BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1001	Date: 06.11.93	Supporting PQR No.:	007	
Rev. No.:	00	Date: ---			
Welding Process: SMAW		Type:	Manual		
			(Auto-Semi-Auto-Manual-Machine)		
Application: Butt-welding of P1 Gr. 1 & Gr.2 tubes without preheat and without PWHT.					

JOINTS (QW-402)

Joint Design	: Groove as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: -- do –
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 1	Group No.: 1 or 2	TO	P. No.: 1	Group No.: 1 or 2

Spec. Type & Grade: N.A.

Chem. Analysis & Mech. Prop.: N.A.

Thickness Range

Base Metal:	Groove: 1.6 to 9.0	Fillet:	N.A.
Weld Metal:	Groove: E6013; 5.0 max. : E7018; Balance		
	Fillet: N.A.		
Pipe dia.:	Groove: Unlimited		
	Fillet: N.A.		

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E6013 + E7018		
Specn. No. (SFA):	5.1	Size of filler metal: See Table	
F. No.:	2,4	Flux Trade Name: N.A.	
A. No.: 1		Consumable insert: N.A.	
		Electrode |Flux (Class): NA.	

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	N.A.
Weld Progression: (Up/Down)	Vertical up

PREHEAT (QW-406)

Preheat temp. (min.):	Nil (min. 10^0C)
Inter pass temp. (max.):	300^0C
Post heat maintenance:	Nil
Others:	Nil

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1001**

PWHT (QW-407)		**GAS (QW-408)**			
			Gases	**Mix.%**	**Flow Rt.**
Temp. Range:	Nil	Shielding	N.A.	---	---
Time Range:	Nil	Trailing	N.A	---	---
Others:	Nil	Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See Table	Polarity: See Table
Amps. (Range): -- do --	Volts: -- do –
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root & 2G: String; Others: String/Weave (3dia max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	**Filler**		**Current**		**Amps.**	**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
	Process	**Class**	**Dia.**	**Type**				
Root	SMAW	E6013	2.5	DCEP	70-130	N.A.	N.A.	Nil
Others	SMAW	E7018	2.5	DECP	70-100	N.A.	N.A.	Nil
- Do -	- Do -	- Do -	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by: (V. Ravindran)
Manager/WTC
Date: 06-11-93

Prepared by: (D.N. Ravishankar)
S.W.E./WTC
Date: 06-11-93

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1228 Date: 15.12.06 Supporting PQR No: 1258

Rev. No :00 Date: ------

Welding Process: FCAW (CO_2) Type: Semi Automatic

(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of IS2062 carbon steel structure up to 50 mm thickness without PWHT. (AS PER AWS D1.1, SIP: NP: 07/01. QCP: 002/02).

JOINTS (QW-402)

Joint Design : Groove / Fillet as per drawing.

Backing (Yes/No) : As per drawing.

Backing Material (type) : Metal

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: -- Group No: -- to P. No: -- Group No: --

Spec. Type & Grade : IS 2062

Chem. Analysis & Mech. Prop : --

Thickness Range :-

Groove: 3.0 mm – 50 mm Fillet: Unlimited.

Pipe dia range: Groove: --- Fillet: ---

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 71T-1 Size of filler metal: Refer table

Specn. No. (SFA): 5.20 Flux Trade Names: N.A

F. No.: 6 Consumable insert: N.A

A. No.: 1 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range: -

Groove: 3.0mm-50mm

Fillet: 3.0mm-50mm

Others:Nil

POSITION (QW-405)

Position of Groove: Flat

Position of fillet: Flat

Weld Progression: N.A.

Others: Nil

PREHEAT (QW-406)

Preheat temp (min):Thickness,T $\leq$38:Nil

38<T $\leq$ 63: 100^{O}c

T> 63: 150^{o}C

Inter pass temp. (Max.): 300^{O}C

Preheat : Nil

Others: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1228**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	CO_2	100%	16-24 LPM
Trailing	Nil	---	----
Backing	Nil	---	----

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): DC	Polarity: EP
Amps. (Range): 180-220	Volts : 26-28
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	Globular
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave
Orifice or Gas cup size:	Max. 3 times dia.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Air arc gouging / grinding for second side welding
Oscillation:	16/18
Contact tube to work distance:	8-15 mm
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Travel speed Range	N.A.
Peening:	N.A.
Others:	Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
All	FCAW	E71T-1	1.6	DCEP	180-220	26-28	N.A.	Nil

Prepared by:	Reviewed by:	Approved by:
(Kinkar P Narzary)	(Dr.K.P.Dhandapani)	(B.Natarajan)
Welding Engineer / WTC	DGM / WTC & WCMC	SDGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1227	Date: 17.11.06	Supporting PQR No: 1332
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of A588 Gr A components with PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: As per production drawing.
Backing Material (type)	: Nil
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: Nil Group No: Nil to P. No: Nil Group No: Nil

Spec. Type & Grade	: A 588 Gr A or equivalent S3 material.	
Chem. Analysis & Mech. Prop	: Nil.	
Thickness Range	**:-**	
	Groove: 5.00 to 32 mm	Fillet: Unlimited.
Pipe dia range: Others: Nil	Groove: Unlimited.	Fillet: Unlimited.

FILLER METALS (QW-404)

AWS No. (Class):	E 8018-B2	Size of filler metal:	Refer table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	Nil
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 32 mm maximum (4 mm maximum per pass)

Fillet: Unlimited. (4 mm maximum per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Post heat :	N.A
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1227**

PWHT (QW-407)

Temp. Range:	655± 15°C
Time Range	2.5 min / mm (Minimum 30 minutes.)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	N.A.	N.A.
Trailing	N.A.	N.A.	N.A.
Backing	N.A.	N.A.	N.A.

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table	Polarity: Refer table
Amps. (Range): Refer table	Volts : Refer table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave (3 dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Back grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
Root	SMAW	E 8018-B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
1 to 2 & Back side	SMAW	E 8018-B2	3.15	DCEP	100-130	N.A.	N.A.	Nil
Further	SMAW	E 8018-B2	4.0	DCEP	140-180	N.A.	N.A.	Nil

Prepared by:	Reviewed by:	Approved by:
(Kinkar P Narzary)	(Dr.K.P.Dhandapani)	(B.Natarajan)
Welding Engineer / WTC	DGM / WTC & WCMC	SDGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1226	Date: 17.11.06	Supporting PQR No: 1331
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of A588 Gr A components with out PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: As per production drawing.
Backing Material (type)	: Nil
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: Nil Group No: Nil to P. No: Nil Group No: Nil

Spec. Type & Grade	: A 588 Gr A or equivalent S3 material.	
Chem. Analysis & Mech. Prop	: Nil.	
Thickness Range	**:-**	
	Groove: 5.00 to 16 mm	Fillet: Unlimited.
Pipe dia range: Others: Nil	Groove: Unlimited.	Fillet: Unlimited.

FILLER METALS (QW-404)

AWS No. (Class):	E 8018-B2	Size of filler metal:	Refer table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	Nil
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 16mm maximum (4 mm maximum per pass)

Fillet: 13mm maximum (4 mm maximum per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Post heat :	N.A
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1226**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	N.A.	N.A.
Trailing	N.A.	N.A.	N.A.
Backing	N.A.	N.A.	N.A.

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table	Polarity: Refer table
Amps. (Range): Refer table	Volts : Refer table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

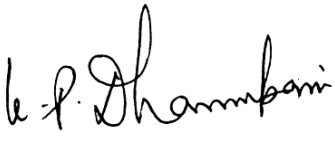
TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave (3 dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Back grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
Root	SMAW	E 8018-B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
1 to 2 & Back side	SMAW	E 8018-B2	3.15	DCEP	100-130	N.A.	N.A.	Nil
Further	SMAW	E 8018-B2	4.0	DCEP	140-180	N.A.	N.A.	Nil

Prepared by: Reviewed by: Approved by:

(Kinkar P Narzary)
Welding Engineer / WTC



(Dr.K.P.Dhandapani)
DGM / WTC & WCMC

(B.Natarajan)
SDGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1225	Date: 04.05.06	Supporting PQR No: 292
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of IS 2062 attachments to SS attachments without Preheat and PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per drg.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: --- Group No: -- to P. No: 8 Group No: 1

Spec. Type & Grade : IS 2062 + Stainless Steel (18Cr –8Ni)

Chem. Analysis & Mech. Prop : N.A.

Thickness Range :-

Groove: 4.5 to 20.0 mm Fillet: Unlimited.

Pipe dia range: Groove: Unlimited. Fillet: Unlimited.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 309	Size of filler metal:	See table
Specn. No. (SFA):	5.4	Flux Trade Names:	N.A
F. No.:	5	Consumable insert:	N.A.
A. No.:	8	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 20.00 max (Maximum 8 mm per pass)

Fillet: Unlimited (Maximum 8 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : Nil

Inter pass temp. (Max.): 350^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1225**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Not required	----	----
Trailing	Not required	----	---
Backing	Not required	----	-----

ELECTRICAL CHARACTERISTICS (QW-409)

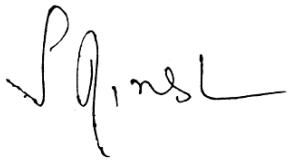
Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts : See table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
All	SMAW	E 309	2.5	DCEP	70-100	N.A.	N.A.	Nil
All	SMAW	E 309	3.15	DCEP	90-130	N.A.	N.A.	Nil
All	SMAW	E 309	4.0	DCEP	120-160	N.A.	N.A.	Nil

Approved by:



(S.Ramesh)
SDGM/WTC & WCMC

Prepared by:

(Dr.K.P.Dhandapani)
DGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1224	Date: 27.04.06	Supporting PQR No: 814, 819
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding butt joints of Galvanized Iron Pipes.		

JOINTS (QW-402)

Joint Design	: Groove as per Drg.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: Nil Group No: Nil to P. No: Nil Group No: Nil

Spec. Type & Grade : IS 3586 and equivalent Carbon content $\leq$ 0.25%

Chem. Analysis & Mech. Prop : Galvanized pipes

Thickness Range :-

Groove: 5.0 to 12 mm Fillet: N.A.

Pipe dia range: Groove: Unlimited. Fillet: N.A.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 12 mm (6 mm per pass max.)

Fillet: 12 mm (6 mm per pas max.)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : Nil

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1224**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	----	
Trailing	N.A.	----	
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): See table Volts : See table
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String or weave (3 dia. max)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: initial grinding of Galvanic coating at the joint / Chipping & Brushing of slags.
Method of back Gouging: N.A.
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil
Others: Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
All	SMAW	E 7018	3.15	DCEP	100-140	N.A.	N.A.	N.A.
All	SMAW	E 7018	4.0	DCEP	140-190	N.A.	N.A.	N.A.
All	SMAW	E 7018	5.0	DCEP	160-210	N.A.	N.A.	N.A.

Approved by:

(S.Ramesh)
SDGM/WTC

Prepared by:

(Dr.K.P.Dhandapani)
DGM / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1223 Date: 25.10.2004 Supporting PQR No: 1121

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of IS8500 Fe 540 Structural components like Ceiling girders / Columns / Built up Beams etc.

JOINTS (QW-402)

Joint Design	: As per production Drg.
Backing (Yes/No)	: As per production Drg.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: Nil Group No: Nil to P. No: Nil Group No: Nil

Spec. Type & Grade : IS 8500 Fe 540 or equivalent

Chem. Analysis & Mech. Prop : Nil.

Thickness Range :-

Groove: 10 to 200 mm Fillet: Unlimited.

Pipe dia range: Groove: Unlimited. Fillet: Unlimited.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 8018-B2	Size of filler metal:	Refer table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 200mm maximum (maximum 5 mm per pass)

Fillet: Unlimited (maximum 5 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : 150^{o}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1223**

PWHT (QW-407)

Temp. Range:	600 –650^{O}c
Time Range	2.5minutes/mm (minimum 120 minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	----	
Trailing	N.A.	----	
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table	Polarity: Refer table
Amps. (Range): Refer table	Volts : Refer table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String or weave (3 dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Air arc gouging / grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	N.A.
Others:	Nil

Weld Layer	Filler		Current		Amps.	Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
	Process	Class	dia.	Type				
Root	SMAW	E8018B2	3.15	DCEP	100-130	N.A.	N.A.	N.A.
Others	SMAW	E8018B2	4.0	DCEP	140-180	N.A.	N.A.	N.A.
Others	SMAW	E8018B2	5.0	DCEP	170-220	N.A.	N.A.	N.A.

Approved by:

(S.Chellaiah)
AGM/WTC/WCMC/TE

Prepared by:

(R.Rajanarayanan)
DM/ WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1220	Date: 19.07.01	Supporting PQR No: 1191
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Fillet welding of AISI 430 components with Preheat & without PWHT.		

JOINTS (QW-402)

Joint Design	: As per drawing.
Backing (Yes/No)	: As per drawing.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 7	Group No: 2	to	P. No: 7	Group No: 2

Spec. Type & Grade : AISI 430 or equivalent.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

	Groove: N.A.	Fillet: 6.0 mm maximum
Pipe Dia. range:	Groove: N.A.	Fillet: 100 mm maximum

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 309	Size of filler metal:	See table
Specn. No. (SFA):	5.4	Flux Trade Names:	N.A
F. No.:	5	Consumable insert:	Nil
A. No.:	8	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: N.A.

Fillet: 6mm maximum (maximum 3 mm per pass)

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	200^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1220**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.		
Trailing	N.A		
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts : N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	N.A.
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 309	2.5	DCEP	70-90	N.A.	N.A.	Nil
All	SMAW	E 310	3.15	DCEP	80-120	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
DGM / WTC

Prepared by:

(R.Rajanarayanan)
Sr.Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1219 Date: 19.07.01 Supporting PQR No: 1043

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of SA 240 Type 310S components without Preheat & without PWHT.

JOINTS (QW-402)

Joint Design : As per drawing.

Backing (Yes/No) : As per drawing.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 8 Group No: 2 to P. No: 8 Group No: 2

Spec. Type & Grade : SA 240 Type 310S or equivalent

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 4.8 mm to 20.0 mm Fillet: Unlimited.

Pipe Dia range: Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 310 Size of filler metal: See table

Specn. No. (SFA): 5.4 Flux Trade Names: N.A

F. No.: 5 Consumable insert: Nil.

A. No.: 8 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: 20.0 mm max. (Max. 4 mm per pass)

Fillet: Unlimited (Max.4 mm per pass)

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : Nil (10^{O}c Min)

Inter pass temp. (Max.): 250^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1219**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A		
Trailing	N.A.		
Backing	N.A..		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts : N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Nil
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 310	2.5	DCEP	70-90	N.A.	N.A.	Nil
All	SMAW	E 310	3.15	DCEP	90-120	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
DGM / WTC

Prepared by:

(R.Rajanarayanan)
Sr. Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1218	Date: 18.07.01	Supporting PQR No: 636
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual
		(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of A 588 Gr A components.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: As per production drg.
Backing Material (type)	: Nil
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: Nil Group No: Nil to P. No: Nil Group No: Nil

Spec. Type & Grade : A 588 Gr A or equivalent

Chem. Analysis & Mech. Prop : Nil.

Thickness Range

	Groove: 1.6 to 6	Fillet: Unlimited.
Pipe Dia. range: Others: Nil	Groove: Unlimited.	Fillet: Unlimited.

FILLER METALS (QW-404)

AWS No. (Class):	E 8018-B2	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 6mm maximum (maximum 3 mm per pass)

Fillet: 6mm maximum (maximum 3 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : Nil (10^{O}c Min)

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1218**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): -do-	Volts : -do-
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave (3 Dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Back grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	Nil.
Peening:	N.A.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 8018-B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	-do-	100-130	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
DGM / WTC

Prepared by:

(R.Rajanarayanan)
Sr.Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1217 Date: 14.07.01 Supporting PQR No: 984

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of SA 240 Type 304 Stainless Steel components without Preheat & without PWHT.

JOINTS (QW-402)

Joint Design : As per drawing

Backing (Yes/No) : As per drawing.

Backing Material (type) : Metal

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 8 Group No: 1 to P. No: 8 Group No: 1

Spec. Type & Grade : SA 240 Type 304 or equivalent.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 3.0 mm to 12.0 mm Fillet: Unlimited.

