Interim Guidance for Assessment of Existing Offshore Structures for Hurricane Conditions

API BULLETIN 2INT-EX
MAY 2007

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Upstream Segment

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1 Scope

1.1 PREFACE

Hurricane Ivan in 2004 and hurricanes Katrina and Rita in 2005 resulted in considerable damage and destruction to fixed and floating facilities in the Gulf of Mexico (GOM). Several API committees are in the process of revising and updating standards to incorporate learnings from these and other recent large intense storms like Opal (1995) as well as other improvements to the industry's understanding of hurricane risk which have occurred over the past 15 years. One major change is a complete revision to the hurricane conditions presently contained in API RP 2A-WSD, 21st Edition, recognizing the higher level of hazard in certain parts of the GOM. Another is the revised understanding of the potential for local wave-in-deck damage. While work on standards development continues, in the interim the following documents are being issued to provide immediate guidance for the design and assessment of offshore Gulf of Mexico fixed and floating facilities in hurricane conditions:

- API Bulletin 2INT-MET *Interim Guidance on Hurricane Conditions in the Gulf of Mexico*, May 2007.
- API Bulletin 2INT-DG *Interim Guidance for Design of Offshore Structures for Hurricane Conditions*, May 2007.
- API Bulletin 2INT-EX *Interim Guidance for Assessment of Existing Offshore Structures for Hurricane Conditions*, May 2007.

The content of API Bull 2INT-MET is undergoing extensive review and evaluation. The final results are planned to be included in a new, stand-alone document (API RP 2MET) that will contain the metocean conditions for use with other API design standards. API RP 2MET will also serve as the basis for a revised U.S. Regional Annex in ISO 19901-1.

1.2 PURPOSE

API Bull 2INT-EX is being issued concurrently with API Bull 2INT-MET to give guidance, at a high level, on how to utilize the updated hurricane winds, waves, surge and current conditions in API Bull 2INT-MET for the assessment of existing offshore structures. The design of new permanent structures is contained in the companion API Bull 2INT-DG.

1.3 BACKGROUND

The hurricane metocean conditions presently contained in the 21st Edition of API RP 2A-WSD have not been updated since 1993. Since that time, several major severe storms, most notably Opal (1995), Ivan (2004) and Katrina (2005), have affected the Gulf, resulting in increases to local extremes in the areas affected by these storms. Most importantly, however, industry's understanding of hurricane risk has continued to evolve. Strong evidence now exists for there being a regional dependence for large, intense wave-making storms. Also, investigations into the underlying hurricane record, HURDAT, used as the foundation for the industry's storm hindcast database, have revealed that storms from the early period of the database are probably biased low in terms of intensity.

API Bull 2INT-MET presents new hurricane conditions for four GOM regions: West, West Central, Central and East, all based on the 1950 through 2005 period of the industry's hindcast database. Differences from hurricane conditions in API RP 2A-WSD, 21st Edition are most pronounced in the Central region; the updated deepwater 100-year return period significant wave height in the Central region is 15.8 m (52 ft), in contrast with the 12 m (40 ft) value implied by API RP 2A-WSD. The differences are primarily driven by the high frequency of intense storms experienced by this region, and to a lesser degree the elimination of the less trusted (pre-1950) portion of the historical hindcast record. Conditions in the other three regions vary slightly from each other, but are close to the values in API RP 2A-WSD.

The main objective of this Bulletin is to provide updated guidance for the use of hurricane metocean conditions in the GOM for existing structures, particularly in the Central Region and its adjoining transition regions.

1.4 APPLICABILITY

This document is intended to cover the design of the structural systems of the following types of offshore structures:

1. Steel template platforms and compliant towers.
2. Minimum non-jacketed and special structures (including caissons) defined in API RP 2A-WSD.
3. Tension Leg Platforms (TLPs).
4. Moored, floating platforms (semi-submersible shaped, spar shaped, ship shaped).

1.5 REFERENCE STANDARDS

This document is intended to explain how to use the content of API Bull 2INT-MET with existing structures designed to these Recommended Practices (RP) and standards:

API

RP 2A-WSD	*Planning, Designing and Constructing Fixed Offshore Platforms—Working Stress Design*, 21st Edition, December 2000 through Supplement 3, June 2007
RP 2FPS	*Recommended Practice for Planning, Designing and Constructing Floating Production Systems,* 1st Edition, March 2001
RP 2RD	*Design of Risers for Floating Production Systems (FPSs) and Tension-Leg Platforms (TLPs),* 1st Edition, June 1998
RP 2SK	*Design and Analysis of Stationkeeping Systems for Floating Structures,* 3rd Edition, October 2005
RP 2T	*Planning Designing and Constructing Tension Leg Platforms,* 2nd Edition, August 1997
Bull 2TD	*Guidelines for Tie-downs on Offshore Production Facilities for Hurricane Season,* 1st Edition, June 2006

These standards, have been actively applied in designs in U.S. waters, and include guidance, methods and criteria to apply met-ocean conditions.

