



# Control Account Manager (CAM)/ Earned Value Management System (EVMS) Training 1

Introduction to EVM

Organization, Planning, Scheduling,  
Budgeting, and Accounting Considerations

Steve Langish

# Overview

- Covering The Basics
  - Introduction to EVMS Web Page/Contents
  - What Is Earned Value Management (EVM)
  - Why Use EVM
  - The EVM Process & How It Applies To You
- Heavy Detail On The Front
  - Organization
  - Planning, Scheduling, & Budgeting
  - Accounting Considerations
- Light Detail On The End (For This Session)
  - Analysis & Management Reports
  - Revisions
- Summary & What 's Up Next
- Time At The End For Questions & Throughout

## PPPL's EVMS Web Page

- <http://www-local.pppl.gov/EVMS/>

# What Is EVM?

- Definition
  - Earned Value Management (EVM) Is A Project Management Technique For Measuring Project Progress In An Objective Manner
  - A Systematic Approach To The Integration & Measurement Of Cost, Schedule, & Technical (Scope) Accomplishments On A Project
- Application
  - Work Is Planned, Budgeted, & Scheduled In Time-Phased Increments To Achieve This
  - Takes Into Consideration Risk, Uncertainties, & Assumptions
  - Involves Project Managers, Control Account Managers, Contractors, Customers, etc
- Objective
  - Encourage The Use Of Effective Internal Cost & Schedule Management Controls
  - Allow Timely Data For Determining Product-Oriented Status

**Gives Control Account  
Managers Control of  
Their Schedule/Budget/Work!**

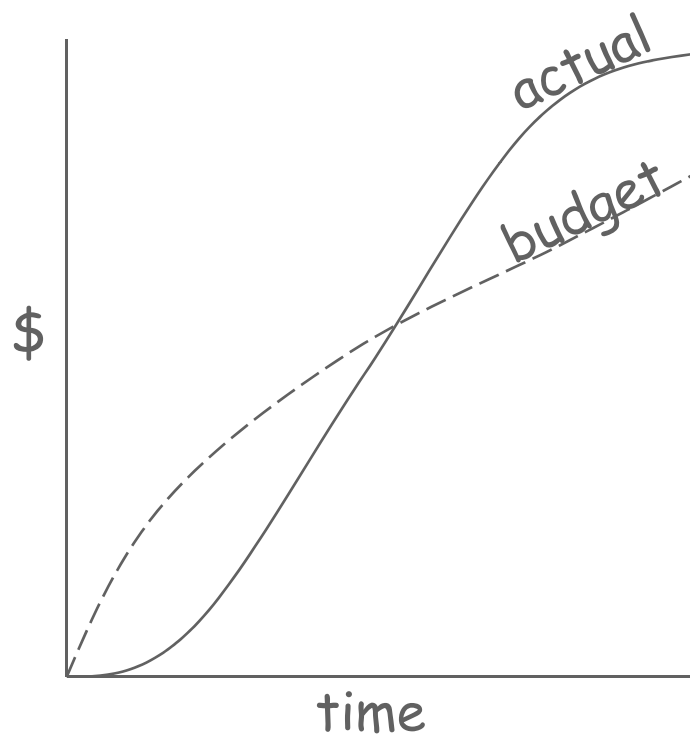
# Why Use EVM?

- Who Wants To Babysit Every Line In A Schedule Of This Size?
  - Management By Exception - Provides Early Warning Of Performance Problems
  - Trip Wires Via Thresholds
  - Using All Views Instead Of Driving With Only The Rearview Mirror (Where Have We Been, Where Are We Now, Where Are We Going)
- Allows For Improved Technical Understanding Of The Project At All Levels
- Enhances Communications Between All Parties Involved
- Keeps Project Team Focused On Achieving Progress
- Helps To Prevent Scope Creep
- Creation Of A More Realistic Project
  - Assumptions
  - Risk Identification
  - Future Use On Similar Projects
- It Is The Natural Product Of Good Project Management Practices So Why Not Put All That Hard Work To Use?

# Why Use EVM?

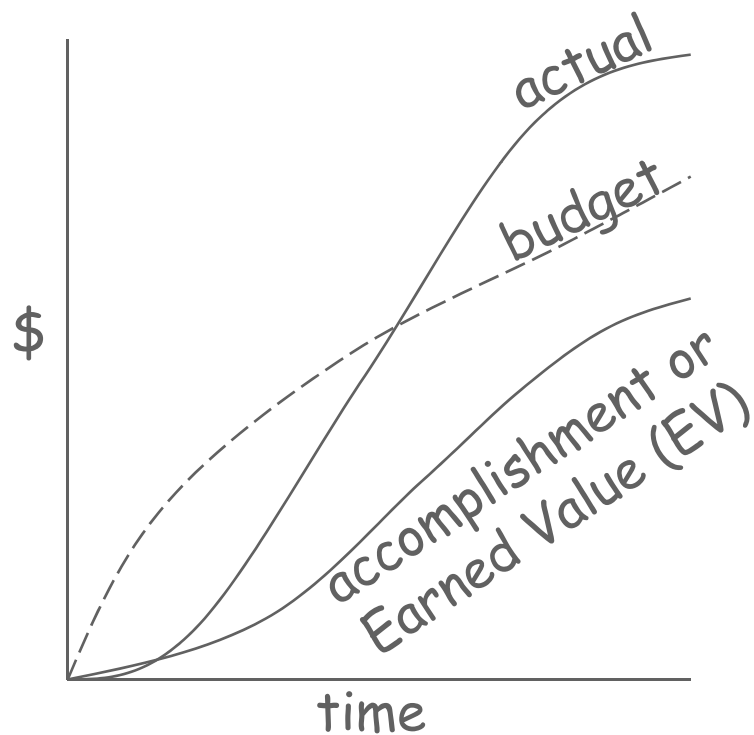
- For PPPL (*because we need a tool like this*)
  - Actually provides value and insights into progress and problems
- For Compliance (*because we have to*)
  - DOE Order 413.3B Mandates Compliance With ANSI/EIA 748-B-2007 For Projects With A Budget Of \$20M Or More, Regardless Of Funding Source
  - PPPL's Project Management System Description (PMSD) is consistent with the requirements above ( $\geq$ \$20 M) and outlines how our laboratory implements EVM.
- For Princeton University (*a flower in the cap*)
  - EVMS certification is an important marketing accomplishment and says to the world that Princeton has demonstrated it's knows how to execute and manage projects.

# Old School Project Management



- Tells You Only How Much You Have Spent Compared To The Budget
- It Doesn't Tell You If
  - Ahead Or Behind Schedule
  - Over Or Under Spent
  - Spent Money On The Right Thing
  - Getting Value For Money
  - Problems Are Over Or Just Started
- This Is Project Management With The Lights Off

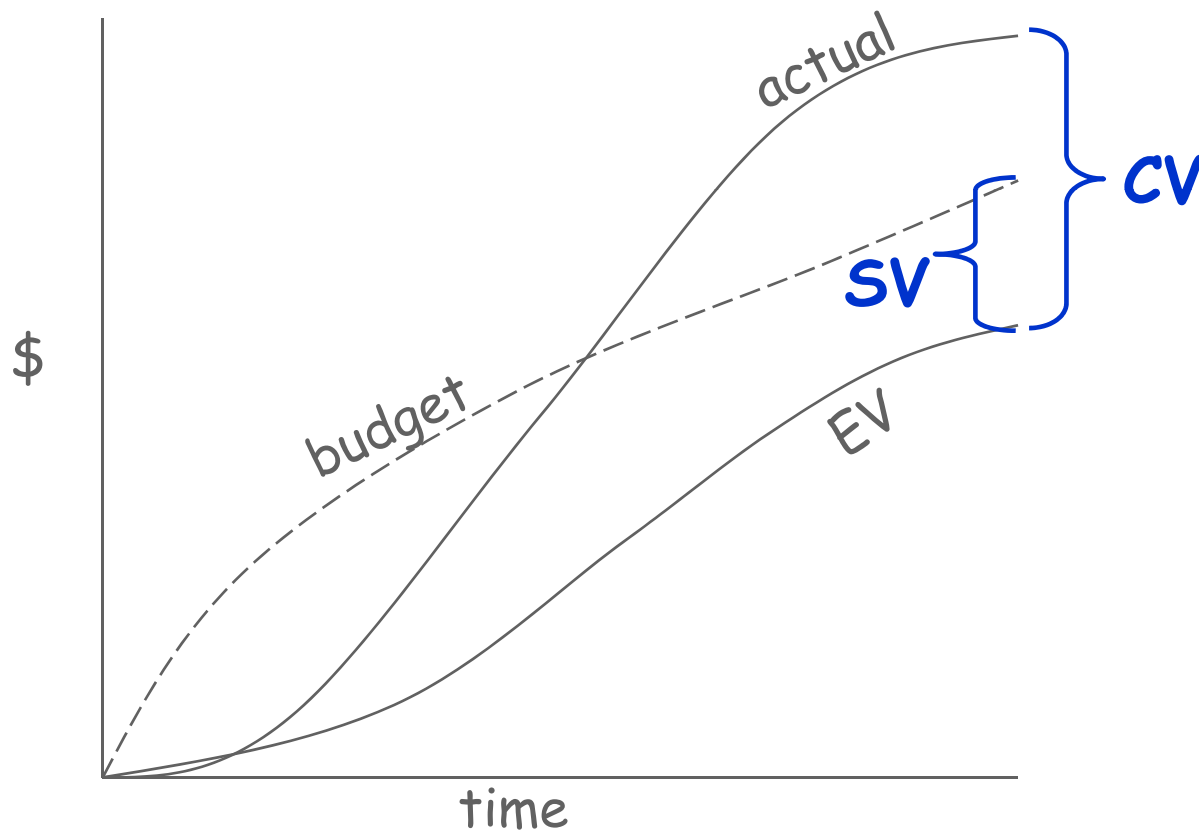
# New School Project Management



- Turn The Lights On With Earned Value
- Tells You How Much Has Been Accomplished
- Accomplished Work Is From Planned Tasks Progressed
- The Budgeted Cost Of That Work Quantifies The Amount Of Accomplishment
- This Gives Many Metrics To Evaluate Project Status & Make More Informed Decisions



# Calculations Graphically



- Cost Variance (CV)  
Good Or Bad?

$$CV = EV - \text{Actual}$$

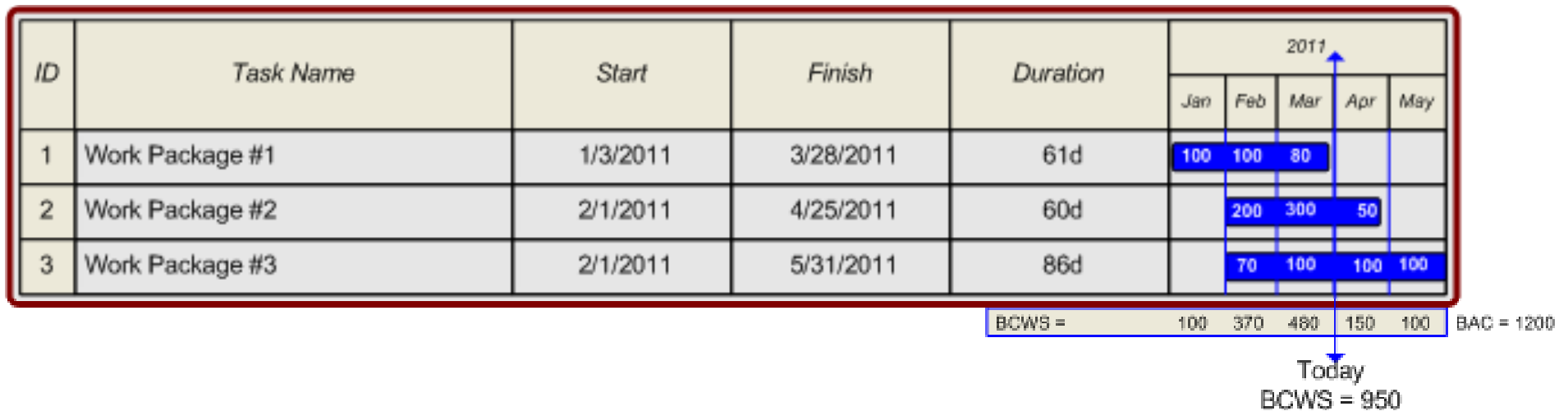
- Schedule Variance (SV)  
Good Or Bad?

