

鋼結構工程銲接技術應用

海洋(離岸)鑽油塔架鋼結構工程

朱豐耀

摘要:鑽油塔架鋼結構工程是屬海洋平台鋼結構動態工程，本公司此次所承接之鑽油塔架製作上與以往一般製作之大樓鋼結構靜態工程不同，本結構所採取之方式為：(1)箱型柱之四角隅接合(corner joint)使用無背墊板全滲透(CPUT)銲接及部份滲透(PP)銲接；為配合施工品質要求施工方法採用箱型柱(BOX)全滲透開槽區外貼緊陶瓷軟帶(ceramic)與在同一邊部份滲透(PP)的銲道，在 BOX 內邊使用小台車兩邊同時採用包藥心線銲接(FCAW)銲接完成，在 BOX 外邊將陶瓷軟帶棄除再用 FCAW 打底，接續採用潛弧銲接(SAW)銲接完成；施工上較一般製作之大樓為困難也較為嚴格；本文敘述銲接相關技術，主要是提供鋼結構業者或施工者在製作時施工之參考，以達到節省工作時間提高工作效率、降低成本為主。

關鍵詞：鑽油塔架、動態、銲接

一、前言：

- (1)本工程屬於海洋(離岸)工程主結構鋼板採用 DET NORSKE VERITAS(DNV)挪威驗船協會規範鋼板材質為 NVA36、NVD36(Z)、NVE36Z、NVF36Z，主體結構中 Base Plate 鋼板厚度 80mm 材質為 NVF36Z，母材使用前必須測試衝擊試驗溫度 -60°C 吸收能量達到 36J(min.)施工首重銲接，尤其施工品質需依據規範要求和加強追蹤配合以確保安全；對於施工前銲接程序、銲接材料、銲工檢定等計劃之製作包含試片切割、組合、銲接、非破壞檢測、取樣加工、機械試驗、化性分析等作業程序均依規劃確實執行。
- (2)本工程施工製造主要是著重在施工技術、設備及人力以符合品質、成本、交期之目標。對於施工的進度、構件之安排、施工的流程及規劃非常重要，皆要求由專業之管理人員配合施工。

二、工程概述：

- (1)本工程承製之鑽油塔架 CAT(D1~D4)4 部機重量 550 噸/部機，每套計有 4 節包含主結構 Base Plate 4 塊板、BOX Column 18 支柱、橫梁、斜撐及雜項等構件成型(詳附外觀照片 1)，主結構母材包含有 NVD36(Z)、NVE36Z、NVF36Z；主結構銲材包含有 SAW AWS(F7A2-EM12K)，AWS(F7A8-EM12K)；FCAW AWS(E71T-1)，AWS(E81T1-K2C)；GMAW AWS(ER80S-G)；SMAW AWS(E7016)。
- (2)本工程為確保銲接品質施工之前先行試作銲接程序試驗 39 種、銲接材料檢定試驗 6 種及銲接人員檢定考試。



鑽油塔架外觀照片 1

(3)本工程與一般工程銲接程序試驗製作不同點如下表：

項次	項目	鑽油塔架工程	一般工程
1	依照規範	DNV-OS-C401	AWS D1.1
2	鋼板材質	NVE36Z	SN490C
3	檢測試驗 (Butt joint)CP	Visual Test	Visual Test
4		Ultrasonic Test	Ultrasonic Test
5		Magnetic Test	NA
6		Impact Test(Weld Metal、Fusion Line、HAZ 2mm、HAZ 5mm)， each 3pecs；-40°C(36J)	配合業主要求製作 Impact Test (Weld Metal 5pecs)；-29°C(27J)
7		Macro-etch(1 面)/Hardness test 15 個 位置 (母材:6 HAZ：6：Weld：3)	NA
8		Tensile Test 2 pecs.	Tensile Test 2 pecs.
9		Side bend Test 2 pecs.	Side bend Test 4 pecs.

三、製程：

(1)鋼板材料管理：

1. 鋼板材料顏色區分

使用 DET NORSKE VERITAS(DNV)挪威驗船協會規範鋼板區分如下：

1. NVA36 橘色(衝擊試驗 0°C，34J min.)

Welding Procedure Specification



中國鋼鐵結構股份有限公司

箱型柱製作 WPS 照片 2

3. 銲接程序檢定試驗計劃及預檢定銲接程序規範如箱型柱 BOX 四角隅單斜槽全滲透如 pWPS-785、pWPS-787-1、BH 填角銲 pWPS-789(詳附表四、表五)
4. 銲接程序規範&檢定試驗報告如箱型柱 BOX 四角隅單斜槽全滲透如 WPS-785&PQR-785、WPS-787-1&PQR-787-1、BH 填角銲 WPS-789&PQR-789(詳附表六~表八)
5. 銲接材料準備：銲接前必須提出銲材使用計畫(詳附表九)，並經 DNV 銲接材料試驗認證核可才可使用現場使用銲接材料照片詳附照片 3

BASE METAL	WELDING PROCESS	CLASSIFICATION	TRADE No.		MANUFACTURER/TYPE APPROVAL CERTIFICATE
			ELEC	FLUX	
			FILLER METAL		
NVD3Z or NVA3Z	SAW	F7A2-EH12K (AWS A5.17)	TSW-12KM (TIEN TAI)	TF565 (TIEN TAI)	TIEN TAI /DSV
	FCAW	E71E-1 (AWS A5.20)	TWE-711 (TIEN TAI)	N/A	TIEN TAI /DSV
NVE6Z or NVE6Z	SAW	F7A8-EH12K (AWS A5.17)	TSW-12KH (TIEN TAI)	TF-210 (TIEN TAI)	TIEN TAI /DSV
	FCAW	E81E-K2C (AWS A5.29)	TWE-81K2 (TIEN TAI)	N/A	TIEN TAI /DSV
	GMAW	ER80S-G (AWS A5.28)	TM-60 (TIEN TAI)	N/A	TIEN TAI /DSV
Track weld	SMAW	E7016 (AWS A5.1)	TL-50 (TIEN TAI)	N/A	TIEN TAI /DSV

銲接使用計劃表(表 9)



銲材使用計畫銲材照片 3

6. 銲工檢定：銲接前必須提出銲工檢定考試計畫(詳附表十)
7. 銲接產品試驗：針對主要結構全滲透接頭試驗確認施工品質如 WPT-863&WPT-837 詳附照片 4&5。
8. 銲接前必須銲接預熱及銲藥、銲條烘烤溫度控制詳附照片 6~8。
9. 銲接產品底板與柱接頭(Base plate to Column) Joint 超厚板銲接銲後熱處理採用電熱片

保溫布方式作業詳附退火處理曲線圖及照片 9~11。

四、結論：

1. 海洋(離岸)鑽油塔架鋼結構工程指動態結構。
2. 本工程 WPS/PQR 製作須採 qualified 的方式。
3. 本工程依據合約規定之母材，選擇適當的銲接方法、接頭 型式、母材、銲接位置、板厚、銲接材料等不同狀況，而區分其銲工資格。
4. 施工前先製作銲接程序檢定、銲材等測試合乎標準，施工時按步就班的確實執行；對於銲接品質必能達到業主之要求，同時也能因銲接穩定性良好，而減少不良率降低成本，達到預定之目標。

銲工檢定考試計畫(表十)

Welder & Welding Operator Qualification plan

A. Purpose:

To evaluate the qualification of welding operators in factory and guarantee the quality of welding operation.

