Linac Coherent Light Source – External Independent Review
October 9-11, 2007

Executive Summary

Stanford Linear Accelerator Center
LLNL
UCLA
Los Alamos NATIONAL LABORATORY
Argonne NATIONAL LABORATORY
BROOKHAVEN NATIONAL LABORATORY

EXECUTIVE SUMMARY

PURPOSE: The Linac Coherent Light Source (LCLS) Project team has been directed to prepare a revised cost and schedule baseline to address the effects of six months of funding uncertainties followed by a reduction in funding due to the FY07 Congressional Continuing Resolution (CR). The purpose of this Executive Summary is to provide an overview of the documentation for the External Independent Review (EIR) of the LCLS Project by the U.S. Department of Energy's Office of Engineering and Construction Management (DOE-OECM).

SUMMARY PROJECT DESCRIPTION: The LCLS is designed to provide laser-like radiation in the x-ray region of the spectrum that is 10 billion times greater in peak brightness than any existing coherent x-ray light source. This advance in brightness is similar to that of a synchrotron over a 1960's laboratory x-ray tube. Synchrotrons revolutionized science across disciplines ranging from atomic physics to structural biology. Advances from the LCLS are expected to be equally dramatic. The LCLS Project will provide the first demonstration of an x-ray Free Electron Laser (X-FEL) in the 1.5 - 15 Angstrom range and will apply these extraordinary, high-brightness x-rays to scientific problems. The LCLS experimental program will commence with: measurements of the x-ray beam characteristics and tests of the capabilities of x-ray optics; instrumentation; and techniques required for full exploitation of the scientific potential of the facility. This will be the world's first such facility.

CURRENT PROJECT STATUS

• CD-0 (Approve Mission Need)	Planned: June '01	Actual: June '01
• CD-1 (Approve Preliminary Range)	Planned: Oct. '02	Actual: Oct. '02
• CD-2a (Approve LLP Budget)	Planned: May '03	Actual: July '03
• CD-2b (Approve Performance Baseline)	Planned: April '05	Actual: April '05
• CD-3a (Approve Start of LLP)	Planned: Dec. '04	Actual: Dec. '04
• CD-3b (Approve Start of Construction)	Planned: Feb. '06	Actual: March '06
• CD-4 (Approve Start of Operations)	Planned: March '09	Forecast: March '09
• Total Estimated Cost (TEC):	$ 315.0M	
• Other Project Cost (OPC):	$ 64.0M	
• Total Project Cost (TPC) :	$ 379.0M	
• TPC Percent Complete (June '07):	Planned: 60.1%	Actual 51.5%

APPROVED CD-2b FUNDING PROFILE*:

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total
PED		5,925	7,456	19,914	2,518	161			35,974
Construction				29,760	82,170	105,740	51,356	10,000	279,026
OPC	1,500		2,000	4,000	3,500	16,000	15,500	21,500	64,000
Annual Total	1,500	5,925	9,456	53,674	88,188	121,901	66,856	31,500	379,000

* April 2005 CD-2b approved funding profile. Due to the FY07 Congressional Continuing Resolution, the Project's FY07 funding has been reduced to $101.0M Construction and $13.0M in OPC. LCLS has been directed by DOE to provide a revised baseline of the project's costs and schedule in order to deliver its commitments to DOE. This revised baseline will be presented for review to DOE (IPR and EIR) in July–October 2007.

BRIEF DESCRIPTION OF PROJECT SCOPE: The LCLS project is constructed on the grounds of Stanford University at the Stanford Linear Accelerator Center (SLAC). LCLS has been designed such that future expansion on the existing site is possible. The LCLS requires a 135 MeV injector to be built at Sector 20 of the 30-sector SLAC linac to create the electron beam required for the X-FEL. The last one-third of the linac will be modified by adding two magnetic bunch compressors. Most of the linac and its infrastructure will remain unchanged. The existing components in the Final Focus Test Beam tunnel have been removed for replacement by a Beam Transfer Hall (BTH). The undulator system will be installed in a below-grade tunnel with associated equipment. Provisions will be made for x-ray endstation enclosures. Two experimental halls will be constructed:

- The Near Experiment Hall (NEH) will be constructed near the PEP Ring Road.
- The Far Experiment Hall (FEH), an underground cavern, will be constructed 250 meters further east.

Two existing SLAC buildings will be renovated to provide office space for operations staff when LCLS becomes operational. The LCLS project will fabricate the Atomic, Molecular and Optical (AMO) physics instrument.

