GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW15829

Auxiliary Oil Cooler Air To Oil Test Procedure Specification

1 Introduction

Note: Nothing in this standard supersedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard shall define the Design Validation (DV), Product Validation (PV), Post Validation Audit (PVA), measurement conditions, performance requirements and the minimum durability specification requirements of various forms of Auxiliary Oil Cooler (AOC) heat exchangers. This may include automatic transmission oil to air coolers and/or engine oil to air coolers with fluids listed in 3.1.10.

1.2 Applicability. This standard will define the performance measurement conditions and the minimum durability specification for the air to oil cooler used for transmission oil, engine oil or other oil cooling applications. This standard defines the AOC as the heat exchanger that transfers heat energy from various powertrain components to air. The AOC is to include the heat transfer surface, inlet and outlet fittings, and any other components attached to or part of the AOC, completing the AOC assembly.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM G85A3	SAE J639	SAE J1344

2.2 GM Standards/Specifications.

GMW3059	GMW14156 (ID)	GMW14671	GMW15827
GMW3116	GMW14157 (ID)	GMW15443	GMW15920
GMW3286	GMW14192	GMW15531	GMW16331
GMW3600	GMW14573	GMW15725	GMW16954
GMW8758	GMW14669	GMW15758	GMW17010

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- CG2995 - Auxiliary Oil Cooler Air to Oil ADVP&R (Validation Cross Reference Index (VCRI) Chart)
- GM1738 Packaging and Identification Requirements for Production Parts
- Statement of Requirements (SOR), Appendices B, C2, F, G2 and G3

3 Requirements

3.1 System/Subsystem/Component/Part Definition. All requirements of this specification shall be met in order to demonstrate compliance with DV, PV and PVA evaluations.

3.1.1 Appearance. The appearance of the AOC shall be submitted and agreed upon between the supplier, GM Design Release Engineer and GM Manufacturing. The same document shall apply to all GM global production sites. The use of a boundary sample PowerPoint document shall be prepared by the supplier. This document shall contain

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all cosmetic appearance variation(s) such as “crazy fin”, fin bunching, fin drop, braze frame marks, finger bent fins, and any other physical variance acceptability. For example:

GM will accept no more than two (2) crazy fins per core, excluding the top and bottom fins. Maximum number of crazy fins per core including the top and bottom fins is four (4): two (2) in the center of the core and one (1) on both the top and bottom core cover.

A generic or specific picture (computer aided design (CAD) picture not permitted) must accompany each variation showing the type of defect and any agreed upon variation. This document shall be created by the supplier and submitted into a GM database with the completed CG2995 Analysis/Development/Validation Plan and Report (ADVP&R) plan. See Section 4.2. All appearance variations shall be cosmetic-only in nature and shall not result in the non-conformance of the part to the requirements in this standard. Any part coming into a GM plant that varies from this boundary sample document may be rejected at the plant’s discretion.

3.1.1.1 Paint. All painted finishes of the AOC must meet paint performance specifications per GMW14671 (Organic Coating Performance for Underhood and Underbody Components) for aluminum style heat exchangers and GMW14669 (Organic Coating Performance for Exterior and Interior Metallic Components) for steel style heat exchangers.

3.1.2 Content.

3.1.2.1 Physical Content. Not applicable.

3.1.2.2 Functional Content. The AOC receives hot oil from the engine or transmission and transfers heat through the tubes into the fins which have air passing through them supplied by the engine fan or electric fan and/or by ram air.

3.1.3 Ambient Environment. Unless otherwise specified, the standard ambient testing temperature environment is defined as 23 °C ± 5 °C.

3.1.3.1 Environmental Conditions. The AOC must be able to withstand under-hood ambient conditions of -40 °C to 150 °C.

3.1.4 Interfaces. All subcomponents and interfaces that build up the AOC including the upper assembly level (if required) must be documented in a block diagram supporting the Design Failure Mode and Effects Analysis (DFMEA), Process Failure Mode and Effects Analysis (PFMEA) and Design Review Based on Failure Mode (DRBFM) as required.