$$SV = EV - \text{Budget (Planned)}$$

# EVM Definitions

- **BCWS** (Budgeted Cost of Work Scheduled) (also referred to as Planned Value (PV))
  - Value Of Work PLANNED To Be Accomplished During A Given Period Of Time. How Much Work Should Be Done?
- **BCWP** (Budgeted Cost of Work Performed) (also referred to as Earned Value (EV))
  - Value Of Work Accomplished Or EARNED VALUE. How Much Work Is Done?
- **ACWP** (Actual Cost Of Work Performed) (also referred to Actual Costs (AC))
  - Cost Of Work Accomplished Or ACTUAL COST. How Much Did It Cost?
- **TPC** (Total Project Cost)
  - Sum Of All Project Costs (Including Estimated & Contingency). How Much Could It All Cost?
- **BAC** (Budget At Completion)
  - Sum Of All Budgets Thru Any Given Level (Without Contingency). What Was The Total Job Supposed To Cost?
- **ETC** (Estimate To Completion)
  - Estimated Value Of The Authorized Work Remaining To Be Completed. How Much Will The Remaining Work Cost?
- **EAC** (Estimate At Completion)
  - Estimate Of Total Cost Of All Authorized Work Thru Project Completion. What Do We Now Expect The Total Job To Cost?
- **SV & CV** (Schedule Variance & Cost Variance)
  - Measure Of Cost & Schedule Performance On A Project. How Far Ahead or Behind Cost or Schedule Am I?
- **SPI & CPI** (Schedule Performance Index & Cost Performance Index)
  - Schedule & Cost Efficiency Representing The Ratio Of Work Performed To Work Scheduled Or Costed. How Efficiently Am I Accomplishing Work?

# Budgeted Cost of Work Scheduled (BCWS) a.k.a. Planned Value (PV)



# Budgeted Cost of Work Performed (BCWP) a.k.a. Earned Value (EV)

280  
440  
270  
990

ID	Task Name	% Complete	Start	Finish	Duration	2011				
						Jan	Feb	Mar	Apr	May
1	Work Package #1	100%	1/3/2011	3/28/2011	61d	100	100	80		
2	Work Package #2	80%	2/1/2011	4/25/2011	60d		200	300	50	
3	Work Package #3	73%	2/1/2011	5/31/2011	86d		70	100	100	100
BCWS =						100	370	480	150	100

Today

BCWP = 990

BCWS = 950

Schedule Variance (SV) = BCWP (EV) – BCWS (PV)

SV = 990 – 950 = 40

# Actual Cost of Work Performed (ACWP) a.k.a. Actual Costs(AC)

280  
440  
270  
990

ID	Task Name	% Complete	Start	Finish	Duration	2011				
						Jan	Feb	Mar	Apr	May
1	Work Package #1	100%	1/3/2011	3/28/2011	61d	100	100	80		
2	Work Package #2	80%	2/1/2011	4/25/2011	60d		200	300	50	
3	Work Package #3	73%	2/1/2011	5/31/2011	86d		70	100	100	100
BCWS =						100	370	480	150	100

