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Run IIb CDF Detector Project

Project Execution Plan

DOE Program
Project Number

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1. INTRODUCTION

This document describes the Project Execution Plan for the Run IIb CDF Detector Project, project # ????.

1.1. Historical Background

CDF first detected $\bar{p}$ p collisions in 1985. The detector has collected data in 1987, 1988-89, 1992-93 ("Run Ia") and 1994-1996 ("Run Ib"). Collider Run IIa began in 2001. A large number of important physics results have been produced by CDF and have been published in numerous articles in refereed physics journals. These results include the discovery of the top quark and precision measurements of its mass and production cross section, precision measurement of the W boson mass, a broad program of electroweak measurements, QCD measurements, B physics, including measurement of lifetimes of exclusive states, and Exotic Physics including limits on the production of a variety of non-Standard Model objects.

CDF has gone through periods of extensive upgrades. Between 1989 and 1992, the detector was improved in several ways. This included the addition of a silicon vertex detector, additional muon detectors to increase the muon acceptance, improvements to existing muon systems, and a new inner tracking chamber used to measure the *z* position of event vertices. The experiment recorded 110 pb^{-1} of integrated luminosity during the 1992-96 operating period (Run I).

In October, 1990 a proposal was submitted to upgrade the CDF detector to allow it to continue to exploit the physics opportunities as improvements, including the Main Injector, were made to the Fermilab collider. The running conditions for collider Run II specified that the detector must be capable of handling peak luminosity up to 2 x 10^{32} cm^{-2} sec^{-1}, bunch spacing as small as 132 ns, and an integrated luminosity of 2 fb^{-1}. The CDF Run IIa upgrade included replacing the plug and forward gas calorimeters with a new scintillator-based calorimeter and replacing the Central Tracking Chamber with a device with shorter drift time to allow tracking in a high-luminosity environment. A completely new silicon system was built and installed. The front-end electronics and trigger systems were upgraded to accommodate data-taking at higher rates and with shorter bunch spacing. Muon detection systems were upgraded to increase acceptance and allow the electronics to work with shorter bunch spacing. The data acquisition system was upgraded to increase throughput and reliability. A new time-of-flight detector was added, as were new detectors in the forward region. The CDF Upgrade Project for Run IIa was successfully completed in March, 2001.

1.2. CDF Run IIb Project Description

The CDF Run IIb project prolongs the useful life of the detector for operation at higher luminosity now anticipated at the Tevatron collider. Specifically, the detector must be capable of handling peak luminosity up to 5 x 10^{32} cm^{-2} sec^{-1} and an integrated luminosity of 15 fb^{-1}. Several detector systems must be replaced or modified in order to meet these requirements.

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1.3. Overview of the Project Execution Plan (PEP)

This document outlines the objectives of the CDF Run IIb project. The project management organization is described, participants are named, and a plan is presented to meet the objectives. The Project Execution Plan is supplemented with the following documents:

1) The CDF Run IIb Technical Design Report (TDR);
2) The CDF Run IIb Cost and Schedule Plan (CSP), including the CDF Financial Plan;
3) The CDF Run IIb subproject Memoranda of Understanding and work plans (MOU's).

The technical scope and physics goals of the project are presented in the Technical Design Report. The Cost and Schedule Plan includes a cost estimate for the project and a resource-loaded schedule, both based on a common Work Breakdown Structure (WBS). The full project is divided into seven subprojects. The MOU's and work plans for each subproject describe all necessary tasks. Appendices to these MOU's reapportion the subproject tasks by institution and indicate explicitly who is responsible for each sub-task.

1.4. Reference Documents

Appendix A contains a list of documents referenced in this PEP or which provide direction to the project. References to these documents appear throughout this plan.

2. JUSTIFICATION OF MISSION and PROJECT DESCRIPTION

The Department of Energy has established the need for the Run IIb CDF Detector Project by completing and approving a Justification of Mission Need (CD-0) document.

2.1. Physics Objectives

The primary goal of the CDF Run IIb Project is to enable the detector to exploit the physics opportunities available during Tevatron operation through 2008. The data from Run II will represent a set of detailed measurements that can be compared with the predictions of the Standard Model at the highest available collision energy. The increased size of the data sample will allow us to study the top quark by measuring the details of its production and decay mechanism. In addition, we plan precision electroweak and QCD measurements, continued searches for a variety of phenomena that are predicted to exist beyond the Standard Model framework, and to explore CP violation in the *b* quark sector. The detailed physics goals of the upgrade are described in the Technical Design Report (TDR).

2.2. Technical Objectives

The major tasks of this upgrade are:
- Replace the silicon micro-vertex detector with a device capable of withstanding the expected radiation dose for Run IIb and with fast r-ϕ and r-z readout.
- Replace the Central Preradiator Chamber with a device with shorter response time to allow

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operation in a high-luminosity environment.
- Upgrade the data acquisition system to increase throughput needed for higher luminosity operation.
- Add timing information into the readout of the central and plug electromagnetic calorimeters to reduce cosmic ray background and improve understanding of unusual events containing photons.
- Upgrade the trigger, including the addition of stereo information to the track trigger.
- Install and commission the detector.

We note that the off-line computing hardware and reconstruction software must be enhanced to assure efficient and timely data analysis and production of physics results from the large amount of information that will be accumulated during Run II. Off-line computing and software are managed as a separate project and will be discussed in a separate document.

Additional technical detail appears in the CDF Run IIb Technical Design Report.

2.3. Cost Objectives for the CDF Run IIb Project

The project estimated costs are summarized below. *(This table needs to be updated.)*

	Upgrade Cost (FY 1995$ K)		Then-Year (Escalated) Cost	
U.S. Equipment				
EQU M&S	6,024,644		6,335,507	
SWF (EQU)	0		0	
G&A	0		0	
Contingency	3,523,826		3,705,650	
Total U.S. Equipment		**9,548,470**		**10,041,157**
U.S. Operating				
SWF *	4,000,000		4,416,656	
G&A	0		0	
Contingency	1,000,000		1,104,164	
Total U.S. Operating		**5,000,000**		**5,520,820**
U.S. Total Detector Cost		**14,548,470**		**15,561,977**
NON-U.S. Costs **		**3,036,240**		**3,225,203**
Total Detector Cost		**17,584,710**		**18,787,179**

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** Financial support for this project includes contributions from CDF's international collaborators (Japan, Italy, Taiwan, Canada, Finland, Korea, Russia, Spain, Switzerland, UK) as described in the CDF Financial Plan. The estimate for international contributions does not include substantial in-kind labor contributions, nor funds contributed for experiment operating expenses.

2.4. Schedule Objectives

The critical objective of the CDF Run IIb Project is to have the upgraded detector ready to install in 2005. Schedule objectives are summarized in the list of milestones presented in Appendix B. Level 1 milestones are to be monitored by the DOE and Level 2 milestones are to be monitored by the FNAL Directorate. The CDF Run IIb project is complete when the complete upgraded detector is installed in the collision hall.

2.5. Project Description

The project is described extensively in the CDF IIb Technical Design Report. A summary description appears later in this document (Chapter 4: Work Breakdown Structure).
The CDF Run IIb project will be funded through a combination of DOE and international funds. It will be scheduled and controlled under general DOE authority with management of non-DOE elements provided through Memoranda-of-Understanding (MOUs).

