



BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPALLI-620 014

WCPS – 811A /Rev. 06

WELDING CONSUMABLE PROCUREMENT SPECIFICATION FOR
AUSTENITIC STAINLESS STEEL STRIP ELECTRODES AND FLUX FOR
CLADDING

WCPS 811 A					
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1.0 SCOPE

This specification prescribes the requirements for austenitic stainless steel strip electrodes of EQ309L & EQ347 with suitable flux for cladding and buttering on 20MnMoNi55 material by submerged arc welding (SAW) process, which will be subsequently subjected to post weld heat treatment (PWHT).

2.0 QUALIFYING CRITERIA

- 2.1 A list of customers with details (Name, contact number, email id.), references of executed purchase orders and a report indicating values achieved for chemical and mechanical tests as reported in test certificates for the batches of above welding consumables supplied previously should be enclosed with the offer. Offers without these documents will not be considered.
- 2.2 The Manufacturer shall agree (clause-by-clause) to the requirements of this document. Any deviation from the requirements shall be clearly mentioned in the offer. Acceptance of any such deviation is subject to the approval of BHEL customer.
- 2.3 The manufacturing plant shall have a valid ASME III certification.
- 2.4 BHEL reserves the right for inspection of Manufacturer's manufacturing works and testing center for evaluation, if required.
- 2.5 Offers from such Manufacturers who have any unresolved issues with previous supplies at the time of offer will not be considered.

3.0 GENERAL REQUIREMENTS

- 3.1 The strip electrodes EQ309L & EQ347 and flux shall comply with requirements specified in the latest edition (applicable on the date of issue of purchase order) of ASME Sec IIC SFA 5.9 and ASME Sec III NB. All tests, acceptance criteria shall be in accordance with this document. Additional requirements specified in this document and purchase order shall also be complied.
- 3.2 The strip electrodes and flux shall have good usability. The arc strike shall be smooth and it shall be stable. The strip electrodes shall melt uniformly with good flat bead formation. It shall be suitable for cladding and buttering on low alloy steel material of grade 20MnMoNi55 with a thickness of about 50 mm with reverse polarity (DCEP) current.
- 3.3 The total quantity delivered shall be in the least possible number of batches. Single batch is preferred. Each batch shall be tested as per the Quality Assurance Plan (QAP) given in the Annexure I.
- 3.4 The welding consumables shall be batch tested. Level of testing shall be as per schedule K of ASME section IIC SFA 5.01. Clearance for shipment will be given only when welding strip electrodes and flux meet all the requirement of this specification.



3.5 Inspection shall be carried out at stages including on raw materials and finished products as per the QAP.

3.6 Purchaser will provide 20MnMoNi55 plates of size as per Figures 1 & 2 for test coupons and batch qualification shall be carried out at M/s. BHEL work center. Only on batch qualification approval by M/s.BHEL, the entire quantity shall be dispatched.

4.0 REQUIREMENTS FOR STRIP ELECTRODES

4.1 **Chemical composition of strip electrodes** shall conform to ASME Section II Part 'C' SFA 5.9 EQ309L and EQ347.

4.2 Strip electrodes size shall be 60 X 0.5 mm.

4.3 Strip electrodes lot class shall be S4.

4.4 The strip electrodes shall have a smooth finish, free from slivers, depressions, seams, laps, scratches, scales, oil, grease and other foreign matter that would adversely affect the welding equipment or the properties of the deposited weld metal.

4.5 The strip electrodes shall be suitable for uniform uninterrupted feeding on submerged arc welding machine.

4.6 Strip Electrodes Coils

4.7 Liners used in coils with support shall be of such material and design to prevent damage or distortion during normal handling and use of the electrodes. Liners shall be sufficiently clean and dry to maintain the cleanliness of the strips.

4.8 Each coil shall be from the same heat and be of continuous length of strip electrode and the coil size shall be as follows.

Inner diameter - 300mm

Width - 60mm

Weight of each coil – 25 Kg

4.9 A spooled strip electrode shall be closely wound in layers with or without gap between layers and without kinks, waves, sharp bends, which would interfere with the free feeding of the electrode or easy unwinding of the spool. The free end of the spooled electrode shall be secured and identified to enable easy location.

4.10 Packaging

4.11 The strip electrodes shall be suitably packaged to ensure against injuries during shipment or storage under normal conditions. The coils shall be wrapped with suitable polythene sheet / paper /cloth and sealed in thick polythene covers or any other moisture proof packing. Each of



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such packs shall contain in card board boxes, several such boxes crated in sea worthy wooden cases.

4.12 An identification tag in English (Specification, classification, size and batch no.) shall be securely attached to inside end of each coil in addition to the label put on every spool and cardboard box.

4.13 Manufacturer shall provide a separate signed sheet with details of self life, recommendation for storage, preservation and redrying of consumables.

