

**MERIT Hg System Decommissioning at CERN  
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The Mercury Intense Target (MERIT) experiment is a proof-of-principal experiment to determine the feasibility of using a free-stream Hg jet as a target for a Neutrino Factory or Muon Collider. High-speed optics are used to record the interaction of a 14- or 24- GeV proton beam with a 20m/s Hg jet inside a 15T solenoid magnet. ORNL was responsible for the design, fabrication, and development of the Hg delivery system. The MERIT in-beam physics run was performed during October 22 – November 12, 2007. Discussion of the Hg system operation during the experimental run was given in a separate NFMCC Note.

ORNL was responsible for the design, fabrication, and development of the mercury delivery system as well as the structural supports needed to locate the experimental equipment within the CERN beam line. Two persons from ORNL traveled to CERN to drain mercury from the system and prepare the equipment for later removal from the experimental area by CERN rigging personnel.



**Figure 1. Mercury draining operations**

Once the fluid draining and spill cleanup equipment was configured and put into position, the mercury draining process was initiated. The mercury draining process utilizes flexible tubing and a peristaltic pump to transfer fluid from a sump tank first to an intermediate container and then to the final shipping flasks. A manual valve on the exterior of the mercury system equipment is opened to allow fluid flow via the pump. Once the intermediate container is filled, this valve should be closed prior to subsequent fluid

transfer into the shipping flask. During the first flask transfer, this valve was inadvertently left open, which allowed the Hg experimental equipment to gravity-feed into the intermediate container, resulting in a small overflow. This overflow allowed mercury spillage into the surrounding retention containers and partly on the concrete tunnel floor. Total overflow volume was approximately 200 ml, of which approximately 50 ml left secondary containment and made it to the floor.

An extenuating circumstance during this occurrence was the operators were in the process of transferring a small quantity of mercury into a separate container for spectroscopic analysis requested by CERN, which was a deviation from the standard procedure. While this deviation did not cause the valve to be left open, attention was drawn away from the intermediate container during the process, so the rising fluid level went unnoticed. The overflow condition was first noticed by non-participating observers. Once the overflow condition was recognized, the valve was immediately closed.

As the operators were wearing appropriate personal protective equipment, including respirators, during the entire process, there was no immediate risk of vapor exposure. All the non-participants were asked to leave the area immediately and to inform the CERN Fire Brigade as per CERN procedure. A CERN Radiological Protection representative was present at all times during the process for monitoring and radiological air sampling. Hg vapor levels at the spill area approached  $2000 \mu\text{g}/\text{m}^3$  immediately after the spill and during the subsequent cleanup operations.

