Data Repositories for Parametric Workflow Models

Using model libraries in Teamwork Cloud to store and retrieve SIS and Launch Vehicle data

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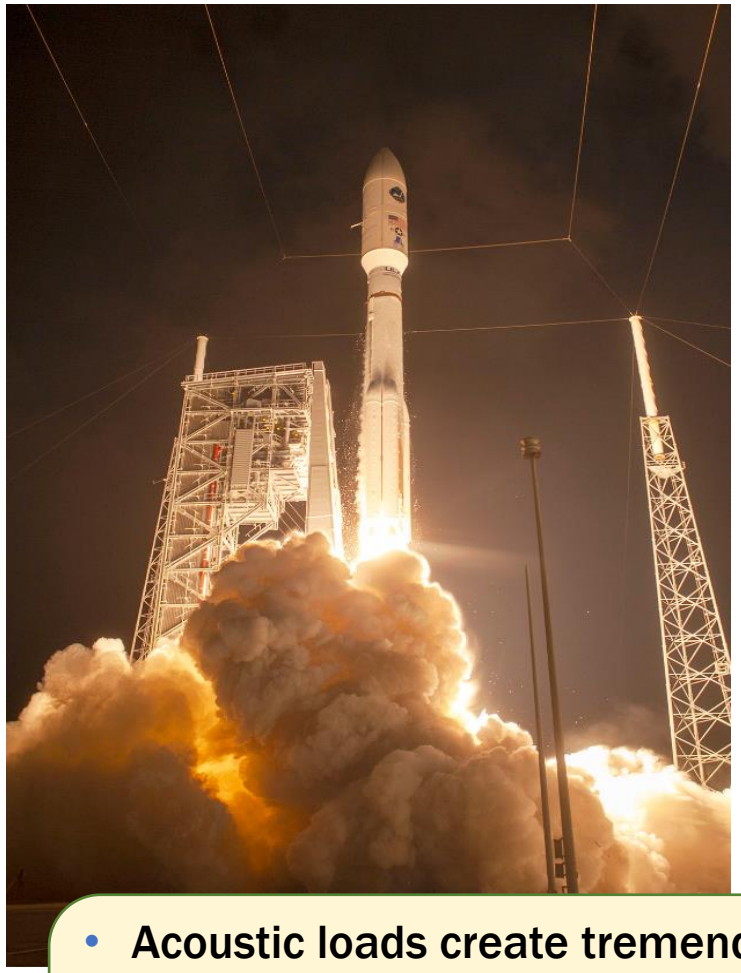
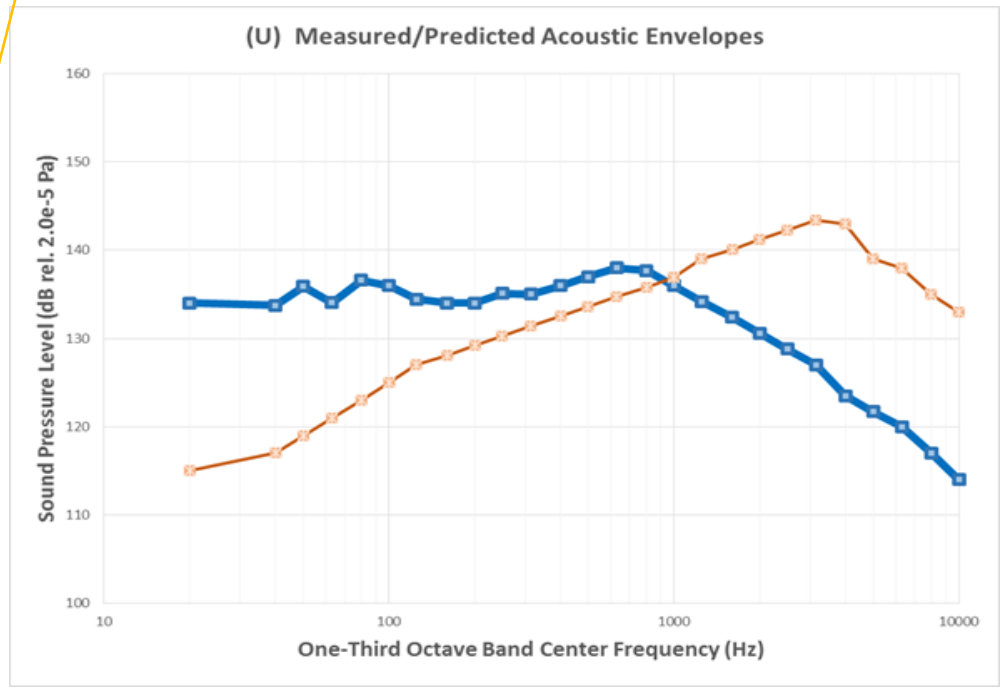
QUANTUM RESEARCH INTERNATIONAL

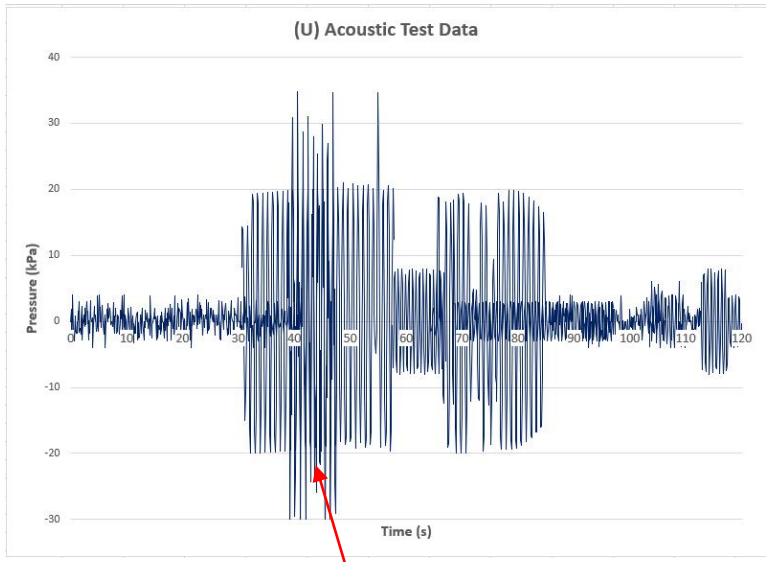
Mission Integration: The Acoustics Problem



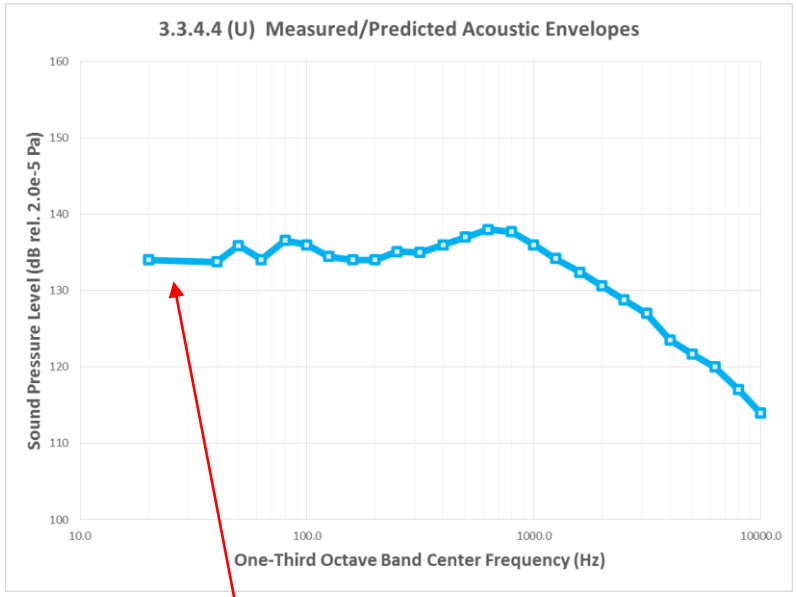


- Acoustic loads create tremendous mechanical stresses on the entire launch vehicle.
- This acoustic environment occurs in two stages –
- 1) hold down, when all the first stage engines are firing and building thrust, followed by
- 2) lift-off when the rocket actually starts to fly.

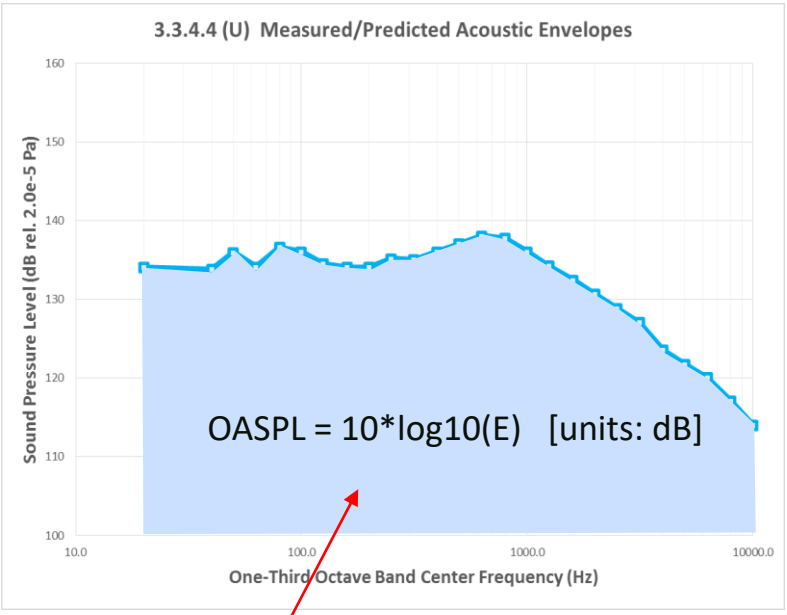
Converting Acoustic Signal into Sound Pressure Levels



Measurement of acoustic signal in time domain (test lab, simulation, or other technique)



Converting time signal to frequency domain. Compare curves from different references and vehicles.
SIS provides general guideline as an envelope which constrains this freq curve.



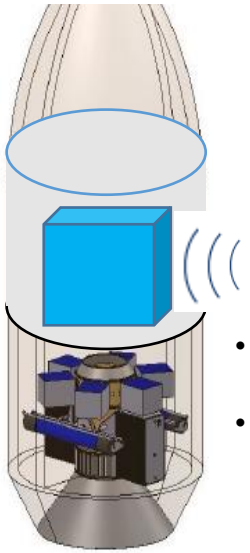
Integrate under freq curve to find Overall Acoustic Sound Pressure Level (OASPL)

- **Calculate the total energy contained in the spectrum, $E = \int S(f)\, df$**
- **Calculate Overall Sound Pressure Level, $OASPL = 10*\log10(E)$ [units: dB]**

Acoustics Algorithm

OASPL results shown on dashboard as a bar chart

Payload SPL vs freq submitted as raw data file, then imported into SysML table



- Measure or Predict
- 20 in from PL Skin

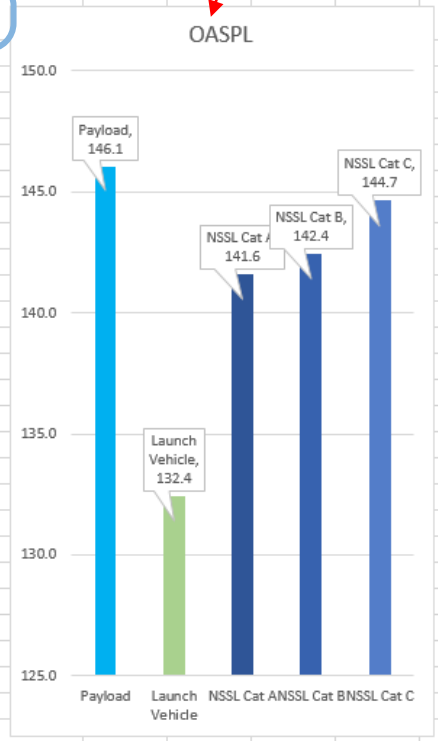
PL Under Consideration

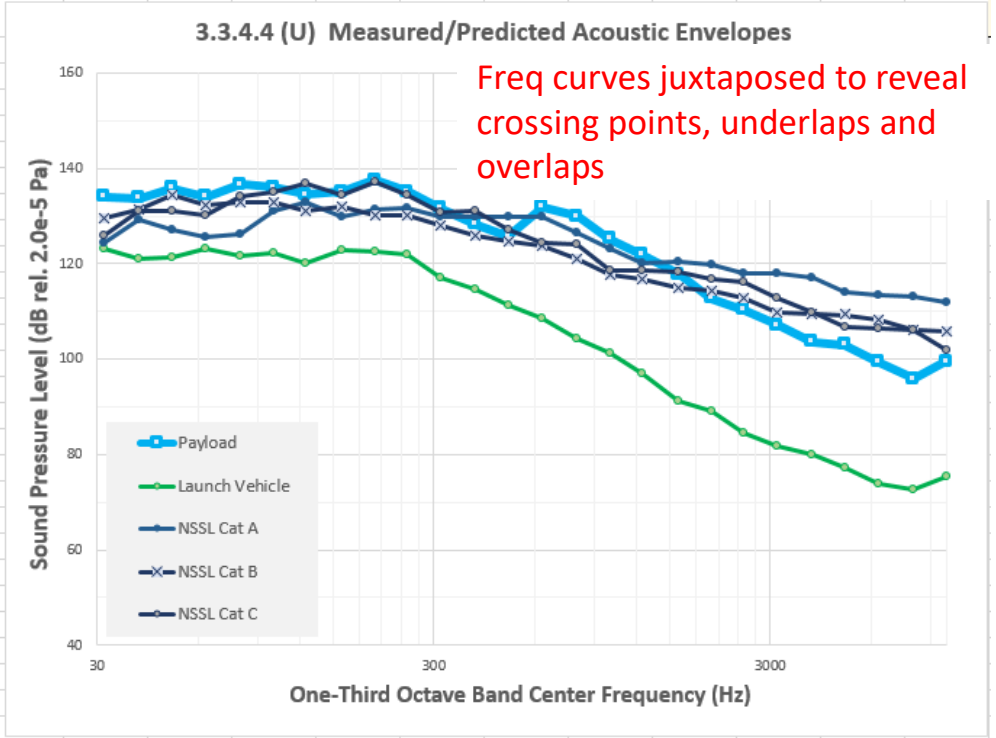
LV Under Consideration (LSP Cloud)

