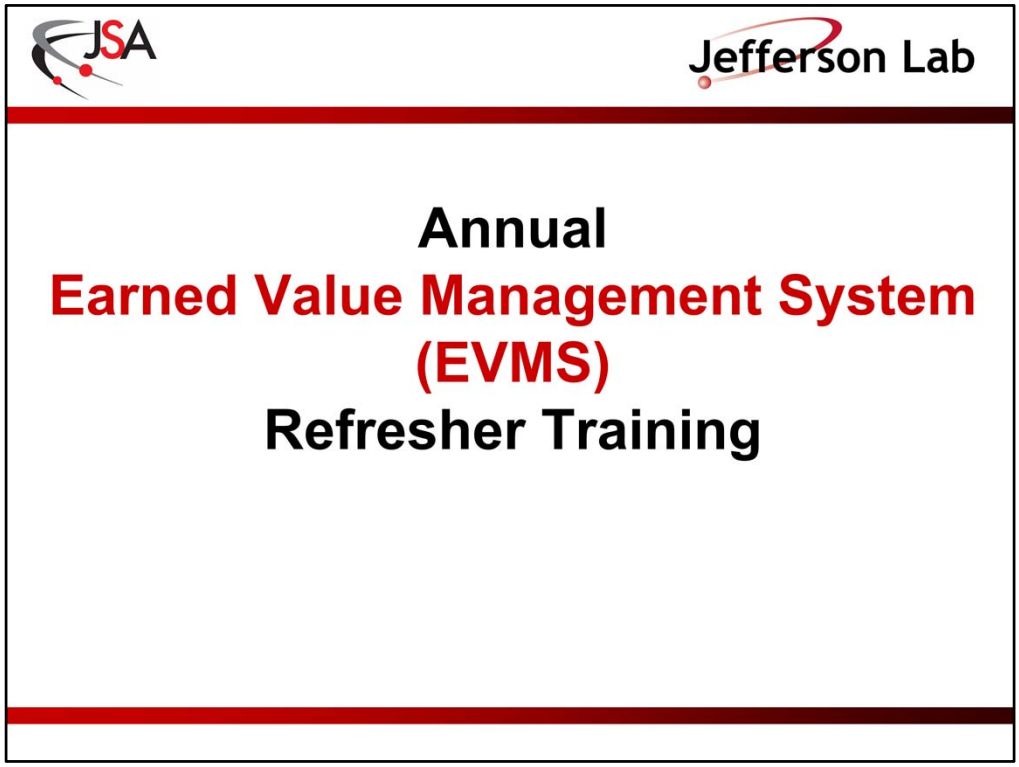
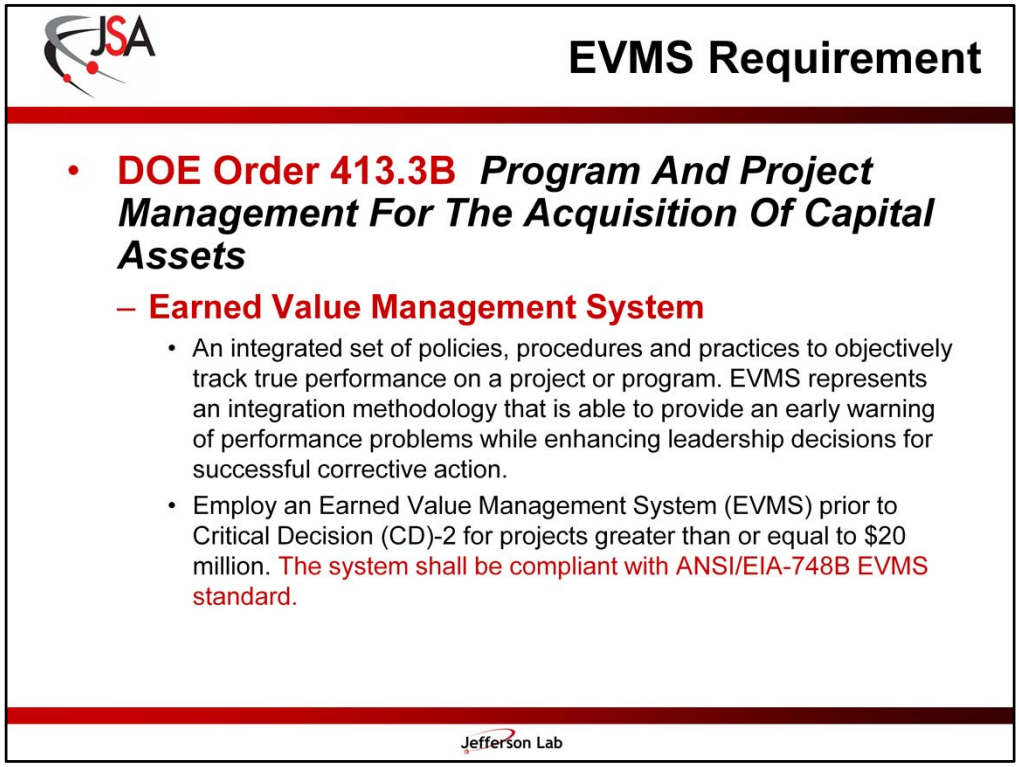


This presentation is an annual review of the Jefferson Science Associates' Earned Value Management System (EVMS) and provides refresher training to Project Managers, Associate Project Managers and Control Account Managers on the objectives, policies, procedures, processes and standards associated with Jefferson Lab's certified Earned Value Management System.

Earned Value Management is a systematic framework to measure project progress and performance in an objective manner.

Because Earned Value Management has the ability to combine measurements of scope, schedule, and cost into a single integrated system, this important project management methodology is able to provide accurate forecasts of project performance problems to the project management team and the project customer.

The EVMS process owner is the Jefferson Lab Project Management Office under the Chief Financial Officer organization.

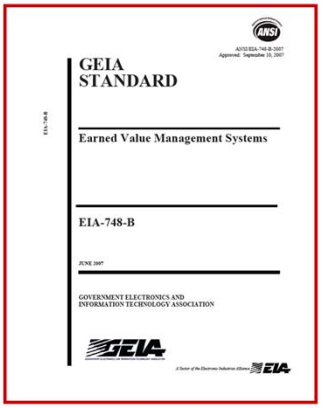


The requirement for an EVMS is prescribed in DOE Order 413.3B for projects with a Total Project Cost of $20 million or greater.

The JSA EVMS has been certified by the Department of Energy as being compliant with the ANSI standard for Earned Value Management Systems.

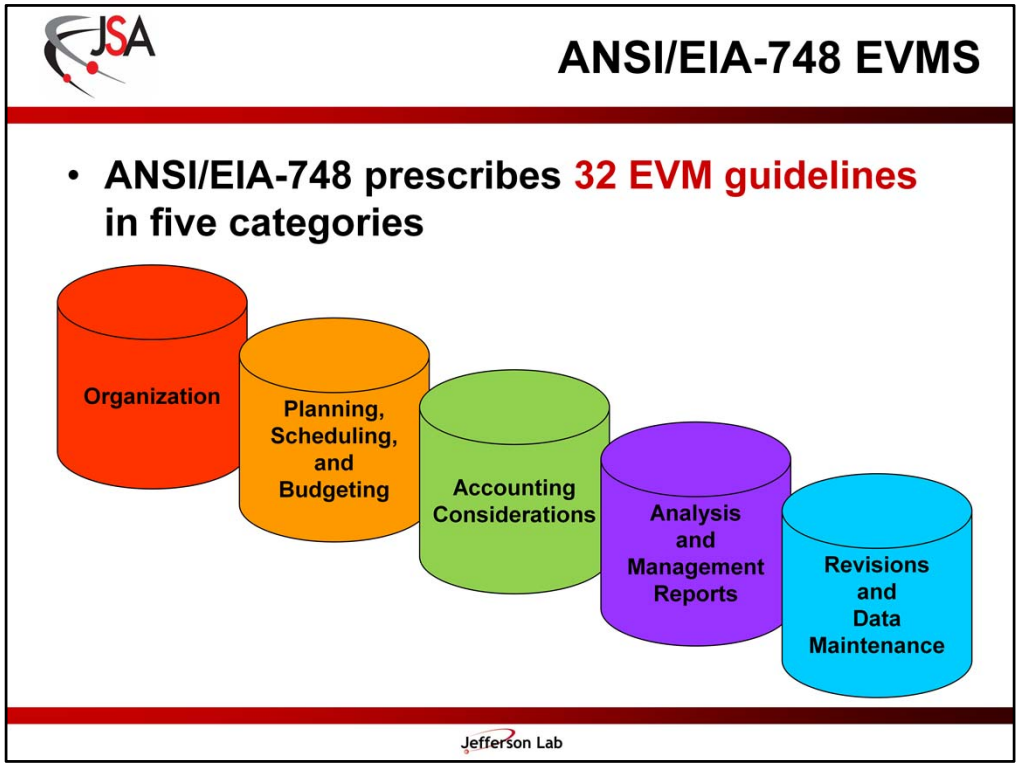
EVMS Reference Documents

- **ANSI/EIA-748 Earned Value Management Systems**
  - **JSA Project Control System Manual**



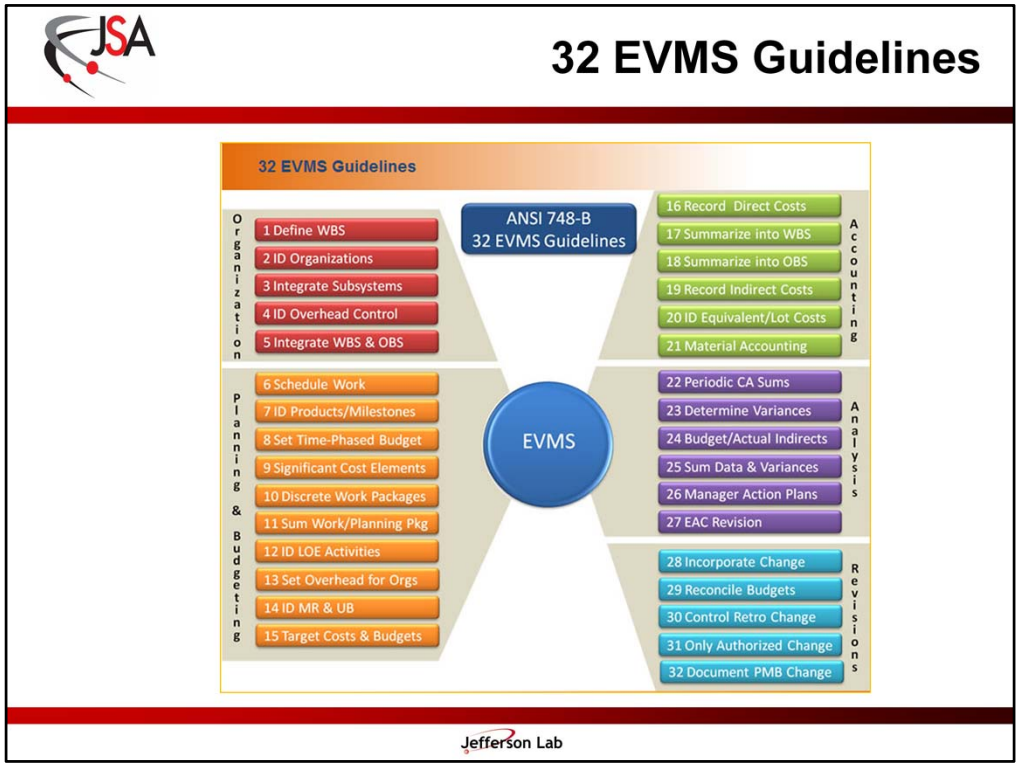
Jefferson Lab

The JSA Project Control System Manual is the EVMS system description for Jefferson Lab and follows the guideline and criteria established by the ANSI Standard for Earned Value Management Systems.

