

has on surface roughness characteristics of submerged structural members.

(8) Earthquake information including the following:

(i) The effects of earthquakes on platforms located in areas known to be seismically active shall be addressed.

(ii) Except for the provision of § 250.905(d)(5)(ii) of this part, the seismicity of the site shall be determined. Preferably, this shall be based on site-specific data. However, regional data shall be deemed acceptable for use when site-specific data are not available and the regional data are interpreted in a manner to produce the most adverse effect on a platform at the specific site. The following data shall be obtained:

(A) Recurrence interval of seismic events appropriate to the design life of the structure,

(B) Proximity to active faults,

(C) Type of faulting,

(D) Attenuation of ground motion between the faults and the site,

(E) Subsurface soil conditions, and

(F) Records from past seismic events at the site or from analogous sites.

(iii) The use of available data to describe the seismic characteristics of the site is permitted where it can be shown that such data are consistent with the requirements of paragraph (d)(8)(ii) of this section.

(iv) The seismic data shall be used to establish a quantitative design earthquake criterion describing the design earthquake-induced ground motion. In addition to ground motion and as applicable to the installation site, the following earthquake-related phenomena shall be taken into account:

(A) Liquefaction of subsurface soils,

(B) Submarine slides,

(C) Tsunamis, and

(D) Fluid motions in tanks.

[53 FR 10690, Apr. 1, 1988; 53 FR 26067, July 11, 1988. Redesignated and amended at 63 FR 29479, 29486, May 29, 1998]

§ 250.905 Loads.

(a) *Introduction.* This section covers the identification, definition, and determination of the loads to which a fixed offshore platform may be exposed during and after its transportation and installation. The requirements contained in paragraphs (b) through (d) of

this section apply to both steel-piled platforms and concrete-gravity platforms. Additional requirements covering steel-piled platforms are contained in paragraph (e) of this section. Additional requirements covering concrete-gravity platforms are contained in paragraph (f) of this section.

(b) *General.* (1) All types of loads specified in paragraphs (c)(1) through (c)(5) of this section shall be accounted for in the design and operation of the platform.

(2) Where applicable, the effects of increased dimensions and weight due to marine growth and snow and ice accumulation shall be addressed in the design.

(c) *Load definition.* (1) *Dead loads.* Dead loads associated with the platform are loads that do not change during the mode of operation under consideration. Dead loads include the following:

(i) Weight in the air of the platform (refer to paragraphs (e)(1) and (f)(1) of this section for itemizations of weight for pilefounded platforms and gravity platforms, respectively).

(ii) Weight of permanent ballast and the weight of permanent machinery including liquids at operating levels.

(iii) External hydrostatic pressure and buoyancy in calm sea conditions calculated on the basis of the design waterline.

(iv) Static earth pressure.

(2) *Live loads.* Live loads associated with the normal operation and use of the platform are loads that could change during the mode of operation considered. Live loads acting after fabrication or installation include the following:

(i) Weight of drilling and production equipment that can be removed such as derrick, draw works, mud pumps, mud tanks, separators, and tanks.

(ii) Weight of crew and consumable supplies such as mud, chemicals, water, fuel, pipe, cable, stores, drill stem, and casing.

(iii) Weight of liquids in storage tanks.

(iv) Forces exerted on the platform due to drilling, e.g., the maximum derrick reaction when placing or pulling casing.

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(v) The forces exerted on the platform during the operation of cranes and vehicles.

(vi) The forces exerted on the platform by vessels moored to the platform.

(vii) The forces exerted on the platform by helicopters during takeoff and landing or while parked on the platform. When applicable, the dynamic effects on the platform of the forces specified in paragraphs (c)(2) (iv) through (vii) of this section shall be taken into account. Live loads occurring during transportation and installation shall be determined for each specific operation involved, and the dynamic effects of such loads shall be addressed (see § 250.910 of this part).

(3) *Deformation loads.* Deformation loads are loads due to deformations imposed on the platform. For an itemization of deformation loads applicable to steel-piled platforms and concrete gravity platforms, see paragraphs (e)(2) and (f)(2) of this section, respectively.

