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Pbar target station elog

The pbar target station elog (http://www-bd.fnal.gov/cgi-mach/machlog.pl?nb=pts&action=toc) covers the operating history of the target station beginning January 2001 and ending March 2013. This notable resource should be useful to future stewards of the target station. Equipment operating procedures, failures, upgrades, motion controls, alarm settings and limits, equipment operating conditions, and much more can be found. Additional operational information following the Tevatron Collider era is available in the current elog.

Pbar Target Station Web Page

A pbar target station web page is available at http://pbar.fnal.gov/documents/targetstation/targetstation.html. The operating history of the presently installed lens, pulsed magnet, target, and target rotation motor are included on this page. Until recently, there have been broken linkages. These have been repaired.

Target Vault Radiation and Electrical Safety System Access Control

The shielding blocks which cover the target vault are not interlocked. Radiation and Electrical Safety Systems for the vault depend upon procedural actions which are under the direct control of the AD RSO, but in practice, are executed by Radiation Technicians under supervision of the RSO. Since the RSO has recently left and remaining resources are no longer in the line management of Accelerator Division function, new lines of authority for the RSS/ESS systems should be established.

Instrumentation and Controls Documentation

The keeper of instrumentation and controls wiring has been carefully and methodically kept by Bernie Wisner. If you are looking at one end of a target station instrumentation cable and want to know where the other end goes, Bernie has records.

AP0 Service Building Ventilation

Ventilation parameters for the AP0 service building are on ACNET page M12, subpage AIR 1. Ventilation controls are necessary to ensure activated air produced in the target vault are released into the PreVault enclosure and subsequently through the exhaust stack at the upstream end of the PreTarget enclosure. If ventilation system parameters are not maintained, airborne radioactivity can escape into occupied portions of the AP0 service building. An airborne radioactivity alarm requiring service building evacuation can be the result. The south drop hatch and cable penetrations need to be sealed up to prevent air infiltration from the PreVault enclosure to the AP0 service building and to maintain efficacy of the exhaust stack located at the upstream end of the PreTarget enclosure. The south drop hatch has been opened during the Muon Campus construction, so the air barrier developed for the hatch has been removed. G. Lauten (AD RSO) was the contact for the maintenance of the air barrier.

```
PA M12 Target Parameters<NoSets><NewDPM-CLX20 (100...
M12  AP0 SERVICE BLDG VENTILATION      SET     D/A   A/D  Com-U ♦Pgm_Tools♦
-<FTP>+ *SA♦ X-A/D  X=TIME*40  Y=I:BEAM  ,F:MC6IC ,F:MC7SC1,
COMMAND BL-- Eng-U  I= 0       I= 0      , 0       , 0       , 0
-< 1>+  r_30 AUTO   F= 6       F= 10     , 1.1E+12, 300000 , 10
  AIR     target    lens     lens     pmag     dump     misc
 ! AP0 SERVICE BUILDING VENTILATION IS DESIGNED TO
 ! PREVENT RADIOACTIVE AIR FROM TARGET VAULT AND
 ! PREVAULT REENTERING THE AP0 SERVICE BUILDING
 D:AR01P            AP0-AP1 Outside Air Pres              -.002  InWC
 D:AR0RP            AP0 to Roof Air Pressure            * -.018  InWC
 D:AR0TP            AP0 to Tunnel Air Press             * -.001  InWC
 D:ARHEPA           AP0 EF3 HEPA Filter Pres            *  .601  InWC
 D:AR1FIP           AP1 to EF3 in Air Press                .305  InWC
 D:AR3LOW           EF3 Low AP0 Air Pres                * -.574  InWC
 ! NAME CONVENTION IS FROM HIGH PRESSURE SIDE TO
 ! LOW PRESSURE SIDE, EXCEPT D:AR3LOW IS OPPOSITE

 ! PRESSURE DIFFERENCES ARE PROVIDED BY BLOWERS:
 D:ARFL1            AP0 EF3 Air Flow                    * 170.8   CFM
 D:ARFL2            AP0 EF1 Stack Air Flow                493.1   CFM
 G:BWRA00           RWLOSS VME CHAN 00                      1  -6
 ! HEPA FILTER REMOVES RADIOACTIVE PARTICULATES
 ! FROM TARGET VAULT EXHAUST AIR
 D:ARFLDP           HEPA Filter Diff Press              * 6.837  InWC

 ! SERVICE BUILDING TEMPERATURES
 D:0UTMP            AP0 Upstrm Bldg Temp                  72.45  DEGF
 D:0MTMP            AP0 Middle Bldg Temp                  62.16  DEGF
 D:0DTMP            AP0 Dnstrm Bldg Temp                  56.7   DEGF

 ! VAULT AIR TEMPERATURE AND HUMIDITY
 D:ARVLTT           AP0 Vault Air Temp                  * 18.75  degC
 D:ARVLTH           AP0 Vault Air Humidity              * 13.85     %

 D:ARM1             AP0   Air Radiation Mon.              588.7  CPM
 G:RD2068           AP0 Air Monitor                       500    Cpm
-G:SCTIME           Time in Super Cycle         60.2      30.33  SEC

 ! NEW VAULT AIR TEMPERATURE AND HUMIDITY
 D:VLTTMP           Vault supply Air Temp                 17.25  degC
 D:VLTHUM           Vlt supply air humidity               33.06  % RH
 D:VLTAIR           Upper vault air temp                  16.95  degC

 !TARGET AIR COOLING LINE MOISTURE DETECTOR
 !NEGATIVE VALUE IS GOOD; POSITIVE VALUE IS BAD
 !INDICATES POSSIBLE WETNESS ON TOP OF MODULE
 D:WTRDET           Tgt Module Wet pos/yes               -9.891  g/m3
```

