

Status Report: 24
Status as of: 31 March 2003

Contract Title:

BOOSTER
APPLICATIONS
FACILITY



Performing Organization:
Location:

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

Reporting Period:

February 1, 2003 – March 31, 2003

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: All systems are complete except for the dosimetry system. Successful tests of the major dosimetry elements have been completed at LBNL and installation of components on the optical bench is in progress.

The Commissioning effort focused on the beam line power supplies.

W.B.S 1.1 Conventional Construction: Complete

W.B.S. 1.2 Booster Modifications: Complete

W.B.S. 1.3 Beam Transport System: Complete

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

1.4.1 Control system installation was completed with final fiber-optic connections to the permit system modules. Full commissioning of that system awaits dosimetry system installation.

W.B.S. 1.5 Experimental Area Outfitting:

1.5.1 Dosimetry Control: 90% complete

The binary filter and controller, control system electronics, high voltage system and cables are now at BNL.

The recycling integrator and accelerator interface boards have been fabricated and are being stuffed. The boards will be shipped to BNL as they are completed.

BNL staff were at LBNL in February for training and a successful end-to-end test of the system.

1.5.2 Support Rooms: Complete

For General NSRL use, we purchased a total of 6 User Computers plus 2 computer security systems, and 1 Physics Dosimetry computer, 7 power strips with surge protectors, a conference table, 5 stacking chairs, 6 conference chairs, 2 erasable marker boards, 1 computer desk, 1 regular desk, 3 small desk/conference chairs, 2 tables, 1 medium desk chair, 1 locker and boot bench, 1 workbench, 1 clock, 6 coat hooks, 1 laser jet printer, 1 multipurpose (FAX/Scan/print) printer. For the Dosimetry computer, we purchased 1 Office XP Professional License, and 1 Office 2000 Professional - CD. We also purchased one cool-temperature incubator for nematode growth. For the Common use room, we purchased 1 Mini flow 8 Workstation with filter. For the C rooms, we purchased 2 Space saver Workstations, 2 Inverted Microscopes, 6 regulators for CO₂ (for CO₂ incubators), Corrosion Inhibitor Liquid (also (or CO₂ incubators), Hoover Floor Mate, 1 indoor recoiling hose. For the A rooms we purchased 2 plastic computer workstations. For the entrance to the Target area, we purchased 1 height-adjustable workstation.

W.B.S. 1.6 Long Term Support Lab: Complete.

W.B.S. 1.7 Installation and Services: Complete.

Commissioning: The 20 degree bend power was commission successfully this reporting period and now meets all design specifications.

W.B.S. 1.8 Project Services

- 1.8.1 Project Management: The delivery of the dosimetry is complete except for the recycling integrator circuit boards. A design error was discovered in the first article units and the subsequent corrective actions has delayed delivery of the production units. Complete system installation is now scheduled to be completed May 30, 2003. This will still give adequate time for the dosimetry system commissioning to be completed before the scheduled project completion date (June 30, 2003).

In consultation with the DOE Project Manager \$150,000 was assigned from contingency. This leaves a balance of \$100,000 on \$1,222,362 remaining to be expensed and committed. The details of these actions are outlined in section 3(f) and Table IV.

- 1.8.2 Fiscal: No change.

- 1.8.3 Environment, Safety and Health: The Accelerator Readiness Review has been completed for the experimental equipment .

Quality Assurance: No issues.

3) Summary Status Assessment and Forecast

a) Financial Status

A total of \$32,582,403 was expensed or obligated of the \$33,904,765 available. Costs represented \$32,385,830 and open commitments stood at \$196,573. The Project Total Estimated Cost (TEC) is \$31,527,000. The Total Project Cost (TPC) is at \$33,904,765.

- 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
Conventional Construction Complete	06/30/02	07/31/02
Booster Modification Installation Complete	09/30/02	09/30/02
Beam Line Installation Complete	12/31/02	01/24/03

<u>Milestones Upcoming</u>	<u>Baseline</u>	<u>Forecast</u>
Experimental Equipment Installation Complete	03/31/02	05/30/03

- e) The critical path for the Project is indicated in Figure 1. The last item remaining in WBS 1.3 is the installation of the dosimetry system. This completion date is now May 30, 2003 and this will still allow sufficient time for system commissioning.
- f) Baseline change proposals: During this reporting period a level III milestone, (1.5.1 Dosimetry System Installation Complete) was delayed two months because of a circuit board design flaw. Additionally, the budgets for the WBS's listed below were augmented /decreased with the transfer of funds to and from contingency. The justifications for the modifications are given in table IV. There is no change in scope or total project cost.

