Comparison of fatigue provisions in codes and standards

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1. INTRODUCTION

The purpose of this technical note is to present a comparison of the fatigue provisions in the following documents:

1. NORSOK Standard. Design of Steel Structures. N-004. Rev 1, December 1998.
2. HSE 4th Edition Guidance Notes. Offshore Installations: Guidance on Design, Construction and Certification. 1993 Consolidated Edition with Amendment 3 (1995).
3. Eurocode 3: Design of Steel Structures - Part 1.1: General Rules and Rules for Buildings. ENV 1993-1-1, April 1992.
4. ISO. Petroleum and Natural Gas Industries - Offshore Structures - Part 2: Fixed Steel Structures. ISO/CD 13819-2. Draft 14.05.99.
5. API. Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms. API RP2A WSD (20th Edition, July 1993) & LRFD (1st Edition, July 1993).
6. IIW. Fatigue Design of Welded Joints and Components. A Hobbacher (ed.). Recommendations of IIW Joint Working Group XIII-XV. XIII-1539-96 / XV-845-96. Abington Publishing, 1996.
7. BSI. Code of practice for fatigue design and assessment of steel structures. BS 7608: 1993 (with amendments AMD 8337, 15 February 1995).

The comparison covers general aspects, including the overall approach taken to fatigue assessment, safety factors, and modifications to S-N or fatigue strength curves (e.g. for thickness effects and weld improvement). The S-N curve parameters are itemised for each document and comparisons between the curves made for joints in air, in seawater with adequate corrosion protection, and in seawater with free corrosion. Comparisons for nodal tubular joints and cast joints are given separately.

In Section 4, a summary table is provided to give an overall comparison between the S-N provisions of the various documents.

2. GENERAL COMPARISONS

2.1 OVERALL APPROACH TO FATIGUE ASSESSMENT

2.1.1 NORSOK N-004

The NORSOK standard is a limit state document dealing with the design of steel offshore structures. As such a partial safety factor approach is taken. Chapter 8 deals with fatigue, and is very short, extensive detail being provided in Annex C. This covers fatigue strength analysis (terminology used for fatigue life calculation), and is supported by three Appendices dealing with classification of structural details, stress concentration factors (SCFs) for tubular joints and SCFs for cutouts.

Fatigue assessment is by the standard combination of appropriately factored nominal stress ranges (either through SCFs or constructional detail classification against “standard types”), S-N curves, and the Palmgren-Miner linear cumulative damage rule. Design fatigue factors (DFFs) are applied as multipliers on the number of load cycles before computation of cumulative damage, and the result compared with unity to assess acceptability. [In practical terms the comparison would be made between unfactored damage and the inverse of DFF]. The DFFs are set according to accessibility for inspection and repair, and damage consequence.

Design S-N curves are provided for a variety of classified structural details (see below) as well as tubular joints. These curves are either bi-linear, or linear, on log-log plots of stress range versus number of cycles to failure (endurance). Separate sets of curves are given for joints in air, in seawater with cathodic protection and in seawater with free corrosion. No endurance limits are specified on these curves, but conditions are given of situations where a detailed fatigue analysis can be omitted.

Modifications to the design S-N curves must be made to allow for thickness effects. Fatigue life enhancements are also allowable, to introduce the influences of weld improvement techniques.

2.1.2 HSE 4th Edition Guidance Notes

The HSE 4th Edition Guidance Notes were not intended to be a comprehensive design code. They have been withdrawn, but were originally issued to provide guidance on specific aspects of design, construction and certification of offshore installations. Section 21 of the document deals with steel, from a design point of view, with subsections 21.2.10 - 15 covering fatigue aspects relevant to welded connections. An appendix to the main section (A21) provides additional information, particularly in respect of derivation of stress concentration factors and construction detail classification for fatigue purposes.

The guidance notes evolved in an era preceding general use of limit state design for steel, and an allowable stress approach was therefore taken in Section 21 of the guidance. It was acknowledged, however, that limit state was due to take pre-eminence and permitted the use of these type of codes/standards provided that the level of safety achieved was not less than that from an allowable stress approach.

Fatigue assessment is by a combination of the product of nominal stress ranges and SCFs or stress factors, S-N curves, and the Palmgren-Miner linear cumulative damage rule. The damage is compared with unity to assess acceptability, but no safety factors are specified in the document.

The setting of SCFs and their derivation is dealt with in the appendix to Section 21. A system of joint classification is used to deal with a variety of constructional details in terms of classification factors which are used as multipliers on stress range in conjunction with the appropriate S-N curve. Welded details are dealt with as either “classified” (i.e. falling within the scope of the information provided) or “unclassified”.

Basic S-N curves are provided for plate connections, cast joints and tubular joints. The plate and tubular joint curves are modified to account for the environment and the degree of corrosion protection. The plate S-N curves are used in conjunction with the classification factors to deal with, largely, non-tubular joint connections. The S-N curves provided are either bi-linear, or linear, on log-log plots of stress range verus endurance. None of the curves has an endurance limit.

Modifications to the basic S-N curves may be made to allow for member thickness effects, and the influences of weld improvement techniques.

2.1.3 Eurocode 3

Eurocode 3 is a limit state code dealing with the design of steel structures. As such, partial safety factors are applied separately to loads and resistances to obtain the required safety level. Part 1.1 covers general rules and rules for buildings, and Chapter 9 deals with fatigue. Being essentially an onshore code, the necessity for fatigue assessment does not include fluid-induced oscillations. Moreover, the code limits the fatigue strengths specified as applicable to structures with suitable corrosion protection and subjected only to a mildly corrosive environment (such as normal atmospheric conditions).

S-N curves are referred to as “fatigue strength curves” and partial safety factors are applied to these according to accessibility of the component during periodic inspection and maintenance, and the consequence of failure.

The fatigue assessment procedures essentially start from a set of defined constructional details. Different routes through the process are taken if the detail

under consideration falls within the classification, or differs from any standard detail classified, and/or is unclassified. The routes prescribe the types of fatigue stress range that can be used in the assessment (nominal or geometric) along with the fatigue strength curve to be applied. Constant amplitude and variable amplitude loading are addressed. In the case of the latter (the more general), assessment may be based on cumulative damage (Palmgren-Miner rule) or equivalent constant amplitude. Normal stresses (to the weld) and shear stresses, individually applied or in combination can be dealt with.

Fatigue strength curves are bi-linear, or linear, on log-log plots of fatigue strength (stress range) versus endurance, with some also having endurance limits (cut off levels).

Fatigue strength modifications may be made according to the thickness of the detail, and the use of weld improvement factors.

2.1.4 Draft ISO/CD 13819-2

The draft ISO document ISO/CD 13819 is a limit state code dealing with the design of offshore structures for the petroleum and natural gas industries. A partial safety factor approach is taken. Part 2 of this draft international standard covers fixed steel structures and Chapter 15 of Part 2 deals with fatigue strength of connections. There is also an extensive background and other information in an appended commentary, the fatigue section of which is A.15.

Fatigue assessment is by a combination of nominal or geometric stress ranges (obtained by the product of nominal stress ranges and SCFs), S-N curves and the Palmgren-Miner linear cumulative damage accumulation rule. A partial safety factor is applied to the cumulative damage, and the result compared with unity to assess acceptability.

Safety factors are intended to depend on the failure consequences of the component under consideration (i.e. criticality) and in-service inspectability. The detailed setting of values of safety factors is, however, discussed in the commentary rather than being prescribed in the body of the standard. The same is true for the values of stress concentration factors for tubular joints, and the determination of geometric stresses for other types of connections. The latter are handled by a system of classification of constructional details, allied to “stress classification factors” instead of SCFs.

Basic design S-N curves are provided for tubular joints (TJ), cast joints (CJ), and other connections corresponding to the classification of constructional details referred to above. It is worth noting that the commentary refers to a class of detail “G” for which no S-N curve is given in the main body of the standard. The S-N curves provided are bi-linear on log-log plots of stress range versus endurance, and options are given for

joints in air or seawater with adequate corrosion protection (CP). Information concerning S-N curves for joints without adequate CP is given in the commentary. No endurance limits are specified for any of the basic S-N curves.

Modifications to the basic S-N curves may be made to allow for thickness effects, and the influences of weld improvement techniques.

2.1.5 API RP2A

API RP2A deals with planning, designing and constructing fixed offshore platforms. Design is according to a load and resistance factor approach or a working stress type approach in the LRFD and WSD versions of this document, respectively. In the LRFD version, whilst not a limit state code, partial safety factors are applied separately to loads and resistances. Section F deals with fatigue and makes reference to Section L, which covers fabrication, including weld profiling.

Fatigue assessment is by means of S-N curves and the Palmgren-Miner linear cumulative damage accumulation rule. Nominal stresses (e.g. from a space frame analysis) are used in the computation of stress ranges, along with suitable stress concentration factors to give hot spot stresses. The microscopic effects, occurring at the toe of a weld under consideration, are reflected in the choice of an appropriate S-N curve. The only S-N curves provided in the document relate to tubular joints in steel structures and modifications are to be applied to these to account for operating environment, thickness effects and so forth.

The cumulative damage is multiplied by a safety factor sufficient to give a design fatigue life of the weld under consideration equal to twice the intended service life of the structure.

2.1.6 IIW Recommendations

The IIW document is not a code of practice or a standard but sets out recommendations for the fatigue design of welded joints and components. It does follow the ISO format insofar that fatigue action and fatigue resistance are clearly separated, allowing for the use of partial safety factors on “load” and “resistance”. No recommendations are given for the fatigue load (action) side, nor for the partial safety factor on fatigue actions.

The fatigue resistance data given in the document refer to non-corrosive environments, with normal protection against atmospheric corrosion assumed. No specific recommendations are given in the document for corrosion fatigue assessment.

The different approaches for the fatigue assessment of welded joints and components considered are: nominal stress, geometric stress (hot spot stress), effective notch

stress, fracture mechanics method and component testing. The approaches of most relevance to the present discussion are those based on nominal stress and geometric stress.

The overall approach taken to fatigue assessment is broadly similar to that in Eurocode 3, discussed above. The process starts with defining the constructional detail under consideration. Different routes through the process are taken if the detail falls within the set of standard classified types given, differs from those classified, or is unclassified. If the joint corresponds to a classified detail, assessment is based on nominal stress. Alternatively, assessment uses the geometric stress, and in the case of nodal tubular joints this would involve the use of the nominal stress and appropriate SCFs. Constant amplitude and variable amplitude loading are dealt with using different fatigue strength (S-N) curves. In the case of variable amplitude loading (the more general case), assessment is based on cumulative damage (Palmgren-Miner). The document recommends that for load spectra which are sensitive to the position on the S-N curve of fatigue limits or cutoff limits, additional assessment using a nonlinear damage calculation method should be carried out. It is also recommended that, in cases where no test data or service experience exist and the stress spectrum is not close to constant amplitude, only half of the calculated life should be assumed.

The fatigue strength curves to be used in variable amplitude loading assessment are bi-linear on log-log plots of stress range versus endurance. They also have cutoff limits.

2.1.7 BS 7608: 1993

BS 7608: 1993 gives recommendations for methods for the fatigue design and assessment of parts of steel structures that are subject to repeated fluctuations of stress. It is restricted to wrought structural steel with a specified minimum yield strength less than 700 MPa. The document is intended to be generic, possibly used as an adjunct to other specific structure-related design codes. As such, it is not stated to be either “limit state” or “working stress” and could take up whatever philosophy is inherent in the citing structure-specific code.

The document has four main sections dealing with: general aspects, classification of details, stress calculations and allowable fatigue stresses. The main document is supported by a number of annexes dealing with specific technical items. These include Annex A, which covers fatigue design philosophy.

Fatigue design and assessment is achieved by the standard combination of stress ranges (nominal, coupled to standard detail classification or geometric, the latter including SCFs), S-N curves for standard details, and the Palmgren-Miner linear cumulative damage rule for joints subjected to a stress spectrum. The joint is deemed satisfactory if the cumulative damage is less than unity.

