



OFFSHORE STANDARD

DNV-OS-C401 DNV 离岸业标准 编号: DNV-OS-C401

FABRICATION AND TESTING OF OFFSHORE STRUCTURES

离岸结构物组装和试验标准

APRIL 2004

DET NORSKE VERITAS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

DNV Offshore Codes consist of a three level hierarchy of documents:

- *Offshore Service Specifications*. Provide principles and procedures of DNV classification, certification, verification and consultancy services.
- *Offshore Standards*. Provide technical provisions and acceptance criteria for general use by the offshore industry as well as the technical basis for DNV offshore services.
- *Recommended Practices*. Provide proven technology and sound engineering practice as well as guidance for the higher level Offshore Service Specifications and Offshore Standards.

DNV Offshore Codes are offered within the following areas:

- A) Qualification, Quality and Safety Methodology
- B) Materials Technology
- C) Structures
- D) Systems
- E) Special Facilities
- F) Pipelines and Risers
- G) Asset Operation
- H) Marine Operations

Amendments and Corrections

This document is valid until superseded by a new revision. Minor amendments and corrections will be published in a separate document on the DNV web-site; normally updated twice per year (April and October). To access the web-site, select short-cut options "Technology Services" and "Offshore Rules and Standards" at <http://www.dnv.com/>

The electronic web-versions of the DNV Offshore Codes will be regularly updated to include these amendments and corrections.

Comments may be sent by e-mail to rules@dnv.com

For subscription orders or information about subscription terms, please use distribution@dnv.com

Comprehensive information about DNV services, research and publications can be found at <http://www.dnv.com>, or can be obtained from DNV, Veritasveien 1, NO-1322 Høvik, Norway; Tel +47 67 57 99 00, Fax +47 67 57 99 11.

© Det Norske Veritas. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, including photocopying and recording, without the prior written consent of Det Norske Veritas.

Computer Typesetting (FM+SGML) by Det Norske Veritas.
Printed in Norway.

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million.
In this provision "Det Norske Veritas" shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.

Main changes

- **General**

The present edition supersedes the January 2001 edition.

- **Main changes**

- Improving definitions of welding procedure particulars, clarifying how to adhere to the term “welding procedures”.
- Introducing enhanced flexibility in selecting method for qualification of WPS by referring to the DNV ship rules. It is an industrial desire to have a reference with basis in line with IACS requirements for steels up to and including grade NV40 F.
- Overall conditions for fracture mechanics (FM) and post weld heat treatment (PWHT) application transferred into relevant design standards; i.e. DNV-OS-C101 and DNV-OS-C201. Related questions to fracture mechanics are directly linked to the *design* assumptions laid down

unit, and thus the relevant requirements must naturally be handled at the *design* stage.

- Requirements related to fracture mechanics (placed in DNV-OS-C101 and DNV-OS-C201) adjusted to reflect latest pertinent research work results.
- Application of welding consumables are linked to category areas of the structure as well as welding consumables adjusted to the material grade/strength group parameter.
- ‘Fabrication and tolerances’ has been reworked to be more comprehensive.
- For tank testing, text has been reworked to make it clearer for the users.

Corrections and Clarifications

In addition to the above mentioned rule changes, a number of corrections and clarifications have been made to the existing

CONTENTS

CH. 1 INTRODUCTION 7	Sec. 2 Fabrication and Tolerances..... 28
Sec. 1 Introduction..... 9	A. General.....28
A. General.....9	A 100 Objective and scope.....28
A 100 Introduction.....9	B. Fabrication Planning.....28
A 200 Objective.....9	B 100 General.....28
A 300 Organisation of contents.....9	B 200 Quality system and workmanship.....28
B. Normative References.....9	C. Inspection.....28
B 100 General.....9	C 100 General.....28
B 200 Offshore service specifications and rules.....9	D. Material Identification, Cutting and Forming.....28
B 300 Offshore Standards.....9	D 100 Material identification.....28
B 400 Other references.....9	D 200 Cutting and forming.....28
C. Informative References.....9	E. Tolerances.....29
C 100 General.....9	E 100 Tolerances for alignment and straightness.....29
D. Definitions.....10	F. Assembly, Welding, Heat Treatment and Repairs.....32
D 100 Verbal forms.....10	F 100 Assembly and welding.....32
D 200 Terms.....10	F 200 Post weld heat treatment (PWHT).....33
D 300 Abbreviations.....10	F 300 Repairs.....33
D 400 Latin symbols.....11	Sec. 3 Non-Destructive Testing..... 35
D 500 Greek symbols.....11	A. General.....35
CH. 2 TECHNICAL PROVISIONS 13	A 100 Scope.....35
Sec. 1 Welding Procedures and Qualification of Welders..... 15	B. Non-Destructive Testing (NDT).....35
A. General.....15	B 100 General.....35
A 100 Scope.....15	B 200 NDT procedures.....35
A 200 Welding processes.....15	B 300 Personnel qualification.....35
B. Welding Procedures.....15	B 400 Extent of NDT.....35
B 100 General.....15	B 500 Acceptance criteria for NDT.....37
B 200 Preliminary welding procedure specification, pWPS.....15	Sec. 4 Other Tests..... 39
B 300 Welding Procedure qualification test (WPQT).....15	A. General.....39
B 400 Welding procedure qualification record (WPQR).....15	A 100 Scope.....39
B 500 Welding procedure specifications (WPS).....15	B. Testing of Tightness.....39
C. Welding Procedure Tests, C-Mn Steel and Low Alloy Steel.....15	B 100 General.....39
C 100 Butt welds on plates.....15	C. Structural Tests.....39
C 200 Butt welds in pipes.....17	C 100 General.....39
C 300 Full penetration T-, Y-, and K- joints.....18	Sec. 5 Corrosion Protection Systems..... 40
C 400 Tubular joints.....18	A. General.....40
C 500 Fillet welds.....19	A 100 Scope.....40
C 600 Re-testing.....19	A 200 General.....40
C 700 Validity of a WPS.....19	A 300 Application of coating.....40
C 800 Fracture mechanic (FM) testing.....22	A 400 Fabrication and installation of sacrificial anodes.....40
D. Welding Procedure Tests, Aluminium.....23	A 500 Fabrication and installation of impressed current systems.....40
D 100 General.....23	Sec. 6 Miscellaneous..... 41
D 200 Butt welds.....23	A. Use General.....41
D 300 Fillet welds.....24	A 100 Scope.....41
D 400 Re-testing.....24	B. Bolts.....41
E. Welding Procedure Tests, Stainless Steel.....25	B 100 Bolts and nuts.....41
E 100 General.....25	C. Mechanical Fastening.....41
E 200 Supplementary requirements for austenitic stainless steel.....25	C 100 Contact surfaces in slip resistant connections.....41
E 300 Supplementary requirements for ferritic-austenitic stainless steel.....25	CH. 3 CERTIFICATION AND CLASSIFICATION 43
F. Qualification of Welders.....26	Sec. 1 General..... 45
F 100 General.....26	A. Introduction.....45
F 200 Standards for qualification testing.....26	A 100 Scope.....45
G. Testing.....26	B. Specific Certification and Classification Requirements.....45
G 100 General.....26	
G 200 Tensile testing at ambient temperature.....26	
G 300 Bend testing.....26	

B	200	Basic requirements	45	B	600	Corrosion protection systems.....	45
B	300	Welding shops and -contractors	45				
B	400	Welding consumables	45	C.		Records and Documentation.....	45
B	500	Welding procedures and qualification of welders.....	45	C	100	General	45



FABRICATION AND TESTING OF
OFFSHORE STRUCTURES

CHAPTER 1

INTRODUCTION

CONTENTS	PAGE
Sec. 1 Introduction	9

SECTION 1 第一章 INTRODUCTION 简介

A. General 概述

A 100 Introduction 简介

101 This standard contains requirements for fabrication and testing of offshore structures. 本标准包括了离岸结构物的装配和测试要求

A 200 Objective 目的

201 The objectives of this standard are to: 本标准的目的是包括:

- provide an internationally acceptable standard to ensure the quality of all welding operations used in offshore fabrication, through identifying appropriate welding procedures, welder qualifications and test methods 通过认可的合适的焊接工艺, 焊工资格和试验方法, 对用于离岸构件的装配的焊接操作质量方面, 提供国际上认可的标准。
- serve as a technical reference document in contractual matters between purchaser and contractor 在买卖双方之间的合同事务方面作为技术参考文件。
- serve as guideline for designer, purchaser and contractor 作为设计者, 买方和卖方的指南
- specify minimum requirements for welding operations subject to DNV certification and classification.

描述了取得DNV证书和入级前提的焊接操作最低要求

A 300 Organisation of contents 内容结构

301 Ch.2 Sec.1 to Ch.2 Sec.6 give common requirements that are considered applicable to all types of offshore units and installations. 从第2章第1节与第2章第6节是适用于所有类型的离岸物体和其安装的通用要求

B. Normative References 通用参考章节

B 100 General 概述

101 The references given in Table B1, Table B2 and Table B3 include provisions, which through reference in this text constitute provisions for this standard. 表B1, B2, B3中参考章节包含的条款构成了本标准的条款。

B 200 Offshore service specifications and rules 离岸服务规范和规则

201 The offshore service specifications and rules given in Table B1 are referred to in this standard. 本标准中参考了表B1中给出的离岸服务规范和规则

Table B1 DNV Offshore Service Specifications and rules 表B1: 离岸服务规范和规则

Reference 参考号	Title 内容
DNV-OSS-101	Rules for Classification of Offshore Drilling and Support Units 离岸钻井和支持物体的入级规则
DNV-OSS-102	Rules for Classification of Floating Production and Storage Units FPS 物体的入级规则
	Rules for Classification of Ships 船舶入级规则

B 300 Offshore Standards 离岸业标准

301 The offshore standards given in Table B2 are referred to in this standard. 本标准中参考了表B2的离岸业标准

Table B2 DNV Offshore Standards 表B2: DNV离岸业标准

Reference 参考号	Title 内容
DNV-OS-B101	Metallic Materials 金属材料
DNV-OS-C101	Design of Offshore Steel Structures, General (LRFD method) 离岸钢结构设计, 通用
DNV-OS-C201	Structural Design of Offshore Units (WSD method) 离岸物体结构设计 (WSD方法)

B 400 Other references 其他参考章节

401 The other references given in Table B3 are referred to in this standard. 本标准参考了表B3所列的其他参考章节

Table B3 Other references 表B3: 其他参考章节

Reference 参考号	Title 内容
ANSI/AWS D1.1	Structural Welding Code – Steel 结构焊接符号-钢
ASME	Section IX, Welding and Brazing Qualifications Non-Interfiled (Boiler and Pressure Vessel Codes) 第9章: 无插入型焊接和镀铜质量 (锅炉和压力容器附号)
ASTM G48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution 标准检验方法和对立, 加上抗腐蚀不锈钢合金钢材及相关的氯化铁使用办法
ASTM E562	Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count 标准检验方法来定量
BS 7448-2	Fracture mechanics toughness tests. Method for determination of K _{IC} , critical CTOD and critical J values of welds in metallic materials 断裂力学韧性试验. 确定K _{IC} , 鉴定的CTOD和焊接J值在金属焊接材料中的方式
EN 287	Approval testing of welders - Fusion welding 焊工认可测试--融接焊接
EN 1418	Welding personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials 焊接人员--通过全机械化、自动钢材材料焊接的焊接操作测验及阻力焊接员操作的认可的人员
IACS	Shipbuilding and Repair Quality Standard, Part A - Shipbuilding and repair Quality Standard for New Construction and Part B - Repair Quality Standard for Existing Ships
	造船和修理质量标准, Part A-新建造物的船舶建造和修理质量标准, Part B-现有船舶修理质量标准
ISO 148	Steel - Charpy impact test (V-notch) 钢铁-Charpy冲击试验(V型凹孔)
ISO 898	Mechanical properties of fasteners made of carbon and alloy steel 碳和合金钢合造的机械道具
ISO 6507-1	Metallic materials - Vickers hardness test - Part 金属材料—Vickers硬度测试—部分
	1: Test method 测试方式
ISO 8501-1	Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings 在使用油漆和相关产品之前钢层的准备—表层清洁的视觉评估--第一部分-无涂层钢层以及将早先涂层完全移走的钢层的生锈等级和预备等级

ISO 9001:2000 Quality management systems - Requirements
Approval testing of welders - Fusion welding ISO 10042 Arc-welded joints in aluminium and its weldable alloys - Guidance on quality levels for imperfections
质量管理体系—需要ISO9006 电焊工的认证测试—需要ISO10042的熔接电焊 铝制和可焊接合金制成的的拱型电焊接口—不达标质量等级保证

NACE MR0175 Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment - Item No. 21302
油田设备的硫化抗压力破裂金属材料-项目第21302号

C. Informative References 参考信息

C 100 General 概况

101 The documents listed in Table C1 include acceptable methods for fulfilling the requirements in the standard and may be used as a source of supplementary information. Other recognised documents as listed below may be used provided it is shown that they meet or exceed the level of safety of the actual standards. 表C1中所列文件包括执行本标准所需要的可接受的方法, 这些文件可作附属资料用。其他认可的表中所列文件也可使用, 只要表明其符合或超过实际标准的安全等级时。

Table C1 DNV Recommended Practices and Classification Notes 表C1: DNV建议操作和入级注意事项	
Reference 参考号	Title 内容
DNV-RP-C203	Fatigue Strength Analysis of Offshore Steel Structures 离岸钢结构疲劳强度分析
Classification Note 30.1	Buckling Strength Analysis 离散强度分析

D. Definitions 定义

D 100 Verbal forms 情态动词的含义

101 Shall: Indicates a mandatory requirement to be followed for fulfilment or compliance with the present standard. Deviations are not permitted unless formally and rigorously justified, and accepted by all relevant contracting parties.

必须: 指强制性要求, 必须执行和符合目前的标准, 不允许有偏差, 除非书面正式确认和有关合同方接受。

102 Should: Indicates a recommendation that a certain course of action is preferred or particularly suitable. Alternative courses of action are allowable under the standard where agreed between contracting parties but shall be justified and documented.

应该: 指建议性要求, 推荐优先的或实际上合适的某些行动过程。符合标准下可以选择别的行动过程, 只要合同各方同意, 但必须备案。

103 May: Indicates a permission, or an option, which is permitted as part of conformance with the standard.

可能: 指允许或选择性, 作为附合标准的一部分, 是可允许的

104 Can: Can-requirements are conditional and indicate a possibility to the user of the standard.

能够: 指有条件能达到的要求, 表明标准使用者的可能性。

105 Agreement, or by agreement: Unless otherwise indicated, agreed in writing between contractor and purchaser.

协议或依协议: 除非相反约定, 指买卖双方书面可意。

D 200 Terms 条款

201 Purchaser: The owner or another party acting on his behalf, who is responsible for procuring materials, components or services intended for the design, construction or modification of a structure.

买方: 指船东或代表船东的其他方, 其负责采购材料, 部件或提供在结构设计, 建造, 变更等的服务

202 Contractor: A party contractually appointed by the purchaser to fulfil all, or any of, the activities associated with fabrication and testing.

卖方: 由买方指定的特定一方, 其履行所有的或商分的与组装有关的活动

203 Welding procedure: A specified course of action to be followed in making a weld, including reference to materials, welding consumables, preparation, preheating (if necessary), method and control of welding and post-weld heat treatment (if relevant), and necessary equipment to be used.

焊接工艺: 指在进行焊接时要遵守的行为规定, 包括相关的材料, 焊接耗材, 准备, 预热(如需要), 焊接的方法和控制, 以及焊后的热处理(如相关的), 以及使用的相关设备。

204 Preliminary welding procedure specification (pWPS): A tentative welding procedure specification providing required welding variables, which is assumed to be adequate by the contractor, but which has not been qualified by the purchaser.

简易焊接工作规范(pWPS): 指临时的焊接工艺规范, 提供所需要焊接变化情况。这个工艺, 卖方认为是足够的, 但尚未取得买方的合格认可。

205 Welding procedure specification (WPS): A welding procedure specification, which has been qualified by the purchaser to conform with an agreed qualification scheme.

焊接工艺规范(WPS): 指这样的焊接工艺规范, 它已由买方合格认可, 以确认约定的质量规程。

206 Welding procedure qualification test (WPQT): The process of accomplishing welding and testing of a standardised test piece, as indicated in the pWPS.

焊接工艺质量试验(WPQT): 在pWPS中所示, 对标准化的试验件进行附合性焊接和试验的工艺。

207 Welding procedure qualification record (WPQR): A record comprising a summary of necessary data needed for the issue of a pWPS.

焊接工艺质量记录(WPQR): 包括必须的数据总结的记录, 用于pWPS。

208 Non-destructive testing (NDT): Visual inspection, radiographic testing, ultrasonic testing, magnetic particle testing, penetrant testing and other non-destructive methods for revealing defects and irregularities.

无损探伤(NDT): 指外观检查, 射线试验, 超声试验, 磁粉检验, 渗透试验和其他无损方法以测出缺陷和不规则处。

209 Structural testing: is a hydrostatic test, carried out in order to demonstrate the tightness of the tanks and the structural adequacy of the design. Where hydrostatic testing is not practically feasible, hydropneumatic testing may be carried out in-structure testing: 是指进行静态压力试验, 以展示舱的密性和设计的结构。对于进行静态压力试验不实际的地方, 进行压力空气试验而不是静态压力试验。

stead under provision that the test is simulating, as far as practicable, the actual loading of the tank. 试验尽量进行模拟, 尽可能地按舱的实际负荷。

210 Leak testing: is an air or other medium test, carried out in order to demonstrate the tightness of the structure.

漏气试验: 用空气或其他介质进行试验, 以展示结构的密性。

211 Hydropneumatic testing: is a combination of hydrostatic and air testing, carried out in order to demonstrate the tightness

of the tanks and the structural adequacy of the design. 压力空气试验: 静态压力和空气试验的混合, 以展示舱的密性和设计的结构

212 Hose testing: is a water test carried out to demonstrate tightness of structural items. 软管试验: 喷水试验, 以展示结构项目的密性

213 Shop primer: is a thin coating applied after surface preparation and prior to fabrication as a protection against corrosion. 车间底漆: 指表面处理完后, 组装之前的一层薄涂层, 以防组装过程的腐蚀。

tion during fabrication.

214 Protective coating: is a final coating protecting the structure from corrosion. 保护涂层: 结构的最终涂层, 以防腐蚀。

215 Watertight: means capable of preventing the passage of water through the structure under a head of water for which the surrounding structure is designed.

水密性: 指防一定水高的、结构物周围的水渗透结构的能力。

216 Weathertight: means that in any sea conditions water will not penetrate into the ship.

海水渗透性: 指在任何海况下, 水无法渗入船舶的能力。

D 300 Abbreviations 简写符号

简写符号

301 The abbreviations given in Table D1 are used in this standard.

本标准中使用了表D1所示的简写符号

Table D1 Abbreviations 表D1: 简写附号

Abbreviation 简写 In full 全称

AC	Alternating current	交流电源
ANSI	American National Standards Institute	美国国家标准
ASME	American Society of Mechanical Engineers	美国机械工程师协会
ASTM	American Society for Testing of Materials	美材料试验协会
AWS	American Welding Society	美焊接协会
BM	Base material	基料
BS	British Standard (issued by British Standard Institution)	英标
CE	Carbon equivalent	碳或相当
C-Mn	Carbon manganese	碳-锰
CTOD	Crack tip opening displacement	裂口张开度
DAC	Distance amplitude curve	位移放大曲线
DC	Direct current	直流
DNV	Det Norske Veritas	挪威船级社
ECA	Engineering critical assessment	工程关键评估
EN	European de Normalisation	欧盟德国正常化
FM	Fracture mechanics	断裂机制
HAZ	Heat affected zone	热影响区
IACS	International Association of Classification Societies	国际船级社协会
ISO	International Organisation for Standardisation	
MAG	Metal active gas (welding)	金属活性气体
MIG	Metal inert gas (welding)	金属惰性气体
NACE	National Association of Corrosion Engineers	腐蚀协会
NDT	Non-destructive testing	无损探伤
PWHT	Post weld heat treatment	焊后热处理
pWPS	Preliminary welding procedure specification	简易焊接工艺规范
RP	Recommended practice	建议执行
SMAW	Shielded metal arc welding	屏蔽金属焊
SMYS	Specified minimum yield stress	最小屈服强度
TIG	Tungsten inert gas (welding)	钨插入型气体(焊接)
WM	Weld metal or Deposit	焊材金属或其贮藏
WPQR	Welding procedure qualification record	焊接工艺质量记录
WPS	Welding procedure specification	焊接工艺规范
WPT	Welding production test	焊接生产试验

D 400 Latin symbols 拉丁符号

401 The following Latin symbols are used:

- a = size of test specimen 试验样本尺寸
- b = size of test specimen 试验样本尺寸
- d = diameter of round tensile test specimen 圆型强度试验样本直径
- d_f = distance from the plane of the fatigue pre-crack to the fusion line 从平面的疲劳预制裂纹到基线的距离
- e = plastic deformation 塑料变形
- h_T = test pressure height 试验压高
- h_{op1} = vertical distance from the load point to the position of maximum filling height 从荷点到最大高度的垂直高度
- h_{s3} = vertical distance from the load point to the top of the tank 从荷点到舱顶的距离
- h_{p0} = height corresponding to valve opening pressure when exceeding the general value 张开压力时相应阀的高度
- h_{op2} = vertical distance from the load point to the position of maximum filling height. For tanks adjacent to the sea that are situated below the extreme operational draught (T_E), h_{op2} is not normally to be taken as being less than T_E 垂直距离从负荷点到最大装载高度的垂直距离。位于极端运作气流之下的近海容器(T_E), h_{op2}并非通常被当作低于T_E
- h_{D2} = pressure head due to flow through pipes 流经管道的压力顶点值
- l_e = equivalent parameter for conical shells 圆锥形壳的等值参数
- l_{min} = breadth of test assembly plates 试验的装配金属的宽度
- l_T = length of template or rod 模板或标尺的长度
- r = nominal radius of the shell 外壳的估算半径
- r_a = actual distance from the centre of the sphere to the shell wall 从球体中心到外壳表面的实际距离
- r_e = equivalent parameter for conical shells 圆锥外壳的等值参数
- r_a = actual distance from the cylinder axis to the shell wall 从圆柱轴心到外壳外面的实际距离
- s = distance between stiffeners or girders 钢筋或梁之间的距离

- t = thickness 厚度
- t1 = wall thickness of the greater tube (can) 更大的管壁厚度
- t2 = wall thickness of the smaller tube (brace) 更小的管壁厚度
- 度A = diameter used in wrap around bending test 用于弯曲测验的直径
- C = diameter of roller in bend test 弯曲测验的滚铜直径
- D = outside diameter 外部直径
- D1 = outside diameter of the greater tube (can) 更大管道或容器的外部直径
- D2 = outside diameter of the smaller tube (brace) 更小管道或支柱的外部直径
- KV = impact energy requirement 冲击能量需要
- L_o = length of test area in test specimens 测试样本的测试区长度
- L_{min} = length of test assembly plates 装配金属的测试长度
- N = number of 数量
- R = radius 半径
- R_c = forming radius 形成半径
- T = thickness of plate in bend test 弯曲测试的金属厚度
- W = width of weld 焊接宽度

D 500 Greek symbols 希腊符号

501 The following Greek symbols are used:

下列希腊符号被使用在以下情况:

- α = tubular joint angle 管状连接点角度
- δ = measure of deformation compared to theoretical geometry 变形参数和理论几何之间的比例
- λ_i = length of area with acceptable location of the fatigue pre-crack 疲劳破裂前可接受区域的长度
- ν = Poisson's ratio 泊松的比率
- σ₁ = largest compressive principal membrane stress 主膜压力的最大压缩力
- σ₂ = principal membrane stress normal to σ₁
- ψ = ratio between principal stresses. 主压力下的比率



CHAPTER 2

TECHNICAL PROVISIONS 技术条款

CONTENTS	PAGE
Sec. 1 Welding Procedures and Qualification of Welders..... 焊接工艺和焊工资格	15
Sec. 2 Fabrication and Tolerances 装配和公差	28
Sec. 3 Non-Destructive Testing 无损探伤	35
Sec. 4 Other Tests 其他试验	39
Sec. 5 Corrosion Protection Systems 防腐体系	40
Sec. 6 Miscellaneous..... 其他	41

SECTION 1 WELDING PROCEDURES AND QUALIFICATION OF WELDERS 焊接工艺和焊工资格

A. General 通则

A 100 Scope 范围

101 This section specifies requirements for welding procedures and welding procedure tests for C-Mn steel and low alloy steel, aluminium, austenitic stainless steels and ferritic-austenitic (duplex) stainless steels as well as qualification of welders.

