Department of Energy

External Independent Review of

RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY

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TABLE OF CONTENTS

EXTERNAL INDEPENDENT REVIEW OF RUN IIb CDF DETECTOR PROJECT and RUN IIb D-ZERO DETECTOR PROJECT at FERMI NATIONAL ACCELERATOR LABORATORY CHICAGO, ILLINOIS

SECTION 1 - EXECUTIVE SUMMARY

1.1 INTRODUCTION

Credible reviews of projects are an expectation of Congress, the Office of Management and Budget, local stakeholders, tribal nations, and the U.S. Department of Energy (DOE). Pursuant to DOE Order 413.3, a performance baseline External Independent Review (EIR) shall be performed on all construction projects over $5M prior to Critical Decision 2 (CD-2) – *Approve Performance Baseline*. EIRs for such projects are to include an Independent Cost Review (ICR). An ICR is used primarily to verify project cost and schedule estimates and to support the CD-2 processes in establishing project performance baselines. EIRs are conducted by reviewers outside DOE; these reviewers are selected by the DOE Office of Engineering and Construction Management (OECM).

The purpose of the EIR is to assist in the validation of the proposed technical, cost, and schedule baseline, by assessing the overall status of the project: cost, schedule, scope and technical elements, management, and elements external to the project but which affect the project. The review provides pertinent objective information to assist DOE in its management of the project.

This report of the EIR of the Run IIb CDF and D-Zero Detector Projects at the Fermi National Accelerator Laboratory (FNAL) presents findings and recommendations resulting from interviews of key project personnel and examination of project documents that describe and document the present state of the projects and their readiness to receive Critical Decision-2 (CD-2), *Approve Performance Baseline*. Although these are two separate projects, because of their close similarity in purpose, design, cost, and schedule, they were reviewed simultaneously, and the findings and recommendations for both are presented in one report. This review also included an Independent Cost Review (ICR) of the project costs and schedules. The result of that review is presented as an attachment to this report.

At this time, both projects are scheduled for Critical Decision (CD) 1, *Approve Preliminary Baseline Range*, CD-2, *Approve Performance Baseline*, and CD-3a, *Start of Construction – Procurement of Long-Lead Materials*, by the Energy Systems Acquisition Advisory Board (ESAAB) on December 17, 2002. However, this EIR/ICR review addresses only those requirements affecting the readiness of the projects to receive CD-2.

1.2 SUMMARY OF FINDINGS / RECOMMENDATIONS

JUPITER conducted an EIR/ICR of the Run IIb CDF and D-Zero Detector Projects in October-November 2002. The findings and recommendations described here resulted from interviews with project managers and project personnel, and examination of project documents. Guidance provided in the OECM report, "Independent Review Procedure," May 14, 2001, was followed in conducting this EIR/ICR and in writing this report.

Following the DOE-approved Final Review Plan, dated November 1, 2002, the areas examined by the EIR/ICR Team were:

- Cost
- Schedule
- Scope/Technical

- **$** Management, Planning, and Control
- **$** External Factors

In conducting its review, the EIR/ICR Team was aware that the Run IIb CDF and D-Zero Detector Projects are neither conventional construction projects nor conventional maintenance and upgrade projects. The projects are specialized elements within larger scientific pursuits at FNAL. It is from exigencies and constraints of these larger pursuits—the High Energy Physics experiments using the CDF and D-Zero detectors—that the functional requirements of the detectors being fabricated and upgraded by these projects are derived. Further, because the culture and environment at FNAL more closely resembles that of an academic institution than a national laboratory, the management systems are not typical of those customarily found at national laboratories. Nonetheless, management of these two projects seem quite effective, and the two detector project teams are working closely together to fully exploit commonalities of design and components, where possible, and synergies that arise from two teams working in close cooperation on similar scientific and engineering tasks.

The major expenditure, both cost and labor, for each project is the design, fabrication, and testing of the silicon detectors, which are comprised of special-order components, to be assembled by Laboratory staff at the Laboratory facilities. However, the projects have sought to employ conventional technology and off-the-shelf equipment and components wherever possible. It should be noted that for both projects, project completion is defined as that point at which the detectors are ready to be installed in their respective collider halls. Installation and commissioning of the detectors is not within the scope of either project.

The approach employed by the EIR/ICR Team in conducting this EIR and ICR under DOE O 413.3, was tailored to the characteristics and particularities of these projects, and the findings and recommendations reflect this fact. The review topics (lines of inquiry) used by the Team are provided in Appendix E to this report.

In the view of the EIR/ICR Team, the Run IIb CDF and D-Zero Detector Projects are quality projects, each with a scope appropriately defined by the scientific experiment that the successful execution of these projects will enable. The projects are well managed. Both have effectively employed peer review—characteristic of scientific research within academia—to provide rigor in project management, schedule and critical path development, project risk analyses, and technical design basis development, all of which are necessary for project success. Merging the best elements of modern project management as reflected in DOE O 413.3 and DOE Project Management Guidance with the peer review processes, without compromising either, is a noteworthy "best practice" of these projects. The design documents developed to this point seem appropriate and are very comprehensive. The projects' use of models and mock-ups in the design process is to be commended. The cost estimate, as checked by the ICR, is reasonable and realistic. In addition to the above noted, other positive practices are being followed by both project teams, including the broad and systematic application of Value Engineering.

The EIR/ICR Team made two essential findings, one finding, and a number of observations in the course of the review. Of the two essential findings, one is a straightforward matter of a need to make appropriate references to the Project Management Plans for each project in the Project Execution Plan, so that it will be complete in accordance with DOE O 413.3. The other is of a more programmatic nature.

The essential findings, finding, and suggested remedies are briefly noted below. A complete discussion is continued in the body of this report, along with observations made by the EIR/ICR Team. In the view of the EIR/ICR Team, upon satisfactory resolution of the two essential findings, both projects will be ready to receive CD-2.

1.2.1 Cost

No essential findings or findings were made.

1.2.2 Schedule

No essential findings or findings were made.

1.2.3 Scope/Technical

No essential findings or findings were made.

1.2.4 Management, Planning, and Control

1.2.4.1 Documents/Requirements

Essential Finding: The Project Execution Plan (PEP) for these projects is incomplete. While included in the Project Management Plans, many technical considerations required to be in the PEP by DOE O 413.3 are neither addressed nor referenced in the PEP. Among these are:

- Value Engineering,
- Quality Assurance, and
- Risk Management

The PEP should be amended to include all required considerations, either directly or by reference.

Essential Finding: Neither project has developed a project specific configuration management and control process, as required by DOE O 413.3. Further, no Laboratory configuration management/control policy or procedure is cited in the Project Management Plan (PMP) of either project. Moreover, no signature or other indication of approval exists on the Technical Design Report (TDR) for either project. An appropriate configuration management/control process should be established and followed by both projects to assure authenticity and currency of drawings, specifications, and other design documents, particularly the TDRs.

Finding: There is no description or reference in the PEP, or in either project PMP, to the flow-down of requirements and processes for Quality Assurance/Quality Control to specifics of design, fabrication, procurement, or establishment/ maintenance of document approval/authenticity. The projects should develop a description of how Laboratory and Department QA/QC policy and procedures are realized in the specifics of design, fabrication, and procurement requirements.

1.2.5 External Factors

No essential findings or findings were made.

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

SECTION 2 – PROJECT REVIEW INFORMATION

In a 1998 report on DOE projects, the National Research Council stated that the Independent Project Review will provide an objective, rigorous review and document and process audit of the project scope, underlying assumptions regarding technology, the cost and schedule baselines, and the acquisition and program management strategies and practices employed by the Department to manage and control program technical requirements, cost, and schedule baselines.[1] Under the aegis of DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*, which is an implementation of recommendations from the above report, the Office of Engineering and Construction Management (OECM) provides for the conduct of External Independent Reviews of DOE construction and environmental restoration projects prior to CD-2, *Approve Performance Baseline*. OECM has provided for a standard process, and report format, for Independent Reviews of DOE projects, through which projects can be evaluated and compared to improve the DOE management process and provide information to the Operations and Field Offices, and to the Congress. These External Independent Reviews are performed by personnel having no direct role or interest in the execution or outcome of the project being reviewed.

2.1 DESCRIPTION OF PROJECT

The High Energy Physics program of the DOE Office of Science conducts basic research at FNAL using the Tevatron Collider. The FNAL Tevatron provides the highest energy particle beams in the world, colliding protons and antiprotons with enormous energy, enabling unique opportunities for scientific discovery. The two detectors, CDF and D-Zero, which observe these collisions, are being used to address the electro-weak interaction, the highest priority research of the U.S. High Energy Physics (HEP) program. The purpose of these projects is to upgrade the CDF and D-Zero detectors, which, in turn, will allow the Tevatron to continue to perform this significant High Energy Physics research until the Large Hadron Collider (LHC) at CERN begins operation in late FY2007.

The general technical goals of the Run IIb CDF and D-Zero Detector Projects are replacement of key components of the detector systems to enable continuing use of the Tevatron. Specifically, the projects will replace portions of silicon detectors and associated electronics. By project:

RUN IIb CDF PROJECT

- Replacement of inner silicon microstrip tracker with a new, more radiation resistant version, capable of improved particle identification and triggering for making physics measurements.
- Upgrade of the central calorimetry system to: provide improved time measurement of electromagnetic energy deposition, and replace the obsolete central preradiator chambers.
- Replacement of obsolete portions of the data acquisition system to permit data collection at rates needed to achieve the physics objectives of Run IIb.

