

Report on the G-Zero Target Safety and Technical Review
February 11, 2002

Jefferson lab requested a review of the G-Zero hydrogen target for safety and technical considerations. The committee consisted of the following:

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| Jim Kilmer | (FNAL) | Chair |
| John Mark | (SLAC) | |
| John Domingo | (JLAB) | |
| Bill Vulcan | (JLAB) | |
| Mike Seely | (JLAB) | |

The committee would like to thank the target group for their presentation. The charge is appended to this report. Comments of the committee are organized to match the items of the charge.

1. Design

- The design includes a recent change to mitigate a thermo-acoustic oscillation problem. The change proposed is to add a 180-degree bend in the supply lines to the target. The committee is not confident that this will work. At a minimum the elbows need to bend upwards as far as possible to provide a vertical rise. This needs to provide a stable liquid interface. It does not seem likely that the 180-degree elbows will provide enough vertical rise to help.

The committee encourages the group to consider making the vent line solid from the elbow back to the point where it can turn up in the service module. Place a flex line vertically in the service module to accommodate movement. If the line is cooled (perhaps by closely tying it to the cooling lines) the horizontal runs will stay full of liquid and the liquid gas interface will be on the vertical leg where the problem is not severe.

- The motor problem is a clear schedule risk. During the review data was shown indicating the old motor running at 20 Hz might be sufficient to operate the target. During the committee's discussion it was mentioned that while the system may operate at 20 Hz it might not provide the fluid flow rate the experiment determined was necessary to keep systematic errors down. This solution may not be acceptable to the entire experiment.

The two new motors are suffering from various delivery problems and it appears to the committee that there may not be time in the test schedule on the test stand to test both motors. If there are further delays in motor deliveries beyond those already anticipated the committee recommends that the group consider using a three phase induction motor already on hand at JLAB. Another obvious comment is that if during testing the first

tested motor works the schedule can be kept by not testing the second motor. Of course, all of the schedule risk could go away if the magnet is not delivered on time.

Since the testing schedule is no longer correct the committee recommends that a new schedule be prepared to account for the new situation. This schedule should be shared with the JLAB staff as soon as possible so the required resources can be made available.

2. Control and Safety Systems

- During the presentations there was a great deal of discussion about the sizing of the relief lines and the calculations for their pressure drops. The committee feels that the vent system is adequate to safely relieve the target.
- In discussing the controls discussion the major topic seemed to be about the Fast Shutdowns and how they were to be implemented. The committee recommends that the group arrange a series of meetings with the relevant JLAB personnel to identify each required FSD input and agree on the interface needed between the target controls and the accelerator systems.

3. Draft Operational Safety Procedures

- The committee found the OSP not to be in the correct form. We believe that the information is contained in the documents we were provided. An OSP should be a set of instructions defining various target conditions off normal and listing the required responses. This document needs to provide emergency instructions to the operator on the scene, most likely without a “black belt” available to help him, in returning the target to a safe condition.

4. Long term Target Support

- The committee feels that the target spares situation is pretty good. Reliability of the new motors is however untested and the group should make fall back plans if motor failures start to occur.
- The group provided a staffing proposal for operating the target that is acceptable. It is important that “brown belts” get sufficient training to recognize problems in the target and emergency procedures detailed enough to allow them to put the target back in a safe condition almost without any outside help.
- For periodic inspections see item 6.

5. Commissioning plan

- The commissioning plan shown to the committee is acceptable. The committee is worried a bit about the schedule risk here. The target will be tested for the first time in the hall with a new motor (nearly untested) and an untested magnet. There is very little time afforded the target group to finish their installation and testing and fine tune their operating procedures.
- During the presentations the test pressure of the system prior to the neon test was stated as 50 psi. The committee does not feel that is adequate. The flask will see a higher pressure than that according to the group's own calculations. We recommend that they test the target to 85 psi as they have done in the past.
- During the neon test the committee was concerned that the helium vessel could be ruined if pressurized as recommended in the operating procedures. The committee feels that it would be acceptable to pressurize the helium flask before the neon test venting is started to a level that would allow it to survive. This would remove the schedule delay that damaging the helium vessel would cause.

6. Target-magnet safety issues

- The only scenario the committee could identify that would allow a flammable mixture into the magnet vacuum space is when the far downstream vacuum window by the dump broke. If it broke and shrapnel were also produced the target could be broken mixing hydrogen and air. The group provided calculations showing that just the target vessel breaking is not a safety issue. The target does not contain sufficient hydrogen to bring the vacuum space volume up to atmosphere.
- The committee has the following recommendations for dealing with the downstream window:
 1. The window should be designed to survive even while being hit with un rastered beam, insofar as possible.
 2. The window should be treated to protect it against corrosion.
 3. The window should be inspected after every run, or at least every six months, and changed as required.

The committee does not believe at this time that a follow-up review needs to be scheduled. JLAB may always request another one as they see fit.

Charge to the Committee:

The target system for the G0 experiment needs to be ready for final installation in Hall C in just a few months. As part of your review please refer to the master G0 installation schedule (see attachment) when assessing the likelihood that the system will be ready to install and will have a high probability of performing as anticipated.

Please review in detail the following aspects of the G0 cryo-target system:

- 1) The design as engineered and its anticipated performance characteristics. This includes any performance testing in the Test Lab.
- 2) The control and safety systems (both passive and active) for the target system.
- 3) The “draft” operational safety procedures (OSP) for the system.
- 4) The plan for long term target support by the collaboration. Specifically, spare parts, manpower, periodic safety inspection/testing, etc.
- 5) The plan for commissioning the target system in the Hall. This needs to include a so-called “Domingo” style fail safe test which involves demonstrating that the passive systems will vent/shut down the target in case of a total electrical failure, etc. Note: An “as-installed” safety inspection, approval and sign-off will be required by the laboratory prior to putting hydrogen in the system.
- 6) A review of any safety issues associated with running the cryo-target inside the magnet. For example – if both the flask and vacuum window were to fail would the resulting air/hydrogen mixture be in an explosive ratio or not?

Finally, depending on the outcome of the review and the committee’s recommendations, a follow-up review may be necessary or recommended. At the very least, it is expected that the G0 collaboration will have to come to closure on a series of punch list items. Also, there will be the final Jlab “as-installed” inspection and sign-off on the entire experiment just prior to the experiment receiving its run certificate.