

US CMS

# Project Management Plan

Draft

August, 1997

## US CMS Project Management Plan

### ABSTRACT

This Management Plan sets forth the specific plans, organization, responsibilities and systems to be used in managing the work necessary for successful completion of the US Compact Muon Solenoid (CMS) construction project. The US CMS construction project is both a DOE Major Systems Acquisition (MSA) project and an NSF Major Research Equipment (MRE) project, with the project office located at the Fermi National Accelerator Laboratory. Fermilab will provide management oversight for this project lead by the Fermilab Deputy Director. This project includes the construction of elements of the CMS detector for which the US groups collaborating on CMS take responsibility.

The US groups will participate in the building of the Compact Muon Solenoid (CMS) experiment which is designed to study the collisions of protons on protons at a center of mass energy of 14 TeV at the Large Hadron Collider (LHC) at CERN. To enable studies of rare phenomena at the TeV scale, the LHC is designed to operate at a luminosity of  $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ . The physics program includes the study of electroweak symmetry breaking, investigation of the properties of the top quark, searches for new heavy gauge bosons, probing quark and lepton substructure, looking for supersymmetry and exploring for other new phenomena.

The US CMS Group agrees to take leadership responsibility in the CMS experiment for the endcap muon system, and for all hadron calorimetry, as well as associated aspects of the trigger and data acquisition system. The US CMS Collaboration also plans to work on important areas of electromagnetic calorimetry, tracking, and common projects. These common projects will be provided as in kind contributions wherever possible.

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**US CMS  
Project Management Plan**

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LIST OF ABBREVIATIONS AND ACRONYMS

AAAP	Advance Acquisition or Assistance Plan
ACWP	Actual Cost of Work Performed
APP	Advance Procurement Plan
BAO	Batavia Area Office
BC	Budgeted Cost
BCCB	Baseline Change Control Board
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
CCB	Configuration Control Board
CD	Construction Directive
CDR	Conceptual Design Report
CERN	European Laboratory for Particle Physics
CH	Chicago Operations Office
CMS	Compact Muon Solenoid
CPR	Cost Performance Report
CSCG	Cost/Schedule Controls Group
CS <sup>2</sup>	Cost Schedule Control System
DAQ	Data Acquisition
DCC	Document Control Center
DHEP	Division of High Energy Physics
DOE	Department of Energy
EA	Environmental Assessment
EAC	Estimate at Completion
ECAL	Electromagnetic Calorimeter
ECR	Engineering Change Request
EMU	Endcap Muon System
ER	Office of Energy Research
ESAAB	Energy System Acquisition Advisory Board
ES&H	Environment, Safety and Health
FES	Facilities Engineering Services
FIFS	Fermilab Integrated Financial System
FNAL	Fermi National Accelerator Laboratory (Fermilab)
FONSI	Finding of No Significant Impact
FSAR	Final Safety Analysis Report
GeV	Giga-electron-Volt
HCAL	Hadron Calorimeter
HENP	High Energy and Nuclear Physics
L2M	Level 2 Manger
MAP	Mitigation Action Plan
MOU	Memorandum of Understanding

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MRE	Major Research Equipment
MSA	Major System Acquisition
NSF	National Science Foundation
PMG	Project Management Group
PMP	Project Management Plan
PSAR	Preliminary Safety Analysis Report
PSWBS	Project Summary Work Breakdown Structure
QA	Quality Assurance
QAC	Quality Assurance Committee
QAP	Quality Assurance Plan
QC	Quality Control
R&D	Research and Development
SOW	Statement of Work
SQIP	Specific Quality Implementation Plan
TEC	Total Estimated Cost
TeV	Tera-electron-Volt
TPC	Total Project Cost
URA	Universities Research Association
WBS	Work Breakdown Structure

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# Section I

# Introduction

## I. Introduction

This document describes the Project Management Plan (PMP) that the US CMS Project will follow to meet the technical, cost, and schedule objectives of the US CMS Project, a Department of Energy (DOE) Major System Acquisition (MSA) and NSF Major Research Equipment (MRE) Project. The project will have its management office at Fermilab, in Batavia, Illinois. Fermilab is a DOE Laboratory operated under contract DE-AC02-76-CH-03000 by the Universities Research Association, Inc. (URA). DOE, NSF, Fermilab and the US CMS Collaboration will work together as a team to accomplish the US CMS Project. This PMP for construction of US CMS, a project baseline and execution document, sets forth the plans, organization and systems that will be used to manage this DOE MSA and NSF MRE project.

### A. The US CMS Project

The US CMS Collaboration is part of CMS. CMS is a collaboration of high energy physicists from many nations which will conduct an experimental investigation of the interactions of protons on protons at a center of mass energy of 14 TeV at the Compact Muon Solenoid (CMS) experiment planned for the Large Hadron Collider (LHC) at CERN. The CMS detector is designed to exploit the full range of physics at the LHC up to the highest luminosities.

There are two systems where the US has overall responsibility: the endcap muon (EMU) system and the hadron calorimeter (HCAL) system. US CMS groups will take construction responsibility for these and other items. The US will design the endcap steel which will be constructed as a CMS common project. The hadron calorimetry is managed by US groups. The US groups will build the barrel, supply the endcap transducers and front-end electronics, and build half of the forward system while maintaining complete HCAL management responsibility. In addition, since the HCAL is supported by the solenoid cryostat, US groups are involved in the design of the cryostat and intend to construct elements of it as a CMS Common Project.

For the other subsystems, the US responsibilities are not global. However, in every case they are focused on particular area of US expertise. For example, US groups have overall CMS trigger management responsibility and will do essentially all endcap muon level 1 triggers, all calorimeter level 1 triggers, and half of the event builder switch. In EM calorimetry the US focus is on transducers, front end electronics and monitoring. In tracking the US groups will build all the endcap silicon pixels.

## **B. The Project Management Plan**

The PMP presents the top level technical, cost, and schedule baselines for the US CMS Project, and sets forth the organization, systems, and plan by which the project participants will manage the US CMS Project. The line of authority at the top levels of the US CMS Project is shown in Table I-1.

The management approach described here is based on ER and NSF experience with projects to construct complex detectors designed as research tools to advance the frontiers of knowledge. Three fundamental principles underlie the development of the organizational structure, the assignment of roles and responsibilities, and the implementation of management systems to optimize the success of the project. These principles are:

- a. The US CMS Project Manager is nominated by the US CMS Collaboration, and is jointly appointed by DOE, NSF, and Fermilab. The US CMS PM has the technical responsibility for the successful achievement of the performance goals within the cost and schedule objective.
- b. Relevant formal management systems and requirements are implemented to optimize the project goals and to account properly for the use of public funds. Fermilab has management oversight responsibility for the US CMS Project. To accomplish the oversight function, Fermilab will convene a project Management Group which will report to DOE and NSF and which will act as the change control board for the US CMS Project.
- c. Project Management incorporates a team approach involving DOE ER, NSF, Fermilab, and US CMS.

Following this introductory section, Section II provides an overview of the US CMS Project, the design goals, scope and objectives. The roles and responsibilities of the major project participants are defined in Section III. Section IV through VII describe the work and its organization and the associated cost, schedule, and technical baselines. A discussion of the system that will be used to manage and control cost and schedule and to measure the technical performance of the project is given in Section VIII. Reporting requirements and review procedures are described in Section IX.

This plan will be reviewed and revised, as required, to reflect new project developments and/or other agreements among the participants. Revisions, as they are issued, will be signed by all participants, and will supersede in their entirety previous editions. To the extent that there are inconsistencies or conflicts between this plan and

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the terms and conditions of applicable laws, regulations, and contracts, the provisions of those documents shall prevail over this plan.

# US CMS Line Authority

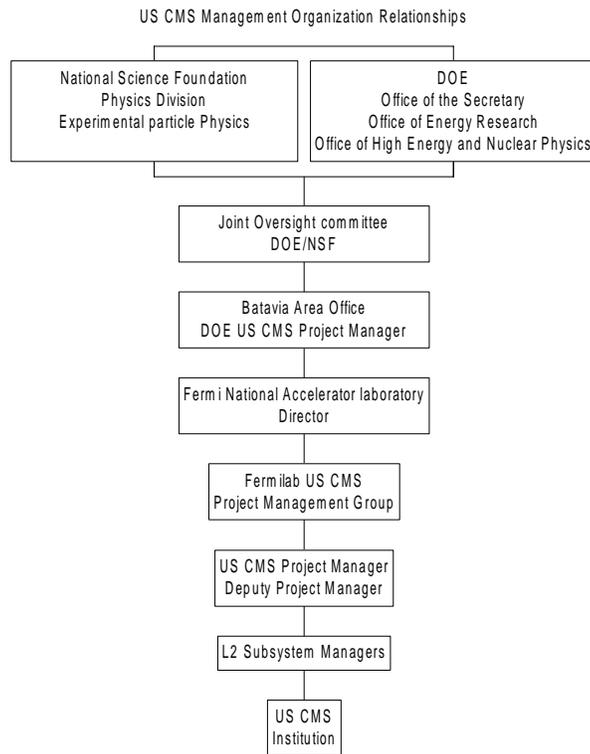


Fig. I-1: US CMS Line Authority.

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# Section II

## Project Objectives

## II. Project Objectives

### A. Project Purpose

The purpose of the US CMS Project is to enable US high energy physicists to participate in research at the high energy frontier available at the Large Hadron Collider (LHC) at CERN.

The US CMS project is described in the US CMS Letter of Intent of September 8, 1995 and in the US CMS Project Status Report of October 15, 1996, and is outlined below. US responsibilities within CMS include both management and construction.

US groups have management responsibility for the endcap muon system, the hadron calorimeter, and the trigger. Construction responsibilities within the US extend to portions of all five CMS subsystems: Muon, Hadron Calorimeter, Trigger/DAQ, Electromagnetic Calorimeter, and Tracking. In addition, there is US participation in the Common Projects and the costs of the Project Office at Fermilab are explicitly called out. Hence, there are seven WBS level 2 categories, as discussed in Section V.

US CMS responsibilities in the muon system are for construction of the endcap muon chambers. US CMS responsibilities in the HCAL system are for construction of the entire barrel, the endcap transducers and readout, and roughly half of the forward system - concentrating on transducers and readout. US physicists also have responsibilities within the CMS trigger and data acquisition system. US CMS groups will construct the level 1 calorimeter and endcap muon trigger and elements of the level 2 event builder switch. US CMS responsibilities in ECAL are to provide some of the transducers, front end electronics, and monitoring systems. The US groups involved in CMS tracking will provide all the forward pixel disks.

### B. Technical Objectives

[To be completed when the Memorandum of Understanding with CERN is complete; and following the baseline review of US CMS by DOE and NSF.]

