DRAFT
Committee Report
Hall A Safety and Operations Documents
7/14/04

Review Committee:

carlini@jlab.org, kashy@jlab.org, mecking@jlab.org, domingo@jlab.org, mack@jlab.org, smithg@jlab.org, manzlak@jlab.org, areti@jlab.org, merz@jlab.org,

The Charge:

Thank you for agreeing to help with an ongoing EH&S review of the "base equipment" in Hall A. The hall documentation has recently been updated and needs to be reviewed as part of the process for evaluating the safety of all experiments that will be carried out in the Physics Division. The Hall A cryotarget, which is now being installed, will also be reviewed by an expert before it resumes operation.

The documents from Hall A provide the material need for your review and can be found at:

http://www.jlab.org/~gen/osp/osp_4.pdf(the full version)	(SAD)
http://www.jlab.org/~gen/osp/osp_o.pdf(the reduced version)	(General Operations Manual)

The documentation is intended to provide adequate information on the equipment, the procedures for using it, and the procedures to be followed. It should be viewed from the perspective of a new user of the equipment who has come to participate in his or her first experiment at JLab.

Please review the system(s) and subsystem(s) listed as your responsibility in the attached table. Your review should focus on two basic questions:

- Is the equipment installed in Hall A safe from the point of view of the area you are asked to cover?
- Does the written material provide adequate information for a new user participating in the experiment?

Your review should consist of:

- A consideration of safety issues that should be addressed in the area of your responsibility;
- A careful reading of the section or parts of the documentation provided that is relevant to the area of your responsibility;
- A discussion (if necessary) of any questions you may have about the equipment, documentation, and/or procedures with the appropriate Hall A staff member (see Kees deJager if you have any doubts about who is the best person to talk with in cases where the area you are being asked to review is not addressed in a specific section f the written material); and
- An inspection of the relevant equipment as installed in Hall A.

Roger Carlini has agreed to chair this review will be in touch to set up meetings, as needed, and will coordinate your individual responses into a final report.

Review Committee Findings:

General Comments:

The documents presented to the committee are generally well written and consisted of a "short" 112 page document titled "Hall A Experimental Equipment Safety Assessment" and a much loner 383 page document titled "Hall A Experimental Equipment Manual and Safety Assessment". The names are confusing and should be changes to reflect what these documents really are. The first should probably be titled "Hall A Safety Assessment Document (SAD) and the second titled simply "Hall A General Operations Manual".

Bottom line: There were a number of editorial errors uncovered, a few useful suggestions made and some expressions of individual committee member preferences expressed for improving the Hall operation and documentation. However, there were no obvious show stoppers uncovered that should prevent the efficient and safe operation of the Hall. It needs to be noted that the material provided does not for the most part address the issue of major installation experiments and their impact on Hall A operations and equipment configuration.

Below are specific comments by committee members on the various sections of the documents and the physical hardware where appropriate. Also, the recent external safety review of the Hall A & C cryo-target systems by J. G. Weisend is also attached as Appendix A.

Target System: (G. Smith)

It's not clear to me what HAS to be included with the SAD or the OSP, since in principle they could each consist of a single sentence referring to more extensive target documentation. Or just a table of target experts to call. Keeping it brief and readable is important, too. So what mix of facts and information should appear in each of these is not so clear. In the following I have tried to identify the few errors I found, and have suggested a few additional pieces of information to add, because I don't see the purpose of this document if it simply refers to other documents to describe the hazards and their mitigation.

I did a walk-through with JP Chen on April 9. I did not identify any problems in the hall, and I think the target system as described in these documents is as safe as it can reasonably be expected to be. I think the ops manual contains plenty of information for the new user, particularly when augmented with the additional material referred to. I found the SAD a little thin, however, and suggested a few additional pieces of information it might include.

<u>The SAD</u>

Ch 6: I think this brief chapter could be improved by adding a little bit of extra information. For example, it should say whether pivot access is restricted (it is in Hall C). Whether eye and ear protection is required when on the pivot and the scattering chamber is under vacuum. And the policy on the use of plastic or aluminum window protection. In other words, it would be useful to spell out how the hazards that are mentioned are mitigated.

