilities. MTB agrees with this conclusion and has used the 1975 edition of the NFPA 59A, in part, as a basis for these proposed regulations. The following tables shows that 59A derivation of standards proposed in this notice:

SUBPART A

Section	Source
193.1	100, 11
193.2	110, 111
193.3	102
193.5	12, 50
193.7	107
193.10	—
193.11	—

SUBPART B

Section	Source
193.101	—
193.103	—
193.105	200
193.107	210, 2120, 2122, 2123, 2124
193.109	210, 2121, including reference 1, 300, 330
193.111	406 including reference 1, 601
193.113	200(3), 200(4), 410, 411
193.115	200(4), 2301, 410
193.117	200(3), 410, 411
193.119	200(3)
193.121	200(4)
193.123	200, 213, 214, 215, 216

SUBPART C

Section	Source
193.201	—
193.203	310, 403, 4060, 4123, 601, 602, 603, 610
193.205	310, 402, 403, 610
193.207	2113, 2200, 360, 404, 4123, 6112, 630
193.209	407, 6112
193.211	337
193.213	6113
193.215	423
193.217	220, 407, 4123
193.219	655

SUBPART D

Section	Source
193.301	—
193.303	2113, 23, 24, 406, 41, 421, 601
193.305	622, 671
193.307	600, 610, 611, 661, 64
193.309	63
193.311	22
193.313	221
193.317	602, 603
193.319	24, 314, 7330
193.321	250, 6225
193.323	75, 76
193.325	763
193.327	331, 338
193.329	333

SUBPART E

Section	Source
193.401	—
193.403	2101, 2114
193.405	2100
193.407	2100
193.409	2113
193.413	(2114 NFPA 59A, 1972 ed.)
193.415	2113
193.417	—
193.419	2115
193.421	—
193.423	926
193.427	2116
193.431	2116
193.433	—
193.435	63
193.437	2110
193.439	2110
193.441	2120(d), 2111
193.443	201
193.445	201

SUBPART F

Section	Source
193.501	—
193.503	—
193.505	401, 402, 405, 411
193.507	802
193.509	411
193.511	—
193.513	401, 47
193.515	401, 47
193.517	—
193.519	402
193.521	410
193.523	24
193.525	407
193.527	70, 71, 73
193.529	4110, 4121
193.531	42
193.533	4123
193.535	4122(f), 4123, 4124, 4126
193.537	4125
193.539	43

SUBPART G

Section	Source
193.601	—
193.603	800, 801, 811
193.605	524, 525, 850, 810
193.607	812
193.609	8603
193.611	8605, 870, 871, 872, 873, 821, 880
193.615	84, 851, 8612, 8614, 8611
193.617	801, 845, 6224

SUBPART H

Section	Source
193.701	—
193.703	—
193.705	510, 511
193.711	522, 7310
193.713	52
193.715	53
193.719	54, 55

SUBPART I

Section	Source
193.801	—
193.803	—
193.805	6224
193.807	711
193.809	812
193.811	3370
193.813	34
193.815	36

SUBPART J

Section	Source
193.901	—
193.903	—
193.905	334, 335, 35, 67
193.907	—
193.909	926
193.911	926
193.915	82
193.917	622
193.919	741
193.921	—
193.925	740
193.927	—

SUBPART K

Section	Source
193.1001	—
193.1002	4000
193.1004	—
193.1005	654
193.1009	23
193.1011	400
193.1013	23, 400, 424, 440, 441, 65
193.1015	—
193.1017	623, 624
193.1019	6124
193.1023	23, 400, 424, 440, 441, 65
193.1025	650, 332
193.1027	65
193.1029	440
193.1031	—
193.1033	4000, 411, 424
193.1037	651, 654, 655

In April 1977, MTB issued an Advance Notice of Proposed Rulemaking (ANPRM) (42 FR 20776, April 21, 1977) inviting public participation at an early stage in the rulemaking process for adoption of new Federal safety standards in 49 CFR Part 193. Although that notice was not a proposal to amend the present standards, it contained a comprehensive set of draft regulations which were intended to serve as a basis for public comment and participation in identification of LNG safety problems and the development of appropriate regulatory solutions to those problems, considering all reasonable alternatives. Subsequently, a correctional notice was published at 42 FR 24758; and a third notice (42 FR 42235, August 22, 1978) extended the comment period to December 1, 1978, and set forth a bibliography of resource information.

The notice of proposed rulemaking (NPRM) is based on Subparts A through K of the ANPRM. These subparts provide a broad coverage of closely related proposed standards for the design and construction of new facilities and parts of existing facilities that are replaced, relocated, or significantly altered. Interested persons can meaningfully comment on this body of proposed standards, since the remaining standards to be proposed for inclusion in Part 193 should not have a significant impact on design and construction.

Persons interested in LNG safety were particularly urged to submit comments regarding those draft regulations in the ANPRM which related to the safety problems mentioned above since those problems involve highly technical fields and LNG spill characteristics which are still being researched. Comments were also solicited on other safety problems and on environmental and economic issues; and persons were asked to support their comments with rationale and documentation, and where appropriate, to propose alternative regulations that would provide an acceptable level of safety.

To ensure that the new Part 193 does not result in costs to the private sector, consumers, or government above those necessary to provide an acceptable level of public safety, in the ANPRM, MTB also encouraged interested persons to submit information on the annual and aggregate costs, benefits, and other anticipated impacts associated with each of the draft regulations and all alternatives which commenters might suggest thereto. The information received has enabled MTB to adequately consider the impact of this rulemaking proposal early in the developmental process. A Draft Evaluation of the impact is in the docket for this proceeding in accordance with the Departmental procedures for improving regulations (43 FR 9582, March 8, 1978). MTB has determined that a Regulatory Analysis is not required under those procedures.

DRAFT EVALUATION REVIEW

The Draft Evaluation, prepared by Booz-Allen and Hamilton, is an impact analysis of the costs and benefits of the alternative potential Federal regulations affecting the sitting, design, and construction of new liquefied LNG facilities. These alternatives are:

- This Notice of Proposed Rulemaking.
- Standard 59A of the National Fire Protection Association (1975 edition).
- Recommendations made in the General Accounting Office Report EMD-78-28.
- The Advance Notice of Proposed Rulemaking issued by MTB on April 21, 1977.

For this impact analysis, the NFPA Standard 59A (1975 edition) was used as the baseline regulatory standard against which the incremental facility costs, safety benefits, employment and environmental effects, and effects on consumers of the other alternative LNG regulations were measured. Standard 59A was considered to be the baseline because it is the minimum standard that normally would be observed if the MTB does not adopt a different one. Impacts were measured for five representative facilities which included baseload, peakshaving, and satellite facilities. Projections of costs and benefits were then made for two levels of planned LNG facilities, a minimum of 6 and a maximum of 64, assumed to be built from 1979 to 1998. In addition, the actual costs of constructing the five facilities were investigated.

The Booz-Allen report concludes that the majority of sections of the NPRM regulatory alternative would not significantly affect the costs of new LNG facilities. Without considering the probability of an accident occuring, the Booz-Allen analysis indicates that a wide range of potential benefits exist. At the lower end of this range, the benefit of avoiding a 10 cubic meter spill of LNG at a remotely located satellite facility in terms of reduced accident costs is estimated at $1.5 million. At the upper end the benefit of avoiding maximum spill and ignition at a large peak-shaving facility in a densely settled area is estimated to be $29 billion.

Of the 130 sections of the NPRM analyzed, 95 sections would involve no incremental costs when compared to baseline safety standards, but 21 of these sections would have major incremental benefits. Of the remaining 35 sections, the Booz-Allen report concludes that 22 sections would have minor incremental costs. Seven of these NPRM sections would produce major benefits while the rest would have minor benefits. Thirteen NPRM sections would create a major incremental cost of more than $50,000 per component of an LNG facility. Eleven of these sections were subjected to a detailed quantitative analysis of their costs and benefits because they comprise the bulk of overall cost impacts. The eleven sections are: § 193.107, *Thermal Radiation Protection;* § 193.109, *Flammable Vapor Gas Dispersion Protection;* § 193.111, *Seismic Investigation and Design;* § 193.113, *Flooding;* § 193.117, *Wind Forces;* § 193.423, *Gas Leak Detection;* § 193.511, *Penetrations;* § 193.513, *Internal Design Pressure;* § 193.535, *Support Systems;* § 193.1027, *Non-Destructive Tests;* and § 193.1033, *Storage Tank Tests.*

Over the next 20 years, the incremental costs (in 1977 dollars, discounted at 10 percent) of these 11 NPRM sections range from $275 million to $502 million for the minimum and maximum estimated level of planned facilities. The annualized cost over the 20-year period ranges from $29 million to $54 million per year. These cost estimates are based on an operator's choosing to purchase or lease land to comply with the proposed vapor dispersion zone under § *193.109.* Buying or leasing land under § *193.109* would represent 80 percent of the incremental costs of these 11 NPRM sections. If the compliance alternative of planned vapor ignition were chosen (§ *193.109(e)*) instead of land acquisition, the 20-year incremental costs would be reduced to either $55 million or $106 million, depending on the number of facilities, and annualized costs could be as low as $6 million. It is important to note that the planned ignition alternative is intended for situations where it would be impractical to provide a vapor dispersion zone (either by land acquisition or zoning) and an operator's plan would have to be approved by MTB.

The aggregate incremental costs of the 11 costly sections shown in the Draft Evaluation are based on an estimated cost of compliance with each section viewed in isolation from the other sections. Because of the many complex design options that might be used at a new facility, the Evaluation does not attempt to relate one section to another to determine where estimated costs or benefits may overlap (although the Evaluation acknowledges a cost overlap with regard to land acquisition under §§ *193.107* and *193.109*). For the same reason, the Evaluation does not indicate how costs might be minimized through design innovations or options. Hereafter, in the discussion with regard to the 11 costly sections, MTB has pointed out ways that compliance costs might be mitigated either through available design options or because compliance with one section may offset the cost of another section. The views of interested persons are particularly invited with regard to the possible cost savings.

The costs and benefits provided herein are intended to provide guidance to what must eventually be a difficult decision. LNG has the potential to play a substantial role in meeting the Nation's future energy needs. In recognizing this, however, we must also recognize that there is a vital need to examine the risks associated with the movement and storage of LNG, and to provide the full measure of protection to the public. What is sought here is to establish the most reasonable alternative, among many difficult ones, or new alternatives as may appear as a result of this rulemaking.

The Evaluation quantitatively estimated the safety benefits at each facility type for the 11 costly sections based on a probability assessment of risk. While each of these sections was projected to have major benefits should an accident occur, Booz-Allen concludes that net benefits would not be expected to exceed added costs because its risk assessment shows very low probability of accident occurrence. Since as the Booz-Allen report states the risk assessment is uncertain, MTB does not think it should be used as an exclusive determinant of what is necessary for public safety. Rather, because of the potential catastrophy which may result from a foreseeable accident, MTB's decision to propose measures for public protection has been based on what can reasonably be accomplished without incurring extreme costs. Comments are specifically requested on this issue.

As further reason for proposing adoption of the 11 costly sections, MTB recognizes that the industry's actual "self-imposed" safety practices in many instances exceed the standards in NFPA 59A. In particular, with regard to §§ 193.107, 193.109, 193.113, 193.423, and 193.1027, the bulk of commenters' suggested changes were adopted, in whole or in part. These comments indicate that in many instances "self-imposed" industry practices exceed NFPA 59A standards. This is supported by the Booz-Allen report that found the most recently completed facility at Elba Island had safety features which exceed the requirements in NFPA 59A. A further discussion of the costs and benefits of all 11 sections is covered hereafter in the discussion related to the sections.

Over 4,000 pages of comments were received on the ANPRM from 135 different commenters. Most of the comments were from industry associations or LNG operators, but a few government agencies, nonindustry-related organizations, and individuals also commented.

About 15 percent of the commenters agreed with MTB's view that the standards in NFPA 59A are inadequate and could be improved. In support of this view comments indicated that most LNG facilities being designed and constructed today are designed and constructed to levels of safety exceeding the current requirements in NFPA 59A.

While the bulk of the comments received related to specific draft regulations set out in the ANPRM, there were many general comments that deserve attention. About one-fourth of the commenters encouraged MTB to continue to adopt the NFPA 59A standards. These commenters argued that the need for new standards has not been demonstrated because the LNG industry has an enviable safety record, with no accidents in operating facilities in over 20 years. Most of these commenters mentioned the excellent quality, experience, and expertise of membership in the NFPA 59A Committee, over 50 experts in LNG technology.

Even though many commenters proposed that MTB continue to reference NFPA 59A, about one-fourth of these commenters recognized the need for improved standards. Many suggested that MTB add to the NFPA 59A standards where necessary, while adopting as much of NFPA 59A as possible.

Over half of the commenters said that the draft Part 193 in the ANPRM would be an excessive or overly burdensome body of regulations, or that the draft needed major modification. Many commenters proposed two sets of standards—one for "peak-shaving" facilities (used by gas distribution companies to supplement gas supplies during periods of high demand) and one for major import terminals. Many persons commented that the draft regulations were too specific and would not permit alternative approaches or implementation of new technological development, and they argued that performance language should be used. Also, several commenters proposed that regulations should be developed in closer cooperation with nongovernment organizations such as the American Gas Association.

MTB does not agree that there is not any need for the development of new, more stringent Federal standards for LNG facilities. The hazard from a catastrophic spill of LNG is very significant. The spill of LNG from a rupture of two LNG storage tanks in Cleveland on October 20, 1944, that killed 130 persons and injured 225 more, very clearly represents the extent of potential hazards and subsequent consequences if a large amount of LNG escapes. Although there have not been any major incidents since then in the operation of LNG facilities in the United States, research conducted by various government agencies and industry groups on thermal radiation and Vapor cloud dispersion has further indicated the significant potential hazards that would occur if LNG escapes. Also, as indicated in the ANPRM and the study by ADL mentioned above, MTB has identified many deficiencies in the present standards which should be corrected to mitigate the potential for a major spill of LNG and provide an acceptable level of public safety. Some of the deficiencies can be corrected by clarifying or restating in enforceable terms provisions of NFPA 59A. However, the more significant ones (such as those relating to seismic design and the design of storage tanks and impounding systems) require the development of entirely new standards.

NFPA continues to express the fear that the new Federal regulations will eliminate the need for the NFPA 59A Committee and result in disbandment of a valuable group of LNG experts. Alternatively, NFPA suggests that MTB work within the NFPA standards-setting process to bring about the needed changes in LNG safety regulations. While MTB fully recognizes the quality, experience, and expertise emobodied in the NFPA 59A Committee, MTB does not agree that such a vital function as setting the level of safety for LNG facilities should be left to a nongovernment organization. Even though the NFPA process for standards development may be fair and open to everyone, it still does not provide a forum equivalent to the Federal rulemaking process where decisions are made on the broadest possible base of information, the decision makers are subject to public scrutiny, and independent judgment is applied to develop standards that serve the public interest. As a consensus standards developing body, by its nature, the NFPA 59A Committee generally reflects a perspective common to the group. Moreover, because of the various ties, most Committee members owe allegiance to the industries affected by the standards. Therefore, while use of the NFPA 59A standards as a basis for Federal safety regulations may be reasonable, the standards still must be evaluated with care in light of public safety and welfare interests—a function inherent in the Federal rulemaking process.

It is clear the the NFPA 59A Committee is important to MTB's regulatory program for LNG facilities, but the functions of each organization differ. The NFPA should devise and recommend means of meeting the governmentally prescribed safety level and investigate new areas where regulations may be needed or existing regulations should be changed. To that end, MTB wants the NFPA 59A Committee to continue to participate in the rulemaking process on the development of the new Part 193 and expects that a signficant public benefit will be achieved.

MTB essentially agrees with the commenters that proposed that MTB adopt NFPA 59A to the extent possible. However, because of the difficulties in adapting the format of NFPA 59A to Federal regulation format and the need for appropriate regulatory language to facilitate enforcement of the LNG regulations, only a few sections of NFPA 59A are being proposed for incorporation by reference in Part 193. Other 59A sections are used as a basis for, and restated as, Part 193 sections.

MTB has reviewed the comments to the ANPRM and has adopted those comments which it deems appropriate. Those draft regulations in the ANPRM which comments indicated were particularly burdensome or unneeded have been revised where appropriate as discussed hereafter. However, the proposal for two separate sets of standards—one for "peak-shaving" facilities and one for large import terminals—as suggested by several commenters, has not been adopted. Instead, as set forth in the draft regulations in the ANPRM, those components that because of size should meet different standards have been designated in the text of the proposed regulations. Commenters to these proposed regulations should further point out those particular areas where different standards might be appropriate because of size of component or the extent of the operation of an LNG facility and its associated risk.

MTB has tried not to be overly rigid and to permit alternative approaches for specific safety concerns. Where appropriate, draft regulations in the ANPRM have been revised to allow this flexibility. In this regard, MTB recognizes the technological development occurring in the LNG field.

MTB has generally stated the proposed requirements in performance terms, using specific requirements where deemed necessary for safety, and also referencing several industry consensus standards. The use of performance language rather than specification (how-to-do-it) language is consistent with the longstanding Departmental policy in prescribing Federal pipeline safety standards. Performance standards prescribe what level of safety must be achieved, leaving the regulated industry free to develop and use improved technological means of meeting the required level. Where necessary, the performance standards may include tests and analytical procedures to check that the level of performance if achieved.

MTB does not concur with those commenters who suggested that the new LNG regulations should be developed in cooperation with private groups outside the government. The groups recommended generally reflect the limited view of the regulated industry. With regard to the comments that MTB develop these regulations in coordination with the U.S. Coast Guard, MTB agrees, and this NPRM has been so developed. Also, the subsequent development of final rules will be in coordination with USCG.

The proposed Part 193 would be adopted under the Natural Gas Pipeline Safety Act of 1968 (49 USC 1671 et seq.). The jurisdiction of that Act is limited to LNG facilities which are used in connection with a system for pipeline transportation of natural gas to consumers. Thus, the contemplated Part 193 would not apply to facilities used exclusively in the transportation of natural gas or LNG by modes other than pipeline. For example, the standards would not apply to an LNG storage and transfer facility at a marine terminal used to transfer LNG between ships or barges and rail or motor carriers unless the facility was also connected with a system for pipeline transportation. Also, Part 193 would not apply to LNG facilities used by ultimate consumers of LNG or natural gas or facilities used in the course of natural gas treatment or hydrocarbon extraction which do not store LNG. With regard to the proposed development of offshore LNG facilities, while the standards would apply, it is proposed that an offshore LNG facility need not comply with any requirement of Part 193 which the Secretary of Transportation finds impractical or unnecessary because of the offshore location (Section 193.2).

While almost all existing and planned facilities involve the supply or delivery of natural gas by pipeline, as LNG facilities become more widespread, it may be necessary to enlarge the scope of the Federal regulations to cover facilities which are not related to the pipeline transportation of natural gas. Any future action that may be taken with regard to these LNG facilities would, under current law, be by authority of the Hazardous Materials Transportation Act (49 U.S.C. 1801 et seq.).

Effective February 7, 1978, the U.S. Coast Guard (USCG) and the Materials Transportation Bureau executed a Memorandum of Understanding (MOU) with respect to a division of regulatory responsibilities for waterfront LNG facilities, or those facilities which are on, or immediately adjacent to, the navigable waters of the United States. This MOU was published in the FEDERAL REGISTER on July 14, 1978 (43 FR 30381).

The division of responsibilities agreed to by the MOU was considered necessary due to the overlapping regulatory authority of the USCG and the MTB affecting the siting, design, construction, operation, and maintenance of waterfront LNG facilities.

The text of the Memorandum of Understanding follows:

MEMORANDUM OF UNDERSTANDING BETWEEN THE UNITED STATES COAST GUARD AND THE MATERIALS TRANSPORTATION BUREAU FOR REGULATION OF WATERFRONT LIQUIFIED NATURAL GAS FACILITIES

I. INTRODUCTION

Within the Department of Transportation (DOT), the United States Coast Guard (USCG) and the Materials Transportation Bureau (MTB) exercise separate and overlapping safety regulatory authority affecting the siting, design, construction, maintenance, and operation of waterfront liquified natural gas (LNG) facilities adjoining the navigable waters of the United States. The USCG derives its authority over such facilities from the Ports and Waterways Safety Act of 1972 (Pub. L. 92-340, 33 U.S.C. 1221-1227) and the Magnuson Act (50 U.S.C. 191). The regulatory authority of the MTB over these same facilities (as well as non-waterfront LNG facilities) is derived from the Natural Gas Pipeline Safety Act of 1968 (Pub. L. 90-481, 49 U.S.C. 1671 *et seq.*) and the Hazardous Materials Transportation Act (Pub. L. 93-633, 49 U.S.C. 1801 *et seq.*).

In recognition of each of the parties' respective regulatory responsibilities, the USCG and the MTB agree that a memorandum of understanding is needed to avoid duplication of regulatory efforts regarding waterfront LNG facilities and to maximize the exchange of relevant information.

II. RESPONSIBILITIES OF THE PARTIES

For the foregoing reasons, the USCG and the MTB agree to the following division of regulatory responsibilities with respect to waterfront LNG facilities and cooperation in carrying out those responsibilities:

USCG RESPONSIBILITIES

The USCG is responsible for establishing regulatory requirements for—

(1) Facility site selection as it relates to management of vessel traffic in and around the facility;

(2) Fire prevention and fire protection equipment, systems, and methods for use at a facility;

(3) Security of a facility; and

(4) All other matters pertaining to the facility between the vessel and the last manifold (or valve) immediately before the receiving tank(s)

MTB RESPONSIBILITIES

The MTB is responsible for establishing regulatory requirements for—

(1) Facility site selection except as provided by paragraph (1) of the "USCG Responsibilities" set forth in this Memorandum; and

(2) All other matters pertaining to the facility beyond (and including) the last manifold (or valve) immediately before the receiving tank(s) except as provided by paragraphs (2) and (3) of the "USCG Responsibilities" set forth in this Memorandum.

JOINT RESPONSIBILITIES

(1) The USCG and the MTB will cooperate and assist each other in carrying out their respective waterfront LNG facility regulatory enforcement activities; and

(2) The USCG and the MTB, in an effort to avoid inconsistent regulation of similar safety matters (including as between waterfront and non-waterfront LNG facilities), will consult with each other before issuing each Advance Notice of Proposed Rulemaking, Notice of Proposed Rulemaking, and final regulation affecting waterfront LNG facilities.

Dated: February 7, 1978.

For the United States Coast Guard.

ADM OWEN W. SILER,
Commandant.

Dated: February 1, 1978.

For the Materials Transportation Bureau.

L. D. SANTMAN,
Acting Director.

Concurrent with this proceeding, the USCG is developing regulations for the storage and handling of hazardous materials, including LNG, at ports. On August 3, 1978, the USCG issued an Advance Notice of Proposed Rulemaking in the FEDERAL REGISTER (43 FR 34362) inviting public participation at the earliest stages in the development of regulations to provide standards for safety, security, and environmental protection in the transportation, transfer, handling, and storage of liquefied natural gas at water front facilities. The USCG intends for these regulations to become an integral part of its revised general waterfront facility regulations. The USCG published an Advance Notice of Proposed Rulemaking as General Waterfront Facilities Requirements (43 FR 15107) on April 10, 1978. MTB and USCG are coordinating their regulatory activities in this area to preclude problems involving overlapping jurisdiction in consonance with the MOU.

The ANPRM issued by MTB included draft regulations relating to (1) fire prevention and fire protection equipment, systems and methods for use at a facility; and (2) security of a facility. At a waterfront LNG facility, in accordance with the MOU between MTB and the USCG, these safety matters will be subject to USCG regulatory responsibility. Accordingly, this NPRM, covering only design and construction, does not include standards for these two areas. Although both fire protection and security for nonwaterfront facilities will be covered in MTB's next NPRM in this proceeding, which will cover operation and maintenance topics, appropriate delineation of the limits of MTB's responsibilities under the MOU over fire protection and security will be set forth in that notice. There are standards in this notice which could be applied to that part of a waterfront facility between the vessel and the last manifold (or valve) immediately before the receiving tank(s), but in accordance with the MOU, an operator would refer to USCG requirements for applicable design and construction regulations for this portion of a waterfront LNG facility (See § 193.1(b)(3)).

MTB and USCG have coordinated in developing a format that would be used by both agencies in the development of regulations for all waterfront facilities, including LNG facilities. Using a similar format for all of the DOT waterfront facility regulations in Part 193 will make it easier for the regulated industry to use these regulations. The proposed format to be used by MTB, as well as by the USCG, in the issuance of the final regulations for LNG facilities will be the following:

Subpart A—General
Subpart B—Siting
Subpart C—Design
Subpart D—Construction
Subpart E—Equipment
Subpart F—Operations
Subpart G—Maintenance
Subpart H—Personnel Qualifications & Training
Supart I—Fire Protection
Subpart J—Security

The notice of proposed rulemaking, however, does not follow this format. The NPRM follows the same format, section by section, as published in the ANPRM. In this way commenters to the ANPRM are able to more easily follow any revisions made by MTB to the draft proposed regulations issued in the ANPRM.

The following portion of the preamble discusses the comments made to each particular section in the draft regulations in the ANPRM as well as any revisions to those draft regulations used in developing the standards proposed in this notice.

SUBPART A—GENERAL

This subpart would explain the applicablity of Part 193 to new and existing facilities and define several terms. If a term used in the proposed Part is not defined, it is used in its ordinary sense or the sense commonly understood in the LNG industry. Subpart A would also set forth rules for interpreting certain regulatory terms, explain how documents are incorporated by reference in Part 193, and make it clear that leaks and spills of LNG are to be reported to the Secretary as required by Part 191 of title 49 of the Code of Federal Regulations.

Applicability. In response to numerous requests that *§ 193.1* indicate more precisely which LNG facilities would be covered by Part 193, this section has been rewritten to refer to facilities used in the transportation of gas by pipeline that are subject to the Natural Gas Pipeline Safety Act of 1968 and the Federal Gas pipeline safety standards in 49 CFR Part 192.

There were many recommendations that LNG facilities not covered by Part 193 should be described in *§ 193.1.* As a result, *§ 193.1(b)* now sets forth three types of facilities not covered by the proposed Part 193. Consistent with the present regulation of LNG facilities in 49 CFR Part 192, the first type is an LNG facility used by an ultimate consumer of the product. The second applies to the large number of refinery-type plants which use low temperature processes. One commenter expressed great concern about the adverse economic effect that could result if these plants were regulated by Part 193. MTB believes that since LNG facilities of this type do not receive, store, or transport LNG, they do not present a level of hazard comparable to a typical LNG facility and, therefore, are not proposed to be covered. A third exemption applies to those aspects of a waterfront LNG facility receiving or sending out LNG by marine vessel which are to be regulated in accordance with the MOU between MTB and the USCG.

A new *§ 193.2* has been added covering "offshore LNG facilities." As mentioned in the ANPRM preamble, MTB believes that if facilities of this type are built, they should comply with the proposed standards to the largest extent practicable. Two commenters to the ANPRM mentioned that such facilities would not be appropriately covered by the draft regulations. MTB agrees, and will study this aspect further to determine what more appropriate standards would be needed for facilities in the offshore environment. However, in the interim, it is proposed under *§ 193.2* that any questions involving the appropriateness of a standard for an offshore facility be resolved by MTB on a case by case basis. Also, MTB recognizes that the USCG as well as other agencies have jurisdictional responsibilities over the safety of offshore facilities. As in the case of waterfront LNG facilities, MTB and the USCG intend to reach an understanding as to how their respective jurisdictional responsibilities will be exercised to preclude any overlaps from becoming an unnecessary regulatory burden. Final rules regarding offshore LNG facilities that are developed as a result of this notice would reflect this understanding.

