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The Mechanical Design of HIRES

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Contents

Chapter 1
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1.1 Abstract

The Spectrograph design was begun in 1987 and published as "HIRES Phase C: Core Proposal" in 1988 (UCO/L.O. Technical Report No. 57). The design has continuously evolved: the latest change was to accommodate the curved CCD from Tektronics (Epps' design #4052 of 6/3/92: 65" convex radius CCD). The instrument will be shipped to Hawaii by mid–1993.

1.2 Introduction

The mechanical design was done by Jack Osborne, Bruce Bigelow and Steve Vogt. Bigelow's work included the slit area items, the corrector lenses, the camera mirror and the instrument cooling system. The "slit area" includes the television guide system and the comparison source system. Also described here will be the collimators; echelle mosaic; cross-disperser mosaic; CCD dewar; main housing; main structure; re-aluminizing and re-alignment; and miscellaneous tooling. Bruce left in September 1992 and Osborne and Vogt finished the alignment, integration and testing. A report detailing the optical components has been prepared by Dave Hilyard. Two separate reports by Terry Ricketts describe the instrument control system and the CCD control system.

The instrument was designed and drawn using AutoCAD software resulting in a complete 2–D representation and a partial set of 3–D drawings. There are 1380 mechanical drawings (25" by 42"). Many assembly drawings are included in this report. We have anticipated changes and additions to the instrument. HIRES was fabricated by the UCO/Lick Observatory shops at UCSC working from full size blueprints. These were prepared from pen plots. Vellums are stored at UCSC as well as the digital files on 1/4" magnetic tape cassettes (8 cassettes). 11" x 17" laserwriter drawings will accompany the instrument to Hawaii. The British Engineering system of units (as opposed to the metric system) was used in this project.

A brief general overview of the optical design and scientific philosophy behind the HIRES instrument was presented by Vogt[21]. The optical design for the HIRES camera is described by Epps and Vogt[1]. The general assembly of the Keck Telescope and HIRES optics are shown on drawing H0010. Drawing H0102 shows the optical layout and H0148 details just the camera. A schematic is shown on H0200. An additional schematic is also in the Appendix.

All drawings and figures are in the Appendices at the rear of this report. Some drawings are used in more than one place. When updating this report please change all copies of the same drawing.

Chapter 2
DESIGN OF THE COLLIMATOR MIRRORS

2.1 Drawing List:

There are 85 E-size drawings which are listed in the locating tree, H2005.

2.2 Mirror Cell:

A single cell supports both the red and blue collimator mirrors. These are 17" diameter Pyrex® mirrors. The 2.7" thickness was set by the manufacturer and agrees with the 6:1 rule of thumb for diameter-to-thickness ratio for glass disks. The radial supports are located at 120° but should have been 90° for the lower two supports. This error should not present a problem. The radial supports are designed to be temperature-compensating. This technique is described by Nelson in TMT Note 28[2]. Details of the design are shown in Drawing H2209. The 3 axial supports are front-defining. Three swivel-foot pads are used on the front of each mirror with spring loaded plungers directly opposite on the rear. The axial supports are also located at 120° around the mirror. The usable light beam was roughly square and so this support geometry cleared the beam. See Drawing H2206 for details of the spring plungers and Drawing H2000 for the cell assembly. The total force on the rear of the mirror should equal 1.5 times the weight of the mirror (90 lbs = 1.5 x 60). The general shape of the cell and shuttle mechanism is narrow along the optical axis of the spectrograph. This is because the original design had the slit 20" further back to allow more room at the slit area. The collimator cell was thus up against the rear wall of the housing. It wasn't until later that more room became available in the area behind the cell. (The slit was moved to improve image quality.)

The two mirrors have the same spherical shape: 327" radius. The difference between them is 0.02". This makes the cell easier to design since the mirror support and cell need only accommodate 0.02" of motion along the mirror axes in locating the two mirrors in their cell.

The mirrors will be removed for re-coating by removing the front faceplate of the double cell. Each mirror will be removed manually after removing the 3 front-defining pad assemblies. The adjustment will not be lost if the collimating screws are not turned. The upper radial support is loosened and a special clip is installed to retain the Delrin® pad. The mirror can be replaced by noting the orientation of the outer edge index mark. Re-installation is the reverse of this. The upper radial support screw is tightened to 5 in-lbs.

The mirror covers are air-operated with magnetic reed switches mounted onto the cylinders to indicate open or closed condition. Speed control valves are mounted to either end of the air cylinders. The covers are not interlocked with the shuttle motion.

2.3 Mirror Shuttle (Red to Blue):

The motion from red collimator to blue collimator is controlled by 2 double-acting air-cylinders. An air switch causes an air-operated 4–bar linkage locking mechanism to hold one of the two upper kinematic mounts tight and an air-operated caliper brake holds the lower kinematic mount tight. The 3rd kinematic mount is loaded by the weight of the cell and focus mechanism (about 300 lbs). The electrical signal to shift from red to blue puts pressure (75 psi) on the release side of the lock which overcomes the 60 psi locking pressure. When the stage moves about 1/2" the mechanical limit switch opens to make the locking pressure zero. The switch is then ready for the blue-to-red motion. The opposite switch causes the opposite lock to engage when the shuttle is within 1/2" of touchdown. This locking motion also helps seat the ball-in-groove kinematic mount since we found that friction was high enough that seating at the ball-in-cone mount was a problem. We added check valves to prevent exhaust air from operating the lock cylinders prematurely. See Drawing H2415 for details of the pneumatic control logic.

The speed control valves on the main motion cylinders are set to bleed slowly so that the shuttle motion is very gentle at the touchdown portion of the travel. Valves were added to bleed the remaining air after touchdown to unload the drive cylinders and speed up the cycle time from red to blue and back. Time delay circuits were designed to open the valves for 4 seconds after arriving at the kinematic mounts. All motion is prohibited during the time these valves are open.

Before the collimator mirrors are aligned to the rest of the spectrograph, the shuttle should be adjusted so that the mirror cell is tilted 1.75° (half of 3.5°) at each end of travel. There are 2 adjustments, one at each of the lower (ball-on-flat) kinematic mounts.

The air exhaust runs through a long, large diameter pipe. A 1/2" tube was tried but the back pressure caused the clamp cylinders to engage the stage while it was moving.

Red or blue position status is via magnetic reed switches mounted to the main drive cylinders.

Drawing H2401 shows the parallel linkage of the shuttle system; Drawing H2415 shows the air system schematically; and Drawing H2460 shows one of the locking mechanisms and one kinematic (ball-in-cone) mount.

There is a middle position for the shuttle: this was designed after assembly. Moving to the middle and staying there is rather crude. Two split, plastic cylinders attach to the main drive cylinder rods to hold the stage in the center position. To center manually, halt the shuttle and release the brake button in the middle of its travel. This should be done with 2 people and lots of light. The rear-mounted autocollimator can now be used without removing either mirror or opening the covers.

2.4 Focus Control:

The focus control was added after the project was begun and the cell was finished. The total travel is about 3/4" along an axis halfway between the incoming and outgoing beams. That is, along the mirror normal axis. The focus control stage is 3 flex plates arranged in a triangular pattern. There is no sideplay in the stage. The stage is driven by 3 THK ball screws bearing on 3 hardened steel pads. Drawing H2600 shows the focus housing and shuttle stage. The mirror cell, shuttle housing and 3 flex plates are all made of aluminum, thus avoiding thermal expansion and contraction problems. Coil springs are used to keep the cell in contact with the 3 screws. The 3 screws are tied together with 3 timing belt sprockets and a long timing belt (337 teeth). A DC servo motor is mounted directly to one of the 3 screws. The motor is mounted to a THK linear slide so that it follows the screw (and cell) relative to the housing of the focus stage. Four limit switches locate the travel ends and an optical interrupter locates the center of travel and which side of center you start from. Encoding is via the motor-mounted incremental encoder. There is no absolute encoder for this stage. The motor is used throughout HIRES but has a 5:1 gear box mounted here for more torque. There are 3 dial indicators which serve as rough alignment devices in case the belt must be removed from the 3 drive screws. Drawing

H2610 is a schematic of the drive. Drawing H2620 is an assembly drawing of the focus stage and shows the triangular arrangement of the 3 flex arms. The motor/encoder is shown in Drawing H2623 and the gearbox is shown in Drawing H2660. The limit switches are shown in Drawing H2630. During the testing we discovered that one of the electric brakes failed causing the belt to come off. We then removed both brakes and saw no drift in the focus. We are still watching for this. The 5:1 gearbox is able to hold the stage from back-driving.

Chapter 3
DESIGN OF THE ECHELLE MOSAIC

3.1 List of Drawings:

There are 93 E-size drawings which are shown on locating tree H3005.

3.2 Grating Support and Subplate:

A 1 x 3 mosaic of gratings was used with overall dimensions of 12.6" by 49.6". The gratings were replicated by Milton Roy from a master grating which they ruled. The substrates are Zerodur® from Schott Glass. Each Zerodur grating is 12.6" by 16.5" by 3" thick. (see Drawing H3454) The rulings run along the 12.6" direction. The two gaps are 0.04" wide. The gratings are stepped by 0.09" to hide the un-used portion in the shadow of each upper grating (about 3/8" wide). See H3150. The pivot axis is arranged to be on the surface of the central grating, parallel to the rulings. See assembly Drawings H3600 and H3100. Drawing H3425 shows the blaze detail. All 3 gratings are held against a 4" thick granite subplate. The grating back support detail is shown in Drawing H3500 and side support details are shown in Drawings H3510, H3511 and H3520. The subplate is held in an aluminum cell. The subplate is black gabro, a type of granite with an elastic modulus of 12 x 10^6 psi. Note: standard tool room granite plates are 30% quartz for better wear resistance but have 1/3 the stiffness ($E = 4 \times 10^6$). The subplate is seen in Drawing H3470. Details of the three subplate back-supports are shown in Drawing H3300. The three side supports are shown in Drawings H3340 and H3345. The finite element analysis results are shown in Drawing H3801: The predicted deflection for 180° gravity change is 0.16 arc-sec for the worst case. This is the relative angular change between the worst 2 grating blanks. The software package used to model this flexure was ANSYS. The location of the 3 back supports was selected to minimize this flexure.

3.3 Grating Supports:

The mosaic concept was to be a passive support. The initial alignment would then be done and no adjusting would be needed forever. The Zerodur gratings would be located by three Zerodur washers against the granite subplate. The details of the support can be seen in Drawings H3500 (back support), H3510 (side support, type I) and H3520 (side support, type II). The washers were polished on one side and fine ground on the other. The polished side was optically contacted to the polished grating surface. The three supports in each grating pull the grating against the subplate with 1.5 times the grating weight (90 lbs = 1.5 x 60). The washers were machined by fine grinding after measurements of the mosaic were made by interferometer. The washers could be measured by Anorad profilometry in 6 places around the perimeter, ground to remove as little as 0.000,02", re-measured and re-installed for another interferometric test in one day. It took one day to evaluate the test results and predict the next cut and it took typically 4 cuts to get one pair of gratings aligned to each other. This was about 8 cuts for the echelle mosaic (and 4 cuts for the cross-disperser mosaic). We did this with bare, polished blanks and then again after replicating. The error in replication turned out to be less than 3 arc-sec. The gratings were aligned in the plane of the gratings by pushing on the sides or on Zerodur blocks which were glued to the sides. These adjustments and supports were aluminum and stainless steel. We found during cold testing that the side supports are not stable enough and so invar parts are being built to replace these components.

3.4 Gluing:

The first experience with mosaics is documented in UCO/Lick Technical Report #49 (Reference 9). This 2 x 2 mosaic used 6" x 8" Zerodur blanks. Each blank was supported with three invar inserts epoxied into the back of each blank. We used Devcon 5 minute epoxy. We scaled up the design for the HIRES mosaics. The under-cut pockets in the back were larger and we used Eccobond 285 with catalyst 11 by Emerson and Cuming to embed the invar threaded inserts. This epoxy cures at an elevated temperature (80°C). We had failures in the glass after this process. The side pads were glued with Eccobond 285 and catalyst 24LV. This is a black adhesive and comes apart at boiling water temperature. The plan was to remove the side blocks for replication after our initial alignment testing, by placing the blanks in boiling water. The rear inserts would then stay in place and not come out. The 285 glue with this catalyst is rated to take up to 177°C. They would not interfere with the replication process at Milton Roy. The side pads were 2" long invar blocks and we had glass failures here, too.

Though the expansion coefficient for invar is small, it is not zero and so we suspect the motion of the invar pads from day to night in the lab caused the glass to be stressed to failure.

The solution to both these problems was to use a different epoxy. We were referred to Hysol EA 9313 by A. DuBois (See Reference 18). Drawing H3040 details the gluing procedure and shows a test block. The side support block is now Zerodur instead of invar and we have had no more problems there. The Hysol epoxy is softened with Methylene Chloride and by using a thin saw blade, the side blocks were removed before replicating. This was a time-consuming process. The blocks were re-attached after replication. The invar inserts were bonded into new holes bored into the grating blanks by Zygo. The old pockets were cleaned out with Eccostrip and then we decided to acid etch the cracks with Ammonium Bisulfate. This caused more problems than it solved because the acid seemed to migrate to all the surfaces of the grating blanks and left stains on every surface. We sent the tarnished blanks to Zygo to polish again.

3.5 Echelle Mosaic Testing:

This topic is covered in greater detail in the optical report. Drawing H3061 shows one of the grating tests using a folding flat mirror and Zygo interferometer. Drawing H3603 shows the final test with the mosaic at 10.5° to the interferometer. An isolation platform using Newport air-mounts was built to test this mosaic. We have tested the mosaic with the interferometer while it is mounted inside HIRES.

The blaze angle turned out to be slightly different from specified and so the drive was modified to move the center position by 1.5° (70.5° instead of 69°). The grating was enough oversize to accommodate this change and the tilted grating and cell did not interfere with the incoming light from the slit. Final alignment of the three gratings in the plane formed by the mosaic is less than 1 arc-sec ("hinge" or dispersion direction). Alignment in the cross-dispersion direction is also sub arc-sec. Alignment of the gratings about the center grating normal axis is less than 5 arc-sec.

We tried to make grating blanks here (UCSC) but found it was cheaper and faster to have Zygo make the blanks. The front and back surfaces have to be flat to 20 waves. Zygo can do this easily. We had tighter tolerances since we were first testing the concept to 1 arc-sec and we needed 1 wave surfaces. This will not be necessary in the future. Zygo bored the mounting pockets in the back.

Zygo also machined the bevels which are very important for proper separation during the replication process. Milton Roy returned our first set of blanks because the bevels were out of tolerance. This "take-apart" process is proprietary and so we never learned exactly what the bevel minimum could be. The success of replication lies in their ability to split apart a 12" by 16" glue joint without damaging the glass or the thin (0.001") layer of epoxy.

3.6 Echelle Drive:

The drive is shown in Drawing H3200 and the bearings in Drawing H3240. Echelle drive and encoder sub-assembly are shown in Drawing H7300 and limit switches are shown in Drawing H7330. A 6" linear stage from Daedal and Heidenhain linear encoder are used here. This encoder was not rated below 0°C but we have tested it to –20°C. We found that the motor encoder works as well as the (expensive) linear encoder. After the echelle drive was finished and tested we decided not to design a linear encoder into the CCD focus stage.

The echelle pivots by two stub axles bolted to the cell. These are carried in two SKF double row spherical roller bearings. One stub axle has a contingency stub protruding from the bearing block. This is for locating a rotary encoder if the linear drive and encoder did not work out. The opposite side of the A-frame support structure has a tab which angles down to the third kinematic mount of the main frame. This was not used but was intended for a stiffening element if the echelle ended up with a low natural frequency. Drawing H3244 shows the alignment tooling for locating the echelle bearings.

3.7 Gluing Notes:

Keck Observatory Technical Notes 194[4] and 160[5] derive practical guidelines for glue joint design. We have used Hysol EA9313 epoxy resin with a nominal thickness of 0.012". A description of the glue methods used in the Keck Telescope was written by A. DuBois as "Keck Observatory PMSS, Epoxy Bonds for Segment Inserts," November 26, 1990. HIRES Drawing H3040 lists our cleaning and preparation methods and shows a 3" x 3" x 3" test block which has been loaded to twice the maximum insert load. The three small side blocks which are arranged around the test block, are loaded to 1 times the maximum expected load. This test assembly was glued and loaded in July, 1991. It was then placed in a freezer at –20°C. It has been stored at that temperature for almost 2 years. It will be kept at UCSC and inspected periodically.

The solvent for this epoxy is Methylene Chloride.

3.8 Cover

The air-operated cover is shown in Drawing H3700 and the pneumatic control is diagramed in Drawing H3703.

Chapter 4
DESIGN OF THE CROSS-DISPERSER MOSAIC

4.1 List of Drawings:

There are 126 E-size drawings which are shown in the locating tree, H4005. 21 of these are for the replacement turntable.

4.2 Grating Support and Subplate:

A 2 x 1 mosaic of 12.5" x 16.5" blanks was designed. The gap is 0.04". The overall size is 16.5" x 25". This is very similar to the echelle support and common parts were used wherever possible. Drawing H4470 shows the subplate. Drawing H4000 shows the cell assembly. Drawing H4700 shows the air-operated doors and Drawing H4751 shows the pneumatic details.

4.3 Mosaic Testing:

The final alignment accuracy yielded a pair of gratings with 0.77 arc-sec error in the direction perpendicular to the echelle dispersion ("cross" dispersion) and less than 0.02 arcsec error in the echelle dispersion plane ("hinge" error at the joint). This corresponds to mismatches of less than 5.4 microns of cross-dispersion error and 0.14 microns of echelle dispersion error at the CCD. We were not sure what kind of specification we had to meet, but are very happy with this result.

4.4 Rotary Table and Drive:

An initial purchase of an Anorad precision rotary table was a disaster. We then found ourselves in the position of designing a precision turntable to fit in a very narrow package to replace the Anorad table. We were successful. The drive uses one of the servo motors used throughout HIRES and a Heidenhain incremental rotary encoder is mounted directly on axis. This encoder has 720,000 pulses per revolution and a single pulse per revolution index track. The resolution is 2 arc-sec. Drawing H4251 shows the encoder. A brake was designed and installed. This is shown on Drawing H4534. It was discontinued because we observed the stage to creep over long (8 hour) time periods. An air cylinder provides a counter balance to the offset weight of the mosaic (450 lbs). See Drawing H4511. Turntable details can be seen in Drawings H4264 and H4530. Drive schematic is on Drawing H4281.

4.5 Lifting Equipment and a Second Cross-Disperser:

The lifting bridle is detailed in Drawing H4740. The manual hydraulic crane is used to exchange grating mosaics. A second mosaic will be built soon.

Chapter 5
CCD DEWAR AND SUPPORT

5.1 List of Drawings:

There are 216 E-size drawings which are shown in the locating tree, H7005.

5.2 Focus Stage and Drive:

Drawing H7250 shows the dewar frame and stage. The stage is 3 flex links mounted with disconnect pins. This is the point where a second dewar will be attached. The dewar frame is then defined by 3 hardened steel pads resting on 3 steel buttons. These are driven through a 20:1 lever system by 3 micrometer screw drives. The micrometer screws are coupled to a single motor by timing belts. See the H73xx series of drawings. Drawing H7350 is a kinematic drawing of the drive. One pulse of the motor encoder represents a theoretical motion of 6.94×10^{-8} inch (1.76 nano-meters). Total focus travel is ±0.012". (The target was ±0.5"/20 = ±0.025", but the double set of limit switches and the required overtravel for each one, limited the focus travel.) There are three manually-adjusted bronze screws in the focus system which allow for a coarse adjustment of ±0.5".

5.3 Vacuum Chamber and Liquid Nitrogen Fill System:

Drawing H7130 shows the CCD dewar and support frame. Drawing H7131 shows the detail of the liquid nitrogen can, Drawing H7180 shows the central vacuum housing with field flattener window and Drawing H7500 shows the pre-amp box which hides in the shadow of the center housing. The liquid nitrogen automatic fill system is shown in Drawing H7600. The design for the level-sensing tri-axial capacitors was borrowed from Lawrence Berkeley Lab[6]. See Drawing H7601.The dewar transport and lifting systems are shown in Drawing H7800.

5.4 Dewar Performance:

The LN_2 reservoir holds 3.5 liters. An ion pump keeps the vacuum at 10^{-8} torr. Details of the dewar design and construction can be found in a UCO/Lick Observatory Technical Report in progress by Osborne. Hold time is approximately 15 hours and so transfer happens twice daily. A 50 liter supply dewar rests on the Nasmyth platform. The utility board in the CCD controller monitors the level sensors and begins the transfer of cryogen and stops it when full. The venting of nitrogen gas is carefully done so that the housing does not fill up with nitrogen which is deadly. The 50 liter supply dewar is pressurized to 2.5 psi with clean, dry compressed air until the transfer is completed.

The Varian ion pump (2 liter/second) power supply has been modified. The schematic is shown in the Appendix. This modification prevents over-heating of the pump unit after power loss and during start up at a pressure higher than about 10^{-4} torr. The pump could get hot enough to cause the o-ring in the valve to fail. Or the pump could get hot enough to start a fire.

Chapter 6
HOUSING and STRUCTURE

6.1 List of Drawings:

There are 225 E-size drawings. These are shown on H6000, the locating tree for Housing and Structure.

6.2 Bally Enclosures:

Three pre-fab modular rooms were bought for this instrument: The small, 6 foot by 6 foot "Vault" contains the electronics and operates above 5°C. It is cooled by Observatory coolant until the temperature drops below 5°C. The heat generated by the electronics component serves to keep the temperature above 5°C. The components are not rated to go below 5°C. The large room was 15'5" by 17'4" when ordered from Bally. It was modified with a large cylindrical portion which fits inside the elevation axle. The design clearance is 1" in radius or 2" in diameter. A 5' by 10' ante-room was added later. These enclosures use 4" thick poured-in-place polyurethane foam for insulation. They come with self-closing sealed doors and insulated floors. The locking latches have been removed (for safety). The incandescent lights are dim. We added 8–foot fluorescent lights which are rated for very low temperatures (-40°F). These fluorescent lights have persistent glow for many minutes after being turned off and also cause the paint of the interior walls to fluoresce. Thus, we recommend that the bulbs be removed during routine operation of the spectrometer and only installed and used during extended periods of maintenance. We added an overhead raceway for wires and hoses. The main enclosure is shown in Drawing H6400. The Vault is shown in Drawing H6425. H6410 is a 3–D drawing of the main housing and vault. It shows the conical transition section and cylindrical "nose." This drawing can only be viewed in the drawing editor in AutoCAD. The single view shown in the Appendix here is one of an infinite number of views.

6.3 Light Trap Ante-room:

An ante-room was added to help keep the main enclosure dark and provide a location for donning clean-room apparel. This room is shown on Drawings H6460 and H6461. It is about 5' by 10'.

6.4 Kinematic Mounting of the Structure on the Nasmyth Platform:

The instrument is located on the RIGHT Nasmyth Platform. The decision to move from the Left platform was made in May, 1993, during packing and shipping. There are benefits in occupying the Right platform: 1. access to the elevation encoder is preserved, 2. access from the fixed Nasmyth Deck structure is easier while the telescope is in the stored position, and 3. no walkways need modifications. Drawing H0010.H shows the new configuration. Drawing H0010.G shows the old configuration. The mounting holes are different between the two platforms. We intend to match the slots in the 3 support feet to the mounting holes (12 mm threaded holes) on the Right Platform by using transfer screws and aligning the feet, then removing the feet and using a milling machine at the Summit to locate the slots.

The attachment to the telescope is through 9 threaded holes (12 mm). The mainframe of HIRES attaches to 3 feet which bolt to the 9 holes in the platform to distribute the load into the telescope. The foot closest to the slit is fitted with a spherical bearing. This bearing is shown in Drawing H6177. A typical foot assembly is shown in Drawing H6120. An adjustment in the up/down direction is provided by a large acme screw (1.5"Dia x 5 TPI). Adjustment in the slit jaw direction (telescope-defined y-axis, that is horizontal direction) is via slots in this foot assembly. The foot near the collimator mirrors has a spherical pad resting on a flat surface. This simulates a ball-on-flat joint. An acme screw here (5 TPI) allows vertical adjustment and a tilt adjustment to align with the telescope elevation axis. The 3rd foot has a simulated ball-in-groove joint. The detail is shown in Drawing H6174. This last foot allows the Nasmyth deck to change shape without introducing forces into the HIRES optical bench structure. This preserves the original alignment of the spectrograph optics. There are slots in this 3rd foot which run in the telescope-defined z-axis (along the instrument axis). This allows the instrument frame to be steered in the plane of the deck to align with the elevation axis. There is no vertical adjustment in this foot. If one is required, then we will use shim plates. It is thus possible the slit jaws will not be perfectly horizontal.

A series of drawings beginning with Drawing H6020 show the day-to-day assembly of HIRES onto the Nasmyth deck. The mounting feet are shown clearly.

6.5 Optical Layout:

The spacing of the optical elements is detailed in Drawing H0102. The Camera layout is shown in Drawing H0148.

6.6 Cooling Tests at UCSC:

Drawing H6470 shows the Bally freezer unit located in the main enclosure. The freezer is not to be shipped to Hawaii. During the initial cold testing in 1989, the temperature was –22°C. The final optical testing in February of 1993 was done at –7°C. The electronics vault also had a Bally freezer installed. Its temperature was kept at 5°C.

Chapter 7
MISCELLANEOUS (SHIPPING AND INITIAL ALIGNMENT)

7.1 Handling Equipment:

The Ruger Crane is a manually operated 1/2 ton crane. It has a 2 speed feature which is not straightforward to initiate: When lifting very heavy items (750 lbs), the relief valve must be set to 1/4 to 1/2 turns open. This is not an obvious thing to do. The crane has 2 mounting sockets. There are 2 lifting arms to reach different items. See Drawing H9000. The main use for the crane will be changing Cross-Dispersers. The socket on the optical centerline will be used for this. Note- be sure to remove the crane aafter using at this station or it will interfere with the optical path of HIRES! See Drawing H9005 for the correct arm location. Other items to be lifted include the Collimator Mirror Cell (used with the white lift arm) and the Echelle mosaic cell. The Echelle can be lifted from either socket (See Drawing H9006). These will not be routine operations.

The pneumatic-tired dollies are for moving the grating mosaics (See Drawing H3075 for the Echelle and Drawing H4075 for the Cross-Disperser cart). This keeps the loads on the fragile subplate supports to less than 1.2 g's. Only manual lifting devices should be used to lift grating cells. A lifting bridle is provided for the Cross-Disperser. A commercial swivel eye is located in the top of the Echelle cell.

The roll-around hand-cranked lifter is for corrector lens cells and the CCD dewar. See Drawing H7800.

The camera mirror and mount are removed as a single unit using the overhead I-beam trolley and manual chain hoist. Be sure to release the hold-down clamps before attempting to lift the camera mirror, or you will lift the entire spectrograph! The mount has 4 casters for rolling once it is lowered to the floor. In the future, there will be both a red and a blue camera mirror. The passing arrangement is shown in Drawing H6936.

Three large steel casters mount onto the mainframe and are for moving during dis-assembly, packing and re-assembly. They will have no other use after commissioning. See Drawing H6605. The mainframe dis-assembles for shipping in 8 foot wide containers. See Drawing H6200.

7.2 Initial Alignment Scenario:

Drawing H6500 shows some of the alignment tooling. The permanent tripod at the rear of the mainframe has been bolted, pinned and welded. It is not intended to be removed or adjusted. An autocollimating telescope is fitted to the tripod and used to align the spectrograph. There are no adjustments to this mounting. The philosophy here was to open the slit jaws and use this same autocollimator to find the telescope optical axis. This will be used in the future for modifications, additions or to look for problems. The Davidson Autocollimator will remain with the HIRES instrument.

Drawing H6510 shows the rear tripod. A moveable tripod assembly which mounts ahead of the slit is shown in Drawing H6530. This device has an aluminum storage plate for protection and a wooden storage crate when not in use. The tripod is fitted with adjustments but should never need adjusting. Should this tripod be needed, it can either be installed through the forward panel which has the entrance hatch (use the "man-lift") or by carefully 'snaking' it into position from the inside of the HIRES housing. Whenever this tripod is re-installed, its alignment should first be verified by checking against the fixed autocollimator mounted behind the collimator cell.

Alignment of the slit area is detailed in Section 18. No re-alignment is intended; all of the joints have been pinned. The only alignment which may need looking after is the tilt of the comparison lamp feed mirror and the centering of the pupil mask in the comparison lamp optical system. The strategy is to ensure that the apparent pupil of the comparison source system coincides precisely with that from the telescope.

Chapter 8
RE-ALUMINIZING AND RE-ALIGNMENT

8.1 Camera mirror (or "Hextek" mirror); about 44" diameter:

This mirror will be coated at Mauna Kea using an adapter which is shown in Drawing H5420. The adapter assembly has been engraved to help identify it. The mirror support hardware is left in place during cleaning and aluminizing. The old coating will be stripped off using chemicals. A strip of 1/4" wide non-hardening strip caulking is placed in the joint just behind the front plate. This will keep any liquid from going into the cavities in the interior of the mirror. This strip of material must be removed before placing in the vacuum chamber. The original coating was done at Mt. Hamilton hanging vertically. The tank at Mauna Kea has the mirror looking face down. The red and blue mirrors will require different coatings. We are assuming that the coating technology will be present at the Summit. This will keep travel to a minimum for these fragile mirrors.

8.2 Sol-gel re-coating:

The 2 large corrector lenses (about 32" diameter) have been Sol-gel coated at the Lawrence Livermore National Lab. They have lifting slings and carrying fixtures which have been reviewed by the technicians there. Refer to UCO/Lick Observatory Technical Report No. 62 dated June 1992 by Bigelow entitled: "Mechanical Engineering Safety Note - Lifting Slings for the HIRES Spectrograph Corrector Optics." (Reference 8). There are 2 clean cases for shipping the lenses.

The field flattener lens (6.5" diameter) has a case but no special sling. This optic will be coated before HIRES arrives in Hawaii. LLNL has slings for this size lens.

The Sol-gel is extremely fragile and scratches ealily if even lightly wiped. The Sol-gel also has 35 times the surface area of the part it is on, so is a virtual sponge for dust and other contamination. Great care must thus be taken to guard against dirt or touching of these coatings.

8.3 Collimator Mirrors (17" diameter) red and blue:

These mirrors have wooden cases for storage and shipping. They will be hand-carried to Z, C & R in Los Angeles for red coating and blue coating. These mirrors weigh 60 lbs each and so can be installed or removed manually.

8.4 Re-aligning the collimator mirrors:

This is done with the Davidson autocollimator mounted in the slit area tripod socket (refer to Drawing H6530). Before removal of one or both of the mirrors, the autocollimator will be installed and the target mounted onto the central pedestal using the kinematic mount and the 3 steel balls (refer to Drawings H6560 thru H6565). We have used this method and achieved 10 arc-sec re-installation accuracy. If a focus drive belt should break, then refer to the 3 dial indicators on the rear of the collimator housing. These will be recorded after initial instrument assembly and checkout. Drawing H2640 would be a good place to record these readings.

8.5 Pumping:

A clean, oil-less vacuum pump must be used inside the HIRES enclosure after the field flattener lens is re-installed onto the dewar since this is the vacuum sealing window. We expect to have such a pump in place after arrival in Hawaii. This pump uses a liquid nitrogen cold trap and so the room must be ventilated while pumping the dewar or while operating the pumping station.

8.6 Mosaic testing:

There is no provision for mosaic (either echelle or cross disperser) re-alignment. This was intended to be a passive support and so far we have seen nothing to change our original intent. We do have hardware for mounting the Zygo interferometer on the main frame to look at either of the 2 echelle mosaic grating joints or the single cross disperser mosaic grating joint. These setups are shown in Drawings H6220 and H6222. We are not leaving the interferometer in Hawaii. We have used it in our shop at UCSC and found it to give stable enough results that an air isolation table was not needed. We hope that the telescope environment is at least this stable. The mounting stand replaces the center hydraulic lift mount socket.

The gratings cannot be re-aluminized, of course. There is no cleaning procedure. The spectrograph was designed with the echelle facing down to minimize dust collection. There is one thumb print on the echelle mosaic and it has been documented on H3640. It is fortunately outside of the beam footprint.

8.7 Re-aligning the corrector lenses:

The first step before removing anything is to align the autocollimator with the corrector lenses: Lift the cross-disperser cell and store it on its cart. The autocollimator adapter fits onto the turntable and the autocollimator can then be rotated to line up with the camera axis. Drawing H4210 shows the adapter. Drawing H6500 shows the autocollimator in place. The inter-lens spacing should be documented. There is no need to locate the lenses along the optical axis to better than 0.01" and the elements will easily go back into their cells to that tolerance.

To re-align the entire camera, the dewar frame and camera mirror must be removed and the second camera mirror mount installed with its autocollimator. (Two autocollimators are required here for efficient aligning) Note that when the second mirror has been installed onto this mount, an additional fixture will be needed for this alignment procedure. It will be designed and built at the same time the mirror support hardware is fabricated. This fixture allows the cross-disperser table to be rotated to align with the camera mirror axis. The camera mirror (and camera mirror mount #1) can now be re-installed to check its alignment using the cross-disperser autocollimator. The corrector lenses are re-installed and checked. Finally, the dewar frame is replaced. If you suspect it has shifted or want to check it, the camera mirror is removed again and the camera mirror mount autocollimator is installed to look at the field flattener. The spacing between the camera mirror and the field flattener cannot be measured directly anymore, unless the field flattener can be recoated since any touching with an inside micrometer will damage the Sol-gel. The spacing can however be measured indirectly by measuring between the mirror and front lip of the dewar body, and then subtracting the known distance from dewar body to lens vertex. See Drawing H0148. The CCD is aligned by taking many spectra at many focus settings. This has been detailed by Vogt in his notes.

Chapter 9

OTHER COMMENTS

Hooks were left for future expansion. The large side door in the housing was located so that in the future a Cross-Disperser might be rotated to look at a camera axis on the other side of the optical axis. See the layout on Drawing H6100. There are 4 stub flanges attached to the main frame to add additional supporting structure.

This project has been reviewed by a committee chaired by Dr. Bob Tull at the University of Texas. Also on that committee was Dr. Frank Melsheimer of DFM Engineering Inc, Longmont, Colorado. Progress was also monitored by 17 Quarterly Reports submitted to the Science Steering Committee (SSC). Software reviews were included with the mechanical reviews and supplemented with reviews of the Low Resolution Imaging Spectrograph (LRIS) together with HIRES.

Chapter 10
The HIRES Slit Area

The HIRES spectrograph slit area is composed of a large steel supporting structure and twelve motorized or air-powered stages for remote control of slit area functions. The intent of this document is to provide a brief overview of the standards and design philosophy used throughout the slit area, and to give a general description of the layout, operation and adjustment of each of the various stages (see Drawing P1001). This document will also serve as a roadmap for any journey in search of engineering information concerning the slit area.

10.1 Slit Area Structure:

Previous experience with slit area instrumentation at Lick Observatory suggested three important features for the HIRES slit area. First, the slit area is subject to improvement and modification throughout the life of the instrument, and should be designed for easy modification from the start. Second, the slit area is typically the most crowded region in the spectrograph, so all structures and components should strive for compactness. Finally, certain accessories will tend to preclude the use of others, so stages should be able to be readily removed or interchanged. These three features of easy modification, compactness and interchangeability will be discussed in relation to the slit area and its motion stages.

The central backbone of the HIRES slit area is the "slit area structure" and several constraints drove its design. One aspect dictated by the telescope was the requirement that the slit area structure be of a cantilever design. The location of the nominal Nasmyth focus at the center of the elevation axis journal required that the slit, decker and autoguider all be located inside the bearing. Another important objective was to leave a maximum amount of space for accessories and relatively easy access to them. Another issue was to design the structure such that its first natural frequency was not likely to be excited by motion of the telescope or the active mirror control system. All of these points and others lead to the design of the cantilevered space frame for the slit area (see Drawings H6710 and H6711). The 2" x 4" structural steel tubes are liberally peppered with 1/4–20 threaded inserts on regular spacings to provide easy installation of new components. Note that the threaded inserts are stainless steel and will gall with stainless fasteners unless they are properly lubricated (i.e. "Never-seez") on assembly. The structure is primarily a rectangular weldment, with several bolt-on diagonals to increase stiffness, but which are removable for access if needed.

10.2 Common Motion Stage Features:

From the outset of the HIRES project, it was clear that there might be as many as twenty (first light) remotely controlled functions, which strongly suggested standardization on a minimum assortment of components. To that end, DC servo systems were selected for all areas requiring precision motion control and air cylinders for all toggling and non-precision motion applications.

We chose to standardize on DC servo systems for all of the precision motion functions for a variety of reasons including freedom from annoying (stepper motor) resonant frequencies, low power and high torque, compact motor/encoder units, and prepackaged servo drive and optimizing software. We selected Galil 50/1000 systems including Galil motor controllers, Pittman 50 oz-in DC servo motors with integral Hewlett-Packard 4000-count per revolution shaft encoders, and the Galil software package. For fiducial location sensing, a TRW OP8970T55 optical interrupter switch was chosen. To provide software limit sensing, Microswitch BZ-2RW822–A2 limit switches were used. A second switch, Microswitch DT-2RV22–A7, was used to cut power to the servo motor in the event of a software or software limit switch failure.

For the roughly twenty non-precision situations, we selected a variety of different sizes of air cylinders manufactured by Bimba. Although we had already decided to use the Microswitch limit switches for the precision stages, we chose to use the Bimba magnetic reed switches for sensing limits on all of the air powered stages. These switches are designed for use with the air cylinders and helped avoid a fair amount of bracket design and fabrication. Along with the cylinders, we standardized on Skinner Magnalatch 4–way solenoid valves, which have the benefit of no power consumption after latching. Wilkerson R16–02–000 air pressure regulators were used throughout. Camozzi "super rapid" quick assembly fittings were used for many areas. These developed trouble during the cold test and are being removed and replaced with Swagelok tube connectors. The nature of the trouble was that these finger-operated fittings couldn't be operated by human fingers at cold temperatures. The Swagelok connectors dis-assemble with small hand tools (wrenches). The Bimba cylinders should always be supplied with clean dry air. We experienced many cold-related problems: moisture freezing caused cylinders to hang up or operate un-reliably; the factory-supplied lubricant became very viscous and caused the speed controls to work slowly. We also had trouble with the latching solenoids sometimes not shuttling from one state to the other. Much of our testing will be done in Hawaii where the temperature is cold while the air is dry. Our testing problems were made worse because we had to keep the instrument full of dry nitrogen during the cold testing to prevent condensation. This required oxygen masks and made testing impossible. We have cleaned all of the air cylinders with the solvent (petroleum distillate) and purged all air lines with dry gas. During shipment all air ports have been sealed to prevent moisture from entering.

There were a variety of linear and rotary bearing requirements in the slit area, and we chose a different manufacturer for each, based on previous experience. For linear bearings and ball screws, THK products were used exclusively. SKF bearings with integral seals are used throughout.

For small mechanical components such as clutches, timing gears and belts, and worm gears, Berg products were used. All worm gearing meshes are lubricated with Nyogel 788 from W. F. Nye Co.

10.3 Slit Area Stages:

The HIRES Phase C Proposal (UCO/Lick Observatory Technical Report No. 57, January 1991, Vogt) briefly listed the remote control functions to be provided in the slit area. All of these were completed in addition to several others. The following sections will give a general description of the design and operation of each stage, as well as a short list of appropriate adjustments for each. The stages are discussed as follows:

1. Slit
2. Slit Accessory Server (Decker)
3. Instrument Filterwheels
4. Shutter
5. TV guider
    a. CCD camera and cooler
    b. Lens Drives (Focus and Aperture Control)

    - c. Filterwheels

6. Comparison Source System
    - a. Light Source Motion Stage
    - b. Thermal Enclosure and cooler
    - c. Filterwheel
    - d. Projection Optics

7. Iodine Cell System (Stage)

Chapter 11
THE SLIT

11.1 General Description:

The slit controls the vertical dimension of the aperture to the spectrograph by opening or closing a bilateral pair (both jaws move about their centerline) of reflective jaws. The slit jaws are opened by a ball-screw driven wedge which separates the flex-pivot mounted slit plates (see H1324). The slit jaws are roughly 2" x 4", made of 420 stainless steel, and polished flat to about 5 waves. Return springs force the slit jaws closed as the wedge is withdrawn. The shaft encoder attached to the motor provides for a theoretical resolution of about 0.5 microns at the slit jaws. An optical interrupter provides the fiducial location, and travel is protected by software and mechanical limit switches (see dig H1326). The slit is mounted at an angle (7.5° nominal) to reflect most of the field back to a TV camera for autoguiding.

11.2 Adjustments:

The slit has individual adjustments for tip, tilt, rotation, and piston on one jaw, while the other jaw remains fixed. The adjustments are made by tightening or loosening the screws supporting the jaw (see dig H1322). The jaws are readily adjusted within 10 arc-sec using an autocollimator and a reference flat for parallelism. The minimum slit opening can be adjusted using the travel limit screws, which can be reached through the access holes, found near the return springs (see dig H1324). The travel limit switches may be adjusted by loosening the mounting screws and sliding the switches in the slots.

The slit assembly as a whole can be adjusted for up/down, left/right, focus, and tilt, using the slotted mounting screws attaching the slit to its support (see dig H6760). In addition the adjustments on the stage, the slit and filterwheel supporting beam can be adjusted for left/right, up/down, and focus, using its slotted mounting screws (see dig H6758).

Chapter 12
THE SLIT ACCESSORY SERVER (Decker)

12.1 General Description:

The Slit Accessory Server (SAS) can provide both vertical and horizontal control over the aperture into the spectrograph. The SAS can be used in conjunction with the slit, or it can be used alone to define the aperture. The SAS carriage has positions for four, 4" square aperture trays, and sufficient travel to see all of the trays, plus a stowed position giving a full unvignetted view of the slit (see Drawing H1359). The aperture plates are EDM machined, and are optically polished flat to a few waves (see Drawings H1384, H1389, H1390 and H1391). The carriage is attached to a timing belt driven by a motor and gearbox. An optical interrupter provides the fiducial location, and travel is protected by software and mechanical limit switches (see Drawing H1378). The shaft encoder attached to the motor provides a theoretical resolution of about 0.8 microns at the aperture plate (see Drawing H1387). Like the slit, the SAS is mounted at a 7.5° angle, in order to reflect most of the field back to a TV camera for autoguiding.

12.2 Adjustments:

No adjustments are provided for the SAS carriage itself. All alignment of the SAS is controlled by adjustment of the upper and lower stage mounts. By translating the upper and lower mounts, left/right, up/down, rotation, and focus can be accomplished (see Drawings H6759 and H6760) . The travel limit switches can be adjusted by loosening the mounting screws and sliding the switches in the slots. The belt tension for the carriage can be adjusted by loosening or tightening the idler pulley adjusting screw. An autocollimator mounted in the front of the slit area is used to align the SAS with the slit on the optical axis, and to adjust the reflected beam to the TV camera. The TV camera, once operational, can be used to verify that the Slit and SAS are both properly aimed.

Chapter 13
FILTERWHEELS

13.1 General Description:

Two 12 position filterwheels provide a wide range of filter options for the spectrograph. Each filterwheel has 12 numbered locations for mounting a HIRES-standard filter holder, which can accommodate a 2" round or 2" square filter, up to 3/8" thick. The number 1 position has an extended opening which allows a 1" x 4" light beam to pass thru unfiltered if desired (see dig H1104). The wheels themselves are interchangeable, so that an observer can have a "personal" set of filters optimized for a given task (see dig H1115). A worm gear drive rotates the filterwheels and precludes the need for a brake to hold position with power off. An optical interrupter provides the fiducial location. A shaft encoder mounted to the motor provides a theoretical resolution of 10.8 arc-seconds (see dig H1114).

13.2 Adjustments:

The worm gear mesh can be adjusted by pivoting the worm gear carrier (see dig H1110) around its mounting shoulder screw. No other adjustments are provided on the filter stage.

The filterwheel assemblies can be aligned left/right, up/down, and focused by adjusting the slit and filterwheel support beam (see Drawings H6758 and H6760). Note that this will also affect the alignment of the slit. The filters are generally oversized for a given aperture, and typically should not require adjustment after initial collimation.

Chapter 14
SHUTTER

14.1 General Description:

A Melles Griot / Ilex (p/n 04 IES 005) 2.5" aperture shutter controls the exposure time for the spectrograph. The shutter is mounted to the back of the second instrument filterwheel, and defines the rear light boundary of the slit area (see dig H1203). The shutter is controlled by the CCD detector controller mounted above the dewar. The shutter was modified at the Lick Instrument Lab to use a reed switch rather than the stock limit switch, in order to improve reliability.

14.2 Adjustments:

The shutter is hard-mounted to the filterwheel via a threaded ring and has no adjustments. With the shutter removed there is a 3.2" diameter clearance hole.

Chapter 15
TV AUTOGUIDER

15.1 General Description:

The TV guider stage is composed of a high quality commercial CCD camera system, a commercial camera lens, and two filterwheels, all mounted together in a compact package. There are two motorized drives for the lens, one for focus and the another for aperture adjustment. Between the CCD camera head and the lens are a pair of 8 position filterwheels for color and brightness control. Due to the variety of features and adjustments to be covered, the CCD camera and the motor driven functions will be discussed individually in the following order: CCD camera system, lens drives, and filterwheels. Finally, the entire stage and its adjustment as a unit will be described.

15.2 CCD Camera System Description:

The TV guider uses a Photometrics 200 series CCD camera system for direct and offset guiding from the slit and/or decker. This system includes a CH250 liquid cooled camera head with a Thomson TH7883 frame transfer CCD, a CE200 camera electronics unit individually tuned for the CCD, a special order 10' cable from the camera head to the electronics box and a LC200 liquid recirculator for cooling the CCD. The camera electronics unit and the liquid recirculator are mounted in a thermal enclosure mounted inside of HIRES but outside of the slit area (see Drawing H1401). The TV thermal enclosure is in turn cooled by the instrument cooling system (see Cooling System Drawing H1406). The last item required in the TV system is the CC200, a controller unit which is provided by the telescope.

15.3 CCD Camera Adjustments:

The only mechanical adjustments for the camera head are by way of the slotted mounting screws which allow some travel in the up/down and focus directions (see Drawing H8105).

15.4 Lens Focus Drive Description:

The TV guider system uses a Canon 200mm focal length, f/1.8 lens to image the slit onto the camera detector. The plate scale at the slit is 1.379 arc-sec/mm, and 0.26 arc-sec/mm at the TV CCD. The Thomson CCD has a 23μm pixel size, giving a detector scale of 0.156 arc-sec/pixel (see Drawing P1003).

The lens focus is driven by a timing belt gear reduction attached to a 60:1 worm gear speed reducer, which is in turn driven by the standard DC servo motor. An optical interrupter provides the fiducial location, and travel is protected by software and hardware limit switches, as well as by a clutch between the worm gearbox and the lens gear. A large split clamp attached to the focus ring of the lens carries the drive gear, limit switch triggers and the optical interrupter blade (see Drawings H8105 and H8119).

15.5 Lens Focus Drive Adjustments:

There are several adjustments for the focus drive which will be discussed in the following order: fiducial, limits, belt tension and clutch.

1) Fiducial:

The blade attached to the clamp ring is adjusted by loosening the clamp ring and rotating the blade until its edge is in the center of the optical switch at the middle of the lens focus travel. This will place the lens focus at its nominal position on power–up.

2) Limits:

The limit switch mounts have oversized holes for attaching the switches, as well as slotted holes for attaching to the mounting plate. By loosening all the mounting screws for the switch, it can be translated and rotated as required to trip sometime before the mechanical stop in the lens is reached. The software limit switch should be adjusted to trip before the mechanical limit switch cuts power to the motor.

3) Belt Tension:

The belt tension is adjusted by loosening the screws which mount the motor and gearbox assembly to the baseplate.

4) Clutch:

The clutch is adjusted by loosening the locknut on the clutch and tightening or loosening the adjusting nut as required. The intent of the clutch is to prevent the motor from overdriving the lens in the case of both limit switches failing.

15.6 Lens Aperture Drive Description:

The Canon lens aperture setting is driven by a bell-crank linkage attached to a 60:1 worm gear speed reducer, and powered by a DC servo motor. An optical interrupter defines the fiducial location. Because the bell-crank rotates freely without any mechanical stop no limit switches are required. One half revolution of the bell crank drives the aperture ring through it full range of travel. A split clamp attached to the aperture ring carries the bell crank link and the fiducial blade (see Drawings H8105 and H8119).

15.7 Lens Aperture Adjustments:

The stroke of the drive wheel is fixed by the radius to the link end. The stroke at the aperture ring can be adjusted by moving the motor-gearbox assembly on its slotted mounting screws, and by varying the position split clamp on the aperture ring.

15.8 TV Filterwheel Description:

Two 8 position filterwheels provide a variety of filter options for the TV guider camera. Each filterwheel has 8 locations for mounting a HIRES-standard filter holder, which can accommodate 2" diameter or 2"x 2" square filters up to 3/8" thick (see Drawing H8326). The wheels themselves are readily removed and are interchangeable, so that an observer can have a "personal" set of guiding filters optimized for a given task (see Drawing H8325). A worm gear drive, identical to the instrument filterwheel drive, rotates the filterwheels. An optical interrupter indicates the fiducial position and the motor encoder provides a theoretical resolution of 10.8 arc-sec. The filterwheels are removed by withdrawing the center mounting pin, rotating the filterwheel assembly out of the guider assembly, depressing the button in the wheel hub, and pulling off the wheel.

15.9 TV Filterwheel Adjustments:

The worm gear mesh can be adjusted by pivoting the worm gear carrier (see Drawing H1110) around its mounting shoulder screw. The filterwheel assemblies can be adjusted left/right using the slotted mounting blocks.

15.10 TV Autoguider Stage Description:

The camera head, lens, and filterwheels are mounted together on the Autoguider stage (see Drawing H8001). The upper and lower pin mounts for the stage provide support and allow the stage to be manually rotated up into a stowed position (see Drawing H8002). By removing all four pins, and disconnecting the electrical and cooling connections, the stage may be removed from the slit area as a unit.

15.11 TV Guider Stage Adjustments:

The four main components of the TV guider; the camera head, lens and filterwheels; may be adjusted relative to each other using the slotted mountings for each part. The camera head mount has slots for adjusting up/down, left/right, and focus. In order to collimate the stage with the reflected slit optical axis, its mounts can be translated to provide left/right, up/down, focus and rotation of the stage.

Chapter 16
COMPARISON SOURCE SYSTEM

16.1 General Description:

The Comparison Source System provides a variety of light sources for calibration of the spectrograph. The initial complement of light sources includes two Thorium-Argon hollow cathode lamps, a diode laser, a 3450°K color temperature quartz lamp and a Deuterium lamp. The latter two lamps are mounted in two 8" Labsphere integrating spheres. Wiring is installed to support up to eight sources (low voltage and current). The motion stage is mounted in a cooled thermal enclosure to prevent thermally induced turbulence above the slit area. The four main parts of the system are the light source motion stage, the thermal enclosure and cooler, the filterwheel and the projection optics.

16.2 Motion Stage Description:

The light source motion stage carries and positions the various lamps which are used for aligning or calibrating the spectrograph (see Drawing H1620). The carriage nominally has 6 positions, each providing 6 square inches for mounting a source. The moving stage is a 8" x 36" long platform with a mounting hole pattern for mounting any number and size of sources as required (see Drawing H1618). The stage has 34" of travel, which is more than sufficient to bring any of the mounting locations on to the optical axis of the slit area. The carriage is driven by the same arrangement designed for the decker, using a timing belt to position the stage, and servo motor and worm gear speed reducer to drive the belt. A pair of negator springs preload the stage to eliminate backlash. An optical interrupter defines the fiducial location and software and mechanical limit switches protect the range of travel. The theoretical resolution of the stage is the same as the decker, about 0.8 microns at the stage. The actual resolution has been measured mechanically to be better than 0.0005". Drawing H1622 gives encoder resolution.

16.3 Motion Stage Adjustments:

The main adjustment for the motion stage is the drive belt tension, which is accomplished by loosening or tightening the idler pulley screw. The limit switches can be adjusted by loosening the screws and sliding the switches in the mounting slots, but will require that the stage be removed from the enclosure. The entire assembly has four pin joint supports for left/right, up/down, focus, and rotation adjustments. By translating the mounting points in their slots, the full range of adjustments can be made. For collimation and alignment, the mounts are designed to be adjusted while the stage is installed in its housing (see Drawing H1688).

16.4 Thermal Enclosure Description:

The comparison sources operate inside of a sealed enclosure in order to avoid thermal convection currents which could disrupt the seeing in the slit area. The enclosure construction consists of a sandwich of extruded fiberglass ribs, polyethylene foam insulation, and aluminum or CPVC skins. The CPVC skins are used internally in locations where the aluminum would create a thermal short to the main instrument enclosure (see dig H1680). The panels and ribs are epoxied and riveted together to form a light, rigid unit. The top and end panels are latched and/or hinged to allow for removal when servicing the calibration lamps. A small heat exchanger and two muffin fans are installed in the top of the enclosure directly above the optical axis. Coolant flows continuously through the system, while a sensor cycles the fans as required to maintain the temperature at the same level as the main housing.

16.5 Thermal Enclosure Adjustments:

Once the motion stage has been aligned, the housing can be realigned with the stage to avoid any interference. Care should be taken to insure that the lamps will always have clearance throughout their travel. This is especially important for the hollow cathodes, which move in a trough on the inside of the housing. Four slotted stainless steel supports carry the weight of the housing and locate it relative to the motion stage. The housing may be moved by loosening the mounting screws and sliding the unit to the desired position. The weight of the housing must be supported while the mounts are being adjusted. The latches for the top and end covers can be adjusted for tightness by turning the threaded catch in or out as required. The hinges are made of delrin and cannot be adjusted. The lamps can be replaced by either removing an end or top panel for access. Poron foam is used as a gasket material to seal the panels. (Boyd Corp., Ceres, CA)

16.6 Filterwheel Description:

The comparison source system is equipped with a filterwheel for controlling source bandpass or brightness. The filterwheel and drive assembly are virtually identical to the main instrument filterwheels, except for their mountings (see "Filterwheels" and Drawings H1701 & H1706).

16.7 Filterwheel Adjustments:

The filterwheel locates a filter between the doublet and the aperture stop of the comparison source optical system. Adjustments are provided to insure adequate clearance between the filters and the optics (see Drawing H1706). Slots in the filterwheel mounts allow for up/down, left/right, and focus adjustments.

16.8 Comparison Source Optics Description:

The design of the comparison source optics attempts to mimic the exit pupil of the telescope, in order to more accurately calibrate the spectrograph. The optical system consists of a 2" doublet, a filter, a fixed aperture stop, a 6" triplet, and a 6" folding flat (see Drawings H1655 and H1692). The comparison source apertures tend to be small compared to the slit width, so the projection optics also provide a 2:1 magnification at the slit. If the entire 4" width of the slit requires illumination, the source can be scanned across the slit using the motion stage. The folding flat reflects the comparison source beam into the spectrograph and stows to one side when not in use. A pupil plate is located between the 2" doublet and the 6" triplet in order to create a circular image with a central obstruction which simulates the telescope and the secondary mirror baffle.

16.9 Comparison Source Optics Adjustments:

There are three main assemblies for the comparison source optics, including the 2" doublet, the 6" triplet, and the 6" flat. The doublet and the triplet both have slotted mounts and tilt adjustments to accommodate up/down, left/right, focus, and rotation (see Drawings H1812 and H1816). The 6" folding flat is mounted in a commercial mirror mount made by Janos (model no. 2017–0003). The mount has two rotational adjustments and a slotted support for focus. Left and right adjustment is controlled by hard stops on the air powered stage that moves the flat in and out of the optical path. Vertical adjustment is accomplished by raising or lowering the folding flat stage (see Drawing H1814).

Chapter 17
IODINE CELL STAGE

17.1 General Description:

The iodine cell stage is an air-powered translation stage mounted to the slit accessory server. The iodine cell can be used to impress a field of iodine spectra on top of an object of interest. The iodine cell stage consists of the iodine cell, a mount to attach the cell to a linear bearing, and an air cylinder to extend or retract the cell in and out of the optical path (see Drawing H1955). Electrical connections to the cell include a 120VAC strip heater, two temperature sensors and limit switches to report the location of the stage to the instrument computer. Travel of the stage is limited by hard stops attached to the linear bearing support. Limit switches attached to the air cylinder indicate the position of the stage. The cell is mounted on a simple platform which could be used to support other accessories if required in the future.

Note that the iodine cell is designed to operate at 122° F, approximately 90° F warmer than the surroundings. No provisions other than insulation have been made to prevent thermal gradients and air motion in the slit area due to heat dissipation by the cell. It remains to be seen if this will be a problem.

17.2 Adjustments:

The stage mounting platform has mounting slots for adjusting focus of the cell. Travel of the stage can be adjusted by moving the stops in their mounting slots. No other adjustments are provided because the stage is designed to be coaxial with the slit accessory server. If the SAS is properly collimated, the iodine cell should be as well.

Chapter 18
SLIT AREA COLLIMATION

The purpose of this section is to describe the order and procedure of collimating the slit area stages. Detailed notes about the collimation procedure can be found throughout Vogt's test/integration lab notes. The procedure begins after the establishment of the instrument optical axis, using alignment telescopes located in the front of the slit area and behind the 17" collimating mirror stage. Once this axis has been set, the stages can be collimated successively in the order listed here.

1) Slit and Filterwheels:

The slit and instrument filterwheels are mounted together on a beam attached to the slit area structure (see Drawings H6758 and H6760). The slit and filterwheels should be adjusted to be at the same height and left/right location relative to each other on the supporting beam. The whole assembly can then be adjusted on to the optical axis by sliding the support beam in the mounting bracket slots. Finally, the slit should be individually collimated for tip, tilt and rotation, taking care not to translate the slit off of the optical axis.

2) Slit Accessory Server (Decker):

The decker should be adjusted to place the back side of the decker plates as close as possible to the slit jaws (about 0.060") to minimize reflection pathlength differences for offset guiding. The decker is supported by upper and lower mounts which provide for up/down, left/right, and two rotations (see Drawings H6758, H6759 and H6760). The decker housing has a cut-out to accommodate the slit housing, and the cut-out should be adjusted to center over the slit. Once the slit and decker have been collimated, their alignment relative to each other should be verified by viewing the slit and decker with the guide camera.

3) Guider TV and filterwheels:

The four main components of the guider system are the lens, the two filterwheels, and the CCD camera head. The lens is attached to the main platform (see Drawing H8105), and the lens height relative to the platform is fixed. Consequently, the lens should be collimated first, by adjusting the four mountings for the platform. Once the lens is collimated, the CCD camera head can be adjusted in its mounting slots to be coaxial with the lens. The filterwheels are not adjustable individually, but are fixed on the platform at the same elevation as the lens, so that if the lens is collimated, the filterwheels should be as well.

4) Comparison Source System:

The comparison source system consists of a motion stage, a thermal enclosure, a filterwheel, and an optical projection system which doubles the size of image of the source at the slit. All parts of the system have a range of adjustments which will allow the various parts to be collimated relative to each other, as well as to the spectrograph. However, the enclosure is probably the limiting component in terms of travel adjustment and distance from the slit, so it will be most practical to establish the optical axis based on the window in the enclosure. Once the optical axis is set, the stage, lens groups and filterwheel should be aligned in that order.

5) Comparison Source Housing:

The comparison source stage is mounted in an insulated enclosure to prevent thermal air disturbances in the slit area. The enclosure has adjustments to allow it to be moved relative to the stage during collimation. The housing mounting brackets have slots for fore/aft and up/down adjustment (see Drawing H1688).

6) Comparison Source Stage:

The comparison source stage is mounted on a steel weldment attached to the slit area frame (see Drawings H1688 and H1692). The four degrees of freedom to be adjusted are focus and the three rotations (tip and tilt relative to the optical axis, and rotation around the direction of travel.) The left/right alignment is controlled by motion of the stage, and the height of the sources is adjusted at the individual source on the stage. All of the stage adjustments are accomplished by sliding mounting brackets in their slots, which are found in the following locations:

1. slots in the individual source mountings on the stage;
2. up/down slots in the pivot brackets attached to the bottom of the stage;
3. fore/aft slots and set-screws in the brackets attaching the stage to the support weldment;
4. fore/aft slots in the support weldment flanges where they attach to the slit area structure;

7) Comparison Source Optics

The comparison source stage (CSS) optical system has a 6" diameter folding flat, a 6" triplet, a 2" aperture stop and a 2" doublet. The optical system is defined to be in the plane of the instrument optical path and plumb to the slit area. This plane is established by hanging a plumb bob through the slit area such that the plumb line is visible at the slit and at the window into the comparison source stage housing. Using the plumb line for a vertical reference, and alignment telescopes for the instrument optical axis, the CSS folding flat, triplet, and doublet can be collimated in that order.

1. Folding Flat: The flat height adjustment is by way of the slots in the supporting beam brackets. The slots can also be used to adjust the angle of beam tilt (see Drawing H1814).
2. Triplet: The triplet has adjustments for focus, left/right, up/down, and two rotations. The adjustments are either by screws in slots or by set-screw (see Drawing H1816).
3. Doublet: The doublet has adjustments for focus, left/right, up/down, and two rotations. The adjustments are either by screws in slots or by set-screw (see Drawing H1812).

8) Comparison Source Filterwheel:

The comparison source system has a 12 position filterwheel which places a filter between the aperture stop and the doublet in the projection optics. The filterwheel and mounting brackets have slotted adjustments for focus, up/down, and left/right (see Drawing H1706). Additional adjustments are by slots in the filterwheel support beam and mounting brackets.

9) Iodine Cell Stage:

The iodine cell is mounted on an air-driven linear bearing which allows the cell to be quickly inserted or removed from the optical path. The iodine cell is essentially a pair of windows with iodine gas between them, with limited adjustments for collimation. The height of the cell is fixed by attachment of the stage to the decker housing. The left/right position of the stage is set by adjusting the travel limit brackets on the stage. The primary collimating adjustment is focus, being the distance from the cell to the decker, and is set by sliding the cell support in its slots (see Drawing H1955). The tip and tilt of the cell relative to the optical axis can be changed by adjusting and shimming the cell in the supporting cradle.

Chapter 19
INSTRUMENT COOLING SYSTEM

19.1 General Description:

A liquid cooling system is provided to reduce the buildup of heat in the spectrograph, and avoid the resulting thermally induced air motion which could degrade seeing in the instrument. Coolant at about 3°C below the ambient air temperature is provided by "the telescope system" at a nominal flow rate of 2.6 gallon per minute (gpm) and 80 psi. The HIRES cooling system is designed to remove all the heat generated in the instrument with the 1500 W of cooling provided. A control panel for the cooling system is located near the large door into HIRES and houses a flow meter and flow control valve, as well as gauges for the inlet and outlet pressures.

The design of the cooling system faced a number of challenges. First, the cooling provided by the telescope was provided over a very narrow temperature difference (5°C), and a relatively low flow rate, both of which made heat removal more difficult. The main variables to balance for an exchanger are the size and the flow rates of the coolant and the air. In most cases in HIRES, the heat exchangers were limited in size by packaging constraints. With the ΔT of the coolant, the exchanger size, and the flow rate all fixed, the main choices left were the coolers themselves and the air flow rates. A second consideration was the cooling circuit through the instrument, and whether to make it a serial or parallel system. Finally, the type and design of the coolers was considered to maximize the efficiency of the system. There are four sources of heat, in decreasing heat load; the electronics vault (600 W), the CCD TV electronics and liquid recirculator (130 W), the CCD controller (100 W) and the Comparison source stage (50 W). This adds up to 880 Watts. The CCD controller chassis is mounted close to the CCD dewar and pre-amp. This thermally insulated box has a cooler mounted inside. See Drawings H1462 and H1463 for details.

The final design of the HIRES cooling system uses a serial fluid circuit and Hayden and LYTRON all-aluminum heat exchangers. The coolant flows first through the comparison source enclosure, which has the smallest heat load (50 W) and the tightest packaging constraints. Because of the size limit in this case, a small Hayden (Thinline TU10416G5–14JE2) cooler is used with a custom plenum and two 12VDC muffin fans (see Drawing H1423). This choice allows the smallest cooler to see the greatest initial temperature difference (ITD) between the inlet coolant and the ambient air in the enclosure, for maximum heat removal. The HIRES instrument computer reads two temperature sensors in the enclosure and cycles the fans to maintain the temperature at the ambient level. The coolant then flows to the CCD TV enclosure (130 W), where it passes through a LYTRON (5221G10) cooler with integral fans (see Drawing H1406). This exchanger was chosen to fit the space constraints and to simplify the mounting of the cooler, shrouding and fans. The temperature is controlled in the same manner as in the Comparison source box. The HIRES electronics enclosure (600 W) has plenty of room for large exchangers and consequently is the last area cooled. In this case, two large LYTRON coolers (5321G10), with two 9" fans each, operate with the smallest ITD (see Drawing H1411). The long coolant path and the high air flow rates allow the exchangers to remove the heat given the worst ITD and the highest heat load in the system. The electronic enclosure must be maintained at 5°C, rather than ambient, but the computer again uses sensors to monitor the temperature and cycles the fans as required.

The design objectives for the rest of the cooling system were to minimize danger to the instrument from coolant leaks and other failures, to simplify assembly and maintenance, and to standardize on plumbing fittings.

Most of the coolant runs are through insulated copper tubing attached to the outside of the instrument housing, which provides several benefits (see Drawing H1450). First, in the event of a leak, the coolant is more likely to run down the sides of the HIRES enclosure rather than onto optical surfaces or electronics. Second, the coolant lines are more easily accessible for removal and reinstallation. Finally, long straight runs of copper tubing are the most economical way to move the coolant over the distances between the various thermal enclosures. In locations where flexibility or disconnection are required, Goodyear "Gorilla" 3/4" ID hose is used. This hose is inert to a variety of solvents, resistant to ozone and remains flexible at low temperatures.

For shipment and re-assembly, there are several logical places to provide quick disconnects in the plumbing circuit. The most obvious break is at the instrument and electronics enclosures where hoses and Parker 60 Series quick disconnects attach to a feedthru to the heat exchangers. Quick disconnects are also found at the comparison source, CCD controller box, and CCD TV enclosures to simplify assembly and removal.

Unfortunately, a wide variety of brass and stainless steel plumbing fittings were required to join the various parts of the cooling system. For brass parts, pipe thread and SAE 45° flare fittings were used whenever possible, with a bias towards the SAE standard. The LYTRON heat exchangers, fabricated with 37° flare ends, were the only exception. Stainless steel tubing and Swagelok fittings were used inside the electronics enclosure because the heat exchangers are hard-mounted to the roof of the housing. The control panel is plumbed with brass fittings and bronze pipe, along with the flow valve, meter and pressure gauges (see Drawing H1432).

Chapter 20
DESIGN OF THE CAMERA MIRROR SUPPORT

The design, analysis and testing of a large mirror mount are described. The optic is a 44" diameter, f/ 0.75 gas-fusion structured mirror manufactured by Hextek (Tucson, AZ). The mirror is the primary reflector for a split-corrector camera system for the Keck Telescope High Resolution Echelle Spectrograph (HIRES). The spectrograph is mounted on the Nasmyth platform of the telescope, with the camera mirror optical axis downward-looking 10.3° below horizontal. This paper describes the finite element analysis of the mirror, conceptual and detail design of the mount, and interferometric testing of the mirror figure before and after installation in the support. This design chapter was extracted from Reference 3 by Bigelow.

20.1 Conceptual Design of the Support:

The Hextek mirror, at 44 inches in diameter, is the largest of its type ever fabricated. The construction of the mirror is a two step process. First, the front and rear face sheets, 0.47" thick Schott Tempax, are fusion bonded to a center section of Tempax tubes. The sandwich of face sheets and tubes is heated to molten temperature, the tubes are inflated at low pressure through holes in the rear face. The face sheets and tubes fuse together. The second step involves reheating the blank as it sits on a convex mold. When the glass softens, it slumps to conform to the shape of the mold.

A variety of design considerations were evaluated for supporting the mirror. The support system was simplified by the fact the mirror would be stationary, and so would always have the same orientation to gravity. The positioning requirements for the mirror were stringent, but once met, would not require repositioning or focusing. The mirror would actually be one of two mirrors, each with a coating optimized for red or blue wavelengths, so the support would need to be as light-weight as possible and readily interchanged. The end result of the two diffraction grating dispersions is that the beam through the camera system is roughly rectangular. Consequently, only about 60% of the clear aperture of the mirror, centered with the long axis vertical with respect to the mirror, must meet the optical specifications. The thermal environment for the mirror would be cold but stable on the order of 4° F per day, with a median temperature of about 32° F. The small daily temperature variation was especially favorable considering the 2 to 3 hour time constant for the 25% weight density mirror. On Hextek's recommendation, it was decided to exercise the internal mounting boss option (for $7000), which provided six 3–inch–square mounting bosses in the plane of the center of gravity, located symmetrically around the mirror at the 0.7 R locations. Hextek had previous experience providing both radial and axial support of smaller mirrors through similar mounting bosses, using a six-link kinematic connection to a sub-cell. The mirror was to be re-coated with its mounting boss hardware intact, which required vacuum rated materials and components. Extensive mirror mounting research and development work conducted by others for the 36 Keck primary mirror segments was reviewed for possible adaptation to the Hextek mirror. The Keck segment design uses 36 individual axial supports bonded to the back of the segments, a torsional link for stiffness about the normal axis, and a stainless steel diaphragm radial support bonded into a pocket in the back of the segment and passing through its center of gravity.

After much consideration and debate, it was decided to use a hybrid of the Keck and Hextek approaches, using the mid-plane mounting bosses for the axial support, a torsional link and a diaphragm bonded to the back of the mirror for the radial support. The six axial supports would be reduced to three mounting points on three whiffletree balance beams. The diaphragm would be designed such that it was very stiff in the radial (in plane) direction and very compliant in the axial direction where it would be in conflict with the axial supports.

Several concepts dictated this choice. First, for collimation and initial focus the mirror support would have to be readily adjustable. The proposed Hextek design would have required a sub-cell for kinematic support of the mirror, and a second cell for carrying and adjusting the mirror by way of the sub-cell. This duplication would be more complicated (and expensive) than a single support cell. The six-link kinematic support uses three pairs of crossed links to constrain the mirror, and these links would be long and relatively more complicated in order to reach into the submerged mounting bosses. In order to reach the sub-cell in the required locations and at the proper angles, the forces in the links would be much larger than required to simply support the mirror at the six locations. The first benefit of the hybrid support was that the kinematic support and the axial tilt adjustability would be combined in a single cell. The radial support minimized the forces input through the mounting bosses, allowed for differential thermal expansion between the radial and axial supports, and simplified the assembly and adjustment of the cell. Separating and isolating the radial and axial supports reduced the danger that the imperfectly realized kinematic supports would excessively strain the optic.

20.2 Finite Element Analysis of the Mirror:

The objective of the analysis was to determine whether or not the proposed support system would acceptably carry the mirror while maintaining its figure to a $\lambda/2$ specification. It was clear from the outset that the radial support, attached several inches away form the CG plane, would add a bending moment into the mirror, which would be counter-acted by the axial supports. The FEA would allow the testing of a variety of connection schemes and would provide insight into the deflections and stresses as a function of the number and location of the radial support points.

Hextek provided a 2–D AutoCAD file containing the mirror's exterior geometry and interior tube structure. A $1/12^{TH}$ symmetric section of this file was translated into ANSYS, using the ANSYS/AutoCAD DXF file translator. Inside the solid modeling preprocessor of ANSYS, the "pie-slice" of tube and facesheet detail was projected onto a spherical surface of areas at the correct radius of curvature, and then spherically offset to create the rear surface of the mirror. Given the front and rear areas of the mirror and the correct tube mesh from the translator, the tube wall areas were created by connecting the corresponding front and rear surface edges. Once the 1/12 section was complete, it was reflected three times to create an accurate half-geometry model. The mounting boss areas were added to the model after the main structure was finished. With solid model plane areas now in place for all the plate geometry of the mirror, 4 node, 3–D plate bending (no shear deformation) elements with the correct material constants and thicknesses were assigned to each area. In order to model the effects of the axial support whiffletrees, 3–D beam elements were defined to connect one pair of support points, while the third remained a simple constraint (see figure 1 in the Appendix). The beam elements were defined by the material constants to be very stiff, so that deformation of the whiffletree would be negligible compared to the displacements of the mirror. The finished model contained 1345 nodes, 2106 elements, and 7959 degrees of freedom (see figure 2 in the Appendix). The weight of the various support components was neglected in the analyses.

A total of about twenty configurations were run with ANSYS several of which were used to determine the sensitivity of the model to parameters such as the modulus of elasticity and plate element thicknesses. The final version of the model showed 0.8λ deformation across the whole front surface, and about 0.5λ across the required aperture (see figure 3 in the Appendix). This residual deformation was primarily astigmatic, and judged to be acceptable for the requirements of the camera system. The analyses also indicated that the mirror was relatively insensitive to small variations in material constants, face sheet and cell wall thicknesses, and small loads such as the weight of the torsional link. The satisfactory results from the FEA gave us the confidence to continue on the detail design of the mirror support.

20.3 Detail Design of the Mountings:

The conceptual design of the mirror support specified a kinematic arrangement of three mutually exclusive constraints for the radial, axial and torsional degrees of freedom. The detail design process was then simply a matter of approximating the idealized supports with reliable hardware that could be easily manufactured and assembled. Stainless steel blade flexures were used in situations where small translations, high stiffness and zero backlash were desired. Simple pin joints with stainless steel pins in aluminum bores were used where stiff, small angle pivots were required. Commercial (THK) spherical ball-joints were used for one-degree-of-freedom constraints. The design features of the radial, axial and torsional supports will be discussed in that order.

20.3.1 Radial Support:

Keck Observatory Technical Note 142[11] derives several useful formulae for designing diaphragms for radial supports. The design of the Keck segment radial support has several well considered features which were adapted for the support of the Hextek mirror. The primary requirement of the diaphragm is that it safely carry the radial loads of the mirror under static (installed), as well as dynamic (transport and installation) loadings. It was anticipated that the mirror might see loads during handling perhaps as high as 6 G's. It was also required that the diaphragm be sufficiently compliant in its axial direction that it not adversely affect the figure of the mirror by over-constraining the six axial supports. Keck Observatory Technical Note 189[12] documents the testing of a 8" diameter, 0.010" thick stainless steel diaphragm and found the small displacement radial and axial spring rates to be 200,000 lbs/in and 894 lbs/in respectively, for a stiffness ratio of 224:1. The results of the finite element analyses had indicated that a diaphragm of the same diameter and thickness as the Keck diaphragm would provide the necessary radial stiffness and axial compliance, even though the Hextek mirror is only 1/6 the weight of a Keck segment (180 lbs vs. 1200 lbs). The in-plane bending stiffness of the diaphragm was found to be the most important consideration because excessive stiffness would overconstrain the axial supports. Testing verified that the diaphragm was compliant enough to avoid deforming the mirror through a range of axial adjustments.

There is a significant difference in the coefficient of thermal expansion for Tempax (borosilicate, 1.8 ppm/°F) and 304 stainless steel (9.6 ppm/°F). For a given temperature change, the diaphragm and its supporting ring would expand or contract 5–6 times as much as the mirror. This difference would lead to an axial strain in the mirror if it were not compensated. The Keck approach was to mount the diaphragm in a pocket at the center of gravity of the segment, with a ring of axial flex springs which would deflect to allow for the temperature induced size variations. The flex springs for the Hextek mirror were designed such that a 40°F change in temperature will create a force of 2–3 ounces at each of the six mounting points. The Keck design was modified for the camera mirror by attaching the flex springs to Pyrex blocks epoxied to the back of the Hextek mirror (see Drawing H5530). A fixture was built to test the radial support system, using a Pyrex plate to substitute for the mirror (see Drawing H5514). This set-up was used to test the mounting blocks and diaphragm assembly under varying temperatures and loads. The assembly was tested to failure in the case of the mounting blocks, two of which showed small fractures at the bond-line at about 1200 lbs, more that six times the weight of mirror. This failure was disappointing, but reassuring in several ways. First, the fractures were in the mounting blocks, which could conceivably be removed and replaced. Second, there was no apparent damage to the mirror. Finally, the failures were in no way catastrophic, and the support continued to carry the load after the fractures appeared.

20.3.2 Axial Support:

Hextek provided six bosses evenly spaced around the mirror approximately two inches inside the back surface, which were to be used for the axial support connecting points. The bosses were 0.47" thick and roughly 3" square, with a 3/4" diameter hole bored through the center of the boss. These holes and the clearance holes in the back sheet, were bored out in the Lick Optical Lab to 1.25" and 2" respectively. Several pieces of 0.47" thick Tempax were provided by Hextek for axial support testing. The first connection design used 2 stainless steel flanges to clamp to the mounting boss. The flanges indexed loosely on the hole, to axially locate the supporting link. Unfortunately, when the two flanges were clamped together, the indexing ridge managed to jam in the hole, and neatly cleaved the test mounting boss in half during tightening. An identical clamp made of Delrin was also able to fracture the mounting boss. With these enlightening experiences fresh in mind, all components expected to contact the glass were redesigned using plastic; Delrin in the case of the axial supports, and CPVC in the case of the radial support block clamps. Additionally, the clamps were redesigned to assure that only compressive stress could be generated in the mounting boss. Drawing H5537 shows the final design of the Delrin 3–point contacting mounts. The Delrin mounting flanges accommodate variations in the thickness of the mounting bosses, and the Delrin contact points are compliant enough to provide low contact stresses and avoid introducing moment loads into the mounting boss. Drawing H5536 shows the remainder of the axial support, showing the THK spherical ball-joints, links and whiffletree balance beams. The threaded connection between the spider and the balance beam allows for collimation.

20.3.3 Torsional Support:

The torsional support is largely redundant but insures that under all conditions, the radial support is not subjected to large torque loads. The weight of the torsion link was a concern initially, but was not found to cause a problem. The weight of the torque link could be counterweighted or supported independently if necessary. Drawing H5539 shows the torque link and its connections to the supporting cell and the mirror. The Pyrex mounting block is identical to the radial support blocks. Note: as of May 1993, this support element has been eliminated. The glass block is still glued to the back of the mirror.

20.4 Mirror Testing:

The mirror was tested in two different positions in order to confirm the finite element modeling and to insure that the figure as polished was still acceptable once installed on the mount. Zenith and 10° below horizontal tests were performed on a large vibration isolation stand which was designed for testing the Keck secondary mirror (see Drawings H5824 and H5825). After several inconclusive tests it was determined that the only good time to test the mirror was early in the morning, before small temperature variations (1°F/hr) in the test tunnel began to change the mirror's figure. The Hextek blank is believed to thermalize in 2 to 3 hours and is unstable under even small temperature changes.

20.4.1 Mirror Figure Tests

The initial tests were performed on the mirror without its supporting cell, mounted instead on a layer of foam which closely matched the back radius of curvature. All mirror figure tests were conducted in the zenith-looking position. Interferograms were taken after a 12 to 18 hour soak in the test tunnel at 67° F. The mirror was then rotated 90°, allowed to soak again and more interferograms taken. The figures found in the samples are very consistent, with amplitudes ranging from 1 to 1.5λ, mostly astigmatic. The amplitude of the astigmatism varied slightly with rotation of the part, suggesting that the foam support might not be as neutral as we thought, but the topography of the figure was very consistent.

20.4.2 Mirror/Cell Figure Tests

After the horizontal testing was completed the mirror was installed in its supporting cell, mounted onto the camera sub-structure and tested again. The finite element analyses had indicated that the predominant aberrations induced by the cell would be astigmatism and coma, with a vertical axis of symmetry. The interferogram and fringe analysis data (WYCO WISP®) shows the predicted astigmatism and coma, with amplitudes roughly three times the expected values. It is not entirely clear how much of the amplitude discrepancy is due to testing and data analysis uncertainty or the FEA model predictions. The 1.28λ P-V and 0.25λ RMS values exceed the initial $\lambda/2$ P-V specification but were judged to be acceptable based on analysis of the worst slope errors. The worst-case slope error of 4.4 micro-radians was found to cause a 6.7μm deviation at the focal plane. The optical design of the camera system (i.e. perfect optics) predicted a 12.6μm RMS image diameter. The actual degraded image diameter can be estimated by adding the predicted image size and worst case ray deviation in quadrature, which yields a 13.9μm RMS image size. This was considered to be a negligible degradation of the ideal image and consequently an acceptable figure for the camera mirror.

