Chapter 13

Cost and schedule summaries

13.1 Detector scope

The MINOS detector includes the following six subsystems: Magnet Steel and Coils; Scintillator Detector Fabrication; Electronics, DAQ and Database; Far Detector Installation; Near Detector Installation; and Project Management[1]. Costs associated with use of the Soudan 2 detector for long-baseline neutrino oscillation studies (Chapter 10), and with the potential emulsion detector upgrade (Chapter 11), are outside the scope of the baseline MINOS detector.

The cost estimate presented in Section 13.2 is a very brief summary of the detailed information given in the NuMI Project Cost and Schedule Plan (CSP)[2]; it is based on the baseline detector design described in the earlier Chapters of this Technical Design Report. Although the cost estimate covers a 5.4 kt far detector composed of two 2.7 kt supermodules, the cost and schedule plan for the Soudan site preparation includes an underground hall designed to accommodate an 8.1 kt, three-supermodule far detector[3]. This is to allow for the possibility of upgrading the experiment by increasing the mass of the far detector sometime in the future, in response to physics developments.

Although the funds allocated for contingency are not meant to allow scope changes[1], we anticipate that the uncertainty in MINOS cost estimates will be reduced substantially as the result of value engineering, firm vendor quotes and detector plane prototype time-and-motion studies. This would lead to lower contingencies and the possibility of moving funds from the present contingency pool to the project's scope reserve. Such funds might then be used for a future upgrade of the experiment, for example, a third far-detector supermodule, a hybrid emulsion detector and/or a narrow-band beam.

13.2 Cost estimate summary

Bottoms up cost estimates for the three competing active detector technologies were developed during 1996 and 1997, under the auspices of the MINOS Installation Committee[4]. Prior to the technology decision of September 24, 1997, the MINOS Collaboration focused substantial effort on the identification of significant cost differences among these technologies, which was one factor used in the technology choice. As a result of this exercise, the

Collaboration determined that the plastic scintillator detector described in this TDR was cost competitive with the other technologies.

Also during 1996 and 1997, bottoms up cost estimates were developed by the MINOS Installation Committee for the Magnet Steel and Coils and Far Detector Installation tasks. Recent effort has focused on developing bottoms up estimates for the remaining subsystems.

Detector costs at WBS Level 3 are summarized in Figure 13.1. The column labeled 'M&S' shows the direct costs associated with purchased Materials and Services. The 'SWF' column (Salary, Wage, Fringe) shows the direct costs for all skilled labor used in fabrication, assembly, testing and installation. Appropriate EDIA (Engineering, Design, Inspection and Acceptance) costs are included at Level 4 for engineering and design effort as well as management and administrative effort. The 'M&S + SWF + G&A' column includes the 'G&A' (General & Administrative) institutional overhead charges applied to the various direct-cost categories in each WBS element. The 'Contingency' and 'Cont %' columns show the weighted average contingencies in dollars and as percentages of the total costs (direct plus G&A). Contingency allowances are calculated using a detailed item-by-item analysis. The 'Escalation' column shows the cost increment resulting from inflation between the base year (FY 1998) and the year in which funds are obligated, assuming the construction schedule described in Section 13.3. The 'Total Cost' column shows the total cost in as-spent, then-year dollars.

Detector funding is primarily through the Fermilab NuMI Project, using funds provided by the U.S. DOE and Fermilab. We anticipate a U.K. contribution to the construction of detector electronics and calibration systems of approximately £1.3M for M&S, plus an additional contribution to cover the U.K. equivalent of all associated SWF, EDIA, G&A and escalation costs. Because the details of this funding arrangement are not yet finalized, the electronics and calibration system cost estimates included in the CSP are calculated under the assumption that this work is performed in the U.S. The value of the expected U.K. contribution, including the 34% contingency allowance, is subtracted from the total cost estimates in the second-to-last line of the table in Figure 13.1. The final MINOS cost estimate includes an average contingency of 37%.

The estimated total U.S. cost of the MINOS baseline detectors, with a 5.4 kt (two supermodule) far detector, is $44.6M in as-spent dollars, including contingency, compared to the $45M Fermilab guideline budget for the MINOS Detectors subproject. Any difference between the actual cost and the guideline budget would be added to the scope reserve for the project.

Further cost details are available in the NuMI Project Cost and Schedule Plan[2]. We anticipate a dramatic improvement in our understanding of costs and schedules when the 4-plane prototype studies, described in Chapters 4 and 7, are completed. The MINOS detector is rather different from conventional high energy physics experiments because such a large fraction of the detector cost is associated with the setup and operation of assembly lines. Time and motion study results and construction procedures based on final steel and detector designs will allow substantial refinement of the current cost and schedule estimates.

13.3 Schedule summary

The overall project schedule is shown in Figure 13.2. The summary task durations represent the time from the beginning of the first task to the completion of the last task. Much more detailed schedules are available in the CSP[2].

13.4 Manpower resources

Currently there are 21 institutions and more than 100 physicists actively participating in the MINOS Collaboration. The substantial physicist effort which is being provided by the collaborating institutions in support of the construction project is not included in the CSP. However, all U.S. nonphysicist technical effort is funded through the construction project and is included in the CSP. Because institutional indirect cost rates may differ, all CSP cost estimates display the overhead (G&A) costs explicitly.

