

**PURPOSE**

To specify the requirements for classification, drawing callouts, checks, test methods and defect allowances for as-cast or machined Al or Mg light alloy castings.

**NOTE:** For cylinder head and head covers of light aluminum alloy obtained by the LOST FOAM (Policast) process, see P.S. 9.02268/01.

This Specification consists of 14 pages and 1 Annex

Edition 6 Ch. A Code CMD -

Change	Date	Description
-	07/11/00	Edition 6 – Completely revised. (DA)
A	07/27/00	Edition 6 – § 5.4.1 modified. (DA)

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**| § "A" : TEST EQUIPMENT**

**NOTE:** Equipment required is as specified in the Standards listed in § "B" below.

**| § "B" : REFERENCES**

00160	Service Classes – Assignment of service classes to motor vehicle components.
01370	Surface texture – Summary. TFO
50106	Tests of metallic material – Brinnell hardness test. TMD
50113	Tension testing – General purpose tests. TMD
50161	Non–destructive tests – Radiographic examination – Defect classification – Callouts on drawing – Methodology – Equipment – Personnel. TMD
50320	Requirements for nonferrous metals – Tensile test specimens for castings – Separately cast specimens. TMD
0.00013	Date of manufacture marking. NPR
1.00040	Contaminants – Deterioration in production of amount and size of contaminant in engines and transmissions. NPR
9.01102	Quality of supplies. CFO
9.01102/01	Supply inspection requirements.
9.01103	Product quality and conformity certificate. CFO
ASTM E 155	Reference Radiographs for inspection of Aluminum and Magnesium Castings.
ASTM E 505	Reference Radiographs for inspection of Aluminum and Magnesium Die Castings.

**| § "C" : ANNEXES**

	1	Specifications Data Sheet
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1

**GENERAL**

1.1

**Scope**

1.1.1

This Specification covers sand, gravity or pressure die cast aluminum and magnesium light alloy castings in as-supplied or machined condition.

1.2

**Field of application**

1.2.1

This P.S. applicable in full to production castings as used on vehicles unless otherwise indicated on drawings, on specific part standards, on Specification Cards or by agreement at time of order. It does not apply to prototype castings.

1.3

**Service classification**

1.3.1

Castings are divided into the following service classes in accordance with P.S. 9.01102:

- Service class 1 (SC1): Safety – related castings, the relation becoming applicable only in particular and exceptional cases in which given concomitant conditions occur.
- Service class 2 (SC2): Castings considered to be of major importance from the service, image and/or expensive replaceability standpoints.
- Service class 3 (SC3): All other castings.

2

**DRAWING CALLOUT**

2.1

**Mandatory requirements**

2.1.1

Reference to this Specification.

2.1.2

Service classes 1 or 2 or 3 (see para 1.3 and Std. 00160).

2.1.3

Code and condition of material and Standard number.


2.1.4

Marking details (relief, bas-relief, etc.)

**2.2****Other requirements (if applicable)****2.2.1**

Coating and associated reference standard.

**2.2.2**

Identification, by symbol  of area from which the cut-up tensile specimen is to be taken.

**2.2.3**

Identification of critical areas. If not indicated on drawing, all fillets, grooves and areas with abrupt geometrical changes are to be considered critical.

**2.2.4**

Definition of defect levels allowed for tests specified in §§ 4.1, 4.11 and 4.12 of this Procurement Specification, should they differ from those normally specified.

**2.2.5**

Pneumatic and/or hydraulic leakage test (class 1 and 2 castings only), unless otherwise specified on drawing, shall be carried out on casting after machining. Test data and acceptance conditions shall be shown on drawing or appropriate Standards.

**3****PRODUCT QUALIFICATION REQUIREMENTS****3.1**

Subject component to the inspections and tests specified in the paragraphs below. Check results for compliance with requirements in annexed Specifications Data Sheet.

**3.2****Test environment** (unless otherwise specified)

Temperature :	23 ± 5 °C
Atmospheric pressure :	860 to 1060 mbar
Relative humidity :	45 to 70 %

**4****REQUIREMENTS****4.1****Visual inspection****4.1.1**

Castings shall be submitted for inspection after deburring and cleaning. Inspection shall be carried out in an area having a minimum light intensity of 100 lux.

