



Slim Line Air Conditioning Sealing Washer R134a and R1234yf

1 Introduction

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

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

Note: Unless otherwise stated as gauge, pressures listed within this specification are absolute.

1.1 Purpose. This specification establishes the minimum requirements for the slim line Air Conditioning (A/C) sealing washer that is intended for use in GM automotive air conditioning systems with liquid and gaseous refrigerant.

- R134a (GM Drawing/Part Number 9985751 or equivalent).
- R1234yf (GM Drawing/Part Number 9986319 or equivalent, see Global Product Description System/Area Parts Manager (GPDS/APM)).
- Polyalkylene Glycol (PAG) compressor oil (Material specification 9986181 for R134a) for R1234yf - PAG oil specification, refer to the following:
- Mahle (formerly Delphi) - PSD1 - 9986364.
- Mitsubishi Heavy Industries (MHI), MHI - PAG46 - 9986365.
- Denso - ND12 - 9986366.
- Sanden - SP-A2 - 9273590.
- Polyolester (POE) compressor oil (Material specification 9986277).

The functions, performance, reliability, qualification tests and shipping requirements for slim line A/C sealing washer are defined in this document.

1.2 Applicability. This standard apply for all A/C system joints where a seal element is required.

1.3 Remarks. PAG and POE compressor oil formulations are unique to each A/C Compressor manufacturer. In order to evaluate the entire spectrum of compressor oil formulations and refrigerants (R134a and R234yf) used in GM vehicles, the A/C sealing washer supplier shall perform the material compatibility tests with the compressor oil formulations and refrigerant type confirmed by the responsible Global Thermal Bill of Materials Family Owner (BFO).

2 References

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

2.1 External Standards/Specifications.

ASTM D1414	SAE CRP 1234-2	SAE J2844
RMA Standard F-1	SAE J639	

2.2 GM Standards/Specifications.

9986181	GMW3116	GMW14727	GMW15760
9986277	GMW3172	GMW14872	
GMW3059	GMW8758	GMW15272	

2.3 Additional References.

- CG2987.

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- GM Drawing/Part Number 11562517.
- GM Drawing/Part Number 11588726.
- GM Drawing/Part Number 12346303.
- GM Drawing/Part Number 52457600.
- GM Drawing/Part Number 52474373.
- GM Drawing/Part Number 52474374.
- GM Drawing/Part Number 52474375.
- GM Drawing/Part Number 52477000.
- GM Drawing/Part Number 52477087.
- GM Drawing/Part Number 88862657 United States.
- GM Drawing/Part Number 88862658 Canada.
- GM Drawing/Part Number 9985751.
- GM Drawing/Part Number 9986161.
- GM Drawing/Part Number 9986319.
- GM1738 (available on GM Supply Power).
- Industry Best Practices.
- SOR Appendix G.

