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ISO OFFSHORE STRUCTURES STANDARD

BACKGROUND SCOPE AND CONTENT

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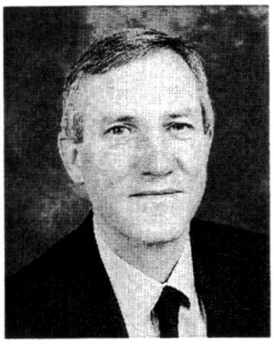

Richard Snell, born in 1947, obtained a degree in Civil Engineering from Leeds University. He is the Chairman of the ISO Offshore Structures Standard Committee and also of the Oil Industry Exploration and Production Forum Structures Sub-Committee.

1. Background to Standardisation in the Oil Industry

The Oil Industry has a long tradition of co-operation between Oil Companies on Engineering Standards. Although the Companies are competing on the acquisition of oil acreage and the efficient development of oil fields engineering integrity is recognised as a common interest and not an area of competition. A problem for one company has an impact on the reputation of the whole of the industry. This recognition also extends to the Contractors and Consultants supporting the Oil Companies who also participate in the preparation of Standards.

The Oil Industry first developed in the USA and a significant number of the principal Oil Companies and Contractors are US based. The American Petroleum Institute (API) has formed the central administrative organisation for Oil Industry Standards since 1923. Although the API is US based the principal non US companies are members and actively participate in the technical work. For a long time the API Standards have been the main Standards addressing the Industries specialised needs and are used worldwide. Where the API Standards do not address a routine Oil Industry topic other Standards have become de-facto Standards and are used by the Industry on a worldwide basis. One example of this is the Norwegian Standard NS 3473 for the design of Concrete Structures.

The first offshore structures were built less than 50 years ago. Initially they were in very shallow water and used pier type technology. In response to an Industry need to move into deeper water the API Offshore Structures Recommended Practice RP2A was developed and first issued in 1969. The pace of technology development and the effort that the Industry has put into this aspect of standardisation has led to 21 updates of this Practice in 25 years. A comparison of figures 1 and 2, 1970 and 1995 vintage structures respectively, shows the improvement that can be attributed to this updating of Industry practice.

Oilfield developments in industrially developed areas outside the USA, notably in N W Europe from the mid 1970's, led to the creation of regulations defining legal and technical requirements for some specific countries. The Oil Industry continued to design primarily to the API Standards with supplementary considerations for country requirements.

The initiative by the EEC European Standards Committee to produce a suite of European Standards and make them mandatory within the EEC provided the impetus for the Oil Industry to re-consider their approach to Standards and to conclude that in the long term a stand alone approach was not appropriate. The Industry, as its operations are worldwide, decided to put its future Standardisation effort into developing Standards under the administration of the International Standards Organisation and in 1989 devised under ISO Technical Committee 67 "Materials and Equipment for Petroleum and Natural Gas Industries" a structure of 7 sub-committees to address the principal technical areas within an oilfield. ISO TC 67 Sub-committee 7 was given a brief to prepare an ISO Offshore Structures Standard.

2. Scope of the ISO Offshore Structures Standard

The scope of work as defined by ISO is:-

Standardisation of:

Offshore Structures used in the Production and Storage of Petroleum and Natural Gas.

Procedures for the Assessment of the Site Specific Application of Mobile Offshore Drilling and Accommodation Units for the Petroleum and Natural Gas Industry.

The includes the sub-structure, station keeping and topsides structure for:-

- Fixed Steel and Concrete Platforms
- Semi-submersibles
- Ship type structures acting as stationary production or storage vessels.
- Tension Leg Platforms
- Spar Buoys
- Arctic Structures

- and the mooring assessment for site specific application of semi-submersibles and strength and stability assessment for jack-up drilling or accommodation units.

To date the Industry has concentrated most of its technical development effort on Fixed Structures of which some 7000 have been built around the world. Floating Production and Storage Structures are comparatively recent and not many have been built. Of those built to date most have been for short life fields in benign environments and have used converted ship or semi submersible hulls. Long life developments in deepwater and/or harsh environments require specific design considerations and conventional solutions may prove inappropriate.

