API 4F – WORKGROUP ITEM 6102 – IMPLEMENTATION OF AISC-360-16 ALLOWABLE STRENGTH DESIGN EDITORIAL REVIEW – March 25, 2019

Please note this is an editorial review of the proposed API 4F changes excluding P-Delta analysis (to come at a later date). The intention is to ensure all parties agree in principle on the terminology used to upgrade API 4F to the AISC 15th Edition.

Current Wording:

8 Design Specification

8.1 Allowable Stresses

8.1.1 General

The steel structures shall be designed in accordance with AISC 335-89, except as further specified in this standard. The portion of AISC 335-89, *Allowable Stress Design*, commonly referred to as *Elastic Design*, shall be used in determining allowable unit stresses. Use of Part 5, Chapter N—*Plastic Design*, is not allowed. AISC 335-89 shall be used for determination of allowable unit stresses, except that current practice and experience do not dictate the need to follow AISC 335-89 for "members and their connections subject to fatigue loading" (Section K4) unless specified by the purchaser and for the consideration of secondary stresses.

For the purposes of this standard, stresses in the individual members of a latticed or trussed structure resulting from elastic deformations and rigidity of joints are defined as secondary stresses. These secondary stresses may be taken to be the differences between stresses from an analysis assuming fully rigid joints, with loads applied only at the joints, and those stresses from a similar analysis with pinned joints. Stresses arising from eccentric joint connection, or from transverse loading of members between joints, or from applied moments, shall be considered primary stresses.

Allowable unit stresses may be increased by 20 % when secondary stresses are computed and added to the primary stresses in individual members, for all loadings except earthquake. However, primary stresses shall not exceed the allowable unit stress. The increase in allowable stresses when secondary stresses are considered may be taken in addition to the increases allowed in 8.1.2.

Earthquake loading and the related allowable stresses are addressed specifically in 8.5. Ice Loading and related allowable stresses are addressed specifically in 8.6.

Proposed Wording:

8 Design Specification

8.1 Allowable Strength

8.1.1 General

The steel structures shall be designed in accordance with AISC 360-16, Allowable Strength Design, except as further specified in this standard. The portion of AISC 360-16 *Allowable Strength Design (ASD)* shall be used in determining allowable member strength. Use of Load Factor and Resistance Design (LFRD) is not allowed. AISC 360-16 shall be used for determination of allowable member strength, except that current practice and experience do not dictate the need to follow AISC 360-16 for "members and their connections subject to fatigue loading" (Section B3.11) unless specified by the purchaser and for the consideration of secondary loads.

Note: Derricks, Masts and Substructures for drilling rigs fall outside the defined scope of the AISC 360-16 Specification. AISC recognizes this and recommends that the use of the AISC Specification outside of the defined scope be used with engineering judgement as it relates to the specific industry.

For the purposes of this standard, axial loads, tension or compression, are defined as primary loads in individual members of a latticed or trussed structure. Moments in the individual members of a latticed or trussed structure resulting from elastic deformations and rigidity of joints are defined as secondary loads. These secondary loads may be taken to be the differences between loads from an analysis assuming fully rigid joints, with loads applied only at the joints, and those loads from a similar analysis with pinned joints.

Loading arising from eccentric joint connection, or from transverse loading of members between joints, or from applied moments, shall be considered primary loads.

When axial loads are the intended primary loads, allowable member strength may be increased by 10%. This shall apply to members that have a plastic section modulus/elastic section modulus (Z/S) ratio of 1.2 or less, when secondary loads are computed and added to the primary loads in individual members, for all loadings except earthquake. The 10% increase in allowable member strength shall not be used when the Z/S ratio exceeds 1.2. The Z/S ratio is taken about either the major or minor member axis for the direction of the applied moment. Required strength due to primary loads shall not exceed the maximum allowable member strength. The increase in allowable member strength when secondary loads are considered may be taken in addition to the increases allowed in 8.1.2.

