



Engine Accessory Drive Dual Arm Single Spring Belt Tensioner

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.

1.1 Purpose. This standard covers supplier requirements for engine accessory drive belt tensioners with the equivalent of two (2) arms and one (1) spring between them. The pulleys apply load on opposite sides of the Motor Generator Inverter Unit (MGIU) or alternator.

1.2 Applicability. These tensioners are usually used for Belt Alternator Starter (BAS) applications, but not with using two (2) tensioners of the hydraulic damped type and/or the conventional rotary mechanical type. The differences in configuration of these designs drive different failure modes and features and, therefore, different validation testing. They merit a specific specification.

1.3 Remarks. This standard covers only specific types of tensioner configurations. There are three (3) other accessory drive belt tensioner specifications that cover linear, GMW16326; and conventional rotary mechanical tensioners, GMW16244; as well as existing application BAS belt tensioners, GMW16327.

2 References

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

2.1 External Standards/Specifications.

ACEA A3/B3	ISO 3745	ISO 11469	SAE J2236
ANSI 1.35	ISO 9001	JIS Z8732	SAE J2436
ISO 1431-1			

2.2 GM Standards/Specifications.

GMW2	GMW3286	GMW16037	GMW16327
GMW5	GMW3359	GMW16244	GMW16331
GMW3044	GMW3396	GMW16290	GMW17081
GMW3059	GMW14671	GMW16291	GMW17095 (ID)
GMW3116	GMW15282	GMW16326	

(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.

- Contecs Engineering Service GmbH, Berlin Germany (www.contecs-engineering.de)
- Forest City Technologies, Wellington, Ohio (www.forestcitytech.com)
- Fundamentals of Acoustics (4th edition), Kinsler, L. E. & Frey, A. R. (2000). New York: Wiley
- Statement of Requirements (SOR)
- Tucker's Pottery Supplies Incorporated, Ontario, Canada (www.tuckerspotttery.com)

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

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3.1.1 Appearance. These tensioners are of three (3) configurations.

3.1.1.1 Arc Shaped Styles. There are supplier specific terms used to describe the arc shape of the designs with a pulley at each end. These can be referred to as arc style tensioners in general. They are typically attached to an alternator or Motor Generator Inverter Unit (MGIU) with pulleys on either side of a spring. One pulley is usually attached to the structure that can rotate around the alternator/MGIU pulley, which is its arm. The other rotates on an arc shaped or equivalent arm on the same center, but independent of the other arm/pulley. The spring has the two (2) arms/pulleys bearing on opposite ends of the spring, and applies load between them. The other execution is a conventional torsion spring, mechanical rotary tensioner applying load to one (1) pulley with its base attached to a rotating arm. This arm is centered at the MGIU centerline for the other pulley to apply load on the other side of the MGIU. A bracket attaches the tensioner assembly to the MGIU in all cases.

3.1.1.2 “V” or “Y” Shaped Style. In these designs, there is a torsion spring inside a conventional aluminum housing with two (2) arms, one (1) on the top, and one (1) on the bottom of the spring housing, or offset to a pivot remote from this housing. Each arm has a conventional idler pulley to apply load. These designs are usually located under or beside the MGIU, and the belt is routed around one (1) pulley, and then the MGIU, and finally around the other pulley. It is unique to BAS applications.

3.1.1.3 Two (2) Independent Arm Style. These devices are mounted to the MGIU or alternator, or alternatively mounted to the engine or a bracket, or any combination thereof. One (1) pulley is attached to an arm that pivots about a point outside the diameter of the MGIU pulley. Similarly, the other pulley is attached to an arm that pivots about a point outside the diameter of the MGIU, and not coincident with the pivot of the first pulley. There is a spring element between the two (2) arms to apply tension to the belt on both sides of the MGIU pulley. This design is typically implemented with travel limiting stops to control the range of motion of the arms.

3.1.2 Content.

3.1.2.1 Physical Content. The part breakdown is different across suppliers and design executions. The attaching bracket to the MGIU can be either an aluminum die casting or a stamped steel part. The arms can be steel or aluminum or just attached with a plastic adapter from the spring to the pulleys. The springs can be flat section arcs or round arcs, or torsion designs or arc/straight coil springs. The most important details are the seals between the bracket and the arm rotating around the MGIU centerline, since contamination resistance is difficult to achieve.

