Status Report: 11
Status as of: 31 January 2001

Contract Title:

BOOSTER APPLICATIONS FACILITY

Performing Organization: Brookhaven Science Associates
Location: Brookhaven National Laboratory
Upton, New York 11973-5000

Reporting Period: December 1, 2000 – January 31, 2001

1) Project Objective:

The purpose of this project is to provide a new experimental facility and beam line and undertake accelerator modifications required to take advantage of heavy-ion beams from the Brookhaven AGS Booster accelerator for radiation effects studies of importance for the NASA Space Program.

Heavy ions will originate in the Brookhaven MP-6 tandem accelerator and be transported to the Booster synchrotron for acceleration to the required energies.

Concurrent operation of the Booster for space radiation research and other kinds of research applications will be achieved by utilizing independent tandem injectors. The beam species and energy for both applications will be independent. Beams from either Tandem will be switched into the common injection line. At the Booster a new slow extraction system will be implemented which will require extensive accelerator modifications and rearrangements. A new beam line and tunnel enclosure will be built to transport the extracted beam to the experimental facility. Uniform beam intensities will be provided over rectangular areas ranging in size from about 1 cm to about 20 cm.

Other existing on-site facilities, such as the medical Department's extensive animal handling installations will also be utilized. Dosimetry and local access control will be provided through a local facility control room.

The conventional facilities to be constructed for the Booster Applications Facility will provide experimental space and support facilities. A labyrinth connects the experimental area with the laboratory support building. The target room is provided with a concrete beam stop imbedded in the back wall. The entire facility is shielded by 15 feet of earth equivalent shielding over the top of the target rooms and transport lines. The laboratory building contains support laboratories, including temporary biological specimen holding and preparation areas, as well as radiological laboratories for work with cell cultures and tissues. Also included are a dosimetry control room, a mechanical service equipment area and rooms for radioactive storage and miscellaneous items.

Power supplies for the beam transport magnets and various other equipment will be located in a power supply building, a pre-engineered steel frame construction.

The funds requested will also provide for spares and facility commissioning.

2) Technical Approach Changes:

No change.

Project Head's Summary Assessment:

	Last Month	This Month
Cost:	satisfactory	satisfactory
Schedule	satisfactory	satisfactory
Technical	satisfactory	satisfactory
Overall	satisfactory	satisfactory

W.B.S. 1.0 BAF Construction Summary

Good progress continues to be made in conventional construction and it is estimated to 37% complete. Fabrication and design of components needed for beam extraction from the Booster continued. Power supply orders have all been placed except for one. Progress continues to be made in instrumentation design; several possible flag materials were tested with beam during the recent NASA run at the AGS. Design and development of the dosimetry system continues.

W.B.S. 1.1 Conventional Construction

The foundations for Power Supply and Experimental Support Buildings are complete. The Alcove structure has been finished and the installation of the corrugated metal tunnel is complete. The Target Room concrete is 90% complete. Site and Power Supply Building electrical work and plumbing is underway. Conventional construction is estimated to be 37% complete.

W.B.S. 1.2 Booster Modifications:

1.2.1.1 Thin Septum: The bellows for the vacuum chamber is ordered. The magnet vacuum chamber detailed design is about 80 % complete . The magnet core and septum assembly detailed design is about 90% complete . The brazing vendor is being consulted for fixturing and assembly guidance. Copper has been ordered for the septum and quotations have been received for cooling/bus tubes. The Monel tubing for the septum cooling and the copper back-leg tube has been received and forming fixtures are being designed. Power feed- throughs have been specified and are being priced. Preliminary design of the drive mechanism and bearings is in process.

1.2.1.2 Thick Septum Magnet: Fabrication requests for magnet steel, vacuum chamber, and magnet stand were submitted to Central Shops in December. The magnet stand has been released for manufacture. The magnet cores have been competed. The vacuum chamber is on hold pending receipt of quotations for BAF extraction tube. Quotations on copper conductor have been received, but will not be ordered until production of vacuum chamber has started. Minor modification of conductor lug design to increase contact area is being reviewed.

