

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 1 of 17

Prepared/Approved By: M. Buckley	Approved By: E. Orr	Approved By: S. Buda
	R. Chmiel	

*Approval signatures on file with master copy.

[Revision Log](#)

Test Reason:	Test Result:	<input type="checkbox"/> Passed	<input type="checkbox"/> Failed
	Test Type:	<input type="checkbox"/> Full	<input type="checkbox"/> Partial
Test Date:	Start Time:	Finish Time:	
Tester 1:	Assistant 1:		
Tester 2:	Assistant 2:		

Definitions:

CS = Check Station Button

IP = Test Person Inside Tunnel

OP = Test Person Outside Tunnel

ES = Emergency Stop Button

SRU = Solenoid Key Release Unit

DG = Door Guard Button

PREPARATION:

- Inform Machine Operator that test will be done.
- Assure Modulators are ready to operate.
- LOTO the LINAC Gun and the LINAC low level RF. Refer to procedure "[LINAC LOTO](#)", [LS-ESH-0012](#)".
- Sign out "SR8 LINAC/Booster Security" key from control room.
- Refer to photos and diagrams in the [Appendix](#) for reference.
- Operation notes:
 - When turning main magnet power supplies and modulators on for test purposes, always turn on at low power.
 - The X-ray and VUV ring injection shutter reach-back tests will require both X-ray and VUV to be unsecured. These tests can also be conducted during the X-ray and VUV ring interlock tests in lieu of the LINAC-Booster test.
 - Personnel must not remain in the LINAC-Booster area when the modulators are on.
 - Testing the Emergency Stop switches in the control room will drop security in either the X-Ray tunnel or VUV Ring.

1. **Search Sequence:** Secure the LINAC/Booster area.

Search sequence

Close Doors and press reset at SR8;

Press DG;

Press (Start Search);

Press CS-1;

Press DG;

Open Entry Door, Exit, & Close door;

Insert key in SRU and rotate into position;

Press CS-E (Search Complete)

After the time-out, interlock A is satisfied on all three modulators

The modulators do not turn on by themselves

On the Control Room Shutter Control Panel, the: Green

LINAC/Booster Enable light is OFF

The Red Disable light is ON

“Area interlock” indicator is ON in control room;

“Kirk Key Secure” indicator is ON in control room

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 2 of 17

- Turn Klystron High Voltage ON via NSLS Pretune (Kly HV)
2. Press the LINAC/Booster Enable Button
 - The button enable light comes ON
 - The B interlock on the modulators is ON
 - The three modulators turn on and pulsing

 3. Break security pressing the Interlock OFF button.
 - Three modulators turn OFF
 Press LINAC/Booster Enable button.
 - The Red Disable light stays ON
 - The Green Enable light stays OFF
 Attempt to turn ON modulators via Pretune.
 - The modulators stay OFF

 4. Press CS-E (outside access door).
 - Interlock does not activate
 Remove key from SRU
 - “Kirk Key Secure” indicator turns OFF in Control Room

 5. One person (IP) goes into tunnel. OP Closes access door, places Kirk Keys in SRU, and rotates keys. IP presses the DG button then the Start Search button (inside LINAC bending magnet cave).
 - The Start Search light goes ON.
 OP presses CS-E.
 - Interlock does not activate
 OP opens the LINAC Door.
 - Light ON Start Search goes out

 6. Close the LINAC Door remove and place Kirk Keys in the SRU, rotate keys. IP presses DG then Start Search button and notes time. IP then presses CS-1 (on south wall of booster).
 - All Five strobe lights turn ON
 - Time until the light ON the Start Search button box goes out is not more than 3 minutes.
 - All Five strobe lights turn OFF
 OP presses CS-E
 - Interlock does not activate
 OP Removes Kirk Keys and opens the LINAC Door. Close the LINAC Door. Remove and place Kirk Keys in the SRU. Rotate keys.

