Incidents Reveal Gaps in Construction Project Lifecycle Management

Executive Summary:

From April to October of 2017, the Laboratory experienced an unusual number of serious incidents related to construction projects. As a result of these incidents, the SLAC Deputy Director of Operations assembled a multi-functional team to collaboratively develop a corrective action plan (CAP) that considered and addressed the common themes and the lessons learned from the incidents with the goal of ensuring that SLAC could sustainably plan and execute all phases of the construction project lifecycle in a safe, effective, and efficient manner. It is important to review all aspects of the project management life cycle to ensure that you have properly integrated and aligned all stages. Also, when performing a review, you should use an experienced multi-functional team that understands all the stages in this life cycle.

Construction Incidents Reviewed:

- **April 7, 2017 – Water Intrusion at Building 950:** Approximately 5,000 gallons of rainwater leaked into Building 950 through three unsealed openings in the penthouse floor that were present as a result of construction work on the Building 950 Utilities Relocation Project. The flooding resulted in a financial impact of $120K for damage to materials and structures and labor costs involved in the clean-up, and threatened the planned re-start of LCLS experimental operations scheduled for June, 2017. (ORPS#: SC--SSO-SU-SLAC-2017-0001)

- **April 26, 2017 – Unexpected Drop of Concrete Block at Building 950:** A rectangular concrete block weighing 515 pounds unexpectedly dropped 17 feet to the floor of the room below while being removed by subcontractor workers from the floor of the Building 950 penthouse as part of the Building 950 Utilities Relocation Project. There were no injuries, as the area below had been barricaded and a spotter had been stationed outside the barricaded area to keep people from entering while the block was being removed. (ORPS#: SC--SSO-SU-SLAC-2017-0002)
• **July 15, 2017 – Girder Dropped During Lift by Mobile Crane at Cryoplant:** A 78-foot bridge crane girder weighing 15,750 pounds unexpectedly dropped 15-20 feet to the ground while being lifted by a mobile crane for installation at the new LCLS-II Cryoplant building. The girder fell because the synthetic slings used to rig the load failed when they slipped off their softeners during the lift and contacted the sharp edges of the girder. The incident caused damage to the girder, damage to the concrete floor, and delays in the project schedule. (ORPS#: SC--SSO-SU-SLAC-2017-0003)

• **August 2, 2017 – Uncontrolled 110-volt Lighting Circuit Struck during Core Drilling at Building 40:** During core drilling through a 12-inch concrete wall to install new process cooling water lines at Building 40, subcontractor workers struck an unidentified and uncontrolled 110-volt lighting circuit embedded within the wall. Before the event, the workers had attempted to use locating equipment to identify potential utilities in the work area, but found none. The as-built drawing for this building showed the presence of the electrical circuit that was hit; however, the workers had not reviewed the drawing because the associated penetration permit, which was approved by SLAC, did not specify this as a requirement. There were no injuries, as the circuit was de-energized at the time it was struck, but the circuit was considered uncontrolled since it was not locked and tagged out. (ORPS#: SC--SSO-SU-SLAC-2017-0004)

• **October 27, 2017 – Energized 277-volt Lighting Circuit Struck during Cleanroom Demolition at Building 31:** During demolition of the cleanroom in Building 31, a subcontractor worker struck an energized 277-volt lighting circuit while using a reciprocating saw to cut through a conduit located above the ceiling of the cleanroom. Prior to cutting the conduit, the worker had asked the superintendent if it was okay to proceed. The superintendent told the worker to proceed, as he mistakenly believed that the circuits in the conduit had been de-
energized and locked out by SLAC as part of the energy “air gap” that was created at the start of the project. There were no injuries but the project schedule was delayed as a result of this incident. (ORPS#: SC--SSO-SU-SLAC-2017-0005)

The multifunctional CAP team consisted of members from all organizations involved in the project management lifecycle, including mission, Supply Chain Management (SCM), Project Management (PM), Finance, Environment, Safety Health (ESH), and Facilities & Operations (F&O). The team reviewed the 2017 incidents against SLAC’s existing processes for managing the overall project lifecycle with the goal of developing a CAP that addressed common themes, specific issues, interdependencies, and shared action items. The team coordinated with all SLAC organizations responsible for resultant corrective actions to ensure a collaborative, consistent, and sustainable plan was developed.

Common Themes and Lessons Learned:

- **F&O, SCM, ESH Policies and Related Training of Construction Support Personnel**: Updates to the construction project-related documents were needed and the construction project lifecycle needed to be documented in an integrated way across all areas. PM Lifecycle training is needed for staff working directly on projects, staff supporting projects, and subcontractors on construction projects.

- **PM Process**: The project management process described in SLAC’s Project Implementation Manual (PIM) was found to be sound; however, the manual was somewhat general and did not always provide enough implementation detail to ensure that the processes were consistently followed. Additionally, many SLAC personnel involved in projects were unaware of the PIM and its contents. More effective onboarding and ongoing training and coaching were needed for all staff involved in projects, including project management, construction management, field safety, supply chain management (or procurement), and finance. Regular forums to discuss best practices and a formal “lessons learned” process were needed to facilitate continuous improvements.

- **Roles and Responsibilities**: Lines of authority and accountability were not always clearly defined or understood by those in management and oversight of construction projects. Personnel may have understood roles and responsibilities associated with their own particular job function, but often had a limited knowledge of others’ roles and responsibilities or understanding of the overall process. Defined roles, responsibilities, authorities, and accountabilities should be included in the training.