3.1.5 Usage Definition. The passing of these test procedures permit the use of the part globally. If more than one material supplier, or more than one toolset produce the same part in different regions, then a separate round of validation testing shall occur. The supplier shall coordinate this activity with GM Engineering to determine the level of testing required and any other opportunity to combine testing.

3.1.6 Test Vehicle/Test Piece. All testing shall be performed on the AOC alone except for Vibration durability and Noise and Vibration (N&V). The vibration durability and N&V test shall be tested with any and all components attached as it is installed in the vehicle. This includes fan motor(s) and shroud assembly and attaching subcomponents like Charged Air Cooler, Condenser, Low Temperature Radiator (LTR), Radiator and Isolators, etc. The testing setup shall be approved by the GM Validation Engineer. The specified sample quantity shall be agreed prior to testing in the ADVP&R plan. All subsystem components required for validation shall be provided by GM.

3.1.7 Test Time. Total testing time shall be considered when planning delivery of parts to meet GM key dates contained in the GM Global Vehicle Development Process (GVDP) schedule. It is highly recommended to leave a buffer of at least two weeks between test completion and the GM milestone when planning, due to an unexpected failure where re-validation would be required. Following is an estimated plan of how long it takes to validate and test one heat exchanger product or part number. Times may vary based on test cell availability and capacity.

Calendar time:	105 d
Test hours:	3000 h
Coordination hours:	500 h

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3.1.8 Test Required Information. The performance measurements and durability test results are to be summarized and reported to GM on the Supplier Analysis/Development/Validation (ADV) plan, CG2995. Full test reports shall be available for viewing by GM personnel on request for the time period defined by GMW15920.

3.1.9 Personnel/Skills. The personnel and skill requirements are the responsibility of the supplier.

3.1.10 Testing Conditions. Transmission fluid used herein is defined as Automatic Transmission Fluid (ATF) (DEXRON® VI) oil according to GMW16954. Engine Oil used herein is defined as SAE 5W-30 engine oil according to GMW15827. Special considerations for alternative fluids may be considered. Contact Subsystem Validation Engineer for a deviation. Test fluid deviations will not be granted for Heat Dissipation testing.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Fixed-value Performance Testing Requirements.

3.2.1.1.1 Internal Cleanliness. The AOC shall meet the following debris requirements when tested per 4.4.2:

3.2.1.1.1.1 Particle Size – Metallic.

- Total distribution for 6 sigma shall not exceed 1 mm maximum.
- No single particle shall exceed 0.8 mm in size.

3.2.1.1.1.2 Particle Size – Non-metallic.

- Total distribution for 6 sigma shall not exceed 3.5 mm maximum.
- No single particle shall exceed 2.1 mm in size.

3.2.1.1.1.3 Total Mass.

- Total distribution for 6 sigma shall not exceed 1.2 mg.

3.2.1.1.1.4 Additional Considerations.

- No Corundum particles permitted in heat exchanger – these normally come from rework processes where sanding or cutting discs are used.

See Table A1 in Appendix A for measurements that pass and fail the criteria above.

3.2.1.1.2 Internal Dryness. The acceptable level of water contamination (M) shall be the lesser of 1000 ppm or 0.1% weight of the oil volume within the AOC.

3.2.1.1.3 Component Data Standard (CDS). CDS data is not only a planning tool for achieving a “near” component accuracy as starting point. It is used for calculating all initial simulations and eventually actual component performance for preproduction and production. Therefore, all CDS data must represent real-world performance and production intent. All CDS data shall be confirmed and reported on the CDS. This includes heat dissipation, air side pressure drop, and oil side pressure drop when tested per 4.4.4, as well as mass and internal volume of the core and end tanks. The results shall be recorded in the release drawing notes as Key Characteristics Designation System (KCDS) “Standard Product Characteristic Documentation Required <DR>” requirements. Results shall represent the “best fit” curve that represents production design. DV part performance shall meet Statement of Requirements (SOR) CDS submission. The Kilowatt of heat rejection, at the CDS data test points, during the PV test shall be a minimum of 98% of the DV test part performance or better. Performance minimum tolerances must be met by the ± 3 sigma limit of the sample population tested.