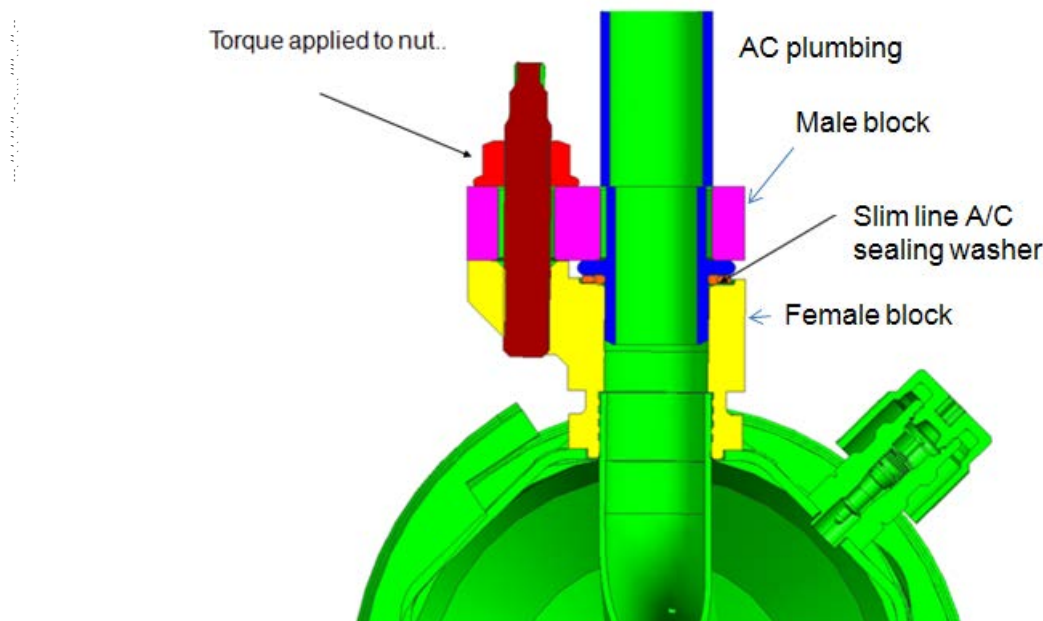
3 Requirements

All requirements of this specification must be met in order to demonstrate compliance with Design Validation, Product Validation and In-Process evaluations.

3.1 System/Subsystem/Component/Part Definition. The slim line A/C sealing washer is the sealing element in mini-block style fluid joints. See Figure 1.

Figure 1: Air Conditioning Seal Washer Assembled in A/C System

Compressor using AC seal washer sealing method



AC Air Conditioning

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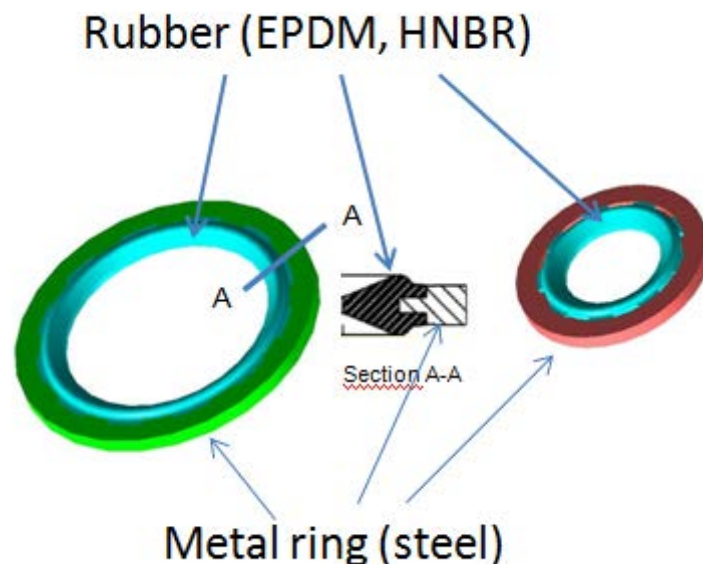
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3.1.1 Appearance. See 4.3.12.

3.1.2 Content.

3.1.2.1 Physical Content. A typical sealing washer consists of an annular elastomeric sealing element type rubber, for example: Ethylene Propylene Diene Monomer (EPDM) (or other material approved by GM Engineering) which is mechanically locked and/or chemically bonded and molded to an annular low carbon steel retainer having a corrosion resistant surface treatment (see Figure 2).

Figure 2: Typical Sealing Washer



HNBR Hydrogenated Nitrile Butadiene Rubber

3.1.2.1.1 A/C Seal Washer. Reference Part Numbers to confirm the latest Part Numbers qualified; contact responsible BFO.

For 10 years lifecycle:

- From both approved suppliers, Hutchinson Seals and Parker Seals: Part Numbers 52474373, 52474374, 52474375 and 52477087.

For 15 years lifecycle:

- From Hutchinson Seals: Part Numbers 13418807, 13418809, 13418806 and 13418808.
- From Parker Seals: Part Numbers 13579649, 13579648, 22872400 and 13579646.

3.1.2.2 Functional Content. The A/C sealing washer provides the seal between the two surfaces of a mini-block style joint (Figure 1). The A/C sealing washer can be placed into both underhood and underbody locations. The steel ring (Figure 2) provides support for the elastomer to assure consistent and uniform seal position and compression. It also provides retention of the seal washer (on the tube feature of the joint) during transport and assembly.

3.1.3 Ambient Environment. The A/C hose and coupling assembly is expected to be fully functional under ambient conditions of:

- Ambient temperature (-40 to +135) °C continuous and (-40 to +140) °C at excursion.

3.1.4 Interfaces. A/C sealing washer interfaces with mainly A/C lines and major A/C components within A/C system:

- A/C line to A/C Compressor.
- A/C line to A/C Condenser.

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- A/C line to A/C line (mid joint).
- A/C line to Accumulator.
- A/C line to Thermal Expansion Valve (TXV) and/or evaporator/chiller.

