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| Prepared By: S PENTTILA 099196 | Primary Location: TA53 0035 101 | INTEGRATED WORK DOCUMENT JHA |
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| JHA Type: MODERATE HAZARD |
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Work Scope

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| JHA Title: FUNCTIONALITY TESTING OF THE NPDGAMMA LIQUID HYDROGEN TARGET |
| Scope/Description: This IWD identifies steps and related hazards and their mitigations for the functionality testing of the NPDGamma liquid hydrogen target system in building MPF-35. The operation of the target system includes use of small quantities of liquid nitrogen and liquid helium. The main hazard of the testing is the 16 liters of liquid hydrogen condensed to the target cryostat. The IWD defines steps in target operation, procedures to perform the steps, personnel, their training, authorization, and response to emergencies. |

JHA Step, Hazards and Controls

| STEP/TASK | HAZARDS | CONTROLS/REQUIREMENTS |
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| GENERAL HAZARDS | Pressure system(85.10.0) | <ul style="list-style-type: none"> Pressure Safety Orientation Course #769 is required. |
| | Compressed gas(85.40.0) | <ul style="list-style-type: none"> Gas Cylinder Safety training Course #9518 is required. Gas distribution lines - air, argon, helium, and hydrogen - content of the line has to be clearly labled. On the entry door of MPF-35 has to be labled: "WARNING Gryogen / Gases in use Evacuate if low oxygen alarm sounds" and "WARNING Flamable gas No Smoking or open Flames". Inside the building has to have lable "WARNING Gryogen / Gases in use Evacuate if low oxygen alarm sounds" This lable has to be also next to the oxygen monitor. On the storage rack and auxiliary rack of hydrogen cylinders have to have lable: "WARNING Flamable gas No Smoking or Open Flames". Next to the flashing light and the buzzer of the LH2 Target Alarm system outside of the building has to have lable: "Hydrogen Target Alarm" Next to the entry door of the MPF-35 has to have a lable: "Authorized Personnel Only". |

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| | | <p>Under the sign has to be "Target Operator in Charge" including name and contact information.</p> <ul style="list-style-type: none">● Before use, inspect the gas cylinders for:<ul style="list-style-type: none">- labling to identify contents and any precautionary warnings- each cylinder is free of dents, severe rust, or corrosion, and has its protective cap in place- cylinder valves do not leak.● Use a cart to move cylinders.● In MPF-35 and in the hydrogen supply rack the cylinders must be secured with a strap. In the hydrogen supply rack can be at the same time three (3) hydrogen cylinders.● When cylinders are not in use, valves shall be closed, regulators shall be removed, and protective caps shall be installed.● Regulators that are not in use shall be stored in plastic bags. |
| | Exposure to vacuum(85.20.0) | <ul style="list-style-type: none">● The cryogenic LH2 Target system has an isolation vacuum and a number of gas and vacuum lines. Several relief devices have been designed and installed to protect over pressures in these volumes. Functionality and sizing of these relief devices and their relief pressures are thoroughly explained in the NPDGamma Liquid Hydrogen Engineering Document, version 1.10. |
| | Exposure to cryogen(85.30.0) | <ul style="list-style-type: none">● Before working with cryogens personnel has to complete the Cryogen Safety Course #8876.● Workers have to follow recommended safe work practices:<ul style="list-style-type: none">- when discharging cryogens, open valves slowly to avoid splashing- prevent air from diffusing down to the neck of a helium Dewar, which can cause blockage- maintain helium Dewars at a positive pressure relative to the surrounding atmosphere- wear a face shield and cryogenic gloves when handling cryogens and closed-toe footwear, loose-fitting long-sleeved protective clothing, and long pants with no cuff.● In MPF-35 an oxygen monitor has been installed that has its own audible alarm signal if the set point 19.5 %, is past. The oxygen |