Collection Lens Power Supply Interlocks

The collection lens power supply must be interlocked to prevent power supply operation when personnel access to the PreVault and PreTarget is possible. The Electrical Safety System permit is provided by the ESH&Q interlocks group to permit lens power supply operation. Failure of lithium containment provided by the lithium lens could lead to serious personnel injury in the event a lithium leak occurs while personnel access to the PreTarget/PreVault enclosures are possible. Since the collection lens power supply is completely new and different, the implementation of the permit needs to be managed.

Pbar Target Vault Dry Sump

In the event a significant target station water system leak occurs in which water is lost in the target vault, water is likely to collect in a dry sump located in the PreVault enclosure. If the sump receives water from the target vault, it must be collected by ESH&Q radiation safety personnel. If the water leak is related to a lithium/water reaction in the target vault, additional precautions for handling caustic liquids must also be observed. The presence of water in the target vault drain line leading to the dry sump is indicated by ACNET device G:RD2073. A dry drain line is indicated by a ~5 Hz signal which appears as a 345 cpm in the one-minute logger for this device. If the water detector has failed or there is water in the drain line, the signal is 0 cpm.

Target Module Range of Motion and Controls

Target module motion control range limits are defined under "Module Motion Controls" at http://pbar.fnal.gov/documents/targetstation/targetstation.html (see bottom left corner of web page). ACNET device transforms and ACNET names for these motion controls are also provided. The spatial relationship between the collection lens and target is explained on the "Target Module Y Motion" button.

