

SPECIFICATION No. TI/SPC/OHE/Fitting/0130(10/13) **Revision 1**



GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION  
FOR  
25 kV A.C. OHE FITTINGS

(For office use only)

ISSUED BY  
TRACTION INSTALLATION DIRECTORATE  
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Specification No. TI/SPC/OHE/Fittings/0130(10/13) Specification for 25 kV,  
A.C. OHE Fittings 50 Hz Traction Overhead Equipment

SCOPE:

This specification supersedes the Spec.No.ETI/OHE/49 (9/95) with A&C slip no. 1 to 5.The Specification covers the requirements of the fittings used on 25 kV A.C. 50 Hz Traction Overhead Equipment.

The fittings are made of copper, copper alloys, malleable cast iron, aluminum alloy, forged steel, fabricated/ welded steel, copper strip and Spheroidal Graphite Cast Iron (SGCI). The material of fittings is specified in drawing of the purchaser but the sampling and the tests shall be done in accordance with the relevant clauses of this Specification.

The fittings shall be grouped as tension joints/anchor clamps, non tension joints, suspension clamps and other fittings used on the cantilever assembly and on OHE.

1. DEVIATION FROM SPECIFICATION:

Any deviation from this Specification calculated to improve the performance, Efficiency and utility of the equipment proposed by the tenderer will be given due consideration provided full particulars with justification thereof are furnished. In such a case the tenderer shall quote according to this Specification and indicate the deviations separately in a "Statement of Deviations".

2. SERVICE CONDITIONS:

The fittings shall be suitable for outdoor use in moist tropical climate and areas subjected to heavy rainfall and severe lightening in India. The limiting weather conditions which the fittings have to withstand in service are indicated below:

3.	(i)	Maximum temperature of air in shade	45 <sup>o</sup> c
	(ii)	Minimum temperature of air in shade	0 <sup>o</sup> c
	(iii)	Maximum temperature attainable by an object exposed to sun	65.5 <sup>o</sup> c
	(iv)	Maximum relative humidity	100%
	(v)	Average annual rainfall	Raining from 1750 to 6250 mm
	(vi)	Maximum number of thunder storm days per annum	85
	(vii)	Maximum number of dust storm days per annum	35
	(viii)	Number of rainy days per annum	120
	(ix)	Basic wind pressure	216 kgf/m <sup>2</sup>
	(x)	Altitude	not exceeding 2500 m

## REFERENCE SPECIFICATIONS:

Reference has been made to the following Indian, International and 'RDSO' Standards in this Specification.

(i)	IS: 306- <del>1997-1983</del> Reaffirmed 2006	Tin bronze ingots and castings.
(ii)	IS:617- <del>2003</del> 1994 Reaffirmed 1999	Aluminium and aluminium alloy ingots and casting for general engineering purposes.
(iii)	IS:737-2008	Specification for wrought Aluminium and Aluminium Alloy sheet and strip for general engineering Purposes.
(iv)	IS:1367 (Pt.xiii)-2002	Technical supply conditions for threaded steel fasteners. Pt.xiii Hot Dip Galvanised castings threaded fastners.
(v)	IS:1500-2005	Method for Brinell Hardness test for metallic Materials.
(vi)	IS:1608-2005	Method for tensile testing of steel products.
(vii)	IS:1865-1991 Reaffirmed 2005	Iron Castings with Spheroidal Graphite & Chemical Composition, Hardness as given in Appendix 'L'.
(viii)	IS:1897-2008	Copper strip for Electrical purposes.
(ix)	IS:2004-1991 Reaffirmed 2001	Carbon steel forging for general engineering Purposes.
(x)	IS:2062-2011	Steel for general structural purposes.
(xi)	IS:14329-1995 Reaffirmed 2005	Black heart malleable iron castings.
(xii)	IS:2486- (Pt.I)-1993 Reaffirmed 2003	Insulator fittings for overhead power line with a nominal voltage > than 1000V General Requirements and tests.
(xiii)	IS:3091 -1999	Aluminium bronze ingots and castings for overhead Fittings in electric traction.
(xiv)	BS: 3288- (Pt.I)-1993 Reaffirmed 2006	Insulator and conductor fittings for overhead power Lines (performance and requirements).

(xv)	IS:3658-1999 Reaffirmed 2000	Code of practice for liquid penetrant flaw detection.
(xvi)	IS:5561-1970 Reaffirmed 2002	Electric power connectors.
(xvii)	ETI/OHE/13 (4/84) with A Slip 1 to3	Hot dip zinc coating on steel masts (rolling and fabricated), tubes and fittings, used on 25 kV a.c. OHE.
(xviii)	TI/SPC/OHE/ Fasteners/0120	Steel and Stainless steel bolts, nuts and washers.

#### GENERAL REQUIREMENT:

The fittings shall be free from defects which are likely to be detrimental to their performance in service.

Aluminium bronze, tin bronze and aluminium alloy cast fittings shall

preferably be made by pressure die-casting process. The castings made out of other processes like gravity die-casting shell moulding/investment casting by lost way method shall also be acceptable so long as fittings/test bars meet all the necessary mechanical and Electrical properties specified in relevant Specifications. Sand casting for these cast fittings are not acceptable.

Steel/Stainless steel bolts, nuts and washers shall conform to RDSO Specification No. TI/SPC/OHE/Fasteners/0120. Non-ferrous bolts/nuts shall not be used.

All parts of the fittings shall be manufactured by the manufacturer in his works. Components such as fasteners, washers and Split pins which form part of the fittings shall be obtained from the approved manufacturers with the specific approval of the Central Organization for Railway Electrification. The supplier of the assembly shall ensure that such bought out components conform to the relevant specification.

#### PROTECTION AGAINST CORROSION:

All fittings shall be either inherently resistant to the atmospheric corrosion or suitably protected against corrosion, both during storage and in service. All ferrous metal parts, except those made of stainless steel, shall be hot dip galvanised in accordance with RDSO Specification No.ETI/OHE/13(4/84) with A & C slip 1 to 3.

Malleable cast iron fittings shall be shot or grit blasted before and after heat treatment.

The threads of the tapped holes shall be cut after galvanisation and shall be adequately oiled or greased. Female threads shall be tapped after galvanisation and shall be oiled.

For male threads, galvanising process shall be so controlled that galvanised fasteners can be assembled by hand with female fasteners. Galvanised fasteners with male threads of size M12 only may be rethread rolled to facilitate assembly, after galvanising in accordance with IS:1367 (Pt.xiii)-

2002. The thread of all bolts and nuts shall be formed conforming to their relevant Specification before galvanising.

Electro-galvanised bolts and nuts shall not be used. Bolts and nuts of 10mm diameter and less shall be of stainless steel unless otherwise stated in the drawing.

Tolerance: Wherever not specified in the drawings, furnished by the Purchaser, the following tolerances shall apply for non mating surfaces:

Dimension	Tolerance
Upto and including 35mm	+/- 0.5mm
Over 35mm	+/- 1.5%

In case of mating surfaces, tolerance shall be +0.5mm

-0.0

On the holes and +0.0 mm on shafts. The tolerance for wall

-0.5

Thickness shall be +1.0 mm

-0.5

#### 5.0 LOT SIZE:

The fittings shall be offered for inspection in lots which may represent either the whole or a part of the quantity ordered.

Non-ferrous cast fittings for different type, category and rating, if manufactured out of same melt shall be considered as one lot.

Physical properties test shall be conducted on test bars and Chemical analysis test shall be conducted on sample fittings drawn from the same heat. Boring of anyone of the cast fittings can be sent for Chemical test instead of sending complete fittings/part of fittings.

The manufacturer shall maintain the records as to the raw materials used and temperature for every cast/lot.

Chemical analysis test for Ferrous OHE fittings shall be conducted on boring of anyone of the sample fittings drawn from the lot instead of complete fittings/part of the fittings. Boring can be sent for Chemical test instead of sending complete fittings/part of the fittings.

#### Castings-

If the weight of the fittings is not more than one kg, a lot shall consist of pieces making upto a weight of not more than 200 kg. If each fitting weighs more than one kg, a lot shall consist of pieces making upto 500 kg for non-ferrous fittings and 1500 kg for ferrous fittings.

The lot size of following ferrous OHE fittings for Chemical test will be 500 Nos (Maximum):-

- a) All dropper clips-RI No.2274-1, 2277 , 2461-1 & 2471-1
- b) Antiwind strap - RI No.2502, 2503 & 2504.
- c) Packing piece - RI No.5067.

The lot sizes for other ferrous OHE fittings will remain unchanged.

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b) The lot size of following ferrous OHE fittings for Chemical test will be as under:

SN	Name of Item	RI No.	Revised Sampling Plan
(i)	u (ii)	(iii)	(iv)
1.	Dropper clip(38)	2774-1	1 sample for 1000 Nos or part thereof
2.	Dropper clip(49)	2777	-do-
3.	Dropper clip(34)	2461-1	-do-
4.	Dropper clip(25)	2471-1	-do-
5.	Section Insulator double -strap assembly	6181-1	-do-
6.	BFB steady arm swivel	2392	1 sample for 500 Nos or part thereof
7.	BFB steady arm piece	2541	-do-
8.	BFB steady arm swivel	2542	-do-
9.	Mast anchor fitting (Welded)	3231	-do-
10.	Guy rod stirrup	5002	-do-
11.	Anchor "V" bolt	5007-1	-do-
12.	Compensating plate	5191	-do-
13.	Equilising Plate	5192	-do-
14.	Compensating Plate	5194	-do-
15.	Equilising Plate (8mm)	5195	-do-
16.	Guy rod double strap(100)	5221	-do-
17.	Guy rod double strap (150/250)	5222	-do-
18.	Post insulator jumper clamp	6094	-do-
19.	Anchor double strap	5031	-do-
20.	Post insulator Busbar clamp	6095	-do-
21.	Counter weight Plate	5098	-do-
22.	Copper split pin		1 sample/10000 Nos or part thereof
23.	Ferrous & Non-ferrous washers		1 sample per 5000 Nos or part thereof
24.	Mast Guy Rod fittings(Welded)	3232	1 sample per 500 Nos or part thereof
25.	Anchor Bolt	5001-3	-do-

Three test bars shall be made for each cast/melt for tensile and elongation, tests. The test bars shall bear identification mark of the lot and date of melt.

Forged Welded Fittings-The lot of forged, welded or fabricated ferrous fittings shall consist of not more than 500 numbers of fittings.

Copper/Aluminum Alloy Strip Formed Fitting-The lot of such fittings weighing each upto 50 gm shall not exceed 2500 numbers while for the fittings weighing more than 50 gm, the lot, shall be restricted to 1000 numbers.

c) The lot size of following non-ferrous copper strips for chemical test will be 1000 Nos (Maximum):-

a) Packing shaddle - RI No. 1174

b) Bridle wire sleeve- RI No. 2125.