Pipe Dia. range: Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 308 Size of filler metal: See table

Specn. No. (SFA): 5.4 Flux Trade Names: N.A

F. No.: 5 Consumable insert: N.A.

A. No.: 8 Electrode |Flux (Class): N.A.

Deposited weld metal thickness

Groove: 12.0 mm max (Max. 5mm per pass)

Fillet: Unlimited (Max.5mm per pass)

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : Nil (10^{O}c min)

Inter pass temp. (Max.): 250^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A		
Trailing	N.A.		
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Nil
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 308	3.15	DCEP	90-120	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
DGM / WTC

Prepared by:

(R.Rajanarayanan)
Sr.. Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1216	Date: 29.03.00	Supporting PQR No: 529
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of 1Cr .5Mo/ 1.25Cr 0.5Mo Steel attachment to 2.25Cr 1Mo Steel attachment.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: As per production drg.
Backing Material (type)	: As per production drg.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 4 Group No: 1 to P. No: 5A Group No: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

	Groove: 9.00 mm	Fillet: Unlimited.
Pipe Dia. range:	Groove: Unlimited.	Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 8018-B2	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 10.0 mm (Maximum 8 mm per pass)

Fillet: 10.0 mm (Maximum 6.0 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1216**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave (3 Dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Air arc gauging /Grinding for second side welding
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	Nil.
Peening:	N.A.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 8018B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

(P.Sivasubramanian)
Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1215	Date: 11.10.97	Supporting PQR No: 790 & 547
Rev. No :01	Date: 04.04.06	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of 2.25Cr1Mo Steels attachments for non-pressure parts & Non Load Carrying applications with pre heat and without PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per drg.
Backing (Yes/No)	: With or without.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 5A Group No: 1 to P. No: 5A Group No: 1

Spec. Type & Grade	: N.A.
Chem. Analysis & Mech. Prop	: N.A.
Thickness Range	**:-**
	Groove: 3.0 to 10 mm Fillet: Unlimited.
Pipe Dia. range:	Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018 B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): ---do-- Volts : --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root& H String; Others: string or Weave (3 Dia. max)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gouging /Grinding for second side welding

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

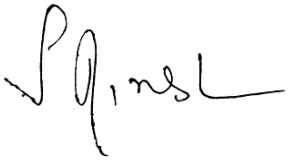
Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E 9018-B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
Others	-Do-	--Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil

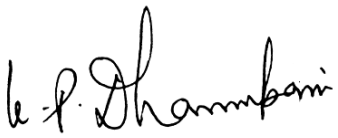
Approved by:



(S.Ramesh)

SDGM/ WTC & WCMC

Prepared by:



(Dr.K.P.Dhandapani)

DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1214	Date: 11.10.97	Supporting PQR No: 685
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual
		(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of 2.25Cr1Mo Steels to carbon Steels with Preheat & without PWHT for Non- Pressure part applications only.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: With or without.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 5A Group No: 1 to P. No: 1/IS 2062 Group No: 1 or 2

Spec. Type & Grade : P5A + P1 / IS 2062 or equivalent.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

	Groove: 3.0 to 10.0 mm	Fillet: Unlimited.
Pipe Dia. range:	Groove: Unlimited.	Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018 B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 10.0 mm (Maximum 8 mm per pass)

Fillet : 10.0 mm (Maximum 8 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: string or weave (3 Dia. max)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging: is	Air arc gauging /Grinding (where second side welding done)
Oscillation:	N.A.
Contact tube to work distance:	N.A.
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E 9018B3	2.50	DCEP	80-100	N.A.	N.A.	Nil
Others	SMAW	E9018B3	3.15	DCEP	100-140	N.A.	N.A.	Nil
Others	SMAW	E9018B3	4.00	DCEP	140-180	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

(R.Rajanarayanan)
Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1213 Date: 06.10.97 Supporting PQR No: 272, 517 & 700

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of Carbon Steel attachments to Carbon steel attachments without PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drg.
Backing (Yes/No)	: With or without.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 1 Group No: 1or 2 to P. No: 1 IS 2062 Group No: 1 or 2/--

Spec. Type & Grade : P1 + P1 / IS 2062

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 4.8 to 38.0 mm Fillet: Unlimited.

Pipe Dia. range: Groove: Unlimited. Fillet: Unlimited.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E7018		
Specn. No. (SFA):	5.1	Size of filler metal:	See table
F. No.:	4	Flux Trade Names:	N.A
A. No.:	1	Consumable insert:	N.A.
		Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 38.0 mm (maximum 8 mm per pass)

Fillet: 38.0 mm (Maximum 8 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : Up to 25 mm: Nil
(Min. 10^{o}C)
Above 25: 150^{o}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1213**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts : N.A.

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String; Others: String or weave (3 Dia. max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gauging/Grinding (where second side welding is done)

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 7018	2.5	DCEP	60-90	N.A.	N.A.	Nil
All	SMAW	E 7018	3.15	DCEP	100-140	N.A.	N.A.	Nil
All	SMAW	E 7018	4.00	DCEP	140-180	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

(R.Rajanarayanan)
Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1212 Date: 20.08.97 Supporting PQR No: 1054

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove & fillet welding of 2 ¼ Cr 1 Mo steel attachments to Stainless steel attachments and non pressure part applications with preheat and without PWHT.

JOINTS (QW-402)

Joint Design : Groove / Fillet as per production drg.

Backing (Yes/No) : With or without.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 5A Group No: 1 to P. No: 8 Group No: 1 or 2

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 3.0 to 10.0 mm Fillet: Unlimited.

Pipe Dia. range: Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 309

Specn. No. (SFA): 5.4 Size of filler metal: See table

F. No.: 5 Flux Trade Names: N.A

A. No.: 8 Consumable insert: N.A.

Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: 10.0 mm maximum (maximum 6.0 mm per pass)

Fillet: 10.0 mm maximum (maximum 6.0 mm per pass)

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : 150^{o}C (on P5A side only)

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1212**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	--

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts : N.A.

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Grinding for second side welding.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E 309	2.5	DCEP	60-90	N.A.	N.A.	Nil
Other layers	SMAW	E 309	3.15	DCEP	70-110	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

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Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1211	Date: 26.07.97	Supporting PQR No: 526
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual
		(Auto,Semi-Auto,Manual,Machine)

Application: Groove / Fillet welding pf CS Compounds. To 2 ¼ Cr 1Mo Steel for Non-Pr. Parts and Non IBR items with Preheat and PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drawing.
Backing (Yes/No)	: With or with out.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 1 Group No: 1 or 2 to P. No: 5A Group No: 1

Spec. Type & Grade : Carbon Steel to 2 ¼ Cr1Mo Steels

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 4.8 – 46.0 mm Fillet: Unlimited.

Pipe Dia. range: Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	Nil.

Deposited weld metal thickness range

Groove: 46.0 m max. (Max.6 mm per pass)

Fillet: Unlimited (Max . 6 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	350^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1211**

PWHT (QW-407)

Temp. Range:	650- 680°C
Time Range	1 Hour / 25 mm
	(Minimum 1 Hour)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.		
Trailing	N.A.		
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: N.A.

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String; Others: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gouging / grinding for second side welding.

Oscillation: Nil.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 7018	2.5	DCEP	60-80	N.A.	N.A.	Nil
All	SMAW	E 7018	3.15	DCEP	80-110	N.A.	N.A.	Nil
All	SMAW	E 7018	4.0	DCEP	110-140	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

(P.Sivasubramanian)
Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1210 Date: 21.07.97 Supporting PQR No: 578

Rev. No :00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet welding of SS attachment to 2.25 Cr 1 Mo Steel attachments with Preheat and without PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per production drawing.

Backing (Yes/No) : Yes

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 5A Group No: 1 to P. No: 8 Group No: 1or 2

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: N.A. Fillet: Unlimited.

Pipe Dia. range Groove: N.A. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 309 Size of filler metal: See table

Specn. No. (SFA): 5.4 Flux Trade Names: N.A

F. No.: 5 Consumable insert: N.A.

A. No.: 8 Electrode |Flux (Class): Nil.

Deposited weld metal thickness range

Groove: N.A.

Fillet: 12.5 max. (Max. 6 mm per pass)

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : 150^{o}C (P5 side only)

Inter pass temp. (Max.): 250^{O}C

Pre heat maintenance: Nil

Other: Nil.

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WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1210**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: N.A.

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil

Oscillation: Nil.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 309	2.5	DCEP	60-80	N.A.	N.A.	Nil
All	SMAW	E 309	3.15	DCEP	80-110	N.A.	N.A.	Nil
All	SMAW	E 309	4.0	DCEP	110-140	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Sr. Manager / WTC

Prepared by:

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Welding Engineer / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1209	Date: 08.11.93	Supporting PQR No: 530, 192
Rev. No :01	Date: 07.02.95	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Groove and Fillet welding of SS components.		

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: 8	Group No: 1	to	P. No: 8	Group No: 1

Spec. Type & Grade	: N.A.	
Chem. Analysis & Mech. Prop	: N.A.	
Thickness Range		
	Groove: 1.6 to 50	Fillet: Unlimited.
Pipe Dia. range: Others: Nil	Groove: Unlimited.	Fillet: Unlimited.

FILLER METALS (QW-404)

AWS No. (Class):	E 347	Size of filler metal:	See table
Specn. No. (SFA):	5.4	Flux Trade Names:	N.A
F. No.:	5	Consumable insert:	N.A.
A. No.:	8	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: Maximum 50.0 (Max. 6 mm per pass)

Fillet: Maximum 50.0 (Max. 6 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	Nil (Min $10^{o}C$)
Inter pass temp. (Max.):	$200^{O}C$
Pre heat maintenance:	Nil
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1209 Rev 01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Grinding for Groove welds where second side welding is done

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: N.A.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E347	2.5	DCEP	60-90	N.A.	N.A.	Nil
-Do-	-Do	-Do	3.15	-Do-	70-110	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	110-150	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)

Manager / WTC

Prepared by:

(D.N.Ravishankar)

SWE / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1208	Date: 08.11.93	Supporting PQR No: 118
Rev. No :00	Date: ------	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Butt and fillet welding of 2 ¼ Cr 1 Mo steel structures with PWHT.

JOINTS (QW-402)

Joint Design	: Groove / Fillet as per production drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: ---do---
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No: --- Group No: --- to P. No: ---- Group No: ---

Spec. Type & Grade	: 2 ¼ Cr 1 Mo steel
Chem. Analysis & Mech. Prop	: N.A.

Thickness Range

Base Metal	Groove: 200 max	Fillet: 200 max.
Weld Metal	Groove: 200 Max	Fillet: 200 Max.
Pipe Dia. range	Groove: N.A.	Fillet: N.A.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E9018B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1208**

PWHT (QW-407)

Temp. Range:	680- 720^{o}C
Time Range	1 Hr / 25 mm
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do--- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String; Others: String or Weave (3dia max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Grinding (for second side welds).
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E9018B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do	-Do	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil
-Do-	-Do-	Do-	5.0	DCEP	200-240	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Prepared by:

(D.N.Ravishankar)
S.W.E./ WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1207 Date: 08.11.93 Supporting PQR No: 543 & 544

Rev. No :02 Date: 06.09.05

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove / Fillet welding 1Cr 0.5 Mo / 1.25Cr 0.5Mo steels to 2.25Cr 1 Mo steels with PWHT.

JOINTS (QW-402)

Joint Design : Groove / Fillet as per production drawing.

Backing (Yes/No) : As per production drg.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 4 Group No: 1 to P. No: 5A Group No: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 4.8 – 200.0 mm Fillet: Unlimited.

Pipe Dia. range Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2 Size of filler metal: See table

Specn. No. (SFA): 5.5 Flux Trade Names: N.A

F. No.: 4 Consumable insert: N.A.

A. No.: 3 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: 200 mm max. (Max. 6 mm per pass)

Fillet: Unlimited (Max . 6 mm per pass)

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

Others: Nil

PREHEAT (QW-406)

Preheat temp (min). : t = 13 : Nil
t> 13: 150^{o}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1207 Rev 02**

PWHT (QW-407)

Temp. Range:	695 ± 15°C
Time Range	2.5 min. / mm
	(Minimum 30 minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): --do--- Volts(range): N.A.
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String; Others: String or Weave (3dia max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Air arc gouging / grinding for second side welding.
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: Nil.
Peening: N.A.
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E8018B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do	-Do	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil

Approved by:

(S.Ramesh)
SDGM / WTC & WCMC

Prepared by:

(Dr.K.P.Dhandapani)
DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1206 Date: 08.11.93 Supporting PQR No: 555

Rev. No :01 Date: 06.09.05

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove and fillet welding of 1Cr 0.5Mo/ 1.25Cr 0.5Mo steel structure with PWHT.

JOINTS (QW-402)

Joint Design : As per production drg.

Backing (Yes/No) : As per production drg.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: 4 Group No: 1 to P. No: 4 Group No: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 200 mm max. Fillet: Unlimited.

Pipe Dia. range Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2

Specn. No. (SFA): 5.5

F. No.: 4

A. No.: 3

Size of filler metal: Refer table

Flux Trade Names: N.A

Consumable insert: N.A.

Electrode |Flux (Class): N.A

Deposited weld metal thickness range

Groove: 200 mm max. (max.5 mm/pass)

Fillet: Unlimited.

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : t = 13 mm : Nil
t > 13 mm : 125^{O}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1206 Rev 01**

PWHT (QW-407)

Temp. Range:	655 ± 15°C
Time Range	2.5 minutes / mm
	(min . 30minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

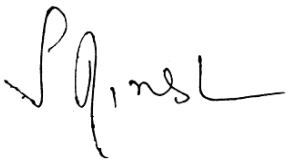
Current (AC/DC): Refer table Polarity: Refer table
Amps. (Range): Refer table Volts: Refer table
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String; Others: String or Weave (3dia max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: N.A.
Method of back Gouging: N.A.
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: N.A.
Others: N.A.

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E8018-B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	E8018-B2	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	E8018-B2	4.0	DCEP	140-190	N.A.	N.A.	Nil
-Do-	-Do-	E8018-B2	5.0	DCEP	200-240	N.A.	N.A.	Nil

Approved by:



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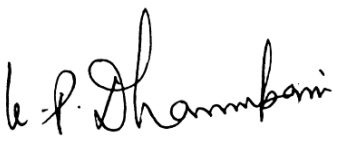

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BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1205 Date: 08.11.93 Supporting PQR No: 674

Rev. No :02 Date: 05.02.01

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Butt and fillet welding of 1Cr/1.25Cr 0.25Mo steel structures with Preheat & without PWHT.

JOINTS (QW-402)

Joint Design : Groove as per production drawing.

Backing (Yes/No) : As per production drg.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: P4 Group No: 1 to P. No: 4 Group No: 1

Spec. Type & Grade : 1Cr / 1.25Cr ½ Mo steel structures.

Chem. Analysis & Mech. Prop : Carbon content $\leq$ 0.15 %

Thickness Range

Groove: 1.6 to 12 Fillet: Unlimited.

Pipe Dia. range: Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2

Specn. No. (SFA): 5.5

F. No.: 4

A. No.: 3

Size of filler metal: See table

Flux Trade Names: N.A

Consumable insert: N.A.

Electrode |Flux (Class): Nil.

Deposited weld metal thickness range:

Groove: 12 max. (6 mm per pass max.)

Fillet: 12 max. (6 mm per pass max.)

POSITION (QW-405)

Position of Groove: All.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : 125^{O}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1205 Rev 02**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	--
Trailing	N.A.	--	--
Backing	N.A.	--	--

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gouging / grinding for second side welding.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E8018B2	2.5	DCEP	70-110	N.A.	N.A.	Nil
All	SMAW	E8018B2	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:

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DGM / WTC

Prepared by:

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Sr. Welding Engineer /WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1204 Date: 08.11.93 Supporting PQR No: 669

Rev. No :02 Date: 05.02.01

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Butt and fillet welding of carbon steel structures to 1Cr /1.25Cr 0.5Mo steel structure with preheat and without PWHT.

JOINTS (QW-402)

Joint Design : Groove as per production drawing.

Backing (Yes/No) : As per production drg.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No: P1 Group No: 1 or 2 to P. No: P4 Group No: 1

Spec. Type & Grade : CS to 1Cr / 1.25Cr 0.5Mo steels.

Chem. Analysis & Mech. Prop : Carbon content $\leq$ 0.15 % for AS

Carbon content $\leq$ 0.25% for CS

Thickness Range

Groove: 1.6 to 12 Fillet: Unlimited.

Pipe Dia. range Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 7018 Size of filler metal: See table

Specn. No. (SFA): 5.1 Flux Trade Names: N.A

F. No.: 4 Consumable insert: N.A.

A. No.: 1 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range: -

Groove: 12 max. (6 mm per pass)

Fillet: 12 max. (6 mm per pass)

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : 125^{O}C

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1204 Rev 02**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	--
Trailing	N.A.	--	--
Backing	N.A.	--	--

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gouging / grinding for second side welding.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018	2.5	DCEP	70-110	N.A.	N.A.	Nil
All	SMAW	E7018	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:

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DGM / WTC

Prepared by:

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Sr. Welding Engineer /WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1203	Date: 08.11.93	Supporting PQR No: 007
Rev. No	:00	Date: ----	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Fillet welding of carbon steel structure (up to 38 mm) without PWHT.

