

<b>SUBJECT:</b>	<b>FERMI RESEARCH ALLIANCE PROCEDURES PROJECT MANAGEMENT</b>	<b>NUMBER:</b>	12.PM-005
<b>RESPONSIBILITY:</b>	Office of Project Management Oversight	<b>REVISION:</b>	<a href="#">43</a>
<b>APPROVED BY:</b>	Head, Office of Project Management Oversight	<b>EFFECTIVE:</b>	<a href="#">03/08/1209/17/09</a>
<b>TITLE</b>	<b>Cost Estimating</b>		

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**1.0 PURPOSE**

This procedure establishes the methods for developing cost estimates and implementing the cost estimating requirements as defined in the FRA *Earned Value Management System Description* document.

**2.0 SCOPE**

This procedure establishes the methodology for developing cost estimates for FRA projects where DOE Order 413.3BA, “*Program and Project Management for the Acquisition of Capital Assets*,” is required, or on projects where an Earned Value Management System (EVMS) is deemed appropriate.

**3.0 RESPONSIBILITIES**

**3.1 Project Manager (PM) is responsible for**

- issuing estimate preparation guidance and instructions
- establishing the project’s WBS and control account (CA) structure
- establishing the project baseline budget consistent with the technical and schedule portions of the project baseline
- approving time-phased CA budgets
- documenting the baseline budget information in the Project Execution Plan (PEP)
- establishing estimate type based on known scope, schedule, pricing basis, and customer or sponsor requirements
- implementing any additional baseline budget development processes, practices, or procedures imposed by the project or customer specific requirements or the Project Manager’s functional organization

**3.2 Control Account Manager (CAM) is responsible for**

- developing cost estimates and establishing time-phased control account budgets
- managing the opening and closing of chargeable task codes as appropriate to support currently active work scope
- identifying and documenting risk and [contingencymanagement reserve](#) estimates
- managing the execution of the work
- providing periodic status update information
- keeping the Project Manager apprised of any changes to the estimated cost at completion
- preparing basis of estimate documentation using direct costs

**3.3 Work Package (WP) Manager**

- Control accounts can be divided into smaller, discrete scopes of work called work packages, and a work package manager can be assigned to specific work packages.

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When this occurs, work package managers have the same responsibilities as CAMs, with reporting responsibilities to the CAM.

**3.4 Functional Managers are responsible for**

- Providing estimates of labor and duration for activities within their area of responsibility

**3.5 Project Controls responsible for**

- Applying burdening rates and escalation to direct costs

**4.0 PROCEDURE**

Cost estimates are prepared in a clear, consistent, comprehensive format that facilitates reviewing the details and assumptions throughout the cost estimate review process. Activities to be estimated are identified in sufficient detail to support the cost estimate methodology used. The estimate details must clearly indicate any productivity factors used and any historical unit rates from national or site specific databases. Cost estimates have backup documentation in a centrally located file that explains the assumptions and calculations on which the estimate is based.

The objectives of the cost estimate process are to:

1. Support the establishment of the Performance Measurement Baseline;
2. Serve as a basis for change control;
3. Support the establishment of the Estimate at Completion (EAC); and
4. Support the establishment of the Estimate to Complete (ETC).

**4.1 Cost Estimating**

The estimate preparation phase begins with the issuance of guidance and instructions from the Project Manager and encompasses those activities that translate the technical design and fabrication into detailed labor and procurement elements of cost. A WBS and WBS dictionary are starting points. The dictionary identifies all activities where costs were or are planned to be estimated, and the WBS is a hierarchical definition of the scope and deliverables required to complete the project effort. (see *WBS, OBS, RAM* (EVMS Procedure 12.PM-001))

Cost estimates are prepared using appropriate estimating methodologies. Estimates should be consistent with [DOE G 413.3-21, Cost Estimating Guide](#)~~DOE Guide 430.1-1, DOE Cost Estimating Guide for Program and Project~~ Management. This guide classifies estimates into one of five categories, based on the Association for the Advancement of Cost Engineering (ACE) Recommended Practice No. 18R-97. Generally, most cost estimates are classified as Class 5 (Order of Magnitude), Class 3 (Preliminary) or Class 1 (Definitive). These classifications, further described in Appendix C, help ensure that the quality of the cost estimate is considered when applying escalation and contingency.

