

LCLS Conventional Facilities System (WBS 1.9) Cost, Schedule and Contingency Analysis

1.0 Executive Summary (WBS 1.9)

1.1 Background

The LCLS project being constructed on the SLAC site includes the construction of utilities between the LCLS and the existing SLAC utilities and communication systems, connections and modifications to existing roads and other infrastructure adjacent to the LCLS site boundaries, site renovations, building demolition, and site development for the main features of the LCLS Conventional Facilities (CF) project. The main features include; construction of an above grade concrete beam enclosure and its related service buildings and associated utilities; construction of approximately ½ mile of underground tunneling with cover varying from 20 feet to 100 feet, tunneling infrastructure including all related utility service buildings and associated utilities; and construction of approximately 78,000sf office complex including common space, wet/dry laboratories, conference space and related utility service buildings and associated utilities. The scope of work described above is referred to as the Research Yard through Central Lab Office Complex (RSY-CLOC).

In addition to the RSY-CLOC scope of work, the CF effort includes the design and construction of three smaller scale ancillary components of the project; the Sector 20 Injector Facility, the Magnetic Measurement Facility (MMF), and the Main Control Center Upgrade (MCCU). These smaller scale projects are within the LCLS CF scope (WBS 1.9), but are separate from the RSY-CLOC. These projects are on a separate design and construction schedule as they are considered part of the Long Lead Procurement (LLP) phase.

1.2 Title I

Title I (Preliminary Design) was completed in May 2004 by an outside Architectural/Engineering (A/E) firm, Jacobs Engineering (JE). As part of the Title I deliverables, JE provided LCLS with a probable cost estimate for LCLS RSY-CLOC scope of work, estimated at \$41,944,695 (direct cost). At the end of Title I, the complete CF scope (WBS 1.9) was estimated at \$62.7M with a 20.5% contingency assessment of \$12.6M. The full CF cost includes Systems Management and Integration, i.e., “owner’s costs” (WBS 1.9.1), Title I and Title II (WBS 1.9.2) and the construction costs for Sector 20 Injector Facility, MMF and MCCU, as well as the RSY-CLOC construction costs. The RSY-CLOC construction schedule was estimated at 24 months.

1.3 Independent Cost Estimate

LCLS contracted an outside consultant, W. D. Wightman & Co (WDWC) to perform an Independent Cost Estimate in October 2004. The scope of this effort focused solely on the RSY-CLOC probable cost, schedule and contingency of the construction for the JE Title I (Preliminary) Design, and to evaluate the RSY-CLOC cost estimate and schedule with respect to reasonableness and accuracy and recommended contingency factors. The ICE was a refreshing perspective of the means and methods to accomplish the project and

an important validation of the JE estimate. Due to WDWC and JE estimates using different assumptions and methodologies, (e.g., JE assumed a contingency of 0%/+25%, while WDWC assumed -10%/+15%), considerable effort was made by the LCLS CF team to reconcile the differences while maintaining an accurate cost, schedule and contingency estimates for the RSY-CLOC scope of work.

1.4 Jacobs Engineering Revised Cost Estimate

As mentioned above, the LCLS CF team held joint discussions with WDWC and JE, to clarify assumptions and methodologies made from both parties. Subsequent to these joint discussions, JE recommended in a memo an upward adjustment (\$5.1M) to reflect the more recent trends in the Bay Area economies as it relates to materials (primarily concrete and steel) and mark-up by the general contractors.

1.5 Comparison of Estimates

A comprehensive comparison was performed between the JE Title I (base cost), the revised JE Estimate, and the WDWC estimate. It was important to develop this comparative analysis to review the various costs in a fair and relative fashion, which required certain assumptions by the CF Manager to develop an “apples to apples” comparison. Some of these assumptions are included in the Base Change Request CF-03, as well as anticipated CLOC modifications and escalation factors. With both the WDWC and JE using a common input, the “apples to apples” comparison showed the WDWC cost estimate ~\$7M higher than the revised JE cost estimate.