JOINTS (QW-402)

Joint Design	: Fillet as per drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: --- Group No.: --- to P. No.: --- Group No.: ---

Spec. Type & Grade	: Carbon steel.
Chem. Analysis & Mech. Prop	: N.A.

Thickness Range

Base Metal	Groove: N.A.	Fillet: 38 Max.
Weld Metal	Groove: N.A	Fillet: 8 Fillet Max.
Pipe Dia. range	Groove: N.A.	Fillet: N.A.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 6013	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	2	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	Nil (Min 10^{o}C)
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1203**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	--
Trailing	N.A.	--	--
Backing	N.A.	--	--

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do-- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: N.A.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E6013	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-DO-	-Do-	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Prepared by:

(D.N.Ravishankar)
S.W.E. / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1202	Date: 08.11.93	Supporting PQR No: 827
Rev. No	:01	Date: 06.09.05	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application:	Butt and fillet welding of carbon steel structures (above 50mm) and tension members of any thickness with PWHT.		

JOINTS (QW-402)

Joint Design	: Fillet as per drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: ---	Group No.: ---	to	P. No.: ---	Group No.: ---
Spec. Type & Grade	: Carbon steel.			
Chem. Analysis & Mech. Prop	: N.A.			

Thickness Range

Base Metal	Groove: 200 Max.	Fillet: 200 Max.
Weld Metal	Groove: 200 Max.	Fillet: 200 Max.
Pipe Dia. range: Others: Nil	Groove: N.A.	Fillet: N.A.

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	Up to 38: Nil
	Above: 100^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1202 Rev 01**

PWHT (QW-407)

Temp. Range:	610±15°C
Time Range	1 Hr / 25 mm
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

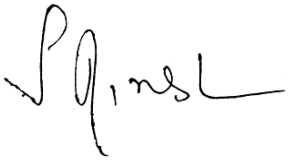
Current (AC/DC): See table Polarity: See table
Amps. (Range): --do-- Volts: --do--
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3dia max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Grinding for double side weld.
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do	-Do	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do	-Do	-Do-	4.0	DCEP	140-190	N.A.	N.A.	Nil
-Do	-Do	-Do-	5.0	DCEP	200-240	N.A.	N.A.	Nil

Approved by:



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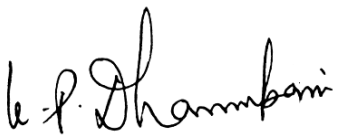

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BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1201	Date: 08.11.93	Supporting PQR No: 814, 819
Rev. No	:01	Date: 28.02.96	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Butt and fillet welding of carbon steel structures without PWHT.

JOINTS (QW-402)

Joint Design	: Groove as per production drawing.
Backing (Yes/No)	: As per production drg.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: -- Group No.: -- to P. No.: --- Group No.: ---

Spec. Type & Grade	: I S 2062 or equivalent
Chem. Analysis & Mech. Prop	: Carbon content $\leq$ 0.25 %

Thickness Range

Groove: 4.8 to 50 Fillet: 4.8 to 50.

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	Nil.

Deposited weld metal thickness range

Groove: 50 max. (6 mm per pass)

Fillet : Unlimited.

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	Upto 38: Nil
	above 38: 150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1201 Rev 01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Air arc gouging / grinding for second side welding.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 7018	3.15	DCEP	100-140	N.A.	N.A.	N.A.
All	SMAW	E 7018	4.0	DCEP	140-190	N.A.	N.A.	N.A.
All	SMAW	E 7018	5.0	DCEP	160-210	N.A.	N.A.	N.A.

Approved by:

(V.Ravindran)
Manager / WTC

Prepared by:

(P.Sivasubramanian)
General Foreman/ WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1113	Date: 15.07.03	Supporting PQR No: 904
Rev. No	:00	Date: --	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Fillet welding of 9Cr 1 Mo 0.25V steel tubes/ pipe with 2.25 Cr 1 Mo attachments with Pre heat. Post heat & PWHT.

JOINTS (QW-402)

Joint Design	: Groove /Fillet as per drawing.
Backing (Yes/No)	: As per Production drawing.
Backing Material (type)	: Metalic
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 5B Group No.: 2 to P. No.: 5A Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: N.A. Fillet: Unlimited.

Pipe Dia. range

Groove: N.A. Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018-B3	Size of filler metal:	Refer table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range:-

Groove: N.A.

Fillet: Unlimited (Maximum 3 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : 220^{o}C

Inter pass temp. (Max.): 350^{O}C

Pre heat maintenance: Post heat at 220Deg C for 2 hours on completion of welding & on interruptions.

Other: Nil.

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1113**

PWHT (QW-407)

Temp. Range:	730 – 760°C
Time Range	2.5 minutes / mm
	(Minimum 30 minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table Polarity: Refer table

Amps. (Range): Refer table Volts: N.A.

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3 Dia. max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: N.A.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E9018-B3	2.5	DCEP	70-100	N.A.	N.A.	N.A.
All	-Do	-Do-	3.15	-Do-	90-120	N.A.	N.A.	N.A.
All	-Do-	-Do-	4.0	-Do-	140-180	N.A.	N.A.	N.A.

Approved by:

(K.Narasimhan)
DGM /WTC

Prepared by:

(R.Rajanarayanan)
DM / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1112 Date: 28.01.02 Supporting PQR No.: 940

Rev. No :01 Date: 31.10.06

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet welding of Non-Load carrying SS attachments to 9Cr1 Mo ¼ V Steel tubes and pipes.

JOINTS (QW-402)

Joint Design : Fillet as per drawing.

Backing (Yes/No) : As per product drg.

Backing Material (type) : Metal.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No.: 5B Group No.: 2 to P. No.: 8 Group No.: 1/2

Spec. Type & Grade : SA213T91 or equivalent to P8

Chem. Analysis & Mech. Prop : Nil.

Thickness Range

Groove: N.A. Fillet: Unlimited.

Pipe Dia. range

Groove: N.A. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 309 Size of filler metal: See table

Specn. No. (SFA): 5.4 Flux Trade Names: N.A

F. No.: 5 Consumable insert: N.A.

A. No.: 8 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: N.A.

Fillet: Unlimited

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

Others: Nil

PREHEAT (QW-406)

Preheat temp (min). : 200 deg C on T91 side

Inter pass temp. (Max.): 300^{O}C

Pre heat maintenance: 220 deg C for 2 hours during interruptions and on completion of welding.

Other: Nil.

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1112 Rev 01**

PWHT (QW-407)

Temp. Range:	730 –760degC
Time Range	1 Hr /25 mm (min. 30 mts.)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.		
Trailing	N.A.		
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E309	2.5	DCEP	60-90	N.A.	N.A.	Nil
All	SMAW	E 309	3.15	DCEP	70-110	N.A.	N.A.	Nil
All	SMAW	E 309	4.0	DCEP	110-140	N.A.	N.A.	Nil

Prepared By:	Reviewed By:	Approved by:
(Kinkar.P.Narzary)	(Dr.K.P.Dhandapani)	(B.Natarajan)
Welding Engr / WTC	DGM/ WTC & WCMC	SDGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1111	Date: 07.02.95	Supporting PQR No.: 516, 632
Rev. No	:01	Date: 06.09.05	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Groove and Fillet welding of Carbon steel attachments to Carbon steel pipe / tubes with PWHT.			

JOINTS (QW-402)

Joint Design	: groove / Fillet as per production drawing.
Backing (Yes/No)	: As per production drawing.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 1	Group No.: 1 or 2	to	P. No.: 1	Group No.: 1 or 2

Spec. Type & Grade : Carbon Steel.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 4.8 to 200. Fillet: Unlimited.

Pipe Dia. range

Groove: Unlimited. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 200 Max. (Maximum 8 mm per pass)

Fillet: 200 Max. (Maximum 8 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	$t \leq 25$ mm : Nil
	> 25 mm: 150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1111 Rev 01**

PWHT (QW-407)

Temp. Range:	610±15°C
Time Range	1 Hr / 25 mm
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

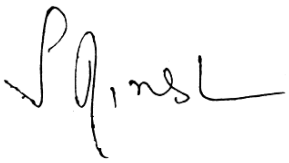
Current (AC/DC): See table Polarity: See table
Amps. (Range): See table Volts: See table
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3dia max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Air arc gouging / grinding wherever.
Oscillation: N.A.
Contact tube to work distance: N.A.
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

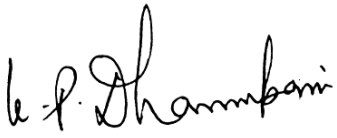
Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018	2.5	DCEP	60-90	N.A.	N.A.	Nil
All	-Do	-Do-	3.15	-Do-	100-140	N.A.	N.A.	Nil
All	-Do-	-Do-	4.0	-Do-	140-180	N.A.	N.A.	Nil.
All	-Do	-Do	5.0	-Do-	180-220	N.A.	N.A.	Nil.

Approved by:



(S.Ramesh)
SDGM / WTC & WCMC

Prepared by:



(Dr.K.P.Dhandapani)
DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1110	Date: 08.11.93	Supporting PQR No: 192
Rev. No	:00	Date: --	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding of P8 tubes to P8 attachments			

JOINTS (QW-402)

Joint Design	: Fillet as per drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 8	Group No.: 1	to	P. No.: 8	Group No.: 1 or 2
Spec. Type & Grade	: N.A.			
Chem. Analysis & Mech. Prop	: N.A.			

Thickness Range

Base Metal	Groove: N.A.	Fillet: 12 Max.
Weld Metal	Groove: N.A.	Fillet: 12 Max.
Pipe Dia. range: Others: Nil	Groove: N.A.	Fillet: 100 Max.

FILLER METALS (QW-404)

AWS No. (Class):	E 309	Size of filler metal:	See table
Specn. No. (SFA):	5.4	Flux Trade Names:	N.A
F. No.:	5	Consumable insert:	N.A.
A. No.:	8	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	Nil (Min 10^{o}C)
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1110**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do-- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E309	2.5	DCEP	60-100	N.A.	N.A.	Nil
-Do	-Do	-Do-	3.15	DCEP	90-130	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Prepared by:

(D.N.Ravishankar)
S.W.E. / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1109	Date: 08.11.93	Supporting PQR No.: 578, 673
Rev. No :00	Date: --	
Welding Process: SMAW		Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding of P8 Tubes to P4/P5A attachments		

JOINTS (QW-402)

Joint Design	: Fillet as per drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 8 Group No.: 1 to P. No.: 4/5A :Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Wetd Metat:	Groove: N.A.	Fillet: 12 mm Max.
Pipe Dia. range:	N.A.	Fillet: 100 max.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 309	Size of filler metal:	See table
Specn. No. (SFA):	5.4	Flux Trade Names:	N.A
F. No.:	5	Consumable insert:	N.A.
A. No.:	8	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	Nil (Min 10^{O}C)
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1109**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do-- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3dia max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A.

Contact tube to work distance: N.A.

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E309	2.5	DCEP	60-100	N.A.	N.A.	Nil
-Do	-Do	-Do-	3.15	DCEP	90-130	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Prepared by:

(D.N.Ravishankar)
S.W.E. / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1108	Date: 08.11.93	Supporting PQR No.: 547
Rev.	:01	Date: 04.04.06	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding of P5A Tubes / Pipes & P1 / P4 / P5A attachments.			

JOINTS (QW-402)

Joint Design	: Fillet as per drawing.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 5A Group No.: 1 to P. No.: P1/4/5A: Group No.: 1 or 2

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: N.A. Fillet: 8 mm Max.

Pipe Dia. range: Unlimited
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018-B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Other:	Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1108 Rev 01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): :--do-- Volts: --do--
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: String: Others: String or Weave (3 Dia. max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: N.A.
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E9018-B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
All	-DO-	-DO-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by: Prepared by:

(S.Ramesh) (Dr.K.P.Dhandapani)
SDGM / WTC & WCMC DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1107	Date: 06.11.93	Supporting PQR No.: 528, 529
Rev.	:02	Date: 04.04.06	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Welding of 1 ¼ Cr ½ Mo/ 1 Cr ½ Mo Tubes / Pipes & Carbon steel / 1 ¼ Cr ½ Mo /1 Cr ½ Mo/ 2 ¼ Cr 1 Mo attachments with pre heat & without PWHT..

JOINTS (QW-402)

Joint Design	: Groove as per Production drg.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 4	Group No.: 1	to	P. No.: 1	:Group No.:1 or 2
Spec. Type & Grade	: N.A.		4	:Group No: 1
Chem. Analysis & Mech. Prop	: N.A.		5A	:Group No: 1

Thickness Range

Groove: N.A.	Fillet: 12 mm.
Pipe Dia. range:	Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E8018-B2	Size of filler metal:	Refer table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove : N.A.

Fillet : 12 mm max., (Max .4 mm / pass)

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). : P4+ P1: 125^{O}C:
P4 + P4: 125^{o}C
P4+ P 5A: 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Post heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1107 Rev 02**

PWHT (QW-408)		**GAS (QW-408)**			
Temp. Range	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A		
Others:	Nil	Trailing	N.A		
		Backing	N.A		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table — Polarity: Refer table
Amps. (Range): Refer table — Volts: N.A.
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String / Weave (3 Dia. Max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Air arc Gouging / Grinding.
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E 8018-B2	2.5	DCEP	70-100	N.A.	N.A.	N.A.
All	SMAW	E 8018-B2	3.15	DCEP	100-140	N.A.	N.A.	N.A.

Approved by:

(S.Ramesh)
SDGM / WTC & WCMC

Prepared by:

(Dr.K.P.Dhandapani)
DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1106	Date: 08.11.93	Supporting PQR No.: 646, 527
Rev.	:00	Date: --------	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Welding of P3 (1/2 Mo steel) tubes to P1/P4/ P5A attachments.

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 3 Group No.: 1 to P. No.: 1/4/5A Group No.: 1 or 2

Spec. Type & Grade	: N.A.
Chem. Analysis & Mech. Prop	: N.A.

Thickness Range

Base Metal:	Groove: N.A.	Fillet: 12 Max.
Weld Metal:	Groove: N.A.	Fillet : 12 Max.
Pipe Dia. range:	Groove: N.A.	Fillet: 100 Max.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018A1	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	2	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	Nil (Min 10^{o}C)
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Other:	Nil

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1106**

PWHT (QW-408)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A.		
Others:	Nil	Trailing	N.A		
		Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do--- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root : String, Others : String or Weave(3 dia. max.)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E 7018A1	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager /WTC

Prepared by:

(D.N.Ravishankar)
SWE / WTC

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1105 Date: 08.11.93 Supporting PQR No.: 010 & 548

Rev. :02 Date: 04.04.06

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Welding of Carbon steel Tubes / Pipes to Carbon steel / 1.25 Cr 0.5 Mo(P4) /2.25Cr 1 Mo (P5A) Steel attachments.

JOINTS (QW-402)

Joint Design	: Groove as per Production drawing.
Backing (Yes/No)	: As per Production drg.
Backing Material (type)	: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 1	Group No.: 1or 2	to	P. No.: P1	Group No.: 1 or 2
Spec. Type & Grade	: N.A.		P4	Group No: 1
Chem. Analysis & Mech. Prop	: N.A.		P5A	Group No: 1

Thickness Range

Groove: N.A. Fillet: 13 mm Max.

Pipe Dia. range: Unlimited.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : P1 + P1: 100Oc when t > 19 mm

P1 + P4: 150^{o}C

P1 + P5A: 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Pre heat maintenance: Nil

Other: Nil.

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1105 Rev 02**

PWHT (QW-408)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A.		
Others:	Nil	Trailing	N.A		
		Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): --do--- Volts: --do--
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Nil.
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil.
Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E 7018	2.5	DCEP	80-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	90-130	N.A.	N.A.	Nil

Approved by: Prepared by:

(S.Ramesh) (Dr.K.P.Dhandapani)
SDGM / WTC & WCMC DGM/ WTC & WCMC

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1104	Date: 08.11.93	Supporting PQR No.:	650, 651
Rev.	:00	Date: -------		652, 653

Welding Process: SMAW Type: Manual
(Auto,Semi-Auto,Manual,Machine)

Application: Welding of SS attachments to P1/P3/P4/P5A Tube/Pipe

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 1/3/4/5A Group No.: 1or 2 to P. No.: 8 Group No.: 1 or 2

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: N.A. Fillet: 8mm Max.

Pipe Dia. range: Unlimited.
Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018-A1	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	2	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : P1/P3Nil (Min 10^{o}C)
P4: 120^{O}C ; P5A: 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Pre heat maintenance: Nil

Other: Nil.

