Abruzzo Costiero S.r.l.

Deposito di Pescara

Progetto di realizzazione del nuovo sealine e del campo boe per lo scarico di gasolio e benzina da navi petroliere al largo del Porto di Pescara

Relazione tecnica di risposta alle richieste di integrazioni formulate dalla Commissione Tecnica nell'ambito della Procedura Istruttoria VIA

(nota prot. CTVA-2013-0002599 del 19/07/2013 trasmessa al proponente mediante comunicazione prot. DVA-2013-0018148 del 31/07/2013)

ALLEGATO 19 – Cap. IX *"Offshore Liquide Pipeline Systems"* della norma ASME B31.4 - 2012

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ICARO

Chapter IX
Offshore Liquid Pipeline Systems

A400 GENERAL STATEMENTS

(a) Chapter IX pertains only to offshore pipeline systems as defined in para. A400.1.

(b) This Chapter is organized to parallel the numbering and content of the first eight chapters of the Code. Paragraph designations are the same as those in the first eight chapters, with the prefix "A."

(c) All provisions of the first eight chapters of the Code are also requirements of this Chapter unless specifically modified herein. If the text in this Chapter adds requirements, the requirements in the original Chapter with the same title and number also apply. If a provision in this Chapter is in conflict with one or more provisions in other chapters, the provision in this Chapter shall apply.

(d) It is the intent of this Chapter to provide requirements for the safe and reliable design, installation, and operation of offshore liquid pipeline systems. It is not the intent of this Chapter to be all inclusive. Engineering judgment must be used to identify special considerations which are not specifically addressed. API RP 1111 may be used as a guide. It is not the intent of this Chapter to prevent the development and application of new equipment and technology. Such activity is encouraged as long as the safety and reliability requirements of the Code are satisfied.

A400.1 Scope

This Chapter covers the design, material requirements, fabrication, installation, inspection, testing, and safety aspects of the operation and maintenance of offshore pipeline systems. For purposes of this Chapter, offshore pipeline systems include offshore liquid pipelines, pipeline risers, offshore liquid pumping stations, pipeline appurtenances, pipe supports, connectors, and other components as addressed specifically in the Code. See Fig. 400.1.1-2.

A400.2 Definitions

Some of the more common terms relating to offshore liquid pipelines are defined below.

buckle arrestor: any device attached to, or made a part of, the pipe for the purpose of arresting a propagating buckle.

buckle detector: any means for detecting dents, excessive ovalization, or buckles in a pipeline.

external hydrostatic pressure: pressure acting on any external surface resulting from its submergence in water.

flexible pipe: pipe that is

(a) manufactured as a composite from both metal and nonmetal components

(b) capable of allowing large deflections without adversely affecting the pipe's integrity

(c) intended to be an integral part of the permanent liquid transportation system

Flexible pipe does not include solid metallic pipe, plastic pipe, fiber reinforced plastic pipe, rubber hose, or metallic pipes lined with nonmetallic linings or coatings.

hyperbaric weld: a weld performed at ambient hydrostatic pressure.

offshore: the area beyond the line of ordinary high water along that portion of the coast that is in direct contact with the open seas and beyond the line marking the seaward limit of inland coastal waters.

offshore pipeline riser: the vertical or near-vertical portion of an offshore pipeline between the platform piping and the pipeline at or below the seabed, including a length of pipe of at least five pipe diameters beyond the bottom elbow, bend, or fitting. Because of the wide variety of configurations, the exact location of transition among pipeline, pipeline riser, and platform piping must be selected on a case-by-case basis.

offshore pipeline system: includes all components of a pipeline installed offshore for the purpose of transporting liquid, other than production facility piping. Tanker or barge loading hoses are not considered part of the offshore pipeline system.

offshore platform: any fixed or permanently anchored structure or artificial island located offshore.

pipe collapse: flattening deformation of the pipe resulting in loss of cross-sectional strength and circular shape, which is caused by excessive external hydrostatic pressure acting alone.

platform piping: on offshore platforms producing hydrocarbons, platform piping is all liquid transmission piping and appurtenances between the production facility and the offshore pipeline riser(s). On offshore platforms not producing hydrocarbons, platform piping is all liquid transmission piping and appurtenances between the risers. Because of a wide variety of configurations, the exact location of the transition between the offshore

pipeline riser(s), platform piping, and production facility must be selected on a case-by-case basis.

propagating buckle: a buckle that progresses rapidly along a pipeline caused by the effect of external hydrostatic pressure on a previously formed buckle, local collapse, or other cross-sectional deformation.

pull tube: a conduit attached to an offshore platform through which a riser can be installed.

pull-tube riser: riser pipe or pipes installed through a pull tube (e.g., J-tube or I-tube).

riser: see *offshore pipeline riser.*

sea floor bathymetry: refers to water depths along the pipeline route.

splash zone: the area of the pipeline riser or other pipeline components that is intermittently wet and dry due to wave and tidal action.

trawl board: a structure that is attached to the bottom of commercial fishing nets and is dragged along the sea floor.

vortex shedding: the periodic shedding of fluid vortices and resulting unsteady flow patterns downstream of a pipeline span.

A401 DESIGN CONDITIONS

A401.1 General

A401.1.1 Offshore Design Conditions. A number of physical parameters, henceforth referred to as design conditions, govern design of the offshore pipeline system so that it meets installation, operation, and other post-installation requirements. Some of the conditions which may influence the safety and reliability of an offshore pipeline system are

(*a*) pressure
(*b*) temperature
(*c*) waves
(*d*) current
(*e*) seabed
(*f*) wind
(*g*) ice
(*h*) seismic activity
(*i*) platform motion
(*j*) water depth
(*k*) support settlement
(*l*) accidental loads
(*m*) marine vessel activity
(*n*) fishing/recreational activities

The design of an offshore pipeline system is often controlled by installation considerations rather than by operating load conditions.

A401.9 Installation Design Considerations

A401.9.1 Loads for Installation Design. The design of an offshore pipeline system suitable for safe installation and the development of offshore pipeline construction procedures shall be based on consideration of the parameters listed in paras. A401.9.2 and A401.9.3. These parameters shall be considered to the extent that they are significant to the proposed system and applicable to the method of installation being considered.

All parts of the offshore pipeline system shall be designed for the most critical combinations of installation and environmental loads, acting concurrently, to which the system may be subjected.

A401.9.2 Installation Loads. Installation loads that shall be considered are those imposed on the pipeline system under anticipated installation conditions, excluding those resulting from environmental conditions.

Loads that should be considered as installation loads include

(*a*) weight, including (as appropriate) the weight of
  (*1*) pipe
  (*2*) coatings and their absorbed water
  (*3*) attachments to the pipe
  (*4*) fresh water or sea water content (if pipe is flooded during installation)
(*b*) buoyancy
(*c*) external pressure
(*d*) static loads imposed by construction equipment

When considering the effect of pipe and/or pipeline component weights (in air and submerged) on installation stresses and strains, the variability due to weight coating, manufacturing tolerances, and water absorption shall also be considered.

