*** See Addendum (page 22) for clarification purposes.

Jefferson Lab — Thomas Jefferson National Accelerator Facility	**Notable Event Worksheet** (See ES&H Manual Chapter 5200 Appendix T1 Event Investigation and Causal Analysis for Instructions)	Click For Word Doc

Title of Event			
Event Title:	Experimental RF Cavity Vacuum Window Failure		
Date and Time of Occurrence:	11-July-2012/~3pm	**Notable Event Number:**	ACC-12-0711
Event Location:	Room 115, Test Lab North Extension (Vacuum Lab)	**Date Notable Event Report is Due*:**	12-August-2012

*The Notable Event Report is due to the ESH&Q Reporting Officer with 30 days of the Initial Fact Finding Meeting unless an extension is requested.

Categorization and Reporting
(To be completed by ESH&Q Reporting Officer within two hours – unless essential information is still pending)

ORPS Determination:	**Date:**	07/13/2012	**Time:**	1439

From Tina Johnson — Reply | Reply All | Forward | Archive | Junk | Delete

Subject **ORPS Determination : ACC-12-0711- Cavity Glass Flange Failure** 7/13/2012 2:39 PM

To Steve Neilson

Cc Mary Logue, Harry Fanning, Henry Robertson — Other Actions

Steve,

Good Afternoon! As you know on 07/11/2012, an ODU grad student was working on a crab cavity in the vacuum lab in the Test Lab. The cavity was under vacuum (~200 torr), when the glass flange failed. The student was hit by the glass on her arm, clavicle, face. The student returned to work on 07/12/2012 with superficial lacerations and no restrictions.

The scene was well preserved and the notable event process began yesterday morning. The exact reason the flange failure is unclear.

The investigation team looking into the event in Vacuum Lab recommended that we report this event to DOE through the Occurrence Reporting & Processing System (ORPS) as a Management Concern- Near Miss (Significance Level 3).

The investigation team also believes that this information is worth sharing with other labs, which is a criteria for reporting under the Management Concern category.

If you have any questions or concerns, feel free to contact me.

Regards,
Tina Johnson
Reporting Officer
Jefferson Lab
12050 Jefferson Ave.
Suite 602
Newport News, VA. 23606
757-876-1750 cell
757-269-7611 office

10 CFR 851 Screen:	**Date:**		**Time:**	

Jefferson Lab – Thomas Jefferson National Accelerator Facility	**Notable Event & Lessons Learned Worksheet**

Categorization and Reporting (To be completed by ESH&Q Reporting Officer within two hours – unless essential information is still pending)			
ORPS Determination:	**Date:** 07/13/2012	**Time:**	1439
Negative: This event does not meet the NTS voluntary reporting criteria either as a discreet event or as a programmatic weakness.			

Unless otherwise specified the following is to be completed by the Lead Investigator.

Step 1 Initial Fact-Finding Meeting			
Date: 07/12/2012	**Time:** 11am	**Location:**	CC F228 & TL 115

Required Attendees:	**Optional Attendees:**	**√ if Present**
Lead Investigator:	**Associate Director:**	
(Print Name): Harry Fanning	(Print Name): Andrew Hutton	
ESH&Q Representative:	**TJSO Observer:**	√
(Print Name): Tina Johnson (Reporting Officer)	(Print Name): Steve Neilson	
Supervisor of involved persons(s):	**Subject Matter Expert(s), Facility/Equipment Owner** as applicable:	
(Print Name): Mentor	(Print Name): Greg Marble (Lead Technician)	√
Involved or impacted person(s):	(Print Name):	
(Print Name): Student 1	(Print Name):	
Witness(es):	(Print Name):	
(Print Name): Technician 1	(Print Name):	
(Print Name): Technician 2	(Print Name):	

Agenda *(Ensure the pace of the meeting allows time for accurate note taking.)*	**√ if Complete**
1. Introduction – Provide Event Title, Date and Time of Occurrence, and Location:	√
2. Attendance - Are Required Attendees present.	√
3. Purpose of Initial Fact-Finding meeting.	√
4. Event Reconstruction – Use information to complete Section 3. Summary of Event and/or Injuries below.	√
a. Personnel and organizations involved in the event.	√
b. Conditions and actions preceding the event.	√
c. Chronology (timeline) of the event; and	√
d. Immediate actions taken in response to the event.	√
5. Clarify information – Subject-Matter Expert (SME) confirms work conditions.	√
6. Stop Work or the Tag Out Required? If "Yes" – establish the restart criteria and inform the affected Management	√

	chain.	
7.	Compensatory Actions Required? If "Yes" determine responsibility and include confirmation documentation.	
8.	Records or documentation required to confirm, clarify, or complete information (i.e., work plans, work control documents, photos, etc).	
9.	Other Questions or Concerns: Ask attendees if there are any other questions, concerns, or information that they wish to provide.	√
10.	Obtain TJSO Observer feedback on conduct of fact finding meeting and potential improvements.	√

Step 2 Investigation Team:		**Date Convened:** (Within 24 hours of Fact Finding Meeting.)	
Role	**Name**	**Department/Group**	**Phone**
Lead Investigator	Harry Fanning	ACCMGT	7619
Co-Lead Investigator	Henry Robertson	EESSAF	7285
Vacuum SME	Greg Marble	MSINST	6024
Pressure System SME	David Meekins	TARGET	5434
ESH Representative	John Kelly	ESHDIV	7531
TJSO Observer	Steve Neilson	TJSO	7215

Step 3 Summary of Event and / or Injuries, including Initial Fact Finding Meeting information: determine the chain of events and timeline. Use attachment as necessary.

On the 11th of July, 2012 at approximately 3pm in the afternoon, a graduate student was superficially injured by flying glass debris when the experimental RF Cavity cell they were working on experienced a vacuum viewport blow-out within a temporary clean area located inside the vacuum lab of the Test Lab. The cavity had previously been under vacuum when it was being slowly bled up to atmosphere with nitrogen gas when the incident occurred. The student's mentor was with them at the time of the incident, though the mentor admitted that this was the first time they had been in the lab where the student had been working for several months. Workers within the vacuum lab (who were unaffiliated with this experiment) came to assist the student and mentor after hearing the loud discharge within the temporary clean area. The student was observed to have superficial lacerations while the mentor seemed fine but a little fazed due to the loud discharge within the enclosed clean area. The student went to the restroom to clean up the wounds before returning to the scene. Once the student returned, the mentor drove the student to the on-site medical services.
After the student was seen by the on-site medical services, they were referred to an off-site eye specialist who ruled out the possibility of an eye injury. The student was returned to work without restriction.
It was reported by the student's mentor that the experimental cavity cell was made of soft material which should have deformed under pressures greater than 1-1/2 to 2 atmospheres, but the cavity did not show any signs of deformation. The Conflat style viewing window which ruptured was a standard 6" Varian vacuum Conflat flange with a glass viewport window which is rated up to 70 psi (~5 atmospheres.)
The Conflat viewport used in this setup had appeared to be in good working condition when it was borrowed from the vacuum lab to assemble the experiment setup. It was unknown how many times the viewport had been used before this incident.
The procedure for this experiment (400 MHz cavity) was written solely by the student but a previous version for a similar experiment (499 MHz cavity) was written by the student with assistance from a JLab engineer. Many of the tasks were similar so relevant information was transferred to the next generation of the procedure by the student. This procedure reported to be at the scene of the incident.