### C. Schedule Decision Points

The key decision points and other milestones for the project are shown in Fig. II-1. This overall CMS schedule defines the US CMS Project schedule in that the US groups are responsible for a subset of the experimental apparatus. Both the schedule and cost are, of course, dependent on the rate of funding. This schedule results from discussions between CERN, CMS, DOE/NSF and US CMS. A more detailed schedule is given in Section VI. A US CMS level 1 schedule is derived from, and is consistent with,

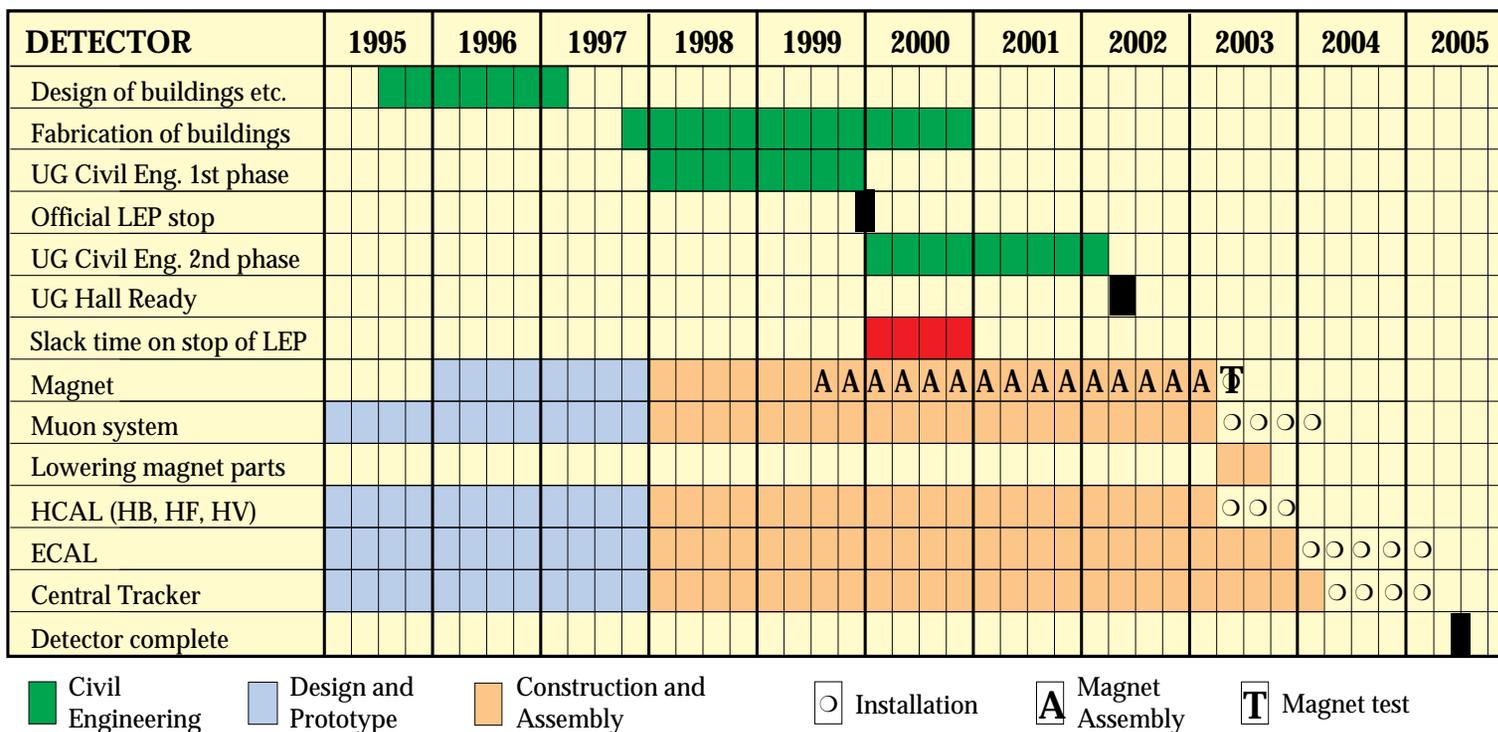
the overall CMS planning. The level 2 managers then create a level 2 schedule which is tied to the level 1 milestones.

**D. Cost Objectives**

The Total Project Cost (TPC) for construction of the US CMS Project is \$168,350,000 in then year dollars. The cost estimate is summarized in Table II-1. Detailed discussion of the cost estimates, together with obligations and cost profiles based on schedules described in Section VI, are presented in Section VII.

# Construction Schedule

Fig. II-1: CMS Construction Schedule.



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US CMS Project Cost Estimate

WBS Number	Description	US Mfg M&S (K\$)	US Mfg Labor (K\$)	US EDIA (K\$)	US Base Cost (K\$)	US Cont (K\$)	Cont (%)	Total US Cost (K\$)	DOE Request (K\$)	NSF Request (K\$)
<b>US CMS Total Project Cost (then-yr \$s)</b>		<b>168,323</b>								
Escalation		18,788								
FY'97 R&D		4,920								
FY'96 R&D (FY'97 \$s)		2,563								
<b>US CMS Total Estimated Cost (FY'97 \$s)</b>		<b>142,052</b>								
<b>Total Subsystem Estimated Cost</b>		<b>60,317</b>	<b>11,007</b>	<b>13,847</b>	<b>85,170</b>	<b>27,431</b>	<b>32</b>	<b>112,601</b>	<b>97,556</b>	<b>15,046</b>
<b>1</b>	<b>Endcap Muon System</b>	<b>18,698</b>	<b>4,465</b>	<b>3,844</b>	<b>27,007</b>	<b>8,172</b>	<b>30</b>	<b>35,179</b>	<b>33,730</b>	<b>1,449</b>
1.1	CSC Chambers	8,639	3,001	1,790	13,430	4,205	31	17,634	17,634	
1.2	Electronics	8,241	937	1,357	10,535	3,183	30	13,718	13,718	
1.3	Mechanical Structure	375	59	46	480	120	25	600	600	
1.4	Assembly/Installation	176	170	80	426	101	24	527	527	
1.5	Monitoring	25		15	40	10	25	50	50	
1.6	Services	560	178	137	875	266	30	1,141	1,141	
1.7	Alignment	682	120	360	1,162	287	25	1,449	1,449	
1.8	RPC Chambers			60	60			60	60	
<b>2</b>	<b>Hadron Calorimeter</b>	<b>24,165</b>	<b>5,210</b>	<b>2,933</b>	<b>32,308</b>	<b>10,271</b>	<b>32</b>	<b>42,579</b>	<b>35,732</b>	<b>6,847</b>
2.1	Barrel Hadron Calorimeter	18,404	4,010	2,502	24,916	7,931	32	32,847	28,236	4,612
2.2	Endcap Hadron Calorimeter	2,867	844	251	3,963	1,311	33	5,274	3,547	1,727
2.3	Forward Calorimeter	2,894	356	179	3,429	1,029	30	4,458	3,949	508
<b>3</b>	<b>Trigger/Data Acquisition</b>	<b>9,234</b>	<b>0</b>	<b>3,801</b>	<b>13,035</b>	<b>4,439</b>	<b>34</b>	<b>17,474</b>	<b>15,952</b>	<b>1,522</b>
3.1	Trigger	4,153		2,214	6,367	1,918	30	8,286	8,286	
3.2	Data Acquisition	5,080		1,587	6,667	2,521	38	9,188	7,667	1,522
<b>4</b>	<b>Electromagnetic Calorimeter</b>	<b>4,992</b>	<b>816</b>	<b>1,966</b>	<b>7,774</b>	<b>2,345</b>	<b>30</b>	<b>10,119</b>	<b>7,635</b>	<b>2,485</b>
4.1	Photodetectors	1,965	157	500	2,622	904	34	3,526	1,042	2,485
4.2	Front-End Electronics	2,358	421	765	3,544	1,207	34	4,751	4,751	
4.3	Special Engineering	130	7	538	675	83	12	757	757	
4.4	Monitoring Light Source	523	231	163	917	152	17	1,069	1,069	
4.5	Crystal Development	16			16			16	16	
<b>5</b>	<b>Forward Pixel Tracker</b>	<b>3,229</b>	<b>515</b>	<b>1,303</b>	<b>5,047</b>	<b>2,203</b>	<b>44</b>	<b>7,250</b>	<b>4,507</b>	<b>2,743</b>
5.1	Readout system	1,426	35	610	2,071	978	47	3,049	1,722	1,328
5.2	Sensor arrays	577		268	845	372	44	1,217	1,217	
5.3	Mechanical and cooling	372	251	271	894	406	45	1,300	1,302	
5.4	Slow controls and monitoring	100		10	110	42	38	152	28	125
5.5	Final assembly and testing	754	229	144	1,127	405	36	1,532	1,455	73
<b>6</b>	<b>Common Projects</b>	<b>21,808</b>	<b>119</b>	<b>1,050</b>	<b>22,977</b>	<b>0</b>	<b>0</b>	<b>22,977</b>	<b>19,965</b>	<b>3,012</b>
6.1	Endcap Iron Flux Return	18,116	119	1,050	19,285			19,285		
6.2	Vacuum Tank	3,692			3,692			3,692		
<b>7</b>	<b>Project Management</b>	<b>0</b>	<b>0</b>	<b>4,991</b>	<b>4,991</b>	<b>1,483</b>	<b>30</b>	<b>6,474</b>	<b>5,932</b>	<b>542</b>
7.1	Project Administration			2,798	2,798	826	30	3,624	3,082	542
7.2	Technical Coordination			2,193	2,193	657	30	2,850	2,850	

Table II-1: US CMS Project Cost Estimate.

# Section III

## Project Organization and Responsibilities

### **III. Project Organization and Responsibilities**

#### **A. Introduction**

The US CMS Project operates within the context of CMS as an internationally funded experiment located at CERN. The CERN management has ultimate responsibilities for CMS and requires that CMS report to it. The executive function in CMS is provided by the CMS Management Board. The CMS Management Board is advised on technical matters by the Technical Board and on financial matters by the Finance Board.

Within CMS, the US CMS Collaboration acts congruently with a governance which is described in "The US CMS Constitution", August, 1997. Nevertheless, as a US Project, US CMS is financially responsible ultimately to DOE and NSF. In turn, CERN and DOE/NSF will jointly sign a Memorandum of Understanding covering the financial obligations and deliverables for the construction of CMS.

#### **B. US CMS Collaboration**

The organization of the US CMS Collaboration is described in a distinct document, the US CMS Constitution of August, 1997. The organization of the full CMS Collaboration is described in the CMS Constitution of September 13, 1996.

#### **C. DOE and NSF Organization and Responsibilities**

The Department of Energy and the National Science Foundation have established the need for the US CMS Project by considering and responding to advice from their advisory panels, and in negotiations with CERN. The Department of Energy and the National Science Foundation provide the majority of the funding for the US CMS Project. The DOE Division of High Energy Physics and the NSF Physics Division provide annual program guidance to US CMS and to the host laboratory as well as annual guidance on the funding profile for the project. The DOE and NSF exercise oversight of the project by:

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

#### **D. Joint Oversight Committee**

The crucial partnership between the DOE and the NSF and their relations with the US CMS Project Office and the Fermilab Directorate will be handled by a Joint Oversight Committee (JOC) consisting of the Head of Physics at the NSF and the Head of High Energy Physics at the DOE and their designees. Since the two agencies are in partnership for US CMS, such a committee is mandatory. The US CMS Project Manager reports directly to the Joint Oversight Committee and to Fermilab. In addition, a key responsibility of the Project Manager is to provide the budget request and to recommend to the JOC, with the concurrence of Fermilab, allocation of the annual budget among the participating institutions. The PM reports to Fermilab on all matters having to do with managing the project to the agreed scope, within cost and schedule.