The lot sizes for other Non-ferrous OHE fittings will remain unchanged.

d) The lot size for following non-ferrous copper fittings for Chemical test will be as under:

a) Locking wire RI No.1182- 5000 Nos.

b) Contact wire swivel clip pin RI No.1222- 5000 Nos.

c) Suspension clamp lock plate RI No.1163- 2500 Nos.

Sample size:

a) The number of fittings to be selected at random from the lot shall be in accordance with column 1 and 2 of table given below. If required, additional number of fittings as given in column 3 of table given below shall be selected at random to satisfy the criteria for conformity in accordance with clause

b) below.



## SAMPLE SIZE AND CRITERION FOR CONFORMITY

Lot size N	First sample size n1	Second sample size n2	Acceptance Criteria c1	Rejection Number c2
1-20	1	2	0	1
21-50	2	4	0	1
51-100	4	8	0	2
101-500	5	10	0	2
501-800	7	14	0	3
801-1300	10	20	0	3
1301-3200	15	30	1	4
3201-8000	25	50	2	5
8001-above	35	70	2	7

## Criterion for Conformity:

The lot shall be considered as conforming to the requirements of the acceptance tests if the number of failures found in the first sample n1 is less than or equal to c1. If the number of failures is greater than or equal to c2. The lot shall be considered as not conforming to the requirements of the acceptance tests and shall be rejected. If the number of failures lies between c1 and c2, a second sample of n2 fittings shall be selected and subjected to acceptance tests. If the number of failures in the two samples combined is less than c2. The lot shall be considered as conforming to the requirements of the acceptance tests otherwise it shall be considered to have failed.

## TESTS:

Tests have been specified according to the material and functional requirement of the fitting and are required to be conducted to determine conformity to the material Specification and requirements of the fitting.

## Classification of test and criteria of acceptance:

The tests are divided into three groups:

- i) Type tests
- ii) Acceptance tests
- iii) Routine tests

Type tests: Type test are intended to establish the general qualities and design characteristics of the fittings and to prove its conformity with the requirements of Specification. The type tests are to be conducted only after all the designs and drawings have been approved and clearance given by RDSO/Purchaser to this effect the manufacturer shall then take up the manufacture of the prototype for RDSO/Purchaser inspection. It is to be clearly understood that any change required to be done in the prototype as required by RDSO/Purchaser shall be done expeditiously. Each test shall be made on 3 samples. If the sample fails in any of the tests the production of further fittings shall be stopped till further investigation and improvements in the manufacturing procedure done.

Acceptance tests: Acceptance tests are carried out to verify the quality of material and workmanship for acceptance of the lot.

Routine tests: Routine tests are carried out on each fitting from the lot to check the requirements which are likely to vary during production. The defective once are rejected. If 10% or more fittings fail to meet the requirement of the routine test the entire lot shall be rejected.

Bulk Manufacture: Only after clear written approval of the results of the tests on the prototype is communicated by RDSO/Purchaser to the manufacturer, shall be take up bulk manufacture of the fittings which shall be strictly with the same material and process as adopted for the prototype. In no circumstances shall material other than those approved in the design/drawings and/or the prototype be used for bulk manufacture on the plea that they had been obtained prior to the approval of the prototype.

Inspection: Before giving the call to RDSO/Purchaser for inspection and testing of the prototype of the system, the manufacturer shall submit a detailed test schedule consisting of schematic circuit diagrams for each of the tests, nature of the test, venue of the test, duration of each test and the total number of days required to complete the test at one stretch. Once schedule is approved, the test shall invariably be done accordingly. However, during the process of type testing or even later, RDSO/Purchaser's during the process of type testing or even later, RDSO/Purchaser's representative reserves the right to conduct any/additional tests besides those specified herein, on any equipment/sub-system or system so as to test the system to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the manufacturer and the RDSO/Purchaser's representative during the process of testing as regards the type test and/or the interpretation and acceptability of the type test results, it shall be brought to the notice of the director General (Traction Installation), RDSO/Purchaser as the case may be whose decision shall be final and binding.

Inspector's responsibility: The inspecting authority shall maintain a proper record of the number of fittings offered for inspection in each lot, the number of fittings on which acceptance tests were done and the results thereof, indicating the number of fittings, if any, rejected and reasons therefore. These records or copies thereof shall be furnished to the consignee as well as to the ordering/purchasing authority. The inspecting authority shall, during his inspection carefully check that proper records of routine tests and prescribed 'quality assurance checks' done at the manufacture's works are maintained in the required manner.

## 7. MATERIAL SPECIFICATION:

Aluminium Bronze: Aluminium bronze alloy used for the fittings shall conform to IS: 3091-1999. The relevant extracts of the specification are given in Appendix 'A'.

Malleable cast iron: The malleable cast iron fittings shall conform to Grade BM: 340 of IS: 14329-1995 **Reaffirmed 2005**. Relevant extracts of the specification are given in appendix- 'B'.

Tin-bronze: The tin bronze fittings shall conform to the IS: 306-~~1997-1983~~ **Reaffirmed 2006**. The relevant extracts are given in Appendix 'C'.

Aluminium alloy: The aluminium alloy fittings shall conform to Grade 4600 of IS: 617-~~2003~~1994 **Reaffirmed 1999**. The extracts are given in Appendix 'D'.

Forged steel: The material of forged steel fittings shall conform to class 2 of IS: 2004-1991 **Reaffirmed 2001**, unless otherwise specified. The relevant extracts are given in Appendix 'E'.

Fabricated steel: The material of fabricated steel fittings unless otherwise stated on the drawings shall conform to Grade A of IS: 2062-2011. The relevant extracts are given in Appendix 'F'.

Copper strip fittings: The material of fittings formed by copper strip shall conform to IS: 1897-2008. The relevant extracts are given in Appendix 'G'.

Aluminium or aluminium alloy strips/sheets: The material of strips shall conform to Grade 52000, condition H2 of IS: 737- 2008. The relevant extracts are given in Appendix 'H'.

Spheroidal Graphite Cast Iron (SGCI) OHE Fittings: The material of SGCI fittings shall conform grade SG 400/15 of IS: 1865-1991 **Reaffirmed 2005** & Chemical Composition, Physical Properties including Hardness shall conform to the relevant extracts are given in Appendix 'L'.

Note: "Electrical Resistivity test specified under Para-9 of IS:1897-2008 shall not be applicable for catenary dropper clip(RI-1192) and bridle wire dropper clip(RI-1194)"

7.9 Due to non-availability of flat size M12x35 mm, the flat size M12x38 mm can be used in lieu, for following fittings:-

- a) Post Insulator Jamper clamp - RI – 6094
- b) Post Insulator Busbar clamp - RI – 6095

#### CONDUCTOR END CLAMPS, MID SPAN TENSION JOINTS ANCHOR FITTINGS AND TURN-BUCKLES (9-TONNE ADJUSTER)

Fittings for clamping the conductors, which are in tension, at the ends & their mid-span splices are called end clamps and tension joints respectively and are covered in this group.

Requirements: End clamps and tension joints shall be manufactured and finished so as to avoid sharp radius of curvature, ridges and excrescences which might lead to localised pressure and damage to the conductor and fitting due to vibration in service. They shall withstand the tests prescribed.

The end clamps and tension joints may be of aluminium alloy casting, aluminium bronze casting, malleable iron casting or forged/fabricated steel as specified in the purchaser's drawings. The material shall conform to the relevant Specifications.

The fitting may be bolted type, cone type, wedge type or compression type, as specified in purchaser's drawing.

#### Tests:

##### Type Tests:

- a) Visual inspection (see Cl.11.1)
- b) Dimensional verification (see Cl.11.2)
- c) Chemical composition test (see Cl.11.3)
- d) Physical properties test (see Cl.11.4)
- e) Failing load test (see Cl.11.5)
- f) Radiographic test (only for castings) (see Cl.11.6)
- g) Electric resistance test  
(For splices only) (see Cl.11.8)
- h) Temperature rise test  
(For splices only) (see Cl.11.9)
- i) Galvanising test (for ferrous  
Fittings only) (see Cl.11.10)
- j) Dye penetration test (see Cl.11.12)
- k) Hardness test (for MCI & SGCI fittings) (see Cl.11.14)

## 8.5.2

### Acceptance Tests:

- |    |  |                |
|----|--|----------------|
| a) | Visual inspection                            | (see Cl.11.1)  |
| b) | Dimensional verification                     | (see Cl.11.2)  |
| c) | Chemical composition test                    | (see Cl.11.3)  |
| d) | Physical properties test                     | (see Cl.11.4)  |
| e) | Failing load test                            | (see Cl.11.5)  |
| f) | Galvanising test (for ferrous fittings only) | (see Cl.11.10) |
| g) | Dye penetration test                         | (see Cl.11.12) |
| h) | Hardness test (for MCI, SGCI fittings)       | (see Cl.11.14) |

Samples taken in accordance with Clause 5.6 shall be subjected to all tests listed under 'Acceptance Tests' except for chemical composition test and physical properties test which should be conducted in accordance with Clause 11.3 and 11.4 respectively.

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### Routine Tests:

- |    |   |                |
|----|---|----------------|
| a) | Visual inspection   | (see Cl.11.1)  |
| b) | Routine verification of dimension                                 | (see Cl.11.13) |
| c) | Dye penetration test for fittings<br>Listed in Appendix 'J' only. | (See Cl.11.12) |

### NON-TENSION JOINTS (PARALLEL GROOVE AND TERMINAL CLAMPS)

Non-Tension Joints: The fittings used on the overhead conductors for electrical continuity which are not subjected to tension are classified as non-tension joints. Such fittings include parallel groove clamps and terminal clamps of jumper assemblies.

General Requirements: Non-tension joints shall be designed so that they meet the requirements of the normal service conditions. A rated current shall be assigned to every joint which shall be the criterion for electrical type tests. Fittings intended to connect conductors of two dissimilar materials shall be so designed that harmful bimetallic corrosion when erected in exposed atmospheric condition is minimised.

Fittings for non-tension joints shall be manufactured and finished so as to avoid sharp radius of curvature, ridges which may lead to the localised pressure or damage to the conductor in service.

Non-tension joints are made of tin-bronze, Aluminium bronze, Aluminium alloy or copper as specified by the purchaser. The material shall conform to the relevant clauses of this specification.

Non-tension joint fittings are generally of bolted type, though there may be some fittings of crimped type or soldered type. All fittings are subjected to

the tests as specified in relevant paras of this specification.