RUN IIb D-ZERO PROJECT

- Replacement of inner silicon microstrip tracker with a new, more radiation resistant version, capable of improved particle identification and triggering for making physics measurements.
- Upgrade of the Level 1 and Level 2 trigger systems to accommodate the higher luminosities from the Tevatron.

[1] *Assessing the Need for Independent Project Reviews in the Department of Energy*, National Research Council, National Academy Press, 1998.

- Replacement of obsolete portions of the online and data acquisition systems to permit data collection at rates needed to achieve the physics objectives of Run IIb.

2.2 PROJECT BUDGETS

The anticipated budgets for the two detector projects are given below. The amounts are presented in dollars escalated by Fiscal Year.

	FY01	FY02	FY03	FY04	FY05	FY06	Total
Run IIb CDF Detector Project							
DOE Equipment	0	3,500	3,469	8,396	8,509	1,113	24,987
DOE R&D	0	1,670	480	0	0	0	2,150
Foreign Contributions	0	300	1,218	1,342	10	0	2,869
U.S. Universities	0	24	225	103	26	0	377
Total Funding *	**0**	**5,494**	**5,392**	**9,841**	**8,544**	**1,113**	**30,383**
Run IIb D-Zero Detector Project							
DOE Equipment	0	3,500	2,752	8,588	5,781	0	20,621
DOE R&D	0	1,499	2,380	0	0	0	3,880
Foreign Contributions	0	258	201	90	49	0	599
NSF–MRI silicon	17	1,326	495	631	0	0	2,469
NSF–MRI trigger	0	0	112	57	430	0	599
U.S. Universities	0	210	141	39	47	0	437
Total Funding**	**17**	**6,793**	**6,080**	**9,407**	**6,307**	**0**	**28,604**

* Approximately 50 percent of foreign contributions to CDF will come in the form of contributed goods, i.e., "in-kind." The remaining half will be in the form of cash, which will pass through the FNAL Procurement Department. This portion will be subjected to the same procurement procedures used for DOE funds.

** All foreign contributions are in-kind, applied toward the trigger. Both the silicon and trigger Major Research Instrument (MRI) grants from the National Science Foundation have been approved, with spending having begun for the silicon MRI. Remaining in-kind funds are from US university support of engineering and other technical personnel.

In September 2002, the Run IIb Detector upgrade projects underwent an Independent Performance Review (IPR). At this time, the projects are scheduled for Critical Decision (CD) 1, *Approve Preliminary Baseline Range*, CD-2, *Approve Performance Baseline*, and CD-3a, *Start of Construction – Procurement of Long-Lead Materials*, by the Energy Systems Acquisition Advisory Board (ESAAB) on December 17, 2002.

2.3 REVIEW PROCESS

The JUPITER EIR/ICR Team performed a detailed review of the entire project: cost, schedule, technical, management, and external factors. The following sections describe the review process, including the review schedule, list of Team members and assignments, project personnel interviewed, and documents reviewed.

2.3.1 Date and Place

Document Review, October 21 – November 3, 2002
On-site Review, November 4 – 8, 2002, FNAL

The principal areas of focus of each EIR/ICR Team members are presented in the table below:

Team Member	Cost	Schedule	Management Planning	Scope/ Technical	External Factors
Joe Bader			**X**	**X**	
F. Costanzi*			**X**	**X**	**X**
W. Davies	**X**	**X**			
K. Farmer**	**X**	**X**			
S. Moore			**X**	**X**	**X**
Cliff Poor			**X**	**X**	

*Team Lead / **Cost Lead

2.3.2 Personnel Interviewed

Name	Position	Phone	E-mail	CDF	D0
Nicola Bacchetta	CDF L2 Mgr Silicon	630 840-4374	Bacchette@fnal.gov	X	
Doug Benjamin	CDF Deputy Project Manager	630 840-8432	DBenjamin@fnal.gov	X	
Jonathan Cooper	DOE/FAO.	630 840-4288	Jon.Cooper@ch.doe.gov	X	X
John Cooper	PPD Division Head	630 840-2235	JCooper@fnal.gov	X	X
William E. Cooper	D0 L3 Mgr – Silicon Mechanical	630 840-4093	Cooper@fnal.gov		X
Marcel Demarteau	D0 L2 Mgr Silicon	630 840-2840	DeMarteau@fnal.gov		X
Jim Fast	D0 L3 Mgr – Silicon Production	630 840-6332	JFast@fnal.gov		X
Brenna Flaugher	CDF L2 Mgr Silicon	630 840-2934	Brenna@fnal.gov	X	
Bill Freeman	D0 Project Office	630 840-3020	WFree@fnal.gov		X
Stuart Fuess	D0 L2 Mgr DAQ/Online	630 840-2452	Fuess@fnal.gov		X
Chuck Grimm	Design & Drafting Group Leader	630 840-4582	Gramm@fnal.gov	X	X
Jonathan Kotcher	D0 Project Manager	630 840-8749	Kotcher@fnal.gov		X
Kurt J. Krempetz	D0 L3 Mgr – Silicon Assembly	630 840-4657	Krempetz@fnal.gov		X
Steve Kuhlmann	CDF L2 Mgr DAQ/Online	630 840-8425	Kuhlmann@anl.gov	X	
Pat Lukens	CDF Project Manager	630 840-8053	PTL@fnal.gov	X	
Paul Philp	DOE FPM	630 840-4481	Paul.Philp@ch.doe.gov	X	X
Kevin Pitts	CDF L2 Mgr Trigger/DAQ	217 333-3946	KPitts@uiuc.edu	X	
T.J. Sarlina	CDF Project Office	630 840-3299	Sarlina@fnal.gov	X	
Colleen Yoshikawa	D0 Project Office	630 840-8887	Cookie@fnal.gov		X

In addition, a number of individuals from the projects and from DOE/FAO attended the In-brief and Out-brief.

2.3.3 Review Team Members

The EIR/ICR Team consists of experienced personnel from JUPITER and subcontractors, approved by DOE. A resume for each Review Team Member is provided in Appendix B.

2.3.4 Documentation Reviewed

The Team reviewed many project documents and reference materials. Some documents were provided prior to the on-site review; others were provided while the Team was on-site. A list of documents reviewed is provided in Appendix C.

2.3.5 Meetings

The on-site review commenced on the morning of November 4, 2002, and concluded with an outbrief on the morning of November 8, 2002. At the initial meeting on November 4, the EIR/ICR Team leader explained the process used to conduct the review. After this initial briefing, the DOE/Fermi Area Office (FAO) project manager and the FNAL project managers provided an overview of the Run IIb CDF and D-Zero Detector Projects. Interviews of project personnel, including managers for the DOE/FAO and FNAL projects, were conducted at FNAL. The review topics contained in the approved EIR plan, dated November 1, 2002, provided points of departure for the interviews. These review topics are provided in this report, Appendix E, Lines of Inquiry. The EIR/ICR Team toured both the CDF and D-Zero project sites, as well as the Silicon Detector Facility (SiDet) on the first afternoon. In addition, the EIR/ICR Team members reviewing cost and schedule issues met separately with cost estimators and managers responsible for developing project costs and schedules. The following is the schedule of the team's activities:

Date & Time	Review Topics	
11/4 Monday AM	8:30 – 9:00 9:00 – 9:30 9:30 – 10:00 10:00 – 10:30 10:30 – 12:30	In-brief by EIR Team for Project Team Projects overview by DOE and Projects Project description CDF Project description D-Zero Tour of CDF, SiDet Facility, and D-Zero locations
11/4 Monday PM	1:30 – 5:30	Cost/Schedule overview – CDF and D-Zero
11/5 Tuesday AM	8:00 – 9:00 9:00 – 11:00 11:00 – 1:00	Technical and design requirements (SVX) – CDF and D-Zero Technical and design requirements – CDF Project Management and Control Overview – CDF
11/5 Tuesday PM	2:00 – 4:00 4:00 – 6:00	Risk Assessment/Management – CDF Value Engineering, PEP, Acquisition Plan – CDF
11/6 Wednesday AM	8:00 – 10:00 10:00 – 12:00	Internal/External interfaces, ISM – CDF Technical and design requirements (other than SVX) – D-Zero
11/6 Wednesday PM	1:00 – 3:00 3:00 – 5:00	Project Management and Control Overview – D-Zero Risk Assessment/Management – D-Zero
11/7 Thursday AM	8:00 – 10:00 10:00 – 12:00	Value Engineering, PEP, Acquisition Plan – D-Zero Internal/External interfaces, ISM – D-Zero
11/8 Friday AM	11:00 – 12:00	EIR Team outbrief

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

SECTION 3 – PROJECT REVIEW FINDINGS AND RECOMMENDATIONS

3.1 COST

3.1.1 Cost Estimate/Project Funding

The *JUPITER* EIR Team reviewed the detailed project cost estimates. Funding profiles are consistent with project schedules and technical scopes. The projects have used recent experience from replacement of similar equipment and systems for the Run IIa upgrades as sources of actual cost data, and for development of project schedules. The review team has determined that, owing to the nature of these detector upgrade projects, Life Cycle Costs are not meaningful, as the scope of these projects encompasses only the upgrading of the existing detectors. These projects will make no additions or modifications to the FNAL facilities or infrastructure. Further, at this point it can not be determined whether or to what extent the systems and equipment of the CDF and D-Zero detectors could or would be used, should new experiments be devised for the accelerator facility following the Run IIb experiments.

