BHARAT HEAVY ELECTRICALS LIMITED
ELECTROPORCELAINS DIVISION
BANGALORE 560 012

PURCHASING SPECIFICATION

SPHEROIDAL GRAPHITE IRON CASTINGS

1.0 GENERAL

This specification governs the requirements of Spheroidal Graphite Iron castings. SG Iron Castings, governed by this specification of BHEL EPD shall generally be in compliance with the provisions of IS-1865:1991 (reaffirmed 2005) and ASTM A536-84 (Reapproved 2014)

2.0 SCOPE

All Insulator fittings like Socket Caps and Flanges

3.0 CONDITION OF DELIVERY

The Castings shall be supplied in galvanised / un-galvanised / as Cast condition as per Purchase order.

4.0 DIMENSIONS & TOLERANCES

Shall confirm to relevant castings and machine drawings.

5.0 MANUFACTURE

5.1 MELTING

Shall be done in an electric furnace

5.2 HEAT TREATMENT

5.2.1 ANNEALING

Annealing shall be undertaken if non-homogeneity is observed with respect to Metallurgical Morphology and Mechanical properties. Annealing cycle shall be designed by the vendor and copy of the same shall be furnished to BHEL for scrutiny.

6.0 FINISH AND WORKMANSHIP

The castings shall be properly Fettled, Shot blasted to ensure removal of Fused Sand and Heat treatment scales from the surface. Machining shall also be done if mentioned in the Purchase Order. The castings shall clearly bear such letters, figures or marks as specified in the drawing apart from vendor' identification mark. Such identification mark shall be incorporated on the Castings after prior approval of BHEL.

7.0 FREEDOM FROM DEFECTS

The castings shall be sound, clean and free from Porosity, Blow holes, Hard spots, Cold shuts, Distortion and other harmful defects. Galvanised items shall be further free from defects such as those mentioned in IS:2629.

PREPARED BY	APPROVED BY
PRATAP MUKHERJEE MANAGER / QUALITY	K V RAVISHANKAR DEPUTY GENERAL MANAGER / QUALITY & BE

8.0 MECHANICAL PROPERTIES

Test specimen / sample castings when tested shall confirm to the following stipulations.

Table : Mechanical properties measured on Test bars from separately Cast test samples.

Grade as per IS-1865: 1991	Grades as per ASTM-A536	Tensile strength (min) (N/mm^2)	0.2% Proof stress min. (N/mm^2)	% Elongation (min) Lo=3D	For information only	
					Brinell hardness	Predominant constituent of Matrix
SG 500/7	–	500	320	7	160 – 240	Ferrite + Pearlite
SG 450/10	–	450	310	12	160 – 210	Ferrite
–	65-45-12	448	310	12	–	Ferrite
SG 400/15	–	400	250	15	130 – 180	Ferrite
–	60-40-18	414	276	18	–	Ferrite
SG 400/18	–	400	250	18	130-180	Ferrite
SG 350/22	–	350	220	22	≤ 150	Ferrite

Note : Test sample for Tensile Test shall be separately Cast test samples fully in compliance with Cl 10.1 of IS:1865:1991

Table : Impact Test (applicable for 400/18 and 350/22 grade only): V-Notch Test Pieces at Ambient Temperature (23± 5 degree centigrade).

Grade	Mean Value	Individual value
SG 400/18	14	11
SG 350/22	17	14

9.0 MICROSTRUCTURE

The specimen shall reveal a microstructure as follows :
Carbon nodules distributed uniformly in a matrix of ferrite or ferrite + pearlite.
one sample/heat treatment or 1 sample/1000 nos to be checked for microstructure.
Acceptance norm as per ASTM – A247 and IS: 7754-1975 (Reapproved in 2003)

10.0 CHEMICAL COMPOSITION

Shall confirm to drawings, when specified.

11.0 TESTS FOR ZINC COATING (Applicable to Galvanised components)

Tests for uniformity of Zinc coating and mass of Zinc coating shall be done in accordance with IS:2633. The component shall withstand minimum six dips of one minute each and mass of Zinc coating shall be 610 gm/m^2 minimum. In case of requirement of higher values for these characteristics the same shall be indicated in the order / drawing.

Note : The test for uniformity of coating shall not be applicable for items with an overall size more than 200mm × 150mm × 100 mm and / or weight exceeding 4 kg.