S-N curves are provided for a variety of classified structural details. These are termed "basic" S-N curves, and are mean fits through experimental data. For the purposes of design, "standard basic" curves are derived from these by taking two standard deviations below the mean values (see below). Strictly speaking, the term "design" curve is used for the curve specific to the detail under consideration. S-N curves are linear on log-log plots of stress range versus endurance, and are made bi-linear in the standard manner to deal with spectra that contain a range of low stress cycles. The curves given are applicable to joints in air, or in contact with seawater but having adequate corrosion protection. Provision for joints in seawater under free corrosion is made by a simple factor applied to the design curve. No endurance limits are specified on these curves, but conditions are given that lead to situations where a detailed fatigue analysis can be omitted.

Modifications to the design S-N curves must be made to allow for thickness effects. Fatigue life enhancements are also allowable, to introduce the influences of weld improvement techniques.

2.2 SAFETY FACTORS

2.2.1 NORSOK N-004

NORSOK N-004 provides partial safety factors (design fatigue factors) which are applied as divisors of unity in the damage accumulation check. Their values depend on the combination of, for the component under consideration, the consequence of damage for the structure as a whole, and its degree of access for inspection and repair. The DFFs are set out in the table below.

Access for Inspection and Repair	**Damage Consequence**	
	Without Substantial Consequence	**Substantial Consequence**
Accessible above splash zone	1	2
Accessible below splash zone	2	3
Inaccessible or within splash zone	3	10

2.2.2 HSE 4th Edition Guidance Notes

No safety factors are specified in this document, but reference is made to background information for an additional factor on fatigue life.

2.2.3 Eurocode 3

Partial safety factors are applied to the fatigue strength curves according to the accessibility of the component during periodic inspection and maintenance, and the consequences of failure. Components are designated as “fail safe” or non “fail safe” according to whether local failure for the component:

- does not result in failure of the structure
- leads rapidly to failure of the structure.

The partial safety factors are summarised in the table below. It should be noted that the UK National Application Document (NAD) sets the values given in brackets in the table.

Periodic Inspection and Maintenance, Accessibility	“Fail Safe” Components	Non “Fail Safe” Components
Accessible joint detail	1.00 (1.00)*	1.25 (1.00)
Poor accessibility	1.15 (1.00)	1.35 (1.00)
* (...) value set by UK National Application Document (NAD)		

2.2.4 Draft ISO/CD 13819-2

The main body of the standard recommends that for inspectable, non-failure critical connections, and in lieu of a more detailed assessment, a safety factor of 2.0 (as a multiplier on cumulative fatigue damage) should be used. When it can be justified, a reduced value can be taken, but only to a minimum of 1.0.

The commentary provides more information and limited guidance on further adjustments to the safety factor. These adjustments may cover risk (safety and environmental), component location (i.e. ease of access) and inspection technique. In the absence of such detailed considerations, it is recommended that the safety factors are taken from the simple matrix of values given below.

Inspection	Non “Failure Critical”	“Failure Critical”
Inspectable	2	5
Not inspectable	5	10

2.2.5 API RP2A

No specific recommendations regarding safety factors are given in this document with the exception of ensuring that the design fatigue life of the connection under consideration is greater than or equal to twice the intended service life of the structure.

2.2.6 IIW Recommendations

No specific recommendations regarding the values to be taken for partial safety factors are given in this document. An appendix outlines statistical considerations for safety and gives a possible example of partial safety factors for fatigue resistance based on consequence of failure and "life strategy" for the component, as follows:

Consequence of Failure	Fail Safe and Damage Tolerant Strategy	Safe Life and Infinite Life Strategy
Loss of secondary structural parts	1	1.15
Loss of entire structure	1.15	1.3
Loss of human life	1.3	1.4

2.2.7 BS 7608: 1993

No specific values of safety factors are given in BS 7608:1993. However, for each class of joint the relationship between the applied stress range and the endurance is as follows:

$$\log N = \log a_0 - d\sigma - m \log \Delta\sigma = \log a - m \log \Delta\sigma$$

where N is the endurance
a_0 is the mean value of the S-N curve constant
d is the number of standard deviations below the mean
σ is the standard deviation of $\log N$
m is the inverse slope of the $\log \Delta\sigma$ versus $\log N$ (S-N) curve
$\Delta\sigma$ is the stress range
a is value of the S-N curve constant used for design/assessment purposes.

Values of a_0, d and σ are tabulated in the document and appropriate curves determined through the use of these. In particular the values of d are related to the nominal probabilities of failure as follows:

Nominal Probability of Failure (%)	d
50	0 §
31	0.5
16	1.0
2.3	2.0 #
0.14	3.0
§ mean line curve # standard design curve	

Thus, the standard design curve would be obtained through the use of a value of d of 2.0, but as indicated in Annex A of the document, other values could be taken depending on the consequential criticality of fatigue cracking.

2.2.8 Nature of S-N Curves in Relation to Safety Factors

The basis of comparison used here is quoted *design* S-N curves from each document. In each case, these tend to be some form of characteristic curve, although their derivation may differ from document to document. The designer, in using the S-N curves and possibly making comparisons between fatigue lives derived from different documents, would not necessarily be cognizant of these subtle differences. Such comparisons would therefore include inherent safety factor differences due to the different derivations of the characteristic S-N curves.

For information, the bases of derivation of each of the characteristic sets of S-N curves are as follows:

Document	Basis for Characteristic/Design S-N Curve
NORSOK N-004	mean minus two x standard deviation on logN test data
HSE 4th Ed GNs	mean minus two x standard deviation on logN test data
EUROCODE 3	75% confidence interval of 95% probability of survival for logN test data, accounting for standard deviation and sample size
ISO/CD 13819-2	95% confidence interval of 97.5% probability of survival for logN test data
API RP2A	Lower bound on test data
IIW	95% probability of survival for logN test data, from mean value two-sided 75% confidence level
BS 7608:1993	mean minus two x standard deviation on logN test data

2.3 MODIFICATIONS TO S-N CURVES

2.3.1 Thickness effects

In all the documents the S-N curves provided are based on a standard thickness t_0. To account for components that have thicknesses that are in excess of this, the stress ranges are changed in the following way:

$$\Delta\sigma_t = \Delta\sigma\left(\frac{t}{t_0}\right)^q$$

where $\Delta\sigma_t$ is the increased value of stress range
$\Delta\sigma$ is the original value of stress range
t is the thickness of the component under consideration
t_0 is the thickness associated with the S-N curve under consideration
q is a thickness correction exponent.

The values of the parameters t_0 and q differ from document to document, and between types of connection as set out in the table given below.

In the case of the **NORSOK** document, for standard connections the thickness correction exponent depends on which S-N curve is under consideration. For tubular joints, the thickness correction exponent depends on the SCF used for the weld under consideration:

$SCF \leq 10$	$q = 0.25$
$SCF > 10$	$q = 0.30$

In the case of **API RP2A**, two S-N curves are provided for tubular joints, each with its respective value of branch thickness.

Otherwise, the respective values of t_0 and q are summarised in the following table.

		NORSOK N-004	HSE 4th Ed GNs	EUROCODE 3	ISO/CD 13819-2	API RP2A	IIW	BS 7608: 1993
Standard Connections	t_0 (mm)	25	16	25	16	-	25	16
	q	0.0, 0.15, 0.20 or 0.30	0.3	0.25	0.3	-	0.1, 0.2 or 0.3	0.25
Tubular Joints	t_0 (mm)	32	16	25	16	16 or 25	-	16
	q	0.25 or 0.30	0.3	0.25	0.3	0.25	-	0.25
Cast Nodes/Joints	t_0 (mm)	25	38	-	38	-	-	-
	q	0.15	0.15	-	0.15	-	-	-

2.3.2 Weld Improvements

The **NORSOK** document, provided certain quality control aspects are followed, allows advantage to be taken of the following weld improvement techniques:

- weld profiling by machining or grinding
- TIG dressing
- hammer peening.

In TIG dressing, the weld toe is remelted and the weld pool is washed into the plate surface in such a way as to produce a smoother weld profile.

The **HSE 4th Edition Guidance Notes** indicate that for welded joints an improvement of 2.2 on fatigue life can be obtained by controlled local machining or grinding to produce a smooth concave profile at the weld toe, which blends smoothly with the parent metal. This benefit may be claimed for welded joints in air, and for joints exposed to seawater with adequate corrosion protection.

ISO/CD 13819-2 suggests that post-weld fatigue improvement techniques may be used to improve fatigue life. These techniques work by modifying the local geometry at the weld toe, reducing the stress concentrations and modifying residual stresses.

The techniques that can be employed include weld profiling, weld toe grinding, flush grinding of butt welds and hammer peening.

API RP2A indicates that weld grinding has beneficial effects on fatigue life and suggests that under certain circumstances, the thickness correction need not be applied in cases where the thickness of the component exceeds that corresponding to the S-N curve under consideration.

The **IIW** recommendations indicate post weld improvement techniques may raise the fatigue resistance. These techniques can be classified into three types:

Improvement of weld profile	Machining or grinding of weld seam flush to surface Machining or grinding of the weld transition at the toe Remelting of the weld toe by TIG, plasma or laser dressing
Improvement of residual stress conditions	Peening (hammer, needle, shot or brush peening) Coining Overstressing Stress relieving thermal treatment
Improvement of environmental conditions	Painting Resin coating

BS 7608: 1993 discusses post-welding treatments (controlled machining, grinding and peening), but recommends that no advantage of improvement techniques should be taken at the initial design stage. However, advantage may be taken when assessment is carried out at a late stage of fabrication, or when the structure concerned is already in service. A specific enhancement factor on fatigue life is only given for weld profiling by machining or grinding.

The various improvement factors, where they are specified in the documents concerned, are summarised in the following table:

Improvement Technique	NORSOK N-004	HSE 4th Ed GNs	EUROCODE 3	ISO/CD 13819-2	API RP2A	IIW	BS 7608: 1993
Weld profiling by machining or grinding	2	2.2	-	2	-	-	2.2
TIG dressing	2	-	-	-	-	-	-
Hammer peening	4	-	-	4	-	-	-

2.4 PROVISIONS FOR CONSTRUCTION DETAILS

2.4.1 NORSOK N-004

This document provides sets of S-N curves for three environments, namely for joints in air, in seawater with cathodic protection, and in seawater with free corrosion. For each environment, fourteen curves (designated as B1 through to W3) are given for standard constructional details and one curve is provided for tubular joints (designated as T). For cast nodes, the C curve from the list of S-N curves for standard details is recommended for use.

Details of the parameters associated with each of the S-N curves are given in Tables A.1, A.2 and A.3 for joints in air, seawater with cathodic protection, and seawater with free corrosion, respectively. Essentially, the S-N curves in air, and in seawater with corrosion protection, are bi-linear on log-log plots of stress range versus endurance limit, taking exponents on stress range of 3 and 5 below and above the endurance at slope change, respectively. The endurance at slope change is 10^7 and 10^6 for joints in air, and in seawater with CP, respectively. They have no endurance limit.

The S-N curves for joints in seawater with free corrosion are a single line on a log-log plot of stress range versus endurance, i.e. no slope change is used. The exponent on stress range is 3. No endurance limit is used.

2.4.2 HSE 4th Edition Guidance Notes

This document provides basic design S-N curves for joints in air, seawater with cathodic protection, and in seawater with free corrosion. For each environment, two curves are given: one for plates (designated as the P curve) and one for welded tubulars (designated as the T' curve). A basic design curve for cast nodes (designated CS) is also provided, but this applies only to joints in air. The P curve is used to deal with standard non-nodal connections (standard construction details) in conjunction with weld classification factors. These act as multipliers on stress range

and by adopting values ranging from 0.64, through 1.00, to 2.54, have the effect of generating a series of eight P curves. The introduction of the weld classification factors has the effect of altering the intercept parameter of the basic design S-N P curve.

