

Status Report: 16
Status as of: 30 November 2001

Contract Title:

BOOSTER
APPLICATIONS
FACILITY



Performing Organization:
Location:

Brookhaven Science Associates
Brookhaven National Laboratory
Upton, New York 11973-5000

Reporting Period:

October 1, 2001 – November 30, 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:

	<u>Last Month</u>	<u>This Month</u>
Cost:	satisfactory	satisfactory
Schedule	satisfactory	satisfactory
Technical	satisfactory	satisfactory
Overall	satisfactory	satisfactory

W.B.S. 1.0 BAF Construction Summary: The construction of the conventional facilities nears completion.

The D6 Septum magnet assembly was completed and testing has begun. Initial results are excellent. This is a critical component for extracting beam from the AGS Booster into the Beam line. All power supplies for Beam extraction have also been completed and are undergoing final testing at the Manufacturers' facilities.

All beam line magnets have been completed and installation of all magnets that can be installed without a Booster shutdown has been accomplished. The water-cooled buss installation is 95% complete. The beam line instrumentation hardware is on schedule and vacuum components are in production.

The Dosimetry system is on schedule.

The Project is estimated to be 60% complete as of November 30, 2001.

W.B.S 1.1 Conventional Construction:

Power Supply Building - structure substantially complete. Experimental equipment installations continuing.

Experimental Support Building – 90% complete. Painting, ceiling installation, and plumbing in progress.

Tunnel – substantially complete and experimental equipment installations continuing.

Site work and utilities - 95% complete.

Balance of site work and tunnel work to be completed upon shutdown of Booster at the end of April 2002. Conventional construction is 90% complete as of 11/30/01.

W.B.S. 1.2 Booster Modifications: (Critical Path)

1.2.1 New extraction equipment (94% complete)

1.2.1.1 Thin Septum: The thin septum test magnet was pulsed for 1 million cycles at 2000 amps at a rep rate of 2 cycles per second. The test repetition rate was twice that of the normal pulse rate and the current was 30% higher than the nominal value exceeding design specifications. The vacuum chambers are on order. The drive mechanisms are being wired for computer control testing. The drawings are being released to the shops. A complete septum coil for installation in the ring has been fabricated and leak checked. 70% complete.
Installation: 0% complete.

- 1.2.1.2 Thick Septum Magnet: The assembly of the magnet has been completed. The magnet is currently being powered for testing and field measurement. Upon completion of testing the final installation of the stripper/collimator/flag will be performed. All parts have been cleaned and baked for vacuum. Final vacuum testing will be performed after delivery projected date of the equipment for bake out.
100% complete.
Installation: 0% complete.
The assembly of the spare magnet is in process (75% complete).
- 1.2.1.3 D6 Foil Stripper/Collimator: 100% complete; ready for installation during booster shutdown.
Installation: 0% complete.
The manufacture of the parts for the spare stripper/collimator is about 90% complete.

1.2.2 Power Supplies: 75% complete

- 1.2.2.1 Thin Septum Supply: Manufacture and test: 95% complete.
Installation: 50% complete
- 1.2.2.2 Ejection Septum Supply: Manufacture and test: 95% complete
Installation: 50% complete
- 1.2.2.3 Tune Quadrupole Supplies: Manufacture and test: 95% complete
Installation: 10% complete
- 1.2.2.4 Sextupole Supplies: Manufacture and test: 95% complete
Installation: 10% complete
- 1.2.2.5 Bumps: Manufacture and test: 75% complete.
Installation: 10% complete.
- 1.2.2.6 Spill Servo: Electronics Complete. Over all - 70% complete.
Installation: 10% complete.

1.2.3 Equipment Modifications: 50% complete

- 1.2.3.1 D4 and D6: Parts in fabrication: 50% complete.
Installation: 0% complete.
- 1.2.3.2 D6 Beam Dump and Wall Current Monitor (WCM): Complete.
Installation: 0% complete
- 1.2.3.3 D3 IPM and Beam Dump Kicker: The design is complete.
Installation: 0% complete
- 1.2.3.4 Vacuum System Modifications: All heating blankets are on order and some blankets have been received. 40% complete.
Installation : 0% complete.