Tests:

Type Tests:

- |    |  |                |
|----|--|----------------|
| a) | Visual inspection                        | (see Cl.11.1)  |
| b) | Dimensional verification                 | (see Cl.11.2)  |
| c) | Chemical composition test                | (see Cl.11.3)  |
| d) | Physical properties test                 | (see Cl.11.4)  |
| e) | Radiographic test<br>(Only for castings) | (see Cl.11.6)  |
| f) | Slip test                                | (see Cl.11.7)  |
| g) | Electric resistance test                 | (see Cl.11.8)  |
| h) | Temperature rise test                    | (see Cl.11.9)  |
| i) | Dye penetration test                     | (see Cl.11.12) |

Acceptance test:

- |    |                           |                |
|----|---------------------------|----------------|
| a) | Visual inspection         | (see Cl.11.1)  |
| b) | Dimensional verification  | (see Cl.11.2)  |
| c) | Chemical composition test | (see Cl.11.3)  |
| d) | Physical properties test  | (see Cl.11.4)  |
| e) | Dye penetration test      | (see Cl.11.12) |

9.5.2.1 Samples taken in accordance with clause 5.6 shall be subjected to all tests listed under 'Acceptance test' except for chemical composition tests and physical properties test, which should be conducted in accordance with clause 11.3 and 11.4 respectively.

Routine Tests:

- |    |                                    |                |
|----|------------------------------------|----------------|
| a) | Visual inspection                  | (see Cl.11.1)  |
| b) | Routine verification of dimensions | (see Cl.11.13) |

## 10. SUSPENSION CLAMPS AND OTHER CANTILEVER ASSEMBLY FITTINGS.

Fittings which are used on the cantilever assembly and the suspension of suspension of conductors are covered in this group.

General Requirements:

The clamps and fittings shall be so designed and manufactured that the effect of vibrations, both on the conductors/cantilever assembly and fitting itself, are minimized.

The suspension clamps, additionally, shall be manufactured and finished so as to avoid sharp radius of curvature, ridges and excrescences which might lead to the localized pressure or damage to the conductor in service. The suspension clamps shall permit the conductor to slip before failure of conductor occurs. The clamp shall have sufficient contact surface to minimize damage by fault currents.

10.3 Tests:

10.3.1

Type tests:

- a) Visual inspection (see Cl.11.1)
- b) Dimensional verification (see Cl.11.2)
- c) Chemical composition test (see Cl.11.3)
- d) Physical properties test (see Cl.11.4)
- e) Failing load test (see Cl.11.5)
- f) Radiographic test (see Cl.11.6)  
(Only for casting)
- g) Slip test (see Cl.11.7)  
(Only for suspension clamp).
- h) Galvanising test (for ferrous fittings only) (see Cl.11.10)
  - i) Assembly test (for contact wire Dropper clip and swivel clips only) (see Cl.11.11)
  - j) Dye penetration test (see Cl.11.12)
  - k) Hardness test (for MCI & SGCI fittings)(see Cl.11.14)

Acceptance Test:

- a) Visual inspection (see Cl.11.1)
- b) Dimensional verification (see Cl.11.2)
- c) Chemical composition test (see Cl.11.3)
- d) Physical properties test (see Cl.11.4)
- e) Failing load test (see Cl.11.5)
- f) Slip test (for suspension clamp)
- g) Galvanising test (see Cl.11.7)  
(For ferrous fitting only) (see Cl.11.10)

- h) Assembly test (for contact wire Dropper clip and swivel clips only) (see Cl.11.11)
- i) Dye penetration test (see Cl.11.12)
- j) Hardness test (for MCI, SGCI fittings) (see Cl.11.14)

Samples taken in accordance with clause 5.6 shall be subjected to all tests listed under 'Acceptance tests' except for chemical composition test and physical properties test which should be conducted in accordance with clause 11.3 and 11.4 respectively.

Routine test:

- a) Visual inspection (see Cl.11.1)
- b) Routine verification of dimension (see Cl.11.13)
- c) Dye penetration test (for fittings Listed in Appendix 'J' only) (see Cl.11.12)

11. TEST METHODS:

Visual Inspection:

All fittings shall be examined visually for good work-manship and smooth finish including marking as specified in Purchaser's drawings and for freedom from defects stipulated in relevant specifications. Galvanized fittings shall be checked in accordance with clause-4.5 of RDSO Specification No.ETI/OHE/13 (4/84) with A & C slip 1 to 3 for visual defects and fittings having defects mentioned in Appendix 'A' of that specification shall be rejected.

Dimensional Verification:

All dimensions of fittings shall be verified with the help of gauges, calipers and micrometers to check that they conform with the approved drawings. Thread gauges shall be used to check threads wherever provided if any. Go and No-Go gauges are used for checking of dimensions, the drawing for such gauges shall be got approved by the manufacturer before use by the inspecting authority.



#### Chemical Composition Test:

The Chemical composition of the material specified shall be tested in accordance with the relevant Specification mentioned in clause-7 .In case of casting, the tests shall be done only on one sample fittings of each melt/lot by taking boring of any one of cast fittings. Material shall conform to the requirements specified in the relevant Specification. In case of forged/welded/ fabricated fittings, the test shall be carried out on one sample each of raw material and concerned fittings upto a lot of 200 Nos. and on two samples each of raw material and fittings upto a lot of 500 Nos. In case of Copper/Aluminium strip formed fittings. the test shall be carried out on the fittings samples on every 500 Nos. or fraction thereof a lot.

#### Physical Properties Test:

In the case of castings the tests for mechanical properties shall be conducted on the test bars/pieces made in accordance with the relevant Specification (Clause 7.) (See relevant Appendices also).

If one test piece fails in any test, two more test pieces shall be tested. The samples shall be deemed to have passed the tests if there is no failure in the retest.

11.4.1.1(a) In case of malleable cast iron (MCI) fittings, the micro-structure (ref. Clause B.2) and hardness (ref. Clause B.5) shall also be tested.

(b) In case of Spheroidal Graphite Cast Iron (SGCI) fittings, the micro-structure (ref. Clause L.2) and hardness (ref. Clause L.5) shall also be tested.

In case of forged/fabricated/welded fittings physical properties tests shall be conducted in accordance with the relevant Specifications on one sample upto a lot of 100 Nos. and on 3 samples for a lot exceeding 100 Nos. which should be selected at random. If one exceeding 100 nos which should be selected at random. If one sample fails in any test, double the number of test pieces shall be tested. The samples shall be deemed to have passed the tests if there is no failure in the retest.

In case of Copper/Aluminium strip formed fittings physical properties test on one sample upto a lot of 500 Nos. shall be conducted.

Failing Load Test:

For Conductor End Clamps, Mid Span Tension Joints and Splices.

The fittings shall be assembled in accordance with the standard drawings on the conductors of the size and type with which it is meant to be used. The assembly shall be held in a tensile testing machine and anchored in a manner approximating as nearly as possible, to the arrangement used in service. The compression end clamps shall be compressed on the specified conductor. The precaution shall be taken to avoid bird caging of the conductor. The length of conductor between the fittings under test and any other clamp or joint in the test assembly shall not be less than 100 times the average overall diameter of the conductor.

A tensile load of about 50% of the breaking load of the conductor shall be applied and conductor shall be marked in such a manner in that movement relative to the fitting can be easily detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 90% of the breaking load and maintained for one minute. There shall be no movement of the conductor relative to the fitting due to slip during this period of one minute.

The tensile load shall then be increased until the conductor either slips out of the fitting under test or snaps or one or more of the component(s), of the fitting fracture or deform.

The fitting shall not break, slip or deform till the conductor breaks. Should the wire or conductor slip in the fitting or any component of the fitting fractures or deforms before the failure of conductor the fitting shall be deemed to have failed in the load test. If the conductor breaks at a load less than 95% of its specified breaking strength, the test shall be repeated.

After the test it should be possible to dismantle the fitting without difficulty and without recourse to any tools other than those normally employed for assembling them.

The minimum failing load of the conductors are indicated in Table-1.

Table-1: Ultimate Tensile Strength of conductors.

Sl.No.	Type	No. and diameter of conductors (mm)	Ultimate tensile strength (kgf)
1.	Cadmium copper catenary (65mm <sup>2</sup> )	19/2.10	3920
2.	Cadmium copper bridle wire	7/2.10	1443
3.	Hard drawn grooved copper contact wire (107mm <sup>2</sup> )	-	3905
4.	Hard drawn grooved copper contact wire (150 mm <sup>2</sup> )	-	5475
5.	Hard drawn stranded copper conductor (150 mm <sup>2</sup> )	37/2.25	6080
6.	Hard drawn stranded cadmium copper conductor (130 mm <sup>2</sup> )	37/2.10	7650
7.	Annealed copper stranded jumper wire (50 sqmm)	19/1.80)	-
8.	Annealed copper stranded jumper wire (105 sqmm)	19/7/1.016	-
9.	Annealed copper stranded jumper wire (160 sqmm)	19/7/1.25	-
10	Hard drawn copper wire for droppers.	5	825
11	Hard drawn copper wire for droppers.	7	1530
12	Earth wire- ACSR (RACCOON)	6/1/4.09)	2746
13	Earth wire Galvanised steel	19/2.50	5100
14	Return conductors (Spider) (All aluminium)	19/3.99	3736
15	Aluminium large jumper	133/1.40	3380
16	Stainless steel wire rope	34x7(6/1)	3800
17	Aluminium alloy conductor	19/2.79	3310

#### Mast Anchor Fittings, Suspension Clamps and other Fittings.

The fitting shall be held in a tensile testing machine in a manner approximating, as nearly as possible, to the arrangement to be used in service. The conductor shall be replaced by a suitable rigid bar (see fig.1). Tensile load equal to 50% of the specified failing load shall be applied and thereafter increased at a steady rate. Fitting shall not fail or deform below the minimum specified failing load maintained for a period of one minute.

Note: The failing loads of the fittings shall be specified after actual tests.

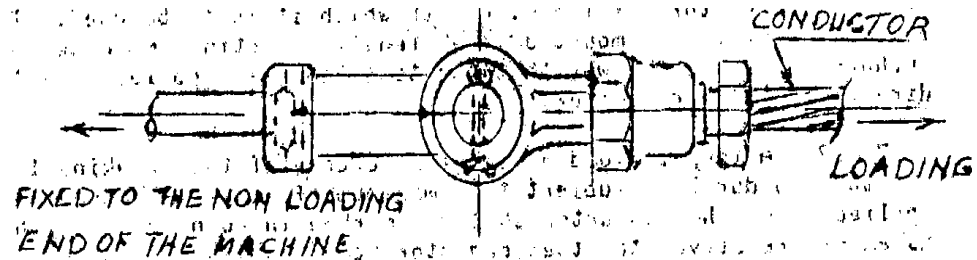


FIGURE-1

#### Radiographic Test:

Castings in each melt/heat shall be subjected to radiographic examination for detection of casting defects. Applicable reference standards for various alloys used on OHE application along with the maximum permissible level of discontinuity are given in Appendix-k.