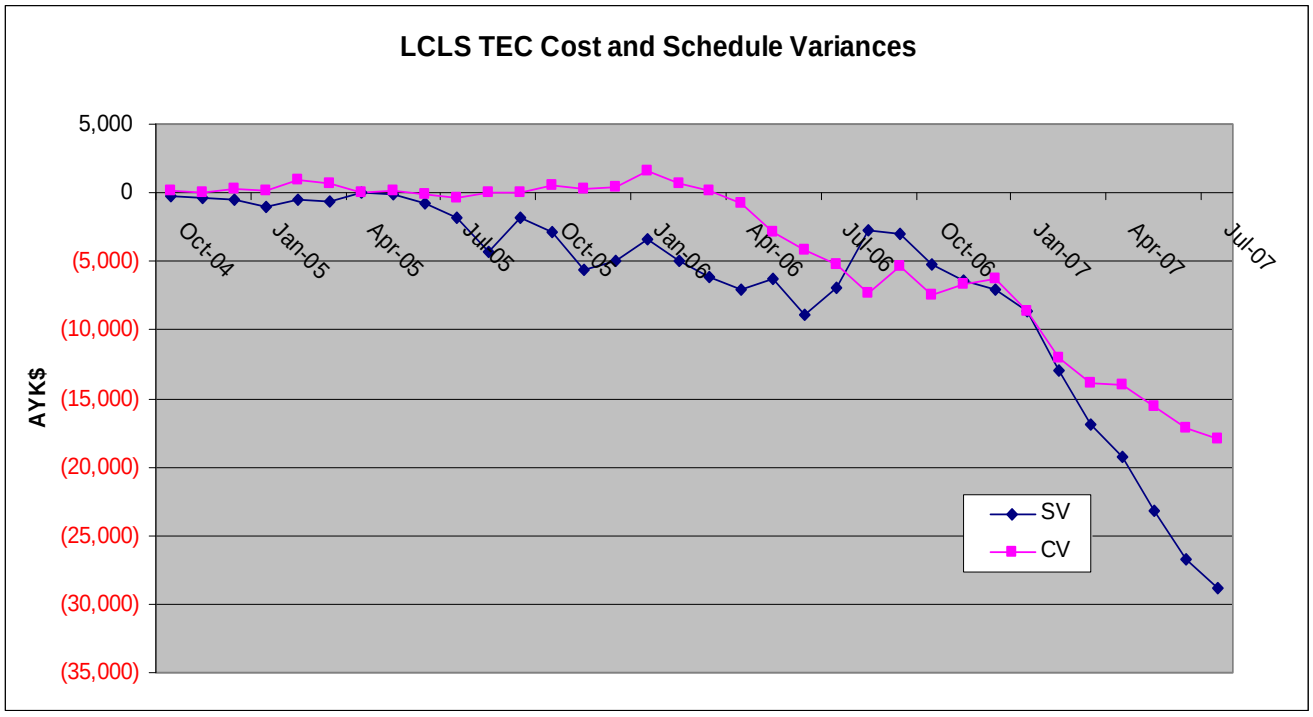
OVERVIEW OF THE IMPACTS AND THE DIRECTED CHANGES:

- During the six months of funding uncertainty, DOE-BES required LCLS Project Office to assess various scenarios and impacts. These unplanned activities resulted in actual costs to the project which reduced contingency. This expenditure is non-recoverable.

- The $8.0M reduction in FY07 funds and its late restoration in FY09 impacted the Project during its peak year of funding. This resulted in a cascading effect of postponing major procurements in FY07/FY08 time frame of state of the art components, controls, and design of office refurbishment, which has impacted the overall CD-4 schedule by sixteen months. These postponements are appropriately reflected in, and consistent with, the proposed Revised Baseline. However, the postponements generate continued and growing schedule variance in the Project status, measured against the present Baseline.

- The deceleration of work during the CR uncertainty followed by accelerating work at the conclusion of the CR adversely affected the project's efficiency which impacted the cost and schedule baseline. The performance indices (SPI and CPI) began to degrade after October 2006 and took a sharp drop beginning in January 2007 as activities were delayed and resources were diverted to re-plan the project.

Figure 1 – LCLS TEC Cost / Schedule Variances over Time



OVERVIEW OF THE REVISED BASELINE: Due to the U.S. Congress FY07 Continuing Resolution (CR), DOE-Basic Energy Sciences (BES) informed LCLS Project management that FY07 funding has been reduced by $8M. BES directed LCLS management to prepare a revised schedule baseline, cost baseline and funding profile that delivers the pre-CR Project technical baseline The results, described below, are based on a comprehensive re-evaluation of the Project's cost, schedule, contingency and risks to mission.

At the summary level, the revised baseline for the LCLS project includes the following:

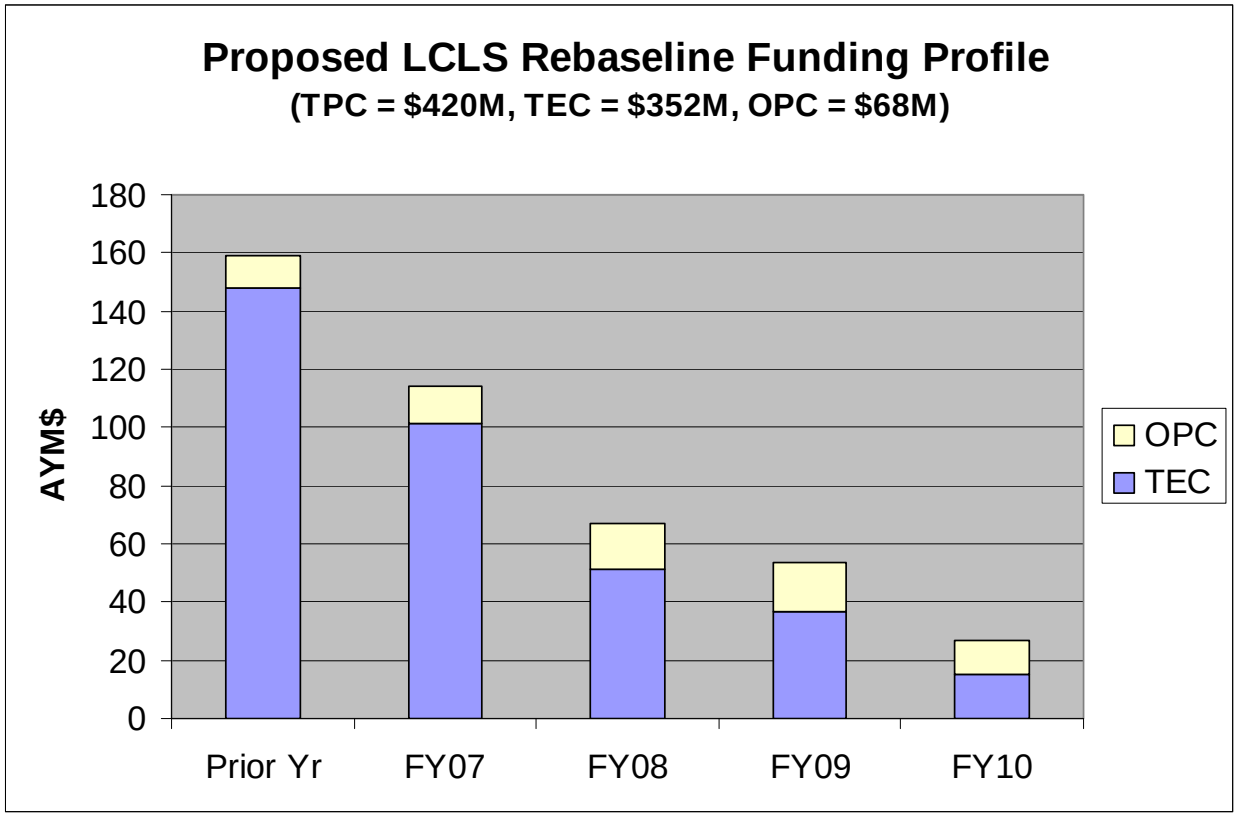
- Changes to the Project Scope: There are no changes to the scope, capability or performance of the LCLS. The key performance parameters in the Project Execution Plan will be achieved.

- Changes to Project Schedule: For completion of the LCLS Project a revised CD-4 milestone is proposed as follows:

    - CD-4 (July 2010 forecast) – All capital facilities installed and commissioned as necessary to demonstrate detection of X-rays in the Near and Far Experimental Halls (NEH and FEH), and demonstrate a single-pulse x-ray with minimum spectral flux density of 10^6 photons/(mm^2 *0.1%BW).

- Changes to Project Cost: The LCLS Project's Total Estimated Cost has been revised to $352.0M and Other Project Cost revised to $68M with a Total Project Cost of $420.0M.

Figure 2 – LCLS Proposed Funding Profile



Proposed LCLS Funding Profile (AYM$)						
	Prior Yr	FY07	FY08	FY09	FY10	Total
TEC	147.74	101.16	51.36	36.50	15.24	352.00
Cum TEC	147.74	248.90	300.26	336.76	352.00	
OPC	11.00	13.00	15.50	17.00	11.50	68.00
Cum OPC	11.00	24.00	39.50	56.50	68.00	
Total	158.74	114.16	66.86	53.50	26.74	420.00
Cum Total	158.74	272.90	339.76	393.26	420.00	

OVERVIEW OF LIMITED EIR SCOPE: The Directed Change to the LCLS funding profile and FY2007 budget uncertainties has made it necessary to re-plan the funding profile and project schedule. There has been no change in LCLS technical baseline or its performance resultant from the Directed Change. For this reason, the scope of the EIR is focused on the affected EIR elements. A brief overview for each EIR element of the limited EIR is described below.

Element #1: Work Breakdown Schedule
Element #2: Resource Loaded Schedule
Element #3: Key Cost and Schedule Assumptions
Element #4: Critical Path
Element #5: Funding Profile
Element #6: Risk Management
Element #11: Start-Up Plan
Element #14: Project Execution Plan

EIR documentation is located on the LCLS Project website at:

http://www-ssrl.slac.stanford.edu/lcls/reviews/2007_oct9-12_eir/index.htm

Additional information relevant to the scope of the limited EIR is provided below:

Element #1 – Work Breakdown Structure*. Assess whether the Work Breakdown Structure (WBS) incorporates all project work, and whether it represents a reasonable breakdown of the project work scope. Assess whether the resource loaded schedule is consistent with Work Breakdown Structure for the project work scope.*

> The Project WBS has been evaluated during the previous EIR (FY2004) and Integrated Project Reviews (IPRs) (FY2004/FY2006), and has not been changed as a result of the Continuing Resolution. There has been no change in technical baseline or the key performance parameters resultant from this revised PMB. For reference, the approved LCLS WBS and WBS Dictionary can be found in the EIR Backup Documentation.