A thorough understanding of the project work scope is necessary to effectively estimate project costs. The level of detail and accuracy of the budget becomes more definitive as

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the project's scope is refined. In a project's earliest phases, the Initiation, or Pre-Conceptual Phase (before CD-0, an order-of-magnitude (or parametric) estimate is required. When a capital asset acquisition project has completed the Conceptual Design Phase, a preliminary budget range is required to establish the Budget Baseline at CD-1. Budget refinements are based on a definitive estimate for every element in the WBS and are required for CD-2.

#### 4.2 Cost Estimate Development

CAMs are responsible for development of cost estimates for work packages and planning packages within the individual Control Accounts. The development of the cost estimate follows the definition of the work package and planning package scope and the development of the initial schedule. The CAM will investigate and assemble basic information concerning the project, including project background, the general description of the technical scope, the anticipated estimate classification, and related background information. The determination of the resources required to accomplish the defined scope within the timeframes scheduled is an iterative process that includes a preliminary Performance Measurement Baseline (PMB) and culminates with a final Performance Measurement Baseline.

The cost estimate is "activity based," which refers to the process of determining the resources required for each activity in the schedule. The development of budget elements and activities is driven by the project scope. Necessary elements for activity definition are that it is measurable and is defined in terms of work output and not simply labor hours to perform. Each activity should have an identifiable unit of measure and, if appropriate, discrete quantities associated with that activity.

This section describes specific steps for preparing cost estimates. In certain cases, specific guidance is necessary to address special requirements, such as those applicable to project work. This guidance is determined by the CAM in consultation with the PM.

Step 1 Review the WBS Dictionary and Technical Scope. - The technical scope provides a detailed description of the work included in the estimate and is described in the WBS Dictionary. The technical scope identifies the activities included in the cost estimate as well as relevant activities excluded from the cost estimate and the rationale for their exclusion.

Step 2 Assemble Technical Scope Detail. - The technical scope detail describes the project purpose, design parameters, and supporting detail. Scope exclusions and the rationale for all exclusions should also be provided. The technical scope detail lists all applicable codes, specifications, quality assurance requirements, drawings, data sheets, bill of material, engineering data, and any other items as required to adequately define the scope of work.

Step 3 Develop Estimate by Specific WBS Element. Cost estimates are prepared and structured consistent with the project WBS and are developed at a schedule activity level. Preparation of an estimate for each specific WBS element for the project is included in the cost estimate. A schedule activity listing provides a clear and concise definition of all activities where costs are estimated.

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Step 4 Identify Estimate Activities - The project scope of work is divided into discrete activities consistent with the project WBS and the schedule activities required to execute the scope of work. Dividing estimate elements into discrete schedule activities provides the following benefits:

- The specific nature of the work can be better defined and understood.
- Portions of the work can be assigned to individual organizational elements.
- Resources can be assigned using cost estimating relationships.
- The work can be better planned and scheduled.
- Changes to the cost estimate can be more easily incorporated.

A tangible work output (deliverable) is associated with each activity wherever possible. If a tangible work output can be associated with an activity, then the activity is considered to be “activity based.” If a tangible work output cannot be associated with an activity then the activity is considered to be “level of effort.”

Activities appearing in an estimate are the same activities that appear in the corresponding schedule, whenever possible. In some instances, several estimate elements are combined to form a single activity in the schedule. An element of the estimate may also be divided into several schedule activities. In any case, elements in the estimate are easily traceable to the corresponding activities in the schedule. The WBS dictionary helps provide this traceability.

This step only applies to planning packages at the point that they are converted into work packages.

Step 5 Develop an Activity-Based Estimate - An activity based estimate has discrete quantifiable units of work associated with each work element.

Step 6 Level of Effort (LOE) Estimate - Certain activities cannot be associated with quantifiable units of work. Instead, these activities are expressed as a defined level of expenditure over time.

