Creating A Fatigue Damage Spectrum Test

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V-Note # 0019

Abstract

The Fatigue Damage Spectrum (FDS) software is easy to use, but there is a sequence of steps that must be followed in order to properly utilize this software. The goal is to start with a single or multiple time history file(s) that represent the vibration a product will experience through its life, then create a Random PSD that is the damage equivalent to one lifetime of that product based on the imported files.

Question

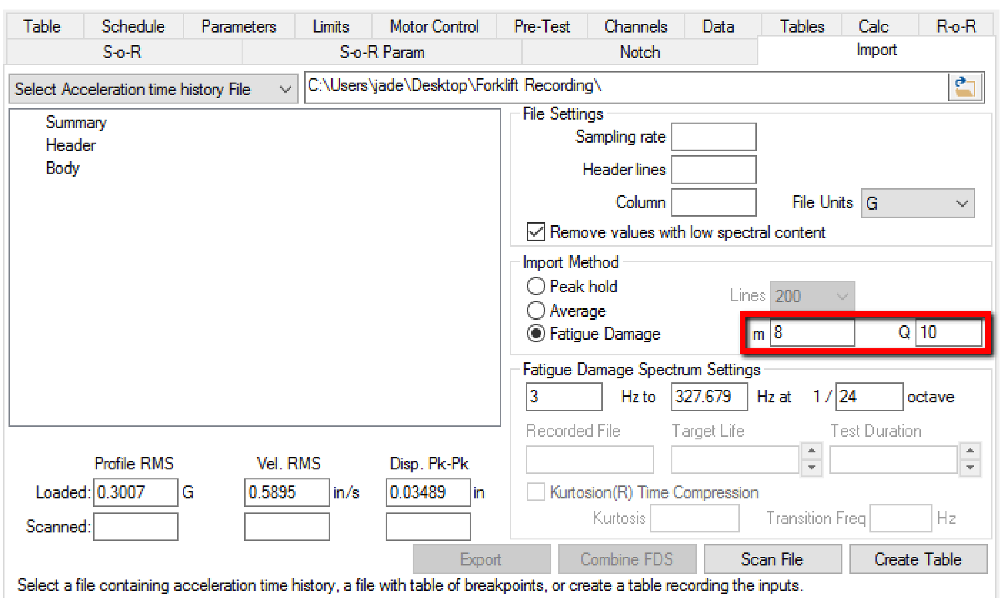
What is the process to create a test using the FDS software?

Answer

Step 1: Create a new FDS Test in VibrationVIEW

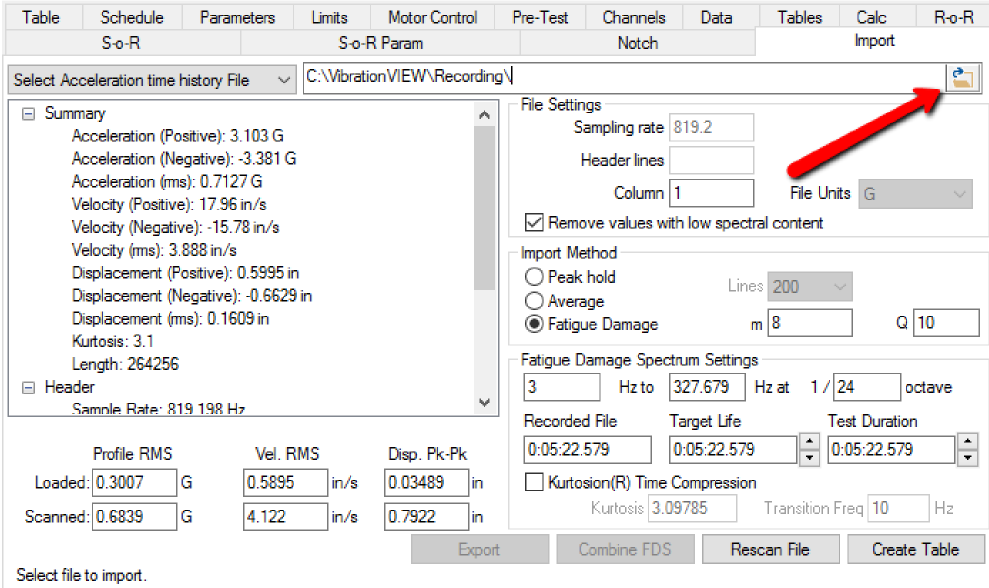
Select “New Test” and choose Fatigue Damage

Step 2: Enter the appropriate *m* and Q values for the product.