Today

Actual Costs from Job Cost Reports

Assume: AC = 800

BCWP = 990

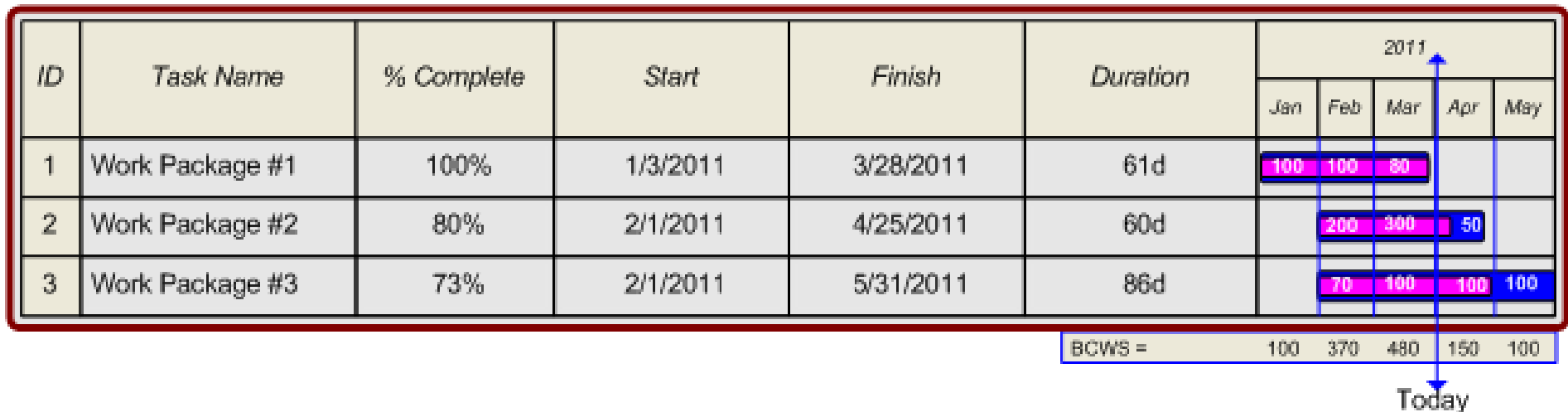
BCWS = 950

ACWP = 800

$$\text{Cost Variance (CV)} = \text{BCWP (EV)} - \text{ACWP (AC)} =$$

$$\text{CV} = 990 - 800 = 190$$

# Cost and Schedule Variances/Indices



$$SV = BCWP - BCWS$$

$$= 990 - 950 = +40$$

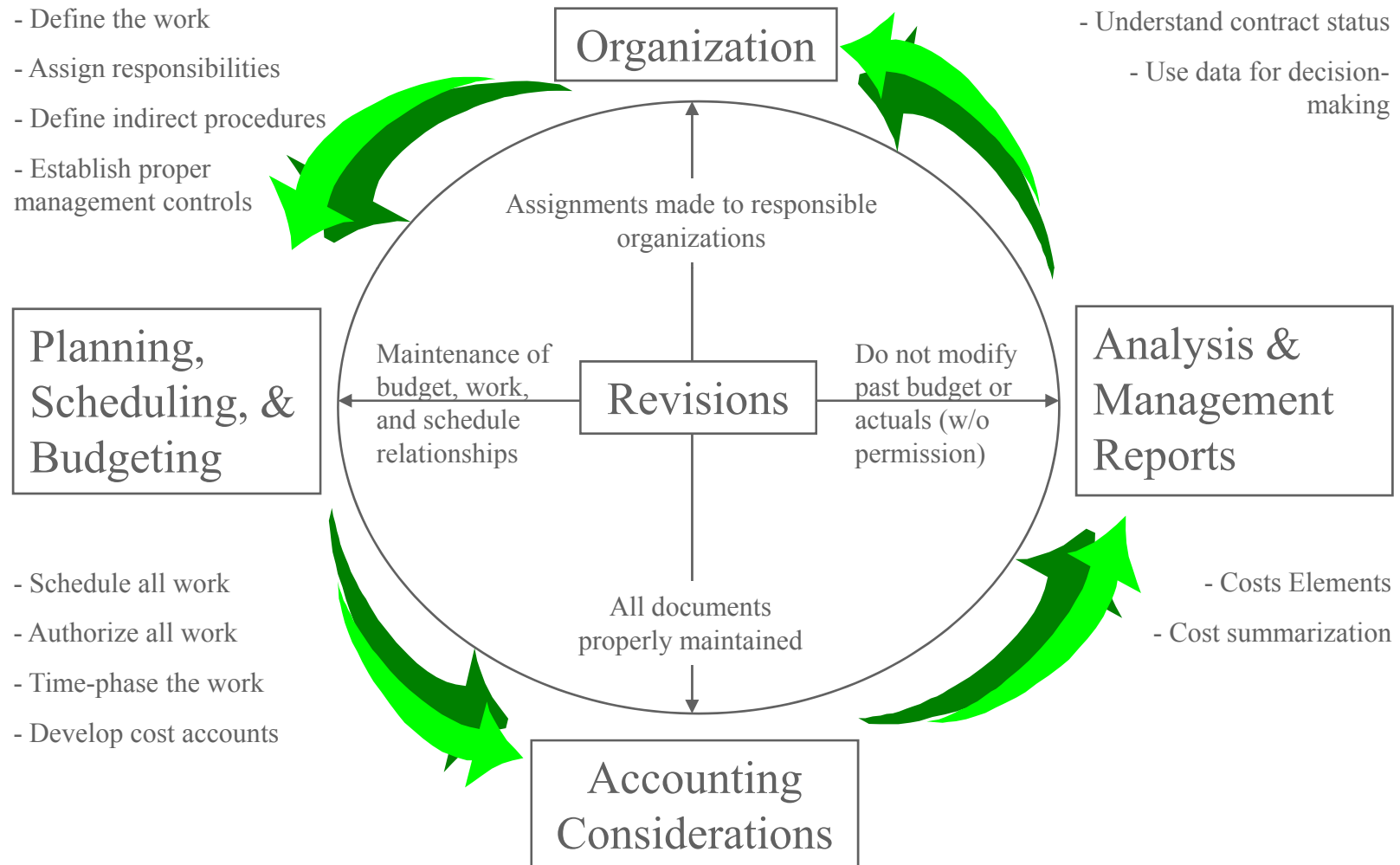
$$SPI = \frac{BCWP}{BCWS} = 1.04$$

$$CV = BCWP - ACWP$$

$$= 990 - 800 = +190$$

$$CPI = \frac{BCWP}{ACWP} = 1.24$$

# Where To Start?



# Organization

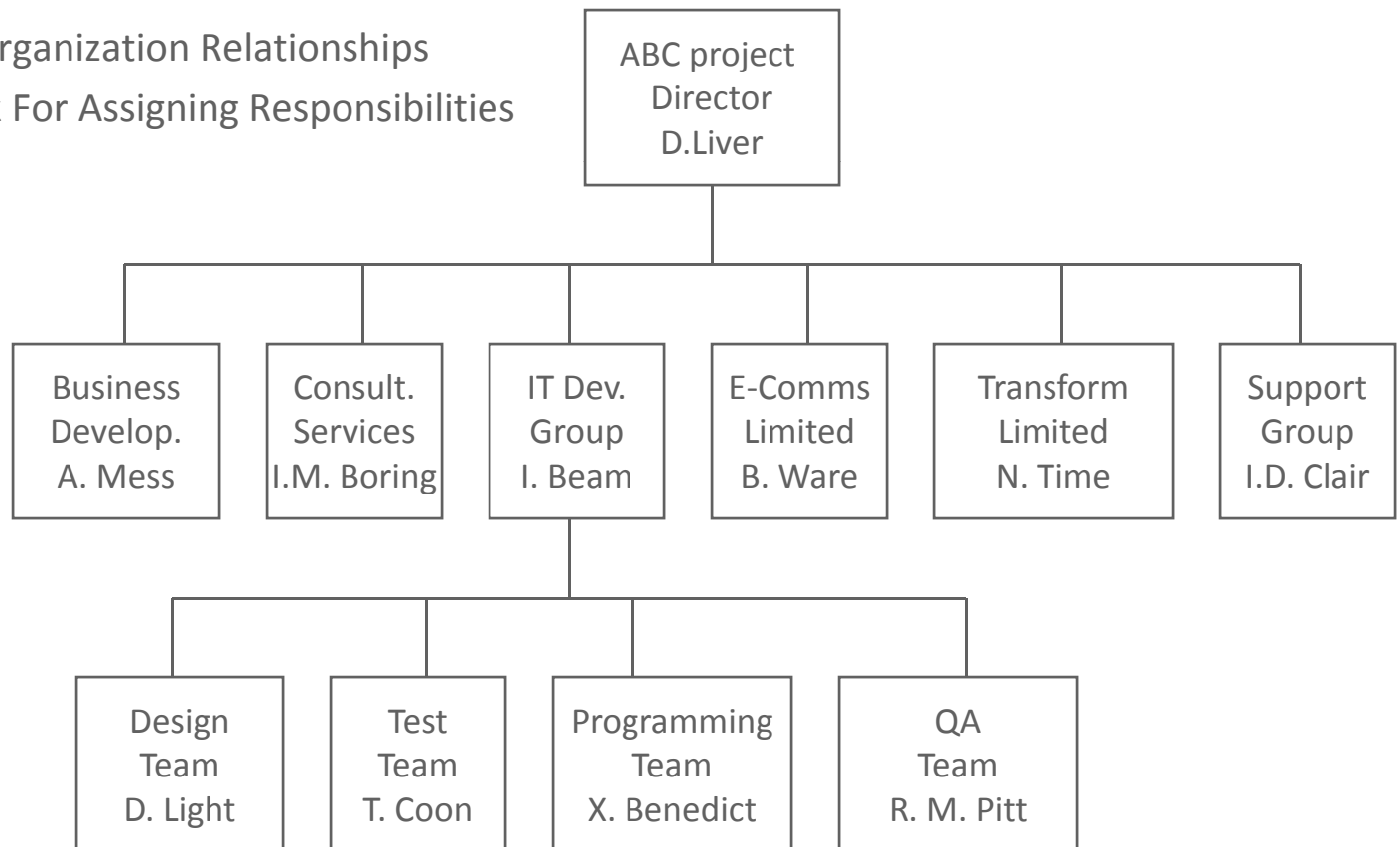
- Applicable Procedure(s)
  - Project Management System Description (PMSD)
  - PMSD Appendix E
    - Procedure 1 Project Execution Plan
    - Procedure 2 Project Work Breakdown Structure (WBS)
    - Procedure 3 Project Organizational Breakdown Structure (OBS) and Responsibility Assignment Matrix (RAM)
- Scope & Definition Of Work
  - Work Breakdown Structure (WBS) & Dictionary
  - Organizational Breakdown Structure (OBS)
  - Project Execution Plan (PEP)
- Assign Responsibilities
  - Responsibility Assignment Matrix (RAM)
  - Control Accounts (CAs)
  - Project Plans
- Establish Proper Management Controls
  - EVMS Guidelines & Procedures
  - Established Completion Metrics & Definitions
  - Risk Management & Contingency
  - Document Assumptions



# Organization - OBS (*Who*)

- Organization Breakdown Structure (OBS)

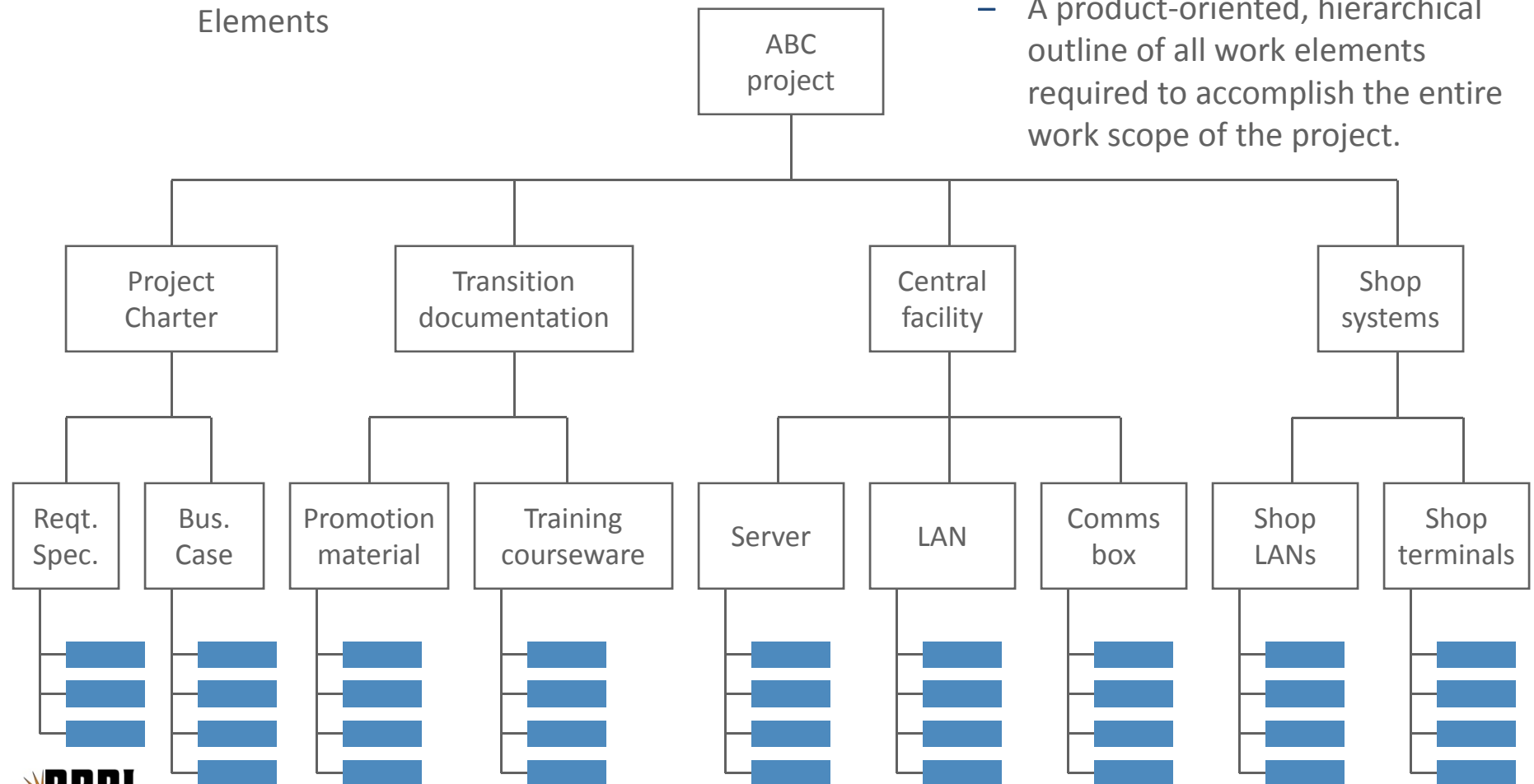
- Process Focused
- Indicates Organization Relationships
- Framework For Assigning Responsibilities



# Organization - WBS (*What*)

- Organizes & Defines A Project
- Groups Discrete Work Elements

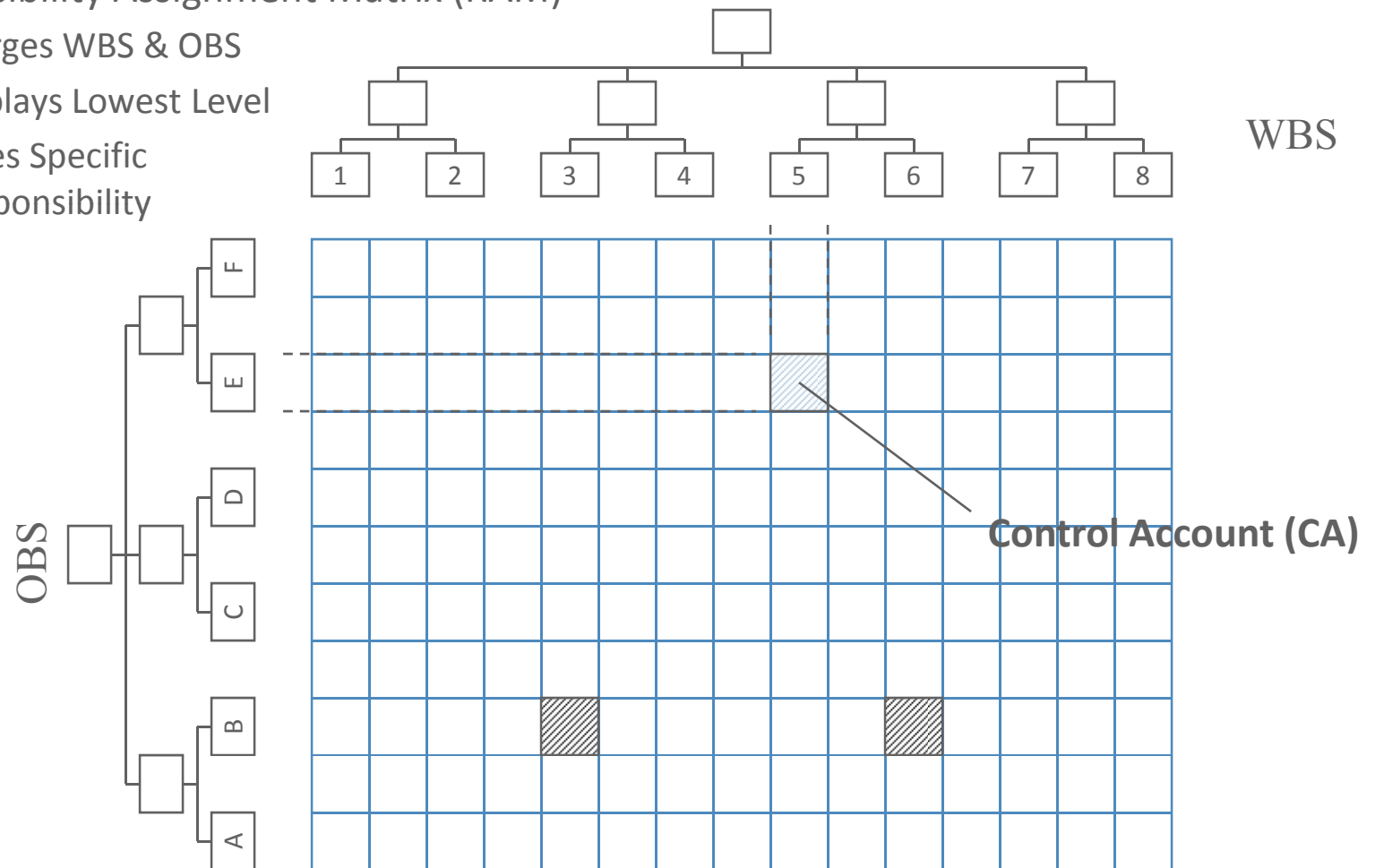
- Framework For Planning & Controlling Cost & Schedule
- A product-oriented, hierarchical outline of all work elements required to accomplish the entire work scope of the project.