#### **E. Fermilab Director**

The Fermilab Director has the overall responsibility to the Department of Energy and the National Science Foundation for the management oversight of the US CMS Project. Management oversight concerns the scrutiny necessary to maintain the cost and schedule goals to achieve the agreed project scope. The US CMS Collaboration consults with the Director as part of the procedure for appointing the US CMS PM. The Project Management Plan, the cost estimate, the schedule and the financial plan for the project require the approval of the Director and DOE and NSF with the concurrence of CMS and CERN. The responsibilities of Fermilab are further described in a letter of joint appointment from DOE and NSF to the Fermilab Director. The Fermilab Director will concur in the MOU between CERN and DOE/NSF and in the MOUs between US CMS and the collaborating institutions

#### **F. Fermilab Deputy Director**

The Fermilab Director has delegated certain responsibilities and authorities to the Deputy Director. The Deputy Director is responsible for management oversight of the project. The PM reports to the Deputy Director. The Deputy Director chairs the Project Management Group (PMG) which meets as necessary to monitor the progress of the project. Oversight of the project is implemented in part through reviews. Along with providing routine interactions with project management the PMG 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.

To implement the work plan for the project, Memoranda of Understanding (MOU) are written assigning responsibilities and describing the work to be executed. The Deputy Director will concur in all Memoranda of Understanding. The Deputy Director advises the Director regarding approval of the PMP, the cost estimate, the schedule, and the financial plan and concurs with these approvals.

## **G. Project Management Group**

The Department of Energy and the National Science Foundation request that Fermilab exercise management oversight for the US CMS detector project. A Project Management Group (PMG), which reports directly to the DOE and NSF through the Joint Oversight Committee, will be convened by Fermilab for this purpose. It is expected that the PMG will include members from Fermilab, DOE, NSF and US CMS. The PMG also serves as the Change Control Board. The PMG receives the reports of the US CMS Project Manager. In turn, it independently reports to the JOC. The US CMS Spokesperson is a member of the PMG, thus insuring that scientific issues will be communicated to the US CMS Collaboration.

## **H. US CMS Project Manager**

The US CMS PM has authority and responsibility for the achievement of the technical, cost, and schedule goals for this project. The US CMS PM will establish a project organization which has designated responsibility for the technical, cost, schedule, procurement, and construction aspects of the project. The US CMS PM is jointly appointed by DOE and NSF and by Fermilab. The PM reports to both Fermilab and to DOE and NSF as described above. Reporting to Fermilab is done through the PMG. The PM directly reports to DOE and NSF the annual budget request for US CMS and its annual allocation among the individual US CMS institutions in order to achieve the goals of the project.

The PM has the responsibility to complete the Cost and Schedule Plan, and the MOU/Work Plans for the project. The scope of the project is defined in the CERN - DOE/NSF MOU. Any change of the scope must be approved by the Fermilab PMG, in consultation with CERN, the JOC and CMS. The Project Manager has the responsibility to complete the US CMS Project on the agreed upon schedule, and within the agreed upon budget.

In addition, the PM is responsible for preparing the Project Management Plan (PMP) and for updating it as necessary with the approval of the Deputy Director. The Project Manager may identify the need for project scope changes. When there is a need for a change having a significant impact on the physics capability of the detector the PM must report to the CMS Management Board and also identify the need to the Director through the PMG. The PM receives technical advice from Internal Review Committees. The PM creates such committees as needed and appoints their members in consultation with the US CMS EB and the CMS MB. The procedure for modification of the scope of the project is described in Section VIII of this document.

The PM is responsible for organizing presentations and at other reviews and for preparing status reports on the project. The PM will initiate reviews of L2 subprojects to insure that the subproject is meeting its technical performance, cost, and schedule milestones. The PM may request a review be organized by the CMS MB when questions of the adequate technical or physics performance of a subsystem arise. The PM is a member of the PMG.

## **I. US CMS Project Office**

### **1. Fermilab as US CMS Host Institution**

Fermilab has agreed to act as host laboratory to the US CMS Project, and will also serve as the location of most project reviews. The US CMS Project Office will physically reside at Fermilab, and will provide administration for DOE funds. (Administration of NSF funds is provided by the US CMS NSF Office; see below.) Fermilab will also provide Service Accounts for US CMS groups, and travel and purchasing support will be available.

Use of Fermilab facilities and services shall be agreed upon via MOU in the same manner as with the use of available infrastructure at any US CMS institution. The Project Manager must report to the Fermilab Director to provide accountability for all services provided by Fermilab to US CMS which are not paid for by US CMS Project funds. The provided services may include services provided to the Fermilab CMS group or may be services provided to another US CMS Institution. Within the framework of the MOU specific items shall be negotiated annually by Fermilab (as host laboratory), by the US CMS Project Manager, and by the collaborating US CMS institution.

### **2. Management Reserve and Annual Allocation**

The Project Manager shall hold a management reserve each fiscal year. That reserve will be committed by the Project Manager during the course of the year based on performance and need of the various groups in the US CMS Collaboration. The reserve will be allocated to individual US CMS institutions in the same manner as the main fiscal year allocation.

The organization of the US CMS Project Office is shown schematically in Fig. III-1. This office is headed by the US CMS Project Manager. Allocations of project funds are the purview of the Project Manager with the scientific advice of the US CMS Executive Board and the concurrence of the Fermilab PMG. All costs of the Project Office

(exclusive of physicist salaries) shall be explicitly borne by the US CMS Project and are called out in the US CMS WBS.

3. US CMS NSF Office

The US CMS NSF Coordinator shall maintain an office responsible for the administration of NSF funds. The NSF Coordinator is appointed by the NSF upon the recommendation of the NSF-funded CMS institutions, and serves as the NSF Liaison on the CMS Finance Board and to the CMS Resource Review Board. The NSF Coordinator is a member of the PMG.

4. Allocation and Funding - PMG and MOU

The allocation of funds to US CMS institutions is annually determined by the Project Manager with the concurrence of the PMG. Subsequently, funding is provided to those institutions (including Fermilab as a US CMS collaborating institution). Explicit arrangements are defined in the US CMS MOU and annual SOW, which appear in Appendices A and B.

5. US CMS Deputy Project Manager

The US CMS PM will appoint a Deputy Project Manager who will assist in the tasks of the PM. The PM will be primarily concerned with the overall management and its interface with CMS and CERN, with the negotiation of MOU and SOWs with US CMS institutions, with the PMP and with reporting to CMS, the PMG and the JOC.

By comparison, more technical aspects of formal project management will devolve to the Deputy PM. The creation and maintenance of the Cost and Schedule Plan, tracking and reporting, and the organization of technical presentations will be largely the province of the Deputy PM. The Deputy PM is a member of the PMG.

6. WBS Level 2 Managers

The WBS level 2 managers are appointed by the US CMS PM with the concurrence of the PMG, and report directly to the US CMS Project Manager and Deputy Project Manager. The L2 managers are members of the PMG. They have the specific responsibilities listed below:

- Perform control account management at the second level of the WBS consistent with management responsibilities, organization structure, and commonly accepted practices.

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- Ensure that the control account and the schedule status are recorded on a timely basis to maintain current period, cumulative-to-date and at-completion records.
- The WBS level 2 managers are responsible for the particular subsystems of the US CMS as defined in the work breakdown structure (WBS).

### 7. Support and Programmatic Organization

The US CMS Project Manager will draw on Fermilab resources as agreed by the Fermilab Director. The use of these resources will follow procedures consistent with the Laboratory's current accounting, budgeting, human resources, and procurement department policies.

The Project will obtain support to the extent agreed from the Laboratory's indirect support group, including:

- Accounting
- Budget
- Environment, Safety and Health
- Human Resources
- Legal
- Material
- Facilities Management
- Quality Assurance and Value Engineering Office
- Information Services

All support functions will be provided through the Laboratory matrix organizational lines of authority and responsibility. The US CMS Project Manager will direct all questions of priority need for Laboratory support assistance not satisfied through normal lines of authority to the Laboratory Director.

### 8. Internal Review Committee

Internal Review Committees provide a means for the PM to review technical, cost, and schedule issues for L2 subprojects. These committees may also be charged with reviewing the physics performance of the subsystem or recommending scope changes. Internal Review Committees are appointed from the CMS membership as required by the PM. The PM charges them, in consultation with the PMG. Reports and recommendations from internal review committees are transmitted to the L2 Managers and are in general made available to the entire US CMS collaboration.

### 9. Subproject Technical Committees

There may be technical committees associated with a subsystem and separate from the US CMS internal review boards discussed above. These are appointed by the L2 manager as needed. Members of such technical committees advise the subsystem L2 managers 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 members of sub-project technical committees are appointed by the L2 manager. These committees act in an advisory capacity. Decision authority remains in the hands of the L2 manager consistent with the line responsibility described above.

#### 10. Project Communications

The US CMS Project necessarily entails coordination between CERN, Fermilab, DOE and NSF. At the experiment level, CMS must coordinate with the US CMS collaboration.

The US CMS Project is conducted as a team effort involving DOE, NSF, CERN, Fermilab, CMS and US CMS. For the Project to progress, all parties need to be fully informed of progress, plans, issues, problems, solutions, and achievements in real time.

Communication among participants is free and informal to the maximum extent feasible. Notes, "drafts," phone calls, electronic mail, and informal discussions are exchanged frequently among the participants to accomplish information flow, raise issues for mutual resolution, and explore the viability of plans and solutions. Distribution of copies of informal correspondence to all participants is desirable to keep them fully apprised of these communications. Each organizational participant will designate an individual to coordinate informal communications and assure their proper distribution within that organization. Formal communication of project business flows along the line authority.

# US CMS Project Office

Project Office - WBS 7.

