ELECTRON BEAM ION SOURCE

DOE Review Documents

Department of Energy Review of the Electron Beam Ion Source Project (EBIS)

May 15 – 16, 2006

Department of Energy Review
of the
Electron Beam Ion Source Project (EBIS)

Brookhaven National Laboratory
Building 490
Medical Research Center Conference Room

May 15 – 16, 2006

AGENDA

Monday, May 15, 2006

08:00	Executive Session – FPD Perspective, Charge	
08:30	Welcome	P. Bond
08:45	Project Overview	J. Alessi
09:45	R&D Status	E. Beebe
10:15	Break	
10:30	Physics Status and Startup / Commissioning Plan	D. Raparia
11:15	Preliminary Engineering Status and Preliminary Design Status	L. Snydstrup
12:15	Lunch	
13:30	ES&H	E. Lessard
14:00	Cost, Schedule, Risk Management, etc.	K. Mirabella
14:45	Description of Financial Tracking System	S. LaMontagne
15:15	Break/Tour	
16:15	Executive Session	
19:00	Dinner	

Tuesday, May 16, 2006

08:30	Homework Assignments, Q&A
09:30	Break Out Sessions - TBD
11:00	Executive Session
12:30	Lunch
13:30	Report Writing
16:00	Closeout
16:30	Adjourn

Acquisition Strategy
For
Electron Beam Ion Source Project
(EBIS)
at Brookhaven National Laboratory

Lead Program Office:

Office of Nuclear Physics
Office of Science
U.S. Department of Energy

Total Project Cost:

$ 14.8 million

May 2006

CONCURRENCES:

______________________________ Date: ____________

Michael A. Butler
Federal Project Director
DOE Brookhaven Site Office

______________________________ Date: ____________

Michael D. Holland
Manager, DOE Brookhaven Site Office

______________________________ Date: ____________

Jehanne Simon-Gillo
Director for Facilities and Instrumentation Division,
Office of Nuclear Physics, Office of Science

______________________________ Date: ____________

Dennis Kovar
Associate Director of the Office of Nuclear Physics,
Office of Science

______________________________ Date: ____________

Daniel R. Lehman
Director, Office of Project Assessment
Office of Science

APPROVED:

______________________________ Date: ____________

Raymond L. Orbach
Director, Office of Science

ACQUISITION STRATEGY
for the
Electron Beam Ion Source (EBIS) Project

1. Desired Outcome and Requirements Definition

1.a. CD-0 Approval

At CD-0, the DOE total project cost (TPC) range was set at \$16.0–\$19.5 million but was reduced at CD-1 to \$12.1 to \$14.8 million. The scientific mission and technical scope have not changed since CD-0 approval. The original project schedule had been accelerated ~ 3 years to realize cost savings in Relativistic Heavy Ion Collider (RHIC) operations sooner, and use a \$4.5 million contribution from the National Aeronautics and Space Administration (NASA) to reduce the total cost of the project to DOE. With the NASA contribution and refinements during the project engineering design phase, the DOE TPC at CD-2 is 14.8M\$.

1.b. Summary Project Description and Scope

The mission of the Nuclear Physics (NP) program is to understand the evolution and structure of nuclear matter from the smallest building blocks, quarks and gluons, to the elements in the universe created by stars. A main objective of this nuclear science field is searching for the quark-gluon plasma and other new phenomena that might occur in extremely hot, dense plasma of quarks and gluons believed to have filled the universe about a millionth of a second after the "Big Bang." The proposed EBIS would be sited at the Brookhaven National Laboratory (BNL) RHIC, NP's flagship user facility for searching for new states of matter, such as the quark gluon plasma, created in hot, dense heavy ion collisions.

The Electron Beam Ion Source: The present pre-injector for heavy ions for RHIC uses the Tandem Van de Graaff accelerator, built around 1970, which if not replaced, will require substantial investments to maintain. BNL is proposing to construct a new heavy ion pre-injector for RHIC, the EBIS, which will lead to more reliable, cost-effective operations and new capabilities important for planned future upgrades of the facility. EBIS would also provide for a major enhancement in capability for the NASA Space Radiation Laboratory (NSRL), which utilizes heavy-ion beams from the RHIC complex. EBIS would allow for the acceleration of all important ion species for the NASA radiobiology program, such as, helium, argon, and neon that are unavailable with the present Tandem injector. In addition, the new system would allow for very rapid switching of ion species for NSRL experiments, reducing delays due to the interference with RHIC injection operations.

The project scope, including DOE and NASA contributions, includes the fabrication of an Electron Beam Ion Source for the production of high charge state heavy ions, plus the procurement of a Radio Frequency Quadrupole (RFQ) and heavy ion Linac to accelerate ions from EBIS to its final energy. A transport line is to be fabricated to transport the beam from the output of the Linac to the existing Booster heavy ion injection point, as shown below in Figure 1-1. The project includes the fabrication or procurement of the dipole and quadrupole magnets, power supplies, diagnostics, vacuum components, and controls to properly operate the EBIS source, accelerators, and beam lines. The project also includes the assembly of subsystems, and the installation and testing of these subsystems in their final location in the equipment bay at the high energy end of the Interdigital-H (IH) Linac building.

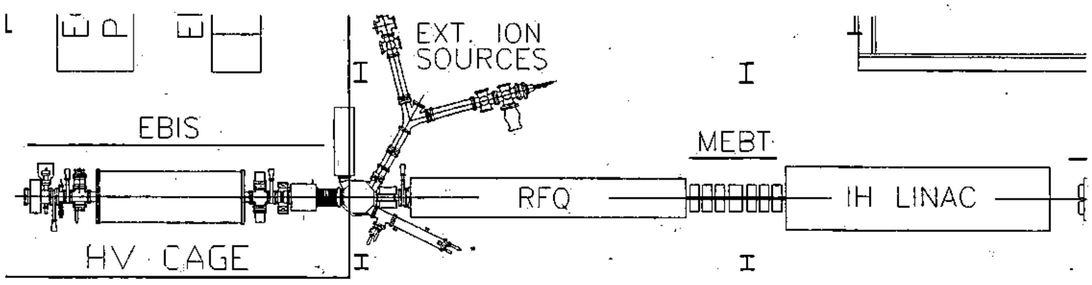


Figure 1-1 Layout of the pre-injector

The DOE scope is the following activities or procurements:

- All Project Engineering and Design (PED), installation, and commissioning for the entire project
- All EBIS chambers, internal structures, and warm magnets
- The Low Energy Beam Transport (LEBT) and external ion injection lines
- All vacuum components, controls, diagnostics, and cooling water systems
- All Medium Energy Beam Transport (MEBT) and High Energy Beam Transport (HEBT) beamline components, except for two HEBT dipoles
- All radio frequency (RF) systems for operation of the RFQ, Linac, and bunchers
- All power supplies for EBIS, LEBT, and external ion sources, except for the electron collector and fast pulsing EBIS platform supplies.
- Electrical services required for the operation of the pre-injector

The NASA scope is the procurement of the following items:

- The EBIS superconducting solenoid
- The Radio Frequency Quadrupole accelerator
- The Linac
- The buncher cavities
- The two HEBT dipole magnets and their power supplies
- The electron collector power supply
- All quadrupole magnet and steering magnet power supplies for the Linac,
- MEBT, and HEBT
- The fast pulsing power supplies for the EBIS drift tubes and platform bias.
- The beam port through the earth shielding between Linac and Booster.

The DOE deliverables are complete when all the items listed as DOE scope, above, have been procured or fabricated; the EBIS, RFQ, Linac, and beam transport lines have been installed; and the CD-4 requirements from Table 1-1 in the next section have been verified.

1.c. Performance Parameters Required to Obtain Desired Outcome

The technical objectives of the new pre-injector need to meet requirements of both the RHIC and NSRL experimental programs. The corresponding performance specifications required at CD-4 are described in Table 1-1. CD-4 performance is to be demonstrated at the Booster input.

Table 1-1

	CD-4 Performance
Species	Fe, Au
Intensity	3×10^8 Au^{32+} / pulse 4×10^8 Fe^{20+} / pulse
Charge-to-mass ratio, Q/m	0.162 (Au) 0.357 (Fe)
Repetition rate	Demonstration of pulsing
Pulse width	10-40 μs
Switching time between species	Demonstration of switching
Output energy	2 MeV/amu

2. Cost and Schedule

2.a. Total Project Cost

The TPC at CD-2 is $14.8 million, including contingency of $2.2 million. The project costs have been refined since CD-1 through a recent bottoms-up cost estimate. The cost estimate is based on current purchase orders, vendor quotes for equipment items and estimates for in-house labor to support design, procurement and installation. Current departmental labor rates and all applicable overheads have been included. The overall project contingency is calculated by estimating the contingency contribution from each Work Breakdown Structure (WBS) element. Each contingency contribution is based on an assessment of the cost, schedule, technical and design risk and then summed to give the total project contingency.

Life-cycle cost: The elements of the EBIS Project could have a useful life of up to 25 years. Operational costs are expected to be more cost effective than present operations with the Tandems, translating to an estimated cost savings in RHIC operations of $1.46 million annually. Costs to operate EBIS are included in the RHIC Operations budget and they are not considered incremental costs.

Table 2.1 Costs of major elements:

WBS	Title	M$
1.1	Structural components	1.4
1.2	Controls Systems	0.8
1.3	Diagnostics	0.7
1.4	Magnet Systems	0.3
1.5	Power Supply Systems	0.9
1.6	RF Systems	2.8
1.7	Vacuum systems	1.5
1.8	Cooling Systems	0.3
1.9	Facility Modifications	0.5
1.10	Installation	1.4
1.11	Project Services	1.1
1.12	Commissioning	0.2
1.13	R&D / CDR	0.7
subtotal		12.6
	Contingency	2.2
Total		14.8

2.b. Funding Profile

Table 2.2 shows the funding profile. Funds in Fiscal Year (FY) 2005 were for R&D and the development of a Conceptual Design Report (CDR); the Research & Development (R&D) efforts are completed in FY 2007. The design phases are funded from the PED funds. Construction activities are started in FY 2007. No construction funds will be used until Critical Decision 3 (CD-3), Approval to start construction, has been approved. Total funding requirements are consistent with the FY 2008 Project Data Sheet, but now reflect a shift of $100K from Preops to Construction in FY2008. The funding profile falls within the Program's outyear budget targets.

Table 2.2 Estimated Funding
(Then Year M$)

	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
R&D/CDR	0.7	0.1			
PED		2.0	0.1		
Const			7.4	4.3	
Preops				0.2	
TEC	-	**2.0**	**7.5**	**4.3**	-
TPC	**0.7**	**2.1**	**7.5**	**4.5**	-

2.c. Key Milestones and Events

Milestones will be used as schedule events to mark the due date for accomplishment of a specified effort or objective. A milestone may mark the start, an interim step, or the end of one or more activities as needed to provide insight into the Project's progress.

Table 2.3 Milestone Levels

Milestone Level	Description
0	Critical Decision milestones
1	Start and/or Completion of Major Project Phases
2	Milestones that support the accomplishment of the Level 0 and level 1 milestones
3	Milestones to monitor and assure progress

The following table shows the key performance milestones as presented in the PEP.

Table 2.4 Milestones

Level	Milestone	Date
0	Critical Decision 0 (CD-0)	Q4,04 (A)
0	Critical Decision 1 (CD-1)	Q4,05 (A)
0	Critical Decision 2 (CD-2)	Q4,06
0	Critical Decision 3 (CD-3)	Q1,07
0	Critical Decision 4 (CD-4)	Q2,10
1	RFQ procurement placed	Q4, 06
1	SC solenoid factory/acceptance test	Q2, 07
1	Linac Procurement placed	Q2, 07
1	Beam port complete	Q4. 07
1	Building addition approved for occupancy	Q2, 08
1	EBIS Safety Assessment Document complete	Q4, 08
1	CASE for EBIS approved by DOE	Q2, 09
1	HEBT dipole installation complete	Q4, 09
1	BHSO letter approving commissioning	Q4, 09
1	Beam out of EBIS	Q4, 09
1	Beam out of RFQ	Q1, 10
1	Beam out of linac	Q1, 10
1	Beam through HEBT	Q2. 10

Level	Milestone	Date
2	Electron collector procurement placed	Q1, 06 (A)
2	R&D EBIS installed on HV platform	Q1, 06 (A)
2	Superconducting solenoid procurement placed	Q2, 06 (A)
2	R&D High Voltage beam tests begin	Q1, 07
2	Electron collector pressure/vacuum tested	Q1, 07
2	EBIS Drift tube structure complete	Q2, 08
2	EBIS preassembly complete	Q3, 08
2	Electron collector ps acceptance tested	Q1, 09
2	ARR review team for EBIS appointed	Q1, 09
2	RF amplifiers acceptance tested	Q2, 09
2	RFQ tested to full power	Q2, 09
2	EBIS installation complete	Q3, 09
2	Accelerator Readiness Review	Q4, 09
2	Linac tested to full power	Q1, 10
2	HEBT dipole ps acceptance tested	Q1, 10
2	RFQ installation complete	Q1, 10
2	Linac installation complete	Q1, 10
2	HEBT beamline installation complete	Q2, 10

Critical Decision 2 approval, establishing the Performance Baseline, is planned for 4Q FY 2006. No construction funds will be used until CD-3 is approved.

3. Major Applicable Conditions

3.a. Environmental, Regulatory and Political Sensitivities

There are no environmental, regulatory or political sensitivities associated with the EBIS project; and there are no additional laws, agreements or other factors to significantly influence the project. BNL will provide staff with the required skills and experience to design and build the EBIS project onsite. In 2003, BNL received a NEPA categorical exclusion for "RHIC II", which included the EBIS project (Chicago office (CH) National Environmental Policy Act (NEPA) Tracking Number BNL-455).

3.b. Others

There are no significant other sensitivities.

4. Risk and Alternatives (Technical, Location, and Acquisition Approach)

4.a. Alternatives:

A considered alternative is to not proceed with the construction of EBIS. If the new linac-based pre-injector is not built, significant upgrades to the Tandems will be required in order to ensure reliable long-term operation for RHIC. Construction began for the Tandem Van de Graaff facility in 1966, and it was commissioned in 1970. Many of the Tandem systems date back to 1960's technology, and need modernization. If one were not to proceed with the EBIS Project, an estimated $9M in Tandem reliability upgrades would be required in order to prevent unexpected failures of the Tandem from suspending RHIC operations for extended periods. In addition, upgrading the Tandems will not lead to new performance capabilities that are needed for the long-term plans of the RHIC facility or NSRL.

Before selecting the EBIS, alternative high charge state heavy ion sources were considered; in particular the Electron Cyclotron Resonance (ECR) source, and the Laser Ion Source (LIS). The EBIS was chosen as best meeting the requirements for a new RHIC preinjector, based on considerations such as intensity, reliability, flexibility in the choice of species, fast switching between species, etc.

The RFQ is the only technology choice for the first acceleration stage of the EBIS beam. The IH linac structure was chosen as the next acceleration stage in the baseline design. This is a low-risk choice, since there are many linacs of this type in operation, particularly the IH linac at CERN for acceleration of lead, which almost exactly meets the EBIS requirements. A superconducting heavy ion linac was considered, but suffers from higher cost and increased operational complexity. During the future detailed design phase, alternative room-temperature linac structures will be considered.

There is no location alternative for the EBIS other than BNL. The RHIC at BNL is presently the world's only heavy-ion collider and the construction of EBIS would not be pursued by the NP program if it were not to be located at BNL.

4b. <u>Risk Analysis:</u>

Cost and Schedule Risk: To the extent feasible, procurements will be accomplished by fixed-price contracts awarded on the basis of competitive bids. Incremental awards to multiple subcontractors to assure total quantity or delivery will be performed to reduce schedule risk. The cost estimates are based in part on existing contracts for the prototype, actual cost of production of similar items, in part on budgetary quotes, and in part on engineering experience.

It is probable that the EBIS project will include foreign procurements. Due to the cost risk associated with an unfavorable dollar vs. Euro exchange rate change an average contingency rate of 35% has been applied to several key items. In addition, risk will be reduced by placing early procurements of some of these key items.

Uncertainties in the Booster operation schedule (for RHIC or NSRL) may impact the EBIS project schedule. This risk will be minimized by careful management of the project, since the majority of work can proceed in parallel with Booster operations. The HEBT dipoles, which can only be installed during a Booster shutdown, will be procured early to allow large schedule float. The beam port through the shielding wall between the linac and Booster is planned for early installation during summer of 2006, in order to minimize schedule risk, since this must also be done during a Booster shutdown period.

Delays in project funding due to Congressional Continuing Resolution could delay the placement of several key long-lead procurements. This is perceived to be a high risk, so BNL will work closely with DOE and NASA to insure that adequate funds are available for key procurement, and there will be an attempt to avoid scheduling large procurements for the first quarter of a fiscal year. In addition, it is expected that some funds will be carried over from a previous fiscal year into the next to avoid impacts of potential Continuing Resolutions on efforts planned for the beginning of a given year.

Funding and Budget Management: Funding for the DOE project scope comes from the Department of Energy through the Nuclear Physics program. EBIS is listed in the FY 2007 President's budget request as a line item construction project. The TPC is $14.8 million and is included in the NP five year budget. NASA is contributing $4.5 million for tasks and hardware identified as part of the NASA scope. Reductions of funding in any given year could slow the implementation of the project.

Technical and Engineering: The technical risks of the EBIS design are low. The successful EBIS ion source pre-conceptual R&D program at BNL has greatly decreased any risk related to a source of this type reaching the planned performance requirements. A prototype EBIS has operated with the full required electron beam current of 10 A, which is a factor of 20 improvement over previous EBIS sources. Since EBIS scaling laws are very well understood, the scaling of the source output by a factor of 2 from the prototype is achieved by a straightforward doubling of the EBIS trap length, that is, by doubling the length of the superconducting solenoid. The RFQ and the Linac accelerators are both mature technologies, with very similar devices operating successfully at BNL as well as at other accelerator laboratories. The present plan is to procure these devices from laboratories where several similar units have been built previously.

Interfaces and Integration Requirements: The project receives program guidance and funding from the Office of Nuclear Physics (NP) and NASA. The Associate Director of NP serves as the EBIS Acquisition Executive (AE). Jehanne Simon-Gillo, Director for Facilities and Project Management Division, DOE-NP, is responsible for programmatic guidance and funding for the EBIS. The Federal Project Director at the DOE Brookhaven Site Office, Michael A. Butler, carries out implementation and project direction. Jim Alessi, BNL, is the Contractor Project Manager managing the project. The project has been integrated with site activities at BNL through the establishment of an Integrated Project Team that includes members from the scientific staff, project management, procurement and Environmental Safety & Health (ES&H) organizations, as well as DOE and NASA.

The technical components produced by the project will be installed according to a detailed integration plan. An objective of the project is to minimize the impact to the ongoing research program at RHIC.

Safeguards and Security: The project activities are completely unclassified, and no safeguards and security issues during design and fabrication are foreseen. No BNL safeguards and security requirements will be impacted during the course of fabricating EBIS and no issues are anticipated during the installation and operation at Brookhaven. Access to the BNL site is controlled to ensure worker and public safety and for property protection.

Location and Site Conditions: Components of EBIS will be fabricated by vendors, collaborating institutions and BNL at their respective sites. Final assembly of EBIS will take place in Building 930 of BNL with a matching beamline to the present RHIC accelerator chain.

Legal and Regulatory: The EBIS project will be in full compliance with all applicable Federal, state and local requirements. There are no known legal or regulatory issues that could impact this project.

Environmental, Safety and Health: This project must comply with all requirements of the NEPA and its implementing regulations, the Occupational Safety and Health Act, the BNL Integrated Safety Management (ISM) Program and applicable ES&H policies and regulations. A NEPA review has been completed and a determination made that EBIS is included under a Categorical Exclusion covering a range of research and related activities. No negative impacts to the environment have been identified or are anticipated as a result of this project. The principles of ISM will be incorporated into EBIS planning and execution. A primary objective of this project is to protect the environment and the safety of workers and the general public.

Stakeholder Issues: There are no significant stakeholder issues anticipated. The primary stakeholder in this project is the RHIC, Alternating Gradient Synchrotron (AGS), NSRL and NP scientific user community.

5. Business and Acquisition Approach

The DOE Office of Nuclear Physics has selected BNL as the prime contractor for EBIS. The main reasons for selecting BNL are:

- Much of the expertise required in designing and fabricating the EBIS source resides with the BNL staff.
- BNL staff has played the lead role in carrying out the R&D.
- BNL has a DOE-approved procurement system with established processes and acquisition expertise needed to obtain the necessary instrument components and build EBIS.
- BNL has experience at managing the design and construction of similar significant pieces of scientific equipment.
- RHIC, which would utilize EBIS, is at BNL.

5.1 Acquisition and Contract Types

BNL, as the prime contractor, is responsible for the design, procurement, fabrication, assembly and integration of the EBIS components.

It is anticipated that other BNL staff will carry out a significant portion of the work associated with the fabrication of the EBIS under standard BNL management practices. In many cases they will be best suited to specify, select and oversee procurement and installation. However, some activities related to this project will be most efficiently, and/or cost effectively, performed by members at universities or at other national laboratories. Such work will be carried out using subcontracts or other appropriate instruments and agreements. The subcontracts will specify deliverables and will include provisions for reports on progress and expenditures. They will be established in accordance with standard DOE and BNL procedures.

The EBIS procurement strategy is to use full and open competition to the maximum extent possible. The following methods of competition will be used where appropriate: Requests for Proposals (RFP), resulting in best value procurements, and Requests for Quotations (RFQ), resulting in procurements to the lowest responsive, responsible offeror. Equipment and material will be procured through fixed-price contracts. Sole-source procurements of one-of-a-kind equipment would be necessary in a case where only one qualified bidder exists.

Specifications will be developed for major procurements to define the performance and delivery requirements. Test and acceptance procedures for equipment and material will be defined in the individual procurement specifications for each item based on the needs of its specific function and manufacturer's recommendations.

5.2 Incentive Approach/Linkage to Performance Metrics

Contract incentives are not planned, but may be used if project management believes they are essential to keep the project on schedule. Incentives, if used, will include specific performance measures to assure that the desired outcome is achieved. BNL's contract with the DOE is a performance-based contract with fee-bearing measures related to project performance.

5.3 Competition

All actions will be competitive and fixed price procurements unless specifically authorized by the project manager(s) and will be in accordance with the DOE-approved BNL procurement policies and procedures.

6. Management Structure and Approach

6.1 Integrated Project Team (IPT), Organizational Structure, and Staffing Skills

The structure of the DOE EBIS Project organization is shown in Figure 6.1.

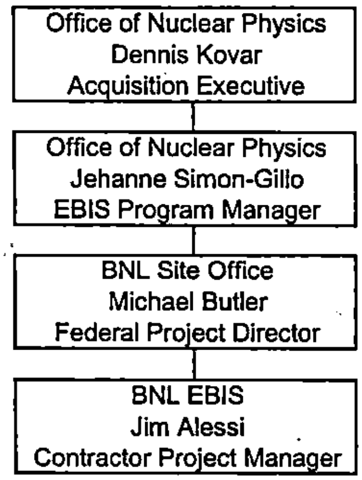


Figure 6.1. DOE EBIS Project Organization

Members of the EBIS IPT who participated in the writing of the Acquisition Strategy are shown with an * in Table 6.1. Consistent with DOE Order 413.3 and DOE Manual 413.3-1, there is an appropriate mix of skills among team members to successfully execute EBIS. Details regarding the IPT and BNL and DOE support functions for this project can be found in the preliminary Project Execution Plan. As the project progresses, membership of the IPT will change as needed.

Table 6.1 Integrated Project Team

DOE Federal Project Director (Chair)	Michael A. Butler*
DOE Site Contracting Officer	Michael D. Holland*
DOE Program Manager for EBIS	Jehanne Simon-Gillo*
DOE Science Program Manager	Gulshan Rai*
NASA Space Radiation Program Manager	Frank Sulzman
BNL Project Manager for EBIS	James Alessi*
BNL Procurement Operations Manager	David E. Dale*
BNL ESSH Lead	Ed Lessard
C-AD Assistant Chair for Administration	Stephanie LaMontagne

6.2 Approach to Performance Evaluation and Validation

The Federal Project Director will monitor and evaluate EBIS performance against technical, cost, and schedule baselines through monthly reports, quarterly performance reviews, and day-to-day operational awareness. Variances to performance baselines will be reviewed and approved by a formal Baseline Change Control process as described in the preliminary Project Execution Plan. In-depth annual performance reviews with a panel of experts will be organized by the Office of Nuclear Physics, with participation from the Office of Science Office of Project Assessment.

The Change Control process is documented in the Project Execution Plan (PEP). The project control levels are defined in a hierarchical manner that provides change control authority at the appropriate level. The highest level of baseline change control authority is defined as level 0. Technical performance will be monitored throughout the project to assure conformance to approved project requirements. Design reviews, Title III inspections, and performance testing of the completed systems will be used to ensure that the facility meets all project requirements.

6.3 Interdependencies and Interfaces

EBIS is led by the host laboratory (BNL) with support from a number of collaborating institutions. The scope, organization, division of responsibilities, approvals, reporting, reviews, safety oversight and financial accounting for the design and/or fabrication of EBIS components has been established in a Memorandum of Understanding between DOE and NASA. A Statement of Work between BNL and NASA is also in place.

Activities that are related to the project include RHIC operations and NASA Radiobiology operations. Installation of the major technical components of the EBIS Project will need to occur such as to minimize impact to RHIC and NSRL operations.

March 9, 2006

Dr. James Alessi
Mail Stop 0930
Brookhaven National Laboratory
Upton, NY 11973

Dear Dr. Alessi:

The Office of Nuclear Physics Facilities and Project Management Division is in the process of organizing an Annual Progress Review of the Electron Beam Ion Source (EBIS) Pre-injector for the Relativistic Heavy Ion Collider (RHIC). As you are aware, this review will take place at Brookhaven National Laboratory on May 15-16, 2006. This review is being organized with input and participation from the Department of Energy (DOE) Office of Project Assessment. A list of the members of the Review Panel and anticipated DOE and National Aeronautics and Space Administration (NASA) participants is enclosed.

The purpose of this review is to assess all aspects of the project's plans – preliminary technical design, cost, schedule, management, and Environment, Safety and Health (ES&H), as well as reviewing project documentation that will be considered for Critical Decision 2 (CD-2, Approve Performance Baseline). The following main topics will be considered at the review:

- The significance and merit of this proposed accelerator improvement project;
- The status of the technical design, including completeness of preliminary design and scope, feasibility and merit of technical approach;
- The feasibility and completeness of the proposed budget and schedule, including workforce availability;
- The effectiveness of the management structure and approach to ES&H;
- Other issues relating to the EBIS Pre-injector.

In addition to the above, the panel will be asked to evaluate drafts of project documentation that will be considered for CD-2, e.g., Hazard Analysis Report, Value Management/Engineering Report, Start-Up Test Plan and Risk Management/Assessment Plan.

The first day will consist of presentations by the laboratory and executive sessions. The second day will be used for a Question and Answer (Q&A), an executive session and preliminary report writing; a brief close-out will end at 3:00 p.m. Preliminary findings, comments and recommendations will be presented at the close-out. The panel members have been instructed to contact Sandy Asselta at BNL at (631)-344-4550 or E-mail: sandylee@bnl.gov regarding any logistics questions. Word processing, secretarial assistance, and wireless computer connection should be made available during the review.

I greatly appreciate your efforts in preparing for this review. It is an important process that allows our office to understand the project and serves as a readiness assessment for CD-2 approval. I look forward to a very informative and stimulating visit.

Sincerely,

Jehanne Simon-Gillo
Director
Facilities and Project Management Division
Office of Nuclear Physics

cc: Dennis Kovar, DOE
Gene Henry, DOE
Mike Butler, BNL Site Office
Derek Lowenstein, BNL
Sam Aronson, BNL
Frank Sulzman, NASA

SC-26.2:JSimonGillo:cld:3-1455:03/01/06: Q:\SimonGillo\Projects\EBIS\CD2 review\Charge Letters\Alessi Charge Letter_Final.doc

Enclosure found at:
Q:\SimonGillo\Projects\EBIS\CD2 review 2006\ Review Panel List.doc

SC-26.1	SC-26.2	SC-26
Rai	SimonGillo	Kovar
3/ /06	3/ /06	3/ /06

Start-Up Plan

for the

Electron Beam Ion Source (EBIS)

April 2006

1.0 Introduction

The EBIS Preinjector will be located in the lower equipment bay area of the linac building, with some equipment occupying an extension of the building. The preinjector will consist of an Electron Beam Ion Source (EBIS), Low Energy Beam Transport (LEBT), Radio Frequency Quadrupole (RFQ) accelerator, Medium Energy Beam transport (MEBT), a Linear Accelerator (Linac) and High Energy Beam Transport (HEBT). The preinjector will inject the ions into to the Booster via the existing Tandem to Booster (TTB) transport line end at the Booster inflector. This preinjector will provide all the ion species with required intensities to RHIC and NASA Space Radiation Laboratories (NSRL) at 2 MeV per nucleon.

The scope of the EBIS preinjector project includes procurement or fabrication of all components, the assembly of subsystems, and the installation and testing of these subsystems in their final location in the equipment bay at the high energy end of the H^- Linac building. The project will be completed upon meeting the technical base line specification given in the EBIS Project Execution Plan.

This preliminary start-up plan follows the facility operation roles and responsibility that have become customary at Brookhaven National Laboratory. The final version of this start up plan will include revisions, if necessary, to conform to the appropriate roles and responsibilities at the time of start-up.

2.0 EBIS Preinjector Performance

The EBIS raises the charge state of ~ singly charged ions injected from an external ion source, or ionizes neutrals from internal gas, to the required charge states by stepwise ionization via an intense electron beam focused by a superconducting solenoid. Ions are trapped in the EBIS by a potential well, created radially by the electron beam space charge, and axially by electrode voltages in the EBIS trap region. When the desired charge state is reached, the axial potential trap is lowered and ions are extracted into the LEBT. The EBIS will provide ions of all the ion species with the desired charge state and required intensities, and will provide a variable pulse length in the range of 10-40 μs. The LEBT is a compact matching line with both electrostatic and magnetic elements for focusing. It is required for transverse matching of the beam into the acceptance of the RFQ, initial injection of ions into EBIS from external ion sources, and direct injection into RFQ from an external source for lower mass ions like D. The RFQ is a four rod structure which will operate at 100.625 MHz. The RFQ is required to bunch the beam and provide acceleration from 17 keV/amu to 300 keV/amu.
The MEBT has magnetic quadrupoles for transverse matching and a buncher for longitudinal matching. The MEBT will provide a matched beam into the linac for all ion species. The Linac, an interdigital-H structure with internal quadrupole triplets for transverse focusing, will accelerate ions from 300 keV/amu to 2 MeV/amu.

Intensity specifications for the EBIS preinjector are established by the RHIC and NSRL requirements, and are listed in Table 1 under "optimum performance".

3. Validation of Technical Specifications

The functions and performance requirements of the various subsystems are given in the Systems Requirement Document. All EBIS preinjector technical specifications for the subsystems, without beam, will be validated prior to CD-4. Prior to the tests with beam described in this Startup plan, all ES&H requirements will have to be fulfilled and required approvals to operate granted. These items are detailed in the Hazard Analysis Report, and have already been entered into an automated tracking system. This includes requirements such as radiation fault studies, survey for x-rays around all RF cavities, approvals to operate at high voltages, engineering approvals of critical devices, etc.

The technical specifications of the subsystems will be verified either as part of acceptance testing upon receipt of a procured item, validation at time of installation of a subsystem, or as part of a scheduled review. Subsequent validation at the time of CD-4 is not required. Support for these acceptance and validation activities are included in the normal course of procurement or installation and no further project funds are required for their completion.

Table 1: CD-4 performance specifications at for the EBIS preinjector Booster input (measured on the Faraday cup located between the two HEBT 73 degrees dipoles).

	CD-4 Performance	Optimum Performance
Species	Fe, Au	He to u (assuming appropriate External ion injection)
Intensity	3×10^8 Au^{+32}/pulse 4×10^8 Fe^{+20} /pulse	2.7×10^9 Au^{+32}/pulse 4.0×10^9 Fe^{+20}/pulse 5×10^{10} He^{+2} /pulse
Charge-to-mass ratio Q/m	0.162 (Au) 0.357 (Fe)	≥ 0.16, depending on ion species
Repetition rate	Demonstration of pulsing	5 Hz
Pulse width	10-40 μs	10-40 μs
Switching time Between species	Demonstration of switching	1 second
Output energy	2 MeV/amu	2 MeV/amu

A one page summary, showing each accelerator physics activity, the sum of which constitutes the Start-Up Plan, is contained in Appendix A. A detailed experimental plan will be developed for each task in this summary table.

3.1 Validation of EBIS and LEBT beam specifications

The goal of the EBIS and LEBT commissioning is to bring the EBIS and LEBT to an operational state, and then measure electron beam power and ion beam parameters at the exit of LEBT (entrance of RFQ). First, an external ion beam will be transported to EBIS, with maximum ion current and corrected orbit. An ion beam of the desired charge state will be extracted and transported to end of LEBT. At the end of the LEBT, ion current, emittance and matching parameters into the RFQ will be measured for Au and Fe ion beams.

3.2 Validation of the RFQ and MEBT beam specification

The RFQ will have been previously operated with beam using the prototype EBIS, and the performance characterized. Once installed in the final location, beam will be transported from the RFQ to the end of MEBT, using calculated quadrupole settings and with the buncher and steering off. Beam current will be maximized on the Faraday cup using quadrupoles and correctors.

The LEBT to RFQ matching can then be adjusted by looking for the maximum output current while varying LEBT settings: energy, lens settings, and beam position. Finally the dependence of output current on input RFQ power will be measured and compared with the reference curve. If no considerable discrepancy is observed we can assume that the output beam has the same parameters as were measured during commissioning on the EBIS test stand.

3.3 Validation of Linac beam specification

First, beam will be transported to the first diagnostic box in the HEBT using calculated RF power, phase, and quadrupole triplet settings. The beam current will then be maximized on the CT using the MEBT and linac correctors and quadrupoles. A fast Faraday cup (GHz) and an emittance measuring device installed in this diagnostic box will allow characterization of the linac and buncher by comparing output beam parameters with calculated values. This will be done using He^{1+} and He^{2+} beams, to avoid the confusion arising from the acceleration of multiple charge states with heavier beams.

3.4 Validation of the HEBT beam specifications

An ion beam with RFQ output energy (300 keV/amu) will first be transported to the diagnostic box between the HEBT dipoles with calculated quadrupole settings, and with buncher and linac RF power off. The beam centroid will be set close to zero by using correctors and beam profiles monitors in the HEBT. The RFQ amplitude will be set by maximizing the beam current of the desired ion species and charge state.

The ion beam will then be transported to the Faraday cup between the HEBT dipoles with the linac power on and calculated quadrupole setting for 2 MeV/amu. The beam centroid will be set close to zero by using correctors and beam profiles monitors in the HEBT. The linac amplitude and phase will then be set by maximizing the ion beam current of the desired ion species between the HEBT dipoles.

Finally, MEBT and HEBT bunchers will be turn on, and the energy spread of the desired ion species minimized by looking at the beam size at the multiwire between the dipoles, where resolution is maximum.

Details for each step, including curves showing calculated parametric dependencies, will be developed prior to startup, once the detailed physics design of the RFQ and Linac has been frozen. Two examples, (without calculated curves) are shown in Appendix B.

Appendix A

Start-Up Plan Summary Form

The following is the listing of start-up plan experiments:

TASK		Contact	Duration
1	**EBIS and LEBT commissioning**		
1.1	External Beam into EBIS	Beebe	
1.2	Steering correction for external ion beam	Beebe	
1.3	Ion extraction into LEBT and transport to LEBT_CT2	Beebe	
1.4	Steering corrections for extracted ion beam	Beebe	
1.5	Tuning of electrostatic lens and LEBT solenoid	Beebe	
1.6	Emittance measurement	Beebe	
1.7	Matching into RFQ	Beebe	
2.0	**RFQ and MEBT Commissioning**		
2.1	Beam transport to end of MEBT	Raparia	
2.2	LEBT steering	Raparia	
2.3	MEBT steering	Raparia	
2.4	Input match into RFQ	Raparia	
2.5	RFQ transmission vs. EBIS extraction voltage	Raparia	
2.6	RFQ transmission vs RFQ power	Raparia	
3.0	**Linac Commissioning**		
3.1	Beam transport to HEBT_CT1	Raparia	
3.2	Tuning of quadrupole triplets in Linac	Raparia	
3.3	Bunch shape measurements on fast FC using He^{1+} and He^{2+}	Raparia	
4.0	**HEBT Commissioning**		
4.1	RFQ beam (300 keV/amu) transported to HEBT_FC2	Raparia	
4.2	Steering corrections	Raparia	
4.3	RFQ amplitude setting	Raparia	
4.4	Linac beam (2MeV/amu) transport to HEBT_FC2	Raparia	
4.5	Steering corrections	Raparia	
4.6	Perform beam-related radiation safety fault studies	Raparia	
4.7	Linac amplitude and phase setting	Raparia	
4.8	Minimize the energy spread by varying MEBT and HEBT bunchers and looking at MW2	Raparia	
4.9	Maximize intensity at HEBT_FC2 for desired species	Raparia	

Appendix B

Start-up Plan
TASK 2.6
RFQ Transmission vs RFQ Power

The purpose of this task is to establish one of the basic operating parameters of the RFQ and compare with theoretical calculations.

Initially, beam is transported to the end of MEBT, orbit corrections in LEBT and MEBT are completed, and maximum beam current at MEBT-CT1 is obtained. RFQ power will then be varied from 5% to 110% for the desired ion species, and current will be monitored and recorded at MEBT-CT1.

Compare this current vs RF power curve with theoretical calculations.

Start-up Plan
TASK 4.8
Energy Spread Minimization at HEBT-MW2

The purpose of this task is to determine the minimum achievable energy spread at the HEBT-MW2 for the desired ion species.

Before measuring the energy spread at the HEBT-MW2 the following steps must be completed:

(1) Linac beam transported to HEBT-FC2
(2) Orbit corrected in the HEBT
(3) Linac phase and amplitude is set
(4) Neighboring charge states are separated
(5) Desired charge state is tuned to the HEBT-MW2

The Dispersion function at the HEBT-MW2 is 1.2 meters, and the horizontal beta function is 0.079 meters. This gives a resolution of 650 for an unnormalized emittance of 11 π mm mrad. A grid search will be performed for the amplitude of MEBT and HEBT bunchers, namely MEBT-B1, HEBT-B1 and HEBT-B2. Once the minimum horizontal beam size on the HEBT-MW2 is obtained, the energy spread can be calculated.

Electron Beam Ion Source (EBIS)

Description of the Financial Tracking System

May 2006

Table of Contents

Electron Beam Ion Source Project

Description of the Financial Tracking System

Overview

The Electron Beam Ion Source (EBIS) Project at Brookhaven National Laboratory (BNL) will utilize BNL's Financial Management System (FMS) as developed and maintained by the Assistant Laboratory Director (ALD) for Finance. The Laboratory's Budget and Fiscal Officers, both direct reports to the ALD for Finance, are responsible for the overall management and performance of the FMS and for ensuring compliance with Laboratory financial policy, standards and procedures. Key contributions of the Budget Office, Fiscal Services Division, the Accounts Payable Group, the General Accounting Group, the Payroll and Labor Cost Distribution Group are described in the Financial Management System Description within BNL's web based Standards Based Management System (SBMS). Appendix A of this document provides a copy of the Financial Management System Description.

The Business Systems Division, also under the auspices of the ALD for Finance, has implemented and maintains the PeopleSoft Financial System which is the repository for all BNL financial data. This system, in addition to providing centralized budget and accounting functions for BNL, also provides cradle-to-grave support for direct labor costing and all procurement related functions. Independent systems developed and/or implemented by various support organizations; such as, the Globalsoft system, operated and maintained by the Central Fabrication Services Division, feed cost and commitment data to the PeopleSoft Financial System.

Funding for the EBIS Project will be directed through BNL's Collider-Accelerator Department (C-AD), and management responsibility for the project resides with the Chairman, Derek Lowenstein. The EBIS Project is a "virtual" organization within the larger C-AD organization. James Alessi, Head of C-AD's Pre-Injector Systems Group, has been appointed by the Department Chair as the EBIS Contractor Project Manager.

The EBIS Contractor Manager has appointed managers within C-AD to be responsible for the various subsystems which comprise the four major EBIS Project systems: the Source and Accelerator Structures, Electrical Systems, Facilities and Installation Support, and Mechanical Systems.

The subsystem managers are responsible not only for the technical and schedule performance of the subsystem, but also the cost performance of the subsystem. Stephanie LaMontagne, C-AD Assistant Chair for Administration, serves as a member of the EBIS Integrated Project Team, and the Administrative Group, under her direction, provides administrative and financial oversight, as well as project management support for the project.

All financial functions will be exercised consistent with DOE and Laboratory policy. EBIS financial reports are prepared on a monthly basis for distribution to EBIS Collider-Accelerator Department Management and EBIS Project Management personnel. Quarterly EBIS financial reports are forwarded to NASA. Data presented in monthly project management reports prepared for the DOE area office and quarterly reports prepared for the Nuclear Physics Program Office is consistent with that presented in the monthly EBIS financial reports.

Chart of Accounts

The EBIS Chart of Accounts is structured to ensure that DOE R&D, project engineering and design (PED), construction, and pre-operations funds are not combined or commingled. A separate chart of accounts has been established for R&D and construction funds to be supplied by NASA. Control accounts are established consistent with the work breakdown structure (WBS). At a minimum, control accounts for PED and construction funds are planned at the second level of the WBS. The current EBIS Chart of Accounts is shown in Appendix B.

EBIS control accounts are identified within the PeopleSoft Financial System. Financial data is coded by resource type which identifies the cost as labor, materials, equipment, high value procurements, allocations, overhead, etc. Resource type is the level at which budgets are developed and tracked within each control account.

At a lower level, financial data is further identified by cost categories. For example, the resource type HV&SP, High Value & Special Procurements, includes cost categories 211, High Value Maintenance Contracts; 213, High Value Service Contracts; 215, High Value Construction Contracts; 216, R&D Sub-Contracts; and 340, Special Procurements. A complete list of resource types and category codes is shown in Appendix C.

Budget, cost, requisition and commitment data are all tracked within PeopleSoft by cost category within resource type and summarized at the control account level.