1.2.1.3 Foil Stripper: The manufacture of the foil stripper, collimator, and flag is complete, including platinum inserts for collimator jaws. Collimator motor and controls ordered, with testing of collimator actuator scheduled for March. Stripper motor and controls will be ordered after collimator testing is complete. Design of camera mounting for flag is in process.

1.2.2 Power Supplies

1.2.2.2 Thin Septum: An order has been placed with Alpha Scientific Electronics for $48,605 and the delivery is scheduled for late July 2001 The Power Supply output is adjustable from 0 to 2000amperes and 0 to 13volts with current regulation of 0.1%. Both DC and Pulsed (1Hz.) modes of operation have been specified. The layout for the current carrying bus between the power supply and the magnet is complete.

1.2.2.2 Thick Septum: Order placed. Design review at vendor scheduled for early February,2001. The detailed design for the current carrying bus between the power supply and the magnet is complete.

1.2.2.3Tune Quads: The final design review for the two "170V, "1100A Bipolar power supplies was completed at IE Power Inc. on December 15, 2000. Delivery is scheduled for early July, 2001.

1.2.2.4 Sextupoles: The final design review for the two "30V, "350A Bipolar power supplies was completed at IE Power Inc. on December 15, 2000. Delivery is scheduled for early August, 2001.

1.2.2.5 Bumps: An order was placed with Danfysik for six +40V, 600A, uni-polar power supplies at a cost of $470,400. Delivery is scheduled for mid-September, 2001.

1.2.2.6 Spill Servo: System level testing of the active filter electronics is in progress.

1.2.3 Equipment Modifications

1.2.3.1 D4 and D6: No Change.

1.2.3.2 D6 Beam Dump and Wall Current Monitor: No Change.

1.2.3.3 D3 IPM and Beam Dump Kicker: The layout of the D3 straight section is complete.

1.2.3.4 Vacuum System Modifications: Design continues.

W.B.S. 1.3 <u>Beam Transport System</u>

1.3.1 Magnets: No Change.

1.3.2 Power Supplies: No Change.

1.3.3 Vacuum System

1.3.3.1 Beam Tubes, Bellow and Valves: The detailed designs for the vacuum pump bellows, pump tee and support stands have been completed and the drawings are in checking. The detailed design for the front section of the extraction beam line in the Booster tunnel is ongoing. A new fast valve with a slim profile was ordered and this solves the interference problem with the D7 Booster half-cell.

1.3.3.2 Pumps, Power Supplies and Gauges: The ion pumps and the ion pump power supplies were ordered. The NEG pump cartridges have been ordered. Vacuum gauge controller options are being evaluated for interface into the controls system.

1.3.3.3 Instrumentation and Controls: Ion gauge, thermocouple, and sector valve cables were ordered and pulled from 930UEB into the Booster. A vendor for red-jacketed RG-213 ion pump cable has supplied pricing and delivery data. A purchase requisition for equipment racks is being generated with input from Vacuum, Controls, and Instrumentation Groups.

1.3.3.4 Transport Line Bake-out System: Preliminary design continued.

1.3.4 Instrumentation

1.3.4.1 Flags and Cameras: Four candidate flag materials (Radlin, Ruby, AlOx, and Gadolinium) were mounted in the AF238 flag box in the A-line for NASA runs. These flags were exposed to the beams used by NASA during the E957 run. A performance comparison of light output was recorded.

Design is continuing for the BAF flag boxes, camera support/motion system, and neutral density filter changer. The steel pipes for the camera cubbies were purchased and received. Materials for a prototype "low profile" filter changer have been ordered and received

1.3.4.2 Collimators: The design is complete. The detailing of drawings will begin once the other instrumentation drawings are released. The mechanical actuator system for the beam plug has been ordered and received.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillator and SWICS: A prototype scintillator/PMT assembly was built and tested during the recent NASA E957 run. Detailed analysis was done on the resulting signals from the intersection with the iron beams.

A final design review was held for the vacuum chamber and mechanical actuation system. Design issues have been addressed and detailed drawings are now in progress.

W.B.S. 1.4 Controls and Personnel Safety System

1.4.1 Controls

Installation of the Booster Event-link modules and event decode PLDs was completed. The system was tested and commissioned in time for the beginning of the current physics run.

