TEMPORARY CHANGE REQUEST

TCR NO. TCR-ENG-053,R0-002
(e.g., TCR-ENG-021,R0-001)

The Temporary Change Request (TCR) Form is to be used to process urgent or minor changes for PPPL Policies, Organization/Mission Statements and Procedures. The TCR should be used when changes are:
1) urgent, and can not wait the 2-4 week period for Department Head review/comment, or
2) minor, and do not warrant Department Head review.

Person Requesting Change: T. N. Stevenson **Phone Ext: 2657**

Department Name: ENGR & INFR

Document Number: ENG-053 **Revision No.: 0**

Document Title: Job Cost Estimate Development and Control

Reason for change:
Add Project Design to Cost section after Introduction section and before Definitions section.

Change description: (Summarize and attach changed pages, with changes clearly indicated)
Project Design to Cost Principles
A fundamental principle for designing to cost is to ensure that the project contains enough scope contingency (i.e., scope that can be removed from the project) such that the overall project cost objective can readily be met. This includes time-phasing the contingency scope in a way that allows it to be removed from the project before unintended costs are incurred.
Cost estimates and projections must be evaluated continuously throughout the life of the project to ensure that the design-to-cost objectives are being met. Whenever the estimate or projection for an element of the project is anticipated to exceed the amount that was planned, one or more of the following steps must be taken:
1. The design of the element must be changed to fit the planned cost constraint.
2. The increased cost associated with the design must be traded off with one or more other elements within the total project.
3. The overall project design must be changed to accommodate the cost increase associated with the offending element and the overall project budget replanned.
4. Scope must be removed from the project (scope contingency) and the remaining budgets adjusted accordingly.
As with all projects, good project management practices are necessary to maintain cost and schedule. Typically, a Design to Cost type project will have a WAF review as part of every design review and will employ EVMS with monthly status.

1. Does this TCR significantly alter the intent or scope of the document? **YES:** **NO:X**

2. Does this TCR significantly impact **ES&H**? **YES:** **NO:X**

If 1 or 2 is **YES**, Explain why the changes should not be routed for Department Head review:

Tim Stevenson **5/6/2015**
Department/Division Head Approval **Date**

John DeLooper **5/6/2015**
Head, Best Practices and Outreach/designee **Date**
Release/Effective date of this TCR: 5/12/2015

Incorporate this TCR into next revision of this document? **YES:X** **NO:**

Subject:	Effective Date:	Initiated by:
Job Cost Estimate Development & Review	November 17, 2010	Head, Office of Project Management
	Supersedes: NEW	Approved: Director

TCR-ENG-053, R0-002

Management System (Primary): 03.00 Engineering
Management System Owner: Associate Laboratory Director for Engineering and Infrastructure
Management Process: 03.06 Technical Project Management
Process Owner: Associate Laboratory Director for Engineering and Infrastructure
Sub-Process: 03.06.12 Scope Management, Planning, Definition, Verification, and Scope Change Control
Sub-Process Owner: Associate Laboratory Director for Engineering and Infrastructure, Head, Project Management
Subject Matter Experts (SMEs): Head, Project Management TCR-ENG-053, R0-002

Applicability

This procedure applies to any activity at PPPL or for collaborations that require established and formal development and review of a job cost estimate as part of proper and consistent project management.

Introduction

Proper job cost estimate development and review is an instrumental part in building a firm foundation for the overall project management and earned value reporting process. At PPPL, the Work Approval Form (WAF) template is a tool for the development of job cost estimates. This template is available on the Engineering web page. The WAF form is a highly configurable spreadsheet that can be tailored to the individual job. It provides the basic framework for a task list, durations, linkages, materials and subcontracts (M&S) costs, and labor demographics, hours, and rates. The WAF also offers a standard methodology for the estimation of contingency and risk. In the case of collaborations, if another format equivalent to the WAF is used, this document can be used in lieu of the WAF for review purposes.

Adequate resources need to be identified, assigned, and supported in executing project work scope including direct and indirect resource allocation for projects. Preparation of WAFs should consider available resources and reasonable workloads. Supervision, RLMs and Project Managers need to identify workload issues early and evaluate priorities to assure that staff assignments are reasonable and support project plans.

Per AFCI LL report Action Item 1312-6, adequate resources need to be identified, assigned, and supported in executing project work scope. The WAF provides a key opportunity to plan resources early in projects. The WAF and WAF review provides an opportunity for the discussion of resources. The discussion should include direct and indirect resource allocation for projects. This TCR adds clarification to ENG-053.