4.14 **MARKING**

a) Each spool and the outside of each package shall be legibly marked with the following information in English: Strip electrode specification and classification

b) Manufacturer name with address and brand designation

c) Strip electrode size and net weight

d) Heat and batch number with manufacturing date

5.0 REQUIREMENTS OF FLUX.

5.1 The flux shall be compatible to use along with strip electrodes as per para 4.0 and it shall be capable of producing weld chemistry, mechanical and metallurgical properties as per para 6.0. The flux classification as per BS EN ISO14174-2012, composition, grain size and basicity shall be specified in the offer.

5.2 The flux shall be manufactured through agglomeration process using granular mixtures of fine raw materials and the flux shall freely flow in the flux feeding hopper, tubes.

5.3 The entire quantity shall be from one batch only and the lot class shall be F2.

5.4 Each batch / lot of flux shall be subjected to chemical analysis and values to be reported. Constitution of the flux by weight percentage along with its basicity & mesh-size shall be reported in test certificates.

5.5 The metallurgical behavior of flux shall be tested as per the above standard and loss/pick of elements shall be reported.

5.6 The slag shall be easily removable by normal means and the weld deposit shall be free from slag entrapment, depressions, cavities, blow holes, pores etc. It shall be capable of making uniform clad deposit. The weld bead shall merge smoothly with each other and base material.

6.0 TESTING AND INSPECTION

6.1 Tests for each combination of batches of strip electrodes and flux shall be carried out on test coupons clad with first layer of EQ309L and subsequent layers of EQ347 using the welding parameters given in Table 1. Number of weld layers, thickness of clad deposit and the welding parameters employed shall be recorded in the welding data sheet. The base metal for test coupon shall be of grade 20MnMoNi55 supplied by purchaser.

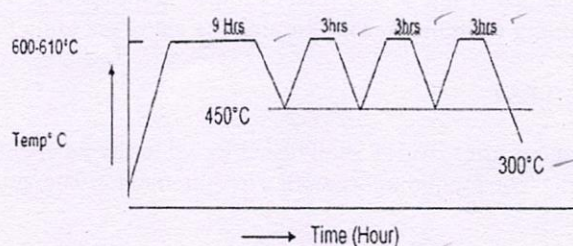
6.2 The test coupon shall be subjected to PWHT as per para 6.5 and all the tests shall be carried out after PWHT.



- 6.3 Test samples for chemical, mechanical & metallurgical test shall be located as per the Material sampling Test plan (MSTP) given in Figures 1 & 2 and the number of samples for each test are given in Table 2.
- 6.4 All test reports shall indicate the Standard followed for the test, acceptance criteria and the actual test results obtained.

6.5 **POST WELD HEAT TREATMENT**

- 6.6 Post weld heat treatment (PWHT) of the welded test plate shall be carried out



Rate of heating and cooling shall be $30^{\circ}\text{C} \pm 5^{\circ}\text{C} / \text{hour}$.
PWHT cycle for the welded test plate

6.7 **NON-DESTRUCTIVE TESTING**

All required NDE as per Annexures II to VI shall be carried out by the trained, qualified and certified NDE personnel as per SNT-TC-1A.

6.8 **Visual Examination**

The welded surface shall be free from craters, cracks, slag, blow holes.

6.9 **Liquid Penetrant Testing (LPT)**

The final machined surface of weld deposit shall be subjected to surface crack examination by LPT as per Annexure II and test result shall be reported as per enclosed format given in Annexure III. Tests shall be carried out in as welded and PWHT condition. Acceptance shall be as per Annexure II.

6.10 **Ultrasonic Testing (UT)**

- 6.10.1 UT shall be carried out from cladding side by straight beam (using special dual crystal probes) and angle beam (using special TR longitudinal wave angle beam probes having maximum sensitivity in the cladding parent metal transition zone) scanning, refer Annexure IV. Tests to be done before & after PWHT.
- 6.10.2 Calibration shall be done as per Annexure V. All indications equal and above 50% of the reference level shall be recorded as per suggested format given in annexure VI. Acceptance shall be as per annexure IV.



6.11 CHEMICAL TEST

6.11.1 Strip electrode

The chemical composition shall be as per para 4.1.

6.11.2 Weld deposit

The chemical composition of machined weld cladding deposit at 5 mm & 7 mm thickness shall meet the requirements of Table 3. Chemical composition shall also be checked at a distance of every 1 mm beginning from the surface through the entire cladding thickness and reported.

6.12 MECHANICAL TEST

6.12.1 The weld test coupons after PWHT shall be subjected to the mechanical tests described below and shall meet the corresponding specified requirements. The guaranteed values shall be furnished in the bid.

6.12.2 Tensile Test

The tensile properties shall meet the requirement of Table 4.

6.12.3 Charpy V notch impact test

Impact test of pure weld shall be carried out at +23°C and the values shall be 50J minimum of only one specimen out of three with an average of 3 specimen shall be 69J.

6.12.4 Bend test

Bend test shall be carried out on specimens located transverse to the direction of cladding and bent through a mandrel of 4 times the thickness of specimen over 180°. The acceptance shall be as per Figure 3. Roll distance shall be as per ASTM E190.