1.4.2 Personnel Safety System:

No change.

W.B.S. 1.5. Experimental Area Outfittng

1.5.1 **Dosimetry Control**

Software :

An initial version of the data scanning system is done. This version includes the ability to generate simulated data for the ion chambers and the wire chambers and the EGG chamber. It remains to generate the simulated data for the 16 x 16 (256-element) chamber, the channels for which have yet to be defined. It also remains to add the capability of reading the hardware, as this hardware does not exist yet. Meanwhile, the capability for generating software-simulated data makes it possible to test the rest of the system.

The fast scaling system is basically done but not yet tested.

A snapshot of the Crocker Nuclear Laboratory proton radiotherapy system running with hardware-simulation has been made, and the resulting raw data will be fed into the software simulation for the BAF system, and be used to verify that the fast scaling system for the BAF system is working correctly.

Work continues on the trace logger.

Work continues on the display system.

Hardware:

We are close to developing an in-house capability for gold-plating kapton.

The prototype PC board for the recycling integrator front-end is partially done.

1.5.2 Support Rooms – General

No change.

1.5.3 Support Room A

No change.

1.5.4 Support Room C

No change.

W.B.S. 1.6 Long Term Support Lab

No change.

W.B.S. 1.7 Installation and Services

1.7.1 **Electric Power Distribution**: Communication and security conduits between Bldg. 911 and Bldg. 930 are 80% complete (AGS must be off to complete).

Substation switch gear has been rigged from existing installation and sent out for reconditioning.

The electrical one line drawing has been reconfigured for actual power supply loads.

1.7.2 **Equipment Cooling Water:** All major equipment pieces have been selected. Approximately 75% of the equipment is on order.

1.7.3 **Installation:** No Change.

W.B.S. 1.8 Project Services

1.8.1 Project Management

A Project Status Update was held at BNL on January 11, 2001.The major issues presented dealt with the modified Project spending profile and related schedule changes.

The summary project schedule is shown in Figure 1.

A detailed schedule of the Critical Path has been added to this report (See figure 2). As detailed design progresses on the Booster Modifications, it has become apparent that more time will be needed to complete the design for the D3 septum magnet and the design complete milestone has been rescheduled for June 30, 2001.This modification has been submitted through the Project change control Process and has been integrated into the critical path schedule. It has no impact on the project completion date.

1.8.2 Fiscal

An additional $ 2,750,000 was received from NASA in early December.

1.8.3 Quality Assurance

No Change.

1.8.4 Environment, Safety and Health

Work continued on the Safety Analysis Document (SAD).

3) Open Items:

4) Summary Status Assessment and Forecast

a) Financial Status

A total of $15,829,5931 was expensed or obligated of the $16,950,000 available. Costs represented $8,441,731 and open commitments stood at $7,387,862. The Project Total Estimated Cost (TEC) is $31,207,000. The Total Project Cost (TPC) is at $33,900,000.

b) Table II shows detailed expenses and commitments.

c) Table III shows the projected project spending profile.

d) Schedule Status

Milestones completed	Baseline	Actual
Title I Start	11/01/98	11/01/98
Booster Modification Start	04/01/99	04/01/99
Title II Start	04/01/99	04/01/99
Title I Complete	06/31/99	06/31/99
Conventional Construction-Start	08/15/99	08/15/99
Booster Penetration Complete	10/15/99	10/29/99
Title II Complete	06/30/00	06/30/00
Beam Transport Design-Complete	09/30/00	09/30/00

Milestones Upcoming	Baseline	Forecast
Booster Mod. Design-Complete	12/30/00	06/30/01

e) Critical Path: Figure 2 outlines the tasks that must be completed for beam extraction from the Booster. The items in this WBS can only be installed when the Booster is in a scheduled shutdown. If the appropriate window of opportunity is missed the Project completion will be delayed .The projected schedule now provides a schedule contingency of 3 months between being ready for installation of Booster modification and start of the shutdown.

f) Baseline Change proposals – During this reporting period, five additional changes have been approved. They are logged as items 15 through 19 Table IV.

g) Cost Performance: Figure 3 provides a measure of project performance relating the planned budget profile versus expenses and commitments. To date performance is satisfactory.