Nothing in this Bulletin is intended to suggest, recommend or endorse a relaxation of provisions in existing API Standards, which remain in effect. The more severe of the metocean conditions in API Bull 2INT-MET or the metocean conditions in existing API Standards should be applied, unless metocean conditions derived from a valid site specific investigation are used.

1.6 USE OF EXISTING ASSESSMENT RESULTS

Specific assessment approaches using structural analyses are described in this document. In many cases, results from an existing assessment or structural analysis that was previously performed on the structure or a similar structure can be used in lieu of the assessments described herein. In such cases, the previous studies should be representative of the structure's current configuration and condition.

1.7 LIMITATIONS

This Bulletin is applicable for existing offshore structures located in the Gulf of Mexico at the time of the publication of this Bulletin. The guidance in this document is not intended for use in designing new platforms. For the design of new platforms, see API Bull 2INT-DG.

Platforms designed according to API Bull 2INT-DG should not use this guide for assessment once the structure is installed, unless some assessment initiator other than functional expansion occurs.

1.8 ORGANIZATION

This Bulletin is organized depending upon whether the structure is fixed or floating and upon its location. Section 2 describes the initiators that are used to determine if a structure should be assessed. Once this is determined, Section 3 describes the assessment approach for fixed structures and Section 4 describes the assessment approach for floating structures. Section 5 provides general recommendations that should be applied where appropriate to all offshore structures in the GOM in order to reduce the risks and consequences of damage from hurricanes.

A commentary is included to provide additional guidance and explain the reasons for selecting the values for this Bulletin.

A part of this Bulletin shall be considered withdrawn only if:

1. The Bulletin is withdrawn in its entirety, or
2. A standard listed in 1.5 is revised, and the new edition contains a specific statement declaring the relevant part of this Bulletin superseded.

As for the future, the API Hurricane Evaluation & Assessment Team (HEAT) is continuing its orderly work on metocean conditions, platform robustness/fragility assessment & calibration, learnings on the direct and indirect economic impact of platform failures, and safety issue mitigations beyond current personnel evacuation, SCSSV, and P&A practices. Modifications to these Interim Guidelines may be expected in terms of practical tradeoffs, evolving practices, and revisions of the referenced standards.

2 Assessment Initiators

2.1 GENERAL

An assessment initiator is used to determine if a platform should be assessed for the API Bull 2INT-MET hurricane conditions. The assessment initiator is based upon a structure's location and if it is fixed or floating. The location is important since it determines the specific metocean conditions to be used according to API Bull 2INT-MET.

Fixed structures include steel jacket or template platforms, towers and compliant towers, caissons, minimum non-jacket and special structures that are fixed to the seafloor. These structures follow API RP 2A-WSD guidelines.

Floating structures include Tension Leg Platforms (TLP), and permanently moored Spars, Deep Draft Caissons, semi submersibles and any other type of floating or tethered structures. These structures follow API RP 2T, API RP 2FPS, and API RP 2SK guidelines.

2.2 ASSESSMENT INITIATORS

The fixed and floating structures that should be assessed are shown in Table 2.1 based upon the hurricane conditions presented in API Bull 2INT-MET. If an assessment is initiated, then the assessment should be performed according to the assessment approach as described in the indicated section of this Bulletin.

Structures located in the transition regions adjacent to the Central Region should also be assessed. In some locations, the updated metocean conditions in the transition region may not have increased as defined in API Bull 2INT-MET and in this situation the structure does not have to be assessed per this Bulletin. See the appropriate fixed or floating assessment section of this document for additional guidance.

If an assessment is not initiated, then a structure should continue to operate according to existing API guidelines relevant for the structure. However, regardless if an assessment is initiated, all fixed and floating structures located anywhere in the GOM should consider the General Recommendations described in Section 5 in order to minimize risks of hurricane damage.

Additional discussion of the assessment initiators is described in the remainder of this section.

Table 2.1—Assessment Initiators Based upon API Bull 2INT-MET

Structure	API Category[1]	Location[2]	Assessment Initiated	Assessment Approach
Fixed	A-1, L-1	Central Region[3]	Yes	Section 3
	A-1, L-1	Other Regions	No	NA[5]
	A-2, A-3, L-2, L-3	All Regions	No	NA
Floating	All[4]	Central Region[3]	Yes	Section 4
		Other Regions	No	NA

Notes:

[1] API RP 2A-WSD, 21st Edition, Supplement 2, 2005, provides definitions of API Categories. L-1, L-2 and L-3 structures are those that were designed to API RP 2A, 21st Edition.
[2] Regions are defined in API Bull 2INT-MET.
[3] Includes structures located in the adjacent transition regions.
[4] All floating structures in the Central Region should be assessed.
[5] NA = Not Applicable.

