Generic Data Processing Flow

1 Scope

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 procedure explains the generic data processing flow for structural durability projects.

1.2 Foreword. Not applicable.

1.3 Applicability. This procedure is applicable as a general guide for all projects performing data processing related to time-based structural durability testing. It may be adapted for use with various commercial software packages, but was originally developed for use with Remote Parameter Control (RPC) III or RPC Pro software from MTS Corporation.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15219	GMW15243	GMW15269
GMW15242	GMW15244	

2.3 Additional References.

- MTS RPC User Manual

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. See 1.3.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time. Not applicable.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions. Not applicable.

4.2.1 Environmental Conditions. Not applicable.

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4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Overall Process. The overall process is shown in Figure A1 (Figures are located in Appendix A). The following material provides details on the steps in this process. Throughout this discussion, parenthetical numbers in the text refer to the processing steps illustrated in the figures.

Each of the 5 high-level data processing steps is detailed in the following sections as follows:

- 4.3.2 – Read and Validate.
- 4.3.3 – Quantify and Summarize.
- 4.3.4 – Edit Data.
- 4.3.5 – Develop Test.
- 4.3.6 – Run Test.

4.3.2 Read and Validate. Data acquired for Structural Durability will generally be validated following a data process as shown in Figure A2.

4.3.2.1 Export and Rename. Generally, data will need to be exported from the recorded data format and converted to RPC format or other format as needed by the data processing system. During the export, files may be renamed to GM standard naming. The standard naming convention is documented in GMW15219.

4.3.2.2 Visual Review. Review the data visually for correct behavior. Examine carefully for anomalies and compliance to standards (see GMW15243). Some of the standards in this procedure may not be met until step 4.3.2.5.

4.3.2.3 Corrections. This step is a “toolbox” of options depending on the issues discovered in the review above, including standards for process channels. Options include:

a. Header corrections - Repeats, points-per-frame, points-per-group.
b. Sample rate adjustment.
c. Filtering (High-Pass, Low-Pass, Notch, Band Pass).
d. Deglitching (removal of spikes or dropouts).
e. Steer angle correction.
f. Wheel Force Transducer Ripple Correction.
g. Coordinate transformation.
h. Drift correction.
i. Point maneuvering.
j. Rescaling.
k. Conversion of Engineering Units.
l. Channel Transformation.

4.3.2.4 Statistics. Minimum statistics to calculate include Maximum (Max), Minimum (Min), Mean, Standard Deviation, Root Mean Square (RMS) and Crest. See also step 4.3.3.1.

4.3.2.5 Final Preparation. Includes offset correction, channel extraction, common channel full scale, file format conversion (if needed) to complete meeting the standards of GMW15243.

4.3.2.6 Archive. Archive and upload to database per local procedure.

4.3.3 Quantify and Summarize. See Figure A3 for these processing steps. This set of steps is a “toolbox” of various tools that can be used to provide a means to understand, quantify and summarize the data. They are called from various locations within the software. Not all steps within this toolbox are used for all data processing projects.

4.3.3.1 Statistics. Statistics are calculated per channel for entire road surface (file). Minimum statistics include Maxima, Minima, Mean, Standard Deviation, RMS and Crest Factor. Optional statistics include Skewness and Kurtosis.

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4.3.3.2 Rainflow Counting. Details for rainflow counting can be found in procedure GMW15269. An option exists for calculating composite rainflow. Rainflow counting for the purpose of providing rainflow histograms to others is often considered part of 4.3.3.7.

4.3.3.3 Fatigue Calculations. Fatigue calculations are to be performed per GMW15269.

4.3.3.4 Pseudo Energy. Pseudo Energy calculations may be calculated per procedure GMW15244. Output includes total energy per road surface, as well as Power time-histories for later editing.

4.3.3.5 Summarize Data. Statistics, time, fatigue, and pseudo-energy should be summarized in standard reports. These summaries can be used to compare two datasets, e.g. “road” and “edited”. When a comparison is involved, it can be used to optimize the repetitions to match damage. Reference GMW15269, Section 4.3.10 for the optimization criteria. The summaries can also be used to create initial data editing limits.

4.3.3.6 “Baseline and Post-Edit”. Frequently, processing steps 4.3.3.1 to 4.3.3.5 may be combined in a single processing tool to create “baseline” data summaries or “Post-edit” summaries.

4.3.3.7 Cycle Counting. Cycle counting includes time-history condensation, level crossing, Markovian peak-valley, and composites of these.

4.3.3.8 Auto-Spectral Density (ASD) Calculations. This processing step calculates the Auto-Spectral Densities for the road surfaces, as well as time-weighted composite ASDs.

4.3.3.9 Simultaneous Peaks. Simultaneous peaks are similar to time-history condensation, but each channel only votes twice: Once at its maxima and once at its minima.

4.3.3.10 Archive. Data must be archived and uploaded per local procedure. As an example, the GMNA process for archiving in the Loads Database is documented on the Global Structural Durability Laboratory Expert Team (GSDLET) RPC Pro Process web page as “SDL Data Archive”. The supplier shall work with the GM Responsible Engineer to comprehend this requirement.

4.3.4 Edit Data. This section is shown in Figure A4.

4.3.5 Develop Test. The processing is shown in Figure A5. Reference MTS RPC User Manual, or the documentation of whatever test development software package is being used, for additional details of the following processing steps.

4.3.5.1 Measure Frequency Response Function (FRF). A system response transfer function of the test rig and specimen is measured. A shaped white noise file is generated with amplitudes based on desired road response amplitude. This shaped white noise is played out into the test rig and specimen. During the play-out the specimen and system responses are measured. The white noise drive and system response are transformed into the spectral domain and convolved. The resultant frequency response function (FRF) is reviewed, band-limited, inverted and expanded. This expanded inverted FRF is used in 4.3.5.2 to create a linear estimate of the drive file.

4.3.5.2 Iterations. Using the expanded and inverted FRF from 4.3.5.1 and the desired road response from 4.3.4, a linear estimate is convolved. This linear estimate is played into the system, the response measured, and the error between the desired and actual response calculated. This error is convolved with the FRF and this correction added to the previous drive. This corrected drive is used as input to another iteration loop and this process continues until the error is reduced to an acceptable level or the error starts to increase (divergence). Determination of error may be made by RMS of the error, amplitude of the extreme error, or occasionally fatigue comparisons.

4.3.5.3 Post Iteration. Once all road surfaces have drive files developed, the final responses are processed through a Post Iteration process. This is the same tool as 4.3.3.6. The results are compared to the Baseline results in 4.3.3.6. During Post Iteration, when there are more channels than were included in the FRF used in 4.3.5.1 and 4.3.5.2, these may be processed and compared as “Correlation Channels”.

4.3.5.4 Archive. Final drive files and related files are archived per local procedure.

4.3.6 Run Test. This processing is illustrated in Figure A6.

4.3.6.1 Setup Test Matrix and Test Monitoring. The test matrix is based on the optimized repeats. Reference GMW15269, Section 4.3.10 for the optimization criteria. Test monitoring is optional but can:

- Ensure test is running properly.
- Ensure specimen is behaving properly.

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