Note: The radiographic test can be conducted by the outside agencies till such time the facilities are established at the premises of the manufacturer. In such situation the sampling plan can be decided as agreed between the manufacturer and purchaser. If the purchaser is satisfied with the quality he may make this test optional.

#### Slip Test:

##### Slip Strength Test for Suspension Clamps:

The suspension clamps shall be vertically suspended by means of a flexible attachment. A suitable length of the conductor with which it is intended to be used shall be fixed in the clamps with bolts and nuts tightened to the required torque. A load shall then be applied gradually at one end of the conductor (rate of increased being 0.5 kN-1.0 kN/second) and the value of the load at which the conductor in the clamp begins to slip shall be noted. The conductor shall not slip at a load of 25% or less of the breaking load of the conductor.

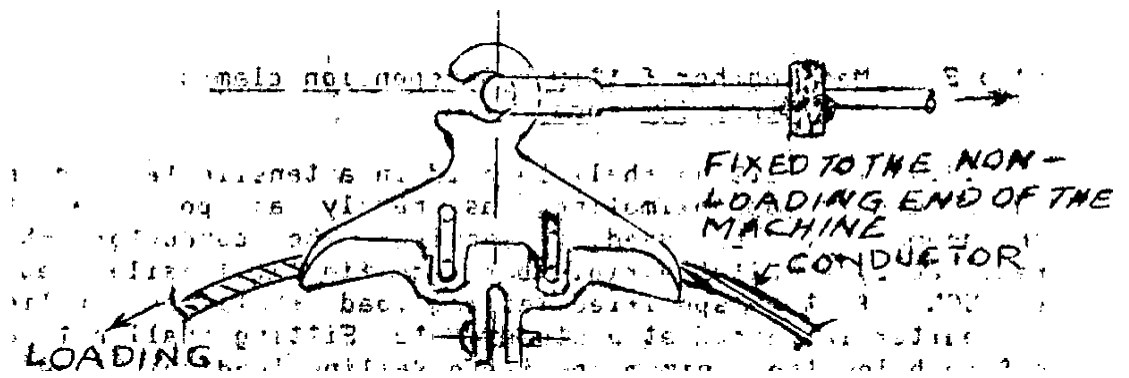


FIGURE-2

Slip Test for Non-Tension Joints:

The joint shall be assembled using the connector under test on conductors of the size with which it is to be used. The assembly shall be mounted in a tensile testing machine and anchored in such a way that the test load is applied in the direction of the conductor.

A tensile load of about 5 percent of the breaking load of the conductor, subject to a maximum of 55 kgf, shall be applied and the conductor shall be marked in such a way that movement relative to the conductor can easily be detected. Without any subsequent adjustment of the conductor, the load shall be steadily & slowly increased to 10% of the breaking load of the conductor. Subject to maximum of 110 kgf. This load shall be maintained for 1 minute. There shall be no movement of the conductor relative to connector due to the slip during this one minute period and no failure of the connector.

Electrical Resistance Tests:

The fittings which are required to carry current shall be subjected to the resistance tests. The test shall be done with direct current. The polarity shall be reversed and test repeated. Average of two results shall be taken as the measured value.

The resistance measurements shall be made by millivolt drop, an accurate resistance bridge or other approved methods.

The actual size of conductor which will be used with the connector or fitting shall be used during the tests.

For Tension Joints:

The fittings shall be assembled in accordance with the standard drawing on the conductors of the size and type with which it is to be used. The electrical resistance shall be measured between two points on the conductors on either side and 25 mm clear of the fitting. The resistance of the conductor with splice shall be of the same order as that of the equivalent length of the conductor. The current connections shall be at a distance of not less than 50 times of the diameter of the conductor from the fitting and shall be made so that effective contact is made with all those strands of conductor which would be taken into account in calculating its equivalent resistance.

For non-tension joints:

The resistance of 1.25m of a conductor, including one connector, such as parallel groove connector shall not exceed the resistance of 1.25m of the identical conductor without connector, by more than 10 percent. For terminal connectors, the resistance measured shall be the sum of the resistance measurement taken from A to B and C to D as shown in figure 3. In cases where the conductor is a stranded cable, the strands shall be suitably bonded at the point of the measurement.

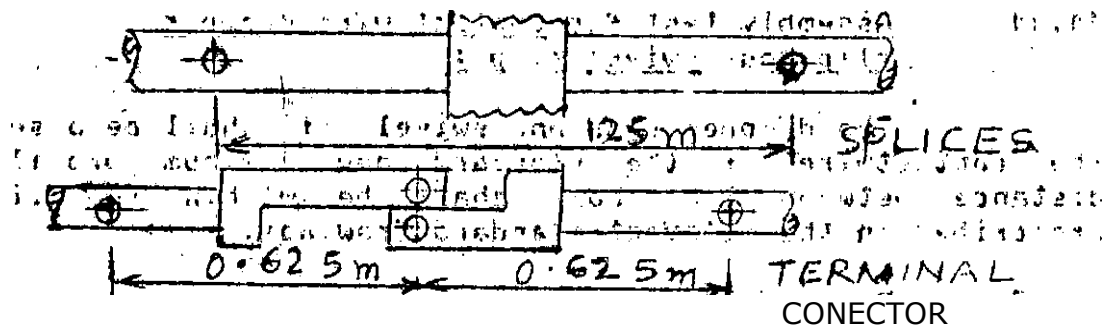


FIGURE-3

### Temperature Rise Test:

The values of the currents to be used in temperature rise test for the various types of connectors/fittings shall be rated current assigned to it. Where no rated current is assigned, it shall be determined in accordance with the following:

- (a) Equipment Connectors: The values of current shall be selected on the basis of the rating of the equipment to which the connector is connected or on the basis of the rated current of the conductor for which the connector is intended whichever is lower.
- (b) Junction Connectors: The value of current shall be selected on the basis of the conductor which has the lower current carrying value.
- (c) 'T' Connectors: The values of current shall be selected on the basis of the full rated current in the tapped conductor only.

The temperature rise test for power connectors shall be made with alternating current at an average frequency not below 95% of the rated frequency.

The connector shall be assembled indoors on conductors of the size and type with which it is to be used. Air shall be freely circulated around the assembly, but no draughts shall be allowed.

Each test shall be made over a period of time sufficient for the temperature to reach a constant value (for practical purposes, the condition is attained when the variation does not exceed 1°C/hour). Temperature measurement shall be made using either thermometer or thermocouple.

The temperature-rise shall not exceed 40 degree C above the reference ambient temperature of 45 degree C. If the ambient temperature exceeds 45 degree C the permissible temperature rise shall be reduced by an amount equal to excess ambient temperature.

### Galvanisation Test:

The galvanised component of the fittings shall be tested for mass of zinc coating (Clause 5.0 of Specification No.ETI/OHE/13 (4/84) with A & C slip 1 to 3), uniformity of coating, adherence and other defects (Clause 3.2 of Specification No.ETI/OHE/13(4/84) with A & C slip 1 to 3).

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Assembly test for contact wire dropper clip and swivel clip:

The dropper clip and swivel clip shall be assembled on the contact wire of the standard and maximum profiles. The distance between the hooks shall be within the limits as prescribed in the relevant standard drawings.

---

Dye penetration test:

Dye penetration test shall be done either by Zyglo, magnaflux or any other approved method in accordance with IS: 3658-1999 **Reaffirmed 2000** "Code of practice for liquid penetrant flaw detection" (For list of fittings see Appendix-J).

---

Routine verification of dimensions:

Important dimensions of all fittings shall be checked preferably by profile gauges of grooves and suitable GO/NO-GO gauges. For purposed of this test, dimensions which effect the assembly dimension which effect the strength of fitting such as wall thickness and machined dimensions shall be taken as important dimensions.

---

Hardness Test:

Hardness of malleable iron castings shall be measured on the product by Brinell method as per IS: 1500-2005. The hardness of malleable iron castings shall not exceed 150 HB.

12. Marking:

For the purpose of identification, the following marking shall invariably be made/cast on each fittings/castings.

- i) Manufacturer's code number
- ii) Railway Identification No. (R.I. No)
- iv) The month and year of production shall invariably be indicated on the fittings/castings. If it is not possible to accommodate any particular marking on the fittings/castings, the manufacturer shall obtain prior approval of the purchaser to delete the markings or to make the marking by any other suitable means.



It is desirable that a code giving the lot or melt number is also cast or engraved on each casting to facilitate the identification of lot number of each fittings. Alternatively, the month and year of production may be provided during casting.

In case of fabricated fittings marking shall be punched on such fittings prior to the galvanisation so that not only the markings are clearly visible after galvanisation, but also there is no damage to the galvanised surface.

A lable indicating the inspectors code number and date shall be fixed indelibly on every fitting immediately after tests and inspection.

13. DISPOSAL OF REJECTED FITTINGS.

The rejected fittings shall be destroyed in the presence of the Inspector to prevent their in-advertent mixing with the future supplies and shall advise RDSO/CORE with the reasons for rejection.

14. PACKING:

For packing, wooden cases shall be employed. The packing shall be fit to withstand rough handling, during transit and storage at destination. The heads and threaded portions of pins and the fitting shall be properly protected against damage. The gross weight of the packing shall not normally exceed 50 kg. Fittings of different types and rating shall be complete with their minor accessories fitted in place. All nuts shall be hand tightened over the bolts and screwed upto the farthest point.

- 15.0 All the provisions contained in RDSO's ISO procedures laid down in document No.- QO-D- 7. 1-1.1 dated 19.07.2016 (Titled " Vendor- change in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways"

16.The "Make in India" policy of Government of India shall be applicable.

Properties of Aluminum Bronze Castings-Extracts from IS: 3091-1999Chemical Composition:

The material when analysed in accordance with IS: 4027-1987\* shall have the chemical composition as given in Table-2.

TABLE-2:  
CHEMICAL COMPOSITION OF ALUMINIUM BRONZE INGOTS  
AND CASTINGS

CONSTITUENT	PERCENT
Aluminium	9.0 to 11.9
Iron	4.0 to 5.0
Manganese	0.1 to 0.5
Copper	Balance

The manufacturer shall supply free of charge a copy of his works analysis of the material. Works analysis may be defined as the routine analysis conducted by the manufacturer in order to control the quality of material.

Casting shall be clean, sound and free from harmful inclusions. Any castings may subsequently be rejected due to manufacturing defects, not withstanding the fact that it had been previously passed for Chemical Composition and Mechanical properties.

The material when tested in accordance with IS: 2654-1977\*\* shall have the tensile properties given in Table-3.