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PRATAP MUKHERJEE MANAGER / QUALITY	K V RAVISHANKAR DEPUTY GENERAL MANAGER / QUALITY & BE

12.0 SELECTION OF SAMPLES

Sampling for various tests / inspection shall be as indicated in the table below:

Sl. No.	Type of Test / Inspection	Sampling plan for supplier while production and BHEL for lot acceptance
1	Dimensional check*	2 nos per 1000 Nos or part thereof.
2	Visual & Gauge§ Inspection	100% visual inspection by Supplier. And samples as per IS:2500 (Part I) inspection level II & an AQL of 0.65 % by BHEL
3	MPI£	100% visual inspection by Supplier. And samples as per IS:2500 (Part I) inspection level II & an AQL of 0.25 % by BHEL
4	Mechanical properties (Ultimate Tensile Strength**, 0.2% proof stress, % Elongation)	Tested on one test bar per treatment batch by supplier and one test bar per lot by BHEL. Test samples to be drawn at least one number per treatment (not exceeding 2000 kgs of fettled castings from one heat) Note: 1. Sufficient no. of test bars (preferably 4 nos) from same melt/heat treatment need to be produced to provide for contingencies of discordance of a test or re-tests. 2. Tensile Tests, Evaluation of Nodularity (respectively in accordance with Cl 13.1 and Cl 9.1 of IS:1865) shall be imposed only at the time of vendor approval and subsequent surveillance checks. Surveillance checks to be carried out once every 6 months irrespective of whether supplies have been effected or not, as long as the vendor is on the PMD listing -Validity of tests : As per Cl 14.1 of IS:1865; Retest : As per Cl 15 of IS:1865

** For bulk supplies only. Detailed check shall be carried out on initial sample to be approved for taking up bulk manufacture.*

*** i) In case of failure of any tensile test 'retest' can be taken up on two additional test bar pertaining to the same batch and both the additional test bars shall pass*

ii) In case a test bar breaks out of the gauge length & 'repeat test' can be taken up on are placement test bar. So also in the event of any defect traceable to the testing conditions or attributable to specimen unsoundness.

£ Test to be carried out by ASNT Level II certificate holders only.

§ Gauges will be applicable as per drawing.

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PRATAP MUKHERJEE MANAGER / QUALITY	K V RAVISHANKAR DEPUTY GENERAL MANAGER / QUALITY & BE

Sl. No.	Type of Test / Inspection	Sampling plan for supplier while production and BHEL for lot acceptance
5	Hardness test on Castings	2 Nos. per lot Test samples: Hardness tests shall be carried out on actual castings drawn at the rate of A) In case of Socket caps: 4 nos from among the castings (of one drawing type) per treatment / 4 noss from among the castings (of one drawing type) per lot of 1000 nos or part thereof. B) In case of Flanges: 2 nos from among the castings (of one drawing type) per treatment / 2 nos. from among the castings (of one drawing type) per lot of 1000 Nos or part thereof. **Location of Hardness test samples:** A) In Case of Socket caps : On the Socket head and sectioned lip portion B) In case of Flanges : On the hub or web whichever is thicker
6.	Load test on Castings (for Socket Caps)	4 nos per 1000 with min 1 no.per melt / treatment
7.	Impact Test	Applicable for 400/18 and 350/22 grade caps only and test to be conducted on separate Test bars at room temperature unless otherwise specified.
8.	Additional test : Test for deformation	On one sample per melt
9.	Surface defects (after galvanising)	IS:2500 (Part I) Inspection level II & and AQL of 0.65%
10.	Test for Zinc coating	3 nos. per batch of 1000 nos.

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PRATAP MUKHERJEE MANAGER / QUALITY	K V RAVISHANKAR DEPUTY GENERAL MANAGER / QUALITY & BE

13.0 INSPECTION AT VENDOR's PREMISES

BHEL's representative shall have free access to all parts of Vendors' premises at all times when work on the contract is being executed. The vendor shall offer BHEL's representative all reasonable facilities to convince the latter that the component is being manufactured and furnished in accordance with this specification.

14.0 TEST CERTIFICATE

The supplier shall submit test certificates giving the following information

a) Purchase Order no.
b) Purchasing specification no.
c) Suppliers reference and name
d) Batch no.
e) Consignment identification
f) Results of various tests as called for in this specification
g) Details of Heat treatment (if any)
h) Melt no. details with traceability

15.0 PACKING AND MARKING

Castings shall be supplied in lots as defined above. Each lot shall be legibly identified with the following information

a) Supplier's Name
b) Purchase Order no.
c) Component drawing no.
d) Consignment identification
e) Lot (or malleablising batch no/identification)
f) Quantity

16.0 REJECTION

Castings not conforming to the above stipulations shall be rejected. Also in the event of the castings proving defective in the course of any further processing the same shall be rejected notwithstanding any previous certification of satisfactory testing and/or inspection.