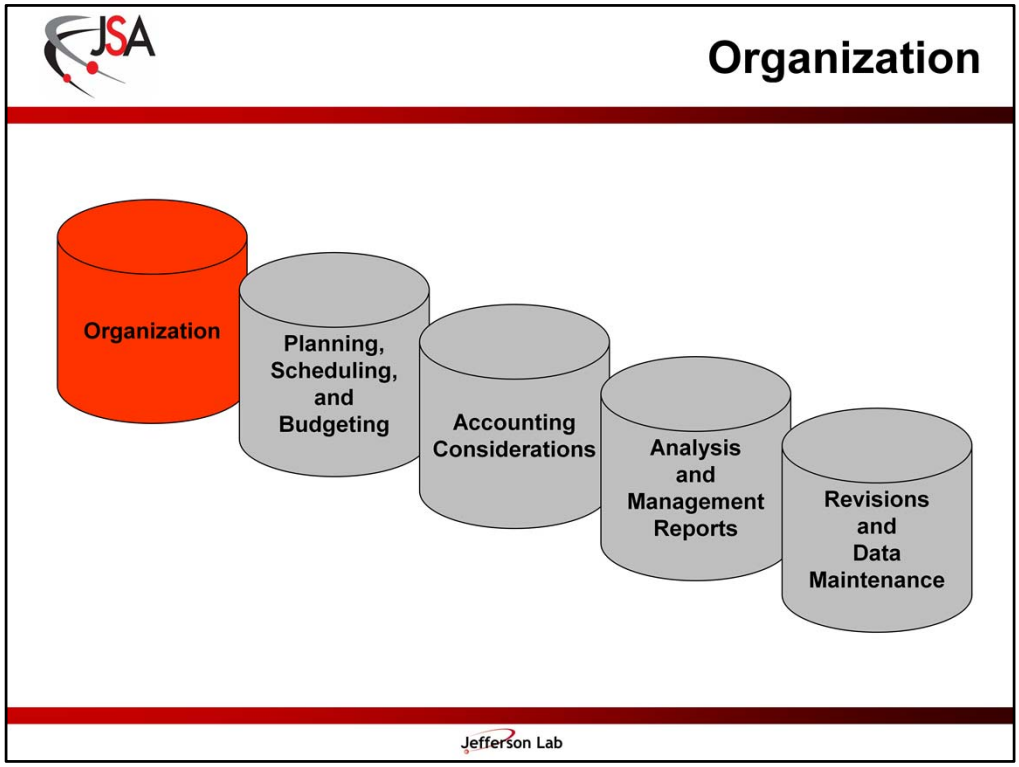


The ANSI EVMS standard prescribes 32 Earned Value Management guidelines within 5 categories:

- Organization
- Planning, Scheduling and Budgeting
- Accounting Considerations
- Analysis and Management Reports
- and Revisions and Data Maintenance.



Each Earned Value Management category within the ANSI EVMS standard has a series of guidelines that define the elements of that category. These 32 criteria are used to evaluate the completeness of an Earned Value Management System.



The first major element of an Earned Value Management System is Organization.

An organizational framework must be developed for the project prior to initiating the planning processes.

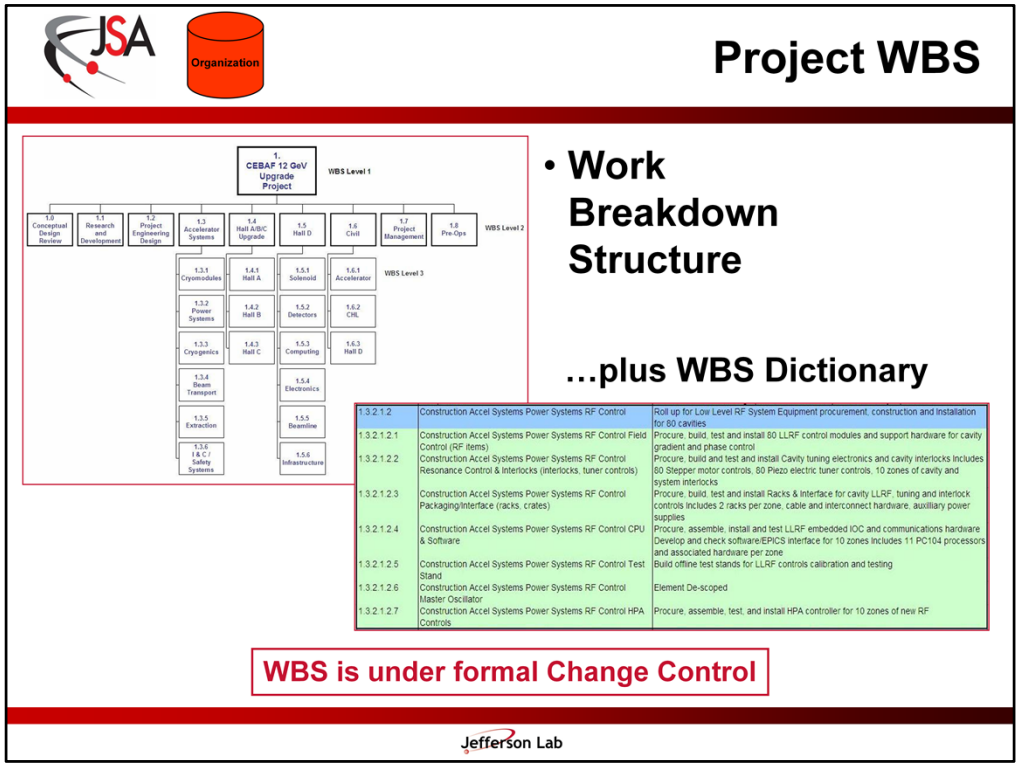
A well thought out project formation will lead to successful planning outcomes.

Jefferson Lab projects with an Earned Value Management System are organized with three key documents:

- the Work Breakdown Structure
- the Organizational Breakdown Structure

and

- the Responsibility Assignment Matrix.



The key framework for organizing a project is the Work Breakdown Structure with its associated WBS Dictionary.

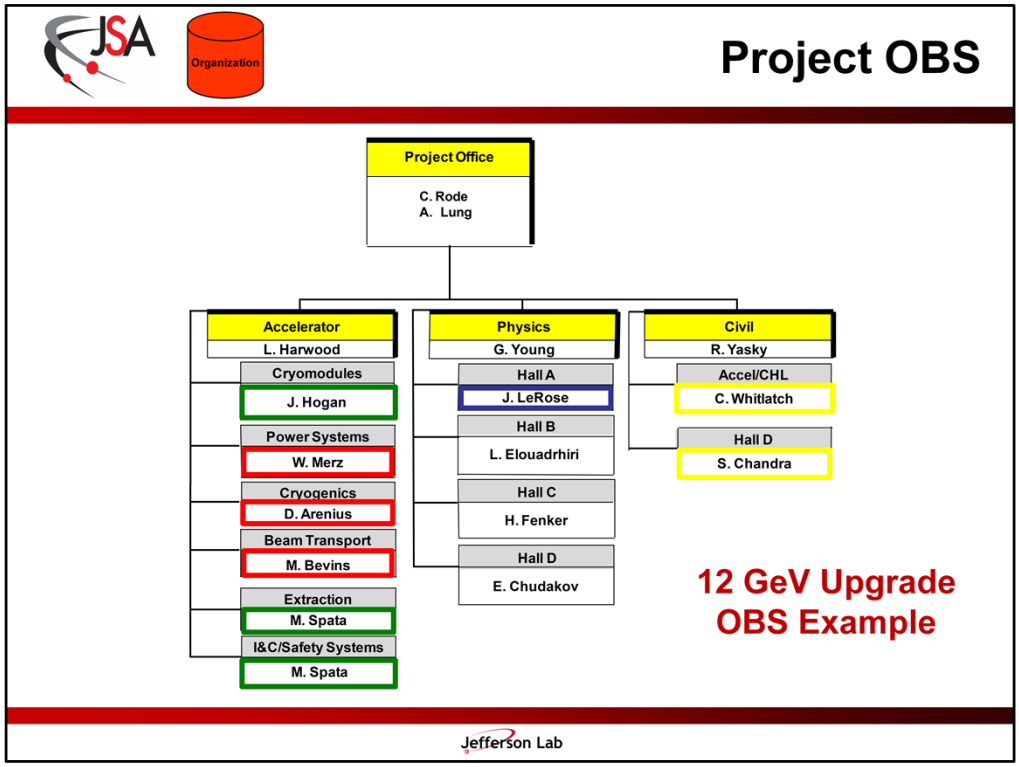
The WBS takes the form of a multi-level hierarchical framework depicting the overall project deliverable broken down into smaller system components.

Its purpose is to divide the project into manageable segments of work to facilitate planning, budgeting, estimating, work authorization, cost accumulation, and performance reporting.

A well designed WBS will incorporate all required project work and will not contain any work that falls outside the actual scope of the project.

A complete Work Breakdown Structure requires an associated dictionary to provide descriptive information for each WBS element. The WBS dictionary thoroughly describes the scope of each work element (including deliverables) identified in the WBS.

The WBS and the WBS dictionary are revised to reflect project changes via the Change Control process and are kept up to date during the life of the project.

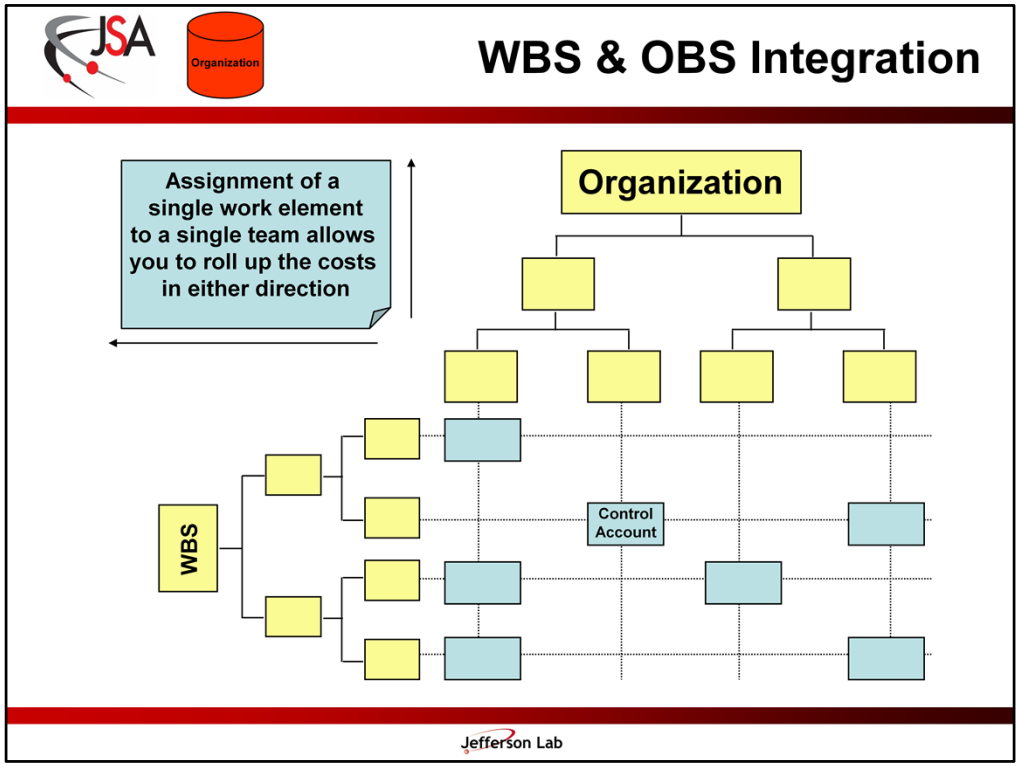


The project Organizational Breakdown Structure is a complementary arrangement to the Work Breakdown Structure.

The OBS defines the project authority and assigns work responsibilities.

Project leadership designs a hierarchical framework where unique work responsibilities can be established for each part of a project.

This framework establishes the formal authority relationships that exist among the various organizational team elements.

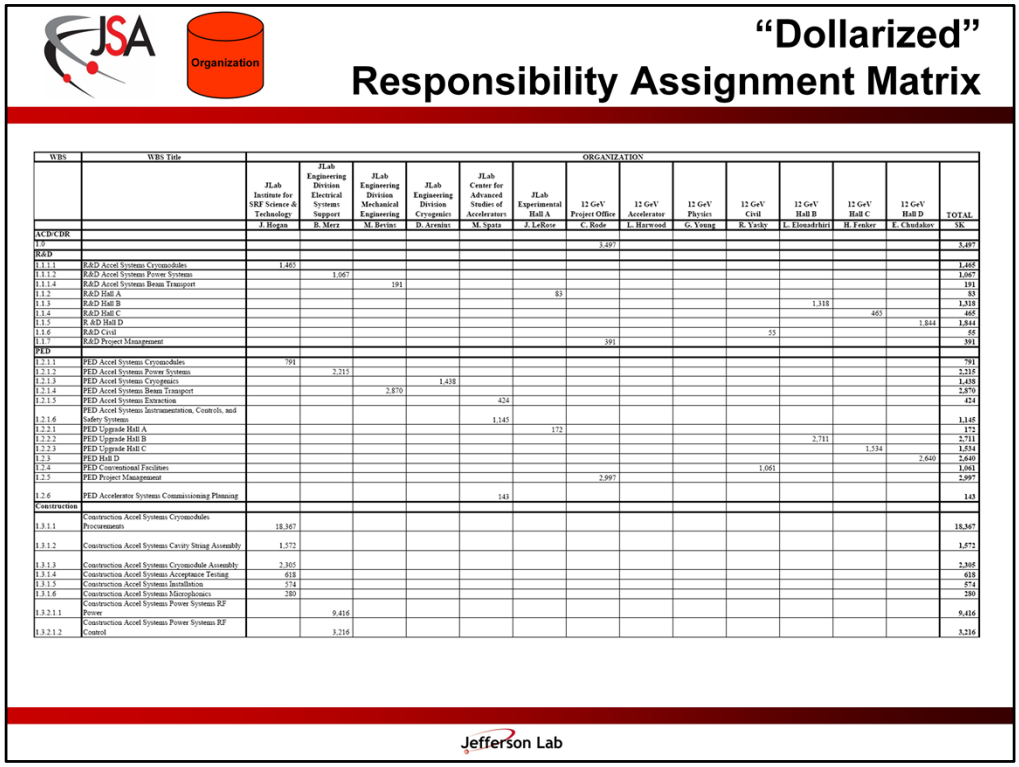


Integrating Jefferson Lab organizations with the Work Breakdown Structure ensures that all project work is accounted for and that each element of work is assigned to the level of responsibility necessary for planning, execution, tracking progress, accumulating costs, and reporting.