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 3 of 17

7. IP presses DG then CS-1. OP presses CS-E.
Interlock does not activate _____
- IP presses Start Search then CS-1. OP presses CS-E
Audible Alarm Sounds _____
- OP Removes Kirk Keys (using the SRU bypass key) and opens the LINAC Door.
Audible alarm stops _____
- OP closes the LINAC Door removes and places Kirk Keys in the SRU and
rotates keys. OP immediately presses CS-E again.
Interlock does not activate _____
8. Search the LINAC-Booster. After completing search and returning key to
SRU, OP goes to LINAC modulators. _____
Interlock light labeled "A Enable" for each mod does not come on until after
warning period. _____
- Warning sounds properly and lasts for at least 30 seconds. _____ sec.
- Press Interlock OFF.
9. Enter LINAC. Close the LINAC door, IP presses DG, Start Search, and then CS-1
DG light is ON _____
"Interlocked" Sign comes ON _____
- OP opens the LINAC door.
"Interlocked" Sign goes out _____
- OP closes the LINAC door and removes the Kirk keys, inserts them in the SRU
and rotates them, OP presses CS-E _____
Interlock does not activate. _____

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 4 of 17

10. **Emergency Stop Test:**

Emergency Stop Switch	Location
ES1	Located on wall behind Gun Tank
ES2	Outside of LINAC bending magnet cave
ES3*	Cable runs along the top of the X-Ray tunnel, the switch is located above the x-ray transport line
ES4	East wall of booster, side towards control room
ES5	West wall of booster, side towards x-ray ring
ES6	Center of booster ring
ES7	LSR8

**Note: For ES3 – pull cable to activate switch. Press button on switch to reset.*

Press an Emergency Stop button

(Test ES switches ES1 - ES6 separately)

	<u>ES1</u>	<u>ES2</u>	<u>ES3</u>	<u>ES4</u>	<u>ES5</u>	<u>ES6</u>
Emergency Stop 'A' light on SR8 goes out	_____	_____	_____	_____	_____	_____
Emergency Stop 'B' light on SR8 goes out	_____	_____	_____	_____	_____	_____
Emergency Stop Latch light goes out	_____	_____	_____	_____	_____	_____
Reset/Pull out ES switch						
Emergency Stop 'A' light on SR8 comes ON	_____	_____	_____	_____	_____	_____
Emergency Stop 'B' light on SR8 comes ON	_____	_____	_____	_____	_____	_____
The Emergency Stop Latch light stays OFF	_____	_____	_____	_____	_____	_____
Press the Reset button at SR8						
The Emergency Stop Latch light comes ON	_____	_____	_____	_____	_____	_____

NOTE: The next two tests will crash the X-ray and VUV ring interlocks. Check that this will not interfere with activities in those areas.

11. A person must watch the emergency stop light on the x-ray security rack at the center of the x-ray ring. **Assure Emergency Stop Fault Indicators are cleared.**

Press ES-CRX (x-ray-injector crash button in the control room).

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 goes out	_____	_____
Emergency Stop Latch 'A' Light goes out at SR8	_____	_____
X-Ray system Emergency Stop light goes out at SR100	_____	_____
Pull ES-CRX back out		
Emergency Stop 'A' and 'B' light at LINAC security rack SR8 comes ON	_____	_____
Emergency Stop Latch 'A' Light stays OFF at SR8	_____	_____
X-Ray system Emergency Stop light comes on at SR100	_____	_____
Press the Reset button at SR8		
Emergency Stop Latch 'A' Light comes ON at SR8	_____	_____

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 5 of 17

12. A person must watch the emergency stop light on the UV ring security rack in the UV ring. **Assure Emergency Stop Fault Indicators are cleared.**

Press the ES-CRU (UV-injector crash button in the control room).

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 goes out

Emergency Stop Latch 'A' Light goes out at SR8

Emergency Stop latch 'A' & 'B' light goes out at SR9 in VUV ring.

Emergency Stop 'A' & 'B' light goes out at SR9 in VUV ring.

Pull ES-CRU back out

Emergency Stop 'A' and 'B' light at LINAC security rack SR8 comes ON

Emergency Stop Latch 'A' Light stays OFF at SR8

Emergency Stop latch 'A' & 'B' light stays out at SR9 in VUV ring.