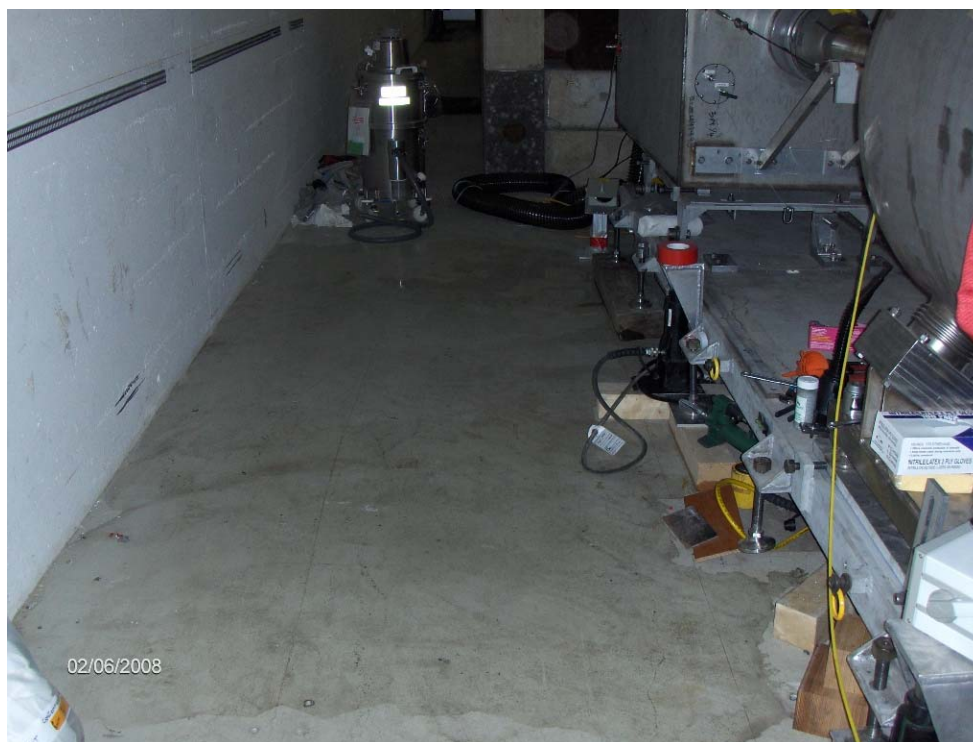
Filling of the first shipping flask continued so as to lower the volume of mercury in the intermediate container. The flask was returned to its shipping barrel, and the draining process was halted while a cleanup plan was formulated. Protective clothing that may have been in contact with liquid mercury was changed, and the specially-designed mercury vacuum cleaner which was nearby was used to re-contain the fluid that overflowed the container. All the draining equipment was wiped with a sulfur-impregnated water solution and then set back up to complete the draining operation. The CERN Fire Brigade responded during this process, reviewed the area and left after being satisfied the cleanup was being handled properly. CERN Chemical Safety personnel also reviewed the situation prior to subsequent draining operations and gave permission to proceed.

Draining operations then proceeded without further incident, and, as shown in Table 1, all the mercury that had filled the system prior to the experiment was drained from the system. Mercury from the vacuum cleaner and the CERN spectroscopic analysis was later added to the shipping flasks.

**Table 1. Hg Fill and Drain Data**

CERN Operations						
System Fill 10 May 07				System Drain 5 Feb 08		
Flask No	Full (lbs)	Empty (lbs)	Loaded (lbs)	Empty (lbs)	Full (lbs)	Drained (lbs)
1	88.3	25.3	63.0	25.3	77.4	52.1
2	---	---	---	---	---	---
3	86.8	17.1	69.7	17.1	77.4	60.3
4	81.2	13.9	67.3	13.9	80.2	66.3
5	---	---	---	---	---	---
6	86.2	15.3	70.9	15.4	78.0	62.6
7	83.4	15.8	67.6	15.7	81.1	65.4
8	---	---	---	---	---	---
9	---	---	---	---	---	---
10	52.2	16.4	35.8	16.4	85.5	69.1
11	---	---	---	---	---	---
		Mass (lbs)	<b>374.3</b>		Mass (lbs)	<b>375.8</b>
		Mass (kg)	<b>169.8</b>		Mass (kg)	<b>170.5</b>
		Volume (liter)	<b>12.5</b>		Volume (liter)	<b>12.6</b>

After the draining operations were concluded, follow-on cleanup of the spill area was performed over the next few days. Hand wiping of the floor and equipment was performed multiple times using first a sulfur-impregnated water solution, and then a Hg-absorbent powder. By the end of the week, vapor levels at the floor had been reduced to approximately 20  $\mu\text{g}/\text{m}^3$ , which is below the recommended maximum vapor exposure levels for workers during an 8-hr day. Figure 2 shows the area after the cleanup efforts were concluded.



**Figure 2. Area of cleanup efforts**

As per CERN procedure, participants were required to visit CERN Medical to discuss the situation with a physician and to provide a blood sample for analysis. Results of the samples were not available at the time of this writing but were not expected to show any abnormalities due to the use of respirators.

The remainder of the decommissioning work was completed as intended. The hydraulic power unit that controlled the syringe pump was drained of its hydraulic fluid, and all control / sensor cables were disconnected. The system was left ready for removal by CERN rigging personnel.

At the end of the week, a discussion was held with the head of the CERN Safety Department to review the incident. The results of this review were documented in an internal CERN report (EDMS #891444) to provide closure of the incident and to provide a means of communicating the lessons learned.