B. Application scope:

To be applicable to all welding operators of steel structure in this project.

C. Qualification contents:

(1) Qualification method:

The welding operators should implement the qualifications based on the relative welding method and position. (Be according to the regulations of AWS D1.1 2006' Table4.10)

(2) Qualification of welders

(A) To be according to the regulations of construction specification.

(B) The welding operators who have been engaging in the similar welding operations in the latest 6 months before the project, or the qualifiers who were qualified by passing the new test before they engaged in the welding operation.

(3) Restricted conditions of welders qualification:

(A) The welder must pass the qualification according to the following relative conditions before he/she is engaged in the relative welding operation.

(B) The qualification items and the relative applicable operation scope:

Qualification level		Operation scope		
Test piecetype	Test piecetype n	groove weld		Fillet weld
		Full penetration	Partial penetration	F、H
Groove Weld (Steel plate)	1G	F、H	F、H	F、H
	2G	F、H	F、H	F、H
	3G	F、H、V	F、H、V	F、H、V
	4G	F、OH	F、OH	F、H、OH
Fillet weld (Steel plate)	1F	--	--	F
	2F			F、H
	3F			F、H、V
	4F			F、H、OH
Steel pipe	2G	F、OH	F、OH	F、OH
	6G	ALL	ALL	ALL

Remark:

1. G=Groove

2. F=Fillet

3. Welding position :

1. Flat position welding -- (F). 2. Horizontal welding -- (H).

3. Vertical welding -- (V). 4. Overhead welding -- (OH).

4. ALL : all positions

(4) Flow chart of welder qualification test :

(5) date, location, quantity of welder qualification test

(A) Associate units:

(a) owner: Aker Solutions

(b) manufacture supervision unit: DET NORSKE VERITAS

(c) contractor: China Steel Structure Co.,Ltd

(b) date、location、quantity: (welders roster)

(d) materials list:

materials	label	specification	size	remark
test piece steel plate	CSC	NVD36Z	25*186*160 mm	3G

(D) The electric welding device of test: DC electric welder.

(E) Instruments and devices

1. Welding bead visual inspection gauge
2. DC voltage meter and current ammeter
3. Surface thermometer
4. Safety goggles
5. Humidity meter
6. Preheating equipment
7. Deslagging machinery

(6) Test description: shown as AWS D1.1 2006' Table4.11

Welder and Welding Operator Qualification-Number and Type of Specimens and Range of Thickness Diameter Qualified (Dimensions in millimeter) (see 4.18.2.1)							
(1) Test on Plate		Number of Specimens'				Qualified Dimensions	
Production Groove or Plug Welds		Face Bend ² (Fig. 4.12)	Root Bend ² (Fig. 4.12)	Side Bend ² (Fig. 4.13)	Macro etch	Nominal Plate, Pipe or Tube Thickness Qualified. mm	
Type of Test Weld (Applicable Figures)	Nominal Thickness of Test Plate T. mm					Min.	Max.
Groove (Fig.4.31 or 4.32)	10	1	1	---	---	3	20 max
Groove (Fig.4.21, 4.22)	10<T<25	---	---	2	---	3	2T max
Groove (Fig.4.21, 4.22)	≥ 25	---	---	2	---	3	Unlimited

(7) Qualification process

The qualification processes of before-welding, in-welding, and after-welding are described as following:

(A) before-welding

Before the welding, the invigilators must check and inspect the following items:

- (1) To check the welding process specification
- (2) To inspect the test piece

To inspect the test piece carefully according to the test piece size chart. The normal backing plate thickness is within 12 mm. When the radioactive rays test (RT) is replaced by the side bend test, the width of backing plate should not be less than 75mm, and the stationary of spot welding bead on backing plate could not be in the field of test welding test. This is to avoid influencing interpretation of negative. To stamp the welder identity number by using steel seal after making test piece.

(3) To check the materials and welding consumables specification

The invigilator should check whether the materials and welding consumables specification are in accordance with the requirements of WPS or not.

(4) To declare the examination rules and check the identity of welder

After the given inspection and checking items of (1)~(4), the invigilator should declare the examination rules and check the identity of welder. The key points as below:

· To declare the qualification items: for the plate manual groove welding, the inspection gesture should be 1G according to WPS; And the welder get the test piece and take his test position. After the stationary of test piece, to notify the invigilator to implement the check before welding.

· Examination room management: Excepts the inspectors, other candidates should await orders in rest area and not enter into the examination room. The impostors would be disqualified.

· Welding conditions: The welding conditions should be according to the regulations of WPS, such as voltage and current values, which could not be set without permission. After the welding, to notify the invigilators to implement the inspection before moving the test piece.

· Test items: After making test piece, to implement the visual inspection. To implement the RT test on qualified pieces.

· Qualified conditions: the welders which are qualified in visual inspection, RT test would be regarded as the qualified welders.

· To check the identity of welders: the invigilators must check the identity of all candidates. The candidate should show the **ID card with photo.**

(B) In welding

In the process of welding, the invigilator should check or advert the following items:

- (1) In the process of welding, the invigilator should wear the safety goggles and prevent the eyes from injuring by welding arc.**
- (2) In case of any suspicion about welder identity, to confirm the identity again to avoid the impostor.**
- (3) In the process of welding, to measure that whether the welding conditions are according to the**

regulations of WPS or not, such as voltage and current. When WPS requires to control the preheating temperature or interlayer temperature, to implement the necessary temperature measurement by using surface thermometer. If the welding conditions are not according to the regulations of WPS, to point out the errors and correct it immediately.

(4) If the test item is vertical weld, to advert that whether the test piece is vertical or not. To avoid the retroversion of test piece caused by slag removing.

(C) After welding

After the welding, the invigilator should check or advert the following items:

- (1) When the welder notify that the welding is finished, to inspect that whether the test piece is still at the original position or not. After the inspection, the test piece could be moved.
- (2) The test pieces that the welding is completed should be gathered and placed to the suitable location. To place the pieces ordered by the welders identity numbers.
- (3) In case of necessary situation, to gather all welders who participates in the test for photograph proofing.
- (4) To implement the visual inspection on all test pieces according to the visual inspection standard. To implement the RT test on the visual inspection qualified **welders**.

(8) Qualified standard

(A) qualified standard of visual inspection

- (1) No crack in welding bead.
- (2) The welding pool must be filled.
- (3) The junction between welding bead and material must be smooth. And the size of welding corrosion should not be larger than 1 mm. The size of welding crown should not be larger than 3 mm.
- (4) No porosity on welding bead surface.

(B) The qualified standard of radioactive testing (RT) should be according to the regulations of AWS-2006 RT inspection standard.

(9) Qualification record

After the welder qualification testing, to fill the welder test record according to the qualification contents and the test result of testing pieces. Shown as attached table; the steel structure factory should record by themselves and the invigilator is only responsible for supervision.

The attached table is *Welding Process Specification*, to attach the welder test record additionally. As attachment 1.

(10) Standard of test requirements

AWS 4.19 Type of Qualification Test Required:

4.19.1 Welders and Welding Operators.

The type and number of qualification tests required for welder or welding operators shall conform to Table 4.10. Detail on the individual NDT and mechanical test requirements are found in the following subsections:

- (1) Visual Inspection.
- (2) RT Test.