The allowable member strength is defined in AISC 360-16 as the nominal strength (R_n) of the member divided by a safety factor (Ω). Allowable Strength = R_n / Ω. AISC 360-16, Chapters D through K give further definition of the nominal strength and safety factor for the applicable limit states.

Earthquake loading and the related allowable strength are addressed specifically in 8.5. Ice Loading and related allowable strength are addressed specifically in 8.6.

Current Wording:

8.1.2 Wind and Dynamic Stresses

For operating and erection conditions, allowable unit stresses shall not be increased (stress modifier = 1.0) over the basic allowable stresses defined in 8.1.1. For transportation conditions, allowable unit stresses may be increased one-third (stress modifier = 1.33) over the basic allowable stresses defined in 8.1.1, if specified by the purchaser.

For the unexpected and expected design storm conditions, allowable unit stresses may be increased one- third (stress modifier = 1.33) over basic allowable stresses defined in 8.1.1 when produced by wind or dynamic loading acting alone or in combination with design dead and live loads.

For purposes of defining the nameplate graph of allowable static hook load versus wind velocity required by 5.2 n) or 5.3 o), a linear transition from a stress modifier of 1.0 for operating cases to 1.33 for the unexpected storm case may be used.

Proposed Wording:

8.1.2 Wind and Dynamic Stresses

For operating and erection conditions, allowable member strength shall not be increased (strength modifier = 1.0) over the basic allowable member strength defined in 8.1.1.

For transportation conditions, allowable member strength may be increased one-third (strength modifier = 1.33) over the basic allowable member strength defined in 8.1.1.

For the unexpected and expected design storm conditions, allowable member strength may be increased one-third (strength modifier = 1.33) over basic allowable member strength defined in 8.1.1.

For purposes of defining the nameplate graph of allowable static hook load versus wind velocity required by 5.2 n) or 5.3 o), a linear transition from a strength modifier of 1.0 for operating cases to 1.33 for the unexpected storm case may be used.

Current Wording:

8.1.4 Crown Shafting

Crown shafts, including fastline and deadline sheave support shafts, shall be designed to AISC 335-89 (see 8.1.1) except that the factor of safety in bending shall be a minimum of 1.67 to yield. Wire rope sheaves and bearings shall be specified in accordance with API 8C.

Proposed Wording:

8.1.4 Crown Shafting

Crown shafts, including fastline and deadline sheave support shafts, shall be designed using an allowable stress method with a maximum allowed bending stress.

Maximum allowed bending stress = $0.60\ F_y\ S_x$.

Where:
F_y = Specified Minimum Yield Strength of shaft material, psi
S_x = Elastic Section Modulus taken about the x-axis, in^3

Wire rope sheaves and bearings shall be specified in accordance with API 8C.

Current Wording:

8.1.5 Hydraulic Cylinders for Mast and Substructure Erection

Hydraulic cylinders for mast and substructure erection shall be designed to have factor of safety to combined buckling and bending per AISC for the expected raising loads over the entire raising envelope. This analysis should account for cylinder mounting conditions and initial imperfections due to cylinder bearing tolerances.

Proposed Wording:

8.1.5 Hydraulic Cylinders for Mast and Substructure Erection

Hydraulic cylinders for mast and substructure erection shall be designed to have adequate factor of safety to combined buckling and bending per a recognized design code for the expected raising loads over the entire raising envelope. This analysis should account for cylinder mounting conditions and initial imperfections due to cylinder bearing tolerances.

<u>Current Wording:</u>

8.5 Earthquake Loads

Earthquake consideration is a special loading condition to be addressed if specified by the user. The user is responsible for furnishing the design criteria, which include design loading, the design analysis method, and allowable response.

The design criteria for land-based units may be in accordance with local building codes, using equivalent static design methods.

For a unit based on an offshore platform, the design method for earthquake loading shall follow the strength level analysis guidelines outlined in API 2A-WSD. The drilling and well servicing units shall be designed to resist the movement of the deck on which they are founded, i.e. the response of the deck to the ground motion prescribed for the design of the offshore platform. The allowable stresses for the combined earthquake, gravity and operational loading may be increased one-third (stress modifier = 1.33) over basic allowable stresses defined in 8.1.1. The computed stresses should include both the primary and the secondary stress components.

