**STATEMENT OF REQUIREMENTS General Motors Powertrain HOUSING ASM-CM/SHF**

**LZ0**

### SOR Appendix C

Technical Specifications

# ***LZ0***

# January 11th, 2024

Action Plan Number #

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**Appendix C**

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Section** | **Revision History Comments** |
| 001 | 14JAN2020 |  | Initial Release made from old format rev002 09MAY2016. Appendix G3 updated for validation and line scrap limits removed. |
| 002 | 15DEC2020 | 12.1.4 | HCF and LCF requirements removed. % Porosity remains to ensure fatigue values are typical as used by SIM. |
| 003 | 15FEB2021 | 12.3.3.1.1.1 | Sustainable Material Section Added |
| 004 | 20APR2021 | 12.3.3.1.1.1 | Sustainable material section removed b/c it is in appendix F9. |
| 005 | 15FEB2022 | 11.0 | See Appendix G4 for analytical requirements. Section 11 is reference only. |
| 006 | 27APR2022 | 1.3 and 14 | Introduced appendix M7 for exceptions and added PPQP measurement requirements |
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**LZ0 HOUSING ASM-CM/SHF**

**Engineering Requirements**

**1.0 INTRODUCTION:**

**1.1. Document Purpose:**

The purpose of this document is to provide prospective suppliers with information from which to assemble and offer to General Motors a competitive quote to supply parts as described herein.

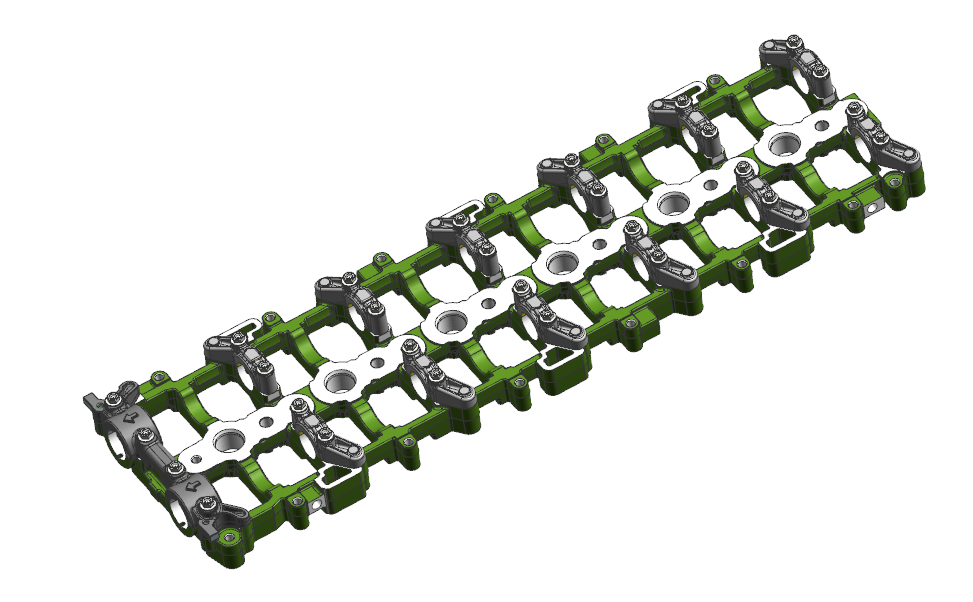
**1.2. Scope of Document:**

This document has been prepared for the 2028 model year aluminum cylinder head program. A unique HOUSING ASM-CM/SHF is required for this program. This program is new for these model years. The supplier must cast the housing, perform the pre-machine and assemble with pins and bearing caps (note: the bearing caps are not involved in the sourcing)