Details of the parameters associated with each of the S-N curves are given in Tables A.4, A.5 and A.6 for joints in air, seawater with cathodic protection, and seawater with free corrosion, respectively. Essentially, the P and T' S-N curves in air and in seawater with corrosion protection, are bi-linear on log-log plots of stress range versus endurance limit, taking exponents on stress range of 3 and 5 below and above the endurance at slope change, respectively. The endurance at slope change is 10^7 (both P and T' curves for joints in air), and 1.026×10^6 (P curves) or 1.745×10^6 (T' curve) for joints in seawater with CP. No curve has an endurance limit.

The S-N curve for cast joints is a single line on a log-log plot of stress range versus endurance, i.e. no slope change is used. The exponent on stress range is 4. No endurance limit is used.

The S-N curves for joints in seawater with free corrosion are a single line on a log-log plot of stress range versus endurance, i.e. no slope change is used. The exponent on stress range is 3. No endurance limit is used.

2.4.3 Eurocode 3

As stated above, the S-N curves provided in the Eurocode 3 document are only applicable to joints in air or in mildly corrosive environments with CP. The curves are designated by an integer number that represents the stress range on the S-N curve (in MPa) corresponding with 2 million cycles. Two sets of curves that are of interest here are given.

The first set of fatigue strength curves relates to the following five categories of typical constructional details:

1. Non-welded details
2. Welded built-up sections
3. Transverse butt welds
4. Welded attachments with non-load carrying welds
5. Welded joints with load carrying welds.

This set contains 14 S-N curves with designations ranging between 160 and 36 MPa. Details of the parameters associated with each of the S-N curves are given in Table A.7. Essentially, the curves are bi-linear on log-log plots of stress range versus endurance limit, taking exponents on stress range of 3 and 5 below and above the

endurance at slope change, respectively. The endurance at slope change is 10^6. They have an endurance limit of 10^8.

The second set of fatigue strength curves relates to joints in tubular lattice girders (the closest classification in this document to nodal joints in offshore steel structures). This set contains six S-N curves with stress range designations ranging between 90 and 36 MPa. Details of the parameters associated with each of the S-N curves are given in Table A.8. Essentially, the curves are linear on log-log plots of stress range versus endurance limit, taking an exponent on stress range of 5, with no slope change. They also have an endurance limit of 10^8.

Only a limited number of tubular lattice girder joints are classified, as follows:

1. Circular hollow sections, K and N joints with gap
2. Rectangular hollow sections, K and N joints with gap
3. Circular and rectangular hollow sections, K joints with overlap
4. Circular and rectangular hollow sections, N joints.

Quite severe restrictions on geometry are imposed on classified joints, to the extent that the majority of major nodes in an offshore structure would be “unclassified” and the most onerous fatigue strength curve (designation 36MPa) would have to be used for fatigue assessment.

2.4.4 Draft ISO/CD 13819-2

This document provides a set of basic design S-N curves for joints in air and in seawater with cathodic protection (single set). Using information given in the commentary, a set for joints in seawater with free corrosion can be derived from these. Thus, for each of these two environments, seven curves (designated as B through to W’) are given for standard constructional details, one curve is provided for tubular joints (designated as TJ), and one for cast nodes (designated as CJ).

Details of the parameters associated with each of the S-N curves are given in Tables A.9 and A.10 for joints in air and in seawater with cathodic protection, and seawater with free corrosion, respectively. Essentially, the S-N curves in air and in seawater with corrosion protection, are bi-linear on log-log plots of stress range versus endurance limit, taking exponents on stress range of 3 and 5 below and above the endurance at slope change, respectively. The endurance at slope change is 10^8. The exceptions to this are the C and CJ curves, which take exponents of 3.5 and 4 below the endurance at slope change, respectively. They have no endurance limit.

The S-N curves for joints in seawater with free corrosion are a single line on a log-log plot of stress range versus endurance, i.e. no slope change is used. The exponent on

stress range is 3 (with the exceptions of 3.5 and 4 indicated in the previous paragraph). No endurance limit is used.

2.4.5 API RP2A

These documents (the LRFD and WSD versions are the same in this respect) provide two basic design S-N curves only for circular tubular joints. They relate to joints in seawater with effective CP. The first curve (designated as the X' curve) relates to welds without profile control, but conforming to the basic standard AWS flat profile and with a branch thickness less than 16mm. The second curve (designated as the X curve) relates to welds with profile control and with branch thickness less than 25mm. Both curves are single lines on a log-log plot of stress range versus endurance, with exponents of 3.74 for X' and 4.38 for X, and have an endurance limit of 2×10^8 cycles.

These basic curves are modified to obtain curves for use on joints in atmospheric service, undergoing free or excessive corrosion, or located in the splash zone, by adjusting the endurance limits. For the case of atmospheric service, the endurance limits for the X' and X curve are set to 20 and 10 million cycles, respectively. For joints undergoing free corrosion, or located in the splash zone, no endurance limit is permitted.

In this way, six S-N curves for circular tubular joints can be generated. The details of the parameters associated with each of them are summarised in Table A.11.

2.4.6 IIW Recommendations

The S-N curves provided in the IIW document are only applicable to joints in air or mildly corrosive environments with CP. The curves are designated an integer number that represents the stress range on the S-N curve (in MPa) corresponding with 2×10^6 cycles.

The curves relate to nine categories of typical construction details:

1. Unwelded parts of a component
2. Butt welds, transverse loaded
3. Longitudinal load-carrying welds
4. Cruciform joints and/or T-joints
5. Non-load-carrying attachments
6. Lap joints
7. Reinforcements
8. Flanges, branches and nozzles
9. Tubular joints.

Despite its name, the last category does not include nodal type joints in steel offshore structures. Assuming these to be fillet welded connections, they are covered by the

procedure for dealing with fatigue resistance against geometric (hot spot) stress. This recommends that fillet welds at the toe should be assessed using curve designations 112 and 100, according to whether the weld toes are ground or in the as-welded condition, respectively.

As shown in Table A.12, the thickness correction exponent can take values between 0.1 and 0.3, according to the following:

Joint Category	Condition of Weld	q
Cruciform joints, transverse T-joints, plates with transverse attachments	as-welded	0.3
Cruciform joints, transverse T-joints, plates with transverse attachments	toe ground	0.2
Transverse butt welds	as-welded	0.2
Butt welds ground flush, base material, longitudinal welds or attachments	Any	0.1

2.4.7 BS 7608:1993

This document provides basic S-N curves that are applicable to joints which are either in air, or exposed to seawater but adequately protected from corrosion. Curves suitable for joints subjected to seawater and without corrosion protection, can be derived from the in-air ones by applying a dividing factor of 2 on fatigue life. Thus for each environment there is a total of eight curves (designated as B through to W) for standard constructional details, one curve for shear studs (S), and one for tubular nodal joints (T).

The standard constructional details are dealt with by twelve tables covering the following types:

1. Plain material
2. Lapped or spliced, rivetted or bolted joints
3. Fasteners
4. Continuous longitudinal welded attachments
5. Other welded attachments
6. Transverse butt welds in plates
7. Transverse butt welds in sections and tubes
8. Load-carrying fillet and T-butt joints
9. Slotted connections and penetrations through stressed members

10. Details related to tubular members
11. Seam welds in vessels
12. Branch connections to vessels.

Details of the parameters associated with each of the curves (in environments of air and seawater with adequate corrosion protection, and seawater with free corrosion) are given in Tables A.13 and A.14. The curves in air (or in seawater with adequate corrosion protection) are bi-linear on log-log plots of stress range versus endurance if low stress cycles are present in the stress range spectrum. The exponents range within 3 - 4, and 5 - 6, below and above the endurance at slope change, respectively. The endurance at slope change is 10^7. No curve has an endurance limit.

The S-N curves for joints in seawater with free corrosion are a single line on a log-log plot of stress range versus endurance, i.e. no slope change is used to deal with additional low stress cycles. The exponent on stress range is in the range 3 - 4. No endurance limit is used.

There are no S-N curves applicable to cast joints.

3. COMPARISON OF S-N CURVES

3.1 JOINTS IN AIR

A comparison between the S-N curves for joints in air is made in Appendix B. This is the only case for which it is possible to compare the curves from all the codes because of the restrictions on environment in Eurocode 3 and the IIW document. The entries from each document have been put into descending order according to the magnitude of the log(a) parameter corresponding with 16mm thickness and endurance less than that at slope change.

The list reveals that the correspondence between NORSOK and Eurocode 3 S-N curves (quoted in the NORSOK document). It would also be possible to place the curves from all the other documents into equivalent groupings. The NORSOK - Eurocode 3 correspondence is as follows:

NORSOK	Eurocode 3
B1	160
B2	140
C	125
C1	112
C2	100
D	90
E	80
F	71
F1	63
F3	56
G	50
W1	45
W2	40
W3	36

3.2 JOINTS IN SEAWATER WITH ADEQUATE CORROSION PROTECTION

A comparison between the S-N curves for joints in seawater with adequate corrosion protection is made in Appendix C. The entries from each document have been put into descending order according to the magnitude of the log(a) parameter corresponding with 16mm thickness and endurance less than that at slope change.

3.3 JOINTS IN SEAWATER WITH FREE CORROSION

A comparison between the S-N curves for joints in seawater with free corrosion is made in Appendix D. The entries from each document have been put into descending order according to the magnitude of the log(a) parameter corresponding with 16mm thickness and endurance less than that at slope change.

3.4 TUBULAR JOINTS

A comparison between the S-N curves for nodal tubular joints is made in Appendix E. Separate tables are given for joints in air, in seawater with adequate corrosion protection, and in seawater with free corrosion.

3.5 CAST JOINTS

A comparison between the S-N curves for cast joints is made in Appendix F. Separate tables are given for joints in air, in seawater with adequate corrosion protection, and in seawater with free corrosion. This excludes Eurocode 3, API RP2A, IIW and BS 7608:1993, as there are no provisions for cast joints in these documents.

4. OVERALL SUMMARY OF S-N CURVE CHARACTERISTICS

The overall summary is presented in the table below and on pages 25 and 26, which condenses the information in Appendix A.

		NORSOK N-004	HSE 4th Ed GNs	EUROCODE 3	ISO/CD 13819-2	API RP2A	IIW	BS 7608: 1993
Joints in Air	**t_0 (mm)**	25	16	25	16		25	16
	q	0 - 0.25	0.3	0.25	0.3		0.1 - 0.3	0.25
	Slope Change N	10^7	10^7	5×10^6	10^8		5×10^6	10^7
	m	3 & 5	3 & 5	3 & 5	3 - 4 & 5		3 & 5	3 - 4 & 5 - 6
	Endurance Limit	N/A	N/A	10^8	N/A		10^8	N/A
Joints in Seawater	**t_0 (mm)**	25	16		16			16
	q	0 - 0.25	0.3		0.3			0.25
	Slope Change N	10^6	10^6		10^8			10^7
	m	3 & 5	3 & 5		3 - 4 & 5			3 - 4 & 5 - 6
	Endurance Limit	N/A	N/A		N/A			N/A
Joints in Seawater Free Corrosion	**t_0 (mm)**	25	16		16			16
	q	0 - 0.25	0.3		0.3			0.25
	Slope Change N	N/A	N/A		N/A			N/A
	m	3	3		3 - 4			3 - 4
	Endurance Limit	N/A	N/A		N/A			N/A

