

**BHARAT HEAVY ELECTRICALS LIMITED****TIRUCHIRAPPALLI-620 014****WCPS - 804****WELDING CONSUMABLE PROCUREMENT SPECIFICATION FOR COVERED INCONEL
WELDING ELECTRODES****WCPS 804**

Rev. No.	01	02	03	04	05	06
Prepared By MW/ATP/BHEL	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	<i>R. S. K. K.</i> 13.04.2016
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Approved By MW/ATP (BHEL)	SIGNED	SIGNED	SIGNED	SIGNED	SIGNED	<i>M. S. K.</i> 16/04/16
Approved By (CUSTOMER)	Approved As Noted 15.01.2010	Approved As Noted 18.02.2010	Approved 06.03.2012	Approved As Noted 07.09.2015	Approved 18.09.2015	<i>M. S. K.</i> 29/04/2016

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1. SCOPE

- 1.1. This specification prescribes the requirements for Inconel covered electrodes for cladding welding by shielded metal arc welding process.

2. QUALIFYING CRITERIA

- 2.1. Offers from such vendors only will be considered who have supplied the Inconel SMAW covered electrode in the past 10 years period. The reference list of customers to whom the earlier supply were made along with details (Name/Phone number/mail) of the contact person for cross reference by BHEL, shall be attached with the offer.
- 2.2. Test certificate of the supplied lot shall be enclosed with the offer. The test certificate should contain chemical analysis & mechanical properties of the weld metal. Offers without such a test certificate will not be considered.
- 2.3. The vendor shall agree 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 approval by BHEL's customer.
- 2.4. Notwithstanding the qualifying criteria, purchaser shall be allowed to visit the vendor's manufacturing and testing centre for further evaluation, if required.

3. GENERAL REQUIREMENTS

- 3.1. The electrodes shall, in general, be classified according to the ENiCrFe-3 classification of SFA 5.11 specification of ASME Section II Part C - latest edition. However, wherever this document, i.e. WCPS 804 rev 06, is found to be in variance with the aforementioned classification, the requirements of WCPS shall take precedence over those of Code.
- 3.2. The total quantity delivered shall be in the least possible number of lots. The consumable shall be lot tested at supplier's works. Level of testing shall be as per Schedule K of SFA 5.01 of ASME Sec II Part C - latest edition. Entire testing shall be done for every lot of consumable. All testing shall be done at a Lab certified by ISO/IEC 17025.
- 3.3. Vendor shall submit Certified Material Test Report (CMTR), duly attested by TPI (see Clause 3.4 below), along with all relevant test reports to BHEL and only on approval by BHEL, the item shall be dispatched. The CMTR shall be as per Type 3.2 of BS EN 10204.
- 3.4. The supplies made by foreign vendors shall be inspected and certified by a Third Party Inspection (TPI) agency. The TPI shall be engaged by the vendor on BHEL's behalf. The TPI shall be one of the following three agencies only: TUV-Nord, BVQ, SGS. For supply source within India, the inspection shall be carried out by NPCIL and BHEL.
- 3.5. The manufacture and testing of consumable including various stages of manufacture viz. raw material inspection, plate material, test weld assy. preparation, NDE examination, HT and mechanical, metallurgical testing shall be carried out as per the Quality plan given in Annexure I.
- 3.6. The base material for the batch testing shall be arranged by the vendor. The cost for arranging the base material in such case shall be indicated separately in the offer. In the event that vendor is unable to arrange the plates, the same shall be provided by BHEL free of cost. Accordingly, vendor is advised to quote keeping the offer exclusive of base material cost.

4. TESTING REQUIREMENTS

A test assembly for cladding and butt welding each shall be prepared meeting the requirements of this specification. Test samples orientation and location shall be as shown in MSTP in Annexure VII & VIII. All test reports shall indicate the Standard followed for the test, acceptance criteria and the actual test results obtained.

4.1. TEST WELD ASSEMBLY PREPARATION

Test weld shall be made using the ordered consumable by cladding on base material 20MnMoNi55 or equivalent material of minimum thickness 20 mm, & meeting the requirements of para 4.3. Proper stiffeners, fixturing, clamping shall be done to avoid distortion. The thickness of cladding and the size of base material shall be sufficiently adequate to cover the standard specimen sizes for tests asked for in this specification.

In addition to the cladding test assembly, a butt weld test assembly shall be made in accordance with ASME Sec IIC, SFA 5.11.