1.6 Summary

The “CF Summary Cost, Contingency and Schedule Comparison” (see table) summarizes the changes to the CF cost, contingency and schedule since the EIR. Overall, for the LCLS CF System, the estimated base cost has been increased by \$11.9M, with \$21.1M added to the CF contingency assessment, and the overall construction schedule extended by 6 months.

The major contributors to the increase in the base cost include; the RSY-CLOC increase recommended by the revised JE estimate, additional CF staff support for the integration of CF controls, a change in the CM/GC model whereby the CM awards the subcontract procurements for managing and constructing the conventional facilities, an extended project schedule through March 2009, and finally, some adjustments to escalation.

The original contingency assessment of 20.5% was found to be “unrealistically low” by the August 2004 DOE “Lehman” committee given the risks in underground tunneling. In addition, the “apples to apples” comparison between the JE and WDWC cost estimates revealed a ~\$7M disparity on the Title I design. LCLS management has chosen to use the Architect of Record, JE, as the basis for the Title I estimate. However to address the uncertainty in the cost and contingency estimates, the contingency assessment on RSY-CLOC construction was increased to provide an additional \$7M contingency. Based upon these recommendations, the overall CF contingency has been reassessed at 46% on remaining work.

While the Wightman assessment of schedule found the LCLS reasonable, the DOE “Lehman” Committee recommended adding additional schedule to the CF in order to ensure meeting the beneficial occupancy milestones for key CF facilities. This was done and is reflected in the most recent LCLS cost and schedule estimate.

CF Summary Cost, Contingency and Schedule Comparison

WBS 1.9 CF Summary	FY03-09 Base Cost	Contingency	TEC Base Cost + Cont.	Title 3 Construction Schedule
CF EIR Estimate (\$315M LCLS TPC)	62.7	12.6	75.3	24 months
CF Revised Estimate (\$379M LCLS TPC)	74.6	33.7	108.3	30 months
"New" vs "Old" Delta	11.9	21.1	33.0	6 months

2.0 Details of Cost Comparative Analysis

2.1 Overview

This section describes the details of the comparison of JE estimates and WDWC cost estimates for the Title 3 RY-CLOC construction effort (does not include S20, MMF, or MCCU). The comparison is detailed in the following spreadsheet as JE Base, JE Revised and WDWC, and is organized by General Contractor (GC) Model and Construction Management (CM) Model. The GC Model reflects a “prime” general contractor and sub contractors performing the work. The CM Model reflects a construction management firm overseeing the subcontractors. The sub-categories on this report contain “hard” costs; costs directly related to discrete effort, and “adders”; indirect costs associated with the discrete effort for general conditions, overhead (OH) and markups.

The comparisons are in FY05 base year costs and do not include SLAC’s standard overhead rate or out-year escalation rates as defined by DOE’s OECM. The OH and escalation are applied in the LCLS PMCS and are included in the fully-loaded LCLS cost estimate.

2.2 JE Base Cost Estimate

2.2.1 “Hard” costs

The initial cost estimate for the Title 3 RY-CLOC construction effort is \$41,945k. These are direct costs which are reflected in the “JE Base” estimate. The breakdown of these costs are as follows: 1) Agreed Costs in the amount of \$25,040k include the access road, service buildings, the CLOC building and parking, utilities, etc., 2) Tunnels in the amount of \$8,586k include the Undulator Hall Tunnel and Alcove, X-ray Transport and Diagnostic Tunnel, and the Far Experimental Hall Tunnel, and 3) Major Structures in the amount of \$8,318k include the Beam Transport Hall, Front End Enclosure, Beam Dump, and Near Experimental Hall.

There were additional items not included in the JE estimates. Baseline Change Request (BCR CF-03) reduced the cost estimate by approximately \$750k, and

also included cost reductions for the BTH tunnel height, HVAC, CLOC building modifications and updated the market value for commodity materials (steel and concrete). BCR CF-03 is pending but it is anticipated it will be an increase to cost in the amount of \$1,000k. Incorporating these updates into the estimate provides for “hard” costs calculated to be \$42,195k.

2.2.2 Adders

JE Base indirect “adder” percentage was 19% and was allocated as follows: Insurance and Bonds, 1%, Contractor Markup, 12%, and Escalation, 6% (excluded in the comparison).