There were no essential findings or findings. The current cost estimates meet the guidelines and intent of DOE O 413.3. However, the EIR Team did make some observations that are discussed below.

Observation: A recap sheet of the project costs is not included in the cost estimates.

A recap is shown in the associated documentation, but its location is not noted in the cost estimate. Because some of the monies for these projects are from National Science Foundation grants and others from foreign sources, the total funding needed from the DOE is less than the total costs of these projects. Without a clear distinction between DOE funds and funds from other sources in the cost estimate, budgeting errors and omission may result, should changes in funding amounts or sources occur.

Recommendation: Revise the cost estimate by adding a recap sheet to the start of the cost estimate.

It should be noted that when this concern was raised, the project immediately set about revising the cost estimate to reflect a recap sheet in accordance with the above recommendation.

Observation: All project costs were escalated using the current DOE escalation factors effective on the date of the estimate. However, the escalation factor used was to the midpoint of the total project.

For these projects, with well-defined costs, escalating to the midpoint of the total project will not introduce significant error in the cost estimate. Nonetheless, a better, more accepted, practice is to escalate to the midpoint of each element in the lowest level of the Work Breakdown Structure (WBS).

Recommendation: Prior to CD-3, revise the cost estimates by escalating to the midpoint of each WBS element.

Observation: Costs of individual WBS elements are not reflected in the project schedules provided to the EIR/ICR Team.

Although the baseline project schedules provided to the EIR/ICR Team contain a cost code account to the lowest level of major work package items and are in accordance with DOE guidelines, element costs were not explicitly shown. To facilitate effective management of the project, as well as earned value reporting, all work shown and listed under the Activity Name column of the schedule should contain a cost, and this cost should be reflected in the cost estimate documentation. The projects did say that schedules that include the cost of each WBS element were available. However, the Team did not have time to see or review them.

Recommendation: Prior to CD-3, *Approve Start of Construction*, the Federal Project Manager should assure that the schedules of both projects contain a cost column, and these columns should contain costs associated with the concurrent Task ID's (Activity).

3.1.2 Cost Risk Analysis

The EIR/ICR Team reviewed project cost risk, including risk identification and estimation of potential cost and schedule impacts of risk. There were no essential findings or findings. However, the EIR/ICR Team did make the following observation:

Observation: Although sources other than DOE are contributing to the funding for these projects, it appears that DOE is assuming the entire contingency for these two projects. Consequently, contingency calculated as a fraction of DOE-required funding exceeds customary guidelines.

The percentage contingencies on the total costs of each project as estimated by the EIR/ICR Team were consistent with DOE guidance. However, it appears that contingency is derived solely from DOE funds, and no argument is made as to why that is the case or that it should be.

Recommendation: The projects should consider distributing contingency across all funding sources.

3.1.3 Cost Reviews/Lessons Learned

The cost estimates for all phases of the project were reviewed in detail down to the cost estimator's take-off sheets and the design drawings. These estimates were found to be quite good and in compliance with generally recognized cost estimating standards. Actual costs of replacement of similar equipment were used in the development of the cost estimate. An IPR had been performed prior to this EIR/ICR. The IPR found that the costs of the projects were reasonable, and the EIR/ICR Team agrees with this conclusion.

3.1.4 Future Cost Forecast

Future Cost forecasts were found to comply with the draft DOE Program and Project Management Manual guidelines. The EIR/ICR Team made no findings or essential findings. There was one observation, discussed below.

Observation: Currently, the contingencies on the cost estimates of the two projects are the sum of the estimated costs of each accepted risk. This may somewhat inflate the estimated amount of contingency needed.

DOE guidance recommends a 15% to 35% contingency for R&D type projects at this stage of development – CD-2. A weighted, probabilistic calculation was performed by the EIR/ICR Team. That calculation yielded contingencies of about 37% of DOE funding, including allowances for QA/QC requirements. This is to be contrasted with the projects' estimates of about 46% of DOE funding.

Recommendation: A new risk calculation should be made, and contingency derived from the quantification of risk employing a Monte Carlo approach, as recommended in DOE Guidance, *Project Management Practices*, October 2000.

3.2 SCHEDULE

3.2.1 Project Schedule

The EIR/ICR Team reviewed the completeness and realism of the project schedules for the design and construction phases of the projects. There were no essential findings or findings, but one observation was made.

Observation: Both projects have fully integrated resource-loaded schedules, in which the critical paths are shown. However, these schedules do not indicate long lead procurements.

Because actual activity times based upon the Run IIa experience were used by the projects in developing the cost estimates and project schedules, the overall times for project execution seem reasonable. Further, the detailed schedules include adequate milestones. However, there are no specific identifications for long-lead time procurements. Further, long lead procurements as well as element costs need to be included in the Critical Path Method (CPM) Schedules so that they can be used as effective tools for efficient management of the projects. In particular, such schedules will be useful for managing both direct and time-related costs as well as facilitating earned value reporting. In addition, such schedules are also useful for efficient cash flow management.

Recommendation: Long lead procurements should be indicated specifically in the CPM schedules for both projects.

3.2.2 Schedule Milestone/Critical Path

The EIR Team reviewed the definition, dates, and incorporation of milestones into the project schedule as well as the identification of a project critical path. The EIR/ICR Team made no essential findings, findings, or observations specific to this area, but notes that WBS element costs should be entered into the critical path schedules as recommended in Section 3.2.1, *Project Schedule*.

3.2.3 Schedule Risk Analysis

The EIR/ICR Team reviewed project schedule risk, including risk identification and estimating potential schedule impacts of risk. The EIR/ICR Team made no essential findings, findings, or observations specific to this area, but notes that WBS element costs should be entered into the critical path schedules as recommended in Section 3.2.1, *Project Schedule*.

3.2.4 Future Schedule Cost

The EIR/ICR Team reviewed future schedule forecasts, reconciliation between projected schedules, status, and schedule of future activities, methods used to develop schedules, and defensibility of the baseline schedule. The EIR/ICR Team made no essential findings, findings, or observations specific to this area, but notes that WBS element costs should be entered into the critical path schedules as recommended in Section 3.2.1, *Project Schedule*.

3.3 SCOPE/TECHNICAL

3.3.1 Solution Alternatives

The EIR/ICR Team reviewed the design process of both projects. The projects began with a set of clearly defined functional requirements and constraints, and through a systematic application of a variety of methods, including trade-off analyses, model making, and broad and systematic use of Value Engineering, they have developed the initial design, and are now completing detailed design specifications for fabrication and procurement. In the view of the EIR/ICTR Team, the projects have both done exemplary jobs in developing the design for the CDF and D-Zero detector upgrades. The EIR/ICR Team made no essential findings, findings, or observations.

3.3.2 Solution Requirements

The EIR/ICR Team reviewed the Environmental, Safety, and Health (ES&H), Hazards Analysis and Classification, and the Integrated Safety Management (ISM) rating elements of the projects. Run IIb will be conducted under current institutional requirements for FNAL. As a result, there are no unique ES&H and ISM requirements for the CDF and D-Zero Run IIb Projects. The facility is designated as Low Hazard Class Radiological Facility - no PSAR and FSAR are required. FNAL has an ISM Plan, dated August 2002, Revision No. 5, and an approved ISM Operating Manual for the Particle Physics Division (PPD) (PPD_OPER_004, Rev 8/27/99). The PPD has an approved Operating Manual (PPD_ESH_006, Rev. 7/24/01) for ES&H Review of Experiments. Periodic ES&H audits and assessments, and fire safety evaluations, are performed on laboratory facilities. The latest examples were provided to the EIR/ICR Team, and were reviewed for relevance and currency. The review resulted in no essential findings, findings, or observations.

3.3.3 Solution Design

The EIR/ICR Team reviewed detailed CDF and D-Zero Run IIb Technical Design Reports (TDRs) issued in September 2002, selected component drawings, and toured the SiDet Laboratory and the control rooms for CDF and D-Zero facilities. Despite intensive collaboration by participating organizations and independent reviews by multidisciplinary groups, there is no documentation of approval of Technical Design Reports (TDR). In contrast, design drawings undergo required checking and approval before being released for bid and fabrication. The need for a document/configuration control process is further discussed in Section 3.4.3, Documents/Requirements. The EIR/ICR Team made no other essential findings, findings, or observations.

3.3.4 Solution Preparation for Next Phase

Certain aspects of the projects are in the detailed design phase, and as installability is a critical constraint on the design, planning is underway for installation of the detectors. Each TDR addresses the detector installation, even though the actual installation is not part of the project. The EIR/ICR Team made no essential findings or findings. One observation is discussed below.

Observation: Although both projects continue to consider issues of installation in completing the detailed detector designs, it appears that the level of detail with regard to constraints on installation differ between the CDF and D-Zero TDRs.

Recommendation: The management of the two projects should review detector installation requirements and procedures to assure that a sufficient degree of planning regarding actual installation has taken place to enable extraction of all installation constraints on design prior to completion of design.

3.4 MANAGEMENT, PLANNING, AND CONTROL

3.4.1 Mission Need/Objectives

The EIR/ICR Team reviewed the project documents and finds the projects fully consistent with the stated mission. The EIR/ICR Team made no essential findings, findings, or observations.

3.4.2 Team/Management Issues

The EIR/ICR Team reviewed the role and functioning of the project team. The EIR/ICR Team made no essential findings or findings. The one observation is discussed below.

Observation: An Integrated Project Team (IPT) as required by DOE O 413/3 is identified in PEP, with appropriate responsibilities of members noted. However, it is not apparent that the IPT has played a role in the DOE management of these projects.