以上為 銲工檢定考試計畫(表十)



WPT-863 銲接產品測試照片 4



WPT-837 銲接產品測試照片 5

FABRICATION WELDING PRODUCTION TEST (FWPT)

Company Name CSSC
 Welding Process FCAW, SAW
 Supporting Document No. WPS-863.POR-863

Identification# WPT-863
 Revision: 0 Date: 04-22-13 By F.Y.Chu
 Authorized by: F.L.Hsu Date: 04-22-2013
 Type: FCAW : Semi-Automatic
SAW : Machine

JOINT DESIGN USED

Type: Comer
 Single Double Weld
 Backing: Yes No
 Backing Material: Ceramic(ABD-G)
 Root Opening: 4mm Root Face Dimension: 0mm
 Groove Angle: 40° Radius(J-U): -
 Back Gouging: Yes No Method: -

POSITION

Position of Groove: IG Fillet: -
 Vertical Progression: UP Down

ELECTRICAL CHARACTERISTICS

Transfer Mode: FCAW : Globular
 Current: FCAW : DCEP
SAW : DCEP AC

BASE METALS

Material Specification: NVE36Z
 Type or Grade: -
 Thickness: Groove 40mm Fillet -
 Diameter (Pipe): -

Other: -

TECHNIQUE

Stringer or Weave Bead: Both
 Multi-pass or Single Pass (Per side): Multi-pass
 Number of Electrodes: 1(FCAW) + 2(SAW)
 Electrode Spacing Longitudinal: -
 Lateral: -
 Angle: -

FILLER METALS

AWS Specification: A5.29 + A5.17
 AWS Classification: TWE-81K2(E81T1-K2C)
TSW-12KH(EH12K)

DNV Grade FCAW : 5Y46S(HS)
SAW : 4Y40M(HS)

Contact Tube to Work Distance: 1.12-20mm 2.40mm

Peening: None

Inter-pass Cleaning: Vibrating or Wire Brush or Grind

SHIELDING

Flux: TF-210(F7A8)
 Gas: FCAW : CO₂
 Composition: -
 Electrode-Flux (Class) - Flow Rate: 20-25 l/min
 Gas Cup Size: 20mm

POSTWELD HEAT TREATMENT

Temperature: N.A

Time: N.A

PREHEAT

Preheat Temp.: Min. 78 °C
 Inter-pass Temp.: Min. 68°C Max. 150°C

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Joint Details (mm)
		Class	Dia.	Type & Polarity	Amps or Wire Feed Speed			
Side B 1	FCAW	E81T1-K2C	1.2mm	DCEP	221	31	210	
Side A 2	FCAW	E81T1-K2C	1.2mm	DCEP	221	31	210	
3	FCAW	E81T1-K2C	1.2mm	DCEP	245	31	210	
4	SAW	EH12K	4.8mm	DCEP	560	32	560	
5	SAW	EH12K	4.8mm	DCEP	560	32	560	
6	SAW	EH12K	4.8mm	DCEP	700	33	645	
7	SAW	EH12K	4.8mm	DCEP	750	34	625	
8	SAW	EH12K	4.8mm	DCEP	740	33	628	
9	SAW	EH12K	4.8mm	AC	680	38	658	
				DCEP	740	33	610	
10	SAW	EH12K	4.8mm	AC	680	38	610	
				DCEP	740	33	610	
11	SAW	EH12K	4.8mm	AC	740	33	583	
				DCEP	740	33	583	
12	SAW	EH12K	4.8mm	DCEP	740	33	610	
				AC	680	38	610	
13	SAW	EH12K	4.8mm	DCEP	740	33	610	
				AC	680	38	610	
14	SAW	EH12K	4.8mm	DCEP	740	33	610	
				AC	680	38	610	
15	SAW	EH12K	4.8mm	DCEP	650	30	680	
				AC	600	33	680	
16	SAW	EH12K	4.8mm	DCEP	650	30	630	
				AC	650	30	630	
17	SAW	EH12K	4.8mm	DCEP	650	30	630	

heat input : FCAW(DC+) = 1.1-1.9 kJ/mm ; SAW(DC+ + AC) = 3.7-5.1 kJ/mm

WELDING PRODUCTION TEST RECORD (WPT)# 863

Test Results

Charpy V-notch Impact Test(-40°C)

Specimen No.	Specimen Dimension mm	Absorbed Energy(J)				
		No.1	No.2	No.3	Average	
WPT-863	Weld Metal	10x10x55	86	107	71	88
	Fusion Line	10x10x55	116	90	104	104
	HAZ(FL+2mm)	10x10x55	109	104	118	110
	HAZ(FL+5mm)	10x10x55	71	97	120	96

Metallographic Examination

Specimen	Result
WPT-863	Refer to Report no: KK-13-03306X (Page No.3 OF 3)

Hardness Test : HV10

No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15
863	165	169	167	167	175	175	199	200	197	188	180	164	174	170	172

VISUAL INSPECTION

Appearance Acceptable
 Undercut None
 Piping porosity None
 Convexity None
 Test date March.29~30.2013
 Witnessed by F. Y. Chu

Visual-Magnetic-Ultrasonic examination

VT report no.: N3113/001541 Result OK
 MT report no.: N3113/001540 Result OK
 UT report no.: N3113/001539 Result OK

MACRO-ETCH TEST RESULTS

OK

Welder's name 余性輝, 阮氏莊

All-weld-metal tension test

Tensile strength, psi -
 Yield point/strength, psi -
 Elongation in 2 in., % -
 Laboratory test no. -

Clock no. - Stamp no. -

Tests conducted by SGS Laboratory -

Test number WPT-863

Per -

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of DNV-OS-C401 (2010) Structural Welding Code-Steel.
 (year)

Signed F. Y. Chu
 Manufacturer or Contractor

By F. Y. Chu

Title FAB Supervisor

Date April.26.2013

FABRICATION WELDING PRODUCTION TEST (FWPT)

Company Name CSSC Identification# WPT-837
 Welding Process GMAW, FCAW Revision: 0 Date 20-06-12 By F.Y.Chu
 Supporting Document No. WPS-837, POR-837 Authorized by: F.L.Hsu Date: 09-10-2012

JOINT DESIGN USED

Type: T joint
 Single Double Weld

Backing: Yes No

Backing Material: -

Root Opening: 5mm Root Face Dimension: 0mm

Groove Angle: 40° Radius(J-U): -

Back Gouging: Yes No Method: -

BASE METALS

Material Specification: NVE36Z, NVF36Z

Type or Grade: -

Thickness: Groove 40mm Fillet -

Diameter (Pipe): -

FILLER METALS

AWS Specification: A5.28, A5.29

AWS Classification: TM60(ER80S-G), TWE-81K2(ER11-K2C)

DNV Grade FCAW: 4YMS(H5), 5Y46S(H5)

SHIELDING

Flux: -

Gas: GMAW: 80%Ar+20%CO2, FCAW: CO2

Composition: -

Electrode-Flux (Class) - Flow Rate: 20-25 l/min

Gas Cup Size: 20mm

PREHEAT

Preheat Temp.: Min. 124°C

Inter-pass Temp.: Min. 89°C Max. 150°C

Type: GMAW: Semi-Automatic

FCAW: Semi-Automatic

POSITION

Position of Groove: 1G Fillet: -

Vertical Progression: UP Down

ELECTRICAL CHARACTERISTICS

Transfer Mode:

GMAW: Globular FCAW: Globular

Current:

GMAW: DCEP FCAW: DCEP

Other: -

TECHNIQUE

Stringer or Weave Bead Both

Multi-pass or Single Pass (Per side): Multi-pass

Number of Electrodes: 1

Electrode Spacing Longitudinal: -

Lateral: -

Angle: -

Contact Tube to Work Distance: 12-20mm

Peening: None

Inter-pass Cleaning: Vibrating or Wire Brush or Grind

POSTWELD HEAT TREATMENT

Temperature: -

Time: -

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Joint Details (mm)
		Class	Dia.	Type & Polarity	Amps or Wire Feed Speed			
1	GMAW	TM-60	1.2mm	DCEP	14-172	23-25	170	
2	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	333	
3	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	265	
4	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	214	
5	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	209	
6	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	200	
7	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	346	
8	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	346	
9	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	310	
10	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	281	
11	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	290	
12	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	273	
13	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	237	
14	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	257	
15	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	265	
16	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	310	
17	FCAW	TWE-81K2	1.2mm	DCEP	260-285	33-34	360	

Note: heat input GMAW(DC+) = 1.2-1.6 kJ/mm; FCAW(DC+) = 1.4-2.4 kJ/mm

WELDING PRODUCTION TEST RECORD (WPT)# 837

Charpy V-notch Impact Test(-40°C)

Specimen No.	Specimen Dimension mm	Absorbed Energy(J)				
		No.1	No.2	No.3	Average	
WPT-837	Weld Metal	10x10x55	46	78	75	65
	Fusion Line	10x10x55	205	194	188	196
	HAZ(FL+2mm)	10x10x55	197	183	185	188
	HAZ(FL+5mm)	10x10x55	134	182	180	165

Metallographic Examination

Specimen	Result
WPT-837	Refer to Report no: KK-13-05705X (See Photo Page No.2 OF 3)

Hardness Test : HV10

No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15
837	178	178	178	194	209	252	235	258	249	265	236	216	176	173	132
	No.16	No.17	No.18	No.19	No.20	No.21	No.22	No.23	No.24	No.25	No.26	No.27	No.28	No.29	No.30
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

VISUAL INSPECTION

Appearance Acceptable
 Undercut None
 Piping porosity None
 Convexity None
 Test date May 31 2013
 Witnessed by F. Y. Chu

Visual Magnetic-ultrasonic examination

VT report no.: N3113/003428 Result OK
 MT report no.: N3113/003427 Result OK
 UT report no.: N3113/003426 Result OK
 MACRO-ETCH TEST RESULTS OK

Welder's name 方世忠

All-weld-metal tension test

Tensile strength, N/mm² -
 Yield point strength, N/mm² -
 Elongation in 2 in., % -
 Laboratory test no. -

Clock no. - Stamp no. -

Tests conducted by SGS Laboratory -

Test number WPT-837

Per -

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of DNV-OS-C401 (2010) Structural Welding Code-Steel.
 (year)

Signed F. Y. Chu

Manufacturer or Contractor

By F. Y. Chu

Title FAB Supervisor

Date Jun 20 2013

銲接預熱標準

鋼板材質：NVA36 NVD36 NVD36Zor NVE36Zor NVF36Z

鋼板厚度 39-65mm(65°C 以上)

> 65mm(110°C 以上)

註：厚薄板接頭以厚板為主並以溫度筆量測。



銲接預熱照 6

鑽油塔架結構工程

銲藥烘乾管制表



產品編號/鋼板材質	烘乾溫度 (保存溫度)	銲藥種類
TF-565 / TF-210 AWS F7A2/F7A8 NVA36 or NVD36Z/ NVE36Zor NVF36Z	260°C / 1 時 (120°C 以上)	燒結型



銲藥烘乾照片 7

鑽油塔架結構工程
鐸條烘乾管制表

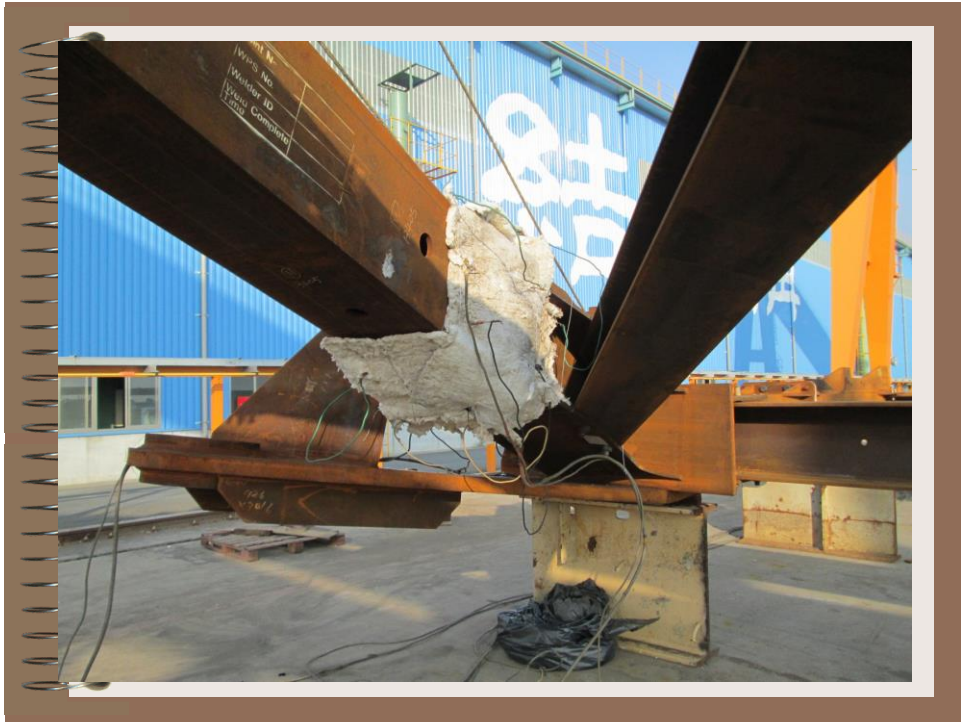
產品編號/鋼板材質	烘乾溫度 (保存溫度)	鐸條種類
TL-50 (AWS E7016)/ NVD36Zor NVE36Zor NVF36Z	260~430°C / 2時 (120°C 以上)	低氫系鐸條