2.3 CM Model

The Construction Management (CM) model is an option for the LCLS Project to contract with a construction management firm to oversee the subcontractors instead of a general contractor or “prime”. To exercise this option, the contractor markup rate of 12% needs to be transferred from what was initially allocated for the GC markup to the Construction Management firm. In addition to this transfer, another 1% increase is needed to account for the insurance and bonds. The estimated cost for the CM is 13% of the “hard” costs or \$5,485k for a total of \$48,102k.

2.4 JE Revised Cost Estimate (source: JE Reconciliation Report (10/27), JE T1 Estimate Revision (10/27))

2.4.1 JE has submitted a revised Title 3 cost estimate which is reflected in the JE Reconciliation Report (10/27). The JE revised cost estimate provides for increases in rates for concrete and steel, and an increase in the indirect costs by 6% for general conditions, OH and markups. JE made further revisions reducing the estimate submitted in the "JE T1 Estimate Revision" worksheet by \$1,490k which included the removal of caissons. The “hard” total plus indirect costs increased by \$5,107k. The revised total for the CM model is \$53,231.

2.5 WDWC Cost Estimate

The Independent Cost Estimate assessment of the Title 3 RY-CLOC construction effort was performed by WDWC. This assessment was based on JE Title I (Preliminary) Design for the Research Yard through the CLOC (not including S20 or MMF). WDWC provided data on the hard costs and general conditions, OH and markups. WDWC primarily focused on two “questioned items” areas; the tunnels and major structures. The total estimated cost for the construction effort submitted by WDWC was \$72,506k.

The next step was to understand the different methodologies used by JW and WDWC. Similar to the JE estimate, the escalation rate (4%) was backed out of the WDWC estimate. It was also determined that JE and WDWC used different pricing models for staffing; JE used the open shop contractor model while WDWC used the union model. Another difference in the bases of estimates was that each used different assumptions for the thickness of the tunnel walls. Applying a common correction for each of these, provides the following;

2.5.1 “Hard” costs

The initial estimate for the Tunnels was \$17,726k. The difference in cost for switching from the union staffing model to the open shop contractor model further reduced the cost estimate by \$3,000k. In addition, a reduction in cost in the amount of \$750k for shotcrete and labor was taken into account for the thickness of the tunnel walls.

As with the JE estimate, BCR CF-03 reduced the cost by \$750k and the pending BCR for the CLOC modification increased the cost by \$1,000k. Additional savings in the amount of \$1,250k were identified by WDWC for relocating the Alcove to grade. Total for the hard costs is \$48,985.

2.5.2 Adders

The WDWC estimate for indirect costs was \$17,623k; general conditions and OH, \$8165k, and a 15% markup in the amount of \$9,457k. As mentioned above, the WDWC estimate assumed union labor instead of open shop contract which inherently has more oversight staffing. LCLS substituted the estimate provided by WDWC with what is the assumed "standard" rates; general conditions and OH, 6%, insurance and bonds, 1%, and markup, 15% for a total of 22% (It should be noted that JE used a 12% markup versus WDWC 15%).

2.6 Bottom Line

The difference in costs using the CM model between JE revised and WDWC is \$7,021k, \$53,231k versus \$60,252k respectively. This variance is accounted for in the LCLS revised Total Project Cost as contingency.

Note: WDWC "picked and pulled" line items from the JE base estimate to evaluate the costs for the tunnels and major structures. Using the same line items, the LCLS team was able to reconcile the estimates on the summary report for the tunnels and major structures for JE Base estimate (JFI) but not for the JE revised estimate (10/18/2004 Reconciled). The square/lineal footage was used for the specific tunnels and major structures to allocate the differences as contingency.