Ch 9: p 46- is kapton really one of the typical solid targets? I think it should read aluminum instead, shouldn't it?

Ch 10: p 47- Tuna cans are typically 4cm in diameter, not 10cm diameter. At least that is the case in Hall C. Sub-cooling is typically 3 degrees not 2 degrees. The statement "Table 10.1 parameters stable..." is no longer true, with ballast tanks outside, the pressure in the loops changes +-1 or 2 psi diurnally. Is the low power heater still in use in Hall A? It isn't used any longer in Hall C. Should say that a Cernox resistor is a thermometer (a new user might not know).

p 48 - I would recommend stating the conditions under which the target has to be staffed by a trained target operator, in addition to when an expert is on-call. Only the latter is discussed. And then one is also obliged to say what the training consists of, how it is policed, and by whom. No mitigations are mentioned for the hazards given. Should that be given here? No safety assessment is provided for the 3,4He cryotargets. No mention of hydrogen sniffers is made. Where are they? What does the alarm sound like, and where does it sound? What happens when the sniffers detect something (eg, FSD?)? What level of H2 or D2 sets them off? The importance of not going sub-atmospheric is not mentioned. The danger of freezing the targets is not discussed. In particular, for deuterium, or for running with 4K coolant instead of the usual 15K. The interaction of target motion (plus what else?) with the FSD should be mentioned. The URL for operational restrictions could be given. Target safety at higher currents relies on the raster system being operational, but this is not mentioned.

Chapter 11: It would be useful to say whether the laser light is in the visible part of the spectrum or not, and what the physical consequences are of being struck by the laser light (not just in the eye). No mention is made of RF/HV hazards. Is activation an issue? Why is irradiation of the target a hazard?

p 53 - It says "...all personnel will be required to be familiar with..." but does not say how this requirement will be enforced. It does not say whether a target operator is on shift whenever the laser is on. When is there a target operator on shift? Why is there no automatic cutoff of the laser power if a temperature sensor goes out of range?

p54- nights and weekends, or nights OR weekends? What are the training requirements referred to?

Ch 12: p 60- "The following subsections..." referred to are not there. No discussion of the hazard associated with potential contamination from the liquid (water) in this system.

<u>The Operations Manual</u>

I think this should be written however Hall A likes it, it is an operations manual, not a safety manual. It would benefit from being proofread by a Hall A person, since there are many instances of awkward/wrong English. Omissions noted above for the SAD should probably also be included in the ops manual, for completeness. Some of the comments I made for the SAD are repeated here, anyway, just because it's stream of consciousness, I guess. In any case, I would suggest that my comments below do not need to be implemented except for the ones which catch errors (like window thicknesses). Otherwise, it's an ops manual, and should have as much or as little in it as the Hall A people want, in my opinion. Need to add something about the new vent line requirement, in-hall bottle inventory (smaller bottles now), vacuum interlock.

p139 There are numerous instances where the quoted target cell window thicknesses are wrong by something like an order of magnitude. An intermittent decimal point problem?

p140 table 10.3: not clear: window thicknesses not consistent. Destructively tested to 55 psig? That's a pretty low failure pressure. Why are testing pressures listed as psig not psid?

p139 What does 20% LEL mean? 20% of H2 or 20% of the 4% relative concentration needed for an explosive mixture? No gas handling/panel schematic is shown. A (very) simplified one would add a lot here, I think. Scattering chamber window cover policy not discussed.

p142: ultimate stress at 35psi. What does that mean? 35 psid overpressure, under pressure, 35 psig, 35 psia? Tested pressure stated on p142 not consistent with that stated on p140. Where does the 4" SC relief vent to? LPH referred to, but it is no longer used. The new target motion, JT & HPH scram switches are not mentioned. Says return coolant temp used to regulate coolant mass flow from ESR. Is that really the case? Power outage/emergency instructions are not provided.

p145: 9000 STP liters of target FLUID.....should say gas, not fluid.

p146 Refers to an orderly shut down of targets. What does that mean? High temps cause an fsd? Nothing said about hazard associated with going sub-atmospheric.

p164 "...final GUI under development..." but by now it must be done.

p221 Only experts are allowed to "go home". How is that limited to experts only?