# Organization - RAM (*Who does What*)

- Responsibility Assignment Matrix (RAM)

- Merges WBS & OBS
- Displays Lowest Level
- Gives Specific Responsibility



# Organization - Control Accounts

- This Is Where All The Magic Happens
- Intersection Of WBS & OBS
  - WBS Element Lowest Level & Activities Grouped Under
  - Control Account Manager (CAM) Responsible
- Key Control Point
  - Schedule, Time-Phased Budget
  - Earned Value Determination
  - Actual Cost Accumulation
  - Earned Value Metrics
  - Variance Analysis (Cost & Schedule)
  - Corrective Actions
  - Change Control

# Organization - Establish Proper Management Controls

- Framework Established By Following Guidelines Listed (PPPL, DOE, ANSI)
- Establishing Reporting Thresholds
  - Found In The PEP
  - Reporting Occurs At A Cumulative Level Of The WBS With Ability To Drill Down To Control Account Level (Levels Three & Four)
  - Detailed Variance Analysis Will Be Provided When Any One Of The Following Occurs:
    - WBS Level Cumulative schedule variance  $\pm 10\%$  AND  $> \$50K$  (NSTX-U Project PEP threshold)
    - WBS Level Cumulative cost variance  $\pm 10\%$  AND  $> \$50K$  (NSTX-U Project PEP threshold)
    - Control Account level variance analysis will be requested by the Project Manager for the NSTX-U Project

# Planning, Scheduling, & Budgeting

- Applicable Procedure(s)
  - PMSD Appendix E
    - Procedure 5 Control Accounts, Work Packages & Planning Packages
    - Procedure 6 Project Schedule
    - Procedure 7 Cost Estimating
- Planning & Schedule Development
  - Schedule (Sequence, Interdependencies, Durations)
  - Identify Products, Milestones, Technical Performance Goals To Measure Progress
  - Further Determine & Document Assumptions, Risk, & Unknowns
- Time Phasing Of Work
  - Budget At Control Account (CA) Level
  - Identify Budget At Significant Cost Elements (Resource Loading)
  - Budget In Terms Of Hours Or Other Units That Equates To Dollars In The End
  - Identify & Control LOE Activity
- Review & Baseline Project
- Authorize Work & Begin Project Execution

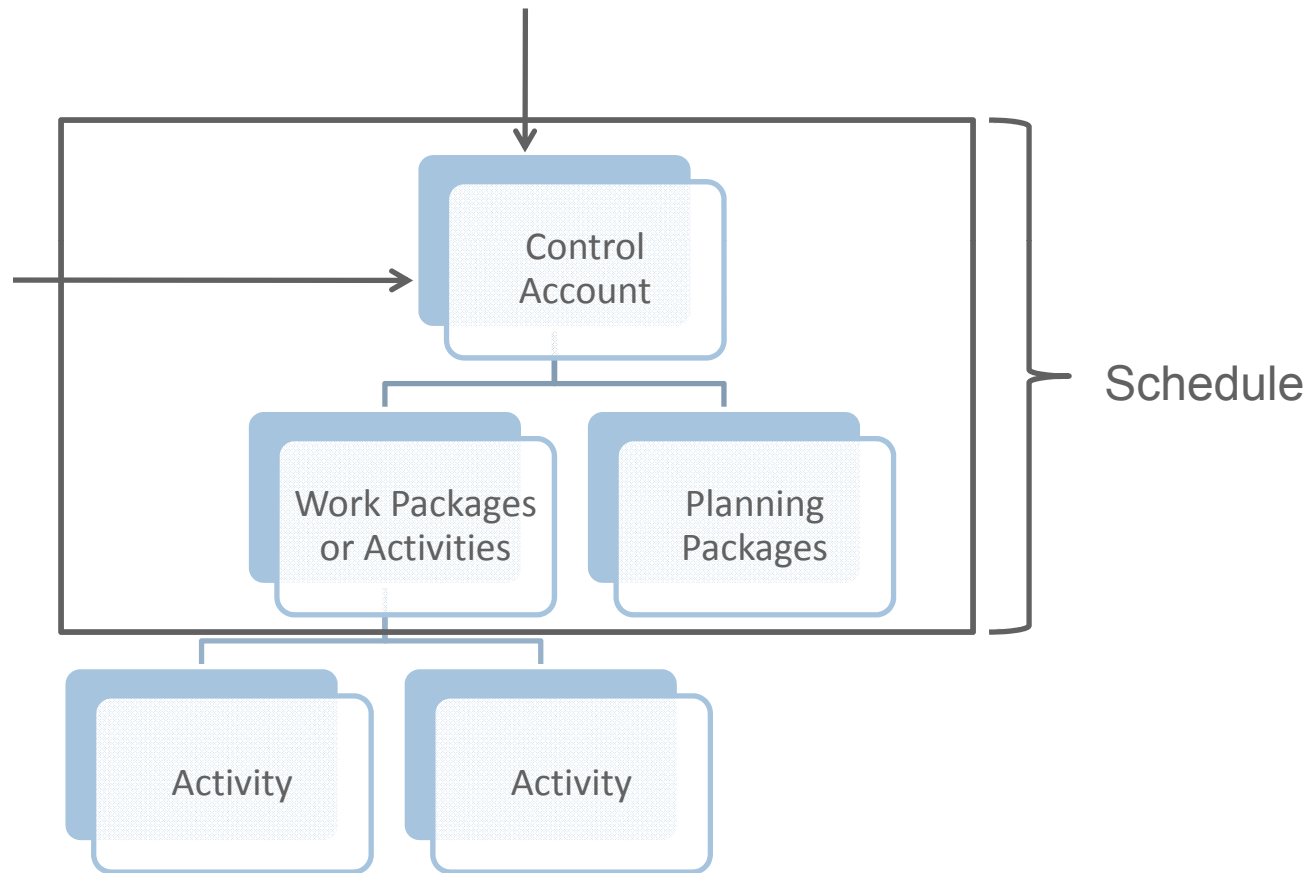
# Planning, Scheduling, & Budgeting - Planning & Scheduling

- Planning & Scheduling Answers These Questions
  - What Will Be Performed?
  - How Will It Be Performed?
  - Where Will It Be Performed?
  - Who Will Perform The Work?
  - In What Sequence Will The Work Occur?
- All Of These Come Together To Determine The Answer To The Final Question
  - When Will The Work Be Performed
- A Schedule Must
  - Represent Work In A Work Package Or Planning Package
  - Include Logical Ties For All Activities
  - Include All Key Milestones & Deliverables
  - Reflect The Agreed To Project Baseline
  - Integrate With The Cost Baseline

# Planning, Scheduling, & Budgeting - Control Accounts, Work Packages, Activities

## WBS

## OBS





# WAF's are the vehicle for estimating cost, schedule and risk

Tab "A"

## Work Approval Form (WAF)

Cost Center: 1180  
Job Number: 2485  
Job Title: NSTX NB2 TVPS  
Job Manager: Craig Priniski  
Rev 1 6/10/2010

### Description:

This job includes Pumping System mechanical and magnetic shielding connections

PPPL Standard estimating methodology provides format and process for capturing work scope, task, estimates, contingency, risks and uncertainties

Tab "C"

### Uncertainty of the Estimate

High

### Design Maturity

### Design Complexity

### Residual Impacts

### Risk Description

### Likelihood of occurring

### Mitigation Plan

### Bar

Leaks discovered during installation/testing

L

Depending on location, field fix or replace with spares

Past NSTX Experience

0

20

### Risks

### Notes:

- (1) Cost impacts should NOT include standing army costs which are separately calculated from the schedule impact
- (2) The schedule impacts should be entered as the min and max impacts on the critical path. If there is no critical path impact then the schedule entries should be zero.
- (3) Likelihood of occurrence should be entered consistent with our risk classification methodology, i.e. VL= Very Likely (P>80%), L=Likely (80%>P>40%), U=Unlikely (40%>P>10%), VU=Very Unlikely (P<10%), NC=Non-credible (P<1%)

Tab "B"

Cost Center: 1180  
Job Number: 2485  
Job Title: NSTX NB2 TVPS  
Job Manager: Craig Priniski

USER INPUT TASKS AND DESCRIPTIONS		Estimate (user input)														Basis of Estimate and Names of req'd skills if known	Category	Uncertainty %			
		SCHEDULE		FY09\$K		HOURS															
		Duration In WORK DAYS	User Input Start Date (optional)	M&S (41)	OVERTIME (31)	EA* EM (Analysis Engr)	EA* DM (Designer)	EC* EM (Consulting Engr)	EC* SMTB (Consulting Tech)	EE* EM (Ext Engr)	EE* SMTB (Ext Tech)	EW* EM (F&M Engr)	EW* SMTB (F&M Tech)								
TASK DESCRIPTION	Resp																				
Physics Requirements																					
Preliminary Design																					
Update Cost & Schedule Estimate	PRINISKI	3	4/19/2010															NA			
Update CAD Models	PRINISKI	10	5/18/2010					32							12			NA			
PDR Prep	PRINISKI	10	6/1/2010				0	0										NA			
CONDUCT PDR	PRINISKI	2	6/23/2010												0			NA			
Final Design																					
Disposition PDR Chits	PRINISKI	15	6/25/2010							18						18		25			
Vacuum Diagnostic Layout	PRINISKI	10	7/16/2010							32						8		20			
Design Drawings	PRINISKI	30	7/16/2010							24						96		10			
Update Cost & Schedule Estimate	PRINISKI	3	7/30/2010							12								15			
PDR Prep	PRINISKI	10	8/27/2010												0			NA			
CONDUCT PDR	PRINISKI	2	3/28/2011															NA			
DR Chit Resolution (all areas)	PRINISKI	20						80								80					
Procurement																					
Item 1: 2600 Vs TMPs x 2	PRINISKI		3/30/2011			\$65															
Prep Requisition and procurement package	PRINISKI	4	3/30/2011													19					
SUBMIT REQ TO PROCUREMENT	PRINISKI	1	4/5/2011													1					
Procurement lead time	PRINISKI	15	4/6/2011																		
AWARD	PRINISKI	1	4/27/2011																		
Fabricate and delivery Fabricate or delivery	PRINISKI	90	4/28/2011																		
Item 2: New Gate Valves	PRINISKI	99	4/5/2011			\$22															
Prep Requisition and procurement package	PRINISKI	2	4/5/2011													2					
SUBMIT REQ TO PROCUREMENT	PRINISKI	1	4/7/2011													1					
Procurement lead time (1)	PRINISKI	15	4/8/2011																		
AWARD	PRINISKI	1	4/29/2011																		
Fabricate or delivery Fabricate or delivery	PRINISKI	80	5/2/2011																		
Item 3: Vacuum Instrumentation	PRINISKI		4/7/2011			\$4															
Prep Requisition and procurement package	PRINISKI	4	4/7/2011														19				

Expanded WAF to include subjective contingency estimate (as % of task estimate)

# Planning, Scheduling, & Budgeting - WAF to Plan

- Job Managers Prepared Work Authorization Forms (WAF's) - realistic , not optimistic estimates
  - Disciplined and uniform approach for all work
  - Excel based spreadsheet includes;
    - Tab A – Work scope description
    - Tab B – Detail estimate; Tasks, resource estimates (labor hours by skill and material cost), schedule and task durations, basis of estimates, and task-by-task contingency estimate
    - Tab C – Risk – Likelihood, cost and schedule impact
      - Tab D – Materials, hardware detail and other backup estimate basis
- Internal Engineering Department Review for all Job Estimates
- Prepared resource Loaded Schedule (Primavera)
- Quantified Contingency by bottoms-up task-by-task subjective estimate, weighted risk plus schedule contingency