Number of weld layers, thickness of clad deposit, grade of base material used and the welding parameters employed shall be recorded in the welding data sheet. Weld beads shall be of uniform size, shape and the slag shall be easily detachable. The welding parameters to be used for preparing the cladding test weld assembly and butt weld test assembly shall be as follows:

Electrode	Dia (mm)	Current (Ampere)	Voltage (Volts)	Polarity	*Preheat(°C)
					*Interpass(°C)
E NiCrFe-3	3.25	70-110	22-24	DCRP	150°
					200°
E NiCrFe-3	4.0	120-140	24-26	DCRP	150°
					200°
E NiCrFe-3	5.0	140-180	26-28	DCRP	150°
					200°

*Soaking: $280 \pm 20^\circ \text{C}$ X 6 hours. During any interruption in welding, soaking shall be done before cooling below the preheat temperature.
 Note: For 3rd layer onwards in cladding deposited using SMAW electrode, preheat is not required.

*For butt welding test assembly – when made in accordance with ASME Sec IIC, preheat and soaking stated above are not required. Other parameters remain same.

4.2. SIMULATED HEAT TREATMENT (SHT)

The cladding test assembly shall be subjected to simulated HT as shown in figure 1. For butt welding test joint, SHT is not required.

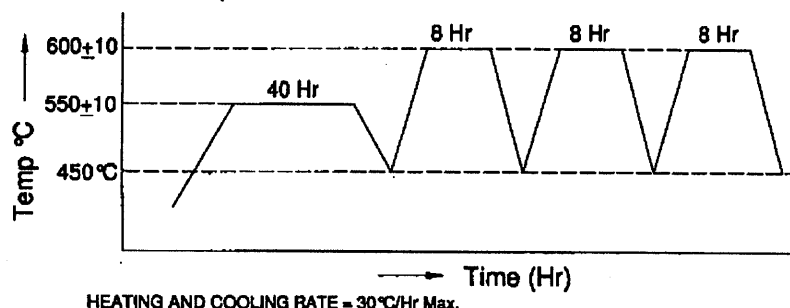


Fig 1: Simulated Heat Treatment

4.3. REQUIREMENTS OF BASE MATERIAL

The chemical composition of the base metal shall meet the following requirements:

Element	Weight %age	Element	Weight %age
C	0.17-0.23	Sn	0.011 max
Mn	1.2-1.5	As	0.015 max
Si	0.15-0.30	Sb	0.007 max
Mo	0.4-0.55	P	0.010 max
Ni	0.5-0.8	S	0.008 max
Cr	0.2 max	N ₂	0.013
Cu	0.12 max	H ₂	1 ppm max
V	0.02 max	O ₂	20 ppm max
Al(total)	0.01-0.04		

The mechanical properties of the base material shall meet the following requirements:

Property	Limits
Ultimate tensile stress	570-670 N/mm ²
Yield Stress (0.2%)	430 N/mm ²
Percentage elongation	18
Percentage reduction in area	45
Charpy V notch impact test	Average of 3 specimens – 41 Joules Lowest single value – 34 Joules
Bend Test	No failure at 4t, 180°
Hardness along length, width & thickness	To be reported

4.4. CHEMICAL COMPOSITION

The chemical composition of the weld metal after machining at 5 mm and 6 mm above the base metal, when deposited as weld cladding, shall meet the following:

Element	Wt. %	Element	Wt. %	Element	Wt. %	Element	Wt. %
C	0.04% max.	Co+Ta	0.08 max.	Mn	2-6%	Fe	4.0 max.
Si	0.50% max.	P	0.015 max.	S	0.015 max.	Mo	2.0 max.
Nb	2.00 - 2.5%	Cr	18.0-22.0	Ti	0.50 max.	N	To be reported
Co	0.03 max.	Ni	67 min.	Cu	0.50 max.	Al	To be reported

The sum total of all other residual elements including N (total) and Al shall not exceed 0.5%. In addition to the above, chemistry analysis shall be done at 1 mm, 2 mm, 3 mm and 4 mm *for information*, and at least for the following elements: Carbon, Silicon, chromium, nickel & niobium.

For chemistry check on butt weld also, above values are applicable.

4.5. NDE EXAMINATION

All required NDE as per Annexures II and III shall be carried out by the trained, qualified and certified NDE personnel as per SNT-TC-1A. For cladding, NDE reporting shall be done taking care of Annexures IV and V. NDE shall be done both before and after simulated heat treatment. For butt weld test joint, NDE shall be done in accordance with SFA 5.11 of ASME Section II, Part C – latest edition.

