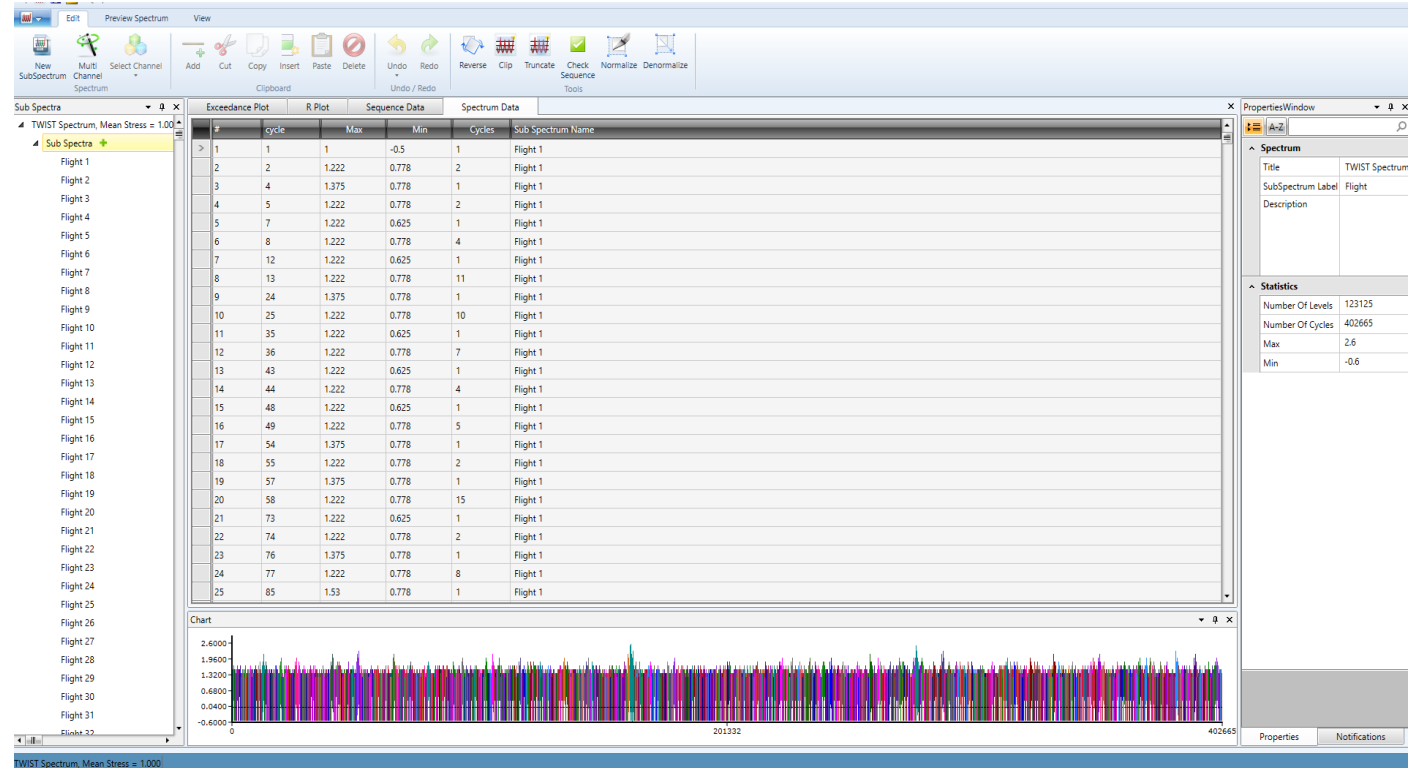


# Spectrum Manager Version 1.1 and Beyond

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# What is Spectrum Manager?

- Next evolution in AFGROW Spectrum generation using XML capabilities
- Used to Generate Spectrum files for use in AFGROW
- Create, Edit, and View Spectra Data through multiple detailed windows
- Customizable window layout



# Basic Capabilities

- Visual spectrum design
- Spectrum level reordering
- Sub-spectra organized in any user-defined sequence
- Sub-spectra may be placed in the sequence more than once
- Sub-spectra may be re-ordered in the sequence
- Spectrum statistics at a glance
- Exceedance curve plotting
- R-plots
- Sub-spectra tagging for future analysis
- Synchronized data views
- Spectrum level damage tagging
- Spectra normalization/de-normalization
- Clipping/Truncation capability
- Import data from “old” text sub files

#	cycle	Max Axial	Min Axial	Max Bending	Min Bending	Max Bearing	Min Bearing	Cycles	Time	LoadType	Environment	DamageTag
1	1	1	-0.5	1	-0.5	1	-0.5	1	0	Random Cyclic		
2	2	1.222	0.778	1.222	0.778	1.222	0.778	2	0	Random Cyclic		
3	4	1.375	0.778	1.375	0.778	1.375	0.778	1	0	Random Cyclic		
4	5	1.222	0.778	1.222	0.778	1.222	0.778	2	0	Random Cyclic		
5	7	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
6	8	1.222	0.778	1.222	0.778	1.222	0.778	4	0	Random Cyclic		
7	12	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
8	13	1.222	0.778	1.222	0.778	1.222	0.778	11	0	Random Cyclic		
9	24	1.375	0.778	1.375	0.778	1.375	0.778	1	0	Random Cyclic		
10	25	1.222	0.778	1.222	0.778	1.222	0.778	10	0	Random Cyclic		
11	35	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
12	36	1.222	0.778	1.222	0.778	1.222	0.778	7	0	Random Cyclic		
13	43	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
14	44	1.222	0.778	1.222	0.778	1.222	0.778	4	0	Random Cyclic		
15	48	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
16	49	1.222	0.778	1.222	0.778	1.222	0.778	5	0	Random Cyclic		
17	54	1.375	0.778	1.375	0.778	1.375	0.778	1	0	Random Cyclic		
18	55	1.222	0.778	1.222	0.778	1.222	0.778	2	0	Random Cyclic		
19	57	1.375	0.778	1.375	0.778	1.375	0.778	1	0	Random Cyclic		
20	58	1.222	0.778	1.222	0.778	1.222	0.778	15	0	Random Cyclic		
21	73	1.222	0.625	1.222	0.625	1.222	0.625	1	0	Random Cyclic		
22	74	1.222	0.778	1.222	0.778	1.222	0.778	2	0	Random Cyclic		
23	76	1.375	0.778	1.375	0.778	1.375	0.778	1	0	Random Cyclic		
24	77	1.222	0.778	1.222	0.778	1.222	0.778	8	0	Random Cyclic		
25	85	1.53	0.778	1.53	0.778	1.53	0.778	1	0	Random Cyclic		

