Strain Gage Loads Calibration Testing With Airbag Support for the Gulfstream III SubsoniC Research Aircraft Testbed (SCRAT)

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GIII Test Aircraft

ACTE Flap

(Adaptive Compliant Trailing Edge)

Motivation and Objectives

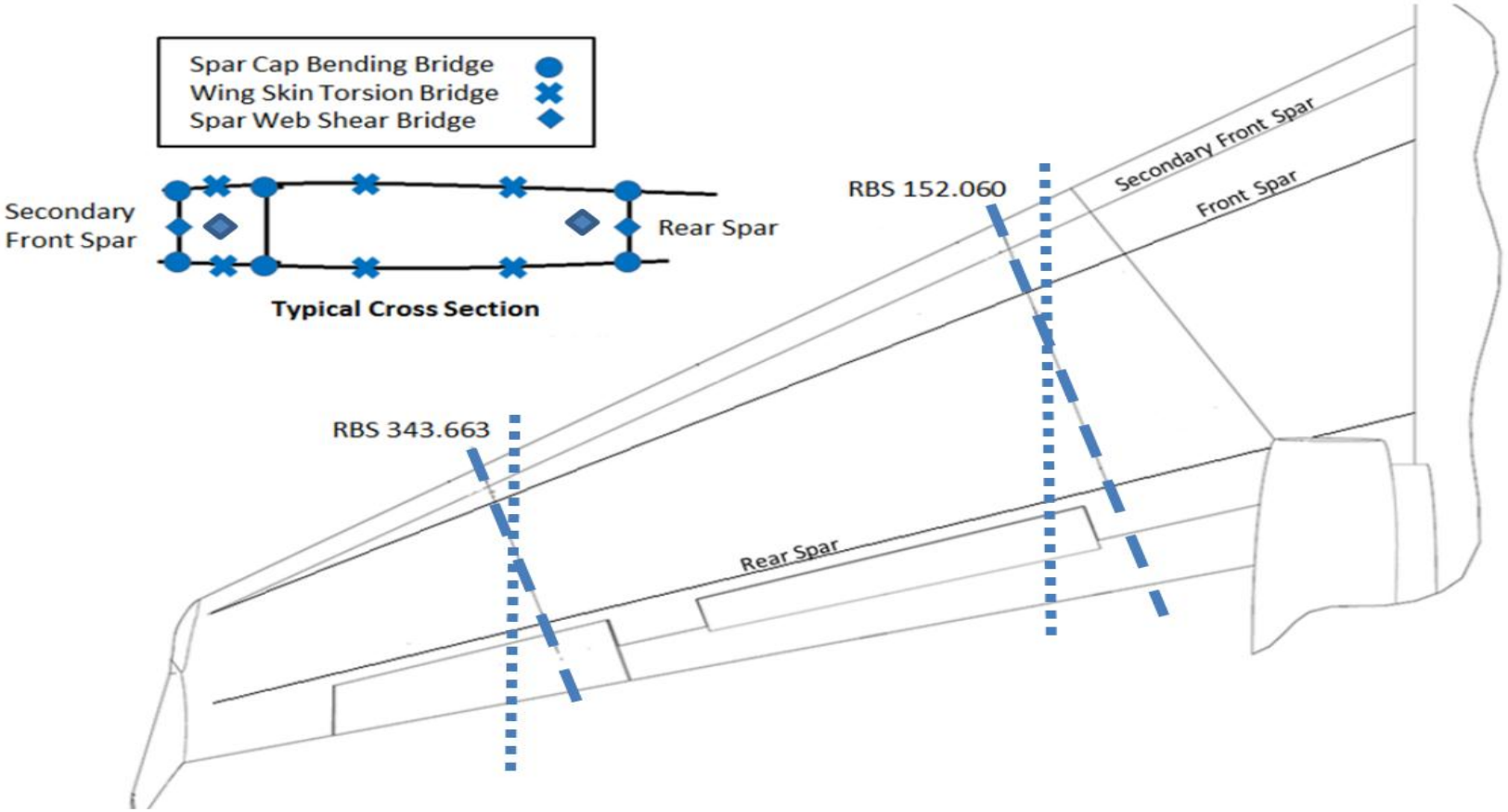
Motivation:

- Preparing to flight test a new flap
- Using a bigger operating envelope
- Predictions indicated bigger wing loads
- Critical at two wing stations: RBS 152 and 343

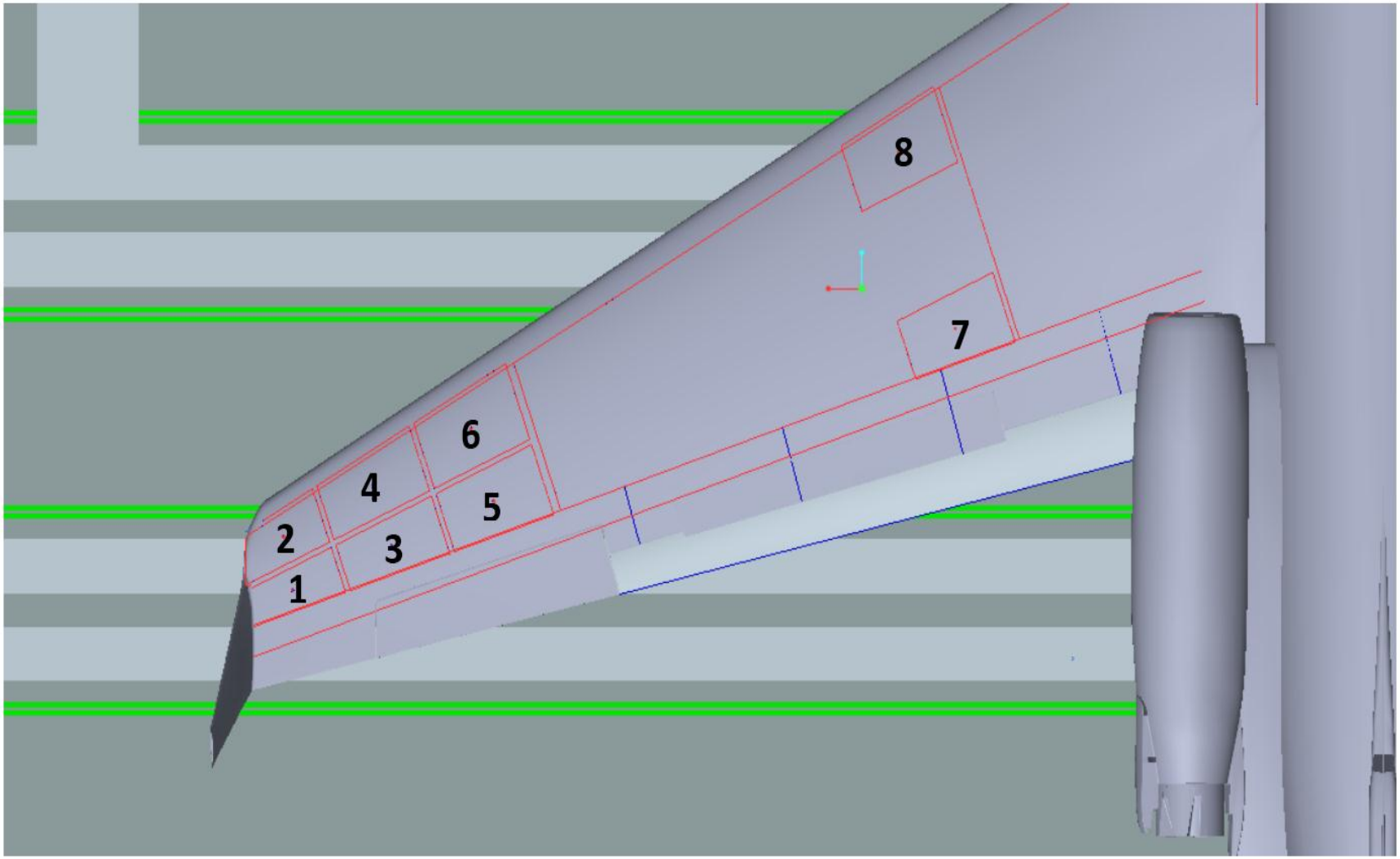
Objectives:

1. Produce an adequate calibration database
2. Record structural deflections
3. Check the AC data system against our lab data system
4. Check for aileron binding with elastically deformed wing

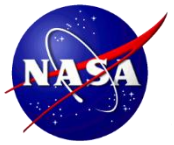
Wing Strain Gage Locations



Wing Load Zones



Load Cases for Wing Calibration Test



Load pad	1	2	3	4	5	6	7	8
Load case 1	-1000	-1000	-1250	-1250	-1500	-1500		
2		-1000		-1250		-1500		-2000
3	2500	-1000	3500	-1250	4500	-1500	6500	-2000
4	2500		3500		4500		6500	
5	-1000		-1250		-1500		-2000	
6	-1000	2500	-1250	3500	-1500	4500	-2000	6500
7		2500		3500		4500		6500
8 (Assym)		2500		3500		4500		6500
9 (Assym)	2500		3500		4500		6500	

Load Cases for Wing Calibration Test

Continued

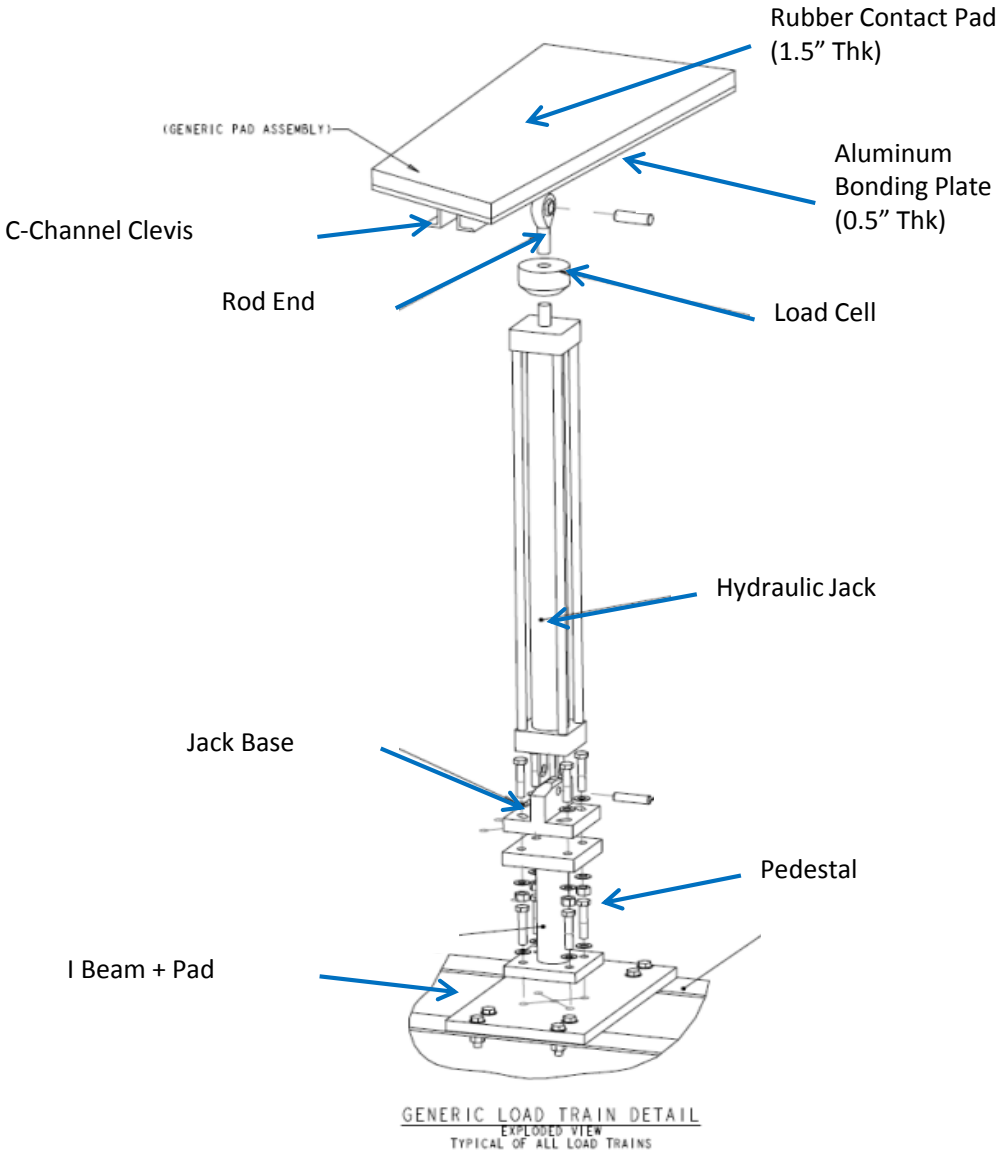
Load pad	1	2	3	4	5	6	7	8
10	2500							
11		2500						
12			3500					
13				3500				
14					4500			
15						4500		
16							6500	
17								6500
18	2500	2500						
19			3500	3500				
20					4500	4500		
21							6500	6500