W.B.S. 1.3 Beam Transport System

1.3.1 Magnets: All beam line magnets are complete; most have already been placed in tunnel.

1.3.2 Power Supplies: Manufacture and test: 75% complete.

1.3.3 Vacuum System: 60% complete

1.3.3.1 Beam Tubes, Bellow and Valves: Pump tee support stands have been fabricated and are complete. An ILR was submitted to Central shops for beam pipe support stands and bellows spreaders. The pump tees were received and are being leak checked. The transport line spool pipe drawings are in checking. Some special chambers and bellows were received and are being tested. 45% complete.

1.3.3.2 Pumps, Power Supplies and Gauges: The turbo roughing pumps stations have been assembled. The controls for the turbo stations are being fabricated. All components have been received.
75% complete.

1.3.3.3 The vacuum control system PC has been prepared for PLC program development. Additional wiring components were ordered and received. Power requirements were updated. Discussions on the Vacuum system to Controls system interfaces continued.
44% complete.

1.3.3.4 Transport Line Bake-out System: All blankets are on order except for two valve blankets, which are being checked at the present time. Control modules for the bake-out cart are on order.
50% complete.

1.3.4 Instrumentation: 60% complete

1.3.4.1 The flag design is complete and parts are in fabrication. Most purchased parts received (except flag material). This uses a 24-volt ball screw actuator with automatic "freewheel" when full in or full out position is achieved. A timed relay (10 seconds) will be used. A trip switch will send a signal for full in and full out. The electronic components for the data acquisition system are on order. Design of stand with adjustable mirror mount and sliding camera system is complete. Drawings are in checking/release process.
60% complete.

1.3.4.2 Beam Plug: Stepping motor and position transducer cable has been ordered. We have received the stepping motors, VME controller board and motor drivers. Details of the rack layout in building 930A for the motion control and interface with the Controls have been worked out.

Design of stand and vacuum box is complete. Drawings are in checking/release process. All actuator hardware has been received. This will have the same exact motor and rotary trip switch as the SWIC-Ion-Scintillator system. The accuracy of the rotary trip switch is more than adequate for this application.
40% complete.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillators and SWICS: 65% complete

- Effort continues on the assembly of SWIC electronics. An upgraded version of the existing SWIC electronics scanner euro-card with remote control gain is being redrawn. Design of vacuum components and motion system is complete. Stands and vacuum box are in the queue for fabrication at the Central shops facility. Due date is mid December. The first thin-window vacuum chamber was received (from Atlas Technologies).
- Continue development of signal transfer interface between C-AD and BAF. The C-AD Controls group has suggested a possibility of using one of their existing boards as the logic portion of the interface, thereby making it a standard Controls component.
- Details regarding the electronic communications between the Instrumentation hardware and the C-AD Control group have been documented. Discussions about the high level Controls applications requirements are underway.
- Most of the Bira High Voltage VME pods and VME boards have been received and the VME chassis should be shipped by year-end. Many smaller components, which were previously ordered, have been received. Assembly and testing continues.
- Conduit layout of for the signals cables has been submitted. The racks for the Equipment building (B-957) are ready to be transported and installed.

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

1.4.1 Controls: 60% complete.

1.4.1.1 Distributed systems: The BAF permit monitor has been routed and all documentation is now complete.

1.4.1.2 Central Services: Software development continued.

1.4.1.3 Process Controls: The type of scalar needed for the instrumentation was selected and the circuit board has been ordered. The RHIC V115 wave-form generator was modified to accommodate interface to the PSI. Testing of the modification was successful. Controls hardware and software integration meetings were begun.

Overall -: Hardware - 95% complete.

Software - 10% complete.

1.4.2 Personnel Safety System: The construction of the sub-systems hardware is over 70% complete. The CCTV and card reader system design is complete and preliminary discussion with the plant engineering personnel for their installation was conducted.

W.B.S. 1.5. Experimental Area Outfitng

1.5.1 Dosimetry Control: 60% complete

Software: Work continues on the foundation of the system (channels for the new ring / quad ion chambers and for the 16 by 16 ion chamber; refinement of various displays).

The dosimetry calibration procedure is about 95% done.

The sample irradiation procedure is about 80% done.

Work has started on a document defining the procedure to calibrate the 16-channel recycling integrator, VME cards for the new ring / quad ion chambers and for the 16 by 16 ion chamber.

Hardware: The Recycling Integrator module is in final board layout. The Binary Filter Driver chassis has been drafted. The High Voltage system has been fabricated and the final drafting is beginning now, after fabrication. All cables have been specified except for the lengths, pending final decision on layout.

