



Jefferson Science Associates, LLC

# **300**

# **Scheduling and Budgeting**

**Project Control System Manual**  
**Revision 7**

## **300 Scheduling and Budgeting**

This chapter of the JSA Project Control System Manual describes the planning processes required to develop a practical project plan that can be implemented by the designated project team. The major goal of this planning effort is an integrated project schedule and budget. Schedule planning results in a schedule that describes the sequence of technical work and the task interdependencies necessary for a successful project outcome. Cost planning begins with the development of a cost estimate for all authorized work that eventually leads to the establishment of the project budget. Proper project planning ensures the amount of work to be accomplished, the time allotted to accomplish the project activities, and the resources required to complete the work scope are properly balanced. Once the initial schedule and cost planning are completed, the resultant plans can be merged to form a time-phased project budget that is seamlessly integrated with the network schedule. This resource loaded schedule and initial project budget are validated and approved as an integrated project baseline which is endorsed by the project team as the Performance Measurement Baseline, a foundational element of earned value management. Meaningful earned value performance metrics enable better management insight and decision making to help keep the project on track.

### **301 Schedule Planning**

The objectives of schedule planning are to generate a reasonable schedule of work that leads to project completion and to establish a schedule that, when loaded with resource elements, will result in an integrated project baseline. The core of the schedule planning process is the Schedule Management System and its associated scheduling software. This system provides the requisite project management tools to plan and sequence project milestones and work activities, to assign resources to the activities, to monitor progress of activities toward project objectives, to forecast future schedule performance, and to provide the basis for earned value and performance calculations.

#### **301.1 Schedule Management System**

- A. The Enterprise Suite consists of schedule and cost software packages that are part of the overall JSA Enterprise Project Structure. The central component to the Schedule Management System is the Enterprise Suite scheduling software. It is a powerful and flexible scheduling tool that is used to perform time analyses of logic network, maintain baseline and status information, prepare standard reports at regular intervals and special custom reports as needed, and provide the basis for earned value and performance calculations by seamless connectivity to the Cost Management System.



- Time analysis is the process of calculating the earliest start and finish dates and the latest start and finish dates of each activity, based on the duration of the activities, the logical relationships between them and the desired completion date of the project. In addition to these calculations, the scheduling software also determines free float (the amount of time an activity can be delayed without delaying subsequent activities), total float (the amount of time an activity can be delayed without delaying project completion as a whole), and the critical path (the longest path from the logic network start to finish and/or the sequence of activities with the least total float). Any delay in a critical path activity will extend the total project schedule.
  - For each work activity in the project schedule, the scheduling software maintains the early start, early finish, late start, late finish, and, after they occur, the actual start and the actual finish dates. Actual start and finish dates affect the remainder of the logic network by changing the early and late start and finishes of subsequent activities. Therefore, a time analysis is conducted after each status update. The scheduling software also maintains a separate file of baseline start dates, baseline finish dates and other baseline data in the schedule baseline. These baseline dates are not affected by actual starts and finishes. Instead they are retained for comparisons between planned and actual dates.
  - The scheduling software produces reports in three different formats (Gantt chart, logic diagram or in tabular format), and has flexible report generation routines. The use of relational databases and the manner in which the information is coded permit the creation of special reports. These are useful to assess the effects of various schedule alternatives, to extract portions of the project, or to select categories of milestones/activities for review.
- B. The scheduling group within the Project Management & Integrated Planning Department is responsible for administration of the Schedule Management System. This includes schedule preparation, horizontal and vertical integration of elements of the scheduling system, maintenance of schedule baselines, status reporting, and programming enhancements to the scheduling system. Information is obtained from all levels of project management in carrying out these responsibilities.

### **301.2 Schedule Development**

- A. From Project Manager to Control Account Manager, the entire project team is responsible for the successful development of the project schedule which is structured and numbered consistent with the project WBS. The approach to



schedule development usually begins with the determination of the key control milestones. These top-level milestones represent the significant events and critical decision points that could affect the technical, schedule, and/or cost performance of the project. The control milestones and their associated definitions are mutually developed by the Jefferson Lab Project Manager and the Project Customer. Once the control milestones schedule has been created, the Project Manager, Associate Project Managers, and Control Account Managers can establish intermediate milestones for the project. These secondary milestones are important for tracking crucial strategic project events.