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3. PROJECT MANAGEMENT, ORGANIZATION, AND RESPONSIBILITIES

3.1. Overview

The prime management responsibility for this Fermilab/DOE project is carried by the Fermilab Director. This project will be carried out in collaboration with the universities and laboratories in the U.S. and other countries that make up the CDF Collaboration. This project will be managed to a predetermined scope, cost, and schedule. Figure 3.1 shows the organization chart for CDF IIb . The descriptions presented here serve to clarify the roles of key personnel.

Construction of the components for the CDF Run IIb detector will be undertaken by Fermilab and many organizations and institutions external to Fermilab. Significant portions of the detector funding will be provided by sources other than Fermilab. For these reasons, part of the responsibility for construction of detector components will reside outside Fermilab. However, responsibility to the Fermilab Director will be maintained by the CDF collaboration management through the CDF Run IIb Project Manager resident at FNAL.

3.2. Department of Energy

As mentioned above, the Department of Energy has established the need for the CDF Run IIb project by completing and approving a Justification of Mission Need (CD-0) document. The Department of Energy has also participated in peer review processes for the Fermilab program including the annual DOE laboratory-wide review and the Fermilab Physics Advisory Committee meetings. The Department of Energy provides the majority of funding for the CDF Run IIb Project . These funds are provided through the Fermilab annual financial plan by contract modification. The Division of High Energy Physics provides annual program guidance to the Laboratory as well as annual guidance on the funding profile for the project. The Department exercises oversight of the project by:

- conducting semi-annual reviews of the project;
- participating in regularly scheduled Project Management Group (PMG) meetings;
- overseeing operations and fabrication activities;
- monitoring project progress via monthly progress reports; and
- monitoring milestones/performance measures.

3.3. Fermilab Director and Deputy Director

The Fermilab Director has the overall responsibility to the Universities Research Association and the Department of Energy for the successful completion of the CDF Run IIb Project and is the only person authorized to commit funds appropriated for Laboratory use. The Director determines the scope of the upgrade project with advice from the Fermilab Physics Advisory Committee in response to proposals from the CDF collaboration. Decisions regarding the scope of the project are made in a two stage process. Stage I approval is given to endorse the scientific merit of the proposal when sufficient information is known regarding technical designs so that costs and schedules can be estimated. Resources can then be allocated so that a project Work Plan and Memorandum of Understanding (MOU) can be developed, in which detailed technical designs can be prepared, and cost estimates and resource-loaded schedules can be made. In addition, a financial plan identifying the necessary funding resources is prepared. Upon the successful completion of these plans, Stage II approval may be granted by the Fermilab Director. Approval for the project may proceed in parts, subsystem by subsystem. Construction of a subsystem normally begins after Stage II approval has been granted for that subsystem but may proceed earlier with the Director's approval.

The CDF Collaboration consults with the Director as part of its procedure for appointing spokespersons. The Technical Design Report, the Project Execution Plan, the cost estimate, the schedule, the financial plan for the project, and any out-of-scope changes in the project require the approval of the Director.

The Director may at his/her discretion delegate tasks to the Deputy Director.

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3.4. Fermilab Associate Director for Research

The Fermilab Director has delegated certain responsibilities and authorities to the Associate Director for Research (ADR). The ADR is responsible for management oversight of the project. The Project Manager is appointed by the ADR and reports to the ADR directly and through the Head of the Particle Physics Division. The ADR chairs the Project Management Group (PMG) which meets as required to monitor the progress of the project. Directorate oversight of the project is implemented in part through reviews including the PMG and Director's reviews. Along with routine interactions with project management these reviews will identify actions and initiatives to be undertaken to achieve the goals of the project including the allocation of both financial and human resources. The Project Management Group will also function as the Baseline Change Control Board for the project. Progress will also be monitored through presentations to and discussions with the PAC.

To implement the work plan for the upgrade project, Memoranda of Understanding are written assigning responsibilities and describing the work to be executed for each subproject. The ADR will approve all Memoranda of Understanding. The ADR is responsible for providing a funding profile consistent with Laboratory funding in consultation and guidance from the DOE program office. The ADR assures that the Laboratory long-range schedule and the dates of important project schedule objectives are provided to the Project Manager in a timely manner. The ADR advises the Director on his/her approval of the TDR, the PEP, the cost estimate, the schedule, and the financial plan and concurs with these approvals.

3.5. Fermilab Particle Physics Division (PPD) Head

The Fermilab Director and ADR have delegated certain responsibilities and authorities to the Fermilab Particle Physics Division (PPD) Head. The PPD Head is responsible for portions of project management and oversight as the line manager for financial resources, human resources, technical resources, space resources, and ES&H issues for this project.

The PPD Head and his/her deputies are members of the Project Management Group. The PPD Head advises the ADR on approval of Memoranda of Understanding relevant to PPD resources and concurs in these approvals. The PPD Head advises the Director and ADR on approval of the PEP and CSP and concurs with these approvals.

On advice from the Director, the PPD Head allocates yearly budgets to the CDF Run IIb project. These project funds are then administered by the Project Manager within the context of PPD procedures and policies and with the assistance of the PPD budget office.

The PPD is the primary source of Fermilab labor and technical resources for the project. The PPD Head and his/her designees make long-term assignments of PPD personnel directly to the project in consultation with the Project Manager and in accordance with the CSP. The Project Manager utilizes assigned personnel to achieve the project goals reporting changes in