**4.1.2**

**Acceptance limits (▲)**

(▲) Components contemplated by Specific Standard, drawing or acceptance standard agreed upon Supplier are excluded.

**Unmachined surfaces**

Shall be smooth, without breakages, cracks, or any other defect impairing the use of component and/or subsequent machining.

Surface discontinuities, typical of sand or die casting at a minimum distance to each other of 10 mm, according to what specified in Table 1, are allowed.

**TABLE 1**  
PRESSURE DIE CAST OR SAND CASTINGS OF Al AND Mg LIGHT ALLOY

<b>ALLOWED DEFECTS DIMENSION</b>			
<b>SERVICE CLASS</b>	<b>CASTING THICKNESS (mm)</b>		
	< 10	10 to 20	> 20
1	< 1 mm	< 2 mm	< 2.5 mm
2 and 3	< 2 mm	< 3 mm	< 3.5 mm

In addition are allowed:

- a) not sharpened burrs and misalignments due to the die/mould parts joints not higher than 2 mm.
- b) burrs due to local cracks of die/mould not higher than 1 mm.

**Machined surfaces**

Isolated defects (gas cavities, shrinkage cavities, inclusions) lower than those indicated in Tables 2 and 3 are allowed.

These defects must be one for each 100 mm<sup>2</sup> of machined surface or two, but having half dimension, in the same surface of 100 mm<sup>2</sup>.

**TABLE 2**  
DIE CAST OR SAND CASTINGS OF Al AND Mg LIGHT ALLOY

<b>ALLOWED DEFECTS DIMENSION</b>			
<b>SERVICE CLASS</b>	<b>CASTING THICKNESS (mm)</b>		
	< 10	10 to 20	> 20
1	< 1 mm	< 2 mm	< 2.5 mm
2 and 3	< 2 mm	< 3 mm	< 3.5 mm

**TABLE 3**  
Al AND Mg ALLOY PRESSURE CASTING

<b>ALLOWED DEFECTS DIMENSION</b>		
<b>SERVICE CLASS</b>	<b>CASTING THICKNESS (mm)</b>	
	≤ 5	5 to 10
1	< 1 mm	< 1.5 mm
2 and 3	< 1.5 mm	< 3 mm

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Diffused porosity, evenly distributed, shall be evaluated by radiographic/radioscopic examination. Isolated pores on castings complying with requirements of x-ray/radioscopic examination are allowed.

## 4.2

### Marking

#### 4.2.1

Shall be as per drawing, easily legible, positioned so as not be removable by subsequent machining, and shall consist of:

- Drawing number of part.
- Identification number of die and impression.
- Date of manufacture (method A, B or C as per Std. 0.00013) where possible and for Service Classes 1 and 2 castings only.
- Producer's trade mark.

## 4.3

### Dimensions and tolerances

#### 4.3.1

Dimensions shall be checked against drawings and/or applicable Standards. Contours, fillets and internal dimensions not measurable on whole casting shall be taken after suitably sectioning of the component.

## 4.4

### Surface roughness

#### 4.4.1

As per applicable drawing or applicable Standard.

## 4.5

### Hand grinding roughness

#### 4.5.1

Ra 16  $\mu\text{m}$  as per Std. 01370.

## 4.6

### Mass

#### 4.6.1

Weight of unmachined casting shall be agreed upon between Supplier and Purchaser, using one of the following methods:

- a) Mathematical calculation on the basis of dimensions and tolerances indicated on drawing, density indicated in Material Standard and any machining stock and technical requirements concerning molding.
- b) Average weight of 10 qualified parts.

A tolerance of  $\pm 5\%$  is admitted for weight thus calculated.

**4.7**

**Chemical composition**

**4.7.1**

As per Standard cross referenced on drawing.

**4.8**

**Hardness**

**4.8.1**

Shall be tested on the surface after grinding off skin as per Std. 50106 in areas where casting function will not be jeopardized. Measured hardness shall conform to requirements of Standard cited on drawing.

For Mg alloy castings this hardness value is indicative only.

**4.9**

**Tensile strength of cut-up specimens**

**4.9.1**

Test specimens shall be taken from area designated on drawing and/or agreed upon with Supplier at time of order. Test method as per Std. 50113.