3.1.5 Usage Definition. Not applicable.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Dimensional. Parts must be within dimensional limits specified on GM approved GM Drawings/Part Numbers (see 3.3.2.1). Two (2) complete heats from the same batch of material (elastomer) are required for dimensional verification. The supplier must provide a mold cavity pattern layout to assist in the dimensional verification of the tool being checked.

3.2.1.2 Material.

3.2.1.2.1 Material requirements for Rubber Sealing for Refrigerant Applications, are defined in GMW14727, Table 1.

3.2.1.2.2 Material Properties for Metal Ring (retainer). See GM latest approved revision. Refer to 3.1.2.1.1.

3.2.1.3 Elastomer/Retainer Retention.

3.2.1.3.1 Plug Gauge Test. The elastomeric sealing element must resist tearing or separating away from the metal retainer in any manner visible to the naked eye. Areas exhibiting potential separation during the visual examination may be examined further with a 6x magnifier to confirm and/or characterize the mode and/or extent of the separation.

3.2.1.3.2 The elastomeric sealing element of the sealing washer shall be mechanically locked and/or chemically bonded to the metal retainer in such a manner as to resist pull-off forces during installation on the air conditioning system fitting or connection particular to its intended use.

3.2.1.3.3 Universal Machine test. Additionally, for any new seal washer release or any change that might impact locking retention force between the sealing element into the metal retainer, a Universal Test Machine Pull Test shall be performed to generate retention curves that shall be shared with the BFO and Validation for approval (for test setup reference see Figure A2).

3.2.1.4 Leak. A complete test fixture assembly must not exceed a leak rate equivalent to 0.1 g/year of R134a or R1234yf refrigerant.

3.2.1.5 Thermal Cycle.

3.2.1.5.1 Maximum allowable leakage is 0.95 g (see Note in 3.3.1.1.3).

3.2.1.5.2 Maximum allowable loss of torque should not exceed 20% of the initial torque.

3.2.1.5.3 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.6 Heat Age.

3.2.1.6.1 Maximum allowable leakage is 0.6 g (see Note in 3.3.1.1.3).

3.2.1.6.2 Maximum allowable loss of torque should not exceed 20% of the initial torque.

3.2.1.6.3 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.7 Cold Age.

3.2.1.7.1 Maximum allowable leakage is 0.5 g (see Note in 3.3.1.1.3).

3.2.1.7.2 Maximum allowable loss of torque should not exceed 20% of the initial torque.

3.2.1.7.3 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.8 Vibration.

3.2.1.8.1 Maximum allowable leakage is 0.6 g (see Note in 3.3.1.1.3).

3.2.1.8.2 Maximum allowable loss of torque should not exceed 20% of the initial torque.

3.2.1.8.3 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.9 Axial Torque Testing.

3.2.1.9.1 Axial Torque Testing at Room Temperature ((+23 ± 3) °C). To evaluate metal ring resistance to the crack at ambient temperature, this test is designed to eliminate clocking, off-center loading, and part-to-part

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variation concerns. This test only applies for seal washer sizes 19.05 mm (3/4 in) and 15.87 mm (5/8 in) as an M8 bolt is required to pass through the fixture.

3.2.1.9.1.1 No crack in metal ring nor excessive stretching ($> 10\%$) is allowed.

3.2.1.9.1.2 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.9.2 Axial Torque Testing for Cold Torque ($(-10 \pm 3)^\circ\text{C}$). To evaluate metal ring resistance to the crack when assembly in low temperature, this test is designed to eliminate clocking, off-center loading, and part-to-part variation concerns. This test only applies for seal washer sizes 19.05 mm (3/4 in) and 15.87 mm (5/8 in) as an M8 bolt is required to pass through the fixture.

3.2.1.9.2.1 Seals shall be tested to torque (30 ± 3) Nm at $(-10 \pm 3)^\circ\text{C}$ (see Note in 3.3.1.1.3).

3.2.1.9.2.2 No crack in metal ring nor excessive stretching ($> 10\%$) is allowable once temperature increases from $(-10 \pm 3)^\circ\text{C}$ to $(+135 \pm 3)^\circ\text{C}$.