Beam Line: (R. Carlini)

The beam line discussions in the documents are a concise summary of the basic sub-systems, their purpose, simple sets of instructions for their use, key safety issues and call lists of authorized experts for each major system. These are for the most part “expert only ’ or “autonomic” systems that users can only “operate” in a very limited fashion. The only element missing is that it might be useful to include some “examples” of anticipated readings or “common sense” status algorithms in the SAD as a guide to helping the average user evaluate the quality and reliability of the data/reading coming out of these various beam line systems independent of the ‘experts”. Much of this is in fact included in the larger operations manual.

In the SAD the various beam line element shown in the figures are labeled with their function name. It would be useful to have a cross reference table (like the one in the operations manual) to the element names used by the operators at the MCC as this would facilitate communications. I would suggest expanding the ARC energy measurement, Moller and Compton polarimeter sections a bit in the SAD as they are probably the three beam line sub-systems who’s capabilities and peculiarities “users” needs to be most cognoscente about.

The operations manual section on the beam line is basically a greatly expanded version of the one in the SAD as is appropriate. There are however a number of photographs of racks and cables that add little to the manual. The photos of the control screens are potentially useful if they are kept up to date.

Detector Systems: (D. Mack)

I have read Chapter 5 (Detectors), inspected both HRS detector huts, find the operations documentation to be adequate, and the safety documentation to have only minor problems. I also walked their beamline. housekeeping in Hall A is generally good. One bizarre exception is a strange waterfall over the downstream Compton calorimeter detector. They built a rain gutter to deflect the stream of rusty water to the wall. Plant Group should fix the problem before someone gets shocked or one of the nearby magnets refuses to turn on due to a ground fault.

1. Since the Operations manual states that at least one shift worker must be "RICH-trained" during experiments which use the RICH, this should be incorporated into the Hall A COO.

2. In my opinion, the biggest hazards in the detector hut are fall, shock, and fire. (Excellent air flow and large gaps in the floor appear to preclude a significant ODH hazard.) The fall and shock hazards are minimized by obvious combinations of engineering and procedural controls. Their good housekeeping also helps here. However, although the low voltage power supply for the VDC cards is identified as a hazard (because it is an ignition source) there is no discussion of the hut fire suppression system. So my recommendation here is:

i) in the introduction to the Detector section, add one clean paragraph describing the fire detection and suppression system, and

ii) in the individual detector sections which list low voltage as a hazard (eg, the VDC's), add one sentence to the effect that a fire will be detected and extinguished by the detector hut fire suppression system (assuming this is the case).

Finally, during my walk-thru, I was not amused to see an electric cart go zipping by me at 10 mph inside Hall A. If I had come running around the corner at the same time, there would have been an accident. It was completely unexpected and unnecessary. Although this is beyond the scope of our documentation review, I mention it since the danger was more real than the hypothetical dangers we are considering. I'm not proposing any guidelines on electric carts, but I want Ed Folts to be aware of the problem sooner rather than later. I "don't recall" who the driver was.

Electric/power/controls: (William Merz – EES Group Leader)

I have reviewed the Hall A Experimental Equipment Safety Assessment (*Info Level 0*) and have the following comments. For the most part I concentrated on the assigned System/area; Electrical, Power and Controls, but I did try to pay attention to other content as well. Section 1.2 defines the purpose of the document as providing a general overview and safety assessment of base equipment. I understand the concept of the general overview and the manual does a reasonable job of meeting its purpose. The safety assessment, however, is less well defined and the goal of that assessment is not clear at all – at least in the *Info Level 0* manual. I am not sure this “short” manual serves a purpose as a stand-alone condensation of the Level 4 manual, as it presently exists. Because much of the safety excerpts are out of context, they do not provide any value added information to the equipment discussions. I believe that the condensed version should catalog the hazards, identify mitigation, describe limits of responsibility for various personnel, and identify who the authorized people are for each system. An index of procedures or references to more complete discussions in the Level 4 manual and a list of training or qualifications for each system should (could) also be included. I did not have time to complete a full review of the Level 4 manual but I found the

content I did check to be much more of what I expected for a safety assessment document. Unfortunately though, I also found the Level 4 document to be almost too detailed on the equipment technical information to be an effective safety reference document. Even with this last caveat, it is a better document than the Level 0 manual, which I believe fails to meet its titled purpose.

