Fermi National Accelerator Laboratory

Technical Division

Project Management of Accelerator Support Jobs

TD-2050

Version 2

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Revision History

Version	Date	Section No.	Specifics
1	10-Oct-2005	All	First version
2	27-Mar-2006	Introduction, 5.3, 5.7, 5.8, 6.4	Updated to reflect organization restructuring.

Controlled Distribution

Technical Division Library

Introduction

Technical Division Mission Statement:
"The development, design, fabrication or procurement, and testing of accelerator and detector components."

In the fulfillment of this mission, the Technical Division works in two primary areas: accelerator operations support, and research & development of technology used in the field of high-energy physics.

Accelerator Operations Support:
For many years the Division has managed the so-called "magnet factory." This part of our organization is responsible for providing all the technical support for the Accelerator Division. This work may entail repairing and refurbishing existing devices, as well the design, fabrication and measurement of new devices for improvements to the accelerator complex.

Research & Development:
The R&D conducted in the Technical Division covers a very broad range, but it is all based on technology used (or proposed for use) in the field of high-energy physics. Our scientists, engineers and technicians, in collaboration with other Laboratories and Universities, work towards the goal of developing the best technology for use in doing physics research. To this end the Technical Division leads projects like high-field and low-field magnets, which are pushing technology to create the magnets needed for future hadron colliders. We also are leading the research of superconducting radio-frequency materials and technology, with the goal of developing and industrializing this technology for a future linear collider and high-intensity proton beam.

In order to complete this broad mission, the Technical Division maintains a diverse work force that has a very wide range of core competencies. The Division has experts in the fields of accelerator physics, engineering, fabrication, tooling, machining/welding, procurement, calibration, testing, operations, maintenance, QA/QC and systems integration. The Division also provides services in project management, project planning, resource management and scheduling.

1.0 Purpose

The purpose of this document is to formally issue and institutionalize this project management system. It is meant to describe the system, and is not intended to be a work instruction that describes every detail of the process. This document can be used as a reference tool to aid the user in understanding how we do the business of project management.

2.0 System Scope

The scope of this system is the design, planning and implementation of fabrication, measurement or investigative projects (or potential projects) for *accelerator support*. Fabrication can include making new devices as well as repairing or upgrading old devices. This system can be applied to both internal (i.e. Fermilab) or external (i.e. other institutions) customers. Not all aspects of the system are applied to all projects – this is dependant on the specific details and requirements of the project, and is handled on a case-by-case basis.

3.0 Mechanics

It was identified that there is a need to keep track of three types of data: schedule data, obligation data and project-specific data. To this end, we use three pieces of software to keep track of these data. It is conceivable, after becoming more proficient with MS-Project, that these three systems will be merged into one. However, at this time it is easier to use MS-Project for keeping track of schedules, use MS-Access to keep track of all non-schedule project information, and use MS-Excel to present obligation, hours spent and estimates to complete information.

3.1 Microsoft Project

MS-Project is used in TD to keep track of individual project schedules, and for combining the individual schedules into an integrated schedule. MS-Project was chosen because of its previous use within TD, for its ease of use, and for its cost. It is worth noting that the interactions of multiple projects and the uneven use of resources within any reasonably defined task make resource-loading these schedules unrealistic.

3.2 Microsoft Excel

MS-Excel is used to report on project obligations, hours spent and estimates to complete. In order to ensure consistency, we have created templates which are used for all fabrication projects. Examples of these templates are attached. It is worth noting that MS-Excel does not actually store the original data, but instead is our

tool of choice for presenting the cost data and estimates to complete (obligation data is pulled from the Laboratory financial system and stored in MS-Access, while the estimates to complete are stored in MS-Access).

3.3 Microsoft Access

At present we utilize MS-Access to track all project data that is not related to schedule. A second MS-Access database is used to manage all the time data (i.e. TDCharge). We then use MS-Excel, html, ASP, or some other format to publish reports from the databases.