本节规范了C-Mn钢及低合金钢、铝、奥氏体不锈钢、奥氏体不锈钢的焊接工艺和焊接工艺试验的要求，以及相应的焊工资格

A 200 Welding processes 焊接工艺

201 Welding may be performed with the following processes unless otherwise specified:

除非另有说明，焊接是指用如下工艺进行的焊接

- manual metal arc welding (metal arc welding with covered electrode) 手动金属电弧焊（带保护电极的金属电弧焊）
- self-shielded tubular-cored arc welding 自动屏蔽管芯电弧焊
- submerged arc welding with one wire electrode 单导线电极的半埋式电弧焊
- submerged arc welding with strip electrode 带状电极的半埋式电弧焊
- metal inert gas welding, (MIG) welding 金属惰性气体焊，（MIG）焊
- metal active gas welding, (MAG) welding 金属活性气体焊，（MAG）焊
- tubular-cored metal arc welding with active gas shield 带活性气体屏蔽的管芯金属电弧焊
- tubular-cored metal arc welding with inert gas shield 带惰性气体屏蔽的管芯金属电弧焊
- tungsten inert gas arc welding, (TIG) welding 钨丝惰性气体电弧焊，（TIG）焊
- plasma arc welding. PLASMA 电弧焊

B. Welding Procedures 焊接工艺

B 100 General 通则

101 A welding procedure specification shall as a minimum contain the following information as relevant for the welding operation: 焊接工艺规范是作为焊接操作的文件，至少应包含如下信息：

- material: standard, grade and modification 材料：标准，等级和修改版
- nominal thickness or diameter range (dimensions) 名义厚度或直径范围（尺寸）
- welding process 焊接工艺
- joint or groove design with tolerance 设计的接头或波口公差
- welding position(s) and direction of progression 焊位和焊接方向
- welding consumables: trade name, electrode or wire diameter, shielding gas, flux and recognised classification 焊接易耗品：牌名，电极或线径，屏蔽气体，流量和指定的船级社
- welding sequence: number and order of passes or layers 焊接流程：焊层数或标号
- electrical parameters: voltage range, current range, polarity 电参数：电压范围，电流，。
- travel speed- and heat input ranges 焊接速度和热影响区
- preheat and interpass temperatures 预热和间隔温度。
- post weld heat treatment parameters 焊后热处理参数
- details on cleaning processes employed and restrictions if any. 如有的话，实施的净化工艺和限制方面的细节信息。

B 200 Preliminary welding procedure specification, pWPS 待批的焊接工艺规范，pWPS

201 A pWPS shall be prepared for acceptance by the pur-

chaser prior to starting up the agreed welding procedure qualification test (WPQT). 在开始经同意的焊接工艺合格测验（WPQT）之前，卖方应将pWPS递交买方接受。

B 300 Welding Procedure qualification test (WPQT) 焊接工艺合格报验

301 When a welding procedure specification (WPS) is required to be qualified by a WPQT, the welding process shall be performed based on the accepted pWPS. (See Sec.2 F112). 当需要由WPQT来判定焊接工艺规范合格时，依认可的pWPS执行焊接工艺。

B 400 Welding procedure qualification record (WPQR) 焊接工艺合格记录

401 A WPQR can be basis for the purchaser's acceptance of a WPS. Prior to starting up production the WPQR shall be submitted to the purchaser for review including any corrosion test results, as applicable. 依买方认可的WPS，进行WPQR。开始生产前，WPQR应递交给船东查阅，如适用时，还包括腐蚀检测结果。

B 500 Welding procedure specifications (WPS) 焊接工艺规范

501 A WPS shall be accepted by the purchaser upon conformity with the requirements of an agreed qualification scheme. WPS应由买方认可。WPS应与约定同意的合格流程的要求相一致。

502 A WPS shall be valid under the provision that production welding is carried out with the same type of welding equipment on which the WPS has been established. 只要是使用同样类型的设备进行产品焊接，并且基于此类设备而形成的WPS，则WPS将一直有效。

503 The conditions on which the WPS has been established shall be representative of the working environment for the work shop or site where the production welding will be performed. (See C700). 建立的WPS的环境必须有工作环境的代表性。工作环境是指进行产品焊接的车间或现场（参阅C700）

C. Welding Procedure Tests, C-Mn Steel and Low Alloy Steel 焊接工艺测试，C-Mn钢和低合金钢

C 100 Butt welds on plates 板上对焊

101 The test assembly may consist of two plates welded together. As far as possible the plates shall have a size that can simulate the heat transfer during the production welding. For manual or semiautomatic welding, a test assembly according to Fig.1 shall be carried out with: 装配测试应含2块板焊接在一起。测试板的尺寸尽可能达到能使产品焊接时热量能够传递。对于手工焊或半自动焊，按图1进行装配测试

$$l_{\min} = 300 \text{ mm}$$

$$L_{\min} = 350 \text{ mm}$$

For automatic welding, the dimensions shall be: 对于全自动焊，则尺寸为：

$$l_{\min} = 400 \text{ mm}$$

$$L_{\min} = 1000 \text{ mm}$$

Edge preparation and fit-up shall be as detailed in the pWPS. The plates shall be joined and held by tack welds to provide the correct gap for the edge preparation used. 50 mm at each end of the test piece shall be discarded.

波口准备和装配（定位）必须详细地按pWPS进行。板必须经定位焊而使他们对接和保持，以使波口间隔正确。测试板的每端50mm将不测试

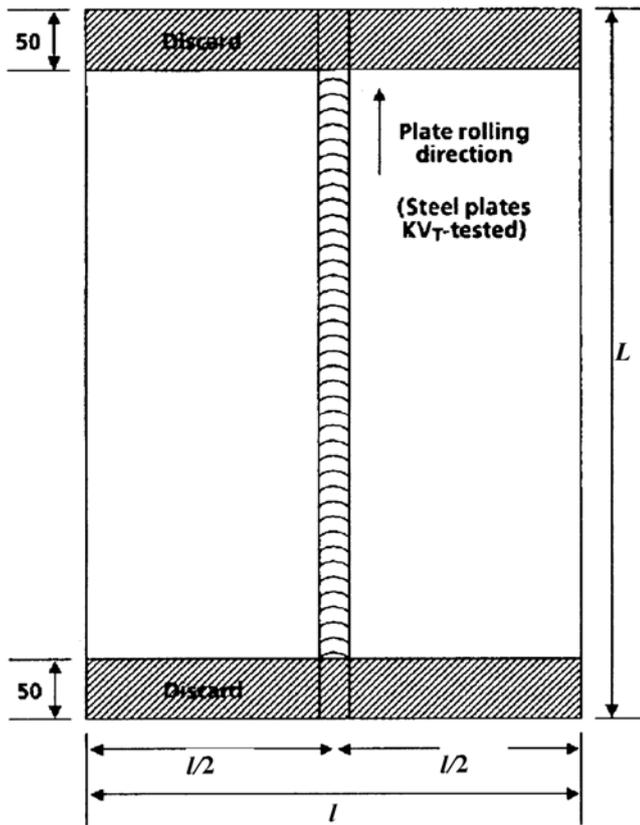


Figure 1 Test assembly for butt welds on plates
图1: 板对焊装配测试图

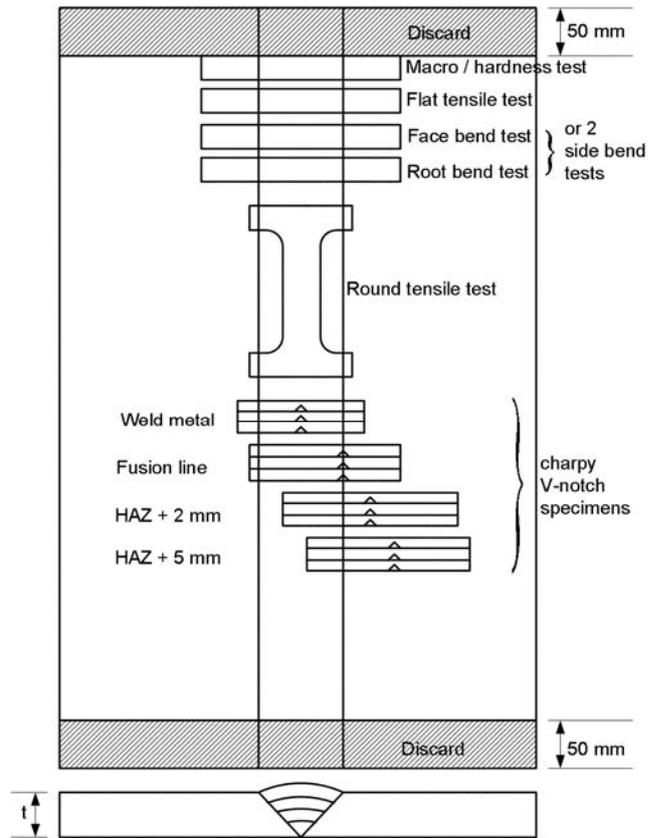


Figure 2 Sampling of test specimens in plates
图2: 测试板取样图

102 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows:
依生产焊接规范要求而制定的规范进行NDT。测试内容包括如下:
— 100% visual inspection 100%外观
— 100% radiographic or ultrasonic testing 100%射线或超声检验
— 100% surface crack detection (dye penetrant or magnetic particle testing). 100%裂纹检验 (干粉渗透或磁粉检验)

The soundness of the weld shall comply with requirements given in Sec.3 B.
焊缝声强必须符合3B节要求

103 The following mechanical tests are required from each assembly (see Fig.2): 每一装配要求进行如下的机械性能试验 (见图2)

- 2 tensile tests (flat specimen transverse to the weld) 2个拉伸试验 (平样板沿焊缝纵向)
- 1 root and 1 face bend tests when $t \leq 20$ mm and 2 side bend tests when $t > 20$ mm 当 $t \leq 20$ mm时, 1个根部和1个面上的弯曲试验, 当 $t > 20$ mm时, 2个边部弯曲试验。
- 4 (6) sets of Charpy V-notch tests with the notch location as given in 107 4 (6) 块V型缺口冲击试验, 缺口位置按107。
- 1 macrosection test (metallographic examination + hardness measurements). 1块宏观剖面试验 (金相检验+硬度测试)

104 Specimens for transverse tensile testing shall be in accordance with G, type B.
纵向拉伸试验取样必须符合G, 类型B

The tensile strength shall not be below the specified minimum tensile strength for the steel grade in question.

抗拉强度必须不低于所使用的钢板等级规定的最低抗拉强度。

105 Transverse side bend, root bend and face bend specimens shall be machined to the dimensions shown in G300. For a mixed or heterogeneous butt joint longitudinal bend test specimens may replace transverse bend test specimens.
横向边弯曲、根本弯曲和面部弯曲试样必须加工至G300的尺寸。对于混合式对焊接缝, 纵向弯曲试样可取代横向弯曲试样。

The test specimens shall be bent on a mandrel with diameter $4t$, where t is the thickness of the specimen, except for extra high strength steel grades NV 550, NV 620 and NV 690 where the diameter shall be $5t$.
试样弯曲时, 其心轴弯曲必须达到直径 $4t$, t 是指试样厚度, 而对高强度钢NV550, NV620和NV690则 $5t$ 。

The bending angle shall be at least 120° . After bending, the test specimens shall not reveal any open defects in any direction greater than 3 mm. Defects appearing at the corners of a test specimen during testing may be ignored in the evaluation, if not associated with obvious defects.

弯曲线角度至少 120 度。试验完后, 试样不能出现在任何方向大于3mm的缺陷。评估时, 如无明显的缺陷, 试验期间可不考虑试样角上的缺陷。

106 The macrosection shall include about 10 mm of unaffected base material and shall be prepared and etched on one side to clearly reveal the fusion line and the HAZ. Cracks and lack of fusion are not accepted.

宏观剖面应含有约10mm的无影响基材, 试样应备好以清晰地露出熔焊线和HAZ。将拒收裂纹和无熔焊线的试样。

The welded joints shall have a regular profile with smooth transitions to the base materials and without significant or excessive reinforcement.

焊缝接口外观必须规则, 光顺地过度到基材, 无明显或大量的焊缝凸量。

107 The Charpy V-notch specimens shall be machined in accordance with the requirements given in DNV-OS-B101. Four sets of three specimens each shall be sampled 2 mm below the surface of the parent material and transverse to the weld.

Charpy V-notch specimens shall be localised in the welded joint as follows:
V型缺口试样按DNV-OS-B101的要求加工。4套, 每套3块试样, 每套有2mm试样块, 低于基材表面2mm, 纵向到焊缝12。

- 3 specimens with the notch along the weld metal centreline 3块试样的V型缺口沿焊缝金属中心线
- 3 specimens with the notch in the fusion line 3块试样的V型缺口在融合线。

- 3 specimens with the notch in the HAZ, 2 mm from the fusion line
3块试样的缺口在HAZ区，离融线2mm
- 3 specimens with the notch in the HAZ, 5 mm from the fusion line.
3块试样的缺口在HAZ区，离融线5mm

The V-notch shall be perpendicular to the plate surface.
V型缺口应平行板表面。

For plate thickness $t > 50$ mm two additional sets of specimens shall be taken from the root area: one with the notch in centre of weld and one with the notch in the fusion line.

板厚 $t > 50$ mm时，应从根部区额外取样2块：一块缺口在焊缝中心，一块缺口在融线。

For dissimilar metal joints and/or joints between cast or forged and rolled materials, impact tests shall be carried out on test specimens with notch in fusion line, 2 mm from fusion line and 5 mm from fusion line in each parent material.

对于不类似材料间的接口，及/或锻件或铸件与压延材料间的接口，必须进行冲击试验，V型缺口在融线区，离融线2mm，离融线切入基材5mm。

The Charpy V-notch test temperature and the average value for absorbed energy (KV) in weld metal, fusion line and HAZ shall be the same as required for the base material in transverse direction (see DNV-OS-B101).

在焊缝区，在融线区和HAZ区的V型缺口试验温度和吸收能量值（冲击值KV）均应与基材在纵向方向要求的值等同（参见DNV-OS-B101）

The requirements given by the DNV Rules for Classification of Ships Pt.2 Ch.3 Sec.2 B308 can be applied as an alternative. For grades of improved weldability (see DNV-OS-B101), the Charpy V-notch test temperature and the average value for absorbed energy in weld metal, fusion line and HAZ shall be the same as required for the base material of the comparable normal weldability grade in transverse direction.

作为一个选择，对于入级DNV Pt2船，可采用DNV规范Ch.3 Sec.2 B308。对于焊接性能改进型钢材料级别（参见DNV-OS-B101），V型缺口试验温度和吸收能量值（冲击值KV）在焊缝区，在融线区和HAZ区均应与可比较的通用焊接能力的基材在纵向方向要求的值等同（参见DNV-OS-B101）

108 In the case of reduced Charpy V-notch test specimens (10 mm x 7.5 mm and 10 mm x 5 mm), the impact energy values to be obtained shall satisfy the requirements in Table C1. 如减少V型缺口试样尺寸（10mm x 7.5mm和10mm x 5mm），所取得的冲击能量值必须满足表C1的表示。

Table C1 Impact energy requirement for sub-size specimens
表C1: 小型尺寸试样的冲击能量要求

Dimensions of Charpy V-notch test specimen 试样尺寸	Impact energy 冲击能量
10 x 10 mm	KV
10 x 7.5 mm	5/6 KV
10 x 5 mm	2/3 KV

109 The average impact requirements shall be satisfied for each notch location, but one single value of three values from specimens from the same notch location may be below the average requirements, but not below 70% of minimum average. 对每一缺口位置，平均上必须满足冲击值要求，但对于同样缺口位置的试样的每个单个冲击值，可允许低于平均要求，但不得低于平均值的70%。

110 Where the results from a set of three impact test specimens do not comply with the requirements, an additional set of three impact test specimens may be taken.

3个冲击试样组成1套试验值，如他们的试验结果不符合要求，收要进行另外地1套的冲击试验。

The results obtained shall be combined with the original results to form a new average, which, for acceptance, shall be not less than the required value. Additionally, for these combined results not more than two individual values shall be less than the required average value, and of these, not more than one shall be less than 70% of the average required value.

第2套试验结果与第1套试验结果一起形成新的平均值，验收时，其不能低于要求的值。此外，这些混合试验结果中，不能有多于2个的单独值低于要求的平均值，均不得低于70%平均要求值。

When the result of any test, other than impact test, fails to meet the requirements, two further tests may be made from the same welded joint. If both these additional tests are satisfactory, the test is acceptable.

当有任何试验结果，除冲击试验外，如有不符合要求时，应对同一焊缝再进行进一步的试验。如果加上这些额外的试验能满足要求，则试验合格。

111 The hardness testing shall be in accordance with ISO 6507-1 or equivalent. The Vickers method (HV10) shall be used.

硬度试验依ISO-6507-1或等同的标准进行。可采用维氏法(HV10)测试。Indentations shall be made along traverses in the weld, HAZ and the parent metal approximately 1 mm below the surface. For each traverse a minimum of 3 indentations shall be made in the weld, HAZ (both sides) and parent metal (both sides). For HAZ the first indentation shall be placed as close to the fusion line as possible. For double sided welds, for fillet and T-butt welds one additional row of indentations shall be made through the root area.

刻痕必须沿焊缝，HAZ和基材的横向分布，约表面以下1mm。对每一个横向，至少3个刻痕分布在焊缝区，HAZ区（两边）和基材（两面）。对于HAZ区，第1个刻痕应尽量靠近融线。对双面焊，角焊和T型焊，一排额外的刻痕必须位于根部区。

For material grades up to and including NV 460, a maximum hardness limit of 350 HV10 shall be met for welds in submerged structures exposed to cathodic protection. Hardness limits for higher grades shall be subject to agreement.

对于材料等级约高于NV460（含），位于阴极保护的水下结构区的焊缝，其硬度值最高极限为350 HV10。

Guidance note: 注意:

For NV 500, NV 550, NV 620 and NV 690 grades a maximum hardness limit of 420 HV10 is recommended for welds in submerged structures exposed to cathodic protection. 对于NV500, NV550, NV620和NV690级钢，则最大硬度极限将议为420 HV10

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

112 When a butt weld is made between two different material grades, the test temperature and achieved impact energy shall comply with the minimum specified requirements for the lower steel grade.

对于两个不同材料级别的对焊，试验温度和所获得的冲击能量值必须符合较低级钢所规定的最低要求。

In the same way, the tensile strength to be obtained on the welded assembly shall be in agreement with the requirements relating to the plate steel having the lower strength.

