SECTION-VII

TECHNICAL SPECIFICATIONS

SECTION-VII

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TECHNICAL SPECIFICATIONS

SECTION-VII

1. Technical Description of ACSR Conductor

1.1 Details of Conductor

1.1.1 The ACSR Conductor shall generally conform to IEC: 61089/ IS: 398 (relevant part)/ ASTM:B-232 except where otherwise specified herein.

1.1.2 Standard Technical Particulars

The Standard Technical Particulars (STP) of the ACSR conductors are enclosed at Annexure-A of this section. The values indicated in the STP are the minimum and/or maximum values required to be met by the supplier.

1.2 Workmanship

1.2.1 All the aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

1.2.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

1.2.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the STP. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand number of dips in Standard Preece test as indicated in STP. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 60888.

1.2.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of complete core. Care shall be taken to avoid, damages to galvanisation during pre-forming and post-forming operation.

1.3 Joints in Wires

1.3.1 Aluminium Wires

1.3.1.1 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

1.3.1.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

1.3.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand as per STP.

1.3.2 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

1.4 Tolerances

The manufacturing tolerances to the extent indicated in the STP shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

1.5 Materials

1.5.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IEC: 60889.

1.5.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

1.5.3 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of purity as indicated in the STP. It shall conform to and satisfy all the requirements of IS:209.

1.6 Standard Length

1.6.1 The standard length of the conductor shall be as indicated in the STP. All lengths outside this limit of tolerance shall be treated as random lengths. Not less than 90% of the total quantity of the conductor shall be supplied in standard lengths.

1.6.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered. At any point, the cumulative quantity supplied of such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.

1.6.3 The purchaser reserves the right to place orders for the lengths above the standard length on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

2.0 Tests and Standards

2.1 **Type Tests**

The following tests shall be conducted on sample/samples of the conductor(s) required under the package from each stranding machine from which the conductor is to be manufactured & supplied:

a)	DC resistance test on stranded conductor	As per Annexure-B
b)	UTS test on stranded conductor	
c)	Corona extinction voltage test (dry) *	
d)	Radio interference voltage test (dry) *	

* Applicable for 220 kV or above voltage level only

2.1.1 Type tests specified under Clause 2.1 shall not be required to be carried out if supplier has conducted these tests earlier on the same conductor & same bundle configuration (applicable for tests 'c' & 'd') and valid type test certificates are available. The test certificate shall be considered valid if,

i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or utility and

ii) Tests conducted on the samples of conductor manufactured from same stranding machine within 3 (three) years prior to the date of commencement of manufacturing for the package. However, the manufacturing of the conductor for the package can be carried till 3 (three) years from the date of type testing.

In case the tests have been conducted earlier than the above stipulated period or carried out on another stranding machine or in the event of any discrepancy in the test report (i.e., any test not applicable due to any design/manufacturing change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the supplier at no extra cost to the purchaser. Also, in case, manufacturing (scheduled/actual) is beyond the 3 (three) years from the date of type testing, supplier has to repeat the above type tests at no extra cost to the purchaser.

2.2 Acceptance Tests

a)	Visual and dimensional check on drum	As per Annexure-B
b)	Visual check for joints, scratches etc. and length measurement of conductor by rewinding	
c)	Measurement of diameters of individual Steel and Aluminium strands	
d)	Check for lay-ratios of various layers	
e)	Galvanizing test on steel strands	
f)	Torsion and Elongation tests on steel strands	
g)	Breaking load test on steel and Aluminium strands	IEC : 60888 & 60889
h)	Wrap test on Steel & Aluminium strands	IEC : 60888 & 60889
i)	DC resistance test on Aluminium strands	IEC : 60889
j)	Procedure qualification test on welded joint of Aluminium strands	As per Annexure-B
k)	Drum strength test (steel drum)	As per Annexure-B
l)	Barrel Batten strength test (wooden drum)	As per Annexure-B

Note: All the above tests except (j) shall be carried out on Aluminium and steel strands after stranding only.

2.2.1 The acceptance tests pertaining to conductor only shall be repeated on one conductor sample taken from site in presence of POWERGRID's representative for each 500km progressive supply or part thereof. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by POWERGRID's site representative and the tests shall be witnessed by POWERGRID's QA&I representative. In case of evidence of non-compliance, it shall be binding on the part of the supplier to prove compliance of the items to the technical specification by repeat tests, or correction of deficiencies, or replacement of defective items all, without any extra cost to the purchaser.

2.3 Routine Test

a) Check to ensure that the joints are as per Specification

b) Check that there are no cuts, fins etc. on the strands

c) Check that drums are as per Specification

d) All acceptance test as mentioned above to be carried out on aluminium and steel strands of 20% of drums

2.4 Tests During Manufacture

a)	Chemical analysis of zinc used for galvanizing	As per Annexure-B
b)	Chemical analysis of Aluminium used for making Aluminium strands	
c)	Chemical analysis of steel used for making steel strands	

2.5 Testing Expenses

2.5.1 In the event of type testing, bidder shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule.

2.5.3 In case of failure in any type test, the supplier is either required to manufacture fresh sample lot and repeat the entire tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expense. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

2.5.4 The entire cost of testing for the type, acceptance, routine tests and tests during manufacture specified herein shall be treated as included in the

quoted unit price of conductor, except for the expenses of the inspector/purchaser's representative.