(4) *Accidental loads.* Consideration shall be given to accidental loadings; and where such loadings are determined to be a factor, they shall be quantified and incorporated into the design. Accidental loads are loads that could occur as the result of an accident or exceptional conditions, such as the following:

(i) Extreme impact loads caused by supply boats, barges, and other craft anticipated to work in the vicinity of the platform;

(ii) Impact loads caused by dropped objects, such as drill collars, casing, blowout-preventer stacks;

(iii) Loss of internal pressure required to resist hydrostatic loading and to maintain buoyancy during the installation of the platform;

(iv) Explosion;

(v) Effects of fire; and

(vi) Iceberg collision.

(5) Environmental load information including the following:

(i) Environmental loads are loads due to wind, waves, current, ice, snow, earthquake, and other environmental phenomena.

(ii) The characteristic parameters defining an environmental load shall be appropriate to the installation site as

determined by the studies required by § 250.904 of this part. Operating environmental loads are loads derived from the parameters characterizing operating environmental conditions (see § 250.904(c)(3) of this part). Design environmental loads are loads derived from the parameters characterizing the design environmental condition (see § 250.904(c)(2) of this part).

(iii) Environmental loads shall be applied to the platform from directions producing the most unfavorable effects on the platform unless site-specific studies allow for a less stringent requirement.

(iv) The combination and severity of design environmental loads shall be consistent with the likelihood of their simultaneous occurrence. The simultaneous occurrence of environmental loads shall be modeled by appropriate superposition methods.

(v) Earthquake loads and loads resulting from accidental or rare environmental phenomena need not be combined with other environmental loads unless site-specific conditions indicate that such combination is appropriate.

(d) *Determination of environmental loads.* (1) Wave load information including the following:

(i) Wave-induced loads shall be calculated using defensible methods or shall be obtained from adequate model or field test data;

(ii) A sufficient range of waves and wavecrest positions relative to the platform shall be investigated to ensure an accurate determination of the maximum wave load on the platform;

(iii) Wave impact loads on structural members below the design wave crest elevation shall be accounted for by defensible theoretical methods or relevant model test of full-scale data;

(iv) Where applicable, the possibility of dynamic excitation of the platform due to flow-induced cyclic loading shall be addressed;

(v) For additional requirements pertaining to steel-piled platforms and concrete gravity-platforms, see paragraphs (e)(3) and (f)(3) of this section, respectively; and

(vi) Where applicable, additional hydrostatic loading effects shall be addressed.

(2) Wind load information including the following:

(i) Wind loads, local wind pressures, and wind profiles shall be determined on the basis of defensible analytical methods or wind tunnel tests on a representative model of the platform,

(ii) In determining design environmental loads on the overall platform, wind loads calculated on the basis of the design-sustained wind velocity shall be combined with other design environmental loads,

(iii) The design gust wind load shall be used in the design of local structure unless the effects of the load combination described in paragraph (d)(2)(ii) of this section are more severe,

(iv) Where appropriate, the dynamic effects due to the cyclic nature of gust wind and cyclic loads due to vortex shedding shall be taken into account. Both the drag and lift components of loads due to vortex shedding shall be taken into account.

(v) Where appropriate, flutter and load amplification due to vortex shedding shall be addressed.

(3) Current load information including the following:

(i) Current-induced loads on immersed members of the platform shall be accounted for by defensible methods or the results of model test or site-specific data,

(ii) The lift and drag coefficients used in the determination of current loads shall be appropriate to the current velocity and structural configuration,

(iii) Current velocity profiles used in design shall be appropriate to the installation site,

(iv) For determination of loads induced by the simultaneous occurrence of wave and current fields, the total velocity field shall be computed by defensible methods before computing the total force, and

(v) Where appropriate, flutter and load amplification due to vortex shedding shall be addressed.