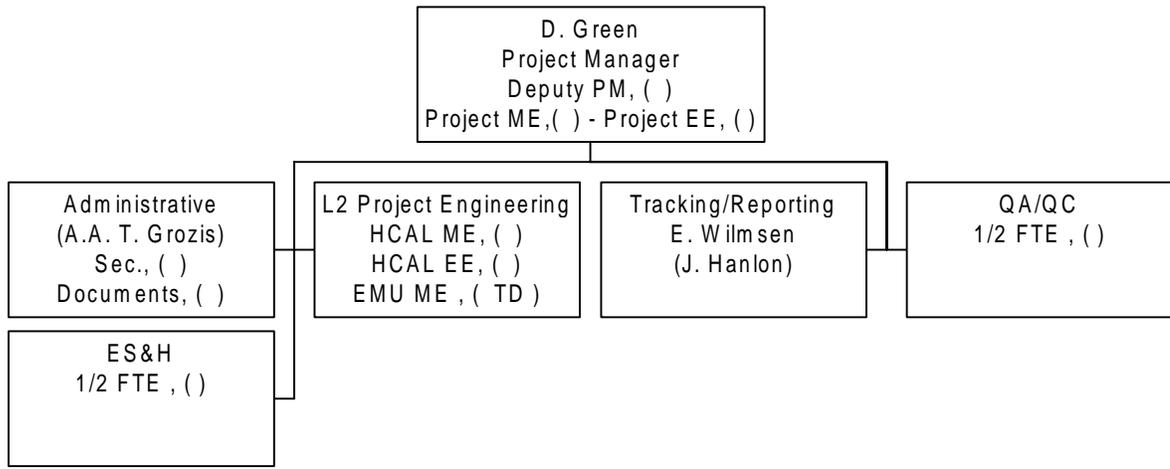


Fig. III-1

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# Section IV

# Work Plan

## IV. Work Plan

### A. Introduction

In this chapter, the work to be performed in the US CMS Project is described in Section IV.B, and the methodology to be used in the execution of the work is described in Section IV.C. The research and development (R&D) program connected with the US CMS Project is described in Section IV.D. System tests and commissioning are discussed in Section IV.E. The final two sections of this chapter describe the programs to be utilized by the US CMS Project for Quality Assurance (Section IV.F) and for Safety Analysis and Compliance and Environmental Compliance (Section IV.G).

### B. Work Description

This project provides for the construction of elements of an experiment to be performed at CERN, designated the US CMS Project. The purpose of the project is described in Section II.A. The salient features of the work that needs to be done are briefly described in Section II of this plan, and in considerable detail in the CMS Technical Design Reports.

### C. Work Execution

[to be completed after full project scope is known]

*Design and Engineering*

*Construction, Fabrication, Assembly, and Installation*

*Inspection and Acceptance*

### D. Research and Development Program

A program of R&D in support of the US CMS construction project has already been initiated. This program will provide for the design and development of new detector components and for the fabrication and testing of prototypes. R&D directed towards the optimization of performance and cost will continue through the early years of construction. The DOE funded efforts in R&D will be done largely in FY96 and FY97. The NSF funded efforts will occur largely FY96, FY97, and FY98. The scope of the FY96 efforts in R&D undertaken by the US CMS collaboration are discussed in the US CMS Project Status Report, (October, 1996). The R&D program has been developed to interface with the construction project milestones.

The R&D effort will be managed by the US CMS Project Manager. Coordination of the R&D work with the construction schedule will be the responsibility of the US CMS Project Manager .

**E. System Tests and Commissioning**

[to be completed after full project scope is known]

**F. Quality Assurance Program**

Quality assurance is an integral part of the design, procurement, fabrication, and construction phases of the US CMS Project. Special attention is being devoted to items that will affect the performance capability and operation of the CMS detectors.

It is the policy of the US CMS project that all activities shall be performed at a level of quality appropriate to achieving the technical, cost, and schedule objectives of the project. To implement this policy, the US CMS project will develop a SQIP that is based on the QA criteria established by DOE and NSF. The responsible person for the QAP for the US CMS is the US CMS Project Manager.

The US CMS project SQIP will define the management policies in regard to 1) QA program, 2) Personnel Training and Qualification, 3) Quality Improvement, 4) Documents and Records, 5) Work Processes, 6) Design, 7) Procurement, 8) Inspection and Acceptance Testing, 9) Management Assessment, and 10) Independent Verification.

Vendors will implement quality assurance programs appropriate to the services being furnished. As specified in the MOU, US CMS activities done at each institution will use the implemented quality assurance programs. All these programs, as well as implementing procedures, are subject to review and audit by the US CMS Project Office at Fermilab.

**G. Environment, Safety and Health Analysis and Compliance**

Implementation of the project ES&H program is the responsibility of the US CMS Project Manager and the line managers in the US CMS organization. The US CMS Project Manager has appointed the US CMS Project Mechanical Engineer to be the US CMS ES&H Supervisor with the responsibility to monitor the implementation of the total US CMS project ES&H program to ensure conformance and to be responsible for coordination of the project-wide ES&H program.

All project activities will be conducted in compliance with the applicable DOE and NSF ES&H directives. CERN requirements will be addressed through consultation with the CMS group leader in matters of safety (GLIMOS).

# Section V

## Work Breakdown Structure

## V. Work Breakdown Structure

All work required for successful completion of the US CMS Project is organized into a WBS. The WBS contains a complete definition of the scope of the project and forms the basis for planning, execution, and control of the US CMS Project. The US CMS WBS is continued to a sufficiently low level to make each deliverable and its provider unique and trackable. Specifically, the WBS provides the framework for the following activities:

### *Budgeting*

Each element of the WBS at the lowest level is assigned a budgeted cost (BC). The budgeted cost of the project can be seen at any level by performing a sum over contributing lower levels.

### *Cost Estimating*

The WBS supports a systematic approach to preparation of the cost estimate for the project. The WBS structure is extended to a level sufficient to allow definition of individual components for which a cost can be reasonably estimated. The BC and cost estimate are equal for the lowest level in each branch of the WBS.

### *Scheduling*

The WBS also supports a systematic approach to preparation of the project schedule. Again each WBS element at the lowest level of the structure is assigned a schedule duration. The project schedule is created by establishing the interdependencies between the various elements.

### *Support Requirements*

The WBS, in conjunction with the associated schedule and cost estimates, provides the framework over the life of the project for projecting funding and manpower requirements over the life of the project.

### *Configuration Control*

The detailed scope of the project is contained within the WBS. Proposed changes to the scope can readily be evaluated within the WBS framework.

### *Performance Measurement*

The WBS supports the monitoring, control, and reporting of cost and schedule performance. Since each element of the WBS, and by association each work element,

has a well defined BC and schedule a view of the progress of the project at any level is available at any time.

**A. Organization of the WBS**

The levels of the WBS reflect the logical breakdown of the work required to complete the project with lower levels providing progressively higher levels of detailed description. The number of levels is established by extending the description down to a level at which individual components can be identified and associated into a well defined piece of equipment or structure.

**B. Project Summary WBS**

The Project Summary WBS is a consolidation of the top three levels of the US CMS Construction Project WBS, and the top two levels associated with Other Project Costs - R&D. The specific Project Summary WBS is given below.

1. US CMS Construction Project
  - 1.1 Endcap Muon System.
    - 1.1.1 CSC Chambers
    - 1.1.2 Electronics
    - 1.1.3 Mechanical Structure
    - 1.1.4 Assembly/Installation
    - 1.1.5 Monitoring
    - 1.1.6 Services
    - 1.1.7 Alignment
    - 1.1.8 RPC Chambers
  - 1.2 Hadron Calorimeter
    - 1.2.1 Barrel Hadron Calorimeter
    - 1.2.2 Barrel Outer Calorimeter
    - 1.2.3 Endcap Hadron Calorimeter
    - 1.2.4 Endcap Outer Calorimeter
    - 1.2.5 Forward Calorimeter
  - 1.3 Trigger/DAQ
    - 1.3.1 Level 1 Trigger
    - 1.3.2 Data Acquisition
  - 1.4 Electromagnetic Calorimeter
    - 1.4.1 Photodetectors
    - 1.4.2 Front-end Electronics
    - 1.4.3 Special Engineering
    - 1.4.4 Monitoring Light Source
    - 1.4.5 Crystal Development
  - 1.5 Forward Pixel Tracking

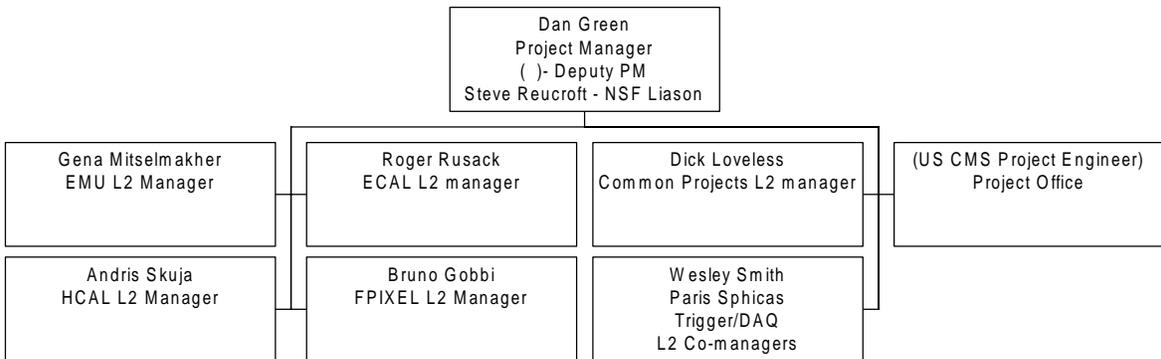
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- 1.5.1 Readout System
- 1.5.2 Sensor Arrays
- 1.5.3 Mechanical and Cooling
- 1.5.4 Slow Controls and Monitoring
- Final Assembly and Testing
- 1.6 Common Projects
- 1.7 Project Management
- 2. Other Project Costs - R&D

The highest levels of the Project Summary WBS are shown in Table V-1.

Table V-1: US CMS Project and WBS Level 2 Managers

# US CMS Project



**C. WBS Dictionary**

The WBS Level 2 Managers are shown in Table V-1. The L2 managers are required to provide the PM a detailed WBS dictionary of their subsystem. This document and the Basis of Estimate provides the documentation which defines the quality of the estimated costs for the project.

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# Section VI

## Project Schedule and Milestones

## VI. PROJECT SCHEDULE AND MILESTONES

### A. Schedule Baseline

The schedule baseline sets forth the major activities, decision points and activity interfaces essential for completion of the US CMS Project.

The baseline schedule includes interpretation and optimization of activities related to the design, procurement, fabrication, assembly, testing, installation and checkout of detector elements. The Project Master Schedule will be developed to include major activities and decision points. It is composed of major WBS level 3 elements with significant milestones included. This schedule will be the top level project schedule and is the basis for baseline development in all lower level project schedules.

Work package schedules at the lowest WBS level (L7) will be assembled into an interconnected activity logic diagram by integrating construction activities within each respective WBS element. Schedule interfaces with other WBS elements will be made. This integrated schedule provides a total project critical path. Summarization of these lower level activities allows status to be rolled up through the various WBS levels to provide intermediate level and master level working schedules. These working schedule dates are compared to the established baseline dates and any variances addressed in the Progress Reports. Consistency of data from work packages through intermediate schedules to the master schedule will be traced through control and event milestones. All milestones contained in the Project Master Schedule are reflected in the lower level schedules.

The schedule management and monitoring system will be developed using Microsoft Project a software tool available at Fermilab and one adopted by CMS. The schedule status is summarized at the various WBS levels, to provide project schedule reporting at the master, intermediate, and detailed levels by WBS and across functional organizations. The master level schedule will also include a critical path, defined by the PM by considering the critical paths of each of the L2 efforts.

The present highest level schedule for CMS is given in Fig. II-1.