Budget Process

The DOE total project cost is $14.8M. NASA is contributing an additional $4.5M to enable the project to be completed in a more timely manner, consistent with NASA mission requirements. The EBIS Project profile is shown below by source of funds:

		FY 05	FY 06	FY 07	FY 08	Total
R&D						
	DOE	0.5	0.1			0.6
	NASA		0.6			0.6
	Total R&D	**0.5**	**0.7**	**-**	**-**	**1.2**
CDR						
	DOE	0.2				0.2
	Total CDR	**0.2**	**-**	**-**	**-**	**0.2**
PED/EDIA						
	DOE		2.0	0.1		2.1
	Total PED/EDIA	**-**	**2.0**	**0.1**	**-**	**2.1**
Construction						
	DOE			7.4	4.2	11.6
	NASA	0.5	0.9	1.5	1.0	3.9
	Total Construction	**0.5**	**0.9**	**8.9**	**5.2**	**15.5**
Pre-Operations						
	DOE				0.3	0.3
	Total CDR	**-**	**-**	**-**	**0.3**	**0.3**
TPC						
	DOE Total Project Cost	0.7	2.1	7.5	4.5	14.8
	Total NASA Contributions	0.5	1.5	1.5	1.0	4.5
	Total	**1.2**	**3.6**	**9.0**	**5.5**	**19.3**

Budget authority will be allocated by the EBIS Contractor Project Manager, based on the approved funding profile and project baseline. Within the PeopleSoft Financial System, budgets are maintained by cost category within control accounts and updated quarterly.

Authorization Protocols

The approval of source documents for the intra-laboratory requisition of goods and services, as well as purchase requests, petty cash vouchers and travel authorizations, conform to a Laboratory prescribed protocol. In addition, C-AD procedures prescribe a review process that ensures that the appropriate safety, quality, funding and technical reviews and authorizations take place.

Laboratory policy requires that all documents authorizing expenditures of less than $50,000 be approved by an employee who has been granted Group I or Group II signature authority. Expenditures exceeding $50,000 must be authorized by an employee who has been granted Group II signature authority. Within the EBIS Chart of Accounts, Group I signature authority is granted to the responsible subsystem manager, the Contractor Project Manager and the EBIS Project Engineer. Additionally, the Deputy Head of Administration is granted Group I signature authority on all C-AD accounts. Group II signature authority is granted to the Department Chair, the Assistant Department Chair for Administration and the Chief Mechanical Engineer, as well as the appropriate Associate Department Chair and his Deputy, for all C-AD control accounts.

As a matter of procedure, the Department Chair or his designee reviews and approves all authorizations exceeding $10,000. This threshold is adjusted dynamically depending on fiscal constraints.

Financial Data Sources

Direct Labor

Direct labor cost is fed to the accounting system through a web-based time card entry system. This system is employee driven. In other words, each employee is responsible for entry of his/her hourly effort by control account, which in the case of the EBIS project identifies the effort as being related to R&D, PED, construction or commissioning. In the case of PED and construction effort, the control account further identifies the WBS element to which the effort applies. Laboratory policy requires that this entry be done, at a minimum, on a weekly basis. For the pay period ending on the last day of each calendar month, effort is recorded from the 21st of the prior month through the 20th of the current month. The final pay period for each fiscal year includes effort for the period August 21st through September 30th. Consequently, the October period is shortened and includes only effort for the period October 1st through October 20th.

At the conclusion of each pay period, the employee forwards the completed time card to his/her supervisor who reviews and approves the effort and leave usage as entered by the employee. Supervisors are expected to ensure that the effort recorded for each of his/her "direct reports" is properly distributed by control account.

Preliminary labor cost reports summarizing cost by control account are reviewed for consistency with both the annual labor budget plan as well as the overall EBIS project plan. Since the EBIS Project organization is a virtual organization, EBIS managers may not directly supervise the employees working on the system or subsystem for which the manager is responsible. Therefore, if the actual level of effort recorded by project differs substantially from that which was expected, the EBIS Contractor Manager may be asked to review the data. He may, in turn, request that the EBIS subsystem managers review the data.

At a summary level, manpower by program and/or project is reported monthly to the Department Chair, as well as the Associate Department Chairs, the C-AD Division Heads and Deputy Division Heads, the Chief Mechanical Engineer and the Chief Electrical Engineer. Detailed reports listing hours reported by employee for all control accounts are posted on the web monthly.

Distributed Technical Services

Cost and commitment for BNL trade labor is based on standard rates developed by BNL's support divisions and maintained by the Budget Office.

BNL machining services are supplied by the Laboratory's Central Fabrication Services Division. A Request for Quote (RFQ's) is entered by the requestor and forwarded to C-AD's Administrative Offices for review. The process is much the same as for a purchase requisition, although the routing for signature approvals is done manually. Approved RFQ's are transferred to an independent system, Globalsoft, purchased and maintained by the Central Fabrication Services Division. Globalsoft supports the Divison's estimating and scheduling functions and records labor effort associated with each RFQ. Estimated and actual hours are fed by Globalsoft to the PeopleSoft accounting system to provide requisition and cost data by control account. Weekly, the Central Fabrication Services Division distributes a report to provide detail activity for each active RFQ in the system.

Other trade labor, including electricians, riggers, carpenters, plumbers, etc. are supplied by the Laboratory's Plant Engineering Division. Effort is requested, scheduled, costed and controlled by work order number via an independent system, Maximo, purchased and maintained by Plant Engineering.

Work Order types which are charged to C-AD include preventive maintenance, the annual assignment of trade labor, verbal requests for short duration efforts and efforts exceeding 40 hours for which formal estimates are prepared by Plant Engineering.

Preventive maintenance is initiated and scheduled by Plant Engineering on equipment that was previously identified by the department as requiring maintenance. These work orders are generated monthly and reviewed by C-AD building managers prior to scheduling the work. The review is performed to ensure that the equipment to be maintained is in use, that the maintenance interval is suitable for the type of equipment and that the control account to be charged is appropriate. It is unlikely that this type of work order would be charged to a facilities construction effort such as EBIS.

Work orders for the annual assignment of trade labor to the department are reviewed and renewed annually. C-AD administrative personnel, in combination with management personnel in C-AD's Experimental Support and Facilities Division, estimate the required level of effort for each trade and advise Plant Engineering of the number of personnel to be assigned and the control accounts to be charged. The value of the estimated effort for the fiscal year is reflected in the Laboratory's financial system as an internal commitment. C-AD's trade labor force generally includes 1 to 2 carpenters, 5 to 7 electricians and 7 to 8 riggers and is primarily contracted to support RHIC Operations and the Experiments. Consequently, within Maximo, effort for assigned personnel is estimated and charged to C-AD operating projects for RHIC Operations and Experimental Support. On an exception basis, trade personnel assigned to the Department will be needed to work on other projects. In those cases, C-AD personnel record hourly effort off-line, and periodic cost transfers are processed to apportion cost to the appropriate control account(s). Thus, assigned trade labor for EBIS will be costed via manual journal vouchers.

Requests for short duration efforts or short orders, generally defined as those efforts not exceeding 40 hours, are made via a phone call to Plant Engineering's Maintenance Management Center (MMC). Short order work is not estimated; hence, no commitment is fed to the Laboratory's financial system. C-AD maintains a list of those individuals who are authorized to initiate work orders through the MMC.

Construction efforts of longer duration are requested by the department via a work order which is routed, approved and entered into the PeopleSoft financial system in the same manner as an RFQ submitted to the Central Fabrication Services Division. Plant Engineering prepares an estimate of labor and materials for the effort and forwards it to the Department for final approval before commencing work. Approved estimates for labor are reflected in the financial system as internal commitments.

Procurements

Using a web-based system, purchase requisitions are entered by the requestor, electronically routed within the department for appropriate signature approvals and finally submitted to the C-AD Administrative Office for review before submission to Procurement & Property Management (PPM) for placement of an order. C-AD administrative personnel review each purchase request to ensure that it is properly completed and that the approvals noted conform to Laboratory policy and C-AD departmental procedures. A budget review to ensure that adequate funding is in place to support the purchase is also performed. Once submitted to PPM, requisitions are tracked within the accounting system by cost category, resource type and control account and appear on our internal financial reports as requisition amounts. Once the order is placed with the vendor, the requisition amount is relieved in the financial system and the value of the order is reported as a commitment on the project. Purchase orders for off-the-shelf items are accrued upon receipt. Cost associated with contracts and purchased services is reflected upon approval of the vendor invoice. In either case, the commitment amount associated with that order is decreased by the amount of the payment.

Monthly, purchase requisition and order activity is reported for each control account and reviewed by C-AD administrative personnel. The status of individual orders is available to all Laboratory personnel via the PeopleSoft procurement module. Thus, requisitioners, sub-system managers and EBIS Project Management personnel may access the delivery and payment status of all purchases.

Organizational Burdens

Fixed expenses for infrastructure costs; such as, space, transportation, building power, fuel oil and communications, departmental allocations for Environmental, Safety, and Health Services and Information Technology Services and the costs associated with departmental overhead functions are distributed to all departmental projects in proportion to the direct labor charged to the project. The rates at which these charges are distributed are developed by the Administrative Group and revised quarterly,

Rates are submitted to the Laboratory's Budget Office and then entered into the PeopleSoft Accounting and Budget System. The distribution of costs is made within the system in the month-end closing process. Year-end variances are distributed to the major programs (generally defined as those programs whose annual costs exceed $500K) managed by the department in proportion to the manpower charged for the current year.

Overheads

Standard Laboratory burden rates are applied to all elements of cost for EBIS. PED and construction costs are assessed overhead at the lower Extraordinary Construction rate. Effort for the CDR, R&D and Pre-Operations are assessed full overhead. Costs born by NASA are also assessed for Site Safeguards & Security, as well as Full Cost Recovery. Overheads are systematically assessed within the PeopleSoft Accounting and Budget System during the month-end closing process.

Reporting

The financial reports described below are utilized by C-AD Management, EBIS Project management, administrative personnel and technical personnel to monitor the overall financial status of EBIS and track detail financial transactions in the system. In addition, the C-AD Administrative Group is available to prepare ad hoc reports and analyses as needed.

The overall financial status of EBIS is summarized monthly in a report prepared by the C-AD Administrative Group for distribution to both C-AD and EBIS management personnel. The report provides a one page summary of project-to-date funding, as well as a one page summary that includes year-to-date and project-to-date expense and commitment. This report is provided to NASA on a quarterly basis. A copy of the report for December 31, 2005 is shown in Appendix D.

A monthly manpower report providing hours charged by person for all C-AD control accounts is also generated monthly and made available on the web. EBIS management personnel and sub-system managers are responsible for reviewing the departmental manpower report to ensure that effort on EBIS has been appropriately reported. A sample of the report is shown in Appendix E.

The C-AD Administrative Group also generates monthly transaction reports for stores issues, credit card procurements and trade labor hours charged. Samples of these reports are shown in Appendices F, G and H.

The Globalsoft System, operated and maintained by the Fabrication Services Division, provides a weekly report of onsite fabrication orders at the drawing number level. A sample of this report is shown in Appendix I.

The People Soft Financial system provides numerous canned reports which are utilized by both administrative and technical personnel to track cost and commitment. A few of the most frequently utilized financial reports are described below:

Appendix J: The Budget & Expense Report provides a complete summary of budget, expense and commitment by cost category within control account. Summary reports based on the EBIS work breakdown structure are also available. This is the primary report utilized by both administrative and technical personnel to monitor cost and commitment on all departmental programs.

Appendix K: The Open Purchase Orders & Requisitions Report provides the current status of all active purchase orders by control account. The total value and outstanding balance for each purchase order are subtotaled by cost category within control account.

Appendix L: The Accounts Payable Control provides a listing of purchase order payments by cost category within control account for a given period. This report is generally run for the current accounting period to provide cost by purchase order number, as reflected in summary on the Budget & Expense Report. The report may also be run project-to-date or year-to-date to provide a more complete history of payments

Standards-Based Management System (SBMS)

BROOKHAVEN NATIONAL LABORATORY Home

Management System Description: Financial Management

Effective Date: Jan 15, 2005 (Reviewed: Jan 15, 2005) | Point of Contact: John Hauser | Management System Steward: John Hauser

[Remove from Favorites]

1.0 Purpose

The Financial Management System (FMS) provides and maintains the budgeting processes; provid relevant and reliable internal financial reporting to Brookhaven National Laboratory's (BNL) Management and Principal Investigators; and aids in making decisions, formulating overall policie long-range planning, and controlling routine operations. In addition the FMS establishes and maintains an effective system of internal controls. The FMS also provides relevant and reliable external reporting to DOE, various government authorities, and other stakeholders.

2.0 Responsibilities

The responsibilities associated with the FMS are as follows:

Laboratory Director

The Laboratory Director is responsible to DOE for the overall performance of the FMS. The Directo is responsible for setting the performance expectations as defined by the management system an for holding direct reports accountable for their performance against these expectations.

Assistant Laboratory Director for Finance

The Assistant Laboratory Director for Finance is the steward of the FMS and is responsible for

- Conducting periodic performance assessments
- Ensuring that systems, processes, and guidance are provided, as needed, to BNL organizational units to fulfill their responsibilities on the FMS
- Serving as the point-of-contact with Brookhaven Science Associates (BSA) on FMS matters.

Fiscal Officer, Budget Officer, and their Direct Reports

The Fiscal Officer and the Budget Officer are responsible for the overall management and performance of the FMS and for ensuring compliance with Laboratory financial policy, standards, and procedures.

Budget Management and staff are responsible for the following:

- Recommending and implementing financial policy for the Laboratory
- Ensuring the proper distribution of costs in support of the missions of the Laboratory
- Interpreting and implementing Cost Accounting Standards (CAS)
- Preparing BNL's CAS Disclosure Statement and ensuring compliance with it
- Reviewing and approving all standard rates
- Developing and implementing all indirect rates
- Receiving and disbursing all funds coming into the Laboratory
- Overseeing execution of the Laboratory's budget and funds control
- Formulating budgets, planning and reporting in support of management decision making
- Signature Authorization
- Developing budget systems and supporting their maintenance
- Administering WFO and Accounts Receivables including user assistance.

Fiscal Management and staff are responsible for the following:

- Establishing and maintaining an effective system of internal accounting controls
- Developing the Laboratory's fiscal policies and procedures; processing the Laboratory's actu cost and revenue transactions via Fiscal Administration, General Accounting, Payroll, Accour Payable, and Accounts Receivable; executing required financial reporting to internal BSA an BNL management
- Fulfilling BSA and BNL's obligation as an integrated contractor by entering required financial data into the Department of Energy's Financial Information System/Management Accountin and Reporting System (FIS/MARS) or successor system
- Administration and appropriate filing of required Payroll, Employment, and other business-related tax returns
- Participating with Human Resources in developing, administering, and transacting employee fringe benefit plans
- Administering Official Foreign Travel
- Administering Conference Management.

Departmental and Division Administrators are responsible for

- Implementing policies and procedures established for financial management at the respecti organizational level;
- Ensuring that expenses are
  - In accordance with Laboratory policy, including allowability
  - Categorized properly by type of funds, i.e., operating, capital, facilities, construction and that the proper Resource Category is used to record the transaction

- Charged to the proper Project/Activity
- Within the approved scope of work

- Ensuring that cost plans are reflective of realistic work plans for the organization and are communicated properly and timely.

3.0 Management System Operation

3.1 Overview

The FMS ensures that BNL costs and budget data are recorded properly and that it supports BSA and BNL values. The system is designed to meet the financial aspects associated with the Laboratory's critical outcomes and objectives, as well as other defined objectives and measures fo operational performance in the BNL Management Plan.

The FMS provides budgeting and financial management support to BNL through the Budget Office well as Fiscal Services, which includes Fiscal Administration, Accounts Payable, General Accountin Accounts Receivable, Official Foreign Travel, Conference Management, and Payroll. Fiscal Operatio also provides entity accounting to BSA. The processes supported by the FMS include Signature Authorization, Personnel Forecasting and Budget, Project Management, Business Management, Human Resources and Payroll, Property, Travel, Business Development, General Accounting Operations and Reporting, Procurement, and Labor Cost Distribution.

3.2 Key Functions/Services and Processes

The FMS supports BNL's research in Energy, Environment, Safety, Health, and other areas by providing timely, reliable, and relevant financial information to maximize benefits to stakeholders using a finite amount of funds. The System helps to ensure that funds are available and used efficiently to support the mission of the Laboratory. For a flowchart of costs, see Figure 1.

3.2.1 Core Functional Elements

The Financial Management System's significant core functional elements are identified in the following sections.

3.2.1.1 Budget

The Budget Office provides the following:

- Coordinated Development of the Laboratory's Annual Budget Submission
- Administers funds for Work for Other Federal Agencies Program
- Maintains WFO Database
- Administers funds for DOE Programs

- Maintains the BNL Cost Accounting Standards Disclosure Statement
- Administers the budget submission reporting system
- Administers the Personnel Forecasting System
- Processes DOE proposals (i.e., Field Work Proposals)
- Monitors Obligation control
  - Contract Modification
  - Program Guidance
  - Funding acceptance letters
  - Inter-laboratory Work Authorization
  - Control of new project establishment
  - Budget & Expense reporting
  - Maintain signature authorization system to obligate/release funds
- Administers Indirect pools
  - Paid Absence pool
  - Fringe Benefit pool
  - Material burden pool
  - Site Support G&A
  - Traditional G&A
- Reviews and approves recharge rates
  - Standard rates
  - Special rates
  - Exemptions
- Provides reports to BNL Management
- Conducts Financial Analysis for DOE
  - Reporting of Functional cost
  - Reporting of Cost ceiling
  - Reporting of Metric
  - Reporting of (FTEs) Manpower Effort
  - Indirect pool cost vs. base reporting
- Conducts Financial Analysis for other agencies
- Approves Reduction in Force actions
- Oversees monthly and year end closing processes
- Administers BSA bridge loan fund
- Processes capital equipment data sheets
- Processes/coordinates inter-governmental personnel agreements.

3.2.1.2 Fiscal Services Division

The Fiscal Services Division (FSD) is comprised of the following:

3.2.1.2.1 The Accounts Payable Group

The Accounts Payable Group within FSD provides the following:

Processing and Payment of Invoices

- Contracts
- Purchase Orders
- Freight Carriers
- Pay-orders
- Non-Purchase-Order Billing

Reimburses Travel Expenses

- Domestic
- Foreign
- Relocation and change of station

Other Non-Employee Payments

- Honorarium
- Consultant
- Collaborator

Cashier Services

- Cash Advances
- Petty Cash
- Cash Receipt Processing

Review of Payments for Compliance to Policy

3.2.1.2.2 The General Accounting Group

The General Accounting Group within FSD provides the following services:

- Reviews and Processes Monthly Journal Vouchers Laboratory-wide

- Monitors Monthly Accrual Of Expenses
- Prepares Schedules and Work-papers For Internal And External Auditors
- Provides Annual Financial Statement Analysis For DOE.
- Prepares and analyzes Monthly Financial Statements
- Coordinates Annual Special Process Spares Physical Inventory
- Reconciles Drafts Payable and Bank Statements
- Processes Requests For Stop Payments
- Coordinates All Banking Activities And Relationships
- Maintains DOE Letter Of Credit
- Coordinate Fixed Asset Accounting with Property and Plant Engineering
- Calculates Annual Depreciation
- Periodically Analyzes General Ledger Accounts
- Maintains Monthly Financial Performance Metrics
- Prepares Quarterly Laboratory-wide Petty Cash Reports
- Provides Accounts Receivable Billing, Collections And Requests For Information
- Prepares Monthly BSA Financial Statements
- Acts as Liaison with the BSA Members, Battelle Memorial Institute, and the Research Foundation of SUNY at Stony Brook
- Maintains the integrity of the BSA general ledger using accounting software, including all entries and account reconciliations
- Maintains all BSA banking activity, including all cash receipts, disbursements, and reconciliations for BSA
- Submits necessary BSA information to management to facilitate affective budgetary decision making
- Provides BSA reporting and analysis support to internal and external auditors
- Provides Regulatory Reporting
  - Monthly FIS/MARS Report To DOE
  - Annual Financial Statement Analysis For DOE
  - Annual DOE Quantity and Usage Data Report
  - Annual DOE Equipment Held For Future Use Report
  - Quarterly DOE International Travel And Expense Report
  - Annual DOE Direct Labor Costs Of Stores Inventory Warehousing
  - Annual 1099 Miscellaneous Income Filings to the IRS
  - Annual and Quarterly 1042 Non-Resident Alien Income Filings
  - Quarterly Grant Reporting
  - Monthly Other Federal Agencies Report To DOE
  - Report of Transfer of Funds Collected for Non-DOE Work Performed (Program 40 And 60)
  - Annual Statement Of Costs Incurred and Claimed Under DOE Contract (SCIC)

- Federal Excise Tax Return, Form 720

3.2.1.2.3 The Payroll and Labor Cost Distribution (LCD) Group

The Payroll and LCD Group within the Fiscal Services Division provides the following services:

- Processes and distributes payroll
- Records, processes, and analyzes all pay adjustments
- Maintains personnel additions and changes
- Maintains employee leave bank
- Processes all Supplemental Retirement Actions for employees
- Processes additions and changes to direct deposits
- Coordinates all payroll tax returns
- Prepares and maintains various correspondences
- Provides payroll garnishment withholding
- Processes W-2 forms, W-4 forms, and other quarterly/annual statutory reporting
- Coordinates the communication of the Labor Cost Distribution System's (LCDS) changes, issues, and improvements to users and service providers
- Provides the central point-of-contact for all LCDS-related issues and prioritizes all changes related to the LCDS system based upon feedback from users
- Trains new users of LCDS

3.2.2 Other BNL Service Providers

Various BNL organizations provide ancillary services to the functional areas of the FMS, including t following:

- **Information Technology Division** - installs and maintains facility networks; telecommunications systems installation and operations
- **Staff Services Division** - conference planning, billing and collections; travel planning and coordination; property system maintenance
- **Business Systems Division** - programming, computer operations, maintenance of FMS, backup of data; maintenance of database and reporting services
- **Human Resources** - maintains new/terminated employees into FMS; maintains COBRA an benefit changes; adjusts salary
- **Procurement and Property Management Division** - enters contract and purchasing dat into FMS

3.3 Critical Support Mechanisms

The FMS relies upon the following critical support mechanisms to ensure efficient and effective functioning:

- Adequate hardware, software, and networking capabilities
- Current Standard Practice Instruction documentation, Supervisor's Personnel Manual
- System Security/Access controls
- Adequate reporting tools
- DOE Policy Guidance
- BSA Contract with DOE

4.0 Outputs

In addition to the system-wide Generic Outputs, the following table describes the products provid by this Management System to its primary customers. It also lists the other managemen systems that use this output.

Outputs	Primary Customer Using this Output	Management System Using this Output
• Field Work Proposal Process and Technical Support • Cost, Invoice, and Proposal Data • Funds Authorization • Insurance Coverage • PeopleSoft Budget System	Project and Account Managers, Line Managers, Administrative Managers, Principal Investigators	
Technical Support for ESHSI Priority Process		Integrated Planning
Budget Documents, Rates, Financial Information and Analysis	Principal Investigators, Account Managers, Line Managers, Administrative Managers	All
Budget Authorization and Certification of Obligation	Line Managers	Science and Technolo Program Managemen Work for Others, Real Property Asset Management, Educational Programs
Information Reporting to Support Strategic Decision-Making	BNL Senior Management, BSA Board	Integrated Planning
Lost Time Reports		Occupational Medicin
Payroll Payments, Benefit Payments, Wage and Tax Data, Labor Cost Data	Staff	Human Resources
Payments for Invoices Travel, Other Property Data, Cost and Billing Data	Line Management, Staff	Property Managemen Administrative Suppor Information Resource Management,

		Acquisition Managem
DOE Financial System Data	DOE	DOE Systems

5.0 Inputs

In addition to the system-wide Generic Inputs, the following table describes inputs provided by th Management System's primary customers and support suppliers.

Inputs	Primary Originator Producing this Input	Management System Providing this Input
Journal Vouchers Entries	Department Administration Staff, Fiscal Services Staff	Financial Management
Acquisition Data, Commitment/Cost Data	Procurement	Acquisition Manageme
Time Cards, Employee Status, Payroll Adjustment Requests, Garnishment Requests	Staff, Line Managers, Government Agencies	
Items Ordered, Items Received, Payment Approval, Travel Expense Reports	Staff, Line Managers	Acquisition Manageme
Energy Charge-Back and Rate Forecast, Space Rate and Planning	Plant Engineering Division	Real Property Asset Management
Operational Security Services	Security Division	Security
Benefits Packages, Tuition Program Forecasts, Compensation Program Packages, Employee Awards, and Labor Relations Negotiations Results	Human Resources Division	Human Resources
Human Resources Information	Human Resources Division	Human Resources
Charge-Back for Transportation Services, Bus Service, Vehicles, Shop Operations, Housing and Conference Costs	Staff Services Division	Administrative Support
Shipping Charges, Excess Property Disposal	Supply and Material Division	Property Management
Intellectual Property Financial Information	Office Of Intellectual Property & Sponsored Research	Intellectual Property
	Office Of Intellectual Property &	

Research Agreement and Account Authorization	Sponsored Research	Work For Others
Plans, Forecasts and Business Planning Decisions	Line Managers	Integrated Planning
Proposals, Contracts	Principal Investigators, Line Managers	Acquisition Manageme Science and Technolog Program Management, Real Property Asset Management, Work Fo Others, Environmental Restoration, Environmental Management System, Educational Programs
Personnel Forecasting, Human Resources Data	Administrators, Human Resources	Human Resources

6.0 Requirements

The following table summarizes requirements that this management system is responsible for.

REQUIREMENTS WITH PRIMARY RESPONSIBILITY	
This Management System is used to demonstrate overall institutional responsibility for the requirements document (versus individual parts of the document). The Primary Management System is responsible for identifying other (parsed) management systems that help implement the requirement.	
Document	**Title**
BSA Contract No. DE-AC02-98CH10886 - Clause H.36 ROD	Lobbying Restriction (Energy and Water Act 2005)
BSA Contract No. DE-AC02-98CH10886 - Clause H.37 ROD	Lobbying Restriction (Interior Act 2005)
BSA Contract No. DE-AC02-98CH10886 - Clause I.98 ROD	Central Contractor Registration - Alternate I (OCT 2003)
CR-20 Chapter V ROD	Accounting Practices and Procedures Handbook - Inventories
CR-20 Chapter X ROD	Accounting Practices and Procedures Handbook - Product Cost Accounting
O 110.3 ROD	CRD - Conference Management
O 130.1 ROD	CRD - Budget Formulation Process
O 135.1 ROD	Budget Execution - Funds Distribution and Control
O 350.2A ROD	CRD - Use of Management and Operating or Other Facility Manageme Contractor Employees for Services to DOE in the Washington, D.C., Area
O 412.1A ROD	Work Authorization System
O 413.1A ROD	CRD - Management Control Program

O 522.1 ROD	Pricing of Departmental Materials and Services
O 534.1B ROD	CRD - Accounting
O 551.1B ROD	CRD - Official Foreign Travel
O 5560.1A ROD	Priorities and Allocations Program

REQUIREMENTS WITH PARSED RESPONSIBILITY	
This Management System is used to demonstrate responsibility and accountability for part of the requirements document (the parsed unit versus the entire document).	
Document	**Title**
O 414.1C	Quality Assurance

7.0 Core Services/Purchased Services

Core Services

Budget core services are provided for the centralized support of the Laboratory's budgeting oversi and funded as part of traditional G&A (see Section 3).

Fiscal core services include those related to General Accounting functions, Invoice Payment and Processing, and all Payroll-related services, which are funded as part of the traditional G&A and material burden as appropriate (see Section 3).

Purchased Services

Budget purchased service is provided to the Laboratory's organizations under the direction of a Business Operations Manager. Costs are recharged to the organization benefiting from the service

8.0 Standards of Performance

Standards maintained by this management system are the following:

- Managers shall review proposals before submitting them to the customer and before initiati work to ensure that risks are identified, evaluated, and accepted before deciding to underta the work.
- All staff shall record their time and reimbursable business expenses accurately and on time.
- Costs and commitments shall be recorded on time and accurately.
- Managers shall reach agreement with customers on work scope deliverables, schedules, an budgets before work begins and assure a formal agreement is negotiated between the Laboratory and the customer.
- The Financial Management System shall provide timely and accurate information on project and business, and assure proper management and protection of BNL and customer assets.

9.0 Other Supporting Information

The following Legacy Documents are maintained by this Management System:

- 8.0 Proposal Guide
- 8.1 DOE/NRC Proposals
- 8.2 WFO Proposals
- Budget Manual
- Budget Manual: Attachment A - Criteria for Off-Site G&A Rates
- Budget Manual: Attachment B - Resource Category Codes
- Budget Manual: Budget Execution: B. Budget Formulation
- Budget Manual: Budget Execution: C. Budget Control and Monitoring
- Budget Manual: Budget Execution: D. Fiscal Year End
- Budget Manual: I - Organization
- Budget Manual: II - Budget Administration and Control Overview
- Budget Manual: IV A. Approved Funding Programs/Work Authorization System
- Budget Manual: V A. Personnel Forecasting and Control
- Budget Manual: V B. Indirect Pools
- Budget Manual: V C. Full Cost Recovery
- Budget Manual: V D. Laboratory Standard Rates for Services and Scientific Devices
- Budget Manual: V E. Accounting Structure
- Budget Manual: V F. Signature Authorization System
- Budget Manual: V H. Special Process Spares/Other Spare Parts
- Budget Manual: V I. Plant and Capital Equipment
- Budget Manual: V J. Environmental restoration and Waste Management AOS
- Budget Manual: V K. Work for Others
- Budget Manual: V L. Leases
- Budget Manual: VI - Cost Estimating
- Budget Manual: VII - Institutional Plan Development
- Budget Manual: VIII - Definitions
- Proposal Writing Guide
- SPI 1-02 Signature Authorization
- SPI 2-01 Laboratory Budget
- SPI 2-02 Use of BNL Services, Research Capabilities, Materials, And Facilities by Non-BNL Organizations
- SPI 2-05 Petty Cash

The following Subject Areas are maintained by this management system:

* Budget Submission Process
* Conference Management
* Domestic Travel
* Official Foreign Travel
* Petty Cash Reimbursements and Cashing of Checks

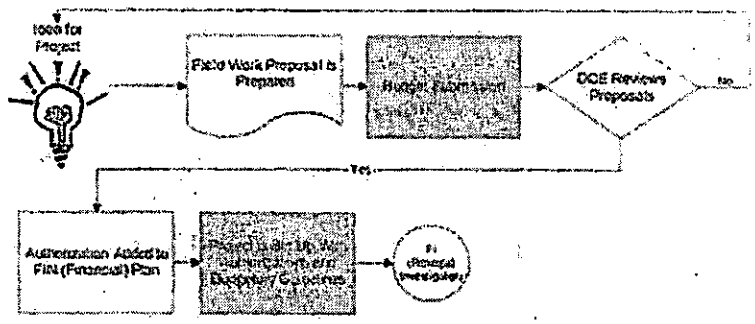
The following Program Descriptions are maintained by this management system:

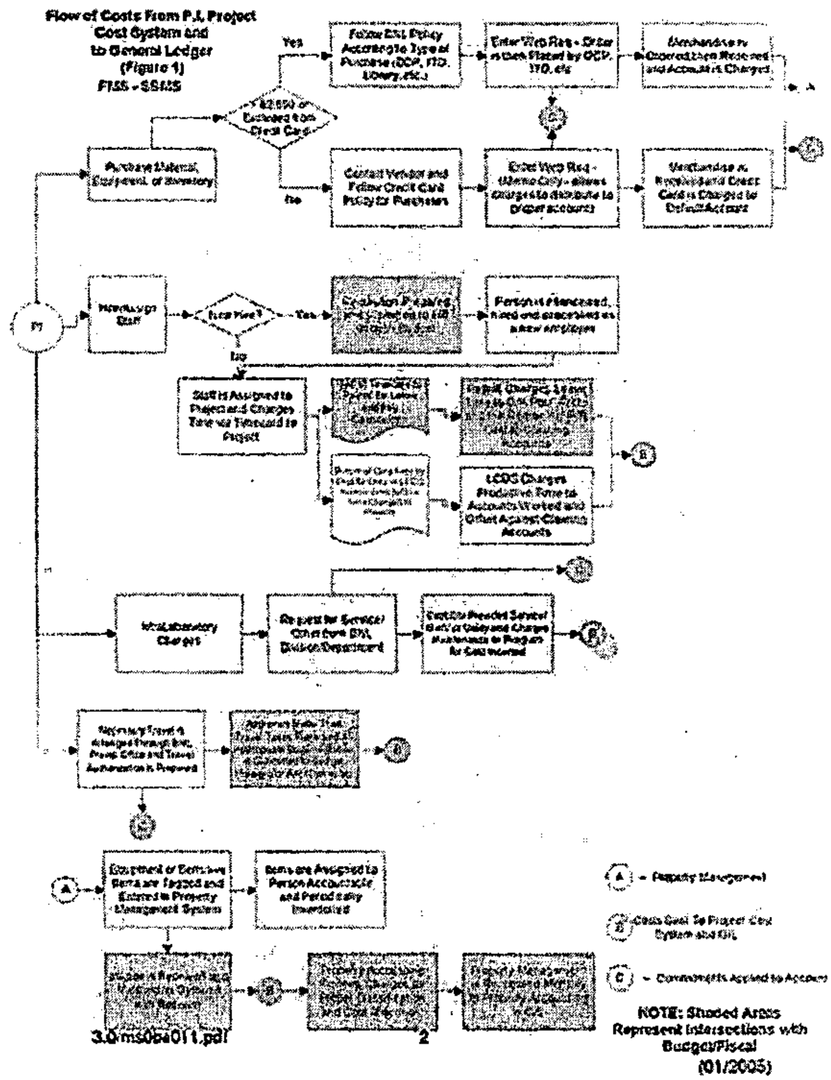
* This Management System does not maintain any Program Descriptions

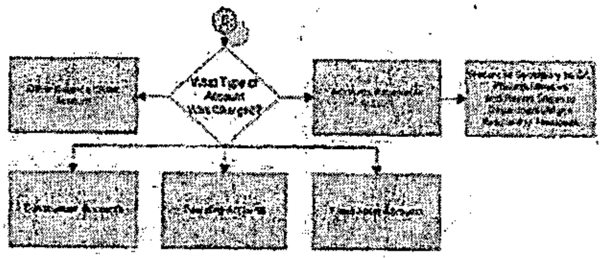
9.1 References

* Supervisors' Personnel Manual
* Employee Guide
* Standard Practice Instructions (SPIs)
* DOE Accounting Directives
* DOE CFO MARS/SGL Chart of Accounts and Related Codes
* DOE CFO Budgeting Handbook
* DOE M 481.1-1A, Change 1, Reimbursable Work for Non-Federal Sponsors Process Manual

Figure 1


Idea for Project
Field Work Proposal is Prepared
DOE Reviews Proposals
No
Yes
Authorization Added to FIN (Financial) Plan


Flow of Costs From P.I. Project
Cost System and
to General Ledger
(Figure 1)
Yes
No
Yes
Costs Sent To Project Cost System and G/L
NOTE: Shaded Areas Represent Intersections with Budget/Fiscal
(01/2005)
2



COLLIDER-ACCELERATOR DEPARTMENT
Electron Beam Ion Source Project
Chart of Accounts

Project	Activity	Description	Signature Authorization: Group I	Signature Authorization: Group II
		Global Authorization:	***J. Alessi***	***S. LaMontagne***
			J. Brinker	***D. Lowenstein***
			L. Snydstrup	***J. Tuozzolo***

1 Electron Beam Ion Source Project

1.1 EBIS DOE Conceptual Design Report

08260	08260	CDR		W. Fischer / T. Roser
08261	08261	CDR Burdens		W. Fischer / T. Roser

1.2 EBIS R&D

1.2.1 DOE R&D

08262	08262	DOE R&D		W. Fischer / T. Roser
08265	08265	DOE R&D Burdens		W. Fischer / T. Roser

1.2.1 NASA R&D

08266	08266	NASA R&D		W. Fischer / T. Roser
08269	08269	NASA R&D Burdens		W. Fischer / T. Roser

1.3 EBIS PED

1.3.1 DOE PED

71075	71075	1.3.1.01 Structural Components	E. Beebe	W. Fischer / T. Roser
71076	71076	1.3.1.02 Controls	D. Barton	W. Fischer / T. Roser
71077	71077	1.3.1.03 Diagnostics / Instrumentation	M. Wilinski	W. Fischer / T. Roser
71078	71078	1.3.1.04 Magnet System	J. Ritter	W. Fischer / T. Roser
71079	71079	1.3.1.05 Power Supply System	R. Lambiase	W. Fischer / T. Roser
71080	71080	1.3.1.06 RF System	A. Zaltsman	W. Fischer / T. Roser
71081	71081	1.3.1.07 Vacuum System	M. Mapes	W. Fischer / T. Roser
71082	71082	1.3.1.08 Cooling System	J. Scaduto	W. Fischer / T. Roser
71083	71083	1.3.1.09 Facility Modifications	A. Pendzick	W. Fischer / T. Roser
71084	71084	1.3.1.11 Project Services		W. Fischer / T. Roser
71085	71085	1.3.1.14 Contingency		W. Fischer / T. Roser

Appendix B

COLLIDER-ACCELERATOR DEPARTMENT
Electron Beam Ion Source Project
Chart of Accounts

Project	*Activity*	*Description*	*Group I*	*Group II*
		Global Authorization:	*J. Alessi* *J. Brinker* *L. Snydstrup*	*S. LaMontagne* *D. Lowenstein* *J. Tuozzolo*

1.4 EBIS Construction

1.4.1 DOE Construction

		To Be Determined		

1.4.2 NASA Construction

14397	14397	1.4.2.01 NASA Structural Components	E. Beebe	W. Fischer / T. Roser
08278	08278	1.4.2.09 NASA Facility Modifcations	A. Pendzick	W. Fischer / T. Roser

Appendix C

ffective Date: April 2004

Budget Manual: Attachment B - Resource Category Codes

This section defines the resource categories and related resource types within the project costing portion of the Peoplesoft Accounting System. Information relating to the General Ledger (GL) may be mentioned here for information; however, specific guidance must be obtained through the Fiscal Office.

BNL Labor-Related Expenses

RC	Resource Type	Resource Category Description/Definition
100- 101	SCIEN PROF MGTAD UNION TECH	**Base Salary** - These resource categories are used to capture the direct salary costs within the Scientific, Professional, Management, Union, and Technical salary classifications. Effective 10/1/2000, the base component of direct overtime salary is no longer captured in this category. See category 121.
102	SCIEN	**Base Salary - Research Associates -** This resource category is used to capture the direct salary costs within the Scientific Research Associate salary classifications. This category receives the full paid absence burden and reduced Fringe Benefit burden (see categories 131 and 141).
105	SCIEN PROF MGTAD UNION TECH	**Temp Base Salary -** This resource category is used to capture the direct salary costs of temporary employees within the **authorized** salary classifications.
110	SCIEN PROF MGTAD UNION TECH	**Shift Salary** - This category is used to capture the differential component of direct salary costs within the **authorized** salary classifications. The base component of the Shift direct salary is captured within the **Base Salary** categories. Effective 10/1/2000, this category is excluded from the Paid Absence Burden, but does receive the full Fringe Benefit Burden.
120	SCIEN PROF MGTAD UNION TECH	**Overtime Premium** - This category is used to capture the premium component of direct salary costs within the **authorized** salary classifications. Effective 10/1/2000, this category is excluded from the Paid Absence Burden, but does receive the full Fringe Benefit Burden.
121	SCIEN PROF MGTAD UNION TECH	**Base Overtime Salary** - Effective 10/1/2000, this category was established to capture the Base component of direct overtime salary costs within the authorized salary classifications. Prior to FY 2001, these costs were being captured within the **Base Salary** categories (i.e., 100). This category is excluded from the Paid Absence Burden, but does receive the full Fringe Benefit Burden.

130	SCIEN PROF MGTAD UNION TECH	**Paid Absence Burden** - This category is used to capture the paid absence burden applied to all direct salary costs within the Scientific, Professional, Management, Union, and Technical salary classifications. Effective 10/1/2000, overtime/shift costs are excluded from the Paid Absence Burden. Paid Absence burden is used to distribute all paid leave-related costs.
131	SCIEN	**Paid Absence Burden - Research Associates** - This category is used to capture the paid absence burden applied to all direct salary costs within the Scientific Research Associate salary classifications. The Paid Absence burden is used to distribute all paid leave-related costs.
140	SCIEN PROF MGTAD UNION TECH	**Fringe Benefits Burden** - This category is used to capture the Fringe Benefit burden applied to direct salary, including shift and overtime, and related paid absence costs within the Scientific, Professional, Management, Union, and Technical salary classifications. The Fringe Benefit burden is used to distribute medical and retirement-related benefits; tuition refunds; general severance costs; and various worker-related insurance.
141	SCIEN	**Fringe Benefits Burden - Research Associates** - This category is used to capture the Fringe Benefit burden applied to direct salary, including shift and overtime, and related paid absence costs within the Scientific Research Associate salary classification. The Research Associates do not participate in the Retirement Program and therefore their direct salary and related paid absence costs are charged a reduced Fringe Benefit burden rate.
50	SCIEN PROF MGTAD UNION TECH	**Awards** - This category is used to capture the costs of Laboratory-approved salary awards, such as the various incentive and performance awards. These costs are exempt from both the paid absence and fringe benefit burdens.
900	SCIEN PROF MGTAD UNION TECH	**Vacation Earned** - represents the cost of an employee's earned vacation during the current FY. This cost is reflected in each employee's "home" organization's "Departmental Paid Absence Pool" project.
901	SCIEN PROF MGTAD UNION TECH	**Sick Leave Used** - represents the cost of an employee's sick leave used during the current FY. This cost is reflected in each employee's "home" organization's "Departmental Paid Absence Pool" project.
902	SCIEN PROF MGTAD UNION TECH	**Holiday Used** - represents the cost of an employee's Holiday leave during the current FY. This cost is reflected in each employee's "home" organization's "Departmental Paid Absence Pool" project.
905	SCIEN PROF	**All Other Paid Leave Used** - represents the cost of an employee's leave other than listed above (i.e., death, jury, military, etc.) used during the current FY. This cost is

Appendix C

	MGTAD UNION TECH	reflected in each employee's "home" organization's "Departmental Paid Absence Pool" project.

Appendix C

Distributed Research Labor

201	SDSLB	**Scientific Distributed Labor** - As is the case with Distributed Technical Services, this category is also used to distribute labor based upon the BNL Standard Labor rates. This specific category is used to record research labor related charges from one organization to another. Typically a separate indirect type project/activity is established to collect the costs and resulting recovery. The offsetting credit is charged to resource category 205. This resource category can only be used by those organizations that have developed a rate, which has been reviewed and approved by the Budget Office.