<u>TIMELINE:</u>
End of March 2012
The cavity was moved into the vacuum lab for the purpose of carrying out an experiment to understand the mechanical deformation that the cavity undergoes due to pressure fluctuations. Minute mechanical deformations were to be measured through variations in radiofrequency output readings.

Step 3 Summary of Event and / or Injuries, including Initial Fact Finding Meeting information: determine the chain of events and timeline. Use attachment as necessary.

Bolts, nuts, washers, Conflat flanges & 6" viewport, and gaskets were borrowed from the vacuum lab for assembly of the experiment setup sometime after the cavity was moved into the lab.

Mid May 2012

The network analyzer was attached and utilized by the student for initial higher order mode frequency measurements of the cavity for use at the IPAC 2012 conference.

Month of June, 2012

Assembly of the cavity setup with parts obtained earlier from within the vacuum lab is conducted mainly by the student. The student assembled the vacuum system to match a similar setup at the cavity manufacturer's lab (Niowave, INC.) which did not include a Nitrogen purge line.

The student requested the help from a colleague to fasten parts to the cavity which the student felt they could not effectively carry out themselves. One of the vacuum technicians within the vacuum lab in passing noticed that a borrowed Convectron gauge within the setup may be a suspected faulty gauge and offered a new replacement gauge to the student's colleague who was assisting the assembly. Neither the student nor the assisting colleague replaced the old (suspect) Convectron gauge with the new Convectron gauge given by the technician because they connected the old gauge to a digital read-back and observed readings they assumed were correct under the conditions. The new gauge was set aside in case it was needed further down the road.

26-June-2012

The cavity is put under vacuum and achieves 8.2x10-6 Torr where it holds for 4-5 hours before being returned to atmospheric pressure.

11-July-2012

0900 – The cavity cell is attached to the local Nitrogen line (set at 70 psi by a localized regulator) to purge the cavity after being pumped down.

0930 – The testing starts with a pump down of the cavity which continued throughout the morning reaching 1.6x10-7 Torr.

14:55 – The student began to slowly purge the cavity cell with Nitrogen with the mentor watching within the setup area. Pressures from within the cavity were being monitored and recorded in a logbook by the student during the purge process.

15:00 – The glass Varian viewport window ruptured at what was believed to be 200 Torr of pressure (below 1 atm) as observed and recorded by the student just before the rupture.

15:00 – Glass fragments forcefully propel from the cavity's viewport end and continue into the adjacent clean work area. No glass fragments are within the cavity.

15:00 – Small shards of glass imbed themselves into the student's face and forearms.

15:00 – The mentor is not injured by flying glass debris but is startled by the loud discharge.

15:00 – The student asks the mentor to secure the Nitrogen line.

15:00 – The mentor secures the Nitrogen line to the cavity.

15:00 – Vacuum technicians within the vacuum lab call out to the student and mentor to see if they are alright.

15:00 – The vacuum techs note and inform the student that the student is bleeding from their wounds.

15:00 – The student goes to a local restroom to assess and clean up the wounds.

15:10 – Once the student returns, the student is transported to on-site medical services by the student's mentor.

~17:00 – On-site medical services release the student without restriction and refer them to an off-site eye doctor after observing local irritation but no visual sign of foreign matter.

~17:00 – Student self-transports to the off-site eye facility and is evaluated with no foreign body found within the irritated eye.

~17:30 – Preliminary investigation is started by Accelerator Division Safety Officer (ADSO) with assistance from ESH&Q Division Head, the mentor and DOE Site Office member.

12-July-2012

09:00 – Student returns to work without restriction after Medical Services evaluation.

Notable Event Report

Emergency Notifications Made (Subsequent to the Event):	Date	Time
Fire, Rescue & Emergency Medical: (9-911)		
Guard Post: x4444; 269-5822		
Occupational Medicine 269-7539	07/11/2012	15:10
ESH&Q Reporting Officer: 876-1750	07/11/2012	15:15
Crew Chief 630-7050		

Industrial Hygiene: 269-7863:		
Other:		

Witness Accounts: (Use attachments as necessary. Box will expand as necessary)

Student's account via e-mail reply to investigator's questions.

Here are the answers for the questions. Thanks for clarifying with me.

1.) Who wrote the procedure you included in your e-mail?

I wrote the procedure by myself. We have two similar designs with 499 MHz and 400 MHz frequencies. The procedure I sent previously is related to the 400 MHz cavity. I wrote the 499 MHz cavity procedure first with the help from JLab Engineer. Then I followed the same steps for the 400 MHz cavity.

2.) Where was the picture taken which you included which you mentioned was your guide for the setup of pressure testing the cavity?

The picture was taken at Niowave, Inc. The cavity was fabricated at their facility.

3.) What level of involvement did your Principal Investigator (PI) have in the design, assembly and oversight of your pressure setup?

The idea in following the experiment was to understand the mechanical deformation that the cavity undergoes due to the pressure fluctuation. And to further understand whether there is a plastic deformation and also to determine the need of additional support required in terms of stiffeners. Mentor mentioned that I can follow the setup as in the picture. I assembled the setup in the vacuum lab. The day that the incident happened was the first time I assembled the complete set up and I asked him to come and have a look at it.

4.) Are you aware of any reviews of that setup, and if so, who was involved (your PI, ODU collaboration, JLab, etc.)?

I wasn't aware of any reviews related to the setup at the vacuum lab. I was asked to setup at the vacuum lab by JLab Engineer.

5.) Are there any specific rules or guidelines (other than your procedure) you followed to assemble your setup?

No I didn't follow and other specific rules or guidelines.

6.) At what step were you in your procedure when the window failed?

I was following the steps 2f and 2g when the window failed. (see attached procedure, pg 13)

7.) How many times had you put this setup under vacuum and purged with Nitrogen?

I had the cavity under vacuum one day prior. I first filled the cavity with N2 on the day the incident took place.

8.) What help (if any) did you have in building the setup you had in the vacuum lab?

I started initially with Jlab Engineer for the initial measurements of the frequencies. Then I worked by myself. Then I asked a colleague to help me to assemble the setup.

9.) Where did you receive parts for the setup (were they new, old, borrowed, etc.)?

The window and other blanks for the conflat flanges, I borrowed them from the vacuum lab. They were used parts as I understood. All the parts were wrapped in Al foil to be reused.

10.) Do you remember where the Varian window (which failed) was obtained and if it was new or used?

The window also I got from the vacuum lab. And it was not a new one. But it was also wrapped in Al foil.

11.) Do you know if the Varian window was ever dropped or if something was dropped on it?

Witness Accounts: (Use attachments as necessary. Box will expand as necessary)

During the time I used it I didn't drop the window. And nothing dropped on it. The Varian window and the other 6 inch conflat blank were the first items I assembled in the setup, as those two ports in the cavity were required to be closed throughout the test.

Also, please write in your own words a summary of the events from as far back as the start of the project up to events at the time of the incident.

We moved the cavity to the vacuum lab end of March 2012. I borrowed the blanks, nuts, bolts and gaskets sometime after that. Then in mid-May I took some preliminary measurements for the higher order mode frequencies of the cavity, by connecting the Network Analyzer, to report at the IPAC 2012 conference. Then in the month of June I started assembling the setup for the vacuum test. On June 26th I connected the setup to the vacuum pump and reached a pressure of 8.2*10-6 Torr. The cavity was under vacuum for about 4-5 hours. Then on July 11th I connected the N2 gas line to the setup in the morning, and let the cavity run under vacuum in order to measure base pressure. Before supplying N2 gas I measured a pressure of 1.6*10-7 Torr. Then we opened up the N2 gas line and started filling up the cavity slowly while taking down the frequency measurements. When the pressure read-out was closer to 200 Torr the window got blown.