TABLE-3:  
TENSILE PROPERTIES OF ALUMIANIUM BRONZE INGOTS AND CASTINGS.

MODE OF CASTING TEST BAR	PROPERTY	VALUE
Chill cast or any other casting process	Tensile strength, minimum	60 kgf/sq-mm
	Elongation on 50 mm g length minimum.	20%
	0.2% permanent set st minimum.	25 kgf/sq-mm

\* IS: 4027-1987: Method of chemical analysis of bronze.

\*\* IS:2654-1977: Method of tensile testing of copper and copper alloys.

Number of Tests.

Three cast to shape test pieces (fig.4) shall made for each lot. The test bar shall be identified with lot and date of melt.

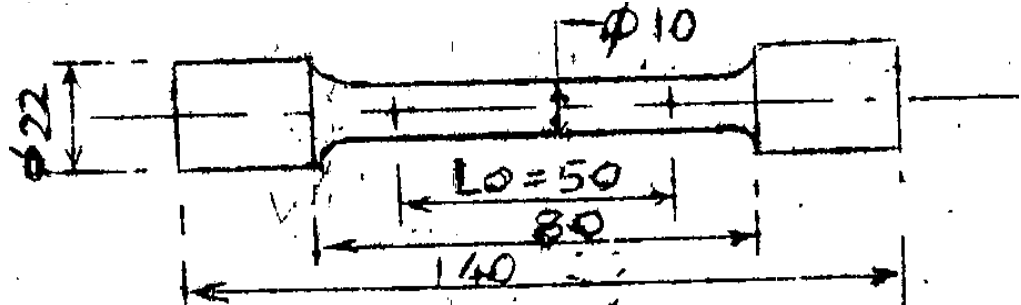


FIGURE-4

The test pieces shall be tested at the expense of the manufacturer in the presence of the Inspector.

One test piece shall be tested. If the mechanical properties are met by this one test, the lot shall be accepted. If the first test piece fails to conform to the specified requirements, the two remaining test pieces shall be tested, and if either of them fails to meet the specified requirements, the whole lot shall be rejected.

-XXXXX-

Properties of black heart malleable cast iron castings-  
Extracts from IS: 14329-1995 Reaffirmed  
2005.

B1. Chemical Composition.

B1.1 The phosphorous content of different grades of malleable cast iron, when tested in accordance with IS: 228-1959\* shall be as follows:

GRADE DESIGNATION (See IS:4843-1968 Reaffirmed 2003.)	PHOSPHORUS, PERCENT MAX.
BM 350	0.12
BM 320	0.15
BM 300	0.18

Micro-structure.

The material shall be free from primary graphite and shall not contain free cementite or pearlite in a form or amount detrimental to the physical properties of machinability of the casting.

Test Bars.

Provision of test bars-All test bar shall be cast separately. They shall be suitably marked so that the castings they represent could be identified.

Test bars shall be cast in green or sand moulds of the same materials as the moulds used for the castings they represent. They shall be cast in the same time and from the same melt as the casting they represent.

Test bars shall in all cases undergo the melleabilising heat treatment being together with the casting they represent.

In the event of any further heat treatment being given to the castings, to meet the requirements provided under B-4, the test bars shall be suitable heat treatment along with the casting they represent.

Tensile test bars shall be cast to the dimensions specified in figure-5. The dimensions of the shanks may be modified to suit the jaws of the testing machine.

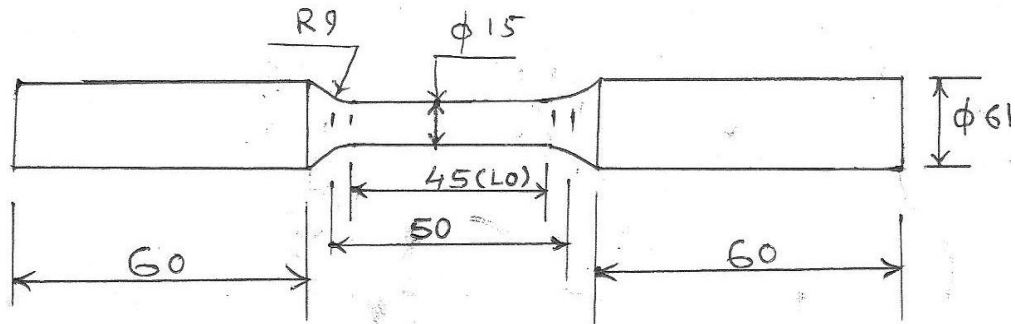


FIGURE-5

The cast tensile test bars may be dressed or cleaned and shall be tested in the un-machined condition.

Mechanical tests:

Tensile test: A tensile test bar, cast as far as practicable to the dimensions shown in figure-5 shall when tested in accordance with IS: 1608-2005 without machining the gauge length, give results not less than those specified in table-4. Since the test bars are in un-machined state. They may not be quite circular, in which case the tensile strength shall be calculated on the mean diameter at the middle of the gauge length by taking two measurements at right angles, one of which shall be maximum diameter.

TABLE-4: TENSILE PROPERTIES OF BLACK HEART MALLEABLE IRON CASTINGS.

	SECTIONAL THICKNESS REPRESENTED (mm)	DIAMETER OF TEST BAR (mm) (D)	TENSILE STRENGTH N/mm <sup>2</sup> (Kgf/mm <sup>2</sup> )	0.2% PROOF STRESS N/mm <sup>2</sup> (Kgf/mm <sup>2</sup> )	ELONGATION (L <sub>0</sub> =3D) (min.) percent
BM 350	All size	15	350(35.7)	200 (21)	10
BM 320	All size	15	320(32.64)	190(19)	12
BM 300	All size	15	300(30.60)	-	6

Hardness test:

Casting of grade BM-340 produced according to this standard shall not have hardness more than 150 HB.

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\* IS: 228-1959: Methods for chemical analysis of the steel.

\*\* IS: 1608-2005: Method for tensile testing of steel products.

+ IS: 4843-1968 **Reaffirmed 2003**: Code for designation of ferrous castings.

-XXXXX-

Properties of tin bronze ingots and Castings – Extracts  
from IS:306-1983.

C-1. Chemical composition:

C-1.1. The material when analysed either by the method specified in IS: 4027-1987+ or any other instrumental/chemical method shall have the chemical composition as given in Table-5:

TABLE-5: CHEMICAL COMPOSITION

CONSTITUENTS	PERCENT (castings)
Tin	9.5-10.5
Zinc	1.5-3.0
*Lead, Max.	1.5
Nickel, Max.	1.0
Iron, Max.	0.15
Aluminium, Max.	0.01
Silicon, Max.	0.02
Bismuth. Max.	0.03
Total impurity Max.(include iron, Aluminium, Arsenic, Antimony, Silicon, Bismuth)	0.50
Copper	Remainder

\* If specifically required by the purchaser, the material may be supplied with restricted lead content.

C.1.2 The manufacturer shall, when required, supply free of charge, a copy of his works analysis of the material. The works analysis is defined as the routine analysis carried out by the manufacturer in order to control the quality of the material.

Mechanical Properties:

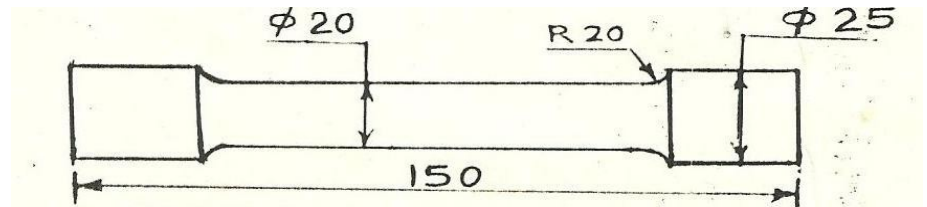
C-2.1 The material when tested in accordance with IS: 2654- 1977+ + shall have the mechanical properties as given in Table-6.

TABLE-6: MECHANICAL PROPERTIES

MODE OF CASTING	TENSILE STRENGTH MPa. Min.	0.2 PERCENT PROOF STRESS MPa. Min.	ELONGATION PERCENT ON GAUGE LENGTH 5.65/A. Min.
Sand Casting (Separately cast)	260	120	13
Chill casting (Separately cast)	210	120	3

Forms of Test Bars:

The test bars shall be according to one of the appropriate types described in IS: 1408-1968\*.



TEST BAR CAST TO SHAPE

FIGURE-6

+IS:4027-1987: Methods of chemical analysis of bronzes.

++IS: 2654-1977: Methods for tensile testing of copper and copper alloys.

\*IS: 1408-1968: Recommended procedure for inspection of copper base alloy sand castings.



Aluminium and Aluminium Alloy Castings-Extracts  
from IS: 617-2003 1994 Reaffirmed 1999.

Chemical Composition and Mechanical Properties.

D-1.1 The Chemical Composition and Mechanical properties of Aluminium and Aluminium alloy are given in Table-7. The Mechanical properties given in Table-6 apply to separately cast test piece. The Chemical Composition of Aluminium alloy fittings/ test bars shall be tested in accordance with IS: 504-2000\*

TABLE-7: Chemical Composition (Gravity or Pressure Die Casting Alloy)

Chemical Composition; (Percent Values given are in max. unless shown as a range).	
Alloy Designation	Percent
Copper	0.1
Silicon	10.0 -13.0
Magnesium	0.10
Iron	0.60
Manganese	0.5
Nickel	0.1
Zinc	0.1
Lead	0.1
Tin	0.05
Titanium	0.2
Aluminium	Remainder
Condition	M

Mechanical Properties:

Tensile Strength

Sand cast, N/sq mm (kgf/sqmm)	165(16.5)
Chill cast, N/sq mm (kgf/sqmm)	190(19.0)
Elongation (percent)(on 5.65 $\sqrt{S_0}$ or 50 mm gauge length)	
Sand cast	5
Chill cast	7

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\*IS: 504-2000: Method of Analysis of Aluminium and its Alloys.

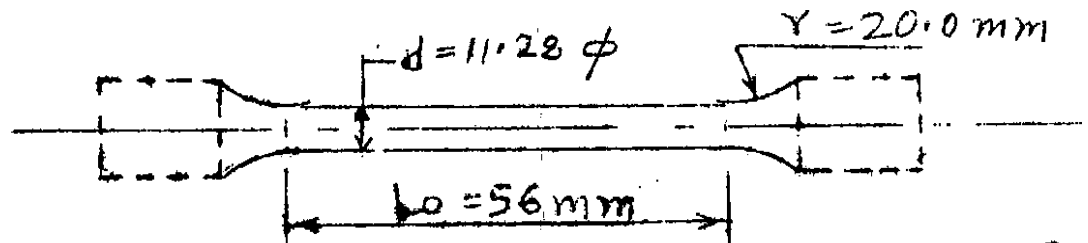
## Sample for Mechanical Tests of Castings.