Recommendation: Include in the PEP a description of how the IPT will be used in DOE management of the projects, in accordance with DOE requirements and guidance.

3.4.3 Documents/Requirements

The EIR/ICR Team reviewed project documentation and other requirements of DOE O 413.3, including the status and adequacy of the PEP, efficacy of the project's acquisition plan, the project's configuration management program, the project's management tools, and use of value engineering in design development. The EIR/ICR Team made two essential findings, no findings, and one observation—all of which are discussed below.

Essential Finding: The PEP for these projects is incomplete.

While included in the Project Management Plans, many technical considerations required to be in the PEP by DOE O 413.3 are neither addressed nor referenced in the PEP. Among these are:

- Value Engineering
- Quality Assurance
- Risk Management

Recommendation: The PEP should be amended to include all required considerations, either directly or by reference.

Essential Finding: Neither project has developed a project-specific configuration management and control process, as required by DOE O 413.3. Further, no Laboratory configuration management/control policy or procedure is cited in the PMP of either project. Moreover, no signature or other indication of approval exists on the TDR for either project.

No project-specific procedures for controlling drawings, specifications, and other engineering records are in place. Current versions of drawings are kept in a central file, and entered in a computerized list. However, there is no specific process or procedure to follow that either establishes or verifies the authenticity and currency of drawings, specifications, and other design documents. In particular, the TDRs, which are the primary design documents for the projects, bear no indication of approval or authenticity. Thus, no assurance is provided that team members are working only with appropriate documents.

Recommendation: A project-specific configuration control procedure should be developed and implemented by each project.

The EIR/ICR Team reviewed the project's quality assurance program and procedures for identification, reduction, and mitigation of risk. No essential findings or observations were made. However, the EIR/ICR Team did make one finding, which is discussed below.

Finding: There is no description or reference in the PEP, or in either project PMP, to flow-down of requirements and processes for Quality Assurance/Quality Control to specifics of design, fabrication, procurement, or establishment/maintenance of document approval/authenticity.

Quality Assurance policies and practices exist at both laboratory and division levels. Further, the QA/QC role and responsibilities of the project manager is clearly stated in both project PMPs. Moreover, detailed QA/QC requirements, including testing requirements, often accompany, or are incorporated into, component specifications. Nonetheless, the logic train leading from laboratory and division policies to component-specific QA/QC requirements is not clear. This need for a road map to trace development of specific QA/QC requirements from broad upper level policies is particularly needed since no independent QA organization for these projects seems to exist. Among topics that should be considered are the following:

INSPECTIONS

- Scope and frequency of inspections
- Identification of all fabrication hold points
- Qualifications of inspectors
- Inspection documentation requirements
- Procedures for nonconformance reporting and corrective actions

ACCEPTANCE TESTING

- List of components and systems subject to acceptance testing
- Acceptance criteria – functional and operational requirements
- Test procedures
- Delineation of responsibilities for acceptance testing between contractors and PFS
- Test schedules.

Recommendation: The projects should develop a description of how Laboratory and Department QA/QC policy and procedures are realized in the specifics of design, fabrication, and procurement requirements. This description should serve as project-specific QA/QC guidance throughout the development of the design and construction of detectors and related systems. This description also should address specific QA/QC topics such as those cited above.

3.5 EXTERNAL FACTORS

3.5.1 Site Integration

The EIR/ICR Team reviewed inter-site and on-site coordination issues as well as possible effects of this project on other activities at FNAL. There were no essential findings, findings, or observations noted.

3.5.2 Site Documents/Requirements

The EIR/ICR Team reviewed the status and schedule for attainment of regulatory approvals and permits needed to proceed with the projects. No project-specific permits or regulatory approvals are required.

Permits and regulatory approvals for the Tevatron encompass these projects and are current. A categorical NEPA exclusion for these projects is on file in the project documentation.

3.5.3 Stakeholder Integration

The stakeholders for this project outside the Laboratory and the Department of Energy are the institutions and individuals participating in the experiments that will use the upgraded CDF and D-Zero detectors during Run IIb at FNAL.

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX A – ACRONYMS and ABBREVIATIONS

CD-2	Critical Decision 2
CDF	Collider Detector at FNAL
CERN	European Organization for Nuclear Research
CPM	Critical Path Method
DOE	Department of Energy
EIR	External Independent Review
ES&H	Environmental Safety and Health
ESAAB	Energy Systems Acquisition Advisory Board
FAO	Fermi Area Office
FNAL	Fermi National Accelerator Laboratory
ICR	Independent Cost Review
IPR	Independent Performance Review
IPT	Integrated Project Team
ISM	Integrated Safety Management
LHC	Large Hadron Collider
MRI	Major Research Instrument (grant)
NSF	National Science Foundation
OECM	Office of Engineering and Construction Management
OPC	Other Project Costs
PEP	Project Execution Plan
PMP	Project Management Plan
PPD	Particle Physics Division
QA	Quality Assurance
QC	Quality Control
SiDet	Silicon Detector Facility
TDR	Technical Design Report
TEC	Total Estimated Cost
WBS	Work Breakdown Structure

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX B - REVIEW TEAM BACKGROUND

FRANK A. COSTANZI, Ph.D., JUPITER
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Education

Ph.D., Physics, Northwestern University, 1971
B.S., Physics, University of Santa Clara, 1966

Experience Summary

Dr. Costanzi has over 20 years of experience planning, developing, and managing multi-million dollar research and regulatory programs over a spectrum of scientific and engineering disciplines including management and disposal of radioactive wastes, light water reactor safety, light water reactor decommissioning, and radiation health effects. He currently leads multidisciplinary teams of experts conducting External Independent Reviews of DOE facilities and projects. Dr. Costanzi has led or participated in over a dozen EIRs with JUPITER.

Dr. Costanzi was the Deputy Director of the Division of Regulatory Applications in the Office of Nuclear Regulatory Research at the U.S. Nuclear Regulatory Commission (NRC) and was responsible for the day-to-day activities of some 60 professionals representing a broad range of skills and expertise: physics, chemistry, geology, materials science, engineering, radiation biology, epidemiology, computer science, environmental science, and economics.

Dr. Costanzi was responsible for the planning and oversight of the development of regulations that shaped, expressed, and implemented regulatory policy of the Nuclear Regulatory Commission. He managed the development and promulgation of over 50 rulemakings dealing with a broad variety of technical and policy subjects: regulations on radiological criteria for decommissioning nuclear power plants, renewal of licenses for nuclear power plants, revisions to the Commission's regulations on radiological protection, management of high-level and low-level radioactive wastes, and numerous rulemakings updating and amending NRC requirements.

Certification/Professional Affiliations

Sigma Xi - American Research Society

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EDUCATION

M.S., Nuclear Engineering, University of Virginia, 1970
B.S., Mechanical Engineering, Villanova University, 1962

EXPERIENCE SUMMARY

Mr. Bader's experience includes managing a nuclear medical-research project, and overseeing facilities design and construction. He has conducted numerous program/project reviews and has extensive knowledge about design, construction, management and operations of R&D, materials production and power plants.

Mr. Bader is experienced in design and construction of fissile nuclear material processing facilities including primary and secondary containment systems. As part of Weapons Complex Reconfiguration, he conducted design reviews of 1.) glove box lines to replace those deactivated at Rocky Flats in 1989 and 2.) Los Alamos National laboratory's TA-55 facilities being considered for production of "diamond-stamped" plutonium pit production. He is knowledgeable of various glove box systems design including the main safety-class and safety-significant systems, structures, and components (SSCs), and auxiliary systems including HEPA filtration systems. Mr. Bader's experience also includes assembly of complex components; planning and selecting materials, equipment and methods; evaluation and characterization of special nuclear materials, systems or components; review of test parameters for materials, components or systems; and systems safety analyses for a glove box containment systems and effluent removal systems.

As a Senior Project Director for Fluor Daniel at the Hanford site, Mr. Bader led a team of managers, professionals and workers in developing a seven-year strategic plan to double the percentage of the annual billion dollar budget applied to actual cleanup and closure activities at the DOE Hanford Site. A major focus was revising the philosophy and application of maintenance and operating procedures for the non-nuclear facilities and systems. He also authored a Hanford site-wide "Critical Self-Assessment" of Fluor Daniel's architectural, engineering, construction, construction management, operations, and maintenance performance. The Assessment was prepared in response to Congressional and State concern over Fluor's initial performance. The final report included recommended actions to resolve performance problems uncovered in the review.

Mr. Bader initiated Fluor's Washington, DC program office supporting the DOE Weapons Complex Reconfiguration Program. Under Mr. Bader's planning, direction, and oversight, Fluor performed design and construction management activities related to a "safer, more modern, more environmentally benign" Weapons Complex. The DC Office provided regulatory and compliance, master scheduling, systems engineering and integration, and support activities to Defense Programs for eight projects over 10 years.

As member of a team comprised of Fluor Senior Project Directors in the government sector, Mr. Bader researched, wrote, published, communicated, and supported training and implementation of Fluor's project management policies and procedures. Research involved in-depth analysis of aerospace and DoD program acquisition systems. Phased training and implementation began with projects in excess of $100 million and ended with corporate-wide deployment. Processes for value engineering, trade analysis, project execution planning, project management planning, systems requirements documentation, roadmapping, and earned value management were evaluated, documented, piloted and implemented.