2.5.5 In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of inspector/purchaser's representative shall be to the supplier's account. Also, if on receipt of the supplier's notice of testing, the purchaser's representative does not find the test samples or testing facilities/equipments ready for testing, the expenses incurred by the purchaser for re-deputation shall be to the supplier's account.

2.6 Additional Tests

2.6.1 The purchaser reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at supplier's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.

2.6.2 The purchaser also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at supplier's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of supplier to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the purchaser.

2.7 Sample Batch For Type Testing

2.7.1 In case the type tests are required to be carried out, the samples for type testing shall be manufactured in accordance with the Standard Manufacturing Quality Plan.

2.7.2 The supplier shall offer at least three drums for selection of sample required for conducting all the type tests.

2.7.3 The supplier is required to carry out all the acceptance tests successfully in presence of purchaser's representative before sample selection.

2.8 Test Reports

2.8.1 In case type tests have been carried out earlier by the supplier and valid type test reports are available as specified in clause 2.1.1 above, the supplier shall submit one copy of the test report along with approval letter issued by POWERGRID or utility.

2.8.2 In case fresh type tests have been carried out under the package, the type test reports shall be furnished in original along with two copies. One copy will be returned duly certified by the purchaser.

2.8.2 The commercial production of the conductor can be taken up by the supplier after clearance from the purchaser.

2.8.3 Record of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser's representative.

2.8.4 Test Certificates of tests during manufacture shall be maintained by the supplier. These shall be produced for verification as and when desired by the purchaser.

2.9 Inspection

2.9.1 The purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the supplier's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

2.9.2 The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

2.9.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the purchaser in writing. In the latter case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

2.9.4 The acceptance of any quantity of material shall in no way absolve the supplier of any of his responsibilities for meeting all requirements of the Specification, and shall not prevent subsequent rejection if such material is later found to be defective.

2.10 Test Facilities

2.10.1 The following test facilities shall be available at the supplier's works:

a) Various testing and measuring equipment for carrying out specified acceptance tests, routine tests and tests during manufacture inter alia including tensile testing machine, resistance measurement facilities, torsion & wrap testing machine, dimension checking instruments viz. digital vernier and micrometer etc., galvanizing test instruments viz. digital elcometer and standard preece test etc., burette, digital thermometer, barometer etc.

b) Digital milli/micro ohm meter along with standard resistance for calibration of resistance bridges.

c) Spectrometer, if supplier has its own properzi mill

c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

2.11 Packing

2.11.1 The conductor shall be supplied in returnable, painted steel drums of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

2.11.2 One standard length shall be wound on each drum. The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

2.11.3 The standard drawing of the drum for conductor is enclosed with the specification. The Bidder shall supply the conductor in the drum conforming to the specification drawing. After preparation of steel surface according to IS:9954, synthetic enamel paint shall be applied after application of one coat of primer.

2.11.4 The ownership of the empty conductor drums shall lie with the conductor supplier who shall ultimately take back the empty conductor drums from the erection contractor's designated stores at project site(s) after the running out of conductor from the drums.

2.11.5 The erection contractor shall intimate the conductor supplier and employer regarding empty steel drums at their designated stores. Necessary coordination for taking back the empty steel drums in this regard shall be done by the conductor supplier with the erection contractor.

2.11.6 The empty drums shall be taken back by the conductor supplier from the stores of erection contractor as & when these are available after usage of conductor. Conductor supplier shall be required to take back the empty steel drum within a period of one month from date of information by erection contractor regarding availability of the drums at erection contractor stores. However, 2% of the total drums shall not be returned to the conductor

supplier as these may be used for storage of spare conductor by the purchaser.

2.11.7 The steel drums may get damaged and/or wear & tear during transportation, normal handling & operation at site, which shall be rectified by the conductor supplier before re-use. However, 2% of the total drums shall not be returned on account of damages / wastage for which no compensation will be payable. The wastage beyond 2% shall be reimbursed by erection contractor.

Thus, 4% of total drums shall not be returnable to the conductor supplier.

2.11.8 Solid Polypropylene sheet of minimum 5mm thickness shall be used for outer covering of conductor. Outside the covering, there shall be minimum two binders consisting of hoop iron/galvanised steel wire. Two numbers of additional binders per drum shall also be supplied for re-wrapping the polypropylene sheet with each lot of conductor and 5 nos. crimping machines with the first lot of conductor for crimping the binders at site. As an alternative, supplier may use wooden lagging of minimum 50 mm thickness for outer covering of conductor without any extra financial implication to the purchaser.

2.11.9 As an alternative to returnable steel drum, bidder may supply the conductor in non-returnable wooden drums. However, for bid evaluation purpose, both types of drums shall be treated at par and bidder may quote accordingly.

2.11.10 The standard drawing of the wooden drum for conductor is also enclosed with the specification. The Bidder shall supply the conductor in the drum conforming to the specification drawing.