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1104**

PWHT (QW-408)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	----	
Trailing	N.A.	----	
Backing	N.A.	----	

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do--- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: - String; Others: - String / weave (3 Dia max)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

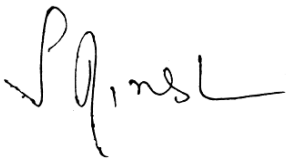
Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 7018-A1	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:



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SDGM / WTC & WCMC

Prepared by:

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1103	Date: 08.11.93	Supporting PQR No.: 547
Rev.	:00	Date: -------	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding of P5A radiographic plug to P5A pipes.			

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 5A Group No.: 1 to P. No.: 5A Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Base Metal	Groove: N.A.	Fillet: Unlimited.
Weld Metal	Groove: N.A.	Fillet: 9 max.
Pipe Dia. Range: Others: Nil	Groove: N.A.	Fillet: Unlimited

FILLER METALS (QW-404)

AWS No. (Class):	E 9018B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Other:	Nil.

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1103**

PWHT (QW-408)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A.		
Others:	Nil	Trailing	N.A		
		Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table — Polarity: See table

Amps. (Range): --do--- — Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: - String; Others: - String / weave (3 Dia. max)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: Nil.

Peening: NA.

Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E9018B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Date: 08/11/93

Prepared by:

(D.N.Ravishankar)
S.W.E./ WTC

Date: 08/11/93

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1102	Date: 08.11.93	Supporting PQR No.: 529
Rev.	:00	Date: -------	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Welding of P4/P5A radiographic plug to P4 pipes.

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 to P. No.: 4/5A Group No.: 1

Spec. Type & Grade	: N.A.
Chem. Analysis & Mech. Prop	: N.A.

Thickness Range

Base Metal	Groove: N.A.	Fillet: Unlimited.
Weld Metal	Groove: N.A.	Fillet: 9 max.
Pipe Dia. range	Groove: N.A.	Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 8018B2	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	3	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.

PREHEAT (QW-406)

Preheat temp (min). :	120^{o}C
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Other:	Nil.

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1102**

PWHT (QW-408)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A.		
Others:	Nil	Trailing	N.A.		
		Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): --do--- Volts: --do--

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: - String; Others: - String / weave (3 Dia. max)

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: Nil.

Peening: NA.

Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E8018B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by:

(V.Ravindran)
Manager / WTC

Date: 08/11/93

Prepared by:

(D.N.Ravishankar)
S.W.E./ WTC

Date: 08/11/93

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1101	Date: 08.11.93	Supporting PQR No.: 010
Rev.	:00	Date: -------	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Welding of radiographic plug to carbon steel pipes.			

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: --do--
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 1	Group No.: 1 or 2	to	P. No.: 1 Group No.: 1 or 2
Spec. Type & Grade	: N.A.		
Chem. Analysis & Mech. Prop	: N.A.		
Thickness Range	**:-**		
Base Metal		Groove: N.A.	Fillet: Unlimited.
Weld Metal		Groove: N.A.	Fillet: 9 max.
Pipe Dia. range:		Groove: N.A.	Fillet: Unlimited
Others: Nil			

FILLER METALS (QW-404)

AWS No. (Class):	E 7018	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	Up to 25: Nil above 25: 100^{o}C above 75 & Grc: 150^{o}C
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Other:	Nil.

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1101**

PWHT (QW-408)

Temp. Range: Nil
Time Range Nil
Others: Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A.	---	---
Backing	N.A.	----	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): --do--- Volts: --do--
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root: - String; Others: - String / weave (3 Dia. max)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back Gouging: Nil.
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: Nil.
Peening: NA.
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by: Prepared by:

(V.Ravindran) (D.N.Ravishankar)
Manager / WTC S.W.E./ WTC

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WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1050	Date: 30.11.06	Supporting PQR No.: 1181
Rev.	:01	Date: 07.12.06	

Welding Process: GTAW +SMAW — Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of 9Cr 1 Mo 0.25 V (T91/P91) steel Tubes/ Pipes for thickness up to 20.00 mm with pre heat & PWHT.

JOINTS (QW-402)

Joint Design	: As per production Drg.
Backing (Yes/No)	: GTAW: No; SMAW: Yes.
Backing Material (type)	: GATW: Nil; SMAW: Metal.
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 5B Group No.: 2 to P. No.: 5B Group No.: 2

Spec. Type & Grade : SA 213 T91 or equivalent.

Chem. Analysis & Mech. Prop :

Thickness Range

Groove: 5.0 to 20.0mm Fillet: N.A.

Pipe Dia. range: Unlimited
Others: Nil

FILLER METALS (QW-404)

	GATW	SMAW		
AWS No. (Class):	E 90S-B9	E9018-B9/E9015-B9	Size of filler metal:	Refer table
Specn. No. (SFA):	5.28	5.5	Flux Trade Names:	N.A
F. No.:	5	5	Consumable insert:	N.A.
A. No.:	6	4	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 5-20 mm max. GTAW: 4.0 mm max. (Max.2 mm per pass) SMAW: Balance (Max.5 mm / pass)

Fillet: Nil.

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	N.A.
Weld Progression: (Up / Down)	Vertical up.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : 220^{O}c
Inter pass temp. (Max.): 350^{O}C
Pre heat maintenance: 220^{O}c (Min)
Other: Insulate while cooling to 80-100degc and keep the job dry. Maintain at 80-100deg c for 1 hr. and conduct PWHT immediately.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1050 Rev 01**

PWHT (QW-408)

Temp. Range: 760 ± 10°C

Time Range: 2.5-mts/ mm (Thickness of weld) (Min.120 Minutes.)

Others: Rate of heating / cooling above 350°C 110° C/Hr maximum

GAS (QW-408)

	Gases	Purity%	Flow Rt.
Shielding	Argon	99.99	6-14 LPM
Trailing	N.A.	----	----
Backing	Argon	99.99	10-20 LPM
		(For root welding)	

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table — Polarity: See table

Amps. (Range): See table — Volts: See table

Tungsten Electrode type and size: EWTh-2/EWCe-2, Ø 2.4 mm.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): Nil.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: 6/9

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back Gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil.

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	GTAW	ER 90S-B9	2.4	DCEN	70-100	N.A.	N.A.	Nil
Others Layers	SMAW	E9018-B9 Or E9015-B9	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	SMAW	-Do-	3.2	DCEP	90-130	N.A.	N.A.	Nil
-Do-	SMAW	-Do-	4.0	DCEP	140-160	N.A.	N.A.	Nil

Prepared by:	Reviewed by:	Approved by:
(Kankar Narzary)	(Dr K.P.Dhandapani)	(B.Natarajan)
Welding Engineer / WTC	DGM/ WTC & WCMC	SDGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1049**	Date	**:** 16/10/2006	Supporting	**1173**
Rev. No	**: 01**	Date	**:** 22/09/2007	PQR. No	

Welding Process : SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove / Fillet welding of 9Cr.1Mo. ¼V (P91 / T91 / F91 / Gr.91) steel components like Branches, Stubs , Attachments etc. to P91 steel pipes

JOINTS (QW – 402)

Joint Design : Groove / Fillet as per drawing
Backing (Yes / No) : As per drawing.
Backing Material Type : Metal.
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. : 5B Group No. : 2 to P. No : 5B Group No. : 2
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 200.0mm Fillet : Unlimited
Pipe Diameter Range : Groove : Unlimited Fillet : Unlimited
Others : Nil

FILLER METALS (QW – 404)

AWS No. (class) : E9015 –B9 / 9018 – B9
Spec. No. (SFA) : 5.5
F. No. : 4
A. No. : 4
Size of Filler metal : Refer Table
Flux trade name : N.A.
Electrode-flux (Class) : N.A..
Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. (Max.6 mm / pass)
Fillet : Unlimited. (Max.6 mm / pass)
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : All
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 220 ^{0}C
Interpass Temp. (Max) : 350 ^{0}C
Preheat Maintenance : Till completion of welding.
Postheat Maintenance: 220-280 ^{0}C for 2 hrs. on completion of welding.
Others : Insulate till PWHT after cooling to room temp. & keep it dry.

PWHT (QW – 407)

Temp. Range : 760 ± 10 ^{0}C
Time Range : 2.5minutes/mm
(Min.120minutes)
ROH / ROC :
t upto 50mm : 110 ^{0}C / hr max.
t 50 – 75mm : 75 ^{0}C / hr max.
t above 75mm : 55 ^{0}C / hr max.
Others : To be done within 72 Hrs.
of welding completion.

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	N.A.	---	---
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : N.A.
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : N.A.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Grinding for double side welding
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	SMAW	E9015-B9 **or** E9018-B9	2.6	DCEP	70 - 100	N.A.	N.A.	Nil
Further	SMAW	--do--	3.2	DCEP	90 - 130	N.A.	N.A.	Nil
--do--	SMAW	--do--	4.0	DCEP	140 - 160	N.A	N.A.	Nil

Approved by
(Dr.K.P.Dhandapani)
DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1048 Date: 13.10.06 Supporting PQR No.: 544

Rev. :00 Date: -----

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Welding of 1Cr ½ Mo / 1 ¼ Cr ½ Mo header to 2 ¼ Cr 1 Mo steel Nipples/Stubs with Pre heat and PWHT at 655 ± 15^{o}C

JOINTS (QW-402)

Joint Design : Fillet as per drawing.

Backing (Yes/No) : As per Drawing.

Backing Material (type) : As per Drawing.

Metal/Non fusing metal/ :

Non metallic/Others

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 to P. No.: 5A Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: N.A. Fillet: P4 : All; P5A :13mm Max.

Pipe Dia. range

Groove: N.A. Fillet: P4: All; P5A 102 mm Max.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2 Size of filler metal: Refer table

Specn. No. (SFA): 5.5 Flux Trade Names: N.A

F. No.: 4 Consumable insert: Nil.

A. No.: 3 Electrode |Flux (Class): N.A.

Deposited weld metal thickness range: -

Groove: N.A.

Fillet: 13 mm Max.

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All

Weld Progression: (Up / Down) Vertical up.

Others: Nil

PREHEAT (QW-406)

Preheat temp (min). : 150^{O}c

Inter pass temp. (Max.): 300^{o}C

Post heat maintenance: Nil.

Others : Nil.

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1048**

PWHT (QW-408)

Temp. Range:	655 ± 15°C
Time Range	1 Hr / 25mm (Min.1Hr.)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	------	----	-----
Trailing	------	----	-----
Backing	-----	----	-----

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC):	Refer table	Polarity: Refer table	
Amps. (Range):	Refer table	Volts: Refer table	
Tungsten Electrode type and size:		N.A.	
Mode of metal transfer for (GMAW):		N.A.	
Electrode wire feed speed range:		N.A.	
Pulsing current (GTAW):		N.A.	

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	----
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	N.A.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 8018-B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
All	SMAW	-do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
All	SMAW	-do-	4.0	DCEP	140-190	N.A.	N.A.	Nil

Prepared by: Reviewed by: Approved by:

(Kankar Narzary) (Dr K.P.Dhandapani) (B.Natarajan)

Welding Engineer / WTC DGM/ WTC & WCMC SDGM/ WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1047 516 | Date: 20.09.2006 | Supporting PQR No.: 00:1330

Rev. :00 | Date: -----

Welding Process: SMAW | Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of 9Cr 1Mo 0.25 V Steel pipes to Stainless, Steel Thermo well with PWHT.

JOINTS (QW-402)

Joint Design	: Groove As per Drawing.
Backing (Yes/No)	: With or without
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 5 B Group No.: 2 to P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 5.0 to 22mm Fillet: Unlimited

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

	GTAW	SMAW	
AWS No. (Class):	ER Ni Cr-3	E Ni Cr Fe-3	Size of filler metal: Refer table
Specn. No. (SFA):	5.14	5.11	Flux Trade Names: N.A
F. No.:	43	43	Consumable insert: Nil.
A. No.:	Nil	Nil	Electrode |Flux (Class): N.A.

Deposited weld metal thickness range: -

Groove: GTAW: 5 mm Max: Balance: SMAW

Fillet: Unlimited

POSITION (QW-405)

Position of Groove:	F,H
Position of fillet:	N.A.
Weld Progression: (Up / Down)	N.A.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	220^{O}c
Inter pass temp. (Max.):	350^{o}C
Post heat maintenance:	N.A.
Others :	N.A.

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1047**

PWHT (QW-408)

Temp. Range:	745± 15^{o}C
Time Range	2.5minutes/mm (Min.1Hr.)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Argon	99.95	8-14 LPM
Trailing		---	---
Backing	Argon	99.95	4-6 LPM

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table	Polarity: Refer table
Amps. (Range): Refer table	Volts: Refer table
Tungsten Electrode type and size:	EW Ce-2, Ø 2.4 mm
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	6/9.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	N.A.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	GTAW	ERNiCr-3	2.4	DCEN	70-85	N.A.	N.A.	Nil
1 to 2	SMAW	ENiCrFe-3	2.5	DCEP	80-85	N.A.	N.A.	Nil
Further	SMAW	EniCrFe-3	2.5	DCEP	85-90	N.A.	N.A.	Nil

For Fillet weld use SMAW only

Prepared by:

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DGM/WCMC& WTC

Approved by:

(B.Natarajan)
SDGM/ WCMC & WTC

BHARAT HEAVY ELECTRICALS LIMITED

WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1046	Date: 30.08.06	Supporting PQR No.:	503, 516 883.
Rev. No.:	00	Date: -----		
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)	

Application: Welding of Carbon Steel Pipe / Headers with Carbon Steel Nipple / Stubs with PWHT.

JOINTS (QW-402)

Joint Design	: Groove and Fillet as per Production Drg.
Backing (Yes/No)	: Yes
Backing Material (type)	: Base Metal / P1 If removable type
Metal/Non fusing metal/ Non metallic/Others	:
Retainers	: Permitted P1 only

BASE METAL (QW-403)

P. No.: 1 Group No.: 1 or 2 to P. No.: 1 Group No.: 1 to 2

Spec. Type & Grade	: N.A.
Chem. Analysis & Mech. Prop	: N.A.

Thickness Range

Groove: 3.0 to 200mm Fillet: Unlimited

Pipe Dia range

Groove: Unlimited Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018-1	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 200 Max. (Maximum 6 mm per pass)

Fillet: Unlimited (Maximum 6 mm per pass)

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	All.
Weld Progression: (Up / Down)	Vertical up
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	a) t < or = 25 mm: Nil (Min. 10^{O}c)
	b) t > 25 mm and SA 106 Gr C > 19 mm 150^{o}C
Inter pass temp. (Max.):	300^{o}C
Post heat maintenance:	Post heat at 150 for 2 Hrs for SA 106 Gr.C if t > 19 mm
Others:	: Nil

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WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1046**

PWHT (QW-408)

Temp. Range:	595 – 650^{o}C
Time Range	2.5minutes/mm (Minimum 30 minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding		--	----
Trailing		---	---
Backing		---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC):	Refer table	Polarity: Refer table	
Amps. (Range):	Refer table	Volts: Refer table	
Tungsten Electrode type and size:		N.A.	
Mode of metal transfer for (GMAW):		N.A.	
Electrode wire feed speed range:		N.A.	
Pulsing current (GTAW):		N.A.	

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: String or Weave (3dia.max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Nil.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E 7018-1	3.15	DCEP	90-140	N.A.	N.A.	For stub t Less than or = 3.6 mm
All All	SMAW SMAW	E 7018-1 E 7018 –1	3.15 or 4.0	DCEP DCEP	90-140 140-190	N.A. N.A.	N.A. N.A.	For stub t grater than 3.6 mm

Approved by:
Kinkar Narzary
Welding Engineer/WTC

Approved by
(Dr.K.P.Dhandapani)
DGM/WTC/WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1045	Date: 18.08.06	Supporting PQR No.: 270
Rev. No.:	00	Date: -----	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Buildup of 2.25 Cr 1Mo Steel components with Pre heat, post heat & PWHT..

JOINTS (QW-402)

Joint Design	: Buildup as per requirements..	
Backing (Yes/No)	: Yes.	
Backing Material (type)	: Metal.	
Metal/Non fusing metal/ Non metallic/Others	:	Note: Bead overlap 50%.