20.5 Conclusions:

A stationary support was designed to carry a very large and fragile gas-fusion structured mirror. Finite element analysis was successfully used to analyze deformation of the mirror under a variety of conditions and orientations. Extensive testing of the mirror confirmed the results of the analyses and although the amplitudes of the deflections were greater than expected, it was not entirely clear how much of the difference was due to the models, the final figure on the mirror, testing conditions or unexpected effects from the cell. In terms of topography, the finite element model did an exceptional job of predicting the flexural behavior of a large and complicated structured mirror. Finally, optical testing and slope error analysis confirmed the acceptability of the mirror, its figure, and the hybrid kinematic mounting.

Thanks to Mark Rodamaker of MCR Associates, Sunnyvale, California for help with the creation of the ANSYS® FEA model and to Robert Parks and Richard Whortley of Hextek Corporation, Tucson, Arizona for assistance concerning the handling, figuring and support of the mirror.

and assemble. A previous paper discussed the initial finite element analyses of the lenses, and a more complicated plan of attack for static figure correction[10]. The earlier work was completed without a good understanding of the required clear apertures, and consequently did not take advantage of the areas on the lenses which were outside the required aperture. In fact, the echelle and cross-dispersed beam is roughly rectangular, with the long axis rotated about 8° from vertical. The clear aperture only uses about 60% of the total aperture of the lenses. Once the beam shape was known, it was clear that the forces could be applied closer to the center of the lenses and that two force points would be sufficient. With a conceptual layout of the support and constraining points, a second round of finite element analysis was undertaken to determine the optimum locations and values for the reforming forces.

21.2 Finite Element Analyses of the Lenses:

The initial finite element analyses for the lenses were described in the previous paper. The same general input routine was used again, with an added subroutine for applying the reforming forces. The ANSYS® finite element models typically used about 1450 nodes, 1050 3–D solid elements, and 4200 degrees of freedom. More than thirty trials were completed for each lens, manually varying the force or location with each run. Given enough computing power, this process could be automated for a more complete optimization. Still, a variety of solutions showing a $\lambda/4$ P-V optical path difference (OPD) were found, and the location requiring the least force was used in each case (see ANSYS input files in the Appendix). Figure 1 shows a typical finite element model of the meniscus lens showing the defining points, symmetric boundary conditions and the locations of the reforming forces. Figures 2 and 3 show the finite element predictions for deformation of the meniscus lens before and after the application of the forces. Figures 4 and 5 show the same plots for the biconvex lens. Note that although the overall P-V deformations are more than $\lambda/4$, the clear apertures (bold lined) are $\lambda/4$ P-V. It is important to note that the reforming forces induce stresses in the fused silica lenses and consequently contribute birefringence effects to the optical path length errors. However, because the stresses never exceeded 50 psi, well below the accepted 500 psi limit for birefringence[17], the OPD errors were considered negligible.

21.3 Detail Design of the Cells:

As mentioned before, a variety of considerations drove the design process for the corrector cells. The corrector lenses would ultimately be anti-reflection coated using a Sol-Gel process, developed and applied at Lawrence Livermore National Lab for the Nova Laser Program. This coating was expected to be stripped and reapplied occasionally, which required that the lenses be completely and readily separable from their cells, and precluded "potting", or elastomeric mounting. The cells would be manufactured in the Lick Observatory Instrument Labs, which required that conventional fabricating and testing processes be used. Reducing cell weight would benefit assembly and handling. Corrosion resistant materials and surface treatments would be used throughout. Detail design of the radial supports, axial supports, force application assemblies and cells will be discussed in that order.

21.3.1 Radial Supports

The justifications for the basic design of the radial supports is discussed in the previous paper. To summarize, the radial support contacts are split twice in the theta direction and twice again in the z-direction (see Detail A in Drawing H5324). The balance beams operate in both directions in order to reduce the bearing stresses in the optic. Two sets of two radial supports were selected to reduce contact stress and minimized the deformation of the lenses. Stainless steel flex pivots were designed to minimize the axial forces transferred to the optic, while allowing minor focus adjustments without lifting the lens off of the support. The flex pivots reduce (but do not eliminate) the risk of axially overconstraining the lens. The Delrin contact pads are mounted to the second flex pivot, to divide the load across the lens center of gravity, again reducing stress and avoiding local deformation of the optic. A single threaded post at the top of the cell constrains the lens in the cell during handling.

21.3.2 Axial Supports

The axial supports provide two functions in the corrector lens cells: First, the axial constraints define the location of the optical surface and provide a way to align the optical axis of the part. Second, the axial contacts provide a location for the force points to react against. So in addition to locating the lens, the axial constraints help to reform the figure. The design of the defining points and backside constraints are identical for both lens cells. The defining surface axial contacts are composed of fine threaded stainless steel posts, with commercial swivel-feet and Delrin caps to follow and protect the surface of the lens (see Drawing H5328). The backside axial constraints are primarily "earthquake clips", to prevent the lens from falling out of its cell during handling. The backside contacts are also threaded stainless steel shafts, with spherical Delrin tips (see Drawing H5328). In the case of the meniscus, the forces applied to correct the figure actually transfer the lower pair of axial loads to the back of the lens, causing the backside (or "uphill") constraints to become the defining points.

21.3.3 Force Application Assemblies

The force application assemblies (force points) provide a means for applying an adjustable force on the optics. The force point consists of a stainless steel shaft, a swivel-foot/Delrin cap, a threaded brass adjusting body, a spring, and a stainless steel end cap (see Drawing H5328). The springs are standard commercial parts that were calibrated for use in the force points. Although the forces applied to the two lenses are different by a factor of two, the force points are identical except for the stiffness of the springs. The length and spring constants for the springs were selected so that both would require about 0.5" of compression to apply the desired force (11.5 lbs for the meniscus, 6.0 lbs. for the biconvex lens). The springs can be compressed from each end, either by tightening the end cap, or by tightening the brass adjusting body. The two adjustments allow for very fine tuning of the force applied and allow the force point to compensate for axial adjustments of the lens.

21.3.4 Lens Cells

The cells house the lenses and provide a base for attaching the defining and forcing hardware. The housing is composed of two stiffened face plates which are screwed to a ring weldment. This construction is relatively light weight and allows the cell to be dismantled for installing or removing the lens. The remainder of the cell includes a door for dust protection and a hoisting ring for handling. Drawings H5324 and H5349 show the complete lens and cell assemblies. For reference, the corrector lenses both weigh about 120 lbs., and the meniscus and biconvex cells weigh 130 lbs. and 110 lbs. respectively.

21.4 Lens Testing:

The preliminary optical specification for the corrector lenses was to achieve a P-V OPD of λ/4 over the specified clear apertures. This is probably the easiest value to work towards during finite element analysis as well as for figuring in the Optical Lab. However, later analysis of the optical system indicated that local slope errors were much more important than the overall P-V figure on a given surface.

21.4.1 Biconvex Lens Testing

Due to convex surfaces and long radii of curvature, it was not practical to perform interferometric testing on the biconvex lens. Instead, all testing of the biconvex lens was completed using 10" diameter test plates. Although the test plates cannot qualify the peak-to-valley specification for the full aperture, they do give an excellent representation of local slope errors. Based on test plate measurements, the biconvex lens was found to be better than λ/4 over any given 10" aperture. The following section will focus entirely on the testing of the concave surface of the meniscus lens, which was the only surface readily tested with the interferometer.

21.4.2 Meniscus Lens Testing

The meniscus lens was tested in two different positions to confirm the results of the finite element analysis and to verify that the figure as polished was still acceptable after installation and figure-correction in the cell. In each case, interferograms were taken and the Wyco WISP® program was used for fringe analysis. Zenith-pointing testing was conducted with the lens mounted on a foam-lined support which was in turn carried on a large vibration isolation structure (see Drawing H5811). Interferograms were taken for several rotations of the lens relative to the foam support. The figures were consistent at about 1.5λ P-V, mostly astigmatism, and 0.25λ RMS.

The next set of tests were run in the final, tilted orientation. The lens cell and interferometer were assembled on a Newport Research Series vibration isolation table down-looking (see Drawing H5826). The first set of tests was to establish the deformed figure without any correcting forces applied. The finite element model predicted about 2 waves of deformation across the full aperture (Figure

2). The measured figure was a little more than 4 waves P-V (Figures 9 and 11), roughly twice the expected amount.

The next set of tests involved applying the correcting forces and taking more interferograms. One of the goals at this stage was to determine if the predicted correcting forces were in fact the optimum. Tests were run at 1 lb. intervals above and below the predicted optimum of 11.5 lbs. The sign of the deformation was seen to reverse between 10.5 lbs. and 12.5 lbs., suggesting that 11.5 lbs. really was the best value. By applying the optimum 11.5 lb. force at each location, the overall figure improved from 4.34 waves to 1.47 waves, a reduction of almost 3 waves of astigmatism (See Figure 14). The 1.47λ P-V was still much worse than the 0.3λ P-V (see Figure 3) prediction from the finite element model, but nevertheless was a dramatic improvement realized by a rather simple mechanical correction. The FEA predictions and interferograms do agree on the topography of the deformed (astigmatic) shape, but the FEA model underestimates the amplitude of the deformation by almost 5 times. Finite element models are typically reliable to 10-20%, not 500%, so there is clearly a problem. Possible contributors include errors in the FEA model, the figure on the lens, errors in the location or assembly of the lens in its cell or other testing error.

The last interferogram shows the figure over the required clear aperture (Figure 17). For this area, the P-V OPD is 0.68λ and 0.10 RMS. Again, the P-V number is worse than predicted, but the RMS value is actually quite good. The fringe analysis program indicated that the worst slope error was 2.1λ/14.15" (14.15" is the pupil radius) for a maximum slope of 3.7×10^{-6} radians. The slope error can then be multiplied by the focal length of the lens to determine the worst case typical ray deviation at the focal plane. In this case, the maximum deviation was 1.4μm and the RMS image diameter was 1.2μm. The diffraction limited image diameter was 1.64μm suggesting that the concave surface was essentially diffraction limited. This conclusion was also indicated by the 0.66 Strehl ratio calculated by WISP (Figure 18).

21.5 Conclusions:

Two novel figure-correcting lens cells were analyzed, designed and tested. Finite element models were successfully used to predict the optimum forces and locations for applying corrections to the lenses. Although the FEA predictions seriously underestimated the amplitude of the deformations, the models closely matched the measured topography of the figures. This result suggests that there is room for improvement in the modeling process, although it is not entirely clear whether the disagreement lies in the FEA, the design or assembly of the cell, or the testing methods. Although much work remains to be done in improving the accuracy of the figure correcting cell, the concept has been tested and proven able to remove as much as 3 waves of elastic deformation.

21.6 Lens Installation and Removal

The lenses are shown in Drawings H5384 and H5385. The removal tool is detailed in Drawing H5363. The lens carrying frames are used during the installation and removal procedures. They are shown in Drawings H5247 and H5254.

21.7 Lens Cell Covers and Doors

Drawing H5376 shows the bi-folding door for the first lens cell. This door replaced the original sliding door which did not provide an adequate seal. The door is air-operated. The air logic diagram is shown in H5375 and the air control station for both lenses and the camera mirror is shown in Drawing H5380. Drawing H5342 shows the meniscus lens cell air-operated door.

Between the two lens cells is a 6" gap. Instead of building doors for these interior cell faces, a flexible cover has been installed around the cells in this gap. It is held on using Velcro strips glued to the cells and cell mounting base structure.

21.8 Lens Lifting Slings

Bigelow[8] describes the Sol-Gel coating procedure at Lawrence Livermore National Lab. Drawings H5266 and H5267 show the lens lifting slings assembled with the lenses.

Appendix A REFERENCES

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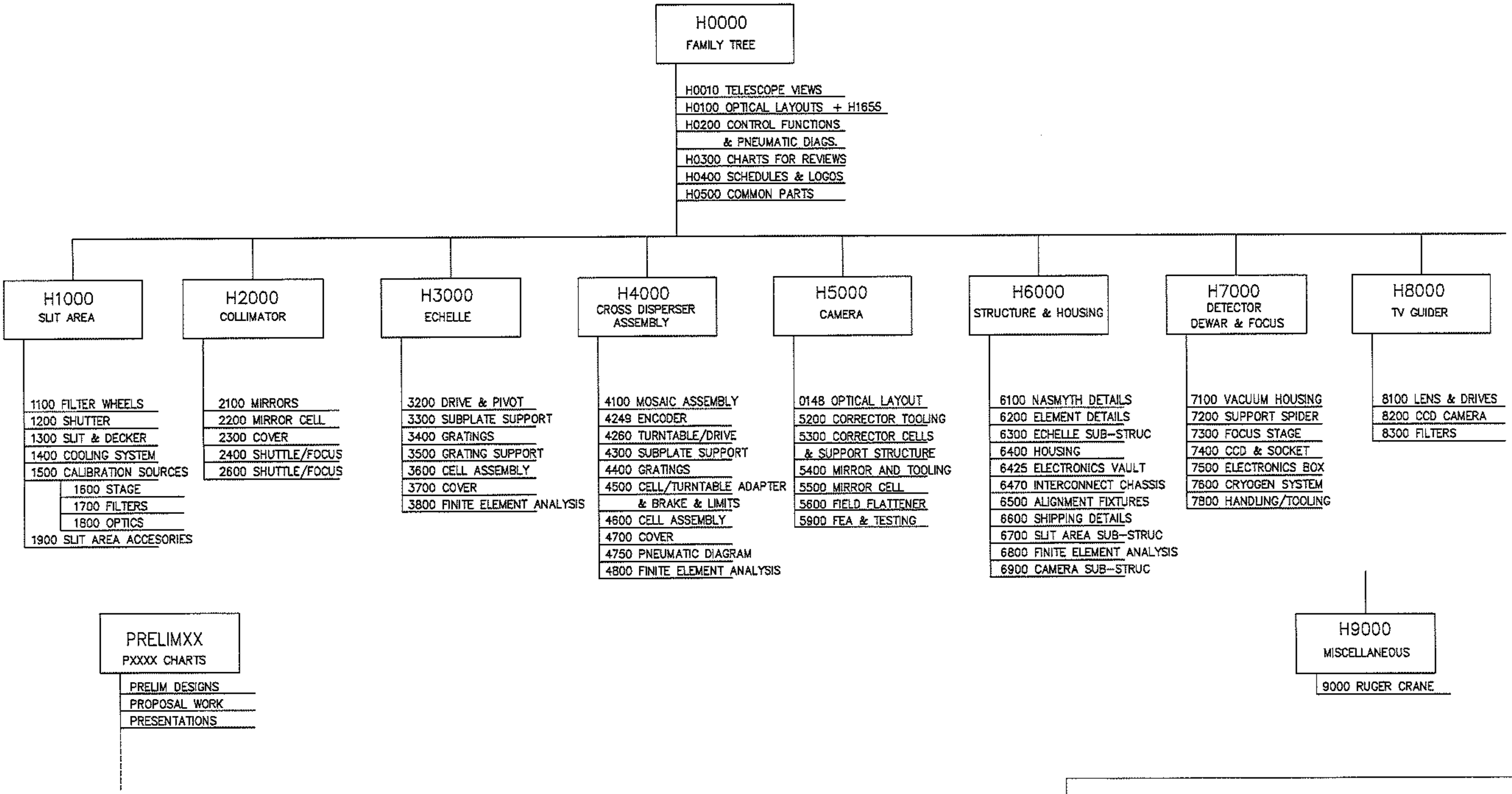
Appendix B List of Drawings — Design

1. H0000 Family Tree, Entire
2. H0001 General Design Tree
3. H0010 General Telescope Assembly
4. H0102 Final Optical Layout
5. H0148 Super-Duper Camera Layout
6. H0200 Control Functions, Schematic
7. Un-named schematic

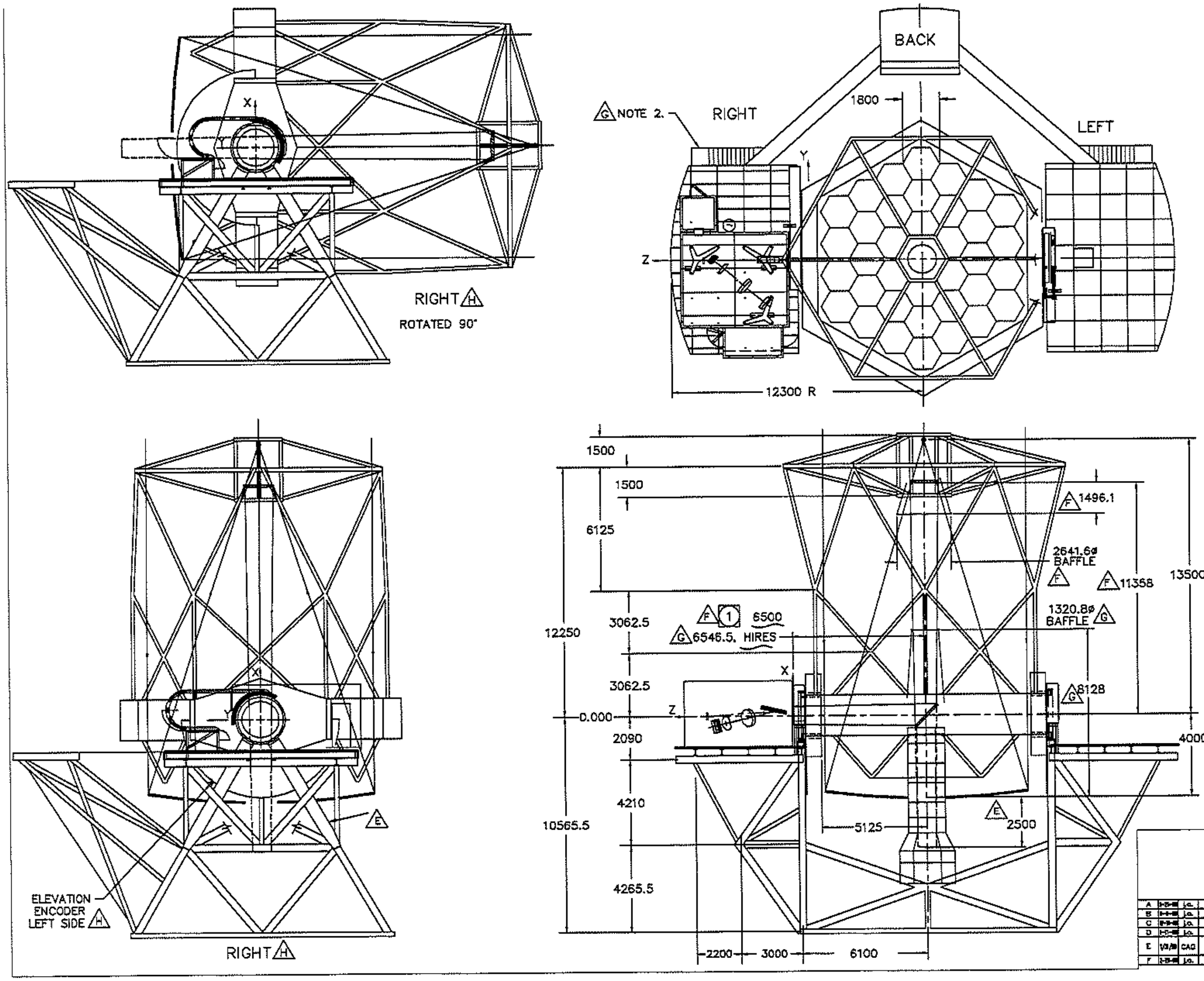


G	[illegible]	j.o.		LOST DRAWING .0; GENERAL REVISIONS
H	[illegible]	j.o.		ADD H0500, H1655 NOTE.
A	[illegible]	j.o.		RENAME. WAS FOS-000.
B	[illegible]	j.o.		REVISE. ADD PRELIMS.
C	[illegible]	j.o.		REVISE.
D	[illegible]	j.o.		RE-NUMBER ALL DRAWINGS.
E	[illegible]	j.o.		GENERAL REVISIONS.
F	[illegible]	j.o.		GENERAL REVISIONS.

KECK/HIRES
FAMILY TREE
AS SHIPPED

j.o. 3 28 88

H0000.H



⊖1 GENERAL ASSEMBLY

NOTES:

1. 6500 IS NOMINAL FOCUS.
2. LANDING AND STAIR AS NOTED BY STEVE VOGT, 3-21-92.

ALL DIMENSIONS ARE MM

3RD ANGLE PROJECTION

G	[illegible]	j.a.		ADD BAFFLE, ADD 6546.5 mm DIMENS.
H	[illegible]	j.a.		HIRES WAS ON LEFT PLATFORM.

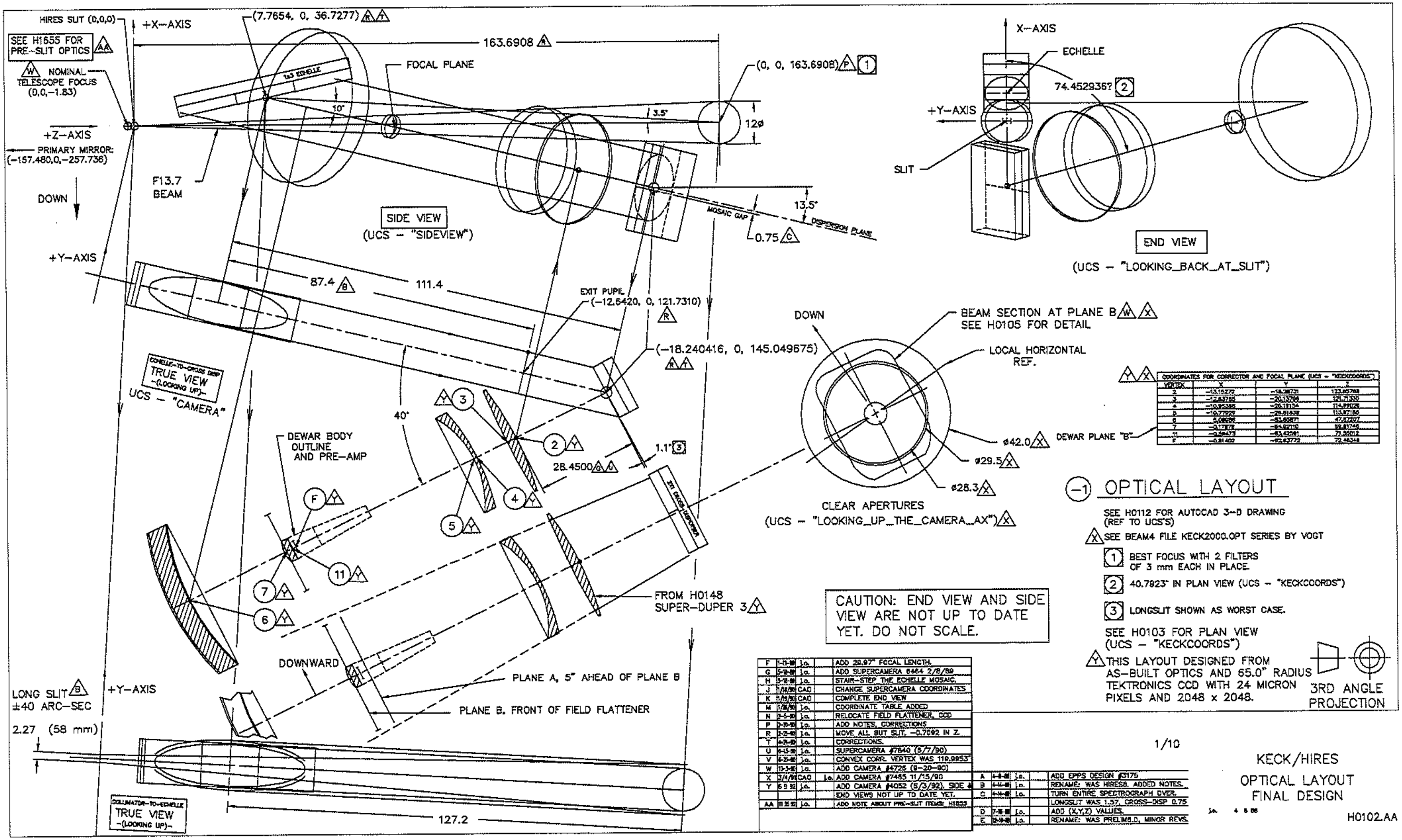
0.0125

A	[illegible]	j.a.		MODIFY, WAS 231K
B	[illegible]	j.a.		RENAME, WAS HIRES12.
C	[illegible]	j.a.		CLEAN UP, CREATE H0011
D	[illegible]	j.a.		MODIFY BEARING SURFACE.
E	[illegible]	CAG		CHANGE MT.1: 600 WAS 350 2500 WAS 3000
F	[illegible]	j.a.		6501.4 WAS 7000, ADD CASS SHIELDS

KECK/HIRES
GENERAL ASSEMBLY

j.a.
C.A.G. 4 20 88

H0010.H



Y X

COORDINATES FOR CORRECTOR AND FOCAL PLANE (UCS – "KECKCOORDS")			
VERTEX	X	Y	Z
2	–13.15272	–18.38731	123.65788
3	–12.63785	–20.13706	121.71330
4	–10.95385	–26.19134	114.89926
5	–10.77929	–29.81838	113.87186
6	5.08686	–53.65871	47.07207
7	–0.17878	–64.92110	89.81746
11	–0.39473	–63.42581	71.35012
F	–0.81402	–62.63772	72.46348

(–1) OPTICAL LAYOUT

SEE H0112 FOR AUTOCAD 3–D DRAWING
(REF TO UCS'S)

X SEE BEAM4 FILE KECK2000.OPT SERIES BY VOGT

1 BEST FOCUS WITH 2 FILTERS OF 3 mm EACH IN PLACE.

2 40.7923" IN PLAN VIEW (UCS – "KECKCOORDS")

3 LONGSLIT SHOWN AS WORST CASE.

SEE H0103 FOR PLAN VIEW
(UCS – "KECKCOORDS")

Y THIS LAYOUT DESIGNED FROM AS–BUILT OPTICS AND 65.0" RADIUS TEKTRONICS CCD WITH 24 MICRON PIXELS AND 2048 x 2048.

CAUTION: END VIEW AND SIDE VIEW ARE NOT UP TO DATE YET. DO NOT SCALE.

3RD ANGLE PROJECTION

F	1-11-89	j.a.		ADD 28.97" FOCAL LENGTH.
G	5-18-89	j.a.		ADD SUPERCAMERA 6464 2/8/89
H	5-18-89	j.a.		STAIR–STEP THE ECHELLE MOSAIC.
J	1/18/90	CAD		CHANGE SUPERCAMERA COORDINATES
K	1/19/90	CAD		COMPLETE END VIEW
M	1/26/90	j.a.		COORDINATE TABLE ADDED
N	2-5-90	j.a.		RELOCATE FIELD FLATTENER, CCD
P	2-15-90	j.a.		ADD NOTES, CORRECTIONS
R	3-2-90	j.a.		MOVE ALL BUT SLIT, –0.7092 IN Z.
T	4-24-90	j.a.		CORRECTIONS.
U	6-13-90	j.a.		SUPERCAMERA #7840 (6/7/90)
V	6-25-90	j.a.		CONVEX CORR. VERTEX WAS 119.9953"
W	10-3-90	j.a.		ADD CAMERA #4726 (9–20–90)
X	3/4/91	CAD	j.a.	ADD CAMERA #7465 11/15/90
Y	6 9 92	j.a.		ADD CAMERA #4052 (6/3/92), SIDE &
				END VIEWS NOT UP TO DATE YET.
AA	11 25 92	j.a.		ADD NOTE ABOUT PRE–SLIT ITEMS: H1655

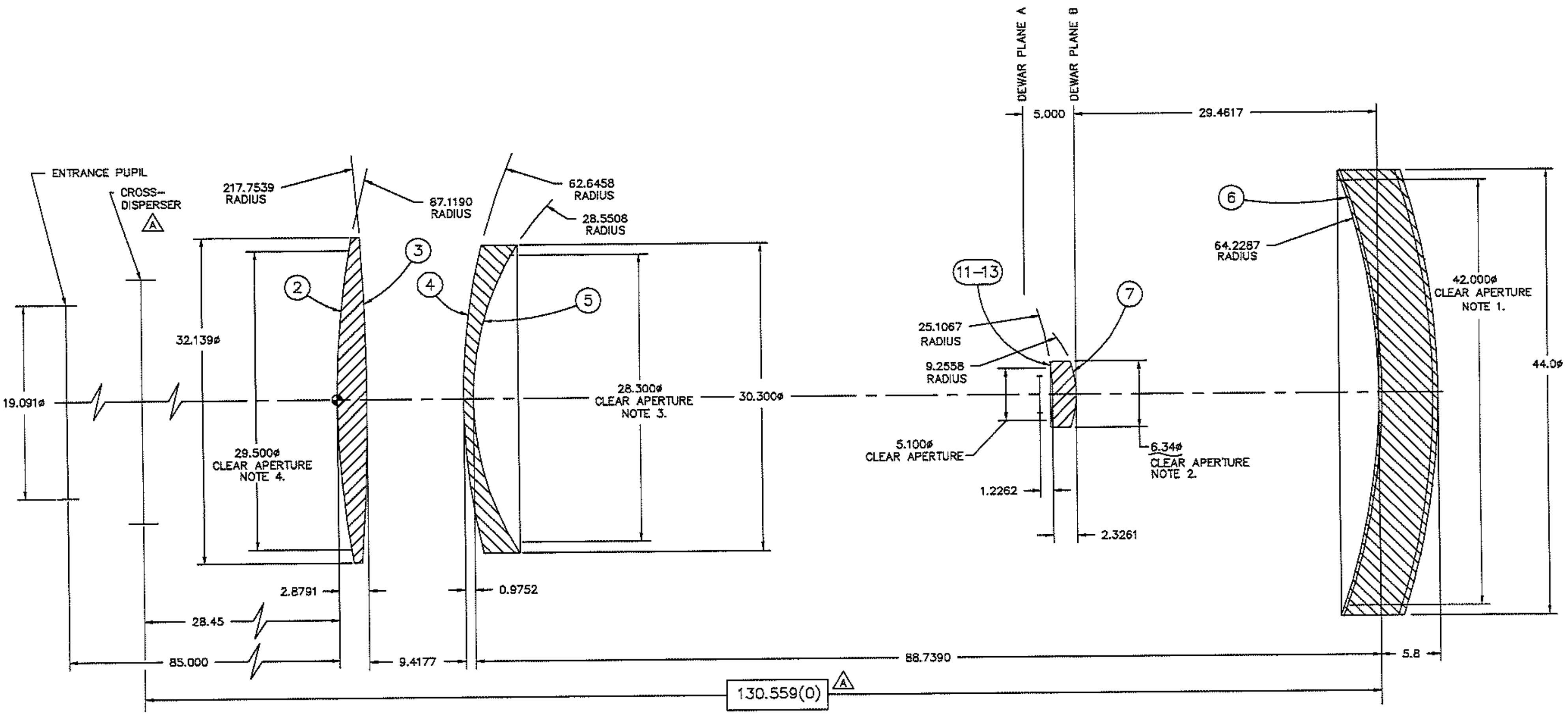
A	4-8-88	j.a.		ADD EPPS DESIGN #3175
B	4-14-88	j.a.		RENAME: WAS HIRES8, ADDED NOTES.
C	4-14-88	j.a.		TURN ENTIRE SPECTROGRAPH OVER.
				LONGSLIT WAS 1.57, CROSS–DISP 0.75
D	7-15-88	j.a.		ADD (X,Y,Z) VALUES.
E	12-8-88	j.a.		RENAME: WAS PRELIM6.D, MINOR REVS.

1/10

KECK/HIRES
OPTICAL LAYOUT
FINAL DESIGN

j.a. 4 5 88

H0102.AA



(-1) EPPS DESIGN #4052 (6/3/92)

FINAL "AS-BUILT" PRESCRIPTION
USE WITH R=65.0" CONVEX TEK CCD
T = 0°C
THIS DRAWING REPLACES H0135, SUPER-DUPER II
WHICH WAS EPPS DESIGN #7465 (11/15/90)

THE FLAT FIELD VERSION #4753 IS DRAWING H0149.

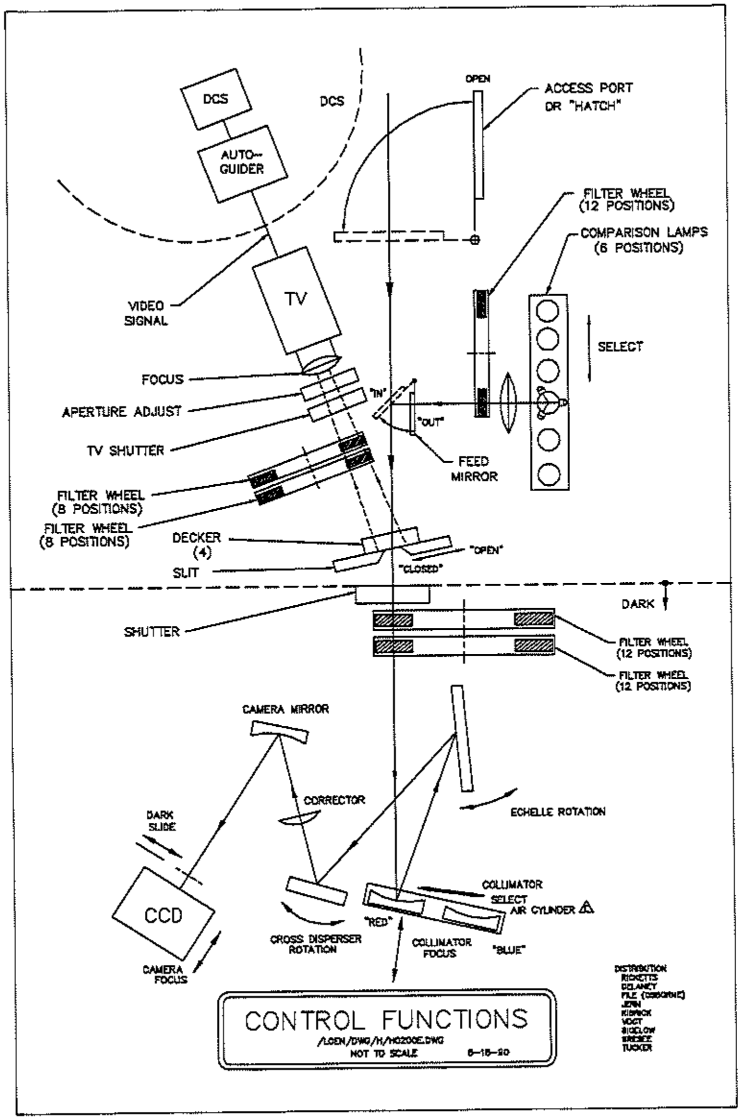
B 6.7" FOV (FIELD OF VIEW)

NOTES:
1. 37.603ø CLEAR APERTURE FOR THIS CCD.
SEE H5400–H5405, H5415, H0144 FOR DETAILS
2. 6.34ø C.A. FROM 6.44ø BLANK
SEE H7181 FOR LENS DETAIL
3. 25.90ø C.A.
SEE H0136, H0142, H0145, H0147
4. 27.13ø C.A.
SEE H0136, H0141, H0146

1/4

A	8 11 92	j.o.		ADD DIMENSION TO CROSS-DISPERSER.
B	5 13 93	j.o.		ADD FIELD OF VIEW NOTE.

KECK/HIRES
SUPER–DUPER CAMERA III
AS–BUILT "CURVED FIELD"
H.EPPS 6 3 92
j.o. 6 5 92
H0148.B



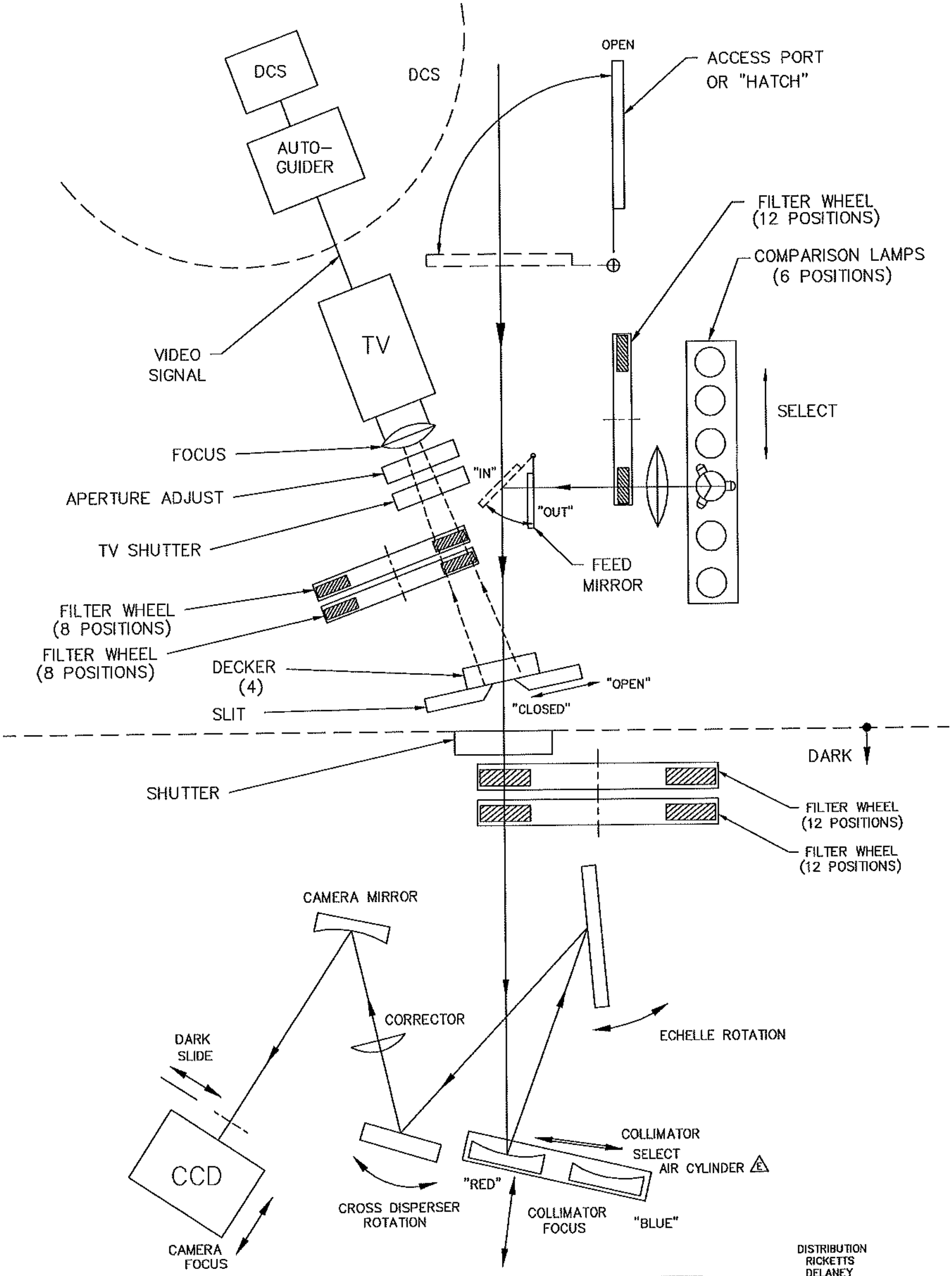
NONE

A	9-1-89	j.a.		UPDATE. SHOW SPECTROGRAPH INTERNAL
B	1-17-90	j.a.		MODIFY FOR SOFTWARE DESIGN REVIEW
C	1-17-90	j.a.		MODIFY FOR SOFTWARE DESIGN REVIEW
D	6-18-90	j.a.		REMOVE CAMERA, CORRECTOR CHANGERS.
E	8-1-91	j.a.		8 POS. TV FILTERS WERE 6-POS.
				AIR CYL. DRIVE WAS 1/3 HP MOTOR.

KECK/HIRES
CONTROL FUNCTIONS
SCHEMATIC

j.a. 6 13 88

H0200.E



DISTRIBUTION
RICKETTS
DELANEY
FILE (OSBORNE)
JERN
KIBRICK
VOGT
BIGELOW
BRESEE
TUCKER

CONTROL FUNCTIONS

/LOEN/DWG/H/H0200E.DWG
NOT TO SCALE 6-18-90

Appendix C List of Drawings — Collimators

1. H2005 Locating Tree
2. H2000 Collimator Assembly
3. H2206 Spring Pad Assembly
4. H2209 Support Detail (and Temperature Compensator)
5. H2401 Transfer Mechanism (Shuttle)
6. H2415 Shuttle Pneumatic Diagram
7. H2460 Stage Locks
8. H2600 Rear View of Cell
9. H2610 Focus Drive Schematic
10. H2620 Drive Detail
11. H2623 Focus Drive Motor
12. H2660 Motor/Gearbox Assembly

H2000	COLLIMATOR ASSEMBLY
H2001	COL. TOP PLATE DET
H2100	RED MIRROR
H2110	BLUE MIRROR
H2200	COLLIMATOR CELL ASSY
H2201	" " DETAIL
H2202	" " DETAIL
H2203	" " DETAIL
H2204	" " DETAIL
H2205	" " DETAIL
H2206	SPRING PAD ASSY
H2207	" " DETAIL
H2208	TOOL
H2209	RADIAL SUPPORT ASSY
H2210	" " DETAIL
H2300	COVER ASSEMBLY AND AIR SCHEMATIC DIAGRAM
H2301	COVER/CYLINDER LAYOUT
H2302	AIR CYLINDER & DOOR
H2303	SPEED CONTROL MOD.
H2304	" " DETAIL

H2401	COL. MIRROR TRANSFER MECH.
H2404	COL. SUPPORT STAND DETAIL
H2405	COL. CHANGER CORNER ASSY
H2406	" " " DETAIL
H2407	COL. SUPPORT VEE PADS
H2408	" " BRACE DETAIL
H2410	COL. CHANGER FLAT MOUNT
H2411	" " " DETAIL
H2412	" " " DETAIL
H2413	" " " DETAIL
H2415	" " PNEUMATIC DIAGRAM
H2416	" " AIR CONTROL PANEL
H2417	" " " " DETAIL
H2420	" " LINK DETAIL
H2421	" " " "
H2422	" " AIR CYL. CLEVIS
H2423	" " AIR CYLINDER
H2460	COL. STAGE LOCKS
H2461	" " DETAIL
H2462	" " DETAIL
H2463	" " DETAIL

H2450	COLLIMATOR JUNCTION BOX ("AC STAGE")
H2451	" " DETAIL
H2452	COL. FOCUS BOX
H2453	" " DETAIL

H2600	COLLIMATOR FOCUS	
H2601	" " DETAIL	
H2602	" " DETAIL	
H2610	" " DRIVE SCHEMATIC	
H2620	" " DRIVE BLOCK ASSY	
H2621	" " " " DETAIL	
H2622	" " " " DETAIL	
H2623	" " " " MOTOR	
H2624	" " BELT TENSIONER ASSY	
H2625	" " " " DETAIL	
H2627	" " BRAKE MOD.	
H2628	" " BRAKE ASSY'S	
H2629	" " BRAKE DETAILS	
H2630	" " LIMITS	
H2631	" " " DETAIL	
H2632	" " " DETAIL	
H2633	" " " DETAIL	
H2603	ALIGNMENT FIXTURE	OBSOLETE
H2604	" " DETAIL	
H2605	" " DETAIL	

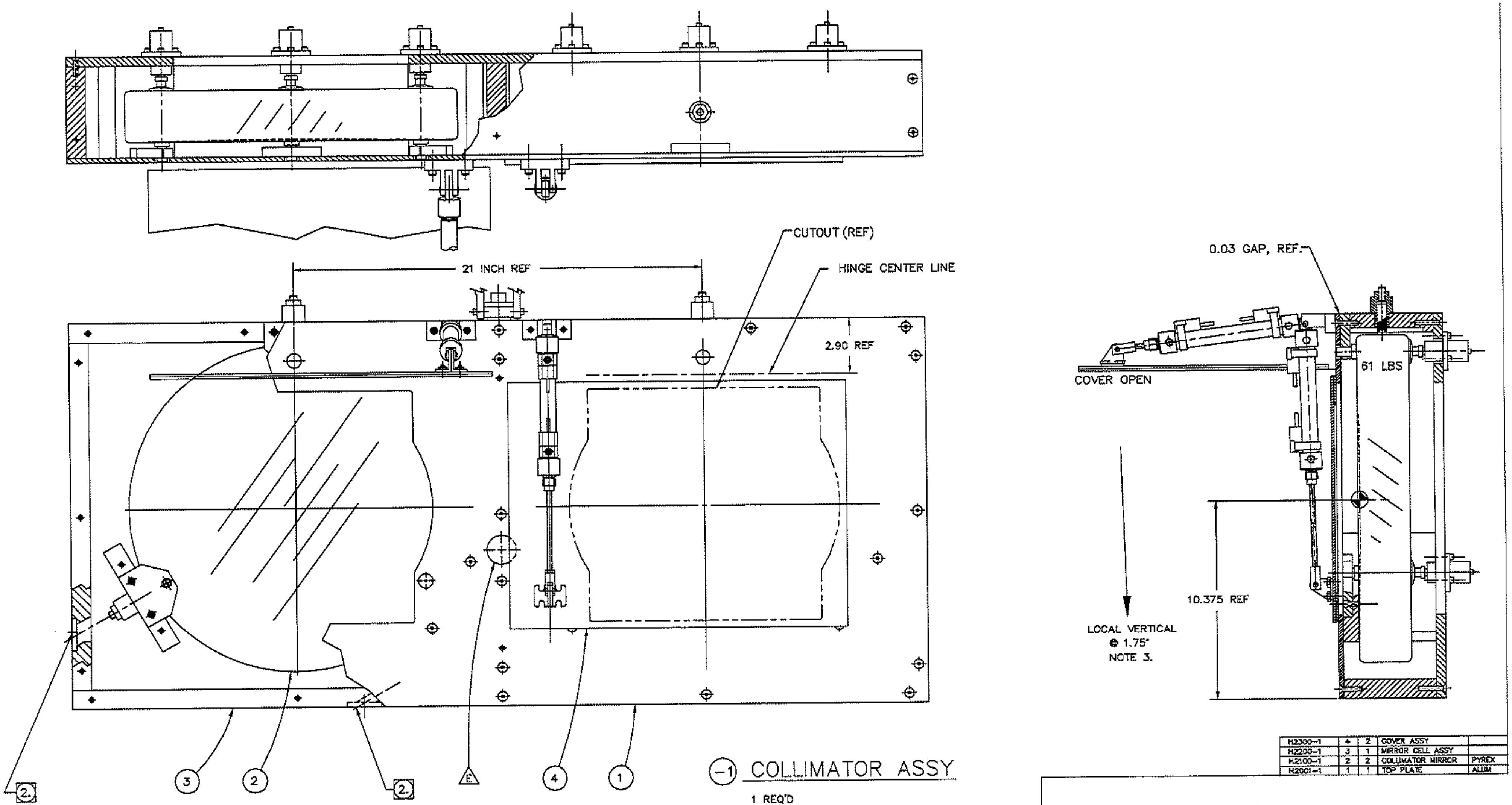
H2634	COLLIMATOR FOCUS SPRING ASSY
H2635	COLLIMATOR FOCUS SPRING ASSY
H2636	" " SPRING DETAIL
H2637	" " " "
H2638	" " " "
H2639	" " DETAIL
H2640	DIAL INDICATORS ASSY
H2641	" " DETAIL
H2645	MOTOR GUARD DETAIL
H2650	COLLIMATOR FOCUS SHUTTLE DETAIL
H2651	" " " "
H2652	" " " "
H2653	" " " "
H2654	" " " "
H2655	" " " "
H2656	" " " "
H2657	" " " "
H2658	" " " " OBSOLETE
H2660	" " GEAR REDUCER
H2661	" " " " ADAPTER

A | 5 28 93 | J.O. | AS SHIPPED.

KECK/HIRES
COLLIMATOR
LOCATING TREE

J.O. 6 2 91

H2005.A



H2300-1	4	2	COVER ASSY	
H2200-1	3	1	MIRROR CELL ASSY	
H2100-1	2	2	COLLIMATOR MIRROR	PYREX
H2001-1	1	1	TOP PLATE	ALUM

(-1) COLLIMATOR ASSY

1 REQ'D

NOTES:

1. REF H2301, COVER/CYLINDER DIMENSIONS.
2. COLLIMATOR ACCESS HOLE (5 PLACES).
3. MIRROR IS MOUNTED SQUARE TO THE CELL. THE CELL IS TILTED 1.75° FROM VERTICAL.

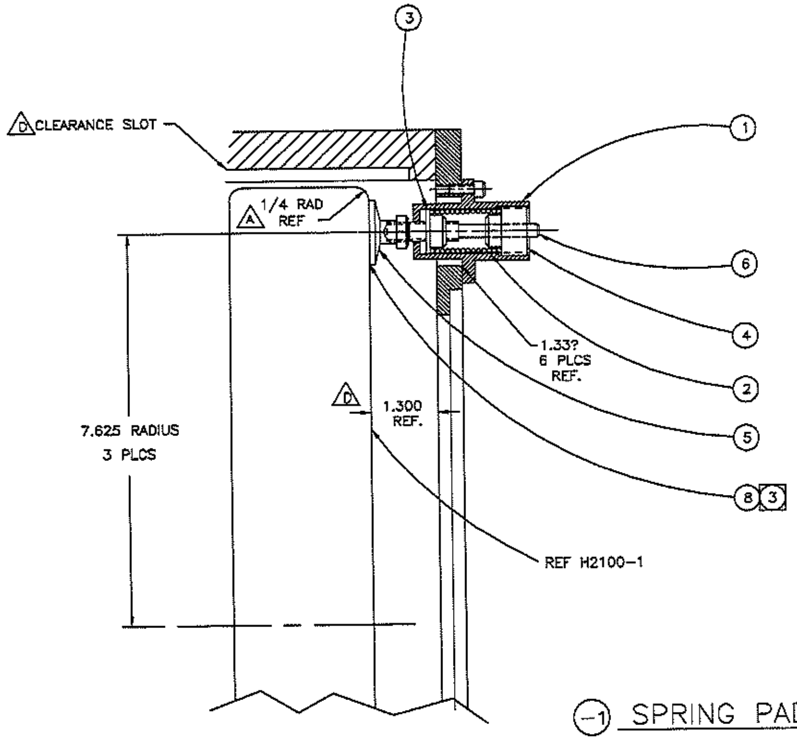
1/2

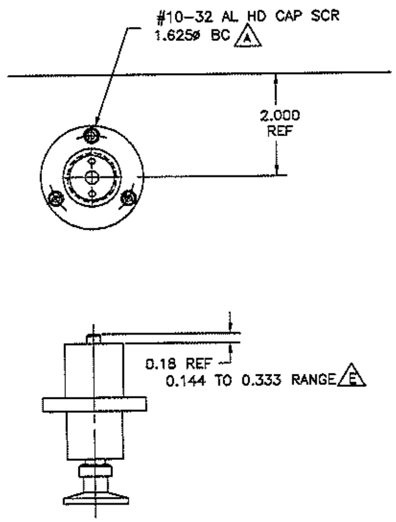
A	[illegible]	J.O.		DESIGN REVIEW CHANGES.
B	[illegible]	J.O.		UPDATE TO AS-BUILT
C	2-12-91	J.O.		BEGIN CHECKING AIR CYL. MOUNTS.
D	2/22/91			REDRAWN
E	8 13 91	J.O.		ADD 1.504 ALIGNMENT HOLE, NOTE.

J.O. 10 31 88
C.A.O. 11 22 88

KECK/HIRES
COLLIMATOR
ASSEMBLY

H2000.E





-1 SPRING PAD ASSEMBLY

6 REQ'D

NOTES

1. SPRING DATA:
   3.5" FREE LENGTH
   0.085? ST STL WIRE
   1.19 SOLID HEIGHT
   (14 TURNS)
   OD IS 0.845,
   DESIGNED FOR 7/8? HOLE
   K = 15.0 lbs/INCH
   DESIGN 2.115" COMPRESSION (32lbs)
   DESIGN HEIGHT IS 1.385"
2. USE LOC-TITE ADHESIVE
   TO ASSEMBLE LEVELING PAD
   TO ROD.

C A 3 ITEM 8 IS TEFLON TAPE APPROXIMATELY 0.006" THICK
P/N 76495A180 McMASTER-CARR 1" WIDE TAPE.

–	8	1	PAD, 1.25ø x 0.5ø	TEFLON
H2208-1	7	1	TIGHTENING TOOL	STL.
H2207-4	6	1	ROD	ST. STL.
–	5	1	LEVELING PAD JERGENS	32501
H2207-3	4	1	LOADING NUT	BRASS
H2207-2	3	1	FLANGED NUT	BRASS
–	2	1	SPRING, LEE	LC-085K-105
H2207-1	1	1	HOUSING	ST. STL.

E	10 I 92	j.o.		ADD NOTE DURING COLLIMATION.

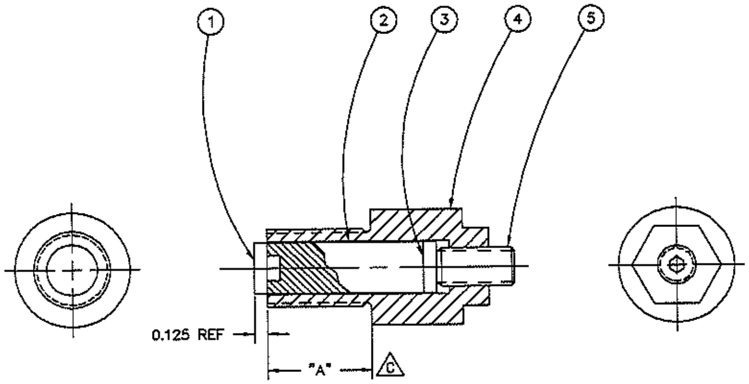
A	2/28/89	j.o.		1.625 WAS 1-5/8, 1/4 WAS 1/8. ADD
				NOTE.
B	6-12-89	j.o.		UPDATE TO AS-BUILT.
C	8-14-89	j.o.		ADD TEFLON TAPE SOURCE PER DES REV
D	6-5-91	j.o.		ADD CUTOUT TO TOP PLATE TO CLR
				MIRROR.

FULL

KECK/HIRES
COLLIMATOR DETAILS
SPRING PAD ASSY

j.o. 11 23 88

H2206.E

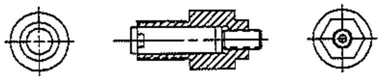


-1 RADIAL SUPPORT ASSY

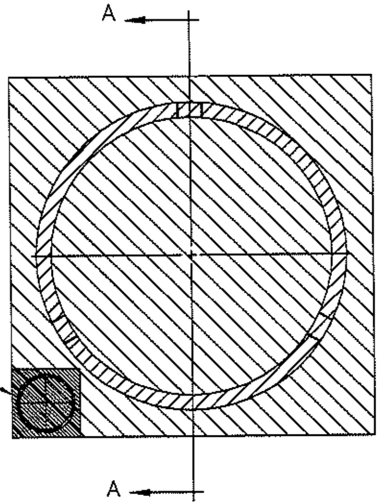
SCALE: 2X

"A"	REQUIRED
1.00	4 (SHOWN)
0.75	2

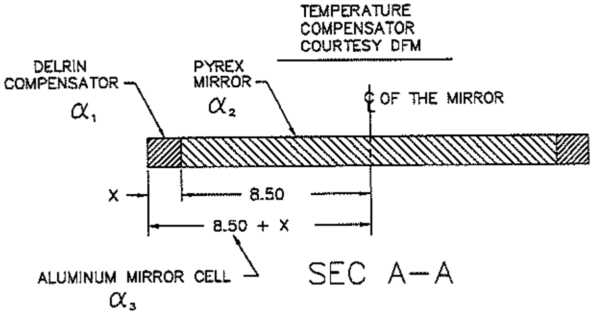
C



FULL SIZE



D NOTE: TEMPERATURE COMPENSATION IS INTENDED TO KEEP THE RADIAL LOADS CONSTANT. IT DOES NOT KEEP THE MIRROR CENTERED.



SEC A—A

$\alpha_1 = 4.84 \times 10^{-5}$ IN/IN-°F

$\alpha_2 = 1.33 \times 10^{-6}$ IN/IN-°F

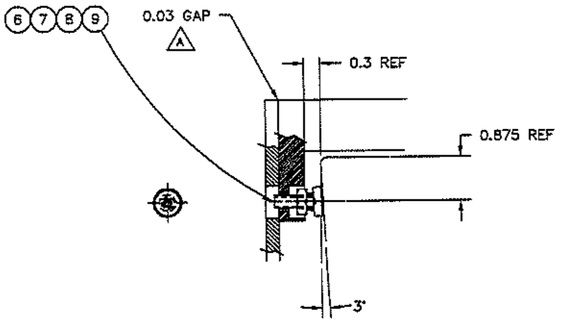
$\alpha_3 - 12 \times 10^{-6}$ IN/IN-°F

$$8.5\alpha_2 + \alpha_1 x = (8.5 + x)\alpha_3$$

REDUCES TO:

$$X - 8.5\left(\frac{\alpha_3 - \alpha_2}{\alpha_1 - \alpha_3}\right)$$ E

X = 2.5" E



-2 DEFINING SCREW ASSEMBLY

6 REQD

LOC-TITE STUD TO TOGGLE PAD

NOTES—

A 1: BROACH HEX IN 1/4-28 END OF STUD

B 2: ITEM 9 IS TEFLON TAPE APPROXIMATELY 0.006" THICK P/N 76495A180 McMASTER-CARR 1" WIDE TAPE.

TOTAL REQ'D

B	—	9	6	9/16øx0.006 THICK	NOTE 2
	—	8	6	1/4-20 TO 28 STUD	ST.STL
	—	7	6	1/4-28 INSERT	ST.STL
	—	6	6	TOGGLE PAD, JERGENS	43502
	—	5	6	3/8-24 SET SCR	ST.STL
A	H2210-3	4	6	HOUSING	ALUMINU
	—	3	6	PUSHER, 1/2øX1/8	ST.STL
	H2210-2	2	6	COMPENSATOR	DELRIN
	H2210-1	1	6	TIP	INVAR

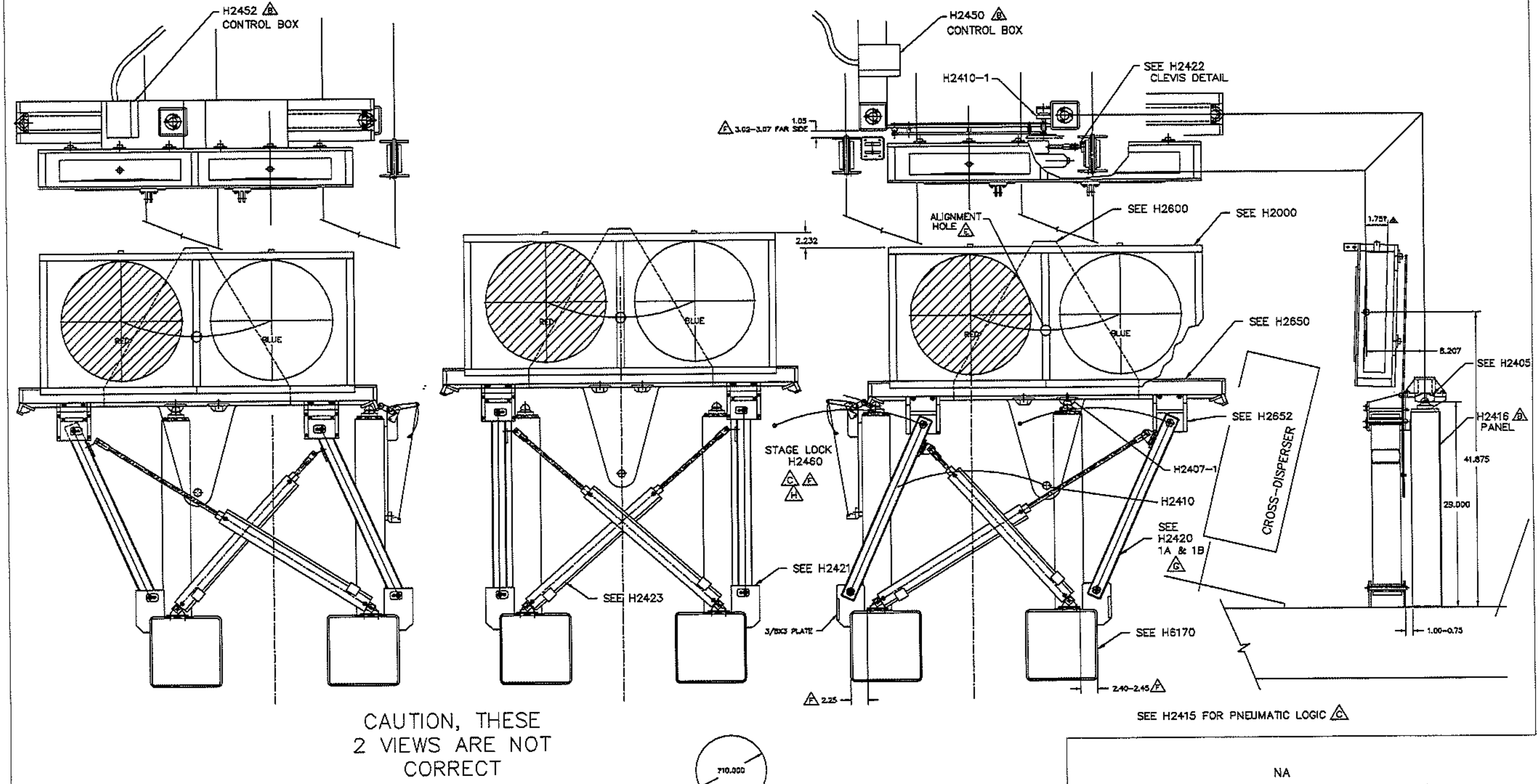
FULL

A	8.12.89	j.o.		UPDATE TO AS-BUILT CONFIGURATION.
B	8.14.90	j.o.		ADD TEFLON TAPE SOURCE PER DES REV
C	4.22.91	j.o.		DIFFERENTIATE PART -1.
D	5.22.92	j.o.		ADD NOTES.
E	10.12.92	j.o.		ERROR: 2.5" WAS 1.5"

KECK/HIRES
COLLIMATOR DETAILS
SUPPORT DETAIL

j.o. 12 # 88

H2209.E



NA

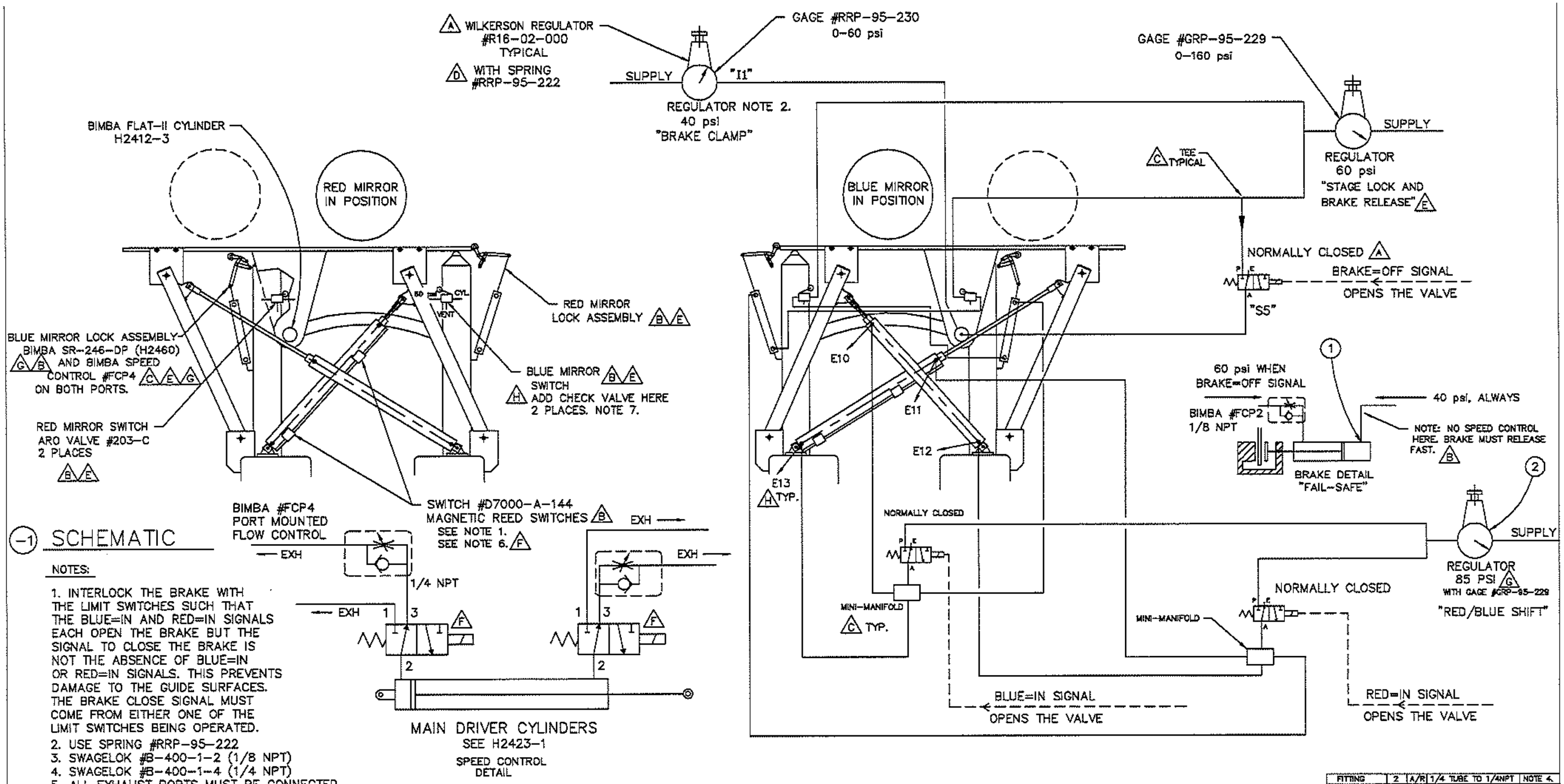
G	10-1-92	j.o.		MODIFY LINK BUSHINGS.
H	9-2-92	j.o.		MODIFY LOCK MECHANISM (ADD ROLLER)

A	8-6-90	j.o.		COMPLETE THE DESIGN AFTER DES REV2
B	1-17-91	j.o.		ADD CONTROL BOXES & PANEL.
C	2-5-91	j.o.		ADD STAGE LOCKS, UPDATE.
D	8-3-91	j.o.		ADD BUSHING NOTES.
E	8 13 91	j.o.		ADD ALIGNMENT HOLE.
F	1 24 92	j.o.		ADD CLEVIS LOCATIONS.

KECK/HIRES
COLLIMATOR MIRRORS
TRANSFER MECHANISM

j.a. 11 30 88

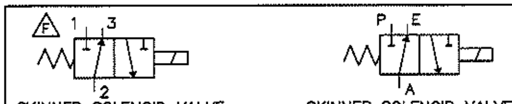
H2401.H



⊖1 SCHEMATIC

NOTES:

1. INTERLOCK THE BRAKE WITH THE LIMIT SWITCHES SUCH THAT THE BLUE=IN AND RED=IN SIGNALS EACH OPEN THE BRAKE BUT THE SIGNAL TO CLOSE THE BRAKE IS NOT THE ABSENCE OF BLUE=IN OR RED=IN SIGNALS. THIS PREVENTS DAMAGE TO THE GUIDE SURFACES. THE BRAKE CLOSE SIGNAL MUST COME FROM EITHER ONE OF THE LIMIT SWITCHES BEING OPERATED.
2. USE SPRING #RRP-95-222
3. SWAGELOK #B-400-1-2 (1/8 NPT)
4. SWAGELOK #B-400-1-4 (1/4 NPT)
5. ALL EXHAUST PORTS MUST BE CONNECTED TO EXHAUST MANIFOLD TO BE VENTED OUTSIDE OF THE HIRES HOUSING.
F 6. THESE SWITCHES ALSO VENT THE MAIN DRIVE CYLINDERS AFTER TOUCHDOWN.
H 7. NUPRO B-2C2-1, WITH 1 PSI SPRING. 1/8 NPT. ADAPTS WITH SWAGELOK B-400-7-2 FEMALE 1/8 NPT TO 1/4⌀ TUBE.



SKINNER SOLENOID VALVE
NON-LATCHING
#V54-DA2-150-24VAC
COIL: 24V AC MOLDED COIL
MULTIPURPOSE, 1/4 NPT, 3-WAY

SKINNER SOLENOID VALVE
NON-LATCHING
#V53-LB2-150-24A
COIL: 24V AC MOLDED COIL
NORMALLY CLOSED, 1/4 NPT, 3-WAY

FITTING	2	A/R	1/4 TUBE TO 1/4NPT	NOTE 4.
FITTING	1	A/R	1/4 TUBE TO 1/8NPT	NOTE 3.

F	10 20 92	J.O.		ADD 3-WAY SOLENOIDS TO MAIN DRIVE
				CYLINDERS TO SPEED UP SHUTTLE.
G	10 26 92	J.O.		LOCKING CYLINDERS WERE 096 SIZE.
				85 PSI WAS 75 PSI (RED/BLUE SHIFT)
H	11 10 92	J.O.		ADD EXHAUST LABELS; CHECK VALVES.

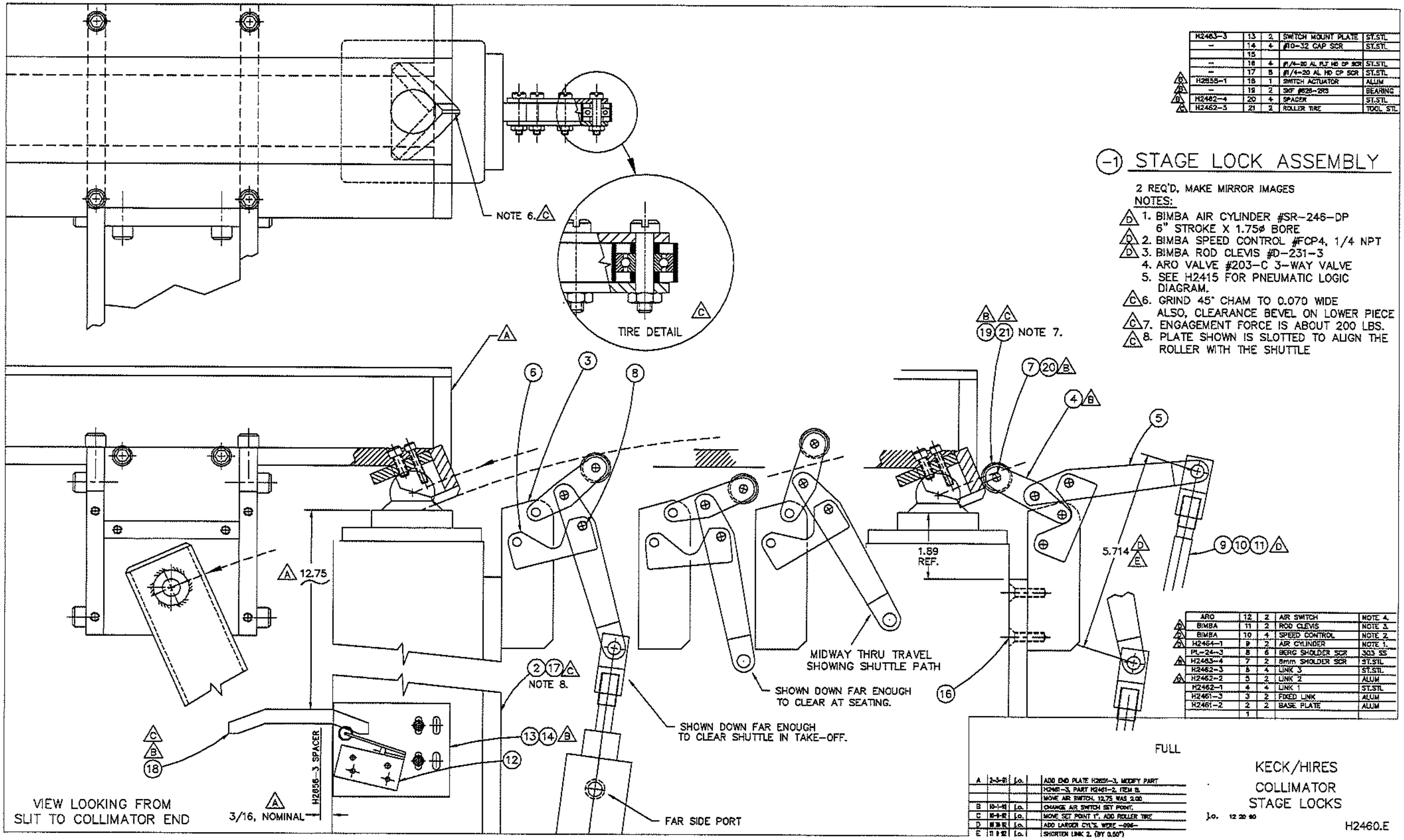
A	5-8-90	J.O.		BRAKE SOLENOID WAS NORMALLY OPEN
				ADD PRESSURE REGULATORS.
B	1-18-91	J.O.		MOVE SWITCH, ADD STAGE LOCK DETAIL
C	3-7-91	J.O.		ADD AIR PLUMBING DETAILS.
D	3-10-92	J.O.		ADD NOTE ABOUT SPRING
E	10-9-92	J.O.		RE-DESIGN LIMIT SWITCHES. NOTES.

N/A

KECK/HIRES
COLLIMATOR CHANGER
PNEUMATIC DIAGRAM

J.O. 5 3 90

H2415.H



	H2463-3	13	2	SWITCH MOUNT PLATE	ST.STL
	—	14	4	#10-32 CAP SCR	ST.STL
		15			
	—	16	4	#1/4-20 AL FLT HD CP SCR	ST.STL
	—	17	8	#1/4-20 AL HD CP SCR	ST.STL
C	H2858-1	18	1	SWITCH ACTUATOR	ALUM
B	—	19	2	SKF #628-2RS	BEARING
B	H2462-4	20	4	SPACER	ST.STL
C	H2462-5	21	2	ROLLER TIRE	TOOL STL

-1 STAGE LOCK ASSEMBLY

2 REQ'D, MAKE MIRROR IMAGES

NOTES:

D 1. BIMBA AIR CYLINDER #SR-246-DP
6" STROKE X 1.75ø BORE

D 2. BIMBA SPEED CONTROL #FCP4, 1/4 NPT

D 3. BIMBA ROD CLEVIS #D-231-3

4. ARO VALVE #203-C 3-WAY VALVE

5. SEE H2415 FOR PNEUMATIC LOGIC DIAGRAM.

C 6. GRIND 45° CHAM TO 0.070 WIDE ALSO, CLEARANCE BEVEL ON LOWER PIECE

C 7. ENGAGEMENT FORCE IS ABOUT 200 LBS.

C 8. PLATE SHOWN IS SLOTTED TO ALIGN THE ROLLER WITH THE SHUTTLE

	ARO	12	2	AIR SWITCH	NOTE 4.
D	BIMBA	11	2	ROD CLEVIS	NOTE 3.
D	BIMBA	10	4	SPEED CONTROL	NOTE 2.
D	H2464-1	9	2	AIR CYLINDER	NOTE 1.
	PL-24-3	8	6	BERG SHOLDER SCR	303 SS
B	H2463-4	7	2	8mm SHOLDER SCR	ST.STL
	H2462-3	6	4	LINK 3	ST.STL
D	H2462-2	5	2	LINK 2	ALUM
	H2462-1	4	4	LINK 1	ST.STL
	H2461-3	3	2	FIXED LINK	ALUM
	H2461-2	2	2	BASE PLATE	ALUM
		1			

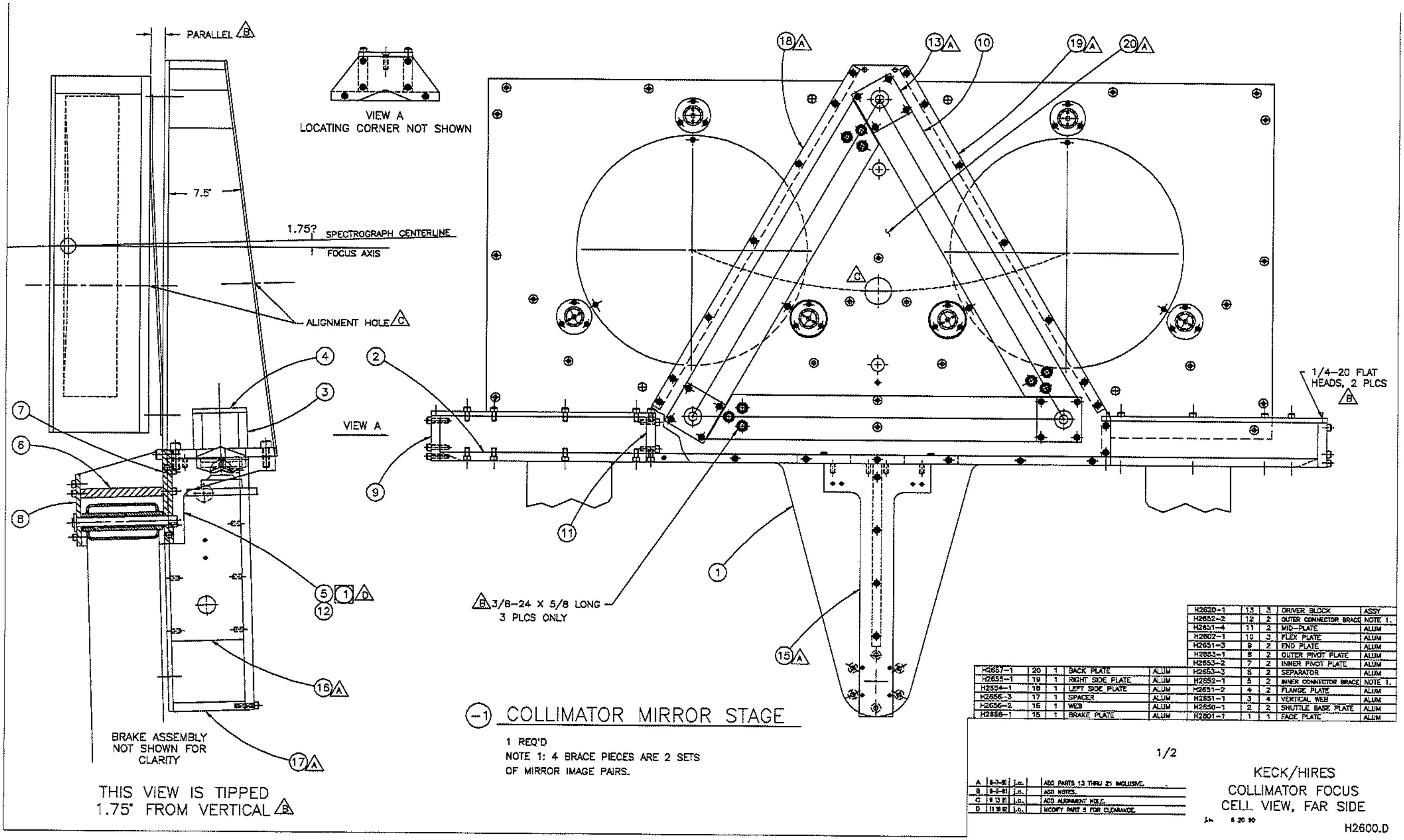
FULL

A	2-3-91	J.o.		ADD END PLATE H2658-3, MODIFY PART
				H2461-3, PART H2461-2, ITEM 8.
				MOVE AIR SWITCH, 12.75 WAS 2.00
B	10-1-91	J.o.		CHANGE AIR SWITCH SET POINT.
C	[illegible]	J.o.		MOVE SET POINT 1", ADD ROLLER TIRE
D	[illegible]	J.o.		ADD LARGER CYL'S. WERE -096-
E	[illegible]	J.o.		SHORTEN LINK 2, (BY 0.60")

KECK/HIRES
COLLIMATOR
STAGE LOCKS

J.o. 12 20 90

H2460.E



-1 COLLIMATOR MIRROR STAGE

1 REQ'D

NOTE 1: 4 BRACE PIECES ARE 2 SETS
OF MIRROR IMAGE PAIRS.