2.11.11 The wooden drums shall generally conform to IS:1778, except as otherwise specified hereinafter. All wooden components shall be manufactured out of seasoned soft wood, free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor. Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts. Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The nails shall not protrude above the general surface and shall not have exposed sharp edges or allow the battens to be released due to corrosion.

2.11.12 Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material over which HDPE sheet to be provided. In case of steel drum, for securing HDPE sheet onto the bamboo paper & drum flanges, the HDPE sheet shall be secured onto

the drum by means of a commercial adhesive/self-locking nylon cable zip ties such that there is no protrusion above the general surface that may cause damage to the conductor strands. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with thick plastic sheet secured using adhesive tapes to preserve the conductor from ingress of water, dirt, grit and damages during storage, transport and handling. Medium grade craft/crepe/polythene paper shall be used in between the layers of conductor.

2.11.13 The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

2.12 Marking

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

(a) Contract/Specification number.

(b) Name and address of the consignee.

(c) Manufacturer's name and address.

(d) Drum number

(e) Size of conductor

(f) Length of conductor in meters

(g) Arrow marking for unwinding

(h) Position of the conductor end (For Wooden Drums only)

(i) Number of turns in the outer most layer.

(j) Gross weight of the drum (with protective lagging in case of wooden drums) including conductor.

(k) Weight of empty drum (with protective lagging in case of wooden drums).

(l) Net weight of the conductor in the drum.

(m) CIP No.

The above should be indicated in the packing list also. To accommodate the above details, conductor manufacturer may suitably design the plate size larger than that specified in the standard drum drawing, if required.

2.13 Verification of Conductor Length

The purchaser reserves the right to verify the length of conductor after unreeling. The quantity for verification shall be between a minimum of five percent (5%) to a maximum of ten percent (10%) in a lot offered for

inspection. The actual quantity will be discussed and mutually agreed to by the supplier & purchaser.

2.14 **Standards**

2.14.1 The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

2.14.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the supplier and those specified in this document will be provided by the supplier to establish their equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209	Specification for zinc	BS:3436
2.	IS: 398 Part-I	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:61089 BS:215
3.	IS:398 Part-II	Aluminum Conductor Galvanised Steel Reinforced	BS:215 IEC:61089
4.	IS:398 Part-V	Aluminum Conductor Galvanised Steel-Reinforced For Extra High Voltage (400 KV) and above	IEC:61089 BS:215
5.	IS : 1778	Reels and Drums for Bare Conductors	BS:1559
6.	IS : 1521	Method of Tensile Testing of Steel Wire	ISO 6892
7.	IS : 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
8.	IS : 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9.	IS : 4826	Galvanised Coating on Round Steel Wires	IEC : 60888 BS:443
10.	IS : 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO 1460
11.	IS : 8263	Method of Radio Interference Tests on High Voltage Insulators	IEC: 60437 NEMA:107 CISPR
12.		Zinc Coated steel wires for stranded Conductors	IEC : 60888
13.		Hard drawn Aluminium wire for overhead line conductors	IEC : 60889

The standards mentioned above are available from:

Reference Abbreviation	**Name and Address**
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND UK
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva SWITZERLAND
BIS/IS	Beureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017 U.S.A.

Annexure-A

Standard Technical Particulars for ACSR Conductors

Sl.	Description	Unit	Standard Technical Particulars Conductors					
			ACSR LAPWING	**ACSR BERSIMIS**	**ACSR SNOWBIRD**	**ACSR MOOSE**	**ACSR ZEBRA**	**ACSR PANTHER**
1.0	**Construction**							
1.1	**Stranding and wire diameter**							
a)	Aluminium wire		45/4.78 mm	42/4.57 mm	42/3.99 mm	54/3.53 mm	54/3.18 mm	30/3.00 mm
b)	Steel wire		7/3.18 mm	7/2.54 mm	7/2.21 mm	7/3.53 mm	7/3.18 mm	7/3.00 mm
1.2	**Layer & no. of wire**							
a)	Steel core		1	1	1	1	1	1
b)	1st steel layer		6	6	6	6	6	6
c)	1st Aluminium layer		9	8	8	12	12	12
d)	2nd Aluminium layer		15	14	14	18	18	18
e)	3rd Aluminium layer		21	20	20	24	24	NA
2.0	**Raw Materials**							
2.1	**Aluminium**							
a)	Minimum purity of Aluminium	%	99.50					
b)	Maximum copper content	%	0.04					
2.2	**Steel wires/ rods**							
a)	Carbon	%	0.50 to 0.85					
b)	Manganese	%	0.50 to 1.10					
c)	Phosphorous	%	Not more than 0.035					