# The resource loaded schedule is the master database for all cost, schedule, and resource requirements

Activity ID	Activity Description	Work Days	Early Start	Early Finish	Total Float	Budgeted Cost	Contingency %	FY10	FY11	FY12	FY13	FY14
<b>NSTX Upgrade Project</b>												
<b>Job: 2485 - Vacuum Pumping System-PRINISKI</b>												
<b>Design</b>												
2485-0013	PDR Prep	10	09JUN10	22JUN10	734	4,116.7	10					
2485-0014	CONDUCT PDR	2	23JUN10*	24JUN10	734	0.00	0					
2485-0015	Disposition PDR Chits	15	25JUN10*	16JUL10	734	4,161.60	2					
2485-0016	Vacuum Diagnostic Layout	10	12JAN11*	25JAN11	616	4,054.40	2					
2485-0017	Design Drawings	30	26JAN11	08MAR11	616	12,163.20	1					
2485-0018	Update Cost & Schedule Estimate	3	09MAR11	11MAR11	616	1,905.12	15					
2485-0019	FDR Prep	10	14MAR11	25MAR11	616	0.00	0					
2485-0020	CONDUCT FDR	2	28MAR11*	29MAR11	616	0.00	10					
2485-0021	FDR Chit Resolution (All Areas)	20	30MAR11*	26APR11	616	19,661.60	10					
<b>Procure, Fab &amp; Assembly</b>												
2485-0022	Prep Req & proc pkg - 3200i/s TMPx2	4	01JUL13*	04JUL13	70	3,411.60	20					
2485-0023	SUBMIT REQ TO PROC - 3200i/s TMPx2	1	05JUL13									
2485-0024	Procurement lead time (1) - 3200i/s TMPx2	15	08JUL13									
2485-0025	AWARD - 3200i/s TMPx2	1	29JUL13									
2485-0026	Fabricate or delivery - 3200i/s TMPx2	90	30JUL13									
2485-0028	Prep Req & proc pkg - New VAT Valves	2	05JUL13	08JUL13	78	341.16	20					
2485-0029	SUBMIT REQ TO PROC- New VAT Valves	1	09JUL13	09JUL13	78	170.58	10					
2485-0030	Procurement lead time (1)- New VAT Valves	15	10JUL13	30JUL13	78	0.00						
2485-0031	AWARD- New VAT Valves	1	31JUL13	31JUL13	78	0.00						
2485-0032	Fabricate or delivery - New VAT Valves	80	01AUG13	20NOV13	78	2,565.25						
2485-0034	Prep Req & proc pkg - Vacuum Instrumentation	4	10JUL13	15JUL13	86	4,411.60						
2485-0035	SUBMIT REQ TO PROC- Vacuum Instrumentation	1	16JUL13	16JUL13	86	170.58	10					
2485-0036	Procurement lead time (1)- Vacuum Instrumentatn	15	17JUL13	06AUG13	86	0.00						
2485-0037	AWARD- Vacuum Instrumentation	1	07AUG13	07AUG13	86	0.00						
2485-0038	Fabricate or delivery - Vacuum Instrumentation	90	08AUG13	11DEC13	86	6,736.67	20					
2485-0040	Prep Req & proc pkg - Misc Mtrl/Comp for Ducts	4	09JUL13	12JUL13	79	2,217.54	15					
2485-0041	SUBMIT REQ TO PROC - Misc Mtrl/Comp for Ducts	1	15JUL13	15JUL13	79	170.58	20					
2485-0042	Procurement lead time (1) - Mtrl/Comp for Duct	15	16JUL13	05AUG13	79	0.00						
2485-0043	AWARD - Misc Mtrl/Comp for Ducts	1	06AUG13	06AUG13	79	0.00						
2485-0044	Fabricate or delivery - Misc Mtrl/Comp for Ducts	70	07AUG13	12NOV13	84	40,298.57	20					
2485-0044A	Fabricate or delivery - All Other Mtrl/Component	90	07AUG13*	10DEC13	79	33,675.00	20					
<b>Installation</b>												
2485-0046	Installation Procedure	10	05JUL13*	10JUL13	167	6,922.20	10					

Contingency estimate %  
Also used to help determine schedule contingency

Base cost = resource estimate (in hours) x loaded rates (does not include contingency)

Resource estimate from WAF (hours for labor \$ for materials)

Total float (in work days.  
Approx 21 per month)

# Planning, Scheduling, & Budgeting - Scheduling

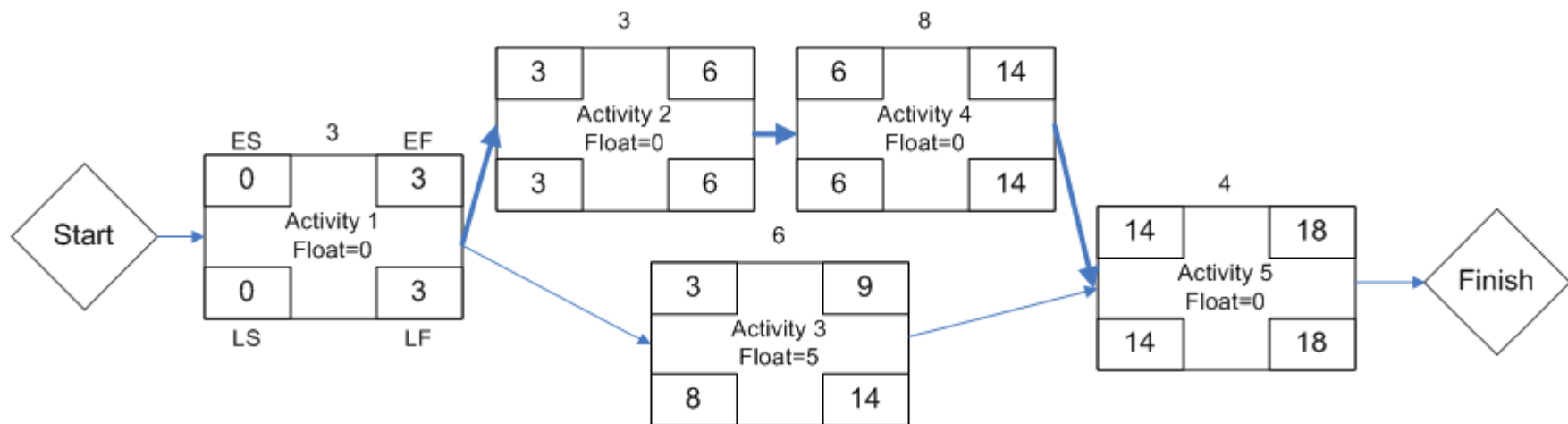
- Assumptions, Risk, & Unknowns Are Evaluated & Documented During This Process
  - Assign Owners
  - Potential Impacts & Probability Of Occurrence
- Occurs Over Many Iterations
  - Examine The Schedule For Feasibility & Logic
  - Independent Quality Assessment
- Determine Critical Path (CP)
  - The Sequence Of Activities That Represents The Longest Schedule Duration
  - A Duration Increase In These Activities Creates A Day For Day Increase In The Project's End Date
  - No Schedule Flexibility (Float)
- Determine Near Critical Path (Near CP)
  - The Sequence Of Activities That Have The Second Longest Path through The Project
  - Monitor For Possible Impact To Critical Path
- Both CP & Near CP Are Equally Important To Manage & Understand

# Planning, Scheduling, & Budgeting - Critical path, float (slack)

- Critical Path: Is the longest duration path through a network diagram and determines the shortest time to complete the project
- How does the Critical Path help a CAM:
  - Helps prove how long the project will take
  - Helps the PM/CAM determine where best to focus his/her project management efforts
  - Helps determine if an issue needs immediate attention
  - Provides a vehicle to compress the schedule during project planning and whenever there are changes
  - Provides a vehicle to determine which activities have float and can therefore be delayed without delaying the project
- Definitions:
  - Total float (slack): the amount of time an activity can be delayed without delaying the project end date or intermediary milestone
  - Free float (slack): the amount of time and activity can be delayed without delaying the early start date of its successor

# Planning, Scheduling, & Budgeting - Precedence Diagramming Method/Critical Path Method

- Precedence Diagramming Method (PDM)
  - Sometimes referred to as “Activity-On-Arrow”



Compute float:

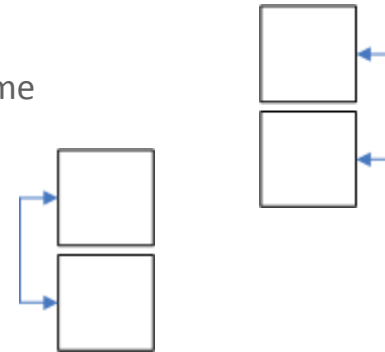
$$LF - EF = 14 - 9 = 5$$

OR

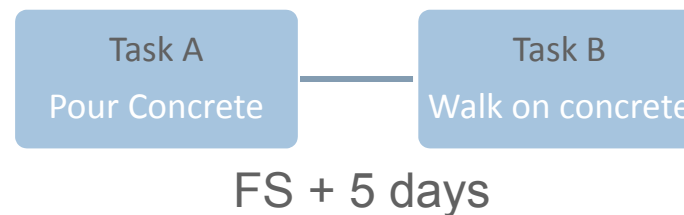
$$LS - ES = 8 - 3 = 5$$

# Planning, Scheduling, & Budgeting - Precedence Diagramming Method/Leads & Lags

- Precedence Diagramming Method (PDM) – method used in Critical Path Methodology (CPM)
  - Sometimes referred to as “Activity-On-Node”
  - Types of relationships (3 most typically used)
    - Finish to Start (FS) – Finish Task 1 before Starting Task 2 (Conventional (default) relationship)
    - Finish to Finish (FF) – Finish Task 1 and Task 2 at same time
    - Start to Start (SS) – Task 1 and Task 2 start at same time



- Leads/Lags



# Planning, Scheduling, & Budgeting - Resources

- Now That We Have A Planned Schedule - Time Phase Work
- Resources Allocated At Activity Level Within The Control Account
  - Discrete Effort
    - Specific End Product Or Result
  - Apportioned Effort
    - Effort Related To Discrete Tasks With Dependent Relationship On Measured Performance
  - Level Of Effort
    - No Final Product Or End Result, Continuing Support
- Measurement Of EVM Technique (Methodology) Needs To Be Kept In Mind When Allocating Resources



# Planning, Scheduling, & Budgeting - EV Methods

- Earned Value falls into 3 categories:
  - Discrete
  - Non-discrete (aka management tasks - LOE)
  - Apportioned
- Examples of discrete EV methods:
  - 0/100 (performance is earned after all work is complete – typically used for short tasks within one accounting period)
  - 50/50 (50% earned at start; 50% earned at finish – typically used for short tasks – less than 3 months)
  - physical % complete (incremental earning based on PMs assessment of %)
  - units complete
  - milestones (30% design, 60% design, etc.)
- Physical % complete is the most popular *but must have a defined or documented rationale for each task or type of tasks!*
- Remember, the method you choose must be objective and consistent throughout the project tasks
- Examples of non-discrete EV methods:
  - Level of Effort (LOE) (Support type with no product, BCWP = BCWS always!)
- Apportioned
  - Parent/child relationship

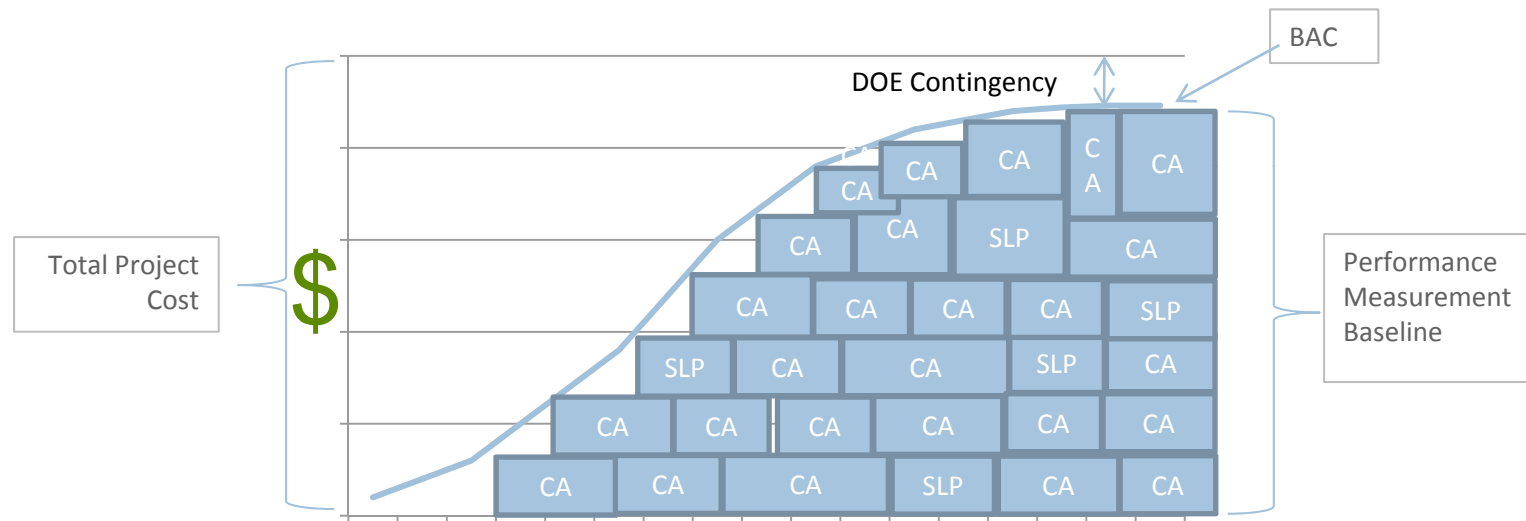
# Planning, Scheduling, & Budgeting - What makes a good schedule?

