

**NATIONAL TECHNICAL SYSTEMS**

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USA

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www.nts.com**TEST REPORT****ARS-600
QUALIFICATION****Prepared For:**

Bill Kobrin

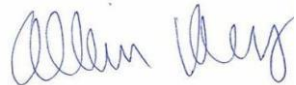
Churchill Navigation

5660 Airport Blvd #101

Boulder, CO 80301

JOB NO.:	100237
P.O. NO.:	05152015A
REVISION NO.:	R0
ISSUE DATE:	02/29/16
SECURITY CLASSIFICATION:	Unclassified
DESCRIPTION OF ITEMS TESTED:	Two (2) ARS-600 S/Ns: 150616, 151204

Approval:

PREPARED BY:	Allen Klug – Test Engineer	
APPROVED BY:	Jit Gupta – Quality Manager	

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TEST SUMMARY

Test Title	Test Dates	Specification	Results	Sample
Altitude	06/19/15	RTCA-DO-160G Section 4 Category B2	Conform	150616
Temperature Variation	02/24/16 to 02/26/16	RTCA-DO-160G Section 4 Category B2, Section 5 Category B	Conform	151204
Humidity	07/21/15 to 07/31/15	RTCA-DO-160G Section 6 Category B	Conform	150616
Vibration	02/12/16 to 02/18/16	RTCA-DO-160G Section 8 Category R Curve U2	Conform	151204
Operational Shocks	02/18/16 to 02/19/16	RTCA-DO-160G Section 7 Category A	Conform	151204
Explosive Atmosphere	02/23/16	RTCA-DO-160G Section 9 Category E	Conform	151204



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ALTITUDE TEST REPORT

TEST DATES

06/19/15

TEST SPECIMENS

One (1) ARS-600 S/N: 150616

REFERENCES AND REQUIREMENTS

Per RTCA-DO-160G Section 4 Category B2, the sample is to operate without issue throughout testing.

TEST PROCEDURE

The unit was installed in the altitude chamber and the interior pressure was reduced to simulate an altitude of 25,000 feet. These conditions were held for two hours. The sample was powered throughout testing.

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

There was no deviation from the agreed upon test method.

TEST RESULTS

Testing was conducted as outlined above. The sample was operational throughout the test and fully functional upon completion of the test.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Alt./Temp. Chamber	Thermotron	F-8-CHA-3-3	TL495	As Used	As Used
Manometer, 15 PSIG	Wallace & Tiernan	FA160	TL496	03/06/15	03/06/16
Chart Recorder	Honeywell	DR45AT	TL638	05/15/15	05/15/16

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PHOTOGRAPHS**Test Setup**



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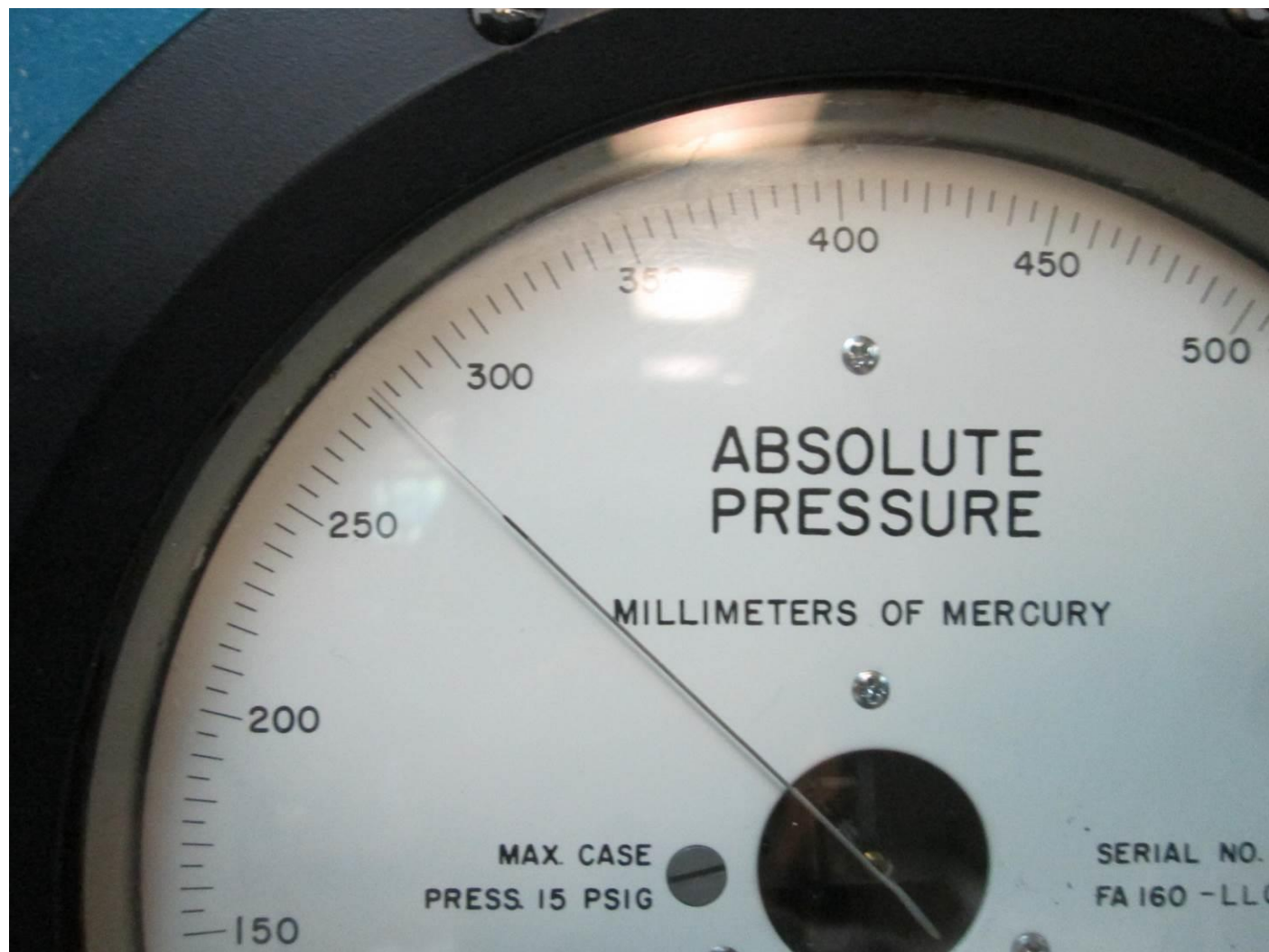
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Pressure at 25,000 feet



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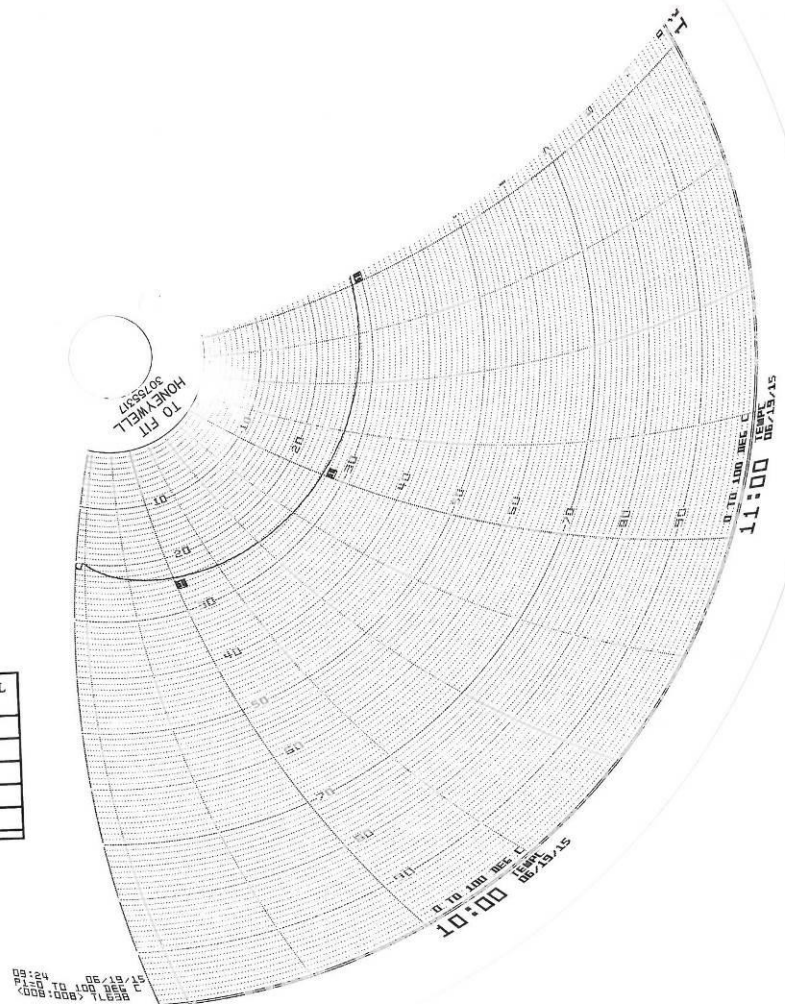
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CHARTS

TRACE LABORATORIES CHICAGO, PALATINE, IL	
CUSTOMER	<u>Chubb</u>
TEST NAME	<u>Asphalt</u>
START DATE	<u>6/14/15</u>
END DATE	<u>6/14/15</u>
CHART DURATION	<u>8hrs</u>
FILE NO.	<u>100237</u>
TEST TECHNICIAN	<u>Manuel</u>





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TEMPERATURE VARIATION TEST REPORT

TEST DATES

02/26/16

TEST SPECIMENS

One (1) ARS-600 S/N: 151204

REFERENCES AND REQUIREMENTS

Per RTCA-DO-160G Section 4 Category B2 and Section 5 Category B, the sample is to be operational at set times during the combined temperature, temperature variation profile. The sample is to operate normally following testing.

TEST PROCEDURE

The ARS-600 was tested to the RTCA-DO-160G Section 4 Category B2, Section 5 Category B standard. The combined profile outlined in Section 5 was used.

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

Following the first test run, all low temperatures were changed to -20°C per customer email dated 06/24/15.

TEST RESULTS

Testing was conducted as outlined above. The sample was operational during each of the powered portions of the test profile and fully functional upon completion of the test.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Temperature Cycle Chamber	Sexton/Espec	PT-HC8-1-1	TL737	As Used	As Used
Chart Recorder	Honeywell	DR45AT	TL486	01/26/15	01/26/16

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PHOTOGRAPHS**Test Setup**



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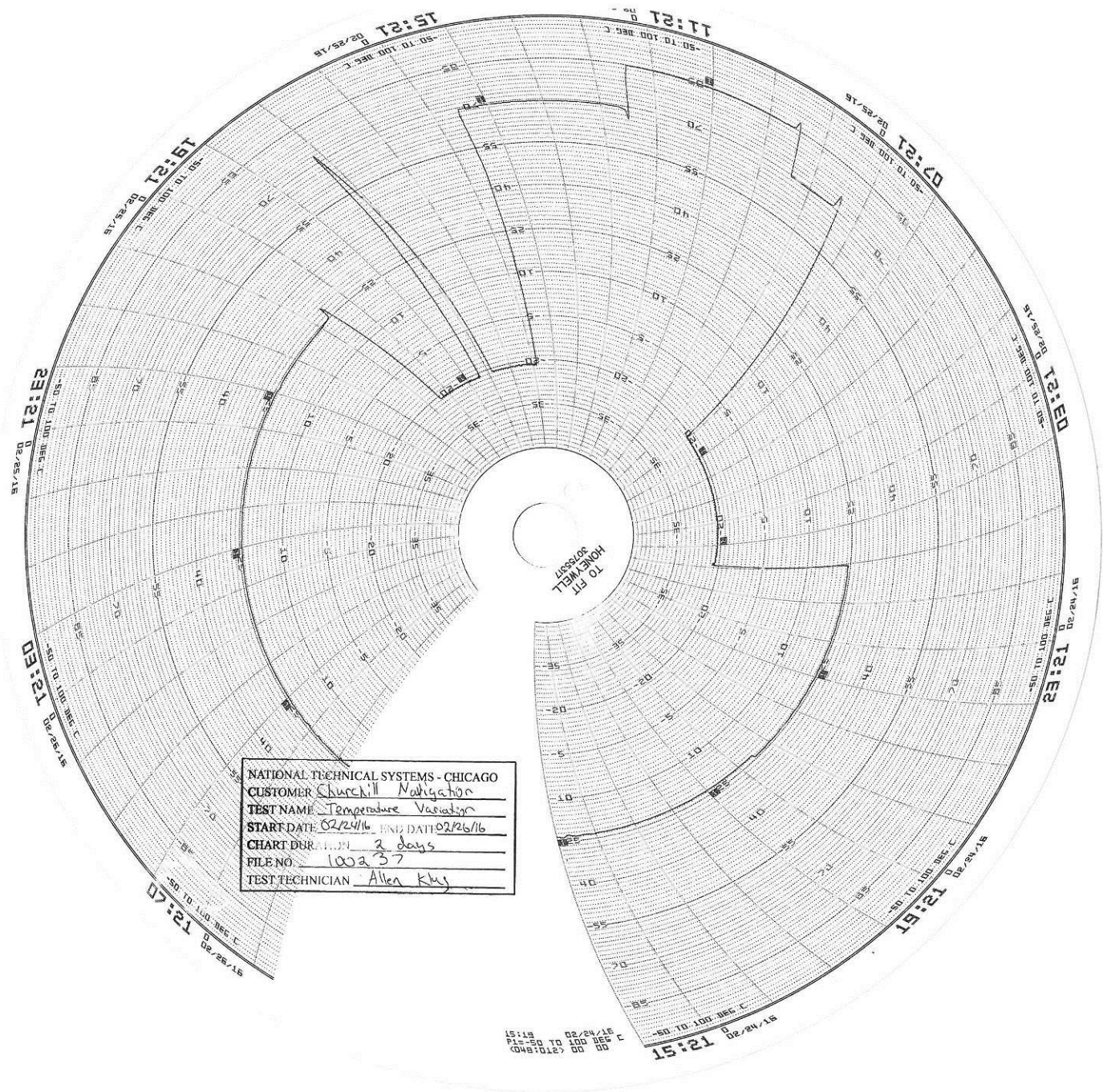
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CHARTS



Temperature Chart



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HUMIDITY TEST REPORT

TEST DATES

07/21/15 to 07/31/15

TEST SPECIMENS

One (1) ARS-600 S/N: 150616

REFERENCES AND REQUIREMENTS

Per RTCA-DO-160G Section 6 Category B, the sample is to undergo 10 cycles of temperature/humidity cycling and should operate normally following testing.