With all that said, let me detail some specific comments on the Level 0 Assessment.

- Chapter 2, Pg13 – PSS does not require an ARM to be a sweeper. A qualified sweeper does not have to be an ARM.
- Chapter 2, Pg 15 – Run Safe Box emergency stop button is labeled "Push To Safe", document should use this nomenclature.
- Chapter 2, general – Power Permit should address possibility of interlocked equipment being energized and high magnetic fields being on. Radiation areas should be identified as having potential contamination problems in racks, etc. and items being removed from the enclosure can be activated, thus needing survey prior to removal.
- Chapter 3.3, Pg 25 – Potential hazards should include high magnetic fields; potential to "grab" ferrous material/tools, possible interference with medical devices, erasure of credit cards, etc. Also should remind personnel of many high voltage and high current cables installed in racks, trays and other accessible areas. Inadvertent damage and contact present personnel harm or equipment damage problems.
- Chapter 3.3, Pg 25 – Access to equipment requiring Lock and Tag training should include equipment specific LT&T training, not just generalized LOTO training.
- Chapter 3.6.1, Pg 27 – BCM monitor maintenance performed by EES group now, not AES group.
- Chapter 7.2.1, Pg 39 – Moeller Quad Power Supplies, power supplies have been changed to single units per magnet with 40 volt, 330 amp ratings, not paralleled 60 amp, 20 volt units for each magnet. Also Dipole Power Supply is a 62 volt, 500 amp maximum unit. Warnings about magnetic fields and power cables may be in order here.
- Chapter 8.2.1, Pg 43 – Compton Dipole Power Supply is a 62 volt, 500 amp unit. Warnings about magnetic fields and power cables may be in order here.
- Chapter 8.2.3, Pg44 – Warning about High Voltage being off prior to work probably should require LOTO prior to work, rather than just off.
- Chapter 11.2 Pg 53 – A warning about the field due to the Helmholtz coils as relates to medical devices might be in order…a few tens of Gauss is above limit I believe. Pacemaker signage required.
- Chapter 14.2, Pg 67-68 – Only warnings with respect to magnet/power supply is about stored energy. Should also include warnings on high current buss & metal tools. Are there any magnetic field issues? A warning on long time constants associated with discharging SC magnets may also be in order.
- Chapter 17.2, Pg81 – Text reference to an "oaf", while humorous, is probably not appropriate for this document
- Chapter 17, 18 ,19 – PMT high voltage, should these be LOTO devices rather than just shut off prior to doing work? This comment actually applies to all references to working on PMT systems or other high voltage devices in the detectors.
- Finally, document should be proof read. It may pass spell checking but usage, tense and language are not always correct. Examples can be given if needed.

Cryogenics: (D. Kashy 5/5/04)

The SAD

I read the smaller document basically cover to cover. Cover: Is it an OSP?

- Pg 11 – is it an OSP?
- Pg 13 CANS limits access to trained?
- Pg15 emergency stop button is really "push to safe" button.
- Pg 17 … each person is wearing proper dosimetry, AND HAS CURRENT ODH TRAINING.
- Pg 18 Is CANS used for access control? It is in B & C maybe it should be in A too.
- Pg 19 and 20 remove borders on figures, rotate and make bigger to be able to read.
- Pg 25 potential hazard: 4. THIN WINDOWS (WHERE), OTHER HAZZARDS: FALL, HIGH MAG FIELDS.
- Pg 30 Add RADCON cell phone.
- Pg 32 Survey folks should be listed?
- Pg 36 0.016" window is quite safe but I wonder about burn through.
- Pg 37 Should Hall A folks contact Cryogenics Group or MCC.
- Pg 40 Vacuum System: Ear/Eye Protection required?
- Pg 40 Target: interlock to current?
- Pg 54 1. … this alignment will be performed only during the night and (OR) weekend.
- Pg 54 2. is the target platform a big enough perimeter for safety from flying glass?
- Pg 67 WBS7 is reference, that term is not too familiar anymore, should be JLAB Cryogenics Group.
- Pg 81: The word OAF should be replaced.
- Pg 85 add lock out tag out or lock, tag and try…
- Pg 90 I did not look into the details of these calculations…

The Operations Manual

I only looked as some sections of this document. Cover: Not a safety assessment. Needs OSP #.

