SN 0346

BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

Date: May 11, 1998

To: William R. Edwards; Deputy Project Head, STAR Detector

From: Ralph L. Brown; Chief Mechanical Engineer, STAR Detector

Subject: Review of the TPC Support Arm, and TPC Installation Process.

On May 4, 1998 I conducted a STAR final design review of the TPC support arms at LBL. Those in attendance were Russ Wells, Gary Koehler, along with Steve Kane, ES&H/BNL, via videoconference. The scope of this portion of the review was the mechanical design of the TPC support arms, STAR Drawing Number "TPC-513-E-1 Rev. A". Russ Wells presented a description of the support arm, stress and deflection analysis, bolt stress and selection, and a discussion of required documentation for fabrication.

STAR Drawing "TPC-513-E-1 Rev. A", which details the two each left and right support arms, was reviewed for form, fit, and function. Each arm will be fabricated from a 12" x 20" x 50" long billet of 6061-T6 aluminum and will require a minimum of a three axis CNC machine tool with multiple setups to fabricate. At the time of this review there was no estimate or vendor quotes for the cost of fabrication, but an engineering estimate of 25 K$ was assumed. The TPC group is investigating both vendors and in-house fabrication scenarios, and I will pursue possible East Coast vendors. STAR Note 0334, Specification # M884 Time Projection Chamber Support Arms, is the fabrication specification for the support arms and was presented in draft form. It is recommended that this specification be completed as soon as possible with enough detail to insure the quality of the fabrication.

STAR Note 0338, Stress and Deflection of the TPC Arm, was reviewed and shows that both stress and deflection in the arm is minimal and well above a safety factor of 3 based on yield strength of the aluminum 6061-T6 material. However, an action item was issued that recommends a load table be added to the note that lists the individual loads from not only the TPC but from other subsystems that comprise the total load supported by the arms. In this manner future reference to the document will clearly define what loads were accounted for in this analysis.

STAR Note 0337, Selection of TPC Support Arm Bolts, was reviewed and concluded that the use of 8 each 1-1/4" 316 stainless steel bolts, certified to minimum ultimate tensile strength of 80 ksi, would be sufficient to support each arm to the magnet inner ring with a minimum safety factor of 4. STAR Note 0117, which had been previously reviewed, had shown that the threaded holes in the magnet inner ring, having a minimum yield strength of 25 ksi, would have a safety factor better than 6. An action item from the TPC group to the magnet group requests the removal of paint from the contact area of the support arms to the magnet inner ring. This would be done to maximize the mounting friction in the connection, the calculation of this connection does not account for this enhancement, and would also eliminate the possibility of any compressive creep or slip of the paint coating.

I concur with the statement made by the TPC group that each arm would be load tested to 1.25 times their maximum load condition while attached to the magnet inner ring at BNL. This was detailed in a test procedure and accomplished by mounting each arm in an orientation that allows them to protrude out of the magnet rather than in towards the TPC. The arms could then be loaded using the AB overhead crane and a calibrated load cell.

It is my recommendation that the TPC Support Arms are adequate to safely support the loads from the TPC to the magnet, and that procurement and fabrication of the support arm should proceed.

The second half of this review was a STAR Preliminary Design Review of the TPC Installation Process, which was conducted with both Russ Wells and Gary Koehler. The original installation scenario has been modified and therefore a new process was discussed. The scope of the review outlined the new installation scenario; stress, deflection, and stability of installation rails; detailed installation procedures and hardware for the TPC; rigging and alignment; and staging and storage of installation hardware.

The TPC, insertion rails, test stand, and lower support frame are nolonger on rollers atop the pole tip rails to be rolled as a unit into the magnet. Instead the new scenario calls for the magnet installation rails to be inserted first using a cable suspension trolley system. Once the rails are secured to exterior support columns bolted to the magnet outer ring, the TPC, test stand, and lower support frame (without rollers) will be rigged onto the pole tip rails at a fixed location from the magnet. The test stand rails will be installed and spliced to the magnet insertion rails. At this point the insertion of the TPC into the magnet is consistent with the original scheme. This is an acceptable change in that it allows for a more precise control of the TPC installation rails when they are inserted or removed from the magnet in the confined space between TPC and EMC modules. It is recommended that a thin rail insertion cable remain installed on either side of the TPC for possible future insertion of the rails.

A draft of the TPC Installation Procedure was presented which was 60 % complete. When completed it will be the required STAR controlled document for the installation and rigging of the TPC into the magnet. It is recommended that this procedure be completed and presented to the RHIC Experimental Safety Committee for review. Insertion of the rails into the magnet by cable suspension trolley system was detailed along with specified cable tensions and forces required for successfully installing the rails. Calculations for installation rail stress and stability were presented and was formally documented as a STAR Note 0271. Although the calculation show the ideal rails to be stable over the 300” span when loaded by the TPC, there is concern about the straightness of the rails once installed in the magnet. If the load line of action on a rail is not maintained over the centerline of the rail, as could be the case in the follower rail, torsional instability could result in buckling failure of the rail. An action item was issued to consider using the same v-groove rail for the follower rail as used for the guide rail. The v-groove roller bearings on the follower rail could then be mounted on axles that allow for lateral movement of the rollers in order to maintain the load line of action through the centerline of the follower rail.

The installation procedure calls for the west TPC support arms to be installed prior to the installation of the TPC into the magnet. The two east support arms are to be installed after the TPC has been rolled into the magnet and is still being supported by the insertion rails in the magnet. With the vertical support columns on the outer ring face, the insertion rails in the magnet, and the TPC support stand 40” off the face of the magnet it appears that the installation of the east TPC support arms will be challenging. An action item was issued to design a support arm-lifting fixture that allows for installation of the arms in this confined space. An alternative to this would be to consider using a 6 o’clock support of the TPC to the magnet on the east end, remove the rails and support stand, and then install the east support arms in the clear opening of the magnet.

The final area for review considered preparations and activities required at BNL for the TPC installation. This included hand tools, rigging equipment, man lifts, and survey and alignment equipment. Storage space for installation equipment and the staging of the TPC and its support frame for installation were also reviewed.

It is my recommendation that the TPC installation scenario, plan, and hardware are adequate and meets the requirements for the safe installation of the TPC into the Magnet. The TPC group should continue in the direction they are proceeding with the installation tooling, fixtures, and hardware design that addresses the action item concerns. They should complete the installation procedure as soon as possible and prepare for a RHIC Experimental Safety Committee review of the overall plan.

Cc: Russ Wells
Gary Koehler
Howard Wieman
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Steve Kane