The following lists some of the information maintained in the project data database. We note that this is not intended to be a complete listing, as the project database is regularly refined with improvements. This list, instead, is intended to provide a basic understanding to the reader of what it is that we track:

Job Number -
Project Name -
Descriptor - e.g. EDBB, TSHH
Description of work -
Quantity Needed -
Quantity completed -
Date Requested -
Priority - set by the customer
Status – e.g. under review, in process
Project/Task Numbers -
Customer Contact Information -
TD contact information -
Job History – this could include links to meeting minutes and other such updates in job status

4.0 <u>Methodology</u>

Although we utilize standard project planning techniques, we thought it important to document a few of the specifics for communication and training purposes.

4.1 WBS Thinking

WBS, which stands for Work Breakdown Structure, is a *deliverable-oriented grouping of project elements which organizes and defines the total scope of the project*. It is good to think in terms of a WBS when planning the work. This will help to ensure that all the appropriate project elements will be thought about and included in the schedule and cost estimate.

4.2 Project Accounting

The primary source of information on actual costs is the Fermilab financial system (Oracle Public Sector Financials, or OPSF). Every charge is associated with a task in the Division WBS, which reflects the Lab-Wide WBS (LWWBS). In the LWWBS many TD jobs fall under the category of accelerator upgrades or accelerator maintenance and operations for one of the accelerator systems. For jobs whose costs we want to track, we require a finer division than that.

Therefore, in addition to a general M&O task for each accelerator system where we accumulate obligations associated the system that we do not choose to differentiate, we may choose to establish a set of tasks for each significant job under the associated accelerator system. Although not the only approach taken, one model in use is to create a parent task for the specific job, and under the parent we have one chargeable task for materials & services (M&S) and one chargeable task for the salaries, wages & fringes (SWF) for each of the TD departments that are expected to participate. The decision to establish these tasks for a specific job is a judgment that is made on a case-by-case basis, depending on the size, visibility, and need for accountability of the job. Additionally, if there is any expectation that the job will become part of a separate project and need to have its costs moved to that project, then those costs need to be segregated in their own tasks from the start.

When TD contributes to a major project, as we often do, with its own WBS, then there is usually a minimum granularity of accounting imposed by the project. TD then discusses whether a finer granularity is useful, based on the criteria noted above. For the sake of uniformity across divisions, these tasks may be coarser than TD chooses for its own jobs, lumping together the M&S and the SWF for all departments. If need be, this information can be easily extracted from the Lab financial system anyway.

4.3 Project Schedule

In principle, the project schedule is created by translating the deliverables, defined in the WBS, into specific tasks. Our practice is to organize the schedule by grouping tasks together. For example, all tasks that are related to design are placed together in the schedule, and all tasks related to procurement are placed together in the schedule. This means that the tasks may not be laid out in chronological order. By placing tasks together in this way, we are in a better position to judge whether or we have addressed all the needs (i.e. WBS thinking) and that we have allowed enough time to get the work done.

4.3.1 Standard Milestones

In our project scheduling process, we make a practice of including standard milestones. These serve as a template when creating the project schedule. Of course, these can, and are, adjusted as needed to meet the requirements of the specific projects.

Preliminary Design Review(s) - The primary purpose of preliminary design reviews is to present and agree to design requirements. Design requirements are then translated into actual designs.

Final Design Review(s) - The primary purpose of final design reviews is to present and agree to the actual design. The Project Engineer presents drawings that describe how the design requirements have been met.

Readiness Review(s) - The primary purpose of readiness reviews is to ensure that Engineering & Fabrication is ready to begin production. This entails the review and publication of drawings, travelers, tooling and parts. We also ensure that a Device Service Record is created for each device (refer to TD-2030 Device Data Management).

4.3.2 Task Durations

We do not want to present schedules that are too tight to fulfill. Because of this, in general, task durations are defined as "worst-case" scenarios. We also incorporate certain tasks into the schedule to demonstrate what could happen, but may not happen. Examples of this may be to include time in the schedule for adjusting a lamination die after the sample laminations have been measured, or to include time for re-machining a solid core after a first article has been magnetically measured.