与此同样，抗拉强度试验也适用此原则。

As an example the test temperature, impact energy and tensile strength for the butt welded joints given in Fig.3 are those required for the plate of grade D in the left assembly and for the plate of grade E in the right assembly. 举例如图3：对焊接口的试验温度，冲击能量值和抗拉强度，左边试块为D级板，右边块为E级板，

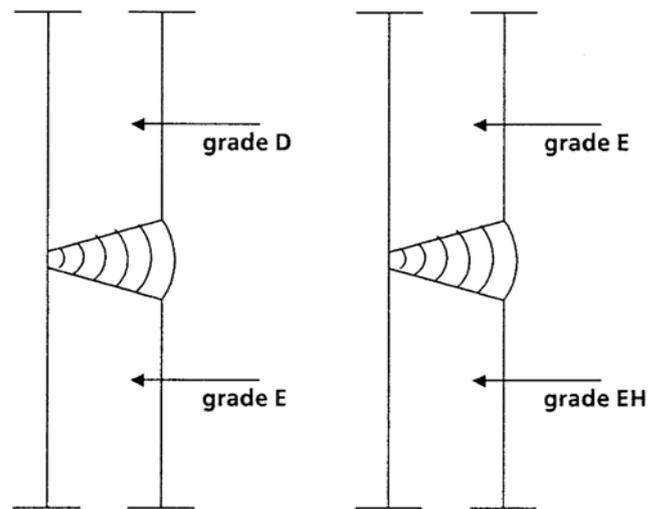


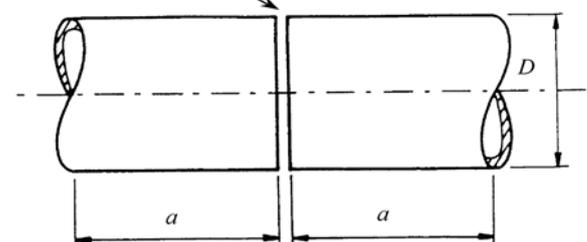
Figure 3 Butt welded plate joints of different grades
图3: 不同级别板材的对焊接口

C 200 Butt welds in pipes 管材对焊

201 The test assembly shall be in accordance with Fig.4. 装配试验按图4

波口准备和定位按pWPW进行

Edge preparation and fit up as detailed in the pWPS



a = minimum value 150 mm 最低值150mm

D = outside diameter 外径

Figure 4 Test assembly for butt welds in pipes 管材对焊装配试验块

202 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows: 按采用的生产焊接规范，进行NDT检验。

- 100% visual inspection

100%外观

- 100% radiographic or ultrasonic testing
100% 射线或超声探伤
 - 100% surface crack detection (dye penetrant or magnetic particle testing).
100% 表面裂纹检查 (干粉渗透或磁粉探伤)
- The soundness of the weld shall comply with requirements given in Sec.3 B. 焊缝声波检验必须符合3B节要求。

203 The following mechanical tests are required from each assembly (see Fig.5): 每试块的机械性能试验要求如下 (见图5)

- 2 tensile tests (flat specimen transverse to the weld)
2个抗拉试验 (焊缝横向的板状试样)
- 1 root and 1 face bend tests when $t \leq 20$ mm and 2 side bend tests when $t > 20$ mm
当 $t \leq 20$ mm 时, 1个根部和1个表面的弯曲试验, 当 $t > 20$ mm 时, 2个边部弯曲试验。
- 4 (6) sets of Charpy V-notch tests with the notch location as given in 107
4 (6) 块V型缺口冲击试验, 缺口位置按107。
- 1 macrosection test (metallographic examination + hardness measurements).
1个宏观剖面试验 (金相检验+硬度测试)

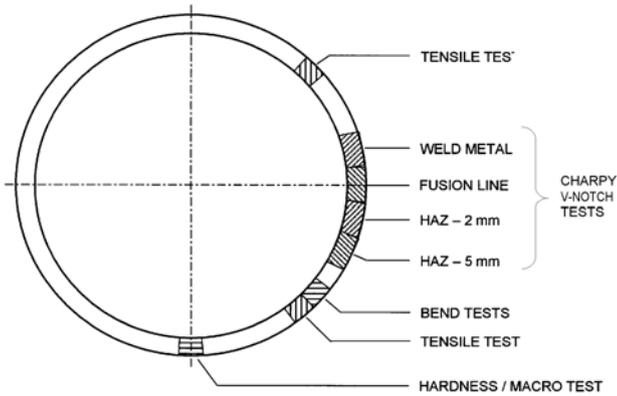


Figure 5 Sampling of test specimens in pipes
图5: 管材试块取样图

204 The results of mechanical testing shall comply with the relevant requirements given in C100. 机械性能试验结果必须符合C100的有关要求。

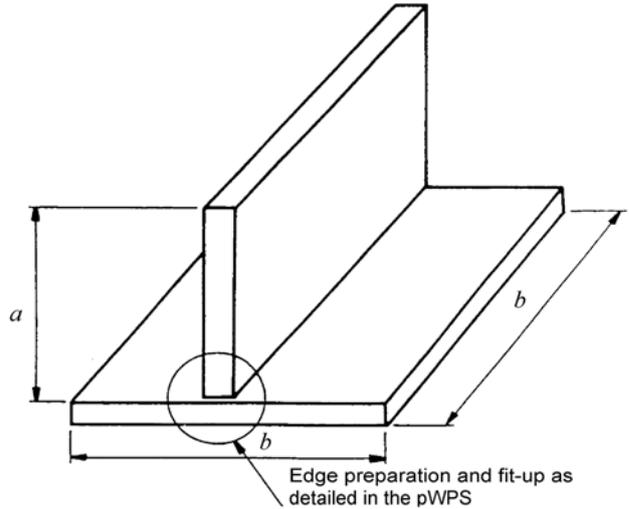
C 300 Full penetration T-, Y-, and K- joints T型, Y型, K型全透焊

301 WPQT's for full penetration groove welds between plates at right angles or inclined, i.e. T- or Y- and K- configurations, shall cover a weld length of minimum 350 mm (see Fig.6). 全透焊的波口WPQT, 直角或斜角板焊缝, 即T型或Y型或K型, 焊缝长至少350mm (见图6)

302 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows:
按生产焊接工艺所要求的进行NDT检验。检验内容包括:

- 100% visual inspection
100% 外观
- 100% ultrasonic testing
100% 超声
- 100% surface crack detection (dye penetrant or magnetic particle testing).
100% 表面裂纹检查 (干粉渗透或磁粉探伤)

The soundness of the weld shall comply with requirements given in Sec.3 B. 焊缝声波检验必须符合3B节的要求



$$a = 3t, \text{ minimum value } 150 \text{ mm} \quad \text{最小值 } 150 \text{ mm}$$

$$b = 6t, \text{ minimum value } 350 \text{ mm} \quad \text{最小值 } 350 \text{ mm}$$

Figure 6 Test assembly for full penetration T-joints
图6: T型焊全透焊试块

303 The following mechanical tests are required from each assembly (see Fig.7): 机械性能试样数量如下: (见图7)

- 4 (6) sets of Charpy V-notch tests with the notch location as given in 107
4 (6) 块V型缺口冲击试验, 缺口位置按107。
- 1 macrosection test (metallographic examination + hardness measurements). 1块宏观剖面试验 (金相检验+硬度测试)

The results of mechanical testing shall comply with the relevant requirements given in C100. 机械性能试验结果必须符合C100的有关要求。

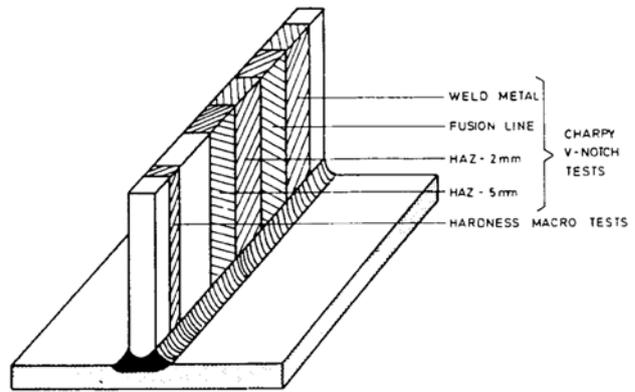


Figure 7 Sampling of test specimens on full penetration T-joints
图7: T型全透焊试块取样图

C 400 Tubular joints 管状接口

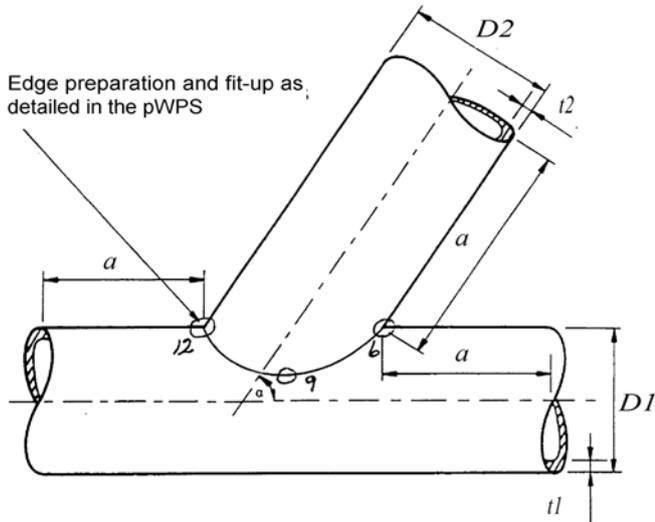
401 The test assembly shall be in accordance with Fig.8. 测试块按图8准备

402 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows:
依生产焊接规范要求而制定的规范进行NDT。测试内容包括如下:

- 100% visual inspection 100% 外观
- 100% ultrasonic testing 100% 超声检验
- 100% surface crack detection (dye penetrant or magnetic particle testing).
100% 裂纹检验 (干粉渗透或磁粉检验)

The soundness of the weld shall comply with requirements 焊缝声波试验必须符合3B节要求

given in Sec.3 B.



a	=	minimum value 150 mm 最小150mm
D1	=	outside diameter of the greater tubular (can)大管厚
t1	=	wall thickness of the can 小管厚
D2	=	outside diameter of the smaller tube (brace) 小管外径
t2	=	wall thickness of the brace 管厚

Figure 8 Test assembly for tubular joints
图8: 管状焊接试块图

403 The following mechanical tests are required from each assembly (see Fig.9): 每试块的机械性能试验要求如下 (见图9)

- 12 Charpy V-notch tests sampled at 9 o'clock and with the notch location as given in 107
12块V型缺口试样, 取样于时钟9点方位, 缺口位如107。
- 2 macro section tests (metallographic examination + hardness measurements) at 12 and 6 o'clock.
2块宏观剖面试验 (金相检验+硬度测试), 位于时钟12点和6点方位。

404 The results of mechanical testing shall comply with the relevant requirements given in C100. 机械性能试验结果必须符合C100的有关要求。

405 Restrictions and testing for joint configuration involving acute angles (less than 15°) should be specified. AWS D1.1 is a good reference for structural welds. 应制定接口形状, 包括实际角度 (小于15度) 等方面的限制和试验要求。AWS D1.1节可供参考。

C 500 Fillet welds 圆角焊

501 The two plates are assembled and positioned edgewise so as to constitute a tee-assembly with no clearance. As far as possible the plates shall be of a sufficient size to ensure a reasonable heat distribution. 两块板对装并定位成无间隔T型装配。板尺寸应尽可能地达以确保合理的热分布。

For fillet welds the test assembly shall be as defined in Fig.9. 对于圆角焊, 其试块准备见图9。

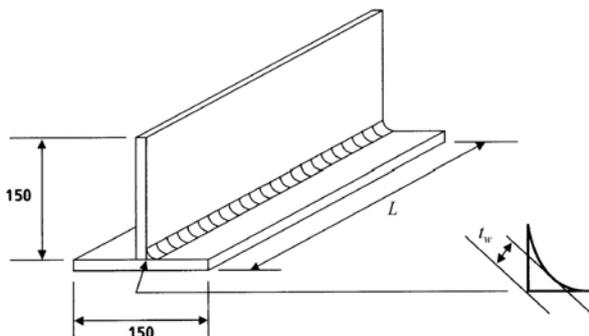


Figure 9 Test assembly for fillet welds
图9: 圆角焊试块图

For manual and semi-automatic welding the length of the test piece shall be: 对于手动或半自动焊, 测度块长度为:

$$L_{min} = 350 \text{ mm} \quad \text{最小350mm}$$

For automatic welding the length shall be: 对自动焊

$$L_{min} = 1000 \text{ mm} \quad \text{最小1000}$$

Weld and fit-up shall be as detailed in the pWPS. 焊接和定位按pWPS进行。

The test assembly shall be welded on one side only. For manual and semi-automatic welding, the stop and restart position shall be included in the test length and shall be clearly marked for subsequent examination.

试块装配必须仅焊边。对于手工或半自动焊, 起点和终点应在测试长度内, 关清晰地标记以使随后检查。

The ends of the specimen are exempted from examination over a length of 50 mm. 端部50mm应剔除。

502 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows: 按生产焊接工艺所要求的进行NDT检验。检验内容包括:

- 100% visual inspection 100%外观
- 100% surface crack detection (dye penetrant or magnetic particle testing).
100%表面裂纹检查 (干粉渗透或磁粉探伤)

The soundness of the weld shall comply with the specified requirements given in Sec.3 B. 焊缝声波检验必须符合3B节的要求

If the stop and restart spot is included in the test length, special attention shall be paid to this position with respect to profile, proper fusion and absence of crater defects. 如起点和终点在试验的焊缝长度内, 应特别注意这些点位的焊缝形状, 合适的熔融区和无栅式缺陷。

503 The following tests shall be performed: 必须进行如下试验:

- 2 macro section tests (metallographic examination, hardness measurements). 2个宏观剖面试验 (金相检验+硬度测试)

One of the macrosections shall be taken at the marked position of the stop and restart (for more details see 106). 在起点和终点焊位标志区各取1个宏观剖面试验 (详见106)

For hardness testing, see 111. 硬度试验, 见111

C 600 Re-testing 再试验

601 If the welding procedure test fails to comply with any of the requirements for NDT one extra test shall be welded and subjected to the same testing. If this additional test does not meet the relevant requirements, the actual pWPS shall be considered as not qualified and a re-specification of the pWPS shall be made prior to a new welding procedure test. 如焊接工艺试验未能满足任何的NDT要求, 则要进行额外的焊接试验, 试验过程是一样的。如第二次试验还是达不到相关的要求, 则实际上pWPS将被视为不合格, 并在新的焊接工艺试验之前应重新制定pWPS。

C 700 Validity of a WPS WPS的有效性

701 The validity of a WPS shall be restricted to the workshop performing the qualification. Workshops, work site or workshop branches under the same technical management and working in accordance with the same QA-program and procedures are considered as one workshop or site work. WPS的有效性限于有执行资格的车间。只要在一个技术管理下, 按同样的QA体系, 由同样的工艺进行, 则车间, 场地或小车间均视为同一个车间或场地。

702 Qualification of a welding procedure remains valid provided the parameters are kept within the qualified ranges of essential variable during production welding. The essential variables and qualified ranges are given in 703. When variations outside the qualification ranges of essential variables occur, the welding procedure qualification shall be considered invalid, and the WPS shall therefore be re-specified and re-qualified. 只要在生产焊接期间, 各种参数保持在合格的必要的变动范围内, 则焊接工艺资格一直有效。703给出了什么叫必要的变动和合格的范围。当参数变动超出了合格的必要的变动参数范围, 则焊接工艺资格无效, WPS要重新制定和重新资格认可。

703 A qualified welding procedure shall be used within the ranges of the parameters of essential variables listed below. Base material

合格的焊接工艺采用的必要的变动参数范围列表如下。基本资料。

The following changes shall lead to a new qualification:

如下方面的变化, 将引起重新资格认可:

- a) In general, significant change of material properties which will obviously affect the weldability and mechanical properties.
总体上, 材料性能明显变化, 这些变化明显地影响焊接机械性能。

Guidance note: 注意

When qualifying a welding procedure, it is recommended to use specified material with highest carbon equivalent (CE) available in the workshop or work site, especially when the thickness is large. 当进行焊接工艺资格认可时, 建议使用指定的材料, 使用在车间或现场能获得最高C含量或等同的材料, 特别是当厚度大时。

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

- b) More specifically, structural steels of both normal and improved weldability are grouped in three strength groups: 特别是, 对于普通的或改进焊接性能的结构钢分成3个强度组:
 - i) Normal strength steel, grades A, B, D and E or equivalent structural steels with tensile strength 400 to 520 N/mm². 普通强度钢, A, B, D和E或相当的结构钢, 其抗拉强度为400-520 N/mm²
 - ii) High strength steel, grades A 27, D 27, E 27, A 32, D 32, E 32, F 32, A 36, D 36, E 36, F 36, A 40, D 40, E 40, F 40 or equivalent structural steels with minimum specified yield strength 265 to 390 N/mm². 对于高强度钢, A27, D27, A32, D32, E32, F32, A36, D36, E36, F36, A40, D40, E40, F40或相当的结构钢, 其最小的名义屈服强度为265-390 N/mm²
 - iii) Extra high strength steels, grades A-F 420, A-F 460, A-F 500, A-F 550, A-F 620, A-F 690 or equivalent structural steels with minimum specified yield strength 420 to 690 N/mm². 高强度钢, A-F 420, A-F 460, A-F 500, A-F 550, A-F 620, A-F 690或相当的结构钢, 其最小名义屈服强度为420-690 N/mm²

The qualification on steel grades of higher toughness requirements will qualify the grades of lower toughness but not vice versa. 已对更高韧性级别的钢的焊接取资格认可, 则合格于更低韧性级别钢的焊接, 但反过来就不行了。

704 Thickness, is defined as follows:
厚度定义如下:

- a) For a butt weld: 对焊
The base metal thickness, which for welds between dissimilar thickness is that of the thinner material. 基材厚度, 对于不类似厚度的对焊, 采用更薄的基材的厚度。
- b) For a fillet weld: 对于圆角焊
The base metal thickness, which for welds between dissimilar thickness is that of the thicker material. However, for each thickness range qualified, as given in Table C2 there is an associated range of qualified throat thickness. 基材厚度. 对于不类似厚度的对焊, 采用更厚的基材的厚度. 然而, 对于每个合格厚度范围, 如表C2, 则有一个相对应的合格的喉厚。
- c) For a set-on tubular joint: 对于对接管状焊接
The thickness of the brace. 斜撑板的厚度
- d) For a set-in or set-through tubular joint: 对于插入式或穿插式管状焊接
The thickness of the can. 管的厚度
- e) For a T-butt joint in plate: 对于在板上的T型焊接
The thickness of the prepared plate (abutting member).
The requirements for qualified thickness range for butt welds shall be as given in Table C2. 备板的厚度 (支撑的那个).
对焊的合格厚度范围要求见表C2

Table C2 Qualified thickness range 合格厚度范围		
Thickness <i>t</i> in mm of test piece 试块厚度	Qualification range ^{1) 2)}	
	for single run or single run from both sides 单层或双边 单层	for multi-run welding and all fillet welds 多层焊或全透焊
$t \leq 12$	0.8 <i>t</i> to 1.1 <i>t</i>	3 mm up to 2 <i>t</i>
$12 < t \leq 100$	0.8 <i>t</i> to 1.1 <i>t</i>	0.5 <i>t</i> to 2 <i>t</i> (maximum 150)
$t > 100$	-	0.5 <i>t</i> to 1.5 <i>t</i>

- 1) The qualification range for vertical downward position is 0.5 *t* to 1.1 *t*
垂直向下位置的合格范围为0.5 *t* 到 1.1 *t*
- 2) For butt welds in plates of thickness > 50 mm, the Charpy V-notch requirement for the root area, ref. 107, shall be complied with.
板厚大于50mm的对焊, 根部区的V型缺口要求参见107, 必须符合要求。

The requirements for qualified thickness range for single run fillet welds are in addition to the requirements of Table C2, that the throat thickness, t_w , shall be in the range 0.75 t_w to 1.5 t_w . However, a test with a throat thickness ≥ 10 mm shall give qualification for all throat thicknesses ≥ 10 mm.

对于单层圆角焊, 合格厚度范围的要求, 除了表C2的要求外, 喉厚, t_w , 变化范围为0.75 t_w 至 1.5 t_w . 然而对于喉厚大于10mm的任一试验, 只要其合格, 则其他都合格。

Where a fillet weld is qualified by means of a butt weld test,

Where a fillet weld is qualified by means of a butt weld test, the throat thickness range qualified shall be based on the thickness of the deposited weld metal.

对于用对焊试验来判定圆角焊合格时, 喉厚的合格范围必须基于舱贮的焊接金额厚度。

Diameter of pipes and tubular joints 管径和管状接口

The qualification of a welding procedure test on diameter D shall include qualification for diameters in the following ranges as given in Table C3. 对于直径D的焊接工艺试验合格必须包括如下表C3所列的直径变动范围的合格。

Table C3 Qualified range for pipes and tubular joints 管对焊和管状焊接合格范围

Diameter of the test piece <i>D</i> (mm) ^{1) 2)} 试块	Qualification range 范围
$D < 168.3$	0.5 <i>D</i> to 2 <i>D</i>
$D \geq 168$	$\geq 0.5 D$ and plates

- 1) *D* is the outside diameter of the pipe or outside diameter of the brace
*D*是管的外径或支撑管的外部直径。
- 2) Qualification given for plates also covers pipes when the outside diameter is greater than 500 mm
当外径大于500mm时, 板的合格覆盖了管的合格。

Angle of tubular joints 管状接口的角度

A welding procedure test carried out on a tubular joint with an angle α shall qualify all tubular joint angles in the range of α to 90°.
进行了一个 α 角度的焊接工艺试验, 角度从 α 到90度间的管状焊接均合格。

Welding consumables 焊材

The following changes shall lead to a new qualification:
如下的焊材变化将导致重新对焊接工艺资格的认可:
— any change in consumable classification 焊材等级的任何变化
— change of consumable brand when impact testing is required at temperatures below -20°C 当需要冲击试验温度低于-20度时, 品牌的变化。
— any significant change of mixture or composition (e.g. change from argon or mixed gas to CO₂ gas), flow rate, filling time and filling volume for shielding and purging gases. 成分发生明显变化 (即, 氩气或混合气到CO₂气的变化), 流率, 屏蔽和冲洗气体的充填时间和充填体积变化

Welding positions 焊接位置

The following changes shall lead to a new qualification.
如下焊接位置的变化将导致重新焊接工艺资格的认可
— Change from one principal welding position (see Fig.10, Fig.11 and Fig.12) to another, unless complying with Table C4.
从一个主要的焊接位置变化到另一焊接位置 (见图10, 11, 12), 除非符合表C4

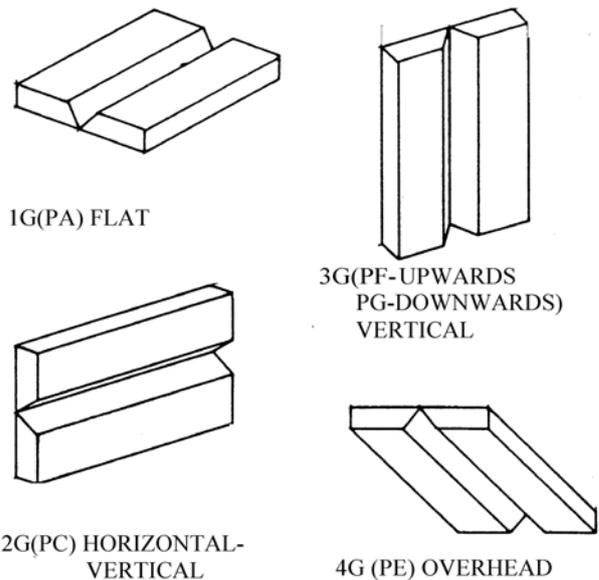


Figure 10 Plate test positions 图10: 平板试验位置

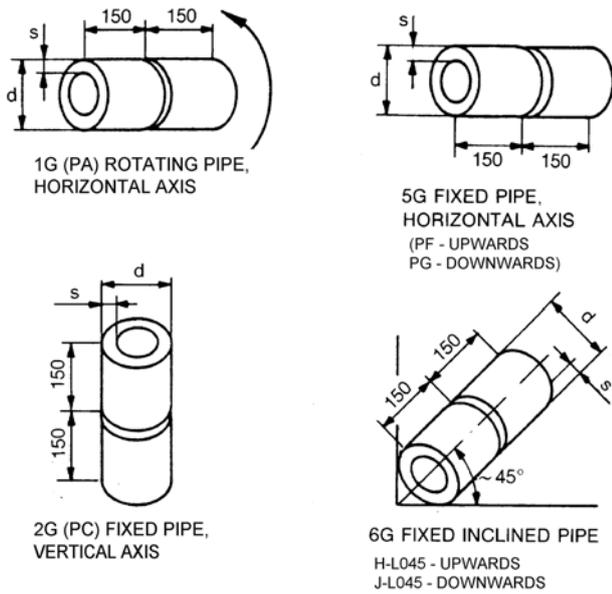


Figure 11 Pipe test positions
图11: 管对焊位置

Type of joint 接口类型

The following changes shall lead to a new qualification:

- change from fillet weld to butt weld 从圆角焊到对焊
- change from two sided welding to one side (but not vice versa) 对二面焊到单面焊 (但反过来则不是)
- deletion of back gouging 背刨去除
- addition or deletion of ceramic backing 陶瓷背除或填加
- deletion of backing in cases where the backing material is equivalent to the base material 撑材相当于基材时, 如撑材去除
- change from T-, Y- or K-joint to butt joint T型, Y型或K型到对焊的变化
- change from butt joint in plates to butt joints in pipes with outside diameter less than 500mm 板对焊到直径小于500mm的管对焊
- any change of groove dimensions specified in the WPS and agreed with the purchaser, such as change of specified type of groove, root face and gap, which may significantly affect penetration, fusion and dilution of the weld. 对WPS中或以买方约定中的波口变化, 此类约定类型的波口, 根部面和间隔的变化将明显地影响焊缝的渗透, 熔合和扩散。

Welding condition 焊接工况

The following changes shall lead to a new qualification:

如下焊接工况的变化将导致对其焊接工艺资格的重新认可

- any change of welding process 焊接工艺变化
- change from weaving to stringer bead technique or vice versa 从堆宽焊接技术到窄道焊技术的变化, 相反也如此。
- stringer to weave ratio outside the tolerances specified in the agreed WPS 窄波比超出WPS规定的公差
- change from multi-pass welding to one-pass welding 从多道焊变化到单道焊
- change in welding current from A.C. to D.C., or vice versa, or change of polarity. If recommended by the consumable manufacturer particular exemption may be given for SMAW in change from A.C. to D.C. 焊接电流从AC到DC变化, 相反也是, 或极性变化。如由焊材制造商建议, SMAW可以例外地从AC变到DC
- change in metal powder or wire addition beyond $\pm 10\%$. 金属粉末或丝额外超出10%的变化
- change from spray arc to short arc pulse, or vice versa 从喷弧到短弧脉冲变化, 相反也是。
- any change beyond 25°C of the maximum interpass temperature 焊层间最大温度超出25度的任何变化。
- change in heat input beyond $\pm 25\%$ for steel up to 420 MPa in specified yield strength. For material with specified yield strength equal to or above 420 MPa the change shall not be more than $\pm 10\%$, unless otherwise qualified 对于至420Mpa的屈服强度的钢, 热输入超出 $\pm 25\%$ 的变化。高于或等于420Mpa的屈服强度的钢, 变化不多于 $\pm 10\%$, 除非取得资格。
- any decrease in preheating temperature 预热温度的任何降低
- change of post weld heat treatment parameters except for holding time, which may be adjusted as a function of thickness. 除了保温时间外, 焊后热处理参数发生变化, 依其厚度而相应调整。

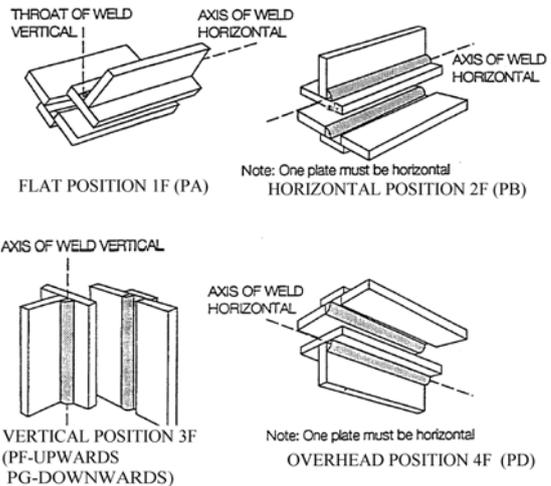


Figure 12 Positions of test plate for fillet welds
图12: 圆角焊试块位置图

Table C4 Qualified principal positions for butt welds and fillet welds, steel 表C4: 对焊, 圆角焊, 主要合格位置, 钢		Qualified positions ³⁾ 合格位置		
Test weld 测试接口形状 Joint configuration ¹⁾²⁾	Principal positions 主位置	Butt welds 对焊		Fillet welds 圆角焊 Plates or Pipes 板或管
		Plates 板	Pipes 管	
Butt welds in plates 板对焊	2G + 3G 1G 2G 3G 4G	All 1G 1G, 2G, 4G 3G 1G, 4G		All 1F 1F, 2F, 4F 3F 1F, 4F
Butt welds in pipes 管对焊	2G + 5G = 6G 1G 2G 5G	All 1G 1G, 2G, 4G All	All 1G 1G, 2G 1G, 5G	All 1F 1F, 2F, 4F All
Fillet welds 圆角焊	2F + 3F 1F 2F 3F 4F 5F			All 1F 1F, 2F, 4F 3F 1F, 2F, 4F All

1) Pipes with D > 500 mm are considered equivalent to plates (apply only to the can in tubular joints) 直径大于500mm的管等同于板 (仅适用于管状焊)
2) Tubular joints shall be qualified separately 管状接口各自资格认可
3) The vertical downwards position shall be qualified separately 垂直向下位各自认可

C 800 Fracture mechanic (FM) testing 断裂机械性能 (FM) 试验

801 Requirements to fracture mechanic testing are given in DNV-OS-C101 or DNV-OS-C201. DNV-OS-C101 or DNV-OS-C201.给出了断裂机械性能的要求

802 The test weld shall be made and tested for the actual combination of steel grade, manufacturer, welding process and welding consumable (brand) used. FM testing is, however, not required for consumables used for root passes only in two-sided welds.

制作的焊缝和试验依所使用的钢等级, 制造商, 焊接工艺和焊材 (名牌) 相应进行。然而, 对于用于根部仅双边焊过度的焊材, 无需FM试验

803 The FM tests shall be carried out on a full penetration butt-weld with K- or single V-preparation. The back of the K and one of the legs of the single V (on which the FM test shall be carried out) shall be perpendicular to the plane of the plate. Tests on either of these weld bevel preparations qualify for all types of bevel preparations.

对于K型或单边V型的全透对焊, 必须进行FM试验。K型背和单边V型的一脚 (对其进行FM试验) 必须平行于板面。任何一个斜角型焊缝的试验准备均适用于其他作何类型的斜角准备。

804 The test weld shall be welded with a heat input representing the maximum heat input used in the fabrication. The test weld shall be made on a plate with a thickness not smaller than 90% of the maximum plate or wall thickness for which the welding procedure shall apply. The test weld also qualifies for plate thicknesses down to 50% of the test weld plate thickness.

试验焊缝应有代表性, 其热输入及代表装配时的最大热输入。试验焊缝形成于板材上, 试验折厚不小于90%的实际焊接工艺执行时的最大板厚或壁厚。试验的焊缝对于小于50%试验板厚均有合适资格。

805 On each test weld at least three FM test specimens shall be tested in each of the weld deposit and the heat affected zone

(HAZ). (Details regarding the required number of test specimens and the location of fatigue pre-cracks are given further below.)

每一试验焊缝, 至少3个试样, 每一均含有焊缝区和热影响区。

806 Testing of the HAZ or the weld deposit can be omitted if tests with satisfactory results according to the requirements in this standard have been carried out previously by either the steel manufacturer or the welding consumable manufacturer.

如依本标准的要求, 已由钢厂或焊材制造商先前已进行了HAZ区或熔焊凝积金属区的FM试验, 并已取得了满意的试验结论, 则此类试验不再进行。

807 The FM tests shall be carried out according to BS 7448 Part 2 (with detailed requirements as given below) using 3-point bend specimens. The CTOD-technique with B x 2B specimens shall be used. For nominal plate thicknesses of the test weld equal to or exceeding 80 mm, B x B specimens may be used.

按BS 7448 Part 2章所述 (如下给出了详仅的要求), 进行FM试验。试验用3点弯曲试样进行。Bx2B试样在试验时使用CTOD技术。对于试验焊缝的名义板厚等于或大于80mm, 也可用BxB试样。

All specimens shall be tested with the fatigue pre-crack placed in the through-thickness direction. For tests of the weld deposit the fatigue pre-crack shall sample the central part of the deposit. For tests in the HAZ the required location of the fatigue crack depth is given in 108.

所有试样均应预制疲劳裂纹, 裂纹贯穿整个厚度。对于熔焊凝积金属区的试验, 疲劳预制裂纹取样于熔区的中心部位。对于HAZ区的试验, 疲劳裂纹深度的位置见108节

An evaluation of the relevant test temperature shall be made for all joints in question. Unless there is a high probability that the extreme loads on the joints will concur with lower temperatures the test temperature shall be:

对有疑问的所有接口均必须相应的试验温度评估。除非在焊缝的极限负荷在更低的温度有极高的可能性发生, 则试验温度必须是:

For joints submerged at lowest waterline: $\leq 0^{\circ}\text{C}$

Other joints: \leq design temperature.

808 Subsequent to the CTOD-test the specimens in the HAZ shall be sectioned and examined as described below. CTOD试验后, HAZ区的试样应剖开并按如下所述进行检测:

A metallographic section according to BS 7448 Part 2 Section 11.2 shall be prepared from each HAZ specimen. The metallographic section shall include weld metal and base metal. If necessary, in order to determine the exact location of the fatigue pre-crack, sections from both sides of the pre-crack shall be prepared. The faces of the metallographic sections shall not be taken deeper than the deepest point of the fatigue pre-crack and not more than 3 mm from the deepest point of the fatigue pre-crack.

按BS 7448 Part 2 Section 11.2制作每一HAZ区试样的金相试样。金相试样必须包含有焊接金属区和基材区。如需要, 为确定准确的预制疲劳裂纹位置, 必须制作预制裂纹双边的金相试样。所取的金相试样表面, 其深度不深于疲劳裂纹的最深点, 也不大于离疲劳预制裂纹最深点3mm。

A figure of a cross-section through the weld (of an un-fractured specimen) is shown in Fig.13. 图13是纵穿焊缝 (非断裂试样) 剖面图。

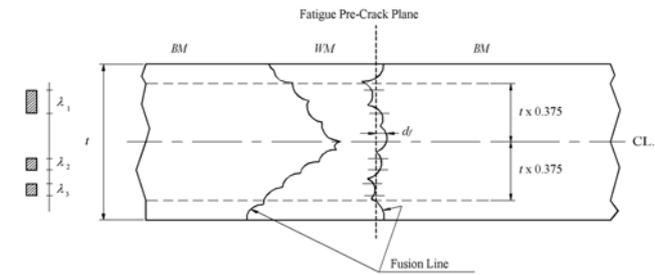


Figure 13 Cross-section through the weld 图13: 焊缝截面图

- BM = Base material 基材
- WM = Weld metal or deposit 熔焊凝积金属区
- df = distance from the plane of the fatigue pre-crack to the fusion line (varies along the fatigue pre-crack) 从疲劳预制裂纹到熔线区的距离 (沿疲劳预制裂纹方向变化)
- li = length (in mm) of area with acceptable location of the fatigue pre-crack (see below) 疲劳预制裂纹可接受位置区的长度 (见下面)
- t = Plate thickness 板厚

Measurements of the distance, df, between the plane of the fatigue pre-crack and the fusion line shall be taken. Within the central 75% of the plate thickness the areas where df \leq 0.5 mm shall be identified. The length, li, of each of these areas shall be determined. The location of the fatigue pre-crack shall satisfy the following criteria:

从疲劳预制裂纹到熔线区的距离df必须测量。在板厚75%的中心区, df小于或等于0.5mm的地方必须加以标注。必须确定这些区中每个区的li长度。疲劳预制裂纹的位置应符合下述标准:

- $\sum N \lambda_i = \leq 3$ mm for $t \leq 20$ mm $t \leq 20$ mm时, ≤ 3 mm for
- $= 0.15 t$ for $20 < t \leq 80$ mm $20 < t \leq 80$ mm时, $0.15 t$ for
- $= \geq 12$ mm for $t > 80$ mm $t > 80$ mm时, ≥ 12 mm for
- N = number of areas with $df \leq 0.5$ mm $df \leq 0.5$ mm区的数量。

809 Results from HAZ specimens on which the location of the fatigue pre-crack does not satisfy the requirement above, are not valid. In addition to these requirements given for HAZ specimens, all the requirements specified in BS 7448 Part 2 apply for both HAZ and weld deposit specimens.

对于HAZ区试验, 如其疲劳预制裂纹位置满足不了上述要求, 则其试样的试验结果无效。HAZ试样除上述要求外, BS 7448 Part 2部分中规定的要求均适用于HAZ区和熔焊凝积金属区。

Three valid tests for each of weld deposit and HAZ shall be carried out. The critical CTOD for all of the specimens shall be equal to or larger than 0.15 mm.

对每一HAZ区和熔焊凝积金属区, 必须有三个有效的试验。所有试样的标准CTOD应等于或大于0.15mm。

If (for HAZ or weld deposit) one or more of the three specimens has a critical CTOD lower than 0.15 mm additional tests may be carried out. In such a case the characteristic value, as defined in Table C5, shall be equal to or larger than 0.15 mm. 如 (对于HAZ区和熔焊凝积金属区), 三个试样中一个或更多的试样具有小于标准0.15mm的CTOD, 则需要进行额外的试验。此种情况下, 按表C5定义的参数值应等于或大于0.15mm。

Table C5 Characteristic value of CTOD 表C5: CTOD参数值

有效试验数 (Number of valid tests ¹⁾)	Characteristic value
3 to 5	Lowest result 最低结果
6 to 10	Second lowest result 次低结果
11 to 15	Third lowest result 低结果

1) All valid tests that have been carried out shall be included in the evaluation. It is not permissible to discard any valid test result. 已进行的所有有效试验必须进行评价。不允许剔除任何有效的试验结果。

810 If the characteristic value as specified in Table C5 is larger than 0.15 mm an ECA (Engineering critical assessment) may be carried out with the purpose of demonstrating that extra capacity may be available in the structure.

如按表C5的参数值, 有大于0.15mm, 必须进行ECA (工程标准评估), 目的是对在结构中可能具有的额外能力进行展示。

D. Welding Procedure Tests, Aluminium

D 100 General

101 Qualified welding procedures are required for all important structural joints. The procedure tests shall be representative of the following:

- each base material or alloy and temper used in

- the thickness and diameter range in question (see Table C2 and Table C3)
- each type of consumable and welding process
- welding position (see Table D1)
- joint and groove design
- number of passes
- preheat (if any)
- volt-ampere characteristics

Test weld Joint configuration	Principal positions	Qualified positions ¹⁾		
		Butt welds, plates	Butt welds, pipes	Fillet welds
Butt welds on plates	1G 2G 3G 4G	1G 1G, 2G, 3G 1G, 2G, 3G All	1G	1F 1F, 2F, 3F 1F, 2F, 3F All
Butt welds in pipes	1G 2G 5G	1G 1G, 2G, 3G All	1G 2G 1G, 5G	1F 1F, 2F, 3F All
Fillet welds	1F 2F 3F 4F 5F			1F 1F, 2F, 3F 1F, 2F, 3F All All

1) The vertical downward position shall be qualified separately.

D 200 Butt welds

201 Each test assembly consists of 2 plates with dimensions 300 x 150 mm. The plates shall be joined with a longitudinal butt weld. For extruded sections and pipes the assembly shall consist of 2 sections each 150 mm long (see Fig.14 and Fig.15).

202 Weld and fit-up shall be as detailed in the pWPS. Welding consumables are those recommended in Table D2.

203 If back-sealing run is specified, this run shall be laid in the same position as for the respective weld.

204 The welds shall be subjected to visual inspection, dye penetrant testing and ultrasonic- or X-ray testing. The requirements for quality level for imperfections shall be as given in ISO 10042 level B.

205 Side-bend tests shall be carried out for thickness equal to and above 10 mm. Two bend specimens shall be taken from each of the welded assemblies.

Base metal alloy	NV-5052, NV-5754 NV-5154, NV-5454 NV-5086	NV-5083 NV-5383	NV-6060, NV-6061 NV-6063, NV-6005A NV-6082
NV-5052, NV-5754 NV-5154, NV-5454 NV-5086	5356, 5556, 5183	5356, 5556, 5183	5356, 5556, 5183
NV-5083, NV-5383	5356, 5556, 5183	5183 ¹⁾	5356, 5556, 5183
NV-6060, NV-6061 NV-6063, NV-6005A NV-6082	5356, 5556, 5183	5356, 5556, 5183	5356, 5556, 5183

Note:
All consumables are covered by the AWS specification. The prefix «ER» is omitted.

1) Other consumables may be used if allowable stresses are reduced.

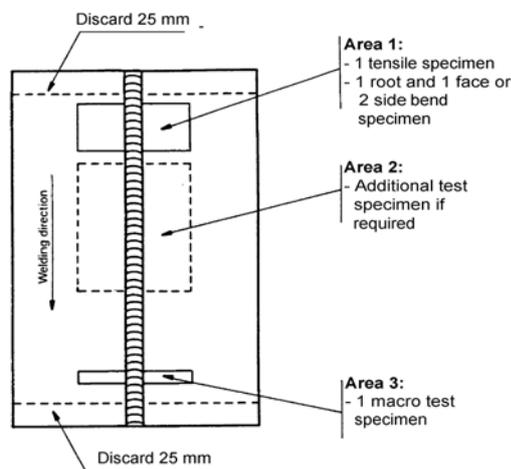


Figure 14
Location of test specimens for a butt weld on plate

206 For thickness below 10 mm one face bend and one root bend test specimens shall be taken. The width shall be 30 mm and the thickness equal to the plate thickness. The diameter of the bending mandrel shall be as given in Table D3.

Base metal alloy	Condition			
	0, H111	H116, H32 H321, H34	T4	T5, T6
NV-5052, NV-5754 NV-5154, NV-5454	4t	4t	-	-
NV-5086, NV-5083, NV-5383	6t	6t	-	-
NV-6060, NV-6061 NV-6063, NV-6005A NV-6082	-	-	-	6t

207 Requirement

No cracks or open defects exceeding 3 mm measured on the convex surface after bending are accepted. Smaller cracks de-

veloping from the edges of the specimens should not be considered as significant, unless there is definite evidence that they result from inclusions or other defects. «Wrap around» bending as shown in Fig.16 is the preferred bending method.

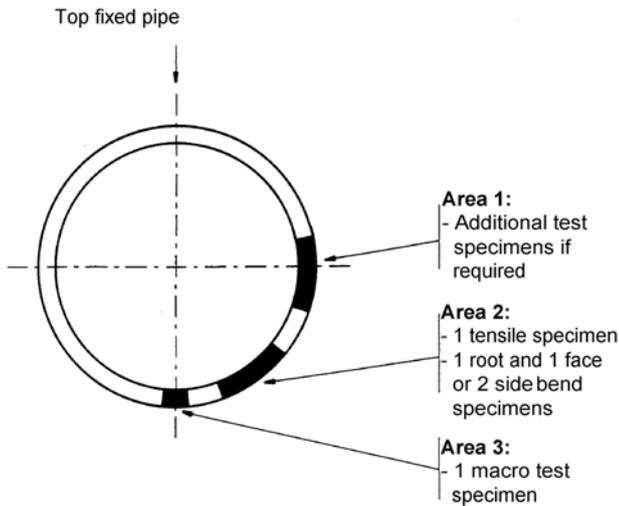


Figure 15
Location of test specimens for a butt weld in pipe

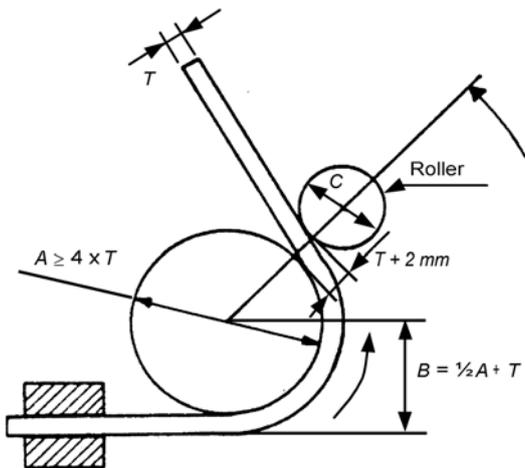


Figure 16
Wrap around bending

208 One tensile specimen shall be taken from each of the welded assemblies. The test specimen, 25 mm wide and with full plate thickness and orientated transverse to the weld, is shown in Fig.17.

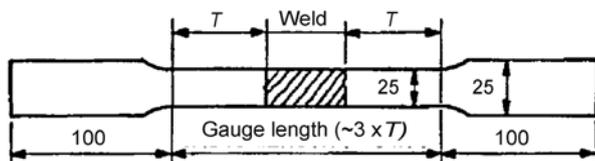


Figure 17
Tensile test specimen

209 The tensile strength of the test specimens shall not be

210 One macrosection shall be prepared from the test assembly to reveal the weldment macro structure. The macrosection shall be visually inspected using a magnification of 5 to 10X. The macrosection shall show a regular weld profile with a smooth transition to the base material without significant undercut or excessive reinforcement and show thorough fusion between adjacent layers of weld metal and base metal. There shall be no cracks, lack of fusion and incomplete penetration. **D 300 Fillet welds**

301 The two plates are assembled and positioned edgewise so as to constitute a tee-assembly with no clearance. As far as possible the plates shall be of a sufficient size to ensure a reasonable heat distribution.

For fillet welds the test assembly shall be as defined in Fig.9. For manual and semi-automatic welding the length of the test piece shall be:

$$l_{\min} = 300 \text{ mm}$$

$$L_{\min} = 350 \text{ mm}$$

For automatic welding the length shall be:

$$l_{\min} = 400 \text{ mm}$$

$$L_{\min} = 1000 \text{ mm}$$

Weld and fit-up shall be as detailed in the pWPS.