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| | <p>monitor is also a part of the LH2 Target Warning and Alm system. If the 19.5 % set point is past, there will be audible Alarm signal and a red LED on the LH2 Target system Warning and Alarm panel will indicate the source of the alarm. If the Alarm signal is on, do not enter the building. To clear the alarm, see section 7. RESPONSE TO TARGET SYSTEM WARNINGS AND ALARMS.</p> <p>Before using the cryogenics in MPF-35, verify the status of the oxygen monitor and the LH2 Target Warning and Alarm system.</p> <p>When hydrogen gas is used in MPF-35, the roll-up door has to be kept open. When hydrogen is condensed to the target, the LH2 Target system has to be continuously manned.</p> |
| Hydrogen(85.40.20) | <ul style="list-style-type: none">● Before using hydrogen gas operators have to complete the Hydrogen Gas Safety Course # 8724 and NPDGamma LH2 Target OJT: Junior Operator Course #38146 or NPDGamma LH2 Target OJT: Senior Operator Course #38146. <p>In MPF-35 hydrogen gas can be used in the LH2 Target only when</p> <ol style="list-style-type: none">a) this IWD is approvedb) the Readiness Review by the facility is hold and MSA checklist approvedc) target personnel authorized by the line management andd) the readiness of the target system is verified by PIC of the IWD. <p>When hydrogen gas is used in the LH2 Target in MPF-35, then</p> <ol style="list-style-type: none">a) the roll-up door has to be kept openb) the tent has to be in placec) the tent ventilation fan running andd) the status of the Warning and Alarm system verified. <p>There are two hydrogen sensors close to the ceiling of the building and two sensors inside the tent. These hydrogen monitors have the warning set point at 10% of LEL and the alarm set point at 25% of LEL, where LEL is the lower flammability limit in air which is 4%.</p> <p>In the front of the roll-up door of MPF-35, around the hydrogen supply bottle stand, and auxiliary hydrogen bottle stand behind of MPF-</p> |

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| | | <p>35 have to be placed barriers to prevent a vehicle from striking the target system.</p> <p>To prevent over pressures in the gas handling system in a case of the regulator failure, after the hydrogen regulators, PR101, PR102, and PR103, flow restrictors with a 20 micron shieve VCR washers have been used.</p> |
| | <p>Exposure to rodents(175.50.0)</p> | <ul style="list-style-type: none"> ● Contact KSL Pest Control (667-6111) to mitigate any pest concerns. |
| | <p>Change to the LH2 Target system configuration(Custom Entry)</p> | <ul style="list-style-type: none"> ● Before performing any changes to the configuration of the LH2 Target system, contact PIC. |
| <p>USING LIQUID NITROGEN AND LIQUID HELIUM</p> | <p>Exposure to pressure, vacuum or cryogen(85.0.0)</p> | <ul style="list-style-type: none"> ● For response to emergencies see section 7. RESPONSE TO TARGET SYSTEM WARNINGS AND ALARMS. |
| | <p>Exposure to cryogen(85.30.0)</p> | <ul style="list-style-type: none"> ● When working with the helium Dewar and transfer line, follow the procedure "Handling of a He Dewar and Transfer Line" which is given in the Operating Procedures for the NPDGamma Liquid Hydrogen Target in TA-53, Building MPF-35, version 1.00 ● Installation of the transfer line is a two-persons job, one worker has to be a Target Operator. ● To prevent condensation of air into the neck of helium Dewars, keep positive pressure in Dewar, check that proper valves are closed, and that caps are in place. |
| <p>PUMPING OF THE TARGET AND LINES AND FLUSHING WITH HYDROGEN</p> | <p>Air and hydrogen get mixed(Custom Entry)</p> | <ul style="list-style-type: none"> ● Before any hydrogen operation, the following tasks have to be performed; <ol style="list-style-type: none"> a) a thorough and sensitive leak check of the target system. <p>When performing a leak check, be familiar with the procedure "Leak Checking of the LH2 Target System in MPF-35" given in the Auxiliary Operating Procedures for the NPDGamma Liquid Hydrogen Target System in TA-53, Building MPF-35. The leak checking can be performed by a Junior target Operator but then results have to be verified and signed off by a Senior Operator. Summary that includes conditions, actions, sensitivity of the</p> |