		NORSOK N-004	HSE 4th Ed GNs	EUROCODE 3	ISO/CD 13819-2	API RP2A	IIW	BS 7608: 1993
Tubular Joints in Air	**t_0 (mm)**	32	16	25	16	16 & 25	25	16
	q	0.25 - 0.3	0.3	0.25	0.3	0.25	0.1 - 0.3	0.25
	Slope Change N	10^7	10^7	N/A	10^8	N/A	5 x 10^6	10^7
	m	3 & 5	3 & 5	5	3 & 5	3.74 & 4.38	3 & 5	3 & 5
	Endurance Limit	N/A	N/A	10^8	N/A	2 & 1 x 10^7	10^8	N/A
Tubular Joints in Seawater with Corrosion Protection	**t_0 (mm)**	32	16		16	16 & 25		16
	q	0.25 - 0.3	0.3		0.3	0.25		0.25
	Slope Change N	10^6	1.7 x 10^6		10^8	N/A		10^7
	m	3 & 5	3 & 5		3 & 5	3.74 & 4.38		3 & 5
	Endurance Limit	N/A	N/A		N/A	2 x 10^8		N/A
Tubular Joints in Seawater with Free Corrosion	**t_0 (mm)**	32	16		16	16 & 25		16
	q	0.25 - 0.3	0.3		0.3	0.25		0.25
	Slope Change N	N/A	N/A		N/A	N/A		N/A
	m	3	3		3	3.74 & 4.38		3
	Endurance Limit	N/A	N/A		N/A	N/A		N/A

		NORSOK N-004	HSE 4th Ed GNs	EUROCODE 3	ISO/CD 13819-2	API RP2A	IIW	BS 7608: 1993
Cast Joints in Air	**t_0 (mm)**	25	38		38			
	q	0.15	0.15		0.15			
	Slope Change N	10^7	N/A		10^8			
	m	3 & 5	4		4 & 5			
	Endurance Limit	N/A	N/A		N/A			
Cast Joints in Seawater with Corrosion Protection	**t_0 (mm)**	25			38			
	q	0.15			0.15			
	Slope Change N	10^6			10^8			
	m	3 & 5			4 & 5			
	Endurance Limit	N/A			N/A			
Cast Joints in Seawater with Free Corrosion	**t_0 (mm)**	25			38			
	q	0.15			0.15			
	Slope Change N	N/A			N/A			
	m	3			4			
	Endurance Limit	N/A			N/A			

APPENDIX A
TABLES OF S-N CURVE PARAMETERS

Containing Document C878\01\032U-A

List of Tables

NORSOK N-004: Joints in air					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B1	25	0	1.00E+007	94	12.913	3	16.856	5
B2	25	0	1.00E+007	82	12.739	3	16.566	5
C	25	0.15	1.00E+007	73	12.592	3	16.320	5
C1	25	0.15	1.00E+007	66	12.449	3	16.081	5
C2	25	0.15	1.00E+007	58	12.301	3	15.835	5
D	25	0.2	1.00E+007	53	12.164	3	15.606	5
E	25	0.2	1.00E+007	47	12.010	3	15.350	5
F	25	0.25	1.00E+007	42	11.855	3	15.091	5
F1	25	0.25	1.00E+007	37	11.699	3	14.832	5
F3	25	0.25	1.00E+007	33	11.546	3	14.576	5
G	25	0.25	1.00E+007	29	11.398	3	14.330	5
W1	25	0.25	1.00E+007	26	11.261	3	14.101	5
W2	25	0.25	1.00E+007	23	11.107	3	13.845	5
W3	25	0.25	1.00E+007	21	10.970	3	13.617	5
T	32	0.25 or 0.30	1.00E+007	53	12.164	3	15.606	5

Table A.1 NORSOK N-004: S-N Curves for Joints in Air

NORSOK N-004: Joints in seawater with adequate CP					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B1	25	0	1.00E+006	148	12.513	3	16.856	5
B2	25	0	1.00E+006	130	12.339	3	16.566	5
C	25	0.15	1.00E+006	116	12.192	3	16.320	5
C1	25	0.15	1.00E+006	104	12.049	3	16.081	5
C2	25	0.15	1.00E+006	93	11.901	3	15.835	5
D	25	0.2	1.00E+006	83	11.764	3	15.606	5
E	25	0.2	1.00E+006	74	11.610	3	15.350	5
F	25	0.25	1.00E+006	66	11.455	3	15.091	5
F1	25	0.25	1.00E+006	58	11.299	3	14.832	5
F3	25	0.25	1.00E+006	52	11.146	3	14.576	5
G	25	0.25	1.00E+006	46	10.998	3	14.330	5
W1	25	0.25	1.00E+006	42	10.861	3	14.101	5
W2	25	0.25	1.00E+006	37	10.707	3	13.845	5
W3	25	0.25	1.00E+006	33	10.570	3	13.617	5
T	32	0.25 or 0.3	1.00E+006	83	11.764	3	15.606	5

Table A.2 NORSOK N-004: S-N Curves for Joints in Seawater with Adequate Corrosion Protection

NORSOK N-004: Joints in seawater with free corrosion					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B1	25	0	N/A	N/A	12.436	3	N/A	N/A
B2	25	0	N/A	N/A	12.262	3	N/A	N/A
C	25	0.15	N/A	N/A	12.115	3	N/A	N/A
C1	25	0.15	N/A	N/A	11.972	3	N/A	N/A
C2	25	0.15	N/A	N/A	11.824	3	N/A	N/A
D	25	0.2	N/A	N/A	11.687	3	N/A	N/A
E	25	0.2	N/A	N/A	11.533	3	N/A	N/A
F	25	0.25	N/A	N/A	11.378	3	N/A	N/A
F1	25	0.25	N/A	N/A	11.222	3	N/A	N/A
F3	25	0.25	N/A	N/A	11.068	3	N/A	N/A
G	25	0.25	N/A	N/A	10.921	3	N/A	N/A
W1	25	0.25	N/A	N/A	10.784	3	N/A	N/A
W2	25	0.25	N/A	N/A	10.630	3	N/A	N/A
W3	25	0.25	N/A	N/A	10.493	3	N/A	N/A
T	32	0.25 or 0.3	N/A	N/A	11.687	3	N/A	N/A

Table A.3 NORSOK N-004: S-N Curves for Joints in Seawater with Free Corrosion

HSE GNs: Joints in air					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
0.64P	16	0.3	1.00E+007	83	12.763	3	16.606	5
0.76P	16	0.3	1.00E+007	70	12.540	3	16.233	5
1.00P	16	0.3	1.00E+007	53	12.182	3	15.637	5
1.14P	16	0.3	1.00E+007	47	12.011	3	15.352	5
1.34P	16	0.3	1.00E+007	40	11.801	3	15.001	5
1.52P	16	0.3	1.00E+007	35	11.636	3	14.728	5
1.83P	16	0.3	1.00E+007	29	11.395	3	14.325	5
2.54P	16	0.3	1.00E+007	21	10.967	3	13.613	5
T'	16	0.3	1.00E+007	67	12.476	3	16.127	5
CS	38	0.15	N/A	N/A	15.170	4	N/A	N/A

Table A.4 HSE 4th Edition Guidance Notes: S-N Curves for Joints in Air

HSE GNs: Joints in seawater with adequate CP					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
0.64P	16	0.3	1.026E+006	131	12.365	3	16.606	5
0.76P	16	0.3	1.026E+006	111	12.142	3	16.233	5
1.00P	16	0.3	1.026E+006	84	11.784	3	15.637	5
1.14P	16	0.3	1.026E+006	74	11.613	3	15.352	5
1.34P	16	0.3	1.026E+006	63	11.403	3	15.001	5
1.52P	16	0.3	1.026E+006	55	11.238	3	14.728	5
1.83P	16	0.3	1.026E+006	46	10.997	3	14.325	5
2.54P	16	0.3	1.026E+006	33	10.569	3	13.613	5
T'	16	0.3	1.745E+006	95	12.175	3	16.127	5
CS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table A.5 HSE 4th Edition Guidance Notes: S-N Curves for Joints in Seawater with Adequate Corrosion Protection

HSE GNs: Joints in seawater with free corrosion					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
0.64P	16	0.3	N/A	N/A	12.286	3	N/A	N/A
0.76P	16	0.3	N/A	N/A	12.063	3	N/A	N/A
1.00P	16	0.3	N/A	N/A	11.705	3	N/A	N/A
1.14P	16	0.3	N/A	N/A	11.534	3	N/A	N/A
1.34P	16	0.3	N/A	N/A	11.324	3	N/A	N/A
1.52P	16	0.3	N/A	N/A	11.159	3	N/A	N/A
1.83P	16	0.3	N/A	N/A	10.918	3	N/A	N/A
2.54P	16	0.3	N/A	N/A	10.490	3	N/A	N/A
T'	16	0.3	N/A	N/A	12.000	3	N/A	N/A
CS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table A.6 HSE 4th Edition Guidance Notes: S-N Curves for Joints in Seawater with Free Corrosion

EUROCODE 3: Joints in air or mildly corrosive environments with CP					N <= Slope Change Endurance		N > Slope Change Endurance		
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m	Stress Range at Cut-off Limit (N = 10^8)
160	25	0.25	5.00E+006	117	12.901	3	17.036	5	64
140	25	0.25	5.00E+006	104	12.751	3	16.786	5	57
125	25	0.25	5.00E+006	93	12.601	3	16.536	5	51
112	25	0.25	5.00E+006	83	12.451	3	16.286	5	45
100	25	0.25	5.00E+006	74	12.301	3	16.036	5	40
90	25	0.25	5.00E+006	66	12.151	3	15.786	5	36
80	25	0.25	5.00E+006	59	12.001	3	15.536	5	32
71	25	0.25	5.00E+006	52	11.851	3	15.286	5	29
63	25	0.25	5.00E+006	46	11.701	3	15.036	5	26
56	25	0.25	5.00E+006	41	11.551	3	14.786	5	23
50	25	0.25	5.00E+006	37	11.401	3	14.536	5	20
45	25	0.25	5.00E+006	33	11.251	3	14.286	5	18
40	25	0.25	5.00E+006	29	11.101	3	14.036	5	16
36	25	0.25	5.00E+006	26	10.951	3	13.786	5	14

Table A.7 Eurocode 3: S-N Curves for Joints in Air or Mildly Corrosive Environments with Corrosion Protection

EUROCODE 3: Hollow section joints in air or mildly corrosive environments with CP					N <= Slope Change Endurance		N > Slope Change Endurance		
S-N Curve ID	**Base level Thickness (mm)**	**Thickness Adjustment Exponent**	**Slope Change Endurance**	**Stress Range at Slope Change Endurance (MPa)**	**log(a) for 16mm**	**m**	**log(a) for 16mm**	**m**	**Stress Range at Cut-off Limit (N = 10^8)**
90	25	0.25	N/A	N/A	16.051	5	N/A	N/A	41
71	25	0.25	N/A	N/A	15.551	5	N/A	N/A	32
56	25	0.25	N/A	N/A	15.051	5	N/A	N/A	26
50	25	0.25	N/A	N/A	14.801	5	N/A	N/A	23
45	25	0.25	N/A	N/A	14.551	5	N/A	N/A	20
36	25	0.25	N/A	N/A	14.051	5	N/A	N/A	16

Table A.8 Eurocode 3: S-N Curves for Hollow section joints in Air or Mildly Corrosive Environments with Corrosion Protection

ISO 13819-2: Joints in air and seawater with adequate CP					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B	16	0.3	1.00E+008	57	15.010	4	16.760	5
C	16	0.3	1.00E+008	41	13.630	3.5	16.040	5
D	16	0.3	1.00E+008	25	12.180	3	14.970	5
E	16	0.3	1.00E+008	22	12.020	3	14.690	5
F	16	0.3	1.00E+008	18	11.800	3	14.330	5
F2	16	0.3	1.00E+008	16	11.630	3	14.060	5
W'	16	0.3	1.00E+008	10	10.970	3	13.330	5
TJ	16	0.3	1.00E+008	31	12.480	3	15.470	5
CJ	38	0.15	1.00E+008	62	15.170	4	15.170	5

Table A.9 Draft ISO/CD 13819-2: S-N Curves for Joints in Air and Seawater with Adequate Corrosion Protection