Element #2 – Resource Loaded Schedule. *For selected Work Breakdown Structure elements (typically, those constituting significant cost and/ or risk), summarize the detailed basis for the cost estimate and schedule duration. Assess the method of estimation and the magnitude for each Work Breakdown Structure element reviewed. Identify and assess key cost and schedule assumptions and evaluate the reasonableness of these assumptions as related to the quality of the cost and schedule estimates. Identify specific work activity that constitutes project completion and whether these completion activities are sufficiently well defined. Include an assessment of whether the project completion activities are consistent with DOE guidance for work to be*

included/ excluded from the Project. Assess whether the project funding profile is consistent with the resource loaded schedule.

The LCLS project's resource-loaded schedule and documents supporting the LCLS revised performance baseline are summarized in the figures below and in the EIR Backup Documentation.

Figure 3 – LCLS Level 2 Cost Table

WBS	System	Budget ($M)
1.1	Project Management	22.10
1.2	Injector System	20.17
1.3	Linac System	27.90
1.4	Undulator System	44.05
1.5	X-Ray Transport and Diagnostics	24.56
1.6	X-Ray Endstations	8.46
1.9	Conventional Facilities	132.38
1.X	LCLS Controls	40.24
	Total Base Budget	**319.86**
	Contingency	**32.14**
	TEC	**352.00**
2.1	Project Management	25.16
2.2	Injector System	5.32
2.3	Linac System	3.32
2.4	Undulator System	10.46
2.5	X-Ray Transport and Diagnostics	3.52
2.6	X-Ray Endstations	8.73
2.9	Conventional Facilities	1.52
2.X	LCLS Controls	1.97
	Total Base Budget	**60.00**
	Management Reserve	**8.00**
	OPC	**68.00**
	Total Project Cost (TEC + OPC)	**420.00**

Figure 4 – LCLS Level 1 Milestones

Level 1 Milestones	Scheduled Date	Completion Date*
CD-0 Approve Mission Need	June 2001	June 2001(A)
CD-1 Approve Preliminary Baseline Range	October 2002	October 2002(A)
CD-2a Approve Long-Lead Procurement Budget	May 2003	July 2003(A)
CD-2b Approve Performance Baseline	April 2005	April 2005(A)
CD-3a Approve Start of Long-Lead Procurement	December 2004	December 2004(A)
CD-3b Approve Start of Construction	February 2006	March 2006(A)
CD-4 LCLS Project Complete – Start Full Ops	July 2010	

** (A) indicates actual milestone completion date*

Figure 5 – LCLS Level 2 Milestones

Level 2 Milestones	Scheduled Date*	Completion Date**
Prelim Safety Assessment (PSAD) Doc Complete	April 2004	April 2004(A)
DOE External Independent Review (EIR) Comp		June 2004(A)
Fire Hazard Analysis Approved	June 2005	August 2005(A)
Prelim Safety Assess (PSAD) Doc Approved	February 2006	February 2006(A)
Delivery of Undulator 1st Articles to MMF	July 2006	June 2006(A)
Sector 20/Alcove Beneficial Occupancy	July 2006	April 2006(A)
Research Yards Mods Beneficial Occupancy	October 2006	August 2006(A)
MMF Qual & Ready to Measure Prod Undulators	August 2006	August 2006(A)
Injector Laser Commissioning Review Complete	January 2007	December 2006(A)
Start Injector Commissioning (Drive Laser)	January 2007	January 2007(A)
Injector Accel Readiness Review (ARR) Comp	January 2007	March 2007(A)
Start Injector Commissioning (Beam on Cathode)	April 2007	April 2007(A)
Linac Water/Power Available	July 2007	March 2007(A)
Start Installation of Beam Transport Hall	February 2008	
Start Installation of Undulator Hall Facility	February 2008	
Linac (Li20 – Li30) Ready for Commissioning	February 2008	
Beam Transport Hall Beneficial Occupancy	April 2008	
Undulator Facility Beneficial Occupancy	April 2008	
Front End Enclosure Beneficial Occupancy	April 2008	
Near Experimental Hall Beneficial Occupancy	April 2008	
Central Utility Plant Beneficial Occupancy	April 2008	
X-Ray Transport Beneficial Occupancy	July 2008	
Far Experimental Hall Beneficial Occupancy	July 2008	
XT Start FEE Installation	August 2008	
Safety Analysis Document (SAD) Approved	August 2008	
Linac (Li20 – Li30) Commissioning Complete	September 2008	
Beam Path Project Close Out	September 2008	
XE Start Installation in NEH	February 2009	
LCLS ARR Complete (BTH thru FEH)	April 2009	
Start Linac-To-Undulator (LTU) Commissioning	April 2009	
2-D Detector Shipped to SLAC	May 2009	
XT Start Tunnel Installation	May 2009	
Start Undulator Commissioning (1st Light)	July 2009	
Start FEE Commissioning with Beam	July 2009	
Initiate Early Experimental Operations[1]	September 2009	
First X – Rays into NEH	September 2009	
XE Start Installation in FEH	September 2009	
First X – Rays into FEH	March 2010	