- B. At this stage in the schedule development, a detailed schedule (Exhibit 5) can be formulated that will encompass all the specific tasks required to accomplish the project work scope. The milestone schedule, populated with the control and intermediate milestones, serves as the framework to add work activities and detail milestones to the project schedule. The detail schedule is developed from scheduling information generated by the Control Account Managers. PM&IP incorporates the schedule information within the Schedule Management System and builds a comprehensive schedule that includes the logic sequence, start and finish dates, and duration of every work activity required to complete the project. Any work package requiring procurement of subcontract work should incorporate relevant subcontractor schedule milestones and activities into the project detail schedule to ensure that accurate schedule analysis can be accomplished. (Subcontractor work scope may initially be added to the project schedule as planning packages until the subcontractor schedule activities are finalized.) The resulting detail schedule contains all project milestones, the work activities, and the logical ties between the various schedule elements. With the appropriate discrete activity interdependencies, the critical path for the complete project can be determined. The project schedule will evolve through many iterations to arrive at a fully mature schedule that will be approved as the baseline schedule.
- C. The baseline schedule constitutes the performance standard against which actual progress is compared. A current (or “progress”) schedule is derived from the baseline schedule and is used as a working tool for evaluating schedule plans and projecting future progress. In order to preserve its value as a baseline, changes to the baseline schedule are carefully controlled and documented. On the other hand, the current schedule is continuously revised as actual work activity status and completion dates are entered and their effects on future scheduled work activities are calculated. Consequently, this results in changes to early/late start and finish dates that may no longer be consistent with the baseline schedule. These revised dates are used to forecast when detail, intermediate and control milestones will actually be achieved and to guide any required management corrective action.



- D. The project team may employ supplemental schedules that are not part of the scheduling system structure. These schedules are used for day-to-day operational planning and management, and supplement the baseline and current schedules, but are not under configuration control. This category would include “what-if” schedules generated to evaluate potential alternate management options.

## **302 Cost Planning**

- A. Cost planning is the other major planning activity required to develop an integrated project baseline. The purpose of cost planning is to identify the resources needed to accomplish the scope of work and estimate the associated costs. Cost represents the dollar value required to accomplish the technical work scope within schedule and programmatic constraints. A preliminary cost estimate can be started after an initial Work Breakdown Structure is developed. Cost estimate integration with the WBS occurs when the work scope in each project work and planning package has a definitive cost/resource estimate associated with it. Once the cost estimate is approved at all management levels, it becomes the cost baseline, i.e., the project’s budget.
- B. Elements of the cost estimate include both direct charges and indirect charges. Direct charges are costs applicable to, and identified specifically with, the project work scope. Examples of these types of costs include labor, travel, material, subcontractor costs, etc. Indirect charges are costs that cannot be consistently or economically identified against a specific Jefferson Lab project and are spread over the total laboratory project portfolio based on the JSA/JLab Cost Accounting Standards Disclosure Statement.

### **302.1 Cost Management System**

The Cost Management System is an integral element of the Enterprise Suite software package used at Jefferson Lab. Initial budget data enters the Cost Management System via its link to the Schedule Management System. Direct and indirect actual costs are imported from the Lab’s financial system. The Cost Management System, together with the Schedule Management System, forms an integrated cost/schedule database that enables the project management team to understand a project’s costs at the transaction level.



### **302.2 Funding Guidance**

At the start of project cost planning, the Project Customer may provide funding guidance to the Project Manager that includes a fiscal year breakout. The Project Manager can use the funding guidance to establish a project budget profile across the WBS Level 2. Target budgets are developed and distributed to the Associate Project Managers and Control Account Managers. This represents the Project Manager's guidance to Associate Project Managers and Control Account Managers when they develop the details of the cost estimate for their portion of the project.

### **302.3 Cost Estimating**

A disciplined and systematic cost estimating process will promote integrity in a new project. As project performance will be measured against the project baselines, it is important that an accurate cost estimate be determined prior to the establishment of the cost baseline. This necessitates an extensive project management evaluation of the proposed project cost be accomplished. Multi-level dialogue among the Project Manager, the Project Management & Integrated Planning Department, Associate Project Managers, and the Control Account Managers will be required to reach consensus on a final cost estimate for the project. Areas can be identified where actions must be taken to restructure work scope or reassess resource requirements to meet anticipated fiscal year and total project funding constraints. Through validation of the cost estimate, a cost baseline can be established for the project. However, cost estimating is a continuous process conducted throughout project execution for refining future work costs.