H2620-1	13	3	DRIVER BLOCK	ASSY
H2652-2	12	2	OUTER CONNECTOR BRACE	NOTE 1.
H2651-4	11	2	MID-PLATE	ALUM
H2602-1	10	3	FLEX PLATE	ALUM
H2651-3	9	2	END PLATE	ALUM
H2653-1	8	2	OUTER PIVOT PLATE	ALUM
H2653-2	7	2	INNER PIVOT PLATE	ALUM
H2653-3	6	2	SEPARATOR	ALUM
H2652-1	5	2	INNER CONNECTOR BRACE	NOTE 1.
H2651-2	4	2	FLANGE PLATE	ALUM
H2651-1	3	4	VERTICAL WEB	ALUM
H2650-1	2	2	SHUTTLE BASE PLATE	ALUM
H2601-1	1	1	FACE PLATE	ALUM

H2657-1	20	1	BACK PLATE	ALUM
H2655-1	19	1	RIGHT SIDE PLATE	ALUM
H2654-1	18	1	LEFT SIDE PLATE	ALUM
H2656-3	17	1	SPACER	ALUM
H2656-2	16	1	WEB	ALUM
H2656-1	15	1	BRAKE PLATE	ALUM

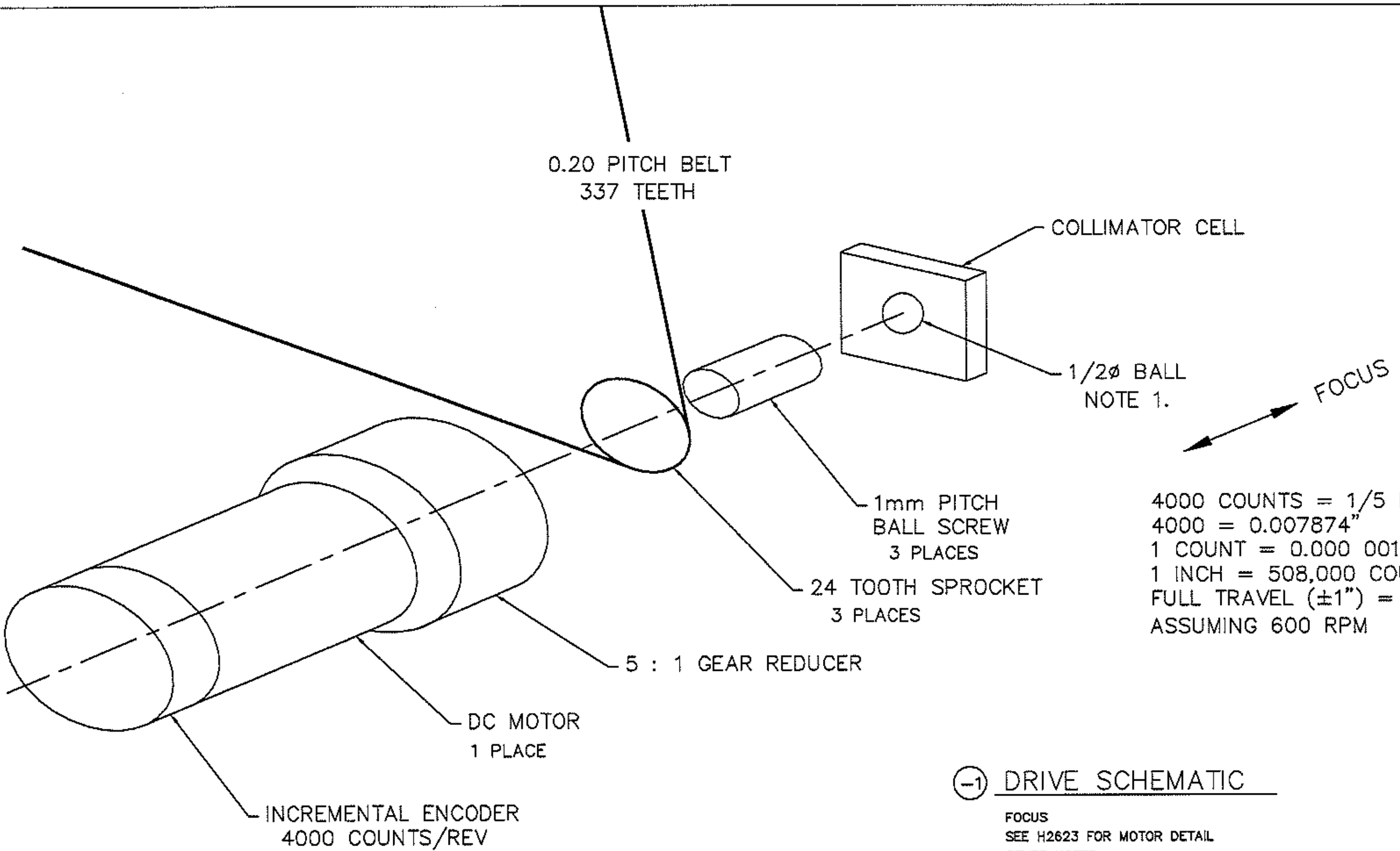
1/2

A	8-7-90	j.c.		ADD PARTS 13 THRU 21 INCLUSIVE.
B	8-5-91	j.c.		ADD NOTES.
C	8 13 91	j.c.		ADD ALIGNMENT HOLE.
D	11 30 92	j.c.		MODIFY PART 5 FOR CLEARANCE.

KECK/HIRES
COLLIMATOR FOCUS
CELL VIEW, FAR SIDE

j.c. 8 20 90

H2600.D



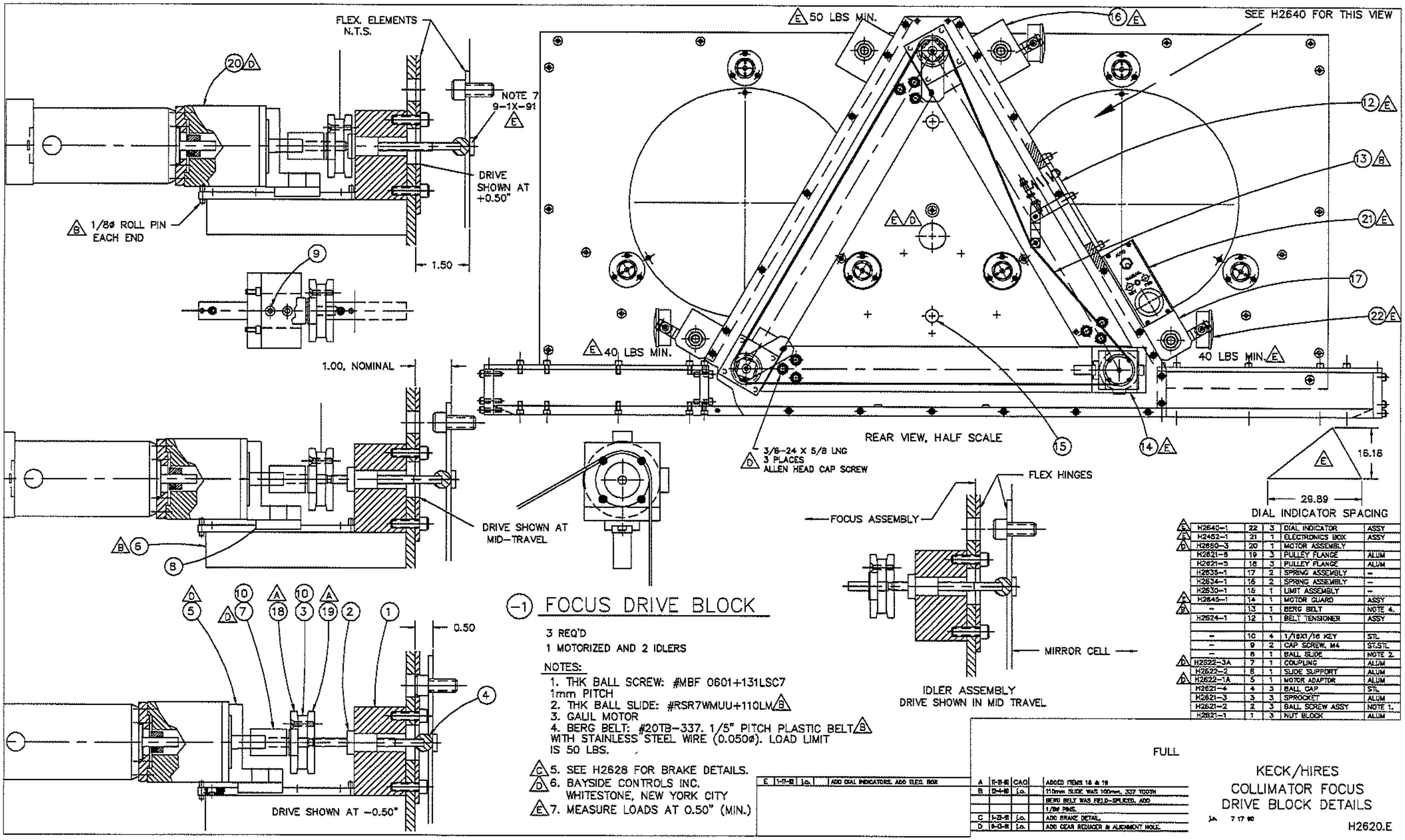
4000 COUNTS = 1/5 REV X 1mm
4000 = 0.007874"
1 COUNT = 0.000 001 9 INCHES
1 INCH = 508,000 COUNTS
FULL TRAVEL (±1") = 13 SEC.
ASSUMING 600 RPM

⊖1 DRIVE SCHEMATIC

FOCUS
SEE H2623 FOR MOTOR DETAIL
OTHER NOTES:
1. CONTACT FORCE VARIES FROM A MINIMUM OF 40 LBS TO A MAXIMUM OF 110 LBS.

KECK/HIRES
FOCUS DRIVE
SCHEMATIC

H2610



①1 FOCUS DRIVE BLOCK

3 REQ'D
1 MOTORIZED AND 2 IDLERS

NOTES:
1. THK BALL SCREW: #MBF 0601+131LSC7
1mm PITCH
2. THK BALL SLIDE: #RSR7WMUU+110LM B
3. GALIL MOTOR
4. BERG BELT: #20TB-337. 1/5" PITCH PLASTIC BELT B
WITH STAINLESS STEEL WIRE (0.050ø). LOAD LIMIT
IS 50 LBS.
C 5. SEE H2628 FOR BRAKE DETAILS.
D 6. BAYSIDE CONTROLS INC.
WHITESTONE, NEW YORK CITY
E 7. MEASURE LOADS AT 0.50" (MIN.)

DIAL INDICATOR SPACING

E	H2640-1	22	3	DIAL INDICATOR	ASSY
E	H2452-1	21	1	ELECTRONICS BOX	ASSY
D	H2660-3	20	1	MOTOR ASSEMBLY	
	H2621-6	19	3	PULLEY FLANGE	ALUM
	H2621-5	18	3	PULLEY FLANGE	ALUM
	H2635-1	17	2	SPRING ASSEMBLY	–
	H2634-1	16	2	SPRING ASSEMBLY	–
	H2630-1	15	1	LIMIT ASSEMBLY	–
E	H2645-1	14	1	MOTOR GUARD	ASSY
B	–	13	1	BERG BELT	NOTE 4.
	H2624-1	12	1	BELT TENSIONER	ASSY
	–	10	4	1/16X1/16 KEY	STL
	–	9	2	CAP SCREW, M4	ST.STL
	–	8	1	BALL SLIDE	NOTE 2.
D	H2622-3A	7	1	COUPLING	ALUM
	H2622-2	6	1	SLIDE SUPPORT	ALUM
D	H2622-1A	5	1	MOTOR ADAPTOR	ALUM
	H2621-4	4	3	BALL CAP	STL
	H2621-3	3	3	SPROCKET	ALUM
	H2621-2	2	3	BALL SCREW ASSY	NOTE 1.
	H2621-1	1	3	NUT BLOCK	ALUM

E	1-17-92	j.o.		ADD DIAL INDICATORS. ADD ELEC. BOX

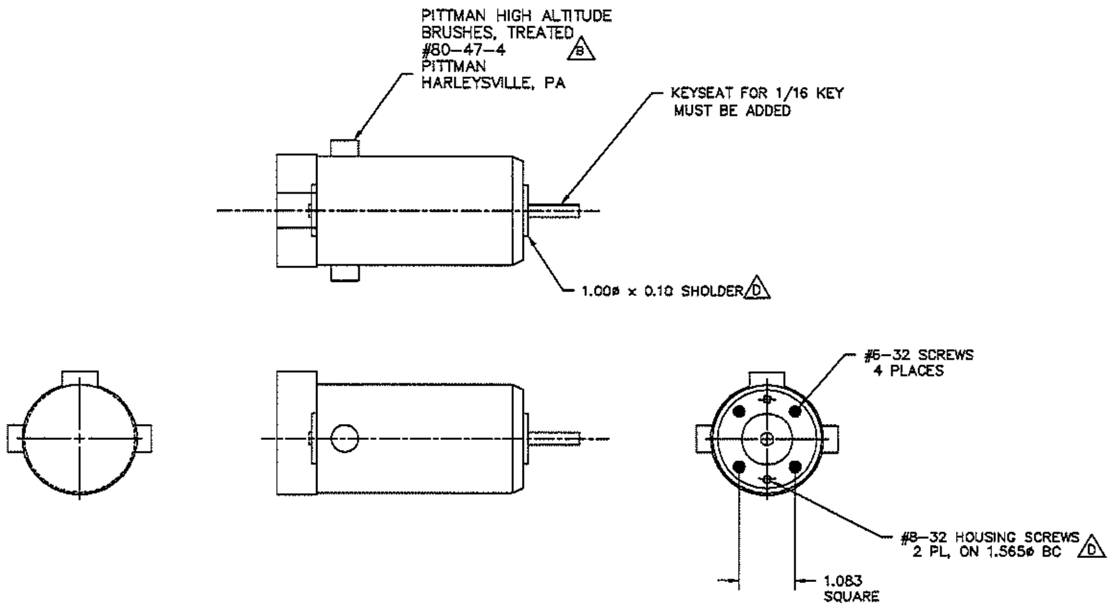
A	11-21-90	CAO		ADDED ITEMS 18 & 19
B	12-4-90	j.o.		110mm SLIDE WAS 100mm, 337 TOOTH
				BERG BELT WAS FIELD-SPLICED. ADD
				1/8ø PINS.
C	1-22-91	j.o.		ADD BRAKE DETAIL.
D	8-13-91	j.o.		ADD GEAR REDUCER & ALIGNMENT HOLE.

FULL

KECK/HIRES
COLLIMATOR FOCUS
DRIVE BLOCK DETAILS

JA 7 17 90

H2620.E



㊀ MOTOR

GALIL #MOTOR-50-1000 [1]
GALIL MOTION CONTROL INC
PALO ALTO, CALIFORNIA
(415) 964-6494

MOTOR SPECIFICATIONS:
PITTMAN #14204-B352
AND HEWLETT-PACKARD ENCODER
SERIES #HEDS-6010

△B [1] THIS MOTOR IS NOW CUSTOM-MOUNTED
TO HP HEDS ENCODER: 10 WEEK DELIVERY

△A MOTOR ALSO COMES WITH BEI
ENCODER ATTACHED.
△B DO NOT USE THIS MOTOR. TEMPERATURE
RANGE IS ONLY +80°C TO -10°C.

MOTOR:
14204-B352 WDG#4
30.3 VOLTS
19.1 AMPS
10.8 IN-OZ/AMP
205 IN-OZ PEAK STALL TORQUE
3670 RPM NO LOAD SPEED

ENCODER:
HEDS-6010 ENCODER
1000 LINE DISC WITH
TIMES-4 LOGIC = 4000
COUNTS PER REV.
INDEX PULSE ALSO.
ENCODER IS GLUED TO MOTOR
BY GALIL.
△B TEMPERATURE RANGE: +63°C TO -20°C
LED LIGHT SOURCE

△A BEI ENCODER
MODEL MX 212-25-1000
SAN MARCOS, CA
△B TEMPERATURE RANGE: +80°C TO -10°C
LED LIGHT SOURCE

NOTE: THIS MOTOR IS USED
IN THE FOLLOWING ASSEMBLY
DRAWINGS:
H2620, COLLIMATOR FOCUS
H1110, FILTER WHEEL, PRIMARY
H1324, SLIT
H1378, SLIT ACCESSORY SERVER
H6705, COMPARISON SOURCES
△C H7300, CCD FOCUS / TEST / ECHELLE DRIVE
H4264, CROSS-DISPERSER DRIVE
△D H7312, CCD FOCUS

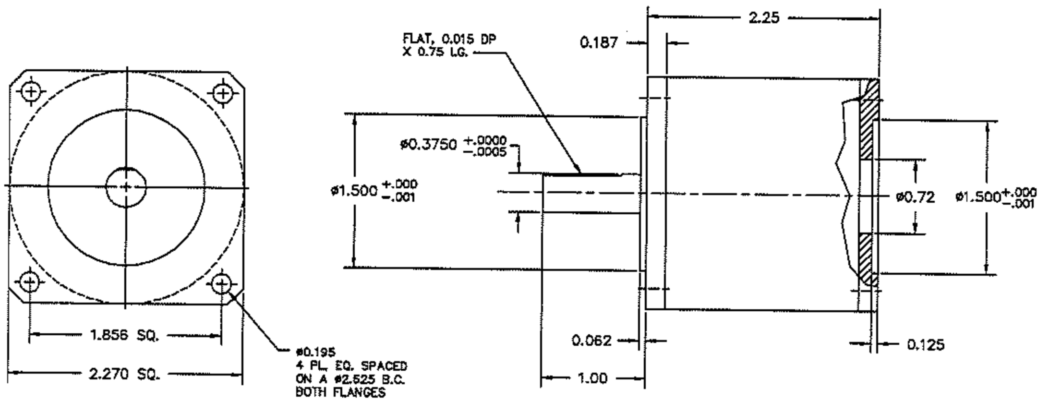
FULL

A	8-7-90	j.o.		MOTOR #4 ORDERED, HAS DIFFERENT ENCODER.
B	9-4-90	j.o.		ADD NOTES, BRUSHES, ENCODER.
C	8-15-91	j.o.		CCD FOCUS MOTOR ADDED.
D	9 28 92	j.o.		ADD 2 #8-32 THD HOLES.

KECK/HIRES
COLLIMATOR FOCUS
DRIVE MOTOR

j.o. 7 24 90

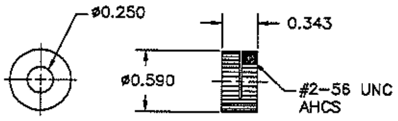
H2623.D



(-1) GEARHEAD

1 REQ'D
PART NO. NE23-05

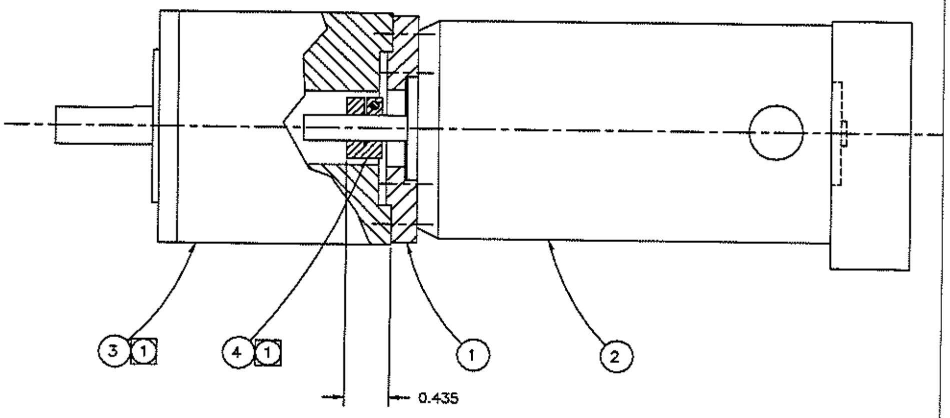
RATIO – 5:1
BAYSIDE CONTROLS, INC.
20-02 UTOPIA PARKWAY
WHITESTONE, NEW YORK 11357
(718) 352-8300
FAX (718) 353-1399



(-2) CLAMP-ON GEAR

1 REQ'D

BAYSIDE CONTROLS, INC.
20-02 UTOPIA PARKWAY
WHITESTONE, NEW YORK 11357
(718) 352-8300
FAX (718) 353-1399



(-3) COLLIMATOR FOCUS MOTOR ASSEMBLY

1 REQ'D
NOTES:

1 ITEMS 3 & 4 PURCHASED AS A SET.

H2660-2	4	1	CLAMP-ON GEAR	
H2660-1	3	1	GEARHEAD ASSY	
H2623-1	2	1	MOTOR	
H2681-1	1	1	GEAR REDUCER ADPTR	ALUM

2/1

KECK/HIRES
COLLIMATOR FOCUS
MOTOR DETAILS & ASSEMBLY
J.o. 8/1/91
CAG 9/18/91
H2660

Appendix D List of Drawings — Echelle Mosaic

1. H3005 Locating Tree
2. H3040 Glue Procedure and Test Assembly
3. H3061 Mosaic Test Setup
4. H3100 Mosaic Assembly on Subplate
5. H3200 Echelle Drive Assembly and Schematic
6. H3240 Echelle Pivot Assembly
7. H3244 Alignment Mirror — Echelle Pivot
8. H3300 Subplate Support, Column
9. H3340 Subplate Support, Lateral Support
10. H3345 Lateral Support Detail
11. H3425 Echelle Grating Blaze Detail
12. H3454 Echelle Grating and Side Pad Assembly
13. H3470 Subplate
14. H3500 Grating Back Support Assembly
15. H3510 Grating Side Support, Type 1
16. H3511 Side Support Detail, Flex Rod
17. H3520 Side Support, Type 2
18. H3600 Echelle Cell Assembly
19. H3603 Testing, Interferometer Layout
20. H3700 Cover Assembly
21. H3703 Air Control Panel
22. H3801 Subplate Finite Element Analysis Results
23. H7300 Encoder Assembly and Drive
24. H7330 Limits, Drive

H3005	LOCATING TREE (THIS DRAWING)
H3040	GLUE PROCEDURE
H3041	GLUE PROCEDURE
H3042	GLUE PROCEDURE
H3043	GLUE PROCEDURE
H3044	GLUE PROCEDURE
H3045	GLUE PROCEDURE
H3046	GLUE PROCEDURE
H3050	JUNCTION BOX
H3051	JUNCTION BOX
H3052	JUNCTION BOX
H3061	MOSAIC TEST DETAIL
H3075	CART ASSEMBLY
H3076	CART DETAIL
H3077	CART DETAIL
H3600	CELL ASSEMBLY
H3610	HOUSING ASSEMBLY
H3615	HOUSING DETAILS
H3620	HOUSING DETAILS
H3625	HOUSING DETAILS
H3630	HOUSING DETAILS
H3635	HOUSING DETAILS
H3640	SAFETY PLATES
H3641	SAFETY PLATES
H3700	COVER ASSEMBLY
H3702	" DETAIL: KINEMATICS
H3703	AIR CONTROL PANEL
H3704	" DETAIL
H3705	" "
H3755	COVER DETAILS
H3801	F.E.A. RESULTS

MISC:

H3602	ALIGNMENT TOOLING
H3603	INTERFEROMETER LAYOUT

H3100	MOSAIC ASSEMBLY
H3150	MOSAIC: SHOWING STAIR–STEP
H3151	70.5° BLAZE ANGLE
H3200	DRIVE ASSEMBLY
H3240	PIVOT ASSEMBLY
H3241	PIVOT DETAIL
H3242	PIVOT DETAIL
H3243	PIVOT DETAIL
H3244	ALIGNMENT MIRROR ASSY
H3300	COLUMN SUPPORT ASSEMBLY
H3310	" DETAIL
H3315	WRENCH DETAILS
H3320	COLUMN DETAILS, ASSEMBLY STEPS
H3340	LATERAL SUPPORT ASSY
H3345	" DETAIL
H3350	LONGITUDINAL SUPPORT ASSY
H3400	GRATING BLANK
H3401	BLANK DETAIL
H3425	BLAZE ANGLE DETAIL
H3450	E3 GRATING
H3451	E2 GRATING
H3452	E1 GRATING
H3453	MASTERS
H3454	GRATING AND SIDE PAD
H3455	ORIGINAL GLUE FIXTURE
H3456	" DETAIL
H3457	" "
H3458	ALIGNMENT JACKS & MISC PARTS
H3459	JACK STAND ASSY
H3460	SPACERS
H3461	ALIGNMENT NOTES
H3462	ALIGNMENT NOTES
H3463	ALIGNMENT NOTES
H3464	ALIGNMENT NOTES
H3465	ALIGNMENT NOTES
H3466	TEST MIRROR & CELL
H3467	TEST MIRROR & CELL
H3470	GRANITE SUBPLATE

SECOND STICKFILE

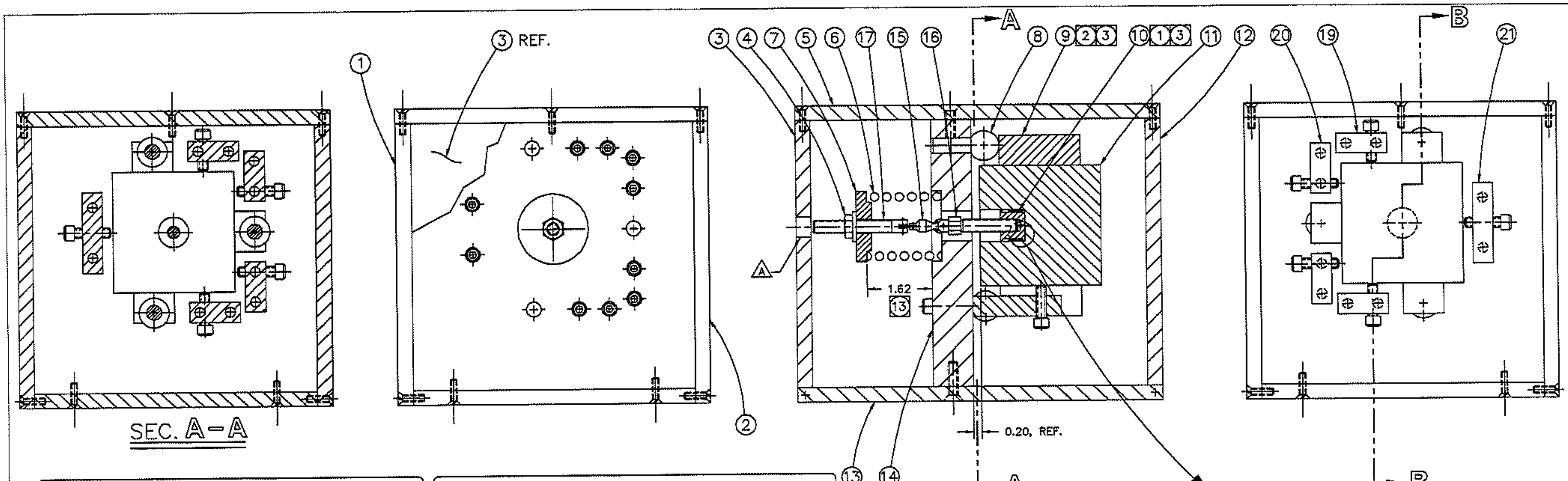
H3201	DRIVE LAYOUT
H3202	" MOUNT BRACKETS
H3203	" "
H3205	" LIMITS
H3206	" "
H3207	" FLEX PLATE

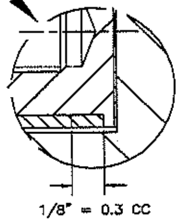
H7300	DRIVE	H7330	ENCODER
H7301	DRIVE	H7331	ENCODER
H7302	DRIVE	H7332	ENCODER
		H7333	ENCODER

H3500	BACK SUPPORT ASSEMBLY
H3501	" " DETAIL
H3502	" " " & CAP
H3510	SIDE SUPPORT
H3511	" FLEX ROD DETAIL
H3512	" SPRING PLUNGER
H3515	" DETAIL
H3516	" INVAR
H3520	SIDE SUPPORT 2
H3525	" DETAIL
	(ZERODUR BLOCKS)

A [illegible] J.O. AS SHIPPED.

KECK/HIRES
ECHELLE MOSAIC
DRAWINGS SHIPPED
J.O. 7 [illegible]
H3005.A





PROCEDURE NOTES:

1 CLEANING PROCEDURE – INVAR:
ACETONE WASH, BEADBLAST, DRY
NITROGEN CLEAN AND ALCOHOL RINSE.

2 CLEANING PROCEDURE – ZERODUR:
DIAMOND TOOL BORING IS FOLLOWED BY
3-DAY AMMONIUM BIFLUORIDE ETCH, THEN
WATER RINSE AND ALCOHOL RINSE.

3 GLUEING PROCEDURE:
A. HYSOL EA9313 MIXED 4:1 BY
WEIGHT OR 3.5:1 BY VOLUME IN
A CLEAN PLASTIC CONTAINER.

B. USE A 1 CC SYRINGE AND
PRE-DEPOSIT 0.3 CC IN HOLE.

C. INSERT IS PLACED WITH 2 TFE GUIDES
D. CURE TIME IS 5 DAYS AT 75°F. A

4. TEST AT 5X DESIGN LOAD (200 LBS)
USE A BUCKET WITH 200 LBS LEAD SHOT
5. STORE AT 2X DESIGN LOAD (86 LBS)
SPRING LOAD.
6. DESIGN LOAD FOR INSERT IS 43 LBS

GENERAL NOTES:

10. GLUE GAP IS TO BE 0.010" THICK:
USE 1/8ø PAD(S) OF EPOXY ON BOTTOM OF PART.

11. REFERENCE: KECK OBSERVATORY PMSS
BY ANDY DUBOIS DATED 11/26/90
"EPOXY BONDS FOR SEGMENT INSERTS"

12. SOLVENT IS METHYLENE CHLORIDE

13 SPRING DATA:
LEE SPRING #LHC-218T-1
K = 228 LBS/INCH
2.5" = 0 LBS
2.123" = 86 LBS (LONG TERM TEST)
1.62" = 200 LBS
1.42" = SOLID HEIGHT
0.218ø WIRE

14. SWIVEL: SEE H3500 FOR DETAIL.

15. HYSOL EA9313 EPOXY RESIN
VENDOR: EV ROBERTS & ASSOC.
8500 STELLER
CULVER CITY, CA 90232
(213) 870-9561
PROPERTIES:
* POT LIFE 60 MIN.
* TENSILE STRENGTH 6300 PSI
* SHEAR STRENGTH 4000 PSI
* USEABLE TEMP. RANGE: ROOM TEMP TO -40°F.
* HUMIDITY AND CONDENSATION TOLERANT.
* 5 DAY CURE AT 75°F. A

⊖1 TEST BLOCK

1 REQ'D
STORE IN A MARKED BOX INSIDE HIRES
LABEL:
HIRES TEST: INSERT
AND SIDE BLOCKS
JULY, 1991

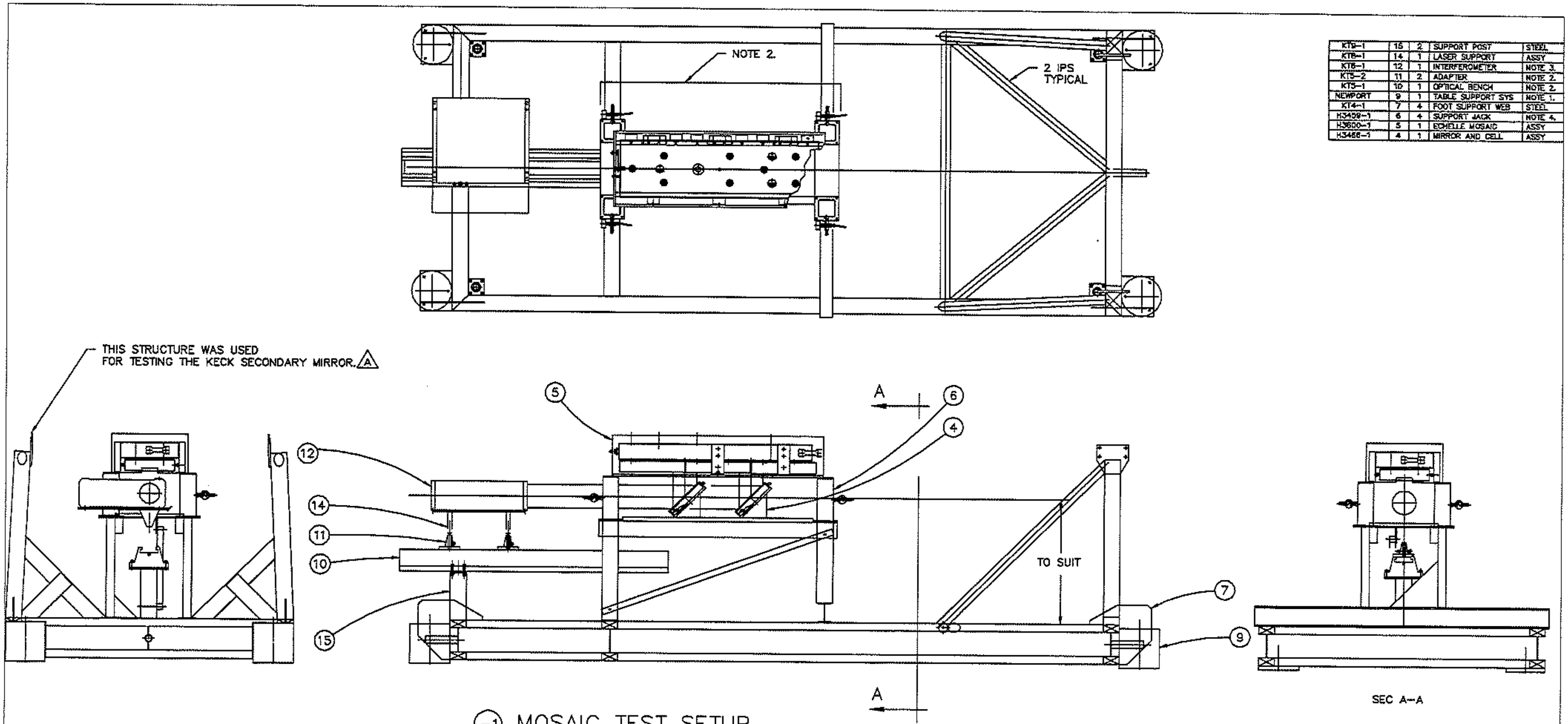
H3044-3	21	1	LOCATOR #3	ALUM
H3044-2	20	2	LOCATOR #2	ALUM
H3044-1	19	2	LOCATOR #1	ALUM
H3043-4	18	6	GUARD SLEEVE	TEFLON
H3043-2	17	1	UPPER SCREW	ST.STL
H3501-2	16	1	LOWER SCREW	ST.STL
–	15	1	SWIVEL	NOTE 14
H3041-3	14	1	FRAME	ALUM
H3041-2	13	1	BASE PLATE	ALUM
H3042-4	12	1	END PLATE	LEXAN
H3041-1	11	1	TEST BLOCK	ZERODUR
H3501-1	10	1	INSERT	INVAR
H3525-2	9	3	PAD	ZERODUR
29005	8	3	TOOLING BALL, JERGENS	440-C SS
H3043-1	7	1	SPRING KEEPER	ALUM
LCH-218T-1	6	1	SPRING	NOTE 13
H3043-3	5	1	TOP PLATE	LEXAN
–	4	1	5/16-24 NUT	ST.STL
H3042-3	3	1	END PLATE	ALUM
H3042-2	2	1	SIDE PLATE	LEXAN
H3042-1	1	1	SIDE PLATE	LEXAN

FULL

A | 2-5-92 | J.O. | | UPDATE: ADD NOTES: 5 DAY WAS 3 DAY

KECK/HIRES
ECHELLE GLUE PROCEDURE
AND TEST BLOCK
JA 7 29 91
H3040.A

KT9-1	15	2	SUPPORT POST	STEEL
KT8-1	14	1	LASER SUPPORT	ASSY
KT6-1	12	1	INTERFEROMETER	NOTE 3.
KT5-2	11	2	ADAPTER	NOTE 2.
KT5-1	10	1	OPTICAL BENCH	NOTE 2.
NEWPORT	9	1	TABLE SUPPORT SYS	NOTE 1.
KT4-1	7	4	FOOT SUPPORT WEB	STEEL
H3459-1	6	4	SUPPORT JACK	NOTE 4.
H3600-1	5	1	ECHELLE MOSAIC	ASSY
H3466-1	4	1	MIRROR AND CELL	ASSY



⊖1 MOSAIC TEST SETUP

SIMILAR TO DRAWING KT1

NOTES:

A 1. SUPPORT JACKS RESTED ON 1" THICK POLYETHYLENE PLATE. 2 FLUORESCENT LIGHT FIXTURES WERE ARRANGED BELOW THIS PLATE. THE PNEUMATIC-TIRED DOLLY SUPPORTED THE LIGHTS AND PLASTIC PLATE.

A 2. AN OUTRIGGER WAS ARRANGED SO THAT THE GRATINGS COULD BE MOVED OUT FROM UNDER THE CELL ON THE LAB JACKS.

A 3. SEE ALSO H3603 FOR TILTED MOSAIC (10.5°)

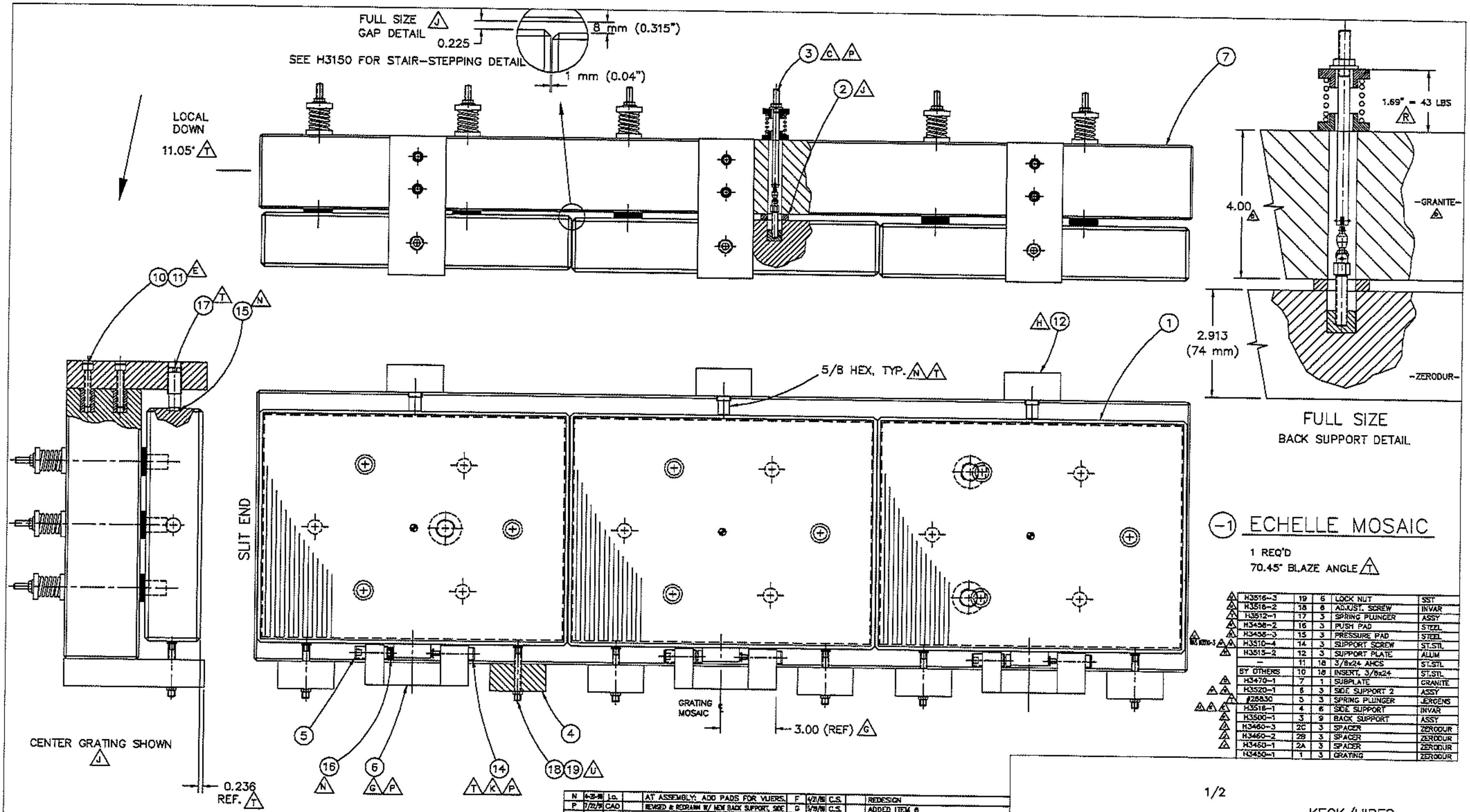
1/10

A | [illegible] | J.O. | UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
MOSAIC TEST SETUP
DETAILS

J.O. 10 3 91

H3061.A



⊖1 ECHELLE MOSAIC

1 REQ'D
70.45° BLAZE ANGLE T

U	H3516-3	19	6	LOCK NUT	SST
U	H3516-2	18	6	ADJUST. SCREW	INVAR
T	H3512-1	17	3	SPRING PLUNGER	ASSY
N	H3458-2	16	3	PUSH PAD	STEEL
N	H3458-3	15	3	PRESSURE PAD	STEEL
G, WAS H3510-3 P, K	H3510-4	14	3	SUPPORT SCREW	ST.STL
H	H3515-2	12	3	SUPPORT PLATE	ALUM
	–	11	18	3/8x24 AHCS	ST.STL
	BY OTHERS	10	18	INSERT, 3/8x24	ST.STL
B	H3470-1	7	1	SUBPLATE	GRANITE
P G	H3520-1	6	3	SIDE SUPPORT 2	ASSY
T	#28830	5	3	SPRING PLUNGER	JERGENS
U K E	H3518-1	4	6	SIDE SUPPORT	INVAR
P	H3500-1	3	9	BACK SUPPORT	ASSY
J	H3460-3	2C	3	SPACER	ZERODUR
J	H3460-2	2B	3	SPACER	ZERODUR
J	H3460-1	2A	3	SPACER	ZERODUR
	H3450-1	1	3	GRATING	ZERODUR

N	4-21-88	j.o.		AT ASSEMBLY: ADD PADS FOR VUERS.
P	7/22/97	CAD		REVISED & REDRAWN W/ NEW BACK SUPPORT, SIDE
				SUPPORT 2 & SUPPORT SCREW (ITEMS 3, 6, & 14)
R	4-6-92	j.o.		ADD 3 NEW GRATING BLANK POCKETS.
T	10 28 02	j.o.		ADD LOCKNUTS TO 3/4-32 SIDE SCREWS
				BLAZE ANGLE WAS 69°, IS 70.45°
				GRATING CHAMFERS MODIFIED.
U	8/3/03	CAD		INVAR SIDE SUPPORTS & SCREWS

F	4/21/88	C.S.		REDESIGN
G	5/19/88	C.S.		ADDED ITEM 6
H	1/28/88	j.o.		ADDED ITEM 12
J	3/16/88	j.o.		STAIRSTEPPED GRATINGS WERE PLANAR
K	3/17/88	j.o.		CHANGE PARTS 13, 14, PART 4 WAS
				H3510-1, ASSY.
M	3-21-90	j.o.		RE-CONSTRUCT LOST DWG FROM H3100.E

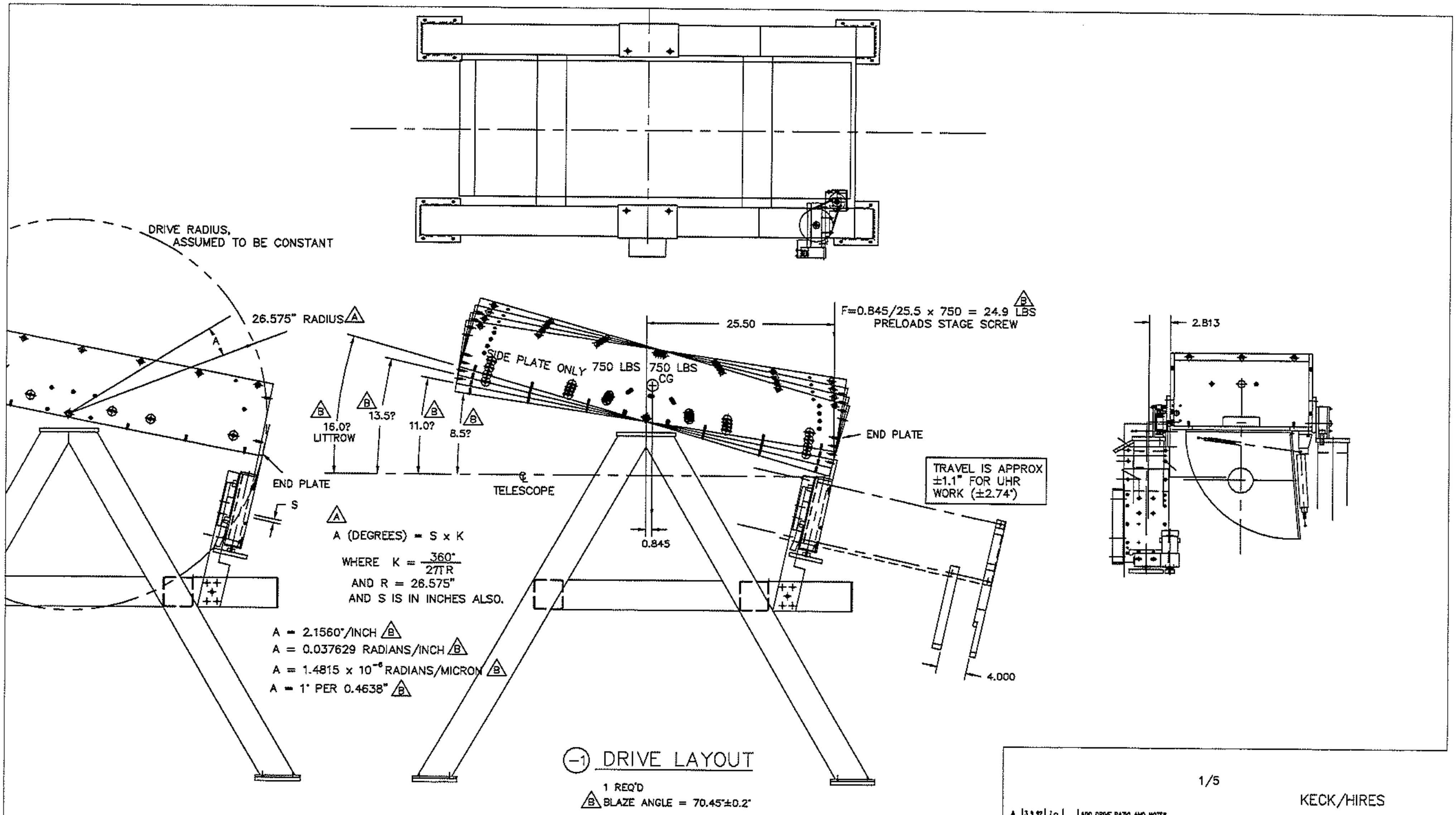
A	[illegible]	j.o.		RENAME, WAS HIRES300.
B	12-8-86	j.o.		CONTINUE DESIGN WORK.
C	1-13-87	j.o.		ALL BEVELS 4mm. BACK SUPPORT DET.
D	1-22-87	j.o.		RADIAL SUPPORT DETAIL; SUBPLATE
				WAS PYREX, 2.12" THICK.
E	2-5-88	j.o.		PART 10 WAS 1/2x20. CHANGE PART 4.

1/2

KECK/HIRES
1x3 ECHELLE MOSAIC
ASSEMBLY

j.o. 4 21 86

H3100.U



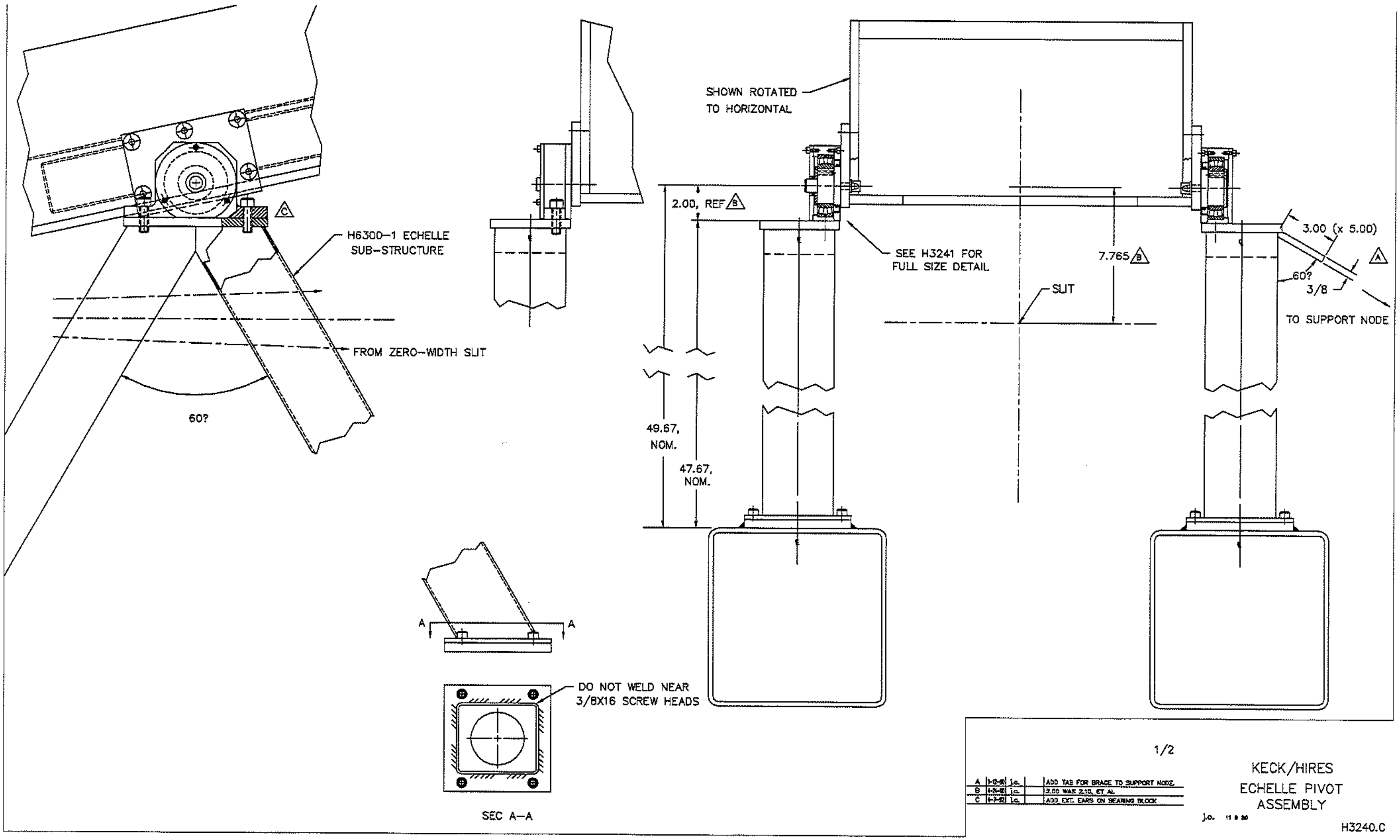
1/5

A	3 3 92	J.o.		ADD DRIVE RATIO AND NOTES.
B	11 17 92	J.o.		CHANGE BLAZE ANGLE, WAS 69°
				2.1560° WAS 0.4638 DEGREES

KECK/HIRES
ECHELLE DRIVE
ASSEMBLY

J.o. 11 25 91

H3200.B



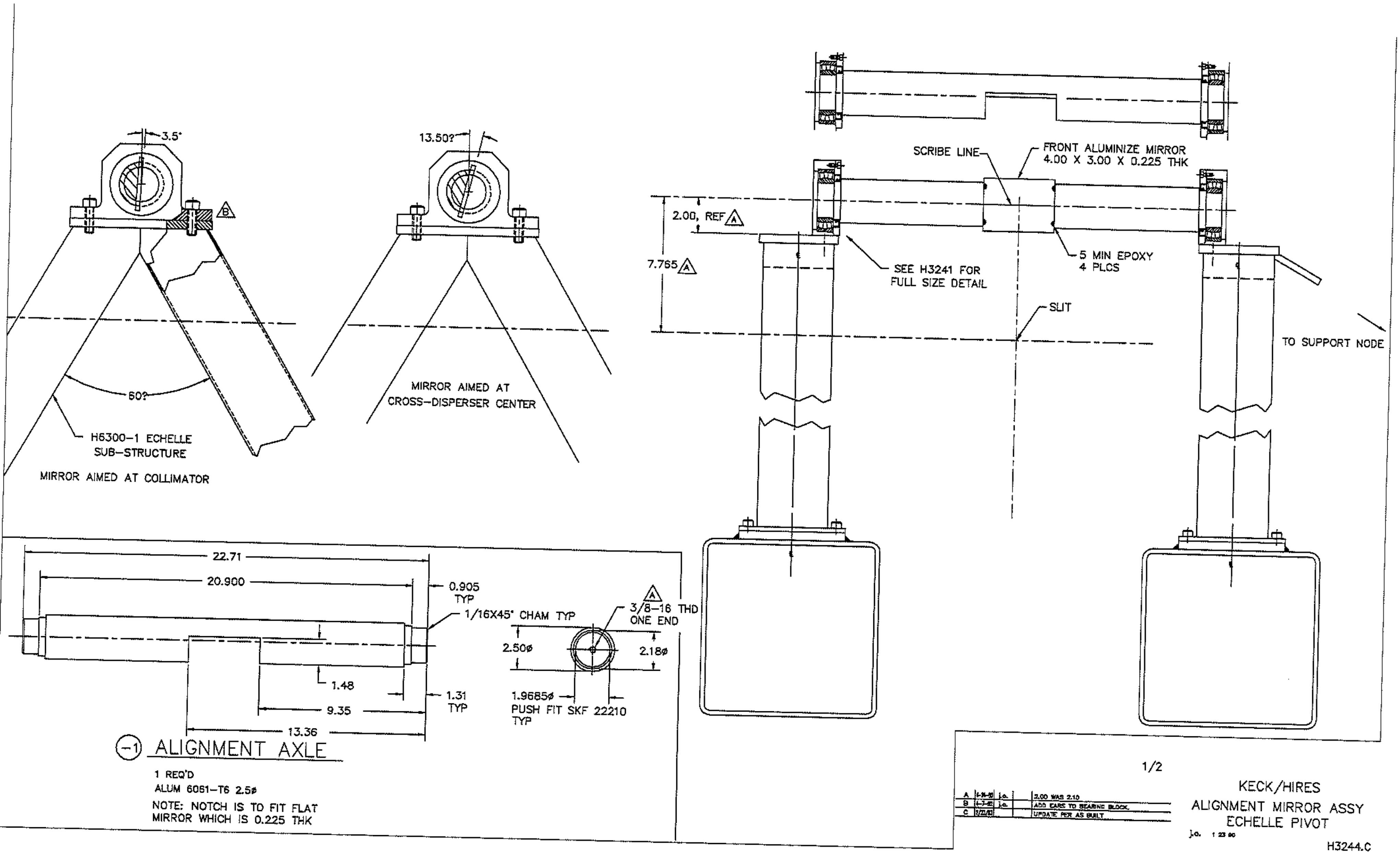
1/2

A	1-12-90	j.o.		ADD TAB FOR BRACE TO SUPPORT NODE.
B	4-26-90	j.o.		2.00 WAS 2.10, ET AL
C	4-7-92	j.o.		ADD EXT. EARS ON BEARING BLOCK

KECK/HIRES
ECHELLE PIVOT
ASSEMBLY

j.o. 11 8 90

H3240.C



-1 ALIGNMENT AXLE

1 REQ'D
ALUM 6061-T6 2.5ø

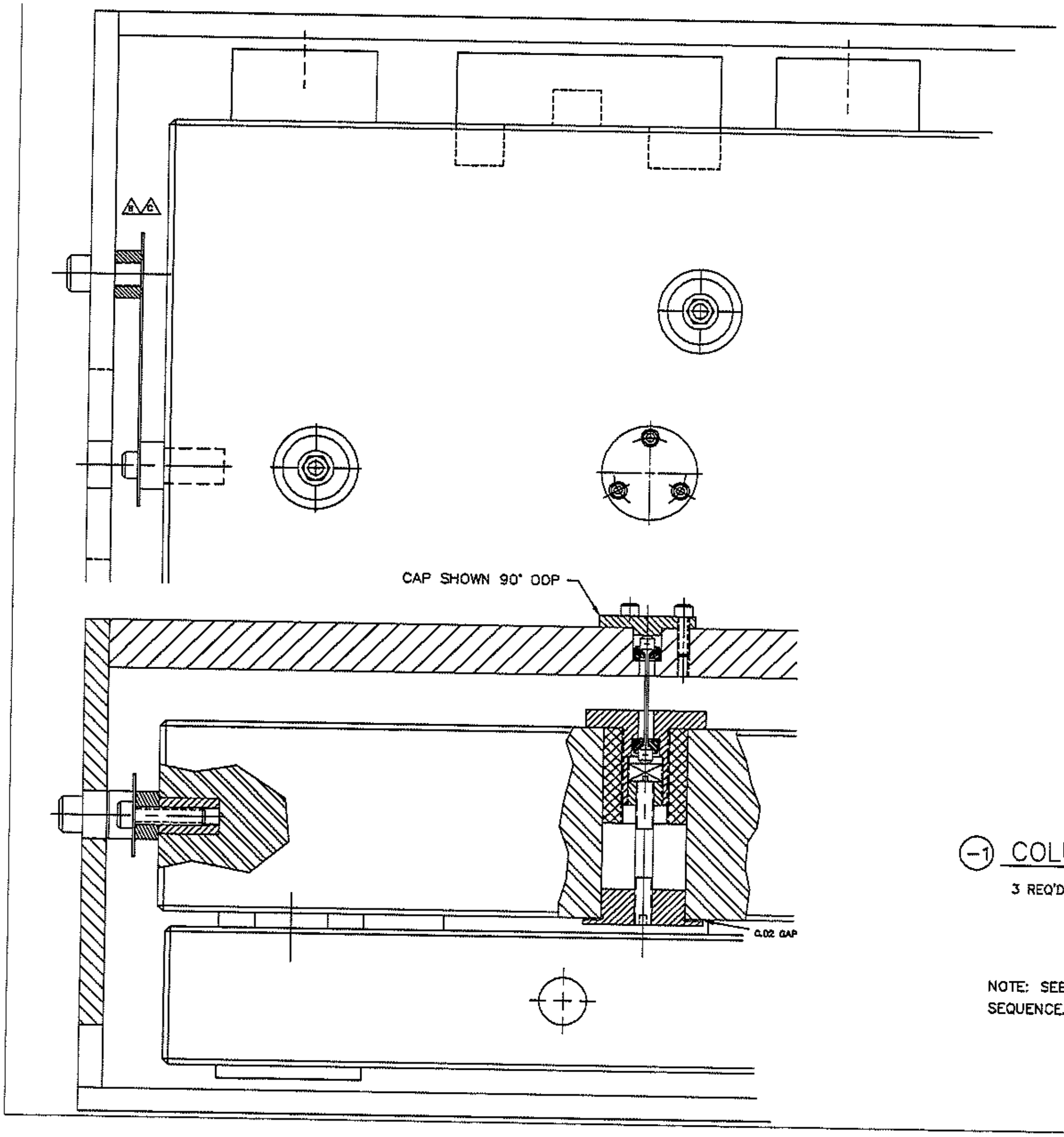
NOTE: NOTCH IS TO FIT FLAT MIRROR WHICH IS 0.225 THK

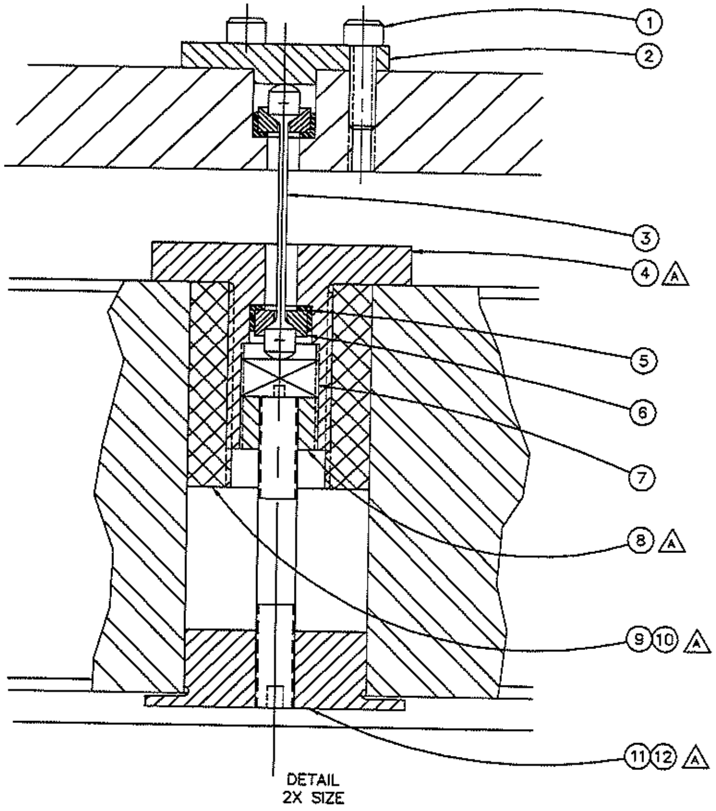
1/2

A	[illegible]	j.o.		2.00 WAS 2.10
B	[illegible]	j.o.		ADD EARS TO BEARING BLOCK
C	[illegible]			UPDATE PER AS BUILT

KECK/HIRES
ALIGNMENT MIRROR ASSY
ECHELLE PIVOT
j.o. 1 23 90

H3244.C





-1 COLUMN SUPPORT

3 REQ'D D

NOTE: SEE H3320 FOR ASSEMBLY SEQUENCE.

A	H3310-6	12	1	3/8x24 STUD	ST STL
A	H3310-5	11	1	SAFETY NUT	ST STL
	BY OTHERS	10	A/R	ADHESIVE	
C A	BY OTHERS	9	1	1x14 INSERT	ST STL
A	H3310-4	8	1	LOCK	ST STL
	H3310-3	7	1	PLUG	17-4-PH
	H3320-3	6	2PR	SPLIT COLLAR	17-4-PH
	H3320-2	5	2	RETAINER	17-4-PH
A	H3310-2	4	1	HOLDER	ST STL
	H3320-1	3	1	COLUMN	17-4-PH
	H3310-1	2	1	CAP	ST STL
	-	1	3	1/4x20 AHCS	ST STL

FULL

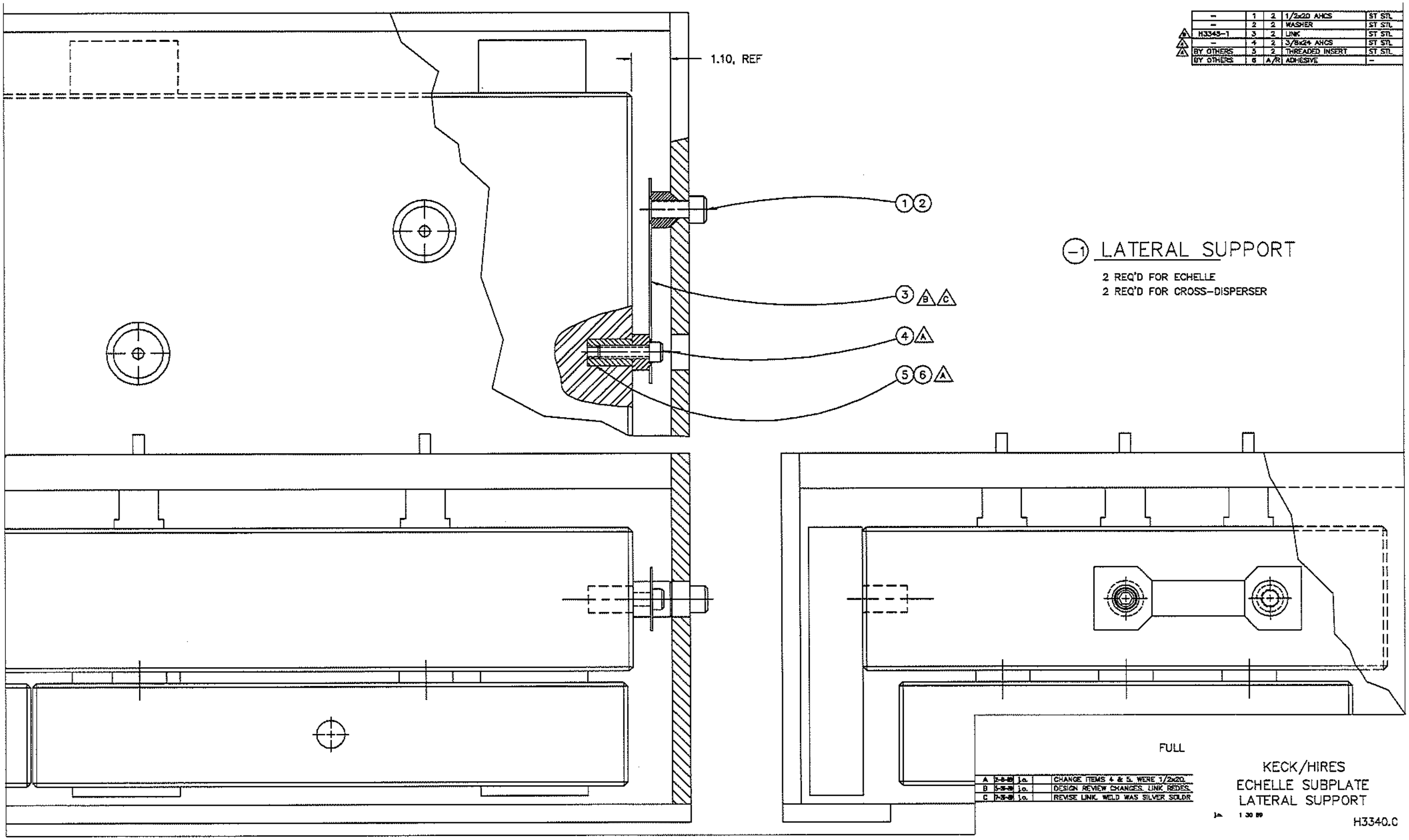
A	[illegible]	J.a.		MODIFY PARTS 4,8,11 FOR INSERT.
				ADD PART 12.
B	[illegible]	C.S.		LINK REDESIGNED PER DESIGN REVIEW.
C	[illegible]	J.a.		1x14 WAS 1x12. TO AS-BUILT COND'N.
D	[illegible]	J.a.		SEPARATE CROSS-DISPERSER SUPPORT.

KECK/HIRES
ECHELLE SUBPLATE
COLUMN SUPPORT

J.a. 1 29 89

H3300.D

	–	1	2	1/2x20 AHCS	ST STL
	–	2	2	WASHER	ST STL
△B	H3343-1	3	2	LINK	ST STL
△A	–	4	2	3/8x24 AHCS	ST STL
△A	BY OTHERS	5	2	THREADED INSERT	ST STL
	BY OTHERS	6	A/R	ADHESIVE	–



(–1) LATERAL SUPPORT

2 REQ'D FOR ECHELLE
2 REQ'D FOR CROSS-DISPERSER

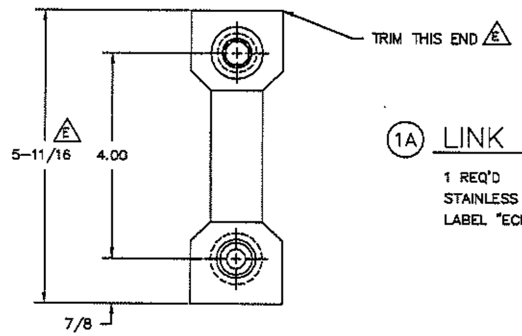
FULL

A	2-8-89	j.a.		CHANGE ITEMS 4 & 5. WERE 1/2x20.
B	5-25-89	j.a.		DESIGN REVIEW CHANGES. LINK REDES.
C	7-25-89	j.a.		REVISE LINK. WELD WAS SILVER SOLDR

KECK/HIRES
ECHELLE SUBPLATE
LATERAL SUPPORT

j.a. 1 30 89

H3340.C

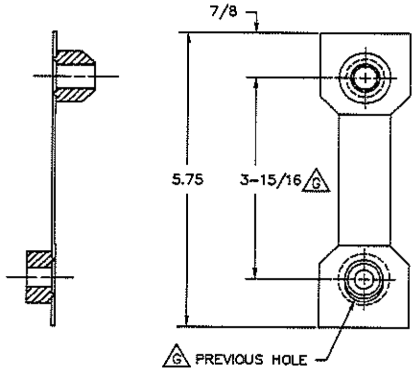


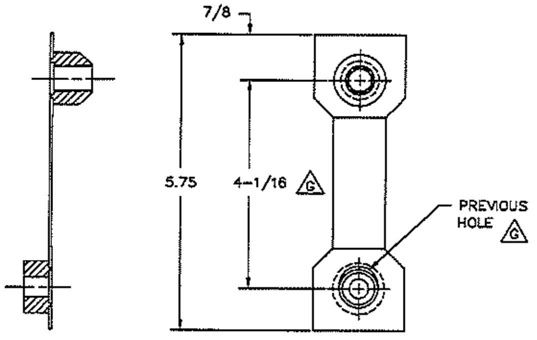
(1A) LINK E

1 REQ'D
STAINLESS STEEL
LABEL "ECH.LONG"

(1B) LINK G

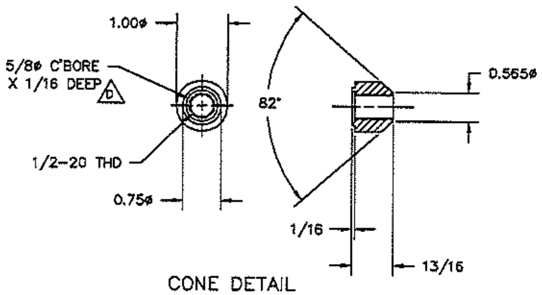
1 REQ'D
STAINLESS STEEL
LABEL "ECH.UPPER"



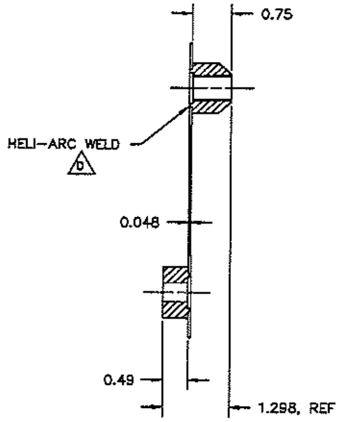


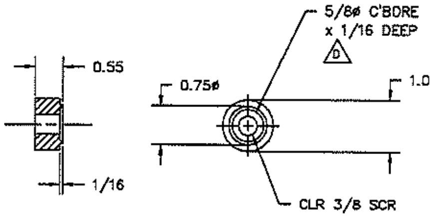
(1C) LINK G

1 REQ'D
STAINLESS STEEL
LABEL "ECH.LOWER"

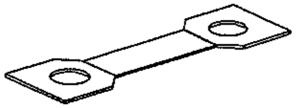


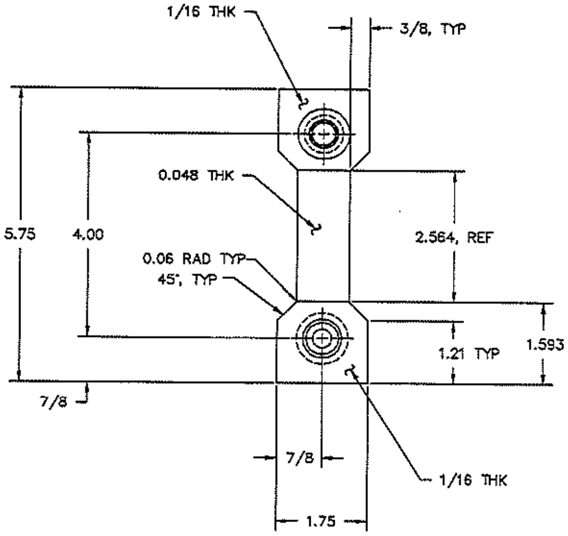
CONE DETAIL





PUCK DETAIL





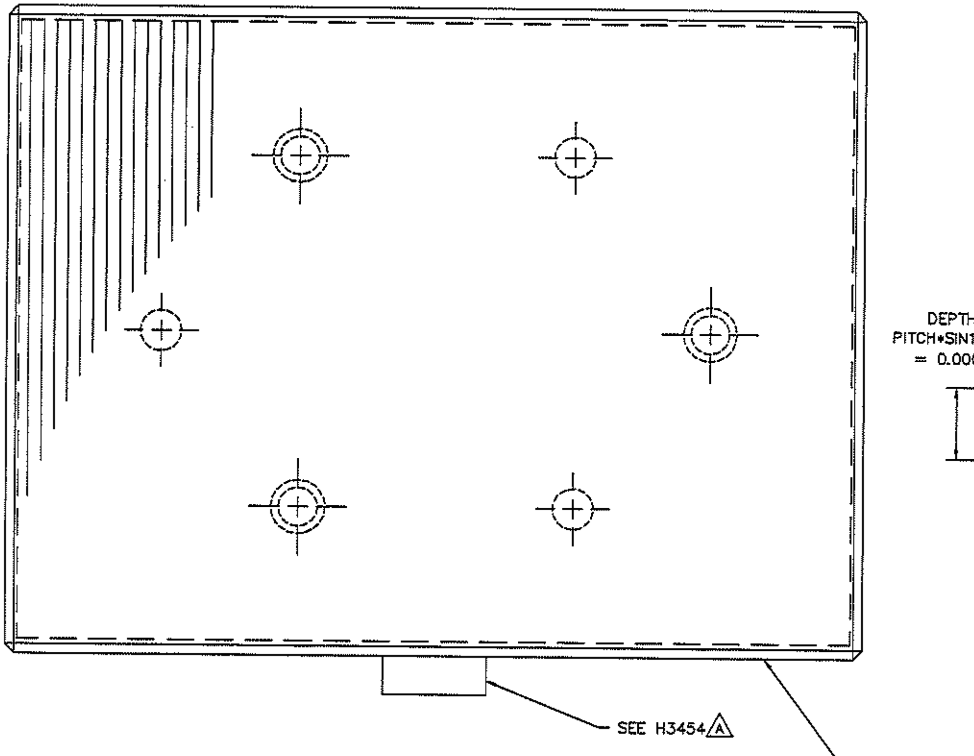
(-1) LINK

3 REQ'D FOR ECHELLE: MODIFIED E G
3 REQ'D FOR CROSS-DISPERSER
STAINLESS STEEL

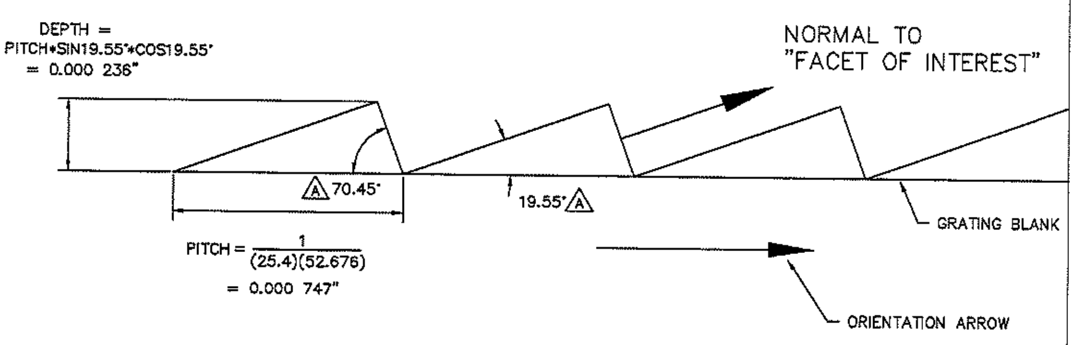
FULL

G	11 29 90	J.o.		MODIFY ECHELLE LATERAL LINKS. 1B: 3-15/16 WAS 4.00. 1C: SAME
A	2-8-89	J.o.		3/8ø WAS 0.6ø.
B	3-21-89	J.o.		OBSOLETE BY DESIGN REVIEW.
C	5-31-89	J.o.		REDESIGN LINK. ADD PART -2.
D	7-26-89	J.o.		WELD LINK WAS SILVER SOLDER.
E	9-11-89	J.o.		CUT AND LABEL ONE LINK. "ECH.LONG"
F	5/30/90	CAC		UPDATE PER DESIGN REVIEW 5/90

KECK/HIRES
ECHELLE SUBPLATE
LATERAL SUPPORT DETAIL
JA 1 30 89
H3345.G



VIEW LOOKING AT
RULED SURFACE

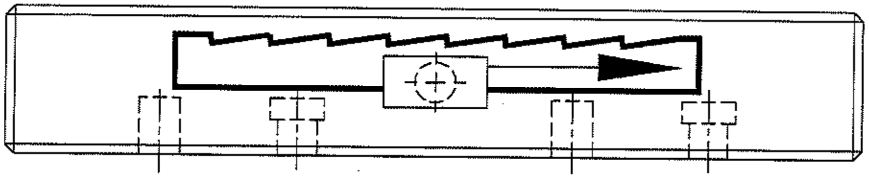


(-1) BLAZE DETAIL

CORE VERSION OF HIRES

NOTES:

1. 52.676 LINES/mm
2. BLAZE ANGLE IS 70.45° (6238 Å)
3. R~2.6 ECHELLE GRATING



MARKINGS ON SURFACE "A"

3RD ANGLE
PROJECTION

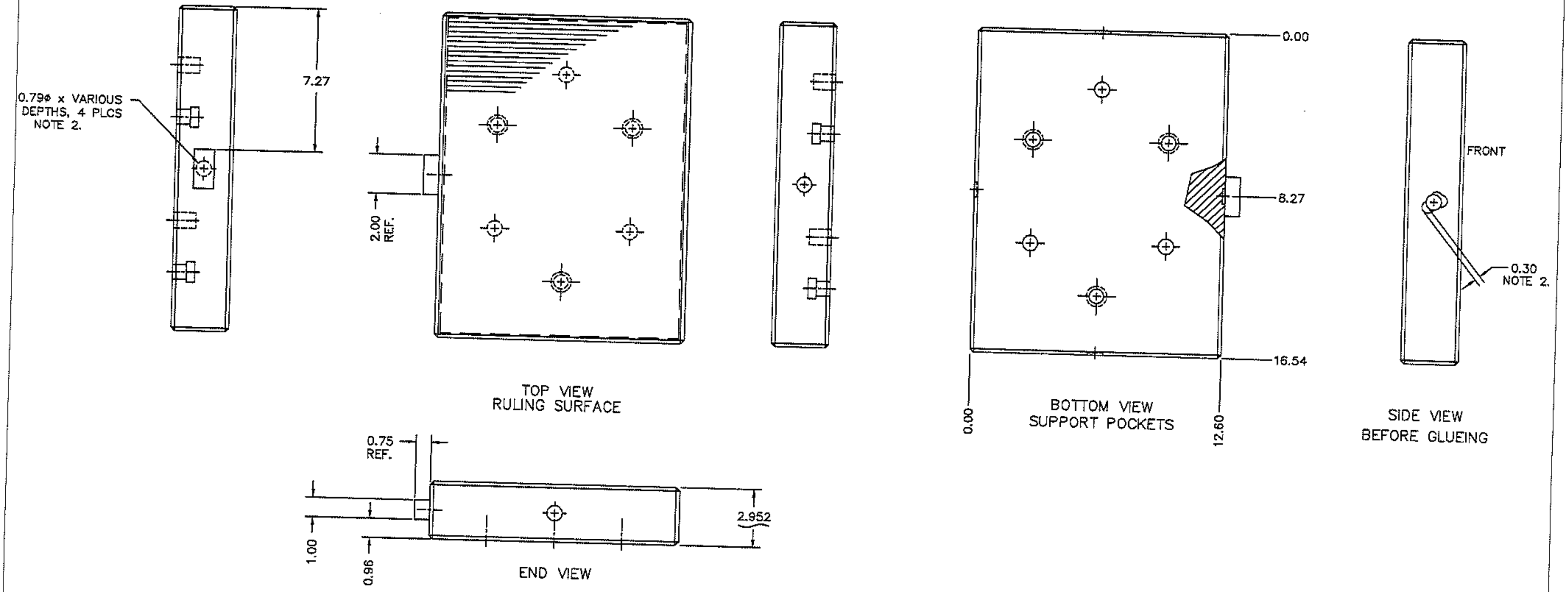
A | [illegible] | J.o. | BLAZE ANGLE WAS 69°

FULL

KECK/HIRES
GRATING BLAZE
ECHELLE

J.o. 4 8 92

H3425.A



⊖1 GRATING AND PAD ASSEMBLY

3 REQ'D

NOTES:

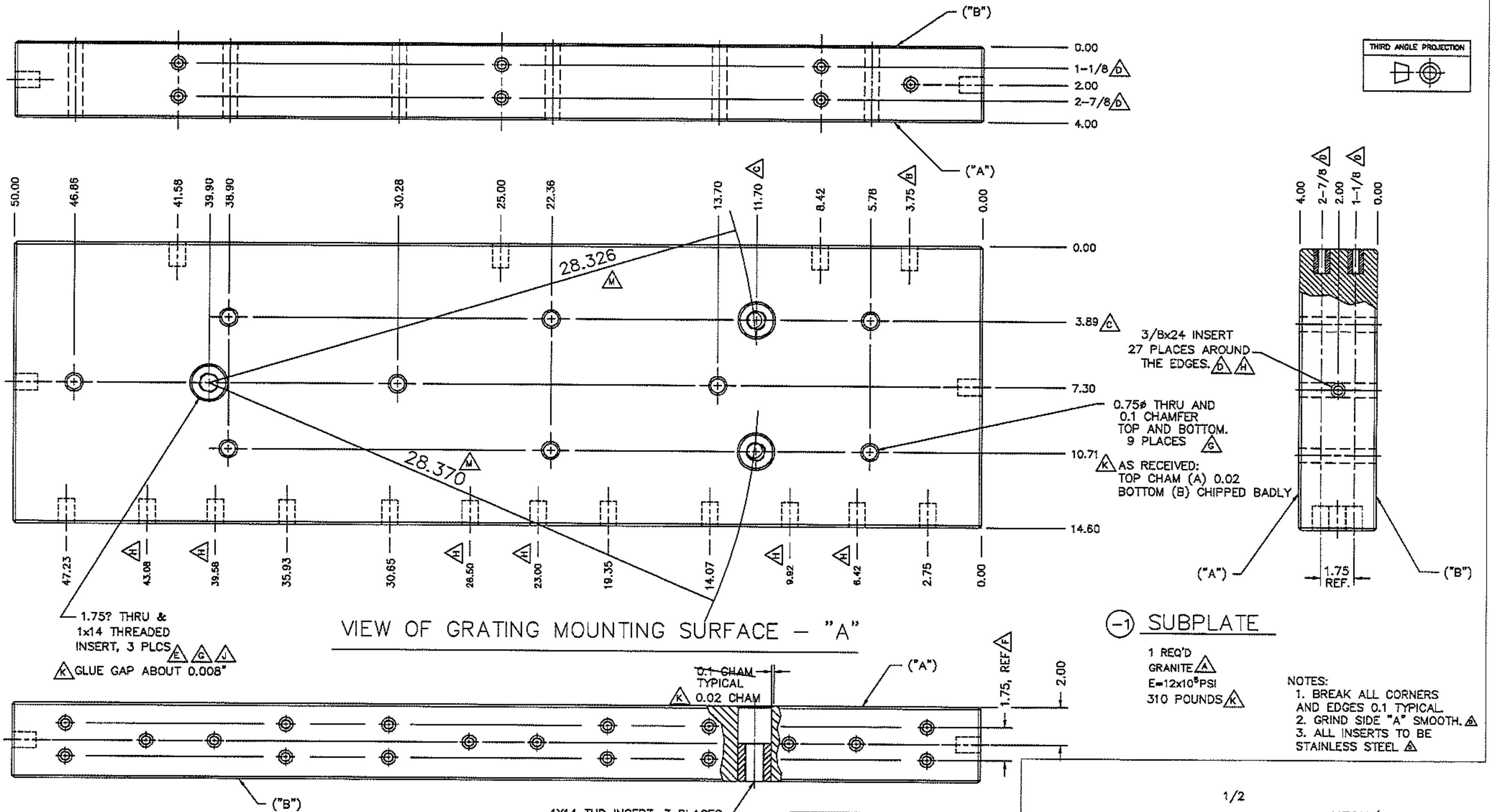
1. ZERODUR PADS ARE H3525-2
2. GRATING E3 SHOWN. SEE H3450,1,2 FOR OTHER GRATING DETAILS.
3. GLUE NOTES ON H3040.A: HYSOL EA 9313 EPOXY RESIN; 5 DAY CURE TIME.
4. FILL POCKET WITH RTV BEFORE GLUEING.