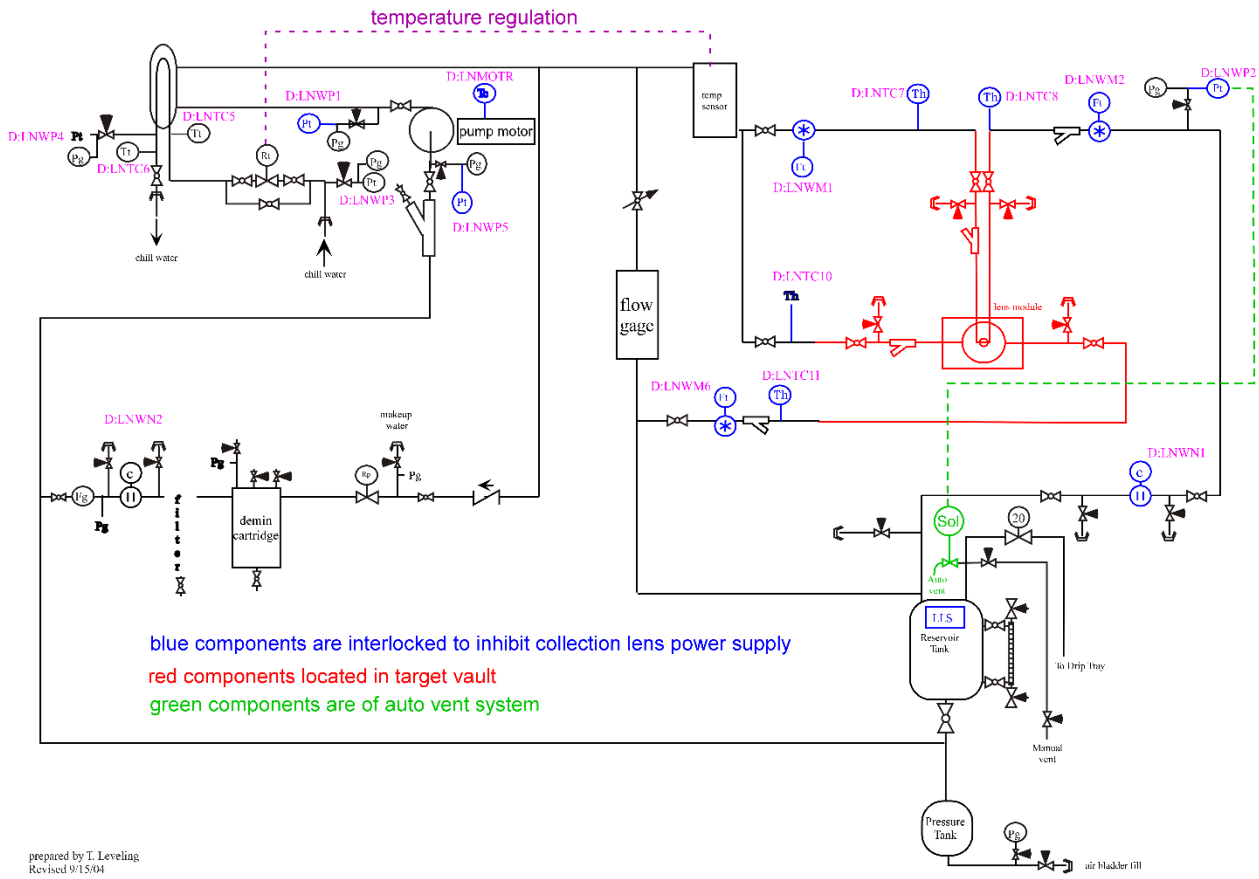
Lens Module Motion Controls

Lens module motion control range limits are specified at http://pbar.fnal.gov/documents/targetstation/targetstation.html. Use of the lens module motion controls should not be required. The lens has been positioned on the module at the nominal beam center of the beam line. Beam steering in the M1 line is a much larger knob and this should be used exclusively to set beam position on the lens. In any event, lens module motion controls should be limited to expert tuners only; attempts to move the lens module motion controls while tuning the beam orbit will bear no fruit and should be considered a purely academic exercise.

Lens/Transformer Water System Parameters

Describe water system remote fill system and LOTO procedure. Describe the system water leak thought to be located at the heat exchanger. Mention the reservoir tank electronic level detection system.

