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COMPANY STANDARDS

TITLE:

SURFACE QUALITY OF
STEEL CASTINGS

AMENDMENT No. 01

DATE : 2007-12-07

STD No. QY1024-C

AMENDMENT SHEET - 1/1

ISSUE No. --

In page 8 of 10, Clause 4.2.1 c) shall be read as follows instead of the existing :

4.2.1 BEML COMPANY STANDARDS :

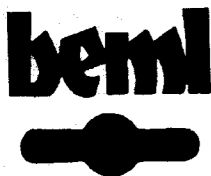
c) PR1029-C .. 'Rust preventive coating for castings and forgings'

APPROVED BY:

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COMPANY STANDARDS

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TITLE: SURFACE QUALITY OF STEEL
CASTINGS

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0. GENERAL INFORMATION :

This standard shall invariably be specified in BEML casting drawings - indicating the grade requirement.

1. SCOPE :

This standard specifies surface quality requirements of steel castings for BEML.

The requirements contained in this standard are applicable to sand castings made of steel grades produced by different moulding practices except shell moulding and investment moulding processes.

The requirements contained in this standard shall not apply where superior surface quality requirements are specified in the applicable documents for specific applications.

2. TERMINOLOGY :

2.1 SURFACE TEXTURE AND DISCONTINUITIES :

2.1.1 EXPANSION DISCONTINUITIES :

2.1.1.1 Veins are raised, narrow, linear ridges that form upon cracking of the sand mold or core due to expansion of sand and the resulting mold or core stresses during filling of the mold with liquid steel.

2.1.1.2 Rat tails are long, narrow, linear depressions or small steps occurring on a casting surface. Rat tails formed as a result of sand expansion and a minor buckling of the mold surface during filling of the mold with liquid metal.

2.1.1.3 A scab is a raised, rough area on a casting that usually consists of a crust of metal covering a layer of sand. Sometimes, a scab consists of a raised, rough area of essentially solid metal on the surface of a casting.

2.1.2 EXTERNAL CHILLS :

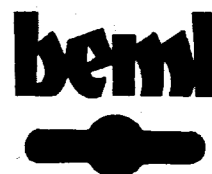
2.1.2.1 External chills are usually metal blocks, or graphite, and carbon blocks that are incorporated into the mold to locally increase the rate of heat

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removal during solidification. Brackets have the same purpose but represent an integral part of the casting. Brackets are produced by providing suitable cavities in the mold or core. External chills may produce flat spots and edges (raised area, or depressions) on the casting surface. Brackets merely change the casting appearance due to their presence. Brackets may be removed or allowed to remain on the casting.

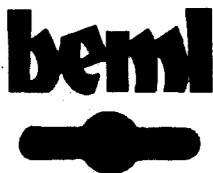
- 2.1.2.2 Parting line and core print fins are thin projections of excess metal at the parting plane between mold halves or core and mold. Causes are improper closing of the mold, insufficient weighting or clamping of the mold for pouring, or uneven pattern surfaces at the matching locations. Core print fins are usually caused by improper dimensions of core prints of the pattern or core box, by rough placement of cores in a soft mold, or by inadequately secured cores.

2.1.3 FUSION DISCONTINUITIES :

- 2.1.3.1 Wrinkles are elongated, smooth depressions of the casting surface, frequently appearing in closely spaced groups. Wrinkles result from irregularities of the liquid metal flow in the mold cavity, frequently associated with low temperature and are distinguished from the more severe phenomenon of laps, folds, or cold shuts where the casting surface is actually folded over.
- 2.1.3.2 Laps, folds and cold shuts are interchangeable terms to describe the appearance of the casting surface that is actually folded over. They develop due to low temperature, unfavourable flow conditions caused by oxide films or combinations thereof.
- 2.1.3.3 Misrun denotes an incompletely formed casting, due to only partial filling of the mold cavity when the liquid metal solidifies prematurely. The resulting casting appearance is characterised by rounded edges for a mild degree of misrun. Irregular, malformed edges of more severe misruns, and not fully formed castings, are characteristic. Frequently, misruns are associated with such discontinuities as wrinkles or laps and folds, or both.

2.1.4 GAS POROSITY :

Gas porosity is a concave discontinuity in castings due to the evolution of gas, either from the solidifying metal, or the surrounding mold.