A	4 5 93	j.o.		TITLE CHANGE

1/2

KECK/HIRES
ECHELLE GRATING
AND PAD ASSEMBLY
△A
j.o. 7 23 92

H3454.A



VIEW OF GRATING MOUNTING SURFACE – "A"

① SUBPLATE

1 REQ'D
GRANITE A
$E=12x10^6$PSI
310 POUNDS K

NOTES:
1. BREAK ALL CORNERS AND EDGES 0.1 TYPICAL.
2. GRIND SIDE "A" SMOOTH. A
3. ALL INSERTS TO BE STAINLESS STEEL A

F	[illegible]	J.o.		MINOR DRAFTING CHANGES.
G	[illegible]	C.S.		REDESIGN, SYMMETRIC 1X12 INSERTS.
H	[illegible]	J.o.		ADD 6 3/8–24 THD INSERTS.
J	[illegible]	J.o.		1x14 WAS 1x12, PYRAMID CHANGE.
K	[illegible]	J.o.		AS RECEIVED CONDITIONS NOTED.
M	[illegible]	J.o.		FITTING INTO CELL BEGINS...

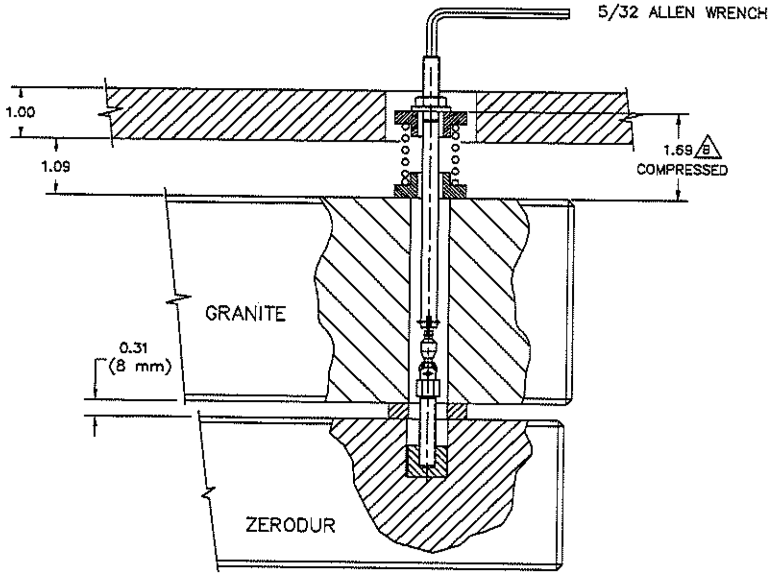
A	[illegible]	J.o.		WAS PYREX, 2.12" THICK.
B	[illegible]	J.o.		MOVE 1/2x20 INSERT: 3.75 WAS 2.75
C	[illegible]	J.o.		MOVE 1x12 INSERT, WAS MIRROR IMAGE
D	[illegible]	J.o.		1–1/8 WAS 0.75, 2–7/8 WAS 3.25,ADD
				NOTES, 3/8x24 WAS 1/2x20
E	[illegible]	J.o.		ADD 1x12 INSERT, WAS 3.

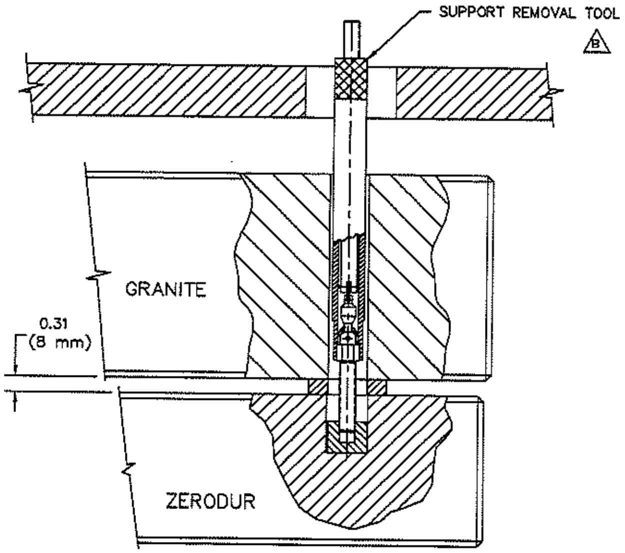
1/2

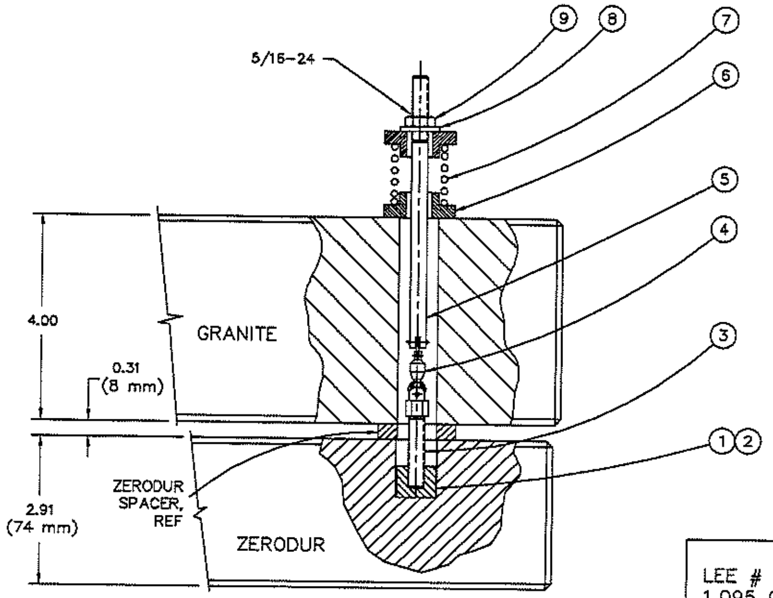
KECK/HIRES
ECHELLE MOSAIC
SUBPLATE DETAIL

J.o. 12 20 88

H3470.M







LEE # LC-135M-0-SS
1.095 O.D., 0.135? ST STL WIRE
K=140 LB/IN
FREE HEIGHT = 1.5"
SOLID HEIGHT = 0.783"
DESIGN HEIGHT 1.19" (43 LBS)
0.783"/0.135"ø = 5.8 WIRE TURNS

B FREE – DESIGN = 0.31"
0.31" X 24 TPI = 7.4 REVS OF NUT

⊖1 BACK SUPPORT ASSEMBLY

9 REQ'D FOR ECHELLE
6 REQ'D FOR CROSS-DISPERSER

NOTES:

C 1. SEE H3040 FOR GLUE PROCEDURE

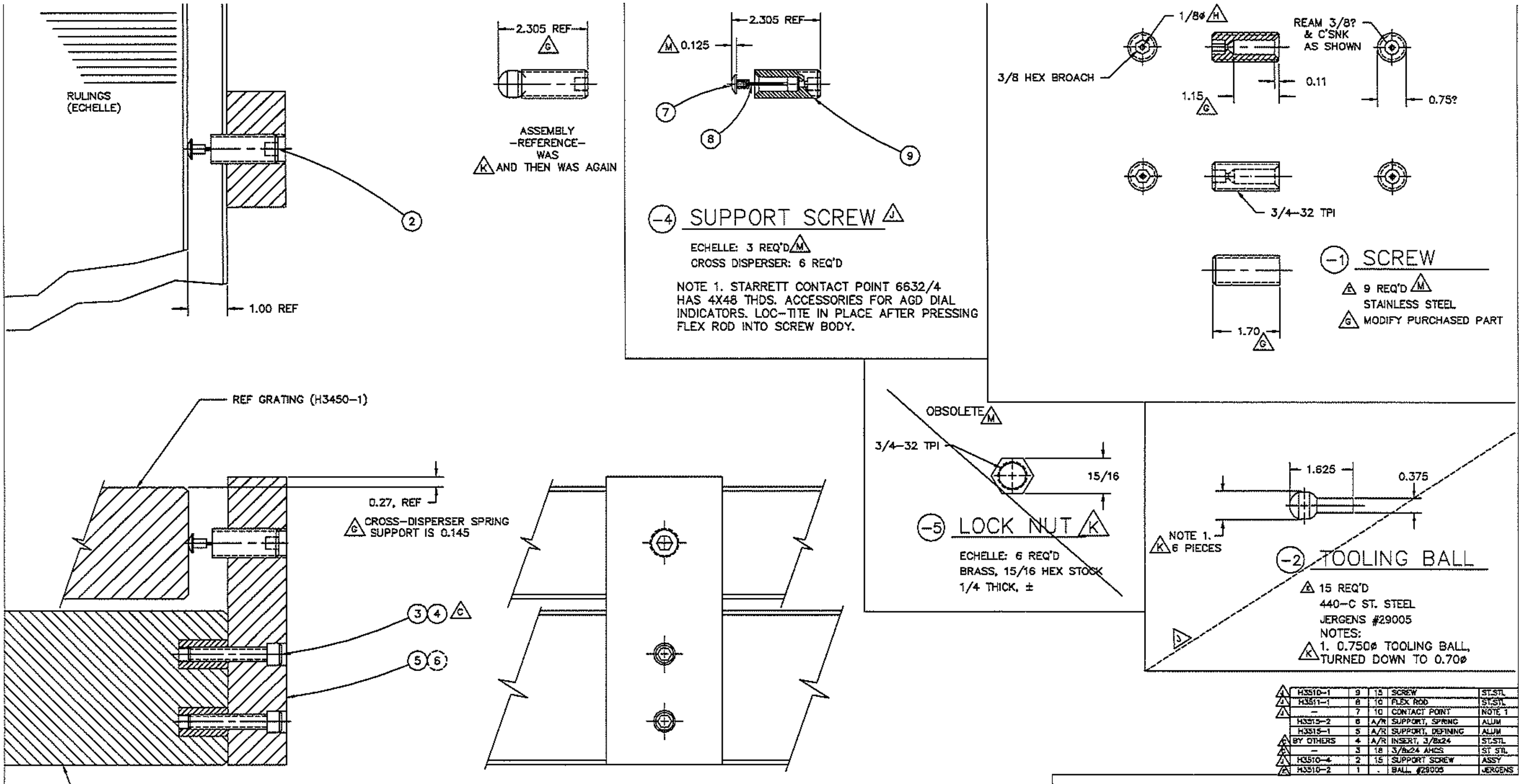
2. SAMPO SWIVEL IS NICKEL WELDED RING SWIVEL (200 LB TEST)
VENDOR:
SAMPO DIVISION OF ROME SPECIALTY
PO BOX 328
BARNEVELD, NY 13304
(315) 896-2606

–	9	1	NUT, 5/16-24	ST STL
–	8	1	WASHER, 3/4øx0.09	ST.STL
135M-0	7	1	LEE SPRING	ST STL
H3502-1	6	2	KEEPER	ALUM
H3501-3	5	1	UPPER SCREW	17-4-PH
X5RZ	4	1	SAMPO SWIVEL #0	NOTE 2.
H3501-2	3	1	LOWER SCREW	17-4-PH
C –	2	A/R	ADHESIVE	NOTE 1.
C H3501-1	1	1	INSERT	INVAR

FULL

A	1-23-89	j.a.		SUBPLATE WAS 2.12" PYREX; SWIVEL
				WAS #4 SAMPO.
B	4-3-90	j.a.		ADD NOTES ON SPRING COMPRESSION.
C	7-15-91	j.a.		REDESIGN GRATING INSERT/GLUE JOINT

KECK/HIRES
ECHELLE MOSAIC
BACK SUPPORT ASSEMBLY
j.a. 12 20 88
H3500.C



J	H3510-1	9	15	SCREW	ST.STL
J	H3511-1	8	10	FLEX ROD	ST.STL
J	—	7	10	CONTACT POINT	NOTE 1
	H3515-2	6	A/R	SUPPORT, SPRING	ALUM
	H3515-1	5	A/R	SUPPORT, DEFINING	ALUM
C	BY OTHERS	4	A/R	INSERT, 3/8x24	ST.STL
C	—	3	18	3/8x24 AHCS	ST STL
J	H3510-4	2	15	SUPPORT SCREW	ASSY
E	H3510-2	1	.	BALL #29005	JERGENS

SIDE SUPPORT ASSEMBLY, REF G

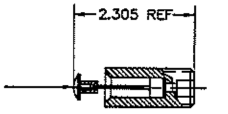
~~ECHELLE: 6 REQ'D~~ M
CROSS-DISPERSER: 2 REQ'D F
SEE H3516 FOR ECHELLE SUPPORT ASSEMBLY M

H	[illegible]	j.o.		UPDATE TO AS-BUILT CONDITION.
J	[illegible]	j.o.		REDESIGN; WAS TOOLING BALL AGAINST GLASS.
K	11 6 92	j.o.		INSTALL PREVIOUS DESIGN, THEN RE-
				MOVE. ADD LOCKING NUT.
M	4 3 93	j.o.		ECHELLE WAS ALUMINUM, 3/4-32 SCR.
				9 REQ'D WAS 15 REQ'D.

A	[illegible]	j.o.		FINISH DESIGN WORK
B	[illegible]	j.o.		SUBPLATE WAS 2-1/8" PYREX.
C	[illegible]	j.o.		CHANGE INSERTS: WERE 1/2x20
D	[illegible]	j.o.		REMOVE INVAR PADS.
E	[illegible]	C.S.		REV QTY FOR ITEMS -1,-3 & PART #1
F	[illegible]	j.o.		2 REQ FOR CROSS-DIS WAS 4
G	[illegible]	j.o.		MODIFY PART 3, ASSY WAS 2.42 LOA

FULL

KECK/HIRES
ECHELLE MOSAIC
SIDE SUPPORT ASSEMBLY
jo 12 20 85
H3510.M



A DESIGN LOAD FOR
CROSS DISPERSER (MAX)
ECHELLE LOADING IS LESS:
18 LBS FOR 2 SUPPORTS
AND 36 LBS FOR SINGLE ONE.

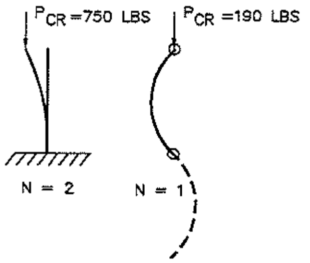
ASSEMBLY

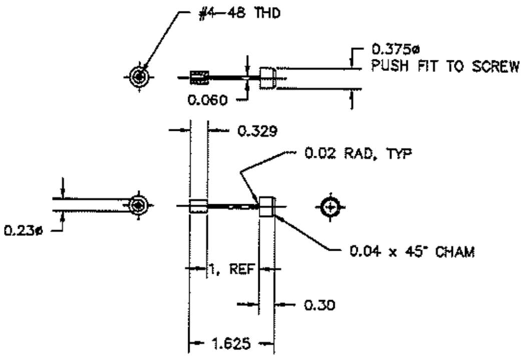
A BUCKLING NOTES:

1. EULER BUCKLING LIMIT IS 750 LBS BASED ON N=2 (PINNED END AND FIXED END), DIAMETER = 0.06ø, LENGTH = 1" AND E = 30 X 10^6 PSI
   A MORE CONSERVATIVE ESTIMATE WOULD BE FOR N=1 (BOTH ENDS PINNED AND FREE TO ROTATE) IN WHICH CASE, PCRIT IS 190 LBS.
2. EULER'S FORMULA:

$$P_{CR} = \frac{N^2 \pi^2 E I}{L^2}$$

WHERE $I = \frac{\pi R^4}{4}$





-1 FLEX ROD

ECHELLE: 3 REQ'D B
CROSS DISPERSER: 6 REQ'D
17–4–PH STAINLESS STEEL

NOTE: ALUMINUM SIDE SUPPORT BRACKET WILL CHANGE 0.004" IN TEMPERATURE RANGE EXPECTED. THIS ROD WILL OFFSET 0.004" WITH A FORCE OF 0.22 LBS. THIS IS A TOLERABLE FORCE AT THE GRATING EDGE SURFACE.

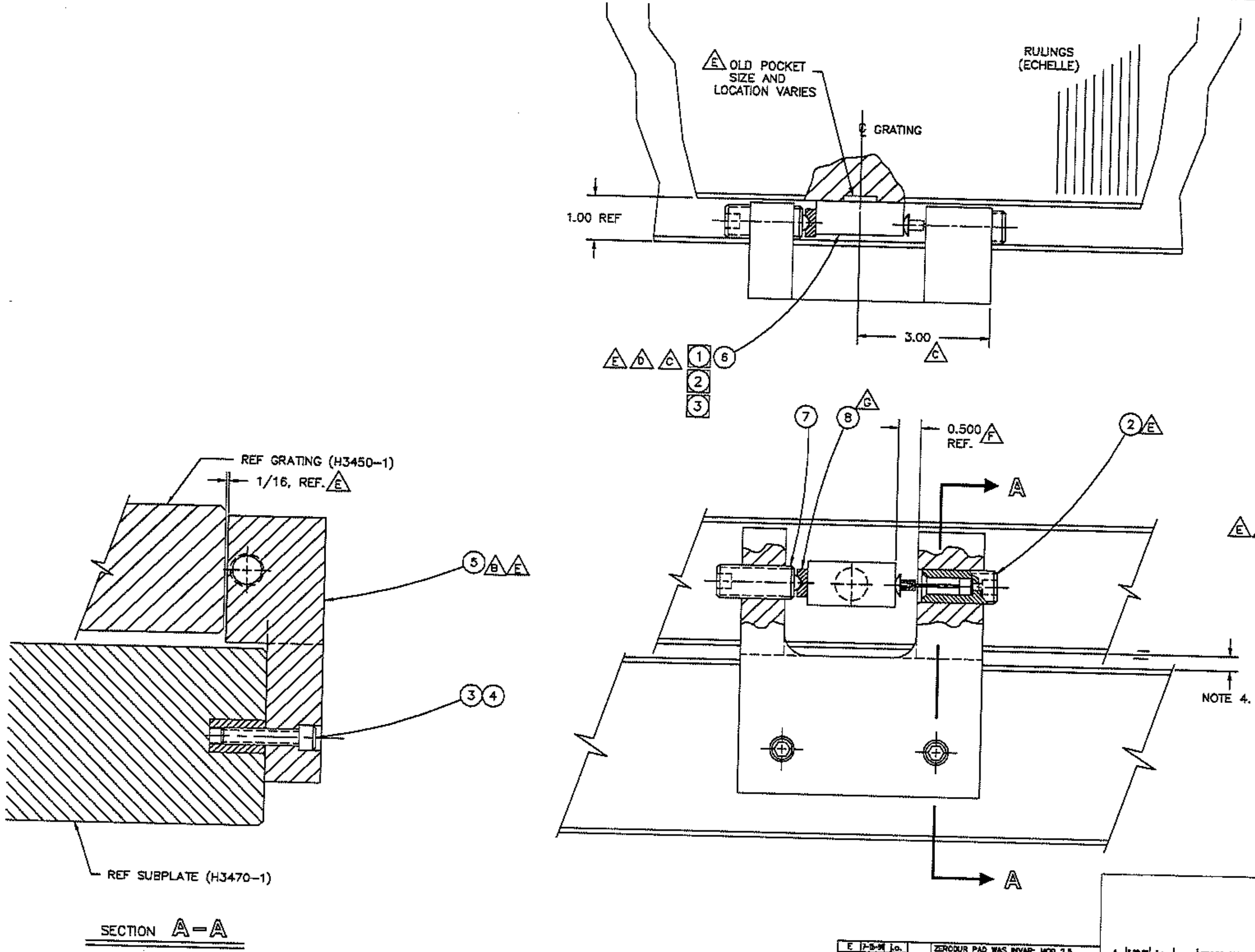
FULL

A	11 30 92	j.o.		ADD BUCKLING CALC'S.
B	4 5 93	j.o.		3 REQ'D WAS 6 REQ'D.

KECK/HIRES
MOSAIC SIDE SUPPORT
FLEX ROD DETAIL

ja 6 6 90

H3511.B



SECTION A–A

(-1) SIDE SUPPORT 2

3 REQ'D (FOR ECHELLE SUPPORT)
4 REQ (FOR CROSS-DISPERSER SUP) △A
2 AS SHOWN AND 2 MIRROR IMAGE

△E △D △C $\boxed{1}$ SEE H3040 FOR GLUE DESCRIPTION.

△D $\boxed{2}$ THEN RULINGS ARE PUT ON.

△D $\boxed{3}$ THEN GLUE PADS BACK ON.

△E 4. 0.31" (5 mm), 0.22", AND 0.40" GAPS

△G	H3458-2	8	3	PAD	STL
OBSOLETE △B	~~—~~	~~9~~	~~14~~	~~SCR. 6-32UNC AHCS~~	~~ST. STL~~
OBSOLETE △B	~~H3525-3~~	~~6~~	~~14~~	~~LINER~~	~~ST. STL~~
	#26830	7	5	SPRING PLUNGER	JERGENS
△E △A	H3525-2	6	7	PAD	ZERODUR
△E △A	H3525-1	5	7	SUPPORT, DEFINING	ALUM
	BY OTHERS	4	A/R	INSERT, 3/8x24	ST.STL
△E	—	3	A/R	3/8-24 AHCS x 1.75 LNG	ST STL
△E	H3510-4	2	5	SCREW	ASSY
△B OBSOLETE	~~H3510-2~~	~~1~~	~~5~~	~~BALL, #26006~~	~~JERGENS~~

FULL

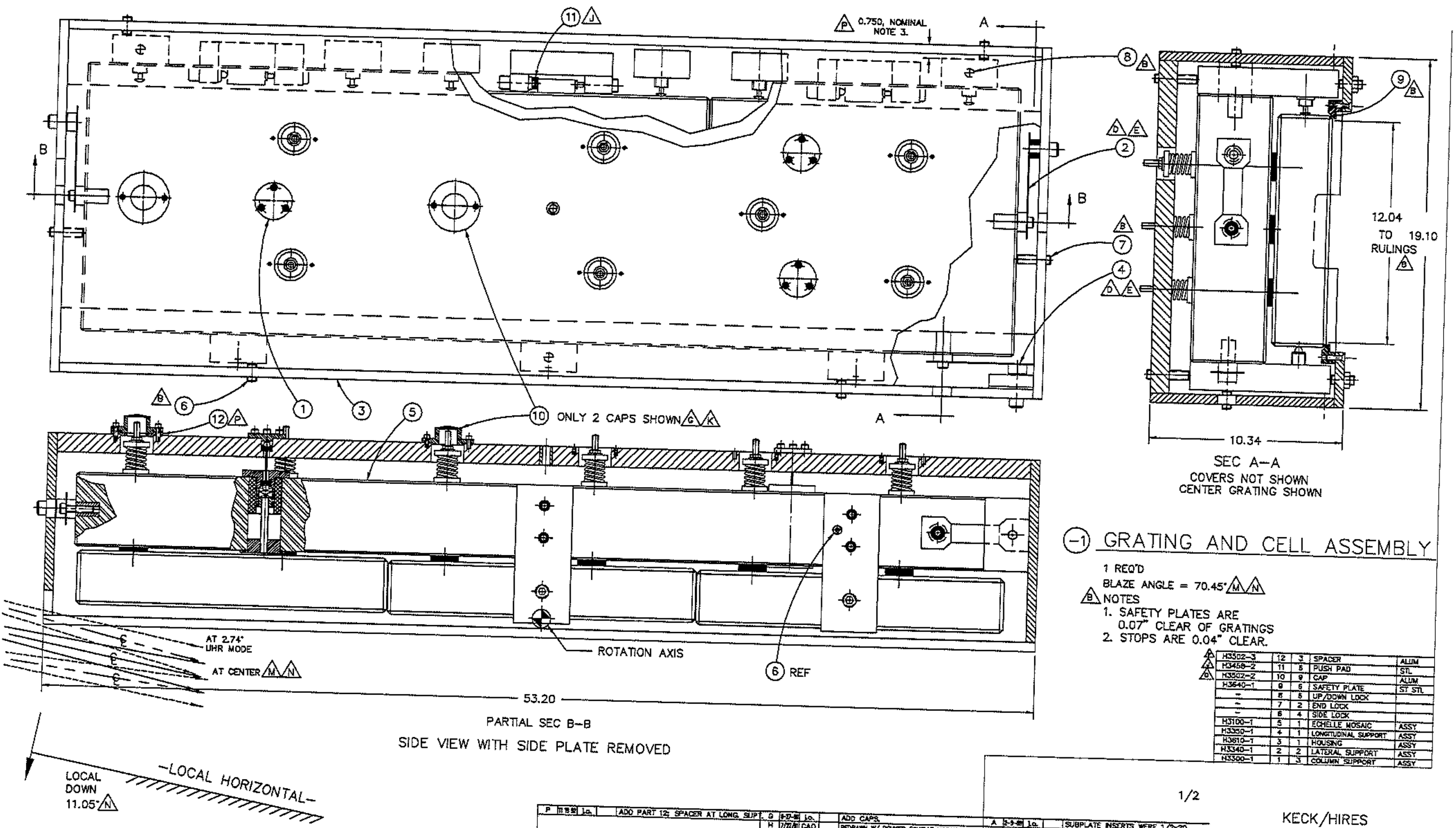
E	7-15-91	J.o.		ZERODUR PAD WAS INVAR; MOD 2,3. CHANGE GLUE METHOD.
F	10 15 92	J.o.		ADD DIMENSION AT FINAL ASSEMBLY.
G	4 5 93	J.o.		ADD PAD.

A	5.29.89	J.o.		CROSS DISP: 4 REQ WAS 2 REQ. INVAR BLOCK: 7 REQ WAS 5 REQ
B	8.9.89	J.o.		MODIFY PART 5.
C	3-23-90	J.o.		MOVE ASSY RELATIVE TO GRATING CL. 3 WAS 2-7/8. ADD EPOXY CALLOUT.
D	5/28/90	CAO		UPDATE PER DESIGN REVIEW 5/90

KECK/HIRES
ECHELLE MOSAIC
SIDE SUPPORT 2

J.o. 5/15/89
C.E. 5/18/89

H3520.G



SEC A–A
COVERS NOT SHOWN
CENTER GRATING SHOWN

PARTIAL SEC B–B
SIDE VIEW WITH SIDE PLATE REMOVED

–1 GRATING AND CELL ASSEMBLY

1 REQ'D
BLAZE ANGLE = 70.45° M N

B NOTES
1. SAFETY PLATES ARE 0.07" CLEAR OF GRATINGS
2. STOPS ARE 0.04" CLEAR.

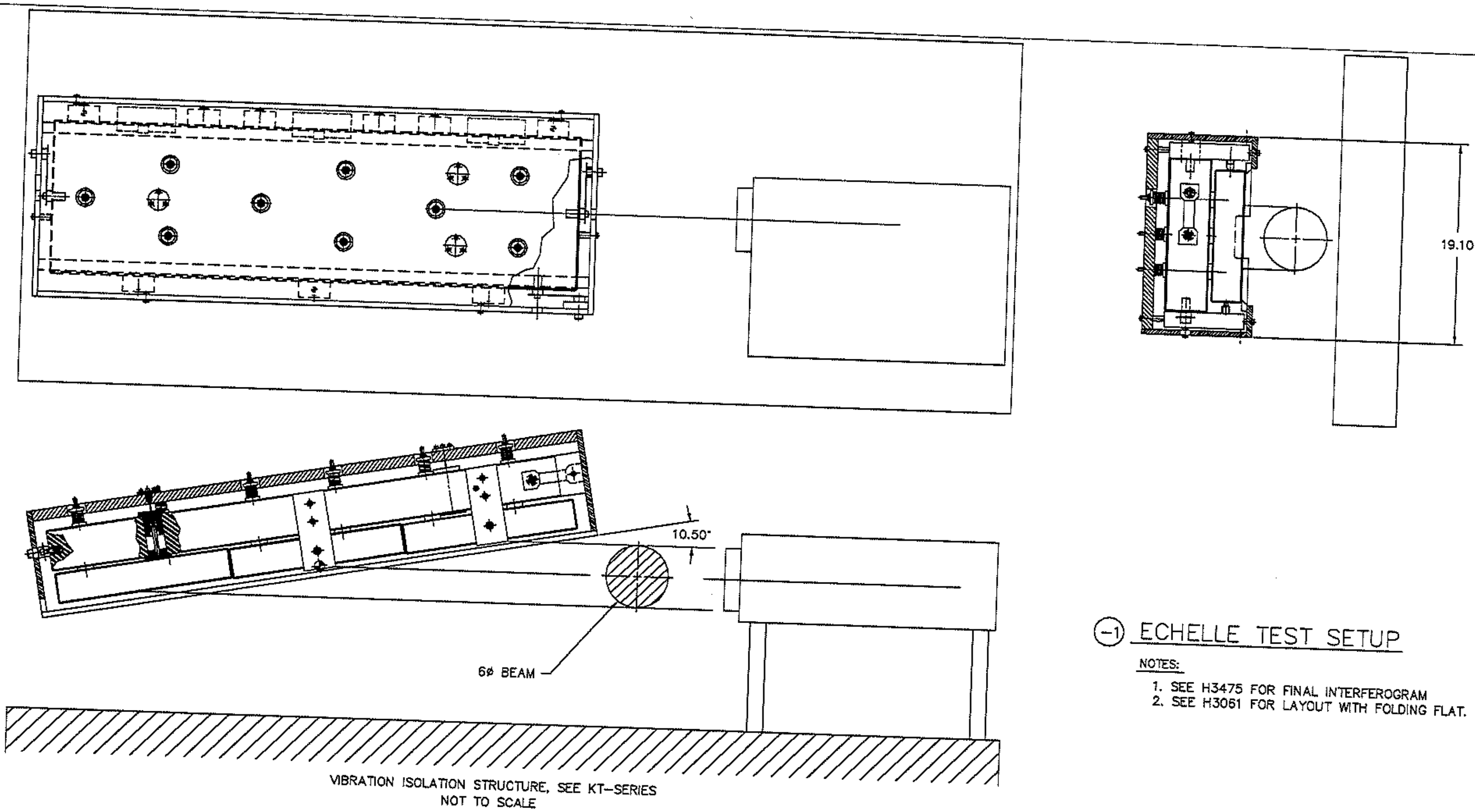
P	H3502–3	12	3	SPACER	ALUM
J	H3458–2	11	5	PUSH PAD	STL
G	H3502–2	10	9	CAP	ALUM
	H3640–1	9	6	SAFETY PLATE	ST STL
	–	8	5	UP/DOWN LOCK	
	–	7	2	END LOCK	
	–	6	4	SIDE LOCK	
	H3100–1	5	1	ECHELLE MOSAIC	ASSY
	H3350–1	4	1	LONGITUDINAL SUPPORT	ASSY
	H3610–1	3	1	HOUSING	ASSY
	H3340–1	2	2	LATERAL SUPPORT	ASSY
	H3300–1	1	3	COLUMN SUPPORT	ASSY

P	11 15 92	J.o.		ADD PART 12; SPACER AT LONG. SUPT.
G	9-27-88	J.o.		ADD CAPS.
H	7/22/91	CAO		REDRAWN W/ REVISED ECHELLE MOSAIC ASSY
J	11-26-91	J.o.		ADD PADS.
K	3 24 92	J.o.		MODIFY ITEM 10 FOR CLRNC AT C/DISP
M	9 20 92	J.o.		ADD ITEM. ADD NEW BLAZE, WAS 69°
N	10 27 92	J.o.		ADD NEW BLAZE, WAS 70°.
A	2-9-88	J.o.		SUBPLATE INSERTS WERE 1/2x20.
B	3/2/88	J.o.		ADD SHIPPING LOCKS, SAFETY PLATES
C	3/21/88	J.o.		ADD SYMMETRY, SIDE-2 GRATG SUPTS.
D	3/25/88	J.o.		ADD MODIFIED LINKS.
E	7-28-88	J.o.		WELD LINKS WERE SILVER SOLDER.
F	8-31-88	J.o.		STAIRSTEPPED GRATINGS WERE PLANAR.

1/2

KECK/HIRES
ECHELLE MOSAIC
CELL ASSEMBLY
J.o. 1 25 88

H3600.P



(-1) ECHELLE TEST SETUP

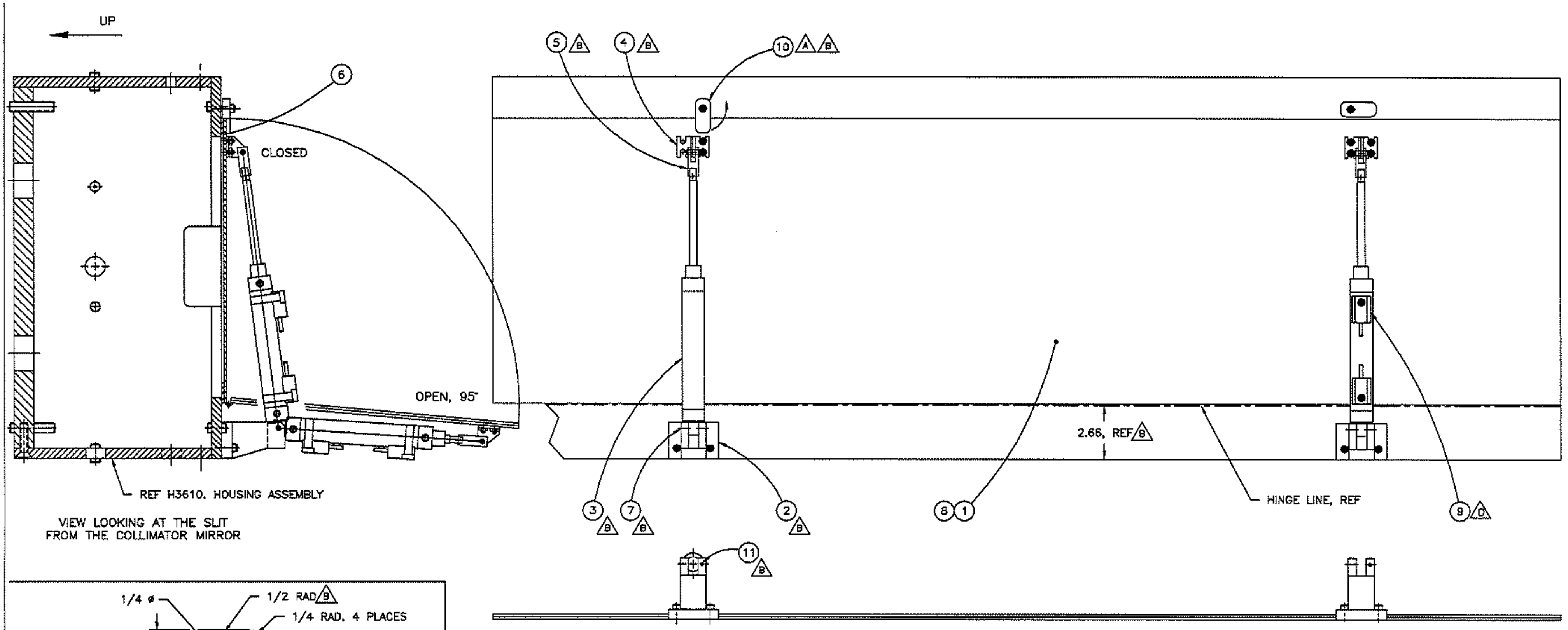
NOTES:

1. SEE H3475 FOR FINAL INTERFEROGRAM
2. SEE H3061 FOR LAYOUT WITH FOLDING FLAT.

1/4

A | [illegible] | J.O. | | UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
ECHELLE MOSAIC TESTING
INTERFEROMETER LAYOUT
J.O. 4 10 90
H3603.A

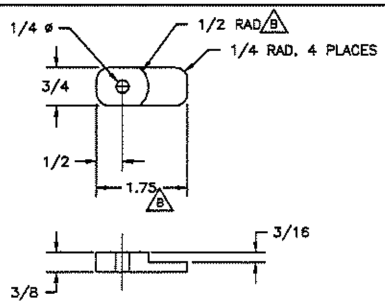


(-1) COVER ASSEMBLY

1 REQ'D

NOTE: ONLY ONE CYLINDER WILL HAVE LIMIT SWITCHES ATTACHED.

B NOTE 1: PIVOT BRACKET #D-8321-A
NOTE 2: CLEVIS #D-8309-A
C NOTE 3: CUT CENTER OUT OF GASKET
USE CONTACT CEMENT TO BOND TO COVER PLATE. PLACE SMOOTH SIDE AGAINST COVER.
CELLULAR URETHANE, #4701-01-20125-1604
WITH ADCHEM #256 ADHESIVE.
BOYD CORP.
2209 FAIRVIEW DR.
CERES, CA 95307



(-2) LATCH A

2 REQ'D
ALUMINUM
BLACK ANODIZE
SCALE: 1/1

B	~	11	2	SET SCREW, #8-32	ST.STL
A B	H3700-2	10	2	LATCH	ALUM
B	–	9	2	SWITCH, MRS-087-XBL-06	BIMBA
	~	8	1	HINGE	ALUM
B	~	7	2	PIN, 1.25 x 0.250	ST.STL
	~	6	1	GASKET	NOTE 3
B	H3702-3	5	2	BIMBA ROD CLEVIS	NOTE 2
B	H3702-2	4	2PR	BIMBA BRACKET	NOTE 1
B	H3702-1	3	2	AIR CYLINDER, BIMBA MRS-094-DXP	
B	H3755-2	2	2	PYLON	ALUM
	H3755-1	1	1	COVER PLATE	ALUM

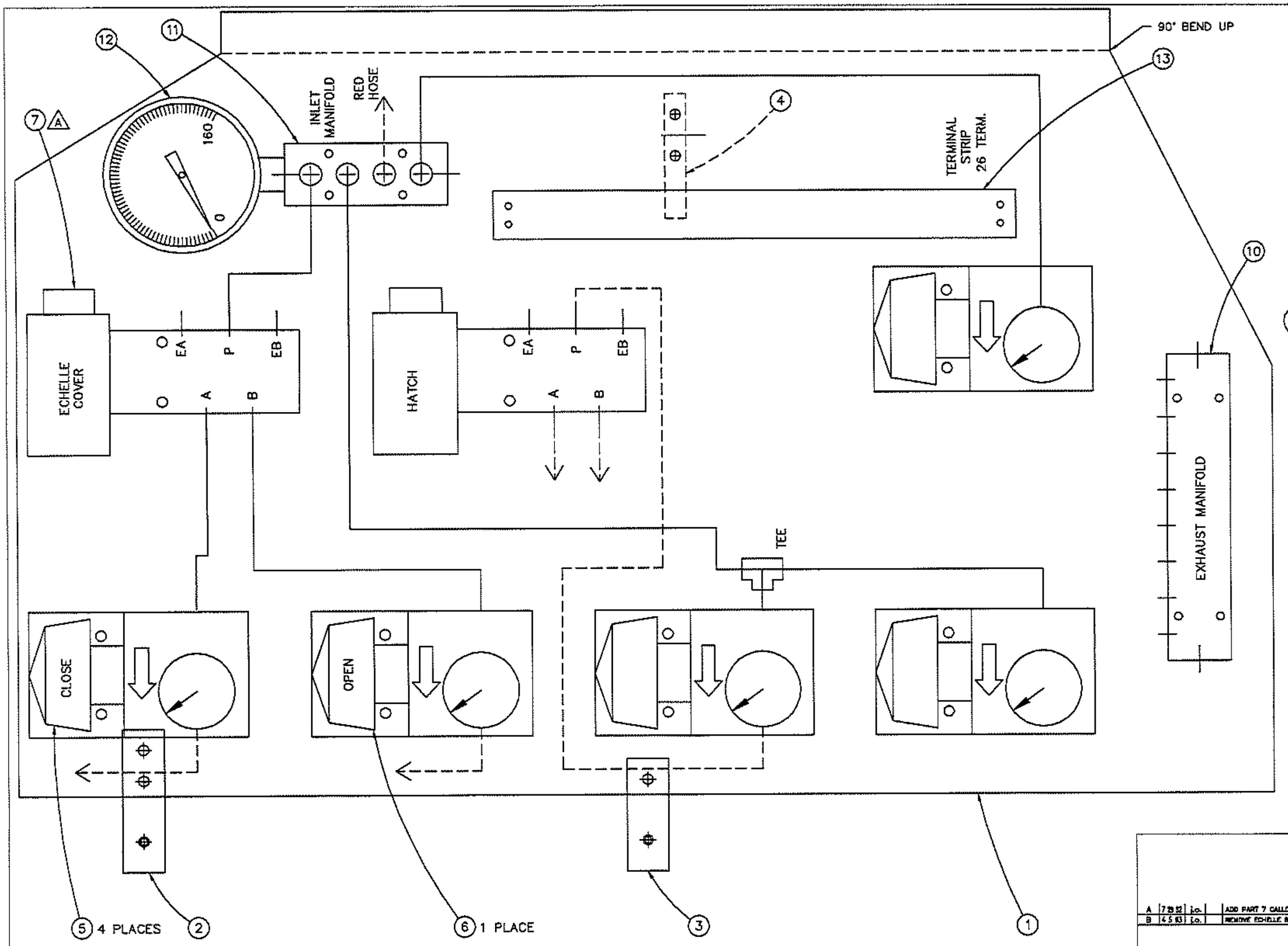
1/2

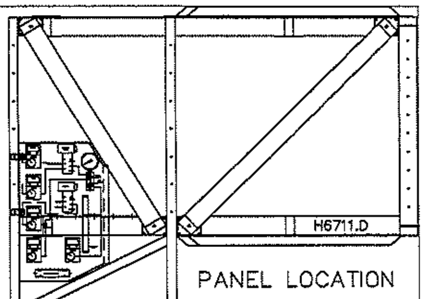
A	7/5/98	C.S.		ADDED LATCHES
B	6/13/98	j.c.		LARGER CYLINDER, UPDATE.
C	4/13/99			REVISED NOTE 3
D	3 10 03	j.c.		LIMIT SWITCHES WORK ON OPP. CYL.

KECK/HIRES
ECHELLE MOSAIC
COVER ASSY

j.c. 5 17 98

H3700.D





PANEL LOCATION

⊖1 PANEL ASSEMBLY

1 REQ'D

NOTES:

1. WILKERSON REGULATOR #R16-02-000 COMES WITH 0-160 PSI SPRING USE GAGE #GRP-95-229.
2. WILKERSON REGULATOR #R16-02-000 WITH SPRING #RRP-95-222 FOR 0-60 PSI RANGE. USE GAGE #RRP-95-230
3. SKINNER MAGNELATCH 4-WAY VALVE. #H935RBM2150-24A. 24VAC COIL. 1/4NPT PORTS, ALUMINUM HOUSING W/SS SLEEVE. BUNA-N SEALS, 1/2NPT CONDUIT OUTLET.
5. JERGENS #61802, ALUMINUM, 8 1/4NPT PORTS AND 2 3/8NPT PORTS (ENDS).
6. JERGENS #61801, ALUMINUM, 4 1/4NPT PORTS AND 2 3/8NPT PORTS (ENDS).
8. GAGE: McMASTER-CARR #4023K35, 0-160PSI

—	13	1	TERMINAL STRIP	
—	12	1	GAGE, 0-160PSI	NOTE 8.
—	11	1	4-PORT MANIFOLD	NOTE 6.
—	10	1	8-PORT MANIFOLD	NOTE 5.
SKINNER	7	2	LATCHING SOLENOID	NOTE 3.
WILKERSON	6	1	REGULATOR	NOTE 2.
WILKERSON	5	4	REGULATOR	NOTE 1.
H3705-3	4	1	BOTTOM BRACKET	ALUM
H3705-2	3	1	SIDE BRACKET	ALUM
H3705-1	2	1	TOP BRACKET	ALUM
H3704-1	1	1	MAIN PANEL	ALUM

FULL

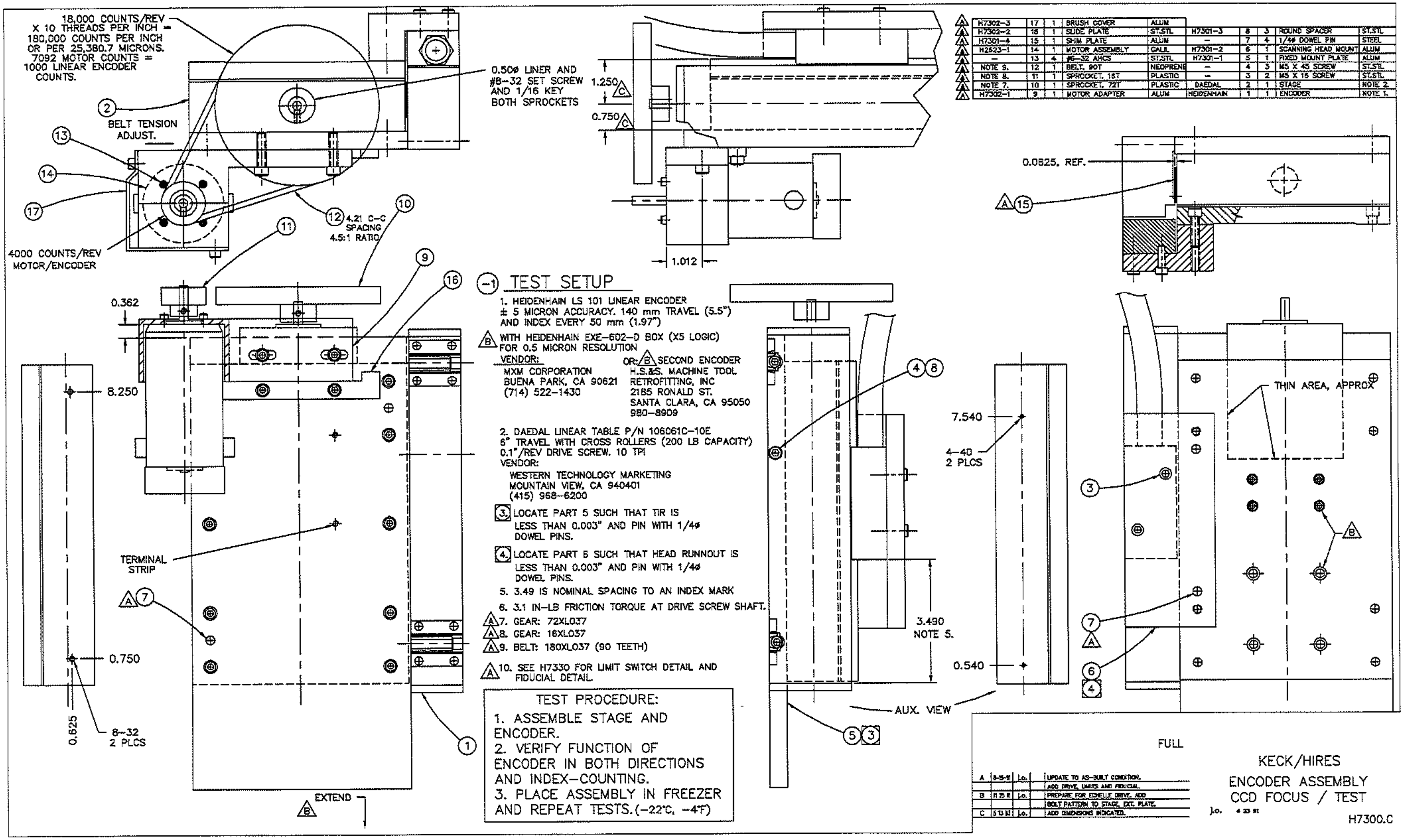
A	7 29 92	j.o.		ADD PART 7 CALLOUT.
B	4 5 93	j.o.		REMOVE ECHELLE BRAKE AND PRELOAD.

KECK/HIRES

ECHELLE AIR CONTROL
MOUNTING PANEL

j.o. 2 14 91

H3703.B



(-1) TEST SETUP

1. HEIDENHAIN LS 101 LINEAR ENCODER
± 5 MICRON ACCURACY. 140 mm TRAVEL (5.5")
AND INDEX EVERY 50 mm (1.97")

B WITH HEIDENHAIN EXE-602-D BOX (X5 LOGIC)
FOR 0.5 MICRON RESOLUTION

VENDOR:

MXM CORPORATION
BUENA PARK, CA 90621
(714) 522-1430

OR: B SECOND ENCODER
H.S.&S. MACHINE TOOL
RETROFITTING, INC
2185 RONALD ST.
SANTA CLARA, CA 95050
980-8909

2. DAEDAL LINEAR TABLE P/N 106061C-10E
6" TRAVEL WITH CROSS ROLLERS (200 LB CAPACITY)
0.1"/REV DRIVE SCREW. 10 TPI
VENDOR:

WESTERN TECHNOLOGY MARKETING
MOUNTAIN VIEW, CA 940401
(415) 968-6200

3. LOCATE PART 5 SUCH THAT TIR IS LESS THAN 0.003" AND PIN WITH 1/4Ø DOWEL PINS.

4. LOCATE PART 6 SUCH THAT HEAD RUNNOUT IS LESS THAN 0.003" AND PIN WITH 1/4Ø DOWEL PINS.

5. 3.49 IS NOMINAL SPACING TO AN INDEX MARK

6. 3.1 IN-LB FRICTION TORQUE AT DRIVE SCREW SHAFT.

A 7. GEAR: 72XL037

A 8. GEAR: 16XL037

A 9. BELT: 180XL037 (90 TEETH)

A 10. SEE H7330 FOR LIMIT SWITCH DETAIL AND FIDUCIAL DETAIL.

TEST PROCEDURE:

1. ASSEMBLE STAGE AND ENCODER.
2. VERIFY FUNCTION OF ENCODER IN BOTH DIRECTIONS AND INDEX-COUNTING.
3. PLACE ASSEMBLY IN FREEZER AND REPEAT TESTS. (-22°C, -4°F)

A	H7302-3	17	1	BRUSH COVER	ALUM					
A	H7302-2	16	1	SLIDE PLATE	ST.STL	H7301-3	8	3	ROUND SPACER	ST.STL
A	H7301-4	15	1	SHIM PLATE	ALUM	–	7	4	1/4Ø DOWEL PIN	STEEL
A	H2623-1	14	1	MOTOR ASSEMBLY	GALIL	H7301-2	6	1	SCANNING HEAD MOUNT	ALUM
A	–	13	4	#6-32 AHCS	ST.STL	H7301-1	5	1	FIXED MOUNT PLATE	ALUM
A	NOTE 9.	12	1	BELT, 90T	NEOPRENE	–	4	3	M5 X 45 SCREW	ST.STL
A	NOTE 8.	11	1	SPROCKET, 16T	PLASTIC	–	3	2	M5 X 16 SCREW	ST.STL
A	NOTE 7.	10	1	SPROCKET, 72T	PLASTIC	DAEDAL	2	1	STAGE	NOTE 2.
A	H7302-1	9	1	MOTOR ADAPTER	ALUM	HEIDENHAIN	1	1	ENCODER	NOTE 1.

FULL

A	8-15-91	J.o.		UPDATE TO AS-BUILT CONDITION.
				ADD DRIVE, LIMITS AND FIDUCIAL.
B	11 25 91	J.o.		PREPARE FOR ECHELLE DRIVE. ADD
				BOLT PATTERN TO STAGE, EXT. PLATE.
C	5 13 93	J.o.		ADD DIMENSIONS INDICATED.

KECK/HIRES
ENCODER ASSEMBLY
CCD FOCUS / TEST

J.o. 4 23 91

H7300.C

-1 LIMIT SWITCH ASSEMBLY

1 REQ'D FOR ENCODER TESTING

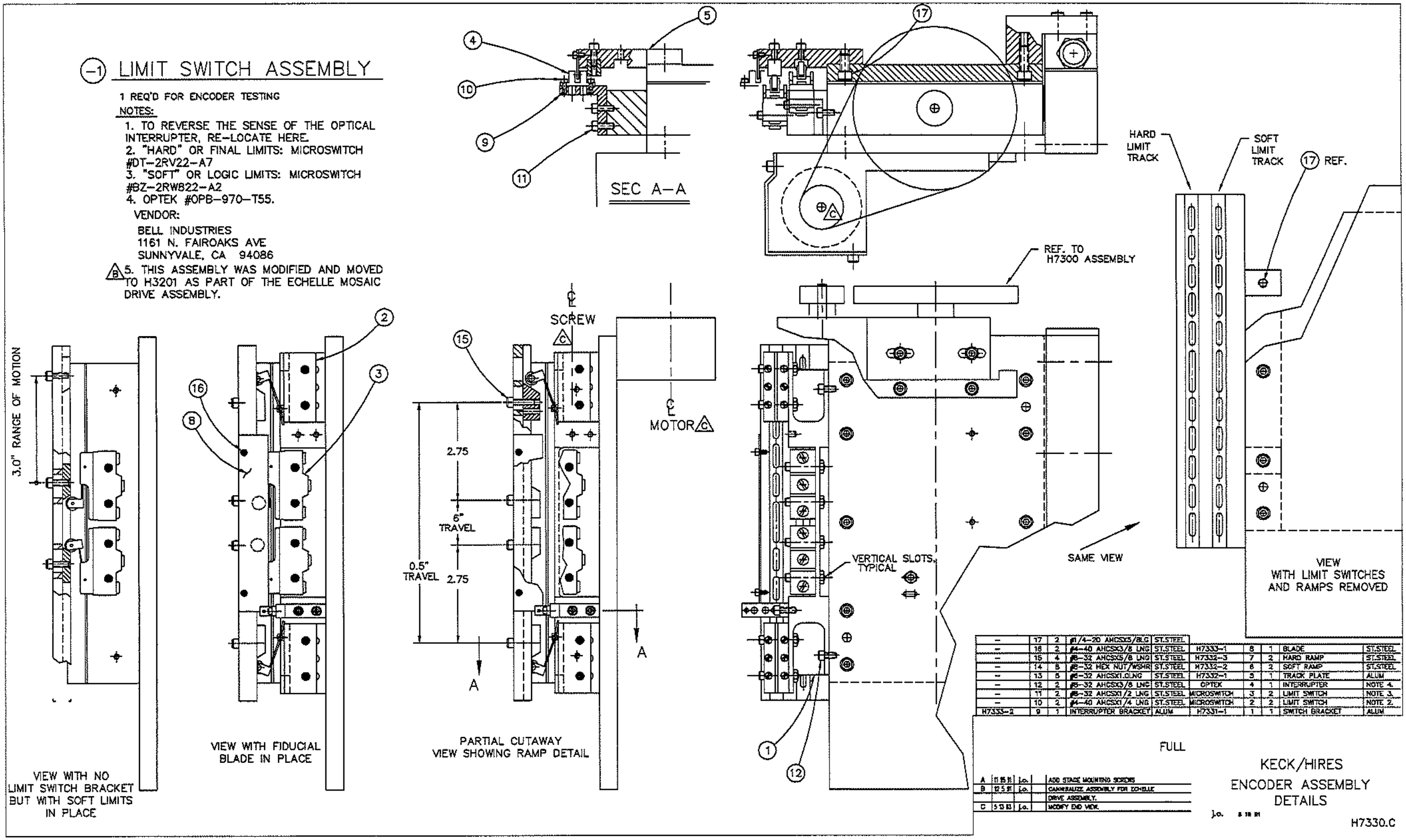
NOTES:

1. TO REVERSE THE SENSE OF THE OPTICAL INTERRUPTER, RE-LOCATE HERE.
2. "HARD" OR FINAL LIMITS: MICROSWITCH #DT-2RV22-A7
3. "SOFT" OR LOGIC LIMITS: MICROSWITCH #BZ-2RW822-A2
4. OPTEK #OPB-970-T55.

VENDOR:

BELL INDUSTRIES
1161 N. FAIROAKS AVE
SUNNYVALE, CA 94086

B 5. THIS ASSEMBLY WAS MODIFIED AND MOVED TO H3201 AS PART OF THE ECHELLE MOSAIC DRIVE ASSEMBLY.



-	17	2	#1/4-20 AHCSX5/8LG	ST.STEEL					
-	16	2	#4-40 AHCSX3/8 LNG	ST.STEEL	H7333-1	8	1	BLADE	ST.STEEL
-	15	4	#8-32 AHCSX5/8 LNG	ST.STEEL	H7332-3	7	2	HARD RAMP	ST.STEEL
-	14	8	#8-32 HEX NUT/WSHR	ST.STEEL	H7332-2	6	2	SOFT RAMP	ST.STEEL
-	13	6	#8-32 AHCSX1.0LNG	ST.STEEL	H7332-1	5	1	TRACK PLATE	ALUM
-	12	2	#6-32 AHCSX3/8 LNG	ST.STEEL	OPTEK	4	1	INTERRUPTER	NOTE 4.
-	11	2	#6-32 AHCSX1/2 LNG	ST.STEEL	MICROSWITCH	3	2	LIMIT SWITCH	NOTE 3.
-	10	2	#4-40 AHCSX1/4 LNG	ST.STEEL	MICROSWITCH	2	2	LIMIT SWITCH	NOTE 2.
H7333-2	9	1	INTERRUPTER BRACKET	ALUM	H7331-1	1	1	SWITCH BRACKET	ALUM

FULL

A	11 25 91	J.o.		ADD STAGE MOUNTING SCREWS
B	12 5 91	J.o.		CANNIBALIZE ASSEMBLY FOR ECHELLE
				DRIVE ASSEMBLY.
C	5 13 93	J.o.		MODIFY END VIEW.

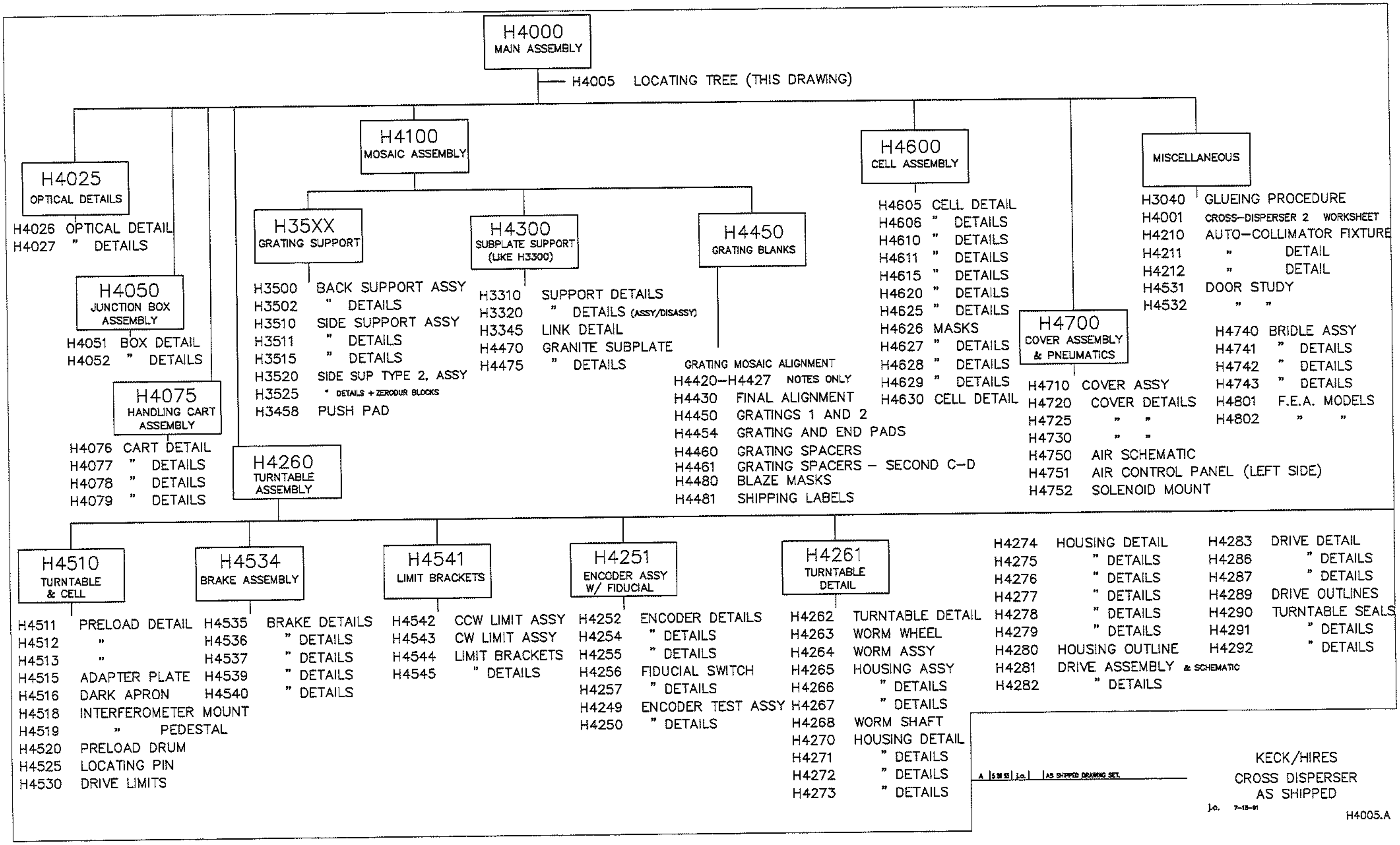
KECK/HIRES
ENCODER ASSEMBLY
DETAILS

J.o. 8 18 91

H7330.C

Appendix E List of Drawings — Cross-Disperser Mosaic

1. H4005 Locating Tree
2. H4000 Cross Disperser Assembly and Cell
3. H4026 Optical Detail and Blaze
4. H4210 Alignment Fixture for Turntable Mounting
5. H4251 Encoder Assembly
6. H4264 Worm Drive Assembly
7. H4281 Drive Assembly and Schematic
8. H4300 Subplate Column Support Assembly
9. H4421 Alignment Notes
10. H4424 Alignment Notes
11. H4450 Grating Detail
12. H4454 Grating and Side Pads
13. H4470 Subplate
14. H4511 Turntable Preload
15. H4530 Turntable Drive Limits
16. H4534 Turntable Brake Assembly
17. H4740 Cell Carrier Assembly
18. H4750 Cell Doors Pneumatic Diagram
19. H4751 Pneumatic Details
20. H4802 Subplate Finite Analysis Results

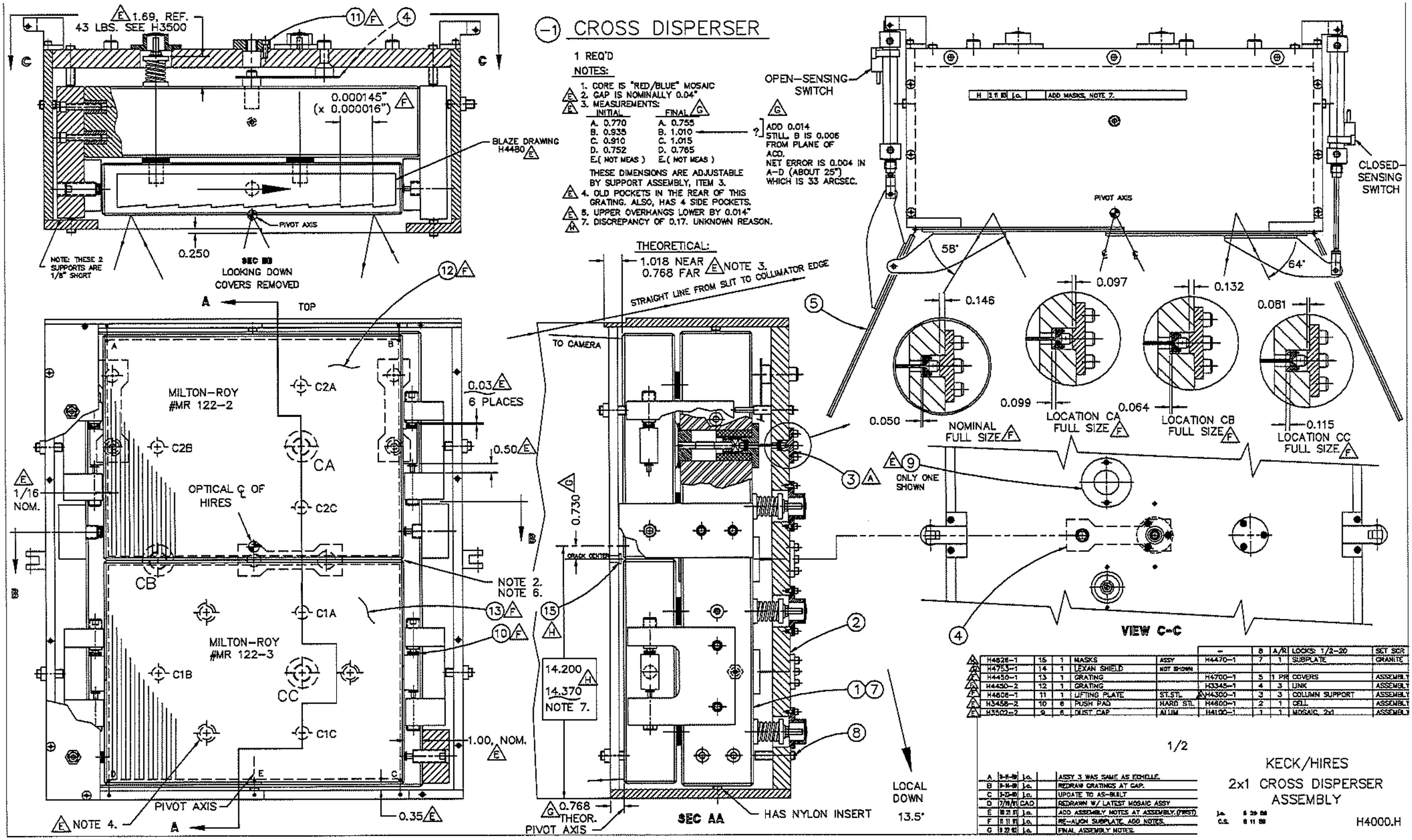


A | 5 31 91 | J.O. | | AS SHIPPED DRAWING SET.

KECK/HIRES
CROSS DISPERSER
AS SHIPPED

J.O. 7-15-91

H4005.A



(-1) CROSS DISPERSER

1 REQ'D

NOTES:

1. CORE IS "RED/BLUE" MOSAIC
2. GAP IS NOMINALLY 0.04"
3. MEASUREMENTS:

INITIAL	FINAL
A. 0.770	A. 0.755
B. 0.935	B. 1.010
C. 0.910	C. 1.015
D. 0.752	D. 0.765
E.(NOT MEAS)	E.(NOT MEAS)

?] ADD 0.014
STILL B IS 0.006 FROM PLANE OF ACD.
NET ERROR IS 0.004 IN A–D (ABOUT 25") WHICH IS 33 ARCSEC.

THESE DIMENSIONS ARE ADJUSTABLE BY SUPPORT ASSEMBLY, ITEM 3.

4. OLD POCKETS IN THE REAR OF THIS GRATING. ALSO, HAS 4 SIDE POCKETS.
5. UPPER OVERHANGS LOWER BY 0.014"
7. DISCREPANCY OF 0.17. UNKNOWN REASON.

H4826-1	15	1	MASKS	ASSY	—	8	A/R	LOCKS: 1/2-20	SET SCR
H4753-1	14	1	LEXAN SHIELD	NOT SHOWN	H4470-1	7	1	SUBPLATE	GRANITE
H4450-1	13	1	GRATING						
H4450-2	12	1	GRATING		H4700-1	5	1 PR	COVERS	ASSEMBLY
H4606-1	11	1	LIFTING PLATE	ST.STL.	H3345-1	4	3	LINK	ASSEMBLY
H3458-2	10	6	PUSH PAD	HARD STL.	H4300-1	3	3	COLUMN SUPPORT	ASSEMBLY
H3502-2	9	6	DUST CAP	ALUM	H4600-1	2	1	CELL	ASSEMBLY
					H4100-1	1	1	MOSAIC, 2x1	ASSEMBLY

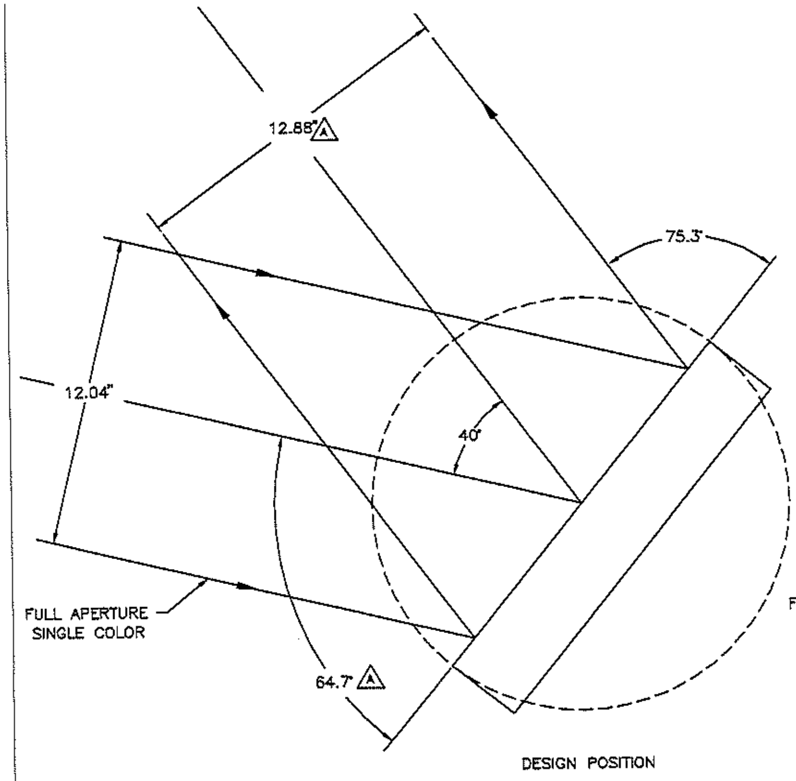
1/2

A	3-11-89	j.o.		ASSY 3 WAS SAME AS ECHELLE.
B	3-14-89	j.o.		REDRAW GRATINGS AT GAP.
C	3-22-89	j.o.		UPDATE TO AS-BUILT
D	7/18/91	CAD		REDRAWN W/ LATEST MOSAIC ASSY
E	10 23 91	j.o.		ADD ASSEMBLY NOTES AT ASSEMBLY.(FIRST)
F	11 11 91	j.o.		RE-ALIGN SUBPLATE, ADD NOTES.
G	3 22 92	j.o.		FINAL ASSEMBLY NOTES.

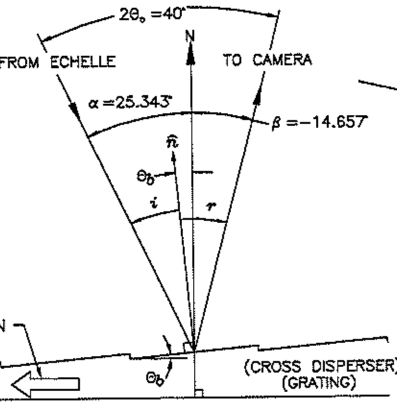
KECK/HIRES
2x1 CROSS DISPERSER
ASSEMBLY

j.o. 8 29 88
C.S. 8 11 88

H4000.H

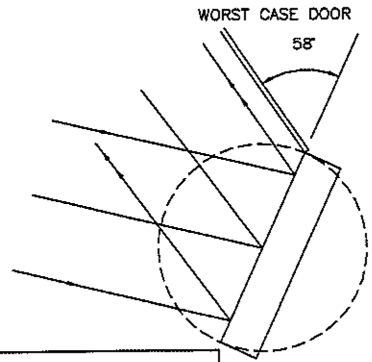


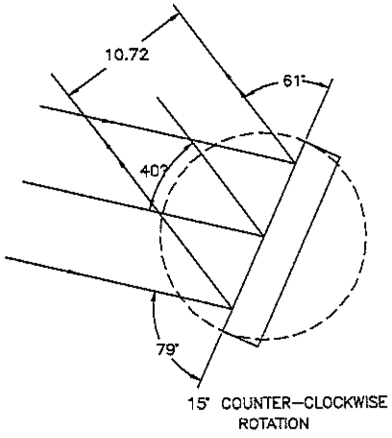
DESIGN POSITION



B ARROW CONVENTION
MILTON ROY USES
THE PROJECTION
OF THE "FACET
OF INTEREST" TO
LOCATE THIS ARROW.
NOT, THE "USE" DIRECTION,
WHICH MIGHT CHANGE.
SEE H4480 FOR PATTERN

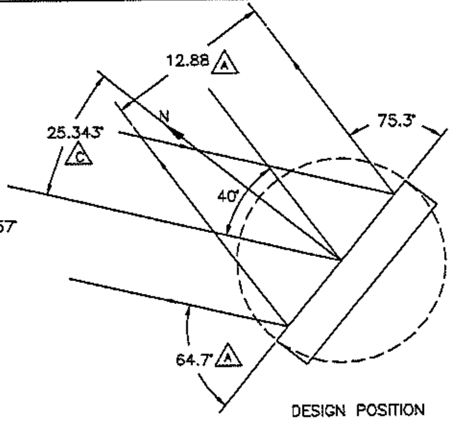
WORST CASE DOOR





15° COUNTER–CLOCKWISE
ROTATION

25.343°/360°X720,000 PULSES/REV = 50,686 PULSES
REF: 40° = 80,000 PULSES C



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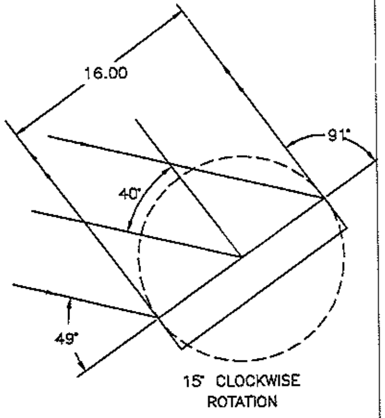


15° CLOCKWISE
ROTATION

(−1) RED/BLUE CROSS DISPERSER

1 REQ'D
2x1 GRATING MOSAIC
A 250 LINES/mm

RED/BLUE
A θ_b=5.343°
ALPHA=25.3428°
BETA=−14.6571°
A λ_b =7000 Å
m=1

GRATING DERIVATIONS A

$$\Theta_b = \frac{\alpha + \beta}{2}$$

$\alpha = \sin^{-1}\left[\frac{m\lambda}{2\sigma \cos \Theta_b}\right] + \Theta_b$ = angle of incidence for diffraction into direction of camera axis

$\beta_o = \alpha - 2\Theta_b$ = angle of diffraction in direction of camera axis

GROOVE SPACING IS 1/250 MM (=0.004MM, OR 0.0001574")

B NOTES:
1. 250 GROOVES/MM WAS SELECTED.
2. BLAZE ANGLE IS DETERMINED FROM 7000 ANGSTROM FIRST ORDER AND 40° COLLIMATOR–TO–CAMERA ANGLE. STEVE CALCULATED 5.343°.

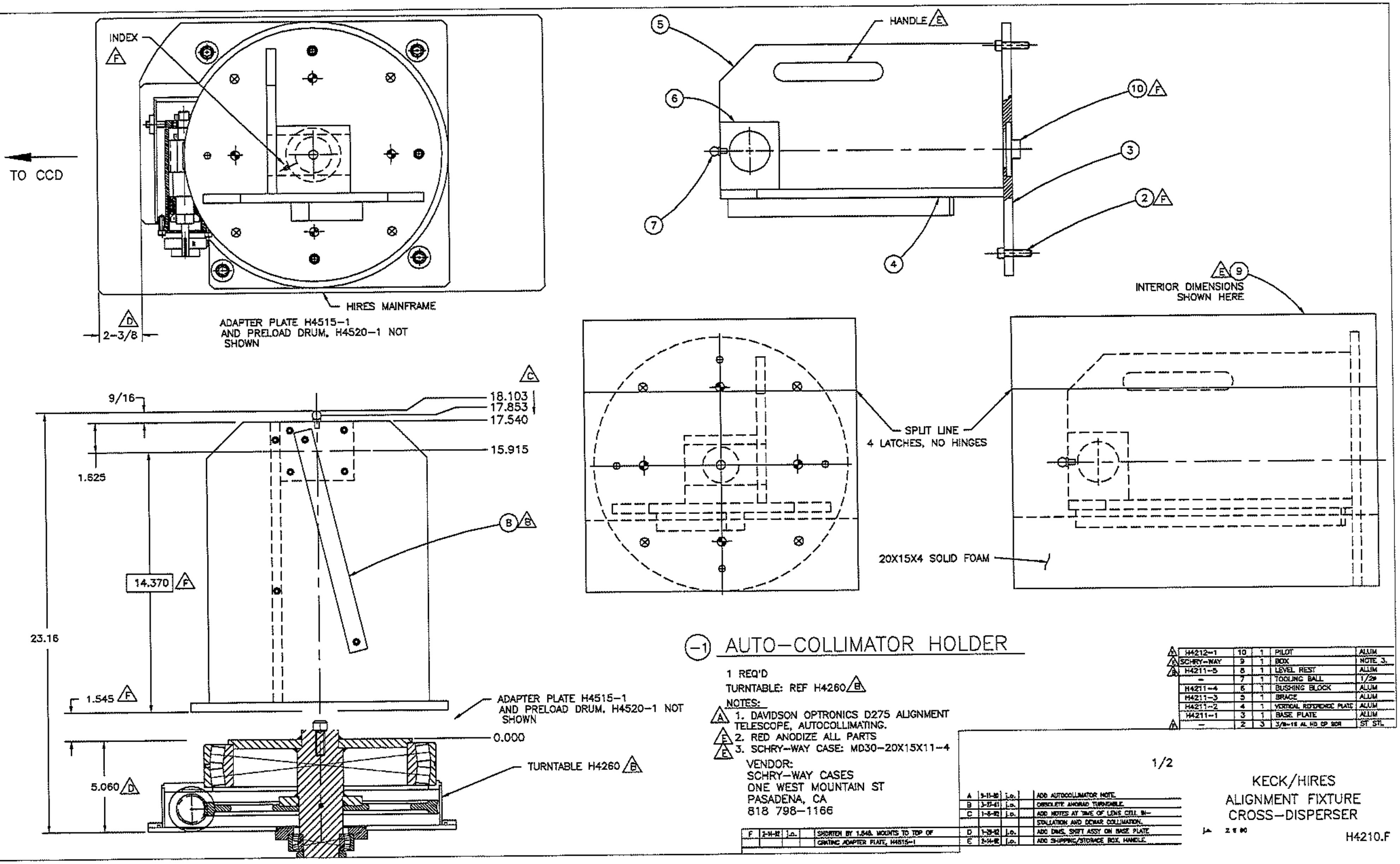
1/2

A	6/5/90	CAD		UPDATE PER S.VOGT REVIEW
				250 WAS 300, 5.3° WAS 8.4°, 12.88
				WAS 13, 64.7° WAS 64°.
B	1-6-93	j.o.		ADD ARROW PER MILTON ROY.
C	6-12-92	j.o.		ADD ALIGNMENT NOTES (ROTATIONS)

KECK/HIRES
CROSS DISPERSER
OPTICAL DETAIL

j.a. 7/7/89

H4026.C



-1 AUTO-COLLIMATOR HOLDER

1 REQ'D

TURNTABLE: REF H4260 B

NOTES:

A 1. DAVIDSON OPTRONICS D275 ALIGNMENT TELESCOPE, AUTOCOLLIMATING.

