freezing until the process of hardening is well in progress;

(iii) In hot weather, the temperature of the fresh concrete shall be controlled so that it does not impair attainment of the desired strength and durability;

(iv) The methods for curing concrete shall ensure maximum compressive and tensile strength, durability, and a minimum of cracking; and

(v) The location and workmanship of construction joints shall not impair the strength, crack resistance, and watertightness of the platform.

(3) *Reinforcement.* (i) Reinforcement shall be free from loose rust, grease, oil, deposits of salt, or any other material that may adversely affect the strength, durability, or bond of the reinforcement. The specified cover of reinforcement shall be maintained accurately. The cutting, bending, and fixing of reinforcement shall ensure that it is correctly positioned and rigidly held.

(ii) The welding of reinforcement shall conform to the requirements of AWS publication, AWS D1.4, Structural Welding Code— Reinforcing Steel.

(4) *Prestressing tendons, ducts, and grouting.* (i) Steps shall be taken to ensure that the achieved prestressing force is that specified in the design.

(ii) Tendons and ducts shall be in a condition that ensures the required strength, durability, and bond.

(iii) The grouting procedures shall produce the required bond strength of the tendons and provide permanent corrosion protection for the tendons. Anchorages shall also be protected adequately against corrosion.

[53 FR 10690, Apr. 1, 1988, as amended at 61 FR 60025, Nov. 26, 1996. Redesignated and amended at 63 FR 29479, 29486, May 29, 1998; 65 FR 15864, Mar. 24, 2000]

§ 250.909 Foundation.

(a) *General*—(1) *Coverage.* Soil investigations, design considerations for the supporting soil, and the influence of the soil on the foundation structure are addressed in this section, including criteria for the strength and deformation characteristics of the foundation employed by both pile founded and gravity platforms.

(2) *Guidelines.* (i) The degree of design conservatism shall reflect prior experience under similar conditions, the manner and extent of data collection, the scatter of design data, and the consequences of failure;

(ii) For cases where the limits of applicability of any method of calculation employed are not well defined or where the soil characteristics are quite variable, the use of more than one method of calculation or a parametric study of the sensitivity of the important design variables shall be considered, and

(iii) A listing of design parameters, necessary calculations, and test results shall be retained by the designer.

(b) *Site investigation*—(1) *General.* (i) The actual extent, depth, and degree of precision to be obtained in the site investigation program shall reflect the type and intended use of the platform, characteristics of the site, similarity of the area based on previous site studies or platform installations as well as the consequences of a failure of the foundation. The site investigation program shall generally consist of three major phases as follows:

(A) Shallow hazards (see paragraph (b)(2) of this section) to obtain relevant geophysical data.

(B) Geological survey (see paragraph (b)(3) of this section) to obtain data of a regional nature concerning the site.

(C) Subsurface investigation and testing (see paragraph (b)(4) of this section) to obtain the necessary geotechnical data. The results of these investigations shall be the basis for the additional site related studies specified in paragraph (b)(5) of this section.

(ii) A complete site-investigation program shall be furnished for each platform. The positioning devices used on the vessel employed in the site investigation as well as those used during the installation of the platform shall have sufficient accuracy to ensure that the data obtained are pertinent to the actual final location of the platform.

(2) *Shallow hazard survey.* (i) Consistent with the objectives of paragraph (b)(1)(i) of this section, a high-resolution or acoustic-profiling survey shall be performed to obtain information on the conditions existing at and near the surface of the seafloor; and

(ii) The information to be obtained from this survey shall include the following items, as appropriate, for the planned platform:

(A) Contours of the sea bed,

(B) Presence of any seafloor surface or near-surface anomaly or obstructions which would adversely affect platform installation at the site,

(C) Shallow faults,

(D) Gas seeps,

(E) Slump blocks,

(F) Occurrence of shallow gas, and

(G) Ice scour of seafloor sediments.

(3) *Geological survey*. (i) Background geological data shall be obtained to provide regional information that can affect the design and siting of the platform. The data shall be considered in planning the subsurface investigation.