Account of Mentor (from Lead Investigator's interview notes)

The Mentor (also known as a Principal Investigator – PI) came into the lab after lunch to observe the deformation experiment the student was carrying out on July 11th, 2012. The cavity was under vacuum and was holding at almost 2x10-7 Torr. Nitrogen was slowly introduced to the cavity to bring it up to atmosphere. Readings were taken during the Nitrogen purge and the student was recording them. Around 3pm, shortly after the third pressure measurement was recorded at 1.98x10-3 Torr, the glass viewport blew out catastrophically.

The cavity moved on the block holding the cavity, but the cavity did not come off of the block from the force of the window blowout.

Technicians within the vacuum lab came over and asked if the Mentor and student were OK. Both Mentor and student replied "yes."

The Nitrogen supply valve was closed and an assessment showed they had lost a viewport window.

One of the technicians noticed that the student was bleeding from small wounds on the face and arm and another technician attempted to assist. The wounds were located: 3 on the left arm, 1-2 on the right forearm, 1 on the neck and 1 on the face.

The student went to the restroom to look at and clean the wounds.

The Mentor discussed with the technicians what had happened while the student was away and when the student returned, the Mentor drove the student to Occupational Medicine, staying with the student until the student was released.

After the student was released and drove off-site, the Mentor came back to the scene and spoke with the preliminary investigation team providing information about the incident.

<u>Mentor's comment at the time</u>: The student was wearing eye protection during the time of the incident, but due to the size of the safety glasses and the smaller size of the student's face, it was unclear if flying debris entered through an exposed corner and into the eye of the student.

Account of Lead Technician (from Lead Investigator's interview notes)

The Lead Technician was in the middle of the vacuum lab when the technician heard an explosion from the experiment setup being hosted in the lab. The Lead Technician immediately yelled, "Are you alright?" The reply from the mentor and the student was, "yes."

Upon opening the plastic sheeting covering the clean area of the experiment setup, the technician saw blood on the student and advised the student to go to the restroom to clean up.

Upon looking over the vacuum setup of the experiment cavity test, a few things caught the eye of the Lead Technician:

1.) The Convectron gauge which the Lead Technician had previously instructed the student to replace looked to be the same gauge. This gauge was suspected to be faulty after initial comments from the student and another student during assembly stages made the Lead Technician believe it was a known faulty gauge which they may have acquired when borrowing parts for the assembly. The Lead Technician had given the students a new gauge to replace the suspected faulty gauge but never heard if they had done so. A possible contributing issue for the faulty readings was the gauge had initially been left in an orientation which would not read accurately and then was repositioned.
2.) There was no need for a visual inspection of the inside of the cavity during the experiment and the viewport was therefore not needed for the setup. The viewport could have been replaced by a regular 6" Conflat blank flange to seal the cavity.
3.) There was no pressure relief in the vacuum setup to prevent over pressurization during purge stages of the experiment. If one was installed on the setup at the entrance of the Nitrogen purge to the cavity, the overpressure should not have occurred.

The Lead Technician secured the scene after the student was transported to Occupational Medicine by stringing red tape across the plastic sheeting and marking on the tape, "Area Under Investigation – Do Not Enter – Area Under Investigation."

Witness Accounts: (Use attachments as necessary. Box will expand as necessary)

The Lead Technician called their supervisor, the Engineering Deputy Director, the vacuum group leader, the Engineering Division Safety Officer and the Accelerator Division Safety Officer to inform them all of the events.

Account of Technician 1 (from Lead Investigator's interview notes)
Technician 1 is listening in on the experiment in progress from Technician 1's work area located nearby. Technician 1 listens to a sound believed to be of the bleeding gas entering the cavity. This was later explained by the student and mentor to be a noise coming from a source which was not related to the purge activities.
There is a loud "bang" from the experiment area and Technician 1, Technician 2 and the Lead Technician immediately investigate to see what happened. Technician 1 hears the student ask the mentor to secure the Nitrogen supply feeding the setup. The mentor secures the Nitrogen supply at the wall. Technician 1 aids the mentor and student until Technician 2 takes over looking after the student.

Account of Technician 2 (from Lead Investigator's interview notes)
Technician 2 was in the center of the lab when the technician heard a loud "bang." Technician 2 went over to the experiment area and saw the student had blood on their face, neck and arms while the mentor seemed physically unharmed. Technician 2 is a trained EMT and offered to assist the student to which they responded, "yes." Technician 2 assessed the student's injuries and found minor lacerations on the face, neck and both arms.
Technician 2 accompanied the student to the restroom where the student did a self assessment and clean the wounds on their own.
Technician 2 came back with the student and advised the mentor that the student should be transported to Occupational Medicine for evaluation.
The student was carried by the mentor to Occupational Medicine and Technician 2 remained behind at the vacuum lab.

Extent of Conditions Interviews
There was extensive interviews which were conducted from the Physics, Accelerator, SRF and Education departments of Jefferson Lab to understand how Principal Investigators (PIs) are chosen and trained; what is the expectations of PIs in regards to student oversight; to what level students are trained and if there are any differences from standard employee training; are there any exclusions of students from work if training is not provided; and there were other questions which will be detailed in the Extent of Conditions CATS item when published.
What was immediately apparent was that there were inconstancies between how students were treated. Some were treated (by law) as minors, were given restricted duties and were governed under a tight leash by their PIs. This practice was consistent with the policies of JLab with regards to minors.
However, other students who were of legal age to engage in less restrictive duties have varying degrees of training, oversight and responsibilities as gauged by their PIs. What was found was a subjective approach to training and oversight by the PIs. Some PIs were in line with training their students with appropriate vigor for the task the student will perform, while other PIs gauged the student's competency by watching the student perform a menial task then making an assertion based on what they observed that the student was ready/not ready for a more complex task. This is highly subjective and can prove problematic regardless of training level.

Environmental Aspects

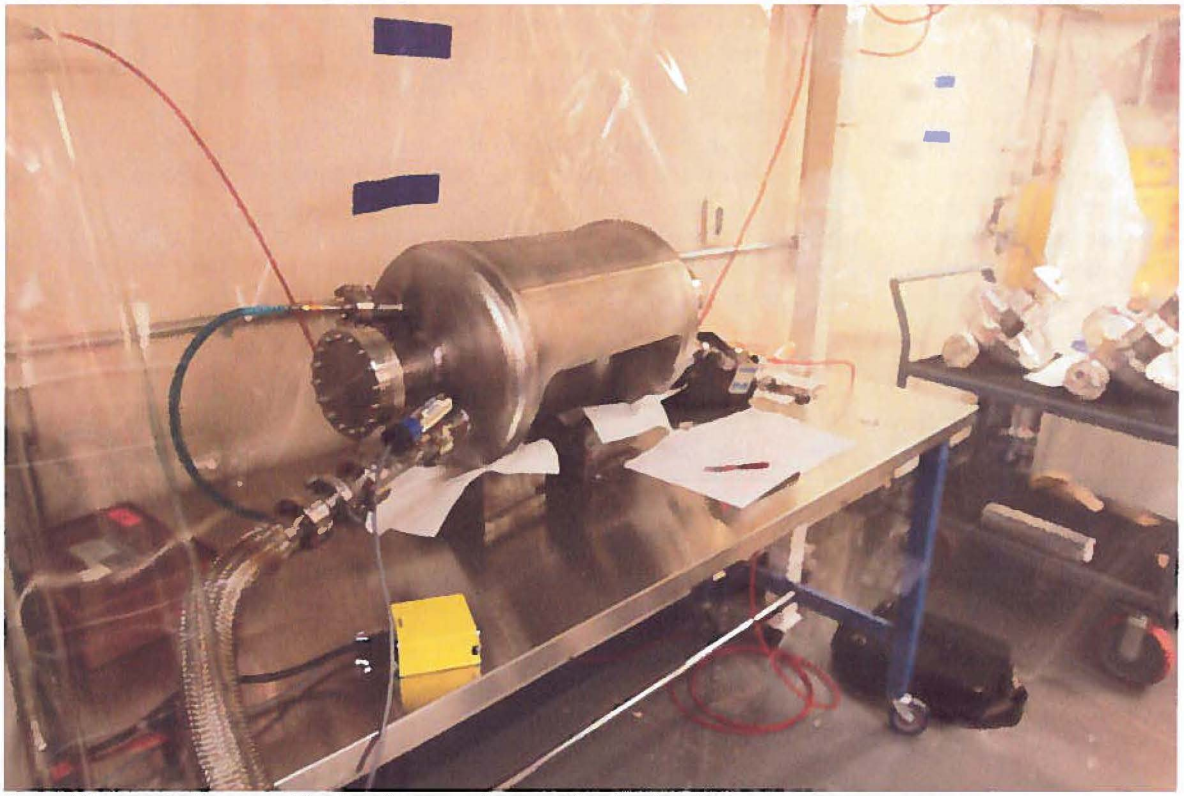
Type of Material Released:	Quantity:
Source:	**Time Flow was Halted or Controlled:**