2004 Collection Lens Water Cooling System

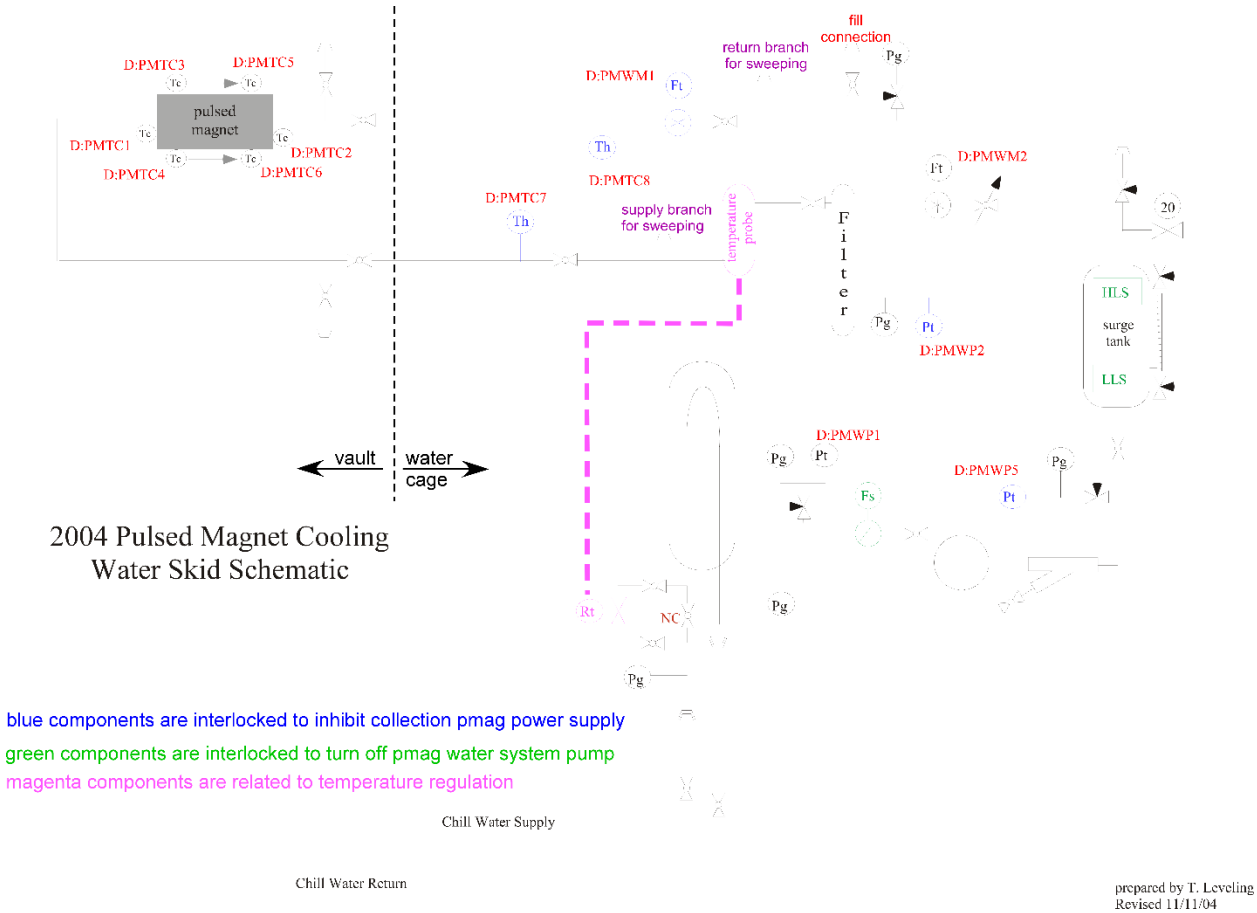


Pulsed Magnet/Collimator Water System Parameters

Web links to the collection lens and pmag water skid schematics are broken; copies are included here:

The pmag skid drawing is not up to date; two parallel supply/return headers were installed to accommodate the collimator and a water cooled target. Parameters for the collimator were recorded in the elog:

Created the following ACNET devices: D:PMWM3 (PMAG **collimator** water cooling flow), D:PMTC9 (PMAG **collimator** water supply temp), D:PMTC10 (PMAG **collimator** water return temp), D:PMTC11 (PMAG **collimator** upstream temp), and D:PMTC12 (PMAG **collimator** downstream temp). The devices have been added to the pmag water system parameter page as shown here. These devices have also been added to the pbar logger at a 1 minute sample rate. Devices appear to be working properly. **collimator** water cooling flow is approximately 3 gpm. This is a good data point to keep in mind; the pmag water skid has been unkind to flow turbines so the device may not remain healthy for long.



Another issue to note about the pmag skid is that the collimator return strainer was periodically becoming clogged with large thin green scale presumably coming from within the collimator water passages. This sort of scale was not observed in any of the other water system loads. The water flow to the collimator could become drastically reduced, so periodic flushing of the strainers is required. Watch the return flow on the collimator strainer during nominal target station parameter surveillance. The scale is quite radioactive and has to be handled under direction of rad techs.

Make inventory of bypassed interlocks

Beam Dump Water system parameters

Beam absorber water skid schematic is available at http://pbar.fnal.gov/documents/targetstation/targetstation.html under "Water Cooling System Schematics". Beam dump water system ACNET parameters are available on M12, DUMP, page 1.

Two modifications were made to the beam dump water system to accommodate the water leak.

1. Chill Water Isolation Valve was installed in the CW supply line to prevent excessive cooling of the dump core during "beam off" conditions. It had been noted that the water leak rate increased significantly whenever the dump core cooled to below about 30 C. This feature should be removed prior to restoring the beam dump water system to service. The isolation valve and

associated temporary hoses are located just outside the north end of the water cage. The associated parameters for this system are located on M12, DUMP, page 3.