- Include the entire scope of work
- All tasks are logically linked and reflect how the work will be accomplished
- Limited use of constraint dates and lags
- Schedule should include meaningful, well defined milestones to assist project in tracking overall progress
- All tasks should include all required coding (WBS, milestone, CAM, etc.)
- Task durations must be reasonable for the scope of work. General rule – Discrete work should be no longer than 1 to 2 months.
- Schedule should address risk with project and include mitigation effort that is to be included in the plan.

# Planning, Scheduling, & Budgeting - Contingency & Baseline

- Now That We Have A Resource Loaded Schedule Let's Establish Contingency Reserve
  - Established To Cover Overruns In Cost & Schedule That May Occur As A Result Of Known (Risk) Or Unknown (Uncertainty) Events
  - Expected Value Of Identified Risks (Probability x Impact)
  - Developed Bottoms Up But Managed At A Program Level, Owned By The Customer
- Time To Baseline!
  - Schedule Baseline
    - Durations, Dates, & Sequence Of Project Activities By Which Major Project Milestones Must Be Accomplished
  - Technical Project Baseline
    - Identification Of All Project Scope
    - Includes Physical, Functional, & Operational Requirements & Configurations
    - Covered In WBS Dictionary
  - Performance Measurement Baseline (PMB)
    - Total Time-Phased Budget Plan Against Which Project Performance Is Measured
    - Does Not Include Contingency Since It Has No Specific Work Scope
- All Provide The Basis For Measuring & Reporting Performance

# Planning, Scheduling, & Budgeting - Performance Measurement Baseline



# Planning, Scheduling, & Budgeting - Plan and Authorize Work

- Let's Get Started! WAIT...What Authorizes You To Start Work?
- Work Authorization Documents (*WADs to authorize*) and *Forms (WAFs to plan/authorize)*
  - Formal Process For Approving The Scope, Budget, & Schedule For Discrete Project Elements Down To The CA Level
  - Each CA Has A WAD Signed By Control Account Manager & Project Manager
  - Answer If Asked, “Can You Accomplish The Work Scheduled For The Budget Authorized?” → YES
- What Kind Of Information Will Be In Yours?
  - Control Account Title, Number, Period Of Performance, Authorized Budget
  - WBS Dictionary
  - Detailed Schedule
  - Budgeted Cost By Month
- These Are For The Life Cycle Of The Project
- All Changes Will Be Documented & Controlled Through A Formal Process


# Planning, Scheduling, & Budgeting - WAD to Authorize

Work Authorization Document NSTX Upgrade Project				
Control Account #:	1000	Title:	CSU Analytical Support	
WBS	1.1	Title:	Torus Systems	
Period of Performance:	04 January 2010 to 05 October 2014			
Authorized Budget:	\$385	Control Account Manager:	Titus	
Revision #:	0	Revision Date:	05/16/11	
<b>Authorized Work Description:</b> As a result of the NSTX Upgrade Project, the NSTX global models and analyses will need to be updated. This WBS element includes analytical support for global models and analysis not presently identified. The global model will provide the basis for updating the analysis to quality components and identify areas of the tokamak requiring further analysis. Identified plasma scenarios and power supply current limit analyses will be run in the global model and current sets that require further analysis will be identified. These analyses also serve to check the results of more detailed analyses.				
<b>Attachments:</b> 1- WBS Dictionary sheet that defines the scope of work for this WBS element. 2- A detailed Control Account schedule showing all work packages and planning packages. 3- A detailed Resource Report by WBS and Schedule activity. 4- Budgeted Cost by month. 5- Original Work Authorization Form (WAF)				
Control Account History				
ECP#	Implement Date	Prior Budget	New Budget	Signature
Approvals	Name	Signature		Date
NSTX-U Project Manager	R. Strykowski			
Control Account Manager	P. Titus			
Functional Manager	P. Helzenroeder			

# Accounting Considerations

- Applicable Procedure(s)
  - Accounting Manual
- Identify Cost Elements
  - Labor
  - Material
  - Contracts
- Subcontract Management
- Approved Accounting System With Ability To Extract Actuals

# Reporting Of Hours Example

 <b>Princeton Plasma Physics Laboratory OnLine TimeSheet</b>																																																			
<a href="#">Main Menu</a>	<a href="#">Log Off</a>																																																		
<b>Time Sheet Information</b>																																																			
Monthly Time Sheet	Paygroup : 8 Name: Stephen W Langish Employee Id: slangish																																																		
Period Ending <input type="text" value="5/20/2011"/> <input type="button" value="Go"/>																																																			
Total Worked Time: 0.00 % Non-Productive Total: 0.00 %																																																			
Timesheet Total: 0.00 % Total Required: 100 %																																																			
<b>Worked Time Section (Reported in Percentages)</b>																																																			
<table border="1"> <thead> <tr> <th>Account</th> <th>Percent</th> </tr> </thead> <tbody> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> </tbody> </table>	Account	Percent	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<table border="1"> <thead> <tr> <th>Account</th> <th>Percent</th> </tr> </thead> <tbody> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> <tr><td><input type="text"/></td><td><input type="text"/> %</td></tr> </tbody> </table>	Account	Percent	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %	<input type="text"/>	<input type="text"/> %																										
Account	Percent																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
Account	Percent																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<input type="text"/>	<input type="text"/> %																																																		
<b>Non-Productive Time Section (Reported in Days)</b>																																																			
Time Off will be calculated from the data below (5% per day off)																																																			
<a href="#">Current Non-Productive Time</a>																																																			
<table border="1"> <thead> <tr> <th>Days Off</th> <th>Z Code</th> <th></th> </tr> </thead> <tbody> <tr><td><input type="text"/></td><td>Z100</td><td>Vacation</td></tr> <tr><td><input type="text"/></td><td>Z201</td><td>Occasional Illness</td></tr> <tr><td colspan="3">Z Codes Requiring Personnel Approval:</td></tr> <tr><td><input type="text"/></td><td>Z202</td><td>Temporary Disability</td></tr> <tr><td><input type="text"/></td><td>Z400</td><td>Death in Family</td></tr> <tr><td><input type="text"/></td><td>Z500</td><td>Civic Duty</td></tr> <tr><td><input type="text"/></td><td>Z600</td><td>Lab Holiday</td></tr> <tr><td><input type="text"/></td><td>Z601</td><td>Optional Holiday</td></tr> <tr><td><input type="text"/></td><td>Z800</td><td>Military Leave</td></tr> <tr><td><input type="text"/></td><td>Z901</td><td>Leave without Pay</td></tr> <tr><td><input type="text"/></td><td>Z603</td><td>Miscellaneous NPT</td></tr> <tr><td><input type="text"/></td><td>Z203</td><td>Sporadic Workers Comp</td></tr> </tbody> </table>	Days Off	Z Code		<input type="text"/>	Z100	Vacation	<input type="text"/>	Z201	Occasional Illness	Z Codes Requiring Personnel Approval:			<input type="text"/>	Z202	Temporary Disability	<input type="text"/>	Z400	Death in Family	<input type="text"/>	Z500	Civic Duty	<input type="text"/>	Z600	Lab Holiday	<input type="text"/>	Z601	Optional Holiday	<input type="text"/>	Z800	Military Leave	<input type="text"/>	Z901	Leave without Pay	<input type="text"/>	Z603	Miscellaneous NPT	<input type="text"/>	Z203	Sporadic Workers Comp	Enter the actual days off Below (This is required data) <table border="1"> <tbody> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> <tr><td><input type="text"/></td></tr> </tbody> </table>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Days Off	Z Code																																																		
<input type="text"/>	Z100	Vacation																																																	
<input type="text"/>	Z201	Occasional Illness																																																	
Z Codes Requiring Personnel Approval:																																																			
<input type="text"/>	Z202	Temporary Disability																																																	
<input type="text"/>	Z400	Death in Family																																																	
<input type="text"/>	Z500	Civic Duty																																																	
<input type="text"/>	Z600	Lab Holiday																																																	
<input type="text"/>	Z601	Optional Holiday																																																	
<input type="text"/>	Z800	Military Leave																																																	
<input type="text"/>	Z901	Leave without Pay																																																	
<input type="text"/>	Z603	Miscellaneous NPT																																																	
<input type="text"/>	Z203	Sporadic Workers Comp																																																	
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			
<input type="text"/>																																																			



# Subcontract Management

When substantial effort associated with large and complex projects is obtained through subcontracts, the subcontracts must be written in such a way that information required for earned value management may be readily obtained from the subcontractor. The scope, complexity (risk), criticality, and cost of the subcontracted work may warrant inclusion in the subcontract of an EV flow-down provision. The project manager will establish reporting requirements for all subcontracts.

## 4.1 SUBCONTRACTS WITH EV FLOW-DOWN

[Guide 9, 10, 16, 22, 23 {2.2d, e, 2.3a, 2.4a, b}]

The earned value flow-down subcontracts are generally high dollar value (required on projects greater than \$20 million), high-risk subcontracts. These subcontracts require careful planning prior to solicitation and award. The solicitation (RFP) or Memorandum of Understanding (MOU) must include the proper language and the subcontract the appropriate contract clauses, including full description of the reporting requirements. The reporting requirements include monthly earned value, and performance reporting from the subcontractor to PPPL. Requirements for reporting are described in the Request for Proposal (RFP) and formalized in the contract.

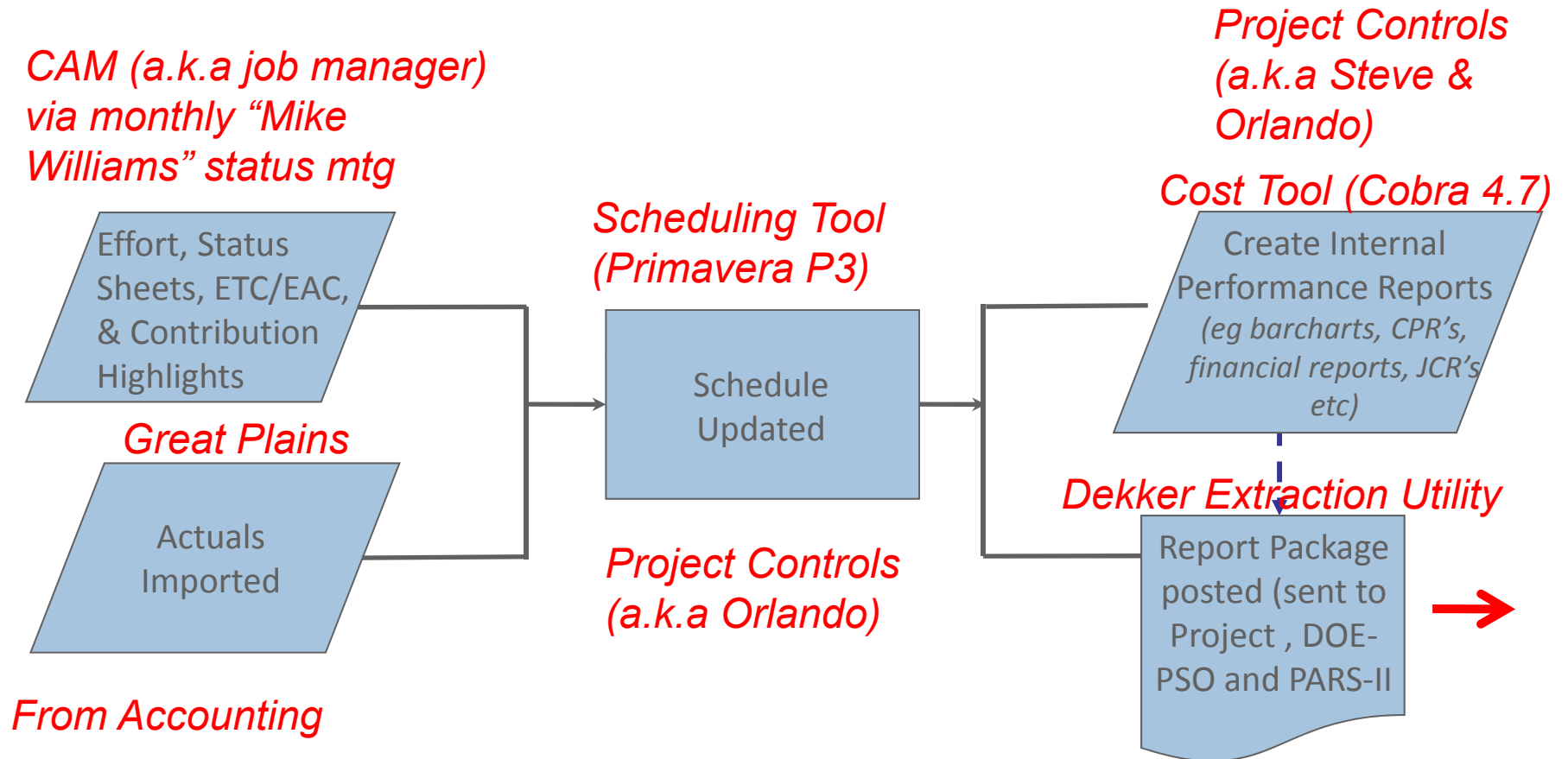
An EV flow-down requirement is not mandatory for any one of the following types of subcontracts:

- Time and material
- Support subcontracts that are primarily LOE

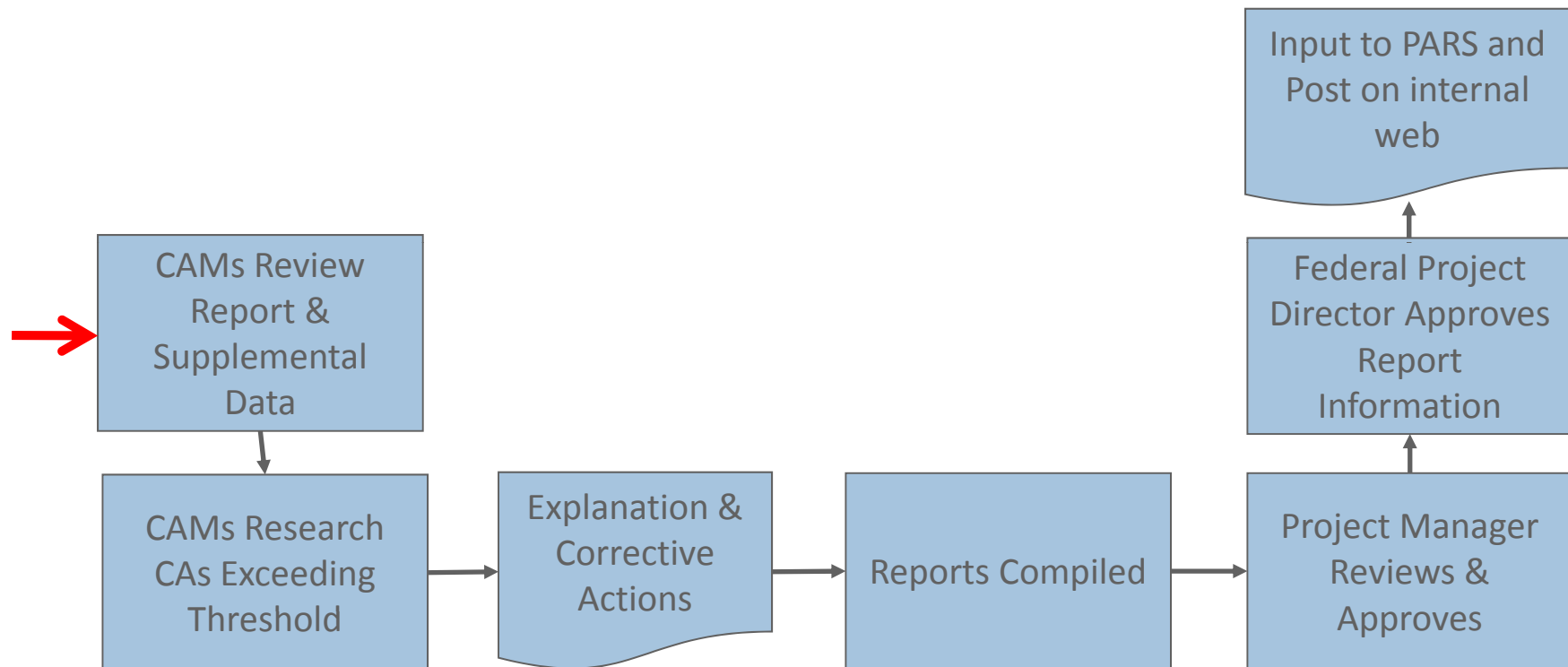
# Analysis & Management Reports

- Applicable Procedure(s)
  - PPPL PMSD Appedix E
    - Procedure 8 Monthly Status Reporting
- Monthly Reporting Requirements On Project Status
  - Contract Performance Reports (CPRs) – Customer
- Identify Significant Differences In Schedule/Cost Performance & Provide Reasons
- Summarize Data & Variances Through The WBS Elements & Compare Results With Baseline
- Implement Recovery Plans, Managerial Actions, & Recommendations Resulting From Reports & Exceeded Thresholds
- Develop Revised Estimates Based On Performance To Date & Future (EAC & ETC)

# Analysis & Management Reports - Reporting Process



# Analysis & Management Reports - Analysis Process

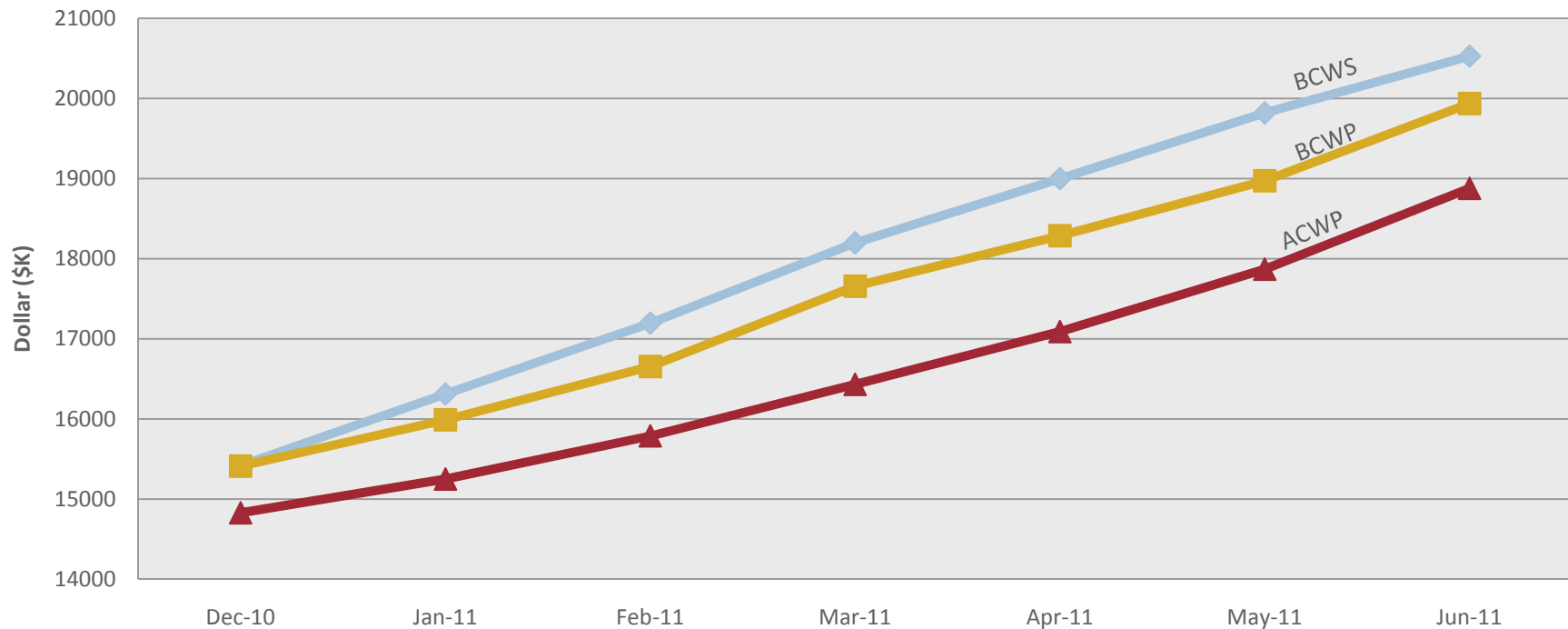


# Analysis & Management Reports - Metrics & Calculations

- Cost Variance (Favorable  $\geq 0$ , Unfavorable  $< 0$ )
  - $CV = BCWP - ACWP$
- Cost Efficiency (Favorable  $> 1.0$ , Unfavorable  $< 1.0$ )
  - Cost Performance Index (CPI) =  $BCWP / ACWP$
- Schedule Variance (Favorable  $\geq 0$ , Unfavorable  $< 0$ )
  - $SV = BCWP - BCWS$
- Schedule Efficiency (Favorable  $> 1.0$ , Unfavorable  $< 1.0$ )
  - Schedule Performance Index (SPI) =  $BCWP / BCWS$
- Estimate At Completion
  - $EAC = ACWP + ETC$
  - Three Alternate Versions But We Use This Mainly
- Variance At Completion (Favorable  $\geq 0$ , Unfavorable  $< 0$ )
  - $VAC = BAC - EAC$

# Analysis & Management Reports - Reporting Example

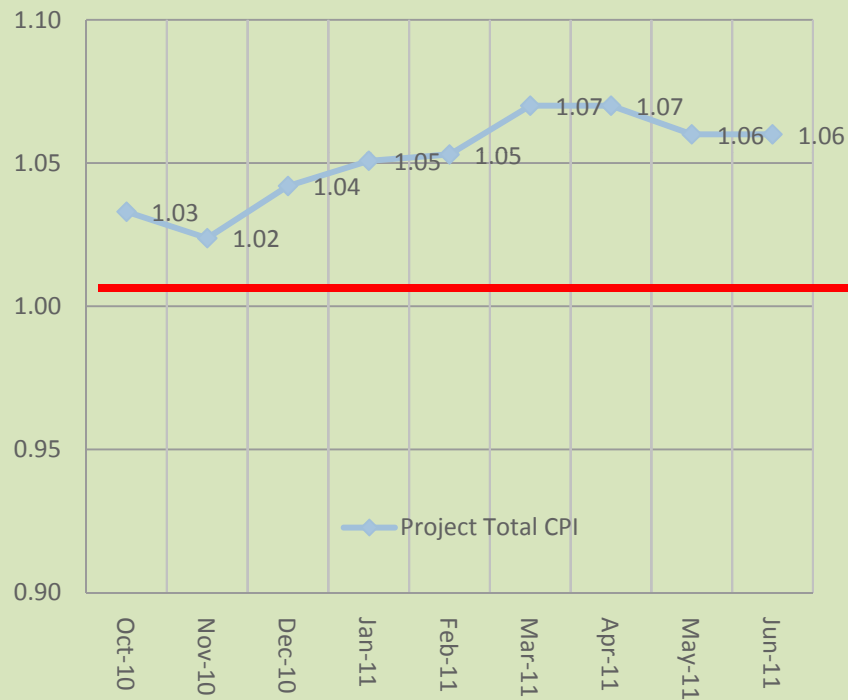
NSTX Upgrade Project Performance since CD-2 Approval