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| | <p>leak detector, results, and calibration of the leak detector, has to be written down to logbook and signed.</p> <p>b) To minimize a possibility of air getting contact with hydrogen gas, the LH2 Target system has several buffer volumes filled with helium between hydrogen volume and ambient air. These buffer volumes are indicated with green color in the target system diagrams, see Operating Procedures for the NPDGamma Liquid Hydrogen Target in TA-53, Building MPF-35.</p> <p>Follow the procedures "Evacuation and Flushing of the Target and Lines with Hydrogen" and "Evacuation and Filling the Helium Buffer Volumes" which are given in the Operating Procedures of the NPDGamma Liquid Hydrogen Target in TA-53, Building MPF-35, version 1.00.</p> <p>These tasks are two-persons jobs, the both workers have to be OJTed Target Operators either by Course # 38145 or # 38146. One of the Operators have to be a Senior Operator. Notes have to be written down to logbook.</p> <p>If an empty hydrogen gas cylinder has to be replaced during the flushing operation, follow section 6. CHANGING OF AN EMPTY HYDROGEN GAS CYLINDER.</p> |
| Hydrogen(85.40.20) | <ul style="list-style-type: none">● IF HYDROGEN ALARM GOES OFF, LEAVE THE BUILDING IMMEDIATELY. <p>See section 7. RESPONSE TO TARGET SYSTEM WARNINGS AND ALARMS for response and how to clear the alarm.</p> <p>To prevent hydrogen accumulation in the ceiling of the building, the whole LH2 Target system including gas panel is inside a tent which is ventilated to the outside of the building. Most of the electrical equipment are located outside of the tent. A hydrogen proof vacuum pump, the only pump, that can be used inside the tent to pump hydrogen gas.</p> <p>If during the task a hydrogen Warning goes off, stop the target filling process by closing the pneumatic valves V100 and V114 using PLC panel view or close manually the valve V131 on the hydrogen manifold outside of MPF-35. If the hydrogen level stays above the warning set point of 10% of LEL but below the ALARM</p> |

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| | | <p>level of 25 % of LEL, use MP101 to pump the hydrogen out from the target and the lines.</p> |
| <p>FILLING AND COOLING THE TARGET WITH HYDROGEN</p> | <p>Exposure to pressure, vacuum or cryogens(85.0.0)</p> | <ul style="list-style-type: none"> ● IF THE HYDROGEN ALARM GOES OFF, LEAVE THE BUILDING IMMEDIATELY. <p>See section 7. RESPONSE TO TARGET SYSTEM WARNINGS AND ALARMS for response and how to clear the Alarm.</p> <p>When filling and cooling the target, follow the procedure "Filling and Cooling the Target with Hydrogen" given in the Operating Procedures for the NPDGamma Liquid Hydrogen Target in TA-53, Building MPF-35.</p> |
| | <p>Exposure to cryogens(85.30.0)</p> | <ul style="list-style-type: none"> ● After completion of the target vessel filling, pump hydrogen gas out from the lines and backfill with helium to a possible pressure. ● To prevent air to leak into the volume where hydrogen is, keep hydrogen pressure in the cryostat always above atmospheric pressure at Los Alamos; 580 Torr=770 mbar =11.2 psia. ● The condensing hydrogen gas into the target vessel is the two-persons job, the both workers have to be OJTed Target Operators either by Course #38145 or # 38146. One of the workers have to be a Senior Operator. |
| <p>WARMING UP THE TARGET</p> | <p>Over pressure(Custom Entry)</p> | <ul style="list-style-type: none"> ● When warming up the target, follow the procedure "Warming up the Hydrogen Filled Target to Room Temperature" given in the Operating Procedures for the NPDGamma Liquid Hydrogen Target in TA-53, Building MPF-35. <p>If the relief devices RV104 and CKV101 fail, the pressure in the target will increase to 61 psia where the rupture disk RD101 will crack and prevents pressure in the vessel never to reach the MAWP of the target vessel and piping which is 71 psia.</p> <p>When the target vessel is empty from liquid hydrogen, then temperature will arise higher than 20 K. Remember to pump the remaining hydrogen gas out from the vessel and lines and to back fill with helium.</p> <p>This task has to be performed by a Junior or Senior Target Operator.</p> |