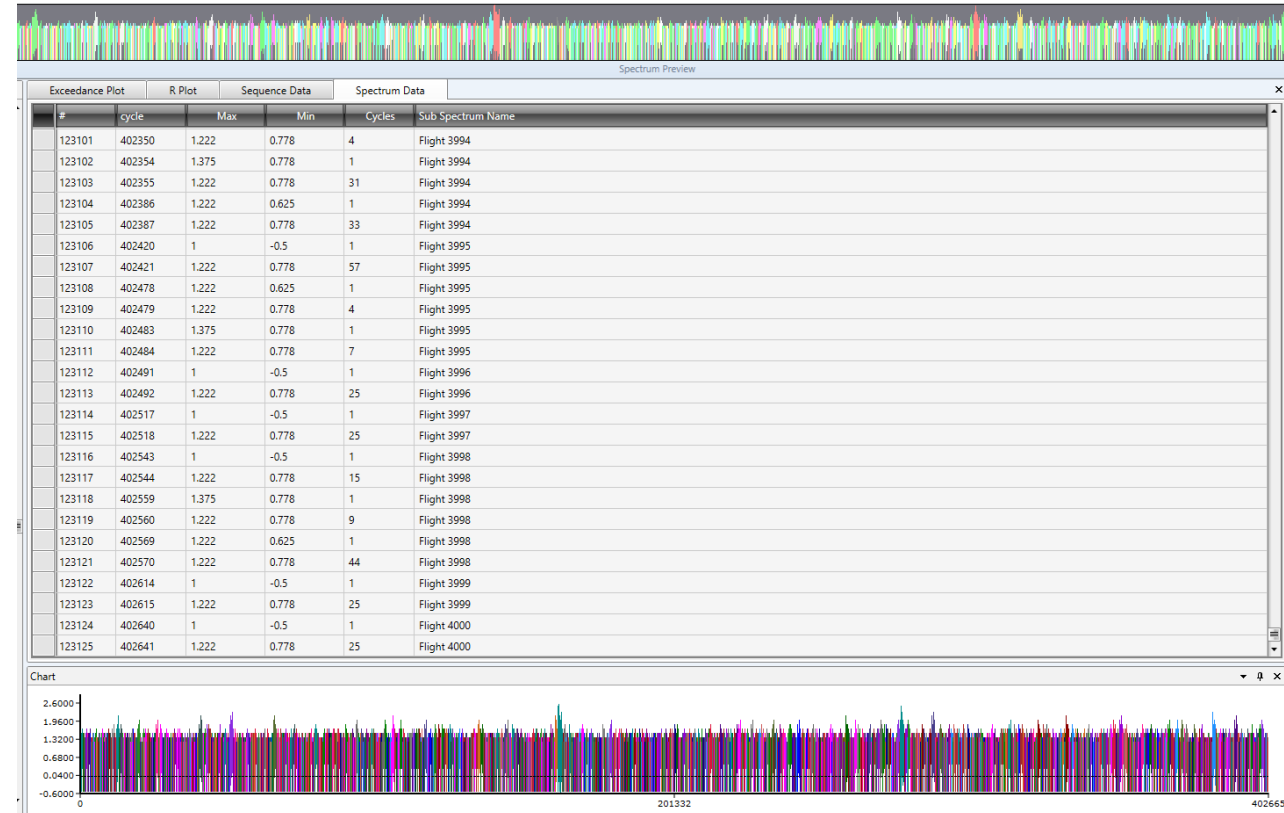
# What is new in Version 1.1

## Features

- Improved Data Storage and Processing
- Spectrum Plot Updates
- More Responsive Preview Spectrum Window
- Improved Error Messages for Data Handling
- Reworked Exceedance and R Plots
- Context-Sensitive Help
- Streamlined Truncation
- Splash Screen

# Improved Data Storage

- Older versions of Spectrum Manager may have encountered issues loading Spectra with a large number of points
- Version 1.1 has improved the internal data storage of the Application. Now, Spectrum Manager is able to handle Spectra with over 1,000,000 cycles
- Spectra with large amounts of data may have a small delay while loading, proportionate to the size of the Spectrum



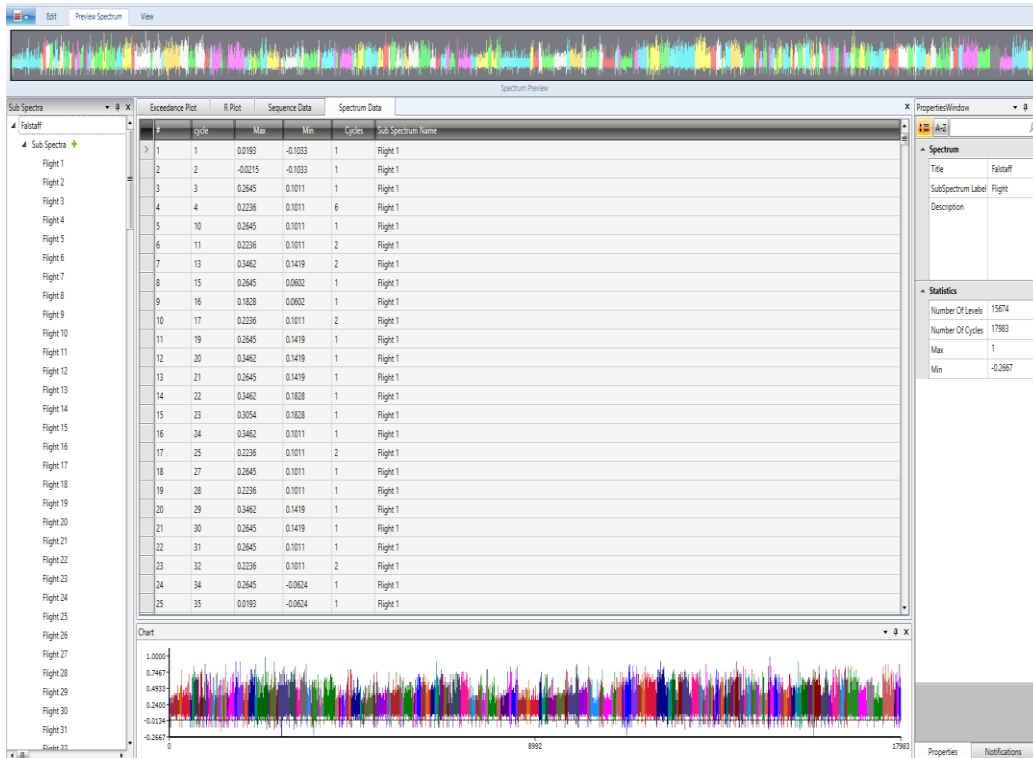


# Spectrum Plot Updates

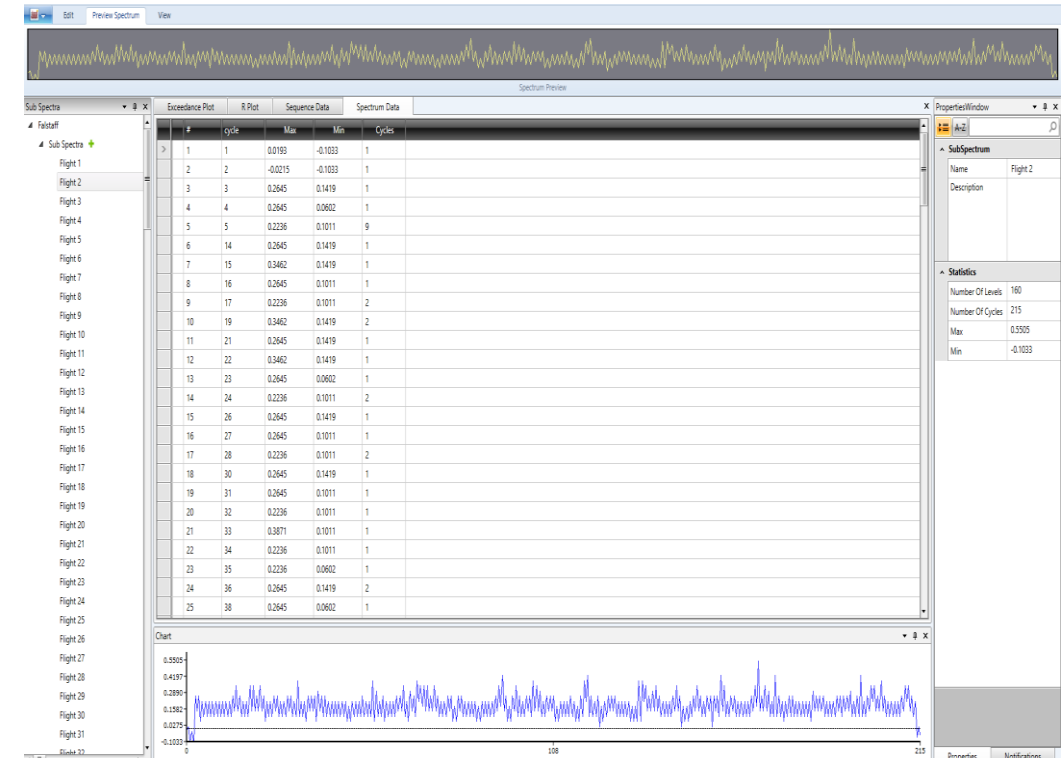
- The Spectrum Plot (located by default at the bottom of the application) will now redraw itself after any change to the Spectrum's Data
- The plot will display the entire Spectrum if no Sub Spectrum is selected. If a Sub Spectrum is selected, only that Sub Spectrum will be displayed. This is also the case with the Preview Spectrum tab