Load Cases for Wing Calibration Test

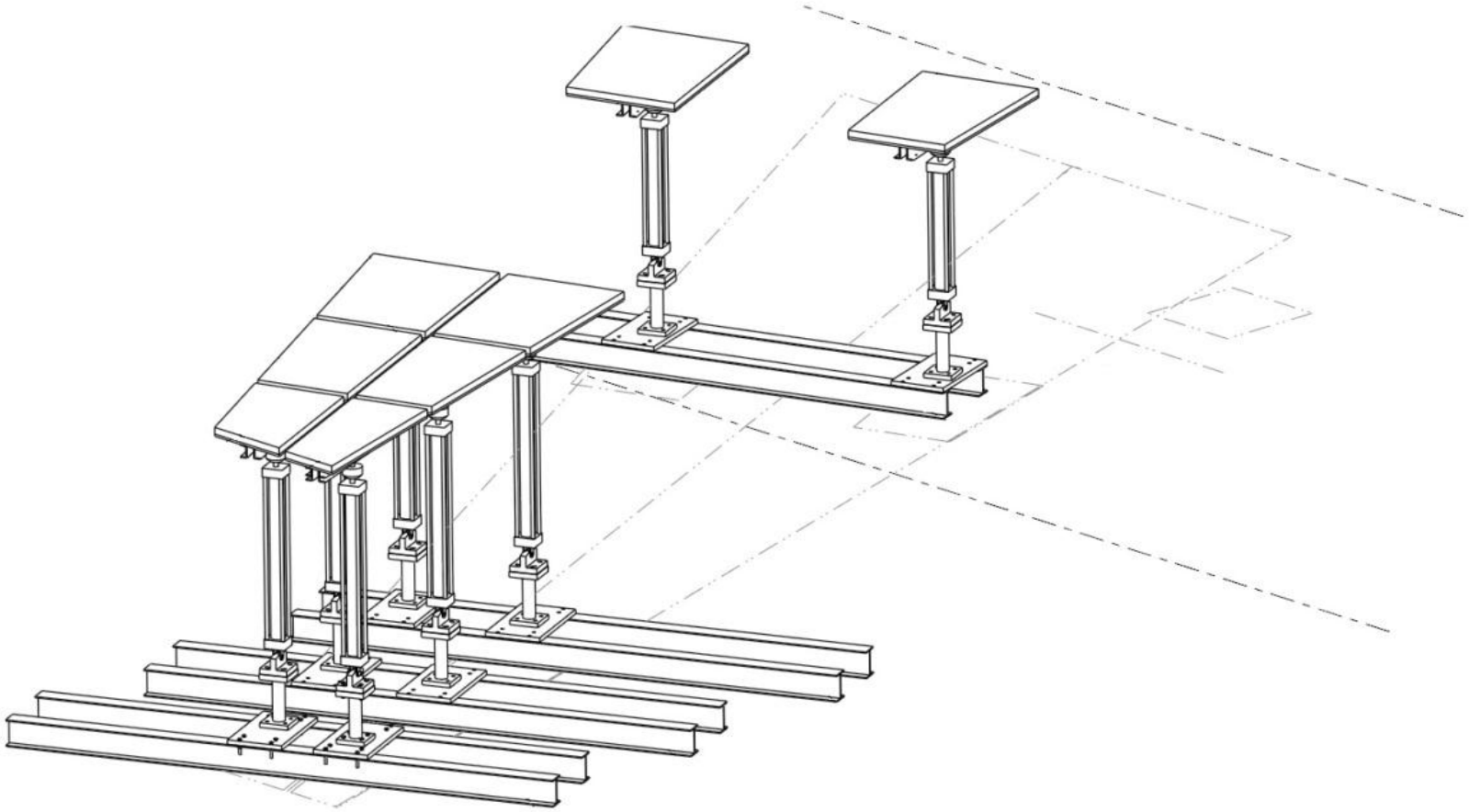
Continued

Load pad	1	2	3	4	5	6	7	8
22	1000	1000	3500	3500			6500	6500
23	500	500	3500	3500	4500	4500		
24	500	500	3500	3500	4500	4500	5000	5000
25	500	500	3500	3500	4500		6500	6500
26	500	500	3500	3500		4500	6500	6500
27	500	500	3500	3500	4500	4500	6500	
28	500	500	3500	3500	4500	4500		6500