External Labor-Related Expenses

180	PURLB	**Consultants** - This category should be used to procure Consultant services. Consultants are appointed under contract to assist the work of the regular BNL Staff. These appointments are handled between the sponsoring Department/Division and the Human Resources & Occupational Medicine Division. Consultants are not BNL employees. The appointments are made for the specific purpose of securing counsel on a phase of the Laboratory's programs, and carry a per diem fee for intermittent services. (Note: Professional service contracts made with a business firm are assigned to category 212.) Since these individuals are not BNL employees, they will be supplied with a Guest number rather than a BNL number.
185	PURLB	**Research Collaborators** - A Research Collaborator is an individual who holds a Ph.D., has a primary affiliation other than BNL, works with members of the scientific staff, or uses the Laboratory's research facilities. Allowance for expenses such as travel, per diem, housing or car rental may be provided. These appointments are typically for renewable one-year (1) terms and are handled between the sponsoring Department/Division and the Human Resources & Occupational Medicine Division. Since these individuals are not BNL employees, they will be supplied with a Guest number rather than a BNL number.
186	PURLB	**OEP Collaborator** - An OEP Collaborator is an individual who is participating in a program funded through the Office of Educational Programs (OEP). The appointments are processed by the OEP and generally do not exceed one year. A stipend as well as an allowance for expenses such as travel and housing may be provided. Since these individuals are not BNL employees, they will be supplied with a Guest number rather than a BNL number. This category is exempt from Laboratory burdens.
190	PURLB	**Contract Labor** - This category should be used with the PS procurement system to capture all the costs and obligations for Contract Labor transactions. The procuring of job shop employees is coordinated between the sponsoring Department/Division and the Human Resources & Occupational Medicine Division. An agreement is entered into between the Laboratory and an outside source for the specific services of a job shop employee. Since these individuals are not BNL employees, they will be supplied with a Guest number rather than a BNL number. Craft Labor employees are coordinated between the sponsoring department (typically Plant Engineering) and the vendor.

Appendix C

195	PURLB	**Patent Awards** - An award made to any consultant or other affiliate or guest of the Laboratory who is an inventor or co-inventor. It is an incentive award given for the development of intellectual property that is submitted to the U.S. Patent Office for patent consideration. An additional award may, with DOE approval, be awarded to each inventor or co-inventor when the U.S. Patent and Trademark Office grants a patent on the patent application.
		<u>Materials/Supplies/Travel/Communications (MSTC)</u>
160	MODC	**Meal Allowance** - This category is used to record the overtime meal allowance granted to exempt employees. Exempt employees are entitled to this allowance after working 3 consecutive hours of overtime. (See <u>Supervisors Personnel Manual 7.0 Pay Policies, Section 2, Monthly Exempt Employees</u> for specifics of policy.)
161	MODC	**Housing** - This category is used to record the distribution of on-site housing cost by the Staff Services Division. This category is exempt from Laboratory burdens.
163	MODC	**Pass Thru** - This category is used for instances in which DOE provides specific instructions within the program guidance for the Laboratory to provide stated dollar amounts to specific institutions. In these situations, BNL has no role in managing or overseeing the work of the other institutions. These transactions will be handled as pass through activities exempt from all burdens. This category can not be used unless proper documentation has been provided to and approved by the Budget Office.
166	MODC	**Labor Grievances** - This category is used by the Accounts Payable group of the Fiscal Services Division to process specific labor grievance settlements. Prior to FY 2001, this was reported against category 110.
170	RELO	**Relocation Expense** - This category is used to record the cost of expenses approved and allowable under the Contract for the relocation of new employees.
210	PURLO	**Maintenance Contract (Low Value)** - This category is used for the procurement of maintenance and repair services to support the maintenance and repairs of facilities and equipment. This category should be used for maintenance contracts with a unit value of **less than $25k.**
211	PURHI	**Maintenance Contract (High Value)** - This category is used for the procurement of maintenance and repair services to support the maintenance and repairs of facilities and equipment. This category should be used for maintenance contracts with a unit value **of $25k or more.**
212	PURLO	**Service Contract (Low Value)** - This category is used for the procurement of laundry services, computer (non-BNL) services, equipment rentals, lease payments for non-BNL equipment, professional service contracts and other contracted services. Professional service contracts are made with an organization to obtain expertise not easily obtained via direct employment. Such contracts must have a defined objective, deliverables, and a finite term. **This category should be used for service contracts with a unit value of less than $25k.** In addition, the cost for **all** registration fees was also recorded in this category through FY 2000. Effective 10/1/2000, category 240 must be used for registration fees.
213	PURHI	**Service Contract (High Value)** - This category is used for the procurement of laundry services, computer (non-BNL) services, equipment rentals, professional service contracts and other contracted services. Professional service contracts are made with an organization to obtain expertise not easily obtained via direct employment. Such contracts must have a defined objective, deliverables, and a finite term. **This category should be used for service contracts with a unit value of $25k or more.**

Appendix C

214	PURLO	**Construction Contract (Low Value)** - This category is used for the procurement of construction contracts for use in BNL's construction and/or fabrication of equipment programs. **This category should be used for construction contracts with a unit value of less than $25k.**
215	PURHI	**Construction Contract (High Value)** - This category is used for the procurement of construction contracts for use in BNL's construction and/or fabrication of equipment programs. **This category should be used for construction contracts with a unit value of $25k or more.**
216	PURHI	**Research & Development Subcontracts** - Cost charged to this category should be clearly identified as Research and Development (R&D) subcontracts. The subcontract should consist of an arrangement with an institution for research or development work to be performed, using their resources for the benefit of a BNL research project. The R&D effort should be carried out under the direction of a named principal investigator with a set of clearly defined tasks, milestones, and specific deliverables.
240	PURLO	**Registration Fees** - The cost for all registration fees is captured in this category (effective 10/1/2000). Prior to FY 2001, these costs were captured under category 212.
250	PURUT	**Electric Power** - This category reflects the cost of electric power obtained by the Laboratory from public utilities and distributed to the various BNL Departments/Divisions by Plant Engineering.
251	DSTUT	**Electric Power-Distributed** - This category reflects the departmental redistribution of electric power cost within their organization. The charge is typically based on a rate charged against the department's direct salary, paid absence, and fringe costs. The credit portion of this distribution is also reflected in this category within the organization's burden cost center.
270	PURUT	**Communications** - This category reflects the cost of telecommunications obtained by the Laboratory from public utilities.
271	DSTUT	**Communications - Recharged** - This category reflects the cost of telecommunications distributed to the various BNL Departments/Divisions by the Information Technology Division (effective 10/1/2000).
272	DSTUT	**Communications - Distributed by SWI** - This category reflects the departmental redistribution of telecommunication cost within their organization. The charge is typically based on a rate charged against the department's direct salary, paid absence, and fringe costs. The credit portion of this distribution is also reflected in this category within the organization's burden cost center.
280	TRAV	**Foreign Travel** - This category is used to record travel to countries outside the United States. Reference the Official Foreign Travel Subject Area for necessary approvals of foreign travel prior to the trip.
290	TRAV	**Domestic Travel** - Travel performed by an employee, consultant, guest, or prospective employee who engages in properly authorized travel during the execution of scientific or administrative business for the Laboratory.
300	MATER	**PO Purchases** - This category is used for the purchase of materials and supplies that have a short useful life. Examples include items such as glassware, film, chemicals, and other expendable materials such as books, periodicals, manuals, replacement parts, supplies, tools and equipment (except "sensitive" and "capital" equipment - see category 311 for "sensitive" equipment and categories 400 thru 475 for "Capital" equipment). **This category cannot be used for Credit Card purchases (see category 319)**

Appendix C

310 MATER **Stores Material** - This category is used to identify cost of inventory (stores) items.

311 MATER **Sensitive Equipment** - This category is used for the procurement of sensitive property purchased by the Laboratory when the unit cost of such items is more than $500 and less than $5,000. Controlled sensitive property is defined as items that are considered to be susceptible to appropriation for personal use and/or can be readily converted to cash. Examples: portable photographic equipment, calculators, and portable tape recorders. Additional information regarding the accounting for these items is published in the Procurement & Property Management Group's Standard Operating Procedures Manual (see SOP 320.1).

312 MATER **Equipment - Low Value** - This category is used to procure equipment that is purchased with both DOE and non-DOE funds that has a procurement value between $5,000 and $24,999.99 and otherwise meets the criteria for capitalization of equipment at BNL. The cost of the equipment is excluded from G&A burden.

315 MATER **Demurrage/Deposits** - This category is used to record the rental charge for cylinders made to an organization's project(s). This is also used to record the charge and credit for all cylinder deposits made to an organization's project(s).

316 MATER **Freight** - This category is used to record freight payments that are billed separately by the vendor. Freight charges billed by the vendor that are inclusive of items purchased are paid through the Accounts Payable PO Purchase module, which does not allow for a separate category for freight.

319 MATER **Credit Card Purchases** - This category is used for purchases made by an authorized cardholder to procure individual fixed price non-stock commercial items of $2,500 or less, other than those specifically excluded. The listing of excluded items can be found in the <u>Procurement Operations Manual, Chapter 2, Section A, Exhibit II-C</u>.

320 OSP **Other Spare Parts Issue** - This category is used to record the credit portion of the transfer of items from SPS/OPS. The debit portion of the entry will use the appropriate category, usually 300 or 340.

340 SPMAT **Special Procurements** - This category is used to record the cost for procurements, which have one of the following characteristics:

1. A rental or lease agreement covering off-site activities which are exclusive of any on-site activity (i.e., ship charter, aircraft lease)
2. An unusually large dollar item including items withdrawn from Special Process Spares or Other Spare Parts Inventories, costing in excess of $25,000 per item. (An item is considered a unit usable as purchased or a group of related items purchased on one order to form a usable assembly.)
3. Reactor Fuel Elements

350 SPMAT **Leased Equipment** - This category is used to record the cost expended for leased equipment of the non-purchase option type.

Distributed Technical Services

The following resource categories are used to distribute labor cost based upon the Laboratory Standard Labor rates. A listing of the Standard Labor rates can be accessed through the Budget Office Home page. **Note:** The offsetting credit to the distributions in the 600 series is Resource Category 205.

600 RECHG **Building Trades Shops** - This category is used to capture costs related to the various BNL crafts within the Building Trades. These services are purchased at an hourly rate by the department requesting these services.

Appendix C

601	RECHG	**Building Trades Shops - Contract** - This category is utilized to capture costs related to the various crafts within the Building Trades that have been procured by Plant Engineering on behalf of the Department/Division requesting this type of service. These services are procured through a Basic Ordering Agreement (BOA) when Plant Engineering determines that the requested work cannot be accommodated from within Plant Engineering's internal workforce for that craft.
602	RECHG	**Building Trades Shops - Assigned** - As with category 600, this category is used to capture costs related to the various BNL crafts within the Building Trades. However, in this case, the Department/Division requesting the service enters into a binding agreement with Plant Engineering to procure the services of a particular craft for a period of a year or more. The Department/Division also assumes the supervisory responsibility for the particular individual. In return, a lower hourly rate is applied to the procured service.
603	RECHG	General Labor
604	RECHG	Engineering & Construction Labor
605	RECHG	Central Shops
606	RECHG	Photography
607	RECHG	Graphic Design
608	RECHG	Printing
609	RECHG	Copy Service
610	RECHG	Document Processing
611	RECHG	Glassblowing Services
612	RECHG	Metallurgical Services
613	RECHG	Vendor Services/Support Rate
614	RECHG	Sampling Team Rate
616	RECHG	Whole Body Count Rate
617	RECHG	Bioassay Sample Rate
618	RECHG	Lost Dosimeter Replacement Rate
619	RECHG	TLD Chip (Area & Environmental) Rate
620	RECHG	Basic TLD + Neutron Rate (A)
621	RECHG	Ring Dosimeter Rate
622	RECHG	Basic TLD Badge Rate (B)
623	RECHG	Alpha/Beta Sample Rate
624	RECHG	Physical Properties
625	RECHG	Gamma Sample Rate
626	RECHG	Strontium Sample Rate
627	RECHG	Tritium Sample Rate
628	RECHG	PCBs Sample Rate

Appendix C

629	RECHG	VOCs/Organics Sample Rate
630	RECHG	Anions
31	RECHG	FSS - Sr. Professional
632	RECHG	Medical
633	RECHG	Motor Vehicle Recharge
634	RECHG	Metals
635	RECHG	Offsite Bioassay
636	RECHG	Nuclide Specific Alpha (NSA)
637	RECHG	FSS - Professional
638	RECHG	FSS - RCT Tech (In-House)
639	RECHG	FSS - RCT Tech (Contractor)
640	RECHG	FSS - RCT Tech OT
641	RECHG	Environmental Compliance Reps
642	RECHG	FSS - Jr. RCT / Trainee
643	RECHG	Industrial Hygiene - ST
644	RECHG	Industrial Hygiene - OT
47	RECHG	Respirator Cleaning
648	RECHG	Hazardous & Industrial Waste
649	RECHG	Rad Solid Waste
650	RECHG	Rad Liquid Waste
651	RECHG	Mixed Waste
652	RECHG	Waste Mgmt Tech/Prof Recharge
680	RECHG	**Misc Distributed Services -** This category is used to capture cost for miscellaneous distributed service rates approved by the Budget Office for which a specific category has not been established. **This category is not to be used for direct salary transfers. Direct salary transfers must be handled through the Labor Cost Distribution System. As stated in the beginning of this section, the offsetting credit is the resource category 205.**

Allocations

500	ALOSV	**Allocated Services** - This category is used to capture cost for miscellaneous allocated services approved by the Budget Office for which a specific category has not been established. The offsetting credit is charged to resource category 205.
501	ALOSV	**Allocated Services - Distributed -** This category reflects the departmental re-distribution of cost within their organization for the various allocated services. The charge is typically based on a rate charged against the department's direct salary, paid absence and fringe costs. The credit portion of this distribution is also reflected in this category within the organization's burden cost center.
502	ALOSV	**ITD Allocation** - This category is used to record the ITD allocation from the

		Information Technology Division (ITD). The offsetting credit is charged to resource category 205.

Appendix C

'03	ALOSV	**ITD - Hardware & Software Services** - This category is used to record the cost to users who have requested specific software support. The charges are based on approved standard hourly rates. The offsetting credit is charged to resource category 205.
505	ALOSV	**Instrumentation & Calibration Allocation** - This category is used to record the cost of the calibration and maintenance program for ES&H instrumentation. Activities include calibrating, maintaining, or repairing ES&H monitoring and ancillary equipment; evaluating and improving calibration techniques; installing and integrating fixed ES&H monitoring instrumentation and systems; and developing and maintaining calibration procedures and data base. The offsetting credit is charged to resource category 205.
506	ALOSV	**Ground Water Well Monitoring** - This category is used to record the monitoring function of the Laboratory's Ground Water Well Monitoring program. It includes the periodic analysis of samples taken from wells throughout the site for contamination from historical and active operations. The offsetting credit is charged to resource category 205.
507	ALOSV	**Waste Management Allocation** - This category is used to record the cost of the Waste Management Allocation from the Environmental and Waste Management Services Division. The offsetting credit is charged to resource category 205. This category was available for budgeting within the budget submission process during FY 2002 and became available for actual charging effective October 1, 2002 (FY 2003).
ˉ08	ALOSV	**Waste Management Allocation** - Distributed - This category is used to reflect the departmental redistribution of the Waste Management Allocation within their organization. The redistribution is typically based on a rate charged against the department's direct salary, paid absence and fringe costs. The credit portion of this distribution is also reflected in this category within the organization's burden cost center. This category was available for budgeting (via allocation process) within the budget submission process during FY 2002 and became available for actual charging effective October 1, 2002 (FY 2003).

Recoveries and Overheads

205	RECOV	**Internal Cost Recovery** - This category is used both in the PeopleSoft project costing and budgeting system to record the credit portion of distributions of recharge, allocated, and organizational burden cost centers as well as the material burden allocations processed each month end. For these cost centers, this category is calculated within the Budget system. Therefore, for organizations with miscellaneous internal recoveries, category 207 has been provided (for budgeting purposes only), to record the recovery portion of the cost plan for the project. Actual cost recovery will continue to be reflected in category 205.
206	RECOV	**External Cost Recovery** - Miscellaneous Cash Recovery
700	OVER	**Organizational Burden** - This category is used to distribute the cost of an organization's organizational burden cost center. The charge is based on a rate charged against the Department's/Division's direct salary, paid absence and fringe costs. The credit portion of this distribution is reflected in category 205 within the organization's burden cost center.
/01	OVER	**Special Organizational Burden** - Same as category 700; however, organizational cost center is at a higher level, such as at the Assistant or Associate Laboratory Director (ALD) or at the Business Operations Manager (BOM) level. The credit

		portion of this distribution is reflected in category 205 within the organization's burden cost center.

Appendix C

702	OVER	**Central Services Distributed** - This category reflects the Departmental/Divisional re-distribution of cost within their organization for the various central services. The charge is typically based on a rate charged against the Department's/Division's direct salary, paid absence and fringe costs. The offsetting credit is charged to resource category 205.
710	OVER	**G&A Burden** - This category is used to record the allocation of the traditional portion of the G&A overhead rate. Only the Budget Office is permitted to make adjustments to this category.
711	OVER	**Adjs to G&A Burden** - Restricted to Budget Office and Fiscal Office use. This category records adjustments made to the Traditional G&A burden (i.e., adjustments due to the Large Procurement Policy).
720	OVER	**Common Support** - This category is used to record the allocation of the common support portion of the G&A overhead rate. Only the Budget Office is permitted to make adjustments to this category.
721	OVER	**Adjs to Common Support Burden** - Restricted to Budget Office and Fiscal Office use. This category records adjustments made to the Common Support G&A burden (i.e., adjustments due to the Large Procurement Policy).
722	OVER	**Site Support - S&S** - This category is used to charge the Safeguards and Security Program assessment to the WFO, NFA, OTHER, and WN projects.
745	OVER	**Procurement** - This category is used to record the allocation of the material burden rate. Only the Budget Office is permitted to make adjustments to this category.
746	OVER	**Adjs to Procurement Burden** - Restricted to Budget Office and Fiscal Office use. This category records adjustments made to the Material burden (i.e., adjustments due to the Large Procurement Policy).

Capital Equipment

The following categories must be used for the procurement of DOE funded capital equipment when purchased against capital equipment projects (project type = CAP). The capitalization cost criteria currently is defined as equipment with a unit cost of $25,000 or more and a useful life of two years or more. The appropriate "Profile ID" must be used with these categories. Only material burden is charged on the cost of the capital equipment and G&A is charged only on the material burden cost. The actual cost of the capital equipment is NOT burdened with G&A.

400	CAPEQ	Hi Value - Shop Equipment
410	CAPEQ	Hi Value - Motor Vehicle
420	CAPEQ	Hi Value - Heavy Mobile Equipment
425	CAPEQ	Hi Value - Laboratory Equipment
430	CAPEQ	Hi Value - Admin/Protect Equipment
440	CAPEQ	Hi Value - Computer Equipment
450	CAPEQ	Hi Value - Hospital/Medical Equipment
460	CAPEQ	Hi Value - Miscellaneous Equipment
475	CAPEQ	**Capital Equipment (Non-DOE Programs)** - This category must be used for the procurement of equipment with other than DOE funds and would otherwise meet the

requirements for tagging of Capital Equipment. Only material burden is charged on the cost of the capital equipment and G&A is charged only on the material burden cost. The actual cost of the capital equipment is NOT burdened with G&A.

Appendix C

Other Direct Costs

480	SPCHG	**Space Charge-Direct** - This category is used to record the space charge allocation from the Plant Engineering Division (EP). The offsetting credit is charged to resource category 205.
481	SPCHG	**Space Charge-Distributed** - This category reflects the departmental redistribution of cost within their organization for the space charge allocation provided by the Plant Engineering Division. The charge is typically based on a rate charged against the department's direct salary, paid absence and fringe costs. The credit portion of this distribution is also reflected in this category within the organization's burden cost center.
485	SPCHG	**Fuel Charge** - Since fuel oil is the most volatile/variable component ofthe space pool, a decision was made to break out the fuel componentfrom the normal space charge. Any increase or decrease in the space related rates can then be easily attributed to the appropriate components (core space vs fuel). The fuel charge will be processed monthly through a flat rate utilizing categories 480 and 481 as the basis for the calculation. The actual charge will be posted to category 485. This category will be assessed the same G&A as categories 480 and 481.
490	RESMA	**Cold Neutron Moderator** - This category is used to distribute the cost of this device. The offsetting credit is charged to resource category 205.
491	RESMA	**Tandem Van De Graaff** - This category is used to distribute the cost of this device. The offsetting credit is charged to resource category 205.
492	RESMA	**60 inch Cyclotron** - This category is used to distribute the cost of this device. The offsetting credit is charged to resource category 205.
493	RESMA	**Other Research Machines** - This category is used to distribute the cost of research machines for which a specific category has not been established. The offsetting credit is charged to resource category 205.
740	FCR	**Full Cost Recovery (FCR) - Non Federal**
741	FCR	**Full Cost Recovery (FCR) - Federal**

The Laboratory is required to charge "full cost recovery" for all work performed against other than DOE research programs. These costs will be classified as Non-fund costs and will be reflected in either category 740 or 741 based on the classification of the sponsoring agency. The full cost rate for non-DOE programs is prescribed by DOE and is applied to total costs, including G&A.

DOE removes the funds for the FCR component from the total funding provided to BNL by other federal agencies. BNL is only provided with the net funding. Therefore, these categories must be excluded when analyzing the cost plans and Year-to-date expenditures of this type of project.

Budget System or Budget Office-Related Resources Categories

164	MODC	**Approved Admin Transfers** - Used strictly by the Budget Office to record special transfers to address split funding and DOE initiated recasting of B&R numbers, Fund types, etc.
207	RECOV	**Direct Cost Recovery** - This category was established for use by those organizations

Appendix C

		(other than recharge, allocated and organizational burden cost centers) that have miscellaneous recoveries as part of their cost plan. This category will permit those organizations to record the miscellaneous recovery portion of their cost plan within the budgeting system. Actual cost recovery will continue to be reflected in category 205. Cost should not be reflected in this category.
698	RESRV	**OP Funds Pending Deob** - This category is used to record funds that are Pending de-obligation. Cost should not be reflected in this category.
699	RESRV	**Reserve** - This category is used when a department has funds that will be spent during the current fiscal year, but is uncertain as to the distribution of funds within the categories. Those funds are budgeted in this category until such time as the Department/Division includes them in its cost plan or moves them to carry forward. The Budget System applies G&A to this category. Cost should not be reflected in this category.
770	OVER	**BUD-Indirect rate recalc adjs** - This category is used to temporarily record the periodic rate changes (organizational and/or Laboratory-wide) that occur within the various Laboratory department/divisions. Typically, a rate is changed so close to the end of the monthly accounting period that the Departments/Divisions do not have sufficient time to re-budget their projects accordingly. Therefore, when an organizational or Laboratory-wide rate is changed, the system temporarily records the delta in this category to allow the departments/divisions sufficient time to re-budget the rate change. This works only if the security access is provided for this feature.
800	BUD	**New Funding - BNL** - This category is used by the Budget System to transfer the new funding from the Budget Execution system to project costing. New Funding represents funds received during the current fiscal year.
801	BUD	**New Funding - Full Cost Recovery** - This category is used by the Budget System to transfer the "New Funding - Full Cost Recover" from the Budget Execution system to project costing. "New Funding - Full Cost Recovery" represents the Full Cost Recovery component of the new funds received during the current fiscal year.
802	BUD	**Total New Funds** - This category is used by the Budget System to transfer the total of Categories 800 and 801 from the Budget Execution system to project costing.
805	BUD	**Carry Over - BNL** - This category is used by the Budget System to transfer the Carry Over from the Budget Execution system to project costing. Carry Over represents uncosted funds from the prior fiscal year.
806	BUD	**Carry Over - Full Cost Recovery** - This category is used by the Budget System to transfer the "Carry Over - Full Cost Recovery" from the Budget Execution system to project costing. "Carry Over - Full Cost Recovery" represents the Full Cost Recovery component of the Carry Over funds from the prior fiscal year.
807	BUD	**Total Carry Over** - This category is used by the Budget System to transfer the total of Categories 805 and 806 from the Budget Execution system to project costing.
810	BUD	**Expected Contract Mod** - This category is used by the Budget System to transfer the "Expected Contract Mod" from the Budget Execution system to project costing. "Expected Contract Mod" represents funds that the Departments/Divisions can reasonably expect to receive from their sponsors during the current fiscal year.
815	BUD	**New Funds - Unassigned** - The purpose of this category will be to temporarily collect the unassigned values to New Funding. It represents the difference between New Funding and the cost plan carry forward that has not been released by the Departments/Divisions. It will help to properly reflect the Funds available on the bottom portion of the monthly B&Es and keep that information static for the period of

Appendix C

		representation. This category will be transparent to the user community. It is needed in the system background in order to run a particular routine for the Budget System.
04	SCIEN PROF MGTAD TECH UNION	**Paid Absence Credits** - This category is used to record Paid Absence Revenue earned from direct salary costs within the Scientific, Professional, Management, Union, and Technical Salary Classifications. The Paid Absence burden is not applied on Shift Salary, Overtime Premium and Base Overtime salary.
906	FRNGE	**Vacation Expense** - Adjustment - This category is used to record the cost related to the reevaluation of the Accrued Vacation Liability. Effective October 1, 2002, the resource type will be changed from SCIEN, PROF, MGTAD, TECH, and UNION to FRNGE.
907	FRNGE	**Consulting Expenses for Postretirement Valuation** - This category is used to record the consulting costs for the valuation of Postretirement Medical performed annually by Aon Consulting. This valuation is required by FASB 106.
908	FRNGE	**Vanguard - Employer Contribution** - This category is used to record the employer's retirement contribution to Vanguard. The Laboratory contributes to the designated retirement account of each enrolled employee the appropriate distribution elected by the employee.
909	FRNGE	**Fidelity - Employer Contribution** - This category is used to record the employer's retirement contribution to Fidelity. The Laboratory contributes to the designated retirement account of each enrolled employee the appropriate distribution elected by the employee.
910	FRNGE	**Dental Plan** - This category is used to record dental expenses for the Easter Benefit Dental (EB) plan. Dental expenses include weekly payments, monthly administration fees offset by withholding and COBRA requirements.
912	FRNGE	**Sick Leave Buy Back** - This category is used to record a reimbursement to nonexempt employees for a portion of their unused sick leave (in excess of 108 days). Eligible employees are reimbursed 25% of their unused sick leave balance.
913	FRNGE	**NYS Unemployment Insurance** - This category is used to record the employer's New York State and Federal Unemployment Insurance payments.
914	FRNGE	**Insurance - Worker's Compensation** - This category is used to record worker's compensation payments to Liberty Mutual. Workers' Compensation assures that employees are compensated to some extent for losses incurred as a result of injuries or illnesses related to employment, including loss of earnings and related medical expenses.
915	FRNGE	**Insurance - Group Life** - This category is used to record basic group life insurance expenses for eligible employees.
916	FRNGE	**TIAA/CREF Employer Contribution** - This category is used to record the employer's retirement contribution to TIAA/CREF. The laboratory contributes to the designated retirement account of each enrolled employee the appropriate distribution elected by the employee.
917	FRNGE	CIGNA Behavioral Health
918	FRNGE	**Insurance - Employers Share FICA** - This category is used to record the employer's portion of the Social Security and Medicare tax.
919	FRNGE	**Medical Plan**- This category is used to record medical expenses for the CIGNA Medical Plan. Medical expenses include weekly payments and quarterly premium

Appendix C

		payments offset by employee withholding and COBRA reimbursements.
920	FRNGE	**Insurance Disability** - This category is used to record disability insurance. Disability insurance provides income protection, at 60% base pay, to covered employees who are unable to work because of a disability caused by illness or injury.
921	FRNGE	**Flex Benefit Admin Fee** - This category is used to record expenses paid to a third party to administer the Health Care and Dependent Day Care Flexible Benefit Plans. The plan costs include maintaining a checking account, processing claim forms, sending out payments, answering inquiries, and preparing monthly activity reports.
922	FRNGE	**Medical Insurance** - Health Maintenance Organizations - This category is used to record medical expenses for the Health Maintenance Organizations (HMOs).
923	FRNGE	**Insurance Credits** - This category is used to record Fringe Benefits Revenue earned from direct salary costs within the Scientific, Professional, Management, Union, and Technical Salary Classifications.
924	FRNGE	**CIGNA Dental Plan** - This category is used to record Dental expenses for the CIGNA Dental Plans. Dental expenses include weekly payments and monthly administration fees offset by employee withholding.
925	FRNGE	**Severance Pay** - This category is used to record severance payments. The severance pay benefit is designed to assist active regular employees, working at least half time, whose earnings are unexpectedly canceled by layoff. Extraordinary severance due to program termination is borne by the appropriate program.
926	FRNGE	**Adoption Assistance Policy** - This category is used to record adoption expenses. The adoption assistance policy provides eligible employees financial assistance for certain expenses related to adoption of an unrelated minor child.
927	FRNGE	**Tuition Refunds** - This category is used to record tuition expenses for regular full-time and part-time eligible employees who successfully complete an approved formal course of study.
928	FRNGE	**Retiree Mementos** - This category is used to record photography, printing, graphic design, building trades labor, and materials for the Retiree Package, which includes a retirement photograph, a video of BNL, and a retirement plaque.
930	FRNGE	**Catastrophic Insurance** - This insurance expense limits maximum Laboratory exposure on individual medical claims.
940	FRNGE	**Prudential Life Insurance** - This category is used to record basic group life insurance expenses for eligible employees. Effective January 2005, the Laboratory changed life insurance vendors from CIGNA to Prudential.
950	FRNGE	**Prudential Disability Insurance** - This category is used to record disability insurance. Disability insurance provides income protection, at 60% of base pay, to employees who are unable to work because of a disability, caused by illness or injury. The Laboratory changed disability insurance vendors from CIGNA to Prudential.

5.2-032005-/ld/ld01/ld01d291.htm

The only official copy of this file is the one online in SBMS. Before using a printed copy, verify that it is the most current version by checking the document effective date on the BNL SBMS website.

Appendix C

Trim # 2 EBIS Funding Status Report DECEMBER 2005 $ in Thousands	NASA					DOE					
	Trim # 2A FY'06 B/A	B/A Expected Funding	Prior Year Carry-Fwd	Total FY'06 Budget	NASA LTD Budget	Trim # 2A FY'06 B/A	B/A Expected Funding	Prior Year Carry-Fwd	Total FY'06 Budget	DOE LTD Budget	LTD Grand Total
• CDR	0	0	0	0	0	0	0	4	4	200	200
• R&D (08266, 08262)	0	600	0	600	600	100	0	431	531	600	1,200
• PED	0	0	0	0	0	2,000	0	0	2,000	2,000	2,000
1.01 Structural Comp (71075)	0	0	0	0	0	299	0	0	299	299	299
1.02 Controls (71076)	0	0	0	0	0	89	0	0	89	89	89
1.03 Diagnostic Instr (71077)	0	0	0	0	0	185	0	0	185	185	185
1.04 Magnet Sys (71078)	0	0	0	0	0	57	0	0	57	57	57
1.05 Power Supply (71079)	0	0	0	0	0	123	0	0	123	123	123
1.06 RF System (71080)	0	0	0	0	0	107	0	0	107	107	107
1.07 Vacuum System (71081)	0	0	0	0	0	156	0	0	156	156	156
1.08 Cooling System (71082)	0	0	0	0	0	31	0	0	31	31	31
1.09 Facility Mod (71083)	0	0	0	0	0	67	0	0	67	67	67
1.11 Proj Svc (71084)	0	0	0	0	0	452	0	0	452	452	452
1.14 Contingency (71085)	0	0	0	0	0	434	0	0	434	434	434
• NASA Construction	0	900	500	1,400	1,400	0	0	0	0	0	1,400
1.01 Structural Compnts (14397)	0	900	500	1,400	1,400	0	0	0	0	0	1,400
1.09 Facility Mod (08278)	0	0	0	0	0	0	0	0	0	0	0
Total Funding	**$0**	**$1,500**	**$500**	**$2,000**	**$2,000**	**$2,100**	**$0**	**$435**	**$2,535**	**$2,800**	**4,800**

Trim # 2
EBIS
Financial Status Report
DECEMBER 2005

$ in Thousands

	NASA						DOE						
	LTD Budget	Current Month Expense	LTD Expense	Burdened Commit	Total Expense Commit	NASA Balance Available	LTD Budget	Current Month Expense	LTD Expense	Burdened Commit	Total Expense Commit	DOE Balance Available	TOTAL Balance Available
CDR	0	0	0	0	0	0	200	0	198	0	198	2	2
R&D (08266, 08262)	600	0	0	0	0	600	600	95	294	230	524	76	676
PED	0	0	0	0	0	0	2,000	3	3	0	3	1,997	1,997
1.01 Structural Comp (71075)	0	0	0	0	0	0	299	0	0	0	0	299	299
1.02 Controls (71076)	0	0	0	0	0	0	89	0	0	0	0	89	89
1.03 Diagnostic Instr (71077)	0	0	0	0	0	0	185	0	0	0	0	185	185
1.04 Magnet Sys (71078)	0	0	0	0	0	0	57	0	0	0	0	57	57
1.05 Power Supply (71079)	0	0	0	0	0	0	123	0	0	0	0	123	123
1.06 RF System (71080)	0	0	0	0	0	0	107	0	0	0	0	107	107
1.07 Vacuum System (71081)	0	0	0	0	0	0	156	0	0	0	0	156	156
1.08 Cooling System (71082)	0	0	0	0	0	0	31	0	0	0	0	31	31
1.09 Facility Mod (71083)	0	0	0	0	0	0	67	0	0	0	0	67	67
1.11 Proj Svc (71084)	0	0	0	0	0	0	452	3	3	0	3	449	449
1.14 Contingency (71085)	0	0	0	0	0	0	434	0	0	0	0	434	434
NASA Construction	1,400	24	54	390	444	956	0	0	0	0	0	0	956
1.01 Structural Compnts (14397)	1,400	24	54	390	444	956	0	0	0	0	0	0	956
1.09 Facility Mod (08278)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Funding	**$2,000**	**$24**	**$54**	**$390**	**$444**	**$1,556**	**$2,800**	**$98**	**$495**	**$230**	**$725**	**$2,075**	**3,631**

4/14/2006

Appendix E

C-AD Manpower Report in FTE's

(Includes Dept Codes AD, AM and RC)

Period: 6

FY: 2006

Activity	Res Type	Period	Corr. Period	Hours	FTE	ID		Name
Project 08040								
08040	SCIEN	6	0	75.00	0.0426	13909	GHOSH	ARUP
08040	SCIEN	6	0	12.00	0.0068	21722	PARKER	BRETT
08040	SCIEN	6	0	6.00	0.0034	07794	SAMPSON	WILLIAM
08040	SCIEN	6	0	25.40	0.0144	10068	WANDERERJR	PETER
		Sub-Total SCIEN		*118.40*	*0.0672*			
08040	PROF	6	0	8.16	0.0046	19098	MURATORE	JOSEPH
		Sub-Total PROF		*8.16*	*0.0046*			
08040	OTHER	6	0	81.10	0.0461	15200	DALESRA	JOSEPH
08040	OTHER	6	0	63.22	0.0359	14640	SPERRYIV	EDWARD
		Sub-Total OTHER		*144.32*	*0.0820*			
	Total Project 08040			*270.88*	*0.1538*			
Project 08042								
08042	SCIEN	6	0	16.25	0.0092	17354	GUPTA	RAMESH
08042	SCIEN	6	0	28.41	0.0150	10068	WANDERERJR	PETER
		Sub-Total SCIEN		*42.66*	*0.0242*			
08042	PROF	6	0	39.01	0.0222	21614	FELTER	RICHARD
08042	PROF	6	0	24.32	0.0138	16977	JOSHI	PIYUSH
08042	PROF	6	0	40.01	0.0227	12188	MCCHESNEY	DAVID
08042	PROF	6	0	66.85	0.0380	19098	MURATORE	JOSEPH
		Sub-Total PROF		*170.19*	*0.0966*			
08042	OTHER	6	0	16.15	0.0092	16918	CINTORINOI	JOHN
08042	OTHER	6	0	0.00	0.0000	16918	CINTORINOI	JOHN
08042	OTHER	6	0	0.00	0.0000	19928	SAUERWALD	ANDREW
08042	OTHER	6	6	2.00	0.0011	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	0.00	0.0000	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	0.00	0.0000	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	0.00	0.0000	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	0.26	0.0001	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	2.30	0.0013	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	4.00	0.0023	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	32.44	0.0184	19928	SAUERWALD	ANDREW
08042	OTHER	6	0	1.20	0.0007	15602	VOTRUBA	DANA
		Sub-Total OTHER		*58.35*	*0.0331*			
	Total Project 08042			*271.20*	*0.1540*			
Project 08068								
08068	SCIEN	6	0	8.10	0.0046	21327	FISCHER	WOLFRAM
		Sub-Total SCIEN		*8.10*	*0.0046*			
08068	PROF	6	0	80.00	0.0454	18195	CAMERON	PETER

Appendix F

STORES REPORT FOR COLLIDER-ACCELERATOR DEPT.

Project	PickTick	Item	Quantity	Amount	Dept	Line Date	Line	Name	Deliver To	Descript
08040	105788	H29450	247.0000	$854.80	PRIN	2/1/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary N/R -HELIUM LIQUID P27407A
08040	109357	H29450	231.0000	$946.50	PRIN	2/7/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary N/R -HELIUM LIQUID P27407A
08040	110106	H29450	223.0000	$901.39	PRIN	2/21/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary N/R -HELIUM LIQUID P27407A
08040 Total				$2,704.65						
08068	105920	A73475	20.0000	$40.40	ADCY	2/8/2006	1	CURCIO,ANTHONY J	curcio	CONNECTOR PLUG 205350-1
08068	107560	A72460	10.0000	$28.19	ADCY	2/8/2006	6	CURCIO,ANTHONY J	curcio	CONNECTOR BACKSHELL SHELL SIZE 23
08068	105559	A73453	20.0000	$31.60	ADCY	2/8/2006	3	CURCIO,ANTHONY J	curcio	CONNECTOR BACKSHELL
08068	116235	A03617	83.0000	$178.10	ADCY	2/24/2006	1	CURCIO,ANTHONY J	curcio	CONNECTOR COAXIAL CABLE
08068	102378	A08517	90.0000	$342.55	ADCY	2/16/2006	1	CURCIO,ANTHONY J	curcio	CONNECTOR COAXIAL CABLE
08068	107590	A73453	20.0000	$40.60	ADCY	2/8/2006	5	CURCIO,ANTHONY J	curcio	CONNECTOR BACKSHELL SIZE 23 STD
08068	105809	A73458	30.0000	$97.50	ADCY	2/8/2006	4	CURCIO,ANTHONY J	curcio	CONNECTOR SHELL SIZE 17 LARGE AMP 960323-1
08068	105827	A73565	20.0000	$30.08	ADCY	2/8/2006	2	CURCIO,ANTHONY J	curcio	CONNECTOR PLUG AMP 206044-1
08068 Total				$740.50						
08114	107157	N20035	8.0000	$16.26	AMBA	2/8/2006	1	DILGEN,THOMAS F	dilgen	ARGON GAS, MIN. PURITY 99.998%, PP, SIZE K, 275 CF, CGA 580
08114 Total				$16.26						
08259	103713	D1430	12.0000	$14.40	PRWH	2/2/2006	6	VESTAL JR,ALVIN J	ZAHARATOS	TERM LUG FOR #4 TO #CABLE
08259	103372	H7266	24.0000	$148.00	PRWH	2/2/2006	1	VESTAL JR,ALVIN J	WELLMINSTER	FILTER POLY RING 24 X 24
08259	109584	H4658	8.0000	$143.08	ADCL	2/9/2006	1	YONTE JR,JOHN D		TUBE COPPER SOFT,3/4 X 0.032
08259	103675	E71683	10.0000	$33.60	ADED	2/9/2006	1	DE JESUS,VANETTE M	PHILLIPS	temporary N/R -PURE WATER 5 GAL DEMI BOTTLE
08259	109112	H2336	2.0000	$7.08	PRWH	2/10/2006	2	VESTAL JR,ALVIN J	WELLMINSTER	FILTER AIR COND 16 X 25 X 2
08259	120143	L4630	4.0000	$2.04	PRWH	2/22/2006	2	VESTAL JR,ALVIN J	BRUCE	HANGER CONDUIT 1-1/2" COND SEMI
08259	110309	H2437	15.0000	$37.20	PRWH	2/28/2006	1	VESTAL JR,ALVIN J	WELLMINSTER	FILTER AIR COND 20 X 25 X 2
08259	110134	170712	2.0000	$8.50	PRWH	2/25/2006	3	VESTAL JR,ALVIN J	FOLK	SEALANT SILICONE RUBBER WHT
08259	110135	H13060	1.0000	$8.03	PRWH	2/23/2006	1	VESTAL JR,ALVIN J	FOLK	GUN CAULKING 9" X 2-1/4"
08259	110533	H2404	8.0000	$15.78	PRWH	2/22/2006	2	VESTAL JR,ALVIN J	WELLMINSTER	FILTER AIR COND 16 X 20 X 2
08259	110188	C2420	100.0000	$19.80	PRWH	2/23/2006	1	VESTAL JR,ALVIN J	FOLK	CONDUIT ELECTRICAL 3/4"X 100FT
08259	110146	[illegible]	2.0000	$23.01	PRWH	2/22/2006	1	VESTAL JR,ALVIN J	BRUCE	CABINET ELECTRICAL 4" X 4" X 4"
08259	110149	126450	2.0000	$3.90	PRWH	2/22/2006	3	VESTAL JR,ALVIN J	BRUCE	CONNECTOR BOX INDR. 1KO
08259	110142	123346	2.0000	$3.73	PRWH	2/22/2006	5	VESTAL JR,ALVIN J	BRUCE	BUSHING ELECTRIC 1-1/4"
08259	110140	123350	2.0000	$13.95	PRWH	2/22/2006	4	VESTAL JR,ALVIN J	BRUCE	BUSHING ELECTRIC 1-1/2"
08259	112144	A08754	10.0000	$106.82	ADCY	2/22/2006	1	CURCIO,ANTHONY J	curcio	CONNECTOR ELEC RF BNC TO N ADAPTER
08259	119129	H28808	4.0000	$107.22	ADCX	2/22/2006	1	LEE,ROBERT D		NITROGEN, 99.999% ULTRA PURE, SIZE K, 257 CF, VENDOR'S CYLN
08259	105712	H2433	8.0000	$23.75	PRWH	2/10/2006	1	VESTAL JR,ALVIN J	WELLMINSTER	FILTER AIR COND 12 X 24 X 2
08259 Total				$367.74						
08271	109714	I82505	4.0000	$160.53	ADCD	2/1/2006	1	BURRELL,ANDREW		MAT 100% NYLON 3 X 5 FT BEIGE
08271	110316	H35731	4.0000	$4.58	ADCD	2/1/2006	9	BURRELL,ANDREW		TISSUE FACIAL TWO PLY RECYCLED
08271 Total				$165.16						
18004	108241	B35585	30.0000	$96.03	PRWH	2/1/2006	1	WILLIAMS,SHELBY L		PAPER RECYCLED COPY/PRINTER WHITE 8-1/2"X11"
18004	108453	K72409	2.0000	$64.45	ADBA	2/3/2006	1	SPARROW,PAUL J		TAPE PSA DELTA WARNING 3" YELLOW/BLACK
18004	103622	A75343	12.0000	$7.80	ADBA	2/8/2006	4	SPARROW,PAUL J		BATTERY 1.5 VOLT SIZE D ALKALINE
18004	103622	A75332	12.0000	$11.52	ADBA	2/8/2006	6	SPARROW,PAUL J		BATTERY 1.5 VOLT DRY
18004	109682	A75333	24.0000	$9.12	ADBA	2/8/2006	2	SPARROW,PAUL J		BATTERY 1.5 VOLT SIZE AA ALKALINE
18004	108693	192322	8.0000	$4.50	ADBA	2/10/2006	3	SPARROW,PAUL J		PLATE WALL 2-3 1 GANG 2 OPENING
18004	110178	H09540	6.0000	$48.84	PRWH	2/23/2006	1	WILLIAMS,SHELBY L		temporary N/R -PROPANE GAS 33-1/2 LB
18004	110174	I82332	1.0000	$8.47	PRWH	2/23/2006	3	WILLIAMS,SHELBY L		RAG WIPING MED DUTY BLUE
18004	110175	I82578	2.0000	$4.48	PRWH	2/23/2006	2	WILLIAMS,SHELBY L		CLEANER ALL SURFACE 22 OZ.
18004	110170	I83276	1.0000	$24.14	ADFJ	2/23/2006	2	MC DONALD,DEAN C		PLATE PAPER 9" DIA
18004	110179	E74060	9.0000	$30.49	ADFJ	2/23/2006	1	MC DONALD,DEAN C		PURIFIED WATER 5 GL PALLETIZED
18004	110042	B35585	30.0000	$96.03	PRWH	2/13/2006	1	WILLIAMS,SHELBY L	WILLIAMS SHELBY L. X3007	PAPER RECYCLED COPY/PRINTER WHITE 8-1/2"X11"
18004	109739	B35583	30.0000	$98.00	PRWH	2/14/2006	1	WILLIAMS,SHELBY L	WILLIAMS SHELBY L. X3007	PAPER RECYCLED COPY/PRINTER WHITE 8-1/2"X11"
18004	107930	I32715	10.0000	$14.09	ADBA	2/13/2006	1	SPARROW,PAUL J		PLATE WALL 2-3 1 GANG BLANK

STORES REPORT FOR COLLIDER-ACCELERATOR DEPT.