3.1.2.1.1 Drawing. This specification shall be referenced “Must meet requirements of GMW17739” on the supplier detail drawing and shall appear on the GM released detail drawing.

No tensioner design shall be proposed by the supplier which uses other than the design preapproved by the GM Technical Specialist.

Parts must be pre-validated, before they can be quoted to satisfy a Statement of Requirements (SOR) and prior to any experimental part build.

3.1.2.1.2 Cross Sectional View. Detail released drawing shall describe all internal parts. Each sub-component part shall be listed by supplier part number, material and latest change date. Plastic and elastomeric parts, as well as greases, shall be described by specifying the second tier source and material supplier for that sub-component and the material source alpha numeric description of the grade and base polymer involved. Only dimensions that involve the mating part interfaces need be on the detail drawing.

3.1.2.1.3 Pulley. Idler pulleys shall contain preapproved ball bearings and internal content. Pulley construction options shall be described as specified in GMW16290 and GMW16291, for example:

- Steel: Grade and finish expressed as GMW callouts.
- Thermoset plastic: Only approved first or second tier suppliers can be used.
- Thermoplastic: Only approved suppliers can be used.
- Powdered, forged or cast and machined iron: Can be used for backside applications only for low volume applications. Copper infiltrated or steamed material can be used to support the paint finish.
- Ball bearing: Approved sources/content only.
- Seal: Elastomer material and lip design type must be specified, preferably as an alpha-numeric code designation.
- Grease: Source and grade/type must be described.

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- Cage: Polymer material and grade must be described; preferably as an alpha-numeric code designation.
- Shield design showing full bearing coverage and approved labyrinth configuration.
- Pulley bolt shall have a flange with a minimum 23.5 mm diameter flat (not outside diameter) on the underside to cover the bearing inner race. This will reduce the stress in the bolted joint, and prevent yield of the shield under the clamp load as well as apply axial load only to the bearing inner race.

3.1.2.1.4 Charts. Written information shall be charted for clarity.

3.1.2.1.5 Confidentiality. The drawing(s) shall be reserved as a record to specify the design being quoted. It shall not be shown to another source or copied for distribution outside General Motors.

3.1.2.1.6 Internal Configuration.

3.1.2.1.6.1 Pivot Designs. Depends on supplier designs. If a conventional torsion spring tensioner design is used as part of the assembly, the damping and pivot must be independent. The pivot must not be a "cone" type, but be of constant diameter construction. For the arc shaped designs, with flat bushings used on some constructions, the design must be approved by the Technical Specialist and be fully protected from contamination, preferably with Thermoplastic Elastomer (TPE) lip seals. Cylindrical pivots must be sealed to prevent any liquid ingress, and flat arc seals also must be fully sealed against liquid ingress. The reason for this is the very small internal volume of these designs. This volume can fill with dissolved salt and/or mud quickly, which cannot escape, but rather harden and then seize the interfacing components. In general, the source and grades of the pivot bushings and sealing components are required to be on the supplier drawing.

3.1.2.1.6.1.1 Pivot Bushings. These parts are of varying construction, depending upon supplier and require pre-approval for design, sealing and materials by the Technical Specialist.

3.1.2.1.6.2 Mechanical Tensioner Pivot Couple Compensation. This only applies to designs using a mechanical torsion spring tensioning component as part of the assembly. Pulley centerline to bearing centroid offset couple, must be compensated for internally to avoid diagonal point wear on the pivot bushing. Design also requires preapproval.

3.1.2.1.6.3 Damping Package. This is also supplier dependent. Must be stable over time after break-in and be completely independent of the pivot, if applicable, for consistency over time. This means a short break-in, < 5 minutes to stabilization, on the cable durability test, and stabilized damping following the break-in within the specified value in 4.3.3 for the life of the part. All designs require Section 4 durability testing of six (6) samples minimum, unless otherwise specified, representing the range of damping element variation possible in production. Generic design performance must be demonstrated prior to source consideration for an engineering application. In general, the sources and grades of the damping components are required to be on the supplier drawing.

3.1.2.1.6.4 "V" or "Y" Mechanical Tensioner Spring Tangs. This also only applies to conventional tensioner incorporated designs, as mentioned in 3.1.2.1.6.2. Offset couple over length of the spring between its tangs must be compensated via the angular tang location relative to the arm at nominal position, so that arm parallelism can be held over normal range of operation.