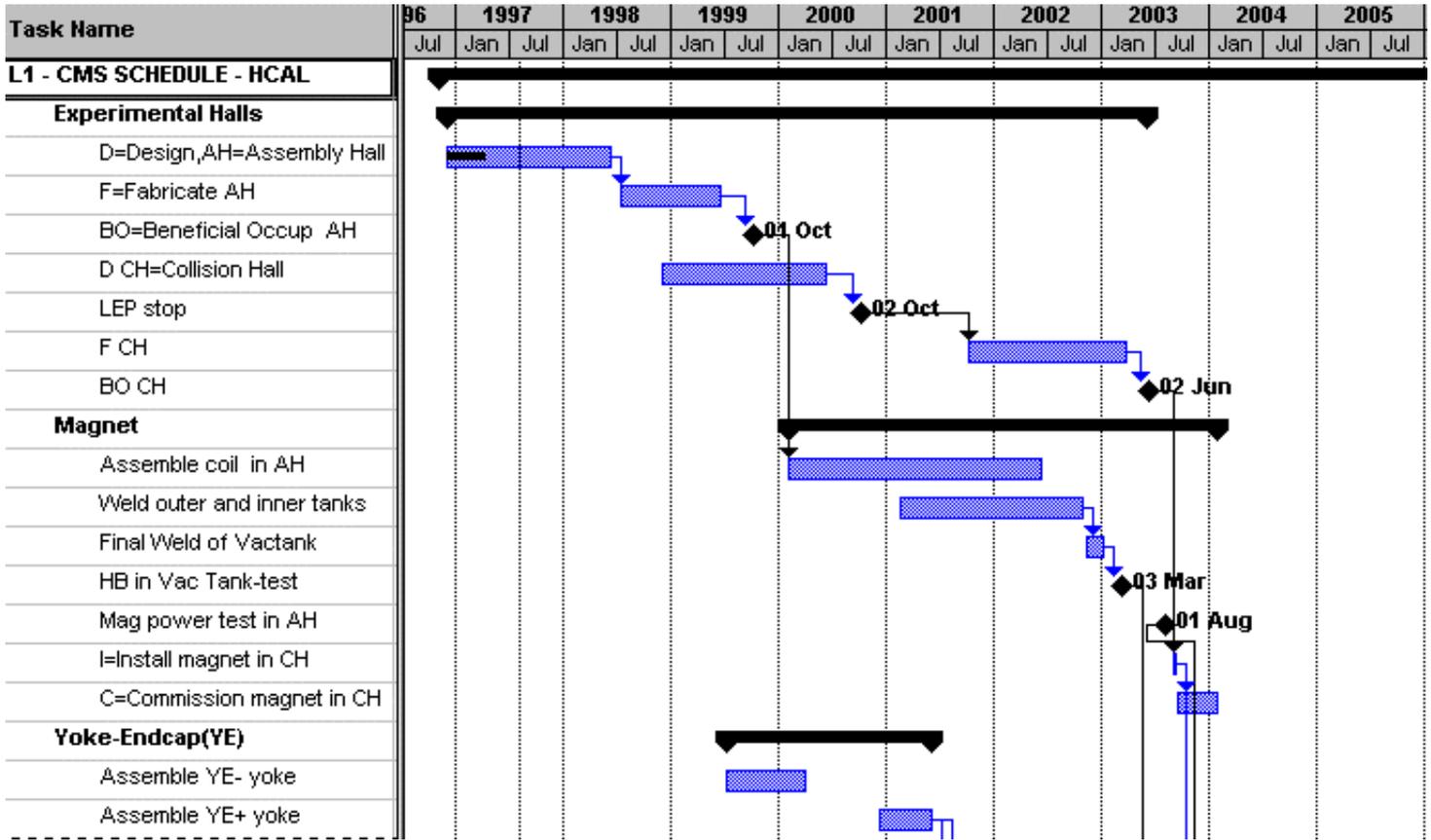
### B. Baseline Milestones

A set of project milestones for L1 schedule has been defined by the US CMS Collaboration, in consultation with the CERN LHC experiments Committee (LHCC). The L1 schedule for US CMS is given in Table VI-1. The corresponding CMS milestones appear in the CMS Interim MOU. The L2 managers provide subsystem schedules which are then linked to the L1 milestones. This linked US CMS schedule is then

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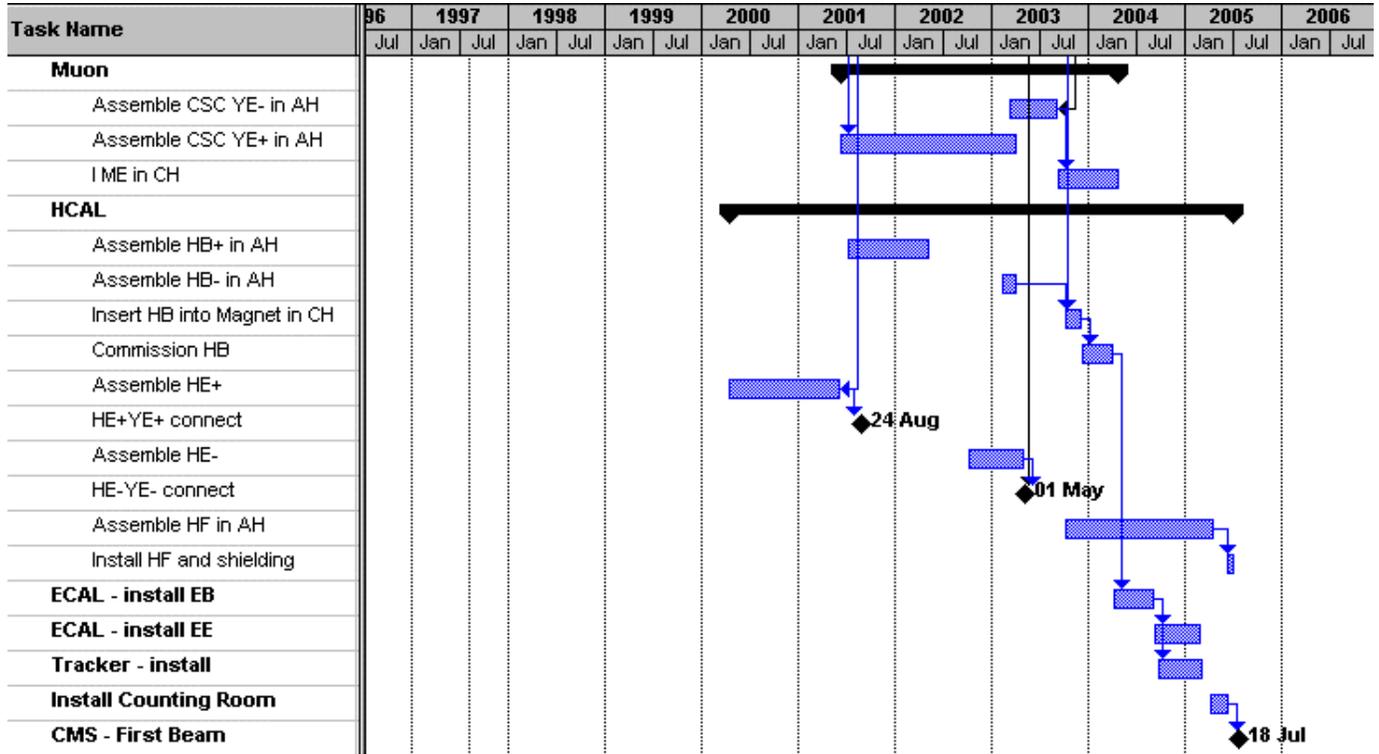
resource loaded in order to provide a US CMS cost profile. CMS has adopted Microsoft Project as the management software, and US CMS has followed that decision.

Table VI-1: US CMS Project Milestones - L1 Schedule.



US CMS Level 1 Schedule.

US CMS Level 1 Schedule.



# Section VII

## Cost and Labor Estimates

## VII. Cost and Labor Estimates

### A. Cost Baseline

The cost baseline will be established when the Project Plan is reviewed. The project cost baseline is equal to the sum of the budgeted costs for each element of the Work Breakdown Structure described in Section V. Changes in cost, technical requirements, schedules, and plans are to be treated as variances to the baseline.

The TPC is \$168.32 M which includes \$7.5M of R&D and \$18.8 M of escalation. This total will not be exceeded. The TEC of the US CMS project is \$142.05M in then-year dollars. Included in the TEC are procurement, assembly, and installation of all technical components, engineering design, inspection, and project management required to assure successful completion of the project. Contingency funds in the amount of 32% of the base cost, excluding common project costs, are also included in the TEC. Uncertainty in the amount of US common project contribution is reflected in the ?? % effective contingency assigned to common projects. The US fraction of the common project costs is about 20% of the total CMS costs.

### B. Obligations and Cost Plans in FY 1997 Dollars

The construction cost estimate is maintained in fixed year (FY 1997) dollars. The TEC in FY 1997 dollars is \$142M.

### C. Escalation

Escalation rates are based upon an assumed annual escalation rate given by guidance from OMB.

### D. Budget Authority and Funding Profile

The project baseline schedule, obligations and cost plan will be based on the best estimate of the funding profile. The obligation plan will be derived from the baseline schedule and cost plans given in this Project Management Plan. Similarly, application of the escalation rates given in C above will result in the cost plan.

### E. Labor Requirements

Labor requirements have been estimated for each work package in the US CMS project. These estimates include the required EDIA and Fermilab-based project management, as well as manufacturing labor.

## Section VIII

# Work Authorization and Project Control System

## **VIII. Work Authorization and Project Control System**

### **A. Introduction**

This section summarizes the techniques that the US CMS Project Manager will use to manage the cost and schedule performance and the technical accomplishments of the Project relative to this PMP. 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 will be employed in an integrated manner in order 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 US CMS Project are expected to 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 defines the management and control procedures which are needed to comply with the requirements of DOE and NSF and Fermilab.

### **B. Guidelines and Policies**

The Work Authorization and Contingency Management System and the Project Control System employed by the US CMS Project will be consistent with DOE and NSF guidelines .

The following policies are applicable for the US CMS:

- All Project work is organized in accordance with the WBS.
- Formal (and informal) reviews by experts are used to establish specifications and designs.
- Established cost, schedule, and technical baselines are used for measuring project performance.
- 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.

- The decision making apparatus employs regular meetings among the US CMS organizational elements. These meetings will serve to identify and resolve interface issues within the project.
- Quality assurance, safety analysis and review, and environment assessment are integral parts of the Work Authorization and Project Control.

### **C. Work Authorization and Contingency Management**

Funds will be made available by the DOE and NSF for support of the US CMS project on an annual basis. Requests for specific amounts, identified at level 3 of the WBS, will be prepared by the US CMS Project Manager. Each such request will include a description of the work to be performed, the requested funds, the forecast cost of the work, and the currently projected contingency requirement at WBS level 3, over the life of the project. Funds will then be released to the institutions who are part of the US CMS Collaboration. A management reserve will be held by the Project Manager and will be applied during the fiscal year on the basis of performance and need, following the principles of change control outlined below.

The PMG, chaired by the Fermilab Deputy Director, will act as the Change Control Board for the US CMS Project. The PMG will have as its purview assignment of contingency funds and any change of the scope of the project. Scope changes arise should projected costs of any L2 subsystem exceed the assigned contingency .