<u>WBS</u>	<u>Description</u>	<u>New Budget</u>
1.1.1	Conventional Construction	\$1,054
1.2.1	New Extraction Equipment	\$1,767
1.3.2	Power Supplies	\$ 998
1.7.3	Installation	\$1,670
1.8.1	Project Management	\$1,029
1.8.2	Fiscal	\$ 337
1.8.3	Quality Assurance	\$ 28
1.8.5	Burdens and Space Charge	\$1,608
Spares		\$1,084

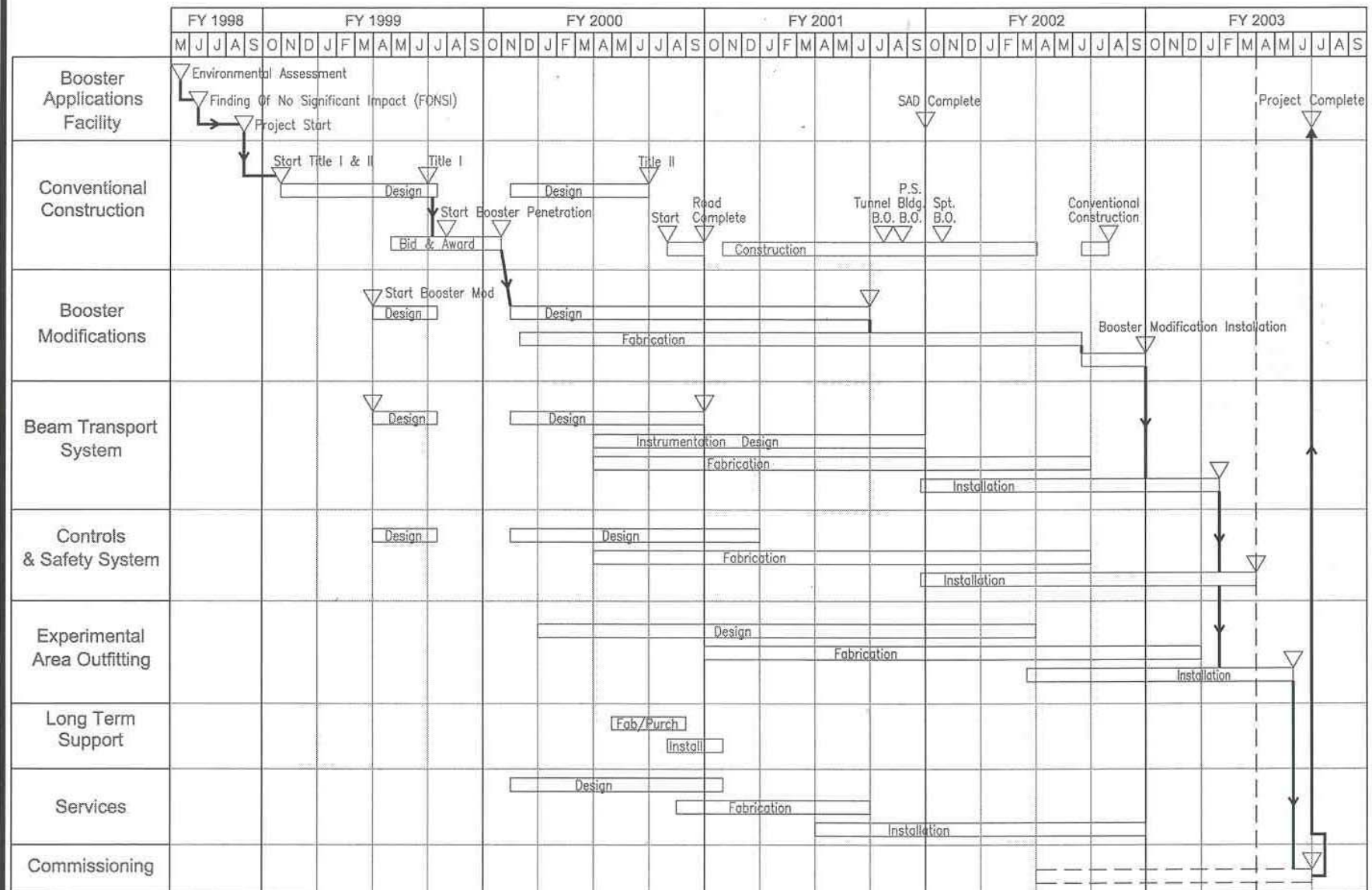
- g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations were \$618,000 less than planned, and expenses were \$764,000 less than forecast. These differences are not significant at this stage of the Project.