6.13 METALLURGICAL TEST

6.13.1 The resistance against inter-granular corrosion (IGC) shall be determined as per ASME A262 Practice E with sensitization heat treatment. The location of specimens shall be at 7.0 mm and 5.0 mm above base metal top as shown in Figure 2. At least 4 samples are to be tested in transverse direction with 2 samples having finished machined surface at 7.0 mm (above base metal) kept in tension and for the other 2 specimens finished machined surface at 5.0 mm (above base metal) kept in tension. Specimen shall be bent through a mandrel of 4 times the thickness of specimen over 180 degrees. No crack is permitted.

6.13.2 Delta ferrite examination shall be done in as welded and PWHT condition. It shall be controlled in the range 4 to 10% in all layers in as welded condition. Delta ferrite after PWHT is only for information and shall be reported. The values shall preferably be controlled to the lower side in the above range. Inter-connected network is not acceptable.

6.13.3 Macro examination shall be done on full cross section as per ASTM E340 & E381 and shall cover all typical location of the cladding, interface overlap of beads and layers, heat affected



zones and base metal. It shall be free from slag, porosity, cracks, gross inclusions, lack of fusion / penetration and shall show proper buildup of layers and adequate fusion. Original photograph at 5-10X shall be provided

6.13.4 Micro examination shall be done as per ASTM-E340 & ASTM-E407 in regions of bead overlap, between two layers and weld metal base metal transition. The microstructure of weld metal must be free from micro fissures & sigma phase. Original photo micro graph at 200X to be provided and it shall show proper micro structural composition and grain formation.

6.13.5 Hardness survey by Vickers pyramid method using 5 kg load shall be done across the full cross section (base metal, HAZ and cladding) as per Figure 4.

6.13.6 SURFACE CRACK EXAMINATION

6.13.7 Cladding shall be ground / machined in steps of 0.5 mm starting from top of cladding upto 2 mm deep into base metal. The ground / machined surface of each step shall be examined by liquid penetrant examination. No cracks are acceptable.

6.14 PACKING AND STORAGE

6.14.1 The flux shall be packed in watertight steel drums and sealed to ensure against damage during shipment or storage under normal tropical conditions.

6.14.2 The flux in the original unopened package shall withstand storage under tropical conditions for at least four years without such storage affecting its welding characteristics or the welding properties.

6.14.3 Manufacturer shall provide the instructions for flux drying, storage and conditions for recycling, re-baking etc.

6.14.4 Material safety data sheet (MSDS) for the consumable shall be sent along with CMTR.

7.0 MARKING

7.1 The outside of each drum and package in which the flux is furnished shall be legibly marked with the following information.

Manufacturer's name & address.

Flux classification and specification.

Brand designation (trade name).

Net weight.

Lot / Batch number, Date of manufacture.

Customer's production order number.

8.0 CERTIFIED MATERIAL TEST REPORT (CMTR)

8.1 Two copies of CMTR in English shall be dispatched along with each supply. It shall include the following information.



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- 1) Purchase order number, specification number and test certificate number
- 2) Specification and classification of the consumables
- 3) Size and quantity
- 4) Batch number
- 5) Quality Assurance plan(QAP)
- 6) Welding parameter used in test coupon welding.
- 7) Heat treatment chart
- 8) Material Sampling & Testing Plan(MSTP) indicating location of specimen
- 9) Reports of all testing & inspection as per QAP
- 10) Recommendations for reconditioning and storage

Table 1. Welding parameters for test plate

Welding sequence (WS)	Current	Voltage	Speed	layers
WS1	750 $\pm$ 50	24-28	150mm/min	1
WS2	750 $\pm$ 50	24-28	150mm/min	As required



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TABLE 2. MSTP FOR STRIP ELECTRODES EQ309L & EQ347 FOR CLADDING AND BUTTERING (REFER FIGURE 1 & 2 FOR SPECIMEN LAYOUT)