E 2. RED ANODIZE ALL PARTS

E 3. SCHRY-WAY CASE: MD30-20X15X11-4

VENDOR:
SCHRY-WAY CASES
ONE WEST MOUNTAIN ST
PASADENA, CA
818 798-1166

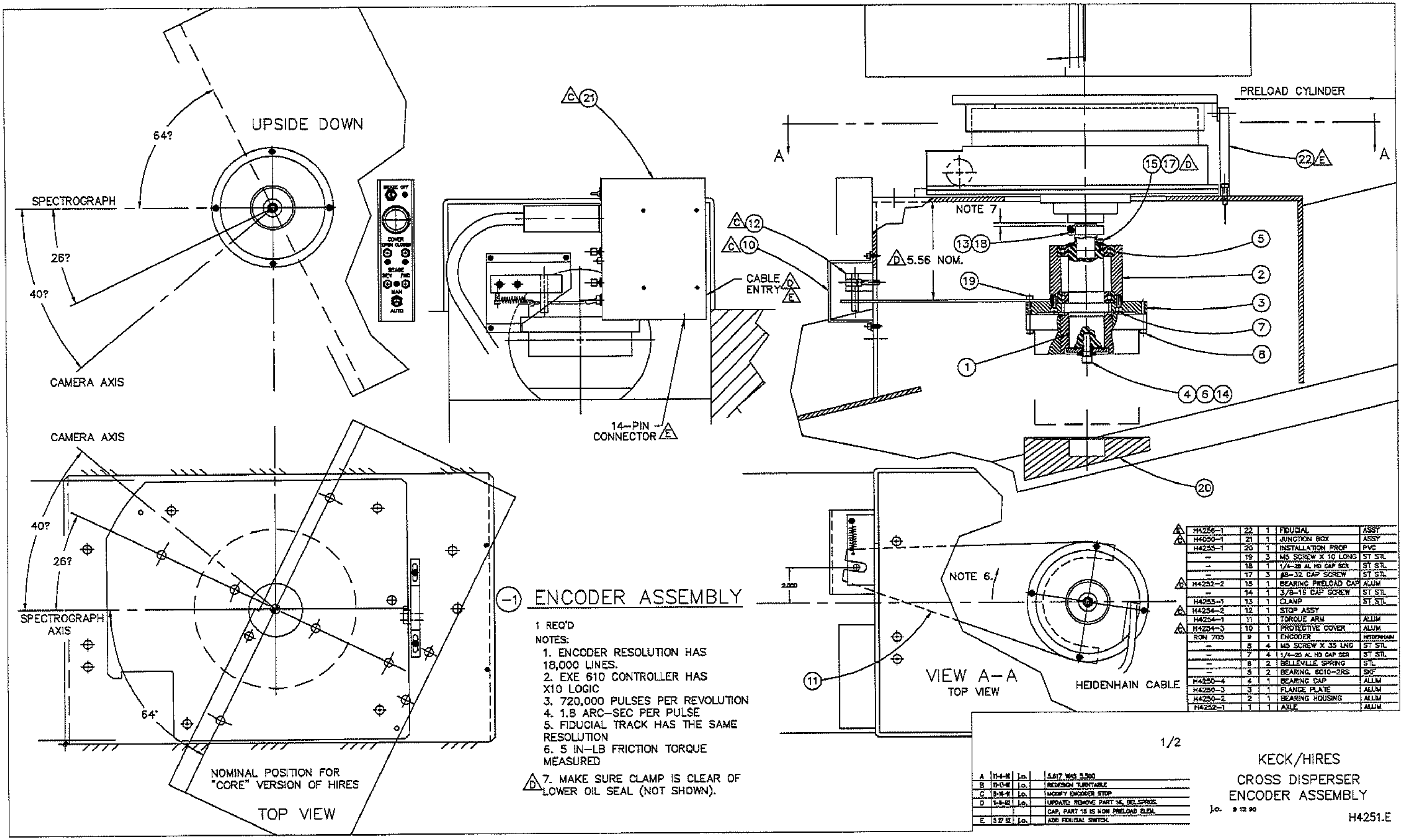
H4212-1	10	1	PILOT	ALUM
SCHRY-WAY	9	1	BOX	NOTE 3.
H4211-5	8	1	LEVEL REST	ALUM
–	7	1	TOOLING BALL	1/2ø
H4211-4	6	1	BUSHING BLOCK	ALUM
H4211-3	5	1	BRACE	ALUM
H4211-2	4	1	VERTICAL REFERENCE PLATE	ALUM
H4211-1	3	1	BASE PLATE	ALUM
–	2	3	3/8-16 AL HD CP SCR	ST STL

1/2

A	9-11-90	J.O.		ADD AUTOCOLLIMATOR NOTE.
B	3-27-91	J.O.		OBSOLETE ANORAD TURNTABLE.
C	1-6-92	J.O.		ADD NOTES AT TIME OF LENS CELL IN-STALLATION AND DEWAR COLLIMATION.
D	1-28-92	J.O.		ADD DIMS. SHIFT ASSY ON BASE PLATE.
E	2-14-92	J.O.		ADD SHIPPING/STORAGE BOX, HANDLE.
F	2-14-92	J.O.		SHORTEN BY 1.648. MOUNTS TO TOP OF GRATING ADAPTER PLATE, H4515-1

KECK/HIRES
ALIGNMENT FIXTURE
CROSS-DISPERSER

H4210.F



①1 ENCODER ASSEMBLY

1 REQ'D

NOTES:

1. ENCODER RESOLUTION HAS 18,000 LINES.
2. EXE 610 CONTROLLER HAS X10 LOGIC
3. 720,000 PULSES PER REVOLUTION
4. 1.8 ARC-SEC PER PULSE
5. FIDUCIAL TRACK HAS THE SAME RESOLUTION
6. 5 IN-LB FRICTION TORQUE MEASURED

D 7. MAKE SURE CLAMP IS CLEAR OF LOWER OIL SEAL (NOT SHOWN).

E	H4256-1	22	1	FIDUCIAL	ASSY
C	H4050-1	21	1	JUNCTION BOX	ASSY
	H4255-1	20	1	INSTALLATION PROP	PVC
	—	19	3	M5 SCREW X 10 LONG	ST STL
	—	18	1	1/4-20 AL HD CAP SCR	ST STL
	—	17	3	#8-32 CAP SCREW	ST STL
D	H4252-2	15	1	BEARING PRELOAD CAP	ALUM
	—	14	1	3/8-16 CAP SCREW	ST STL
	H4255-1	13	1	CLAMP	ST STL
C	H4254-2	12	1	STOP ASSY	
	H4254-1	11	1	TORQUE ARM	ALUM
C	H4254-3	10	1	PROTECTIVE COVER	ALUM
	RON 705	9	1	ENCODER	HEIDENHAIN
	—	8	4	M5 SCREW X 35 LNG	ST STL
	—	7	4	1/4-20 AL HD CAP SCR	ST STL
	—	8	2	BELLEVILLE SPRING	STL
	—	5	2	BEARING, 6010-2RS	SKF
	H4250-4	4	1	BEARING CAP	ALUM
	H4250-3	3	1	FLANGE PLATE	ALUM
	H4250-2	2	1	BEARING HOUSING	ALUM
	H4252-1	1	1	AXLE	ALUM

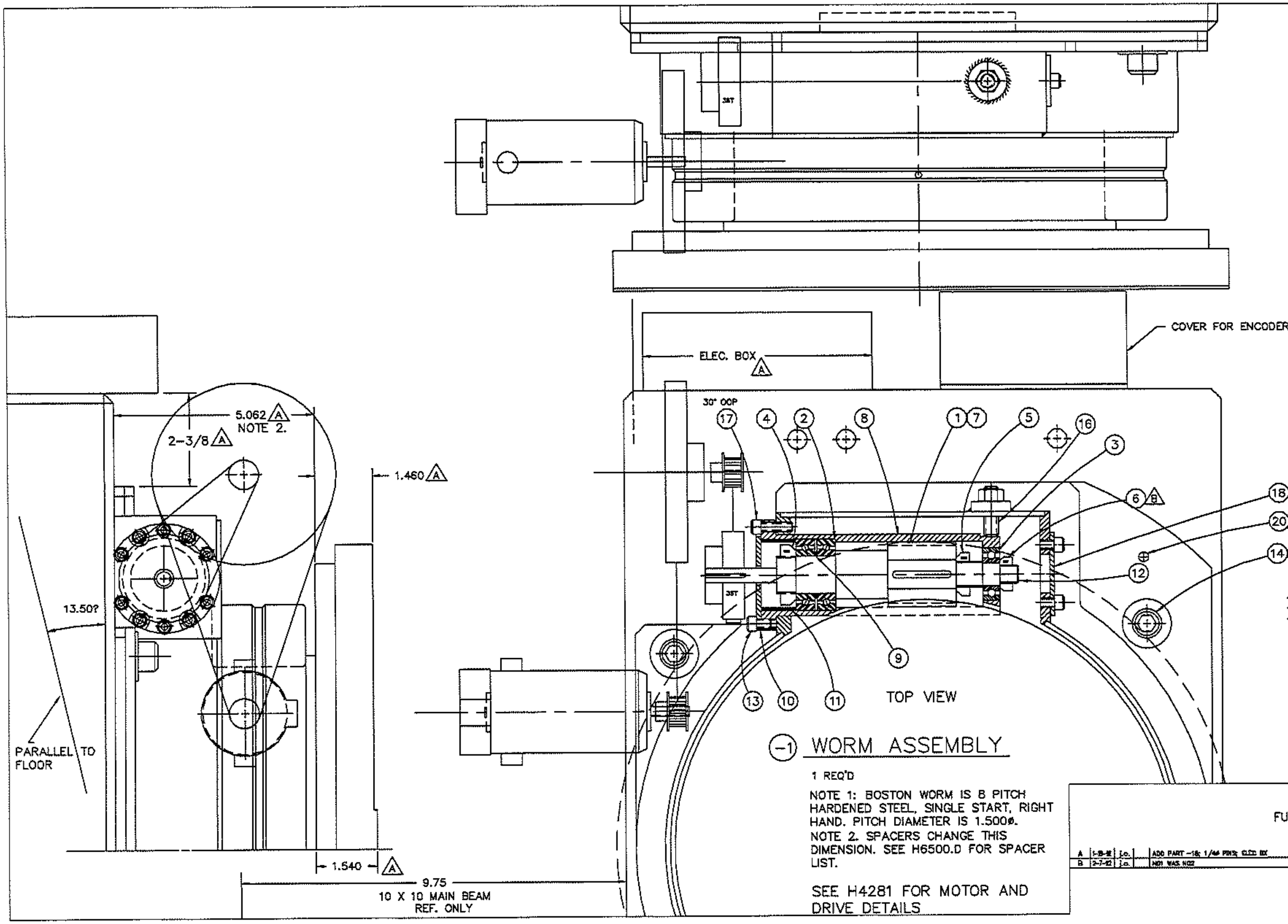
1/2

A	11-4-90	J.O.		5.617 WAS 5.500
B	12-13-90	J.O.		REDESIGN TURNTABLE
C	8-16-91	J.O.		MODIFY ENCODER STOP
D	1-8-92	J.O.		UPDATE: REMOVE PART 16, BEL.SPRGS.
				CAP, PART 15 IS NOW PRELOAD ELEM.
E	5 27 92	J.O.		ADD FIDUCIAL SWITCH.

KECK/HIRES
CROSS DISPERSER
ENCODER ASSEMBLY

J.O. 9 12 90

H4251.E



-1 WORM ASSEMBLY

1 REQ'D

NOTE 1: BOSTON WORM IS 8 PITCH HARDENED STEEL, SINGLE START, RIGHT HAND. PITCH DIAMETER IS 1.500ø.
NOTE 2. SPACERS CHANGE THIS DIMENSION. SEE H6500.D FOR SPACER LIST.

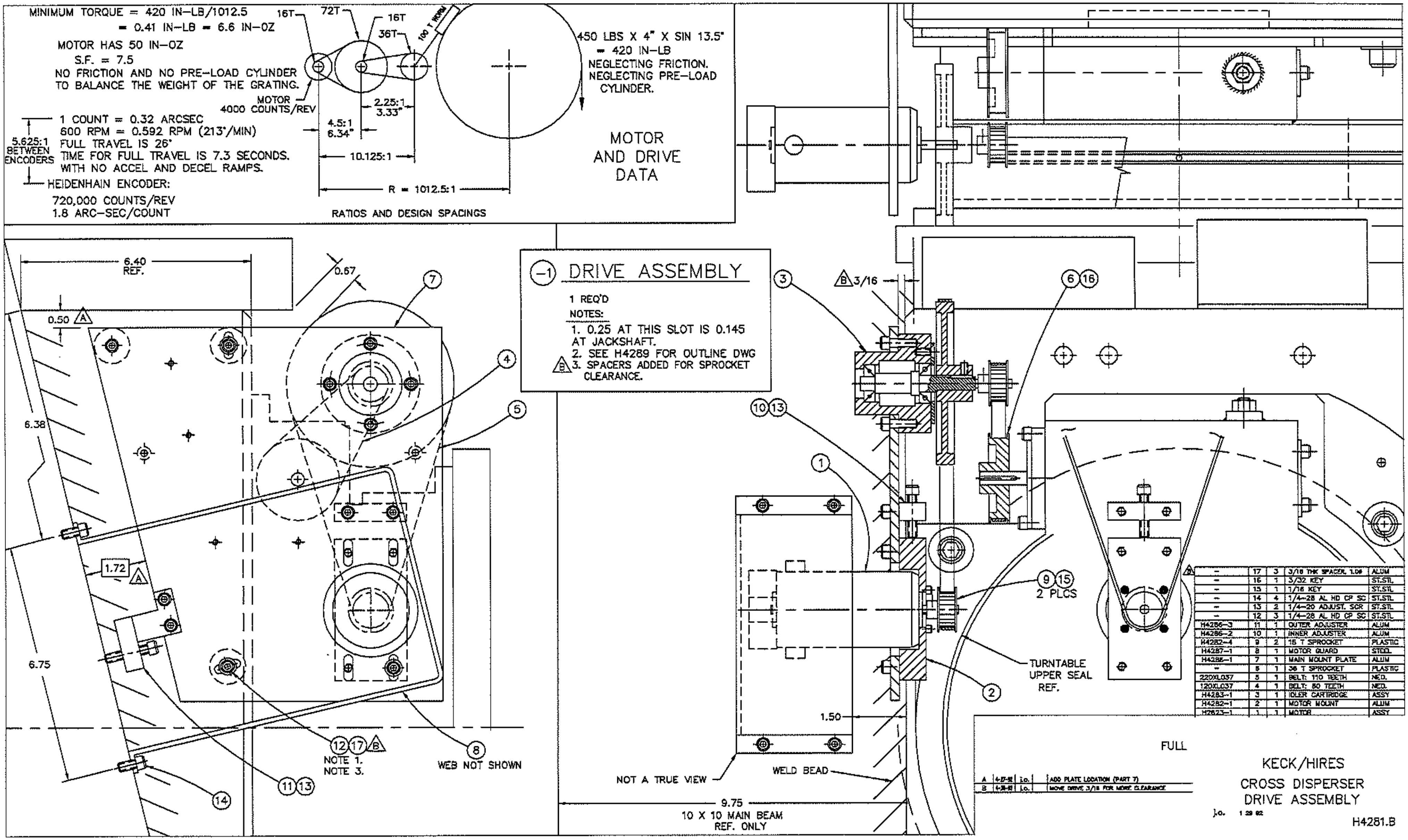
SEE H4281 FOR MOTOR AND DRIVE DETAILS

A	—	20	A/R	1/4ø DOWEL PIN	STEEL
A	—	19	1	GASKET	PAPER
A	H4279-1	18	1	COVER PLATE	ST STL
	—	17	4	#1/4-28 AHCS X 3/4 LNG	ST STL
	10 lb	16	1	VLIER PLUNGER	3/8-16
	—	15	4	1/2ø FLAT WASHER	ST.STL
	—	14	4	1/2-20 AL HD CP SC	ST STL
	—	13	6	#1/4-28 AHCS X 3/8 LNG	ST STL
	H4268-1	12	1	WORM SHAFT	ST.STL
	H4267-3	11	1	OUTER RACE SPACER	ST.STL
	H4267-2	10	1	LOCK RING	ST STL
	H4267-1	9	1	INNER RACE SPACER	ST STL
	H4266-1	8	1	WORM CARRIER	ST.STL
	—	7	1	3/16 KEY	ST STL
B	N01	6	1	SKF NUT	STL
	N03	5	1	SKF NUT	STL
	N05	4	1	SKF NUT	STL
	6202-2RS	3	1	SKF BALL BEARING	SKF
	6005-2RS	2	2	SKF BALL BEARING	SKF
	H1076RH	1	1	WORM	NOTE 1.

A	1-13-92	j.o.		ADD PART -18; 1/4ø PINS; ELEC BX
B	2-7-92	j.o.		N01 WAS N02

FULL

KECK/HIRES
CROSS DISPERSER TURNTABLE
WORM HOUSING ASSEMBLY
j.o. 12 12 90
H4264.B



MINIMUM TORQUE = 420 IN-LB/1012.5
= 0.41 IN-LB = 6.6 IN-OZ
MOTOR HAS 50 IN-OZ
S.F. = 7.5
NO FRICTION AND NO PRE-LOAD CYLINDER
TO BALANCE THE WEIGHT OF THE GRATING.

1 COUNT = 0.32 ARCSEC
600 RPM = 0.592 RPM (213°/MIN)
FULL TRAVEL IS 26°
TIME FOR FULL TRAVEL IS 7.3 SECONDS.
WITH NO ACCEL AND DECEL RAMPS.
5.625:1 BETWEEN ENCODERS
HEIDENHAIN ENCODER:
720,000 COUNTS/REV
1.8 ARC-SEC/COUNT

450 LBS X 4" X SIN 13.5°
= 420 IN-LB
NEGLECTING FRICTION.
NEGLECTING PRE-LOAD
CYLINDER.

MOTOR
AND DRIVE
DATA

⊖1 DRIVE ASSEMBLY

1 REQ'D

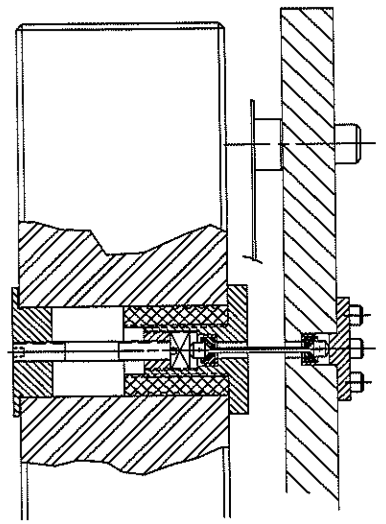
NOTES:

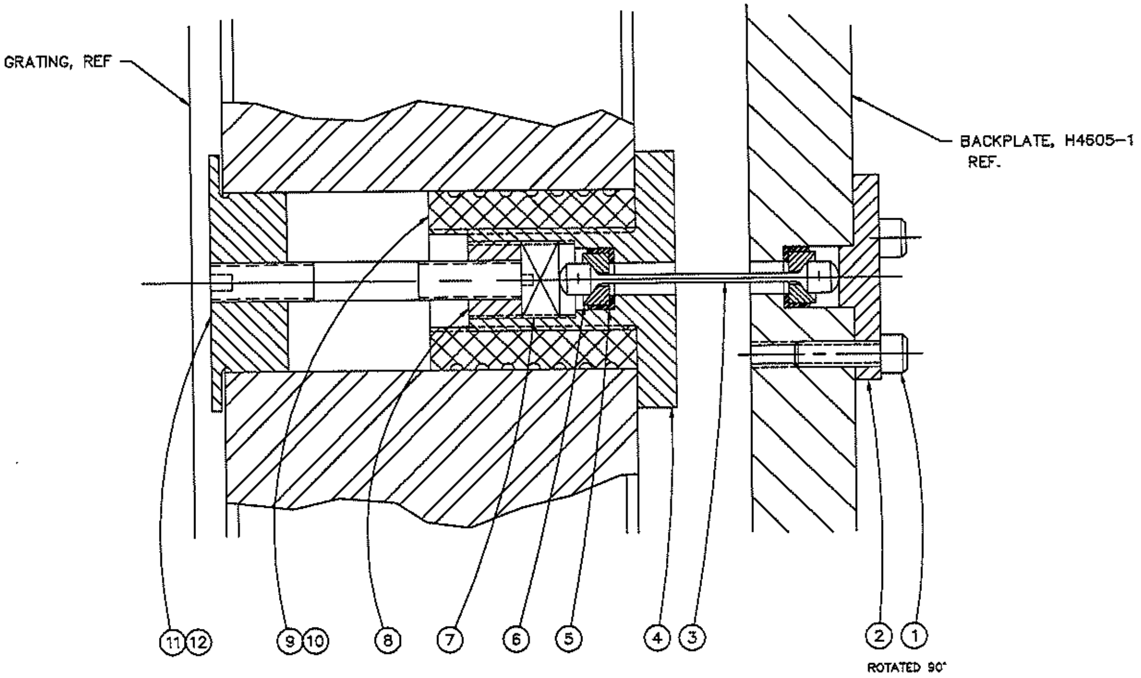
1. 0.25 AT THIS SLOT IS 0.145 AT JACKSHAFT.
2. SEE H4289 FOR OUTLINE DWG
3. B SPACERS ADDED FOR SPROCKET CLEARANCE.

–	17	3	3/16 THK SPACER, 1.0#	ALUM
–	16	1	3/32 KEY	ST.STL
–	15	1	1/16 KEY	ST.STL
–	14	4	1/4–28 AL HD CP SC	ST.STL
–	13	2	1/4–20 ADJUST. SCR	ST.STL
–	12	3	1/4–28 AL HD CP SC	ST.STL
H4286–3	11	1	OUTER ADJUSTER	ALUM
H4286–2	10	1	INNER ADJUSTER	ALUM
H4282–4	9	2	15 T SPROCKET	PLASTIC
H4287–1	8	1	MOTOR GUARD	STEEL
H4288–1	7	1	MAIN MOUNT PLATE	ALUM
–	6	1	36 T SPROCKET	PLASTIC
220XL037	5	1	BELT: 110 TEETH	NEO.
120XL037	4	1	BELT: 60 TEETH	NEO.
H4283–1	3	1	IDLER CARTRIDGE	ASSY
H4282–1	2	1	MOTOR MOUNT	ALUM
H2623–1	1	1	MOTOR	ASSY

A	4-27-92	j.o.		ADD PLATE LOCATION (PART 7)
B	4-28-92	j.o.		MOVE DRIVE 3/16 FOR MORE CLEARANCE

KECK/HIRES
CROSS DISPERSER
DRIVE ASSEMBLY
j.o. 1 29 92
H4281.B





2X SIZE

H3310-6	12	1	3/8x24 STUD	ST STL
H3310-5	11	1	SAFETY NUT	ST STL
BY OTHERS	10	A/R	ADHESIVE	
H4475-1	9	1	1x14 INSERT	ST STL
H3310-4	8	1	LOCK	ST STL
H3310-3	7	1	PLUG	17-4-PH
H3320-3	6	2PR	SPLIT COLLAR	17-4-PH
H3320-2	5	2	RETAINER	17-4-PH
H3310-2	4	1	HOLDER	ST STL
H3320-1	3	1	COLUMN	17-4-PH
H3310-1	2	1	CAP	ST STL
-	1	3	1/4x20 AHCS	ST STL

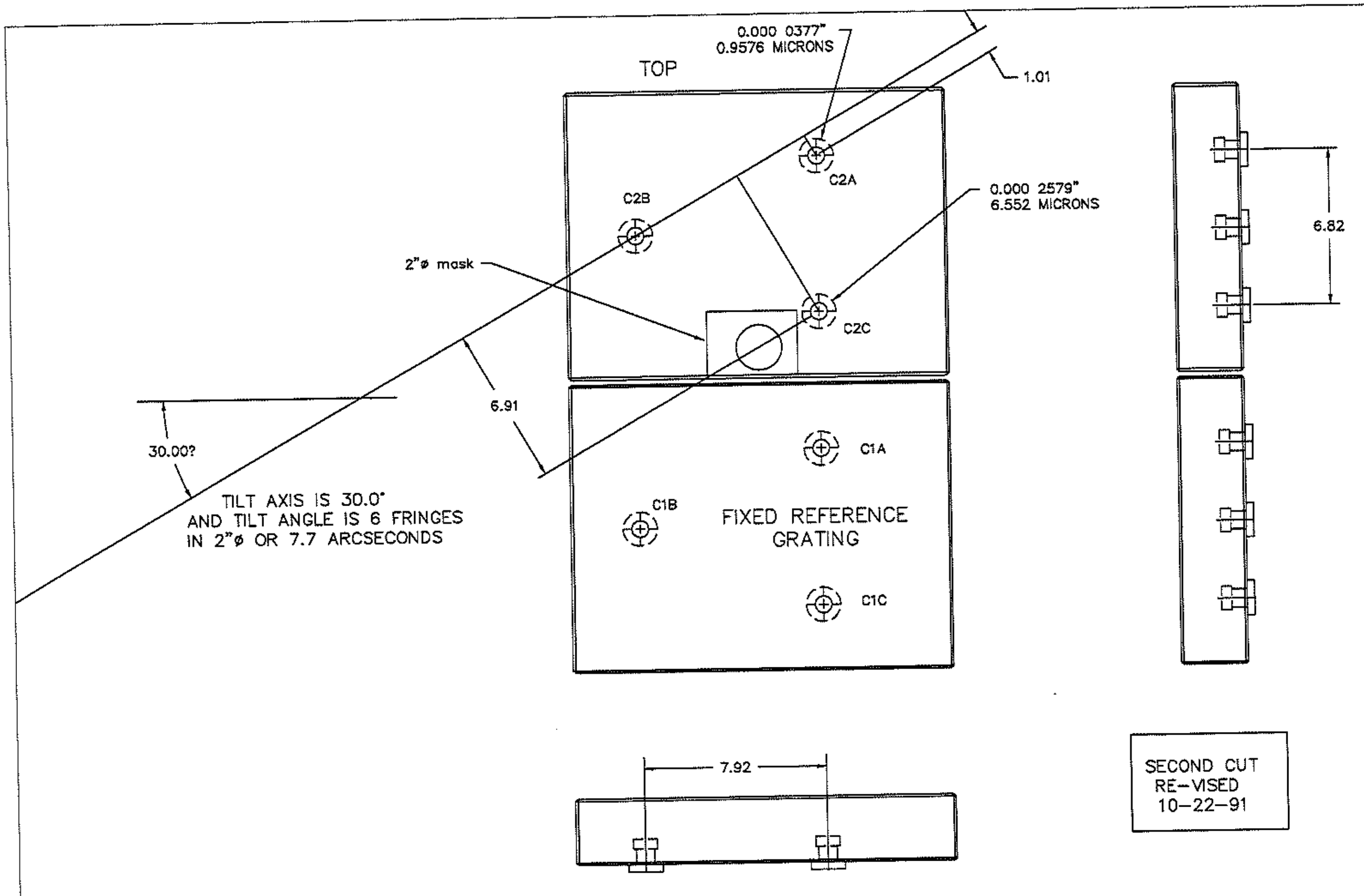
⊖1 COLUMN SUPPORT

3 REQ'D
FOR ASSY/DISASSY, SEE H3320

REV

FULL

KECK/HIRES
CROSS DISPERSER SUBPLATE
COLUMN SUPPORT ASSY
ja 8 29 98
ja 9 11 98
H4300

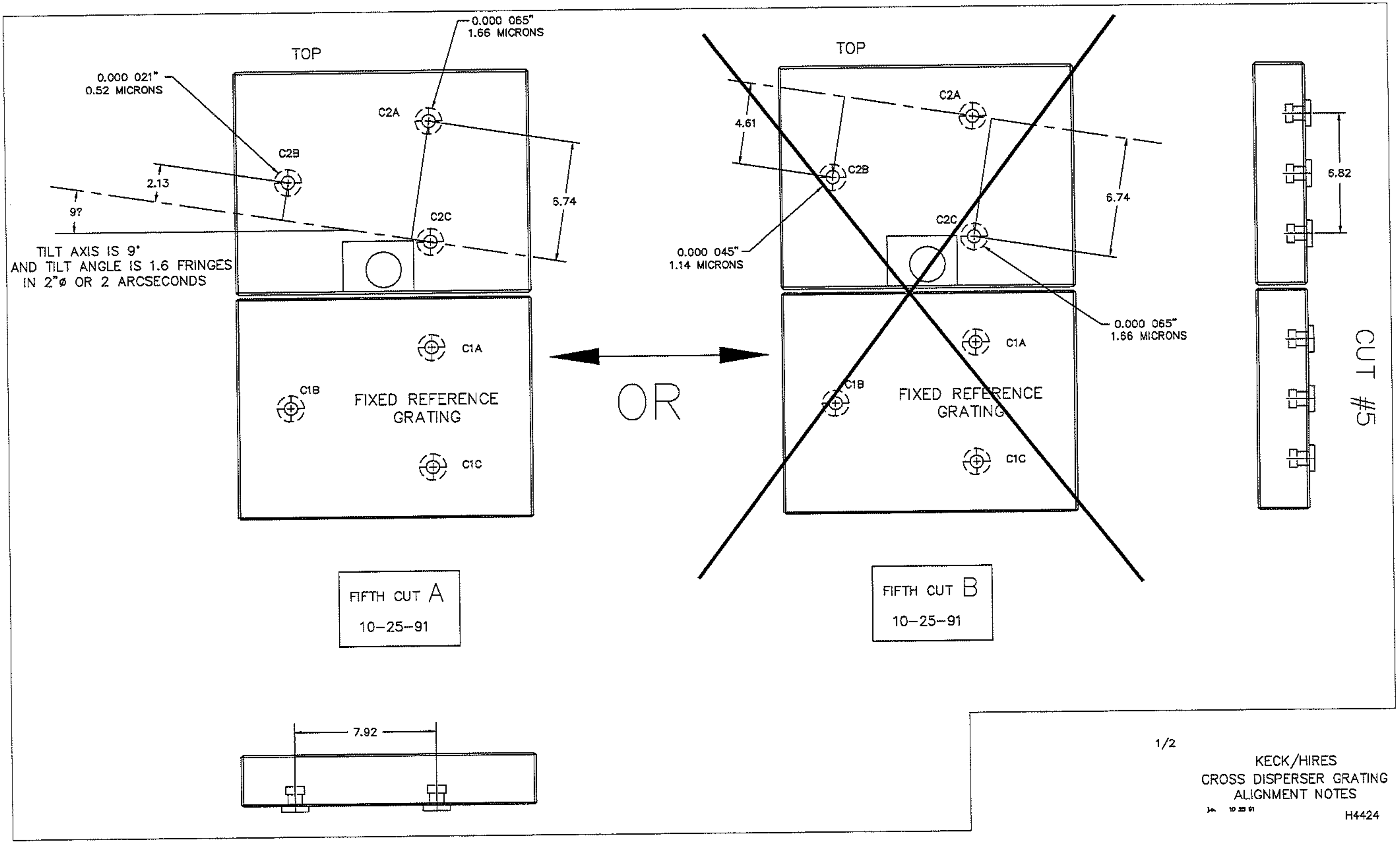


TILT AXIS IS 30.0°
AND TILT ANGLE IS 6 FRINGES
IN 2"ø OR 7.7 ARCSECONDS

SECOND CUT
RE-VISED
10-22-91

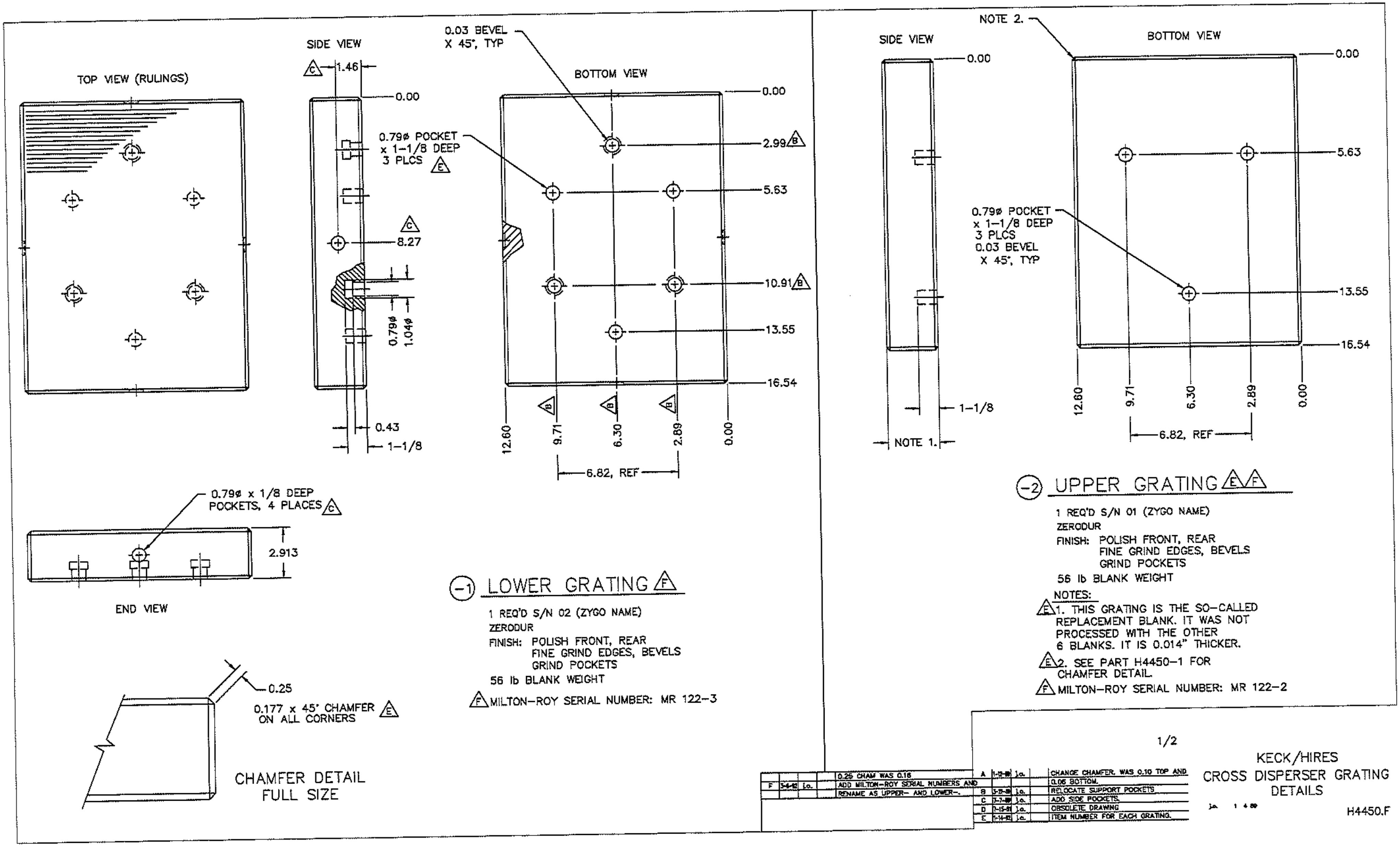
1/2

KECK/HIRES
CROSS DISPERSER GRATING
ALIGNMENT NOTES
ja 10 22 91
H4421



1/2

KECK/HIRES
CROSS DISPERSER GRATING
ALIGNMENT NOTES
ja. 10 25 91
H4424



⊖1 LOWER GRATING △F

1 REQ'D S/N 02 (ZYGO NAME)
ZERODUR
FINISH: POLISH FRONT, REAR
FINE GRIND EDGES, BEVELS
GRIND POCKETS
56 lb BLANK WEIGHT

△F MILTON-ROY SERIAL NUMBER: MR 122-3

⊖2 UPPER GRATING △E△F

1 REQ'D S/N 01 (ZYGO NAME)
ZERODUR
FINISH: POLISH FRONT, REAR
FINE GRIND EDGES, BEVELS
GRIND POCKETS
56 lb BLANK WEIGHT

NOTES:

△E 1. THIS GRATING IS THE SO-CALLED REPLACEMENT BLANK. IT WAS NOT PROCESSED WITH THE OTHER 6 BLANKS. IT IS 0.014" THICKER.

△E 2. SEE PART H4450-1 FOR CHAMFER DETAIL.

△F MILTON-ROY SERIAL NUMBER: MR 122-2

1/2

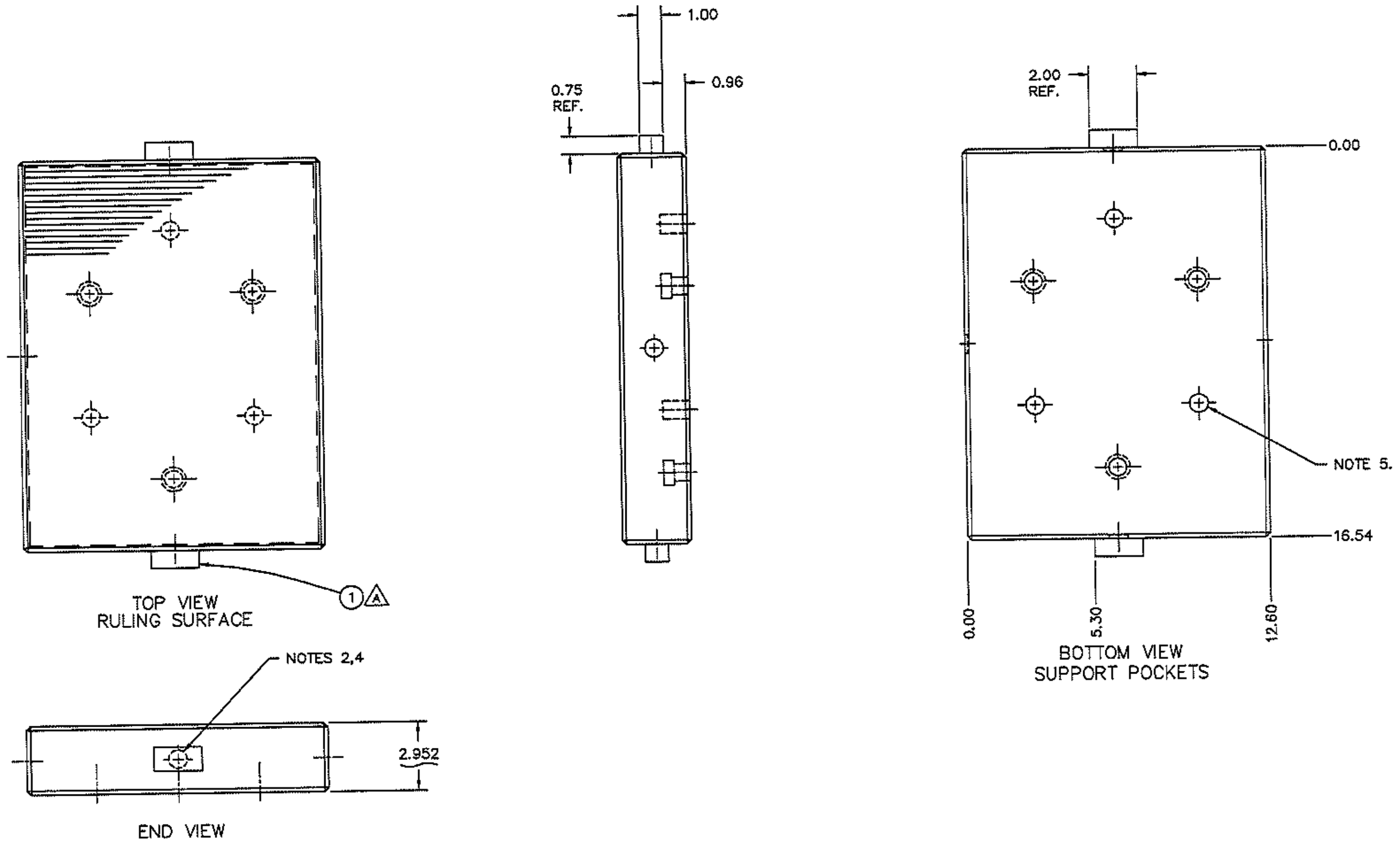
				0.25 CHAM WAS 0.16
F	3-4-92	j.o.		ADD MILTON-ROY SERIAL NUMBERS AND
				RENAME AS UPPER- AND LOWER-.

A	1-12-89	j.o.		CHANGE CHAMFER. WAS 0.10 TOP AND
				0.06 BOTTOM.
B	3-22-89	j.o.		RELOCATE SUPPORT POCKETS
C	7-7-89	j.o.		ADD SIDE POCKETS.
D	7-15-91	j.o.		OBSOLETE DRAWING
E	1-14-92	j.o.		ITEM NUMBER FOR EACH GRATING.

KECK/HIRES
CROSS DISPERSER GRATING
DETAILS

j.o. 1 4 89

H4450.F



(-1) CROSS–DISPERSER GRATING A

2 REQ'D

NOTES:

1. GRATING H4450–1 IS SHOWN ("REPLACEMENT GRATING")
2. GRATING H4450–2 HAS NO SIDE POCKETS.
3. GLUE NOTES ON H3040.A: HYSOL EA 9313
   EPOXY RESIN; 5 DAY CURE TIME.
4. FILL POCKET WITH RTV BEFORE GLUEING.
5. GRATING H4450–2 HAS ONLY 3 REAR POCKETS.

PER ASSY

H3525–2	1	2	PAD	ZERODUR

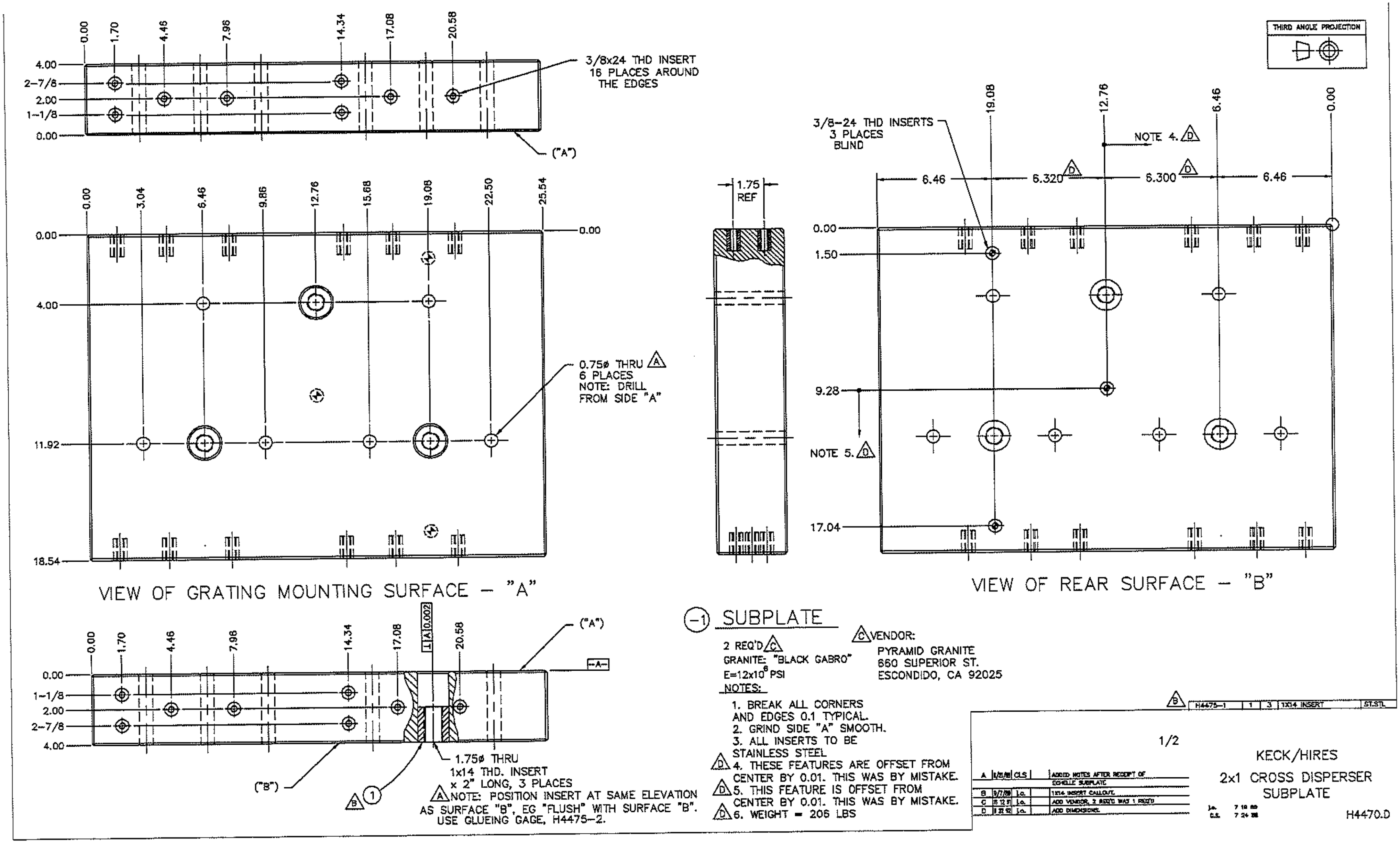
1/2

A	1 23 93	J.o.	ADD PART CALLOUT, RE–NAME ASSY

KECK/HIRES
GRATING AND END PADS
GLUE DETAIL

J.o. 7 23 92

H4454.A



VIEW OF GRATING MOUNTING SURFACE – "A"

VIEW OF REAR SURFACE – "B"

A NOTE: POSITION INSERT AT SAME ELEVATION AS SURFACE "B", EG "FLUSH" WITH SURFACE "B". USE GLUEING GAGE, H4475-2.

(-1) SUBPLATE

2 REQ'D C
GRANITE: "BLACK GABRO"
E=12x10^6 PSI

C VENDOR:
PYRAMID GRANITE
660 SUPERIOR ST.
ESCONDIDO, CA 92025

NOTES:

1. BREAK ALL CORNERS AND EDGES 0.1 TYPICAL.
2. GRIND SIDE "A" SMOOTH.
3. ALL INSERTS TO BE STAINLESS STEEL
D 4. THESE FEATURES ARE OFFSET FROM CENTER BY 0.01. THIS WAS BY MISTAKE.
D 5. THIS FEATURE IS OFFSET FROM CENTER BY 0.01. THIS WAS BY MISTAKE.
D 6. WEIGHT = 206 LBS

B H4475-1	1	3	1X14 INSERT	ST.STL

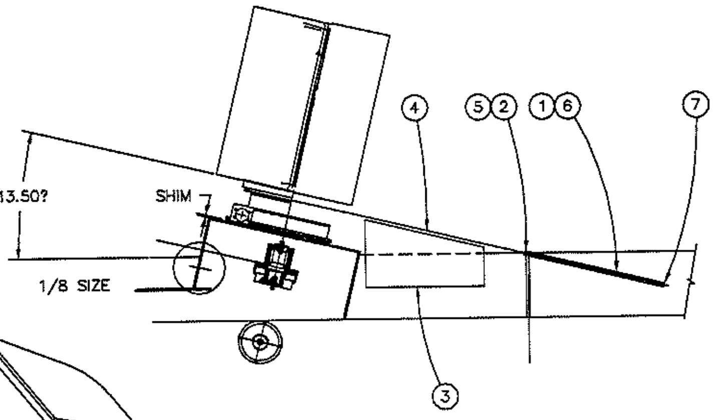
1/2

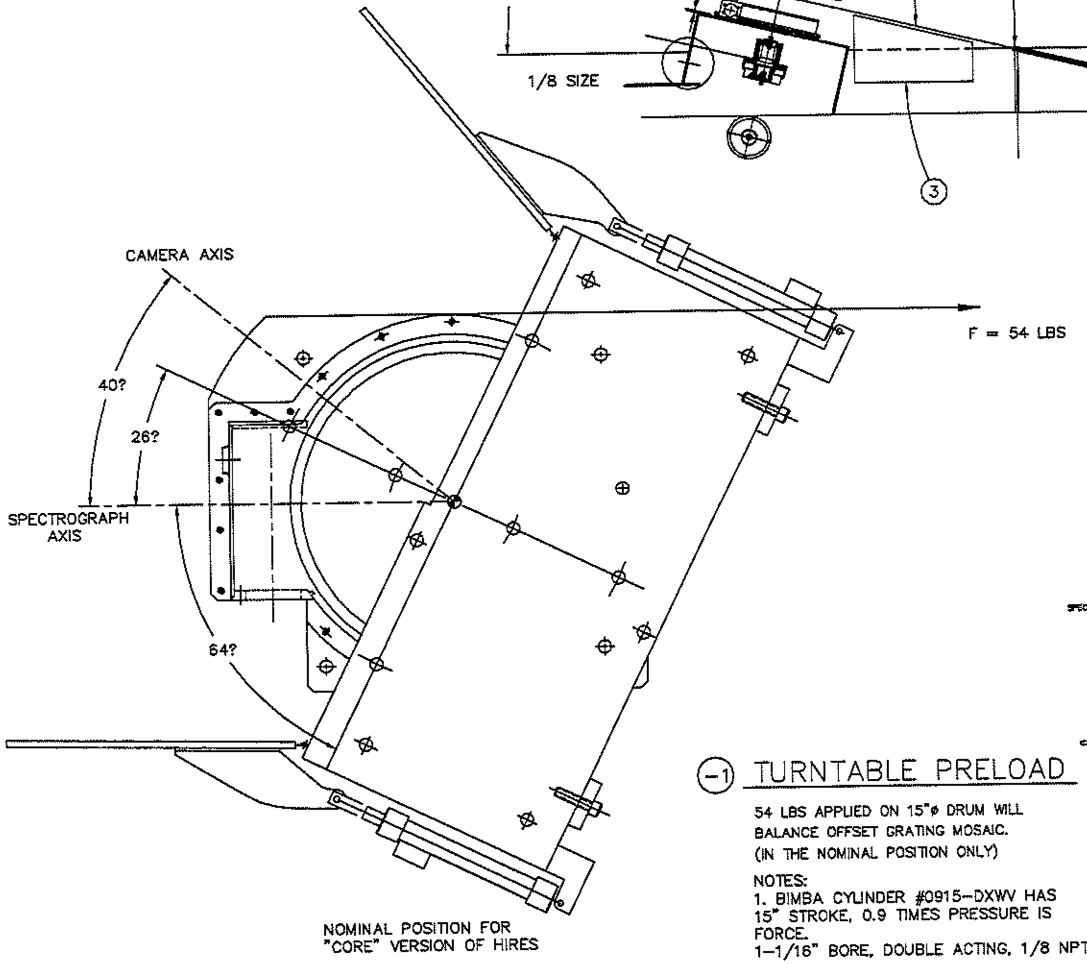
A	[illegible]	CLS		ADDED NOTES AFTER RECEIPT OF ECHELLE SUBPLATE.
B	9/7/89	J.o.		1X14 INSERT CALLOUT.
C	11 12 91	J.o.		ADD VENDOR, 2 REQ'D WAS 1 REQ'D
D	1 22 92	J.o.		ADD DIMENSIONS.

KECK/HIRES
2x1 CROSS DISPERSER
SUBPLATE

J.o. 7 19 89
C.S. 7 24 [illegible]

H4470.D



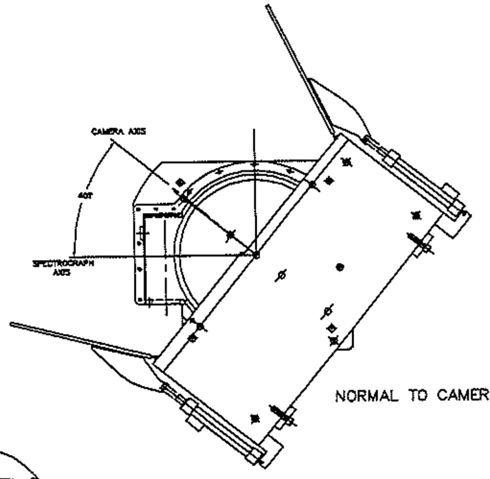


NOMINAL POSITION FOR
"CORE" VERSION OF HIRES

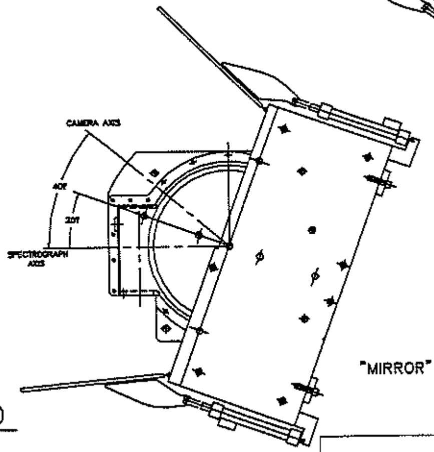
⊖1 TURNTABLE PRELOAD

54 LBS APPLIED ON 15"ϕ DRUM WILL
BALANCE OFFSET GRATING MOSAIC.
(IN THE NOMINAL POSITION ONLY)

NOTES:
1. BIMBA CYLINDER #0915-DXWV HAS
15" STROKE, 0.9 TIMES PRESSURE IS
FORCE.
1-1/16" BORE, DOUBLE ACTING, 1/8 NPT THDS.



NORMAL TO CAMERA, ROTATED -13°



"MIRROR" MODE, ROTATED +6°

D-13498-A	7	1	PIVOT BRACKET (PAIR)	BIMBA
D-166-1	6	1	PISTON ROD CLEVIS	BIMBA
D-9	5	1	BIMBA MOUNTING NUT	ALUM
H4513-3	4	1	STRAP	ST STL
H4513-2	3	1	GUIDE PLATE	ALUM
H4513-1	2	1	CYLINDER MOUNT	ALUM
-	1	1	AIR CYLINDER	NOTE 1.

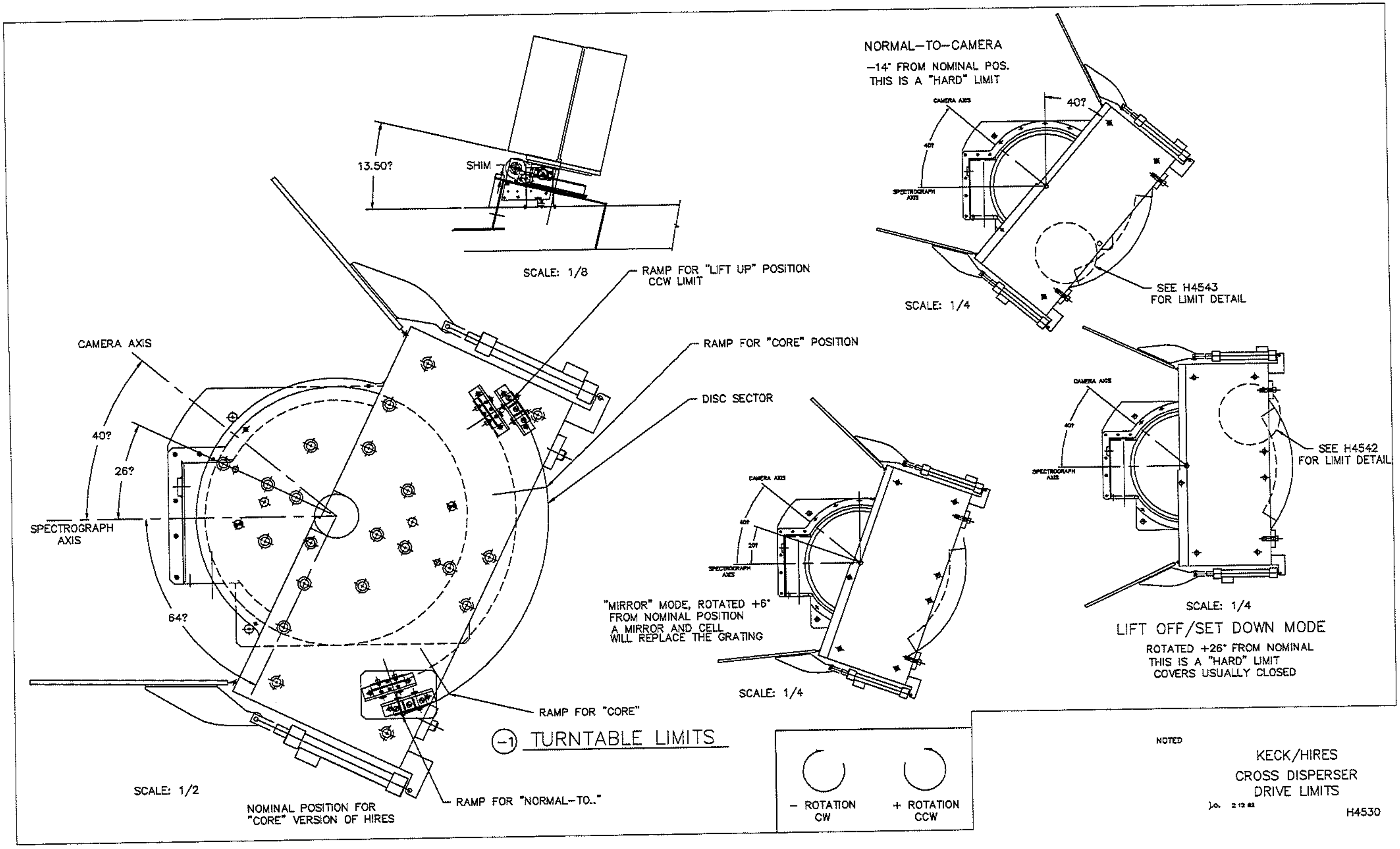
1/2

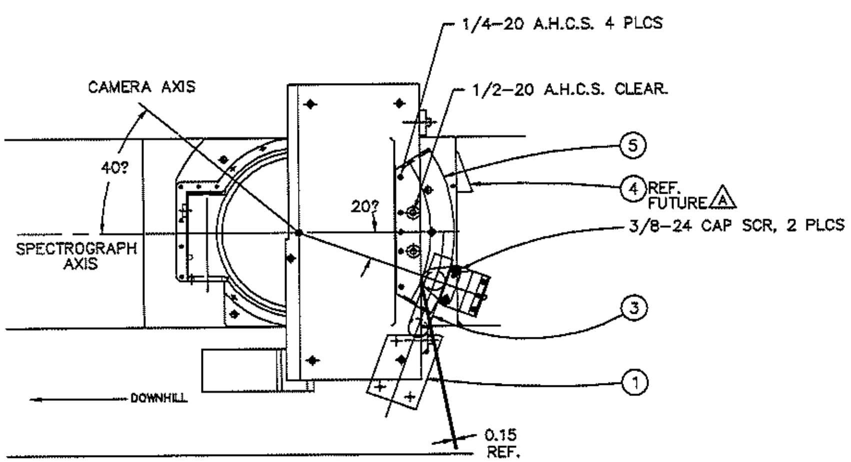
A | 1 13 92 | J.O. | | REPLACE ANORAD TURNTABLE W/H4260-1

KECK/HIRES
CROSS DISPERSER
PRELOAD DETAIL

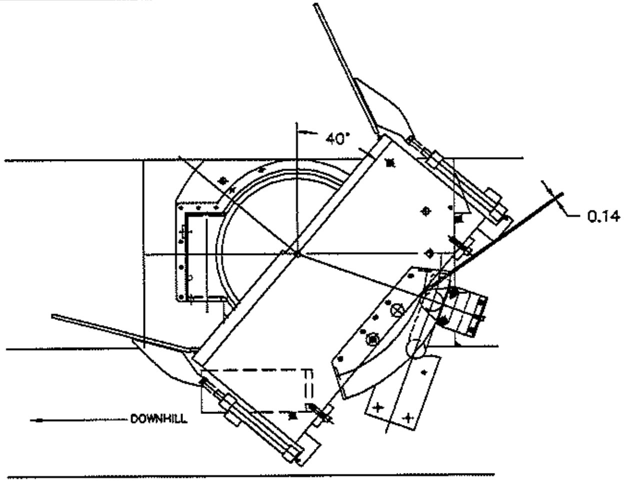
J.O. 8 30 90

H4511.A

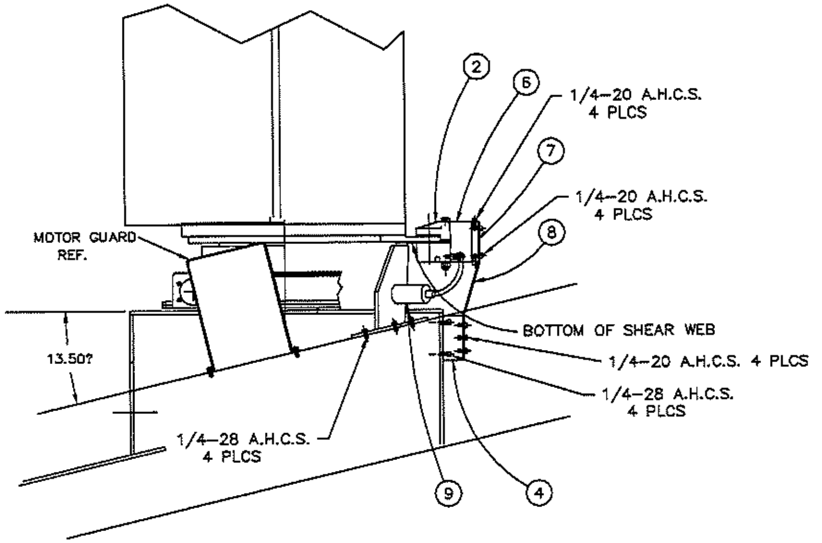

NORMAL–TO–CAMERA
–14° FROM NOMINAL POS.
THIS IS A "HARD" LIMIT
40?
CAMERA AXIS
40?
SPECTROGRAPH AXIS
SEE H4543
FOR LIMIT DETAIL
SCALE: 1/4
13.50?
SHIM
SCALE: 1/8
RAMP FOR "LIFT UP" POSITION
CCW LIMIT
RAMP FOR "CORE" POSITION
DISC SECTOR
CAMERA AXIS
40?
26?
SPECTROGRAPH
AXIS
64?
CAMERA AXIS
40?
20?
SPECTROGRAPH AXIS
"MIRROR" MODE, ROTATED +6°
FROM NOMINAL POSITION
A MIRROR AND CELL
WILL REPLACE THE GRATING
SCALE: 1/4
CAMERA AXIS
40?
SPECTROGRAPH AXIS
SEE H4542
FOR LIMIT DETAIL
SCALE: 1/4
LIFT OFF/SET DOWN MODE
ROTATED +26° FROM NOMINAL
THIS IS A "HARD" LIMIT
COVERS USUALLY CLOSED
RAMP FOR "CORE"
-1 TURNTABLE LIMITS
SCALE: 1/2
NOMINAL POSITION FOR
"CORE" VERSION OF HIRES
RAMP FOR "NORMAL–TO.."
– ROTATION
CW
+ ROTATION
CCW
NOTED
KECK/HIRES
CROSS DISPERSER
DRIVE LIMITS
J.O. 2 12 92
H4530

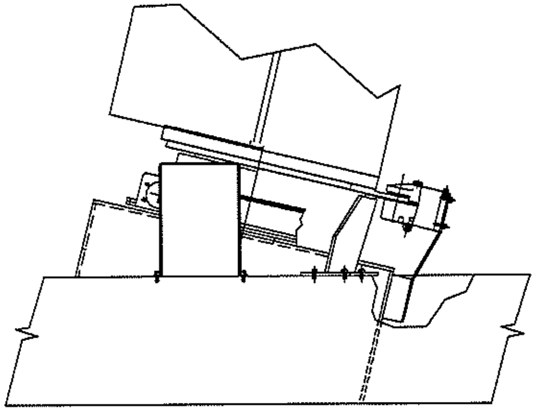


ROTATED +26° FROM NOMINAL
THIS IS A "HARD" LIMIT
COVERS ARE CLOSED



NORMAL TO CAMERA, ROTATED -14°
FROM NOMINAL POSITION
THIS IS A "HARD" LIMIT





-1 BRAKE

NOTES:

1. BRAKE FUNCTION IS "NORMALLY ON" THAT IS, WHENEVER THERE IS AIR PRESSURE IN THE HIRES ENCLOSURE, THE BRAKE WILL BE PREVENTING THE STAGE FROM ROTATING. A SIGNAL TO THE SOLENOID VALVE TO STOP THE AIR WILL BE PRESENT BEFORE DRIVING THE STAGE.
2. SEE ALSO H4533 FOR LIMITS
3. B SKINNER #V55LB2150-23A. 3-WAY SOLENOID VALVE. 11 WATTS. 1/4NPT PORTS, SS BODY, 1/2NPT CONDUIT OUTLET.

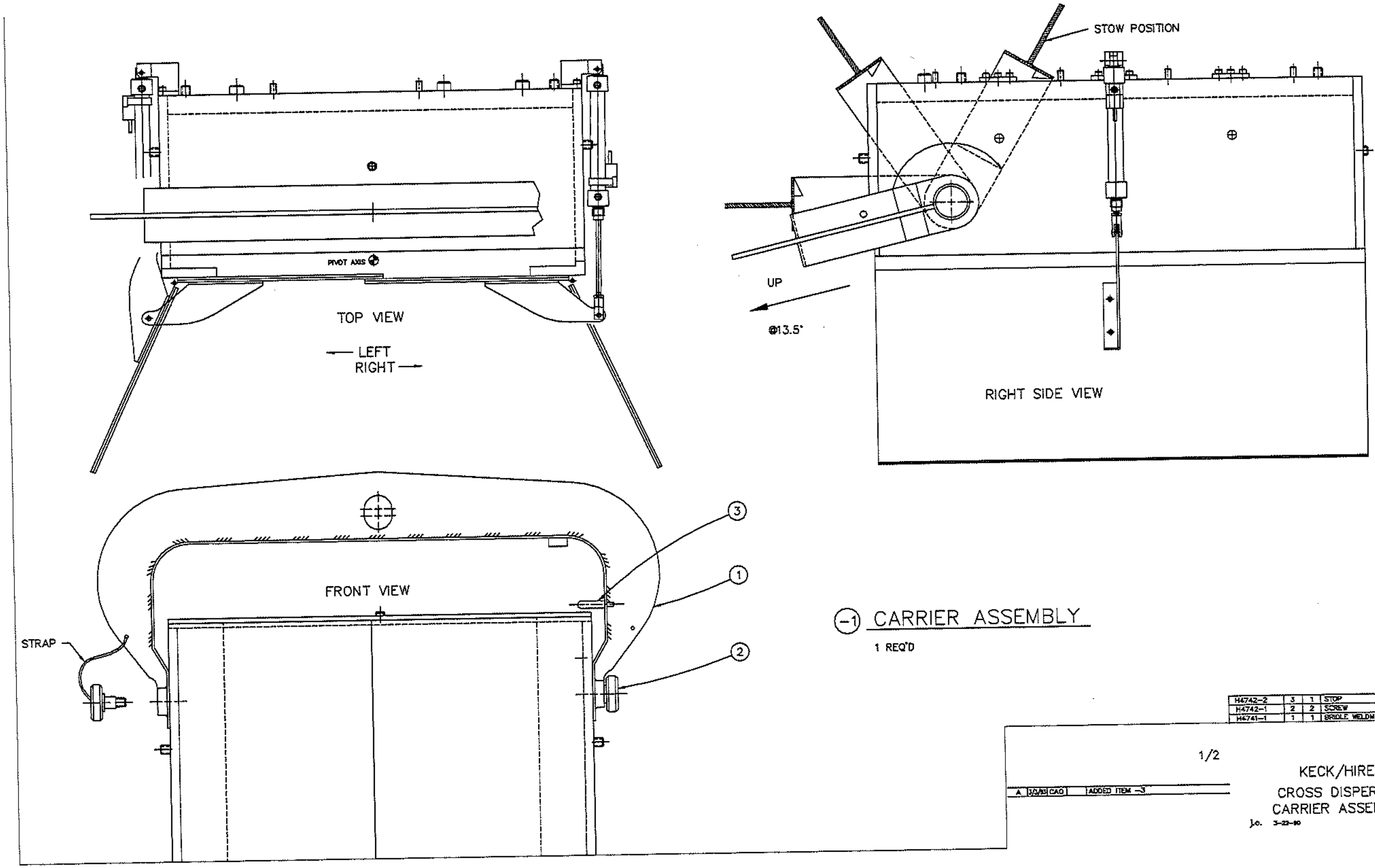
B	-	9	1	SOLENOID VALVE	NOTE 3.
	H4540-3	8	1	BRACKET	STEEL
	H4540-2	7	1	PLATE	ALUM
	H4540-1	6	2	FLEX PLATE	ST.STL
	H4539-1	5	1	DISC SECTOR	ALUM
	H4537-1	4	2	MOUNT BLOCK	ALUM
	H4537-1	3	1	SHEAR WEB	ST.STL.
	H4536-1	2	1	TOL-O-MATIC BRAKE	
	H4535-1	1	1	SHEAR WEB MOUNT	STEEL

1/4

A	4-30-92	J.O.		UPDATE TO AS-BUILT CONDITION.
B	8-31-92	J.O.		ADD NOTE 3.

KECK/HIRES
CROSS-DISPERSER
BRAKE SUPPORT ASSY
J.O. 3 20 92

H4534.B



⊖1 CARRIER ASSEMBLY

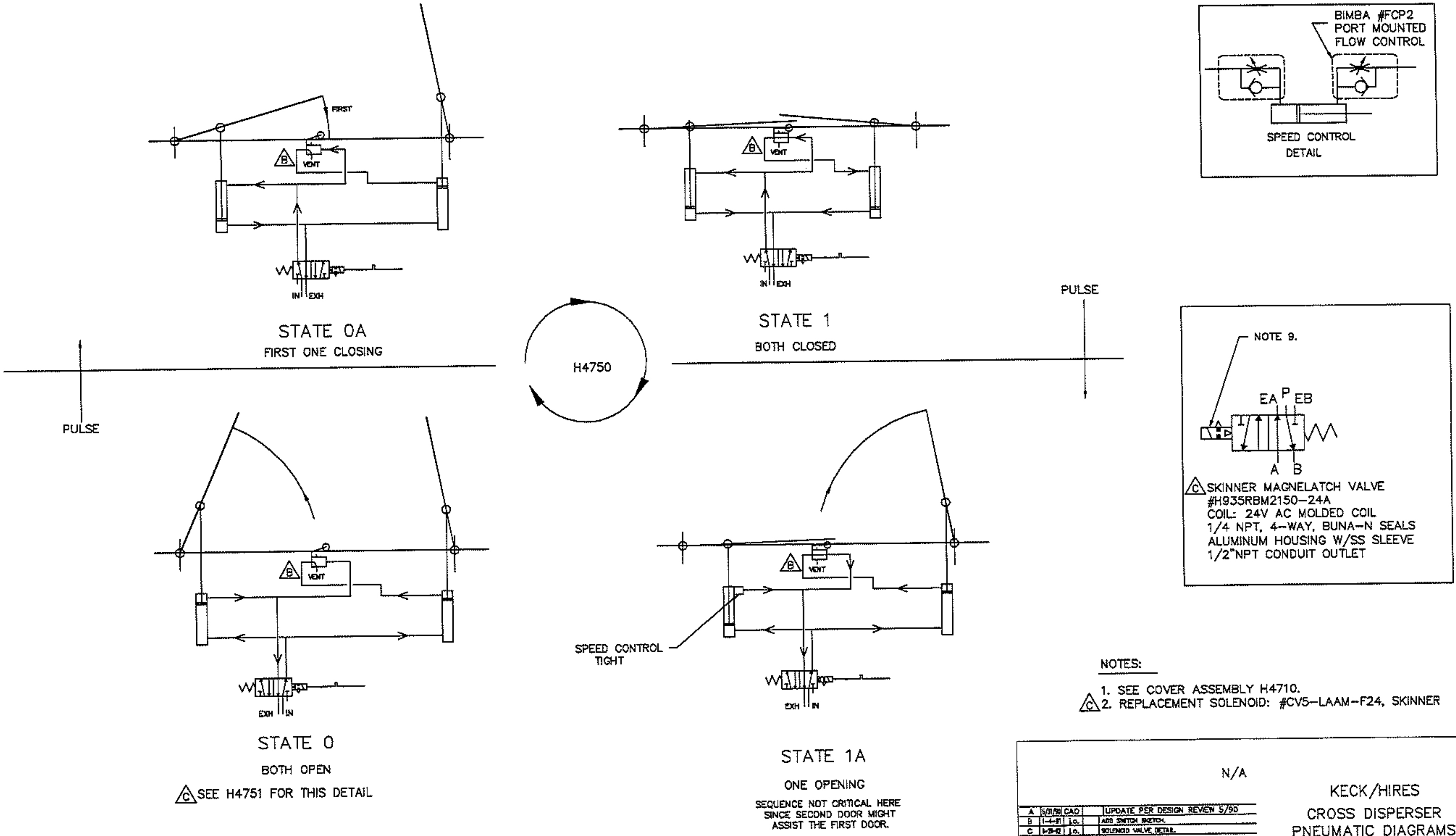
1 REQ'D

H4742-2	3	1	STOP	RUBBER
H4742-1	2	2	SCREW	ST STL
H4741-1	1	1	BRIDLE WELDMENT	STL

1/2

A	3/3/93	CAO		ADDED ITEM -3

KECK/HIRES
CROSS DISPERSER
CARRIER ASSEMBLY
J.o. 3-22-90
H4740.A



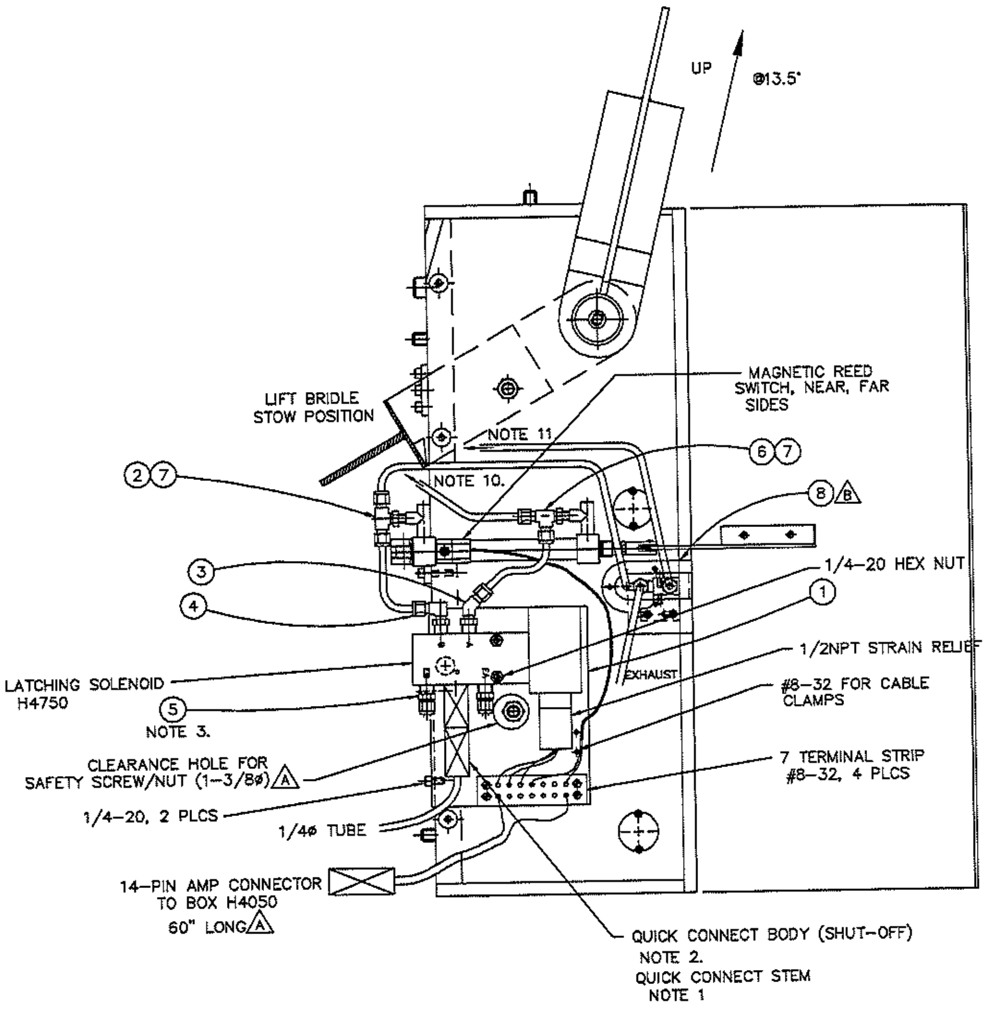
NOTES:

1. SEE COVER ASSEMBLY H4710.
C 2. REPLACEMENT SOLENOID: #CV5-LAAM-F24, SKINNER

N/A

A	5/31/90	CAO		UPDATE PER DESIGN REVIEW 5/90
B	1-4-91	J.O.		ADD SWITCH SKETCH.
C	1-29-92	J.O.		SOLENOID VALVE DETAIL.

KECK/HIRES
CROSS DISPERSER
PNEUMATIC DIAGRAMS
J.O. 7 24 89
H4750.C



LEFT SIDE VIEW

⊖1 AIR SOLENOID DETAIL

NOTES:

1. SWAGELOK B–QC4–S–4PM (1/4 NPT, MALE)
2. SWAGELOK B–QC4–B–400 (1/4⌀ TUBE)
3. EXHAUST PORTS USE SWAGELOK 1/4⌀ TUBE
4. SWAGELOK B–400–3TMT (MALE RUN TEE, 1/8 NPT, 1/4⌀ TUBE)
5. SWAGELOK B–400–3TTM (MALE BRANCH TEE, 1/8 NPT, 1/4⌀ TUBE)
6. SWAGELOK B–400–5–4 (45° 1/4 NPT TO 1/4⌀ TUBE)
7. SWAGELOK B–400–2–4 (90° 1/4 NPT TO 1/4⌀ TUBE)
8. SWAGELOK B–400–1–4 (MALE CONNECTOR 1/4 NPT TO 1/4⌀ TUBE)
9. BIMBA FCP2, SPEED CONTROL (1/8 NPT)
10. GOES TO FRONT OF FAR SIDE CYLINDER.
11. GOES TO REAR (FIXED PIVOT END) OF FAR SIDE CYLINDER.