2.3 FIXED STRUCTURE INITIATORS

Fixed structures should be assessed according to their API Category defined in API RP 2A-WSD, Section 17 and Section 1. The assessment should follow the guidance contained in API RP 2A-WSD, Section 17 as modified by the information contained Section 3 of this Bulletin and should use API Bull 2INT-MET or a valid site specific study for metocean conditions.

Existing fixed structures designed prior to API RP 2A-WSD, 21st Edition are categorized according to Assessment Categories defined in API RP 2A-WSD, Section 17. There are three Assessment Categories consisting of A-1 High Assessment Category, A-2 Medium Assessment Category and A-3 Low Assessment Category. The assessment initiators for these platforms are summarized as follows:

- A-1 structures located in the Central Region and the associated transition regions should be assessed for the updated hurricane conditions. A-1 structures located in the other three regions do not need to be assessed for the purposes of this Bulletin.
- A-2 structures located anywhere in the four regions do not need to be assessed for the purposes of this Bulletin.
- A-3 structures located anywhere in the four regions do not need to be assessed for the purposes of this Bulletin.

Existing fixed structures designed according to API RP 2A-WSD, 21st Edition are defined according to Exposure Categories defined in API RP 2A-WSD, Section 1. These structures are categorized as L-1, L-2 and L-3, with the categorization depending upon life-safety and consequences of failure. According to API RP 2A-WSD, 21st Edition, these structures are not intended to use the assessment approaches and reduced criteria contained in Section 17, and instead, assessment should be in accordance with the criteria originally used for design of the structure. However, for the purposes of this Bulletin, existing L-1 structures located in the Central Region and located in the adjoining transition regions should be considered as A-1 structures and also follow the assessment approach as described in Section 3. The assessment initiators for these platforms are summarized as follows:

- L-1 structures located in the Central Region and located in the adjacent transition regions should be considered an A-1 structure for the purposes of this Bulletin. L-1 structures located in other three regions do not have to be assessed for the purposes of this Bulletin.
- L-2 and L-3 structures located anywhere in the four regions do not need to be assessed for the purposes of this Bulletin.

L-2 structures are designed to a higher level of strength than required for life safety on A-2 manned-evacuated structures. There is no formal recommendation for assessing L-2 structures in the Central Region on account of their economic importance. However, the stakeholders may want to assess these structures for purposes of risk evaluation and mitigation, particularly for processing and transportation hubs. See Commentary.

2.4 FLOATING STRUCTURE INITIATORS

Floating structures located in the Central Region and located in the adjacent transition regions should be assessed. The assessment should follow the guidance contained in Section 4 and should use API Bull 2INT-MET or a valid site specific study for metocean conditions.

Floating structures located in the three other regions do not need to be assessed for the purposes of this Bulletin.

2.5 SITE SPECIFIC METOCEAN CONDITIONS

This document refers to API Bull 2INT-MET for updated Gulf of Mexico hurricane conditions. Alternatively, a valid site specific metocean study may be used provided that the study is conducted according to the guidance contained in API Bull 2INT-MET.

3 Assessment Approach for Fixed Structures

3.1 SCOPE

Fixed structures should be assessed according to their API Category and locations as previously shown in Table 2.1. Table 3.1 shows the associated assessment conditions and acceptance criteria. The assessment approach generally follows that described in API RP 2A-WSD, Section 17, with the exception of the use of metocean conditions per API Bull 2INT-MET. Additional guidance is provided in the remainder of this section.

Table 3.1—Assessment Approach for Existing Fixed Structures

API Category[1]	Location[2]	Metocean Condition[2]	Acceptance Criteria[4]
A-1, L-1	Central Region[3]	100-year Return Period	RSR = 1.2

Notes:

[1] API RP 2A-WSD, 21st Edition, Supplement 2, 2005, provides definitions of API Categories. L-1 structures are those that were designed to API RP 2A-WSD, 21st Edition.
[2] Location and Conditions are defined in API Bull 2INT-MET. A site specific study that follows the guidance in API Bull 2INT-MET can also be used.
[3] Includes structures in the adjacent transition regions.
[4] RSR = Reserves Strength Ratio computed as the ratio of the structure's ultimate capacity to the base shear from the 100-year metocean condition.