The test assembly shall be welded on one side only. For manual and semi-automatic welding, the stop and restart position should be included in the test length and shall be clearly marked for subsequent examination.

The ends of the specimen are exempted from examination over a length of 50 mm.

302 NDT shall be carried out in accordance with the specification given for the production welding in question. The extent of the testing shall be as follows:

- 100% visual inspection
- 100% surface crack detection (dye penetrant).

The soundness of the weld shall comply with ISO 10042 level B.

If the stop and restart spot is included in the test length, special attention shall be paid to this position with respect to profile, proper fusion and absence of crater defects.

303 The following tests shall be performed:

- two macrosection tests (metallographic examination).
- One of the macrosections shall be taken at the marked position of the stop and restart (for more details see C106).

D 400 Re-testing

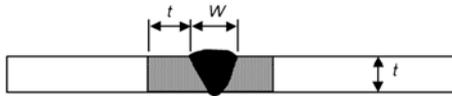
401 If any of the tests do not satisfy the specified requirements, new procedure tests in duplicate may be carried out. The results of both re-tests shall meet the specified requirements, otherwise the test shall be rejected.

Guidance note:

HAZ softening adjacent to welds

The strength of a weldment is a function of the welding process, filler metal and the aluminium alloy in question. For design purposes it is assumed that the strength is reduced in HAZ. The extent of the HAZ is assumed to have the same width as the weldment plus the plate thickness in each direction of the weld as shown in Fig.18.

If the strength shall be measured for information, this shall be carried out on a gauge length $2t + W$ of the weld (approximately $3t$).



t = Plate thickness
W = With of weld

Figure 18
Extent of HAZ

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

Table D4 Mechanical properties in the welded condition

Alloy	Temper	Filler	Tensile strength R_m minimum (N/mm ²)	Yield stress in HAZ, R_p minimum (N/mm ²)
NV-50520	F, H111 H32, H34	5356	170	65
NV-5754	0, F, H111, H24	5356-5183	190	80
NV-5154A	0, H111	5356-5183	215	85
NV-5454	0, F, H111, H34	5356-5183	215	85
NV-5086	0, F, H111, H116, H32, H34	5356-5183	240	100
NV-5083	0, F t < 6 mm	5183	270	125
	0, F t > 6 mm	5356-5183	270	115
	H116, H321	5356	270	115
	H116, H321	5183	270	125
NV-5383	0, H111, H116, H321	5183	290	140
NV-6060	T5	5356-5183	95	65
NV-6061	T4	5356-5183	165	115
	T5 or T6		165	115
NV-6063	T5	5356-5183	100	65
	T6		100	65
NV-6005A	T5 or T6	5356-5183	165	115
NV-6082	T4	5356-5183	170	110
	T5 or T6		170	115

E. Welding Procedure Tests, Stainless Steel

E 100 General

101 When welding procedure tests are required, the tests shall be performed in accordance with C and the supplementary requirements stated in D200 and D300 (if not otherwise specified herein).

102 The welding procedure tests shall cover all relevant dimensions, positions and material combinations. Details regarding essential variables and validity of the procedure shall be as described in C. Mechanical testing shall be as described in C100, if not otherwise specified in D200 and D300.

E 200 Supplementary requirements for austenitic stainless steel

201 Impact testing is not required for design temperatures above – 105°C. If used at below – 105°C, the test temperature shall be at minimum design temperature.

202 If impact testing is required, the average impact value for the three specimens shall not be less than 34 J.

203 When a butt weld is made between dissimilar material

E 300 Supplementary requirements for ferritic-austenitic stainless steel

301 Impact testing shall be carried out at design temperature or – 20°C, whichever is the lower. The average impact value for the three specimens shall not be less than 27 J.

302 When a butt weld is made between dissimilar material grades, both sides of the weld shall be impact tested.

303 Butt welds and fillet welds shall be corrosion tested according to ASTM G48, Method A. The test specimen shall be in the as welded state after normal weld cleaning operation. The test specimens shall be exposed to the solution at a constant temperature of 20°C for 24 hours.

The following test requirements shall be fulfilled:

- no pitting attack shall be visible on the test face(s)
- general weight loss shall not be less than 4 g/m².

Guidance note:

Welds between ferritic-austenitic stainless steels and C- and C-Mn steels need not be subjected to corrosion test.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

304 A microstructural examination comprising the weld metal, heat affected zone and base metal is required for each welded assembly. The microstructure shall be suitably

and examined at 400X magnification and shall be free from grain boundary carbides and precipitates. The ferrite content in the weld metal root and not re-heated weld cap shall be determined in accordance with ASTM E562 and shall be in the range of 25% to 70%.

F. Qualification of Welders

F 100 General

101 The welding processes for which qualifications are required include those which are designated as manual or partly mechanised welding. Welders shall pass a qualification test in accordance with 200. Contractors are required to keep records of the welders' qualifications and, when required, furnish copies of valid welders' certificates.

F 200 Standards for qualification testing

201 Welders shall be tested according to a recognised standard, e.g. EN 287, ISO 9606, ASME Section IX or ANSI/AWS D1.1.

202 Welding operators using fully mechanised or fully automatic processes need generally not pass a qualification test. However, operators shall receive adequate training in setting or programming and operating the equipment. Appropriate records of training shall be maintained. Contractors may be required to furnish valid qualification test certificates. EN 1418 may be used as a reference.

G. Testing

G 100 General

101 Testing of welds shall be carried out as specified in 200 and 300.

G 200 Tensile testing at ambient temperature

201 For tensile testing of all-weld-metal and butt welds two different types of test specimens may be used, round test specimens or flat test specimens (see Fig.19) as described below: *A - Deposited metal tensile test*

Normally, round test specimens with the following dimensions shall be used:

- d = 10 mm
- L_o = 50 mm
- L_c = 60 mm
- R ≥ 5 mm

B - Butt weld tensile test for testing of the weld as a whole

Flat test specimens with the weld machined flush with the surface of the plate, shall be used. The dimensions shall be as follows:

- a = thickness of plate, t
- b = 25 mm
- L_o = L_c = 3 t or 2 t + width of weld, (whichever is the greatest)
- R = 25 mm

C - Butt weld tensile test

Flat test specimens with the weld machined flush with the surface of the plate, shall be used. The dimensions shall be as follows:

- a = thickness of plate, t

- b = 30 mm
- L_o = 6 mm + width of weld + 6 mm
- R = 50 mm

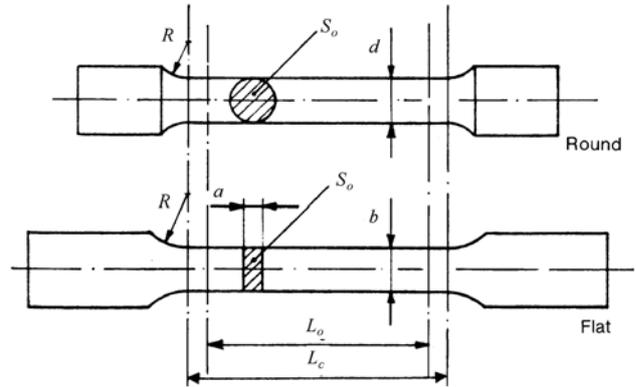


Figure 19
Tensile test specimen

G 300 Bend testing

301 Flat bend test specimens, as given in Fig.20 shall be used. Edges on tension side shall be rounded to a radius of 1 to

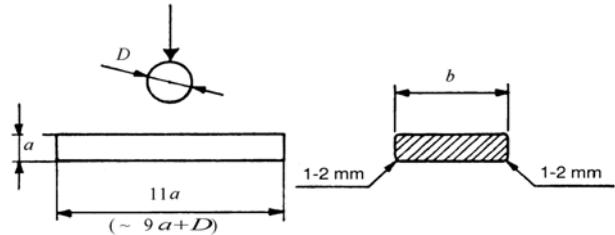


Figure 20
Bend test specimen

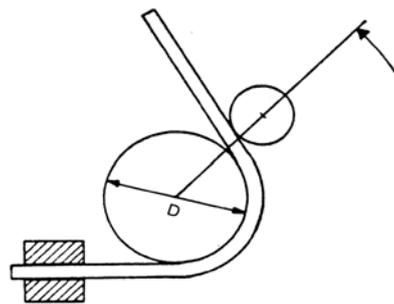


Figure 21
Wrap around bend test

302 When the wrap around bend test, exemplified Fig.21 is used, e.g. for the side bend test of a weld, the length of the test specimen shall be greater than the length 11a shown in Fig.20.

303 For butt weld bend test specimens, the weld shall be machined flush with the surface of the plate.

304 For transverse face-bend and root-bend test specimens for butt weld test the dimensions shall be as follows:

- a = as rolled thickness t of the plate
- b = 30 mm

If the as rolled thickness t is greater than 25 mm, it may be reduced to 25 mm by machining on the compression side of the test specimen.

305 For transverse side-bend test specimens for butt weld test the dimensions shall be as follows:

a = 10 mm

b = as rolled thickness t of the plate

If $t \geq 40$ mm, the side-bend test specimen may be subdivided, each part being at least 20 mm wide.

306 When a longitudinal face-bend or root-bend weld test is required, a test specimen according to an appropriate standard will be accepted.

SECTION 2 FABRICATION AND TOLERANCES 装配和公差

A. General

A 100 Objective and scope 目的和范围

101 This section gives requirements for fabrication and tolerances of offshore structures. 这部分讲述了离岸结构物的装配和公差要求

102 In order to determine the structural categorisation, this section shall be read in conjunction with the following applicable standards:

为了确定离岸结构物数据,本部分将适用下列标准

DNV-OS-C101 Section 4 and relevant Object Standard, Section 2 "Selection of Material and Extent of Inspection" or DNV-OS-C201 Section 4.

B. Fabrication Planning 装配计划

B 100 General

101 As a prerequisite for fabrication, procedures, inspection and test plans and work instructions for execution and control of fabrication activities shall be established. The purpose of the procedures and work instruction shall be:

- to provide instructions and information regarding the requirements for and the principles of the work execution
- to identify and document the responsibilities and plans for the work execution in accordance with the project requirements
- to provide information to the purchaser on how the work is executed and controlled
- to identify applicable procedures, test plans, work instructions, acceptance criteria, hold points and documents to be generated
- to serve as basis for quality audits.

将军 为执行和控制离岸结构物,应以制造, 规程, 检查和实验计划和工作规程的建立为前提.过程和工作规程的目的在于:

- 为工作施行的要求和规范提供相关说明和信息
- 根据工程要求,确定和说明工作施行的责任和计划
- 提供信息给采购商关于工作如何执行和控制
- 确定可适用的规程, 实验计划, 工作规程, 验收标准, 掌握可能产生的要点和陈述

--为质量审核提供基础

102 Relevant procedures, including information of pre-assembled items and the sequence of fabricating the parts into structure, shall be prepared.

B 200 Quality system and workmanship

201 Contractors involved in fabrication of structural members shall have a documented and implemented quality system according to ISO 9001 or equivalent. The extent of the quality management system shall be dependent on the size and type of the organisation, complexity and interaction of the processes and competence of personnel.

202 Workmanship shall be in accordance with written procedures accepted by the purchaser.

203 All work shall be executed with adequate control by the contractor. Repair work shall be carried out in accordance with written procedures accepted by the purchaser. Faults and deficiencies shall be corrected before painting or other means of permanent covers have been applied.

204 Prior to commencement of the work the contractor shall submit a plan for NDT, NDT procedures and documents for NDT inspectors' certification for acceptance by the purchaser. The programme shall contain information and documents for planning, controlling, reporting etc. Acceptance criteria for NDT shall be accepted by the purchaser if they are not specified in relevant documents. 102 相关的规程, 包括被预装配的项目的信息和制造部分序列到结构里, 将准备。

B 200 质量系统和手艺

201 在结构件的制造介入的承包商根据ISO 9001或等值将有一个被提供的和被实施的质量系统。 质量管理系统的程度将依靠组织的大小和类型, 人员过程和能力的复杂和互作用。

202 手艺将是与采购员接受的书面规程符合。

203 所有工作将执行以充分控制由承包商。 修理工作将被执行与采购员接受的书面规程符合。 缺点和缺乏, 在申请了之前, 将改正永久盖子绘的或其它方法。

204 在工作的开始之前承包商为NDT将递交计划, NDT规程和文件为NDT审查员'证明为采纳由采购员。 节目将包含信息和文件为计划, 控制, 报告等。 如果他们在相关文档, 没有指定验收标准为NDT将由采购员接受。

C. Inspection

C 100 General

101 Inspection shall be carried out by the contractor in accordance with accepted inspection and test plans to confirm that all project requirements are fulfilled to the satisfaction of the purchaser. 检查应由承包商根据可接受的检验和测试来实行,并且此检验和测试需满足采购商的项目要求

The inspection shall cover items such as:

此检验应符合如下条款:

- correct identification and documentation and use of materials 材料的确定、说明和使用
- qualification and acceptance of fabrication procedures and personnel 制造过程和人员的资格和采纳
- inspection of preparatory work (assembly, fit-up form work, reinforcement etc.) 准备工作(装配、安装形成、加固)的调查
- welding inspection 焊接检查
- inspection of fabrication work for compliance with specifications and procedures 符合规格和规程的装配工作的检验
- witnessing NDT, control and testing 可证实NDT, 控制和测试
- inspection of repairs 修理检验
- inspection of corrosion protection systems 防腐蚀系统的检查
- ensure functionality of examination or testing equipment and of recording and/or measuring devices vital for correct functioning of equipment and machinery used in fabrication. 确定检测或测验器材的功能, 录音的功能和对于在装配中起至关重要作用的设备和机械的测量。

102 Due consideration shall be given to the access and the time required for adequate inspection during fabrication. 对于装配期间的过程和时间应被给予适当的考虑

103 High non-conformance rates in execution of the work or in the product itself shall call for special considerations. Such special considerations may include, but not be limited to, increased inspection, re-qualification of personnel or other agreed remedial actions. 工作执行中出现高度不一致的比率或产品本身有特别考虑事项。这样特别的事项应包括, 但不限于, 增加检验, 人员资格或其他协商通过的补充行动

104 Inspectors shall be qualified according to a recognised scheme and shall be able to provide documentation of proficiency. 101 根据认可的规定, 检验员应具有能熟练提供检验证明的能力。

D. Material Identification, Cutting and Forming 材料确定、切割和组成

D 100 Material identification 材料确定

101 A traceability system that ensures correct installation and documentation of the material grade or strength classes shall be established by the contractor throughout the prefabrication and installation process. 确定材料等级或说明的正确设施和文献, 由承包商通过预装配和安装过程来建立的强度等级的一个可描绘系统。

Proper care shall be exercised during handling and storage to preserve identification of such material. 应当注意处理和保存这些证明材料。

D 200 Cutting and forming 切割和组成

201 The effect of work hardening shall be considered if shearing is used for cutting of material. Special attention shall be paid to the risk of cracked edges. 功能硬化的作用应考虑如果剪羊毛为材料割使用。 特别留意破裂的边缘的风险。

202 Attention shall be paid to excessive local hardening and carbon contaminations by thermal cutting. This may be reduced by suitable heat treatment or removed by mechanical means. 将由热量切口注意过份本机硬化和碳污秽。 这也许被适当的热治疗减少或通过机械手段去除。

203 Forming and straightening of materials shall be performed according to agreed procedures. Such work shall be controlled by the contractor. 形成和矫正材料应根据协商的规程来执行。 这样工作将由承包商控制。

204 The degree of cold deformation of special and primary structural elements shall be less than 5%. If the deformation exceeds 5%, either heat treatment or strain ageing tests shall be carried out according to an agreed procedure. 程度特别和主要结构元素的冷的变形少于5%将是。 如果变形超出5%, 热治疗或应变时效测试根据一个协商的做法将被执行。

Guidance note: 指导说明

The plastic deformation e may be calculated by the following, simplified formulae: 下列公式可计算出塑料变形

Single-curvature deformation 单一弯曲变形

Cold rolling or pressing of plates to cylindrical forms:

圆柱体的金属的冷旋转或压力

$$e = \frac{D}{D} 100\%$$

Cold bending of straight pipes to bends 平直管的冷弯曲:

$$e = \frac{D}{1000\%}$$

Double curvature deformation 双重弯曲变形

Forming of plates to spheres: 球形金属的形成

$$= \frac{t}{2R_c} 100\%$$

- t = material thickness 材质厚度
- D = outside diameter of pipe or vessel 管或容器的外部直径
- R_c = forming radius 形成半径
- ν = Poisson's ratio (0.5 for plastic condition). 泊松比率 (0.5为塑料情况)

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

E. Tolerances

E 100 Tolerances for alignment and straightness

101 Allowable fabrication tolerances shall be submitted to the purchaser for acceptance.

102 Special considerations shall be given in providing proper alignment of structural members. Allowable fabrication tolerances shall be established on basis of due consideration to the criticality of the design.

103 The maximum fabrication tolerances may generally be taken in compliance with IACS Shipbuilding and Repair Quality Standard Part A Sec.6 and Sec.7.

Guidance note:

Special and primary category areas shall be regarded as "strength" members and secondary category area shall be regarded as "other" in the IACS Shipbuilding and Repair Standard.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

104 Straightness of members shall be within the tolerances given by the buckling code.

105 Straightness of members which are based on buckling calculations according to DNV-RP-C201 and/or DNV-RP-C202 shall be within the tolerances given in Table E3.

106 Alignments of the non-continuous plates in cruciform joints and butt welds shall be within the tolerances given in Fig.1, Table E1 and Table E2.

105 根据DNV-RP-C201或DNV-RP-C202在表E3里所提供的公差，成员的坡度应基于扣住计划

106 非持续的金属的对准线在十字接头和对接焊点在公差之内，如表E1和表E2，F1所示。

Guidance note:

Larger imperfections may be applied provided accounted for in the design calculations. See e.g. DNV-RP-C203, Sec. 2.5. 更大的不完整性可能适用于提供设计演算。如，看 DNV-RP-C203, 第2.5部分。

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

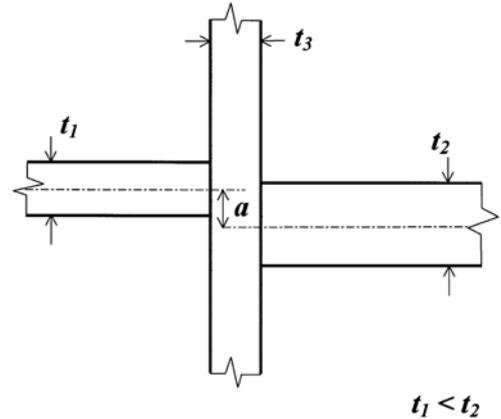


Figure 1
Alignment of cruciform joint

Table E1 Cruciform joints Misalignment a	
<i>Structural category 结构计算</i>	<i>Maximum misalignment 最大化未对准系数</i>
Special 特别	$0.15 t_1$
Primary 初级	$0.30 t_1$
Secondary 次要	$0.50 t_1$

t_1 is the smaller thickness of t_1 , t_2 and t_3
 t_1 是三者的比较小的厚度

Table E2 Butt welds 对接焊点. Misalignment a	
<i>Structural category</i>	<i>Maximum misalignment</i>
Special	$0.10 t_1$
Primary	$0.15 t_1$
Secondary	$0.30 t_1$

t_1 is the smaller of the two abutting thicknesses

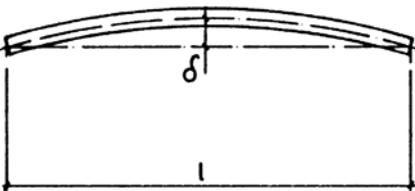
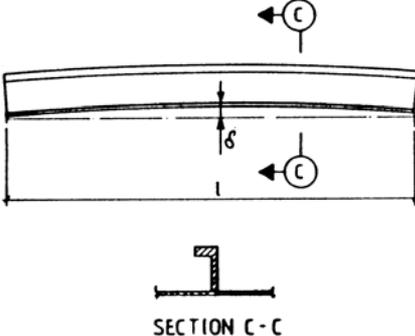
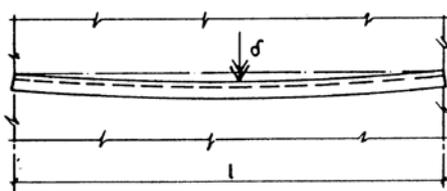
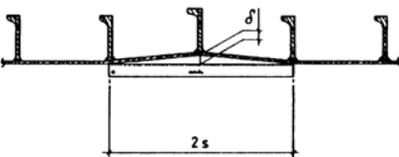
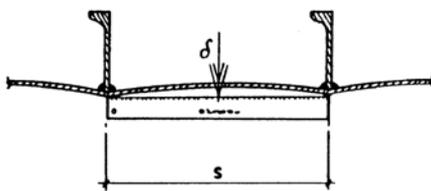
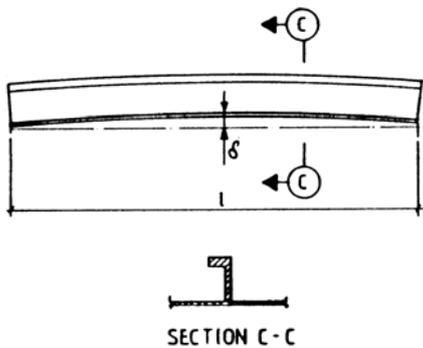
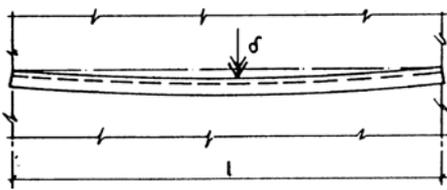
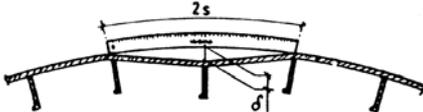
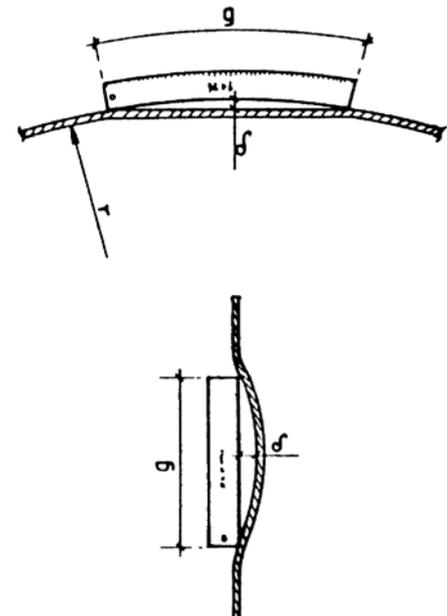
Table E3 Tolerances for straightness			
Detail	Tolerance	Fig.	Comments
Bars and frames	Max. out of straightness $\bar{\delta} = 0.0015 l$		$l =$ unsupported length
Pillars, vertical columns	Max. inclination $\bar{\delta} = 0.001 l$		$l =$ unsupported length
Stiffened plane plates. Stiffener or girder webs relative to the plate plane. 硬化平面金属。强化钢筋或梁网与金属板的比较。	Max. out of straightness $\bar{\delta} = 0.0015 l$		$l =$ Unsupported length of the stiffener or girder
Stiffened plane plates. Stiffener or girder flanges relative to the web plate 硬化平面金属。强化钢筋或梁边缘与金属网的比较。	Max. out of straightness $\bar{\delta} = 0.0015 l$		$l =$ Unsupported length of the flange
Stiffened plane plates. Parallel stiffeners or girders 硬化平面金属。平行强化钢筋或梁	Max. misalignment $\bar{\delta} = 0.02 s$		$s =$ distance between parallel stiffeners or girders
Stiffened plane plates. Plates between stiffeners or girders. 硬化平面金属。强化钢筋或梁之间的金属。	Max. out of plane displacement $\bar{\delta} = 0.005 s$		$s =$ unsupported width of the plate panel