Chapter 13 References

[1] The Fermilab NuMI Project Staff, "NuMI Project Management Plan," October 1998, Fermilab report NuMI-359.

[2] The Fermilab NuMI Project Staff, "NuMI Project Cost and Schedule Plan," October 1998, Fermilab report NuMI-362. Complete Microsoft Project and Excel files for the costs and schedules summarized in this document are available from the NuMI/MINOS project management office at Fermilab.

[3] The University of Minnesota, CNA Consulting Engineers, Ericksen-Ellison Associates, Inc., and Miller-Dunwiddie, Inc., "MINOS Far Detector Laboratory Technical Design Report (Including Basis of Estimate & WBS) for Cavern Construction, Cavern Outfitting & Detector Outfitting," October 1998, Fermilab report NuMI-L-263.

[4] J. Alner *et al.*, "Report of the MINOS Installation Committee," September 1997, Fermilab report NuMI-L-259.

1.0

WBS	Name	M&S (FY98k$)	SWF (FY98k$)	M&S + SWF (FY98k$)	M&S + SWF + G&A (FY98k$)	Contin-gency (FY98k$)	Cont %	Escalation (FY98k$)	Total Cost (Then Yr k$)
2.1	**Magnets: Steel & Coils**	**$ 5,846**	**$ 621**	**$ 6,466**	**$ 7,442**	**$ 2,580**	**35%**	**$ 788**	**$10,810**
2.1.1	Steel Plane Fabrication	$ 4,759	$ 75	$ 4,834	$ 5,370	$ 1,686	31%	$ 628	$ 7,684
2.1.2	Steel handling fixtures	$ 151	$ 102	$ 253	$ 325	$ 125	38%	$ 24	$ 474
2.1.3	Near Detector Support Structures	$ 88	$ 8	$ 96	$ 116	$ 41	35%	$ 11	$ 168
2.1.4	Magnet Coil	$ 746	$ 192	$ 938	$ 1,161	$ 471	41%	$ 97	$ 1,730
2.1.5	Detector Plane Prototypes	$ 26	$ 244	$ 270	$ 380	$ 213	56%	$ 19	$ 612
2.1.6	Steel Management	$ 75	$	$ 75	$ 89	$ 45	50%	$ 9	$ 142
2.2	**Scintillator Detector Fabrication**	**$ 9,626**	**$ 3,428**	**$13,055**	**$15,887**	**$ 5,834**	**37%**	**$ 1,603**	**$23,325**
2.2.1	Scintillator Strips	$ 2,540	$ 441	$ 2,981	$ 3,645	$ 1,303	36%	$ 369	$ 5,316
2.2.2	Fiber	$ 2,645	$ 163	$ 2,808	$ 3,313	$ 1,518	46%	$ 400	$ 5,231
2.2.3	Scintillator Modules	$ 1,248	$ 148	$ 1,396	$ 1,688	$ 410	24%	$ 123	$ 2,222
2.2.4	Photodetector Systems	$ 1,473	$ 170	$ 1,643	$ 1,983	$ 682	34%	$ 219	$ 2,884
2.2.5	Mux boxes and Connectors	$ 436	$ 730	$ 1,166	$ 1,515	$ 659	44%	$ 162	$ 2,336
2.2.6	Calibration Systems	$ 318	$ 171	$ 488	$ 590	$ 205	35%	$ 42	$ 837
2.2.7	Ass'y & Test Equipment	$ 586	$ 169	$ 755	$ 937	$ 337	36%	$ 53	$ 1,327
2.2.8	Factories	$ 194	$ 1,361	$ 1,556	$ 1,888	$ 668	35%	$ 212	$ 2,768
2.2.9	Scintillator Management	$ 186	$ 75	$ 261	$ 329	$ 52	16%	$ 23	$ 403
2.3	**Electronics & DAQ**	**$ 1,793**	**$ 1,265**	**$ 3,058**	**$ 3,731**	**$ 1,279**	**34%**	**$ 262**	**$ 5,273**
2.3.1	Front Ends	$ 1,071	$ 363	$ 1,433	$ 1,675	$ 561	34%	$ 145	$ 2,380
2.3.2	Hubs & Interface Crate	$ 169	$ 299	$ 468	$ 603	$ 237	39%	$ 39	$ 879
2.3.3	Central System & Trigger Farm	$ 438	$ 445	$ 883	$ 1,100	$ 326	30%	$ 63	$ 1,489
2.3.4	Data Acquisition	$ 37	$ 27	$ 64	$ 78	$ 43	55%	$ 2	$ 123
2.3.5	Database	$ 29	$ 92	$ 122	$ 165	$ 75	45%	$ 9	$ 249
2.3.6	Auxiliary Systems	$ 26	$ 39	$ 65	$ 82	$ 34	41%	$ 3	$ 119
2.3.7	Electronics Management	$ 24	$	$ 24	$ 29	$ 3	10%	$ 2	$ 33
2.4	**Far Detector Installation**	**$ 259**	**$ 3,119**	**$ 3,378**	**$ 4,192**	**$ 1,945**	**46%**	**$ 554**	**$ 6,691**
2.4.1	Infrastructure	$ 91	$ 161	$ 252	$ 297	$ 131	44%	$ 30	$ 458
2.4.2	Materials Receiving & Handling	$ 46	$ 778	$ 823	$ 1,025	$ 504	49%	$ 138	$ 1,667
2.4.3	Detector Assembly	$ 111	$ 2,141	$ 2,252	$ 2,808	$ 1,279	46%	$ 379	$ 4,466
2.4.4	Alignment and Survey	$ 11	$ 40	$ 51	$ 62	$ 31	50%	$ 7	$ 100
2.5	**Near Detector Installation**	**$ 62**	**$ 1,188**	**$ 1,250**	**$ 1,773**	**$ 887**	**50%**	**$ 277**	**$ 2,937**
2.5.1	Infrastructure	$ 51	$ 186	$ 237	$ 327	$ 160	49%	$ 45	$ 532
2.5.2	Materials Handling	$ 6	$ 344	$ 350	$ 500	$ 255	51%	$ 81	$ 835
2.5.3	Detector Assembly	$	$ 647	$ 647	$ 926	$ 462	50%	$ 148	$ 1,537
2.5.4	Alignment & Survey	$ 5	$ 10	$ 15	$ 20	$ 10	50%	$ 3	$ 34
2.6	**Project Management**	**$ 40**	**$ 972**	**$ 1,012**	**$ 1,438**	**$ 14**	**1%**	**$ 94**	**$ 1,547**
2.6.1	Salary support	$	$ 972	$ 972	$ 1,391	$	0%	$ 90	$ 1,481
2.6.2	Travel support	$ 40	$	$ 40	$ 48	$ 14	30%	$ 4	$ 66
	Sub-total	**$17,626**	**$10,593**	**$28,219**	**$34,463**	**$12,541**	**36%**	**$ 3,578**	**$50,582**
	UK Funds	$ 2,045	$ 1,414	$ 3,459	$ 4,213	$ 1,444	34%	$ 297	$ 5,954
	Total	**$15,581**	**$ 9,179**	**$24,760**	**$30,250**	**$11,096**	**37%**	**$ 3,281**	**$44,628**