3.2.1.9.2.3 Seal washer appearance must meet 3.2.1.12 and be considered as re-useable.

3.2.1.10 Elastomer Permeability. Maximum allowable leakage of 40 g/cm²/year.

3.2.1.11 Corrosion Resistance. When tested per 4.3.11, the following requirements shall be met:

a. The A/C slim line seal washer shall meet:

1. The cosmetic corrosion requirements using method defined in GMW15272, Performance Specification, Table B4 for Underhood components.
2. The functional corrosion resistance using method defined in GMW15272, Performance Specification, Table B5 for Underbody components.

Note: Approval shall be the responsibility of the GM Global Thermal BFO.

3.2.1.12 Appearance and Cleanliness. All exterior ring surfaces shall be clean, free of rust, excessive rubber material over the metallic ring, ridges, sharp edges, nicks, scratches and manufacturing lubricants to assure positive sealing. Roughness must conform to Root Mean Square (RMS) - Roughness Average RMA Standard F-1 unless otherwise noted on part detail GM Drawing/Part Number.

Elastomeric materials must be homogeneous and free of any internal or surface blisters so as to ensure consistent swell, strength, and hardness characteristics. External surfaces of the sealing element must be free of defects and surface contamination such as bloom, aluminum debris, talc, mold release agents, and flash.

3.2.2 Physical Characteristics. The seal washer geometry has been designed to work under a joint that generally consists in two main mating components, male pilot and female block. The male pilot and female block shall follow a dimensional template to assure proper sealing, require latest template revision available to responsible BFO.

3.2.2.1 Dimensions and Capacity. Any seal washer installed in the GM A/C mating components hardware must be able to handle application torque and the full range of temperatures the application may be subjected to throughout operation without deforming or cracking.

3.2.2.2 Mass Properties. Not applicable.

3.2.2.3 Design Validation (DV). Slim line A/C sealing washers shall be tested for conformance per the sections listed in Table 1.

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Table 1: Design Validation (DV) and Product Validation (PV) Test Table
(Applies for Both DV and PV)

Section	Test	Number of Samples
4.3.1	Dimensional	12
4.3.2	Material	1 Batch
4.3.3.1	Elastomer/Retainer Retention - Plug Gauge test	12
4.3.3.2	Elastomer/Retainer Retention - Universal Machine Test	12
4.3.5	Thermal Cycle	6 (see 3.2.3.2)
4.3.6	Heat Age	6 (see 3.2.3.2)
4.3.7	Cold Age	6
4.3.8	Vibration	6 (see 3.2.3.2)
4.3.9	Axial Torque Room Temperature	6 (see 3.2.3.2)
4.3.9	Axial Torque Cold Temperature	6 (see 3.2.3.2)
4.3.10	Elastomer Permeability	1 Batch
4.3.11	Corrosion Resistance	12
4.3.12	Appearance	12

3.2.2.3.1 Design Validation Test Samples Requirements.

- Slim line A/C sealing washers manufactured for Design Validation (DV) tests shall be completely representative of production level dimensions and materials. The exceptions are those assemblies needing to be specially manufactured under extremes of dimensions and/or tolerance to meet the test requirements of the specification. Any exceptions to this requirement must be reviewed beforehand and approved by the GM Global Thermal BFO issuing the approval.
- All DV test specimens must be retained by the supplier for a minimum of one year and supplied to the GM Global Thermal BFO for review upon request.

3.2.2.3.2 Design Validation Approval. The appropriate Tier One A/C line supplier **or** the A/C slim line sealing washer supplier shall provide DV approval to the appropriate GM Global Thermal BFO and GM Global Thermal Validation Engineer through the Production Part Approval Process (PPAP).

3.2.2.4 Product Validation (PV). Slim line A/C sealing washers shall be tested for conformance per the sections shown in Table 1 (Table 1 applies for both DV and PV tests). If required, each individual test shall be run with statistically-based sample size per GMW15760, such that the reliability requirements stated in 3.2.3.2 are satisfied.

3.2.2.4.1 Product Validation Test Samples Requirement. Slim line A/C sealing washers manufactured for Product Validation (PV) tests shall have dimensions, materials and manufacturing equipment representative from production level. Potential variations from production tooling, process and place of manufacturing must be evaluated as well.

3.2.2.4.2 PV Approval. The appropriate Tier One A/C line supplier **or** A/C sealing washer supplier shall provide PV approval to the appropriate GM Global Thermal BFO and GM Global Thermal Validation Engineer through the PPAP process.

