GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW25

Mechanical Properties and Material Requirements for Externally Threaded Fasteners

1 Scope

This specification defines the mechanical and material requirements for externally threaded fasteners sized M39 and smaller. This specification is based on ISO 898-1. However, only property class described in this document shall be used.

1.1 Material Description. The fasteners applicable to this specification are formed from wire steel and heat treated by quench and tempering, as required by the property class. The chemical composition, internal cleanliness of the steel, mechanical properties, microstructure, and other physical properties are described in this document.

1.2 Symbols. Not applicable.

1.3 Applicability. This specification applies to bolts, screws, SEMS (bolts with washer assembly), threaded plugs, and studs.

1.4 Remarks.

1.4.1 GM does not allow new release of fasteners with property class 9.8. The properties listed are for reference for legacy parts only.

1.4.2 General Motors have restrictions on usage of fasteners above property class 10.9. Fasteners above property class 10.9 shall be released only after approval from GM Fastener and Materials Engineers. Special "underlined grades" (identified as 12.9 and 10.9 for example) per ISO 898-1 are not permitted.

1.4.3 The scope of ISO 898-1 does not include threaded plugs. For the purpose of this specification, a threaded plug can be considered a very short bolt.

2 References

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

2.1 External Standards/Specifications.

ISO 898-1	ISO 6157-1	ISO 16047	SAE/USCAR-8
ISO 898-2	ISO 6157-3	SAE J422	

2.2 GM Standards/Specifications.

GMW3059

2.3 Additional References.

- GM Parts Drawing 24502102

3 Requirements

All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to submit a full material composition disclosure to GM via the International Material Data System (IMDS) or via a completed GMW3059 report form.

Fasteners manufactured to this specification shall meet the requirements and test methods of ISO 898-1 unless otherwise specified in this document.

Note: Fasteners with modified material or mechanical properties outside of specified range for the base property class shall not have the property class identified on the head of the fastener.

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3.1 Test Reporting. Table A3 lists the tests required to be performed and reported for Production Part Approval Process (PPAP) and also for each production lot. When requested, other requirements described in this standard shall be produced by the fastener supplier.

3.2 Steel Chemistry. Fasteners to this standard shall be made of steel conforming to the chemical composition requirements specified in Table A1.

3.2.1 In addition to the chemistry requirements, the supplier must ensure that the selected grade of steel has sufficient hardenability to produce a heat treated microstructure of minimum 90% martensite before tempering.

3.3 Steel Inclusions. The inclusion rating of steel shall not exceed 3-O (oxide) or 4-S (silicate) as per SAE J422.

Note: This requirement is for referee purpose only.

3.4 Mechanical Properties. Parts shall meet the mechanical requirements specified in Table A2 when tested per ISO 898-1.

Note: In the case of special bolts and screws with alternative configurations, such as drilled heads, which make the heads weaker than the threaded section, tensile strength requirements may not be met. Supplier is required to run tensile test of the special head fasteners for information purposes. This test result, including the failure mode, shall be included in PPAP submission. Short bolts/screws (length smaller than 2.5 diameters) are excluded from tensile test.

3.4.1 In the case of property class 8.8 SEMS where the washer and bolt is heat treated as an assembly, the maximum surface and core hardness of the bolt may reach a maximum of 36 HRc (354 HV).

3.5 Microstructure. For fasteners with property class 8.8 and higher, the microstructure shall consist of minimum 90% tempered martensite.

3.6 Decarburization. Fasteners of property class ≥8.8 shall meet the decarburization limits described in ISO 898-1.

3.7 Surface Discontinuities.

3.7.1 Fasteners of property class 6.8 and below shall meet the requirements of ISO 6157-1.

3.7.2 Fasteners of property classes 8.8 and higher shall meet the requirements of ISO 6157-3.

3.7.3 Discontinuities at thread root caused by usage of serrated thread forming dies are permissible if the depth does not exceed 0.5% of the fastener's nominal diameter. These discontinuities are the in form of scallops at the root and follow contour of thread root.

3.7.4 For threaded plugs sized M20 and larger, conformance to ISO 6157-3 section 3.7 shall be met, except the maximum torque value allowed for screwing on a GO-ring gauge is 7 Nm.

Note: The surface discontinuity test is applied to parts before any finishing/coating processes.

