1.0 **Qualifying Criteria**

1.1 Offers, from such vendors only, will be considered, who have manufactured, tested and supplied the inconel strip and flux in the recent past five years period.

1.2 A test certificate of a batch, supplied within the last five years should be enclosed with the offer. The test certificate should contain chemical analysis & mechanical properties for weld metal(for SAW) . Offers without such a test certificate will not be considered.

1.3 Notwithstanding the qualifying criteria, BHEL/NPCIL shall be allowed to visit the vendor's manufacturing and testing centre for further evaluation, if required.

2.0 SCOPE

2.1 This specification prescribes the requirements for inconel strip electrodes and flux for cladding by submerged arc welding process.

3.0 STRIP ELECTRODE

3.1 GENERAL REQUIREMENT

3.1.1 The technical delivery conditions shall be as per DIN 1736, Part 1.

3.1.2 The electrode shall be manufactured and controlled according to ASME Section III NB Div I & ASME Sec II Part C.

3.1.3 The electrode shall be certified according to DIN 50049-3.1 B.

3.1.4 The entire quantity ordered shall be supplied in one melt only.

3.1.5 Third party inspection shall be engaged for carrying out welding and testing.

3.1.6 Batch test TC to be submitted to BHEL & only after BHEL 's approval and acceptance the T.C , the dispatch should be effected.

3.2 CHEMICAL COMPOSITION

The chemical composition of the strip electrode shall conform to DIN 1736 Part 1, S-Ni Cr 20 Nb material No.2.4806 with the following restrictions.

C	-	0.025% max.			
Cr	-	19.5% min.	Co	-	0.03% max.
Nb	-	2.5% min.	Co+Ta	-	0.08% max.
Si	-	0.2% max.	N	-	To be reported

Ti	-	0.4% max.	Al	-	To be reported
P	-	0.015% max.	Fe	-	1.0% max.

Note : Since it is contemplated to use this strip in conjunction with an all mineral type agglomerated flux, it is suggested that all necessary care be taken to maintain the minimum essential levels of intentionally added alloys like Cr & Nb and restrict to the extent possible the maximum levels of permitted impurities like Si, Ti & Fe.

3.3 FINISH AND TEMPER

3.3.1 The strip electrode shall have a smooth finish, free from slivers, depressions, seams, laps, scratches, scale or other foreign matter that would adversely affect the welding characteristics, the operation of the welding equipment, or the properties of the deposited weld metal.

3.3.2 Strip electrodes shall be suitable for uniform uninterrupted feeding on automatic or semi-automatic welding equipment.

3.4 WINDING REQUIREMENTS

3.4.1 Liners used in coils with support are for the purpose of preventing damage or distortion during normal handling and use of electrodes upon them. Liners shall be of such material and design to accomplish this. Liners shall be sufficiently clean and dry to maintain the cleanliness of the strip electrode.

3.4.2 Each coil shall be of only one heat and be of continuous length of electrode.

3.4.3 A spooled 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.

3.5 PACKAGING

The electrodes shall be suitably packaged to insure against injuries during shipment or storage under normal conditions.

3.5.1 COIL SIZE

Inner diameter	300 mm
Width	60 mm
Approx. Weight	25 kg.

3.5.2 The coils shall be wrapped in corrosion shielding gas paper and sealed with plastic foil or any other moisture proof packing. Each of such packs shall be contained in cardboard boxes, several such boxes being created in sea worthy wooden cases.

3.5.3 An identification tag shall be attached to each coil in addition to the label put on every spool and cardboard box.

3.6 MARKING

3.6.1 Each spool and the outside of each package shall be legibly marked with the following information:

1. Classification and specification numbers.
2. Supplier's name and trade designation.
3. Electrode size length and net weight.
4. Lot, control or heat number.

4.0 FLUX

4.1 GENERAL REQUIREMENTS FOR FLUX

4.1.0 Form and Particle size : Flux shall be granular in form and shall be capable of flowing freely through the flux feeding tubes, valves and nozzles of standard submerged arc welding equipment.

4.1.1 The flux shall be manufactured and controlled according to ASME Section III NB Div I & ASME Sec II Part C.

4.1.3 The technical delivery conditions shall be as per DIN 1736, Part 1.

4.1.4 The flux shall be certified according to DIN 50049-3.1B.

4.1.5 The entire ordered quantity shall be from one batch only.

4.2 WELD METAL COMPOSITION

The strip electrode and flux combination shall be used to produce test plates of minimum 20.0 mm thickness (proper stiffeners, fixturing , clamping to be done to avoid distortion), equivalent to 20MnMoNi55 (modified) by using cladding technique and subjected to following examinations and tests.