(4) Ice and snow load information including the following:

(i) For platforms located in areas associated with ice movement, contact loads caused by floating ice shall be determined according to defensible theoretical methods, model test data, or full-scale measurements;

(ii) In locations where platforms are subject to ice and snow accumulation, the additional weight of snow and ice on the platform shall be addressed;

(iii) The effects of ice accumulation and ice jam, including the effects of changes in configuration due to adhesion, shall be accounted for in the determination of the total environmental load; and

(iv) The incident pressure due to pack ice, pressure ridges, and where appropriate, ice island fragments impinging on the platform shall be addressed.

(5) Earthquake load information including the following:

(i) For platforms located in seismically active areas, design earthquake-induced ground motions shall be determined on the basis of seismic data applicable to the installation site. Design earthquake ground motions shall be described by either applicable ground motion records or response spectra consistent with the recurrence period appropriate to the design life of the platform.

(ii) Available and defensible standardized spectra applicable to the region of the installation site are acceptable if such spectra reflect those site-specific conditions affecting frequency content and energy distribution. These conditions include the type of active faults in the region, the proximity of the site to the potential source faults, the attenuation or amplification of ground motion between the faults and the site, and the soil conditions at the site.

(iii) Ground-motion descriptions shall consist of three components corresponding to two orthogonal horizontal directions and the vertical direction. All three components shall be applied to the platform simultaneously.

(iv)(A) When the response spectrum method is used for structural analysis, input values of ground motion (spectral acceleration representation) shall not be less severe than the following:

(1) One hundred percent in a principal horizontal direction,

(2) Sixty-seven percent in the orthogonal horizontal direction, and

(3) Fifty percent in the vertical direction.

(B) The horizontal components shall also be applied in the alternative orthogonal horizontal directions.

(v) If the time history method is used for structural analysis, at least three sets of ground-motion time histories shall be employed. The manner in which the time histories are used shall account for the potential sensitivity of the platform's response to variations in the phasing of the ground-motion records.

(vi) When applicable, effects of soil liquefaction and/or loads resulting from submarine slides or creep, tsunamis, and earthquake motions shall be addressed.

(e) *Loads on steel pile-supported platforms.* The following requirements apply to loads on steel pile-supported platforms and shall be applied together with the requirements in paragraphs (b), (c), and (d) of this section:

(1) The dead load of the platform shall include, as appropriate, the weight in air of the jacket, piling, grout, superstructure modules, stiffeners, decking, piping, heliport, and any other fixed structural part less buoyancy, with due allowance for flooding.

(2) Where appropriate, the deformation loads to be accounted for are those resulting from temperature variations leading to thermal stresses in the platform, and those resulting from soil displacements (e.g., differential settlements or lateral displacements).

(3) Wave load information including the following:

(i) For platforms composed of members having diameters that are negligible in relation to the wave lengths considered, semiempirical formulations accounting for wave-induced drag and inertia forces based on the water particle velocities and accelerations on an undisturbed, incident flow field are acceptable;

(ii) When a method as described in paragraph (e)(3)(i) of this section is used, the wave field shall be described by a defensible wave theory appropriate to the wave heights, wave periods, and water depth at the installation site;

(iii) The coefficients of drag and inertia used in calculating wave loads shall be determined on the basis of model

test results, published data, or full-scale measurements appropriate to the structural configuration, surface roughness, and wave field; and

(iv) For platforms composed of members whose diameters are not negligible in relation to the wave lengths considered and for structural configurations that will substantially alter the undisturbed, incident flow field, diffraction forces and the hydrodynamic interaction of structural members shall be taken into account.

(f) *Loads on concrete-gravity platforms.* The following requirements apply to loads on concrete-gravity platforms and shall be applied together with the requirements described in paragraphs (b), (c), and (d) of this section.

(1) The dead load of the platform shall include, as appropriate, the weight in air of the foundation, skirts, columns, superstructure modules, decking, piping, heliport, and any other fixed structural part less buoyancy with due allowance for flooding. Weight calculations based on nominal dimensions and mean values of density are acceptable.