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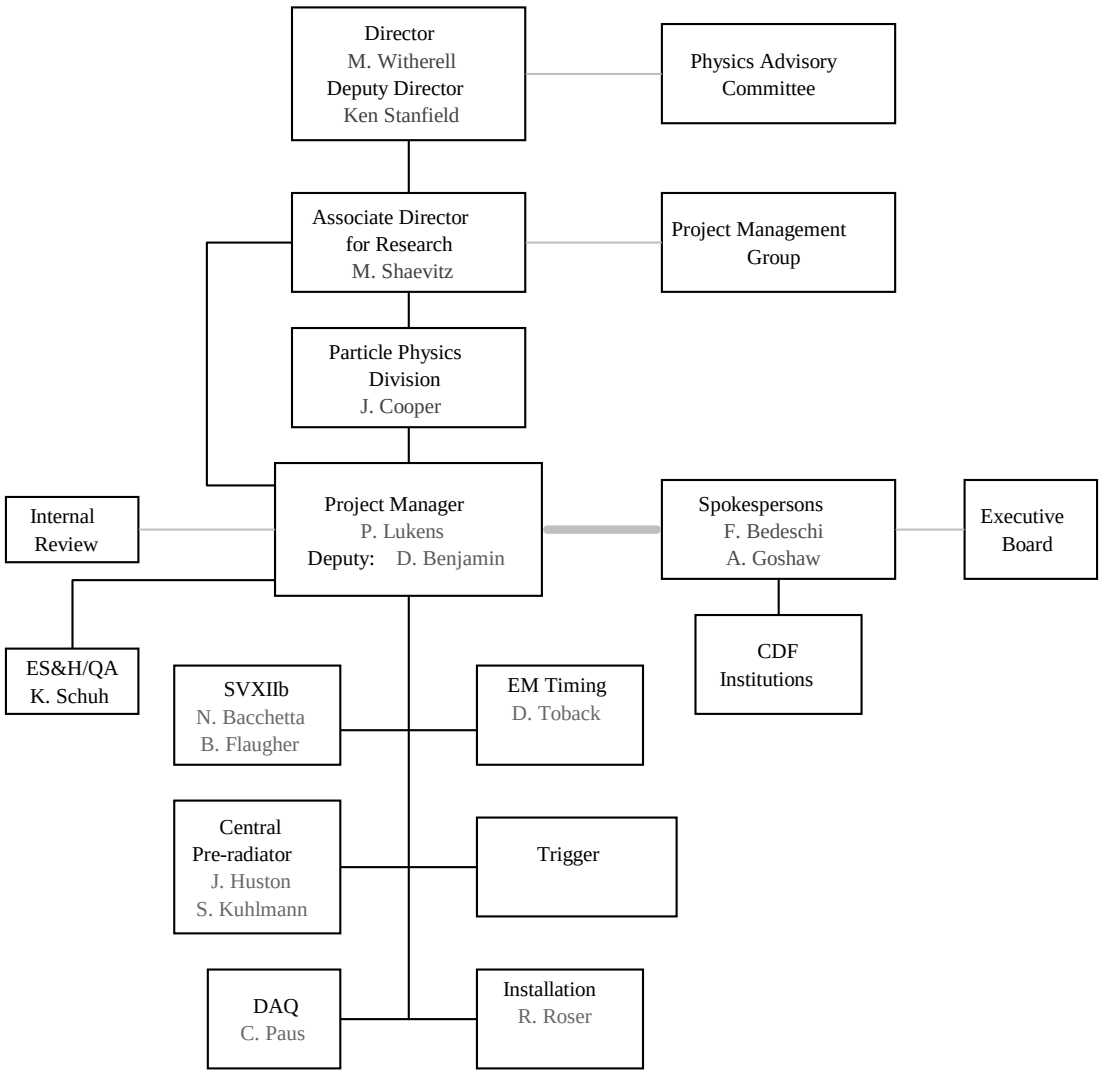
assignments to the PPD Head. The PPD Head maintains line management responsibility for these PPD employees and the Project Manager is part of the line management chain.

The PPD also provides support to the project through PPD technical resource groups in accordance with the CSP via specific work plans or Memoranda of Understanding. The PPD Head has direct line management responsibility for such PPD resources.

Figure 3.1
CDF Run IIb Organization



Since the Particle Physics Division is the primary source of Fermilab labor needed to achieve the project schedule goals, any mismatch of labor to the needs of the project must be reported in a timely fashion. The PPD head or designee will advise the Project Manager and ADR and report to the CDF PMG if insufficient labor is available to meet the requirements specified in the CSP. In this event, the Project Manager will conduct a schedule impact study and submit a schedule variance as appropriate to the ADR as required by the project controls.

3.6. Project Manager (PM)

The Project Manager (PM) has the responsibility to complete the Technical Design Report, the Cost and Schedule Plan, and the MOU/Work Plans for the project. The scope of the project is that proposed in the Technical Design Report by the CDF collaboration as well as any out-of-scope changes approved by the Fermilab Director. As part of the CSP, the PM will provide the Laboratory with labor profiles required to complete the project on schedule. Once the CSP is agreed upon and the necessary resources provided, the Project Manager has the responsibility to complete the CDF Run IIb Project on the agreed upon schedule, and within the agreed upon budget and scope.

The PM is responsible for preparing the Project Execution Plan (PEP) and for updating it as necessary with the approval of the ADR. The Project Manager may identify the need for project scope changes as they arise. When there is a need for a change having a significant impact on the physics capability of the detector the PM reports to the CDF Collaboration Executive Board and also identifies the need to the Director through the PMG. The PM receives technical advice from Internal Review Committees. The PM creates such committees as needed for technical advice and, in consultation with the CDF spokespersons, appoints their members. The procedure for out-of-scope changes to the project is described in Section 6 of this document. The Spokespersons, representing the collaboration, seek approval for all scope changes having a significant impact on the physics capability of the upgraded detector by making scientific proposals to the Director.

The PM is responsible for organizing presentations at reviews and status reports on the upgrade project to respond to the Director and funding agencies. The PM has the authority to speak for the Collaboration on technical questions raised in these processes. The PM will initiate reviews of upgrade subprojects to insure that adequate progress is being made and that the subproject is meeting its technical performance, cost, and schedule milestones. The PM may request that a godparent review be organized by the CDF spokespersons when questions of the adequate technical or physics performance of a subsystem are raised.

The Project Manager, in consultation with the CDF Spokespersons and PPD head, has the authority to appoint deputy and assistant managers and sub-Project Leaders (PL). The PM, working with the subproject leaders, is responsible for the completion of the CSP and the Work Plan/Memorandum of Understanding (MOU) for each subproject specifying the contribution to that subproject from each collaborating institution. The MOU's describe responsibilities for the design, construction and test of new detector components that are a part of this project. Additional MOU’s describe work plans for activities which support and maintain existing parts

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of the CDF detector complex. The MOU's are considered to be supporting documents for both the PEP and CSP.

The PM has the authority to negotiate on behalf of CDF with collaborating institutions and Fermilab Section and Division heads for collaboration or Laboratory resources. The project manager has responsibility for coordinating all collaboration-wide resources for the project via the MOU's. The PM has authority to negotiate with all institutions for optimal utilization and management of these resources. The PM has fiscal authority for U.S. funds and is responsible to the Fermilab ADR through the PPD head for monitoring expenditures of U.S. and international funds as well as tracking and reporting variances from baseline scope, schedule and cost estimates specified in the CSP.

The PM is appointed by the ADR with the approval of the CDF spokespersons and the PPD head. Within the PPD organization, the PM's position is at the level of a department head.

3.7. Project Leaders

The major sub-projects which make up the detector are shown in Figure 3.1. Each of these sub-projects is a major enterprise in itself and is headed by one or more Project Leaders (PL). The Project Leaders are appointed by the Project Manager as described in section 3.6 and report directly to the PM. For subprojects that involve construction of equipment, the Project Leaders are responsible for the design, fabrication, integration, and testing of all components of that particular subsystem. Subsystem fabrication activities will generally be widely dispersed, not only within the U.S., but throughout international collaborating institutions. All coordination, tracking, and technical communications for the design and production of a subsystem are the responsibilities of the PL.

In some cases project funds to support the subsystem activities originate with Fermilab and are allocated to subsystem projects on the authorization of the PM. The PM in general delegates limited signature authority to the PLs for items to be purchased with such funds on their subproject. In most cases however, even if the PL is U.S. based, part of the support will come from international. funds. The PLs interact closely with the international leaders of activities relevant to their subsystem to ensure that international funds are appropriately spent on the subproject and to maintain good coordination. The PM does not have budget authority for international funds or for contributions to the project made by collaborating U.S. institutions, but they do have the authority and responsibility to ensure that project work at all institutions is technically adequate and within the approved scope of the project. Collaborating institutions agree to the scope, schedule and cost estimate for their work though the MOU process. The PM will interact with the PL's and the representatives of collaborating international institutions to ensure that the distribution of resources is matched to the project objectives and schedule.