SIS Categories (GovCloud)

q (Hz)	Payload	Launch Vehicle	NSSL Cat A	NSSL Cat B	NSSL Cat C
40	133.7	121.1	129.1	131.3	130.9
50	135.9	121.4	127.0	134.3	131.1
	134.1	123.2	125.7	132.3	130.2
	136.6	121.7	126.[illegible]	[illegible]	[illegible]
100	136.0	122.2	13[illegible]	[illegible]	[illegible]
125	134.5	120.1	13[illegible]	[illegible]	[illegible]
1[illegible]	[illegible]	[illegible]	12[illegible]	[illegible]	[illegible]
2[illegible]	[illegible]	[illegible]	131.4	130.1	127.3
25	131.7	130.1	134.4		
31	129.7	128.0	130.8		
400	128.2	114.7	130.0	126.0	131.0
500	125.8	111.3	129.8	124.8	127.2
630	132.0	108.5	130.0	123.6	124.4
800	129.9	104.2	126.4	121.1	124.0
1000	125.2	101.4	123.1	117.8	118.7
1250	121.9	97.1	120.1	116.7	118.7
1600	117.8	91.1	120.4	115.0	118.3
2000	112.8	89.1	119.7	114.5	116.9
2500	110.2	84.5	118.1	112.9	116.1
3150	107.1	81.7	118.1	109.7	112.8

Freq points from other vehicles and/or references



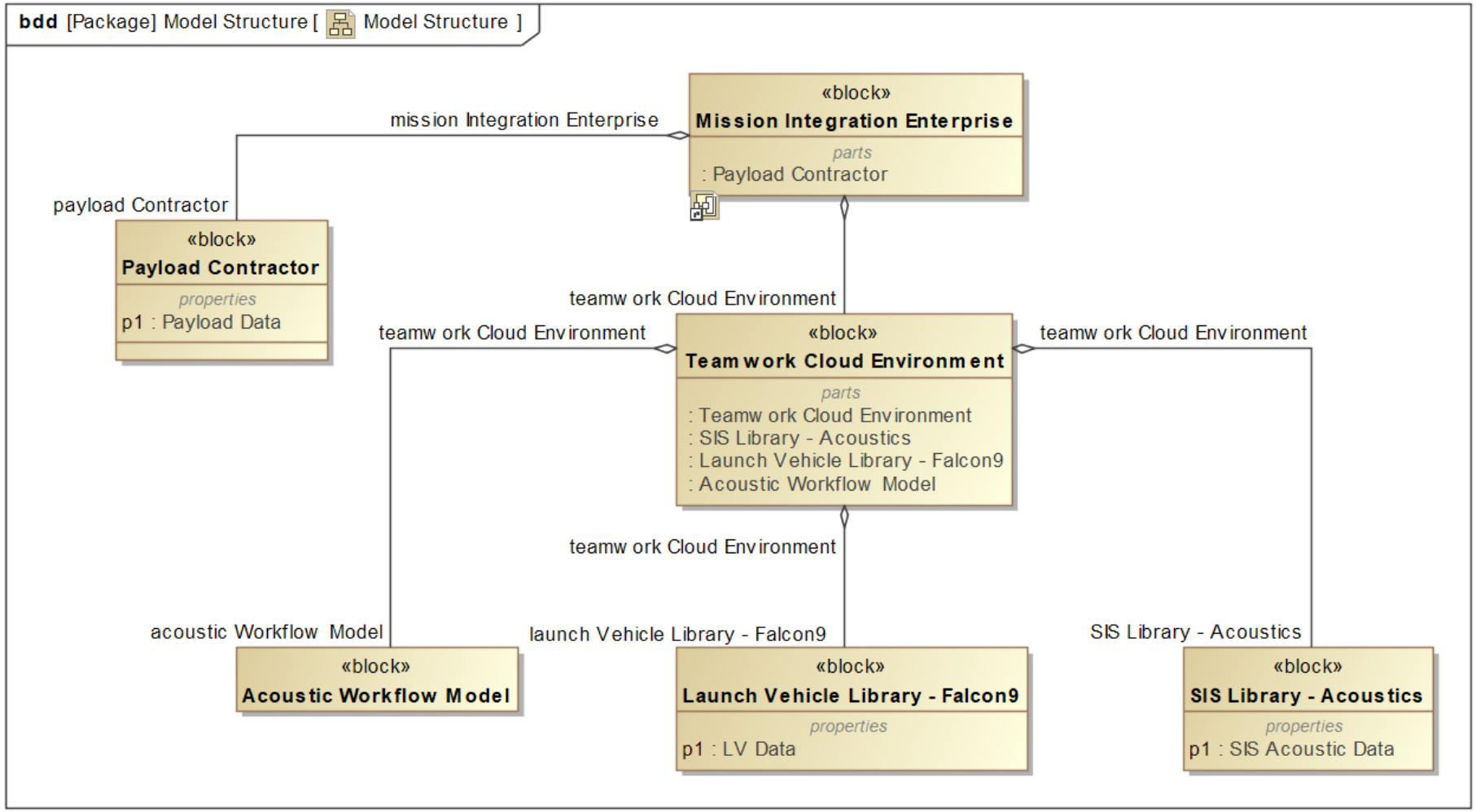


Freq curves juxtaposed to reveal crossing points, underlaps and overlaps

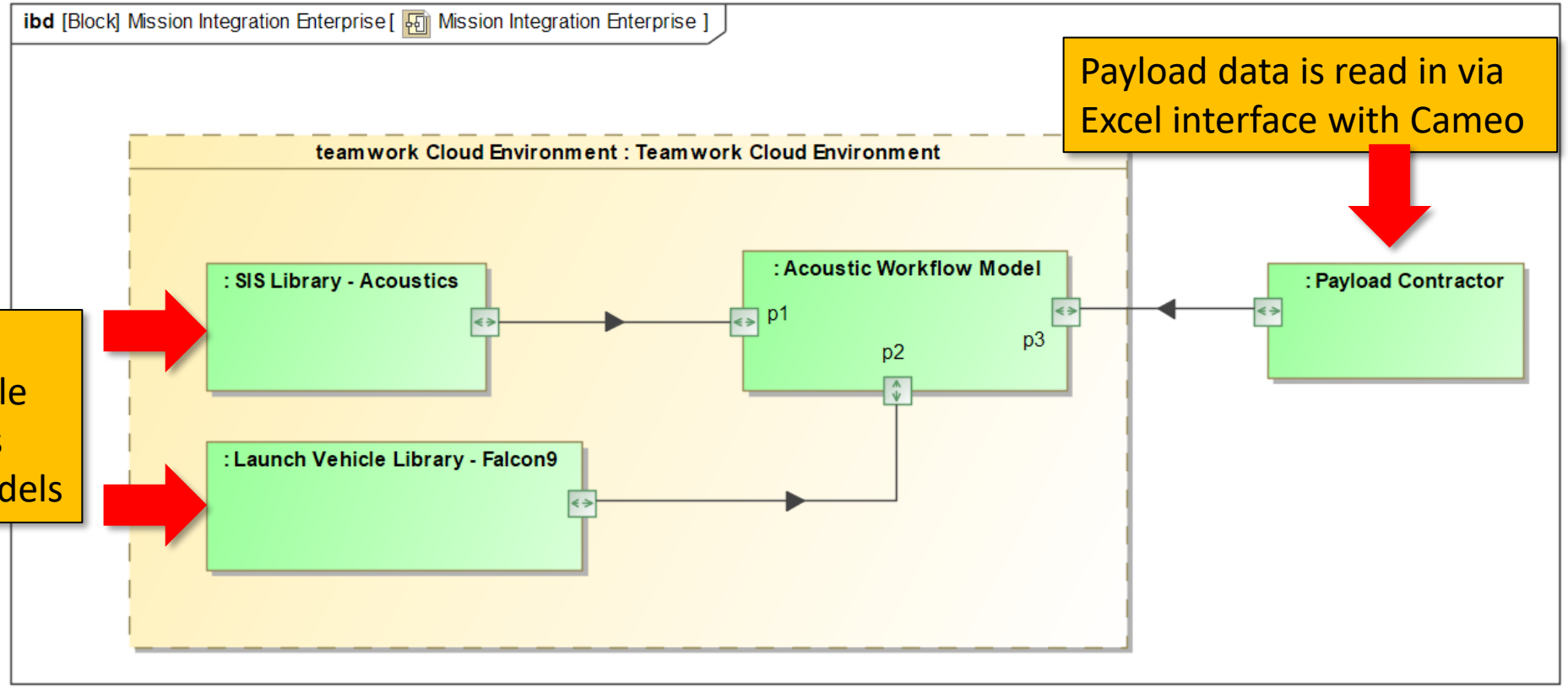
Summary of main steps

- **Assumptions**
  - P95/50 (95% Probability with 50% Confidence)
  - PL shall be designed to tolerate the acoustic levels generated by LV
  - From liftoff through SV separation
  - Reference pressure 20 µPa
- **Workflow Steps**
  - Obtain V(t) [voltage time trace from microphone]
  - Calc p'(t) = mic.constant * V(t)
    - where p'(t) = pressure fluctuation
  - Normalize p'(t) using reference pressure 20 µPa
  - Calc S(f) using FFT
    - where S(f) = spectrum of normalized p'(t)
  - Correct S(f) for mic response and atmospheric absorption
  - Compute Sound Pressure Level (SPL) Spectrum
    - SPL(f) = 10*log10(S(f)) [units: dB/Hz]
  - Compute Overall Sound Pressure Level (OASPL)
    - $E = \int S(f)\, df$ [total energy contained in the spectrum]
    - OASPL = 10*log10(E) [units: dB]
  - Identify SPL and OASPL exceedances