As discussed in V-Note #0017 there are general values that can be used (*m* = 8, Q=10), but these values do have an effect on the FDS generation and test compression. To increase accuracy V-Note #0018 provides instruction for developing more precise *m* and Q values for a product.

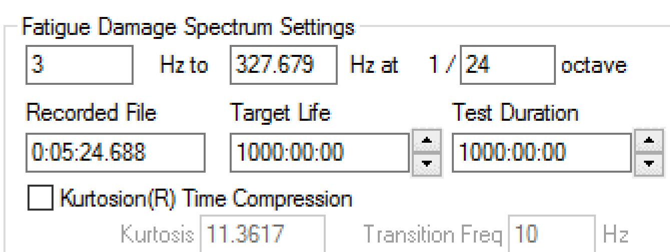
Step 3: Import the time history file(s).



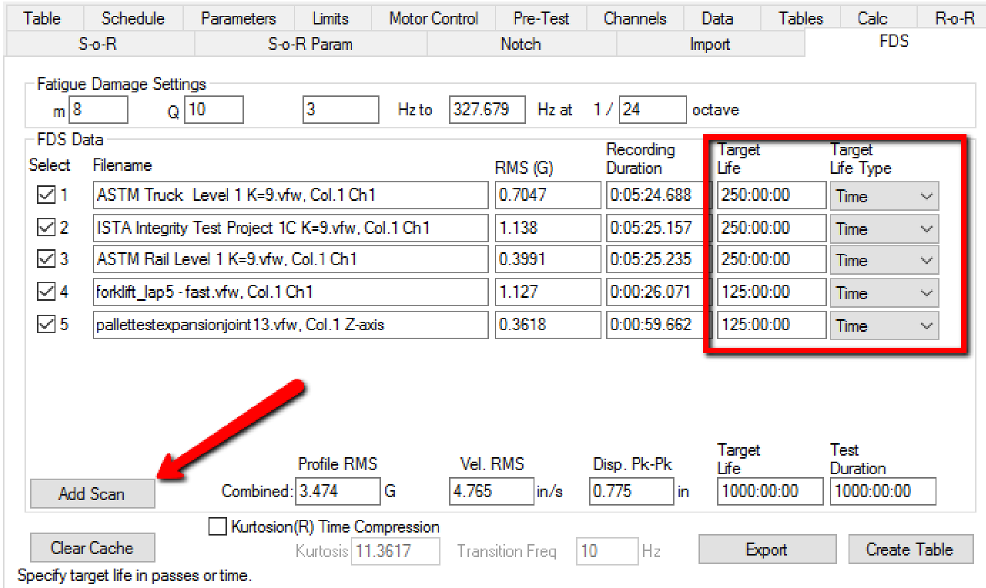
The time history files should be representative of all the vibration that a product experiences in a lifetime. The files do not have to be a 1:1 replication of a lifetimes of damage, but it is important to be as accurate as possible. The FDS process analyzes the time history data using a single degree of freedom oscillator, automatically adjusting for each frequency. For each degree of freedom, a Rainflow count is taken to create a volume integral, the cumulative amount of damage for each frequency bin.

Step 4: Enter the Target Life.

For a single imported time history file, the target life is the amount of time or number of cycles the time history file should be run in order to represent 1 lifetime of damage to the product. This could also be the length of a product warranty, or simply how long the product should survive when exposed to the imported time history file.



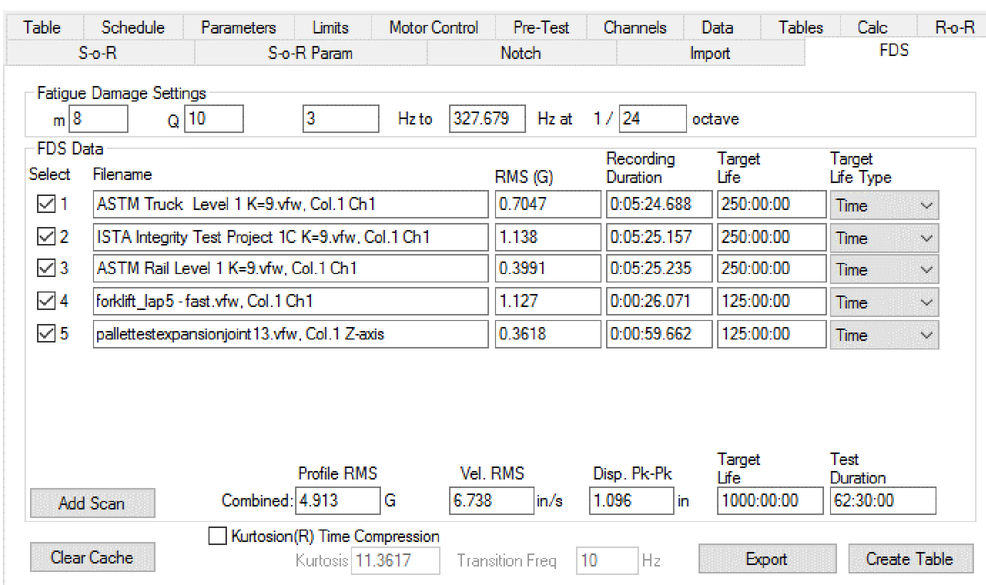
For multiple time history files, the sum of the target life for each imported file is equal to the total target life of the product. Assigning different target life values to each waveform is the method of weighting the effects of each waveform in the lifetime of the product.



