**Engineering Note**
**for**
**E906 Detector Assembly**

**PROJECT:** E906

**TITLE:** Station 3 Minus Drift Chamber Support

**AUTHOR:** Kevin G. Bailey – Argonne National Laboratory

**DATE:** July 25, 2011

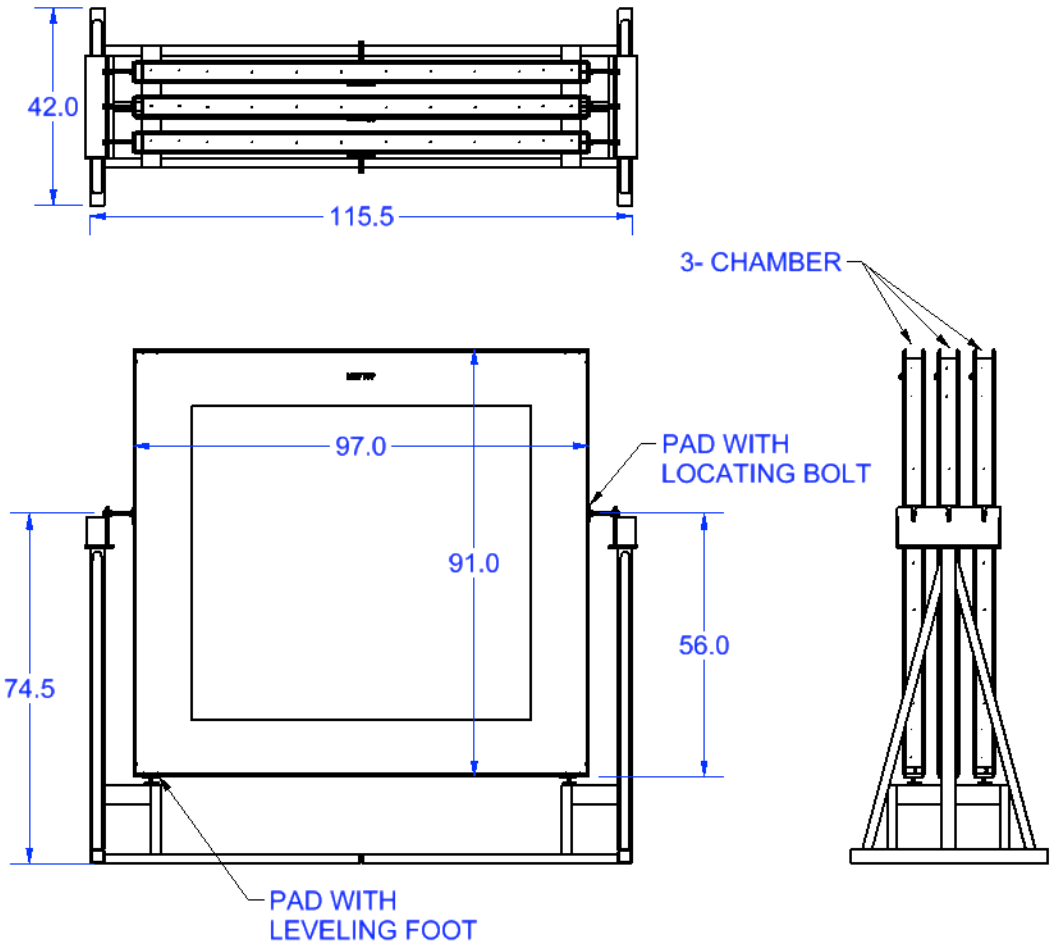
**REVIEWER(S):** Tom O'Connor – Argonne National Laboratory

**ABSTRACT:** This document describes the fixture used to support the Station 3 Minus (lower) drift chamber in E906.

**OVERVIEW:**
The station 3 Minus detector recycles drift chambers previously used on E866. The detector consists of three separate aluminum chamber frames mounted in a steel support. The chamber support sits on the SeaQuest Hall floor.

This note addresses the installation of the chamber and the stand for E906. The construction of the E866 chambers should be covered in a previous engineering note.