(2) The deformation loads to be accounted for are those due to prestress, shrinkage and expansion, creep, temperature variations, and differential settlements.

(3) Wave load information including the following:

(i) For platforms composed of large gravity bases and one or more columns whose diameters are not negligible in relation to the wave lengths considered, defensible wave-load theories which account for the drag, inertia, and diffraction forces on the platform shall be employed;

(ii) For complex structural configurations, the hydrodynamic interaction of large, immersed structural members shall be addressed;

(iii) When diffraction forces and hydrodynamic interaction are negligible, only semiempirical formulations comparable to those mentioned in paragraphs (e)(3) (i) and (iii) of this section accounting for drag and inertia forces are acceptable; and

(iv) The undisturbed, incident flow field shall be addressed by a defensible wave theory appropriate to the wave

heights, wave periods, and water depth at the installation site.

[53 FR 10690, Apr. 1, 1988; 53 FR 26067, July 11, 1988. Redesignated and amended at 63 FR 29479, 29486, May 29, 1998]

§ 250.906 General design requirements.

(a) *General.* This section specifies the general concepts and methods of analysis to be incorporated in the design of a platform.

(b) *Analytical approaches.* (1) Structural response information including the following:

(i) Methods of analysis employed in association with the specifications of these requirements shall treat geometric and material nonlinearities in a defensible manner. When nonlinear methods of analysis are used to assess collapse mechanisms, it shall be demonstrated that the platform has sufficient ductility to develop the required resistance or structural displacements.

(ii) Where theoretically based analytical procedures covering the platform or parts thereof are unavailable or not well defined, model studies shall be utilized. The acceptability of model studies depends on the procedures employed, including enumeration of the possible sources of errors, the limits of applicability of the model test results, and the methods of extrapolation to full-scale data.

(2) Loading format information including the following:

(i) Either a deterministic or spectral format shall be employed to describe various load components. When a static approach is used, it shall be demonstrated, where appropriate, that the general effects of dynamic amplification were addressed. The influence of waves other than the highest waves shall be investigated for their potential to produce maximum peak stresses resulting from possible resonance with the platform.

(ii) When considering the design earthquake as discussed in §250.905 of this part, a dynamic analysis shall be performed. A dynamic analysis shall also be performed to assess the effects of environmental or other types of loads if significant dynamic amplification is expected.

(iii) For fatigue analysis, the long-term distribution of the stress range,

with proper consideration of dynamic effects, shall be obtained for relevant loadings anticipated during the design life of the platform (see §§250.907(c)(6) and 250.908(c)(6) of this part).

(3) Combinations of loading components information including the following:

(i) Loads imposed during and after installation shall be taken into account. Of the various loads described in §250.905, of this part, those loads to be considered for design shall be combined in a manner consistent with their probability of simultaneous occurrence. However, earthquake loadings shall be applied without consideration of other environmental effects unless conditions at the site necessitate their inclusion. The direction of applied environmental loads shall be that producing the highest possible influences on the platform, considering the platform's orientation and location with respect to bottom topography, direction of fetch, and nearby land masses.

(ii) While it is required to obtain and use those loading components which produce realistic maximum effects on the platform, loading combinations corresponding to conditions after installation shall reflect both operating and design environmental loadings. Sections 250.907, 250.908, and 250.909 of this part give the minimum load combinations to be considered.

(iii) The operating environmental conditions and the maximum tolerable environmental loads during installation shall be specified.

(c) *Overall design considerations.* (1) *Design life.* The design service life of the platform shall be specified as prescribed in §250.904(c)(2)(iv) of this part.

(2) *Air gap.* An air gap of 5 feet shall be provided between the maximum crest elevation of the design wave (including tidal effects) and the lowest portion of the platform upon which wave forces have not been included in the design. After accounting for the initial and long-term settlements resulting from consolidation and subsidence, the elevation of the crest of the design wave shall be based on the elevation of the mean low-water line, astronomical and storm tides, wave runup, the tilting of the platform, and where necessary, tsunamis.