Table I
BAF Project Milestones

		Modified
Project Start	10/01/98	
Title I Start (Preliminary Design)	11/01/98	
Booster Modification Design Start	04/01/99	
Title II Start (Final Design)	04/01/99	
Title I Complete	06/31/99	
Conventional Construction Start	08/15/99	
Booster Penetration Complete	10/15/99	
Title II Complete	06/30/00	
Booster Modifications Design Complete	12/31/00	06/30/01
Beam Transport System Design Complete	09/30/00	
Safety Analysis document (SAD) Complete	09/30/01	
Conventional Construction Complete	06/30/02	
Booster Modifications Installation Complete	08/31/02	
Beam Transportation System Installation Complete	12/30/02	
Experimental Equipment Installation Complete	03/31/03	
Project Complete	06/30/03	

Figure 1

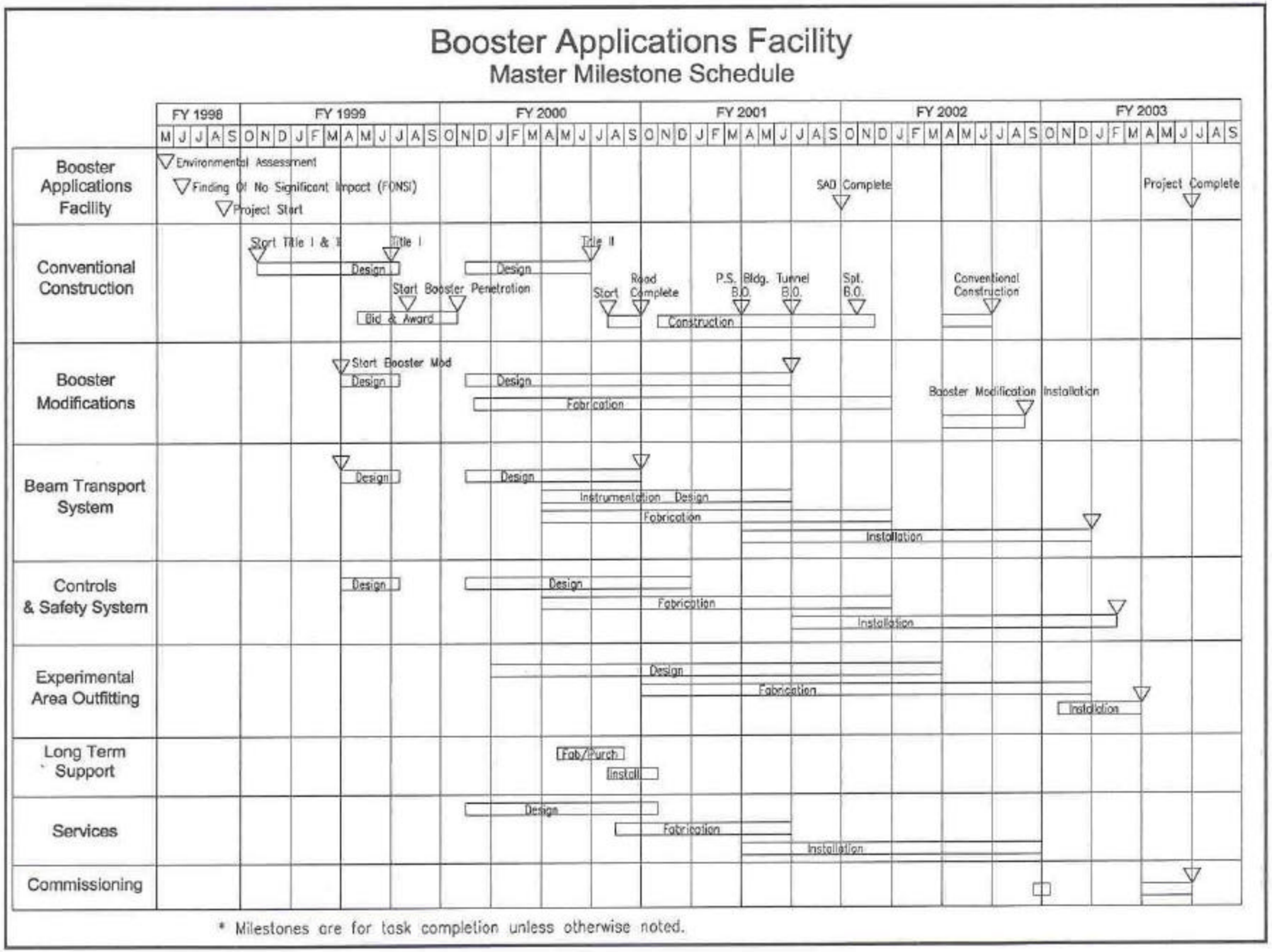

Booster Applications Facility
Master Milestone Schedule
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Booster Applications Facility
Environmental Assessment
Finding Of No Significant Impact (FONSI)
Project Start
SAD Complete
Project Complete
Conventional Construction
Start Title I & II
Title I
Design
Start Booster Penetration
Bid & Award
Design
Title II
Start
Road Complete
P.S. B.O.
Bldg. B.O.
Tunnel B.O.
Spt. B.O.
Construction
Conventional Construction
Booster Modifications
Start Booster Mod
Design
Design
Fabrication
Booster Modification
Installation
Beam Transport System
Design
Design
Instrumentation Design
Fabrication
Installation
Controls & Safety System
Design
Design
Fabrication
Installation
Experimental Area Outfitting
Design
Fabrication
Installation
Long Term Support
Fab/Purch
Install
Services
Design
Fabrication
Installation
Commissioning
* Milestones are for task completion unless otherwise noted.