Each of the three chambers weighs approximately 600lbs.
Figure dimensions are in inches.




E906 STATION 3 MINUS AND SUPPORT

Figure 1

DESIGN:
The support stand is constructed of A36 2x2 and 2x3 steel box tubing. The tubing is welded together to form two stand halves. Each half has two beams that provide a base

and a vertical section on one side. The two halves are then joined with bolts where the base beams meet along the hall floor. The connected stand is secured to the concrete hall floor with concrete anchor bolts (see figure 1 & 2)

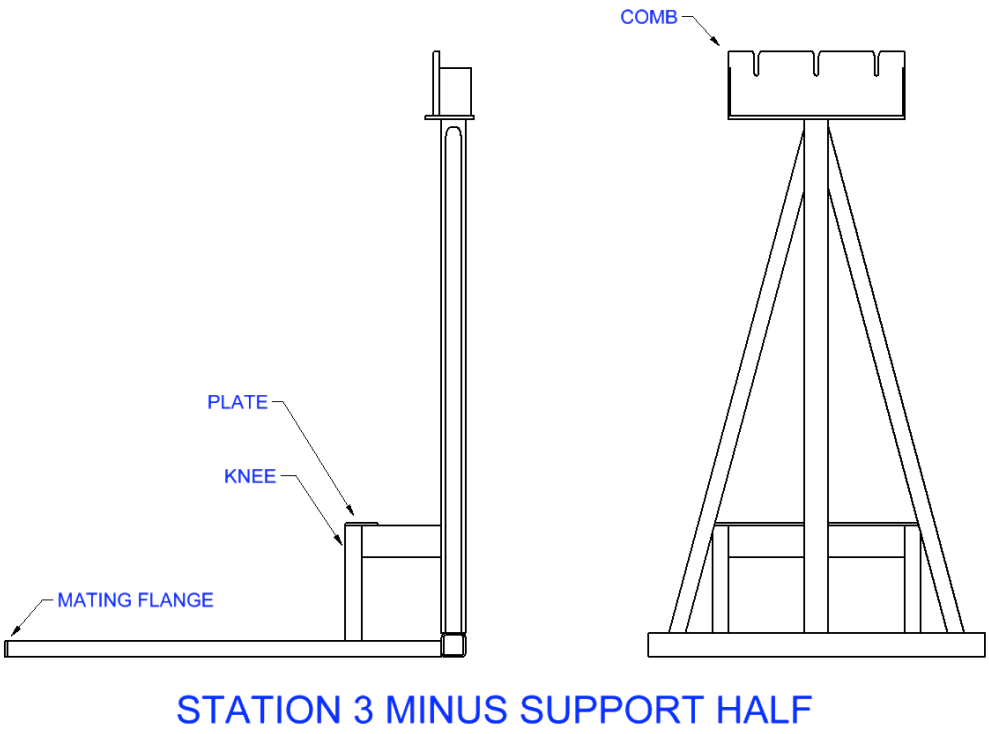



Figure 2

An aluminum pad rests on the aluminum C channel chamber frame at each bottom corner. The pad is secured to the chamber using a ¼-20 SHCS (McMaster Carr Part 91251A551) into an existing ¼" hole on the chamber (see figure 3).