Emergency Stop 'A' & 'B' light comes ON at SR9 in VUV ring.

Press the Reset button at SR8 at LINAC.

Emergency Stop Latch 'A' Light comes ON at SR8

Press the Reset button at SR9 in VUV ring.

Emergency Stop latch 'A' & 'B' light comes ON at SR9 in VUV ring.

13. Search the LINAC-booster – **All personnel must leave the LINAC-Booster area.**

Open LEBT Valve.

Turn ON the modulators. Press E-Stop #7 on the booster security rack LSR8.

All three modulators turn OFF

"A enable" and "B enable" lights are OFF

LEBT Valve Close indicator is ON

Attempt to secure LINAC-Booster Area

LINAC-Booster area cannot be secured

Attempt to Open LEBT valve

LEBT valve cannot be opened

Reset the Emergency Stop and the Emergency Stop Latch.

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 6 of 17

Caution:
Do Not allow personnel in the LINAC/Booster area with the Modulators ON

14. **Booster Door test:**

Obtain booster door key from SRU, open booster door and place "latch device" on lock so key can be removed with door open. Place a "switch holder" on each door switch. OP returns key to SRU.

Booster Door Closed 'A' light is ON

OP presses reset button.

Booster Door Latch 'A' light comes ON

Search LINAC-Booster. Open LEBT Valve.

IP removes holder from #2 Door switch.

The Booster Secure B light goes out

The LEBT Valve closes. Closed indicator is ON

IP replaces switch holder #2

The Booster Secure B light remains out

OP resets the B chain with the RIB Test Key

The Booster Secure B light is ON

LEBT valve does not automatically Open

Request Control Room (CR) to Open LEBT valve via control room panel.

LEBT Valve indicates open

IP removes holder from #1 Door switch.

Booster Door Latch 'A' light goes out

Booster Door Closed light goes out

LINAC-Booster Interlock drops out

LEBT valve closes and Close indicator is ON.

IP replaces switch holder #1

Booster Door Closed 'A' light comes ON

The Booster Door Latch 'A' light remains out

OP presses the Reset button at LA1SR8

The Booster Door Latch 'A' light comes ON

Press Interlock OFF.

15. IP presses DG, Start Search button and CS-1.

Start Search & CS-1 lights come ON

IP removes holder from the #1 switch and replaces it. OP presses CS-E.

Interlock does not activate

Start Search & CS-1 lights go out

All five strobe lights go out

Reset the Booster Door Latch.

Search LINAC/Booster

All personnel remain outside of the LINAC/Booster area.

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 7 of 17

16. Turn all three modulators ON if they are not already ON. IP removes the holder from booster door switch #2.
 - All modulators turn OFF _____
 - "B enable" light is out and "A enable" light is ON _____
 - Booster Secure "B" light turns OFF _____

Replace holder on switch #2

 - 'B' Enable on all three modulators stays out. _____
 - Booster Secure "B" light stays OFF _____

Reset RIB

 - Booster Secure "B" light turns ON _____

17. Turn all three modulators ON. IP removes the holder from booster door switch #1.
 - All modulators turn OFF _____
 - "A enable" lights are OFF _____
 - "B enable" lights are ON. _____

Replace the holder on switch #1 and reset booster door latch at SR8.

18. Obtain Kirk key for booster door. Remove switch holders and latch device from door. Open and close door and observe switches.
 - Both switches operate freely and each clicks when door is opened _____

19. OP returns key to SRU and resets booster door latch at SR8.
 - Booster door latch 'A' light comes ON _____

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 8 of 17

20. **LINAC Door Test:**

Open LINAC door. Place latch device on lock and holders on door switches.

Return Kirk key to SRU. Search the LINAC – Booster.

LINAC Door Closed 'A' is ON

Booster Secure 'A' and 'B' are ON

Turn ON the modulators.

All three modulators are ON

Remove the holder from switch #2

All three modulators turn OFF

'B Enable' goes out on all three Modulators

Booster Secure 'B' light goes out

Replace the holder and press CS-E

Attempt to Turn ON modulators

'B Enable' stays OFF on all three Modulators

Booster Secure 'B' light stays out

Reset the 'B' chain with the RIB Test Key

Booster Secure 'B' light comes ON

Turn ON the modulators.