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| <p>CHANGING OF AN EMPTY HYDROGEN GAS CYLINDER</p> | <p>Gas Cylinder Change(Custom Entry)</p> | <ul style="list-style-type: none">● When an empty hydrogen gas cylinder has to be replaced, follow the procedure " Change of Empty Hydrogen Gas Cylinder" given in the Operating Procedures for the NPDGamma Liquid Hydrgen Target in TA-53, Building MPF-35. <p>This task has to be performed by either a Junior or Senior Target Operator.</p> |
| <p>LH2 TARGET WARNINGS AND ALARMS</p> | <p>Response to warnings and alarms(Custom Entry)</p> | <ul style="list-style-type: none">● IF AN ALARM GOES OFF;<ol style="list-style-type: none">1) FIND OUT FROM THE LED PANEL WHICH ALARM IT IS2) LEAVE THE BUILDING3) IF THE TARGET IS CONNECTED TO THE HYDROGEN SUPPLY STAND, THEN IF IT IS SAFE TO DO SO, CLOSE THE MANUAL VALVE V131 ON THE H2 SUPPLY MANIFOLD4) CONTACT SENIOR OPERATOR IN CHARGE5) NOTIFY THE LUJAN EAM AND P-23 MANAGEMENT. <p>IF THE ALARM SHUTS OFF, THE SENIOR OPERATOR HAS TO ENTER FIRST THE BUILDING TO CHECK THE CONDITION OF THE TARGET.</p> <p>IN A CASE THAT THE ALARM STAYS ON, THEN BEFORE ENTERING THE BUILDING TO CLEAR THE ALARM, THE SENIOR OPERATOR HAS TO DECIDE IF IT IS SAFE TO ENTER THE BUILDING. THROUGH THE OPEN ROLL-UP DOOR THE SENIOR OPERATOR CAN OPSERVE THE ROOM AND SEE MOST OF THE TARGET INSTRUMENTATION AND CAN MAKE A DECISION FOR THE SAFE ENTRY. WHEN ENTERING THE SENIOR OPERATOR HAS TO HAVE A HAND-HELD OXYGEN MONITOR TO VERIFY CONDITION.</p> <p>IF THERE IS A FIRE IN MPF-35 OR THERE IS ANOTHER REASON TO BOIL OFF FAST THE LIQUID HYDROGEN FROM THE TARGET VESSEL, PUSH THE PANIC BUTTON NEXT TO THE EXIT DOOR. LEAVE THE BUILDING AND FOLLOW THE REPOSE STEPS ABOVE.</p> <p>If a warning goes off,<ol style="list-style-type: none">1) find out from the LED Warning and Alarm</p> |

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| | | <p>panel which warning it is 2) try to find out the reason for the warning 3) contact Senior Operator in charge.</p> |
| <p>TARGET OPERATORS; TRAINING AND AUTHORIZATION</p> | <p>Target Operators(Custom Entry)</p> | <ul style="list-style-type: none"> Senior Operators have to complete OJT Course # 38145 and to be authorized by P-23 line management. Senior Operator can perform independently target operations. During the hydrogen operation a Senior Operator is in charge and his or her contact information has to be posted on the entry door of building MPF-35. Junior Operators have to complete OJT Course # 38146 and to be authorized by P-23 line management. Juniro Operator can only perform target operations under supervision of a Senior Operator. Supervision here means on site supervision. |
| <p>TESTING OF THE LOSS OF VACUUM FAILURE MODE</p> | <p>Hydrogen over pressure(Custom Entry)</p> | <ul style="list-style-type: none"> During the failure mode testing the hydrogen pressure in the target vessel will Increase. The first relief device that will open, is the relief valve RV104 at 31 psia. If the through put of the RV104 is not enough, the pressure will continue to increase till the rupture disk RD101 will crack at 60 psia. This should keep the hydrogen pressure less than the MAWP of 71 psia of the target vessel. The increasing target pressure will trip the vacuum pressure alarm. Purpose of this test only, the Operator may disregard this particular alarm, but must respond to al other alarms as discribed in Step 7. RESPONSE TO THE TARGET SYSTEM WARNINGS AND ALARMS. |

Facility Notes

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| <p>TA53 WORK AREA TRAINING REQUIREMENTS</p> | <p>TA-53 Facility-Specific Training or escort required. Contact LANSCE Training Office 5-6256.</p> |
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Approvals

| Name | Role | Status | Status Date | Approver UID |
|------------|------|----------------|-------------|--------------|
| LISOWSKI,P | | NEEDS APPROVAL | 03/16/2006 | |
| PENTTILA,S | | APPROVED | 03/16/2006 | 099196 |

| Name | Role | Status | Status Date | Approver UID |
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| SINNIS,C | | APPROVED | 03/16/2006 | 109258 |