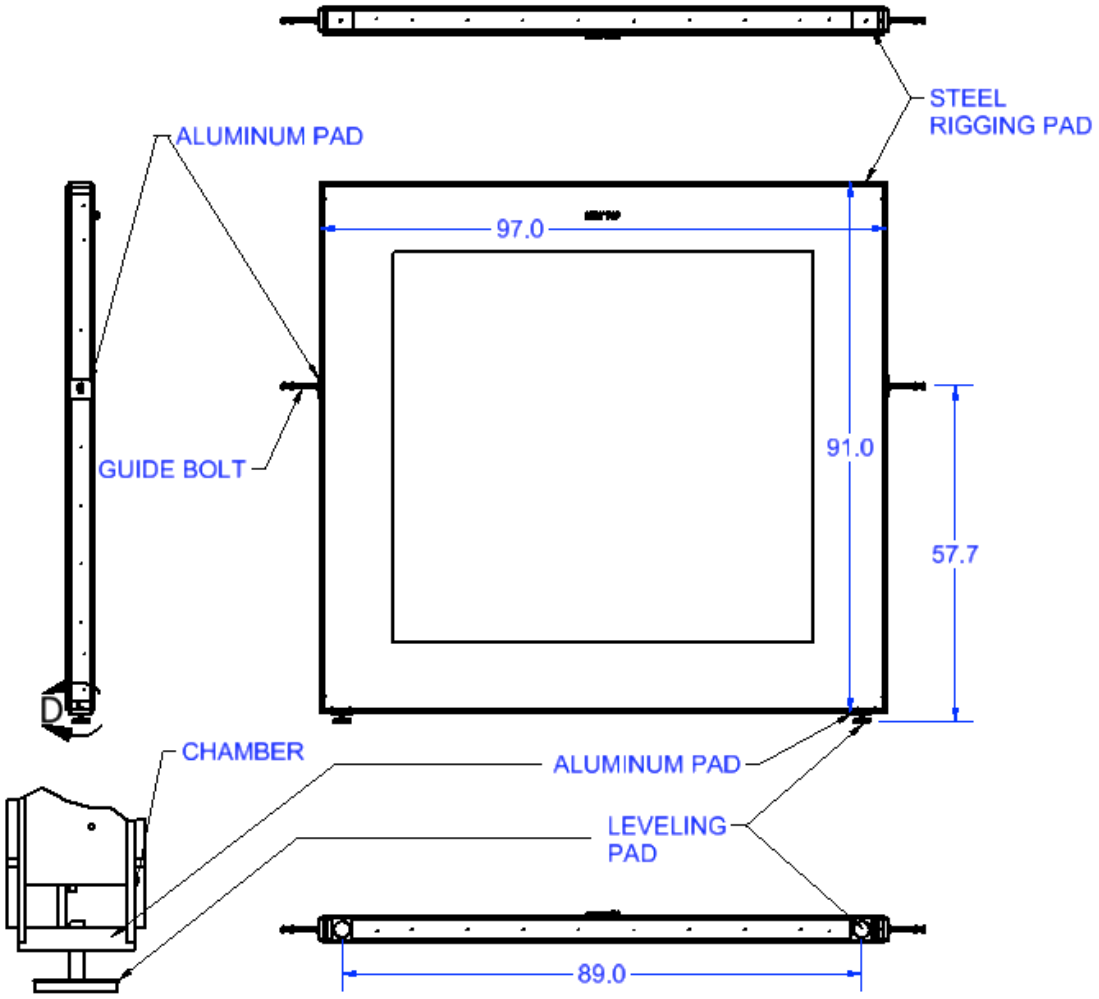



Figure 3

An equipment leveling foot (McMaster Carr part 62805k41) rated for 500lbs is threaded into the pad at each bottom corner. The foot allows up to 2" height adjustment

The leveling foot rests on a ¼" steel plate that is welded to the box beam support knee. The weight of the chamber is on this steel plate.

The vertical section is a tall post with a comb shaped weldment at the top. The slots in the comb are to resist movement forward/aft movement of the detector. The comb slots are located above the chamber center of gravity.

An aluminum pad is positioned on each side of the chamber. The aluminum pad is secured with a ¼-20 SHCS (McMaster Carr part 91251A551) into an existing hole on each side of the chamber. The pad has a tapped hole for a ½-13 grade 5 bolt (McMaster Carr part 92865A738). The 1/2" bolt  rests in the comb slot. Nuts are used to fix the position. The chamber position aligned to the beam height places the bolt above the low point of the comb slot.

The E906 installation requires a 90 degree rotation of the 3 E866 chambers. The E866 lifting points were removed. New steel lifting pads are affixed. The two steel lifting pads are attached to the chamber using 3/8" bolts thru both flanges of the C channel.