D-2.1 The metal for the test sample shall be taken from the crucible or ladle from which, the castings are poured and shall not be subjected to any further treatment other than adjustment of the temperature to that suitable for pouring.

D-2.1.1 Sand Casting: The test samples shall be cast in dry sand moulds which shall have internal dimensions as shown in figure-1 or 2 of IS:617-2003 1994 Reaffirmed 1999. The moulds shall be inclined from the vertical at the commencement of pouring and the metal shall be poured into the top of the moulds. The sand of the moulds may be rammed into any convenient container (such as steel tube), provide that the portion of the bar tapering from 25 to 24 mm is separated from the container walls by not less than 27 mm of sand.

### Tests for physical Properties.

D-3.1 Tensile Test: Test pieces, prepared from test samples cast as specified in D-2 shall be machined to the dimensions of the standard round test piece fig.-7 and those from chill moulds as per fig-6 of IS:617-2003.



CROSS SECTIONAL AREA  $S_a = 100 \text{ mm}^2$

FIGURE-7

D-3.2 The testing procedure for carrying out the tensile test shall be as laid down in IS: 1816-1979\*.

D-3.3 Should a test piece break outside the middle half of the gauge length, test may at the option of the supplier be discarded and another test made.

\*IS: 1816-1979 Method for tensile test for light metals and their alloys.

Forged Steel- Extract from IS: 2004-1991 (Reaffirmed 2001).E-1 Chemical Composition

E-1.1 Ladle Analysis- The analysis of the steel shall conform to the requirements given in Table-8. The methods of chemical analysis shall be as prescribed in the relevant part of IS: 228-1959.

TABLE-8: CHEMICAL COMPOSITION

CLASS	DESIGNATION IS:1762 (Pt-1) -1974*	CONSTITUENT, Percent				
		Carbon	Silicon	Manganese	Sulphur Max.	Phosphorus Max.
1	14 C6	0.10 to 0.18	0.15 to 0.35	0.40 to 0.70	0.040	0.040
1A	15 C8	0.10 to 0.20	0.15 to 0.35	0.60 to 0.90	0.040	0.040
2	20 C8	0.15 to 0.25	0.15 to 0.35	0.60 to 0.90	0.040	0.040
2A	25 C8	0.20 to 0.30	0.15 to 0.35	0.60 to 0.90	0.040	0.040
3	30 C8	0.25 to 0.35	0.15 to 0.35	0.60 to 0.90	0.040	0.040
3A	35 C8	0.30 to 0.40	0.15 to 0.35	0.60 to 0.90	0.040	0.040
4	45 C8	0.40 to 0.50	0.15 to 0.35	0.60 to 0.90	0.040	0.040
5	55 C8	0.50 to 0.60	0.15 to 0.35	0.060 to 0.90	0.040	0.040
6	65 C6	0.60 to 0.70	0.15 to 0.35	0.50 to 0.80	0.040	0.040

Note: When the steel is Aluminium killed or killed or killed with both Aluminium and Silicon, the requirement of minimum Silicon content shall not apply. For Aluminium killed steel the total Aluminium content shall be within 0.02 to 0.05 percent.

\*IS: 1762 (Pt-I) - 1974: Code for designation of Steels- based on the letter Symbols.

IS: 228: Method for Chemical Analysis of steel.

E-1.2 Check Analysis: The purchaser may specify check analysis on finished forgings. The number of samples on which the analysis has to be carried out shall be at the rate of one sample per cast per section.

E-1.2.1 The permissible deviation in Check Analysis from the specified composition Limits shall be as given below:

Constituent Percent	Variation from the specified limits, percent
Carbon Upto 0.25	+/-0.02
Over 0.25 and upto and including 0.50	+/-0.03
over 0.50	+/-0.04
Silicon	+/-0.03
Manganese	+/-0.04
Sulphur	+/-0.005
Phosphorus	+/-0.005

Note: Variations shall not be applicable both over and under the specified limits in several determinations in a heat.

E-1.3 Elements not specified in table 8 shall not be added to the steel, except when agreed to, other than for the purpose of finishing the heat and shall not exceed the following:

Constituent Percent	Percent
Nickel	0.30
Chromium	0.30
Copper	0.25
Molybydenum	0.05
Vanadium	0.05
Tin	0.05
Boron	0.0003

E-2 Mechanical Test:

E-2.1 Tensile Tests: The tensile test shall be carried out in accordance with IS: 1608-2005\* the test pieces shall be machined length-wise from each test sample. The tensile properties shall conform to the requirements given in table 9.

\*Note: See extract of IS: 1608-2005 attached after Appendix 'F'.

Table 9- TENSILE PROPERTIES AND HARDNESS

CLASS	TENSILE STRENGTH Min(MPa)	YIELD STRENGTH Min(MPa)	ELONGATION PERCENT Min.(gauge length) 5.65 <sub>l</sub> /S <sub>o</sub>	HARDNESS Min.(HB)	NORMALIZING TEMPERATURE DEGREE C
1	370	200	26	100	880-910
1A	410	220	25	110	880-910
2	430	230	24	120	880-910
2A	460	250	22	130	880-910
3	490	270	21	140	860-890
3A	540	280	20	155	850-880
4	620	320	15	175	830-860
5	710	350	13	200	810-840
6	740	370	10	210	800-830

\*IS: 1608-1995: Methods for tensile testing of steel products.

-XXXXX-

APPENDIX- 'F'

Structural Steel- Extracts from IS: 2062-2006.

Chemical Composition:

The Chemical Composition shall be determined on the samples of finished product from the standard position, the specified contents are as under:-

Grade	Designation	Ladle <u>C</u>	Analysis <u>Mn</u>	Percent <u>S</u>	Max. P	<u>Si</u>
A	Fe410W A	0.23	1.5	0.050	0.050	-
B	Fe410W B	0.22	1.5	0.045	0.045	0.4
C	Fe410W C	0.20	1.5	0.040	0.040	0.4

Mechanical Tests:Tensile Tests:

The tensile strength, yield strength and percentage elongation of steel shall be determined from standard test pieces cut length-wise or crosswise from plates and lengthwise from sections, flats and bars. The test shall be carried out on standard test pieces prepared in accordance with IS: 1608-2005.

As a rule only proportional test pieces complying with the requirements  $L_0 = 5.65 \sqrt{S_0}$  should be used for tensile test, where  $L_0$  is the Gauge Length and  $S_0$  is the Cross Sectional Area of the test piece.

The gauge lengths other than  $5.65 \sqrt{S_0}$  may also be used in which case the elongations shall be read from IS: 3803 (Pt-1) – 1989\*.

The tensile strength, yield strength and percentage elongation determined in accordance with IS: 1608-2005 shall be as given in Table-10.

In case of sections the thickness of which is not uniform throughout the profile, the limits of sizes given in Table-10 shall be applied according to the actual maximum thickness of the piece adopted for testing.

\*IS: 1608-2005

- Method for tensile testing of steel products.

\*\*IS: 3803 (Pt-1)-1989- Steel conversion of elongation values: carbon and low alloy steels.

**TABLE-10 MECHANICAL PROPERTIES**

Grade	Designation	Tensile strength Min. MPa  (Kgf/mm)	Yield strength Min. MPa (Kgf/mm <sup>2</sup> )			Elongation percent Min (In gauge length) 5.65_/So	Bend test (Internal DIA) Min.
			2<20 mm	20-40 mm	>40 mm		
A	Fe410W A	410 (42)	250 (25.5)	240 (24.5)	230 (23.5)	23	3t
B	Fe410W B	410 (42)	250 (25.5) (23.5)	240 (24.5)	230	23	2t for less than or equal to 25 mm thickness. 3t for more than 25 mm thick products.
C	Fe410W C	410 (42)	250 230 (25.5) (23.5)	240 (24.5)		23	2t

't' is the thickness of the material.

Bend Test:

Bend Test Piece:

Test pieces shall be cut lengthwise or crosswise from plates and strips and lengthwise from sections, flats and bars. When sections permit, these shall not be less than 40 mm wide.

In all bend test pieces, the rough edge or arris resulting from shearing may be removed by filing or grinding or machining but the test pieces shall receive no other preparation. The test pieces shall not be annealed or otherwise subjected to heat treatments unless the material from which these are taken is similarly treated. In such cases, the test pieces shall be similarly treated in the same furnace with the material before testing.

Bend test shall be conducted in accordance with IS: 1599-2012.

For bend test, the test piece at room temperature shall withstand bending through 180 Deg. to an internal diameter not greater than that given in Table-10.

Relevant extract from IS: 1608-2005:

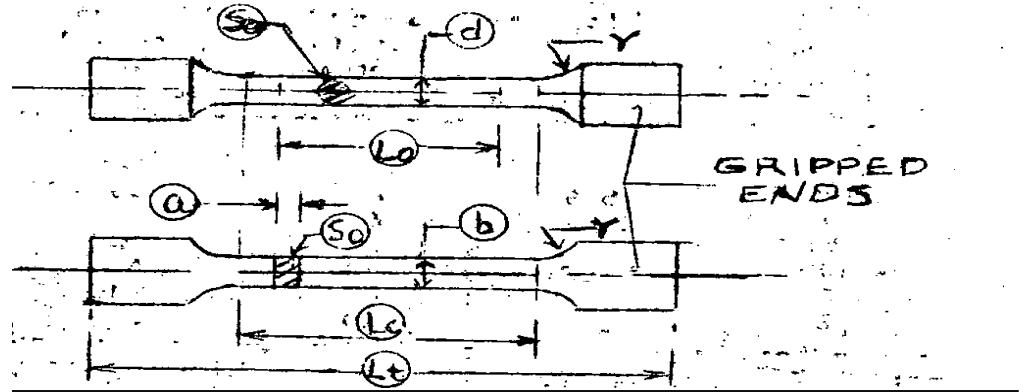


FIGURE-8

Test pieces of Circular and Rectangular Cross-Section

Note- The form of end of test piece is only intended as a guide.

### F3.1 Test Pieces:

The Cross-Section of the test piece may be circular, square, rectangular or in special cases, of other form. For test pieces of rectangular section it is recommended that the ratio of the width to thickness of 8:1 should not be exceeded.

Test pieces shall generally be made to the dimension given in Table-11 and 12. Sections, bars etc. may however, be tested without being machined. There should be a transition radius between the gripped ends and the parallel length. The dimensions of this transition are important and, unless otherwise stated, shall conform to the requirements given in Table-1 and 2. The gripped ends may be of the any shape to suit the holders of the testing machine.

The tolerances on the dimensions of the test pieces shall be in accordance with those given in Table-13 and 14.

