


BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPALLI-620 014.
ADVANCED TECHNOLOGY PRODUCTS
WCPS – 802/ Rev.04

**WELDING CONSUMABLE PROCUREMENT SPECIFICATION
FOR FERRITIC COVERED ELECTRODE E 9018-G
FOR WELDING 20MnMoNi55 MATERIAL**

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DATE	09/08/2013
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NUCLEAR POWER CORPORATION OF INDIA LTD.

- ☒ अनुमोदित / APPROVED
- ☐ टिप्पणी के अनुसार अनुमोदित / APPROVED AS NOTED
- ☐ संशोधन को आगे बढ़ाएं / रोकें ।
- ☐ PROCEED WITH/ HOLD FABRICATION
- ☐ अंतिम ट्रांसपैरेंसी एवं प्रिंटों भेजें ।
- ☐ SEND FINAL TRANSPARENCIES & PRINTS
- ☐ संशोधन करें एवं अनुमोदन के लिए पुनः प्रस्तुत करें।
- ☐ REVISE AND RESUBMIT FOR APPROVAL

जांचकर्ता CHECKED BY <i>[Signature]</i> 13/08/13	समीक्षकर्ता REVIEWED BY <i>[Signature]</i> 13/8/13	अनुमोदन कर्ता APPROVED BY <i>[Signature]</i> 13/8/13
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Purchase specification for covered ferritic electrode E9018-G

बिना जानेवाले कार्य का अनुमोदन आपूर्तिकर्ता को विनिर्देशनों के अनुसार आपूर्ति के उत्तरदायित्व से मुक्त नहीं करता।
 The Approval of the work to be done does not relieve the supplier of responsibility of supply according to specifications.



WELDING CONSUMABLE PROCUREMENT SPECIFICATION FOR FERRITIC COVERED ELECTRODE E 9018-G FOR WELDING 20MnMoNi55 MATERIAL

1.0 SCOPE

This specification prescribes requirements for covered ferritic welding electrode E9018-G for welding 20MnMoNi55 material.

2.0 QUALIFYING CRITERIA

- 2.1 The vendors should have manufactured and supplied E90XX-X type SMAW electrodes with impact requirements at -15 °C and lower. **Test certificate of previous supply and list of organizations to which supply is made shall be sent to qualify the offer.**
- 2.2 Notwithstanding the above, if required, BHEL will visit the vendors' manufacturing plant, testing centre for assessment of vendor's capability to manufacture the indented consumable.

3.0 APPLICABLE STANDARDS

The electrode in general shall meet the requirements of ASME Sec II - Part C, SFA -5.5 and ASME Section III NB Div I. However additional, modified requirements if any, specified in this specification (WCPS) shall be adhered to.

In addition, the following standards are applicable.

- a) AWS A5.4 Standard methods for determination of diffusible hydrogen of ferritic, bainitic and martensitic weld metal produced by arc welding.
- b) AWS A 5.01 Filler metal procurement guideline

4.0 QUALITY REQUIREMENTS

- 4.1 The vendor shall submit Quality assurance plan (QAP) indicating the quality checks to be performed including on raw material and at various stages of manufacture and testing of the consumable. Suggested QAP is given in Annexure I. Vendor can add additional checks if required.
- 4.2 Manufacture of consumable shall be taken up only after BHEL approval of QAP.
- 4.3 The entire quantity of consumable shall be from **single lot**. Lot classification shall be as per ASME Sec III NB 2420.
- 4.4 Supply from foreign sources shall be inspected and certified by a third party inspection agency. The vendor shall engage only any of the three agencies TUV (Nord), BVQI, SGS.

Supply from Indian manufacturers shall be inspected and certified by BHEL and NPCIL.

Test certificate of the batch/lot shall be sent to BHEL for approval. Only after BHEL approval, supply shall be made.

5.0 TEST REQUIREMENTS

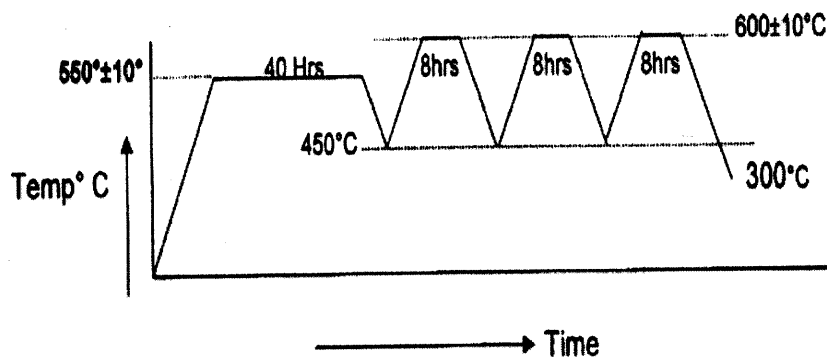
- 5.1 The test coupon shall be prepared using the ordered electrode and the following tests shall be carried out.
- Radiography, Chemical composition, Tensile test at room temperature, tensile test at elevated temperature, thro' thickness tensile test, CVN impact test, drop weight test, bend test, hardness, macro and micro test.
- 5.2 Summary of tests, sample size and samples location in the test coupon shall be as per Material Sampling and Testing Plan (MSTP) given in Annexure II.
- 5.3 Tests for diffusible hydrogen and coating moisture content shall be carried out and it shall meet ASME Sec II - Part C, SFA -5.5 requirements.

