Costing Goals

- Achieve CD 0.4 rollup 9/00
- Re-baseline all technical/cost models
- Collect costs in categories consistent with new WBS form
- Encourage 50% confidence cost estimates
- Apply learning curves as applicable
- Do not cost escalation or contingency at subsystem level
- Fill all estimates at expense of bottom-up detail
Subsystem Cost Categories

- Conceptual Design
- R&D
- Design
- Sustaining Engineering
- Acquisition
- Installation and Test

- New since Lehman, categories include time phasing CD1-4
- Adopt formula to spread existing numbers
- Assure all phases properly covered
Summary of NLC Cost Estimating Guidelines
Revised 041100 – Rev. 1

1: Goals for the April 24-27 Project Costing Workshop

2: NLC General Cost Estimate Guidance & Examples

3: General Instructions and Definitions
   Table 3.1: Cost Category Definitions & Example Activities
   Table 3.2: General Definitions
   Table 3.3: Definitions of Labor and M&S, B&H

4: Guidelines for Applying Labor Rates
   Table 4.1: Labor Rates and Codes

NLC Management Group
March 30, 2000
Cost Goals

1. Goals for the April 24-27 Project Costing Workshop

Cost the machine that most closely represents the projected CDR 0.4 version (June 8/September 2000) of the NLC. Provide a rolled-up cost that we can contrast with the $5.1/$7.9 B Lehman costs.

Probe the basis for and reasonableness of the architecture choices and cost estimates that drive the cost of the NLC.

How:
- Use the projected CDR 0.4 configuration.
- Use the new cost and contingency guidelines.
- Use the new WBS.
- Do not get distracted by details.

What is required:
- Redefine the treaty points/boundaries for the new WBS.

Machine Configuration Implications
- A forecasted/projected configuration (June 8/September 2000) is required in addition to/instead of the “current” configuration.
- We need an emphasis on architecture and parameters that affect cost. We need a de-emphasis/segregation of descriptive, physics, and performance information.

WBS Implications
- We need to agree on a WBS structure and roll-up mechanism for April that will be hassle-free and require a minimum of time to feed and roll-up. This will allow everyone to focus on the quality of their cost estimates and any duplication and omission problems.
- The consequence is that we will forgo for April any significant analytical use of the WBS by the Planning Group (ability to add things up many different ways). The WBS will need to be a streamlined version that accepts a manageable number of aggregated cost buckets from the area coordinators and rolls up a total project cost.
2. NLC General Cost Estimate Guidance & Examples

• The Design Selected for Costing Should Represent the Optimal Balance (Best Value) Between Technical Performance, Reliability, Acquisition Cost, and Operating Cost

• The Cost of the Best Value Design Should Be as Low as is Practicable, Feasible, and Reasonable, and Consistent with Performance and Reliability

• The Cost Estimate Must Be Comprehensive - Low Cost Should Not Be Obtained at the Expense of Completeness

• Since Multiple Sites Exist for Both Design and Construction, Estimators Need to Make Provisions to Accept Labor Rates from the Planning Group That Will Change as Various Sites Are Considered

• Estimates Will Be Based on Costs for Accomplishing the Work During FY 2000. Escalation to Cover the Higher Costs That Will Be Incurred in the Year in Which the Work Is Actually Performed Will Be Added Later, Using the Integrated Project Schedule.

• Cost Estimators Should Test Their Costs Against Available Metrics to Ensure That They Are Not Too High

• Estimators Should Minimize the Time Spent Tracking the Migration of Their Cost Estimate from the May, 1999 Lehman Review to Now (Broad Brush-Stroke Summary Only), and Concentrate on the Goals Listed Here

• The Cost Review Process Will Provide for Management Modification and/or Replacement of Estimator-Generated Estimates That Are Perceived to Be Unacceptable

• There Will Be No Scoring of the Contingency Factors for This Round of Costing

• All Costs Will Reflect a 50% Confidence Level (50% Chance That the Actual Costs Will Be Either Higher or Lower Than the Cost Estimate). This Contrasts with the May, 1999 Costs Where the Confidence Level Was Determined by the Estimator.

• Probability Distributions of Costs Aggregated at the Work Package Level Will Be Required. Instructions Will Be Provided Separately.

The scope of the NLC is such that cost will always be a major factor. Cost estimates should be prepared in acknowledgement that there will be a continuous and aggressive program to drive down costs both in the design and in the construction phases of the project. While an estimator will endeavor to make his/her estimate clear and supportable, this should not be done at the expense of a higher cost.
3. General Instructions and Definitions

1. This document provides instructions for Technical Systems Engineering (TSET) Teams on how to generate Subsystem or Component cost estimates for each element of the WBS. Refer to the top level WBS on the NLC web page for a description of the overall structure, area branches and definitions.

2. The information needed for each estimate is:
   - Engineering (four flavors time phased)
   - Acquisition (Materials and Services, including purchased assemblies and related labor), and
   - Installation, Integration and Testing.

3. Each of these six categories are to be cost analyzed for Labor and M&S. Estimates required are:
   - Labor hours
   - Labor dollars
   - M&S dollars
   Labor estimates also need to show the Labor Code from the Labor Rate Table. Details are provided in this document, Section 2, Guideline for Applying Labor Rates.