## **303 Control Account Plan Development**

- A. With any budget targets provided by the Project Manager, the Control Account Manager can start to develop the Control Account Plan. The Control Account Plan represents the Control Account Manager's strategy for accomplishing the project work within the control account. Along with the work scope defined in the WBS dictionary, the Control Account Plan also includes a detailed schedule, a resource plan, and a time-phased budget (Exhibit 6). The Control Account Plan will be appended to the Work Authorization Document described in Section 400. This collective documentation will convey the agreement between the Control Account Manager and the Project Manager to accomplish this plan and provides authorization to proceed with work.
- B. A control account will normally consist of multiple work packages and may include planning packages. To develop an initial resource-loaded schedule,



the Control Account Manager can use the Work Package Development Excel spreadsheet (Exhibit 7) (or other suitable schedule development tool) to produce a detailed schedule and resource plan for each required work package. The Control Account Manager divides the work package into discrete manageable and measurable segments of work for the purpose of developing plans and determining progress. Each activity is sequenced in a manner that provides logical support for the project schedule.

- C. With the work activities identified, the Control Account Manager next estimates the resources (labor, expenses, and procurements) and the quantity (hours, dollars) required to accomplish the work activities. Labor resources are estimated according to various cost element categories, such as Plant Engineer, Mechanical Engineer, and Scientist, etc. Expense estimates are prepared for such items as supplies and materials, travel, and consulting. Labor and expense estimates are assigned to the month/fiscal year during which they will be used or expended. Estimates for procurements are also made and are assigned to the month/fiscal year in which payment is anticipated to occur. Nominally, the cost estimates are entered in current year direct dollars. Once the resources have been identified and their costs estimated, a schedule of the work activities is developed with start dates, activity durations, and activity predecessors. Data from the schedule development tool is used to develop the initial detail schedule within the Schedule Management System. Schedule and cost data is imported by the Cost Management System where burden and escalation financial factors are applied. The resultant product is the time-phased budget portion of the Control Account Plan.
- D. One essential product of the Control Account Plan is the identification of the types and levels of labor resources that must be provided by functional organizations supplying labor to the project. Summary reports showing labor requirements in support of work scope as documented in the Control Account Plans are prepared by Project Management & Integrated Planning and used by senior project management to assure the availability of such personnel when needed.
- E. At this stage in the planning process, three project baselines have been established: the technical baseline, the schedule baseline, and the cost baseline. The technical baseline, organized around a WBS framework, describes the desired configuration, performance, and characteristics of the project and establishes the project's mission, technical objectives, and functional requirements. The required work activities to satisfy the project's mission need are logically linked in a schedule baseline integrating the entire work scope while reflecting all programmatic constraints. The cost baseline is based on validated cost estimates developed for the project work scope and ensures resources for labor, services, subcontracts, and materials are



established at the requisite levels. In total, these three baselines produce the integrated project baseline. The approved Control Account Plans that form the integrated project baseline represent the life-cycle budget plan for accomplishing all of the project work scope.

- F. The integrated project baseline lays the foundation through which project objectives can be achieved and progress can be managed and monitored during project execution. Data that form the integrated project baseline are recorded in an integrated cost/schedule database using the Cost and Schedule Management Systems. These systems share the data to produce a resource-loaded schedule and time-phased budget plan.