For Investigation Team (√ All That Apply):

☐ Reportable Quantity ☐ Impact Ground/Soil ☐ Storm Water Channel/Drain ☐ Sanitary Sewer

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

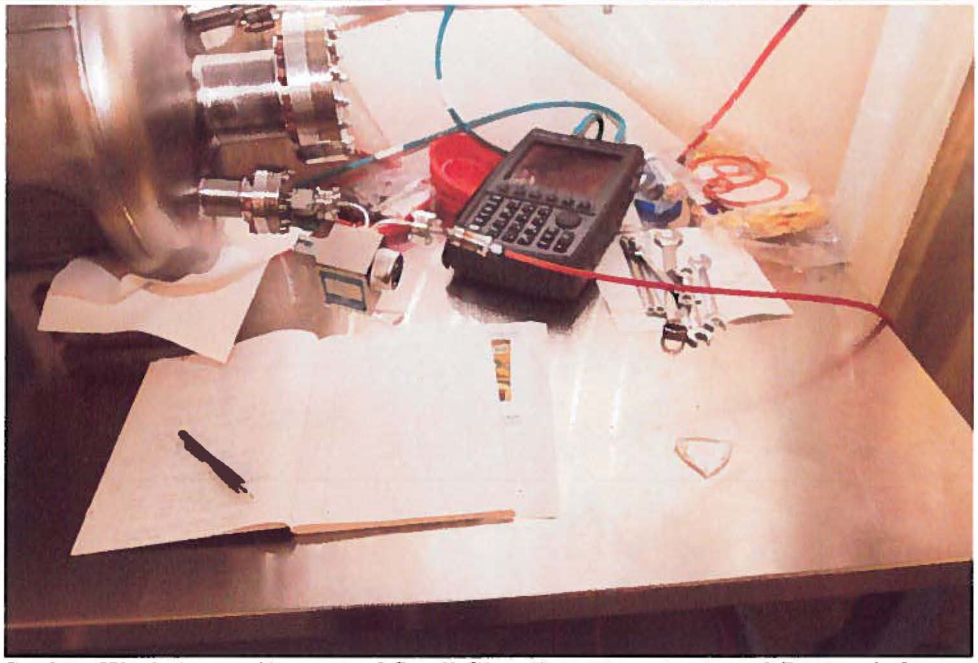
Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)



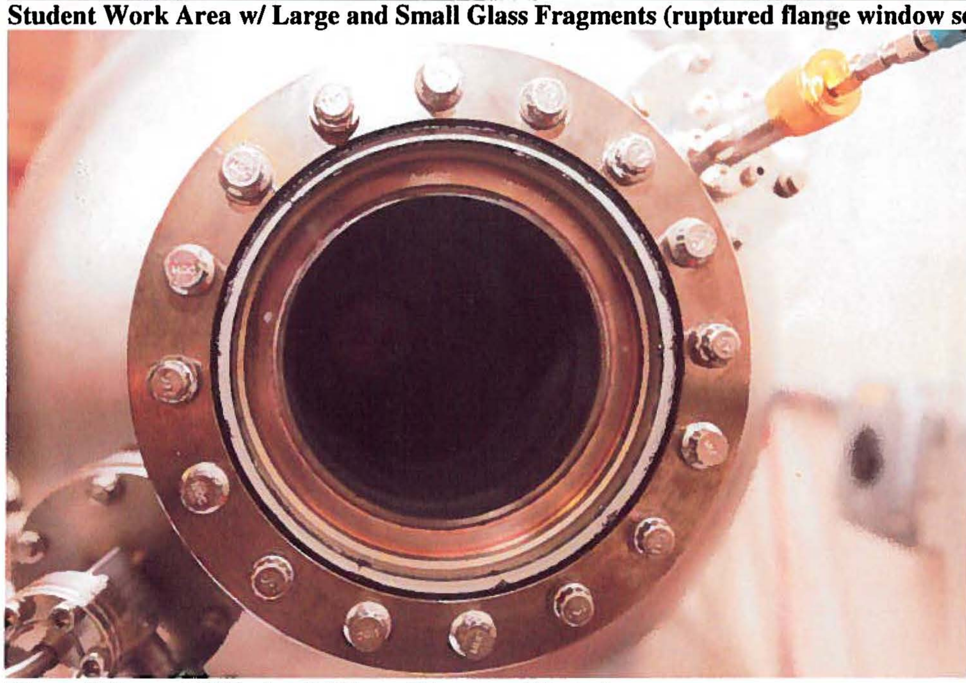
Scene Picture (taken outside the clean work area plastic sheeting)

Fragments of Glass on Floor (taken within the clean work area)

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)



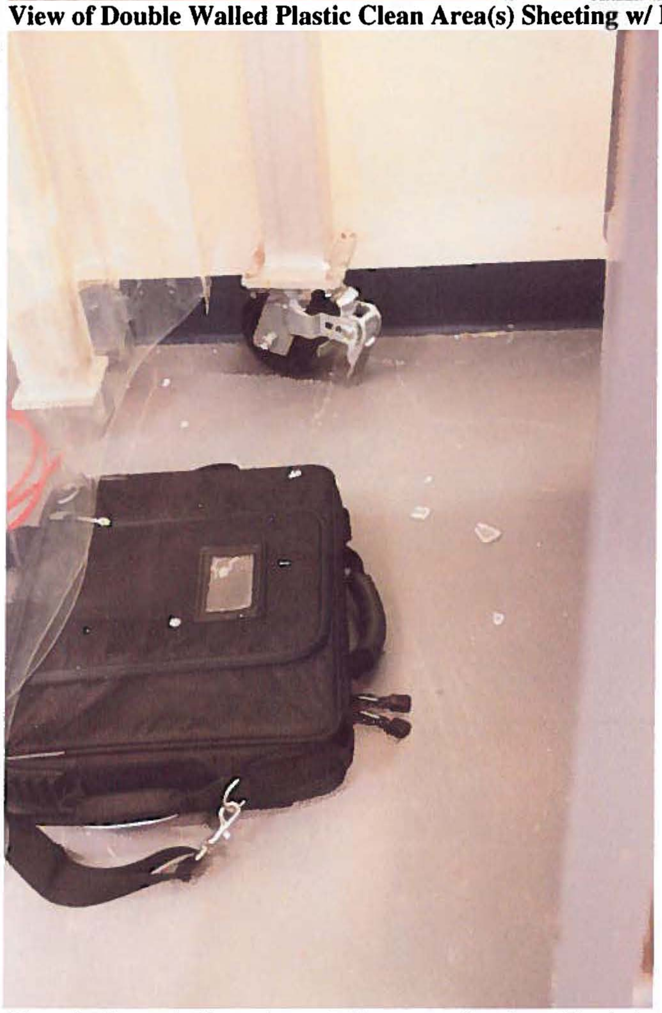
Student Work Area w/ Large and Small Glass Fragments (ruptured flange window seen in upper left)