The lifting pads are tapped to accept a ½" hoist ring.

The chambers are lifted vertical using the hoist rings. The leveling pads are attached. The chamber is lowered into the support so the pad rest on the flat plate and the ½" bolts are located in the comb slots. Removal for service is in the reverse order.

**ANALYSIS:**

Knee:
The adjustable leveling pads of the 3 minus chambers rest on a ¼" steel plate. The steel plate is welded to a steel knee constructed of 2x3" and 2x2" steel box beam. The welds constructing the ledge must be strong enough to support the chamber load. Three chambers with a weight per side of 300lbs, yield a 900lb load on each knee. The box tubing is A36 steel with a tensile strength of at least 36ksi. Each piece of tubing is welded to another with at least 4" of ¼" fillet weld. Using a throat of 0.177in for a welds yields a throat area of 0.708in^2 minimum per weld. The load on a weld is 900lbs/0.708in^2 = 1271psi. The allowable shear strength for 60XX filler is (0.3)(60ksi) = 18ksi. The welded knee structure is strong enough to support the chambers weight.

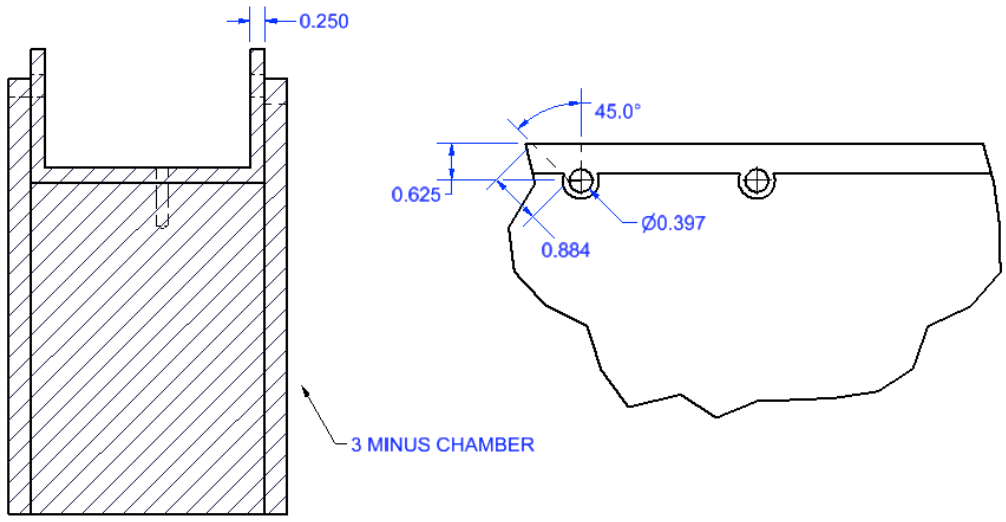
Comb:
The comb is a ½" steel plate weldment with slots cut to accept the chamber side locating bolts. The slots are 0.0531" in width and approximately 57" from the knee plate. A ½" locating bolt will allow a vertical chamber to tilt 0.016 degrees in the slot. Half the chamber weight of 300lb will place a side load on one bolt of 0.084lbs. This load on the 5" bolt places a 0.43lb load on the pad and chamber C channel. The locating bolts are adequate for keeping the chamber vertical.

Rigging pads:
A steel lifting pad is affixed to the top corners of each detector. The aluminum C channel has two holes through both flanges. The rigging pad is attached using two 3/8-16 SHCS bolts (McMaster Carr part 91251A651) Grade 8 steel and conforms to ASTM A574. The bolts have a tensile strength of 180ksi. Using an allowable shear of $17\%F_u$=30.8ksi as per ASD 9$^{th}$ ed. table J3.2.

The sheer load on each bolt
300lbs/2 = 150lbs
Tensile stress area for 3/8-16 fastener = 0.0775in^2
Shear load = 150lbs/0.0775in^2 = 1935psi

Tear out of aluminum C channel
Load on a 0.397 hole = 150lbs
Effective cross sectional area
Area = (2 flanges)(0.884in)(2)(0.25 thickness) = 0.884in^2
Shear on hole = 150lbs/0.884 = 170psi

The load on the bolts is within acceptable limits and the aluminum C channel is adequate to secure the lifting pads.