Under the Natural Gas Pipeline Safety Act of 1968, general safety standards affecting the design and construction of "pipeline facilities" may not apply to facilities in existance when the standards are adopted (49 U.S.C. 1672(b)). Section 193.3 in intended to apply this statutory requirement with respect to LNG facilities that would be subject to Part 193.

The majority of commenters addressing *§ 193.3* in the ANPRM felt that to apply the design and construction requirements of Part 193 to facilities "substantially under development" when the new rules are adopted, even if such application were practical, would be much too indefinite and could lead to enforcement difficulties as well as adverse economic effects. A wide variety of recommendations were given for establishing an appropriate cutoff point whereby an existing facility would not be subject to the design and construction standards intended for new facilities. Many commenters recommended the beginning of construction as an appropriate cutoff point. This view was adopted as most reasonable and easy to apply. As restated, *§ 193.3(b)* now provides that any component of an LNG facility upon which construction, installation, relocation, replacement, or significant alteration is begun after Part 193 is issued would have to meet the requirements of Part 193 related to design and construction, including siting and initial testing and inspection. Of course, as stated in *§ 193.3(a)*, all facilities would have to comply with the requirements of Part 193 which affect operation and maintenance.

Considerable concern was expressed also that the suggested scopes of various subparts in the ANPRM would make design and construction requirements apply retroactively to all components of an existing facility if any one component were changed. Since this result was not intended, MTB has modified the scope of individual subparts in this notice (Subpart B and K) to more clearly define each subpart's intended applicability to new or existing facilities, consistent with § 193.3. (See §§ 193.101, 193.201, 193.301, 193.401, 193.501, 193.601, 193.701, 193.801, 193.901, 103.1001). In this regard, MTB believes that it is in the public interest to require that existing LNG facilities meet the design and construction requirements applicable to new facilities to the exent an existing facility is replaced, relocated, or significantly altered. In applying the standards in this way, it is not intended to unnecessarily restrict the improvement or expansion of existing facilities, but to enchance their level of safety.

Definitions. Many commenters suggested changes to various definitions in § *193.5*. Appropriate editorial and clarifying revisions were made to the suggested definitions of certain terms in response to comments. The terms "bunkering," "gasification," and "gasifier" are deleted because changes to the proposed standards and the division of responsibility with the USCG made these definitions unnecessary. The suggested definitions of "LNG" and "LNG facility" are combined. Also, the term "storage tank" is changed to include underground caverns to assure that if caverns are used to store LNG they meet the applicable safety requirements of Part 193. The following definitions have been significantly changed as a result of comments to the ANPRM:

"Cargo transfer system" is made more concise and revised to apply to the transfer of hazardous "fluids" rather than hazardous "liquids" between piping and a tank car or tank truck.

"Controllable emergency" and "emergency" are revised to mean situations where prudent action can prevent "harm" rather than prevent a "hazard," since some form of hazard is implicit in either term.

"Determine" is revised to mean an "appropriate" investigation using scientific methods rather than a "thorough" investigation.

"Exclusion zone" is revised to permit governmental control as well as control by an operator of activities within the zone in accordance with the proposed § *193.107* and § *193.109*. This change would allow means others than ownership by an operator to provide the required restrictions on land development around an LNG facility.

"Piping system" is revised to delete the reference to "insulation" and to make the term applicable to the containment of hazardous fluids.

Regulatory Terms. In § *193.7*, subparagraph (b)(3) has been deleted because the gender of sex is not used in the proposed Part 193.

Inspection and Maintenance Plans. As an improvement in format, § *193.9* in the ANPRM, "Filing inspection and maintenance plans," has been transferred to Subpart M, Maintenance, and will be incorporated in the NPRM on that subject to be issued in March, 1979.

Reporting. Operators of gas distribution systems and transmission systems which include LNG facilities are required to report leaks and spills of gas or LNG at LNG facilities under the reporting requirements of 49 CFR Part 191. A new § *193.10* is added in this notice to assure that there is no misunderstanding regarding this reporting requirement. The MTB recognizes that LNG facilities are not effectively covered by the present reporting forms under Part 191. Until these forms are changed, however, information applicable to leaks or spills of gas or LNG at LNG facilities must be reported to the maximum extent possible on the existing forms prescribed by Part 191.

SUBPART B—SITE RELATED DESIGN REQUIREMENTS

This subpart would establish design criteria pertaining to the site of a new LNG facility or the site of an existing critical component which is replaced, relocated, or significantly altered. A site would have to provide safe separation distances needed for public protection in the event of a spill and would have to be designed to withstand the effects of natural and manmade hazards which may occur at the site.

Site Acceptability. A small number of comments were made about § *193.103* in the ANPRM, which suggested that a site not be used for an LNG facility unless it is investigated and designed in accordance with Subpart B. The most significant comments proposed that Section 20 of NFPA 59A be adopted instead, or that § *193.103* be deleted because it duplicates Federal, State, or local authority in establishing an acceptable LNG facility site. The proposal to use the more general NFPA wording was not adopted because MTB feels that the present requirements in NFPA 59A are not sufficient to ensure the adequate investigation of a site for an LNG facility. The proposed Subpart B has considerably broader and more appropriate requirements. With regard to the comments suggesting possible duplication of other governmental authority, MTB acknowledges the authority of other agencies over the nonsafety related aspects of siting an LNG facility, but DOT authority is primary with regard to the safety aspects of siting. Therefore, § *193.103* is necessary and does not duplicate any other Federal, State, or local jurisdiction.

Persons commenting on the general siting criteria suggested by § *193.105*, suggested editorial changes which they felt would clarify the intent of this provision. A few commenters felt that general siting requirements should be limited to a land-based site so as not to preclude use of offshore locations that could not comply with the suggested requirement for ease of access to the site. This suggestion was not adopted since the proposed standards in Part 193 are intended to apply to offshore facilities to the maximum extent practical and MTB feels that offshore LNG facilities could comply with a proposed requirement for "ease of access." Several suggestions to modify the term "ease of access" were not adopted. MTB feels that this phrase adequately describes the space needed for access by offsite emergency response personnel and as one commenter suggested, evacuation of personnel. Similarly, MTB feels that the term "jeopardize" adequately describes the intent of the proposed requirement that an operator investigate all site characteristics which have potential for harm to the facility. MTB did not adopt the comments that Sections 200 and 925 of NFPA 59A be adopted as a general requirement because it was felt that § *193.105* better states the broad intent of this proposal rather than the narrower wording of NFPA 59A. The suggested rule is modified, however, to adopt those comments that argued that as a general standard, a site should enable a facility to be "designed to minimize hazards."

Thermal radiation protection. Under § *193.107* each space provided for impounding, or holding, a spill of LNG would have to be located a sufficient distance away from certain structures, or areas of public assembly (as set forth in § *193.107(d)*) outside the LNG facility so that persons would have protection from the heat of any fire which may occur at the impounding space. Added protection is necessary because even a small spill of LNG into an impounding system can result in a fire just as hot as that from a large spill. For a new facility, the proposed distances could range from about 50 to 500 meters.

The current Federal standard for protection against the heat, or thermal radiation, from a fire (49 CFR 192.12) as well as the 1975 edition of NFPA 59A prescribe a safe distance based on a fixed level of heat flow at the plant boundary (measured as units of thermal flux equal roughly to 10,000 BTU/ft²hr.). A formula is provided for computing a safe distance depending on the area of impoundment ($d=.8A^{.5}$). However, evidence shows that at the prescribed distance, persons would not be adequately protected if they are openly exposed to such heat levels or in buildings that do not provide adequate shielding from the heat.

In the ANPRM, MTB suggested that safety be provided by safe distances to structures, with distances varying according to the effect of heat on the structure, and by distance to open areas based on the time people would need to walk away or seek shelter. By using a diagram to precisely define a method for measurement of the distance, the ANPRM approach took into account site topography and the effect of wind on a fire that might be expected during the early stages of ignition.

Some commenters appeared to favor retention of the NFPA method, but many commenters supported the use of allowable thermal flux levels as the basis for determining a safe zone rather than prescribing the distances. In consideration of these views, § *193.107* has been modified. Under § *193.107(d)*, maximum allowable thermal flux levels are proposed for different structures and open areas, and under § *193.107(b) and* (c), a method for measuring and determining distance is proposed.

Section *193.107(a)* of the ANPRM has been changed to clearly show that a "thermal exclusion zone" is defined by the computed safe distances. A number of commenters objected to use of the word "target" to refer to a structure or open area, stating that it has an unfavorable meaning. However, in view of the general acceptance of the definition of target and because the term is used extensively in technical literature on thermal flux from an LNG fire, adoption of this comment does not appear justified. Some commenters to § 193.107(a) in ANPRM also objected to use of the term "flammable liquid," preferring instead "LNG." Considering the relative quantities of flammable liquids other than LNG at a facility, exclusion zones for other liquids should fall within the boundaries of exclusion zones for the larger LNG volumes. Therefore, § 193.107(a) is changed to apply only to LNG impounding systems.

A large number of commenters stated that local weather conditions should be considered in defining safe distances. Neither NFPA 59A nor the ANPRM, which each rely on assumed fixed conditions, provide for local variations. However, in view of the comments and the wide range in ambient weather conditions that may exist at proposed sites, and the effect variations may have in defining appropriate thermal exclusion zones, provisions for site specific conditions appear justified.

Among the commenters who proposed procedures for determining the thermal exclusion zone, only one proposed a precise method of measurement. This proposal essentially was based on the diagram in § *193.107(b)* of the ANPRM, but added modifications for flame angle and length related to flame base dimensions and local wind condition. Although the ANPRM method did not intend to specifically account for flame angle and height because of the uncertainities involved in LNG fire characteristics, in this notice the measurement diagram is changed in § *193.107(b)* to provide for site specific determination of flame angle and length of the flame. The flame angle and length of flame would affect the amount of thermal radiation in the thermal exclusion zone.

One commenter presented a comparison showing the differences that can be expected in flame angle depending on the method of computation used. Others indicated that a specific method should not be mandated due to the lack of verification by current technology. These comments serve to illustrate the uncertainties involved and emphasize the need for a definitive procedure to assure uniform safety levels at all facilities. Most commenters who specifically addressed the flame angle aspect recommended use of the American Gas Association (AGA) report. MTB proposes that the AGA Interim Report, IS-3-1 (July 1, 1974) be used for determining flame angle and length under § *193.107(b)*.

Commenters said that using the ANPRM method for measuring distance would not reflect flame length when impoundment dimensions are long and narrow, as the case might be with transfer piping. Consequently, a requirement to account for this situation has been included as a note under § *193.107(c)*. The note provides that the thermal flux on a target must be determined on the basis of multiple fire sources when impounding systems with base dimensions in a ratio of more than 2 are involved.

In accordance with the suggestion of one commenter, the term "innermost" has been added to the definition of point (D) under § *193.107(b)* to better describe the way a safe distance is measured. This change is needed in order to make clear which dike is referenced in a multiple diking system.

Most commenters who suggested methods to determine safe distances proposed that AGA report IS-3-1, or "a method at least as accurate" be used. Others did not reference a data source but specified factors to be considered in determining distances and some suggested that determinations should be made by an engineering consultant. Two prepared comparative data showing the diversity of results that might be expected depending on the method employed.

While the AGA report does not provide a unique model for distance determination, two commenters proposed a unique model for distance determination based on that report (see Columbia LNG Corp. Consolidated Systems LNG Co. comments). The model suggested appears to be appropriately conservative. Accordingly, with some modification, this model is proposed in this Notice under § *193.107(c)(2)*. The model provides for site specific parameters suggested by many other commenters and thermal flux levels discussed under § *193.107(d)*. Although the commenters' model is based on a thermal flux of 31,500 BTU/ft.^{2} hr., at the fire, the MTB proposes that 45,000 BTU/ft.^{2} hr. be used in view of the uncertainties regarding this value. For example, the AGA IS-3-1 report suggests a value of 56,000 BTU/ft.^{2} hr. for use in one instance. Also, large verification testing has not yet been performed to determine maximum flux from a large fire, which some experts believe may exceed 50,000 BTU/ft.^{2} hr. In addition, preliminary results from research performed for the Department at China Lake, California, have shown that there are still uncertain characteristics about LNG fires.

These same commenters also proposed that a mathematical formula on thermal flux be permitted as an alternate method for determining distance. MTB has incorporated this proposal under § *193.107(c)(1)*, since it will permit LNG facilities, particularly those of smaller size, to establish thermal exclusion zones with less data accumulation and computation.

Several commenters to § *193.107(c)*, in the ANPRM felt that thermal exclusion distances derived as suggested would be much too short. Many others argued that the ANPRM distances would be excessive and proposed retention of the 10,000 BTU/ft.^{2} hr. thermal flux level set by NFPA 59A. With regard to open areas (category (1) under § *193.107(d)*) most commenters recommended that the flux level be 1,600 BTU/ft.^{2} hr., since it is the level for human exposure recommended in recent technical reports. This level was said to be conservative because clothing could afford some protection and there would be sufficient time (20 seconds) for a person to either find shelter or move away. Also, the commenters asserted that if a wind factor is used in conjunction with the measurement diagram it would afford some safety when the wind speed is low, or, for remotely located areas, provide some cooling effect. In addition, altering position to change the area of the body exposed to the radiant heat would allow additional escape time.

At the same time, the Department of Housing and Urban Development (HUD), who is developing its own standards for locating HUD sponsored outdoor recreational projects near LNG or other highly volatile liquid facilities, has expressed a vew in a letter dated November 28, 1978, that 1600 BTU/ft^2 hr. would provide little time for people to take protective measures. In HUD's view a 20-second reaction time to find refuge before experiencing pain would be unrealistic, since it is doubtful that people at a crowded beach, swimming pool, or other exposed recreational area would be able to find shelter within that time. HUD also asserts that special attention should be given to the limited mobility of the elderly, small children, and the handicapped. Accordingly, HUD recommends, that a more realistic reaction time be provided such as 2 minutes which corresponds to a thermal flux of 500 BTU/ft² hr. HUD further recommends making this thermal flux level applicable to yard areas associated with residential dwellings since the levels recommended by the ANPRM would not allow sufficient time for persons outside their homes to escape radiant heat in the event of an LNG fire. On this latter point MTB does not agree because setting a low level for yards would have the concomitant effct of requiring unnecessarily long separation distances for houses, and unlike outdoor recreational areas, houses are readily available as shelter for persons in yards. Because of questions raised by HUD and the differing views stated by commenters, MTB is proposing that a level between 500 and 1600 BTU/ft² hr. be adopted for open areas under category (1) of § *193.107(d)*. To avoid confusion, the 1600 BTU/ft² hr. level is shown in the text of the rule, but this level may be reduced in the final rule depending on the views expressed by commenters.

With regard to certin cellulose (wood or wood fiber) or metal structures, (category (2) under § *193.107(b)*), commenters recommended that 4,000 BTU/ft² hr. be adopted, since at this level structural properties available to shield persons or materials will not be impaired. This recommended flux level is adopted for this Notice.

In response to recommendations that safe distances for transportation facilities be specifically addressed, a new category (3) is included in this Notice. For reasons given above, and since either shelter or a more rapid means of escape would be expected, the flux level for category (2) applies to this new category also.

A flux level of 10,000 BTU/ft² hr. for masonry structures (category (3) in the ANPRM) was generally accepted and is retained in this Notice as category (4).

With regard to the proposed flux of 6,700 BTU/ft² hr. for other cellulose, metal or masonry structures (category (4) in the ANPRM) one commenter thought it could be too restrictive in some situations and not restrictive enough in others. Two who proposed detailed procedures did not object to the category and flux level. This category and flux is retained in this Notice as category (5) to provide protection for less critical structures. Some safety factor is included for the integrity of metal structures and ignition of cellulose materials in view of the many uncertainties that remain with respect to thermal radiation levels.

Some of the commenters suggested varying acceptable flux levels, with structures identified by local zoning descriptions. MTB, however, believes the concept of zoning would not be useful since, for example, in an industrial zone, a high-concentration of humans could be exposed to high levels of thermal flux.

A variety of methods to mitigate heat radiating from a fire, such as high expansion foam and water screens, have been considered for inclusion in the Notice. Many commenters, including one who prepared an extensive report covering this and other factors, felt that a reduced exclusion zone should be permitted when a facility has foam systems. Based on available data, it appears that high expansion foam can reduce the magnitude of heat radiation. However, MTB is not proposing that exclusion distance determinations be modified to account for any potential mitigating effects of foam or other systems since there is insufficient data to assure predictable results particularly for large scale events.

The Draft Evaluation for this Notice shows that the proposed § *193.107* would have a major cost impact on construction of a new LNG facility as compared to NFPA 59A because of the additional land area that would have to be acquired. MTB believes that there are factors which may lessen the cost impact of the proposed § *193.107*:

(1) Selection of a site which minimizes the need for construction of additional pipelines so that the combined cost of land and piping is not high.

(2) Choosing a site where, because of the nature of the surrounding area, the thermal flux permitted under the proposed § *193.107* would equal or approach that allowed by NFPA 59A.

(3) Locating a facility where local meteorological conditions would result in lower exclusion distances.

(4) Utilizing government land controls to provide the necessary distances rather than purchasing the land.

(5) Utilization of alternative plant designs to reduce the exclusion distances. For example, the use of either Class I impounding system (§ *193.407*), cavern storage, or a larger number of small tanks would minimize the necessary distances. Such designs could also provide savings in compliance with other proposed standards.

Protection Against Gas Dispersion. While the thermal exclusion zone requirements in § *193.107* would provide protection from thermal radiation of a potential fire on a facility, § *193.109* would protect against the hazards of a vapor plume traveling downwind from a large spill of LNG. Section § *193.109* would require that each LNG impounding space be surrounded by a "vapor dispersion exclusion zone" computed on the basis of separation distances within which places of outdoor assembly and certain structures (as set forth in § *193.109(a)*) would be prohibited and LNG vapor would dissipate. Alternatively, safety would be provided by igniting LNG vapors at the plant site. Depending on the site of a facility, as stated in the Draft Evaluation, an exclusion zone could range from about 500 to 5,000 meters.

The Draft Evaluation for this Notice shows that § *193.109* would have a major cost impact if the "exclusion zone" alternative is chosen in design rather than planned ignition of vapors. Since the bulk of this cost would be due to land acquisition, most of the factors discussed under § *193.107* on how land costs might be mitigated are equally applicable to § *109.109*. Even assuming a low probability of accident event that would cause flammable vapors to leave a plant site, MTB believes the added costs involved are justified by the potentially disastrous effects that could result from ignition of a vapor plume in a populated area.

Several commenters expressed concern that § *193.109(a)*, which suggested that new LNG facilities be surrounded by a dispersion exclusion zone, would prohibit any structure, even control rooms, within LNG plant boundaries. Obviously, each structure or component in an LNG facility must be located within the facility's exclusion zone and, therefore, § *193.109(a)* is changed in this Notice to make it clear that items prohibited within the zone are not those associated with the LNG facility.

With respect to § *193.109(b)* in the ANPRM, a number of commenters objected to an exclusion zone being required for impounded liquids other than LNG, because of the differences in physical characteristics and possible conflict with acceptable practices. Objections were also expressed to the suggestion that an additional safe distance to protect against thermal radiation be added to the dispersion distance on the grounds that continuous burning of dispersed gas, as with a pool fire, would be unlikely. Regarding these comments, MTB agrees that because of the larger dispersion distance needed for LNG, a safe distance for LNG is likely to extend well beyond that needed for other liquids. MTB also agrees that it appears unlikely that ignition would occur at the precise instant of maximum dispersion. Consequently, § *193.109(b)* is changed in this Notice to eliminate reference to commodities other than LNG and to any added distance.

A mathematical model in the AGA report, IS-3-1, was suggested in §*193.109(c)* of the ANPRM for use in determining a safe dispersion distance for LNG spills. Many commenters agreed with the use of IS-3-1. Similarly, the NFPA 59A, 1975 ed., recommends IS-3-1 for determining vapor dispersion distances. However, many commenters objected to the proposed model on the basis that it is applicable to instantaneous spills only, and is now outdated. They suggested that other models should be adopted or that the selection of a model should be delayed pending further research. Upon further evaluation, it appears that some error in test data may have existed and that an alternative to the IS-3-1 model should now be proposed.

MTB believes a specific model giving conservative results should be adopted as a standard to assure that adequate safety levels are uniformly established. The model being proposed (Appendix B of "Evaluation of LNG Vapor Control Methods" American Gas Association) was recommended by many of the commenters and currently is believed to have a sound basis and background development.

The ANPRM suggested that computation of dispersion distance be based on gas concentrations of 2.0 percent. This value is changed in this notice to 2.5 percent, a more appropriate level.

Instead of fixed weather conditions suggested in the ANPRM, site specific variables are proposed for use in the model. This change was proposed by many commenters and is justified for the same reasons discussed above regarding the use of site specific variables in determining safe distance for thermal radiation.

MTB is not proposing that less distance be permitted if higher dikes are used since current evidence to support this change appears insufficient.

Most commenters to § *193.109(d)* in the ANPRM regarding vaporization rates indicated that to determine dispersion distances based on an assumed sudden instantaneous spill would not be creditable. Other commenters proposed use of the 10-minute design spill rate set forth in NPFA 59A, but MTB believes that use of an arbitrary design spill could result in an excessive dispersion distance in some cases and not enough in others.

Both the ANPRM and this Notice base the proposed protection against the threat of gas dispersion under § *193.109* on the premise that more stringent design requirements for components would make a catastrophic failure unlikely as long as accident causes are predictable and can be accommodated by engineering design. Under this condition projected spill rates into an impounding system can safely be based on the discharge from a failed transfer line, and vapor generation rates limited to the spill rate itself plus flash vaporizations. Where transfer piping runs over a dike and automatic shutdown is available, as proposed by this Notice, the entire impounding and retention space can be assumed to be available for vapor retention. Additional dispersion distance to protect against failure of the component served by impoundment would be necessary only where accident causes are unpredictable or cannot be accommodated by design. Accordingly, the essential features of § *193.109(d)* in the ANPRM are retained in this Notice, with some modifications for detail and clarity as proposed by comments. The seismic acceleration suggested in the ANPRM as a design standard for unpredictable seismic motion has been increased from .3G to .4G to reflect areas where earthquake activity is high but can be accommodated be design. Also, in paragraph (d)(3), a new equation for determining a more realistic time of spillage is proposed based on a comment by Columbia LNG Corporation and Consolidated Systems LNG Company.

As recommended by most comments on the subject, the ANPRM's suggested specifications describing heat transfer properties and insulation design in an impounding system have been changed in this Notice to permit greater flexibility and use of future technological improvements.

The planned ignition suggested in § *193.109(e)* was opposed by most commenters. Some felt that requiring ignition of LNG vapor could increase the hazard of a small spill and argued that insurance on facility equipment would be unobtainable. Still others advocated planned ignition as an alternative to a dispersion exclusion zone as long as it would not have to operate automatically. Several opposed only the suggested requirement for redundancy in hardware.

MTB believes that planned ignition would provide a needed safety alternative to the vapor dispersion distance that would otherwise be required by § *193.109(a)* to (1) allow for future development at existing LNG facilities with limited or unsuitable land to meet the distance requirement, and (2) permit new facilities to be sited on the basis if criteria that may be more relevant than population density, such as seismic or land use considerations. However, because there is not enough information about ignition systems on which to base an adequate performance standard, an acceptable level of safety would be assured under § *193.109(e)* by requiring operators who choose the planned ignition alternative to obtain Secretarial approval of the plan.

The suggested requirement for automatic ignition has been deleted from § *193.109(e)* in this Notice to allow personnel responsible for responding to emergencies greater latitude in action under an ignition plan.

Earthquake Design. Section *193.111* would establish site investigation requirements and design criteria for response spectra (ground motion) caused by earthquakes to protect against the catastrophic failure of certain critical components. Storage tanks and impounding systems at facilities located where there has been a relatively high incident of seismic activity, would have to be designed to withstand response spectra that has a 99.5 percent probability of not being exceeded in 50 years. Alternatively, an operator would have to base seismic design on the effect of recorded earthquakes at the site if there would be a higher damaging effect.

Under NFPA 59A seismic study is required for a facility of any size when located in Zones 2 and 3 of Seismic risk Map of the Uniform Building code, 1973. However, specific seismic design provisions apply only to storage tanks, and no consideration is mandated for potential vertical seismic motion. In addition, only seismic acceleration rather than critical "response spectra" must be addressed, and no method of prescribing the level of motion intensity is included so that a uniform level of safety among facilities would be unlikely. Factores which should be considered, such as surface faulting, motion amplification, soil liquefaction, land slide, foundation and dike design in areas of high seismic activity, and reaction of contained liquid are also omitted in 59A. Considering the failure to address these critical features, particularly vertical seismic motion, and the lack of uniformity in seismic safety design, current standards do not appear to provide an adequate level of safety.

The proposed rule addresses all of the factors discussed above. Consideration of seismic loading would be required for all flammable fluid containers, shutdown control, transfer piping and impounding systems as well as the storage tanks. Most significantly, it proposes to require design accommodation of vertical seismic motion and establish a uniform level of seismic safety at all facilities with more stringent requirements for storage tanks and their impounding systems, the most critical components from a safety viewpoint in an LNG facility.

Several commenters to § *193.111* in the ANPRM advocated that the seismic design requirements of the Nuclear Regulatory commission (NRC) be adopted. Others felt the NRC requirements should be strengthened, making specific suggestions. In contrast, most commenters declared that the suggested design earthquake for a storage tank and dikes (based on a 10,000-year recurrence interval) would be excessive (see § 193.111(d) of the ANPRM), and they argued that the Uniform Building Code (UBC) design method should be used since it has been proven by experience to be adequate.

Obviously, the probability of a natural disaster occurring at an LNG facility may be similar to that of a nuclear facility, and this in Subpart B the ANPRM addressed the same range of natural occurrence risks as the NRC regulations. However, MTB believes the release of LNG in an accident would not have the long term implications presented by escaping radioactive materials and this difference in consequences should be reflected in any design standard intended to protect against the potentially catastrophic effects of natural occurrences. For example, in § 193.111(c), the return period for the proposed design seismic motion is either 475 or 9,975 years, while the period for a nuclear plant may be from 10 thousand to 10 million years. thus, even though the most critical components of an LNG facility would have a level of seismic safety closely approximate to some components in nuclear plants, the overall level of design would not be as high.

Engineering literature shows that the UBC basis for design earthquakes is not universally considered adequate and is not suitable for critical components, particularly those components in areas of high seismic activity. MTB believes that more stringent design criteria are needed, and the concept of 99.5 percent probability of seismic response spectra not being exceeded in 50 years would provide a uniform level of risk for all facilities. Some commenters also supported this view.

A number of commenters to § *193.111(a)* in the NPRM proposed that the need for a detailed geotechnical investigation should be based solely on the potential for earthquakes at the site, as shown by the UBC Seismic Risk Map, and not on storage capacity. Since an investigation is probably not warranted even for a large facility where seismic activity is low, this Section has been revised to propose detailed investigation of all sizes of facility in zones 2, 3, and 4 of the UBC map. However, even in these higher risk areas, sites for small storage tanks such as "bullets" should not have to be investigated unless there is evidence indicating a potential for surface faulting.