6.0 PREPARATION OF TEST COUPON

- 6.1 Weld test coupons shall be made in accordance with SFA 5.5 and ASME Sec III NB.
- 6.2 Test coupon welding shall be done adopting the parameters of welding document provided in the Annexure III.
- 6.3 Drop weight test coupon shall be welded as per the Annexure IV.

7.0 POST WELD HEAT TREATMENT

The welded test coupon shall be subjected to the post weld heat treatment cycle given below. The maximum rate of heating and rate of cooling shall be $30^{\circ}\text{C} / \text{h}$.



Max. rate of heating and cooling 30°C/hr .

8.0 TESTS

8.1 RADIOGRAPHY TEST

The electrode shall be capable of making sound weld metal in groove joints in all positions and the weld metal shall be free from cracks and any other systematic defects of porosity and slag inclusions. The test coupon shall be radiographed as per ASME Sec IIC.

8.2 CHEMICAL ANALYSIS OF WELD METAL

The chemical composition of the weld metal produced using the filler metal shall generally conform to the classification E9018-G of SFA 5.5 section II part C of the current ASME code with the following restrictions.

C	0.05 max%	Ni	0.90 - 1.20%
Mn	0.80 – 1.60 %	Mo	0.20- 0.65%
S	0.012% max	V	0.05Max.
P	0.012% max	Cr	0.015%max
Si	0.30 max	Cu	0.06% max.
Co	0.03 max.		

Elements Ti , Al , V , Ta , Sn & N shall be analysed and reported.

8.3 TENSILE TEST

One tensile test along welding direction, each at room temperature and at 350°C shall be carried out. The tensile properties shall meet the specification limits given in the table. In addition, one tensile test shall be carried out to check thro' thickness tensile strength of weld metal at room temperature.

Tensile properties	RT	350°C
Tensile strength (N/mm ²)	580 - 700	510 min
Yield strength (N/mm ²)	430 min	360 min.
% Elongation in 50 mm Gauge length	19 min.	14 min.
% Reduction in area	45 min.	To be reported.

8.4 IMPACT TEST

Charpy V notch impact test shall be conducted at six different temperatures as shown in MSTP to fully define upper and lower energy shelves. Charpy V plots shall be made using the minimum absorbed energy, lateral expansion and % shear fracture values against temperatures. The upper energy shelf shall have 100% shear fracture and lower energy shelf shall have a minimum of 10% shear fracture. Test reports shall include absorbed energy, percent shear fracture and lateral expansion plotted against temperature. CVN test at -15°C and at +18°C shall meet the criterion of average and minimum energy values specified in the table below.

CVN energy ; Average of 3 specimen (at -15°C)	41J
CVN energy; Min. Single value (at - 15°C)	34J
CVN energy ; At +18°C min.	68J
Lateral expansion min.	0.9 mm

8.5 DROP WEIGHT TEST

Drop weight test shall be carried on the weld sample which has been prepared entirely from the weld metal as described in Annexure IV. Test shall be carried out as per ASTM-E-208 at -15°C and both the samples shall not break at this temperature.

8.6 SIDE BEND TEST

The transverse side bend specimen shall withstand being bent cold through 180° without cracking on the outside of the bent portion, using a mandrel of diameter of 4 x thickness.

8.7 DIFFUSIBLE HYDROGEN TEST

Diffusible hydrogen content of weld deposit shall be less than 5ml / 100 g of deposit weld metal. It shall be determined and reported as per AWS A 5.4 or ISO 3690.

8.8 Coating moisture test

Coating moisture content test shall be performed as per SFA 5.5 and shall meet the limits specified in the standard.

8.9 COATING ECCENTRICITY

Shall be within the limits of SFA 5.5

8.10 USABILITY CHARACTERISTICS

The electrode shall have good usability for welding in all positions including horizontal and vertical. It shall melt smoothly and shall not cause undue spatter. It shall be capable of depositing weld metal in groove joints up to 100 mm depth and the slag shall be easily detachable.

8.11 FINISH

Electrodes shall have a smooth and uniform coating, free from any coating damage and cracks that would adversely affect the welding characteristics or the properties of the deposited weld metal.

9.0 CERTIFIED MATERIAL TEST REPORT

Supplier shall send certified material test report and all records as per QAP stages.

10.0 PACKING & DESPATCH

The electrodes shall suitably be packed to avoid any damage during transit and storage under normal conditions.

Each package shall be legibly marked with the following information.

1. Classification and specification.
2. Supplier's name and trade designation.
3. Electrode size and net weight.
4. Lot/ batch number.

11.0 GENERAL CONDITIONS

Deviations if any, shall be explicitly listed against the technical specification, citing the clause number of the BHEL specification.