3.2.2.5 In-Process (IP) Evaluation.

- In-Process (IP) Evaluation tests shall be completed satisfactorily with parts randomly selected from production process per GMW15760.
- Samples shall be selected at random to represent the entire production quantity.
- Every 6 month period, or more frequently as required, the supplier shall run the tests listed in Table 2.

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Table 2: In-Process (Process Verification) Test Table

Section	Test	Number of Samples
4.3.1	Dimensional	per GMW15760
4.3.2	Material GMW14727 Hardness Elongation at Break Tensile Strength Stress at a Given Strain (Modulus) Thermal Gravimetric Analysis (TGA) Glass Transition GMW14727 Hardness Density TGA	each Batch
4.3.3	Elastomer/Retention - Plug Gauge test	per GMW15760
4.3.9	Axial Torque Room Temperature	per GMW15760
4.3.9	Axial Torque Cold Temperature	per GMW15760
4.3.12	Appearance	per GMW15760

3.2.2.5.1 In-Process (IP) Approval. IP tests are self-approved by the manufacturer's supplier, subject to audit by GM Supplier Quality Engineering.

3.2.2.5.2 Alternative In-Process Compliance. Supplier may request an exception from IP testing, provided the supplier can demonstrate that sufficient process controls are in place so as to make IP testing unnecessary. Approval to be provided by the GM Supplier Quality Engineer and/or the GM Global Thermal BFO. The period of testing (6 months) may vary, depending on data shown by supplier. GM Supplier Quality Engineering and the GM Global Thermal BFO will determine final IP period.

3.2.2.5.3 Lot Retention. In case of IP test non-conformance, the affected production lot shall be retained by the supplier until Root Cause Analysis is completed. The supplier shall then decide the disposition of the affected production lot. The supplier has three (3) options for this retained lot. It shall be either:

- Scrapped.
- Corrected and certified (which may mean lot testing the revised part again) based on the root cause analysis.
- Shipped without correction if deemed to be acceptable based upon the root cause analysis.

In any event, GM Supplier Quality Engineering and GM Global Thermal BFO shall be notified whenever any of the previous listed options (a through c) is exercised.

3.2.2.5.4 Record Retention. All DV, PV and IP test data must be retained by the manufacturer for a minimum of 10 years from date of test and be subject to audit by the GM Global Thermal BFO and/or GM Supplier Quality Engineer (SQE).

3.2.2.5.5 Deviations From This Standard. Deviations from the requirements of this standard shall have prior written approval from the responsible GM Global Thermal BFO. Such requirements shall be specified on component GM Drawings/Part Numbers, test certificates, reports, etc.

3.2.2.5.6 Audit Inspection Testing. If not defined otherwise, the testing required for audit inspection will be as indicated in 3.2.2.3.

3.2.2.6 Physical Characteristics. Physical Characteristics must conform to reference GM released Drawings/Part Numbers indicated in 3.3.2.1.

3.2.2.7 Dimensions and Capacity. See 3.3.2.1.

3.2.2.8 Mass Properties. Not applicable.

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3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. This specification as written provides a test exposure representing a Reliability Evaluation Point (REP) of 15 years.

The GM Global Thermal BFO will inform the A/C slim line washer supplier which REP number must use.

3.2.3.2 Reliability Requirements. This specification, as written, supports demonstration of the required minimum reliability of 97% at a 50% confidence (R97C50). This requirement is applicable for Thermal Cycle, Vibration and Heat Age tests using minimum samples for test lives shown in SOR Appendix G, CG2987, Analysis/Development/Validation Plan and Report (ADVP&R).

3.2.3.3 To assess reliability, there is a need for certain parameters:

- Test life.
- Confidence level.
- Sample size.
- Slope of failure distribution. Slope can be based on actual test data; data from past test results, or expected engineering distribution for the type of failure mechanism. A slope of 2 is used for mechanical systems as a default value (value from historical data).

3.2.3.4 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 (see GMW8758). GM Validation Engineering shall review and accept reliability demonstration test plans prior to the supplier submitting the ADV (Analysis Development Validation) Test Plan for approval.

3.2.4 Serviceability. Not applicable.

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

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines.