3.1.2.1.6.5 Sealing. Contamination protection is required for each opening to atmosphere using approved designs. Elastomeric or TPE, or resin seals must be provided on arc shaped designs to meet the requirements of the most severe applications. These materials must meet requirements of ozone exposure, 70 h at 100 pphm with a zero (0) rating per ISO 1431-1, as well as heat aging for 1008 h at 130 °C to 150 °C (depending upon material), with 50% retention of elongation and tensile strength per SAE J2236. These provisions are required, but the specific implementation may vary on each application if packaging forces change from the basic supplier intent due to packaging constraints. Parts run on hot cycle durability tests must be exposed to these tests prior to start of 4.3.7.4.1. In general, the source and grades of the sealing components are required to be on the supplier drawing.

3.1.2.1.6.5.1 Arc Shaped Design Tensioner Sealing. Labyrinth sealing is not adequate as a design approach, but rather elastomeric/TPE contact seals. Contamination is a particularly difficult performance criteria to meet with these designs. All designs require Technical Specialist preapproval.

3.1.2.1.6.5.2 Conventional Mechanical Tensioner Feature Design Sealing. Also depends on design, but the torsion spring housing and arm require a labyrinth between the castings so that there is no direct path for contaminants to enter the interior of the housing. The other arm interface also requires sealing for any bearing surface involved. Individual designs require Technical Specialist pre-approval. Some designs will require contact

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seals at the top and/or bottom of the pivot to prevent entry of contaminants. The basis for sealing requirements is that no contaminants may enter the pivot or damping interfaces. On some applications, the entire spring cavity must be sealed against liquid entry. On those applications where this requirement is known at the time of sourcing, it will be specified in the SOR, but in most cases, it will only surface after GM testing in the vehicle. The supplier must respond with the sealed design in those cases as they arise, but should have a concept ready so as not to preclude the potential of accomplishing this requirement.

3.1.2.1.7 Fracture Resistance. The rotation feature and stops in the arm and base castings must be capable of resisting twice the loads applied by the spring, or a greater value if detailed in the SOR for cases where the access is limited or awkward. Performance must be demonstrated on six (6) samples of parts off of each cavity of production tooling. Care must be exercised to consider frequent application of this feature for service and the wear of the feature from imperfect actuation. Final designs require GM Technical Specialist and Release Engineer approval.

3.1.2.1.8 Arm to Spring Housing Angular Location Indicator. This feature may be required in a visible location as installed in vehicle. Technical Specialist and Release Engineer approval is required. Not all designs require this feature.

3.1.2.1.8.1 Location Indicator Configuration. Since there are two (2) arms and no certain null position, the positional indicator requirement may be waived. The configuration is application specific, and will be discussed and agreed upon with the supplier and the Release Engineer.

3.1.2.1.9 Tensioner Angular Location Feature. A pin(s) or multiple fastener or other feature on the tensioner mounting surface must be provided to control its location. A dot and slot feature is required on multiple fastener applications. Release Engineer approval is required.

3.1.2.1.9.1 Dot and Slot Attachment Provision. Tensioner mounting holes must conform to net hole/net slot design concept. One (1) hole must be 8.00 mm minimum to 8.20 mm maximum, and the other hole in the same plane, must be a slot with its major centerline intersecting the center of the net hole. Width is to be 8.00 mm to 8.20 mm and length of 9.50 mm. Exceptions require Release Engineer approval.

3.1.2.1.10 Features/Hardware. In general, tensioners must be shipped in the installation position by inclusion of pins or other features to hold the arms and pulleys out of the way for belt installation.

3.1.2.2 Functional Content. The tensioner provides load to the belt through its pulleys to prevent slip, and with damping to resist torsional input vibration. Damping can be achieved between the bracket and arm, or in the conventional torsion spring tensioner, or both. All functional content requires Technical Specialist preapproval and pre-validation. Some function is addressed in the requirements of the tests in Section 4.

3.1.2.2.1 Tensioner Travel. In general, tensioners should be designed to avoid hard stops. It is preferred for the belt length to provide the end positions of the tensioner travel. In this case, one (1) belt span approaches straight while pulley wrap on one (1) of the tensioner pulleys approaches zero (0). Travel must be sufficient to meet the requirements of the geometry of the application, including belt length and other component variation, as well as temperature effects.