As an example in a recent study BP has identified the technical, cost and schedule merits of concrete for hull construction.

In undertaking this task TC 67/SC 7 also has to:-

- Harmonise the API design provisions with the latest technology and with regional regulatory design criteria.
- Allow the use of a worldwide spread of national or regional standards for non-oil industry specific issues such as design of conventional components, materials, weld quality, corrosion etc.
- Allow variation in serviceability levels according to criticality as assessed by regional practice.
- Continue to provide the highly detailed primarily informative technical content normally in API Standards, considered essential to our Industry, within the essentially normative format of ISO Standards.
- Take into account existing ISO, IMO and Classification Society documents.
- Whilst making reference to other national and international design provisions for discrete components, which may vary in the reliability of the product, maintain and acceptable consistency in the reliability and serviceability of the overall structure.

It is an understatement to say that the breadth of this scope, the pace of technical development, the complexity that internationalisation of reference standards and hence the variability that it creates and the number of areas where new technology has to be developed presents a challenge.

3. Content of the Standard

The content of the ISO Offshore Structures Standard will address issues specific to the Oil Industry and make reference to other Standards for aspects not unique to our Industry and adequately addressed elsewhere. In general topics such as the design of concrete and conventional steel sections, materials, testing, fabrication and corrosion are handled by reference.

Topics addressed in detail in the Offshore |Structures Standard are:-

- Derivation of oceanographic design criteria.
- Marine soils investigation.
- Procedure for derivation of site seismicity and seismic design.
- Procedure for calculation of environmental loads.
- Extreme, persistent, transient, accidental and serviceability design limit states.
- Loads and load combinations.
- Load Factors and Resistance Factors for the design of substructure components.
- Performance service levels.
- Load Factors and loads for topsides design.
- Strength equations and material resistance factors for large diameter tubular structures.
- Large diameter pile design provisions.

- Guidance on analysis and modelling.
- Materials and fabrication requirements.
- Design procedures for hydrocarbon fire and blast events.
- Whole life cost issues.
- Re-assessment of existing structures.
- Hull requirements in addition to Class Rules for Production or Storage duty.
- Design procedures for Tension Leg Platforms.
- Design procedures for a spread mooring system including system considerations and integration with marine risers.
- Jack-Up platform strength and stability assessment procedures.
- Weight Control.
- Good practice experience that contributes to safe operation.

4. Format of the Standard

The format of the Standard, recognising the difficulty of using a 1000+ page document, has been planned the meet the likely needs of designers and the requirement to allow for future updates of discrete sections without re-printing the whole document.

Part 1 General Requirements
General Annexes to Part 1 on Metocean, Foundation, Seismic and Topsides
Regional Annexes to Part 1 identifying regional provisions and regulations

Part 2 Fixed Steel Structures
Informative Annex

Part 3 Fixed Concrete Structures
Informative Annex

Part 4 Floating Structures
Sub-parts for each structural form, moorings and risers.

Part 5 Site Specific Application of MODU's
Sub-parts for Semi-submersibles and jack-ups.

Figures 3 and 4 give an indication of the document format.

5. Programme

Part 1 is complete and should be published as ISO Standard 13819 in late 1995. It is intended that Parts 2 and 3 be completed by ISO TC 67/SC 7 and forwarded to ISO for ballot by the end of 1997. Part 4 should reach this stage by the end of 1998.

6. Principal Design Considerations for an Offshore Structure

The driving criteria for the in place design of a fixed offshore structure are the water depth, the wind/wave/current loading and the configuration and mass of the topsides. The primary requirement is adequate strength and durability. For a floating structure motions, stability, buoyancy and station keeping are also fundamental requirements.

6.1 Environmental Actions

For most structures the designer has to determine the design environmental events from first principles. This requires ownership or access to data which can be used to generate long term extreme criteria in terms of wave height, period, crest elevation, wind speed, and the tidal, surge, surface shear etc components of current. All these have seasonal and directional variation. Individual extremes for each element are combined to predict directional design events, normally with a return period of 100 years.