Proposed Wording:

8.5 Earthquake Loads

Earthquake consideration is a special loading condition to be addressed if specified by the user. The user is responsible for furnishing the design criteria, which include design loading, the design analysis method, and allowable response.

The design criteria for land-based units may be in accordance with local building codes, using equivalent static design methods.

For a unit based on an offshore platform, the design method for earthquake loading shall follow the strength level analysis guidelines outlined in API 2A-WSD. The drilling and well servicing units shall be designed to resist the movement of the deck on which they are founded, i.e. the response of the deck to the ground motion prescribed for the design of the offshore platform. The allowable member strength for the combined earthquake, gravity and operational loading may be increased one-third (strength modifier = 1.33) over basic allowable member strength defined in 8.1.1. The computed member strength should include both the primary and the secondary load components.

<u>Current Wording:</u>

8.6 Ice Loads

Ice loading is a special loading condition to be addressed if specified by the user. The user is responsible for furnishing the design criteria, which include design loading and load combinations and allowable stress modifier.

Proposed Wording:

8.6 Ice Loads

Ice loading is a special loading condition to be addressed if specified by the user. The user is responsible for furnishing the design criteria, which include design loading and load combinations and allowable strength modifier.

Current Wording:

8.9 Overturning and Sliding

The maximum allowable static coefficient of friction to be used in overturning or inadvertent rig sliding calculations of drilling structures supported by soil, concrete, or wood matting foundations shall be limited to 0.15, and to 0.12 for those supported by steel foundations, except as follows: alternative values for the maximum design coefficient of friction may be used provided such values have been validated thru testing and are consistent with rig operating procedures (e.g. an offshore skiddable rig design incorporating a coefficient of friction consistent with ungreased surfaces would require that the owner/operator maintain and inspect the beams to ensure that they are not inadvertently greased).

For all stability and sliding calculations, dead weights providing resistance to overturning or sliding shall be limited to a maximum of 90 % of their expected minimum weight. The calculation of minimum weight shall assume the removal of all optional structures and equipment, and fluid tanks shall be considered empty, unless otherwise specified in the rig instructions for storm preparations or rig erection. For drilling structures subject to vertical heave, the stabilizing weights shall be further reduced by the magnitude of the negative heave acceleration.

Freestanding structures on land shall have a minimum factor-of-safety against overturning of 1.25, calculated as the ratio of the minimum stabilizing moment of the dead weight of the structure, taken about a tipping line, divided by the overturning moment of the sum of any overhanging vertical live loads plus environmental loads, including wind or earthquake, taken about the same tipping line or axis. The designer shall consider suitable tipping lines so as to determine the minimum factor of safety and shall consider the possibility of overturning loads from any possible direction of application. Determination of the location of a tipping line shall be such that the tipping line shall lie along the centroid of the nominal vertical ground support reactions for the case considered; the distribution of ground support reactions shall be limited to comply with design allowable ground bearing pressures for the structures under consideration. The manufacturer shall include foundation loading diagrams and the required safe ground bearing pressure allowables for erection and operating conditions in the rig manual. Freestanding land drilling structures shall have a minimum factor of safety against inadvertent sliding of 1.25, calculated as the ratio of the minimum sliding resistance at the design maximum allowable static coefficient of friction, divided by the total applied shear loads due to environmental loads.