F.3.1.1.2 In general, the diameter of the measured position of the machined cylindrical test pieces should not be less than 4.0 mm.

As a rule, only proportion test pieces complying with requirement  $L_o = 5.65 \cdot S_o$  should be used.

It is recommended that the parallel length ( $L_c$ ) of the test pieces of circular cross-section should be between  $L_o + 2d$  and  $L_o + d/2$  and



of test pieces of rectangular cross-section between  $Lo+1.5_{\sqrt{So}}$  and  $Lo+2.5_{\sqrt{So}}$ .

Provided there is sufficient material, the parallel length ( $L_c$ ) used for arbitration purpose should be  $Lo+2d$  for test pieces of circular cross section and  $Lo+2_{\sqrt{So}}$  for test pieces at rectangular cross-section.

Table-11: DIMENSIONS OF CIRCULAR SECTION TEST PIECES.  
(Clause 5.1.1)  
Gauge length  $Lo=5.65_{\sqrt{So}}$

Cross Sectional Area Sqmm	Diameter d Mm	Gauge length diameter $Lo$ mm	Minimum parallel length $L_c=5.5 d$	Minimum transition radius $r$ mm
400	22.56	113	124	23.5
200	15.96	80	88	15
150	13.82	69	76	10
100	11.28	56	62	10
50	7.89	40	44	8
25	5.84	28	31	5
12.2	3.99	20	22	4

Note-1: The gauge length is given to the nearest 1 mm and the minimum parallel length is adjusted accordingly.

Note-2: Test pieces with diameters other than these given in this table may be used provided that the gauge length  $Lo=5.65_{\sqrt{So}}$ .

Table 12: DIMENSIONS OF RECTANGULAR SECTION TEST PIECES  
(NON-PROPORTIONAL) (CLAUSE 5.1.1)  
All dimensions in mm.

WIDTH $b$	GAUGE LENGTH $Lo$	MINIMUM TRANSITION RADIUS $r$	APPROXIMATE TOTAL LENGTH $L_t$
40	200	25	450
20	200	25	375
25	100	25	300
12.5	50	25	200
6	24	12	100
3	12	6	50

Note-1: Notwithstanding the above, test pieces having a gauge length equal to  $5.65_{\sqrt{So}}$  are permitted.

Note-2: For any width from 3 to 25 mm a gauge length of 50 mm may be used, the total length being adjusted accordingly.

Note-3: A straight, parallel test piece without enlarged ends is permissible for any size.

Table-13: TOLERANCE ON DIMENSIONS OF CIRCULAR CROSS-SECTION TEST PIECES (CLAUSE 5.1.2)  
(All dimensions in mm.)

Nominal dimensions	Machining tolerance* on nominal dimensions	Tolerance on form
4 to 6	+/- 0.06	0.03
Over 6 to 10	+/- 0.075	0.04
Over 10 to 18	+/- 0.09	0.04
Over 18 to 30	+/- 0.105	0.05
* The machining tolerance applies when it is desired to use the nominal cross-section without measurement or calculation.		

Table-14: TOLERANCE ON DIMENSIONS OF RECTANGULAR SECTION TEST PIECES MACHINED ON TWO OPPOSITE FACES.  
(Clauses 5.1.2)

(All dimensions are in mm.)

NOMINAL DIMENSION	TOLERANCE ON FORM VALUES
3 to 6	0.18
6 to 10	0.22
10 to 18	0.22
18 to 30	0.33
30 to 50	0.39

Note-1: Dimensions of the ends of the reduced section of test pieces should not differ in width by more than 0.1mm.

Note-2: For rectangular section test pieces machined on the four faces, same tolerances as for diameter of circular section test pieces shall apply.

-XXXXX-

## COPPER STRIP FOR ELECTRICAL PURPOSES

(Extracts from IS: 1897-2008)

G.1 Chemical Composition.

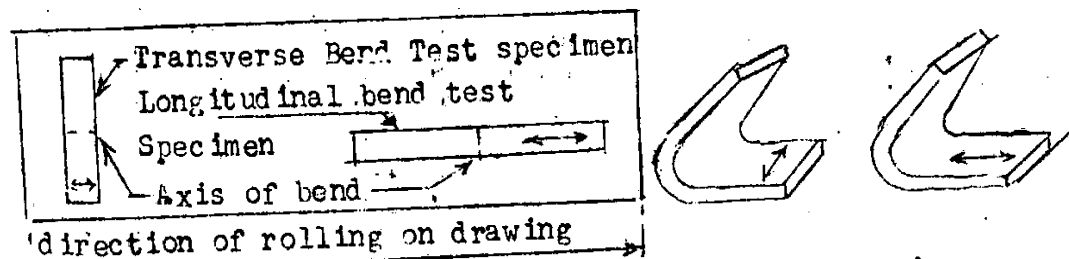
G1.1.1 The Chemical Composition shall be determined either by the method specified in IS: 440-1964\* or any other established Instrumental/Chemical Method. In case of dispute the procedure specified in latest edition of IS: 440-1964\* for Chemical analysis shall be the reference method. The material shall conform to grade ETP or FRHC of IS: 191 (Pt-I to X) - 1980.  
\*\*

G2. Physical Properties.

G.2.1 The material when tested in accordance with IS: 3260-1965# and IS: 2654-1977+ shall have the Physical Properties as given in Clause 7.2 & 7.3 respectively.

Bend Test.

Where possible, the strip shall be subjected to a transverse bend test made on test pieces cut with their major axes at right angles to the direction of rolling (see Fig.9); where this is not possible it shall be subjected to a longitudinal bend test made on test pieces cut with their major axes parallel to the direction of rolling. (See figure-9). Both surfaces of the pieces shall be tested.



TRANSVERSE AND LONGITUDINAL BEND TEST SPECIMEN

FIGURE-9

The Test Pieces shall not crack when bent once through the appropriate angle as specified below:-

**BEND TEST**

Thickness	Condition	Bend Test	
		Transverse or Longitudinal	
		Angle in Degree	Radius
Upto and including 10 mm	Annealed(O)	180	Close
	Half hard(HB)	180	t
	Hard(HD)	90	t
t is the thickness			

The Test pieces shall be of convenient length and the width shall be as follows:

Thickness	Width
Upto and including 6.0 mm	15 mm where possible, otherwise full width
Over 6.0 mm	2 times the thickness of material

The longer edges shall be carefully rounded and smoothed longitudinally so that the cross. Section has approximately semi-circular edges.

Tensile Test.

Material of thickness 0.50 mm and upto and including 10 mm shall comply with the requirements of Tensile Test given in Table-15. Material below 0.50 mm thick shall not be subjected to Tensile Test.

Test pieces of full thickness of the material with a gauge length 4<sub>√</sub>Area or 50 mm shall be used. The longitudinal axis of the test piece shall be in the direction of rolling.

**TABLE-15: TENSILE PROPERTIES OF STRIP**

Thickness		Temper	Upto and including 300 mm width		Over 300 mm upto and including 1000 mm width	
Over mm	Upto & including mm		Tensile Strength kgf/mm <sup>2</sup> (Min.)	Elongation % on 4√Area or 50 mm Gauge Length(Min.)	Tensile Strength kgf/mm <sup>2</sup> (Min.)	Elongation % on 4√Area or 50 mm Gauge Length(Min.)
0.50	2.50	Annealed(O)	21.0	35.0	21.0	35.0
		Half hard(HB)	25.0	10.0	25.0	10.0
		Hard(HD)	31.5	-	29.0	-
2.50	10.0	Annealed(O)	21.0	35.0	21.0	35.0
		Half hard(HB)	25.0	15.0	25.0	15.0
		Hard(HD)	30.0	-	28.0	-

- \* IS: 440-1964: Methods of Chemical Analysis of Copper.
- \*\* IS: 191(Pt-I to x) - 1980: Specification for Copper.
- # IS: 3260-1965: Method for bend test for Copper and Copper Alloys.
- + IS: 2654-1977: Method of Tensile Testing of Copper and Copper Alloys.

Electrical Resistivity Test.

The standard values at 20°C for the Electrical Resistivity of annealed high conductivity copper shall be taken as 0.01724 ohm mm<sup>2</sup> /m. The Electrical Resistivity of strip shall be measured in accordance with IS: 3635-1966\*. The Electrical Resistivity values are given in Table-16.

**TABLE-16: ELECTRICAL RESISTIVITY**

Condition	Resistivity (Ohm mm <sup>2</sup> /m) at 20°C (Max.)	Conductivity (% Min.)
Annealed(O)	0.01737	99.25
Half hard(HB)	0.01777	97.00
Hard(HD)	0.01777	97.00

Note: conductivity percent is expressed as percentage of the standard value for standard annealed copper of 100% conductivity as laid down by the International Electrotechnical Commission.

- \* IS: 3635-1966: Methods of Test for Resistance of Metallic Electrical Resistance Material.

Properties of wrought Aluminium and Aluminium Alloys, sheet & strip-  
Extract from IS: 737-2008

Chemical Composition.

The Chemical Composition and Mechanical properties of wrought Aluminium and Aluminium Alloys, sheet and strip are given in Table-17. Chemical analysis shall be carried out in accordance with IS: 504-2000\*.

TABLE-17: CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES.

A. Chemical composition: (Values given are in percent, Maximum unless shown otherwise)	
Alloy Designation-52000, Condition- H2	
Copper	0.1
Magnesium	0.7 to 2.6
Silicon	0.6
Iron	0.7
Manganese	0.5
Zinc	0.2
Chromium	0.25
Titanium and /or other grain refining elements	0.2
Aluminium	Remainder
Remarks: Chromium+Manganese	
B. Mechanical Properties:	
(i) Tensile Strength, MPa(kgf/mm <sup>2</sup> )	230 to 250 (23.5 to 28.0)
(ii) Elongation on 50 mm gaugelength, min. in percent for thickness over 2.6 to 6.3 mm.	4
(iii) 0.2% proof stress (min) MPa (kgf/sqmm)	17.5(18)

Mechanical Test:

Tensile Test and proof stress- Tensile test shall be carried out and proof stress determined thereby in accordance with a IS: 1816-1979. The values obtained shall comply with the requirements given in Table-17.

The Tensile Test piece shall be of rectangular section and having the dimension as given in a IS: 1816-1979 with a gauge length of 50 mm. The test piece shall be cut transverse to the direction of rolling for sheet and strip 300mm wide and over and parallel to the direction of rolling for sheet and strip under 300mm wide. When the width of the material to be tested is insufficient to permit preparation of the standard tensile test piece, a piece of full width of the material may be used.

Bend Test: The bend test piece less than 15 mm wide of convenient length and cut with its longer axis transverse to the direction of rolling. The longer edges shall be carefully rounded and smoothed longitudinally, so that the cross section of the test piece has approximately semi-circular ends.

