Review Committee Report for the LCLS II Engineering Peer Review on Niobium Procurement

Review Date: April 17, 2014

Report Date: April 28, 2014

**Review Committee:**

Allan Rowe (Chair) – FNAL

Gigi Ciovati – JLab

Marc Ross – SLAC

Barry Miller – SLAC

John Zweibohmer – FNAL

**Charge:**

We will review the technical specification and plan toward procurement of the niobium and other materials for LCLS-II SRF cavities. The reviewed topics shall include: drawing readiness, materials specifications, the QA/QC plan, cost estimates, the contingency plan, and the schedule. Technical and procurement experts have been invited to form a review team. **The outcome of this review is a set of action items to lead us to the procurement readiness (gate) review prior to procurement.**

Specifically, the review committee is charged to evaluate the readiness of the LCLS-II Cryogenic Systems Niobium material procurement. The review committee should evaluate by responding to the following questions as posed by the Cryogenic Systems Deputy Systems Manager:

1. **Technical Scope and Schedule**
   1. Has the responsibility for fabrication, inspection, test, and acceptance for the material flow through each participating party been defined?
   2. Have all participating partner laboratories agreed to the procurement schedule and timeline?
2. **Procurement Team Roles and Responsibilities**
   1. Have all key project team members been identified with roles and responsibilities defined?
3. **Procurement Package Documentation Status**
   1. Are the material specifications defined and agreed upon by all participating parties?
   2. Has the relevant procurement documentation been approved formally by all parties?
4. **Procurement Acquisition Strategy**
   1. Does the procurement strategy as presented provide confidence from fabrication, inspection, test and final delivery that schedule, budget and quality will be achieved?
   2. Has the proposal evaluation process been developed and approved by affected stakeholders?
5. **Cost Estimate**
   1. Is the cost estimate basis defined and valid for the requisition?
   2. Are the costs reported from the RFI responses within budget?
6. **Quality Assurance**
   1. Have all inspection and test plans with clearly defined acceptance criteria been developed, reviewed and approved?
   2. Are all approved specifications and drawings under configuration control and are they available to partner laboratories?
   3. Has the nonconformance reporting and problem disposition process been defined and agreed upon by partner laboratories?
   4. Has the inspection/test records archive plan been clearly defined and is the information available to affected stakeholders?
   5. Has the supplier surveillance plan, including any required pre-award surveys, mandatory inspection points, or production/inspection readiness reviews been developed and vetted with affected project stakeholders?
7. **Lessons Learned**
   1. Have lessons learned from similar procurements and/or other laboratories been reviewed and applied?
8. **Risks, Issues, and Concerns**
   1. Are there any risks, issues, or other concerns?

**Niobium Engineering Peer Review Agenda:**

13:00 - 13:10 Welcome and Logistics 10' Speaker**: Richard Stanek** (Fermilab)

13:10 - 13:20 Review Overview 10' Speaker: **Camille Ginsburg** (Fermilab)

13:20 - 13:40 Schedule 20' Speaker: **Marc Kaducak** (Fermilab)

13:40 - 14:10 Advance Acquisition Plan 30' Speaker: **Bob Cibic** (Fermilab)

14:10 - 14:40 Materials Specifications 30' Speaker: **Dr. Lance Cooley** (Fermilab)

14:40 - 15:00 Fabrication Drawings 20' Speaker: **MICHAEL FOLEY** (FNAL/TD)

15:00 - 15:40 Request for Proposal 40' Speaker: **MICHAEL FOLEY** (FNAL/TD)

16:00 - 16:20 QA/QC plans 20' Speaker: **Camille Ginsburg** (Fermilab)

16:20 - 17:00 Review Team Discussion 40' Speaker: Allan Rowe (Fermilab)

17:00 - 17:20 Closeout 20' Speakers: Allan Rowe (Fermilab), Camille Ginsburg (Fermilab)

Review Comments:

This Engineering Peer Review was the first LCLS-II Cryogenic Systems multi-lab pre-procurement engineering review. The review was successful and sets a good example for future reviews of this type. Sincere thanks to all involved.