Tensile strength shall conform to requirements of Standard called-out on drawing.

**4.10**

**Tensile strength on separately cast specimen**

**4.10.1**

Test shall be performed on specimens cast separately as per Std. 50320. The number of specimens to be supplied for each lot shall be agreed at time of order.

Tensile strength shall conform to requirements of Standard called out on drawing.

**4.11**

**Surface integrity**

**4.11.1**

**Acceptance limits**

**4.11.1.1**

As per applicable drawing or, if not specified, as per Table 4.

**TABLE 4**

**ACCEPTANCE LIMITS FOR SURFACE INTEGRITY CHECKS**

<b>Defects</b>	<b>Service Class 1</b>	<b>Service Class 2</b>	<b>Service Class 3</b>
Linear indications (■)	Not allowed		
Non-concentrated, non-linear indications (■)	Excess mat. indications allowed and, in any case, if acceptable upon radiographic inspection	Permissible if defect is acceptable upon radiographic inspection	

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**ACCEPTANCE LIMITS FOR SURFACE INTEGRITY CHECKS**

Defects	Service Class 1	Service Class 2	Service Class 3
Single–non–linear indications (■)	Permissible if defect cannot be detected upon visual inspection	Acceptable if defect is not prejudicial to correct use of part	

(■) By linear indication is meant a defect where length of indication to width of indication ratio is  $\geq 5$  mm.

**4.12**

**Radiographic inspection**

**4.12.1**

**Procedure**

**4.12.1.1**

Subject component to the inspections as per Std. 50161.

**4.12.2**

**Acceptance limits**

**4.12.2.1**

As per drawing, or if not specified, as per Table 5.

**TABLE 5**

**ACCEPTANCE LIMITS FOR RADIOGRAPHIC INSPECTION**

Service Class 1		Service Class 2		Service Class 3	
Critical areas	Other areas	Critical areas	Other areas	Critical areas	Other areas
Level A or better	Level B or better	Level B or better	Level C or better	Level C or better	Level D or better

- Level are identified by specimen radiographs in the following Standards:
  - ASTM E 155 Series II for sand or mold gravity cast Al alloy – see Table 6;
  - ASTM E 505 for pressure die cast Al and Mg alloys – see Table 7;
  - ASTM E 155 Series II for Mg alloy sand–gravity castings – see Table 8;
- Castings shall be rated as “Not acceptable” when two or more types of defect closes to the maximum tolerance are present at the same time.

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**TABLE 6**

**ACCEPTANCE LIMITS FOR SAND OR MOLD GRAVITY CAST AI ALLOY PARTS**

Defect	Level A		Level B		Level C		Level D	
	Radiographic thickness (mm)							
	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10
Gas cavity	1	2	2	3	3	4	4	5
Round porosity	2	2	2	3	4	4	5	6
Elongated porosity	2	2	2	3	3	4	4	4
Shrinkage cavity	1	1	2	2	3	3	4	4
Sponginess	2	2	2	2	2	3	5	5
Low density inclusions	1	2	2	3	4	4	5	5
High density inclusions	1	1	2	2	3	3	4	4

**TABLE 7**

**ACCEPTANCE LIMITS FOR PRESSURE DIE CAST AI AND Ng ALLOY PARTS**

Defect	Level A		Level B		Level C		Level D	
	Radiographic thickness (mm)							
	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10
Porosity	2	2	2	3	3	3	3	3
Cold laps	None		1		2		2	
Shrinkage cavity	1		2		2		3	
High density foreign material inclusions	None		None		Less than ASTM E 505 sample sheet		Less than ASTM E 505 sample sheet	

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TABLE 8

ACCEPTANCE LIMITS FOR Mg ALLOY  
SAND – GRAVITY CASTINGS

Defect	Level A		Level B		Level C		Level D	
	Radiographic thickness (mm)							
	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10	< 10	≥ 10
Gas cavity	1	2	2	3	2	3	4	4
Segregation	2	2	2	3	3	3	4	4
Feathery microshrinkage	2	2	2	3	2	3	4	4
Sponge microshrinkage	1	1	2	2	2	3	4	4
Less dense inclusions	1	2	2	3	3	3	5	5
More dense inclusions	1	1	2	2	3	3	4	4
Two-dimensional defects	None							

**4.13****Pneumatic and/or hydraulic leakage test****4.13.1**

As per applicable drawing or Standard.