A401.9.3 Environmental Loads During Installation. Environmental loads that shall be considered are those imposed on the pipeline system by environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(*a*) waves
(*b*) current
(*c*) wind
(*d*) tides
(*e*) ice
(*f*) dynamic loads imposed by construction equipment and vessel motions

The effects of large tidal changes and water depth variations on construction equipment shall be considered.

An appropriate design return interval storm shall be selected for the anticipated installation duration. This design return interval shall not be less than three times the expected exposure period for the pipeline during installation, or 1 yr, whichever is longer.

Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental loads to be used with the installation loads, as described in para. A401.9.1.

Loads imposed by construction equipment and vessel motions vary with the construction method and construction vessel selected. The limitations and behavioral characteristics of installation equipment shall be considered in the installation design. The effect of vessel motions on the pipe and its coating shall be considered.

Local environmental forces are subject to radical change in offshore areas. As a result, those potential changes should be considered during installation contingency planning as well as during installation design.

A401.9.4 Bottom Soils. Soil characteristics shall be considered in on-bottom stability analysis during the installation period, span analysis, and when installation procedures are developed for the following:

(*a*) riser installation in pull tubes
(*b*) laying horizontal curves in the pipeline routing
(*c*) pipeline bottom tows
(*d*) trenching and backfilling

A401.10 Operational Design Considerations

A401.10.1 Loads for Operational Design. The design of an offshore pipeline system suitable for safe operation shall be based on considerations of the parameters listed in paras. A401.10.2 and A401.10.3. These parameters shall be considered to the extent that they are significant to the proposed system.

All parts of the offshore pipeline system shall be designed for the most critical combinations of operational and environmental loads, acting concurrently, to which the system may be subjected. The most critical combination will depend upon operating criteria during storm conditions. If full operations are to be maintained during storm conditions, then the system shall be designed for concurrent action of full operational and design environmental loads. If operations are to be reduced or discontinued during storm conditions, then the system shall be designed for both

(*a*) full operational loads, plus maximum coincidental environmental loads

(*b*) design environmental loads, plus appropriate reduced operational loads

A401.10.2 Operational Loads. Operational loads that shall be considered are those imposed on the pipeline system during its operation, excluding those resulting from environmental conditions.

Loads that should be considered operational loads include

(*a*) weight, including (as appropriate) the weight of
  (*1*) pipe
  (*2*) coatings and their absorbed water
  (*3*) attachments to the pipe
  (*4*) transported contents
(*b*) buoyancy
(*c*) internal and external pressure
(*d*) thermal expansion and contraction
(*e*) residual loads
(*f*) overburden

Anticipated impact loads, such as those caused by trawl boards, should be considered as an operational load.

A401.10.3 Environmental Loads During Operation. Environmental loads that shall be considered are those imposed on the pipeline system by environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(*a*) waves
(*b*) current
(*c*) wind
(*d*) tides
(*e*) ice loads (e.g., weight, floating impacts, scouring)
(*f*) seismic events
(*g*) dynamically induced soil loads (e.g., mud slides, soil liquefaction)

An appropriate design return interval storm shall be selected for the anticipated operational life of the offshore pipeline system but shall not be less than 100 yr.

Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental loads to be used with the operations loads, as described in para. A401.10.1.

A401.10.4 Bottom Soils. When establishing on-bottom stability requirements and maximum allowable spans for irregular seabeds, consideration shall be given to seabed soil characteristics.

A401.11 Hydrostatic Test Design Considerations

A401.11.1 Loads for Hydrostatic Test Design. The design of an offshore pipeline system suitable for safe hydrostatic testing and the development of offshore pipeline hydrostatic test procedures shall be based on consideration of the parameters listed in paras. A401.11.2 and A401.11.3. These parameters shall be considered to the extent that they are significant to the proposed test.

All parts of the offshore pipeline system shall be designed for the most critical combinations of hydrostatic test and environmental loads, acting concurrently, to which the system may be subjected.

A401.11.2 Hydrostatic Test Loads. Hydrostatic test loads that shall be considered are those imposed on the offshore pipeline system under anticipated test conditions, excluding those resulting from environmental conditions.

Loads that should be considered hydrostatic test loads include

(a) weight, including (as appropriate) the weight of
(1) pipe
(2) coatings and their absorbed water
(3) attachments to the pipe
(4) fresh water or sea water used for hydrostatic test
(b) buoyancy
(c) internal and external pressure
(d) thermal expansion and contraction
(e) residual loads
(f) overburden

A401.11.3 Environmental Loads During Hydrostatic Test. Environmental loads that shall be considered are those imposed on the pipeline system by environmental conditions. Loads that should be considered under this category include, as appropriate, those arising due to

(a) waves
(b) current
(c) wind
(d) tides

An appropriate design return interval storm shall be selected for the anticipated hydrostatic test duration but shall not be less than 1 yr.

Direction of waves, wind, and currents shall be considered to determine the most critical expected combination of the environmental loads to be used with the hydrostatic test loads, as described in para. A401.11.1.

A401.11.4 Bottom Soils. When establishing on-bottom stability requirements and maximum allowable spans for irregular seabeds, consideration shall be given to seabed soil characteristics.

A401.12 Route Selection Considerations

(a) Offshore pipeline routes shall be selected to minimize the adverse effects of

(1) installation and related environmental loads (see para. A401.9)

(2) operational and related environmental loads (see para. A401.10)

(3) hydrostatic test and related environmental loads (see para. A401.11)

(b) Selection of offshore pipeline routes shall consider the capabilities and limitations of anticipated construction equipment.

(c) Surveys of the pipeline route shall be conducted to identify

(1) seabed materials

(2) subsea (including sub-bottom) and surface features that may represent potential hazards to the pipeline construction and operations

(3) subsea (including sub-bottom) and surface features that may be adversely affected by pipeline construction and operations, including archaeological and sensitive marine areas

(4) turning basins
(5) anchorage areas
(6) shipping lanes
(7) foreign pipeline and other utility crossings

(d) Routing shall be selected to avoid, to the extent practical, the identified hazards.

A402 DESIGN CRITERIA

A402.3 Allowable Stresses and Other Stress Limits

The allowable stresses and other stress limits given in para. 402.3 are superseded by the provisions of paras. A402.3.4 and A402.3.5.

Design and installation analyses shall be based upon accepted engineering methods, material strengths, and applicable design conditions.

A402.3.4 Strength Criteria During Installation and Testing

(a) *Allowable Stress Values.* The maximum longitudinal stress due to axial and bending loads during installation shall be limited to a value that prevents pipe buckling and that will not impair the serviceability of the installed pipeline system. Other stresses resulting from pipeline installation activities, such as spans, shall be limited to the same criteria. Instead of a stress criterion, an allowable installation strain limit may be used.