1.5.2 Support Rooms – General: Component selection and purchasing in process. 10% complete.

1.5.3 Support Room A: Component selection and purchasing in process. 10% complete.

1.5.4 Support Room B and C: Component selection and purchasing in process. 10% complete.

W.B.S. 1.6 Long Term Support Lab: 90% complete

The majority of the required equipment has been purchased and installed.

W.B.S. 1.7 Installation and Services:

1.7.1 Electric Power Distribution: A temporary feed from one substation to the other was installed to allow testing and commissioning to continue while a transformer is being repaired. The repaired transformer should be back on site by early February. 90% complete.

1.7.2 Equipment Cooling Water: Progress is on schedule. Presently, there are no known major obstacles. Cooling Tower - The Cooling Tower installation is nearly complete. Supply and Return lines are in place, Ozone and drain lines have been installed. Heat tracing and insulation remain to be completed along with ancillary tower controls.

Pump Room – Pump Room activity is moving along at a rapid pace. All pumps and their heat exchangers have been installed. The PLC cabinet preparation has been completed for Pump Room installation in the coming month.

Magnet Piping - The major portion of tunnel piping is complete. All installed pressure piping has been tested. The remaining portion can't be installed until access to the Booster Tunnel is provided during the planned shutdown to begin on May 1, 2002.

Power Supply Piping – Piping to the supplies in Bldg 957 is under design. This item remains to be submitted to the contractor for bidding. The major piping underground between 957 and 930 was installed early in the construction stage. The pumps, heat exchanger, temp control and all pump room piping are now complete. The piping distribution within 930 remains to be completed. This can't be started because of limited access and has been scheduled during the shutdown early next year. The contract for this effort is in place.

Overall - 90% complete.

- 1.7.3 Installation: Water-cooled buss installation is 95% complete. Fifteen Magnets have been placed in the tunnel. Magnet survey is 25% complete.
Overall - 50% complete.

W.B.S. 1.8 Project Services

- 1.8.1 Project Management: Strong effort in all areas continued during this reporting period. In consultation with the DOE Project Manager, \$924,000 was assigned from contingency. This leaves a balance of \$1,916,000 on \$8,349,530 remaining to be expensed and committed. The details of these actions are outlined in Section 3) f and Table IV. Starting with this report, progress estimates for each WBS are given.
- 1.8.2 Fiscal: Fiscal year 2002 funding in the amount of \$4,028,572 was received during this reporting period. This brings the cumulative funding to date to \$25,309,572.
- 1.8.3 Quality Assurance: No issues.
- 1.8.4 Environment, Safety and Health: Open Items: SAD has been completed and awaits DOE approval. Beneficial Occupancy Reviews are in progress.

3) Summary Status Assessment and Forecast

a) Financial Status

A total of \$23,637,470 was expensed or obligated of the \$25,309,572 available. Costs represented \$20,504,240 and open commitments stood at \$3,133,230. 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

<u>Milestones completed</u>	<u>Baseline</u>	<u>Actual</u>
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
Booster Mod. Design-Complete	06/30/01	06/30/01
Safety Analysis Document (SAD) Complete	09/30/01	06/15/01
<u>Milestones Upcoming</u>	<u>Baseline</u>	<u>Forecast</u>
Conventional Construction Complete	06/30/02	06/30/02

- e) The critical path for the Project is indicated in Figure 1. The crucial parts of the critical path are items in WBS 1.2. 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 presently scheduled for May 1, 2002. Financial contingency will be maintained to assure this critical effort is completed during the shutdown.
- f) Baseline Change Proposals – During this reporting period, the budgets for the following WBS's were augmented with funds from contingency. The justification for the modifications are given in Table IV. There is no change in scope or total project cost.

WBS	Description	New Budget
1.1	Conventional Construction	\$6,500,000
1.2	Booster Modifications	\$5,351,000
1.3	Beam Transport System	\$5,764,000
1.7	Installation & Services	\$3,096,000

- g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations and expenses were \$427,300 higher than predicted, and expenses were \$274,200 higher. These results reflect the early start of Beam line installation and the aggressive use of available manpower in preparation of the critical path activities during shutdown.