Freestanding offshore drilling structures shall have a minimum factor-of-safety against overturning of 1.50, calculated as the ratio of the minimum stabilizing moment of the dead weight of the structure, taken about a tipping line, divided by the overturning moment of the sum of any overhanging vertical live loads plus environmental loads, including wind, earthquake, or dynamic loads due to vessel motion, taken about the same tipping line or axis. The designer shall consider suitable tipping lines so as to determine the minimum factor of safety and shall consider the possibility of overturning loads from any possible direction of application. Determination of the location of a tipping line shall be such that the tipping line shall lie along the centroid of the nominal foundation support reactions for the case considered. The distribution of foundation support reactions shall be limited to comply with allowable design loadings of the supporting structures foundations, if so specified by the purchaser. The manufacturer shall include diagrams defining the maximum foundation support loads based on the factored lateral loads with the rig instructions. Freestanding offshore drilling structures shall have a minimum factor of safety against inadvertent sliding of 1.5, calculated as the ratio of the minimum sliding resistance at the design maximum allowable static coefficient of friction, divided by the total applied shear loads due to environmental loads.

Structures unable to meet the requirements for freestanding structures shall incorporate suitable devices to prevent such movements to include the following.

a) Such components, when used on skiddable drilling structures shall be termed tie-down clamps and shall be rated to resist overturning and sliding loads in all load combinations calculated using overhanging vertical live loads, design lateral wind, seismic and dynamic forces due to vessel motion factored by a value of 1.25, at AISC allowable stress levels without the $^1/3$ increase for wind or dynamic loading.

b) Structural components other than tie-down clamps shall be rated in accordance with 8.1.

Some structural connections provide two methods or paths for carrying loads. Examples of such a dual-load path connection are a derrick leg splice or derrick base plate connection with flange connections, where compression is carried by the bearing of one flange plate on the other and tension is carried by bolts in tension. Mast legs designed to carry compression loads by contact bearing and tension loads through pin connections are another example.

In addition to meeting the requirements of 8.1, dual-load path connections, other than tie-down clamps, shall also be designed to resist primary loads calculated using overhanging vertical live loads, design lateral wind, seismic and dynamic forces due to vessel motion, as appropriate, factored by a value of 1.25:

— in all operating and erection load combinations with a $^{1}/3$ increase in allowable stresses;

— in expected and unexpected wind load combinations with a $^{2}/3$ increase in allowable stresses;

— in transportation load combinations with a $^{1}/3$ increase in allowable stresses, or $^{2}/3$ increase in allowable stresses if so specified by the purchaser.

In no case shall the absolute value of the design loadings for one load path of a dual-load path connection be less than 20 % of those of the alternate load path.

The manufacturer shall provide suitable instructions in the drilling structure documentation to be delivered with the unit regarding the proper installation of clamps, pins, and bolts used for tie downs. Tie-down components incorporating bolts that are expected to be tensioned multiple times shall be designed with specified preloads of bolts no greater than 50 % of the bolt material minimum ultimate strength times its nominal cross-sectional area, so as to allow reuse of the bolts. Clamp installation instructions shall include pretension values and tolerances. Bolt tensioning shall be achieved using calibrated tensioning methods. Bolts that are specified to be pretensioned to higher values shall only be used once.

The rig owner/operator shall develop procedures to include storm preparation information including proper clamp installation, based on the manufacturer's recommendations.

Proposed Wording:

8.9 Overturning and Sliding

The maximum allowable static coefficient of friction to be used in overturning or inadvertent rig sliding calculations of drilling structures supported by soil, concrete, or wood matting foundations shall be limited to 0.15, and to 0.12 for those supported by steel foundations, except as follows: alternative values for the maximum design coefficient of friction may be used provided such values have been validated thru testing and are consistent with rig operating procedures (e.g. an offshore skiddable rig design incorporating a coefficient of friction consistent with ungreased surfaces would require that the owner/operator maintain and inspect the beams to ensure that they are not inadvertently greased).

For all stability and sliding calculations, dead weights providing resistance to overturning or sliding shall be limited to a maximum of 90 % of their expected minimum weight. The calculation of minimum weight shall assume the removal of all optional structures and equipment, and fluid tanks shall be considered empty, unless otherwise specified in the rig instructions for storm preparations or rig erection. For drilling structures subject to vertical heave, the stabilizing weights shall be further reduced by the magnitude of the negative heave acceleration.