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	07/31/02
Booster Modifications Installation Complete	09/30/02
Beam Transport System Installation Complete	12/30/02
Experimental Equipment Installation Complete	05/30/03
Project Complete	06/30/03

Figure 1

Booster Applications Facility Master Milestone Schedule



→ Critical Path

* Milestones are for task completion unless otherwise noted.

Figure 2

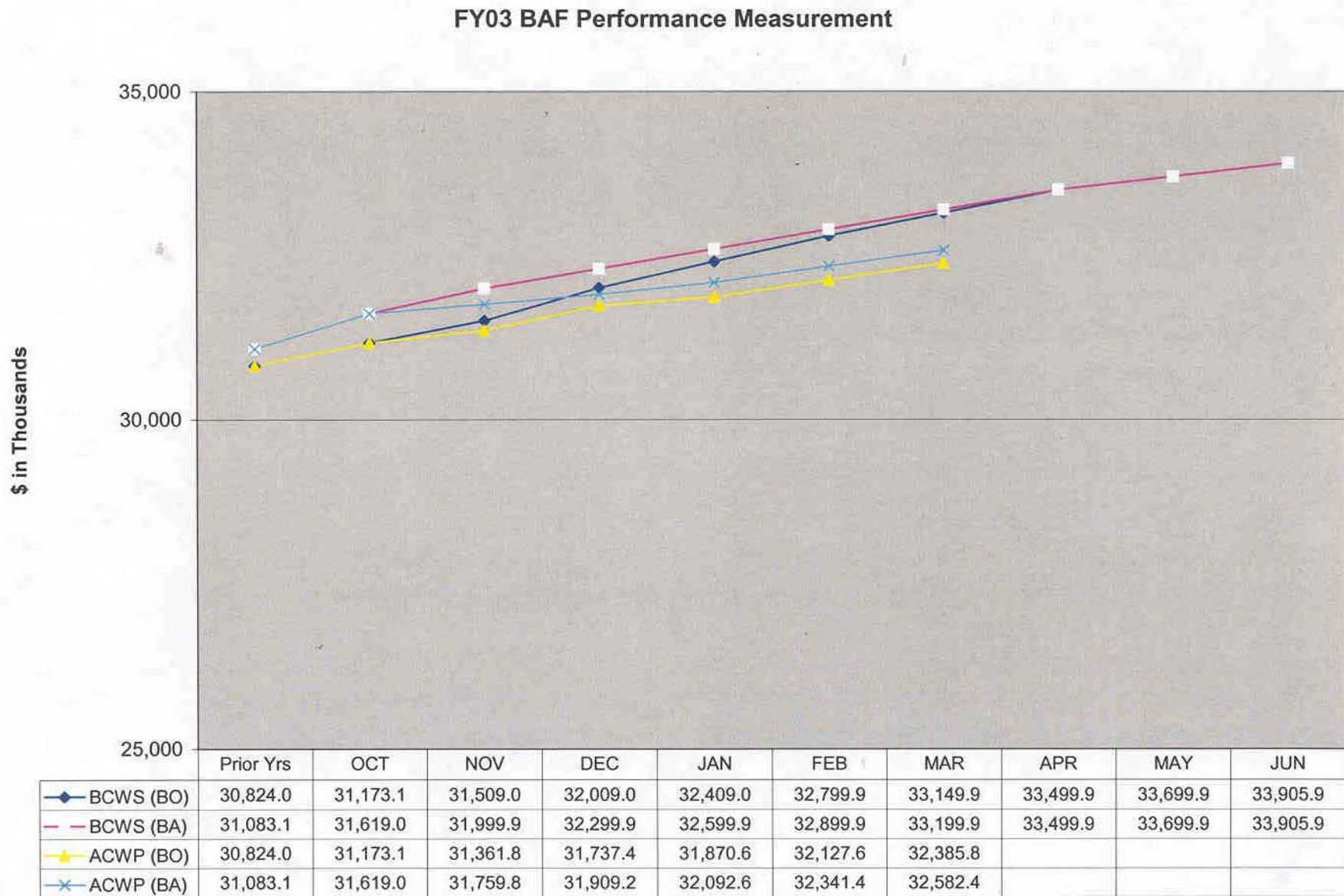


TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of March 31, 2003

	Budget	Salary & Wage	EXPENSES Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
1.1 Conventional Construction	6,648,000	133,094	984,081	4,928,058	602,725	6,647,958	0	6,647,958	42
1.2 Booster Modifications	6,066,000	2,181,196	722,524	2,163,676	997,999	6,065,395	0	6,065,395	605
1.3 Beam Transport System	5,706,000	2,189,374	401,293	2,167,862	899,046	5,657,575	40,108	5,697,683	8,317
1.4 Controls & Personnel Safety System	1,782,000	723,296	145,893	591,658	298,615	1,759,462	3,709	1,763,171	18,829
1.5 Exp. Area Outfitting	3,624,000	122,747	94,398	3,008,695	304,140	3,529,980	60,424	3,590,404	33,596
1.6 Long Term Support Lab	456,000		2,095	374,591	69,133	445,819	8,465	454,284	1,716
1.7 Installation & Services	3,681,000	1,025,357	298,488	1,867,581	480,772	3,672,198	0	3,672,198	8,802
1.8 Project Services	3,464,000	1,091,745	99,006	305,856	1,767,008	3,263,615	688	3,264,303	199,697
CONTINGECY	100,000					0		0	100,000
SPARES	1,084,000	103,276	88,978	496,187	134,533	822,974	32,935	855,909	228,091
Commissioning	1,293,765	260,005	74,597	70,916	115,336	520,854	50,244	571,098	722,667
1 BAF Construction	33,904,765	7,830,090	2,911,353	15,975,080	5,669,307	32,385,830	196,573	32,582,403	1,322,362

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

WBS	ELEMENT	TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
1.1	Conventional Construction	6,648	290	80	4,628	989	648	13
1.2	Booster Modifications	6,066		282	1,747	1,886	2,059	92
1.3	Beam Transport System	5,706		56	961	2,547	1,927	215