Sl.	Description	Unit	Standard Technical Particulars Conductors					
			ACSR LAPWING	**ACSR BERSIMIS**	**ACSR SNOWBIRD**	**ACSR MOOSE**	**ACSR ZEBRA**	**ACSR PANTHER**
d)	Sulphur	%	Not more than 0.045					
e)	Silicon	%	0.10 to 0.35 (Max.)					
2.3	**Zinc**							
a)	Minimum purity of Zinc	.%	99.95					
3.0	**Aluminum strands after stranding**							
3.1	Diameter							
a)	Nominal	mm	4.78	4.57	3.99	3.53	3.18	3.00
b)	Maximum	mm	4.81	4.60	4.02	3.55	3.20	3.02
c)	Minimum	mm	4.75	4.54	3.96	3.51	3.16	2.98
3.2	Minimum breaking load of strand							
a)	Before stranding	KN	2.87	2.64	2.12	1.57	1.29	1.17
b)	After stranding	KN	2.73	2.51	2.02	1.49	1.23	1.11
3.3	Max.resistance of 1 m length of strand at 20 deg. C	Ohm	0.001595	0.001746	0.002295	0.002921	0.003604	0.004053
4.0	**Steel strand after stranding**							
4.1	Diameter							
a)	Nominal	mm	3.18	2.54	2.21	3.53	3.18	3.00
b)	Maximum	mm	3.24	2.59	2.25	3.59	3.24	3.06
c)	Minimum	mm	3.12	2.49	2.17	3.47	3.12	2.94
4.2	Minimum breaking load of strand							
a)	Before stranding	KN	10.43	6.87	4.74	12.86	10.43	9.29
b)	After stranding	KN	9.91	6.53	4.49	12.22	9.91	8.83

Sl.	Description		Standard Technical Particulars Conductors											
			ACSR LAPWING		ACSR BERSIMIS		ACSR SNOWBIRD		ACSR MOOSE		ACSR ZEBRA		ACSR PANTHER	
4.3	**Galvanising**													
a)	Minimum weight of zinc coating per sq.m.	gm	250		230		230		250		250		240	
b)	Minimum number of dips that the galvanised strand can with stand in the standard preece test	Nos.	2 of one minute & 1 of half minute		2 of one minute				2 of one minute & 1 of half minute					
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16		16		16		16		16		16	
d)	Min. elongation of the steel strand (after stranding) for a gauge length of 250 mm (after break)	%	3.5		3.5		3.5		3.5		3.5		3.5	
5.0	**Stranded Conductor**													
5.1	Overall diameter	mm	38.22		35.04		30.57		31.77		28.62		21.00	
5.2	Sectional area of Aluminium	sq. mm	807.5		688.9		525.2		528.5		428.9		212.1	
5.3	Total sectional area	sq. mm	863.1		724.4		552.1		597.0		484.5		261.5	
5.4	Minimum UTS of the conductor	kN	188.0		154.0		118.0		161.20		130.32		89.67	
5.5	Lay length of outer steel layer		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
a)	1st steel layer	mm	30	18	24	16	24	16	18	16	18	13	28	16
b)	1st Aluminium layer	mm	17	10	16	10	16	10	14	12	17	10	16	10
c)	2nd Aluminium layer	mm	16	10	16	10	16	10	13	11	16	10	14	10
d)	3rd Aluminium layer	mm	13	10	13	10	14	10	12	10	14	10	NA	NA
5.6	DC resistance of the conductor at 20°C	ohm/km	0.0358		0.04242		0.05516		0.05552		0.06868		0.1390	
5.7	Standard length of the conductor	m	1800		2100		2100		2100		2200		2300	
5.8	Tolerance on Standard length	%	(+/-) 5											
5.9	Direction of lay of outer layer		Right Hand											

Sl.	**Description**		**Standard Technical Particulars Conductors**					
			ACSR LAPWING	**ACSR BERSIMIS**	**ACSR SNOWBIRD**	**ACSR MOOSE**	**ACSR ZEBRA**	**ACSR PANTHER**
5.10	Linear mass of the conductor							
a)	Standard	kg/km	2667	2181	1657	2004	1621	974
b)	Minimum	kg/km	2628	2142	1632	1969	1589	954
c)	Maximum	kg/km	2707	2221	1682	2040	1653	993

ANNEXURE-B

1. Tests on Conductor

1.1 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or digital ohm-metre of sufficient accuracy by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per IS:398. The resistance corrected at 20^0C shall conform to the requirements indicated in the STP.

1.2 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of the UTS of conductor and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and this value shall be recorded.

1.3 Corona Extinction Voltage Test

The sample assembly with each conductor of 5 m length shall be strung as per the configuration shown in the Table below:

Line Configuration	No of conductors per Bundle	Sub-conductor Spacing (mm)	Maximum Height of the conductor above ground (m)	Minimum Corona extinction voltage (kV)
220 kV with ACSR ZEBRA conductor	1	N.A.	7	154
400 kV with twin ACSR MOOSE conductor	2	450	8.84	320
400 kV with twin ACSR LAPWING conductor	2	450	8.84	320
400 kV with Triple ACSR SNOWBIRD conductor	3	457	8.84	320
400 kV with Quad ACSR MOOSE conductor	4	457	8.84	320
765 kV with Quad ACSR BERSIMIS conductor	4	457	15	510

Line Configuration	No of conductors per Bundle	Sub-conductor Spacing (mm)	Maximum Height of the conductor above ground (m)	Minimum Corona extinction voltage (kV)
765 kV with Hexa ACSR ZEBRA conductor	6	457	15	510
±500 kV HVDC Bipole line with Quad ACSR LAPWING/BERSIMIS conductor	4	457	12.5 *	550
±800 kV HVDC Bipole line with Hexa ACSR LAPWING conductor	6	457	18 *	880

* *Height shall be suitably adjusted so as to achieve a surface gradient of 22 kV/cm on the conductors.*

The sample assembly when subjected to power frequency/dc voltage under dry condition shall have a corona extinction voltage of not less than the values indicated in the table above. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The atmospheric conditions during testing shall be recorded and test results should be corrected for standard atmospheric conditions.