If the SOR includes additional load points, beyond those specified in 4.4.4, include those performance points in the CDS file submitted to GM.

3.2.1.1.4 Leak Test. The AOC shall exhibit a leakage rate ≤ 3 cc/minute dry air when tested per 4.4.1.

3.2.1.1.5 Maximum Pressure Test (Burst). During the procedure recorded in Section 4.4.5, the AOC shall not present any permanent deformation, shall not leak beyond 4.4.1, and shall not exhibit pressure loss before Minimum Burst Pressure is reached.

3.2.1.2 Endurance Testing Requirements.

3.2.1.2.1 Thermal Cycle Durability Test. The AOC must pass Leak Test (4.4.1) prior to and after AOC thermal exposure test in Section 4.4.6.

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3.2.1.2.2 Pressure Cycle Durability Test. Run AOC pressure cycle test in 4.4.7. The AOC must pass Leak Test (4.4.1).

3.2.1.2.3 External Corrosion Test (Sea Water Acetic Acid Test (SWAAT)). After the SWAAT test in 4.4.8, the AOC must pass Leak Test (4.4.1). If the disposition of the AOC is such that it cannot be tested per 4.4.1, then air under water testing may be used at 1034 kPa_g ± 5 kPa_g.

3.2.1.2.4 External Corrosion Test (Neutral Salt Spray (NSS)). After the Neutral Salt Spray test in 4.4.9, the AOC must pass Leak Test (4.4.1). The dissimilar mating material shall have no more than 1.32 g ± 0.13 g (60 µm ± 6 µm) cosmetic mass loss. This procedure is only required when two different materials are in contact with one another which can cause galvanic corrosion. This does not include GM released fasteners nor GM standard parts applied to other different materials.

3.2.1.2.5 Vehicle Validation. Vehicle level testing will be completed by GM. If the GM engineer supplies the AOC back to the supplier (post-test), the AOC shall pass Leak Test (4.4.1). The testing includes, but is not limited to, the following tests:

3.2.1.2.5.1 General Durability with Corrosion. When the vehicle validation test is completed in 4.4.10, the Condenser AOC Fan Module (CRFM) components must not result in customer complaint.

3.2.1.2.5.2 Stone Impact Test. This test is only required when the AOC is the first component in the airflow. AOC stone guard material shall be validated through GMW15725, Type 1 (Performance Requirements for Engine Compartment Plastic Parts), and after being subjected externally to 3 J on the Charpy Impact Testing device as described in 4.4.11, the AOC must pass Leak Test (4.4.1). The AOC plastic grill may have limited damage, but must maintain full function (attachments and stone protection) throughout the test procedure without causing further damage to the AOC or itself.

3.2.1.2.5.3 Vibration Durability Test. Test the AOC as described in Section 4.4.12, the AOC shall pass Leak Test (4.4.1) before and after testing. After each test, the AOC shall be able to function 100% without leaking. Failure is defined as, but not limited to, the loss of function, loss of structure, unacceptable performance degradation, and nonconformance of the component as stated in this specification. No fractures shall appear in any mounting brackets. No tears shall appear in any isolators. Post-test inspection results shall be included in the detailed test report.

3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. The dimensions, mass, and internal volume of the AOC and the CRFM shall meet all drawing specifications. This shall be proven statistically with a multi-part layout at DV and PV according to the ADV plan.

3.2.2.2 Mass Properties. The program mass targets provided in the CDS must be met and confirmed before testing can begin.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. This standard, as written, provides a test exposure representing a reliability evaluation point (REP) of 15 years and 240 000 km (150 000 mi) of severe customer usage at the vehicle level. For a REP of 320 000 km (200 000 mi), multiply the test cycles for endurance tests by 1.33.

3.2.3.2 Reliability Requirements. This standard as written supports demonstration of the required reliability of 99.0% or greater at a 50% confidence (R99C50) at the REP for the Heat Exchanger when tested in a component test. The supplier shall utilize “vehicle equivalent” laboratory test setups to simulate “in vehicle” orientations. If the orientation may be different from vehicle to vehicle, use the orientation which will provide the worst case loads, for all physical level reliability demonstration testing.