4.4 Initial Estimates

Providing an initial schedule and cost estimate is important in that they are needed by the customer so that they can decide how to best spend their resources. These types of estimates are generally based on a rough WBS and prior experience, and may be done by the Project Engineer or by the group leaders. Typically 50% contingency is placed on initial estimates.

We attempt to acknowledge all time and effort involved in a project:

- Startup efforts (e.g. work to design the magnet and tooling, work to create the travelers, work to setup the tooling);
- Ongoing operations (e.g. time spent on production floor to assist in the fabrication process, time spent to address DRs);
- Meetings (e.g. time spent internally or with the customer at status update meetings);
- “Head scratching” (e.g. time spent thinking about issues and waiting for feedback from the customer).

4.5 Establishing the Project Baseline

In an effort to define reasonable commitments, a baseline is set for each project schedule and cost estimate. Actual progress will be compared to the baseline. In this way, we will track our progress towards our commitments, as well as learn to improve our project planning methodology.

The question is, when do we set the baseline? In principle, the baseline is set when we have reached an appropriate level of comfort with the data. This comfort level is normally reached after many iterations between the Schedule Coordinator and the other project personnel, and should occur at some point prior to starting fabrication. Typically 10-25% contingency is placed on baselined estimates.

4.6 Establishing a Re-Baseline

As a project implementation proceeds, sometimes we find that we cannot meet the schedule and/or cost baseline. This can happen for various reasons, including design changes, scope changes, as well as reevaluation of labor and M&S estimates based on the experience of working on the project tasks. Whatever the reason, some projects will require the schedule and/or cost to be re-baselined. This is important for both TD and the customer, so that we accurately reflect the requirements and commitments of the project.

The question is, when do we re-baseline the schedule? In principle, the baseline is changed when we have collectively decided that a change is necessary. Factors that will most likely necessitate a re-baseline include:

- A change in project requirements;
- A change in project scope;
- A major design change;

Sometimes we may also find that our assumptions for creating the schedule and cost estimates were incomplete or incorrect. And as we track progress we find that we are quite different than our estimates. In this case, it may be necessary to adjust the baseline to take into account what has been learned as the project has progressed. An example of this situation is when we did not factor in time spent waiting for feedback from the customer before proceeding to the next step. If we did not factor this into our estimates, then the simple fact that the project is taking longer will also translate into higher costs. This, typically, warrants a re-baseline.

4.7 Project Tracking

Keeping accurate records of project schedule and cost is very important for each project. Pragmatically speaking, it is necessary due to customer schedule requirements and finite budgets. However, it also serves as a tool to gauge how well we are doing as compared to our estimates.

4.7.1 Which projects?

The degree to which an individual job is tracked is a judgment that is made on a case-by-case basis, depending on the size, visibility, and need for accountability of the job. There is a large amount of work associated with project cost tracking, estimating, and maintaining schedules, and we cannot possibly apply the fullest rigors for every project on which we work. We currently can 'fully' track up to 10 jobs at a time. A larger number could be managed if the level of tracking is decreased. One threshold that is often applied for determining if a project should be fully tracked is whether or not the deliverables are needed for an accelerator shutdown; if yes, then the project is typically fully tracked (i.e. schedule, cost and estimates are managed each month).

4.7.2 Obligations and estimates to complete

Presently we gather obligation data once a month after Business Services updates the OPSF system. At the same time we gather hours worked from the TD time-reporting database (TDCharge). These data are reported in the project cost template, and each group leader estimates the remaining work for each project. The combination of the actual costs and the future estimates provides our working estimates of the total project cost at completion.

These factors are considered in updating estimates:

- How much work has already been completed? How much effort did it take to complete this work?
- How much work is yet to be done? Based on our previous experience, how much effort do we expect is needed to complete the work?
- We should be communicating with those who are doing the work to better understand the work completed and the effort needed to finish the project.
- *In order to gauge how much effort is needed to complete the project, we need to understand how much of the project is already completed.*

4.7.3 Schedules

Schedule updates are done throughout the month. This work entails the Schedule Coordinator receiving periodic updates from the Project Engineer and other group leaders.