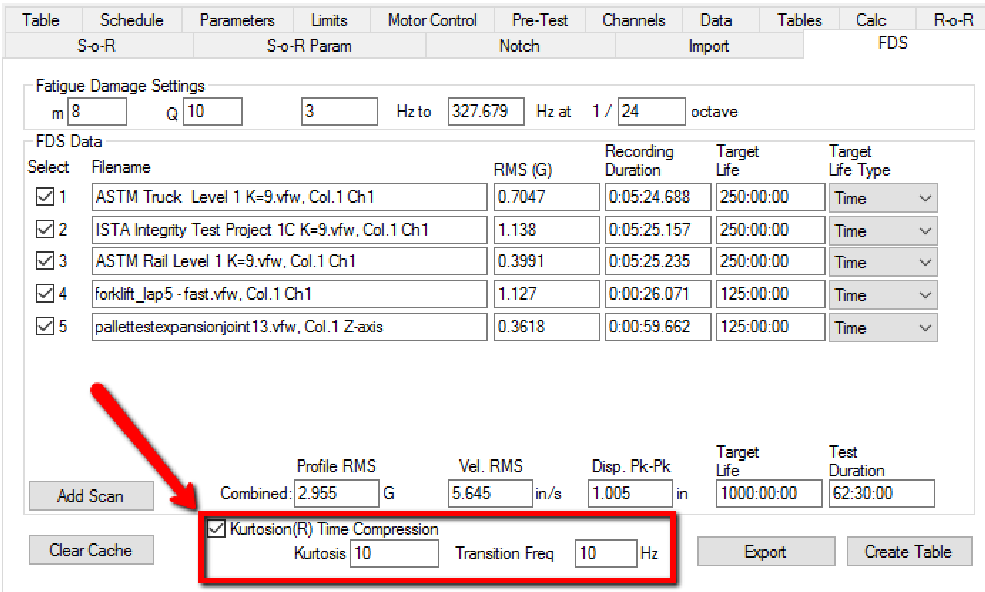
Step 5: Accelerate the test.

The test profile can be accelerated, but an accelerated test is not the same as running for the full amount of time. The less the test is accelerated, the more accurate representation of the real world data. Also, the test acceleration is only as accurate as the *m* value selected for the product. The more the test is accelerated, the more important the accuracy of *m* becomes. At a minimum, the instantaneous stress limit of the product cannot be exceeded.

MIL-STD-810G recommends the acceleration factor should generally not exceed values of 1.414^(S1/S2) or 1.414^(*m*). Thus, for a product with *m* = 8 the maximum ratio between in-service time and test time can be 1.414^8 ≈ 16. If the target life of the product is 1,000 hours, it is recommended to run the test in no less than 62.5 hours.