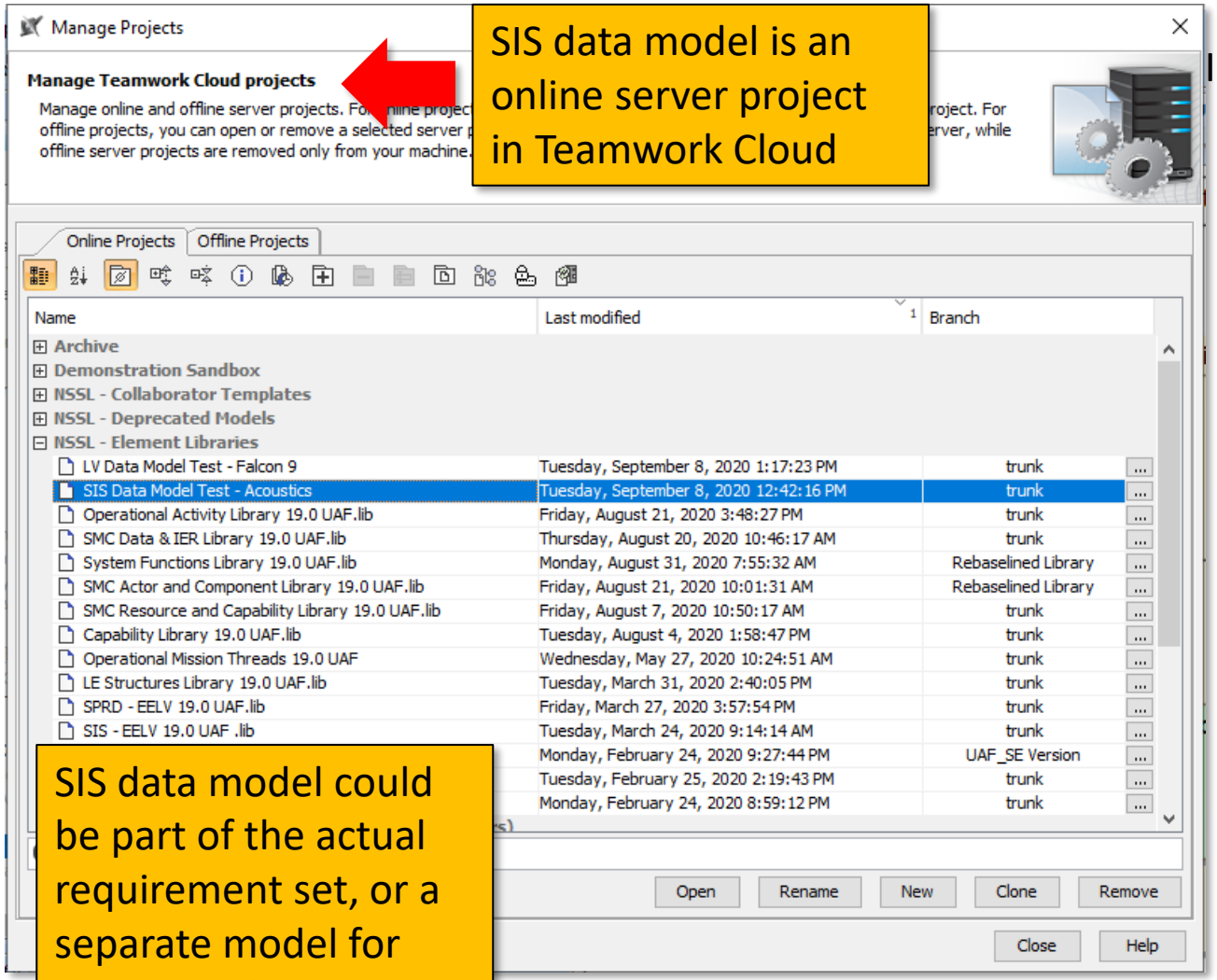
Workflow Analysis Model Structure



Mission Integration Enterprise Internal Connectivity



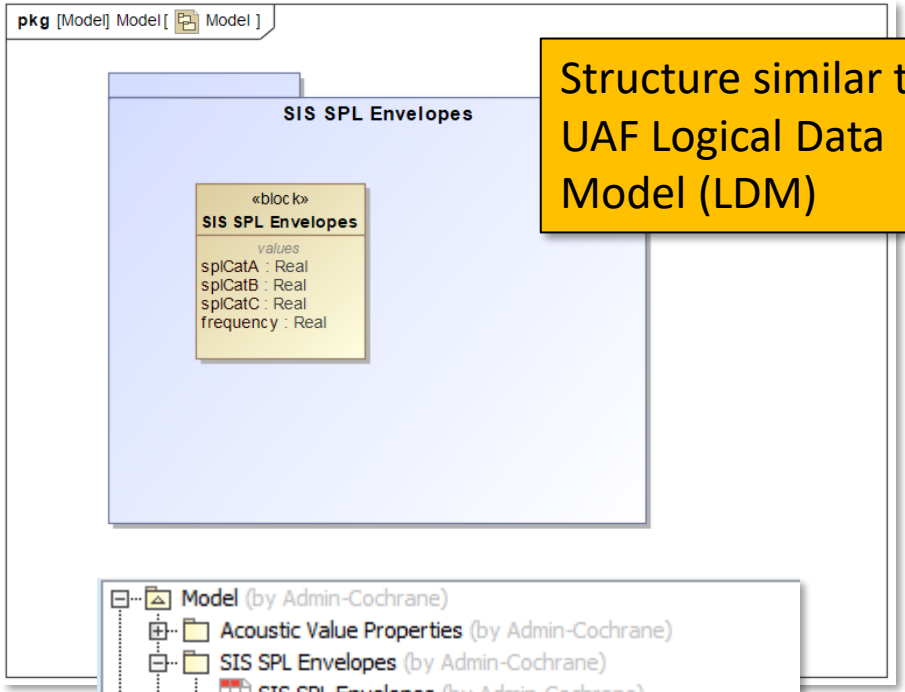
SIS Library Model



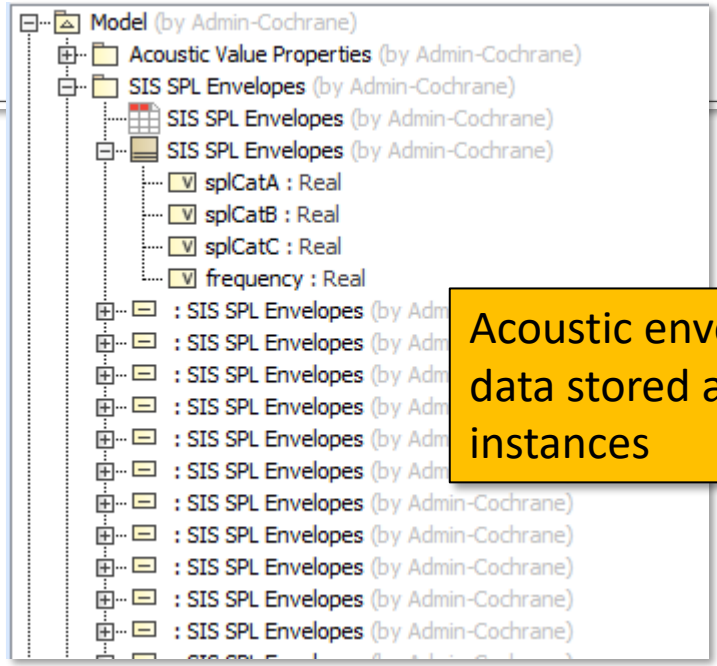
SIS data model is an online server project in Teamwork Cloud

SIS data model could be part of the actual requirement set, or a separate model for each workflow.

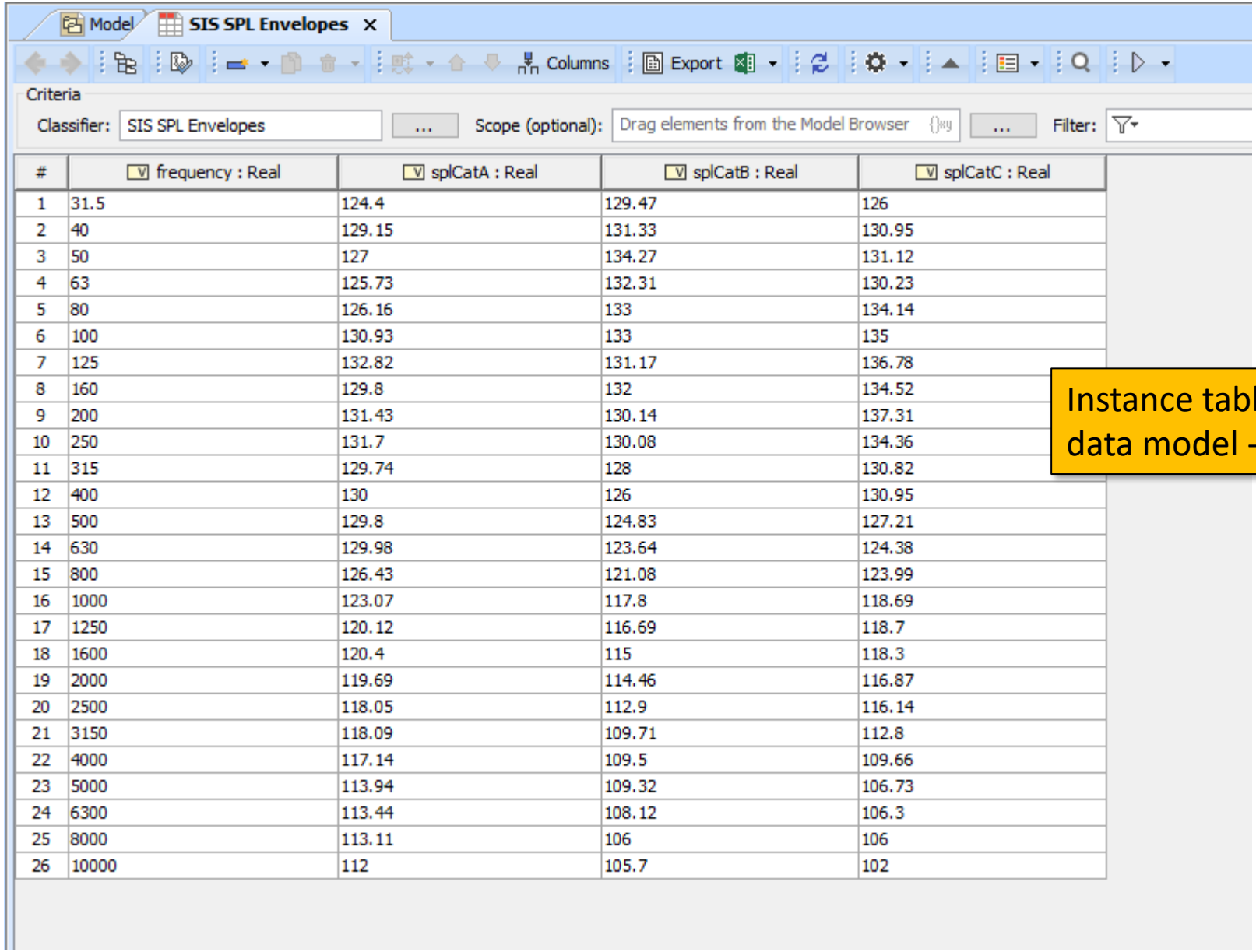
IED



Structure similar to UAF Logical Data Model (LDM)



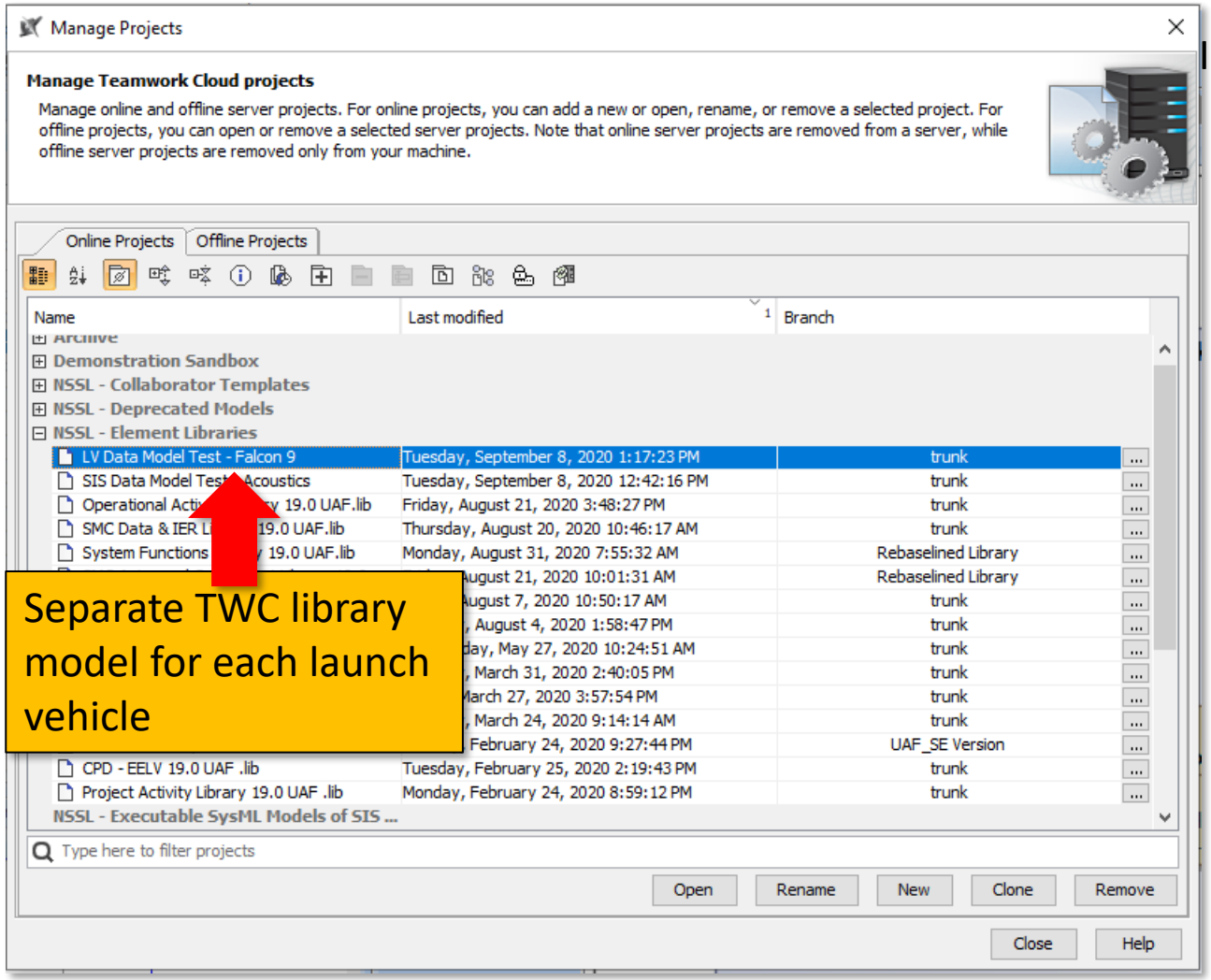
Acoustic envelope data stored as instances