Table I
BAF Project Milestones

	<u>Projected</u>
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	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 2

BAF Performance Measurement

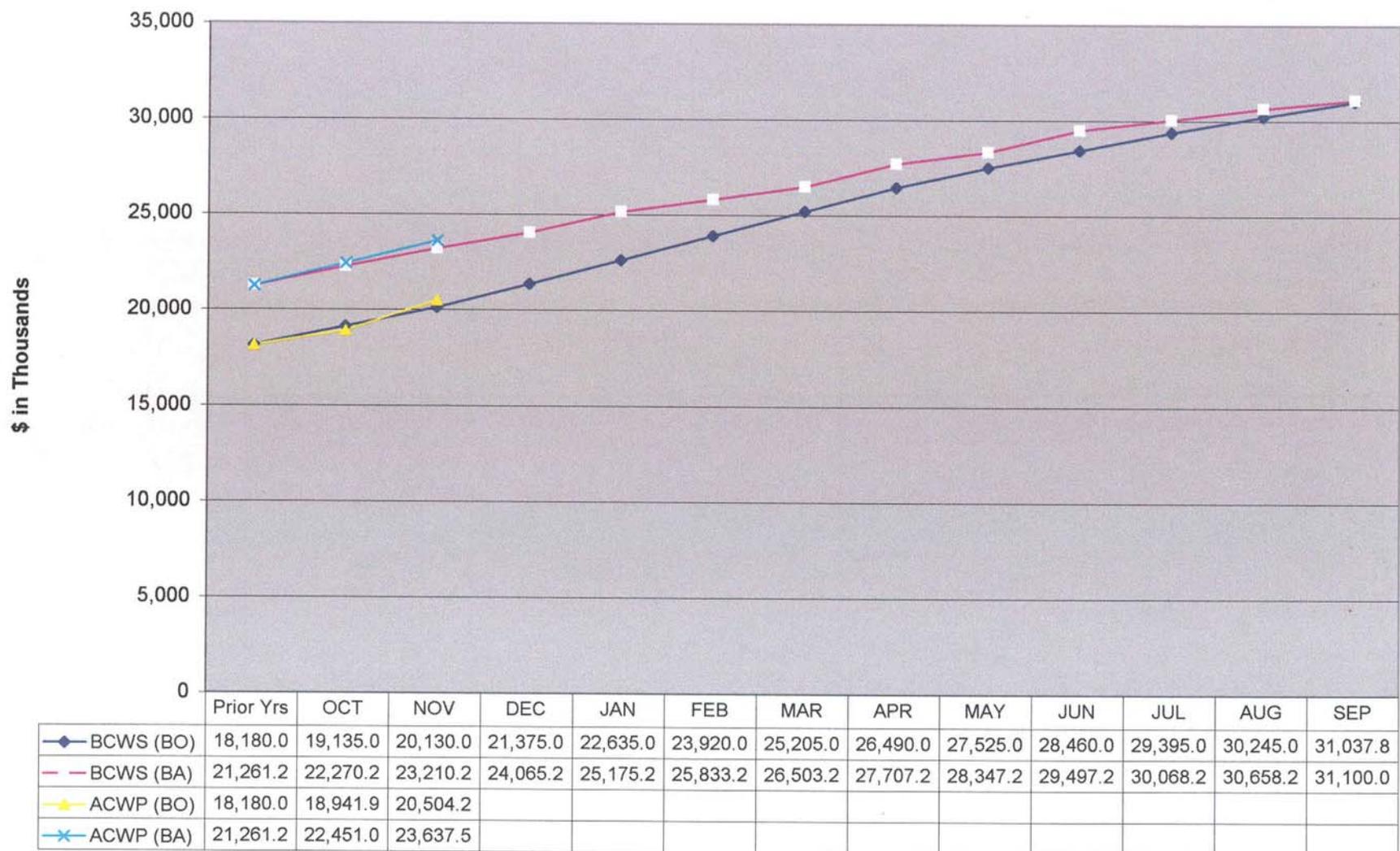


TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of November 30, 2001

	Budget	Salary & Wage	EXPENSES			TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
			Other Labor	Material & Contracts	Overhead				
1.1 Conventional Construction	6,500,000	125,760	771,253	4,281,001	525,977	5,703,991	660,964	6,364,955	135,045
1.2 Booster Modifications	4,668,000	1,548,096	310,307	1,101,659	609,587	3,569,649	923,069	4,492,718	175,282
1.3 Beam Transport System	4,355,000	1,393,982	219,150	1,081,820	510,719	3,205,671	829,538	4,035,209	319,791
1.4 Controls & Personnel Safety System	1,158,000	422,313	51,195	487,235	197,867	1,158,610	40,025	1,198,635	(40,635)
1.5 Exp. Area Outfitting	2,300,000	19,874	0	1,704,067	149,511	1,873,452	316,960	2,190,412	109,588
1.6 Long Term Support Lab	383,000	0	2,095	299,658	48,229	349,982	2,279	352,261	30,739
1.7 Installation & Services	2,670,000	645,587	93,959	1,423,338	326,877	2,489,761	222,744	2,712,505	(42,505)
1.8 Project Services	2,190,572	786,469	339	65,219	1,105,157	1,957,184	5,745	1,962,929	227,643
CONTINGECY	333,000					0		0	733,000
SPARES	352,000	325	65,298	97,411	32,906	195,940	131,906	327,846	24,154
1 BAF Construction	25,309,572	4,942,406	1,513,596	10,541,408	3,506,830	20,504,240	3,133,230	23,637,470	1,672,102