TEST PROCEDURE

The ARS-600 was subject to the temperature/humidity profile outlined in Section 6.3.2 of the RTCA-DO-160G standard.

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

There was no deviation from the agreed upon test method.

TEST RESULTS

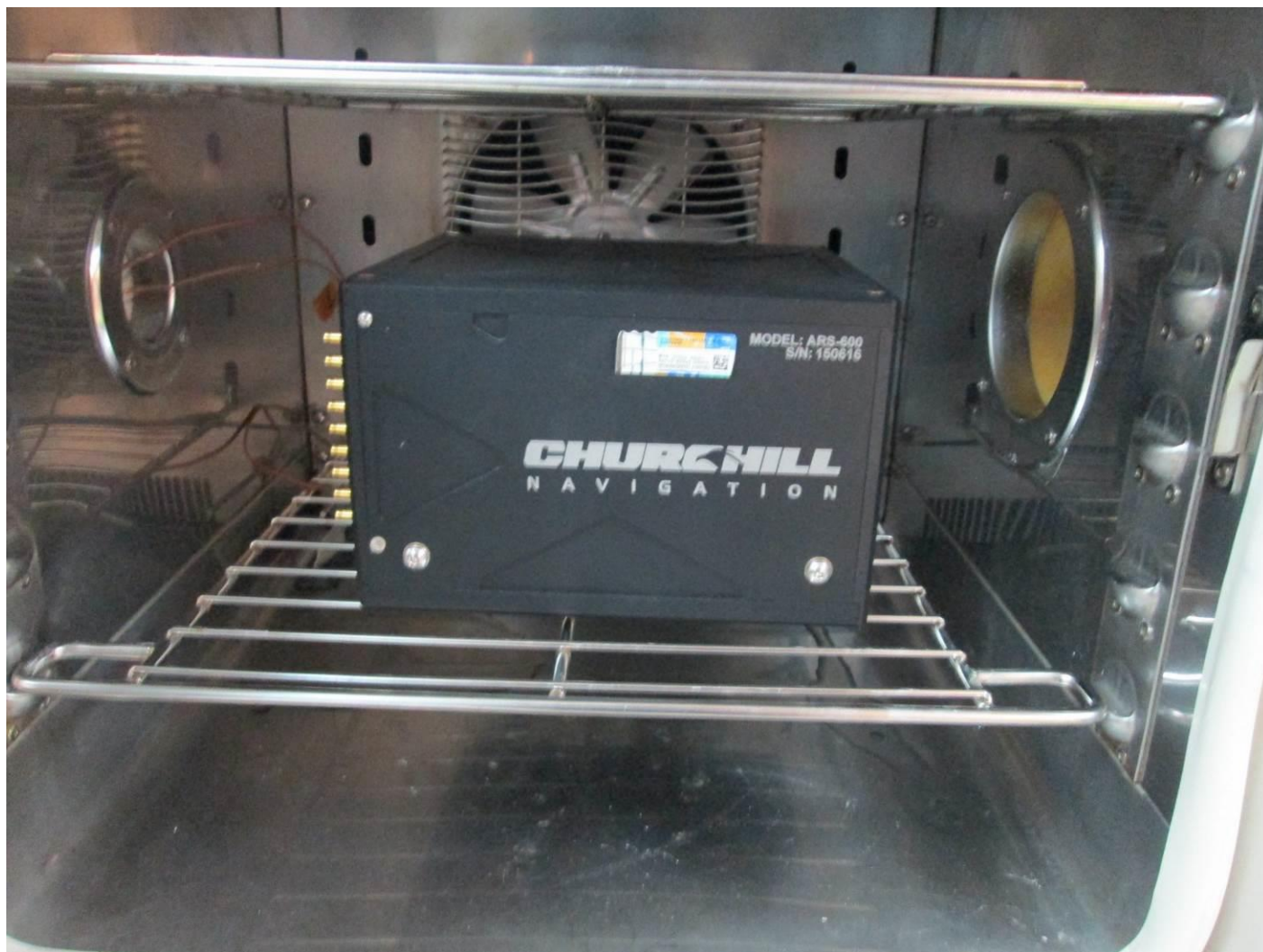
Testing was conducted as outlined above. The sample showed no visual signs of damage and operated normally following testing.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Temp/humidity Ch.	ESPEC	SH-661	TL1113	As Used	As Used
Chart Recorder	Honeywell	DR45AT	TL629	11/11/14	11/11/15

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PHOTOGRAPHS



Test Setup



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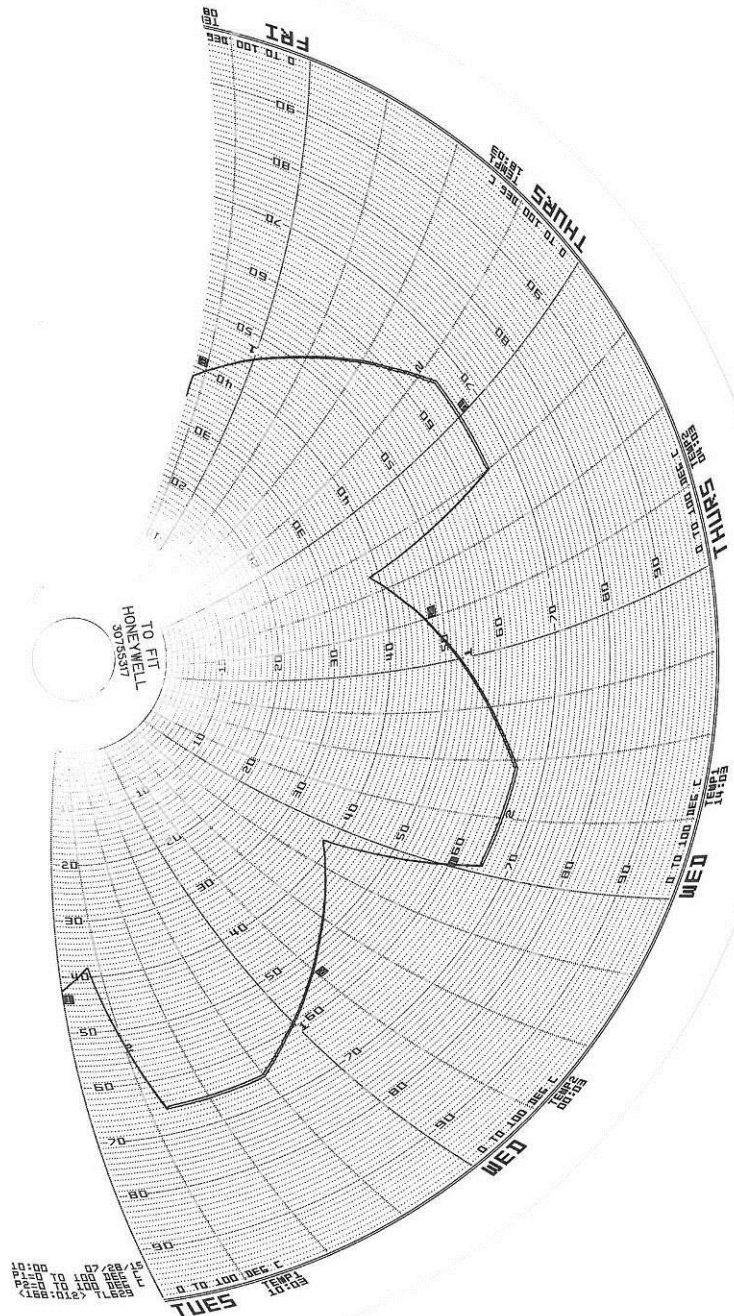
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TRACE LABORATORIES CHICAGO, PALATINE, IL	
CUSTOMER	Churchill
TEST NAME	Humidity
START DATE	7/28/15
END DATE	7/31/15
CHART DURATION	7 days
FILE NO.	100237
TEST TECHNICIAN	Manal



Temperature/Humidity Chart 2



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VIBRATION TEST REPORT

TEST DATES

02/12/16 to 02/18/16

TEST SPECIMENS

One (1) ARS-600 S/N: 151204

REFERENCES AND REQUIREMENTS

Testing was conducted per RTCA-DO-160G Section 8 Category R.

TEST PROCEDURE

Sample was secured to vibration fixture as per the photos in the photo section of the report. One (1) control accelerometer was used to measure and adjust input vibration as per the required level. One (1) response accelerometer was used to measure the sample response. Sample was ON during vibration testing. All graphs and photos are included in the respective section. Random vibration testing was performed as per RTCA-DO-160G section

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

There was no deviation from the agreed upon test method.

TEST RESULTS

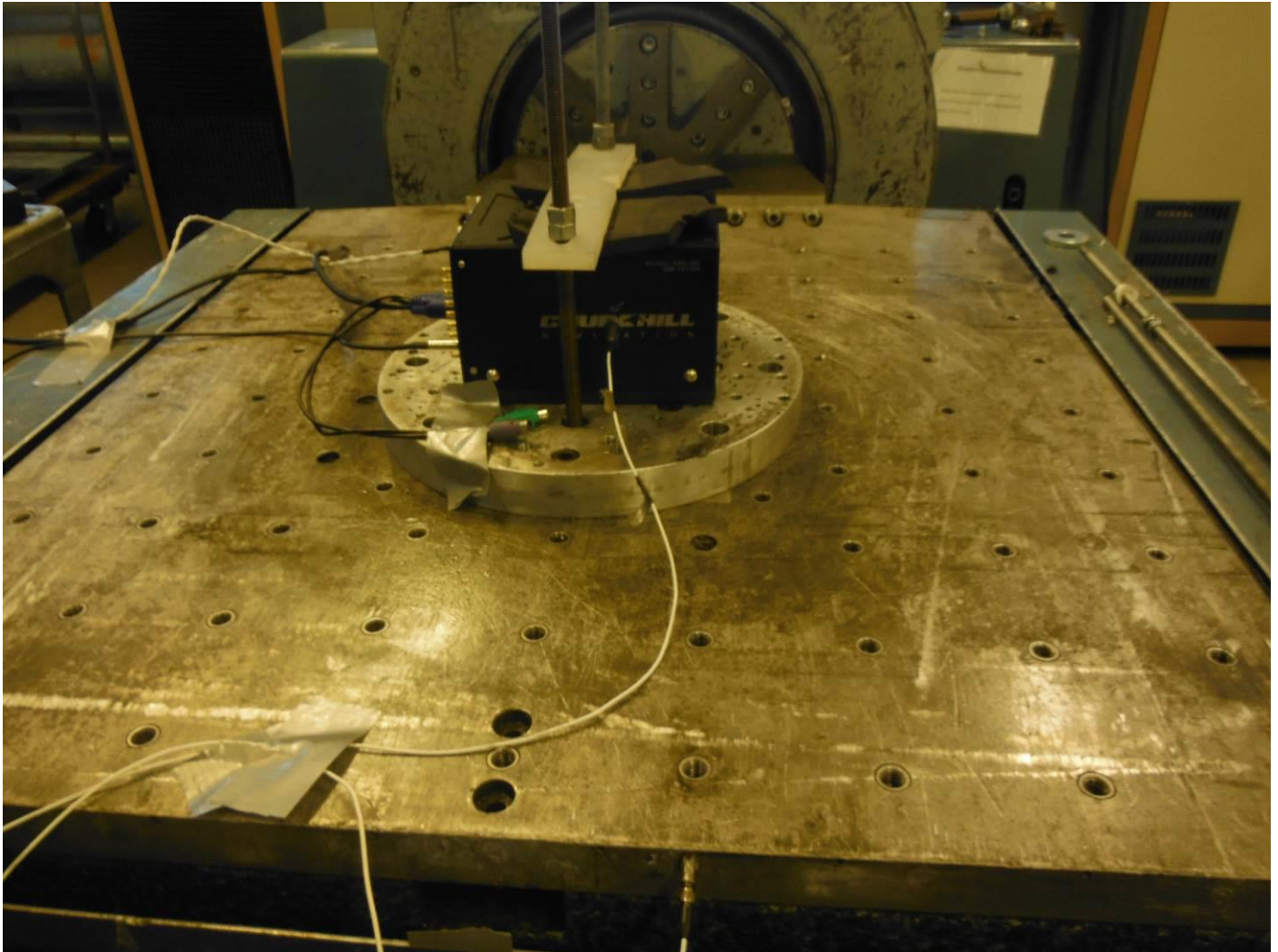
Testing was conducted as outlined above. The sample was operational during testing and fully functional upon completion of the test with no sign of visible damage.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Electro Dynamic Shaker	UDCO	T2000	TL 1243	Ref	Ref
Shaker vibration Controller	UDCO	UD VWIN II	TL 1213	09/09/15	09/09/16
Signal Conditioner	PCB	482A16	TL 1153	09/08/15	09/08/16
ICP Accelerometer	PCB	353B18	TL 1384	06/15/15	06/15/16
ICP Accelerometer	PCB	353B18	TL 1386	12/02/15	12/02/16