# Example

## Entire Spectrum selected



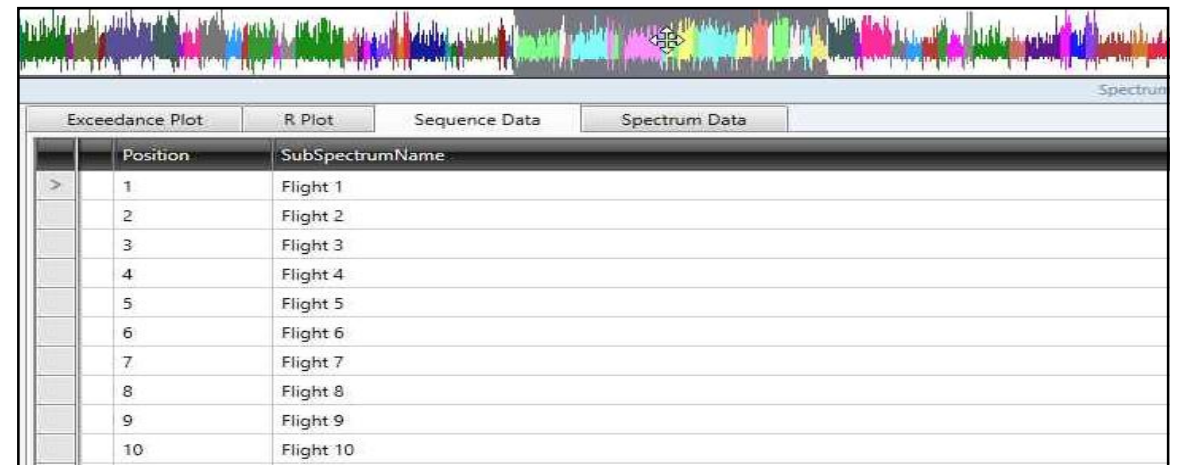
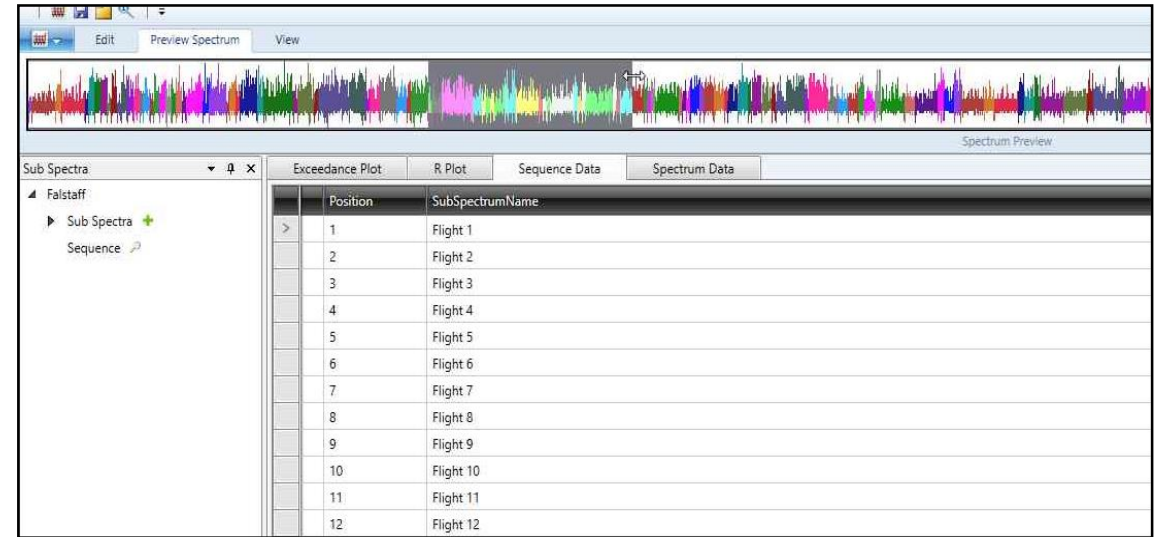
## Sub Spectrum Selected





## Preview Spectrum Window – Selection box

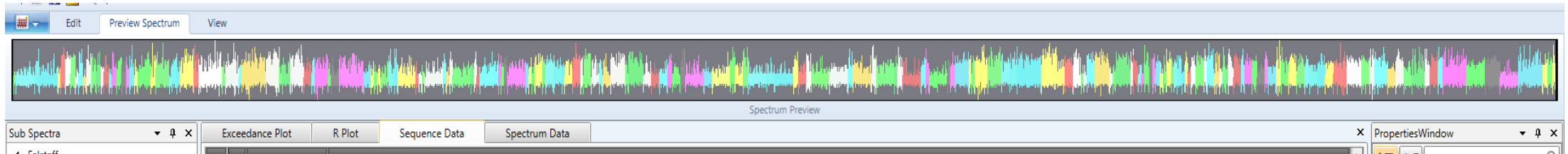
- The Preview Spectrum select box has historically been difficult to use. We have made a number of small changes aimed to improve the responsiveness of the select box
- The select box now changes the cursor to reflect what actions the user can perform on the box



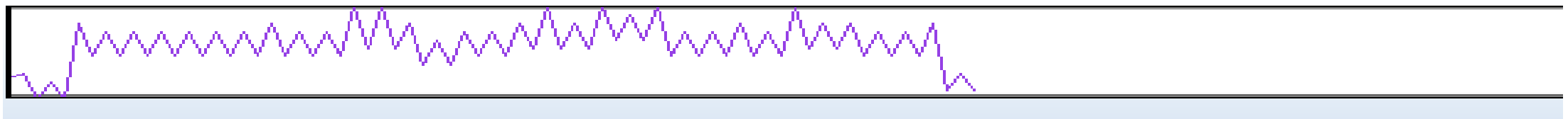
# Preview Spectrum Window - Zoom

- If the selection box covers the entire Spectrum/Sub Spectrum, the zoom option is enabled

## Zoom Enabled

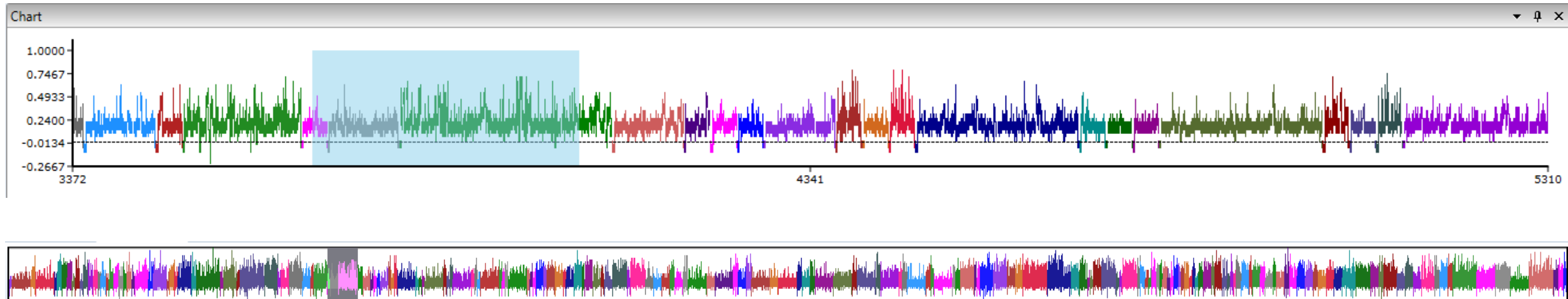


## Not Zoom Enabled



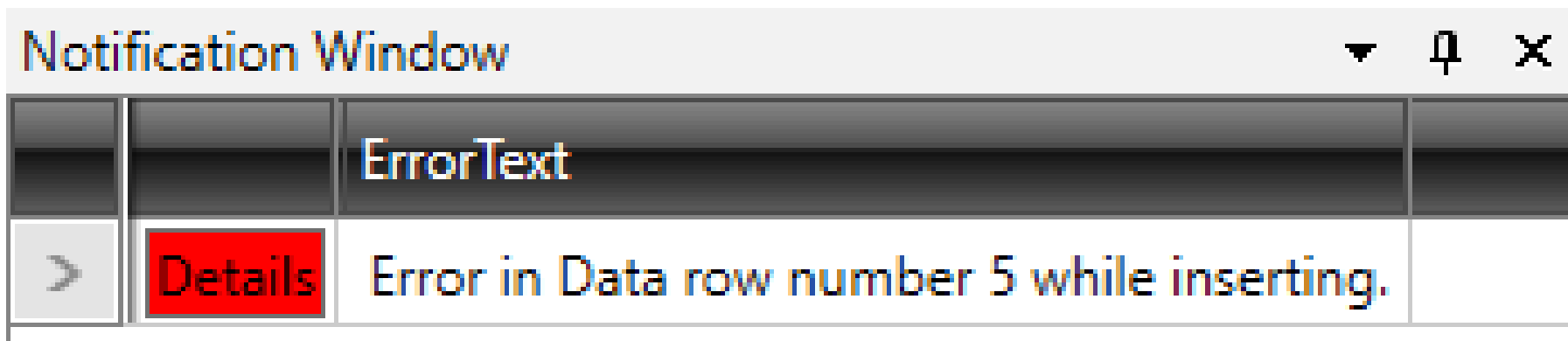
# Preview Spectrum Window - Zoom

- The user must select an area of the Spectrum Plot to interact with the select box. After the user selects a portion of the Spectrum Plot, the select box will appear over the corresponding area in the Preview Spectrum tab