At selected levels of the WBS, the Project Manager establishes the project control accounts.

A control account is comprised of a WBS work element and a Control Account Manager assigned from a Jefferson Lab organization with the responsibility and authority to accomplish this work.

Control accounts represent a management control point where work performance can be measured via Earned Value methods.



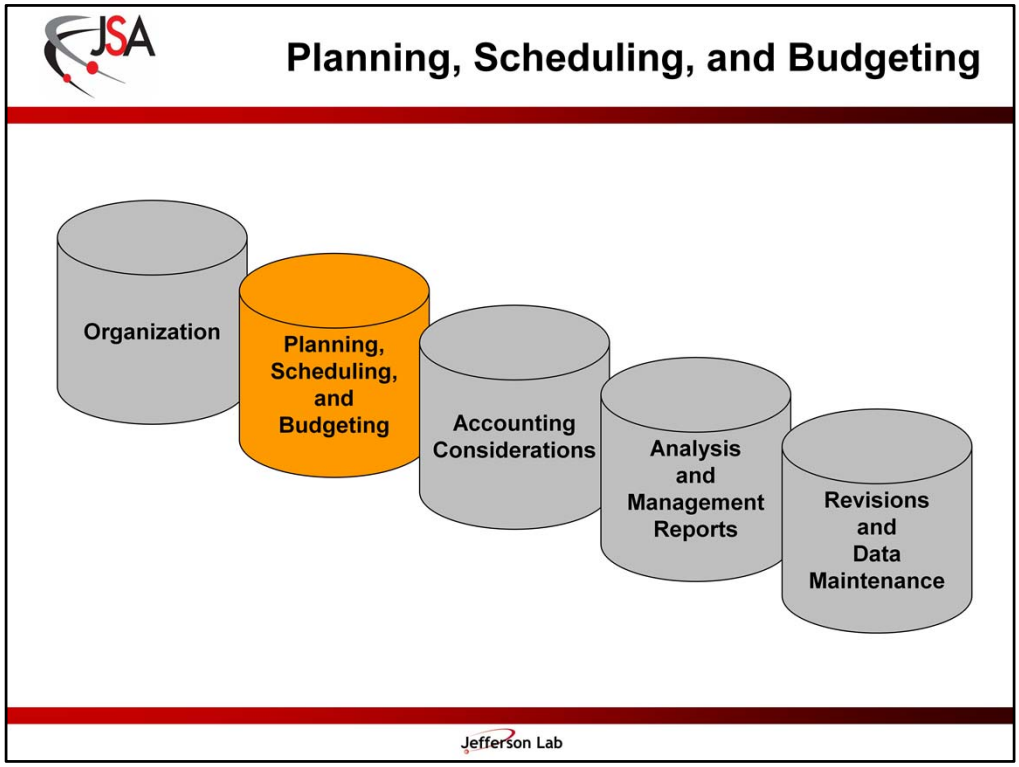
WBS	WBS Title	ORGANIZATION													
		JLab Institute for SRF Science & Technology	JLab Engineering Division Electrical Systems Support	JLab Engineering Division Mechanical Engineering	JLab Engineering Division Cryogenics	JLab Center for Advanced Studies of Accelerators	JLab Experimental Hall A	12 GeV Project Office	12 GeV Accelerator	12 GeV Physics	12 GeV Civil	12 GeV Hall B	12 GeV Hall C	12 GeV Hall D	TOTAL
		J. Hogan	B. Merz	M. Bevins	D. Arenius	M. Spata	J. LeRose	C. Rode	L. Harwood	G. Young	R. Yasky	L. Elouadrhiri	H. Fenker	E. Chudakov	$K
ACD/CDR															
1.0								3,497							3,497
R&D															
1.1.1	R&D Accel Systems Cryomodules	1,465													1,465
1.1.1.2	R&D Accel Systems Power Systems		1,067												1,067
1.1.1.4	R&D Accel Systems Beam Transport			191											191
1.1.2	R&D Hall A						83								83
1.1.3	R&D Hall B											1,318			1,318
1.1.4	R&D Hall C												465		465
1.1.5	R &D Hall D													1,844	1,844
1.1.6	R&D Civil										55				55
1.1.7	R&D Project Management							391							391
PED															
1.2.1.1	PED Accel Systems Cryomodules	791													791
1.2.1.2	PED Accel Systems Power Systems		2,215												2,215
1.2.1.3	PED Accel Systems Cryogenics				1,438										1,438
1.2.1.4	PED Accel Systems Beam Transport			2,870											2,870
1.2.1.5	PED Accel Systems Extraction					424									424
1.2.1.6	PED Accel Systems Instrumentation, Controls, and Safety Systems					1,145									1,145
1.2.2.1	PED Upgrade Hall A						172								172
1.2.2.2	PED Upgrade Hall B											2,711			2,711
1.2.2.3	PED Upgrade Hall C												1,534		1,534
1.2.3	PED Hall D													2,640	2,640
1.2.4	PED Conventional Facilities										1,061				1,061
1.2.5	PED Project Management							2,997							2,997
1.2.6	PED Accelerator Systems Commissioning Planning					143									143
Construction															
1.3.1.1	Construction Accel Systems Cryomodules Procurements	18,367													18,367
1.3.1.2	Construction Accel Systems Cavity String Assembly	1,572													1,572
1.3.1.3	Construction Accel Systems Cryomodule Assembly	2,305													2,305
1.3.1.4	Construction Accel Systems Acceptance Testing	618													618
1.3.1.5	Construction Accel Systems Installation	574													574
1.3.1.6	Construction Accel Systems Microphonics	280													280
1.3.2.1.1	Construction Accel Systems Power Systems RF Power		9,416												9,416
1.3.2.1.2	Construction Accel Systems Power Systems RF Control		3,216												3,216

The Responsibility Assignment Matrix is developed to correlate the relationship between the project work scope and an appointed authority responsible for accomplishing this work.

The matrix is created such that the intersection of a WBS element and an OBS element identifies the control account.

The RAM is "dollarized" by annotating the control account cell with the amount of project budget allocated to the control account.

The RAM is updated when baseline changes are made to the control account.



The next phase of an Earned Value Management System is Planning, Scheduling and Budgeting.

The main goal of the project planning effort is an integrated project schedule and budget.

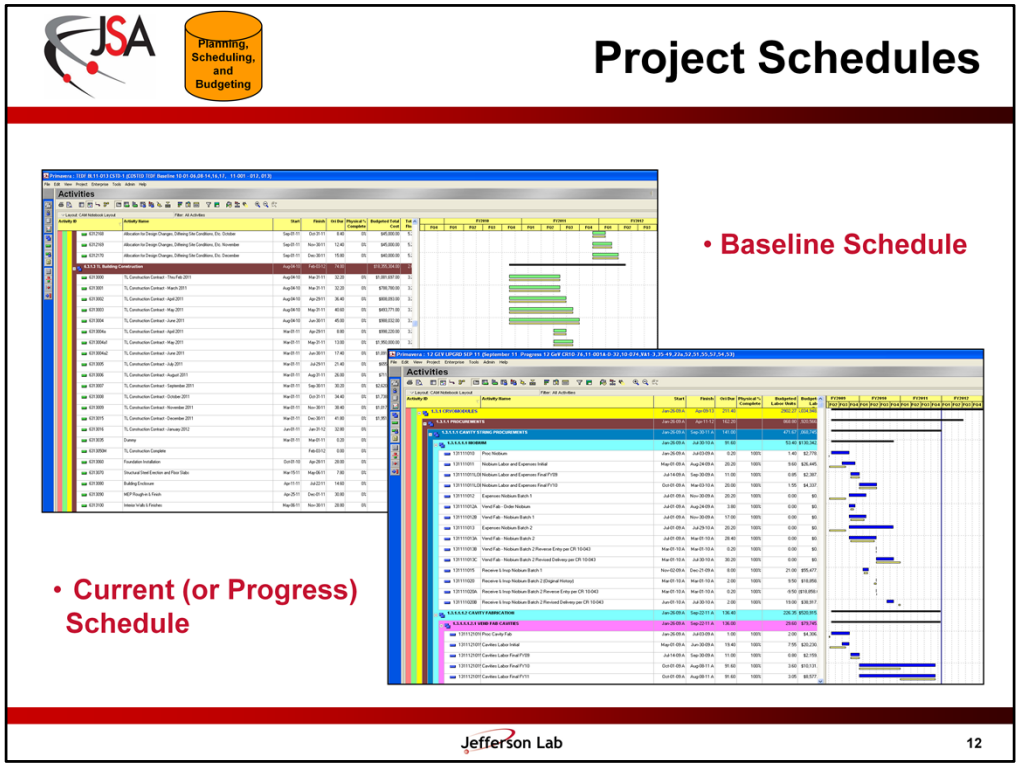
Proper project planning ensures the amount of work to be accomplished, the time allotted to accomplish the project activities, and the resources required to complete the work scope are properly balanced.

The resultant 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.

There are three key documents for the planning, scheduling and budgeting phase of a project:

- the Primavera P6 schedule
- the Control Account Plan
- and the Work Authorization Document

These documents describe the schedule and budget of the project plan and define the responsibility for accomplishing specific project work scope.



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 Primavera P6 scheduling 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.

A baseline schedule and a current “progress” schedule are maintained for each project.

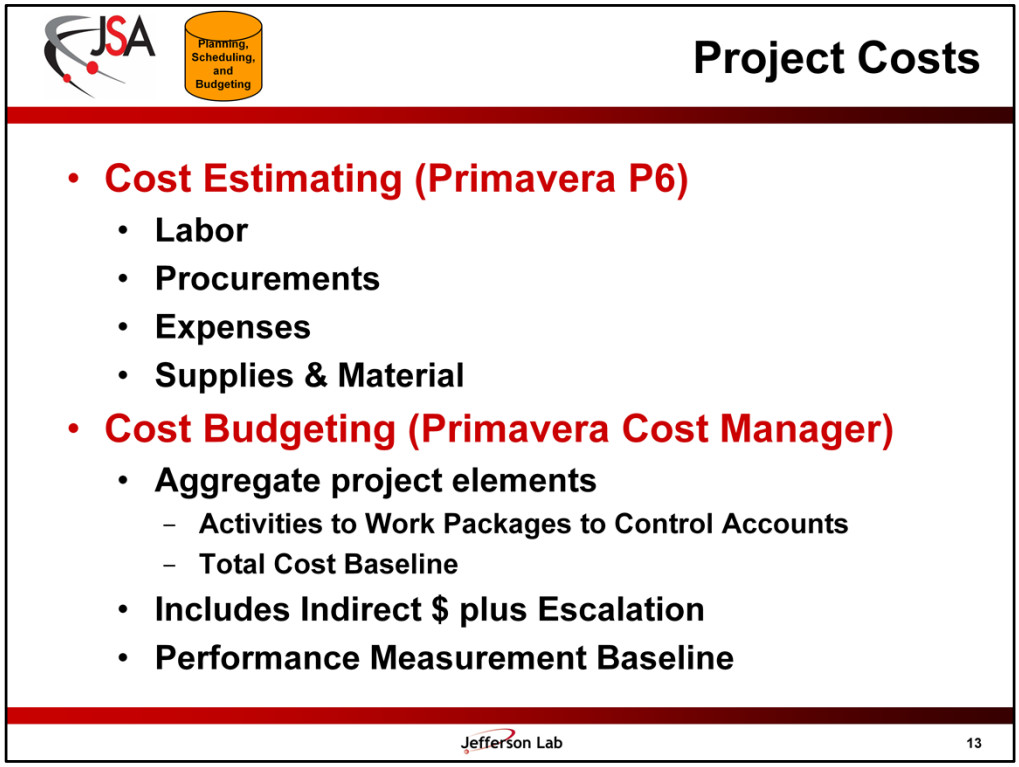
The baseline schedule constitutes the performance standard against which actual progress is compared.

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.

The current schedule is kept up to date with actual start/finish dates and measured percent complete on each activity.

Schedule progress is nominally measured once a month.

By evaluating the current schedule against the baseline schedule, the project team can assess how the project is progressing compared to the baseline plan.