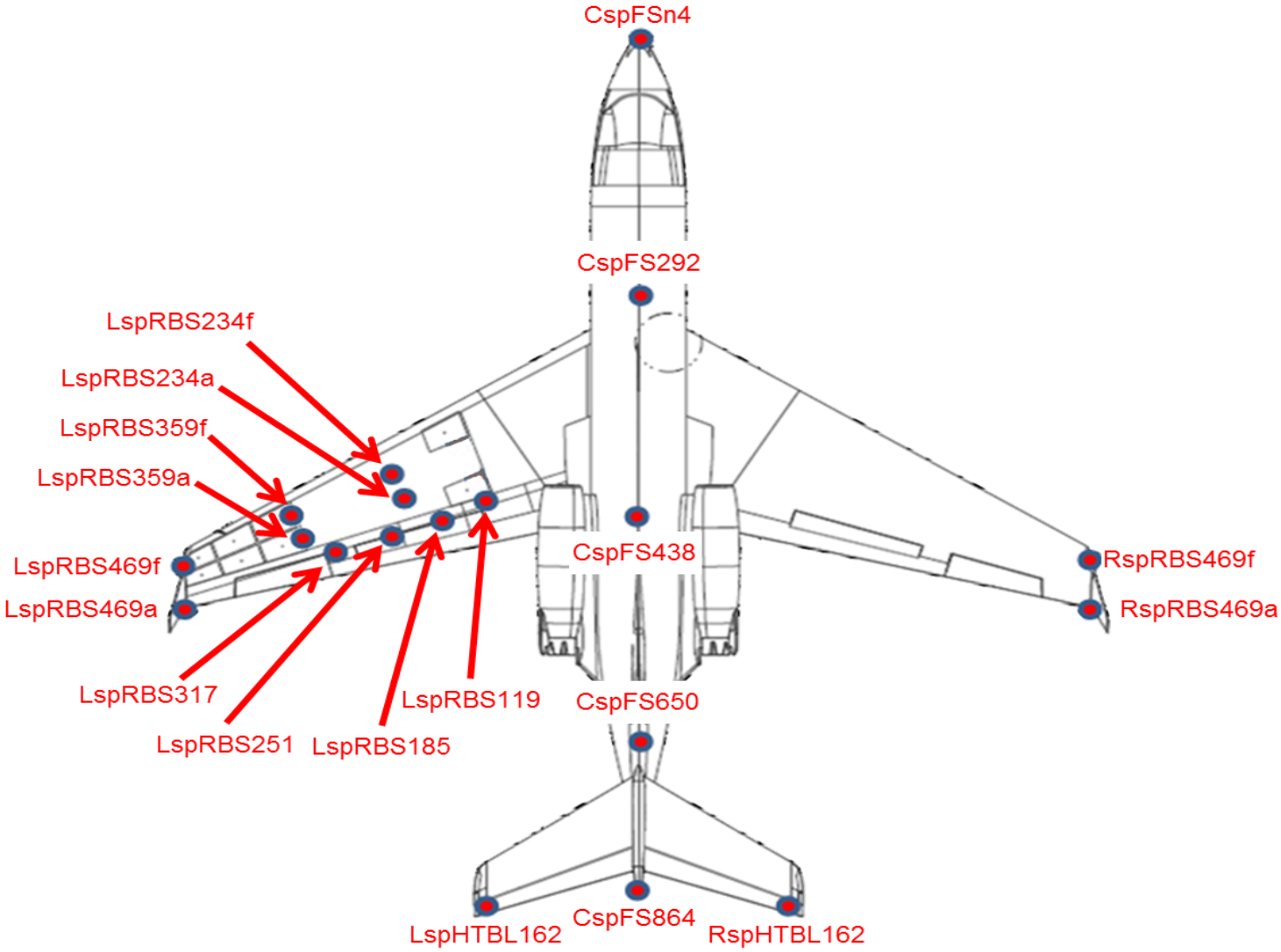
Typical Hydraulic Load Column



Left Side Loading Hardware



String Potentiometer Locations



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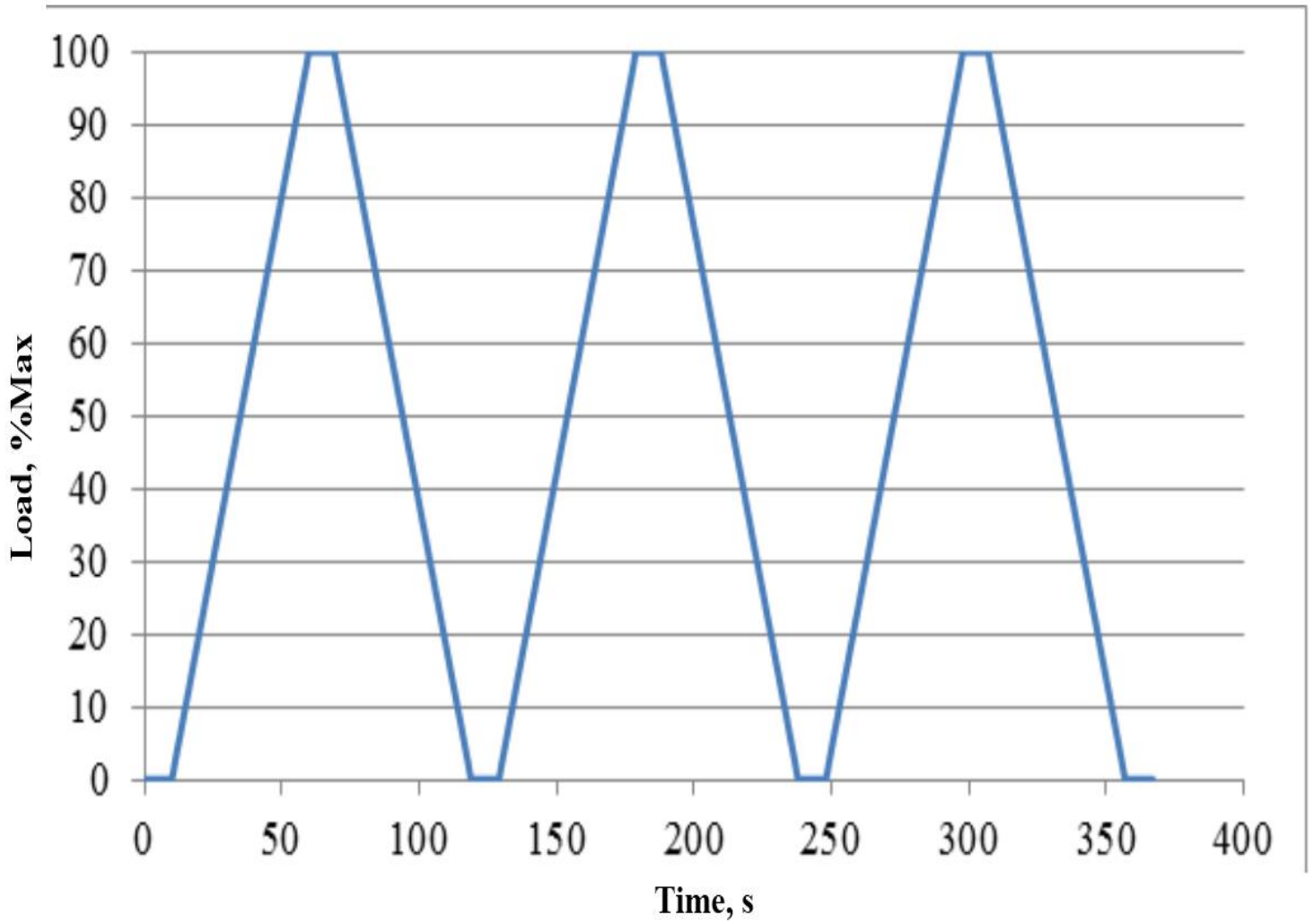
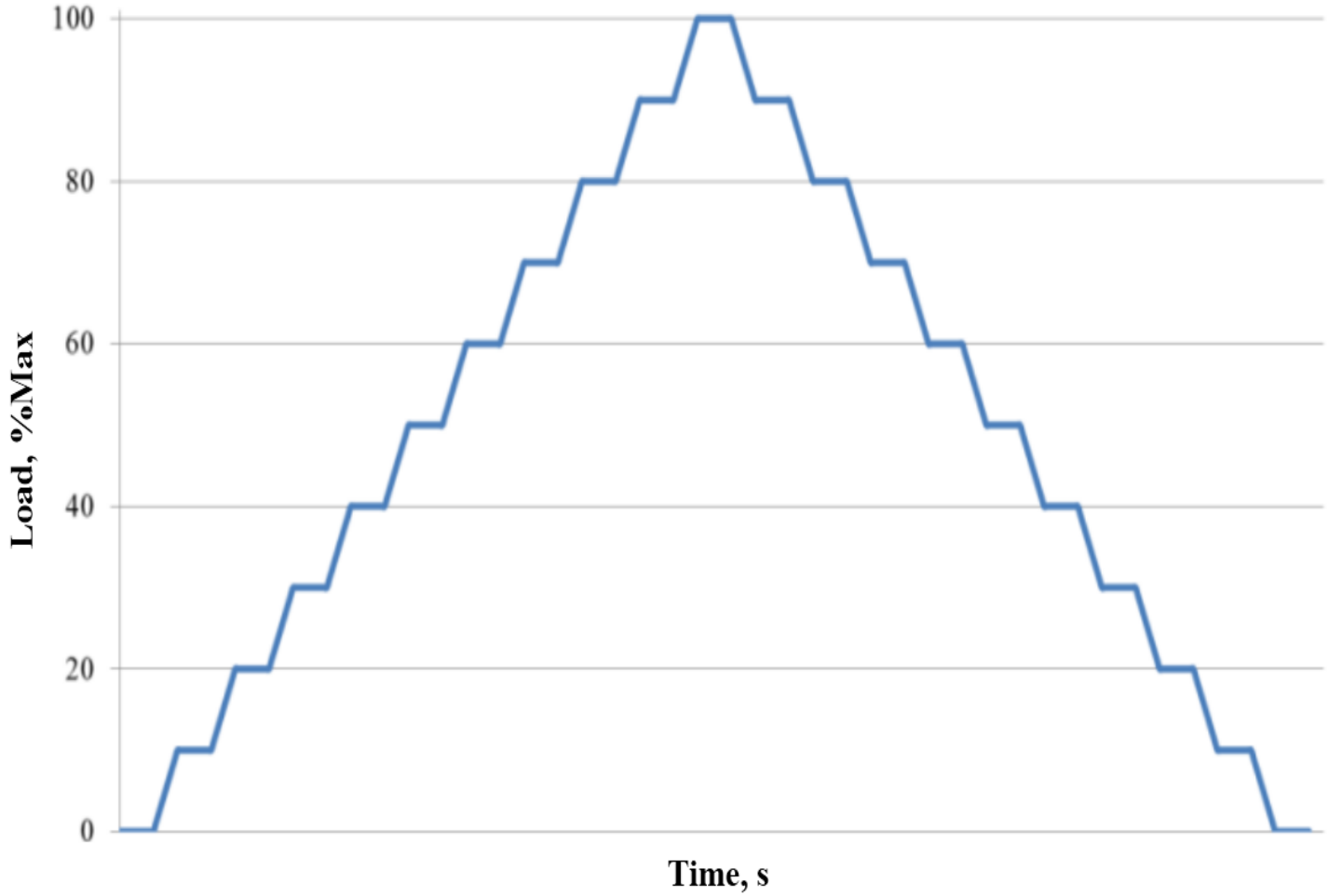
Hydraulic Load Profile