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Education

B.S., Chemical Engineering, Auburn University, 1961

Experience Summary

Mr. Davies specializes in Cost Engineering, Estimating, and Scheduling of construction projects. He advises private industry and governmental agencies in reviewing and evaluating project construction, startup, operation schedules and cost estimates. He prepares construction estimates and schedules of proposed commercial and industrial facilities as well as definitive estimates of completed designs prior to release for construction. He acts as client agent in reviewing construction plans and schedules to assure the design is followed and completion dates can be achieved.

Mr. Davies has over 25 years of experience in Estimating, Scheduling, and Cost Engineering of projects in the nuclear fuel cycle. He has successfully completed assignments at most of the DOE field locations as well as for private industries utilizing nuclear technology. He has held responsible positions such as Manager of Estimating for the Advanced Technology Division of a large construction company; Manager of Technical Services, responsible for scheduling, estimating, and cost control on a multi-billion dollar project for a commercial client; and Field Construction Engineer for a major chemical company.

R. KYLE FARMER, JUPITER
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Education

Undergraduate courses, Engineering, Amarillo College
Undergraduate courses, Architecture, Texas Tech University
Professional development courses in computer sciences and cost estimating, Amarillo College and West Texas State University

Experience Summary

Mr. Farmer has over 40 years of experience in civil engineering and cost engineering. He has supervised a full range of service, supply, construction contract estimates, and construction contract modification estimates. Mr. Farmer provides cost estimating, scheduling, and cost engineering expertise in the conduct of external independent reviews of DOE.

Mr. Farmer served as Manager of the Construction Cost Estimating Section for Mason-Hanger Silas Mason Inc., where he was responsible for providing a full range of estimating services for construction, service, and supply contracts for DOE's Pantex Plant in Amarillo, TX. This included project retention of plant historical cost data, verification of general contractor change order costs, and compliance with DOE Orders 4700.1, 5700.2C, and MA-0063 relative to cost submittals for Conceptual Design Reports and Project Data Sheets. He directed and supervised five to seven cost and scheduling estimators estimating a cost volume of $195 billion per year. He participated as a member and sub-team leader for Independent Cost Estimating for the DOE EM Cost Quality Management Assessments.

Mr. Farmer served as a Construction Cost Estimator at Pantex and was responsible for architectural, structural and civil estimating including collection and retention of their historical cost data. He was responsible for ensuring that cost estimates were in compliance with relevant DOE orders. As a Project Engineer at Pantex, Mr. Farmer was responsible for the budgets, schedules, funding and progress tracking, and design of projects at the Pantex Plant. Average volume of projects per year was $25M. He was also detailed to the Joliet Army Ammunition Plant project for four months.

He has co-authored several DOE publications, including:

- Rewrite of DOE Order 5700 for DOE Headquarters
- Rewrite of Section 8, BOD/MA-0063 for DOE Headquarters
- DOE Order 5700 for DOE Albuquerque
- U.S. DOE Construction Contingency Analysis Guidelines
- U.S. DOE Engineering, Design, and Inspection Analysis Guidelines
- Environmental Cost Guidelines for DOE Headquarters

Certifications/Professional Affiliations

American Association of Cost Engineers
American Society of Professional Estimators

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Education

M.S. Nuclear Physics, University of South Carolina, 1986
B.S., Math and Physics, University of South Carolina, 1982

Experience Summary

Mr. Moore has more than seventeen years of experience supporting nuclear, environmental, and project management programs for DOE, NRC, and their contractors. He has a wide range of experience in the design, development, and implementation of scientific databases, especially those related to waste and materials management.

Mr. Moore participates in independent evaluations of DOE construction and programmatic projects under the authority of Public Law 105-62, Conference Report H.R.105-271, and DOE Order 413.3. These evaluations provide an independent assessment of project progress and status prior to critical decisions in the project life. Mr. Moore has participated in more than 10 such reviews over the past three years. For the DOE Office of Contract Reform and Privatization, Mr. Moore led a study of contract transition at DOE sites, focusing on management and operating/management and integrating contracts. . He also reviewed draft Requests for Proposals for major DOE procurements (Yucca Mountain Project and the Hanford Waste Treatment Plant Project).

Mr. Moore provided support to NRC for the development of the National Sealed Source and Device Registry (NSS&DR) System. This support included detailed data modeling, data conversion, and development, implementation, and documentation of an object-oriented application.

Mr. Moore managed and supported a broad range of technical programs for DOE's Office of Environmental Management (EM), including the Waste Management Information System, the DOE EM Roadshow, DOE's Technology Information Exchange (TIE) Program, radioactive metals policy development, and the development of a regulatory compliance guide for transportation of radioactive materials.

For DOE's Office of Civilian Radioactive Waste Management (OCRWM), Mr. Moore was the principal investigator for the Characteristics Database System, OCRWM's official source of the characteristics of the wastes that require long-term isolation. He also participated in a Production Budget and Cost Estimating Review for DOE's Isotope Production Program and led the development of regulatory cross-reference guide for the K-1435 TSCA Incinerator.

Certifications/Professional Affiliations

American Physical Society

CLIFFORD F. POOR, JUPITER
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Education

Ph.D., Chemical Engineering, Montana State University, 1959
B.S., Chemical Engineering, Montana State University, 1956
Postgraduate course work in chemical engineering, nuclear engineering, process computer application, nuclear waste technology and project management.

Experience Summary

Dr. Poor has more than 30 years of technical and management experience in the investor-owned and government nuclear and environmental management sectors. He served as Technical Leader, Project Manager, Program Manager and Vice President overseeing complex projects requiring the coordination of interacting companies, organizations, and multi-disciplinary groups to accomplish design, development, construction, testing, and operation of nuclear facilities and environmental restoration and waste management projects at Department of Energy (DOE) operations and field offices. He was a key contributor to corporate strategic planning activities and served on the Board of Directors' operating committee of an investor-owned corporation.

Dr. Poor is a Senior Project Manager with JUPITER and assigned to perform external independent reviews and other project activities. As an independent consultant, Dr. Poor most recently participated on an Independent Project Review (IPR) for EM-1 on the Hanford Waste Treatment and Immobilization Project. As Vice President for the Legin Group, Dr. Poor managed projects providing management, technical, and administrative support services to the DOE Office of Environmental Management (EM), Office of Science, and the Office of Engineering and Construction Management (OECM), and the Human Health Services, Health Resources and Services Administration (HRSA). He was a principal contributor to EM's Independent Project Reviews (IPRs) having participated in ten major project reviews; he prepared the Quality Assurance Plan for the HRSA contract; and he managed and participated in Legin's tasks supporting OECM's Project Managers Career Development Program. Dr. Poor managed multi-disciplinary technical and administrative staff supporting DOE's Environmental Restoration Program, where he served as the EM-44 Northwestern Area Programs Manager. With a multi-contractor and multi-discipline staff, Dr. Poor provided management and technical support to the EM Team Leaders for DOE Offices at Richland, Idaho National Engineering and Environmental Laboratory (INEEL), Oakland, and Chicago. He was a key participant in the initial formation of the EM Privatization Program with the preparation and administration of the billion dollar FY 98 privatization project proposals. For UNC Analytical Services, Dr. Poor served as Vice President and Special Isotope Separation (SIS) Project Manager; Idaho Falls, ID and Livermore, CA. Dr. Poor's earlier career included assignment to serve as liaison between DOE Idaho and UNC GEOTECH at Grand Junction, CO in support of the uranium mill tailings and vicinity properties cleanup activities. Dr. Poor organized, staffed, and managed a multi-disciplinary project coordination group charged with the review and approval of design, procurement specifications, as well as vendor and plant acceptance testing for new and upgraded systems for the Hanford N Reactor.

Certificates/Professional Affiliations

Professional Engineer, Nuclear Engineering; California, 1976
American Institute of Chemical Engineering, Sigma Xi Research Fraternity, Tau Beta Pi Engineering Scholastic Fraternity, Phi Kappa Phi Scholastic Fraternity

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX C – LIST OF DOCUMENTATION REVIEWED