2. A dump water remote makeup water system was installed to permit remote additions of makeup water. This system should no longer be required and should be uninstalled. Control parameters and read backs for the system are located at M12, DUMP, subpage 2.

Test Station Water system parameters

Test station water skid schematic is available at http://pbar.fnal.gov/documents/targetstation/targetstation.html under "Water Cooling System Schematics". The system is able to supply cooling water to either the ORBUMP test station power supply or the PPS 100 test station power supply.

Target Rotation and Vertical Motion Controls

Significant effort was applied to ensure that target rotation and other target motion controls remain reliable. Stalled target rotation would have led to severe target damage in just a few minutes during pbar production days (70 kW). Target power will be reduced to about 16 kW for muon g-2 operation. The target should last for perhaps years if motion rotation and vertical motion controls are retained. The target rotation period is 45 seconds with the SNEF (should never, ever fail) motor. The vertical target position was shifted by 1 mm after each 2E17 protons using an ACL script. The parameters for the vertical motion control are on M12, air, page 9. The ACL script is available at

/export/home1/leveling/tgtmover/advmover.acl

The script was automatically run every hour as a batch job by AD controls. This batch service should be restarted by Denise in controls before muon g-2 operation begins.

Target rotation mechanism, motor and bearings were periodically maintained by Ron LeBeau and others. A reali-slim thrust bearing is perhaps the most fragile part of the rotation maintenance. We had problems for a while when target cooling air was too cold and would permit water to condense on rotation mechanisms. To monitor for the possibility of condensation on top of the target module parameters listed at M12, target page 10 were developed; see especially D:WTRDET. Target rotation motor endplate temperature was monitored (D:TGTMTR) to check rotation motor deterioration. Target blower air flow was (D:TGTFLW) was also monitored and would cause an alarm in the event of blower failure.

Autovent controllers

All pbar target station water systems are closed systems running with reservoir tank nominal operating pressure of 9 to 15 psig. Hydrogen gas production occurs during beam on operations. The pressure building in the reservoir tanks is monitored and an electric solenoid valve is opened to vent pressure at a pre-determined set point. The Autovent controller was designed by Dave Peterson and is documented at beams doc.db 1207-v1. The controller circuit boards are installed on Velcro and reside inside the electrical cabinets for the lens/transformer, beam dump, and pmag/collimator water skids.

AP0 Service Building Humidity Issue

The following is a posted notice on the water cage shield door. During summertime, especially during high humidity periods, the sump drain has plugged, water collects on the water cage floor, and building humidity rises to very high levels. Pour a quart of bleach into the floor drain opening; the drain will open within minutes without mechanical agitation and should remain open for a year or more. The authorization to use this technique is included in the posting.

NOTICE

AC UNIT CONDENSATE DRAIN

The floor drain in the AP0 water cage consists of a plastic pipe about 5 feet long surrounded by a layer of gravel. The gravel may be continuous with the gravel backfill placed during construction of the target vault.

This drain periodically becomes plugged due to in growth of biological agents (e.g., slime, algae). As a result, the floor in the water cage beneath the AC unit becomes flooded which leads to inefficient operation of the AC units and excessive humidity levels in the AP0 Service Building. The Beams Division ES&H department in conjunction with the ES&H Section has determined that periodic additions of bleach or copper sulfate are acceptable methods of preventing the formation of slime and algae.

As a preventative measure, we may add bleach to the floor drain to inhibit slime and algae growth. Such additions would be useful two to three of times a year, specifically, during periods of extended AC unit operation beginning in late spring and ending early in the fall.

Subject: Bleach OK!

Date: Wed, 06 Sep 2000 08:57:27 -0500

From: Tony Leveling <hamburg@fnal.gov>

To: "James P. Morgan" <jpmorgan@fnal.gov>,

"Elvin R. Harms Jr." <harms@fnal.gov>,

Duane A Plant <plant@fnal.gov>,

"Frankie C. Kelly" <fckelly@fnal.gov>,

Ron Lebeau <lebeau@fnal.gov>, Hiep M Le <hle@fnal.gov>

Barry Fritz approached Rod Walton of the ES&H Section regarding the use

of bleach in the condensate drain at AP0. The bottom line is that we CAN

use bleach to clean/unclog this drain. Rod also suggested that copper

sulphate might be even better. Barry said that no quantities or

concentration limits were specified.