### **303.1 Performance Measurement Baseline**

- A. After an in-depth review, the project management team validates the integrated project baseline thereby establishing the Performance Measurement Baseline (PMB). This time-phased budget plan encompasses all the individual work activities of the control accounts with the resources necessary to accomplish them. The PMB sets the criteria against which actual performance is measured during project execution. This comparison process helps identify problem areas early and aids the development of a recovery plan. Changes to the PMB must be completed in accordance with the Change Control process described in Section 800.
- B. Earned Value Management employs three sets of project data to provide project management with insight into the progress of the project. From the Performance Measurement Baseline, the Budgeted Cost of Work Scheduled (BCWS) can be established. This metric represents the sum of the time-phased budgets established for all effort scheduled to be accomplished within a given time period. BCWS can be called “Planned Value.” At the project completion time point, the BCWS should equal the Budget At Completion (BAC). BAC is the budgetary goal for accomplishing all of the authorized work contained in the control accounts. While BCWS is derived from project planning, the second set of data, Budgeted Cost of Work Performed (BCWP), is determined during project execution. BCWP, or “Earned Value,” is the sum of the time-phased budgets for work completed during a specified time period; i.e., the value of the work accomplished. The third set of data, also collected during project execution, is Actual Cost of Work Performed (ACWP) or “Actual Costs.” Actual Costs are the project costs incurred and recorded in accomplishing the work performed (i.e., Earned Value) within a given time period. With these three earned value metrics, project management can evaluate the status of the project in relation to the technical, schedule, and cost baselines established for the project. An Estimate At Completion (EAC) can be calculated that sums the actual costs incurred to date plus the estimate of costs for all authorized work remaining.



### **304 Contingency, Management Reserve and Undistributed Budget**

- A. During development of the project cost plan, contingency funds may be identified to provide budget that covers future risk elements to the project. These funds are part of the Total Project Cost but reside outside the Performance Measurement Baseline. Contingency is normally developed "bottoms-up" from a risk assessment of individual work elements within the project WBS. This contingency is then extracted from the individual WBS elements and summed into a project contingency account. Funds held in the contingency account are nominally controlled by the project customer. A portion of the contingency funds, designated management reserve, may be allocated to the project manager for his approval authority. Management reserve funds provide flexibility in managing baseline changes to control accounts within the project Performance Measurement Baseline.
  
- B. The release of contingency/management reserve funds is managed through the change control process and determined by approval thresholds defined in the Project Execution Plan. Transactions for these accounts are documented in the project baseline change control log. As a project nears completion, the project customer will determine the final disposition of any unused contingency or management reserve.
  
- C. Undistributed budget is budget for work scope that has been authorized but has not yet been distributed to a specific control account. This budget element is used to accommodate temporary situations where time constraints prevent adequate budget planning or where contract effort can only be defined in very general terms. Undistributed budget is held in a short term holding account within the Performance Measurement Baseline and should be allocated to a designated control account in a timely manner.

### **305 Exhibits**

- 5. Detail Schedule Example
- 6. Control Account Plan Example
- 7. Work Package Development Spreadsheet