Stanford Linear Accelerator Center
Stanford Synchrotron Radiation Laboratory

LCLS Project
CF Title 3 RY Through CLOC (JE Base vs JE Revised vs WDWC)
FY05 Base Cost Only - No SLAC OH or escalation

source data:
1) T1 Conceptual Statement of Probable Cost
2) WDWC Comparison

source data:
1) JE reconciliation report (10/27)
2) JE T1 Estimate Revisions (10/27)

source data:
1) WDWC Comparison Report
2) WDWC Memo "SLAC/LCLS Construction Cost Est Review" (10/28)

Description	JE Base (CR00)	JE Base NOTES	Variance CR00 vs JE recon	JE Revised (10/27)	JE (10/27) NOTES	Variance JE recon vs WDWC	WDWC (10/28)	Comments
GC Model "Hard" Title 3 Construction (RY-CLOC)								
Agreed Costs (Research Yard through CLOC)	25,040,499	JE direct costs	0	25,040,499	JE direct costs	0	25,040,499	incl. access rd,CLOC,parking,service bldg
Tunnels	8,586,040	JE direct costs	(459,320)	9,045,360	JE direct costs + Raw Matl Market Adj	(4,249,201)	13,294,561	UH, XRTD, FEH
							17,726,343	WDWC Tunnel Estimate
							(681,782)	Less 4% esc
							17,044,561	subtotal
							(3,000,000)	less \$3m (union v open shop)
							(750,000)	less \$750 (shotcrete/labor)
							13,294,561	subtotal
Major Structures	8,318,156	JE direct costs	(1,705,187)	10,023,343	JE direct costs + Raw Matl Market Adj	(1,627,002)	11,650,345	BTH, FEE, BD, NEH
				11,513,359	JE Direct Estimate (10/18)		12,116,359	WCWC Major Structures Estimate
				(1,490,016)	less \$1490k (JE 10/27. caissons, misc)		(466,014)	less 4% esc
				10,023,343	subtotal		11,650,345	subtotal
subtotal	41,944,695	JE direct costs	(2,164,507)	44,109,202		(5,876,203)	49,985,405	
BCR-03	(750,000)	BTH Tunnel Height,HVAC, Matl Mrkt Adj	0	(750,000)	BTH Tunnel Height,HVAC, Matl Mrkt Adj	0	(750,000)	BTH Tunnel Height,HVAC, Matl Mrkt Adj
CLOC Modifications	1,000,000	CLOC mods not incl in JE base	0	1,000,000	CLOC mods not incl in JE base	0	1,000,000	CLOC mods not incl in JE base
Alcove Relocation @ Grade	0		0	0		1,250,000	(1,250,000)	WDWC: Alcove Relocation/Buildout Savings
"Hard" Total (not incl Adders)	42,194,695		(2,164,507)	44,359,202		(4,626,203)	48,985,405	
Adders								
General Conditions, OH and Markup (no escalation)	13% 5,485,310			19% 8,428,248			22% 10,776,789	Mgmt/sprv,adm, furniture, trailers,phones, travel,testing,office supplies,toilets,etc.
	1% Insurance and Bonds			1% Insurance and Bonds			6,165,400	WDWC Gen Cond and OH Estimate
	12% Markup			6% General Conditions			9,457,290	plus 15% WDWC Markup
	6% Escalation (not included in this analysis)			12% Markup			17,622,690	subtotal
	19% subtotal of "Hard" cost			6% Escalation (not included on this analysis)				
	13% subtotal (less JE escalation)			25% subtotal of "Hard" costs				Substituted w/ Standard Rates @ 22%
				19% subtotal (less JE escalation)				1% Insurance and Bonds
								6% General Conditions
								15% Markup
								15% Markup
								subtotal of "Hard" costs
								WDWC orig estimates assumed union labor (more mgmt, admn, etc)
"Hard" Total plus Adders	47,680,005		(5,107,445)	52,787,450		(6,974,743)	59,762,194	
CM Model								
General Contractor (GC)								
Less GC Effort against "Hard" cost	12% (5,063,363)			12% (5,323,104)			12% (5,878,249)	
subtotal	42,616,642		(4,847,704)	47,464,346		(6,419,599)	53,883,945	
Construction Management								
Plus Construction Management (% of "Hard" cost)	13% 5,485,310			13% 5,766,696			13% 6,368,103	
CM Model Total	48,101,952		(5,129,090)	53,231,042		(7,021,005)	60,252,048	