View of Flanged "Window" Where Glass was Ejected

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

View of Double Walled Plastic Clean Area(s) Sheeting w/ Holes from Projected Glass



Glass in Second Clean Area Adjacent to Student Work Area (left of white pillar)

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

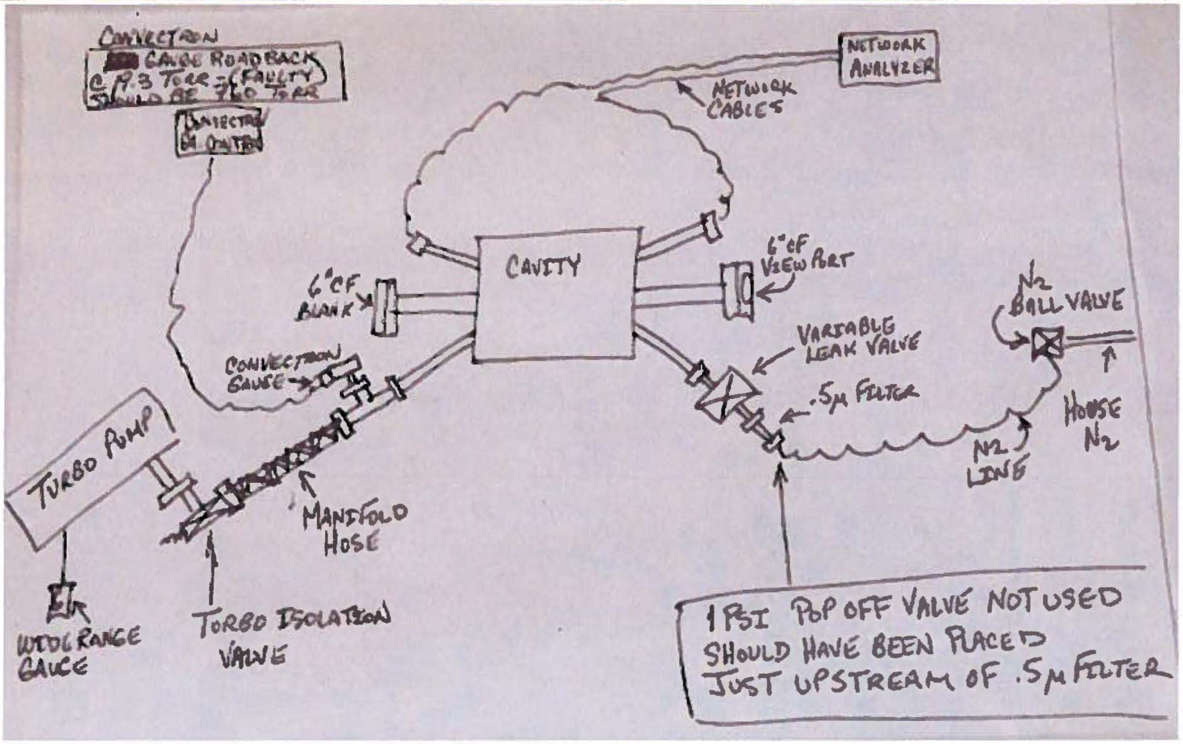


Diagram of Cavity Setup (drawn by Incident Witness)