3.2 ASSESSMENT CONDITIONS

A-1 and L-1 structures located in the Central Region and adjacent transition regions should be assessed. The 100-year return period metocean conditions defined in API Bull 2INT-MET for the Central Region and adjacent transition regions should be used for the assessments.

For structures located in a transition zone, if the interpolated 100-year return period wave height is equal to or less than the Ultimate Strength wave height in API RP 2A-WSD, Section 17, Figure 17.6.2-2a, then an assessment is not necessary for the purposes of this Bulletin. In shallow water regions less than 20 m (66 ft) water depth, storm surge may be larger for the API Bull 2INT-MET metocean conditions, while wave height may be less. In such cases, a combination of the wave height and storm surge should be considered to determine the wave crest elevation. If the combination is smaller for API Bull 2INT-MET, then an assessment is not necessary for the purposes of this Bulletin.

3.3 ASSESSMENT PROCESS

An Ultimate Strength Analysis should be used as defined in API RP 2A-WSD, Section 17.7.3. However, the A-1 Ultimate Strength full population hurricane conditions contained in API RP 2A-WSD, Table 17.6.2-1 and API RP 2A-WSD, Figure 17.6.2-2a should be replaced by the 100-year return period metocean conditions defined in API Bull 2INT-MET. This includes wave height, storm tide, direction, current, wave period and wind speed. The full population hurricane deck height criteria shown in API RP 2A-WSD, Figure 17.6.2-2b no longer pertains for the Central Region.

Several methods can be used to perform the Ultimate Strength Analysis as follows. If the structure does not pass one of these methods then other valid methods may be considered. The analysis methods do not have to be used in the sequential order as shown, and any one of the analyses can be performed at any time. API RP 2A-WSD, Section 17 provides additional guidance on these approaches.

1. *Linear Ultimate Strength Analysis*. This is essentially an API RP 2A-WSD, Section 17 Design Level Analysis with all safety factors and known sources of conservatism removed to provide an equivalent ultimate strength. API RP 2A-WSD, Sections 17.7.3.a and 17.7.3.b provide guidance. The safety factors to be removed are defined in API RP 2A-WSD. Mean material strength should be used instead of nominal. This analysis provides a conservative estimate of ultimate strength of a fixed structure. The structure passes assessment if no members or joints or other structural elements have exceeded their equivalent ultimate strength. If there are a few overloaded members and/or joints, local overload considerations may be used to justify that the structure will not collapse in a global manner. Other valid equivalent linear methods can be used to determine the structure's ultimate strength provided that they can be justified to provide conservative or the same results as nonlinear methods.
2. *Nonlinear Ultimate Strength Analysis*. This is typically called a pushover analysis that utilizes nonlinear analysis techniques to determine the maximum metocean loading that the platform can sustain without collapse. API RP 2A-WSD, Section 17.7.3.c provides guidance. Assessment factors described for the Linear Ultimate Strength Analysis, such as the use of mean material strength, should also be used for this analysis.
3. *Prior Exposure*. The structure should have survived with no or little damage with metocean loading that is as severe as or more severe than that required to demonstrate the Acceptance Criteria in 3.4. The procedure determines, from either measurements or calibrated hind-casts, the expected maximum base shear to which the platform has been exposed, and then checks to see if it exceeds, by an appropriate margin, the Acceptance Criteria. API RP 2A-WSD, Sections 17.5.1 and C17.5.1 provide guidance. If a structure has an exposure direction with less capacity than the direction to which the prior exposure loading approached, assessment for the appropriate loadings in these directions should also be addressed. The structure's current con-

figuration and condition should be the same as when the prior exposure occurred. If the prior exposure included wave-in-deck, then such loading should be included in the analysis using appropriate techniques and should reflect actual wave inundation based upon observed damage. Care should be taken to not overestimate wave-in-deck loading based only upon observation of wave loading on a small portion of the deck.

The API Bull 2INT-MET metocean conditions may result in wave loading on the structure's deck that was not present in previous analysis of the structure. API RP 2A-WSD, Section C17.6.2 provides an acceptable approach. Alternative valid approaches may also be used, such as accounting for three-dimensional wave effects to more adequately represent the reduced impact area of a short-crested wave.

3.4 ACCEPTANCE CRITERIA

The structure should have a minimum Reserve Strength Ratio (RSR) of 1.2. The RSR is computed as the ratio of the structure's ultimate capacity (based on it's designed or since modified configuration) to the base shear computed using the 100-year return period conditions defined in API Bull 2INT-MET or from a valid site specific study. An RSR of 1.2 matches the criteria used to develop API RP 2A-WSD, Section 17.