S. No.	Type of test	Orientation	Legend	Specimen size (width x thickness x length) mm	Qty Nos.	Remarks
1.	Side Bend Test	Transverse	SB1 & SB2	40x 10 x 250	2	
2.	Corrosion Test at 5 mm from base metal top (IGCT)	Transverse	IC1 & IC3	25 x 2 x 75	2	From pure weld metal
3.	Corrosion Test at 7 mm from base metal top (IGCT)	Transverse	IC2 & IC4	25 x 2 x 75	2	From pure weld metal
4.	Impact Test @ +23°C	Transverse	IP1 to IP3	10 x 10 x 55	3	Notch in pure weld metal as per Figure 1
5.	Impact Test @ +23°C	Vertical	IP4 to IP6	10 x 10 x 55	3	Notch in middle of EQ309L layer as per Figure 1
6.	Round tensile test at Room Temperature	Longitudinal	TR1	φ10 x 150	1	From pure weld metal
7.	Round tensile test at 350 °C	Longitudinal	TH1	φ 10 x 150	1	From pure weld metal
8.	Round tensile test at Room Temperature	Vertical	TR2 & TR3	φ 10 x 100	2	From transition. Gauge length center at base metal top
9.	Round tensile test at 350 °C	Vertical	TH2 & TH3	φ 10 x 100	2	From transition. Gauge length center at base metal top
10.	Chemical Test	-	CH1	50 x 50X75	1	At every 1 mm depth from top layer
11.	Micro, Macro, Delta Ferrite Examination	Transverse	M	50X50X100	1	Delta ferrite to be measured in each layer in as welded and PWHT conditions
12.	Hardness	Full cross section	M	Refer Figure 4	1	Base metal, HAZ and cladding
13.	Surface crack examination	-	H	150 x 100 X T	1	PT at every 0.5 mm up to 2 mm deep into the base metal
14.	Chemistry of strip electrodes EQ309L & EQ347	-	C	As per ASME Sec IIC SFA5.9	1 1	
15.	Test pieces for purchaser	Transverse	-	100 x 400 70 x 120 100 x 210	1 1 1	Refer Figure 1 Refer Figure 1 Refer Figure 2



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TABLE 3. CHEMICAL COMPOSITION OF MACHINED CLADDING DEPOSIT AT 5.0 AND 7.0MM ABOVE THE BASE METAL

Element	%
Carbon	0.03 max
Manganese	2.0 max
Silicon	0.8 max
Sulphur	0.010 max
Phosphorus	0.020 max
Chromium	17.0 min.
Nickel	9.0 min.
Nitrogen	0.050 max.
Cobalt	0.05 max
Nb+Ta	8 x %C min
Molybdenum	To be reported
Copper	0.09 max
Trace Element	%
Aluminium	0.05 max.
Titanium	0.01 max.
Lead	0.001 max.
Arsenic	0.005 max.
Antimony	0.005 max.
Tin	0.005 max.
Tungsten	0.005 max.
Vanadium	0.05 max.

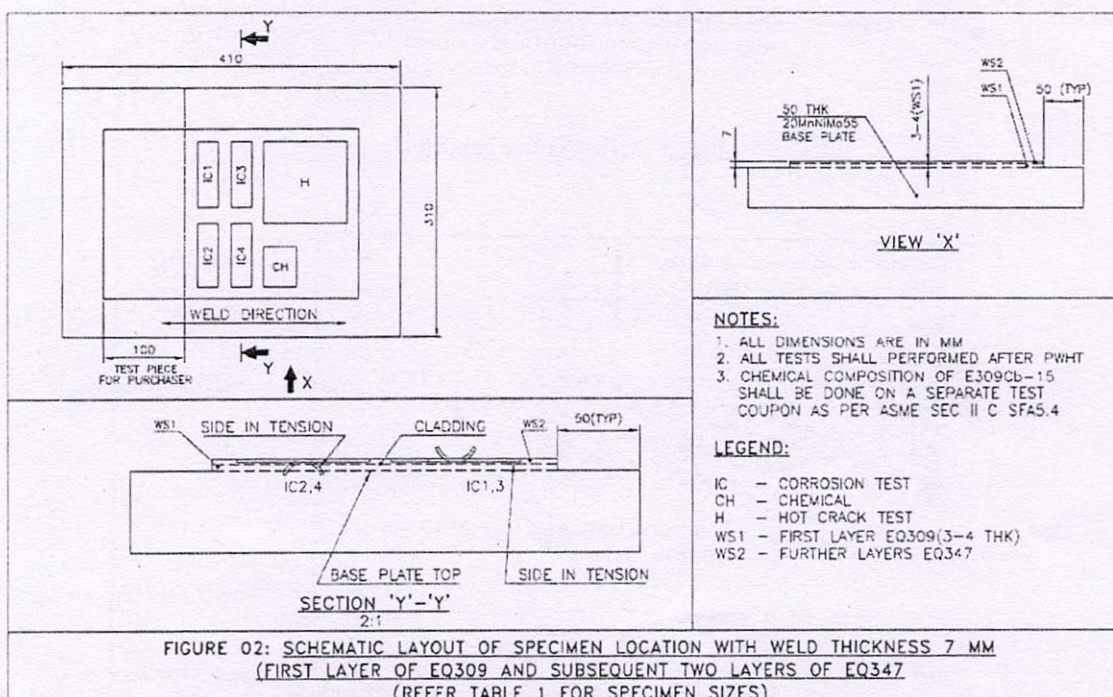
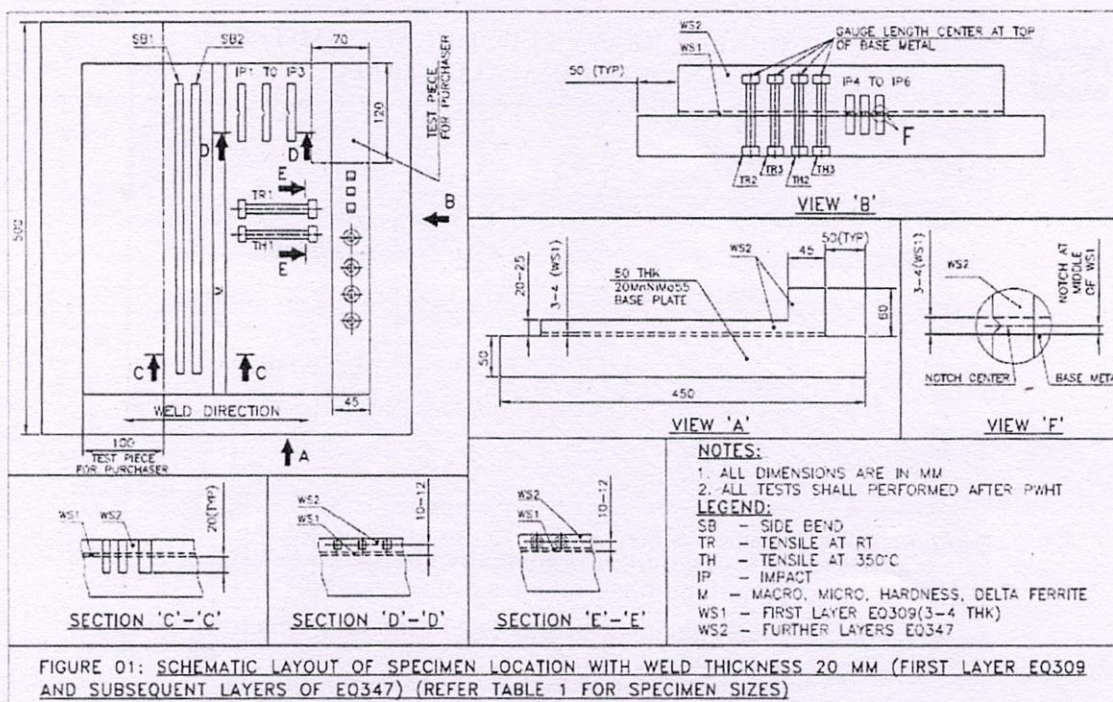
NOTE:.. Other Trace elements shall be as low as possible and reported for information.
Guaranteed values of these elements shall also be indicated in the offer.