Step 7 Define Resources - Resources include the labor, material, equipment, services, and any other budget items required to perform a scope of work. One or more resources may be assigned to a schedule activity. A list of the resources and their associated unit prices is defined before resources are applied to activities in the schedule. Unit prices for labor include wages, taxes, insurance, fringe benefits, overtime, and shift differential when applicable. Unit prices for material include the material price, sales taxes, and shipping costs when applicable

Step 8 Apply Quantities to Estimate Activities - Each activity must have an identifiable unit of measure and a quantity associated with that activity. If level of effort is used, the quantity may be “one” and the unit of measure “lot”.

Step 9 Document Qualifications and Assumptions - The project team documents and defines the assumed conditions under which the project work scope will be performed. The qualifications and assumptions describe the type of work expected, the amount of work

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expected, the source of various materials, the conditions in which the work is to be performed (winter, hazardous conditions, etc.), and any other information that significantly influences the estimate but is not clearly identified in the technical scope description. Major assumptions and exclusions that affect the project or the accuracy of the estimate are also described. The project team identifies areas where work scope descriptions have deficiencies, or where key information is missing and must be assumed. Relevant information about the project is also identified, and qualifications and assumptions are described and documented at the most detailed level practical. This description should be detailed enough to allow an individual not intimately involved with the project to understand the estimate's basis.

Step 10 Assign Resources to Schedule Activities.

**Detailed Work Scope**—Once estimate elements have been defined, units of measure identified, and quantities determined, resources are assigned to each schedule activity. To the extent possible, the resources assigned should correspond with the resources that will be used in completing the work. Unit rates are used to assign resources to estimate activities.

Regardless of the method used to assign resources to a schedule activity, the following is true for each activity:

- All costs are identified
- Labor hours, when applicable, are identified
- Labor type for all labor hours is identified.

All costs must be “fully burdened.” A description of what is included in the burdened rate is included because the definition of “fully burdened” frequently varies.

**Direct labor**—Unit rates can be expressed as dollars per unit, as labor hours per unit, or as a percentage of an associated cost. Unit rates expressed as labor-hours per unit require that the type of labor (carpenter, engineer, secretary, etc.) be identified by associating a labor type or a crew with each unit rate.

A crew is defined by the various labor types within the crew. Each labor type has a corresponding wage rate to allow calculation of cost in dollars. The wage rates for each labor type includes the base rate, payroll taxes and insurance, fringe benefits, travel or subsistence, and adjustment for overtime, if required.

**Collaborator Effort**—Effort from external project collaborators are treated similarly to Fermilab labor, such that collaborator effort can be included in the project schedule and tracked.

**Percentages**—Some activities may use percentages to assign resources (i.e., preliminary design is six percent of construction cost). The appropriateness of using percentages for such items as project management and construction management will depend on the level of maturity in the work scope definition. Percentages should be supported by historical

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data or other applicable data.

**Summary Work Scope**—When details of the work scope are not known, the work scope may be estimated by using the analogy technique or the parametric technique. These techniques may use unit rates expressed as dollars per unit, labor hours per unit, or percentages.

Step 11 Apply Indirect Rates – The development of Fermilab indirect rates is the responsibility of the Fermilab Finance Section Chief Accounting Officer. Fermilab indirect rates are developed by the Finance Section.. Backup information describing how the indirect rates were developed is available and maintained by Accounting. Indirect rates are evaluated and revised on a periodic basis as necessary, in accordance with Finance policies. If applicable, external collaborators will provide their indirect costs for inclusion in the project cost estimate.

Step 12 Apply Escalation Factors – Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, or other costs over time and is calculated using escalation rates or indexes. Most cost estimating is done using current dollars and then escalated to the time when the work is expected to be performed. A base-year must also be established for the purposes of life-cycle cost estimating (see [DOE G 413.3-21, Cost Estimating Guide](#)~~DOE-413.3-1~~ for more on life-cycle cost estimating). Escalation has two main purposes:

- 1. Convert historical costs to current costs.** This is usually accomplished by using indexes from recognized sources. The estimator ensures that the indexes used are applicable to the type of cost being updated.
- 2. Project current costs into the future.** This is done using DOE or customer prescribed escalation rates or indexes. Escalation rates are evaluated by the project team for possible regional or economic differences.