The classical method of deriving the extreme design load is to predict the environment and then derive loads using a well proven and calibrated procedure based on the Morrison equation. As structures move into deeper water and become more dynamically sensitive the more sophisticated designers are calculating structure response to a population of severe storms, extrapolating to a 100 year response and then deriving an associated set of environmental inputs for detailed component design. The environmental load factor varies on a regional basis depending on the environmental conditions. The variability associated with a tropical storm (hurricane) environment is greater than that associated with extra tropical areas such as N W Europe. Typically a load factor of 1.35 is used on a 100 year return period event. The associated material resistance factor is 0.85.

For a floating structure the extreme event may not be associated with the most extreme conditions. Situations where the current is acting in a different direction to the waves may well provide the most extreme mooring forces. Hull forces on a monhull are driven at the margins more by wave steepness than extreme wave height. A semi-submersible is often most vulnerable to quartering seas when the wave action is trying to alternatively part then close the hulls. Design predictions are normally made using model testing to confirm and calibrate analyses. The limit state design procedure is stretched when addressing highly compliant structures. Applying a load factor other than 1.0 to heave, pitch, roll, surge, sway and yaw motions is meaningless.

6.2 Transient Actions

Whilst the overall design of and offshore installation is governed by global loads many of the individual components are likely to be governed by transient actions. The actions arising from lifting or skidding a large structure onto a transport barge, transit to site and launch or lift into place are structure specific and whilst general load factors will be provided it is acknowledged that they are subject to individual Project situations.

Typically the variance in potential loads as a structure is skidded along beams and onto a transport barge will depend on:-

- Vertical stiffness of piles supporting the launch beams.
- Barge stiffness.
- Structure stiffness.
- Barge ballast system control.

In transit the variance in loads is a function of the roll and pitch motions of the barge. These can be controlled within reason by accepting weather limitations on the tow but roll angles of 15 degrees are generally considered for harsh condition tows.

The variance in potential loads in the slings and lifting structure during a heavy offshore lift is governed by crane barge control. There are essentially three very large masses. A typical scenario would be a 120,000T crane barge, a 30,000T transit barge with a 10,000T module to be lifted from it. For defined control capabilities load factors for the slings and lifting structure have been developed.

6.3 Accidental Actions

Typical accidental actions would comprise impact by a ship, hydrocarbon fire and/or blast, dropping of a heavy object and helicopter heavy landing.

For vessel impact the structure would be expected to withstand the impact energy associated with low speed manoeuvring of a supply vessel. It is not feasible to design to withstand a large commercial vessel at normal transit speed thus collision management measures are used as the primary means of defence. A load factor of 1 is used on energy absorbed.

Hydrocarbon incidents are addressed by a risk based design approach. The objective being to limit the risk of fatality of any individual working offshore. Normally this translates into limiting the spread of damage and ensuring personnel can be evacuated. It is reasonably practicable to design to withstand overpressures of 1.5 bar and fires of up to 1200 degrees centigrade for a limited duration. In so doing the limit states are related to deflections which might cause supplementary hydrocarbon releases rather than load.

6.4 Serviceability

To satisfy operational requirements a number of serviceability limits in terms of deflection of plant support structure have to be provided. These are often expensive if obtained by stiffness of the primary structure and may be achieved by local substructures for discrete plant items.

The serviceability of the overall structure is primarily an issue of fatigue and ductility requirements. A typical N W Europe structure would see around 5 million wave cycles per annum and have a life of 20 years. Specific design requirements for an offshore structure are provide in the Standard but the underlying technology is not unique to our Industry. Where we are potentially setting a first is in the harmonisation of fatigue curves and material performance requirements on a worldwide basis. Serviceability for fatigue is normally expressed in multiples of the design life with differing requirements according to in service inspectability. The fatigue durability of highly loaded tubular joint fabrications are sensitive to fabrication tolerances and weld quality thus the Standard gives very specific guidance on these aspects.

In addition to material considerations ductility of the whole structure as a system is normally calculated by a non linear "push over" analysis where the design load is factored up in successive analyses with failed components removed in a realistic manner to determine the Reserve Strength. This approach is particularly relevant when considering an innovative geometry and when re-assessing an existing structure or one that has suffered some damage.