鐸條烘乾照片 8



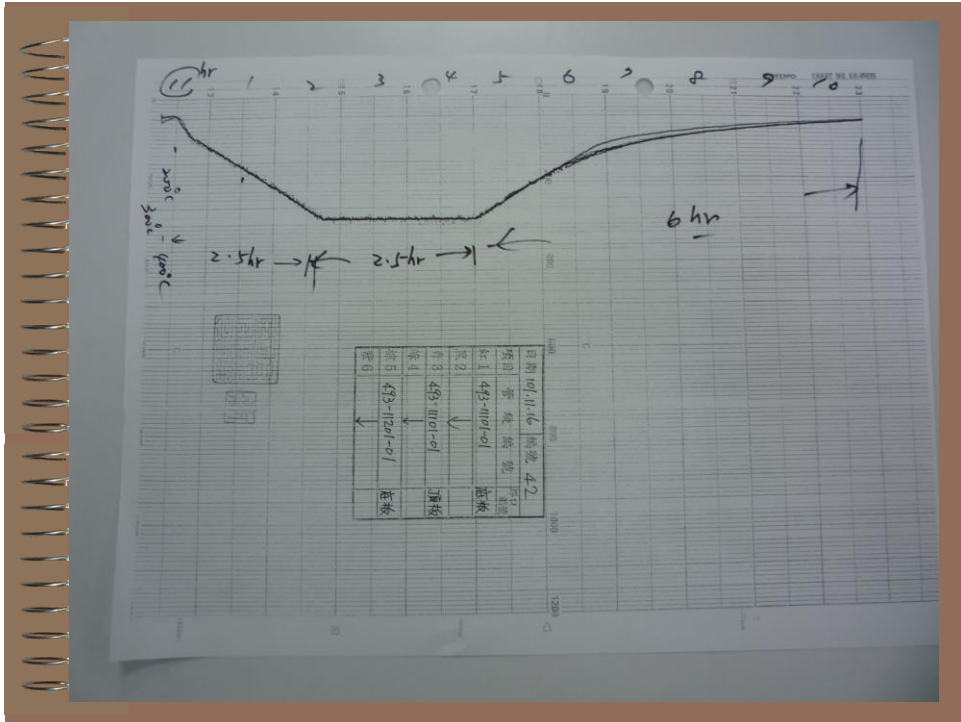
鐸後熱應力消除照片 9



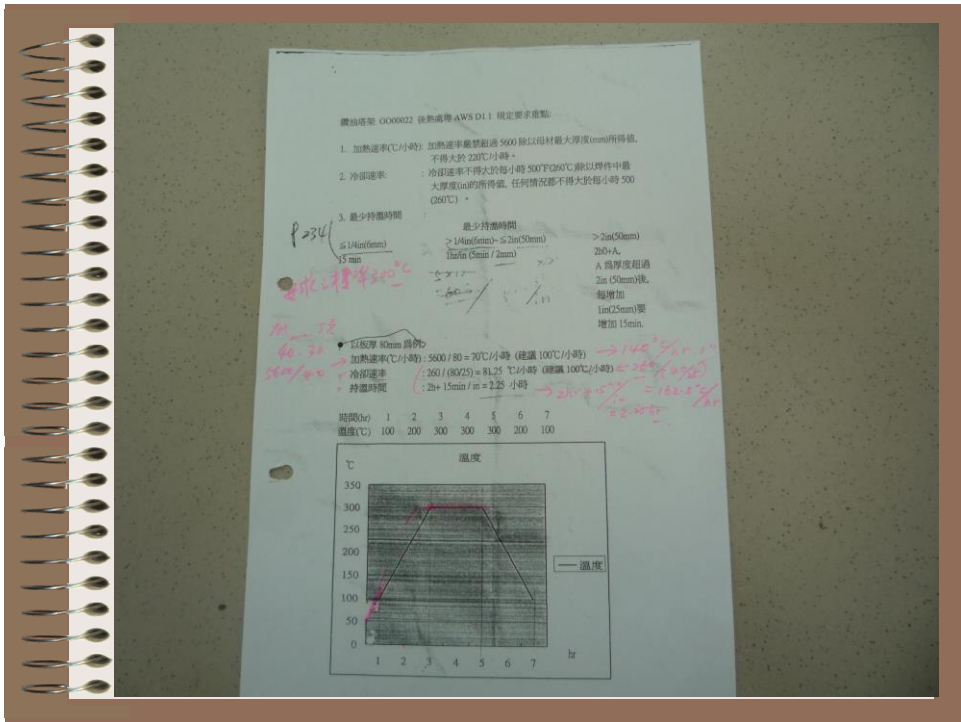
銲後熱應力消除照片 10



銲後熱應力消除照片 11



銲後熱應力消除實測曲線圖



銲後熱應力消除 AWS D1.1 曲線圖

DUAL DERRICK STEEL STRUCTURE PPROJECT

(Welding Procedure Qualification Test Plan)

1. Welding process & Test Assembly

WPS NO.	Welding Process	Material Specification		Test Assembly (mm)		Joint
		Base Metal	Welding Rod(mm)	Base Metal	Backing	
pWPS - 785	FCAW , SAW	NVD36Z	TWE-711 TSW-12KM × TF565 (Tien Tai) 1.2*20KG + 4.8*350KG	35*400*400 1 pec(No G.) 35*200*400 1 pec(G 30°)	Ceramic	Corner joint (Single bevel type Groove CP)
pWPS - 787	FCAW , SAW	NVD36Z	TWE-711 TSW-12KM × TF565 (Tien Tai) 1.2*20KG + 4.8*350KG	35*400*400 1 pec(No G.) 35*200*400 1 pec(G 60°)	-	Corner joint (Single bevel type Groove PP)
pWPS - 789	FCAW , SAW	NVD36Z	TWE-711 TSW-12KM × TF565 (Tien Tai) 4.8*350KG	35*200*1000 2 pec(No G.)	-	T joint (Tack Weld+Fillet Weld)
Pwps -791	FCAW	NVD36Z	TWE-711 (Tien Tai) 1.2*20KG	35*200*600 2 pec(G 30°)	Ceramic	Butt joint (V type Groove CP)
pWPS -795	SAW	NVD36Z	TSW-12KM × TF565 (Tien Tai) 4.8*350KG	35*200*1000 2 pec(G 30°) root : 3-5mm	-	Butt joint (V type Groove CP)
pWPS -801	SMAW , FCAW	NVD36Z	TL-50 TWE-711 (Tien Tai) 1.2*20KG	35*200*400 2 pec(No G.)	-	T joint (Tack Weld+Fillet Weld)
pWPS -803	FCAW	NVD36Z	TWE-711 (Tien Tai) 1.2*20KG	35*200*600 1 pec(No G.) 35*200*600 1 pec(G 45°)	-	Butt joint (K type Groove CP)

二. Date of Qualification

Date	WPS No.	Descriptions of Testing	
100.12.26 (一)	pWPS-785	1. Visual Test 2. Radiographic or Ultrasonic Test 3. Impact Test (weld metal , fusion line HAZ 2mm , HAZ 5mm) -20°C (36J) each 1 pec. 4. Macro/Hardness test each 1 pec	1. All welded assembly shall be evaluated by visual inspection before testing 2. Code: DNV-OS-C401 ISO-5817 ISO-6507-1
100.12.27 (二)	pWPS-787	1. Visual Test 2. PT or MT 4. Macro/Hardness test each 1 pec	"
100.12.27 (二)	pWPS-789	1. Visual Test 2. PT or MT 3. Macro/Hardness test each 1 pec	"
101.1.2 (一)	pWPS-791	1. Visual Test 2. Radiographic or Ultrasonic Test 3. Impact Test (weld metal , fusion line HAZ 2mm , HAZ 5mm) -20°C (36J) each 3 pecs. 4. Macro/Hardness test each 1 pec 5. Flat tensile test 1 pec 6. Side bend test 2 pecs 7. Round tesile test 1 pec	1. All welded assembly shall be evaluated by Visual inspection before testing 2. Code: DNV-OS-C401 ISO-5817 ISO-6507-1
101.1.2 (一)	pWPS-795	1. Visual Test 2. Radiographic or Ultrasonic Test 3. Impact Test (weld metal , fusion line HAZ 2mm , HAZ 5mm) -20°C (36J) each 3 pecs. 4. Macro/Hardness test each 1 pec 5. Flat tensile test 1 pec 6. Side bend test 2 pecs 7. Round tesile test 1 pec	"
101.1.3 (二)	pWPS-801	1. Visual Test 2. PT or MT 3. Macro/Hardness test each 1 pec	"
100.1.3 (二)	pWPS-803	1. Visual Test 2. Radiographic or Ultrasonic Test 3. Impact Test (weld metal , fusion line HAZ 2mm , HAZ 5mm) -20°C (36J) each 3 pecs. 4. Macro/Hardness test each 1 pec 5. Flat tensile test 1 pec 6. Side bend test 2 pecs 7. Round tesile test 1 pec	"