Freestanding structures on land shall have a minimum factor-of-safety against overturning of 1.25, calculated as the ratio of the minimum stabilizing moment of the dead weight of the structure, taken about a tipping line, divided by the overturning moment of the sum of any overhanging vertical live loads plus environmental loads, including wind or earthquake, taken about the same tipping line or axis. The designer shall consider suitable tipping lines so as to determine the minimum factor of safety and shall consider the possibility of overturning loads from any possible direction of application. Determination of the location of a tipping line shall be such that the tipping line shall lie along the centroid of the nominal vertical ground support reactions for the case considered; the distribution of ground support reactions shall be limited to comply with design allowable ground bearing pressures for the structures under consideration. The manufacturer shall include foundation loading diagrams and the required safe ground bearing pressure allowables for erection and operating conditions in the rig manual. Freestanding land drilling structures shall have a minimum factor of safety against inadvertent sliding of 1.25, calculated as the ratio of the minimum sliding resistance at the design maximum allowable static coefficient of friction, divided by the total applied shear loads due to environmental loads.

Freestanding offshore drilling structures shall have a minimum factor-of-safety against overturning of 1.50, calculated as the ratio of the minimum stabilizing moment of the dead weight of the structure, taken about a tipping line, divided by the overturning moment of the sum of any overhanging vertical live loads plus environmental loads, including wind, earthquake, or dynamic loads due to vessel motion, taken about the same tipping line or axis. The designer shall consider suitable tipping lines so as to determine the minimum factor of safety and shall consider the possibility of overturning loads from any possible direction of application. Determination of the location of a tipping line shall be such that the tipping line shall lie along the centroid of the nominal foundation support reactions for the case considered. The distribution of foundation support reactions shall be limited to comply with allowable design loadings of the supporting structures foundations, if so specified by the purchaser. The manufacturer shall include diagrams defining the maximum foundation support loads based on the factored lateral loads with the rig instructions. Freestanding offshore drilling structures shall have a minimum factor of safety against inadvertent sliding of 1.5, calculated as the ratio of the minimum sliding resistance at the design maximum allowable static coefficient of friction, divided by the total applied shear loads due to environmental loads.

Structures unable to meet the requirements for freestanding structures shall incorporate suitable devices to prevent such movements to include the following.

a) Such components, when used on skiddable drilling structures shall be termed tie-down clamps and shall be rated to resist overturning and sliding loads in all load combinations calculated using overhanging vertical live loads, design lateral wind, seismic and dynamic forces due to vessel motion factored by a value of 1.25, at AISC-360-16 allowable strength levels without the $^{1}/_{3}$ increase for wind or dynamic loading.

b) Structural components other than tie-down clamps shall be rated in accordance with 8.1.

Some structural connections provide two methods or paths for carrying loads. Examples of such a dual-load path connection are a derrick leg splice or derrick base plate connection with flange connections, where compression is carried by the bearing of one flange plate on the other and tension is carried by bolts in tension. Mast legs designed to carry compression loads by contact bearing and tension loads through pin connections are another example.

In addition to meeting the requirements of 8.1, dual-load path connections, other than tie-down clamps, shall also be designed to resist primary loads calculated using overhanging vertical live loads, design lateral wind, seismic and dynamic forces due to vessel motion, as appropriate, factored by a value of 1.25:

— in all operating and erection load combinations with a $^{1}/_{3}$ increase in allowable strength;

— in expected and unexpected wind load combinations with a $^{2}/_{3}$ increase in allowable strength;

— in transportation load combinations with a $^{1}/_{3}$ increase in allowable strength, or $^{2}/_{3}$ increase in allowable strength if so specified by the purchaser.

In no case shall the absolute value of the design loadings for one load path of a dual-load path connection be less than 20 % of those of the alternate load path.