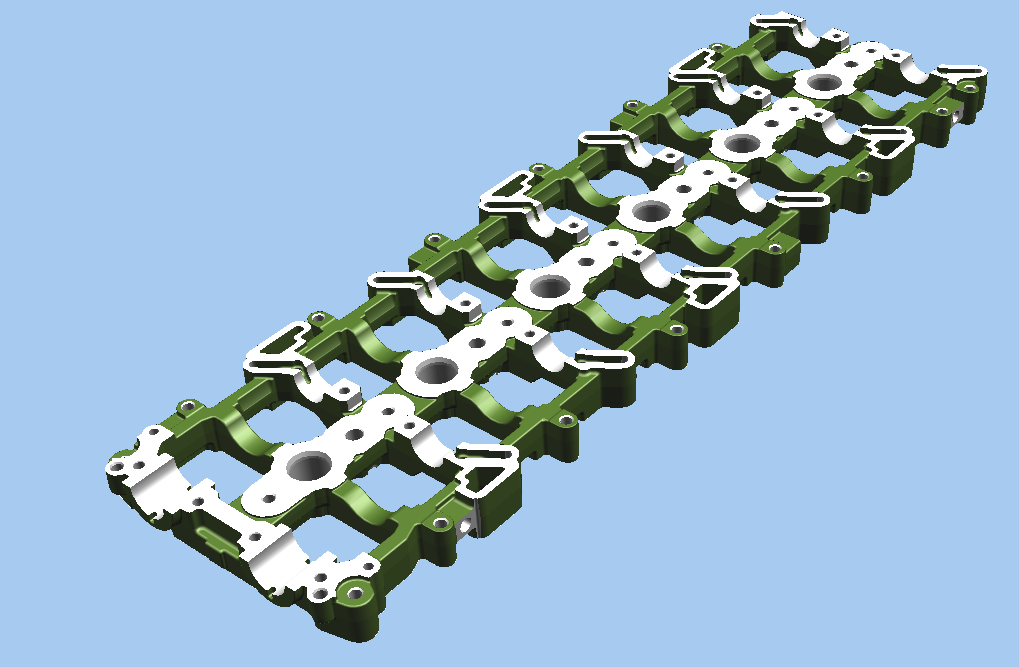
**1.3 Deviations and Exceptions to this Document via Appendix M7**

Suppliers requesting deviations/exceptions to this document are to list them in Appendix M7. GM will review M7 and either approve or reject as denoted in the M7. This SOR appendix C will not be updated to reflect those deviations. Thus, to fully understand the content and specifications sourced, both this SOR appendix C document and the M7 are needed.

HOUSING ASM-CM/SHF – PN 40009546



CARRIER ASM-CM/SHF (MCHG) - PN 40009545



**2.0 ASSEMBLY / COMPONENT CONTENT:**

**2.1.1 Purpose:**

The HOUSING ASM-CM/SHF is to be assembled to an aluminum overhead cylinder head and provide a durable bearing surface for the camshafts during engine operation. The primary function of the HOUSING ASM-CM/SHF is to support the camshaft and in the case of the thrust cap, to restrict the axial movement of the camshaft. The HOUSING ASM-CM/SHF will be used to transfer oil to cam bearing caps.

Critical characteristics of the HOUSING ASM-CM/SHF include mechanical properties, fatigue strength, heat transfer, pressure tightness, and dimensional accuracy.

The components of the HOUSING ASM-CM/SHF will be cast using a process approved by GMPT. Subsequent to the casting process, the HOUSING ASM-CM/SHF will be cleaned, visually inspected for defects, partially machined, and leak tested.

Partial machining will include all machining on the HOUSING ASM-CM/SHF and components except for the final machining pass on the cam bore inside diameters, fuel pump bore, cam thrust face surfaces, and front face T-Joint surface. The final machining of the cam bore inside diameters must be done after the HOUSING ASM-CM/SHF is installed on the cylinder head at the GMPT machining plant.

**Component Content:**

For purposes of calculating cost, the HOUSING ASM-CM/SHF will weigh approximately 3.06 kg.

##### The camshaft bearing caps and housing are to be cast from aluminum alloy meeting AA 383 per GMW5M-AL-C-D-Si10Cu2Fe1-F. Alternate alloys may be chosen by the supplier with agreement from GM Powertrain Product and Materials Engineering. Exact chemistry and microstructure specifications shall be included with the proposal. Bearing cap properties include strength, density, wear resistance, compatibility with bearing material, and machinability.

**Mechanical Properties:**

Mechanical properties per GMN7152 – Class 3:

3 point break test 40 kN (Minimum)

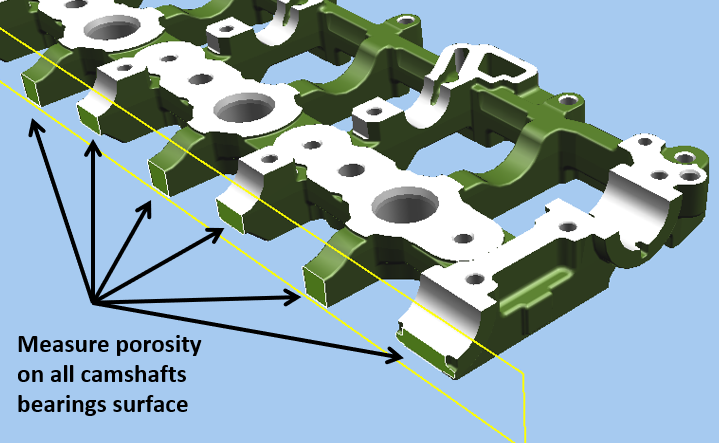
Test conditions: Room Temperature ~ 20oC

Brinell Hardness: 80 HBW 10/500 Min.