(b) *Design Against Buckling.* The offshore pipeline system shall be designed and installed in a manner to prevent local buckling of the pipe wall, collapse, and column buckling during installation. Design and installation procedures shall consider the effect of external hydrostatic pressure; bending, axial, and torsional loads; impact; mill tolerances in the wall thickness; out-of-roundness; and other applicable factors. Consideration shall also be given to mitigation of propagation buckling that may follow local buckling or denting. The pipe wall thickness shall be selected to resist collapse due to external hydrostatic pressure.

(c) *Design Against Fatigue.* The pipeline shall be designed and installed to limit anticipated stress fluctuations to magnitudes and frequencies that will not impair the serviceability of the installed pipeline. Loads that may cause fatigue include wave action and vibrations induced by vortex shedding. Pipelines and riser spans shall be designed to prevent vortex-induced resonant vibrations, when practical. When vibrations must be tolerated, the resulting stresses due to vibration shall be considered. If alternative acceptance standards for girth welds in API 1104 are used, the cyclic stress analysis shall include the determination of a predicted fatigue spectrum to which the pipeline is exposed over its design life.

(d) *Design Against Fracture.* Prevention of fractures during installation shall be considered in material selection in accordance with the requirements of para. A423.2. Welding procedures and weld defect acceptance criteria

shall consider the need to prevent fractures during installation. See paras. 434.8.5 and A434.8.5.

(e) Design Against Loss of In-Place Stability. Design against loss of in-place stability shall be in accordance with the provisions of para. A402.3.5(e), except that the installation design wave and current conditions shall be based upon the provisions of para. A401.9.3. If the pipeline is to be trenched, it shall be designed for stability during the period prior to trenching.

(f) Impact. During the period when the pipe is susceptible to impact damage during installation and testing, consideration shall be given to impacts due to

(1) anchors
(2) trawl boards
(3) vessels
(4) ice keels
(5) other foreign objects

(g) Residual Stresses. The pipeline system shall normally be installed in a manner so as to minimize residual stresses. The exception shall be when the designer purposefully plans for residual stresses (e.g., reeled pipe, cold springing of risers, pull-tube risers).

(h) Flexible Pipe. The manufacturer's recommended installation procedures should be adhered to during installation. Flexible pipe shall be designed or selected to prevent failure due to the combined effects of external pressure, internal pressure, torsional forces, axial forces, and bending. (See API RP 17B.)

(12) **A402.3.5 Strength Criteria During Operations**

(a) Allowable Stress Values. Allowable stress values for steel pipe during operation shall not exceed those calculated by the equations in paras. A402.3.5(a)(1) through (3).

(1) Hoop Stress. For offshore pipeline systems, the tensile hoop stress due to the difference between internal and external pressures shall not exceed the values given below, in eq. (1).

S_h shall be calculated by eq. (2) or eq. (3). It is recommended that eq. (2) be used for D/t greater than or equal to 20 and that eq. (3) be use for D/t less than 30.

NOTE: Sign convention is such that tension is positive and compression is negative.

$$S_h \le F_1 (S_y) \tag{1}$$

$$S_h = (P_i - P_e)\frac{D}{2t} \quad \textit{(U.S. Customary Units)} \tag{2}$$

$$S_h = (P_i - P_e)\frac{D}{20t} \quad \textit{(SI Units)}$$

$$S_h = (P_i - P_e)\frac{D-t}{2t} \quad \textit{(U.S. Customary Units)} \tag{3}$$

$$S_h = (P_i - P_e)\frac{D-t}{20t} \quad \textit{(SI Units)}$$

where

D = nominal outside diameter of pipe, in. (mm)
F_1 = hoop stress design factor from Table A402.3.5-1
P_e = external pressure, psig (bar)
P_i = internal design pressure, psig (bar)
S_h = hoop stress, psi (MPa)
S_y = specified minimum yield strength, psi (MPa)
t = nominal wall thickness, in. (mm)

(2) Longitudinal Stress. For offshore pipeline systems, the longitudinal stress shall not exceed values found from

$$|S_L| \le F_2(S_y)$$

where

A = cross-sectional area of pipe material, in.^{2} (mm^2)
F_a = axial force, lb (N)
F_2 = longitudinal stress design factor from Table A402.3.5-1
i_i = in-plane stress intensification factor from Table 402.1-1
i_o = out-of-plane stress intensification factor from Table 402.1-1
M_i = in-plane bending moment, in.-lb (N·m)
M_o = out-of-plane bending moment, in.-lb (N·m)
S_a = axial stress, psi (positive tensile or negative compressive) (MPa)
= F_a/A
S_b = maximum resultant bending stress, psi (MPa)
= $\pm\sqrt{(i_i M_i)^2 + (i_o M_o)^2}/Z$
S_l = maximum longitudinal stress, psi (positive tensile or negative compressive) (MPa)
= $S_a + S_b$ or $S_a - S_b$, whichever results in the larger stress value
S_y = specified minimum yield strength, psi (MPa)
Z = section modulus of the pipe, in.^{3} (cm^3)
$|\,|$ = absolute value

(3) Combined Stress. For offshore pipeline systems, the combined stress shall not exceed the value given by the Maximum Shear Stress Equation (Tresca Combined Stress)

$$2\left[\sqrt{\left(\frac{S_L - S_h}{2}\right)^2 + S_l^2}\right] \le F_3(S_y)$$

where

A = pipe cross-sectional area, in.^{2} (mm^2)
F_a = axial force, lb (N)
F_3 = combined stress design factor from Table A402.3.5-1
i_i = in-plane stress intensification factor from Table 402.1-1
i_o = out-of-plane stress intensification factor from Table 402.1-1

Table A402.3.5-1 Design Factors for Offshore Pipeline Systems

Location	Hoop Stress, F_1	Longitudinal Stress, F_2	Combined Stress, F_3
Pipeline	0.72	0.80	0.90
Riser and platform piping [Note (1)]	0.60	0.80	0.90

GENERAL NOTE: In the setting of design factors, due consideration has been given to, and allowance has been made for, the underthickness tolerance and maximum allowable depth of imperfections provided for in the specifications approved by the Code.

NOTE:

(1) Platform piping does not include production facility piping on a platform; see definitions in para. A400.2.

