Bubble Chamber Experiment Readiness Review

The ERR was held August 18, 2015 to evaluate the readiness of the Bubble Chamber Test experiment at the CEBAF Injector. The review committee was assembled by Patrizia Rossi (NP SO).

Committee members: Volker Burkert (Chair), Harry Fanning, Todd Kujawa, Eric Sun, Paul Vasilauskis, Jennifer Williams.

Two presentations were given to explain the purpose and expected results of the test experiment, and the operation and safety features of the bubble chamber.

1) Riad Suleiman (accelerator physics) "Bubble Chamber: Experimental Overview"

2) David Meekins (senior staff engineer, JLab DA)" Bubble Chamber: Detector System"

Brad DiGiovine (Argonne National Lab, ANL) participated remotely and answered questions.

Executive Summary:

The presented plan of the test experiment and the design and planned operation of the bubble chamber at the low electron beam energy (< 10 MeV) is considered "low risk" as the only person allowed to conduct major operations on the chamber, such as filling and venting of the chamber, is the lead designer and fabricator of the system, Brad DiGiovine.

The chamber design was demonstrated as a fail save system as the critical high-pressure parts are fully contained in a pressure vessel rated at 1700 psi and fully isolated from users of the system. Many possible failure modes were discussed and demonstrated that they will not compromise the integrity of the pressure vessel.

The test will be carried out with two different target materials of 40-60 ml N_2O (or C_2F_6), which float on 150ml of Mercury (Hg) as buffer material. In case of operational failures, any repair of the bubble chamber requiring access to the internal components, such as the target glass vessel and the mercury volume, will not be carried out at JLab. Instead, the chamber will be shipped back to ANL for repair.

The committee assessed the bubble chamber design and proposed operational procedures as "fail save" and approved of the presented operation provided the recommendations listed below are addressed before the start of the experiment.

Findings:

1) The applicable code for the components of the bubble chamber is ASME B31.3 2010 as the maximum inner diameter of the pressure vessel is less than 6 inches. The code calculation was properly done and well documented. Elastic plastic analysis of the bubble chamber vessel and the beam port per ASME VIII Division 2 was conducted using nonlinear material properties from MPDB. Protection against plastic collapse and local failure, and protection from cyclic loading are checked and documented.

2) The systems appear to be a well thought out design with many fail-safe features. From an Accelerator Operations stand point the experiment is safe and does not involve any undue conditions or operations beyond what is normally required of Ops.

3) From an Industrial Hygiene perceptive Dave, Riad, and Brad have done a fine job preparing for the bubble chamber to be used in the Injector tunnel.

4) The experiment seems well planned and primary safety concerns appear to be addressed with proper mitigations with no major show stoppers.

5) The electrical system is modular rack type built construction and powered by a 208-volt/5-wire cord and plug connection. This type of modular connection simplifies the de-energizing process if access into one of the chassis is required. The electrical components have been visually inspected to ensure safe use of this equipment; no concerning deficiencies or problems relating to systems or components were noted. It was requested to add a Jefferson Lab one-time use locking clip to the high voltage chassis enclosure and to bond the equipment rack to an accelerator ground system; both of these recommendations have been put into place. Schematics for the electrical design have been provided and reviewed; fusing for individual components has been incorporated into the design. Overall the electrical design and build has been done in a professional work-like manner

Comments:

1) There is a typo in "Argonne Bubble Chamber Test" Section 9.1.7 Emergency De-energizing - step 2. Turn "of" refrigerator.

2) There is no document on the conduct of operation and on the radiological safety assessment.

Recommendations:

1) A pretest verification checklist of the equipment should be created.

2) Rope off the immediate area to ensure untrained staff not involved in the experiment keep out.

3) Provide a call list to Ops in case of an emergency, problems or questions after hours.

4) Provide a short presentation and walk through to Ops staff showing basic layout and controls in the service building and tunnel.

5) Install a fan to promote mixing in the Injector tunnel when venting N_2O and C_2F_6 from the bubble chamber. The fan can be temporarily placed in the tunnel during venting of the chamber.

6) Section 6.1 of the TOSP needs to include potential exposure concentration of N_2O and C_2F_6 along with the exposure limits for each. This information can be placed in a table (see example below) or include calculations as an attachment to the TOSP.

Gas	Anticipated concentration in tunnel when vented	Exposure limit
N2O	25 ppm	50 ppm
C2F6	xxx ppm?	1000 ppm

7) The TOSP form used is expired and needs to be updated. Contact Harry Fanning for guidance before submitting form for review/signatures.

8) The TOSP and THA both point to an unnamed attached document, which does not have a tracking number and can cause confusion if the "attached document" is not attached. For better document control and tracking, add document number with revision number to "Argonne Bubble Chamber Test" and use that document number within the TOSP and THA when citing references from it.

9) Brad DiGiovine is currently the only person assigned to perform certain tasks adding a level of risk to the experiment should something happen to him. Suggest adding an additional qualified back up to the list of contacts should something happen.

10) Have a representative available at each 8 am Accelerator summary meetings during experimental runs to communicate experiment progress and needs.

11) Utilize electronic communication tools (i.e. ATLis, electronic logs, etc.) to communicate progress of the experiment.

12) Prepare a document that outlines the conduct of operation (COO) during the test run and post it in the test beam area. This could be a short version of what has been done for the special setups in the experimental Halls. (see example: https://www.jlab.org/Hall-B/run-web/hps/COO_HallB-HPS.pdf).

13) While there is no expectation of significant radiation that could cause activation of equipment during the test run, a statement by the RADCON group to that effect should be made available and posted in the test area.