5.0 <u>Roles and Responsibilities</u>

The project management system involves many interdependent roles. These roles, and their respective responsibilities, are defined below.

5.1 Customer

The *Customer* is the person(s) who have requested the work, and who will receive the deliverables from Technical Division. The customer should provide the following:

- Specific requirements to define the work of the project, which include:
  - Description of work;
  - Quantity needed;
  - Need-by date;
  - Priority, as it relates to other work for the Customer.
- A contact person for coordinating communication on project needs and status;
- Devices to repair or upgrade, as required;
- Project/Task Numbers.

5.2 TD/Customer Liaison

The primary role of the TD/Customer Liaison, as it pertains to fabrication jobs, is to be the central person for communication between TD and the Customer. Most jobs are routed through the Liaison to the TD, and most preliminary information is provided back to the Customer through the Liaison. The Liaison also schedules and runs coordination meetings between TD and the Customer, and is responsible for having the appropriate project/task numbers created or assigned.

As the project progresses, there is a shift from the Liaison to the Project Engineer for communication between the TD and the Customer.

5.3 Process Engineering

Process Engineering is a Group within the Magnet Systems Department. Working with the Process Engineering Group are Traveler Coordinators and the Schedule Coordinator. Their roles are defined as follows:

Traveler Coordinator:

- Working with Production and Engineering to maintain travelers and parts kits for each fabrication project;
- Organizing Production Readiness Review(s);

Schedule Coordinator:

- Designing and maintaining the project tracking database;
- Coordinating all work related to each job, which includes:
  - Assigning a job number for each job;
  - Interfacing with all people involved with the project to maintain accurate data related to the project.
- Maintaining the project schedules, which includes:
  - Maintaining a schedule for each project;

    - Interfacing with all people involved with the project to maintain accurate schedules;
    - Integrating all schedules into a master schedule.
- Maintaining the project cost estimates, which includes:
    - Creating the cost spreadsheet for each project;
    - Collecting data from the OPSF and TD effort-reporting databases, and publishing the data in the cost sheets;
    - Collecting estimates from group leaders and publishing in the cost sheets.
- Issuing reports on project status.

5.4 Project Engineer

The *Project Engineer* is the central figure in the project management system, and so has many roles to fill:

- Along with the Customer Liaison, the Project Engineer is the main contact for communication with the customer, which includes:
    - Working with the customer to define and document project requirements;
    - Providing initial cost and schedule estimates to the customer.
- Providing detailed design drawings for release;
- Reviewing/revising cost estimates as the design matures.
- Providing schedule and cost input to the Schedule Coordinator through regular meetings;
- Organizing Design Review(s);
- Providing all technical input for the creation and use of the traveler(s);

5.5 Production Manager

The *Production Manager* is responsible for the following:

- Providing schedule and cost input to the Schedule Coordinator through regular meetings;
- Allocating appropriate resources to fulfill the schedule requirements;
- Providing input to Traveler Coordinators for the creation and maintenance of travelers;

5.6 Material Control Department

The Material Control Department is responsible for providing procurement, incoming inspection and storage services to the Division and Laboratory. For the purposes of the project management system, the roles of Material Control include:

- Providing design-related input on the use of industry practices for the fabrication of parts/assemblies or other services;
- Providing cost estimates and potential sources for acquisitions;

- Procuring and inspecting the parts needed for the project;
- Providing schedule and cost input to Project Management through regular meetings, which includes:
    - Maintaining appropriate information regarding the procurement status of parts needed for the project.

5.7 Magnet Test Facility

The *Magnet Test Facility (MTF*) is operated by the Test & Instrumentation Department. MTF is responsible for conducting cold and warm measurements of devices to measure characteristics such as quench currents and magnetic strength & harmonics. For the purposes of the project management system, the roles of MTF include:

- Working with the Measurement & Analysis Group to design, install and configure measurement systems;
- Measuring devices, as required for the project;
- Providing schedule input to the Schedule Coordinator;
- Publishing measurement data.