M_i = in-plane bending moment, in-lb (N·m)
M_o = out-of-plane bending moment, in.-lb (N·m)
M_t = torsional moment, in.-lb (N·m)
S_a = axial stress, psi (positive tensile or negative compressive) (MPa)
$= F_a/A$
S_b = maximum resultant bending stress, psi (MPa)
$= \pm \sqrt{(i_i M_i)^2 + (i_o M_o)^2}/Z$
S_h = hoop stress, psi (MPa)
S_L = maximum longitudinal stress, psi (positive tensile or negative compressive) (MPa)
$= S_a + S_b$ or $S_a - S_b$, whichever results in the larger stress value
S_t = torsional stress, psi (MPa)
$= M_t/2Z$
S_y = specified mimimun yield strength, psi (MPa)
Z = section modulus of the pipe, in.^{3} (cm^3)

Alternatively, the Maximum Distortional Energy Theory (Von Mises Combined Stress) may be used for limiting combined stress values. Accordingly, the combined stress should not exceed values given by

$$\sqrt{S_h^2 - S_L S_h + S_t^2 + 3S_t^2} \le F_3(S_y)$$

(4) Strain. When the pipeline experiences a predictable noncyclic displacement of its support (e.g., fault movement along the pipeline route or differential subsidence along the line) or pipe sag before support contact, the longitudinal and combined stress limits may be replaced with an allowable strain limit, so long as the consequences of yielding do not impair the serviceability of the installed pipeline. The permissible maximum longitudinal strain depends upon the ductility of the material, any previously experienced plastic strain, and the buckling behavior of the pipe. Where plastic strains are anticipated, the pipe eccentricity, pipe out-of-roundness, and the ability of the weld to undergo such strains without detrimental effect should be considered. These same criteria may be applied to pull tube or bending shoe risers or pipe installed by the reel method.

(b) Design Against Buckling. The pipeline shall be designed with an adequate margin of safety to prevent local buckling of the pipewall, collapse, and column buckling during operations. Design and operating procedures shall consider the effect of external hydrostatic pressure; bending, axial, and torsional loads; impact; mill tolerances in the wall thickness, out-of-roundness, and other applicable factors. Consideration shall also be given to mitigation of propagation buckling that may follow local buckling or denting. The pipe wall thickness shall be selected to resist collapse due to external hydrostatic pressure.

(c) Design Against Fatigue. The pipeline shall be designed and operated to limit anticipated stress fluctuations to magnitudes and frequencies that will not impair the serviceability of the pipeline. Loads that may cause fatigue include internal pressure variations, wave action, and pipe vibration, such as that induced by vortex shedding. Pipe and riser spans shall be designed so that vortex-induced resonant vibrations are prevented, whenever practical. When vibrations must be tolerated, the resulting stresses due to vibration shall be considered in the combined stress calculations in para. A402.3.5(a). In addition, calculated fatigue failure shall not result during the design life of the pipeline and risers.

(d) Design Against Fracture. Prevention of fractures during operation shall be considered in material selection in accordance with the requirements of para. A423.2. Welding procedures and weld defect acceptance criteria shall consider the need to prevent fractures during operation. See paras. 434.8.5 and A434.8.5.

(e) Design Against Loss of In-Place Stability

(1) General. Pipeline design for lateral and vertical on-bottom stability is governed by permanent features such as sea floor bathymetry and soil characteristics and by transient events, such as hydrodynamic, seismic, and soil behavior events, having a significant probability of occurrence during the life of the system. Design conditions to be considered are provided in paras. A402.3.5(e)(2) through (4).

The pipeline system shall be designed to prevent horizontal and vertical movements or shall be designed so that any movements will be limited to values not causing

allowable stresses and strains to be exceeded. Typical factors to be considered in the stability design include

(a) wave and current forces
(b) soil properties
(c) scour and resultant spanning
(d) soil liquefaction
(e) slope failure

Stability may be obtained by such means as, but not limited to

(f) adjusting pipe submerged weight
(g) trenching and or covering of pipe
(h) anchoring

When calculating hydrodynamic forces, the fact that wave forces vary spatially along the length of the pipeline may be taken into account.

Two on-bottom stability design conditions that shall be considered are installation and operational.

(2) *Design Wave and Current Conditions.* Operational design wave and current conditions shall be based upon an event having a minimum return interval of not less than 100 yr. The most unfavorable expected combination of wave and current conditions shall be used. Maximum wave and maximum current conditions do not necessarily occur simultaneously. When selecting the most unfavorable condition, consideration must be given to the timing of occurrence of the wave and current direction and magnitude.

(3) *Stability Against Waves and Currents.* The submerged weight of the pipe shall be designed to resist or limit movement to amounts that do not cause the longitudinal and combined stresses, as calculated by the equations in para. A402.3.5(a), to exceed the limits specified in para. A402.3.5(a). The submerged weight may be adjusted by weight coating and/or increasing pipe wall thickness. Hydrodynamic forces shall be based on the wave and current values for the design condition at the location. See para. A402.3.5(e)(2).

Wave and current direction and concurrence shall be considered.

The pipeline and its appurtenances may be lowered below bottom grade to provide stability.

Backfill or other protective covering options shall use materials and procedures that preclude damage to the pipeline and coatings.

Anchoring may be used alone or in conjunction with other options to maintain stability. The anchors shall be designed to withstand lateral and vertical loads expected from the design wave and current condition. Anchors shall be spaced to prevent excessive stresses in the pipe. Scour shall be considered in the design of the anchoring system. The effect of anchors on the cathodic protection system shall be considered.

Intermittent block-type, clamp-on, or set-on weights (river weights) shall not be used on offshore pipelines where there is a potential for the weight to become unsupported because of scour.

(4) *Shore Approaches.* Pipe in the shore approach zone shall be installed on a suitable abovewater structure or lowered or bored to the depth necessary to prevent scouring, spanning, or stability problems that affect integrity and safe operation of the pipeline during its anticipated service life. Seasonal variation in the nearshore thickness of sea floor sediments and shoreline erosion over the pipeline service life shall be considered.

(5) *Slope Failure and Soil Liquefaction.* The pipelines shall be designed for slope failure in zones where they are expected (mud slide zones, steep slopes, areas of seismic slumping). If it is not practical to design the pipeline system to survive the event, the pipeline shall be designed for controlled breakaway with provisions to minimize loss of the pipeline contents.

Design for the effects of liquefaction shall be performed for areas of known or expected occurrence. Soil liquefaction normally results from cyclic wave overpressures or seismic loading of susceptible soils. The bulk specific gravity of the pipeline shall be selected, or alternative methods shall be selected to ensure both horizontal and vertical stability.

Seismic design conditions used to predict the occurrence of bottom liquefaction or slope failure shall be at least as severe as those used for the operating design strength calculations for the pipeline. Occurrence of soil liquefaction due to wave overpressures shall be based on a storm interval of not less than 100 yr.

(6) *Bottom Soils.* The pipe-soil interaction factors that are used shall be representative of the bottom conditions at the site.

(f) *Impact.* During operations, consideration shall be given to impacts due to

(1) anchors
(2) trawl boards
(3) vessels
(4) ice keels
(5) other foreign objects

A402.3.6 Design for Expansion and Flexibility. Unburied subsea pipeline systems and platform piping shall be considered as aboveground piping [see paras. 419.1(a), (b), and (d)] where such definition is applicable.

Thermal expansion and contraction calculations shall consider the effects of fully saturated backfill material on soil restraint.

Allowable strength criteria shall be in accordance with para. A402.3.5 in lieu of the allowables listed in para. 419.6.4. Equations in para. 419.6.4 are valid for calculating the indicated stresses. See paras. A401.10 and A401.11 for loads that must be considered in design. Where appropriate, allowable strain criteria in para. A402.3.5(a)(4) may be used in lieu of allowable stress criteria.