BASE METAL (QW-403)

P. No.: 5A	Group No.: 1	to	P. No.: -- Group No.: --
Spec. Type & Grade	: ASTM A.217 WC9/SA 234 WP 22 Cl 1 or equivalent		
Chem. Analysis & Mech. Prop	: N.A.		
Thickness Range			
	5.0 to 200.0 mm		
Pipe Dia. range	Unlimited		

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018 –B3	Size of filler metal:	See table
Specn. No. (SFA):	5.5	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	4	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Buildup: Maximum 200 mm. (Maximum 6 mm per pass)

POSITION (QW-405)

Position of Overlay:	Flat
Position of fillet:	N.A.
Weld Progression: (Up / Down)	N.A.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	200^{o}C
Inter pass temp. (Max.):	350^{o}C
Post heat maintenance:	Post heat at 200^{O}c for 2 Hrs on completion of welding & interruptions.
Others:	: Nil

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1045**

PWHT (QW-407)

Temp. Range:	695 ± 15°C
Time Range	2.5 min/ mm
	(Minimum 30 minutes)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	----
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

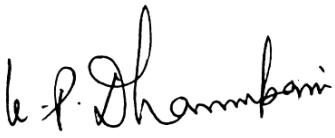
Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: See table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Gouging:	Nil.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	Nil.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E9018-B3	3.15	DCEP	100-140	N.A.	N.A.	Nil
-do-	-do-	E9018-B3	4.0	-do-	140-180	N.A.	N.A.	Nil

Prepared By:
(Kinkar Narzary)
Welding Engineer/ WTC



Reviewed By:
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DGM / WTC

Approved By:
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SDGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1044	Date: 13.06.2006	Supporting PQR No.:	644
Rev. No.:	00	Date: -----		
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)	
Application:	Groove and Fillet welding of Stainless Steel to Carbon Steel components without Pre heat and without PWHT.			

JOINTS (QW-402)

Joint Design	: Groove and Fillet as per Drg.
Backing (Yes/No)	: As per Drg.
Backing Material (type)	: -do-
Metal/Non fusing metal/ Non metallic/Others	:

BASE METAL (QW-403)

P. No.: 1 Group No.: 1 or 2 to P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 5.0 to 12.5 mm Fillet: 12.5 mm Max.

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	EniCrFe-3	Size of filler metal:	See table
Specn. No. (SFA):	5.11	Flux Trade Names:	N.A
F. No.:	43	Consumable insert:	N.A.
A. No.:	Nil	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: Maximum 12.5 mm (Max.4 mm per pass).

Fillet: Maximum 12.5 mm (Max.4 mm per pass)

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	All.
Weld Progression: (Up / Down)	Vertical up
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	Nil
Inter pass temp. (Max.):	300^{o}C
Post heat maintenance:	Nil
Others: :	Nil

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1044**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	----
Trailing	N.A.	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: See table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back Grinding:	By Grinding
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	Nil.
Peening:	N.A.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	EniCrFe-3	3.15	DCEP	70-110	N.A.	N.A.	Nil

Approved by: (S.Ramesh)
SDGM / WTC & WCMC

Prepared: (Dr.K.P.Dhandapani)
DGM / WTC & WCMC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1043**	Date	**:** 08/04/2006	Supporting	**1329**
Rev. No	**: 01**	Date	**:** 22/09/2007	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove, Fillet & Socket welding of Carbon steel pipe to 2¼ Cr.1Mo.steel Pipes with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : GTAW : No ; SMAW : Yes.
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : GTAW : Nil ; SMAW : Metal.

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 or 2 to P. No : 5A Group No. : 1
Spec. Type & Grade : Carbon steel to 2¼ Cr.1Mo.steels.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 8.0mm Fillet : Max. 13mm
Pipe Diameter Range : Groove : Max. Ø102mm Fillet : Unlimited
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)
Groove : 12.0mm Max. GTAW : 4.0mm.Max.; SMAW: Balance (Max.5mm / pass)
Fillet : Unlimited (Max.5mm / pass)
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All.
Position(s) of Fillet : All.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil
Others : Slow cool

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 10
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 – 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	60 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	90 - 140	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1042 Date: 28.12.2005 Supporting PQR No.: 516

Rev. No.: 00 Date: -----

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Welding of Carbon Steel Pipes/Headers with Carbon Steel Nipples/ Nozzles etc with PWHT.

JOINTS (QW-402)

Joint Design : Groove and Fillet as per Drg.

Backing (Yes/No) : Yes

Backing Material (type) : Metal

Metal/Non fusing metal/

Non metallic/Others

BASE METAL (QW-403)

P. No.: 1 Group No.: 1 or 2 to P. No.: 1 Group No.: 1 to 2

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 5.0 to 49.0 mm Fillet: Unlimited

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E7018-1	Size of filler metal:	See table
Specn. No. (SFA):	5.1	Flux Trade Names:	N.A
F. No.:	4	Consumable insert:	N.A.
A. No.:	1	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 49.0 mm (Maximum 6 mm per pass)

Fillet: Unlimited (Maximum 6 mm per pass)

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	N.A.
Weld Progression:	Vertical
(Up / Down)	up
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). : For thickness < 25 mm: Nil

> 25 mm & P1 Gr 2> 19 mm: 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Post heat maintenance: post heat at 150deg C for P1Gr2>19mm for 2 Hrs.

Others: : Nil

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1042**

PWHT (QW-407)

Temp. Range:	610±15deg C
Time Range	1 Hr./25 mm (min. 30 mts)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	--	----
Trailing	N.A	---	---
Backing	N.A.		

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A.
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	Root: String; Others: String or Weave (3 Dia. Max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	N.A.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root & Capping	SMAW	E 7018-1	3.15	DCEP	90-140	N.A.	N.A.	Nil
Others	-do-	-do-	4.0	-do-	140-190	N.A.	N.A.	Nil
-do-	-do-	-do-	5.0	-do-	180-250	N.A.	N.A.	Nil

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Prepared: (Dr.K.P.Dhandapani)
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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1041**	Date	: 27/09/05	Supporting PQR. No	**526**
Rev. No	: **01**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding in Carbon steel to 2¼ Cr.1Mo.steel components with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : No.
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : No.

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 or 2 to P. No : 5A Group No. : 1
Spec. Type & Grade : Carbon steel to 2¼ Cr.1Mo.steels.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 46.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 46.0mm Max. GTAW :5.0mm.Max.; SMAW: Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 350 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : 695 ± 15 ^{0}C

Time Range : 2.5minutes/mm (Min.30minutes)

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9 / 13
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	70 - 130	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-1	4.0	DCEP	140 -190	N.A	N.A	Nil
--do--	SMAW	E7018-1	5.0	DCEP	180 -260	N.A	N.A	Nil

Approved by
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DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1040	Date: 19.08.05	Supporting PQR No.: 555, 939
Rev. No.:	00	Date: -----	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Groove and fillet welding of 1Cr 0.5Mo/1.25Cro.5Mo steel Components of Pr. Vessels / Heat Exchangers etc. With PWHT and without impact.

JOINTS (QW-402)

Joint Design	: Groove and fillet as per drg.
Backing (Yes/No)	: As per drg.
Backing Material (type)	: Metal
Metal/Non fusing metal/	
Non metallic/Others	

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 to P. No.: 4 Group No.: 1

Spec. Type & Grade : N.A.

Chem. Analysis & Mech. Prop : N.A.

Thickness Range

Groove: 5.0 TO 200 Fillet: Unlimited

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2

Specn. No. (SFA):	5.5	Size of filler metal:	See table
F. No.:	4	Flux Trade Names:	N.A
A. No.:	3	Consumable insert:	N.A.
		Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: 200max. (Max. 6 mm per pass)

Fillet: Unlimited

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	All
Weld Progression: (Up / Down)	Up hill only.
Others:	Nil

PREHEAT (QW-406)

Preheat temp (min). :	150^{o}C
Inter pass temp. (Max.):	300^{O}C
Pre heat maintenance:	Nil
Others: :	Nil

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1040**

PWHT (QW-407)

Temp. Range:	650-670^{O}c
Time Range	1Hr/25mm (Min .0.5 hr)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.S.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: See table
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil.

TECHNIQUES (QW-410)

String or Weave Bead:	String or Weave (3 Dia Max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil.
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E8018-B2	2.5	DCEP	70-100	N.A.	N.A.	N.A.
-DO-	SMAW	E8018-B2	3.15	DCEP	100-130	N.A.	N.A.	N.A.
-DO-	SMAW	E8018-B2	4.0	DCEP	140-180	N.A.	N.A.	N.A.
-DO-	SMAW	E8018-B2	5.0	DCEP	180-240	N.A.	N.A.	N.A.

Approved by: (S.Ramesh)
SDGM/ WTC&WCMC

Prepared: (Dr.K.P.Dhandapani)
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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1039**	Date	**:** 30/10/2004	Supporting	**507**
Rev. No	**: 01**	Date	**:** 22/09/2007	PQR. No	

Welding Process **:** GTAW + SMAW Type **:** Manual (Auto/Semi-Auto/Manual/Machine)

Application **:** Groove welding of Carbon steel tubes with ½Mo. tubes with PWHT.

JOINTS (QW – 402)

Joint Design **:** As per drawing
Backing (Yes / No) **:** GTAW : No ; SMAW : Yes.
Backing Material Type **:** GTAW : Nil ; SMAW : Metal.
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. **:** Group No. **:** 1 or 2 to P. No **:** 3 Group No. **:** 1 or 2
Spec. Type & Grade **:** Carbon steel + ½ Mo. Steel or equivalent
Chem. Analysis & Mech. Prop. **:** N.A.
Thickness Range **:** Groove **:** 1.5 to 18.0mm Fillet **:** N.A
Pipe Diameter Range **:** Groove **:** Unlimited Fillet **:** N.A.
Others **:** Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class) **:**	ER70S – A1	E7018 –A1	Size of Filler metal : Refer Table
Spec. No. (SFA) **:**	5.28	5.5	Flux trade name : N.A.
F. No. **:**	6	4	Electrode-flux (Class) : N.A..
A. No. **:**	2	2	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove **:** 18.0mm Max. GTAW :4.0mm.Max.;SMAW:Balance (Max.3mm / pass)
Fillet **:** N.A.
Others **:** Nil

POSITION (QW – 405)

Position(s) of Groove **:** All
Position(s) of Fillet **:** N.A.
Weld Progression.(Up/Down)**:** Vertical up
Others **:** Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) **:** t < 13mm : Nil (min 10^0C)
t > 13mm :150^0C)
Interpass Temp. (Max) **:** 300 ^{0}C
Postheat Maintenance **:** Nil
Others **:** Nil

PWHT (QW – 407)

Temp. Range : 620 – 650 ^{0}C
Time Range : 2.5 minutes/mm
(Min.30 minutes)

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 12
Trailing :	N.A ---		---
Backing :	N.A. ---		---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 90	N.A.	N.A	Nil
Further	SMAW	E7018-A1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-A1	3.15	DCEP	90 -130	N.A	N.A	Nil

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Form No. 101 - 401

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1038**	Date	**:** 31/07/2003	Supporting PQR. No	**904 & 1099**
Rev. No	**: 03**	Date	**:** 22/09/2007		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of 2 ¼Cr.1Mo.steel (P22/T22/F22/Gr22) to 9Cr.1Mo. ¼V steel (P91 / T91 / F91 / Gr.91) for site fabrication with preheat & with PWHT. **(For t < 20mm only)**

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : GTAW : No ; SMAW : Yes.
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : GTAW : Nil ; SMAW : Metal.

BASE METAL (QW – 403)

P. No. : 5A Group No. : 1 to P. No : 5B Group No. : 2
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 20.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class)	: ER90S – B3	E9018 –B3	Size of Filler metal : Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name : N.A.
F. No.	: 6	4	Electrode-flux (Class) : N.A..
A. No.	: 2	4	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 20.0mm Max. GTAW : 4.0mm.Max.(Max. 2 mm / pass)
SMAW : Balance (Max.5 mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 220 ^{0}C
Interpass Temp. (Max) : 350 ^{0}C
Preheat Maintenance : Nil
Others : After welding cool the joint to 80 – 100 ^{0}C & hold it for 1 hour minimum, before PWHT.

PWHT (QW – 407)

Temp. Range : 745 ± 15 ^{0}C
Time Range : 2.5minutes/mm
(Min.60minutes)
Others : **Induction heating**
ROH (Above 350 ^{0}C) : 120 ^{0}C / hr max.
ROC (Upto 350 ^{0}C) : 120 ^{0}C / hr max.

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	8 - 14
Trailing :	N.A	---	---
Backing :	Argon .	99.99	8 - 14

(For Root welding)

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER90S-B3	2.4	DCEN	70 - 100	N.A.	N.A	Nil
Further	SMAW	E9018-B3	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E9018-B3	3.15	DCEP	90 -120	N.A	N.A	Nil
--do--	SMAW	E9018-B3	4.0	DCEP	140 -180	N.A	N.A	Nil

Approved by
(Dr.K.P.Dhandapani)
DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1036**	Date	**:** 26/11/2002	Supporting PQR. No	**1257**
Rev. No	**: 05**	Date	**:** 22/09/2007		

Welding Process **:** GTAW Type **:** Manual (Auto/Semi-Auto/Manual/Machine)

Application **:** Groove welding of 9 Cr.1Mo. ¼V (T91) steel tubes with preheat & with PWHT. for site applications.

JOINTS (QW – 402)

Joint Design **:** Groove as per drawing
Backing (Yes / No) **:** As per drawing.
Backing Material Type **:** Metal
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. **:** 5B Group No. **:** 2 to P. No **:** 5B Group No. **:** 2
Spec. Type & Grade **:** SA 213 T91 or equivalent
Chem. Analysis & Mech. Prop. **:** N.A.
Thickness Range **:** Groove **:** 1.5 to 11.0mm Fillet **:** N.A
Pipe Diameter Range **:** Groove **:** Unlimited Fillet **:** N.A.
Others **:** Nil

FILLER METALS (QW – 404)

AWS No. (class) **:** ER90S – B9 Size of Filler metal : Refer Table
Spec. No. (SFA) **:** 5.28 Flux trade name : N.A.
F. No. **:** 6 Electrode-flux (Class) : N.A..
A. No. **:** -- Consumable insert : N.A.

Deposited weld metal thickness range (t)
Groove **:** 11.0mm Max. (Max.3mm / pass)
Fillet **:** N.A.
Others **:** Nil

POSITION (QW – 405)

Position(s) of Groove **:** All
Position(s) of Fillet **:** N.A.
Weld Progression.(Up/Down)**:** Vertical up
Others **:** Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) **:** 220 ^{0}C
Interpass Temp. (Max) **:** 350 ^{0}C
Preheat Maintenance **:** Nil
Others **:** After welding cool the joint to 80 – 100 ^{0}C & hold it for ½ hour minimum,before PWHT.

PWHT (QW – 407)

Temp. Range : 750 - 770 ^{0}C
Time Range : 2.5minutes/mm (Min.90minutes)
Others : **Induction heating**
ROH (Above 350 ^{0}C) : 120 ^{0}C / Hr. Max.
ROC (Upto 350 ^{0}C) : 120 ^{0}C / Hr. Max.

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	Argon	99.99	10 - 25

(For Root welding)

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : **For preheating & PWHT resistance heating technique can be used**

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
All Layers	GTAW	ER90S-B9	2.4	DCEN	80 - 120	N.A.	N.A	Nil

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Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1035**	Date	**:** 17/04/99	Supporting PQR. No	**904**
Rev. No	**: 03**	Date	**:** 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of 2 ¼Cr.1Mo.steel (P22/T22/F22/Gr22) to 9Cr.1Mo. ¼V steel (P91 / T91 / F91 / Gr.91) for site fabrication with preheat & with PWHT. **(For t > 20mm)**

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : GTAW : No ; SMAW : Yes.
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : GTAW : Nil ; SMAW : Metal.

BASE METAL (QW – 403)

P. No. : 5A Group No. : 1 to P. No : 5B Group No. : 2
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 20.0 to 200.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER90S – B3	E9018 –B3	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	4	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. GTAW : 5.0mm.Max.(Max. 3mm / pass)
SMAW : Balance (Max.5 mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 220 ^{0}C
Interpass Temp. (Max) : 350 ^{0}C
Preheat Maintenance : Nil
Others : After welding cool the joint to 80 – 100 ^{0}C & hold it for 1 hour minimum, before PWHT.

PWHT (QW – 407)

Temp. Range : 745 ± 15 ^{0}C
Time Range : 2.5minutes/mm
(Min.60minutes)
Others : **Induction heating**
ROH / ROC :Above 350 ^{0}C as below
t upto 50mm : 110 ^{0}C / hr max.
t 50 – 75mm : 75 ^{0}C / hr max.
t above 75mm : 55 ^{0}C / hr max.