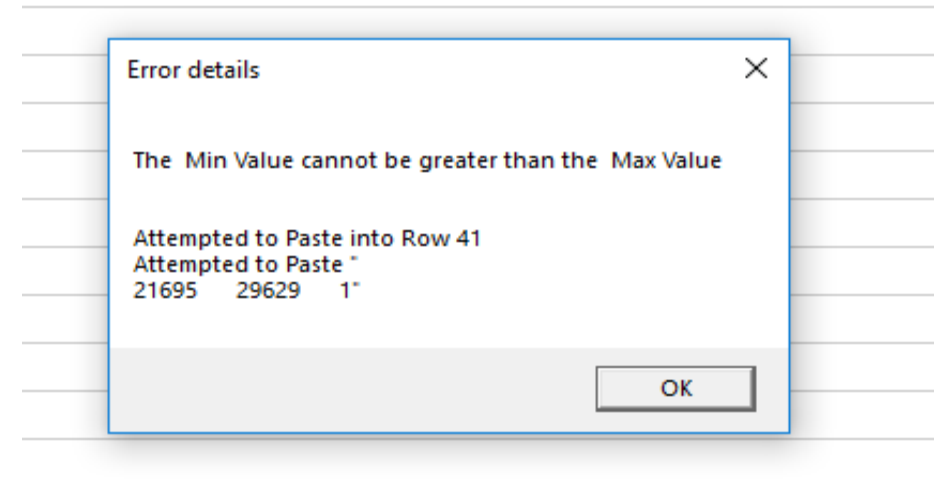
# Data Error Messages

- There are additional error messages available for the Spectrum Data window when pasting data into the Spectrum
- The error details contain the line number of the pasted data which caused the error to occur, as well as the exact text content of the erroneous line of data



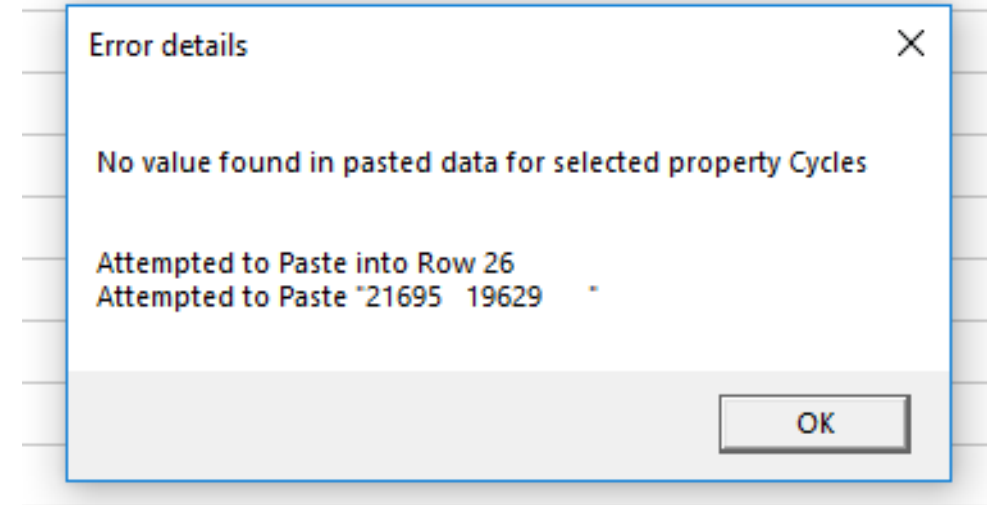
# Max less than Min

- The first of the new error messages occurs if the user attempts to paste data that has a Max value less than the Min value
- By default, Spectrum Manager uses the first value in the data as the Max, and the second value as Min



# Missing Value

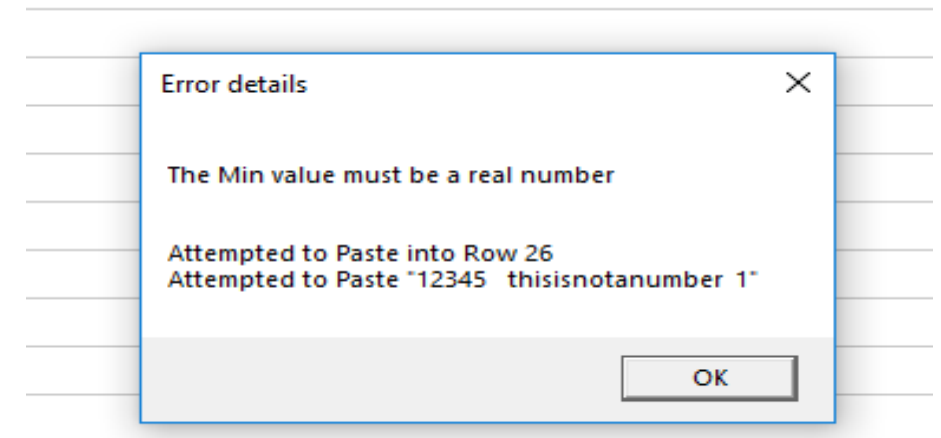
- The second new error message occurs when there are not enough data in the pasted line to fill the required fields in Spectrum Manager
- This normally occurs if a pasted data line is missing a value
- If a user only wants to paste data into specific columns, click on the column header, then hold the Ctrl key and click any additional columns they would like to fill



	Exceedance Plot	R Plot	Sequence Data	Spectrum Data	
	#	cycle	Max	Min	Cycles
>	1	1	0.0193	-0.1033	1
	2	2	-0.0215	-0.1033	1
	3	3	0.2645	0.1011	1
	4	4	0.2236	0.1011	6
	5	10	0.2645	0.1011	1
	6	11	0.2236	0.1011	2
	7	13	0.3462	0.1419	2
	8	15	0.2645	0.0602	1
	9	16	0.1828	0.0602	1

# Not a valid Number/Data Type

- This error appears if the pasted data values are not in the correct format
- Common examples of this are text instead of numeric, real numbers instead of integers, or negative instead of positive numbers



# Incorrect Load Type value

- A subset of the Non Valid Number/Data Type error is the Incorrect Load Type error
- Load Type is unique in that a user can use the numbers 1, 2, or 3 to select a Load Type, or they can use the text value of one of the 3 options (Random Cyclic, Ramp Up, Ramp Down)

#	cycle	Max	Min	Cycles	Time	LoadType	Environment	DamageTag
3	3	23761	17563	1	0	Random Cyclic		
4	4	21695	19629	6	0	Random Cyclic		
5	10	23761	17563	1	0	Random Cyclic		
6	11	21695	19629	2	0	Random Cyclic		
7	13	21695	19629	2	0	Random Cyclic		
8	15	21695	19629	1	0	Random Cyclic		
9	16	21695	19629	1	0	Random Cyclic		
10	17	23761	17563	2	0	Random Cyclic		
11	19	23761	17563	1	0	Random Cyclic		
12	20	23761	17563	1	0	Random Cyclic		
13	21	21695	19629	1	0	Random Cyclic		
14	22	25827	-24015	1	0			
15	23	23761	17563	1	0			
16	24	21695	29629	1	0			
17	25	0.2236	0.1011	2	0			
18	27	0.2645	0.1011	1	0			
19	28	0.2236	0.1011	1	0			
20	29	0.3462	0.1419	1	0			
21	30	0.2645	0.1419	1	0	Random Cyclic		
22	31	0.2645	0.1011	1	0	Random Cyclic		
23	32	0.2236	0.1011	2	0	Random Cyclic		

Error details

LoadType must be a 1, 2, or 3

Attempted to Paste into Row 27  
 Attempted to Paste '21695 19629 1 0 4 22  
 DamageTag'