(ii) Where necessary, the seismic activity at the site shall be assessed. Fault zones, the extent and geometry of faulting, and attenuation effects of conditions in the vicinity of the site shall be identified.

(iii) For platforms located in a producing area, the possibility of seafloor subsidence shall be considered.

(4) *Subsurface investigation and testing.* (i) The primary objective of the subsurface investigation and testing program shall be the attainment of reliable geotechnical data concerning the stratigraphic and engineering properties of the soil. These data shall be used to properly design the foundation to the desired structural safety level.

(ii) The subsurface investigation and soil testing program shall consist of adequate in situ testing, boring, and sampling to examine all important soil and rock strata. The testing program shall reveal the necessary strength, classification, and deformation properties of the soil. Further tests, as needed, shall describe the dynamic characteristics of the soil.

(iii) At least one borehole having a minimum depth of the anticipated length of the pile plus a zone of influence shall be drilled at the installation site for a pile-supported platform. Previously gathered borehole data may be used on a case-by-case basis, when approved by the Regional Supervisor. The zone of influence shall be sufficient to ensure that punch through failures will not occur. Additional boreholes of a lesser depth shall be required by the Regional Supervisor if discontinuities in the soil are indicated to exist in the area of the platform.

(iv) For a gravity-type platform foundation, the required depth of the borehole shall be equal to at least the depth of the zone of influence which the structure imposes on the supporting soil. Where possible, in situ tests shall be performed to a depth that will include the anticipated shearing failure zone.

(v) When samples from the field are sent to a laboratory for further testing, they shall be packed carefully and accurately labeled, and the results of visual inspections shall be recorded.

(vi) A summary report showing the results of the soil testing program shall be prepared. The report shall describe briefly the various field and laboratory test methods employed and shall indicate the applicability of these methods as they relate to the quality of the sample, the type of soil, and the anticipated design application.

(vii) The engineering properties of the soil to be used in the design shall be listed for each stratum. The selected design properties shall specify the uncertainties inherent in the overall testing program and in the reliability and applicability of the individual test methods.

(5) *Additional requirements.* Based on the results of the overall site investigation program, studies shall be performed, as applicable, to assess the following effects of the installed platform:

(i) Scouring potential of the seafloor,

(ii) Hydraulic instability and the occurrence of sand waves,

(iii) Instability of slopes in the area where the platform is to be placed,

(iv) Liquefaction and/or possible reduction of soil strength due to increased pore pressures, and

(v) Degradation of subsea permafrost layers.

(c) *Foundation design requirements*—(1) *General.* (i) The loadings used in the design of the foundation shall include those defined in paragraph (c)(6)(ii) of this section.

(ii) Foundation displacements shall be evaluated to ensure that they are

within limits that do not impair the intended function and safety of the platform.

(iii) The soil and the platform shall be considered as an interactive system, and the results of the analysis as required in paragraphs (c)(2) through (c)(6) of this section shall be evaluated from this point of view.

(2) *Cyclic loading effects.* Evaluation of the short-term and long-term effects of cyclic loading with respect to changes in soil characteristics, whether caused by conditions during installation, seismic activity, or storms, shall be accomplished by using defensible methods.

(3) *Scour.* (i) For unprotected foundations, the depth and lateral extent of scouring, as determined in the site investigation program, shall be accounted for in design; and

(ii) If scour is not accounted for in design, either effective protection shall be furnished soon after the installation of the platform or frequent visual inspection shall be carried out, particularly after major storms.

(4) *Settlements and displacements.* (i) Based on the type and function of the platform, tolerable limits shall be established for settlements and lateral deflections. Due consideration shall be given to the effect of these movements on risers, pilings, and other components which interact with the platform;

(ii) Maximum allowable values of platform movements, as limited by these structural considerations or overall platform stability, shall be considered in the design.

(5) *Dynamic considerations.* (i) For dynamic-loading conditions, a defensible method shall be employed to simulate the interactive effects between the soil and the platform, and

(ii) The evaluation of the dynamic response of the platform shall account for, as appropriate, the nonlinear and inelastic characteristics of the soil, the possible deterioration of strength, the increased or decreased damping due to cyclic soil loading, and the influence of nearby platforms.