The following represent sources of escalation rates and indexes:

**Project Estimates**—DOE-Headquarters provides annual escalation rates for developing the project baseline for construction, waste management, and environmental restoration projects; these rates are to be used. Rates are evaluated by the project team for possible regional differences.

**Other Sources**—The following sources provide escalation indexes that can be used to facilitate escalating historical cost data to current price levels. This list is not intended to be all inclusive. The estimate preparer selects the indexes most appropriate for the intended use.

- “Means Construction Cost indexes” construction cost indexes on a quarterly basis.

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- The “Engineering News Record” historical construction cost indexes on a quarterly basis.
- The “Means Construction Cost Data, The Annual Edition” historical construction costs indexes for 162 major U.S. and Canadian cities, and includes formulas for calculation
- The “Bureau of Labor Statistics, Monthly Labor Review, Employment Cost Index Section” historical labor cost indexes.
- Historical field data developed at Fermilab.
- Escalation rates obtained from engineering and/or construction industry sources.

Step 13 Assign Risk Based Management Reserve Contingency – The application of ~~contingency management reserve~~ for managing known risk is considered in all estimates and is both prudent and necessary. The known risk component of contingency is sometimes referred to as “management reserve” ~~Management reserve and is~~ is derived from a risk analysis of various aspects of the scope being estimated. This analysis takes into consideration budget, schedule, and technical risks as they apply to the project effort, underscoring the uncertainties that exist in each of the elements. The magnitude of the ~~known risk contingency management reserve~~ estimate will depend on the status of planning, design, procurement, and construction, and the complexities and uncertainties of the operation or component parts of the project element.

~~Contingency Management reserve~~ estimates are generally applied as a percentage of a particular cost or category of work. ~~Contingency Management reserve~~ is held outside the project WBS based on a review of each major cost category/activity.

The project cost estimate is based on using the best available information to develop the expected cost, and then a risk analysis is performed to develop the ~~required management reserve~~ known risk contingency component budget based on risk probability and consequence. ~~C Management reserve~~ characteristics include:

- Association with the specific project risk event.
- Consideration of the varying degree of risk associated with a scope of work.
- Not being used to avoid the effort required to prepare a properly detailed and documented cost estimate.

Higher or lower ~~contingency management reserve~~ amounts for known risks are appropriate throughout the project based on an analysis of project complexity, technical characteristics, and associated risks.

The distribution of ~~contingency management reserve~~ to control accounts or work packages is controlled through a formal change control process.

Step 14 Prepare Estimate Summary – The format of the estimate summary should be based on a format provided by the Project Manager.

Step 15 Review and Check the Estimate – Competent and qualified personnel who have not been involved in preparing the estimate are involved in the review of cost estimates. This review provides an unbiased check of the assumptions, productivity, and cost data

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used to develop the estimate. A peer review is a vital step in providing consistent, professionally prepared cost estimates and to verify estimate completeness. The review is documented to indicate the name of the reviewer(s), the date of the review, and the reviewers' comments and comment disposition.

Step 16 Assemble the Cost Estimate Package – The cost estimate package is assembled in accordance with the direction and format provided by the Project Manager in order to facilitate estimate rollup.

#### 4.3 Basis of Estimate Documentation

A well-documented estimate will withstand scrutiny. If rigorous documentation and estimate procedures are followed, the credibility of a cost estimate increases. It is important to document all steps of the cost estimating process described above in the project's Basis of Estimate (BoE). Appendix C provides descriptions of several estimate types, and Appendix E illustrates a Example Basis of Estimate Form. Use of this particular format is not required, but at a minimum, the documentation should contain the information shown.