Project	PickTick	Item	Quantity	Amount	Dept	Line Date	Line	Name	Deliver To	Descript
18004	100522	A71354	12.0000	$7.83	ADBA	2/6/2006	3	SPARROW,PAUL J		BATTERY 1.5 VOLT SIZE C ALKALINE
18004	108522	A75356	6.0000	$9.65	ADBA	2/6/2006	6	SPARROW,PAUL J		BATTERY LITHIUM 3 VOLT
18004	108522	A75357	24.0000	$12.91	ADBA	2/6/2006	1	SPARROW,PAUL J		BATTERY ALKALINE SIZE AAA
18004	109483	H30049	3.0000	$24.42	PRWH	2/9/2006	1	WILLIAMS,SHELBY L	WILLIAMS SHELBY L. X3007	temporary ISR-PROPANE GAS 33-1/3 LB
18004	109152	B74649	20.0000	$243.00	ADBA	2/22/2006	1	DE JESUS,VANETTE M	SPARROW	PURIFIED WATER 5 GL PALLETIZED
18004 Total				$303.43						
18007	110036	990951	1.0000	$90.00	IOAA	2/17/2006	1	MC DONAN,JOHN A	DUMONT	PAGER RADIO NUMERIC DISPLAY BRAVO 501
18007 Total				$90.00						
18011	109534	H29993	8.0000	$73.91	ADAC	2/14/2006	1	DE JONG,WILLEM		ARGON, COMMERCIAL, MIN. PURITY 99.998, SIZE K, 244 CF, CGA 5
18011 Total				$73.91						
18026	108314	H2198	12.0000	$57.02	PRWH	2/1/2006	1	VESTAL, JR,ALVIN J	CARROLL	FILTER AIR COND 16 X25 X1"
18026	109460	183330	6.0000	$15.49	PRWH	2/3/2006	2	VESTAL, JR,ALVIN J	WELLMEISTER	RAG WIPING MED DUTY BLUE
18026	109460	182795	3.0000	$43.26	PRWH	2/3/2006	3	VESTAL, JR,ALVIN J	WELLMEISTER	CLEANSR HAND TOWELS PRE-MOIST
18026	109402	177310	16.0000	$30.84	PRWH	2/3/2006	1	VESTAL, JR,ALVIN J	WELLMEISTER	GREASE LUBE GRADE 556
18026	109495	832109	150.0000	$4.85	ADCA	2/6/2006	1	PETWAY,ANNABELLE	Anna Petway	ENVELOPE INTRA LAB USE ONLY GREEN #10
18026	109719	H2404	12.0000	$60.60	PRWH	2/10/2006	1	VESTAL, JR,ALVIN J	DONO	FILTER AIR COND 16 X 20 X 2
18026	109718	118260	1.0000	$4.15	PRWH	2/13/2006	4	VESTAL, JR,ALVIN J	DONO	BELT-V 4L520 STD
18026	109715	118215	1.0000	$4.07	PRWH	2/13/2006	3	VESTAL, JR,ALVIN J	DONO	BELT-V 4L500 STD
18026	109715	118170	1.5000	$3.74	PRWH	2/10/2006	2	VESTAL, JR,ALVIN J	DONO	BELT-V 4L410 STD
18026	109606	170658	1.0000	$3.09	PRWH	2/14/2006	1	VESTAL, JR,ALVIN J	LAPNIS	ADHESIVE SILICON RUBBER 3 OZ.
18026	109916	880250	1.0000	$4.20	ADCA	2/16/2006	1	PETWAY,ANNABELLE	Anna Petway	FORM 22119 SAFETYGLASS
18026	109927	813048	1.0000	$60.84	PRWH	2/16/2006	5	VESTAL, JR,ALVIN J	TRIOLO	TOWEL CELLULOSE 1-PLY 10X82"
18026	109727	179301	1.0000	$6.35	PRWH	2/15/2006	1	VESTAL, JR,ALVIN J	TRIOLO	BAG PLASTIC POLY 23 X 14 X 60
18026	109919	A75357	88.0000	$41.98	ADCA	2/16/2006	3	PETWAY,ANNABELLE	Anna Petway	BATTERY ALKALINE SIZE AAA
18026	109919	A75345	90.0000	$38.45	ADCA	2/16/2006	2	PETWAY,ANNABELLE	Anna Petway	BATTERY 1.5 VOLT SIZE AA ALKALINE
18026	110045	H2329	2.0000	$11.60	PRWH	2/17/2006	1	VESTAL, JR,ALVIN J	WALTERS	FILTER AIR COND 24 X 24 X 4
18026	110045	H2395	12.0000	$41.89	PRWH	2/17/2006	3	VESTAL, JR,ALVIN J	WALTERS	FILTER AIR COND 13 X 25 X 2
18026	110045	H3364	8.0000	$37.18	PRWH	2/17/2006	2	VESTAL, JR,ALVIN J	WALTERS	FILTER POLY RING 24 X 12
18026	110070	170540	100.0000	$36.00	PRWH	2/20/2006	1	VESTAL, JR,ALVIN J	TRIOLO	BAG PLASTIC POLY 22 X 14 X 60
18026	110196	H3433	16.0000	$316.82	PRWH	2/23/2006	1	VESTAL, JR,ALVIN J	TRIOLO	FILTER POLYESTER BAG 24X24X18
18026	110196	183754	1.0000	$3.47	PRWH	2/23/2006	2	VESTAL, JR,ALVIN J	TRIOLO	TAPE DUCT 2"W ALUM
18026	110211	H2192	2.0000	$7.80	PRWH	2/27/2006	2	VESTAL, JR,ALVIN J	MERLE	FILTER AIR COND 20 X20 X1"
18026	110211	118190	2.0000	$12.16	PRWH	2/23/2006	3	VESTAL, JR,ALVIN J	MERLE	BELT-V 4L460 STD
18026	110211	H2191	3.0000	$11.50	PRWH	2/23/2006	1	VESTAL, JR,ALVIN J	MERLE	FILTER AIR COND 24 X 24 X 1
18026 Total				$929.30						
18032	109516	B74445	10.0000	$32.65	ADCJ	2/6/2006	1	DE JESUS,VANETTE M	ZAHARATOS	temporary ISR -PURE WATER 5 GAL DESK BOTTLE
18032	110031	990991	1.0000	$39.00	IOAA	2/17/2006	1	MC DONAN,JOHN A	DUMONT	PAGER RADIO NUMERIC DISPLAY BRAVO 501
18032	110090	B74405	8.0000	$78.21	ADCJ	2/21/2006	1	DE JESUS,VANETTE M	ZAHARATOS	temporary ISR -PURE WATER 5 GAL DESK BOTTLE
18032 Total				$149.34						
18033	109287	H29400	125.0000	$405.85	PRWH	2/1/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -HELIUM LIQUID P27407A
18033	109308	H30238	200.0000	$15.62	PRWH	2/6/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%
18033	109374	H30238	2472.0000	$190.93	PRWH	2/6/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%
18033	109402	H29400	65.0000	$367.27	PRWH	2/6/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -HELIUM LIQUID P27407A
18033	109478	137470	350.0000	$148.70	ADDH	2/8/2006	1	PASCOE,BRIAN F	R.Vasker	3-CORD ELEC SOOY YH 18 AWG 3C
18033	109763	H29477	4.0000	$34.59	ADDH	2/2/2006	1	LO DESTRO,VINCENT		HELIUM 99.999% UHP, SIZE K, 245 CF, CGA 580, 3K6-14 RH(F)
18033	109901	H30238	1600.0000	$173.97	PRWH	2/6/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%
18033	109679	835626	20.0000	$64.63	ADDH	2/9/2006	1	LO DESTRO,VINCENT		PAPER RECYCLED COPY/PRINTER WHITE 8-1/2"X11"
18033	109053	H29477	4.0000	$34.49	ADDH	2/10/2006	1	LO DESTRO,VINCENT		HELIUM 99.999% UHP, SIZE K, 245 CF, CGA 580, 3K6-14 RH(F)
18033	109949	H30238	200.0000	$15.02	PRWH	2/16/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%
18033	110136	H30238	200.0000	$15.02	PRWH	2/23/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%
18033	110246	H30238	2752.0000	$172.18	PRWH	2/24/2006	1	DE JESUS,VANETTE M	DEJESUS	temporary ISR -LIQUID NITROGEN BULK #2 99.997%

BROOKHAVEN NATIONAL LABORATORY

CREDIT CARD TRANSACTIONS **(BNLPR013)**

Includes Transactions Processed After 2/23/2006

Department: AD

Card Holder: MC CAFFERTY,DANIEL R   Card Number: 9428

Purchase Date	Vendor	Web Activity	Charged Activity	Amount
03/16/2006	TRUSTPRICE.COM	08266	03263	$356.00
02/27/2006	SYX*TIGERDIRECT.COM	18033	18033	$238.56
03/07/2006	WW GRAINGER E01	03268	03268	$157.95
03/02/2006	DKC	08266	08266	$36.86
03/03/2006	LABELCITY INC	18033	18033	$66.20
03/11/2006	FAISON OFF PRODUCTS	18033	18033	$32.41
			Total Charges:	$909.07

BROOKHAVEN NATIONAL LABORATORY

C-AD Maximo Labor Expenses Report

For the period ending March 31, 2006

Project 08042

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
08042	600	MAX	4.50	400.28	EP159181	AIR COMPRESSOR, HOUSE	EP
		Total	4.50	400.28			

Project 08093

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
08093	600	MAX	6.00	533.70	EP160794	transport drawing file cabinet	AM
		Total	6.00	533.70			

Project 08259

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
08259	600	MAX	7.50	667.13	EP157250	LOW HUMIDITY ALARM	AD
08259	600	MAX	2.00	177.90	EP150190	REPLACE HUMIDITSTATS IN ALA	AD
08259	600	MAX	28.50	2,535.11	EP156140	NEED MAINT ON VARIOUS A/C UNI	AD
08259	600	MAX	1.00	88.95	EP155264	HVAC A DISCHARGE TEMP BELOW 40	AD
08259	603	MAX	0.00	0.00	EP158746	CUSTODIAN TO CLEAN AND MOP BLD	AD
		Total	39.00	3,469.09			

Project 18004

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
18004	600	MAX	2.00	177.90	EP158087	ELEVATOR, FREIGHT	EP
18004	600	MAX	2.00	177.90	EP155377	ELEVATOR, FREIGHT	EP
18004	600	MAX	2.00	177.90	EP158063	ELEVATOR, FREIGHT	EP
18004	600	MAX	2.00	177.90	EP155353	ELEVATOR, FREIGHT	EP
		Total	8.00	711.60			

Project 18011

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
18011	600	MAX	1.00	88.95	EP160390	F/A SHUT DOWN ESBA AREA. 03/1	AD
18011	600	MAX	1.50	133.43	EP160130	SWEEP, MOP, PREP FLOOR FOR P	AD
18011	603	MAX	0.00	0.00	EP160130	SWEEP, MOP, PREP FLOOR FOR F	AD
18011	600	MAX	65.50	5,826.23	EP160131	PAINT FLOORS, SEE FRED K. FI	AD
		Total	68.00	6,048.61			

Project 18026

Activity	Categor	Source	Hours	Charge	Work Order	Description	Dept
18026	600	MAX	2.00	177.90	EP159206	AIR COMPRESSOR, INST	EP
18026	600	MAX	2.00	177.90	EP159183	AIR COMPRESSOR, HOUSE	EP

GSS Weekly Report As Of: Monday, April 03, 2006

DEPT: AD
JOB #: 005760 EXCERL LIFT CART ASSEMBLY/KCS Date Due: 013106 Proj/Act #: 8011
DEPT: AD

Item	Loc.	Drawing	Descr./Req'r/Estimator	QTY ORD	QTY COMP	Est. Hrs.	Hrs. Used	Bal Hrs.	$'s Est.	$'s Chrgd.	Bal. $'s	COMMENTS	Shop Assign.	Priority	Dt.Closed	Item
001	M	010601149	LIFT CART ASSEMBLY	1	1	0.00	0.00	0.00	$0	$0	$0		REFERENCE		031006	001
002	M	010601109	LIFT CART WELDMENT	1	1	32.00	78.00	-46.00	$3,504	$8,541	$5,037)		OF ROLLED TUBES, 479 FIT-UP,479 W. OF ANODIZE(RED)		012406	002
003	M	010601134	CLAMP	1	0	3.00	6.00	-3.00	$329	$657	($329)		479 MILL/DRILL			003
004	SM	010601141	CABLE BRACKET	2	1	7.00	12.00	-5.00	$767	$1,314	($548)		479 SM,479 HOLES, FIN INSP		012606	004
005	M	010601143	CABLE END	1	1	5.50	11.00	-5.50	$641	$1,243	($602)		479 TWEDM,479 LATHE, FIN INSP.		123005	005
006	M	010601152	TENSIONER MOUNT	1	1	4.00	5.00	-1.00	$477	$586	($110)		479 TWEDM,479 MILL, FIN INSP		123005	006
007	W	010601136	PLATE, SUPPORT WELDMENT	1	1	9.00	8.00	1.00	$986	$876	$110	ITEMS 8,9,10,11 USED HERE	479W CLEAN,479 WELD, FIN INSP		010506	007

Appendix I

Item	Loc	Drawing	Descr./Req'r./Estimator	QTY ORD	QTY COMP	Est. Hrs.	Hrs. Used	Bal Hrs.	$'s Est.	$'s Chargd.	Bal. $'s	COMMENTS	Shop Assign.	Priority	Dt.Closed	Rem
008	W	010601104	STAND-OFF, LONG	1	2	9.00	2.00	7.00	$986	$219	$767		479 LATHE,479 MILL,479W, FIN INSP.		123005	008
009	M	010601105	STAND-OFF, SHORT	2	2	9.00	12.00	-3.00	$986	$1,366	($380)		479 LATHE,479 MILL, 479W, FIN INSP		123005	009
010	M	010601135	TUBE END	4	4	12.00	10.00	2.00	$1,314	$1,095	$219		479 TAPE LATHE, RT TO ITEM 007		123005	010
011	W	010601137	PLATE SUPPORT	1	1	2.00	8.00	-6.00	$219	$876	($657)		479W WATERJET CUT		011906	011
Totals for Job 001760						93	152.00	-59.50	$10,206	$16,773	($6,567)					
JOB 001770			ARMED RHC REFRIGERATION VJP	Date Due: 033106				Proj/Act#: 18649						DEPT:	AO	
001	W	Fabricate Pipi	Fabricate Piping	1	0	860.00	767.00	93.00	94,170	$83,987	10,184		479W,479			001
Totals for Job 001770						860	767.00	93.00	$94,170	$83,987	$10,184					
JOB 001783			FABRIC INJECTION LINE KICKER MAG FA	Date Due: 043006				Proj/Act#: 18306						DEPT:	AO	
001	M	52015043	MAIN CONDUCTOR	3	0	148.00	55.50	92.50	16,258	$6,077	10,180		PROG,479 VMC,ST.REL(SIKORA), 479 MILL, FIN INSP.			001
002	M	52015052-002	POTTING FIXTURE PARTS ITEM 1	2	0	21.00	0.00	21.00	$2,312	$0	$2,312		PROG, 479 TAPE, 479 MILL, FIN INSP.			002
003	M	52015052-003	POTTING FIXTURE PARTS ITEM 3	3	0	25.00	0.00	25.00	$2,750	$0	$2,750		PROG, 479 VMC, 479 MILL, FIN INSP.			003

Item	Loc.	Drawing	Descr./Req'r./Estimator	QTY ORD	QTY COMP	Est. Hrs.	Hrs. Used	Bal Hrs.	$'s Est.	$'s Chargd.	Bal. $'s	COMMENTS	Shop Assign.	Priority	Dt.Closed	Item
004	M	52015052-004	POTTING FIXTURE PARTS ITEM 6	1	0	8.00	0.00	8.00	$876	$0	$876		PROG,479 TAPE,FIN INSP.			004
005	M	52015052-005	POTTING FIXTURE PARTS ITEM 8	1	0	4.00	6.00	-2.00	$438	$657	($219)		479 MILL, FIN INSP			005
006	M	52015052-006	POTTING FIXTURE PARTS ITEM 4	1	0	26.00	8.00	18.00	$2,873	$876	$1,997		PROG,479 VMC, 479 MILL, FIN INSP.			006
Totals for Job 001783						232	69.50	162.50	$25,507	$7,610	$17,897					
JOB 001784			ROBERTO THAN TURBINE POD SUPPORT [illegible]	Date Due: [illegible]				Proj/Acct# [illegible]					DEPT:		AD	
001	W	31015143	TURBINE POD SUPPORT FRAME	1	0	32.00	32.00	0.00	$3,504	$3,504	$0		479,479W			001
Totals for Job 001704						32	32.00	0.00	$3,504	$3,504	$0					
Total For Dept: AD						1,217	1,021	196	$133,387	$111,874	$21,514					

AD - Collider Accelerator Dept

WBS ID: EBIS
B&R#: 000000000
Distribute To: MIRABELLA, K

Budget And Expense Report

Page 1
FY:2006 Period: 3
01/03/06 10:29:43_AM

WBS Level:	1
Project:	Appendix J
Activity:	
Description:	EBIS PROJECT

Resource Category (Group Name = ADAM) (C) = Category Type Commit, (A) = Adjust Req.	Total Funds	Actual Costs: Currrent Month	Actual Costs: Year To Date	Actual Costs: Life To Date	Commitments & Requistions: Commit.	Commitments & Requistions: Reqs.	Commitments & Requistions: Total Commit.	Tot. Com. + Tot. Costs	Balance Available
MGTAD SALARY TOTALS	**40,954.33**	**1,704.82**	**1,704.82**	**1,704.82**	**0.00**	**0.00**	**0.00**	**1,704.82**	**39,249.51**
PROF SALARY TOTALS	**553,270.56**	**11,973.19**	**18,956.27**	**18,956.27**	**0.00**	**0.00**	**0.00**	**18,956.27**	**534,314.29**
SCIEN SALARY TOTALS	**219,061.79**	**10,025.62**	**37,362.40**	**37,362.40**	**0.00**	**0.00**	**0.00**	**37,362.40**	**181,699.39**
TECH SALARY TOTALS	**313,141.42**	**21,692.06**	**55,396.18**	**55,396.18**	**0.00**	**0.00**	**0.00**	**55,396.18**	**257,745.24**
SALARY TOTALS	**1,126,428.10**	**45,395.69**	**113,419.67**	**113,419.67**	**0.00**	**0.00**	**0.00**	**113,419.67**	**1,013,008.43**
605 Central Shops	14,000.00	8,235.15	14,695.65	14,695.65	0.00	0.00	0.00	14,695.65	-695.65
RECHG TOTALS	**14,000.00**	**8,235.15**	**14,695.65**	**14,695.65**	**0.00**	**0.00**	**0.00**	**14,695.65**	**-695.65**
300 PO Purchases	121,059.31	15,747.45	31,085.64	31,085.64	1,004.93	1,000.00	2,004.93	33,090.57	87,968.74
310 Stores Material	5,000.00	89.70	271.20	271.20	0.00	0.00	0.00	271.20	4,728.80
316 Freight	0.00	3.62	181.59	181.59	0.00	0.00	0.00	181.59	-181.59
319 Credit Card Purchases	5,000.00	1,131.07	1,831.04	1,831.04	0.00	0.00	0.00	1,831.04	3,168.96
280 Foreign Travel	0.00	1,703.27	3,754.27	3,754.27	0.00	2,424.00	2,424.00	6,178.27	-6,178.27
MSTC TOTALS	**131,059.31**	**18,675.11**	**37,123.74**	**37,123.74**	**1,004.93**	**3,424.00**	**4,428.93**	**41,552.67**	**89,506.64**
340 Special Procurements	2,100,246.69	0.00	0.00	0.00	132,220.00	390,000.00	522,220.00	522,220.00	1,578,026.69
HV&SP TOTALS	**2,100,246.69**	**0.00**	**0.00**	**0.00**	**132,220.00**	**390,000.00**	**522,220.00**	**522,220.00**	**1,578,026.69**
745 Procurement	162,325.39	1,307.26	2,598.67	2,598.67	0.00	0.00	0.00	2,598.67	159,726.72
MHB TOTALS	**162,325.39**	**1,307.26**	**2,598.67**	**2,598.67**	**0.00**	**0.00**	**0.00**	**2,598.67**	**159,726.72**
501 Allocated Services-Distributed	33,567.56	1,352.79	3,379.91	3,379.91	0.00	0.00	0.00	3,379.91	30,187.65
502 ITD Allocation	55,653.82	2,188.07	5,466.83	5,466.83	0.00	0.00	0.00	5,466.83	50,186.99
633 Motor Vehicle Recharge	8,787.00	354.09	884.68	884.68	0.00	0.00	0.00	884.68	7,902.32
ODC TOTALS	**98,008.38**	**3,894.95**	**9,731.42**	**9,731.42**	**0.00**	**0.00**	**0.00**	**9,731.42**	**88,276.96**
251 Electric - Distributed	37,528.71	511.85	1,108.03	1,108.03	0.00	0.00	0.00	1,108.03	36,420.68
POWER TOTALS	**37,528.71**	**511.85**	**1,108.03**	**1,108.03**	**0.00**	**0.00**	**0.00**	**1,108.03**	**36,420.68**
481 Space Charge - Distributed	190,816.93	7,690.04	19,213.31	19,213.31	0.00	0.00	0.00	19,213.31	171,603.62

AD - Collider Accelerator Dept

WBS ID: EBIS
B&R#: 000000000
Distribute To: MIRABELLA, K

Budget And Expense Report

FY:2006 Period: 3
01/03/06 10:29:43_AM

WBS Level:	1
Project:	Appendix J
Activity:	
Description:	EBIS PROJECT

Resource Category (Group Name = ADAM) (C) = Category Type Commit, (A) = Adjust Req.	Total Funds	Actual Costs Currrent Month	Actual Costs Year To Date	Actual Costs Life To Date	Commitments & Requistions Commit.	Commitments & Requistions Reqs.	Commitments & Requistions Total Commit.	Tot. Com. + Tot. Costs	Balance Available
485 Fuel Charge	38,735.84	1,561.08	3,900.31	3,900.31	0.00	0.00	0.00	3,900.31	34,835.53
SPACE TOTALS	**229,552.77**	**9,251.12**	**23,113.62**	**23,113.62**	**0.00**	**0.00**	**0.00**	**23,113.62**	**206,439.15**
272 Communications-Distrib -by SWI	11,602.23	467.58	1,168.23	1,168.23	0.00	0.00	0.00	1,168.23	10,434.00
700 Organizational Burden	20,163.07	812.59	2,030.23	2,030.23	0.00	0.00	0.00	2,030.23	18,132.84
701 Special Org Burdens	61,728.27	2,487.69	6,215.42	6,215.42	0.00	0.00	0.00	6,215.42	55,512.85
ORGBRD TOTALS	**93,493.57**	**3,767.86**	**9,413.88**	**9,413.88**	**0.00**	**0.00**	**0.00**	**9,413.88**	**84,079.69**
164 Approved Admin Transfers	0.00	-2,730.79	-2,730.79	-2,730.79	0.00	0.00	0.00	-2,730.79	2,730.79
FUNDS TOTALS	**0.00**	**-2,730.79**	**-2,730.79**	**-2,730.79**	**0.00**	**0.00**	**0.00**	**-2,730.79**	**2,730.79**
710 G&A Burden	237,114.33	5,898.65	14,118.95	14,118.95	0.00	0.00	0.00	14,118.95	222,995.38
720 Common Support	225,645.59	23,370.89	55,286.93	55,286.93	0.00	0.00	0.00	55,286.93	170,358.66
722 Site Support - S & S	20,614.88	588.39	1,316.71	1,316.71	0.00	0.00	0.00	1,316.71	19,298.17
770 Bud-Indirect rate recal adjs	-0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.46
OVERHD TOTALS	**483,374.34**	**29,857.93**	**70,722.59**	**70,722.59**	**0.00**	**0.00**	**0.00**	**70,722.59**	**412,651.75**
741 FCR - Federal	58,252.42	703.09	1,573.44	1,573.44	0.00	0.00	0.00	1,573.44	56,678.98
FCR2 TOTALS	**58,252.42**	**703.09**	**1,573.44**	**1,573.44**	**0.00**	**0.00**	**0.00**	**1,573.44**	**56,678.98**
810 Expected Funding	-3,100,000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3,100,000.00
FUNDS2 TOTALS	**-3,100,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-3,100,000.00**
GRAND TOTALS	**1,434,269.68**	**118,869.22**	**280,769.92**	**280,769.92**	**133,224.93**	**393,424.00**	**526,648.93**	**807,418.85**	**626,850.83**

BROOKHAVEN NATIONAL LABORATORY

OPEN PURCHASE ORDERS AND REQUISITIONS REPORT

As of 4/3/2006

Department: AD / Project: 08262

ITEM DESCRIPTION	REQ/P.O. DT.	REQUESTOR	REQ/P.O. ID	STATUS	VENDOR	COMMITMENT AMT. REQ/P.O.	COMMITMENT AMT. BALANCE
Project 08262 / Activity 08262							
Resource Category 300: PO Purchases							
EBIS FRAMING MATERIAL	09/20/2005	RITTER,JOHN A	0000102816	PO	Airline Hydraulics Corp	893.82	30.90
EBIS STAND HARDWARE	09/19/2005	RITTER,JOHN A	0000102842	PO	McMaster-Carr Supply Co	258.17	89.39
EBIS ELECTRON GUN CERAMICS	11/17/2005	RITTER,JOHN A	0000104779	PO	CeramTec North America	830.00	830.00
EBIS FRAME MATERIALS	11/29/2005	RITTER,JOHN A	0000104799	PO	Airline Hydraulics Corp.	19.00	2.00
EBIS rack pwr strips	01/11/2006	WAIDE,CORNELIUS E	0000105947	PO	Schwing Electrical Supply	495.00	495.00
					Resource Category 300 Total:		**1,247.29**
Resource Category 340: Special Procurements							
EBIS Accelerating Tube	10/17/2005	LO DESTRO,VINCENT	0000102468	PO	Budker Institute Of Nuclear Physics	33,000.00	33,000.00
EBIS Electron Collector	12/14/2005	SNYDSTRUP,LOUIS P	0000103271	PO	Brush Wellman, Inc.	99,220.00	99,220.00
EBIS Isolation Transformer	03/20/2006	LAMBIASE,ROBERT F	0000107909	REQ	Stangenes Industries, Inc.	60,000.00	60,000.00
					Resource Category 340 Total:		**192,220.00**
					Project 08262 / Activity 08262 Total:		**193,467.29**
					Project 08262 Total:		**193,467.29**

Appendix K

BROOKHAVEN
NATIONAL LABORATORY

ACCOUNTS PAYABLE CONTROL

(BNLAP001)

Accounting Dates Between 03/01/2006 and 03/31/2006

Department: AD / Project: 08266

VENDOR	ACCTG DATE	VOUCHER NUMBER	PO ID	P.O. AMT.	DISTRIB. AMT.	COMM. RELIEF	BALANCE REM.
Project 08266 / Activity 08266							
Resource Category 300: PO Purchases							
Burle Electro-Optics, Inc			0000105039	$0.00	$0.00	$0.00	$0.00
		Resource Category 300 Total:		**$0.00**	**$0.00**	**$0.00**	**$0.00**
Resource Category 312: Equipment - Low Value							
Burle Electro-Optics, Inc.			0000105039	$5,276.00	$0.00	$0.00	$5,276.00
		Resource Category 312 Total:		**$5,276.00**	**$0.00**	**$0.00**	**$5,276.00**
		Project 08266 / Activity 08266 Total		$5,276.00	$0.00	$0.00	$5,276.00
		Project 08266 Total:		**$5,276.00**	**$0.00**	**$0.00**	**$5,276.00**

Appendix L

Collider-Accelerator Department
Hazard Screening Report for EBIS Project

Compiled by

Edward T. Lessard

Revision 2

April 24, 2006

Hazard Screening Report for EBIS Project

Introduction

A hazard-screening tool (Appendix 1) was designed to assist in identifying the hazards associated with each sub-system for the EBIS Project to determine the level of hazard analysis required and follow-up actions. The tool was used by each sub-system manager.

In the sections that follow, the EBIS sub-system is listed (first level or one dot), with detail in some cases down to three levels (three dots). This is followed by a summary of the hazards identified using the hazard-screening tool, with an associated hazard rating. Also included are follow-up assignments that must be completed by the sub-system manager. These assignments have a designated responsible individual and are tracked in the C-AD Family Action Tracking System.

In Figure 1, the overall 'hazard-analysis-process' at C-AD is shown. The hazard-screening step, which is one of the initial steps in the 'hazard-analysis-process', is represented by the blue box in the figure. This report documents the hazard-screening step and the action assignments that resulted from that step. The C-AD Family Action Tracking System will be used to track hazard-screening step actions.

Resolutions to actions identified during other steps in the overall 'hazard-analysis-process' will be documented several ways. See OPM Chapter 9 for committee procedures and SBMS Accelerator Safety Subject Area for details. This documentation will include:

- Safety committee minutes
- Facility drawings
- Work packages
- Operations procedures
- Start-up check-off lists
- Documents showing resolution of items from internal reviews
- Documents showing resolution of Accelerator Readiness Review items
- Interlock system installation and testing documentation, if any
- Commissioning procedures for beam operation
- Operator or system specialist training and qualification records
- Shielding drawings
- Radiation monitoring documentation
- Fire hazards analysis
- Quality assurance documents
- Fault study plan
- Accelerator Safety Envelope
- Commissioning plans

In the overall 'hazard-analysis-process', many forms of documentation will be completed to explain the basis of an issue and the basis for any follow-up action. The C-AD ESHQ Division will maintain a centralized record of this documentation for auditing purposes, as per requirements in C-AD OPM 13.4.2 Records Index.

Work planning will be used throughout construction, commissioning and operations in order to address hazards and controls for each job each day. Work planning at a minimum consists of a pre-job briefing and a work-site walk-down. This is done to prepare workers for what is to be accomplished that day and to sensitize workers for what is to be avoided. Post-job reviews and formal Job Risk Analyses will be documented as required. Greater details regarding work planning can be found in C-AD OPM 2.28 C-A Procedure for Work Planning and Control for Operations.

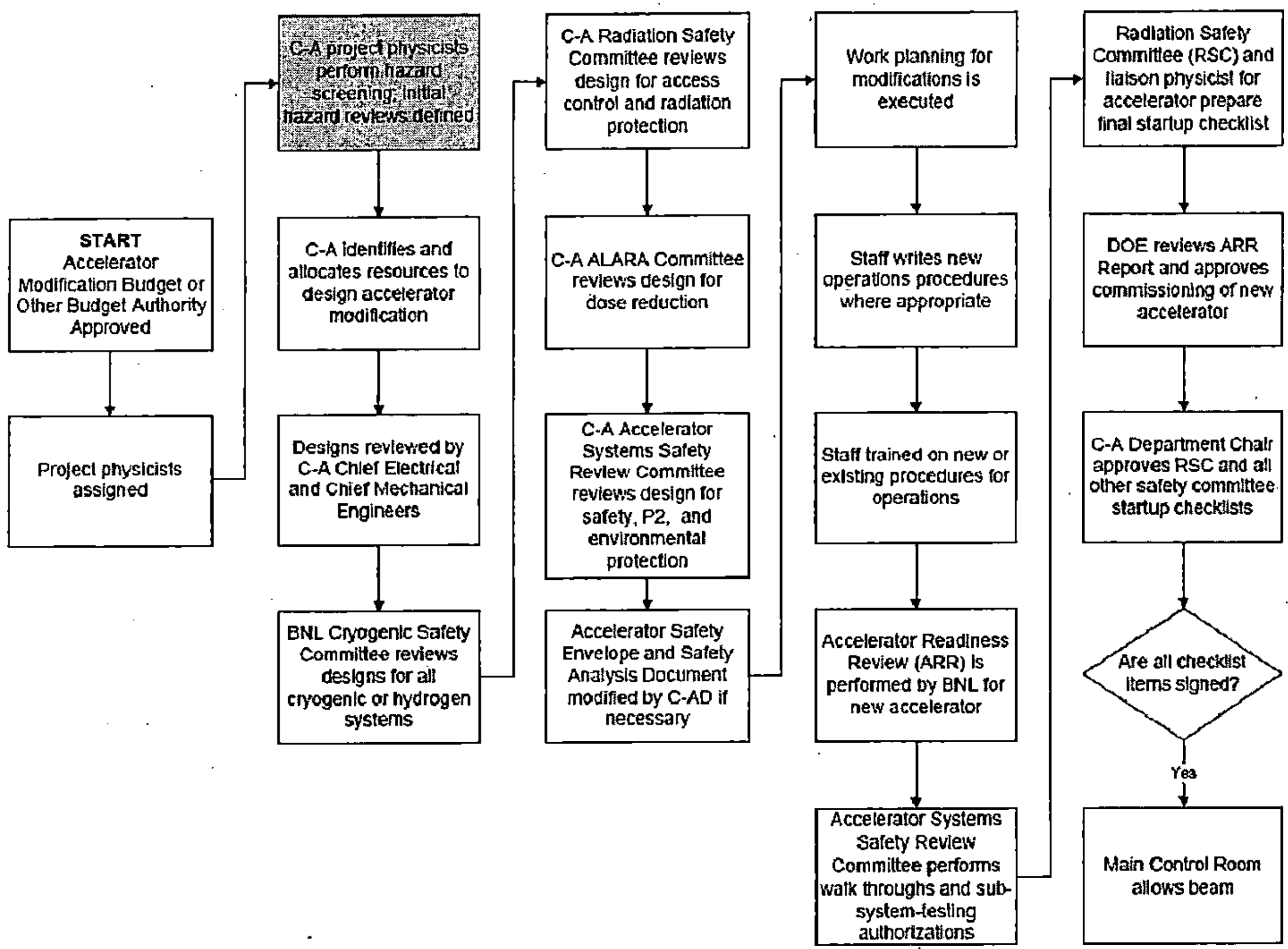


Figure 1 Accelerator Hazard Analysis Process

Executive Summary

Details of the proposed hazards and the follow-up safety review actions are described in this report. Responsible persons are identified. All follow-up actions identified in this screening report will be tracked to closure.

The hazards and controls for EBIS subsystems have been found to be similar to hazards and controls described in the existing C-AD Safety Assessment Document. C-AD occupational safety and health (OSH) programs and environmental (E) programs to be employed at the activity level are described in detail on the C-AD ESHQ web and compared to the Integrated Safety Management System for DOE. These OSH and E programs will be adhered to throughout the construction, commissioning and operation of the EBIS.

EBIS facilities or modifications have undergone a National Environmental Policy Act (NEPA)/Cultural Resources review. This review was conducted separately from this hazard screening.

EBIS Subsystems (Sub-system Manager), Associated Hazards and Follow-up Actions

1.1 Structural Components (E. Beebe)

Structural components consist of the following:
- EBIS Hardware
- LEBT and External Ion Injection
- RF Structures

The major structural components will be installed in the EBIS facility in Building 930.

1.1.1 EBIS Hardware

The following mechanical components comprise the EBIS source.

1.1.1.1 Superconducting Solenoid

The superconducting solenoid is a major element of EBIS and its function is to focus the electron beam generated in the electron gun and maintain its diameter in a region of the ion trap. No shielding is planned for the solenoid in order to enable use of its magnet field "tails" for the electron beam transmission in areas where use of other coils is difficult. The solenoid is located on the EBIS platform and it should require minimum maintenance for refilling of cryogens.

1.1.1.2 Electron Gun

The EBIS electron gun generates the electron beam used for the ionization and confinement of ions in a trap. Since the electron beam propagates through the areas with very low potentials and with different magnetic fields, the requirements on the laminarity of the electron beam are high. For this reason, the magnetic field on the cathode is high enough to determine formation of the electron beam in a cathode-anode gap. The cathode material (Ir-Ce) provides high emission current density with a lifetime of several thousand hours. The electron gun chamber is separated from the rest of the EBIS by two gate valves, which in a case of gun failure allows replacement of whole gun unit by a new one without venting the gun chamber and venting only small buffer volume between gate valves.

1.1.1.3 Drift Tube and Chamber Structures

Drift tubes are installed along the EBIS axis to control ion trap operation and propagation of the electron beam. Drift tubes are electrically isolated from the ground and connected to the external power supplies via electrical feedthroughs in a vacuum jacket. Vacuum chambers form a vacuum envelope around the EBIS with the pressure of residual gas in the range of 1×10^{-10} Torr. Three gate valves separate different parts of the EBIS for maintaining high vacuum in parts that are not vented during modification or repair.

1.1.1.4 Stands and Platform Hardware

This includes the mechanical support structures for the EBIS, the electron gun, the LEBT line, and the external ion sources. It also include the 100 kV insulating platform for the EBIS source and its associated power supplies, as well as the electrical system required to put a ramp on the EBIS trap electrodes for fast ion extraction.

1.1.2 Low Energy Beam Transport (LEBT) and External Ion Injection

These are the beam lines between the EBIS output and RFQ input.

1.1.2.1 LEBT

The LEBT is a transitional portion of the pre-injector and is used for:

- Transmission and forming for the injection into RFQ of the ion beam extracted from the EBIS
- Transmission of the ion beam from the external ion injector into the EBIS
- Diagnostic measurements of the ion beams
- Vacuum pumping of the electron collector

The LEBT consists of two vacuum chambers separated by a gate valve; it contains optical electrostatic elements (deflectors, lenses), magnetic lenses for focusing the ion beam into the RFQ and diagnostic elements.

1.1.2.2 External Ion Injection

A set of two or more ion sources generating low charge state ions for injection into EBIS. This also includes ion optics, a switching station for electronically selecting the desired ion species for ion injection, ion current monitors, vacuum system and power supplies.

1.1.3 RF Structures (J. Alessi)

Resonant cavities used to accelerate or decelerate, for bunching, the ion beam. When radiofrequency power is fed into these resonant cavities, the appropriate electric fields for acceleration or deceleration are produced.

1.1.3.1 RFQ

The Radio Frequency Quadrupole (RFQ) is a resonant structure in which four long, continuous vanes or rods, machined with precise modulations and configured in a quadrupole geometry, provide bunching, focusing, and acceleration of the injected ion beam. This type of structure is able to provide efficient rf acceleration at the low energies ion beams have when initially extracted from an ion source. A 4-rod RFQ operating at 101.28 MHz is planned.

1.1.3.2 Linac

The Linac is a resonant structure, which generates time dependent axial electric fields to accelerate ions. When the rf field direction is reversed, the ion bunches are shielded from the decelerating fields by internal drift tubes. An "Interdigital-H"- type Linac operating at 101.28 MHz is planned.

1.1.3.3 Buncher Cavities

A resonant cavity in which the time dependent field in a gap is adjusted to decelerate the front of a beam bunch arriving at the gap, and accelerate the back of the bunch, so that all particles in the bunch arrive at a downstream point more closely spaced in time. By changing the phase of the cavity by 180 degrees relative to the bunch, it can be used to remove energy spread in the beam ("debuncher") instead.

Hazard Rating and Follow-up Assignments for Structural Components (E. Beebe and J. Alessi)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a high initial risk.

The following questions were answered YES and are considered a hazard rating of 3:

2c (1). Does this operation use RGDs that are built locally or are commercially available units that have been modified?