Table E3 Tolerances for straightness (Continued)

Detail	Tolerance	Fig.	Comments
<p>Circular cylindrical shells. 圆形的圆柱外壳</p>	<p>Max. deviation from the nominal radius measured at ringstiffener or bulkhead $\delta = (r_a - r) = 0.005 r$</p>		<p>r_a = actual distance from the cylinder axis to the shell wall. r = nominal radius of the shell</p>
<p>Circular cylindrical shells. Longitudinal stiffeners or girders. 圆形的圆柱外壳。纵向强化钢筋或梁。</p>	<p>Max out of straightness $\delta = 0.0015 l$</p>		<p>l = Unsupported length of the</p>
<p>Circular cylindrical shells. Flanges of longitudinal stiffeners or girder webs. 圆形的圆柱外壳。纵向强化钢筋或梁网的轮缘。</p>	<p>Max. out of straightness $\delta = 0.0015 l$</p>		<p>l = Unsupported length of the flange</p>
<p>Circular cylindrical shells. Longitudinal stiffeners. 纵向强化钢筋</p>	<p>Max. misalignment $\delta = 0.02 s$</p>		<p>s = stiffener spacing</p>
<p>Circular cylindrical shells. Local out of roundness. Local out of straightness.</p>	<p>Max. imperfection $\delta = \frac{0.01}{g}$</p>		<p>A circular template or straight rod held anywhere on the shell. 一把圆模板或平直的标尺任何地方在壳举行了。</p> <p>The length of the circular template shall be the smallest of: 圆模板的长度将是 最小的</p> <p>$s, 1.15 \sqrt{l\sqrt{t}}$ and πr</p> <p>s = stiffener spacing (of longitudinal stiffeners)</p> <p>l = distance between rings or bulkhead.</p> <p>The length of the straight rod shall be taken equal to the smallest of: 平直的标尺的长度将被采取相等与最小</p> <p>l and $\sqrt{4} rt$</p>
<p>Conical shells</p>			<p>The tolerance requirements given for cylindrical shells are applicable also for conical shells. 指定的容忍要求的圆柱形壳为圆锥形壳也是可适用的。</p>

F 100 Assembly and welding

- 101 Assembly and welding operations shall be carried out by qualified personnel and supervision.
- 102 A fabrication sequence shall be established to ensure that the structure can be assembled in a manner which allows for effective control at all stages of work.
- 103 Fit-up, preparation for welding and welding operations shall take place in accordance with procedures accepted by the purchaser.
- 104 The welding sequence shall be such that the amount of shrinkage, distortions and residual stresses are minimised.
- 105 Difference in plate thickness of butt welds exceeding 4 mm the thicker plate shall be tapered not steeper than 1 : 3 generally. Butt joints, which are prone to fatigue loading shall be tapered not steeper than 1 : 4. See Fig. 2.

F. 组装 焊接, 热治疗和修理

F 100 组装和焊接

101 组装和焊接操作将由具有资格的人员和监检员执行。102 装配顺序应以保证考虑到结构物能在一个被有效控制的工作范围内来建立。103 焊接和焊接操作的安装、准备应符合采购商所接受的程序来进行。104 焊接顺序将根据收缩、变形和剩余量而最小化。105 对焊的两块板厚差别超过4mm时, 较厚的板必须打波口, 通常来说, 波口的坡度不高于1: 3。但对于常受疲劳负荷的对焊缝, 则波口坡度不深于1: 4。见图2。

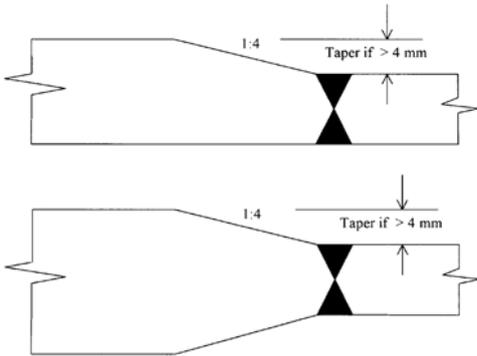


Figure 2 Tapering of butt joints

图2: 对焊波口图

- 106 Tubular members framing into joints shall be carefully contoured to obtain accurate alignment. The bevel shall be formed providing a continuous transition from maximum to minimum bevel angle around the circumference. Generally, the fabrication shall be planned in such a manner that back welding can be performed to the largest extent possible.
- 107 Members to be welded shall be brought into correct alignment and held in position by clamps, other suitable devices or by tack welds until welding has been completed or progressed to a stage where the holding devices or tack welds can be removed without danger of distortion, shrinkage or cracking. Suitable allowances shall be made for distortion and shrinkage where appropriate.
- 108 The use of permanent steel backing strips may be permitted after thorough corrosion evaluation and when properly accounted for in the design analysis.
- 109 Corners of cut-outs shall be given appropriate radii minimising local stress concentrations. Where temporary cut-outs are made, such cut-outs shall be made of sufficient size to allow sound replacement.
- 110 The fit-up shall be checked for dimensional accuracy before welding. Surfaces to be welded shall be free from mill scale, slag, rust, grease, paint etc. Edges are to have a smooth and uniform surface. No welding shall be performed when the surfaces are damp. Suitable protection shall be arranged when welding is performed during inclement weather conditions. The groove shall be dry at the time of welding.
- 111 Preheating shall preferably be performed with electric heating elements. Gas burners may be used under controlled conditions. Cutting torches should not be used.
- 112 For welds of structural category special, primary and butt-welds in secondary structural elements a WPS shall be established for acceptance by the purchaser.
- 106 构筑入联接的筒形成分将仔细地塑造外形获得准确对线。将被形成提供连续的转折从最大值的斜面给极小的单边坡口角度在圆周附近。通常, 装配计划以后面焊接可以进行的最大的可能程度上的方式。107 待焊的构件必须正确地划线定位, 并可用夹具、其他合适的装置或定位焊进行定位保持。定位保持直到焊接全部完成或保持到这些定位器具或定位焊去除时不致产生变形、收缩或开裂的危险。对于允许的地方, 适当变收和收缩是允许的。108 对永久钢垫板的用途在详尽的腐蚀评估以后被允许, 当适当地占据设计分析。109 将给保险开关的角落使局部应力集中减到最小的适当的半径。在那里临时保险开关被做, 这样保险开关由足够的大小制成允许声音替换。110 适合将在焊接之前检查尺寸准确性。将被焊接的表面将是原木板检验尺解脱, 炉渣, 铁锈, 油膏, 漆等。边缘是有光滑和一致的表面。当表面是潮湿的, 焊接不会进行。在气候严酷的天气情况期间, 适当的保护应受安排, 当焊接还在进行时。凹线在焊接之时将是干燥的。111 预热将更好地执行靠运用电发热设备。瓦斯炉也许在受控情况下使用。切割吹管不应该使用。
- 112 对于结构类别在特级、1级的焊接, 以及结构类别在2级的对焊焊接, 则必须制定WPS, 并由买方认可。

Guidance note:

The weld connection between two components shall be assigned the structural category area equal to the higher category of the joined components. For stiffened plates not classified as structural category special, the weld connection between stiffener and stringer and girder web to plate may normally be assigned structural category secondary.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

- 113 A WPS can be established by one of the following methods:
 - performing of welding procedure test(WPQT) and subsequent review of the welding procedure qualification records(WPQR)
 - review of previously qualified welding procedures tests (WPQT) which has been witnessed by a party recognised by the purchaser
 - review of WPS
 - review and verification of documentation showing successful application of welding procedures over a prolonged period of time.

114 Tack welding shall, when integrated in production welding, be qualified. For welds specified in 112 a WPS shall be submitted to the purchaser for acceptance.

115 All fabrication welding shall be performed within the limits of essential variables of the qualified welding procedure. This also includes tack welding, seal welding, welding of lifting lugs and attachment welds as well as repair welding.

116 When resuming welding on partially filled joints in special areas, preheating shall be performed and the temperature within the specified tolerances, shall if not otherwise agreed, be equal to the interpass temperature for the welding pass in question.

117 Grooves produced by gouging shall be followed by grinding removing carbonised material and the groove shall be dressed to a shape consistent with tolerances in agreement with the purchaser.

118 Welding consumables shall be classified with respect to strength, application area and hydrogen level according to recognised scheme.

Electrodes for welding of high strength steels (see DNV-OS-B101) shall satisfy a hydrogen test requirement for at least suffix H10, i.e. $H_{DM} \leq 10 \text{ ml}/100\text{g}$ in weld metal.

指导说明:

二个组分之间的焊接连接将被分配结构类别区域相等与被加入的组分的更高的类别。为硬化的板材没被分类为结构类别特别, 加强筋和纵梁和大梁网之间的焊接连接与板材也许通常被分配结构类别次要。

113 WPS可以由以下方法之一建立:

- 执行焊接工艺测试(WPQT), 以及随后对焊接工艺合格纪录进行核查(WPQR)
- 核查已有的合格的焊接工艺试验。此类已有的合格焊接工艺试验已由买方认可的方面见证过。
- 核查WPS
- 核查并修正文件。这些文件是指其时间超过了延长期, 其记录着焊接工艺的成功应用。

114 用于生产焊接的定位焊需经合格认可。对于在112节规定的焊接, WPS必须递交给买方接受认可。

115 进行的所有装配焊接必须限定在合格的焊接工艺变化允许的限度内。这里所说的所有装配焊还包括定位焊、密封焊、吊环焊、辅助焊以及返修焊。

116 在特殊区域进行部分填充接头进行焊接时, 必须进行预热, 其预热温度在规定的范围内。如无其他约定, 则预热温度等于焊道的过渡层温度。

117 碳刨而产生的波口必须随之进行打磨, 以去除碳化材料。波口打磨成形, 其形状与经买方协议认可的公差要求相一致。

118 对于焊材的强度、应用范围和含H量方面, 必须按认可的流程对焊材进行入级焊接消费品将分类关于力量, 应用范围和氢水平根据被认可的计划。

电极为高强度钢焊接(参见DNV-OS-B101)将满足至少词尾H10的氢测试要求, i.e. $H_{DM} \leq 10 \text{ ml}/100\text{g}$ 在焊接金属。

Electrodes for welding of extra high strength steel (see DNV-OS-B101) shall satisfy a hydrogen test requirement for the suffix H5, i.e. $H_{DM} \leq 5 \text{ ml}/100\text{g}$ in weld metal.

Hydrogen testing shall be according to ISO 3690 or equivalent.

119 Consumables that have been contaminated by moisture, rust, oil, grease, dirt or other deleterious matter, shall be discarded unless properly reconditioned.

Storage and handling of welding consumables shall be in accordance with the manufacturer's recommendations, and in accordance with procedures giving details regarding conditions in storage rooms, temperature in storage ovens and quivers, length of exposure and conditions, as applicable.

Recycling of fluxes for submerged-arc welding shall be performed in a manner that ensures a mixture of new and used flux with continually homogenous properties.

120 Welds shall be terminated in a manner that will ensure sound welds without end-craters. Extension bars and run-off plates shall be removed upon completion and cooling of the weld. The end of the weld shall be made smooth and flush with the edges of abutting parts. 电极为特别高的力量钢焊接(参见DNV-OS-B101)将满足词尾H5的氢测试要求, i.e. $H_{DM} \leq 5 \text{ ml}/100\text{g}$ 在焊接金属。

氢测试将是根据ISO 3690或等值。

119 湿气沾染了的消费品, 铁锈, 油, 油膏, 土或其他有害问题, 将放弃, 除非适当地重造。

存储和处理焊接消费品将是与制造商的推荐符合, 并且与提供细节关于条件的规程符合在贮藏室, 温度在贮藏烤箱和颤抖, 暴露持续时间和情况, 如可适用。

回收涨潮为保证新和半新涨潮混合物与连续地同源物产的淹没弧焊接有些将进行。

120 将保证酣然的焊接, 不用结束火山口的焊接有些将被终止。伸出杆和决赛板材将被去除在完成和冷却焊接。焊接的末端将使成为光滑和注满以繁靠的零件连接。

121 Grinding of welds with the intention of increasing the fa-

tigue life and/or reducing the probability of brittle fracture shall be carried out according to agreed specifications.

122 Welding production tests shall be made during fabrication of welds in special areas and in primary structural elements to verify that the produced welds are of acceptable quality. Minimum one test coupon is required from each applied welding process.

The welding parameters for the WPT shall be as for the actual weld and the environmental conditions shall be kept as realistic as possible. The requirements for a WPT are in general the same as for the relevant welding procedure test.

123 If one or more production tests fail to give satisfactory results, two more shall be made, both of which shall give acceptable results.

Should one or both of the additional tests fail, the total production welding performed with the welding procedure in question shall be evaluated based on testing of welds and base material cut-out from the actual structure fabricated.

124 In all cases the failure of a production test shall lead to a review of the welding performed to establish the reason for the failure, and appropriate corrective action shall be carried out.

125 Shop primers applied over areas, which will subsequently be welded, shall be of a suitable quality demonstrated to have acceptably low detrimental effect on the finished weld.

F 200 Post weld heat treatment (PWHT)

201 Post weld heat treatment (PWHT) of C-Mn steels if required by DNV-OS-C101 or DNV-OS-C201, shall be performed in accordance with a procedure specification including:

- heating and cooling rates
- temperature gradients
- soaking temperature range and minimum holding time
- heating facilities
- insulation
- control devices
- recording equipment
- configuration of structure to be post-weld heat treated or details if local PWHT shall be carried out.

Heat treatment records shall be kept throughout the heat treatment process.

Guidance note:

The procedure specification may be worked out on basis of combined material thicknesses as shown in Figure 3. 121 研焊接打算增加疲劳生活和或减少脆性断裂的可能性根据同意的规格将被执行。

122 焊接生产测试将被做在生产焊接期间在特别区域和在主要结构元素核实导致的焊接是合格的质量。极小值一测试优惠券从每个应用的焊接过程需要。

WPT的焊接参量将是至于为实际焊接和环境状况将被保持一样现实尽可能。WPT的要求一般来说是同样为相关的焊接工艺测试。

123 如果一个或更多生产测试失败令人满意的结果，二更将被做，其中之二将给可接受的结果。

如果其中一个或两个另外的测试出故障，总生产焊接进行以焊接工艺在考虑中将被评估根据测试焊接和基本材料保险开关从被制造的实际结构。

124 在所有的情况下生产测试的失败将导致进行的焊接的回顾建立失败的原因，并且适当的惩治行为将被执行。

125 商店底漆应用结束区域，哪些随后将被焊接，被展示的将是适当的质量可接受有低恶劣效果在完成的焊接。

F 200 岗位焊接热治疗(PWHT)

201 由DNV-OS-C101或DNV-OS-C201如果必须张贴焊接热治疗(PWHT)CmN钢，将执行在依照与a做法规格包括:

- 加热的和冷却的率
- 温度差
- 浸泡的温度范围和极小值保留时间
- 热化设施
- 绝缘材料
- 控制设备
- 录音设备
- 如果地方PWHT将被执行，是结构的配置岗位焊接热被对待的或细节。

热治疗纪录将被保留在热治疗过程中。

指导说明:

做法规格也许解决根据联合的物质厚度的依据如图3所示。

---e-n-d--of--G-u-i-d-a-n-c-e--n-o-t-e--

202 Heat treatment shall be performed at a soaking temperature in the range 580 to 620°C, for a time of at least 2 minutes per mm thickness. Soaking temperature and time shall be selected considering recommendations for the welding consumables and steel grade in question. Soaking temperature for quenched and tempered steels shall be decided in each case.

203 The temperature difference between the outside and the inside surface during soaking shall not exceed 30°C within the heated area. Double-sided heating shall be applied as far as possible.

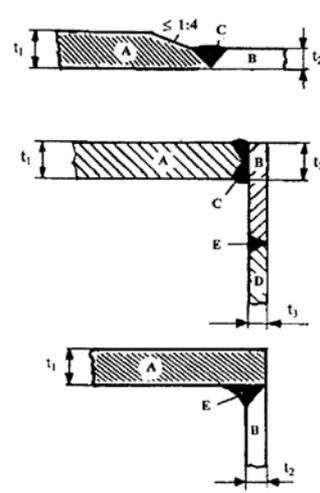
204 Heating, soaking and cooling shall be carried out in a controlled manner that prevents cracking or distortions outside the dimensional tolerances. The temperature difference along lines or planes of symmetry shall normally not exceed 30°C when the material temperature is above 300°C.

205 The heat-treatment cycle and the actual metal temperature shall be recorded using thermocouples equally spaced externally, and whenever possible internally, throughout the heated region. 202 热治疗将在进行在一个浸泡的温度在范围580到620°C，一度每种毫米厚度至少2分钟的。将被选择考虑对焊接消费品的推荐和在考虑中的浸泡的温度和时间钢成绩。浸泡的温度为熄灭的和被磨炼的钢在每个案件将决定。

203 外部和又瓦的基面之间的温度区别在浸泡期间在激昂的区域之内不会超出30°C。将应用得两面的热化尽可能的。

204 热化，浸泡和冷却将被执行以防止裂化或畸变在尺寸容忍之外的受控方式。当物质温度在300°C之上，温度区别按照线或对称平面通常不会超出30°C。

205 热治疗周期和实际金属温度使用热电偶将被记录等隔外地，并且，每当可能内部，在激昂的区域中。



Base material	Weld/HAZ	PWHT
A: t ₁	C: t ₂	C: t ₂
B: t ₂		

Base material	Weld/HAZ	PWHT
A: t ₁	C: t ₁	C: t ₁
B: t ₂	E: t ₃	E: t ₃
D: t ₃		

Base material	Weld/HAZ	PWHT
A: t ₁	E: t ₂	E: t ₂
B: t ₂		

Figure 3 Guidance on material thickness for PWHT

图3: PWHT材料厚度指南

206 Heat treatment, wherever possible, shall be carried out in an enclosing furnace according to written procedures agreed upon. The temperature distribution throughout heating furnaces shall be controlled within ± 15°C.

Where it is impractical to heat-treat the whole item in a closed furnace, local heat treatment may be adopted.

207 Only welding consumables recommended for PWHT by the manufacturer shall be used for joints to be post weld heat treated.

F 300 Repairs

301 Repairs shall be carried out in accordance with qualified repair procedures subject to agreement.

302 Guidance to repair work may be found in IACS Ship-building and repair Quality Standard, Part A Sec.9 and Part B.

303 Members distorted by welding may be straightened by mechanical means or by carefully supervised application of a limited amount of localised heat. The application of heat or mechanical force shall be in accordance with a written procedure.

304 Defects in welds may be rectified by grinding, machining or welding. Welds of insufficient strength, ductility or notch toughness shall be completely removed prior to repair. The mechanical properties of repair weld shall satisfy the minimum specified properties of the steel in question.

305 Repair welding in the same area may be carried out twice. Further repairs shall be evaluated in each individual case.

306 Whenever a defect is removed, the gouged and ground area shall be examined by magnetic particle testing or other suitable methods to verify complete removal.

307 Repair welding shall be performed using welding consumables satisfying the hydrogen test requirement given in 118. The preheating and working temperature shall when making shallow and local repairs in special and primary structural elements be raised 50°C above the level specified for production welding and be at least 100°C unless otherwise agreed. The working temperature shall be maintained until the repair has been completed. To ensure sound repair welds, the single repair length shall not be shorter than 50 mm.

206 对于可进行热处理的地方，必须按书面同意的工艺在封闭式炉中进行热处理。整个加热炉中的温度分布必须控制在± 15°C。对于整个项目在一封闭式炉中进行加热实际上是不可能的地方，必须采用局部热处理。

207 仅焊材部分由焊材厂商推荐进行PWHT，则对焊缝必须必须进行焊后加热。

F 300 返修

301 返修必须按合格的返修工艺进行。返修工艺需经协商同意。

302 在IACS造船和返修质量标准中的A部分第9章节和B部分已给出返修工作指南。

303 因焊接产生变形的部位应进行校直。校直的方法可采用机械法或局部火工法。用火工法进行校直时应仔细监督，限制其校正量。火工法和机械法必须附有书面工艺要求。

304 用打磨法，机械法或焊接法进行矫正焊接缺陷。对于强度、延展性或缺口韧性不足的焊缝，在对其返修之前必须全部去除。修理焊接机械性能将满足钢的极小的指定的物产在考虑中的。

305 修理焊接在同一个区域可以两次被执行。进一步修理在每个单独案件将被评估。

306 每当去除瑕疵，被抠出的和被研的区域将由磁粉探伤试验或其他适当的方法审查核实完全撤除。

307 修理焊接使用满足氢测试要求的焊接消费品将执行指定在118。预热和工作温度将，当使浅，并且地方修理在特别和主要结构元素是被上升的50°C在为生产焊接指定的水平之上并且除非经同意是至少100°C。运作的温度将被维护，直到修理完成了。保证酣然的修理焊接，唯一修理长度比50毫米不会短。

the defect as confirmed by NDT. Long defects may be required repaired in several steps to avoid overloading or cracking. Each repair step shall be controlled so as not to cause plastic deformation of the remaining material when removing the defect. 焊接处修理将通过去除焊接的不能接受的部分执行没有基本材料坚固撤除。为平面瑕疵修理长度在瑕疵的每一边比瑕疵的大小50毫米长如由NDT证实。在几步也许需要长的瑕疵修理避免超载或裂化。当去除瑕疵时，每修理步将是受控的至于不导致剩余的材料塑料变形。

309 Repair welding of post-weld heat-treated joints shall unless otherwise agreed initiate a new heat treatment. 修理焊接岗位焊接热处理后的联接除非同意将创始新的热治疗。

310 Minor discontinuities may be removed by grinding or machining, making a smooth transition into the surrounding material. The thickness shall not be reduced to less than 93% of the nominal thickness but in no case by more than 3 mm. The extent of such repair shall be agreed upon.