Sampling Plan / Frequency: 1/week or 1/5000 (whichever provides greatest sample size /week)

Microstructure Specifications:

Porosity: (30 Frames @ 50X) 1.5% Max.



Material properties from parts produced in production intent process and production intent alloy shall be provided to GM Materials Engineer for approval. See GMW5.

Please refer to section 12.1.4 (Testing and Validation Requirements) for material testing specifications.

**2.3.1 Part Numbers for HOUSING ASM-CM/SHF LZ0:**

The part numbers to be used for this part is 40009546.

The upper cam caps, bolts and dowels will be included in the housing assembly. Bolts for fastening the housing to the cylinder head are to com POA as part of the housing assemblies.

The supplier must make the CARRIER ASM-CM/SHF (Machining) and assemble the HOUSING ASM-CM/SHF (Assembly)

The part numbers to be used for the rear cam cap, intermediate cam caps and pin/dowels are shown below.

HOUSING ASM CM-SHF – PN 40009546 (Parts shown on Drawing)

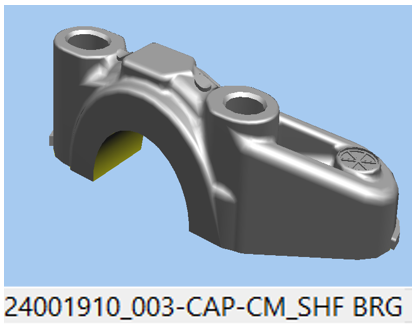
A close-up of a list

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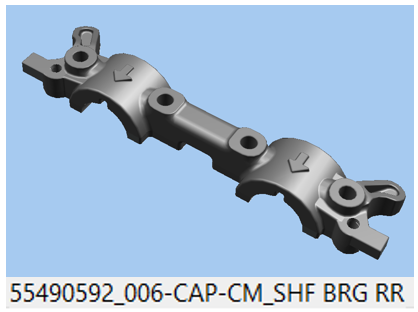
CARRIER ASM-CM/SHF (MCHG) - PN 40009545 (Parts shown on Drawing)

A screenshot of a computer

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P/N – 24001910 Intermediate cam bearing cap (not involved in the sourcing)

P/N – 55490592 Rear cam bearing cap (not involved in the sourcing)



Note1: 28x M5 Bolts p/n 55490850 to fasten the cam bearings to the housing will be retained in the housing assembly utilizing an axi-rad or equivalent means and shipped POA to GM Powertrain machine plant.

Note2: 16x M5 Bolt Holes are to fasten the housing to the cylinder head in GM Plant

### 2.4.1 Assembly

The housing assembly is installed on the cylinder head as received from the source and machined through the cam bores. The housing assembly is removed to torque the head bolts on the assembly line.

**3.0 QUOTE RESPONSE REQUIREMENTS**

In addition to requirements specified in GMN11303, the following list of items should be returned in your response to this quotation:

1. Summary of past relevant project experiences
2. Cycle time and capacity estimates for your production site
3. Proposed plant layout
4. Explanation of equipment and processes
5. Explanation of any quote deviations or assumptions made
6. Production contingency plans in the event that production is interrupted
7. Any major new equipment required for this program
8. GMPT Preproduction Material Survey Form (attached below). Intent of form is to capture key differences in tooling, equipment, material, and processes for preproduction build events as compared to production intent. Expand rows of form and/or add attachments as needed.



1. Volumes to be supplied with-in Appendix B, which is included in the quotation package.

Quotes must provide the minimum amount of detail as outlined in GMN11303 and above. Bids that do not contain the required information will not be considered.

GMPT is receptive to ideas that will permit the best possible system at the lowest cost. Any alternative ideas and suggestions should be discussed prior to the due date for this request for quote. If mutually agreed upon, the supplier can quote the system outlined in those specifications on a separate line item basis for each proposed option.

**4.0 PACKAGING AND INTERFACE**

**4.1 Packaging**

For the purpose of this quote, HOUSING ASM-CM/SHF will be packaged for shipment in preformed dunnage to the plants as identified in Appendix B. Dunnage will be designed, purchased, and supplied by GM. The supplier will be responsible for inspection, including cleanliness, and track all damaged unusable dunnage. For the purpose of this quote assume the dunnage will be capable of TBD housings per layer and TBD layers can be stacked on a pallet. Please supply quotes assuming TBD parts per pallet. The supplier is responsible for cleanliness of returnable dunnage used. Tier 1 supplier is responsible for all other dunnage; tier 2 to tier 1 dunnage, and in process dunnage.

### 4.2 Identification and Marking

Parts are to be identified in their shipping container per requirements of GMPT engine plants. Source is responsible for lot control of shipments with known date of manufacture and ship date of parts.