Section *193.111(b)* in the ANPRM specified information (patterned after the NRC regulations) that would have to be determined from a detailed investigation to assure a sound basis for design. In this Notice, performance language in § *193.111(a)* is intended to cover the important aspects of the investigation.

In accordance with comments to § 193.111(f) in the ANPRM requesting that a minimum distance be prescribed for proximity of surface faulting to critical components, considering other factors of the investigation, one mile has been proposed as a reasonable minimum.

In response to several comments to § *193.111(g)* in the ANPRM, the maximum seismic acceleration above which additional design requirements would be imposed on certain critical components has been increased from 30 to 40 percent of gravity under § *193.111(e)* in recognition of arguments that seismic forces up to this level can be accommodated without the added design measures.

The suggestion that a large dike width be one of the added design features was strongly opposed by a number of commenters. This provision is not changed, however. MTB believes that added dike width is the best means of preventing impounding capability from being breached by fissures caused by earth movement.

The Draft Evaluation for this Notice shows that the proposed § *193.111* would have a major cost impact on construction of a new LNG facility as compared to NFPA 59 A because of the more detailed seismic investigation proposed for high risk areas, more stringent seismic design requirements, and the added cost of structural steel, concrete and earthwork. A large proportion of this impact can be attributed to the proposal that facility design account for a vertical component of motion even in areas of relatively low seismic (See § *193.111(b)(2)*), since low risk zones predominate over the United States. MTB believes that the impact of seismic design (not including the cost of investigation) should be minimal because of one or more of the following conditions:

(1) Overstressing of foundations and materials by as much as ⅓ above design operating stress would be permitted under the proposed Part 193 for the accommodation of seismic loading.

(2) Design for wind loads (§ *193.117*) may be adequate to accommodate some or all of the seismic loading on outer shells.

(3) Additional design features above 59A requirements necessary to account for the proposed hydraulic testing of storage tanks may be adequate to accommodate some or all of the seismic design loads on hydraulically loaded tanks (assuming an earthquake does not occur during testing.)

(4) Using an underground cavern for storage would offset added seismic design costs since there would be no need to design for vertical or horizontal seismic motion.

Protection Against Other Natural Occurrences. Sections 193.113, 193.115, 193.117, and 193.119 would require that a facility be designed to protect against natural occurrences other than earthquakes. These sections have been included in this Notice because MTB believes the comparable NFPA 59A provision would not require a design adequate for safety and would not provide a uniform level of safety. NFPA 59A would require only that an operator consider the "degree to which a plant can, within the limits of practicality, be protected against forces of nature," without mentioning the type or magnitude of occurrence to be considered or the components that are to be protected.

Protection Against Other Natural Occurrences. Sections 193.113, 193.115, 193.117, and 193.119 dealing with natural occurrences were in the ANPRM and have been included in this Notice because MTB believes the present standards in NFPA 59A do not adequately address the requirements to protect an LNG facility against these events.

With regard to § *193.113*, Flooding, most commenters felt that the design frequency of flooding specified by the ANPRM would be an excessively stringent standard. Most of these commenters suggested that the design flood be based on that worst flood predictable in a 100-year period, which is generally accepted as a very conservative design basis. One commenter pointed out the 100-year flood level for a coastal area is based on a combination of worst possible conditions of storms, wind, tides, and surface drainage which makes this design basis sufficiently conservative. Some commenters suggested that the design flood be the worst anticipated flooding conditions. MTB has revised the flooding design proposed in this Notice to require that operators use a 100-year flood. In addition, MTB has made some editorial changes to clarify this Section.

The Draft Evaluation also identifies § *193.113* as a major cost item due to the cost of additional concrete and earthwork needed to protect a facility against the dynamic and flotation forces of flooding. MTB believes that except for marine terminals, careful site selection would minimize the impact on new facilities. Even where costs are high, MTB believes and the Evaluation shows that should a design flood occur, major benefits would accrue through prevention of catastrophic failure of critical components.

Some commenters to § *193.115*, Soil Characteristics, felt that a soil load bearing capacity safety factor of 1.3 would not be appropriate for all equipment located at all sites. They felt that such a safety factor should vary according to the site condition and the hazard associated with the component. A few commenters pointed out that in some cases, a higher safety factor may be appropriate. This provision has been revised to permit operators to use "appropriate" safety factors in determining load bearing capacities of soils. MTB has made editorial and drafting changes in § *193.115(b)* by consolidating the list of loads.

Most commenters to § *193.117*, Wind Forces, felt that critical components should be designed to withstand the wind loadings specified by the UBC rather than the comparatively high loading suggested by the ANPRM (wind with probability of being exceeded 0.5 percent in 50 years). They pointed out that the UBC had been developed utilizing many years of historical data. They further argued that the wind loading designs in the UBC had historically been proven to provide an adequate design basis since the procedures in that code include provisions for shape of structure, location, elevation, and horizontal and uplift wind pressures. Section *193.117(a)* is changed in accordance with these comments.

Most commenters to § *193.117(b)* took issue with the suggested tornado design loads (250 mph, if probability of occurrence is at least 0.5 percent in 50 years) for storage tanks and dikes. Many pointed out that a requirement to evaluate the effect of tornadoes and other severe weather conditions would be covered in § *193.117*. Many others felt that the suggested probability of occurrence would be too stringent, and the design wind loads of 250 mph too excessive. A few made the observation that it would be unreasonable to require design based on a probability of occurrence of tornadoes where such an occurrence cannot be accurately determined. MTB believes that tornado wind loads are so excessive that they should be specifically set forth in Part 193 as suggested in the ANPRM rather than cover these loadings under a general design requirement for other severe weather conditions in § *193.119*. While the probability of occurrence of a tornado specified in § *193.117(b)* may seem low for design purposes, the magnitude of wind loads in tornadoes of this frequency of occurrence is not very different from the wind loads in tornadoes which occur much more frequently. With regard to the comments that a 250 mph wind load from a tornado is excessive, MTB believes that many large tornadoes have had winds in excess of 250 mph. MTB acknowledges, however, that applying the suggested design requirement may be too stringent where the probability of tornadoes occurring cannot be quantitatively predicted. As pointed out by some commenters, the probability of tornadoes occurring cannot be predicted in some regions of the country because the occurrence of tornadoes in these regions is so infrequent that valid statistics have not been recorded. Under § *193.117(b)* in this Notice, if the probability of occurrence cannot be determined, only the UBC design criteria would have to be met.

The Draft Evaluation identifies § *193.117* as a proposal with major cost impacts primarily because of the high tornado design wind load and the low threshold probability of occurrence of tornadoes. MTB believes that cost savings can be obtained by selecting a site with low probability of tornadoes occurring or by using a below or partly below ground tank design. Also, design of foundations to meet the proposed test requirements for storage tanks (§ *193.1033*) or seismic design requirements (§ *193.111*) might be used to offset design for toe load due to wind, with a partial reduction in the cost of this Section. Considering these factors, together with the 33 percent allowable overstressing of materials and foundations, MTB believes that the costs would not be as high as projected.

The provision for wind load design is another proposal which MTB believes necessary to mitigate the likelihood of catastrophic failure of an LNG storage tank. If a dispersion exclusion zone is provided under § *193.109(a)*, the proposed wind load design would also assure that vapor dispersion can, in most cases, reliably be based on transfer line failure alone.

While most commenters did not suggest changes to § *193.119* regarding other severe wheather and natural conditions a few commenters felt that it would be unreasonable to expect a "worst combination of other weather and natural conditions" at the facility site in addition to those conditions specifically covered by §§ 193.111, 193.113, 193.115, and 193.117. This Section has been revised to permit operators to determine the worst "effect," rather than the worst "combination," of other wheather and natural conditions which may predictably occur at the facility.

Adjacent Activities. The need for taking into consideration man-made activities adjacent to an LNG facility as suggested in § *193.121* was addressed in the G.A.O. report on Liquefied Energy Gas Safety. This important subject is not specifically covered in the present NFPA standards. Most commenters to this Section felt that it was impossible for an operator to accurately predict the adjacent activities which will occur during the operating life of an LNG facility. These commenters pointed out that a site chosen in a remote location could initiate development and result in activities which were not predictable and would not be under the control of the LNG plant operator. Many of these commenters felt that an operator should, however, take reasonable precautions based on estimates of the area's development potential, this Section has been changed to permit the operator the flexibility of determining the "reasonably foreseeable," rather than the "predictable," activities adjacent to a facility.

Separation of Components. Under § *193.123* adequate clearance would have to be provided between critical components and between components and the site boundary to provide for the movement of personnel and equipment during normal operations and in an emergency and to minimize hazards to persons and property on and off the facility site.

A large number of commenters to § *193.123* suggested revising the Section to require operators to provide distances between critical components and specified in NFPA 59A. These commenters argued that the NFPA 59A requirements establish certain specific distances that through experience have proven adequate to minimize hazards from these components as well as permit movement of personnel and equipment around these components. In consideration of these views and until MTB develops a more complete performance standard on this subject, MTB believes that the public interest is better served by requiring operators to comply with Sections 213 through 216 of Chapter 2 of NFPA 59A.

SUBPART C—MATERIALS

This subpart would establish criteria for the use of materials for components at an LNG facility. The main objective of the proposed criteria is to ensure that materials are used which enable components to function over the expected range of high and low temperatures.

Most commenters to § *193.201*, *Scope*, pointed out that operators do not "design" material. Thus, the phrase, "selection and qualification" is now proposed.

With regard to § *193.203*, *General*, a majority of commenters agreed with the wording of the ANPRM. However, several commenters suggested replacing the word "predictable" with the word "design" in paragraph (a) to describe those loadings that material must withstand. This change was adopted to keep the material requirements consistent with the design required for components.

Temperature Ranges. Revisions were not made to the suggested language of § *193.205* regarding normal, extreme temperatures since there were no substantive objections to the wording used in the ANPRM.

In response to several comments about the lack of need to protect all components against the effects of unexpected contact with LNG or fire, in *193.207*, the term "critical" is inserted before the word "components" in paragraphs (a), (b), and (c). However, it is not considered appropriate to so limit the scope of paragraph (d) which is intended to preclude an uncontrollable emergency in the event of a small fire around a flammable fluid component. Paragraph (d) was revised in response to several comments pointing out that some fluid release may not be hazardous or detrimentally affect safety.

Insulation. In Section *193.209*, a new paragraph (a) is added to propose that insulation have thermal and mechanical load bearing capabilities during normal operation. This provision was recommended by commenters. To eliminate redundancy, the suggested provision of § *193.209* regarding outside insulation is combined with that of § *193.525(b)*, and the latter section is deleted. A further change also eliminates the problem several commenters pointed out that there are no insulating materials that would provide adequate insulating properties and also "not support combustion." In this notice, the term "self extinguishing" is used to describe materials with needed thermal properties that provide the needed safety as well.

Cold Boxes. Most comments to § *193.211* agreed with the suggestion in the ANPRM that cold boxes should be made of noncombustible materials. There were some commenters who pointed out that requirements for insulation should be covered in § *193.209* and need not be duplicated for "cold boxes" under § *193.211*. However, this comment was not adopted because of the need for special treatment of cold box insulation.

Piping. Most commenters were in agreement with the suggested prohibition in § *193.213* against use of cast, malleable, or ductile iron piping at low temperatures. However, a few comments pointed out that some other piping materials also develop undesirable characteristics at low temperatures. Other commenters were in favor of totally prohibiting the use of cast, malleable and ductile iron pipe, as in Section 6113 of NFPA 59A. In response to these issues, MTB has revised the wording of § *193.213* to propose that cast, malleable or ductile iron piping not be used to carry cold refrigerants and flammable fluids and that materials intended to operate at less than −28.9C (−20° F) be qualified by testing to determine that the materials meet the general requirements of § *193.203(b)*.

Concrete. With regard to § *193.215*, one commenter pointed out that there are other refrigerants than LNG in LNG facilities that could cause thermal shock to concrete and adversely affect the integrity of a structure. For that reason, the term "LNG" is changed to "cryogenic". Other commenters pointed out that concrete can have minor spalling occur that will not be detrimental to safety. Thus, in paragraph (a) the word "detrimental" is inserted before "spalling".

It is MTB's feeling that the performance language of § *193.215* would provide an acceptable concrete materials standard, which permits innovation, and that the specifications listed in 4230 of NFPA 59A should not be adopted as some commenters recommended. Meeting the NFPA specifications should suffice, however, to comply with the proposed § *193.215*. In this regard, interested persons should note that, in contrast to this section, the more detailed concrete specifications of Section 42 of NFPA 59A are proposed in § *193.527* for concrete storage tanks and containers because of the greater need for specificity in a standard regarding storage tanks and the associated hazards involved.

Use of Combustible Materials. Under § *193.217* an operator could not use combustible materials for buildings or equipment where ignition would worsen an emergency. Several comments emphasized that the class of materials that has "limited combustible" characteristics should be an allowable alternative to noncombustibles when the latter is not available. MTB concurs since the recommendation is consistent with the intent of the suggested rule, and § *193.219* is changed accordingly.

Records. The great majority of the commenters to § *193.219* indicated that records should be limited to "critical" components, to avoid unessential paper work. MTB believes that the compliance objective of this proposed requirement can be satisfied by limiting the required records to "critical components."

SUBPART D—DESIGN OF COMPONENTS AND BUILDINGS

The purpose of this subpart is to ensure that those parts of an LNG facility that are related to safety are designed to withstand anticipated loadings and to properly contain or control hazardous fluids. In addition, buildings would have to be designed to minimize the effects of explosion and be ventilated if used to handle flammable fluids.

General. With regard to § *193.303(a)*, several commenters suggested that the word "design" should replace "predictable" to describe the loadings that a component must withstand. MTB does not agree, however, because the purpose of § *193.303* is to set the standard for design loadings. Paragraph (b) in the ANPRM has been deleted as redundant with § *193.207*, and paragraph (c) has been redesignated as paragraph (b).

Personnel. In response to a number of comments, to § *193.303(c)*, the suggested qualifications for persons who design and fabricate components in an LNG facility are changed to permit qualification by either training or experience on LNG or other cryogenic facilities. Also, the proposed qualifications would only apply to persons involved with critical components. Although for clarity § *193.303(c)* in the ANPRM is restated as § *193.304*, it is anticipated that in the final rules this section would be transferred to the new subpart on personnel qualifications and training.

Valve. In § *193.305* of the ANPRM paragraph (a) is deleted as redundant with § *193.307(a)*, paragraph (b) is redesignated as paragraph (a), and paragraph (c) is redesignated as paragraph (b). In response to several comments, paragraph (b) has been changed to recognize that there are extended bonnet valves available that operate satisfactorily in cryogenic service with the valve stems in any position relative to horizontal. Paragraph (d) in the ANPRM which related to relief valves is incorporated in § *193.905*, which covers this topic.

Piping. In response to comments to § *193.307*, MTB changed the word "process" to "cryogenic" in paragraph (b) since the need for purge connections is important for piping carrying cryogenic or flammable fluids and the word "process" is more indefinite. The suggestion that each piping system be identified by color coding, painting, or labeling is now limited to aboveground cryogenic or flammable fluid piping to apply the requirement only to areas of greatest benefit. Paragraph (d) is revised to permit the use of pipe with a longitudinal seam that has a joint efficiency rating of 1.0 under ANSI B31.3 for handling LNG and other hazardous liquids rather than requiring that only seamless pipe be used. Several commenters pointed out that longitudinal weld seam pipe is more uniform in wall thickness than seamless pipe and, thus, often of a higher quality. MTB adopted this revision for this reason and because the 100 percent radiograph requirement of B31.3 assures the integrity of the longitudinal seam. In paragraph (e) the referenced paragraph number has been corrected to read 323.2.3 of ANSI B31.3. The suggestion in paragraph (e) that threaded pipe be at least Schedule 80 was changed in response to several commenters who pointed out that such heavy wall pipe is only justified on cryogenic or flammable fluid service. Paragraph (g) is deleted as redundant because the difficulties with using furnace lap welded or butt welded pipe are covered by the revision of paragraph (d) of this section. Because paragraph (h) concerned pipe material, it is more appropriately covered by § *193.213*.

Pipe Supports and Attachments. Section *193.309(a)*, in the ANPRM is changed to refer to § *193.207*, which more appropriately covers the problem of pipe stability in the event of an LNG spill or fire. In paragraph (b) the word "supports" is replaced by "pipe attachments and supports" to clarify the intent of this proposal regarding the effects of heat transfer. In response to one commenter who pointed out that "unintentional" piping restraint is a safety problem with ice formation, the words "piping restraints" are replaced by "unintentional restraint of piping."

Buildings. Several commenters to § *193.311* argued that small quantities of flammable fluids in a building would not constitute a potential hazard justifying special design and construction to protect against the effects of explosion, as might be the case for shops, warehouses, and offices. MTB agrees that the suggested design requirement probably would not be reasonable for every building in which any amount of flammable fluid is handled. Thus, in this notice, only those buildings with "potentially hazardous quantities of" flammable fluids would have to meet the proposed requirements. The proposed rule also would require design and construction to minimize "potential fire hazards" in response to one commenter who pointed out that fire is more often the major hazard rather than explosion.

Commenters to § *193.313* also stressed that the suggested ventilation requirements of paragraph (a) would be inappropriate for buildings where small quantities of flammable fluids are handled because ventilation is intended to minimize the possibility of a hazardous accumulation of gas in air. MTB agrees, and the ventilation requirements are proposed for buildings with potentially hazardous quantities of hazardous fluids. With regard to the suggested gas concentration limit of 5 percent of the lower flammable limit (LFL), virtually all commenters argued the lack of instrument accuracy at such low levels. Thus, MTB has revised the limit for activation of the ventilation system to 15 percent LFL, a level lower than that which is proposed under § *193.605* for automatic shutdown of transfer piping. In paragraph (b), the second sentence is revised to propose that a proportional amount of air reach each level of buildings with two or more levels where vapors heavier than air can be present. This change is made in response to commenters who pointed out that the suggested requirement that one-half of the ventilation be from the lower level could lead to a situation of more ventilation than necessary in one area and insufficient ventilation in other areas.

Low Temperature Effects and Loadings. Paragraph (a) and (b) of § *193.315* in the ANPRM were deleted since they are duplicative of § *193.205* (a) and (b) regarding the effects of cryogenic temperatures on components. Paragraph (c) of this section concerning the separation of valves under icy conditions is moved to § 193.321(c).

There were no unfavorable comments regarding the substance of § *193.317* and it is unchanged in this notice.

Section *193.319* concerns the problem of frost heave, or ground uplift, due to freezing soil. In § *193.319* only minor changes are made in the wording used in the "temperatures of the component" that may cause frost heave. Paragraph (b) is changed in response to several comments that reliability, accuracy, and durability of sensing devices for detecting frost heave are questionable in some applications and that visual inspection is much more reliable when based on reference monuments. Upon further consideration of this issue, an alternative to instruments and alarms is added to paragraph (b) to allow monthly inspections using reference monuments and surveying instruments to detect changes in elevation of the facility.

Section *193.321*, regarding protection from ice and snow loads contains a clarifying change in paragraph (a). A new paragraph (c) is transferred to this section from § *193.315(c)*.

Electrical Systems. Regarding § *193.323*, two commenters pointed out that the suggested requirements of paragraph (a)(1) regarding areas where electrical ignition could occur is covered equally as well in NFPA 70 which is referenced in paragraph (a)(2). As a result, paragraph (a)(1) is deleted, and paragraph (a)(2) is revised for clarity. In response to several commenters who convincingly argued that more definitive requirements are needed for electrical grounding and bonding, paragraph (b) in the ANPRM is revised by referencing Sections 760 and 761 of NFPA 59A. Paragraph (c) has been revised for the same reason by referencing Section 762 of NFPA 59A. Paragraph (d) was deleted in response to several commenters indicating that paragraph (a)(2) of the ANPRM would require design and installation in accordance with NFPA 70 which covers the suggested subject of paragraph (d), ground fault detection devices.

Lightning Protection. Section *193.325* is changed to state that the purpose of rods, arrestors and grounds in protecting against lightning is to "minimize the hazard." This change is made in response to several commenters who argued it would be impossible for the devices to "protect" everything from lightning. MTB agrees that installation of lightning protection devices cannot provide a complete guarantee agsinst damage.

Boilers. Commenters to § *193.327* requested that Section IV of the ASME Boiler and Pressure Vessel Code be established as a design standard for boilers, as well as Section I. MTB concurs with this change since it permits the use of hot water boilers as well as steam boilers.

Combustion Engines. Section *193.329* is unchanged from the ANPRM in requiring that combustion engines and gas turbines meet the requirements of NFPA 37.

SUBPART E—IMPOUNDMENT DESIGN AND CAPACITY

The purpose of this subpart is to require the construction of a structurally sound, leak free impounding system (composed of dikes and floors) to catch and hold spills of LNG from storage tanks and other critical components. For large spills impounding systems also serve to retard the rate of vaporization of LNG and any subsequent downwind vapor travel.

Components Requiring Impoundment. The ANPRM would have made it mandatory to provide impoundment for each of the components and areas listed in § *193.403* to contain a potential spill of LNG or other hazardous liquid. Many commenters recommended deletion of various individual items in the list. Others suggested that each component or area be protected, but not necessarily by impoundment, arguing that less potentially hazardous leaks or spills could be handled more cost effectively by proper grading and drainage, or that impoundment is unnecessary because of rapid vaporization. MTB concedes that grading and drainage can be substituted for impoundment where the same degree of protection from a potential spill can be reasonably assured.

Under § *193.403(a)* impoundment would be required for three items: storage tanks, transfer piping above 4 inches in diameter, and tank car or tank truck loading or unloading areas. MTB believes that large diameter transfer lines should have impoundment because of the large volume that could be spilled in the case of a line break. Using this guideline, piping in excess of 4 inches in diameter is proposed to require impoundment. An operator would have the option under paragraph (b) for smaller piping and the other items listed to provide safety by grading and drainage or impoundment. MTB welcomes comments on (1) the proposed diameter breakpoint for transfer piping with suitable backup for any differing views, and (2) whether some other criterion, such as pressure, should be used as a breakpoint. Because MTB believes it is more appropriate to apply the proposed new impounding design rules solely to the containment of LNG, a new paragraph (c) has been added to require that impounding systems for other hazardous liquids be built in accordance with NFPA 30, the standard followed by industry for these facilities.

General Features of Impoundment. The phrase "to the maximum extent possible" has been added to § *193.405* to modify the level of spill containment which an impounding system must provide, recognizing that absolute protection may not be possible. Many commenters objected to the provision that trajectory and splash of spilled liquid be contained. MTB believes, however that these are reasonably predictable ways by which LNG could escape impoundment and that dikes should be designed with sufficient shape and size to handle these factors. The trajectory issue is further discussed under § *193.419* in this preamble. Also, under § *193.405*, interested persons should note that if an underground cavern is used for LNG storage (see definition of "storage tank"), the cavern would be an "impounding system" and would have to be sealed against leakage.

The majority of the commenters recommended deletion of the suggested impounding system classifications under § *193.407* as they did not see any need for them. Classification of impounding systems is useful in § *193.439* for example, as well as in other sections of Subpart E and Subpart B so that requirements may vary according to system design. The Section has been simplified, however, by eliminating the types in each classification. MTB does not believe that the arguments that this Section would stand in the way of technological development or would not permit an operator to choose a system to achieve the design requirements are valid because of the general language used in the classification descriptions.

Structural Integrity. Many commenters were concerned that § *193.409(a)* in the ANPRM would require that all materials in an impounding system, including insulation be designed to meet structural requirements. The intent of this Section has been clarified by specifically referring to the design of structural parts. Insulation would be covered to the extent it serves some structural purpose. Also, in the lead-in to paragraph (a), the suggested requirement that surfaces of an impounded component which could be contacted by spilled liquid be designed to the same requirements as the impounding system has been deleted because design requirements for specific components are covered by other Sections.

Regarding protection against highway or rail traffic, there were comments that "adjacent" traffic in paragraph (a)(5)(ii) of the ANPRM would be ambiguous and the term has been changed to "adjoining" in this Notice. Commenters claimed highways or railways would not be permitted in the exclusion zone but such was not suggested under either § *193.107* or § *193.109*. There are existing LNG facilities where tank car or tank truck cargo transfer systems are adjacent to, or adjoin, impounding systems. Many commenters also objected to the suggested requirement that dikes withstand impact loadings from aircraft when they are near an airport. MTB has quantified this proposal by using the distance of 20,000 feet established by the Federal Aviation Regulations (14 CFR Part 77) to define a critical area surrounding a large airport. Under § *193.409(c)*, a Class I dike would have to be designed to withstand the impact of the heaviest aircraft which can operate to or from the airport.

MTB concurs with the majority of commenters that "a sudden total release," from a storage tank, as used in § *193.409(b)*, is not a credible design accident. Nevertheless, it is being retained in this Notice to provoke the development of a realistic, definable spill condition. Comments submitted on this point to the ANPRM do not fulfill this objective. Further comment in this regard is solicited. Absent any acceptable definitive alternative, MTB will develop its own design spill or adopt the proposed spill condition.

In § *193.409(c)(1)* the term "self-extinguishing" is being used instead of "must not support combustion."

As suggested, § *193.409(d)* in the ANPRM regarding insulation, sealants and other coatings has been combined with the suggested § *193.409(c)* and restated in a new § *193.410*.

Section *193.411* in the ANPRM regarding system surfaces has been deleted, as recommended by the majority of the commenters. Paragraph (a) duplicated § *193.405* with regard to leakage, paragraph (b) is considered impractical, and the problem of seepage is handled by § *193.431*.

Floors. There were varying objections to the suggested slope requirements in § *193.413* regarding the design of impounding system floors: that they were too specific, such as requiring a two percent slope, or unreasonable to meet. After reviewing suggested wording, MTB is proposing more performance oriented requirements consistent with the purpose of a sloped floor, which is to drain spilled LNG to a safe area and prevent water from collecting on the floor. Under this section, channels would be required to minimize the wetted floor area in the event of a spill.

Dikes. The majority of the commenters felt that compacted earth dikes would not be permitted under § *193.415(a)* in the ANPRM which suggested that dikes be "reinforced and contiguously interlocked." MTB is not proposing that such dikes be prohibited, and since the structural standards for dikes would be covered by § *193.409*, paragraph (a) of § *193.415* in the ANPRM is deleted in this Notice.

Many commenters to § *193.415(b)* in the ANPRM felt that properly designed penetrations should be permitted in dikes to accommodate piping or other purposes. MTB still feels it is in the interest of safety to prohibit them. Water drains from sumps would be particularly vulnerable. There are existing local ordinances that now prohibit such penetrations. Commenters also stated that dike penetrations would greatly simplify LNG pump installations. This could be true if bottom tank penetrations were permitted, but is not important with the proposed top penetrations under § *193.511*.

Section § *193.415(c)* in the ANPRM has been modified to permit a component wall to serve as a dike in a Class 1 impounding system that is designed to meet the requirements of § *193.409(c)*, which applies to facilities near airports. MTB requests comments as to how this provision might be further modified to allow sufficiently strong walls of components to serve as dikes in the case of facilities not near airports. What should be the design standard for such walls? How should a modified standard apply to underground caverns?

A large number of commenters to § *193.417* questioned the need for "vapor barriers" if a dispersion exclusion zone, as calculated under § *193.109*, would eliminate the possibility of a flammable vapor cloud extending beyond the exclusion zone. Erected on top of dikes, vapor barriers can retard the rate at which vapor leaves an impounding system. Section *193.417* would not require the use of vapor barriers, but if they are used in conjunction with dikes as a means of reducing the extent of the exclusion zone, such barriers would have to be designed in accordance with Part 193 is as a critical component and be capable of entraining cold vapor.