JUPITER Document Number	Document Title	Author	Date
03A-001	The CDF IIb Detector Technical Design Report		02-Sep-02
03A-002	The Run Iib CDF Detector Project Presentation	Patrick T. Lukens	24-Sep-02
03A-003	Run IIB Silicon Upgrade: Cost and Schedule Presentation	Brenna Flaugher	24-Sep-02
03A-004	CDF & D-Zero Acquisition Execution Plan		23-Sep-02
03A-005	CDF Project Management Plan		12-Sep-02
03A-006	Memorandum of Understanding Between <Institution> and the CDF Run IIb Project at Fermilab - Draft		06-Sep-02
03A-007	Statement of Work by the CDF Run IIB Group at <Institution> for Activities Related to the CDF Run IIB <Subsystem> Subsystem During Fiscal Year 2002 - Version 2.0		
03A-008	CDF Preliminary Hazard Assessment for Run IIb		23-May-02
03A-009	Q&A of the Risk of the EM Timing Project and Our Plans (CDF)		01-Jul-02
03A-010	Risk Analysis CDF Run IIb Silicon Detector Upgrade		
03A-011	Risk Analysis for Level 2 Upgrade		23-Sep-02
03A-012	Risk Analysis for Event Builder and Level 3 Upgrade		23-Sep-02
03A-013	Run IIa Silicon Schedule (Cost Loaded)		23-Sep-02
03A-014	Historical Overview of the SiDet Workforce for Collider Run	J. Cooper	11-Sep-02
03A-015	Single Channel Signal Flow Diagram		
03A-016	Using Pulsar as an upgrade for L2 decision crate (CDF)	Ted Liu	
03A-017	XFTIIB: Online Track Processor for CDF Run IIB	Brain Winer/Richard	25-Sep-02
03A-018	Event Builder/Level-3 Upgrade for CDF Run II	Christoph Paus	01-Sep-02
03A-019	SVT Changes for SVX 2b Geometry (CDF)	Bill Ashmanskas	
03A-020	Comparison of the CDF and D0 Silicon Detectors		12-Sep-02
03A-021	CDF Run 2b (CDF Physics Collaboration)	Nigel Lockyer	24-Sep-02
03A-022	CDF Run IIB Calorimeter, Trigger & Data Acquisition Upgrades	Kevin Pitts	24-Sep-02
03A-023	Italian Support for Run IIB Outline	F. Bedeschi	
03A-024	Draft DOE Project Execution Plan for Run IIb CDF Detector Project and Run IIb D-Zero Detector Project at Fermi National Accelerator Laboratory		23-Sep-02
03A-025	Run IIb Silicon Upgrade: Technical Presentation Baseline Readiness Review	Nicola Bacchetta	24-Sep-02
03A-026	WBS Dictionary as of Friday 9/20/02 CDF Run IIb Administration Schedule		20-Sep-02
03A-027	WBS Dictionary as of Thursday 9/19/02 CDF Run IIb Calorimeter Schedule - (High Level - 4)		19-Sep-02
03A-028	WBS Dictionary as of Thursday 9/19/02 CDF Run IIb Calorimeter Schedule - (Low Level - 5&6)		19-Sep-02
03A-029	WBS Dictionary as of Friday 9/20/02 CDF Run 2B Data Acquisition and Trigger Upgrade - (High Level - 4)		20-Sep-02
03A-030	WBS Dictionary as of Fri 9/20/02 CDF Run 2B Data Acquisition and Trigger Upgrade - (Low Level 5&6)		20-Sep-02
03A-031	WBS Dictionary as of Fri 9/20/02 CDF Run2B Silicon Detector Schedule - (High Level - 4)		20-Sep-02

JUPITER Document Number	Document Title	Author	Date
03A-032	WBS Dictionary as of CDF Run 2b Silicon Detector Schedule - (Low Level 5&6)		20-Sep-02
03A-033	Acquisition Execution Plan CDF & D-Zero		03-Oct-02
03A-034	Memorandum of Understanding Between <Institution> and the D0 Run IIb Project at Fermilab, VI.4		09-Dec-02
03A-035	Statement of Work by the D0 Group at <Institution> for Activities Related to the D0 IIb <SUBSYSTEM> Subsystem During Fiscal Year 2003 V.1		
03A-036	Memorandum of Understanding between *Collaborator* and the D0 Collaboration		01-Aug-02
03A-037	DOE Project Execution Plan (CDF & D-Zero)		25-Oct-02
03A-038	WBS 1.5 Installation Presentation - D0	Rich Smith	24-Sep-02/ Nov. 4-8, 2002
03A-039	Run IIb Silicon Mechanical Design - D0	W. E. Cooper	24-Sep-02
03A-040	Monitoring (1.1.6) Silicon Radiation and Temperature Monitoring - D0	Marj Corcoran	24-Sep-02
03A-041	Silicon Sensors Procurement and Quality Assurance WBS 1.1.1(D0)	Regina Demina	24-Sep-02
03A-042	Detector Production WBS 1.1.4 D0	James Fast	26-Sep-02
03A-043	Quality Assurance, Testing and Burn-in WBS 1.1.4 D0	Cecilia Gerber	24-Sep-02
03A-044	1.1.7 - Silicon software and simulation D0	Elizaveta Chabalina	24-Sep-02
03A-045	Run 2B Silicon Electronics D0	Andrei Nomerotski	24-Sep-02
03A-046	Progress on the L1 Calorimeter Trigger (WBS 1.2.1) D0	Hal Evans	24-Sep-02
03A-047	Silicon Track Trigger (WBS 1.2.5) D0	Ulrich Heintz	24-Sep-02
03A-048	Calorimeter - Track Trigger (WBS 1.2.2) D0	Ken Johns	24-Sep-02
03A-049	L1CTT Physics Case and Simulations D0	Mike Hildreth et a..	24-Sep-02
03A-050	L2 Beta WBS 1.2.4 D0		24-Sep-02
03A-051	L1CTT Implementation	Meenakshi Narain	26-Sep-02
03A-052	DOE Project Manager's/Director's Milestones		
03A-053	DOE Level 1 Milestones		
03A-054	Run IIb Installation (Silicon, L1, L2 Triggers) Schedule		23-Oct-02
03A-055	Run IIb Online/DAQ Schedule		23-Oct-02
03A-056	Run IIb Silicon Tracker Schedule		23-Oct-02
03A-057	Run IIb Trigger Schedule		23-Oct-02
03A-058	WBS Dictionary as of 10/23/02 Run IIb Installation		23-Oct-02
03A-059	WBS Dictionary as of 10/23/02 Run IIb Online/DAQ		23-Oct-02
03A-060	WBS Dictionary as of 10/23/02 Run IIb Project		23-Oct-02
03A-061	WBS Dictionary as of 10/23/02 Run IIb Silicon Schedule		23-Oct-02
03A-062	WBS Dictionary as of 10/23/02 Run IIb Trigger		23-Oct-02
03A-063	Run IIb Installation (Silicon, L1, L2 Triggers) Resources		29-Oct-02
03A-064	Run IIb Online/DAQ Resources		29-Oct-02
03A-065	Run IIb Project Administration Resources		29-Oct-02
03A-066	Run IIb Silicon Tracker Resources		29-Oct-02
03A-067	Run IIb Trigger Resources		29-Oct-02
03A-068	Run IIb Silicon Tracker Critical Path Schedule		23-Oct-02
03A-069	Run IIb Installation (Silicon, L1, L2 Triggers) Schedule		23-Oct-02
03A-070	Run IIb Online/DAQ Schedule		23-Oct-02
03A-071	Run IIb Project Administration Schedule		23-Oct-02
03A-072	Run IIb Silicon Tracker Schedule		23-Oct-02
03A-073	Run IIb Trigger Schedule		23-Oct-02
03A-074	Report of the Combined Director's Review Committee - Director's Review of CDF and D0 Run IIb Detector Upgrades		15-Aug-02
03A-075	D0 Responses to the Report of the Director's Baseline Review Committee for the Run IIb Detector Upgrades		08-Jun-02
03A-076	D0 Responses to Questions from the Physics Advisory Committee		04-Jun-02

JUPITER Document Number	Document Title	Author	Date
03A-077	Responses to the June 2002 PAC Recommendations – The D0 Collaboration		08-Aug-02
03A-078	D0 Response to PAC Question 5: Detailed Evaluation of Silicon Track Trigger Update Options. Prepared for the Fermilab PAC Meeting, Aspen		02-Jun-02
03A-079	Silicon Management D0 Presentation	Alice Bean	24-Sep-02/ Nov. 4-8, 2002
03A-080	The D0 Run 2b Silicon Tracker Project, A Technical Overview Presentation	Marcel Demarteau	24-Sep-02/ Nov. 4-8, 2002
03A-081	DAQ and Online (WBS 1.3) D0 Presentation	S. Fuess/P. Slattery	24-Sep-02/ Nov. 4-8, 2002
03A-082	Run IIb D-Zero Detector Project Presentation	Jon Kotcher	24-Sep-02/ Nov. 4-8, 2002
03A-083	The D0 Collaboration and the Run IIb Upgrade: Goals and Commitment Presentation	John Womersley	26-Sep-02/ October 2002
03A-084	D0 Run IIb Trigger Upgrade: WBS 1.2 Presentation	Darien Wood	26-Sep-02/ Nov. 4-8, 2002
03A-085	Project Management Plan for the Run IIb D-Zero Detector Project		28-Oct-02`
03A-086	D-Zero Detector Project, Cost Book 1, WBS 1.1.1 – 1.1.2 Silicon Detector		
03A-087	D-Zero Detector Project, Cost Book 2, WBS 1.1.3 – 1.1.4 Silicon Detector		
03A-088	D-Zero Detector Project, Cost Book 3, WBS 1.1.5 – 1.1.8 Silicon Detector		
03A-089	D-Zero Detector Project, Cost Book 4, WBS 1.2 Trigger		
03A-090	D-Zero Detector Project, Cost Book 5, WBS 1.3 DAQ/Online		
03A-091	DOE Review Committee Report on the Baseline Review of the Run IIb CDF and D-Zero Detector Project		Sept. 2002
03A-092	Reconstructed Top-antiTop Quark Event		
03A-093	Physics Highlights from the D0 Experiment 1992-1999		
03A-094	Run 2b Silicon Working Group Report: Findings and Recommendations	T. Affolder, et al.	03-Dec-00
03A-095	Silicon Sensor Quality Assurance for the CDF Run 2b Silicon Detector (DRAFT)	N. Baccetta, et al.	30-Sep-02
03A-096	CDF Run 2b: Hybrids Assembly, Test, and Quality Assurance		
03A-097	Routine Inputs to Project Management		01-Nov-02
03A-098	Report from the TDC Review Committee		30-May-02
03A-099	Run IIb CDF Detector Project and Run IIb D-Zero Detector Project	Paul Philp	04-Nov-02
03A-100	Costs Accounts for Run IIb	Connee Trimby	04-Nov-02
03A-101	Equipment Cost Accounts for CDF and D-Zero	Connee Trimby	04-Nov-02
03A-102	Cost and Schedule Methodology	Bill Freeman	04-Nov-02
03A-103	D0 Run IIb Cobra Procedures	Colleen Yoshikawa	04-Nov-02
03A-104	D-Zero Run IIb Risk Analysis		
03A-105	Review of the Manpower Requirements at the Silicon Detector Facility for Run IIb and CMS	J. Howell et al.	11-Jun-02
03A-106	NEPA Determination at Fermi National Accelerator Laboratory – Run IIb CDF Detector Project.	Jane Monhart	17-Sep-02
03A-107	NEPA Determination at Fermi National Accelerator Laboratory – Run IIb D-Zero Detector Project.	Jane Monhart	30-Sep-02
03A-108	Fermilab Integrated Safety Management Plan, Rev. 5		August 2002
03A-109	Particle Physics Division Operating Manual – Integrated Safety Management		31-Aug-99
03A-110	Particle Physics Division Operation Manual – ES&H Review of Experiments		27-Jul-01