**5.0 FUNCTIONAL REQUIREMENTS**

**5.1. Finish / Appearance:**

**5.1.1 Foreign material** - All parts must meet print dimensional specification and be free of excessive burrs, excessive oil, and/or debris upon receiving. The maximum retained material for the partial machined cam carrier assembly is 0.02 gram total. Measurement of retained material to be per GMW16037.

**5.2. Environmental Operating Range:**

**5.2.1. Material Compatibility –** The housing material must be

compatible with the aluminum cylinder head material upon which it is

mounted and with the camshaft material which rotates in the bearing cap.

There are no other specific requirements.

**5.2.2. Chemical Compatibility –** The HOUSING ASM-CM/SHF is expected to operate in a diesel automotive engine. The only chemical with which the cam housing will come into contact is engine oil. The cam housing shall not contain any material which is not compatible with engine oil nor any material that can degrade the quality of engine oil.

**5.2.3. Mechanical Loads –** The thrust surfaceson the rear bearing cap and housing base support the thrust loads from the cam shafts. The load on the intermediate cam bearing caps will include an alternating load from the camshaft journal during the valve opening operation and an alternating load from the retaining bolts as they thermal cycle with engine oil temperature. Analysis done by GMPT will ensure that the cast material specified with appropriate mechanical properties will be sufficient to withstand these loads with normal casting quality.

**5.2.4. Thermal Loads –** The camshaft housing will experience mechanical loads resulting from the thermal distribution within the cylinder head and fluids at different temperatures being in contact with different parts of the cylinder head.

**5.3. Corrosion Resistance, External:**

There are no specific requirements for external corrosion resistance.

**5.4. Fluid Resistance, Internal:**

Refer to Chemical Compatibility (section 5.2.2).

**5.5. Flow Characteristics:**

**5.5.1 Pressurized Oil Passages**

Oil must flow unimpeded through pressurized oil passages. Passages must be free of any foreign material that could impede flow. The assembly shall be tested as part of the air decay system to insure that a flow restriction greater than 50% does not exist as part of PPAP, and 100% of production volume.

**6.0 LEAK RATE:**

The castings must pass the following leak test requirements.

|  |  |  |
| --- | --- | --- |
| Cavity | Maximum Leak Rate based on pressure decay of air | Test Pressure |
| Oil galleries | 6 cc/min | 140 kPa |
| Oil cavity | 12 cc/min | 140 kPa |

Impregnation of castings is not allowed. Welding of castings is not allowed. Any repair of casting must received the approval of the Cylinder Head DRE.

**7.0 QUALITY / RELIABILITY REQUIREMENTS**

The HOUSING ASM-CM/SHF must function as designed without failure.

All rejected HOUSING ASM-CM/SHF at the cylinder head machining line must be replaced without cost to GM. Rejects may also result in reimbursement to GM for the housing machining cost and the cylinder head cost.

**8.0 DURABILITY REQUIREMENTS**

In order to demonstrate the above durability, the following tests will be performed by GMPT - Engineering and must pass all tests satisfactorily.

Standard Dynamometer Tests

1. See appendix G3

A satisfactory completion of the above tests includes no cracks, distortion, internal corrosion, or wear as determined by the GMPT DRE at end of test review of cylinder heads.

**9.0 MANUFACTURING PROCESS**

**9.1 Partial machining –** The housing assembly shall be partially machined by the casting supplier. Outsourcing of this partial machining to a Tier 2 is not permitted. Surfaces and tolerances to be included with the partial machining operation are shown in the Appendix E.

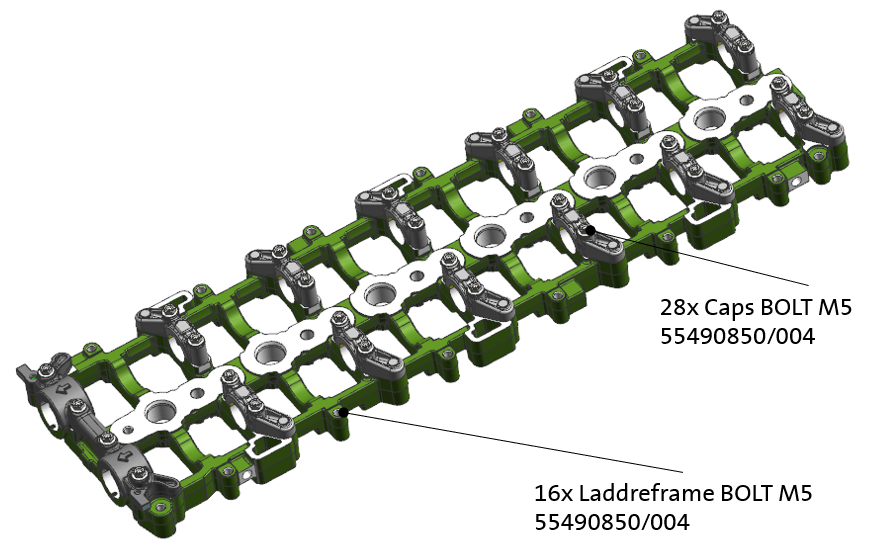
**9.2 Machining -** This casting will be machined with production machining operations that include milling, boring, drilling, reaming, spot facing, and tapping. It is required that the casting will have no inclusions or other defects that would inhibit such machining operations.