At any time the project contingency is the difference between the project TEC and the sum of the current Estimates at Completion (EAC) at level 3 of the WBS. The contingency is held by the PM. The contingency funds are allocated through the project change control. The PM and the PMG would jointly either descope the effort in question or assign contingency funds from another portion of the full US CMS Project should costs exceed contingency allocations. To that end, each L2 manager will provide the PM a scope contingency scenario to reduce the scope of the relevant US CMS subsystem.

The principles of contingency management that the US CMS project will follow are as follows:

- The cost estimate for each L2 subsystem will include contingency funds based on an assessment of uncertainties and risks associated with the budgeted cost.
- The actual expenditure of contingency will be reflected in a revised EAC, updated annually.

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- The Fermilab US CMS PMG will consider and approve all Change Requests (CRs) that will require future utilization of contingency. A log of such approved requests will be maintained by the US CMS project office and the PMG.
- The initial funding request of each fiscal year may, with the concurrence of the US CMS Fermilab PMG, assign 25% of the contingency available in that year to US CMS for application.
- The US CMS Project Manager may adjust the budgeted cost of any WBS level 3 package by 10% or \$100K, whichever is less, as long as the L2 Project TEC is not exceeded.
- All cost changes to the baseline costs shall be traceable.
- The PM with the concurrence of the PMG must give prior approval to all procurements requiring the use of contingency.

The funds included in each funding request are under the authority of the US CMS Project Manager. Subject to the above conditions the US CMS Project Manager can request the PMG to authorize change requests which, if approved, will then be implemented without further DOE or NSF approval.

### **D. Project Control System**

The Project Control System includes the three categories listed below:

- **Baseline Development:** This includes management actions necessary to define initial 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 manage risk.
- **Change Management:** This includes management actions necessary to ensure adequate control of project baselines, including the performance measurement baseline.

#### **1. Baseline Development**

Each L2 subsystem manager prepares a formal cost estimate and schedule. All necessary resources assumed in this cost estimate are identified in the MOUs of member institutions, who agree to a best effort contribution.

#### **2. Project Performance**

Standard accounting practices and the Project Control System will collect costs for completed work. Performance analysis of costs, schedule, and work scope performance will provide a determination of project status. Each year the PM and L2 managers adjust the schedule and distribute the allocated funding in order to utilize the available resources as effectively as possible. These actions are reflected in the collection of annual SOW with the member institutions.

The cost of the project is captured in the Laboratory's General Ledger and is tracked by work packages based on the Work Breakdown Structure. In general, work packages are assigned to WBS Level 7 elements for cost collection. The L2 managers are responsible for obtaining reporting from their respective contributing institutions to track costs at that level. The mechanism for tracking and reporting is defined in detail in the MOU template (Appendix A of this document).

Summary and detailed cost reports are prepared quarterly by the Project Management. Reports of costs and obligations for capital equipment funds are submitted to Laboratory management and the Department of Energy and NSF.

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.

### **Schedule Variance**

At the end of each quarter, 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**

Quarterly 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 quarterly analysis of the resources available (labor and funds) will be performed by the project office 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.

### 3. Change Control

The US CMS Fermilab PM will control changes in requirements, cost, and schedule in consultation and agreement with the US CMS PMG. Any change that affects the interaction between detector subsystems or that significantly impacts the performance, schedule, or safety of the detector must also be referred to the CMS Management Board by the PM.

#### Scope Changes

If the costs of any L2 subsystem were projected to exceed the base estimate plus contingency, remedial action must be taken by the PM. Following the change control procedures defined above, the PM may propose modification of the L2 scope or adjustments to the estimated costs, so long as the TEC is not exceeded. If such adjustment is not possible, the situation must be reported by the PM and the PMG to the CMS MB and the JOC respectively. Reducing the scope of the US CMS Project so as to remain within the TEC is the only allowable action. That scope reduction must be formulated to DOE, NSF and the PMG by the PM with the advice of the CMS MB.

#### Baseline Changes

Any change to the US CMS Project that does not trigger scope change as defined above does not require a new proposal to be submitted. Although the project scope is not affected, changes resulting in cost variations, changes of personnel assignments or schedule impact are considered baseline changes. Baseline changes must have the approval of the US CMS PM. Baseline changes that result in increases in the US CMS Project Estimate at Completion (EAC) must be initiated by a Change Request. Changes that result in increases in any level 2 WBS element, must be initiated by a Change Request (CR) form presented at the US CMS PMG. Such requests will require the approval of the Deputy Director and/or Director as indicated below.

The US CMS PMG functions as the Change Control Board for the project. The US CMS Project Manager will maintain current records of all CRs and their disposition.

Notes

- The record of US CMS Project documentation revision status is maintained by the PM.
- The record of US CMS Project Management Group meetings will be maintained by the Fermilab Directorate.
- A record of all CRs will be maintained by the US CMS Project Manager.
- All changes from baseline cost shall be traceable.

# Section IX

## Reporting And Review

## **IX. Reporting And Review**

The CMS experiment reports to CERN as the responsible host of the experiment. In turn, the US CMS collaboration reports on technical progress to the full CMS collaboration. The US CMS PM is the point of contact with CERN and CMS concerning US CMS finances.

Tracking and reporting begins with a report by the individual US CMS institution to the relevant L2 manager. The reporting is passed to the PM and the project office which is responsible for tracking all US CMS funds. Each institution will provide monthly financial information to the Project Manager in a specified format, see Appendix A and Appendix B, which provides cost and commitment information at the lowest level of the WBS. Each L2 manager will provide quarterly reports on technical progress to the PM and the PMG.

The US CMS Project Office is responsible for tracking and reporting all US CMS Project activities. The project office shall prepare and issue periodic reports of earned value and cost and schedule variance for the US CMS Project.

The US CMS PM reports both to the US CMS Fermilab PMG on the status of the US CMS Project, and in addition reports to the US funding agencies, DOE and NSF. The US CMS PM also reports to the CMS MB, TB and FB on the status of the project. In turn, the CMS Management Board reports to the CERN Resource Review Board, whose members include DOE and NSF representatives. The PMG reports directly to the JOC.

Memoranda of Understanding will exist both within the CMS collaboration as a whole, and for the US CMS collaboration.

A Memorandum of Understanding (MOU) is to be negotiated between CERN as the host laboratory, the collaborating CMS institutions (represented by the CMS Collaboration Board) and their funding agencies (DOE and NSF in the US). A draft of an Interim MOU covering the initial phase of the CMS experiment has been signed for the 1996 and 1997 period of R&D.

Within the US CMS Project, a US MOU will be executed. A draft version of this MOU and of the annual SOW have been written, and appear here as Appendices A and B. The signatories of this MOU are threefold: Fermilab as host laboratory, the US CMS collaborating institution, and the US CMS PM. By means of the MOU agreement the L2 managers and the US CMS Project Manager will identify the work to be done at each member institution of US CMS, together with the necessary resources. It will also establish reporting to be done by each institution of both financial and schedule milestones.

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Tracking and reporting and the record of performance will form the basis for continuing annual authorization of funds to a particular institution by the Project Manager with the scientific advice of the US CMS Executive Board and the CMS MB and with the concurrence of the US CMS Fermilab PMG within the framework of the US CMS MOU.

In turn, the US CMS Project reports cost, labor, schedule, and performance data to the US CMS Fermilab PMG. The objective of the reporting and review activity is to provide for the collection and integration of essential technical, cost, schedule, and performance progress data into the reports and reviews needed for managing and monitoring the US CMS Project. The following paragraphs describe the status and technical reports that will be provided.

### **A. Status Reporting**

Project reporting and review will be divided into external and internal categories.

Status Reports will be prepared on a periodic basis. These reports are designed to portray the technical, cost, and schedule status of the Project at that particular point in time. In general, the reports will contain the following: Project cost trends; schedule accomplishments; critical items; commitment status; status of major procurements; budget versus cost projections; management assessments; variance analysis results and planned corrective action. The US CMS Project Manager will report at level 3 of the WBS. Reporting will be to the US CMS Fermilab PMG as the change control board and the group charged by DOE and NSF with management oversight.

### **B. Design Reports**

Design reports will be prepared and updated at the completion of a major system or component. The major phases are the Conceptual Design, Title I design, Title II Design, and as-built. The design reports will be prepared by the responsible level 2 manager and approved by the US CMS Project Manager. Technical reviews in addition to the Technical Design Report (TDR) required by CERN for subsystem approval will be organized by the PMG. The project office will be the central depository of the drawings and appropriate documentation.

**C. Meeting and Reviews**

1. Internal US CMS Meetings

The US CMS PM and L2 managers will meet regularly with the US CMS Executive Committee to assess the current status of the prooject, management issues, and proposed major changes. Communication with the US CMS collaboration at large is done at the biennial US CMS full collaboration meetings.

2. Meetings with DOE and NSF

*Monthly Meeting*

A monthly meeting will be held between the PMG and the US CMS Project Manger and L2 managers to review the current status of Project work, to discuss outstanding issues, and to update previously identified action items. It is assumed that local representatives of both DOE and NSF will be members of the PMG.

*Annual Review*

Approximately every twelve months, a comprehensive review of the Project's cost, schedule, and technical status will be held by ER and NSF. Presentations by key US CMS Project personnel will address issues on an agenda agreed to in advance by ER, NSF, and the US CMS Project Manager.

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**Appendix A.**

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Memorandum of Understanding  
between

<Institution>

and

US CMS Collaboration  
Project Management  
at Fermilab

<date signed>

**1. Introduction**

This Memorandum of Understanding (MOU) describes the collaboration by members of <Institution> in the Compact Muon Solenoid (CMS) Project in the United States. The purpose of this collaboration is the design, fabrication, operation and scientific exploitation of the CMS Detector. The detector is described in the CMS Technical Proposal, December 15, 1994, the Technical Design Reports, and subsequent technical documents elaborating that design. The contribution of the US CMS Collaboration to the CMS Detector Project is defined by the scope of work set out in the US CMS WBS and accepted as the baseline set of deliverables by DOE and NSF. This scope of work forms the basis of the MOU between CERN and DOE/NSF.

The US CMS project management infrastructure (US CMS Project Office) resides at Fermilab, and the responsibility for US CMS project management resides in the US CMS PM who reports to the US CMS Fermilab Project Management Group (PMG) and to DOE and NSF. The US CMS PM has appointed level two (L2) managers who are responsible to him for subsystems of the US CMS project.

This Memorandum of Understanding describes the long-term contributions of <Institution> to the design, construction and operation of the CMS Detector. It is understood that these contributions of <Institution> may later be modified or that additional responsibilities may be added.

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An annual Statement of Work (SOW) will detail the contributions of <Institution> as the detector construction proceeds and will contain the specific activities, deliverables and funding required. The normal period of performance will be the US fiscal year (October 1-September 30). A separate SOW will be written for each L2 subsystem, while the MOU will be a single document for each US CMS Institution.