3.1.2.2.1.1 Stops. Should the design incorporate stops, the balance between stop durability and contact noise must be demonstrated prior to any consideration for preapproval. Stops have the advantage of limiting travel, which may be a packaging advantage in some applications. For these designs, there must be bias in the geometry to cause the tensioner to rest on the regeneration (regen)/charge stop under most operating conditions. The tensioner would only leave that location in the event of a torque reversal from the regen to the boost condition. This limits contact frequency on one (1) stop and can limit or increase the impact on the other stop. These designs cannot be considered for quote without approval of the Technical Specialist after analysis and testing review. Approval will consider behavior both hot (120 °C to 130 °C application specific) and cold (-40 °C) and after being thermocycled between those temperatures or as specified in the application SOR. Actual maximum temperature may be higher on some applications and will be specified in the SOR.

3.1.3 Ambient Environment. Varies by application, but is assumed to be -40 °C to 121 °C. The extremes are excursions. The hot environment temperature will be the internal temperature of the moving parts as measured at an outside temperature of 38 °C. Prior to application measurements, existing data will be used. Exposure to contaminants is covered in Section 4.

3.1.4 Interfaces. The belt/pulley interface is covered in Appendix A, Table A1.

3.1.5 Usage Definition. General purpose.

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3.2 Product Characteristics.

3.2.1 Performance Requirements. Durability and noise performance are addressed in Section 4.

3.2.1.1 Specification Values. Design must be capable of default values shown in applicable paragraphs containing alpha characters corresponding to the values and paragraph definition in Appendix A, Table A1. Sensitive or quiescent applications, however, may be assigned more or less stringent values from Table A1 in Appendix A, corresponding to alpha codes in the applicable paragraph text.

3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. Dimensional requirements are in Appendix A, Table A1.

3.2.2.1.1 Dimensional. To be reflected on engineering drawing. Gage Repeatability and Reproducibility (Gage R&R) as well as the procedure/fixture for measurement must be reported with dimensional capability/measurement, prior to the Global Propulsion Systems (GPS) beta design phase. Note that shadowgraphs for measuring compliance to pulley profile requirements are not permissible in favor of digital profilometers or laser/vision systems. The measurement technique must be approved by the Technical Specialist.

3.2.2.1.2 Tensioner Mounting Surface Offset to Idler Pulley Bearing Seat. See Appendix A, Table A1. Measurements are made with the tensioner against its mounting surface and the arms rotated to their nominal position, and design hub load applied in the design direction relative to the arm centerlines. The plane of the mounting surface must be parallel to the plane of the idler pulley bearing seats within ± 0.40 degrees (**L**). This value may increase to ± 0.50 degrees (**M**) at the end of the cyclic durability test in 4.3.7.4.4. In addition, the dimension from plane of mounting to plane of bearing seats must be within 1.00 mm $\pm$ 0.5 mm axial plane offset (**N**) at the nominal arm locations.

3.2.2.1.3 Mounting Surface Flatness. See Appendix A, Table A1. The surface flatness must be within 0.25 mm (**P**). This is intended to imply machining on sensitive applications. Normal flatness is 0.50 mm for as-cast applications.

3.2.2.1.4 Pulley Centerline to Bearing Seat. See Appendix A, Table A1. The pulley centerline (or reference surface) must be located relative to bearing seat within 0.25 mm (**R**) excluding free rock. This applies to groove side pulleys, which are not normally used and only at the specific request of the Release Engineer.

3.2.2.1.5 Pulley Runout. The radial and lateral runouts are to be within 0.25 mm. This applies to the pulley as a sub-component.

3.2.2.1.6 Pulley Bearing Free Rock. There is no specific free rock requirement, since it is not generally measured in the bearing industry. It is a function of clearance and race curvature, which is at the discretion of the supplier and approved by GM through validation. Mounted clearance is a function of the pulley design, and the specified clearance from the bearing supplier. Measurement may be performed by rotating the outer race about a centered ball on one (1) side with 2 N side force applied on the other side.

Note: Can also be calculated from radial clearance range with a given source/race curvature (usually 1.02 times to 1.04 times the ball diameter).