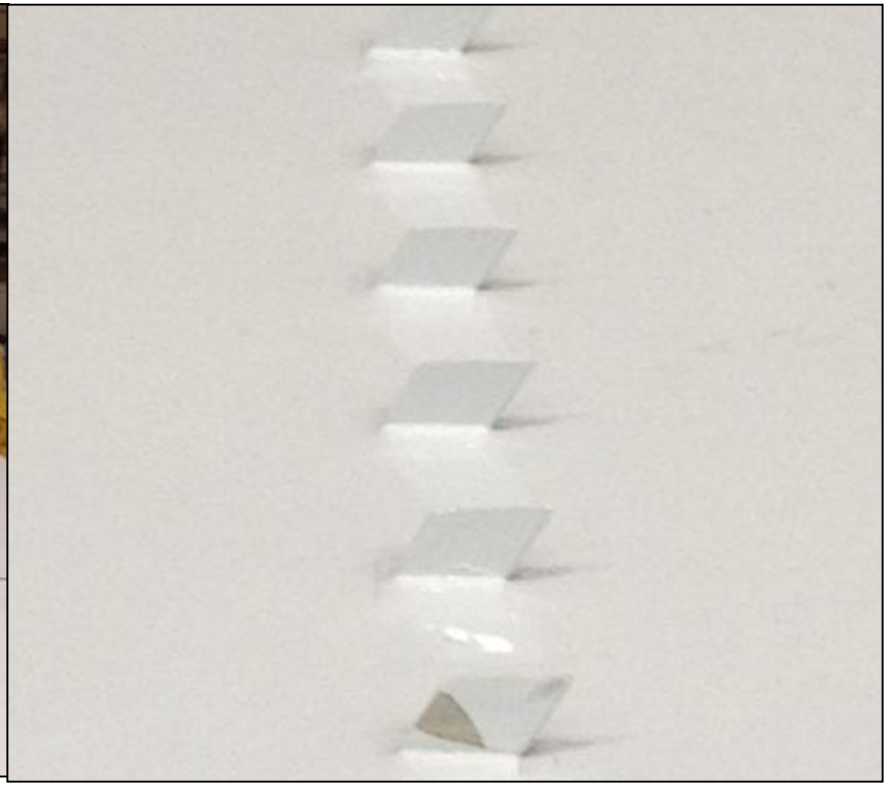
Shot Bag Loading Profile



Shot Bag Stacking

Shot bag stacking illustration

Vortex Generators



Shot Bags for Maximum Down Load

Shot Bags Placed for Max Torque

Max Torque Case

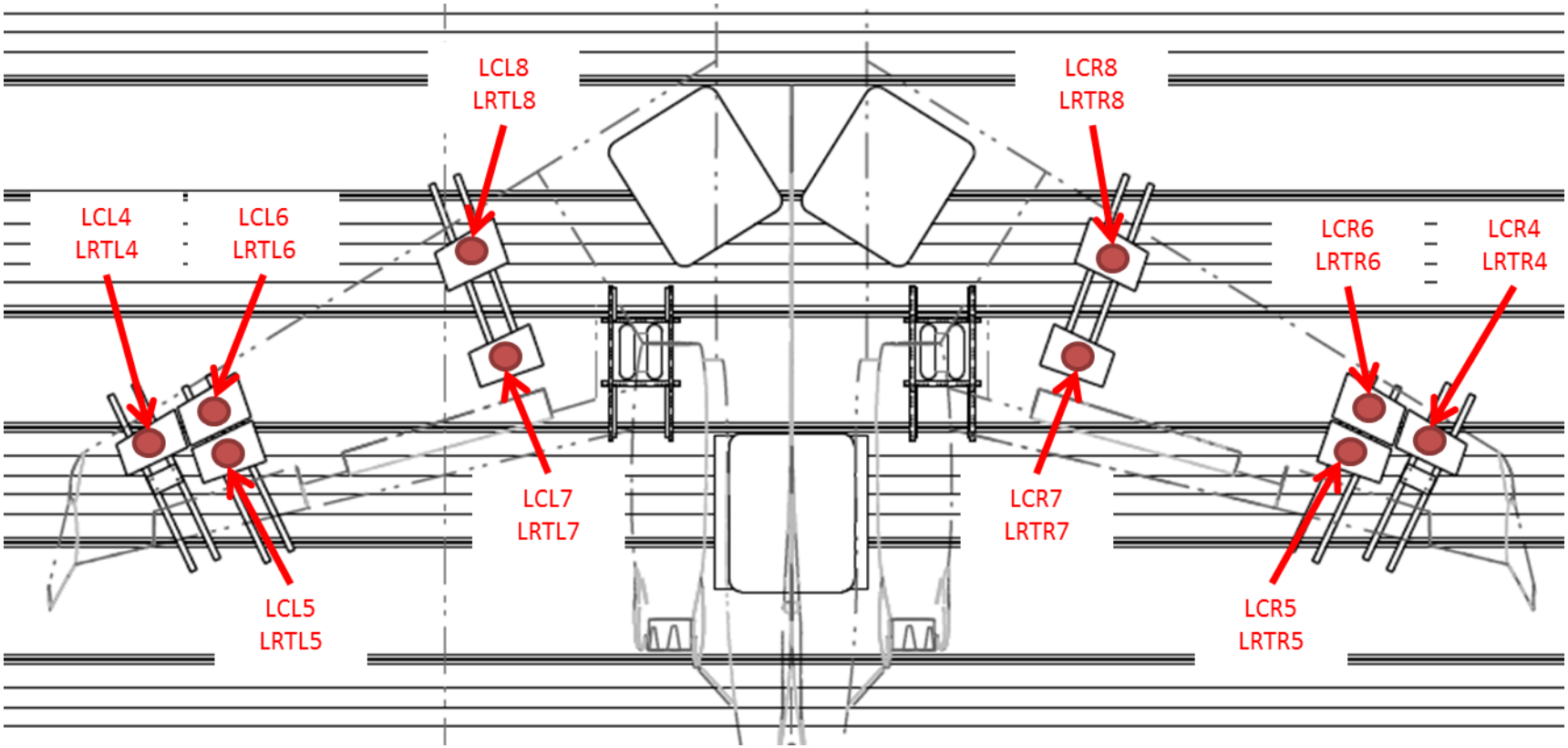
Testing Sequence

Timeline	Test	Aircraft	Configuration	Objective
Feb 2013	Live Load Test	GIII	Supported by main gear	Assess main gear influence on gages
April 2013	Fueling Test	GIII	Supported by main gear	Assess main gear influence on gages
May-June 2013	Load Calibration Test	GIII	Supported by main gear	Develop multi-gage load equations
March 2014	Practice Airbag Lift	GII	Supported by airbags	Validate airbag operations on surrogate GII
April 2014	Check Load Test	GIII	Supported by airbags	Correct and validate multi-gage load equations