Higher RSRs should be considered for structures that are critical to field operations, or structures that are critical to the Gulf of Mexico infrastructure. This latter category would include structures used in gathering production from other structures (hubs), structures tied-back to deep water structures, structures with high production, structures with pipeline crossings, structures designated as safe refuge, etc.

If an A-1 or L-1 structure does not meet the Acceptance Criteria, then mitigation such as load reduction, raising the deck, or strengthening should be considered as discussed in Section 5. If mitigation is not implemented then the platform configuration should not be changed such that it lowers the structure's assessed RSR.

3.5 CONFIGURATION CHANGES

For A-1 and L-1 structures located in the Central Region, the structure's configuration should not be modified such that the structure no longer meets the RSR acceptance criteria defined in 3.4. Examples include additional conductors, risers, topsides, etc. Such changes may be acceptable if it can be demonstrated that the structural performance of the structure has not changed. In some cases, the structure's configuration may be modified to accommodate functional expansion but not degrade performance. Examples include removing unused conductors to add new conductors.

Owners/operators should carefully consider the cost-risk tradeoffs for configuration changes that reduce the RSR of a platform, even though the RSR of the reconfigured structure still meets the Acceptance Criteria. Likewise, consideration should be given to mitigation that increases the RSR or reduces the structure's consequence of failure. The Acceptance Criteria contained in this Bulletin should be considered as minimum and additional safety may be appropriate for some structures in order to decrease risks in hurricanes.

4 Assessment Approach for Floating Structures

4.1 SCOPE

Floating facilities located in the Central Region and in the adjacent transition regions should be assessed for the updated hurricane conditions defined in API Bull 2INT-MET. Assessment for the extreme events should follow the evaluation process in this document utilizing the extreme event criteria from API Bull 2INT-MET. Assessment of operational and damaged conditions should follow existing API codes such as API RP 2FPS, API RP 2T, API RP 2RD and API RP 2SK utilizing the appropriate criteria from API Bull 2INT MET.

4.2 ASSESSMENT CONDITIONS

The 100-year return period hurricane conditions defined in API Bull 2INT-MET for the Central Region and adjacent transition regions should be used to assess structure survival. Survival criteria are further defined in 4.3.2 and 4.4.2.

Site-specific conditions are typically used to design floating facilities. If the site specific conditions used to design the structure are equal to or greater than the environment condition in the Central Region or transition regions, and the structure has not been modified from the design conditions, then the structure passes the assessment.

4.3 ASSESSMENT PROCESS

Specific existing guidance for assessment of existing floating facilities similar to fixed structures is not currently available. The current API guidance for floating structures utilizes a design level approach as recommended in API RP 2T, API RP 2FPS, API RP 2RD and API RP 2SK based on a 100-year return period condition. In lieu of a formal area wide risk study for floating structures the following criteria for assessment should be used. Alternatively, operators may elect to perform their own site specific study for a detailed assessment of the risks.

The floating system's ability to survive a hurricane event for assessment may be evaluated as described below:

1. Reference to original design cases as documented in the approved Certified Verification Agent (CVA) design reports that evaluated metocean conditions that meet or exceed the event.
2. Re-analysis of the as-built systems to establish the overall capacity of the floating system without safety factors. Analysis methods should give accurate or conservative representations of the system response as validated by model tests or field data. Loads due to loss of air gap need to be included.
3. Proven survivability from an actual hurricane event in the system's current configuration that meets or exceeds the 100-year return period hurricane conditions defined in API Bull 2INT-MET or a valid site specific study.

The results of the most recent inspection including hull, mooring and other components should be used where appropriate to update the corrosion allowances and other assumptions used for the original design of the facility.

To assess that a minimum risk level is evaluated for all floating structures in the central region and adjoining transition regions, a three-step assessment process is recommended.

4.3.1 Step 1—Design Level Check

4.3.1.a Current Condition Design Check

The Design Level Check is recommended to evaluate the floating structure for all changes and as-built configuration since the structure was originally installed. This check will evaluate any changes in configuration that could increase or decrease the loads or operating envelopes on the critical system components.

Using the environmental criteria that were used for the original design approved by the CVA of the structure, perform a design level check of the structure taking into account all changes that have or may have affected the structure since it has been installed. These changes should include not only additions or removal of payload, but also any damage or corrosion that may have occurred to the risers, anchoring system or hull.

Acceptance Criteria is provided in 4.4.1.

4.3.1.b Life Safety and Operational Checks

The Life Safety and Operational Checks are recommended to evaluate the system for conditions while manned and operating during the hurricane season in the Central Region and in the adjacent transition regions.