When an offshore pipeline is to be laid across a known fault zone or in an earthquake-prone area, consideration

shall be given to the need for flexibility in the pipeline system and its components to minimize the possibility of damage due to seismic activity. Flexibility in the pipeline system may be provided by installation of the pipeline on or above the seabed and/or by use of breakaway couplings, slack loops, flexible pipe sections, or other site-specific solutions.

A402.3.7 Design of Clamps and Supports. Clamps and supports shall be designed such that a smooth transfer of loads is made from the pipeline or riser to the supporting structure without highly localized stresses due to stress concentrations. When clamps are to be welded to the pipe, they shall fully encircle the pipe and be welded to the pipe by a full encirclement weld. The support shall be attached to the encircling member and not the pipe.

All welds to the pipe shall be nondestructively tested. Clamps and supports shall be designed in accordance with the requirements of API RP 2A-WSD.

Clamps and support design shall consider the corrosive effects of moisture-retaining gaps and crevices and galvanically dissimilar metals.

A402.3.8 Design of Connectors and Flanges. Connectors and flanges shall be designed or selected to provide the smooth transfer of loads and prevent excessive deformation of the attached pipe.

A402.3.9 Design of Structural Pipeline Riser Protectors. Where pipeline risers are installed in locations subject to impact from marine traffic, protective devices shall be installed in the zone subject to damage to protect the pipe and coating.

A402.3.10 Design and Protection of Special Assemblies. Design of special assemblies, such as connections, subsea tie-in assemblies, subsea valves, expansion loops, seabed riser connections, and subsea pipeline manifolds, shall consider the additional forces and effects imposed by a subsea environment. Such additional considerations include design storm currents and potential for seabed movement in soft sediments, soil liquefaction, increased potential for corrosion, thermal expansion and contraction, and stress due to installation procedures.

Appropriate measures shall be taken to protect special assemblies in areas where the assemblies are subject to damage by outside forces, such as fishing and marine construction activities.

A402.3.11 Design of Flexible Pipe. Due to its composite makeup, the mechanical behavior of flexible pipe is significantly different from that of steel pipe. Flexible pipe may be used for offshore pipelines if calculations and/or test results verify that the pipe can safely withstand loads considered in paras. A401.9, A401.10, and A401.11. Careful consideration should be given to the use of flexible pipe due to its permeable nature and possible rapid decompression failure of the liner material and collapse of the inner liner due to residual gas pressure in the annulus upon pipeline depressurization. (See API RP 17B.)

A402.3.12 Design of Pipeline Crossings. Subsea pipeline crossings shall be designed to provide a minimum 12 in. (300 mm) separation between the two lines. Dielectric separation of the two pipelines shall be considered in design of pipeline crossings. Soil settlement, scour, and cyclical loads shall be considered in the design of pipeline crossings in order to ensure that the separation is maintained for the design life of both lines.

When two liquid pipelines cross, the longitudinal stress and combined stress, as calculated by the equations in para. A402.3.5(a), shall not exceed the limits specified in Table A402.3.5-1. Where appropriate, allowable strain criteria in para. A402.3.5(a)(4) may be used in lieu of allowable stress criteria. Where crossing pipelines are governed by different codes, the allowable stress limits shall be in accordance with the provisions of the applicable code.

A402.4 Allowances

A402.4.3 Weld Joint Factors. Pipe with a weld joint factor less than 1 (Table 403.2.1-1) shall not be used in offshore pipeline systems.

A404 PRESSURE DESIGN OF COMPONENTS

A404.1 Straight Pipe

A404.1.1 General

(b) For offshore pipeline systems, the applicable allowable stress value specified and defined in para. 404.1.1(b) shall be as follows:

$$S = F_1 (S_y)$$

where F_1 and S_y are defined in para. A402.3.5.

A404.3 Intersections

A404.3.1 Branch Connections

(d) Reinforcement of Single Openings

(1) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

(e) Reinforcement of Multiple Openings

(4) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

A405 PIPE

A405.2 Metallic Pipe

A405.2.1 Steel Pipe

(a) The provisions of para. 405.2.1(a) are superseded by the following. New pipe of the specifications listed in Table 423.1-1 may be used in accordance with the design equations of para. 404.1.2 subject to para A404.1.1 and to the testing requirements of paras. 437.1.4(a)(1), (2), (4), and (5); paras. 437.1.4(b) and (c); and paras. 437.4.1 and A437.1.4.

(c) Paragraph 405.2.1(c) does not apply.

(d) Pipe that has been cold worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold worked specifically for the purpose of meeting dimensional requirements.

A405.3 Flexible Pipe

Selection of flexible pipe shall be in accordance with API RP 17B. (See also para. A402.3.11.)

A406 FITTINGS, ELBOWS, BENDS, AND INTERSECTIONS

A406.2 Bends, Miters, and Elbows

A406.2.2 Mitered Bends. Mitered bends are prohibited in offshore liquid pipeline systems.

A406.4 Reductions

A406.4.2 Orange Peel Swages. Orange peel swages are prohibited in offshore liquid pipeline systems, other than temporary construction components or other non-pressure-containing components.

A406.6 Closures

A406.6.4 Fabricated Closures. Orange peel bull plugs and fishtails are prohibited in offshore liquid pipeline systems, other than temporary construction components or other non-pressure-containing components.

A407 VALVES

A407.1 General

Paragraph 407.1(b) does not apply. Cast iron or ductile iron valves are prohibited for applications in offshore liquid pipeline systems.

A408 FLANGES, FACINGS, GASKETS, AND BOLTING

A408.1 Flanges

A408.1.1 General. Paragraph 408.1.1(c) does not apply. Cast iron or ductile iron flanges are prohibited for applications in offshore liquid pipeline systems.

A408.3 Flange Facings

A408.3.1 General

(c) Ring joint-type flanges are preferred in offshore liquid pipeline systems.

A409 USED PIPING COMPONENTS AND EQUIPMENT

Used piping components, such as fittings, elbows, bends, intersections, couplings, reducers, closures, flanges, valves, and equipment, may be reused as noted in section 409, except that the reuse of piping components of unknown specification is prohibited in offshore liquid pipeline systems.

A410 OTHER DESIGN CONSIDERATIONS

A410.1 Pigs and Internal Inspection Tools

When specifying in-line piping components for offshore pipelines, consideration shall be given to the need for running pipeline pigs and internal inspection tools. Selection of bend radius, launcher and receiver traps, bend configuration, internal diameter variations (including ovality), and other internal obstructions shall allow the passage of such devices, except where not practical.

A410.2 Special Components

System components that are not specifically covered in this Code shall be validated for fitness by either of the following:

(a) documented full-scale prototype testing of the components or special assemblies

(b) a documented history of successful usage of these components or special assemblies produced by the same design method

Documentation shall include design and installation methods that have been proven for the service for which the component is intended.