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
1d(1). Does this operation involve the use of hydrogen gas?
1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?
1h. Will this operation involve use of heavy metals such as mercury, silver, or cadmium?
2. Are there any accelerators or other radiation generating devices involved in this operation?
2b. Are there any radiation generating devices (RGD) used in this operation?

2c. Does the radiation generating device only produce radiation incidental to its primary function (such as electron microscopes, electron beam welders, ion implantation equipment)?
4a. Will this operation generate non-radioactive air emissions or effluents?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7k. Is any part of this system/operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8e. Is there any radiofrequency or microwave field generated by a source greater than 7W in a space that might be occupied?8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
8l. Is there any possibility of creating an Oxygen Deficient Atmosphere?
11b. Will operation require work outside normal working hours?
11d. Will this operation require special attention in the event is left unexpectedly for long periods of time?
11e. Will this operation require an emergency procedure due to unusual or complicated shutdown instructions?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13b. Are interlocks used in this operation?
13c. Is any personal protective equipment used in this operation?
15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel deserve further consideration?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical which is regulated by OSHA?
3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7e. Will you be purchasing any ladders or scaffolds?
7f. Will this operation require any elevated work?
7i. Does any equipment operate at pressures above 15 psig or under a vacuum?
7l. Does the operation include the use of typical shop equipment?
8h. Are there any surface temperatures less than 0 deg F or greater than 150 deg F?
10. Does this operation involve: the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?
11. Will this operation require trained operators or close surveillance?
12e. Could this equipment act as an ignition source?

Follow-up Assignments (E. Beebe)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area. This would apply to gases, uranium or any other source materials to be used. Implement a process that requires you to review source materials with Peter Cirnigliaro (x5636) before they are introduced to EBIS in the future. Review the use of uranium ions in EBIS with E. Lessard and initiate a change to the RHIC Accelerator Safety Envelope if required.

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material. See Peter Cirnigliaro (x5636) for more information or assistance.

(1d1) When working with hydrogen, special requirements apply. At a minimum in the event of an emergency (total loss of containment), the percent of hydrogen gas in the room are cannot exceed 0.4% (Flammability range is 4-75%). Please include calculations or comments addressing this issue in the analysis for this operation. Present these calculations to the ASSRC. Contact Woody Glenn (x4770), Chair of the ASSRC.

(1e) Work with caustic/corrosive chemicals must be done in an area with an eyewash and shower. See Peter Cirnigliaro (x5636) for more information or assistance.

(1h) Use of heavy metals such as mercury, silver, or cadmium may involve special handling and training. See Peter Cirnigliaro (x5636) for more information or assistance.

(2a) Please list keV of accelerator and general operating guidelines in analysis. Have this accelerator reviewed by the Radiation Safety Committee (RSC). Please contact the RSC Chair, Dana Beavis (x7124).

(2b, 2c(1)) RGDs require that they be inventoried and that surveys be conducted annually. If your device is not accounted for or is not surveyed annually contact Paul Bergh (x5992). Also, note this registration in the analysis for your operation by the Radiation Safety Committee. Please contact the RSC Chair, Dana Beavis (x7124).

(3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative, Paul Bergh (x5992).

(3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(3f, 4d) Provide a list of all material being stored at Collider-Accelerator, and intended location. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(4c, 4c(1)) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(4a, 4b) Operations involving air emissions or wastewater discharges require assessment to determine whether they meet current permit limits or require a permit. Contact Mel VanEssendelft (x2905), the Environmental Compliance Representative, for additional guidance.

(4c) Waste generators must have proper training. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer. Contact Joe Tuozzolo (x3966) for a review.

(7e) Ladders must not be wooden. Scaffolding must be reviewed by the C-AD ESH Coordinator. Please contact Asher Etkin (x4006).

(7f) Elevated work may require fall protection and/or a fall protection plan. Consult with Peter Cirnigliaro (x5636).

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO_2 require review. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis. Also, see the Oxygen Deficiency Hazard Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss.

(8h) Surface with temperatures less than 0 deg F or greater than 150 deg F must be labeled, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8l, 8m) The guidelines of SBMS Subject Area, Oxygen Deficiency Hazard should be followed.

(10) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls. Certification by the Chief Electrical and/or Chief Mechanical Engineer may be required. Contact Jon Sandberg (x4682) for electrical device review and Joe Tuozzolo (x3966) for mechanical device review.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b, 11d, 11f) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11e) An emergency procedure must be developed in accordance with C-A OPM 3.0. Contact Peter Ingrassia (x4272).

(13a) Local ventilation systems must be certified annually as well as any time there is a modification/maintenance conducted on the system. See Peter Cirnigliaro (x5636) for more information or assistance.

(13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(13c (1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact the ESH Coordinator, Asher Etkin (x4006) for further guidance and list the required type of gloves in the analysis for your operation.

The Following Facility Systems May Impact Your Operations

Be sure that these systems are mentioned in your analysis when you present the EBIS Project to the Accelerator Systems Safety Review Committee, contact Woody Glenn (x4770). Verify that the associated hazard controls are functional prior to beginning operations.

- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Hoists and Cranes
- Heating Water
- Oxygen Monitoring System
- Public Address

Follow-up Assignments for RF Structures (J. Alessi)

(2b, 2c) RGDs require that they be inventoried and that surveys be conducted annually. If your device is not accounted for or is not surveyed annually contact Paul Bergh (x5992). Also, note this registration in the analysis for your operation by the Radiation Safety Committee. Please contact the RSC Chair, Dana Beavis (x7124).

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(13c (1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact the ESH Coordinator, Asher Etkin (x4006) for further guidance and list the required type of gloves in the analysis for your operation.

(15) For additional hazards that have not been addressed, please contact the ESH Coordinator, Asher Etkin (x4006), for help with reviewing these hazards and applying proper controls.

The Following Facility Systems May Impact Your Operations

Verify that the associated hazard controls are functional prior to beginning operations.

- Compressed Air
- Compressed Gas
- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Hoists and Cranes
- Heating Water

- Oxygen Monitoring System
- Potable Water
- Sanitary Sewer
- Ventilation Supply/Exhaust

1.2 Controls (D. Barton)

Networked, front-end interfaces will be connected via Ethernet to control console workstations and central C-AD servers. Full pulse-to-pulse modulation functionality will be provided. Custom application software will be provided as needed, but extensive re-use will be made of existing software designs with EBIS database additions.

1.2.1 Timing & Infrastructure

C-AD fiber optic infrastructure will be extended to the EBIS equipment area and a standard network switch and timing chassis will be provided. Workstations and monitor screens will be provided for console-level control access, along with supporting software and database configuration.

1.2.2 EBIS

Waveform generation and data acquisition for EBIS will be provided using the fiber-optically isolated PSI interface and VME function generator. The fiber link interface of these standard C-AD modules will be modified to operate at 50 to 100 kHz for this application. Additional fiber optic links will carry pulsed trigger signals to the high voltage platforms. Standard VME chassis will be provided. Minor modifications will be required to existing front-end software for the function generator. A custom console application program will be developed for power supply waveform control.

1.2.3 Accelerators and Beam Transport

Commercial and C-AD standard VME modules will be used to control magnet power supplies and beam-line instrumentation. Standard VME chassis assembly and timing modules will be provided for these systems and for RF system interfaces. Front-end software effort will be mainly configuration and database setup. Existing console programs for beam line diagnostics will be modified to include the EBIS transport lines.

Hazard Rating and Follow-up Assignments for Controls (D. Barton)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following question was answered YES and is considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

Follow-up Assignments (D. Barton)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

The Following Facility System May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Electric Power (includes Grounding and UPS)

1.3 Diagnostics/Instrumentation (M. Wilinski)

1.3.1 Faraday Cup

A fully destructive measurement is made when a detector head is plunged into the beam path to collect the entire ion beam. The captured charge is measured as a current in the processing electronics. Several types of detector heads can be employed depending on the characteristics of the desired measurement. Channeltrons or multichannel plates are used for fast high bandwidth response.

1.3.2 Current Transformers

A ferrite toroid wound with many turns of signal wire is positioned around a ceramic break in the beam transport, all enclosed in a protective shroud. This is used as a non-destructive technique to measure the ion beam current characteristics with respect to time. A separate set of wire turns on the toroid is used for injecting a calibration signal.

1.3.3 Profile Monitors

Transverse beam profiles are measured by plunging an array of thin wires into the beam path. Each of the wires collects the charge from the small portion of the ion beam it intercepts; this charge is detected as a current in the processing electronics.

Hazard Rating and Follow-up Assignments for Diagnostics/Instrumentation (M. Wilinski)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

Follow-up Assignments (M. Wilinski)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

The Following Facility System May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Electric Power (includes Grounding and UPS)

1.4 Magnet Systems (J. Ritter)

1.4.1 EBIS Warm Solenoids

The EBIS warm solenoids consist of three solenoid magnets. The electron gun solenoid is designed with water-cooled hollow conductors, pancake-style coils and no iron return. The electron gun coil provides the necessary field for proper electron beam launching and transport. The electron collector solenoid is similar in design to the electron gun solenoid. The electron collector solenoid focuses the beam to allow for proper electron collector operation. The remaining magnet, the LEBT solenoid, is a pulsed solenoid located directly in front of the RFQ. The LEBT solenoid focuses the EBIS beam into the RFQ. The design of the LEBT solenoid uses pancake coils with a laminated iron return similar in design to the BNL Optically Pumped Polarized Ion Source (OPPIS) LEBT solenoid.

1.4.2 MEBT Quadrupoles

The EBIS MEBT quadrupole magnets are used to provide the necessary focusing for beam transport between the RFQ output and the Linac input. The quadrupole magnets have been sent to BNL from Los Alamos National Laboratory, where they were released from the LEDA project. These LANL quadrupole magnets have half the magnetic length needed for the EBIS MEBT. To produce the required magnetic length, two quadrupole magnets will be positioned closely together around each of the four original quadrupole magnet positions. The estimate includes the support system of magnets and necessary water manifolds.

1.4.3 HEBT Dipoles

The HEBT dipoles are two similar 73° bending dipoles. The basic design of the dipoles is a C style with the open end facing the outer curve to allow the chamber to have a port for the Tandem-to-Booster (TTB) line into the Booster. The magnets will be constructed of laminations of different sizes which when assembled will produce the required bend shape. The magnet coils will be made of water-cooled hollow copper conductor.

1.4.4 HEBT Quadrupole Magnets

The HEBT quadrupoles will be air-cooled Danfysik magnets. Originally used for other projects at BNL, these magnets are available for the EBIS beam line. These magnets will allow switching of values in ~ 1 second for running of different magnetic rigidity beams.

Hazard Rating and Follow-up Assignments for Magnet Systems (J. Ritter)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk

- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?

The following questions were answered YES and are considered a hazard rating of 1:

7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7l. Does the operation include the use of typical shop equipment?
11. Will this operation require trained operators or close surveillance?

Follow-up Assignments (J. Ritter)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer. Contact Joe Tuozzolo (x3966) for a review.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

The Following Facility Systems May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Hoists and Cranes
- Heating Water
- Non-potable Water

1.5 Power Supply Systems (R. Lambiase)

1.5.1 EBIS

These are power supplies to support EBIS itself:
- Solenoid, cathode, cathode heater, collector and grid supplies
- Platform bias supplies and the transformers to isolate them
- Drift tube supplies, Behlke switches, and transverse magnetic supplies

1.5.2 External Ion Injectors and LEBT

These are power supplies to support two external ion sources, the transport from the ion sources to the LEBT, and the LEBT itself:
- Heater, arc pulser and extractor power grid supplies
- Platform bias supplies and the transformers to isolate them
- Supplies for electrostatic and electromagnetic steering elements and lenses
- Mass analyzer and focusing solenoid power supplies

1.5.3 MEBT, IH LINAC, and HEBT

These are power supplies for the MEBT, IH LINAC, and HEBT:
- Pulsed quadrupole magnets and steering magnet power supplies
- Linac drift tube quadrupole magnet power supplies
- Pulsed bending magnet power supplies

Hazard Rating and Follow-up Assignments for Power Supply Systems (R. Lambiase)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following question was answered YES and is considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

The following questions were answered YES and are considered a hazard rating of 1:

7b. Does the operation include the use of hoist, crane, forklift, or rigging?
11a. Will this operation be left unattended?

Follow-up Assignments (R. Lambiase)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(11a) If your operation will be left unattended and it poses a hazard to individuals who may enter the area for whatever reason then you must ensure that the area is posted with the name of the contact and phone number along with associated hazards when unattended. This information and instructions for a safe shutdown should be included in the analysis for your operation. Contact the Accelerator Systems Safety Review Committee Chair, Woody Glenn (x4770), to schedule a review of the systems prior to operations.

1.6 RF Systems (A. Zaltsman)

1.6.1 High Level RF

The final rf amplifier stages are powering the RFQ, Linac, and three bunchers. This includes the coaxial transmission line connecting the amplifier outputs to the rf cavities.

1.6.2 Low Level RF

These are low power rf systems that provide the phase and amplitude controls for the high level rf systems, and frequency control for the resonant cavities.

Hazard Rating and Follow-up Assignments for RF Systems (A. Zaltsman)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

8e. Is there any radiofrequency or microwave field generated by a source greater than 7 W in a space that might be occupied?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
8j. Is it required for personnel to work in an area with a Noise Level between 85 dBA and 100 dBA?
11b. Will operation require work outside normal working hours?
11d. Will this operation require special attention in the event is left unexpectedly for long periods of time?

Follow-up Assignments (A. Zaltsman)

(8e, 8f) Non-ionizing radiation sources (NIRs) must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact Asher Etkin, ES&H Coordinator, x4006, for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss.

(8j) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(11b, 11d) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11e) An emergency procedure must be developed in accordance with C-A OPM 3.0. Contact Peter Ingrassia (x4272).

(13, 13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your work planning documents. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

1.7 Vacuum Systems (M. Mapes)

1.7.1 Beampipes/Chambers

These are pipes or chambers that have vacuum pressure inside and provide a path for the ion to be transported, as well as provide a housing for special components inside the vacuum system.

1.7.2 Vacuum Instrumentation & Control

A PLC-based control system is used to monitor and control the vacuum system and components such as gauges, pumps and valves.

1.7.3 Vacuum Pumps

These are pumps used to evacuate or pump down a vacuum chamber from atmospheric pressure to the desired high vacuum or ultra-high vacuum range.

1.7.4 Vacuum Valves

These are manual or pneumatically operated valves used to isolate vacuum pumps and/or a section of the beam line from another section or vacuum chamber.

Hazard Rating and Follow-up Assignments for Vacuum Systems (M. Mapes)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
7k. Is any part of this system/operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
7i. Does any equipment operate at pressures above 15 psig or under a vacuum?
7l. Does the operation include the use of typical shop equipment?

Follow-up Assignments (M. Mapes)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material. See Peter Cirnigliaro (x5636) for more information or assistance.

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO2 require review by Ray Karol (x5272). See the Oxygen Deficiency Hazards Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

1.8 Cooling Systems (J. Scaduto)

The cooling system is comprised of three separate and independent closed loop systems that will run off the present Linac chilled water system and dissipate heat into the existing Linac cooling tower. Each system consists of individually skid-mounted components: a pump/motor, filter, heat exchanger, expansion tank, temperature and pressure control valves, and water treatment as required. The active on-line deionized water controls on two of the systems maintain the required resistivity. The exception is for the rf structures, which will have a 4109 iron corrosion inhibitor control system.

A chilled water source is required to supply the necessary 70 ^{0}F temperature. The existing Linac chilled water system is the preferred choice.

Hazard Rating and Follow-up Assignments for Cooling Systems (J. Scaduto)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?
4a. Will this operation generate non-radioactive air emissions or effluents?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
4c2. Will this operation generate any hazardous wastes?
6b. Is it required for personnel to work on energized systems greater than 50V (Range A) but less than 600 V (Range B&C)?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8j. Is it required for personnel to work in an area with a Noise Level between 85 dBA and 100 dBA?
11b. Will operation require work outside normal working hours?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical that is regulated by OSHA?
4c. Is any waste generated from this operation?
11. Will this operation require trained operators or close surveillance?

Follow-up Assignments (J. Scaduto)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1e) Work with caustic/corrosive chemicals must be done in an area with an eye wash and shower.

(4a, 4b) Operations involving air emissions or wastewater discharges require assessment to determine whether they meet current permit limits or require a permit. Contact Mel VanEssendelft (x2905), the Environmental Compliance Representative, for additional guidance.

(4c) Waste generators must have proper training. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6b, 6c) Working On or Near Energized Conductors training is required for work on energized equipment. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8i, 8j, 8k) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

The Following Facility Systems May Impact Your Operations

Verify that the associated hazard controls are functional prior to beginning operations.

- Compressed Air
- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Process Cooling Water
- Sanitary Sewer
- Steam

1.9 Facility Modifications (A. Pendzick)

1.9.1 Beam Access Port, Exit Door From Linac and Vertical Ports Into Booster Tunnel

A new access port for the EBIS beam line will be installed through the earth shielding from Linac to the Booster.

A new exit door from the upper equipment bay at Linac will exit onto a staircase on the Booster berm, approximately 20 feet into the Booster radiation area.

The present plan is to install two 8" vertical ports through the top of the Booster tunnel in the "C" area to power the dipoles in the EBIS beam line.

1.9.2 Power modification

This modification provides for the relocation of existing power and tray in the Linac area where the EBIS beam line will be installed.

Hazard Rating and Follow-up Assignments for Facility Modifications (A. Pendzick)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

2. Are there any accelerators or other radiation generating devices involved in this operation?
3d. Will any radioactive material/waste be transported as a result of this operation?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
4c1. Will this operation generate any radioactive waste?
7c. Are there any structures supporting heavy loads?
7d. Does this operation require a structural change to any crane or building?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13c. Is any personal protective equipment used in this operation?

The following questions were answered YES and are considered a hazard rating of 1:

3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?

Follow-up Assignments (A. Pendzick)

(2) Installation of new penetrations into the Linac or Booster must be reviewed by the Radiation Safety Committee (RSC). Contact the RSC Chair, Dana Beavis, x7124.

(3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative, Paul Bergh (x5992).

(3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(3d) The transportation of radioactive materials is strictly controlled at Brookhaven National Laboratory. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(4c, 4c(1)) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c, 7d) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer, Joe Tuozzolo (x3966).

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8i, 8j, 8k) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(13c) All PPE requirements must be listed in your work planning documents. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used. Contact Peter Cirnigliaro, C-AD Work Control Manager (x5636) for guidance.

(13c(1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact Peter Cirnigliaro, C-AD Work Control Manager (x5636) for guidance.

1.10 Installation (L. Snydstrup)

The major systems and components of the EBIS are installed at the facility site in building 930, including structural components, control systems, diagnostic and instrumentation systems, magnets, power supplies, RF systems, vacuum systems, and cooling systems. The installation effort also includes any minor additions or changes to the building and facility necessary to accommodate these systems and components.

1.10.1 Structural Components

The major structural components installed in the facility include the Electron Beam Ion Source (EBIS), RFQ and Linac. Other components will include smaller devices located in the LEBT, MEBT and HEBT beam transport regions, such as auxiliary ion sources (LEBT), bunchers, electrostatic beam transport devices and beam monitoring devices.

1.10.2 Controls

This includes installation of controls for the entire project.

1.10.3 Diagnostics/Instrumentation

This includes installation and checkout of all diagnostics in the beam lines.

1.10.4 Magnet Systems

This includes installation of the magnet systems installed in the beam transport line, which are dipole, quadrupole, solenoidal and steerer magnets. This work also includes survey of elements.

1.10.5 Power supply Systems

This includes installation of all power supplies in their final locations, the connection of power from breaker boxes to the supplies and the connections from the power supplies to the elements.

1.10.6 RF Systems

This includes installation of the rf power supplies, as well as the connection of the coaxial transmission line between the rf amplifiers and the rf cavities.

1.10.7 Vacuum Systems

This includes installation of beam pipes, chambers, pumps, and valves. This work also includes leak checking and bake out of systems.

1.10.8 Cooling Systems

This includes installation of all cooling systems.

Hazard Rating and Follow-up Assignments for Installation (L. Snydstrup)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1g. Will this operation involve more than 30 minutes handling time with lead?
4c. Will any waste (radioactive, hazardous, mixed, sanitary, etc.)be produced as a result of this operation?
6b. Is it required for personnel to work on energized systems greater than 50 V (Range A) but less than 600 V (Range B&C)?
6d. Has this equipment been built locally, modified or not listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
7k. Is any part of this system /operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
11b. Will operation require work outside normal working hours?
12d. Will this operation change the risk level of fire protection?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13c. Is any personal protective equipment used in this operation?
15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel are deserving of further consideration?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials or hazardous materials handled, generated, used or stored in this operation, including oils and solvents?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7f. Will this operation require any elevated work?
7l. Does the operation include the use of typical shop equipment?

11. Will this operation require trained operators or close surveillance?
11c. Will this operation require the 2-person rule?

Follow-up Assignments (L. Snydstrup)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area.

(1g) Air monitoring is required for lead handling of more than 30 minutes. Respiratory protection may also be required. Consult with Peter Cirnigliaro (x5636).

(4c) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6b, 6c) Working On or Near Energized Conductors training is required for work on energized equipment. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c, 7d) Structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer, Joe Tuozzolo (x3966).

(7f) Elevated work may require fall protection and/or a fall protection plan. Consult with Peter Cirnigliaro (x5636).

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO2 require review by Ray Karol (x5272). See the Oxygen Deficiency Hazards Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11c) In your procedures, delineate any tasks that require a two-person rule as a control.

(12c,12d) Any deviations from Life Safety Code or change in the risk level of fire protection m must be approved by the Fire Protection Engineer. Contact Michael Kretchmann (x5274).

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(15) Please review the additional hazard of "working with multiple groups" with the C-AD Work Control Manager, Peter Cirnigliaro (x5636).

Appendix 1: Questions Used in the Collider-Accelerator Department's Hazard Identification Tool

1. Are there any chemicals, toxic materials or hazardous material handled, generated, used, or stored in this operation, including oils and solvents?

1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical that is regulated by OSHA?

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogen?

1c Does this operation involve the use, storage or generation of peroxide forming chemicals, shock sensitive chemicals or picric acid?

1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?

1d (1). Does this operation involve the use of hydrogen gas?

1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?

1f. Will this operation involve the use of beryllium - other than articles made of beryllium or that contain beryllium?

1g. Will this operation involve more than 30 minutes handling time with lead? Will this operation involve use of heavy metals such as mercury, silver or cadmium?

1i. Does this operation involve the use or transportation of explosives or explosive wastes?

2. Are there any accelerators or other radiation generating devices involved in this operation (other than the Collider-Accelerator)?

2a. Is there an accelerator used in this operation?

2a (1). Does this operation use accelerators that are built locally or are commercially available units that have been modified?

2b. Are there any radiation generating devices (RGD) used in this operation?

2b(1). Are radiation generating devices capable of creating a High Radiation Area (>100 mrem/hr at 30 centimeters)?

2b(2). Are the radiation generating devices capable of creating a radiation area?

2c. Does the radiation generating device only produce radiation incidental to its primary function (such as electron microscopes, electron beam welders, ion implantation equipment)?

2c(1). Does this operation use RGDs that are built locally or are commercially available units that have been modified?

2d. Is the radiation generating device an intentional x-ray generating device which produces radiation as part of the primary function (i.e. x-ray diffractometers, x-ray machines)?

2d (1). Is the device built locally or been modified OR is it being used outside design specifications?

3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?

3a. Does this operation involve handling of radioactive materials or sources?

3b. Does this operation involve radionuclides listed in the Radionuclide Threshold Table in amounts that exceed 10% of the quantity listed?

3c. Is dispersible radioactive material being used in this operation?

3d. Will any radioactive material/waste be transported as a result of this operation?

3e. Does this operation involve any accountable sources? (Sealed Radioactive Source Accountability Table)

3f. Any radioactive material being left or stored at Collider-Accelerator facilities?

4. Are there any possible environmental impacts with this operation?

4a. Are there any non-radioactive emissions or effluents from this operation?

4b. Are there any radioactive emissions or effluents from this operation?

4c. Is any waste generated from this operation?

4c(1). Is the waste radioactive?

4c(2). Is the waste hazardous?

4c(3). Is the waste mixed waste?

4d. Are any hazardous materials (such as lead, mercury or beryllium) being left or stored at Collider-Accelerator facilities?

4e. Does this operation require any new above or under ground storage tanks?

4f. Does this operation use ozone depleting substances?

4g. Are any changes required to the Environmental Management System (as determined by the Environmental Compliance Rep)?

4h. Is this work being done within 1/2 mile of the Peconic River?

5. Does this operation involve the use of lasers?

5a. Do personnel use or have the potential to be exposed to Class IV lasers?

5b. Do personnel use or have the potential to be exposed to Class IIIb lasers?

5c. Does the operation involve Class I, II or IIIa lasers?

5d. Does this operation involve Class I lasers with embedded IIIb or IV lasers?

5e. Have any of the lasers involved in this operation been built locally or have any commercially available lasers been modified?

5f. Is the laser registered at BNL with the Laser Safety Officer?

6. Is any energized electrical equipment used in this operation?

6a. Is there any exposed electrical components where there is the potential for personnel to be exposed to voltages greater then 50V (Range A)?

6b. Is it required for personnel to work on energized systems greater than 50 V (Range A) but less than 600 V (Range B&C)?

6c. Is it required for personnel to work on energized systems greater than 600 V (Range D)?

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

6e. Does your operation require the development of an Electrical Working On or Near Energized Conductors Permit?

6f. Are emergency shut-off controls provided for shutting down electrical power?

6g. Is required fusing provided for all relevant equipment?

7. Are there any mechanical hazards or work hazards such as material handling, elevated work, vacuum or pressure vessels, scaffolds, stored energy or structural considerations?

7a. Are there any material handling devices including all large moving equipment?

7b. Does the operation include the use of a hoist, crane, forklift, or rigging?

7c. Are there any structures supporting heavy loads?

7d. Does this operation require a structural change to any crane or building?

7e. Will you be purchasing any ladders or scaffolds?

7f. Will this operation require any elevated work?

7g. Does work require fall protection equipment (i.e. harness, lanyard)?

7h. Does the operation include the use of hydraulic or pneumatic lift?

7i. Does any equipment operate at pressures above 15 psig or under a vacuum?

7j. Does this system have any vacuum windows?

7k. Is any part of this system/operation involve a cryogenic system or dewar installation?

7l. Does the operation include the use of typical shop equipment?

7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

7m1. Is the source capable of being easily isolated or can it be LOTO'd?

7m2. Is disassembly required to isolate energy (i.e. inserting blank flange)?

8. Does this operation require work with or generate any of the following physical hazards--confined spaces, RF or microwave radiation, magnetic fields, hot or cold surfaces, high noise levels, or oxygen deficiency?

8a. Does this operation create any space that might meet the definition of a confined space?

8b. Is it required for personnel to enter any Class 1 Confined Spaces?

8c. Is it required for personnel to enter any Class 2A or 2B Confined Spaces?

8d. Is it required for personnel to enter any Class 2C Confined Spaces?

8e. Is there any radiofrequency or microwave field generated by a source greater than 7W in a space that might be occupied?

8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?

8g. Is it required for any personnel to be exposed to a magnetic field greater than 600 Gauss?

8h. Are there any surface temperatures less than 0 deg F or greater than 150 deg F?

8i. Does this operation generate any equipment which could operate at greater than 80 dbA?

8j. Is it required for personnel to work in an area with a Noise Level between 85-100 dBA?

8k. Is it required for personnel to work in an area with a Noise Level above 100 dBA?

8l. Is there any possibility of creating an Oxygen Deficient Atmosphere?

8m. Is it required for any personnel to work in an existing Oxygen Deficiency Hazard Area?

9. Are there any additional hazards, not mentioned above, that should be considered? Such as biological hazards, ergonomics or heat stress?

9a. Could a worker be exposed to any biological hazard including handling of human body fluids, human tissues, or mouse droppings?

9b. Will personnel perform functions that involve repetitive motion, excessive force or vibration, lifting, or other ergonomic concerns?

9c. Will personnel be required to perform this operation in extreme climates or temperatures?

10. Does this operation involve the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?

10a. Has this equipment received review by the C-A Chief Mechanical Engineer and/or Chief Electrical Engineer?

10b. Was this equipment built at a University or Laboratory in another country?

11. Will this operation require trained operators or close surveillance?

11a. Will this operation be left unattended?

11b. Will operation require work outside normal working hours?

11c. Will this operation require 2-person rule?

11d. Will this operation require special attention in the event it is left unexpectedly for long periods of time?

11e. Will this operation require an emergency procedure due to unusual or complicated shutdown instructions?

11f. Will group operational procedures be required for normal operation of this equipment?

11g. Is there a list of designated and trained personnel for this equipment/operation?

11h. During construction, use, or storage of spare parts and materials, are valuable materials attractive for theft and worth more than $1000 (e.g. precious metals; or copper, platinum, tungsten, stainless, aluminum) involved with this project?

12. Are there any fire protection or life safety concerns in this operation?

12a. Will welding or cutting or spark/flame producing operations be conducted in association with this operation?

12b. Does this operation generate, store or use any combustible materials in significant quantities?

12c. Will this operation require a deviation from the Life Safety Code (consider changes in exits, change in occupancy?

12d. Will this operation change the risk level of fire protection?

12e. Could this equipment act as an ignition source?

13. Are there any engineering controls or Personal Protective Equipment (PPE) required (i.e., ventilation, fume hoods, interlocks, HEPA filters/vacuum cleaners, respirators)?

13a. Is any local ventilation used in this operation?

13b. Are interlocks used in this operation?

13c. Is any personal protective equipment used in this operation?

13c(1) Are gloves used in this operation?

13d. Are HEPA filters in place/used?

13d(1). On ventilation systems?

13d(2). HEPA vacuum cleaners?

13e. Will respiratory protection be required for this operation?

14. Do you rely on any facility utilities (listed as sub questions) to provide safety controls for your operations?

14a. Compressed Air

14b. Compressed Gas

14c. Chilled Water

14d. De-Ionized/De-mineralized Water

14e. Electric Power (includes Grounding and UPS)

14f. Emergency electrical power

14g. Fire Protection

14h. Hoists and Cranes

14i. Heating Water

14j. Non-potable Water

14k. Oxygen Monitoring System

14l. Public Address

14m. Potable Water

14n. Process Cooling Water

14o. Sanitary Sewer

14p. Steam

14q. Utility Gas (natural gas)

14r. Vacuum

14s. Ventilation Supply/Exhaust

15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel deserve further consideration?

Project Execution Plan
for the
Electron Beam Ion Source Project
(EBIS)

Project # 06-SC-002

at
Brookhaven National Laboratory
Upton, NY

For the U.S. Department of Energy
Office of Science
Office of Nuclear Physics (SC – 26)

May 2006

Project Execution Plan
for the
Electron Beam Ion Source Pre-Injector
(EBIS)
at Brookhaven National Laboratory

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TABLE OF CONTENTS

1 INTRODUCTION

Brookhaven National Laboratory (BNL), located in Upton, NY, is owned by the U.S. Department of Energy (DOE) and operated by Brookhaven Science Associates (BSA) under the U.S. Department of Energy Contract No. DE-AC02-98CH10886. The flagship Nuclear Physics facility at BNL is the Relativistic Heavy Ion Collider (RHIC). Successful RHIC operations depend on an accelerator complex that accelerates ions to intermediate energies leading up to RHIC injection. This process starts in the Tandem Van de Graaff heavy ion pre-injector. BNL is fabricating a new heavy ion pre-injector for RHIC, the Electron Beam Ion Source (EBIS), which will lead to more reliable, cost-effective operations and new capabilities. This project will provide a new heavy ion pre-injector for RHIC, based on a high charge state heavy ion source, a Radio Frequency Quadrupole (RFQ) accelerator and a short Linear accelerator (Linac).

CD-0 Approve Mission Need:

Authority – Director, Office of Science

On August 2, 2004 Raymond L. Orbach approved the statement of Mission Need for the Electron Beam Ion Source Preinjector with a Total Project Cost (TPC) range of $16 million to $19.5 million. The approval also designated the Associate Director for Nuclear Physics as the Acquisition Executive for this project with authority to approve all subsequent Critical Decisions.

CD-1 Approve Preliminary Baseline Range

Authority -Associate Director for Nuclear Physics

On September 30, 2005 Dennis Kovar approved the EBIS preliminary baseline range and authorized preliminary design. The DOE TPC range at CD-1 had decreased to $12.1 million - $14.8 million, which reflected NASA's $4.5M funding contributions and refinements to the cost and schedule.

CD-2 Approve Performance Baseline

Authority -Associate Director for Nuclear Physics.

Since CD-1, there have been no changes to the technical scope or project cost and schedule plans. The DOE TPC at CD-2 is $14.8 million.

This Project Execution Plan (PEP) describes the coordination of efforts of the project team, including the processes and procedures used by the EBIS Contractor Project Manager (CPM) and Federal Project Director (FPD) to ensure that the project is completed on time and within budget. The PEP defines the project scope and the organizational framework, identifies roles and responsibilities of contributors, and presents the work breakdown structure (WBS) and schedule. The PEP also describes the formal change control process by which project cost, schedule, or scope may be revised in consultation with the FPD and the DOE Office of Science, Office of Nuclear Physics.

2 MISSION NEED

The mission of the Nuclear Physics (NP) program is to foster fundamental research in nuclear physics that will provide new insights and advance our knowledge on the nature of matter and energy and develop the scientific knowledge, technologies and trained manpower that are needed to underpin the DOE missions for nuclear related national security, energy and environmental quality. As part of its strategic mission, the NP program plans, constructs and operates major scientific user facilities and fabricates experimental equipment to serve researchers at universities, national laboratories and industrial laboratories. The program provides world-class, peer-reviewed research results in the scientific disciplines encompassed by the NP mission areas under the mandate provided in Public Law 95-91 that established the department.

EBIS provides research capabilities that directly support the NP mission and address the NP Program Goal 05.20.00.00 to understand the evolution and structure of nuclear matter from the smallest building blocks, quarks and gluons, to the elements in the universe created by stars. A main objective of this nuclear science field is searching for the quark-gluon plasma and other new phenomena that might occur in extremely hot, dense plasma of quarks and gluons believed to have filled the universe about a millionth of a second after the "Big Bang." Most of the world's current experimental effort on this question is carried out using relativistic heavy-ion collisions at RHIC, which is supported by the DOE NP program.

The present pre-injector of heavy-ions for RHIC uses Tandem Van de Graaff accelerators built around 1970. The beam is transported to the Booster accelerator via an 860-meter long line. The successful development of an EBIS prototype at BNL makes it possible to replace the present pre-injector with a reliable, low maintenance and cost effective Linac-based pre-injector. This new pre-injector would consist of an EBIS high charge state ion source, an RFQ accelerator and a short Linac. EBIS would increase the reliability and efficiency of RHIC operations, reduce the costs of RHIC operations and provide new experimental capabilities.

EBIS supports the Science Strategic Goal within the DOE's Strategic Plan to protect national and economic security by providing world-class scientific research capacity and advancing scientific knowledge. More specifically, this effort supports the General Goal within the DOE Strategic Plan:

> "General Goal 5, World-Class Scientific Research Capacity: Provide world-class scientific research capacity needed to ensure the success of Department missions in national and energy security, to advance the frontiers of knowledge in physical sciences and areas of biological, medical, environmental and computational sciences and to provide world-class facilities for the Nation's science enterprise."

The pre-injector system will also provide for a major enhancement in capability for the NASA Space Radiation Laboratory (NSRL), which utilizes heavy-ion beams from the RHIC complex. EBIS would allow for the acceleration of all important ion species for the NASA radiobiology program, such as, helium, argon, and neon which are unavailable with the present Tandem injector. In addition, the new system would allow for very rapid switching of ion species for NSRL experiments, reducing delays due to the interference with RHIC injection operations, and allowing enhanced mixed radiation-field studies.

The EBIS pre-injector project (EBIS source, Linac and RFQ) has been endorsed several times by a variety of panels, including DOE Science and Technology review panels of international experts, BNL Machine Advisory Committees and the joint DOE/NSF Nuclear Science Advisory Committee.

The new pre-injector offers the following advantages:

- Replacement of the two Tandems as the Booster preinjector, resulting in more stable beam intensities.
- Elimination of the need to use the 860-meter long transport line from Tandem to Booster; using instead a much simpler and economic 30-meter long line from EBIS to reduce setup time and allow fast switching between beams of different rigidities.
- Simplification of Booster injection scheme.
- Capability to provide ions not presently available for the NASA program, such as noble gas ions (major components of galactic cosmic rays), as well as more massive ions such as uranium and, with additional enhancements, polarized ^{3}He, for the RHIC program.
- Increased flexibility to handle the multiple needs of RHIC, NSRL and Alternate Gradient Synchrotron (AGS). Two Tandems are needed for fast beam switching, while the EBIS preinjector will be able to switch species on a pulse-to-pulse basis.
- Improvements in reliability, setup time and stability should lead to increased integrated luminosity in RHIC and increased productivity for NSRL.
- Reduced operating costs. The Tandem facility requires a staff of approximately 12 Full Time Equivalents (FTEs) to support maintenance and a 24-hour shift rotation during operations. The Linac-based pre-injector should be able to run unattended at most times, as with the present proton Linac, and will require only a staff of approximately 3 FTEs.

If the new EBIS pre-injector is not built, significant upgrades to the Tandems will be required in order to ensure reliable long-term operation for RHIC and NSRL. This is discussed in more detail in Section 4.6.

3 FUNCTIONAL REQUIREMENTS

The technical objectives of the new pre-injector need to meet requirements of both the RHIC and NASA NSRL experimental programs. The corresponding technical scope and performance specifications required at Critical Decision-4 (CD-4) are described in Table 4.1. The system parameters desired from a new pre-injector are as follows:

- **Species: d to U.** The EBIS will produce helium to U beams. A deuterium beam may be produced in a simple plasma source injecting directly into the RFQ. The RFQ, Linac, and transport lines must be designed to handle all species in this range.

The species extracted from EBIS depend on the injected singly charged ions. With the external ion sources included in the present design, beams from typical gases and solids as required by RHIC and NSRL will be available. Production of some more exotic beams may require additional development or resources devoted to the external source of such ions for injection.

- **Intensity at injection into the Booster: up to 1.1 x 10^{11} charges/pulse with EBIS.** Species which have been run for RHIC and NSRL are shown in Table 3-1, along with intensities at Booster injection which are required in order to reproduce previously observed intensities. The EBIS pre-injector should at least match this performance in all cases.

Table 3-1 Beams and intensities at Booster input required to match past performance

Species	User	Q	Ions/pulse	Charges/pulse
Au	RHIC	32+	2.7 x 10^9	8.6 x 10^{10}
D	RHIC	1+	2.5 x 10^{11}	2.5 x 10^{11}
Cu	RHIC	11+	1.0 x 10^{10}	1.1 x 10^{11}
C	NSRL	5+	2 x 10^{10}	1 x 10^{11}
O	NSRL	8+	6.7 x 10^9	5.3 x 10^{10}
Si	NSRL	13+	5 x 10^9	6.5 x 10^{10}
Ti	NSRL	18+	1.3 x 10^9	2.4 x 10^{10}
Fe	NSRL	20+	1.7 x 10^9	3.4 x 10^{10}

- **Injected pulse width: variable, 10 – 40 μs.** This allows 1-4 turn injection into the Booster. This simplifies the injection, and should greatly reduce the sensitivity to small beam losses at injection, which could otherwise lead to a pressure bump resulting in further beam loss.

- **Repetition rate: 5 Hz.** This keeps overall RHIC fill times to only a few minutes.

- **Switching time between two species: 1 second.** There are presently several operating scenarios for RHIC and NSRL, depending on, among other things, whether either is running alone, or the two are running concurrently. To allow operation with the desired flexibility, the new pre-injector must be able to switch beam species and transport line rigidity in 1 second.

- **Injection energy: 2 MeV/amu.** At present, injection from the Tandems is at 0.92 MeV/amu for Au. At this energy, there is a significant beam loss due to electron capture during Booster injection. By raising the injection energy to 2 MeV/amu, the capture cross section is reduced by a factor of 20-40.

- **Q/m: 0.16 or greater.** This ratio equals that presently delivered for Au from the Tandem. For lighter ions a higher q/m is required (Si^{13+}, Fe^{20+}) in order to achieve the desired Booster output energy for NSRL, within the rigidity constraints of the Booster and extraction transport lines.

4 PROJECT OVERVIEW

The project, including DOE and NASA contributions, includes the fabrication of an Electron Beam Ion Source for the production of high charge state heavy ions, plus the procurement of an RFQ and heavy ion Linac to accelerate ions from EBIS to a final energy of at least 2 MeV/amu. A transport line is to be fabricated to transport the beam from the output of the Linac to the existing Booster heavy ion injection point, as show below in Figure 4.2. The project includes the fabrication or procurement of the dipole and quadrupole magnets, power supplies, diagnostics, vacuum components, and controls to properly operate the EBIS source, accelerators, and beam lines. The project also includes the assembly of subsystems, and the installation and testing of these subsystems in their final location in the equipment bay at the high energy end of the H^- Linac building.

The EBIS project is divided in four major systems, including (a) Source & Accelerator Structures; (b) Electrical Systems; (c) Mechanical Systems; (d) Facilities & Installation Support. The sections below describe the present design for the EBIS pre-injector for both the DOE and NASA efforts.

4.1 SOURCE & ACCELERATOR STRUCTURES

The Source & Accelerator Structures form the framework of the EBIS Pre-Injector. The superconducting solenoid, trap region electrodes, electron gun and electron collector are the major hardware items for the EBIS. External ion injection sources feed singly charged ions into the EBIS trap for further ionization to the desired final charge state. The Low Energy Beam Transport (LEBT) provides matching of the beam extracted from the EBIS into the RFQ. This line includes magnetic and electrostatic focusing and steering, and appropriate diagnostics. The RFQ provides initial acceleration of the beam to an energy sufficient for injection into a single Linac cavity. The Linac, an Interdigital-H (IH) structure in the present design, then accelerates the beam to the final required energy of 2 MeV/amu. The frequency presently chosen for both the RFQ and Linac is 100.625 MHz, which matches many existing Linacs and RFQs.

A layout of the pre-injector is shown in Figure 4.1.

