# HOW ACCELERATOR OPERATIONS DOES BUSINESS AT JEFFERSON LAB

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### ABSTRACT

The accelerator is staffed 24 hours a day by the MCC Operations Group. Shift rotations are for seven days on shift, followed by seven days off shift, of which three days are spent on off-shift activities. Personnel spend 70% of their time on shift and 30% off shift. The off-shift time is utilized for meetings, training and individual projects. Individual projects can consist of hardware or software development, training, documentation development or other areas of interest, depending on the individual.



Figure 1: Aerial View of Jefferson Lab

#### JEFFERSON LAB CONTROL SYSTEM

The Control Systems at Jefferson Lab are based on the Experimental and Industrial Control System (EPICS). EPICS uses a client/server model and provides communication between computers distributed around the Jefferson Lab site. At Jefferson Lab, EPICS is used for control and monitoring of the Continuous Electron Beam Accelerator, the experimental halls and the Free Electron Laser (FEL). The EPICS configuration for the accelerator utilizes Motorola VME boards as IOCs and HP-UX Workstations for high level control, data archiving, retrieval and visualization and operator interfaces in the control room.

#### **OPERATIONS DATA**

#### Laboratory mission:

Jefferson Lab's mission is to provide forefront scientific facilities, opportunities and leadership essential for discovering the fundamental nature of nuclear matter, to partner with industry its advanced technology, and to serve the nation and its communities through education and public outreach, all with uncompromising excellence in environment, health and safety.

Type of accelerator: **Recirculating Linac Machine** utilizing Superconducting Electron Accelerating Technology Maximum energy (GeV): 5.5 Maximum current (uA): 180 Commissioning date: 1994 Number of staff in MCC Operations Group: 21 Type of maintenance program: Preventative/Opportunistic Number of Operators per shift: 3 (1 Crew Chief and 2 operators) Percentage of time Operators operate: 70% Years of experience for operators: Total Mean: 3.9 Total Median: 2.8 Crew Chief Mean: 6.9 Crew Chief Median: 7.5 Operator Mean: 2.3 **Operator Median:** 2.3

A new operator typically has a physics background or US Navy nuclear power training.



Figure 2: Accelerator Operations Department

# CONTROL ROOM CONFIGURATION



Figure 3: Machine Operations Consoles



Figure 4: Safety System Operator Console



Figure 5: Operator Monthly Shift Schedule

An accelerator day begins at 2300 and ends at 2259. This period is divided into 3 distinct shifts:

Owl Shift (2300 - 0700)

Day Shift (0700 - 1500)

Swing Shift (1500 - 2300)

Each MCC Control Room crew consists of a Crew Chief and two or three operators.

Shifts for the operators and Crew Chiefs are staggered by one hour, with the operators starting shift one hour later than the Crew Chiefs (0000, 0800, 1600).

# **PROGRAM DEPUTY**

The Program Deputy (PD) is a Jefferson Lab staff member appointed to serve for two-week periods. During the two-week period, the PD is responsible for the accelerator program for all shifts. The PD conducts the Daily Summary meeting and communicates with all shifts on a daily basis.

The Program Deputy (PD) develops a shift plan for each shift, detailing the program plan, any operating limits, special test plans and any other pertinent information for that shift.

The PD develops the Weekly Summary detailing Goals for the previous and upcoming week. The Weekly Summary contains details of the performance for the previous week.

	Accelerator Division Management			
Nuclear Physics Experiment Scheduling Committee (NPES)	Facility Priorities			
Long Range Planning (6-mo. schedule on WWW)	PROGRAM	Short-Term Schedule (2-week period,	Shift Plan (detailed	Crew Chief
Experimental Halls – Experiment Representatives	DEPUTY	posted on MCC white board)	each 8-hour shift)	Operators
Short-Term Beam Requirements	Accelerator Operability			
	Accelerator Availability			

Figure 6: Inputs to PD planning.