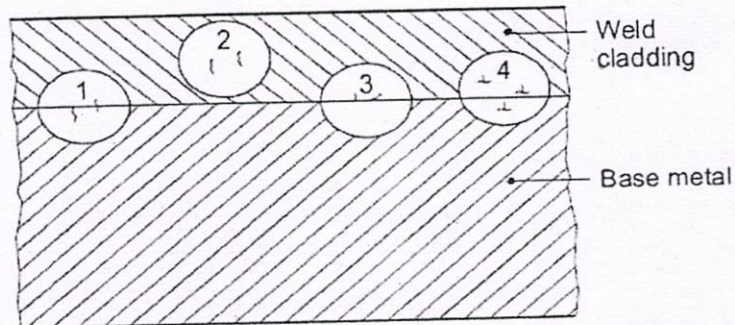
TABLE 4. TENSILE PROPERTIES OF WELD DEPOSIT

Sl. No.	Properties	RT	350° C
01	*UTS	515 MPa	452 MPa ✓
02	*YS (0.2% Offset)	205 MPa	136 MPa ✓
03	*Elongation on 5d(%)	30	To be reported
04	%RD	To be reported.	To be reported ✓
*Minimum			



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- Defect type 1: Discontinuities affecting the base metal are not permitted if the empirical value for the elongation of the base metal is not exceeded.
- Defect type 2: Discontinuities in the weld cladding which do not contact the fusion line are permitted as isolated defects up to a length of 1.6 mm.
- Defect type 3: Discontinuities in the weld cladding which are in contact with the fusion line are permitted as isolated defects up to a length of 1.6 mm.
- Defect type 4: Discontinuities which are due to allowable structural discontinuities already existing in the unbent condition will not be rejected.