311 All repairs shall be re-inspected with the same NDT methods to the same or increased extent as necessary.

310 较小的不连续性焊缝用打磨法或机械方法去除，使焊缝平顺地过渡到周边的材料。不连续性焊缝去除后，板的厚度不能少于名义厚度的93%，但无论如何，去除的厚度不得多于3毫米。返修程度需经同意。

311 所有返工的地方必须用同样的NDT方法进行再次验收，验收的范围或是一样，或是如需要则增加验收范围。

SECTION 3 NON-DESTRUCTIVE TESTING 无损探伤

A. General 通则

A 100 Scope 范围

101 This section gives requirements for non-destructive testing. 本章节给出了无损探伤的要求

B. Non-Destructive Testing (NDT) 无损探伤测试 (NDT)

B 100 General 通则

101 Prior to commencement of fabrication the contractor shall submit a plan for NDT, NDT procedures and documents for NDT inspectors' certification for acceptance by the purchaser. The programme shall contain information and documents for planning, controlling and reporting. 在装配前, 卖方必须向买方递交 NDT 图, NDT 工艺文件以及 NDT 人员资格证, 并经卖方接受。这个程序必须包括计划、控制和报告 NDT 的信息和文件。

102 The inspection categories shall be defined in accordance with DNV-OS-C101 Sec.4 or DNV-OS-C201 Sec 4 and shall be specified in relevant design drawings. NDT 类别必须按 DNV-OS-C101 第 4 节或 DNT-OS-C201 第 4 节规定进行, 并指明相关的设计图。

103 Welds shall be subject to NDT in progress with fabrication. The results of these activities shall be consecutively reported to the purchaser. 装配进展过程中就应进行 NDT, 这些 NDT 的结果必须随时报告给买方。

104 Methods of NDT shall be chosen with due regard to the conditions including the sensitivity of the method and the method's ability to detect defects likely to occur as a consequence of the chosen welding process. NDT 的方法将依如下条件而定: NDT 方法的敏感性, 所选的焊接法可能引起的 NDT 检测缺陷的能力。

105 Final inspection and NDT of structural steel welds shall not be carried out before 48 hours after completion, except where PWHT is required. 除非需要 PWHT (焊后热处理), 则在钢结构完成后的 48 小时内, 必须进行钢结构焊接的终检和 NDT。

The time delay may upon agreement be reduced for NV 36 grades or lower and for NV 420 grades or lower for plate thicknesses less than 40 mm, if consistent low failure rate of delayed cracking has been documented for the materials and welding consumables in question. 对于 NV36 级及其更低级的材料, NV420 级及其更低级的材料, 或板厚小于 40mm, 如发现坚实的低延迟开裂失效率, 以及如发现焊接耗材有问题时, 依协议, 可缩短终检和 NDT 的推迟时间。

106 When heat treatment is performed, the final NDT shall be carried out when all heat treatments have been completed. 当进行热处理进, 等到所有的热处理都完成了才进行终检 NDT。

107 All welds shall be 100% visually inspected prior to carrying out NDT. 在进行 NDT 前, 所有焊缝均必须 100% 外观检验。

108 All NDT shall be properly documented in such a way that the performed examination can be duplicated. The reports shall identify the defects present in the weld area and state if the weld satisfies the acceptance criteria or not. 所有的 NDT 应当适当记录, 以达到进行的检验能以复制进行。无论焊接是否满足接收标准, NDT 报告必须标明焊接区的缺陷比例并相应说明。

B 200 NDT procedures NDT 工艺

201 NDT shall be performed in accordance with agreed written procedures that, as a minimum, give detailed information on the following aspects: NDT 必须符合书面同意的 NDT 工艺, 至少应给出如下方面的详细信息:

- applicable code or standard 适用的符号或标准
- materials and dimensions 材料和尺寸
- welding process 焊接方法
- joint configuration and dimensions 接头形状和尺寸
- technique 技术
- equipment, main and auxiliary 设备 (主要设备和辅助设备)
- sensitivity 敏感性
- calibration techniques and calibration references 校验技术和校验基准
- testing parameters and variables 测验参数和变量
- assessment of imperfections 不完美性评估
- reporting and documentation of results 起草报告和结论文件
- reference to applicable welding procedure(s) 适用焊接工艺参考
- personnel qualification 人员资格
- acceptance criteria. 接收标准

B 300 Personnel qualification 人员资格

301 Personnel performing NDT and interpretation of examination results shall be certified according to a recognised certification scheme subject to agreement and shall provide a valid certificate of proficiency. The certificate shall state the qualifications as to which examination method and within which category the operator is qualified. 依协议的证明程序以证明进行 NDT 人员和试验结果整理, NDT 人员应提供有效的能力证明。

B 400 Extent of NDT NDT 范围

401 The extent of NDT shall be based on type and level of design stresses and on the importance of the connection in question. The welds shall be assigned inspection categories equal to the highest structural category of the two components. For stiffened plates, which are not assigned Inspection category I, the weld connection between stiffener and stringer and girder web to the plate may normally be inspected according to Inspection Category III. NDT 范围取决于设计应力类型和级别, 也取决于与问题相关的重要性, 焊缝应进行检验分类, 有 2 个分类的, 取高者。如扶强板, 对于其不划入检验类别 I 的, 扶强材和纵桁间的焊接接口处, 以及至纵桁筋的板的焊缝通常应按 NDT 检验类别 III 进行检验。

The inspection categories shall be applied to the drawings. Aspects that shall be considered in determining the extent of NDT are:

- stress level and stress direction 应力水平和应力方向
- cyclic loading 周期负荷
- material toughness 材料韧性
- redundancy of the member 构件的冗余
- overall integrity of the structure 结构的全部完整性
- accessibility for examination in service. 检验时的可接近性

402 Unless otherwise agreed, NDT shall normally be carried out to an extent not less than required in Table B1. For welds that are examined for only a given percentage, the importance to the integrity of the structure shall be considered when selecting the welds to be examined. 除非另行同意, NDT 范围通常不低于表 B1 的要求。对于仅有一个给定的检验比例, 当对所选焊缝进行 NDT 检验时, 考虑结构的完整性很重要。

A representative sampling of welds, with due regard to fabrication assembly and welding methodologies, shall be performed. 对于分段组装和焊接方法论, 所选的 NDT 检验焊缝样本必须有代表性。

403 If a consistently low NDT failure rate is documented, the extent of NDT inspection required for elements within structural category primary may be reduced, but shall not be less than for Inspection category III. 若发现持续的低 NDT 失效率, 则在结构件内需要 NDT 检验的要素, NDT 范围类别可相应减小, 但不低于检验类别 III。

404 Radiographic examination may be replaced by ultrasonic examination and vice versa, when methodologically justifiable and in agreement with the purchaser. 当方法正当时, 依协议, 超声检验可由射线检验替代, 相反也如此。

405 Frequent repairs shall result in increased extent of NDT. The extent of NDT shall be increased in a manner such that all relevant defects are discovered in the areas of concern and that representative sampling is carried out on all welds. When the weld quality level has been restored, the extent of examination may be reduced in agreement with the purchaser. 经常性的返工将导致增加 NDT 范围。当关注的焊区发现所有相关的缺陷时, NDT 范围将增加, 并且在所有焊缝上取具代表性的样品。当焊接质量已回复时, 依与买方的协议, 检验范围可相应减小。

406 If severe defects (i.e. cracks and other planar defects or excessive slag lines) occur repeatedly, all welds made with the same welding procedure during the period in question, shall be examined full length. 如重复性地发生严重的缺陷 (如裂纹和其他平面缺陷或大量的熔渣线), 在发生问题期间使用同样焊接工艺的所有焊缝必须全部检验。

Frequent occurrence of excessive porosity can be indicative of inadequate handling of welding consumables. If inadequate handling is confirmed, the welds made during the period in question shall be investigated by adequate methods for hydrogen induced cracking. 经常性地出现大量的气孔, 则表明焊接耗材使用不够。如确认为焊接耗材处理不够, 则在发生问题期间焊出的焊缝, 必须用适当的方法来测定其氢诱裂纹。

407 NDT shall cover start and stop points of automatically welded seams. 对于自动焊缝, 在焊缝的开始处和终止处必须进行 NDT。

408 Ultrasonic examination of welds shall include examination of the area adjacent to the weld for laminations and scanning for transverse defects in the weld and base material. 焊缝的超声检验必须包括检查涂层焊缝相邻区域, 并扫描焊缝和基材内的横向缺陷。

409 Plates which are subjected to significant tensile stresses in the thickness direction in way of cross joints, etc. shall be ultrasonically tested after welding into the structure, to make sure that lamellar tearing has not taken place.
If steel with improved through thickness properties has been adopted, this test may be reduced to spotchecks only.

对于诸如在焊缝交接等处沿厚度方向存在明显拉应力的板，其焊至结构后，必须进行超声检验，以确保无层状撕裂。

如整个厚度性能得以改进了，则超声检验可减少至仅点测试。

Inspection Category 类别	Type of connection 焊接类型	Test method 检验方法			
		Visual 外观	Magnetic 1) 磁	Radiography 2) 射线	Ultrasonic 3) 超声
I	Butt weld 对焊	100%	100%	100%	-
	Cross- and T-joints, full penetration welds 十字和T形全透焊	100%	100%	-	100%
	Cross- and T-joints, partly penetration and fillet welds 十字和T形非全透加填料焊	100%	100%	-	-
II	Butt weld 对焊	100%	20% 4)	10% 5)	-
	Cross- and T-joints, full penetration welds 十字和T形全透焊	100%	20%	-	20%
	Cross- and T-joints, partly penetration and fillet welds 十字和T形非全透加填料焊	100%	20%	-	-
III	Butt weld 对焊	100%	Spot 6)	Spot 6)	-
	Cross- and T-joints, full penetration welds 十字和T形全透焊	100%	Spot 6)	-	Spot 6)
	Cross- and T-joints, partly penetration and fillet welds 十字和T形非全透加填料焊	100%	Spot 6)	-	-

1) Liquid penetrant testing to be adopted for non ferro-magnetic materials 液体渗透检验适合于非铁磁性材料
 2) May be partly or wholly replaced by ultrasonic testing upon agreement 依协议可部分或全部由超声检验代替
 3) Ultrasonic examination shall be carried out for plate thicknesses of 10 mm and above 厚度大于10mm (包括) 必须进行超声检验
 4) For weld connections on hull shell not subjected to high residual stress, spot check will be accepted as sufficient. 对于无高残余应力的船体壳板焊缝接口处，点查就够了。
 5) See DNV-OS-C101 Section 4 C305 and C306 or DNV-OS-C201 Section 4 C305 and 306. 参阅DNV-OS-C101第4节C305和C306或DNV-OS-C201第4节C305和C306。
 6) Approximately 2 to 5% 大约2-5%

410 Radiographic testing 射线检验

Radiographic testing shall be performed by x-ray according to approved procedures. Use of γ-ray is subject to acceptance in each case. The procedures shall be established in accordance with recognised standards. 依批准的工艺，用X-射线进行射线检验。而用γ-射线来检验则依情况而定。必须按认可的标准来建立工艺规程

411 Suspect planar indications discovered by radiographic testing shall be type determined, located and sized by ultrasonic testing. 由射线检验发现的可疑平面迹象，必须用超声检验来决定其类型，位置和大小。

412 Processing and storage shall be such that the films maintain their quality throughout the agreed time of storage. 在整个同意的贮藏期内，射线片的制作和贮藏方法必须维持片子的质量。

413 Ultrasonic testing 超声检验

Ultrasonic testing shall be performed according to approved procedures. The procedures shall be established according to recognised standards. 依批准的工艺规程进行超声检验。必须按认可的标准来建造工艺规程。

414 Ultrasonic examination equipment is to: 超声检验的设备是指:

- be applicable for the pulse echo technique and for the double-probe technique 应用了脉冲回声技术和双控制技术。
- cover as a minimum the frequency range from 2 to 6 MHz 最低声波频率范围为2-6MHz。
- have a calibrated gain regulator with minimum 2 dB per step over a range of at least 60 dB 有校准增益调节装置，至少在60dB范围，每步最小2dB
- have a flat screen accessible from the front for direct plotting of reference curves or equipped with automatic calibration or DAC (Distance Amplitude Curve) -display presentation 有前部易卸的一平面屏幕，以便标准曲线的直接形成，或装备有自动校准器或DAC (距离放大曲线) 影像扫描。
- echoes with amplitudes of 5% of full screen height shall be clearly detectable under test conditions 在检验条件下，必须清晰地检测到全屏高5%幅度的回音
- include straight beam transducers and angle beam transducers of 45°, 60° and 70°. 含有直波束传感器和45°, 60° 和70°的角波束传感器

415 Calibration of the ultrasonic equipment shall be carried

out whenever it has been out of function for any reason including on and off and whenever there is any doubt concerning proper functioning of the equipment. 无论什么原因，包括使用着或没在使用着，设备不正常工作，也包括当设备功能正常发挥有疑问时，必须进行超声设备的校准。

416 The IIW or ISO calibration block shall be used for calibration of range and for angle determination. 必须用IIW或ISO校准块来校准波范围和角度决定

417 For evaluation of flaw indications a reference curve shall be established. The curve shall be plotted on the instrument screen. Imperfections, which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such imperfections and evaluate them in terms of the acceptance criteria. All defects exceeding the acceptance criteria shall be reported unless more stringent requirements are agreed. 为评估缺陷信号，必须建立标准曲线。仪器屏幕上必须绘制标准曲线。当缺陷产生的响应曲线大于标准级别20%时，必须进行测定以达到超声检验人员能确定缺陷形状、类别、位置并依验收标准来评估这些缺陷。除非同意更多的STRINGENT要求，所有超过验收标准的缺陷均应作出报告。

418 Reference blocks shall be made with thickness and side-drilled holes, as described in Table B2, and shall be used for gain calibration and construction of reference curves. The reference block shall normally be manufactured from the actual material examined and have approved dimensions. When ultrasonic testing is to be performed on steel produced by controlled rolling or thermomechanical treatment, reference blocks shall be produced both perpendicular to, and parallel to, the direction of rolling. The rolling direction shall be clearly identified. 制作的标准块必须按表B2所述的厚度和钻边孔。这个标准块被用于增益校准和标准曲线的制作。标准块的制作通常选材于被检的实际材料。标准块的大小应经批准。当对轧辊或热处理的钢进行超声检验时，应沿轧辊的平行方向和垂直方向制作标准块。必须清晰地标示轧辊方向

419 Calibration of ultrasonic equipment shall be undertaken in accordance with recognised code or standard. 按认可的编号或标准进行超声设备的调校

420 For ultrasonic examination the contact surface shall be clean and smooth, i.e. free from dirt, scale, rust, welding spatter, etc. which may influence the results of the examination. 当超声检验时，接触面应干净和光滑，即无粉尘、污垢、锈迹、飞溅等，否则会影响检验结果。

421 The weld shall normally be examined from both sides and the testing is to include the area adjacent to the weld for laminations and scanning for transverse indications in the weld and base material. Use of multiple angle probes scanning in addition to normal probe scanning is required. 焊缝通常必须双面检测，检测区域包括选层焊缝邻近区域，在焊缝和基材进行横向扫描。除了用通常的探头扫描外，还应用多角度探头进行扫描。

422 For flaw detection the corrected primary gain shall be increased by 6 dB. Defect size evaluation shall not be performed at this increased gain level. 对裂纹检验时，正确的primary增益必须增加6dB。在增加的地增益级别，不必进行缺陷大小的评估。

423 The indications shall be investigated by maximising the echoes with different angle probes and by rotating the probes. For dimensional evaluation, either the «20 dB-drop» method or the «half-value-drop» method shall be used. 用最大回声来测定信号，采用的方法是用不同的角探头和转动探头。对缺陷大小的检验，必须或用《20dB降落》法或《半值降落》法。

Table B2 Calibration reference block requirements 表B2: 高校标准块的要求

被测材料厚度	标块厚度	孔径	离开表面的孔径距离
Thickness of material to be examined (mm)	Thickness of block (mm)	Diameter of hole (mm)	Distance of hole from one surface (mm)
10 < t ≤ 50	40 or t	Ø 3 ± 0.2	t/2 and t/4. Additional allowed and recommended
50 < t ≤ 100	75 or t		
100 < t ≤ 150	125 or t		
150 < t ≤ 200	175 or t	Ø 6 ± 0.2	
200 < t ≤ 250	225 or t		
t > 250	275 or t		

424 Magnetic particle testing 磁粉探测

Magnetic particle testing shall be performed according to procedures subject to agreement. The procedures shall be established according to recognised standards.

依协议的工艺规程进行磁粉探测。依认可的标准建造工艺规程。

425 The equipment shall establish a field strength between 2.4 kA/m and 4.0 kA/m for prods. Prods shall be soft tipped with lead or similar. Use of prods soft tipped with copper is not permitted. Sparks between the prods and the material tested shall be avoided. Electromagnetic A.C. yokes shall develop a minimum lifting force of 5 kg at maximum leg spread. Field strength and lifting force shall be checked at regular intervals. 磁粉探测设备必须产生磁场强度介于2.4 kA/m和4.0 kA/m间 for prods. 磁头必须是带铅或类似的软尖头。不准使用带铜的软尖磁头。必须严禁在磁头与被测材料间产生火花。电磁AC磁轭必须在最大变压器铁芯柱距时产生最小5kg提升力。必须有规律地间隔检查磁强度和提升力。

426 Use of permanent magnets is not permitted. 严禁使用永磁。

427 The surface to be tested shall be clean and dry, free from dirt i.e. paint, grease, oil, lint, scale, welding flux etc. which may interfere with the testing. 被测表面必须干净和干燥，即无灰尘、油漆、油迹、油、棉线、锈皮、焊剂等，否则可对检验产生干扰。

428 To ensure detection of discontinuities having axes in any direction, the testing of each area shall be performed with magnetic field shifted in at least two directions approximately perpendicular to each other, and with sufficient overlap to cover the area to be tested. 为确保在任何方向坐标上不连续检测，用至少在两个大约相互垂直的方向移动磁场的办法，或有足够的平等交叉地进行（重叠）检测以覆盖被测表面的方法，进行每一表面的检测。

429 Non-fluorescent wet or dry particles shall provide adequate contrast with the background or the surface being tested. 无荧光湿粉或干粉必须提供足够的与被测体的背面和表面的接触。

430 De-magnetisation should be considered in areas where residual magnetism could be detrimental. 对于 残留磁性区域，应考虑退磁。

431 Liquid penetrant testing 流体渗透检验

Liquid penetrant testing shall be performed according to approved procedures. The procedures shall be established according to recognised standards. 按批准的工艺规程进行流体渗透试验。依认可的标准建立其工艺规程。

B 500 Acceptance criteria for NDT NDT验收标准

501 Acceptance criteria for welds in steel are given in Table B3, Table B4 and Table B5. As the test methods differ in their limitations and/or sensitivities special acceptance criteria are given for each method where necessary. Alternative evaluation ensuring an equivalent level of quality may be considered in special cases. 表B3和B4给出了钢焊缝的验收标准。由于检验方法的不出，表中也给出了每一不同检验方法的限制和验收标准的敏感性。特殊情况下，应考虑可选的评估方法，以确保质量的相当一致。

502 Acceptance of defects exceeding the given limits may be granted based on fracture mechanics testing and appropriate calculations. If this approach is considered, the inherent inaccuracy of the NDT methods shall be considered when the critical defect size is determined. 依断裂机械试验和适当的计算，可验收超过表中所给极限的缺陷。当发现严重的缺陷尺寸时，当考虑近似法时，必须考虑NDT法固有的不精确性。

503 The soundness of welds shall comply with the acceptance criteria for each of the NDT methods used. Defects exceeding the limits shall be repaired and after repair welding has been performed, the complete weld, (i.e. the repaired area plus at least 100 mm on each side) shall be subjected to at least the same NDT method(s) as specified for the original weld. 焊接的无缺陷性必须符合每一使用的NDT法的验收标准。超过极限的缺陷必须进行返工，返工焊接完成后，全部的返工焊缝（即修复区+至少每边100mm）至少达到用同种NDT法所述的质量水平。

Table B3 Visual and magnetic particle testing acceptance criteria for structural steel welds 表B3:

Type of defect 缺陷种类	Structural steel weld appearance and magnetic particle testing acceptance criteria		
	Special 特级	Primary 初级	Secondary 第2级
Cracks 裂纹	Not acceptable 不验收		
Incomplete penetration or lack of fusion 没完全焊透或熔化不足	Not acceptable 不验收		
Surface porosity 表面气孔	Not acceptable 不验收	On the root side of welds for which back welding is not required: Length < t/2, maximum 10 mm and not closer than t in weld root. 长度 < t/2, 最大 10mm, 不近于 t.	
Undercut, maximum depth, mm 咬边, 最大深度, mm	Not acceptable 不验收	Not acceptable in areas with tensile stresses. In other areas the accumulated pore diameters in any area of 10 x 150 mm are not to exceed 15 mm. Maximum size of single pore; t/4 or 4 mm (whichever is the smaller) 对张应力区, 不验收。其他区, 在任何10x150mm区内的累积的小孔直径不应超过15mm。最大的单个小孔尺寸: t/4或4mm (小者为准)。	
		Not acceptable when transverse to tensile stresses. Maximum depth allowed in other areas 0.75 mm 当横张应力时, 不验收。其他区域, 最大允许深度为0.75mm。	

t is the nominal plate thickness. t是名义板厚

General requirements: 通常要求:

Welds shall be of correct shape, size and geometry. Welds shall have a regular finish and merge smoothly into the base material. Groove welds shall have slight or minimum reinforcement or root penetration not exceeding 3 mm in height. The face of fillet welds shall be slightly convex or concave or flat and leg lengths shall be equal.