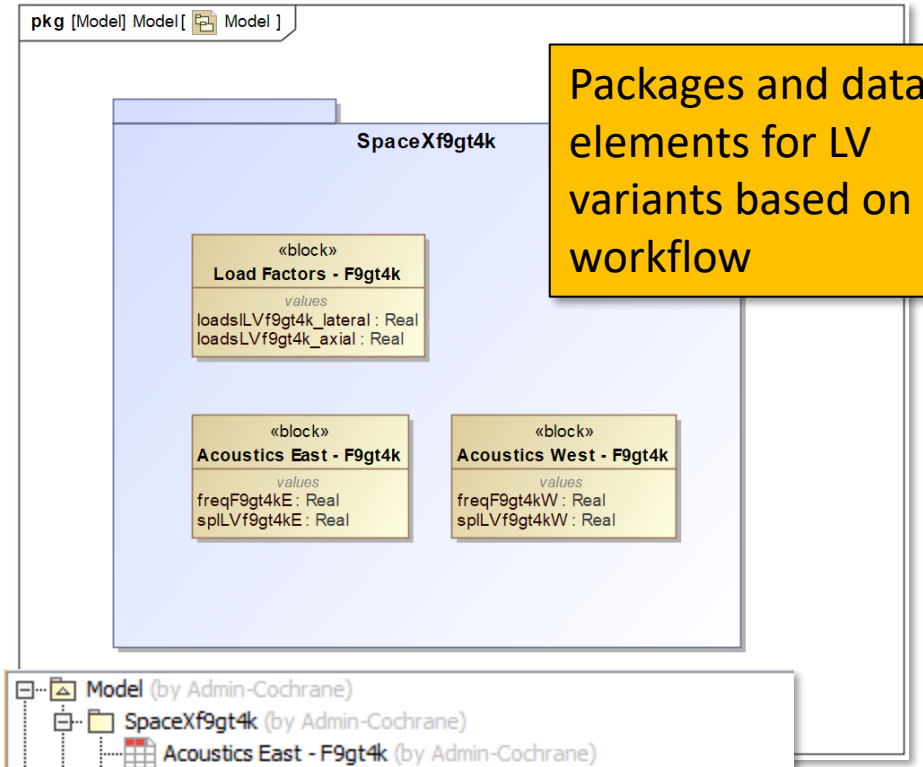
#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real
1	31.5	124.4	129.47	126
2	40	129.15	131.33	130.95
3	50	127	134.27	131.12
4	63	125.73	132.31	130.23
5	80	126.16	133	134.14
6	100	130.93	133	135
7	125	132.82	131.17	136.78
8	160	129.8	132	134.52
9	200	131.43	130.14	137.31
10	250	131.7	130.08	134.36
11	315	129.74	128	130.82
12	400	130	126	130.95
13	500	129.8	124.83	127.21
14	630	129.98	123.64	124.38
15	800	126.43	121.08	123.99
16	1000	123.07	117.8	118.69
17	1250	120.12	116.69	118.7
18	1600	120.4	115	118.3
19	2000	119.69	114.46	116.87
20	2500	118.05	112.9	116.14
21	3150	118.09	109.71	112.8
22	4000	117.14	109.5	109.66
23	5000	113.94	109.32	106.73
24	6300	113.44	108.12	106.3
25	8000	113.11	106	106
26	10000	112	105.7	102

Instance table for SIS data model - acoustics

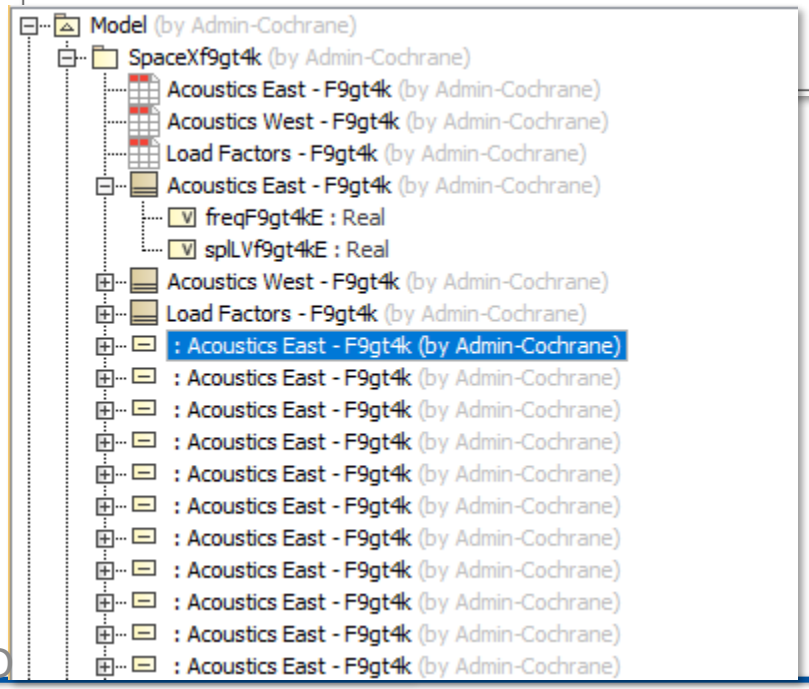
Launch Vehicle Library Model



Separate TWC library model for each launch vehicle



Packages and data elements for LV variants based on workflow



Model | Load Factors - F9gt4k | **Acoustics East - F9gt4k** ×

Columns

Criteria

Classifier: Acoustics East - F9gt4k ... Scope (optional): Drag

#	freqF9gt4kE : Real	splLVf9gt4kE : Real
1	31.5	118
2	40	119.5
3	50	120
4	63	120
5	80	119.8
6	100	120.5
7	125	121.5
8	160	122
9	200	121.5
10	250	120.5
11	315	119
12	400	117
13	500	115
14	630	113
15	800	111
16	1000	109.5
17	1250	108
18	1600	107
19	2000	106
20	2500	105
21	3150	104
22	4000	103
23	5000	102
24	6300	101
25	8000	100
26	10000	99

Model | **Acoustics West - F9gt4k** × | Load Factors - F9gt

Columns

Criteria

Classifier: Acoustics West - F9gt4k ... Scope (optional): D

#	freqF9gt4kW : Real	splLVf9gt4kW : Real
1	31.5	119.75
2	40	120
3	50	120
4	63	120
5	80	119.8
6	100	120.5
7	125	121.5
8	160	122
9	200	121.5
10	250	120.5
11	315	119
12	400	117
13	500	115
14	630	113
15	800	111
16	1000	109.5
17	1250	108
18	1600	107
19	2000	106
20	2500	105
21	3150	104
22	4000	103
23	5000	102
24	6300	101
25	8000	100
26	10000	99