7. Summary

The Oil Industry is preparing an ISO Offshore Structures Standard incorporating the knowledge held within the Industry. It is a substantial task in that it will have a large number of structural forms and controlling criteria with regional variations for worldwide application. The Standard references other existing Codes for all no Oil Industry specific issues.

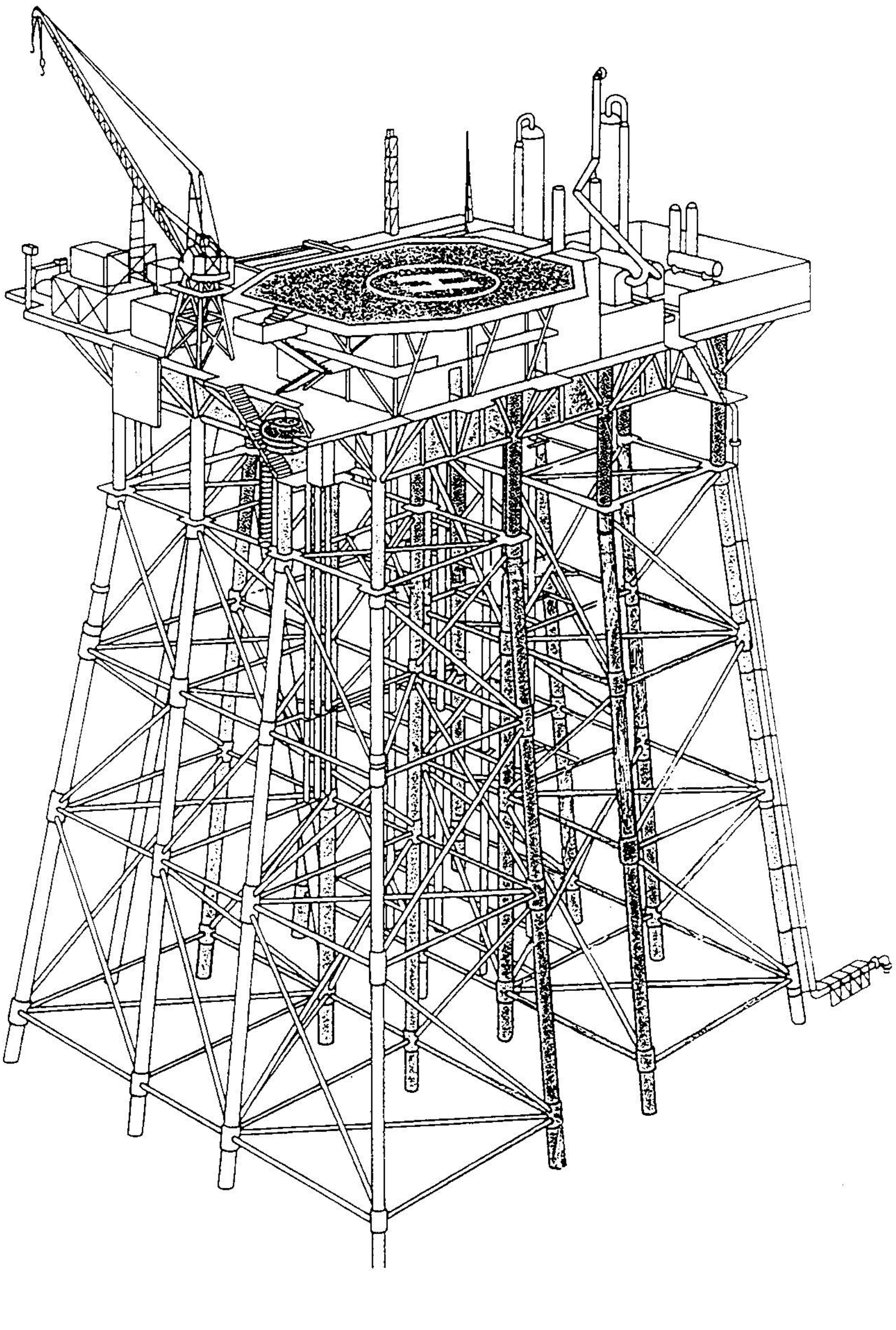

FIGURE 1