The Engineering Peer Review (EPR) was performed to assess the technical readiness of the Niobium and NbTi Procurement plan in advance of the forthcoming Procurement Readiness Review (PRR). The EPR review committee understands that the material presented will serve as a technical and organizational framework to be used in preparation for the PRR. The committee has assessed material presented and evaluated its contents in the context of the target review questions posed by the Deputy Systems Manager for the Cryogenic Systems for LCLS-II. The committees’ responses are formulated as answers to each of the review questions. Specific action items, if deemed necessary, are listed within each response.

1. **Technical Scope and Schedule**
   1. Has the responsibility for fabrication, inspection, test, and acceptance for the material flow through each participating party been defined?

The procurement plan partially defines the various responsibilities. Fermilab is responsible for the material procurement, but responsibility for inspection, testing, and acceptance is currently undetermined. The most attractive option, as presented in the QA/QC plan presentation, is for LCLS II to utilize the expertise and infrastructure developed at DESY for the XFEL material procurement. The Review Committee is of the opinion that LCLS II should take advantage of the system developed at DESY if possible. Utilizing DESY may offer a cost-effective turn-key solution whereas infrastructure and staffing build-up efforts would be required at both FNAL and JLab to perform the same effort.

**Action Item:** Determine whether DESY is a viable option to perform all QA/QC on the Nb and Nb55Ti material. Define the most efficient mechanism (Purchase Order, WFO, CRADA, etc.) to engage DESY in this work. Evaluate the cost trade-off between engaging DESY and staffing/tooling up in-house to perform the work.

**Action Item:** If DESY is determined *not* to be a viable option, develop a formal personnel training and infrastructure improvement plan to perform the QA/QC in-house at Fermilab.

**Action Item:** Determine the division of responsibility between FNAL and JLab regarding the review and approval all generated QA/QC documentation.

**Action Item:** The APP should clearly identify who is making the source selection decision.

* 1. Have all participating partner laboratories agreed to the procurement schedule and timeline?

Though the Advanced Procurement Plan (APP) and schedule presentation had some schedule inconsistencies, the Review Committee believes all partner laboratories agree with the procurement schedule and timeline as they were discussed during the review. All partner laboratories understand that the material procurement schedule float is very small and therefore adequate resources will be committed to manage this procurement. Other details that potentially negatively affect the procurement schedule were discussed (proposal evaluation timelines, DOE site-office approval loop, etc.)

**Action Item:** Review whether the complete evaluation and approval process is adequately accounted for in the procurement schedule.

**Action Item:** Show the QA/QC effort in the procurement schedule.

**Action Item:** Determine whether vendor visits are necessary during the proposal review process and include time in schedule for such visits.

1. **Procurement Team Roles and Responsibilities**
   1. Have all key project team members been identified with roles and responsibilities defined?

The draft APP lists the Technical Evaluation Team (TET) members by name with the exception of Gigi Ciovati (Jefferson Lab) who will be added. In addition, a responsible SLAC representative should be added. The APP outlines the TET responsibilities.

**Action Item:** Add Gigi Ciovati (JLab) and appropriate SLAC representative to TET as defined in the APP.

1. **Procurement Package Documentation Status**
   1. Are the material specifications defined and agreed upon by all participating parties?

There are two niobium (and Nb/Ti) specifications to choose from: 1) Fermilab FNAL 371073-C or 2) XFEL-007 for SRF sheets and 1) ASTM B884 or XFEL-008 for Nb/Ti.

There is not full agreement on the material specifications for the RRR Grade Nb: the need for RRR>300 for cavity fabrication to meet the gradient specification of the project (16 MV/m) hasn’t been justified for machine performance reasons. The maximum concentration of each of the main impurities according to FNAL 371037 Rev C (identical to that of ASTM B393 for Type 5 niobium) and XFEL/007 Rev C results in a contribution to RRR shown in Table 1 below:



Table 1: RRR contribution from the allowed concentration for each impurity according to ASTM B393 and XFEL/007 RRR-grade Nb specifications.