1.4 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage below 1000 microvolts. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-60437.

1.5 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

1.6 Visual Check for Joints, Scratches etc. and length measurement of conductor by rewinding

Conductor drums shall be rewound in the presence of the Employer. The Employer shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification.

1.7 Measurement of diameters of individual Steel and Aluminium strands

The diameters of the individual strands shall be checked to ensure that they conform to the requirement of this Specification.

1.8 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

1.9 Galvanizing Test

The test procedure shall be as specified in IEC 60888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.10 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause No. 10.3 of IEC 60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the STP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 3.5% for a gauge length of 250 mm after stranding.

1.11 Procedure Qualification test on welded Aluminium

Two Aluminium wire shall be welded as per the standard quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

1.12 Drum Strength Test of Steel Drums

The test shall be conducted as per IS 15976 on one drum of each lot offered for inspection with one standard length of conductor wound on the drum.

1.13 Barrel Batten Strength Test of Wooden Drums

The test shall be conducted as per IS 1778 on one drum of each lot offered for inspection. Barrel batten strength shall not be less than 300 Kg.

1.14 Chemical Analysis of Zinc

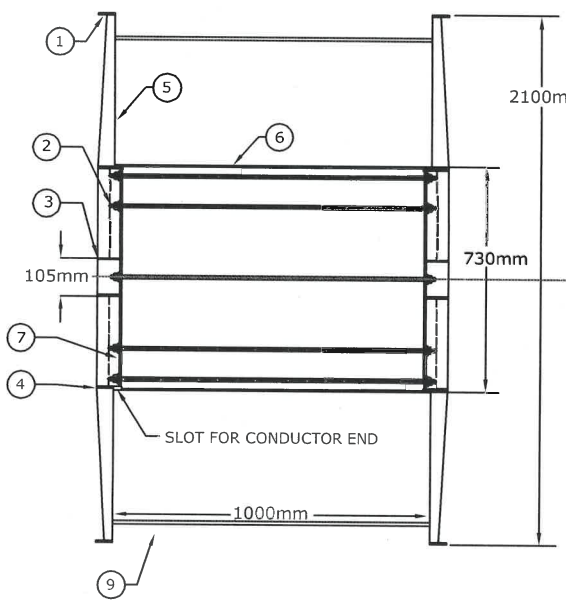
Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

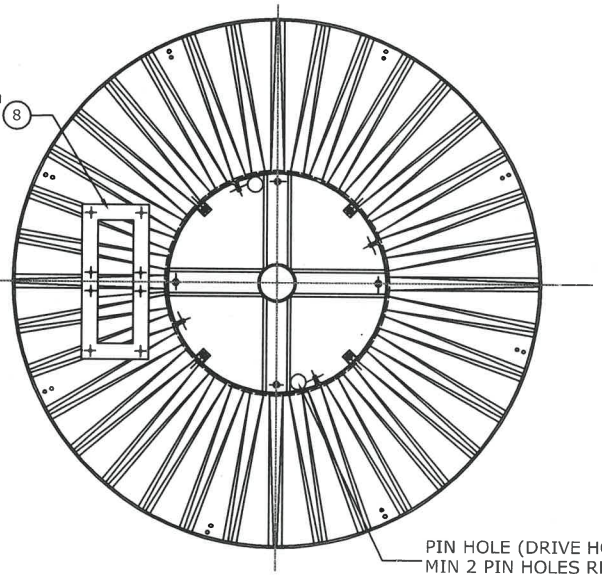
1.15 Chemical Analysis of Aluminium

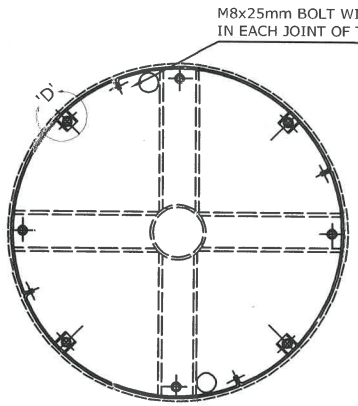
Samples taken from the aluminium ingots/rods shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

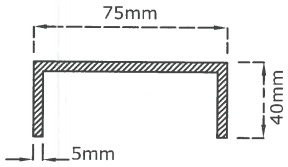
1.16 Chemical Analysis of Steel

Samples taken from the steel rods shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.