- a. Metal retainer ring material supplied under this specification:
 1. Must be fabricated as per retainer material specification indicated in 3.3.2.1 released GM Drawings/Part Numbers with certifications from the mill as to material alloy designation and physical properties.
 2. Must be identified upon receipt of the material by the retainer manufacturer.
- b. The seal washer supplier shall monitor continuously for material certification for chemical and physical properties (including Chemical composition, hardness, Tensile strength and Elongation) in all the supply chain including Steel Mill, Importer, Strip Distributor, Stamper and Seal supplier, to assure that no physical properties have been affected more than the typical process variation from the initial design intent.
- c. Rubber compound material supplied under this specification must be fabricated as per compound code indicated in 3.3.2.1 released GM Drawings/Part Numbers.

3.3.1.1.1 Recycling Guidelines.

- a. There are no recycling guidelines for rubber parts. Rubber cannot be recycled as material.
- b. Materials developed to this specification shall be optimized to provide maximum end-of-life cycle value utilizing the Recyclability Checklist and GM Recycling Design Guidelines.
- c. Recycled content shall be reported to the approving and procuring Materials Engineering Department utilizing the Recycled Content Report Form. Reference the Recyclability/Recoverability Guidelines, GMW3116.

3.3.1.1.2 Restricted and Reportable Substances for Parts. All materials supplied to this specification must comply with the requirements listed in GMW3059.

3.3.1.1.3 Material Compatibility. See 1.3 for details on fluids selected for tests. The acceptance requirements are identical for any combination of refrigerant and compressor oil.

The compatibility test shall perform one (1) time for each combination of refrigerant type and compressor oil formulation.

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Note: Pre-lube with hydrocarbon based or mineral oil is NOT PERMITTED for any type of Ethylene Propylene Diene Monomer (EPDM) seal washer.

3.3.1.2 Processes Guidelines. All production A/C slim line sealing washers must be manufactured with the same materials and processes used to manufacture the originally approved sample sealing washers. No change is permissible without prior written approval from the responsible GM Global Thermal BFO.

Suppliers shall use Statistical Process Control (SPC) and industry best practices for all manufacturing activities.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Design Guidelines and Constraints.

3.3.2.1 Drawing/Part Number Requirements. A/C slim line sealing washers supplied under this specification must conform to released GM Drawings/Part Numbers approved by GM Thermal Design Release Engineer (DRE) and the BFO.

3.3.3 Identification and Marking.

3.3.3.1 Supplier Identification.

- a. A/C slim line sealing washers supplied under this specification must be visually identified in a manner exclusive and unique to each supplier to permit rapid identification of each respective sealing washer manufacturer such that they do not affect the function and/or performance of the part.
- b. Identification methods must be submitted to and approved by the Global Thermal BFO.

3.3.4 Workmanship.

- a. Key Product Characteristics (KPC) will be defined on the GM approved engineering GM Drawings/Part Numbers.
- b. The A/C slim line sealing washer shall have manufacturing capability such that all dimensions are targeted at print nominal.
- c. The supplier shall submit a detailed improvement plan which describes how their manufacturing process for each part/operation shall achieve a process distribution of ± 6 sigma, which must be less than or equal to the tolerance spread as specified on the detailed GM Drawing/Part Number. The improvement plan shall be submitted to the Global Thermal BFO.

3.3.5 Interchangeability. The list of approved A/C slim line sealing washer suppliers shall be listed on GM Drawings/Part Numbers indicated in 3.3.2.1.

3.4 Documentation. Documentation released in the DV and PV tests stage shall be approved by the GM Global Thermal BFO and GM Global Thermal Validation Engineer prior to start of delivery of production level parts. IP tests documentation is contained in 3.2.1.3.1. Documentation submitted for material qualification shall include:

- a. A/C Slim Line Seal Washer Part Number.
- b. Tool Number.
- c. Batch Number.
- d. Date of Molding.
- e. Elastomeric Material Compound Number.
- f. Retainer Material.
- g. Type and Manufacturer of Refrigerant.
- h. Type and Manufacturer of Compressor Oil Used for Validation Performance.

3.4.1 Failure Mode and Effects Analysis (FMEA). Detailed design and process FMEAs shall be submitted to the GM Global Bill of Material Family Owner (BFO) and GM Global Thermal Validation Engineer and they will be maintained as part of the records of the Design and Product Validation. The FMEAs shall be updated each time a design or process change occurs. FMEAs shall be submitted with the GM Production Part Approval Process (PPAP) documentation.

3.4.2 Design Validation and Product Validation. Documentation of DV and PV test reports shall be through the normal PPAP process. Any non-compliance during Design Validation or Product Validation phases must be documented and resolved before validation is considered complete.

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