3.8 Grain Flow. Grain flow at the head-shank junction of a bolt must follow the contour of the fillet. No end grain exposure is allowed at the filler or adjacent shank area. Grain flow must conform to SAE/USCAR-8.

3.9 Dephosphating. For fasteners with property class 10.9 and 12.9, any phosphate coating must be removed prior to heat treatment. A metallographically detectable (400x magnification) white phosphorous enriched layer is not permitted.

Note: The metallographic test is for referee purpose only.

3.10 Retempering Test. To test the effectiveness and stability of the tempering operation, take 3 hardness measurements on parts before and after retempering at 415 °C (tolerance of +5 -0 °C) for 30 minutes. The mean average hardness after retempering shall not be more than 20 HV lower.

Note: This requirement is for referee purpose only.

3.11 Torsional Yield Test. This test procedure is only applicable to parts drawings specifying a torsional yield requirement. This procedure may be used in place of the requirements on GM part drawing 24502102.

3.11.1 The following characteristics will be determined and reported:

- Torsional yield load
- Ultimate strength
- Angular ductility

3.11.2 The test equipment and fixtures shall meet the following requirements:

- Load cell with 0.3% (full scale) accuracy and minimum capacity 130% of the average peak load of fastener to be tested.

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- Torque transducer with 0.3% (full scale) accuracy and minimum capacity 130% peak torque of fastener to be tested.
- Angle transducer accurate to 1 degree of angular rotation.
- Data acquisition system capable of recording load versus angle and load versus torque measurements.
- Plain HL washer and plain test nut per ISO 16047 or other suitable part as agreed to by GM fastening engineer. The washer and nut shall be degreased in solvent within 2 h of performing this test.
- Torque chatter and thread stripping will invalidate the test.

3.11.3 Test Procedure.

a. Test a minimum of 12 parts randomly selected from each production lot.

b. Install test bolt onto test fixture, shimming as necessary to duplicate the clamp length from actual application (obtained from fastener engineer). The head of the bolt shall bear against the test washer. The test washer shall be restrained from turning during tightening. Finger assemble the bolt approximately 2 threads into the test nut.

c. Using the electric tool, tighten at 20 rpm to 100 rpm spindle speed until bolt reaches ultimate strength.

d. During tightening, load, torque, and angle of the bolt is recorded continuously a minimum of 1 data point per degree rotation.

3.11.4 Calculations.

a. Ultimate Strength - The highest load measured during the test.

b. Torsional Yield Point (load) - Determine the slope of the elastic (linear) portion of the Load-angle plot between 80% and 30% of ultimate strength. Draw a line with the same slope, but offset 30 degrees to the right. The intersection of this line with the load-angle plot is the Torsional Yield Point.

c. Angular Ductility – The angle of turn from the Torsional Yield Point to the Ultimate Strength.

See Figure A1 in Appendix A for an illustration of the calculations.

3.11.5 For parts with torsional yield requirements, the tensile and hardness test results can deviate from the values in Table A2. However, the supplier shall maintain a tensile strength range of 110 MPa and hardness range of 4 points HRc. For example: Hardness 36.0 to 40.0.

4 Manufacturing Process

4.1 Heading Practice. Methods other than forging are permitted only by special agreement.

4.1.1 Property class 4.6 may be hot or cold headed at the option of the supplier.

4.1.2 Property classes 4.8 to 12.9 bolts and screws in nominal thread diameters ≤ M20, and in product lengths ≤150 mm shall be cold headed. Larger diameter and longer lengths may be cold or hot headed at the option of the supplier.

4.2 Threading Practice. Fasteners sizes ≤ M20 and lengths ≤ 150 mm shall be roll threaded unless otherwise agreed upon. Threading practice for fasteners of all other sizes shall be at the option of the supplier.

4.3 Heat Treatment.

4.3.1 Property classes 4.8, 5.6, 5.8 and 6.8 bolts and screws shall be stress relieved at 470 °C minimum temperature to assure the soundness of the head to shank junction.

4.3.2 Property class 8.8 and higher bolts, screws and studs shall be austenitized and quenched to obtain a structure of 90% minimum martensite in the core of the threaded section and tempered at a minimum temperature of 425 °C.

4.3.3 SEMS bolt and washer may be heat treated separately. See 3.4.1 for exceptions.

4.3.4 For fasteners with property class 10.9 or higher, the phosphate coating used for wire drawing or parts forming must be removed completely before quench and temper heat treatment.

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