5.8 Measurement & Analysis

Measurement & Analysis is a Group in the Magnet Systems Department. This Group is responsible for defining measurement plans for the Magnet Test Facility to carry out, and for reporting the results of the MTF measurements. For the purposes of the project management system, the roles of M&A include:

- Working with the TD/Customer Liaison to define the measurement plans;
- Designing and developing new measurement systems, as required for the project;
- Analyzing and reporting on data collected at MTF on the measurement of the devices.

6.0 <u>Structure</u>

The overall structure is defined in the process flow diagram (last page).

The process flow is iterative. This means that we continually go through the process of planning, implementing, checking and adapting, until we are finished with the project. A fabrication project, for example, will loop through the plan-implement-review cycle at each of the request, conceptual design, final design and fabrication stages.

The process flow diagram is a very broad look at the project management process. Following are more details about each of the steps in the process.

It is understood that each step involves updating the information in the Jobfile and/or other project records.

6.1 Request for Work

Remarks:
- Work could involve initial estimates, or other information, as well as fabricating a device;
- Requests for work could be very informal or small, e.g. a question over lunch or a request for basic information;
- It is expected that some number of requests will never result in the creation of a job in the system.
- The timing for when to assign a job number is a judgment call. The threshold comes when it is decided that we either want the work to appear on a report, or when we feel we will be applying a sufficient amount of effort to the task. Determining the sufficient amount of effort threshold includes considering the number of people involved, the amount of time involved, and, in the case of requests for information such as cost estimates, the complexity and value of retaining the work done.
- An initial request may evolve into multiple jobs for the sake of tracking, such as a split into a design and prototype phase and a production phase.

Inputs:
- A need for something

Outputs:
- Job request
- Job number in the system
- Jobfile

Roles:
- **Customer** - provides the request to TD
- **Liaison** - works with the Customer and TD personnel to develop the request, and determines when a job number should be assigned
- **Schedule Coordinator** - assists the Liaison in developing the request, and then assigns a job number and creates the Jobfile

6.2 Decide next step, or Plan

Remarks:
- Project Engineer is assigned to project
- Questions to ask, and answer include:
  - "Is design required, and if so, how much?"
  - "Is engineering effort required, and if so, how much?"
  - "Is procurement required, and if so, how much?"
  - "What are the tooling needs?"
  - "What are the limiting factors?"
- Develop WBS, initial schedule, cost estimate and work plan, as needed
- Identify meeting routines and project review milestones, as needed
- Identify resources needed to complete project

Inputs:
- Job request

Outputs:
- Decisions and plans

Roles:
- **Project Engineer** - coordinates making decisions and plans, based on the job request
- **Schedule Coordinator** - assists Project Engineer in the creation of WBS, initial schedule, cost estimate and work plan

6.3 Implement Plan

Remarks:
- Work is done on the project. This may entail gathering information and creating a report, or it may entail design, procurement and fabrication;
- Project data is recorded in the Jobfile and other project tracking systems.

Inputs:
- Job request
- Plans

Outputs:
- Cost and schedule estimates, as needed
- Revisions to cost and schedule estimates, as needed
- Design specifications and drawings
- Procurement of parts
- Fabrication of device(s)

Roles:
- **Liaison** - works with Customer management to establish priority of projects; communicates status to TD and Customer division management
- **Project Engineer** - coordinates all work done on the project
- **Schedule Coordinator** - maintains appropriate records to reflect up-to-date work on project; serves as link between all personnel working on project
- **Traveler Coordinator** - develops travelers
- **Production Manager** - coordinates all fabrication-related work
- **Material Control** - procures and inspects needed parts
- **Magnet Test Facility** - measures devices

6.4 Review work and provide feedback

Remarks:
- On a regular basis, the work on the project is reviewed and compared to the plan;
- Based on the review, the schedule, cost estimate and plans are adjusted as needed;
- Status reports are generated and information is communicated internally within the Division and back to the Customer;
- Reports could take the form of formal reports, e-mail messages, or other formal and informal communications.

