CONSTRUCTION STATUS QUO

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1. Introduction

The construction status quo of the 48 BCAL modules, as budgeted for in subcontract JSA 09-R280857-CR (for the construction of the Barrel Calorimeter – BCAL) and in Appendices 1 and 2, is described herein.

The contract was issued on August 6, 2009, signifying the start of the construction, the hiring of personnel and ordering of materials and supplies. Mr. Kolybaba was hired as the BCAL Construction Manager position, effective on October 1, 2009. Mr. Kolybaba had spent considerable time as 'contributed labour' over and above what was budgeted under the Construction Prototype contract, JS 09-Q280781, which allowed a seamless continuation through the approval of the full construction contract, JSA 09-R280857-CR.

2. Infrastructure, Materials and Student Labour

2. 1 Infrastructure

The infrastructure towards the construction of the 48 production modules was in place by the time of the BCAL Readiness Review on November 4, 2009. Specifically:

- The Construction Lab facility (LB113) was possessed, cleaned and prepared over May-June 2009. As permanent fixtures, it includes an operational fume hood with external ventilation, a faucet and sink, cupboards, drawers and shelving for storage of consumables and lead sheets. The lab has ample storage space for tested-and-approved fibres. Two new compressed air lines with pressure regulators and adequate power outlets have been installed. A PC running windows is located in this lab and is used to log build and swaging statistics in Excel sheets, and affords browser access to the electronic E-log. A second PC running Linux and hosting the E-log server is operational in an adjacent room (LB114); on it the students carry out attenuation length and photoelectron analyses. Backups of both machines to a remote server are carried out nightly. The lab is equipped with two cranes: a 0.5-2.0 ton adjustable 'cherry picker' and a 2-ton A-frame.
    - Status: 100% operational.
- Electro-pneumatic Presses:

- Press 1 was installed in June 2009, was surveyed, re-leveled and retrofitted to rectify past errors in its construction. Minor leaks in the pressure manifold system were repaired.
  - Status: 100% operational.
- Press 2 was completed on November 4, 2009. It is a look-alike to Press 1, with a few improvements. It was similarly leveled.
  - Status: 100% operational.
- Spare parts are on hand: three spare kits for cylinder (piston) repairs and 10 valve kits.

• The Lead Swager has been in operation since May 2009 in LB113 and since July 2009 in its dedicated alcove in LB113.3. Early in October the out-feed side of the table was removed and small adjustments were made to rectify a minor problem of lead snagging on the table's lip.

- Status: 100% operational.
- Critical spare parts are on hand: a spare motor, controller for the motor, gear box, belts and one pulley.

• The Fibre Sorting/Lead Trimming Table has half its surface covered with a special rubber cutting pad, and the other half with a grounded thin copper sheet upon which fibres are sorted, which reduces static electricity build up.

- Status: 100% operational.

• The Fibre Testing Lab (LB127) serves as the main detector development and testing lab. Wall-mounted shelving was installed in the summer for tested fibre storage. The lab is fully instrumented to populate three test stations: a) fibre attenuation length station using a photodiode or spectrophotometer and a laptop for readout, b) number of photoelectrons station using a ^{90}Sr source, calibrated PMT, trigger counter all inside a dark box and readout by a CAMAC-based DAQ system, and, c) SiPM testing station.

- Status: 100% operational.
- Spare fibre polisher parts are on hand: one diamond cutter, a dozen stops, two photodiodes, LEDs, PMTs, NIM and CAMAC modules.
- There are no backup systems for the spectrophotometer, HV crate, CAMAC crate and controller, and NIM crate. It is possible that departmental facilities can be borrowed for the duration of repairs if this timing does not interfere with teaching requirements.

• The Underground Lab (LY002) has been cleaned and prepared to receive overflow testing. It has its own fume hood, for storage of extra epoxy. If necessary, it can accommodate the attenuation length station and measurements.

- Status: 100% operational.

• Storage space for the lead has been allocated in LB113.1, LB113.2, College Avenue Campus and the university's old Storage in another building. Lead is also stored at Ross Machine Shop.