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2.1.5 INSERTS :

2.1.5.1 Chaplets are metallic (steel) devices used to maintain the spacing between the core and the mold. Low liquid metal temperature and unfavourable flow conditions in the mold may produce insufficient fusion and cause irregular contact areas on the casting surface.

2.1.5.2 Internal chills are metallic (steel) devices used to locally increase the rate of heat removal during solidification. Incomplete fusion due to low liquid steel temperatures and prevailing flow conditions may produce irregularities of the surface similar to those which may be associated with chaplets.

2.1.6 LINEAR DISCONTINUITIES :

Elongated discontinuities are considered linear if their length equals or exceeds three times the width.

2.1.6.1 Cracks :

Cold and hot cracks are less jagged, sometimes straight ruptures that occur after solidification of the casting, due to excessive strain. Sometimes cracks are referred to as cold, hot, or heat-treat cracks to indicate the condition of the castings, or the operation during which the cracks occur.

2.1.6.2 Hot tears :

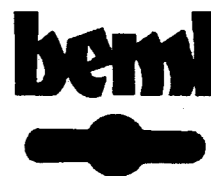
Hot tears or jagged ruptures in castings that occur during the final stages of solidification, while there is still some liquid in interdendritic spaces, or shortly after solidification is complete.

2.1.7 METAL REMOVAL MARKS :

Flame cutting and air carbon-arc cutting produce parallel grooves in the cut-off area. Finer marks are produced with the abrasive cut-off wheel, and grinding.

2.1.8 NONMETALLIC INCLUSIONS :

casting surface inclusions such as ceroxides, slag, and are partially or completely removed during the cleaning process of pressure blasting. Surface discontinuities left by these inclusions



are referred to by the inclusion type that caused their formation.

2.1.8.1 Ceroxides cause depressions on the surface of the casting by displacement of molten metal. Ceroxides consist of a mixture of low-melting oxides and partially fused sand. The crater-like appearance of the casting surface depression is typical.

2.1.8.2 Depressions on the casting surface caused by slag are similar to those caused by ceroxides. They differ by a more rounded appearance of the depression, and do not exhibit the crater-like appearance of ceroxides.

2.1.8.3 Depressions caused by sand are similar to those of ceroxides and slag. Their appearance may, at times, more closely reflect the granular nature of the sand.

2.1.9 SHRINKAGE UNDER RISERS & GATES AND REVEALED BY MACHINING:

A shrinkage void is a discontinuity in castings due to the lack of available liquid feed metal during solidification contraction. Riser removal and machining may reveal shrinkage that extends from the interior of the casting to the near surface area.

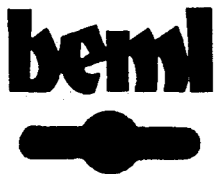
2.1.10 SURFACE TEXTURE :

Cast surfaces have a multi-directional lay, without the uniform sequence of ridges and valleys of machined surfaces.

2.1.11 WELDING :

2.1.11.1 Weld undercuts are narrow elongated depressions which border the weld contour and result from improper welding conditions or inadequate control of welding operations.

2.1.11.2 Weld spatter represents weld metal droplets which solidified against, and adhere to the component being welded.



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3. ACCEPTANCE NORMS :

3.1 SURFACE FINISH :

3.1.1 SURFACE UNEVENNESS - CAST SURFACES :

PERMISSIBLE SURFACE UNEVENNESSS, MICROMETRE, MAX.

UNIT WEIGHT OF CASTING, kg	GRADE A	GRADE B	GRADE C
UPTO 50	100	200	-
51 to 200	140	400	-
OVER 201	200	600	-

NOTE : The surface unevenness of castings shall be evaluated with the help of straight edges and templates to suit the surface profiles. The unevenness values shall be reported along with factors causing the unevenness.

3.1.2 SURFACE ROUGHNESS - CAST SURFACES (Ra Value) :

Grade	Ra Value, max. micrometre	Sampling length mm
A	50	8.0
B	100	8.0
C	300	25.0

3.1.3 SURFACE ROUGHNESS AFTER BLAST CLEANING :

Grade	Ra Value, max. micrometre	Sampling length mm
A	12.5	2.5
B	25	2.5
C	25	2.5

NOTE : The unit of measurement for surface roughness shall be the arithmetical mean deviation (Ra). This shall be evaluated by instrumental methods (e.g. Profilometer etc.) or by comparison with reference specimens.