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PHOTOGRAPHS



Axis One



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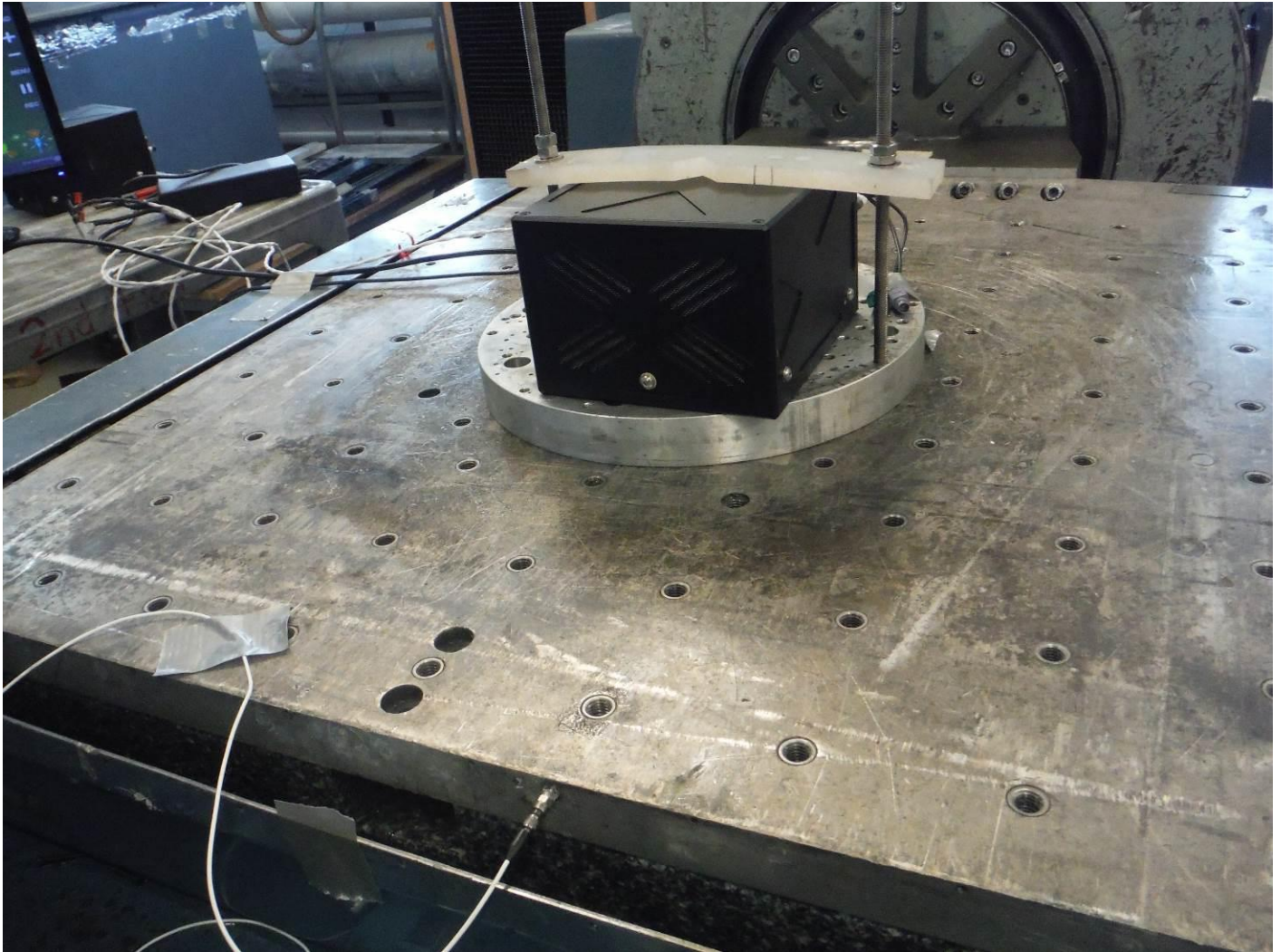
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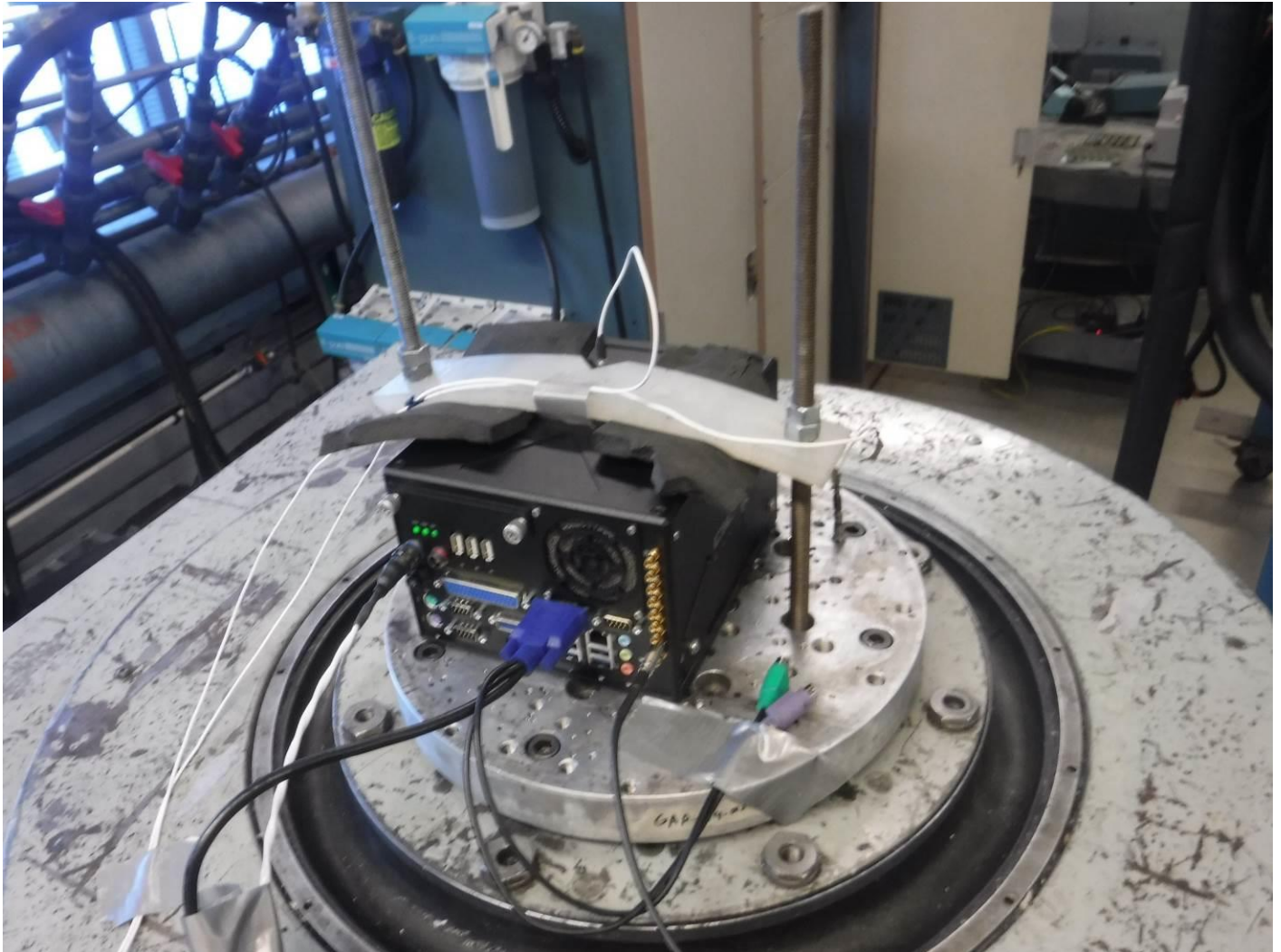
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Axis Two

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Axis Three



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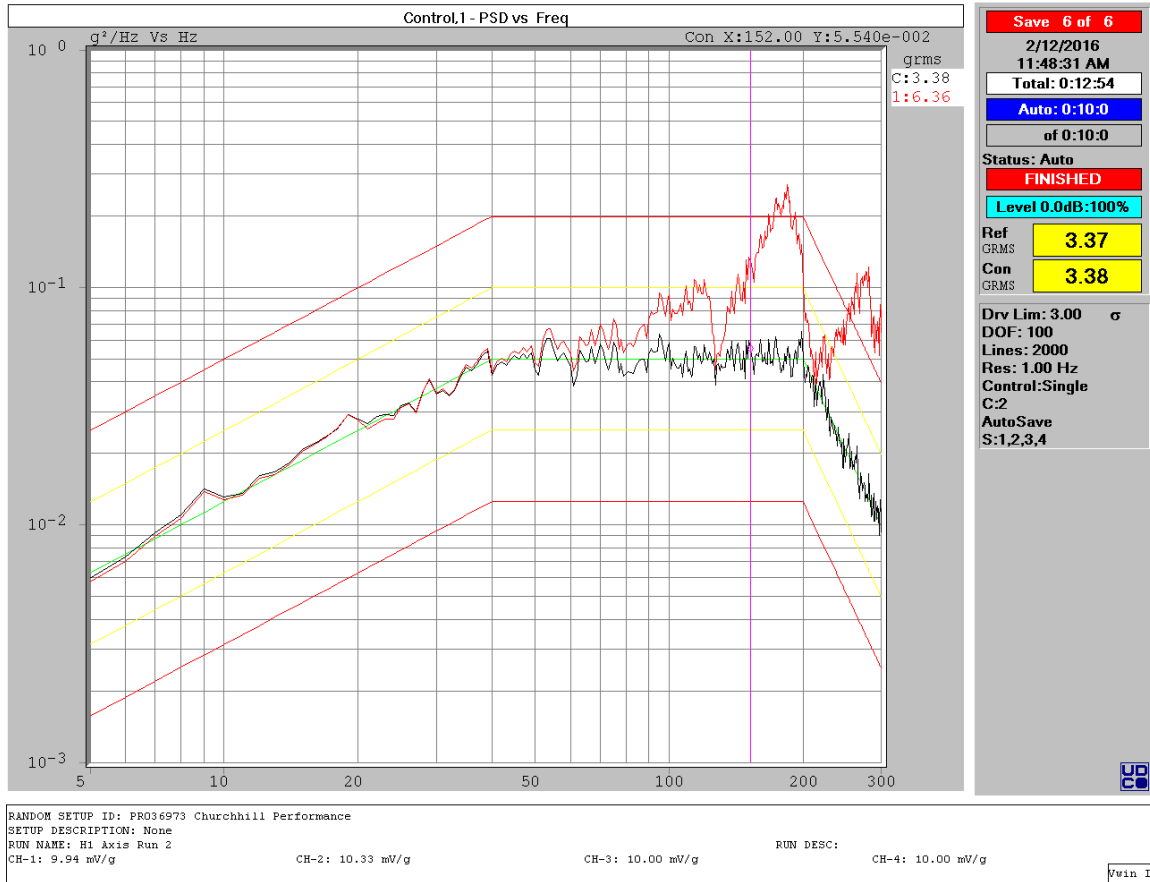
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GRAPHS