It is the responsibility of the PL to bring to the attention of the PM any anticipated changes in the subproject from the approved baseline that may significantly affect the cost, completion date, or performance of the subsystem. The PLs will provide information on the detailed cost, schedule and performance of the subsystem and will make presentations to review committees, funding

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agencies, and the directorate when requested to do so by the PM. Task Managers and appropriate subproject organizations for each subsystem may be specified by the PL's. Further subproject organizational details appear in the subproject work plan/MOUs. The PLs are responsible for quality assurance plans for their subprojects and for assuring that their subsystems meet the ES&H standards of Fermilab.

3.8. Spokespersons

The CDF spokespersons are responsible for all scientific aspects of the CDF collaboration including operation and upgrades of the detector, data analysis, and publication of the results. In this capacity they provide the means of contact between the CDF Collaboration and the Laboratory, and represent the collaboration in interactions with the Laboratory. The Spokespersons serve as chairs of the CDF Executive Board and are a principal contact point for the PM's to communicate and coordinate discussion and review of issues that impact the entire collaboration. The spokespersons are elected to two year terms by the collaboration at large with the approval of the Fermilab Director.

3.9. Advisory Functions

3.9.1. Project Management Group

The Project Management Group (PMG), chaired by the ADR, brings together for regular meetings, at least monthly, those who have management responsibility for the success of the Run IIb Project and who have authority to redirect resources within the Laboratory and the Collaboration. The PMG also functions as the Baseline Change Control Board for the project.

3.9.2. CDF Executive Board

The CDF Executive Board advises the spokespersons on scientific and sociological aspects of the collaboration. The Board consists of the Group Leaders (or designates) of each collaborating institution. The Board also approves the addition of new collaborating institutions, as well as significant changes to the detector or the scientific goals of the collaboration. The CDF Executive board is the decision making body that determines the scope to propose to the Laboratory as the CDF Run IIb Project. Decisions by the Executive board are based on consultation with the full CDF collaboration. The Executive board is required to ratify actions by the PM only if the fundamental definition of the Scope of the Run IIb and its physics potential are at issue.

3.9.3. Internal Review Committees

Internal review committees provide a means for the PM to review technical, cost, and schedule issues for upgrade subprojects. These committees may also be charged with reviewing the physics performance of the subsystem or recommending scope changes. Internal review committees are appointed as required by the PM. The PM charges them, often in consultation with the Spokespersons. Reports and recommendations from internal review committees are transmitted to the Project Manager and are in general made available to the entire collaboration.

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Internal review committees are also a vehicle for communication between the PM and the Collaboration. In particular, in response to a technical concern raised by members of the collaboration, if the PM has not already done so, the spokesperson may request of the PM that an internal review committee be appointed to provide advice regarding the concern.

3.9.4. Subproject Technical Committees

There may be technical committees associated with a subsystem and separate from the CDF internal review committees discussed above. These are appointed by the PL as needed. Members of such technical committees advise the subsystem PL on technical directions, alternatives, and methods of performance. The members of the committee would include scientists responsible for the design and fabrication of the subsystem or of major tasks within it. Other technical experts may also be included. The membership of sub-project technical committees is chosen by the PL. These committees act in an advisory capacity with decision authority in the hands of the PL. Their reports are made available to the Spokespersons, PM, and internal review committees.

3.9.5 Godparent Committees

"Godparent" committees provide an additional means of reviewing complex technical and physics performance issues. These committees provide additional guidance related to physics goals and a means for collaboration input into the upgrade project. Godparent committees are appointed as required by the spokespersons. The spokespersons charge them, often in consultation with the Project Manager. Reports and recommendations from the godparent committees are transmitted to the spokespersons and the Project Manager.

4. WORK BREAKDOWN STRUCTURE, RESOURCE PLAN and LIFE-CYCLE BASELINES

4.1 Run IIb Summary Description

The technical description of the CDF Run IIb upgrade is presented in the TDR. The TDR describes the principal components of the detector and serves as reference for the following descriptions of detector subsystems. Detector subsystems are the basis for defining the high-level WBS of the detector upgrade project. The WBS to level 2 is shown in Figure 4.1. The task-based WBS extends to many levels to facilitate planning, scheduling and cost estimation. Detailed cost estimates and the resource-loaded schedule are contained in the CSP. The resource-loaded schedule in the CSP provides the basis to track project cost, estimate future labor requirements and financial needs, document project changes, and estimate the project completion date.

We provide below a description of the project at WBS level 2.

4.1.1. SVXIIb

WBS 1.1 includes work to build a new silicon vertex detector, called SVX IIb. The CDF

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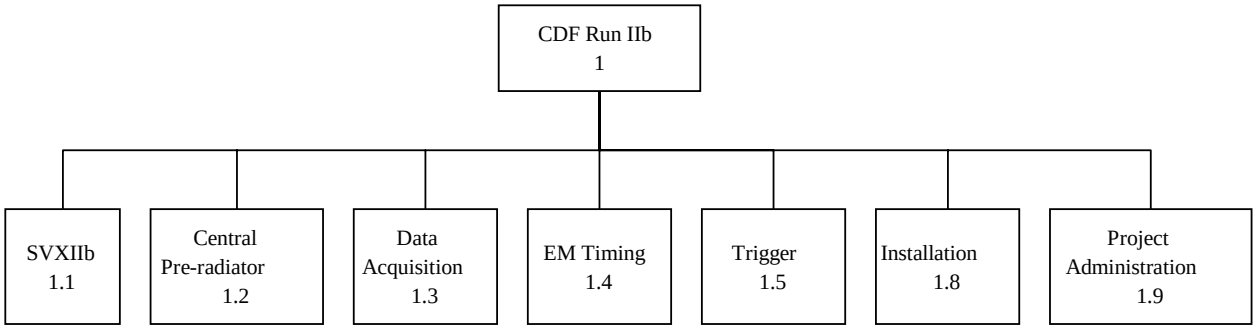
collaboration has considerable experience with state-of-the-art silicon detectors. The original SVX was implemented in a "radiation-soft" technology and as expected suffered considerable radiation damage before the end of Run Ia. Between Run Ia and Ib the SVX detector was replaced with a new device, SVX', of nearly identical geometry but using AC-coupled silicon detectors and a radiation-hard readout chip. Since the SVX' readout chip would not work with 132 ns bunch spacing the SVX' was replaced for Run IIa (SVX II). The SVX II detector was designed to address several shortcomings of the SVX'. The barrel (central) region is longer to cover the luminous region with higher efficiency. This substantially increases the b-tagging efficiency for top decay. The detectors are double-sided to provide *r-z* readout for pattern recognition. SVX II was designed to withstand much larger radiation doses. The readout chip is pipelined for 132 ns bunch spacing. SVX II has five layers for improved pattern recognition.

SVXIIb will consist of single-sided silicon detectors which are easier to manufacture than the double-sided detectors used in SVX II. The design uses a single mechanical structure throughout which reduces both construction time and cost. The readout chip ("SVX4") will be manufactured in a standard process to minimize costly schedule delays. Both the DAQ and cooling systems will be retained from SVX II.