Life Safety is assessed by comparing the 100-year Sudden Hurricane conditions per API Bull 2INT-MET to the 100-year hurricane condition used for the design of the facility. If the 100-year Sudden Hurricane conditions per API Bull 2INT-MET are higher than the 100-year hurricane condition used in the design, repeat the Design Level Check in 4.3.1.a with the 100-year Sudden Hurricane conditions.

Operational and damaged conditions used for this check should be consistent with the original criteria except using the updated conditions defined in API Bull 2INT-MET. Note operational or damaged conditions originally evaluated for winter storm conditions do not need to be re-evaluated since updated criteria for winter conditions are not proposed.

Acceptance Criteria is provided in 4.4.1.

4.3.2 Step 2—Survival Check

The Survival Check is recommended to evaluate the system for survivability to prevent major environmental damage and to evaluate the system's capability for further expansion.

Evaluate the floating system's ability to survive the 100-year return period condition defined in API Bull 2INT-MET. Overall survival of the floating system should be determined without exceeding the capacity of the key elements or causing disconnect of the system.

Acceptance Criteria is provided in 4.4.2.

4.3.3 Step 3—Robustness Check

The Robustness Check is recommended to evaluate the floating structure critical components for overload that could precipitate premature failure in events near the 100-year extreme loads that were checked for survival.

The Robustness Check should be performed using a return period equal to or higher than the 200-years, preferably the 1000-year for floating systems that passed the Survival Check in Step 2 in order to determine the capacity of each critical component. For those floating systems that did not pass the Survival Check in Step 2, the highest return period should be determined for each critical component to identify the weak link(s) for operator mitigation efforts. The objective of this system robustness check is to assure that the designer and the operator have a clear understanding of the weak links in the system.

Acceptance Criteria is provided in 4.4.3.

4.4 ACCEPTANCE CRITERIA

4.4.1 Design Level Check Acceptance Criteria

The Design Level Check should use either the original design environmental criteria or the updated Sudden Hurricane conditions defined in API Bull 2INT-MET, whichever is greater, along with the appropriate API Standard that governs the design of such structures at this time. Structures designed prior to the first edition of API RP 2FPS should be assessed using API RP 2FPS. If any conditions required by API RP 2FPS are not met for this Design Level Check, it should be demonstrated that these requirements are beyond the original design requirements of the previous rules or standards that were in-place at the time of the original structure design.

If a platform does not meet or exceed the recommended criteria, then modifications to the hurricane and damage control procedures should be evaluated to mitigate the additional risk while manned.

4.4.2 Survival Check Acceptance Criteria

Survival is defined as no failure of the floating superstructure, risers, pipelines or mooring system that would lead to the catastrophic loss of the structure.

Survival acceptance per this interim Bulletin is that the floating system meets as a minimum the following criteria:

1. The floating stability of the structure is maintained to the approved certification criteria.
2. For conventionally moored structures, the mooring system should not fail for the maximum tension case in the intact condition. The mooring system, in case of one line damaged, should not lead to sequential failures of one line after the other, otherwise known as system unzipping. Transient analysis may consider the limited duration over which peak loads are maintained. All mooring interface hardware should remain within geometric operating limits.
3. For Tension Leg Platforms, the tendon system should not fail for the maximum tension case and should maintain a tensile load greater than zero for minimum tension case in the intact condition. Minimum tension cases less than zero can be allowed if it is part of the original design criteria but it should be demonstrated that unlatching would not occur. All tendon interface hardware should remain within geometric operating limits.
4. Primary structural elements of the hull and deck, if required for hull integrity or stability, should be checked to verify that stresses are generally below yield with no safety factors and that the structural elements are fit for purpose to prevent loss of overall stability of the floating unit. Stress redistribution to lower stress areas should be evaluated with regards to allowable strain limits and buckling.
5. Pipelines and risers should not fail and all their interface hardware should remain within geometric operating limits.
6. No catastrophic failure of critical connections that secure major production and drilling modules to the structure is allowed.

Floating structures that do not pass the 100-year return period Survival Check should be evaluated to determine the highest return period to which the structure will pass the Survival Check to provide the operator with a clear understanding of the risks to evaluate future mitigations and expansions.

In addition, if a platform does not pass the Survival Check, then hydrocarbon inventories on the structure and any incoming or outgoing flow should be significantly reduced to eliminate environmental concerns if the floating system fails in the extreme event. Also, mitigation efforts such as load reduction or strengthening should be considered as discussed in Section 5.

4.4.3 Robustness Check Acceptance Criteria

The Robustness Check should include, as a minimum, structural integrity of the deck and hull, the mooring system, and the production and export risers.