**9.2.1 Supplier**

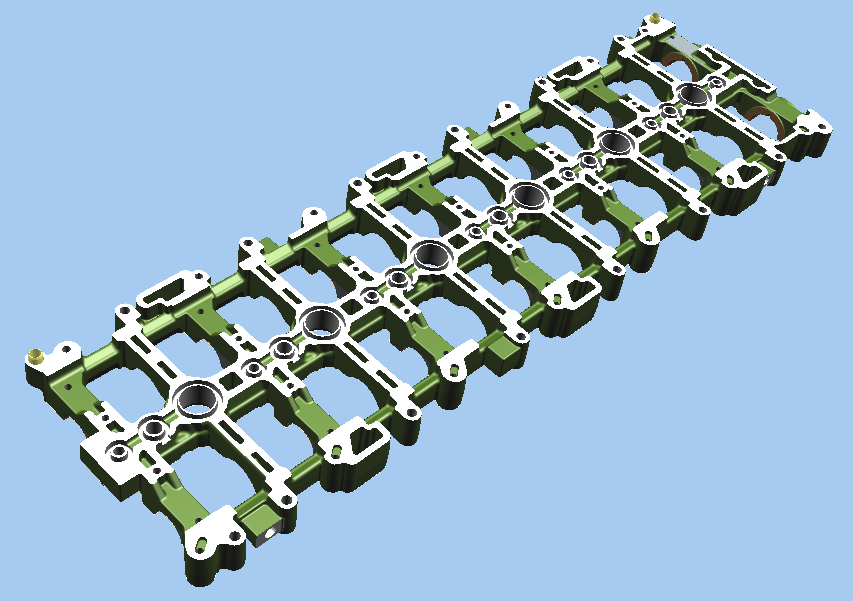
The supplier of the HOUSING ASM-CM/SHF will be responsible for machining in the 40009546 and 40009545 drawings. Following the main features:

1. All bolt holes
2. Cam Bearing faces pre-machined
3. Low Pressure Oil feed holes
4. Split face with cam bearing caps
5. Cylinder head mounting surface on base Housing ASM-CM/SHF
6. Dowel holes Rear cam bearing cap
7. Dowel holes on lower base Housing ASM-CM/SHF
8. Oil grooves