Extensive data available in the literature and simple quench models indicate that RRR>150 would be sufficient to meet the project gradient specification and could result in Nb sheet material cost savings. Such RRR spec would be consistent with the allowable impurities’ concentration in ASTM B393 Type 5 Nb. From the technical standpoint RRR>150 specification should not have a negative impact on the “high-Q0” process which introduces impurities (nitrogen) in the Nb surface (reduces the RRR of the surface layer). The RRR of the Nb surface is, in any case, lower than that of the bulk because of the presence of oxides and higher concentration of interstitials such as oxygen and hydrogen and defects such as vacancies at the surface, where the RF current flows, compared to the bulk.

The Review Committee believes that either FNAL 371037 Rev C or XFEL/007 Nb material specification may be used without technical risk.

The Review Committee believes that either ASTM B884 or XFEL-008 for Nb/Ti material specification may be used without technical risk. If Nb55Ti is chosen, flash radiography at ingot vendor is recommended to ensure QA of adequately controlled melt.

**Action Item:** Choose a Nb sheet material specification from the currently utilized FNAL 371037 Rev C or XFEL/007. If Nb material cost is a project concern, consider lowering the impurity standards to accommodate RRR>150 Nb material.

**Action Item:** Include in the Nb55Ti RFP for the Nb ingot supplier to perform flash radiography thereby guaranteeing the proper alloy composition. If ASTM B884 is ultimately chosen, the flash radiography QA requirement likely isn’t necessary.

* 1. Has the relevant procurement documentation been approved formally by all parties?

A draft of the APP was presented. The document is logical and well thought out. However, some corrections are necessary and listed below in the Action Item.

No procurement documentation is currently approved by any partner Laboratory since no final drafts have been circulated for review and approval. These approvals will occur prior to the PRR .

Preliminary mechanical drawings were presented that require some corrections and/or modifications to accommodate LCLS-II requirements. The review team did not compare the raw material drawings to fabrication drawings. However, the drawing set shown was recently used as part of multiple successful cavity orders from US vendors.

**Action Item:** Edit the APP to show the following: consistent schedule, correct purchase quantities of the various materials, delivery destinations, QA/QC references, split award options, and evaluation/selection criteria as determined by the TET.

**Action Item:** Contact DOE site office to discuss documentation requirements and APP modifications.

**Action Item:** Finalize all material drawings and include approvals from both FNAL and JLab representatives prior to release. Reference the agreed-upon material specifications.

**Action Item:** Develop a baseline QA/QC plan. Given the timeline, this document may be in draft form at the time the procurement hits the streets.

1. **Procurement Acquisition Strategy**
   1. Does the procurement strategy as presented provide confidence from fabrication, inspection, test and final delivery that schedule, budget and quality will be achieved?

The proposed schedule is consistent with the (albeit limited) RFI responses. The RFI cost-responses are 10 to 15% higher than the initial CD-1 estimates – this is a concern. The path to proper quality has been established by the Fermilab team and discussed with the DESY E-XFEL team, though no agreement exists.

**Action Item:** Since the delivery schedule is tight, evaluate whether a performance bonus for early material delivery for critical components is worthwhile.

* 1. Has the proposal evaluation process been developed and approved by affected stakeholders?

The formal evaluation criteria will be defined in the APP and determined by the TET as indicated above.

The basic premise of an evaluated procurement (cost/price tradeoff) is agreed by the partner Laboratories.

**Action Item:** Develop and finalize selection criteria the TET will use during evaluations and obtain concurrence from the LCLS II System Manager.

1. **Cost Estimate**
   1. Is the cost estimate basis defined and valid for the requisition?

Fermilab has a number of historic procurements to validate the estimated cost.

The cost estimate basis is derived from the E-XFEL procurement (2010). RFI cost-responses have been received for each of the four qualified (E-XFEL) vendors.

There was some inconsistency in the expected amount of material to order. An overage of 3% was agreed upon. However, the basis upon which the 3% overage was shown to be either 280 or 288 cavities.

The Nb sheet material order may be minimized if round blanks are ordered rather than square sheet. The center drop off could be used as the material tracking and QA/QC coupons.

The final cost may vary from the cost estimates supplied in the RFI responses based on material specifications chosen. The RFI included the most difficult to meet Nb specification (XFEL/0007).

**Action Item:** Finalize the quantity of material to order and whether Nb sheets will be ordered as square or round blanks.

* 1. Are the costs reported from the RFI responses within budget?