GII Practice Lift

GII Supported by Airbags

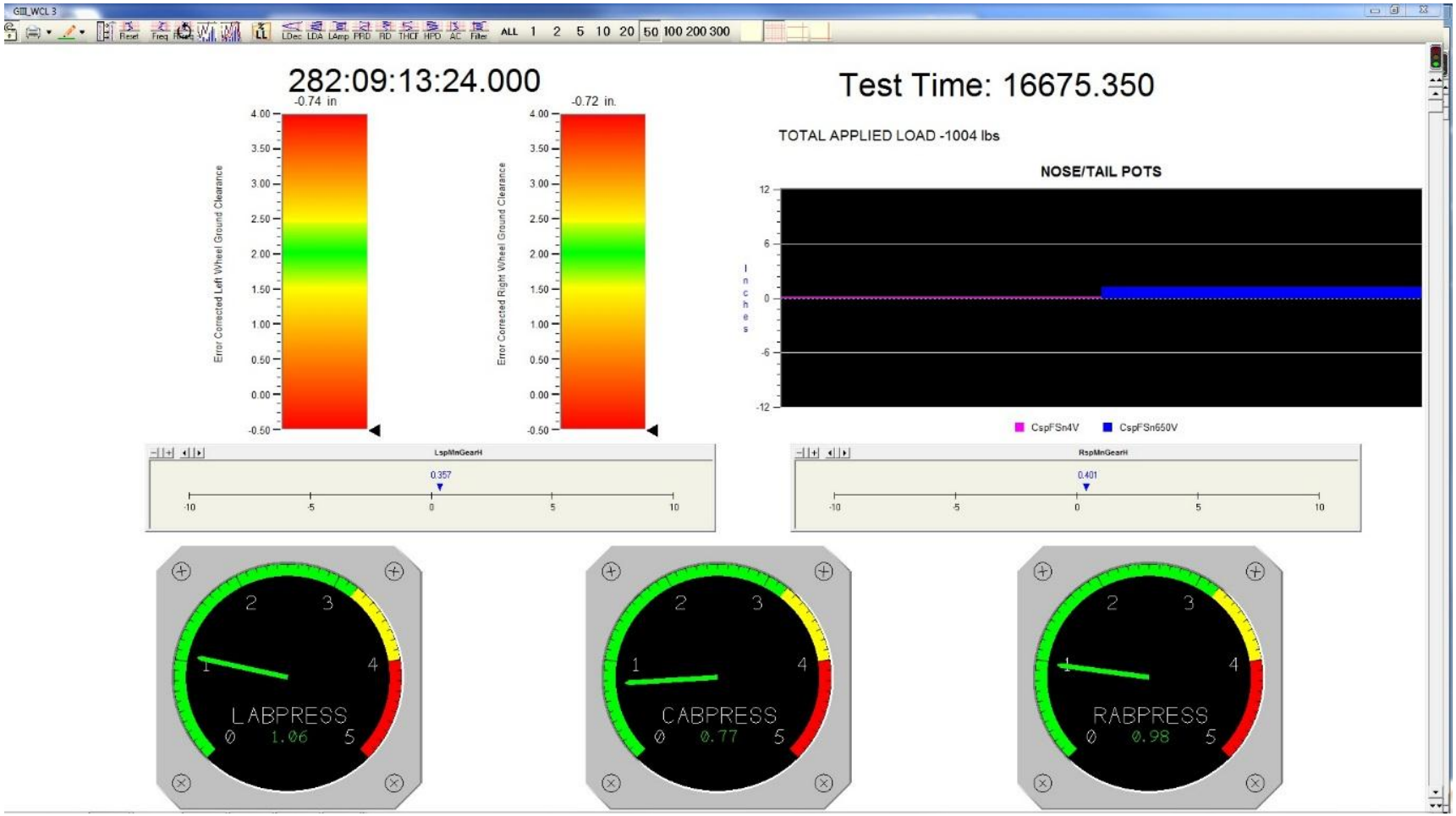
Load Cell and Jack LRT Locations



Main Gear Wheel Box

Airbag Control Manifold

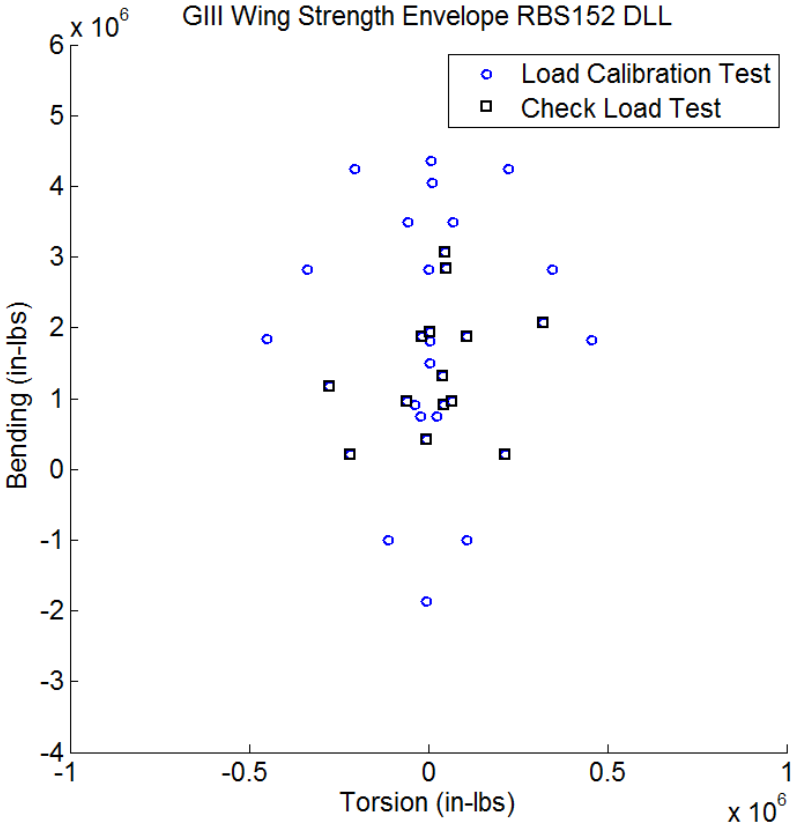
Airbag Data Display

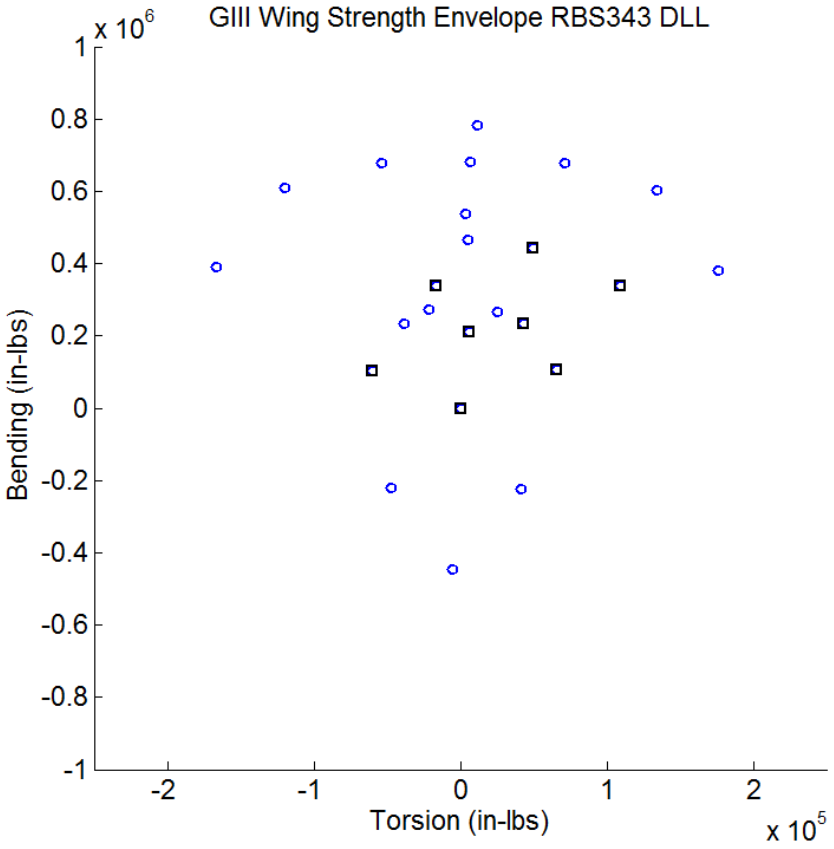


Wing Check Load Cases

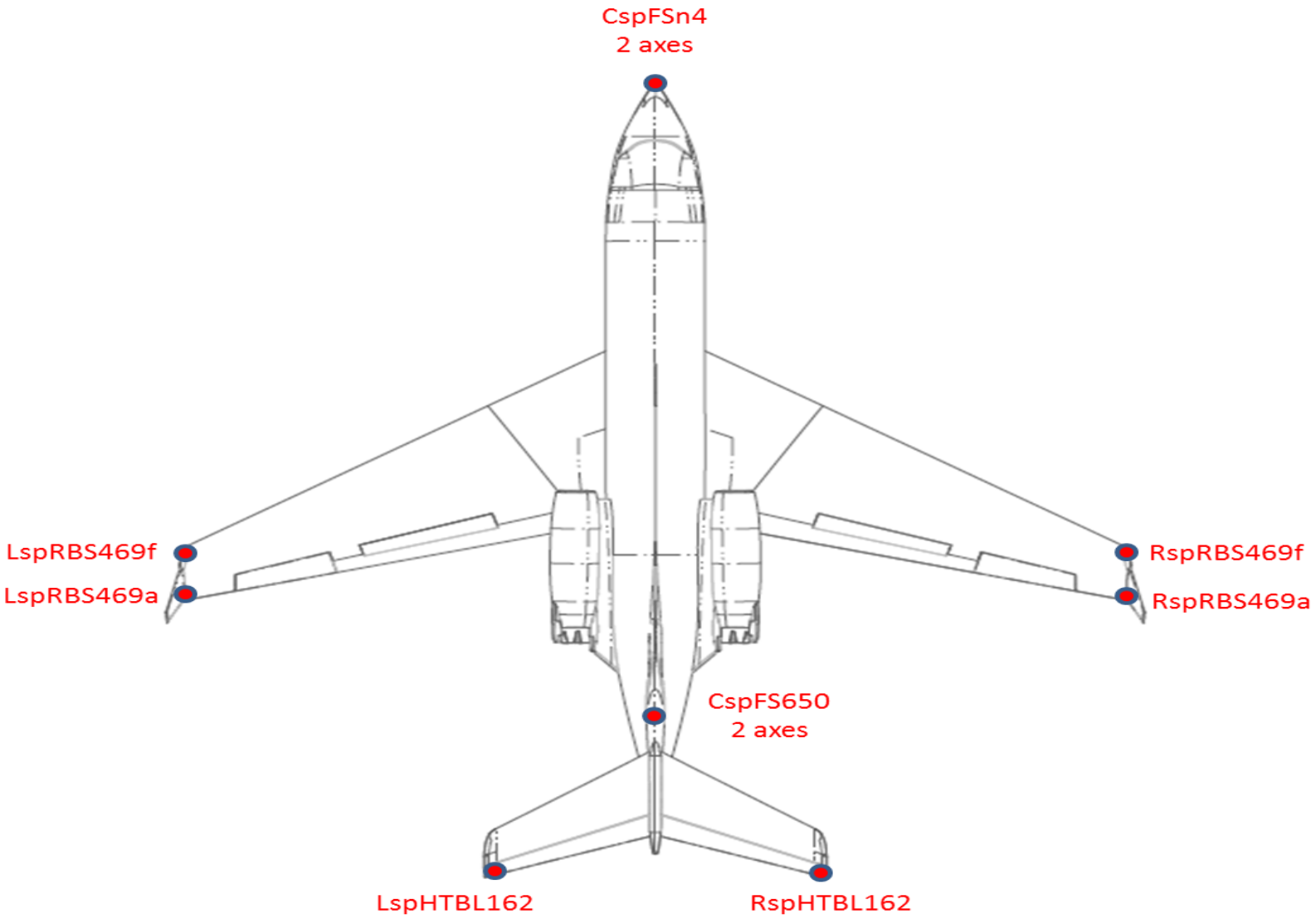
Load case	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Load pad 4	3500					3500	3500			3500		3500	3500	3500
Load pad 5		4500				4500		4500	4500	4500				3500
Load pad 6			4500				4500	4500		4500		4500		3500
Load pad 7				6500					6500		6500		6500	3500
Load pad 8					6500						6500	6500	6500	3500