The Draft Evaluation shows that § *193.417* would have a major cost impact if an operator chooses to install vapor barriers. However, costs attributed to the design of barriers should be offset somewhat by a reduction in land cost under § *193.109*. In any event, MTB believes the costs would be justified by the added assurance that a vapor dispersion zone designed on the basis of vapor barriers would not be exceeded in the event of a design spill.

The majority of comments to § *193.419* recommended that paragraph 2115 of NFPA 59A be used to determine dike dimensions and stated that some of the suggested requirementst were not feasible, particularly with regard to interception of jets of liquids from transfer lines. Notwithstanding the transfer line issue, MTB has determined that the formula X>0.6Y used in Figure 2-1 of NFPA 59A results in dike dimension which will not intercept all credible trajectories of discharged liquids. MTB believes, however, that increasing the constant factor from 0.6 to 1.0 would provide the needed protection in most cases, although operators would still have to make appropriate calculations to determine the dike dimensions and configuration necessary to prevent the escape of liqued by splash and other mechanisms described under § *193.405*, and to provide the necessary impoundment capacity.

Covered Impounding Systems. Most commenters recommended that § *193.421* concerning covered systems be deleted. Objections were not to the suggested requirements as much as to the implication of the suggested standard that covered impounding systems are practicable to design. They would be prohibitively expensive according to many commenters. It was also stated that such systems could be dangerous and detrimental to a safe LNG facility. Granting these arguments, MTB believes that by definition there are existing facilities that could fall into this category, and advances in technology could make such systems more feasible in the future. Accordingly, this Section, with clarifying revisions, is being retained.

Gas Detection. Section *193.423* proposes that impounding systems be continuously monitored for the presence of gas in order to assure that an LNG or gas leak will be detected quickly. Current standards are indefinite with respect to this safety feature. Section 92 of NFPA 59A states that, because of the wide differences in LNG facilities, fire and leak control measures shall be coordinated with the authority having jurisdiction, and local emergency agencies. This is not appropriate for a Federal safety standard since neither performance criteria nor control measures are stated.

There were a number of varied comments in regard to § *193.423* pertaining to detection of gas concentrations: that the number of sensors would be excessive; that they would be ineffective in some of the specified locations, such as the low point of an impounding space where a low temperature alarm would be more appropriate to detect presence of LNG; and that the alarm set point for gas concentrations should be 25 percent. MTB recognizes the validity of these arguments and has revised this Section to propose a more performance oriented requirement. There were some commenters who felt that mandatory gas detection systems were unwarranted, that they did not contribute to safety, and would create serious maintenance problems. MTB and the majority of the commenters do not agree with this reasoning. Leak detectors and alarm systems are needed to permit an operator time to correct a problem and prevent it from becoming an uncontrollable emergency.

The Draft Evaluation shows that this Section would have a major cost impact because of the instrumentation that would have to be provided to detect leaks. MTB believes that an operator could minimize this cost by using a design which reduces the amount of impounding space floor area and thus the amount of instrumentation. The added costs are justified by the early warning that would be provided should a leak occur. Even with a minor leak, the extreme cold of LNG could produce high thermal gradients and potentially excessive localized thermal stress in surfaces contacted. Resulting cracks could damage the structural integrity of a component making it susceptible to failure possibly of a catastrophic nature, from natural or other forces which it was initially designed to accommodate. With current designs of high dikes located closely adjacent to a component, a small leak of either LNG or cold gas could result in a combustible mixture forming between a component and its diking. If ignited, high overpressure might result either from deflagration or detonation depending on the mixture and degree of confinement. Many uncertainties remain regarding this hazard, but the potential for simultaneous failure of both the component and its diking is of such serious concern that it should not be overlooked.

Inerting Systems. All commenters indicated that the installation of a carbon dioxide inerting system as suggested by § *193.425* in the ANPRM should not be required. Most felt the suggested system could decrease safety and would be impractical to maintain. MTB concurs that charges generated by the system could ignite a gas-air mixture. The National Fire Council has warned against the use of carbon dioxide systems because of such static ignition. It was pointed out that such systems had been examined in the past and found of questionable benefit in open air conditions. For these reasons, this Section has been deleted.

Sump Basin. Many of the commenters objected to the suggested requirement under § *193.427* for sumps to collect small spills of LNG on grounds that pumping out such liquid as suggested by § *193.429* would be impractical. While MTB is proposing that a sump be required, its purpose would be for collection of rain water and small spills of LNG, rather than to provide for pumping out LNG. MTB believes that sumps provide an added safety benefit of preventing unnecessary spreading of small spills.

Removal of LNG spills from sump basins was suggested in the ANPRM by § *193.429*. The majority of commenters argued the impracticability of such removal. They pointed out that a slow cooldown of all components involved would be required and an adequate liquid pressure would be required to establish a suction. Spare storage capacity would be required to receive the pumped liquid, which would probably be contaminated and unusable. It is also questionable if pumping equipment and piping could be considered in a fail-safe mode, as § *193.429* would have required, since power is required for the pumps. MTB believes the many problems involved override the potential benefits and has deleted this Section.

The purpose of § *193.431* is to keep an impounding space as free of water as possible in order to maintain the space available for impounding LNG. Some commenters objected to the suggested requirement in § *193.431(a)* that piping for removal of water from sumps be installed over the dike. MTB's position on dike penetrations for piping is stated under § *193.415(b)* and it does not appear that an over-the-dike arrangement for water drain piping would be onerous, and, in fact, it could be more economical. Commenters also argued that the suggested requirement in paragraph (c)(2) for redundant shutdown capabilities when LNG is present in the sump would only add to the cost, without a commensurate safety benefit. MTB does not concur with this assessment and has retained the redundancy requirement.

Shared Impounding Systems. The ANPRM would have prohibited the use of a single impounding system to serve more than one component (except when small capacities were involved) in order to minimize the chance that an emergency at one component might endanger another. Such a prohibition would require construction of more systems at each facility and would not allow operators to use design concepts or topography to mitigate the hazards involved.

MTB has therefore rewritten § *193.433* in performance language. Although it was suggested that Section 211 of NFPA 59A be used to govern shared impoundment, MTB does not agree with paragraph 2110(c) that would allow other components to be exposed to low temperature or heat if impoundment were provided for the contents of all of the containers.

Piping. Section *193.435* has been changed to remove the duplication of § *193.207* with respect to critical components inside an impounding system. Also, protection of piping would be required where failure would "worsen" an emergency in recognition of the fact that an emergency may already exist at the time of failure.

Impoundment Capacity. MTB has retained the basic concept suggested in the ANPRM under § *193.437* for general capacity requirements that allowance must be made for displacement by objects within an impounding system. A minor change is made in recognition of the fact that water would not be used to fight an LNG fire.

With respect to § *193.439*, the majority of the commenters felt that 100 percent of a storage tank's maximum liquid capacity would be adequate for impoundment capacity. This capacity would be consistent with the present NFPA 59A requirements. However, there were also many commenters who acknowledged that provision for additional capacity should be included to hold foaming or boiling LNG. MTB accepts this latter concept for Class 1 and covered impoundment systems serving a single tank, and accordingly is proposing a 110 percent requirement for such systems.

However, there are many more factors that must be considered in establishing capacity for Class 2 and Class 3 systems, such as jetting, splash, wave action and others. Additional capacity would also assist in the containment of the initial rapid generation of vapor inherent with spills into such systems. It is significant that all States which now have existing or proposed LNG regulations as well as local ordinances (such New York City) have a 150 percent requirement. MTB is proposing that this capacity be adopted for Class 2 and Class 3 systems which serve a single storage tank. The requirement should not be unduly onerous, considering the advantages derived.

In regard to § *193.441*, most commenters felt that a capacity equal to 150 percent impoundment of the volume of liquid in equipment and transfer systems "and" the liquid which would be discharged during twice the time period necessary for spill detection, instrument response, and sequenced shutdown by the automatic shutdown system would be too large. It was suggested that "or" be substituted for "and," but MTB does not agree because these two volumes are additive. However, it is proposed that the sum of 100 percent of the volume of liquid in the component served, plus that liquid which could be discharged before shutdown, would provide adequate impoundment capacity for equipment and transfer facilities.

Section *193.443*, concerning parking areas and portable vessels, has been revised to be consistent with § *193.403*, as impoundment would not be mandatory if grading and drainage are used to insure that critical components or adjoining property are not endangered.

Section *193.445*, concerning flow capacity to remote systems, has also been revised to be consistent with other changes made in this Subpart.

Many commenters argued that if § *193.429* Pertaining to LNG spill removal from sumps were deleted, § *193.447* covering sump capacity would no longer be relevant. MTB does not agree, however, because of the importance of a sump in preventing the spreading of a small spill across an impoundment system floor and thus reducing the time before vapor begins to overflow the dikes. MTB is proposing, therefore, that the suggested requirements of § *193.447* be adopted to govern sump basin capacity. While some commenters to the ANPRM argued that basins of the size suggested in the ANPRM would be too large, unnecessary, or difficult to manage in design, these commenters did not say what size basin would be appropriate. MTB invites comments on this point with the view that § *193.447* would be changed in the final rule, if comments show that sump basins of a different size than proposed would be more appropriate.

SUBPART F—LNG STORAGE

A storage tank is the most critical component of an LNG facility because of the large quantity of stored energy and the threat of catastrophy in the event of a failure. This subpart would establish additional design considerations to assure structural integrity and preclude accident causes such as overpressure or underpressure.

Scope. In regard to § *193.501*, a comment was made that the suggested requirements of Subpart F were essentially applicable only to LNG storage tanks. As this was the intent, the title of this Subpart and the scope have been changed accordingly.

Membrane Liners. Containers used to hold LNG in a storage tank must be strong enough to support operational and environmental loads. Thus, under § *193.503(b)* in the ANPRM, MTB suggested that a membrane liner, because of its doubtful reliability, not be permitted in a storage tank as an inner container. There were a number of varying comments to this Section. Commenters generally argued that such a prohibition would limit future technological development, that the provision should only be applicable to permanent land based LNG storage tanks, and that only nonmetallic liners or flammable liners should be bannerd. One commenter submitted a report to support the view that disallowing membrane liners would be too general and not reflect the present state of the art. Another commenter stated that although membrane liners may not be economically attractive at this time, their prohibition is not realistic. Based on these views, MTB has revised paragraph (b) to prohibit only flammable nonmetallic liners.

Design Loads. As recommended by many commenters, the word "maximum" has been deleted in § *193.505(a)* and "minimum" § *193.505(b)* as well as throughout this part, to be consistent with the terminology used in industry practice and standards regarding "design pressure." There were some comments that the suggested list of design forces for storage tanks be deleted and replaced by general language. Others stated the list did not include all possible forces or combinations of forces. While the latter comment is true, the list was not intended to be exhaustive, but only illustrative. Because of the significance of tank design, MTB feels it is necessary to supplement the general language used to refer to possible loadings in the lead-in to § *193.505* with examples. Also, at the suggestion of one commenter, the word "predictable" has been added to paragraph (f) (formerly paragraph (e)), as it was pointed out that some settlement may be unpredictable. A new paragraph (e) identifies the loads that would be caused by pressure testing under § *193.1033*.

Stratification. If LNG in a storage tank is allowed to stratify, or develop layers of different density, hazardous "rollover" and overpressure could result. The hazard occurs when the bottom layer rises to the top (rollover) and releases excess heat through rapid vaporization. The majority of comments to § *193.507* felt that suggested design requirements for protection against the effects of stratification would be too specific and should be written in performance language. They also stated that any one of the methods listed would alone provide adequate protection and that requiring all of them would be unnecessary. A number thought the term "mixing devices" should be defined. One commenter thought that both top and bottom connections would be needed to comply, although the latter would be prohibited by *§ 193.511*. MTB's revised Section is more performance oriented. A choice of mitigating methods would be allowed, and reference to mixing. A choice of mitigating methods would be allowed, and reference to mixing devices has been deleted. It should be noted that the bottom of a tank can be reached through top connections.

Tank Movement. A safe tank design must consider the predictable movement of parts after construction. Section *193.509, Movement and Stress,* is unchanged in this Notice.

Penetrations. To preclude the possibility that any failure of piping that enters a tank would also cause a major spill from the tank, MTB believes that all piping should enter, or penetrate, the tank at the top. This design feature would place connections above the top liquid level in a tank and prevent gravity discharge of the liquid in the event of a piping failure. In addition, the integrity of the walls and bottom of a tank would be increased by the elimination of indeterminate stresses caused by connected piping. NFPA 59A does not contain any similar provision.

The majority of comments to *§ 193.511* objected to the suggested requirement that all tank penetrations be symmetrically located on top of the tank as close as possible to the center. They stated that locating penetrations at the center could cause structural, safety, and financial problems. It was argued that penetrations near the edge would be easier to support (structurally), and surveillance, protection, or fire control would be a greater problem with center penetrations. The Notice eliminates the suggested requirement in the ANPRM that penetrations be located as close as possible to the center, but retains the proposal that all tank penetrations be located on the top of the tank. A number of commenters agreed with MTB's view that top penetrations are inherently safer than those at the side or bottom because the potential for more hazardous side or bottom rupture would be removed in the event of a line break during severe environmental conditions. While the probability of such an event is reduced for lines designed as proposed by this Notice, MTB feels that the possible disadvantages and added costs of top connections are justified by the additional safety that would be provided.

The Draft Evaluation for this Notice assigns a major cost impact to the proposal to require top penetrations. Many existing facilities have piping connections of this type, and top penetrations would normally be selected if new storage tanks are designed with berms or high close-in dikes to satisfy other safety objectives. Since these designs may be the most reasonable choice for new facilities in mitigating such problems as thermal radiation, vapor dispersion, wind loading, and leak detection, the impact of this Section may not be as high as projected.

Design Pressure. Section *193.513* proposes that a storage tank's internal design pressure be no lower than the vapor pressure resulting from filling, rollover, atmospheric pressure change, heat input from insulation loss, or flash vaporization from pumping. Excessive internal pressure could result in catastrophic tank failure or a spill which could cause vapor dispersions to surpass design limits. The purpose of the proposal is to assure that factors particularly relating to low pressure storage of a cryogenic flammable fluid are included in design in order to reasonably assure that design pressure will not be exceeded during operation and to mitigate the possibility of a release of excessive volumes of LNG vapors. Existing standards do not specifically address these aspects of design.

Most of the comments in regard to *§ 193.513,* concerning storage tank design pressure, pertained to the ANPRM's use of terminology that is not generally accepted. MTB has revised the title of this Section as well as the wording in paragraphs (a) and (b) to be consistent with accepted terminolgy with regard to design pressure. Paragraph (c) regarding redundant relief devices, has been deleted from this Section and incorporated in *§ 193.905.*

The same general comments were made in respect to *§ 193.515* which also concerns design pressure and similar changes in the terminology have been made here. Paragraph (c) which suggested the use of redundant vacuum relief devices is deleted and incorporated in *§ 193.905.* Many commenters argued that the suggested 2 psi minimum design pressure in paragraph (b) would be contrary to accepted practice and would impose an unnecessary cost burden. In view of these comments, this suggested requirement has been deleted inasmuch as the remainder of paragraph (b) should provide an adequate design standard.

The Draft Evaluation states that *§ 193.513* would result in a major cost impact. The impact derives from the additional hoop strength that would be needed in the commonly used low pressure storage tanks, but the impact would not be as significant for high pressure tanks. While the impact of this Section alone may be high, since added tank strength would be needed as well to meet proposed wind and seismic load requirements, the combined impact of these proposals is probably not as high as projected.

Temperatures. Section *193.517,* concerning the effects of LNG spills on storage tanks, is deleted as redundant with §§ *193.205* and *193.107.*

In *§ 193.519,* by restricting the requirements of this Subpart to LNG storage tanks, MTB believes that the apparent misunderstanding by many of the commenters as to the wording in the ANPRM has been removed. Under this Section, a tank would have to withstand the lowest temperature of LNG which could occur under design conditions.

Foundation. Practically all commenters to *§ 193.521* objected to paragraph (d), which would have prohibited the use of piles to provide foundation support for a storage tank. The major argument advanced was that piling is an accepted structural engineering practice and as reliable as any other form of foundation. Test piles are used to verify load capacity and factor of safety. Commenters also stated that excluding piles would considerably reduce available sites for LNG facilities. Although one commenter felt that possibly this prohibition should be applied to areas of hish seismic loads, another commenter, the California Public Utilities Commission, stated that use of batter piles could provide acceptable lateral resistance to seismic design loads. In view of the weight of these comments, MTB has deleted paragraph (d).

The wide majority of commenters did not object to *§ 193.523,* which would require an alarm to warn of any malfunction in the heating system used to protect a foundation against frost heave. It is retained in this Notice, but modified consistent with the change to *§ 193.319.*

Insulation. Many commenters felt that *§ 193.525(a)* contradicted paragraph (b). Paragraph (a) has been reworded to clarify the intent that outside insulation may not be used on storage tanks for operational purposes. Also, paragraph (b) is deleted, as commenters suggested, and incorporated in *§ 193.209.* The provision in paragraph (c), suggesting a prohibition against flammable insulation has been changed to propose that insulation be "self extinguishing", since a nonflammability requirement would preclude the use of many insulating materials

Instrumentation. Concerning *§ 193.527,* commenters suggested various deletions of the instrumentation suggested by the ANPRM for monitoring certain conditions to provide for the safe operation of storage tanks. By far, the largest number recommended that items (5), (6), (7), and (8) be deleted because of the high maintenance costs involved and disagreement over the need for such extensive monitoring. MTB has determined that since some of the instrumentation suggested is of the laboratory type, it would not be readily adaptable to continuous field use, making it unreliable and requiring extensive maintenance. Accordingly, items (5), (7), and (8) of the ANPRM have deleted in this Notice. Item (6) concerning excessive stress is restated to apply to thermal stress, and a new item (7) is added dealing with excessive relative movement determined under *§ 193.509*.

Metal and Concrete Tanks. Under §§ *193.529* and *193.531* both the inner container and outer shell of a metal or concrete storage tank would have to be designed and constructed according to applicable industry codes. A double-wall tank with different materials (concrete shell, metal container) would have to meet the applicable portions of the codes. Most of the commenters felt that *§ 193.531* in respect to a concrete storage tank was not comprehensive enough, and recommended that Section 42, of NFPA 59A-1975 be adopted. MTB, after a review of Section 42, finds that it more comprehensively covers the needed safety measures and provides detailed references. Consequently, Section 42 is proposed to be used instead of the requirements suggested by *§ 193.531* in the ANPRM. One commenter stated that there was no adequate standard available for concrete tanks in cryogenic service, and that consideration be given to incorporating ASME Section III, Division 2, to strengthen the requirements for concrete tanks. MTB will welcome any comments or elaboration in this regard.

Tank Support. All commenters recommended deletion of *§ 193.535(d)* in the ANPRM which suggested that installation of tank bottoms above grade (or ground) level be prohibited. Commenters argued that requiring the bottom of a storage tank to be at grade level would eliminate the use of foundations installed on top of elevated piles. With this type of foundation natural convection under the tank may be used rather than ground heaters to prevent frost heave. Other commenters misunderstood the intended meaning of "grade level." In a recent study, the General Accounting Office points to the potential hazards of ignition of an LNG spill which runs under a tank or enters the open space provided by an elevated, or above grade, foundation. If such a spill and ignition were to occur, a tank could fail catastrophically by overpressure or thermal stress due to heating the bottom of the tank or by the force of any explosion which might occur. While MTB has determined that the level of this potential hazard is uncertain, paragraph (d) was intended to preclude such eventualities for large tanks, and the provision is retained in this Notice. It is modified, however, for clarity.

While the Draft Evaluation shows a major cost impact for this Section, MTB believes the impact could be mitigated by selecting sites where piling is not needed for support or by using special fill material underneath a tank to minimize the use of ground heaters.

Piping. Most commenters questioned the suggested requirement for excess flow valves under *§ 193.537(b)*. Some stated that such valves did not exist for cryogenic service; others stated that large sizes were not available. Two commenters stated that the experience in the liquefied petroleum gas industry with such valves was decidedly mixed, and the current trend is to use other devices such as internal valves. As a pressure differential is required for the proper functioning of excess flow valves, it was suggested they only be used where pressures exceeds 15 psi. MTB has adopted this recommendation.

Tank Marking. All comments to *§ 193.539* pointed out that the referenced codes under *§ 193.529* and *§ 193.531* for design of metal and concrete tanks specify name plate data. It was said that all of the additional items listed in the ANPRM are not pertinent, serve no useful purpose, do not add to safety, and would be available in an operator's design file if it should be needed. MTB agrees that the items listed in the design codes provide sufficient name plate data and has so changed *§ 193.539*.

SUBPART G—DESIGN OF TRANSFER SYSTEMS

This subpart would prescribe additional design requirements for piping used to transfer hazardous fluids between containers or between containers and a tank car or tank truck. The subpart would assure structural integrity of the piping when it expands and contracts and require the use of operational devices to minimize the effects of line breaks or piping malfunctions.

Expansion and Contraction. With respect to *§ 193.603(b)*, in the ANPRM, the majority of commenters objected to the suggested prohibition of the use of bellows-type expansion joints unless a transfer system is maintained at a temperature near its operating temperatures. The requirement was suggested because bellows could fail due to icing or fatigue cracking. Commenters pointed out that maintaining a piping system in a cooled-down condition would not be a practical alternative because of increased operating costs, and that it would not be possible or practical to use expansion loops as an alternative means of protection in all cases. In view of these problems and MTB's belief that bellows joints can be used safely if they are properly designed (taking into account the frequency of thermal cycling so as to avoid fatigue) and maintained free of ice. MTB has revised paragraph (b) to be more performance oriented and deleted reference to expansion and bellows joints. However, slip-type expansion joints would be prohibited because they are susceptible to failure, and packing-type joints would not be permitted under cryogenic temperatures because the packing materials could leak.

Shutdown. For the following reasons, many commenters objected to the suggested requirement in *§ 193.605* that redundant shutdown control systems be installed on transfer systems. Because of operational problems commenters said the suggested redundant mechanism would need an elaborate computer; it would not contribute substantially to reliability; it would not be economically justifiable; or it would cause problems in safe operation. After reviewing these considerations, MTB has deleted the redundancy requirement. However, a backup means for operation of the shutdown system would be required by *§ 193.921*. The gas concentration set forth in paragraph (e) has been changed to 25 percent. As many commenters pointed out, this level is more consistent with accepted practice. Editorial changes have also been made in paragraphs (a) and (b). Paragraphs (c) and (d) have been transferred to *§ 193.617*.

Backflow from a container in the event of a line break could increase the severity of a spill. Therefore, *§ 193.607(b)* has been added based on Section 812 of NFPA 59A, to propose that the means installed for protection against backflow be located near the receiving container, thus minimizing the volume of backflow.

Commenters to *§ 193.609(a)* regarding the possible overfilling of a container pointed out that manual shutdown is a more desirable method than relying on automatic shutdown to prevent overfilling. Commenters also said that prevention of overfilling by pumping predetermined amounts of liquid would be dependent on metering facilities, and it was stated such metering technology for large volume cryogenic installations is in its infancy. In the ANPRM, MTB did not intend that manual shutdown should be precluded, but that safe alternatives should be available. MTB believes this alternative would be provided by the automatic shutdown proposed under § *193.605* and has rewritten § *193.609* to propose means for manual control.

As some commenters recommended, the term "design maximum liquid level" is proposed in §§ *193.605(b)* and *193.609* as more appropriate than "design load limit" to define the dangerous overfill level.

Design of Cargo Transfer Systems. The major comment in regard to § *193.611* was that the same design requirement should not apply to arms as well as hoses (devices used to transfer liquid between piping and tank cars or tank trucks). MTB concurs that a design burst pressure of not less than five times the operating pressure is only applicable to hoses. Similar changes are made to other provisions os § *193.611(b)*, based on Section 870 of NFPA 59A. It was further suggested that paragraph (a) be clarified to require venting of each cargo transfer system, such as a hose from a manifold valve to a tank truck valve. As this was the intent, wording has been changed accordingly for clarification under § *193.611(a)(1)*. Paragraph (a)(3), concerning protection barriers, which is similar to Section 843 of NFPA 59A, has been added, at it is felt this provision contributes to the safety at cargo transfer areas. Section § *193.613*, pertaining to marine transfer systems, has been deleted because of the memorandum of understanding between the U.S. Coast Guard and MTB, effective February 8, 1978 (43 FR 30381), which assigns regulatory responsibilities involving waterfront LNG facilities to the Coast Guard.

MTB agrees with the many commenters who stated that § *193.615(a)* and (c) in the ANPRM were more properly operational procedures than design consideratins. Both of these topics will be incorporated in the upcoming Notice of proposed rulemaking on Subpart L of the ANPRM.

Shutoff Valves. Section *193.617* has been retitled to cover all shutoff valves on transfer systems and combined with the suggested § *193.605(c)* and (d) to prescribe valve locations and design stress. Wording has also been changed to clarify, consistent with Section 845 of NFPA 59A, that valves would be required in transfer piping supplying cargo transfer systems where they can be readily operated in an emergency.

SUBPART H—VAPORIZATION EQUIPMENT

This subpart is intended to provide design and installation requirements needed to assure the safe operation of vaporization equipment. At LNG facilities vaporization equipment is used to convert LNG to natural gas to satisfy sudden or long term demands for gas. The process occurs when LNG is heated either directly by burning gas (fired) indirectly by steam, or by transferring heat from large quantities of air or water (ambient vaporizers).

Based on the views of the majority of the commenters, the terms "gasifier" and "gasification" have been changed throughout this subpart to "vaporizer" and "vaporization" respectively, because these terms are more commonly used in the LNG industry.

Design. Some commenters mentioned that "ambient vaporizers" should also be subject to the design requirements in § *193.705* suggested for "fired vaporizers." MTB believes that all vaporizers should be designed in accordance with the applicable provisions of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code; and § *193.705* has been changed accordingly. Based on the recommendation of one commenter, paragraph (b) has been added to require a design for pressure based on the pump or container pressure supplying the vaporizer.

Overpressure and Temperature. Section *193.707* in the ANPRM concerning overpressure in vaporizers or downstream piping, has been deleted as redundant with §§ *193.913, 193.917*, and *193.1107*. Similarly, § *193.709* in the ANPRM concerning temperature is redundant with §§ *193.203* and *193.913*, and it has been deleted.

Controls for Operation. Monitoring devices, valves, and relief devices are needed for safe control of the vaporization process. In regard to § *193.711*, MTB agrees with the commenters who pointed out that paragraphs (b) and (c) in the ANPRM related to operational procedures, and, therefore, they will be incorporated in Subpart L. Paragraph (d) has been deleted as redundant with § *193.605*. As suggested, § *193.711(a)* is changed to require monitoring of "heating medium fluids". It is agreed, as suggested by commenters, that monitoring of the inlet and outlet temperatures and pressures is more meaningful than monitoring the temperature and pressures in the vaporizer as suggested in the ANPRM.

It was suggested that manifolded ambient vaporizers with inlets 2 inches or less in size be excepted from the two inlet valve proposal under § *193.711(e)* in the ANPRM (now § *193.711(b)* to be consistent with paragraph 5220 of NFPA 59A-1975. MTB believes this is not an onerous proposal and can see no valid justification for such an exception.