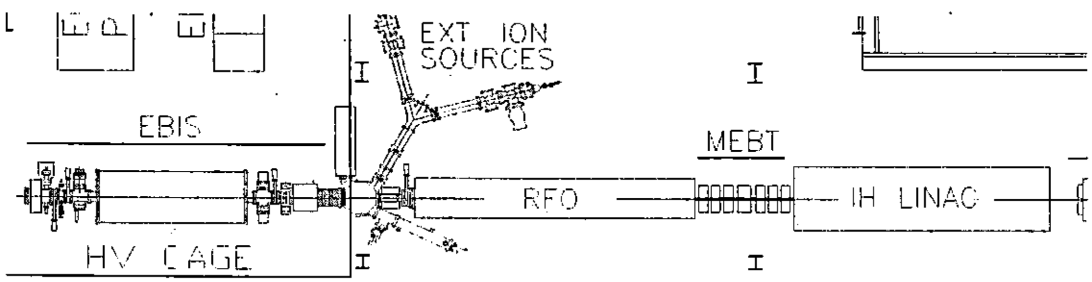

Figure 4.1 Layout of the pre-injector

4.2 ELECTRICAL SYSTEMS

The Electrical systems include all power supplies, diagnostic instrumentation, Radio Frequency (RF) systems and controls systems required for the operation of the EBIS, RFQ, Linac, and associated beam transport lines. There are five 100.625 MHz RF amplifier systems required, feeding the RFQ, IH Linac, and three buncher cavities. These systems will include amplitude and phase regulation, and cavity frequency tuning. Diagnostics include Faraday cups, current transformers, profilė monitors, and time of flight spectrometers. Controls will be implemented in the same way as other recent installations such as the new polarized ion source and NSRL. All transport line diagnostics are similar to existing equipment, and applications software already exists. Vacuum equipment will be controlled via Programmable Logic Controllers (PLC's), with a PLC interface module to tie into the control system.

4.3 MECHANICAL SYSTEMS

The Mechanical Systems include both Magnet and Vacuum systems. Two 73-degree dipoles in the high energy beam transport line will bend beam into Booster. These dipoles will be able to switch field in 1 second, for fast changes in beam species. The High Energy Beam Transport (HEBT) line will use existing quadrupole and steering magnets. The vacuum systems will be sufficient to provide the required vacuum of 10^{-9} to 10^{-10} Torr in the EBIS trap region. Cryo pumping will be used on the RFQ and Linac.

4.4 FACILITIES & INSTALLATION SUPPORT

This includes facility modification, cooling systems and installation of the EBIS components. The new pre-injector will be housed in the lower equipment bay of Building 930 as shown in Figure 4.2. It will connect to the existing Tandem-to-Booster transfer line just before it enters the Booster electrostatic inflector. Cooling systems are required for the EBIS electron collector, EBIS magnets, RFQ and Linac cavities, and several power supplies.

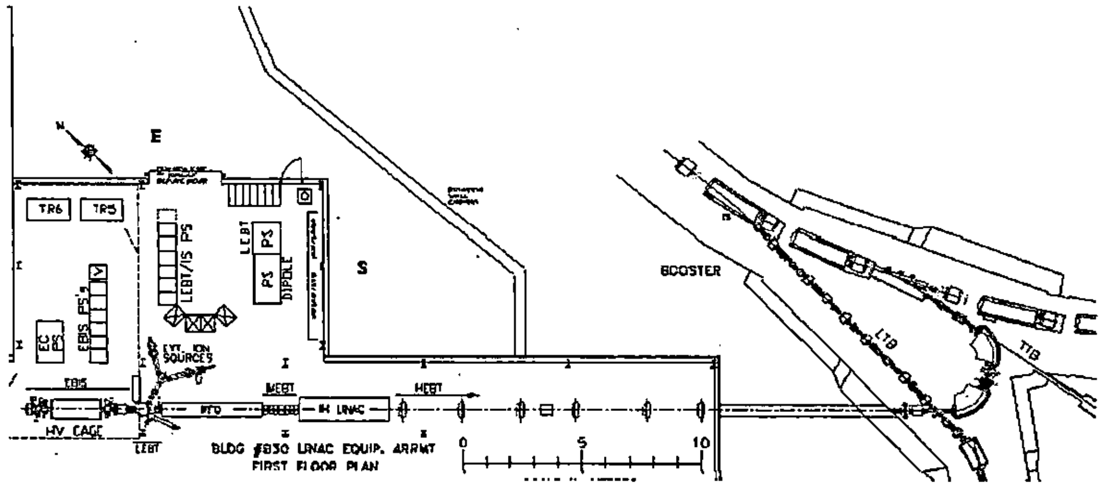

Figure 4.2 Placement of EBIS Pre-Injector in lower equipment bay of 200 MeV Linac.

4.5 TECHNICAL SCOPE AND DELIVERABLES

The DOE scope is the following activities or procurements:

- All Project Engineering and Design (PED), installation, and commissioning for the entire project
- All EBIS chambers, internal structures, and warm magnets
- The LEBT and external ion injection lines
- All vacuum components, controls, diagnostics, and cooling water systems
- All Medium Energy Beam Transport (MEBT) and HEBT beamline components, except for two HEBT dipoles
- All RF systems for operation of the RFQ, Linac, and bunchers
- All power supplies for EBIS, LEBT, and external ion sources, except for the electron collector and fast pulsing EBIS platform supplies.
- Electrical services required for the operation of the pre-injector

The NASA scope is the procurement of the following items:

- The EBIS superconducting solenoid
- The RF Quadrupole accelerator
- The Linac structure
- The buncher cavities
- The two HEBT dipole magnets and their power supplies
- The electron collector power supply
- All quadrupole magnet and steering magnet power supplies for the Linac,
- MEBT, and HEBT
- The fast pulsing power supplies for the EBIS drift tubes and platform bias.
- The beam port through the earth shielding between Linac and Booster.

The DOE deliverables are complete when all the items listed as DOE scope, above, have been procured or fabricated; the EBIS, RFQ, Linac, and beam transport lines have been installed; and the CD-4 requirements from the Table 4-1 below have been verified.

The NASA deliverables are complete when all the items listed as NASA scope, above, have been delivered to BNL, and the beam port is installed.

Table 4-1 CD-4 performance to be demonstrated at Booster input (measured on the current transformer located between the two HEBT 73 degree dipoles).

	CD-4 Performance	**Optimum Performance**
Species	Fe, Au	He to U (assuming appropriate external ion injection)
Intensity	3×10^8 Au^{32+} / pulse 4×10^8 Fe^{20+} / pulse	2.7×10^9 Au^{32+} / pulse 4×10^9 Fe^{20+} / pulse 5×10^{10} He^{2+} / pulse
Charge-to-mass ratio, Q/m	0.162 (Au) 0.357 (Fe)	≥ 0.16, depending on ion species
Repetition rate	Demonstration of pulsing	5 Hz
Pulse width	10-40 μs	10-40 μs
Switching time between species	Demonstration of switching	1 second
Output energy	2 MeV/amu	2 MeV/amu

4.6 ALTERNATIVE ANALYSIS

Substantial pre-conceptual Research & Development (R&D) was carried out and the technology needed to realize an Electron Beam Ion Source meeting RHIC requirements was developed, leading to a successful demonstration of the "proof of principle". Before selecting the EBIS, alternative high charge state heavy ion sources were considered; in particular the Electron Cyclotron Resonance (ECR) source, and the Laser Ion Source (LIS). The EBIS was chosen as best meeting the requirements for a new RHIC pre-injector, based on considerations such as intensity, reliability, flexibility in the choice of species, fast switching between species, etc.

The LIS has serious reliability problems, and the species it can produce are limited to those coming from solid targets, preferably with high melting points. Pulse-to-pulse switching of species is probably not possible.

The ECR source cannot produce a sufficient intensity of high charge state heavy ions to meet the RHIC requirements. In addition, it has less flexibility than an EBIS in the choice of ion species. Maximum ECR outputs vary considerably with species (it favors gases and low melting point metals). Pulse-to-pulse switching of species would be difficult to do with maximum intensity, since there is often a "memory" effect when changing species, meaning the source has to clean up over time after a change in species to reach optimum performance. A final concern with the ECR source is the increased difficulty of transporting and matching of these high current beams into an RFQ. The required charge states tend to be in the tail of the ECR charge state distribution for heavy beams, so only a few percent of the total current would be in the desired charge state, meaning that the total extracted current is very high, leading to space-charge problems in transport.

In contrast to the alternatives, the EBIS can meet the intensity goals. With the pre-conceptual R&D prototype, a factor of 20 increase in EBIS performance compared to previous EBIS's was achieved. To meet RHIC requirements, the EBIS must be scaled in the same manner by only another factor of 2. With the EBIS the required charge states can be easily produced, and the EBIS can produce ions of any species; and with external ion injection species can be changed on a pulse-to-pulse basis. The current produced is independent of species. At least 20% of the total current out of EBIS is contained in the charge state of interest for any EBIS beam, so the total current extracted remains at a reasonable level. Finally, with an EBIS, a fixed amount of charge per pulse is extracted, and the beam pulse width can be controlled to match optimally the Booster injection requirements.

The RFQ is the only technology choice for the first acceleration stage of the EBIS beam. The Interdigital-H (IH) Linac structure was chosen as the next acceleration stage in the baseline design. This is a low-risk choice, since there are many Linacs of this type in operation. The IH Linac used at CERN for acceleration of Pb, in particular, almost exactly meets the EBIS requirements. A superconducting heavy ion Linac was considered, but suffers from higher cost and increased operational complexity.

An internal technical review of the pre-conceptual design was held on January 27-28, 2005, and the external committee of source and accelerator experts endorsed the choices made for both ion source and accelerators.

If the new Linac-based pre-injector is not built, significant upgrades to the Tandems will be required in order to ensure reliable long-term operation for RHIC and NSRL. Construction began for the Tandem Van de Graaff facility in 1966, and it was commissioned in 1970. Many of the Tandem systems date back to 1960's technology and need modernization. Should EBIS not be approved, alternative high cost (approximately $9 million, FY04 $) risk mitigation plans will have to be initiated in order to prevent unexpected failures of the Tandem from suspending RHIC operations for extended periods. Alternatively stated, the EBIS project would provide potential contingency in scheduling of the RHIC accelerator. Upgrading the Tandems will not lead to new performance capabilities that are needed for the long-term plans for the RHIC facility or NSRL.

5 MANAGEMENT ORGANIZATION

5.1 GENERAL

This document provides the management organization for the EBIS as defined for the development, construction and final assembly. Agreements between DOE SC and NASA and between BNL and NASA were established and documented. (see Appendix C) Figure 5-1 outlines the management structure for EBIS.

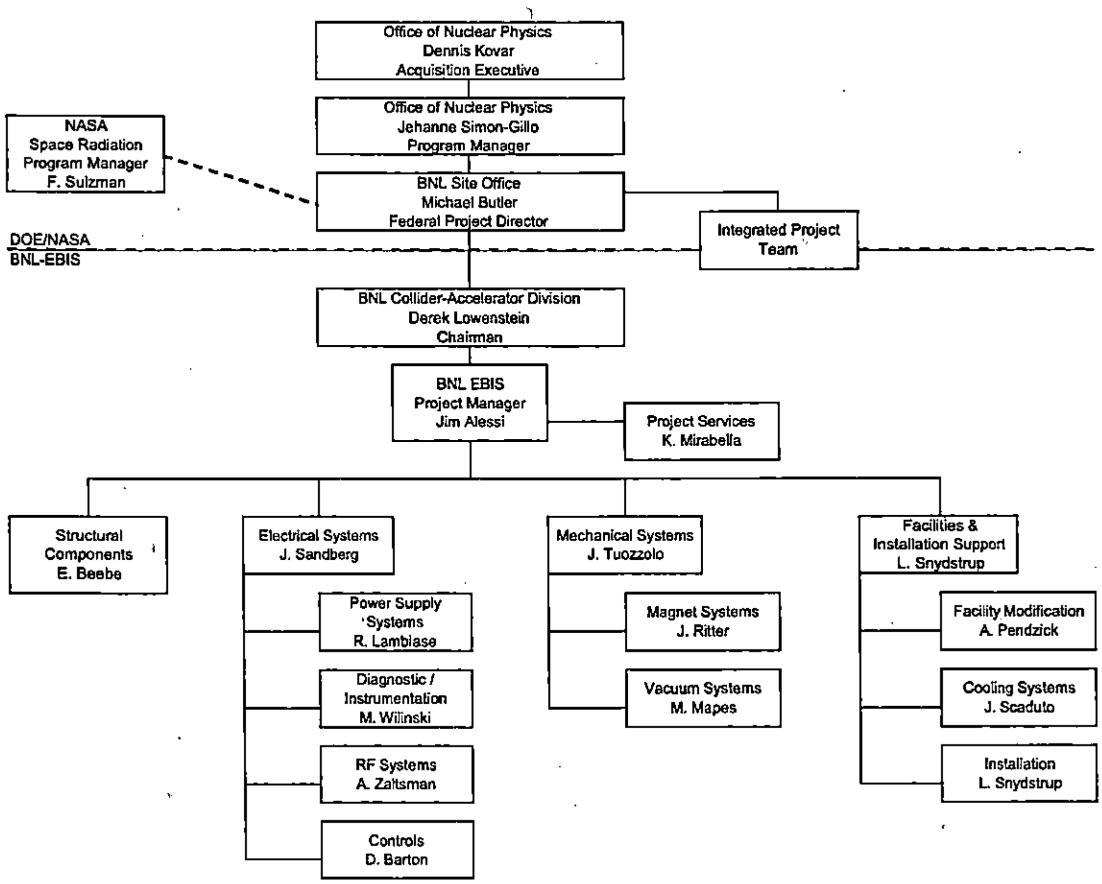

Figure 5.1 Management Organization Chart for EBIS

5.2 PROJECT MANAGEMENT RESPONSIBILITIES

5.2.1 Department of Energy

Within the DOE Office of Science (SC), the Office of Nuclear Physics (SC-26) has overall DOE responsibility for the EBIS project.

Responsibilities

The Acquisition Executive is Dennis Kovar, Associate Director of the Office of Science for Nuclear Physics (SC-26). As such, he has full responsibility for project planning and execution, and for establishing broad policies and requirements for achieving project goals. Specific responsibilities for the EBIS project include:

- Chairs the ESAAB Equivalent Board.
- Approves Critical Decisions and Level 1 baseline changes.
- Approves the Project Execution Plan.
- Delegates approval authority for Level 2 baseline changes to the Federal Project Director.
- Conducts Quarterly Project Reviews.
- Ensures independent project reviews are conducted.

The Office of Nuclear Physics (SC-26.2) is responsible for planning, constructing, and operating user facilities to provide special scientific and research capabilities to serve the needs of U.S. universities, industry, and private and Federal laboratories. Within NP, the Facilities and Project Management Division (SC-26.2) has direct responsibility for providing funding, and programmatic guidance to the EBIS project. The EBIS Program Manager, in SC-26.2, is the primary point of contact with the following responsibilities:

- Oversees development of project definition, scope and budget.
- Prepares, defends, and provides project budget with support from the field organizations.
- Reviews and provides recommendations to the AE on Level 1 baseline changes.
- Monitors Level 1 and 2 technical, cost, and schedule milestones.
- Participates in Quarterly Reviews, ESAAB Equivalent Board meetings, and project reviews.
- Ensures ES&H requirements are implemented by the project.
- Coordinates with other SC Staff offices, HQ program offices and the OECM.

Jehanne Simon-Gillo is the Federal EBIS Program Manager.

Michael A. Butler at the Brookhaven Site Office (BHSO) is assigned as the Federal Project Director. The Federal Project Director responsibilities include:

- Overall responsibility for planning, implementing, and completing EBIS.
- Provides overall project management oversight.
- Issues key work authorization.
- Provides necessary funds via approved financial plans.
- Manages and allocates the contingency funds according to the procedure defined in the Baseline Change Control (Section 7).
- Submits key project documents and critical decisions to DOE and reports project progress.
- Ensures that the project complies with applicable ES&H requirements (e.g., National Environmental Policy Act [NEPA] requirements).
- Approves Level 2 Baseline changes.

5.2.2 NASA

Frank M. Sulzman, Space Radiation Program Manager, NASA Headquarters is the NASA representative to the EBIS Project.

Responsibilities

- Functions as NASA point of contact for project matters.
- Reviews relevant project documentation
- Participates in monthly and quarterly Project teleconferences, as well as key Project reviews (Preliminary Design Review, Critical Design Review, Operational Readiness Review, etc.)

5.2.3 Brookhaven National Laboratory

Chairman for the Collider-Accelerator Department at BNL

Funding for this project will be directed through BNL's Collider-Accelerator Department (C-AD). Fiscal and management responsibility for the fabrication of EBIS will reside with the Chairman, Derek Lowenstein. The Chairman is the designated Principal Investigator for the NASA Space Radiation Laboratory Facility.

Responsibilities

The Chairman for the Collider-Accelerator Department at BNL shall be administratively and fiscally responsible for the entire project. In particular he must do the following:

- Provides overall management oversight for all aspects of the project.
- Appoints the Contractor Project Manager.
- Approves key personnel appointments made by the Contractor Project Manager.
- Approves major subcontracts recommended by the Contractor Project Manager.

- Ensures that adequate staff and resources are available to complete EBIS in a timely and cost effective manner (within constraints of the budget provided by DOE).
- Ensures that EBIS has demonstrated that it meets the functional requirements.
- Provides documentation and access to information necessary for operation of EBIS at other sites.
- Ensures the work is performed safely and in compliance with the ISM rules.
- Reports to the Associate Laboratory Director for High Energy and Nuclear Physics regarding the operations of the Collider-Accelerator Department.
- Reports to Frank Sulzman, NASA, regarding NSRL operations.

5.2.4 Contractor Project Manager

The Chairman for the Collider-Accelerator Department, Derek Lowenstein, has appointed James Alessi the EBIS Contractor Project Manager.

Responsibilities

The Contractor Project Manager shall report directly to the Chairman for the Collider Accelerator Department and will be in charge of the overall management of EBIS. The CPM shall appoint the key staff needed for the project with the approval of the Chairman for the Collider-Accelerator Department. The CPM also will have the following responsibilities:

- Responsible and accountable for the successful execution of contractor's project scope of EBIS.
- Supports FPD in implementing DOE project management process.
- Provides input on project documentation.
- Implements contractor performance measurement system.
- Delivers project deliverables as defined in this PEP.
- Identifies and ensures timely resolution of critical issues within contractor's control.
- Allocates the contingency funds according to the procedure defined in the Baseline Change Control (Section 7).
- Acts as the spokesperson for the project to the DOE and the scientific community.
- Collaborates with the Associate Lab Director for High Energy Nuclear Physics and the Chairman for the Collider-Accelerator Department to assemble the staff and resources needed to complete the project.
- Keeps the scientific community informed on the progress of the project.
- Appoints the Quality Assurance Manager (QAM).
- Provides monthly input to the Federal Project Director to be used in report to DOE.
- Submits quarterly status reports to BHSO Federal Project Director.
- Ensures the work is performed safely and in compliance with the Integrated Safety Management (ISM) rules.

- Produces necessary Environment Safety and Health (ES&H) documentation (e.g., NEPA).
- Approves baseline changes up to and including Level 3.

5.2.5 Subsystem Managers

The EBIS Project contains four major systems: Structural Components Electrical Systems, Facilities and Installation Support, and Mechanical Systems. The EBIS Contractor Project Manager has appointed managers to be responsible for the subsystems, which comprise the major systems. They are: Edward Beebe for Structural Components, Bob Lambiase for Power Supply Systems, Michelle Wilinski for Diagnostic Instrumentation, Donald Barton for Controls, Alexander Zaltsman for RF Systems, John Ritter for Magnet Systems, Mike Mapes for Vacuum Systems, Alexander Pendzick for Facility Modifications, Joseph Scaduto for Cooling Systems, and Louis Snydstrup for Installation. They will be responsible for the design, construction, installation, and testing of their subsystem, in accordance with the performance requirements, schedule, and budget.

Responsibilities

- Collaborate with the CPM to assemble the staff and resources needed to complete the subsystem.
- Communicate the system design requirements to the staff.
- Ensure that subsystems meet the EBIS system design requirements, including interfaces.
- Responsible for carrying out the design, construction and assembly of the subsystem in accordance with the scope, schedule and budget, assuming funding and resources as described in the PEP.
- Provide regular reports on the status of the subsystem to the Contractor Project Manager.
- Ensure the work is performed safely and in compliance with the ISM rules.

5.2.6 Quality Assurance Manager

David Passarello has been assigned as the QAM.

Responsibilities

- Collaborates with the CPM and Deputy Contractor Project Manager to ensure the quality of EBIS.
- Ensures that the quality system is established, implemented, and maintained in accordance with the EBIS Quality Assurance Plan.
- Provides oversight and support to the partner labs and institutions to ensure a consistent quality program.

INTEGRATED PROJECT TEAM

The composition of the EBIS Integrated Project Team (IPT) is given in Table 5-1. Its responsibilities are described in the DOE directive. The team will meet at least quarterly, or more frequently if necessary. The DOE Federal Project Director will chair the IPT.

Table 5-1. EBIS Integrated Project Team

DOE Federal Project Director (Chair)	Michael A. Butler
DOE Site Contracting Officer	Michael D. Holland
DOE Program Manager for EBIS	Jehanne Simon-Gillo
DOE Science Program Manager	Gulshan Rai
NASA Space Radiation Program Manager	Frank Sulzman
BNL Project Manager for EBIS	James Alessi
BNL Procurement Operations Manager	David E. Dale
BNL ESSH Lead	Ed Lessard
C-AD Assistant Chair for Administration	Stephanie LaMontagne

5.3 OPERATION PHASE

The EBIS will operate as the ion source and first stage injector to the RHIC facility. The ion source, RFQ and Linac form an injector chain for ion injection into the Booster synchrotron. This facility will be a permanent installation that is dedicated to providing ions to the Collider-Accelerator Department accelerator complex. RHIC will have first priority for these beams. In addition, when RHIC does not require its use, the EBIS injector chain can provide beams for the NASA Space Radiation Laboratory (NSRL) at the Booster or for beams to be used at the AGS. The EBIS injector system operation will be totally integrated into the C-AD Pre-injector Group.

The cost of operation of the EBIS pre-injector will be lower than that of the Tandem. The Tandem facility requires a staff of approximately 12 FTE's to support maintenance and 24 hour shift rotation during operations. The EBIS pre-injector will require a staff of ~3 FTE's for operation and maintenance, since it should be able to run unattended at most times, and will be monitored by C-AD Main Control Room personnel. Operating cost savings have been estimated at $1.46 million per year ('06 $), with approximately 100 k$ going to NASA, and the remainder going to DOE NP.

5.4 LIFE CYCLE COSTS

- Construction costs: described in this document
- Operation: it is expected that ~ 3 FTE's will be required to operate and maintain the EBIS pre-injector. Included is a core scientific, engineering, technical support from within the C-AD Preinjector Group, plus additional support at a smaller scale from other groups within C-AD (Controls, Diagnostics, Vacuum, Power

Supply, Cooling Systems, RF, Drafting, etc.). Costs for electrical power and materials are estimated at < 1 M$ for 32 weeks of operations per year, which is slightly less than required for Tandem operation.

- Decommissioning and decontamination: The EBIS pre-injector will be fully integrated with the rest of the C-AD complex, and has already been incorporated in the current Safety Assessment Document for the Department. Decommissioning and decontamination will be included as a part of the D&D of the RHIC facility. With the low final energy from the pre-injector for any ion species, there will be no activation of components, so D&D activities would involve either the disposal or reuse of standard scientific equipment.

6 SCHEDULE AND COST SCOPE

EBIS has been organized into a Work Breakdown Structure (WBS) for purposes of planning, managing and reporting project activities. Work elements are defined to be consistent with discrete increments of project work. EBIS has thirteen major WBS Level 2 components: Structural Components, Controls Systems, Diagnostic/Instrumentation, Magnet Systems, Power Supply Systems, RF Systems, Vacuum Systems, Cooling Systems, Facility Modifications, Installation, Project Services, Commissioning and R&D.

6.1 SCHEDULE SCOPE

Figure 6.1 shows a high level schedule of the key elements of the EBIS project. The WBS dictionary is available in Appendix A. The schedule is fully integrated to include both the DOE and NASA efforts.

ID	Task Name	Start	Finish
1	R&D	Fri 4/1/05	Fri 3/30/07
3	CD1 approval	Wed 9/14/05	Wed 9/14/05
4	Engineering and Design	Thu 12/1/05	Sun 11/26/06
6	CD2 approval	Fri 9/1/06	Fri 9/1/06
7	CD3 approval	Fri 12/1/06	Fri 12/1/06
8	Procurements	Sun 1/1/06	Fri 9/19/08
91	Manufacturing	Mon 10/2/06	Tue 8/7/07
92	EBIS components	Wed 11/1/06	Tue 8/7/07
93	Drift tubes and chambers	Wed 11/1/06	Tue 6/5/07
98	Electron gun assembly	Fri 12/1/06	Fri 5/4/07
103	EBIS warm solenoids	Thu 2/1/07	Tue 8/7/07
108	LEBT elements	Mon 10/2/06	Thu 3/15/07
113	Pre-assembly	Thu 3/15/07	Wed 8/8/07
114	EBIS	Fri 5/11/07	Wed 8/8/07
119	LEBT	Thu 3/15/07	Mon 5/21/07
123	Beam access port installation	Fri 7/28/06	Mon 8/7/06
128	Linac building addition complete	Fri 9/28/07	Fri 9/28/07
130	Installation	Wed 8/8/07	Thu 11/27/08
131	EBIS	Wed 8/8/07	Tue 6/17/08
136	LEBT	Thu 8/30/07	Thu 4/17/08
141	RFQ	Mon 7/28/08	Tue 10/7/08
147	Linac	Mon 11/3/08	Thu 11/27/08
152	HEBT (Booster side)	Mon 5/5/08	Thu 7/10/08
158	HEBT (Linac side)	Mon 10/8/07	Tue 10/14/08
164	Test RFQ with Test EBIS	Tue 1/15/08	Tue 4/15/08
169	Commissioning	Mon 6/16/08	Mon 3/30/09
170	RHIC EBIS/LEBT	Mon 6/16/08	Tue 7/29/08
174	EBIS & RFQ/MEBT	Mon 10/6/08	Tue 11/4/08
178	EBIS/RFQ/Linac	Wed 11/26/08	Tue 12/30/08
183	HEBT (to Booster input)	Mon 12/29/08	Mon 3/30/09
186	CD4 approval	Mon 3/1/10	Mon 3/1/10

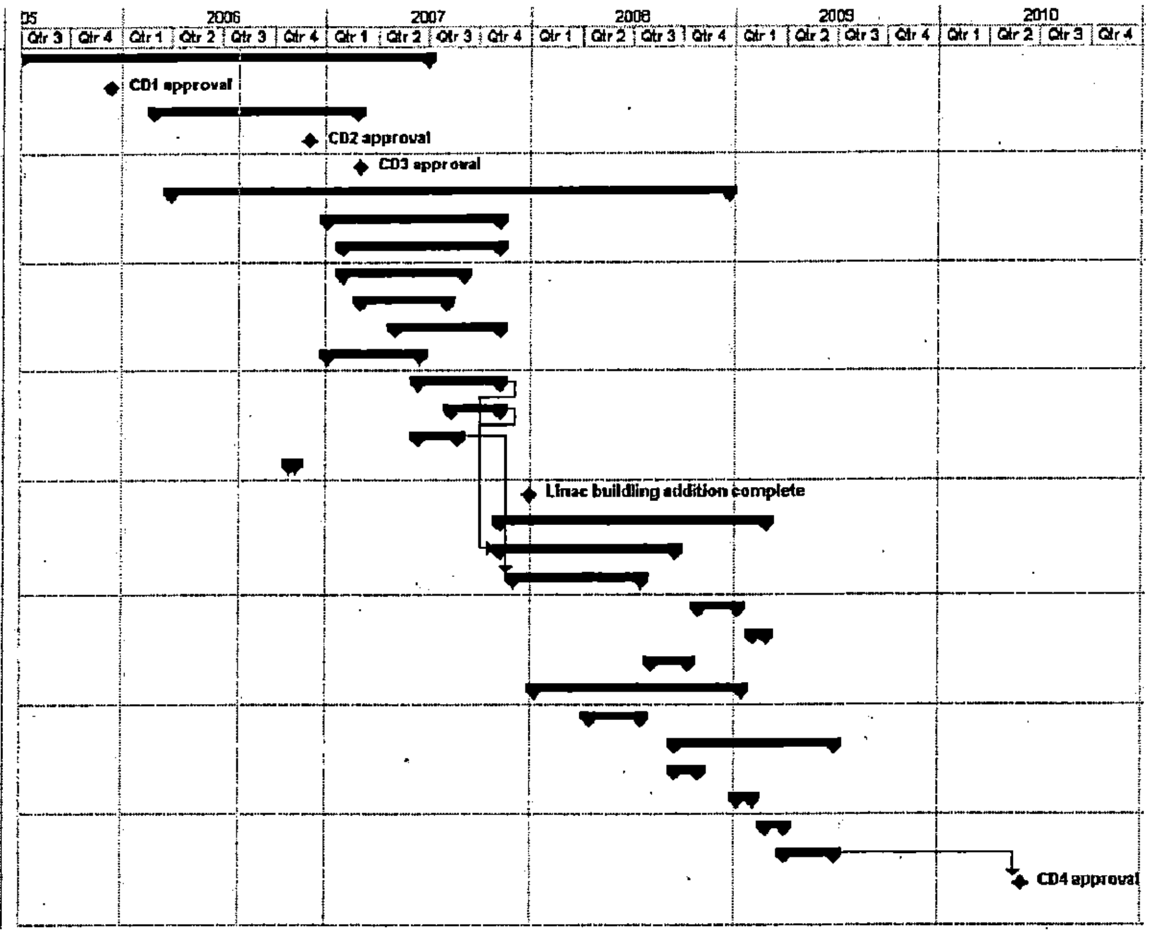

Figure 6.1 High level schedule of the EBIS project (early finish dates for tasks are shown).

6.1.1 Milestones

Milestones will be used as schedule events to mark the due date for accomplishment of a specified effort or objective. A milestone may mark the start, an interim step, or the end of one or more activities as needed to provide insight into the Project's progress. Milestones are assigned to different levels (Table 6-1) depending on their importance and criticality to other milestones and the overall Project schedule.

Table 6-1 details the EBIS Milestone levels

Milestone Level	Description
0	Critical Decision milestones
1	Start and/or Completion of Major Project Phases
2	Milestones that support the accomplishment of the Level 0 and level 1 milestones
3	Milestones to monitor and assure progress

2 shows the project performance milestones.

Level	Milestone	Date
0	Critical Decision 0 (CD-0)	Q4,04 (A)
0	Critical Decision 1 (CD-1)	Q4,05 (A)
0	Critical Decision 2 (CD-2)	Q4,06
0	Critical Decision 3 (CD-3)	Q1,07
0	Critical Decision 4 (CD-4)	Q2,10
1	RFQ procurement placed	Q4, 06
1	SC solenoid factory/acceptance test	Q2, 07
1	Linac Procurement placed	Q2, 07
1	Beam port complete	Q4, 07
1	Building addition approved for occupancy	Q2, 08
1	EBIS Safety Assessment Document complete	Q4, 08
1	CASE for EBIS approved by DOE	Q2, 09
1	HEBT dipole installation complete	Q4, 09
1	BHSO letter approving commissioning	Q4, 09
1	Beam out of EBIS	Q4, 09
1	Beam out of RFQ	Q1, 10
1	Beam out of linac	Q1, 10
1	Beam through HEBT	Q2. 10

Level	Milestone	Date
2	Electron collector procurement placed	Q1, 06 (A)
2	R&D EBIS installed on HV platform	Q1, 06 (A)
2	Superconducting solenoid procurement placed	Q2, 06 (A)
2	R&D High Voltage beam tests begin	Q1, 07
2	Electron collector pressure/vacuum tested	Q1, 07
2	EBIS Drift tube structure complete	Q2, 08
2	EBIS preassembly complete	Q3, 08
2	Electron collector ps acceptance tested	Q1, 09
2	ARR review team for EBIS appointed	Q1, 09
2	RF amplifiers acceptance tested	Q2, 09
2	RFQ tested to full power	Q2, 09
2	EBIS installation complete	Q3, 09
2	Accelerator Readiness Review	Q4, 09
2	Linac tested to full power	Q1, 10
2	HEBT dipole ps acceptance tested	Q1, 10
2	RFQ installation complete	Q1, 10
2	Linac installation complete	Q1, 10
2	HEBT beamline installation complete	Q2, 10

6.2 COST SCOPE

Table 6-3 shows the estimated DOE TPC cost summary for the EBIS. The following standard DOE escalation factors were used of 2.8% (2006) and 2.6% (2007-2009).

Table 6-3 Cost Baseline for EBIS project.

WBS	Title	M$
1.1	Structural components	1.4
1.2	Controls Systems	0.8
1.3	Diagnostics	0.7
1.4	Magnet Systems	0.3
1.5	Power Supply Systems	0.9
1.6	RF Systems	2.8
1.7	Vacuum systems	1.5
1.8	Cooling Systems	0.3
1.9	Facility Modifications	0.5
1.10	Installation	1.4
1.11	Project Services	1.1
1.12	Commissioning	0.2
1.13	R&D / CDR	0.7
subtotal		12.6
	Contingency	2.2
Total		14.8

6.2.1 Funding

The EBIS project is being funded by DOE-NP and NASA. With refinements during the project engineering design phase, the estimate for the DOE TPC at CD-2 is $14.8 million. The DOE funding profile at CD-2 is shown in Table 6-4. (See Appendix B for NASA information.)

Table 6-4 EBIS Project Funding Profile

Fiscal Year	CD- 2 Budget Authority Profile (M$)
2005	0.7
2006	2.1
2007	7.5
2008	4.5
2009	0.0
Totals	14.8

The DOE TPC is allocated as follows:

Category	Cost (M$)
CDR	0.2
R&D	0.6
PED/EDIA	2.1
Construction	11.7
Pre-ops	0.2
DOE TEC	**13.8**
DOE TPC	**14.8**

6.2.2 Contingency

The FPD manages the contingency funds according to the DOE Order 413.3 procedure defined in the Baseline Change Control section and as specified in the Change Control table in Table 7-1. Table 6-5 shows the estimated average contingency rate by subsystem, utilized to develop the overall project contingency.

Table 6-5 Average Contingency on DOE Scope

WBS	Title	Average Contingency %
1.1	Structural components	17.5
1.2	Controls Systems	16.5
1.3	Diagnostics	15.8
1.4	Magnet Systems	23.3
1.5	Power Supply Systems	25.7
1.6	RF Systems	14.6
1.7	Vacuum systems	13.5
1.8	Cooling Systems	20.0
1.9	Facility Modifications	25.2
1.10	Installation	20.5
1.11	Project Services	20.0
1.12	Commissioning	20.0
1.13	R&D / CDR	14.3
	Project total	18.0

The contingency percentages were derived by evaluating every task for cost, technical, schedule and design risks, and applying a weighting factor. The contingency rates are determined by considering the development status of the items, and the uncertainties plus risks in completing the construction and testing. The guidelines used to establish the contingency percentages are listed in Table 6-6.

Table 6-6 Contingency risk and weighting factors

TECHNICAL, COST, SCHEDULE and DESIGN RISK FACTORS

Risk Factor	Technical	Cost	Schedule	Design
0	Not used	Not used	Not used	Detail design > 50% done
1	Existing design and off the shelf H/W	Off the shelf or catalog item	Not used	Not used
2	Minor modifications to an existing design.	Vendor quote from established drawings.	No schedule impact on any other item	Not used
3	Extensive modifications to an existing design	Vendor quote with some design sketches	Not used	Not used
4	New design; nothing exotic	In-house estimate based on previous similar experience	Delays completion of non-critical subsystem item	Preliminary design >50% done; some analysis done
6	New design; different from established designs or existing technology	In-house estimate for item with minimal experience but related to existing capabilities	Not used	Not used
8	New design; requires some R&D but does not advance the state-of-the-art	In-house estimate for item with minimal experience and minimal in-house capability	Delays completion of critical path subsystem item	Conceptual design phase; some drawings; many sketches
10	New design of new technology; advances state-of-the-art	Top-down estimate from analogous programs	Not used	Not used
15	New design; well beyond current state-of-the-art	Engineering judgment	Not used	Concept only

TECHNICAL, COST, SCHEDULE and DESIGN WEIGHTING FACTORS

	Condition	Weighting Factor
Technical	Design OR Manufacturing	2
	Design AND Manufacturing	4
Cost	Material Cost OR Labor Rate	1
	Material Cost AND Labor Rate	2
Schedule	Same for all	1
Design	Same for all	1

6.2.3 Research and Development (R&D)

The primary purpose of the R&D is to test the ion beam extraction, acceleration, and transport line focusing system presently being considered for matching the EBIS beam into the RFQ. R&D efforts include the implementation of a test stand that will be used to test the RHIC EBIS electron collector design for thermal load handling. Finally, the test stand is be able to provide a beam at the required input energy for initial testing of the final RFQ at BNL prior to installation in the final location. These developments will serve to reduce technical and schedule risks on the project. The R&D includes the procurement of the full power electron collector, which will later be used on the RHIC EBIS. Procurement of a 100 kV isolation transformer, high voltage isolation, and some EBIS power supply modifications will allow the EBIS to be operated from a high voltage platform, producing beams at the final energy required for injection into the RFQ. Finally, a prototype of the final LEBT design will be built and tested. Completion of the R&D is scheduled for Q1 FY07.

7 CHANGE CONTROL

Changes to the technical, cost and schedule baselines will be controlled using the thresholds described in Table 7-1.

All changes that include or exceed Level 3 approval thresholds (as defined in Table 7-1) should first be submitted to the CPM using a Project Change Request (PCR). For changes exceeding Level 3, the CPM will endorse the request (i.e., recommend approval) to higher authority or reject the request. If endorsed, the CPM will then transmit the PCR to the FPD with recommendations. If the request exceeds Level 2, the BHSO Baseline Change Control Board (BCCB) will submit the PCR to the FPD in DOE Headquarters for approval. All Level 2 PCRs will be reviewed and approved by the BHSO BCCB and all Level 3 PCRs will be reviewed and approved by the CPM.

The BHSO BCCB will consist of the EBIS FPD (chair), the BHSO Director, the Associate Director for HENP at BNL (or designee), the Chairman of the Collider-Accelerator Department, the CPM, and others as directed by the FPD. Technical advisors will be included as needed in the BHSO BCCB. The chair has the final responsibility to endorse the PCR. For Level 3 changes and requests for higher-level changes the CPM will consult with the Project Engineer.

If the change is approved, the copy of the approved PCR, together with any qualifications or further analysis or documentation generated in considering the request is returned to the requestor, and copies are sent to the official at the next higher control level and to EBIS for filing. If approval is denied, a copy of the PCR, together with the reasons for denial, is returned to the requestor, and a copy is filed. The official at the next higher control level may review the granted change to ensure proper application of the procedure and consistency of the change with the goals and boundary conditions of the project.

Table 7-1. Summary of Baseline Change Control Thresholds

Change Level	Cost (Table 6-3)	Schedule (Figure 6.1)	Technical Scope (Table 4-1)
DOE-SAE	> 25% cumulative increase to TPC	6 or more months increase (cumulative) to project completion date	Any change affecting conformance to mission need requirement
DOE-SC-26 Program (Level 1)	Any increase in the TPC or cumulative allocation of more than $500k contingency	3-month or more delay of a Level 0 or 1 milestone date	Any change in CD-4 deliverable that affects mission need requirement
DOE-BHSO Federal Project Director (Level 2)	A cumulative increase of more than $250k in WBS Level 2 or cumulative allocation of more than $250k contingency	> 1-month delay of a Level 0 or 1 milestone date or > 3-month delay of a Level 2 milestone date	Any deviation from technical deliverables that does not affect expected performance specifications
EBIS Contractor Project Manager (Level 3)	Any increase of >$50k in the WBS Level 2	> 1-month delay of a Level 2 milestone date or any change greater than 3 months to a level 3 milestone	Any significant change in the System Requirements document.

8 ANALYSES, ASSESSMENTS AND PLANS

8.1 ENVIRONMENT, SAFETY AND HEALTH

8.1.1 Purpose of the ESSH Chapter

The purpose of this chapter is to briefly describe the rigorous environmental protection, safety, security, health and quality (ESSH) activities associated with the EBIS Project that will be completed prior to commencement of construction, commissioning and operations.

8.1.2 Review of ESSH Issues Associated with the EBIS Design

The shielding policy for this facility is the same as that for the rest of the Collider-Accelerator facilities since the new pre-injector and beam line are to be the responsibility of the Department. Specifically, the Collider-Accelerator Department's Radiation Safety Committee will review facility-shielding configurations to assure that the shielding has been designed to:

- Prevent contamination of the ground water.
- Limit annual site-boundary dose equivalent to less than 5 mrem.
- Limit annual on-site dose equivalent to inadvertently exposed people in non-Collider-Accelerator Department facilities to less than 25 mrem.
- Limit dose equivalent to any area where access is not controlled to less than 20 mrem during a fault event.
- Limit the dose equivalent rate to radiation-workers in continuously occupied locations to ALARA but in no case would it be greater than 0.5 mrem in one hour or 20 mrem in one week.
- Limit the annual dose equivalent to radiation workers where occupancy is not continuous to ALARA, but in no case would it exceed 1000 mrem.

In addition to review and approval by the Radiation Safety Committee, the Radiation Safety Committee Chair or the ESHQ Associate Chair must approve final shield drawings. Shield drawings are verified by comparing the drawing to the actual configuration. Radiation surveys and fault studies are conducted after the shield has been constructed in order to verify the adequacy of the shield configuration. The fault study methodology that is used to verify the adequacy of shielding is described and controlled by Collider-Accelerator Department procedures.

The DOE ESHQ requirements applicable to the new pre-injector are listed in Table 8-1. All hazards, including radiological hazards, associated with DOE accelerator facilities are addressed comprehensively in DOE Order 420.2A, Safety of Accelerator Facilities. Appropriate and adequate protection of workers, the public, and the environment from ionizing radiation is also covered under 10CFR1035, "Occupational Radiation Protection," which applies to all DOE facilities regardless of the source and type of ionizing radiation. The C-A Department implements the DOE requirements indicated in Table 8-1 using procedures and training. At the BNL level, the Standards Based Management System (SBMS) is used to keep DOE requirements current and to flow requirements down to the Department level. At the C-A Department level, SBMS requirements are flowed down into routine operations procedures. All ESHQ requirements and hazard controls are documented in detail in the C-A Operational Procedures (OPM).

In order to meet the requirements in DOE Order 420.2A, Safety of Accelerator Facilities, C-AD has incorporated a description and safety assessment of the new pre-injector into the current <u>Safety Assessment Document for C-AD</u>. At the appropriate time, the C-A Department will obtain an approved Accelerator Safety Envelope for the new pre-injector from DOE and perform an Accelerator Readiness Review in accord with Order 420.2A prior to commissioning and operations.