PREPARED BY	APPROVED BY
PRADAP MUKHERJEE MANAGER / QUALITY	K V RAVISHANKAR DEPUTY GENERAL MANAGER / QUALITY & BE

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DEPT : QUALITY
SEC : 372/PSH/GAL
REV : 01
DATE : 29.08.2006
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TECHNICAL REQUIREMENT PERTAINING TO HOT DIP GALVANISING OF FERROUS COMPONENTS

1. The components are to be hot dip galvanised in accordance with IS:2629/1985 (Refer Table-3 : General Galvanising procedure in line with IS:2629/1985 for ferrous components)

2. The Zinc used for hot dip galvanising should be of grade Zn 99.95 as per IS:209/1979

3. Adequate facilities should be available to ensure process control as per IS:2629/1985 and product testing as detailed at Clause '6'

4. The records of the following parameters checked as per the periodicity indicated against each of them to be maintained by sub-contractor and submitted for scrutiny to BHEL when asked for :

	Parameter		Peroidicty
4.1	Acid concentration	Of the pickling bath	At an interval of 4 hours
4.2	Specific gravity		
4.3	Iron content		
4.4	Specific gravity of the flux solution		
4.5	Temperature of galvanising bath		At an interval of half an hour
4.6	Purity of zinc ingot		Every consignment purchased by vendor (One sample)

5. Galvanised components shall be inspected for freedom from surface defects (100% Visual Inspection) such as those mentioned in IS:2629/1985. Dimensions of component are altered by galvanising, Hence, dimensional inspection is necessary after galvanising (for critical dimensions only). Inspection of profiles / contours may call for suitable gauges (100% Gauge check) and the same gauges shall be provided by BHEL

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YOGESH SHARMA SENIOR ENGINEER / QUALTY	S RAVIKUMAR SR. DY. GENERAL MANAGER / Q & CI

6. Further, coating characteristics described below shall be tested for, on the galvanised products.

	Coating characteristic	Acceptance norms	No. of samples to be tested per lot of 1000 or part thereof
6a)	Uniformity of Zinc coating (Copper sulphate dip test as per IS:2633/1986)	As indicated in Table 1	As indicated in table 2 below
6b)	Mass of Zinc coating as per IS:6745/1972	As indicated in Table 1 below	As indicated in table 2 below
6c)	Adhesion of coating (knife test as per IS:2629/1985)	The coating shall not peel off	2

TABLE 1: ACCEPTANCE NORM FOR UNIFORMITY OF ZINC COATING & MASS OF ZINC COATING TESTS

Acceptance Norm	Under Category				
Characteristic	A	B	C	D	E
Uniformity of zinc coating (no. of one minute dips to be withstood)	6	8	6	6	6
Mass of zinc coating (gm/m^2)	610	650	650	800	1150

TABLE 2 : SAMPLING PLAN FOR UNIFORMITY OF ZINC COATING & MASS OF ZINC COATING TESTS

Acceptance Norm	Under Category				
Characteristic	A	B	C	D	E
Uniformity of zinc coating	3	9	6	5	6
Mass of zinc coating	3	3*	3	6	6

* Test coupons also may be processed for determining mass of zinc coating whenever provided.

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YOGESH SHARMA SENIOR ENGINEER / QUALITY	S RAVIKUMAR SR. DY. GENERAL MANAGER / Q & CI

7. Items of a particular type with a total quantity in number of continuous production not exceeding 1,000 shall constitute a lot. Number of samples indicated refers only to normal conditions of galvanising process. It is liable to be enhanced from time to time at the instance of performance proving not satisfactory.

8. In case of socket caps bituminous paint must be applied inside the bell portion uniformly. The bituminous paint used should have following properties as per IS:158/1981

Sl. No.	Test Description	Acceptance Norms
1.	Visual Inspection	Glossy & Smooth Coating
2.	Specific gravity	0.84
3.	Viscosity (For B4 Fort Cup)	> 60 sec.
4.	Drying Time	8 Hours Maximum

(In case bituminous paint application, asked at particular portion of Metal parts other than socket caps the same will be applicable.)

9. The sub-contractor shall satisfy himself first as to the quality of the lot for carrying out the inspection / tests detailed above. Lots shall be offered for inspection to BHEL, along with reports of inspection / tests carried out by the sub-contractor. Lot offered without prior inspection / testing by the sub-contractor shall not be entertained.

