Temporary Operational Safety Procedure (TOSP)

Division serial number _____

Issue Date: **5/20/02**	
Expiration Date: **6/20/02** (No later than 3 months after issue date.)	
Title: **G0 Target Neon Test**	
Location: **Hall C**	
Risk classification (See EH&S Manual Chapter 3210.)	Without mitigation measures:
	With specified measures implemented:
Author(s): Silviu Covrig	

Supplemental technical validations:	
Hazard reviewed:	Reviewer signature:
Targets	Mike Seely
Engineering	Dave Kashy
Cryo	Dana Arenius
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Signatures
EH&S staff reviewer: Bert Manzlak
Division EH&S officer approval: Dennis Skopik
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Safety Warden:

Distribution:
Copies to: affected area, authors, division EH&S officer
Original: EH&S Reporting Manager

Version 1, 5/17/02

G0 Cryotarget Neon Test in Hall C at Jlab

1. Purpose

Silviu Covrig, May 10, 2002

To test if the venting system in place for the G0 cryogenic target in Hall C is able to relieve the target safely in a sudden loss of vacuum.

2. Introduction

The G0 cryogenic target system underwent several tests in the Test Lab during the last year and a half. A complete description of the tests is given in [1, page7]. The target system passed all the required controlled pressure tests and went through several cooldowns with He on He in the Test Lab that tried to assess the performances of the cryogenic pump and heat exchanger and the overall functionality of the target controls. Based on these tests several improvements have been implemented and tested. The cryogenic pump is operated by a sensorless brushless DC motor made by Barber & Nichols. The performance of the motor in cold He was as expected. Target controls were continuously improved and now there is a manual that describes them, posted on the web [2]. We are using the same kind of data logging that Hall C cryotargets are using for archiving target parameters. The logger can archive data at 1 Hz and since the boil off with Neon is supposed to take more than 1 min this frequency should be sufficient. Also, based on a recommendation made by the G0 Target Safety Review Committee that met at JLab on Feb 11, 2002, the internal service lines for H2 have been redirected to come out of the service module on top of the cryo-can instead of the side of the service module, to add some vertical drop for a more stable interface between liquid and gas [3,4].

As part of the G0 target system pre-beam commissioning, the first in a series of tests in-situ is the Neon Safety Test. The target system has been installed in Hall C during the month of April 2002 and the target itself sits inside the G0 magnet. This is the configuration in which the target will undergo the Neon safety test.

3. Description of the test and run plan

Prior to the test we will have the on-site safety inspection called "the punch list items review" by John Domingo, David Kashy and William Vulcan, and before we can cool down the target, the commissioning of the cryogenic lines in Hall C has to be completed.

In what follows we discuss about the catastrophic boil offs produced by loss of vacuum. The relief system for the G0 target is described in [1, page27]. According to this document the pressure rise during a boil off with H_2 will be 29 psia compared to a pressure rise to 38 psia for a boil off with Neon. Safety factor is 1.31. For a similar test performed on the Hall A cryogenic target the expected boil off pressures were 58 psia for H_2 and 72 psia for Neon. The safety factor for the Hall A target was 1.24. The boil off time for the G0 target with H_2 is 20s compared to 73s

it will take to boil off the target with Neon. If the target survives the Neon boil off test it may survive a Hydrogen accident.

There is a real danger that Neon might freeze in the target loop. The coolant delivered to the heat exchanger is at 15K and the only control on the coolant will be through the JT valve. The normal operating point for the loop is 25psia (1.7 atm) and 2K subcooled liquid. Neon at 25 psia liquefies at 28.98K and freezes at 24.56K, about 9.5K above the coolant in and with a gap of only 4.5K for liquid. The heat exchanger is a double coil fin tubing designed to have a large area for heat exchange. To assure that, there is a flow diverter inserted in the middle of the heat exchanger blocking the flow through the middle and forcing the fluid inside of the loop to go through the fin tubing. Maximum theoretical power removal by the coolant with LNe in the loop is 1581W, if the coolant goes from 15 K to 28.98 K.