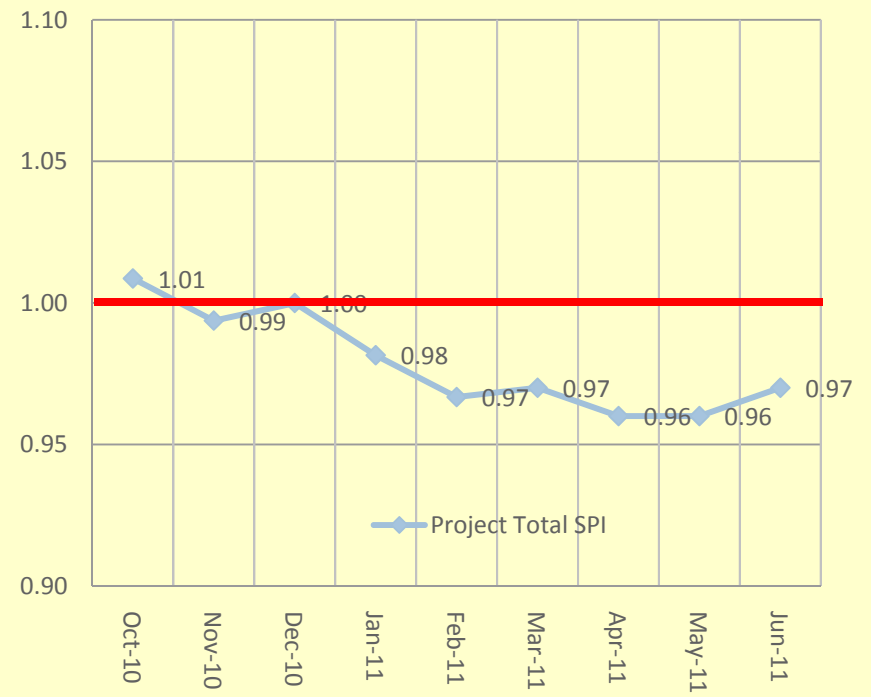
	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11
BCWS	15419	16311	17196	18197	18999	19819	20528
BCWP	15412	15989	16655	17656	18287	18972	19937
ACWP	14828	15249	15788	16431	17090	17869	18878

# Analysis & Management Reports - Reporting Example

## NSTX UPGRADE PROJECT OVERALL



## NSTX UPGRADE PROJECT OVERALL



# Revisions

- Applicable Procedure(s)
  - PPPL PMSD Appendix E
    - Procedure 8 Change Control
- Establish Change Management System With Thresholds
- Incorporate, Control, & Document Authorized & Retroactive Changes (Includes Cost, Schedule, Scope, & Administrative)
- Record Updates & Effects To Budget & Schedule
- Prevent Unauthorized Changes To Baseline
- When Can Changes Occur?
  - Contractual Changes/Modifications
  - The Use Of Contingency/Management Reserve
  - Re-Planning
  - Formal Reprogramming
  - Bottom Line: Any Change To Scope (Technical), Responsibility, Schedule, Or Budget

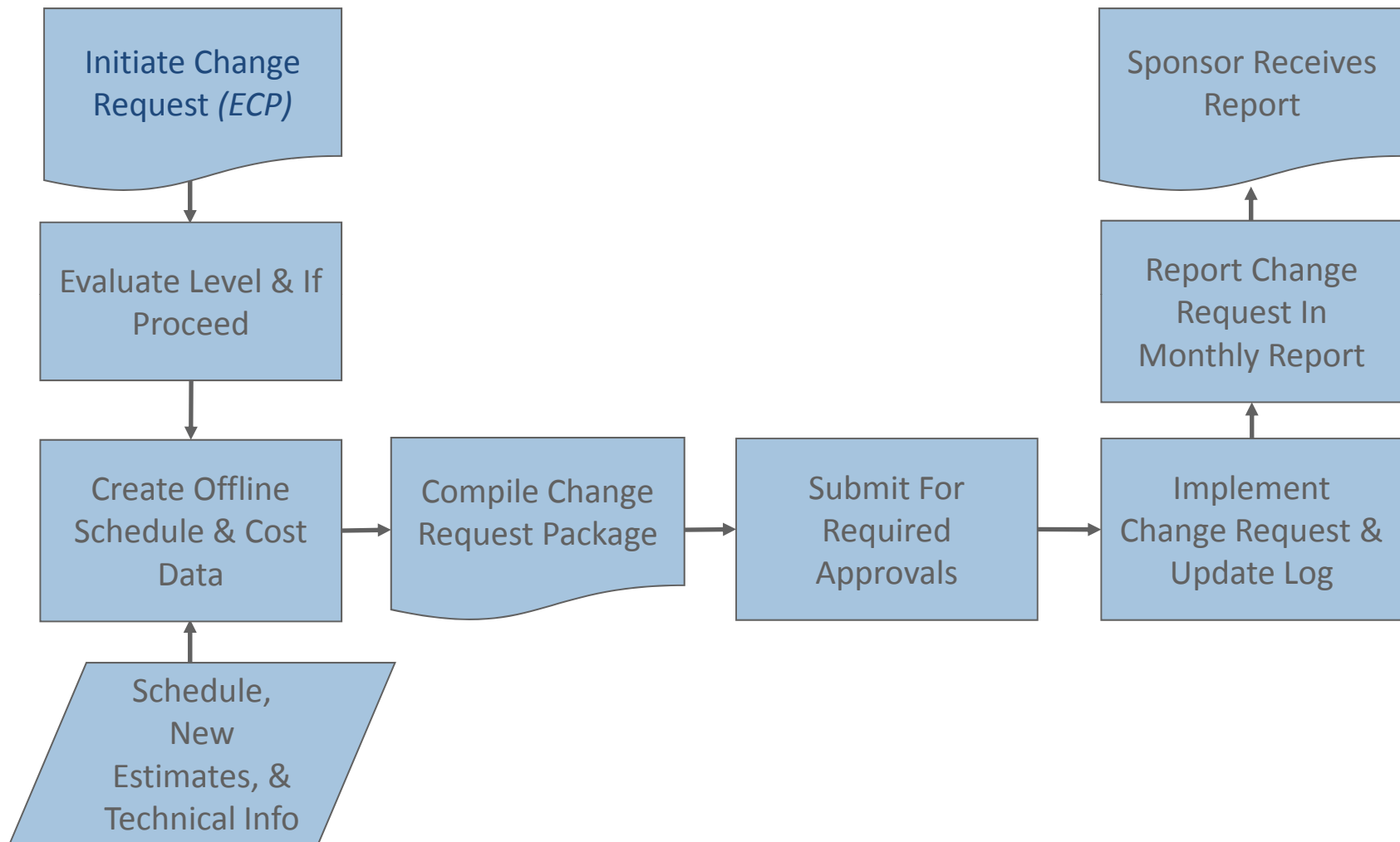


# Revisions - Thresholds

- Change Approval Thresholds (NSTXU PEP Table 4)

Change Level	Approval Level	Technical Scope	Schedule	Cost
0	Deputy Secretary of Energy	Any change in scope and/or performance that affects mission need requirements as show in Section 2.2.2 or is not in conformance with the current approved OMB-300.	6 month or greater increase (cumulative) in the original project completion date as show in Section 2.2.4.	Increase in excess of 25% (cumulative) of the original cost baseline as show in Table 1, Section 2.
1	Director of Science, SC-1	Changes to technical requirements and parameters that affect safety basis and operation function, but do not affect mission need objectives.	Less than a 6 month increase (cumulative) in the original project completion date as show in Section 2.2.4.	Increase of the original cost baseline as show in Table 1, Section 2.
2	NSTX Upgrade Project Federal Project Director	Changes with ES&H impacts significant enough to affect the approved NEPA/EA documentation.	Change in DOE level II milestones discussed in Section 2.2.4	Changes requiring the use of contingency funds as referenced in Table 1, Section 2.
3	NSTX Upgrade Project Manager	Changes not requiring DOE approval.	All other changes to the performance measurement baseline that do not affect level II milestones.	All other changes to the performance measurement baseline costs not requiring DOE approval.

# Revisions - Change Process



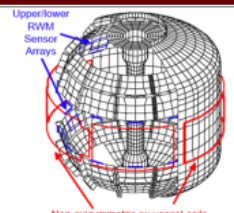
# How P3 & Cobra Play?

- Just Tools To Complete The Job (For Project Management)
  - P3 – Resource Loaded Schedule
  - Cobra– Actuals & PMB
- Communicates Project Status To Upper Management & The Customer
- Imports Actuals From Financial
- Organizes Tasks, Maintains Schedule, & Allocated Budget
- Calculates EVM Metrics & Summarizes For Reporting
- Generates Documents For Monthly Reports
- Acts As Repository For Historical Data

# Communication Is Key...

**Project Web Sites**

[Experiment Dept](#) [FIRE](#) [ITER & Tokamaks](#) [NCSX](#) [NSTX](#) [PS&T](#) [QPS](#) [TFTR](#) [TFTR D&D](#)



**Accomplishments**

[Drag & Drop](#)

[Home](#)

[Meetings](#)

[Operations](#)

[Organization](#)

[Overview](#)

[Program](#)

[Project](#)

[Publication](#)

[Software](#)

[Topical Science Groups](#)

[NSTX Upgrade](#)

**Work Breakdown Structure**

- [WBS Dictionary](#)

**Work Authorization Forms (WAFs)**

**Project Status**

- [Earned Value Management System \(EVMS\)](#)
  - [Cost Account Manager \(CAM\) Notebook](#)
- [Project Performance & Status](#)
  - [Cost Performance Reports \(CPRs\)](#)
  - [Variance Reports](#)
  - [Statused Barcharts, Labor Reports](#)
  - [Latest Performance Trends](#)
- [Engineering Change Proposals \(ECPs\)](#)
- [Risk Register](#)
  - [Latest Risk Register \(R18\)](#)

**1** [Control Account Manager Responsibilities](#)

**2** [Work Authorization Document\(s\)](#)

**3** [Organizational Breakdown Structure](#)

**4** [Responsibility Assignment Matrix](#)

**5** [Schedules/Variations/Work Package Summary](#)

**6** [Critical and Near Critical Paths](#)

**7** [Project Specific Procedures](#)

**8** [Performance Trends](#)

**9** [Earned Value Methods](#)

**10** [Reference Documents](#)

2nd Lithium Upgrade April 2010

Site Address: <http://nstx-upgrade.pppl.gov>

# What's Up Next?

- Next Time (Yes, There's More Training To Come)
  - In Depth Focus On Analysis, Reporting, & Revision
  - Examples & Exercises Based On Other Project's Reports
  - EVMS Review & Interview Question Preparation

# Summary

- Understand That Earned Value
  - Helps Determine If Your Project Is On Schedule & Within Budget
  - Assesses The Project On The Basis Of Cost & Schedule As Compared To What Has Been Accomplished In The Baseline Plan
  - Three Key Components:
    - Cost, Schedule, & Technical Baselines (Planned Value - BCWS)
    - Actual Charges (Actual Value - ACWP)
    - Reported Accomplishments (Earned Value - BCWP)
  - Is the Result Of Following Good Management Practices
    - Organization
    - Planning, Scheduling, & Budgeting
    - Accounting Considerations
    - Analysis & Management Reporting
    - Revisions & Data Maintenance
- What's Up Next?
  - In Depth Focus On Analysis, Reporting, & Revision
  - Examples & Exercises Based On Other Project's Reports
  - EVMS Review & Interview Question Preparation

# Additional Resources

- Websites
  - EVM - <http://www-local.pppl.gov/EVMS/>
  - Overkill On EVM Information - <https://acc.dau.mil/evm>

# Questions?