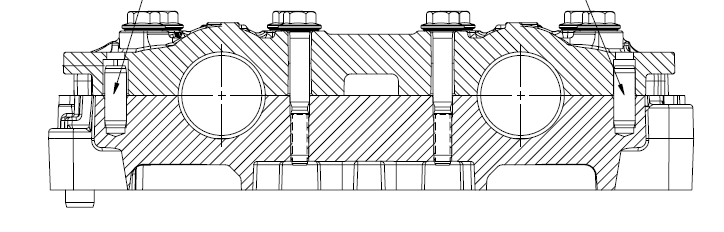
Top side - All bolt holes



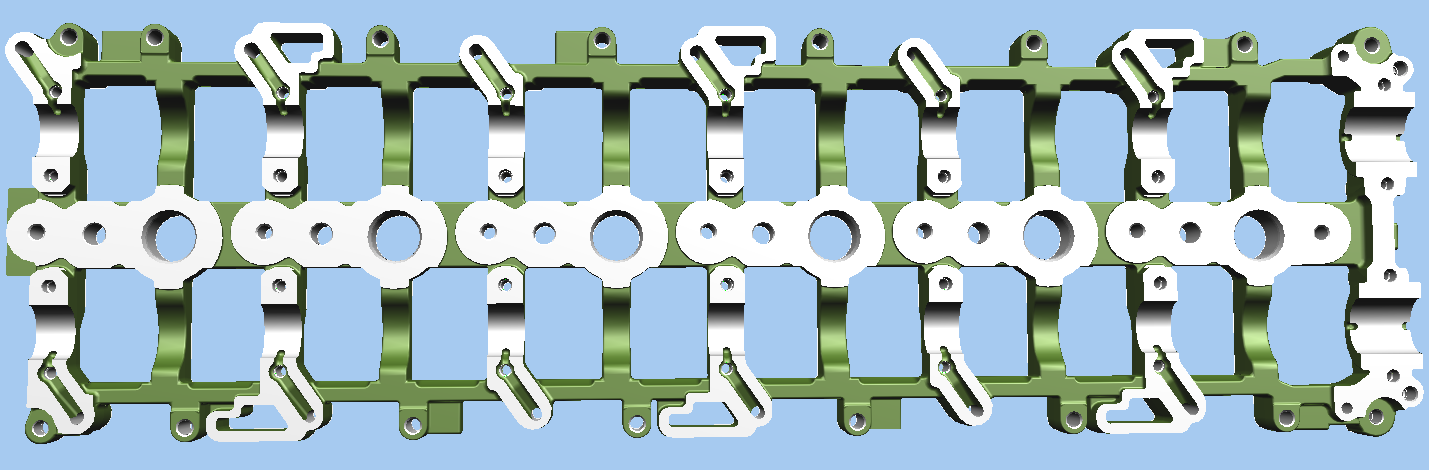
Bottom side - Dowel holes on lower base housing



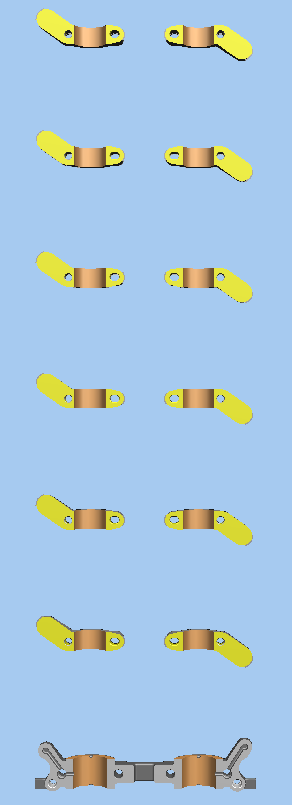
Dowel holes Rear cam bearing cap



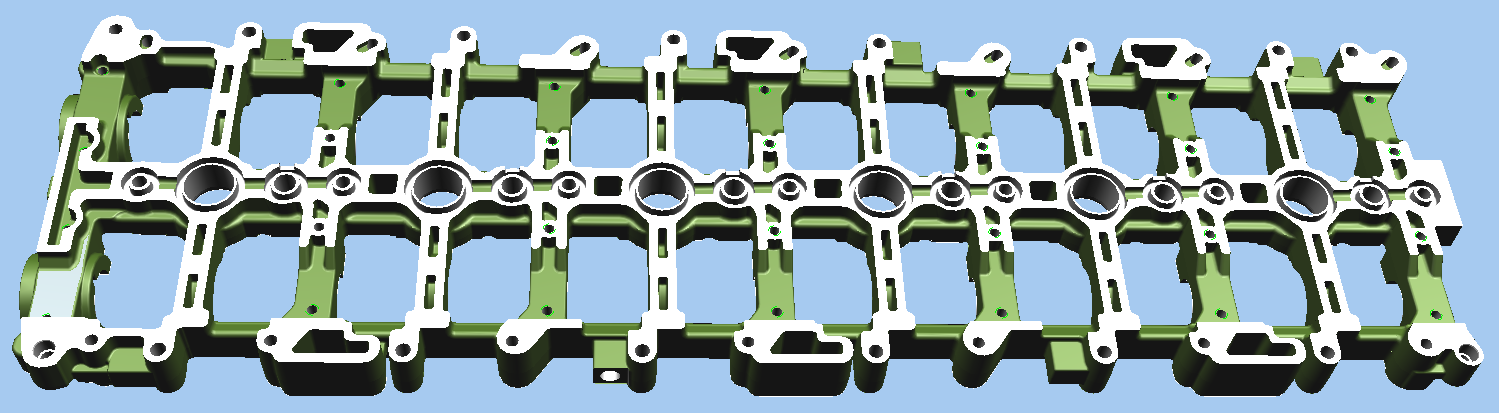
Top side - Oil Grooves/Holes, Cam Bearing faces pre-machined; Split face with cam bearing caps



Bearing Caps – Cam Bearing faces pre-machined;



Bottom side – Cylinder head mounting surface



**9.2.2 Machinability of Cam Bearing Caps**

# The cam bearing housing shall be machined using diamond boring tools. They shall experience comparable tool life as machining the cast aluminum cylinder head to which the cam bearing camshaft housing is assembled.

**9.2.3 GM Powertrain**

Tool Description: The cam bore is the only feature on the cam bearing camshaft housing to be machined by GMPT.