5. MECHANICAL TESTS

The mechanical test as per MSTP in Annexure VII shall be carried out on the undiluted clad metal deposit after subjecting to simulated heat treatment. The mechanical tests for butt weld test joint, as per Annexure VIII, shall be done in as-welded condition only. All mechanical tests shall be carried out as per ASME Sec IIC and AWS B4.0.

5.1. TENSILE TEST and IMPACT TEST

The Inconel cladding undiluted weld metal shall have the following mechanical properties in the simulated heat treated condition. For the tensile test, two strip tensile specimens covering the top and bottom regions of the cladding shall be tested.

Tensile strength min. (at Room Temperature)	620-690 N/mm ²
Yield strength (0.2 % proof stress at RT)	390 N/mm ² min.
% Elongation (L=5d)	30% min
% Reduction in Area	To be quoted and reported subsequently
Minimum absorbed energy (CHARPY v at 20°C)	79 Joules

The above values are also applicable for mechanical tests on butt weld test joint.

5.2. BEND TEST

Bend test for cladding shall be carried out as per MSTP in Annexure VII. Four transverse side bend test specimens of size 10mm thick X 26 mm wide and 300 mm long shall be bent through 180° around a mandrel of 40 mm diameter and shall successfully pass the test. Two transverse face bend specimens of 30 mm wide, 26 mm thick and 300 mm long shall be bent through 180 around a mandrel of 120 mm diameter such that the cladding is in tension.

Note: For butt weld test joint, bend test shall be done in accordance with SFA 5.11 of ASME Section II, Part C – latest edition.

5.2.1. Acceptance Criteria for Side Bend Test

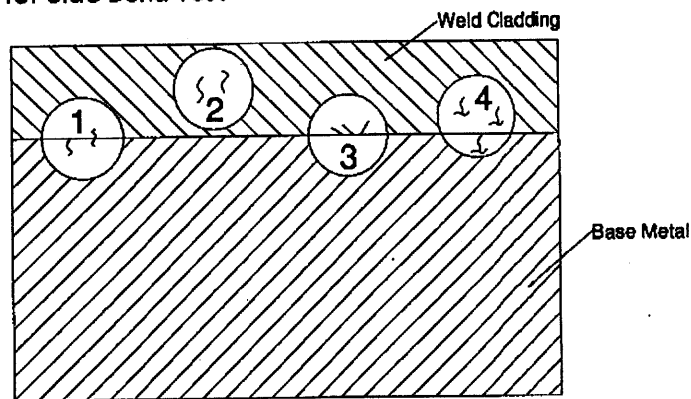


Fig 2: Defects in Side Bend Specimen

- Defect Type 1: Cracks extending into the base metal are not acceptable.
- Defect Type 2: Cracks in weld cladding which do not touch the fusion line are not acceptable.
- Defect Type 3: Isolated cracks in the cladding which form at an angle to and start from the fusion line are allowed provided they do not exceed 1.6 mm in length.
- Defect Type 4: Discontinuities which already existed in the unbent condition are not cause for rejection provided these discontinuities do not exceed 1.6 mm in cladding and 3 mm along base metal-weld interface.

5.2.2. Acceptance Criteria for Face Bend Test

The bend sample when evaluated with an unaided eye, shall be free from any opening/ fissure that are attributed to welding. Openings due to pre-existing acceptable defects like slag, gas pores shall be carefully examined and analysed. Openings attributable to discontinuities which existed before the specimen was bent are not cause for rejection provided these discontinuities do not exceed 1.6 mm.

5.3. THOMAS SHAEFFLER'S TEST

The electrodes shall be subjected to hot crack test as per Thomas Shaeffler as described in Annexure VI. For this test, SHT is not applicable. The tests shall indicate absence of sensitivity to hot cracking.

5.4. MACRO and MICRO EXAMINATION

A section taken after SHT, and transverse to the welding direction, shall be examined for macro and microstructure at suitable magnification. The examination shall be as per ASTM E340-15 and E 407-07 for macro and micro examination respectively, and shall cover all typical location of the cladding, interface overlap of beads and layers, heat affected zones and base metal.

The specimen shall be free of cracks. Isolated small pores and slag inclusion shall not be cause of rejection. Systematic defects are unacceptable.