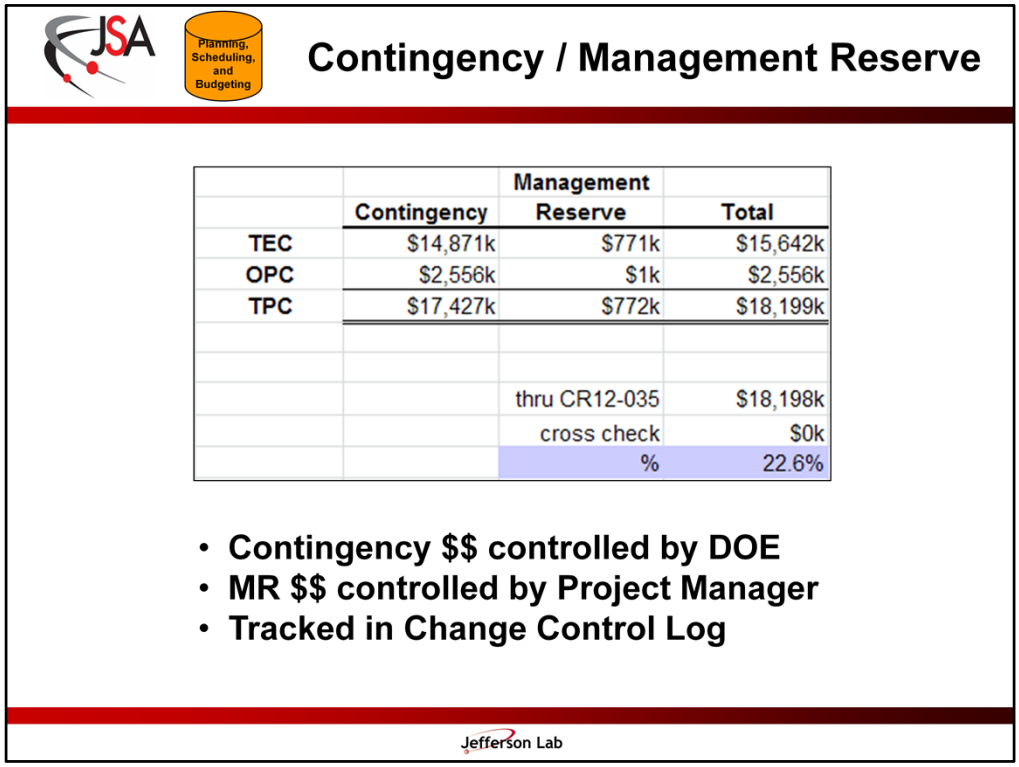
Cost planning begins with the development of a cost estimate for all authorized work that eventually leads to the establishment of the project budget.

The budgeting process establishes a means for developing and tracking the cost goals for all contractually authorized work.

Resources, such as Labor, Procurement, and Expenses, are added to appropriate activities in the Primavera P6 scheduling system.

Resource data from Primavera P6 are accessed by the Primavera Cost Manager program where the resource direct dollars are properly burdened and escalated.

Once the cost estimates are endorsed by the project management team, the aggregate control accounts then become the Performance Measurement Baseline.



During development of the project cost plan, reserve 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.

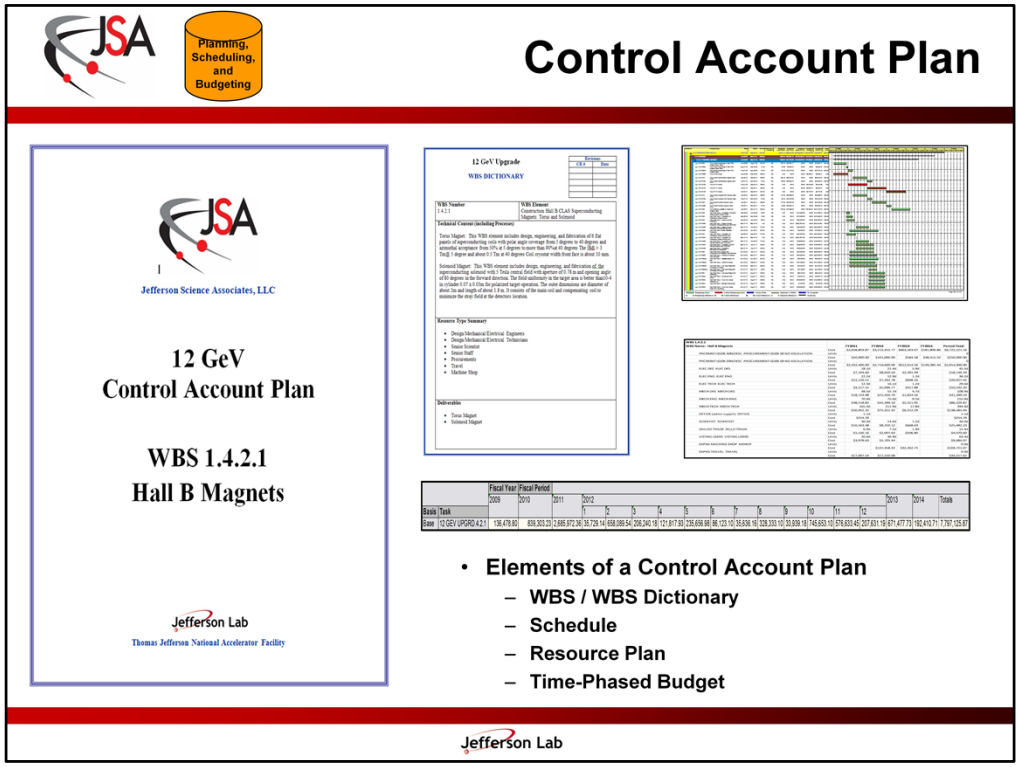
Contingency is normally developed "bottoms-up" from a risk assessment of individual work elements within the project WBS.

Funds held in the contingency account are nominally controlled by the project customer.

A portion of the reserve funds, designated management reserve, may be allocated to the project manager for his approval authority.

The release of contingency and management reserve funds is managed through the change control process.

Transactions for these accounts are documented in the project baseline change control log.

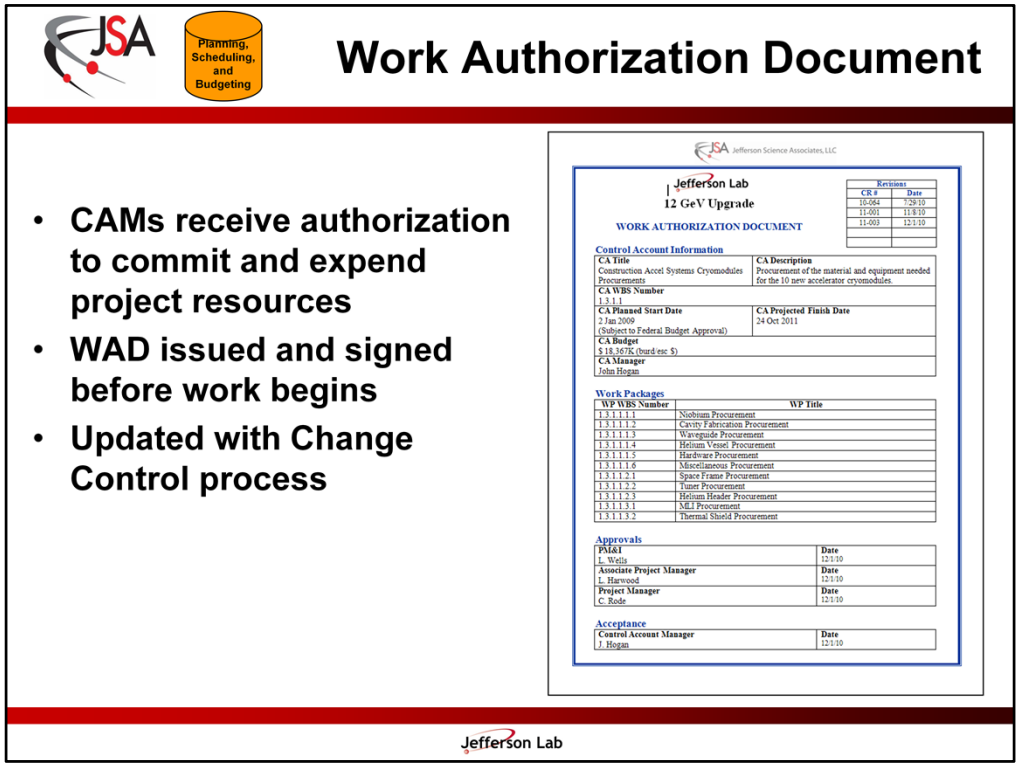


The Control Account Plan represents the Control Account Manager's strategy for accomplishing the project work within the control account.

The CAP summarizes the extensive planning conducted to produce the baseline schedule and budget for the control account.

Along with the work scope defined in the WBS dictionary, the CAP also includes a detailed schedule, a resource plan, and a time-phased budget.

The Control Account Plan is updated after a relevant Change Request has been approved.



A work authorization system is required during the project execution phase to control the flow of work to be accomplished within the authorized project budget.

This formal procedure is used to sanction project work with limits being imposed on managers in their authority to commit and expend resources that will be charged to the project.

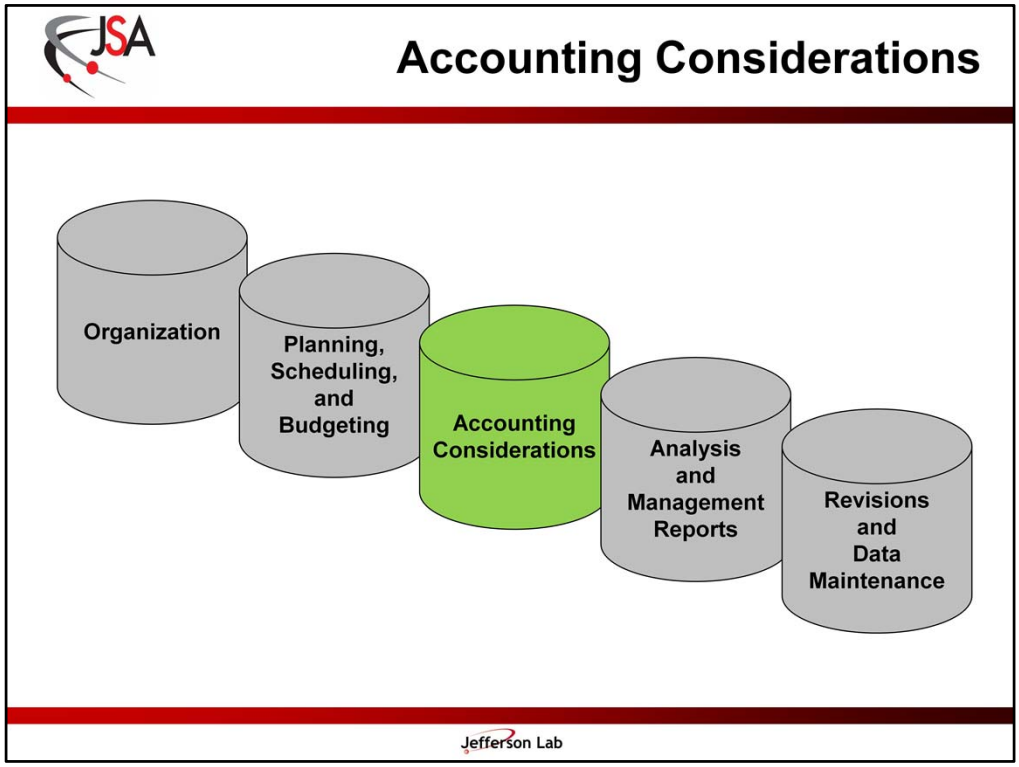
These limitations provide assurance to the Project Manager that no work is authorized unless it has been properly planned and budgeted.

Work authorization is the specific mechanism where Control Account Managers receive the authority to begin the work defined in their validated Control Account Plans.

The WAD contains the control account information, a list of associated work packages, approval signatures, and acceptance signature of the Control Account Manager.

The signed WAD empowers the Control Account Manager to implement the Control Account Plan.

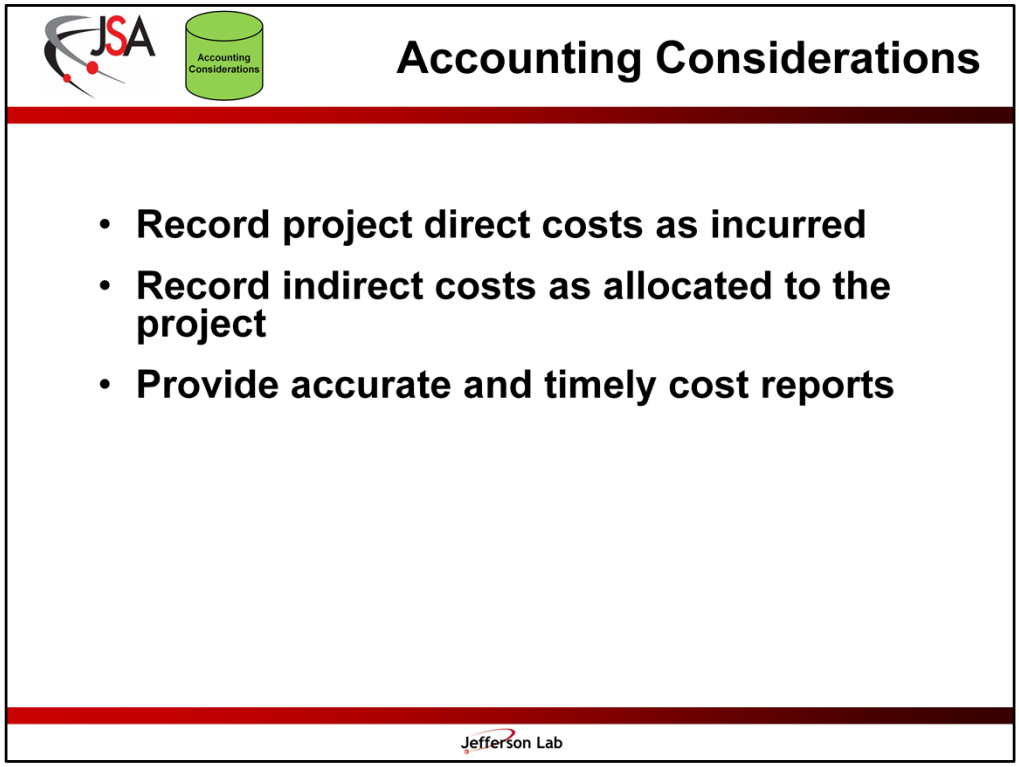
The approved control account can only be changed with appropriate change approval. WADs shall be updated to reflect each approved change request.