Fig. 3 -Criteria for bend test

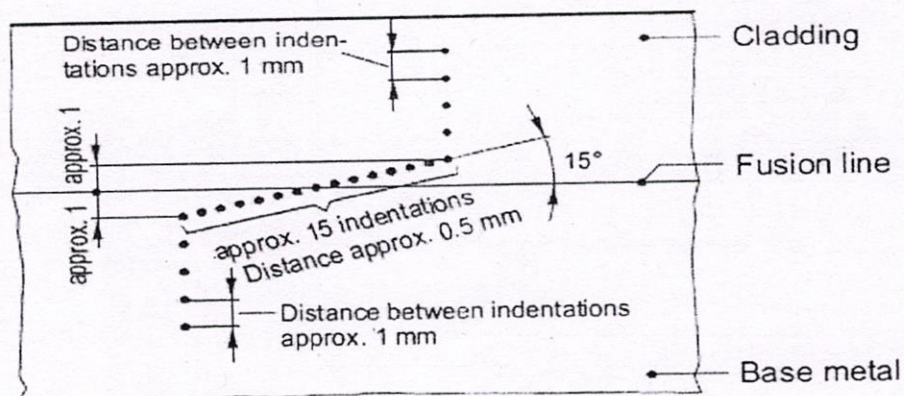


Fig.4 -Hardness measurement locations

Annexure 1

QUALITY ASSURANCE PLAN

Product- Austenitic stainless steel welding strip				P.O No. & Dt		
Doc. No.						
Sl No.	Description	Type of check	Ref. document	Inspection/ Test by Manufacturer	BHEL	Format of record
1.	Strip size	Dimension & surface finish	SFA 5.9	RR	RR	Inspection report
2.	Strip electrodes	Chemical analysis for each melt	WCPS 811A/ 05& SFA 5.9	HP	HP	Test report
3.	Flux	Dry mix / blend chemical analysis	Manufacturer doc.	HP	RR	-
4.	Flux	Particle size	WCPS 811A/05	HP	RR	Inspection Report
5.	Test plate material Spec,size-20MnMoNi 55	Chemical & mechanical properties	ASTM, WCPS 811A/ 05	RR	HP	Test Report
6.	Test assy. Welding	Welding parameters,	WCPS 811A/05 & SFA 5.14	WP	WP	Welding data sheet
7.		Bead uniformity for size & shape slag release characteristics	WCPS 811A/ 05	WP	RR	Welding data sheet
8.	PWHT	No. of cycles Rate of Heating / Cooling, Soaking temp. & Time	WCPS 811A/ 05	WP	Witness PWHT start & end; Review of HT Chart	HT chart



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Sl.No.	Description	Type of check	Ref. document	Inspection/ Test by Manufacturer	BHEL	Format of record
9.	NDE before &after PWHT	LPI on cladding machined top surface	BHEL Approved NDE procedure	WP	WP	NDE report
10.	NDE before &after PWHT	UT on Cladding	BHEL Approved NDE procedure	WP	WP	NDE report
11.	Cladding	Chemical analysis	WCPS 811A/ 05, SFA 5.9	WP	WP	Test report
12.	Metallurgical tests	Tensile , side bend, macro, micro, hardness test for each batch	WCPS 811A/ 05, AWS B4.0	WP	WP	Test report
13.	Surface crack examination	Sensitivity to cracking	WCPS 811A/05	WP	WP	Test report
14.	Strip electrodes, flux packing & shipping	Packing, identification	WCPS 811A/ 05 , SFA 5.9	HP	HP	Test certificate
15.	TC & Reports	Review	WCPS 811A/05	HP	HP	CMTR

RR- Review of reports / Records
WP- Witnessing of activity
HP- Hold point



Annexure II

LIQUID PENETRANT EXAMINATION

1.0 Scope

This specification covers procedure for liquid penetrant examination of cladding deposit.

2.0 Surface Condition

The surfaces to be examined shall be free from dirt, grease, scales, weld spatters, weld flux, oil and other extraneous matters that can interfere with the examination. The surface machined surface shall be better than 6.3 microns.

3.0 General remarks

Liquid penetrant examination shall be carried out using approved penetrants & developers. Suitability of the employed media, if not already established, shall be determined using ASME comparator block. Medium used for Liquid Penetrant Examination shall not contain halogen and sulphur more than 25 ppm each.

4.0 Procedure

4.1 Application of Penetrant

Penetrant shall be applied by means of brushing or spraying. In case, compressed air type apparatus is used for spraying the penetrant filters shall be placed on the upstream side near the air inlet to preclude contamination of the penetrant by oil, water or dirt sediments that may have collected in the lines. The entire surface shall be covered by the penetrant.

4.2 Penetration Time and Temperature

Duration of penetration and test temperature shall be in accordance with ASTM E165. Penetrant shall be applied during the period of the test to prevent drying of penetrant upon surface.

4.3 Cleaning of the test surface

When chemical solvent is being used as the cleaner. Care should be taken to ensure the penetrant is not removed from the flaws. When the cleaner is water, the pressure of the jet should be kept low. (Not exceeding 3-5 kgf/cm², and temperature below 43°C).

4.4 Application of the Developer

The developer shall be applied with spray nozzle of a spray gun. The developer shall be sprayed on the entire, test surface in such a way that a uniform thin layer is deposited.

4.5 Cleaning of the tested object

All the residual media of the liquid penetrant test shall be removed before subsequent welding operation.

4.6 Interpretation of Test results

When using the Liquid Penetrant Inspection, the interpretation shall be restricted to citing the absence or presence of flaws, their general nature, magnitude and location. Evaluation of cladding shall be performed after the time intervals of ½hr, 1hr, 3hr & 4hr besides the initial examination after applying the developer. All the results shall be recorded in the test report.