AXIS ONE PRE- ENDURANCE PERFORMANCE VIBRATION GRAPH



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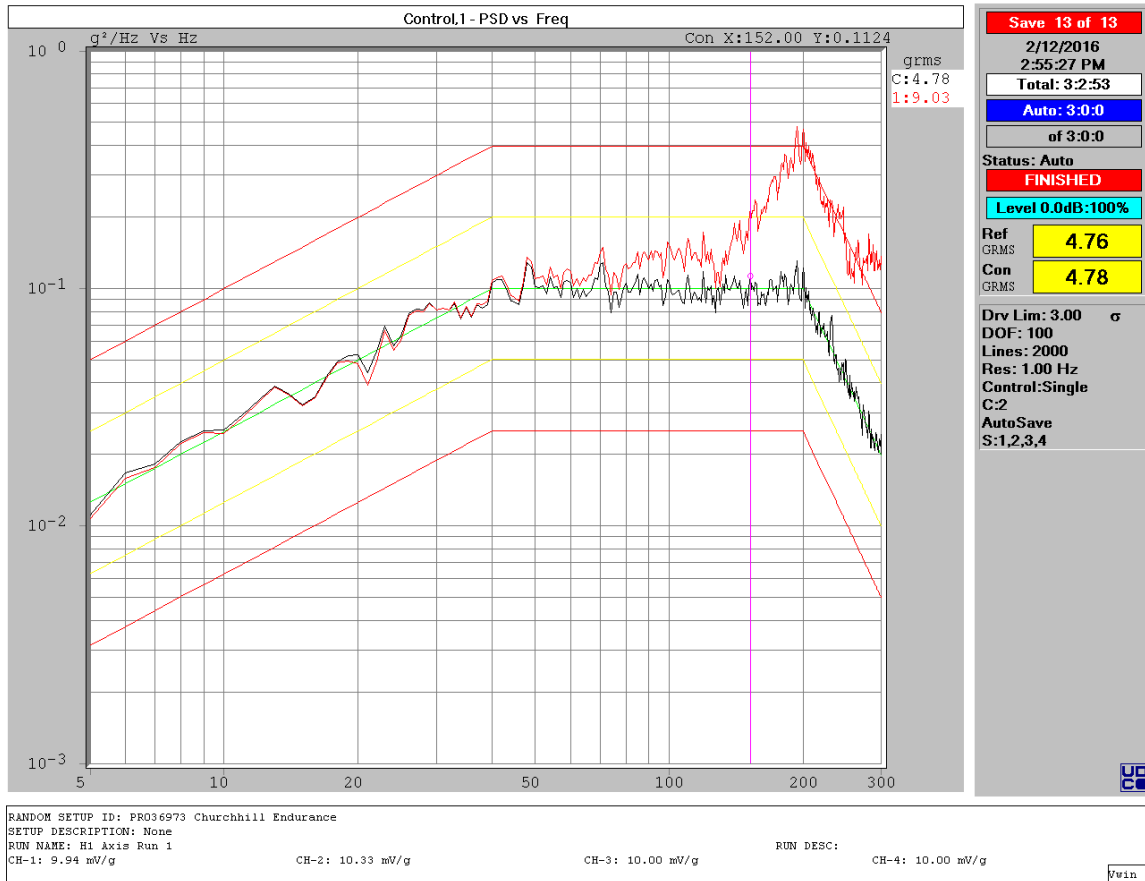
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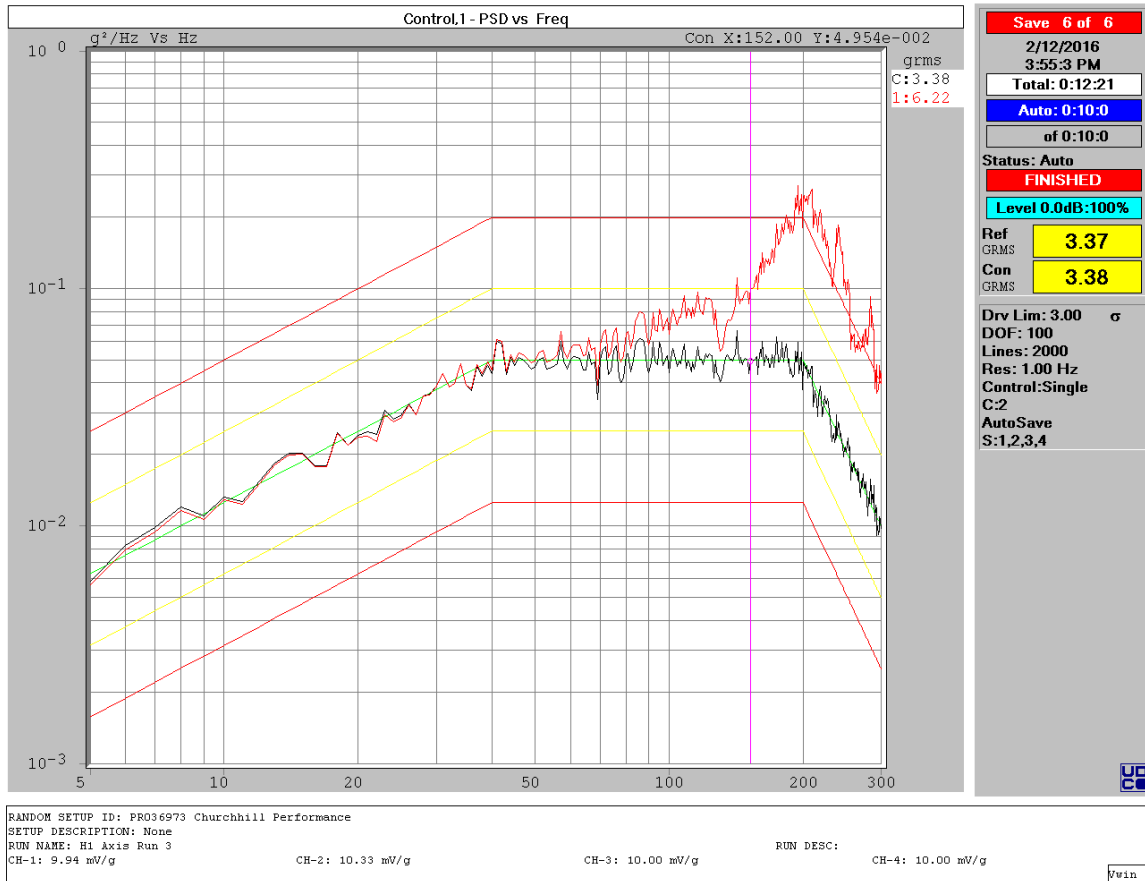
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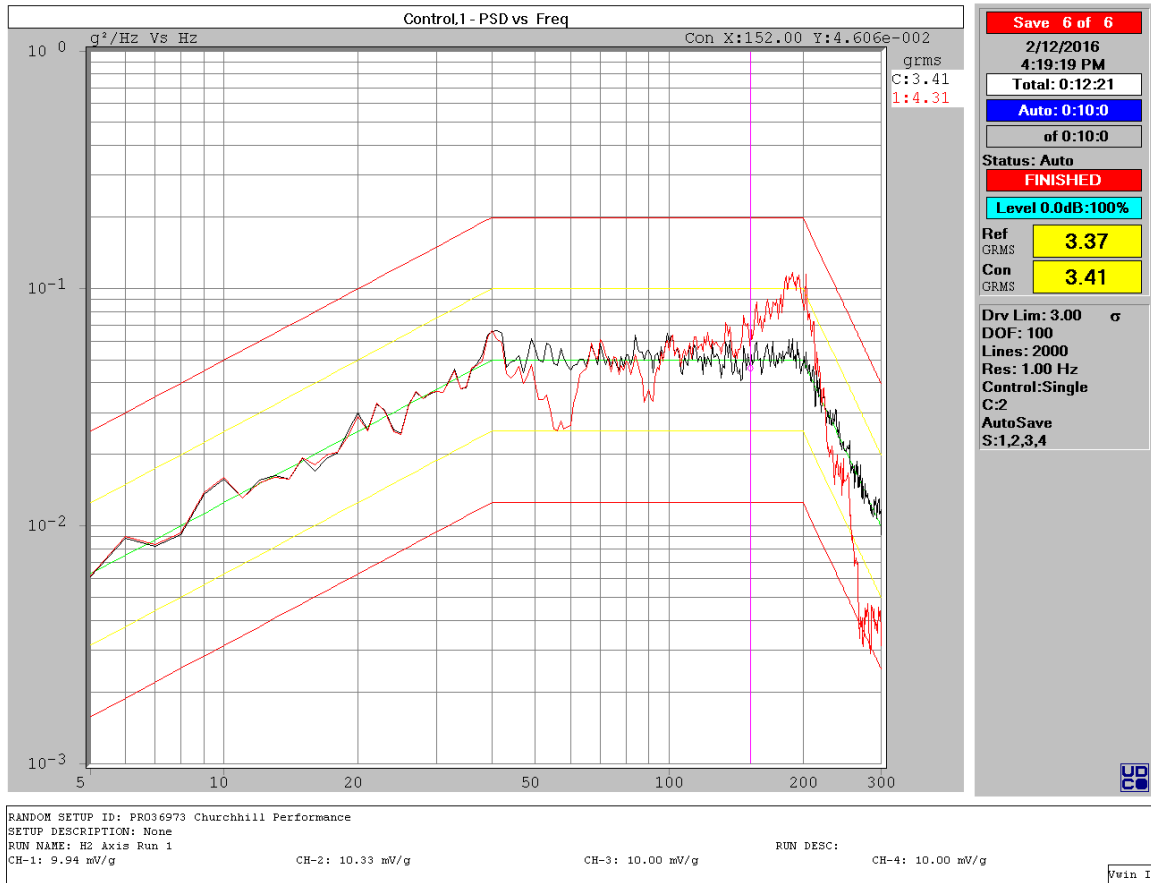
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AXIS ONE POST- ENDURANCE PERFORMANCE VIBRATION GRAPH



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AXIS TWO PRE- ENDURANCE PERFORMANCE VIBRATION GRAPH



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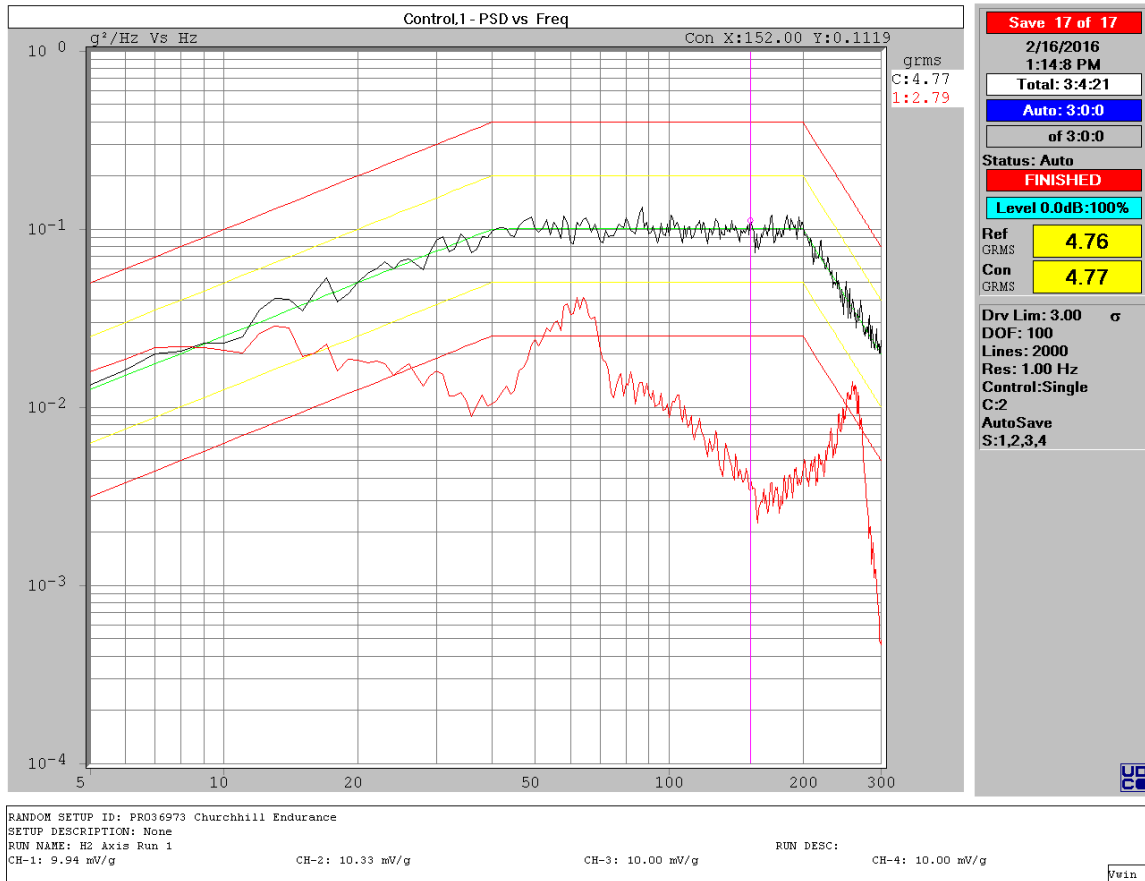
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AXIS TWO ENDURANCE VIBRATION GRAPH