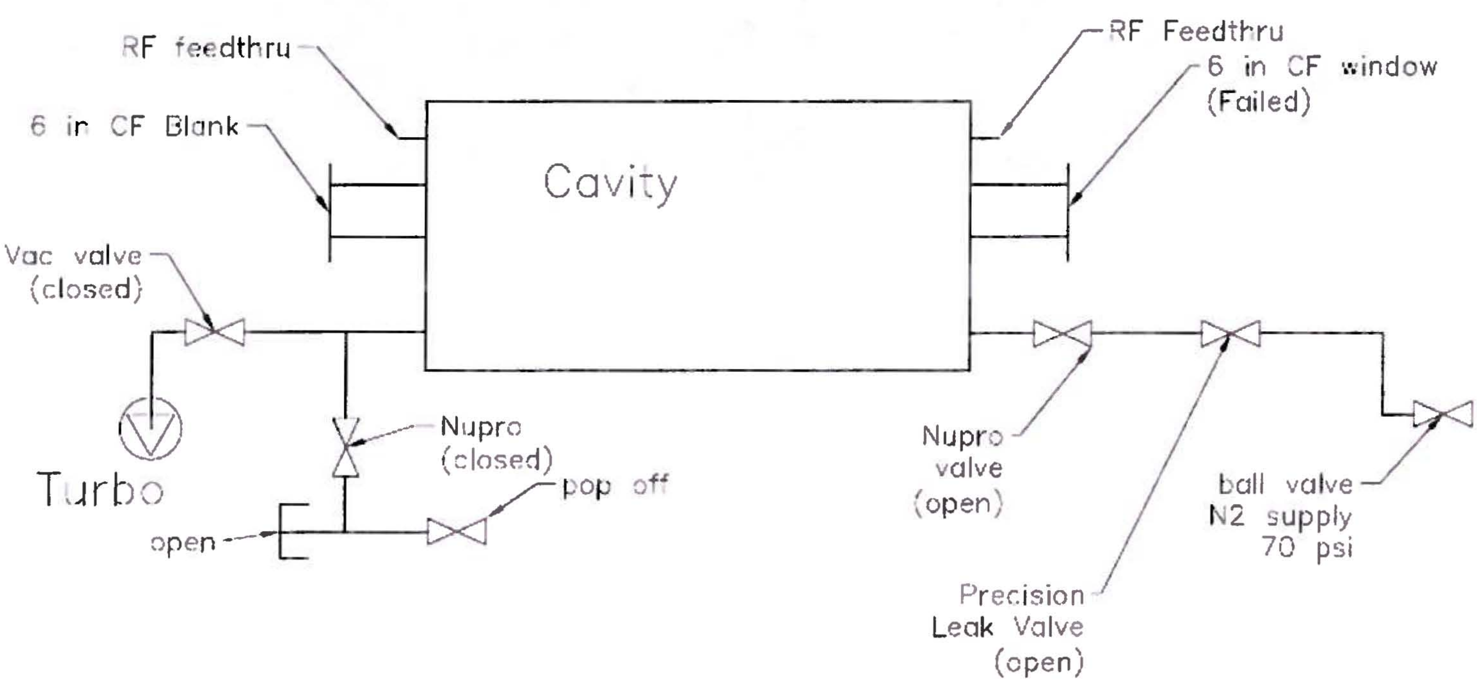
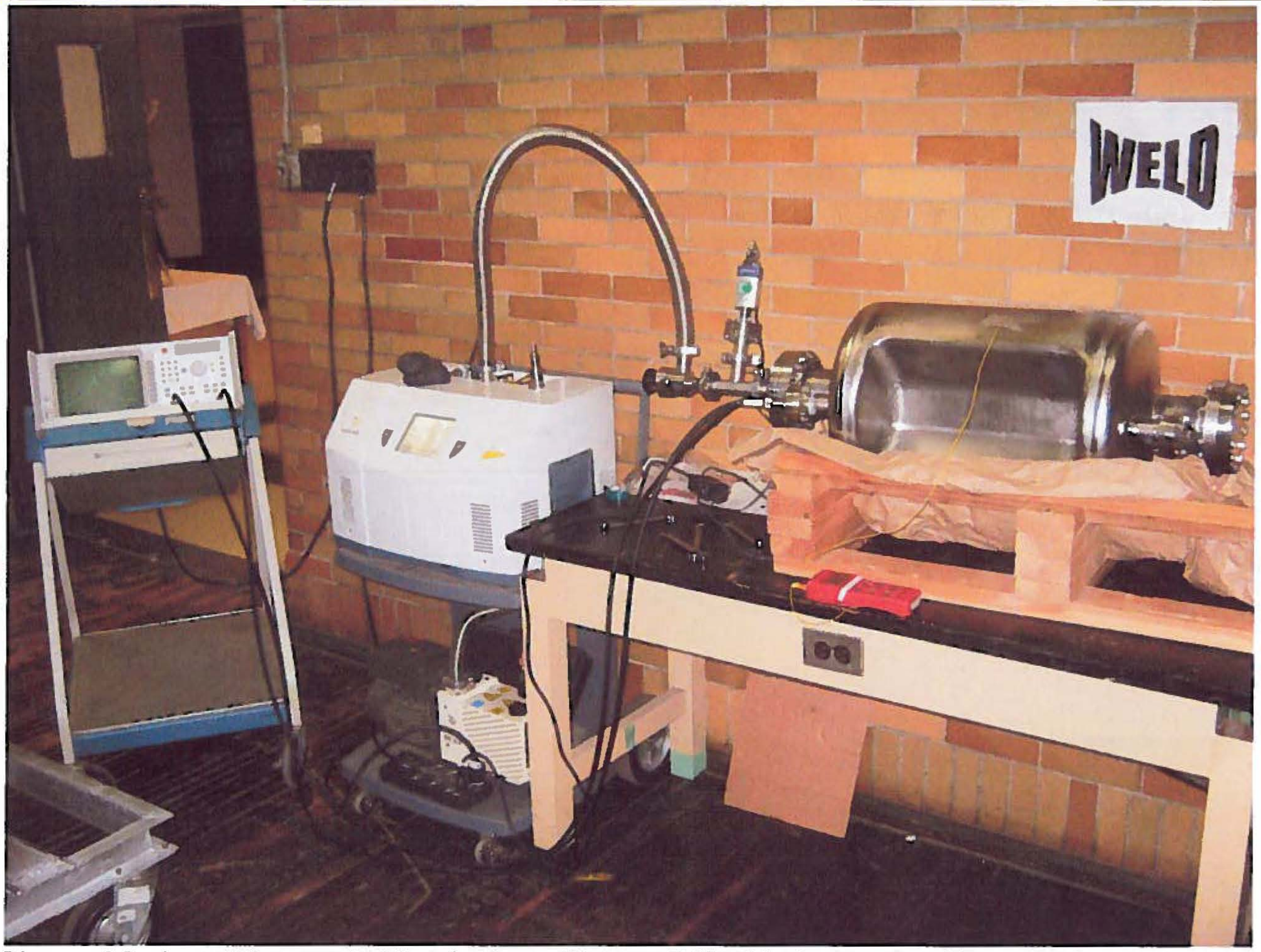


Diagram of Cavity Vacuum Setup (sketch by Investigation Team member)

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

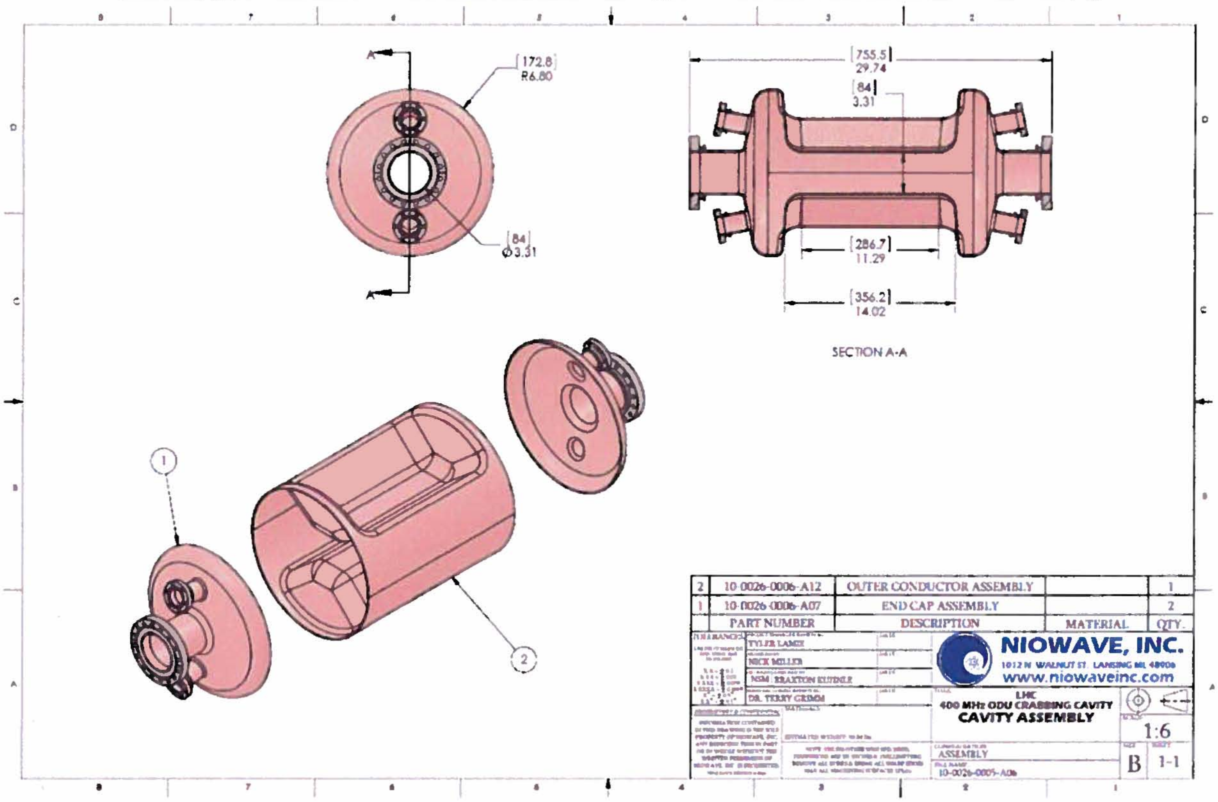


Picture of Cavity and Setup at the Manufacturer – Niowave, INC. (this photo was used by the student as an assembly guide.)