10. Prior intimation in advance of atleast one day in case of local parties or one week in case of outstation parties should be given for arranging inspection. All necessary documents like, purchase order and records maintained should be furnished for raising necessary inspection documents.

11. At the time of lot offering for BHEL inspection, internal test reports comprising details like date of galvanising, results of various tests on products and also process parameters mentioned earlier shall be produced to BHEL personnel for verification.

12. Surveillance checks to be carried out at least once in 6 months irrespective of whether supplies have been effected or not, as long as the vendor is on the PMD listing.

13. Rejection
Components not conforming to the above stipulations shall be rejected. However, re-galvanising of the components may be taken up with due approval of BHEL in case of rejection.

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YOGESH SHARMA SENIOR ENGINEER / QUALITY	S RAVIKUMAR SR. DY. GENERAL MANAGER / Q & CI

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Table 3 : GENERAL GALVANISING PROCEDURE IN LINE WITH IS:2629/1985 FOR FERROUS COMPONENTS

STEPS	OPERATION DESCRIPTION
Step – 1	If oil, Grease or paint is/are present on the component surface, cleaning of the components using NaOH solution (Concentration approximately 10 to 15 kg per 100 Liter) or suitable solution may be used. **Note:** In general Components for galvanising are shot blasted and are free from oil, Grease or paint.
Step – 2	**Pickling** – To clean the scale (due to aging after shot blasting) on the metal surface dilute Sulphuric acid to be used followed by water rinse. Then any of the following solution may be used for pickling • Dilute Technical Grade Hydrochloric acid (Concentration 100 to 150 gm/Liter) should be used with suitable inhibitor. • Dilute Technical Grade Sulphuric acid (Concentration approximately 100 to 150 gm/Liter) should be used with suitable inhibitor. This Sulphuric acid solution at elevated temperature (60° C to 80° C) gives better results. Brushing / Scrubbing may be resorted if necessary.
Step – 3	**Rinsing** – After pickling, the component should be rinsed using fresh water (preferably running water)
*Step – 4	**Fluxing** – Any one of the following process may be adopted **Dry process-** Strong solution of Zinc Ammonium Chloride (in general concentration is 200 to 400 gm Zinc Ammonium Chloride per liter) is prepared and some wetting agent also must be added in the flux solution. The components are dipped in the solution. The temperature may be around 80° C. **Wet process-** A deep flux cover is used on the zinc bath. The component immerses through the flux layer with or without prior fluxing.
*Step – 5	**Pre-heating** **Dry process-** Component should be dried on hot mesh or an air oven. Pre-heating of component shall be undertaken by taking care of non-decomposition of flux. **Wet process-** Component drying is not considered essential.

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YOGESH SHARMA SENIOR ENGINEER / QUALTY	S RAVIKUMAR SR. DY. GENERAL MANAGER / Q & CI

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Step – 6	**Galvanising** **Quality of Zinc** – Purity of zinc used for Galvanising should be greater than 99.95 % **Immersion in molten Zinc bath** – Bath temperature may vary from 440^0 C to 460^0 C and the working temperature is 450^0 C. Dross should be allowed to settle at the bottom of the zinc bath and should not disturb more than necessary during dipping operation. The component should be immersed as rapidly as possible. Component will be left in the bath until it reaches the temperature of the bath, which is usually indicated by the stopping of the boiling action. **Withdrawal** – The rate of withdrawal determines the thickness of the unalloyed zinc layer left on the component. The rate of withdrawal should be controlled so that zinc drains freely from the surface. While component withdrawal access zinc removal should be taken care by shaking / vibrating the component. **Water quenching** – After withdrawal, the galvanised component should be immediately dipped into water to allow the coating to set and prevent the components from sticking to each other. Water used in quenching should be clean (preferably running water)
Step – 7	**Post treatment** – To avoid the "white rust" and "wet storage stain" post treatment like Chromating should be done. Chromating solution contains 1% Sodium dichromate and 0.5% sulphuric acid solution. The solution is kept at room temperature and its temperature should never be more than 65^0 C while usage. The galvanised components are dipped into the chromating solution after the galvanising and water quenching operations.

* In place of Fluxing and Preheating processes hot flux solution to be used particularly for socket caps and similar design casting and forging. In this process component after rinsing must be dipped in hot flux solution (Concentration 200 to 400 gm Zinc Ammonium Chloride per liter at Temperature around 80^0 C) for some time and taken out and kept for drying. Dried component to be taken for galvanising.

Prepared by	Approved by
YOGESH SHARMA SENIOR ENGINEER / QUALITY	S RAVIKUMAR SR. DY. GENERAL MANAGER / Q & CI