The third element of an Earned Value Management System is Accounting Considerations.

The purpose of an accounting system is to collect the actual costs incurred by a project, which when compared with Earned Value data, can provide project management with the status of a project's budget.

Accurate cost accounting is essential to gaining a true understanding of how a project is performing with regards to the Performance Measurement Baseline.

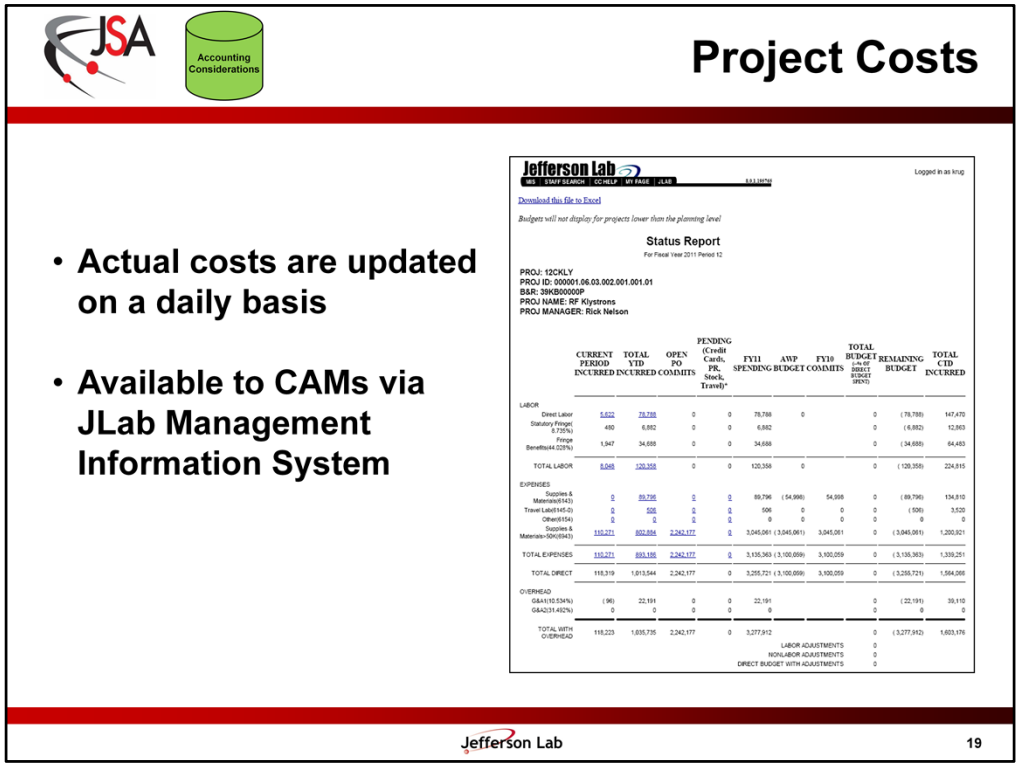


The key objective of an accounting system is to record project direct costs within the appropriate WBS element and charge code.

This allows the direct costs to be summarized at the proper control account level.

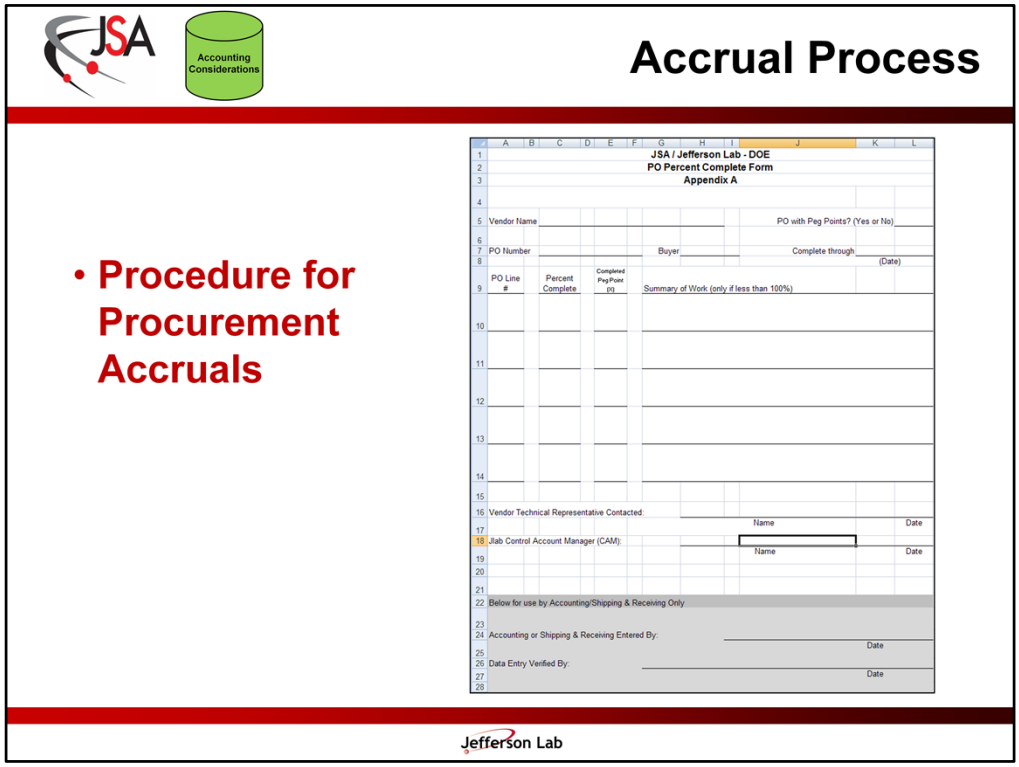
The accounting system must also allocate any project indirect costs to the appropriate WBS element.

To aid the project team in managing the project, cost reports must be generated in an accurate and timely manner.



Actual costs for the various JLab functions and projects are updated each day.

Cost data can be accessed using the Status Report in the JLab Management Information System.



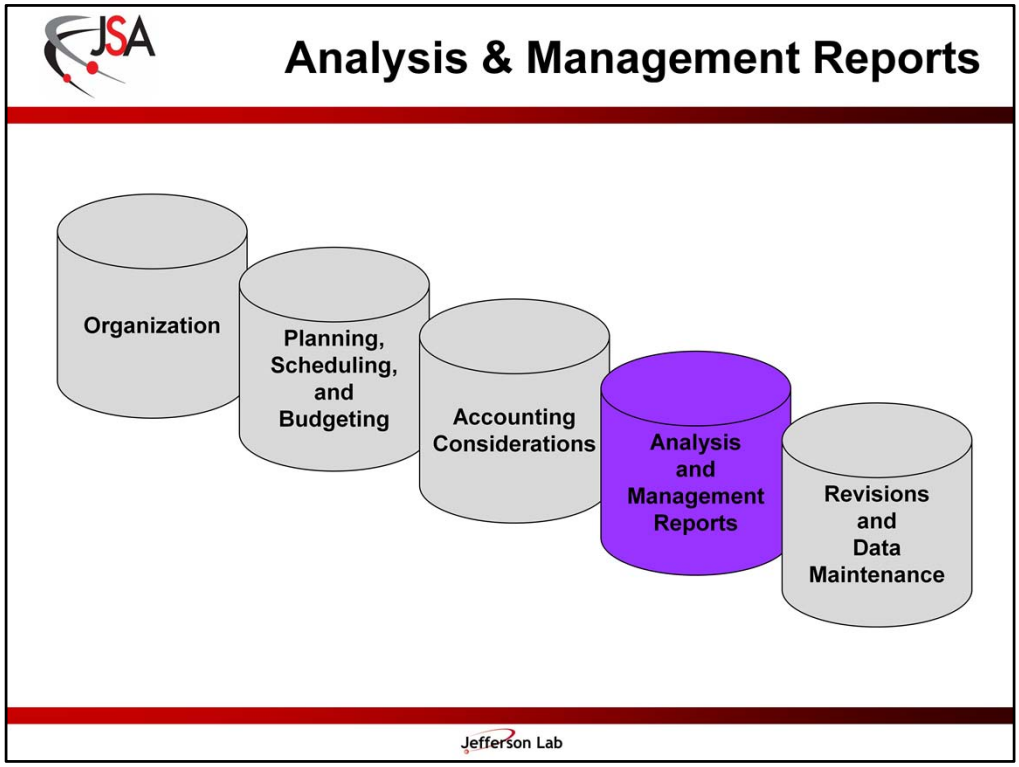
For some procurement contracts, the vendor may not submit his invoice in a timely manner.

In order to keep Earned Value and Actual Costs in sync to give an accurate portrayal of any cost variance, the accrual process is used to account for work that has been accomplished but actual payment has not occurred.

There is a procedure for procurement Accruals that CAMs can use to insert accrued costs into the accounting system.

In order for accruals to be entered into the JLab financial system, they must be accomplished not later than the end of the progress month.

Once the vendor's bill has been paid, the accrual cost is replaced with the true actual cost.

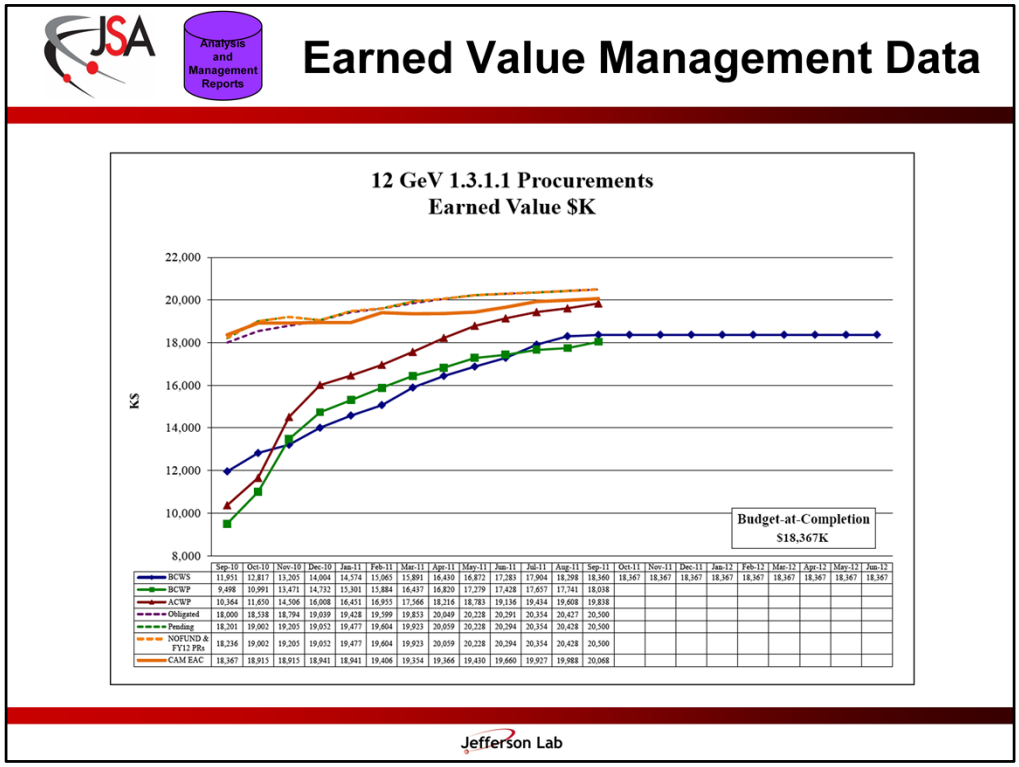


The fourth EVMS category is concerned with generating accurate project performance data and conducting proper analysis of this data to forecast schedule and costs problems.

Management reports and charts are developed that will aid project personnel in deciding the proper path forward.

The objectives of project performance analysis and reports are:

- to provide schedule, cost, and scope reports to the project management team, usually on a monthly basis;
- and to analyze the actual project performance against the established project baseline.