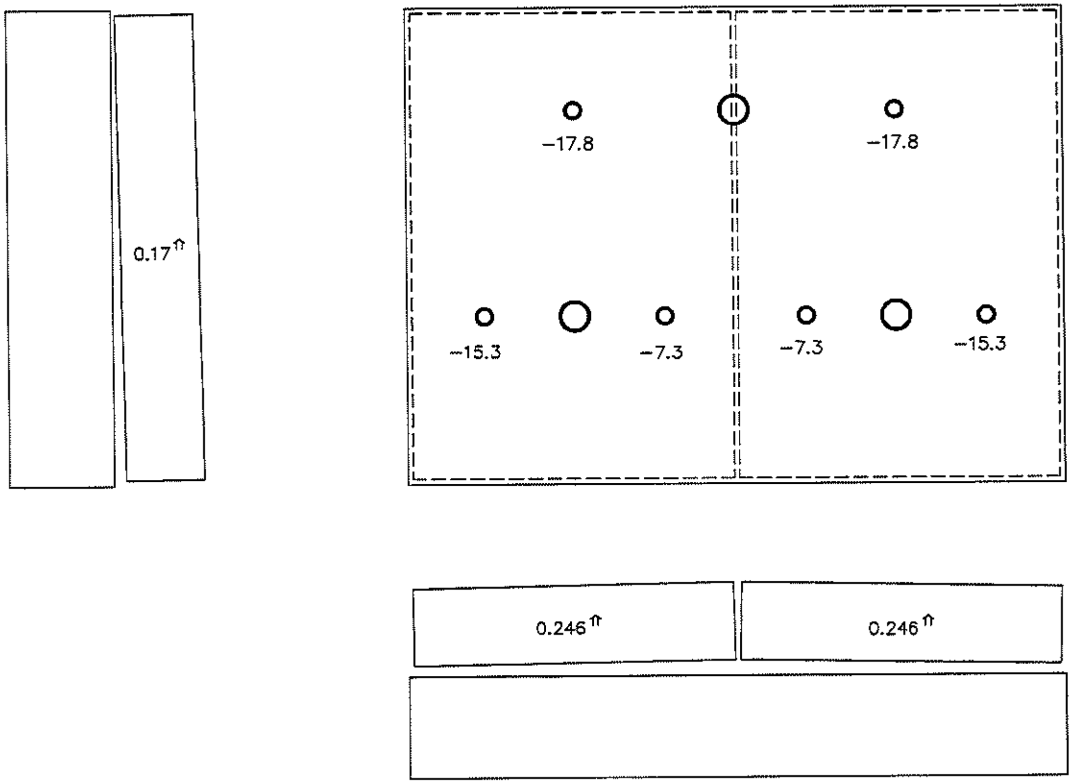
B	H4811–3	8	1	DUST COVER	PVC
	–	7	2	SPEED CONTROL	NOTE 9.
	–	6	1	TEE	NOTE 4.
	–	5	2	CONNECTOR	NOTE 8.
	–	4	1	90° CONNECTOR	NOTE 7.
	–	3	1	45° CONNECTOR	NOTE 6.
	–	2	1	TEE	NOTE 5.
	H4752–1	1	1	SOLENOID MOUNT	ALUM

1/2

A	6 29 92	j.o.		UPDATE TO AS–BUILT CONDITION.
B	9 24 92	j.o.		ADD ITEM 8: DUST COVER

KECK/HIRES
CROSS DISPERSER
AIR SOLENOID MOUNTING
j.o. 5 28 92
H4751.B

DEFLECTION IN MICRO–INCHES



TILTS IN ARC–SECONDS

KECK/HIRES
CROSS DISPERSER
FEA RESULTS
BCS 5 30 90
H4802

Appendix F List of Drawings — CCD Dewar

1. H7005 Locating Tree
2. H7130 CCD Dewar and Support Frame
3. H7131 CCD Dewar Inner Can and Support
4. H7161 CCD Cooling Detail
5. H7180 CCD Dewar Window (Field Flattener)
6. H7187 CCD Socket Alignment Tool Assembly
7. H7192 CCD and X-Y Stage Assembly
8. H7209 Dewar Support Frame Assembly
9. H7250 Dewar and Stage Assembly
10. H7260 Dewar With CCD and Echelle Format Layout
11. H7312 CCD Focus Drive Sub-Assembly
12. H7350 CCD Drive Schematic
13. H7500 CCD Electronics (Pre-Amp) Housing
14. H7600 Liquid Nitrogen Fill System
15. H7601 Liquid Nitrogen Level Sensor
16. H7800 Dewar Lifter and Cart
17. H7815 Dewar Cart Assembly
18. EL-1027–2S Ion Pump Modification

H7005 DEWAR LOCATING TREE

H7000	PRELIMINARY DEWAR ASSEMBLY
	TEK CCD WITH 27 MICRON PIXELS
H7010	RAYTRACE THRU FIELD FLATTENER
H7011	DETAIL OF FIELD FLATTENER
H7050	CCD CAMERA JUNCTION BOX
H7051	" " DETAILS
H7052	" " DETAILS
H7060	ALIGNMENT TOOL (MIRROR)
H7110	VACUUM HOUSING ASSEMBLY
H7112	TRANSFER PIPE ASSEMBLY
H7113	" " DETAILS
H7114	VACUUM HOUSING BODY, TEK
H7115	VACUUM HOUSING BODY, 2X2 FORD
H7116	CCD DEWAR LID DETAILS
H7117	" FLANGE
H7118	" LID DETAIL
H7119	" "
H7120	" COLD FINGER ASSEMBLY
H7121	" ION PUMP
H7122	" LIQ. NITROGEN CAN ASSY
H7123	" INNER CAN DETAIL
H7124	" VACUUM DETAIL
H7125	" VACUUM DETAIL
H7126	" OUTER CYLINDER
H7127	" SEALING FLANGE
H7128	" 41-PIN SOCKET
H7129	" VACUUM DETAIL
H7130	DEWAR AND SUPPORT FRAME
H7131	" INNER CAN SUPPORT
H7132	" SUPPORT DETAIL
H7135	" COLD FINGER
H7136	" COLD FINGER SUPPORT
H7140	" INNER SUPPORT DETAIL
H7160	" COOLING DETAIL
H7161	" "
H7162	" "
H7163	" "
H7170	FORD SPIDER
H7171	DARKSLIDE & SHUTTER FOR CCD TESTING
H7172	" "
H7173	" "

(65° RAD)	H7180	WINDOW CHANGE (TO #802) ASSEMBLY
	H7181	DEWAR WINDOW (LENS)
	H7182	WINDOW HOLDER (TEST)
	H7183	LENS HOLDER (TEST, DARKSLIDE)
	H7184	DEWAR WINDOW (FUTURE)
	H7186	DEWAR SOCKET, TEK
	H7187	ROUGH ALIGNER
	H7188	" DETAILS
	H7190	SOCKET DETAILS
	H7191	" DETAILS
	H7192	" DETAILS, X-Y STAGE
	H7193	" DETAILS, SLIDES
	H7194	" DETAILS
	H7195	" DETAILS, SPIDER
	H7196	" DETAILS
	H7197	" DETAILS
	H7198	MASK SEE H7410
	H7199	SOCKET ADJUSTMENTS
	H7100	PRELIMINARY DEWAR ASSEMBLY
	H7200	DEWAR TEST ASSEMBLY
		TEK CCD WITH 27 MICRON PIXELS
	H7201	DEWAR TEST PLATE, ROUND
	H7202	DEWAR TEST PLATE, OBLONG
	H7205	" " DETAIL
	H7206	" " DETAIL
	H7207	" " DETAIL
	H7208	DEWAR TEST - BIG WINDOW
	H7209	DEWAR SUPPORT FRAME ASSEMBLY
	H7210	" " DETAIL
	H7211	" " DETAIL
	H7212	" " DETAIL
	H7213	3-D OF DEWAR FRAME
	H7214	DEWAR SUPPORT FRAME MACHINING DETAIL
	H7215	DEWAR SUPPORT BASE ASSEMBLY
	H7216	" " DETAIL
	H7217	" " DETAIL
	H7218	" " DETAIL
	H7219	" " DETAIL
	H7220	" " DETAIL
	H7221	" " DETAIL

	H7225	DEWAR SUPPORT BASE WELDING LOCATION
	H7230	DEWAR SUPPORT FRAME DETAIL
	H7231	" " DETAIL
	H7232	DEWAR SUPPORT FRAME SPIDER
	H7233	" " DETAIL
	H7234	" " DETAIL
	H7235	" " DETAIL
	H7236	" " DETAIL
*	H7250	DEWAR, FRAME, BASE ASSEMBLY
	H7251	DEWAR FRAME FLEX ARM
	H7252	" " BRACKETS
	H7253	" " 3-D
	H7260	CCD PIN 1 DEFINED
	H7261	CCD CONTROLLER LOCATION
	H7270	DARKSLIDE ASSEMBLY
	H7271	DARKSLIDE DETAILS
	H7273	" "
	H7274	" "
	H7276	DEWAR LENS SUPPORT
	H7277	" "
	H7278	" "
	H7279	" "
	H7280	DEWAR LENS COLLAR
	H7281	" "
	H7282	" "
	H7290	DARKSLIDE DETAILS
	H7291	" "
	H7292	" "
	H7293	" "
	H7294	" "
	H7295	" "
	H7296	" "
	H7297	" "
	H7298	" "
	H7303	CCD FOCUS: PUSHRODS ASSEMBLY
	H7304	" " DETAIL
	H7305	" " DETAIL
	H7306	LOWER DRIVE ASSEMBLY
	H7307	CCD FOCUS: PUSHROD DETAIL
	H7310	" " DETAIL
	H7311	" " DETAIL
	H7312	CCD FOCUS SCREW ASSEMBLY
	H7313	" " JOINT DETAIL
	H7314	" " JOINT DETAIL
	H7315	CCD FOCUS SCREW DETAIL
	H7316	" " DETAIL
	H7317	" " JOINT DETAIL
	H7318	" " " "
	H7319	" " " "
	H7320	" " " "
	H7321	" " " "

H7322	CCD FOCUS DETAIL	
H7323	" "	
H7324	" "	
H7325	CCD FOCUS, SLIT SIDE DRIVE ASSY	
H7326	" "	
H7327	" "	
H7328	" "	
H7329	" "	
H7340	DRIVE STRUCTURE 3-D	
H7350	KINEMATICS OF FOCUS DRIVE	
H7351	BELT & PULLEY DETAIL	
H7360	DRIVE DETAIL (AND LIMITS)	
H7365	DRIVE DETAIL (LIMITS)	
H7366	DRIVE DETAIL (LIMITS)	
H7367	DRIVE DETAIL (LIMITS)	
H7368	DRIVE DETAIL (LIMITS)	
H7369	DRIVE DETAIL	
H7370	DRIVE DETAIL - TENSIONER	
H7400	CCD HEADER DETAIL (FORD)	15 MICRON PIXELS
H7401	TEKTRONICS CCD	24 MICRON PIXELS
H7402	FOCUS TESTING	
H7410	MASK	
H7411	MEASURE CCD	
H7500	CCD ELEC. BOX - PRE-AMP	
H7501	PRE-AMP BOX DETAIL	
H7502	PRE-AMP BOX DETAIL	
H7503	PRE-AMP BOX DETAIL	
H1462	CCD CONTROLLER BOX	
H7600	LIQUID NITROGEN TRANSFER	
H7601	SENSOR ASSEMBLY	
H7602	SUPPLY DEWAR MOD.	
H7603	DETAIL	
H7604	SUPPLY DEWAR ASSY	
H7605	DETAIL	
H7606	CONTROL BOX	
H7607	DETAIL	
H7608	DETAIL	
H7609	DETAIL	
H7610	TRANSFER LINE	
H7611	DETAIL	
H7619	DETAIL	
H7620	DETAIL	
H7621	DETAIL	
H7622	VENT ASSEMBLY	

H7800	LIFTER
H7805	BOOM
H7810	3 DEWAR VIEWS
H7815	DEWAR CART ASSY
H7816	WHEEL
H7817	CART DETAIL
H7818	WHEELS
H7819	CASTER
H7820	LIFTER FRAME
H7822	LIFTER FRAME
H7823	LIFTER DETAIL
H7824	LIFTER DETAIL
H7825	LIFTER DETAIL
H7826	LIFTER DETAIL
H7827	LIFTER DETAIL
H7828	LIFTER DETAIL
H7830	LIFTER BEAM
H7831	BEAM DETAIL

H7300	ENCODER ASSEMBLY - CCD FOCUS TEST	H7330	ENCODER TEST DETAILS
H7301	" " DETAIL	H7331	" " DETAIL
H7302	" " DETAIL	H7332	" " DETAIL
		H7333	" " DETAIL

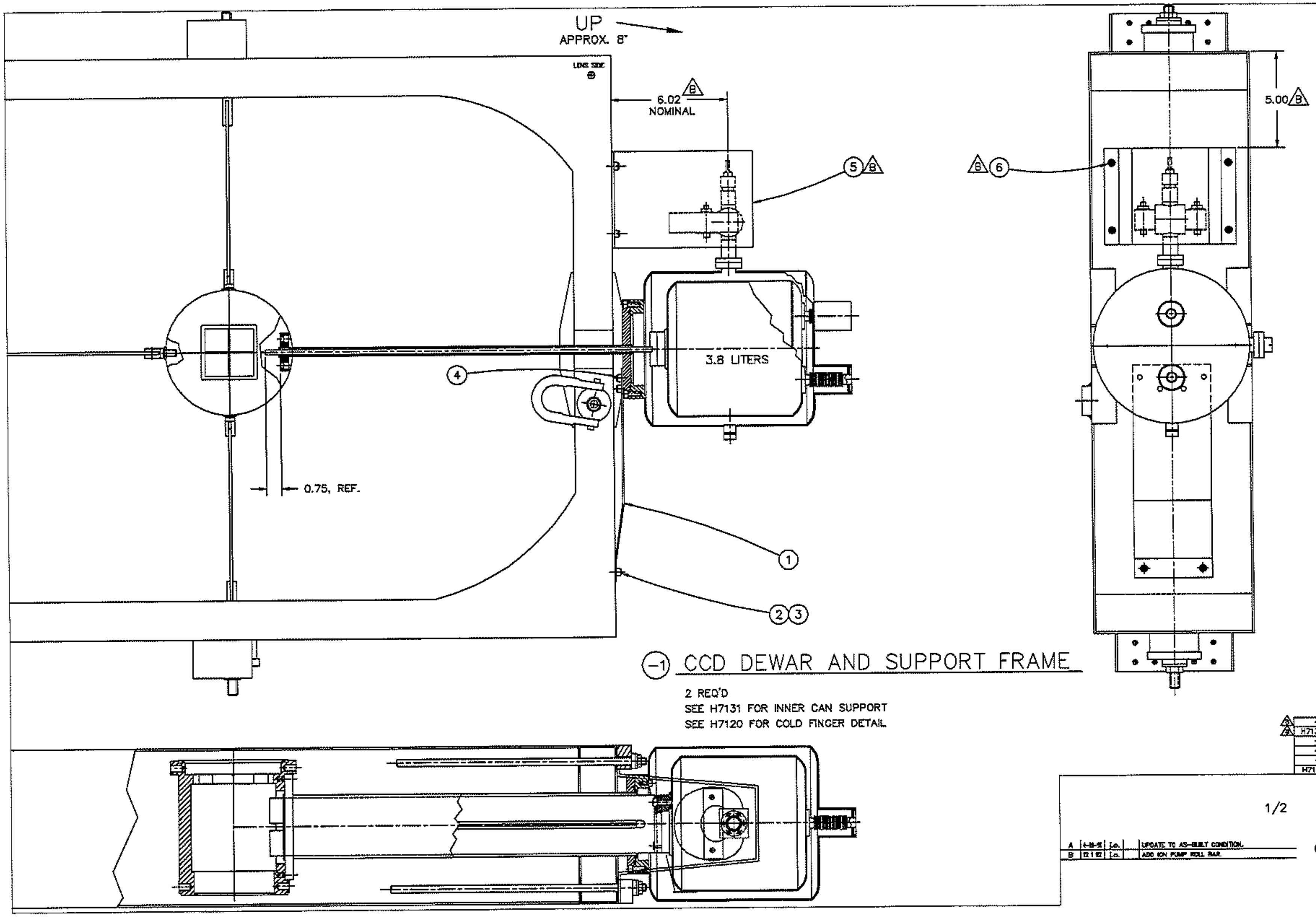
BECAME ECHELLE ENCODER AND DRIVE

A | 6 29 93 | J.o. | | SHIPPING DRAWING

KECK/HIRES
DEWAR LOCATING TREE
FINAL VERSION A

J.o. 8 30 93

H7005.A



(-1) CCD DEWAR AND SUPPORT FRAME

2 REQ'D
SEE H7131 FOR INNER CAN SUPPORT
SEE H7120 FOR COLD FINGER DETAIL

PER ASSEMBLY B

B	—	6	4	#1/4-28 A.H.C.S.	ST STL
B	H7132-2	5	1	ROLL BAR	ALUM
	—	4	2	#1/4-28 A.H.C.S.	ST STL
	—	3	2	THREADED INSERT	ST STL
	—	2	2	#1/4-20 A.H.C.S.	ST STL
	H7132-1	1	1	WEB	ST STL

1/2

A	4-18-95	J.o.		UPDATE TO AS-BUILT CONDITION.
B	12 1 92	J.o.		ADD ION PUMP ROLL BAR

KECK/HIRES
CCD DEWAR AND SUPPORT
ASSEMBLY

J.o. 3 14 91

H7130.B

⊖1 INNER CAN SUPPORT

2 REQ'D

NOTES:

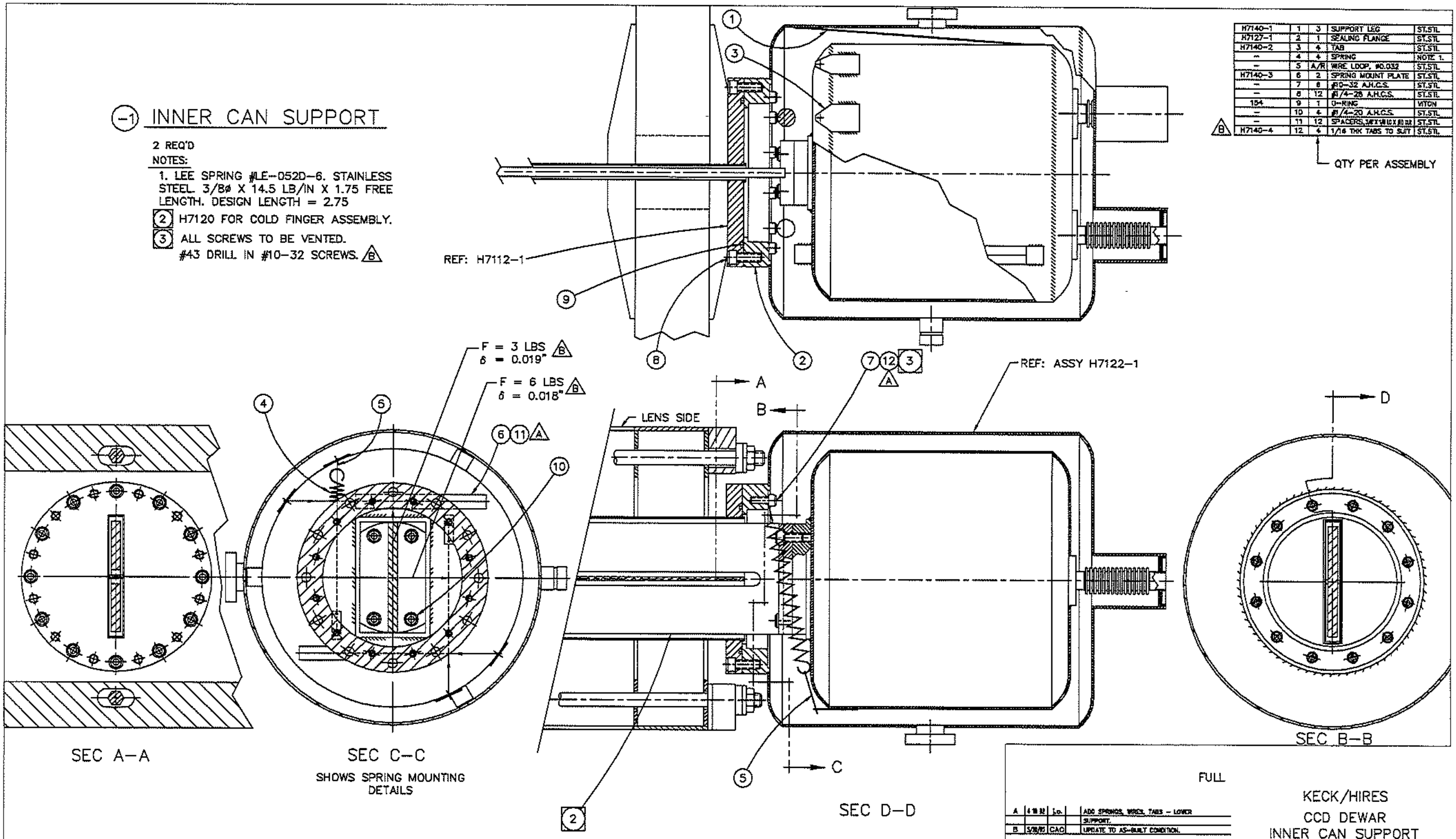
1. LEE SPRING #LE-052D-6. STAINLESS STEEL. 3/8Ø X 14.5 LB/IN X 1.75 FREE LENGTH. DESIGN LENGTH = 2.75

2. H7120 FOR COLD FINGER ASSEMBLY.

3. ALL SCREWS TO BE VENTED. #43 DRILL IN #10-32 SCREWS. △B

H7140-1	1	3	SUPPORT LEG	ST.STL
H7127-1	2	1	SEALING FLANGE	ST.STL
H7140-2	3	4	TAB	ST.STL
–	4	4	SPRING	NOTE 1.
–	5	A/R	WIRE LOOP, #0.032	ST.STL
H7140-3	6	2	SPRING MOUNT PLATE	ST.STL
–	7	8	#10-32 A.H.C.S.	ST.STL
–	8	12	#1/4-28 A.H.C.S.	ST.STL
154	9	1	O-RING	VITON
–	10	4	#1/4-20 A.H.C.S.	ST.STL
–	11	12	SPACERS,[illegible]	ST.STL
H7140-4 △B	12	4	1/16 THK TABS TO SUIT	ST.STL

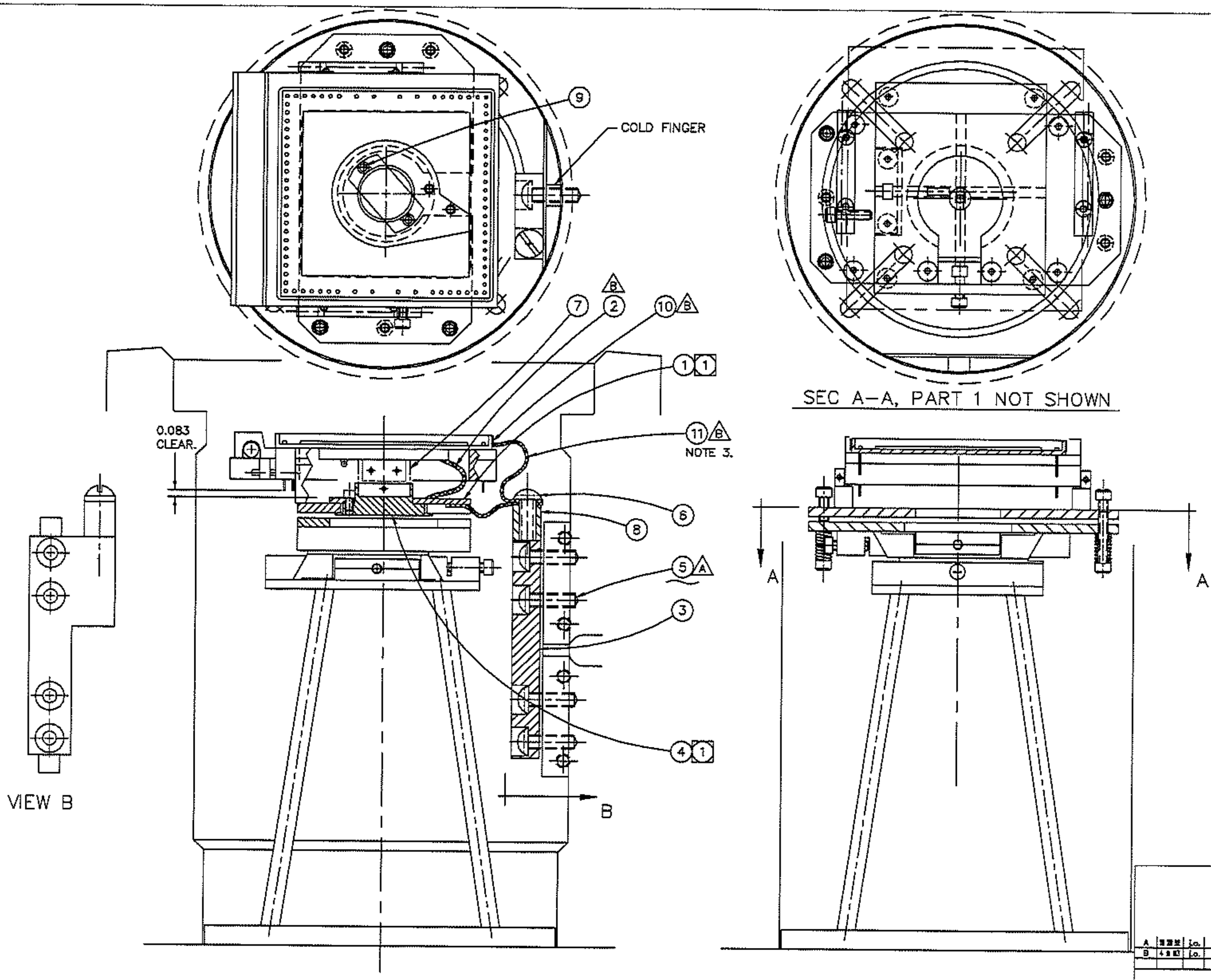
QTY PER ASSEMBLY



FULL

A	4 18 92	J.O.		ADD SPRINGS, WIRES, TABS – LOWER SUPPORT.
B	5/28/95	CAO		UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
CCD DEWAR
INNER CAN SUPPORT
J.O. 3 25 91 2
H7131.B



⊖1 COOLING CONNECTIONS

NOTES:

1. ASSEMBLY SHOULD HAVE 0.02" VERTICAL CLNCE.
2. THIS CONFIGURATION IS FOR A TEKTRONICS CCD
3. SEE H7162 FOR COLD STRAP DETAIL.

B	H7164–1	10	1	TOP COOLING CLAMP	ASSY
	–	9	2	#2–56 AL HD SCR	ST.STL
	H7162–3	8	1	SPOOL	OFHC
	H7160–6	7	1	COIL SPRING	LEE
	x 1.00 LNG	5	1	VENTED SCREW, 10–32	BRASS
A	x 0.62 LNG	5	4	VENTED SCREW, 8–32	BRASS
	H7163–1	4	1	FLANGED AXLE	ALUM
	H7162–2	3	1	COLD FINGER ADAPTER	OFHC
	H7160–4	2	1	PAD ASSEMBLY	ASSY
B	H7162–1	1	1	COOLING PLATE	OFHC

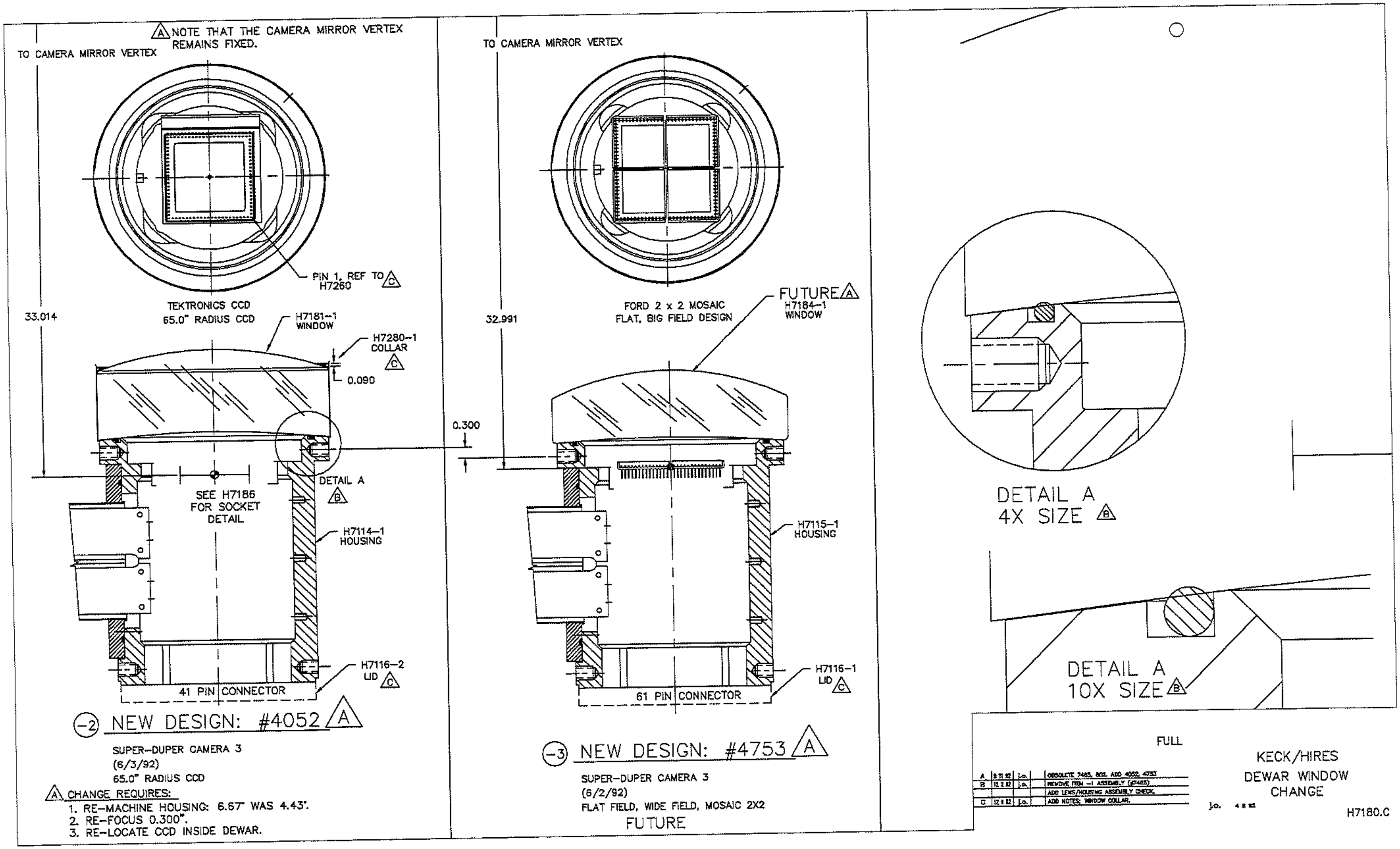
2:1

A	11 23 92	j.o.		PART –5: #8–32 WAS #10–32
B	4 8 93	j.o.		MODIFY PART 1; ADD PART 10, NOTE 3
				NO 90° ALTERNATE POSITION.

KECK/HIRES
CCD COOLING
DETAIL

j.o. 7 27 92

H7161.B



A NOTE THAT THE CAMERA MIRROR VERTEX REMAINS FIXED.

(-2) NEW DESIGN: #4052 A

SUPER–DUPER CAMERA 3
(6/3/92)
65.0" RADIUS CCD

A CHANGE REQUIRES:
1. RE–MACHINE HOUSING: 6.67" WAS 4.43".
2. RE–FOCUS 0.300".
3. RE–LOCATE CCD INSIDE DEWAR.

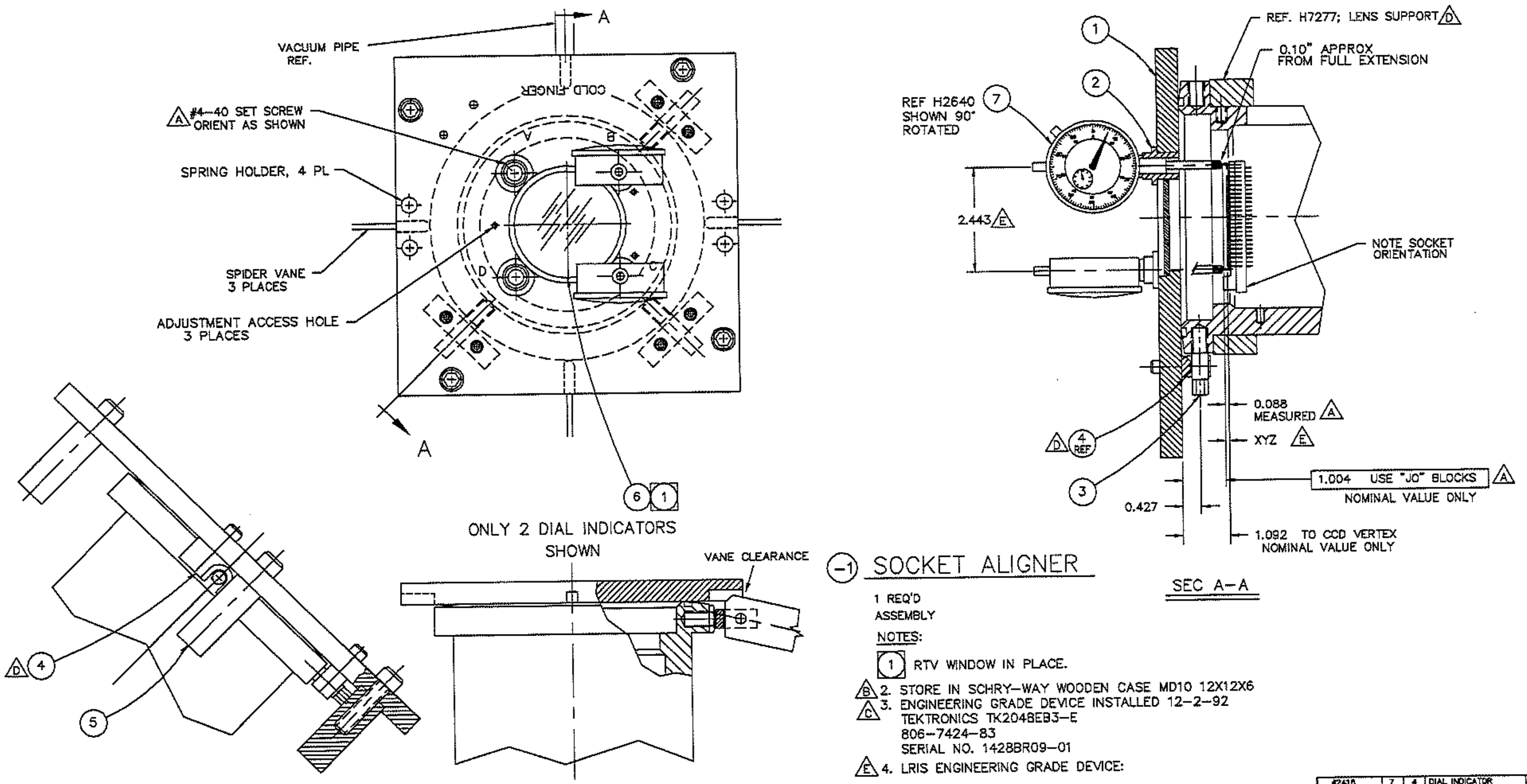
(-3) NEW DESIGN: #4753 A

SUPER–DUPER CAMERA 3
(6/2/92)
FLAT FIELD, WIDE FIELD, MOSAIC 2X2
FUTURE

A	8 11 92	J.O.		OBSOLETE 7465, 802. ADD 4052, 4753
B	12 2 92	J.O.		REMOVE ITEM –1 ASSEMBLY (#7465)
				ADD LENS/HOUSING ASSEMBLY CHECK.
C	12 1 92	J.O.		ADD NOTES; WINDOW COLLAR.

KECK/HIRES
DEWAR WINDOW
CHANGE

H7180.C



ONLY 2 DIAL INDICATORS SHOWN

SEC A–A

(-1) SOCKET ALIGNER

1 REQ'D
ASSEMBLY

NOTES:

1. RTV WINDOW IN PLACE.
2. STORE IN SCHRY–WAY WOODEN CASE MD10 12X12X6
3. ENGINEERING GRADE DEVICE INSTALLED 12–2–92
   TEKTRONICS TK2048EB3–E
   806–7424–83
   SERIAL NO. 1428BR09–01
4. LRIS ENGINEERING GRADE DEVICE:

FIRST IMAGING CHIP

SECOND IMAGING CHIP

CORNER READINGS				
CORNER	12–2–92	1–12–93	2–10–93	3–11–93
"A"	1.0158	0.9788	1.0000 – 0.0169 = 0.9831	1.0000 – 0.0137 = 0.9863
"B"	1.017	0.9800	1.0000 – 0.016 = 0.9840	1.0000 – 0.0137 = 0.9863
"C"	1.0165	0.9795	1.0000 – 0.025 = 0.9750	1.0000 – 0.0440 = 0.9560
"D"	1.0160	0.9790	1.0000 – 0.044 = 0.9560	1.0000 – 0.0830 = 0.9170

#2418	7	4	DIAL INDICATOR	MITUTOYO
–	6	1	WINDOW, 2.744 x 1/8 THK	
H7188–5	5	4	FOOT	ALUM
H7188–4	4	3	GUIDE BLOCK	ALUM
H7188–3	3	3	ALIGNMENT PIN	SST
H7188–2	2	4	BUSHING	BRASS
H7188–1	1	1	ALIGNMENT PLATE	ALUM

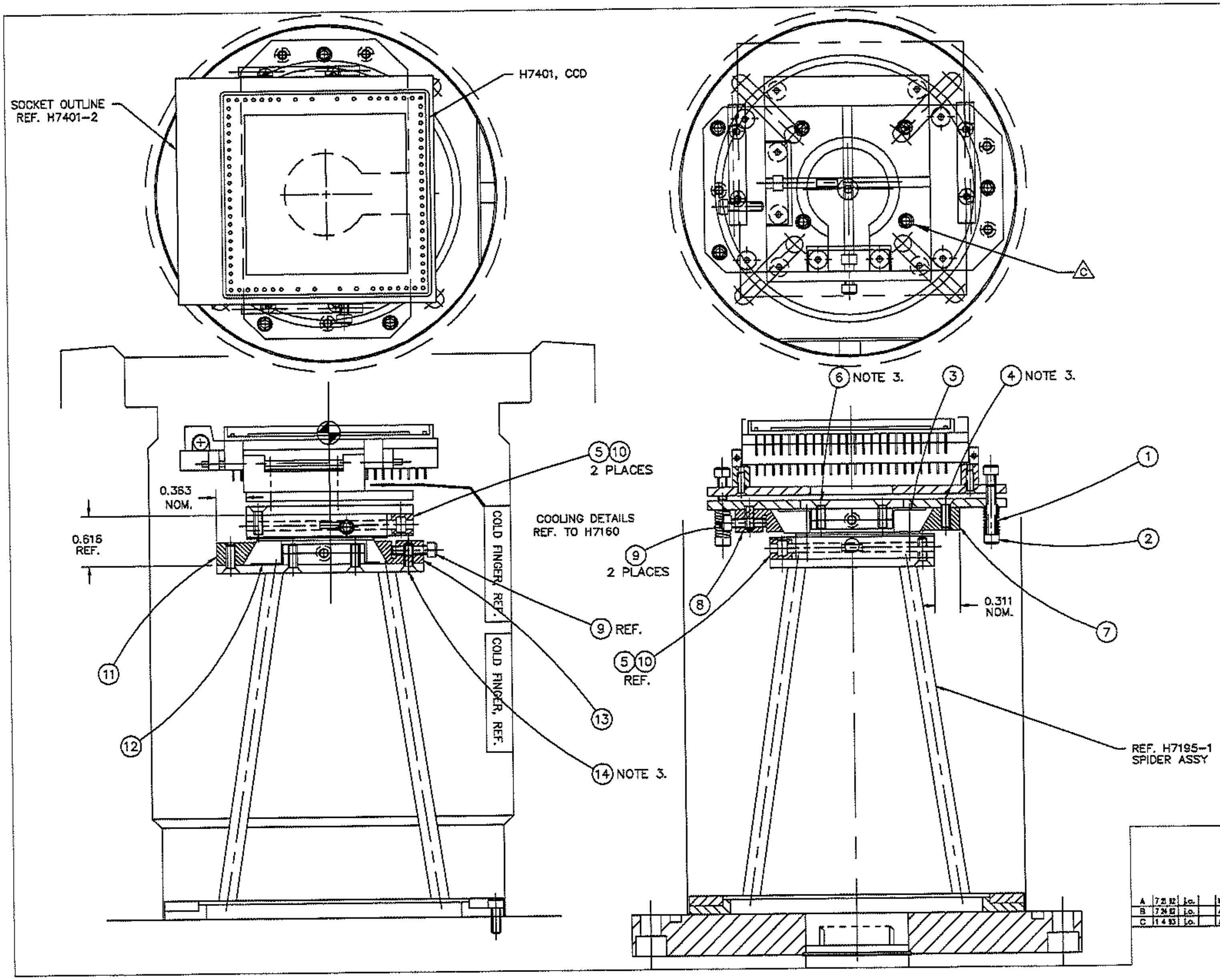
F	3 12 93	J.O.		CLOSE TO FINAL ADJUSTMENT OF CCD.
A	7 30 92	J.O.		UPDATE TO AS–BUILT CONDITION.
B	12 1 92	J.O.		ADD CASE INFORMATION.
C	12 2 92	J.O.		ALIGN NEW CHIP.
D	1 22 93	J.O.		CUT OFF GUIDE BLOCKS TO CLEAR LENS
				SUPPORT HARDWARE.
E	3 3 93	J.O.		DOC'T 3RD MOVE. PREP FOR NEXT CCD

FULL

KECK/HIRES
CCD ROUGH ALIGNER
ASSEMBLY

J.O. 7 1 92
G.A.G. 7/7/92
J.O. 7 8 92

H7187.F



⊖1 X–Y STAGE ASSEMBLY

1 REQ'D

NOTES:

1. LEE, 23 LB/IN, 9/16 FREE LENGTH, 0.026ø WIRE, 10 TURNS, 0.264 SOLID HEIGHT: 6-3/4 LBS.
2. SEE H7199 FOR X-Y STAGE ADJUSTING PROCEDURE.
3. USE SOCKET DRIVE FLAT HEAD SCREWS (1/16 HEX)
4. SEE H7193 FOR UPPER/LOWER SLIDE ASSY
5. B THIS ASSEMBLY IS FOR THE TEKTRONICS CCD WITH 65" CONVEX RADIUS.

–	14	4	#4-40 FLT HD SCR	ST.STL
H7194-3	13	1	LOWER LOCKING GIB	ALUM
H7193-2	12	1	LOWER SLIDE	ALUM
H7194-2	11	1	LOWER FIXED GIB	ALUM
x 1.0 LONG	10	2	#4-40 AL HD CP SCR	ST.STL
x 0.44 LONG	9	2	#4-40 AL HD CP SCR	ST.STL
H7194-4	8	1	UPPER LOCKING GIB	ALUM
H7194-5	7	1	UPPER FIXED GIB	ALUM
–	6	4	#4-40 FLT HD SCR	ST.STL
H7194-1	5	2	SPLIT BUSHING	ASSY
–	4	4	#4-40 FLT HD SCR	ST.STL
H7193-1	3	1	UPPER SLIDE	ALUM
x 0.61 LONG	2	3	#4-40 AL HD CP SCR	ST.STL
LC-026B-5	1	3	SPRING, NOTE 1.	ST.STL

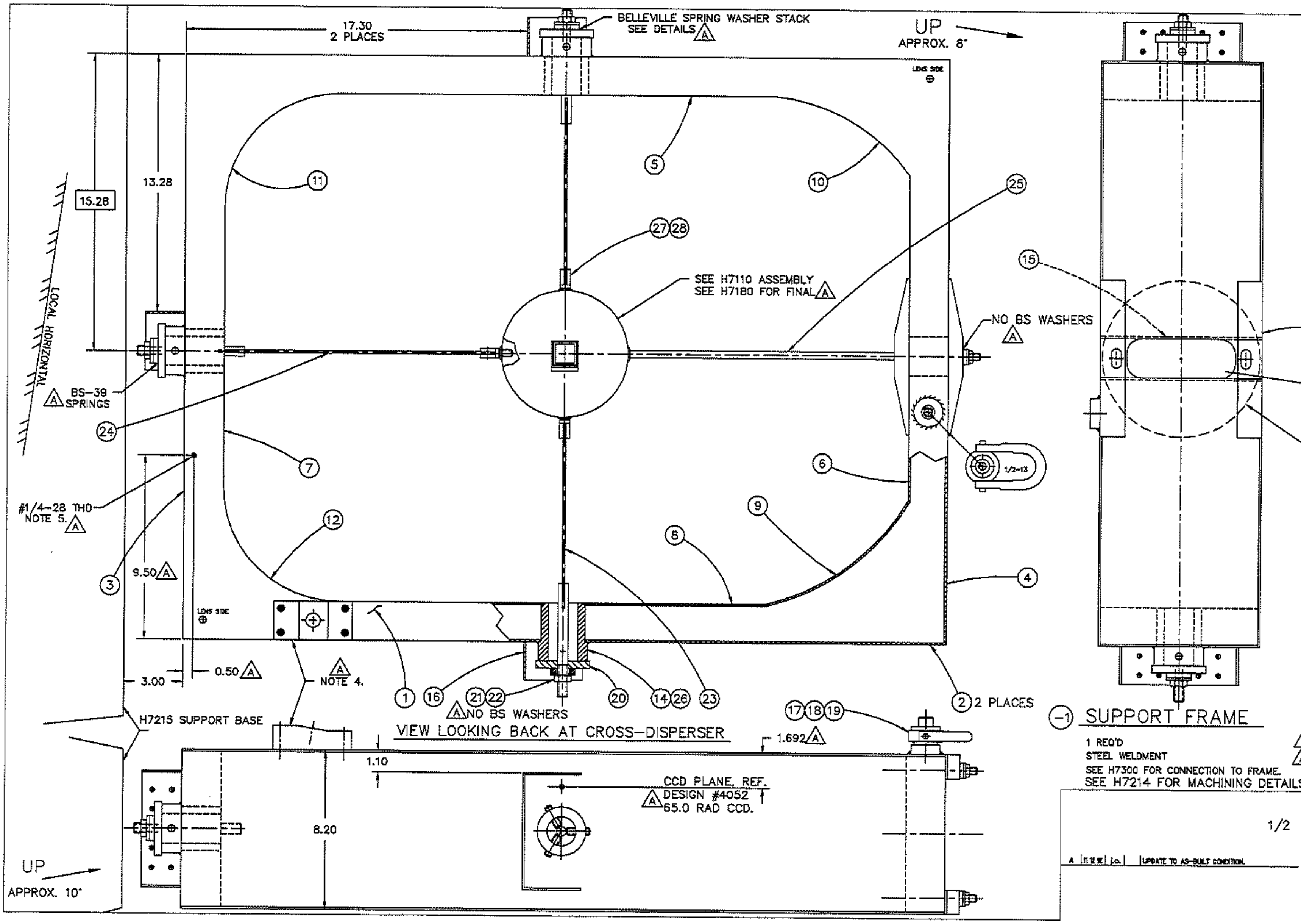
2:1

A	7 21 92	j.o.		MODIFY LOWER PLATE, H7191-2
B	7 24 92	j.o.		ADD CHIP, REMOVE SLOT IN SPIDER
C	1 4 93	j.o.		ADD X-Y STAGE SCREWS.

KECK/HIRES
CCD DEWAR
X–Y STAGE

j.o. 7 8 92

H7192.C



A BELLEVILLE WASHER DETAIL:
#BS-39
12 AS SHOWN
IN 2 LOCATIONS.
86 LBS AT 3/4 OF
FLAT CONDITIONS.
0.18" COMPRESSION.
≈3.6 REVS OF
1/2-20 NUT.
"A" – "B" = 0.18"
1.012ø X 0.562ø
X 0.016 MATERIAL
H = 0.036

H7236-3	28	6	PIN	ST STL
H7236-2	27	6	CLEVIS	4340 STL
–	26	9	3/8-24 SET SCR0.25 LNG	ST STL
H7236-1	25	2	TENSION ROD	ST.STL
H7233-1	24	1	SPIDER VANE, LONG	ASSY
H7232-1	23	2	SPIDER VANE, SHORT	ASSY
–	22	3	1/2-20 HEX NUT	ST STL
–	21	3	SPHER. WSHR. PAIR	NOTE 3.
H7230-4	20	3	WASHER PLATE	ST STL
–	19	1	1/2-13 KEEN-SERT	ST STL
–	18	1	HOIST RING	NOTE 1
H7231-2	17	1	LIFTING PAD	STL
H7231-1	16	3	STAGE BRACKET	STL
H7230-3	15	2	WEB	STL
H7230-2	14	3	ALIGNER TUBE	STL
H7230-1	13	4	STIFFENER	STL
H7212-4	12	1	LOWER RIGHT CORNER	STL
H7212-3	11	1	LOWER LEFT CORNER	STL
H7212-2	10	1	UPPER LEFT CORNER	STL
H7212-1	9	1	UPPER RIGHT CORNER	STL
H7211-8	8	1	INNER RIGHT PLATE	STL
H7211-7	7	1	BOTTOM INNER PLATE	STL
H7211-6	6	1	TOP INNER PLATE	STL
H7211-5	5	1	INNER LEFT PLATE	STL
H7211-3	4	1	TOP OUTER PLATE	STL
H7211-2	3	1	BOTTOM OUTER PLATE	STL
H7211-1	2	2	SIDE PLATE	STL
H7210-1	1	2	FACE PLATE	STL

(-1) SUPPORT FRAME

1 REQ'D
STEEL WELDMENT
SEE H7300 FOR CONNECTION TO FRAME.
SEE H7214 FOR MACHINING DETAILS.

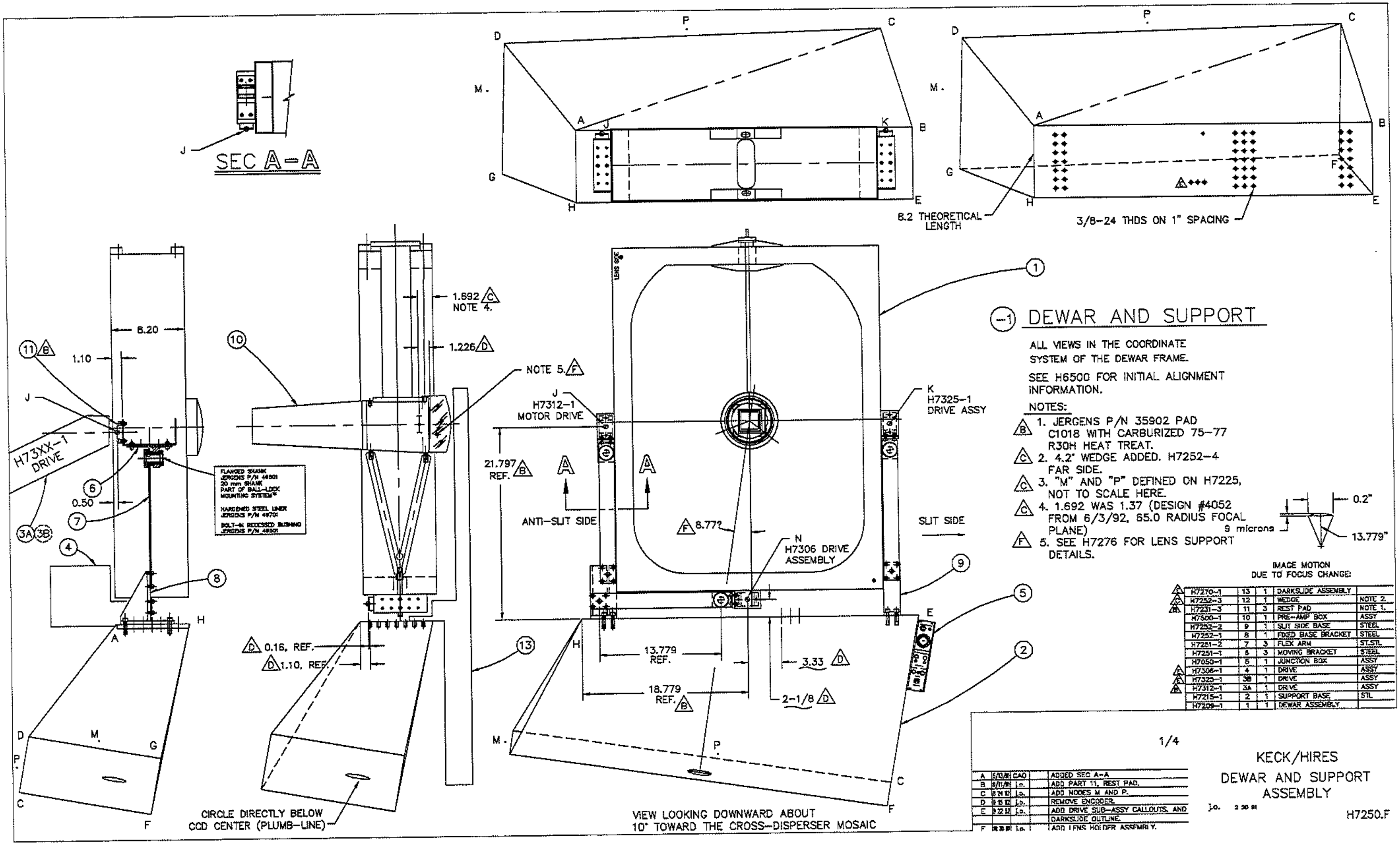
NOTES:

1. JERGENS 23410
2. SEE H7213 FOR 3-D VERSION
3. JERGENS 41105
4. A SEE H7816 FOR PIVOT BLOCKS
5. A SPRING MOUNT HOLE

1/2

A | 11 12 98 | J.O. | UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
DEWAR SUPPORT FRAME
ASSEMBLY
J.O. 1 30 91
H7209.A



(–1) DEWAR AND SUPPORT

ALL VIEWS IN THE COORDINATE SYSTEM OF THE DEWAR FRAME.

SEE H6500 FOR INITIAL ALIGNMENT INFORMATION.

NOTES:

- B 1. JERGENS P/N 35902 PAD C1018 WITH CARBURIZED 75–77 R30H HEAT TREAT.
- C 2. 4.2° WEDGE ADDED. H7252–4 FAR SIDE.
- C 3. "M" AND "P" DEFINED ON H7225, NOT TO SCALE HERE.
- C 4. 1.692 WAS 1.37 (DESIGN #4052 FROM 6/3/92, 65.0 RADIUS FOCAL PLANE)
- F 5. SEE H7276 FOR LENS SUPPORT DETAILS.

IMAGE MOTION DUE TO FOCUS CHANGE:

F	H7270–1	13	1	DARKSLIDE ASSEMBLY	
C	H7252–3	12	1	WEDGE	NOTE 2.
B	H7231–3	11	3	REST PAD	NOTE 1.
	H7500–1	10	1	PRE–AMP BOX	ASSY
	H7252–2	9	1	SLIT SIDE BASE	STEEL
	H7252–1	8	1	FIXED BASE BRACKET	STEEL
	H7251–2	7	3	FLEX ARM	ST.STL
	H7251–1	6	3	MOVING BRACKET	STEEL
	H7050–1	5	1	JUNCTION BOX	ASSY
E	H7306–1	4	1	DRIVE	ASSY
E	H7325–1	3B	1	DRIVE	ASSY
B	H7312–1	3A	1	DRIVE	ASSY
	H7215–1	2	1	SUPPORT BASE	STL
	H7209–1	1	1	DEWAR ASSEMBLY	

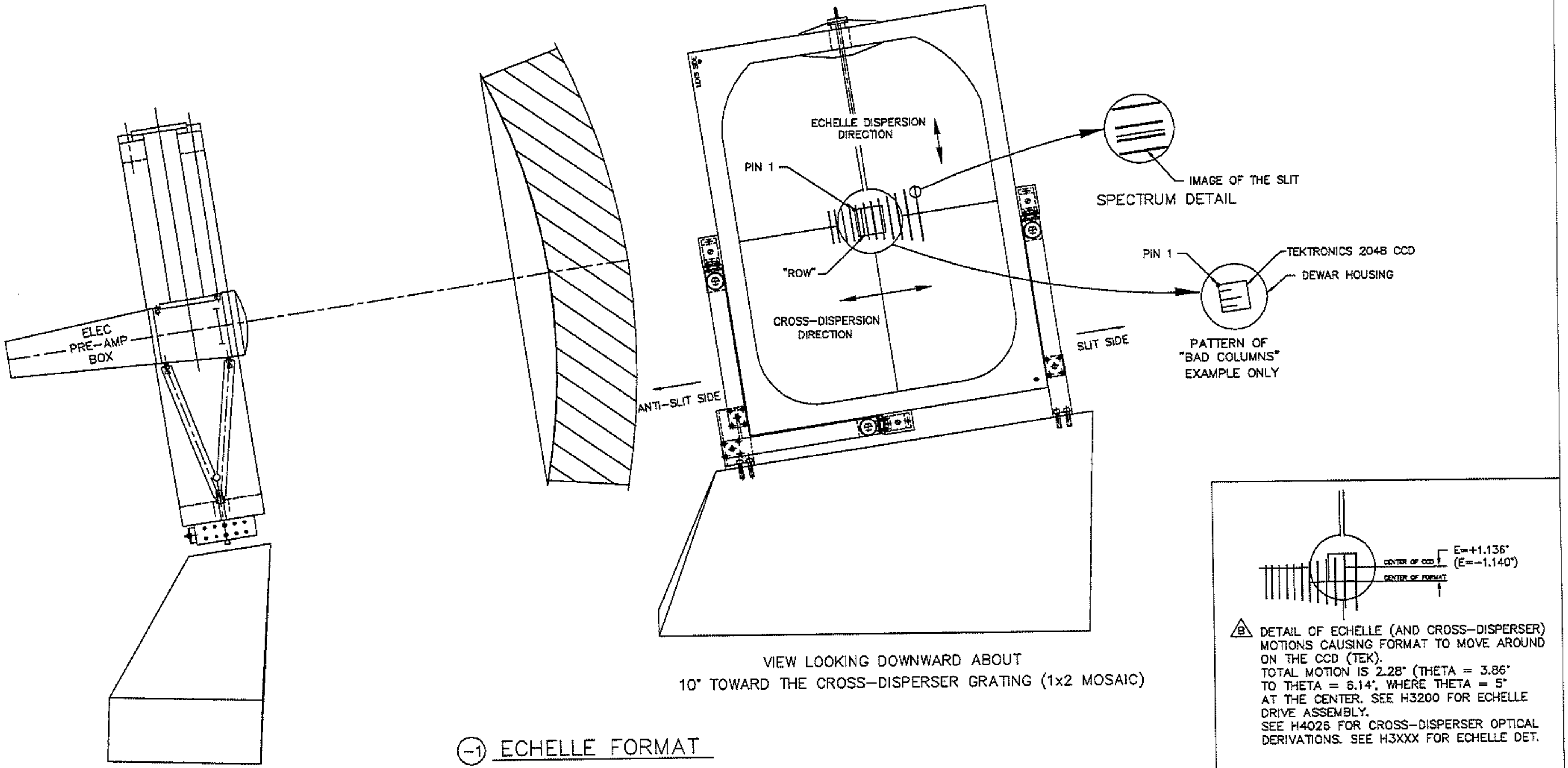
1/4

A	6/13/91	CAO		ADDED SEC A–A
B	9/11/91	J.o.		ADD PART 11, REST PAD.
C	8 24 92	J.o.		ADD NODES M AND P.
D	9 15 92	J.o.		REMOVE ENCODER.
E	9 22 92	J.o.		ADD DRIVE SUB–ASSY CALLOUTS, AND
				DARKSLIDE OUTLINE.
F	[illegible]	J.o.		ADD LENS HOLDER ASSEMBLY.

KECK/HIRES
DEWAR AND SUPPORT
ASSEMBLY

J.o. 2 20 91

H7250.F



VIEW LOOKING DOWNWARD ABOUT
10° TOWARD THE CROSS-DISPERSER GRATING (1x2 MOSAIC)

(-1) ECHELLE FORMAT

NOTES:
1. CCD CAN BE ROTATED 180ø WITHOUT ROTATING THE SOCKET. PIN 1 WOULD BE ON A DIAGONAL CORNER TO THAT SHOWN.
2. THE SOCKET MAY BE ROTATED 90° BUT NOT -90°.

△B DETAIL OF ECHELLE (AND CROSS-DISPERSER) MOTIONS CAUSING FORMAT TO MOVE AROUND ON THE CCD (TEK).
TOTAL MOTION IS 2.28° (THETA = 3.86° TO THETA = 6.14°, WHERE THETA = 5° AT THE CENTER. SEE H3200 FOR ECHELLE DRIVE ASSEMBLY.
SEE H4026 FOR CROSS-DISPERSER OPTICAL DERIVATIONS. SEE H3XXX FOR ECHELLE DET.

3RD ANGLE
PROJECTION

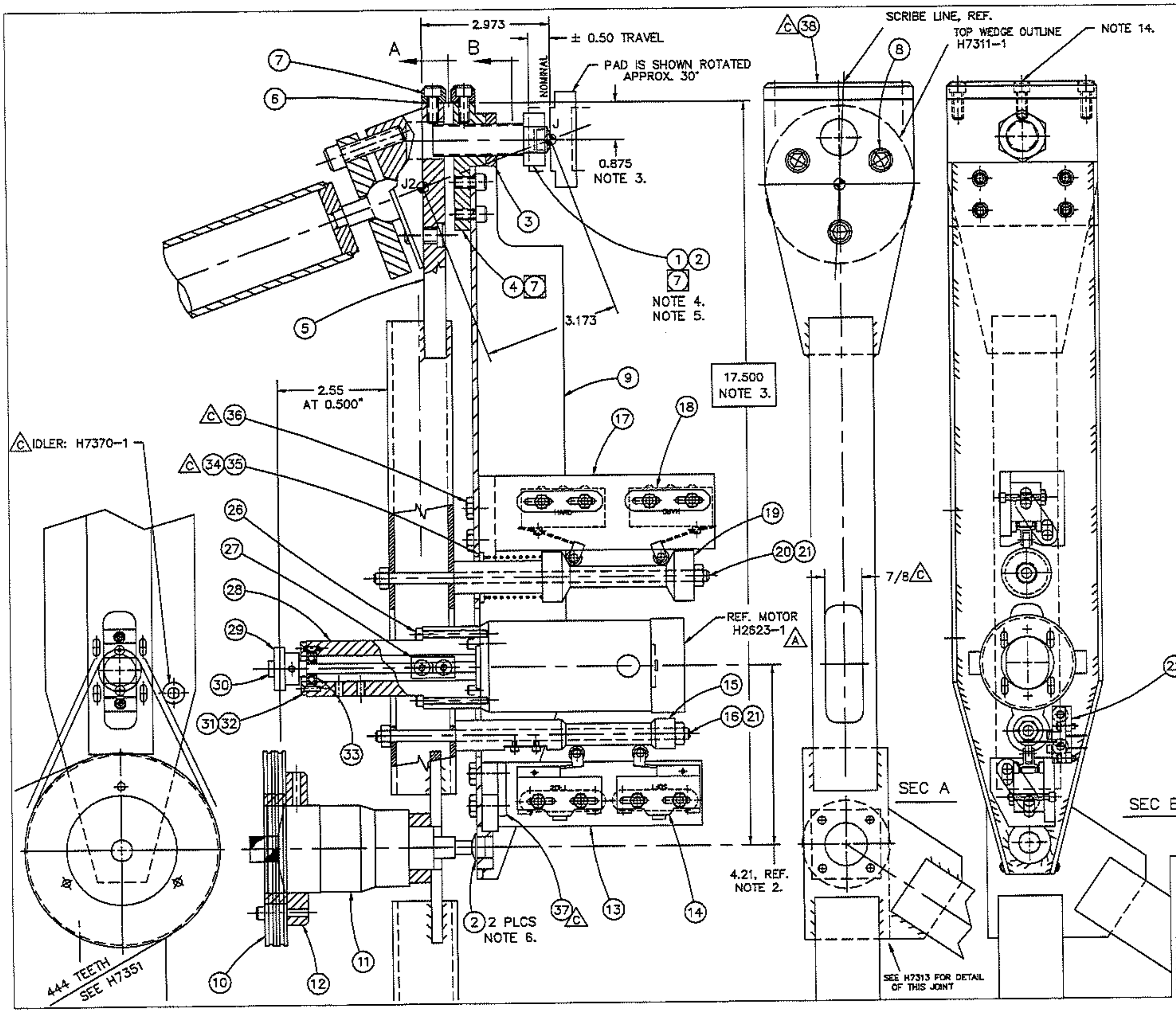
A	5 8 92	J.o.		RE-DRAW ECHELLE FORMAT.
B	10 21 92	J.o.		ADD ECHELLE TILT NOTES.

1/4

KECK/HIRES
DEWAR WITH CCD
ORIENTATION

J.o. 5 4 92

H7260.B



① DRIVE ASSEMBLY

3 REQ'D, SIMILAR

NOTES:

1. LOW HEAD SOCKET DRIVE SCREW
2. 4.5:1 FROM 16T TO 72T SPROCKET AND 90T BELT (BERG 20TB-90)
3. 20:1 LEVER: ± 0.50" MICROMETER TRAVEL IS ±0.025" STAGE TRAVEL. 1/8 THICK FILTER REQUIRES 0.002" RE-FOCUS.
4. ± 0.50" BRONZE SCREW ALLOWS INITIAL ALIGNMENT ONLY.
5. UPPER SCREW CONTACT FORCE IS T.B.D. △C
6. LOWER SCREW CONTACT FORCE IS 6.75 LBS. △C
7. USE 85% FOR SCREW/NUT ENGAGEMENT.
8. MICROSWITCH BZ-2RWB22-A2
9. △C MICROSWITCH DT-2RV212-A7
10. INTERRUPTER: TRW OPB-970-T55
11. SEE H7365 FOR EXTREMES OF LIMITS.
12. △C LEE SPRING. 4.1 LB/IN. DESIGN HT = 1.4" (10.5 LBS) FREE HT = 4", SQUASH HT = 0.62". DESIGNED TO WORK IN 1ø HOLE.
13. △C MCMASTER-CARR 91246-A540, ST.STEEL
14. △C CAUTION. SHORT SCREW HERE.

H7316-4	38	2	CLAMP	ST STL
H7385-1	37	2	NUT PLATE	ST STL
–	36	4	HEX HD 1/4-28 SCR	NOTE 13
–	35	1	WASHER: 1.125x0.75x0.06	ALUM
LC-083L-12	34	1	COMPRESSION SPRING	NOTE 12
626-2RS	33	1	BALL BRG & 2 SEALS	SKF
–	32	2	#4-40 SOC DRV FLT HD	ST.STL
H7369-4	31	1	RETAINER	ALUM
H7369-3	30	1	SHAFT	ST.STL
BERG 20TP8-16	29	1	SPROCKET, 16T	ALUM
H7369-2	28	1	BEARING HOUSING	ALUM
H7369-1	27	1	COUPLING	ST.STL
–	26	2	#8-32 x 1.5 UNC AHCS	ST.STL
–	25	2	#10-32 SOC DRV FLT HD	ST.STL
–	24	2	#4-40 AL HD SCR	ST.STL
–	23	1	INTERRUPTER	NOTE 10
H7367-1	22	1	INTERRUPTER MOUNT	ASSY
–	21	4	#1/4-20 HEX NUT	ST.STL
H7368-3	20	1	TOP ROD	ST.STL
H7368-2	19	1	UPPER ACTUATOR ROD	ALUM
–	18	2	FINAL LIMIT SWITCH	NOTE 9.
H7368-1	17	1	UPPER SWITCH BKT	ALUM
H7366-4	16	1	LOWER ROD	ST.STL
H7366-3	15	1	LOWER ACTUATOR ROD	ALUM
–	14	2	LOGIC LIMIT SWITCH	NOTE 8.
H7366-2	13	1	LOWER SWITCH BKT	ALUM
H7360-2	12	1	DRIVE COLLAR	ALUM
H7360-1	11	3	MICROMETER HEAD	
H7360-3	10	2	SPROCKET, 72T	ALUM
H7316-3	9	1	LEVER ARM	ST.STL
–	8	3	3/8-16 SCR X 0.75 UNC	NOTE 1.
–	7	A/R	1/4-28 AL HD CAP SCR	ST.STL
H7316-2	6	3	LEAF SPRING	ST.STL
H7316-1	5	1	WEDGE HOLDER	ST.STL
H7315-4	4	3	NUT PLATE	ST.STL
H7315-3	3	3	LOCK NUT	ST.STL
H7315-2	2	6	HARDENED TIP	TOOL ST
H7315-1	1	3	SCREW	BRONZE

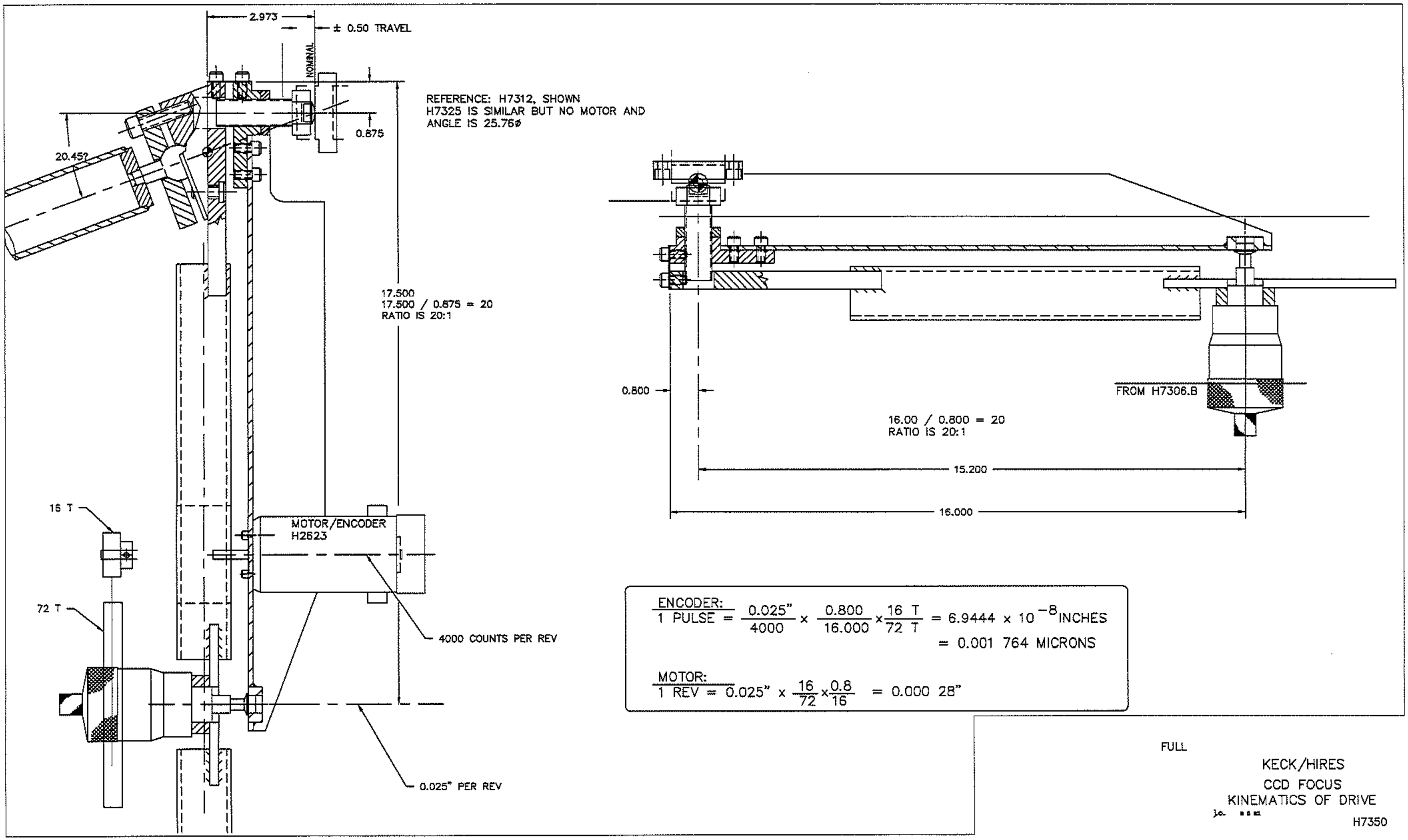
FULL

A	8 27 92	J.o.		UPDATE TO AS-BUILT CONDITION.
				ADD MOTOR NOTES.
B	9 22 92	J.o.		ADD DRIVESHAFT AND SPROCKET, ETC
C	11 16 92	J.o.		ADD PARTS 34, 35: SPRING, WASHER
				MICROSWITCH DT-2RV212-A7 WAS RV22
				ADD PARTS 36, 37 (FLEX PLATE CLMP)

KECK/HIRES
CCD FOCUS
SCREW ASSEMBLY

J.o. 7 11 91

H7312.C



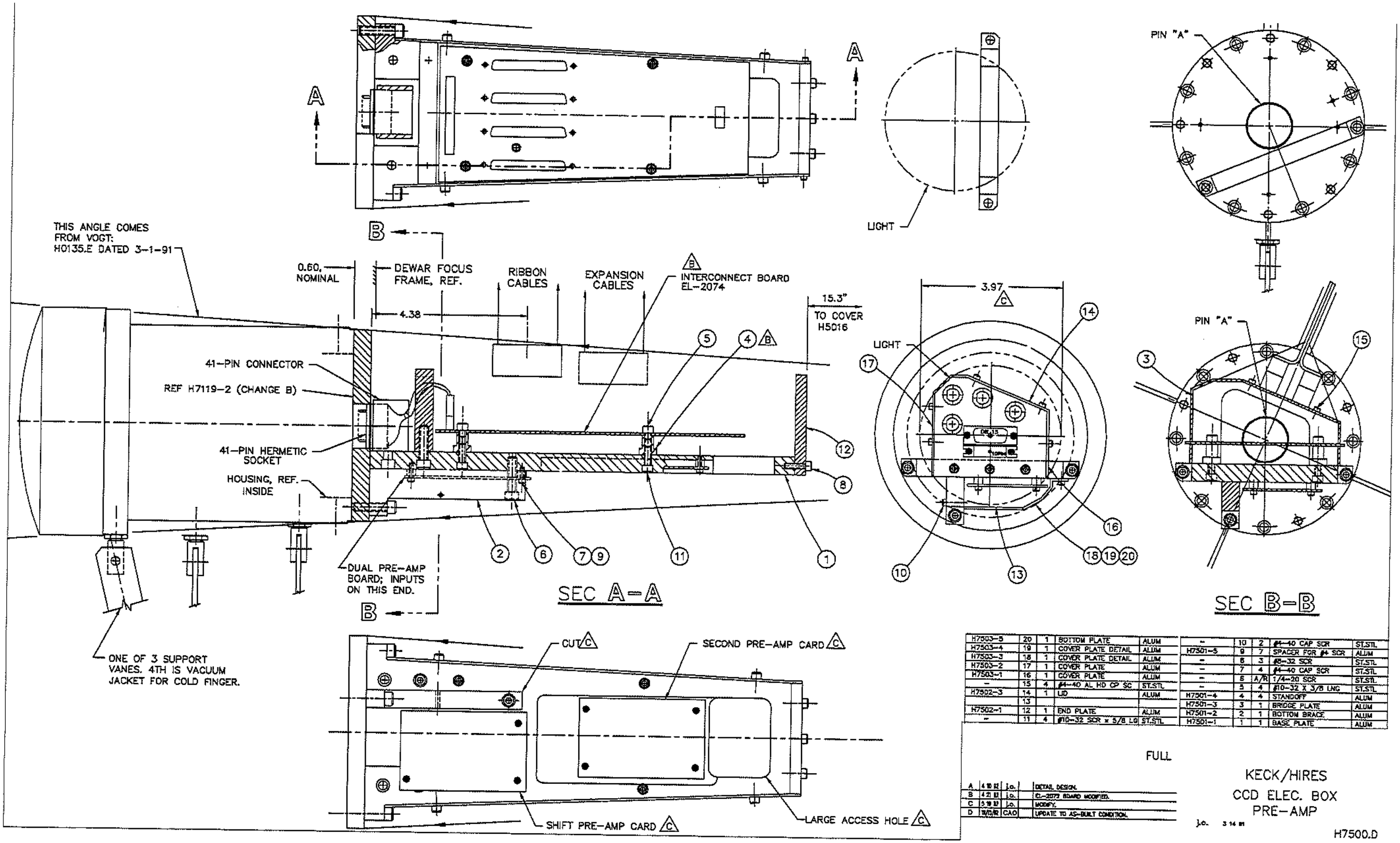
$$\frac{\text{ENCODER:}}{\text{1 PULSE}} = \frac{0.025''}{4000} \times \frac{0.800}{16.000} \times \frac{16\ \text{T}}{72\ \text{T}} = 6.9444 \times 10^{-8}\text{INCHES}$$

$$= 0.001\ 764\ \text{MICRONS}$$

$$\frac{\text{MOTOR:}}{\text{1 REV}} = 0.025'' \times \frac{16}{72} \times \frac{0.8}{16} = 0.000\ 28''$$

FULL

KECK/HIRES
CCD FOCUS
KINEMATICS OF DRIVE
j.o.
H7350



H7503-5	20	1	BOTTOM PLATE	ALUM	-	10	2	#4-40 CAP SCR	ST.STL
H7503-4	19	1	COVER PLATE DETAIL	ALUM	H7501-5	9	7	SPACER FOR #4 SCR	ALUM
H7503-3	18	1	COVER PLATE DETAIL	ALUM	-	8	3	#8-32 SCR	ST.STL
H7503-2	17	1	COVER PLATE	ALUM	-	7	4	#4-40 CAP SCR	ST.STL
H7503-1	16	1	COVER PLATE	ALUM	-	6	A/R	1/4-20 SCR	ST.STL
-	15	4	#4-40 AL HD CP SC	ST.STL	-	5	4	#10-32 X 3/8 LNG	ST.STL
H7502-3	14	1	LID	ALUM	H7501-4	4	4	STANDOFF	ALUM
	13				H7501-3	3	1	BRIDGE PLATE	ALUM
H7502-1	12	1	END PLATE	ALUM	H7501-2	2	1	BOTTOM BRACE	ALUM
-	11	4	#10-32 SCR x 5/8 LG	ST.STL	H7501-1	1	1	BASE PLATE	ALUM

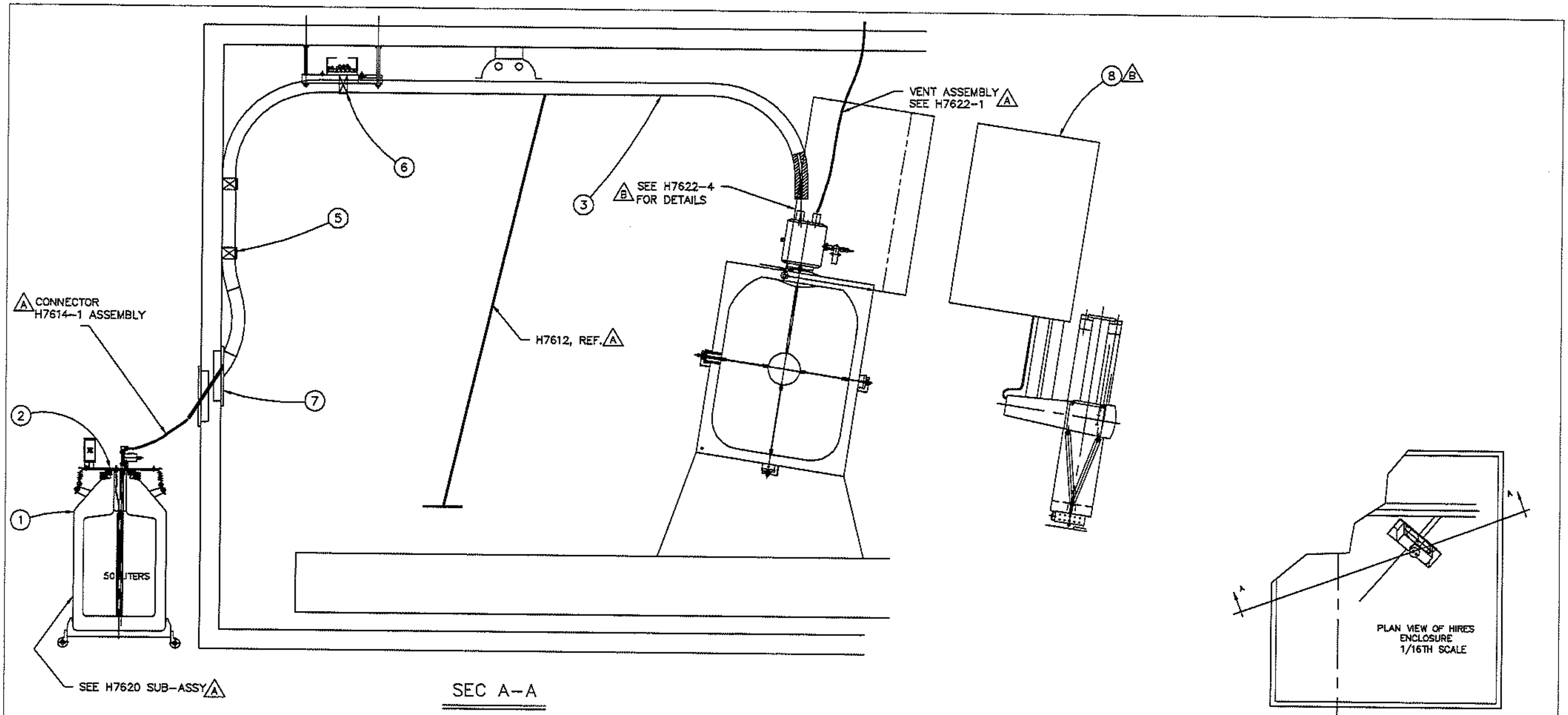
FULL

A	4 10 92	J.O.		DETAIL DESIGN.
B	4 21 92	J.O.		EL-2073 BOARD MODIFIED.
C	5 19 92	J.O.		MODIFY.
D	10/6/92	CAO		UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
CCD ELEC. BOX
PRE-AMP

J.O. 3 14 91

H7500.D



SEC A-A

(-1) LIQUID NITROGEN FILL/VENT SYSTEM

NOTES:

1. DO NOT SCALE THIS DRAWING.
△B 2. SEE H1462 ET AL FOR CCD CONTROLLER BOX

△B	H1462-1	8	1	CCD CONTROLLER BOX	ASSY
	H7620-1	7	2	WALL FEEDTHRU	PVC
	H7619-2	6	2	HANGER ASSEMBLY	ALUM
△A	H7619-1	5	1	CLAMP	ALUM
		4			
	H7610-1	3	1	TRANSFER LINE	
	H7604-1	2	1	CONTROL ASSEMBLY	
	H7502-1	1	1	SUPPLY DEWAR, 50 L	

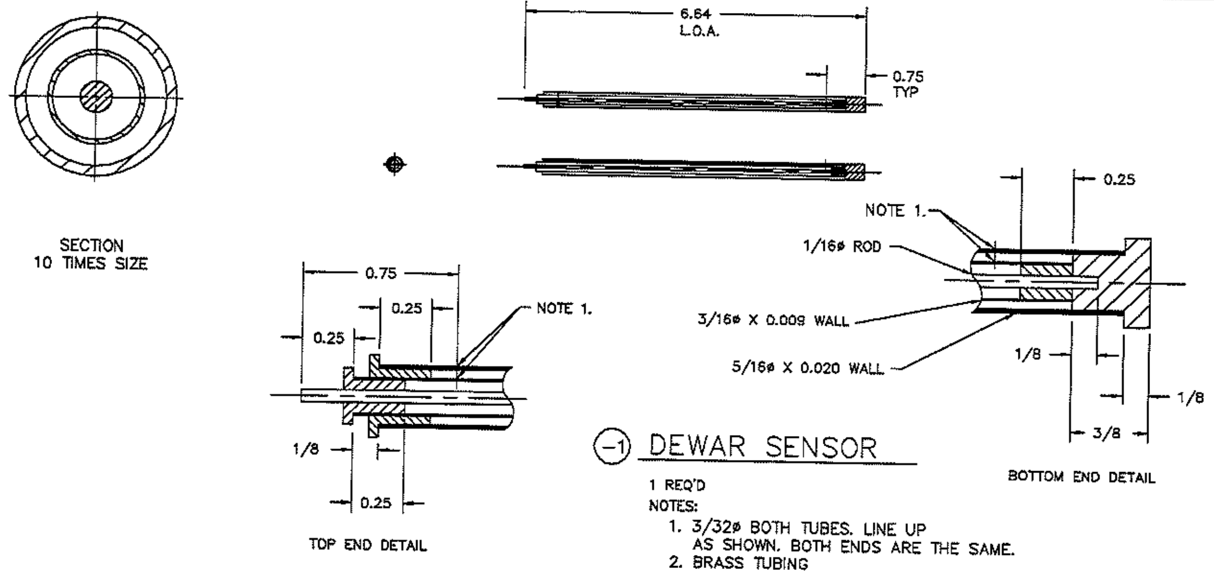
1/8

A	1 5 93	j.o.		MODIFY SUPPORT FOR TRANSFER LINE.
				ADD NOTES, CHANGE VENT & CONNECTOR
B	2 18 93	j.o.		INSERT CCD CONTROLLER BOX

KECK/HIRES
CCD-DEWAR
CRYOGENIC TRANSFER

j.o. 3 11 92

H7600.B

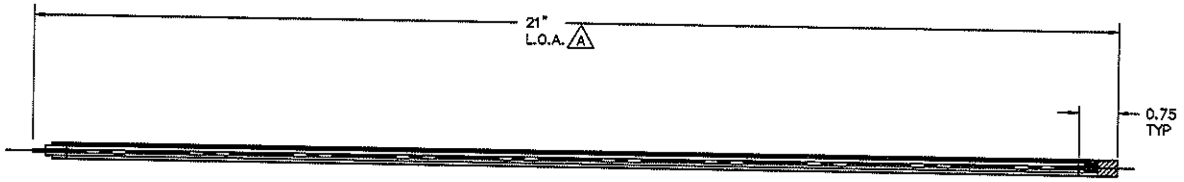


⊖1 DEWAR SENSOR

1 REQ'D

NOTES:

1. 3/32ø BOTH TUBES. LINE UP AS SHOWN. BOTH ENDS ARE THE SAME.
2. BRASS TUBING
3. LEXAN SPACERS, PRESS FIT. FLANGES ARE FOR REMOVAL.
4. DESIGN BORROWED FROM LAWRENCE BERKELEY LAB REPORT LBL-19674 DATED MAY 1985, D.A. LANDIS



⊖2 SUPPLY DEWAR SENSOR

1 REQ'D

NOTES:

1. 3/32ø BOTH TUBES. LINE UP AS SHOWN. BOTH ENDS ARE THE SAME.
2. BRASS TUBING
3. LEXAN SPACERS, PRESS FIT. FLANGES ARE FOR REMOVAL.
4. △A USE WITH TAYLOR WHARTON 50 LITER DEWAR SEE H7602 FOR DETAIL.