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

Test Procedure which Student Wrote and Followed:

Cavity Fabrication and Testing Procedure – 499 MHz Deflecting Cavity



1. Fabrication of parts – Completed at Niowave
   a. Material Nb of RRR 250 Fine Grain
   b. Parts 1&3 – End Caps
   c. Parts 2 – Body
2. Vacuum test with frequency measurement
   a. Connect vacuum pump
   b. Connect a feed through and pick up probes to the network analyzer
   c. Connect a N_2 gas to one of the ports
   d. Evacuate the cavity
   e. Measure frequency as the cavity is evacuated – Pressure vs. freq
   f. Start filling cavity with N_2
   g. Measure frequency with pressure

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

h. Repeat steps d-g two more times

3. Bead Pull Measurement

a. Set up bead pull with motor and network analyzer

b. Along the beam axis (metallic bead) → $E_x(z)$ and $H_y(z)$

c. Along the beam axis (dielectric bead) → $E_x(z)$

d. Off axis (needle) → longitudinal $E_z(z)$ at an offset in x direction

e. On axis (disk) → to determine the direction ($E_x(z)$) of the field components

4. Bulk BCP of **60 µm**

a. BCP cavity on the BCP cabinet – Find the flange adapters required

b. Cover flanges

c. Degrease the cavity

d. Measure cavity frequency

5. Ultrasonic degreasing of the cavity

6. Baking in the furnace

a. At 600 ^{0}C for 10 hours

b. Frequency measurement

7. Couplers

a. Input power coupler → Adapter

b. Pick probe

c. Check input coupler under cryogenic temperature

8. Cavity Tuning - optional

a. Frequency measurement of all the modes

b. Tuning → Frequency

c. Frequency measurement of all the modes after tuning

9. High pressure rinsing

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

   a. Rinsing at the cabinet
   b. Check flange connections needed
   c. Let it dry on the cart → Need a support to hold the cavity vertically in assembling and drying

10. Assemble parts in clean room
    a. Parts: Burst disk, 3 blanks, 2- Cu rods, input coupler, pick up probe, gaskets, nuts and bolts
    b. Degrease all parts except input coupler
    c. Blow N_2 of all parts at the particle counter
    d. Connect input coupler at CP_2, pick up probe at CP_1
    e. Connect burst disk to BP_1 and then to the vacuum port
    f. Close the ports CP_3, CP_4 and BP_2 with blanks
    g. Connect a pump and evacuate the cavity
    h. Leak check the cavity on the cart
11. VTA assembly one the cage with the insert
    a. Insert preparation → Check LLRF system at 400 MHz
    b. Assemble the cavity into the cage with the insert and support rods
    c. Support for the coupler
    d. Leak check with full assembly
    e. Frequency measurement
12. Base line cold test – At both 4K and 2K (At low power)
    a. Frequency measurement
    b. Cable calibration
        i. Measure Q_L of feed through and pick up probe
        ii. Adjust probe penetration for required coupling
    c. Surface Resistance with temperature (R_S vs. T)
    d. Low power test

Records, Documents, Pictures, and Other References: (Copy and paste, use attachments or document links as necessary)

i. Find out the testing plan?

e. High power test

i. Find out the testing plan?

ii. Q_0 vs. E_T

13. Mild baking

a. At the baking box with hot N_2 gas in vacuum

b. Set up the temperature sensors (using thermocouples)

c. At 120 ^{0}C for 10 hours, 24 hours and 48 hours

14. Cold Test – At both 4K and 2K

a. Repeat steps in 10 after each baking period

Purchase List

(1) Clamps

(2) PTFE valves and hose

(3) Burst disk

(4) Coupler fabrication

a. Bellows

b. Coupler flanges

c. Antenna – Cu rods

(5) Thermometers

Causal Analysis: (Use attachment as necessary)

Root Cause:	*The Standards, Policies, or Admin Controls (SPAC) – Needs Improvement (NI).* Training of employees for performing tasks is very specific, however, students receive inconsistent application of training due to compressed on-site schedules not allowing for comprehensive training, a lack of available courses while on-site or lack of understanding by sponsors what tasks require specific training for students since they are not consistently tracked by sponsors in the Learning Management System (LMS) like JLab employees. Even though sponsors are pulled from a bank of experienced personnel, their training and expectations with regards to managing students is inconsistent. Though the JLab Administrative Manual briefly explains

Causal Analysis: (Use attachment as necessary)	
	the responsibility of the "JLab Host" to assist students in their training requirements, it may not be clear enough to provide guidance to all sponsors, mentors, PI's or supervisors of students to utilize both the LMS system and the Work Planning, Control and Authorization process to define the training catalog of the students they oversee. NOTE: Root cause analysis for this investigation was performed using TapRoot® causal analysis methods and terminology developed by System Improvements, INC based in Knoxville, Tennessee.
Contributing Causes: (List as many as apply.)	1. *Procedure not followed* – This cavity system is considered a vacuum system and is governed by the ESH Manual under Chapter 6151 appendix T5 for Pressure Systems. As stated in this appendix this vacuum system should have been classified as a Category II and under section 4.3.3 this system should have had adequate pressure relief to prevent pressurization beyond 15 psid. A relief of this type was connected to the system but was not utilized and expressly valved out. A proper engineer should have been assigned to ensure the vacuum system design, fabrication and testing met the requirements of Chapter 6151 Appendix T5. Also, the setup the student was to follow (see Niowave, INC. setup picture) showed a Varian VS Series Helium Mass Spectrometer Leak Detector. The manual for this device states in section 4.2 "*You may want to vent the leak detector test port with dry nitrogen when the system is vented.*" "***NOTE** The nitrogen supply line should have a pressure relief valve installed so that the pressure does not exceed two psi.*" This guidance was not followed when it was configured at JLab. Reference: *http://www.chem.agilent.com/Library/usermanuals/Public/6999-09-942F_Eng%20VS%20Series%20Helium%20Mass%20Spectrometer%20Leak%20Detectors%20Operations%20Manual.pdf* 2. *No Procedure* – There is a lack of divisional policies and procedures for Supervisors, Sponsors and PI's on proper management of student projects, task analysis and the required technical and safety training. Some mentors and PI's are not employed by the lab and may not feel they need to follow any established JLab policies for "normal" work flow processes for their students. There are adequate procedures and policies regarding employee work conducted and their supervision requirements, but this is somehow not being translated to the work flow process for students at the lab in a consistent manner. There should be no differentiation in work flow processes. 3. *Training – Task not analyzed.* The task was not thoroughly analyzed by the mentor to identify the vacuum vessel once connected to a pressurized source (Nitrogen gas at 70 psi) became a pressure system so the pressure system aspect of the task was missed and therefore proper training was neither sought nor provided. As per the ESH Manual Chapter 6151, all persons using pressure systems shall have pressure system awareness training. The student and the mentor did not have this training at the time of the incident and were not cognizant of the requirements. 4. *Quality Control – No Inspection: No hold point.* There are guidelines which stipulate how experiments are reviewed before they are carried out in the Experimental Halls of the Accelerator. However, there is no clear policy on how to review experiments in smaller labs. Two SME's who reviewed the setup after the incident instantly and separately recognized the lack of pressure relief for the pressure system. A design review by SME's could have prevented this incident. 5. *Walk-thru NI* – The mentor did not walk the student through the steps needed to prevent the incident. This is tied into the Root Cause where the SPAC needs improvement. While the task may not have the complexity of other tasks performed at the Lab, the student's lack of familiarity with Vacuum System requirements could have been compensated by a walk-through by the mentor or an SME.