Figure 2

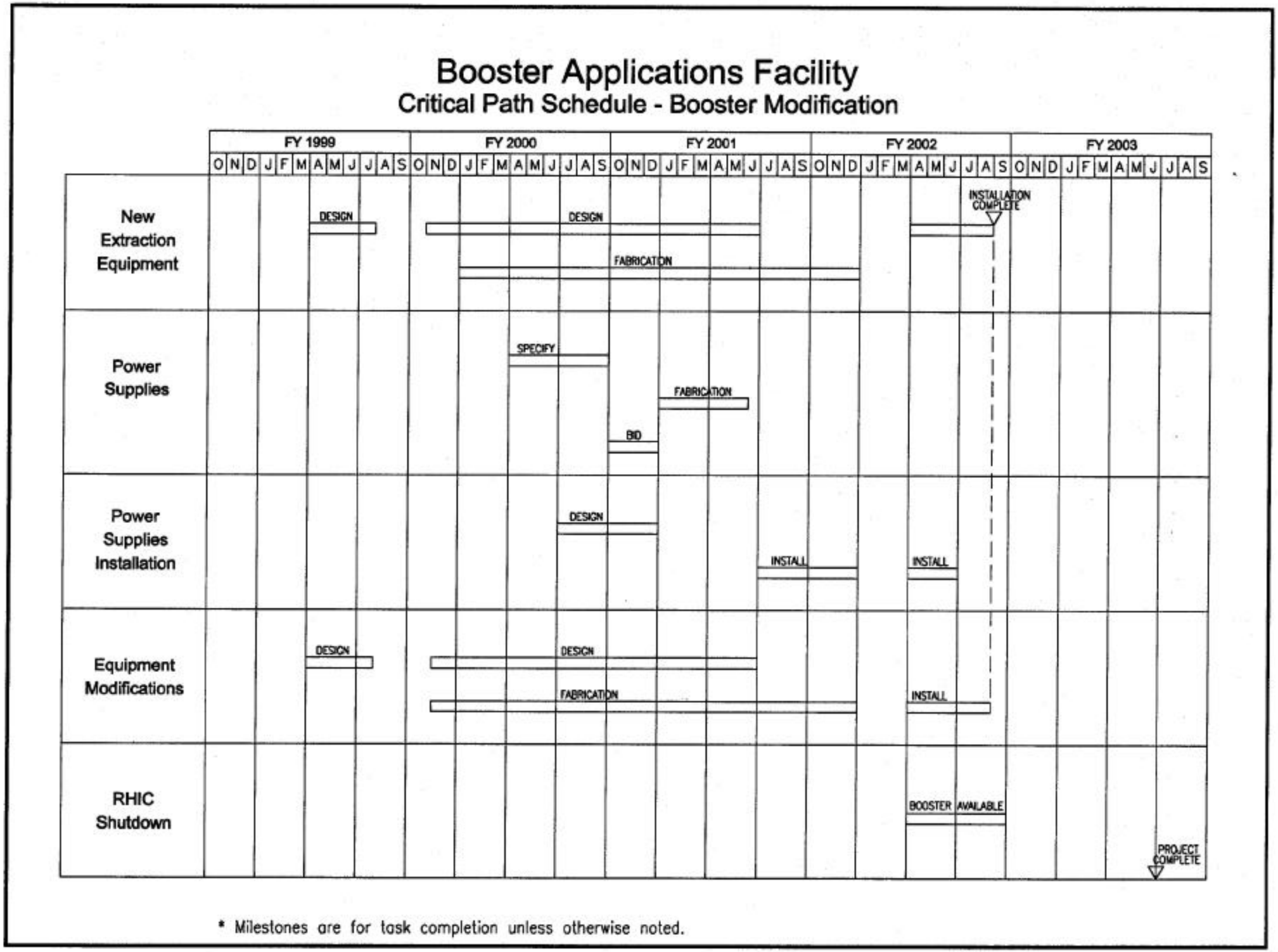