5.5. HARDNESS TEST

Hardness shall be measured on the specimen used for metallographic examination, by Vickers pyramid method using 1 kg load. The hardness check shall cover transition, overlap of beads & layers, heat affected zone of base material and typical cladding.

Approximately 15 indentations spaced at 0.5mm, apart shall be taken in interface region (oblique line) and indentations spaced approximately at 1 mm shall be taken in base material & overlay sections, as shown in the figure below.

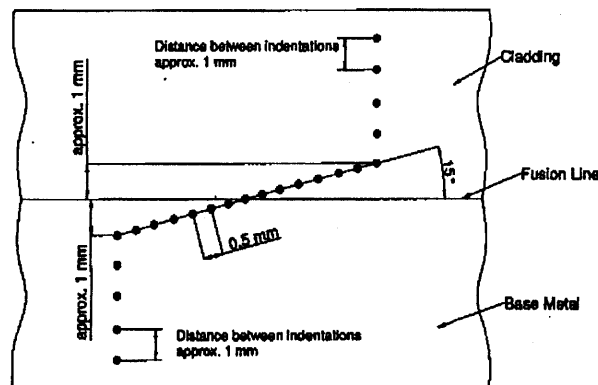


Figure 3: Hardness test

5.6. HOT CRACK TEST

Resistance to hot crack shall be checked by depositing a sequence of cross welded stringer beads on the cladding *after* simulated heat treatment.

The beads shall be approximately 25mm spaced, and shall be both along and transverse to the welding direction. The bead shall be deposited using the available size of coated Inconel electrodes and a single fusion pass using GTAW process, as shown in figure 4. The welding parameter shall be same as used in the cladding of the test assembly. No preheat shall be applied for this welding.

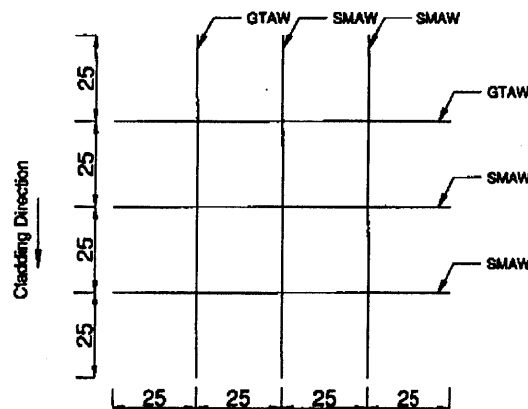


Figure 4: Hot crack test

After grinding to the cladding surface the weld shall be examined by Liquid penetrant examination as per approved procedure.

The cladding shall be further ground in steps each of 0.5mm such that the underlying layer is reached. Every step shall be subjected to penetrant examination.

The acceptability conditions are given below.

- Round indications shall show no material separation visible to unaided eye.
- Linear indications shall not be longer than 2mm
- The spacing between indications shall not be less than 50 mm.
- There shall not be more than 5 indications in an area of 100 cm².
- The arrangement of indications shall not indicate systematic nature.
- Metallographic investigations of the indications specified further shall be satisfactory.

- Metallographic investigations shall be performed in all cases where there is reason to suspect the presence of cracks or the presence of systematic defects. Particular attention shall be paid to possible discontinuities in the heat affected zone of the stringer beads within the underlying cladding.

6. CORE WIRES AND COVERINGS

- 6.1. Core wires and coverings shall be free of defects which would interfere with uniform performance of the electrodes.
- 6.2. The covering on the electrode shall be concentric to the extent that the maximum core plus one covering dimension shall not exceed the minimum core plus one covering dimension by more than 7% of the mean dimension in size 2 mm and 2.4 mm, 5% of the mean dimension in sizes 3.2 mm and 4 mm and 4% of the mean dimension in sizes 4.8 mm and larger. The concentricity may be measured by any suitable means.
- 6.3. The diameter of core wire shall not vary more than ± 0.05 mm from size specified. The length shall not vary more than ± 6.4 mm from that specified.

7. EXPOSED CORE

- 7.1. One end of each electrode shall be bare for a distance of 20 mm but not more than 30 mm to provide for electrical contact with the holder.
- 7.2. The other end of each electrode shall be sufficiently bare and the covering tapered to permit easy striking of the arc. The length of the bare portion of the arc end of electrode shall not exceed 1.6 mm or one half of the diameter of the core wire whichever is less.