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	8 - 14
Trailing :	N.A	---	---
Backing :	Argon .	99.99	10 - 25
	(For Root welding)		

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER90S-B3	2.4	DCEN	70 - 100	N.A.	N.A	Nil
Further	SMAW	E9018-B3	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E9018-B3	3.15	DCEP	90 -120	N.A	N.A	Nil
--do--	SMAW	E9018-B3	4.0	DCEP	140 -180	N.A	N.A	Nil

Approved by
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DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1034**	Date	**:** 30/03/2000	Supporting	**1173**
Rev. No	**: 02**	Date	**:** 22/09/2007	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of 9 Cr.1Mo.¼V (P91 / F91 / Gr.91 etc.) steel components for site fabrication with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : GTAW : No ; SMAW : Yes.
Backing Material Type : GTAW : Nil ; SMAW : Metal.
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. : 5B Group No. : 2 to P. No : 5B Group No. : **2**
Spec. Type & Grade : 9 Cr.1Mo.¼V or equivalent
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 20.0 to 200.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER90S – B3	E9015 –B9	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	5	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. GTAW : 3.0mm.Max.(One pass only)
SMAW : Balance (Max.4mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down) : Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 220 ^{0}C
Interpass Temp. (Max) : 350 ^{0}C
Preheat Maintenance : Nil
Others : After welding cool the joint to 80 – 100 ^{0}C & hold it for 1 hour minimum,before PWHT.

PWHT (QW – 407)

Temp. Range : 745 ± 15 ^{0}C
Time Range : 2.5minutes/mm
(Min.60minutes)
Others : **Induction heating**
ROH / ROC :Above 350 ^{0}C as below
t upto 50mm : 110 ^{0}C / hr max.
t 50 – 75mm : 75 ^{0}C / hr max.
t above 75mm : 55 ^{0}C / hr max.

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	Argon	99.99	10 - 25
	(For Root welding)		

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER90S-B3	2.4	DCEN	70 - 100	N.A.	N.A	Nil
Further	SMAW	E9018-B9	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E9018-B9	3.2	DCEP	90 -130	N.A	N.A	Nil
--do--	SMAW	E9018-B9	4.0	DCEP	140 -160	N.A	N.A	Nil

Approved by
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DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1033**	Date	**:** 17/04/99	Supporting	**296**
Rev. No	**: 02**	Date	**:** 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of P4 steel to P1 Group 1 carbon steel with PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : Yes.
Backing Material Type : Metal.
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 200.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. GTAW :5.0mm.Max.; SMAW: Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : 655 ± 15 ^{0}C

Time Range : 2.5minutes/mm (Min.60minutes)

Others : Nil

GAS (QW – 408)

Gases		Mix/Purity %	Flow.Rt.(lpm)
Shielding	: Argon	99.99	6 - 14
Trailing	: N.A	---	---
Backing	: N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9 / 13
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	90 - 120	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-1	4.0	DCEP	140 -200	N.A	N.A	Nil

Approved by
(Dr.K.P.Dhandapani)
DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1032 Date: 19.03.98 Supporting PQR No.: 192, 530

Rev. No.: 00 Date: ------

Welding Process: GTAW + SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of type 316 Stainless Steel components.

JOINTS (QW-402)

Joint Design : Groove as per production Drawing

Backing (Yes/No) : GTAW : No ; SMAW: Yes

Backing Material (type) : GTAW : Nil ; SMAW : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 8 Group No.: 1 To P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: 1.6 to 50.0 Fillet: N.A.

Pipe Dia. range

Groove: Unlimited Fillet: N.A.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): ER347, E316

Specn. No. (SFA): 5.9, 5.4 Size of filler metal: See table

F. No.: 6, 5 Flux Trade Names: N.A

A. No.: 8 Consumable insert: Nil

Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: 50.0 Max. {GTAW: Max: 5.0; SMAW: Balance} (max: 6 mm per pass)

Fillet: N.A.

POSITION (QW-405)

Position of Groove: All

Position of fillet: N.A.

Weld Progression: (Up / Down) Vertical up

PREHEAT (QW-406)

Preheat temp (min). : Nil (Min.10^{o}C)

Inter pass temp. (Max.): 220^{o}C

Pre heat maintenance: Nil

Others : Nil

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1032**

PWHT (QW-407)

Temp. Range: Nil

Time Range Nil

Others: Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	6-10 LPM
Trailing	N.A	---	---
Backing	N.A.	---	6-7 LPM

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: See table

Tungsten Electrode type and size: EWTh-2; Dia. 2.4

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: 6/9

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	GTAW	ER 347	2.4	DCEN	60-90	N.A.	N.A.	Nil
All	SMAW	E 316	2.5	DCEP	60-90	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	-Do-	90-130	N.A	N.A	Nil

Approved by: (V. Ravindran)
Sr. Manager /WTC

Prepared: (P. Sivasubramanian)
Welding Engineer/WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1031 Date: 08.10.97 Supporting PQR No.: 644.

Rev. No.: 00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding of P8 stub material to CS Stub/Tube material without PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per Drawing.

Backing (Yes/No) : Yes

Backing Material (type) : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 8 Group No.: 1 or 2 to P. No.: 1 Group No.: 1 or 2

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: Unlimited.

Pipe Dia. range

Groove: N.A. Fillet: Unlimited.

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	EniCrFe-3		
Specn. No. (SFA):	5.11	Size of filler metal:	See table
F. No.:	43	Flux Trade Names:	N.A
A. No.:	Nil	Consumable insert:	N.A.
		Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range

Groove: N.A.

Fillet: 9.0 mm max. (Max. 6 mm per pass)

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All.
Weld Progression: (Up / Down)	Vertical up

PREHEAT (QW-406)

Preheat temp (min).	: Nil (Min.10^{o}C)
Inter pass temp. (Max.)	: 300^{o}C
Pre heat maintenance	: Nil
Others	: Nil

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1031**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: N.A

Tungsten Electrode type and size: N.A.

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: String

Orifice or Gas cup size: N.A.

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back gouging: Nil.

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	EniCrFe-3	2.5	DCEP	70-100	N.A.	N.A.	Nil
Others	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by: (V.Ravindran)
Sr.Manager /WTC

Prepared: (P.Sivasubramanian)
Welding Engineer/WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1030 Date: 08.10.97 Supporting PQR No.: 528.

Rev. No.: 01 Date: 04.04.06

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding P4 Tubes/Pipes with Pre heat and without PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per Drawing.

Backing (Yes/No) : Yes

Backing Material (type) : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 to P. No.: 4 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: 13 mm max.

Pipe Dia. range

Groove: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018-B2

Specn. No. (SFA): 5.5 Size of filler metal: See table

F. No.: 4 Flux Trade Names: N.A

A. No.: 3 Consumable insert: Nil.

Electrode |Flux (Class): N.A.

Deposited weld metal thickness range

Groove: N.A.

Fillet: 13 mm max. (Max.6 m per pass)

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All.

Weld Progression: (Up / Down) Vertical up

PREHEAT (QW-406)

Preheat temp (min). : 120^{o}C

Inter pass temp. (Max.): 300^{o}C

Post heat maintenance: Nil

Others : Nil

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1030 Rev 01**

PWHT (QW-407)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A.	---	---
Others:	Nil	Trailing	N.A	---	---
		Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table
Amps. (Range): See table Volts: N.A
Tungsten Electrode type and size: N.A.
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A.

TECHNIQUES (QW-410)

String or Weave Bead: Root & H: String: Others: String or Weave (3 Dia. Max.)
Orifice or Gas cup size: N.A.
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back gouging: Nil.
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil
Others: Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
Root	SMAW	E8018-B2	2.50	DCEP	70-100	N.A.	N.A.	Nil
Others	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

Approved by: (S.Ramesh)
SDGM/WTC&WCMC

Prepared: (Dr.K.P.Dhndapani)
DGM,/WTC&WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1029 Date: 06.10.97 Supporting PQR No.: 570

Rev. No.: 00 Date: ------

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding 18Cr8Nri Stainless steel Tubes/Pipes without PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per prodn. drg.

Backing (Yes/No) : Yes

Backing Material (type) : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 8 Group No.: 1 to P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: Unlimited

Pipe Dia. range

Groove: Unlimited Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 347

Specn. No. (SFA): 5.4 Size of filler metal: See table

F. No.: 5 Flux Trade Names: N.A

A. No.: 8 Consumable insert: N.A

Electrode |Flux (Class): N.A.

Deposited weld metal thickness range:

Groove: N.A.

Fillet: Unlimited. (Max. 6.00 mm per pass)

POSITION (QW-405)

Position of Groove: N.A.

Position of fillet: All.

Weld Progression: (Up / Down) Vertical up

PREHEAT (QW-406)

Preheat temp (min). : Nil (Min 10^{o}C)

Inter pass temp. (Max.): 300 Deg. C

Pre heat maintenance: Nil

Others : Nil

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WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1029**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	N.A.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E 347	2.5	DCEP	70-100	N.A.	N.A.	Nil
Others	-Do-	-Do-	3.15	-Do-	80-120	N.A.	N.A.	Nil
---Do--	-Do-	-Do-	4.00	-Do-	120-150	N.A	N.A	Nil

Approved by: (V.Ravindran)
Sr.Manager /WTC

Prepared: (P.Sivasubramanain)
Welding Engineer/WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1028**	Date	: 16/03/95	Supporting PQR. No	**1057**
Rev. No	: **01**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of Carbon steel to 1 Cr. ½Mo. / 1¼Cr. ½Mo steel Tubes /Pipes(Dia. Upto 100mm) with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : With or without
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : Metal

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 13.0mm Fillet : N.A
Pipe Diameter Range : Groove : Dia upto 100mm Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 13.0mm Max. GTAW :5.0mm.Max.; SMAW: Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil
Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 10
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil

Approved by
(Dr.K.P.Dhandapani)
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Prepared by
(S.Singaravelu)
Manager / WTC

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1027	Date: 03.10.97	Supporting PQR No.:	578&673
Rev. No.:	02	Date: 04.04.06		
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)	

Application: Fillet and Socket welding of P4/P5A steel components to P8 Steel with Preheat and without PWHT.

JOINTS (QW-402)

Joint Design	: As per Production Drawing
Backing (Yes/No)	: Yes
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 or 2 to P. No.: 8 Group No.: 1or 2

P 5A Group No: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: 13 mm max.

Pipe Dia range: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 309	**Size of filler metal:**	**See table**
Specn. No. (SFA):	5.4	Flux Trade Names:	Nil
F. No.:	5	Consumable insert:	Nil
A. No.:	8	Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range:

Groove: N.A

Fillet: 13 mm max. (Maximum 6 mm per pass)

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All.
Weld Progression: (Up / Down)	Vertical up

PREHEAT (QW-406)

Preheat temp (min). :	150^{O}C (On P4/P5A side only)
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Others :	Nil

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1027 Rev 02**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A.

TECHNIQUES (QW-410)

String or Weave Bead:	String.
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E309	2.50	DCEP	70-100	N.A.	N.A.	Nil
Others	-Do-	E309	3.15	DCEP	100-130	N.A.	N.A.	Nil

Approved by: (S.Ramesh)
SDGM/WTC&WCMC

Prepared: (Dr.K.P.Dhandapani)
DGM/WTC&WCMC

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1026 Date: 10.09.97 Supporting PQR No.: 1057

Rev. No.: 01 Date: 13.03.03

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet and Socket welding of Carbon steel to1Cr 0.5Mo/1.25Cr 0.5Mo Steel Tubes/Pipes (Dia. up to 100) with Preheat and without PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per production drg.

Backing (Yes/No) : As per production drg.

Backing Material (type) : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 1 Group No.: 1 or 2 to P. No.: 4 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: 13.00 mm max.

Pipe Dia range

Groove: N.A Fillet: Dia. Up to 100.00 mm

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 7018-1

Specn. No. (SFA): 5.1 Size of filler metal: See table

F. No.: 4 Flux Trade Names: N.A

A. No.: 1 --- Consumable insert: Nil
Electrode |Flux (Class): N.A.

Deposited weld metal thickness range:

Groove: N.A

Fillet: 9.0 mm max. (maximum 3 mm/pass)

POSITION (QW-405)

Position of Groove: N.A..

Position of fillet: All.

Weld Progression: (Up / Down) vertical up

PREHEAT (QW-406)

Preheat temp (min). : 125 Deg.C

Inter pass temp. (Max.): 300 Deg. C

Pre heat maintenance: Nil

Others : Nil

Others: Nil

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1026 Rev 01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A.	---	---
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	N.A.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil

TECHNIQUES (QW-410)

String or Weave Bead:	Root : string, Others: string or weave (3 Dia. Max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	N.A.
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	SMAW	E 7018-1	2.5	DCEP	70-100	N.A.	N.A.	Nil
Others Layers	SMAW	E 7018-1	3.15	DCEP	90-130	N.A.	N.A.	Nil

Approved by: (K.Narasimhan)
DGM/WTC

Prepared (R.Rajanarayanan)
DM/WTC

BHARAT HEAVY ELECTRICALS LIMITED
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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1025	Date: 08.09.07	Supporting PQR No.: 1076
Rev. No.:	01	Date: 06.09.05	

Welding Process: GTAW + SMAW — Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of Carbon Steel Pipes/Stubs to Stainless Steel thermo well with PWHT.

JOINTS (QW-402)

Joint Design	: Groove as per production drg.
Backing (Yes/No)	: As per production drg.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 1 Group No.: 1or 2 to P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: 4.8 to 40mm — Fillet: N.A

Pipe Dia range

Groove: Unlimited — Fillet: N.A

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	GTAW: ERNiCr-3; SMAW: ENiCrFe -3		
Specn. No. (SFA):	5.14, 5.11	Size of filler metal:	See table
F. No.:	43	Flux Trade Names:	N.A
A. No.:	Nil ---	Consumable insert:	Nil
		Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: 40.0 max. (GTAW: 5.0 max; SMAW: 35.0 mm max.) (Max.6mm/pass)

Fillet: Nil

POSITION (QW-405)

Position of Groove:	F.H.
Position of fillet:	N.A.
Weld Progression: (Up / Down)	N.A

PREHEAT (QW-406)

Preheat temp (min). :	Upto 25 mm: Nil (min.10 Deg. C)
Above 25 mm 150 Deg. C.	
Inter pass temp. (Max.):	300^{o}C
Preheat maintenance:	Nil
Others:	Nil

WELDING PROCEDURE SPECIFICATION

PWHT (QW-407)

Temp. Range:	610±15 Deg. C.
Time Range	2.5 minutes/mm
(Minimum 30 minutes)	
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Argon	--	6-12 LPM
Trailing	N.A	---	---
Backing	Argon	---	4-6 LPM

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	EWTh-2; Dia.2.4 mm.
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	6/9
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root Pass	GTAW	ERNiCr-3	2.4	DCEN	70-100	N.A.	N.A.	Nil
Others Layers	SMAW	ERNiCrFe-3	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	SMAW	ERNiCrFe-3	3.15	DCEP	90-130	N.A	N.A	Nil
-Do-	SMAW	ERNiCrFe-3	4.0	DCEP	120-170	N.A	N.A	Nil

Approved by: (S.Ramesh)
SDGM/WTC&WCMC

Prepared by: (Dr.K.P.Dhandapani)
DGM/WTC&WCMC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1024 Date: 08.08.97 Supporting PQR No.: 840

Rev. No.: 00 Date: ----

Welding Process: GTAW + SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of 2 ¼ Cr1Mo Steel Pipes/Stubs with Stainless Steel Thermo well with PWHT

JOINTS (QW-402)

Joint Design : Groove as per production drg.

Backing (Yes/No) : As per production drg.

Backing Material (type) : ---do---

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 5A Group No.: 1 TO P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: 5.0 to 40 mm Fillet: N.A

Pipe Dia range:

Groove: Unlimited Fillet: N.A

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): GTAW : ERNiCr-3; SMAW : ENiCrFe -2

Specn. No. (SFA): 5.14, 5.11 Size of filler metal: See table

F. No.: 43 Flux Trade Names: N.A

A. No.: Nil --- Consumable insert: Nil
Electrode |Flux (Class): N.A.

Deposited weld metal thickness range:

Groove: 40.0 max. (GTAW: 5.0 max,; SMAW: 35.0 mm max.) (Max.6mm/pass)

Fillet: N.A

POSITION (QW-405)

Position of Groove: All

Position of fillet: All.

Weld Progression: (Up/Down) Vertical up

PREHEAT (QW-406)

Preheat temp. : 150^{O}c (On P5A side)

Inter pass temp. (Max.): 300^{o}C

Pre heat maintenance: Nil

Others: Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1024**

PWHT (QW-407)

Temp. Range:	680-720^{O}c
Time Range	1Hr/25mm(min.1 Hr.)
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Argon	---	6-12 LPM
Trailing	N.A	---	---
Backing	Argon	---	4-6 LPM

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	EWTh2 ; Ø 2.4mm
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil

TECHNIQUES (QW-410)

String or Weave Bead:	String
Orifice or Gas cup size:	6/9
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	GTAW	ERNiCr-3	2.40	DCEN	70-130	N.A.	N.A.	Nil
Others	SMAW	EniCrFe-2	2.50	DCEP	70-100	N.A.	N.A.	Nil
-Do-	SMAW	EniCrFe-2	3.15	DCEP	100-130	N.A	N.A	Nil

Approved by: (V.Ravindran)
Sr.Manager/WTC

Prepared by: (PSivasubramainan)
WELDING ENGINEER/WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1023	Date: 01.08.97	Supporting PQR No.: 509.118.
Rev. No.:	00	Date: ----	
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)
Application: Fillet & Socket welding of P5A tubes/ pipes with PWHT.			