In regard to the design of shut off valves under § *193.713*, a number of commenters suggested that the minimum separation distances in paragraphs 524, 5240, and 525 of NFPA 59A-1975, would provide less chance of damage to valves by explosion or fire. MTB feels the performance type language in paragraph (a), as revised, is more appropriate. The ANPRM suggested that a valve be located near an "emergency exit". This provision has been deleted from § *193.713(a)(2)* because as a number of commenters stated, a building could have a number of exits, none of which would be designated as an emergency exit. Section *193.713(a)(3)* in the ANPRM regarding emergency shutdown has been deleted, as MTB believes these suggested requirements would be redundant with other provisions.

MTB concurs with the majority of the commenters on § *193.715* who pointed out that setting relief devices so that the pressure does not rise above the vaporizer's maximum allowable operating pressure (MAOP) would be impractical. If a vaporizer were operating at MAOP, the relief device would continuously chatter and would rapidly deteriorate. The revised Section is consistent with Section 53 of NFPA 59A-1975 and with the ASME Boiler and Pressure Vessel Code in permitting a 10 percent increase in pressure above the MAOP.

Section *193.717* has been deleted as redundant with § *193.911*, which would require warning devices to warn of potential or existing hazardous conditions detected by all sensing devices proposed by this Notice.

Combustion Air Intakes. In regard to § *193.719*, MTB agrees with the large number of commenters stating that combustion air intakes in themselves cannot prevent the induction of a flammable mixture. This Notice proposes a device to detect induction of a flammable vapor. However, MTB believes the device should detect the presence of any flammable vapors (or gases) rather than of a gas mixture which is in a flammable concentration.

SUBPART I—LIQUEFACTION EQUIPMENT

Liquefaction equipment is used to cool natural gas to the point it becomes a liquid. Some important safety features in the liquefaction area of an LNG facility are covered elsewhere in this notice (e.g., spill collection (§ *193.403*), leak detectors and alarms (§§ *193.909* and *193.911*), and fire resistant materials (§ *193.207*). This subpart covers additional design requirements specifically applicable to liquefaction equipment.

Shutoff Valve. An operator should be able to shut off gas entering a liquefaction process in the event of an emergency. In response to many comments, § *193.805* has been revised to propose that a shut-off valve be required for piping leading to each "liquefaction system" rather than "liquefaction equipment." This change is intended to clarify that a shut-off valve would not be required for each piece of equipment used in the liquefaction process. Subparagraph (a) in the ANPRM has been changed to propose that shutdown begin when gas concentrations reach 40 percent of the lower flammable limit "in the area of liquefaction equipment" rather than "near liquefaction equipment." The suggested requirement for automatic shutdown at 30 percent of the lower flammable limit has been increased to 40 percent because MTB considers 30 percent to be unrealistic for mandatory shutdown in the case of liquefaction equipment. Several commenters also pointed out that automatic shutdown systems could not detect when a fire is uncontrollable, as would be necessary if Subparagraph (b) were proposed as suggested in the ANPRM. Therefore, the suggested requirements of subparagraph (b) have been changed to propose that shutdown be required when high or low temperature in the area of liquefaction equipment exceeds the limits determined under § *193.205*.

Contaminants. Commenters to § *193.807* pointed out that subparagraph (b), on monitoring the buildup of ice or other contaminants within liquefaction equipment, would not be needed for safety. It was argued that such buildup would be detected by normal pressure and temperature indicators long before it becomes dangerous. Since these plant operating characteristics are normally monitored to achieve efficient operation and such monitoring was suggested as a safety measure under § *193.1107* in the ANPRM, Subparagraph (b) is deleted.

Backflow. Section *193.809* has been revised to be consistent with the wording used elsewhere in the proposed Part 193, by replacing the term "reverse flow" with "backflow" both in the title and the text. In addition, the text in § *193.809* has been revised to clarify the level of protection required against backflow in a multiple parallel piping system.

Coldboxes. Section *193.811* has been revised for clarity and to respond to comments indicating that the insulation space surrounding liquefaction equipment may contain an atmosphere of air, natural gas, or inert gas. The intent of the proposed rule is to avoid explosions and fires by restricting the concentration of gas in air to ranges that are not flammable. The flammable range of natural gas in air varies slightly but is about 5 to 15 percent by volume. Commenters pointed out that the lack of instrument accuracy at low concentrations such as 5 percent of the lower flammable limit. Because of this and to be consistent with other revisions to this proposal, the lower limit for introduction of purge gas was raised to 25 percent lower flammable limit, which corresponds to 1.25 percent by volume.

There has been no established limit for avoiding the upper flammable limit of gas in air. Therefore, MTB has selected 30 percent by volume as the concentration for introduction of purge gas. Discussion of this upper limit is specifically requested from commenters to this Notice.

Air In Gas. No changes are proposed to § *193.813*, regarding the prevention of a flammable mixture in incoming gas, because many commenters agreed with the concept stated in the ANPRM.

Equipment Supports. Section *193.815* has been changed to clarify that equipment supports must comply with the material requirements of § *193.207* regarding high and low temperatures.

SUBPART J—CONTROL SYSTEMS

This subpart concerns significant design features such as backup power supplies, redundant relief capacity for LNG storage tanks failsafe design and central control for components used manually or automatically to control the operation of other components.

General. Section *193.903(c)* was revised to recognize the fact that it would not be reasonable to require that all control systems be accessible, as pointed out by some commenters. However, they should be maintained, and the design and installation should accommodate future inspection or testing. Separate routing of control lines is being proposed under § *193.903(d)* to avoid simultaneous damage in the event of an accident.

Relief Devices. Sections *193.905(a)* and *(b)* in the ANPRM, relating to relief valve capacity, are combined in Paragraph (a) in this Notice. Changes make this paragraph consistent with other changes to the proposed part, that relief devices should release fluid so as to prevent pressures from exceeding 110 percent of the maximum allowable operating pressure. The suggested redundancy of relief devices, suggested by Paragraph (b) in the ANPRM, has been deleted except for LNG storage tanks, but MTB is proposing under Paragraph (b) in this Notice that a separate manual means be provided to relieve pressure in an emergency. Over design of relief capacity in the case of LNG storage tanks would provide an added safeguard against unexpected events without much extra cost. The term "override" has been deleted with regard to manual controls to avoid the misunderstanding that they could be used to avert automatic pressure release.

Paragraph (c) (paragraph (d) in the ANPRM) is changed to eliminate the suggested requirements for vents on pressure relief devices to prevent harmful discharges of fluids. The proposed paragraph (c) is performance oriented and would permit any means of minimizing a discharge hazard. Paragraph (d) (paragraph (e) in the ANPRM), concerning the relief of vacuum conditions has also been modified to be more in keeping with Paragraph 335 of NFPA 59A.

As commenters noted, the means for adjusting the setpoint pressure of relief devices rather than the pressure, itself, should be sealed, and § *193.905(e)* in this Notice is changed accordingly. Section *193.905(f)* has been modified to prohibit the use of relief devices installed to limit maximum or minimum pressures to handle boiloff and flash gases. This changed is consistent with NFPA 59A, Paragraph 334. Section 193.905(h) in the ANPRM, regarding operating temperatures of relief devices has been deleted as redundant with § *193.205*.

Fluid Discharge. Section *193.907(a)* has been modified to propose that discharge of fluids be prohibited in confined spaces as well as in buildings. Paragraph (b) has been changed to apply only to boiloff vents, which is consistent with Paragraph 33, NFPA 59A.

Sensing and Warning Devices. As suggested by a number of commenters, tow changes were made in § *193.909*. The word "critical" was inserted before "component" in paragraph (a)(1) to limit the number of components that are monitored for malfunctions to those where serious hazards could result. To be consistent with accepted practices, "5 percent" was changed to "25 percent" in paragraph (b) as the warning level for hazardous gas concentrations.

Many commenters objected to the suggesed requirements that warning devices be installed at all locations frequently by personnel as proposed by § *193.911* in the AMPRM. MTB concurs that such a requirement would be unreasonable and is proposing that such devices be installed in the control center. However, under § *193.921(e)*, a means would have to be available for communicating hazardous conditions warnings from the control center to locations frequented by personnel.

The words "potential" or "existing" are not used to describe the hazard for which an alarm is sounded, because, as it was pointed out, a warning indicates an actual hazardous condition. MTB also agrees that sensing devices can only detect the nature of a hazard, not the cause as suggested in the ANPRM.

Section *193.913* has been deleted, as discharged pressure and temperatures are adequately covered by §§ *193.917*, *193.205*, *193.207*, and *193.709*.

Pump Controls. As suggested by some commenters, the word "idle" in § *193.915(a)(2)* has changed to "off" to clarify the intended meaning that a light show when a pump or compressor in service is not in operation. Paragraph (3) in the ANPRM has been broken down to paragraph (a)(3) and (4) for clarify. Also, paragraph 820 of NFPA 59A has been used as basis for a new paragraph (b) to establish the location of controls for pumps or compressors used in loading or unloading operations.

Shutdown. As pointed out by many commenters, in § *193.917*, the term "shutoff valves" is adopted as more appropriate than "control valves" for the purpose of requirements related to safe valve closure. Also, Paragraph (a) in the ANPRM is deleted as duplicative of other proposed requirements in Part 193 regarding the control of fluid flow.

Section *193.919* has been redrafted for clarity and to propose in Paragraph (a) that all critical components have control systems to automatically shutdown the component in certain events. However, a provision for a reasonable delay between warning and the actuation of shutdown at a manned facility permits an operator to take appropriate action which could remove the hazard and consequently eliminate the need for a shutdown. This delay would not apply to unattended facilities, where no personnel would be available to take such action. In addition to automatic shutdown system for critical components, it is proposed that each LNG facility have a manual shutdown control system which can be actuated to shutdown all operations of the whole facility.

Control Center. As pointed out by some commenters, an LNG facility may have more than one centralized location for operating control systems, with specialists in attendance at each center. This is recognized in the Notice in the redrafted version of § *193.921*. Personnel would have to be in attendance at any center when critical components under its control are operational. Under paragraphs (b) and (c) requirements would be established for redundant means of communication between centers, and for means of communicating hazardous condition warnings from the control centers to other locations frequented by personnel at the LNG facility, only when critical components under its control are in operation. Under paragraphs (b) and (c) requirements would be established for redundant means of communication between centers, and for means of communicating hazardous condition warnings from the control centers to other locations frequented by personnel at the LNG facility.

Auxiliary Controls. Section *193.923*, which would have required auxiliary control devices in addition to those required by other Sections of Part 193, has been deleted. Some of the suggested requirements in this Section of the ANPRM were redundant with other sections (e.g., § *193.915(a)(1)* and MTB believes that a requirement for additional controls is not economically justified.

Failsafe Design. In § *193.925*, in response to some commenters, the words "liquefaction equipment, storage tanks, and gasification equipment" have been replaced by "critical components." Under this proposal and § *193.917(a)*, each control system for a critical component and each shutoff valve would have to be designed to provide a safe condition in the event of a malfunction or failure of either the power supply, the valve on the system, or the component being controlled.

Power Supply. Many commenters objected to the suggested requirement in § *193.927* for separate and redundant sources of electrical power, and pointed out that other types of power than electrical could be utilized, such as diesel or gas driven systems, as a second power source. Upon consideration of the comments, MTB believes that a requirement for backup power sources should be applied broadly and not just to electrical power. Wording is also changed to clarify the proposal regarding the intended separate and redundant power sources.

An additional proposed requirement would provide for the protection of auxiliary generators which may be installed to furnish a second source of electricity, and for the protection of the fuel supply to such units.

SUBPART K—CONSTRUCTION

Under this subpart MTB is proposing new requirements for reliable construction procedures, inspection of construction activities, personnel qualifications, and for field testing components. The objective of the subpart is to assure that components comply with design plans and material specifications and have sufficient structural integrity to operate safely when placed in service.

General. The text of § *193.1021* in the ANPRM titled "Testing acceptance" has been restate in § *193.1002* in this Notice and named "Construction acceptance." Section *193.1002* proposes a general requirement that a component must pass all applicable inspections and tests before it is placed in service. While most commenters agreed with the wording of this Section in the ANPRM, a few felt it should apply only to critical components and not to incidental parts of an LNG facility. The proposed definition of "component" in § *193.5* should alleviate this problem since the definition would only refer to parts of a facility that are related to safety.

Section *193.1003* in the ANPRM has been deleted, since it was essentially redundant with other suggested requirements and personnel qualifications are now addressed more effectively in § *193.1009*.

Construction Procedures. With respect to § *193.1005*, most commenters said that the suggested requirements that operators prepare and follow construction procedures for each component should apply only to critical components so as to limit the impact of the requirements to components whose failure could cause or worsen a hazard. The proposed definition of "component" should help alleviate this issue. Also, § *193.1005* is changed to apply only to "critical processes," or those processes of construction, installation, inspection or testing that are necessary to ensure the performance reliability or structural integrity of a component. The change to § *193.1005* also incorporates the views of a large number of commenters that construction be in accordance with written specifications and drawings. Two commenters pointed out that field changes are made in construction processes, and recommended that changes be promptly reflected in the records. On this point, § *193.1005* would require that comprehensive written procedures be followed for all critical processes, whether they are processes changed in the field or original ones. The last sentence of § *193.1005(a)* as stated in the ANPRM, requiring tests for joining procedures, has been restated and set forth as § *193.1005(b)* for greater clarity. The language has been revised to be consistent with § *193.1005(a)* and broadened to propose that all procedures be substantiated by testing or experience.

Section *193.1007*, in the ANPRM concerning the identification of construction processes that are critical to the safety of a facility has been deleted in this Notice. Instead, the term "critical process" is defined in § *193.5*. *This term forms the basis for several proposed requirements in Subpart K. The suggested requirement under* § *193.1007*, in the ANPRM, which would have allowed each operator to determine critical processes at an LNG facility, would not provide an adequate standard because of the potential variations in interpretation of the word "critical."

Personnel Qualifications. In order to eliminate redundent language and thereby simplify this Subpart, the suggested inspector qualifications in § *193.1013* of the ANPRM have been included in § *193.1009* regarding the qualification of personnel in general. Accordingly, § *193.1009* proposes qualifications for personnel used in all critical processes of construction, including inspection and testing.

The principal position of most commenters was that the suggested requirements of both § *193.1009* and

§ *193.1013* in the ANPRM would be too rigorous. Generally, commenters objected to the suggestion that personnel be qualified by both training (or experience) and testing and recommended that either one should satisfy the need for a qualification standard. This viewpoint has not been adopted since MTB believes that qualification either by testing and training or by testing and experience is necessary in critical processes for the safety and reliability of an LNG facility. MTB feels that testing is necessary to assure that a worker's prior training or experience can be applied in practice.

A number of commenters said that the suggested personnel qualifications requirements would conflict with "right to work" laws in certain States. Notwithstanding such conflict, if any, MTB believes it is empowered to establish reasonable qualifications for construction personnel working on an LNG facility.

Other commenters felt that it should not be the obligation of the operator to test and evaluate the competence of personnel involved in critical processes. Some commenters said that reliance on a third party's decision in testing would be desirable. MTB agrees that an operator need not be the one to give performance qualification tests; an appropriate test given by others should suffice. However, where a new employee, for example, has not yet demonstrated competency by testing, under § *193.1009* it would be the operator's obligation to see that such testing is performed. The language of § *193.1009(a)(2)* has therefore been modified to make clear that an operator must verify that qualification tests relevant to the assigned function are passed.

In the final rules, the provisions of § *193.1009* will be relocated to a separate Subpart on personnel training and qualifications.

Inspection. Section *193.1011*, relating to inspection of construction activities, is changed by incorporating the suggested material inspection requirements of § *193.1035*. Although many commenters agreed with the wording of § *193.1011(a)*, regarding inspection to assure compliance with Subpart K, some commented that inspection should be to verify compliance with specifications, industry codes, and drawings but not Federal regulations. While the language has been modified to clearly point out that inspection requirements apply to all construction activities required by Subpart K, including testing, MTB believes that in addition, an essential purpose of inspection should be to assure compliance with the other appicable Federal safety standards in Part 193. This concept has therefore been retained in the revision.

Provisions of other Sections (E.g., §§ *193.1023(b)* and *193.1035*) concerning the type and scope of insepctions and tests are restated in a new § *193.1014*, called "Inspection and testing methods". This new Section would establish a general requirement that each operator determine the nature and scope of tests and inspections performed under Subpart K (that are not otherwise specified) and the extent of inspection and testing procedures prepared under § *193.1005*.

Cleanup. Most commenters on § *193.1015* agreed with the concept that components should be cleaned after construction to remove potentially damaging contaminants. Therefore, this Section is retained in this Notice; and it is combined with several provisions from § *193.1417*, which also dealt with cleanup. Several commenters suggested that the clause "which could cause a hazard" be deleted, stating that all detrimental contaminants should be removed. MTB agrees that removal of all contaminants is good practice, but the purpose of this proposed requirement is to prevent hazards resulting from contaminants.

Pipe Welding. There were several minor modifications suggested by commenters for § *193.1017* which proposes standards for welding pipe. The following modifications have been made in accordance with applicable comments: In § *193.1017(a)(1)* a revision has been made to permit welding qualification under either ASME Section IX or API 1104 as applicable. Subsection *193.1017(a)(2)* has been modified slightly, only to clarify intent. Two commenters stated that in § *192.1017(d)*, prohibition of dye stamping should be based on wall thickness and temperature of pipe rather than nternal pressure. Since material must be selected to have adequate toughness at predictable operating temperature, MTB has not included temperature as a factor to consider in deciding whether to field dye stamp the pipe. Otherwise, MTB agrees that thickness should be the controlling factor and has revised § *193.1017(d)* accordingly. Also, a suggested welding provision regarding alloy welded joints is transferred to this section from § *193.1417(d)* in the ANPRM.

Pipe Connections. A large number of commenters recommended that the suggested piping connection requirements of § *193.1019* be limited to LNG and hazardous fluid piping, and the proposed definition of "piping" should satisfy this concern. A number of commenters to § *193.1019(a)* felt that non-welded connections should be permitted for unusual situations where welding would not be practical. MTB agrees and a change has been made to propose that threaded or flanged connections be allowed for "special connections" such as those needed to attach instruments to pipe. Many commenters advocated the use of NFPA 59A as a basis for this Section. MTB has essentially followed this recommendation, expanding the Section to include most of the provisions of NFPA 59A, Paragraphs 6210 and 6211. Based on the views of one commenter that clearances in socket fittings must be assured, MTB has added a new paragraph (b) covering this topic.

Retesting. Section *193.1023(c)* in the ANPRM has been revised in response to a majority of commenters who argued that a component should not have to be retested in every case that welding is performed on the component after initial testing. MTB has re-examined potential harm that could be caused by welding after a component is tested and the need for such welding. Section *193.1023* now provides that retesting would be required only in the event of penetration welding (other than tie-in welds). In addition, MTB is proposing that retesting be required if the components structural integrity is disturbed in any way after an initial test.

Strength Tests. Many commenters objected to the suggestion under § *193.1025(a)* in the ANPRM that each component be tested for strength because as the term "component" was defined in the ANPRM, many needless tests would be run. MTB agrees and under this Notice only "piping systems and containers" would have to be tested. Components which do not contain a hazardous fluid, such as a control system, need not be strength tested to prove their design capabilities; and it would not be practical to strength test other components, such as dikes. Some commenters questioned how loading from ice or snow could be considered in tests as suggested in § *193.1025*. This may be accomplished by calculating deflection, settling, and movement due to thermal contraction and comparing the value with field measurements taken during testing. As another example, calculated toe loads due to wind or seismic motion might be correlated with settlement measurements during hydrostatic test to determine the effects of the projected loading.

A number of commenters on § *193.1025(b)* said that the suggested 1.5°C temperature limitation on pressure testing low alloy and carbon steel piping would not be practical since ambient temperatures could be lower and many steels retain adequate toughness at that temperature. Once commenter said there should be no low temperature limit, since testing at a low temperature would be more rigorous. Accordingly, the low temperature limit for testing has been deleted. A new clause proposing that test pressures include a uniform safety factor, consistent with test requirements for ordinary gas piping and hydrostatic tests under B31.3, has been included for critical components.

Testing Welds. A wide range of viewpoints was expressed in comments to § *193.1027(a)* concerning the nondestructive testing of circumferential welds on piping to check for welding defects. Some felt that a requirement for testing all welds would be excessive; 59A requires that only 30 percent of the welds on piping be tested. On the other hand, many commenters indicated that a 100 percent testing requirement would be appropriate, or appropriate for certain temperature ranges or fluids. After further consideration, MTB believes that a higher level of testing should be required for critical piping, or piping whose failure could cause an emergency, in order to adequately assure weld acceptability. Assurance is most important in the case of cryogenic piping because of the unusual problems in welding the materials involved. Therefore, this Section has been revised to proposed that 100 percent of welds be nondestructively tested on critical piping and 30 percent on noncritical piping.

Most commenters agreed with the suggested requirement of § *193.1027(a)(3)* in the ANPRM for 100 percent testing of longitudinal seams in transfer piping. MTB believes this requirement would be appropriate, and it is proposed under § *193.1027(c)* along with 100 percent testing of spiral welds.

With respect to § *193.1027(d)*(§ *193.1027(b)* in the ANPRM) commenters opposed adopting a requirement for testing 100 percent of the welds in metal storage tanks with curved surfaces because of the low stress levels in some areas of most tanks and because pressure tests § (*193.1033*) assure quality of construction. A number of these commenters contended that testing should be no more stringent than currently required by the industry standard, API 620, since it has not been shown to be inadequate. However, other commenters indicated that a 100 percent requirement would be appropriate for LNG tanks or those operating at temperatures below −20°F. MTB has not adopted these comments because the 59A standard (and reference to API 620) appears ambiguous and does not impose any appreciably higher standard for LNG storage tanks than tanks holding any other fluid. Also, pressure testing may not be adequate to assure that joints meet the proposed design requirements for loading because under § *193.1033* some joints might not be tested to the stress level that would result from wind or seismic loads. MTB has revised this suggested requirement to make clear that it applies only to butt welds in hydraulic load bearing shells of tanks with curved surfaces that are to operate at cryogenic temperatures. In view of the potential for disaster in case a storage tank containing a flammable fluid fails and the level of difficulty associated with welding the curved surfaces and cryogenic metals involved, MTB believes that testing 100 percent of the welds is appropiate. In addition, testing to this degree is necessary to assure structural integrity so that a vapor dispersion distance under § *193.109* for an LNG tank justifiably be based, in most cases, on a piping failure and not on a total sudden release of the tank contents.

The Draft Evaluation has identified § *193.1027* as a provison with high cost impact. The additional testing that would be required would obviously have some additional cost. MTB believes this impact would not be harsh because the added testing could be done by personnel already at a job site to comply with any less stringent testing standard that might be adopted and during the same time period.

Leak Tests. Most commenters addressing § *193.1029(a)* on testing components for leaks after construction, objected to the suggested testing of all "components." The Section is modified to apply to containers and piping systems, those components which will contain hazardous fluids and would pose a hazard if a leak occurs.

In § *193.1029(b)* (paragraph (c) in the ANPRM) the words "design maximum pressure" have been revised to "design pressure."

Testing Control Systems. Section *193.1031*, concerning the testing of control systems to assure their performance, is unchanged from the ANPRM.

Pressure Tests for Storage Tanks. Many commenters strongly opposed the full hydrostatic test suggested by § *193.1033(a)* for storage tanks (filling the tank with water to its maximum liquid level) and recommended that the API 620, Appendix Q, test procedure be adopted without exceptions. In connection with the hydrostatic loading, most of these commenters objected particularly to paragraph (f) which would have prohibited overloading of the tank foundation during testing. Only one commenter advocated that the full hydrostatic test requirement be retained as suggested in the ANPRM, stating the API 620, Appendix Q, procedure is ambiguous. API 620, Appendix Q, provides that a tank be filled with water to the design liquid level, but then permits filling to a lower level if excessive overstressing or foundation overloading would result. As a consequence, load bearing surfaces of an LNG tank are usually not tested for even the static loads that will result when the tank is placed in service.

MTB believes, first, that a full hydrostatic test would be consistent with overpressure tests proposed or now required as a safety factor for less critical components. The test would assure that a tank is liquid and gas tight at all its level and that foundation bearing is adequate. In addition, MTB believes this more stringent test is needed as a safeguard against catastrophic failure of a tank by dynamic or other loads that, as allowed by design procedures would cause static loads to be exceeded. It also would provide justification for basing the vapor dispersion distance computed under § 193.109, in most cases, on piping failure rather than on a sudden total release of the tank contents. Accordingly, the suggested requirement for a full hydrostatic test has been retained in this Notice. However, subparagraph (f) in the ANPRM has been deleted in order to permit overloading of the foundation during testing (as permitted by API 620, Appendix Q), recognizing that lower profile tanks may be necessary for compliance in some cases. This deletion, together with the allowable overstressing of materials and design provisions for certain dynamic loading, should mitigate the onerous aspects of this test.

The Draft Evaluation shows that this provision would have a major cost impact mostly because of the extra cost of concrete and earthwork to support the added foundation loading for most tanks. MTB believes that this impact could be lessened by taking full advantages of the allowable overstressing of material and foundation, by careful site selection, and by using alternate tank designs. Also, any costs for added strength would, to some extent, be included in the costs associated with compliance with proposed Sections related to seismic design, wind load, and internal pressure.

A large number of commenters also opposed the relatively high pneumatic test pressure (1.5 times the design pressure) suggested by § *193.1033(b)* in the ANPRM. In view of the comments and other factors, the test pressure proposed in this Notice is reduced to 1.25 times the design pressure, the pressure provided by API 620, Appendix Q.

In accordance with the number of comments on § *193.1033(c)*, stating that thermal stabilization cannot be achieved, the wording "after thermal stabilization" has been deleted.

The majority of commenters recommended that § *193.1033(d)* in the ANPRM be deleted, stating that unsealed concrete shells should be tested in the same manner as other tank parts. Although the suggested requirement for an additional test on unsealed surfaces was not intended to supplant other requirements, it does not appear to add to safety and has been deleted.

Based on the views of many commenters, § *193.1033(e)* in the ANPRM has been changed using more performance type language, and incorporated in § *193.1033(c)* along with § *193.1033(g)* of the ANPRM.

The majority of comments on § *193.1033(g)* in the ANPRM agreed with the need to use reference measurements to detect tank motion during testing. MTB believes this suggested requirement is appropriate for safety, and it is, therefore, retained under § *193.1033(c)*.

Records. Although a number of commenters to § *193.1037* agreed with the need to keep construction records, some felt that retention of a record of each personnel test and each component inspection would be excessive. Commenters argued that only the results of such tests and inspections should be kept. MTB agrees and has revised § *193.1037* accordingly.

In consideration of the foregoing, MTB proposes to amend Title 49 of the Code of Federal Regulations by establishing Subparts A-K of a new Part 193 as set forth below.

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CESAR DE LEON,
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PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS

Subpart A—General

Sec.
193.1 Scope of part.
193.2 Offshore facilities.
193.3 Applicability.
193.5 Definitions.
193.7 Rules of regulatory construction.
193.10 Reporting.
193.11 Incorporation by reference.

Subpart B—Site Related Design Requirements

193.101 Scope.
193.103 Acceptable site.
193.105 General.
193.107 Thermal radiation protection.
193.109 Flammable vapor-gas dispersion protection.
193.111 Seismic investigation and design.
193.113 Flooding.
193.115 Soil characteristics.
193.117 Wind forces.
193.119 Other severe weather and natural conditions.
193.121 Adjacent activities.
193.123 Separation of components.