The manufacturer shall provide suitable instructions in the drilling structure documentation to be delivered with the unit regarding the proper installation of clamps, pins, and bolts used for tie downs. Tie-down components incorporating bolts that are expected to be tensioned multiple times shall be designed with specified preloads of bolts no greater than 50 % of the bolt material minimum ultimate strength times its nominal cross-sectional area, so as to allow reuse of the bolts. Clamp installation instructions shall include pretension values and tolerances. Bolt tensioning shall be achieved using calibrated tensioning methods. Bolts that are specified to be pretensioned to higher values shall only be used once.

The rig owner/operator shall develop procedures to include storm preparation information including proper clamp installation, based on the manufacturer’s recommendations.

Current Wording:

11.6.1 Structural Steel

Structures and products produced shall conform to applicable sections of the AISC 335-89 concerning fabrication.

Proposed Wording:

11.6.1 Structural Steel

Structures and products produced shall conform to applicable sections of the AISC 360-16 concerning fabrication.

Current Wording:

11.10.3 Bolt Pretensioning

When a preload is specified by the design, bolt pretensioning shall be considered a process requiring validation.

When such values are as specified in accordance with the values in AISC 335-89, process validation in accordance with the turn-of-the-nut method per AISC's Research Council on Structural Connections document "Specification for Structural Joints using ASTM A325 or A490 Bolts" is acceptable.

Proposed Wording:

11.10.3 Bolt Pretensioning

When a preload is specified by the design, bolt pretensioning shall be considered a process requiring validation.

When such values are as specified in accordance with the values in AISC 360-16, process validation in accordance with the turn-of-the-nut method per AISC's Research Council on Structural Connections document "Specification for Structural Joints using High-Strength Bolts" is acceptable.

.

Current Wording:

B.7 Design Loading

Operating, erection, and transportation load cases include a purchaser-defined wind velocity, to be not less than a specified minimum depending on type of structure and application (onshore or offshore).

No increase in allowable stresses is allowed for operating or erection cases with wind or inertia forces. The nameplate curve of hook load versus wind velocity is made using a linear transition from a stress modifier of 1.0 for operating cases to 1.33 for the unexpected storm case.

The choice of the wind velocity for operating cases is not considered a structural safety concern as it is generally trivial to reduce hook load by setting the pipe string off in the rotary slips; rather, the level chosen represents a trade-off of costs and benefits to the user—higher costs for higher wind speed ratings versus reduced operational window for lower wind speed ratings. Arbitrarily, the specification minimums for operating wind velocity are set to a level that generates about 20 % of the Unity Checks (UCs) from unexpected (setback) wind load case UCs on land rigs and 20 % of maximum expected wind load case UCs on offshore structures. Because the nameplate also includes the curve of allowable hook load versus wind loads, the user will have the necessary information to develop suitable rig operating procedures and to plan rig operations to mitigate the effects of weather conditions on operations for wind conditions in excess of the operating case design wind velocity.

<u>Proposed Wording:</u>

B.7 Design Loading

Operating, erection, and transportation load cases include a purchaser-defined wind velocity, to be not less than a specified minimum depending on type of structure and application (onshore or offshore).

No increase in allowable strength is allowed for operating or erection cases with wind or inertia forces. The nameplate curve of hook load versus wind velocity is made using a linear transition from a strength modifier of 1.0 for operating cases to 1.33 for the unexpected storm case.

The choice of the wind velocity for operating cases is not considered a structural safety concern as it is generally trivial to reduce hook load by setting the pipe string off in the rotary slips; rather, the level chosen represents a trade-off of costs and benefits to the user—higher costs for higher wind speed ratings versus reduced operational window for lower wind speed ratings. Arbitrarily, the specification minimums for operating wind velocity are set to a level that generates about 20 % of the Unity Checks (UCs) from unexpected (setback) wind load case UCs on land rigs and 20 % of maximum expected wind load case UCs on offshore structures. Because the nameplate also includes the curve of allowable hook load versus wind loads, the user will have the necessary information to develop suitable rig operating procedures and to plan rig operations to mitigate the effects of weather conditions on operations for wind conditions in excess of the operating case design wind velocity.