8. MARKING

Each package shall be legibly marked on outside with the following information:

- Electrode specification and classification numbers.
- Suppliers name, Trade name of electrode.
- Electrode size, numbers and net weight.
- Lot, control, heat and batch number.
- Date of manufacture.

9. ELECTRODE IDENTIFICATION

All electrodes shall be identified in accordance with the following:

- At least one legible imprint of the electrode classification and trade name shall be applied to the electrode covering as near as practical to the grip end of the electrode and within 65 mm of grip end.
- The numbers and letters of the imprint shall be of bold block type of a sufficient size to be easily readable.
- The ink used for imprinting shall provide sufficient contrast with the electrode coverings such that the numbers and letters shall be readable before and after baking at user's works and after normal welding applications.

10. PACKAGING

Electrodes shall be suitably packaged to insure against injury during shipment and storage under tropical conditions. The package weight shall be as agreed upon by the supplier and the purchaser.

Annexure I
Quality Assurance Plan (QAP) for Cladding

SI No.	Description	Type of check	Ref. document	Inspection/ Test by Vendor	Inspection agency	Format of record
1	Core wire (Inconel wire)	Physical, chemical	Vendor's document	RR	RR	Supplier TC and/or tests conducted by vendor
2	Extrusion of electrode	Coating – visual check	WCPS 804 rev 06	WP	RR	Vendor to provide related docs for in process control carried out during production
3	Core wires and coverings	Concentricity	WCPS 804 rev 06	WP	RR	Vendor to provide related docs for in process control carried out during production
4	Electrodes	Dimensions of electrodes	WCPS 804/ 06	WP	WP	Random check by inspection agency
5	Test plate material spec size: 20MnMoNi55 or equivalent	Chemical & mechanical properties	WCPS 804/ 06	RR	HP	Supplier TC/Test reports
6	Test assy. Welding	Welding parameters, weld thickness	WCPS 804/06	WP	WP	Welding data sheet
		Bead uniformity for size & shape, slag release characteristics	WCPS 804/ 06	WP	RR	Welding data sheet
8	NDE before SHT	LPI on cladding UT on Cladding	WCPS 804/ 06	WP	WP	NDE report
7	Simulated Heat Treatment	No. of cycles, Rate of Heating / Cooling, Soaking temp. & Time	WCPS 804/ 06	WP	Witness SHT at start & end, review of HT chart	HT chart

Sl.No	Description	Type of check	Ref. document	Inspection/ Test by Vendor	Inspection Agency	Format of record
8	NDE after SHT	LPI on cladding UT on Cladding	WCPS 804/ 06	WP	WP	NDE report
9	Chemistry Check	Chemical analysis	WCPS 804/06, SFA 5.11 ASME Section IIC	WP	WP	Test report
10	Mechanical tests (Cladding)	Tr. Tensile , impact, face bend, transverse side bend, macro, micro, hardness test, Thomas Shaeffler test for each lot	WCPS 804/06, SFA 5.11 ASME Section IIC	WP	HP	Test report
11	Hot crack test	Sensitivity to hot cracking	WCPS 804/06	WP	WP	Test report
12	Electrode packing, marking identification, Shipping	Packing, identification	WCPS 804/06, SFA 5.11 ASME Section IIC	WP	HP	Test report
13	Certified Material test report	CMTR	WCPS 804/06	HP	HP	All test reports and TCs

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

Quality Assurance Plan (QAP) for Butt Welding

SI No.	Description	Type of check	Ref. document	Inspection/ Test by Vendor	Inspection agency	Format of record
1	Core wire (Inconel wire)	Physical, chemical	Vendor's document	RR	RR	Supplier TC and/or tests conducted by vendor
2	Extrusion of electrode	Coating – visual check	WCPS 804 rev 06	WP	RR	Vendor to provide related docs for in process control carried out during production
3	Core wires and coverings	Concentricity	WCPS 804 rev 06	WP	RR	Vendor to provide related docs for in process control carried out during production
4	Electrodes	Dimensions of electrodes	WCPS 804 rev 06	WP	WP	Random check by inspection agency
5	Test plate material	Chemical & mechanical properties	SFA 5.11, ASME Sec IIC	RR	HP	Test Report
6	Test assy. Welding	Welding parameters, weld thickness	WCPS 804/06	WP	WP	Welding data sheet
		Bead uniformity for size & shape, Slag release characteristics		WP	RR	Welding data sheet