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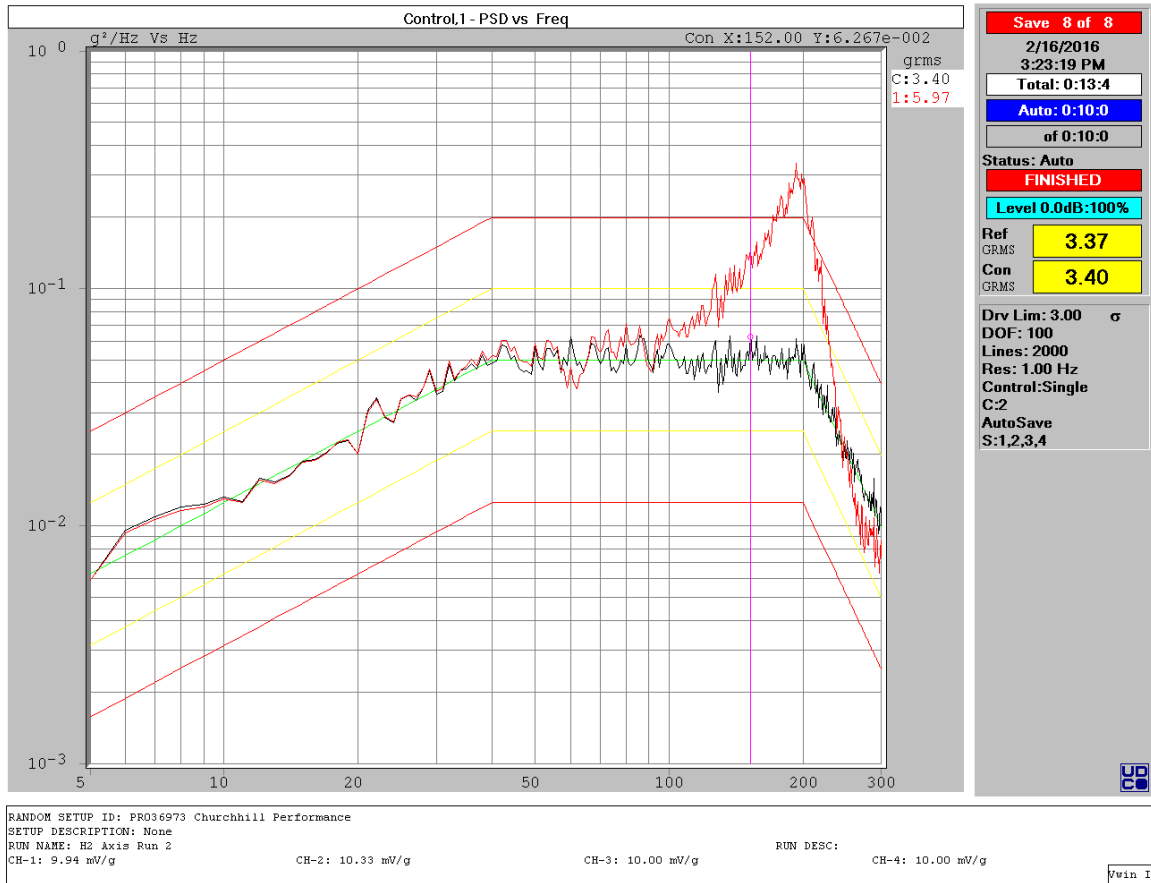
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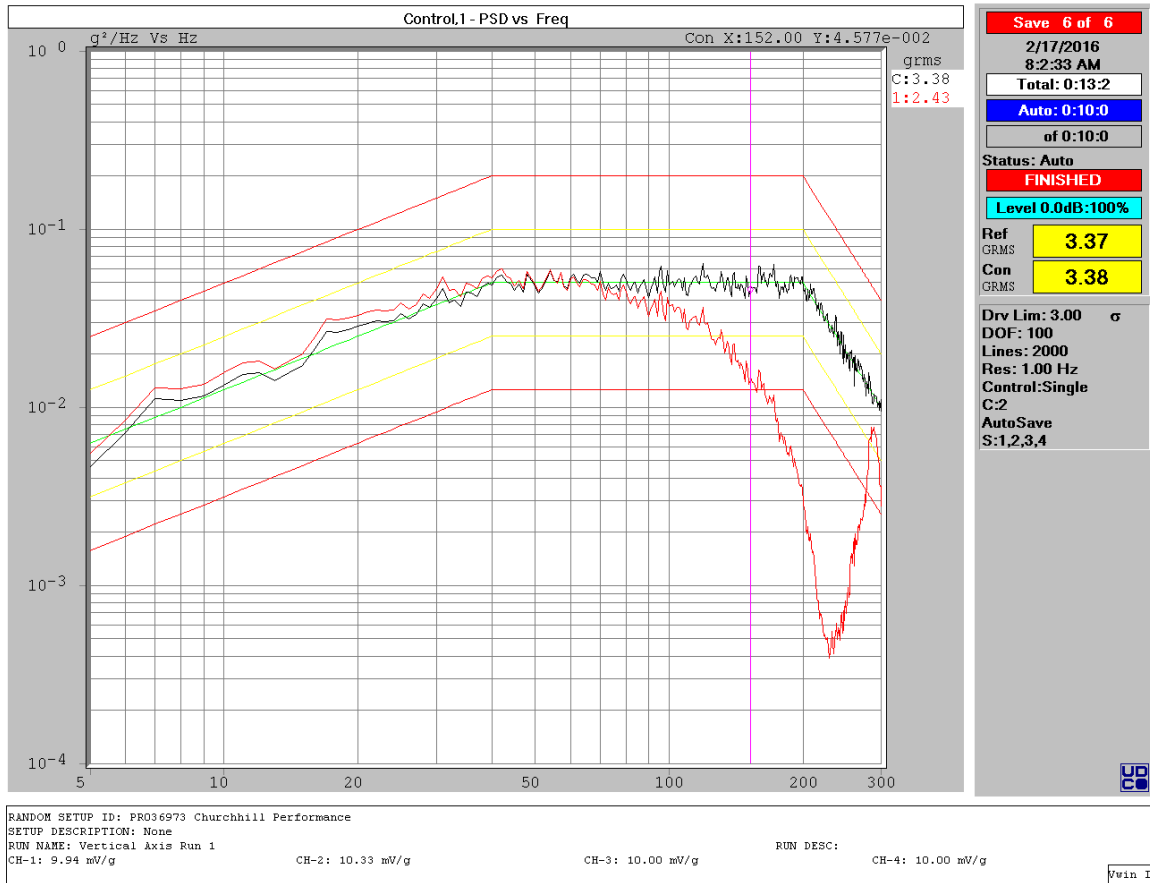
AXIS TWO POST- ENDURANCE PERFORMANCE VIBRATION GRAPH



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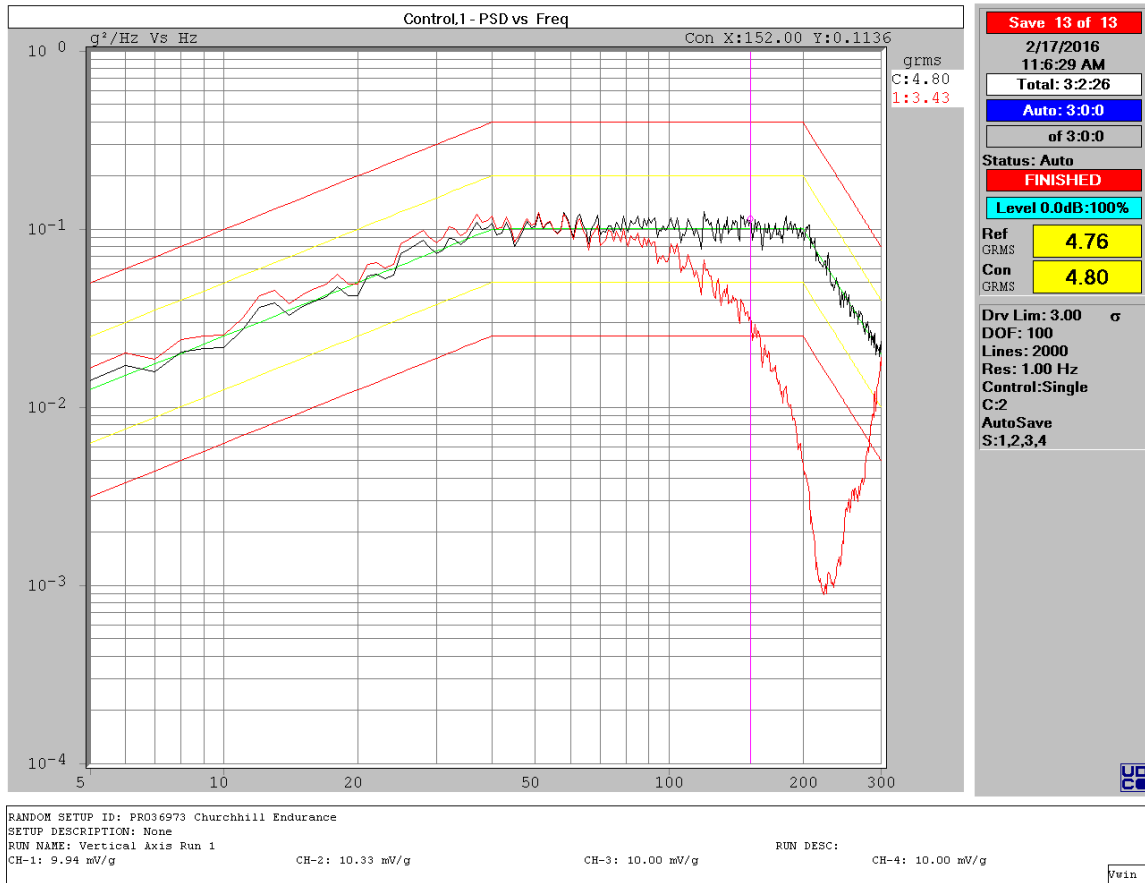
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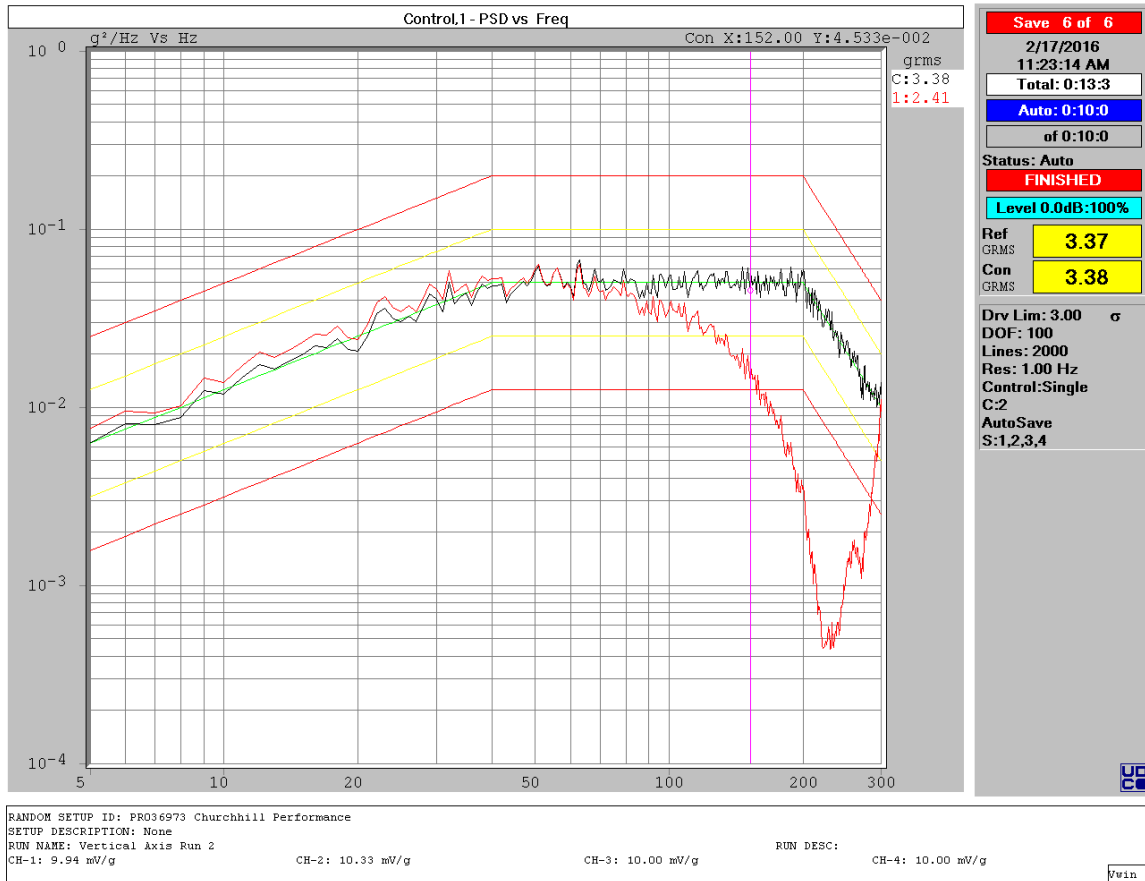
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AXIS THREE POST- ENDURANCE PERFORMANCE VIBRATION GRAPH



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OPERATIONAL SHOCKS TEST REPORT

TEST DATES

02/18/16 to 02/19/16

TEST SPECIMENS

One (1) ARS-600 S/N: 151204

REFERENCES AND REQUIREMENTS

Testing was conducted per RTCA-DO-160G Section 7 Category A.

TEST PROCEDURE

Sample was secured to the test fixture. One (1) control accelerometer was used to measure and adjust the input shock level. Sample was ON during operational shock. All graphs and photos are included in the respective test section.

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

There was no deviation from the agreed upon test method.