The RFI cost-responses are 10 to 15% higher than the initial CD-1 estimates, as provided (and escalated) by the E-XFEL team. This is a concern.

Consider updating the draft cost baseline information for the Nb and Nb/Ti cost with the average RFI response values.

1. **Quality Assurance**
   1. Have all inspection and test plans with clearly defined acceptance criteria been developed, reviewed and approved?

The material acceptance criteria for the existing material specifications are well defined and reviewed, although for other projects. For the LCLS-II project, they have not been approved. Once the material specifications are chosen and approved, the relevant acceptance criteria can then be approved.

* 1. Are all approved specifications and drawings under configuration control and are they available to partner laboratories?

The drawings of the Nb and Nb55Ti components are under FNAL configuration control as is the FNAL 371073-C material specification.

**Action Item:** Provide access to the material above to the partner Laboratories.

* 1. Has the nonconformance reporting and problem disposition process been defined and agreed upon by partner laboratories?

The reporting and problem disposition process has been discussed and a process similar to that used by DESY for the E-XFEL project has been suggested, but not fully laid out, agreed-upon and signed-off.

FNAL has a formal system set up to prepare Discrepancy Reports and Quality Control Reports. This system may only be valid in the event material inspections occur at FNAL.

**Action Item:** Define clear material rejection criteria and how to address nonconformance. Include these criteria as part of the material specification if utilized as the quality control document. Items to address: material rejection, return, reprocessing, and replacement.

* 1. Has the inspection/test records archive plan been clearly defined and is the information available to affected stakeholders?

The team has a tentative agreement to use the JLab-based ‘Pansophy’ program, but no formal agreement or plan is currently in place. The DESY Team-Center program utilized for the E-XFEL documentation may not be directly integrated with Pansophy or the FNAL Vector systems, however, some linked-database option should be integrated and accessible across partner Labs.

**Action Item:** Develop an inspection/test records archive plan that incorporates a commonly accessible database utilizing an agreed-upon system like the JLab Pansophy or FNAL Vector systems. A formally approved plan may not be possible by the time of the procurement.

* 1. Has the supplier surveillance plan, including any required pre-award surveys, mandatory inspection points, or production/inspection readiness reviews been developed and vetted with affected project stakeholders?

The TET will evaluate whether a supplier surveillance plan, pre-award surveys, mandatory inspection points, or production readiness reviews are necessary. This procurement is not deemed highly technical and likely will include only moderate vender oversight. The awarded vendor(s) are likely to be fully capable of meeting the material specifications, delivery schedules, and required quantities.

1. **Lessons Learned**
   1. Have lessons learned from similar procurements and/or other laboratories been reviewed and applied?

Lessons learned from similar procurements by Fermilab have been incorporated in FNAL 371073-C and lessons learned by DESY in the recently completed E-XFEL niobium procurement have been written-up, discussed and will be applied. Most notable (from DESY) is the need to provide timely quality-feedback to the sheet-vendor.

1. **Risks, Issues, and Concerns**
   1. Are there any risks, issues, or other concerns?
      1. The correct material quantity should be carefully reviewed and approved. There is far less risk in having too much material than too little.
      2. Employing DESY to perform the QA/QC should be prioritized. This solution is likely more cost effective than increasing staff at FNAL or developing dual capabilities at both FNAL and JLab.
      3. By the time the material is delivered, will the DESY team still be in place to perform the QA/QC?
      4. If DESY is chosen as the QA/QC vendor, document management may be a concern as their system is believed to be incompatible with both Pansophy and Vector.
      5. There is little schedule float in the material procurement. The cavity vendors will essentially need the material as it is delivered. This schedule should be linked with QA/QC completion.
      6. Multiple vendor supply should be a conscious procurement strategy to limit schedule risk.
      7. The schedule for the procurement is technically driven and developed in isolation of other possibly competing schedules. The assumption is that LCLS-II has the priority at all partner labs.
      8. The cavity vendors need to be informed what material shapes they will have to work with at the time of the cavity RFP.
      9. Vendor QA/QC documentation should be added as deliverables in the RFP.
      10. A formal contingency plan addressing under-estimated cost and schedule is still required.