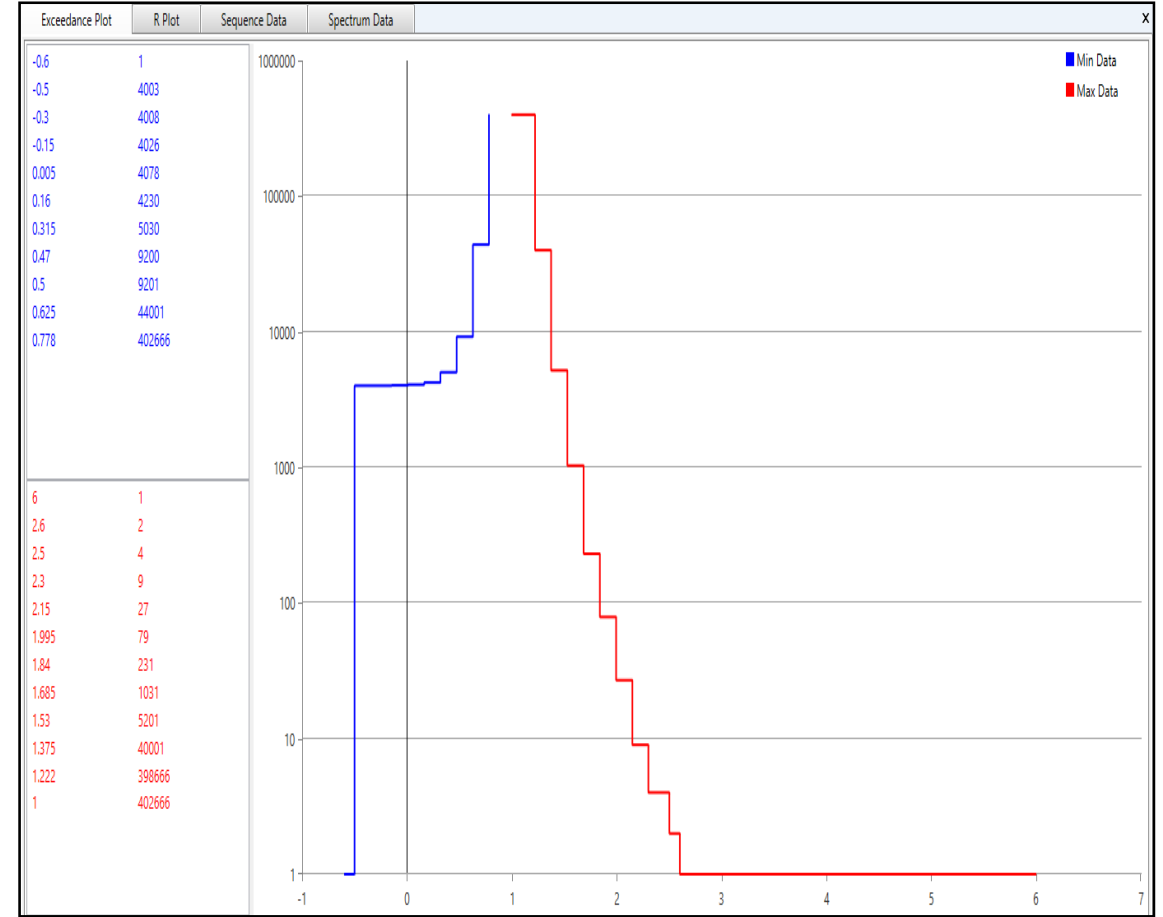
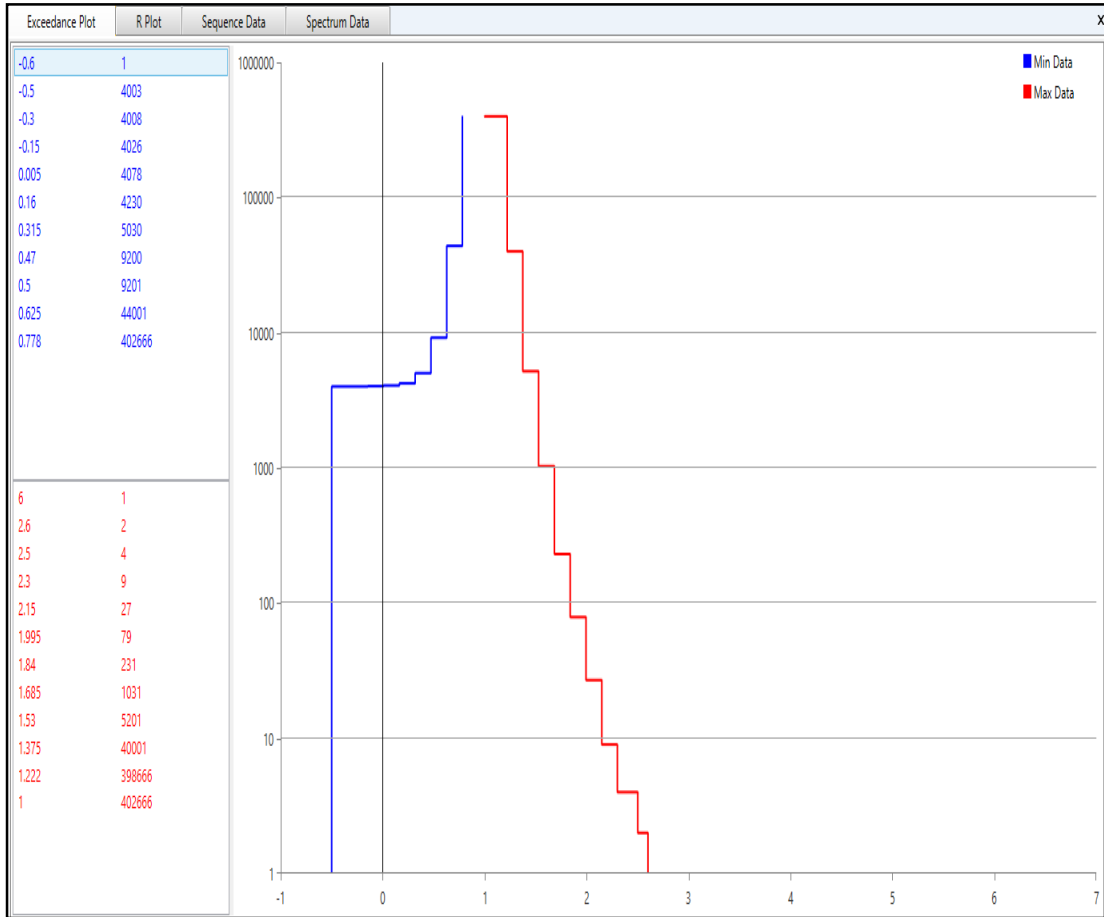
OK



# Exceedance Plot

- We have changed the underlying data structure of the Exceedance Plot to a much more up to date plotting graphic
- The layout of the plot is the same, but now has a much cleaner look
- In addition, the plot is now able to display exceedance data that lie directly on the plot axis, which may have previously been obscured