- **Resource Management (Field Construction Management/Project Management/Field Safety/Supply Chain Management/Finance)**: Hiring of critical management positions (Design and Construction Services manager) and project-related positions (FCM, PM, Field Safety, SCM, and Finance) were not timely and resulted in staffing shortages for construction projects. Resource planning needed to be an ongoing process throughout the year (Annual Laboratory Planning (ALP), Strategic Capital Planning meetings, regular customer meetings, etc.). The resource planning actions and staff augmentation contracting strategies needed to be timely to allow for enough time for the hiring/contracting process and adequate onboarding.
• **Schedule Pressure:** Maintaining project completion dates was seen as a priority to project team members and SLAC leadership. Decisions were made to recover schedule by working longer hours, including weekends. Extended work hours added stress and fatigue that may have led to reduced focus on oversight and work planning and control. These decisions should be escalated, in the case of SLAC to the Laboratory Director's Office, who in consultation with the mission and the project, would determine if the Laboratory should significantly modify work schedules, weighing the risk to a project against risk to the Laboratory.

• **Risks Associated with Projects on Active Mission Facilities:** Although risk assessment and planning is included in the early stages of the project management process, the potential risks to SLAC's science mission due to work on or near active facilities were not always specifically identified as part of this process (e.g., unplanned interruption of ongoing experimental work, delays to upcoming experimental work, damage to scientific equipment or facilities, etc.). As a result, the project management team may not have been fully aware of the severity of impact to SLAC if these risks were to be realized, and agreement by the customer on general mitigations that would be implemented throughout the project did not consistently occur. The organization that is responsible for an active mission facility has the lead in ensuring identification and mitigation of mission and operations risks for that facility. This organization must be ultimately responsible for safety and work planning and control in that facility with assurance from F&O that appropriate controls are in place for the project. It is F&O's responsibility to provide regular updates and proposed mitigations as conditions change.

• **Construction Work Planning and Control (WPC):** SLAC's WPC process for this type of construction work (in this case, known as "red work") did not always address unique aspects of construction projects where job scoping, identification of hazards and controls, and performance of work is done by subcontractors rather than SLAC personnel. As a result, deficiencies in these areas may not be caught by the WPC "red work" process and only discovered after an incident occurs. WPC processes should be improved and better tailored for construction projects involving multiple tiers of contractors and subcontractors.

• **Flow Down of Requirements:** Flow down of requirements and standards from SLAC to all subcontractor tiers did not occur consistently, often because they were not communicated in a form that was easily understandable by subcontractor workers performing the work. Clear summary of processes and forms should be provided to contractors and subcontractors (i.e., using an effective website for use by construction contractors).

• **Enforcement of Requirements:** General contractors are responsible for ensuring that sub-tier contractors meet all SLAC requirements and standards. When general contractors fail to do so, SLAC did not always hold general contractors accountable, particularly for small issues early in a project's lifecycle. As a result, these leading indicators were not consistently acted upon, and actions were only taken when a larger issue or incident occurred.
• **Senior Management Oversight:** Senior management needs to be informed of potential issues through their management walk-rounds and via regular updates. Quarterly reports to the SLAC Operations Council and an annual summary with lessons learned and improvements to the Senior Management Team should be developed. Senior management, in this case the Deputy Laboratory Director and the Deputy Director of Operations, should be involved in the decision to authorize significant “overtime” work in attempts to recover schedule.

• **Leading Indicators:** Cost and schedule are typical measures that are tracked in projects. In addition, leading indicators should be tracked and monitored. Examples of leading indicators include performance issues with subcontractors, quality of work, safety trends, communication, housekeeping, adequacy of Field Construction Management (FCM) support, quality of tailgates, risk and risk mitigation management, coaching/PM performance guidance, procurement methods (errors/omissions, incentives, liquidated damages, change orders), and staffing levels. Leading indicators need to be analyzed and course corrections need to be timely.

• **Procurement Strategies:** Improvement is needed to increase vendor pool of bidders. Procurement acquisition strategies need to be assessed based on the project risk (design/build, design/bid/build, etc.). Active recruitment of vendors is needed and an external website for contractors is needed for outreach and as a resource to vendors. Once subcontractors are performing work, SLAC needs to partner with subcontractors to provide incentives, tools and information to help them be successful. Guidance needs to be documented for vendor corrective actions. A procurement operating manual should be developed and data tracked and analyzed quarterly for trends and improvements to processes, including the field change order process. Improvements to training on procurement processes is needed for staff related to construction projects, including initial onboarding, ongoing training, lessons learned and tracking of training completion.

• **Financial Support:** Financial reconciliation and forecasting of projects was hampered due to a lack of communication and not having access to all the information available and less than adequate communication between the Project Management, SCM and Finance teams. In addition, there was turnover in these positions, resource shortages and unclear assignment of responsibility. A project management dashboard/report should be developed to show resource assignments and key performance indicators, including cost changes, schedule changes, RFIs, change orders, etc. that allow the Design and Construction Manager (DCS) to review during regular status updates. Monthly reporting and meetings between DCS, SCM and Finance to discuss status, trends and issues, is recommended. To facilitate better communication, touchdown spaces for Finance and SCM in the Project Management office building will give project staff more readily available access to these resources.

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