Key assessment considerations that should be considered when performing the robustness check are:

- Positioning of down-stop and up-stop of riser support systems.
- Capacity and ductility of key riser system components.
- Mooring line safety factors, and the capacity of key mooring components as well as the capacity and ductility of their support structures.
- Tendon unlatching for TLPs.
- Key structural components, such as: deck to hull connection, truss to hard tank connections of a spar, or pontoon to column connections on a semi-submersible.
- High-stress, low-cycle fatigue of critical structural elements, or mooring and tendon components.
- Global stability and down flood points (e.g., access hatches and other points) should be checked to prevent potential water ingress with regard to wave impact loads and full emersion to appropriate rules for the 100-year wave crest conditions defined in API Bull 2INT-MET.

Even though the Robustness Check is recommended, the implementations of any mitigations that may be identified from this check are not required. The learning's from this check should be used to manage the risk of the structure.

4.5 CONFIGURATION CHANGES

The structure's configuration should not be modified such that the structure no longer meets the Design Level Check and the Survival Level Check as described in 4.3.1 and 4.3.2, respectively.

Examples of configuration changes include additional equipment, topsides payload, additional risers, etc. Such changes are acceptable if it can be demonstrated that the global performance and the structural performance of the structure has not changed per these checks. In some cases the structure configuration may be able to be modified to accept the changes but not degrade performance. Examples include removing unused equipment or modifications to ballasting or mooring.

4.6 MARINE OPERATIONS MANUAL

The Marine Operations Manual of the structure (MOM) should be updated to reflect any changes to the marine operations identified by the results of the evaluations from this interim Bulletin. Marine operations staff on-board the structure should be properly trained to assure that all affected procedures are followed for storm safe conditions and for hurricane evacuation.

5 General Recommendations for All Structures

5.1 SCOPE

The previous sections describe specific analyses that can be performed to determine the acceptability of the structures to the updated GOM metocean conditions. These generally deal with global performance of the structure, and if the platform does not pass the assessment then mitigation is required. Several types of mitigation are described in this section.

In addition, mitigation should be considered by all structure owners for the entire GOM, regardless of the outcome of the analytical assessment, and even for structures where assessment was not initiated. A significant portion of the hurricane damage to existing fixed and floating structures was the result of damage to structures and systems that do not affect the structure's global strength. Examples include damage to topsides safety equipment and systems especially on lower decks subject to wave loading, and toppled deck equipment due to a combination of inadequate securing and high winds. Such damage can result in safety issues when the structure is re-boarded following a hurricane and may also result in significant repair, downtime and economic consequences.

Owners should therefore evaluate all of their offshore structures in the GOM with this in mind, regardless if it is fixed or floating and the structure's' consequence category. The remainder of this section provides general guidance to reduce such damage.

5.2 MITIGATION

Mitigation can help extend the life of a structure or improve its chances of survival in a design event if implemented early. Mitigation typically involves decreasing the structure's load such as removing unused risers, or increasing the structure's strength such as grouting the pile-leg annulus. Mitigation can also include active programs to minimize the consequence of dam-

age or failure, such as plugging and abandoning unused wells or removing inactive process equipment. Mitigation should be evaluated on a cost-benefit basis for each structure, although many of them can be implemented at low cost or as part of the normal planned structure maintenance.

Examples of load reduction are as follows:

- Relocating or removing piping and other systems located below the lowest deck.
- Relocating or removing equipment on the lowest decks subject to wave loading.
- Removal of unused boat landings, walkways, stairs, barge bumpers, etc.
- Removal of unused conductors and risers.
- Removal of process equipment, tankage or piping no longer employed in order to decrease surface areas exposed to wind and waves as well as decrease dead load.
- Raising the deck (s) to prevent wave loading on the deck.
- Laying down or removing a drilling rig during hurricane season.
- Operational plans to reduce hydrocarbon or other liquid inventories prior to an expected hurricane arrival.

Examples of strengthening are as follows. Strengthening should be based upon a specific engineering assessment for the structure.

- Improved tie-down of topsides structure and equipment. See API Bull 2TD and API Bull 2INT-DG for guidance.
- Strengthening members or the addition of auxiliary bracing members.
- Strengthening of joints.
- Grouting of the pile-leg annulus.
- Addition of auxiliary piles tied back to the structure.
- Addition of a separate auxiliary structure tied-back to the original structure to provide additional strength.

Examples of actions that can minimize the consequences of damage or failure are as follows:

- Relocating or removing piping and other systems located below the lowest deck.
- Relocating or removing equipment on the lowest decks subject to wave loading.
- "Hardening" of piping, equipment and other systems located on the lowest decks from potential damage due to wave loading.
- Plug and abandon unused wells.
- Reduction of any hydrocarbons and/or chemicals on the facility.
- Provision of alternate means of production if a platform is damaged or destroyed, such as pre-planning for alternate sales lines, emergency jumper lines to alternative undamaged platforms, etc.