**Level 2 scheduled date includes ~2months float to the early finish milestones*

*** (A) indicates actual milestone completion date*

[1] *This level 2 milestone is approved by Director of the Office of Basic Energy Sciences.*

Element #3 – Key Project Cost and Schedule Assumptions. *Identify and assess key cost and schedule assumptions and evaluate the reasonableness of these assumptions as related to the quality of the cost and schedule estimates for each WBS. Assess cost and schedule contingency and other cost and schedule factors related to TPC and the project completion schedule. Ensure that the TPC and project completion date incorporates all activities necessary to successfully complete the project.*

The key cost, schedule, technical and programmatic assumptions used in establishing the LCLS revised performance baseline can be found in the EIR Backup Documentation.

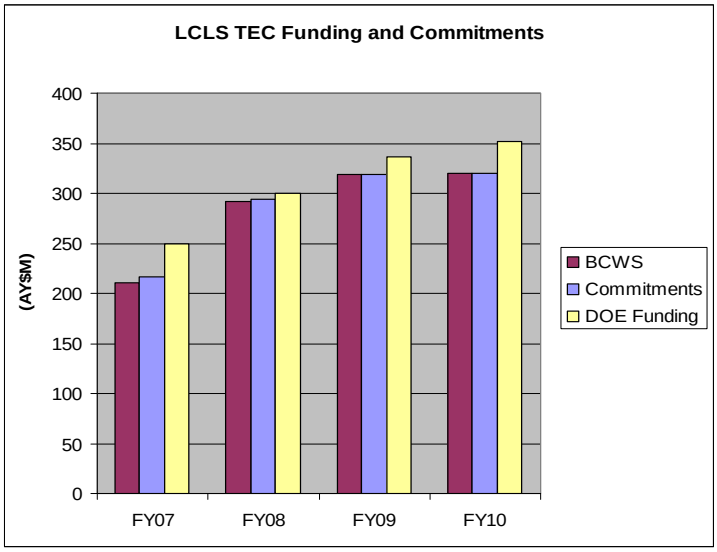
Element #4 – Critical Path. *Review the Critical Path schedule and assess whether the Critical Path is reasonably defined and whether the schedule is integrated and reflects reasonable schedule durations.*

CD-4 (July 2010) – The total float between early finish and the CD-4 DOE milestone is 101 working days (~20d/month).The details of the critical path activities leading up to CD-4 can be found in the EIR Backup Documentation.

Element #5 – Funding Profile. *Assess whether the project funding profile is consistent with the resource loaded schedule.*

Funding Profile – A revised TEC funding profile for the LCLS Project is shown below in figure 6. Adequate contingency is available on a year-by-year basis to address unplanned issues except in FY08. The FY08 funding is fixed at the original baseline level because therefore restoration of FY07 funding shortfall will not occur until FY09. The shortage in budget authority in FY08 does not provide optimal contingency. LCLS has identified FY08 non-critical path (swing) procurement activities that could be deferred until FY09 should the need for additional contingency arise.

Figure 6 – Revised LCLS TEC Funding Profile



***Element #6 – Risk Management**. Determine if risks have been identified and properly classified as high, medium, and low. Assess whether appropriate risk mitigation actions have been incorporated into the baseline. Assess whether adequate contingency has been included in Total Project Costs and Schedule. Describe the approaches used to determine risk and assess adequacy.*

LCLS risk management policies and procedures have not been affected by the Continuing Resolution. The LCLS Project has utilized a Risk Management Plan (RMP) which addresses risks over the entire scope and life cycle of the project. The LCLS RMP is consistent with the requirements established in DOE Order 413.3A. The LCLS RMP has evolved to accommodate the various phases of the project, consistent with the project's critical decision process. Post CD-3, the LCLS RMP utilizes a Risk Registry to capture known project risks, assesses the consequence and probability of each risk, and when appropriate, develops a risk mitigation or avoidance plan (termed a 'Risk Handling Plan'). The Risk Registry is reviewed every month and is used as a "punch list" by LCLS senior management to execute the Risk Handling Plan in a timely manner. The current LCLS RMP and Risk Registry are provided in the EIR Backup Documentation.

***Element #11 - Start-up Test Plan.** Assess whether the start-up test plan identifies the acceptance and operational system tests required to demonstrate that system meets design operational specifications, and safety requirements. Review key tests to ensure that sufficient description is provided to estimate cost and schedule durations associated with these tests.*

The LCLS Start-Up Test Plan (PRD 1.1-002) was reviewed and approved in May 2004. At a high-level, the purpose of the LCLS Start-Up Plan is to identify the commissioning plan, its goals and its schedule as well as to identify the requirements to accept systems as operational. Previous Self-Amplified Spontaneous Emission (SASE) FEL demonstrations have operated at considerably longer wavelengths where many important tolerances are much relaxed. Therefore, the LCLS commissioning plan is unique and beyond the state of the art.