Figure 4.1
CDF Work Breakdown Structure



4.1.2. Central Preradiator System

WBS 1.2 is the Central Preradiator (CPR) Replacement. The current preradiator chamber system is a gas-based chamber that increases the experiment's power to discriminate between photons and high transverse momentum π^0's. Because the gas chamber system contains data from several bunch crossings, the high luminosity environment anticipated for run IIb will give the CPR an extremely high occupancy. The gas chamber system will be replaced by a scintillator system

whose timing characteristics are more appropriate for the 132 ns bunch crossing time.

4.1.3. Event Builder

WBS 1.3 covers the upgrade of the data acquisition system. This system acquires the digitized data from front-end electronics and delivers it through a high level processor farm (Level 3 system) where the final decision is made to write data to tape and/or on-line monitoring programs. The upgraded system is designed to satisfy the following general requirements:

- Deliver events at the rate of at least 1000 Hz to the Level 3 trigger system with a negligible system dead time beyond that due to the Level 2 hardware trigger decision time and front end digitization time.

- Deliver events to mass storage at the rate of at least 30-40 Hz.

- Deliver events at the rate of at least 5 Hz to on-line monitoring processes distributed over a number of workstations.

- Accommodate an average event size of approximately 250 KB implying a minimum aggregate throughput of 250 MB/sec to meet the 1000 Hz requirement.

- Be scalable to accommodate new or upgraded detector components without major modification.

This system looks almost identical to the IIa plan. Any other changes needed for IIb?

4.1.4. EM Timing

Need text here.

4.1.5. Trigger

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4.1.6. Installation and Infrastructure

WBS 1.8 includes the beam pipe, shielding, luminosity and loss monitoring, gas systems, HVAC, safety systems, and other needed experimental facilities upgrades.. The HVAC system in B0 must be replaced to provide reliable operation for Run II. Although a maintenance expense and not strictly part of the upgrade the HVAC tasks are intertwined with other installation and infrastructure tasks and are managed as part of this subsystem. The plan is to replace the existing cooling system, in both the collision hall and the counting rooms on the first floor of B0 as well as portions of the fire protection system. A new Be Beam pipe is required to allow the SVX II to reside as close as practical to the collision region. Detailed simulation of Tevatron backgrounds to CDF muon detectors indicate that adding steel shielding around the beam line can substantially reduce muon low level trigger rates. Modifications to the CDF gas system are required to allow use of gas mixtures containing CF_4 including modifications required if this gas is to be recirculated. This WBS item covers the work required to design, build and install these

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and other support systems. This WBS item also includes work associated with detector integration and installation including substantial rigging effort associated with installing the detector in the collision hall.
This looks identical to the IIa plan. Need to update for IIb.

4.1.7. Project Administration

WBS 1.9 includes work required for project administration. The tasks include but are not limited to technical oversight and management of the project, cost and schedule estimates, construction of work plans/ MOU's, planning and assistance in the administration of international funding, communication and liaison with the Laboratory management, cost and schedule tracking, funding profiles and projections, contingency analysis, procurement support, change control documentation, preparation for project reviews and reports.

Excellent communication on upgrade activities is maintained throughout the CDF collaboration using Electronic mail, the World Wide Web, video-conferences, frequent subsystem and collaboration meetings and periodic subproject progress reviews (mini-reviews). These ensure good coordination of the overall project.

This WBS element includes the salaries of administrative and management personnel involved in these tasks and the cost of necessary computing equipment to support project administration.

4.2. Resource Plan

The resource plan is included in a separate document: Run IIb CDF Detector Cost and Schedule Plan.

4.3. Lifecycle Baselines

The technical baseline is described in the CDF IIb Technical Design Report. Cost and Schedule baselines are described in the CDF IIb Cost and Schedule Plan (CSP). The methodology used to develop the project schedule is to construct a task-based, resource-loaded schedule for each upgrade subproject and then combine these schedules for the entire upgrade project, including installation tasks. This combined schedule provides the means whereby the required funding and labor requirements for the entire project can be assessed and best matched with the resources available from Fermilab, other collaborating institutions, and other sources. Critical path analysis is done both at the subproject level and for the project as a whole.

In the CSP each sub-task is described in a WBS dictionary for each subproject. The dictionary contains details of the cost estimates and provides a contingency analysis for that sub-task. The CSP contains a list of critical milestones. These milestones are incorporated into the resource-loaded schedule and will be used to track the progress of the project. A milestone list appears in Appendix B.

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5. RISK MANAGEMENT ASSESSMENT

This section is being developed.

6. PROJECT CONTROLS SYSTEM

This section also includes Baseline Change Control Approval Thresholds.

6.1. Introduction

This section summarizes the management systems that the CDF Run IIb Project Manager will use to manage the cost and schedule performance and the technical accomplishments of the Project. The significant interfaces that exist among the various management systems are noted in the individual narrative descriptions below. Although these systems are described separately they are mutually supportive and are employed in an integrated manner to achieve the project objectives. As conditions change during the evolution of the project, the management systems will be modified appropriately so as to remain responsive to the needs for project control and reporting. Consequently, while the policy and objectives of each management system will remain fixed, the methods, techniques, and procedures that will be employed by the CDF Run IIb Project may change as conditions dictate, over the life of the project.

The Work Authorization and Contingency Management System and the Project Control System described in this chapter constitute the required management and control procedures.

6.2. Guidelines and Policies

The Contingency Management System and the Project Control System employed by the CDF Run IIb Project will be consistent with the Fermilab "Project Control System Guidelines", dated May 1, 1994.

The following policies are applicable for the CDF Run IIb :

- All Project work is organized in accordance with the Work Breakdown Structure.

- Formal (and informal) reviews by experts are used to obtain specifications and designs.

- Established cost, schedule, and technical baselines are used for measuring project performance. The technical baseline for the project is described in the Technical Design for each system included in the scope of the upgrade project.

- Changes to the approved cost, schedule, and technical baselines proceed via a Change Request (CR) process described below.

- A project management system which features performance measurement and critical-path scheduling, is used to control the project and to provide forecast and feedback information to management.

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• The decision making apparatus employs regular meetings among the CDF Run IIb Project organizational elements. These meetings serve to identify and resolve interface issues within the project.

• Quality assurance, safety analysis and review, and environmental assessment are integral parts of the Work Authorization and Project Control.

6.3. Work Authorization and Contingency Management

Funds will be made available by the Director to the CDF Run IIb Project on an annual basis following the receipt of the Initial Financial Plan from DOE. These funds will correspond to a financial plan and a funding profile to project completion as determined by the Director. The funding profile will include contingency in each year of the project.

Cost accounting will follow the WBS structure. The accumulation of M&S costs will be initiated through purchase requisitions originating with the engineering and scientific staff assigned to the various sub-systems. Signature authority levels will be provided to the Fermilab Business Services Section by the CDF Run IIb Project Manager to assure that only authorized work is initiated. Labor costs are also tracked but at a higher level of the WBS.

At any time the project contingency is the difference between the project Total Estimated Cost (TEC) and the sum of the current Estimates at Completion (EAC) at level 2 of the WBS. The Project Managers will hold the contingency and allocate it subject to the project change control described below.

The principles of contingency management that the CDF Run IIb Project will follow are as follows:

• The cost estimate for each sub-system will include contingency funds based on an assessment by the preparer of uncertainties and risks associated with the budgeted cost.

