

## **Rationale for Removal of CARMs on Hall A and C Domes from the PSS System and Placement on a Separate Diagnostic Communication Loop**

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### ***Introduction***

Currently, the PSS system utilizes a number of Controlled Area Radiation Monitors (CARMs) as a means of protecting personnel from radiation exposure as a result of beam missteering, or other catastrophic events involving undesired termination points for the electron beam in CEBAF. On top of Hall C is RM-47, which is interlocked in the PSS system to terminate electron beam production at a setpoint of 450 mrem/hr for gamma radiation, and 140 mrem/hr neutron radiation. Similarly, on top of Hall A is RM-48, which has the same setpoints; however, it is **not** interlocked to the PSS system.

During the PSS system certification of February 2005, it was accidentally discovered that the wiring in the ADM-600 of RM-47 was such that RM-47 was not failsafe. Although RM-47 would shut the accelerator down if a setpoint were exceeded, it would **not** cease beam operations if detectors were disconnected, or the CARM unit were powered down. RM-48 was discovered to be hardwired in the same non-failsafe manner. This led to an investigation as to what the true purpose of RM-47 and RM-48 is, and how best to incorporate their use within the context of the Jefferson Lab safety system.

As currently arranged, RM-47 and RM-48 perform the following functions:

- 1) Provide radiation data for use by the RadCon Group (RCG) in calculating annual and experiment-specific radiation boundary dose
- 2) Provide radiation data to Experimental Hall A and C
- 3) Shut off beam to Hall C if a "true" gamma or neutron dose rate of approximately 450 mrem per hour were exceeded at the CARM location (RM-47) on Hall C dome
- 4) Provide an alarm at the MCC for Hall A if a "true" gamma or neutron dose rate of approximately 450 mrem per hour were exceeded at the CARM location (RM-48) on Hall A dome

### **Background:**

- Hall C finished construction and was operational prior to Hall A. Due to the warranted conservatism and curiosity as to dose rates on the dome, RM-47 was installed on Hall C dome, prior to a fence being installed. At this time, RM-47 was incorporated into the PSS system.
- Hall A was subsequently made operational, and RM-48 was installed, but not incorporated into the PSS system, for an as yet undefined reason.

- After significant radiation characterization by the RCG, clearly marked "Radiation Area" fences were marked around the perimeter of the Hall A and Hall C domes.
- The fence remains locked, and the RCG maintains control of the keys. Nobody is permitted within the fenced area during running conditions.
- The only serviceable items on the domes are air conditioning units and the CARM units.
- The slope and terrain of the domes is such that it is challenging to approach the dome fence in any direction other than the provided steps and entrance.
- The fence and locks on the dome are checked by qualified personnel and documented on a Pre-startup Checklist prior to commencing an experimental run through CEBAF.
- Currently, in the PSS system for CEBAF there are three types of CARM units – 2 ADM-600s on the Hall A and C domes, and the remainder of the units divided between the "older" ADM-610 units, and "newer" ADM-616 units. The remaining ADM-610 units are scheduled to be replaced during the September SAD in 2005.
- It is believed that subtleties in software programming for several different CARM unit types (600/610/616) may contribute to communication loop problems whereby a CARM will "lock up" or go into de-bug mode, and prevent readback information from any of the other CARMs on the same communication loop, until the respective CARM is cycled. Cycling of the PSS related CARMs would result in a temporary shutdown of the CEBAF accelerator.
- "Lock up" of the communication loop for RM-47 and RM-48 prevents transmission of radiation data for that period which is used in determining radiation boundary dose data.
- Current trip setpoints (which correspond to a "true" dose rate of 450 mrem/hr gamma and 450 mrem/hr neutron for a total potential radiation dose rate of 900 mrem/hr or 0.9 rem/hr) are set as a means of meeting 10 CFR 835.502(b) which require at least one physical control exist in areas that an individual could exceed a deep dose equivalent to the whole body of 1 rem (0.01 sievert) in any one hour at 30 centimeters from the source or any surface that the radiation penetrates. Another option that is referenced (and used currently) is "Entryways that are locked".
- During June 28-29, 2002, a thick lead target experiment was run in Hall A at a current of up to 75 microamps. RM-48 gamma readings reached a level of 50 mrem/hr (see attachment 1), and a neutron level of 11 mrem per hour which, (as a result of Andersen Braun detector readings that indicate CARM neutron probes underrespond by a factor of 3.5,) corresponds to approximately 40 mrem/hr. It is unlikely that a significantly thicker target will be run at a significantly higher current (enough to purposely increase the radiation dose rate by an order of magnitude).
- Any accidental beam loss in Halls A and C would be terminated by Machine Protection System components such as the Beam Loss Monitoring System or the Beam Loss Ion Chambers. If this loss were not caught, the beam pipe damage would cause a loss of vacuum, which would terminate delivery of accelerator

beam. Chances of a person willfully breaking and entering to gain access to the dome on Hall A or C, while such a casualty occurred simultaneously is exceedingly slim.

## **Recommendations:**

### **Remove RM-47 and RM-48 from the PSS system**

RM-47 and RM-48 are not serving as PSS devices. They are serving as a back-up system for an administrative requirement from 10 CFR 835 for an unusual condition (i.e., 1 rem/hr dose rate) that would be difficult to sustain, and is already covered by having entry ways locked prior to running beam.

### **Put RM-47, RM-48, and other "in-hall" CARMs on a separate communication loop from the PSS CARMs.**

This would prevent communication "glitches" on diagnostic CARMs from interfering with PSS CARMs, and vice versa. Also, because after September 2005, all PSS CARMs would be ADM-616 units, there would not be software programming differences, and, therefore, frequency of PSS CARM "lock ups" should decrease.

### **Set the "alert" setpoints for RM-47 and RM-48 at 50 mrem/hr gamma and 14 mrem/hr neutron with an alarm in the MCC with a message to call the RCG Head if the trip points are exceeded.**

This will trigger a response from the RCG to see if extending temporary radiation area boundaries around the respective dome fence is warranted or not. Those setpoints ensure that the fence boundary does not become a high radiation area boundary.

### **Set the "high alarm" setpoints for RM-47 and RM-48 at 450 mrem/hr for gamma radiation, and 140 mrem/hr neutron radiation with an alarm in the MCC with a message to call the RCG Head if trip points are exceeded.**

This will provide information as to whether a 1 rem/hr dose rate is about to be exceeded. (As stated before, this would be for all intents and purposes impossible given other MPS components in the halls.)

**As a note, these setpoints could be adjusted at the discretion of the Radiation Control Manager based on subsequent survey or trip information, or change of conditions (such as changes in CEBAF operating parameters, or location of dome fences.)**

RM-48(y) (mrem/h) - Hall A top of the roof



Hall A: Beam Current (µA)