3.1.4 MACHINED SURFACES :

Surface roughness of machined surfaces shall conform to the requirements specified in the applicable drawing.



3.2 RISER AND GATE PROJECTIONS :

Castings shall have gates and risers removed to maintain the design contour and to conform to the limitations as given in the table below :

RISER/GATE DIMENSION Diameter (mm)	MAXIMUM PROJECTION mm	MAXIMUM DEPRESSION mm
0 - 100	1.5	1.0
101 - 250	3.0	2.0
251 - 500	6.0	4.0
Over 500	9.0	6.0

3.3 DISCONTINUITIES :

3.3.1 NOT PERMISSIBLE TO ANY DEGREE :

A) Linear discontinuities : Cracks and hot tears

B) Shrinkage cavities

C) Surface grooves : Orange peel, sand erosion,
flow marks

D) Stress raisers and notches due to weld repairs

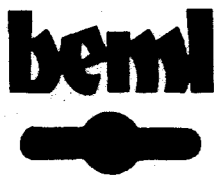
These discontinuities, if present, shall be eliminated before despatch of castings by the supplier.

3.3.2 PERMISSIBLE DISCONTINUITIES :

These shall conform to the limits specified in the following table :

DISCONTINUITY	GRADE A	GRADE B	GRADE C
Pin hole	Max. depth 2 mm	Max. depth 5 mm or 1/5th of wall thickness, whichever is less	Max. depth 6 mm or 1/4th of wall thickness, whichever is less
Blow hole	Less than 2 mm dia. Max. 2 nos. in a circle of 5 cm. dia. Spacing between discontinuities shall be 15 mm min.	Less than 3 mm dia. Max. 3 nos. in a circle of 5 cm. dia. Spacing between discontinuities shall be 15 mm. min.	Less than 3 mm dia.; Max. 5 nos. in a circle of 5 cm dia. ED (cumulative dia.) not to exceed 18 mm dia (See Note 1). Over 6 mm not allowed. Spacing between discontinuities shall be 15 mm minimum.

Contd...



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DISCONTINUITY	GRADE A	GRADE B	GRADE C
Sand & Slag inclusion	Upto 2 mm dia. max.	Upto 3 mm dia. permissible when unit weight is less than 500 kg. 3-6 mm - max. 1 no. in a circle of 5 cm dia. when unit weight is over 500 kg. Over 6mm dia - not permissible	Upto 6 mm dia. permissible when unit weight is less than 500 kg. 6-10 mm - max. 1 no. in a circle of 5 cm dia, when unit weight is over 500 kg. Over 10 mm dia - not permissible

Fusion discontinuities (Wrinkles, laps/folds/cold shuts, misruns) <----- Stress raisers and notches shall be removed ----->

(Wrinkles, laps/folds/ cold shuts, misruns	Spacing of defects : 50 mm minimum		Spacing of defects : 30 mm minimum		Spacing of defects : 10 mm minimum	
	<u>Main dimen- sion of casting (mm)</u>	<u>Max. length of defect</u>	<u>Main dimen- sion of casting (mm)</u>	<u>Max. length of defect</u>	<u>Main dimen- sion of casting (mm)</u>	<u>Max. length of defect</u>
	upto 500	1/15 of main dim.	upto 500	1/10 of main dim.	upto 500	1/7 of main dim.
	501 to 1500	1/13 of main dim.	501 to 1500	1/8 of main dim.	501 to 1500	1/5 of main dim.
	over 1500	1/10 of main dim.	over 1500	1/5 of main dim.	over 1500	1/3 of main dim.

Expansion discontinuities (Scabs, rat tails, veins etc. misruns)

<-- Not permitted -->

Unit weight of casting,kg	Max. size of defect	Unit weight of casting,kg	Max. size of defect
Upto 50	None permitted	Upto 100	Dia 15 mm max 2 nos. in a circle of 10 cm dia.
over 50	Dia 15mm 1 no. in a circle of 10 cm dia.	over 100	Dia 15mm max. 3 nos.in a circle of 10 cm dia.
Defect size over 15 mm in dia. not permissible		Upto 100	Over Dia 15 mm not permissible
		over 100	15 to 30 mm - Max 1 in a circle of 10 cm dia.
			over 30 mm dia. defects not permissible

Contd....