Care should be exercised in any new application of existing designs to ensure suitability for the intended service.

A414 THREADED JOINTS

A414.1 General

Threaded connections for in-line piping component sizes, NPS 2 (60.3 mm) or larger, are prohibited in offshore pipeline systems, except as permitted in para. A410.2.

A419 EXPANSION AND FLEXIBILITY

See para. A402.3.6 for additional provisions.

A421 DESIGN OF PIPE-SUPPORTING ELEMENTS

See para. A402.3.7 for additional provisions.

A423 MATERIALS — GENERAL REQUIREMENTS

A423.1 Acceptable Materials and Specifications

Concrete weight coating materials (cement, aggregate, reinforcing steel) shall meet or exceed the requirements of applicable ASTM standards.

Flexible pipe shall be manufactured from materials meeting the requirements of API RP 17B and ASTM or ASME standards applicable to the materials selected by the designer.

A423.2 Limitations on Materials

"Unidentified" pipe, plastic pipe, ASTM A120 pipe, plastic pipe with nonmetallic reinforcement, cast iron pipe, ductile iron pipe, and pipe that has been cold-worked in order to meet the specified minimum yield strength are prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold-worked specifically for the purpose of meeting dimensional requirements.

In addition to the requirements contained in referenced standards, certain other requirements may be considered for components used offshore, depending on water depth, water temperature, internal pressure, product composition, product temperature, installation method and/or other loading conditions. For example, consideration of additional limitations or requirements for pipe may include one or more of the following:

(a) wall thickness tolerance

(b) outside diameter tolerance

(c) out-of-roundness tolerance

(d) maximum and minimum yield and tensile strengths

(e) pipe chemistry limitations

(f) fracture toughness

(g) hardness

(h) pipe mill hydrostatic testing and other nondestructive testing

For sour service (H_2S), refer to NACE MR-01-75.

A434 CONSTRUCTION

A434.2 Inspection

Repairs required during new construction shall also be in accordance with paras. A434.8 and A461.1.2.

A434.3 Right-of-Way

A434.3.3 Survey and Staking or Marking. The route of the offshore pipeline shall be surveyed, and the pipeline shall be properly located within the right-of-way by maintaining survey route markers or by surveying during installation.

A434.6 Ditching

The provisions of para. 434.6 are not applicable for offshore pipelines. Offshore pipelines should be trenched where necessary for stability, mechanical protection, or prevention of interference with maritime activities.

The methods and details of the pipeline trenching and lowering operations shall be based on site-specific conditions. Methods and details shall be selected to prevent damage to the pipe, coating, and pipeline appurtenances.

A434.7 Bends, Miters, and Elbows

Miter bends shall not be used in offshore liquid pipeline systems.

A434.7.1 Bends Made From Pipe

(a) Pipe that has been cold-worked solely for the purpose of increasing the yield strength to meet the specified minimum yield strength is prohibited in offshore liquid pipeline systems. This does not preclude the use of pipe that has been cold-worked specifically for the purpose of meeting dimensional requirements.

A434.8 Welding

A434.8.3 Welding Qualifications. Welding procedures and welders performing hyperbaric welding on offshore pipeline systems shall be qualified in accordance with the testing provisions of either API 1104 or ASME Section IX, as supplemented by AWS D3.6 for Type "O" welds.

A434.8.5 Welding Quality

(a) *Inspection Methods*

(2) Welds in offshore pipeline systems may also be evaluated on the basis of para. A434.8.5(b).

(4) The requirements of para. 434.8.5(a)(4) are superseded by the following provisions. All circumferential welds on offshore pipeline systems shall meet the requirements in para. 434.8.5(a) for a pipeline that would operate at a hoop stress of more than 20% of the specified minimum yield strength of the pipe. One hundred percent of the total number of circumferential butt welds on offshore pipeline systems shall be nondestructively inspected, if practical; but in no case shall less than 90% of such welds be inspected. The inspection shall cover 100% of the length of such inspected weld.

(b) *Standards of Acceptability.* For girth welds in offshore pipeline systems, alternative flaw acceptance limits may be based upon fracture mechanics analysis and fitness-for-purpose criteria as described by API 1104. Such alternative acceptance standards shall be supported by appropriate stress analyses, supplementary welding procedure test requirements, and nondestructive examinations beyond the minimum requirements specified herein. The accuracy of the nondestructive techniques for flaw depth measurement shall be verified.

A434.8.9 Stress Relieving

(a) On offshore pipeline systems, the demonstration specified in para. 434.8.9(a) shall be conducted on materials and under conditions that simulate, as closely as practical, the actual production welding.

A434.11 Backfilling

Backfilling of trenched offshore pipelines is not normally required but may sometimes be utilized to provide additional stability or protection.

A434.13 Special Crossings

A434.13.1 Water Crossings. See para. A402.3.5(e)(3) concerning the use of river weights.

A434.14 Offshore Pipeline Construction

A434.14.1 Pipe Depth and Alignment. Plans and specifications shall describe alignment of the pipeline, its design depth below mean water level, and the depth below the sea bottom, if trenching is prescribed. Special consideration shall be given to depth of cover and other means of protecting the pipeline in the surf zone and other areas of potential hazards, such as near platforms, anchorage areas, and shipping fairways.

A434.14.2 Installation Procedures and Equipment Selection. Installation procedures shall be prepared prior to beginning construction. Installation procedures shall address the design considerations in para. A401.9 and strength considerations in para. A402.3.4.

A434.14.3 Movement of Existing Pipelines. Consideration should be given to reducing operating pressures in the existing pipelines to obtain the lowest practical stress levels prior to movement of the existing lines. Whether the pipeline pressure is reduced or not, the following steps should be taken prior to movement of the existing lines:

(a) perform a physical survey to determine the actual position of the pipeline

(b) determine wall thickness and mechanical properties of the existing pipeline section to be moved

(c) investigate possible pipe stress that may exist in the pipeline in its present condition

(d) calculate additional stresses imposed by the proposed movement operation

(e) prepare a detailed procedure for the proposed movement

Investigation of the possible pipe stresses that may be induced in the existing pipeline during the relocation should be performed regardless of the anticipated internal pressure. This investigation should consider appropriate elevation tolerances for the lowering. Pipe stresses resulting from the relocation should not exceed the criteria in para. A402.3.4, and pipe stresses resulting from existing pipeline operation after lowering should not exceed the criteria in para. A402.3.5.

A434.15 Block and Isolating Valves

A434.15.1 General

(a) Block and isolating valves shall be selected to provide timely closure and to limit both property and environmental damage and provide safety under emergency conditions.

(b) On offshore platforms, consideration shall be given to locating block and isolating valves, or valve operator controls where used, in areas that are readily accessible under emergency conditions.

(c) Submerged valves shall be marked or spotted by survey techniques and recorded on permanently retained as-built records to facilitate location when operation is required.

A434.18 Line Markers

Line markers are not required on offshore pipeline systems.