Inputs:
- Jobfile
- Tracking database
- Schedule
- Cost estimate

Outputs:
- Updates to schedule, cost estimate and plans
- Report(s)

Roles:
- **Liaison** - periodically reviews progress with the Customer's division management and reassesses priorities
- **Project Engineer** - works with Schedule Coordinator to review work and update records
- **Schedule Coordinator** - works with all personnel on project to review work and update records
- **Production Manager** - works with Schedule Coordinator to review work and update records
- **Measurement & Analysis** - issues report(s) stating the results of MTF measurements
- **All others** - provide feedback to Schedule Coordinator on work progress

6.5 Project complete?

Remarks:
- In order to closeout the project, we must determine if we have met the requirements of the project. This decision ultimately comes from the Customer;
- Upon review, if it is determined that the project is not complete, then the iterative cycle continues with planning (7.2 above).

Inputs:
- Jobfile
- Tracking database
- Schedule

Outputs:
- Decision to close project or to continue

Roles:
- **Customer** - decides whether or not the project is complete to their satisfaction

6.6 Project closeout

Remarks:
- A final review is completed to compare are actual cost and schedule to our estimates. This is done so that we can improve our planning methodology.
- Although all deliverables have been completed, it is important to ensure that the project records are also completed.
- Everyone working on the project needs to ensure that their records are complete and accurate.

Inputs:
- Decision to close project

Outputs:
- Complete and accurate project records, possibly including a

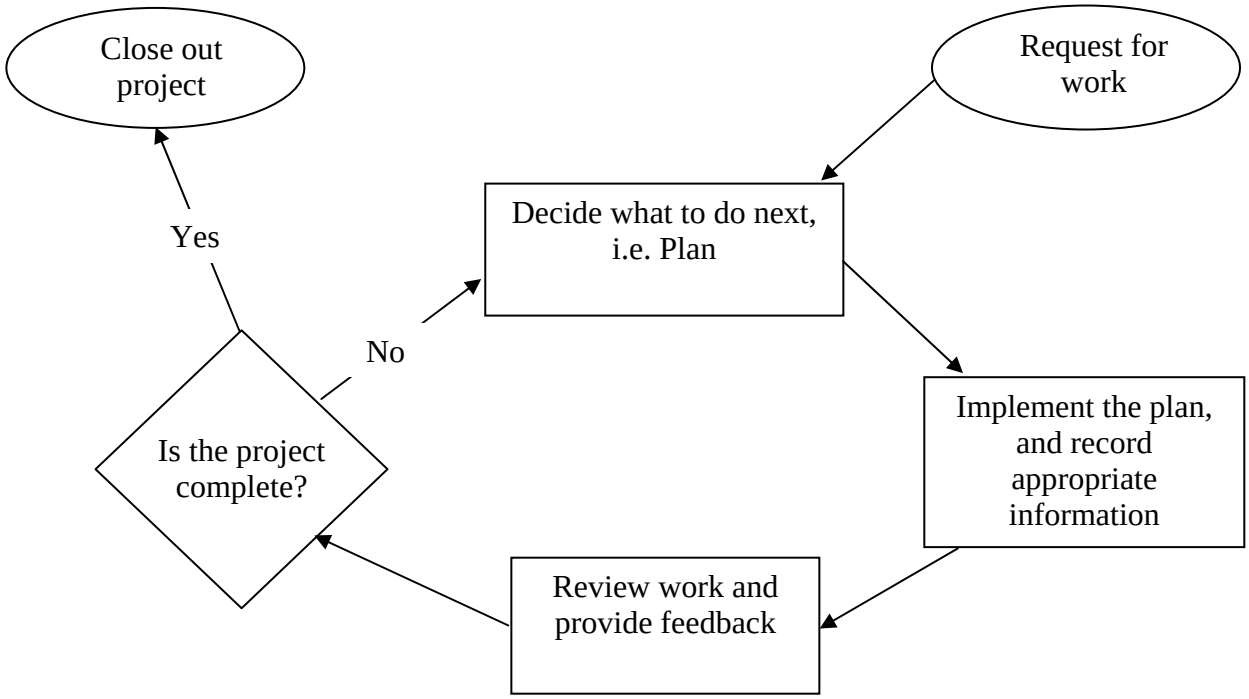
closeout report

- Knowledge gained from completing the project

Roles:

- **Project Engineer** - works with the Schedule Coordinator to closeout the project files
- **Schedule Coordinator** - works with project personnel to closeout the project files; provides a summary of our degree of success in meeting our estimates
- **Quality Assurance Manager** – writes the closeout report
- **Production Manager** - ensures that Device Service Records are up-to-date
- **All others** - ensure that their records are appropriately closed out

Process Flow Diagram



Job 195	NDA	Procure and assemble at least (10) Accumulator trim dipoles.
Codes 30.8.2.06.21.*	Robotham	
M+S 30.8.2.06.21.9		
2004-06	Alsip	

Labor Hours

Baseline Hours Estimate Date set: 15-Jul-2004			Hours to Date: This month		Hours to Date: Total	Estimated Hours to Complete			Estimated Hours at Completion	
Contingency		15%				Contingency		15%	3157.5	100.0%
Eng+Des						Eng+Des			441	14.0%
	M	260	0	M	220		M	40	8.2% 260	
	W	181	0	W	161		W	20	5.7% 181	
				C					0	
Traveler						Traveler			304.5	9.6%
	M	294.5	23	M	217.5	54	M	77	9.3% 294.5	
	W	10	0	W	0		W	10	0.3% 10	
			0	C	0				0	
Schedule						Schedule			166	5.3%
	M	0		M			M		0	
	W	166	0	W	116		W	50	5.3% 166	
				C					0	
Tool Group						Tool Group			91.5	2.9%
	M	0	0	M	0		M	0	0	
	W	91.5	0	W	38.5		W	53	2.9% 91.5	
				C					0	
Production						Production			1938	61.4%
	M	104	0	M	24		M	80	3.3% 104	
	W	1834	61	W	1085	688	W	749	58.1% 1834	
				C	0				0	
Prod Inspection						Prod Insp			216.5	6.9%
	M	0		M			M		0	
	W	216.5	3.5	W	102.5	110.5	W	114	6.9% 216.5	
				C					0	
Material Control						Matl Control				
	M	2		M	2		M			
	W	53		W	53		W			
				C						
Development+Test						Develop+Test				
	M	0		M	0		M			
	W	0		W	0		W			
				C						
M+S Labor										
Contingency		5%				Contingency		5%		
Machine Shop		4	Machine Shop		4	Machine Shop				4
Welding		63	Welding		23	Welding		40		63
			#N/A			#N/A				

Job Cost

Baseline Cost Estimate: Date set: 15-Jul-2004			Obligation to Date			Estimated Cost to Complete		
Hourly Rate			Calc Rate			Hourly Rate		
	M	$ 63		M	$ 64		M	$ 63
	W	$ 40		W	$ 36		W	$ 40
				C				
Machine Shop		$ 55	Machine Shop		$ 55	Machine Shop		$ 55
Estimated Labor Cost			Reported Labor Cost			Estimated Labor Cost		
	M	$ 48,000		M	$ 29,687		M	$ 15,000
	W	$ 108,000		W	$ 56,192		W	$ 44,000
				C	$ -			
Machine Shop		$ 4,000	Machine Shop		$ 1,485	Machine Shop		$ 3,000
Other M+S		$ -	Other M+S		$ 25,338	Other M+S		$ -

Baseline Estimate		Obligation to Date			Cost to Comp			Estimated Cost at Completion
Labor	$ 156,000	Labor	$ 85,879	+	Labor	$ 59,000	=	$ 145,000
M+S	$ 4,000	M+S	$ 26,823	+	M+S	$ 3,000	=	$ 30,000
Total	**$ 160,000**	**Total**	**$ 112,702**	+	**Total**	**$ 62,000**	=	**$ 175,000**