Extent of Condition Check	**Responsible Person(s)**	**JLab CATS Number**	**Target Date**
1. ADSO to check all known processes involving oversight of students by mentors on-site and investigate requirements regarding training of students and mentors alike. Investigation should point out gaps (if any) within training of students versus the established training of employees performing the same tasks. **NOTE**: This step has already been completed during the investigation of this incident to best understand the root cause. Details and follow-up of this extent of condition check will be provided in the appropriate CATS entry.	H. Fanning	NE-2012 19-01-07	09/28/2012

Notable Event & Lessons Learned Worksheet

Extent of Condition Check	Responsible Person(s)	JLab CATS Number	Target Date
2. ES&H representative to check for and confirm the existence of lab-wide or divisional specific policies and procedures related to the safety training of all student types.	J. Kelly	NE-2012-19-01-08	09/28/2012

Corrective Action(s)	JLab CATS Number	Target Date
CA1. ADSO to distribute memorandum to all Mentors, Sponsors, Principal Investigators at JLab who are responsible for the oversight of students (of any level) to ensure that training of all their students is in line with the tasks being performed by the students. The memorandum shall state that students without training equal to JLab employees performing the same tasks shall receive training before performing this task again.	NE-2012-19-01-01	09/28/2012
CA2. JLab Management to write a policy to describe mentor and graduate student expectations regarding oversight and training. Students performing tasks shall have the same training required of JLab employees performing the same task. Policy will describe that training requirements of students will be evaluated and tracked by the on-site sponsors equal to the evaluation and tracking of JLab employee training requirements by JLab supervisors. Tasks to be performed by graduate students shall be reviewed by the mentor/sponsor and this evaluation shall be in line with JLab work flow practices as defined in ESH Manual Chapter 3210.	NE-2012-19-01-02	12/31/2012
CA3. Education department to write policy to define expectations with regard to safety training of students while employed at the Lab. General and task specific training shall be well defined by mentor analysis of student tasks and shall be in line with JLab employee training requirements for performing equal tasks.	NE-2012-19-01-03	12/31/2012
CA4. JLab Management to write policy which describes that experiments conducted at JLab (outside CEBAF Experiment Review Process) shall have a uniform review process and work plan. NOTE: The CEBAF Experiment Review Process (ESH Manual Chapter 3120) takes into account experiments installing new or modifying base equipment within the Experimental Halls.	NE-2012-19-01-04	12/31/2012

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Notable Event & Lessons Learned Worksheet

Corrective Action(s)	JLab CATS Number	Target Date
CA5. Update general training such that all personnel (Staff, Users, Students, etc.) are cognizant of the definition of a pressure/vacuum system and their associated hazards.	NE-2012-19-02-01	04/30/2012
CA6. EHS&Q representative to review lab-wide and divisional (all divisions) policies and procedures to ensure that in all areas in which students are at work they receive the same training as would JLab employees doing the same work.	NE-2012-19-01-05	12/31/2012
CA7. Engineering and Accelerator DSOs will review division managed specialty labs to ensure adequate procedures for task oversight are in place.	NE-2012-19-01-06	12/31/2012
CA8. Lessons Learned from this event to be entered into the DOE Lessons Learned Database.	NE-2012-19-02-02	10/31/2012

Lessons Learned (Confer with Division/Department Lessons-Learned Coordinator) (Use attachment as necessary)	JLab COE Number
The student involved in this incident had improperly fitted eye protection and did not seem to understand that some safety eyewear is adjustable. Eyewear should be properly fitted to the individual and provide adequate coverage of protection. (Eyewear safety tips can be published in the weekly JLab electronic fliers and/or within the monthly Safety Warden publications.)	
When experiments are being conducted in shared areas, hazards should be adequately communicated to all parties within the shared area. A Work Planning, Control and Authorization tool (TATL) which could have provided this communication effectively was not utilized during the planning, setup and execution of this particular experiment. To date, a set of CATS items are in place to track the rectification of this issue within the Test Lab.	
Policies and procedures for mentors and students should encompass all categories of students. Students should have the same training required of employees performing similar tasks.	

Notable Event & Lessons Learned Worksheet

Investigation Team Confirmation:
The below signees, confirm to the best of their knowledge, that the information presented in this document is accurate and complete.

Role	Print	Signature	Date
Lead Investigator	Harry Fanning	[signature]	10 SEP 2012
Co-Lead Investigator	Henry Robertson	[signature]	9-11-12
	Greg Marble	[signature]	9-11-12
	David Meekins	[signature]	9/11/12
	John Kelly	[signature]	9-11-12

Upon confirmation submit document to the ES&H Reporting Officer for completion and distribution.

Documentation of Findings: (To be Completed by ESH&Q Reporting Officer)

Notable Event Number:	ACC-12-0711
CATS Number:	NE-2012-19
JLab COE Number:	TBD
ORPS Number:	SC--TJSO-JSA-TJNAF-2012-0009
NTS Number:	N/A
CAIRS Entry:	N/A
DOE Cause Code:	A4 Mgmt Problem, B1 Mgmt. Methods LTA,C01 Mgmt. policy guidance/expectations not well defined, understood or enforced; B4 Supervisory Methods LTA, C01, A6B1C02,A1B4C03
ISM Code:	Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls , Perform Work within Controls

Acceptance/Acknowledgement of Facts

	Print	Signature	Date:
Associate Director/ Department Manger	Andrew Hutton	[signature]	9/12/12

Distribution:

- ES&H Reporting Officer (Original)
- Associate Director/Department Manager
- Division Safety Officer
- Investigation Team Members

Form Revision Summary
Revision 1.3 – 01/31/12 – Updated ESH&Q Reporting Officer assignment from SSmith to CJohnson per MLogue
Edited to clarify process steps.
Revision 1.2 – 10/20/11 – Updated ESH&Q Reporting Officer assignment from JKelly to SSmith per MLogue.

Revision 1.1 – 05/24/11 - Edited to clarify process steps.
Revision 1 – 11/23/10 – Updated to reflect current laboratory operations.

ISSUING AUTHORITY	FORM TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	EXPIRATION DATE	REV.
ESH&Q Division	Tina Johnson	10/19/09	10/09/12	1.3

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Addendum: Notable Event Report – ACC-12-0711 Experimental Cavity Vacuum Window Failure

22-October-2012

This addendum was written to clear up a few issues with the Notable Event Investigation report regarding the 07/11/2012 Experimental Cavity Vacuum Window Failure.

With regards to the terms Mentor, Sponsor and Principal Investigator (PI), they were used by various personnel but refer to the same level of authority. This person sponsors the student and is responsible for providing training, oversight and resources necessary for the student to carry out their tasks in a safe fashion.

With regards to term Experiment when speaking to the task the student was performing at the time of the event, the term can be thought of as an equivalent to small scale experiment, experimental measurement or any other term appropriate for such tasks.

It has been noted that the way the report reads there is an unintended emphasis placed on the student's responsibilities versus the sponsor's responsibilities. The investigation team focused on the lack of involvement from the sponsor and noted that areas like training, resources and supervision were lacking in this case. The lack of supervision by the PI, subsequent interviews with other PIs and lack of policies regarding PI supervision involvement showed that an inconsistent method of supervising students exists. This is an indicator that something is broken within the program of hosting student activities at Jefferson Lab as supervision roles within the lab are very clear on these points.

Though formal reviews are not necessarily needed for small scale experiments or measurements, it was noted that the lack of understanding from both the PI and their student on pressure system requirements pointed to training issues on each level. A review by a competent System Matter Expert (SME) before tasks commenced for this project would have found the pressure relief deficiencies within the system. This task, like all tasks at Jefferson Lab, should have had the proper rigor in hazard analysis by the PI and/or area owner before being allowed to commence by the student. This again points to the supervisory role needing improvement in this case.