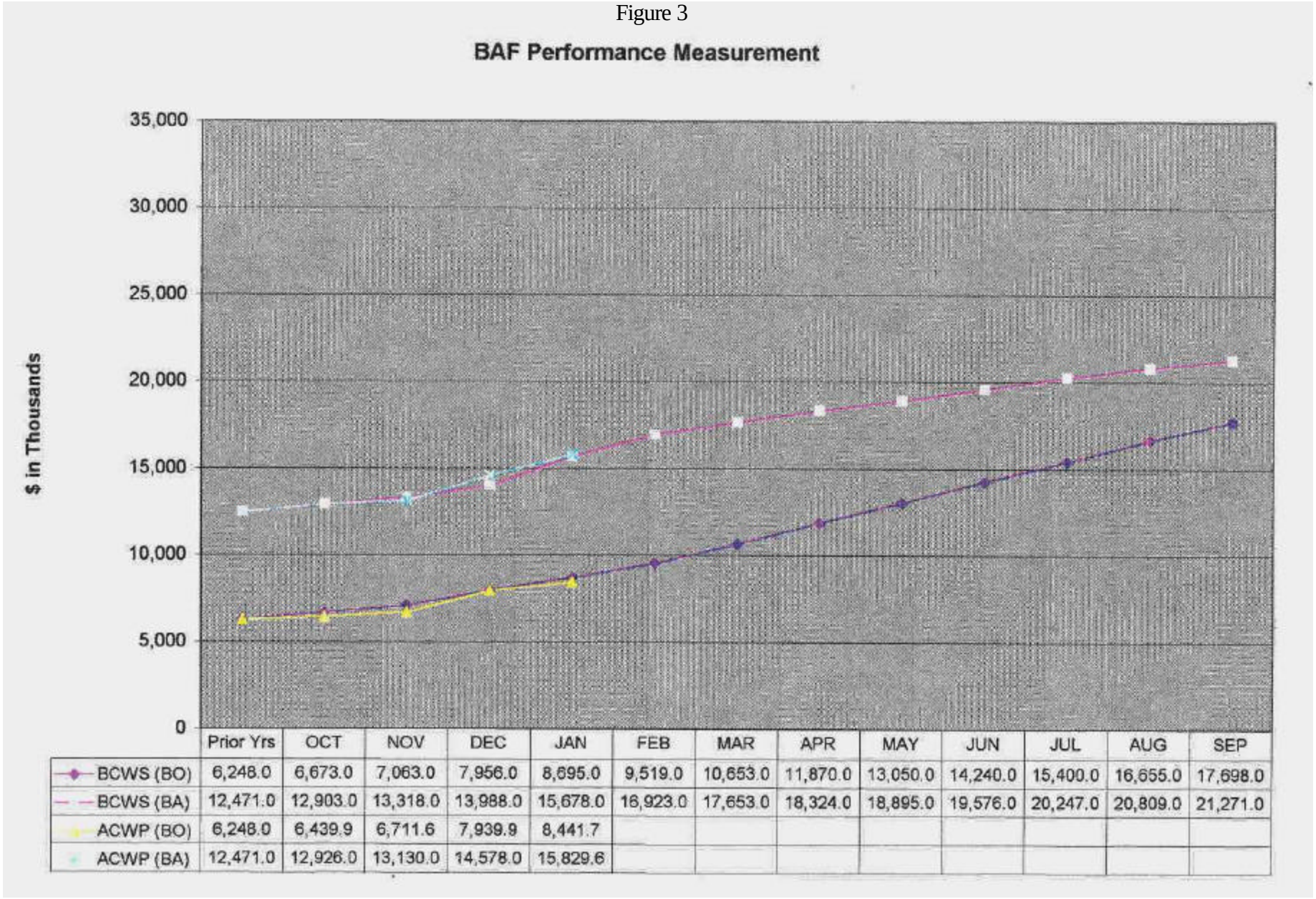