3.2.2.2 Mass Properties. Not applicable. Mass is system design dependent and subject to packaging constraints. System design is GPS responsibility. Mass shall be minimized within these constraints.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. Evaluated by performance to validation test series in Section 4 and manufacturing process approval. The effect on the engine/vehicle is a function of the GM accessory drive design, and a given application will be durable for varying lifetimes depending on the system design and performance requirements. The intent is for the GM design to operate within the pre-validated test parameter levels in this document. The supplier is not responsible for the system design, but is responsible for SimDrive system analysis and testing.

3.2.3.2 Reliability Requirements. Supplier must meet requirements of Section 4, and have the production manufacturing process approved by the Global Technical Specialist. These test requirements are intended to meet the GM vehicle 240 000 km and 15 year reliability requirements. Some systems will not be able to meet these requirements because the physical limitations of the GM system design and vehicle packaging. The supplier is only required to meet the requirements of this specification and other requirements added in the SOR, if applicable.

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3.2.4 Serviceability. This is a system issue, which is not covered in this specification. An arm rotation feature for each arm is required to facilitate belt installation and removal.

3.2.5 User System/Subsystem/Component/Part Interface. The supplier must meet the packaging environment of the math data delivered with the SOR. The system interface and packaging responsibility belongs to GPS.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines. All sub-component materials must be specified by the supplier, and approved by the GPS Materials Engineer and the Technical Specialist.

General material specifications shall be North American controlled standards, e.g., GM, GMW, SAE International (SAE), ASTM International (ASTM), and Metal Powder Industries Federation (MPIF) where possible. International standards, such as German Institute for Standardization (DIN), Japanese Industrial Standards (JIS) and the like may be acceptable, as may be supplier internal standards if none other exists.

3.3.1.1 Material Guidelines.

3.3.1.1.1 Restricted and Reportable Substances. All component parts must meet GMW3059. This includes, but is not limited to, hexavalent chrome free finishes.

3.3.1.1.2 Part Cleanliness. Every detail drawing must call out, "Parts as delivered to assembly plant shall be clean and free of debris, residual abrasive material and corrosion products adversely affecting function or appearance". No laboratory part cleanliness testing (reference GMW16037) is required.

3.3.1.1.3 Coatings/Platings/Finishes. All finishes must be called out on the detail drawing to the appropriate GM specification. If an electrocoat, electrodeposition paint operation, or powder epoxy finish is used, the following are options:

- Clean, zinc phosphate and paint black by cathodic electrocoat or electrodeposition paint operation, conforming to GMW14671 Type A-U/H with scribed 168 h salt spray testing only. Corrosion and creepback must meet the requirements of GMW3286 and GMW15282, respectively. No other testing is required.
- Clean, zinc phosphate and paint black with powder epoxy conforming to GMW14671 Type A-U/H with scribed 168 h salt spray testing only. Corrosion and creep back must meet the requirements of GMW3286 and GMW15282, respectively. No other testing is required.

3.3.1.1.4 Metals. Callouts are required on the detail drawing as follows:

- **Die Cast Aluminum:** Shall employ GMW5 specification. A380 is equivalent to GMW5M-AI-C-D-Si8Cu3Fe-F, and A383 is equivalent to GMW5M-AI-C-D-Si10C2Fe1-F. Note that the GMW5 callouts follow ISO 9001, based on chemical symbols applicable to all the light metals and their alloys. International symbols are used in GMW5 to cover the major alloying elements and significant residual elements. Alloying elements, defined as those with an upper and lower limit (other than zero) in the chemical composition are listed left to right in order of decreasing content, or in alphabetical order in the case of equal percentages. Each chemical symbol is followed by whole numbers denoting the nominal percent present in the alloy. In Asia, ADC10 or ADC12 alloys are permissible using the preceding GMW5 callouts with exceptions in alloy percentages noted on the detail drawing.
- **Steel:** GMW2M-ST-S-CR1/HR0 (except pulley) with the finishes as in 3.3.1.1.4. In Asia, JIS standard callouts are permissible, but must be approved by the GM Technical Specialist and Materials Engineer. Some suppliers may employ alloyed steels with greater capability as required by their design limitations. These also require approval by the GM Technical Specialist and Materials Engineer.

3.3.1.1.5 Polymers. Callouts are required on the detail drawings using applicable GMW, ASTM, or SAE specifications. Include information on the group, class, grade, and glass content, as applicable.

3.3.1.1.5.1 Pivot/Damping/Sealing Components. These components require specification of the sub-supplier and grade of each material on the tensioner assembly drawing.