5.3 HURRICANE PREPAREDNESS

Advanced planning can also assist in reducing hurricane risks as well as improving post hurricane response. Written hurricane preparedness plans should be developed in terms of general activities for a fleet of offshore structures as well as plans on a structure specific basis. Check lists and platform specific guides can assist during the evacuation process. Structures with higher life safety and economic risk may require additional consideration.

Examples of hurricane preparedness are as follows:

- Evacuation planning for major hurricanes, including first evacuation for platforms that are at greater risk of failure and those that are furthest from shore. Initial evacuation of non-essential personnel should begin early.
- Evacuation planning for Sudden Hurricanes that occur on short notice should be given special consideration including evacuation to offshore structures that have been demonstrated to be able to safely survive Sudden Hurricane conditions.
- Begin preparing structure operations for safe shut-in as early as possible including system pump down, securing equipment and control panels, reducing liquid inventories, etc.
- Secure loose objects and equipment that can become airborne projectiles. Store movable equipment in safe and dry areas (e.g., generators).
- Develop advance plans for accessing the structure post hurricane should normal access and safety systems such as boat landings, walkways, power, etc. not be available due to damage.
- Establish guidelines for safe re-boarding of a damaged structure in terms of how and when, with minimum acceptance criteria for platform access and egress.

COMMENTARY

C.2.2 Assessment Initiators

The assessments are initiated for all of the high-consequence fixed and floating structures in the Central Region where the updated hurricane conditions have increased significantly. These are minimum recommended assessments intended to minimize risks to the high-consequence structures a defined by API. Structure owners should evaluate their structures on a case-by-case basis, as well as on a fleet basis, in order to determine risks based upon consequence of failure relative to their own operations. This should include the effects of consequence of failure to others that may share operations on a structure, such as a hub platform. The recent hurricanes demonstrated that post hurricane remediation of destroyed platforms can be very significant, especially related to plug and abandonment of wells. These factors may increase the number of platforms that an owner assesses, beyond the minimum number identified by using this Bulletin. For critical structures, owners should consider increasing the minimum acceptance criteria defined in Sections 3 and 4.

C.2.3 Fixed Structure Initiators

Existing L-2 structures have been designed to approximately 50-year hurricane load conditions (with 100-year deck clearance and normal API safety factors), as a way of optimizing the cost-risk tradeoff on moderate economic risks in water depths less than 122 m (400 ft). The companion document API Bull 2INT-DG recommends 50-year hurricane conditions for the design of L-2 platforms to be located in the Central Region. Thus, the 50-year hurricane conditions in API Bull 2INT-MET provide a good starting point for assessment of an L-2 structure, if the owner elects to determine the risk of failure. In terms of an assessment approach as described in Section 3, there is no set acceptance criteria provided herein in terms of an RSR for an L-2 structure. Instead, the approach could use a Reserve Strength Factor, defined as the ratio of the structure collapse load to the specified loading (50-year in this case). The RSF provides a useful comparative measure of risk. For example, an RSF of 0.85 corresponds to approximately 50% probability of survival in the specified loading event, considering the safe side bias found in calibrations on hurricanes Andrew through Ivan (Energo Engineering, Inc., "Assessment of Fixed Offshore Platform Performance in Hurricanes Andrew, Lili and Ivan," U.S. Department of the Interior, Mineral Management Service, Report No. 549, January 2006).

C.3.1 Scope (Fixed Platforms)

Existing A-1 and L-1 structures represent the high-consequence structures in the Central Region. These structures are often major producing platforms, hub platforms, major quarters platforms and other critical structures critical to the platform owner, and in some cases, critical to oil and gas production in the Gulf of Mexico in general. High-consequence structures are traditionally designed to 100-year conditions and this is the selected reference level condition for assessment per this Bulletin. Fixed platforms have the advantage of prior detailed work performed by API to develop API RP 2A-WSD, Section 17 (Kreiger, et al., "Process for Assessment of Existing Fixed Platforms to Determine their Fitness for Purpose," OTC Paper 7482, *Offshore Technology Conference*, Houston, Texas, 2 – 5 May, 1994). This work determined that the acceptable RSR for A-1 manned-evacuated GOM structures is 1.2.

C.4.3 Assessment Process (Floating Structures)

For floating structures, there is little existing guidance for assessment. Floating platforms do not have the benefit of a single strength measure, like the RSR for fixed platforms, due to their intricate design, complex motions and influence on other critical systems such as risers. A three step approach is therefore described that includes a Design Level Check, a Survival Check and a Robustness Check.

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