3 MINUS CHAMBER RIGGING PAD DETAIL

Figure 4

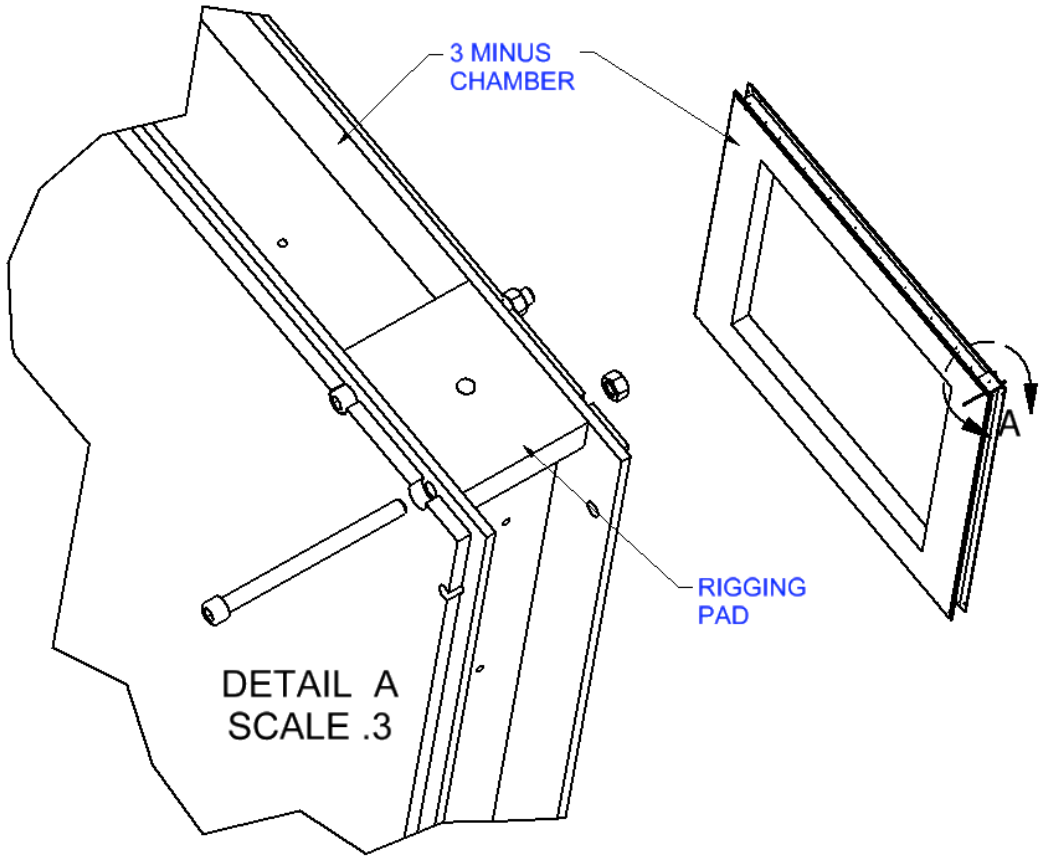



Figure 5

Hoist rings:

The ½-13 hoist rings used to lift the aluminum C channel framed chamber vertical are also used to lift the assembly and place it on the stand. Each hoist ring supports approximately 300-lbs. The area of a ½-13 bolt, based on a minor diameter of 0.4041-$in^2$, is 0.128-$in^2$ and the resulting shear stress in each eyebolt is 300/0.128 = 2344psi. We have identified swivel eyebolts made from forged alloy steel type AISA-SAE 4140 (American Drill Bushing, part number 33515) with a minimum tensile strength of 180ksi. These bolts are certified for a work load limit of 2500-lbs with a pivot range of 180 degrees and a swivel range of 360 degrees and are suitable for this application.