• The actual expenditure of contingency will be reflected in a new EAC to be updated every 6 months.

• Contingency funds are allocated as needed throughout the year, within the following guidelines:

- The PM may adjust the estimated cost of any WBS level 2 subproject by as much as $100K, as long as the Project TEC is not exceeded. If the estimated cost of any WBS level 2 subproject changes by more than $100K, a change request shall be submitted, as described below.

- Use of contingency above the amount budgeted for the year requires approval of a change request.

- Any unused contingency will be used to fund tasks scheduled for subsequent years.

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6.4 Project Control System

The Project Control System includes the three categories listed below:

Baseline Development: This includes management actions necessary to define project scope and responsibilities, establish baselines, and plan the project.

Project Performance: This includes management actions after work commences that are necessary to monitor project status, report and analyze performance and available resources, and manage risk.

Change Management: This includes management actions necessary to ensure adequate control of project baselines, including the performance measurement baseline.

6.4.1 Baseline Development

Each upgrade subproject prepares a formal cost estimate and schedule. These are included in the CDF Run IIb Cost and Schedule Plan. The subprojects all have defined Work Breakdown Structures (WBS) which are detailed subsets of the WBS presented in Figure 4.1 of this document. In addition, technical specifications for each subproject are contained in the CDF Run IIb Technical Design Report.

6.4.2 Project Performance Measurement

Project performance aspects of the Project Control System consist of the following:

Funds Management

The cost plan for the project is based on the Laboratory's funding profile. This plan reflects the best estimate of funding levels and the baseline schedule. Changes in the Laboratory funding profile may affect the overall cost and schedule for the project. Each year, subproject budgets are set based on the current funding profile guidance. The Project Managers and Project Leaders adjust the resource-loaded schedule so that the available funding is distributed optimally balancing cost and schedule considerations.

Accounting

The actual cost of the project is captured in the Laboratory's General Ledger and is tracked by the Work Breakdown Structure. Summary and detailed cost reports are prepared each month by the Project Management. Monthly reports of costs and obligations for capital equipment funds are submitted to Laboratory management and the Department of Energy through the Laboratory FIS system and the Cost Budget Report prepared by the Laboratory accounting department. Information for the CDF Run IIb Project is reported by Budget and Reporting (B&R) Code and by Budget Reference Number (BRN).

Performance Measurement and Analysis

The principal functions of performance measurement and analysis are to identify, quantify, analyze, evaluate and rectify significant deviation from the baseline plan as early as possible.

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Schedule Variance

At the end of each month, the milestone list and critical path tasks will be evaluated to identify deviations from the baseline schedule. Any deviations that have a significant impact on the project, either by delaying completion or by affecting the cost or labor plan of the project will be identified. A plan to rectify any delays will be developed and may include either alteration of the project schedule to optimize work and reduce delay or allocation of additional resources to shorten the time required to perform the tasks involved.

Any change that would alter the schedule, cost or required labor resources will be subject to change control as described in this plan.

Cost Variance

Monthly cost variance will be determined by comparing the actual cost of work performed at WBS level 2 with the budgeted cost of work performed as represented in the current EAC. Cost variances that exceed the established thresholds are formally reported as required in this plan.

Resource Variance

A monthly analysis of the resources available (labor and funds) will be performed to ensure that shortfalls in either which could lead to schedule and/or cost variances are identified in a timely manner and brought to the attention of the PMG.

6.4.3 Change Control

Change Management aspects of the Project Control System consists of the following:

Out-of-Scope Changes

An Out-of-Scope Change is a proposed change to the CDF Run IIb Project that would alter the physics capabilities of the detector in a major way or introduce a new detector system.

Any change to the CDF Run IIb Project outside the Laboratory approved scope must be initiated by a formal proposal to the Director for consideration. The Scope of the project includes the design, construction, and installation of the collection of systems or improvements to systems, proposed to the Laboratory for approval as part of the CDF Run IIb project, that have been granted Stage I approval by the Director. The initial scope of the project is described by the Technical Design Report.

The procedure for Out-of-Scope changes is described schematically in Figure 6.1. An Out-of-Scope Change begins with a CDF note and presentation at a CDF Run IIb meeting. The

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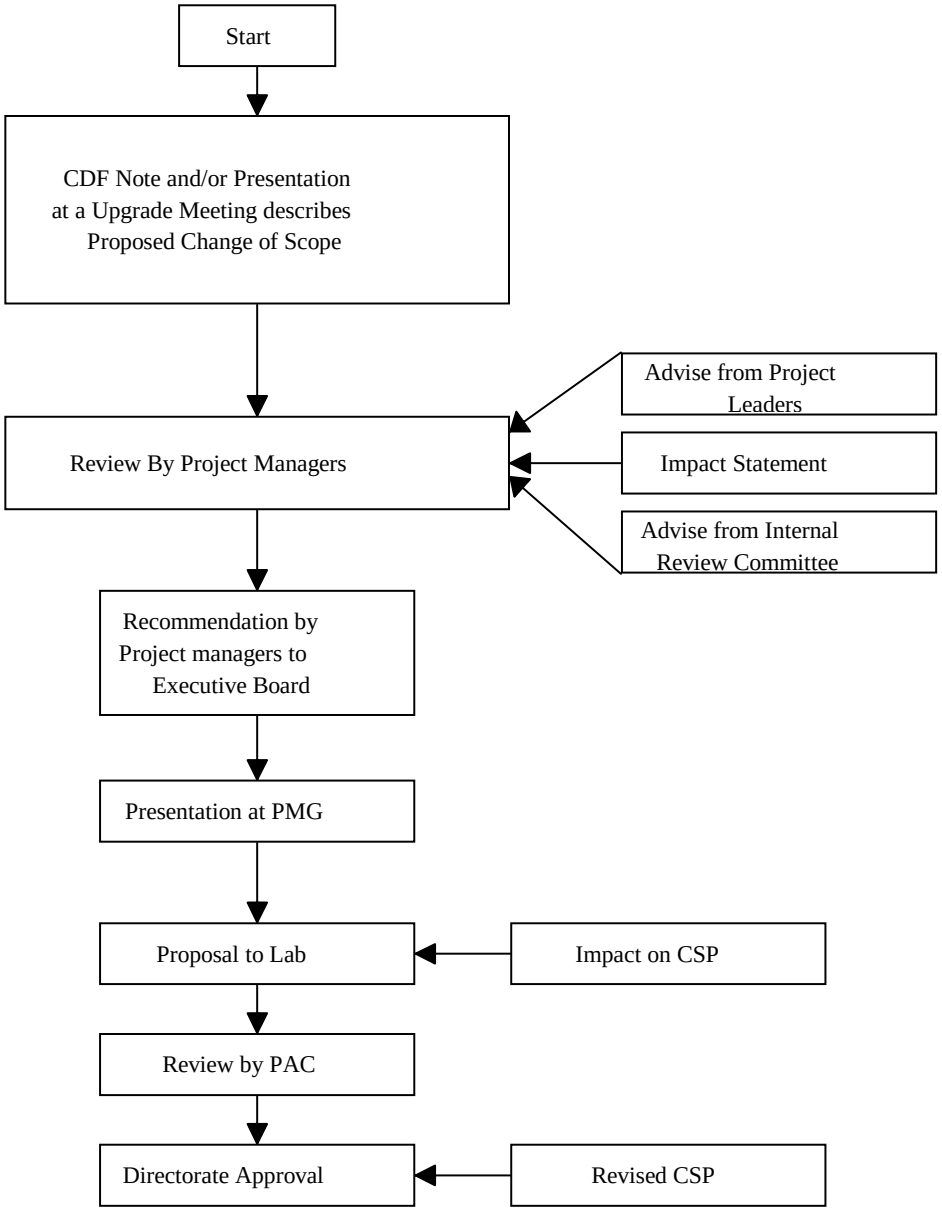
Figure 6.1
Procedure for CDF Run IIb Scope Change