JUPITER Document Number	Document Title	Author	Date
03A-111	Listing, Audits/Assessment of the SiDet Facility		
03A-112	Audit Details: Beryllium (Be) Rule implementation: Handling of Be/BeO at SiDet		27-Sep-02
03A-113	Draft Fire Safety Evaluation for the Neutrino Lab A		10-Oct-02
03A-114	Draft Fire Safety Evaluation for the Neutrino Lab B		10-Oct-02
03A-115	Draft Fire Safety Evaluation for the Neutrino Lab C		10-Oct-02
03A-116	Draft Fire Safety Evaluation for the Neutrino Lab D		10-Oct-02
03A-117	Exhaust System Survey		24-Jul-02
03A-118	Lab A Life Safety Correction	Hans Jostlein	5-Nov-02
03A-119	Individual Training Needs Assessment		
03A-120	Individual Training Summary, TJ Sarlina		5-Nov-02
03A-121	Individual Training History, TJ Sarlina		5-Nov-02
03A-122	Fermilab Work Smart Standards Set		5-Nov-02
03A-123	List of Applicable Directives, URA Contract with DOE		
03a-124	DOE Fermi Area Office Run II Operations Concurrence	Jane L. Monhart	16-Mar-01
03A-125	Comments on the EM Timing Proposal	P. Lukens, et al.	29-Nov-01
03A-126	Run 2b Tracking Godparent Committee	B. Winer, et al.	6-Jul-01
03A-127	Low Hazard and Radiological Facility Classifications for the Fermilab D-Zero Detector	Andrew Mravca	25-Mar-94
03A-128	Fermilab Drafting Standards		January 2001
03A-129	Indirect Burden Rates for Run IIb Upgrade Projects Costs Estimates	Connee Trimby	5-Nov-02
03A-130	Fermi IDM CAD Table of Contents, Release 1.0 Draft		18-Feb-02
03A-131	FY02 PPD Expenditures by Project/Activity		
03A-132	CDF Run IIa Costs Estimates		18-Dec-97
03A-133	CDF Run IIa Change Request Log		
03A-134	Low Hazard Facility Classification for the Collider Detector at Fermilab.	Andrew Mravca	9-May 95
03A-135	Document-Index System	F.T. Cole et al.	18-Feb-70
03A-136	SOW for D0 Group at UI-Chicago for D0 during FY2003		12-Sep-02
03A-137	Drawing Release Procedures for SiDet	Chuck Grimm	15-Mar-01
03A-138	D0 Long Lead Procurements, Starts before July 1, 2003		7-Nov-02
03A-139	MOU Between UI – Chicago and the D0 Run IIb Project		12-Sep-02
03A-140	Reporting/Managing Schedules, Statusing	Jonathan Kotcher	25-Oct-02
03A-141	CDF Schedule Outputs – Gantt Charts, Milestones, Critical Path, & WBS Dictionaries		23-Oct-02
03A-142	CDF Equipment Costs Before July 2002		7-Nov-02
03A-143	SiDet Group Coordinate Measuring Machine Operator Authorization	Michael Roman	
03A-144	SiDet Micro Bonding Group Job Qualification	Tamara Hawke	
03A-145	CDF Total Costs and Funding		7-Nov-02
03A-146	Project Cost/Obligation Tables in FY02$, Run IIb D0 Detector Project	Jonathan Kotcher	4-Nov-02
03A-147	Run IIb Upgrade Technical Design Report	D0 Collaboration	12-Sep-02

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX D – INDEPENDENT COST REVIEW (ICR)

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Engineering and Construction Management (OECM), within the Office of the Chief Financial Officer, provides construction management oversight for DOE projects. OECM has been designated lead DOE office in establishing guidelines to ensure that project performance baselines are developed for each new project, to ensure that independent reviews are undertaken to verify and validate project baseline, and to develop procedures which make availability of project funding contingent upon successful review and approval by OECM.

Pursuant to DOE Order 413.3 a performance baseline EIR shall be performed on all capital projects over $5M before CD-2, *Approve Performance Baseline*. EIRs for such projects are to include an Independent Cost Review (ICR). The entire cost estimate was reviewed in detail by the ICR Team to verify that nothing had been omitted or misrepresented in the estimate. The approach used was to verify the validity of the methods and reasoning used by the project and make findings and recommendations, as appropriate. The scope for the ICR is the current target schedule, current cost estimate, and project design documents. The ICR validation is provided to OECM to support the CD-2 process.

The ICR of the project cost estimate produced findings, observations, recommendations, and a noted best practices. These are presented in the Cost and Schedule Section of the EIR report of which this report is a part.

ICR BACKGROUND

Objective of the ICR

The objectives of the ICR review are:

- To provide specific feedback to DOE, and to the contractor, as to the quality of the cost estimate, and suggest potential improvements, thereby strengthening the project management system.
- To determine if the cost estimate components (i.e., procurement, construction, and support, etc.) have been developed using uniform estimating methods as well as consistent estimate terminology.
- Examine all cost elements and note any anomalies.

REVIEW METHODOLOGY

ICR Scope Detail Basis

The ICR was prepared using materials provided by the project – drawings and component and system descriptions included in the preliminary design documents, the current cost estimate, and the current schedule – and drawing upon discussions held with the projects' estimators and managers. Guidance published in DOE Guide 430.1-1 was employed as a development basis for the ICR and this report.

In the course of conducting this ICR, the ICR Team examined the following:

- Conceptual Drawings
- Component Drawings
- Equipment Specifications
- Basis of Cost Estimate

During a five-day site visit from November 4 – 8, 2002, the ICR Team met with team members of both projects to obtain further clarification on the project controls system and design details, as well as to resolve issues that were identified during preliminary review of project documents.

Estimating Techniques

The ICR Team validated the estimating techniques used by the project estimators using techniques described below:

Bottoms-up Technique—A work statement and set of drawings and specifications were used to "take off" material quantities required to perform each discrete task performed in accomplishing a given operation or producing an equipment component. From these quantities, direct labor, equipment, and overhead costs were derived and added.

Specific Analogy Technique—Specific analogies, based upon the known cost of an item used in prior projects (e.g. Run IIa), were used as the basis for the cost of a similar item in these projects. Adjustments are made to known costs to account for differences in relative complexities of performance, design, and operational characteristics.

Expert Opinion Technique—The "Expert Opinion" of the ICR reviewers was used to judge the reasonableness of estimates in those areas where no source of specific data and supporting materials independent of the projects was available.

CONCLUSION

The cost review focused on completeness, reasonableness, and accuracy of the CDF and D-Zero upgrade projects cost estimates. The ICR team put special emphasis on costs for detector fabrication, escalation, contingency, project management, and markups. The ICR team reviewed costs for compliance with DOE Order 430.1, OMB Circular A-11, and DOE Cost Guide, 430.1-1.

The ICR team developed production cost estimates for both projects with its own quantity takeoffs and used the Davis-Bacon wage rates for labor costs, locally adjusted for the locale of the FNAL site. The ICR Team check estimate for the D-Zero project is 0.63% lower than the site estimate and the check ICR Team estimate for the CDF project TPC is 1.68% higher than the site estimate. Time did not permit a thorough review of the site estimate for equipment, but the ICR team noted that many of the equipment costs were based on actual purchases and vendor quotes. The projects' estimates of equipment costs were used by the ICR team in its check estimates.

The ICR Team developed its own estimates of hours for project management, and used the site hourly rates to estimate management costs. Markups were not separately identified in the project estimates, but were reviewed by the ICR team. The ICR team estimate of $5,873,296 is 43.65% lower than the D-Zero site estimate and $6,754,321 is 36.41% lower than the CDF site estimate. The parametric estimating program used by the review team allocates labor on equipment to the equipment costs.

The ICR Team developed its own contingency analysis. The ICR Team contingency estimate for the D-Zero project was $5,640,510, which was 37% of the D-Zero project TEC. The ICR Team contingency estimate for the CDF project was $6,314,874 – again, 37% of the CDF project TEC. The D-Zero and CDF project contingencies are $6,490,000, and $7.850,000, respectively, both 46% of TEC.

The current D-Zero project cost estimate is $28,600,000 TPC and $20,620,000 TEC. The current CDF project cost estimate is $30,380,000 TPC and $24,990,000 TEC. The ICR Team check estimate of the D-Zero project was $28,424,595 TPC and $20,742,512 TEC—0.63% lower than the project's estimate. ICR Team check estimate of the CDF project was $29,871,599 TPC and $23,236,501 TEC—1.68% lower than the project's estimate. Cost review guidance typically requires that a review estimate be within 10% of the project's estimate. Using this guidance, the ICR team believes that, overall the projects' cost estimates are reasonable.