三. Place of Qualification: China Steel Structure(Kaohsiung Plant)。

四. Agency of Testing: SGS Taiwan Ltd.(Kaohsiung City)。

銲接程序檢定試驗計劃(表四)

DUAL DERRICK STEEL STRUCTURE PPROJECT
(Welding Procedure Qualification Test Plan)

一. Welding process & Test Assembly

WPS NO.	Welding Process	Material Specification		Test Assembly (mm)		Joint
		Base Metal	Welding Rod (mm)	Base Metal	Backing	
pWPS-787-1	FCAW , SAW	NVD36Z	TWE-711 TSW-12KM × TF565 (Tien Tai) 1.2*20KG , 4.8*350KG	35*400*400 1 pec(No G.) 35*200*400 1 pec(G 30°)	Ceramic	Corner joint (Single bevel type Groove PP)
pWPS-793	FCAW	NVD36Z	TWE-711 (Tien Tai) 1.2*20KG	35*400*400 1 pec(No G.) 35*200*400 1 pec(G 30°)	Ceramic	T joint (Single bevel type Groove CP)
pWPS-791-1	FCAW	NVD36Z	TWE-711 (Tien Tai) 1.2*20KG	35*200*600 2 pec(G 30°)	Ceramic	Butt joint (V type Groove CP)

二. Date of Qualification

Date	WPS No.	Descriptions of Testing	
101.2.8 (三)	pWPS-787-1	1. Visual Test 2. PT or MT 3. Macro/Hardness test each 1 pec	1. All welded assembly shall be evaluated by visual inspection before testing 2. Code : DNV-OS-C401 ISO-5817 ISO-6507-1

銲接程序檢定試驗計劃(表五)

WELDING PROCEDURE SPECIFICATION (WPS) Yes
PREQUALIFIED _____ QUALIFIED BY TESTING x
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Company Name CSSC
 Welding Process FCAW, SAW
 Supporting PQR No. PQR-785

Identification# WPS-785
 Revision : 0 Date : 2011/12/16 By F.Y.Chu
 Authorized by : Z.Y.Horng Date : 2012/02/16
 Type : Manual Semi-Automatic
 Machine Automatic

JOINT DESIGN USED

Type: _____ Corner _____
 Single Double Weld
 Backing: Yes No
 Backing Material : _____ Ceramic _____
 Root Opening: 4-6mm Root Face Dimension : 0mm
 Groove Angle: 30° Radius(J-U): _____ -
 Back Gouging: Yes No Method : _____ -

POSITION

Position of Groove: 1G Fillet : _____ -
 Vertical Progression: UP Down

BASE METALS

Material Specification : NVA36, NVD36Z
 Type or Grade : _____ -
 Thickness: Groove 18~70mm Fillet _____ -
 Diameter (Pipe) : _____ -

ELECTRICAL CHARACTERISTICS

Transfer Mode (FCAW, SAW) Short-circuiting
 Globular Spray
 Current : AC DC(+) DC(-) Pulsed
 Other: _____ -
 Tungsten Electrode (GTAW)
 Size : _____ -
 Type : _____ -

FILLER METALS

AWS Specification : A5.20, A5.17
 Trade name(Filler) : TWE-711(E71T-1), TSW-12KM(EM12K)
 DNV Grade FCAW : III YMS(H10) , SAW : III YM(H10)

TECHNIQUE

Stringer or Weave Bead : _____ Both
 Multi-pass or Single Pass (Per side) : _____ Multi-pass
 Number of Electrodes : _____ 1(FCAW), 2(SAW)
 Electrode Spacing Longitudinal : _____ -
 Lateral : _____ -
 Angle : _____ -

SHIELDING

Flux : TF-565(F7A2) Gas : CO2 , -

Contact Tube to Work Distance : 1.12-15mm 2 32-40mm
 Peening : _____ None
 Inter-pass Cleaning : Vibrating or Wire Brush or Grind

Composition : _____ -
 Electrode-Flux (Class) _____ - Flow Rate : 20-25 l/min
F7A2-EM12K Gas Cup Size : 20mm

PREHEAT 3-20mm(0°C) , 21-38mm(10°C)

Preheat Temp. : Min. 39-65mm(65°C) , >65mm(110°C)
 Inter-pass Temp. : Min. 10°C Max. 150°C

Welding Machine No. M99-6 (SAW) A33-2 (FCAW)
 Temperature : _____ N.A
 Time : _____ N.A

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Joint Details (mm)
		Class	Dia.	Type & Polarity	Amps or Wire Feed Speed			
1(side-A)	FCAW	E71T-1	1.2mm	DC+	189-232A	30-32	199-257	
2-3(side-B)	FCAW	E71T-1	1.2mm	DC+	247-273A	32-34	269-375	
4	SAW	EM12K	4.8mm	DC+	522-578A	31-33	509-591	
5-11	SAW	EM12K	4.8mm	DC+	550-680	32-34	550-650	
	SAW	EM12K	4.8mm	AC	650-740	33-40	550-650	

Note : heat input 1-3pass FCAW(DC+) = 1.2~2.2kJ/mm ; 4-11 pass SAW(DC+ , AC) = 3.3~6.1kJ/mm

WELDING PROCEDURE SPECIFICATION (WPS) Yes
PREQUALIFIED _____ QUALIFIED BY TESTING x _____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Company Name _____ CSSC
Welding Process _____ FCAW , SAW
Supporting PQR No. _____ PQR-787-1

Identification# _____ WPS-787-1
Revision : 0 Date : 2012/02/29 By F.Y.Chu
Authorized by : Z.Y.Horng Date : 2012/03/05
Type : Manual Semi-Automatic
Machine Automatic

JOINT DESIGN USED

Type: _____ Corner
Single Double Weld
Backing: Yes No
Backing Material : _____ -
Root Opening: 0 Root Face Dimension : _____ -
Groove Angle: 60 Radius(J-U): _____ -
Back Gouging: Yes No Method : _____ -

BASE METALS

Material Specification: _____ NVA36,NVD36Z
Type or Grade : _____ -
Thickness: Groove 18~70mm Fillet _____ -
Diameter (Pipe) : _____ -

FILLER METALS

AWS Specification : _____ A5.20 , A5.17
Trade name(Filler): TWE-711(E71T-1) , TSW-12KM(EM12K)
DNV Grade FCAW : III YMS(H10) , SAW : III YM(H10)

SHIELDING

Flux : TF-565(F7A2) Gas : CO2 , -

Composition : _____ -
Electrode-Flux (Class) _____ - Flow Rate : 20-25l/min
F7A2-EM12K Gas Cup Size : 20mm

PREHEAT

3-20mm(0°C) , 21-38mm(10°C)
Preheat Temp. : Min. 39-65mm(65°C) , >65mm(110°C)
Inter-pass Temp. : Min. 10°C Max. 150°C

POSITION

Position of Groove: 1G Fillet : _____ -
Vertical Progression: UP Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (FCAW , SAW) Short-circuiting
Globular Spray
Current : AC DC(+) DC(-) Pulsed
Other: _____ -
Tungsten Electrode (GTAW)
Size : _____ -
Type : _____ -

TECHNIQUE

Stringer or Weave Bead : _____ Stringer
Multi-pass or Single Pass (Per side) : _____ Multi-pass
Number of Electrodes : _____ 1(FCAW) , 2(SAW)
Electrode Spacing Longitudinal : _____ -
Lateral : _____ -
Angle : _____ -