The high power heater was configured to work in a feedback loop with the beam current, based on the Sample target design and experience at MIT-Bates. To avoid the freezing situation we reconfigured the high power heater to work in a pid loop with one of the temperature sensors, based on the Hall C experience with this kind of feedback, but we, the G0 target group, never had the chance of testing it in the G0 cryogenic target. Based on JLab's Polarized Cryogenic Target Group experience with both pid feedback mechanism and Neon Safety Tests we may never need to use the feedback. After pumping and purging the service lines, the gas panel and the loop with He we will perform a check of the venting system on the gas panel for the target by pressurizing the lines with He until the smallest RV set opens and after that we will finally change over to Neon in the loop following procedure C. in the Neon test manual [5]. We will try to liquefy on the liquid-gas equilibrium curve. Once the loop is full of liquid we will shut off the JT valve and break the vacuum in the magnet and service module with room temperature dry N_2 to about 1 atm, following procedure D. in the Neon test manual [5]. The port for breaking the vacuum is located on the SM and we will use house Nitrogen. The pressure rise in the magnet vessel will be monitored using magnet vacuum instrumentation, consisting of two thermocouple gauges. After the boil off is over there will be a visual safety inspection of the target cell and loop.

4. Authority and Responsibility

The members of the JLab's Polarized Cryotarget Group and the G0 Target Group participating in the test will be responsible for following safe work procedures. During the actual boil off with Neon only people that signed this TOSP will be allowed in the vicinity of the magnet vessel and all the personnel present into Hall C at the time the boil off will start will be required to wear eye and hearing protection. ESR personnel are responsible for coolant delivery. U. of Maryland subgroup is responsible for the target controls. For the whole duration of the test a target expert will carry a cellular phone, whose number is 757-810-7698.

5. Analysis of Special Hazards and ODH

The G0 cryogenic target is described in [6]. The target loop, when full contains less than 8l of liquid. Neon is a nonexplosive gas. The expansion factor between liquid Neon at 25 psia and 29K and Neon at room temperature and one atmosphere is 1425.5. The gas system for the G0 target vents into the Hall C Nitrogen vent line and not into the Hall. If the loop ruptures and the gas will make it into Hall C the Neon will expand to 11404l in Hall C. The Hall C volume was evaluated by Mike Fowler at 26,600,000l. Using the formula from pg 21 of the JLab's ODH Manual, the resulting Oxygen percentage in this case will be 20.991. Based on this, Hall C will classified as an ODH0 area for the duration of the Neon test. If the loop ruptures but the gas stays inside the G0 magnet vessel the pressure rise in the vessel is expected to be, for Neon, 6.76 psia. A 3" lift relief valve (rated at ~ 1 psig, or 16psia) is mounted on the 4-way cross of the target service module [1, page 38]. There is also a 1.2 atm parallel plate relief on the magnet vessel.

Beyond the ODH issue, since the target is inside the G0 magnet there is no danger to personnel if the loop ruptures.

Additions to this list will have to be approved by:
Dr. Greg Smith, JLab

I have read and understood the attached TOSP "G0 cryogenic target Ne test"

List of Personnel

Institution/Name	Signature	Date
Caltech		
Robert McKeown		
Robert Carr		
Silviu Covrig		
Jeffery Martin		
Lars Hannelius		
U. of Maryland		
Elisabeth Beise		
Retief Neveling		
Jianglai Liu		
JLab		
Mikell Seely		
Greg Smith		
David Meekins		
Christopher Keith		
Walter Kellner		
Mark Hoegerl		

Attachments:

[1] "Report to the G0 Cryotarget Safety Review Committee", K. Gustafsson, Feb.1, 2002

[2] "The G0 Target Controls Manual", E. Beise, Mar.1, 2002

[3] "Report on the G-Zero Target Safety and Technical Review", Feb. 11, 2002

[4] Sketch of the H_2 service lines modifications

[5] "The G0 Neon Target Test Manual", R. Carr, Jan. 30, 2002

[6] "G0 Liquid Hydrogen Target Preliminary Design Document", C. Jones and E. Beise, Nov 25, 1998

[7] Neon test part of the pre-beam commissioning plan for the G0 target

[8] G0 target gas panel diagram

[9] Addendum to Appendix E of the Target Preliminary Design Document [6]