ISO 13819-2: Joints in seawater with free corrosion					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B	16	0.3	N/A	N/A	14.533	4	N/A	N/A
C	16	0.3	N/A	N/A	13.153	3.5	N/A	N/A
D	16	0.3	N/A	N/A	11.703	3	N/A	N/A
E	16	0.3	N/A	N/A	11.543	3	N/A	N/A
F	16	0.3	N/A	N/A	11.323	3	N/A	N/A
F2	16	0.3	N/A	N/A	11.153	3	N/A	N/A
W'	16	0.3	N/A	N/A	10.493	3	N/A	N/A
TJ	16	0.3	N/A	N/A	12.003	3	N/A	N/A
CJ	38	0.15	N/A	N/A	14.693	4	N/A	N/A

Table A.10 Draft ISO/CD 13819-2: S-N Curves for Joints in Seawater with Free Corrosion

API RP2A: Tubular joints					N <= Slope Change Endurance		N > Slope Change Endurance			
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
X' in air	16	0.25	N/A	N/A	13.398	3.74	N/A	N/A	2.00E+007	43
X' sw + cp	16	0.25	N/A	N/A	13.398	3.74	N/A	N/A	2.00E+008	23
X' sw + fc	16	0.25	N/A	N/A	13.398	3.74	N/A	N/A	Not permitted	
X in air	25	0.25	N/A	N/A	15.061	4.38	N/A	N/A	1.00E+007	69
X sw +cp	25	0.25	N/A	N/A	15.061	4.38	N/A	N/A	2.00E+008	35
X sw + fc	25	0.25	N/A	N/A	15.061	4.38	N/A	N/A	Not permitted	
sw + cp = seawater with adequate corrosion; sw + fc = seawater with free corrosion										

Table A.11 API RP2A: S-N Curves for Tubular Joints

IIW RECOMMENDATIONS: Joints in air or mildly corrosive environments with CP					N <= Slope Change Endurance			N > Slope Change Endurance			
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Stress Range at Cut-off Limit (N = 10^8)
225	25	0.1, 0.2, 0.3	5.00E+006	166	13.358	13.358	3	17.797	17.797	5	91
200	25	0.1, 0.2, 0.3	5.00E+006	147	13.204	13.204	3	17.541	17.541	5	81
180	25	0.1, 0.2, 0.3	5.00E+006	133	13.067	13.067	3	17.312	17.312	5	73
160	25	0.1, 0.2, 0.3	5.00E+006	118	12.913	12.913	3	17.057	17.057	5	65
140	25	0.1, 0.2, 0.3	5.00E+006	103	12.739	12.739	3	16.766	16.766	5	57
125	25	0.1, 0.2, 0.3	5.00E+006	92	12.592	12.592	3	16.520	16.520	5	51
112	25	0.1, 0.2, 0.3	5.00E+006	83	12.449	12.449	3	16.282	16.282	5	45
100	25	0.1, 0.2, 0.3	5.00E+006	74	12.301	12.301	3	16.036	16.036	5	40
90	25	0.1, 0.2, 0.3	5.00E+006	66	12.164	12.164	3	15.807	15.807	5	36
80	25	0.1, 0.2, 0.3	5.00E+006	59	12.005	12.005	3	15.551	15.551	5	32
71	25	0.1, 0.2, 0.3	5.00E+006	52	11.855	11.855	3	15.292	15.292	5	29
63	25	0.1, 0.2, 0.3	5.00E+006	46	11.699	11.699	3	15.033	15.033	5	25
56	25	0.1, 0.2, 0.3	5.00E+006	41	11.546	11.546	3	14.777	14.777	5	23
50	25	0.1, 0.2, 0.3	5.00E+006	37	11.398	11.398	3	14.531	14.531	5	20
45	25	0.1, 0.2, 0.3	5.00E+006	33	11.261	11.261	3	14.302	14.302	5	18
40	25	0.1, 0.2, 0.3	5.00E+006	29	11.107	11.107	3	14.046	14.046	5	16
36	25	0.1, 0.2, 0.3	5.00E+006	27	10.970	10.970	3	13.817	13.817	5	15
32	25	0.1, 0.2, 0.3	5.00E+006	24	10.817	10.817	3	13.561	13.561	5	13
28	25	0.1, 0.2, 0.3	5.00E+006	21	10.642	10.642	3	13.272	13.272	5	11
25	25	0.1, 0.2, 0.3	5.00E+006	18	10.495	10.495	3	13.025	13.025	5	10
22	25	0.1, 0.2, 0.3	5.00E+006	16	10.328	10.328	3	12.748	12.748	5	9
20	25	0.1, 0.2, 0.3	5.00E+006	15	10.204	10.204	3	12.541	12.541	5	8
18	25	0.1, 0.2, 0.3	5.00E+006	13	10.067	10.067	3	12.312	12.312	5	7
16	25	0.1, 0.2, 0.3	5.00E+006	12	9.913	9.913	3	12.057	12.057	5	6
14	25	0.1, 0.2, 0.3	5.00E+006	10	9.739	9.739	3	11.766	11.766	5	6

Table A.12 IIW RECOMMENDATIONS: S-N Curves for Joints in Air or Mildly Corrosive Environments with Corrosion Protection

BS 7608: 1993: Joints in air and seawater with adequate CP					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B	16	0.25	1.00E+007	100	15.006	4	19.008	6
C	16	0.25	1.00E+007	78	13.626	3.5	17.412	5.5
D	16	0.25	1.00E+007	53	12.182	3	15.636	5
E	16	0.25	1.00E+007	47	12.015	3	15.359	5
F	16	0.25	1.00E+007	40	11.800	3	15.001	5
F2	16	0.25	1.00E+007	35	11.634	3	14.724	5
G	16	0.25	1.00E+007	29	11.394	3	14.323	5
W	N/A	N/A	1.00E+007	25	11.197	3	13.995	5
S	N/A	N/A	1.00E+007	82	22.319	8	26.149	10
T	16	0.25	1.00E+007	53	12.164	3	15.606	5

Table A.13 BS 7608: 1993: S-N Curves for Joints in Air and Seawater with Adequate Corrosion Protection

BS 7608: 1993: Joints in seawater with free corrosion					N <= Slope Change Endurance		N > Slope Change Endurance	
S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance	Stress Range at Slope Change Endurance (MPa)	log(a) for 16mm	m	log(a) for 16mm	m
B	16	0.25	N/A	N/A	14.704	4	N/A	N/A
C	16	0.25	N/A	N/A	13.325	3.5	N/A	N/A
D	16	0.25	N/A	N/A	11.881	3	N/A	N/A
E	16	0.25	N/A	N/A	11.714	3	N/A	N/A
F	16	0.25	N/A	N/A	11.499	3	N/A	N/A
F2	16	0.25	N/A	N/A	11.333	3	N/A	N/A
G	16	0.25	N/A	N/A	11.093	3	N/A	N/A
W	N/A	N/A	N/A	N/A	10.896	3	N/A	N/A
S	N/A	N/A	N/A	N/A	22.018	8	N/A	N/A
T	16	0.25	N/A	N/A	11.863	3	N/A	N/A

Table A.14 BS 7608: 1993: S-N Curves for Joints in Seawater with Free Corrosion

APPENDIX B
COMPARISON OF S-N CURVES FOR JOINTS IN AIR

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COMPARISON OF S-N CURVES FOR JOINTS IN AIR						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
ISO 13819-2	B	16	0.3	1.00E+008	57	15.010	14.777	4	16.760	16.469	5	N/A	N/A
BS 7608: 1993	B	16	0.25	1.00E+007	100	15.006	14.812	4	19.008	18.718	6	N/A	N/A
ISO 13819-2	C	16	0.3	1.00E+008	41	13.630	13.426	3.5	16.040	15.749	5	N/A	N/A
BS 7608: 1993	C	16	0.25	1.00E+007	78	13.626	13.456	3.5	17.412	17.146	5.5	N/A	N/A
IIW	225	25	0.1, 0.2, 0.3	5.00E+006	166	13.358	13.358	3	17.797	17.797	5	1.00E+008	91
IIW	200	25	0.1, 0.2, 0.3	5.00E+006	147	13.204	13.204	3	17.541	17.541	5	1.00E+008	81
IIW	180	25	0.1, 0.2, 0.3	5.00E+006	133	13.067	13.067	3	17.312	17.312	5	1.00E+008	73
IIW	160	25	0.1, 0.2, 0.3	5.00E+006	118	12.913	12.913	3	17.057	17.057	5	1.00E+008	65
NORSOK	B1	25	0	1.00E+007	94	12.913	12.913	3	16.856	16.856	5	N/A	N/A
EUROCODE 3	160	25	0.25	5.00E+006	117	12.901	12.901	3	17.036	17.036	5	1.00E+008	64
HSE GNs	0.64P	16	0.3	1.00E+007	83	12.763	12.589	3	16.606	16.315	5	N/A	N/A
EUROCODE 3	140	25	0.25	5.00E+006	104	12.751	12.751	3	16.786	16.786	5	1.00E+008	57
IIW	140	25	0.1, 0.2, 0.3	5.00E+006	103	12.739	12.739	3	16.766	16.766	5	1.00E+008	57
NORSOK	B2	25	0	1.00E+007	82	12.739	12.739	3	16.566	16.566	5	N/A	N/A
EUROCODE 3	125	25	0.25	5.00E+006	93	12.601	12.601	3	16.536	16.536	5	1.00E+008	51
NORSOK	C	25	0.15	1.00E+007	73	12.592	12.592	3	16.320	16.320	5	N/A	N/A
IIW	125	25	0.1, 0.2, 0.3	5.00E+006	92	12.592	12.592	3	16.520	16.520	5	1.00E+008	51
HSE GNs	0.76P	16	0.3	1.00E+007	70	12.540	12.365	3	16.233	15.942	5	N/A	N/A
EUROCODE 3	112	25	0.25	5.00E+006	83	12.451	12.451	3	16.286	16.286	5	1.00E+008	45
NORSOK	C1	25	0.15	1.00E+007	66	12.449	12.449	3	16.081	16.081	5	N/A	N/A
IIW	112	25	0.1, 0.2, 0.3	5.00E+006	83	12.449	12.449	3	16.282	16.282	5	1.00E+008	45
IIW	100	25	0.1, 0.2, 0.3	5.00E+006	74	12.301	12.301	3	16.036	16.036	5	1.00E+008	40
EUROCODE 3	100	25	0.25	5.00E+006	74	12.301	12.301	3	16.036	16.036	5	1.00E+008	40
NORSOK	C2	25	0.15	1.00E+007	58	12.301	12.301	3	15.835	15.835	5	N/A	N/A
HSE GNs	1.00P	16	0.3	1.00E+007	53	12.182	12.008	3	15.637	15.346	5	N/A	N/A
BS 7608: 1993	D	16	0.25	1.00E+007	53	12.182	12.036	3	15.636	15.394	5	N/A	N/A
ISO 13819-2	D	16	0.3	1.00E+008	25	12.180	12.006	3	14.970	14.679	5	N/A	N/A