4.2.1 The composition of the weld metal at 5 and 6 mm above the base metal shall conform to following requirement.

C	0.025% max.
Si	0.50% max.
Nb	2.00 - 2.50%
Co	0.03% max.
Co + Ta	0.08% max.
P	0.015% max.
Cr	18.0 – 22.0%
Ni	67.0% min.
Mn	2.50 - 3.50%
S	0.015% max.
Ti	0.75% max.
Cu	0.50% max.
Fe	3.0% max.
Mo	2.0% max.
Nitrogen	To be reported
Al	To be reported

The sum total of all other residual elements including Nitrogen and Al shall not exceed 0.5%.

4.3 FLUX : USABILITY

4.3.1 The flux shall permit the production of uniform, well-shaped beads that merge smoothly with each other and the base metal. Undercut, if any, shall not be so deep or so widespread that a subsequent weld pass will not remove it.

4.4 NON-DESTRUCTIVE TESTING (NDT)

4.4.1 Liquid Penetrant (surface crack) examination

4.4.1.1 Each layer of the weld deposited cladding shall be examined by penetrant test. However if Multi-layer cladding is carried out in a single preheating period, the intermediate examinations are omitted.

4.4.1.2 The final machined surface shall be subjected to surface crack examination by liquid penetrant testing before and after simulated heat treatment.

4.4.1.3 Surface indication of any nature and type are not acceptable. Non systematic individual minor indications may be dressed up by light grinding and re-examined.

The following are the acceptance limits :

Broad areas of pigmentation which could mask indications of discontinuities are unacceptable and the areas should be cleaned and re-examined.

All cracks or defects with crack like indications are not acceptable. Spot indications of 1.5mm diameter and less are acceptable upto 10 numbers per metre length of weld provided they are separated by at least 2 mm.

4.4.2 Ultrasonic examination

4.4.2.1 The inconel cladding shall be subjected to ultrasonic examination by straight beam scanning and angle beam scanning and shall cover the entire area.

4.4.2.2 Under bead cracks and bonding defects are not acceptable

The following are the acceptance limits :

All indications having amplitude equal to or greater than 50% of the reference level shall be recorded. If the signal : noise ratio is less than 6 DB, this is to be recorded and further activities have to be agreed upon.

The calibration block shall be made by cladding on an acoustically same base material as that of component under examination over laid with the same technique as that of the component.

For Straight beam examination a side drilled hole of 1.5 mm diameter by 38 mm depth or at least 25 mm minimum depth shall be drilled into the block at the clad interface.

For Angle beam examination 2 mm diameter Flat bottom hole has to be used.

The probe shall be placed over the cladded surface and directed towards the hole.

The signal from the hole adjusted to 80% height. This has taken as reference line for sensitivity setting.

All indications with a signal amplitude equal to or greater than the reference level are unacceptable.

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

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

4.5 MECHANICAL TESTING

4.5.1 The acceptance limits for mechanical tests are as follows,

4.5.1.1 The inconel cladding undiluted weld metal shall have the following mechanical properties In the heat treated condition.

Tensile strength, minimum	600 N/mm^2
Yield strength (0.2%), minimum	380 N/mm^2
% Elongation (on 5d), minimum	30%

4.6 The test plates for consumable qualification test shall undergo a simulated heat treatment as the detail given in Annexure -1.

4.7 The weld metal chemistry at 5 and 6 mm above the base metal for cladding shall meet the requirements of 4.2.1.

4.8 The chemical properties as specified above shall be obtained from a weld deposit made Using the proposed flux in conjunction with strip meeting the requirements of 3.2.

4.9 Test to be done for consumable batch testing

	Type of test	Direction	Quantity	Remarks
1	Face bend	transverse	2 (4t-180)	Note-2
2	Side bend	transverse	4 (4t-180)	Note-1
3	Tensile	Transverse per layer	1	
4	Chemical		1	
5	Hot crack test	Penetrant examinations to be carried out in steps of 0.5mm up to 2.0mm below the base metal surface. 3 Nos		
6	Micro / Macro/ Hardness	transverse	1	

Remarks :

Note:1 For two specimen the bead overlap in the first layer and for two other Specimens the bead overlap in second layer will be at the point of maximum bending.

Note: 2 Bead overlap shall be at the point of maximum bending.

5.0 MARKING

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

1. Flux classification and specification numbers.
2. Supplier's name and trade designations.
3. Net weight.
4. Lot, batch or control number, Date of manufacture.