The LCLS Start-Up Plan is used as a broad commissioning plan. As each major system nears the commissioning phase, a detailed commissioning plan is prepared and undergoes thorough review and approval by the SLAC Director and DOE Stanford Site Office (SSO). To date, LCLS has successfully commissioned the LCLS Injector System. Based upon experience (lessons learned) from the start-up of the LCLS Injector, LCLS management is preparing a revised start-up plan for the remainder of the LCLS. This is expected to ensure a more efficient transition from construction, through commissioning and into operations.

***Element #14 – Project Execution Plan.** Review the Project Execution Plan and determine if it reflects and supports the way the project is being managed, is consistent with the other project documents, and establishes a plan for successful execution of the project.*

Project Execution Plan – The LCLS Project Execution Plan (PEP) was approved by DOE's Under Secretary for Science in April 2005. The PEP has been modified to reflect the proposed revision to the LCLS approved baseline. DOE Federal Project Director and LCLS Project Office will manage and control work at SLAC in accordance with the revised PEP. The modified revised PEP will be approved as part of approving the revised cost and schedule baseline.

BACKGROUND ON OMMITTED EIR ELEMENTS: For those EIR elements omitted from the scope of the limited EIR, a justification for their omission as well as background information on the project's approach to each EIR element is provided below:

Element #7 – Hazards Analysis. *Evaluate the quality of the Hazard Analysis and assess whether all scope, schedule, and costs necessary for safety are incorporated into the baseline. Review the classification of Systems Structures and Components (SSCs) as safety class or safety significant. Assess the Hazards Analysis process, including the use of internal and external safety reviews. Review any Defense Nuclear Facilities Safety Board and/or Nuclear Regulatory Commission interface and discuss the status of their involvement.*

Justification for omission: The EIR conducted prior to CD-2b and IPRs conducted prior to CD-2b and CD-3b have evaluated Projects' Safety Envelopes and Hazard Analysis process and concluded the program satisfies the requirements. The DOE site office reviews and approves the safety envelopes and hazard analysis. The proposed baseline change does not impact Project's safety requirements and processes. Hazard Analysis will not be addressed as part of the Limited EIR.

Background Information: In accordance with requirements of DOE O 413.3A, SLAC Integrated Safety Management (ISM) Plan and DOE Accelerator Safety Order 420.2B, the LCLS Preliminary Hazard Analysis (PHA) was prepared as part of the Critical Decision 1 (CD-1) in June 2002. Hazard identification and assessment was provided to the degree possible at the early stages of design. Ultimately the PHA will fold into a larger program which will address all sources of risk, ensure that they are properly characterized and subsequently controlled or mitigated in a manner consistent with the Preliminary and Final Safety Assessment Documents (SAD), which defines the Safety Envelope.

The LCLS Injector Preliminary Safety Assessment Document (SAD) was reviewed in February 2007 via an independent Accelerator Readiness Review and the Injector Safety Envelope approved by the SLAC Director and DOE. These approvals authorized the LCLS commissioning team to commence operating in the LCLS Injector in April 2007. Prior to operating the newly constructed LCLS facilities, the SLAC SAD will be revised to incorporate any and all hazards related to the commissioning and operations of the LCLS facilities.

Element #8 – System Functions and Requirements. *Assess whether "design to" functions and requirements are reflected in the baseline, including safety and external requirements such as permits, licenses, and regulatory approvals. Evaluate whether system requirements are derived from and consistent with Mission Need.*

Justification for omission: Past EIR (FY2004/FY 2005) and IPR (FY2004), conducted prior to CD-2b, have evaluated design to functions and requirements reflected in the

Baseline as well as consistency with Mission Need. Re-assessment is not required. System functions and requirements have been defined and documented. The Directed Change does not impact the project system requirements.

Background Information: Prior to CD-2b, and in accordance with requirements of DOE O 414.1C, Quality Assurance, LCLS has implemented its Quality Implementation Plan (QIP). To facilitate an integrated, high-quality design the LCLS QIP requires that key design specifications and requirements for the LCLS systems and components are well-defined and formally approved and maintained as controlled documents within a centrally-available database. These documents, initially predicated upon the Mission Need of the LCLS are defined as:

- LCLS Global Requirements Document (GRD) – A single global-level requirements document that specifies the performance requirements for the LCLS x-ray free electron laser.
- Physics Requirements Documents (PRD) – PRDs are a flow-down from the GRD. PRDs typically specify the performance requirements for each LCLS System. These documents cover how a system needs to perform and what criteria the system needs to meet to satisfy the GRD. This is a physics specification generally used as a starting point in the engineering design.
- Engineering Specification Documents (ESD) – ESDs typically define system and/or component level specifications or parameters. The ESDs are typically engineering specifications and can be used as a 'design-to' specification for outside or inside fabrication.
- Interface Control Documents (ICD) – ICDs are interface or boundary documents that define the boundaries between two systems. ICDs can be written to define vertical interfaces (Inj-Lin, Lin-Und, etc.) or horizontal (Vacuum-Controls, Diagnostics-Controls, etc.). ICDs are use to describe the boundaries or endpoints of one specific system with respect to another system, the physical interface between the two, and the limits of responsibilities for the two.
- Room Data Sheets (RDS) – RDSs are conventional facilities documents that specify the facility dimensions and functional requirements used as basis for architectural design for each of the conventional systems. These documents were provided to the Architect/Engineer as 'design-to' documents and provide a basis for design reviews.