The test piece may be bent by hand to a U-form and the piece thus obtained shall subsequently be closed in a vice until the inner surface of the test piece are twice the thickness (of strip) apart.

H.2.2.3When tested in accordance to Clause H2.2, the outer surface of the bend shall not show any visible crack.

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\* IS: 504-2000: Method of Chemical Analysis of Aluminium and its Alloys.

IS: 1816-1979: Method for tensile test for light metals & their Alloys.

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APPENDIX-'J'

List for fittings on which dye penetration test is required to be carried out as routine test.

S.No.	Description of item	R.I.No./Drg.No.
I.	Malleable cast iron fittings:	
1.	Contact Wire ending clamp body	1118
2.	Suspension clamp	1161-1
3.	Double suspension clamp	1171-1
4.	Strain clamp body	1601
5.	Standard suspension bracket	2110-1
6.	Large suspension bracket	2130
7.	Standard register arm hook	2151-1 2152-1
8.	Large register arm hook	2161-1 2162-1
9.	25mm drop bracket part	2361
10.	Steady arm hook (BFB)	2391
11.	Register arm eye piece, 25 mm	2422-1
12.	Steady arm clamp body	2491-1
13.	Double clevis	3010
II.	<u>Aluminium Bronze Fittigns:</u>	
1.	Contact wire splice	1081
2.	Contact wire splice (toothed typed)	1081-1
3.	Catenary splice	1090
4.	Catenary ending clamp	1120



5.	Catenary suspension clamp	1160
6.	Steel wire ending clamp	1360
7.	Standard catenary suspension bracket	2110
III.	<u>Aluminium Alloy Fittings:</u>	
1.	Earth wire strain clamp	7050
2.	Crimp type repair sleeve for Aluminium alloy catenay	ETI/OHE/SK/285
3.	Envelope type end clamp assembly for all aluminium alloy stranded catenary	ETI/OHE/SK/436
IV.	<u>Forged Fabricated Steel Fittings:</u>	
1.	9-tonne adjuster	5020
2.	9-tonne adjuster (eye & clevis type)	5020-1
3.	9-tonne adjuster (double clevis type)	5020-2
4.	5-tonne adjuster	5010
5.	Clevis	5041
6.	Mast anchor fitting	3231
7.	Mast guy fitting	3232
8.	Double eye distance rod	5191
9.	Counter weight eye rod	5183
V.	<u>All fittings made of SGCI</u>	

APPENDIX 'K'

Maximum permissible level of Discontinuity in Radiographic examination

Sl.No.	Alloy	Specification for standard reference radiographs	Discontinuity level permissible
1	2	3	4
1.	Aluminium Bronze castings	Material specification IS: 3091-1999 General conditions for radiograph as per ASTM E-272 (Standard). a) Sensitivity of radiographs- 2% b) IQI must be used in all cases	a) Hot tears- not permitted. b) Shrinkage- not permitted. c) Porosity- pinhole porosity at isolated locations permitted. Clusters of pinhole porosities not permitted. The minimum distance between pinholes to be 15 mm. Defects near edges not acceptable. d) Inclusions- Inclusions due to dross and foreign material rounded in shape of the size not exceeding 2 mm at one or two places permitted.
2.	Tin bronze casting	Material Specification IS: 306-1997. General conditions for radiographs standard as per ASTM E-310. a) Sensitivity of radiographs- 2% b) IQI must be used in all cases.	a) Hot tears- not permitted. b) Shrinkage – not permitted. c) Gas holes- Rounded or elongated smooth edged discontinuities permitted at isolated locations. Clustering of holes not permitted. Maximum size of the holes not to exceed 1.5 mm and minimum distance between 2 gas holes, if present not to be closer than 15 mm. Defects near edges not acceptable. d) Inclusions- Inclusions due to dross and foreign material rounded in shape of the diameter not exceeding 1.5 mm at isolated places permitted. Clustering of inclusions and presence of inclusions near edges not acceptable.

3.	Aluminium alloy casting	<p>Material Specification IS: 617-20031994  Reaffirmed 1999 General conditions for radiograph standard as per ASTM E-505.</p> <p>a) Sensitivity of radiographs- 2%  b) IQI must be used in all cases</p>	<p>a) Cracks- not acceptable.  b) Shrinkage- not acceptable.  c) Porosity- pinhole porosity at isolated places of size not exceeding 1 mm permitted. Clusters of pinholes not permitted. Presence of pin holes near edges not permitted.  d) Foreign material- Inclusions due to dross and foreign material round in shape of the size not exceeding 1.5 mm at isolated places permitted. Clustering of inclusions and presence of inclusions near edges not permitted.</p>
4.	Malleable iron castings	<p>Material specification IS:14329-1995  Reaffirmed 2005 General condition for radiograph standard- as per ASTM E-446</p> <p>a) Radiograph sensitivity- 2%  b) IQI must be used in all cases.</p>	<p>a) Porosity- size of porosity of pin holes shall not be more than 1 mm in diameter and the distance between two pin holes shall not be less than 20 mm. Clustering of pin hoes shall not be permitted.  b) Slag inclusion – Slag inclusion of the size not inclusion not more than 1 mm and the distance between slag inclusion particles shall not be less than 20 mm. Clustering of inclusion particles shall not be allowed.  c) Sand inclusion-do-  d) Hot tears- not permitted.  e) Crack- not permitted.  f) Shrinkage- The total shrinkage area shall not exceed 5% of the radiographic area.</p>

5.	SGCI castings	<p>Material specification- SG 400/15 of IS: 1865-1991  <b>Reaffirmed 2005</b> &amp;          Chemical Composition shall conform to IJERT-2012, General condition for radiograph standard- as per ASTM E-446</p> <p>a) Radiograph sensitivity- 2%          b) IQI must be used in all cases.</p>	<p>a) Porosity- size of porosity of pin holes shall not be more than 1 mm in diameter and the distance between two pin holes shall not be less than 20 mm. Clustering of pin holes shall not be permitted.</p> <p>b) Slag inclusion – Slag inclusion of the size not inclusion not more than 1 mm and the distance between slag inclusion particles shall not be less than 20 mm. Clustering of inclusion particles shall not be allowed.</p> <p>c) Sand inclusion-do-</p> <p>d) Hot tears- not permitted.</p> <p>e) Crack- not permitted.</p> <p>f) Shrinkage- The total shrinkage area shall not exceed 5% of the radiographic area.</p>

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Properties of Spheroidal Graphite Cast Iron:-

L1. Chemical Composition-Based on minutes of meeting (MOM) held in Traction Installation Directorate of RDSO on 2<sup>nd</sup> May, 2014 between RDSO(TI) and Manufacturers.

L1.1 Chemical composition of SGCI of grade 400/15 shall be as below

S.N.	SPECIFICATION /Grade	C %	Si %	Mn %	S %	P %	Mg %	Cu%
1	400/15	3.30-3.75	2.20-2.70	0.50	0.03 max	0.08 max	0.030-0.050	--

Extracts from: IS: 1865:1991 **Reaffirmed 2005.**

Micro-structure.

The micro structure of the material shall be as per IS: 7754:1975 **Reaffirmed 2003.**

Test Bars.

Provision of test bars-All test bar shall be cast separately. They shall be suitably marked so that the castings they represent could be identified.

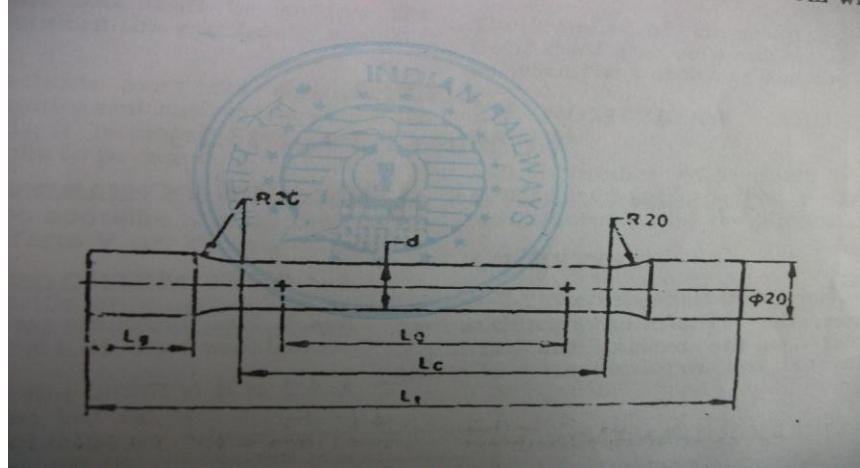
Test bars shall be cast in green sand or dry sand moulds of the same materials as the moulds used for the castings they represent. They shall be cast in the same time and from the same melt as the casting they represent.

Test bars shall in all cases undergo the heat treatment cycle being together with the casting they represent.

In the event of any further heat treatment being given to the castings, to meet the requirements provided under L-4, the test bars shall be suitable heat treatment along with the casting they represent.

Tensile test bars shall be cast to the dimensions specified in figure-10. The dimensions of the shanks may be modified to suit the jaws of the testing machine.

The cast tensile test bar shall be dressed or cleaned and shall be tested in the machined condition.



EXTRACT FROM IS: 1865:1991 Reaffirmed

2005-TENSILE TEST PIECE

FIGURE-10

Mechanical tests:

Tensile test: A tensile test bar, cast as far as practicable to the dimensions shown in figure-10 shall when tested in accordance with IS: 1608-2005 with machined condition to give result not less than those specified in table-4

TABLE-4: TENSILE PROPERTIES OF SGCI CASTINGS.

GRADE DESIGNATION (See IS:1965-1991)+	SECTIONAL THICKNESS REPRESENTED (mm)	DIAMETER OF TEST BAR (mm) (D)	TENSILE STRENGTH N/mm <sup>2</sup> (Kgf/mm <sup>2</sup> )	0.2% PROOF STRESS* N/mm <sup>2</sup> (Kgf/mm <sup>2</sup> )	ELONGATION (L <sub>0</sub> =3D) (min.) percent
SG 400/15	All size	14	400(40.8)	250 (25.5)	15

\* 0.2% Proof Stress 250 N/mm<sup>2</sup> shall not be applicable in case of acceptance test.

Hardness test:

Casting of grade SG-400/15 Produced according to this standard shall have hardness between 130-180 HB. In case of higher side of Hardness up to 200 HB should also be acceptable with meeting the physical properties as IS: 1865-1991 **Reaffirmed 2005**.

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- \* IS: 228-1959: Methods for chemical analysis of the steel.
- \*\* IS: 1608-2005: Method for tensile testing of steel products.
- + IS: 4843-1968 **Reaffirmed 2003**.: Code for designation of ferrous castings.

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