proposed change is reviewed by the Project Managers who in general will seek advice from the Project Leaders and other technical experts. The Project managers may also seek advice from a CDF godparent committee or CDF Internal Review Committee. The PM may request of the proponents that an Impact Statement that identifies the Performance, Cost, and Schedule impact of the proposed change be prepared. Following the Project Managers review of the proposed change the Project managers make a recommendation to the CDF Executive Board. If the recommendation of the PM is to proceed with the change and the Executive Board ratifies the recommendation, the proposed change, including the effect on the CSP, is presented to the CDF Project Management Group.

In response to an Out-of-Scope change proposal the FNAL Director may seek the advice of Fermilab's Physics Advisory Committee, the CDF PMG or a Director's review. The proposed change can be granted Stage I approval; deferred for further clarification of the physics potential, technique, cost and/or schedule; or it may be rejected.

In-Scope Changes

Any change to the CDF Run IIb Project that does not alter the Scope of the Project as defined above does not require a new proposal to be submitted to the Laboratory.

Although the Scope of the project is not affected, changes resulting in cost variations, changes of personnel assignments or schedule impact are considered In-Scope Changes. Procedures for these changes are discussed in the following.

In-Scope Changes must have the approval of the CDF Run IIb PM.

In-Scope Changes that result in increases in the CDF Run IIb Project Estimate at Completion (EAC) must be initiated by a Change Request. Changes that result in increases in any level 2 WBS element greater than $100K, must be initiated by a Change Request (CR) form presented at the CDF PMG. Such Requests will require the approval of the Deputy Director and/or Director as indicated below.

In-Scope Changes that result in a schedule change such that the Baseline Schedule Objectives for project completion cannot be met must be reported to the Director. Any change which results in a change of a milestone held by the Director or DOE of more that one month will be reported to the Director by a CR submitted for approval to the CDF PMG. The response to such a CR may be to initiate a plan to reallocate resources to recover the schedule, a plan to stage or descope the detector, or a plan with revised project Schedule Objectives.

In-Scope Changes that result in an increase of Fermilab personnel resources by 10% for any level 2 system above that indicated by Cost and Schedule Plan must be reported to the CDF PMG.

The following in-scope changes required the approval of DOE headquarters:
- Any increase in the total U.S. Equipment cost; or
- Any delay greater than six months in a Level 1 milestone.

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The CDF PMG functions as the Baseline Change Control Board for the project. The CDF Project Managers will maintain current records of all CRs and their disposition. A sample CR is given in Figure 6.2.

Figure 6.3 summarizes change control thresholds and responsibilities.

Notes

- The record of CDF Run IIb Project documentation revision status is maintained by the CDF Run IIb PM.
- The record of CDF Run IIb Project Management Group meetings will be maintained by the Directorate.
- A record of all CR's will be maintained by the CDF Run IIb Project Manager.
- All changes from baseline cost shall be traceable.

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Figure 6.2
CDF Run IIb Change Request

CDF RUN IIb Change Request	Date: Rev Date:	Change Request #:	Page ____ of _____
Title:			
WBS:			
Affected Items:			
Originator:	Email:		Phone:

CCB DISPOSITION **DATE**	**Approval:**
Accepted · Rejected · Forward to Director ·	Level 1 _____ Date _____
Chairperson:	Level 2 _____ Date _____
	Level 3 _____ Date _____

Summary:
- A very brief, simple paragraph will provide the following:
- What's being requested
- Why it's necessary
- What it costs and the impact on other costs
- When it will be done and the impact on the schedule
- Other pertinent information if necessary

Part I: Technical
- Problem or reason for the change
- Description of proposed change
- Analysis showing that the change will solve the problem, add to the capability, or reduce cost
- Impact on interfaces with other elements
- Alternatives considered
- Impact if Change is not approved

Part II: Schedule
- Justification for requested schedule change (if not previously covered)
- Impact to the time phasing of budget (if none, so state)
- Impact to any Level 2 or Level 3 milestone(s) (if none, so state)
- Impact to interfaces; other activities (if none, so state)

Part III: Cost
- Cost estimate, current budget available, and delta cost

Part IV: Work Breakdown Structure (WBS) & Dictionary
- WBS elements to be added/deleted, including identification of cost accounts
- Justification for the requested WBS change, if not already covered
- Impact to cost and schedule if not already covered.
- Changes required in the WBS Dictionary

Part V: ES&H Impact
- Indicate any ES&H impact

Part VI: Labor
- Impact on Labor required (if none, so state)

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Figure 6.3
CDF RUN IIb Change Control Thresholds

	DOE Headquarters	FNAL Director/Deputy Director	CDF RUN IIb Project Managers
Technical		Changes that affect ES&H requirements or impact accelerator systems. Out-of-scope changes to upgrade physics capabilities.	Changes that don't affect ES&H requirements and do not change upgrade project scope.
Cost	Any increase to the total U.S. Equipment cost..	Any increase in a level 2 subproject by $100K.	Any change in level 2 subproject by $100 K
Schedule	Any delay greater than six months for a Level 1 milestone.	Any change in the project critical path by more than 1 month.	Any change in a sub-system critical path by more than 1 month.
Personnel		Any increase in required FNAL project personnel of 10% relative to CSP.	Any change in level 2 subproject personnel of 10% for the year.

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6.5 Information and Reporting

6.5.1 Project Meetings

The CDF Run IIb Project group leaders meet every two weeks to discuss progress on upgrades and issues of interest across subsystem boundaries. There is a general upgrade collaboration meeting held weekly. Minutes of these meetings are kept. The Project Management Group meets as needed, currently bi-weekly. Progress on upgrades is presented to the collaboration at collaboration meetings four times per year. The individual upgrade projects all have meetings of their own, typically weekly. Additional meetings will be scheduled as needed.

6.5.2 Reporting

Project leaders review their schedules monthly. This includes an assessment of task scheduling and estimated costs. Updated resource-loaded schedules are submitted by the PLs to the PM. Project Managers prepare monthly progress reports to the Director including a brief narrative technical section and a consolidation of the subproject cost and schedule status. CDF Run IIb monthly progress reports will be submitted to the DOE by the Fermilab Directorate.

Run IIb project subsystem leaders give status reports about once a month at the collaboration

upgrade meeting. Copies of transparencies presented at these meetings provide a written record of subproject progress on this time scale. Minutes are also kept for these meetings. Quarterly written progress reports are submitted to the PM by the PL. These narratives contain a description of technical progress that is more detailed than that submitted monthly.