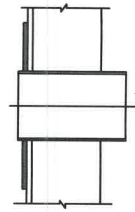




DETAIL at 'D'

BARREL IN MAXIMUM FOUR SEGMENTS

PIN HOLE (DRIVE HOLE)
MIN 2 PIN HOLES REQUIRED PER FLANGE
DIA = 65mm (5mm thick)
LENGTH=70mm



NOTE :	
(i)	Flanges shall have non corrosive primer coat and enamel paint .
(ii)	Washers are required on all bolts.
(iii)	Barrel and inner surface of flange shall have water proof protective HDPE sheet.
(iv)	Medium grade Craft/Crepe/Polythene Paper shall be used in between the Layers of Conductor.
(v)	Tolerance overall :+5mm.
(vi)	Tolerance on sheet metal :+0.1mm.
(vii)	Tolerance on other M.S items :+3mm.
(viii)	Tolerance on thickness for other M.S items :+0.5mm.
(ix)	Tolerance on bush :+2mm.
(x)	All dimensions are in mm
(xi)	All mild steel shall conform to IS-2062

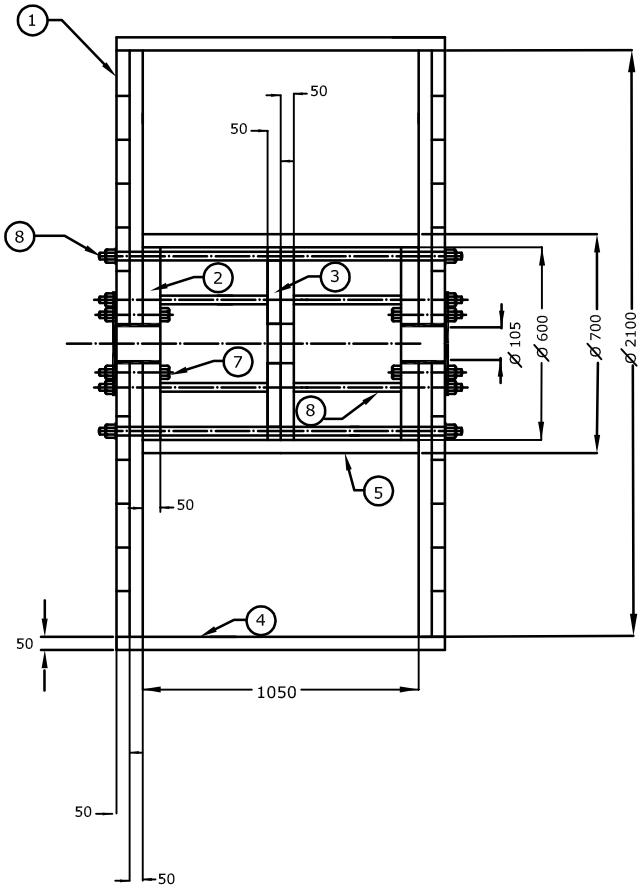
	Name of the Parts	Material Specification	Quantity	Dimensions
1	OUTER RING	M.S.PLATE	2	63x8 mm (FLAT RING)
2	TIE ROD	M.S.ROD	8	18 mm DIA
3	CENTRE BUSH	M.S.PIPE	2	105 mm IDx115 mm OD
4	INNER RING	M.S.PLATE	2	100x6 mm
5	FLANGE	H.R.SHEET	Max 3 CORRUGATED SHEETS PER FLANGE	1.6 mm THICK (min 36 nos. of corrugations)
6	BARREL SHEET	H.R.SHEET	Max 4 SEGMENTS	2.5 mm THICK
7	CROSS ARM	MILD STEEL	4	100mmx70mm,6mm THICK OR MS CHANNEL 125mmX65mmX6.6mm (LC125)
8	FRAME SIZE(FOR MARKING)			250mmx400mm (APPROX)
9	SOLID PP SHEET	POLY PROPYLENE		5 mm THICK (min)

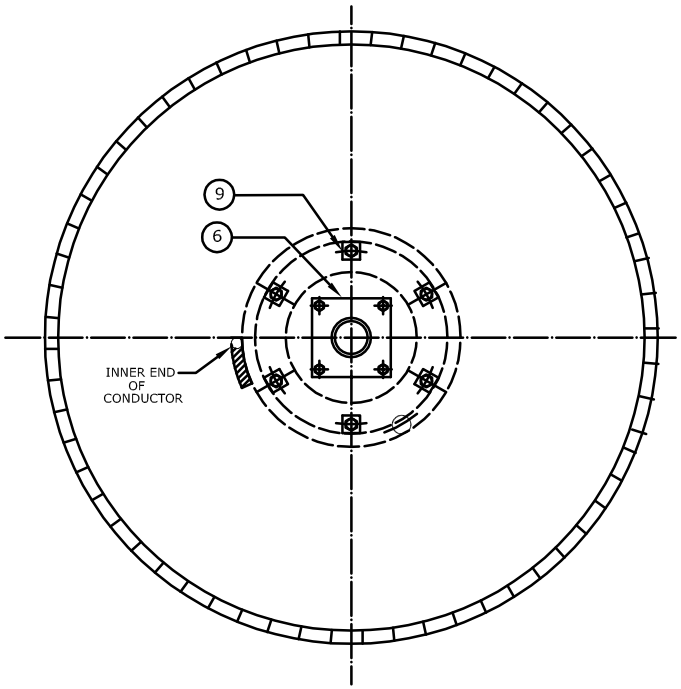
STANDARD DRAWING

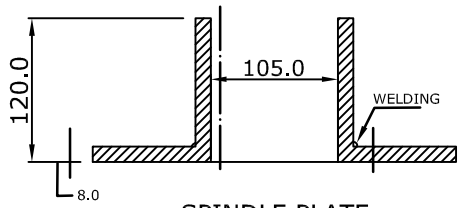
STANDARD CONDUCTOR LENGTH	ACSR LAPWING	ACSR BERSIMIS	ACSR MOOSE	ACSR SNOWBIRD	ACSR ZEBRA	ACSR PANTHER
L in Meters	1800	2100	2100	2100	2200	2300

POWER GRID CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

REVISION					CLEARED BY			TITLE: STEEL DRUM DRAWING FOR CONDUCTOR	
REV. No	DESCRIPTION	CHKD	REVWD	APPD	CHECKED	REVIEWED	APPROVED	SCALE N.T.S.	DRAWING NO:CC:ENGG:TL:COND:ST REV. 1
1	Note no. 4 added.								