- Pg 75 No discussion about thin windows, safety, protection, design.
- Pg 75 how are chambers 2. and 3. different.
- Pg 132 wording is poor on "This loop is usually not been used for …".
- Pg 132 replace "to save cooling power" with "prevent freezing and contamination" (if this is correct).
- Pg 139 10.3.2 What to do if pressures are different.
- Pg 139 10.3.2.1 Windows are 0.003" to 0.0045" not 10x thicker (I'm guessing).
- Pg 140 last line: "relief valve set at _____."
- Pg 141 I think the relief valves are no longer connected to the N2 vent line from the magnets.
- Pg 141 2nd to last line "Each window is seven in high. 6 inch was described on pg 75.
- Pg 145 I believe that some times 4.5k gas is used to cool H2 and or D2 targets…
- Pg 229 Why use ball screws? Acme threaded jacks are non back driving and will not free fall.
- Pg 235 Only trained personnel can handle Be?
- Pg 251 WBS7 is reference, that term is not too familiar anymore, should be JLAB Cryogenics Group.
- Pg 262 I have not looked recently but some of the main magnet burst discs do present a hazard to persons working nearby.

Access: (J. Domingo)

Hall A Safety Document (SAD)

Page 14: Under 2.1.3 it is not clear how people are "counted" via TV head count, or key count or both. Under 2.1.4 A four-minute delay between klaxon for Power Permit and Beam Permit is perhaps a little short depending where the person is stuck to get to a run safe box.

Page17: Under 2.2.2 need to stress that each person must replace his key or one can't move to beam permit. At other labs people going off shift with a key in the pocket have resulted in day delays in getting the beam back. Also it should be stressed that due to the very restricted sight in the shield house with the detectors in place, one should double check that no one is hidden before rearming the door.

Pages 19 and 20: It would be good to have better figures although I understand this is difficult due to the quality of the originals

APPENDIX A

Review of the JLab LH_2 Target Safety Policy and Hall A Target Safety

J. G. Weisend II

SLAC

April 6, 2004

Introduction

I have reviewed the Jlab LH_2 target safety policy as well as the Hall A and Hall C hydrogen target safety assessment document (SAD). I have also inspected the target facilities in Hall A (Hall C is currently running the G0 experiment). I have gone over the operating procedures in detail for Hall A targets. I have not reviewed the Hall C target procedures but my comments should also apply to those procedures. I have not checked in detail the pressure drop calculations in the safety assessment document but find that the formulas used and the assumptions made are appropriate. An additional independent check of the calculations would be appropriate to catch any arithmetic errors.

In general, both the policy and the SAD are well thought out and complete. JLab has done a good job of thinking about the possible hazards and applying appropriate mitigations. The target group and other members of the JLab physics division have been very helpful and cooperative in this review. I believe the existing target system can be operated safely. I encourage you to apply the recommendations below for an increased margin of safety but these may be added in later and need not prevent the planned operation of the Hall A target later this month.

JLab LH_2 Safety Policy

This policy is clear and basically complete. The division of targets into small, intermediate and large systems with graduated mitigations is appropriate and consistent with the ISMS philosophy. It is worth pointing out that in today's regulatory environment that any fire, however minor, will result in a significant investigation and associated downtime for the target system. The most important part of the policy is that all systems, regardless of size, be independently reviewed at JLab. The policy's statements on using Class 1, Group B, Division 2 equipment where possible is appropriate. It's clear that in a research lab using such equipment everywhere is not possible and the Jlab policy seems to strike an appropriate balance.