I suggest we try a quart of household strength bleach and watch it for

awhile.

Tony

Flow turbines and Electronic Flow Meters

Many of the water flow turbines on the water systems were replaced with electronic flow meters. The turbine flow meters were failing due to sticky and/or worn bearings and the electronic meters were thought to be an acceptable substitute. The meters worked well for a time but then began to fail. We think the meters began to fail due to very high radiation dose rates created by activation of cooling water. The radiation type is photons resulting from PET isotopes produced by the beam. We tried replacing the failed meters for a time. At some point months before the collider program was terminated, we started simply bypassing alarms that were coming in due to failed flow meters. Prior to startup of the water cage systems for beam operation, it will be prudent to restore flow meter functionality and enable water flow alarms.

Beam Dump Water System Controls

Make status of interlocks. What is status of chill water regulation adaptation? What is status of beam dump water cooling system interlocks? There is a CW start/stop control system installed on the beam dump skid. It needs to be removed from the dump skid since the functionality will no longer be required.

Supplemental lead shielding in water cage

Describe the function of the brick pile at the south end of the water cage

Collection lens water system purge systems

Point to documentation about why it is no longer used. The philosophy of operation is included here:

http://pbar.fnal.gov/documents/pbarnotes/pdf_files/PbarNote696.pdf

Collection Lens unfilling procedure

We unfilled some collection lens to do post mortems on ones that had failed. This could come in handy in the future with 12 Hz average pulsing. A lens unfilling procedure is documented at http://pbar.fnal.gov/documents/pbarnotes/pdf_files/PbarNote664-rev.pdf There is a glove box located at AP0 which was used for this purpose. Apparatus created for this purpose is stored in a Radioactive Material storage cabinet at the south end of AP0 service building. Documentation for the specific lenses which were unfilled is available at http://pbar.fnal.gov/documents/targetstation/targetstation.html under the heading “Lithium Lens Autopsy Work”.

Lithium metal inventory

There is a fair stock pile of lithium metal stored in mineral oil at AP0. ESH&Q periodically tracks the inventory. ESH&Q will probably be looking for a new contact person (following the departure of R. Schultz) if one has not already been appointed.

Target Vault LOTO procedure

The existing Target Vault LOTO procedure will be out-of-date due to the ongoing reconfiguration of the collection lens and pulsed magnet. Other systems requiring LOTO while accessing the target vault are collection lens and pulsed magnet water systems, target rotation motor, and target blower. EE Support help and advice will be necessary for the lens and pmag power supplies. A comprehensive LOTO procedure requires consideration of all of the foregoing. The existing LOTO lockout on the target vault needs to be transferred to the Target Department.

PPS 100 test station power supply

There are several important issues associated with this supply.

1. There is a supplemental choke that was added to the supply while retrofitting it for 12 Hz operation. The choke:
    a. is not yet located within an electrical enclosure
    b. has exposed bus
    c. is sitting in a location that creates additional exposed bus at Cabinet 5,
    d. is an arc flash hazard, and
    e. was operated extra precautions to

    This issue should be brought to the attention of the EE Support Department with the goal of restoring operation of PPS100 with abatement of the arc flash hazard.

2. Operation of PPS100 was developed by Ken Bourkland and Tony Leveling. Howie Pfeiffer is familiar with many aspects of the supply. Ryan Schultz had been trained to operate the supply. A new PPS 100 operator needs to be designated and trained in order to retain test station operation capability.
3. LOTO for PPS 100 needs to be transferred to the Target Department.

ORBUMP test station power supply

The ORBUMP supply was formerly used to test collection lenses and pulsed magnets. The power supply has not been used in years. This function has been transferred to PPS 100. The ORBUMP supply could be removed from AP0. The blue stand used for attaching loads and carrying strip lines could also be removed. If this is done, so plumbing modifications would be necessary at the test station water skid.

LOTO for this test stand needs to be transferred the Target Department.

Test Station Water Supply

The test station water supply provides cooling water to lens/transformers and pulsed magnets during testing. Water skid parameters are interlocked to shut down the test station power supplies and must

be configured depending on which supply is running. It is currently configured to test a pulsed magnet on PPS 100.