(2x Rear final bore diameter in the cyl.head assembly are 26.01 +/-0.01 mm, all other (x12) final machined bore diameters in the cyl.head assembly are 24.01 +/- 0.01 mm)

1. Mark upper cam caps to identify their positions

**9.3 Casting** – Provide housing assemblies using the production representative tooling and manufacturing process. With written GMPT DRE prior approval, the supplier can utilize “soft tools” to produce beta and gamma samples if a production die is not available when the parts are required. All production die cast molds must be made from steel. Any deviations should be approved by General Motors. The type of steel used is to be discussed at the Tech. Review.

**10.0 DOCUMENTATION**

**10.1 Engineering Drawings:**

The GMPT design policy is attached.

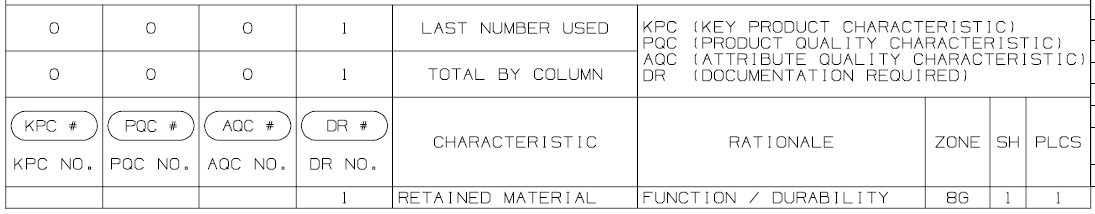


The supplier must be able to use U.G. with no translation allowed.

Model transactions to GM must be in the latest version of UG.

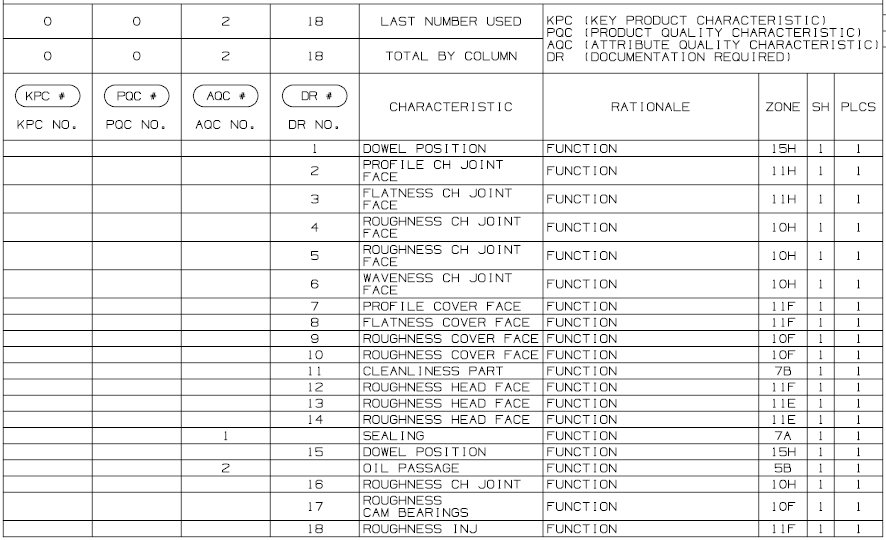
* + 1. **KPC/PQC:** The standard KCDSs for the Housing CM-SHF are shown below:

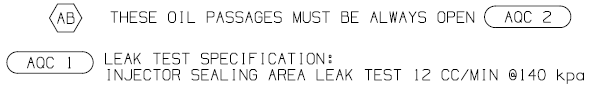
HOUSING ASM CM-SHF p/n 40009546:





CARRIER ASM-CM/SHF (MCHG) p/n 40009545:





A Unigraphics model of the casting and the machining are included with this Statement of Requirements.

**10.1.2. KCC:**

This is left to the supplier of the cylinder head casting. All KCCs must be identified as part of the control plan.

**10.2.1. Supplier:**

Supplier must include with the proposal the following information:

1. Room temperature mechanical properties including ultimate tensile strength, 0.2% offset yield strength, and percent elongation.
2. Chemical composition of the proposed material.
3. Hardness, heat treat condition (if applicable) and typical microstructures of the proposed materials.
4. Refer to 12.1.4
5. Density of the proposed materials.

**10.2.2. General Motors Powertrain:**

General Motors Powertrain will make available test results upon request. It will be left to the discretion of General Motors Powertrain to share the procedures of these tests with suppliers.

**11.0 ANALYTICAL MODELS:**

**See appendix G4 for analytical requirements. Section 11 is ref only.**

**11.1. Supplier**

**11.1.1** The supplier is required to conduct fill and solidification modeling to assure the integrity of the casting. The supplier must be capable of and demonstrate the use of analytical tools (Magma, ProCast, AnyCasting, or equivalent software) to do this work.