Exhibit 5. Detail Schedule Example

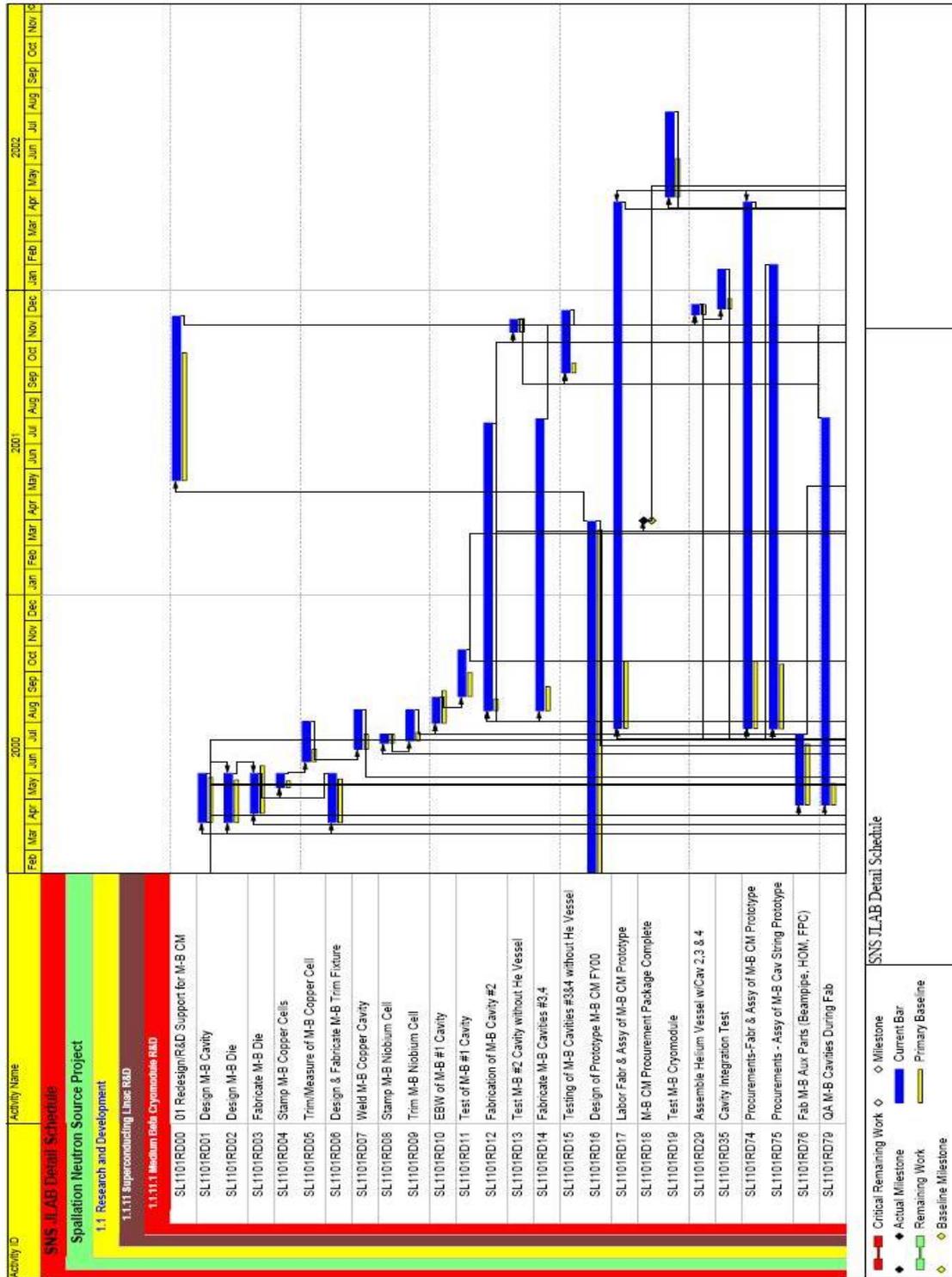


Exhibit 6. Control Account Plan Example



Jefferson Science Associates, LLC

**12 GeV  
Control Account Plan**

**WBS 1.4.2.1  
Hall B Magnets**

The Jefferson Lab logo features the text 'Jefferson Lab' in a bold, sans-serif font. The 'J' is black, and the 'e' is red. To the left of the text is a stylized red swoosh.

Thomas Jefferson National Accelerator Facility

Exhibit 6. Control Account Plan Example

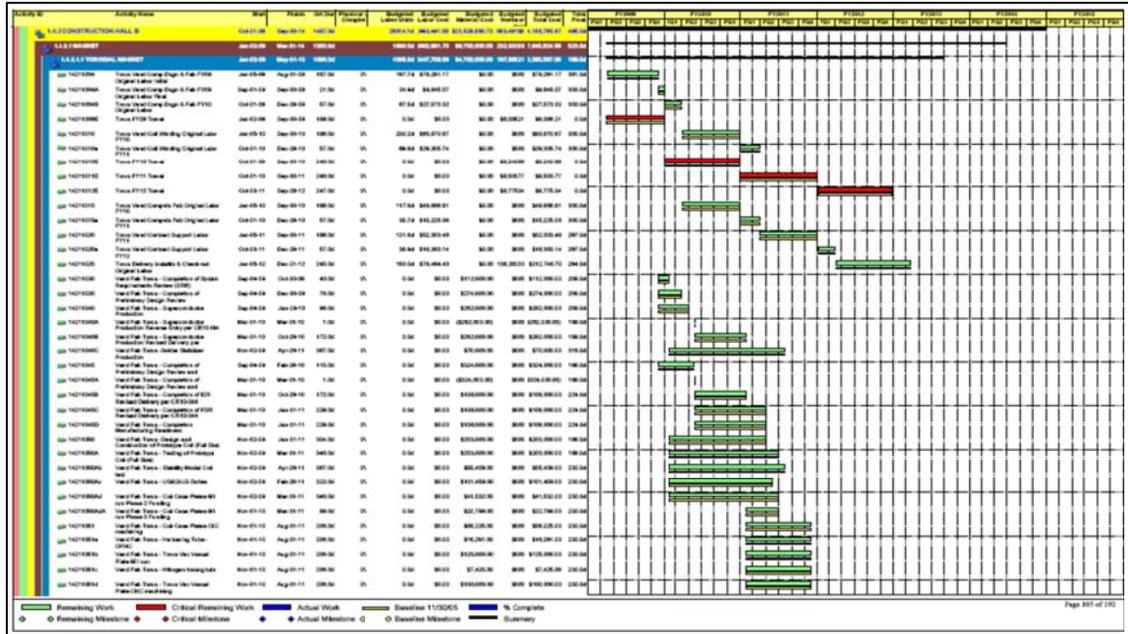
(WBS Dictionary)