Per this procedure, job cost estimates are reviewed by the Engineering Department, the Office of Project Management, and the Planning & Control Division at a WAF review. WAF reviews are intended to ensure compliance and consistency, provide oversight and feedback, assess uncertainty and risk, and strengthen the integrity of the project management function and process.

For large capital projects, as defined by DOE Order 413.3A, the PPPL Project Management System Program Description (PMSD) defines the overarching requirements of a project and the need for a Work Breakdown Structure (WBS). The WBS will further define a list of jobs. This procedure implements the PMSD at the job cost level within each WBS. For smaller projects, as defined by DOE Order 413.3A, this procedure is a stand alone implementing procedure for job costs providing a graded approach where the full applicability of the PMSD is not required.

Guidelines for preparing basic estimates at PPPL are included in this procedure to provide a relatively simple starting point for the development of cost estimates that track well throughout the life cycle of a job. Additional Project Management techniques and theories can be considered for cost estimate development if needed.

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Typically, a Design to Cost type project will have a WAF review as part of every design review and will employ EVMS with monthly status. **TCR-ENG-053, R0-002**

Definitions

COG – The individual assigned responsibility for performing the scope of work. This individual prepares the cost estimate (WAF) and is responsible for the job costs and reporting the status of the schedule to execute the activity.

P&CO – The Planning and Control Officer responsible for creating a resource loaded schedule based on the WAF. This individual uses the business systems and input from the COG for tracking job progress and reporting and measuring the earned value of a job.

RLM – The Responsible Line Manager who is responsible for oversight of the work assigned to the COG and monitors progress per ENG procedures, sound Project Management principles, and Integrated Safety Management (ISM). The performing RLM can be different from the funding RLM.

WAF – Work Approval Form. A job cost estimate tool (PPPL Excel spreadsheet template) that documents the work scope to be performed, establishes a schedule, provides a cost estimate, identifies a responsible person for accomplishing the work, and provides for time phased cost and manpower profiles.

WAF Review Board – A panel consisting of the Associate Director for Engineering and Infrastructure, involved Engineering Department Division Heads, Office of Project Management, involved Planning and Control Officers, and the Requesting and Performing Department Heads. This board holds a job cost estimate meeting to review and critique a job cost estimate.

WBS – Work Breakdown Structure. A product-oriented grouping of project elements that organizes and defines the total scope of the project. The WBS is a multilevel framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. It is the structure and code that integrates and relates all project work (technical, schedule, and cost) and is used throughout the life cycle of a project to identify and track specific work scopes.

Work Plan – The process of planning a job beginning with a Work Planning form. The Work Planning form is used by the Cog and RLM to define the job and includes the scope and Integrated Safety Management (ISM) core functions at the earliest stage of a job.

References

DOE Order 413.3A	Program and Project Management for the Acquisition of Capital Assets
ENG-032	Work Planning Procedure
PMSD	Project management System Description

Procedure

WAFs are usually prepared after initial peer reviews and Conceptual Design Reviews (CDRs) when scope is known. WAFs can be revised for the Preliminary Design Review (PDR) if needed or at any time as required. The WAF review process is the same for new and revised WAFs.	
COG	1. Prepares a Work Plan per ENG-032 including job definition, requirements, design, ES&H issues, NEPA, engineering reviews and deliverables, analysis of hazards and controls, and interfaces with other groups. This work should be rigorous

	enough to provide a skeletal outline for the WAF task list.
RLM	2. Approves WP which includes definition of the scope, requirements, reviews, ES&H, and Interfaces.
COG	3. Prepares a job cost estimate (WAF). (See Guidelines.) This effort should include a task list at an appropriate level of detail for the job, durations, linkages, hours, M&S, and contingency and risk, as well as the basis of each estimate. The WAF should be at a level commensurate with the associated stage of the design. (A WAF at the CDR stage will be general in nature. A PDR WAF will be much more detailed and may become part of a baseline as part of CD-2 per DOE 413.3A.)
RLM	4. Evaluates WAF to ensure appropriate considerations have been made per the WP.
P&CO	5. Evaluate WAF to ensure it is at an appropriate level of development to create a resource loaded schedule.
COG	6. Schedules a WAF Review with the Associate Director for Engineering and Infrastructure.
WAF Review Board	7. Reviews WAF to vet the scope, tasks, estimates, methodology, resource allocation and availability, and contingency and risk. Issues action items as needed.
COG	8. Updates WAF per action items.
COG, RLM, and P&CO	9. Approves updated WAF with signature.
Associate Director for Engineering and Infrastructure	10. Approves WAF with signature.
P&CO	11. Uses WAF input to develop a resource loaded schedule and input to business systems for tracking at the appropriate point in the job.