1.4	Controls & Personnel Safety System	1,782		8	497	579	563	135
1.5	Exp. Area Outfitting	3,624		0	1,200	679	1,385	360
1.6	Long Term Support Lab	456		0	343	0	113	0
1.7	Installation & Services	3,681		9	1,237	1,117	1,293	25
1.8	Project Services	3,464	10	165	985	650	1,321	333
		31,427	300	600	11,598	8,447	9,309	1,173
	Contingency	100	0	0	0	0	0	100
1 (TEC)	BAF Construction (BA AY \$)	31,527	300	600	11,598	8,447	9,309	1,273
	Spares	1,084			50	266	337	431
	Commissioning	1,294					175	1,119
1 (TPC)	Total Project Cost (BA AY \$)	33,905	300	600	11,648	8,713	9,821	2,823
1 (TPC)	BAF Construction (BO AY \$)	33,905	300	600	5,348	11,932	12,644	3,081

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 Overhead Escalation FCR	3,796 4,649 1,912 993	1,037 0 0 0	4,833 0 0 0	4,833	4,833	
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		1,122	200	1,322	(200)	3,740	Design effort exceeded estimate
11/30/00	12	1.2.2		2,182	200	2,382	(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

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	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	1.2.1		1,322	100	1,422	(100)	3,100	Design effort increased.
09/30/01	22	1.2.2		2,382	100	2,482	(100)	3,000	Buss work design effort increased.
09/30/01	23	1.7		2,739	160	2,899	(160)	2,840	Higher than expected Vendor bids
11/30/01	24	1.1		5,689	602	6,300	(602)		Increase required for HVAC controls, doors and canopy at alcove, HVAC duct work, structural steel work, berm liner, engineering and inspection and overhead cost increases
11/30/01	25	1.2.1		1,422	50	1,472	(50)	2,188	Increase required for D3 septum development.
11/30/01	26	1.2.2		2,482	50	2,532	(50)	2,138	Buss work fabrication for D3 and D6 power supply installation.
11/30/01	27	1.3.1		999	25	1,024	(25)	2,113	Increase required for magnet monitoring system and octupoles.
11/30/01	28	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.
01/31/02	29	1.1		6,300	300	6,600	(300)	1,616	Increased cost for engineering oversight.