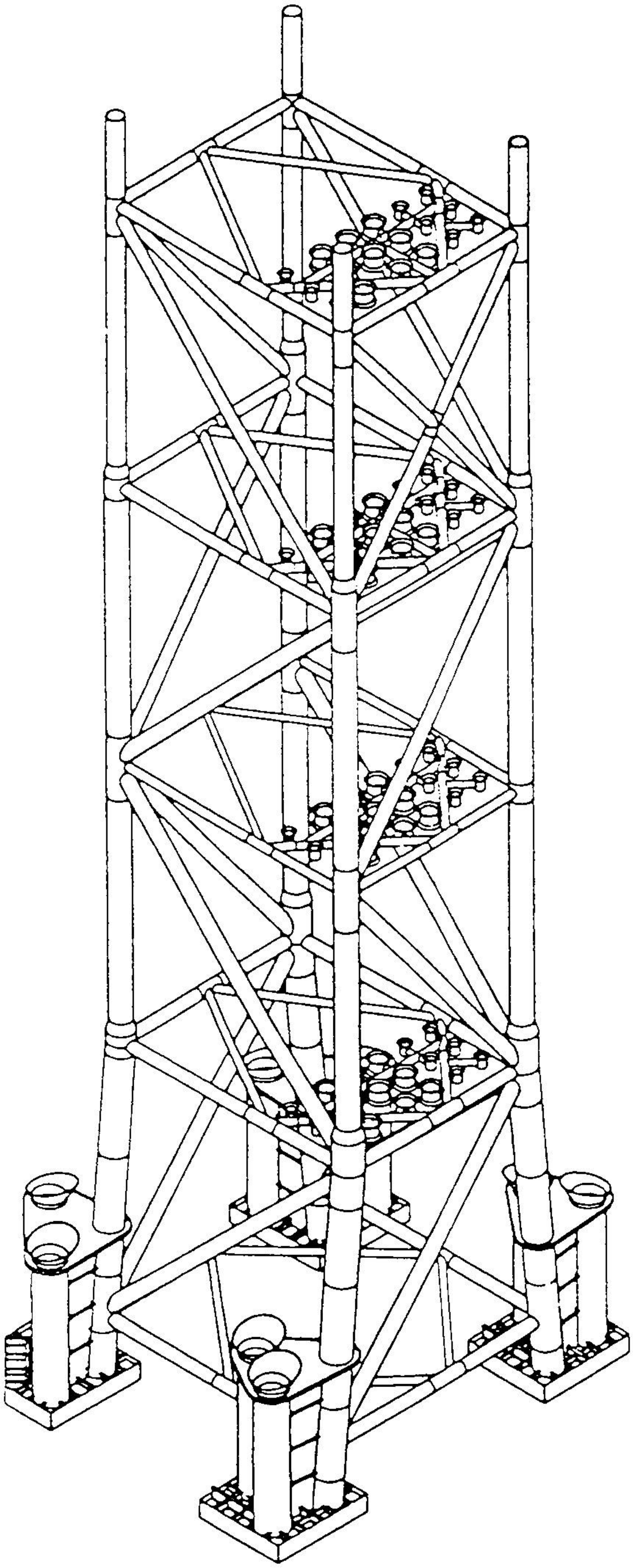

FIGURE 2

ISO Standard for Offshore Structures

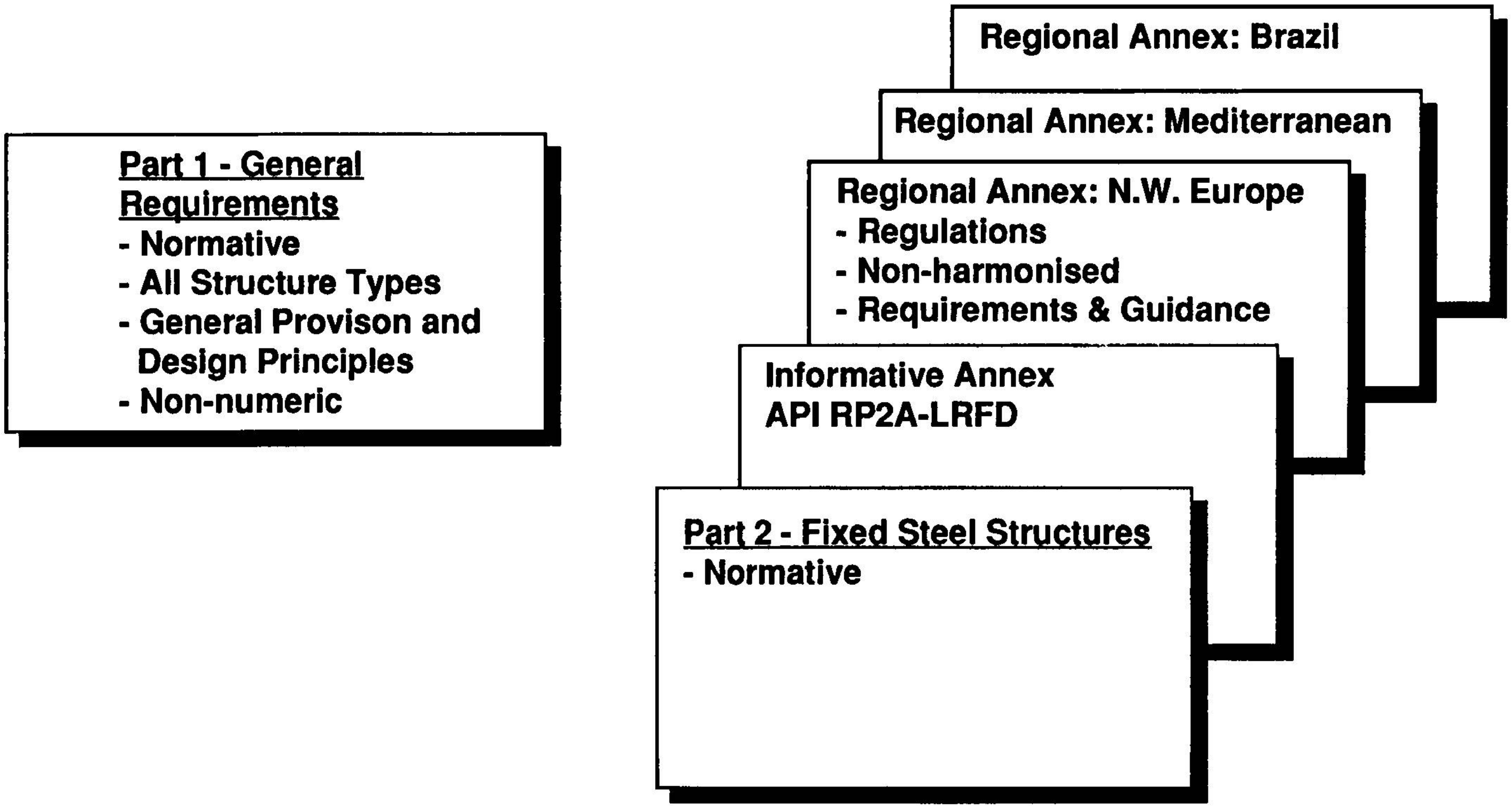

FIGURE 3

ISO Standard for Offshore Structures

Regional Annex

Informative Annex to Part 2

Part 2

FIXED STEEL STRUCTURES

- Normative
- Whole Life-Cycle Design
- Harmonised Technical Requirements
- Loads
- Resistances Foundation
- Substructure
- Topsides Structure

Regional Annex

Informative Annex to Part 3

Part 3

FIXED CONCRETE STRUCTURES

- Normative
- Whole Life-Cycle Design
- Harmonised Technical Requirements
- Loads
- Resistances Foundaton
- Substructure
- Topsides Structure

Regional Annex

Informative Annex to Part 4

Part 4

FLOATING STRUCTURES

- Normative
- Whole Life-Cycle Design

Regional Annex

Informative Annexes

Further Parts

- Arctic Structures
- MODU Site-specific assessments

FIGURE 4

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