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: Yes.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.:5A	Group No.: 1	TO	P. No.: 5A	Group No.: 1
Spec. Type & Grade		: N.A		
Chem. Analysis & Mech. Prop		: N.A		

Thickness Range

Groove: N.A	Fillet: Unlimited

Pipe Dia range:

Groove: N.A	Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 9018B3			
Specn. No. (SFA):	5.5		Size of filler metal:	See table
F. No.:	4		Flux Trade Names:	N.A
A. No.:	4	---	Consumable insert:	N.A
			Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range: -

Groove: N.A

Fillet: Unlimited (Max.6 mm per pass)

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All.
Weld Progression:	Vertical up

PREHEAT (QW-406)

Preheat temp. :	$t \leq 13$: Nil (Min10^{O}C min)
	t > 13: 150^{o}C
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	200^{O}c for 2 hrs. for pipes
Others:	Nil

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1023**

PWHT (QW-407)

Temp. Range:	680-750 ºC
Time Range (min.1 Hr. for pipe & ½ hr for tube)	1Hr/25mm
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	--	----
Trailing	N.A	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): -Do-	Volts: -do-
Tungsten Electrode type and size:	EWTh2 ; Ø 2.4mm
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil

TECHNIQUES (QW-410)

String or Weave Bead:	Root & H: String; Others: String/Weave (3 Dia. max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	N.A
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E9018B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A	N.A	Nil

Approved by: (V.Ravindran)
Sr.Manager/WTC

Prepared by: (PSivasubrmainan)
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BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1022	Date: 01.08.97	Supporting PQR No.: 522.
Rev. No.:	00	Date: ----	
Welding Process: SMAW			Type: Manual
			(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding of P1 Gr 2 components to P1 group 1 or 2 without Preheat and without PWHT. (Other than SA 106 Gr C).

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: Yes.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 1	Group No.: 2	TO	P. No.: 1Group No.: 1 or 2
Spec. Type & Grade		: N.A	
Chem. Analysis & Mech. Prop		: N.A	

Thickness Range

Groove: N.A	Fillet: 9 mm max.

Pipe Dia

Groove: NA	Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	E 7018-1			
Specn. No. (SFA):	5.1		Size of filler metal:	See table
F. No.:	4		Flux Trade Names:	N.A
A. No.:	1	---	Consumable insert:	N.A
			Electrode |Flux (Class):	N.A.

Deposited weld metal thickness range:

Groove: N.A

Fillet: 9.0 mm max. (Max. 6 mm per pass)

POSITION (QW-405)

Position of Groove:	N.A.
Position of fillet:	All.
Weld Progression:	Vertical up

PREHEAT (QW-406)

Preheat temp. :	Nil (10^{O}C min)
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Others:	Nil

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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1022**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	--	----
Trailing	Nil	---	---
Backing	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	N.A
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A

TECHNIQUES (QW-410)

String or Weave Bead:	Root & H: String; Others: String/Weave (3 Dia. max.)
Orifice or Gas cup size:	N.A.
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018-1	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1021	Date: 01.08.97	Supporting PQR No.:	517, 522.
Rev. No.:	01	Date: 04.04.06		
Welding Process: SMAW			Type: Manual (Auto,Semi-Auto,Manual,Machine)	

Application: Fillet & Socket welding of P1 Gr 1 tubes / pipes & SA 106 Gr C pipes without Pre heat and without PWHT.

JOINTS (QW-402)

Joint Design	: Fillet as per drawing
Backing (Yes/No)	: Yes.
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 1	Group No.	: 1 /2*	TO P. No.: 1	Group No.: ½*
Spec. Type & Grade		: N.A	**<u>*Gr2, only SA 106 Gr. C up to 19mm</u>**	
Chem. Analysis & Mech. Prop		: N.A		

Thickness Range

Groove:	N.A	Fillet:	19 mm max.
Pipe Dia Range:	Unlimited		
Others:	Nil		

FILLER METALS (QW-404)

AWS No. (Class):	E 7018-1			
Specn. No. (SFA):	5.1		Size of filler metal:	See table
F. No.:	4		Flux Trade Names:	N.A
A. No.:	1	---	Consumable insert:	N.A
			Electrode |Flux (Class):	N.A.

<u>Deposited weld metal thickness range: -</u>

Groove: N.A

Fillet: 19 mm max. (Max.6 mm per pass)

POSITION (QW-405)

Position of Groove:	All.
Position of fillet:	All.
Weld Progression: (Up/Down)	Vertical up
Other :	Nil

PREHEAT (QW-406)

Preheat temp. :	Nil (10^{O}C min)
Inter pass temp. (Max.):	300^{o}C
Pre heat maintenance:	Nil
Others:	Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1021 Rev.01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	--	----
Trailing	Nil	---	---
Backing	Nil	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table Polarity: See table

Amps. (Range): See table Volts: N.A

Tungsten Electrode type and size: N.A

Mode of metal transfer for (GMAW): N.A.

Electrode wire feed speed range: N.A.

Pulsing current (GTAW): N.A

TECHNIQUES (QW-410)

String or Weave Bead: Root & H: String; Others: String/Weave (3 Dia. Max.)

Orifice or Gas cup size:

Initial and inter pass cleaning: Brushing/Chipping/Grinding

Method of back gouging: Nil

Oscillation: N.A

Contact tube to work distance: N.A

Multiple or single pass (per side): Single or Multiple

Multiple or single electrode: Single

Electrode spacing: N.A.

Peening: Nil

Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E7018-1	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A	N.A	Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1020 Date: 01.08.97 Supporting PQR No.: 547

Rev. No.: 01 Date: 04.04.06

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding of P5A components without PWHT

JOINTS (QW-402)

Joint Design : Fillet as per drawing

Backing (Yes/No) : Yes.

Backing Material (type) : Metal

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 5A Group No.: 1 TO P. No.: 5A Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: 13 mm max.

Pipe Dia Range Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 9018B3

Specn. No. (SFA): 5.5 Size of filler metal: See table

F. No.: 4 Flux Trade Names: N.A

A. No.: 4 --- Consumable insert: N.A
Electrode |Flux (Class): N.A.

Deposited weld metal thickness range:

Groove: N.A

Fillet: 13 mm max. (Max.6 mm per pass)

POSITION (QW-405)

Position of Groove: N.A

Position of fillet: All

Weld Progression: (Up/Down) Vertical up

Other : Nil

PREHEAT (QW-406)

Preheat temp. : 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Pre heat maintenance: Nil

Others: Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1020 Rev.01**

PWHT (QW-407)		**GAS (QW-408)**			
Temp. Range:	Nil		**Gases**	**Mix%**	**Flow Rt.**
Time Range	Nil	Shielding	N.A	--	----
Others:	Nil	Trailing	N.A	---	---
		Backing	N.A	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): See table	Volts: N.A
Tungsten Electrode type and size:	N.A
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A

TECHNIQUES (QW-410)

String or Weave Bead:	Root & H: String; Others: String/Weave (3 Dia. max.)
Orifice or Gas cup size:	
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	**Process**	**Filler**		**Current**		**Volt Range**	**Travel speed range**	**Others (hot wire, torch angle etc.)**
		Class	**Dia. mm**	**Type**	**Amps.**			
All	SMAW	E9018B3	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A	N.A	Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.: 1019 Date: 01.08.97 Supporting PQR No.: 543,544

Rev. No.: 00 Date: ----

Welding Process: SMAW Type: Manual

(Auto,Semi-Auto,Manual,Machine)

Application: Fillet & Socket welding of P4 tubes/pipes with P5A tubes/pipes with PWHT.

JOINTS (QW-402)

Joint Design : Fillet as per drawing

Backing (Yes/No) : As per drg.

Backing Material (type) : -do-

Metal/Non fusing metal/
Non metallic/Others

BASE METAL (QW-403)

P. No.: 4 Group No.: 1 TO P. No.: 5A Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: N.A Fillet: Unlimited

Pipe Dia.

Groove: N.A Fillet: Unlimited

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class): E 8018B2

Specn. No. (SFA): 5.5 Size of filler metal: See table

F. No.: 4 Flux Trade Names: N.A

A. No.: 3 --- Consumable insert: N.A
Electrode |Flux (Class): N.A.

Deposited weld metal thickness range:

Groove: N.A

Fillet: Unlimited (Max .6mm per pass)

POSITION (QW-405)

Position of Groove: N.A

Position of fillet: All

Weld Progression: Vertical up

PREHEAT (QW-406)

Preheat temp. : $t \leq 13$: Nil (Min.10^{o}C)
$T > 13$: 150^{o}C

Inter pass temp. (Max.): 300^{o}C

Pre heat maintenance: 200^{0}C for 2 hrs. for pipes

Others: Nil

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WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1019**

PWHT (QW-407)

Temp. Range:	680-720oC
Time Range	1 Hr / 25mm
(Min .1 Hr. for pipe & ½ hr. for tube)	
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	N.A	--	----
Trailing	Nil	---	---
Backing	Nil	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table — Polarity: See table
Amps. (Range): ---do-- — Volts: N.A
Tungsten Electrode type and size: N.A
Mode of metal transfer for (GMAW): N.A.
Electrode wire feed speed range: N.A.
Pulsing current (GTAW): N.A

TECHNIQUES (QW-410)

String or Weave Bead: Root & H: String; Others: String/Weave (3 Dia. max.)
Orifice or Gas cup size: N.A
Initial and inter pass cleaning: Brushing/Chipping/Grinding
Method of back gouging: N.A
Oscillation: N.A
Contact tube to work distance: N.A
Multiple or single pass (per side): Single or Multiple
Multiple or single electrode: Single
Electrode spacing: N.A.
Peening: Nil
Others: Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
All	SMAW	E8018B2	2.5	DCEP	70-100	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	3.15	DCEP	100-140	N.A.	N.A.	Nil
-Do-	-Do-	-Do-	4.0	DCEP	140-190	N.A	N.A	Nil

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Sr. Manager / WTC

Prepared by: (P.Sivasubramanian)
Welding Engineer/WTC

BHARAT HEAVY ELECTRICALS LIMITED
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WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1018**	Date	: 16/03/95	Supporting PQR. No	**947**
Rev. No	: **02**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of 1 Cr. ½Mo. / 1¼Cr. ½Mo components to Carbon steel components with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. : 1 Group No. : 2 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 50.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –A1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	2	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 50.0mm Max. GTAW :5.0mm.Max.; SMAW: Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : 655 ± 15 ^{0}C

Time Range : 2.5minutes / mm

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : N.A
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-A1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-A1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-A1	4.0	DCEP	130 -170	N.A	N.A	Nil
--do--	SMAW	E7018-A1	5.0	DCEP	170 -220	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
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WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1017**	Date	: 06/11/93	Supporting PQR. No	**1057**
Rev. No	: **03**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of Carbon steel to 1 Cr. ½Mo. / 1¼Cr. ½Mo tubes / pipes (Dia upto 127mm) with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : Metal

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 or 2 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 13.0mm Fillet : N.A
Pipe Diameter Range : Groove : Max. 127mm Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 13.0mm Max. GTAW :5.0mm.Max.;SMAW:Balance (Max.3mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 125 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil
Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 10
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil

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(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
WELDING TECHNOLOGY CENTRE
Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1016	Date: 06-11-93	Supporting PQR No.: 530
Rev. No.:	01	Date: 17.07.03	

Welding Process: GTAW+SMAW — Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Groove welding of stainless steel tubes without Preheat and without PWHT.

JOINTS (QW-402)

Joint Design	: As per drawing.
Backing (Yes/No)	: GTAW: No: SMAW: Yes
Backing Material (type)	: Metal
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 8 Group No.: 1 TO P. No.: 8 Group No.: 1

Spec. Type & Grade : N.A

Chem. Analysis & Mech. Prop : N.A

Thickness Range

Groove: 1.6 to 12.0 mm Fillet: N.A.

Pipe Dia.:

Groove: Unlimited Fillet: N.A

Others: Nil

FILLER METALS (QW-404)

	GTAW	SMAW	
AWS No. (Class):	ER347	E347	
Specn. No. (SFA):	5.9	5.4	Size of filler metal; Refer table
F. No.:	6	5	Flux Trade Names: N.A
A. No.:	8	8	Consumable insert: N.A
			Electrode |Flux (Class): N.A

Deposited weld metal thickness range:

Groove: 12 mm max. [(GTAW: 4mm Max: Max.2mm/pass) (SMAW: Balance)]

Fillet: N.A.

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	N.A.
Weld Progression: (Up/Down)	Vertical up

PREHEAT (QW-406)

Preheat temp. :	Nil (Min.10^{o}C)
Inter pass temp. (max):	250^{0}C
Pre heat maintenance:	Nil
Others:	Nil

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1016 Rev 01**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Argon	--	6-14 LPM
Trailing	N.A	---	---
Backing	Argon	---	3-6LPM

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): Refer table	Polarity: Refer table
Amps. (Range): Refer table	Volts: Refer table
Tungsten Electrode type and size:	EWTh2; ø 2.4 mm
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	N.A

TECHNIQUES (QW-410)

String or Weave Bead:	String only
Orifice or Gas cup size:	6/9
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	N.A
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	N.A
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
Root	GTAW	ER347	2.4	DCEN	60-110	N.A.	N.A.	Nil
Others	SMAW	E347	2.5	DCEP	60-100	N.A.	N.A.	Nil
Others	SMAW	E347	3.15	DCEP	90-130	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
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WELDING PROCEDURE SPECIFICATION

Form No. 101-401

WPS No.:	1015	Date: 06-11-93	Supporting PQR No.:	556
Rev. No.:	00	Date: ---		

Welding Process: GTAW — Type: Manual (Auto,Semi-Auto,Manual,Machine)

Application: Butt welding of P5A tubes P8 tubes with P8 tubes with Preheat and without PWHT

JOINTS (QW-402)

Joint Design	: Groove as per drawing
Backing (Yes/No)	: As per drg.
Backing Material (type)	: -do-
Metal/Non fusing metal/ Non metallic/Others	

BASE METAL (QW-403)

P. No.: 5A	Group No.: 1	TO	P. No.: 8	Group No.: 1
Spec. Type & Grade		: N.A		
Chem. Analysis & Mech. Prop		: N.A		

Thickness Range

Base Metal:	Groove: 1.6 to 8.0	Fillet:	N.A.
Weld Metal	Groove: Max 8.0	Fillet :	N.A
Pipe dia.:	Groove: Unlimited	Fillet:	N.A

Others: Nil

FILLER METALS (QW-404)

AWS No. (Class):	ERNiCr3		
Specn. No. (SFA):	5.14	Size of filler metal: see table	
F. No.:	43	Flux Trade Names: N.A	
A. No.:	N.A	Consumable insert: Nil	
		Electrode |Flux (Class): N.A	

POSITION (QW-405)

Position of Groove:	All
Position of fillet:	N.A.
Weld Progression:	Vertical up

PREHEAT (QW-406)

Preheat temp. :	150^0C
Inter pass temp. (Max.):	300^0C
Pre heat maintenance:	Nil
Others:	Nil

BHARAT HEAVY ELECTRICALS LIMITED
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Tiruchirappalli-620014

WELDING PROCEDURE SPECIFICATION

Form No. 101-401 **WPS No.: 1015**

PWHT (QW-407)

Temp. Range:	Nil
Time Range	Nil
Others:	Nil

GAS (QW-408)

	Gases	Mix%	Flow Rt.
Shielding	Argon	--	6-14 LPM
Trailing	Nil	---	---
Backing	Nil	---	---

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC/DC): See table	Polarity: See table
Amps. (Range): --do--	Volts: --do--
Tungsten Electrode type and size:	EWTh2; ø 2.4 mm
Mode of metal transfer for (GMAW):	N.A.
Electrode wire feed speed range:	N.A.
Pulsing current (GTAW):	Nil

TECHNIQUES (QW-410)

String or Weave Bead:	Root & 2G: String; Others: String/Weave (3 Dia. Max.)
Orifice or Gas cup size:	6/9
Initial and inter pass cleaning:	Brushing/Chipping/Grinding
Method of back gouging:	Nil
Oscillation:	N.A
Contact tube to work distance:	N.A
Multiple or single pass (per side):	Single or Multiple
Multiple or single electrode:	Single
Electrode spacing:	N.A.
Peening:	Nil
Others:	Nil