Subpart C—Materials

193.201 Scope.
193.203 General.
193.205 Extreme temperatures; normal operations.

Sec.
193.207 Extreme temperatures; emergency conditions.
193.209 Insulation.
193.211 Cold boxes.
193.213 Piping.
193.215 Concrete materials subject to cryogenic temperatures.
193.217 Combustible materials.
193.219 Records.

Subpart D—Design of Components and Buildings

193.301 Scope.
193.303 General.
193.304 Personnel.
193.305 Control valves.
193.307 Piping.
193.309 Pipe attachments and supports.
193.311 Buildings; design.
193.313 Buildings; ventilation.
193.317 Expansion and contraction.
193.319 Frost heave.
193.321 Ice and snow.
193.323 Electrical systems.
193.325 Lightning.
193.327 Boilers.
193.329 Combustion engines and gas turbines.

Subpart E—Impoundment Design and Capacity

193.401 Scope.
193.403 Impoundment required.
193.405 General design characteristics.
193.407 Classes of impounding systems.
193.409 Structural requirements.
193.410 Coatings and Coverings.
193.413 Floors.
193.415 Dikes, general.
193.417 Vapor barriers.
193.419 Dike dimensions.
193.421 Covered systems.
193.423 Gas leak detection.
193.427 Sump basins.
193.431 Water removal.
193.433 Shared impoundment.
193.435 Piping.
193.437 Impoundment capacity; general.
193.439 Impoundment capacity; LNG storage tanks.
193.441 Impoundment capacity; equipment and transfer facilities.
193.443 Impoundment capacity; parking areas; portable vessels.
193.445 Flow capacity in Class 3 impounding systems.
193.447 Sump basin capacity.

Subpart F—LNG Storage Tanks

193.501 Scope.
193.503 General.
193.505 Loading forces.
193.507 Stratification.
193.509 Movement and stress.
193.511 Penetrations.
193.513 Internal design pressure.
193.515 External design pressure.
193.519 Internal temperature.
193.521 Foundation.
193.523 Frost heave.
193.525 Insulation.
193.527 Instrumentation for LNG storage tanks.
193.529 Metal storage tanks.
193.531 Concrete storage tanks.
193.533 Thermal barriers.
193.535 Support systems.
193.537 Internal piping.
193.539 Marking.

Sec.

Subpart G—Design of Transfer Systems

193.601 Scope.
193.603 General.
193.605 Shutdown control system.
193.607 Backflow.
193.609 Overfilling.
193.611 Cargo transfer systems.
193.615 Cargo transfer area.
193.617 Shutoff valves.

Subpart H—Gasification Equipment

193.701 Scope.
193.703 General.
193.705 Vaporizer design.
193.711 Operational control.
193.713 Shutoff valves.
193.715 Relief devices.
193.719 Combustion air intakes.

Subpart I—Liquefaction Equipment

193.801 Scope of part.
193.803 General.
193.805 Control of incoming gas.
193.807 Contaminants.
193.809 Back flow.
193.811 Cold boxes.
193.813 Air in gas.
193.815 Equipment supports.

Subpart J—Control Systems

193.901 Scope.
193.903 General.
193.905 Relief devices.
193.907 Vents.
193.909 Sensing devices.
193.911 Warning devices.
193.915 Pump and compressor control.
193.917 Shutoff valves.
193.919 Shutdown control systems.
193.921 Control center.
193.925 Failsafe control.
193.927 Sources of power.

Subpart K—Construction

193.1001 Scope.
193.1002 Construction acceptance.
193.1005 Procedures.
193.1009 Qualification of personnel.
193.1011 Inspection.
193.1014 Inspection and testing methods.
193.1015 Cleanup.
193.1017 Pipe welding.
193.1019 Piping connections.
193.1023 Retesting.
193.1025 Strength tests.
193.1027 Nondestructive tests.
193.1029 Leak tests.
193.1031 Testing control systems.
193.1033 Storage tank tests.
193.1037 Construction records.

Appendix A—Incorporation by Reference

AUTHORITY: Sec. 3, Pub. L. 90-481, 82 Stat. 721 (49 USC 1672); 49 CFR 1.53, Appendix A of Part 1, and Appendix A of Part 106.

Subpart A—General

§ 193.1 Scope of part.

(a) This part prescribes safety standards for LNG facilities used in the transportation of gas by pipeline that is subject to the Natural Gas Pipeline Safety Act of 1968 and Part 192 of this chapter.

(b) This part does not apply to—

(1) LNG facilities used by ultimate consumers of LNG or natural gas.

(2) LNG facilities used in the course of natural gas treatment or hydrocarbon extraction which do not store LNG.

(3) In the case of a waterfront LNG facility engaged in marine transfer, any matter pertaining to the facility between the marine vessel and the last manifold (or in the absence of a manifold, the last valve) on transfer piping located immediately before a storage tank.

§ 193.2 Offshore facilities.

An offshore LNG facility need not comply with any requirement of this part which the Secretary finds impractical or unnecessary because of the offshore location. In making such a finding, the Secretary may impose appropriate alternative safety conditions.

§ 193.3 Applicability.

(a) No person may operate an LNG facility that does not meet the applicable requirements of this part governing operation, maintenance, personnel qualifications and training, fire protection, and security.

(b) No person may operate any component of an LNG facility upon which construction, installation, replacement, relocation, or significant alteration was begun after (date Part 193—Design and Construction is issued) unless that component meets the applicable requirements of this part governing siting, design, installation, and construction.

§ 193.5 Definitions.

As used in this part—

"Ambient vaporizer" means a vaporizer which derives heat from naturally occurring heat sources, such as the atmosphere, sea water, surface waters, or geothermal waters.

"Cargo transfer system" means a component or system of components for transferring hazardous fluids in bulk between the closest inline valve on transfer piping and a tank car, or tank truck, including connections, arms, hoses, and associated area.

"Component" means any part or system of parts functioning as a unit that is used in an LNG facility for controlling, processing, or confining hazardous fluids or to provide safety.

"Container" means a component other than piping which confines a hazardous fluid.

"Control system" means a component or system of components functioning as a unit, including control valves, and sensing, warning, relief, shutdown and failsafe devices, which is activated either manually or automatically to establish or maintain the performance of another component.

"Controllable emergency" means an emergency where reasonable and prudent action can prevent harm to persons or property.

"Critical component" means a component which may cause, fail to prevent, or increase an emergency if operational capability is impaired or malfunction occurs.

"Critical process" means a process of construction, installation, inspection, or testing that is necessary to ensure the performance reliability and structural integrity of a component.

"Cubic metre" means a volumetric unit which is 6.2898 barrels, 35.3147 feet^3, or 264.1720 U.S. gallons, each volume being considered as equal to the other.

"Determine" means make an appropriate investigation using scientific methods, reach a decision based on sound engineering judgment, and record the decision and its basis.

"Dike" means a structural arrangement, which may be of natural geological formation, compacted earth, concrete, or other material, forming an impermeable barrier to prevent liquid from flowing in an unintended direction.

"Emergency" means a deviation from normal operation, a structural failure, or severe environmental conditions that probably would cause harm to persons or property.

"Exclusion zone" means an area surrounding an LNG facility in which an operator or government agency legally controls all activities in accordance with §§ 193.107 and 193.109 for as long as the facility is in operation.

"Failsafe" means a design feature which will maintain or result in a safe condition in the event of malfunction or failure of a power supply, component, or component part.

"G" or "g" means the standard acceleration of gravity of 9.806 metre per second^2 (32.17 feet per second^2).

"Gas," except when designated as inert, means natural gas, flammable gas, or gas which is toxic or corrosive.

"Hazardous fluid" means gas or any liquid that is subject to Parts 172 and 173 of this Chapter.

"Heated vaporizer" means a vaporizer which derives heat from other than naturally occurring heat sources.

"Impounding space" means a volume of space formed by dikes and floors which is designed to hold a spill of LNG or other hazardous liquid.

"Impounding system" includes an impounding space and dikes and floors, including those for conducting the flow of spilled hazardous liquids to an impounding space.

"Liquefied natural gas" or "LNG" means natural or synthetic gas having methane (CH_4) as its major constituent which has been changed to a liquid by reduction in temperature.

"LNG facility" means a facility for liquefying natural gas or transferring, storing, or vaporizing liquefied natural gas, including rights-of-way, buildings, equipment, piping, and associated facilities, but not including tank cars, tank trucks, marine vessels, fuel systems for motor vehicles, or portable dewar vessels.

"Maximum allowable operating pressure" means the maximum pressure at which a component may be operated under this part.

"Normal operation" means functioning within design ranges of pressure, temperature, flow, or other operating criteria withour malfunction or personnel error which results in the activation of any safety control system.

"Operator" means a person who owns or operates an LNG facility.

"Person" means any individual, firm, joint venture, partnership, corporation, association, state, municipality, cooperative association, or joint stock association and includes any trustee, receiver, assignee, or personal representative thereof.

"Piping" or "piping system" means all pipe, tubing hoses, fittings, valves, pumps, connections, safety devices or related components for containing the flow of hazardous fluids.

"Secretary" means the Secretary of Transportation or any person to whom authority in the matter concerned has been delegated.

"Storage tank" means a container for storing a hazardous fluid, including an underground cavern.

"Transfer piping" means all permanent and temporary piping, supports, and associated area used for transferring hazardous fluids between containers, and between a container and a cargo transfer system.

"Transfer system" includes transfer piping and cargo transfer system.

"Vaporization" means an addition of thermal energy changing a liquid medium to a vapor or gaseous state.

"Vaporizer" means a heat transfer facility designed to introduce thermal energy in a controlled manner for changing a liquid medium to a vapor or gaseous state.

"Waterfront LNG facility" means an LNG facility located on or immediately adjacent to a navigable waterway of the United States.

§ 193.7 Rules of regulatory construction.

(a) As used in this part—

(1) "Includes" means including but not limited to;

(2) "May" means is permitted to or is authorized to;

(3) "May not" means is not permitted to or is not authorized to; and

(4) "Shall" or "must" is used in the mandatory and imperative sense.

(b) In this part—

(1) Words importing the singular include the plural; and

(2) Words importing the plural include the singular.

§ 193.10 Reporting.

Leaks and spills of LNG must be reported in accordance with the requirements of Part 191 of this chapter.

§ 193.11 Incorporation by reference.

(a) Any documents or parts thereof incorporated by reference in this part are a part of this regulation as though set out in full.

(b) All incorporated documents are available for inspection in Docket Room 6500, Trans Point Building, 2100 Second Street, SW., Washington, D.C. 20590. In addition, the documents are available at the addresses provided in Appendix A to this part.

(c) The titles and applicable editions for the publications incorporated by reference in this part are provided in Appendix A to this part.

Subpart B—Site Related Design Requirements

§ 193.101 Scope.

This subpart prescribes site related requirements for the design of a new LNG facility or an existing critical component which is replaced, relocated, or significantly altered.

§ 193.103 Acceptable site.

A site may not be used for an LNG facility or critical component unless it is investigated in accordance with the requirements of this subpart.

§ 193.105 General.

An LNG facility must be located at a site of suitable size, topography, and configuration so that the facility can be designed to minimize the hazards to persons and property resulting from leaks and spills of LNG and other hazardous liquids at the site. In selecting a site, each operator shall determine all site related characteristics which could jeopardize the integrity and security of the facility. A site must provide ease of access so that personnel, equipment, and materials from offsite locations can reach the site for fire fighting or controlling spill associated hazards or to evacuate personnel.

§ 193.107 Thermal radiation protection.

(a) *Thermal exclusion zone.* Each LNG facility must have a thermal exclusion zone. Within the thermal exclusion zone an impounding system for LNG may not be located closer to targets listed in paragraph (d) of this section than the exclusion distance "d" determined according to this section unless the target is part of an LNG facility. If grading and drainage are used under § 193.403(b), operators must comply with the requirements of this section by assuming the space needed for drainage and collection of spilled liquid is an impounding system.

(b) *Measurement.* The exclusion distance "d" is measured as shown in the following diagram along the line (PT) in a vertical plane defined by the points (T) and (D) where—

(T) is a point at the top of the target;

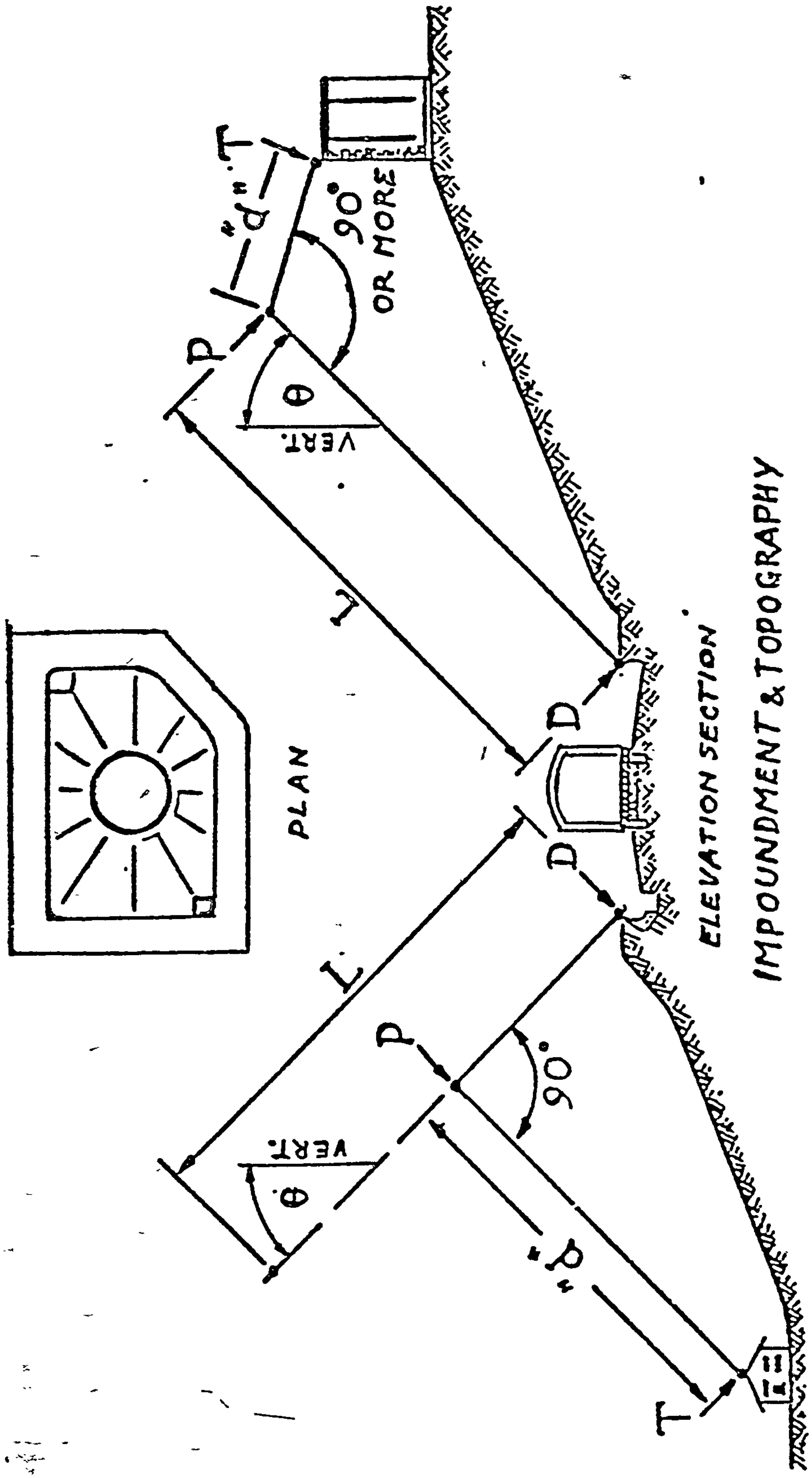
(D) is a point closest to (T) on the top inside edge of the innermost dike;

( ) is the flame tilt angle measured from the vertical as calculated from Equation G-4 of AGA IS-3-1, using the maximum wind speed that is exceeded less than 5 percent of the time based on recorded data for the area.

(L) is the flame length as calculated from Equation G-7 or G-8 of AGA IS-3-1;

(PD) is a line in the vertical plane which intersects (D) at an angle with the vertical;

(P) is located where (PT) and (PD) intersect at an angle of 90° or more, or where (PD) equals (L), whichever results in the shortest length of (PD).


PLAN
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(c) *Exclusion distance length.* The length of an exclusion distance in feet for each impounding space may not be less than the distance "d" determined in accordance with one of the following:

$$(1)\ d=(qA/4\pi q'')^{1/2}$$

(1) Where—

A=Area measured across the top of the impounding space in square feet.
q"=Radiation flux level for the target prescribed by paragraph (d) of this section.
q=Emissive power of LNG fire equals 45,000 Btu/ft.^{2}hr.

(2) Determine "d" from a detailed analysis of the radiation from LNG fires, using the model beginning on Page G-40 of AGA IS-3-1, making certain the analysis accounts for:

(i) Transmissivity of the atmosphere based on the minimum daily relative humidity that is exceeded at least 95 percent of the time based on recorded data for the area;

(ii) Emissivity of the flame;

(iii) Geometric view factor between the flame and the target;

(iv) Emissive power of LNG fire equals 45,000 Btu/ft.^{2}hr.; and

(v) Radiation flux level for the target is as prescribed by paragraph (d) of this section.

NOTE.—In the case of an impounding space with base dimensions in a ratio of more than 2, the distance "d" must be calculated by assuming simultaneous radiation from a series of impounding spaces each with base dimensions in a ratio of 2 or less and taking into account the combination of radiation flux.

(d) *Permissible thermal flux on targets.* Thermal radiation from an impounding space may not result in more than the following thermal flux at a target:

Targets	Maximum Incident Radiation Flux (Btu/ft.^{2}hr.)
(1) Places of outdoor assembly, including beaches, parks, playgrounds, and outdoor theaters	1,600
(2) Structures made of cellulose or metal which—(i) Are frequently occupied by humans; (ii) Contain flammable or toxic materials; (iii) Have exceptional value or contain objects of exceptional value, or (iv) Could result in additional hazard if damaged by thermal radiation	4,000
(3) Public streets, highways, and main lines of railroads	4,000
(4) Structures made of brick, stone, or other masonry materials, which are fire resistant and have not more than 10 percent window area	10,000
(5) Other structures made of cellulose, metal or masonry materials	6,700

§ 193.109 Flammable vapor-gas dispersion protection.

(a) *Dispersion exclusion zone.* Except as provided by paragraph (e) of this section, each LNG facility must have a dispersion exclusion zone with a boundary described by the minimum dispersion distance computed in accordance with this section. The following are prohibited in a dispersion exclusion zone unless it is part of an LNG facility.

(1) Places of outdoor assembly; and

(2) Structures which—

(i) Are frequently occupied by humans;

(ii) Contain flammable or toxic materials;

(iii) Have exceptional value or contain objects of exceptional value; or

(iv) Could result in additional hazard if damaged by concussion or fire.

(b) *Measuring dispersion distance.* The dispersion distance is measured radially from the inside edge of an impounding system along the ground contour to the exclusion zone boundary.

(c) *Computing Dispersion distance.* A minimum dispersion distance must be computed for each impounding system which serves components containing LNG. Computing dispersion distance in accordance with applicable parts of the mathematical model in Appendix B in the report, "Evaluation of LNG Vapor Control Methods" prepared for the American Gas Association by A. D. Little, Inc. If grading and drainage are used under § 193.403(b), operators must comply with the requirements of this section by assuming the space needed for drainage and collection of spilled liquid is an impounding system. Computation of dispersion distance is subject to the following and paragraph (d) of this section:

(1) Average gas concentration in air = 2.5 percent.

(2) Weather conditions are those which result in longer predicted downwind dispersion distances than 95 percent of other weather conditions occurring at the site based on U.S. Government weather data.

(3) Dispersion parameters y, z, and H=O.

(d) *Vaporization design rate.* In computing dispersion distance under paragraph (c) of this section, the following applies:

(1) For sites not subject to paragraph (d)(2) of this section, dispersion distance is based on the following conditions:

(i) Vaporization equals the maximum constant rate of discharge by failed transfer piping which has the greatest overall flow capacity durng the time necessary to wet 100 percent of the impounding floor area as determined by equation C-9 in the report, "Evaluation of LNG Vapor Control Methods, prepared for the American Gas Association by A. D. Little, Inc., plus the flash vaporization from the assumed piping failure.

(ii) After the time required to wet the impounding floor has been exceeded, the vaporization rate is a decreasing function of time and spill surface properties.

(iii) Vapor detention space is all space provided for liquid impoundment and vapor detention outside the component served, less the valume occupied by the spilled liquid at the time the vapor escapes the vapor detention space.

(2) For sites located in active seismic areas having a potential for ground rupture or seismic accelerations in excess of 0.4G as determined under § 193.111, or where other surrounding conditions exist such that structural integrity of the vessel served cannot be assured with a high degree of certainty (e.g., high density commercial or military air traffic, and military test sites for aircraft and missiles), and for areas under § 193.403(b)(4) and (5), dispersion distance is based on the following conditions, as applicable:

(i) For Class 2 and Class 3 impounding systems—

(A) Vaporization results from a release of the maximum contents of the largest vessel impounded, timed in accordance with paragraph (d)(3) of this section, which contacts all exposed surfaces of the impounding system and outer vessel surfaces, plus flash vaporization from the contents of the vessel served; and

(B) Vapor detention space is all space provided for liquid impoundment and vapor detention outside the vessel served less the volume occupied by the spilled liquid at the time the vapor escapes the vapor detention space.

(ii) For Class 1 impounding systems, vaporiztion results from a volume discharged from transfer piping equal to the impoundment capacity required by § 193.441 for transfer piping, which contacts all exposed surfaces of the impounding system, heat transfer to the liquid from any collapsed component roof, plus flash vaporization from the maximum contents of the component served or from the liquid discharged by transfer piping, whichever is greater.

(3) For sites subject to paragraph (d)(2) of this section, the assumed maximum time (t) required for the release of liquid from a vessel served is determined in accordance with the following equation:

$$t=\frac{2A(h_1)^{0.5}-(h_2)^{0.5}}{ca(2g)^{0.5}}$$

where:

A = cross-sectional area of vessel in feet.
a = area of credible spill opening in feet but not less than 5 percent of the nonhorizontal wetted surface of the vessel.
c = coefficient of discharge = 0.75.

h_1 = original height of contained liquid in feet.

h_2 = equilibrium height of impounded liquid in feet.

(4) Unless the requirements of paragraph (d)(5) of this section are met, the boiling rate of LNG on which dispersion distance is based is determined using the weighted average value of the thermal properties of the soil, sealant, and other contact surfaces in the impounding space determined from eight representative experimental tests on the materials involved.

(5) If impounidng surfaces are insulated and the insulation is designed, installed and maintained so that it will retain its performance characteristics under spill conditions, the boiling rate of LNG is determined in accordacne with paragraph (d)(4) of this section both with and without the insulation system in place, using a value of not less than the average of the weighted average value without insulation and the weighted average value with insulation.

(e) *Planned ignition.* An LNG facility need not have a dispersion exclusion zone if the Secretary finds that compliance with paragraph (a) of this section would be impractical and the operator prepares and follows a plan for igniting LNG that is found acceptable by the Secretary. The plan must include circumstances under which LNG vapor is ignited to preclude the dispersion of a flammable mixture from the LNG facility under all predictable environmental conditions that could adversely affect ignition. The reliability of the method of ignition must be demonstrated by testing or experience with LNG spills.

§ 193.111 Seismic investigation and design.

(a) At the site of each of the following LNG facilities each operator shall conduct a detailed geotechnical investigation and determine proximity to faults, the seismic response spectra, potential for motion amplification, potential for soil liquefaction, and potential for surface rupture:

(1) A facility which is located in Zone 2, 3, or Zone 4 of the "Seismic Risk Map of the United States," UBC, or in Puerto Rico, not including a facility with total LNG storage capacity provided by one or more horizontal cylindrical double wall metal storage tanks of less than 100,000 gallon capacity each, mounted within 2 feet of the ground.

(2) A facility located where there is evidence indicating a potential for surface faulting.

(b) In the case of LNG facilities not listed in paragraph (a) of this section, the critical components listed in paragraph (c) of this section must be designed and built to withstand—

(1) The horizontal seismic acceleration and other applicable factors set forth in the UBC, Volume 1, corresponding to the zone of the "Seismic Risk Map of the United States" in which the facility is located; and

(2) A vertical seismic acceleration equal to the horizontal acceleration and the associated applicable factors.

(c) In the case of LNG facilities listed in paragraph (a) of § 193.111, the critical components set forth below must be designed and built to withstand the most critical maximum horizontal and vertical response spectra (with respect to the natural period of the structure) determined to have occurred at the site as a result of an earthquake or determined to have the following probability of not being exceeded at the site in 50 years, whichever is larger, considering motion amplication and symmetric and asymmetric reaction forces resulting from hydrodynamic pressure and motion of contained liquid in interaction with the component structure:

Critical Component	Probability of response spectra not being exceeded
Storage tanks and their impounding systems	99.5%
Transfer piping, shutdown control systems, other flammable fluid containers	90.0%

(d) An LNG facility is prohibited in the following locations:

(1) A location where surface faulting within one mile of a critical component is determined by the seismic investigation under paragraph (a) of this section to have more than a 0.5 percent probability of occurring within 50 years.

(2) A location where the maximum horizontal or vertical seismic acceleration, or any combined vector thereof, at the foundation of the following critical components is determined to have more than the indicated percent probability of exceeding 80 percent (g) in 50 years:

Component	Probability
Storage tanks and their impounding systems	0.5%
Transfer piping, shutdown control system, other flammable fluid containers	10.0%

(3) A location where soil liquefaction or landslide has more than 0.5 percent probability of occurring in 50 years.

(e) If the maximum horizontal or vertical seismic acceleration at a site is determined to have more than a 0.5 percent probability of exceeding 40 percent (g) in 50 years, the following applies:

(1) Foundations of LNG storage tanks must be a monolithic structure on bedrock.

(2) Impounding systems must be designed and installed so that surrounding dike elevation is not below the level of stored liquid for a distance from the inner edge of the dike equal to $4(A)^{0.5}$, where A is the inside area across the top of the impounding space.

(f) Each container which does not have a structurally sound, liquid-tight cover, must have sufficient freeboard with an appropriate configuration to prevent the escape of liquid due to sloshing, wave action, and vertical liquid displacement caused by seismic motion.

§ 193.113 Flooding.

(a) Each operator shall determine the effects of flooding on an LNG facility site based on the worst occurrence in a 100-year period. The determination must take into account:

(1) Volume and velocity of the floodwater;

(2) Tsunamis;

(3) Potential failure of dams;

(4) Predictable land developments which would affect runoff accumulation of water; and

(5) Tidal action.

(b) Each LNG facility must be located and designed so that the effect of the flooding determined under paragraph (a) of this section cannot reasonably be expected to result in a hazardous condition involving—

(1) Foundations, impounding systems, and other critical components;

(2) Access from outside the facility or movement of personnel and equipment about the LNG facility site for the control of fires and other emergencies;

(3) Power supply to the facility;

(4) Operational capability of control systems, whether electrical, pneumatic, or otherwise powered; or

(5) Structural integrity of critical components and their support systems.

§ 193.115 Soil characteristics.

(a) Soil investigations including borings and other appropriate tests must be made at the site of an LNG facility to determine bearing capacity, settlement characteristics, potential for erosion, and other soil characteristics applicable to the integrity of an LNG facility.