#### Program Deputy Shift Plan

Date: January 23, 2003		
Shift: Day		
Program Deputy		
Scheduled Program(s) for	th e	Shift

Scheduled Program	Number of Hours	Hall with Priority (X)	Experiment#
Hall A	6		e01-012
Hall B	6		e1
Hall C	all C 6 X		g0
Scheduled Program Accelerator Beam Studies		Number of Hours	
		2	
Accelerator Restora	tion		
Accelerator Configu	ration Change (AC	C)	
	10000		

Figure 7: PD Shift Plan

	PD we	екіў з	sumn	nary		Page 1 o
PROGRAM DEPU	TY:					
DATE (from): Inn	am: 15, 2002					
DATE (noni). Jan	ary 15, 2005					
DATE (to): January	22, 2003					
PROGRAM						
PRECEDING WE	EK:					
<ul> <li>Hall C (g0): 3 p;</li> </ul>	iss, 40 uA polariz	zed beam	, 3.026	GeV (F	riority H	all)
• Hall B (e1): 2 pa	iss, 15 nA polariz	zed beam	, 2.036	GeV		
• Hall A (E01-012	!): 4 pass, 12 uA	polarized	i beam,	4.016 0	ieV	
<ul> <li>Hall A (E01-01)</li> </ul>	!): 5 pass, 12 uA	polarized	l beam,	5.006 C	ie∨ (Thu	rsday swing)
Hall C (a0): 3 p	n: ur. 40 nA polari:	rad baam	3.026	GaV (I	Priority H	all Friday ovel)
<ul> <li>Hall B (e1): 2 pr</li> </ul>	iss, 40 uA polaria	zed beam	2.036	GeV (i GeV	nonty n	an, Filday owij
<ul> <li>Hall B (e1): 2 pr</li> </ul>	uss, 15 nA polariz	red beam	3.056	GeV		
<ul> <li>Hall A (E01-013)</li> </ul>	2): 5 mass 12 µA	polarized	l beam	5.056.0	leV.	
HALL WITH BEA	M DELIVERY PE	IORITY	r ocum,	0.000		
<ul> <li>Hall C through I</li> </ul>	riday owl					
• Hall A						
	PD W	eekly	Sun	nma	ry	Pag
PROGRAM GOALS	(last week)					
MUST:	40		2.026	C-1/1-	. Hall C	(down)
<ul> <li>Deliver 3 pass,</li> <li>Deliver 2 pass</li> </ul>	15 nA polarized	beam a	2.036	GeV ti GeV ti	Hall B	(done)
<ul> <li>Deliver 4 pass,</li> </ul>	12 uA polarized	beam a	4.016	GeV to	Hall A	(done)
<ul> <li>Deliver 5 pass,</li> </ul>	12 uA polarized	beam a	5.006	GeV to	Hall A	(done)
<ul> <li>Demonstrate pa</li> </ul>	rity quality bear	m for G0	(ongo	ng)		
SHOULD:						
Continue stabil	ization injector I	RF phase	28 work	(ongo	ing)	
LIKE:	M firmwora					
PROGRAM GOALS	(upcoming week	c)				
MUST:	(ap					
<ul> <li>Deliver 3 pass,</li> </ul>	40 uA polarized	beam a	13.026	GeV to	Hall C	(through Friday ov
<ul> <li>Deliver 2 pass,</li> </ul>	15 nA polarized	beam a	t 2.036	GeV to	Hall B	
<ul> <li>Deliver 3 pass,</li> </ul>	15 nA polarized	beam a	13.056	GeV to	) Hall B	
<ul> <li>Deliver 5 pass,</li> </ul>	12 uA polarized	beam a	5.056	GeV to	Hall A	
<ul> <li>Demonstrate pa</li> </ul>	rity quality bear	n for GC	,			
	PD We	екіу	sum	mary	/	Page :
SHOULD:						
Cut over and cor	nmission the nev	A BCM	Tuesda	y)		
- Opdate new BC	vi inmware					
•						
AVAILABILITY SUMM	IARY					
Table 1: Beam I	o Halls for the P	receding	Week	Monda	v 2400 -	Monday 2400)
Table T. Beam	Sched.	Accele	erator	Acce	ptable	Hall
	Program	Availa	bility	В	eam	Availability
	(hours)	(%	•)	in U	se (%)	(%)
Hall A	160	73	.4	5	7.8	89.3
Hall B	160	67	.9	5	6.7	91.8
Hall C	160	57	.5	4	6.5	83.4
Table 2:	Accelerator-Spe	cific Act	ivities f	or the l	Precedin	g Week
	(Monday	2400 -	Monday	2400)		
	Barrier Other		Schee	ruled	Actu	a
Accel.	Beam Studies		-		6.0	
Accel.	nestoration			,	0.0	

Figure 8: PD Weekly Summary

# **ELECTRONIC LOGGING**

Jefferson Lab utilizes an electronic log for log entries problem reporting with links to most required information needed by operators during beam delivery.