The Project Manager controls supporting documentation and ensures that it is retained by WBS element. The CAM forwards electronic copies of the documentation to the project database, where the file should be maintained under configuration management after the baseline is established. Proper care must be given to protect business-confidential and proprietary information from unauthorized disclosure.

Documents and records generated are generated in a manner suitable for reproduction. Documents, records, and work papers should include but are not limited to the following:

- Estimate spreadsheet.
- Work papers, including vendor quotes, telephone records, material quantity measurements from design drawings, basis notes, calculations, etc.
- Analysis, such as contingencies, escalation application, and quantity discounts.
- Estimating codes, such as labor disciplines and phase codes.
- Application rates and associated application methodology.

#### 5.0 REFERENCES

DOE Order 413.3BA, *Program and Project Management for the Acquisition of Capital Assets*  
[DOE G 413.3-21, Cost Estimating Guide](#)~~DOE Guide 430.1-1, DOE Cost Estimating Guide for Program and Project Management~~

Association for the Advancement of Cost Engineering (AACE) Recommended Practice No. 18R-97

*FRA Earned Value Management System Description*

FRA EVMS Procedure 12.PM-001 *Project WBS, OBS and RAM*

FRA EVMS Procedure 12.PM-002 *Control Accounts, Work Packages, and Planning Packages*

FRA EVMS Procedure 12.PM-004 *Project Scheduling*

FRA EVMS Procedure 12.PM-007 *Change Control*

#### 6.0 APPENDICES

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- 12.PM-005A:** Appendix A: Signature Page and Revision History
- 12.PM-005B:** Appendix B: Acronyms and Glossary
- 12.PM-005C:** Appendix C: Cost Estimate Classifications
- 12.PM-005D:** Appendix D: Cost Estimate Methodologies
- 12.PM-005E:** Appendix E: Example Basis of Estimate Form

**Appendix A**  
**SIGNATURE PAGE AND REVISION HISTORY**

This procedure approved by: \_\_\_\_\_ DATE \_\_\_\_\_  
**Director, Office of Project Management and Oversight**  
**Fermi National Accelerator Laboratory**  
**Dr. L. E. Temple**

**TABLE OF REVISIONS**

Author(s)	Description	Revision	Date
	Initial Version	0	10/17/08
E. McCluskey	Word Change: Policy to Guidance.	1	12/02/08
E. McCluskey	Word Change: contingency to contingency / management reserve	2	3/27-09
E McCluskey	Removed reference to OHEP Guidance document in Step 10; revised MR/Contingency wording; removed contingency from BOE form.	3	09/17/09
<a href="#">M. Kaducak</a>	<a href="#">Updated all references to DOE O 413.3A to DOE O 413.3B and references to DOE Guide 430.1-1 to DOE G 413.3-21, <i>Cost Estimating Guide</i>. Updated usage of management reserve and contingency.</a>	<a href="#">4</a>	<a href="#">03/08/12</a>

## Appendix B ACRONYMS AND GLOSSARY

**PB** — Performance Baseline  
**PED** — Project Engineering and Design  
**PEP** — Project Execution Plan  
**PMB** — Performance Measurement Baseline  
**PM** — Project Management

**Collaborator** – A university or laboratory partner who participates in a project by providing labor and/or materials through direct funding from the project, or through in-kind contributions.

**Performance Measurement Baseline (PMB)** - The collected key performance, scope, cost, and schedule parameters. The Performance Measurement Baseline defines the threshold and boundary conditions for a project. The PMB is modified in accordance with the change control process.

**Total Estimated Cost (TEC)** - DOE Order 413.3<sup>BA</sup> defines Total Estimated Cost to include project costs incurred after CD-1 such as costs associated with the acquisition of land and land rights; engineering, design, and inspection; direct and indirect construction/fabrication; and the initial equipment necessary to place the plant or installation in operation.

**Other Project Costs (OPC)** - DOE Order 413.3<sup>BA</sup> defines Other Project Costs to include all project costs that are not identified as Total Estimated Cost costs. Generally, Other Project Costs are costs incurred during the Initiation and Definition Phases for planning, conceptual design, research and development, and during the Execution Phase for startup and operation.