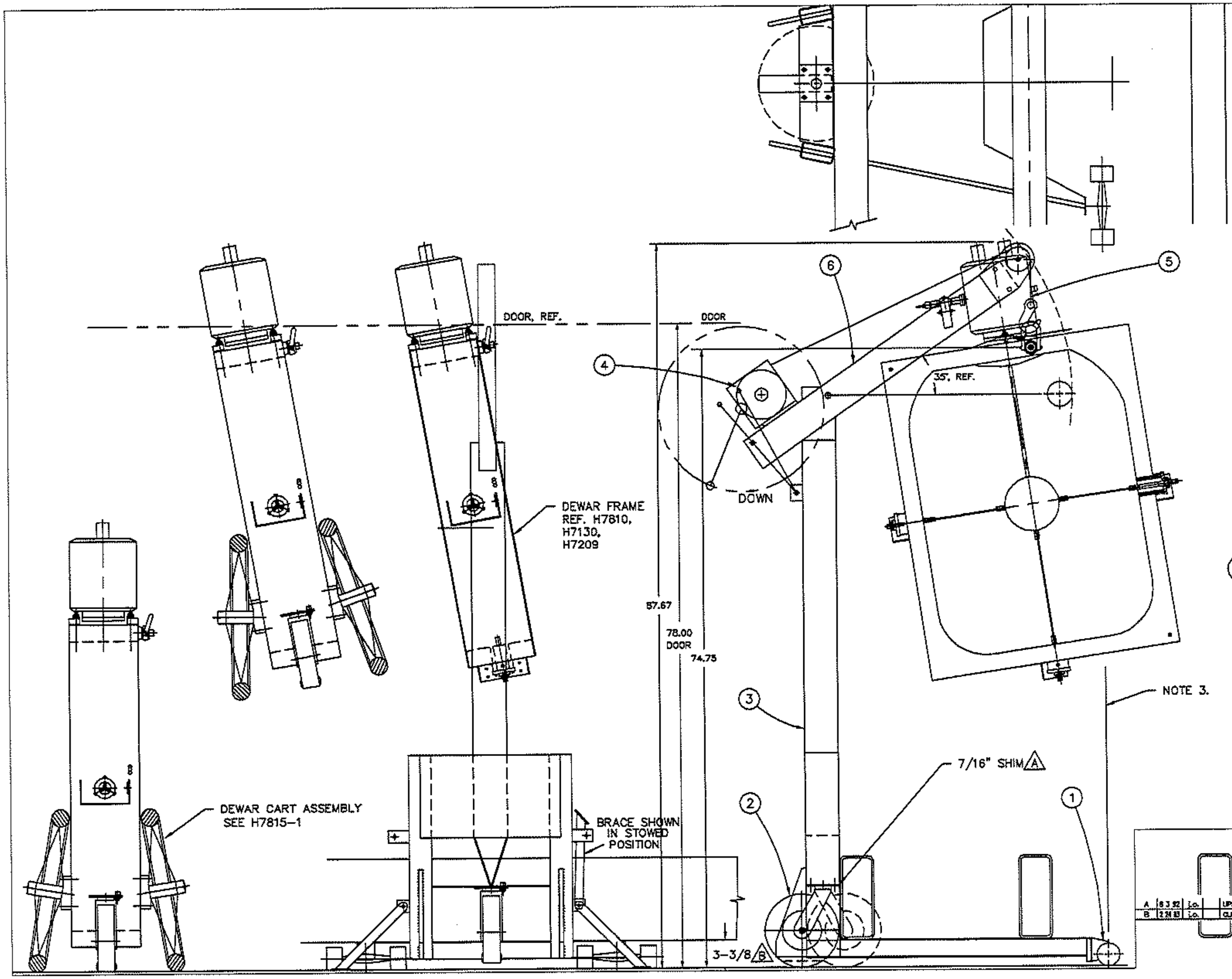
A	4-10-92	j.o.		DEWAR LENGTH ESTABLISHED.
B	2 8 93	j.o.		ADD SECTION VIEW AT 10X SIZE.

FULL

KECK/HIRES
LIQUID NITROGEN FILL
SENSOR ASSEMBLY

j.o. 3 16 92

H7601.B



⊖1 DEWAR LIFTER

1 REQ'D

NOTES:

1. 1300 LBS. DUTTON-LAINSON CO.
   (402) 462-4141
2. 4000 LBS. STRAP AND GALVANIZED HOOK
   △A CUT FROM D/L 25 FOOT STRAP. 92" LONG WITH
   4" LOOP AT UN-HOOK END. STITCHED BY LARSEN
   SAILS, SANTA CRUZ.
3. LOAD NOT TO EXCEED THIS LINE.

H7830-1	5	1	BEAM	ASSY
DL 6148	5	1	2" STRAP AND HOOK	NOTE 2.
DL 1302	4	1	HAND HOIST	NOTE 1.
H7820-1	3	1	FRAME	ASSY
H7819-1	2	1	CASTER	ASSY
H7818-1	1	2	SKATE WHEEL SET	ASSY

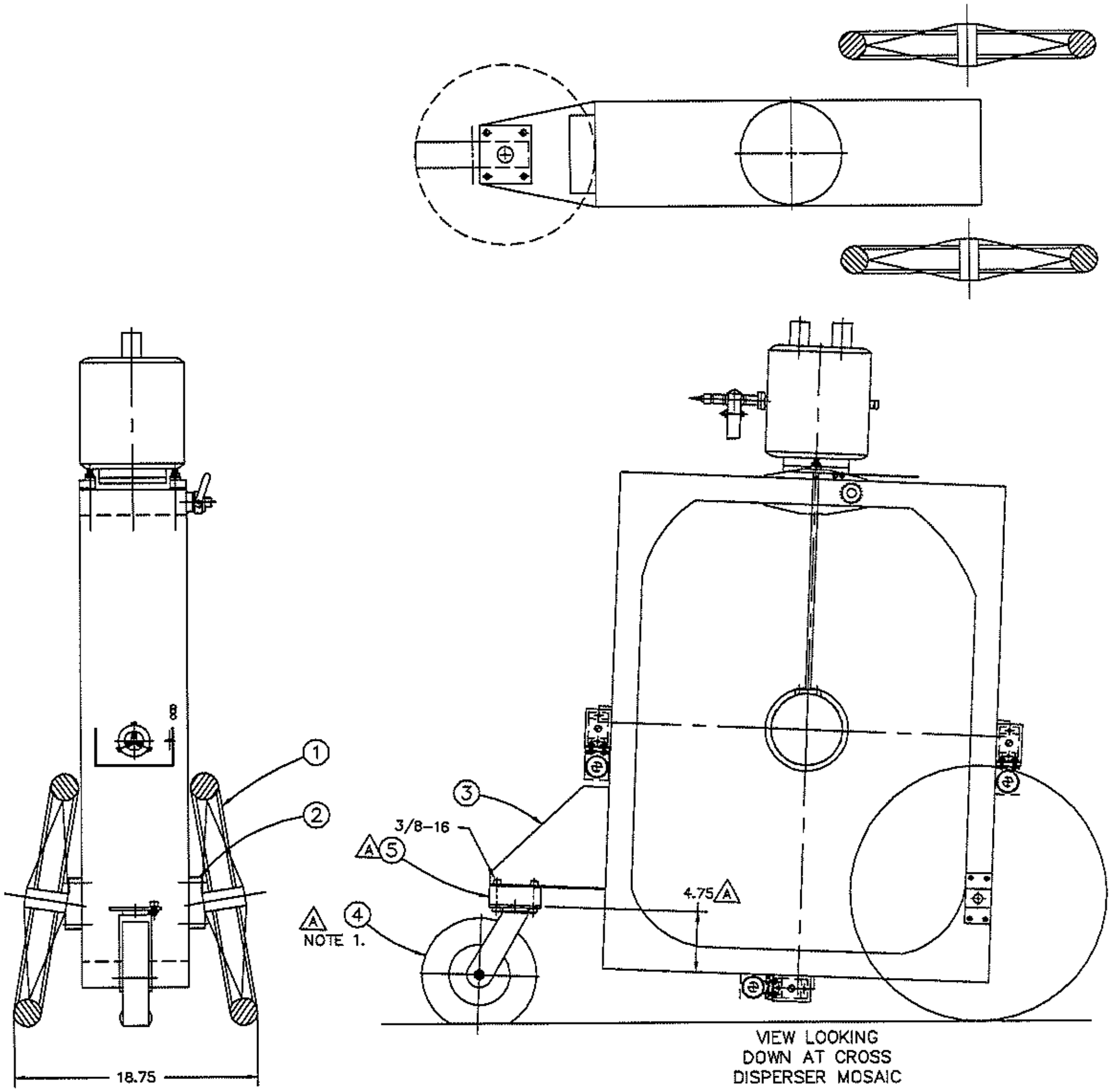
A	8 3 92	j.o.		UPDATE TO AS-BUILT CONDITION.
B	2 24 93	j.o.		CLEANUP; ADD NOTES.

1/5

KECK/HIRES
CCD DEWAR LIFTER
GENERAL ASSEMBLY

j.o. 3 17 92

H7800.B



VIEW LOOKING
DOWN AT CROSS
DISPERSER MOSAIC

(-1) DEWAR CART ASSEMBLY

2 REQ'D A

NOTES:

1. UNDER-INFLATE TIRE AS SHOWN

PER ASSEMBLY

A	H7817-3	5	1	SPACER	ALUM
	H7819-1	4	1	CASTER	–
	H7817-2	3	1	CASTER MOUNT	STEEL
	H7817-1	2	2	PIVOT BLOCK	STEEL
	H7815-1	1	2	20" PNEUMATIC WHEEL	

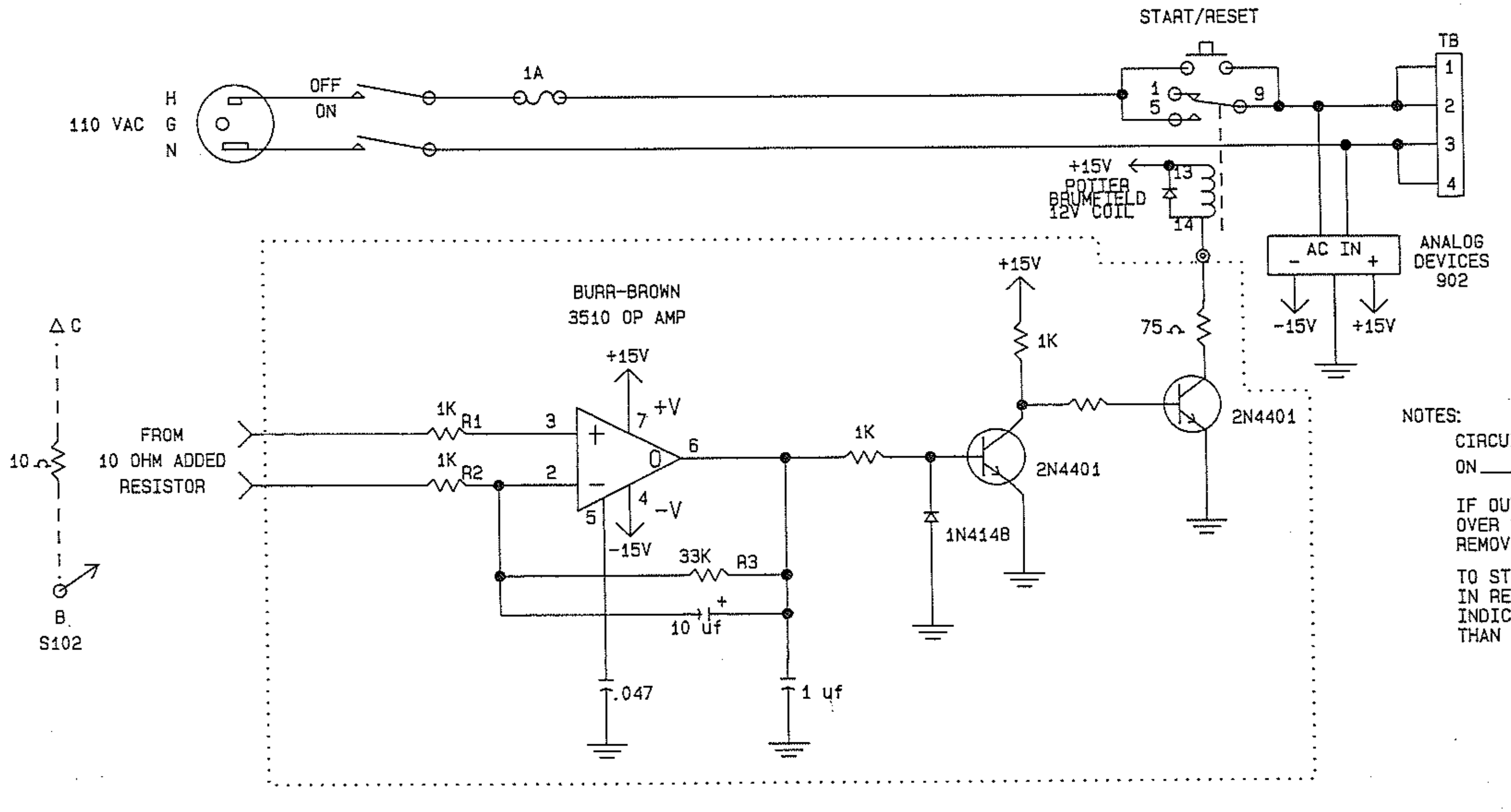
1/4

A	12 1 92	J.O.		ADD BLOCK FOR MORE GROUND CLEARNCE

KECK/HIRES
DEWAR CART
ASSEMBLY

J.O. 3 25 92

H7815.A



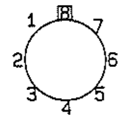
NOTES:

CIRCUIT ADDED AT LICK OBSERVATORY

ON ____________________

IF OUTPUT CURRENT EXCEEDS 3.5 MA FOR OVER 2 SEC. RELAY WILL DROP OUT AND REMOVE AC POWER FROM UNIT.

TO START OR RESET: TURN ON AND HOLD IN RESET PUSHBUTTON UNTIL METER INDICATES OUTPUT CURRENT IS LESS THAN 3.5 MA. RELEASE BUTTON.



TOP VIEW
3510 OP AMP

MARK	DATE	DRW'N	CH'KD	REVISION
	1-24-90	CD		ENTERED IN PCAD

UNIVERSITY OF CALIFORNIA
LICK OBSERVATORY

OVERLOAD PROTECTION FOR
VARIAN ION PUMP

DES'N BY	LBR CRD	APPROVED BY	
DRW'N BY	CD		
CHK'D BY		DATE	4-19-84

DWG. NO.
EL-1027-2S

Appendix G List of Drawings — Housing & Structure

1. H6000 Locating Tree
2. H0010 General Telescope Assembly
3. P0010 General Layout
4. H0012 Elevation Axle Detail
5. H0102 Final Optical Layout
6. H0148 Super-Duper 3 Layout
7. H6100 Main Assembly Drawing
8. H6102 Nasmyth Deck and Leg Detail
9. H6120 Support Foot Detail (Ball-On-Flat)
10. H6170 Optical Bench Assembly (Main Structure)
11. H6174 Support Foot Detail (Ball-In-Groove)
12. H6177 Support Foot Detail (Ball-In-Cone)
13. H6200 Main Support Framework
14. H6220 Interferometer Mounting for Mosaic Testing
15. H6222 Details of Testing
16. H6400 Main Housing Assembly
17. H6410 3–D of Main Housing
18. H6425 Electronics Vault Assembly
19. H6429 Hatch Assembly
20. H6460 Light Trap Assembly
21. H6461 Light Trap Details
22. H6470 Housing and Freezer During Testing at UCSC

H6000	LOCATING TREE (THIS DRAWING)
H6050	JUNCTION BOX/HATCH
H6051	" DETAILS
H6052	" DETAILS
H6100	MAIN ASSEMBLY DRAWING
H6101	NASMYTH INTERFACE
H6102	NASMYTH DECK BOLT PATTERN
H6103	FLOOR DETAIL — CUTOUTS
H6104	PATTERNS
H6105	PATTERNS
H6106	PATTERNS
H6107	FEET SPACERS
H6110	SUPPORT FOOT — BALL/GROOVE
H6111	PATTERNS
H6112	PATTERNS
H6113	WEB DETAIL
H6114	SUPPORT FOOT DETAIL
H6115	SUPPORT FOOT — BALL/CONE
H6116	PATTERNS
H6117	PATTERNS
H6118	WEB DETAIL
H6119	SUPPORT FOOT DETAIL
H6120	SUPPORT FOOT — BALL/PLANE
H6121	PATTERNS
H6122	PATTERNS
H6123	SUPPORT FOOT DETAIL
H6140	MAT PATTERNS
H6141	" DETAILS
H6142	" DETAILS
H6143	" DETAILS
H6144	" DETAILS
H6145	" DETAILS
H6146	" DETAILS
H6147	" DETAILS
H6148	" DETAILS
H6151	TURNTABLE MOUNT ASSEMBLY
H6160	" DETAILS
H6170	OPTICAL BENCH ASSEMBLY
H6172	BALL/FLAT ASSEMBLY
H6173	" DETAILS
H6174	CROSSED ROLLER ASSEMBLY
H6175	OPTICAL BENCH DETAILS
H6177	BALL/CONE ASSEMBLY
H6179	CROSSED ROLLER DETAILS
H6180	OPTICAL BENCH DETAILS
H6181	" DETAILS
H6182	" DETAILS
H6185	CROSSED ROLLER DETAIL

H6200	OPTICAL BENCH DETAILS
H6201	" DETAILS
H6202	" DETAILS
H6203	" DETAILS
H6204	" DETAILS
H6205	" DETAILS
H6206	" DETAILS
H6207	" DETAILS
H6220	ZYGO INTERFEROMETER
H6221	MOUNTING FOR
H6222	MOSAIC TESTING
H6223	" DETAILS
H6300	A-FRAME ASSEMBLY (ECHELLE)
H6305	" DETAILS
H6306	" DETAILS
H6307	" DETAILS

SEE HOXYZ STICK FILE

{ SEE ALSO H4518,9 FOR ZYGO MOUNT TO TEST COLLIMATOR

H6400	HOUSING ASSEMBLY
H6401	LIGHTING PLAN IN BIG ROOM
H6402	THERMAL MODEL (MATHEMATICAL)
H6403	"
H6404	"
H6405	"
H6406	"
H6407	"
H6408	"
H6409	"

SEE HOXYZ STICK FILE

H6410	3D HOUSING DRAWING
H6411	TRANSITION CONE ASSEMBLY
H6412	" DETAILS
H6413	" DETAILS
H6414	NOSE: CYLINDER ASSEMBLY
H6415	HOUSING RACEWAY ASSEMBLY
H6416	" DETAILS
H6417	" DETAILS
H6420	OUTER CONE DETAIL
H6421	NOSE DETAILS
H6422	" DETAILS
H6423	" DETAILS
H6424	" DETAILS
H6425	ELECTRONICS VAULT ASSEMBLY
H6427	HATCH ASSEMBLY
H6428	HATCH: PNEUMATIC DOOR DETAIL
H6429	HATCH: PNEUM. DOOR ASSEMBLY
H6430	BALLY BUILDING. QUOTATION DRAWING
H6431	NOSE: BRACES
H6432	NOSE: INNER PANEL
H6433	THERMAL BAFFLES
H6434	THERMAL BAFFLES
H6440	INSIDE FRONT WALL DETAIL
H6450	THERMAL TESTING
H6460	LIGHT TRAP ROOM
H6461	" DETAILS

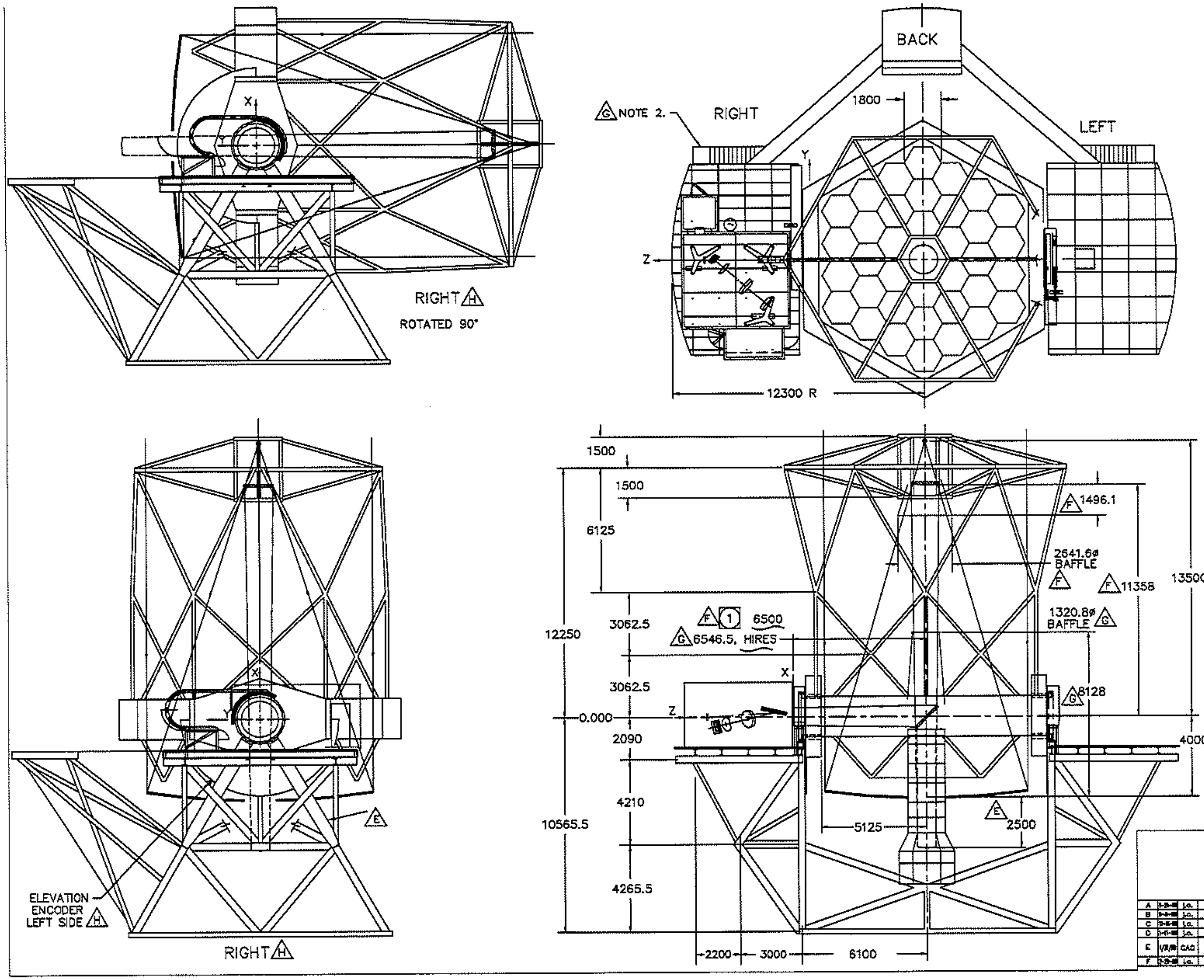
H6470	HOUSING & REFRIGERATOR DURING TESTING

H6474	INTERCONNECT CHASSIS
H6475	" DETAILS
H6476	" DETAILS
H6477	" DETAILS
H6478	" DETAILS
H6479	" DETAILS
H6480	" DETAILS
H6481	" DETAILS
H6482	" DETAILS
H6483	" DETAILS
H6484	" DETAILS
H6485	" DETAILS
H6486	" DETAILS
H6487	" DETAILS
H6490	JUNCTION PANEL
H6491	" DETAILS
H6492	" DETAILS
H6493	" DETAILS
H6494	" DETAILS
H6495	" DETAILS
H6496	" DETAILS

H6500	ALIGNMENT SCENARIO
H6510	ALIGNMENT FIXTURE REAR AUTOCOLLIMATOR MOUNT
H6511	" DETAILS
H6512	" DETAILS
H6513	" DETAILS
H6520	SLIT ALIGNER ASSEMBLY
H6521	PEDESTAL ASSY
H6522	" DETAILS
H6523	" DETAILS
H6524	PEDESTAL ROLL BAR
H6525	" DETAILS
H6526	" DETAILS
H6514	XYZ STAGE, MIRROR, ASSY
H6515	" DETAILS
H6530	SLIT END ALIGNMENT FIXTURE (AUTO-COLLIMATOR)
H6531	" DETAILS
H6532	" DETAILS
H6533	" DETAILS
H6534	" DETAILS
H6535	" DETAILS
H6536	" DETAILS
H6537	" DETAILS
H6538	" DETAILS
H6539	STORAGE BOX
H6540	" DETAILS
H6551	PUPIL FINDER
H6560	ALIGNMENT TARGET
H6605	CASTERS ASSEMBLY
H6606	" DETAILS
H67..	SERIES } STRUCTURE, ET AL } SEE H6001
H68..	SERIES } SEE BRUCE }
H69..	SERIES
H6907	LIFT DETAIL
H6922	CAMERA MIRROR TRACK AND LIFT
H6936	3D OF CAMERA MIRROR TRACK AND LIFT

A | 5 27 93 | J.O. | | AS SHIPPED INDEX

KECK/HIRES
STRUCTURE & HOUSING
DRAWING INDEX
J.O. 5 30 91
H6000.A



(-1) GENERAL ASSEMBLY

NOTES:

1 6500 IS NOMINAL FOCUS.

G 2. LANDING AND STAIR AS NOTED BY STEVE VOGT, 3-21-92.

ALL DIMENSIONS ARE MM

3RD ANGLE PROJECTION

G	4 5 93	j.a.		ADD BAFFLE, ADD 6546.5 mm DIMENS.
H	5 10 93	j.a.		HIRES WAS ON LEFT PLATFORM.

0.0125

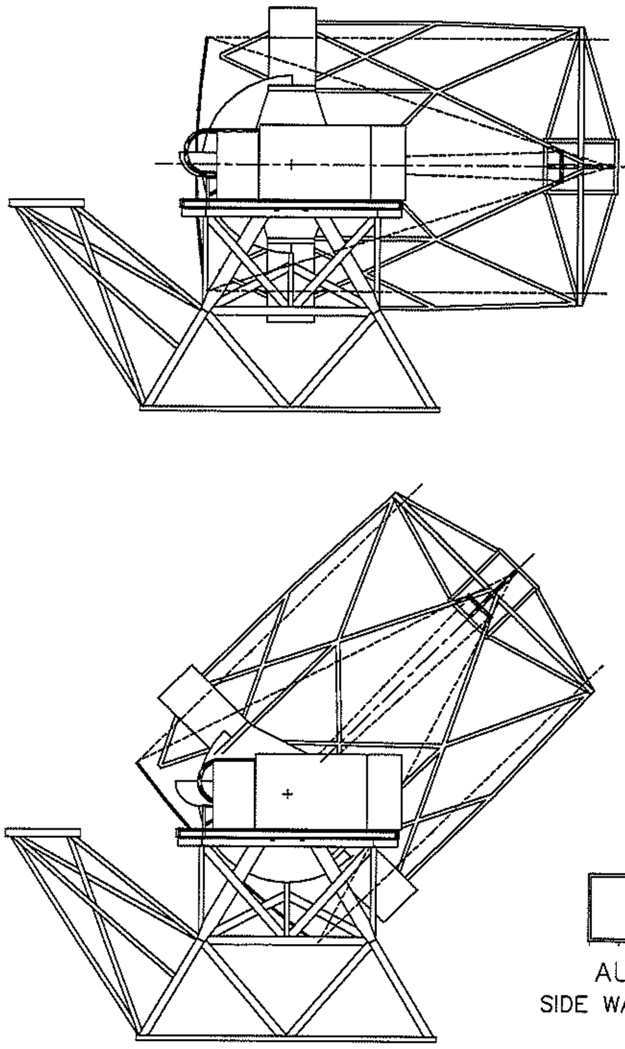
A	[illegible]	j.a.		MODIFY, WAS 231K
B	[illegible]	j.a.		RENAME, WAS HIRES12.
C	[illegible]	j.a.		CLEAN UP, CREATE H0011
D	[illegible]	j.a.		MODIFY BEARING SURFACE.
E	[illegible]	CAO		CHANGE MT.1: 600 WAS 350 2500 WAS 3000
F	[illegible]	j.a.		6501.4 WAS 7000, ADD CASS SHIELDS

KECK/HIRES
GENERAL ASSEMBLY

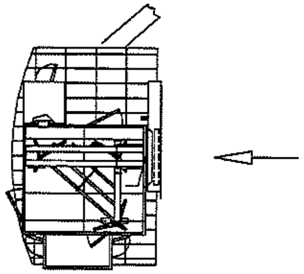
j.a.
C.A.O. 4 20 88

H0010.H

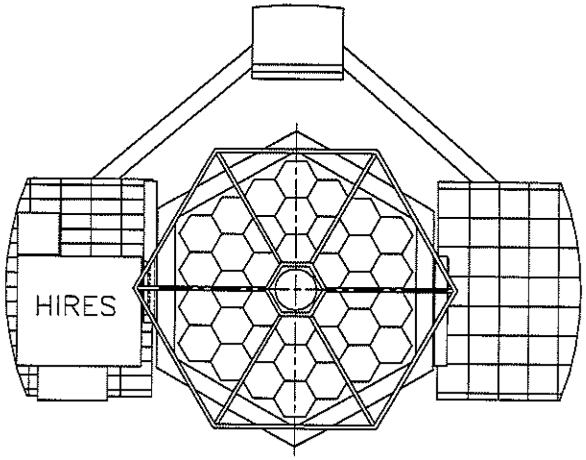
HIGH RESOLUTION SPECTROGRAPH MOUNTED ON THE KECK TELESCOPE



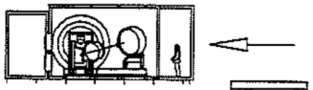
SIDE VIEWS WITH ROTATION



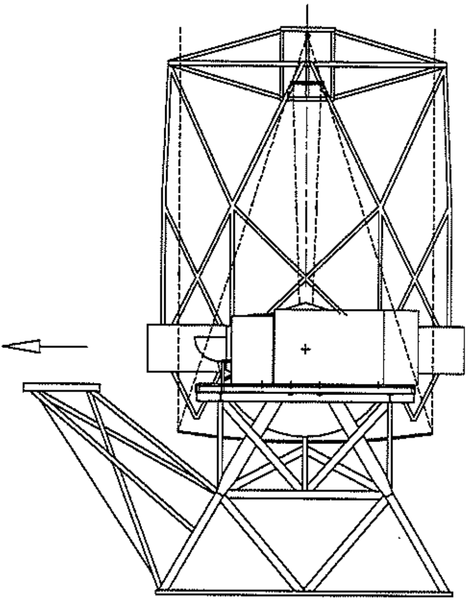
TOP VIEW
ROOF REMOVED



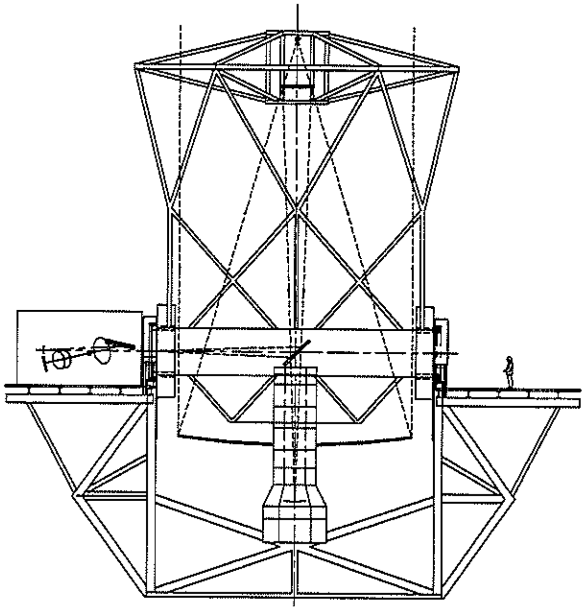
TOP VIEW



AUX. VIEW
SIDE WALLS REMOVED

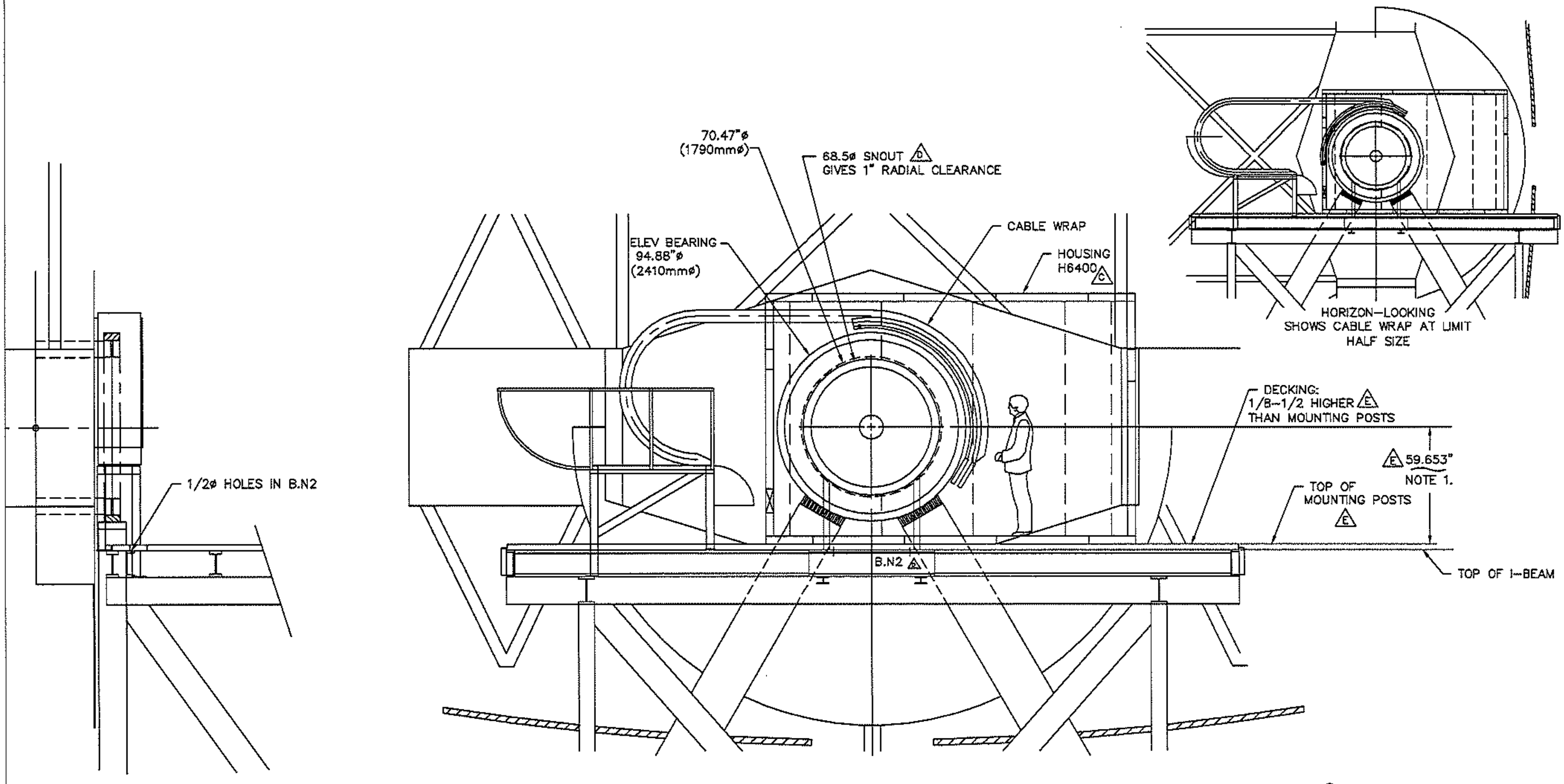


SIDE VIEW



FRONT VIEW

P0010.A
j.o. 3 30 93



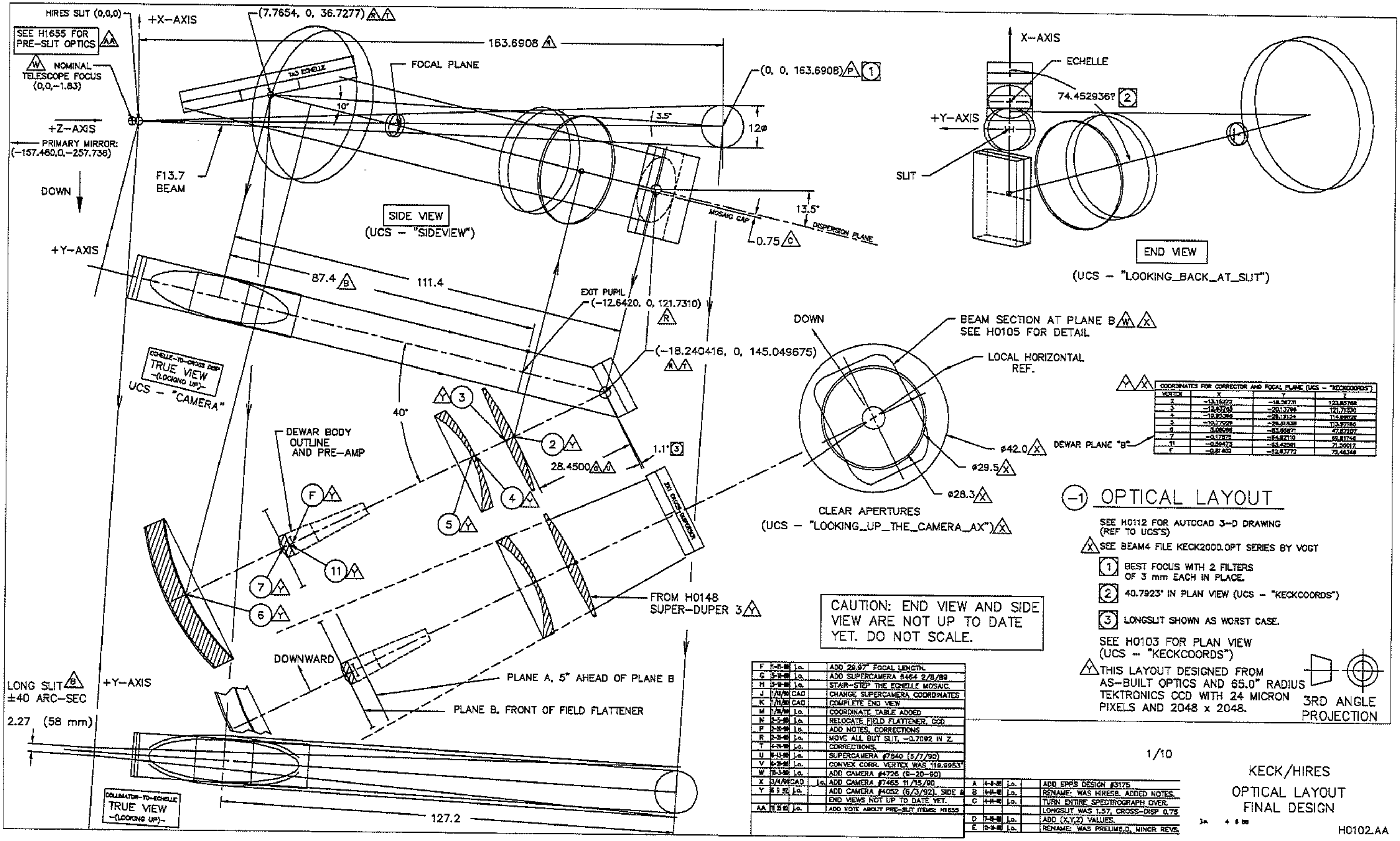
(-1) LEFT NASMYTH PLATFORM

NOTES:
1. RON LAUB MEASURED THIS DISTANCE ON 5-16-91. E
2. FOR REFERENCE, RIGHT NASMYTH DISTANCE IS 59.450.

1/20

A	[illegible]	J.a.		ADD HOUSING OUTLINE.
B	[illegible]	J.a.		RENAME, WAS HIRES13.
C	[illegible]	J.a.		CHANGE HOUSING
D	[illegible]	J.a.		ADD NOTES, BEAM B.N2
E	[illegible]	J.a.		59.653 WAS 59.1.

KECK/HIRES
GENERAL ASSEMBLY
ELEVATION AXLE DETAIL
J.a. 6 14 88
H0012.E



COORDINATES FOR CORRECTOR AND FOCAL PLANE (UCS – "KECKCOORDS")			
VERTEX	X	Y	Z
2	-13.15272	-18.26731	123.85768
3	-12.83765	-20.13794	121.71330
4	-10.92366	-28.12124	114.99928
5	-10.77929	-29.61838	113.97186
6	0.06696	-53.66927	47.67297
7	-0.17878	-54.82110	68.81746
11	-0.09473	-53.42961	71.36012
F	-0.81400	-62.63772	73.46348

(-1) OPTICAL LAYOUT

SEE H0112 FOR AUTOCAD 3-D DRAWING (REF TO UCS'S)

X SEE BEAM4 FILE KECK2000.OPT SERIES BY VOGT

1 BEST FOCUS WITH 2 FILTERS OF 3 mm EACH IN PLACE.

2 40.7923° IN PLAN VIEW (UCS – "KECKCOORDS")

3 LONGSLIT SHOWN AS WORST CASE.

SEE H0103 FOR PLAN VIEW (UCS – "KECKCOORDS")

Y THIS LAYOUT DESIGNED FROM AS-BUILT OPTICS AND 65.0" RADIUS TEKTRONICS CCD WITH 24 MICRON PIXELS AND 2048 x 2048.

CAUTION: END VIEW AND SIDE VIEW ARE NOT UP TO DATE YET. DO NOT SCALE.

F	[illegible]	J.a.		ADD 29.97" FOCAL LENGTH.
G	[illegible]	J.a.		ADD SUPERCAMERA 8464 2/8/89
H	[illegible]	J.a.		STAIR-STEP THE ECHELLE MOSAIC.
J	[illegible]	CAO		CHANGE SUPERCAMERA COORDINATES
K	[illegible]	CAO		COMPLETE END VIEW
M	[illegible]	J.a.		COORDINATE TABLE ADDED
N	[illegible]	J.a.		RELOCATE FIELD FLATTENER, CCD
P	[illegible]	J.a.		ADD NOTES, CORRECTIONS
R	[illegible]	J.a.		MOVE ALL BUT SLIT, -0.7092 IN Z.
T	[illegible]	J.a.		CORRECTIONS.
U	[illegible]	J.a.		SUPERCAMERA #7840 (5/7/90)
V	[illegible]	J.a.		CONVEX CORR. VERTEX WAS 119.9953"
W	[illegible]	J.a.		ADD CAMERA #4726 (9-20-90)
X	3/4/91	CAO	J.a.	ADD CAMERA #7465 11/15/90
Y	6 9 92	J.a.		ADD CAMERA #4052 (6/3/92). SIDE &
				END VIEWS NOT UP TO DATE YET.
AA	[illegible]	J.a.		ADD NOTE ABOUT PRE-SLIT ITEMS: H1655

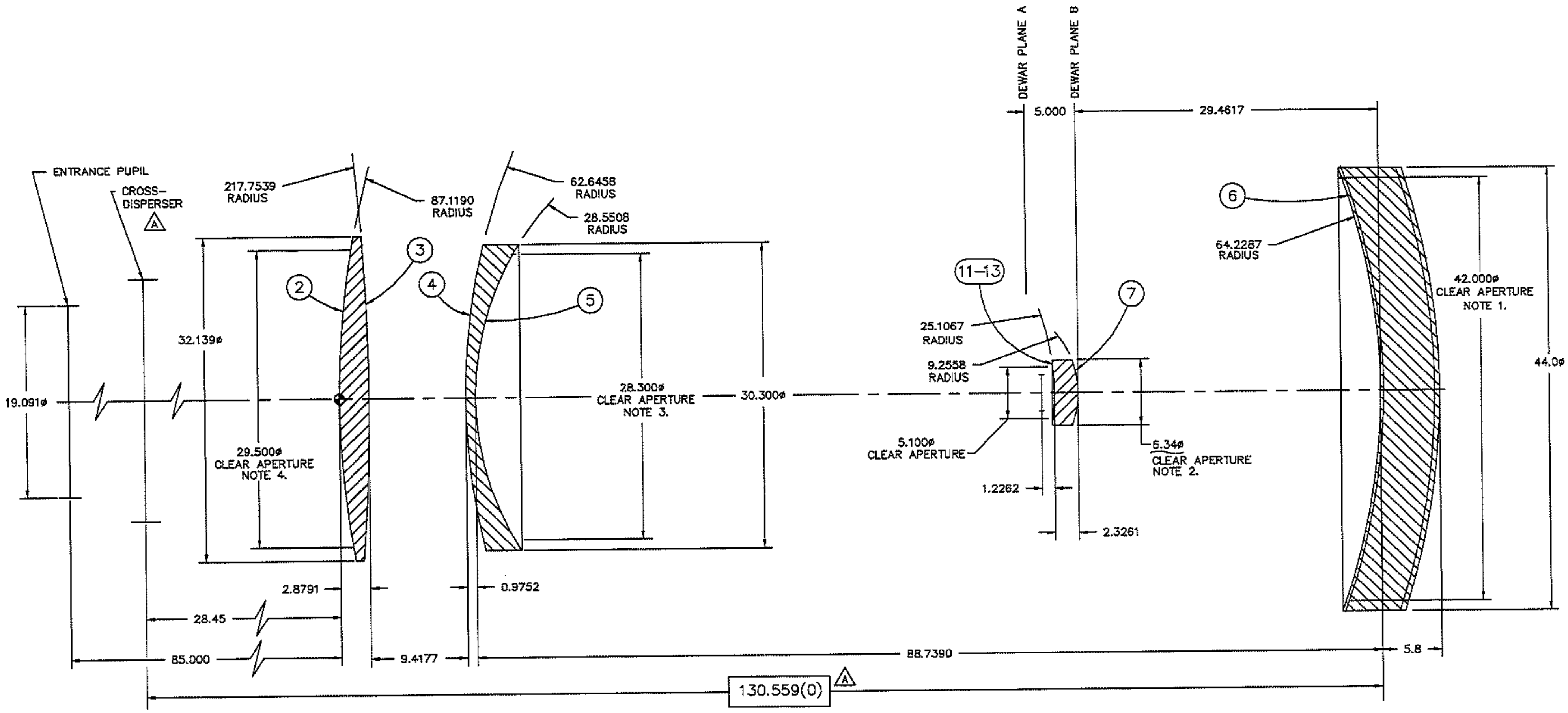
A	[illegible]	J.a.		ADD EPPS DESIGN #3175.
B	[illegible]	J.a.		RENAME: WAS HIRES8. ADDED NOTES.
C	[illegible]	J.a.		TURN ENTIRE SPECTROGRAPH OVER.
				LONGSLIT WAS 1.57, CROSS-DISP 0.75
D	[illegible]	J.a.		ADD (X,Y,Z) VALUES.
E	[illegible]	J.a.		RENAME: WAS PRELIM6.D, MINOR REVS.

1/10

KECK/HIRES
OPTICAL LAYOUT
FINAL DESIGN

Ja. 4 6 88

H0102.AA



⊖1 EPPS DESIGN #4052 (6/3/92)

FINAL "AS-BUILT" PRESCRIPTION
USE WITH R=65.0" CONVEX TEK CCD
T = 0°C
THIS DRAWING REPLACES H0135, SUPER-DUPER II
WHICH WAS EPPS DESIGN #7465 (11/15/90)
THE FLAT FIELD VERSION #4753 IS DRAWING H0149.

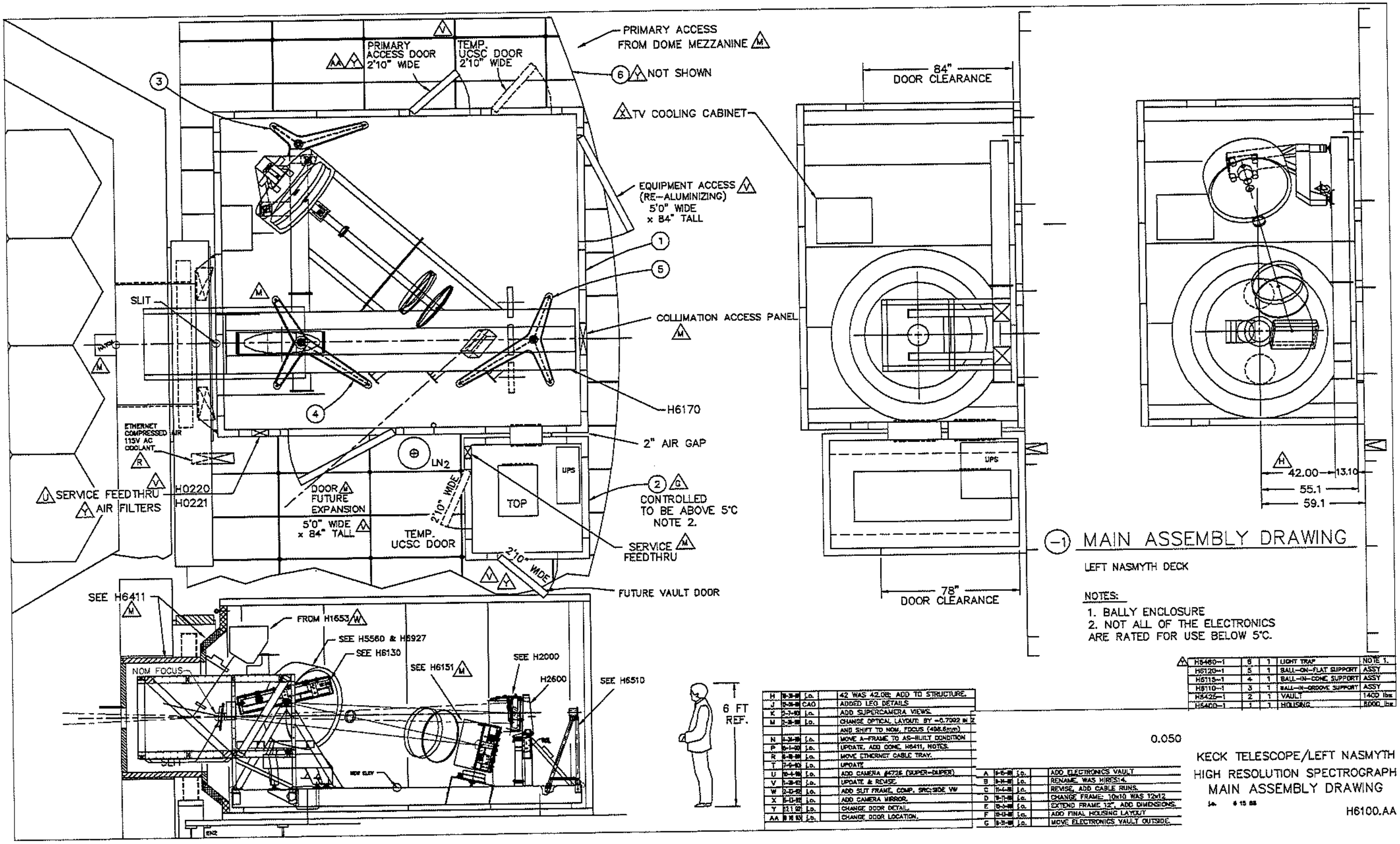
△B 6.7° FOV (FIELD OF VIEW)

NOTES:
1. 37.603ø CLEAR APERTURE FOR THIS CCD.
SEE H5400–H5405, H5415, H0144 FOR DETAILS
2. 6.34ø C.A. FROM 6.44ø BLANK
SEE H7181 FOR LENS DETAIL
3. 25.90ø C.A.
SEE H0136, H0142, H0145, H0147
4. 27.13ø C.A.
SEE H0136, H0141, H0146

1/4

A	8 11 92	J.a.		ADD DIMENSION TO CROSS-DISPERSER
B	5 13 93	J.a.		ADD FIELD OF VIEW NOTE

KECK/HIRES
SUPER–DUPER CAMERA III
AS–BUILT "CURVED FIELD"
H.EPPS 6 3 92
J.a. 8 5 92
H0148.B



(-1) MAIN ASSEMBLY DRAWING

LEFT NASMYTH DECK

NOTES:
1. BALLY ENCLOSURE
2. NOT ALL OF THE ELECTRONICS ARE RATED FOR USE BELOW 5°C.

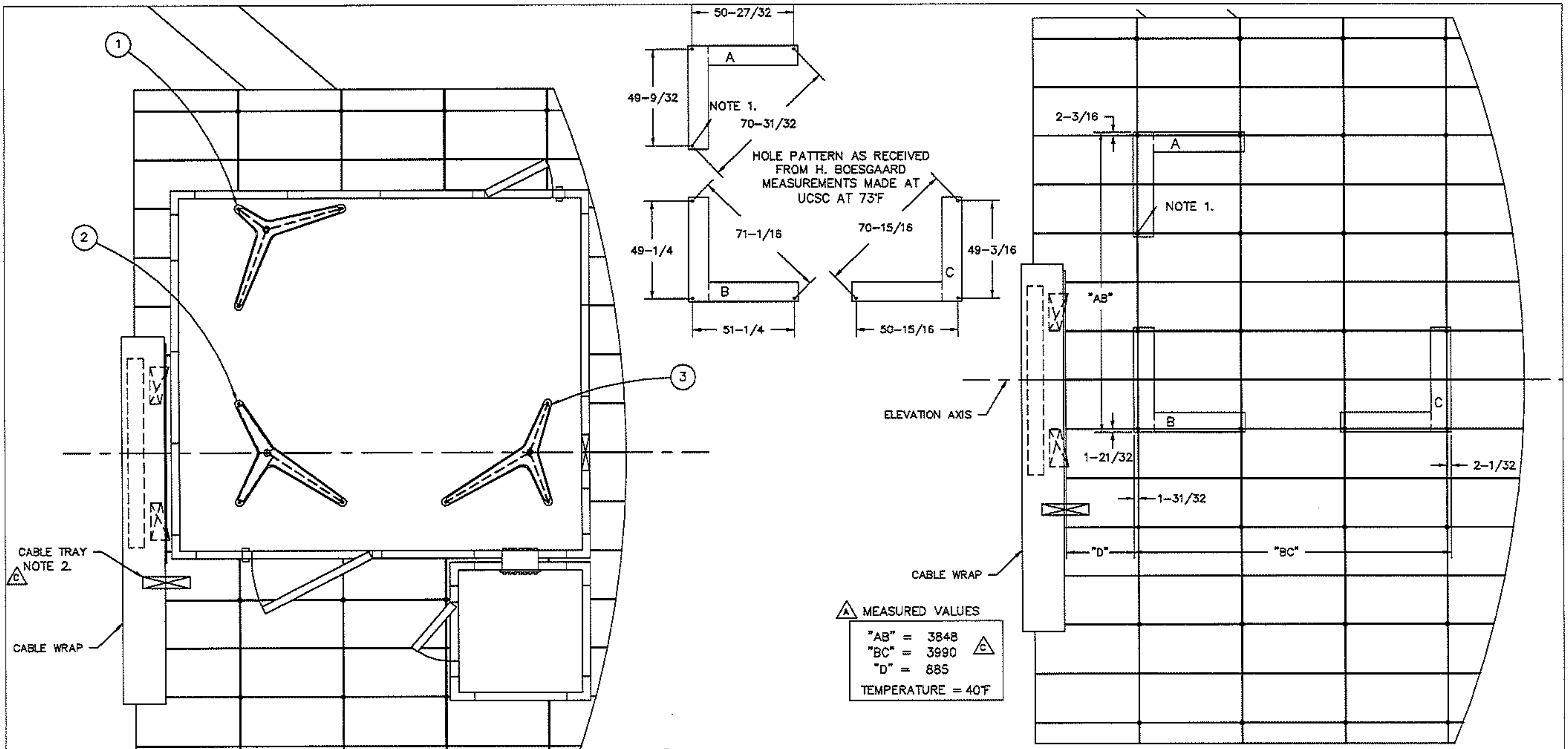
H	[illegible]	j.o.		42 WAS 42.08; ADD TO STRUCTURE.
J	[illegible]	CAO		ADDED LEO DETAILS
K	2-7-90	j.o.		ADD SUPERCAMERA VIEWS.
M	[illegible]	j.o.		CHANGE OPTICAL LAYOUT: BY -0.7092 IN Z
				AND SHIFT TO NOM. FOCUS (496.6mm)
N	[illegible]	j.o.		MOVE A-FRAME TO AS-BUILT CONDITION
P	[illegible]	j.o.		UPDATE, ADD CONE, H6411, NOTES.
R	[illegible]	j.o.		MOVE ETHERNET CABLE TRAY.
T	7-9-90	j.o.		UPDATE
U	[illegible]	j.o.		ADD CAMERA #4726 (SUPER-DUPER)
V	[illegible]	j.o.		UPDATE & REVISE.
W	[illegible]	j.o.		ADD SLIT FRAME, COMP. SRC;SIDE VW
X	[illegible]	j.o.		ADD CAMERA MIRROR.
Y	12.1.92	j.o.		CHANGE DOOR DETAIL.
AA	[illegible]	j.o.		CHANGE DOOR LOCATION.

A	[illegible]	j.o.		ADD ELECTRONICS VAULT
B	[illegible]	j.o.		RENAME. WAS HIRES14.
C	[illegible]	j.o.		REVISE, ADD CABLE RUNS.
D	[illegible]	j.o.		CHANGE FRAME: 10x10 WAS 12x12
E	[illegible]	j.o.		EXTEND FRAME 12", ADD DIMENSIONS.
F	[illegible]	j.o.		ADD FINAL HOUSING LAYOUT
G	[illegible]	j.o.		MOVE ELECTRONICS VAULT OUTSIDE.

Y H6460-1	6	1	LIGHT TRAP	NOTE 1.
H5120-1	5	1	BALL-ON-FLAT SUPPORT	ASSY
H5115-1	4	1	BALL-IN-CONE SUPPORT	ASSY
H5110-1	3	1	BALL-IN-GROOVE SUPPORT	ASSY
H5425-1	2	1	VAULT	1400 lbs
H5400-1	1	1	HOUSING	5000 lbs

0.050

KECK TELESCOPE/LEFT NASMYTH
HIGH RESOLUTION SPECTROGRAPH
MAIN ASSEMBLY DRAWING
j.o. 6 15 88
H6100.AA



A MEASURED VALUES

"AB" = 3848 C
"BC" = 3990
"D" = 885
TEMPERATURE = 40°F

① NASMYTH DECK LEG DETAIL

LEFT PLATFORM

C NOTE 1. TEMPLATE HOLE IS 2mm OFF IN THIS DIRECTION. SEE SCRATCHES ON TEMPLATE. HOLE SHOULD MOVE IN DIRECTION OF ARROW.

C NOTE 2. TRAY WAS ON OPPOSITE SIDE OF ELEVATION AXIS.

H6120	3	1	BALL-ON-PLANE SUPPORT	ASSY
H6115	2	1	BALL-IN-CONE SUPPORT	ASSY
H6110	1	1	BALL/GROOVE SUPPORT	ASSY

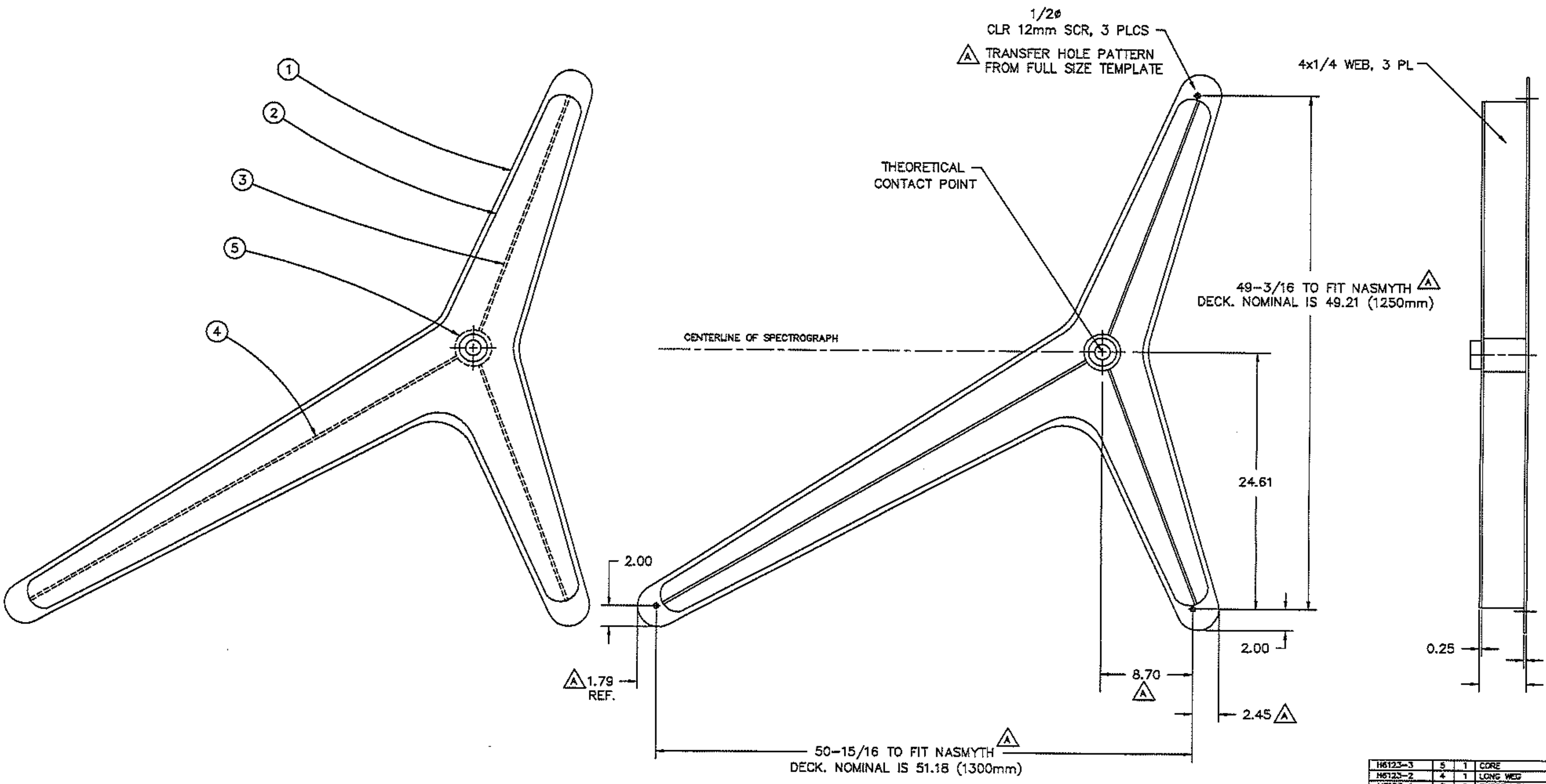
0.050

A	3-21-90	j.a.		ADD LOCATING TEMPLATE CALLOUT.
B	4-3-90	j.a.		ADD CATWALK, CHANGE SHAPE OF TEMPL.
C	1-15-90	vj.a.		ADD NOTES FROM MAUNA KEA.

KECK/HIRES
NASMYTH DECK
LEG DETAIL

j.a. 6 18 88
CAD 12 04 89

H6102.C



H6123-3	5	1	CORE	STEEL
H6123-2	4	1	LONG WEG	STEEL
H6123-1	3	2	SHORT WEB	STEEL
H6122-1	2	1	TOP PLATE	STEEL
H6121-1	1	1	BOTTOM PLATE	STEEL

-1 BALL-ON-FLAT SUPPORT ASSEMBLY

1 REQ'D
STEEL WELDMENT

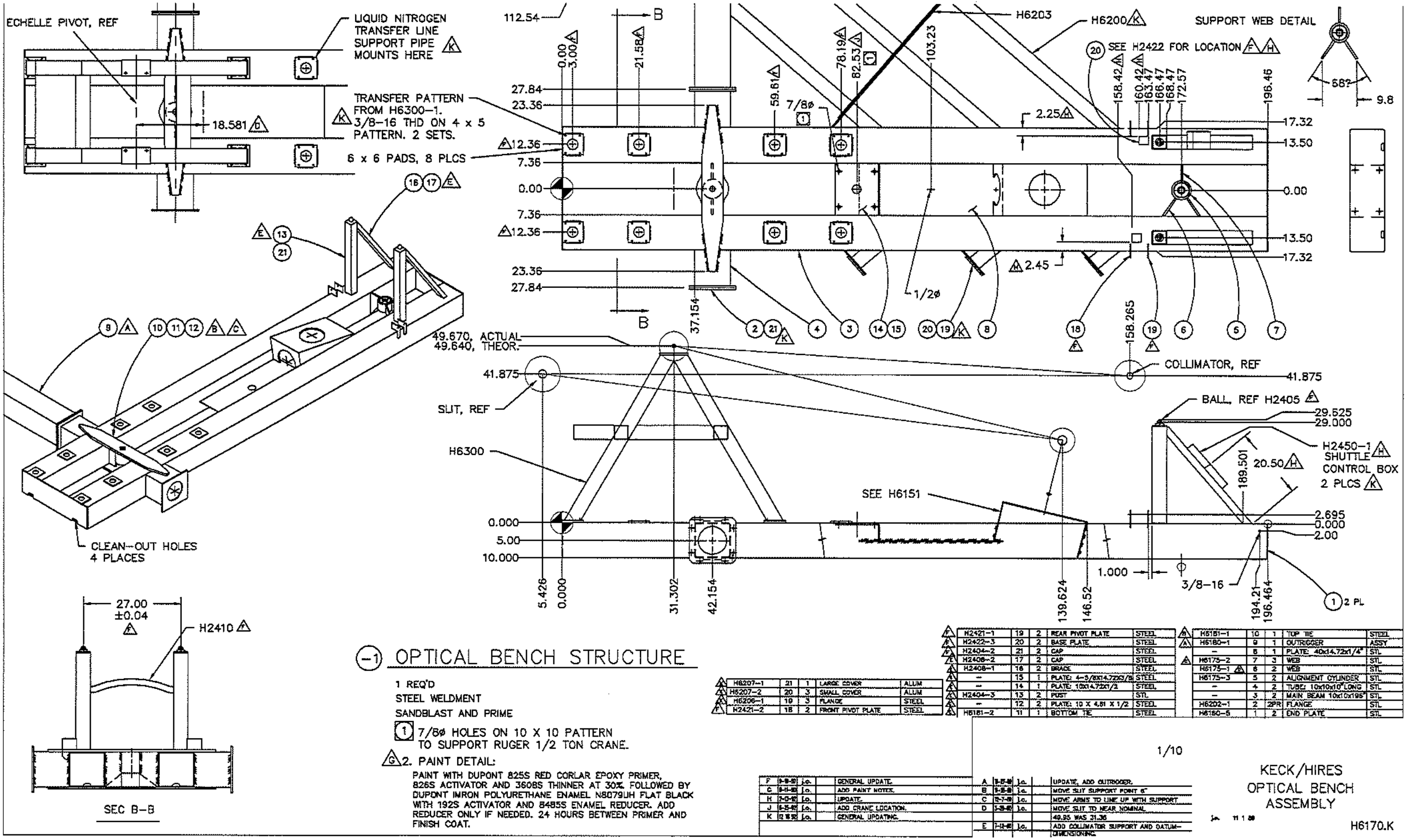
1/4

A | 7-30-90 | j.o. | | ADD HOLE LOCATIONS FROM TEMPLATE

KECK/HIRES
SUPPORT FOOT
BALL-ON-PLANE

j.o. 11 30 89

H6120.A



(-1) OPTICAL BENCH STRUCTURE

1 REQ'D

STEEL WELDMENT

SANDBLAST AND PRIME

1 7/8Ø HOLES ON 10 X 10 PATTERN TO SUPPORT RUGER 1/2 TON CRANE.

G 2. PAINT DETAIL:

PAINT WITH DUPONT 825S RED CORLAR EPOXY PRIMER, 826S ACTIVATOR AND 3608S THINNER AT 30%. FOLLOWED BY DUPONT IMRON POLYURETHANE ENAMEL N8079UH FLAT BLACK WITH 192S ACTIVATOR AND 8485S ENAMEL REDUCER. ADD REDUCER ONLY IF NEEDED. 24 HOURS BETWEEN PRIMER AND FINISH COAT.

A	H6207-1	21	1	LARGE COVER	ALUM
A	H6207-2	20	3	SMALL COVER	ALUM
A	H6206-1	19	3	FLANGE	STEEL
F	H2421-2	18	2	FRONT PIVOT PLATE	STEEL

F	H2421-1	19	2	REAR PIVOT PLATE	STEEL
F	H2422-3	20	2	BASE PLATE	STEEL
F	H2404-2	21	2	CAP	STEEL
E	H2408-2	17	2	CAP	STEEL
A	H2408-1	16	2	BRACE	STEEL
A	–	15	1	PLATE: 4-3/8X14.72X3/8	STEEL
A	–	14	1	PLATE: 10X14.72X1/2	STEEL
A	H2404-3	13	2	POST	STL
A	–	12	2	PLATE: 10 X 4.81 X 1/2	STEEL
A	H6181-2	11	1	BOTTOM TIE	STEEL

B	H6181-1	10	1	TOP TIE	STEEL
A	H6180-1	9	1	OUTRIGGER	ASSY
	–	8	1	PLATE: 40x14.72x1/4"	STL
E	H6175-2	7	3	WEB	STL
	H6175-1 E	6	2	WEB	STL
	H6175-3	5	2	ALIGNMENT CYLINDER	STL
	–	4	2	TUBE: 10x10x10" LONG	STL
	–	3	2	MAIN BEAM 10x10x196"	STL
	H6202-1	2	2PR	FLANGE	STL
	H6180-5	1	2	END PLATE	STL

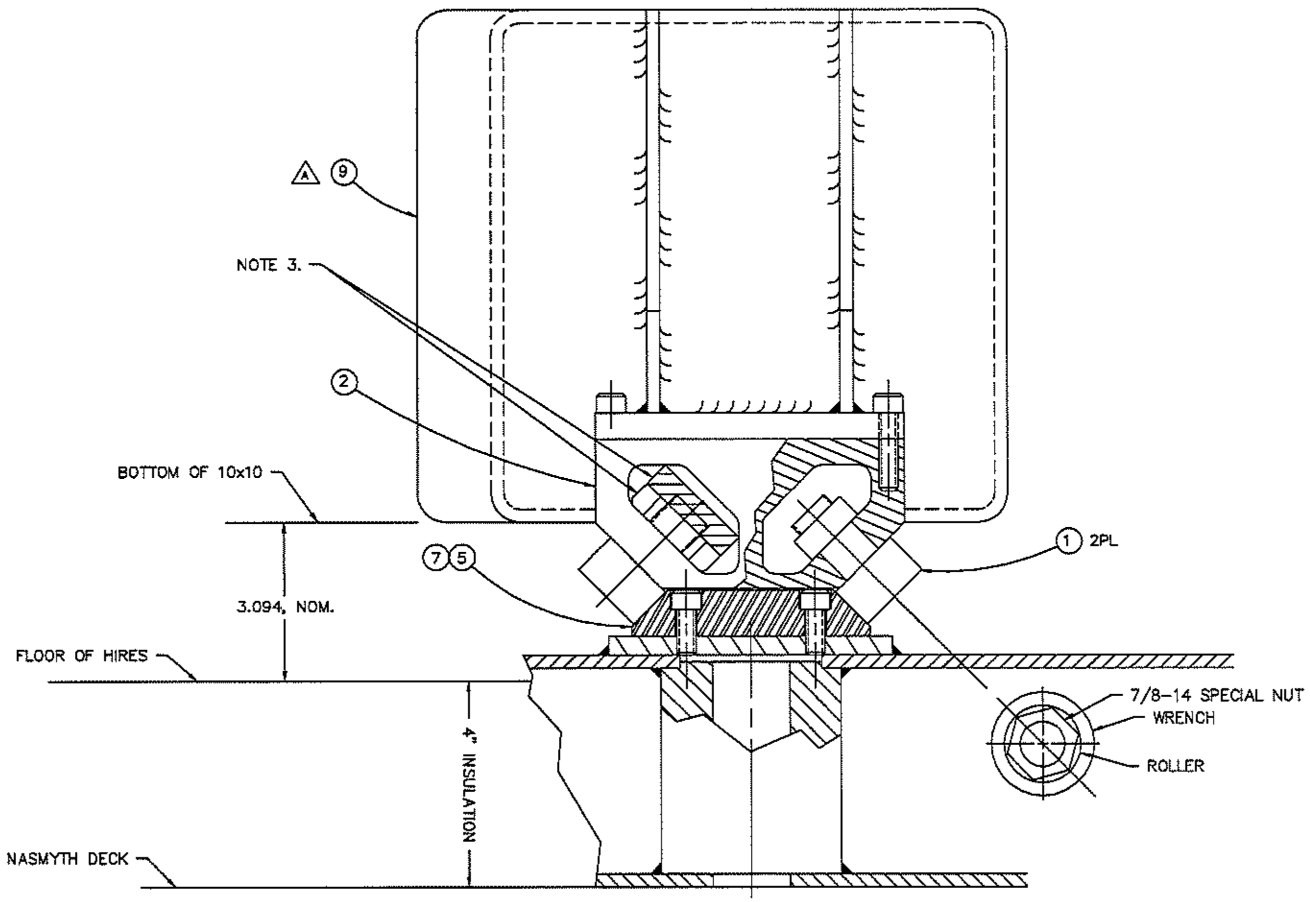
1/10

F	[illegible]	j.o.		GENERAL UPDATE.
G	[illegible]	j.o.		ADD PAINT NOTES.
H	[illegible]	j.o.		UPDATE.
J	[illegible]	j.o.		ADD CRANE LOCATION.
K	[illegible]	j.o.		GENERAL UPDATING.

A	[illegible]	j.o.		UPDATE, ADD OUTRIGGER.
B	[illegible]	j.o.		MOVE SLIT SUPPORT POINT 6"
C	[illegible]	j.o.		MOVE ARMS TO LINE UP WITH SUPPORT
D	[illegible]	j.o.		MOVE SLIT TO NEAR NOMINAL
				49.95 WAS 31.36
E	[illegible]	j.o.		ADD COLLIMATOR SUPPORT AND DATUM-DIMENSIONING.