COMPARISON OF S-N CURVES FOR JOINTS IN AIR						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	D	25	0.2	1.00E+007	53	12.164	12.164	3	15.606	15.606	5	N/A	N/A
IIW	90	25	0.1, 0.2, 0.3	5.00E+006	66	12.164	12.164	3	15.807	15.807	5	1.00E+008	36
EUROCODE 3	90	25	0.25	5.00E+006	66	12.151	12.151	3	15.786	15.786	5	1.00E+008	36
ISO 13819-2	E	16	0.3	1.00E+008	22	12.020	11.846	3	14.690	14.399	5	N/A	N/A
BS 7608: 1993	E	16	0.25	1.00E+007	47	12.015	11.870	3	15.359	15.116	5	N/A	N/A
HSE GNs	1.14P	16	0.3	1.00E+007	47	12.011	11.837	3	15.352	15.062	5	N/A	N/A
NORSOK	E	25	0.2	1.00E+007	47	12.010	12.010	3	15.350	15.350	5	N/A	N/A
IIW	80	25	0.1, 0.2, 0.3	5.00E+006	59	12.005	12.005	3	15.551	15.551	5	1.00E+008	32
EUROCODE 3	80	25	0.25	5.00E+006	59	12.001	12.001	3	15.536	15.536	5	1.00E+008	32
NORSOK	F	25	0.25	1.00E+007	42	11.855	11.855	3	15.091	15.091	5	N/A	N/A
IIW	71	25	0.1, 0.2, 0.3	5.00E+006	52	11.855	11.855	3	15.292	15.292	5	1.00E+008	29
EUROCODE 3	71	25	0.25	5.00E+006	52	11.851	11.851	3	15.286	15.286	5	1.00E+008	29
HSE GNs	1.34P	16	0.3	1.00E+007	40	11.801	11.626	3	15.001	14.711	5	N/A	N/A
BS 7608: 1993	F	16	0.25	1.00E+007	40	11.800	11.655	3	15.001	14.758	5	N/A	N/A
ISO 13819-2	F	16	0.3	1.00E+008	18	11.800	11.626	3	14.330	14.039	5	N/A	N/A
EUROCODE 3	63	25	0.25	5.00E+006	46	11.701	11.701	3	15.036	15.036	5	1.00E+008	26
IIW	63	25	0.1, 0.2, 0.3	5.00E+006	46	11.699	11.699	3	15.033	15.033	5	1.00E+008	25
NORSOK	F1	25	0.25	1.00E+007	37	11.699	11.699	3	14.832	14.832	5	N/A	N/A
HSE GNs	1.52P	16	0.3	1.00E+007	35	11.636	11.462	3	14.728	14.437	5	N/A	N/A
BS 7608: 1993	F2	16	0.25	1.00E+007	35	11.634	11.489	3	14.724	14.481	5	N/A	N/A
ISO 13819-2	F2	16	0.3	1.00E+008	16	11.630	11.456	3	14.060	13.769	5	N/A	N/A
EUROCODE 3	56	25	0.25	5.00E+006	41	11.551	11.551	3	14.786	14.786	5	1.00E+008	23
NORSOK	F3	25	0.25	1.00E+007	33	11.546	11.546	3	14.576	14.576	5	N/A	N/A
IIW	56	25	0.1, 0.2, 0.3	5.00E+006	41	11.546	11.546	3	14.777	14.777	5	1.00E+008	23
EUROCODE 3	50	25	0.25	5.00E+006	37	11.401	11.401	3	14.536	14.536	5	1.00E+008	20
NORSOK	G	25	0.25	1.00E+007	29	11.398	11.398	3	14.330	14.330	5	N/A	N/A
IIW	50	25	0.1, 0.2, 0.3	5.00E+006	37	11.398	11.398	3	14.531	14.531	5	1.00E+008	20

COMPARISON OF S-N CURVES FOR JOINTS IN AIR						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
HSE GNs	1.83P	16	0.3	1.00E+007	29	11.395	11.220	3	14.325	14.034	5	N/A	N/A
BS 7608: 1993	G	16	0.25	1.00E+007	29	11.394	11.249	3	14.323	14.081	5	N/A	N/A
NORSOK	W1	25	0.25	1.00E+007	26	11.261	11.261	3	14.101	14.101	5	N/A	N/A
IIW	45	25	0.1, 0.2, 0.3	5.00E+006	33	11.261	11.261	3	14.302	14.302	5	1.00E+008	18
EUROCODE 3	45	25	0.25	5.00E+006	33	11.251	11.251	3	14.286	14.286	5	1.00E+008	18
BS 7608: 1993	W	N/A	N/A	1.00E+007	25	11.197	N/A	3	13.995	N/A	5	N/A	N/A
IIW	40	25	0.1, 0.2, 0.3	5.00E+006	29	11.107	11.107	3	14.046	14.046	5	1.00E+008	16
NORSOK	W2	25	0.25	1.00E+007	23	11.107	11.107	3	13.845	13.845	5	N/A	N/A
EUROCODE 3	40	25	0.25	5.00E+006	29	11.101	11.101	3	14.036	14.036	5	1.00E+008	16
NORSOK	W3	25	0.25	1.00E+007	21	10.970	10.970	3	13.617	13.617	5	N/A	N/A
ISO 13819-2	W'	16	0.3	1.00E+008	10	10.970	10.796	3	13.330	13.039	5	N/A	N/A
IIW	36	25	0.1, 0.2, 0.3	5.00E+006	27	10.970	10.970	3	13.817	13.817	5	1.00E+008	15
HSE GNs	2.54P	16	0.3	1.00E+007	21	10.967	10.793	3	13.613	13.322	5	N/A	N/A
EUROCODE 3	36	25	0.25	5.00E+006	26	10.951	10.951	3	13.786	13.786	5	1.00E+008	14
IIW	32	25	0.1, 0.2, 0.3	5.00E+006	24	10.817	10.817	3	13.561	13.561	5	1.00E+008	13
IIW	28	25	0.1, 0.2, 0.3	5.00E+006	21	10.642	10.642	3	13.272	13.272	5	1.00E+008	11
IIW	25	25	0.1, 0.2, 0.3	5.00E+006	18	10.495	10.495	3	13.025	13.025	5	1.00E+008	10
IIW	22	25	0.1, 0.2, 0.3	5.00E+006	16	10.328	10.328	3	12.748	12.748	5	1.00E+008	9
IIW	20	25	0.1, 0.2, 0.3	5.00E+006	15	10.204	10.204	3	12.541	12.541	5	1.00E+008	8
IIW	18	25	0.1, 0.2, 0.3	5.00E+006	13	10.067	10.067	3	12.312	12.312	5	1.00E+008	7
IIW	16	25	0.1, 0.2, 0.3	5.00E+006	12	9.913	9.913	3	12.057	12.057	5	1.00E+008	6
IIW	14	25	0.1, 0.2, 0.3	5.00E+006	10	9.739	9.739	3	11.766	11.766	5	1.00E+008	6

APPENDIX C
COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH ADEQUATE CORROSION PROTECTION

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COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH ADEQUATE CP						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
ISO 13819-2	B	16	0.3	1.00E+008	57	15.010	14.777	4	16.760	16.469	5	N/A	N/A
BS 7608: 1993	B	16	0.25	1.00E+007	100	15.006	14.812	4	19.008	18.718	6	N/A	N/A
ISO 13819-2	C	16	0.3	1.00E+008	41	13.630	13.426	3.5	16.040	15.749	5	N/A	N/A
BS 7608: 1993	C	16	0.25	1.00E+007	78	13.626	13.456	3.5	17.412	17.146	5.5	N/A	N/A
NORSOK	B1	25	0	1.00E+006	148	12.513	12.513	3	16.856	16.856	5	N/A	N/A
HSE GNs	0.64P	16	0.3	1.026E+006	131	12.365	12.191	3	16.606	16.315	5	N/A	N/A
NORSOK	B2	25	0	1.00E+006	130	12.339	12.339	3	16.566	16.566	5	N/A	N/A
NORSOK	C	25	0.15	1.00E+006	116	12.192	12.192	3	16.320	16.320	5	N/A	N/A
BS 7608: 1993	D	16	0.25	1.00E+007	53	12.182	12.036	3	15.636	15.394	5	N/A	N/A
ISO 13819-2	D	16	0.3	1.00E+008	25	12.180	12.006	3	14.970	14.679	5	N/A	N/A
HSE GNs	0.76P	16	0.3	1.026E+006	111	12.142	11.967	3	16.233	15.942	5	N/A	N/A
NORSOK	C1	25	0.15	1.00E+006	104	12.049	12.049	3	16.081	16.081	5	N/A	N/A
ISO 13819-2	E	16	0.3	1.00E+008	22	12.020	11.846	3	14.690	14.399	5	N/A	N/A
BS 7608: 1993	E	16	0.25	1.00E+007	47	12.015	11.870	3	15.359	15.116	5	N/A	N/A
NORSOK	C2	25	0.15	1.00E+006	93	11.901	11.901	3	15.835	15.835	5	N/A	N/A
BS 7608: 1993	F	16	0.25	1.00E+007	40	11.800	11.655	3	15.001	14.758	5	N/A	N/A
ISO 13819-2	F	16	0.3	1.00E+008	18	11.800	11.626	3	14.330	14.039	5	N/A	N/A
HSE GNs	1.00P	16	0.3	1.026E+006	84	11.784	11.610	3	15.637	15.346	5	N/A	N/A
NORSOK	D	25	0.2	1.00E+006	83	11.764	11.764	3	15.606	15.606	5	N/A	N/A
BS 7608: 1993	F2	16	0.25	1.00E+007	35	11.634	11.489	3	14.724	14.481	5	N/A	N/A
ISO 13819-2	F2	16	0.3	1.00E+008	16	11.630	11.456	3	14.060	13.769	5	N/A	N/A
HSE GNs	1.14P	16	0.3	1.026E+006	74	11.613	11.439	3	15.352	15.062	5	N/A	N/A
NORSOK	E	25	0.2	1.00E+006	74	11.610	11.610	3	15.350	15.350	5	N/A	N/A
NORSOK	F	25	0.25	1.00E+006	66	11.455	11.455	3	15.091	15.091	5	N/A	N/A
HSE GNs	1.34P	16	0.3	1.026E+006	63	11.403	11.228	3	15.001	14.711	5	N/A	N/A
BS 7608: 1993	G	16	0.25	1.00E+007	29	11.394	11.249	3	14.323	14.081	5	N/A	N/A

COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH ADEQUATE CP						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	F1	25	0.25	1.00E+006	58	11.299	11.299	3	14.832	14.832	5	N/A	N/A
HSE GNs	1.52P	16	0.3	1.026E+006	55	11.238	11.064	3	14.728	14.437	5	N/A	N/A
BS 7608: 1993	W	N/A	N/A	1.00E+007	25	11.197	N/A	3	13.995	N/A	5	N/A	N/A
NORSOK	F3	25	0.25	1.00E+006	52	11.146	11.146	3	14.576	14.576	5	N/A	N/A
NORSOK	G	25	0.25	1.00E+006	46	10.998	10.998	3	14.330	14.330	5	N/A	N/A
HSE GNs	1.83P	16	0.3	1.026E+006	46	10.997	10.822	3	14.325	14.034	5	N/A	N/A
ISO 13819-2	W'	16	0.3	1.00E+008	10	10.970	10.796	3	13.330	13.039	5	N/A	N/A
NORSOK	W1	25	0.25	1.00E+006	42	10.861	10.861	3	14.101	14.101	5	N/A	N/A
NORSOK	W2	25	0.25	1.00E+006	37	10.707	10.707	3	13.845	13.845	5	N/A	N/A
NORSOK	W3	25	0.25	1.00E+006	33	10.570	10.570	3	13.617	13.617	5	N/A	N/A
HSE GNs	2.54P	16	0.3	1.026E+006	33	10.569	10.395	3	13.613	13.322	5	N/A	N/A

APPENDIX D
COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH FREE CORROSION