Table 8-1 Current DOE ESHQ Requirements for BNL Accelerators

Topic	DOE Requirements Document
Authorization Basis Documents	DOE O 420.2B, Safety of Accelerator Facilities DOE O 420.1A, Facility Safety (Natural Phenomenon and Fire Protection Sections)
Conduct of Operations	DOE O 54100.19 Chg 2, Conduct of Operations Requirements for DOE Facilities
Quality Assurance	DOE O 414.1B, Quality Assurance
Maintenance Management	DOE O 430.1B, Real Property Asset Management DOE O 430.2A, Departmental Energy And Utilities Management
Training and Qualification Programs	DOE O 54100.20A Chg 1, Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities
Radiation Protection	Title 10, Code of Federal Regulations, Part 1035, Occupational Radiation Protection
Transportation and Packaging	DOE O 460.2 Chg 1, Departmental Materials Transportation and Packaging Management DOE O 460.1B, Packaging and Transportation Safety
Worker Protection	DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees
Environmental Protection	DOE O 450.1, Environmental Protection Program DOE O 451.1B Chg 1, National Environmental Policy Act Compliance Program - Change 1
ESH Reporting	DOE O 231.1A, Environment, Safety, and Health Reporting
ESH Standards	DOE O 54100.4 Chg 4, Environmental Protection, Safety, and Health Protection Standards
Accident Investigation	DOE O 225.1A, Accident Investigations
Radioactive Waste Management	DOE O 435.1 Chg 1, Radioactive Waste Management

The C-A Department conforms to the requirements of ISO 14001, Environmental Management System, and OHSAS 18001, Occupational Safety and Health Management System, and achieves third-party registration for these internationally recognized management systems. Thus, in addition to DOE requirements, documentation of environmental protection and occupational safety and health programs for new pre-injector facilities will be prepared and audited by independent parties. This documentation will include:

- Environmental Process Evaluations for all processes with significant environmental aspects.
- Facility Risk Assessments for all facilities and areas.
- Job Risk Assessments for all jobs.

DOE O 420.1A, Facility Safety, has two sections that are applicable to accelerator facilities: Natural Phenomenon and Fire Protection Sections. DOE STD-1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities, describes the Performance Criteria (PC) to be used for evaluating building design for earthquake, wind and flood phenomena. DOE-STD-1020-2002 employs the graded approach in assigning PC categories to DOE buildings. The graded approach enables cost-benefit studies to be used to address categorization. It is noted that the radioactivity entrained within the new pre-injector components would not have a significant off-site impact as a result of an earthquake, high winds or flood. Based on the small amounts of hazardous materials that will be present at the new pre-injector facilities, the PC1 category is applicable. That is, BNL will use model building codes for the new pre-injector facilities that include earthquake, wind, and flood considerations. BNL is currently using PC1 for all other C-AD facilities for life safety issues.

Significant environmental aspects of the new pre-injector project include:

- Excavation
- Chemical Storage/Use
- Liquid Effluent
- Hazardous Waste
- Radioactive Waste
- Radiation Exposures
- New or Modified Federal/State Permits

Based on the disposition of cooling tower discharge, the existing New York State Pollutant Discharge Elimination System (SPDES) permit would be revised as necessary. The cooling system would be a closed loop deionized water system using ion exchange beds that would be removed for regeneration or disposal by a contractor off site. In no case would the ion beam strike the water directly. At the proposed beam current and ion-beam energy, no induced activity would be expected. Discharge of contaminants to the ground or to the sanitary system would be neither planned nor expected from the cooling system. The closed loop cooling system would be connected to the cooling tower via a heat exchanger. Cooling-tower water would be treated either with ozone or with biocides and rust inhibitors, and would meet all SPDES effluent limits.

8.1.3 ESSH Plans for Construction

All requests for goods or services will be processed through a formal and well-documented system of review to incorporate any special ESSH requirements of the contractor or vendor. BNL will review the proposed contract scope of work using <u>Work Planning and Control for Experiments and Operations</u> Subject Area. The building modification and utility drawings for the new pre-injector will be sent to the BNL's Safety and Health Services Division for review by the appropriate Environment, Safety and Health (ES&H) disciplines.

C-AD will define the scope of work with sufficient detail to provide reviewers and support personnel with a clear understanding of what is needed, expected, and required. This will include the type of work to be performed, location of work, defined contract limits, allowed access routes, and any sensitive or vulnerable laboratory operations or infrastructure that may be impacted by this work. The C-AD will ensure that facility hazards are characterized and inventoried specific to the expected construction location and activities.

The C-AD will ensure that minimum ESSH competency requirements for contractors are detailed and provided to the Procurement & Property Management Division (PPM). PPM will include those requirements in the bid and contract documents to qualify contractors for award. Competency requirements will be consistent with the project, facility and job to be performed.

8.1.4 ESSH Plans for Commissioning, Operations and Decommissioning

The Collider-Accelerator Department has already identified hazards and associated on-site and off-site impacts to the workers, the public and the environment from the C-AD accelerator facilities, including the new EBIS based pre-injector, for both normal operations and credible accidents. Sufficient detail was provided to DOE in the current C-AD Safety Assessment Document (SAD) to ensure that C-AD has performed a comprehensive hazard and risk analysis. The amount of descriptive material and analysis in the SAD related to both the complexity of the facility and the nature and magnitude of the hazards. In addition, the SAD provides an understanding of radiation risks to the workers, the public and the environment.

The risk analysis in the SAD addresses the hazards of the entire system of pre-injectors and accelerators. It also addresses hazards, controls and risks for all facilities such as pre-injectors, injectors, accelerators, experimental halls, experiments and their associated targets and detectors. The C-AD SAD follows the generally accepted principles identified in DOE Order 420.2B.

8.2 PROJECT QUALITY ASSURANCE PROGRAM

8.2.1 Program

The project, through the Collider-Accelerator (C-A) Department, shall adopt in its entirety the BNL Quality Assurance (QA) Program. This QA Program describes how the various BNL management system processes and functions provide a management approach which conforms to the basic requirements defined in DOE Order 414.1B, Quality Assurance.

The quality program embodies the concept of the "graded approach" i.e., the selection and application of appropriate technical and administrative controls to work activities, equipment and items commensurate with the associated environment, safety and health risks and programmatic impact. The graded approach does not allow internal or external requirements to be ignored or waived, but does allow the degree of controls, verification, and documentation to be varied in meeting requirements based on environment, safety and health risks and programmatic issues.

The BNL QA Program shall be implemented within the Project using C-A QA implementing procedures. These procedures supplement the BNL Standards Based Management System (SBMS) documents for those QA processes that are unique to the C-A Department. C-A QA procedures are developed by C-A QA and maintained in the C-A Operations Procedures Manual, Chapter 13.

The C-A QA philosophy of adopting the BNL Quality Program and developing departmental procedures for the implementation of quality processes within C-A ensures that complying with requirements will be an integral part of the design, procurement, fabrication, construction and operational phases of the Electron Beam Ion Source Project.

A Quality Representative has been assigned to serve as a focal point to assist C-A management in implementing QA program requirements. The Quality Representative has the authority, unlimited access, both organizational and facility, as personnel safety and training allows, and the organizational freedom to: assist line managers in identifying potential and actual problems that could degrade the quality of a process/item or work performance, recommend corrective actions, and verify implementation of approved solutions. All C-A personnel have access to the Quality Representative for consultation and guidance in matters related to quality.

8.2.2 Personnel Training And Qualifications

The BNL Training and Qualification Management System within the Standards Based Management System (SBMS) supports C-A management's efforts to ensure that personnel working on EBIS are trained and qualified to carry out their assigned responsibilities. The BNL Training and Qualification Management System is implemented within the C-A Department with the C-A Training and Qualification Plan of Agreement.[1]

8.2.3 Documents and Records

The BNL Records Management System and controlled document Subject Areas within SBMS, supplemented by C-A procedures, provide the requirements and guidance for the development, review, approval, control and maintenance of documents and records.

C-A documents encompass technical information or instructions that address important work tasks, and describe complex or hazardous operations. They include plans, and procedures, instructions, drawings, specifications, standards and reports.

[1] http://www.agshome.bnl.gov/AGS/Accel/SND/Training/trainplan.pdf C-A Department Training and Qualifications Plan

8.2.4 Work Process

Work is performed employing processes deployed through the BNL SBMS. SBMS Subject Areas are used to implement BNL-wide practices for work performed. Subject Areas are developed in a manner that provides sufficient operating instructions for most activities. However, C-A management has determined that it is appropriate to develop internal procedures to supplement the SBMS Subject Areas. These C-A procedures are bounded by the requirements established by the BNL Subject Areas.

Group leaders and technical supervisors are responsible for ensuring that employees under their supervision have appropriate job knowledge, skills, equipment and resources necessary to accomplish their tasks. Where applicable, contractors and vendors are held to the same practices.

8.2.5 Design

Design planning shall establish the milestones at which design criteria, standards, specifications, drawings and other design documents will be prepared, reviewed, approved and released. The design criteria shall define the performance objectives, operating conditions, and requirements for safety, reliability, maintainability and availability, as well as the requirements for materials, fabrication, construction, and testing. Appropriate codes, standards and practices for materials, fabrication, construction, testing, and processes shall be defined in the design documentation. Where feasible, nationally recognized codes, standards and practices shall be used. When those are either overly restrictive, or fall short of defining the requirements, they shall be modified, supplemented, or replaced by BNL specifications.

Specifications, drawings and other design documents present verifiable engineering delineations in pictorial and/or descriptive language representations of parts, components or assemblies for EBIS. These documents shall be prepared, reviewed, approved and released in accordance with C-A procedures. Changes to these documents shall be processed in accordance with the C-A configuration management program.

8.2.6 Procurement

Personnel responsible for the design or performance of items or services to be purchased shall ensure that the procurement requirements of the purchase request are clear and complete. Using the graded approach, potential suppliers of critical, complex, or costly items or services shall be evaluated in accordance with predetermined criteria to ascertain that they have the capability to provide items or services which conform with the technical and quality requirements of the procurement. The evaluation shall include a review of the supplier's history with BNL or other DOE facilities, or a pre-award survey of the supplier's facility. C-A personnel shall ensure that the goods or services provided by the suppliers are acceptable for intended use.

8.2.7 Inspection and Acceptance Testing

The BNL Quality Management System within the SBMS, supplemented by C-A procedures, provides processes for the inspection and acceptance testing of an item, service or process against established criteria and provides a means of determining acceptability. Based on the graded approach, the need and/or degree of inspection and acceptance testing shall be determined during the activity/item design stage. Inspection/test planning has as an objective the prompt detection of nonconformances that could adversely affect performance, safety, reliability, schedule or cost.

8.3 RISK ASSESSMENT

Risk of not proceeding with the EBIS project:

If the new Linac-based pre-injector is not built, significant upgrades to the tandems will be required in order to ensure reliable long-term operation for RHIC. This has been discussed in Section 4.6.

Technical, Cost and Schedule Risks:

The technical risks of the EBIS design are low. The successful EBIS ion source R&D program at BNL has greatly decreased any risk related to a source of this type reaching the planned performance requirements. A prototype EBIS has operated with the full required electron beam current of 10 A, which is a factor of 20 improvement over previous EBIS sources. Since EBIS scaling laws are very well understood, the scaling of the source output by a factor of 2 from the prototype is achieved by a straightforward doubling of the EBIS trap length, that is, by doubling the length of the superconducting solenoid. The development described in Section 6.2.3 helps minimize technical and schedule risk related to the LEBT design.

The RFQ and the Linac accelerators are both mature technologies, with very similar devices operating successfully at BNL as well as at other accelerator laboratories. The present plan is to procure these devices from laboratories where several similar units have been built previously. Therefore, technical risk on these devices is low. There is a perceived higher than normal schedule risk on these devices, however, because it is likely that these items will procured either from, or with the assistance of, University laboratories in Europe. There is a risk of schedule delays due to potential conflicts with other commitments that may arise at these laboratories. This risk will be minimized by early procurement of both the RFQ and linac, and frequent communication with these collaborators.

Currency exchange risk – it is probable that the EBIS project will include foreign procurements. Due to the cost risk associated with an unfavorable dollar vs. Euro exchange rate change, an average contingency rate of 35% has been applied to several key items. In addition, risk will be reduced by placing early procurements of some of these key items.

Uncertainties in the Booster operation schedule (for RHIC or NSRL) may impact the EBIS project schedule. This risk will be minimized by careful management of the project, since the majority of work can proceed in parallel with Booster operations. The HEBT dipoles, which can only be installed during a Booster shutdown, will be procured early to allow large schedule float. The beam port through the shielding wall between the linac and Booster is planned for early installation during summer of 2006, in order to minimize schedule risk, since this must also be done during a Booster shutdown period.

Delays in project funding due to a Congressional Continuing Resolution could delay the placement of several key long-lead procurements. This is perceived to be a high risk, so BNL will work closely with DOE and NASA to insure that adequate funds are available for key procurements, and there will be an attempt to avoid scheduling large procurements for the first quarter of a fiscal year.

9 PROJECT CONTROLS AND REPORTING SYSTEMS

The EBIS project has been entered into the Project Assessment and Reporting System (PARS) and is updated on a monthly basis by the FPD.

The CPM leads monthly cost and schedule reviews and reports the result to the FPD. In addition, he leads quarterly overall cost, schedule and technical performance reviews and reports the results to the BHSO-DOE office. The FPD reports progress to the DOE Program Manager on a quarterly basis. The FPD and CPM participate in monthly teleconference calls with the DOE Office of Nuclear Physics. The Office of Nuclear Physics conducts annual progress reviews with a panel of experts.

The standard BNL accounting system is the basis for collecting cost data, and the Control Account structure for EBIS separates costs according to funding source (DOE or NASA), funded phase (R&D, PED, Construction, Pre-Ops), and WBS. A direct one-to-one relationship has been established between each WBS element of Level 2 or lower and a separate control account in the BNL accounting system.

Technical performance is monitored throughout the project to insure conformance to approved functional requirements. Design reviews and performance testing of the completed systems are used to ensure that the equipment meets the functional requirements.

APPENDIX A: WBS DICTIONARY

This dictionary gives a succinct definition of some of the most important tasks included in the WBS and describes both DOE and NASA activities.

1.1 Structural Components

1.1.1 EBIS Hardware

The mechanical components which comprise the EBIS source.

1.1.1.1 SC Solenoid

The superconducting solenoid is a major element of EBIS and its function is to focus the electron beam generated in the electron gun and maintain its diameter in a region of the ion trap. No shielding is planned for the solenoid in order to enable use of its magnet field "tails" for the electron beam transmission in areas where use of other coils is difficult. The required magnetic field in the center of solenoid is determined by the combination of parameters (cathode emission current density, ion confinement time, tolerated level of impurities, ability of the electron collector to dissipate certain power). The solenoid is located on the EBIS platform and should require minimum maintenance for refilling of cryogens. (A portion of this WBS is funded by NASA)

1.1.1.2 Electron Gun

The EBIS electron gun generates the electron beam used for the ionization and confinement of ions in a trap. Since the electron beam propagates through the areas with very low potentials and with different magnetic fields the requirements on the laminarity of the electron beam are high. For this reason the magnetic field on the cathode is high enough to determine formation of the electron beam in a cathode-anode gap. The cathode material (IrCe) provides high emission current density with a lifetime of several thousand hours. The electron gun chamber is separated from the rest of the EBIS by two gate valves, which in a case of gun failure allows replacement of whole gun unit by a new one without venting the gun chamber and venting only small buffer volume between gate valves.

1.1.1.3 Drift Tube & Chamber Structures

Drift tubes are installed along the EBIS axis to control ion trap operation and propagation of the electron beam. Drift tubes are electrically isolated from the ground and connected to the external power supplies via electrical feedthroughs in a vacuum jacket. Vacuum chambers form a vacuum envelope around the EBIS with the pressure of residual gas in the range of $1x10^{-10}$ Torr. Three gate valves separate different parts of the EBIS for the purpose of maintaining high vacuum in parts that are not vented during modification or repair.

1.1.1.4 Stands, Platform Hardware

This includes the mechanical support structures for the EBIS, the electron gun, the LEBT line, and the external ion sources. It also include the 100 kV insulating platform for the EBIS source and its associated power supplies, as well as the electrical system required to put a ramp on the EBIS trap electrodes for fast ion extraction.

1.1.2 LEBT and External Ion Injection

The beamlines between the EBIS output and RFQ input.

1.1.2.1 LEBT

The LEBT is a transitional portion of the pre-injector and is used for:

- transmission and forming for the injection into RFQ of the ion beam extracted from the EBIS,
- transmission of the ion beam from the external ion injector into the EBIS,
- diagnostic measurements of the ion beams (total ion current measurements, ion beam content measurements),
- vacuum pumping of the electron collector.

The LEBT consists of two vacuum chambers separated by a gate valve; it contains optical electrostatic elements (deflectors, lenses), magnetic lenses for focusing the ion beam into the RFQ and diagnostic elements.

1.1.2.2 External Ion Injection

A set of two or more ion sources generating low charge state ions for injection into EBIS. This also includes ion optics, a switching station for electronically selecting the desired ion species for ion injection, ion current monitors, vacuum system and power supplies.

1.1.3 RF Structures

Resonant cavities used to accelerate or decelerate (for bunching) the ion beam. When radiofrequency power is fed into these resonant cavities, the appropriate electric fields for acceleration or deceleration are produced.

1.1.3.1 RFQ

The Radio Frequency Quadrupole (RFQ) is a resonant structure in which four long, continuous vanes or rods, machined with precise modulations and configured in a quadrupole geometry, provide bunching, focusing, and acceleration of the injected ion beam. This type of structure is able to provide efficient rf acceleration at the low energies ion beams have when initially extracted from an ion source. A 4-rod RFQ operating at 100.625 MHz is planned. (A portion of this WBS element is funded by NASA)

1.1.3.2 Linac

The Linac is a resonant structure, which generates time dependent axial electric fields to accelerate ions. When the rf field direction is reversed, the ion bunches are shielded from the decelerating fields by internal drift tubes. An "Interdigital-H" - type Linac operating at 100.625 MHz is planned. (A portion of this WBS element is funded by NASA)

1.1.3.3 Buncher Cavities

A resonant cavity in which the time dependent field in a gap is adjusted to decelerate the front of a beam bunch arriving at the gap, and accelerate the back of the bunch, so that all particles in the bunch arrive at a downstream point more closely spaced in time. By changing the phase of the cavity by 180 degrees relative to the bunch, it can be used to remove energy spread in the beam ("debuncher") instead. (A portion of this WBS element is funded by NASA)

1.2 Controls

Networked, front-end interfaces will be connected via Ethernet to control console workstations and central C-AD servers. Full pulse-to-pulse modulation functionality will be provided. Custom application software will be provided as needed, but extensive re-use will be made of existing software designs with EBIS database additions.

1.2.1 Timing & Infrastructure

C-AD fiber optic infrastructure will be extended to the EBIS equipment area and a standard network switch and timing chassis will be provided. Workstations and monitor screens will be provided for console-level control access, along with supporting software and database configuration.

1.2.2 EBIS

Waveform generation and data acquisition for EBIS will be provided using the fiber-optically isolated PSI interface and VME function generator. The fiber link interface of these standard C-AD modules will be modified to operate at 50 to 100 kHz for this application. Additional fiber optic links will carry pulsed trigger signals to the high voltage platforms. Standard VME chassis will be provided. Minor modifications will be required to existing front-end software for the function generator. A custom console application program will be developed for power supply waveform control.

1.2.3 Accelerators & Beam Transport

Commercial and C-AD standard VME modules will be used to control magnet power supplies and beam-line instrumentation. Standard VME chassis assembly and timing modules will be provided for these systems and also for RF system interfaces. Front-end software effort will be mainly configuration and database setup. Existing console programs for beam line diagnostics will be modified to include the EBIS transport lines.

1.3 Diagnostics/Instrumentation

1.3.1 Faraday Cup

A fully destructive measurement is made when a detector head is plunged into the beam path to collect the entire ion beam. The captured charge is measured as a current in the processing electronics. Several types of detector heads can be employed depending on the characteristics of the desired measurement. Channeltrons or multichannel plates are used for fast high bandwidth response.

1.3.2 Current Transformers

A ferrite toroid wound with many turns of signal wire is positioned around a ceramic break in the beam transport, all enclosed in a protective shroud. This is used as a non-destructive technique to measure the ion beam current characteristics with respect to time. A separate set of wire turns on the toroid is used for injecting a calibration signal.

1.3.3 Profile Monitors

Transverse beam profiles are measured by plunging an array of thin wires into the beam path. Each of the wires collects the charge from the small portion of the ion beam it intercepts; this charge is detected as a current in the processing electronics.

1.4 Magnet Systems

1.4.1 EBIS Warm Solenoids

The EBIS warm solenoids consist of three solenoid magnets. The electron gun solenoid is designed with water-cooled hollow conductors, pancake-style coils and no iron return. The electron gun coil provides the necessary field for proper electron beam launching and transport. The electron collector solenoid is similar in design to the electron gun solenoid. The electron collector solenoid focuses the beam to allow for proper electron collector operation. The remaining magnet, the LEBT solenoid, is a pulsed solenoid located directly in front of the RFQ. The LEBT solenoid focuses the EBIS beam into the RFQ. The design of the LEBT solenoid uses pancake coils with a laminated iron return similar in design to the BNL Optically Pumped Polarized Ion Source (OPPIS) LEBT solenoid.

1.4.2 MEBT Quadrupoles

The EBIS MEBT quadrupole magnets are used to provide the necessary focusing for beam transport between the RFQ output and the Linac input.

1.4.3 HEBT Dipoles

The HEBT dipoles are two similar 73° bending dipoles. The basic design of the dipoles is a C style with the open end facing the outer curve to allow the chamber to have a port for the Tandem-to-Booster (TTB) line into the Booster. The magnets will be constructed of laminations of different sizes which when assembled will produce the required bend shape. The magnet coils will be made of water-cooled hollow copper conductor. (A portion of this WBS element is funded by NASA)

1.4.4 HEBT Quadrupole Magnets

The HEBT quadrupoles will be air-cooled Danfysik magnets. Originally used for other projects at BNL, these magnets are available for the EBIS beam line. These magnets will allow switching of values in ~ 1 second for running of different magnetic rigidity beams.

1.5 Power Supply Systems

1.5.1 EBIS

Power supplies to support EBIS itself:

- Solenoid, cathode, cathode heater, collector and grid supplies.
- Platform bias supplies and the transformers to isolate them.
- Drift tube supplies, Behlke switches, and transverse magnetic supplies.
  (A portion of this WBS element is funded by NASA)

1.5.2 External Ion Injectors and LEBT

Power supplies to support two external ion sources, the transport from the ion sources to the LEBT, and the LEBT itself:

- Heater, arc pulser and extractor power grid supplies.
- Platform bias supplies and the transformers to isolate them.
- Supplies for electrostatic and electromagnetic steering elements and lenses.
- Mass analyzer and focusing solenoid power supplies.

1.5.3 MEBT, IH LINAC, and HEBT

Power supplies for the MEBT, IH LINAC, and HEBT:

- Pulsed quadrupole magnets and steering magnet power supplies.
- Linac drift tube quadrupole magnet power supplies.

- Pulsed bending magnet power supplies.
(A portion of this WBS element is funded by NASA)

1.6 RF Systems

1.6.1 High Level RF

The final rf amplifier stages powering the RFQ, Linac, and three bunchers. This also includes the coaxial transmission line connecting the amplifier outputs to the rf cavities.

1.6.2 Low Level RF

The low power rf systems which provide the phase and amplitude controls for the high level rf systems, and frequency control for the resonant cavities.

1.7 Vacuum Systems

1.7.1 Beampipes/Chambers

Pipes or chambers that have vacuum pressure inside and provide a path for the ion to be transported, as well as provide a housing for special components inside the vacuum system.

1.7.2 Vacuum Instrumentation & Control

A PLC-based control system used to monitor and control the vacuum system and components such as gauges, pumps and valves.

1.7.3 Vacuum Pumps

Pumps used to evacuate or pump down a vacuum chamber from atmospheric pressure to the desired high vacuum or ultra-high vacuum range.

1.7.4 Vacuum Valves

Manual or pneumatically operated valves used to isolate vacuum pumps and/or a section of the beam line from another section or vacuum chamber.

1.8 Cooling Systems

The cooling system will use the excess capacity of the NSRL deionized water system to supply 325 gpm to the preinjector facility equipment. A high pressure flow loop will branch from this supply, consisting of a boost pump and heat exchanger, for two high pressure applications: the electron collector and the Linac quadrupoles. The present Linac chilled water system, which dissipates heat into the existing Linac cooling tower, will be extended for the air conditioning in the new building addition. Low flow chillers for tight temperature range control and special water conditioning will be used for the RF equipment, as necessary. The active on-line deionized water controls will maintain the required resistivity. The RF Linac chilled water loop will have a 4109 iron corrosion inhibitor control system.

1.9 Facility Modifications

1.9.1 Beam Access Port

A new access port for the EBIS beam line will be installed through the earth shielding from Linac to the Booster. (A portion of this WBS is funded by NASA)

1.9.2 Power modification

Provides for the relocation of existing power & tray in the Linac area where the EBIS beam line will be installed.

1.10 Installation

The major systems and components of the EBIS are installed at the facility site in building 930, including structural components, control systems, diagnostic and instrumentation systems, magnets, power supplies, RF systems, vacuum systems, and cooling systems. The installation effort also includes any minor additions or changes to the building and facility necessary to accommodate these systems and components.

1.10.1 Structural Components

The major structural components installed in the facility include the Electron Beam Ion Source (EBIS), RFQ, and Linac. Other components will include smaller devices located in the LEBT, MEBT, and HEBT beam transport regions, such as auxiliary ion sources (LEBT), bunchers, electrostatic beam transport devices, and beam monitoring devices.

1.10.2 Controls

Installation of controls for the entire project.

1.10.3 Diagnostics/Instrumentation

Installation and checkout of all diagnostics in the beamlines.

1.10.4 Magnet Systems

The magnet systems installed in the beam transport line include dipole, quadrupole, and solenoidal magnets, and steerers. Also includes survey of elements.

1.10.5 Power supply Systems

Installation of all power supplies in their final locations, the connection of power from breaker boxes to the supplies, and the connections from the power supplies to the elements.

1.10.6 RF Systems

Installation of the rf power supplies, as well as the connection of the coaxial transmission line between the rf amplifiers and the rf cavities.

1.10.7 Vacuum Systems

Installation of beampipes, chambers, pumps, and valves. Also includes the leak checking and bakeout of systems.

1.10.8 Cooling Systems

Installation of all cooling systems.

1.11 Project Services

Level of effort tasks associated with the daily management, oversight, and assessment of the project.

1.11.1 Project Management & Support

This WBS contains the effort associated with the Project Office at BNL for the EBIS. The effort includes: the CPM, Project Controls, ESH&Q, installation and conventional facilities coordination, financial oversight, documentation and reporting, and the Project Office secretary.

1.12 Commissioning

System integration with beam. This includes beam tuning and characterization from the EBIS, through the LEBT, RFQ, MEBT, Linac, and HEBT. Activities will include the measurements of beam currents, profiles, emittances, verification of beam energy and energy spread, and measurement of charge state distributions for several ion species. Commissioning ends when the performance required for CD4 has been demonstrated.

1.13 R&D

A development program which uses the existing Test EBIS to verify the validity of several key design choices related to the extraction, acceleration, and initial transport of the ion beam from the EBIS. The R&D also includes testing the EBIS electron collector design for thermal load handling. These developments will serve to reduce technical and schedule risks on the project. The R&D includes the procurement of the full power electron collector, which will later be used on the RHIC EBIS. Procurement of a 100 kV isolation transformer, high voltage isolation, and some EBIS power supply modifications will allow the EBIS to be operated from a high voltage platform, producing beams at the final energy required for injection into the RFQ. Finally, a prototype of the final LEBT design will be built and tested. (A portion of this WBS element is funded by NASA)

APPENDIX B: NASA ITEMS

Per the Statement of Work between BNL and NASA, NASA will contribute $4.5M (AY $) to the project costs. These funds allow the schedule to be accelerated to approximately four years. Within the overall EBIS project, items have been identified for acquisition with these funds. The NASA scope includes the Radio Frequency Quadrupole, the Linac and bunchers, the EBIS superconducting solenoid, the HEBT dipole magnets, a beam access port, and various power supplies. A detailed list follows the funding tables.

NASA Funding: the planned levels of funding per fiscal year are as follows:

Fiscal Year	Funding profile (M$)
2005	0.5
2006	1.5
2007	1.5
2008	1.0
Totals	4.5

Application of NASA funds:

WBS	Title	M$
1.1	Structural components	1.6
1.2	Controls Systems	0.0
1.3	Diagnostics	0.0
1.4	Magnet Systems	0.3
1.5	Power Supply Systems	1.0
1.6	RF Systems	0.0
1.7	Vacuum systems	0.0
1.8	Cooling Systems	0.0
1.9	Facility Modifications	0.1
1.10	Installation	0.0
1.11	Project Services	0.0
1.12	Commissioning	0.0
1.13	R&D / CDR	0.5
subtotal		3.5
	Contingency	1.0
Total		4.5

	Planned use of NASA funds	
1.1	**Structural Components**	
	1.1.1.1	SC Solenoid
		Procure solenoid & ps
		Procurement and Vendor interface and inspection
		Vendor site inspection (2)
		Incoming inspection
		Onsite installation service
	1.1.3.1	RFQ
		Procurement
		Travel to vendor
		Shipping
		Incoming inspection
	1.1.3.2	Linac
		Procurement
		Travel to vendor
		Shipping
		Incoming inspection
	1.1.3.3	Bunchers
		Procurement
		Shipping
		Incoming inspection
1.4	**Magnet Systems**	
	1.4.3	HEBT dipoles
		Procurements
		Laminations
		Coils
		Magnet stands
		Jacks
		Bus terminations
		Water manifolds
		Vendor visits (2)
		Procurement/Vendor interface and inspection
		Incoming inspection
1.5	**Power Supplies**	
	1.5.1.2	Alternate anode PS
		Electron Collector PS
		Ion extractor PS
		Supressor PS
	1.5.1.3	Drift tube PS
	1.5.2.1	Platform bias PS
		Lens PS
	1.5.3.1	MEBT Materials
		Quad PS
		Steerer PS
		Racks
	1.5.3.2	IH LINAC Materials
		Quad PS
	1.5.3.3	HEBT Materials
		Big bend dipole PS
		Quad PS
		Steerer PS
		Racks
		Travel
1.9	**Facility Modifications**	
	1.9.1	Beam Access Port
		Disc/reconnect LTB equipment
		Remove/install equipment
		contract supervision
		port installation contract
		as-builts & design changes

Appendix C: Agreements

Department of Energy
Washington, DC 20585

January 11, 2006

MEMORANDUM FOR RAYMOND L. ORBACH
DIRECTOR
OFFICE OF SCIENCE

FROM: DENNIS KOVAR
ASSOCIATE DIRECTOR OF THE OFFICE OF SCIENCE FOR NUCLEAR PHYSICS

SUBJECT: ACTION: Sign the Implementing Agreement between the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) which establishes the roles and responsibilities with respect to the construction of the Electron Beam Ion Source (EBIS) at Brookhaven National Laboratory (BNL).

ISSUE: The DOE Office of Nuclear Physics initiated the EBIS project with conceptual design efforts in FY 2005. NASA plans to contribute funding of $4,500,000 to the EBIS project over three years in order to accelerate the project completion, reducing the DOE estimated Total Project Cost to $14,800,000. DOE Office of Science shall be solely responsible for managing the construction, commissioning and decommissioning of the EBIS project.

BACKGROUND: The EBIS project will deliver a new pre-injector for the Relativistic Heavy Ion Collider (RHIC) facility at BNL, replacing the aging and high-maintenance Tandem van de Graaff accelerators currently being used. This new linac-based pre-injector will lead to increased integrated luminosity and is a critical component for successfully implementing the RHIC II upgrade and eRHIC.

The proposed pre-injector will also provide a major enhancement in capability for the NASA Space Radiation Laboratory (NSRL), which utilizes heavy-ion beams from the RHIC complex. EBIS would make it possible to deliver to the NASA radiobiology program accelerated beams of important ion species such as helium, argon, neon and calcium that are unavailable with the present pre-injector. The new system would additionally allow for rapid switching of ion species for NSRL experiments, providing for enhanced mixed radiation field studies and reducing delays due to the interference with RHIC injection operations and thereby improving the effectiveness of the NSRL program.

Since this agreement was drafted, NASA provided $500,000 in FY 2005. They plan to contribute the balance of the $4,500,000 on a yearly basis through FY 2008.

SENSITIVITIES: None

POLICY IMPACT: None

RECOMMENDATION: Sign the attached Implementing Agreement.

Attachment:
Implementing Agreement signed by NASA on 12/12/2005

IMPLEMENTING AGREEMENT

BETWEEN

THE DEPARTMENT OF ENERGY

AND

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

REGARDING THE

ELECTRON BEAM ION SOURCE

AT

BROOKHAVEN NATIONAL LABORATORY

1.0 INTRODUCTION

The purpose of this Implementing Agreement is to establish the roles and responsibilities of the National Aeronautics and Space Administration (NASA) and the Department of Energy (DOE) with respect to the construction of the Electron Beam Ion Source (EBIS). The EBIS project is a joint DOE and NASA project, which will be managed by DOE. NASA has a vested interest in contributing to the construction because of the enhanced capabilities EBIS will provide to the NASA Space Radiation Laboratory (NSRL) situated at the Brookhaven National Laboratory (BNL).

This agreement is complementary to the policy established in the Memorandum of Understanding regarding Energy-Related Civil Space Activities between the NASA and DOE dated July 9, 1992, and to the Memorandum of Agreement between NASA and BNL dated April 8, 1994. This Implementing Agreement does not alter the terms established under the Implementing Arrangement between DOE and NASA regarding the NSRL (formerly the Booster Applications Facility) dated October 29, 1997.

2.0 SCOPE OF ACTIVITY

The EBIS project to be executed by DOE and NASA within the framework of this agreement shall consist of inter-agency cooperation, exchange of information and funding contributions. Management and control of the EBIS project shall be vested in the DOE, Office of Science.

3.0 AGENCY AUTHORITIES

3.1 The NASA is acting pursuant to authorities conferred under the National Aeronautics and Space Act of 1958, Public Law No. 85-568, As Amended.

3.2 The DOE is acting pursuant to authorities conferred in the Department of Energy Organization Act, 42 U.S.C. §7101, et seq., (42 U.S.C. § 7151), the Atomic Energy Act of 1954, 42 U.S.C. §2011 et seq., including, but not limited to, 42 U.S.C. §2051.

3.3 These authorizations for the two agencies, together with the internal policies and procedures of each agency, define the authority of the two agencies to establish and manage their respective programs.

3.4 The authorities that the two agencies bring to the execution and integration of EBIS into the BNL program are those which they have independently as program offices within their respective agencies.

3.5 In the implementation of the agencies' decisions and resultant actions, each will follow the policies and procedures of their respective agencies.

4.0 PROJECT DESCRIPTION

The EBIS project will deliver a new pre-injector for the Relativistic Heavy Ion Collider (RHIC) facility, replacing the aging and high-maintenance Tandem van de Graaff accelerators currently being used. This new linac-based pre-injector will lead to increased integrated luminosity and is a critical component for successfully implementing the RHIC II upgrade and eRHIC. These two proposed projects are identified in the 2003 Office of Science's *Facilities for the Future of Science: A Twenty Year Outlook*

The proposed pre-injector will also provide a major enhancement in capability for the NASA Space Radiation Laboratory (NSRL), which utilizes heavy-ion beams from the RHIC complex. EBIS would make it possible to deliver to the NASA radiobiology program accelerated beams of important ion species such as helium, argon, neon and calcium that are unavailable with the present pre-injector.

The new system would additionally allow for rapid switching of ion species for NSRL experiments, providing for enhanced mixed radiation field studies and reducing delays due to the interference with RHIC injection operations and thereby improving the effectiveness of the NSRL program.

5.0 AGENCY ROLES AND RESPONSIBILITIES

5.1 The DOE Office of Science shall have executive management responsibility for the EBIS project.

5.2 The DOE Office of Science shall be responsible for the oversight of the management, construction and commissioning of the EBIS project, as described in the EBIS Project Execution Plan following its approval.

5.3 The DOE Office of Science shall retain title to the equipment procured within the scope of work referenced under the EBIS project.

5.4 NASA shall be responsible for providing the agreed level of funding under article 6.2 in a timely manner to enable the acceleration of the project profile in order to shorten the completion time of the project.

5.5 The NASA Exploration Systems Mission Directorate shall be responsible for oversight of NASA participation in the EBIS project.

5.6 DOE and NASA shall each designate an official point of contact representing each agency for this project. For DOE that person shall be the Federal Project Director. For NASA that person shall be the Human Research Program Executive.

6.0 FINANCIAL RESPONSIBILITIES

6.1 DOE and NASA shall be responsible for the costs they respectively incur in their own interest related to the support of this Implementing Agreement.

6.2 NASA shall partially fund the EBIS project in order to accelerate the project completion. For this purpose, NASA is requesting support from its budget as early as FY 2005, for this project. The proposed support is $1,500,000 per year for three years, for a total of $4,500,000.

6.3 The DOE Office of Science shall be responsible for the construction, commissioning, decommissioning, and environmental cleanup for the EBIS project, including funding except that provided by NASA for the level and purpose as stated in article 6.2 above.

6.4 The DOE is responsible for compliance with the National Environmental Policy Act (NEPA) requirements for the EBIS project.

6.5 The DOE shall pay the costs incurred by the Brookhaven Site Office to fulfill its management responsibilities.

6.6 Implementation of this agreement by DOE and NASA is subject to the requirements of the Anti-Deficiency Act, 31 U.S.C. Sec. 1512, et seq., and the availability of appropriated funds. Any requirement for the payment or obligation of funds by NASA or DOE established by the terms of this Implementing Agreement shall be subject to the availability of appropriated funds. Both Parties acknowledge that they will not be required under this Implementing Agreement to expend appropriated funds unless and until an authorized officer of that agency acts to commit to such expenditures as evidenced in writing. This agreement does not transfer funds.

7.0 OVERSIGHT AND COORDINATION

7.1 The DOE Office of Science shall perform reviews of the EBIS project to assess project performance.

7.2 NASA shall be informed of the parameters of any relevant DOE review and be invited to attend.

7.3 The Office of Nuclear Physics within the DOE Office of Science shall be informed of the parameters of any relevant NASA review and be invited to attend.

8.0 MISCELLANEOUS

8.1 The NASA and DOE agree that any requests for information received under the Freedom of Information Act (FOIA) shall be processed in accordance with the receiving agency's FOIA regulations; however, the receiving agency agrees to consult the other agency prior to the release or denial of any information requested under the FOIA. The NASA and DOE also agree that prior to the release of any significant information regarding this Implementing Agreement, or EBIS experiments conducted by or at DOE laboratories or facilities, such as a statement to the press, they shall consult together regarding the content of such a release.

9.0 AMENDMENTS, DISPUTES, APPROVALS, DURATION AND TERMINATION

9.1 This Implementing Agreement becomes effective on the date of the last signature and remains effective for a period of ten (10) years unless renewed by the Approval signatories or their successors.

9.2 The Approval signatories or their successors in office shall resolve all disputes or unresolved items or issues covered by this Implementing Agreement at the participant level within their respective agencies, using Federal law and regulation as necessary. If an informal resolution is not possible at the participant level, the Approval Signatories to this Implementing Agreement, or their successors in office, shall be so advised and they shall take the appropriate actions to resolve the inconsistency or conflict.

9.3 This Implementing Agreement between NASA and DOE Offices of Science, as specified above, is made by the signatories below and can be modified as required by the mutual consent of the same signatories or their successors. Either the Director of the Office of Science at DOE or the Associate Administrator for the Exploration Systems Mission Directorate at NASA may terminate this Implementing Agreement upon presentation of ninety (90) days written advance notice to the other, or by the agreement in writing of both Parties.

Signatories

Approved by:

Scott J. Horowitz
Associate Administrator
Exploration Systems Mission Directorate
NASA

12/12/2005
Date

Raymond L. Orbach
Director
Office of Science
DOE

Feb. 2 2006
Date

Statement of Work

Construction of a New Pre-injector for the NASA Space Radiation Laboratory at Brookhaven National Laboratory

Overview

The NASA Space Radiation Laboratory, NSRL, at BNL supplies ion and proton beams to support experiments that are designed to understand the effects of cosmic radiation to humans in space and to develop countermeasures. This statement of work covers the NASA support of a joint modification project with the Department of Energy, during the period of October 1, 2005 to September 30, 2008. The details are provided in the attached conceptual design report that is entitled; Electron Beam Ion Source Preinjector Project (EBIS). The project will provide for enhanced capabilities of the NSRL facility. Both the DOE and NASA have a joint need to replace the present Tandem accelerator injectors that provide particle beams for NSRL and the Relativistic Heavy Ion Collider (RHIC) scientific programs. The two Tandem accelerators inject ion beams into the Booster synchrotron, which accelerates these ions to higher energy. The ions are subsequently extracted to the NSRL experimental station or to the Alternating Gradient Synchrotron (AGS) for further acceleration subsequent to injection to the two RHIC synchrotron / storage rings. The joint project will replace the two Tandem accelerators with an Electron Beam Ion Source (EBIS), followed by a Radio Frequency Quadrupole (RFQ) accelerator, and a short Linac.

Benefits for NASA

The highly successful development of an EBIS at BNL now makes it possible to replace the present Tandem accelerators, with a reliable, low maintenance linac-based pre-injector. The advantages for the NASA program are the following:

I. **Full coverage of space radiation elements:** Tandem beams are limited to ions that are produced with negative charge states, while the EBIS can produce all ions. Tandems can not accelerate ions with low electron affinity. Some of these ions, including He, Ne, Mg, Ar, and Ca, are major components of galactic cosmic rays (GCR), and significant components of the dose equivalent. This is illustrated in Table I.

Table I. GCR charge group contributions to dose equivalent (5 g/cm^2 Al).

