

		SNO+ Manipulator Operation Procedures	
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1 Manipulator System Shutdown

1.1 Purpose

The purpose of these procedures is to shutdown the calibration manipulator electronics in an orderly fashion. The circumstances when this should be done are when there is a scheduled power outage to the underground lab. Except in an obvious emergency, the manipulator computer should only be shutdown with the permission of the Calibration Group and the AV group.

1.2 Outline of Procedure

- Stop the manipulator control program.
- Turn off the manipulator computer.
- Turn off the manipulator computer monitor.
- Turn off the data concentrator.
- Turn off the watchdog timer box.

1.3 Prior to Starting Procedure

- Obtain permission to shutdown the manipulator computer from the Calibration Group and the AV Group.

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1.4 Procedure

1. Enter the DCR. The Manipulator electronics are in "Aksel's Garage", the alvoo immediately to the right of the entry way to the DCR.
2. If the monitor is off, turn it on. The manip program should be running. This can be seen by the

`manip>`

prompt at the bottom of the screen.

3. At the prompt, type the command.

`quit`

The manip program should shutdown returning to the terminal prompt.

4. Shut down the computer from the OS menu. (Check the system)
5. Turn off the monitor.
6. Turn off the watchdog timer box. (The location needs to be verified)

2 Manipulator System Startup

The purpose of this procedure is to start the manipulator control computer after it has been turned off. This procedure should only be done with the permission of the Calibration Group.

2.1 Outline of Procedure

- Turn on the manipulator computer monitor.
- Turn on the data concentrator.
- Turn on the watchdog timer.
- Turn on the computer.
- Verify that the manip program has started correctly.
- Verify that the CMA system has connected to the manipulator computer.

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2.2 Prior to Starting Procedure

- Obtain permission to start the manipulator computer from the Calibration Group.
- Verify that access to the DCR can be obtained.

2.3 Procedure

1. Enter the DCR. The Manipulator electronics are in "Aksel's Garage", the alcove immediately to the right of the entry way to the DCR.
2. If the monitor is off, turn it on.
3. Turn on the Watchdog Timer Box. (Location/Update needed)
4. Get ready to turn on the Manipulator Computer. This computer is located on the desk in the garage. Ensure that the USB switch is connected to the computer via the USB port on the back of the computer. The power switch is on the front. This is a CentOS computer and it will go through the typical Linux startup checklist when turned on prior to reaching the login screen. Get the password for the "calibration" user from the Calibration Group Leader.
5. Open a terminal window and type `cd manip` at the command line prompt. Once running the screen should display the manipulator status and have a `manip>` prompt at the bottom.

3 URM Light Leak Check

After a URM has been opened up (cover plate taken off or removed from the glovebox), it is necessary to do a check for light leaks. This is done using the OWL tubes and Neck tubes on the detector itself. This monitor consists of doing singles rate reads of the top OWL tubes that look up towards the deck and the DCR and glovebox.

1. Contact detector operator, verify that either the detector is in a maintenance run or has the UC bit set.
2. Turn on Owl Tubes (Crate 16 HV B)
3. Turn off DCR lights.
4. Poll CMOS rates on crates 3/13/18. Watch rates on tubes
 - 3/15/20,23,25,26,27,28,29,30,31

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- 13/15/0,1,2,3,22,23,24,25,26,27,28,29,30,31
- 18/15/21,22,23,24,25,26,27,28,29,30,31

5. While Watching the Owl Tube Light Monitor:

- Open the gate valve for the URM being lightleak checked.
- Shine flashlight around the gate valve, and then around all seals on URM

Note that the light monitor only updates once a second. The flashlight must be moved at an appropriate speed.

4 URM Central Rope Length Calibration

The length calibration of the central rope for each URM is determined by sighting the pivot of the manipulator carriage against a fiducial line scribed on the window of the source tube viewing port. The height of the fiducial mark is also indicated on the side of each source tube. If the number on the source tube differs from the one listed above use the number written on the tube.

4.1 Prior to Procedure:

- Source is above the gate valve.
- Gate valve is **closed**.
- Gate valve is locked or handle is removed.

4.2 Procedure

- Verify gatevalve on glovebox below source tube is locked in the **CLOSED** position.
- Open view port on the source tube. This requires a 7/16" wrench.
- Operate manipulator until the centre of the manipulator carriage is at the horizontal line marked on window. *Note: the example below assumes the n16 source. For the laserball or a different source replace the object name n16 below as appropriate.*
From the Manip console:

console	manip > n16 by <dx> <dy> <dz>
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for example:

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n16 by 0 0 2

moves the n16 2cm up and

n16 by 0 0 -0.5

moves the n16 0.5 cm down.

4. Set the calibration in the manip program

console	manip > n16 locate 0 0 1558.5
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the position 1558.5 is the location of the calibration mark on the view port window. It was determined by measuring the height of the source tube and the location of the AV below deck.

5. Reseal the view port window.
6. When appropriate (after the URM has been flushed) perform a light leak check (see procedure ??).

5 Calibrating East/West Side Ropes

Before each use, the side ropes require both a tension calibration and a length calibration.

5.1 Calibrating Side Rope Tension Offsets

The load cells that measure rope tension are prone to have their offsets drift. Although the slope of the load cell calibration does not change, the apparent zero tension point drifts. This is potentially very bad since when operating the manipulator with side ropes on, it is necessary to go down to low tension (low is on the order of 5N or less). **If the ropes are operated at zero tension they will unspool from the takeup reels in the motor units resulting in tangling and requiring major intervention.** Therefore this procedure to reset the zeros on the load cells is important. Unfortunately it involves taking all the tension off the rope units and thus risks the same problem it is trying to prevent. **Extreme care must be taken when performing this procedure.**

5.2 Calibrating the (East) Side Rope Tension Offset

In the following we outline the steps needed to calibrate the East Rope. The calibration of the other ropes is identical except for the obvious change of the object name. Note that the offset on the southrope is weird and that one may have to "lie" to it to get the proper offset (is this still true?) Contact the OCE if you're trying to calibrate the South Rope and do not understand what to do.

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1. Obtain permission from OCE to (re-)calibrate the sideropes
2. Go to expert mode at the manipulator console

console	manip > expert room601
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Note: Expert mode has a 30 minute time out. If you take longer than this it will be necessary to reenter expert mode.

3. Drive out 30 to 40 cm of rope under constant tension.
 - Have one person apply tension to the rope in question while another sets the rope in constant tension mode. For example:

console	manip > eastrope tension 15
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*In tension mode the motor will attempt to keep the rope under constant tension. However, motors have a maximum speed of 4 cm per second so whatever you do **do is slowly!** Note that a STOP command (or really low tension) causes manip to exit tension mode*

- The person at the glovebox can now pull out the desired amount of rope. **Do it slowly!**

If the rope is not completely slack repeat the above steps.

4. Check what the tension is by doing a

console	manip > eastrope monitor
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If the tension is within 0.2 N of zero there is no need to do the next two steps

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6 Revision History

Originating Date: 2017-07-13			
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01	2017-07-13	Ryan Bayes	Drafted from SNO Calibration Operators Manual (Manipulator Operation Procedures, Revision 2) with minor revisions and editable blocks added for user notes. Included corrections from Erica Cadens to the URM light leak check section.