This Memorandum of Understanding is made between <Institution> , the US CMS Project Manager and Fermilab as part of its role in management oversight. It does not constitute a legal contractual obligation on the part of any of the parties. It reflects an arrangement that is currently satisfactory to the parties involved. The parties agree to negotiate amendments to this memorandum as required to meet the evolving requirements of the CMS detector construction program.

## 2. Personnel

### 2.1. List of Scientific Personnel

Participating scientists committed to CMS over the full project period are listed below. No scientific personnel will be funded by US CMS project funds.

Name	CMS Fraction*	Other Research Commitments/Comments
------	------------------	--

\*Time devoted to CMS over and above the indicated CMS research fraction is considered to be <Institution> service effort in support of CMS.

### 2.2. Collaboration Board Representative

<Name> is the present representative of <Institution> to the US CMS Collaboration Board.

2.3. List of Technical Personnel

Participating technical staff members foreseen to participate over the full project period are:

*Engineers*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

*Designers*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

*Technical Specialists*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

*Programmers*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

*Others*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

2.4. Other Key Personnel

The Environment, Safety and Health officer for <Institution> responsible for compliance with applicable ES&H policies associated with CMS participation by this institution is currently <name> of <Institution>. The Quality Assurance officer for <Institution> responsible for QA compliance of tasks performed by this institution is currently <name> of <Institution>.

**3. Design, Fabrication and Installation Responsibilities**

**3.1. Design and Fabrication Responsibilities - Construction Period**

**3.1.1 *Description of Items Provided:***

The US CMS Work Breakdown Structure (WBS) contains a detailed cost estimate of the items needed to complete the US CMS project. By this MOU <Institution> agrees to make a best effort to provide the following items at a cost not to exceed the WBS base cost estimate. Procedures to be followed in the event of a necessary variation of cost from the base cost are described in section 3.3 below.

WBS Cost -Base, k\$	WBS (L7)	Description

**3.1.2 *Transportation***

Unless specifically indicated otherwise here, items produced by <Institution> for use in the CMS detector or subsystems shall be transported by the providing institution to the agreed upon point of delivery. <Institution> shall be responsible for safe transport of all items to these delivery points. The method of transport and packaging are to be authorized by the US CMS Project Engineer.

**3.1.3 *Installation and Commissioning***

<Institution> will participate in the installation and commissioning of their contributed items at CERN as listed. The <Institution> will also participate in the maintenance and operation of these items.

<Item 1>  
<Item 2>...

**3.2. Coordination and Reporting**

The US CMS L2 manager for the <subsystem> subsystem is <name1>. The institution contact person for <subsystem> activities at <Institution> is <name2>. The task managers for <subsystem> activities carried out at <Institution> are as follows

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The progress of the design, fabrication, and testing of these components will be reported by the above-named task managers on a quarterly basis, by WBS element to L3 in detail, to the US CMS L2 Manager, who in turn will report subsystem progress to the US CMS PM. The PM will, in turn, report to the Fermilab PMG.

Technical reporting to CMS project management will be performed by the US CMS Subsystem Coordinator. Financial reporting to CMS will be made by the US CMS PM.

### 3.3. Procurement Authorization

The authorized financial officer at <Institution> is <name>. The US CMS PM delegates expenditure authority regarding the designated WBS items in the SOW to the authorized financial officer subject to the following requirements. The base cost of the WBS items are given in section 3.1.1 without contingency. The officer agrees that these cost ceiling cannot be exceeded without the authorization the PM and the relevant L2 manager. In addition, the officer agrees that item purchases exceeding the delegated limit (currently <\$xxK>) must be authorized by the US CMS L2 manager. Major procurements (currently <\$xxK>) must in addition have the written authorization of the US CMS PM. Items purchased as CMS Common Project items (WBS category 6) must be explicitly authorized by the US CMS PM and approved by the CMS Finance Board Chair, regardless of the cost. Items purchased for Project Office items (WBS category 7) must be authorized by the PM.

### 3.4. Reporting to US CMS Project Management

<Institution> will report all CMS related expenditures and labor charges together with associated technical progress in each item of work by Work Breakdown Structure (WBS) category (Level 7) on a quarterly basis through the appropriate US L2 Manager(s) to the US CMS PM. Cost reporting will apply to US CMS Project funds related to detector fabrication. Other, non-DOE and non-NSF costs will be reported in a manner that is agreed to by the L2 Manager(s), the US PM and <Institution>. Any request for variance from the base cost must be immediately reported to the appropriate L2 manager.

Technical progress will be reported by WBS element L3 to the L2 Manager and the PM on a quarterly basis and will cover all items covered in this Statement of Work regardless of the specific nature of the funding support.

The institution agrees to furnish complete documentation of the quality control and performance checks which are carried out for US CMS. Further, the institution agrees to furnish full documentation of all equipment and services which it provides for the US CMS project. This will include engineering drawings of equipment, full

schematics of electronics, and documentation of all software. Where relevant, an acceptable level of spares (~10%) will be provided and maintained by the institution.

Each Institution agrees, with this document, to set up and maintain a ledger, of a form specified by US CMS Project Management. This ledger will contain information on cost items at L7 of the US CMS WBS. A draft of the information to be contained in this ledger is given in Appendix I of this document. Each Institution agrees to provide and maintain this ledger so as to provide timely information to the L2 Manager and the US CMS PM.

**3.5. Collaboration with Other Groups and Institutions**

Design, construction and installation related to the <subsystem> subsystem will be carried out in close communication and collaboration with other groups working on this and related subsystems.

WBS / Task (L3)	Collab. Group	Responsibility with <Institution>

**4. Contribution of Effort, Services and Facilities**

**4.1. Effort**

Subject to funding by DOE or NSF, <Institution> will provide support for the scientific and technical personnel as indicated in section 2. This contribution refers only to support provided outside the US CMS Project.

**4.2. Services**

The services of the <Institution> Purchasing, Expediting, and Receiving Departments and the Administrative Staff will be available to the CMS project to the degree required to carry out the fabrication responsibilities of <Institution>. By this MOU, <Institution> agrees to provide the services of the responsible financial officer.

#### 4.3. Facilities and Equipment

The following <Institution> facilities and equipment will be made available to the CMS project to the degree necessary to carry out the design and fabrication responsibilities of the group:

#### 4.4. Operating Costs

<Institution>, subject to the availability of funds from DOE or NSF, will support the normal research operating expenses (such as physicists' salaries, travel expenses, miscellaneous supplies, administrative support, etc.) of the <Institution> group working on the CMS project. These normal operating expenses are not considered as part of the CMS detector cost estimate nor will they be borne by the US CMS project.

### 5. **Expected Fermilab (as host institution) Effort, Services and Facilities**

Subject to agreement, to be negotiated annually with the Fermilab Director, <Institution> expects the following Fermilab resources to be available in support of <Institution's> design, fabrication, and installation responsibilities:

#### 5.1. Administrative and Technical Personnel

Participating Fermilab staff members foreseen to be available to the project are:

##### Administrative Staff

Name	CMS Fraction	Source of Support
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##### Engineers

Name	CMS Fraction	Source of Support
------	--------------	-------------------

##### Designers

Name	CMS Fraction	Source of Support
------	--------------	-------------------

##### Technical Specialists

Name	CMS Fraction	Source of Support
------	--------------	-------------------

Programmers

Name	CMS Fraction	Source of Support
------	--------------	-------------------

Others

Name	CMS Fraction	Source of Support
------	--------------	-------------------

Administrative and technical staff salary support may be paid by the US CMS Project, or may be provided by Fermilab as project host. The salary support of Fermilab staff contributing to <Institution's> responsibilities must be negotiated annually with the Fermilab Director as part of the SOW. Support provided by Fermilab will be tracked and reported by the <institutional> representative to the Fermilab Director and the PMG.

5.2. Services

The services of the Fermilab Purchasing, Expediting, and Receiving Departments are expected to be available to <Institution> for the procurement of the following items:

- <Item 1>
- <Item 2>...

5.3. Facilities and Equipment

<Institution> expects that the following Fermilab facilities, equipment, and laboratory space will be available during the course of the project:

**6. Costs and Funding**

6.1. Expected Sources of Funding

The cost of the detector elements covered under the US CMS WBS are taken in detail from the current US CMS Cost Estimate (<Date>). DOE (NSF) Funds indicate the project funds to be provided. <Institute> agrees to not exceed the costs shown above, estimated cost less contingency, subject to the procedures given in section 3.3.

6.2. Management Reserve

Each year, a SOW will be written with each US CMS Institution for each L2 subsystem which is relevant. The allocation of funds for the fiscal year will be in two parts. The first will cover work for the first six months. The remaining funds needed to complete the tasks described in the SOW will be provided subject to availability of funding and performance during the first half year. Tight management control requires the review and concurrence of the L2 Manager and the PM, as needed, for major expenditures, as defined above. The release of funds above the given thresholds by the responsible financial officer as named above will be contingent upon this concurrence.

## **7. Method of Funding Transfers**

The expenditures by <Institution> are to be covered by funds provided by DOE or NSF, upon the allocation decision of the US CMS PM with the concurrence of the US CMS Fermilab PMG.

Funds to cover work or expenditures described in this document may be provided directly to <Institution> by DOE or NSF, or by subcontract from the US CMS Project Office at Fermilab. The choice of funding method shall be at the option of <Institution>, provided the arrangement is satisfactory to the US CMS PM.

All equipment items bought or fabricated using DOE or NSF funds will be properly marked as the property of DOE or NSF. Any other equipment furnished by <Institution> as part of the detector will remain <Institution> property. In either case, the equipment will remain part of the CMS detector until it is dismantled or the detector element in question is replaced.

## **8. General Considerations**

### **8.1. Safety and Engineering Practices**

The experimenters from <Institution> agree to familiarize themselves with DOE and NSF safety policies and to adhere to them. All detector components must be designed, fabricated, installed and operated in conformity with DOE, NSF and CERN safety policies and practices as well as DOE, NSF and CERN engineering standards. All engineering, design, quality assurance, safety, and other activities shall be in compliance with ISO standards. All major components will undergo appropriate design, safety, and engineering reviews.

### **8.2. Operations**

<Institution> agrees to maintain, to the best of their ability, equipment provided for the CMS detector as long as <Institution> is a member of the CMS collaboration.

## 9. Schedules and Milestones

<Institution> will make every effort to carry out their institutional responsibilities consistent with the schedule for the fabrication of the CMS detector. These schedules may have to be changed as the project progresses. Changes that affect <Institution> will be noted in the annual SOW.

## 10. Makers and Concurrence

The following persons concur in the terms of this Memorandum of Understanding. These terms will be updated as appropriate in Amendments to this Memorandum.

Makers of this Memorandum:

_____ <Name> US CMS PM	date	_____ Administrative Officer <title> <Institution>	date
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_____ <Name> US L2 Manager <Subsystem> Subsystem	date	_____ Institution Representative <Name> <Institution>	date
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Concurrence:

_____ <Name> Deputy Director Fermilab	date	_____ <Name> CMS Technical Representative	date
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**Appendix I: Responsibility of Institutions for Reporting**

The US CMS Project requires that an Excel template/worksheet be set up and used at all participating institutions. Each institution will then be responsible for entering accurate and timely data relating to their part of the project at L7 of the WBS. This file/ledger would reside on a local server and made accessible to the appropriate L2 Manager(s) and the US CMS PM. The Project Office will be responsible for consolidating and rolling up these numbers to a higher level in order to provide overall project reporting. The Project Office will provide help in setting up this system.