Containing Document C878\01\032U-A Pages 1 - 2

COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH FREE CORROSION						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
ISO 13819-2	B	16	0.3	N/A	N/A	14.533	14.300	4	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	B	16	0.25	N/A	N/A	14.704	14.511	4	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	C	16	0.25	N/A	N/A	13.325	13.155	3.5	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	C	16	0.3	N/A	N/A	13.153	12.949	3.5	N/A	N/A	N/A	N/A	N/A
NORSOK	B1	25	0	N/A	N/A	12.436	12.436	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	0.64P	16	0.3	N/A	N/A	12.286	12.112	3	N/A	N/A	N/A	N/A	N/A
NORSOK	B2	25	0	N/A	N/A	12.262	12.262	3	N/A	N/A	N/A	N/A	N/A
NORSOK	C	25	0.15	N/A	N/A	12.115	12.115	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	0.76P	16	0.3	N/A	N/A	12.063	11.888	3	N/A	N/A	N/A	N/A	N/A
NORSOK	C1	25	0.15	N/A	N/A	11.972	11.972	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	D	16	0.25	N/A	N/A	11.881	11.735	3	N/A	N/A	N/A	N/A	N/A
NORSOK	C2	25	0.15	N/A	N/A	11.824	11.824	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	E	16	0.25	N/A	N/A	11.714	11.569	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	1.00P	16	0.3	N/A	N/A	11.705	11.531	3	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	D	16	0.3	N/A	N/A	11.703	11.528	3	N/A	N/A	N/A	N/A	N/A
NORSOK	D	25	0.2	N/A	N/A	11.687	11.687	3	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	E	16	0.3	N/A	N/A	11.543	11.368	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	1.14P	16	0.3	N/A	N/A	11.534	11.360	3	N/A	N/A	N/A	N/A	N/A
NORSOK	E	25	0.2	N/A	N/A	11.533	11.533	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	F	16	0.25	N/A	N/A	11.499	11.354	3	N/A	N/A	N/A	N/A	N/A
NORSOK	F	25	0.25	N/A	N/A	11.378	11.378	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	F2	16	0.25	N/A	N/A	11.333	11.188	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	1.34P	16	0.3	N/A	N/A	11.324	11.149	3	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	F	16	0.3	N/A	N/A	11.323	11.148	3	N/A	N/A	N/A	N/A	N/A
NORSOK	F1	25	0.25	N/A	N/A	11.222	11.222	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	1.52P	16	0.3	N/A	N/A	11.159	10.985	3	N/A	N/A	N/A	N/A	N/A

COMPARISON OF S-N CURVES FOR JOINTS IN SEAWATER WITH FREE CORROSION						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	m	log(a) for 16mm	log(a) for 25mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
ISO 13819-2	F2	16	0.3	N/A	N/A	11.153	10.978	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	G	16	0.25	N/A	N/A	11.093	10.948	3	N/A	N/A	N/A	N/A	N/A
NORSOK	F3	25	0.25	N/A	N/A	11.068	11.068	3	N/A	N/A	N/A	N/A	N/A
NORSOK	G	25	0.25	N/A	N/A	10.921	10.921	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	1.83P	16	0.3	N/A	N/A	10.918	10.743	3	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	W	N/A	N/A	N/A	N/A	10.896	N/A	3	N/A	N/A	N/A	N/A	N/A
NORSOK	W1	25	0.25	N/A	N/A	10.784	10.784	3	N/A	N/A	N/A	N/A	N/A
NORSOK	W2	25	0.25	N/A	N/A	10.630	10.630	3	N/A	N/A	N/A	N/A	N/A
NORSOK	W3	25	0.25	N/A	N/A	10.493	10.493	3	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	W'	16	0.3	N/A	N/A	10.493	10.318	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	2.54P	16	0.3	N/A	N/A	10.490	10.316	3	N/A	N/A	N/A	N/A	N/A

APPENDIX E
COMPARISON OF S-N CURVES FOR NODAL TUBULAR JOINTS

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COMPARISON OF S-N CURVES FOR TUBULAR JOINTS IN AIR						N <= Slope Change Endurance				N > Slope Change Endurance					
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	T	32	0.25 or 0.30	1.00E+007	53	12.164	12.164	12.164	3	15.606	15.606	15.606	5	N/A	N/A
HSE GNs	T'	16	0.3	1.00E+007	67	12.476	12.302	12.205	3	16.127	15.836	15.675	5	N/A	N/A
EUROCODE 3	36	25	0.25	N/A	N/A	14.051	14.051	13.917	5	N/A	N/A	N/A	N/A	1.00E+008	16
ISO 13819-2	TJ	16	0.3	1.00E+008	31	12.480	12.306	12.209	3	15.470	15.179	15.018	5	N/A	N/A
API RP2A	X' in air	16	0.25	N/A	N/A	13.398	13.217	13.117	3.74	N/A	N/A	N/A	N/A	2.00E+007	43
API RP2A	X in air	25	0.25	N/A	N/A	15.061	15.061	14.944	4.38	N/A	N/A	N/A	N/A	1.00E+007	69
IIW	112	25	0.1, 0.2, 0.3	5.00E+006	83	12.449	12.449	12.352	3	16.282	16.282	16.121	5	1.00E+008	45
IIW	100	25	0.1, 0.2, 0.3	5.00E+006	74	12.301	12.301	12.205	3	16.036	16.036	15.875	5	1.00E+008	40
BS 7608: 1993	T	16	0.25	1.00E+007	53	12.164	12.018	11.938	3	15.606	15.364	15.230	5	N/A	N/A

COMPARISON OF S-N CURVES FOR TUBULAR JOINTS IN SEAWATER WITH ADEQUATE CP						N <= Slope Change Endurance				N > Slope Change Endurance					
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	T	32	0.25 or 0.3	1.00E+006	83	11.764	11.764	11.764	3	15.606	15.606	15.606	5	N/A	N/A
HSE GNs	T'	16	0.3	1.745E+006	95	12.175	12.001	11.904	3	16.127	15.836	15.675	5	N/A	N/A
EUROCODE 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	TJ	16	0.3	1.00E+008	31	12.480	12.306	12.209	3	15.470	15.179	15.018	5	N/A	N/A
API RP2A	X' sw + cp	16	0.25	N/A	N/A	13.398	13.217	13.117	3.74	N/A	N/A	N/A	N/A	2.00E+008	23
API RP2A	X sw +cp	25	0.25	N/A	N/A	15.061	15.061	14.944	4.38	N/A	N/A	N/A	N/A	2.00E+008	35
BS 7608: 1993	T	16	0.25	1.00E+007	53	12.164	12.018	11.938	3	15.606	15.364	15.230	5	N/A	N/A

COMPARISON OF S-N CURVES FOR TUBULAR JOINTS IN SEAWATER WITH FREE CORROSION						N <= Slope Change Endurance				N > Slope Change Endurance					
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	log(a) for 16mm	log(a) for 25mm	log(a) for 32mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	T	32	0.25 or 0.3	N/A	N/A	11.687	11.687	11.687	3	N/A	N/A	N/A	N/A	N/A	N/A
HSE GNs	T'	16	0.3	N/A	N/A	12.000	11.826	11.729	3	N/A	N/A	N/A	N/A	N/A	N/A
EUROCODE 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	TJ	16	0.3	N/A	N/A	12.003	11.828	11.732	3	N/A	N/A	N/A	N/A	N/A	N/A
API RP2A	X' sw + fc	16	0.25	N/A	N/A	13.398	13.217	13.117	3.74	N/A	N/A	N/A	N/A	N/A	N/A
API RP2A	X sw + fc	25	0.25	N/A	N/A	15.061	15.061	14.944	4.38	N/A	N/A	N/A	N/A	N/A	N/A
BS 7608: 1993	T	16	0.25	N/A	N/A	11.863	11.717	11.637	3	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX F
COMPARISON OF S-N CURVES FOR CAST JOINTS

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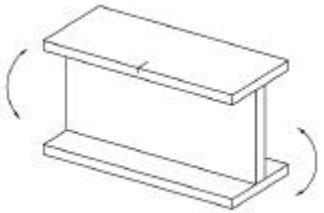
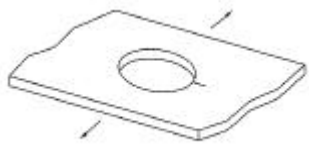
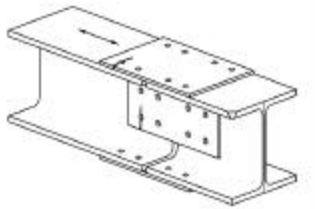
COMPARISON OF S-N CURVES FOR CAST JOINTS IN AIR						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 25mm	log(a) for 38mm	m	log(a) for 25mm	log(a) for 38mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	C	25	0.15	1.00E+007	73	12.592	12.510	3	16.320	16.184	5	N/A	N/A
HSE GNs	CS	38	0.15	N/A	N/A	15.170	15.170	4	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	CJ	38	0.15	1.00E+008	62	15.170	15.170	4	15.170	15.170	5	N/A	N/A

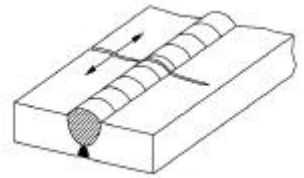
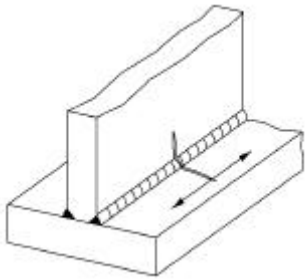
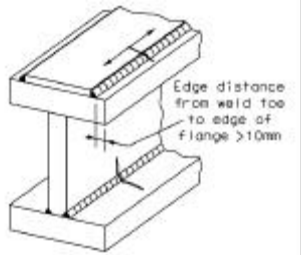
COMPARISON OF S-N CURVES FOR CAST JOINTS IN SEAWATER WITH ADEQUATE CP						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 25mm	log(a) for 38mm	m	log(a) for 25mm	log(a) for 38mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	C	25	0.15	1.00E+006	116	12.192	12.110	3	16.320	16.184	5	N/A	N/A
HSE GNs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	CJ	38	0.15	1.00E+008	62	15.170	15.170	4	15.170	15.170	5	N/A	N/A

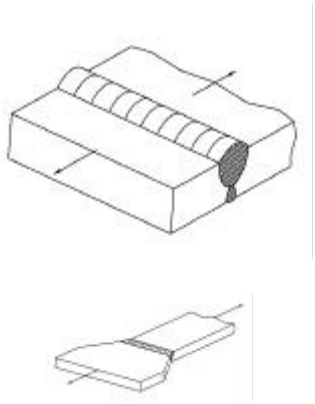
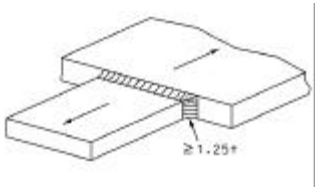
COMPARISON OF S-N CURVES FOR CAST JOINTS IN SEAWATER WITH FREE CORROSION						N <= Slope Change Endurance			N > Slope Change Endurance				
Document	S-N Curve ID	Base level Thickness (mm)	Thickness Adjustment Exponent	Slope Change Endurance Limit	Stress Range at Slope Change Endurance Limit (MPa)	log(a) for 25mm	log(a) for 38mm	m	log(a) for 25mm	log(a) for 38mm	m	Endurance Cut-off Limit	Stress Range at Endurance Cut-off Limit
NORSOK	C	25	0.15	N/A	N/A	12.115	12.033	3	N/A	N/A	N/A	N/A	N/A
HSE GNs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ISO 13819-2	CJ	38	0.15	N/A	N/A	14.693	14.693	4	N/A	N/A	N/A	N/A	N/A

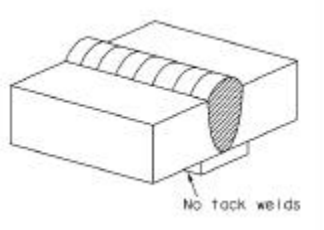
APPENDIX G
PROVISIONS IN DOCUMENTS FOR JOINT TYPES

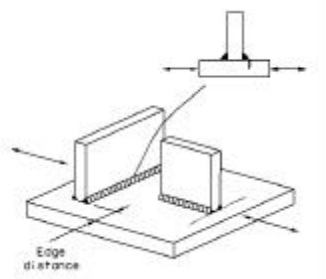
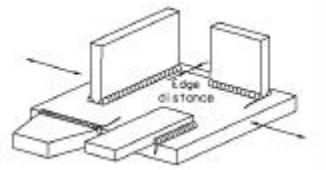
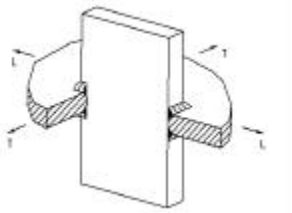
Joint Types used in ISO/CD 13819-2	
Joint Type	**Description**
1	Material free from welding
2	Welds essentially parallel to the direction of applied stress
3	Transverse butt welds in plates and tubulars (perpendicular to the direction of stress)
4	Welded attachments on the surface of a stressed member
5	Load-carrying fillet and T butt welds
6	Details in welded girders and tubulars