Remove the holder from switch #1

All three Modulators turn OFF

'A Enable' light goes out on modulators

Booster Secure 'A' light goes out

LINAC Door Closed 'A' is out

Interlock drops out

Replace the switch holder and press CS-E

'A Enable' stays OFF on all three Modulators

Booster Secure 'A' stays out

LINAC Door Closed 'A' is ON

Booster Secure 'B' is ON

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 10 of 17

	Sextupole supply turns OFF	_____	_____
	Sextupole "B chain" indicator is OFF	_____	_____
Verify the following kicker supplies remain On:			
	LBIFB1 (Not In Use)	NA	NA
	LBIFB2	_____	_____
	LBISH	_____	_____
	BXSBLW	_____	_____
	BXESH1	_____	_____
	BXESH2	_____	_____
	BXEKF	_____	_____
	BUSBLW	_____	_____
	BUESH1	_____	_____
	BUESH2	_____	_____
	BUEKF	_____	_____

Command all Main Magnet Power Supplies OFF

Replace holder on **switch #2**.
 Reset the B chain using the RIB Test Key.

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 13 of 17

25. **Magnet Test Key:** Turn ON modulators and Booster Main power supplies.
Magnet Test Kirk Key Normal light is ON

Remove "Magnet Test" Kirk key.

Three modulators turn OFF

"A enable" and "B enable" lights are OFF

Dipole supply turns OFF

Dipole "A chain" & "B chain" indicator is OFF

Quad supply turns OFF

Quad "A chain" & "B chain" indicator is OFF

Sextupole supply turns OFF

Sextupole "A chain" & "B chain" indicator is OFF

Magnet Test Kirk Key Test light is ON

Booster Secure 'A' and 'B' are out

Attempt to secure the Booster.

The area does not secure.

Replace the "Magnet Test" Kirk Key.

Booster Secure 'A' and 'B' remain out

The Magnet Test Kirk Key can only be removed in the TEST position

Place "Magnet Test" Kirk key in Normal Mode.

26. **Lockout Switch:**

Search the LINAC area and turn ON the modulators.

Rotate the lockout switch to OFF.

All three modulators turn OFF

Booster secure 'A' and 'B' are out

"A enable" and "B enable" lights are OFF

Attempt to secure the booster with the lockout switch in the OFF position.

Booster does not secure

Attempt to turn ON the modulators

All three modulators remain OFF

Rotate the lockout switch to 'ON'.

27. Remove latch unit and switch holders from LINAC door. Open and close door and observe switches.

Both switches operate freely and each makes a click sound when door is opened

Take custody of the KK Test/RIB reset Key

Return SR8 LINAC/Booster Security key to Control Room

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 14 of 17

28. **PLC Watchdog:**

Secure LINAC-Booster. Turn On Modulators, Dipole, Sextupole, and Quadrupole supplies.
 Press Watchdog test button in SR8 for ~ 3 sec.

Watchdog ok indicator turns OFF _____

Dipole turns off and "A chain" indicator is OFF _____

Quadrupole turns off and "A chain" indicator is OFF _____

Sextupole turns off and "A chain" indicator is OFF _____

Modulator Turns OFF on "A-Chain" _____

Request for Machine Operator to command all power supplies OFF.

Press Watchdog reset in SR8.

Watchdog OK indicator is ON _____

Remove the interlock test keys from the NSLS Power Supply Interface boxes on the Booster Dipole, Quadrupole, and Sextupole power supplies.

29. **X-Ray ring Injection Shutter Reach-Back:**

Completed during X-Ray Ring Test

Preparation: Run an extension cord from the X-Ray injection shutter area to the booster supply area outside the booster door area. Plug in the X-Ray injection shutter test cable to the appropriate interlock connector and the extension cord. Do not plug in the extension cord at this time.