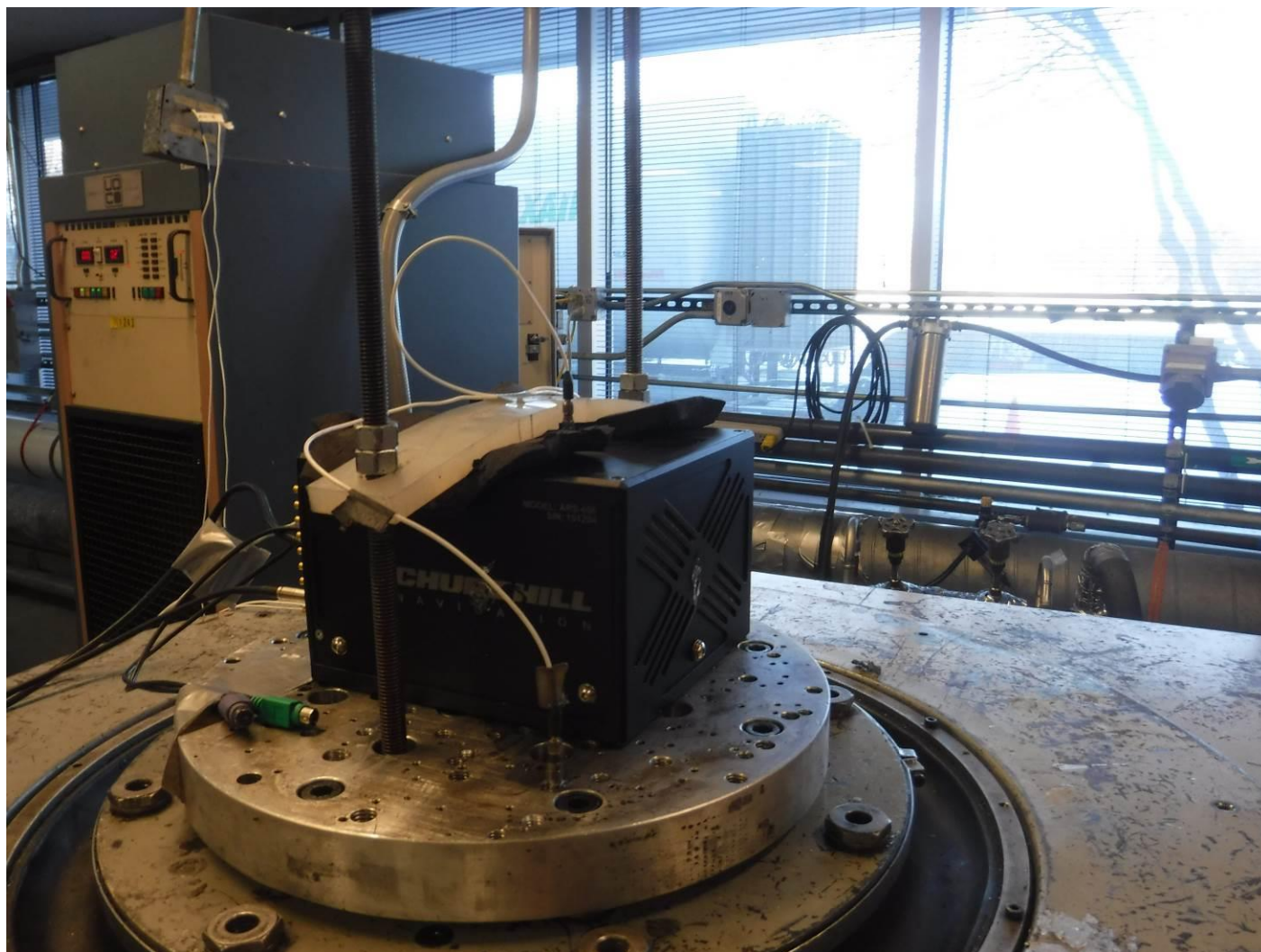
TEST RESULTS

Testing was conducted as outlined above. The sample was fully functional upon completion of the test and had no sign of visible damage.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Electro Dynamic Shaker	UDCO	T2000	TL 1243	Ref	Ref
Shaker vibration Controller	UDCO	UD VWIN II	TL 1213	09/09/15	09/09/16
Signal Conditioner	PCB	482A16	TL 1153	09/08/15	09/08/16
ICP Accelerometer	PCB	353B18	TL 1384	06/15/15	06/15/16
ICP Accelerometer	PCB	353B18	TL 1386	12/02/15	12/02/16

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PHOTOGRAPHS**Axis One**



NATIONAL TECHNICAL SYSTEMS

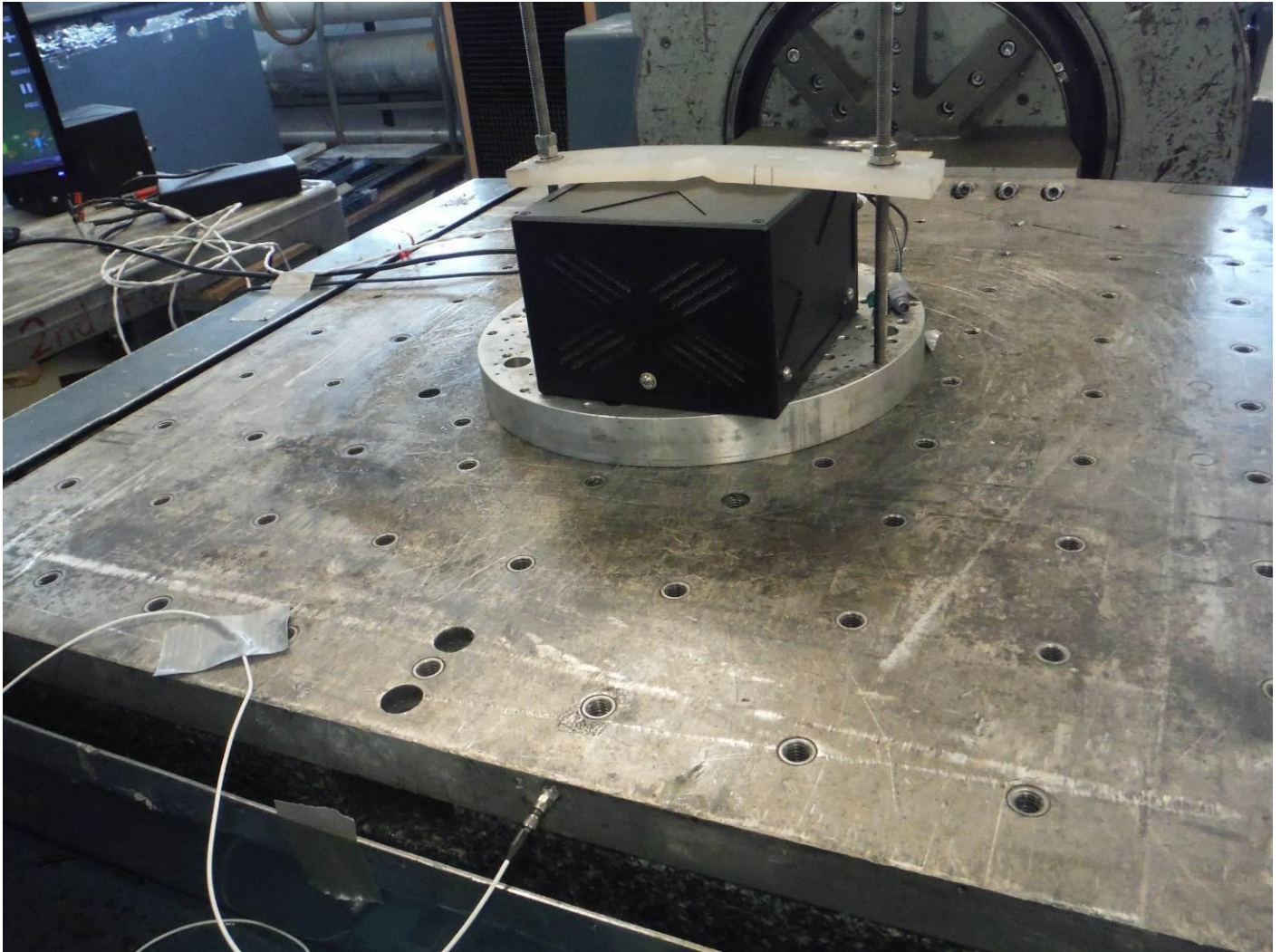
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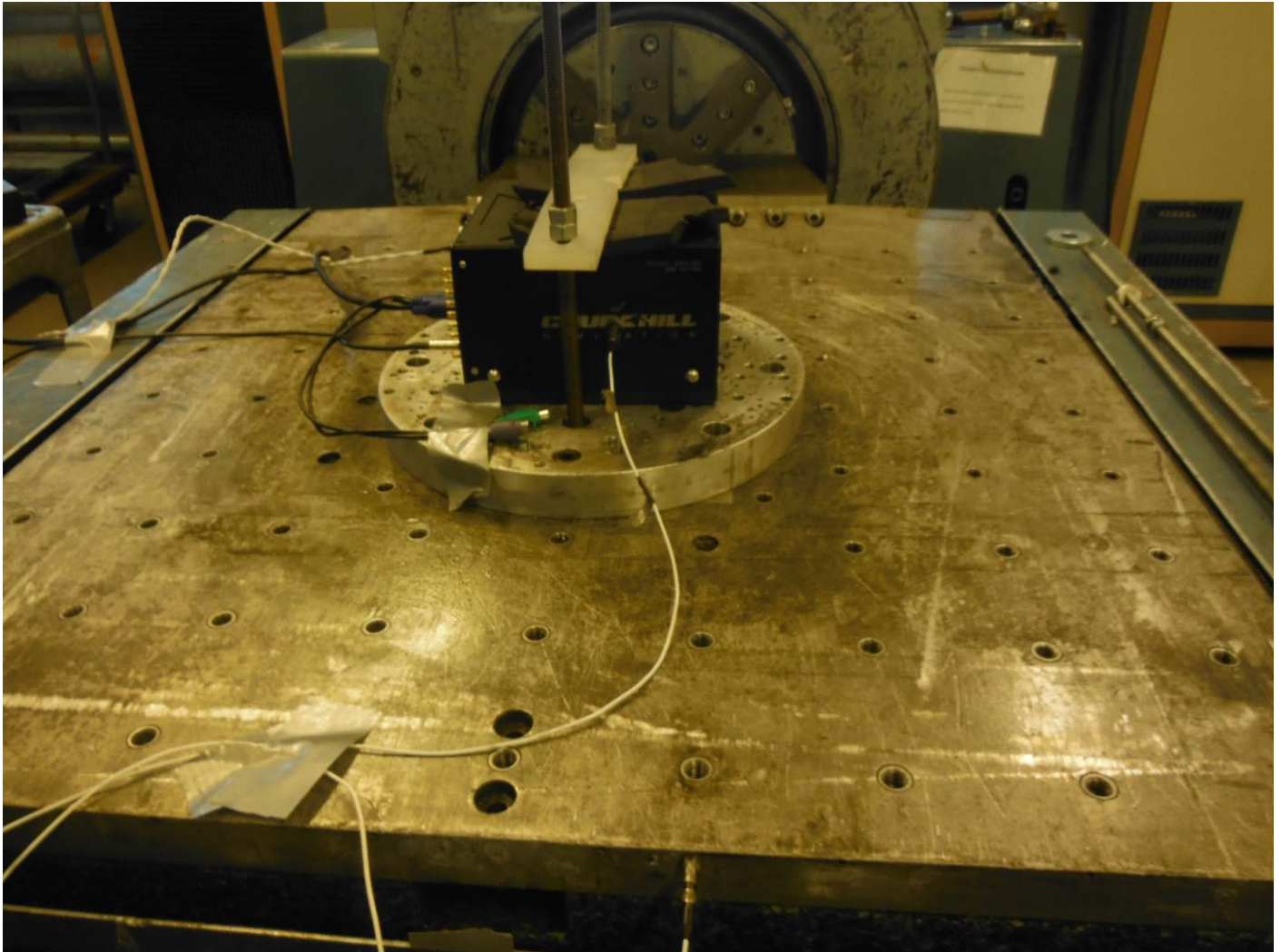
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Axis Two