**4.14****Coatings****4.14.1**

Properties of any coatings shall be as per Standard referred to in applicable drawing.

**4.15****Cleanliness check** (Engine and transmission components only)**4.15.1**

Check component cleanliness to be as per Std 1.00040.

**4.16****Supplementary checks****4.16.1**

Supplementary tests not considered in this Procurement Specification may be established upon request and agreement between the contracting Parties.

5

**PRODUCTION CYCLE REQUIREMENTS**

5.1

**Shakeout**

5.1.1

Al alloy castings shall be allowed to cool in their molds. Mg alloy castings shall be shaken out when temperature is 120 to 150°C to avoid grain growth.

5.2

**Removal of risers, heads and runners**

5.2.1

Castings shall be submitted for inspection after cleaning and deburring. Removal of risers, heads and runners shall be done in such a way as not to damage the part. If such removal is sufficiently difficult to require the use of machines, this operation shall be agreed upon between Supplier and Purchaser.

5.3

**Scarfig**

5.3.1

Any unacceptable surface defects shall be removed by filling, hand grinding or milling. Repaired area shall then be blended so as not to leave sharp corners, after which test described in §§ 4.1 and 4.11 shall be repeated. Component shall be considered acceptable on condition that:

- defect has been completely removed;
- dimensions of repaired area are within tolerances specified on drawing.

5.4

**Repairs**

5.4.1

**Castings**

5.4.1.1

Repairs by welding, partial sealing or impregnation shall be permissible unless otherwise indicated on drawing, or associated Standard.

In case such activities are carried out, repair execution, check procedures and acceptance limits will be agreed; for what concerns the impregnation, Supplier shall communicate the commercial name of the resin to be used. If the impregnation process is carried out at room temperature with meta-acrylic resins, it is sufficient to validate the component by the repetition of leakage test of § 4.13 of this P.S.

In case of use of materials and/or cycles different it is necessary to agree further checks on finished product.

## 5.4.2

### Cylinder heads and head covers

#### 5.4.2.1

##### Repair by welding

##### 5.4.2.1.1

Not allowed in critical areas (see § 5.4.2.1.2). In other areas, two repair welds for component are allowed (unless otherwise specified on drawings) on condition that the max. area of each weld does not exceed 200 mm<sup>2</sup>.

Repairs by welding on heat treated castings shall be made prior to heat treatment.

##### 5.4.2.1.2

##### Critical areas

- 1) cylinder head:
  - combustion chambers (spark plug seat(s) included)
  - valve seats
  - intake and exhaust ducts
  - valve tappet seats
  - camshaft journal bearing supports
  - abutment faces:
    - cylinder head to crankcase, in annular area 5 mm around combustion chambers
    - intake and exhaust manifolds, in annular area 5 mm around ducts
    - rocker cover or cylinder head cover in gasket area (✱)
    - thermostat mounting flange, in gasket area
- 2) cylinder head cover:
  - valve tappet seats
  - camshaft journal supports
  - cylinder head to rocked cover faying faces.

(✱) Repairs by welding are allowed in seating surface of non-formed gaskets intended for subsequent shop processing.

##### 5.4.2.1.3

##### Weld procedure and inspection.

Blend the area to be repaired avoiding abrupt sharp profile changes, at the same time being careful to remove the defect in full.

At the end of the repair, excess weld material shall be removed and the component submitted to dimensional checking (see § 4.3), visual inspection (§ 4.1) and pneumatic leakage test (§ 4.13).

Welds shall be first quality, without any defects such as cracks, gas occlusions, oxidation, shrinkage and in any case without defects prejudicial to the strength and/or leak tightness properties of the casting.

**6**

**REQUIREMENTS FOR SUPPLY INSPECTION**

(to be carried out Plant Quality Depts)

Supply inspection shall be carried out according to P.S. 9.01102/01 (Restricted distribution).

**7**

**SUPPLIER REQUIREMENTS**

The Supplier shall comply with the general requirements contained in P.S. 9.01102 "QUALITY OF SUPPLIES".