The acceptance / non-acceptance of the deviations in offers will be based on review by BHEL customer.

The information in the specification shall not be disclosed to any one and shall not be used for any purpose other than intended.

Annexure I
QUALITY ASSURANCE PLAN

FIRM		Document No. BHEL - CQ/QAP/001	Description of product SMAW Electrode E 9018-G		P.O NO.:	Customer M/s, BHEL		
Sl No.	Description	Characteristics	Type of check	Quantum of check	Ref. Doc.	Format of Record	Inspection by firm	Inspection by TPI or BHEL and NPCIL
1.	Raw material –Core wire	Chemical composition	Physical	Each melt	ASME Sec II, Test certificate	Test report	Perform	Witness
2.	Flux material	Chemical composition	Physical	Each lot	Vendor Qc doc.	-	Perform	Review
3.	Welding of test plate	-	-	-	-	-	-	-
3.1	Plate material	Chemical composition and tensile properties	Review of TC, lab report	Each lot, each size	ASME Sec IIA, ASME Sec III NB	Lab test report / mill TC	Perform	Review
3.2	Welding of test plate	Welding parameters,	Physical	Each lot, each size of electrode	ASME Sec III NB, SFA 5.5 & WCPS/ 802 Rev 04	Welding report	Perform	Witness
3.3	NDE	Weld metal Soundness	RT	100%	ASME Sec III NB, SFA 5.5 & WCPS/ 802 Rev 04	NDE report	Perform	Witness

3.4	PWHT	Temperature, time	Physical	100%	ASME Sec III NB, SFA 5.5 & WCPS/ 802 Rev 04	HT report	Perform	Review HT chart
3.5	NDE after PWHT	Weld metal Soundness	RT & UT	100%	ASME Sec III NB, ASME Sec V WCPS/ 802 Rev 04	NDE report	Perform	Witness
3.6	Sample preparation	Identification, location, orientation	Physical	100%	MSTP, SFA 5.5 & WCPS/ 802 Rev 04 ASME Sec III NB	MSTP	Perform	Witness
4.0	Testing	Physical	Physical	100%	ASME Sec III NB, SFA 5.5 & WCPS/ 802 Rev 04, MSTP	Lab test report	Perform	Witness
5.0	Packing & dispatch of electrodes	Batch Identification	Physical	Visual	Purchase order, WCPS 802/Rev 04	Firm QC report	Perform	Hold- issue Shipping release order

Legend

Review - Review of documents; Witness- Witness the operations; Hold point- certify & release shipping note ;

(Firm)

(M/s, BHEL)

(Customer)

Annexure II

Material Sampling Testing Plan [MSTP]

SPECIFICATION : WCPS-802				MATERIAL SAMPLING AND TESTING PLAN FOR E9018-G			MSTP: BHEL- CQ-E9018-G
CONSUMABLE QUALIFICATION				orientation	Identifi- cation	Test temp. Deg.C	<p>Weld direction</p> <p>70 mm</p> <p>T</p> <p>weld</p> <p>T3</p> <p>T1 T2 IP 1-18 SB1-2 DP1-2 T3</p> <p>Note: For establishing S-curve for the test under Sl. No. 4 & 5 test results of the impact shall be taken.</p> <p>** Drop weight test as per ASTM-E-208 ## For bend test through 180°, using a mandrel of dia. 4x thickness @@ Chemical analysis shall be done on separate sample pad as indicated in ASME Sec. II part C</p>
n	Specimen Type	Size (mm) Ø/ w x t	Length				
1	Tensile	Dia. 10	180	Longitudinal.	T1	RT	
2	Tensile	Dia. 10	180	Longitudinal	T2	350	
3	Tensile (Through thickness)	Dia 5.0	60	Normal	T3	RT	
4	Impact	10x10	55	Transverse	IP1-3 IP4-6 IP7-9	-15 +18	
5	Impact (S curve)	10x10	55	Transverse	IP10-12 IP13-15 IP16-18	-80 -60 -40 +30	
6	Side bend ##	10xt	250	Transverse	SB1-2	RT	
7	Drop weight test **	50x19	130	Transverse	DP1-2	-15	
8	Chemical analysis@@	25X25	100	---	C1	---	
Firm				BHEL			Customer

Annexure III

Parameters for welding test coupon and drop weight test sample

I) Parameters for welding of test coupon						
Process	Filler Metal		Current		Volt (Range)	Preheat / Interpass temp (deg C)
	Classification	Dia. mm	Type & Polarity	Amp. (Range)		
SMAW	E9018G	3.2	DCEP	110-140	24-28	150 °C/ 200 °C
SMAW	E9018G	4.0	DCEP	140-180	26-30	150 °C/ 200 °C
SMAW	E9018G	5.0	DCEP	200-220	30-32	150 °C/ 200 °C
II)Parameters for welding of crack starter bead on Drop weight test sample						
SMAW	FOXDURE electrode	5.0	DCEP	180-200	20-26	150 °C/ 200 °C