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
01/31/02	30	1.2.1		1,472	100	1,572	(100)	1,516	Development and manufacturing costs exceeded estimates.
01/31/02	31	1.2.3		1,547	200	1,347	200	1,716	Design and manufacturing costs lower than estimate.
01/31/02	32	1.3.1		1,024	200	1,224	(200)	1,516	Fabrication and procurement exceeded estimate.
01/31/02	33	1.3.2		1,263	300	963	300	1,816	Procurement costs lower than estimate.
01/31/02	34	1.3.3		1,620	100	1,720	(100)	1,716	Fabrication costs exceeded estimate.
01/31/02	35	1.4.2		486	100	586	(100)	1,616	Design change added costs to building access system.
3/31/02	36	1.2.1		1,572	50	1,622	(50)	1,566	Cover increased manufacturing costs for thin septum magnet
3/31/02	37	1.2.2		2,532	150	2,682	(150)	1,416	Cover installation effort and materials for power supplies
3/31/02	38	1.5.1		2,706	296	3,002	(296)	1,120	Additional software and hardware effort required to complete Dosimetry system
3/31/02	39	1.7.3		1,245	50	1,295	(50)	1,070	Increased effort in survey and installation coordination
3/31/02	40	1.8.4		122	165	287	(165)	905	Funding to re-rout storm line located under Booster B 6 Dump
3/31/02	41	Spares		1,294	450	844	450	1,355	Spares estimate more than as built shops and manufacturer's costs
5/31/02	42	1.1		6,600	60	6,660	(60)	1,295	Cost increase for retaining wall
5/31/02	43	1.2.1		1,622	50	1,672	(50)	1,245	Magnet measurement cost increase
5/31/02	44	1.3.1		1,224	(135)	1,089	135	1,380	Magnet system came in under budget
5/31/02	45	1.7.1		685	25	710	(25)	1,355	Re-installation of repaired transformer
5/31/02	46	1.7.2		1,151	100	1,251	(100)	1,255	Control system cost increases
5/31/02	47	1.7.3		1,295	250	1,545	(250)	1,005	Rigging and survey costs exceeded estimates
5/31/02	48	1.8.4		287	75	362	(75)	930	Beam dump cap under estimated
7/31/02	49	1.1		6,660	(25)	6,635	25	955	Credits from Vendor
7/31/02	50	1.2.1		1,672	93	1,765	(93)	862	Installation underestimated
7/31/02	51	1.2.2		2,682	110	2,792	(110)	752	Buss work had to be reworked

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\$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
7/31/02	52	1.2.3		1,347	(16)	1,331	16	768	Work over estimated
7/31/02	53	1.4.2		586	65	651	(65)	703	Installation costs underestimated
7/31/02	54	1.7.1		710	10	720	(10)	693	Added installation effort
7/31/02	55	1.7.2		1,251	10	1,261	(10)	683	Increased costs
7/31/02	56	1.7.3		1,545	115	1,660	(115)	568	Survey and rigging cost underestimated
7/31/02	57	1.8.4		362	50	412	(50)	518	Requirements underestimated for Dump Cap
7/31/02	58	1.3.3		1,720	(138)	1,582	138	656	Job overestimated
9/31/02	59	1.2.2		2,792	25	2,817	(25)	631	Water cooled bus system required extensive rework
9/31/02	60	1.2.3		1,331	76	1,407	(76)	555	D6 half cell required modification
11/30/02	61	1.2.1		1,765	25	1,790	(25)	530	Installation redone because of component rework
11/30/02	62	1.2.2		2,817	75	2,892	(75)	455	Rework of water cooled buss
11/30/02	63	1.3.1		1,089	35	1,124	(35)	420	Low field magnet measurements and installation hardware
11/30/02	64	1.3.4		1,857	145	2,002	(145)	275	Instrumentation production cost increase
11/30/02	65	1.4.2		651	60	711	(60)	215	System documentation costs underestimated.
11/30/02	66	1.7.1		720	15	735	(15)	200	Labor costs underestimated
11/30/02	67	1.8.1		1,089	(35)	1,054	35	235	Management oversight costs reduced
11/30/02	68	1.8.2		412	(50)	362	50	285	Fiscal oversight costs reduced
11/30/02	69	1.8.4		412	50	462	(50)	235	ES&H oversight costs increased
11/30/02	70	1.9.2		1,405	(110)	1295	110	345	Commissioning costs re-estimated
11/30/02	71	1.8.5		1,835	(165)	1670	165	510	Burdens and space charges re-estimated
11/30/02	72	1.5.1		3,002	260	3,262	260	250	Beam line target area support systems funded.
03/31/03	73	1.1.1		1,041	13	1,054	(13)	237	Impervious liner field change
03/31/03	74	1.2.1		1,790	(23)	1,767	23	260	Redistribution of costs between installed unit and spare thick septum
03/31/03	75	1.3.2		963	35	998	(35)	225	Monitoring system installation 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
03/31/03	76	1.7.3		1,660	10	1,670	(10)	215	DC cable installation exceeded estimate
03/31/03	77	1.8.1		1,054	(25)	1,029	25	240	Management oversight costs reduced
03/31/03	78	1.8.2		362	(25)	337	25	265	Fiscal management costs reduced
03/31/03	79	1.8.3		41	(13)	28	13	278	Quality Assurance costs reduced
03/31/03	80	1.8.5		1,670	(62)	1,608	62	340	Overhead cost lower then estimated
03/31/03	81	Spares		844	240	1,084	(240)	100	Rework of thick septum and foil stripper to conform to design change.