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	6,500	290	80	4,628	989	513	0
1.2 Booster Modifications	5,351		282	1,747	1,886	1,436	0
1.3 Beam Transport System	5,764		56	961	2,547	2,200	0
1.4 Controls & Personnel Safety System	1,557		8	497	579	473	0
1.5 Exp. Area Outfitting	3,068		0	1,200	679	1,065	124
1.6 Long Term Support Lab	456		0	343	0	113	0
1.7 Installation & Services	3,096		9	1,237	1,117	733	0
1.8 Project Services	3,499	10	165	985	650	1,034	655
	29,941	300	600	11,598	8,447	8,217	779
Contingency	1,544	0	0	0	0	1,485	431
1 (TEC) BAF Construction (BA AY \$)	31,207	300	600	11,598	8,447	9,052	1,210
Spares	1,294			50	266	787	191
Commissioning	1,399					0	1,399
1 (TPC) Total Project Cost (BA AY \$)	33,900	300	600	11,648	8,713	9,839	2,800
1 (TPC) BAF Construction (BO AY \$)	33,900	300	600	5,348	11,932	12,858	2,862

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	
06/30/00	1	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8		3,803 3,742 4,478 1,236 2,710 851 1,708 1,129	870 1,109 1,160 321 358 104 463 2,129	4,673 4,851 5,638 1,557 3,068 455 2,171 3,258			Modified WBS elements to include overhead, escalation and FCR.	
			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				
08/31/00	2	1.1		4,673	425	5,098	(425)	4,408		Vendor bid exceeded estimate
08/31/00	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 coincide with NASA operating plan
11/30/00	5	1.0		Changed Project Completion Date from 09/30/02 to 06/30/03						Modified schedule to match spending profile
11/30/00	6	1.3		Changed Completion Date from 04/31/02 to 09/30/02						Modified schedule to match spending profile
11/30/00	7	1.4		Changed Completion Date from 05/30/02 to 03/31/03					Modified schedule to match spending profile	
11/30/00	8	1.5		Changed Completion Date from 06/30/02 to 03/31/03					Modified schedule to match spending profile	
11/30/00	9	Commissioning		Changed Completion Date from 09/30/02 to 06/30/03					Modified schedule to match spending profile	
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 & 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	

**TABLE IV
BAF CHANGE CONTROL
\$1000's
(continued)**

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
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 08/31/02					RHIC operating schedule modified, eliminating FY01 summer shutdown
01/20/01	19	1.2		Design complete extended from 12/31/00 to 06/30/01					Design effort extended due to loss of personnel
09/30/01	20	1.8		3,659	160	3,499	160	3,200	Reduced budget due to projected lower project burden and fiscal and FS&H expenses.
09/30/01	21	1.1		5,698	(200)	5,898	(200)	3,000	Increase engineering design effort for electrical distribution & building modifications
09/30/01	22	1.7		2,739	(160)	2,899	(160)	2,840	Increased budget required for higher than expected vendor bids
11/30/01	23	1.1		5,698	602	6,500	(602)	2,238	Increase required for HVAC controls, doors and canopy at alcove, HVAC duct work, structural steel work, berm liner, engineering and inspection and overhead costs increases.
11/30/01	24	1.2		5,251	100	5,351	(100)	2,138	Increase required for D3 septum development and buss work fabrication for D3 and D6 power supply installation.
11/30/01	25	1.3		999	25	1,024	(25)	2,113	Increase required for magnet monitoring system and octupoles.

TABLE IV
BAF CHANGE CONTROL
\$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
11/30/01	26	1.7		2,899	197	3,096	(197)	1,916	Increase required for electrical distribution system transformer rework and cooling system changes for power supplies.