Booster Applications Facility
Critical Path Schedule - Booster Modification
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
New Extraction Equipment
DESIGN
DESIGN
FABRICATION
INSTALLATION COMPLETE
Power Supplies
SPECIFY
FABRICATION
BID
Power Supplies Installation
DESIGN
INSTALL
INSTALL
Equipment Modifications
DESIGN
DESIGN
FABRICATION
INSTALL
RHIC Shutdown
BOOSTER AVAILABLE
PROJECT COMPLETE
* Milestones are for task completion unless otherwise noted.

Figure 3



	Prior Yrs	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
BCWS (BO)	6,248.0	6,673.0	7,063.0	7,956.0	8,695.0	9,519.0	10,653.0	11,870.0	13,050.0	14,240.0	15,400.0	16,655.0	17,698.0
BCWS (BA)	12,471.0	12,903.0	13,318.0	13,988.0	15,678.0	16,923.0	17,653.0	18,324.0	18,895.0	19,576.0	20,247.0	20,809.0	21,271.0
ACWP (BO)	6,248.0	6,439.9	6,711.6	7,939.9	8,441.7								
ACWP (BA)	12,471.0	12,926.0	13,130.0	14,578.0	15,829.6								

TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of January 31, 2001

	Budget	EXPENSES Salary & Wage	Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
..1 Conventional Construction	5,698,000	84,159	451,366	1,353,359	352,290	2,241,174	3,367,244	5,608,418	89,582
..2 Booster Modifications	2,639,000	788,871	171,699	237,760	267,663	1,465,993	1,022,607	2,488,600	150,400
..3 Beam Transport System	2,471,000	674,152	106,807	176,007	170,640	1,127,606	1,056,805	2,184,411	286,589
..4 Controls & Personnel Safety System	615,000	237,187	49,050	122,902	94,682	539,821	119,662	659,483	(44,483)
..5 Exp. Area Outfitting	1,300,000	0	0	788,414	94,131	882,545	894,213	1,776,758	(476,758)
..6 Long Term Support Lab	383,000	0	2,095	286,650	45,112	333,857	637	334,494	48,506
..7 Installation & Services	1,552,000	360,322	20,407	69,467	85,065	535,261	909,641	1,444,902	107,098
..8 Project Services	1,969,000	601,874	0	44,397	644,110	1,290,381	5,745	1,296,126	672,874
CONTINGECY	200,000					0		0	200,000
SPARES	123,000		11,235	10,044	3,814	25,093	11,308	36,401	86,599
BAF Construction	16,950,000	2,782,565	812,659	3,089,000	1,757,507	8,441,731	7,387,862	15,829,593	1,120,407