Figure 13.1: Summary of MINOS detector cost estimate at WBS Level 3.

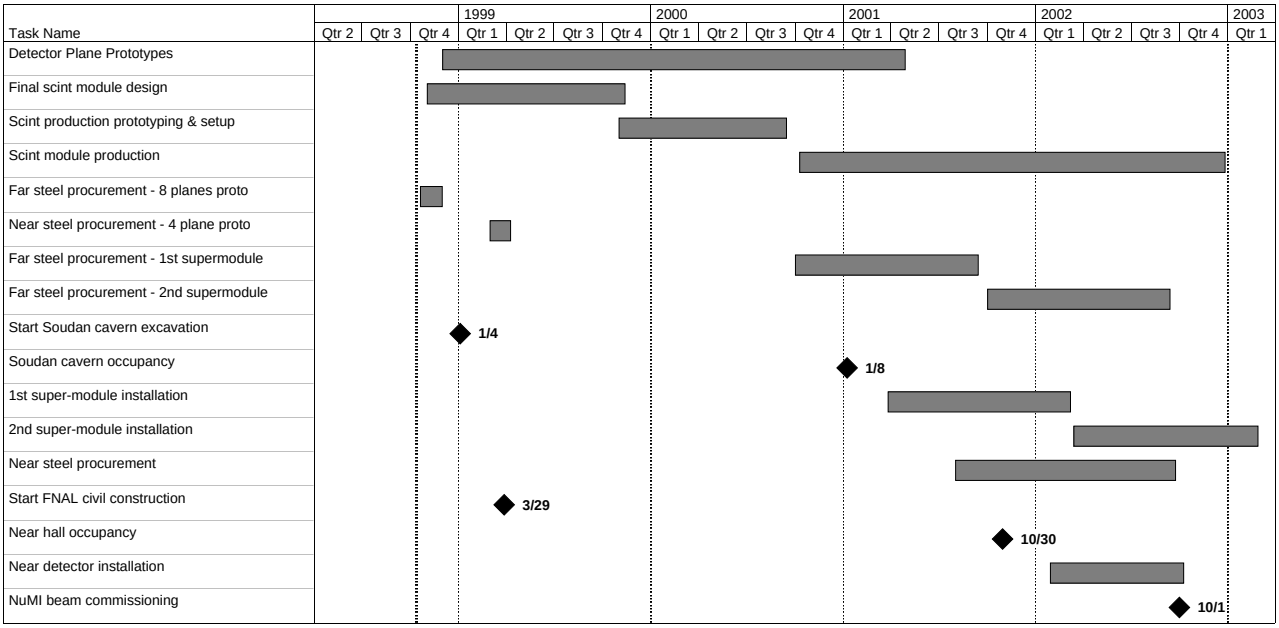

Figure 13.2: Overall schedule for MINOS detector construction. Time is in calendar years.