12. CD 0.4 Estimate: Precision of Estimates
   The general guidelines request a 50% confidence factor estimate. This may derive from a bottom up or a parametric estimate or something in between. The message is that we desire, for April, a first cut of the “real” configuration that we are aiming for in September. This requires an aggressive approach, meaning that we must cost new approaches that show promise of major cost reductions with less precision than our former estimates for Lehman.

13. Contingency Budget
   Subsystem estimates should not include a contingency since this will be applied globally by management as a post process.
14. Cost Escalation
   Estimators should not account for this but should estimate in FY2000 dollars, and clearly separate the Labor, M&S and Installation and Test cost categories as described above. Management will apply escalation as a post process over the entire project.

15. Reliability vs. Redundancy
   Earlier estimates were ultra-conservative in applying redundancy in power supply systems, such as the 2/3 hot swappable linac quad model. Later estimates greatly reduced costs of supplies and cable plants by stringing while still retaining redundancy of bulk supplies. Reliability models have not kept up with these changes. …. Later reliability modeling may lead to modification or refinement of decisions made for CD 0.4.

16. Planned Lifetime of Design
   Systems in an accelerator are typically planned to have a 20-year lifetime…

17. Learning Curves
   The estimator will apply learning curves…..
### Key Definitions

<table>
<thead>
<tr>
<th>Activity</th>
<th>Detailed Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conceptual Design</strong></td>
<td>Design activities from CD1, authorization for conceptual design, to CD2, just after completion of Conceptual Design Report. System analysis of requirements, interfaces, simulations, modeling, planning, estimating, scheduling, reports, manufacturability, design reviews.</td>
</tr>
<tr>
<td><strong>R&amp;D</strong></td>
<td>Demonstration of feasibility and development of related pre-production components, equipment, subsystems, systems.</td>
</tr>
<tr>
<td>R&amp;D Design</td>
<td>Restricted to large cost items, such as klystrons or the solid state modulator. <em>Note Dictionary definition.</em> Consult with management on this item. Regular test and lab equipment or field test equipment should be listed as M&amp;S against the appropriate activity.</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>Engineering design activities between CD2, start of preliminary design, to CD3, start of construction. Includes subsystems engineering (requirements analyses, subsystems integration analysis, DFM, reliability, documentation, procurement plans, cost &amp; schedule estimates). Design includes Preliminary Design (Title I EDI&amp;A) and Definitive Design (Title II EDI&amp;A) activities. The former are pre-production prototypes and the latter are finished and fully documented designs. A Definitive Design Review is a prerequisite for CD3.</td>
</tr>
<tr>
<td><strong>Sustaining Engineering</strong></td>
<td>Post-CD3 engineering, inspection, construction management, pre-operational maintenance. Covers engineering activities after design and during construction, receipt of materials, supervision of pre-assembly and factory or incoming inspection. This item is called Title III EDI&amp;A.</td>
</tr>
<tr>
<td><strong>Manufacturing-Pre-Production</strong></td>
<td>Develop manufacturing plan, quality plan, contracts for pre-production, design &amp; develop jigs and testers, factory tests for pre-production, design reviews, reports.</td>
</tr>
<tr>
<td><strong>Factory design &amp; setup</strong></td>
<td>Design factory, procure special fabrication and test equipment, coordinate with builders and crafts, plan and fulfil staffing, develop work methods and procedures, develop training plans. Calculate floor space requirements for use by Conventional Facilities. <em>Note special Dictionary definition of Equipment.</em></td>
</tr>
</tbody>
</table>
### Key Definitions

<table>
<thead>
<tr>
<th>Activity</th>
<th>Detailed Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>Acquisition activities for the technical systems, subsystems and components such as purchasing or components for in-house manufacturing, during construction (CD3-CD4).</td>
</tr>
<tr>
<td>Manufacturing - Production</td>
<td>Place manufacturing contracts, deliver special jigs and testers, install QC procedures, coordinate/track production.</td>
</tr>
<tr>
<td>Inventory &amp; Storage</td>
<td>Design storage areas, coordinate with Conventional Facilities and Crafts, develop inventory system, staff operation.</td>
</tr>
<tr>
<td><strong>Installation, Integration and Testing</strong></td>
<td>Activities for planning and executing installation, integration and testing of technical systems, subsystems and components, during construction (CD3-CD4).</td>
</tr>
<tr>
<td>Installation - Cable Plant</td>
<td>Define cable plant requirements, design cables, coordinate cost estimates with Cable Shop for engineering, fabrication and installation and QC costs for each subsystem. Cables/cable assemblies will be installed by Contract (Davis Bacon Labor) unless pre-assembled on Girders. <em>Cable Shop will be responsible for cost estimate of total Tray requirements.</em></td>
</tr>
<tr>
<td>Installation - Hardware</td>
<td>Develop installation, QC and training plan, contract installation, procure equipment and materials, supervise installation, design review, installation reports. <em>TSET teams need to coordinate on estimates to define treaty points and avoid overlaps.</em></td>
</tr>
<tr>
<td>Installation - Software</td>
<td>Develop installation, QC and training plans for firmware/software installation, hire/train personnel, supervise installation, QC, reports. <em>Controls Department will install global system software but subsystems need to check out using the global system.</em></td>
</tr>
<tr>
<td>System Test &amp; Integration</td>
<td>Design &amp; develop system test, QC and manpower/training plans, procure equipment and materials hire/train personnel, integrate with neighbor systems, test through controls, develop supporting documentation for Operations and Maintenance, perform integrated hardware/software tests of all features possible without beam in the Accelerator.</td>
</tr>
<tr>
<td>System Commissioning</td>
<td>System Commissioning begins when all systems begin turn-on to establish beam in the Accelerator. <em>This is Post-CD-4 work that is not included in the construction budget.</em> Management will consult with TSET groups in filling these estimates at the appropriate time.</td>
</tr>
</tbody>
</table>
# Labor Rates & Codes