Contact Tube to Work Distance : 1.12-15mm 2.32-40mm
Peening : _____ None
Inter-pass Cleaning : Vibrating or Wire Brush or Grind

Welding Machine No. M99-6(SAW) A33-2 (FCAW)
Temperature : _____ N.A
Time : _____ N.A

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Joint Details (mm)
		Class	Dia.	Type & Polarity	Amps or Wire Feed Speed			
1-2	FCAW	E71T-1	1.2mm	DC+	232-312	28-32	192-311	
3-6	SAW	EM12K	4.8mm	DC+	646-714	33-35	545-694	
	SAW	EM12K	4.8mm	AC	703-777	39-41	545-694	

Note : heat inputs : 1 - 2 pass FCAW(DC+) = 1.3~3.1kj/mm ; 3-6 pass SAW(DC+ , AC) = 4.2~6.3kj/mm

WELDING PROCEDURE SPECIFICATION (WPS) Yes
PREQUALIFIED _____ QUALIFIED BY TESTING _____ x
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Company Name CSSC
Welding Process (es) FCAW(Tack Weld) , SAW
Supporting PQR No.(s) PQR-789

Identification# WPS-789
Revision 0 Date 2011/12/16 By F.Y.Chu
Authorized by Z.Y.Hong Date 2012/02/16
Type-Manual Semi-Automatic
Machine Automatic

JOINT DESIGN USED

Type: T-joint
Single Double Weld
Backing: Yes No
Backing Material: -
Root Opening: 0mm Root Face Dimension -
Groove Angle: - Radius (J-U) -
Back Gouging: Yes No Method -

POSITION

Position of Groove: - Fillet: 1F
Vertical Progression: UP Down

BASE METALS

Material Spec. NVA36 , NVD36Z
Type or Grade -
Thickness: Groove - Fillet 18 ~70mm
Diameter (Pipe) -

ELECTRICAL CHARACTERISTICS

Transfer Mode (FCAW , SAW) - Short-Circuiting
Globular Spray
Current: AC DC(+) DC(-) Pulsed
Other -
Tungsten Electrode (GTAW)
Size: -
Type: -

FILLER METALS

AWS Specification A5.20 , A5.17
Trade name(Filler): TWE-711(E71T-1) , TSW-12KM(EM12K)
DNV Grade FCAW : IIIYMS(H10) , SAW : III YM(H10)

SHIELDING

Flux TF-565(F7A2) Gas -
Composition -
Electrode-Flux (Class) F7A2-EM12K Flow Rate 20-25 l/min
Gas Cup Size 20mm

PREHEAT 3-20mm(0°C) , 21-38mm(10°C)
Preheat Temp., Min 39-65mm(65°C) , > 65mm(110°C)
Interpass Temp., Min 10°C Max 150°C

TECHNIQUE

Stringer or Weave Bead: Stringer
Multi-pass or Single Pass (Per side) Single pass
Number of Electrodes 1
Electrode Spacing Longitudinal -
Lateral -
Angle -
Contact Tube to Work Distance 12-15mm , 25-32mm
Peening None
Interpass Cleaning: Slag Removed
Welding Machine No : .A33-2(FCAW) , M99-6(SAW)
Temp. N.A
Time. -

LDING PROCEDURE

Tack Weld Length : 60mm

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed (mm/min)	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			
Tack Weld 1-2	FCAW SAW	E71T-1 EM12K	1.2mm 4.8mm	DC+ DC+ AC	218-252A 760-840A 712-788A	29-32V 32-34V 32-34V	241-365 437-602 437-602	<p>Unit : mm</p>

Note : heat input 1-2pass SAW(DC+ , AC) = 4.7~7.6 kJ/mm

WELDING PROCEDURE SPECIFICATION (WPS) Yes
PREQUALIFIED _____ QUALIFIED BY TESTING _____
or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Company Name CSSC
 Welding Process FCAW, SAW
 Supporting PQR No. PQR-785

Identification# WPS-785
 Revision : 0 Date : 2012/02/06 By F.Y.Chu
 Authorized by : Z.Y.Horng Date : 2012/02/10
 Type : Manual Semi-Automatic
 Machine Automatic

JOINT DESIGN USED

Type: Corner
 Single Double Weld
 Backing: Yes No
 Backing Material : Ceramic
 Root Opening: 4mm Root Face Dimension : -
 Groove Angle: 30° Radius(J-U): -
 Back Gouging: Yes No Method : -

BASE METALS

Material Specification : NVD36Z
 Type or Grade : -
 Thickness: Groove 35mm Fillet -
 Diameter (Pipe) : -

FILLER METALS

AWS Specification : A5.20, A5.17
 Trade name(Filler) : TWE-711(E71T-1), TSW-12KM(EM12K)
 DNV Grade FCAW : III YMS(H10) , SAW : III YM(H10)

SHIELDING

Flux : TF-565(F7A2) Gas : CO2 , -

Composition : -
 Electrode-Flux (Class) - Flow Rate : 25 l/min
F7A2-EM12K Gas Cup Size : 20mm

PREHEAT

Preheat Temp. : Min. 23°C
 Inter-pass Temp. : Min. 60°C Max. 150°C

POSITION

Position of Groove: 1G Fillet : -
 Vertical Progression: UP Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW) Short-circuiting
 Globular Spray
 Current : AC DC(+) DC(-) Pulsed
 Other: -
 Tungsten Electrode (GTAW)
 Size : -
 Type : -

TECHNIQUE

Stringer or Weave Bead : Both
 Multi-pass or Single Pass (Per side) : Multi-pass
 Number of Electrodes : 1(FCAW), 2(SAW)
 Electrode Spacing Longitudinal : -
 Lateral : -
 Angle : -

Contact Tube to Work Distance : 1.12-15mm 2 40mm
 Peening : None
 Inter-pass Cleaning : Vibrating or Wire Brush or Grind

Welding Machine No. M99-6 (SAW) A33-2 (FCAW)
 Temperature : N.A
 Time : N.A

WELDING PROCEDURE

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts (V)	Travel Speed (mm/min)	Joint Details (mm)
		Class	Dia.	Type & Polarity	Amps or Wire Feed Speed			
1(side-A)	FCAW	E71T-1	1.2mm	DC+	221	31	228	
2-3(side-B)	FCAW	E71T-1	1.2mm	DC+	260	33	307-333	
4	SAW	EM12K	4.8mm	DC+	550	32	550	
5-11	SAW	EM12K	4.8mm	DC+	610-680	33-34	602-650	
				AC	650-740	34-40	602-650	

Note : heat input 1-3pass FCAW(DC+)= 1.4~1.8kj/mm ; 4-11 pass SAW(DC+ , AC)=4.7~5.2kj/mm

Procedure Qualification Record (PQR)# 785

Test Results

Charpy V-notch Impact Test(-20 ° C)

Specimen No.		Specimen Dimension mm	Absorbed Energy(J)			
			No.1	No.2	No.3	Average
pWPS-785	Weld Metal	10x10x55	24	33	32	30
	Fusion Line	10x10x55	70	56	61	62
	HAZ(FL+2mm)	10x10x55	87	150	87	108
	HAZ(FL+5mm)	10x10x55	175	172	167	171

Metallographic Examination

Specimen	Result
pWPS-785	See Photo(Page No.3 OF 6)

Hardness Test : HV10

No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15
785	169	163	179	160	173	181	199	198	196	199	186	169	163	164	163