Current Wording:

B.8.9 Overturning and Sliding

The specification defines allowable maximum values for coefficients of friction for use in overturning and sliding calculations, unless higher values are validated by testing and operational procedures are consistent with such values.

Stabilizing dead weights are limited to 90 % of their expected value, and the added stability against sliding and overturning resulting from fluid loads or temporarily installed equipment is not allowed unless documented in rig instructions by the manufacturer and also on the structure nameplate when required for erection.

The specification defines overturning and sliding factors-of-safety for freestanding structures and requires the calculation of the factor-of-safety in light of the allowable support loadings of the underlying foundation to prevent foundation collapse.

A graph of design loads for tie-down clamps versus increasing overturning and sliding loads may exhibit highly nonlinear or bilinear loading; the clamp sees no load until a load level is reached there the stabilizing effect of gravity loads is overcome. Tie-down clamp loads are calculated using a 1.25 load factor applied to overturning vertical live loads and sliding loads and with “lightship” dead weights; allowable stresses may not be increased for tie-down clamps. This requirement ensures a measure of robustness in the event of overload caused by a storm event greater than the design event.

Dual load path components, other than tie-down clamps, must meet not only the requirements of 8.1 (with an allowable stress multiplier of 1.33 for extreme events) but also the requirements of cases calculated using a 1.25 load factor applied to overturning vertical live loads and sliding loads and with “lightship” dead weights, with an allowable stress multiplier of 1.67. If the nominal factor of safety in AISC is taken as
1.67 (that of a bar in tension or a beam in bending), the nominal minimum factor-of-safety for the unfactored cases will be this value reduced by the allowable stress multiplier, or 1.67/1.33 = 1.25. Similarly, the additional requirement would provide a nominal minimum factor-of-safety for the factored load cases of $1.67/1.67 \times 1.25 = 1.25$. Thus, the additional requirement ensures a consistent factor of safety even if these elements exhibit sharply nonlinear or bilinear loading with the level of overturning and sliding loads.

Proposed Wording:

B.8.9 Overturning and Sliding

The specification defines allowable maximum values for coefficients of friction for use in overturning and sliding calculations, unless higher values are validated by testing and operational procedures are consistent with such values.

Stabilizing dead weights are limited to 90 % of their expected value, and the added stability against sliding and overturning resulting from fluid loads or temporarily installed equipment is not allowed unless documented in rig instructions by the manufacturer and also on the structure nameplate when required for erection.

The specification defines overturning and sliding factors-of-safety for freestanding structures and requires the calculation of the factor-of-safety in light of the allowable support loadings of the underlying foundation to prevent foundation collapse.

A graph of design loads for tie-down clamps versus increasing overturning and sliding loads may exhibit highly nonlinear or bilinear loading; the clamp sees no load until a load level is reached there the stabilizing effect of gravity loads is overcome. Tie-down clamp loads are calculated using a 1.25 load factor applied to overturning vertical live loads and sliding loads and with "lightship" dead weights; allowable strength may not be increased for tie-down clamps. This requirement ensures a measure of robustness in the event of overload caused by a storm event greater than the design event.

Dual load path components, other than tie-down clamps, must meet not only the requirements of 8.1 (with an allowable strength multiplier of 1.33 for extreme events) but also the requirements of cases calculated using a 1.25 load factor applied to overturning vertical live loads and sliding loads and with "lightship" dead weights, with an allowable strength multiplier of 1.67. If the nominal factor of safety in AISC is taken as 1.67 (that of a bar in tension or a beam in bending), the nominal minimum factor-of-safety for the unfactored cases will be this value reduced by the allowable strength multiplier, or 1.67/1.33 = 1.25. Similarly, the additional requirement would provide a nominal minimum factor-of-safety for the factored load cases of $1.67/1.67 \times 1.25 = 1.25$. Thus, the additional requirement ensures a consistent factor of safety even if these elements exhibit sharply nonlinear or bilinear loading with the level of overturning and sliding loads.