	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
BCWS	11,951	12,817	13,205	14,004	14,574	15,065	15,891	16,430	16,872	17,283	17,904	18,298	18,360	18,367	18,367	18,367	18,367	18,367	18,367	18,367	18,367	18,367
BCWP	9,498	10,991	13,471	14,732	15,301	15,884	16,437	16,820	17,279	17,428	17,657	17,741	18,038									
ACWP	10,364	11,650	14,506	16,008	16,451	16,955	17,566	18,216	18,783	19,136	19,434	19,608	19,838									
Obligated	18,000	18,538	18,794	19,039	19,428	19,599	19,853	20,049	20,228	20,291	20,354	20,427	20,500									
Pending	18,201	19,002	19,205	19,052	19,477	19,604	19,923	20,059	20,228	20,294	20,354	20,428	20,500									
NOFUND & FY12 PRs	18,236	19,002	19,205	19,052	19,477	19,604	19,923	20,059	20,228	20,294	20,354	20,428	20,500									
CAM EAC	18,367	18,915	18,915	18,941	18,941	19,406	19,354	19,366	19,430	19,660	19,927	19,988	20,068									

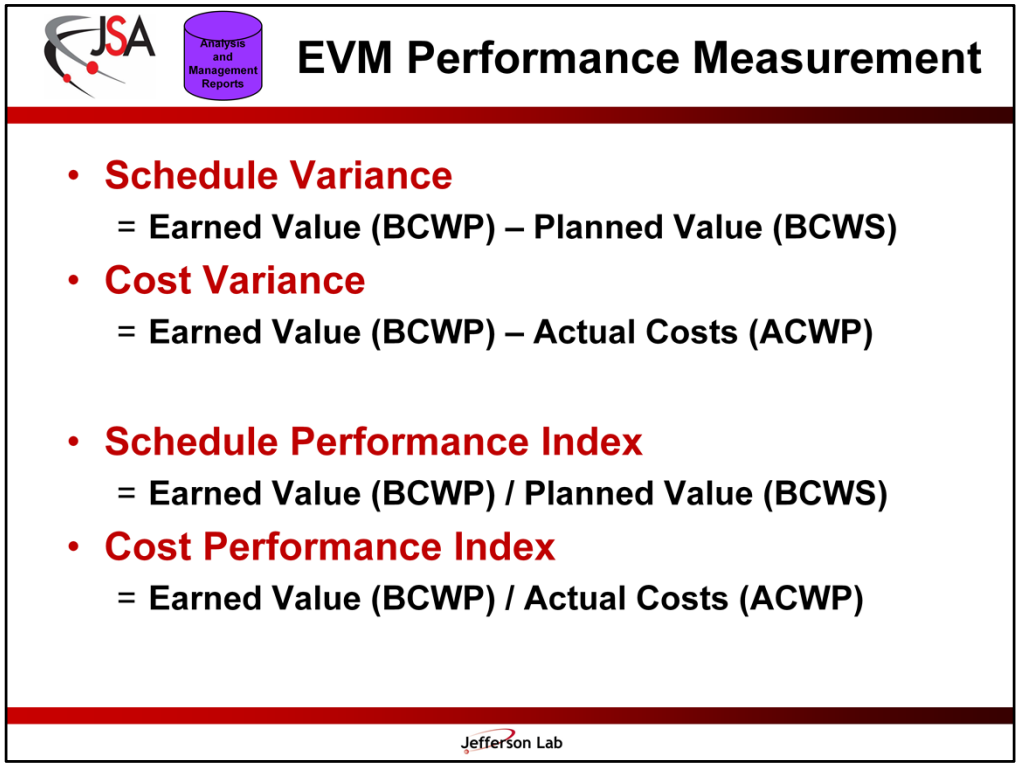
There are three elementary project data that form the basis of Earned Value Management:

- Budgeted Cost of Work Scheduled (or Planned Value)
- Budgeted Cost of Work Performed (or Earned Value)

and

- Actual Cost of Work Performed (or Actual Costs)

These project data are tracked on a monthly basis as well as a cumulative basis.



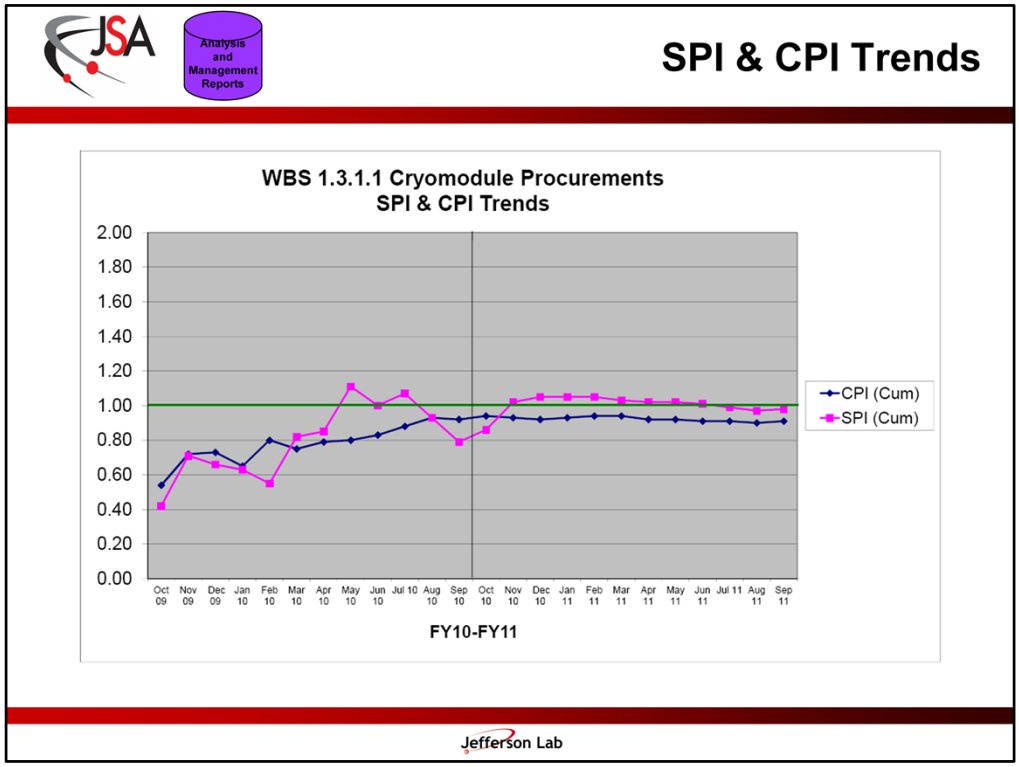
The three project data are used to express the main performance measurement elements.

Schedule Variance is calculated by subtracting Planned Value from Earned Value while the Schedule Performance Index is Earned Value divided by Planned Value.

The cost numbers are calculated in a comparable manner.

The performance measurement elements are calculated for each control account and at other designated WBS levels.

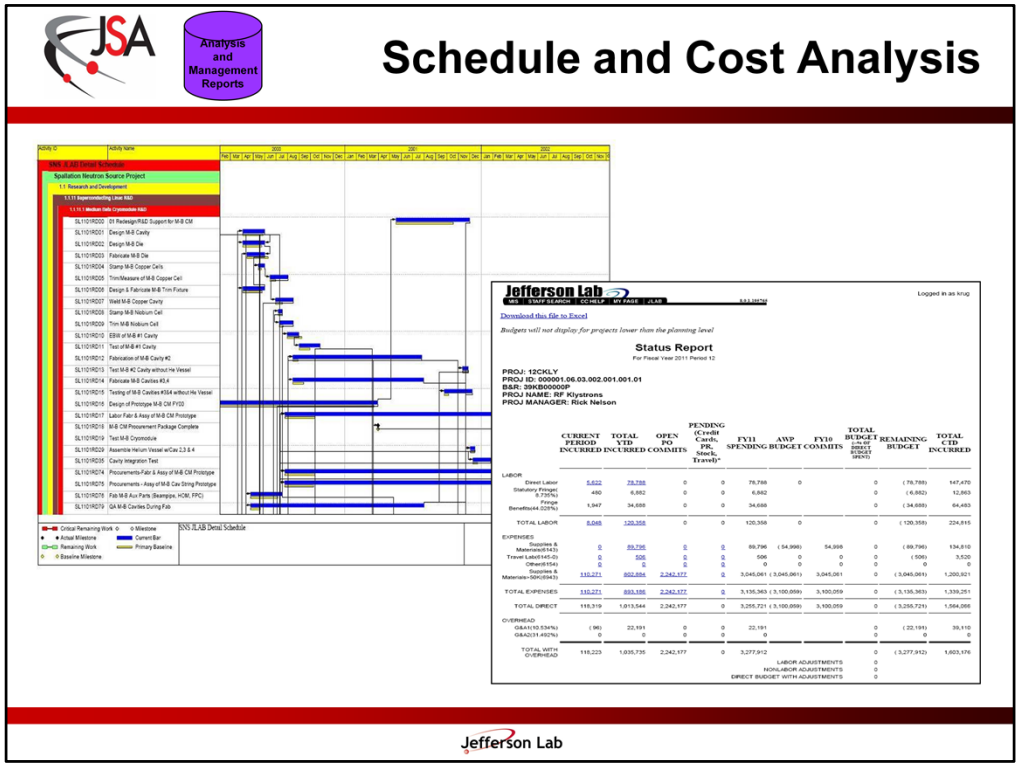
They provide the Control Account Managers with an indication of how their control accounts are performing as measured against the established Performance Measurement Baseline.



One of the useful tools is the Schedule and Cost performance index trend tracking charts.

These trends readily tell the Control Account Manager if the control account performance is trending toward the baseline plan or not.

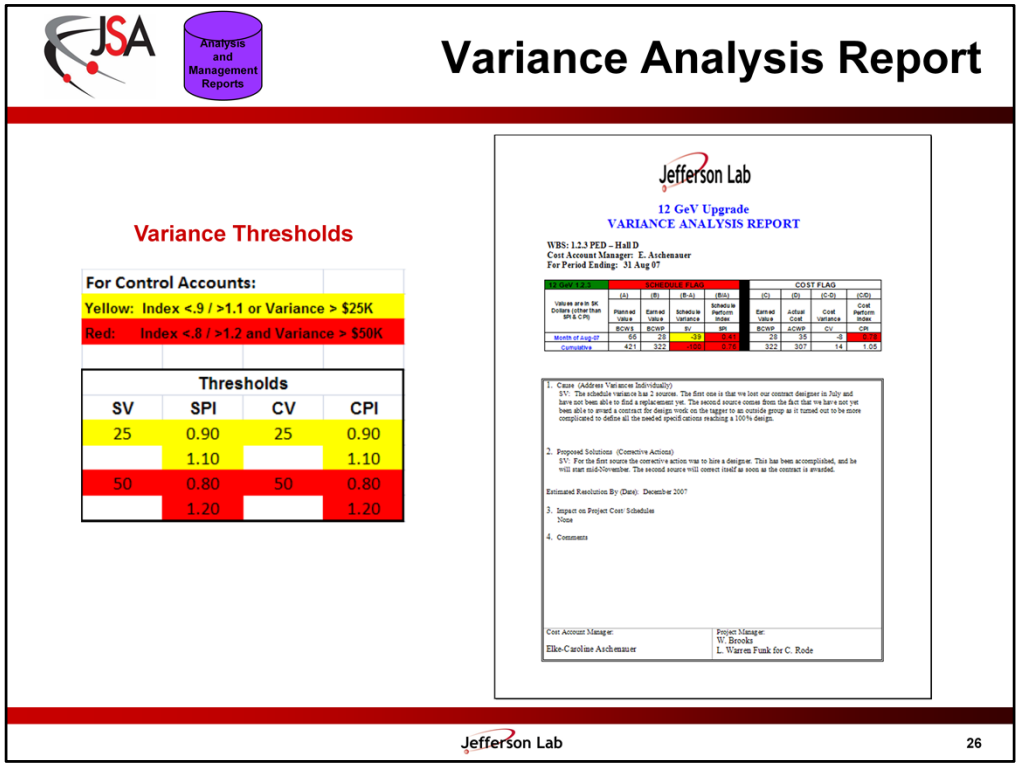
It also tells the CAM if any corrective action taken is getting the control account back on track.



The variances and performance indices for schedule and cost only indicate the general status of a control account.

To find a root cause of a problem, a more thorough examination of the project schedule and cost reports must be undertaken to pinpoint the root cause of the variance.

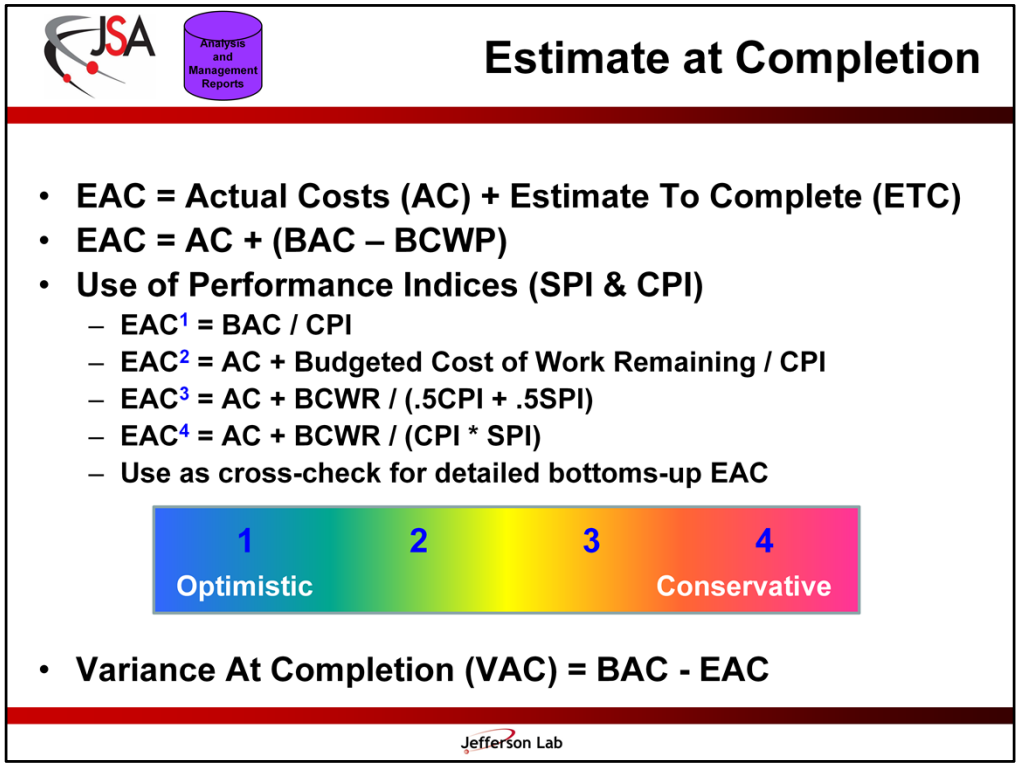
Once a root cause is identified, the CAM can develop corrective action plans to remedy any schedule or cost performance issues.