VISUAL INSPECTION

Appearance Acceptable
 Undercut None
 Piping porosity None
 Convexity None
 Test date Dec.26.2011
 Witnessed by F. Y .Chu

Welder's name 余文章，余性輝

Radiographic-ultrasonic examination
 RT report no.: - Result -
 UT report no.: N3112/000190 Result OK

MACRO-ETCH TEST RESULTS

All-weld-metal tension test
 Tensile strength, psi -
 Yield point/strength, psi -
 Elongation in 2 in., % -
 Laboratory test no. -
 Clock no. - Stamp no. -

Tests conducted by SGS Laboratory -

Test number PQR-785

Per -

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of DNV-OS-C401 (2010) Structural Welding Code--Steel.
 (year)

Signed F. Y. Chu
 Manufacturer or Contractor

By F. Y. Chu

Title FAB Supervisor

Date Feb.09.2012

WELDING PROCEDURE SPECIFICATION (WPS) Yes

PREQUALIFIED _____ QUALIFIED BY TESTING _____

or PROCEDURE QUALIFICATION RECORDS (PQR) Yes

Company Name CSSC
Welding Process (es) FCAW(Tack Weld) , SAW
Supporting PQR No.(s) PQR-789

JOINT DESIGN USED

Type: T-joint
Single Double Weld
Backing: Yes No
Backing Material: -
Root Opening: 0mm Root Face Dimension -
Groove Angle: - Radius (J-U) -
Back Gouging: Yes No Method -

BASE METALS

Material Spec. NVD36Z
Type or Grade -
Thickness: Groove - Fillet 35mm
Diameter (Pipe) -

FILLER METALS

AWS Specification A5.20 , A5.17
Trade name(Filler): TWE-711(E71T-1) , TSW-12KM(EM12K)
DNV Grade FCAW : IIIYMS(H10) , SAW : III YM(H10)

SHIELDING

Flux TF-565(F7A2) Gas -
Composition -
Electrode-Flux (Class) F7A2-EM12K Flow Rate 20-25 l/min
Gas Cup Size 20mm

PREHEAT

Preheat Temp., Min 20°C
Interpass Temp., Min 10°C Max 150°C

Identification# WPS-789
Revision 0 Date 2012/02/06 By F.Y.Chu
Authorized by Z.Y.Hong Date 2012/02/10
Type-Manual Semi-Automatic
Machine Automatic

POSITION

Position of Groove: - Fillet: 1F
Vertical Progression: UP Down

ELECTRICAL CHARACTERISTICS

Transfer Mode (GMAW) Short-Circuiting
Globular Spray
Current: AC DC(+) DC(-) Pulsed
Other _____
Tungsten Electrode (GTAW)
Size: -
Type: -

TECHNIQUE

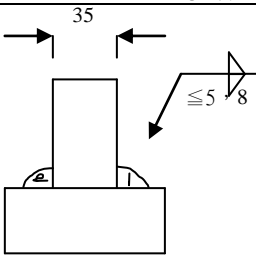
Stringer or Weave Bead: Stringer
Multi-pass or Single Pass (Per side) Single pass
Number of Electrodes 1
Electrode Spacing Longitudinal -
Lateral -
Angle -

Contact Tube to Work Distance 12-15mm , 40-50mm
Peening None
Interpass Cleaning: Slag Removed

Welding Machine No : .A33-2(FCAW) , M99-6(SAW)
Temp. N.A
Time. -

WELDING PROCEDURE

Tack Weld Length : 60mm

Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed (mm/min)	Joint Details Unit : mm
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			
1 1-2	FCAW SAW	E71T-1 EM12K	1.2mm 4.8mm	DC+ DC+ AC	230-240A 800A 750A	30-31V 33V 33V	275-325 472-560 472-560	

Note : heat input 1-2pass SAW(DC+ , AC) = 5.2~6.1 kJ/mm

Procedure Qualification Record (PQR)# 789

Test Results

Charpy V-notch Impact Test(-20 ° C)

Specimen No.	Specimen Dimension mm	Absorbed Energy(J)				
		No.1	No.2	No.3	Average	
pWPS-789	Weld Metal	10x10x55	-	-	-	-
	Fusion Line	10x10x55	-	-	-	-
	HAZ(FL+2mm)	10x10x55	-	-	-	-
	HAZ(FL+5mm)	10x10x55	-	-	-	-

Metallographic Examination

Specimen	Result
pWPS-789	See Photo(Page No.4 OF 6)

Hardness Test : HV10

No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15
789	152	154	161	172	182	198	211	209	212	217	217	194	174	170	168
No.	No.16	No.17	No.18	No.19	No.20	No.21	No.22	No.23	No.24	No.25	No.26	No.27	No.28	No.29	No.30
789	161	161	164	181	188	203	214	214	206	207	193	179	166	165	168

VISUAL INSPECTION

Appearance Acceptable

Undercut None

Piping porosity None

Convexity None

Test date Dec.28.2011

Witnessed by F . Y .Chu

Welder's name 余文章，余性輝

Radiographic-ultrasonic examination

RT report no.: _____ - _____ Result _____ - _____

MT report no.: N3112/000119 Result OK

MACRO-ETCH TEST RESULTS

All-weld-metal tension test

Tensile strength, psi _____ - _____

Yield point/strength, psi _____ - _____

Elongation in 2 in., % _____ - _____

Laboratory test no. _____ - _____

Clock no. _____ - _____ Stamp no. _____ - _____

Tests conducted by SGS Laboratory _____ - _____

Test number PQR-789

Per _____ - _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of DNV-OS-C401 (2010) Structural Welding Code--Steel.

(year)

Signed F. Y. Chu

Manufacturer or Contractor

By F. Y. Chu

Title FAB Supervisor

Date Feb.09.2012

Procedure Qualification Record (PQR)# 787-1

Test Results

Charpy V-notch Impact Test(-20 ° C)

Specimen No.		Specimen Dimension mm	Absorbed Energy(J)			
			No.1	No.2	No.3	Average
pWPS-787-1	Weld Metal	10×10×55	-	-	-	-
	Fusion Line	10×10×55	-	-	-	-
	HAZ(FL+2mm)	10×10×55	-	-	-	-
	HAZ(FL+5mm)	10×10×55	-	-	-	-

Metallographic Examination

Specimen	Result
pWPS-787-1	See Photo(Page No.3 OF 6)

Hardness Test : HV10

No.	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15
787-1	152	156	162	180	177	188	205	203	204	199	178	177	178	175	173

VISUAL INSPECTION

Appearance Acceptable
 Undercut None
 Piping porosity None
 Convexity None
 Test date Feb.08.2012
 Witnessed by F . Y .Chu
 Welder's name 李正忠，余文章

Visual-Magnetic examination
 VT report no.: N3112/001053 Result OK
 MT report no.: N3112/001052 Result OK
MACRO-ETCH TEST RESULTS OK
 All-weld-metal tension test
 Tensile strength, psi -
 Yield point/strength, psi -
 Elongation in 2 in., % -
 Laboratory test no. -
 Clock no. - Stamp no. -

Tests conducted by SGS Laboratory -

Test number PQR-787-1

Per -

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of DNV-OS-C401 (2010) Structural Welding Code--Steel.
(year)

Signed F. Y. Chu

Manufacturer or Contractor

By F. Y. Chu

Title FAB Supervisor

Date Mar.20.2012

WPS & PQR-785 , 787-1 , 789(表六~表八)