Chill Water Regulation Valves

Pneumatic/mechanical valves may be stuck after some years of inactivity and will need to be watched to ensure they are functioning before leaving them unattended. Water skids (Lens, PMAG, and test stand) with 5 HP pumps can overheat if cooling water is not provided; target cooling air is also chilled by the CW system which will be required to prevent target damage. Electrical loads in the target vault can sweat if the minimum of the temperature range is not kept above 25 C or so. Chill water is currently isolated from the AP0 service building CW service is perhaps one of the first systems requiring restoration prior to restarting target station systems.

Thermistors and Thermocouple applications

The target station uses a variety of temperature monitoring devices. Many water system supply and return temperatures are provided by thermistors. The electronics for signal conditioning are located in the 6 bay rack near the south entrance of the AP0 service building. The beam dump (now removed) was equipped with J type thermocouples which remained in service throughout the dump history. E type thermocouples were employed for collection lens and pulsed magnet and collimator temperature applications. A switch was made for these devices from J to E type when beam power increases due to slip stacking were incorporated. A list of temperature monitoring parameters and device type are listed in the following table:

Target SEM parking place

A new Target SEM was installed in the vault in the mid-2000s. It took a long time to build and took a lot of ingenuity and initiative to finally get it installed in the target vault. It had been the practice to not leave the SEM grid wires in the beam because they could be readily destroyed by 70 kW, 120 GeV, 8E12 ppp. It has not been determined whether the wires would survive in the 16 kW, 8 GeV beam to be used for muon g-2. It is suggested that the wires be removed from the beam until there is a clear determination.

Bypassed interlocks

The following is a list of alarm card interlocks which have been removed from service due to failed instrumentation:

Beam dump water filter flow

Beam dump water return flow

Pulsed magnet return flow

Collection lens supply flow

Collection lens return flow

Transformer return flow

Pulsed magnet supply temperature

Pulsed magnet filter bypass flow

Cable penetration between AP0 target vault and AP0 service building

These have to be sealed up. A reinforced plastic hose used for JASMIN could be removed.

Blue alignment stand at south end of AP0

Used for alignment of target station components. Has fiducials established by alignment. Either keep it or formulate plane for another method.

Test cage

PPS 100 requires cage access to be controlled to protect against exposed electrical conductors. The cabinet 5 door cannot be closed. This should be addressed before permitted further operation.

Transport exhaust trunk

Will the exhaust from this trunk need to be monitored for Mu2e operation?

Lift table controls

Dead man switch prevents inadvertent table motion which can cause harm to loads. This was added because a pbar production target was badly damaged by inadvertent operation of the lift table controls. Just for awareness.

Disconnecting the pulsed magnet from the pmag module during magnet changes

The removal of pmag from its module during magnet changes can catch one off guard. Slight imbalance of the pmag load causes alignment pins to be side loaded which prevent magnet/module separation. A long piece of unistrut or a similar pry bar has been useful in rocking the magnet to allow alignment pin disengagement. The elog has records of such occurrences.

Conductivity cells and measurements

Conductivity cell response was studied. This is a good subject to be aware of when interpreting conductivity cell signals.

The collection lens system has been equipped with valves and quick disconnects to permit testing conductivity cells in situ with a standard solution. The reference for the technique used is provided below.

One big lesson we learned is that the presence of non-ionic solutions such as ethyl alcohol are not detectable with conductivity cells. However, if such a substance is irradiated, for example, while passing through a lithium lens, the conductivity response is alarmingly high. It can give a false signal that a collection lens failure (lithium in contact with water) has occurred. Ethyl alcohol has been used as a cleaning agent for collection lens. It is not unusual to see elevated conductivity when a lens is first

exposed to beam. Lenses which are tested on the test stand are not irradiated by the beam and consequently, the issue of alcohol contamination does not appear until the lens sees its first beam. pH paper has been used as a cross check to determine if a lithium containment breach has occurred. pH paper is intended to be used with buffered solutions, and the lithium lens water system, constantly polished by a demineralizer system, is not buffered. Nevertheless, pH paper can be used as a go/no go test of lithium lens containment breach.

A study of conductivity cell response can be found at http://pbar.fnal.gov/documents/pbarnotes/pdf_files/PB674.pdf.

Spare alarm cards in cabinet #1

Experts

Bernie Wisner

Dave Peterson