(6) *Loading conditions.* (i) Loadings producing the worst effects on the foundation during and after installation shall be addressed; and

(ii) In-place platform loadings to be checked shall include at least those relating to both the operating and design environmental conditions, combined in accordance with the following:

(A) Operating environmental conditions with dead and live loads appropriate to the function and operation of the platform,

(B) Design environmental conditions with dead and live loads appropriate to the function and operation of the platform, and

(C) Design environmental conditions with dead and minimum live loads appropriate to the function and operation of the platform.

(d) *Pile foundations*—(1) *General.* The following requirements apply to pile-founded platforms. Pertinent parts of these requirements dealing with steel design shall be consulted regarding the design of the steel piles.

(i) In the design of individual piles and piles in a group, the effects of axial, bending, and lateral loads shall be addressed.

(ii) The design of a pile shall reflect the interactive behavior between the soil and the pile, between the pile and the platform, and between piles in a group.

(iii) Methods of pile installation shall be consistent with the type of soil at the site and the installation equipment available. If unexpectedly high-driving resistance or other conditions lead to a failure of the pile to reach the desired penetration, the pile's capacities shall be reevaluated by considering the actual installation situation.

(iv) Pile driving shall be performed and supervised by qualified and experienced personnel. Driving records which include such information as blowcounts and estimated hammer performance and stoppages shall be retained.

(v) Where necessary, the effects of bottom instability in the vicinity of the platform shall be assessed.

(2) *Axial piles.* (i) For piles in compression, the axial capacity shall be considered to consist of the skin friction, Q_f, developed along the length of the pile and the end bearing, Q_p, at the tip of the pile. The various parameters needed to evaluate Q_f and Q_p shall be

predicted by using a defensible analytical method that employs reliably obtained soil data consistent with the prediction method selected. The acceptability of any method used to predict the components of pile resistance shall be demonstrated by showing satisfactory performance of the method under conditions similar to those existing at the actual site.

(ii) The results of the dynamic pile driving analysis alone shall not be used to predict the axial load capacity of a pile.

(iii) For piles driven through clay, the estimated skin friction developed over any increment of the pile surface shall not exceed the shear strength of the clay.

(iv) The capacity of the internal plug of an open-ended pile shall be considered since it may limit the estimated end bearing to the pile.

(v) When combining side friction and end-bearing effects in determining axial pile capacity, the load deflection response of the soil-pile system shall be addressed.

(vi) For piles subjected to pullout loads, the contribution of the end resistance of the pile to its axial capacity shall not be considered. The possible variation of predicted pile-skin friction between the compressive and tensile modes of the axial-pile loading shall be considered.

(3) *Laterally loaded piles.* (i) In evaluating the pile's behavior when acted upon by lateral loadings, the combined load deflection characteristics of the soil and the pile and the pile and the platform shall be addressed.

(ii) The representation of the soil's lateral displacement when it is subjected to lateral loads shall adequately reflect the deterioration of the lateral load capacity when the soil is subjected to cyclic loading.

(iii) The description of the lateral load versus displacement characteristics for the various soil strata shall be based on constitutive data obtained from suitable soil tests. The use of empirical methods to provide the description of the soil's lateral response shall be permitted if such methods are documented.

(iv) Where applicable, the rapidly deteriorating cyclic lateral load capacity of stiff clays, especially those exhibiting the presence of a secondary structure, shall be addressed in the design.

(v) Calculation of pile deflection and stress induced by lateral loads shall account for the nonlinear interaction between the soil and the pile.

(4) *Pile groups.* Where applicable, the effects of close spacing on the load and deflection characteristics of pile groups shall be determined. The allowable load for a group, both axial and lateral, shall not exceed the sum of the apparent individual pile allowable loads.

(5) *Plastic analysis.* When the design of a platform is based on the formation collapse mechanisms associated with a plastic analysis method, influence of the soil's support on the pile shall be addressed.

(e) *Gravity platforms foundations*—(1) *General.* The following requirements apply to soil foundations for gravity platforms. Section 250.138 of this part shall be consulted regarding the design of the base slab.