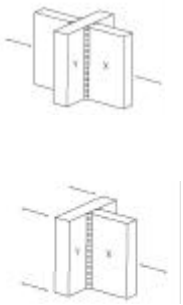
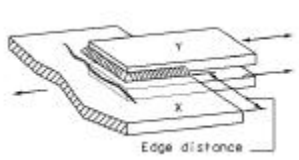
Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
1.1 Plain steel (a) In as-rolled condition or ground smooth or machined after cutting		A.15.4-1	1.1(a)	B	1	1.1, 1.2	B1	TYPE 1	1.1(a), (b), 1.2	0.64P	9.8.1	1, 2, 3	160	3.2-1	111	160, m=5	1	1.1, 1.2	A, B
(b) With edges flame cut	 		1.1(b)	C	1	1.3, 1.4	B2, C	TYPE 1	1.1(c)	0.76P	9.8.1	4, 5	140, 125	3.2-1	121 -124	80 - 140, m=3	1	1.3, 1.4	B, C
1.2 Bolted connection			1.2	C	2	2.1, 2.2	C1				9.81	6, 7	112				2	2.1 - 2.7	C, D, E, G

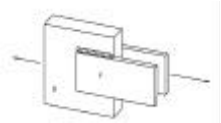
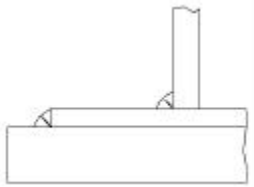
Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
2.1 Complete or partial joint penetration groove Parent or weld metal in members; without attachments; built up of plates or sections; joined by continuous welds (a) Complete joint penetration groove welds; weld overfill dressed flush with surface; machine-finished in direction of stress; free from significant defects		A.15.4-2	2.1(a)	B	3	3.1	C	TYPE 2	2.1(a)	0.64P	9.8.2	1	125 - 140	3.2-1	312	125	4	4.1	B
(b) Groove or fillet welds made from both sides; automatic process; no stop-starts			2.1(b)	C	3	3.1, 3.2	C	TYPE 2	2.1(b)	0.76P	9.8.2	2	125	3.2-1	313	125	4	4.2	C
(c) As (b) weld from one side			2.1(c)	D	3	3.6	C2	T2	2.1(b)	0.76P	9.8.2	4	112	3.2-1	323	90			
(d) As (b) with stop-starts			2.1(d)	D	3	3.3	C1	T2	2.1(c)	1.0P	9.8.2	3	112	3.2-1	313	90	4	4.3	D
(e) As (b) manual welding			2.1(e)	D	3	3.5	C2				9.8.2	5	100	3.2-1	323	90			
2.2 Discontinuous weld			2.2	6.5	4	4.1	E	T6	6.5	1.14P		8	80		324	<80	4	4.4	E

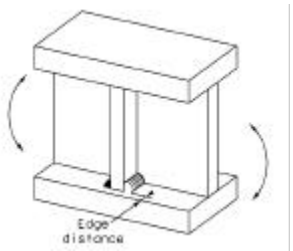
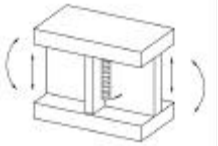
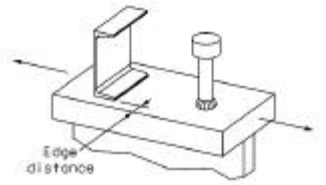
Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
3.1 Parent and weld metal at complete penetration butt joints welded from both sides (a) With weld cap ground flush with surface; free from significant defects		A.15.4-3	3.1(a)	C	5	5.1, 5.2, 5.3	C1	TYPE 3	3.1(a)	0.76P	9.8.3	1, 2, 3	112	3.2-1	211	125	6	6.1	C
(b) Weld made manually or automatically other than submerged arc; all runs made in downhand position			3.1(b)	D	5	5.4 - 5.7	D	TYPE 3	3.1(b)	1.0P	9.8.3	4, 5, 6	90	3.2-1	212	100	6	6.2	D
(c) Welds made other than in (a) or (b)			3.1(c)	E				TYP 3	3.1(c)	1.14P	9.8.3	7	80	3.2-1	213	80	6	6.3	E
(d) Welds between plates of unequal width; welds ground to radius not less than 1.25t			3.1(d)	F2	5	5.8	F1, F3	TYPE 3	3.3	1.52P							6	6.5	F2

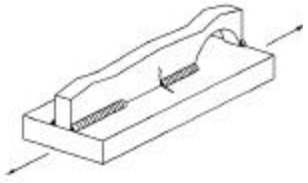
Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
3.2 Parent and weld metal at complete joint penetration butt joints made from one side on a permanent backing strip *If backing strip is fillet welded or tack welded to member, joint shall be assessed using joint type 4(c)*		A.15.4-3	3.2	F	6	6.2	F	TYPE 3	3.2	1.34P	9.8.2	4	112, 100	3.2-1	214, 215	80, 71	6	6.4	F
3.3 Parent and weld metal at full penetration weld made from one side without permanent backing strip			3.3	F2	6	6.1	W3							3.2-1	216	71, 45			

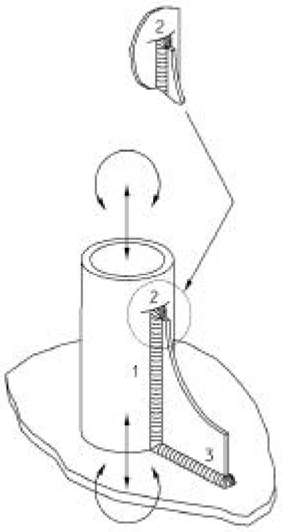
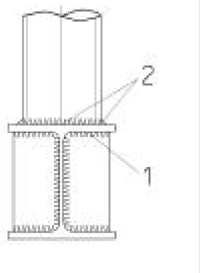
Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
4 Welded attachments Parent metal of stressed member: • adjacent to toes or ends of groove or fillet welded attachments (loaded or unloaded); regardless of orientation and continuity of weld • at toe of full penetration weld connecting stressed member to another slotted member through it (a) With attachment length (parallel to direction of applied stress) <= 150 mm and edge distance >= 10 mm	 	A.15.4-4	4(a)	F	7	7.1 - 7.4	E, D, F, F1, F3, G, W1, W2	TYPE 4	4.1(a)	1.34P	9.8.4	1, 2	90, 80, 71, 50, 45	3.2-1	511, 521	100 - 71, 80 - 50	5	5.2	F
(b) With attachment length > 150 mm and edge distance >= 10 mm			4(b)	F2	7	7.1	F1, F3	TYPE 4	4.1(b)	1.52P	9.8.4	1	50	3.2-1	511, 521		5	5.3	F2
(c) Weld within 10 mm of edges or corners of stressed member			4(c)	G	7	7.8	G	TYPE 4	4.2	1.83P							5	5.5	G

Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
5.1 Parent metal adjacent to cruciform joints or T-joints (member marked X in sketches) (a) Joint made with complete joint penetration groove welds and with any undercutting at corners of member dressed out by local grinding		A.15.4-5	5.1(a)	F	8	8.1	F	TYPE 5	5.1(a)	1.34P	9.8.5	1	71				8	8.1	F
(b) Joint made with partial penetration or fillet welds with any undercutting at the corners of the member dressed out by local grinding			5.1(b)	F2	8	8.2	G	TYPE 5	5.1(b)	1.52P	9.8.5	2	36				8	8.1	F2
5.2 Parent metal adjacent to toe of load-carrying fillet welds that are essentially transverse to direction of applied stress (member X in sketch) (a) Edge distance >= 10 mm			5.2(a)	F2	8	8.3	F1	TYPE 5	5.2(a)	1.52P	9.8.5	3	63	3.2-1	611	63	8	8.6, 8.7	F2, G
(b) Edge distance < 10 mm			5.2(b)	G				T 5	5.2(b)	1.88P									

Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
5.3 Parent metal at ends of load-carrying fillet welds that are essentially parallel to direction of applied stress, with weld end on plate edge (member Y in sketch)		A.15.4-5	5.3	G	8	8.4	W1	TYPE 5	5.3	1.83P	9.8.5	4	45	3.2-1	6.12	50	8	8.8	G
5.4 Weld metal in load-carrying joints made with fillet or partial joint penetration groove welds, with welds either transverse or parallel to direction of applied stress (based on nominal shear stress on the minimum weld throat area)			5.4	W'	8	8.4	W3	TYPE 5	5.4	2.54P	9.8.5	6, 7	80, m=5	3.2-1	611, 612	45, 50	11	11.3, 11.5	D, W

Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
6.1 Parent metal at toe of weld connecting stiffener, diaphragm, etc, to girder flange (a) Edge distance >= 10 mm (see joint type 4.2)		A.15.4-6	6.1(a)	F	7	7.5, 7.6	E, F	TYPE 6	6.1(a)	1.34P	9.8.4	3, 4, 5	80, 71						
(b) Edge distance < 10 mm			6.1(b)	G	7		F, F1		6.1(b)	1.83P									
6.2 Parent metal at end of weld connecting stiffener, diaphragm, etc, to girder web in region of combined bending and shear (includes all attachments to girder webs)			6.2	E	7	7.5, 7.6	E, F	TYPE 6	6.2	1.14P	9.8.4	3, 4, 5	80, 71	3.2-1	512	100 - 71			
6.3 Parent metal adjacent to welded shear connectors (a) Edge distance >= 10 mm			6.3(a)	F	7	7.7	E	TYPE 6	6.3(a)	1.34P	9.8.4	6	80	3.2-1	513	80	5	5.1	F
(b) Edge distance < 10 mm (see type 4(a))			6.3(b)	G	7	7.7	G	TYPE 6	6.3(b)	1.83P									

Description	Examples	ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
		Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve	Table No	Item No	S-N Curve
6.4 Parent metal at end of partial length welded cover plate, regardless of whether plate has square or tapered ends and whether or not there are welds across ends (includes cover plates which are wider than flange)	 	A.15.4-6	6.4	G	8	8.5	G, W3	TYPE 6	6.4	1.83P	9.8.5	5	50, 36	3.2-1	711, 712	56 - 45, 71 - 56	5	5.4	G
6.5 Parent metal adjacent to ends of discontinuous welds, e.g., intermittent web/flange welds, tack welds unless subsequently buried in continuous runs; the same, adjacent to cope holes			6.5	F	4	4.1, 4.2	E, F	TYPE 6	6.5	1.14P, 1.34P	9.8.2	8, 9	80, 71	3.2-1	324, 325	36 -80, 36 - 71	4	4.4, 4.5	E, F

		ISO 13819-2			NORSOK			HSE GNs			Eurocode 3			IIW			BS 7608		
Description	**Examples**	**Table No**	**Item No**	**S-N Curve**	**Table No**	**Item No**	**S-N Curve**	**Table No**	**Item No**	**S-N Curve**	**Table No**		**S-N Curve**	**Table No**	**Item No**	**S-N Curve**	**Table No**	**Item No**	**S-N Curve**
6.6 Gusseted connections (a) Parent metal of gusset plate adjacent to or weld in full penetration welds connecting gusset plate to member - Location 1			6.6(a)	F				TYPE 7	7.6(a)	1.34P									
(b) Parent metal of member adjacent fillet, full or partial penetration welded gusseted connection - Location 2. Full penetration welds normally required in such joints		A.15.4-6	6.6(b)	F	10	10.3	F1	TYPE 7	7.6(b)	1.34P				3.2-1	522, 523	90, 71 - 63	10	10.4	F
(c) Weld metal in fillet or partial-penetration welds attaching gusset plate to member - Location 3			6.6(c)	W'	10	10.4	F3	TYPE 7	7.6(c)	2.54P									

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