焊缝形状、大小和几何形状应正确。焊缝必须规则光滑和光滑地溶入基材。可有轻微的坡口焊缝或在高度上不超过3mm的最小再加强或要部渗透。

Table B4 Radiographic testing, acceptance criteria 表B4: 射线检验的验收标准			
Type of defect 缺陷类型	Structural category 结构类别		
	Special 特级	Primary 1级	Secondary 2级
Porosity 气孔 1) 2)			
— Isolated: Maximum pore diameter, mm 孤立的: 最大小孔直径	t/5, maximum 4	t/4, maximum 5	t/3, maximum 6
— Cluster: Largest pore diameter, mm 成群的: 最大的小孔直径	2	3	4
— Piping porosity: Maximum length along the weld of projected pore area, mm 管状气孔: 沿投射小孔区的最大长度	20	25	30
— Scattered: Maximum accumulated pore diameters in any 10 x 150 mm area of weld 散状: 在任何10x150mm区域内, 焊缝的最大累计小孔直径	15	20	25
Slag inclusion 夹渣 1) 3) 4)			
— Maximum width, mm 最大宽度, mm	t/5, maximum 4	t/4, maximum 6	t/3, maximum 6
— Maximum length, mm 最大长度, mm	t	2 t	4 t
Incomplete penetration length 不完全焊透 5) 6) mm	Not accepted in connections where full penetration is required 在接缝处时, 不能验收。接缝处必须全焊透	≤ t, maximum 25	≤ 2t, maximum 50
Lack of fusion length 无融结长度 5) 6) mm	Not accepted 不验收		≤ 2t, maximum 50
Cracks 裂纹	Not accepted 不验收		
<p>1) If the distance between the similar defects (pore or slag) is less than the largest extent of one of the defects, they shall be considered as one continuous defect. If the amount of pores or slag may mask other defects, the testing shall be supplemented with radiographic or ultrasonic testing. 如小缺陷 (小孔或夹渣) 间距离小于最大的缺陷间距, 则认为它们属连续的缺陷。如小孔或夹渣的数量较其他缺陷明显时, 必须补以射线或超声检验。</p> <p>2) If the distance between pores is less than 3 times the diameter, the pores are said to form a line or a cluster. Pores on a line must not be located in the weld surface. 如小孔音的距离小于其直径的3倍, 则应将小孔视为形成孔线或成群。线状小孔不应位于焊缝表面。</p> <p>3) Defects of lengths in the direction of the weld exceeding 3 times their widths form a line. If the distance between slag lines is less than 3 times the largest extent of the defect, the lines are considered as one defect. 在焊缝方向的缺陷长度超过3倍于其宽度而形与线状缺陷。如夹渣线间距离小于3倍的最大缺陷十字结间距, 此缺陷即被认为是线缺陷。</p> <p>4) If parallel slag lines are found the examination shall be supplemented with ultrasonic tests. 如发现平行线状夹渣, 则必须补以超声检验。</p> <p>5) Defects on a line where the distance between the defects is shorter than the longest defect shall be regarded as one continuous defect. 如在一条线上的缺陷, 其缺陷间距离小于最大的缺陷间距离时, 则此类缺陷应视为边续型缺陷。</p> <p>6) Not surface open. For incomplete penetration or lack of fusion on root side of welds for which back welding is not required, see Table B3. 表面未张开。对于不完全焊透或于焊缝根部融透不够, 则这此无需背焊, 参见表B3。</p>			

Table B5 Ultrasonic testing 超声检验			
Indication 信号 1)2)3)	Structural category 结构类别		
	Special 特级	Primary 1级	Secondary 2级
Echo height above 回声高于	50% of reference level 标准级50%	100% of reference level 标准级100%	100% of reference level 标准级100%
Maximum length 最大长度 4), mm	t/3 or maximum 10 t/3或最大10	t/2 or maximum 10 t/2或最大10	t or maximum 20 t或最大20
Cracks are not acceptable regardless of size or amplitude. 无论大小还是幅值, 不验收裂纹。			
<p>1) Indications which the operator based on experience, knowledge of the welding method and joint geometry deems likely to be cracks, lack of fusion or lack of penetration may be unacceptable regardless of echo amplitude and length. In such cases an independent examination by another operator shall be performed. 依检验者对焊接方法和焊接接头几何形状的经验、知识, 检验者若认为缺陷可能是裂纹, 融焊不够或焊透不够, 无论回波幅值还是长度, 均不能验收此信号。在此情况下, 必须由另一个检验员进行独立地再检验一次。</p> <p>2) If only one side of the weld is accessible for examination, all indications with a length > t/4 and exceeding 20% of the reference curve for the special category and 50% otherwise, may be regarded as cracks, lack of fusion or lack of penetration unless otherwise proven. In such cases an independent examination by another operator or by different methods shall be performed. 如只有焊缝的一边能够进行检验, 除非有其他相反的证明, 若所有信号的长度大于t/4以及超过特级类别标准曲线的20%和其他级别标准曲线的50%, 则应认为是存在裂纹、融焊不够或焊透不够。在这种情况下, 必须由另一个检验员进行独立地再次检验或用其他不同的检验方法进行再次检验。</p> <p>3) For longitudinal defects where the indications intermittently are above and below the acceptance level, the type of defect shall be determined when the areas exceeding the acceptance level are repaired. If the defect is found to be crack, lack of fusion, lack of penetration or slagline(s) the whole defect length is unacceptable regardless of echo amplitude. 对于纵向缺陷, 其信号脉动地高于或低于验收等级, 当超过验收等级处有修复时, 必须确定其缺陷类型。如发现缺陷是裂纹、融焊不够或焊透不够或属夹渣线时, 无论回波幅度如何, 均拒收整个缺陷。</p> <p>4) Length is defined as distance between points where the echo amplitude reach or pass the stated percentages of reference level. 所谓的长度定义为: 两点音的音距, 此两点为超过或达到所述的标准等级的比例。</p>			

SECTION 5 CORROSION PROTECTION SYSTEMS

A. General

A 100 Scope

101 This section lists requirements for application of coating and requirements for fabrication and installation of sacrificial anodes and impressed current systems.

A 200 General

201 Installation or application of corrosion protection systems shall be carried out in conformance with recognised standards of workmanship and specifications agreed upon.

A 300 Application of coating

301 The area to be coated shall be defined and if necessary limited by masking. Components and areas, which may be damaged by the pre-treatment and/or by the coating, such as anodes, shall be shielded.

302 The surfaces to be coated shall be clean and dry. Oil, grease or dirt shall be removed by washing with a suitable detergent. Salts shall be removed by washing with fresh water.

303 Sharp edges shall be rounded and surfaces blast-cleaned to the profile and degree of cleanliness as required in the coating specification and in accordance with the coating manufacturer's recommendations. Normally, the minimum requirements for steel surface quality for primer coating application is ISO 8501-1 Sa 2 1/2 or equivalent for external surfaces and internal zones exposed to sea-water or otherwise intended for coating.

304 Final blast-cleaning and coating application shall when possible be carried out only when the steel temperature is $> 3^{\circ}\text{C}$ above the dew point and the relative humidity $< 85\%$ in order to prevent condensation of moisture on the surface.

305 Coating systems shall be applied in the number of coats and within the thickness ranges as stated in the specification agreed upon and in accordance with the manufacturer's recommendations.

306 Inspection, repair and touch-up shall be performed according to specifications agreed upon.

307 Primer-coated surfaces shall be inspected and, if necessary, be adequately cleaned and prepared before applying the next coating layer.

308 Adequate curing times in relation to temperature and humidity conditions, overcoating intervals, dry-film thickness of individual coats and total dry-film thickness, shall be within tolerances stated in the coating specification.

A 400 Fabrication and installation of sacrificial anodes

401 Fabrication and installation of anodes shall be carried out

A200 概述

201 防腐蚀系统的安装或应用，应遵照被认可的工艺和规格标准来进行。

A300 涂层的应用

被涂层的区域应被定义和如果需要可用伪装来限制。组分和区域，可以被预处理损坏和或由涂层，例如阳极，将被保护。

302 将被涂上的表面将是干净和干燥的。油、油脂或污土将被用一种适当的洗涤剂来洗涤。盐将被用淡水来洗涤。

303 锋利的边缘将被环绕，并且表面将疾风被清洗到外形和程度洁净根据需要涂层规格和与涂层制造商的符合推荐。通常，钢表面质量的极小的要求为更加雷管的涂层应用是ISO 8501-1 Sa 2 1/2或等值为外在供涂层使用被暴露在海水或否则打算的表面和内部区域。

304 最后的喷抛清理和涂层将可能当钢温度是 $> 3^{\circ}\text{C}$ 的时候，为了防止湿气结露在表面，相对湿度 $< 85\%$ 时被采用。

305 涂层系统应被应用在外层上并且在厂商推荐和规格书一致的厚度范围之内。

306 检查，修理和触碰应根据规格书来进行。

307 底漆上涂的表面将被检查，如果需要，在应用下涂层之前应充分地被清洗并且准备。

308 关于温度和湿气情况应有适当的加工时间，涂层间隔时间，各自的外套和总干燥膜片厚度的干燥影片厚度，在涂层规格陈述的公差之内。

A400 牺牲阳极的装配和安装

401 阳极的装配和安装应按101来实施

out according to drawings and specifications.

402 Anode shapes and their fastening devices (studs, clamps, etc.) shall be subject to agreement with the purchaser. Fabrication and installation of anodes shall be carried out according to drawings and specifications.

For anodes fastened by other means than welding, attention should be paid to the establishing of good electrical contact. Resistance measurements may be required.

Welding of connections shall be carried out to procedures accepted by the purchaser and by qualified welders.

Anodes shall if not otherwise agreed, be connected to the structure in way of local stiffening.

Any doubling plates to which anodes are welded, shall have a thickness normally not less than 10 mm, well rounded corners ($r > 20$ mm), and shall be continuously welded. Material grades of the doubling plates and anode studs or pads welded directly to main plating, shall be in accordance with the requirements given in DNV-OS-C101 Sec.4 or DNV-OS-C201 Sec.4. The doubling plates shall be of the material strength group as the main plate.

403 For anodes connected to bulkhead plating, girder web plates etc. having a thickness equal to or less than 15 mm, at least one of the studs shall be welded on or close to a local stiffener. Anodes connected to shell plating of trusses etc., where no internal stiffening is provided, shall be fastened to doubling plates permanently welded to the shell.

404 Submerged zone: anodes located in way of internal stiffening, except on columns close to truss connections, may be welded directly to the shell plating without doubling plates. Below light water line, such direct welding will be accepted only for anode studs or pads not intended to be removed by renewal of anodes. In any case, anodes located on slim trusses without internal stiffening and on columns close to truss connections shall be fastened to doubling plates permanently welded to the shell.

A 500 Fabrication and installation of impressed current systems

501 The anodes, the cables and the signal receivers shall be furnished with relevant material certificates and be properly marked for identification.

502 The installation of the system shall be carried out according to an agreed specification.

503 All equipment, cables etc. shall be accepted for use in the respective hazardous zones, if applicable. 为其它方法紧固的阳极比焊接，应该注意建立好电接触。也许需要抵抗测量。

连接焊接将被执行到具有资格的焊工接受的由采购员和规程。

阳极将如果否则不同意，连接到结构用方式地方僵住。

阳极被焊接的任何双夹板，通常将有一种厚度不少于10毫米，圆满完成的角落

($r > 20$ 毫米)，并且连续将被焊接。双夹板的物质成绩和阳极螺柱或者垫焊接了直接地到主要镀层，将是在与DNV-OS-C101 Sec.4或DNV-OS-C201给的要求符合

Sec.4. 双夹板将是物质力量小组作为主要板材。

403 为阳极连接到隔框镀层，大梁网镀等。有厚度相等或少于15毫米，其中至少一个螺柱将被焊接在或紧挨地方加强筋。阳极连接到外壳捆绑金属，那里没有提供内部硬钢，将被永久紧固到被焊接在外壳的双夹板。

404 被淹没的区域：位于内部钢硬化的阳极，除了在专栏紧挨捆连接，愿被焊接直接地到船壳板，不用双夹板。在轻水线之下，这样直接焊接为没意欲的阳极螺柱或垫将仅被接受被阳极更新去除。无论如何，位于专栏的微小的捆，无需内部硬钢和阳极紧挨捆连接将被紧固到双夹板永久地被焊接对壳。

A500 被铭记的当前系统的装配和安装

阳极，缆绳和信号接收器将装备与相关的物质证明和为证明适当地被标记。

502 系统的安装应根据协议规定来执行。

503 所有设备，电缆应被接受用于各自危害区域，若可能。

504 Testing of the proper functioning of the systems shall be carried out. The test method and results shall be reported.

505 Final testing and acceptance of the system shall be performed after installation. 504 系统固有作用的测试将被执行。测试方法和结果将报告。

505 系统的最终测试和认可应在安装后进行。

SECTION 6 MISCELLANEOUS

A. Use General

A 100 Scope

101 This section covers requirements for bolts and mechanical fastening.

B. Bolts

B 100 Bolts and nuts

101 Bolts and nuts considered as essential for structural and operational safety shall conform to a recognised standard, e.g. ISO 898.

102 Major pressure retaining or structural bolts and nuts with specified min. yield stress above 490 N/mm² shall be made of alloy steel, i.e. (% Cr + % Mo + % Ni) ≥ 0.50 and supplied in the quenched and tempered condition.

103 For general service, the specified tensile properties shall not exceed ISO 898 property Class 10.9 when the installation is in atmospheric environment. For equipment submerged in seawater, the tensile properties shall not exceed property class 8.8 or equivalent.

Guidance note:

For bolted joints to be part of equipment designed for sulphide stress cracking service, lower tensile properties than for 8.8 class may be necessary in order to comply with NACE MR0175. 101 这个部分包括螺栓和机械紧固的要求。

B. 螺栓

B 100 螺栓和螺母

101 螺栓和螺母应和认可标准一致，如：ISO 898，并且对结构物和操作安全是十分必要的。

102 主要压力保留或结构螺栓和螺母以指定的min屈服应力在490 N/mm²之上由合金钢制成，如：(%Cr+ % Mo + % Ni) ≥ 0.50，和供应在熄火的和被磨炼的情况。

103 为一般服务，当设施在大气环境里时，指定的拉伸物产不会超出ISO 898财产分类10.9。为在海水淹没的设备，拉伸物产不会超出财产分类

8.8或等值。

指导说明：

为了螺栓的联接成为设备设计的一部分，为硫化压力破裂服务，比对于8.8类可以必要为了依从NACE MR0175降低拉伸物产。

--e-n-d--of--G-u-i-d-a-n-c-e--n-o-t-e--

C. Mechanical Fastening

C 100 Contact surfaces in slip resistant connections C. 机械紧固 C 100 滑动接触面的抗性连接

101 If required, contact surfaces in preloaded joints shall be prepared to produce the class of friction surface as required.

102 Details of surface treatments, which may be assumed to provide the stated classes of friction surface, are given in DNV-OS-C101 Sec.5.

103 The class of friction surface produced by other treatment may be determined according to other international recognised standards.

104 Contact surfaces shall be cleaned and roughened by blasting with an appropriate material to produce a surface conforming the required quality. In case of coated surfaces, this treatment shall be followed immediately by the application of the appropriate coating.

105 At the time of assembly, the contact surfaces shall be free from all contaminants, such as oil, dirt or paint, except for a slip resistant coating. Burr that would prevent solid seating of the connecting parts shall be removed.

106 Oil shall be removed from the surface by using chemical cleaners, not by flame-cleaning.

107 If un-coated surfaces cannot be assembled directly after preparation of the contact surfaces, they should be freed from all thin films of rust and other loose material by brushing with a steel brush. Care should be taken not to damage or smooth the roughened surface. 101 如果必要，接触面在预载的联接处将准备导致所需求的摩擦表面等级。

102 表面处理细节，可以假设提供所陈述的摩擦表面等级，在DNV-OS-C101 第5章中指出。

103 根据国际认可的标准，摩擦表面等级由其他细节产生。

104 接触面将通过以适当材料导致表面的炸开清洗并且粗化证实必需的质量。在上漆的表面的情况下，这种做法将跟随适当的涂层的应用。

105 在组装之时，接触面将从所有污染物中解脱，例如油，土或油漆，除了滑动抗性涂层。

震动小舌将防止连接零件的坚实座次将被去除。

106 油应使用化学擦净剂从表面清除，不使用火焰清洁剂。

107 如果未上漆表面不可能直接地在接触面准备后被装配，应该从铁锈和其他松散料所有薄膜释放他们通过掠过用钢刷子。应该采取注意不损坏或不使被粗化的表面光滑。



FABRICATION AND TESTING OF
OFFSHORE

CHAPTER 3

CERTIFICATION AND CLASSIFICATION

CONTENTS	PAGE
Sec. 1 General	45

SECTION 1 GENERAL

A. Introduction

A 100 Scope

- 101 This section lists requirements relating to certification and classification.
- 102 When this standard is used as basis for Classification, the term “purchaser” shall apply to the Society and pertinent activities contractually associated with the “Contractor”. 101 这个部分列出与资格审核和入级相关的要求。
- 102 当这个标准作为入级的基础而使用时，“采购商”将适用于社会和与“承包商”有关的合同中相关活动。

B. Specific Certification and Classification Requirements

B 100 General

101 The following requirements shall be applied in conjunction with the technical requirements in the main body of this standard when used for certification or classification purposes. B 200 Basic requirements

201 Welding of special, primary and secondary structures for hull, welding of superstructure, piping systems and equipment shall be carried out by approved welders, with approved welding consumables and at welding shops and -contractors recognised by DNV.

B 300 Welding shops and -contractors

- 301 Welding shops and -contractors will have to prove their qualifications for the welding operations in question.
- 302 It is assumed that the welding shops and -contractors make use of the necessary equipment for carrying out inspection of the welding operations in a satisfactory manner.
- 303 Important welding operations shall be carried out under daily supervision of an inspector, who has the experience and qualifications, which enable him to judge this type of work. The work of each welder shall be regularly examined.
- 304 The welding shops and -contractors shall keep a card index or register of all approved welders. The register shall give information on training of the welders and date and results of qualification tests. Information about the base metal, type of welding consumable, joint design and welding positions shall be stated in the event of re-qualification tests. The surveyor shall be allowed to examine the register at any time.

B 400 Welding consumables

401 Consumables for welding of offshore structures intended for classification shall be approved by the Society.

B. 具体资格审核和入级要求

B 100 概述

101 以下要求应与这个标准的主体部分技术要求相适应，当运用在资格审核或入级目的时。 B 200 基本要求

201 船体特别、主要、次要结构的焊接，上层建筑，管道系统和设备的焊接将由认可的焊工执行，与认可的焊接消耗品和DNV认可的承包商和焊接车间。

B 300 焊接车间和承包商

- 301 焊接车间和承包商将必须证明他们的焊接操作资格。
- 302 假设焊接车间和承包商利用必要的设备，以令人满意的方式为焊接操作进行检验。
- 303 重要焊接操作将被执行在审查员的每日监督下，审查员必需有经验和资格，有能力判断这个类型的工作。每位焊工的工作应被定期审查。
- 304 每个焊接车间和承包商将保持一张卡片索引或登记所有认可的焊工。登记信息应含有焊工训练和资格测试日期与结果。关于碱金属的信息，焊接消耗品的类型，焊接设计和焊接部位应在再资格测试的情况下陈述。测量员将被允许任何时候审查登记表。

B 400 焊接消耗品

401 消耗品应为被船级社认可的欲入级离岸结构物的焊接消耗品。

402 Type approval of welding consumables will be considered subject to compliance with the requirements given in the Rules for Classification of Ships Pt.2 Ch.3 Sec.3 焊接消耗品的种类认可将被认为与船级社所给规则的要求一致（Pt.2 Ch.3 Sec.3.）。

403 All brand names under which a tested and approved welding consumable is marketed shall be registered by the Society. In order to avoid duplication of tests, the manufacturer shall certify that the welding consumables marketed under alternative brand names are identical with the consumables tested for approval. 403 被测试和认可的焊接消耗品应被船级社所登记后方可推向市场。为了避免测试的重复，制造商应证明在可变换品名下市场焊接消耗品应和获得认可的消耗品一致。

B 500 Welding procedures and qualification of welders

501 The welding procedure qualification test shall be witnessed by the surveyor.

502 Welding and testing of weld assemblies for approval of welders shall be performed in the presence of the surveyor. Upon successful completion, the Society will certify that the welder has passed the approval testing.

503 Where certification is performed by other IACS members or independent organisations, e.g. accredited or nationally approved certification bodies, recognition of such certification will be evaluated on a case by case basis. The Society reserves the right, however, to require verification of welders' qualifications when deemed necessary. Such verification may include testing prior to production, extra NDT and/or welding production tests.

B 600 Corrosion protection systems

601 Application of coating, steel surface preparation with respect to application of coating and fabrication and installation of sacrificial anodes and impressed current cathodic protection systems are not included in the Society's scope of work unless upon special agreement.

C. Records and Documentation

C 100 General

101 Adequate records related to the fabrication of the structure shall be prepared to document that the structure meets the specified requirements. Such records shall be compiled in parallel with the fabrication process. Compiled records shall be systematic and fully traceable. Such records shall reflect all relevant testing, alterations, additions, corrections and revisions made during the fabrication period in order to provide information required during the in-service life of the structure.

B 500 焊接工艺和焊接人员资格

- 501 焊接工艺资格测试应由调查者证实。
- 502 认可焊接员焊接组装的焊接和测试焊接在测量员面前进行。如成功的完成，船级社将证明焊工通过认可测试。
- 503 证明由其他IACS成员或独立组织执行，e.g. 被检定的或全国性认可证明主体，这样证明的认可将根据具体情况被评估。社会预留权利，然而，必要时，要求焊工的资格的证明。这样证明也许在生产之前包括测试，额外NDT和或焊接生产测试。

B 600 防腐蚀系统

601 涂层的应用，牺牲阳极和被铭记的当前阴极保护系统的表面处理关于涂层和制造的应用和设施，在船级社的工作范围内没有包括，除非在特殊协议。

C. 纪录和文件

C 100 概括

101 充分纪录与结构物装配有关的内容应准备提供结构符合具体的要求。这样纪录将被编写与制造过程平行。编写纪录应是系统和充分地可追踪的。这样纪录将影响所有相关测试，改变，加法，更正和修正，在结构物的服务生命期间，为了提供需要的信息。