Below is an extract from the EMU WBS showing ME2/1 breakdown to level 7. Nothing would be charged directly to 1.1.4 or 1.1.1.4.2 because they each have components at a lower level. 1.1.1.4.1, 2 & 3 on the other hand must be charged directly even though they are a higher level because they have no lower level components. Nothing would ever be charged directly to any WBS # unless there is no further breakdown of that category.

<u>EMU WBS</u>	
<b>1.1.4</b>	ME2/1
1.1.1.4.1	Design and documentation
<b>1.1.1.4.2</b>	Materials
1.1.1.4.2.1	Anode wire
1.1.1.4.2.2	Gap frames
1.1.1.4.2.3	Anode wire fixation bars
1.1.1.4.2.4	Anode signal distribution boards
1.1.1.4.2.5	HV distribution bars
1.1.1.4.2.6	Guard strips
1.1.1.4.2.7	HV insulating strips
1.1.1.4.2.8	Standard electrical components
1.1.1.4.2.9	Non-standard electrical components
1.1.1.4.2.10	Mechanical components
1.1.1.4.2.11	External frame
1.1.1.4.2.12	Misc. (epoxy, RTV, solder, tape)
1.1.1.4.3	Chamber assembly in Russia
1.1.1.4.4	Shipping materials

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The table below is an example of the Excel template/worksheet that contains the MINIMUM information required.

- **WBS#:** This is the prime essential identifier of the system, as discussed above this is what we are reporting on.
- **PO#:** This may vary from institution to institution but it is necessary to record commitments/obligations. The semantics may vary but when something is on order it needs to be recorded. The source document # is needed for a adequate trail. The PO numbers shown are for example only and will be whatever identifier the member institution uses.
- **Description:** Allows a short description and/or comment.
- **PO Date:** This is required because it's necessary to record everything in the correct period i.e. an order placed in March must be recorded in March.
- **PO \$Amt:** Self Evident.
- **Invoice #** Required for audit trail.
- **Invoice Date:** As with the PO Date, the proper period is needed.
- **Invoice \$Amt:** Self Evident.
- **Institution:** Needed to be able to select on a given US CMS group.
- **Fund Source:** Needed to track NSF, DOE, or base costs separately.

<u>Excel template/worksheet</u>									
WBS#	PO#	Description	PO Date	PO \$Amt	Invoice#	Invoice Date	Invoice \$Amt	Inst	Fund Source
1.1.1.4.1	w11141		11/25/97	125,650.00					
			7						
1.1.1.4.2.1	w111421		12/2/97	25,300.00					
1.1.1.4.2.10	w1114210		12/5/97	3,625.00					
1.1.1.4.2.1	w111421				15258	1/15/98	18,350.00		
1.1.1.4.1	w11141				18254	1/20/98	82,540.00		
1.1.1.4.4	w11144		1/15/98	15,200.00					
1.1.1.4.2.9	w111449		1/10/98	22,650.00					
1.1.1.4.2.10	w1114210				869851	1/16/98	3,625.00		
1.1.1.4.2.9	w111429				856543	1/20/98	22,650.00		
1.1.1.4.2.1	w111421				869852	1/17/98	2,250.00		

It should be noted that once a PO is entered and the \$Amt recorded that the PO \$Amt field is left blank when the subsequent invoice transactions are recorded. Only if there is a change to the PO either increasing or decreasing the order amount should additional \$ amounts be entered with the same PO#. The *Form Entry* should be used to enter the

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information. This reduces the potential for error. An example of the form for this worksheet/database is shown below.

**Entry form PO Entry**

**Entry form Invoice Entry**

WBS#:	<input type="text" value="1.1.1.4.1"/>		1 of 10
PO#:	<input type="text" value="w11141"/>		<b>New</b>
PO Date:	<input type="text" value="11/25/1997"/>		<b>Delete</b>
PO \$Amt:	<input type="text" value="125650"/>		<b>Restore</b>
Invoice#:	<input type="text"/>		<b>Find Prev</b>
Invoice Date:	<input type="text"/>		<b>Find Next</b>
Invoice \$Amt:	<input type="text"/>		<b>Criteria</b>
			<b>Close</b>
		<b>Help</b>	

WBS#:	<input type="text" value="1.1.1.4.2.1"/>		4 of 10
PO#:	<input type="text" value="w111421"/>		<b>New</b>
PO Date:	<input type="text"/>		<b>Delete</b>
PO \$Amt:	<input type="text"/>		<b>Restore</b>
Invoice#:	<input type="text" value="15258"/>		<b>Find Prev</b>
Invoice Date:	<input type="text" value="1/15/1998"/>		<b>Find Next</b>
Invoice \$Amt:	<input type="text" value="18350"/>		<b>Criteria</b>
			<b>Close</b>
		<b>Help</b>	

The institution is a constant for each file and can be identified easily. The funding source field will be required in the case of all universities that have two sources of funding or who wish to have base program costs tracked..

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**Appendix B.**

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**Statement of Work**

**by**

**<Institution>**

**for Activities Related to the US CMS <subsys> Subsystem**

**During Fiscal Year FY98**

**<date signed>**

**1. Introduction**

This Statement of Work (SOW) is made to provide the yearly details of the work agreed to in the Memorandum of Understanding between US CMS and <Institution> dated <xxxx>. It covers the specific period of performance from October 1, 1997 through September 30, 1998. It is subject to all the points of agreement and conditions in the current version of the US CMS Project Management Plan.

**2. Personnel**

**2.1. List of Scientific Personnel**

Participating scientists with anticipated fraction of their research time committed to CMS during this period of performance are listed below. No support for these individuals comes from project funds.

Name	CMS Fraction*	Other Research Commitments/Comments
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\*Time devoted to CMS over and above the indicated CMS research fraction is considered to be <Institution> service effort in support of CMS.

2.2. List of Technical Personnel

Participating technical personnel with the anticipated fraction of their time committed to CMS during this period of performance and their source(s) of support are:

*Engineers*

Name	CMS Fraction	Source of Support
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*Designers*

Name	CMS Fraction	Source of Support
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*Technical Specialists*

Name	CMS Fraction	Source of Support
------	-----------------	-------------------

*Programmers*

Name	CMS Fraction	Source of Support
------	-----------------	-------------------

*Others*

Name	CMS Fraction	Source of Support
------	--------------	-------------------

2.3. Other Key Personnel

The Environment, Safety and Health officer for <Institution> currently responsible for compliance with applicable ES&H policies associated with CMS participation by this institution is <ES&H Name> of <Institution>. The Quality Assurance officer for <Institution> currently responsible for QA compliance of tasks performed by this institution is <QA Name> of <Institution>.

**3. Responsibilities for this Period of Performance**

3.1 WBS Items at L7, Estimated Cost and Deliverable

During this period of performance <Institution> agrees to supply the following deliverables at a cost not to exceed the estimated base cost given in the US CMS WBS. The following itemized list describes the items (or partial completion of items) provided in this period (Statements of Work).

WBS (L7)	Task - Deliverable	WBS Cost - Base k\$	DOE (NSF) Funds - k\$

3.2. Coordination and Reporting

The US CMS L2 Manager for the <subsystem> subsystem is <name1>. The institution contact person for <subsystem> activities at <Institution> is <name2>. The task managers for <subsystem> activities carried out at <Institution> are as follows:

3.3. Procurement Authorization

Item purchases exceeding the delegated limit (currently <\$xxK>) must be authorized in advance of obligation by the US CMS L2 manager. Major procurements (currently <\$xxK>) must in addition have the written authorization of the US CMS PM. Items purchased as CMS Common Project items must be explicitly authorized by the US CMS PM and approved by the CMS Finance Board Chair, regardless of the cost.

**3.4. Reporting to US CMS Project Management**

As described in the MOU between US CMS and <Institution>, the <Institution> will report all CMS related expenditures and labor charges together with associated technical progress in each item of work by Work Breakdown Structure (WBS) category (Level 7) .

Technical progress will be reported by WBS element L3 to the L2 Manager and the PM on a quarterly basis and will cover all items covered in this Statement of Work regardless of the specific nature of the funding support.

As described in the MOU, the <institution> agrees to furnish complete documentation of the quality control and performance checks which are carried out for US CMS in the performance of this work.

As described in Appendix I of the MOU, <Institution> agrees to maintain a ledger of a form specified by US CMS Project Management.

**3.5. Collaboration with Other Groups and Institutions**

Design, construction and installation related to the <subsystem> subsystem will be carried out in close communication and collaboration with other groups working on this and related subsystems.

WBS / Task (L3)	Collab. Group	Responsibility with <Institution>

**4. Contribution of Effort, Services and Equipment**

Subject to adequate funding by DOE or NSF, <Institution> will provide support for the scientific and technical personnel as indicated in section 2 during this period of performance. This contribution refers only to support provided outside the US CMS Project.

**5. Fermilab (as host institution) Effort, Services and Facilities**

Tracking of Fermilab CMS support, whether provided by Fermilab or paid by the US CMS Project, will be done using appropriate effort reporting codes. The costs incurred will be reported to the Fermilab Director.

Contributing Fermilab personnel with the anticipated fraction of their time committed to CMS during this period of performance and their source(s) of support are:

**5.1. Administrative Staff**

Name	CMS Fraction	Source of Support
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**5.2. Engineers**

Name	CMS Fraction	Source of Support
------	-----------------	-------------------

**5.3. Designers**

Name	CMS Fraction	Source of Support
------	-----------------	-------------------

**5.4. Technical Specialists**

Name	CMS Fraction	Source of Support
------	-----------------	-------------------

5.5. Programmers

	CMS	
Name	Fraction	Source of Support

5.6. Others

	CMS	
Name	Fraction	Source of Support

**6. Costs and Funding**

A total amount of \$<x,xxx>K will be provided to cover work for the first six months. The remaining funds needed to complete the tasks described above will be provided subject to availability of funding and performance during the first half year. Management control requires the review and concurrence of the L2 Manager and the PM, as needed, for major expenditures, as defined above. The release of funds above the given thresholds will be contingent upon this concurrence.

**7. Schedules and Milestones**

<Institution> will make every effort to carry out their institutional responsibilities consistent with the overall CMS schedule. In this Statement of Work are listed the program milestones for this period of performance.

The program milestones for this period of performance relevant to <Institution> are listed here:

Program Milestones	Baseline Date	Current Date

## 8. Makers and Concurrence

The following persons concur in the terms of this Statement of Work. These terms will be updated as appropriate in later Statements.

Makers of this Memorandum:

---

<Name> date  
US CMS PM

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Institution Representative date  
<title>  
<Institution>

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US L2 Manager  
<Name> date  
<Subsystem> Subsystem

Concurrence:

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<Name> date  
Director  
Fermilab

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<Name> date  
CMS Technical Representative