A436 INSPECTION

A436.2 Qualification of Inspectors

In addition to the requirements of para. 436.2 offshore inspection personnel shall be capable of inspecting the following, as applicable:

(a) offshore vessel positioning systems

(b) diving operations

(c) remotely operated vehicle (ROV) operations

(d) pipeline trenching and burial operations

(e) special services for testing and inspection of offshore pipeline facilities, such as subsea pipeline lateral tie-ins, and subsea pipeline crossings as may be required

(f) pipelay parameters

A436.5 Type and Extent of Examination Required

A436.5.1 Visual

(b) Construction

(9) When offshore pipelines are trenched, the condition of the trench, trench depth, and fit of the pipe to the trench shall be inspected when feasible.

(11) When offshore pipelines are to be backfilled, the backfilling operations shall be inspected for quality of backfill, possible damage to the pipe coating, and depth of cover.

(12) Pipelines shall be inspected for spans.

(13) Pipeline crossings shall be inspected for specified separation.

(15) Where specified, special assemblies and protection measures as described in para. A402.3.10 shall be inspected for protection against damage by outside forces, such as fishing and other marine activities.

A437 TESTING

A437.1 General

A437.1.4 Testing After New Construction

(a) Systems or Parts of Systems

(3) Provisions of para. 437.1.4(a)(3) are superseded by the following. All pipe and pressure-containing piping components shall be tested in accordance with the provisions of para. 437.1.4(a)(2).

(b) Testing Tie-Ins. Nonwelded tie-in connections shall be observed for leaks at operating pressure. Tie-in welds and girth welds joining lengths of pretested pipe shall be inspected by radiographic or other accepted nondestructive methods in accordance with para. A434.8.5(a)(4), if system is not pressure-tested after tie-in.

(d) Hydrostatic Test Medium. The hydrostatic test medium for all offshore pipeline systems shall be water, except in arctic areas. Additives to mitigate the effects of corrosion, biofouling, and freezing should be considered. Such additives should be suitable for the methods of disposal of the test medium.

In arctic areas where freezing of water is a restraint, the use of air, inert gas, or glycol is allowable, provided appropriate detail considerations are addressed.

Disposal of all materials shall be done in an environmentally safe manner.

(e) Diameter Restrictions. Testing for buckles, dents, and other diameter restrictions shall be performed after installation. Testing shall be accomplished by passing a deformation detection device through the pipeline section, or by other methods capable of detecting a change in pipe cross-section. Pipe having deformation that affects the serviceability of the pipeline facilities shall be repaired or replaced. Consideration should also be given to repairing ovality that may interfere with pigging operations or internal inspections.

A437.4 Test Pressure

A437.4.3 Leak Testing. Provisions of para. 437.4.3 are not applicable for offshore pipeline systems.

A437.6 Qualification Tests

Pipe of unknown specification and ASTM A 120 specification pipe are not allowed in offshore pipeline systems. See para. A423.1.

A437.7 Records

"As-built" records shall also include the location of anodes and buckle arrestors (if used) by pipe joint installation sequence. Subsea valve, tie-in, and other special assembly locations shall be recorded by coordinates.

A450 OPERATION AND MAINTENANCE PROCEDURES AFFECTING THE SAFETY OF LIQUID AND SLURRY TRANSPORTATION PIPING SYSTEMS

A450.2 Operation and Maintenance Plans and Procedures

The provisions of paras. 450.2(d), (e), and (i) are superseded by the following:

(d) Have a plan for reviewing conditions affecting the integrity and safety of the pipeline system, including provisions for periodic patrolling and reporting of construction activity and changes in conditions.

(e) Establish and maintain liaisons with local offshore authorities who issue permits in order to prevent accidents caused by new construction. Establish and maintain liaisons with available offshore firefighting and pollution control entities.

(i) In establishing plans and procedures, give particular attention to those portions of the system presenting the greatest hazard to the public and to the environment in the event of emergencies or because of construction or extraordinary maintenance requirements.

A451 PIPELINE OPERATION AND MAINTENANCE

A451.3 Markers

The provisions of para. 451.3 do not apply to offshore pipeline systems.

A451.4 Right-of-Way Maintenance

The provisions of para. 451.4 do not apply to offshore pipeline systems.

A451.5 Patrolling

(a) The provisions of paras. 451.5(a) and (b) are superseded by the following. Each offshore pipeline system operator shall maintain a periodic pipeline patrol program to observe surface conditions on, and adjacent to, the pipeline right-of-way, indication of leaks, construction activity other than that performed by the operator, and any other factors affecting the safety and operation of the pipeline. Consideration should be given to increased patrols in areas more susceptible to damage by outside forces. Such areas are listed in para. A451.11.

A451.6 Pipeline Repairs

A451.6.1 General. Additional requirements for repairs to offshore pipeline systems are as follows:

(a) Repair operations shall not result in imposed deformations that would impair the integrity of the pipe materials, and weight or protective coating.

(b) Subsea equipment used in the repair of offshore pipeline systems shall be carefully controlled and monitored to avoid damaging the pipeline, external coating, or cathodic protection system.

(c) When lifting or supporting pipe during repairs, the curvature of a pipe sag bend and overbend shall be controlled to prevent overstressing, denting, or buckling the pipe or damaging the coating. Lifting equipment shall be selected to comply with this requirement.

(d) Wave and current loads shall be considered in determining total imposed stresses and cyclical loadings in both surface and subsurface repairs.

(e) When pipe is repaired, damaged coating shall be repaired.

(f) Replacement pipe and components shall be protected from corrosion.

Consideration should be given to obtaining pipe-to-water potentials during the repair operations to verify conformance to cathodic protection requirements.

A451.6.2 Disposition of Defects

(b) Allowable Pipeline Repairs

(4) Patches shall not be used on offshore pipeline systems.

(6) Partial encirclement half soles shall not be used on offshore pipeline systems.

(c) Repair Methods

(5) Patches shall not be used on offshore pipeline systems.

(8) Welded fittings allowed by para. 451.6.2(c)(8) to cover defects shall not be used in offshore pipeline systems.

(13) Half soles for repairs in offshore pipeline systems are prohibited.

A451.6.4 Repair of Flexible Pipe

(a) Major Structural Damage. If the serviceability of the flexible pipe is impaired, the damaged pipe section shall be replaced.

(b) Surface Cuts. In the event of surface cuts and abrasions that do not expose the load-carrying members to potential corrosion, the repair shall be performed in a manner recommended by the manufacturer.

A451.7 Derating a Pipeline to a Lower Operating Pressure

(c) If a component is installed during the repair that has a maximum pressure rating less than the allowable operating pressure of the pipeline, the pipeline shall be derated to the pressure rating of the component, analyzed in accordance with para. 451.1(a).

A451.8 Valve Maintenance

Provisions of para. 451.8 do not apply to offshore pipeline systems. Pipeline block valves that would be required by the emergency plan (see sections 454 and A454) to be operated during an emergency shall be inspected periodically, and fully or partially operated at least once a year.