7	NDE	RT	WCPS 804/ 06 SFA 5.11 ASME Sec IIC	WP	WP	NDE report
8	Chemistry Check of weld metal	Chemical analysis	WCPS 804/ 06, SFA 5.11 ASME Sec IIC	WP	WP	Test report
9	Mechanical tests	Tensile, impact, side bend test, hardness, macro, micro	WCPS 804/ 06, SFA 5.11 ASME Sec IIC	WP	HP	Test report
10	Electrode packing, marking identification, Shipping	Packing, identification	WCPS 804/ 06, SFA 5.11 ASME Section IIC	WP	HP	Test report
11	Certified Material test report	CMTR	WCPS 804/06	HP	HP	All test reports and TCs

Annexure II

Ultrasonic Examination of Cladding

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 calibration procedure shall be submitted by the manufacturer for approval by the purchaser.

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, 2 mm 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 reexamined.

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 6DB, 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 straight beam scanning, 30 recordable indications with a maximum continuous length of 10 mm subject to a total length of 250 mm/meter length of the scanned area are acceptable.

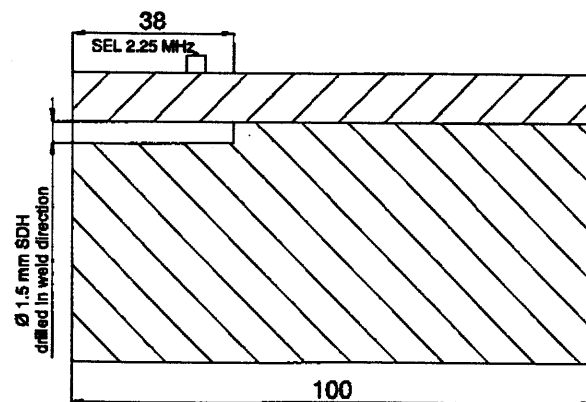
6.4 Whenever the indications are interpreted as cracks they are unacceptable regardless of the length and amplitude.

7.0 Final Cleaning

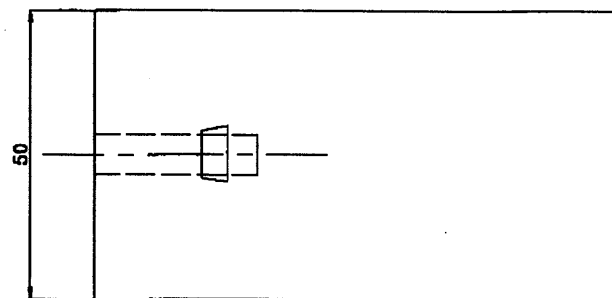
After the examination is over, the couplant shall be thoroughly cleaned and removed from the surface.

8.0 Report

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

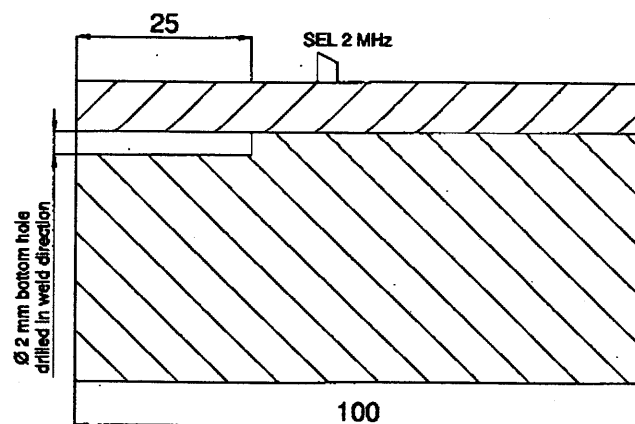


CALIBRATION BLOCK

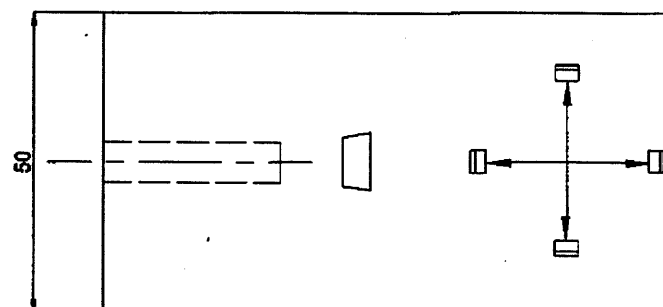


ULTRASONIC STRAIGHT BEAM EXAMINATION OF WELD DEPOSITED CLADDING

Sketch I



CALIBRATION BLOCK



ULTRASONIC ANGLE BEAM EXAMINATION OF WELD DEPOSITED CLADDING

Sketch II

Annexure III**Liquid Penetrant Examination of Cladding****1. Scope**

- 1.1. This specification covers procedure for liquid penetrant examination of cladding deposited with Inconel consumable.