(i) The influence of hydraulic and slope instability, if any, shall be determined for the structural loading cases that include the design environmental loading.

(ii) The effects of adjacent platforms and the variation of soil properties in the horizontal direction shall be considered, as appropriate.

(iii) The stability of the foundation with regard to bearing and sliding failure modes shall be investigated by employing the soil shear strengths determined with consideration of paragraphs (b)(4) and (c)(2) of this section.

(iv) When an underpressure or overpressure is experienced by the seafloor under the platform, provisions shall be made to prevent piping that could impair the integrity of the foundation.

(v) Initial, consolidation, and secondary settlements, as well as permanent horizontal displacements, shall be determined.

(vi) If the intended site is not level, the predicted tilt of the overall platform shall be based on the average bottom slope of the seafloor and the tolerance of the measuring device used in the site-investigation program. Differential settlement shall also be calculated and the tilting of the platform

caused by this settlement shall be combined with the predicted structural tilt of the overall platform. Any increased loading effects caused by tilting of the platform shall be addressed in stability requirements specified for the foundation.

(2) *Stability.* (i) The bearing capacity and lateral resistance shall be calculated by considering the most unfavorable combination of loads. The long-term redistribution of bearing pressures under the base slab shall be considered to ensure that the maximum edge pressures are used in the design of the base.

(ii) The lateral resistance of the platform shall be investigated considering various potential shearing planes. The presence of any soft layers shall require special consideration.

(iii) Calculations for overturning moment and vertical forces induced by the passage of a wave shall include the vertical pressure distribution across the top of the foundation and along the seafloor. The foundation shall not lose contact with the soil due to uplift created by the maximum overturning moment.

(iv) The capacity of the foundation to resist a deep-seated bearing failure shall be analyzed.

(v) Where present, the additional effects of penetrating walls or skirts that transfer vertical and lateral loads to the soil shall be investigated for their contribution to bearing load capacity and lateral resistance.

(3) *Soil reaction on the platform.* (i) For conditions during and after installation, the reaction of the soil against all structural members seated on or penetrating into the seafloor shall be determined and accounted for in the design of these members.

(ii) The distribution of soil reactions shall be based on the results obtained in paragraphs (b)(2) and (b)(4) of this section, and the calculations of soil reactions shall account for any deviation from a plane surface, the load-deflection characteristics of the soil, and the geometry of the platform base.

(iii) Where applicable, effects of local soil stiffening, nonhomogeneous soil properties, and boulders and other obstructions shall be addressed in the design. During installation, the possibility of local contact pressures due to irregular contact between the base and the seafloor shall be considered. Contact pressures shall be added to the hydrostatic pressure.

(iv) The penetration resistance of structural elements projecting into the seafloor below the foundation structure shall be analyzed. The design of the ballasting system shall reflect uncertainties associated with achieving the required penetration of the platform.

§ 250.910 Marine operations.

(a) *General*—(1) Marine operations means all activities necessary for the transportation and installation of a platform from the time it enters the marine environment until it is fixed in place at its final destination. Marine operations generally include such activities as follows:

(i) Lifting and mooring,

(ii) Loadout or initial flotation,

(iii) Fabrication afloat,

(iv) Towing,

(v) Launching and uprighting,

(vi) Submergence,

(vii) Pile installation, and

(viii) Final field erection.

(2) The requirements of this section apply to all platforms covered by this subpart, regardless of structural type or material of construction.

(b) *Objective.* The structural strength and integrity of a platform shall not be reduced or otherwise jeopardized by the performance of the activities required to install the platform on site. The type and magnitude of loads and load combinations to which a platform will be exposed during marine operations shall be the subject of an analysis pursuant to paragraph (c) of this section, except where the use of proven and well-controlled methods of fabrication and installation are proposed and justified. Sufficient equipment shall be provided to ensure installation of the platform in a safe and well-controlled manner.

(c) *Analysis.* (1) Analyses shall be performed to determine the type and magnitude of the loads and load combinations to which the platform will be exposed during the performance of marine operations.