6.0 Acceptance Standards

- 6.1 All indications shall be examined in terms of the acceptance standards of the referencing "Examination and Testing Specification".
- 6.2 Broad areas of pigmentation which could mask relevant indications & discontinuities are unacceptable and the areas should be cleaned and re-examined.
- 6.3 Acceptance standard for cladding is as indicated in Table XX

Acceptance standard for cladding is as indicated in Table XX			
Type of defects	Dimension of defect on indicator trace (mm)	Permissible number of defects	
	Permissible linear dimension (mm)	At any section 100 x 100mm	At any section 200 x 200mm
Single pore and slag	3.0	4.0	8.0
Crack in clad & HAZ	Not permissible		
Note: Single defect of 0.2 mm dimension is not considered.			

7.0 Procedure Qualification

Before application of the procedure, the Manufacturer shall demonstrate that the procedure strictly conforms to the stipulation laid down in the preceding paragraphs.

8.0 Personnel Qualification

The examination shall be performed and the results evaluated by qualified personnel only. The personnel shall be qualified to comparable levels of competency by subjection to examination on the particular method adopted.

9.0 Report

Final report, describing the details of the technique adopted together with the analysis of the results shall be submitted by the Manufacturer



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Annexure III

LIQUID PENETRANT EXAMINATION REPORT

Sl. No.	Description	Remarks
1	Certificate No. & Date	
2	Purchase Order No. & Date	
3	Customer Name	
4	Procedure reference	
5	Description of test piece	
6	Identification of test piece	
7	Material specification	
8	Description of filler metal	Specification & Brand
9	Stage of test	Before SHT/ After SHT
10	Surface condition	
11	Details of chemical used	
12	Dwell time of penetrant	
13	Dwell time of developer	
14	NDE operator level	
15	Test results	
16	Approved by - NDE level	



Annexure IV

ULTRASONIC EXAMINATION

1.0 Scope

- 1.1 This specification provides the technical requirements for the straight beam and angle beam ultrasonic examination of weld deposited cladding.
- 1.2 This specification is intended to detect defects parallel to surface and also perpendicular to surface.

2.0 Time of Examination

The final acceptance examination shall be carried out after the cladding has been subjected to heat treatment.

3.0 Surface Condition

The surface of the cladding shall be plane, free of notches and machined to a finish to ensure acoustical contact of the search unit. Waviness of surface shall be such that distance between surface and probe does not exceed 0.5 mm.

4.0 Scanning zones

Scanning shall be done over 100% of the surface with at least 10% overlap.

5.0 Examination

5.1 Equipment

- 5.1.1 Pulse Echo type of equipment generating frequencies over the range of 1 to 5 MHz shall be used.
- 5.1.2 Equipment shall be calibrated as per Cl. 5.3 before testing.
- 5.1.3 The equipment shall have proven accuracy and stability.

5.2 Search Units

The transducer dimensions shall not exceed 12 mm x 25 mm. Transmitter receiver probes (SE probes) of test frequency 2 to 4 MHz shall be used for straight beam examination.

Angle beam search units type SEL MHZ "System BAM" or equivalent shall be used for angle beam examination.

The use of the search units requires Purchaser's approval. The search units shall have their maximum sensitivity at the clad/base metal interface.



5.3 Calibration

The adjustment of the pulse energy and gain shall be carried out using a Standard calibration block. The calibration block shall be made by cladding On a similar base material as that of test assembly overlaid with the same Technique as on the test assembly. A flat bottom Hole 1.5 mm in diameter.

By 38 mm minimum depth shall be drilled into the block at the clad interface as shown in sketch I for straight beam cladding. For angle beam cladding, 2mm FBH is used as shown in sketch II. The probe shall be placed over the Cladded surface and directed towards the hole. The settings of the unit shall be adjusted so that the amplification of the peak is 80% of the screen height.

- 5.4 Calibration of the equipment shall be done at every half an hour of the testing. When significant deviations occur, all areas which are examined after the last calibration control shall be re-examined.
- 5.5 After calibration of the equipment as above, the component shall be examined. Contact method and manual scanning shall be used.
- 5.6 The Couplant (glycerin or SAE 30 or equivalent) shall not have halogens and sulphur exceeding 25 ppm each. The same couplant shall be used for calibration and examination.
- 5.7 The maximum speed of testing shall be 150 mm/sec.
- 5.8 As far as possible, scanning shall be done at twice the amplitude setting of the calibration of defect standard.
- 6.0 Recording and acceptance criteria**
- 6.1 All indications having an amplitude equal to or greater than 50% of the reference level shall be recorded. If the signal: noise ratio is less than 10dB, this is to be recorded and further activities have to be agreed upon.
- 6.2 All indications with a signal amplitude equal to or greater than the reference level are unacceptable.
- 6.3 For indications with signal amplitude crossing 50% of DAC, following conditions for acceptance applies:
- Single recordable indication up to a length of 30mm is permissible.
 - Two indications shall be separated by at least the edge to edge length of the longer indication.
 - Total length of indications occurring in a meter shall not exceed 250mm subject to the conditions in points (i) and (ii).
 - Eight indications of maximum 100mm² each are allowed per square meter on any examination surface.
- 6.4 For flaw indications equal or crossing 3mm CRR level, following criteria to be followed.
- Indications more than 5mm CRR (1.5mm CRR + 10dB) irrespective of length is rejected.