Weld Layer	Process	Filler		Current		Volt Range	Travel speed range	Others (hot wire, torch angle etc.)
		Class	Dia. mm	Type	Amps.			
A1	GTAW	ERNiCr3	2.4	DCEN	60-110	N.A.	N.A.	Nil

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Manager /WTC
Date: 06/11/93

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Date: 06/11/93

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WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1014**	Date	**:** 06/11/93	Supporting PQR. No	**118 & 509**
Rev. No	**: 02**	Date	**:** 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Groove welding of P5A tubes / pipes with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. : 5A Group No. : 1 to P. No : 5A Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 200.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class)	: ER90S – B3	E9018 –B3	Size of Filler metal : Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name : N.A.
F. No.	: 6	4	Electrode-flux (Class) : N.A..
A. No.	: 2	4	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. GTAW :5.0mm.Max.;SMAW:Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : t < 13mm : Nil (min 10^0C)
t > 13mm :150^0C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : 150 ^{0}C for 2 hrs. for pipes
Others : Nil

PWHT (QW – 407)

Temp. Range : 680 – 750 ^{0}C
Time Range : 2.5 minutes/mm
(Min.30 minutes for tubes & Min. 60 minutes for pipes)
Others : Nil

GAS (QW – 408)

Gases		Mix/Purity %	Flow.Rt.(lpm)
Shielding	:	Argon 99.99	6 - 14
Trailing	:	N.A ---	---
Backing	:	N.A. ---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER90S-B3	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E9018-B3	2.5	DCEP	70 - 110	N.A.	N.A	Nil
--do--	SMAW	E9018-B3	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E9018-B3	4.0	DCEP	140 -190	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1013**	Date	: 06/11/93	Supporting	**547**
Rev. No	: **01**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P5A tubes with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 5A Group No. : 1 to P. No : 5A Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech .Prop. : N.A.
Thickness Range : Groove : 1.5 to 8.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class)	: ER90S – B3	E9018 –B3	Size of Filler metal : Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name : N.A.
F. No.	: 6	4	Electrode-flux (Class) : N.A..
A. No.	: 2	4	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 8.0mm Max. GTAW :4.0mm.Max.;SMAW:Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150 ^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & H :String ; Others :String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER90S-B3	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E9018 -B3	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E9018 -B3	3.15	DCEP	100 -140	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	**: 1012**	Date	**:** 06/11/93	Supporting PQR. No	**543 & 544**
Rev. No	**: 02**	Date	**:** 22/09/07		

Welding Process **:** GTAW + SMAW Type **:** Manual (Auto/Semi-Auto/Manual/Machine)

Application **:** Butt welding of P4 tubes / pipes with P5A tubes / pipes with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design **:** As per drawing
Backing (Yes / No) **:** With or without
Backing Material Type **:** Metal
(Metal/Non fusing metal/Non metallic/Others)

BASE METAL (QW – 403)

P. No. **:** 4 Group No. **:** 1 to P. No **:** 5A Group No. **:** 1
Spec. Type & Grade **:** N.A.
Chem. Analysis & Mech. Prop. **:** N.A.
Thickness Range **:** Groove **:** 5.0 to 200.0mm Fillet **:** N.A
Pipe Diameter Range **:** Groove **:** Unlimited Fillet **:** N.A.
Others **:** Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	**:** ER80S – B2	E8018 –B2	Size of Filler metal	: Refer Table
Spec. No. (SFA)	**:** 5.28	5.5	Flux trade name	: N.A.
F. No.	**:** 6	4	Electrode-flux (Class)	: N.A..
A. No.	**:** 2	3	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove **:** 200.0mm Max. GTAW :5.0mm.Max.;SMAW:Balance (Max.5mm / pass)
Fillet **:** N.A**.**
Others **:** Nil

POSITION (QW – 405)

Position(s) of Groove **:** All
Position(s) of Fillet **:** N.A.
Weld Progression.(Up/Down)**:** Vertical up
Others **:** Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) **:** t < 13mm : Nil (min 10^0C)
t > 13mm :150^0C)
Interpass Temp. (Max) **:** 300 ^{0}C
Preheat Maintenance **:** 200 ^{0}C for 2 hrs. for pipes
Others **:** Nil

PWHT (QW – 407)

Temp. Range : 680 – 720 ^{0}C
Time Range : 2.5 minutes/mm
(Min.30 minutes for tubes & Min. 60 minutes for pipes)
Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A ---		---
Backing :	N.A. ---		---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER80S-B2	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E8018-B2	2.5	DCEP	70 - 110	N.A.	N.A	Nil
--do--	SMAW	E8018-B2	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E8018-B2	4.0	DCEP	140 -190	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1011**	Date	: 06/11/93	Supporting	**529**
Rev. No	: **01**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P4 tubes to P5A tubes with preheat & without PWHT

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 4 Group No. : 1 to P. No : 5A Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 8.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER80S – B2	E8018 –B2	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 3	3	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 8.0mm Max. GTAW :4.0mm.Max.;SMAW:Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150^{0}C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER80S-B2	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E8018-B2	2.5	DCEP	70 - 110	N.A.	N.A	Nil
--do--	SMAW	E8018-B2	3.15	DCEP	100 -140	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1010**	Date	: 06/11/93	Supporting	**555**
Rev. No	: **05**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of 1 Cr. ½Mo. / 1¼Cr. ½Mo tubes / pipes with preheat & with PWHT.

JOINTS (QW – 402)

Joint Design : As per Production drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 4 Group No. : 1 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : **5**.0 to 200.0mm Fillet : N.A
Pipe Diameter Range : Groove : OD > 127mm Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class) :	ER80S – B2	E8018 –B2	Size of Filler metal	: Refer Table
Spec. No. (SFA) :	5.28	5.5	Flux trade name	: N.A.
F. No. :	6	4	Electrode-flux (Class)	: N.A..
A. No. :	2	3	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 200.0mm Max. GTAW :5.0mm.Max.;SMAW:Balance (Max.5mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150^{0}C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : 655 ± 15^{0}C

Time Range : 2.5 minutes/mm
(Min.30 minutes)

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 12
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 13.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER80S-B2	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E8018-B2	2.5	DCEP	70 - 110	N.A.	N.A	Nil
--do--	SMAW	E8018-B2	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E8018-B2	4.0	DCEP	140 -190	N.A	N.A	Nil

Approved by
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DGM / WTC

Prepared by
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Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1009**	Date	: 06/11/93	Supporting	**528**
Rev. No	: **02**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of 1 Cr. ½Mo. / 1¼Cr. ½Mo tubes / pipes with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 4 Group No. : 1 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 13.0mm Fillet : N.A
Pipe Diameter Range : Groove : Max. 127mm Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER80S – B2	E8018 –B2	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	3	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 13.0mm Max. GTAW :4.0mm.Max.;SMAW:Balance (Max.4mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 150^{0}C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

WPS. No. : **1009** Revision : **02**

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 12
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : N.A.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER80S-B2	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E8018-B2	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E8018-B2	3.15	DCEP	100 -140	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
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WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1008**	Date	: 06/11/93	Supporting	**548**
Rev. No	: **02**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of ½Cr or ½Cr. ½Mo. tubes to 1 Cr. ½Mo. / 1¼Cr. ½Mo tubes with preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 3 Group No. : 1 or 2 to P. No : 4 Group No. : 1
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 13.0mm Fillet : N.A
Pipe Diameter Range : Groove : Max. 127mm Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –A1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	2	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 13.0mm Max. GTAW : 5.0mm.Max.;SMAW:Balance (Max.4mm / pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : 125^{0}C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

WPS. No. : **1008** Revision : **02**

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

		Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding	:	Argon	99.99	6 - 12
Trailing	:	N.A	---	---
Backing	:	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : N.A.
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-A1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-A1	3.15	DCEP	100 -140	N.A	N.A	Nil

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WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1007**	Date	: 06/11/93	Supporting	**527**
Rev. No	: **01**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P3 tubes without preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : As per Production drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 3 Group No. : 1 to P No : 3 Group No. : 1
Spec. Type & Grade : ½ Mo steel
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.6 to 10.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 – A1	Size of Filler metal	: Refer Table
Specn. No. (SFA)	: 5.28	5.5	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	2	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 10.0mm Max. GTAW : 5.0mm.Max.;SMAW:Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : Nil (min. 10^0C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : Root & 2G : String; Others : String /weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-A1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-A1	3.15	DCEP	100 -140	N.A	N.A	Nil

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WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1006**	Date	: 06/11/93	Supporting	**527**
Rev. No	: **02**	Date	: 22/09/07	PQR. No	

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P1 tubes to P3 tubes without preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 or 2 to P. No : 3 Group No. : 1
Spec. Type & Grade : Carbon steel to ½ Mo steel
Chem. Analysis & Mech .Prop. : N.A.
Thickness Range : Groove : 1.5 to 9.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 – 1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 9.0mm Max. GTAW : 5.0mm.Max.;SMAW:Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up

Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : Nil (min. 10^0C)
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil

Others : Nil

PWHT (QW – 407)

Temp. Range : Nil

Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Single or multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1005**	Date	: 06/11/93	Supporting PQR. No	**1327**
Rev. No	: **05**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P1 Gr. tubes / pipes with PWHT.

JOINTS (QW – 402)

Joint Design : As per Production drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 1 Group No. : 2 to P. No : 1 Group No. : 2
Spec. Type & Grade : N.A.
Chem.Analysis & Mech.Prop. : N.A.
Thickness Range : Groove :**9**.0 to 200mm Fillet : N.A
Pipe Diameter Range : Groove :Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class)	: ER70S – A1	E7018 – A1	Size of Filler metal : Refer Table
Spec. No. (SFA)	: 5.28	5.5	Flux trade name : N.A.
F. No.	: 6	4	Electrode-flux (Class) : N.A..
A. No.	: 2	2	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 200 mm Max. GTAW : 5.0mm.Max.; SMAW: Balance (Max.5mm/pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : t < 25mm:Nil (min 10^0C)
t 25 to75mm : 100 ^{0}C
t >75mm :150^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance :150 ^{0}C for 2hrs.on completion & interruptions for Gr. C pipes
Others : Nil

PWHT (QW – 407)

Temp. Range : 620 -650 ^{0}C
Time Range : 2.5 minutes / mm
(Min.30 minutes)

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9/13
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-A1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-A1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-A1	4.0	DCEP	140 -190	N.A	N.A	Nil

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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1004**	Date	: 06/11/93	Supporting PQR. No	**516 & 632**
Rev. No	: **03**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P1 Gr.1 tubes / pipes to P1 Gr.1 or 2 tubes / pipes with PWHT.

JOINTS (QW – 402)

Joint Design : As per drawing
Backing (Yes / No) : With or without
Backing Material Type : Metal
(Metal/Non fusing metal/Non metallic/Others) :

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 to P. No : 1 Group No. : 1 or 2
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 5.0 to 200mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW	
AWS No. (class)	: ER70S – A1	E7018 – 1	Size of Filler metal : Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name : N.A.
F. No.	: 6	4	Electrode-flux (Class) : N.A..
A. No.	: 2	1	Consumable insert : N.A.

Deposited weld metal thickness range (t)

Groove : 200 mm Max. GTAW : 5.0mm.Max.; SMAW: Balance (Max.5mm/pass)
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down): Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : t < 25mm: Nil (min 10^0C)
t 25 to75mm : 100 ^{0}C
t >75mm : 150^{0}C
Interpass Temp. (Max) : 300 ^{0}C
Preheat Maintenance : Nil
Others : Nil

PWHT (QW – 407)

Temp. Range : 610 ± 15 ^{0}C
Time Range : 2.5 minutes / mm
(Min.½ hr)

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow.Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S-A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-1	4.0	DCEP	140 -190	N.A	N.A	Nil

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TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1003**	Date	: 06/11/93	Supporting PQR. No	**517,522**
Rev. No	: **03**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P1 Gr.1 Tubes / Pipes & SA106 Gr. C Pipe without preheat & without PWHT.

JOINTS (QW – 402)

Joint Design : As per Production drawing
Backing (Yes / No) : With or without
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : Metal

BASE METAL (QW – 403)

P. No. : 1 Group No. : 1 / 2* to P. No : 1 Group No. : 1 or 2*
Spec. Type & Grade : P1 Gr1/ Gr2* (Only SA106 Gr. C. carbon content ≤ 0.25%)
Chem. Analysis & Mech. Prop. : N.A.
Thickness Range : Groove : 1.5 to 19.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 – 1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : 19.0 mm Max. GTAW : 5.0mm.Max.;SMAW: Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down) : Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : Nil (Min.10^0C)

Interpass Temp. (Max) : 300 ^{0}C
Postheat Maintenance : Nil
Others : Nil

PWHT (QW – 407)

Temp. Range : Nil
Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow. Rt. (lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S -A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil
--do--	SMAW	E7018-1	4.0	DCEP	140 -190	N.A	N.A	Nil

Approved by
(Dr.K.P.Dhandapani)
DGM / WTC

Prepared by
(S.Singaravelu)
Manager / WTC

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620014
WELDING TECHNOLOGY CENTRE

WELDING PROCEDURE SPECIFICATION

WPS. No.	: **1002**	Date	: 06/11/93	Supporting PQR. No	**522**
Rev. No	: **03**	Date	: 22/09/07		

Welding Process : GTAW + SMAW Type : Manual (Auto/Semi-Auto/Manual/Machine)

Application : Butt welding of P1 Gr.2 tubes / pipes to P1 Gr1 or 2 tubes / pipes other than SA106 Gr. C without pre heat & without PWHT.

JOINTS (QW – 402)

Joint Design : Groove as per drawing
Backing (Yes / No) : With or without
Backing Material Type (Metal/Non fusing metal/Non metallic/Others) : Metal

BASE METAL (QW – 403)

P. No. : 1 Group No. : 2 to P. No : 1 Group No. : 1 or 2
Spec. Type & Grade : N.A.
Chem. Analysis & Mech. Prop. : Carbon content not exceeding 0.3%
Thickness Range : Groove : 1.5 to 9.0mm Fillet : N.A
Pipe Diameter Range : Groove : Unlimited Fillet : N.A.
Others : Nil

FILLER METALS (QW – 404)

	GTAW	SMAW		
AWS No. (class)	: ER70S – A1	E7018 –1	Size of Filler metal	: Refer Table
Spec. No. (SFA)	: 5.28	5.1	Flux trade name	: N.A.
F. No.	: 6	4	Electrode-flux (Class)	: N.A..
A. No.	: 2	1	Consumable insert	: N.A.

Deposited weld metal thickness range (t)

Groove : **9.**0 mm Max. GTAW : 5.0mm.Max.; SMAW: Balance
Fillet : N.A.
Others : Nil

POSITION (QW – 405)

Position(s) of Groove : All
Position(s) of Fillet : N.A.
Weld Progression.(Up/Down) : Vertical up
Others : Nil

PRE HEAT (QW – 406)

Preheat Temp.(min) : Nil (Min.10^0C)

Interpass Temp. (Max) : 300 ^{0}C
Postheat Maintenance : Nil
Others : Nil

PWHT (QW – 407)

Temp. Range : Nil
Time Range : Nil

Others : Nil

GAS (QW – 408)

	Gases	Mix/Purity %	Flow. Rt.(lpm)
Shielding :	Argon	99.99	6 - 14
Trailing :	N.A	---	---
Backing :	N.A.	---	---

ELECTRICAL CHARACTERISTICS (QW – 409)

Current (AC / DC) : Refer Table Polarity : Refer Table
Amps (Range) : Refer Table Volts : Refer Table
Tungsten Electrode type & size : EW Th-2 / EW Ce-2 Ø 2.4mm
Mode of Metal transfer for GMAW : N.A.
Electrode wire feed speed range : N.A.
Pulsing current (GTAW) : N.A.

TECHNIQUES (QW – 409)

String or weave bead : String / weave bead (Max. 3 Dia.)
Orifice or Gas cup size : 6 / 9
Initial and Interpass cleaning : Chipping / Brushing / Grinding
Method of Back Gouging : Nil
Oscillation : Nil
Contact tube to work distance : N.A.
Multiple or Single pass per side : Multiple
Multiple or Single Electrode : Single
Electrode Spacing : N.A.
Peening : N.A.
Others : Nil

Weld Layer	Process	Filler metal		Current		Voltage range	Travel speed Range	Others(Hot wire, Torch angle, ROL)
		Class	Dia	Type	Amps			
Root	GTAW	ER70S -A1	2.4	DCEN	60 - 110	N.A.	N.A	Nil
Further	SMAW	E7018-1	2.5	DCEP	70 - 100	N.A.	N.A	Nil
--do--	SMAW	E7018-1	3.15	DCEP	100 -140	N.A	N.A	Nil

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