3.3.1.1.5.1.1 Pivots. The designs of the pivots must be such as to eliminate contact of parts that are separated from one another on the Galvanic Scale by 0.2 V or more. This is to prevent galvanic corrosion. This includes the condition where steel shafts contact DU style bushings with a copper and/or brass base material covered by Polytetrafluoroethylene (PTFE). It also includes prevention of designs where liquid contamination can connect dissimilar materials separated on the Galvanic Scale by 0.2 V or more. Note that pre-aging of these non-metallic

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parts is required prior to start of durability testing. See 3.1.2.1.6.5. All designs require GM Technical Specialist approval.

3.3.1.1.5.1.2 Damping Components. The thermoplastic components for damping are critical for noise, durability and damping level over time. In general, it is required to have as equal as possible levels of static and dynamic Coefficient of Friction (CoF) to prevent stick-slip noise. Suppliers must report the static and dynamic CoF levels of these components. Materials are at the discretion of the supplier, but must pass all test requirements in this specification and require GM Technical Specialist approval. Note that pre-aging of these parts is required prior to start of durability testing. See 3.1.2.1.6.5.

3.3.1.1.5.1.3 Sealing Components. Polymeric sealing components require use of materials that combine flexibility and durability. As a consequence, the choice of materials is critical to performance both new and throughout the life of the tensioner. Especially on designs that require complete sealing, the materials must have properties that resist compression set and elongation loss with time. This means that all elastomeric components must be post-cured to limit compression set. Durability testing requires pre-aging of these parts prior to start of test. See 3.1.2.1.6.5.

3.3.1.1.5.2 Recycling. Some plastic parts may be subject to recycling consideration. Generally, tensioner parts are not in this classification because of composite fillers. At the direction of the Release or Materials Engineer, it may be necessary to mold in a symbol to identify the material for potential use in collecting and handling of parts for recycling. In such cases, the drawing note shall read, "Mark parts per ISO 11469. Marking size and location per GMW17081".

3.3.1.1.5.3 Reground Plastic. Thermoset plastic parts shall be made of 100% virgin polymer and fillers, and must be called out as such. Thermoplastic parts must have a note on the detail drawing designating the permissible level of regrind (even if zero, which is normally the case). The note shall read, "Regrind content: Re XXHS maximum per GMW17081". Levels will vary depending on the nature of the composite reinforcement and the length of fiberglass fibers when used. No callout presence shall default to 100% virgin material. No post-industrial or post-consumer material shall be used, but rather home scrap (runners/sprues) from the same process, when allowed. See GMW3116 Recyclability/Recoverability Guidelines for more information.

3.3.1.1.6 Tensioner Pulley. Material may be steel: GMW2M-ST-S-HR1/CR2. Thermoset plastic or thermoplastic polyamide (nylon 6/6) glass filled or equivalent can only be used with specific sub-supplier approval from the GPS Technical Specialist. Plastic resin fill and grade also require this same approval. Upon occasion, powdered metal or forged and machined pulleys will be used to address very low volume. There are a number of acceptable materials that can be used. If this is the case, then the material will be addressed on an application by application basis so as to provide flexibility to the supply base for optimized cost.

3.3.1.1.7 Fastener Corrosion Protection. Must meet the requirements called out in GMW3359 or GMW3044 8K240/120T.

3.3.1.2 Processes Guidelines. See 7.3.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Design Guidelines and Constraints. Covered in each paragraph in this specification where applicable.

3.3.3 Identification and Marking. Label requirements shown on engineering chart/drawing. In general, the supplier identification is not allowed.

As described in GMW16331, the GM part number and the traceability information is required as well as use of the GM logo is required where practical. Depending upon region, bar code or data matrix traceability/identification information may be required as detailed in the SOR.

3.3.4 Workmanship. Not applicable.

3.3.5 Interchangeability. Not applicable.

3.4 Documentation. Not applicable.

3.5 Support of System/Subsystem/Component/Part After Sale. Supplier must provide root cause analysis and corrective action for issues identified in service/warranty by Supplier Quality and/or Product Engineering.