Reference GMW14156 Test Reliability Requirements Guidelines, and GMW14157 Statistical Confidence Level for Reliability Validation Testing.

The Reliability Demonstration is provided by the Design Validation (DV) Endurance Tests. In contrast to DV, the Endurance Tests specified for Product Validation (PV) are intended to confirm the reliability demonstrated during PV of components manufactured from high volume tooling and at all manufacturing sites.

3.2.3.3 Accelerated Test Methods. GM encourages the use of appropriate accelerated test methods, wherever possible; for example, the use of accelerated stress testing to reduce test time (reference GMW8758).

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Note: GM Validation Engineering shall review and accept Reliability demonstration test plans prior to the supplier submitting the ADV Test Plan for approval.

3.2.4 Serviceability. All serviceable parts shall be able to be disassembled within the assembly (if required) and returned without showing signs of degradation. For example, a screw into a plastic tank boss shall be able to disassemble and reassemble without losing thread engagement. Plastic clips must be able to return to their "before" and "after" positions without cracks or breakage. GM's requirement is that the part must be able to be disassembled and reassembled at least 10 times without damage. The supplier must demonstrate by test, using real or surrogate data, that the design can withstand re-use without breakage. The supplier must choose the right design, torque, and consider all other factors that might influence serviceability. In-vehicle serviceability to be approved by GM Service Engineer prior to first design freeze.

Service parts shall be adequately protected to ensure satisfactory assemblies after a storage period of five years beyond the date of shipment from the manufacturer's plant.

3.2.5 User System/Subsystem/Component/Part Interface. Not applicable.

3.3 Design and Construction. Not applicable.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines. Refer to SOR Appendix F. Elastomeric and aluminum materials supplied under this specification must be homogeneous, free of defects and surface contamination such as bloom, talc, mold release agents, and flash. Machine surface finish must be measured on a 30 part layout and be according to drawing specification. See SOR for drawing guidelines on AC connections.

3.3.1.2 Processes Guidelines. Not applicable.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.1.4 Recycling. Materials shall be recyclable per GMW3116 (Recyclability/Recoverability). Attempts shall be made to minimize the variety of materials used to make recycling more viable. All plastic parts shall be identified for recycling per SAE J1344.

3.3.2 Design Guidelines and Constraints.

3.3.2.1 Drawing Requirements. AOC assemblies supplied under this specification must conform to the detailed drawing approved by Design Release Engineer (DRE).

3.3.3 Identification and Marking. The AOC assemblies supplied under this specification shall be visually identified in a manner exclusive and unique to each supplier to permit rapid identification of each respective AOC assembly manufacturer by the responsible GM Supplier Quality Engineer. Identification methods must be submitted to and approved by the GM Design Release Engineer. All assemblies must be labeled with the GM part number, date code and tool/cavity number in a visible location to comply with GMW16331. All labels shall conform to GMW14573.

3.3.4 Workmanship. All exterior surfaces shall be clean, dry, and free of weld and/or braze splatter, flash, ridges, sharp edges, flux paste, roughness and manufacturing lubricants.

All AOC connections shall have the sealing surfaces and threads free of damage, and foreign material (e.g., paint, dirt, etc.) Sealing surfaces shall be smooth and free of nicks, and scratches to assure positive sealing.

KCDS requirements shall be defined on the GM approved engineering drawings. The AOC assembly shall have manufacturing capability such that all dimensions are targeted at print nominal dimensions. The supplier shall submit a detailed improvement plan which describes how their manufacturing process for each part/operation shall achieve a process distribution of a value determined by the GM Supplier Quality Engineer.

3.3.5 Interchangeability. Not applicable.

3.3.6 Packaging. See GM1738, Packaging and Identification Requirements for Production Parts.

3.4 Documentation. GM Validation Engineering shall review and accept Reliability demonstration test plans prior to the supplier submitting the ADV Test Plan for approval. For PV, the supplier shall submit documentation per GMW3600 in order to finalize that all the requirements for the component(s) have been met. For AOC see form CG2995.

3.5 Support of System/Subsystem/Component/Part After Sale. Not applicable.

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