TABLE III
BOOSTER APPLICATIONS FACILITY (BAF)
COST ESTIMATE
Spending Profile
($ in Thousands)

		TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
1.1	Conventional Construction	5,698	290	80	4,728	600	0	0
1.2	Booster Modifications	5,251		282	1,747	2,128	1,094	0
1.3	Beam Transport System	5,739		56	963	2,616	2,104	0
1.4	Controls & Personnel Safety System	1,557		8	507	309	733	0
1.5	Exp. Area Outfitting	3,068		0	1,200	502	1,242	124
1.6	Long Term Support Lab	456		0	383	73	0	0
1.7	Installation & Services	2,739		9	1,237	827	666	0
1.8	Project Services	3,659	10	165	985	949	915	635
		28,168	300	600	11,750	8,004	6,754	759
	Contingency	3,040	0	0	0	200	2,390	450
1 (TEC)	BAF Construction (BA AY $)	31,207	300	600	11,750	8,204	9,144	1,209
	Spares	1,294			50	396	656	192
	Commissioning	1,399					0	1,399
1 (TPC)	Total Project Cost (BA AY $)	33,900	300	600	11,800	8,600	9,800	2,800
1 (TPC)	BAF Construction (BO AY $)	33,900	300	600	5,348	11,452	12,500	3,700

TABLE IV
BAF CHANGE CONTROL
$1000's

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
6/30/00	1	1.1		3,803	870	4,673			Modified WBS elements to include overhead, escalation and FCR.
		1.2		3,742	1,109	4,851			
		1.3		4,478	1,160	5,638			
		1.4		1,236	321	1,557			
		1.5		2,710	358	3,068			
		1.6		351	104	455			
		1.7		1,708	463	2,171			
		1.8		1,129	2,129	3,258			
			Contingency	3,796	1,037	4,833	4,833	4,833	
			Overhead	4,649	0	0			
			Escalation	1,912	0	0			
			FCR	993	0	0			
8/31/00	2	1.1		4,673	425	5,098	-425	4,408	Vendor Bid exceeded estimate
8/31/00	3	1.7		2,171	68	2,239	-68	4,340	Vendor Bid exceeded estimate
11/30/00	4	1.0		31,100	800	31,900	200	4,540	Modified spending profile to coinside with NASA operating plan
11/30/00	5	1.0		Changed Project Completion Date from 9/30/02 to 6/30/03					Modified schedule to match spending profile
11/30/00	6	1.3		Changed Completion Date from 4/31/02 to 9/30/02					Modified schedule to match spending profile
11/30/00	7	1.4		Changed Completion Date from 6/30/02 to 10/31/03					Modified schedule to match spending profile
11/30/00	8	1.5		Changed Completion Date from 6/30/02 to 3/31/03					Modified schedule to match spending profile

TABLE IV continued
BAF CHANGE CONTROL
$1000's

Date	Change No.	W.B.S.	Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
11/30/00	10	1.1	5,098	600	5,698	-600	3,940	Vendor Change orders to cover soil conditions, upgrading water line under beam tunnel and Plant Engineering oversight
11/30/00	11	1.2.1	1,322	200	1,522	-200	3,740	Design effort exceeded estimate
11/30/00	12	1.2.2	1,982	200	2,182	-200	3,540	Vendor bid exceeded estimate
11/30/00	13	1.7.1	353	200	553	-200	3,340	Substation reconditioning more extensive than estimated
11/30/00	14	1.7.2	641	300	941	-300	3,040	Detailed Design increased cost
12/30/00	15	1.3.2	1,513	-250	1,263	250	3,290	Vendor bids lower than estimate
12/30/00	16	1.3.4	2,007	-150	1,857	150	3,440	Detailed design resulted in lower device costs
12/30/00	17	1.3.1	599	400	999	-400	3,040	Vendor bids exceeded estimate,design effort exceeded estimate
12/30/00	18	1.2	Booster Modification Completion Date changed from 10/31/01 to 8/31/02					RHIC operating schedule modified,eliminating fy'01 summer shutdown
01/20/01	**19**	**1.2**	**Design complete extended from 12/31/00 to 6/30/01**					**Design effort extended due to loss of personnel.**