6.0 PACKAGING AND STORAGE

6.0.1 Flux shall be suitably packaged to insure against damage during shipment or storage under tropical conditions.

6.0.2 A flux in the original unopened package shall withstand storage under tropical conditions for atleast four years without such storage affecting its welding characteristics or the weld properties.

6.0.3 The flux shall be packed in 250 kg water tight steel drums and sealed.

7.0 **General Requirments**

7.0.1 The offers from vendors should contain a "LIST OF DEVIATIONS" in which the deviations against the technical specification, citing the clause number of the BHEL specification, should be explicitly listed.

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

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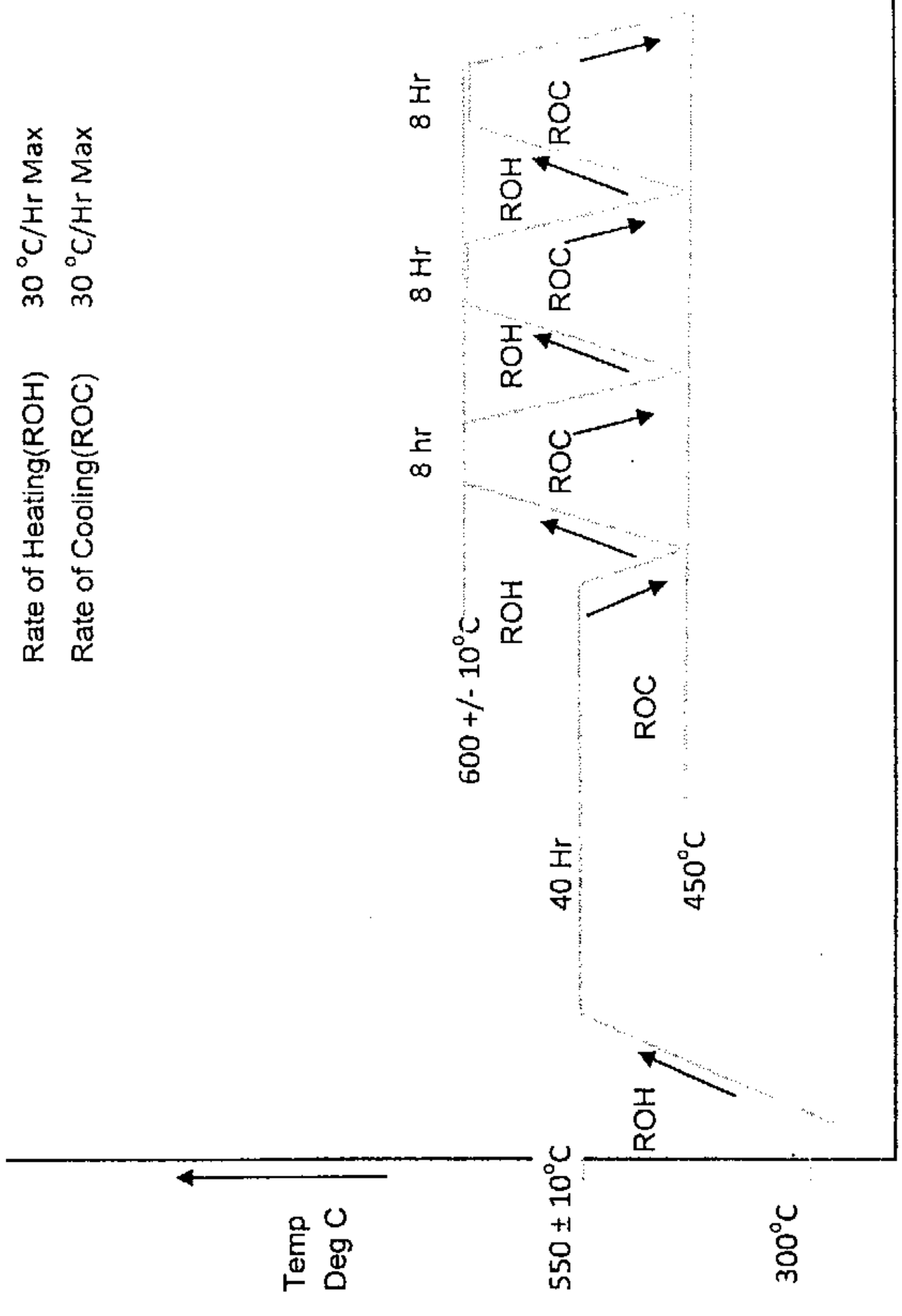
ANNEXURE-1



Rate of Heating(ROH)	30 °C/Hr Max
Rate of Cooling(ROC)	30 °C/Hr Max