SPINDLE PLATE

NOTE :

1.	ALL DIMENSIONS ARE IN MM.
2.	DRUMS SHALL GENERALLY CONFIRM TO IS 1778-1980 AMMENDMMENT No.1 Of june 1989 EXCEPT OTHERWISE SPECIFIED.
3.	ONE LENGTH OF CONDUCTOR SHALL BE WOUND ON EVERY DRUM
4.	THE STANDARD LENGTH OF THE CONDUCTOR AND EQUIVALENT SIZE OF CONDUCTOR IS L mtrs (INIDCATED IN THE TABLE BELOW) WITH TOLERANCE OF ± 5%.
5.	TOLERANCE ON DIMENSIONS OF WOOD IS + 3mm.
6.	TOLERANCE ON STEEL COMPONENTS OF THE DRUM IS ± 0.50mm.
7.	INNER & OUTER SURFACE OF FLANGE & BARREL SHALL BE BITUMIN PAINTED.
8.	BARREL & INNER SURFACE OF FLANGE SHALL HAVE WATER PROOF HDPE SHEET
9.	OUTER SURFACE OF CONDUCTOR SHALL BE COVERED BY WATER PROOF POLYTHENE PAPER
10.	MEDIUM GRADE CRAFT/CREPE/POLYTHENE PAPER SHALL BE USED IN BETWEEN THE LAYERS
11.	ALL NUTS OF ROD SHOULD BE TACK WELDED.
12.	3 nos. BINDER SHALL BE USED FOR BINDING THE EXTERNAL LAGGING.
13.	FLANGE SHALL BE NAILED IN 5 CIRCLES WITH NAIL SIZE OF 125X4.

STANDARD DRAWING

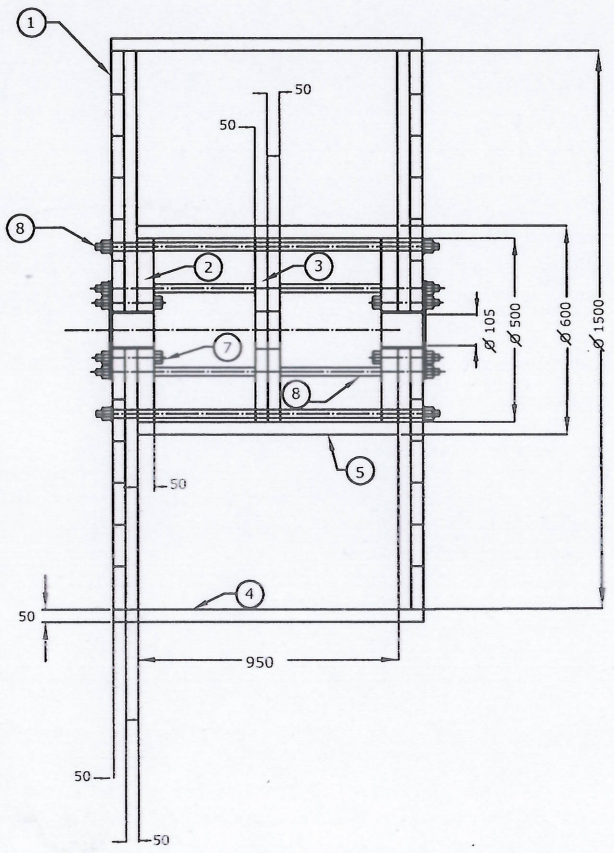
STANDARD CONDUCTOR LENGTH	ACSR LAPWING	ACSR BERSIMIS	ACSR MOOSE	ACSR SNOWBIRD	ACSR ZEBRA
L in Meters	1800	2100	2100	2100	2200