2. Surface Condition

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

3. General remarks

Liquid penetrant examination shall be carried out using approved penetrants, cleaners and 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. 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. Sufficient penetrant shall be applied during the period of the test to prevent drying of penetrant upon the surface.

4.3. Cleaning of the test surface

When chemical solvent is being used as the cleaner, care should be taken to ensure that 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 kg/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.

5. 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 the Inconel cladding shall be performed after following durations.

- a. First time after drying of developer.
- b. After ½ hour
- c. After 1 hour
- d. After 3 hours
- e. After 4 hours

All results shall be recorded.

6. 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 indications of discontinuities are unacceptable and the areas should be cleaned and re-examined.

7. Procedure Qualification

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

8. 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. Report

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

Annexure IV

LIQUID PENETRANT EXAMINATION REPORT

S 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 V – ULTRASONIC EXAMINATION 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					

Annexure VI

Thomas Shaeffler's Test

1.0 Scope

This test method is applicable for austenitic stick electrodes and coated electrodes with dia. more than 3.25 mm and drawn wires with dia. more than 1.2 mm.

2.0 Specimen form

Base material shall be TYPE 347 or any austenitic stainless steel, of dimensions as shown below.

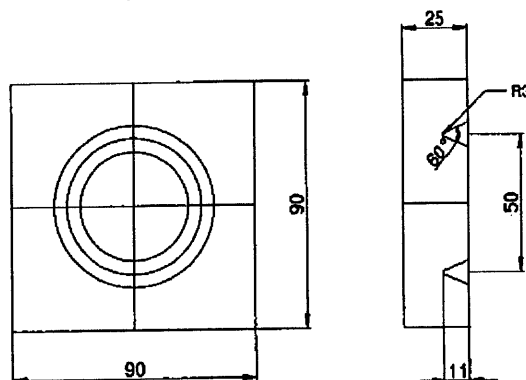


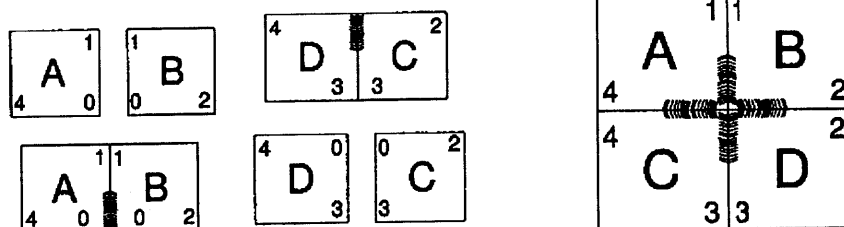
Figure 5

3. Procedure

Four equal quadrant parts of 25 mm thick and 45 mm square length have to be taken. The rolling surface can be maintained.

Preparation of test specimen:

- a) Surface 1-0 of part A & B and Surface 3-0 of part C & D shall be ground.
- b) Part A & B and Part C & D shall be clamped together.
- c) Part A & B and Part C & D shall be joined by tack welding both sides (25 mm long).
- d) Surface 4-0-2 of tack welded parts A-B and C-D shall be ground.
- e) Tack welded part A-B and C-D shall be clamped together.
- f) Tack welded parts A-B and C-D shall be joined by tack welding both sides (50 mm long).
- g) In the specimen turn a groove as shown in Fig 5.

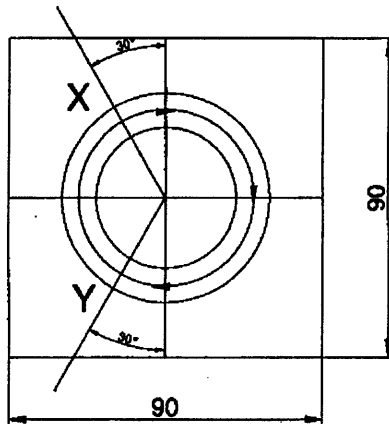


4.0 Method of welding

Consumables: Inconel covered SMAW electrode as ordered

Weld Data: Welding current/polarity as per para 4.1 of this document.