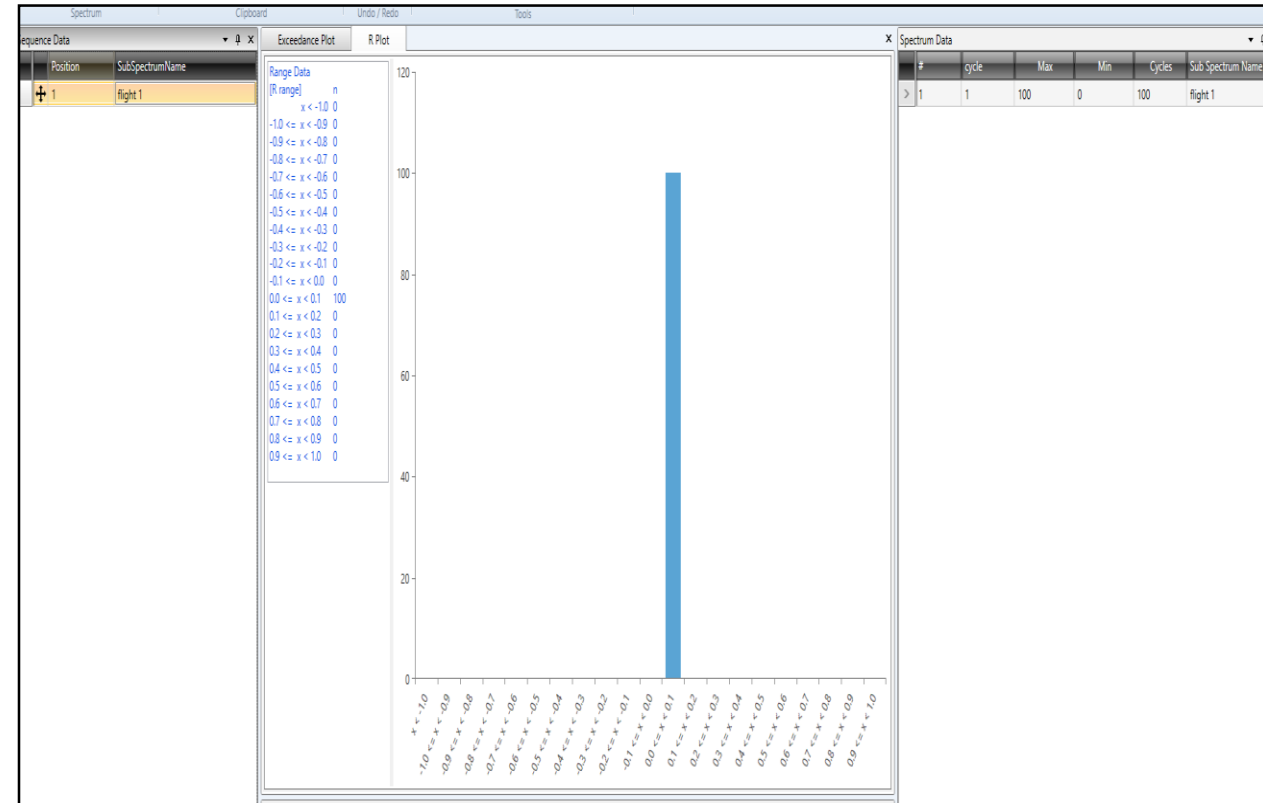
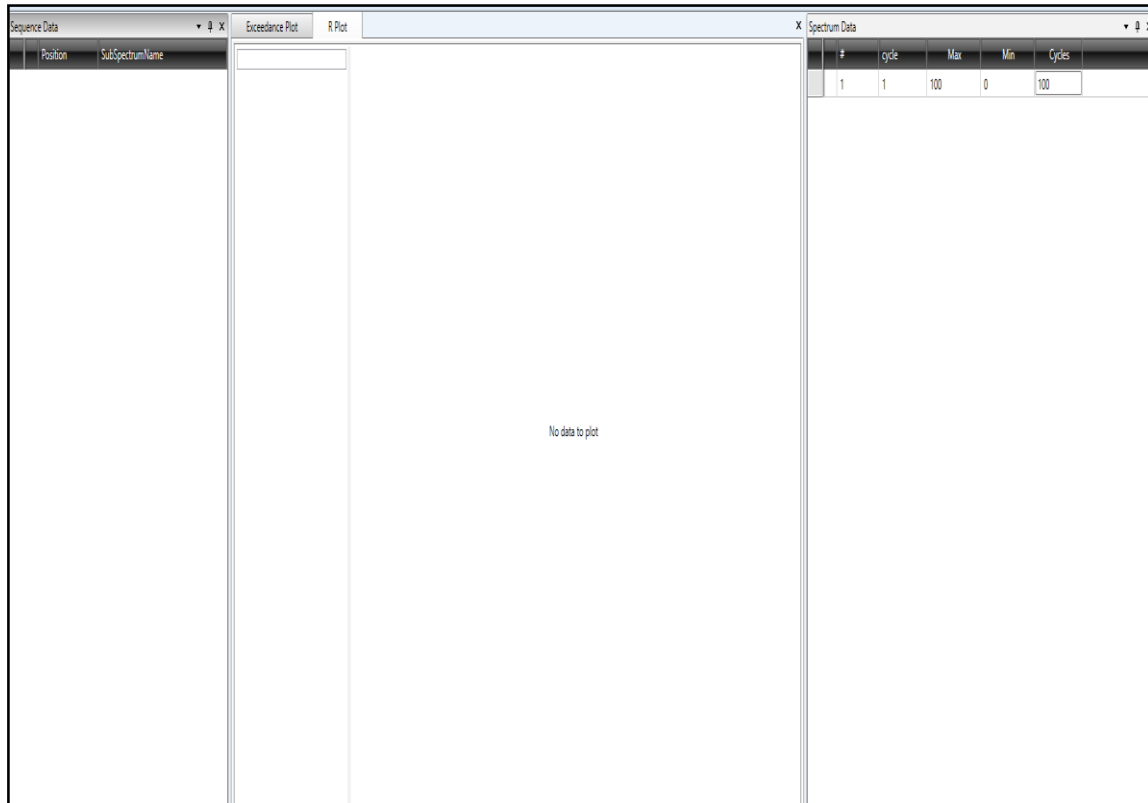
# Example



# R Plot

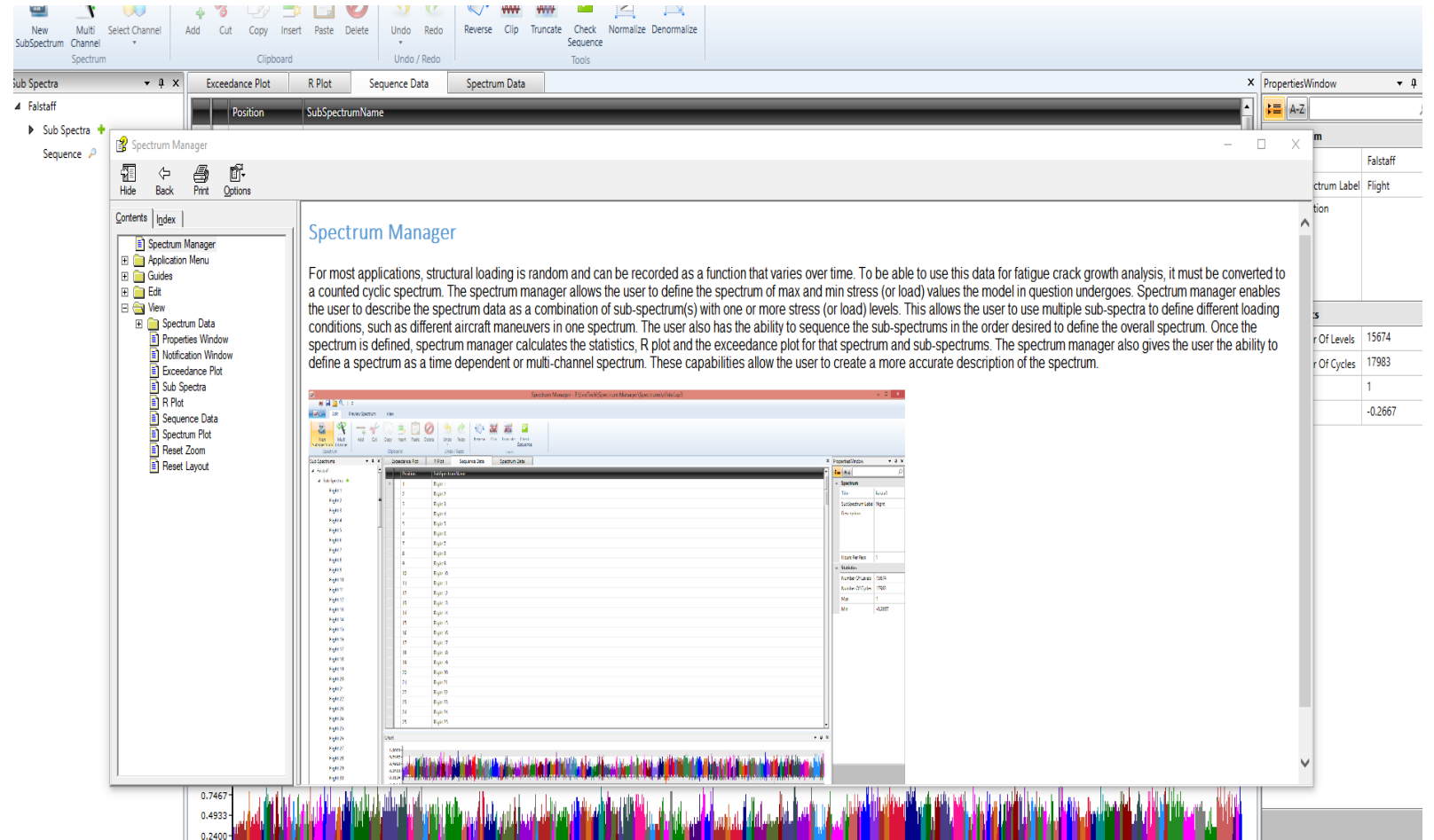
- In previous versions, the R Plot would display data from all Sub Spectra rather than those that had been added to the Spectrum Sequence
- The R Plot now displays data only for sequenced Sub Spectra

# Example



# New Help Pages

- Spectrum Manager has a wide range of functionality, but users may not know where a specific command is located, or how to use all of the capabilities of the program
- Several detailed Help pages have been created to explain the various components of the application



The screenshot displays the Spectrum Manager software interface. The main window shows a help page titled "Spectrum Manager" with the following text:

For most applications, structural loading is random and can be recorded as a function that varies over time. To be able to use this data for fatigue crack growth analysis, it must be converted to a counted cyclic spectrum. The spectrum manager allows the user to define the spectrum of max and min stress (or load) values the model in question undergoes. Spectrum manager enables the user to describe the spectrum data as a combination of sub-spectrum(s) with one or more stress (or load) levels. This allows the user to use multiple sub-spectra to define different loading conditions, such as different aircraft maneuvers in one spectrum. The user also has the ability to sequence the sub-spectra in the order desired to define the overall spectrum. Once the spectrum is defined, spectrum manager calculates the statistics, R plot and the exceedance plot for that spectrum and sub-spectra. The spectrum manager also gives the user the ability to define a spectrum as a time dependent or multi-channel spectrum. These capabilities allow the user to create a more accurate description of the spectrum.