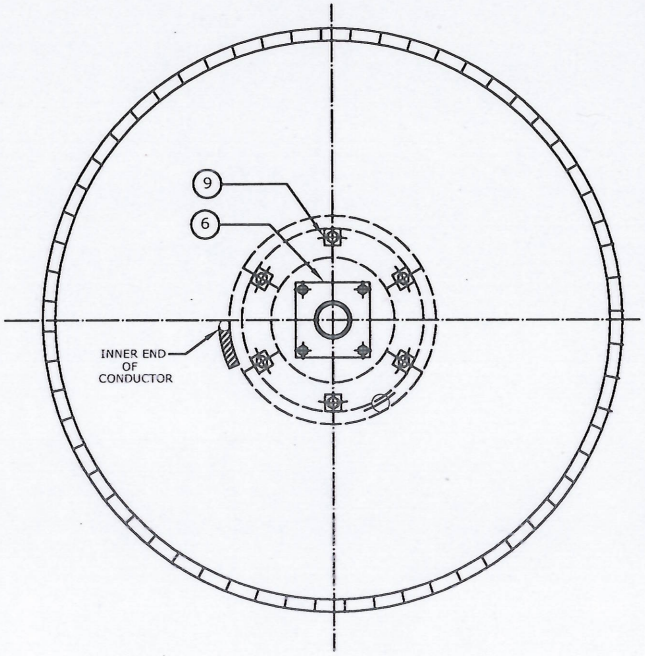
	DRUM COMPONENTS	MATERIAL SPECIFICATION	QUANTITY	DIMENSION
1.	FLANGE	SEASONED WOOD	2	Ø 2100x100(50+50)
2.	BARREL END SUPPORTS	SEASONED WOOD	2	Ø 600x50
3.	BARREL MIDDLE SUPPORT	SEASONED WOOD	1	Ø 600x100(50+50)
4.	OUTER LAGGING	SEASONED WOOD	--	1250x50
5.	BARREL BATTENS	SEASONED WOOD	--	1050x75x50
6.	SPINDLE PLATE	MS	2	300x300x8
7.	BUSH PLATE STUD	MS	8	Ø 16X180
8.	TIE ROD	MS	6	Ø 22X1325
9.	TIE ROD WASHER	MS	12	75x75x6

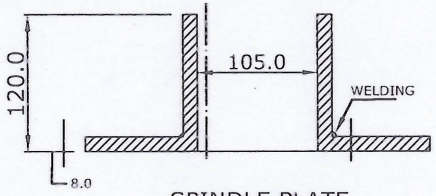
POWER GRID CORPORATION OF INDIA LIMITED

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REVISION					CLEARED BY			TITLE: WOODEN DRUM DRAWING FOR CONDUCTOR		
REV. No	DESCRIPTION	CHKD	REVWD	APPD	CHECKED	REVIEWED	APPROVED	SCALE N.T.S.	DRAWING NO:CC:ENGG:TL:COND:WD	REV. 0







SPINDLE PLATE

NOTE :

1.	ALL DIMENSIONS ARE IN MM.
2.	DRUMS SHALL GENERALLY CONFIRM TO IS 1778-1980 AMMENDMMENT No.1 Of june 1989 EXCEPT OTHERWISE SPECIFIED.
3.	ONE LENGTH OF CONDUCTOR SHALL BE WOUND ON EVERY DRUM
4.	THE STANDARD LENGTH OF THE CONDUCTOR AND EQUIVALENT SIZE OF CONDUCTOR IS L mtrs (INIDCATED IN THE TABLE BELOW) WITH TOLERANCE OF ± 5%.
5.	TOLERANCE ON DIMENSIONS OF WOOD IS + 3mm.
6.	TOLERANCE ON STEEL COMPONENTS OF THE DRUM IS ± 0.50mm.
7.	INNER & OUTER SURFACE OF FLANGE & BARREL SHALL BE BITUMIN PAINTED.
8.	BARREL & INNER SURFACE OF FLANGE SHALL HAVE WATER PROOF HDPE SHEET
9.	OUTER SURFACE OF CONDUCTOR SHALL BE COVERED BY WATER PROOF POLYTHENE PAPER
10.	MEDIUM GRADE CRAFT/CREPE/POLYTHENE PAPER SHALL BE USED IN BETWEEN THE LAYERS
11.	ALL NUTS OF ROD SHOULD BE TACK WELDED.
12.	3 nos. BINDER SHALL BE USED FOR BINDING THE EXTERNAL LAGGING.
13.	FLANGE SHALL BE NAILED IN 5 CIRCLES WITH NAIL SIZE OF 125X4.

	DRUM COMPONENTS	MATERIAL SPECIFICATION	QUANTITY	DIMENSION
1.	FLANGE	SEASONED WOOD	2	Ø 1500x100(50+50)
2.	BARREL END SUPPORTS	SEASONED WOOD	2	Ø 500x50
3.	BARREL MIDDLE SUPPORT	SEASONED WOOD	1	Ø 500x100(50+50)
4.	OUTER LAGGING	SEASONED WOOD	--	1150x50
5.	BARREL BATTENS	SEASONED WOOD	--	950x75x50
6.	SPINDLE PLATE	MS	2	300x300x8
7.	BUSH PLATE STUD	MS	8	Ø 16X180
8.	TIE ROD	MS	6	Ø 22X1225
9.	TIE ROD WASHER	MS	12	75x75x6

STANDARD CONDUCTOR LENGTH	ACSR PANTHER
L in Meters	2300

STANDARD DRAWING

POWER GRID CORPORATION OF INDIA LIMITED

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REVISION					CLEARED BY		
REV. No	DESCRIPTION	CHKD	REVWD	APPD	CHECKED	REVIEWED	APPROVED

TITLE: WOODEN DRUM DRAWING FOR ACSR PANTHER CONDUCTOR

SCALE N.T.S. | DRAWING NO:CC:ENGG:TL:COND:WD | REV. 0