**Table 4.1: Labor Rates and Codes**

## Resource Rates for NLC Work

FOR COST ESTIMATION ONLY

<table>
<thead>
<tr>
<th>Resource Code</th>
<th>Resource Description</th>
<th>Exempt (E)</th>
<th>Non-Exempt (N)</th>
<th>Proposed Average Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMG</td>
<td>Administrative Manager</td>
<td>E</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>ADST</td>
<td>Administrative Staff</td>
<td>N</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>ALMS</td>
<td>Surveyor-Alignment</td>
<td>N</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>ASCA</td>
<td>Assoc. Engineer/Coordinator-Alignment</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCC</td>
<td>Assoc. Engineer/Coordinator-Civil</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCE</td>
<td>Assoc. Engineer/Coordinator-Electronic</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCEE</td>
<td>Assoc. Engineer/Coordinator-Electronic</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCK</td>
<td>Assoc. Engineer/Coordinator-Cryogenic</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCM</td>
<td>Assoc. Engineer/Coordinator-Mechanical</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCP</td>
<td>Assoc. Engineer/Coordinator-Plant</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCS</td>
<td>Assoc. Engineer/Coordinator-Software</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASCV</td>
<td>Assoc. Engineer/Coordinator-Vacuum</td>
<td>E</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>ASEMNO</td>
<td>Assembly Technician-Electro-Mechanical (Non Precision-Offshore)</td>
<td>C</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>ASMA</td>
<td>Assembly Technician-Alignment (Non Precision)</td>
<td>N</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ASME</td>
<td>Assembly Technician-Electronic (Non Precision)</td>
<td>N</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ASMEE</td>
<td>Assembly Technician-Electrical (Non Precision)</td>
<td>N</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ASMEM</td>
<td>Assembly Technician-Electro-Mechanical (Non Precision)</td>
<td>N</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ASMK</td>
<td>Assembly Technician-Cryogenic (Non Precision)</td>
<td>N</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>ASMM</td>
<td>Assembly Technician-Mechanical (Precision)</td>
<td>N</td>
<td>63</td>
<td></td>
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<tr>
<td>ASMMF</td>
<td>Assembly Technician-Mechanical (FNAL Perm. Mag.)</td>
<td>N</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>ASMP</td>
<td>Assembly Technician (Precision)</td>
<td>N</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>ASMPO</td>
<td>Assembly Technician-Mechanical (Precision-Offshore)</td>
<td>C</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>ASMV</td>
<td>Assembly Technician-Vacuum (Precision)</td>
<td>N</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>

These rates replace the earlier Excel table that was posted under the Planning Group. The earlier table has been removed. You may find it convenient to leave old files connected to your old copy and only use the new table for new work. However, the new table does have some useful new rate so a conversion is advisable and should not be very painful. If you did not link from a private copy but from the web copy, and need the old table, call Z. Wilson, wilson@slac.stanford.edu. The new rate table has been sorted by Labor Code so rates and additions can be easily updated in future as well as more intelligently linked. Using the labor code as the search parameter, it is advisable to call both the labor rate and the descriptor into separate columns of your worksheet. Once established, the links will continue to work for future issues of the rate table regardless of new rates that have been inserted, or rate modifications, as long as the labor code remains valid. If you have trouble setting this up in Excel, see M. Browne, mjb@slac.stanford.edu.
Subsystem Status

• Methods and tools appear to be working
• All subsystems costs and models vs. Lehman reviewed
• Concentrated on getting revised configurations, WBS categories and new unit costs understood
• Only *some* submitted costs made it into new area rollups by AC’s
• Some very new costs, esp. tunnel electronics and vacuum pumps, too late for inclusion
Subsystem Status

• Estimates are mixed bottom-up from prototypes and parametric from previous work
• Not all estimators followed same script (eg. Labor codes & learning curves)
• All subsystems esp. new models need further review
• Technical and cost reviews, reliability models will continue
• Results could change models
Conclusion

- New models show significant progress and suggest other components to examine.
- Continue aggressive cost reduction program over all subsystems for duration of R&D program.
- In practice progress will be limited by R&D effort that can be applied to each area within cost and manpower limitations.