Cost Variance Tables
D-Zero Project

Work Activity	EIR/ICR Team Quantitative Takeoff Estimate	Project Cost Estimate	Percent Variance
Equipment	14,869,216	10,196,000	
Site Labor	5,873,296	10,424,000	
Subtotal	20,742,512	20,620,000	0.59%
Other Project Cost			
R & D	3,578,083	3,880,000	
NSF	3,068,000	3,068,000	
Foreign	599,000	599,000	
US Univ.	437,000	437,000	
Total	28,424,595	28,604,000	0.63%

CDF Project

Work Activity	EIR/ICR Team Quantitative Takeoff Estimate	FNAL Cost Estimate	Percent Variance
Equipment	16,482,180	13,548,000	
Site Labor	6,754,321	10,621,000	
Subtotal	23,236,501	24,139,000	3.74%
Other Project Cost			
R & D	3,385,098	2,964,000	
Foreign	2,870,000	2,870,000	
US Univ.	380,000	380,000	
Total	29,871,599	30,383,000	1.68%

It should be noted that equipment take off method used by the ICR Team to estimate the equipment costs yields the total cost of each equipment item, which includes the labor costs associated with the equipment item. However, the projects' estimate of equipment costs does not include the cost of associated labor. Similarly, the projects' labor estimates include the labor costs associated with the equipment items as well as the administrative, management, and testing and installation costs, whereas the ICR Team's estimates of labor covers only these latter categories. For this reason, the cost comparisons as displayed in the above tables are made between the totals of equipment and labor.

Although the installation of the completed detectors into the collider halls and their subsequent commissioning is explicitly outside the scope of these two projects, to provide a perspective on the total costs of the detector upgrades, the ICR Team estimated the costs of installation and commissioning. These estimates are based upon both the WBS elements for installation and commissioning included in the D-Zero WBS dictionary (WBS elements 1.5.X), and the actual costs of the installation and commissioning of the Run IIa upgrade projects. In addition, the ICR Team also added in the costs of the Fermi and University physicists and support personnel that are assigned to the projects, but who are uncosted. These ICR Team estimates of additional costs should be considered rough estimates since data needed to support a precise estimate is not detailed in the project documents furnished to the ICR Team. Nonetheless, the ICR Team was able to make some reasonable assumptions, based upon the hourly rate for physicists provided by the DEF project.

The ICR Team estimated cost for installation and commissioning of both detectors and their supporting services is approximately $2,475,000. In addition, the uncosted physicist labor associated with this activity is approximately $ 3,804.000.

The estimated cost of the Fermi and University physicists and their support personnel, including post-doctoral fellows, graduate students, and technicians for both projects is approximately $ 26,865,000.

The estimated cost for installation and commissioning of both detectors and their supporting services is approximately $2,475,000.

The estimated cost of physicist and support personnel is based on Fermi Laboratory furnished data for physicist salary of $98,500 per year plus G & A.

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX E – LINES OF INQUIRY

The following topics have been developed to establish the general scope and work activities of the EIR. Topics were developed independently by the OECM Technical Monitor for this EIR and provided to the Review Team as work activities. The EIR Team has adapted the review topics and amplified or clarified the topics, as appropriate, in discussion with the OECM Technical Monitor for the review. These topics are intended to clearly communicate the scope of the EIR to the project team, program office, OECM, and the review team. For each project, the review will include lines of inquiry that address the topics and work activities listed below:

1. **Resource/Cost-Loaded Schedule:** Review the overall resource/cost-loaded schedule including the critical path, and the supporting documentation for the cost & schedule. For selected WBS elements (approximately 30% of the overall cost), review the detailed line items, including the detailed basis for the cost and schedule. The "perform construction" WBS element should be included in the cost review. Perform an independent cost-schedule estimate for the same elements reviewed in detail as a check-estimate. Perform a parametric estimate of the total project as an additional independent check of the project cost. As part of assessing the basis, address adequacy of cost/schedule contingency. The review team should utilize current project design drawings, including status drawings, vendor quotes, and related information for the detailed WBS cost review.

2. **Funding Profile:** Review the project funding profile and compare to resource/cost-loaded schedule. Review the funding profile for consistency with the Project Data Sheets.

3. **WBS:** Review the project WBS used for project management, including cost/schedule development. Assess completeness of the WBS for the project scope and work plans. Review the WBS dictionary.

4. **Risk Management Plan:** Review and assess the project risk management plan including: 1) completeness of risk identification; 2) as appropriate, whether risk mitigation actions been incorporated into the baseline; 3) as appropriate, whether cost and schedule contingency have been included in the baseline. Determine whether the risk assessment was derived using a deterministic approach generated from assessment of uncertainties in each of the WBS elements. If not, assess contingency based on probabilistic approach. Assess the effectiveness of the risk mitigation approach. Determine whether the risk analysis includes both direct project risks based on specific project line items (WBS) and overall project risks.

5. **Preliminary Design:** Review and assess the technical baseline. Assess the completeness of the Preliminary Design package including the baseline drawings, diagrams, and lists. Review the results and proposed responses of the Design Review of the Preliminary Design. As appropriate, assess whether necessary additional work identified in the design review has been incorporated into the baseline.

6. **System Requirements:** Review the system functional and technical requirements against the project scope. Assess the completeness and consistency of the flow-down from the functional and technical requirements to design criteria and to project design documents. Assess whether the Preliminary Design appropriately incorporates the design requirements.

7. **Integrated Safety Management (ISM):** Evaluate the ISM implementation on the projects for completeness and appropriateness per DOE O 413.3 as tailored for the projects.

8. **Value Engineering:** Determine whether Value Engineering has been performed on the project and determine whether results are reflected into the baseline. Determine if trade off studies have been appropriately performed on the project design to assist in design decision-making.

9. **Project Controls:** Review the project control systems presently in use and any planned for use prior to CD-2, to assess their adequacy and completeness. Evaluate the cost and schedule control and reporting system, including project procedures. Assess the availability and suitability of project controls for reporting earned value against the CD-2 baseline.

10. **Project Execution Plan (PEP):** Determine if the PEP is complete, and ready for appropriate approval, per DOE O 413.3. In particular, evaluate the completeness of the required PEP sections, or referenced documents, including: Project Management Plans, Quality Assurance Plan, configuration management and control system, program and project organization including defined roles and responsibilities, and integration of management elements. Evaluate appropriateness of Federal staffing levels and disciplines of Integrated Project Team.

11. **Acquisition Execution Plan:** Review the AEP for completeness and compliance with DOE O413.3.

12. **External Interfaces:** Determine if appropriate project and program interfaces have been identified and are being used appropriately to assure success of the project, including both on-site and off-site agreements, public involvement, and regulatory oversight.

EXTERNAL INDEPENDENT REVIEW OF
RUN IIb CDF DETECTOR PROJECT
and
RUN IIb D-ZERO DETECTOR PROJECT
at
FERMI NATIONAL ACCELERATOR LABORATORY
CHICAGO, ILLINOIS

APPENDIX F – CORRECTIVE ACTION PLAN

ID No	Section Ref	Pg Ref	Recommendation	Required Action (Discussion)	Action Office	Start/Compl.	Current Status	Site Use	Review Team Perspective
1	3.1.1 Cost Estimate / Project Funding	8	Revise the cost estimate by adding a recap sheet to the start of the cost estimate.						
2	3.1.1 Cost Estimate/Project Funding	8	Prior to CD-3, revise the cost estimates by escalating to the midpoint of each WBS element.						
3	3.1.1 Cost Estimate / Project Funding	9	Prior to CD-3, *Approve Start of Construction*, the Federal Project Manager should assure that the schedules of both projects contain a cost column, and these columns should contain costs associated with the concurrent Task ID's (Activity).						
4	3.1.2 Cost Risk Analysis	9	The projects should consider distributing contingency across all funding sources.						
5	3.1.4 Future Cost Forecast	10	A new risk calculation should be made, and contingency derived from the quantification of risk employing a Monte Carlo approach, as recommended in DOE Guidance, *Project Management Practices* , October 2000.						
6	3.2.1 Project Schedule	10	Long lead procurements should be indicated specifically in the CPM schedules for both projects.						

ID No	Section Ref	Pg Ref	Recommendation	Required Action (Discussion)	Action Office	Start/Compl.	Current Status	Site Use	Review Team Perspective
7	3.3.4 Solution Preparation for Next Phase	11	The management of the two projects should review detector installation requirements and procedures to assure that a sufficient degree of planning regarding actual installation has taken place to enable extraction of all installation constraints on design prior to completion of design.						
8	3.4.2 Team / Management Issues (IPT)	12	Include in the PEP a description of how the IPT will be used in DOE management of the projects, in accordance with DOE requirements and guidance.						
9	3.4.3 Documents / Requirements	12	The PEP should be amended to include all required considerations, either directly or by reference.						
10	3.4.3 Documents / Requirements	13	A project-specific configuration control procedure should be developed and implemented by each project.						
11	3.4.3 Documents / Requirements	13	The projects should develop a description of how Laboratory and Department QA/QC policy and procedures are realized in the specifics of design, fabrication, and procurement requirements. This description should serve as project-specific QA/QC guidance throughout the development of the design and construction of detectors and related systems. That description also should address specific QA/QC topics such as those above.						

Red = Essential Finding / Yellow = Finding / Green = Observation