Each project defines the schedule and cost performance thresholds for when a Variance Analysis Report is due.

If a control account has breached the Red Flag variance and performance index thresholds, then the Control Account Manager is required to complete the VAR form.

It is essential that the correct cause of the variance is identified such that any initiated corrective action will be successful in progressing the control account toward planned baseline performance.



One of the important numbers to a Project Manager is the Estimate At Completion, or EAC.

The EAC is the actual cost to-date plus an objective estimate of costs for the remaining authorized work on the project.

There are several methods of developing an Estimate To Complete, or ETC.

The project Control Account Managers can formulate an ETC for their control accounts by conducting a bottoms-up cost assessment of their remaining project work.

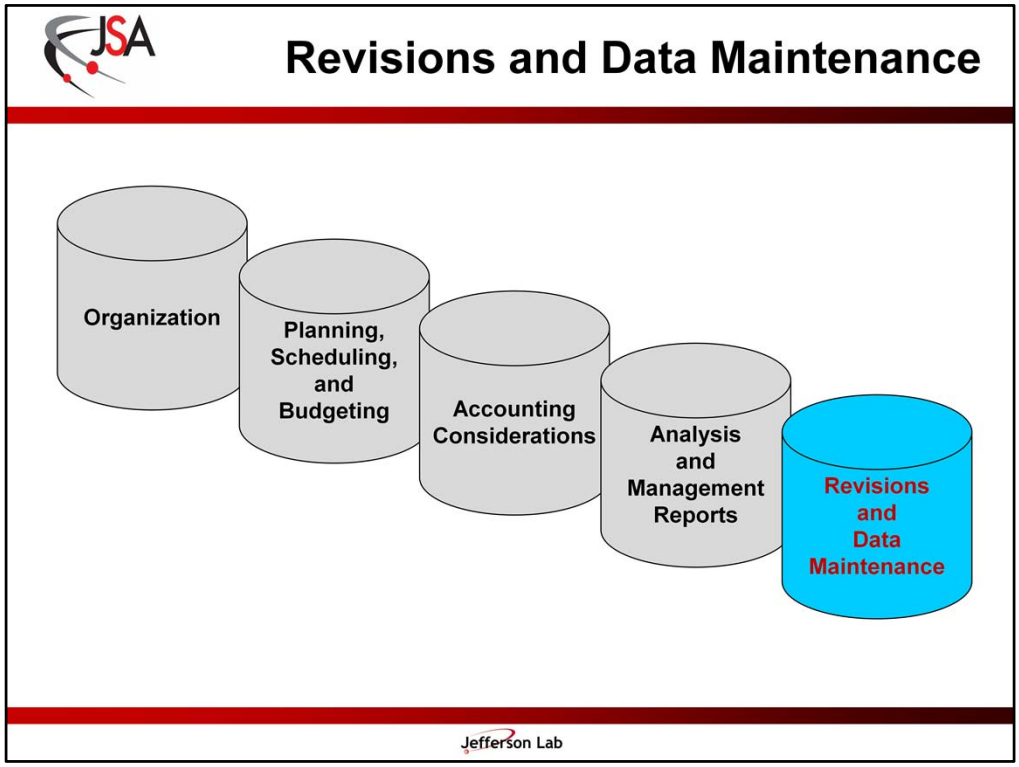
All control account estimates are summed to produce a project EAC.

An ETC can also be calculated by subtracting the to-date cumulative value of Budgeted Cost of Worked Performed from the project's Budget At Completion.

Additionally, there are methods for calculating an EAC that involve using project EVM performance data.

The calculated EAC can then be used to cross-check against the EAC derived from the CAMs' assessment.

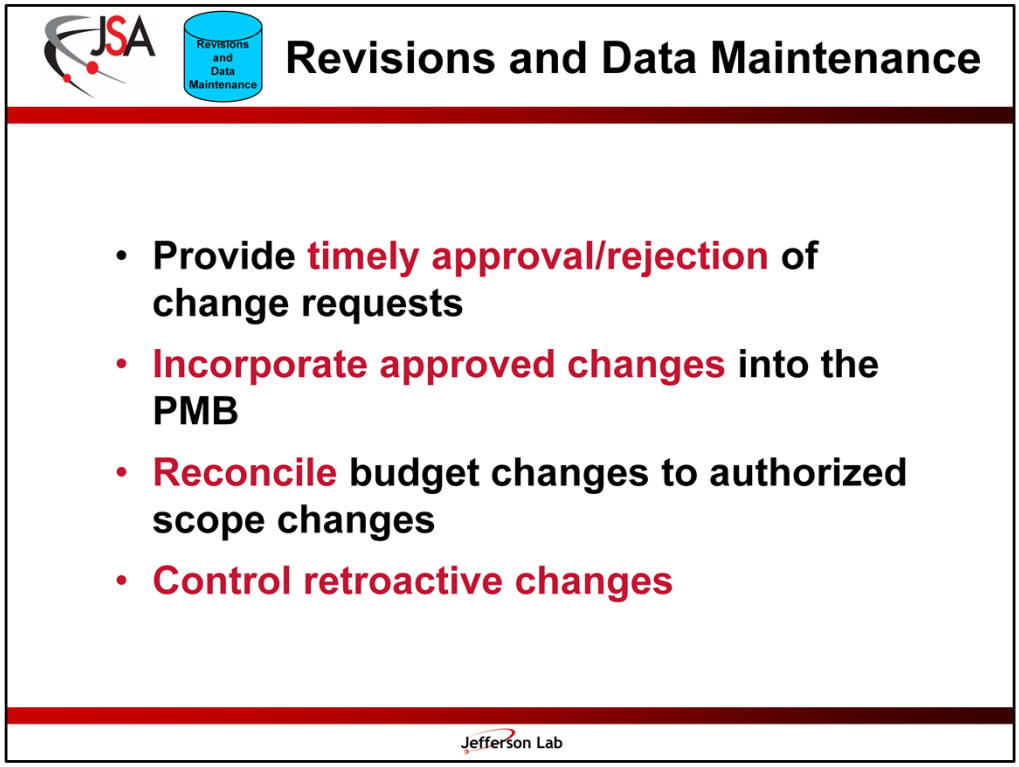
With an EAC in hand, the projected Variance at Completion can be established by subtracting the Estimate At Completion from the Budget At Completion.



The final EVMS category is Revisions and Data Maintenance.

Sometimes the best project plans need to be revised to keep them current and relevant.

This portion of the presentation represents the process of making changes to the Performance Measurement Baseline and maintaining the integrity of the project EVMS data.

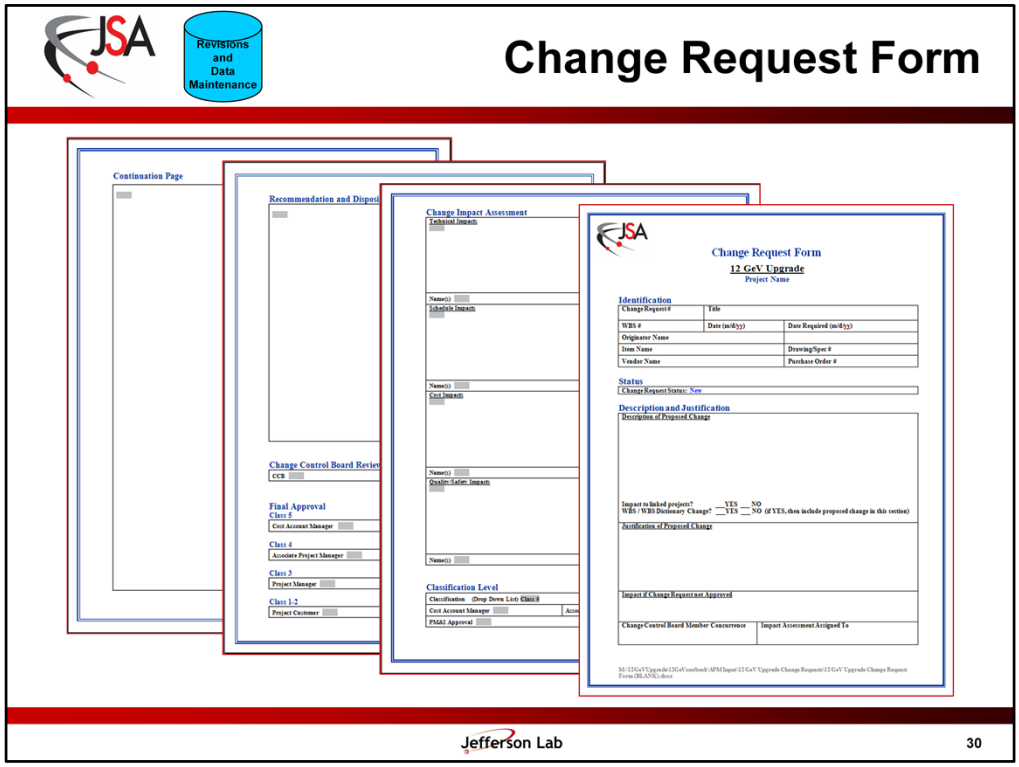


The Change Control Process is used to establish, analyze, communicate, and record approved changes to the project baseline.

Baseline changes may occur as a result of contractual modifications, application of undistributed budget, use of contingency/management reserve funds, replanning, or formal reprogramming.

The key objectives of the Change Control process are:

- Provide approval (or rejection) of all change requests in a timely manner
- Incorporate all approved changes into the Performance Measurement Baseline
- Reconcile current budgets to prior budgets in terms of changes to authorized work scope
- And Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets.



The Change Request form is used to document the proposed baseline change.

The originator of the Change Request describes the proposed change and provides a justification for its approval.

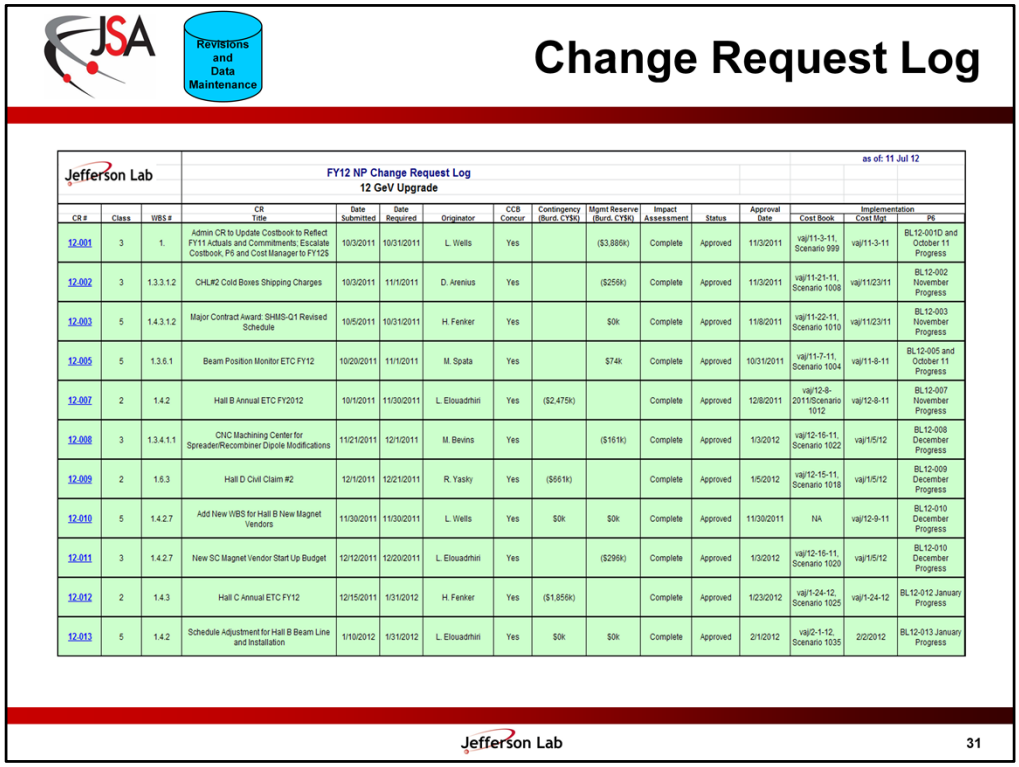
Once a member of the project Change Control Board has concurred with the proposal, assessments are conducted on technical, schedule, cost and quality and safety impacts of the proposed change.