GCR Charge, Z	% Dose Equivalent	GCR Charge, Z	% Dose Equivalent
0	0.57	15	0.61
1	16.97	16	2.48
2	15.88	17	0.82
3	0.07	18	1.39
4	0.10	19	1.11
5	0.51	20	2.46
6	3.05	21	0.74
7	1.30	22	2.36
8	8.15	23	1.27
9	0.33	24	2.43
10	2.81	25	1.91
11	0.97	26	14.73
12	6.53	27	0.07
13	1.64	28	0.77
14	7.95	Total-All Charge	100.00

Total Not accessible to Tandem 29.10%

- The Van de Graaff limitations restrict the science accessible to the research program in the following ways
  i) For radiobiology research a detailed understanding of the radiobiology of helium ions cannot be obtained. Helium ions are a major component of GCR, as seen above, and have distinct particle track structures at the cellular and tissue level that cannot be simulated with other particles, and requires their direct use and studies with these other ions would be preferred.
  ii) For physics and shielding research, detailed data bases can not be completed without direct use of these beams (He, Ne, Mg, Ar, etc.). Table II shows in the beams and energies for which the Space Radiation Initiative (SRI) has a commitment to provide shielding data The full circles indicate points where data are required; the crosses show where some data are available. The particles that cannot currently be obtained have particularly stable nuclear configurations, so that their nuclear interaction properties cannot be accurately inferred from interpolation of data between neighboring species on the periodic table.

Table II. Points for Physics Data Base

ε_P (GeV/ u)	**PARTICLE SPECIES**										
	H	He	C	N	O	Ne	Si	Ar	Ca	Mn	Fe
0.1		●	●		●		●				●
0.2	●	●	●X	X	●X		●X	X			●X
0.4			●		●		●	●			●
0.6		●			●	X	●X				●X
0.8							●	●			●
1.0	●										●X
1.5		●	●		●		●	●	●	●	●
2.0	●										●
5.0	●	●			●		●				●

iii) Studies with nearby charge groups are a reasonable substitute for radiobiology of the primary particles, but not as a means of understanding the biological characteristics of the radiation environment inside a shielded enclosure or behind shielding materials, because the physical environment cannot be predicted accurately in the absence of physics data.

iv) Mixed-field exposures: The tandem limits NSRL simulations to two ion species in one experiment, with the possibility of a third species if the BNL Linac is used to accelerate protons. EBIS-based injection would allow for the rapid switching of many ion types such that a full GCR simulation becomes possible.

II. **Improved Operations:** Overhead rates for beam setups and switching at NSRL currently occur at a rate of 30-40 % percent of the total operation hours. The addition of the EBIS pre-injector has the potential to reduce operations costs through reduction of overhead hours and FTE support for the EBIS versus Tandem injector to the Booster synchrotron.

- The EBIS will switch ion species very quickly, for fast switching between concurrent RHIC and NSRL operations, and fast switching of ion species for NSRL experiments, a feature that is not presently available. This will allow for enhanced mixed-field studies at NSRL. This optimizes the productivity for both NSRL and RHIC scientific programs.

- The new pre-injector system will require substantially fewer personnel to operate and maintain. The Tandem components are increasingly becoming obsolete and are at or beyond their expected lifetime. This will reduce the overall costs to run the pre-injector system.

- The EBIS based pre-injector will allow for a much simpler system to tune for optimum beam performance. This will increase the productivity of NSRL operations.

RISK OF CURRENT CONFIGURATION TO NASA

I) The tandem van de Graaff injectors are no longer manufactured and availability of spare parts is limited. BNL operates two tandems, one of which is required by the RHIC science program. If one of the van de Graaff injectors breaks down, the other one would have to become the RHIC injector. In that case, the beams available for NSRL would be significantly limited by the need to assure availability of RHIC beam species. The impact to NASA would be:

a) Inability to complete the research program if use of NSRL is restricted to operating while RHIC is on.
b) Significantly increased costs if NSRL is operated without RHIC, because NSRL operation is no longer incremental.
c) Possible loss of access to NSRL capabilities if a single remaining van de Graaff injector is required to provide only RHIC particles and may no longer stand by to deliver NSRL beams (there is no overlap between the beam species required by the two facilities).

II) The capabilities provided by the proposed EBIS system are essential for the health of the long-term BNL heavy ion research program. For example, EBIS would enable RHIC to obtain uranium beams for high-energy nuclear physics studies. In turn, the lifetime of the BNL nuclear physics research program is essential for continued availability of NSRL. NASA requires that NSRL remain available for the next 10-15 years; this is not assured absent the EBIS modernization project.

Project Management

DOE and the BNL are proposing to replace the two Tandem accelerators, that provide beam to the Booster and then subsequently to the NSRL, with an Electron Beam Ion Source (EBIS), a Radio Frequency Quadrupole (RFQ) accelerator, and a short Linac to the Booster. The replacement of the Tandems is proposed as a joint project between the DOE and NASA. DOE and BNL will execute this joint project under the existing Memorandum of Agreement between NASA and the DOE, dated February 2002. BNL will manage the project under the prevailing DOE regulations (DOE 413.3).

In addition to the delivery of the operational EBIS, DOE will provide to NASA the EBIS Project Execution Plan, which will be jointly signed by NASA and the DOE, Project cost and schedule documents, and DOE quarterly reports. NASA is invited to participate in monthly and quarterly teleconferences to monitor the progress of the project, as well as key Project reviews (PDR, CDR, ORR, etc).

Project Cost

The EBIS Project has been estimated at a Total Project Cost of $19.3M. This total cost will be shared between NASA (4.5M$) and DOE (14.8M$) over the period FY05-08, see tables below. Project costs are provided in FY05$ and @Yr$, and the NASA and DOE funding in @Yr$.

Estimated Costs in FY 05M$

	FY 05	FY 06	FY 07	FY 08	FY 09	Total
Pre-R&D						-
R&D	0.5	0.7				1.2
CDR	0.2					0.2
PED/EDIA		1.9	0.5			2.4
Cons		0.8	5.7	7.6		14.1
Pre-Ops				0.3		0.3
TEC	-	2.7	6.2	7.6	-	16.5
TPC	0.7	3.4	6.2	7.9	-	18.2

Estimated Costs in @YrM$

		FY 05	FY 06	FY 07	FY 08	FY 09	Total
Escalation	Annual		2.800	2.600	2.600	2.600	
	Cumulative		1.028	1.055	1.082	1.110	
Pre-R&D		-	-	-	-	-	-
R&D		0.5	0.7	-	-	-	1.2
CDR		0.2	-	-	-	-	0.2
PED/EDIA		-	2.0	0.5	-	-	2.5
Cons		-	0.8	6.0	8.2		15.1
Pre-Ops		-	-	-	0.3		0.3
TEC		-	2.8	6.5	8.2	-	17.6
TPC		0.7	3.5	6.5	8.5	-	19.3

DOE FUNDING IN @YRM$

Pre-R&D						-
R&D	0.5	0.1				0.6
CDR	0.2					0.2
PED/EDIA		2.0	0.5			2.5
Cons			4.5	6.7		11.2

Pre-Ops				0.3		0.3
TEC	-	2.0	5.0	6.7	-	13.7
TPC	0.7	2.1	5.0	7.0	-	14.8

NASA FUNDING IN @YRM$

Pre-R&D						-
R&D		0.6				0.6
CDR						-
PED/EDIA						-
Cons		0.9	1.5	1.5		3.9
Pre-Ops						-
TEC	-	0.9	1.5	1.5	-	3.9
TPC	-	1.5	1.5	1.5	-	4.5

NASA Funding

NASA will provide a total of $4.5M, at $1.5M per year (FY06-08). It is expected that the first DOE funding that will permit purchase of materials will be available in FY07, and that FY06 NASA funds will be available for the purchase of the long-lead items that are on the critical path for project completion. The FY06 NASA funds are expected to be obligated towards the following major purchases amongst other items:

- RFQ $400K
- Superconducting solenoid $500K

The FY07 and FY08 NASA funds will be used to produce those items that will provide new capabilities for NSRL operations. The NASA funds will be combined with the DOE funding to complete the construction effort and institute commissioning in FY09. BNL will report monthly to both NASA and DOE the progress of construction, including costs, obligations and schedule variations.

Attachment

GLOSSARY

AGS	Alternating Gradient Synchrotron
ALARA	As Low As Reasonably Achievable
BCCB	Baseline Change Control Board
BHSO	Brookhaven Site Office
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CAA	Clean Air Act
C-A	Collider-Accelerator
C-AD	Collider-Accelerator Department
CD-0	Critical Decision - 0
CD-1	Critical Decision – 1
CD-2	Critical Decision - 2
CD-3	Critical Decision – 3
CD-4	Critical Decision - 4
CDR	Conceptual Design Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERN	Conseil European pour la Recherché Nucleaire (European Laboratory for Particle Physics)
CFR	Code of Federal Regulations
CGC	Color Glass Condensate
CPM	Contractor Project Manager
DART	Days Away or Restricted Time
DOE-HQ	U.S. Department of Energy – Headquarters
EBIS	Electron Beam Ion Source
ECR	Electron Cyclotron Resonance
EMR	Experience Modification Rates
EMS	Environmental Management System
EPA	Environmental Protection Agency
ES&H	Environment, Safety and Health
ESHQ	Environment, Safety, Health and Quality Assurance
ESSH	Environmental Protection, Safety, Security, Health and Quality
FPD	Federal Project Director
FTE	Full Time equivalent
FY	Fiscal Year
HEBT	High Energy Beam Transport
HEDP	High Energy Density Physics
HENP	High Energy & Nuclear Physics
IH	Inter-Digital H Structure
IPT	Integrated Project Team
ISM	Integrated Safety Management
ISO	International Organization for Standardization
LEBT	Low Energy Beam Transport

LINAC	Linear Accelerator
LIS	Laser Ion Source
LOTO	Lock-Out/Tag-Out
LTB	Linac to Booster
MEBT	Medium Energy Beam Transport
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NP	Nuclear Physics
NSRL	NASA Space Radiation Laboratory
NYSDEC	New York State Department of Environmental Conservation
OBS	Organization Breakdown Structure
OPM	Operational Procedures Manual
OPPIS	Optically Pumped Polarized Ion Source
OSHA	Occupational Safety and Health Act
PARS	Project Assessment and Reporting System
PC	Performance Criteria
PCR	Project Change Request
PED	Project Engineering and Design
PEP	Project Execution Plan
PLC	Programmable Logic Controller
PPM	Procurement & Property Management Division
QA	Quality Assurance
QAM	Quality Assurance Manager
R&D	Research & Development
RCRA	Resource Conservation Recovery Act
RFQ	Radio Frequency Quadrupole
RHIC	Relativistic Heavy Ion Collider
SA	Self-Assessment Program
SAD	Safety-Assessment Document
SBMS	Standards Based Management System
SC	Office of Science
SDWA	Safe Drinking Water Act
SPDES	State Pollutant Discharge Elimination System
STD	Standard
TEC	Total Estimated Cost
TPC	Total Project Cost
QAP	Quality Assurance Program
WBS	Work Breakdown Structure

Electron Beam Ion Source (EBIS)
Annual Progress Review
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Risk Management Plan
for the
Electron Beam Ion Source Project
(EBIS)

Project # 06-SC-002

at
Brookhaven National Laboratory
Upton, NY

For the U.S. Department of Energy
Office of Science
Office of Nuclear Physics (SC – 26)

1. Background and References

1.1 Background

The EBIS Project will manage risks, where "risk" refers to factors within the Project's control that threaten project performance. There are three specific areas of risk that can be controlled and managed by the EBIS Project team and these are:

> Technical risk – the possibility that a product might not meet requirements;
> Cost risk – the possibility that the cost might exceed the target value; and
> Schedule risk - the possibility that a task might take longer to complete than planned.

Control of the environment, safety, and health hazards, while part of risk management in a broader sense, are not unique to the EBIS Project and are enveloped by the Brookhaven National Laboratory (BNL) Integrated Safety Management (ISM) program that is applicable to all BNL projects and operations. The BNL ISM clearly indicates that risk management is everybody's business and will be factored into every project decision throughout the life of the EBIS Project.
https://sbms.bnl.gov/sbmsearch/ProgDesc/ISM/ISM_PD.cfm

Most onsite activities related to the EBIS project require the preparation and completion of reviews, work planning, hazard analysis, and controls to properly manage the job. The first step in this process is to recognize the potential risk consequences and to assign ownership for the specific work. The Collider-Accelerator Department's Operations Procedure Manual (OPM) provides the guidelines to be used to plan the anticipated requirements of a job; define the scope of the work; perform hazard analysis; provide for all environmental, safety, and health issues as part of the work planning and review process, establish procedural and testing requirements; and make other determinations, as necessary, to provide clear approvals indicating ownership of the work. These procedures shall be followed whenever planning new or modifying existing work for EBIS.
http://www.agsrhichome.bnl.gov/AGS/Accel/SND/info.htm

While anyone working on the EBIS Project can identify risks, the responsibility for risk management for the EBIS Project rests with the EBIS line management. As part of weekly technical discussions, the EBIS Contractor Project Manager, WBS Managers, scientists, engineers and cognizant personnel will identify risks; assess the potential impact of the risk from a cost, schedule, and technical perspective; identify and address potential risk mitigation strategies, and report on the status of implementing these strategies. Any EBIS Team member, with the appropriate management oversight, can establish the specific approaches to addressing the individual risk elements.

Lessons learned from the EBIS prototyping experience provided guidance for identifying some technical risk drivers. In addition, the early stages of the design process were structured to identify risks, and where possible address those risks through design improvements, manufacturing studies, prototypes, and contingency. The contingency methodology is outlined in the Project Execution Plan. In many cases the risk mitigation can comprise several of the above listed mitigation elements. The estimated costs and contingencies to mitigate these risks are incorporated in the Project baseline cost and schedule estimates.

The 2005 Preliminary Risk Assessment prepared for CD-1 evolved into the "Risk List". The Risk List is tracked and updated as a living document so as to avoid overlooking important risks and to assure that the risk mitigation has adequate management oversight.

1.2 References

DOE Order on Project Management (DOE Order 413.3) emphasizes the importance of risk management. As outlined in the *EBIS Project Execution Plan* and the *Configuration Management Plan,* risk management is the driving force in establishing and maintaining the technical, cost, and schedule baselines for EBIS. In addition, within the Standards Based Management System, *"Risk Management Plan Outline,"* provides BNL's Labwide guidance in establishing project requirements based on risk management approaches and consequences.
https://sbms.bnl.gov/sbmsearch/subjarea/92/92_Exh49.cfm?ExhibitID=6529

2. Criteria for Risk Identification and Assessment

a) Likelihood of Occurrence

- Very likely (VL): risk is likely to occur with a probability greater than or equal to 90%
- Likely (L): risk is likely to occur with a probability greater than or equal to 50%
- Unlikely (U): There is a less than 50% chance that this event will occur

b) Consequence

Consequence attempts to identify the impact that occurrence of an event will have on cost, schedule and/or technical performance. Risks whose impacts can be discretely defined are categorized per the table below.

	Level 3 Risk	Level 2 Risk	Level 1 Risk
Cost Impact	>$50k in a level 2 WBS	>$250k in a level 2 WBS	>$500k in the TPC
Schedule Impact	affects a Level 3 milestone date	affects a Level 2 milestone date	affects a Level 0 or 1 milestone date
Technical Impact	changes the System Requirements document	changes the technical deliverables but does not affect performance	affects a mission need requirement

If not enough information is available (for example, an increase in vendor price is at present an unquantifiable risk), the item is assumed to be a Level 2 Risk, and Likely to occur.

c) Risk Categorization Matrix

Likelihood of Occurrence	Level 3 Risk	Level 2 Risk	Level 1 Risk
Very Likely	Medium	High	High
Likely	Low	Medium	High
Unlikely	Low	Low	Medium

All identified risks, regardless of likelihood or consequence, are placed on the risk list by providing the following information via email to EBIS Project Controls.

WBS:
Risk:
Type:
Likelihood:
Consequence:
Perceived risk:
Details:
Mitigation:

The Risk List is reviewed weekly at the Project Status meeting. Once an item is placed on the Risk List, it is tracked until it occurs, or until it is determined that the risk no longer exists (for example: the risk of a funding delay would be removed from the list due to the on-time signing of the budget.)

Systems Requirement Document for the Electron Beam Ion Source Project (EBIS)

Project # 06-SC-002

at
Brookhaven National Laboratory
Upton, NY

For the U.S. Department of Energy
Office of Science
Office of Nuclear Physics (SC – 26)

1 OVERVIEW

The EBIS Project provides a replacement for the Tandem Van de Graaff accelerators, the present heavy ion preinjector for RHIC, with a modern, reliable linac-based preinjector. This new preinjector will provide enhanced capabilities for both the RHIC and NSRL programs, at lower operating costs.

The project, including DOE and NASA contributions, includes the fabrication of an Electron Beam Ion Source for the production of high charge state heavy ions, plus the procurement of an RFQ and heavy ion Linac to accelerate ions from EBIS to a final energy of 2 MeV/amu. A transport line is to be fabricated to transport the beam from the output of the Linac to the existing Booster heavy ion injection point, as show below in Figure 1. The project includes the fabrication or procurement of the dipole and quadrupole magnets, power supplies, diagnostics, vacuum components, and controls to properly operate the EBIS source, accelerators, and beam lines. The project also includes the assembly of subsystems, and the installation and testing of these subsystems in their final location in the equipment bay at the high energy end of the H^- Linac building.

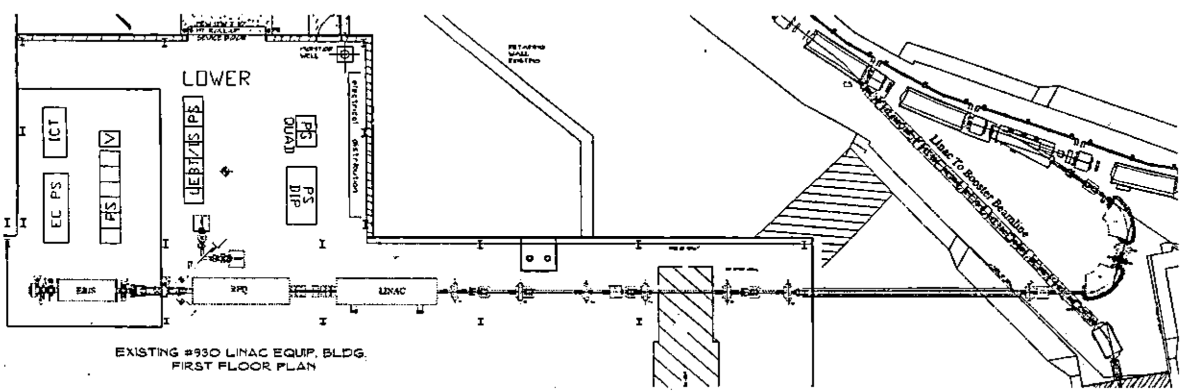


Figure 1 Layout of the EBIS Preinjector.

2 FUNCTIONAL REQUIREMENTS

The technical objectives of the new pre-injector need to meet requirements of both the RHIC and NASA NSRL experimental programs. The corresponding technical scope and performance specifications required at Critical Decision-4 (CD-4) are described in Table 2-2. The system parameters desired from a new pre-injector are as follows:

- **Species: d to U.** The EBIS will produce helium to U beams. A deuterium beam may be produced in a simple plasma source injecting directly into the RFQ. The RFQ, Linac, and transport lines must be designed to handle all species in this range. The species extracted from EBIS depends on the injected singly charged ions. With the external ion sources included in the present design, beams from typical gases and solids as required by RHIC and NSRL will be available. Production of some more exotic beams may require additional development or resources devoted to the external source of such ions for injection.

- **Intensity at injection into the Booster: up to 1.1×10^{11} charges/pulse with EBIS.** Species, which have been run for RHIC and NSRL, are shown in Table 2-1, along with intensities at Booster injection that are required in order to reproduce previously observed intensities. The EBIS pre-injector should at least match this performance in all cases.

Table 2-1 Beams and intensities at Booster input required to match past performance

Species	User	Q	Ions/pulse	Charges/pulse
Au	RHIC	32+	2.7×10^{9}	8.6×10^{10}
D	RHIC	1+	2.5×10^{11}	2.5×10^{11}
Cu	RHIC	11+	1.0×10^{10}	1.1×10^{11}
C	NSRL	5+	2×10^{10}	1×10^{11}
O	NSRL	8+	6.7×10^{9}	5.3×10^{10}
Si	NSRL	13+	5×10^{9}	6.5×10^{10}
Ti	NSRL	18+	1.3×10^{9}	2.4×10^{10}
Fe	NSRL	20+	1.7×10^{9}	3.4×10^{10}

- **Injected pulse width: variable, 10 – 40 μs.** This allows 1-4 turn injection into the Booster. This simplifies the injection, and should greatly reduce the sensitivity to small beam losses at injection, which could otherwise lead to a pressure bump resulting in further beam loss.

- **Repetition rate: 5 Hz.** This keeps overall RHIC fill times to only a few minutes.

- **Switching time between two species: 1 second.** There are presently several operating scenarios for RHIC and NSRL, depending on, among other things, whether either is running alone, or the two are running concurrently. To allow operation with the desired flexibility, the new pre-injector must be able to switch beam species and transport line rigidity in 1 second.

- **Injection energy: 2 MeV/amu.** At present, injection from the Tandems is at 0.92 MeV/amu for Au. At this energy, there is a significant beam loss due to electron capture during Booster injection. By raising the injection energy to 2 MeV/amu, the capture cross section is reduced by a factor of 20-40.

- **Q/m: 0.16 or greater.** This ratio equals that presently delivered for Au from the Tandem. For lighter ions a higher q/m is required (Si^{13+}, Fe^{20+}) in order to achieve the desired Booster output energy for NSRL, within the rigidity constraints of the Booster and extraction transport lines.

Table 2-2 CD4 performance to be demonstrated at Booster input (measured on the current transformer located between the two HEBT 73 degree dipoles).

	CD4 Performance	Optimum Performance
Species	Fe, Au	He to U (assuming appropriate external ion injection)
Intensity	3×10^8 Au^{32+} / pulse 4×10^8 Fe^{20+} / pulse	2.7×10^9 Au^{32+} / pulse 4×10^9 Fe^{20+} / pulse 5×10^{10} He^{2+} / pulse
Charge-to-mass ratio, Q/m	0.162 (Au) 0.357 (Fe)	≥ 0.16, depending on ion species
Repetition rate	Demonstration of pulsing	5 Hz
Pulse width	10-40 μs	10-40 μs
Switching time between species	Demonstration of switching	1 second
Output energy	2 MeV/amu	2 MeV/amu

3 SYSTEM REQUIREMENTS

All systems, which together comprise the EBIS-based RHIC preinjector, must be designed such that the functional requirements given in Section 2 are met. In addition, the preinjector must do this while also ensuring reliability and maintainability. Performance requirements given in the following sections, when combined, will result in overall system performance that meets the functional requirements. This overall performance of the entire system, using requirements given below, has been verified with beam optics simulations, including "end-to-end" simulations. The subsystem requirements represent our present design, but may change with further optimization.

The approach taken to ensure reliability is to use proven technologies, and designs based on past experience within the accelerator community. Whenever possible, we have chosen components and approaches that are the same or similar to that used elsewhere in the RHIC accelerator complex, using standard components and designs.

3.1 ELECTRON BEAM ION SOURCE

The EBIS must produce ions of all desired species at the required charge state with sufficient intensity to meet the requirements for RHIC and NSRL. Requirements for the EBIS source are given in Table 3-1. These requirements are based on our past experience on a prototype EBIS source operating at BNL, plus well established scaling laws. The final EBIS parameters are what we feel is an optimum combination that meets requirements for intensity, beam emittance, flexibility in production of ion species, and reliability, based on past experience and the experimental results of the prototype EBIS at BNL. Other than a straightforward scaling of the length of the ion trap, the parameters chosen for the RHIC EBIS do not deviate in any significant way from those demonstrated in the very successful prototype EBIS.

Electron beam current and trap length are those required to produce the required ion charge. Extraction voltage is chosen high enough to minimize space charge effects in the LEBT line, without being excessive, but where voltage holding and power supply requirements become more difficult, the RFQ length increases.

Table 3-1 EBIS Parameters

Parameter	RHIC EBIS
e-beam current	10 A
e-beam energy	20 keV
e-beam density	~575 A/cm^2
Ion trap length	1.5 m
Trap capacity (charges)	11 x 10^{11}
Yield positive charges, total	5.5 x 10^{11} (Au, 10 A)
Pulse length	$\leq$ 40 μs
Yield Au^{32+}, design value	3.4 x 10^9 ions/pulse
Extraction energy	17 keV/u

3.2 LEBT

The Low Energy Beam Transport (LEBT) transports the beam from the EBIS and matches it to the RFQ. Table 3-2 shows the Twiss parameters at the beginning, and end of the LEBT for Au^{+32} with a kinetic energy of 17 keV/amu. These are present parameters based on our nominal RFQ design, which could change some once the RFQ detailed design is fixed.

Table 3-2 Twiss parameters at the beginning and end of the LEBT.

Parameters	Beginning of LEBT	End of LEBT	Units
α_x	0.0	1.057	
β_x	0.075	0.0639	mm/mrad
ε_x (rms, norm)	0.035	0.072	π mm mrad
α_y	0.0	1.057	
β_y	0.075	0.0639	mm/mrad
ε_y (RMS, norm)	0.035	0.072	π mm mrad

3.3 RADIOFREQUENCY QUADRUPOLE ACCELERATOR (RFQ)

Preliminary performance requirements for the RFQ are given in Table 3-3. The input energy is that required by space charge considerations in the injection line. The general frequency range was driven by space charge considerations at the RFQ entrance, and within that range, the exact frequency was chosen to be one half the frequency of the present 200 MeV H- linac. In this way, if one were to add additional accelerating cavities in the future, where the cavities would typically be at a higher frequency, one might use rf systems from the H- linac. With these requirements, the RFQ is very similar to several existing and well proven RFQs.

Table 3-3 Preliminary RFQ Performance Requirements

Parameter	Value	Units
Type	4-rod	
Operating Frequency	100.625	MHz
Design Beam Current	10	mA
Maximum Beam Current	> 20	mA
Charge-to-Mass (q/m) Ratio Range	0.16 to 1.0	
Repetition Rate, Max.	5	Hz
Pulse Width	≤ 1.0	Ms
Input Energy	17.0	keV/u
Input Emittance (normalized, 90%)	0.35	π mm mrad
Acceptance (normalized, 90%)	≥ 1.7	π mm mrad
Output Energy	300	keV/u
Emittance Growth	≤ 20	%
Output Emittance, longitudinal	≤ 34.0	π MeV deg, 90%
Transmission Efficiency	> 90	%
Length	≤ 4.4	M
Power Consumption, Peak (no beam)	≤ 180	kW
Tuning Range	≥ 300	kHz

3.4 MEBT

The purpose of the Medium Energy Beam Transport (MEBT) is to match the beam from the RFQ to the IH structure in all three planes (two transverse, and longitudinal). The RFQ has a FODO lattice with 1 $\beta\lambda$ period and the IH structure has quadrupole triplet focusing. The RFQ and the IH structure have the same RF frequency of 100.625 MHz. Table 3-4 shows the Twiss parameters at the output of the RFQ and input of the IH structure.

These parameters are based on preliminary RFQ and Linac designs, and could change once the final designs for these two structures is fixed.

Table 3-4 Twiss parameters at the end of the RFQ and entrance of the IH structure.

Parameter	End of RFQ	Entrance of IH	Units
α_x	0.0	1.80221	
β_x	1.0	1.01	mm/mrad
ε_x (90%,unnorm)	24.0	24	π mm mrad
α_y	0.0	0.60246	
β_y	0.05	0.59391	mm/mrad
ε_y (90%, unnorm)	22.0	22	π mm mrad
α_z	0.054	0.37	
β_z	0.0203	0.24	deg/keV
ε_z (90%)	34168	34168	π keV deg

3.5 IH LINAC

Performance requirements for the linac are given in Table 3-5. As with the RFQ, a design was chosen based on a proven technology and closely matching several existing linacs.

Table 3-5 Main parameters of the IH Linac

Parameters	BNL	Units
Q/m	0.16-0.5	
Input energy	0.300	MeV/amu
Output Energy	2.0	MeV/amu
Frequency	100.625	MHz
Max rep rate	5	Hz
Length	<4.0	Meters
Input emittance	0.55	πmm mrad, norm, 90%
Output emittance	<0.61	π mm mrad, norm, 90%
Output energy spread	<20.0	keV/amu
Transmission	>90	%

3.6 HEBT

The High Energy Beam Transport (HEBT) matches beam transversely from the Linac to Booster injection, minimizes the energy spread at the injection, provides ion charge state discrimination, and provides space for diagnostics. A beamline penetration through the Linac shielding provides a short, direct path into the Booster allowing injection using the existing heavy ion inflector. Since the RFQ and Linac will not eliminate all unwanted charge states, the line will be designed for charge discrimination. Two debuncher cavities will be used in HEBT to rotate the longitudinal phase space to minimize the energy spread at Booster injection. Table 3-6 gives the Twiss parameters at the end of the Linac and entrance of the Booster for the mismatched injection scheme, for Au^{32+}. The parameters at the exit of the IH linac could change based on the linac design.

Booster input parameters are based on the existing injection hardware and planned injection scheme.

Table 3-6 Twiss parameters at end of the IH Linac and entrance of the Booster for mismatch injection scheme.

Parameters	End of IH Linac	Entrance to Booster	Units
α_x	2.1	-1.87	
β_x	3.0	2.5	mm/mrad
ε_x (90%, unnorm)	11.0	11.0	π mm mrad
α_y	-1.59	0.87	
β_y	3.45	4.8	mm/mrad
ε_y (90%,unnorm)	10.2	10.2	π mmrad
ΔE (90%) for Au^{+32}	±1345	±726	keV
ΔE (90%) for He^{+2}	±37.57	±29.5	keV

3.7 DIAGNOSTICS

One must have appropriate types of diagnostics in sufficient number and at appropriate locations to allow the setup of the various beams and the monitoring of the source and preinjector performance during operations. The location, number, and types of diagnostics have been verified through the development of a tune-up scenario.

	Location and Quantity							
Device	EIL	LEBT	MEBT	HEBT	TOTL	Dyn. Range	Resolution	Comments
Current Transformer Toroid	1	2	1	3	7	10uA-10mA	0.1 uA	Pulse
Faraday Cup Fast Faraday Cup Faraday Cup	 2	 1	 1	 1 2	 1 6	 10uA-10mA 10uA-10mA	 0.1 uA 0.1 uA	 Pulse Pulse
Profile Monitor Multiwire		1		2	3	10uA-10mA	1 mm	Pulse 32H x 32V

3.8 VACUUM

EBIS vacuum requirements are based on the extensive experience on the Test EBIS, where vacuum design features were key to the successful performance. RFQ and Linac vacuum requirements are based on our experience with the operating RFQ and linac. The HEBT vacuum requirements are based on the vacuum requirements of the Tandem-to-Booster and Booster vacuum systems.

3.8.1 EBIS Vacuum

Ion confinement times as long as 100 ms may have to be used to reach the charge states of interest. The background pressure in the trap region should be low enough that one does not produce a significant number of ions from the background gas. For a residual gas pressure $P=1\times10^{-10}$ Torr, one estimates that less than 2% of the accumulated ions in the trap will be background gas ions. One can tolerate values even a factor of 10 above this, so this gives a range of acceptable vacuum conditions in EBIS of 10^{-9} – 10^{-10} Torr. Requirements for the concentration of hydrogen are less rigorous, and its partial pressure can be 5 times higher. Requirements on the pressure of residual gas in the electron gun region are dictated primarily by the need for proper conditions for operation of the cathode, and in the electron collector by the need for stable transmission of the electron beam without plasma formation. Normally, the pressure in the regions of electron gun and electron collector can be higher than in the ionization region, provided there is efficient vacuum separation between the sections.

3.8.2 RFQ, MEBT, and Linac

The fully assembled RFQ and Linac shall be designed to achieve vacuum levels of 7.5 X 10^{-8} Torr without RF power and 2 X 10^{-7} Torr with RF power. A similar vacuum level is sufficient for the short, connecting MEBT line.

3.8.3 HEBT

Vacuum levels of 10^{-8} and 10^{-9} Torr are sufficiently low for the partially stripped low energy ion beams for most of HEBT, due to the single pass nature, except at the downstream end. Vacuum of 10^{-10} Torr is needed in the last section of HEBT to minimize the diffusion of residual gas into the 10^{-11} to 10^{-12} Torr Booster ultrahigh vacuum system.

3.9 ALIGNMENT

Alignment tolerances for the MEBT and HEBT magnets is given in Table 3-7.

Table 3-7

Type of Error	Tolerance
Translation (x and y)	+/- 0.1 mm
Pitch and yaw	+/- 1 mrad
Rotation	+/- 0.5 deg

3.10 SAFETY

The EBIS preinjector and all its components must comply with all laboratory safety requirements. Equipment must undergo design and safety reviews and have all required approvals prior to operation. Detailed environmental, safety and health requirements are given in the Hazard Analysis Document.

3.10.1 Radiation

There must be sufficient shielding, or personnel access must be limited on the Linac side of the beam penetration in to the Booster. X-ray levels from RF cavities must be shielded, or access limited, as appropriate. Two independent, failsafe methods must be provided for keeping beam from entering the Booster. All radiological work will comply with requirements in the BNL Radiological Control Manual.

3.10.2 Electrical

All electrical equipment must be certified by a Nationally Recognized Testing Laboratory, or be approved for use by the local authority having jurisdiction. All high voltages must be proper barriered. All equipment must be properly grounded. All electrical work must be performed by trained and qualified staff, and all staff, including supervisors and Group Leaders, will help ensure the use of personal protective equipment by workers.

3.10.3 Cryogenic / Oxygen Deficiency Hazards

The EBIS superconducting solenoid must undergo the required Cryogenic Safety Committee reviews, which will verify appropriate pressure relief devices, pressure vessel certifications, etc. There should be appropriate venting of gasses such that the EBIS area does not exceed ODH-0 classification, which is a BNL standard.

3.10.4 Environmental

All oils must be non-PCB, and must have appropriate containment, dependent on the volume of oil. An environmental process assessment must be performed prior to operations to determine inputs and outputs, waste minimization opportunities and applicable requirements.

Value Engineering
for the
Electron Beam Ion Source Project
(EBIS)

Project # 06-SC-002

at
Brookhaven National Laboratory
Upton, NY

For the U.S. Department of Energy
Office of Science
Office of Nuclear Physics (SC – 26)

Value engineering (VE) is defined as the effort directed at analyzing the function of systems, equipment, and facilities for the purpose of achieving the essential function at the lowest life cycle cost. The function is defined by the technical specifications, performance and operating requirements, reliability, maintainability, quality and safety requirements, and environmental regulations. Value engineering is applied particularly during the planning and design phase, but is also applicable to the construction phase. VE is implemented using the graded approach, which means that the level of effort used is commensurate with the importance or value of the system or equipment. VE has the potential to reduce project construction costs and operating costs, and to improve schedules. Regardless of the contract stage, the VE process must be cost effective, such that the savings exceed the implementation cost. Some implementation methods are listed below.

During planning and design:

- Define minimum basic function, eliminating excessive requirements.
- Identify and evaluate alternatives to achieve basic function.
- Consider trade-off analysis to optimize value.
- Include reliability and maintainability into design to reduce operating costs, improve system availability and minimize downtime.
- Simplify and improve procurement efficiency by using clear and concise specifications.

During construction VE is achieved by:

- Scheduling and using resources efficiently.
- Simplifying and clarifying installation, assembly and calibration procedures.
- Reducing waste.

VE is applied to system design and procurement decisions by considering life cycle costs and cost factors: initial cost, operating costs, reliability, and expected life. The initial cost of equipment and systems may be a tradeoff with operating costs and reliability, and initial cost will have less influence on procurement decisions when safety and high system reliability and availability are of paramount importance, as in the Collider Accelerator complex. In high reliability designs the return on funding invested in scientific programs is increased by reducing failures and minimizing system downtime. High utility power rates have placed even greater emphasis on the need to lower operating costs. The dipole magnets described in the example below shows how the design was affected by operating costs. The design and initial cost of the amplifiers for the RFQ and Linac was significantly affected by expected life of the amplifier tubes.

For high technology projects the number of alternatives that can achieve the essential function may be limited. High reliability through proven performance and limited alternatives are conditions that apply to two of the RF structures. The RFQ and Linac planned for used in the EBIS Project are similar to existing devices designed at the Institute of Applied Physics (IAP), University of Frankfurt. These RF structures have proven performance and minimum technical risk. The RFQ is a 4-rod type similar to the REX-ISOLDE RFQ and the HITRAP RFQ produced for GSI Darmstadt. The Linac is an interdigital-H type similar to the CERN Pb Linac and the one at GSI in the HLI injector. The plan is to procure the RFQ and Linac from IAP to minimize technical risk and maximize reliability.

For the EBIS Project, value engineering is integrated into the normal design and development process. The following list summarizes the results of applying VE methodology to the pre-injector facility: Some examples showing the VE process for the EBIS Pre-injector are listed below:

1. Electron Beam Ion Source
2. Facility Site Selection
3. Large Dipole Magnets
4. Superconducting Solenoid Magnet System
5. Use of Existing Equipment and Systems

1. Electron Beam Ion Source Facility.

The EBIS Facility is a principal example of value engineering. While the new pre-injector is expected to provide improved performance and versatility, higher reliability, and lower maintainability over the existing Tandem Pre-injector, the operation of the EBIS will also reduce yearly operating costs approximately $1.5M. The calculation of annual savings was submitted to DOE on 31 January 2006.

2. Facility Site Selection.

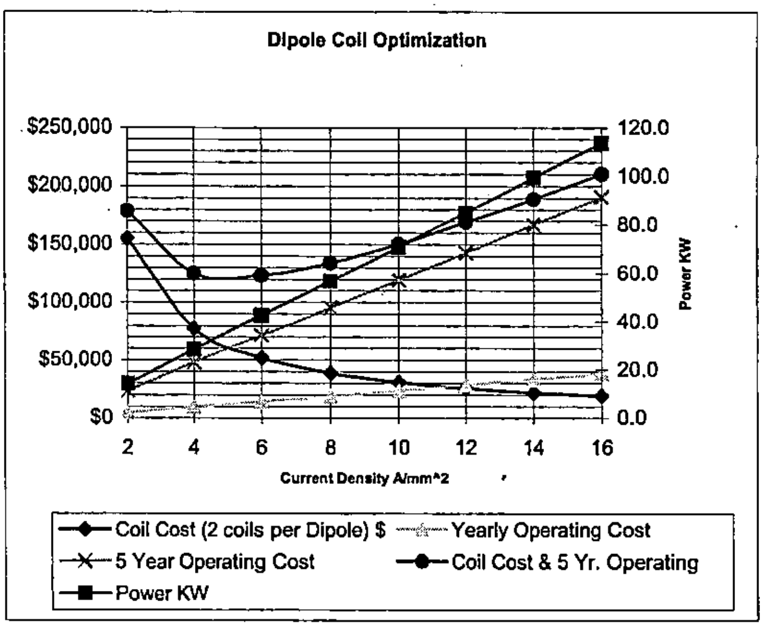
Alternative sites for the EBIS were evaluated. The costs of a new building versus the costs of an addition to the existing Building 930 were compared. Placement of the preinjector in existing Building 930 was subsequently decided. A summary of the ROM costs are as follows:

New Building		Bldg. 930 Addition	
Item	Cost	Item	Cost
-----	-----	-----	-----
Building, Stub Tunnel, All Utilities	2.27M	Bldg. Addition	1.1M
		Bldg. Preparation	.19
		Beam Port	.08
EBIS Power Distribution	< .1	Power	.34
Cooling Water System	.53	Cooling Water	.34
Beam Line Magnets	.2	Beam Line Magnets	.22
Totals	$3.1 M		$2.3 M

Note: The building construction costs (new or addition) are not in the DOE contract scope of work, but are included here as part of project VE study.

3. Large Dipole Magnets.

Once the physics requirements (field, gap and magnet length) have been determined, there is only one parameter which can be chosen in order to optimize the lifetime costs of the magnet system for a facility. That parameter is the current density, j. Therefore, based on the various cost parameters, a design current density can be selected for different magnet systems. The choice of current density will affect the coil cost, lamination cost, power supply cost, and operating cost. Historical magnet optimization studies point values between 4 and 6 A/mm^2 current densities. Below is a plot of coil cost, operating cost, and power vs. current density. The plot used a power cost of $100/MWHR, finished coil price of $19/lb and 30 turn dipole coils.



Using this data a commercially available conductor was chosen and evaluated. For the HEBT dipole coils a 26.5 X 26.5 X 13.5ID conductor with a 5A/mm^2 current density was chosen.

4. Superconducting Solenoid Magnet System (SSMS).

An evaluation of technical alternatives and tradeoff considerations provided the opportunity to optimize the value of the SSMS. The quotation for the SSMS described the following three alternatives:

1. A dewar filled system for liquid nitrogen and liquid helium;
2. A liquid helium system with a heat shield cooled by a cryocooler (dewar filled helium, no liquid nitrogen);

3. A liquid helium system with high temperature SC leads, cryocooled heat shield (no liquid nitrogen) and cryocooler recondensing of liquid helium.

Based on VE considerations, system 2 was selected. System 2 reduced the downtime for refilling by 75% over system 1. System 2 avoided the potential reliability risk of system 3, which had a higher susceptibility to power outages and a limited field history. System 2 also had the lowest initial cost.

5. Use of Existing and Proven Equipment and Systems.

During the planning and early design phase of the EBIS facility, an onsite and offsite inventory of available magnets, power supplies, and transformers was conducted. The use of existing hardware and designs reduces both design and material costs. The results are as follows:

1. Eight spare quadrupole magnets and several magnetic steerers from C-AD stock will be used in the HEBT region.

2. Vacuum Components:
   a. Three 20 l/sec and four 260 l/sec ion pumps from C-AD stock will be used.
   b. Use of proven design for beam line NEG strips and special ceramic support insulators for NEG strips from C-AD stock.

3. Profile monitors and faraday cups installed, but infrequently used, in the Tandem-to-Booster line will be transferred to the EBIS beam line. Also, the existing processing electronics for both the profile monitors and faraday cups will be used.

The use of existing and proven designs for instrumentation and controls include the following:

1. Vacuum. The instrumentation and control system design uses proven reliable hardware and software that has been implemented in NSRL (2002), Booster (2003), and AGS (2004), with logic that is based on the RHIC vacuum system (1995). The PLC programming software tools that are used to write and download ladder programs and create graphical user interfaces are in house and have been used by past C-AD projects/upgrades. PLC processor, input/output, and communication modules are on hand, so EBIS PLC program development can start immediately. In addition, the Controls data exchange with the vacuum PLC, gauge controllers, and ion pump controllers use reliable existing drivers.

2. Control System infrastructure and software, using SNS and Booster configurations.

3. RF Low Level design, using AGS and Booster design.