The overall Project Execution Plan (this document) may be updated as needed with the approval of all the signatories.

Progress on the CDF Run IIb is reported to the FNAL Directorate via presentations to the PMG, directors reviews, and Physics Advisory Committee. The baseline technical, cost, and schedule for the project will be established at a DOE review. Subsequent progress on the upgrade project will be reported at periodic DOE reviews. The DOE also provides representatives to the FNAL PAC meetings.

7. ACQUISITION STRATEGY PLAN

The acquisition strategy is discussed in a separate document: "Run IIb CDF and D0 Detector Projects Acquisition Execution Plan".

8. ALTERNATE, TRADEOFFS

This section is under construction.

9. TECHNICAL CONSIDERATIONS

Technical considerations are treated in the Technical Design Report.

9.1. Research and Development

Subsystems and their components are designed to meet the requirements outlined in the TDR. Research and development is performed on detector components to ensure that the chosen technology will meet the physics and engineering requirements of the detector. Designs are documented in design reports and drawings are checked by peers, senior engineers, and/or managers. Design reviews are performed as outlined in Section 6. Design reports, specifications, drawings and other documentation will be delivered to FNAL to ensure that detector components can be supported and maintained.

9.2. Quality Assurance and Tests

Quality Assurance for the CDF Run IIb project will be in concurrence with the FNAL Quality Assurance plan to ensure that the detector systems will achieve the technical and reliability requirements needed for operation at the upgraded Tevatron. In general, the Quality Assurance plan for CDF has the following structure:

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1) The collaboration through internal reviews and godparent committees reviews the plans for the upgraded detectors. Periodic reports on prototype and pre-production devices as well as computer simulated performance of the final detectors are evaluated to assure that the upgraded detector will meet the CDF physics goals.

2) The planned detector upgrades and their performance are documented in the TDR. This document defines the baseline upgraded CDF detector. The TDR is reviewed by the Fermilab Physics Advisory Committee and by the Department of Energy as part of establishing the baseline cost and schedule for the upgrades. Work plans/MOUs are written which document how the work will be carried out including responsibilities for testing and documentation. QA documentation is considered one of the deliverables for project components whether built at Fermilab or at other institutions.

3) PLs have responsibility for the following aspects of quality control:

- Incorporation of the necessary design reviews into the project CSP and establishing adequate approval processes prior to procurement and fabrication of subproject components.

- Incorporation of necessary acceptance tests into fabrication plans and practice.

- Verification of system performance requirements.

- Incorporation of sufficient "on-site inspection" at off-site and/or international institutions to assure adequate quality of deliverables fabricated using these sources.

- Documentation and management of records related to the design, development, production, fabrication, installation, operation, servicing, and repair of subsystems.

10. INTEGRATED SAFETY MANAGEMENT PLAN

This section needs to be updated. This text is from the Run IIa Project Management Plan.

This section describes the policies for ensuring that Environmental, Safety and Health (ES&H) considerations are adequately addressed within the CDF Run IIb project activities. The information below provides an overview of key issues. Policies, procedures and descriptive information are contained in the CDF ES&H Implementation Plan. ES&H is a line management responsibility and will be implemented down through the sub-system organizations.

10.1 Overview

10.1.1 Introduction and Scope

The ES&H program for the CDF Run IIb and supporting systems is described herein. The CDF Run IIb Project fully supports the FNAL ES&H policies and procedure, as described in the FNAL ES&H Manual. The ES&H program at CDF is intended to ensure that all relevant and

necessary actions are taken to provide a safe working environment at FNAL for the design, construction, installation, test, operation and decommissioning of the CDF detector. The CDF detector was designated a Low Hazard Radiological Facility and the Safety Envelope approved in 1995. The Directorate, advised by the ES&H Section will determine the need for updates or addenda to the CDF Safety Analysis Document.

10.1.2 Objectives

The following general objectives have been established by FNAL for the ES&H program for detectors:

- To establish and administer an ES&H program which promotes the accomplishment of FNAL ES&H objectives for employees and non employees.
- Protect the general public and the environment from harm.
- To comply with federal, state and local laws, rules and regulations.
- To prevent personnel injury or loss of life during detector-related work.
- To prevent damage to equipment caused by accidents during detector-related work.
- To prevent any environmental contamination during detector development, fabrication, commissioning and operation.

10.2 Organization and Responsibilities

The ES&H program for the entire CDF Run IIb is the responsibility of the CDF Run IIb PM. The CDF PM and their designees are responsible for establishing policies and requirements for ES&H during development and commissioning of the detector, and related experimental systems.

The CDF PM have the responsibility for identifying specific ES&H issues and risks, and for ensuring that PL establish appropriate safeguards and procedures for addressing those risks for each subproject. The PM are responsible for ensuring that CDF Safety documentation is adequate for operating the upgraded detector. The PM and their appointed Project Leaders are the laboratory line management on matters of safety for the CDF department and for operations aspects of the upgraded detector.

An associate head in charge of ES&H for the project and a standing CDF internal safety committee are appointed by the project managers to review ES&H issues for the CDF project. At the request of the Project manager the internal safety committee will review any existing system, upgrade project, or other activity in the CDF department. In addition, the chair of the CDF internal safety committee and the associate head for ES&H are charged with monitoring activities in the department acting in a proactive manner to recommend other reviews to the PM when appropriate. An ES&H electrical and mechanical review committee is appointed by the Particle Physics Division head to review all major upgrade subsystems. This committee conducts

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reviews of each system as part of the operational readiness clearance required prior to normal operation of the system.

10.3 Documentation and Training

The CDF PM are responsible for providing, as required, specific requirements and procedures, as well as hazard assessments, and other documents to comply with DOE and FNAL requirements. CDF safety and ES&H documents are defined in the CDF Operations Guidelines Manual.

Those who on the CDF project at the FNAL site will be provided with the training and information required to ensure their safety, and to reduce risks associated with their work. Briefings and presentations will be made to all managers and supervisors to communicate ES&H policies, documentation and information associated with assuring safety of CDF activities. Job-specific training will be provided on issues including electrical safety, cryogenic safety, radiation safety and chemical safety, as well as issues related to detector transportation, installation and testing activities. Proficiency testing is performed to gauge comprehension.

All visitors to CDF will be informed of FNAL ES&H rules and procedures applicable to their visit. In general, visitors will not be allowed to work in areas without the advance permission of the CDF project managers or their designee. All visitors to CDF must be accompanied by a Host who is familiar with FNAL and CDF ES&H rules and procedures. Hosts are responsible for the safety of the visitors they accompany.

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APPENDIX A

List of Referenced Documents

CDF Run IIb Technical Design Report.

CDF Run IIb Cost and Schedule Plan.

CDF Memoranda of Understanding and Work plans for each sub-project.

Justification of Mission Need

Fermilab Project Control Systems Guidelines, May 1, 1994.

Fermi National Accelerator Laboratory Run IIb CDF and D0 Detector Projects Acquisition Execution Plan.

FNAL ES&H Manual.

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APPENDIX B

CDF IIb Major Milestones

Level 1	Run IIb detector components ready for installation	Jan 1, 2005
Level 1	Ready for collisions	July 1, 2005

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