3.6 System/Subsystem/Component/Part Operator Training. Not applicable.

3.7 System/Subsystem/Component/Part Characteristics. Not applicable.

3.7.1 System/Subsystem/Component/Part Definition. Not applicable.

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4 Validation

4.1 General. Validation testing is intended to be done by the supplier on bench test rigs which address each specific failure mode as it applies to the design configuration. These tests are intended to provide durability test data to satisfy the GPS required 240 000 km and 15 year durability requirements. Some applications may overstress the supplier designs because of unusual system input conditions and/or packaging compromises. These GM application design issues are the responsibility of GPS and may require a scheduled part replacement in service. Special tests may be required of the supply base if exceptional failure modes surface as a result of packaging or if unexpected input issues arise in GM testing. This will be avoided in most cases.

4.2 Validation Cross Reference Index. Not applicable.

4.3 Supporting Paragraphs. Validation testing.

4.3.1 Noise. There shall be no audible (noise above the background level, as measured by GM) pivot bearing, spring, stop, idler pulley including tonal "hoot" or damping package noise at the beginning and at the end of the cyclic durability test in 4.3.7.4.4.

4.3.1.1 Rattle/Contact Noise Evaluation. Airborne sound power shall be measured by GM on the total powertrain, from outside the vehicle with the hood up from a three (3) microphone array 1 m above and forward of the hood opening. All engine and MGIU operating conditions will be measured, including conditions that force the tensioner into end stop (if equipped) conditions, such as BAS starts, key starts, and boost to regen conditions. The tensioner as a component shall not exceed 70 dB(A) sound power, as measured per applicable standards (ANSI 1.35, JIS Z8732, ISO 3745) when hard mounted (over 350 Hz first mode) in a room with maximum anechoic cutoff frequency of 250 Hz. Tonal noises shall not exceed masking described in "Fundamentals of Acoustics" (reference 2.3). Generally, this requirement is to represent no audible noise at the vehicle level, so no measurements need be made by the supplier if no noise issues arise. Any noise issue found in GM testing, regardless of level, and significantly beyond the engine and vehicle masking levels, must be addressed by the tensioner supplier. Since noise quality is subjective, suppliers can prepare for noise testing by evaluating mule and development hardware together with the GM Technical Specialist and Release Engineers.

4.3.1.1.1 High Mileage, Heavy Duty Applications. On heavy duty applications where applicable, noise deterioration is permissible as in 4.3.1.1.1.1.

4.3.1.1.1.1 Airborne Sound Power. Airborne Sound Power may increase from 65 dB(A) when new to 70 dB(A) at the end of the cyclic durability test in 4.3.7.4.4. Tonal noises may increase by 5 dB(A) during this period as measured in 4.3.1.1 to compliment the expected increase in engine background masking noise. Again, no audible noise on the application will satisfy this requirement. This 5 dB(A) level is a general requirement and the absolute noise performance of the tensioner component can be greater provided it is masked.

4.3.1.2 Hoot Noise Test. After a conditioning or break-in, consisting of 10 h of rotary fatigue testing at 50 N to 1000 N hub load, the bearings are to be cooled to -30 °C and placed on a test rig with low pulley wrap (10 degrees to 15 degrees) and load (50 N to 110 N). Speed is to be swept from 0 rpm to 3000 rpm at 500 rpm/minute maximum rate. No audible hoot noise above engine masking is the requirement. In general, this means almost no audible noise on this test, since the noise is tonal. Use of the approval idler pulley bearings in the GMW16291 specification will normally satisfy this requirement, but occasional noise may arise on specific applications. Changes in bearing content by the supplier may be required if noise manifests itself.

4.3.1.2.1 Hoot Noise Criteria. No tonal noise above background level shall be present exceeding the masking level in 4.3.1.1 manifested as a single peak frequency or harmonics octaves of some fundamental frequency. Measurement is by single microphone, 150 mm in front of pulley at its centerline.

4.3.1.2.1.1 GM Noise Procedure.

4.3.2 Nominal Load - General. For these tensioners, nominal position of the tensioner shall be defined as the positions of the tensioners with a nominal 14 N·m charging MGIU torque from the MGIU. Torque at the crankshaft will depend upon final drive ratio. This will bias the tensioners in the "dead zone" when the load in both tensioner arms is nearly identical. This "dead zone" is the range of arm position where the system friction exceeds the difference in load applied by each arm. The tensioners can rest in this zone until the difference in tensioner load exceeds the system friction. Since the geometry of the drive changes in the "start" mode, so will the belt loads on the spans on either side of the tensioner pulleys. On some designs it may be more convenient to measure the spring load at a fixed length, representing the nominal position or at the stop positions in each direction, if

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applicable. Agreement must be reached between the supplier, the Technical Specialist, and the Release Engineer as to how the load is measured.