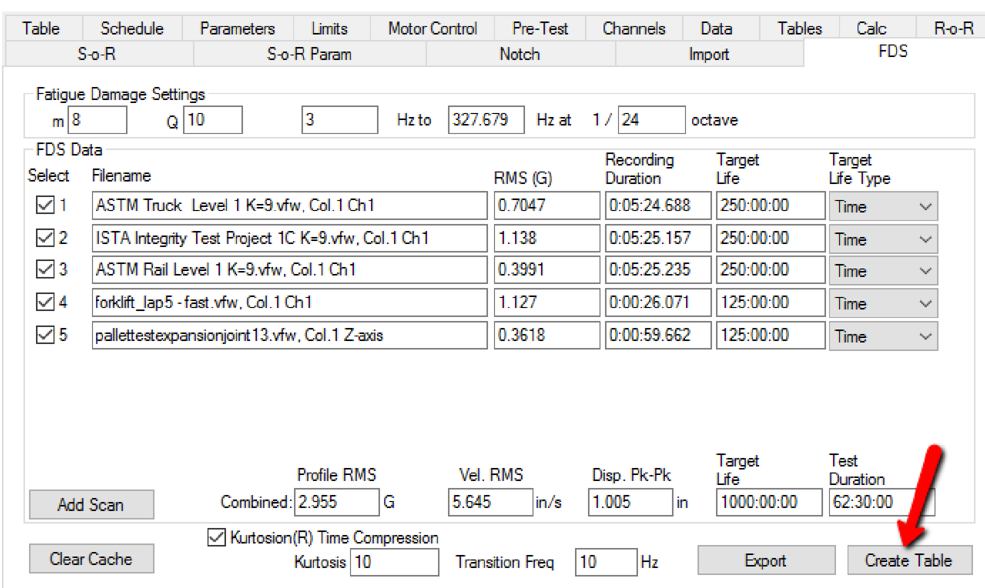


Step 6: Add kurtosis

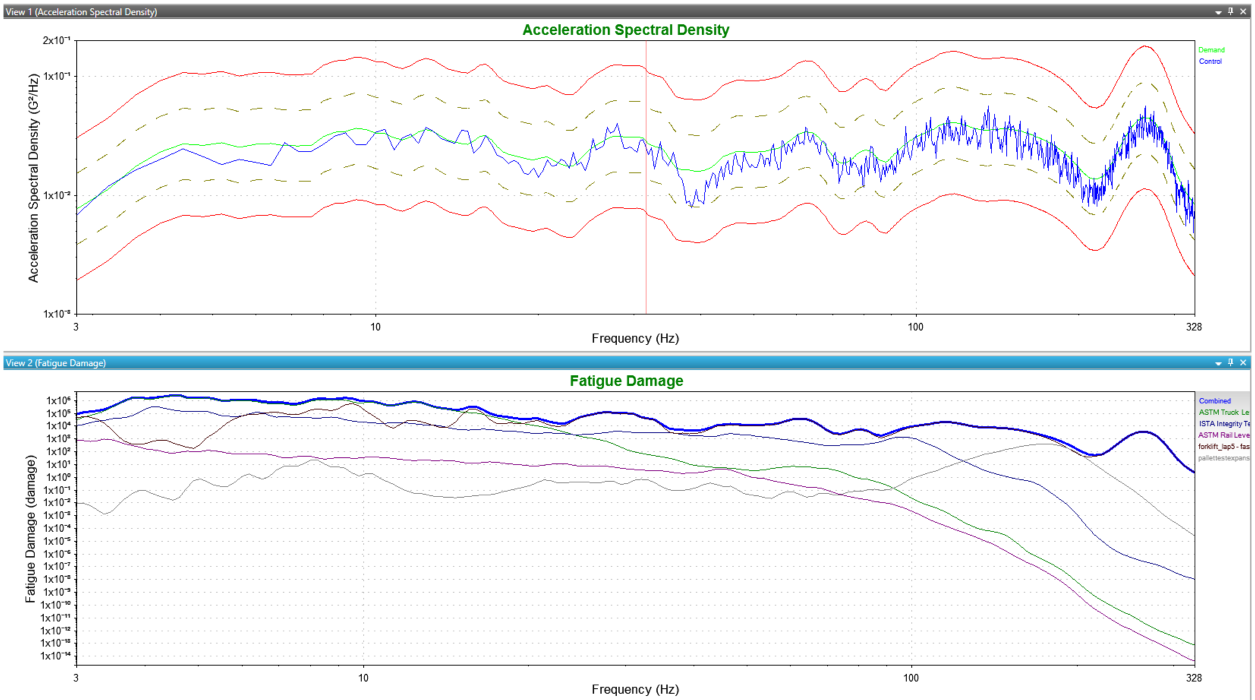


Lowering the G_{RMS} of the test is a primary reason for adding kurtosis. Another valid reason is to increase the kurtosis of the random PSD to reflect the peaks of the imported time history files, especially when the kurtosis of the input waveform is very high. Using Kurtosion®, it is possible to introduce this kurtosis, and vary the transition frequency to create peaks that are representative of the original files. The FDS software will automatically adjust for the added kurtosis to ensure that the generated profile is the damage equivalent of the input waveform(s). Notice the difference in the Combined Profile RMS before and after the addition of kurtosis.

Step 7: Create the breakpoint table



Step 8: Run the Test



The Random PSD generated is the damage equivalent to the lifetime of the product based on the imported files, *m* and Q values, Target Life, Test Duration, and kurtosis. This is valuable information in every phase of testing from initial product development to re-creating field failures in a lab environment.

For more information, please watch our webinar on the Fatigue Damage Spectrum software or contact an application engineer at VRSales@vibrationresearch.com