The first step in the Change Request process is to develop a What-If schedule with the proposed revisions to activity dates, links, and resources in the Primavera P6 scheduling system.

This will generate a new Budgeted Cost of Work Scheduled (or Planned Value) curve for the control accounts affected by the change.

Budget changes to control accounts in the P6 scheduling system are incorporated using direct dollars.

Burden and escalation factors will be added to the affected control accounts via the Cost Manager EVM system.



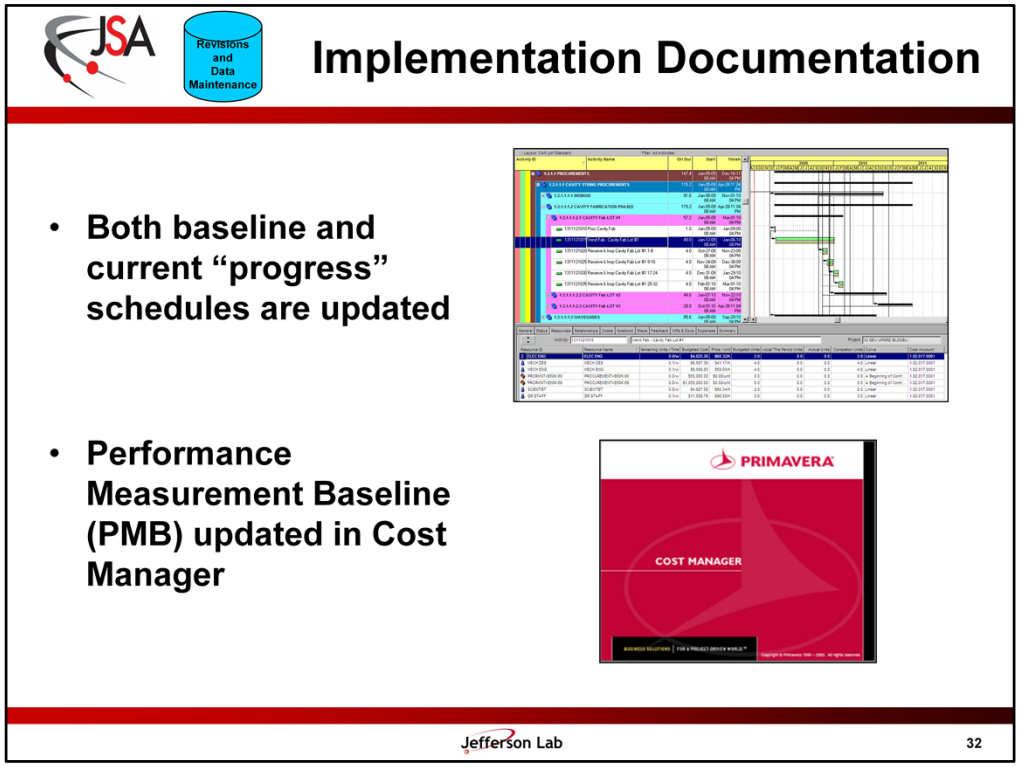
CR #	Class	WBS #	CR Title	Date Submitted	Date Required	Originator	CCB Concur	Contingency (Burd. CY$K)	Mgmt Reserve (Burd. CY$K)	Impact Assessment	Status	Approval Date	Implementation		
													Cost Book	Cost Mgt	P6
12-001	3	1.	Admin CR to Update Costbook to Reflect FY11 Actuals and Commitments; Escalate Costbook, P6 and Cost Manager to FY12$	10/3/2011	10/31/2011	L. Wells	Yes		($3,886k)	Complete	Approved	11/3/2011	vaj/11-3-11, Scenario 999	vaj/11-3-11	BL12-001D and October 11 Progress
12-002	3	1.3.3.1.2	CHL#2 Cold Boxes Shipping Charges	10/3/2011	11/1/2011	D. Arenius	Yes		($256k)	Complete	Approved	11/3/2011	vaj/11-21-11, Scenario 1008	vaj/11/23/11	BL12-002 November Progress
12-003	5	1.4.3.1.2	Major Contract Award: SHMS-Q1 Revised Schedule	10/5/2011	10/31/2011	H. Fenker	Yes		$0k	Complete	Approved	11/8/2011	vaj/11-22-11, Scenario 1010	vaj/11/23/11	BL12-003 November Progress
12-005	5	1.3.6.1	Beam Position Monitor ETC FY12	10/20/2011	11/1/2011	M. Spata	Yes		$74k	Complete	Approved	10/31/2011	vaj/11-7-11, Scenario 1004	vaj/11-8-11	BL12-005 and October 11 Progress
12-007	2	1.4.2	Hall B Annual ETC FY2012	10/1/2011	11/30/2011	L. Elouadrhiri	Yes	($2,475k)		Complete	Approved	12/8/2011	vaj/12-8-2011/Scenario 1012	vaj/12-8-11	BL12-007 November Progress
12-008	3	1.3.4.1.1	CNC Machining Center for Spreader/Recombiner Dipole Modifications	11/21/2011	12/1/2011	M. Bevins	Yes		($161k)	Complete	Approved	1/3/2012	vaj/12-16-11, Scenario 1022	vaj/1/5/12	BL12-008 December Progress
12-009	2	1.6.3	Hall D Civil Claim #2	12/1/2011	12/21/2011	R. Yasky	Yes	($661k)		Complete	Approved	1/5/2012	vaj/12-15-11, Scenario 1018	vaj/1/5/12	BL12-009 December Progress
12-010	5	1.4.2.7	Add New WBS for Hall B New Magnet Vendors	11/30/2011	11/30/2011	L. Wells	Yes	$0k	$0k	Complete	Approved	11/30/2011	NA	vaj/12-9-11	BL12-010 December Progress
12-011	3	1.4.2.7	New SC Magnet Vendor Start Up Budget	12/12/2011	12/20/2011	L. Elouadrhiri	Yes		($296k)	Complete	Approved	1/3/2012	vaj/12-16-11, Scenario 1020	vaj/1/5/12	BL12-010 December Progress
12-012	2	1.4.3	Hall C Annual ETC FY12	12/15/2011	1/31/2012	H. Fenker	Yes	($1,856k)		Complete	Approved	1/23/2012	vaj/1-24-12, Scenario 1025	vaj/1-24-12	BL12-012 January Progress
12-013	5	1.4.2	Schedule Adjustment for Hall B Beam Line and Installation	1/10/2012	1/31/2012	L. Elouadrhiri	Yes	$0k	$0k	Complete	Approved	2/1/2012	vaj/2-1-12, Scenario 1035	2/2/2012	BL12-013 January Progress

A Change Request Log is maintained to track the status of project change requests.

The Log is kept current as a change request progresses through the change control process.

A Contingency and Management Reserve Log is part of the Change Request Log to track the status of these two reserve budgeting categories.

Upon the change request approval requiring additional budget, dollars are transferred from these reserve funds to the appropriate control account in the Performance Measurement Baseline.



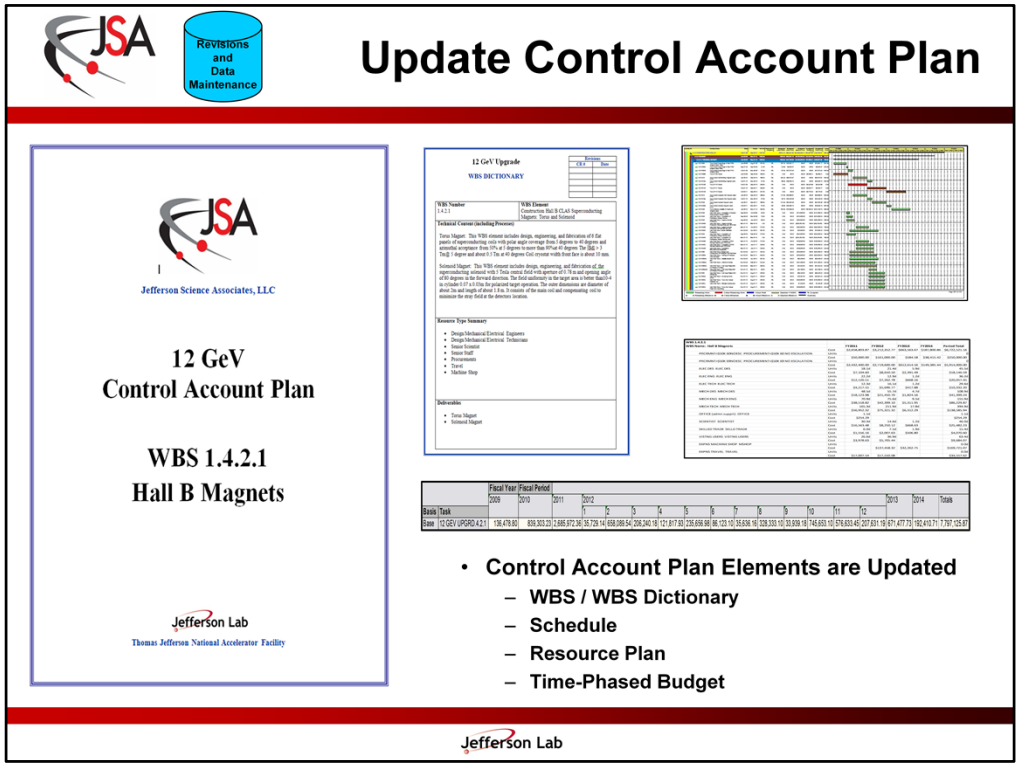
Once the change request has been approved, the baseline documents are formally updated.

Both the baseline and the current “progress” schedules are updated to reflect the approved changes.

And the Performance Measurement Baseline is updated in the Cost Manager EVM system.

Integrity of the Performance Measurement Baseline is very important.

Changes to historical EVM data are not made; any errors to be corrected are done in the current month, not in the month they occurred.

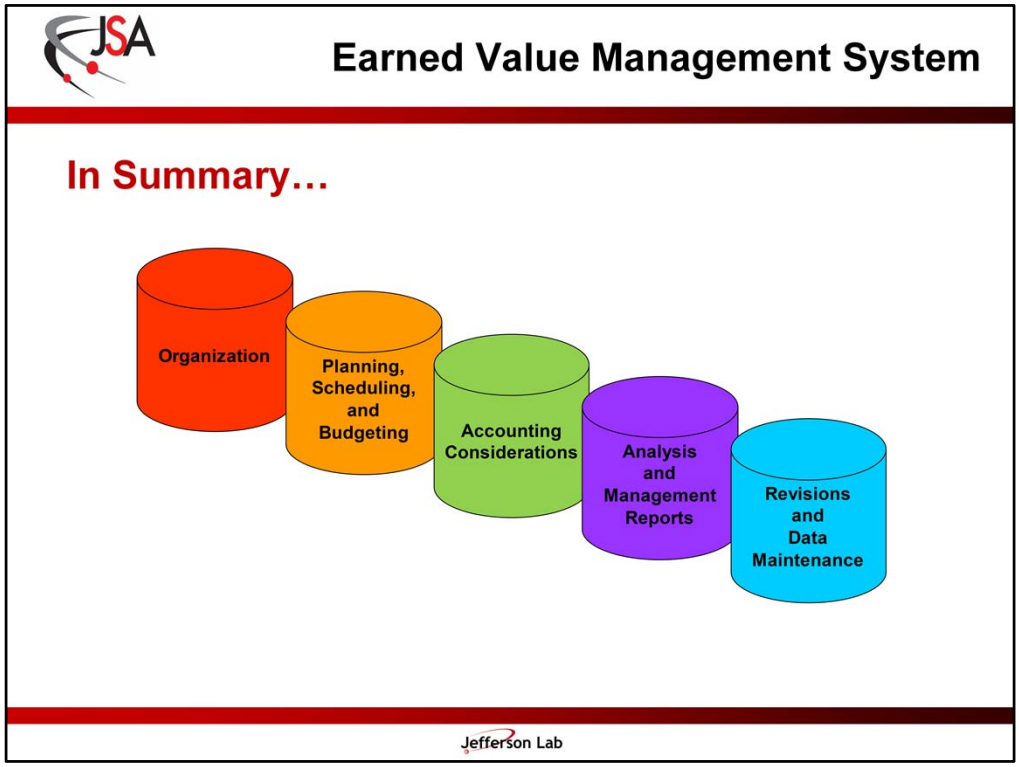


After the Change Request is approved, the various elements of the relevant Control Account Plan are updated, as required.

The revised Control Account Plan is then appended to the associated Work Authorization Document.

The Work Authorization Document for the control account is the final document to be updated after change request approval.

By signing this document, the Control Account Manager accepts the new schedule and budget of the revised control account plan.



JSA's Earned Value Management System is a valuable tool and methodology for JLab project teams to use as they organize, plan and execute their projects.

By adhering to the standard practices as outlined in this presentation, the probability of successful project outcomes is enhanced.

You have now completed your annual refresher training on EVMS.

Any follow-on questions pertaining to Earned Value Management can be addressed to Dennis Miner, Project Management Office at miner@jlab.org or extension 7281.