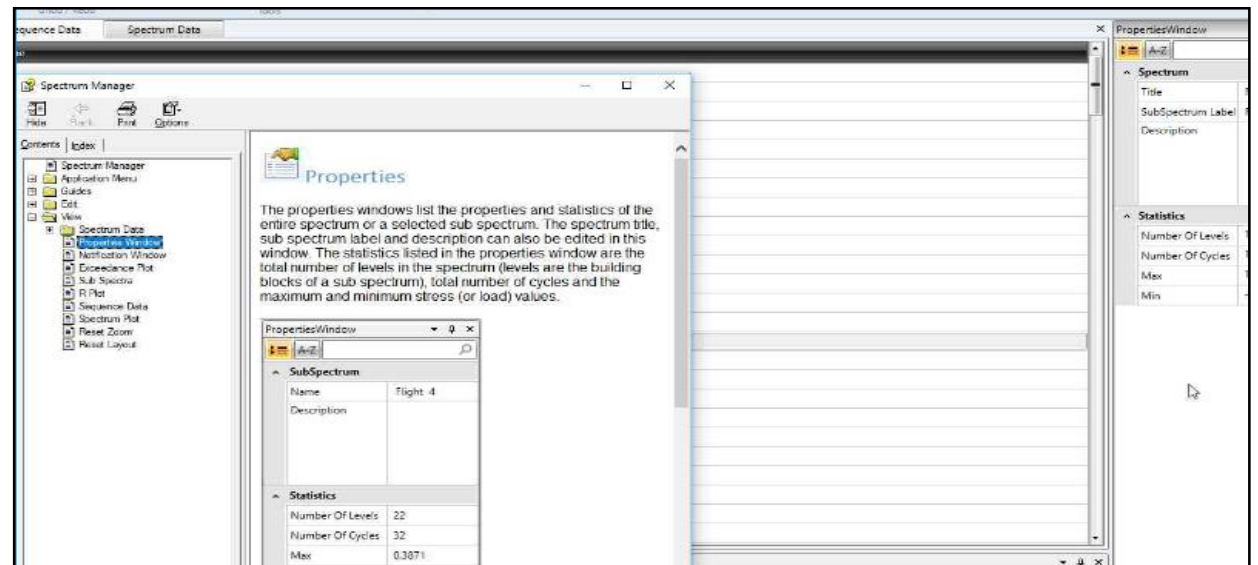
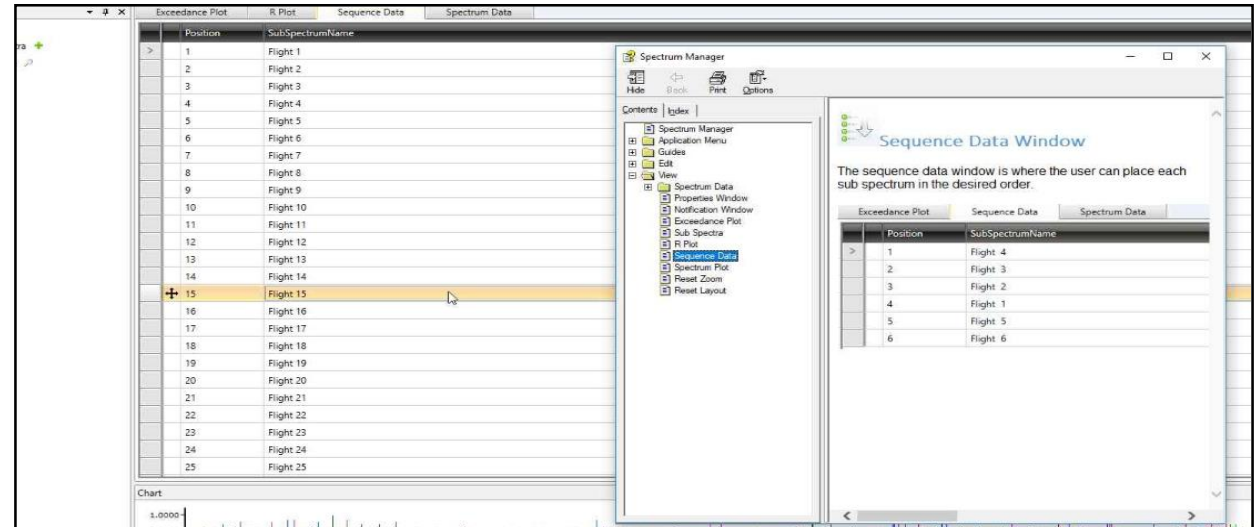
The interface also shows a "Contents" pane on the left with a tree view of help topics, including "Spectrum Manager", "Application Menu", "Guides", "Edit", "View", "Spectrum Data", "Properties Window", "Notification Window", "Exceedance Plot", "Sub Spectra", "R Plot", "Sequence Data", "Spectrum Plot", "Reset Zoom", and "Reset Layout".

At the bottom of the screenshot, a multi-colored spectrum plot is visible, showing stress levels ranging from 0.2400 to 0.7467. The plot is divided into sub-spectra, with the following statistics shown in the PropertiesWindow:

Property	Value
Number Of Levels	15674
Number Of Cycles	17983
Min	-0.2667

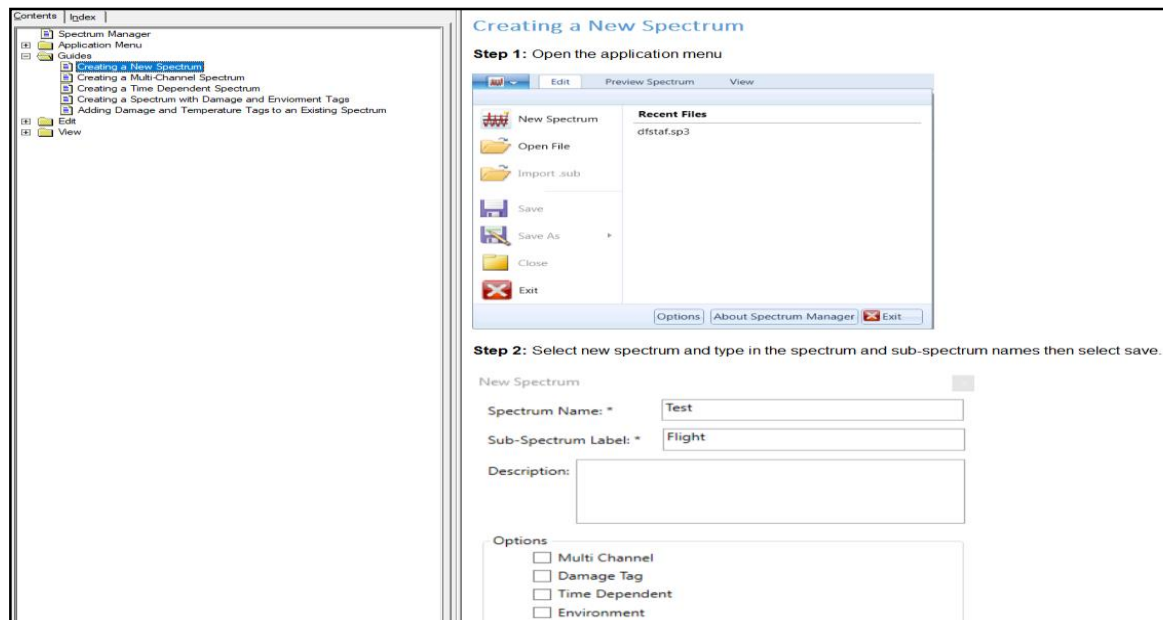
# Help - Context Sensitive

- The new Help is context-sensitive
- Depending which window was last used, the Help command will display Help associated with that window



# Help – All Options

- There is a section for each of the Application Commands, Edit Commands, and guides for some of the most frequently used operations of Spectrum Manager



**Creating a New Spectrum**

**Step 1:** Open the application menu

**Step 2:** Select new spectrum and type in the spectrum and sub-spectrum names then select save.

New Spectrum

Spectrum Name: \*

Sub-Spectrum Label: \*

Description:

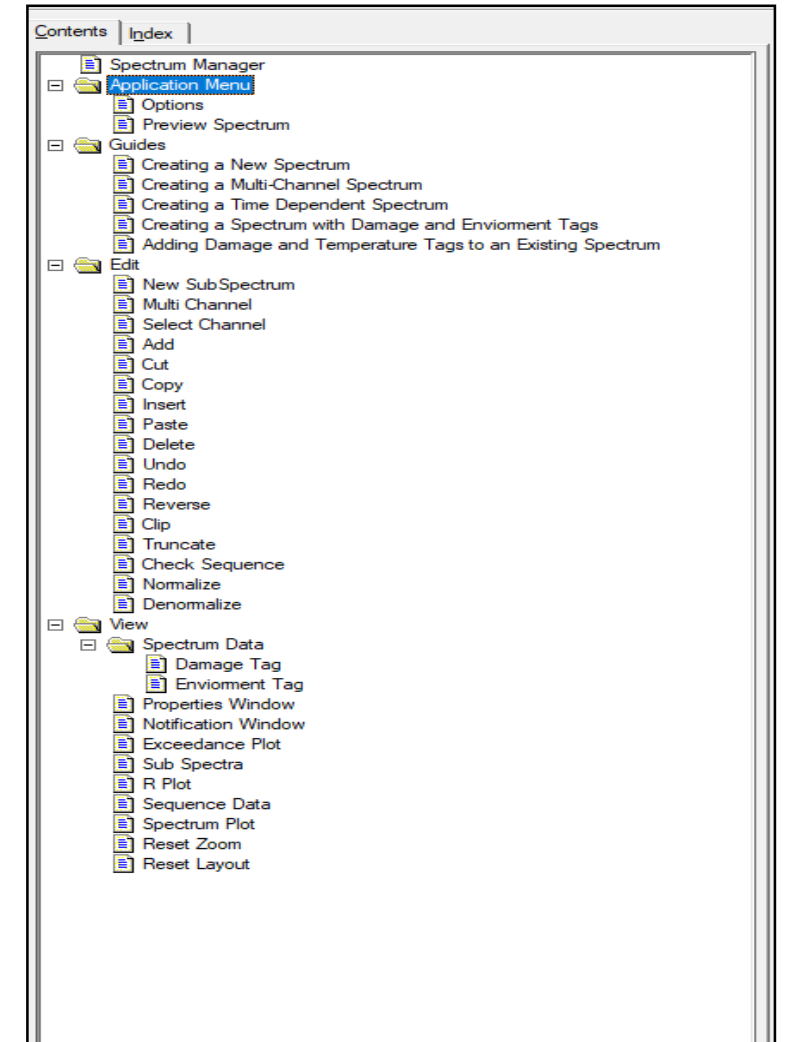
Options

Multi Channel

Damage Tag

Time Dependent

Environment

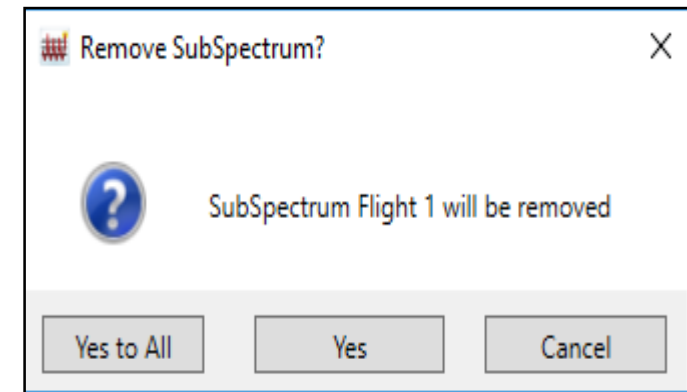


Contents | Index

- Spectrum Manager
  - Application Menu
    - Options
    - Preview Spectrum
  - Guides
    - Creating a New Spectrum
    - Creating a Multi-Channel Spectrum
    - Creating a Time Dependent Spectrum
    - Creating a Spectrum with Damage and Envioment Tags
    - Adding Damage and Temperature Tags to an Existing Spectrum
  - Edit
    - New Sub Spectrum
    - Multi Channel
    - Select Channel
    - Add
    - Cut
    - Copy
    - Insert
    - Paste
    - Delete
    - Undo
    - Redo
    - Reverse
    - Clip
    - Truncate
    - Check Sequence
    - Normalize
    - Denormalize
  - View
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      - Damage Tag
      - Envioment Tag
    - Properties Window
    - Notification Window
    - Exceedance Plot
    - Sub Spectra
    - R Plot
    - Sequence Data
    - Spectrum Plot
    - Reset Zoom
    - Reset Layout

# Streamlined Truncation

- In the case that all levels in a Sub Spectrum have been truncated, a pop-up message will appear prompting the user to remove the empty Sub Spectrum
- The new “Yes to All” button automatically removes all empty Sub Spectra at once





# Bug Fixes in Version 1.1

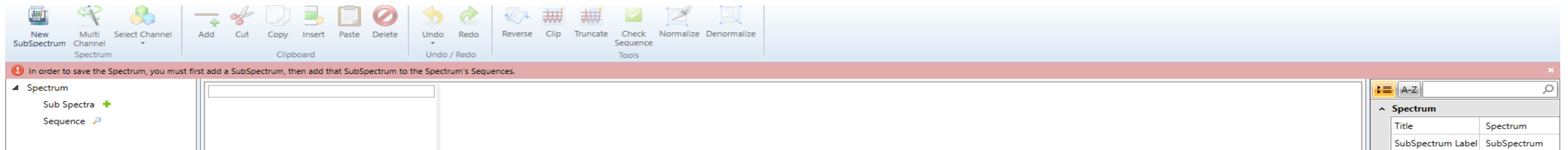
- Cycle Shape renamed to Load Type
- Opening a Spectrum file now clears old Exceedance Plot Points
- Solved an issue with Environment, Time Dependent, and Number of items being saved correctly
- Saving as a .SPX file is correctly enabled when appropriate
- Removed an obsolete legacy window from layout

# Short Term Future Development Plans

- Information alerts
- Option to Truncate compressive cycles
- Import file of Max-Min data
- Import file of Max-Min-Cycles-DamageTag data
- COM Support

# Information Alerts

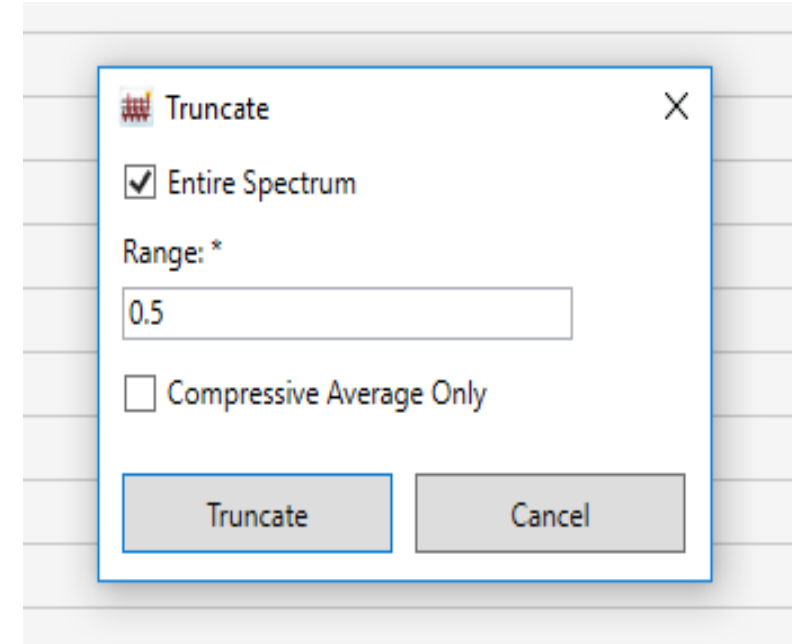
- The Information Alert Bar will display messages about the state of the Spectrum
- For instance, if a user creates a new Spectrum, an alert would appear telling them that they cannot save the Spectrum until they create a Sub Spectrum and add it to the Sequence



- The alert bar is dismissible, appearing by default under the command ribbon

# Truncating Compression Cycles

- The Truncate dialogue will include an option to truncate cycles with a compressive average (user request)
- This will Truncate a level if the average cycle value is negative AND if the delta of the Max Min range is within the specified bounds



# Import Max-Min File

- A new option to import a two-column file of Max and Min data
- If a user has a text file with two columns of numeric data, they can automatically add those values to a new sub spectrum
- The Notification Window will display an error message if the data is improperly formatted (Max being less than the min)

# Import Max-Min-Cycles-DamageTag File

- Another option will be added to import a 4-column file, containing max, min, number of cycles, and a damage tag
- If a user has a 4 column text file, they can automatically populate a new Sub Spectrum with the data
- The Notification Window will display an error message if the data is improperly formatted (Max being less than the min, cycles less than 1)

# COM Support

- We are adding COM interfacing for common Spectrum Manager operations
- Users will have the ability to create and save Spectra and perform commands such as Check Sequence, Clip, Reverse, and Truncate on their Spectrum inside of Microsoft Excel

# Long Term Future Development Plans

- Stress Range Reporting
- Spectrum Generation from Exceedance Curve Data
- Spectrum Cycle Counting



# Conclusion

Spectrum Manager v 1.1 features improved data handling, reworked Exceedance and R Plotting capability, Context-Sensitive Help, and multiple bug fixes

Upcoming additions include information alerts, compression truncation, and a COM interface

# Questions/Comments?