- ii. Single indications of more than 20 mm length is not acceptable.
- iii. Two indications shall be separated by at least the edge to edge length of the longer indication failing which they should be treated as single indication and evaluated according to point (ii).
- iv. Total length of indications per meter shall not exceed 100mm subject to conditions in points (ii) and (iii).
- v. Cumulative area of defects in 200x200mm area shall not exceed 50mm².

7.0 Final Cleaning

After the examination is over, the couplant shall be thoroughly cleaned and removed from the surface.

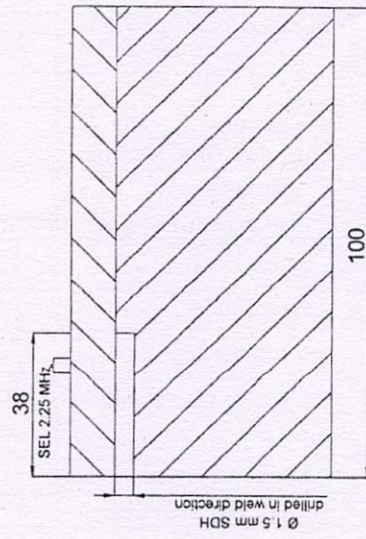
8.0 Report

Final report describing the details of the technique adopted together with the analysis of results shall be submitted by the manufacturer.

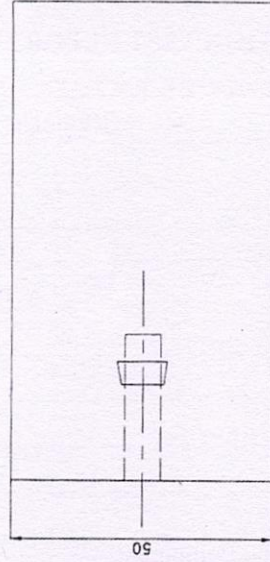


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Annexure V

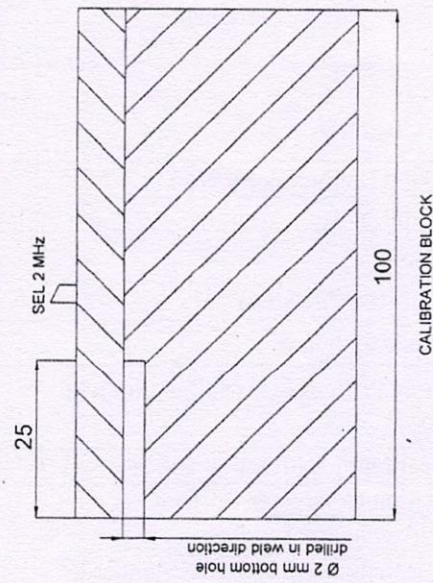


CALIBRATION BLOCK

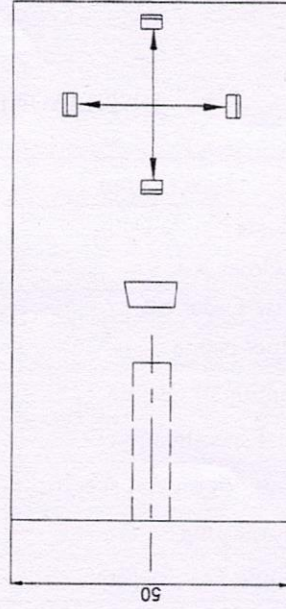


ULTRASONIC STRAIGHT BEAM EXAMINATION OF WELD DEPOSITED CLADDING

Sketch I



CALIBRATION BLOCK



ULTRASONIC ANGLE BEAM EXAMINATION OF WELD DEPOSITED CLADDING

Sketch II



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Annexure VI

ULTRASONIC EXAMINATION TEST REPORT

S No	Description	Remarks				
1	Certificate No. & Date					
2	Work Order No.					
3	Purchase Order No.					
4	Customer Name					
5	Description of test piece					
6	Material specification					
7	Welding filler metal specification					
8	Stage of testing					
9	Ultrasonic Test Method					
10	Details of the Equipment					
Item No.	Component	Drg. No./Size (in mm)	Qty.	Job Sl. No.	Group No.	Material Specification
	Surface Condition		Type of Couplant used & Brand Name			
	Search Unit (including Sl. No.)		Scanning			
	Search Unit Size		Range (mm) of CRT			
	Frequency		Pulse Energy			
	Ultrasonic Test Standard		Amplitude			
	Acceptance Standard		Suppression			
	Applicable Procedure, Specification with Rev. No.		Type of Cable and length			
	Identification of Calibration Block		Operator Name			
	Examination Conducted Surface		NDE Qlfn LEVEL			
11	Attenuator Setting					
11a.	Attenuator Reference Standard:					
11b.	Attenuator Testing Sensitivity:					
12	Test Result					
13	Operator Name & level					
14	Approver Name & level					
15	Inspection agency remark					