Recommendations

1. All targets, regardless of size, should have primary and secondary relief paths. Both these paths should be able to handle the worst case credible accident with out target failure. Both these relief paths should vent outside the hall. In the case of small targets this may take the form of simply redundant relief valves or a relief valve in parallel with a burst disc. In targets that have both hydrogen feed and return lines, there should be a relief system on each

line if at all possible. This will help prevent the issue of freezing in the hydrogen lines impacting the venting system.

2. There should be no valves between the target and the relief systems. This will prevent human error from compromising the relief system.

3. Even in the case of small systems, the isolation vacuum should have appropriate relief valves which vent outside the hall.

4. Unless there are strong technical reasons otherwise, even small target systems should have their target cells and isolation vacuum vessel tested to 1.5 times the pressure they will see in the worst credible accident. If this isn't possible, the review committee should look carefully at the resultant risk.

5. The policy should capture the general practice of JLab of not allowing Swagelock connections in hydrogen systems. VCR and other metal flanged connections are better. I agree that, if possible, the use of soft solder joints in target cells should be avoided.

6. All target systems should be required to have a failure modes and mitigations analysis done as part of their design. This can be a very short, simple table but should capture the hazards.

Hall A & Hall C Target Systems

The safety analysis and mitigations for these targets are well thought out. The application of Class 1, Group B, Division 2 components, vent headers and hydrogen gas detectors are appropriate. The operating procedures are complete and with the exception of a couple of minor corrections (already communicated to M. Seely) should provide for safe operation. My opinion is that the target system can run as is, but I encourage you to implement the recommendations below when possible as they will increase the margin of safety.

Recommendations

I) Relief and Venting System

1. In the current Safety Analysis Document, only the primary relief system is calculated to handle the worst case pressure rise resulting from the loss of isolation vacuum. Both the primary and secondary relief systems should be sized to handle this event.

2. The primary relief system has manual ball valves between the target and the storage tank into which into which it vents. These valves are required for operational reasons. However, I believe it is bad practice to have closeable valves in relief systems. Even though these valves can be locked open and the target group checks the system carefully there is still room for human error. It is clear that recovering the gas particularly for (D_2 and ^3He) is important. A better solution would be to have a parallel path (without any valves between it and the target) on the primary relief path that vents outside at a high though still safe pressure. This will protect you from the possibility of a closed valve and will make the primary and secondary relief systems truly redundant. At the very least, valves MV58,

MV62, MV72, MV73, MV155 and MV159 should be fitted with locks and locked open during normal operations.

3. Concern is rightly given to frozen air blocking relief paths and the operating procedures are carefully designed to reduce this possibility. Future target systems should, if possible, be designed so that the primary and secondary relief systems are on opposite sides of the target (i.e. one on the feed line and one on the return line). The small tubing on the precool heat exchanger prevents this in the current Hall A system. Installing the relief valves in this manner reduces the risk of a blockage closing off your relief system. Since the vacuum vessel provides a secondary containment for the hydrogen, I don't believe that retrofitting the existing Hall A target system to meet this recommendation is needed.

II) Operating Procedures

1. A check list of all the appropriate final valve positions should be given at the end of each procedure. This is a useful double check. If possible a list of correct starting positions of the valves should also be given at the start of each procedure.

2. In procedures where the step is to open or close all the valves of a panel, a check list of the valves should be given.

3. In those procedures where pumping and purging are carried out, the final step is typically to leave the system sealed off with the appropriate gas at greater than one atmosphere. This certainly works is the system is completely leak tight. At SLAC, we would always leave the system floating on a large higher than one atmosphere source of helium or hydrogen. Whether this is appropriate to JLab really depends on operational considerations such as the relative size of helium and hydrogen and whether the supplies are likely to be interrupted with out the target group's knowledge.

III) Hydrogen Gas Detectors

1. Given the large volume of Hall A and the relative small size of the targets its not surprising that the gas detectors didn't go off during gas releases. Nevertheless, the detectors do provide some safety margin. A local audio and visual alarm tied to the detectors should be placed near the gas panel and target system and people trained to leave the area if the alarm goes off.

2. SLAC practice is to use duplicate sensor heads at each location. I don't believe this is necessary for the existing Hall A target systems but if you go to large targets this level of redundancy is advisable.