<h2 style="margin: 0;">12 GeV Upgrade</h2> <h3 style="margin: 0;">WBS DICTIONARY</h3>		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Revisions</th> </tr> <tr> <th style="text-align: center;">CR.#</th> <th style="text-align: center;">Date</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> </tbody> </table>	Revisions		CR.#	Date										
Revisions																
CR.#	Date															
<b>WBS Number</b> 1.4.2.1	<b>WBS Element</b> Construction Hall B CLAS Superconducting Magnets: Torus and Solenoid															
<b>Technical Content (including Processes)</b>																
<p>Torus Magnet: This WBS element includes design, engineering, and fabrication of 6 flat panels of superconducting coils with polar angle coverage from 5 degrees to 40 degrees and azimuthal acceptance from 50% at 5 degrees to more than 90% at 40 degrees. The <math>B_{d1} &gt; 3</math> Tm @ 5 degree and about 0.5 Tm at 40 degrees. Coil cryostat width front face is about 10 mm.</p> <p>Solenoid Magnet: This WBS element includes design, engineering, and fabrication of the superconducting solenoid with 5 Tesla central field with aperture of 0.78 m and opening angle of 80 degrees in the forward direction. The field uniformity in the target area is better than <math>10^{-4}</math> in cylinder 0.07 x 0.03m for polarized target operation. The outer dimensions are diameter of about 2m and length of about 1.8 m. It consists of the main coil and compensating coil to minimize the stray field at the detectors location.</p>																
<b>Resource Type Summary</b>																
<ul style="list-style-type: none"> <li>• Design/Mechanical/Electrical Engineers</li> <li>• Design/Mechanical/Electrical Technicians</li> <li>• Senior Scientist</li> <li>• Senior Staff</li> <li>• Procurements</li> <li>• Travel</li> <li>• Machine Shop</li> </ul>																
<b>Deliverables</b>																
<ul style="list-style-type: none"> <li>• Torus Magnet</li> <li>• Solenoid Magnet</li> </ul>																



Exhibit 6. Control Account Plan Example

(Schedule)



(Resource Plan)