**Total Project Cost (TPC)** - DOE Order 413.3<sup>BA</sup> defines Total Project Cost as the sum of the Total Estimated Cost (TEC) and Other Project Costs (OPC)

## Appendix C

### Cost Estimate Classifications

Cost Estimate Classification	Primary Characteristics		Corresponding Critical Decision
	Level of Definition (% Complete Definition)	Cost Estimating Description (Techniques)	
<b>Class 5, Order of Magnitude</b>	0% to 2%	Stochastic, most parametric, judgment (parametric, specific analogy, expert opinion, trend analysis)	CD-0
<b>Class 4, Intermediate</b>	1% to 15%	Various, more parametric (parametric, specific analogy, expert opinion, trend analysis)	
<b>Class 3, Preliminary</b>	10% to 40%	Various, including combinations (detailed, unit-cost, or activity-based; parametric; specific analogy; expert opinion; trend analysis)	CD-1
<b>Class 2, Intermediate</b>	30% to 70%	Various, more definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)	
<b>Class 1, Definitive</b>	50% to 100%	Deterministic, most definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)	CD-2

**Appendix D**  
**Cost Estimate Methodologies**

<i>Code</i>	<i>Type of Estimate</i>	<i>Description</i>
7	Catalog Listing Or Industrial/ Construction Databases	This category will be used when most of the costs in an estimate can be documented from current vendor catalogs or from published or proprietary industrial or construction databases.
6	Documented Vendor Estimate Based On Drawings/ Sketches & Specifications	The estimate is primarily based on vendor estimates obtained for the specific item or activity. To the extent possible, these estimates will be written rather than oral. Such quotes by a vendor indicate that a design is sufficiently mature that its cost can be independently estimated (i.e., significant detail in drawings and specifications have been prepared), although the quotes will not be taken as an offer to sell at that price.
5	Engineering Estimate Based On Drawings/Sketches & Specifications	Estimates in this category have the same level of detail available as in (2) above, but the estimates are done by an estimator, or a subcontractor who is not likely to be a vendor.
4	Engineering Estimated Based On Similar Items Or Procedures	Estimates are chiefly based on items or activities that have previously been procured or undertaken. The basis for scaling up of down, or “factoring” (e.g., known cost sensitivities) should be documented in the estimate files. Given the variable degree of similarity between components of various FRA projects, judgment must be used in selecting between (4) and (5).
3	Engineering Estimate Based On Analysis	Estimates of items or procedures that are different from previous experience, and while sketches and specifications may exist, the level of detail is not sufficient to qualify for (3) above. Some labor costs, such as assembly of an item not previously built, may fall into this category. Supporting background for procured items would include, for example, standard costs for fabricating a given material and the mass of material needed.
2	Expert Opinion (Engineering Allowance)	This category should be used for items or procedures having little documented basis for the estimate. It indicates little confidence in the estimate. Its use should obviously be minimized in the final estimate. It will be used as the estimate preparation develops, however, to measure the maturity of the estimate at any given point.
1	Existing Purchase Order	A subcontract has already been awarded.

**Appendix E**  
**Example Basis of Estimate Form**

(Space for Logo Here)	<b>Cryomodule Production Project</b> Project Office <b>BASIS of ESTIMATE FORM (BoE)</b>	<b>Document Number: 4773</b> <hr/> <b>Date of Estimate: 7/17/2008</b> <b>Revision #: FINAL</b> <b>Prepared by: G. Coldham</b>
<b>WBS Section: 1.3.3.2.3 Cavity Processing</b>		<b>Unique ID numbers:</b> See Table 1
<b>Task Names:</b> See Table 1		
<b>Cost Type:</b> <input checked="" type="checkbox"/> M&S <input checked="" type="checkbox"/> Labor	<b>Costing Method:</b> <input checked="" type="checkbox"/> Engineering Estimate <input checked="" type="checkbox"/> Prior purchase or experience. Source: ILC R&D <input type="checkbox"/> Catalog Price. Source: _____ <input type="checkbox"/> Vendor Quote (attached) <input type="checkbox"/> Other- Description: _____	
<b>Attach Relevant Documents (including but not limited to):</b> RFP, Responses to RFP, Technical Evaluation of RFP, Vendor Quotes, Technical Specifications, drawing numbers		
<b>Task Total Duration</b> (calendar weeks, 85% achievable): <i>Facility capacity = 100 cycles /52 weeks. Require ~320 cycles</i> <i>Total Task Duration = 3.2 years for all 320 cavities</i>		
<b>Task Total M&amp;S Cost</b> (2008 \$): $\$2,712 \times 320 = \$867,840$	<b>Task Total Labor</b> (resource type & work hours or % for duration of task, 85% efficiency assumed): <i>Sci 0.07 ME 0.3 MT 1.6 weeks /cycle</i> <i>For 320 cycles: Sci 22.4 ME 96 MT 512 weeks</i>	