**7.1**

**Product Qualification Supplies**

The Supplier shall submit the amount of product specified in the purchase order and attach the Quality and Conformity Certificate (see P.S. 9.01103); all characteristics specified on the annexed Specifications Data Sheet shall be checked. "Non-conforming" supplies are not permissible.

**7.2**

**Product supplies**

The supplied product shall conform with drawing and this Specification. When establishing the manufacturing process to be adopted and severity of inspections, the Supplier shall take into account the classes of importance that FIAT has assigned to each of the characteristics to which requirements refer (see § 8).

**NOTE:** Checks may be performed on components which have been subjected to non-destructive test (indicated with NM in § 8) during product qualification and supply inspection. Components which have been subjected to destructive tests (M) may not be used for further test or inspections unless otherwise specified case by case.

**8**




**CLASSIFICATION OF CHARACTERISTIC S**

CHARACTERISTICS (O)	CHARACTERISTICS OF SERVICE CLASS			TYPE OF TEST
	Service Class 1	Service Class 2	Service Class 3	
Visual inspection	I.C.Q. = 0 [1] [2]	Major	Major	NM
Marking	I.C.Q. = 0			NM
Dimension and tolerances	As per P.S. 9.01102 unless otherwise specified on drawing			NM
Surface roughness				NM




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CHARACTERISTICS (○)	CHARACTERISTICS OF SERVICE CLASS			TYPE OF TEST	
	Service Class 1	Service Class 2	Service Class 3		
Hand-grinding roughness	Minor	Minor	Minor	NM	
Mass	Minor	Minor	Minor	NM	
Chemical composition	Major	Minor	Minor	M	
Hardness (Al alloys only)	Major	Major	Minor	NM	
Tensile strength on cut-up specimens	R	Major	Minor	Minor	M
	Rs				
	A				
Tensile strength on separately cast specimens	R	On agreed specimens			NM
	Rs				
	A				
Surface integrity	I.C.Q. = 0  	Major	Minor	NM	
Radiographic inspection	Minor	Minor	Minor	NM	
Hydraulic and/or pneumatic leakage test (see § 4.13)	100%	100%	–	NM	
Coatings	As per Standard called out on drawing				
Cleanliness check 	Major	Major	Major	NM	

(○) For any other characteristic checks, classes of importance shall be indicated on drawing or Standards.

-  I.C.Q. = 0 means that all the supplied parts shall meet the compliance requirements (see P.S. 9.01102). This can be achieved by either ensuring the stability and accuracy of the production process or by making product surveillance more severe up to a 100% inspection. Whenever the Departments concerned deem 100% inspection necessary, this shall be specified on drawing.
-  The Supplier shall record the results of this test on "Quality Certificate" for each lot.
-  For engine and transmission components only.

CHARACTERISTICS		TEST CONDITIONS	REQUIREMENTS OR EVALUATIONS	Code
Visual inspection		§ 4.1.1	§ 4.1.2	-
Marking		§ 4.2	§ 4.2	-
Dimensions and tolerances		§ 4.3	§ 4.3	Ch.
Surface roughness		§ 4.4	§ 4.4	6
Hand – grinding roughness		Std. 01370	Ra 16 µm	Edition
Mass		§ 4.6	as per dwg. with tolerance ± 5%	
Chemical composition		§ 4.7	as per Std. called out on applicable drawing	
Surface hardness (●)		§ 4.8 and Std. 50106	as per Std. called out on applicable drawing	
Tensile strength	on cut – up specimen	§ 4.9 and Std. 50113	as per Std. called out on applicable drawing	
	on separately cast specimen	§ 4.10 and Std. 50320	as per Std. called out on applicable drawing	
Surface integrity		–	§ 4.11.1	
Radiographic inspection		Std. 50161	§ 4.12.2	
Pneumatic and/or hydraulic leakage test		§ 4.13	as per Dwg. and/or specific standards	
Coatings		– –	as per Std. called out on applicable drawing	
Cleanliness check (■)		Std. 1.00040	as per Std. 1.00040	

- (●) For Mg alloy casting the determination is indicative.
- (■) For engine and transmission components only.

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