Model | **Load Factors - F9gt4k** × | Acoustics West - F9gt4k | Ac

Columns | Expor

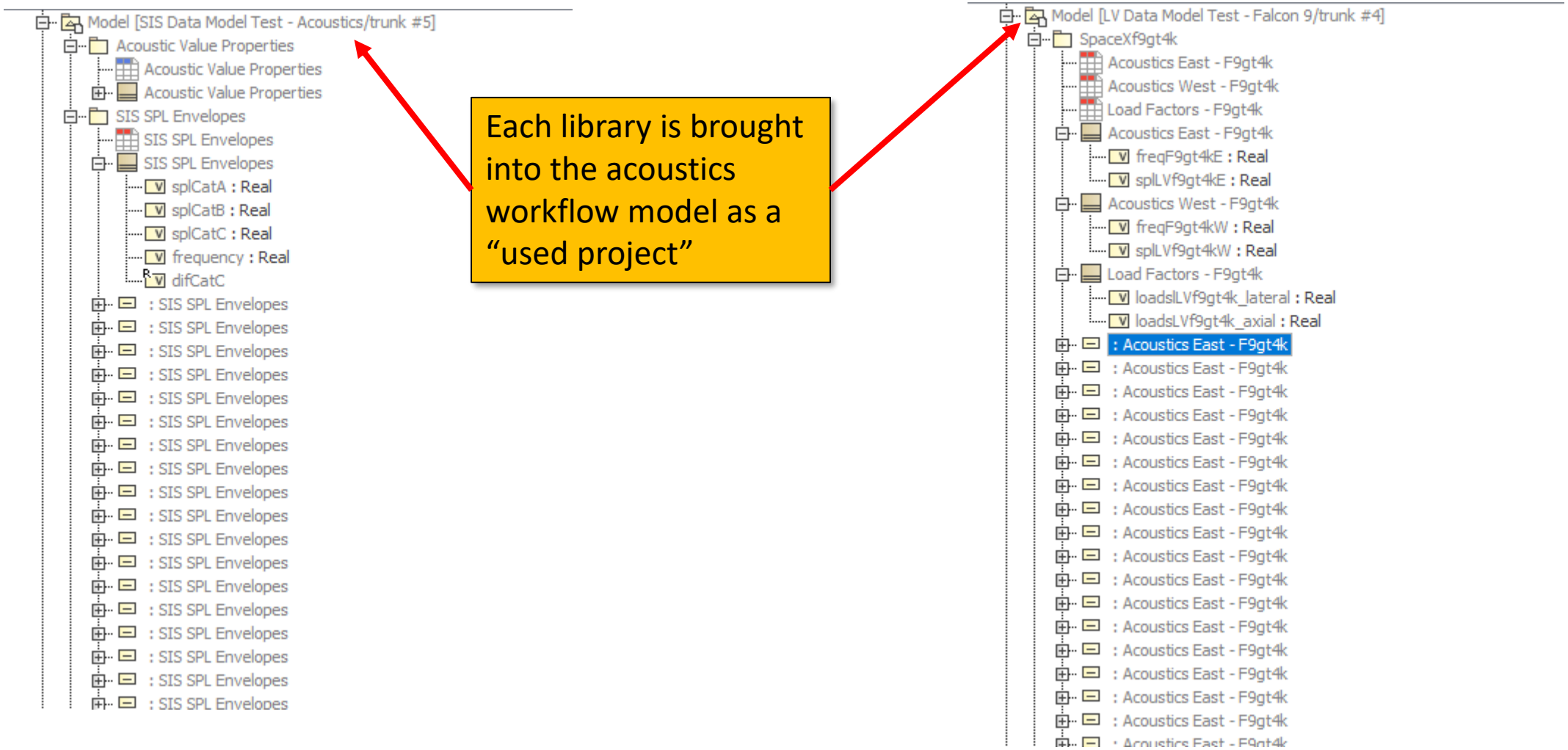
Criteria

Classifier: Load Factors - F9gt4k ... Scope (optional): Drag elemen

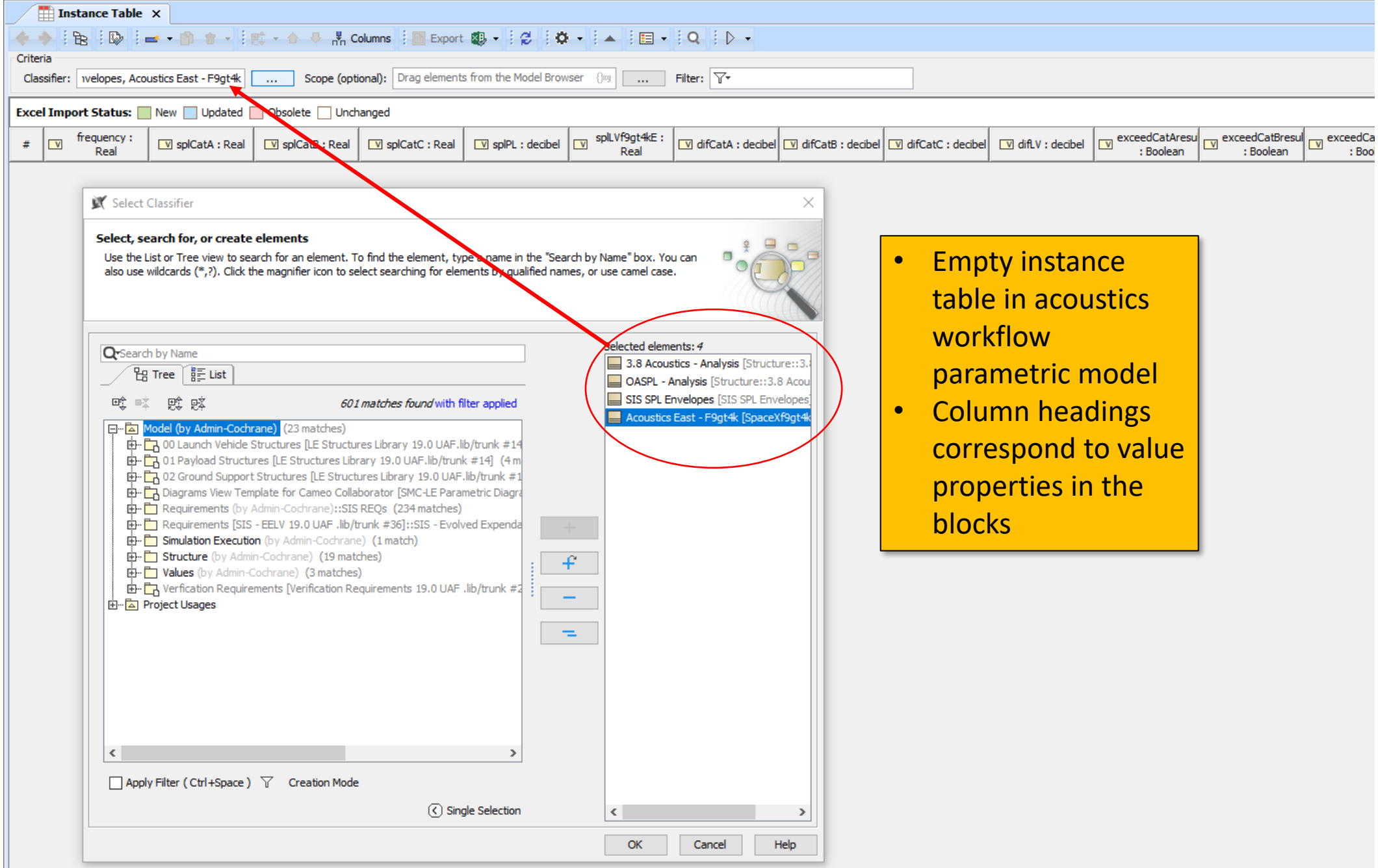
#	loadslLVf9gt4k_lateral : Real	loadsLVf9gt4k_axial : Real
1	0	8.5
2	2	8.5
3	2	4
4	3	4
5	3	-1.5
6	2	-1.5
7	2	-4
8	-2	-4
9	-2	-1.5
10	-3	-1.5
11	-3	4
12	-2	4
13	-2	8.5
14	0	8.5

Falcon 9 (> 4k lbs) acoustics and loads instance tables

Project Usages

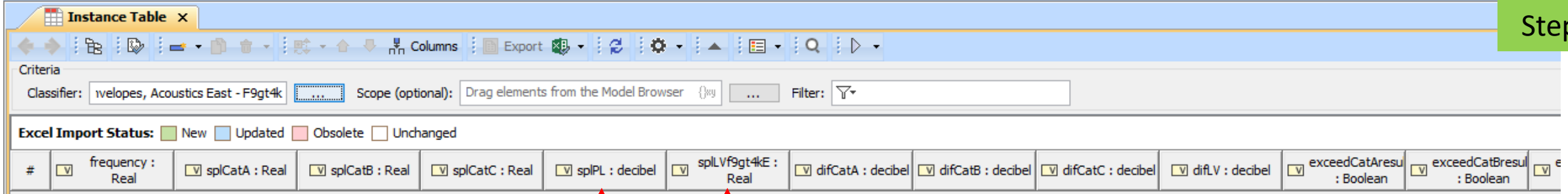


Using the Library Models



- Empty instance table in acoustics workflow parametric model
- Column headings correspond to value properties in the blocks

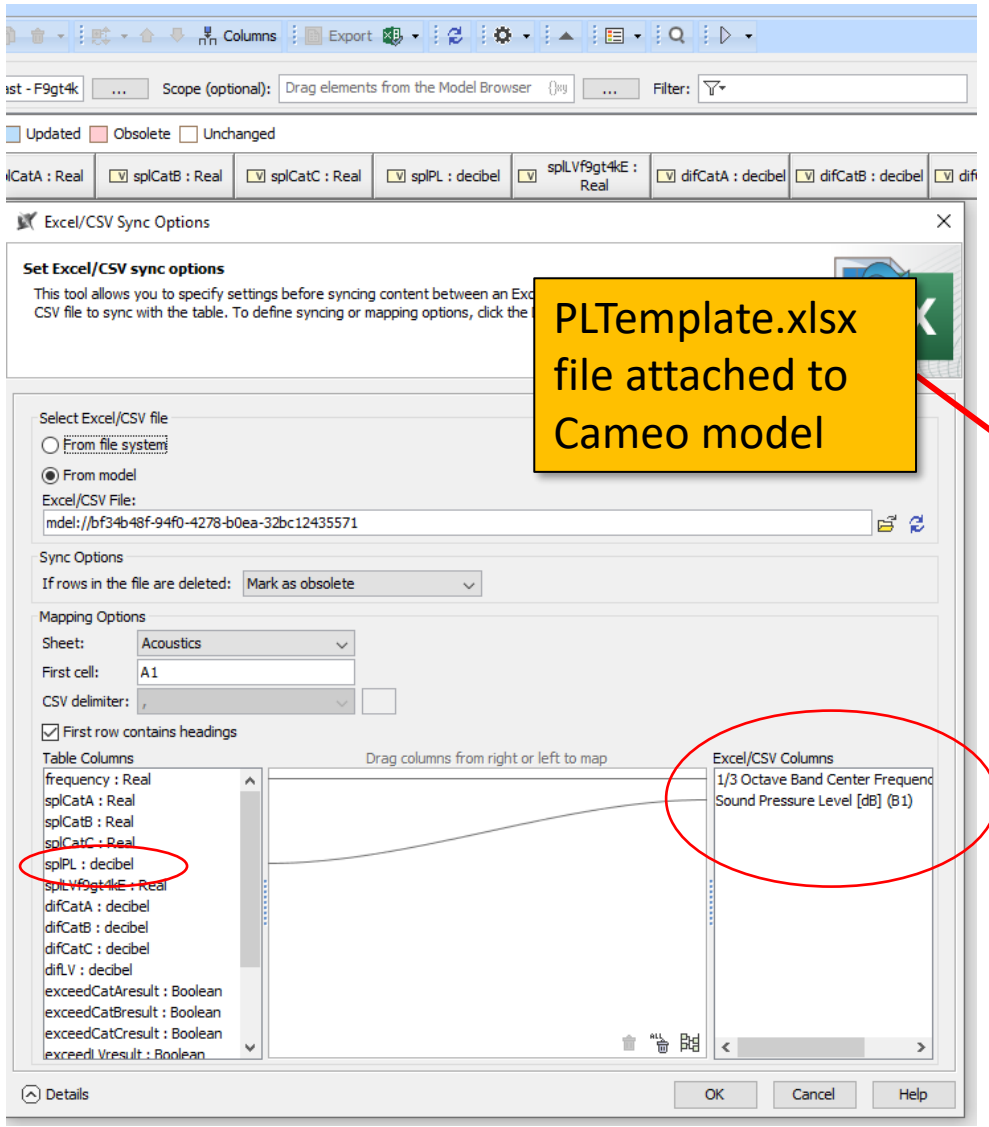
Step 1



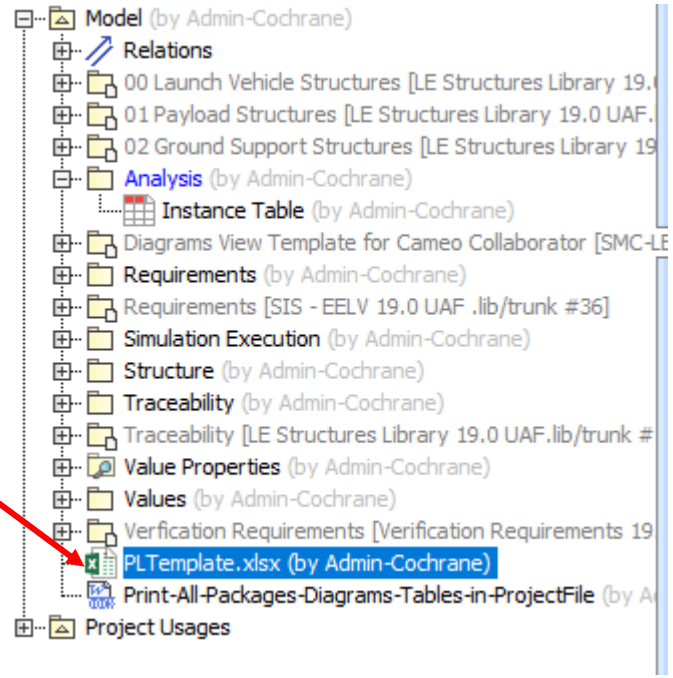
These columns will be populated with SIS data

This column is synced to Excel file for payload input data

This column will be populated with instance data from the LV library



PLTemplate.xlsx file attached to Cameo model



Read in payload data from synced Excel file

	A	B	C	D
1	1/3 Octave Band Center Frequency [Hz	Sound Pressure Level [dB]		
2	25	114		
3	32	121		
4	40	126.8		
5	50	125.2		
6	63	126.3		
7	80	128		
8	100	129		
9	125	130		
10	160	130		
11	200	130		
12	250	130		
13	315	130		
14	400	129.5		
15	500	128		
16	630	125		
17	800	124		
18	1000	123		
19	1250	122		
20	1600	121		
21	2000	120		
22	2500	119		
23	3150	118		
24	4000	117		
25	5000	116		
26	6300	115		
27	8000	114		
28	10000	113		
29				

GeneralProperties | LoadFactors | Acoustics | FlightDesignMatlab

READY

Step 2

Read in payload data from synced Excel file

Instance Table

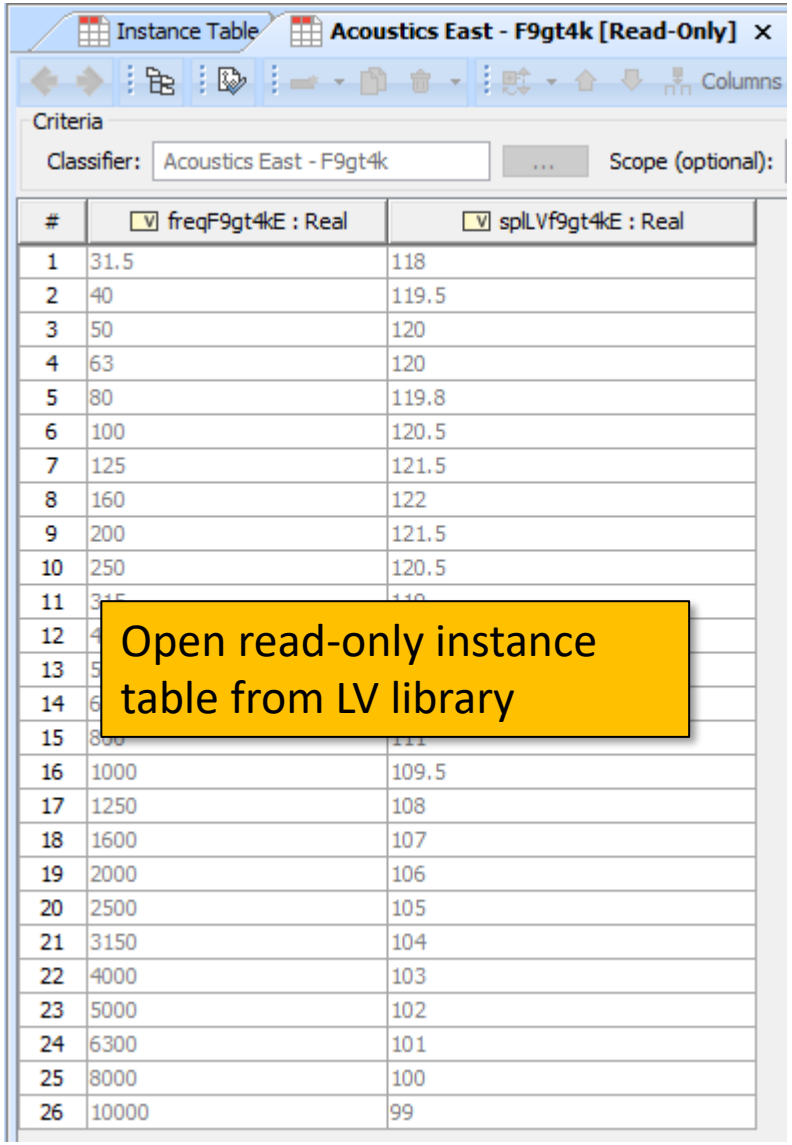
Columns | Export

Criteria

Classifier: ıvelopes, Acoustics East - F9gt4k ... Scope (optional): Drag elements from the Model Browser ... Filter:

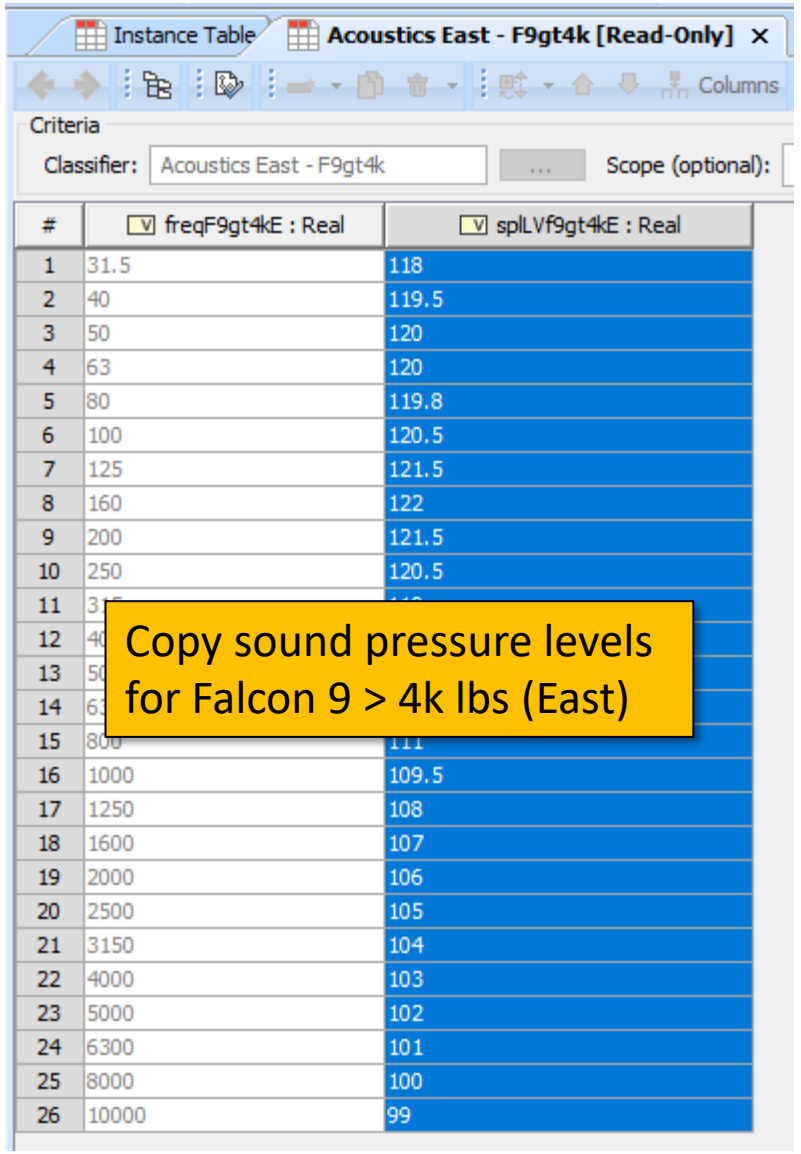
Excel Import Status: New Updated Obsolete Unchanged

#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real	splPL : decibel	splLVf9gt4kE : Real	difCatA : decibel	difCatB : decibel	difCatC : decibel	difLV : decibel	exceedCatAresu : Boolean	exceedCatBresul : Boolean
1	31.5				134						<undefined>	<undefined>
2	40				133.7436						<undefined>	<undefined>
3	50				135.8914						<undefined>	<undefined>
4	63				134.0533						<undefined>	<undefined>
5	80				136.575						<undefined>	<undefined>
6	100				136						<undefined>	<undefined>
7	125				134.4546						<undefined>	<undefined>
8	160				135.1186						<undefined>	<undefined>
9	200				137.5318						<undefined>	<undefined>
10	250				135.1229						<undefined>	<undefined>
11	315				131.6						<undefined>	<undefined>
12	400				128.2021						<undefined>	<undefined>
13	500				125.7519						<undefined>	<undefined>
14	630				131.9686						<undefined>	<undefined>
15	800				129.9381						<undefined>	<undefined>
16	1000				125.234						<undefined>	<undefined>
17	1250				121.9223						<undefined>	<undefined>
18	1600				117.8164						<undefined>	<undefined>
19	2000				112.7856						<undefined>	<undefined>
20	2500				110.2492						<undefined>	<undefined>
21	3150				107.1						<undefined>	<undefined>
22	4000				103.6133						<undefined>	<undefined>
23	5000				103.046						<undefined>	<undefined>
24	6300				99.4076						<undefined>	<undefined>
25	8000				95.8446						<undefined>	<undefined>
26	10000				99.5						<undefined>	<undefined>



#	freqF9gt4kE : Real	splLVf9gt4kE : Real
1	31.5	118
2	40	119.5
3	50	120
4	63	120
5	80	119.8
6	100	120.5
7	125	121.5
8	160	122
9	200	121.5
10	250	120.5
11	315	119
12	400	117
13	500	115
14	630	113
15	800	111
16	1000	109.5
17	1250	108
18	1600	107
19	2000	106
20	2500	105
21	3150	104
22	4000	103
23	5000	102
24	6300	101
25	8000	100
26	10000	99

Open read-only instance table from LV library

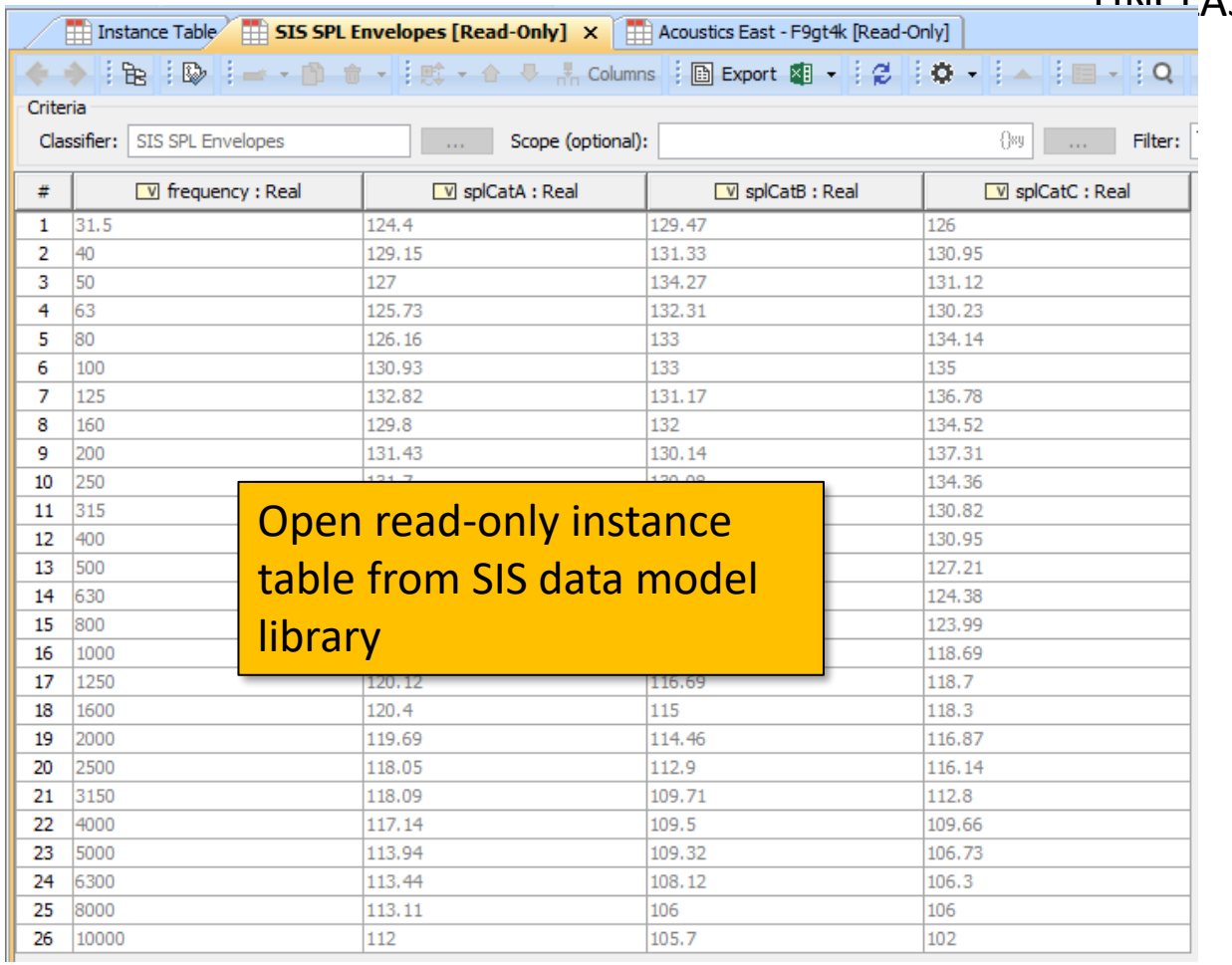


#	freqF9gt4kE : Real	splLVf9gt4kE : Real
1	31.5	118
2	40	119.5
3	50	120
4	63	120
5	80	119.8
6	100	120.5
7	125	121.5
8	160	122
9	200	121.5
10	250	120.5
11	315	119
12	400	117
13	500	115
14	630	113
15	800	111
16	1000	109.5
17	1250	108
18	1600	107
19	2000	106
20	2500	105
21	3150	104
22	4000	103
23	5000	102
24	6300	101
25	8000	100
26	10000	99

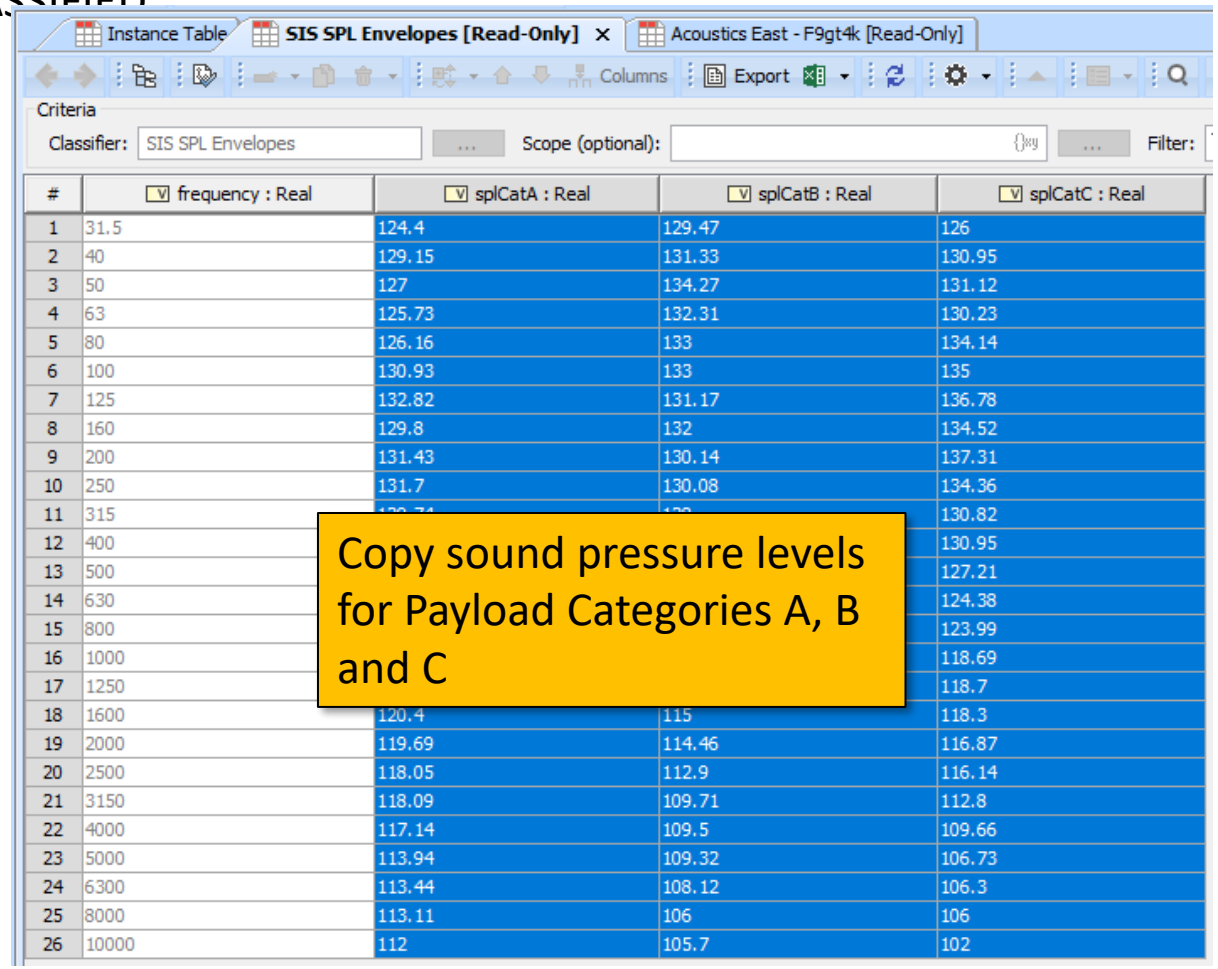
Copy sound pressure levels for Falcon 9 > 4k lbs (East)