Applied Load Cases





String Potentiometer Locations

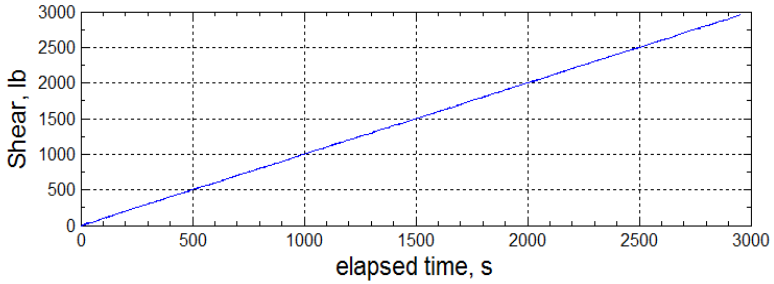


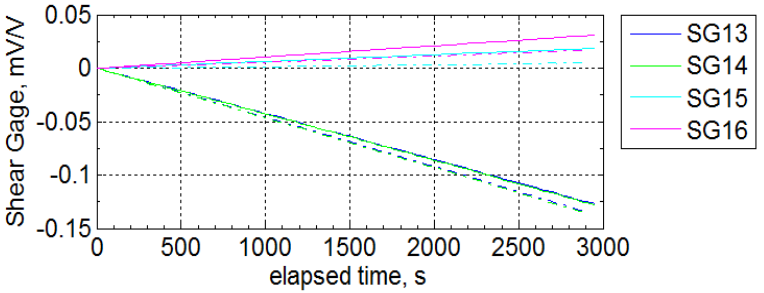
GIII Configured for Check Load Testing

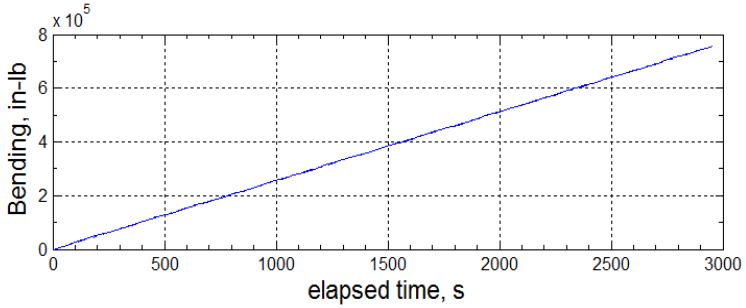
Max Up Load

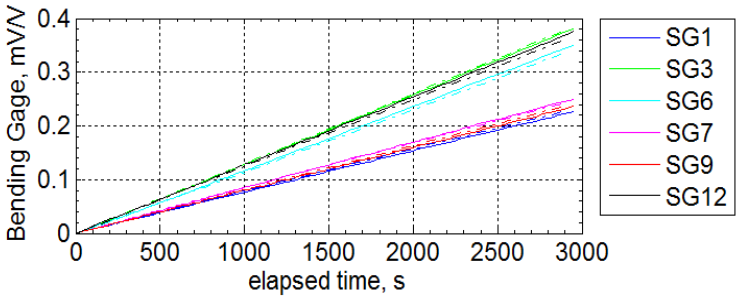
Test Information Displays

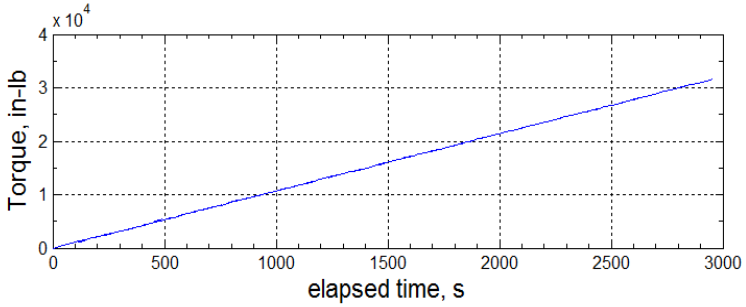
Applied Load and Strain Gage Data at RBS 152

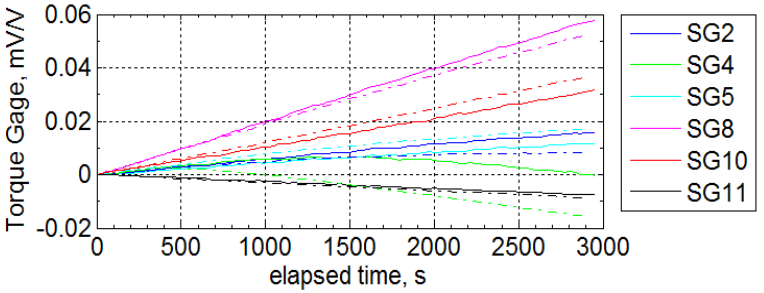












Load Equation RMS Error Summary

for Station 152

	Flight equations RBS 152, percent			
Eq. no.	SHR	BND	TRQ	
1	0.51	0.56	10.21	Check case from load calibration test (4,7,10,11,25)
2	1.09	0.28	5.14	
3	2.03	0.45	25.62	
1	0.40	0.50	1.27	Check case from check load test (32,39)
2	0.28	0.37	1.66	
3	0.26	0.36	2.12	

Load Equation RMS Error Summary

for Station 343

	Flight equations RBS 343, percent			
Eq. no.	SHR	BND	TRQ	
1	0.61	1.89	7.77	Check case from load calibration test (4,7,10,11,25)
2	0.65	0.95	6.69	
3	0.87	1.09	57.40	
1	0.50	7.38	1.28	Check case from check load test (32,39)
2	1.65	5.82	0.97	
3	0.78	9.10	3.55	
1	0.55	1.97	0.64	Check case from check load test (37)
2	0.85	3.04	0.56	
3	2.46	3.60	2.32	

Summary and Conclusion

- Calibration database was produced
- Multi-gage load equations were derived
- Load equations were evaluated
- “Floated” strain gage zeroes were recorded
- Elastic deflection data was recorded
- Aircraft data system was validated
- Ailerons were free from binding under load
- Airbag support scheme was effective