WBS 1.4.2.1		FY2011	FY2012	FY2013	FY2014	Period Total
<b>WBS Name: Hall B Magnets</b>						
PRCRMNT<\$50K 60NOESC PROCUREMENT<\$50K 60 NO ESCALATION	Cost	\$2,658,803.87	\$3,212,352.77	\$663,563.67	\$187,800.86	\$6,722,521.16
	Units					0
PRCRMNT>\$50K 69NOESC PROCUREMENT>\$50K 69 NO ESCALATION	Cost	\$50,000.00	\$161,000.00	\$584.58	\$38,415.42	\$250,000.00
	Units					0
ELEC DES ELEC DES	Cost	\$2,432,400.00	\$2,719,600.00	\$612,614.56	\$149,385.44	\$5,914,000.00
	Units	18.1d	21.4d	5.9d		45.5d
ELEC ENG ELEC ENG	Cost	\$7,104.60	\$8,650.50	\$2,391.49		\$18,146.59
	Units	22.2d	12.9d	1.2d		36.2d
ELEC TECH ELEC TECH	Cost	\$12,126.51	\$7,262.78	\$668.16		\$20,057.45
	Units	12.3d	16.1d	1.2d		29.6d
MECH DES MECH DES	Cost	\$4,217.55	\$5,696.77	\$417.88		\$10,332.20
	Units	48.5d	55.7d	4.7d		108.9d
MECH ENG MECH ENG	Cost	\$18,123.98	\$21,450.70	\$1,824.56		\$41,399.24
	Units	70.9d	75.6d	9.5d		155.9d
MECH TECH MECH TECH	Cost	\$38,518.82	\$42,399.10	\$5,311.95		\$86,229.87
	Units	165.3d	211.9d	17.8d		394.9d
OFFICE (admn supprt) OFFICE	Cost	\$56,952.32	\$75,321.32	\$6,312.29		\$138,585.94
	Units	1.1d				1.1d
SCIENTIST SCIENTIST	Cost	\$254.29				\$254.29
	Units	30.3d	14.6d	1.2d		46.0d
SKILLED TRADE SKLLD TRADE	Cost	\$16,563.48	\$8,250.12	\$668.63		\$25,482.23
	Units	6.0d	7.5d	1.9d		15.4d
VISTNG USERS VISTNG USERS	Cost	\$1,556.16	\$2,007.63	\$506.80		\$4,070.60
	Units	26.6d	36.9d			63.4d
EXPNS MACHINE SHOP MSHOP	Cost	\$3,978.63	\$5,705.44			\$9,684.07
	Units					0.0d
EXPNS TRAVEL TRAVEL	Cost		\$137,458.32	\$32,262.75		\$169,721.07
	Units					0.0d
	Cost	\$17,007.54	\$17,550.08			\$34,557.62

(Time-Phased Budget)

Basis Task	Fiscal Year	Fiscal Period	2012												2013		2014	Totals
	2009	2010	2011	1	2	3	4	5	6	7	8	9	10	11	12	2013	2014	Totals
Base 12 GEV UPGRD 4.2.1	136,478.80	839,303.23	2,685,972.36	35,729.14	658,089.54	206,240.18	121,817.93	235,656.98	86,123.10	35,636.16	328,333.10	33,939.18	745,653.10	576,633.45	207,631.19	671,477.73	192,410.71	7,797,125.87



Exhibit 7. Work Package Development Spreadsheet

A	B	C	D	E	F	G	H	I	J	K	L																																																																											
<b>Work Package Development Sheet</b>																																																																																						
1	Project																																																																																					
2	VBS	<b>Test</b>																																																																																				
3	CAM	TESTDDM.3.2.1																																																																																				
4	VBS Description																																																																																					
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<b>CAP TOTAL</b>		<b>\$195.5 K</b>																																																																																				
STEP #6 Act ID (read note)	STEP #1 Activity Description <small>To read attached note, place cursor over this field (read note)</small>	STEP #2 Enter Activity Duration in Weeks <small>(read note)</small>	STEP #3 Resources <small>multiple rows for multiple resources (read note)</small>	Select Use <small>Use for multiple resources (read note)</small>	STEP #4 Budgeted Labor Person Weeks <small>(read note)</small>	STEP #5 Budgeted Expense / Procurement <small>\$</small>	STEP #7 Predecessors <small>(read note)</small>	STEP #8 Planned Start Date <small>(read note)</small>	STEP #9 Planned Finish Date <small>(read note)</small>	STEP #10 External Predecessor Links <small>(read note)</small>																																																																												
34	ISM	0.0																																																																																				
35	Start Milestone																																																																																					
36	2	2.0	ELEC DES		4.0		ISM	4/22/11	5/5/11																																																																													
37	2	4.0	ELEC ENG		4.0																																																																																	
38	3	4.0	ELEC TECH		1.0		2	5/8/11	6/2/11																																																																													
39	4	4.0	ELEC ENG		2.0		3	6/2/11	6/30/11																																																																													
40	4	8.0	ELEC TECH		2.0		4	7/1/11	8/25/11																																																																													
41	5	6.0	PRCRMIT <\$50K 60			\$25.0 K	4	7/1/11	8/1/11																																																																													
42	6	6.0	PRCRMIT >\$50K 69			\$50.0 K	4	7/1/11	8/1/11																																																																													
43	7	1.0	EXPNS SUPPLS & MATLS			\$50.0 K	5,6	8/26/11	9/1/11																																																																													
44	8FM	0.0	EXPNS TRAVEL			\$2.0 K	7	9/1/11	9/1/11																																																																													
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