- Secure the LINAC-Booster area.
-
- All X-Ray Main power supplies and RF must remain OFF.
- Open LEBT valve.
- Turn ON modulators and have them pulsing.

Plug in extension cord to a nearby power outlet.

X-ray injection shutter Open indicator is ON _____

LEBT valve Closes _____

Three modulators turn off _____

Three "Interlock A" lights turn off _____

Three "Interlock B" lights turn off _____

LEBT valve closes _____

Unplug extension cord. Break security in LINAC-Booster, disconnect test cable and extension cord. Return x-ray injection shutter connection to its required configuration. _____

Secure LINAC-Booster. _____

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 15 of 17

30. **VUV Injection Shutter Reach-Back:**

Completed during VUV Ring Test

Preparation: Run an extension cord from the VUV injection shutter area to a nearby outlet. Plug in the VUV injection shutter test cable to the appropriate interlock connector and the extension cord. Do not plug in the extension cord at this time.

-
- All VUV Main power supplies must remain OFF.
- Turn ON modulators and have them pulsing.
- Open LEBT valve.

Plug in extension cord to a nearby power outlet.

VUV injection shutter Open indicator is ON

LEBT valve Closes

Three modulators turn off

Three "Interlock A" lights turn off

Three "Interlock B" lights turn off

Disconnect VUV injection shutter test cable and extension cord. Return VUV injection shutter connection to its required configuration.

31. Remove red tags and turn ON or plug in pulsed amplifier and open LEBT valve. Inform Machine Operator that LINAC-Booster test is complete and request that a notation be made in the shift log.

Appendix: System photos and diagrams



Figure 1: Injection Control Panel (located at Operator's Console)