The GRD, PRDs, ESDs, RSDs, or ICDs as key design requirements and/or specifications are under configuration and revision control. The author is responsible for ensuring that his/her document remains in agreement with the Mission Need of the LCLS.

Element #9 – Basis of Preliminary Design*. Evaluate adequacy of preliminary design including adequacy of drawings and specifications, and assess whether they are consistent with system functions and requirements. Assess whether all safety Structures, Systems, and Components are incorporated into the preliminary design.*

Justification for omission: The adequacy of Basis of Design has been reviewed during the previous EIR (FY2004/FY2005) and IPR (FY2004) prior to CD-2b. Conventional facilities design is complete and under construction. This Directed Change does not modify the Basis of Design.

Background Documentation: For LCLS technical systems, regular design reviews are conducted, from conceptual to final, during the design process to ensure that the design meets all technical and safety requirements. Comments and recommendations are documented during the design review process. See Element #11 for further information.
For LCLS conventional facilities, regular design reviews have been conducted, from conceptual to final, during the design process to ensure that the design meets all technical, operational and safety requirements. Room Data Sheets were used to initially define and document the conventional facilities requirements. Reviews at the preliminary design (Title I) and 30%, 60% and 100% detailed design (Title II) were conducted by Jacobs Facilities, Inc. (JFI), the Architect of Record. Members of SLAC's ES&H, Radiation Physics, Fire Department and Maintenance & Operations participated in each review. In addition, LCLS has made formal presentations to SLAC's Safety Overview Committee and its relevant Citizen's Committee (Seismic, Electrical, Laser, Hoisting & Rigging, etc.) to review hazards associated with the LCLS.

Currently, the LCLS is under construction. Documentation used by the LCLS General Contractor (Turner Construction, Inc.) are the Issue for Construction (IFC) drawings approved by JFI. An on-site JFI contract administrator is managing changes to the IFC drawings to ensure that field changes are incorporated into the final 'as-built' drawings.

Element #10 – Preliminary Design Review & Comment Disposition. *Review results of the preliminary design review and assess whether additional work identified in the design review has been incorporated into the Performance Baseline.*

Justification for omission: This is a pre-CD-2 requirement accomplished during the previous EIR (FY2004/FY 2005) and IPR (FY2004) prior to CD-2b. The project is post CD-3. Review of this requirement is not relevant to post CD-3.

Background Information: At the project-level, the LCLS meets biannually with its Facilities Advisory Committee (FAC) and its Scientific Advisory Committee (SAC). The FAC is a standing committee of outside experts appointed by the LCLS Project Director, which provides advice on the progress of LCLS technical design, construction & ES&H. The SAC is a standing committee of outside experts appointed by the LCLS Project Director to provide guidance on the LCLS scientific research program.

For LCLS technical systems, design reviews are essential to good engineering practice and are a key quality assurance metric to ensure the successful construction of the LCLS. LCLS ESD 1.1-324-r0 establishes guidelines for design reviews conducted by the LCLS

Systems. Comments and recommendations are documented during the design review process. All LCLS components, systems, installation and start-up activities are subject to the technical design review process. The level of review will be commensurate with complexity, cost, or safety importance of the design. The reviews will be based upon an appropriate selection from the following system reviews:

- System Concept Review (SCR)
- Preliminary Design Review (PDR)
- Final Design Review (CDR)
- Readiness Review (RR)

The primary responsibility for the execution of the design review process rests with LCLS System Managers, which is consistent with budgetary and resource authority. System Managers shall appoint key technical experts as review team members. If the required discipline expertise is not available within the LCLS Project, membership from outside the project should be considered.

Element #12 – Project Controls/Earned Value Management System. *Assess whether all project control systems and reporting requirements will be in place prior to Critical Decision-2. For projects where Earned Value Management System is not required, assess the adequacy of an alternate project control system for monitoring and controlling project costs and schedules.*

Justification for omission: This is a pre-CD-2 requirement that has already been evaluated. FY2004 EIR review concluded the system satisfies established requirements. An OECM review of the EVMS was conducted in 2006 and the project is awaiting certification. Project is post CD-3 with complete project controls/EVMS in place. Re-assessment not required.

Background Information: The LCLS EVMS is a key component in the effective management of the LCLS project. The EVMS is used to integrate project management elements required to effectively organize, plan, and control complex projects. The LCLS EVMS provides a comprehensive exposition of processes and guidance for cost, schedule, and technical performance management and reporting as well as for effective project execution using earned value management.