splPL : decibel	splLVf9gt4kE : Real
134	118
133.7436	119.5
135.8914	120
134.0533	120
136.575	119.8
136	120.5
134.4546	121.5
135.1186	122
137.5318	121.5
135.1229	120.5
131.6	119
128.2021	117
125.7519	115
131.9686	113
129.9381	111
125.234	109.5
121.9223	108
117.8164	107
112.7856	106
95.8446	100
99.5	99

Paste into splLVf9gt4kE column of analysis instance table



#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real
1	31.5	124.4	129.47	126
2	40	129.15	131.33	130.95
3	50	127	134.27	131.12
4	63	125.73	132.31	130.23
5	80	126.16	133	134.14
6	100	130.93	133	135
7	125	132.82	131.17	136.78
8	160	129.8	132	134.52
9	200	131.43	130.14	137.31
10	250			134.36
11	315			130.82
12	400			130.95
13	500			127.21
14	630			124.38
15	800			123.99
16	1000			118.69
17	1250	120.12	116.69	118.7
18	1600	120.4	115	118.3
19	2000	119.69	114.46	116.87
20	2500	118.05	112.9	116.14
21	3150	118.09	109.71	112.8
22	4000	117.14	109.5	109.66
23	5000	113.94	109.32	106.73
24	6300	113.44	108.12	106.3
25	8000	113.11	106	106
26	10000	112	105.7	102



#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real
1	31.5	124.4	129.47	126
2	40	129.15	131.33	130.95
3	50	127	134.27	131.12
4	63	125.73	132.31	130.23
5	80	126.16	133	134.14
6	100	130.93	133	135
7	125	132.82	131.17	136.78
8	160	129.8	132	134.52
9	200	131.43	130.14	137.31
10	250	131.7	130.08	134.36
11	315			130.82
12	400			130.95
13	500			127.21
14	630			124.38
15	800			123.99
16	1000			118.69
17	1250			118.7
18	1600	120.4	115	118.3
19	2000	119.69	114.46	116.87
20	2500	118.05	112.9	116.14
21	3150	118.09	109.71	112.8
22	4000	117.14	109.5	109.66
23	5000	113.94	109.32	106.73
24	6300	113.44	108.12	106.3
25	8000	113.11	106	106
26	10000	112	105.7	102

Step 4

Instance Table | SIS SPL Envelopes [Read-Only] | Acoustics East - F9gt4k [Read-Only]

Columns | Export

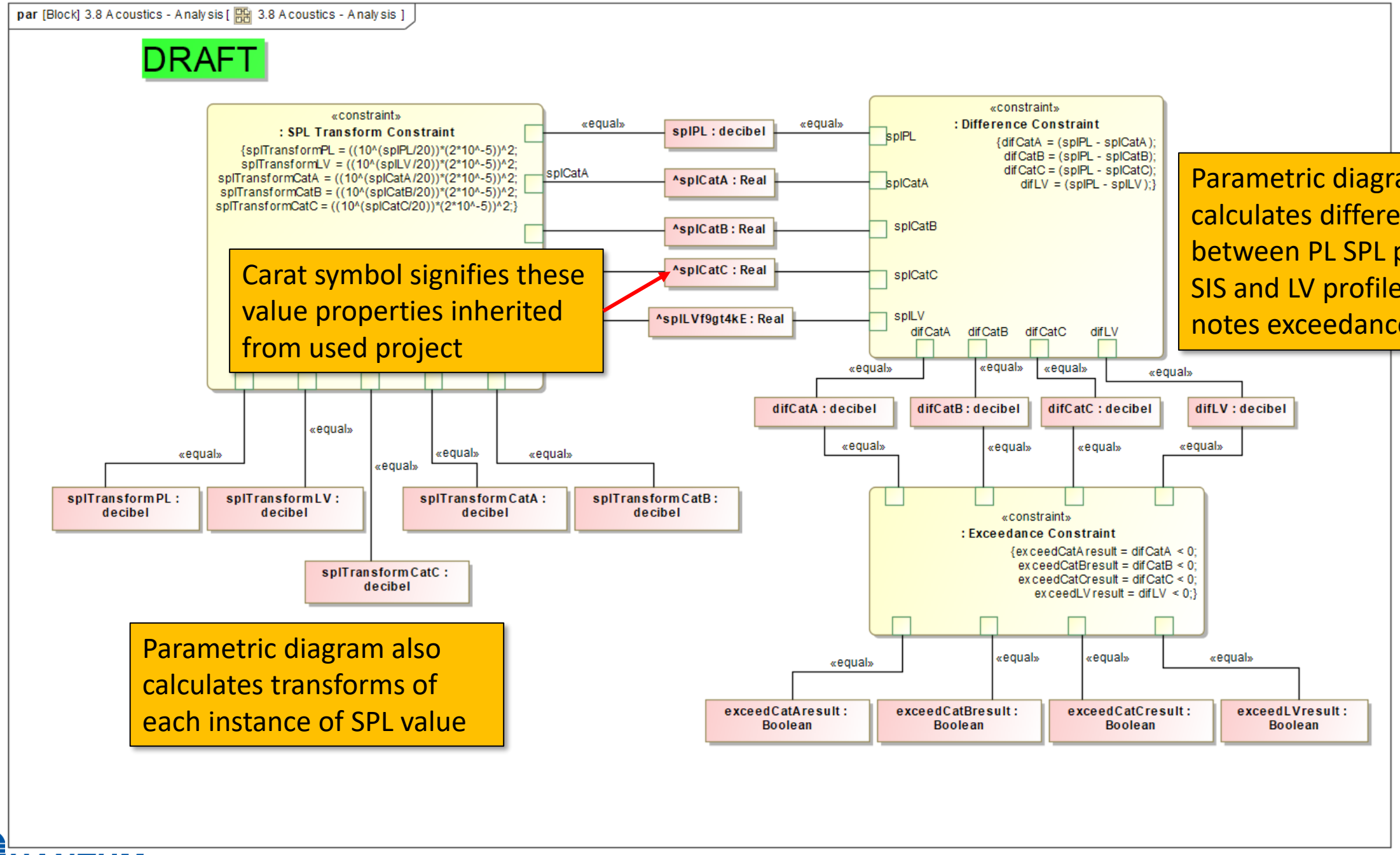
Criteria

Classifier: ıvelopes, Acoustics East - F9gt4k ... Scope (optional): Drag elements from the Model Browser ... Filter:

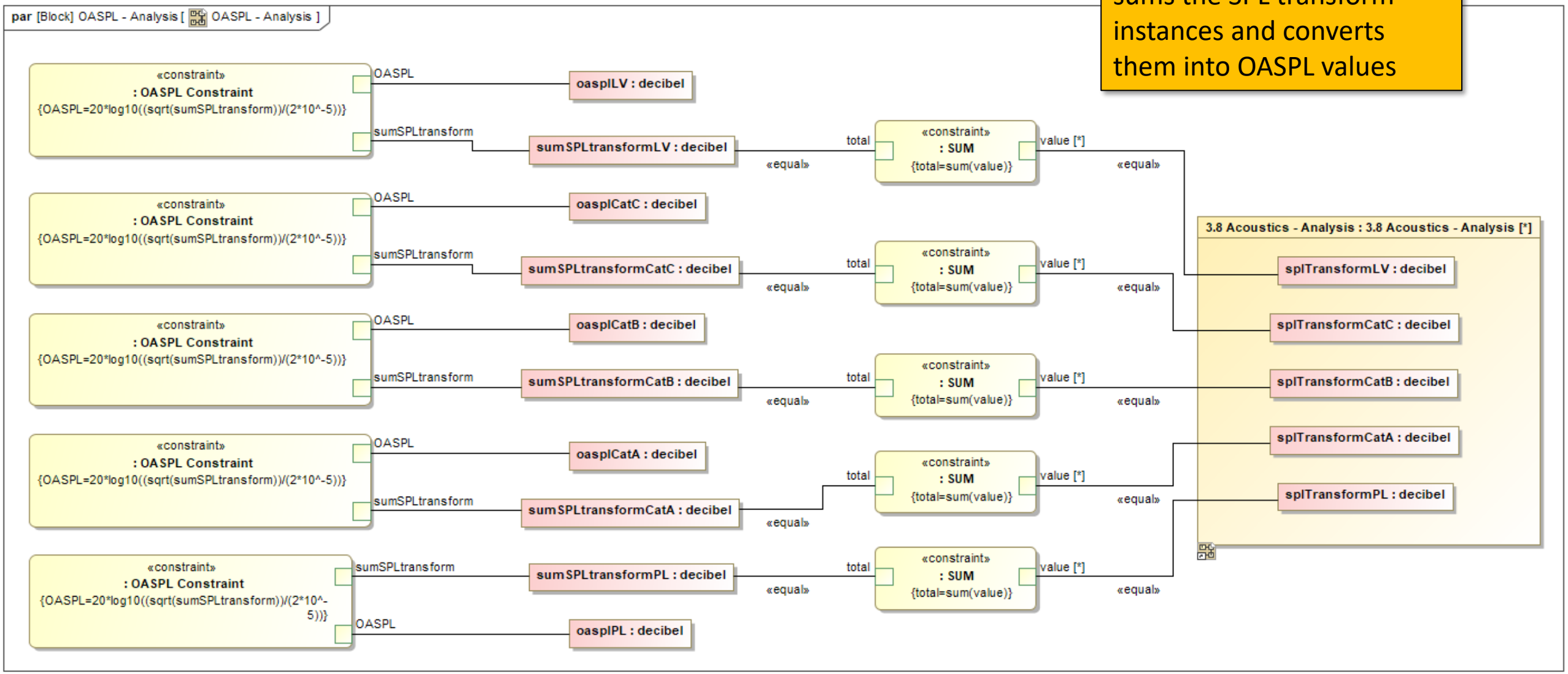
Excel Import Status: New Updated Obsolete Unchanged