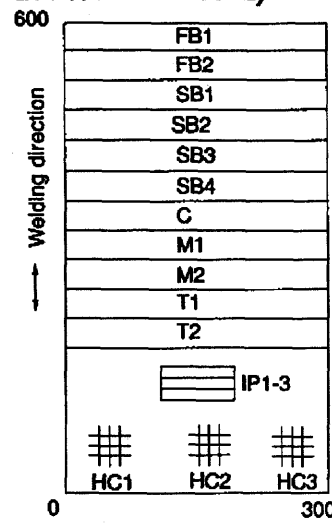
Welding position: Horizontal 1G

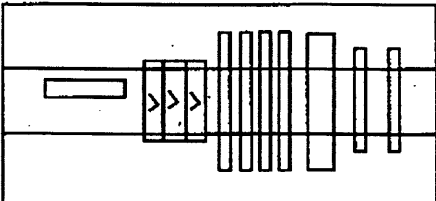


From point X to point Y has to be welded without any oscillation and interruption. The speed of welding shall be around 150 mm/min which corresponds to the welding time of about 42 seconds. After cooling the test specimens and cleaning (removing of weld slag and spattered metal) of the bead surface and groove, the point Y to X shall be welded as before in the clockwise direction without any oscillation and interruption in about 21 seconds. The welding speed of 150 mm per minute is indicate for a 4.0 mm diameter electrode.

5.0 Testing

The testing of the surface shall be done by means of Dye penetrant test. The performance and assessment shall be same as that for main cladding test assembly described in WCPS. During assessment, crater cracks are not considered for rejection.

		Annexure VII - MATERIAL SAMPLING AND TESTING PLAN				MSTP NO: MSTP:1:804	
TEST SPECIFICATION WCPS 804		Consumable Qualification for Covered Inconel Welding Electrodes for Cladding					
Sl. no.	Specimen details			Position	Identification	Base Material designation and Size are as per WCPS:804 (Size of Plate to be cladded = 20T x 300W x 600L)	
	Description	Size w x t	Length				
1.	Face Bend	30x26	300	Tr	FB1-2		
2.	Side Bend	10x26	300	Tr	SB1-4		
3.	Chemical	30x26	300	Tr	CH1		
4.	Micro	10x26	100	Tr	M1		
5.	Macro	10x26	100	Tr	M2		
6.	Hardness	10x26	100	Tr	M1		
7.	Strip Tensile	19x3	300	Tr	T1-2		
8.	Hot Crack Test	100xT	100	Tr	HC1-3		
9.	Thomas Schaefflers Test #	90x25	90	Tr	#		
10.	Impact Charpy V	10X10	55	Tr	IP1-3		
						Note: 1) Bend diameter 4t for 180°. For Side bend, two specimens the bead overlap in the first layer and for two others specimens the bead overlap in the second layer will be at the point of maximum bending. For Face bend, bead overlap shall be at the point of maximum bending 2) Micro: 100 X magnification with photograph. Macro: 10X with photograph. 3) HV-1kg load (Refer clause: 5.5 of WCPS). 4) Tensile: Two transverse strip tensile specimens covering the top and bottom regions of the cladding. # 5) Schaefflers test shall be done on SS-347 specimen of size 90 mm x 90 mm x 25 mm with welding done by the consumable to be qualified. 6) Impact Test: 79 Joules at 20°C.	

		TEST SPECIFICATION WCPS 804		Annexure VIII: MATERIAL SAMPLING AND TESTING PLAN (ATP)		MSTP NO: MSTP:2:804
				Consumable Qualification for Covered Inconel Welding Electrodes for Butt Welding		
Sl. no.	Specimen details			Position	Identification	Base Material designation and Size are as per WCPS:804 Minimum Defect free length require for Testing = 300 mm.  T1 IP1-3 SB1-4 CH1 M1 M2
		Size w x t	Length h			
1.	Tensile	Ø5	95	L	T1	
2.	Impact(V notch at Weld)	10x10	55	Tr	IP1-3	
3.	Side Bend	10xt	200	Tr	SB1-4	
4.	Chemical	25xt	300	Tr	CH1	
5.	Micro	10xt	300	Tr	M1	
6.	Macro	10xt	100	Tr	M2	
7.	Hardness	10xt	100	Tr	M2	
Note: 1) Tensile : As per WCPS 2) Impact : As per WCPS 3) Side Bend Test : Bend diameter 4t for 180°. 4) Micro: 100 X magnification with photograph.Macro:10X with photograph. 5) HV-1kg load (Refer clause:5.5 of WCPS).						