**11.1.2** The supplier is not required to supply analytical models for this part but General Motors Powertrain may require specific information regarding this part including a 3D model to support modeling efforts.

**12.0 TESTING AND VALIDATION REQUIREMENTS**

**12.1.1. Bench Testing**

Three (3) point break strength testing per GMW17270 to be conducted by the supplier.

**12.1.2 Vehicle Testing**

There are no specific vehicle tests specified at this time.

**12.1.3. Engine Dynamometer Requirements**

Please refer to section 8.

**12.1.4 Material**

The following material tests will be conducted on the cam bearing camshaft housing components to illustrate the material’s chemical and mechanical properties. These tests are run in accordance to ASTM guidelines where appropriate.

1. Chemical Analysis (per GMW 5)
2. Microstructure Analysis
3. Porosity
4. Density
5. Hardness (per ASTM E10)
6. Yield Strength (per ASTM B557M)
7. Ultimate Tensile Strength (per ASTM B557M)
8. 3 points break strength

For illustration purposes a photograph at 200 and 500 magnification of the material shall be attached to all material analysis reports.

The source is to provide UTS, YS, and elongation, with all data measured and reported per GMN7152 Appendix C, on production-type parts from their process during development and before PPAP of the production part.

Production mechanical property requirements will be detailed on the print, which will be specified per GMN7152-Class 3 with the special requirements outlined above. The casting source shall be required to audit their mechanical properties per GMN7152 Appendix C (Specification and Verification of Tensile and Fatigue Properties in Cast Components), and at a test facility approved by GMPT Materials Engineering.

See GMW3059 and / or GMN7152.

**12.1.5Other**

Special Tests - Individual parts may be subject to specific tests that target a particular failure mode

**13.0 SUPPLIER CERTIFICATION**

The supplier shall be certified and compliant with all GMPT quality system requirements.

**14.0 PRE-PRODUCTION TIMING, PRICING, AND INSPECTION**

**14.1 Timing**

See Appendix-B1 for all volumes and timing.

For general planning purposes assume approximately 50-100 gamma engines (Obtain qty estimates from the program team.) These quantities should be multiplied by 1.75~2.0 to account for non-engine testing, rebuilds, miss-builds, etc.

MRD dates shown in Appendix B are for the engines –MRD dates will be 8-12 weeks earlier.

Gamma parts are required to be off production tooling and using the production process. Any deviations from this must be approved by the DRE.

(One engine contains (1) Housing AMS CM-SHF)

**14.2 Pre-Production Pricing**

Pre-Production part pricing and quantity will be discussed and negotiated at time of technical review. Suppliers are expected to provide best pre-production tooling and piece price at that time, and this must be included in the presentation material. If the supplier fails to discuss this during the technical review, GPS will assign a reasonable and customary pre-production piece price and tooling price based on recent GPS experience.

**14.3 Pre-Production Inspection**

To meet PPQ requirements for shipments, supplier is responsible for providing measurement data on each batch of parts. KCDS dimensions as defined on the part print, excerpt of template print, or SOR must be measured on 100% of the parts. Remaining dimensions on the print are required on a minimum of 3 pieces per batch, or 10% of the quantity, whichever is greater. Samples should be evenly distributed across the batch to account for variation. Final quantity and distribution should be discussed prior to the order being placed. Data from the measurements shall be provided to the GM DRE 1 week prior to shipment.

|  |  |
| --- | --- |
| Samples with 100% - dimensional check | Min 3 parts or 10% of batch, whichever is greater. First part, last part, then an even distribution across the order quantity. |
| **KCDS Dimensions**  (PQCs, AQCs, KPCs, DRs, etc.) | 100% inspection of all parts |
| Supplier provide PPQP warrant for signature | 1 week prior to shipment |

## 15.0 REQUIRED INFORMATION TO BE SUPPLIED FOR TECHNICAL REVIEW

15.1 Cost of pre-production parts (tooling) (See note on piece cost – section 14.1).

15.2 Mass of each assembly.

15.3 Cost estimate of dunnage based on initial shipping proposal.

15.4 Plan to meet MRD for Gamma hardware.

15.5 Plans for outsourcing individual components and names of likely Tier 2 suppliers.

15.6 Plan for providing on-site technical support during the development program.

15.7 Production experience with the proposed design.

15.8 Proposed production process documented step by step.

15.9 Initial process control plan to maintain production quality.

15.10 Letter of feasibility of meeting all the SOR specifications

15.11 Production plan to meet LCR and MCR volumes; number of shifts per week.

**16.0 CONTACTS**

|  |  |
| --- | --- |
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