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Axis Three



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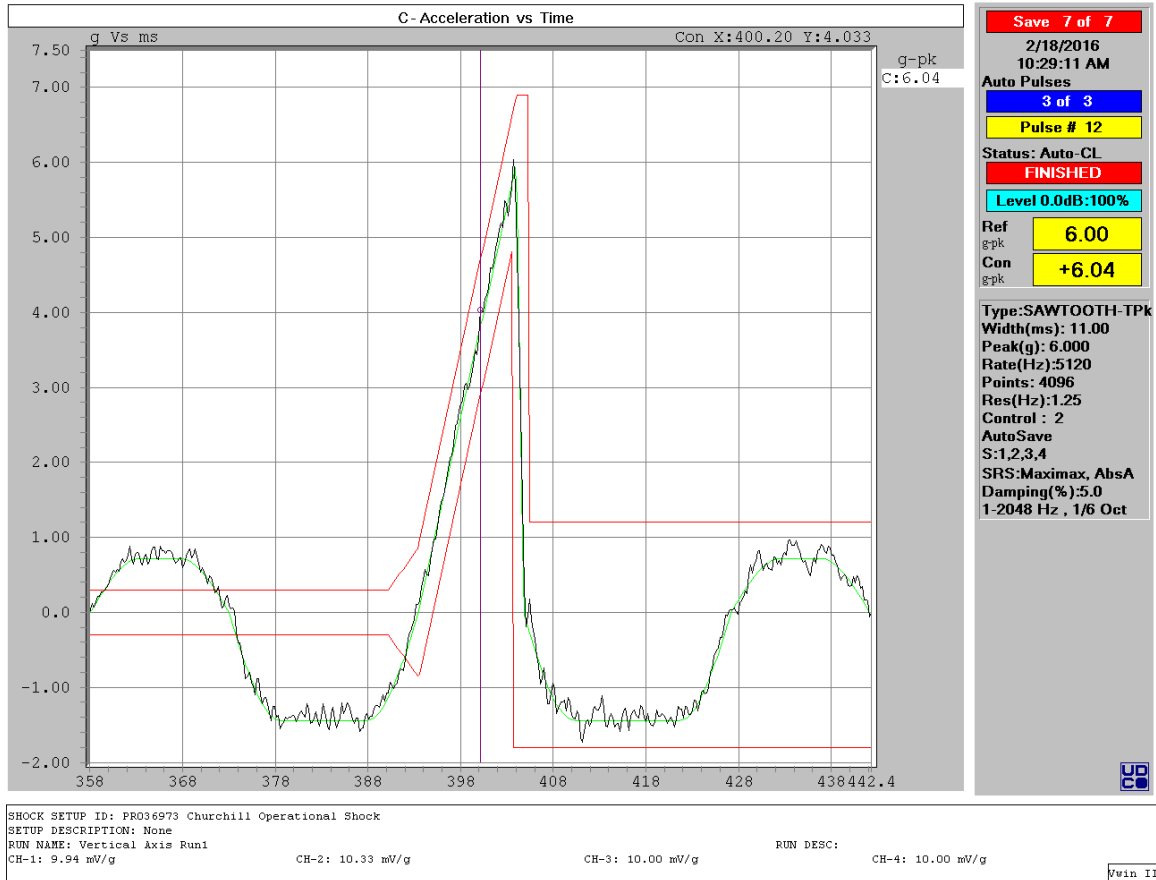
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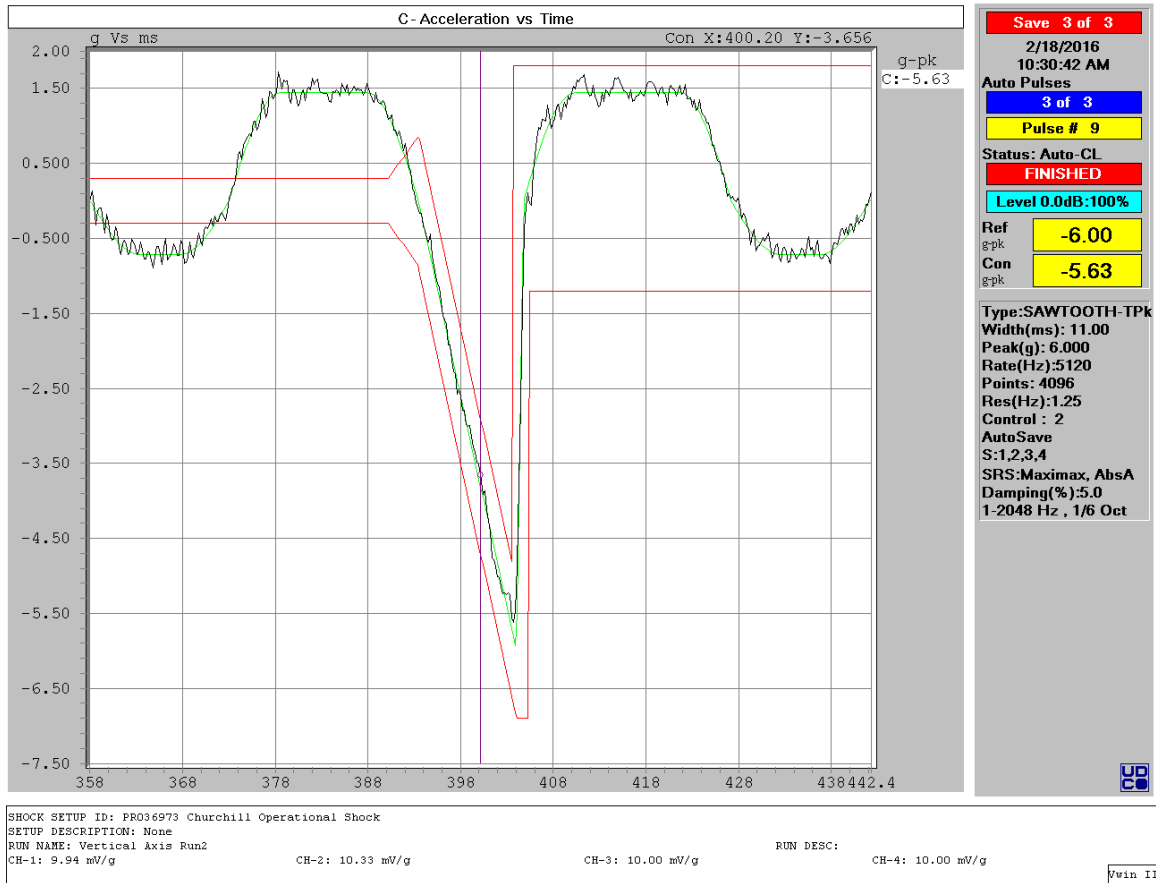
GRAPHS



AXIS ONE POSITIVE IMPULSE



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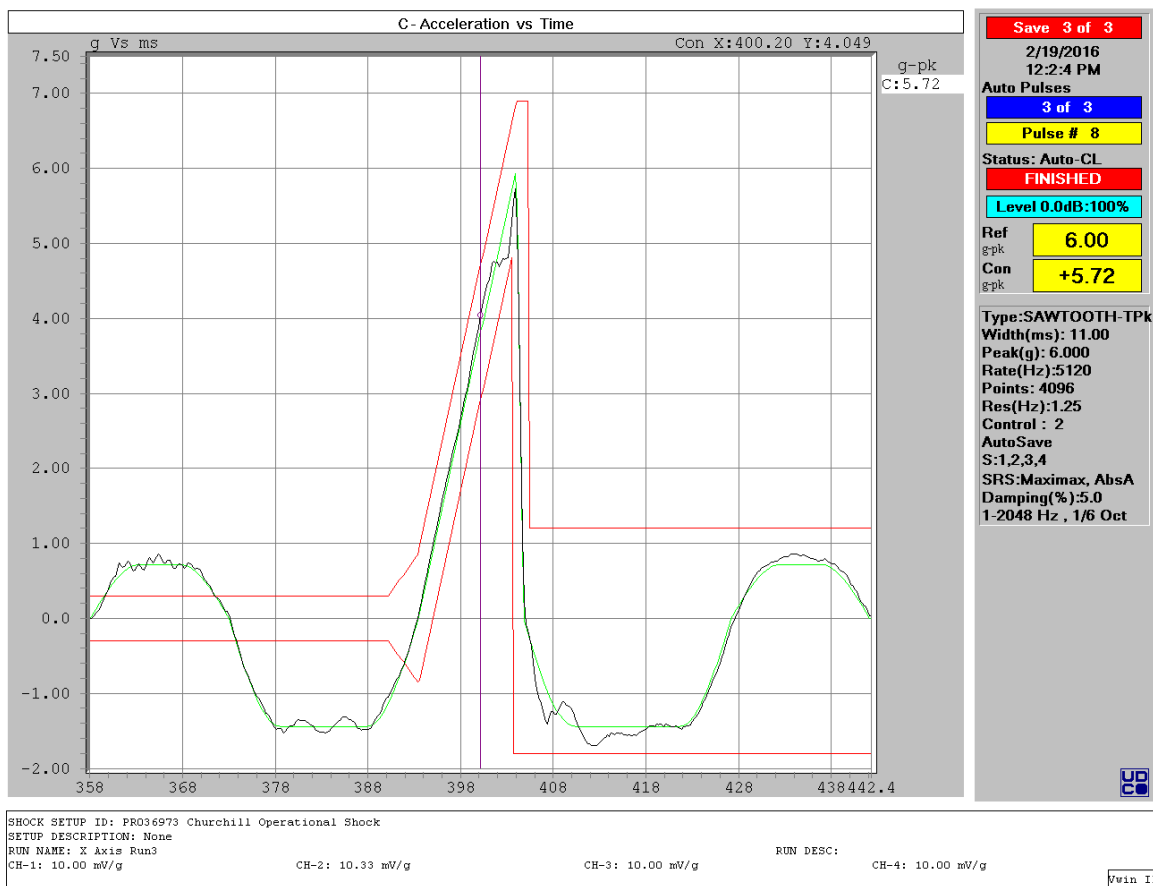
AXIS ONE NEGATIVE IMPULSE



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AXIS TWO POSITIVE IMPULSE



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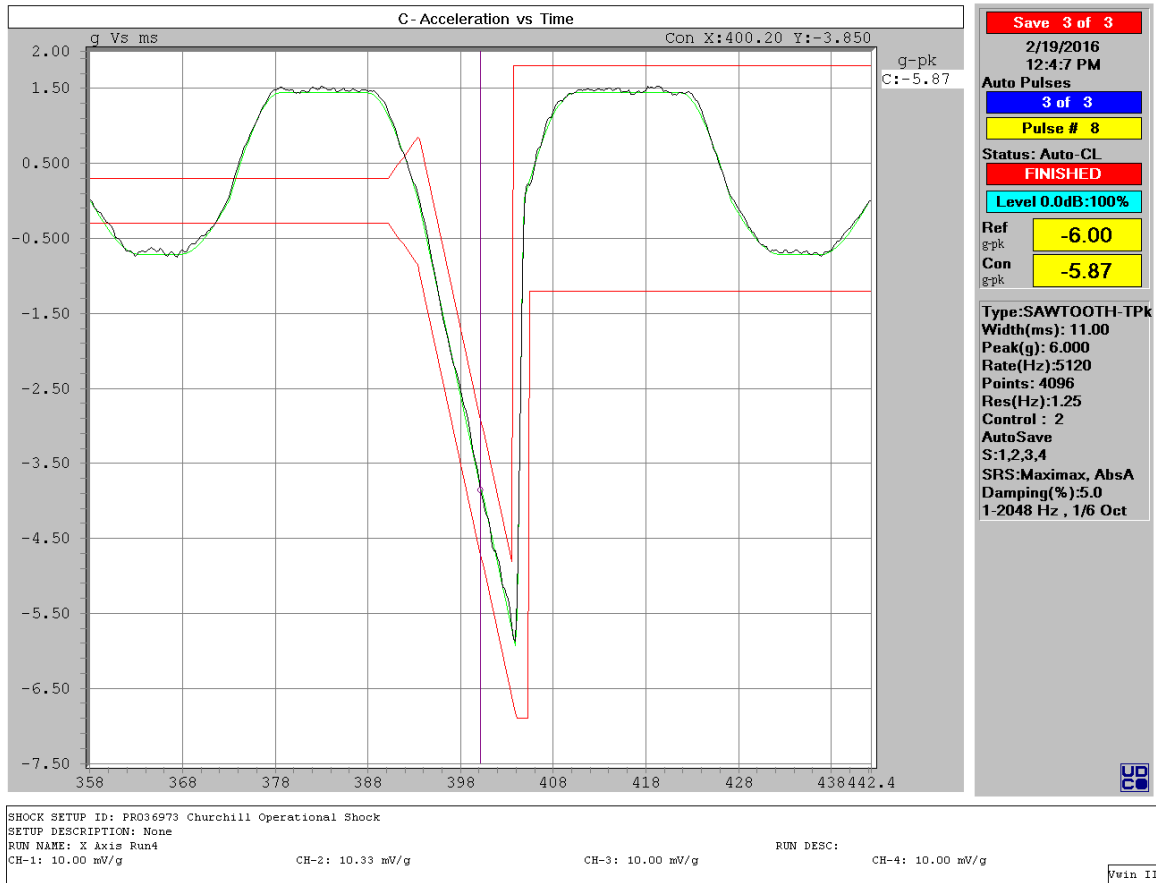
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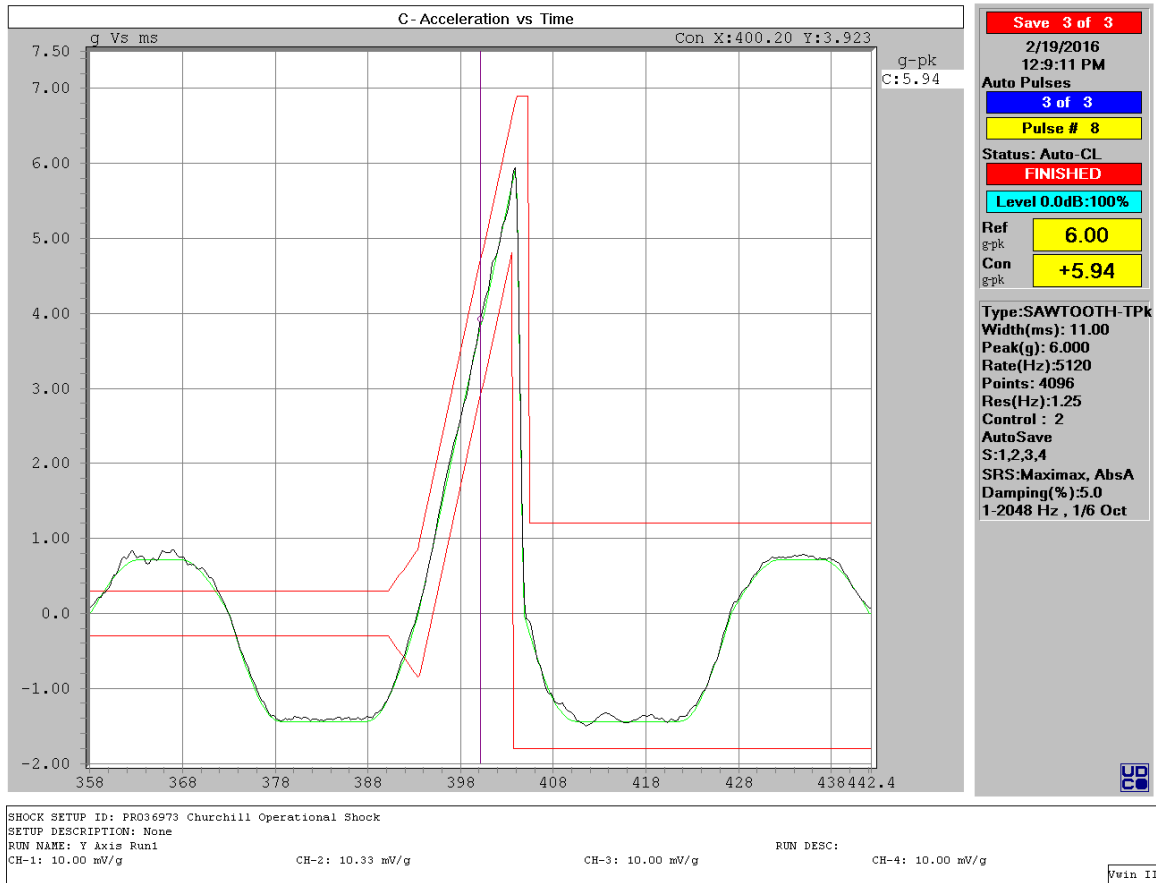
AXIS TWO NEGATIVE IMPULSE