Dectronic Logbook & OPS-PR System - Netscape			_ 0 :
Elle Edit View Go Bookmarks Tools Window Help			
G S S S S http://opweb.acc.jlab	.org/CSJEApps/elog0	2/elog.php 🖸 🔍 Search	ງ 💐 🔊
Iogbooks: <u>BLOG</u>   CLOG   <u>BLOG</u>   <u>BLOG</u>   <u>BOLOG</u> <u>BLOG</u>   <u>BDLOG</u>   <u>BCLOG</u>   <u>TLOG</u> actions: <u>Nake on Retry</u>   <u>Logbook prefs</u>   <u>Scrollah</u>	BDLOS   FLOS	FURIOS   MISIOS   60102 ook.   Pending entries.   .Meinister.	
Other Links:			
Pager ACE-PR		OPS-PR Ouerv	
PD Shift Plans Run Coord Weekly Rep-	ort	Whiteboard Schedule	
Experiment Schedule Beam Charts		SWIS	
AccefTest Plan Approved Sweepers List		Ops Home Page	
Ops Documentation Ops Reconfiguration Plan	- ns	Hall Line Optics	
EES Status Page MO Perf Data	-	Software Documentation	
Bugger Log		C CLARKE & C COMPONENTIAL	
Start Date: Echnica: VI 21 VI 2002 VI 0.00 VI	[		
Sealer Sace. Tebrahy 1 21 2005 1 0.00	End Date: Will		-1
ELUG Entry Type: ALL	Sort Order:	DESCENDING Source: ALLLOGS	
Search(?):		Apply Filters	
N N			
number date name	type	title	
Indiaday			
1138149 27-Feb-03 18:57	LOGENTRY	TOCSE11/injector_boms	
1138147 27-Feb-03 17:36	LOGENTRY	2L10 warm window struggle	
1138146 27-Feb-03 17:27	LOGENTRY	Cables For Skew Quads	
1138145 27-Feb-03 17:25	LOGENTRY	Box Supplies PM	
1138143 27-Feb-03 17:03	LOGENTRY	2L21 Diode Readbacks	
1138142 27-Feb-03 16:09	LOGENTRY	RF Preventive Maintenance (PM	1)
1138140 27-Feb-03 15:44	LOGENTRY	Shunt Status Chassis (W202B10	))
• 1138135 27-Feb-03 14:08	OPS-PR	rms values in lute fit are by	gus
d			

Figure 9: Electronic Log

#### TRAINING

Jefferson Lab has developed several simulators to allow operators experience in performing critical machine operations. The Safety System Simulator is an example of this. We place a great emphasis on allowing newer operators to perform procedures even though a more senior operator might perform the action more rapidly. An essential duty of the Crew Chiefs is to provide training of the operators. Safety is strongly emphasized during a new operator's training.

March Science (1983)				LDX
Nilo task		Der de s	e e e e e e e e e e e e e e e e e e e	
ŀ	BDV Magnes For builten For reades	a: Unpressed = offlout, Pressed = cks: Green = offlisade, Red = onla East Arc Beam stopper	Applied The State of the S	
	West Arc Magnet Supplies           Hall A Magnet Supplies           Hall B Magnet Supplies	<ul> <li>Hall A Beam stopper</li> <li>Hall B Beam stopper</li> <li>Hall C Beam stopper</li> </ul>	South Lines State     BSY State     Browner Access     Hell A State     Committee Access	
	Hall C Magnet Supplies	Rorth Linec RF Power	Hall B State     Hall C State     Hall C State	
	E Recirculate Mode	South Line: RF Power	For conventivientors contact Michele (ent-@Jato.org)	

Figure 10: Safety System Operator Simulator



Figure 11: RF Separation Simulator

#### TROUBLESHOOTING

Coordination and communication between Operations staff and support personnel are essential to ensure a timely resolution of any equipment or software issues. Part of the training of operators is troubleshooting and analysis to aid support personnel in identifying the source of a problem. Our EES Group has developed a troubleshooting flowchart to help ensure problems are investigated in an organized fashion and to ensure the proper personnel are contacted.



Figure 12: Excerpt from EES Troubleshooting Flowchart