(b) The soil characteristics at each LNG facility site must provide load bearing capacities, using appropriate safety factors, which can support, without excessive lateral or vertical movement, all loads resulting from:

(1) Static loading caused by components and their contents and hydrostatic testing of components; and

(2) Dynamic loading caused by movement of contents of components including flow, sloshing, and rollover.

§ 193.117 Wind forces.

(a) All critical components must be designed to withstand wind forces in accordance with the UBC.

(b) In addition to the requirements of paragraph (a) of this section, each operator shall determine the probability of occurrence of tornadoes in the area in which the LNG facility is located. If tornadoes are determined to have at least a 0.5 percent probability of occurring within a 50-year period, storage tanks and dikes must be designed to withstand loading from sustained wind speeds of not less than 250 miles per hour, plus stress or impact which could result from the failure and collapse of all connected transfer piping and other appurtenances unless the connected transfer piping and appurtenances also are designed to withstand a wind speed of 250 miles per hour.

§ 193.119 Other severe weather and natural conditions.

(a) In addition to the requirements of §§ 193.111, 193.113, 193.115, and 193.117, each operator shall determine from historical records and engineering studies the worst effect of other weather and natural conditions which may predictably occur at an LNG facility site.

(b) The facility must be located and designed so that such severe conditions cannot reasonably be expected to result in a hazard involving the factors listed in § 193.113(b).

§ 193.121 Adjacent activities.

(a) Each operator shall determine the present and reasonably foreseeable activities adjacent to an LNG facility site that could adversely affect the operation of the LNG facility or the safety of persons or property located off the site if damage to the facility occurs.

(b) An LNG facility must not be located where present or projected offsite activities would be reasonably expected to—

(1) Adversely affect the operation of control systems;

(2) Cause failure of critical components; or

(3) Cause the LNG facility not to meet the requirements of this part.

§ 193.123 Separation of components.

Each LNG facility site must be large enough to provide for minimum separations between critical components and between components and the site boundary to—

(a) Permit movement of personnel, maintenance equipment, and emergency equipment within and around the facility;

(b) Minimize spill and collapse hazards to persons and property on and off the site, unless protection comparable to separation is provided; and

(c) Comply with distances between the critical components specified in Section 213 through 216 of NFPA 59A.

Subpart C—Materials

§ 193.201 Scope.

This subpart prescribes requirements for the selection and qualification of materials for new components or any portion of an existing component which is replaced, relocated, or significantly altered.

§ 193.203 General.

Materials for all components must be—

(a) Able to maintain their structural integrity under all design loadings, including applicable environmental design forces under Subpart B of this part;

(b) Physically, chemically, and thermally compatible with any fluid or other materials with which they are in contact; and

(c) Qualified in accordance with the applicable requirements of this subpart.

§ 193.205 Extreme temperatures; normal operations.

Each operator shall—

(a) Determine the range of temperatures to which components will be subjected during normal operations, including required testing, initial startup, cooldown operations and shutdown conditions; and

(b) Use component materials that meet the design standards of this part for strength, ductility, and other properties throughout the entire range of temperatures to which the component will be subjected in normal operations.

§ 193.207 Extreme temperatures; emergency conditions.

(a) Each operator shall determine the effects on critical components which are not normally exposed to extreme cold of a spill or other operational error which could cause LNG or cold refrigerant to contact the component.

(b) Each operator shall determine the effects on critical components of the extreme heat which will result if a spill of LNG or other flammable fluid were ignited.

(c) If an operator determines that a critical component would fail due to extreme high or low temperature, the component may not be used unless it is made of suitable materials, or is protected, to prevent failure from at least two hours' exposure to the extreme temperatures to which the component may be subjected.

(d) If a material that has low resistance to flame temperatures is used in any component containing a flammable fluid, the material must be protected so that any heat resulting from a controllable emergency does not cause the release of fluid that would result in an uncontrollable emergency.

§ 193.209 Insulation.

(a) During normal operations, insulation materials must—

(1) Maintain insulating values; and

(2) Withstand thermal and mechanical design loads.

(b) Insulation used on the outside of a component to protect it against temperature extremes must be covered, must provide a vapor barrier, and maintain insulating properties if exposed to water.

The insulation and covering must be self-extinguishing. The covering must also have a melting point above 1500° F, not be subject to ultraviolet decay, withstand wind in accordance with UBC, and withstand anticipated impact loading which could occur in a controlled emergency, including the force of fire hose streams.

§ 193.211 Cold boxes.

All cold boxes and their insulation must be made of materials which do not support combustion in the installed condition.

§ 193.213 Piping.

(a) Piping made of cast iron, malleable iron, or ductile iron may not be used to carry any cold refrigerants or hazardous fluid.

(b) Piping materials intended for use at temperatures below (−28.9° C) −20° F must be qualified by testing in accordance with ANSI B31.3 to comply with § 193.203(b).

§ 193.215 Concrete material subject to cryogenic temperatures.

Concrete subject to cryogenic temperatures may not be used unless—

(a) Materials, measurements, mixing, placing, prestressing, and poststressing of concrete meets generally accepted engineering practices;

(b) Metallic reinforcing, prestressing wire, structural and nonstructural members used in concrete are acceptable in the installed condition for the temperature and stress levels encountered at design loading conditions; and

(c) Tests for the compressive strength, the coefficient of contraction, an acceptable thermal gradient, and, if applicable, acceptable surface loading to prevent detrimental spalling are performed on the concrete at the lowest predictable service temperature or similar test data on these properties are available.

§ 193.217 Combustible materials.

Combustible materials are not permitted for the construction of buildings, plant equipment, and the foundations and supports of buildings and plant equipment in areas where ignition of the material would worsen an emergency. However, limited combustible materials may be used when an operator determines that noncombustile materials are not commercially available.

§ 193.219 Records.

Each operator shall keep a record of all critical components and their materials as necessary to verify that the requirements of this subpart and design requirements of this part are complied with. These records must be maintained for the life of the component.

Subpart D—Design of Components and Buildings

§ 193.301 Scope.

This subpart prescribes requirements for the design and installation of new components and buildings or any portion of existing components and buildings which is replaced, relocated, or significantly altered.

§ 193.303 General.

The components of each LNG facility must be designed, fabricated and installed to withstand predictable loadings including applicable environmental design forces under Subpart B of this part.

§ 193.304 Personnel.

For the design and fabrication of critical components, each operator shall use—

(a) With respect to design, persons who have demonstrated competence by training or experience in the design of critical components for use in an LNG facility or other cryogenic facility; and

(b) With respect to fabrication, persons who have demonstrated competence by training or experience in the fabrication of critical components for use in an LNG facility or other cryogenic facility.

§ 193.305 Control valves.

(a) Each oerator shall—

(1) Determine appropriate locations for, and install, control valves which are necessary for operation in a controllable emergency; and

(2) Equip those valves for local manual operation and both local and remote power operation.

(b) Control valves used for cryogenic liquid service must be designed to operate in the position in which they are to be installed.

§ 193.307 Piping.

(a) Piping must be designed, manufactured, and tested according to written specifications based on generally accepted engineering practices to function under the full range of operating conditions, including pressure and temperature, that are predictable for the piping's use.

(b) All cryogenic and flammable fluid piping must have connections to facilitate blowdown and purge.

(c) Each cryogenic or flammable fluid piping system that is above ground must be identified by color coding, painting, or labeling.

(d) Seamless pipe or pipe with a longitudinal joint efficiency of 1.0 determined in accordance with ANSI B31.3 must be used for process and transfer piping handling cryogenic or other hazardous liquids.

(e) For longitudinal or spiral weld pipe handling LNG or flammable refrigerants—

(1) The design maximum pressure must result in stresses less than 50 percent of the maximum allowable stress set forth in Appendix, Table 1 of ANSI B31.3, unless the weld is subjected to 100 percent radiographic or ultrasonic inspection to indicate any defects which could adversely affect the integrity of the weld or pipe; and

(2) The heat affected zone of the weld must comply with Section 323.2.3 of ANSI B31.3.

(f) Threaded piping used in cryogenic or flammable fluid service must be at least Schedule 80.

(g) Delete.

(h) Delete.

§ 193.309 Pipe attachments and supports.

(a) Pipe supports must be designed to comply with § 193.207.

(b) Pipe attachments and supports for LNG or refrigerant piping must be designed to prevent excessive heat transfer which can result in either unintentional restraint of piping caused by ice formations or the embrittlement of supporting steel.

§ 193.311 Buildings; design.

Each building or structural enclosure in which potentially hazardous quantities of flammable fluids are handled must be designed and constructed to minimize—

(a) Potential fire hazards; and

(b) The probability of an explosion within the structure initiating—

(1) A blast wave by pressure containment;

(2) Collapse of support members; or

(3) Shrapnel-like fragmentation.

§ 193.313 Buildings; ventilation.

(a) Each building in which potentially hazardous quantities of flammable fluids are handled must be ventilated to minimize the possibility, during normal operation, of hazardous accumulation of a flammable gas and air mixture, hazardous products of combustion, and other hazardous vapors in enclosed process areas by one of the following means:

(1) A continuously operating mechanical ventilation system;

(2) A combination gravity ventilation system and normally off mechanical ventilation system which is activated by suitable flammable gas detectors at a concentration not exceeding 15 percent of the lower flammable limit of the gas;

(3) A dual rate mechanical ventilation system with the high rate activated by suitable flammable gas detectors at a concentration not exceeding 15 percent of the lower flammable limit of the gas; or

(4) A gravity ventilation system composed of a combination of wall openings, roof ventilators, and if there are basements or depressed floor levels, a supplemental mechanical ventilation system.

(b) The ventilation rate must be at least one cubic foot per minute of air per square foot of floor area. If vapors heavier than air can be present, the ventilation must be proportioned according to the area of each level.

§ 193.317 Expansion and contraction.

Each operator shall determine the amount of contraction and expansion of each component during operating and enviornmental thermal cycling and shall—

(a) Provide components that operate without deterimental stress or restriction of movement, within each component and between components, caused by contraction and expansion; and

(b) Prevent ice buildup from detrimentally restricting the movement of components caused by contraction and expansion.

§ 193.319 Frost heave.

(a) Each operator shall—

(1) Determine which critical components and their foundations could be endangered by frost heave from ambient temperatures or operating temperatures of the component; and

(2) Provide protection against frost heave which might impair their structural integrity.

(b) For each critical component and foundation determined under paragraph (a) of this section, instrumentation and alarm systems must be installed to warn of potential structural impairment due to frost heaving unless the component is inspected monthly using reference monuments and surveying instruments to detect changes in elevation of the facility.

§ 193.321 Ice and snow.

(a) Components must be designed to support the weight of ice and snow which could normally collect or form on them.

(b) Each operator shall provide protection for components from falling ice or snow which may accumulate on structures.

(c) Valves under § 193.302(a) and moving critical components must not become inoperative due to ice formation on the component.

§ 193.323 Electrical systems.

(a) Each operator shall select and install electrical equipment and wiring for components in accordance with NFPA-70 and, where applicable, Section 751 of NFPA-59A.

(b) Electrical grounding and bonding must be in accordance with Section 760 and Section 761 of NFPA-59A.

(c) Protective measures for stray or impressed currents must be provided in accordance with Section 762 of NFPA-59A.

(d) DELETE

§ 193.325 Lightning.

Each operator shall install lightening rods, arrestors, and grounds as necessary to minimize the hazard to plant personnel and critical components, including all electrical circuits, from damage as a result of lightning.

§ 193.327 Boilers.

Boilers must be designed and fabricated in accordance with section I or Section IV of the ASME Boiler and Pressure Vessel Code. Other pressure vessels subject to that Code must be designed and fabricated in accordance with Division 1 or Division 2 of Section VIII.

§ 193.329 Combustion engines and turbines.

Combustion engines and gas turbines must be installed in accordance with NFPA-37.

Subpart E—Impoundment Design and Capacity

§ 193.401 Scope.

This subpart prescribes requirements for the design and construction of new impounding systems or any portion of an existing impounding system that is replaced, relocated, or significantly altered.

§ 193.403 Impoundment required.

(a) An impounding system must be provided for the following components and areas to contain a potential spill of LNG or other flammable liquid:

(1) Storage tanks;

(2) Transfer piping in excess of 4 inches in diameter; and

(3) Cargo transfer systems.

(b) Grading and drainage or an impounding system must be provided to insure that accidental spills or leaks from the following components and areas do not endanger critical components or adjoining property or enter navigable waterways:

(1) Liquefaction and other process equipment;

(2) Vaporization equipment;

(3) Transfer piping four inches or less in diameter;

(4) Parking areas for tank cars or tank trucks; and

(5) Areas for loading, unloading, or storing portable containers and dewar vessels.

(c) Impounding systems must be designed and constructed in accordance with this subpart except that impounding systems intended for containment of flammable liquids other than LNG must conform to NFPA 30.

§ 193.405. General design characteristics.

(a) An impounding system must have a configuration or design which, to the maximum extent possible, will prevent liquid from escaping inpoundment under the worst predicatable spill condition by leakage, splash from collapse of a structure or part thereof, momentum and low surface friction, foaming, failure of pressurized piping, and accidental pumping.

(b) The basic form of an impounding system may be excavation, a natural geological formation, manufactured diking, such as berms or walls, or any combination thereof.

§ 193.407 Classes of impounding systems.

(a) For the purpose of this part, impounding systems are classified as follows:

Class 1. A system which surrounds the component served with the inner surface of the dike constructed against the outer surface of the component.

Class 2. A system which surrounds the component or area served with the dike located a distance away from the component or at the periphery of the area.

Class 3. A system which conducts a spill by dikes and floors to a remote impounding space which does not surround the component or area served.

(b) In the case of an impounding system consisting of a combination of classes, requirements of this part regarding a single class apply according to the percentage of impoundment provided by each class.

§ 193.409 Structural requirements.

(a) Subject to paragraph (b) of this section, the structural parts of an impounding system must be designed and constructed to prevent impairment of the system's performance reliability and structural integrity as a result of the following:

(1) The imposed loading from—

(i) Full hydrostatic head of impounded LNG;

(ii) Hydrodynamic action, including the effect of any material injected into the system for spill control;

(iii) The impingement of the trajectory of an LNG jet discharged at any predictable angle; and

(iv) Anticipated hydralic forces from a rupture in the component or iten served, assuming that the discharge pressure equals design pressure.

(2) The erosive action form a spill, including jetting of spilling LNG, and any other anticipated erosive action including surface water runoff, ice formation, dislodgement of ice formation, and snow removal.

(3) The effect of the temperature, any thermal gradient, and any other anticipated degradation resulting from sudden or localized contact with LNG.

(4) Exposure to fire from impounded LNG or from sources other than impounded LNG.

(5) If applicable, the potential impact and loading on the dike due to—

(i) Collapse of the component or item served or adjacent components; and

(ii) If the LNG facility adjoins the right-of-way of any highway or railroad, collision by or explosion of a land vehicle that could cause the most severe loading.

(b) For spills from LNG storage tanks, imposed loading and surging flow characteristics must be based on a sudden total release of the full contents of the tank. For other spills, imposed loading and surging flow characteristics from the volume to be impounded must be based on the impounding capacities and conditions of discharge set forth in this subpart.

(c) If an LNG storage tank is located within a horizontal distance of 6,100 meters (20,000 feet) from the nearest point of the nearest runway of any airport, a Class 1 impounding system must be used which is designed to withstand collision by, or explosion of, the heaviest aircraft which can take off or land at the airport.

§ 193.410 Coatings and coverings.

Insulation, sealants, or other coatings and coverings which are part of an impounding system—

(a) Must be self-extinguishing when exposed to fire in an installed condition;

(b) Must withstand exposure to fire from sources other than impounded LNG for a period of time until fire protective or fire extinguishing action is taken;

(c) Where such materials might be consumed during combustion of the impounded LNG, must not release toxic fumes that would be hazardous to personnel; and

(d) Must withstand thermal shock from LNG.

§ 193.413 Floors.

Floors of Class 2 and Class 3 impounding systems must—

(a) Slope away from the component or item impounded and to a sump basin installed under § 193.427;

(b) Slope to the extent feasible away from the nearest adjacent critical component;

(c) Drain surface waters from the floor at rates based on predictable rainfall and other water sources; and

(d) Contain channels designed to minimize the wetted floor area.

§ 193.415 Dikes; general.

(a) Penetrations in dikes to accommodate piping or any other purpose are prohibited.

(b) An outer wall of a component served by an impounding system may not be used as a dike except for a concrete wall designed to comply with the requirements of § 193.409(c).

§ 193.417 Vapor barriers.

If vapor barriers are installed to meet the requirements of § 193.109, they must be designed and constructed—

(a) As a critical component; and

(b) To entrain cold vapor.

§ 193.419 Dike dimensions.

In addition to dike dimensions needed to comply with other requirements of this subpart, to minimize the possibility that a trajectory of accidentally discharged liquid would pass over the top of a dike, the distance from the inner wall of the vessel served to the closest inside edge of the top of the dike must at least equal the vertical distance from the maximum liquid level in the vessel served to the inside edge of the top of the dike.

§ 193.421 Covered systems.

(a) A covered impounding system is prohibited unless it is—

(1) Sealed from the atmosphere and filled with an inert gas; or

(2) Permanently interconnected with the vapor space of the component served.

(b) Membraneous covering is prohibited in a covered system.

(c) For systems to which paragraph (a)(2) of this section does not apply, instrumentation and controls must be provided to—

(1) Maintain pressures at a safe level; and

(2) Monitor gas concentrations.

(d) Dikes must have adequate structural strength to assure that they can withstand impact from a collapsed cover and all anticipated conditions which could cause a failure of the impounding space cover.

§ 193.423 Gas leak detection.

Appropriate areas within an impounding system where collection or passage of LNG or gas could be expected must be equipped with sensing and warning devices to continuously monitor for the presence of LNG or gas and to warn before gas concentration levels exceed 25 percent of the lower flammable limit.

§ 193.427 Sump basins.

Except for Class I impounding systems, a sump basin must be located in each impounding system for collection of water and small spills of LNG.

§ 193.431 Water removal.

(a) *Except* for Class 1 systems, impounding systems must have sump pumps and piping running over the dike to remove water collecting in the sump basin.

(b) The water removal system must have adequate capacity to remove water at rates which equal the maximum predictable collection rate from rainfall and other natural causes.

(c) Sump pumps for water removal must—

(1) Automatically operate as necessary to keep the impounding space as dry as practical; and

(2) Have controls for operation and redundant automatic shutdown controls to prevent operation when LNG is present.

§ 193.433 Shared impoundment.

When an impounding system serves more than one component, tank car, tank truck, or dewar vessels, a means must be provided to prevent low temperature of fire resulting from leakage from any one of the items served causing any other item to leak. If § 193.109(a) applies, the means must not result in a vapor dispersion distance which exceeds the exclusion zone.

§ 193.435 Piping.

Piping and piping supports located within an impounding system must be protected against failure due to fire, contact with spilled liquids, or predictable impact by falling objects that could result in or worsen an emergency.

§ 193.437 Impoundment capacity; general.

(a) For covered impounding systems, space between the outer wall of the component served and the dike may not be used to provide the capacity required by this subpart which exceeds the component's maximum liquid capacity unless the imponding space and the component are covered by a roof that is separate and independent from the component.

(b) In addition to capacities otherwise required by this subpart, an impounding system must have sufficient volumetric capacity to provide for—

(1) Displacement by the component tank car, tank truck, or dewar vessel served; and

(2) Where applicable, displacement which could occur when a higher density substance than the liquid to be impounded enters the system, considering all relevant means of assuring capacity.

§ 193.439 Impoundment capacity, LNG storage tanks.

Each impounding system serving an LNG storage tank must have a munimum volumetric liquid impoundment capacity as follows:

Number of tanks in system	Class or type of system	System capacity in percent of LNG tanks' maximum liquid capacity
1	Class 1 and covered systems.	110 percent.
	Class 2 and 3	150 percent.
More than 1	Class 2 and 3	100 percent of all tanks or 150 percent of largest tank, whichever is greater.

§ 193.441 Impoundment capacity; equipment and transfer facilities.

Each impounding system serving a component under § 193.403(a)(2) and (3) and, when applicable, under § 193.403(b)(1)-(3), must have a minimum volumetric liquid impoundment capacity equal to the sum of—

(a) 100 percent of the volume of liquid that could be contained in the component and, where applicable, tank car of tank truck served; and

(b) The maximum volume of liquid which could discharge into the impounding space from any single failure of equipment or piping during the time period necessary for spill detection, instrument response, and sequenced shutdown by the automatic shutdown system under § 193.605.

§ 193.443 Impoundment capacity; parking areas; portable vessels.

If an impounding system is used to serve an area listed under §§ 193.403(b)(4) or (5), it must have a mumimum volumetric liquid impoundment capacity which complies with the requirements or § 193.439, assuming each tank car, tank truck, portable container, or dewar vessel to be a storage tank.

§ 193.445 Flow capacity in Class 3 impounding systems.

(a) Each spill conducting space in a Class 3 impounding system must have adequate flow capacity for the following volumes and flow rates of a potential spill at all points along its traverse:

(1) For storage tanks, the worst combination of flow rates and 150 percent of the volume from a sudden and complete release of the largest above grade maximum liquid capacity of any single tank served, plus the discharge from all transfer piping which could be loading that tank, assuming the loading transfer piping is discharging at maximum potential open end capacity during the time period set forth by § 193.441(b), and less any upstream or intermediate capacity.

(2) For components listed under § 193.403(a)(2) and (3), and, when applicable, under §§ 193.403(b)(1)-(3), the worst combination of flow rates and volumes determined in accordance with § 193.441, less any upstream or intermediate impounding capacity.

(3) For areas listed under § 193.403(b)(4) and (5), the requirements of paragraph (a)(1) of this section apply, assuming each tank car, tank truck, portable container, or dewar vessel to be a storage tank.

(b) When intermediate impounding space is used to provide the capacity of conducting space required by this section, the capacity of the intermediate space must be based on the combination of applicable volumes and flow rates set forth in paragraph (a) of this section to assure adequate capacity of the conducting space.

§ 193.447 Sump basin capacity.

(a) Sump basins in impounding systems for LNG storage tanks must have a mumimum volumetric capacity equal to the discharge from relevant connected sections of transfer piping which can operate simultaneously, assuming the transfer piping discharges at maximum potential open end capacity for the time period necessary for spill detection, instrument response, and sequenced shutdown by the automatic shutdown system.

(b) Sump basins in impounding systems for components listed in §§ 193.403(a)(2) and (3) and, if applicable, §§ 193.403(b)(1)-(3), must have a minimum volumetric capacity equal to half of the lesser of—

(1) The volume of liquid which could discharge into the impounding system from any single failure of equipment or piping during the time period necessary for spill detection, instrument response, and sequenced shutdown by the automatic shutdown system; or

(2) The volume of liquid that could be contained in the component served.

(c) Sump basins in impounding systems for areas listed in §§ 193.403(b)(4) and (5) and must have a minimum volumetric liquid capacity which meets the requirements of paragragh (a) of this section, assuming each tank car, tank truck, portable container, or dewar vessel to be a storage tank.

Subpart F—LNG Storage Tanks

§ 193.501 Scope.

This subpart prescribes requirements for the design and construction of new LNG storage tanks or any portion of an existing LNG storage tank that is replaced, relocated, or significantly altered.

§ 193.503 General.

(a) LNG storage tanks must comply with the requirements of this subpart and the other applicable requirements of this part.

(b) A flammable nonmetallic membrane liner may not be used as an inner container in a storage tank.

§ 193.505 Loading forces.

Each part of an LNG storage tank must be designed to withstand any predictable combination of forces which would result in the highest stress to the part, including the following:

(a) Internal design pressure determined under § 193.513.

(b) External design pressure determined under § 193.515.

(c) Weight of the structure.

(d) Weight of LNG to be stored determined at its highest density and at the level creating the highest stress.

(e) Loads due to testing required by § 193.1033.

(f) Nonuniform reaction forces on the foundation due to predictable settling and other movement.

(g) Superimposed forces from piping, stairways, and other connected appurtenances.

(h) Predictable snow and ice loads.

(i) The loading of internal insulation on the inner container and outer shell due to weight and movement of the container and shell over the design life of the insulation.

(j) In the case of vacuum insulation, the forces due to the vacuum.

(k) In the case of a positive pressure purge, the forces due to the maximum positive pressure of the purge gas.

§ 193.507 Stratification.

LNG storage tanks with a capacity of 5,000 barrels or more must be equipped with means to mitigate a potential for rollover and overpressure by:

(a) Selective filling at the top and bottom of the tank;

(b) Circulating liquid from the bottom to the top of the same tank; or

(c) Transferring liquid selectively from the bottom of the tank to the bottom or top of any adjacent storage tank.

§ 193.509 Movement and stress.

(a) Each operator shall determine for normal operations of each LNG storage tank—

(1) The amount and pattern of predictable movement of components, including transfer piping, and the foundation, which could result from thermal cycling, loading forces, and ambient air changes; and

(2) For a storage tank with an inner container, the predictable movement of the inner container and the outer shell in relation to each other.

(b) Storage tanks must be designed to provide adequate allowance for stress due to movement determined under paragraph (a) of this section, including provisions that—

(1) Backfill does not cause excessive stresses on the tank structure due to expansion of the storage tank during warmup;

(2) Insulation does not settle to a damaging degree or unsafe condition during thermal cyclying; and

(3) Expansion bends and other expansion or contraction devices are adequate to prevent excessive stress on tank penetrations, especially during cooldown from ambient temperatures.

§ 193.511 Penetrations.

(a) All penetrations in an LNG storage tank must be located on the top of the tank.

(b) Penetrations must be designed to ensure that any failure of the penetrating component does not result in hazardous structural damage to the tank.

§ 193.513 Internal design pressure.

(a) Each operator shall determine the internal design pressure at the top of each LNG storage tank.

(b) The internal design pressure of a storage tank may not be lower than the highest vapor pressure resulting from each of the following events or combination thereof that predictably might occur:

(1) Filling the tank with LNG including effects of increased vaporization rate due to superheat and sensible heat of the added liquid;

(2) Rollover resulting from adding LNG which has a different density than liquid already in the tank, or from weathering in storage;

(3) Fall in barometric pressure, using the worst combination of amount of fall and rate of fall which might credibly occur;

(4) Loss of effective insulation that may result from an adjacent fire, leak of liquid into the intertank space, or other predictable accident; and

(5) Flash vaporization resulting from pump recirculation.

§ 193.515 External design pressure.

(a) Each operator shall determine the external design pressure at the top of each LNG storage tank.

(b) The external design pressure may not be higher than the lowest vapor pressure resulting from each of the following events or combinations thereof that predictably might occur:

(1) Withdrawing liquid from the tank;

(2) Withdrawing gas from the tank;

(3) Adding subcooled LNG to the tank; and

(4) Rise in barometric pressure, based on the worst combination of amount of rise and rate of rise which predictably might occur.

§ 193.519 Internal temperature.

LNG storage tanks must be designed to withstand the minimum temperature of the LNG Liquid to be stored at the external design pressure determined in § 193.515(b).

§ 193.521 Foundation.

(a) Each LNG storage tank must have a stable foundation designed in accordance with generally accepted structural engineering practices. The design must take into account the forces which may exist due to the difference in density between the contained liquid and the displaced ground.

(b) Each foundation must support design loading forces without detrimental settling that could impair the structural integrity of the tank.