4.3.2.1 Nominal Load. See Appendix A, Table A1. Nominal load (**A**) on new stabilized parts shall be held within 20% ($\pm 10\%$) (**B**). Nominal load is defined as the demonstrated broken-in value **after** spring set has taken place. New part load must be adjusted upward to compensate for set. Nominal load shall be defined as the arithmetic average of the extremes of hysteresis from operation in both directions at the nominal arm position in the hub load direction. Break-in load decay must be measured, based on the particular internal construction preapproved by the Technical Specialist prior to source selection.

In production manufacture, this value is to be measured after stroking the arms to stabilization by a hydropulser or electropulser and on an audit basis. The same data is to be used to measure damping for some tensioner designs per 4.3.3. The as-built value is to be measured on each tensioner as a referenced specification with no tolerance, to assure correct assembly. Frequency of audit and number of arm/strut strokes/time to achieve stabilization must be mutually agreed between supplier and Release Engineer/Technical Specialist prior to pilot.

4.3.2.1.1 End of Life Load. At the end of the cyclic durability test in 4.3.7.4.4, the load shall not degrade from the broken-in value in 4.3.2.1 by more than 5%.

4.3.3 Tensioner Damping. See Appendix A, Table A1. The damping value in units of Newton-centimeters/millimeter on new parts is defined as the stabilized value measured at a temperature within the range from 50 °C to 75 °C (**K**) (as measured immediately **after** break-in/stabilization depending on the damping design) and at an arm stroke rate of 20 Hz (**C**) at ± 1 degree to ± 3 degrees (**D**) arm amplitude at nominal arm position in the hub load direction. This is measured after break-in as demonstrated on the same test described in 4.3.2, and preapproved by the Accessory Drive Technical Specialist. On tensioner designs with pivot damping on individual pivots, the measurement can be made by moving both arms simultaneously to stabilization. The time to stabilization must be experimentally determined.

Initial damping on new parts must be adjusted upward or downward to compensate for break-in effects. The area of the hysteresis loops of load versus arm displacement measured about the installed/nominal position as the average of 1 s of consecutive 20 Hz loops (dependent upon sampling rate) in units of Newton-centimeters/millimeter of stroke is to be measured on an audit basis in production manufacture after stroking the arm to stabilization. Load may be calculated from this same data, if applicable (see 4.3.2). Arc type tensioners may require independent spring and damping measurement depending upon design. Differences in measurement technique and equipment may be required, but must have Technical Specialist approval.

Frequency of audit and number of strokes/time to stabilization must be mutually agreed between supplier and Release/Supplier Quality Engineer/Technical Specialist prior to the Production Part Approval Process (PPAP). The as-built damping value is to be measured statically on each part as a reference value with no tolerance specification for the purpose of signature analysis to assure correct assembly.

At the end of the cyclic durability test in 4.3.7.4.4, the damping shall not degrade from the stabilized value in 4.3.3 by more than 5%.

4.3.3.1 Arc Style Tensioner. Must comply at the end of the cyclic durability test of 4.3.7.4.4 with no more than a 5% degradation in stabilized damping. See Appendix A, Table A1.

- **Range:** The tensioner must be designed such that the nominal stabilized damping can be varied between just pivot friction and added damping package friction, depending on design and application requirements. The maximum level of achievable damping must be reported by the supplier. On some applications requiring high damping, a low achievable level may disqualify a supplier. This is possible, but unlikely. The stabilized value (**E**) must be within $\pm 15.0\%$ (**F**) of the nominal value on new, broken-in parts. This value cannot be changed in production, since damping is inherent in the interfacing materials and loads, which are not adjustable and this value shall never be identified as a Key Product Characteristic (KPC) or Product Quality Characteristic (PQC).

4.3.3.2 Mechanical "V" or "Y" Tensioner. Must comply at the end of the cyclic durability test of 4.3.7.4.4 with no more than a 5% degradation. See Appendix A, Table A1.

- **Potential Nominal Range:** From pivot friction to 50 N·cm/mm, depending on application (after break-in).
- The stabilized value (**H**) must be within $\pm 15.0\%$ (**J**) of the nominal value. This value cannot be changed, so it shall never be identified as a KPC or PQC.

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