Guidelines for Job Cost Estimate Development

Requirements and Job Definition

- The integrity and accuracy of a WAF is largely based on the knowledge and understanding of the requirements and scope needed to accomplish the job.
- Physics, Engineering, ES&H, Environmental, and Management requirements need to be identified at an early stage during job definition.
- If requirements development is iterative and R&D or further analysis is required, hold/decision points should be included. Care and caution should be exercised with estimates in this case to avoid R&D cost growth. These hold/decision points can be a series of peer reviews prior to a CDR held to approve

changes to adequately assess the job for scope and requirements creep and associated cost and schedule growth.

- If the job is beyond experience, appropriate R&D, prototyping, testing, or survey of external and industry expertise must be included at the pre-conceptual stage to adequately assess and capture scope, cost, and schedule variables.
- Job definition should include enough scoping study early on to determine any real key restrictions and to eliminate any unnecessary constraints or assumptions.
- ES&H, environmental impacts, Davis Bacon Determination, IH, and HP considerations and costs need to be considered and included where needed.
- Labor hours should be based on a proficient worker performing correct work with acceptable but not extraordinary productivity. For extraordinary build difficulty, it may be necessary to overbuild quantities to obtain enough units or to provide sufficient contingency to account for rework.
- A COG may be asked to prepare an estimate for a job that includes novel scope or goes beyond normal purview. Other experienced staff should contribute when necessary.

Design and Drafting

- Adequate time in the job definition phase can greatly improve the accuracy of the estimated Engineering time.
- Engineering time can vary widely from job to job and during the normal course of a job, but once the job starts it needs some amount of oversight.
- Engineering hours should be included for design work, modeling, analysis, calculations, Design Reviews, WAF creation and maintenance, Drafting, shop supervision, procurement package preparation, procedures, etc. as required. Adequate labor hours to cover any external reviews, job supervision, and management should be included unless accounted for in other project WAFs.
- A design may be simple enough such that the COG or a single discipline engineer can perform the design and analysis or it may require a team of individuals with a variety of skills. Careful assessment of the design process, demographics, and linkages required to successfully complete the design greatly improve the accuracy of the estimate and the tracking of actual versus planned costs.
- Drafting can vary extensively with the type of job. 40 hours per drawing is an often used rule of thumb.
- Procurements require drawings.
- Shops require drawings.
- Installation and testing require approved procedures.

Framing Out the Cost Estimate

- Base cost estimates should be realistic but prepared to account for normal inefficiencies.
- Estimates can be derived from national standards, previous experience, comparable work, engineering judgment, industrial methodologies, external sources, prototypes and tests, vendor quotes and catalogues, as well as other means.
- The costs and schedules specified by the WAF should be updated periodically, especially following a CDR, PDR, and FDR.
- For long task durations (greater than 3 weeks) include modest overage to allow for personnel nonproductive time, training (lab and job), and other lab functions. Durations are often dictated by resource availability and priorities as well as other restrictions.

- Task line items should be specific enough to accurately reflect job scope and demographics required to perform the task.
- Labor hours for tasks need to be realistic but still account for normal inefficiencies.
- Linkages can vary from straightforward technical progress to complex mergers of interlaced subsystems. Tasks should be listed, linked, and grouped in an orderly way such that job statusing and EVMS can be readily performed. The WAF estimate essentially becomes the Budgeted Cost of Work Planned (BCWP). The WAF tasks become a resource loaded schedule.
- Granularity of the task steps, M&S, and labor hours for the estimate should be established at a level of detail low enough to allow for creation of an accurate estimate and EVMS tracking.
- For technical work, the staffing levels should be commensurate with modest use of lab resources unless priorities indicate otherwise. For example, do not assume all machinists will be available to work on one specific job unless it is a job of high priority.
- Many technical tasks require teams of people to accomplish the work (Hoisting and Rigging, Confined Space, HP RWP work). The cost estimate should account for the team and full duration of the task in an adequate manner so coverage for JHAs, pre-job briefs, training, and other job performance requirements are included.