#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real	splPL : decibel	splLVf9gt4kE : Real	difCatA : decibel	difCatB : decibel	difCatC : decibel	difLV	exceedLVresult : Boolean	3.8 Acoustics - Analysis : 3.8 Acoustics - Analysis	oasplPL : decibel	eedCatCresu : Boolean
1	31.5	124.4	129.47	126	134	118					<undefined>			defined>
2	40	129.15	131.33	130.95	133.7436	119.5					<undefined>			defined>
3	50	127	134.27	131.12	135.8914	120					<undefined>			defined>
4	63	125.73	132.31	130.23	134.0533	120					<undefined>			defined>
5	80	126.16	133	134.14	136.575	119.8					<undefined>			defined>
6	100	130.93	133	135	136	120.5					<undefined>			defined>
7	125	132.82	131.17	136.78	134.4546	121.5					<undefined>			defined>
8	160	129.8	132	134.52	135.1186	122					<undefined>			defined>
9	200	131.43	130.14	137.31	137.5318	121.5					<undefined>			defined>
10	250	131.7	130.08	134.36	135.1229	120.5					<undefined>			defined>
11	315	129.74	128	130.82	131.6	119					<undefined>			defined>
12	400	130	126	130.95	128.2021	117					<undefined>			defined>
13	500	129.8	124.83	127.21	125.7519	115					<undefined>			defined>
14	630	129.98	123.64	124.38	131.9686	113					<undefined>			defined>
15	800	126.43	121.08	123.99	129.9381	111					<undefined>			defined>
16	1000	123.07	117.8	118.69	125.234	109.5					<undefined>	: 3.8 Acoustics		defined>
17	1250	120.12	116.69	118.7	121.9223	108					<undefined>	: 3.8 Acoustics		defined>
18	1600	120.4	115	118.3	117.8164	107					<undefined>	: 3.8 Acoustics		defined>
19	2000	119.69	114.46	116.87	112.7856	106					<undefined>	: 3.8 Acoustics		defined>
20	2500	118.05	112.9	116.14	110.2492	105					<undefined>	: 3.8 Acoustics		defined>
21	3150	118.09	109.71	112.8	107.1	104					<undefined>	: 3.8 Acoustics		defined>
22	4000	117.14	109.5	109.66	103.6133	103					<undefined>	: 3.8 Acoustics		defined>
23	5000	113.94	109.32	106.73	103.046	102					<undefined>	: 3.8 Acoustics		defined>
24	6300	113.44	108.12	106.3	99.4076	101					<undefined>	: 3.8 Acoustics		defined>
25	8000	113.11	106	106	95.8446	100					<undefined>	<undefined>	<undefined>	
26	10000	112	105.7	102	99.5	99					<undefined>	<undefined>	<undefined>	

Analysis instance table is nearly ready to run the simulation. Final step is to add an instance to receive the sums of the SPL transforms to calculate OASPL


par [Block] 3.8 Acoustics - Analysis [3.8 Acoustics - Analysis]
DRAFT
«constraint»
: SPL Transform Constraint
{splTransformPL = ((10^(splPL/20))*(2*10^-5))^2;
splTransformLV = ((10^(splLV/20))*(2*10^-5))^2;
splTransformCatA = ((10^(splCatA/20))*(2*10^-5))^2;
splTransformCatB = ((10^(splCatB/20))*(2*10^-5))^2;
splTransformCatC = ((10^(splCatC/20))*(2*10^-5))^2;}
splPL : decibel
^splCatA : Real
^splCatB : Real
^splCatC : Real
^splLVf9gt4kE : Real
splCatA
«equal»
Carat symbol signifies these value properties inherited from used project
«constraint»
: Difference Constraint
{difCatA = (splPL - splCatA);
difCatB = (splPL - splCatB);
difCatC = (splPL - splCatC);
difLV = (splPL - splLV);}
splPL
splCatA
splCatB
splCatC
splLV
difCatA
difCatB
difCatC
difLV
Parametric diagram calculates differences between PL SPL profile and SIS and LV profiles and notes exceedances
difCatA : decibel
difCatB : decibel
difCatC : decibel
difLV : decibel
splTransformPL : decibel
splTransformLV : decibel
splTransformCatA : decibel
splTransformCatB : decibel
splTransformCatC : decibel
«constraint»
: Exceedance Constraint
{exceedCatAresult = difCatA < 0;
exceedCatBresult = difCatB < 0;
exceedCatCresult = difCatC < 0;
exceedLVresult = difLV < 0;}
exceedCatAresult : Boolean
exceedCatBresult : Boolean
exceedCatCresult : Boolean
exceedLVresult : Boolean
Parametric diagram also calculates transforms of each instance of SPL value

OASPL Parametric diagram sums the SPL transform instances and converts them into OASPL values



#	frequency : Real	splCatA : Real	splCatB : Real	splCatC : Real	splPL : decibel	splLVf9gt4kE : Real	difCatA : decibel	difCatB : decibel	difCatC : decibel	difLV : decibel	exceedCatAresu : Boolean	exceedCatBresul : Boolean	exceedCatCresu : Boolean	exceedLVresult : Boolean
1	31.5	124.4	129.47	126	134	118	9.6	4.53	8	16	false	false	false	false
2	40	129.15	131.33	130.95	133.7436	119.5	4.5936	2.4136	2.7936	14.2436	false	false	false	false
3	50	127	134.27	131.12	135.8914	120	8.8914	1.6214	4.7714	15.8914	false	false	false	false
4	63	125.73	132.31	130.23	134.0533	120	8.3233	1.7433	3.8233	14.0533	false	false	false	false
5	80	126.16	133	134.14	136.575	119.8	10.415	3.575	2.435	16.775	false	false	false	false
6	100	130.93	133	135	136	120.5	5.07	3	1	15.5	false	false	false	false
7	125	132.82	131.17	136.78	134.4546	121.5	1.6346	3.2846	-2.3254	12.9546	false	false	true	false
8	160	129.8	132	134.52	135.1186	122	5.3186	3.1186	0.5986	13.1186	false	false	false	false
9	200	131.43	130.14	137.31	137.5318	121.5	6.1018	7.3918	0.2218	16.0318	false	false	false	false
10	250	131.7	130.08	134.36	135.1229	120.5	3.4229	5.0429	0.7629	14.6229	false	false	false	false
11	315	129.74	128	130.82	131.6	119	1.86	3.6	0.78	12.6	false	false	false	false
12							-1.7979	2.2021	-2.7479	11.2021	true	false	true	false
13							-4.0481	0.9219	-1.4581	10.7519	true	false	true	false
14							1.9886	8.3286	7.5886	18.9686	false	false	false	false
15							3.5081	8.8581	5.9481	18.9381	false	false	false	false
16							2.164	7.434	6.544	15.734	false	false	false	false
17							1.8023	5.2323	3.2223	13.9223	false	false	false	false
18							-2.5836	2.8164	-0.4836	10.8164	true	false	true	false
19							-6.9044	-1.6744	-4.0844	6.7856	true	true	true	false
20							-7.8008	-2.6508	-5.8908	5.2492	true	true	true	false
21							-10.99	-2.61	-5.7	3.1	true	true	true	false
22							-13.5267	-5.8867	-6.0467	0.6133	true	true	true	false
23							-10.894	-6.274	-3.684	1.046	true	true	true	false
24							-14.0324	-8.7124	-6.8924	-1.5924	true	true	true	true
25							-17.2654	-10.1554	-10.1554	-4.1554	true	true	true	true
26							-12.5	-6.2	-2.5	0.5	true	true	true	false

oasplPL : decibel	oasplLV : decibel	oasplCatA : decibel	oasplCatB : decibel	oasplCatC : decibel
146.066	131.2819	141.6036	142.424	144.6696

Overall Sound Pressure Level values for payload, launch vehicle and SIS payload fairing categories

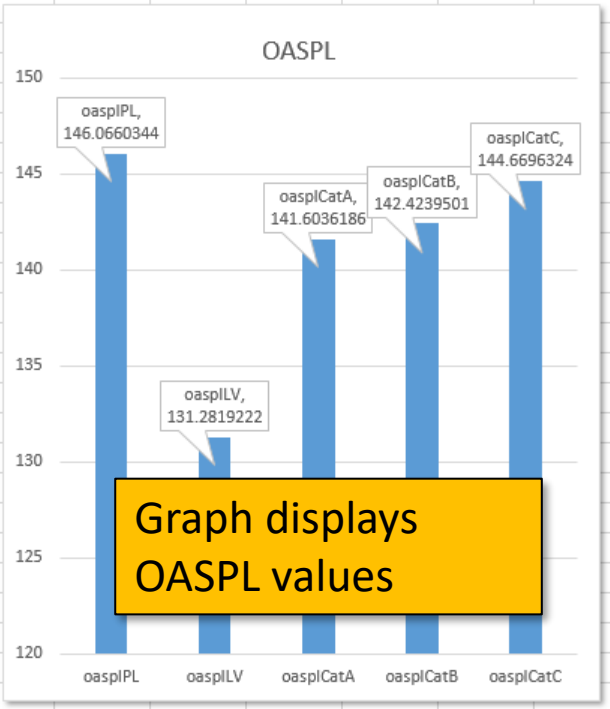
Differences calculated

TRUE checked if exceedance exists

Export Results to Attached Excel File

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	frequency : hertz	splCatA : decibel	splCatB : decibel	splCatC : decibel	splPL : decibel	splLV : decibel	difCatA : decibel	difCatB : decibel	difCatC : decibel	difLV : decibel	exceedCatAr esult : Boolean	exceedCatBr esult : Boolean	exceedCatCr esult : Boolean	exceedLVres ult : Boolean	oasplPL	oasplLV	oasplCat A	oasplCat B	oasplCat C		
2	31.5	124.40	129.47	126.00	134.00	118.00	9.60	4.53	8.00	16.00	FALSE	FALSE	FALSE	FALSE							
3	40	129.15	131.33	130.95	133.74	119.50	4.59	2.41	2.79	14.24	FALSE	FALSE	FALSE	FALSE							
4	50	127.00	134.27	131.12	135.89	120.00	8.89	1.62	4.77	15.89	FALSE	FALSE	FALSE	FALSE							
5	63	125.73	132.31	130.23	134.05	120.00	8.32	1.74	3.82	14.05	FALSE	FALSE	FALSE	FALSE							
6	80	126.16	133.00	134.14	136.58	119.80	10.42	3.58	2.44	16.78	FALSE	FALSE	FALSE	FALSE							
7	100	130.93	133.00	135.00	136.00	120.50	5.07	3.00	1.00	15.50	FALSE	FALSE	FALSE	FALSE							
8	125	132.82	131.17	136.78	134.45				(2.33)	12.95	FALSE	FALSE	TRUE	FALSE							
9	160	129.80	132.00	134.52	135.12				0.60	13.12	FALSE	FALSE	FALSE	FALSE							
10	200	131.43	130.14	137.31	137.53				0.22	16.03	FALSE	FALSE	FALSE	FALSE							
11	250	131.70	130.08	134.36	135.12				0.76	14.62	FALSE	FALSE	FALSE	FALSE							
12	315	129.74	128.00	130.82	131.60	119.00	1.86	3.60	0.78	12.60	FALSE	FALSE	FALSE	FALSE							
13	400	130.00	126.00	130.95	128.20	117.00	(1.80)	2.20	(2.75)	11.20	TRUE	FALSE	TRUE	FALSE							
14	500	129.80	124.83	127.21	125.75	115.00	(4.05)	0.92	(1.46)	10.75	TRUE	FALSE	TRUE	FALSE							
15	630	129.98	123.64	124.38	131.97	113.00	1.99	8.33	7.59	18.97	FALSE	FALSE	FALSE	FALSE							
16	800	126.43	121.08	123.99	129.94	111.00	3.51	8.86	5.95	18.94	FALSE	FALSE	FALSE	FALSE							
17	1000	123.07	117.80	118.69	125.23	109.50	2.16	7.43	6.54	15.73	FALSE	FALSE	FALSE	FALSE							
18	1250	120.12	116.69	118.70	121.92	108.00	1.80	5.23	3.22	13.92	FALSE	FALSE	FALSE	FALSE							
19	1600	120.40	115.00	118.30	117.82	107.00	(2.58)	2.82	(0.48)	10.82	TRUE	FALSE	TRUE	FALSE							
20	2000	119.69	114.46	116.87	112.79	106.00	(6.90)	(1.67)	(4.08)	6.79	TRUE	TRUE	TRUE	FALSE							
21	2500	118.05	112.90	116.14	110.25	105.00	(7.80)	(2.65)	(5.89)	5.25	TRUE	TRUE	TRUE	FALSE							
22	3150	118.09	109.71	112.80	107.10	104.00	(10.99)	(2.61)	(5.70)	3.10	TRUE	TRUE	TRUE	FALSE							
23	4000	117.14	109.50	109.66	103.61	103.00	(13.53)	(5.89)	(6.05)	0.61	TRUE	TRUE	TRUE	FALSE							
24	5000	113.94	109.32	106.73	103.05	102.00	(10.89)	(6.27)	(3.68)	1.05	TRUE	TRUE	TRUE	FALSE							
25	6300	113.44	108.12	106.30	99.41	101.00	(14.03)	(8.71)	(6.89)	(1.59)	TRUE	TRUE	TRUE	TRUE							
26	8000	113.11	106.00	106.00	95.84	100.00	(17.27)	(10.16)	(10.16)	(4.16)	TRUE	TRUE	TRUE	TRUE							
27	10000	112.00	105.70	102.00	99.50	99.00	(12.50)	(6.20)	(2.50)	0.50	TRUE	TRUE	TRUE	FALSE							
28															146.066	131.2819	141.6036	142.424	144.6696		

Differences and exceedances in red



Graph displays OASPL values

Questions?