2.2 Materials

- 10 sets of cold-rolled steel bar pairs have been purchased and have been drilled, bored and straightened at RMS. One set of two bars was installed on the Construction Prototype, leaving nine sets for future builds; six to eight are used at any given time. The bars are removed from the aluminum base plates of the modules just prior to crating for shipment to Newport News.
- 50 Aluminum top (inner) plates have been purchased. All have been machined: one was used for the Construction Prototype and the rest are for the 48 modules, with one spare.
- 50 Aluminum base (outer) plates have been purchased. All have been machined: one was used for the Construction Prototype and the rest are for the 48 modules, with one spare. The base plates are stored at RMS and delivered to the UofR as needed for the builds.
- 48 wooden shipping crates will be constructed to allow shipment of modules from the university to RMS and eventually JLab, and for their storage at JLab until detector installation takes place. A new, sturdy design for their bases has been implemented and twelve crates have been constructed already. An agreement is in place with the customs-broker and transportation company for all 11 shipments.
- Fibre shipments from Kuraray arrive like clockwork. We currently have 13 shipments comprising nearly 50% of the entire number of fibres required, which is an enormous safety margin at this stage. The fibres are meeting specifications.
- Lead shipments from Vulcan will be broken into four main shipments (all in Regina now), a smaller fifth to account for rejection rates in the build of 48 modules (due in July), and a yet smaller sixth for wide sheets used for the tops of each build to prevent epoxy migration (due later in the year). Currently we have enough lead to complete 46 modules. The lead is meeting specifications.
- We have received about 50 one-gallon Bicron 600 epoxy kits (resin plus hardener) so far. BICRON has been notified of our delivery schedule for the duration of construction to assure a supply of freshly made epoxy (another 142 one-gallon kits) will be available in a timely fashion. We have enough epoxy on hand for a two-month (four-module) lead in the schedule.
- Industrial two-component epoxy is at hand, enough for two-and-a-half-month (six-module) lead in the schedule.
- Consumables (ethanol, wipes, plastic cups and spoons, etc) are available either from Science Stores or retail stores. 2200 paintbrushes were recently acquired (from WalMart!), which are adequate for the completion of the project.

2.3 Labour

Five Engineering students were hired in September 2009, four on one-year industrial internships and one on an eight-month Co-Op work term; the sixth position was filled by two experienced Physics students working half-time, who had

laboured on the Construction Prototype over the summer of 2009. The current students are now well trained due to crew rotation through all tasks:

I. Fibre quality assurance
    i. Attenuation Length station (photodiode and spectrophotometer)
    ii. Number of Photoelectrons station
II. Matrix Construction
    i. Lead cutting, swaging and swager operation
    ii. Fibre sorting
    iii. Epoxy mixing and application
    iv. Fibre laying
    v. Lead rolling
    vi. Base and top plate preparations
    vii. Press and crane operation

With plenty of SciFi's and Pb now at the UofR, the students have been prepping, cutting, swaging and stockpiling Pb sheets, and have been carrying out the QA of fibers. Lead inspecting, processing and swaging is staying well ahead of demand on the builds, and random testing of fibres from the first 12 shipments has been concluded and these fibres are suitable for the construction process.

Additional crew includes the Construction Manager, two faculty members, one research scientist, two graduate students, and other undergraduates with past experience that are available on an hourly basis in the event of illness or absence of members of the main crew.

There will be a turnover of four experienced students at the end of August 2010, with the two other slots fortunately filled by remaining students. In order to improve training and to mitigate possible errors by the new crew, each of these internship students will be brought on campus for a week of training during the summer, when they will have the opportunity to observe the existing students at each station and be trained by them, over and above reading the construction manuals and procedures. This on-the-job training will replace our training video.

3. Construction of Modules

Module 1 construction started on November 9, 2009, approximately three months after contract approval, following problems during the build of the Construction Prototype. That and the caution in proceeding with modules 01 and 02 have led to a 2.5 months delay in the schedule, which is fortunately covered by the project float. We are now operating at full speed in testing and construction, with pairs of modules built in about a month. Double shifts have been tried successfully during the build of the Construction Prototype and are an option in the event of delays in construction. It should be stressed that absolute priority is assigned to all aspects of

the construction, implying that the students assigned to fibre QA may be pulled for duty on the construction to combat delays, at the expense of testing fewer fibres.

The modules are shipped to RMS one or two at a time and stored until there are four, and then all four are machined as a group through each stage (rough cut, sides, ends) according to the signed drawings. Rough and final machining operations for four modules takes approximately three weeks for four modules and a few business days are needed for QA and document preparation. Shipping takes about a week in total.

At the time of writing this document, Modules 01-04 have been received at JLab, modules 05-08 are being machined at RMS, modules 09-10 have been shipped to RMS and are in the queue, and while modules 11 and 12 are nearing completion on the build side.

4. Final Remarks

Before the contract was awarded, the most worrisome issue for the project was being able to secure adequate student labour. This has been achieved for the first year of construction and likely also for the second year (we've made offers to the next group of students and are awaiting this outcome).

Four experienced students are continuing with us in half-time slots. One pair will work during the fall semester and the second pair for the winter semester. These students will work partially during working hours but also on evenings and weekends, mainly by testing fibres and swaging lead.

Everything is in place and 100% operational for the smooth construction of the 48 modules. Of course, time will tell, but we believe we have optimized testing and construction procedures, have built up spare capacity, possess spare components and are experienced to handle any type of conceivable problem.