As a DOE project, LCLS follows the requirements in DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets*, and are compliant with the accompanying guidance in manual (DOE M 413.3-1), which delineates earned value requirements. The LCLS EVMS also fulfills the requirements of the Office of Management and Budget Circular No. A–11, Part 7, Section 300, *Planning, Budgeting, Acquisition, and Management of Capital Assets* which also delineates earned value requirements. The LCLS EVMS process and organization are designed to comply with the *American National Standards Institute (ANSI) and Electronic Industries Alliance (EIA) Standard for Earned Value Management Systems* (ANSI/EIA-748-A, January,

2006). The ANSI/EIA-748-A standard is an industry best practice as well as the official DOE and federal government standard for EVMS.

The LCLS EVMS utilizes Primavera Project Planner (P3) to track its resource-loaded schedule and COBRA as the cost processor. The LCLS EVMS provides monthly status reports to DOE as well as detailed performance measurement data to the LCLS Control Account Managers (CAMs) who are responsible for LCLS control account management.

Element #13 – Value Management/Engineering. *Assess the applicability of Value Management/Engineering (VE), and whether a Value Engineering analysis been performed with results being incorporated into the baseline. Also provide an assessment of the Value Engineering process for this project.*

Justification for omission: Project's VE approach and incorporation into the Baseline. As preparation for CD-2b, EIR review (2004/2005) and the IPR review (2004) evaluated LCLS approach to VE and report on VE applications. VE options were incorporated into the final conventional facility design and the technical design and VE continues during project execution. Re-assessment is not required.

Background Information: Value Management/Engineering is a continuous process over the life of any project. However, value management / engineering has a bigger impact if done effectively early in the project life cycle. LCLS conducted rigorous value management / engineering efforts in both its technical systems and its conventional facilities. For the LCLS technical systems, each LCLS system conducted an in-depth review of its overall system design to ensure that the current scope of the system meets the needs of the LCLS physics performance requirements. These integrated system reviews helped to ensure that each overall LCLS system is complete and that its scope is mature enough to support a baseline estimate of its cost and schedule. The reviews for each TDR were as follows:

- Injector System TDR – November 2003
- Linac System TDR – December 2003
- Undulator System TDR – March 2004
- X-Ray Transport, Optics and Diagnostics System TDR – March 2004
- X-Ray Endstations TDR – December 2004

For specific technical risks, the LCLS team conducted targeted reviews using expert peer review to address particularly complex areas of the LCLS. Some of the targeted reviews were:

- Undulator Parameters Workshop (October 2003)
- Undulator Magnet Review (November 2003)
- Undulator Commissioning Workshop (January 2004)

- Injector Laser Review (January 2004)
- Injector "Heater" Review (February 2004)
- Injector – Linac Cost Review (March 2004)
- LCLS-wide Controls Review (April 2004)

In addition to system-wide TDR's, the LCLS has also conducted its first LCLS-wide integrated technical review by its standing Facilities Advisory Committee (FAC) in April 2004.

For LCLS Conventional Facilities, Jacobs Engineering, the Architect/Engineer conducted a targeted value engineering session in March 2004 which resulted in a savings of ~$4M while maintaining the full functionality of the LCLS baseline design. In addition, LCLS management requested that Jacobs evaluate the current construction schedule for the LCLS to ensure that all current assumptions are reasonable and that the work is organized in a logical and efficient manner.

To ensure that the LCLS properly addresses the needs of the FEL scientific community, the LCLS held the following meetings with the LCLS Scientific Advisory Committee (standing);

- Experimental Hall Layout/Functionality (September 2004) – In this one-day review at SLAC, LCLS management reviewed the layout and design of the LCLS experimental hutches and incorporated many features suggested by the SAC.
- SAC Winter Meeting (December 2004) – This meeting of the SAC reviewed the present concepts of the LCLS to ensure that the requirements of the FEL community are being addressed.

As noted earlier, the process of value engineering will continue throughout the LCLS construction phase in order to optimize the LCLS design and performance and reduce risk.

Element #15 – Acquisition Strategy. *Review the Acquisition Strategy to determine if it is consistent with the way the project is being executed. The Review Team should evaluate any changes from Critical Decision-1 that may impact whether the current strategy represents best value to the government.*

Justification for omission: This is a CD-1 pre-requisite that has been accomplished. Also, the LCLS Acquisition Strategy (formerly known as Acquisition Execution Plan), a pre-requisite for CD-2b, was approved by the Under Secretary on Oct 2002. Project is post CD-3 with over 95% of conventional construction contracts awarded; a re-assessment is not required.

Background Information: The purpose of the Acquisition Execution Plan was to select the best approach to acquire the LCLS. The document concluded that SLAC

management and construction of the LCLS was the best value for the government instead of DOE directly managing the LCLS acquisition. This decision is still applicable.

Element #16 – Integrated Project Team. *Assess whether the project management staffing level is appropriate, and determine if appropriate disciplines are included in the Integrated Project Team. Identify any deficiencies in the Integrated Project Team that could hinder successful execution of the project. Required Documentation*

Justification for omission: This is a CD-1 pre-requisite that has already been achieved; the IPT is in place and functioning. The BCP does not impact the IPT. Re-assessment not required.

Background Information: For additional information on the LCLS Integrated Project Team, see the draft LCLS Project Execution Plan (PEP) in Section 15.