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 16 of 17

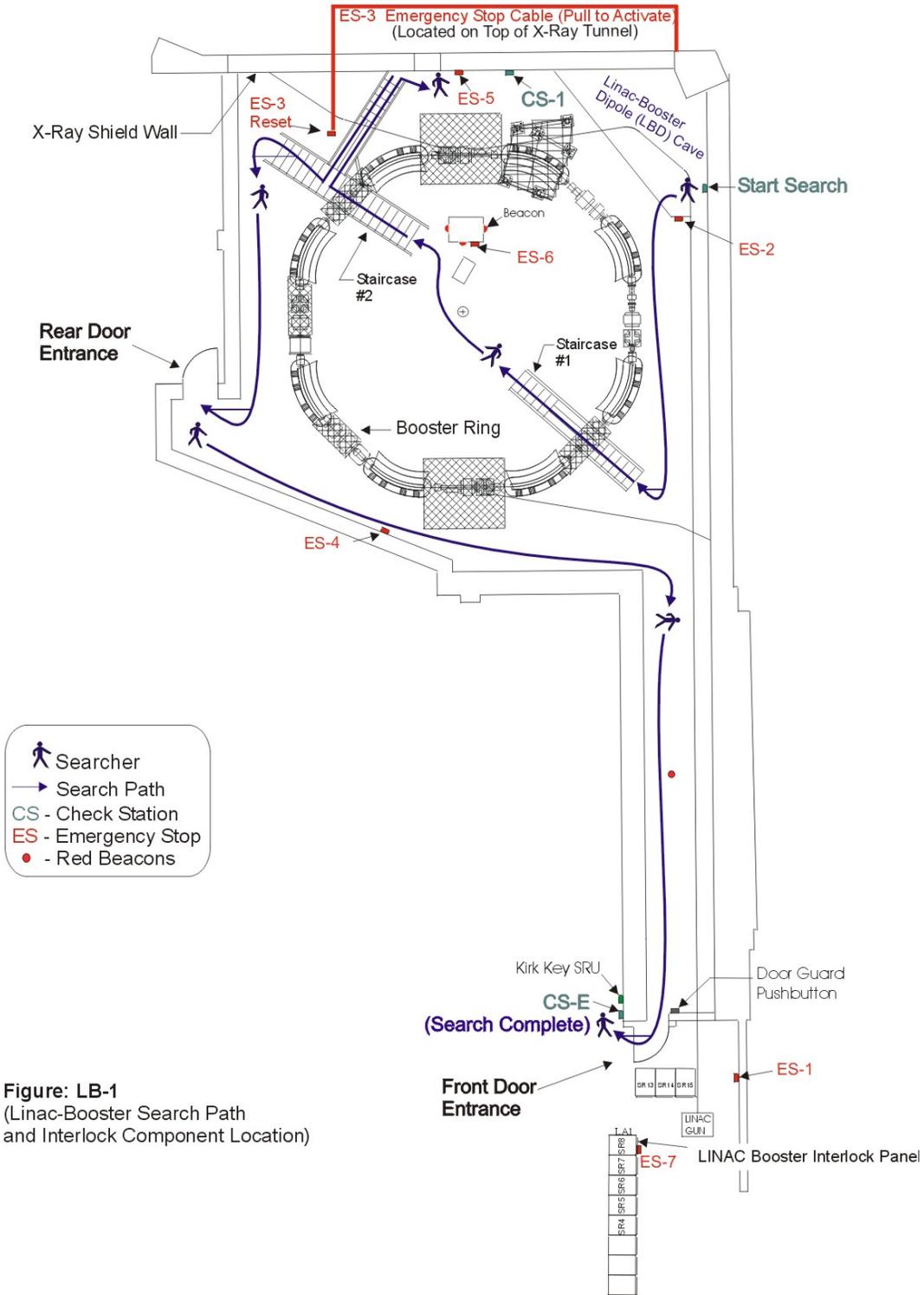


Figure: LB-1
(Linac-Booster Search Path and Interlock Component Location)

Figure 2: LINAC-Booster Layout

Subject:	LINAC-Booster Radiological Interlock Test		
Number:	LS-PPS-0013	Revision:	F
		Effective:	2/6/2008
			Page 17 of 17

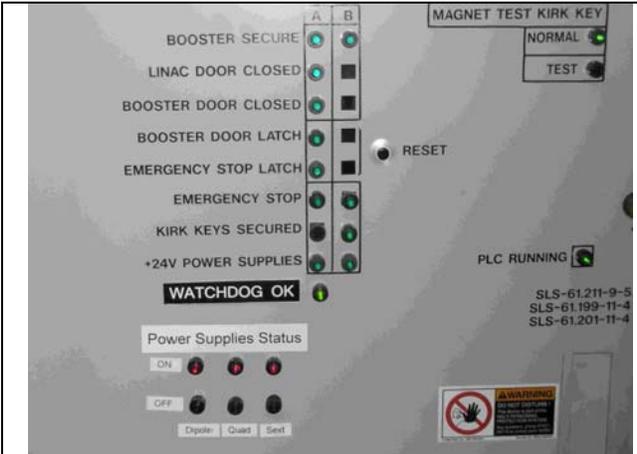


Figure 3: SR8 – Bottom Panel



Figure 4: Solenoid Release Unit (SRU)



Figure 5: SR8 - Full Panel

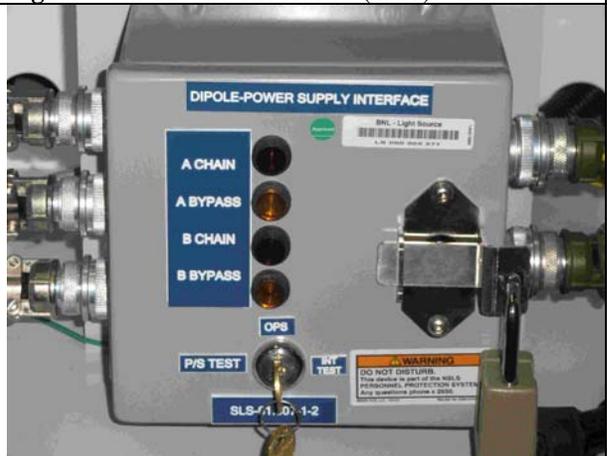


Figure 6: Power Supply Interface Box Example

* * *

The only official copy of this file is the one on-line in the NSLS Quality Assurance website. Before using a printed copy, verify that it is the most current version by checking the document effective date on the NSLS QA website.