(c) When the location of an LNG storage tank foundation is subject to flooding or is near the natural water table, each operator shall determine the weight of the foundation and the empty tank and shall anchor the tank so that the buoyant water forces will not float the tank or impair the structural integrity of the tank.

§ 193.523 Frost heave.

If the protection provided for LNG storage tank foundations from frost heave under § 193.319(a) includes heating the foundation area—

(a) An instrumentation and alarm system must be provided to warn of malfunction of the heating system; and

(b) A means to correct the malfunction must be provided.

§ 193.525 Insulation.

(a) Insulation on the outside of an LNG storage tank may not be used to maintain stored LNG at an operating temperature.

(b) Insulation between an inner container and the outer shell of an LNG storage tank must—

(1) Be compatible with the contained liquid and its vapor;

(2) In its installed condition, be self extinguishing; and

(3) Not significantly lose insulating properties by melting, settling, or other means if a fire occurs outside the outer shell.

§ 193.527 Instrumentation for LNG storage tanks.

(a) Each storage tank must be equipped with redundant sensing devices and personnel warning devices, as prescribed, which operate continuously while the tank is in operation to assure that each of the following conditions is not a potential hazard to the structural integrity or safety of the tank.

Condition	*Instrumentation*
(1) Amount of liquid in the tank.	Liquid level gauges and recorders with top fill alarms and a separate overfill alarm.
(2) Vapor pressure within the tank.	Pressure gauges and recorders with high and low pressure alarms.
(3) Temperatures at representative critical points in the foundation.	Temperature indicating and recording devices with alarm.
(4) Temperature of contained liquid at various vertical intervals.	Temperature recorders.
(5) Excessive thermal stress in tank structure.	Thermocouples located at representative critical points with recorders.
(6) Excessive relative movement of inner container and outer shell.	Linear and rotational movement indicators located between inner container and outer shell with recorders.

(b) Each storage tank must be designed as appropriate to provide for compliance with the inspection requirements of this part.

§ 193.529 Metal storage tanks.

(a) Metal storage tanks with internal design pressures of not more than 15 psig must be designed and constructed in accordance with API Standard 620 and, where applicable, Appendix Q of that standard.

(b) Metal storage tanks with internal design pressures above 15 psig must be designed in accordance with the applicable division of Section VIII of the ASME Boiler and Pressure Vessel Code.

§ 193.531 Concrete storage tanks.

Concrete storage tanks must be designed and constructed in accordance with Section 42 of NFPA 59A.

§ 193.533 Thermal barriers.

Thermal barriers must be provided between piping and an outer shell when necessary to prevent the outer shell from being exposed to temperatures lower than the design temperature.

§ 193.535 Support system.

(a) Saddles and legs must be designed in accordance with generally accepted structural engineering practices, taking into account loads during transportation, erection loads, and thermal loads.

(b) Storage tank stress concentrations from support systems must be minimized by distribution of loads using pads, load rings, or other means.

(c) For a storage tank with an inner container, support systems must be designed to—

(1) Minimize thermal stresses imparted to the inner container and outer shell from expansion and contraction; and

(2) Sustain the maximum applicable loading from shipping an operating conditions.

(d) The bottom of a storage tank with a capacity of more than 15,000 barrels or its foundation may not be installed over an air space.

§ 193.537 Internal piping.

(a) Piping connected to an inner container that is located in the space between the inner container and outer shell must be designed for not less than the pressure rating of the inner container. The piping must contain expansion loops where necessary to protect against thermal and other secondary streeses created by operation of the tank. Bellows may not be used within the space between the inner container and outer shell.

(b) Storage tanks with a design pressure above 15 psig must be equipped with internal excess flow valves.

§ 193.539 Marking.

(a) Each operator shall install and maintain a name plate in an accessible place on each storage tank and mark it in accordance with the applicable code or standard incorporated by reference in § 193.529 or § 193.531.

(b) Each penetration in a storage tank must be marked indicating the function of the penetration.

(c) Marking required by this section must not be obscured by frosting.

Subpart G—Design of Transfer Systems

§ 193.601 Scope.

This subpart prescribes requirements for the design and installation of new transfer systems or any portion of an existing transfer system that is replaced, relocated, or significantly altered.

§ 193.603 General.

(a) Transfer systems must comply with the requirments of this subpart and other applicable requirements of this part.

(b) The design of transfer systems must provide for stress due to the frequency of thermal cycling and intermittent use to which the transfer system may be subjected.

(c) Slip type expansion joints are prohibited and packing-type joints may not be used at cryogenic temperatures.

(d) A suitable means must be provided to precool the piping in a manner that prevents excessive stress before transferring cold fluids.

(e) Stresses due to thermal and hydraulic shock in the piping system must be determined and accommodated by design to avoid damage to piping.

§ 193.605 Shut down control system.

Each transfer system must be equipped with a shutdown control system. The control system must automatically actuate the shutdown of appropriate valves and pumping equipment and provide pressure relief as necessary for trapped fluids when any of the following occurs:

(a) Transfer piping failure;

(b) Liquid in the receiving vessel reaches design maximum liquid level;

(c) Pressure outside the limits of the maximum and minimum allowable operating pressure;

(d) Temperature outside the range determined under § 193.205;

(e) Gas concentrations in the atmosphere exceeding 25 percent of the lower flammable limit; or

(f) A sudden flow change, pressure loss, or other condition indicating an accidental spill or potential spill.

§ 193.607 Backflow.

(a) Each transfer system must operate with a means to—

(1) Prevent backflow of liquid from a receiving container, tank car, or tank truck from causing a hazardous condition; and

(2) Maintain one-way flow where necessary for the integrity or safe operation of the LNG facility.

(b) The means provided under paragraph (a)(1) of this section must be located as close as practical to the point of connection of the transfer system and the receiving container, tank car, or tank truck.

§ 193.609 Overfilling.

Each transfer system must be equipped with sensing devices and a means which alerts personnel when the amount of liquid in a receiving vessel approaches the design maximum liquid level. The alert must be given in time for the safe termination of the transfer.

§ 193.611 Cargo transfer systems.

(a) Each cargo transfer sytem must have—

(1) A means of safely depressurizing and venting that system before disconnection;

(2) A means to provide for safe vapor displacement during transfer;

(3) Transfer piping, pumps, and compressors located or protected by suitable barriers so that they are safe from damage by tank car or tank truck movements;

(4) A signal light at each control location of remotely located pumps or compressors used for transfer which indicates whether the pump or compressor is idle or in operation; and

(5) A means of communication between loading or unloading areas and other areas in which personnel are associated with the transfer operations.

(b) Hoses and arms must be designed as follows—

(1) The design must accommodate operating pressures and temperatures encountered during the transfers;

(2) Hoses must have a bursting pressure of not less than five times the operating pressure.

(3) Arms must meet the requirements of ANSI B31.3.

(4) Adequate support must be provided, taking into account ice formation.

(5) Couplings must be designed for the frequency of any coupling or uncoupling.

§ 193.615 Cargo transfer area.

The transfer area of a cargo transfer system must be designed—

(a) To accommodate tank cars and tank trucks without excessive maneuvering; and

(b) To permit tank trucks to enter or exit the transfer area without backing.

§ 193.617 Shutoff valves.

(a) Shutoff valves on transfer systems must be located:

(1) At the inlet of each vaporizer;

(2) On return lines and on manifolds used in cargo transfer;

(3) At the connection of a transfer system with a pipeline; and

(4) To provide for proper operation and maintenance of each transfer system.

(b) Transfer system shutoff valves must be power and manually operable at the valve and power operable at a remote location at least 50 feet from the valve.

(c) In addition to valves required by paragraph (a)(2) of this section, transfer piping supplying a cargo transfer system must be equipped with a shutoff valve for each liquid and each vapor line, including a common line to multiple transfer areas, where it can be operated readily during a controllable emergency.

(d) Shutoff valves must be designed and installed so that excessive strain in the piping system does not excessively stress the shutoff seats of the valves.

Subpart H—Vaporization Equipment

§ 193.701 Scope.

This subpart prescribes requirements for the design, fabrication, and installation of new vaporization equipment or any portion of existing vaporization equipment that is replaced, relocated, or significantly altered.

§ 193.703 General.

Vaporizers must comply with the requirements of this subpart and the other applicable requirements of this part.

§ 193.705 Vaporizer design.

(a) Vaporizers must be designed and fabricated in accordance with applicable provisions of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

(b) Each vaporizer must be designed for a maximum allowable operating pressure at least equal to the maximum discharge pressure of the pump or pressurized container system supplying it, whichever is greater.

§ 193.711 Operational control.

(a) Vaporizers must be equipped with devices which monitor the inlet and outlet temperature and pressure of the LNG, natural gas, and heating medium fluids.

(b) Manifolded vaporizers must be equipped with:

(1) Two inlet valves in series to prevent LNG from entering an idle vaporizer; and

(2) A means to remove LNG or gas which accumulates between the valves.

§ 193.713 Shutoff valves.

(a) Each shutoff valve located on transfer piping supplying LNG to a vaporizer must meet the following applicable requirements—

(1) A shutoff valve must be located at a sufficient distance from the vaporizer to minimize potential for damage from explosion or fire at the vaporizer.

(2) If the vaporizer is installed in a building, the valve must be located outside the building.

(b) A shutoff valve must be located on each outlet of a vaporizer.

(c) For vaporizers designed to use a flammable intermediate fluid, a shutoff valve must be located on the inlet and outlet line of the intermediate fluid piping system where they will be operable during a controllable emergency involving the vaporizer.

§ 193.715 Relief devices.

The capacity of pressure relief devices required for vaporizers by § 193.905(b) is governed by the following:

(a) For heated vaporizers, the capacity must be at least 110 percent of rated natural gas flow capacity without allowing the pressure to rise more than 10 percent above the vaporizer maximum allowable operating pressure.

(b) For ambient vaporizers, the capacity must be at least 150 percent of rated natural gas flow capacity without allowing the pressure to rise more than 10 percent above the vaporizer maximum allowable operating pressure.

§ 193.719 Combustion air intakes.

(a) Combustion air intakes to vaporizers must be equipped with sensing devices to detect the induction of a flammable vapor.

(b) If a heated vaporizer or vaporizer heater is located in a building, the combustion air intake must be located outside the building.

Subpart I—Liquefaction Equipment

§ 193.801 Scope of part.

This subpart prescribes requirements for the design of new natural gas liquefaction equipment or any portion of existing natural gas liquefaction equipment that is replaced, relocated, or significantly altered.

§ 193.803 General

Liquefaction equipment must comply with the requirements of this subpart and the other applicable requirements of this part.

§ 193.805 Control of incoming gas.

(a) A shut-off valve must be located on piping delivering natural gas to each liquefaction system; and

(b) The valve must be actuated automatically by a shut-down control system when any of the following occurs:

(1) Gas concentrations in the area of liquefaction equipment exceed 40 percent of the lower flammable limit; or

(2) Temperatures exceed the limits determined under § 193.205.

§ 193.807 Contaminants.

Each operator shall provide a means of monitoring the incoming gas to liquefaction equipment to ensure that detrimental contaminants are removed.

§ 193.809 Backflow.

Each multiple parallel piping system connected to liquefaction equipment must have devices to prevent backflow from causing a hazardous condition.

§ 193.811 Cold boxes.

Each cold box in liquefaction equipment must be equipped with a means of:

(a) Detecting a concentration of natural gas in the insulation space; and

(b) Introducing a purge gas to reduce the possibility of a gas in air concentration between 25 percent lower flammable limit and 30 percent by volume.

§ 193.813 Air in gas.

Where incoming gas to liquefaction equipment contains air, each operator shall provide a means of preventing a flammable mixture from occurring under any operating condition.

§ 193.815 Equipment supports.

Supports for liquefaction equipment must comply with the requirements of § 193.207.

Subpart J—Control Systems

§ 193.901 Scope

This subpart prescribes requirements for the design and installation of new control systems or any portion of an existing control system that is replaced, relocated, or significantly altered.

§ 193.903 General.

(a) Control systems must comply with the requirements of this subpart and other applicable requirements of this part.

(b) Each control system must be capable of performing its design function under normal operating conditions and in a controllable emergency.

(c) Control systems must be designed and installed in a manner to permit maintenance, including inspection or testing, in accordance with this part.

(d) Local, remote, and redundant signal lines installed for control systems must be routed separately.

§ 193.905 Relief devices.

(a) Each component containing a hazardous fluid must be equipped with a system of automatic relief devices which will release the contained fluid at a rate sufficient to prevent pressures from exceeding 110 percent of the maximum allowable operating pressure. In addition, each LNG storage tank must be equipped with a redundant system of automatic relief devices. In establishing relief capacity, each operator shall consider trapping of fluid between valves; the maximum rates of boiloff and expansion of fluid which may occur during normal operation, particularly cooldown; and controllable emergencies.

(b) In addition to the automatic relief devices, a manual means must be provided to relieve pressure in an emergency.

(c) Relief devices must be installed in a manner to minimize the possibility that release of fluid could—

(1) Cause an emergency; or

(2) Worsen a controllable emergency.

(d) A component in which internal vacuum conditions can occur must be equipped with a system of relief devices or other control system to prevent development in the component of a vacuum that might create a hazardous condition. LNG storage tanks must be equipped with a redundant relief system. Introduction of air or gas into a component must not create a flammable mixture within the component.

(e) The means for adjusting the setpoint pressure of all adjustable relief devices must be sealed.

(f) Relief devices which are installed to limit minimum or maximum pressure may not be used to handle boiloff and flash gases.

§ 193.907 Vents.

(a) Flammable fluids may not be relieved into the atmosphere of a building or other confined space.

(b) Boiloff vents for flammable fluids may not draw in air during operation.

§ 193.909 Sensing devices.

(a) Each operator shall determine the appropriate location for and install sensing devices as necessary to—

(1) Monitor the operation of critical components to detect a malfunction which could cause a hazardous condition if permitted to continue; and

(2) Detect the presence of fire or combustible gas in areas determined in accordance with Section 500-4 of NFPA 70 to have a potential for the presence of flammable fluids.

(b) Buildings in which potentially hazardous quantities of flammable fluids are used or handled must be continuously monitored by gas sensing devices set to activate audible and visual alarms in the building and at the control center when the concentration of the fluid in air is not more than 25 percent of the lower flammable limit.

§ 193.911 Warning devices.

Each operator shall install warning devices in the control center to warn of hazardous conditions detected by all sensing devices required by this part. Warnings must be given both audibly and visibly and must be designed to gain the attention of personnel. Warnings must indicate the location and nature of the existing or potential hazard.

§ 193.915 Pump and compressor control.

(a) Each pump and compressor for flammable fluids must be equipped with—

(1) A control system, operable locally and remotely, to shut down the pump or compressor in a controllable emergency;

(2) A signal light at the pump or compressor and the remote control location which indicates whether the pump or compressor is in operation or off;

(3) Adequate valving to insure that the pump or compressor can be isolated for maintenance; and

(4) A check valve on each discharge line where pumps or compressors operate in parallel.

(b) Pumps or compressors in a cargo transfer system must have controls at the loading or unloading area and at the pump or compressor site.

§ 193.917 Shutoff valves.

Each shutoff valve or combination of valves must—

(a) Have a failsafe design;

(b) Operate to stop fluid flow which would endanger the operational integrity of plant equipment; and

(c) Close at a rate to avoid fluid hammer which would endanger the operational integrity of a critical component.

§ 193.919 Shutdown control systems.

(a) Each critical component other than a control center must be equipped with an automatic shutdown control system. The control system must automatically actuate the shutdown of the critical component when any of the following occurs:

(1) Temperatures in the area of the component exceed the limits determined under § 193.205;

(2) Relief valves open;

(3) Gas concentrations in the area of the component exceed 25 percent of the lower flammable limit; and

(4) Failure of the component.

(b) Except for critical components other than the control center that are designed to operate unattended, a reasonable delay may be programmed in automatic shutdown control systems required by this part between warning and automated shutdown to provide for manual response.

(c) Each LNG facility must have a shutdown control system to safely shut down all operations of the facility. The system must be operable at—

(1) The control center; and

(2) In the case of a facility where critical components other than the control center are designed to operate unattended, at the site of the critical components.

§ 193.921 Control center.

(11) Each LNG facility must have a control center from which operations and warning devices are monitored as required by this part. A control center must have the following capabilities and characteristics—

(a) It must be located apart or protected from other critical components so that it is operational during a controllable emergency.

(b) Each remotely actuated control system and each automatic shutdown control system required by this part must be operable from the control center.

(c) Each control center must have personnel in continuous attendance while any of the critical components under its control are in operation, unless the control is being performed from another control center which has personnel in continuous attendance.

(d) If more than one control center is located at a facility, each control center must have more than one means of communication with each other center.

(e) Each control center must have a means of communicating a warning of hazardous conditions to other locations within the facility frequented by personnel.

§ 193.925 Failsafe control.

Control systems for critical components must have a failsafe design. A safe condition must be maintained until personnel take appropriate action either to reactivate the component served or to prevent a hazard from occuring.

§ 193.927 Sources of power.

(a) Electrical control systems, means of communication, lighting, and fire fighting systems must have at least two sources of power which function so that failure of one source does not affect the capability of the other source.

(b) Where auxiliary generators are used as a second source of electrical power—

(1) They must be located apart or protected from critical components so that they are not unusable during a controllable emergency; and

(2) Fuel supply must be protected from hazards.

Subpart K—Construction

§ 193.1001 Scope.

This subpart prescribes requirements for the construction or installation of a new component or any portion of an existing component which is replaced, relocated, or significantly altered.

§ 193.1002 Construction acceptance.

No person may place in service any component until it passes all applicable inspections and tests prescribed by this subpart.

§ 193.1005 Procedures.

(a) In performing a critical process, an operator must follow comprehensive written specifications, procedures, and drawings, as appropriate, that are consistent with this part, taking into account relevant mechanical, chemical, and thermal properties, component functions, and environmental effects that are involved.

(b) All procedures must be substantiated by testing or experience to produce a component that is reliable and complies with the design and installation requirements of this part.

§ 193.1009 Qualification of personnel.

(a) Supervisors and other personnel utilized for critical processes must have demonstrated their capability to perform satisfactorily the assigned function by—

(1) Appropriate training in the methods and equipment to be used or related experience and accomplishments; and

(2) Performance on any generally accepted qualification test relevant to the assigned function.

(b) Each operator must periodically determine whether inspectors performing duties under § 193.1011 are satisfactorily performing their assigned function.

§ 193.1011 Inspection.

(a) All construction, installation, and testing activities must be inspected as frequently as necessary in accordance with a written plan to assure that—

(1) Activities are in compliance with all applicable requirements of this subpart; and

(2) Components comply with the applicable material, design, fabrication, installation, and construction requirements of this part.

(b) In addition to the requirements of paragraph (a) of this section, the construction of concrete storage tanks must be inspected in accordance with ACI-311-75.

(c) Each operator shall inspect component materials to verify that they comply with the design specifications and are free of detrimental defects.

§ 193.1014 Inspection and testing methods.

Except as otherwise provided by this subpart, each operator shall determine, commensurate with the hazard that would result from failure of the component concerned, the scope and nature of

(a) Inspections and tests required by this subpart; and

(b) Inspection and testing procedures required by § 193.1005.

§ 193.1015 Cleanup.

After construction or installation, as the case may be, all components must be cleaned to remove all detrimental contaminants which could cause a hazard during operation, including the following:

(a) All flux residues used in brazing or soldering must be removed from the joints and the base metal to prevent corrosive solutions from being formed.

(b) All solvent type cleaners must be tested to ensure that they will not damage equipment integrity or reliability.

(c) Incompatible chemicals must be removed.

(d) All contaminants must be captured and disposed of in a manner that does not reduce the effectiveness of corrosion protection and monitoring provided as required by this part.

§ 193.1017 Pipe welding.

(a) Each operator shall provide the following for welding on pressurized piping for LNG and other flammable fluids:

(1) Welding procedures and welders qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code or API 1104, as applicable.

(2) When welding materials which are qualified by impact testing, welding procedures selected to minimize degradation of low temperature properties of the pipe material; and

(3) When welding attachment to pipe, procedures and techniques selected to minimize the danger of burn throughs and stress intensification.

(b) Oxygen fuel gas welding is not permitted on flammable fluid piping with a service temperature below −20°C (−22°F).

(c) Marking materials for identifying welds on pipe must compatible with the basic pipe material.

(d) Surfaces of components that are less than 6.35 mm (0.25 in.) thick may not be field die stamped.

(e) Where die stamping is permitted, any identification marks must be made with a die having blunt edges to minimize stress concentration.

(f) All contaminants must be captured and disposed of in a manner that does not reduce the effectiveness of corrosion protection and monitoring provided as required by this part.

§ 193.1019 Piping connections.

(a) Piping more than two inches nominal diameter must be joined by welding, except that—

(1) Threaded or flanged connections may be used where necessary for special connections, including connections for material transitions, instrument connections, testing, and maintenance;

(2) Copper piping in cryogenic service may be joined by silver brazing; and

(3) Material transitions may be made by any joining technique proven reliable under § 193.1005(b).

(b) If socket fittings are used, a clearance of 1.6 to 3.2 mm (0.63 to 0.126 in.) between the pipe end and the bottom of the socket recess must be provided and appropriate measurement reference marks made on the piping for the purpose of inspection.

(c) Threaded joints must be—

(1) Free of stress from external loading; and

(2) Seal welded, or sealed by other means which have been tested and proven reliable.

(d) Compression type couplings must—

(1) Not be larger than 12.7 mm (0.50 in.) nominal pipe size for service temperatures below −30°C (−22°F); and

(2) Meet the requirements of Section 318 of ANSI B31.3.

§ 193.1023 Retesting.

After testing required by this subpart is completed on a component to contain a hazardous fluid, the component must be retested:

(a) Penetration welding other than tie-in welding is performed; or

(b) The structural integrity of the component is disturbed.

§ 193.1025 Strength tests.

(a) A strength test must be performed on each piping system and container to determine whether the component is capable of performing its design function, taking into account—

(1) The maximum allowable operating pressure;

(2) The maximum weight of product which the component may contain or support;

(3) The weight of ice and snow which may reasonably accumulate on the component resulting from weather and from conduction on cold from LNG or refrigerants; and

(4) Other applicable environmental design forces under Subpart B of this part.

(b) For piping, the test required by paragraph (a) of this section must include a pressure test conducted in accordance with Section 337 of ANSI B31.3, except that test pressures for piping that is a critical component must not be less than prescribed by Subsection 337.4.2 of ANSI B31.3.

(c) All shells and internal parts of heat exchangers to which Section VIII, Division 1 or Division 2 of the ASME Boiler and Pressure Vessel Code, applies must be pressure tested, inspected, and stamped in accordance therewith.

§ 193.1027 Nondestructive tests.

(a) The following percentages of each day's circumferentially welded pipe joints for flammable fluid piping, selected at random, must be nondestructively tested over the entire circumference to indicated any defects which could adversely affect the integrity of the weld or pipe:

Weld type	Critical Component	Other	Test method
Butt welds more than 2 inches in nominal size.	100	30	Radiographic or ultrasonic.
Butt welds 2 inches or less in nominal size.	100	30	Radiographic, ultrasonic, liquid penetrant, or magnetic particle.
Fillet and socket welds.	100	30	Liquid penetrant or magnetic particle.

(b) Evaluation of weld tests and repair of defects must be in accordance with the requirements of ANSI B31.3 or API 1104, as applicable.

(c) Where longitudinally or spiral welded pipe is used in transfer systems, 100 percent of the seam weld must be examined by radiographic or ultrasonic inspection.

(d) The butt welds in metal shells of storage tanks must be radiographically tested in accordance with Section 0.7.6, API 620, Appendix Q, except that for hydraulic load bearing shells with curved surfaces that are subject to cryogenic temperatures, 100 percent of both longitudinal (or meridional) and circumferential (or latitudinal) welds must be radiographically tested.

§ 193.1029 Leak tests.

(a) Each container and piping system must be initially tested to assure that the component will contain the product for which it is designed without leakage.

(b) Shop fabricated containers and all flammable fluid piping must be leak tested to a minimum of the design pressure after installation but before placing it in service.

(c) For a storage tank with vacuum insulation, the inner container, outer shell, and all internal piping must be tested for vacuum leaks in accordance with an appropriate procedure.

§ 193.1031 Testing control systems.

Each control system must be tested before being placed in service to assure that it has been installed properly and will function as required by this part.

§ 193.1033 Storage tank tests.

In addition to other applicable requirements of this subpart, low pressure tanks for cryogenic flammable fluids must be tested in accordance with Section Q.8 and Q.9 of API 620, Appendix Q, as applicable except that—

(a) For the hydrostatic test, each tank must be filled with water to its maximum liquid level, and reduction of this water level in accordance with Section Q.9.1 is prohibited;

(b) The hydrostatic and pneumatic pressure tests must be maintained for a period of 36 hours; and

(c) Reference measurements must be made with appropriate precise instruments to assure that the tank is gas tight and lateral and vertical movement of the storage tank does not exceed predetermined design tolerances.

§ 193.1037 Construction records.

For the service life of the component concerned, each operator shall retain appropriate records of the following:

(a) Specifications, procedures, and drawings prepared for critical processes; and

(b) Results of tests and inspections required by this subpart.

APPENDIX A—INCORPORATION BY REFERENCE

I. LIST OF ORGANIZATIONS AND ADDRESSES

A. American Concrete Institute (ACI), P.O. Box 19150, Redford Station, Detroit, Michigan 48219.

B. American Gas Association (AGA), 1515 Wilson Boulevard, Arlington, Virginia 22209.

C. American Petroleum Institute (API), 2101 L Street N.W., Washington, D.C. 20037.

D. American Society of Mechanical Engineers (AMSE), United Engineering Center, 345 East 47th Street, New York, New York 10017.

E. International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601.

F. National Fire Protection Association (NFPA), 470 Atlantic Avenue, Boston, Massachusetts 02210.

II. DOCUMENTS INCORPORATED BY REFERENCE

A. American Concrete Institute (ACI)

1. ACI Standard 311-75 "Recommended Practice for Concrete Inspection," 1975 edition (ANSI A188.2).

B. American Gas Association (AGA)

1. American Gas Association Project IS-3-1, LNG Safety Program Interim Report of Phase II work, July 1974.

2. Evaluation of LNG Vapor Control Methods, October 1974.

C. American Petroleum Institute (API)

1. API Standard 620 Recommended Rules for Design and Construction of Large, Welded, Low Pressure Storage Tanks, sixth edition, July 15, 1977.

D. American Society of Mechanical Engineers (ASME)

1. ANSI B31.3 Chemical and Plant Petroleum Refinery Piping, 1976 edition.

2. ASME Boiler and Pressure Vessel Code Section 1, Power Boilers, 1977 edition.

3. ASME Boiler and Pressure Vessel Code, Section VIII Division 1, Pressure Vessels; Division 2, Alternative Rules, Pressure Vessels 1977 edition.

4. ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications, 1977 edition.

E. International Conference of Building Officials

1. UBC, Uniform Building Code, 1976 edition.

F. National Fire Protection Association (NFPA)

1. NFPA No. 10, Portable Fire Extinguishers, 1978.

2. NFPA No. 37, Stationary Combustion Engineers and Gas Turbines, 1975.

3. NFPA No. 51B, Cutting and Welding Processes, 1977.

4. NFPA No. 59A, Storage and Handling Liquifed Natural Gas, 1975.

5. NFPA No. 70, National Electrical Code, 1978.

6. NFPA No. 77, Static Electricity, 1977.

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