**Details of Estimate:**

The cavity processing task will adhere to the standardized steps for 1.3 GHz cavities which reference the following procedures:

- PN-12345 BCP and EP Processing
- PN-23456 QC Checks for Incoming Cavities
- PN-45678 Final HPR
- PN-78910 Leak Checking Cavities

M&S costs are associated with the procurement of acid, distilled water, sealing flanges and consumables and are based on the latest information and data available from the ANL and JLab processing facilities for a standard process cycle. Acid costs and are based on current vendor bid (attached). Distilled water is based on current contract (attached).

Labor estimates are based on the latest information and data available from the ANL and JLab processing facilities. In some cases there is a two person rule for operation which implies the total FTE for that task is split between two technicians. Assume personnel efficiency due to breaks, interruptions, etc., of 85%.

**TABLE 1. TASK TABLE**

UID/WBS #	Task Name	Duration (wks)	M&S (\$)	M&S MR(%)	Labor Resource Types	% effort for duration for each labor type respectively	Labor MR(%)
1.3.3.2.3.1	Receive and Prepare Cavity	0.2	\$200	25%	ME	10%	10%
					MT	100%	10%
1.3.3.2.3.2	Perform Bulk EP-1	0.4	\$1,500	35%	Sci	5%	20%
					ME	10%	20%
					MT	25%	20%
1.3.3.2.3.3	Perform First Rinse R-1	0.2	\$100	10%	ME	10%	20%
					MT	25%	20%
1.3.3.2.3.4	Perform First HP Rinse HPR-1	0.2	\$100	10%	Sci	5%	30%
					ME	10%	30%
					MT	25%	30%
1.3.3.2.3.5	Perform H Degassing 600C	0.4	\$0	0%	ME	10%	20%
					MT	50%	20%
1.3.3.2.3.6	Perform Field Flatness Tuning	0.2	\$0	0%	Sci	5%	30%
					ME	10%	30%
					MT	100%	30%
1.3.3.2.6.7	Perform Fine EP-2	0.2	\$250	35%	Sci	10%	20%
					ME	10%	20%
					MT	25%	20%
1.3.3.2.3.8	Perform Second Rinse R-2	0.2	\$100	10%	ME	10%	20%
					MT	50%	20%
1.3.3.2.3.9	Perform Second HP Rinse HPR-2	0.2	\$100	10%	Sci	5%	30%
					ME	10%	30%
					MT	25%	30%
1.3.3.2.3.10	Assemble and Seal Cavity	0.2	\$200	25%	ME	10%	30%
					MT	100%	30%
1.3.3.2.3.11	Bake Cavity 120C	0.4	\$0	0%	ME	10%	20%
					MT	50%	20%
1.3.3.2.3.12	Ship Cavity to VTS	0.2	\$162	25%	ME	10%	10%
					MT	100%	10%
	<b>Total</b>	<b>3</b>	<b>\$2,712</b>				

**Assumptions:**

- 1.) Cavity processing will start as soon as cavities arrive from the vendor.
- 2.) Processing time can be decreased by authorizing work on the weekends or going to multiple shift operation. For this estimate a single shift without weekend work is used.

**Comments:**

None