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AXIS THREE POSITIVE IMPULSE



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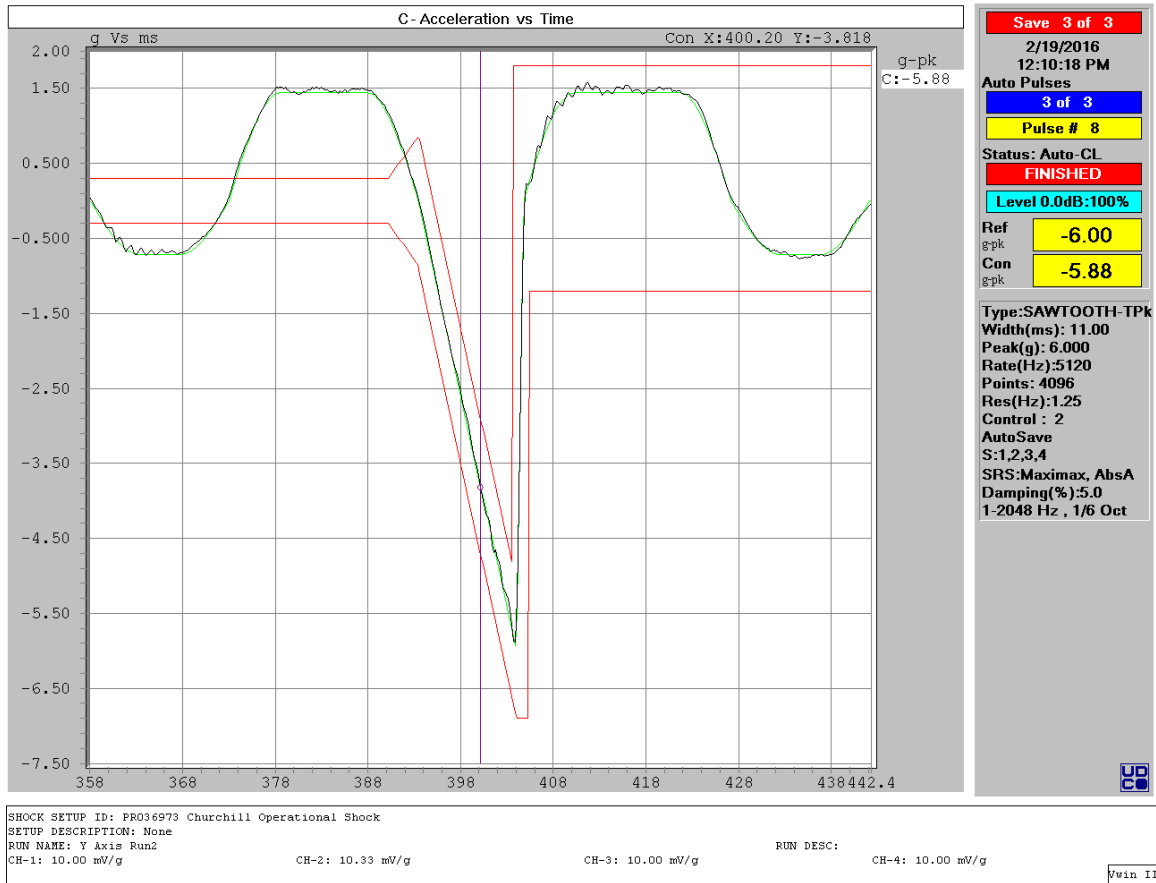
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AXIS THREE NEGATIVE IMPULSE



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EXPLOSIVE ATMOSPHERE TEST REPORT

TEST DATES

02/23/16

TEST SPECIMENS

One (1) ARS-600 S/N: 151204

REFERENCES AND REQUIREMENTS

Testing was conducted per RTCA-DO-160G Section 9 Category E.

TEST PROCEDURE

The sample was placed in an explosive atmosphere chamber and the air temperature set to 70°C with the sample unpowered. The sample and chamber wall temperature was allowed to stabilize within 11°C of the air temperature and then 242 ml of n-hexane was added to the chamber. After allowing the n-hexane to evaporate and circulate, the unit was powered cycled several times and allowed to operate for 3 minutes. After operating the sample, a portion of the chamber air was ignited in a separate chamber to ensure an explosive mixture was present.

LIST OF ANY DEVIATION/EXCLUSION FROM AGREED TEST METHOD

There was an issue with the initial sample temperature readings being too high. The thermocouple was replaced and the sample given additional time to stabilize before starting testing.

TEST RESULTS

Testing was conducted as outlined above. The sample operated as intended without igniting the explosive atmosphere in the chamber. After operating the sample, the air in the chamber was confirmed to be explosive when tested.

TEST APPARATUS

EQUIPMENT	MANUFACTURER	MODEL#	LAB#	LAST CAL.	NEXT CAL.
Explosion Chamber	Bowser Tech	396	TL936	N/A	N/A
Data Acquisition Unit	Agilent	34970A	TL977	05/21/15	05/21/16
20 Channel Multiplexer	Agilent	34901A	TL1067	10/22/15	10/22/16
Stop watch	Control Company	1042	TL1456	04/17/15	04/17/16



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TEST DATA

Ambient Pressure	
Chamber Length (in)	79.00
Chamber Length (ft)	6.58
Radius Chamber (in)	18.00
Radius Chamber (ft)	1.50
Volume of chamber (ft^3)	46.53
Test Altitude (feet)	750.00
Chamber Pressure (psia)	14.35
Chamber Temperature (°C)	70.00
Chamber Temperature (°F)	158.00
Chamber Temperature (R)	617.67
Ambient Temperature (°C)	7.00
Relative Density of n-Hexane	0.671
Constant	150.41
n-Hexane Volume to use (mL)	242.37

Chamber/Test Parameters



NATIONAL TECHNICAL SYSTEMS

1150 W. Euclid Avenue

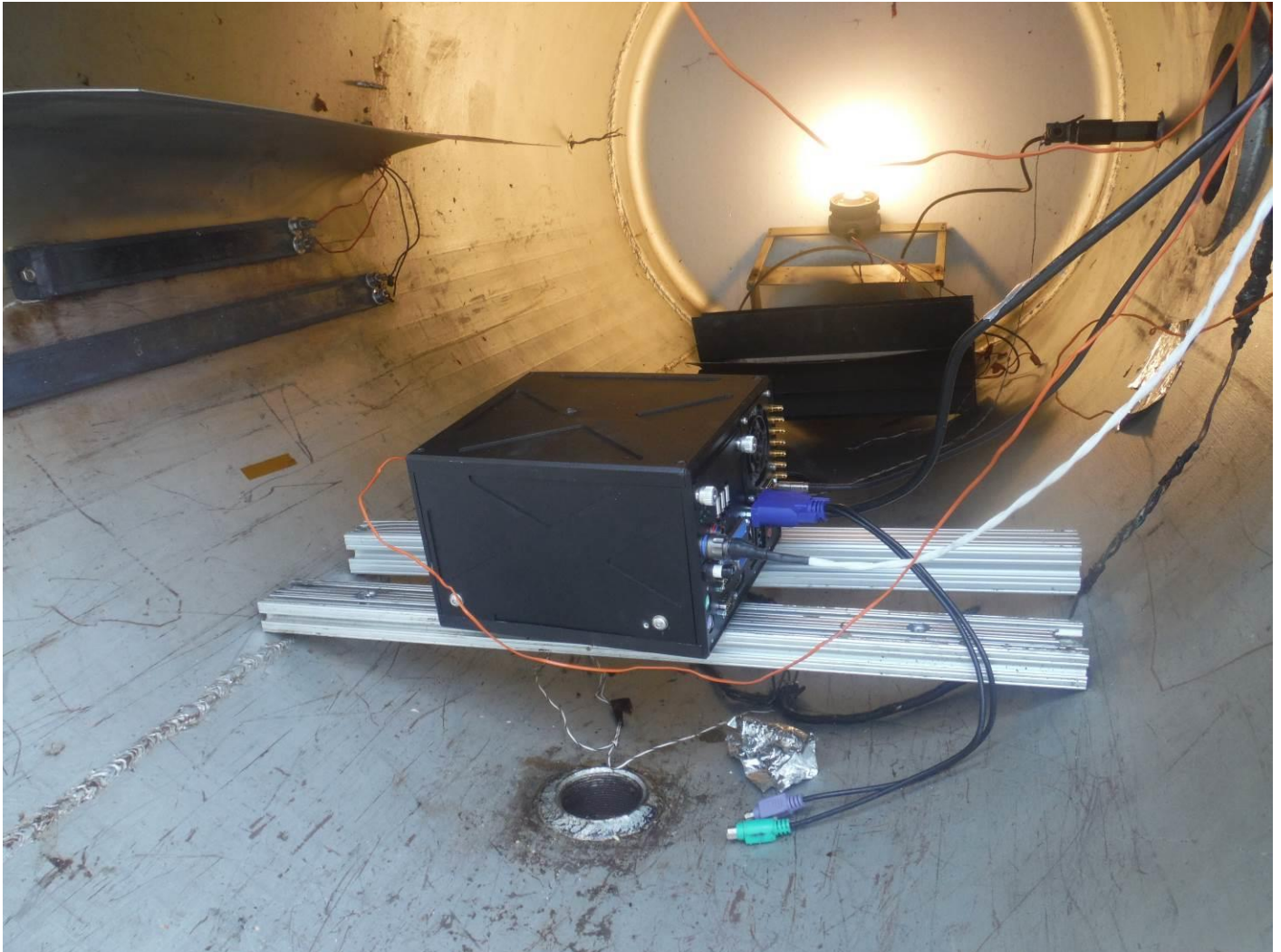
Palatine, IL 60067 USA

847-934-5300

www.nts.com

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PHOTOGRAPHS



Sample in Chamber



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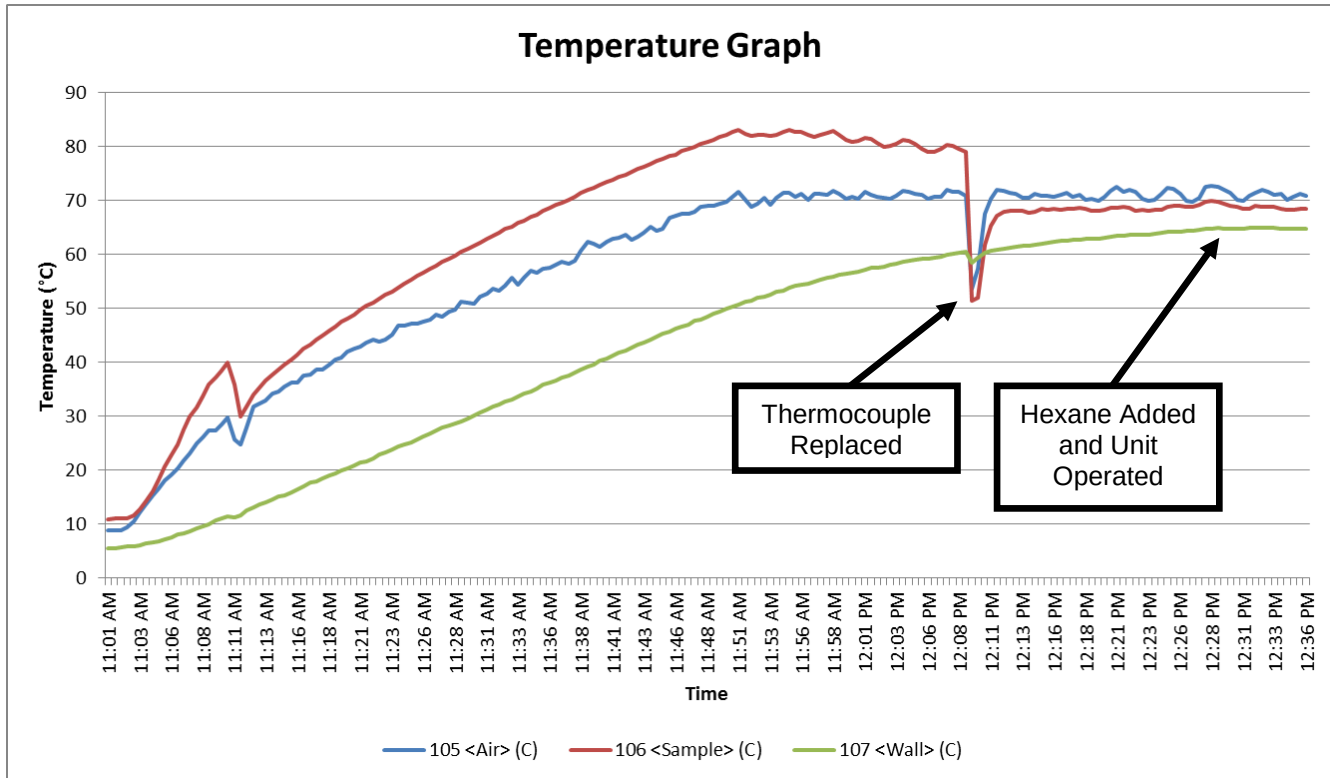


Test Setup



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GRAPHS





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REVISIONS

Revision #	Reason for Revision	Date
R0	Initial Release	02/29/16