A451.9 Railroads and Highways Crossing Existing Pipelines

The provisions of para. 451.9 do not apply to offshore pipeline systems.

A451.10 Offshore Pipeline Risers

The provisions of para. 451.10 do not apply to offshore pipeline systems.

A451.11 Inspection

As a means of maintaining the integrity of its pipeline system, each operating company shall establish and implement procedures for continuing surveillance of its facilities. Studies shall be initiated and appropriate action taken when unusual operating and maintenance conditions occur, such as failures, leakage history, unexplained changes in flow or pressure, or substantial changes in cathodic protection requirements.

Consideration should be given to inspection of pipelines and pipeline protection measures in areas most susceptible to damage by outside forces. Such areas may include shore crossings, areas near platforms, shipping fairways, pipeline crossings, span rectifications, subsea assemblies, and shallow water areas. If the operating company discovers that the cover or other conditions do not meet the original design, it shall determine whether the existing conditions are unacceptable. If unacceptable, the operating company shall provide additional protection by replacing cover, lowering the line, installing temporary or permanent warning markers or buoys, or using other suitable means.

When such studies indicate the facility is in an unsatisfactory condition, a planned program shall be initiated to abandon, replace, or repair. If such a facility cannot be repaired or abandoned, the maximum allowable operating pressure shall be reduced commensurate with the requirements described in paras. 451.7 and A451.7.

Offshore pipeline risers shall be visually inspected annually for physical damage and corrosion in the splash zone and above. Consideration should also be given to periodic visual inspection of the submerged zone of the riser. The extent of any observed damage shall be determined, and if the serviceability of the riser is affected, the riser shall be repaired or replaced.

Consideration should be given to the periodic use of internal or external inspection tools to monitor external and internal pipeline corrosion and to detect other unsafe conditions.

A452 PUMP STATION, TERMINAL, AND STORAGE FACILITIES OPERATION AND MAINTENANCE

A452.5 Fencing

Fencing is not applicable for offshore facilities.

A452.7 Prevention of Accidental Ignition

Smoking shall be prohibited in all areas of offshore facilities in which the possible leakage or presence of vapor constitutes a fire or explosion hazard.

A454 EMERGENCY PLAN

(d) The provisions of para. 454(d) do not apply to offshore pipeline systems.

(e)(5) The provisions of para. 454(e)(5) do not apply to offshore pipeline systems. To minimize public exposure to injury and to prevent accidental ignition, provisions for halting or diverting marine vessel traffic shall be included in the emergency plan.

A460 GENERAL

(a) In addition to the provisions of para. 460(a), special considerations shall be given to corrosion control of offshore pipeline systems because they cannot easily be inspected after installation and there is the possibility of damage to the coating system. Special attention shall be given to the selection, design, and application of corrosion control coatings, the cathodic protection system, and other corrosion design elements.

(c) NACE RP-06-75 provides a guide for procedures to implement requirements herein and to monitor and maintain cathodic protection systems for offshore pipeline systems.

A461 EXTERNAL CORROSION CONTROL FOR OFFSHORE SUBMERGED PIPELINES

A461.1 New Installations

A461.1.1 General

(c) In addition to the provisions of para. 461.1, a minimum clearance of 12 in. (300 mm) shall be maintained between the outside of any offshore pipeline and any other structure that may affect the cathodic protection of the offshore pipeline, except where impractical (e.g., bundled pipelines) and where adequate provisions for corrosion control have been made.

A461.1.2 Protective Coating

(f) In addition to the provisions of paras. 461.1.2 and 461.2.8, consideration should be given to insulating the carrier pipe from the casing pipe when the carrier pipe is pulled into pull-tube risers. Consideration should also be given to preventing oxygen replenishment in the water in the annulus between carrier pipe and casing by sealing at least one end of pull-tube risers or other measures to prevent corrosion.

A461.1.3 Cathodic Protection System

(a) In addition to the provisions of para. 461.1.3(a), where impressed current systems are used, the system shall be designed to minimize outages. The design formula for galvanic anode systems shall include the percentage of exposed pipe, current output of the anodes, design life of the system, anode material, and utilization efficiency. Anodes should be compatible with the operating temperature of the pipeline and the marine environment. Consideration should be given to the effects on cathodic protection of variations in oxygen content, temperature, and water/soil resistivity of the particular offshore environment in which the pipeline is installed.

For installations containing flexible pipe, consideration shall be given to the need for galvanic anodes or impressed current at the end connections. A cathodic protection system shall be installed at the time of pipeline installation or as soon as practical after pipeline installation. Owners of other offshore pipelines or facilities that may be affected by installation of a cathodic protection system shall be notified of said installation.

A461.1.4 Electrical Isolation

(a) In addition to the provisions of para. 461.1.4, consideration shall be given to electrically isolating supporting devices, such as clamps and pipe supports, from the riser on platforms. Wiring and piping connections to an electrically isolated pipeline shall also be insulated from devices grounded to the platform.

A461.1.5 Test Leads

(a) It is considered impractical to locate test leads on submerged portions of offshore pipeline systems. Consideration should be given to installing test leads on platform risers, platform piping, and pipeline shore crossings.

A461.1.6 Electrical Interference

(c) When new pipeline are laid in the vicinity of existing lines, measures shall be taken to minimize electrical interference.

A461.3 Monitoring

(b) Evidence of adequate level of cathodic protection shall be by one or more of the criteria listed in NACE RP-06-75.

(h) If repairs are made to offshore pipelines below water, inspection for evidence of external corrosion or coating deterioration shall be made; and necessary corrective action shall be taken to maintain the corrosion protection of the pipeline.

When an offshore pipeline is lifted above water for maintenance or repair purpose, the operating company shall visually inspect for evidence of coating deterioration, external corrosion, and where possible, the condition of any exposed anode. If excessive corrosion is present, remedial action shall be taken as necessary.

(i) Consideration should be given to the periodic use of internal inspection tools to monitor external pipeline corrosion.

A463 EXTERNAL CORROSION CONTROL FOR OFFSHORE PIPING SYSTEMS EXPOSED TO ATMOSPHERIC CONDITIONS

A463.1 New Installations

The option of demonstrating "by test, investigation, or experience in area of application that a corrosive atmosphere does not exist," does not apply to offshore pipeline systems. The type of protective coating selected shall be resistant to the environment existing in offshore

locations. The surface preparation and coating application shall be performed in accordance with established specifications and the manufacturer's recommendations. The selected coating should have the following characteristics:

(a) low water absorption
(b) resistance to water action
(c) compatibility with system operating temperature
(d) resistance to atmospheric deterioration
(e) resistance to mechanical damage
(f) ease of repair

The splash zone area of the offshore pipeline system shall be designed with additional protection against corrosion. This shall be accomplished by one or more of the following:

(g) special coating
(h) special protective systems and techniques
(i) other suitable measures, including selection of pipe material