DISCONTINUITY	GRADE A	GRADE B	GRADE C
External chills & parting line and core print fins	<-----Not permissible----->		
Inserts (chaplets & internal chills)	1) Not to be visible on surface 2) should not cause leakage	Permissible, should not cause leakage	Permissible

Note : 1) ED indicates the total of diameters of discontinuities when discontinuities of different sizes exist together.

2) See sketches to illustrate discontinuities in Annexure.

4. GENERAL REQUIREMENTS :

4.1 Castings shall be inspected by the supplier.

Surface discontinuities not permissible (as detailed above) shall be eliminated.

Castings shall be heat treated as specified in the applicable documents.

Castings shall be blast cleaned.

The blast cleaning shall be such as to remove all rust and scale (casting scale and heat treatment scale), and provide the surface finish specified.

The castings after blast cleaning shall be provided with rust (corrosion) preventive coating as per Company Standard PR1029-C.

4.2 CONNECTED STANDARDS :

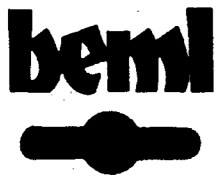
4.2.1 BEML COMPANY STANDARDS :

- a) QY 1025-C .. Surface Quality of S.G & Gray Iron Castings
- b) QY 1018-C .. Ferrous Castings - Classification & Acceptance norms
- c) PR 1029-B .. Rust Preventive Coatings for Castings & Forgings

4.2.2 NATIONAL/INTERNATIONAL STANDARDS :

IS:4290 (Parts 2&3)-1992/ISO:2632 (Parts 2&3)-
Roughness Comparison Specimens

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ANNEXURE

REFERENCE RELATING TO LIMITS OF DEFECTS

DEFECTS \ GRADE	A	B	C
SAND INCLUSION			
SLAG INCLUSION			
BLOW HOLE			
PIN HOLE (DEPTH)			NOT SPECIFIED PARTICULARLY

FIGURE- 1

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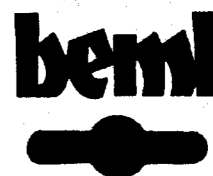
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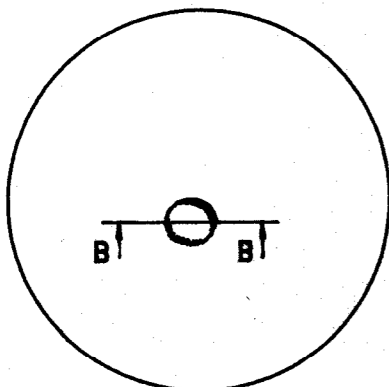
ANNEXURE

SCAB

GRADE B



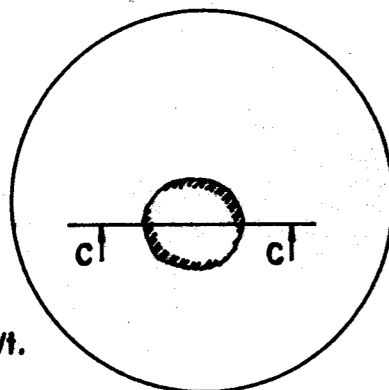
SECTION BB



GRADE C

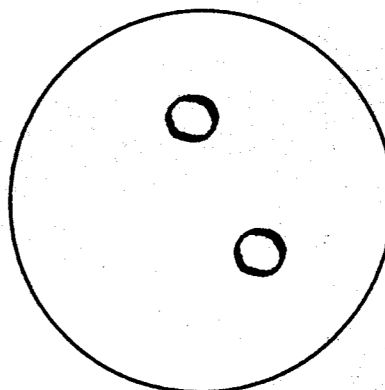


SECTION CC



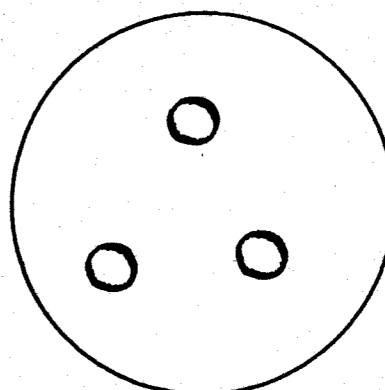
(100 Kg IN UNIT Wt.
AND OVER)

GRADE C



(LESS THAN
100 Kg IN
UNIT Wt.)

GRADE C



(100 Kg IN
UNIT Wt.
AND OVER)

FIGURE. 2

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