Procurements, Purchases, Materials and Supplies, and Stock Room

- Long Lead items should be identified and included as pacing items for the fabrication phase.
- Adequate time for Procurements should be included in durations and factored in prior to the fabrication process.
- M&S costs should be as defined as possible given the maturity of the design.
- The basis of the estimate for M&S should be included.
- If the availability of the M&S item is unknown, this should be entered into the risk register and adequate contingency should be included for recovery, i.e. redesign, vendor development, or in-house fabrication. The risk can be retired if and when availability is confirmed.
- Other costs should be adequately considered. (Training, travel, new software licenses, etc.)

Fabrication, Assembly, Installation, and Testing

- Labor hours should be based on a proficient worker performing correct work with acceptable but not extraordinary productivity.
- It is often more realistic to round out a task to the natural working unit of time. For instance, a task that takes 7.5 hours can be rounded to an 8 hour day. An effort that sums to 39 hours would be more accurately estimated as a 40 hour work week.
- Field and shop work estimates usually need field and shop input to improve accuracy.
- Many ES&H, Hoisting & Rigging, RWP tasks require safety watches, door guards, fire watches or other special personnel to permit work to take place and must be included in estimates.
- Labor rates should be the latest available per the WAF template.
- Schedules for starting work, linkages to other tasks, and completion dates should reflect a cautiously optimistic approach if tasks moved along normally through the laboratory complex.
- Procedures are required for some technical work and significant time can be spent writing, reviewing, and approving procedures.

- Testing by its nature seeks out problems which may require rework. Systematic testing from simple tests through preoperational tests to integrated system tests should be folded into any field work where testing is required.

Uncertainty, Contingency, and Risk

- While the risk analysis is used to inform the Project Manager about the need for contingency, risk should not be used to pad the job estimate but should be covered by the contingency held by the Project Manager.
- Uncertainty at pre-conceptual and CDR stage should be considered high unless the job is very similar to previous work.
- As the design verification progresses, uncertainty should decrease. A standard for assessing design maturity and complexity is included in the WAF template.
- Contingency should be based on an assessment of the confidence level in the job and cost estimate.
- Contingency can include technical, cost, or schedule source terms.
- Contingency covers the unknown unknowns that can undermine the execution of a job.
- Undue contingency should not be used to compensate for incomplete job definition or a lack of requirements. Do more homework.
- Contingency based on the WAF table can be performed across the job or line by line and summed. Risks are typically tangible concerns that might affect the underlying assumptions on which the job cost estimate is based.
- For larger projects a risk registry is used to capture predicted risks from all contributing jobs. For smaller projects, the WAF risk table can be used to predict and resolve risks.
- Risks should be identified based on concerns that underlying assumptions will not hold true, for instance a specialty machine breaks and must be replaced to complete the job.
- Risks can be assessed on a probabilistic or likelihood basis.
- Risks can and should be retired by including tasks into the job or by other means.

Checking the Result

- It is often helpful to step back and examine the big picture. For example:
    - Can a peer review, CDR, PDR, and FDR be completed in six months? (0.5 FTE EM labor)
    - Can five technicians working for a year complete this job? (approximately $1 million)
    - Does M&S seem correct if compared to a similar purchase?
- Ask for guidance from Planning & Control or the Office of Project Management.

TRAINING (SECTION REQUIRED FOR ALL PROCEDURES)

TCR-ENG-053, R0-002

Author

1. Specifies the appropriate training methods and means (below) and obtains concurrence of the Management System Owner and the Management Process Owner.

A. Target Audience: COG's, RLM's and Project Managers
Instructor: Head, Project Management
Training Method: X Classroom
Frequency: X Annual

B. Target Audience: Supervisors
Instructor: Best Practices Division
Training Method: Standard email distribution of revised procedures.
Frequency: Upon revision and TCR of this procedure.

C. Target Audience: Council
Instructor: Associate Laboratory Director for Engineering and Infrastructure
Training Method: Briefing of Council on the procedure changes at a weekly Laboratory Management Meeting (LMM).
Frequency: Upon significant revision of this procedure.

Management System Owner or Designee

2. Notifies the Human Resources Training Office of the training so that they will be aware of the training requirements and be able to provide assistance and guidance in the course development, implementation, tracking, and maintenance. TCR-ENG-053, R0-002

Records Requirements Specific To This Procedure

Records Custodians must assure records are maintained as follows:

Record Title	Record Custodian	Location	Retention Time
Work Approval Form (WAF)	Cognizant Individual	Operations Center or Department-designated Central File Location	Until project completion or termination whichever is earlier. *Reference: Admin 17 Cartographic, Aerial Photographic, Architectural, Engineering, and Facility Management Records (30.a)*

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