KECK/HIRES
OPTICAL BENCH
ASSEMBLY

H6170.K

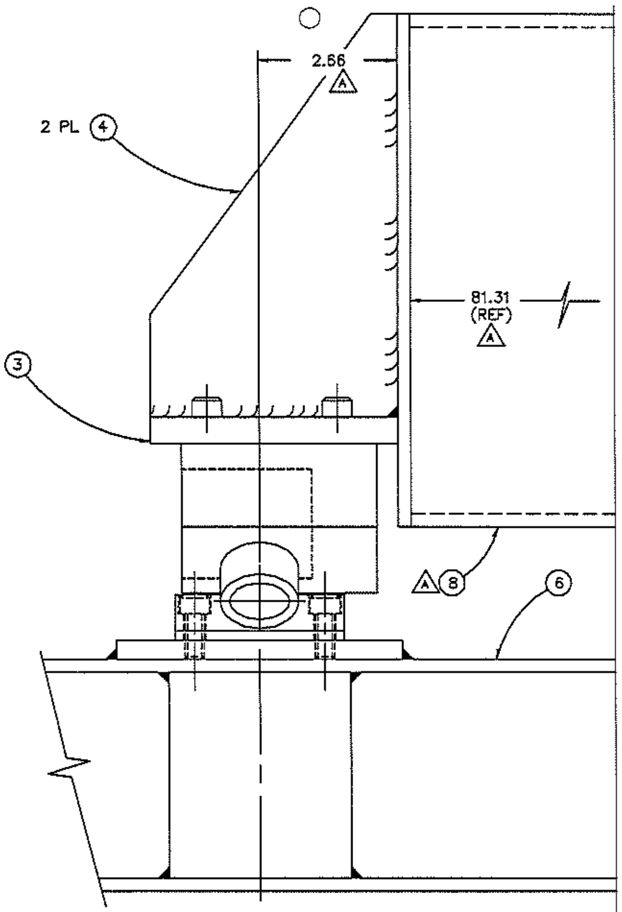


VIEW LOOKING AT THE
SLIT BUT PERPENDICULAR
TO THE OPTICAL CENTERLINE

⊖1 CROSSED ROLLER SUPPORT

1 REQ'D
NO VERTICAL ADJUSTMENT
11,280 lbs ON CAM FOLLOWERS

NOTES:
1. CROWNED, HEAVY DUTY, SEALED CAM FOLLOWER
2. TRACK GROUND STRAIGHT (NOT CROWNED) AFTER HEAT TREATING TO ROCKWELL 60C.
3. SHOWS WRENCH – 3000 IN-LBS CLAMPING TORQUE.



A	H6182-3	9	1	FLANGE	STEEL
A	H6180-1	8	1	OUTRIGGER	STEEL
	–	7	4	3/8-24 AHCS	S.STL
	H6110-1	6	1	SUPPORT FOOT	ASSY
	H6165-1	5	1	WEAR STRIP	4140 STL
	H6182-2	4	2	SUPPORT	STEEL
	H6182-1	3	1	SUPPORT BASE	STEEL
	H6179-1	2	1	CAM FOLLOWER MOUNT	STEEL
	CS448L	1	2	CAM FOLLOWER, RBC	NOTE 1.

FULL

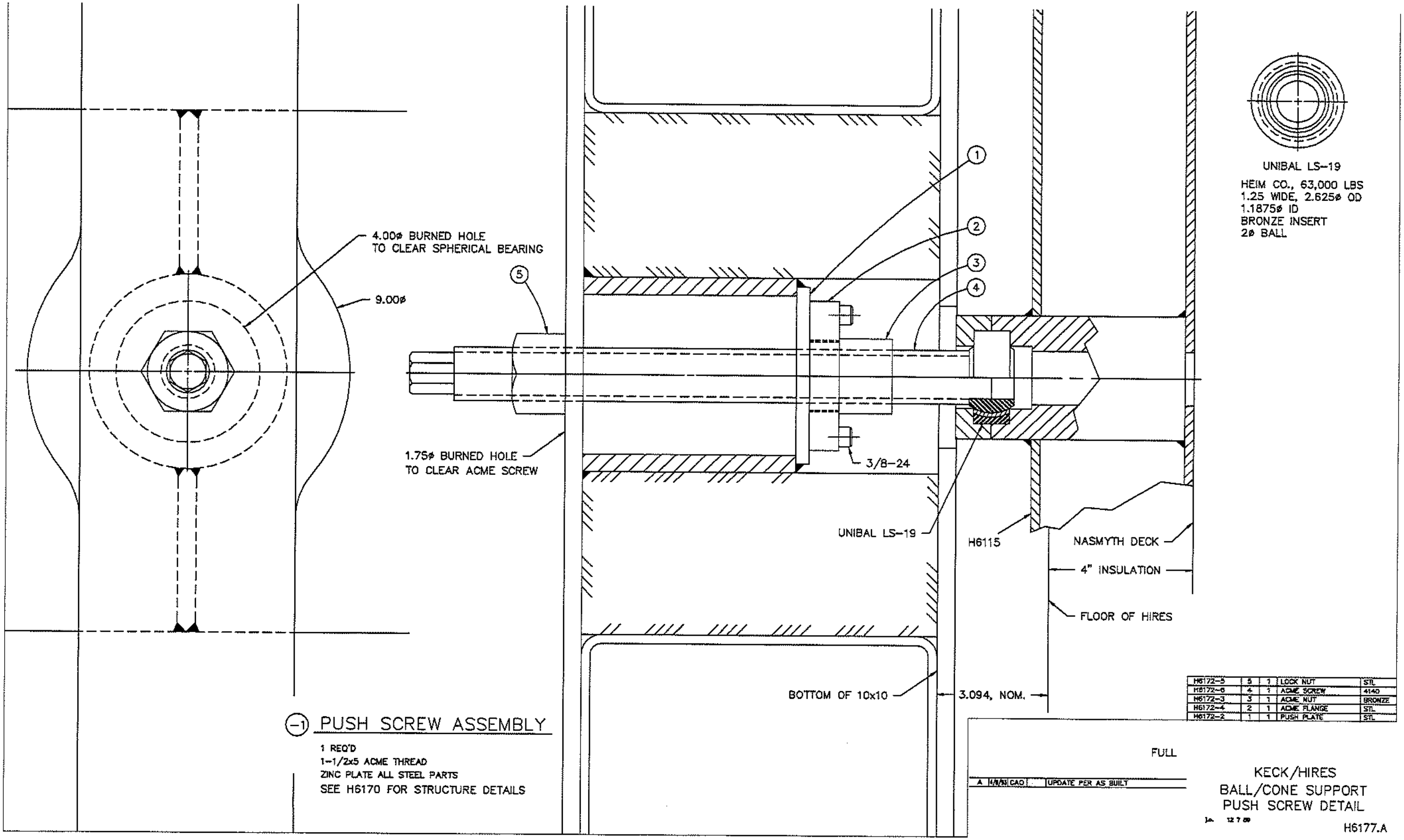
A	4/26/9	CAO		2.66 WAS 2.25; ADD ITEMS 8 & 9

REV

KECK/HIRES
OPTICAL BENCH
CROSSED ROLLER ASSY

JA 12 6 88

H6174.A



-1 PUSH SCREW ASSEMBLY

1 REQ'D
1-1/2x5 ACME THREAD
ZINC PLATE ALL STEEL PARTS
SEE H6170 FOR STRUCTURE DETAILS

H6172-5	5	1	LOCK NUT	STL
H6172-6	4	1	ACME SCREW	4140
H6172-3	3	1	ACME NUT	BRONZE
H6172-4	2	1	ACME FLANGE	STL
H6172-2	1	1	PUSH PLATE	STL

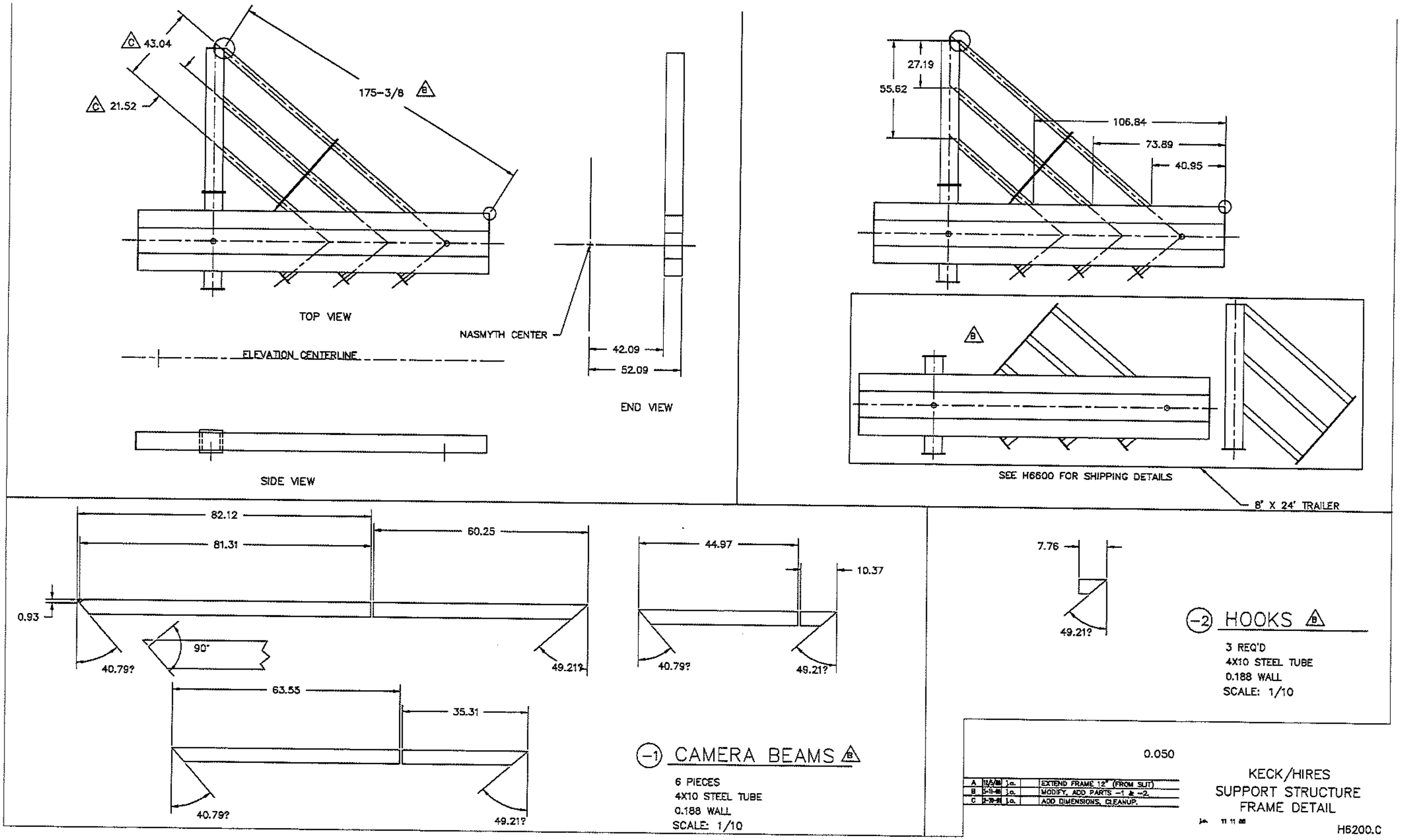
FULL

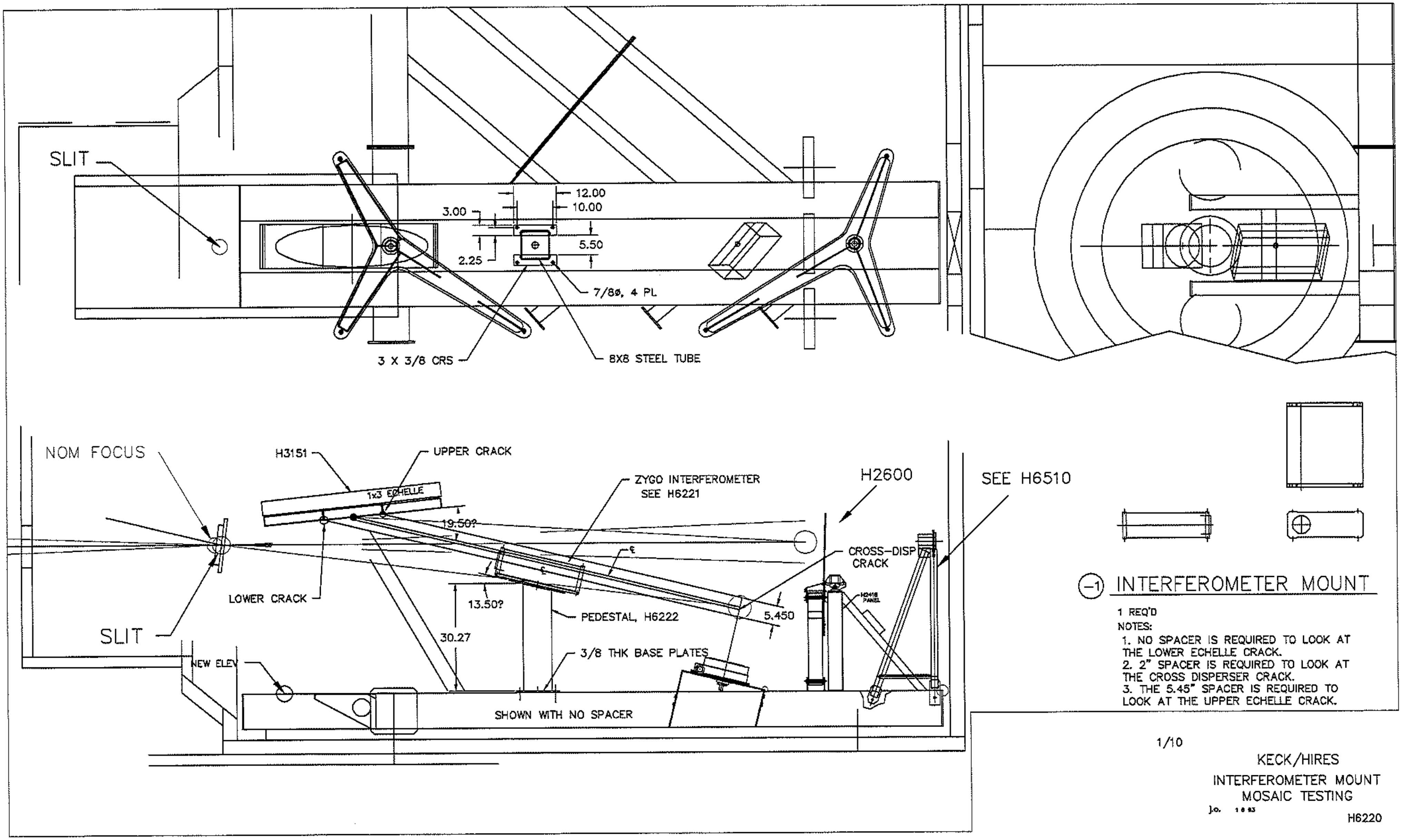
A	4/8/93	CAO		UPDATE PER AS BUILT

KECK/HIRES
BALL/CONE SUPPORT
PUSH SCREW DETAIL

JA 12 7 89

H6177.A


43.04
21.52
175-3/8
TOP VIEW
NASMYTH CENTER
ELEVATION CENTERLINE
42.09
52.09
END VIEW
SIDE VIEW
27.19
55.62
106.84
73.89
40.95
SEE H6600 FOR SHIPPING DETAILS
8' X 24' TRAILER
82.12
81.31
60.25
0.93
90°
40.79?
49.21?
44.97
10.37
40.79?
49.21?
63.55
35.31
40.79?
49.21?
-1 CAMERA BEAMS
6 PIECES
4X10 STEEL TUBE
0.188 WALL
SCALE: 1/10
7.76
49.21?
-2 HOOKS
3 REQ'D
4X10 STEEL TUBE
0.188 WALL
SCALE: 1/10
0.050
A 11/5/88 J.a. EXTEND FRAME 12" (FROM SUT)
B 5-11-88 J.a. MODIFY, ADD PARTS -1 & -2.
C J.a. ADD DIMENSIONS, CLEANUP.
KECK/HIRES
SUPPORT STRUCTURE
FRAME DETAIL
J.a. 11 11 88
H6200.C



① INTERFEROMETER MOUNT

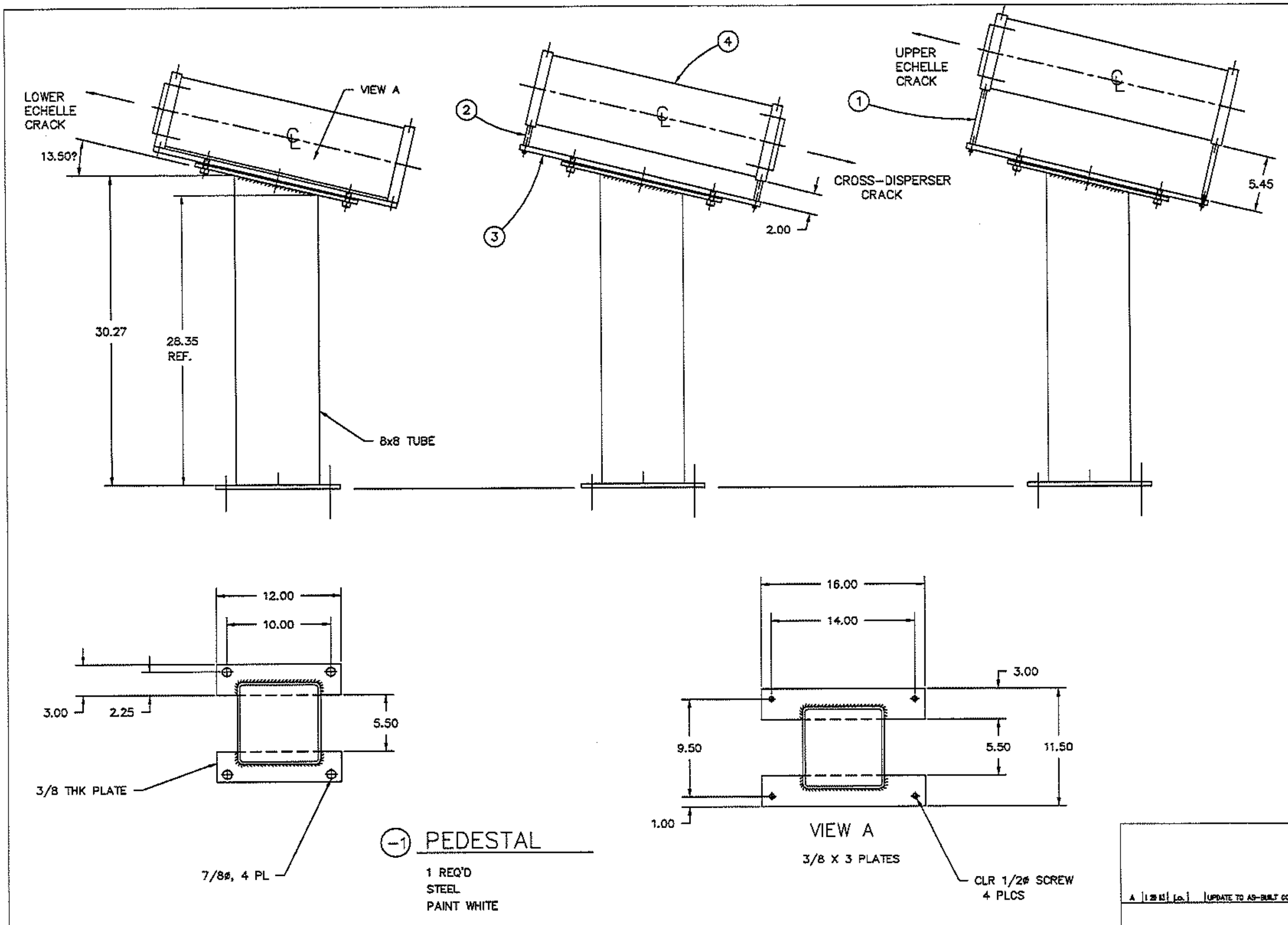
1 REQ'D

NOTES:

1. NO SPACER IS REQUIRED TO LOOK AT THE LOWER ECHELLE CRACK.
2. 2" SPACER IS REQUIRED TO LOOK AT THE CROSS DISPERSER CRACK.
3. THE 5.45" SPACER IS REQUIRED TO LOOK AT THE UPPER ECHELLE CRACK.

1/10

KECK/HIRES
INTERFEROMETER MOUNT
MOSAIC TESTING
J.O. 1 6 83
H6220



-1 PEDESTAL

1 REQ'D
STEEL
PAINT WHITE

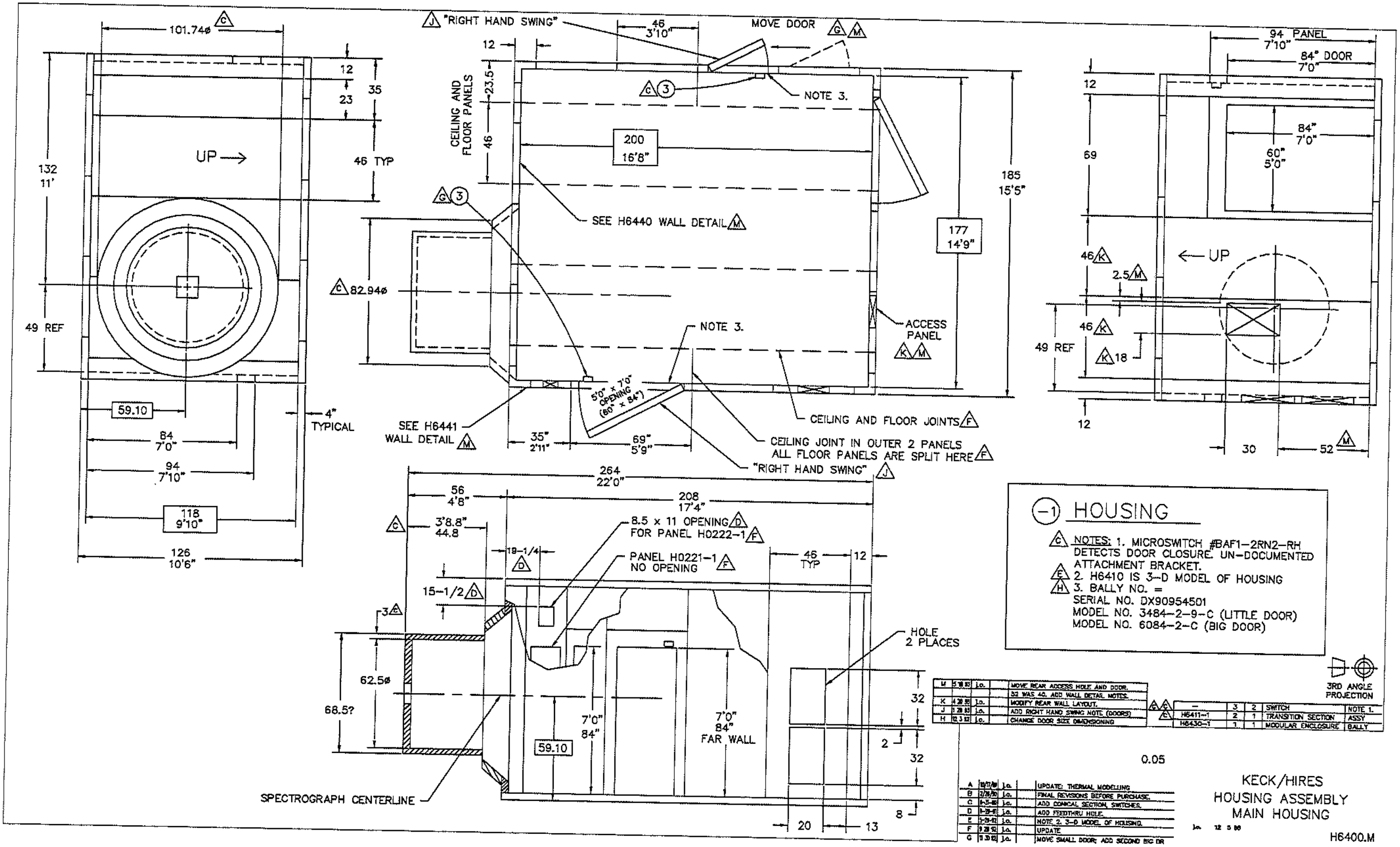
H6221-1	4	1	INTERFEROMETER	ZYGO
H6223-1	3	1	BASE	ALUM
H6223-2	2	2	SHORT RISER	STL
H6223-3	1	2	TALL RISER	STL

A | 1 25 93 | J.O. | | UPDATE TO AS-BUILT CONDITION.

1/4

KECK/HIRES
INTERFEROMETER MOUNT
PEDESTAL DETAIL
J.O. 1 7 93

H6222.A



(-1) HOUSING

C NOTES: 1. MICROSWITCH #BAF1-2RN2-RH DETECTS DOOR CLOSURE. UN-DOCUMENTED ATTACHMENT BRACKET.

E 2. H6410 IS 3-D MODEL OF HOUSING

H 3. BALLY NO. =
SERIAL NO. DX90954501
MODEL NO. 3484-2-9-C (LITTLE DOOR)
MODEL NO. 6084-2-C (BIG DOOR)

M	5 18 93	j.o.		MOVE REAR ACCESS HOLE AND DOOR.
				32 WAS 40. ADD WALL DETAIL NOTES.
K	4 28 93	j.o.		MODIFY REAR WALL LAYOUT.
J	1 28 93	j.o.		ADD RIGHT HAND SWING NOTE (DOORS)
H	12 3 92	j.o.		CHANGE DOOR SIZE DIMENSIONING

—	3	2	SWITCH	NOTE 1.
H6411-1	2	1	TRANSITION SECTION	ASSY
H6430-1	1	1	MODULAR ENCLOSURE	BALLY

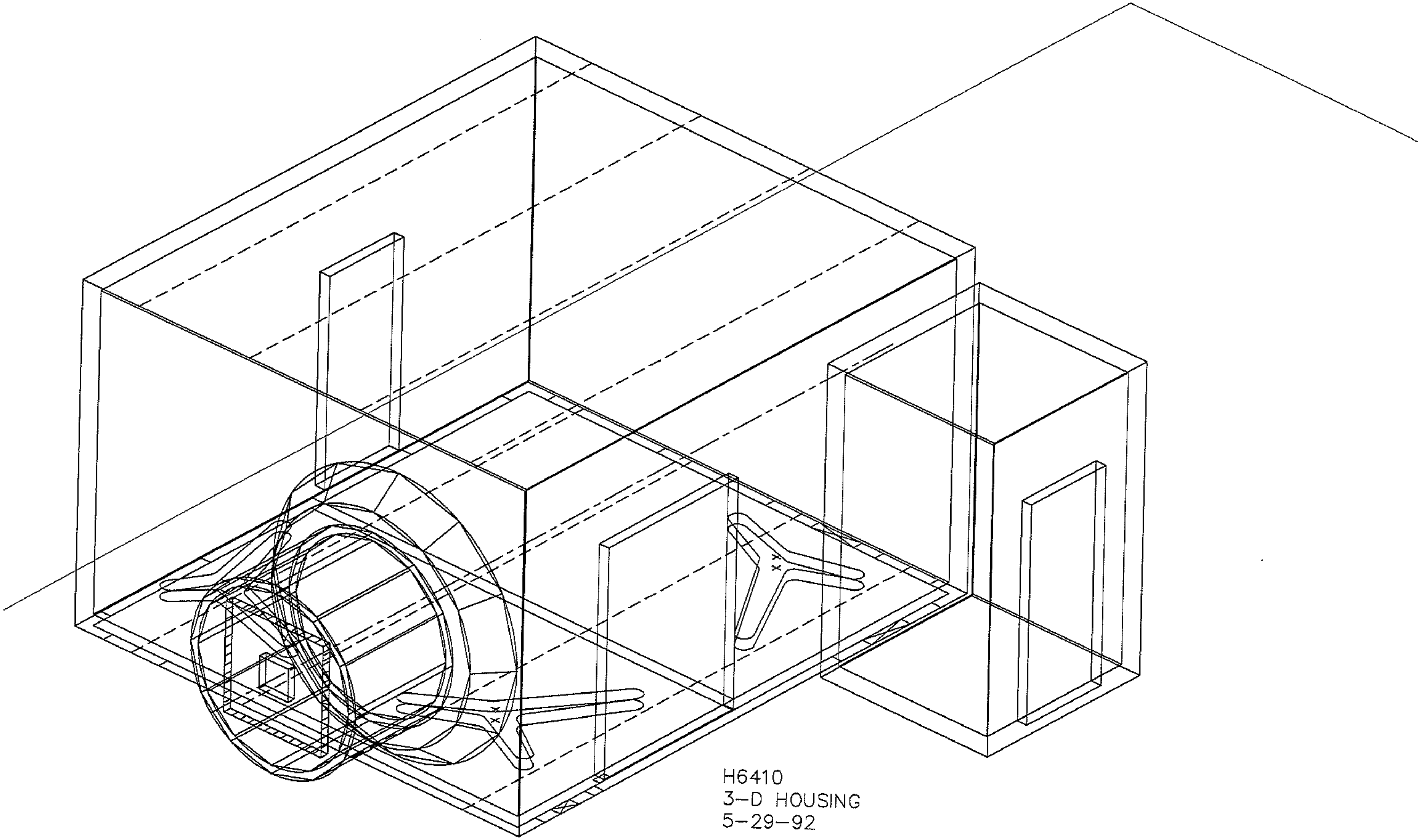
0.05

A	10/17/89	j.o.		UPDATE: THERMAL MODELLING
B	2/28/90	j.o.		FINAL REVISIONS BEFORE PURCHASE.
C	6-5-90	j.o.		ADD CONICAL SECTION, SWITCHES.
D	8-29-91	j.o.		ADD FEEDTHRU HOLE.
E	5-29-92	j.o.		NOTE 2. 3-D MODEL OF HOUSING.
F	9 28 92	j.o.		UPDATE
G	11 30 92	j.o.		MOVE SMALL DOOR; ADD SECOND BIG DR

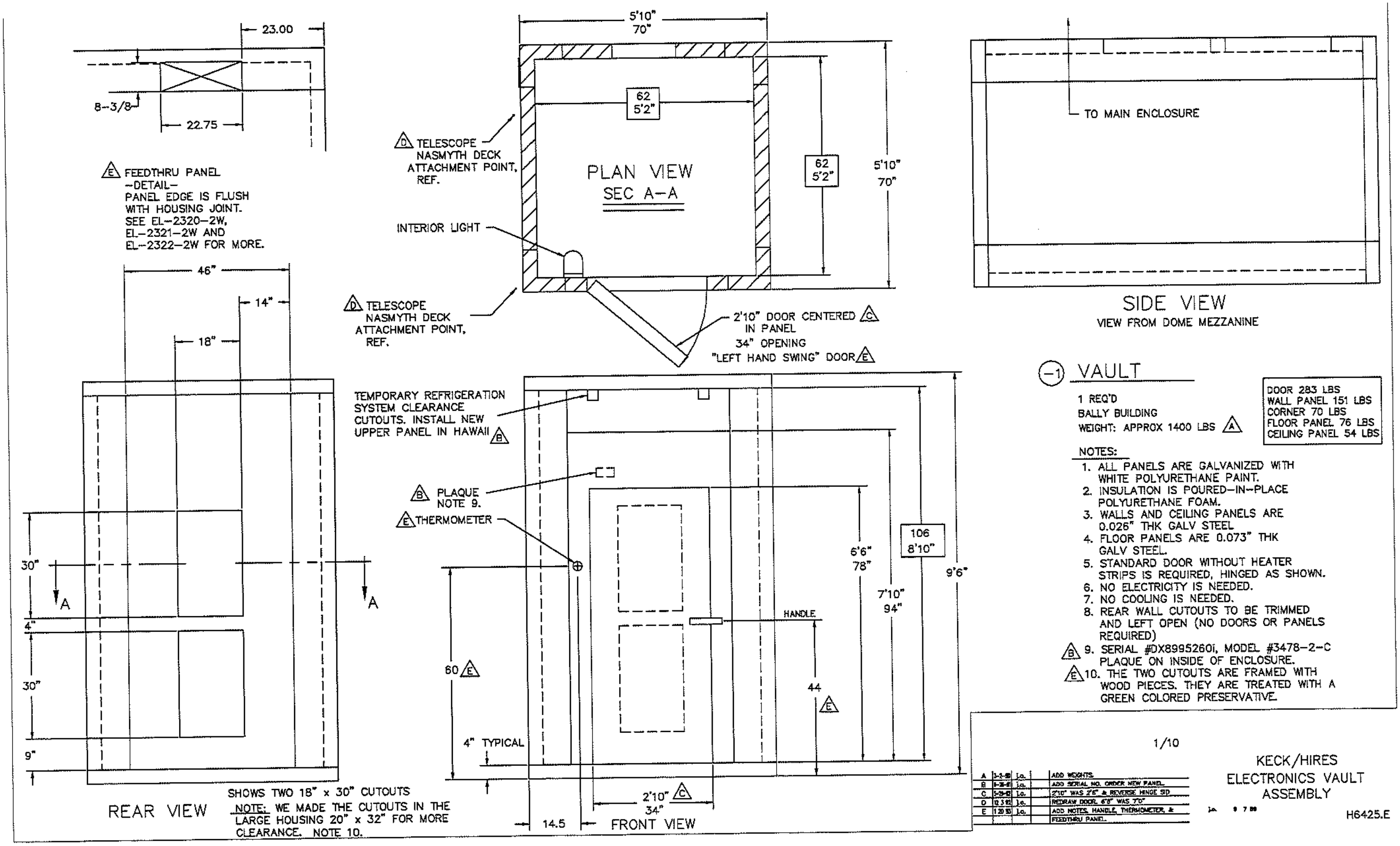
KECK/HIRES
HOUSING ASSEMBLY
MAIN HOUSING

j.o. 12 5 90

H6400.M



H6410
3-D HOUSING
5-29-92



Ⓔ FEEDTHRU PANEL
–DETAIL–
PANEL EDGE IS FLUSH
WITH HOUSING JOINT.
SEE EL–2320–2W,
EL–2321–2W AND
EL–2322–2W FOR MORE.

Ⓓ TELESCOPE
NASMYTH DECK
ATTACHMENT POINT,
REF.

Ⓓ TELESCOPE
NASMYTH DECK
ATTACHMENT POINT,
REF.

2'10" DOOR CENTERED Ⓒ
IN PANEL
34" OPENING
"LEFT HAND SWING" DOOR Ⓔ

TEMPORARY REFRIGERATION
SYSTEM CLEARANCE
CUTOUTS. INSTALL NEW
UPPER PANEL IN HAWAII Ⓑ

Ⓑ PLAQUE
NOTE 9.

Ⓔ THERMOMETER

SHOWS TWO 18" x 30" CUTOUTS
NOTE: WE MADE THE CUTOUTS IN THE
LARGE HOUSING 20" x 32" FOR MORE
CLEARANCE. NOTE 10.

(–1) VAULT

1 REQ'D
BALLY BUILDING
WEIGHT: APPROX 1400 LBS Ⓐ

DOOR 283 LBS
WALL PANEL 151 LBS
CORNER 70 LBS
FLOOR PANEL 76 LBS
CEILING PANEL 54 LBS

NOTES:

1. ALL PANELS ARE GALVANIZED WITH WHITE POLYURETHANE PAINT.
2. INSULATION IS POURED–IN–PLACE POLYURETHANE FOAM.
3. WALLS AND CEILING PANELS ARE 0.026" THK GALV STEEL
4. FLOOR PANELS ARE 0.073" THK GALV STEEL.
5. STANDARD DOOR WITHOUT HEATER STRIPS IS REQUIRED, HINGED AS SHOWN.
6. NO ELECTRICITY IS NEEDED.
7. NO COOLING IS NEEDED.
8. REAR WALL CUTOUTS TO BE TRIMMED AND LEFT OPEN (NO DOORS OR PANELS REQUIRED)
9. Ⓑ SERIAL #DX8995260i, MODEL #3478–2–C PLAQUE ON INSIDE OF ENCLOSURE.
10. Ⓔ THE TWO CUTOUTS ARE FRAMED WITH WOOD PIECES. THEY ARE TREATED WITH A GREEN COLORED PRESERVATIVE.

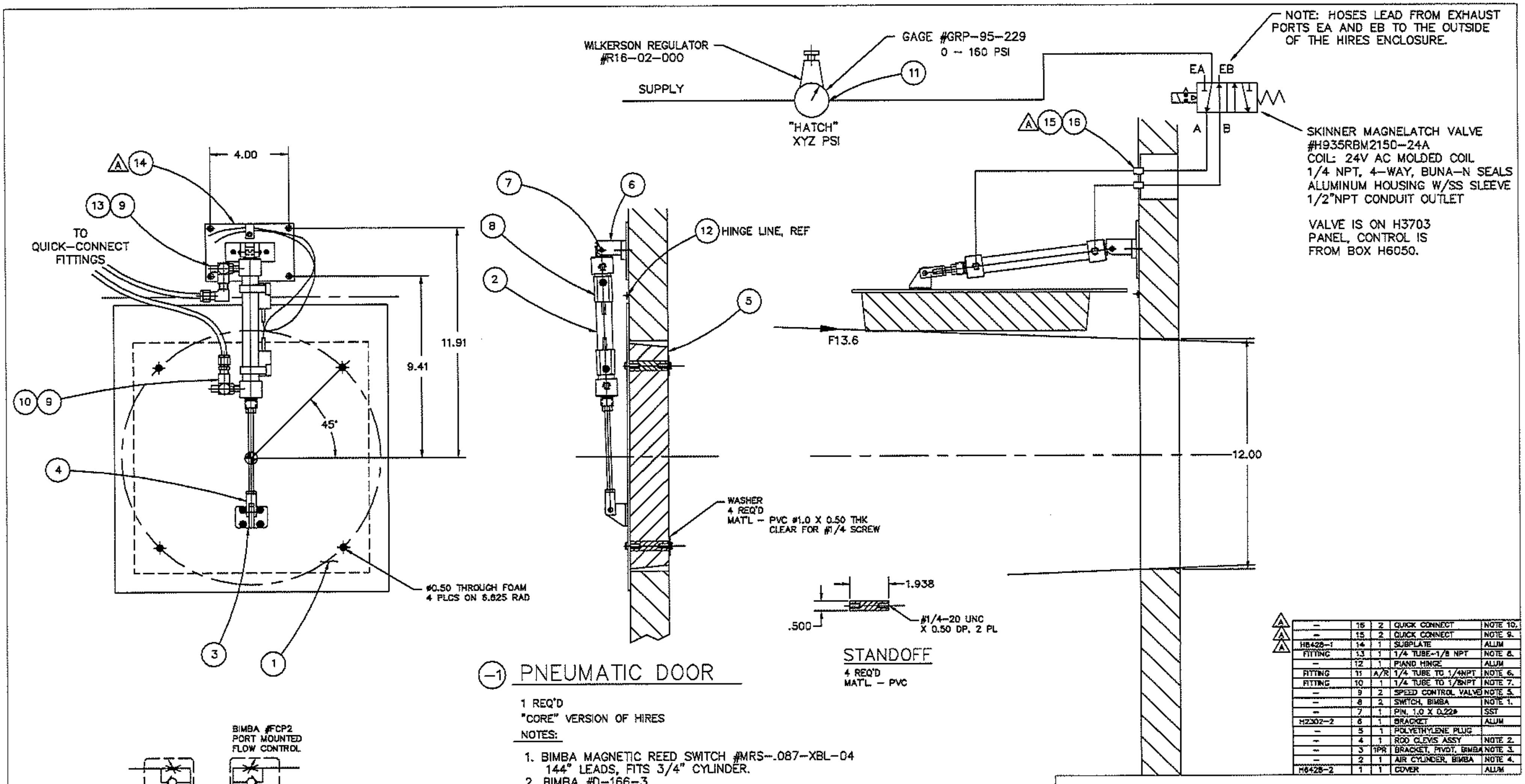
1/10

A	3-2-[illegible]	j.o.		ADD WEIGHTS.
B	[illegible]	j.o.		ADD SERIAL NO. ORDER NEW PANEL.
C	5-29-92	j.o.		2'10" WAS 2'6" & REVERSE HINGE SID
D	12 3 92	j.o.		REDRAW DOOR. 6'8" WAS 7'0"
E	1 20 93	j.o.		ADD NOTES, HANDLE, THERMOMETER, &
				FEEDTHRU PANEL.

KECK/HIRES
ELECTRONICS VAULT
ASSEMBLY

j.o. 9 7 89

H6425.E



-1 PNEUMATIC DOOR

1 REQ'D
"CORE" VERSION OF HIRES

NOTES:

1. BIMBA MAGNETIC REED SWITCH #MRS-.087-XBL-04
   144" LEADS, FITS 3/4" CYLINDER.
2. BIMBA #D-166-3
3. BIMBA #D-167
4. BIMBA #MRS-044-DXF.
5. BIMBA # FCP2, 1/8 NPT.
6. SWAGELOK FITTING #B-400-1-4 (1/4 NPT)
7. SWAGELOK FITTING #B-400-1-2 (1/8 NPT)
8. SWAGELOK FITTING #B-400-2-2 (1/8 NPT & 90° ELBOW)
9. A SWAGELOK STEM #B-QC4-S1-400
10. A SWAGELOK BODY #B-QC4-B-400, SHUT-OFF STYLE

A	–	16	2	QUICK CONNECT	NOTE 10.
A	–	15	2	QUICK CONNECT	NOTE 9.
A	H6428-1	14	1	SUBPLATE	ALUM
	FITTING	13	1	1/4 TUBE-1/8 NPT	NOTE 8.
	–	12	1	PIANO HINGE	ALUM
	FITTING	11	A/R	1/4 TUBE TO 1/4NPT	NOTE 6.
	FITTING	10	1	1/4 TUBE TO 1/8NPT	NOTE 7.
	–	9	2	SPEED CONTROL VALVE	NOTE 5.
	–	8	2	SWITCH, BIMBA	NOTE 1.
	–	7	1	PIN, 1.0 X 0.22⌀	SST
	H2302-2	6	1	BRACKET	ALUM
	–	5	1	POLYETHYLENE PLUG	
	–	4	1	ROD CLEVIS ASSY	NOTE 2.
	–	3	1PR	BRACKET, PIVOT, BIMBA	NOTE 3.
	–	2	1	AIR CYLINDER, BIMBA	NOTE 4.
	H6428-2	1	1	COVER	ALUM

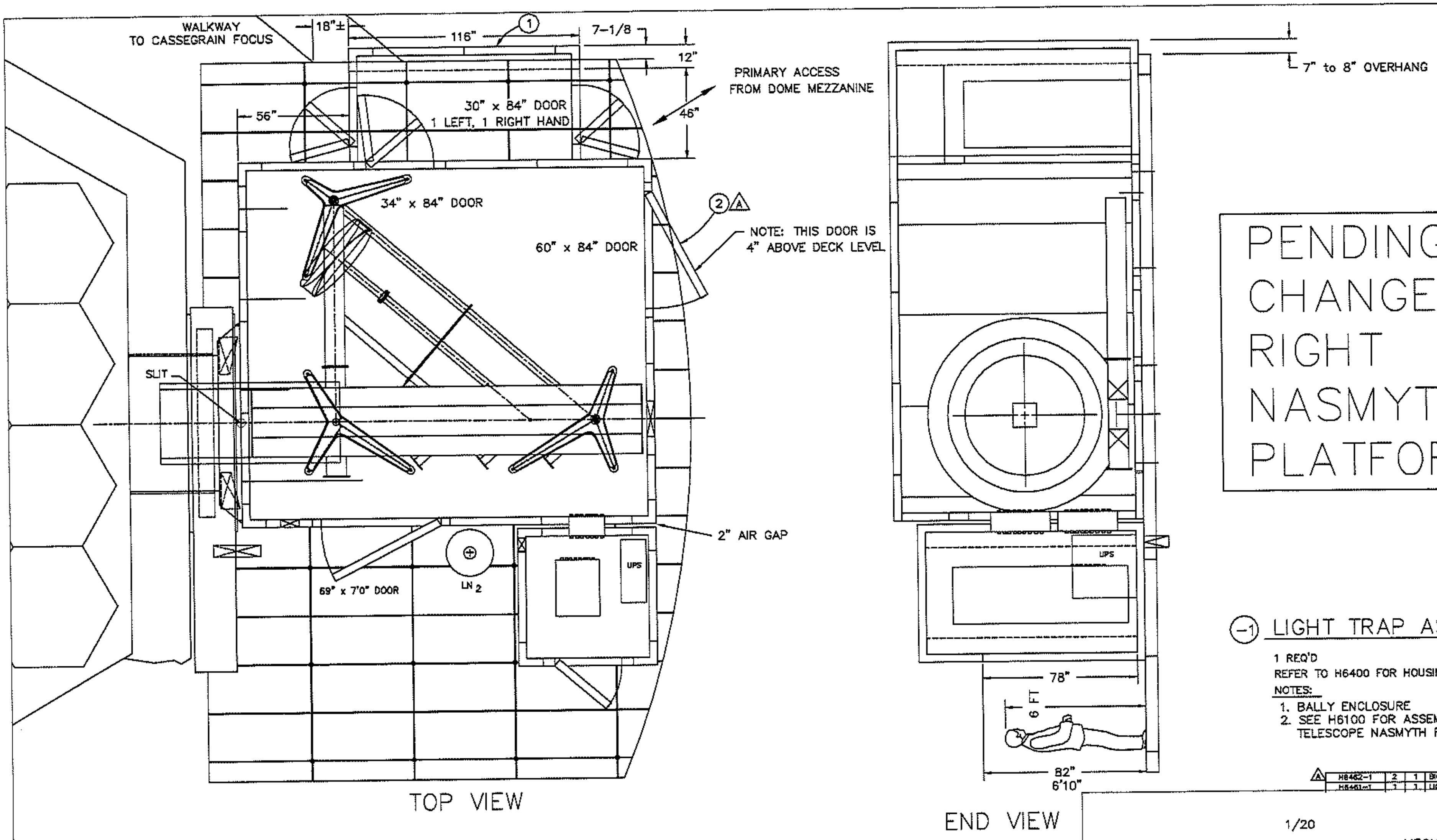
1/2

A	12-8-91	J.O.		ADD DETAIL FROM H6428
B	4/7/93	CAO		UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
HATCH DETAIL
PNEUMATIC DOOR

J.O.

H6429.B



PENDING
CHANGE.
RIGHT
NASMYTH
PLATFORM.

-1 LIGHT TRAP ASSEMBLED

1 REQ'D

REFER TO H6400 FOR HOUSING DETAIL

NOTES:

1. BALLY ENCLOSURE
2. SEE H6100 FOR ASSEMBLY ON TELESCOPE NASMYTH PLATFORM

A	H6462-1	2	1	BIG DOOR	BALLY
	H6461-1	1	1	LIGHT TRAP	NOTE 1.

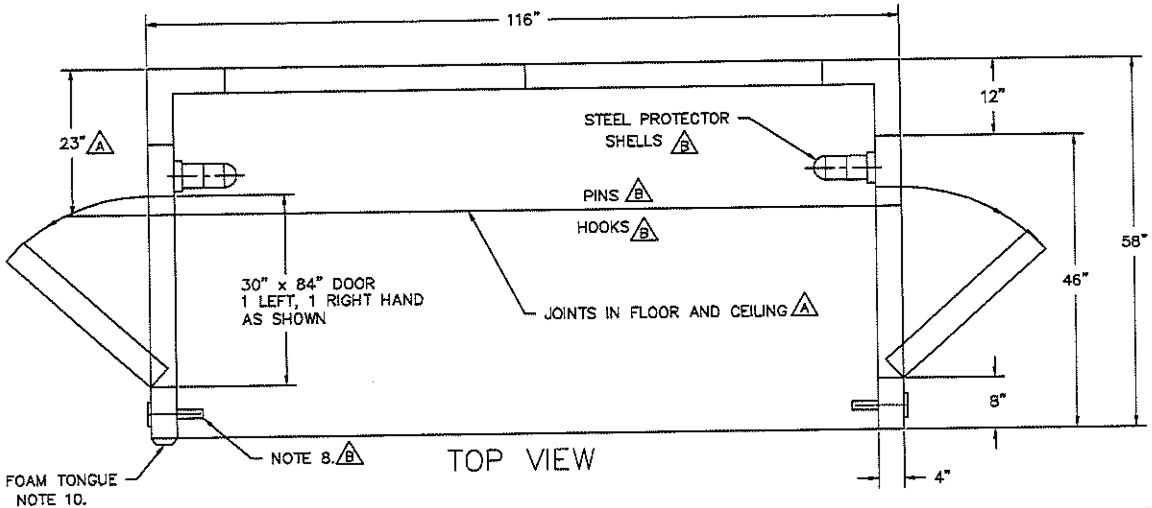
1/20

A	3 15 93	j.o.		ADD PART 2, RE-TITLE, WAS STUDY.

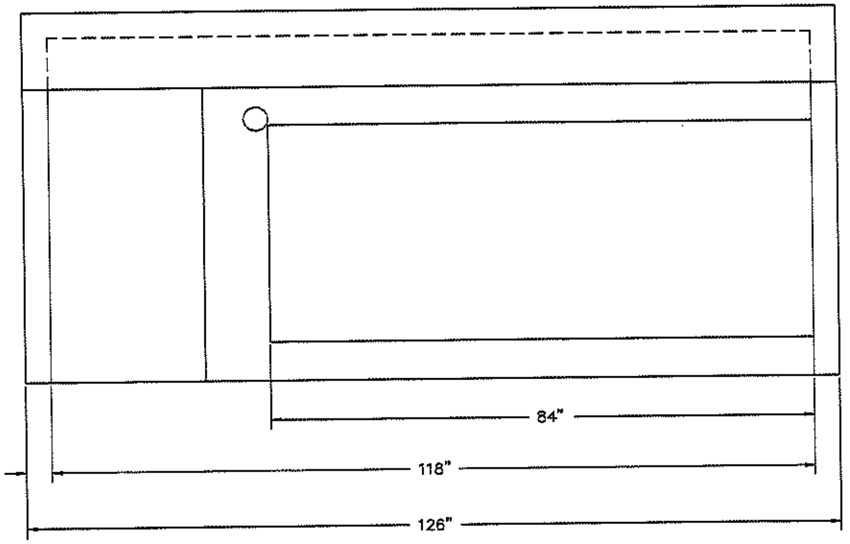
KECK/HIRES
HOUSING AND LIGHT TRAP
ASSEMBLY

j.o. 12 7 92

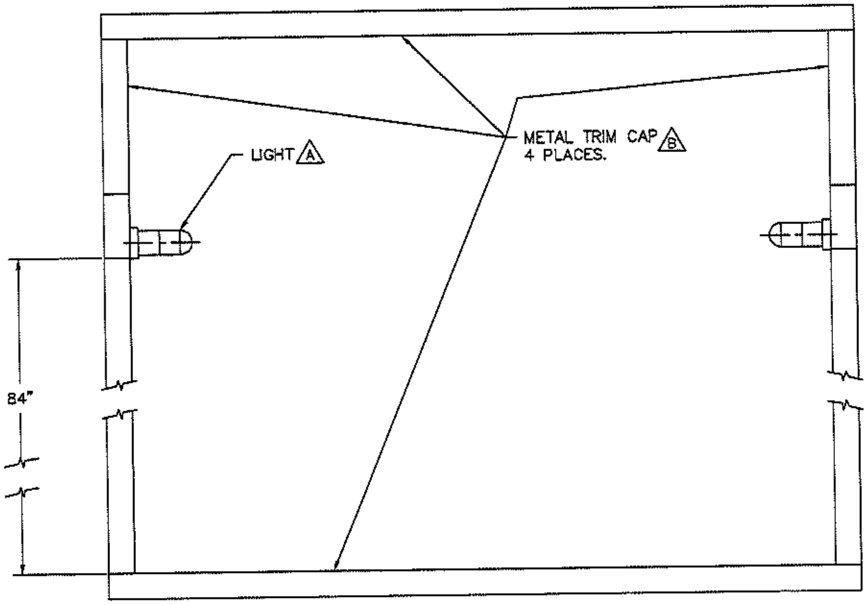
H6460.A



TOP VIEW



END VIEW



SIDE VIEW (OPEN SIDE)

(-1) LIGHT TRAP ROOM

1 REQ'D
MODULAR CONSTRUCTION
WEIGHT:

B REFER TO BALLY DWG 311846

46" WALL PANEL 175 LBS
SMALL DOOR 303 LBS
CORNER 70 LBS
TOTAL WEIGHT = 750 LBS B

NOTES:

1. ALL PANELS ARE GALVANIZED WITH WHITE POLYURETHANE PAINT. TEXTURE IS NOT SMOOTH LIKE THE OTHER B TWO ENCLOSURES. HAS SMALL BUMPS.
2. INSULATION IS POURED-IN-PLACE POLYURETHANE FOAM. (4" THICK)
3. WALLS AND CEILING PANELS ARE 0.026" THK GALV STEEL
4. FLOOR PANELS ARE 0.073" THK GALV STEEL.
5. STANDARD DOOR WITHOUT HEATER STRIPS IS REQUIRED. HINGED AS SHOWN.
6. NO COOLING IS NEEDED.
7. SERIAL NO. 311846 PLAQUE ON INSIDE OF ENCLOSURE.
8. 2 THERMOMETERS ARE REQUIRED.
9. 2 LIGHTS ARE REQUIRED: 1 PER DOOR.
10. B REMOVE FOAM TONGUE AND SEAL WITH EPOXY PAINT.

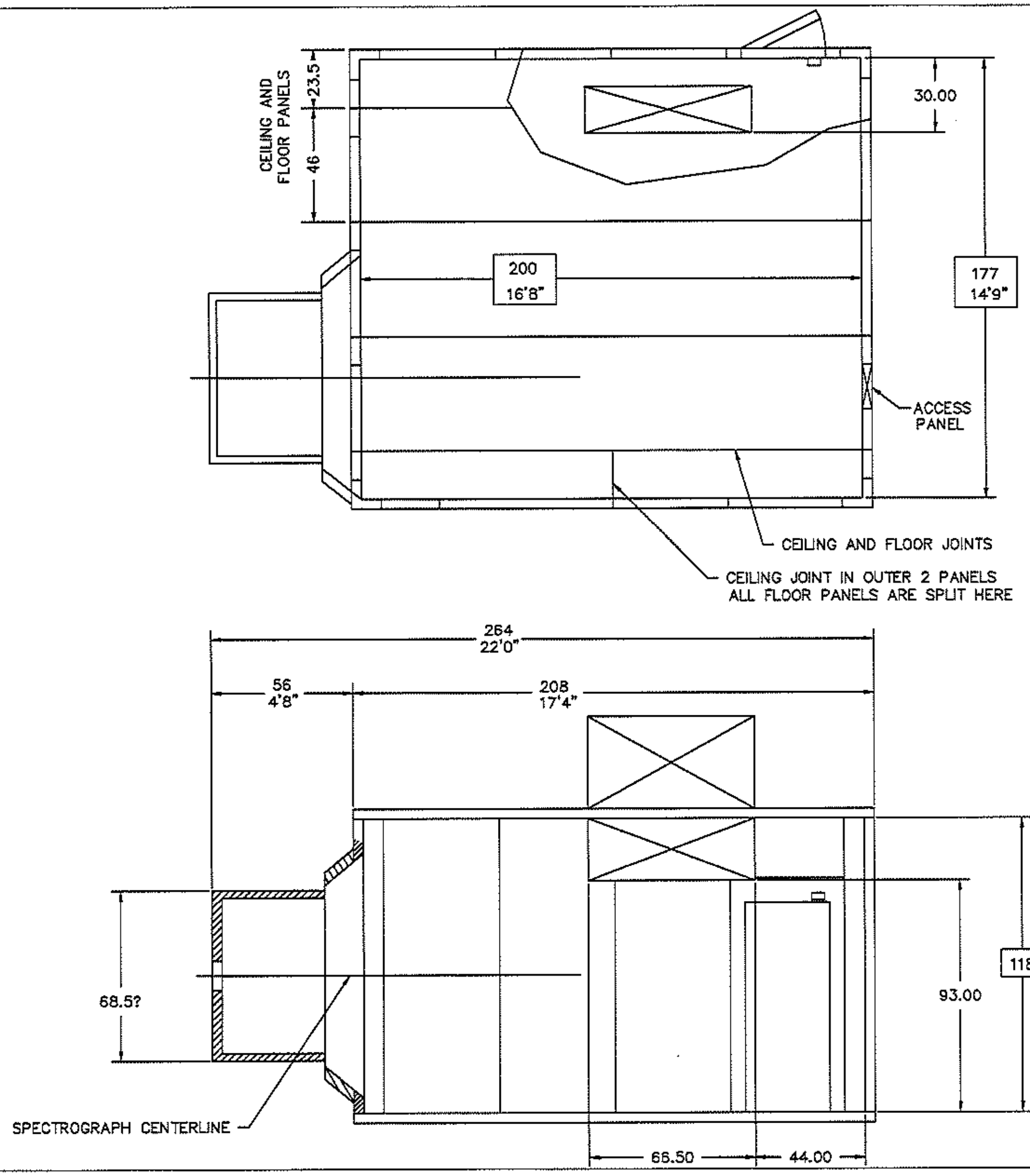
1/8

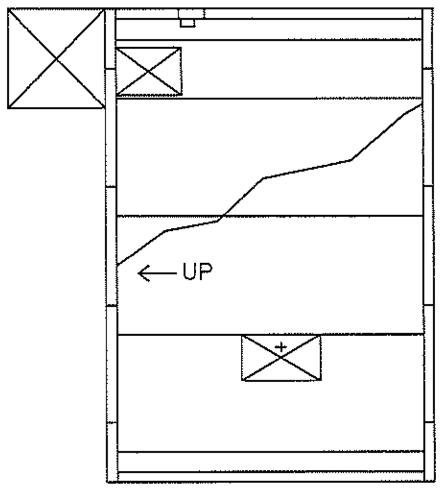
A	3 8 93	J.o.		UPDATE AT TIME OF ORDER.
B	4 8 93	J.o.		UPDATE AT TRIAL ASSEMBLY.

KECK/HIRES
LIGHT TRAP
BALLY DRAWING

J.o. 12 1 92

H6461.B





(-1) HOUSING & FREEZER

NOTES:
1. BALLY FREEZER
2. TESTED TO −22°C

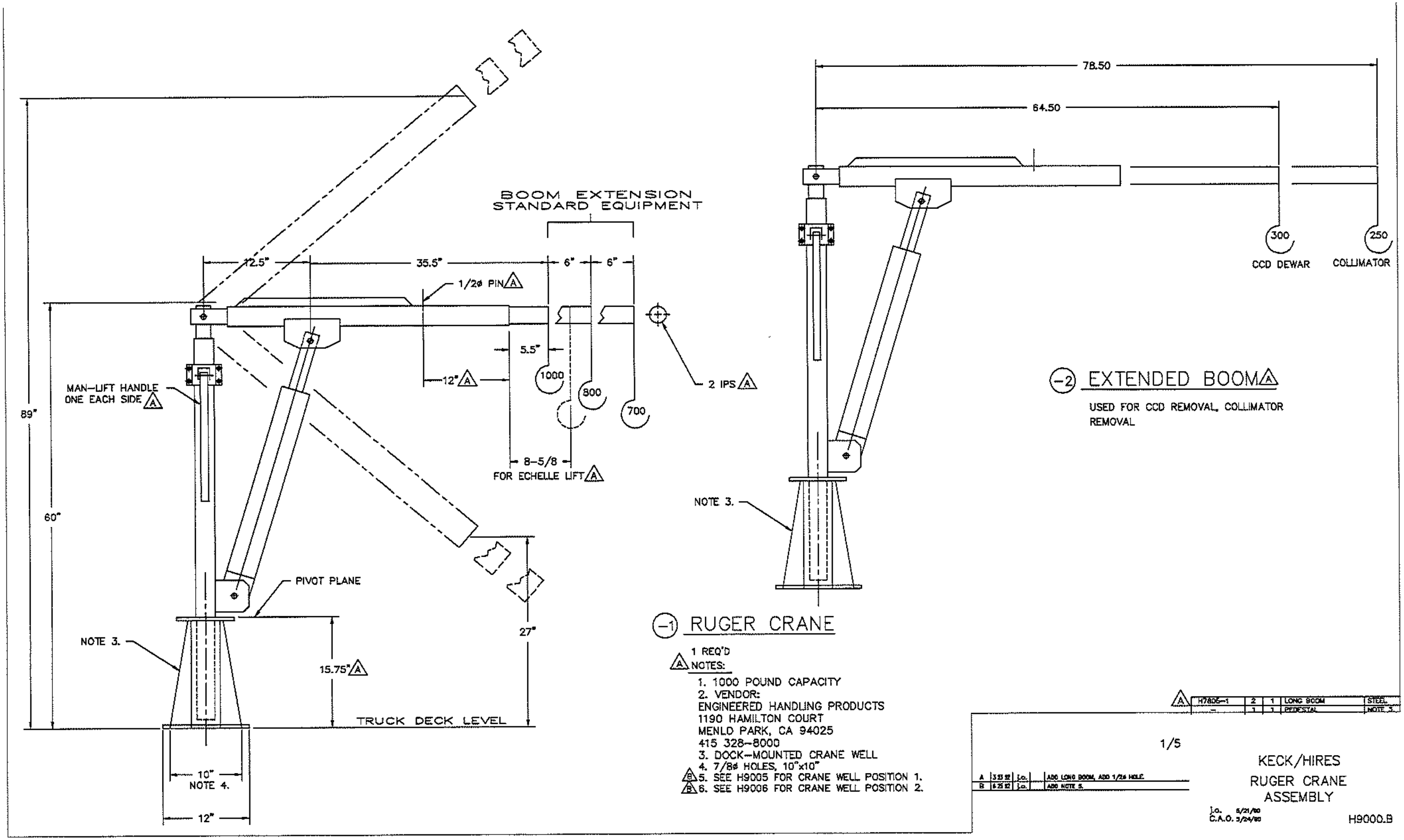
3RD ANGLE PROJECTION

0.05

KECK/HIRES
HOUSING & REFRIGERATOR
DURING TESTING
ja 8 4 93
H6470

Appendix H List of Drawings — Shipping & Initial Alignment

1. H9000 Ruger Crane Assembly and Extended Boom
2. H9005 Ruger Crane, Position 1
3. H9006 Ruger Crane, Position 2
4. H3075 Echelle Mosaic Cart
5. H4075 Cross Disperser Cart
6. H6605 Main Frame Casters
7. H6936 Camera Mirror Moving Details



⊖2 EXTENDED BOOM A

USED FOR CCD REMOVAL, COLLIMATOR REMOVAL

⊖1 RUGER CRANE

1 REQ'D

A NOTES:

1. 1000 POUND CAPACITY
2. VENDOR:
ENGINEERED HANDLING PRODUCTS
1190 HAMILTON COURT
MENLO PARK, CA 94025
415 328-8000
3. DOCK-MOUNTED CRANE WELL
4. 7/8ø HOLES, 10"x10"
5. B SEE H9005 FOR CRANE WELL POSITION 1.
6. B SEE H9006 FOR CRANE WELL POSITION 2.

A H7805-1	2	1	LONG BOOM	STEEL
—	1	1	PEDESTAL	NOTE 3.

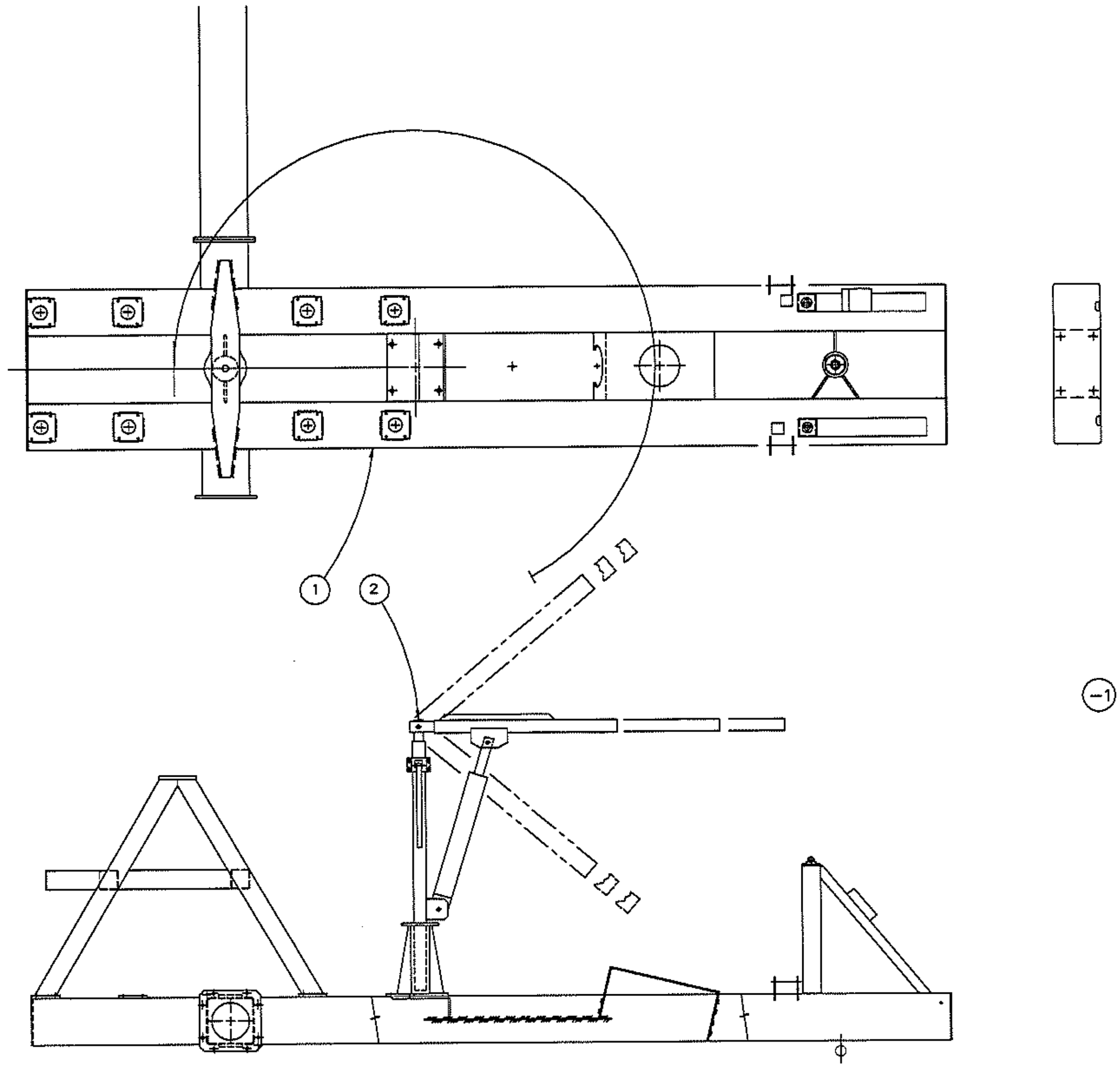
A	3 23 92	J.O.		ADD LONG BOOM, ADD 1/2ø HOLE.
B	6 25 92	J.O.		ADD NOTE 5.

1/5

KECK/HIRES
RUGER CRANE
ASSEMBLY

J.O. 6/21/90
C.A.O. 5/24/90

H9000.B



⊖1 CRANE MOUNTED IN SOCKET 1

NOTES:

1. CROSS–DISPERSER ACCESS

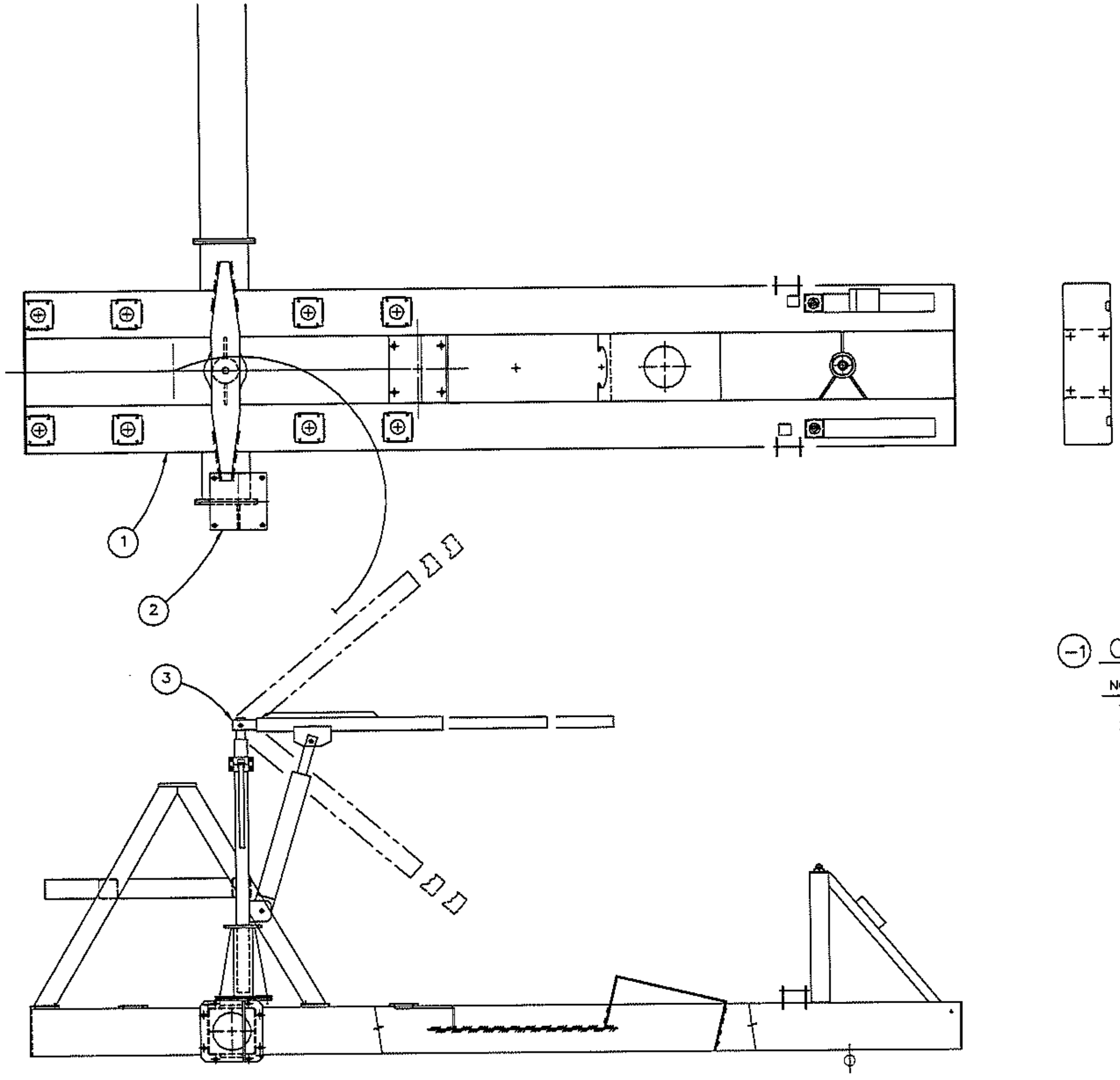
H9000–1	2	1	RUGER CRANE	
H6170–1	1	1	OPTICAL BENCH STRUC	

1/10

KECK/HIRES
CRANE
POSITION 1

JA xx/yy/zz
8/1/92 8/15/92

H9005



(-1) CRANE MOUNTED IN SOCKET 2

NOTES:
1. ECHELLE MOSAIC ACCESS
2. CRANE STORAGE POSITION

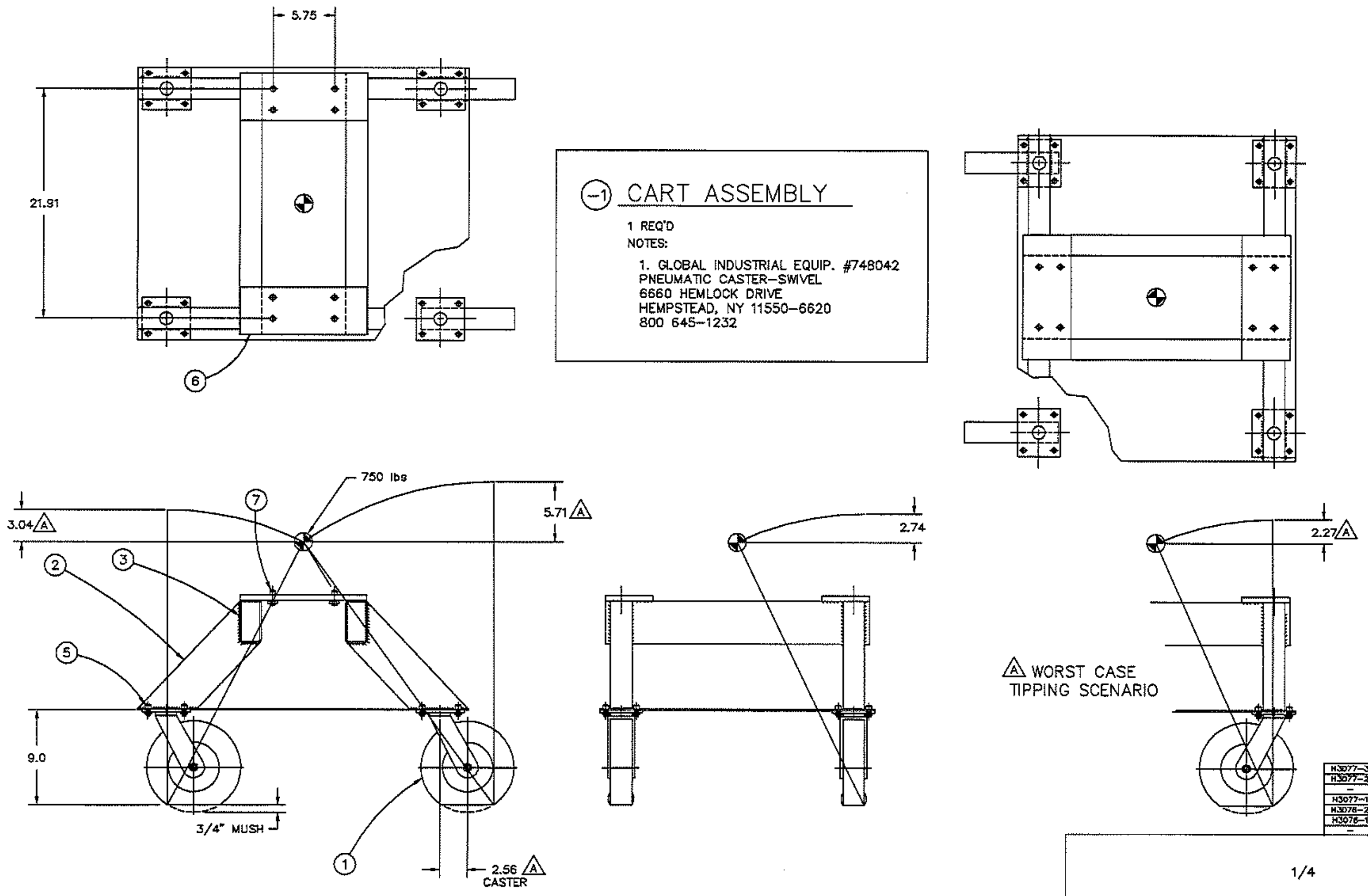
H6607-1	3	1	RUGER CRANE BASE	
H9000-1	2	1	RUGER CRANE	
H6170-1	1	1	OPTICAL BENCH STRUCTURE	

1/10

KECK/HIRES
CRANE
POSITION 2

J.A. 6/1/92
CAD 3/24/92

H9006



⊖1 CART ASSEMBLY

1 REQ'D

NOTES:

1. GLOBAL INDUSTRIAL EQUIP. #748042
PNEUMATIC CASTER-SWIVEL
6660 HEMLOCK DRIVE
HEMPSTEAD, NY 11550-6620
800 645-1232

A WORST CASE TIPPING SCENARIO

H3077-3	7	4	GUIDE PIN	ST.STL
H3077-2	6	2	TOP PLATE	STEEL
–	5	16	3/8 SCREW/WSHR/NUT	ST.STL
H3077-1	4	1	BOTTOM PLATE	STEEL
H3076-2	3	2	CROSS-PIECE	STEEL
H3076-1	2	4	STRUT	STEEL
–	1	4	WHEEL	NOTE 1.

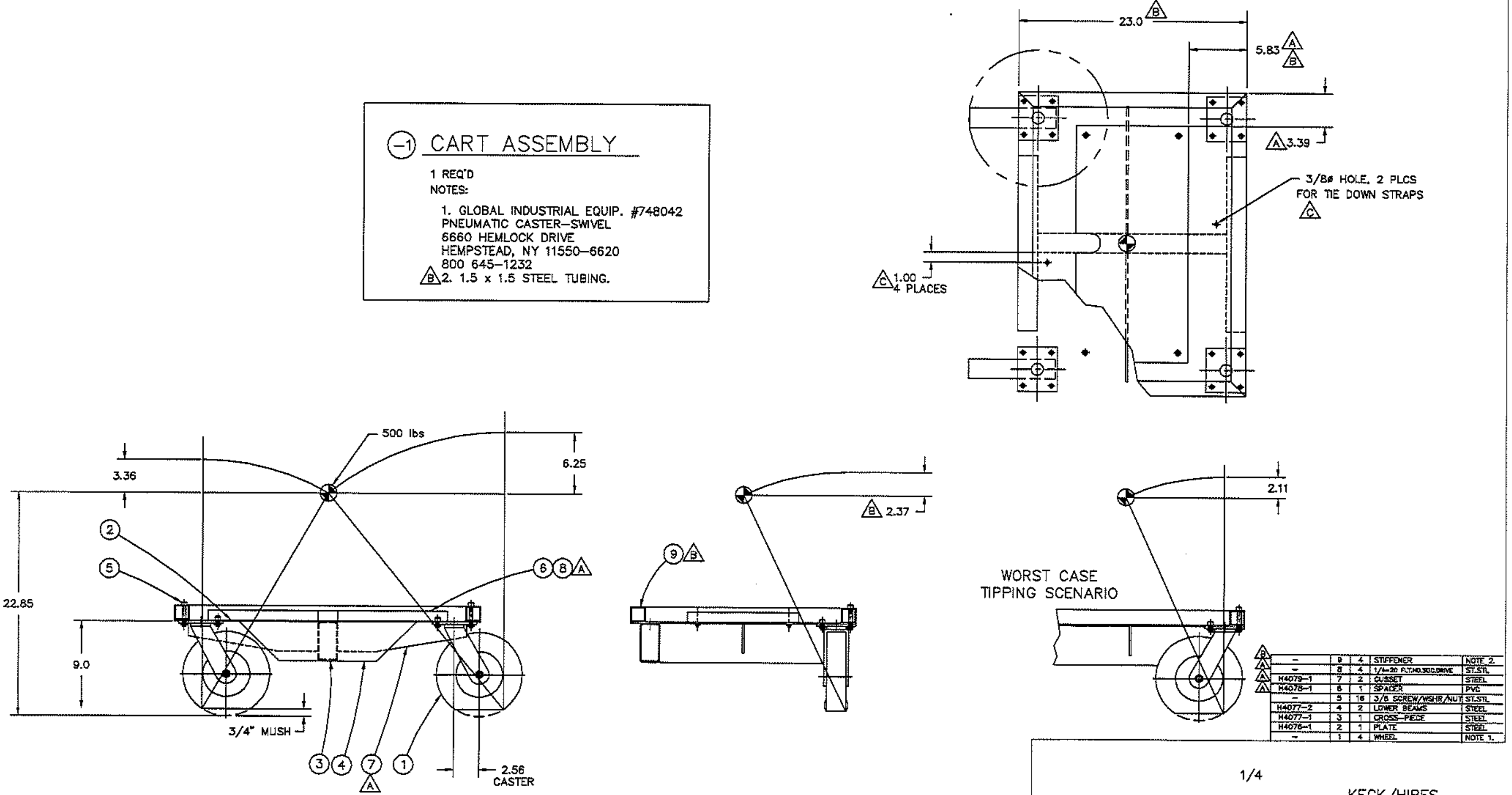
A	3-[illegible]	j.o.		CHANGE CASTER: 2.56" WAS 3/8"
				ADD WORST CASE TIPPING SCENARIO.

1/4

KECK/HIRES
ECHELLE MOSAIC CART
ASSEMBLY

j.o. 7 2 [illegible]

H3075.A



⊖1 CART ASSEMBLY

1 REQ'D

NOTES:

1. GLOBAL INDUSTRIAL EQUIP. #748042
PNEUMATIC CASTER–SWIVEL
6660 HEMLOCK DRIVE
HEMPSTEAD, NY 11550–6620
800 645–1232

B 2. 1.5 x 1.5 STEEL TUBING.

B	–	9	4	STIFFENER	NOTE 2.
A	–	8	4	1/4–20 FLT.HD.SOC.DRIVE	ST.STL
A	H4079–1	7	2	GUSSET	STEEL
A	H4078–1	6	1	SPACER	PVC
	–	5	16	3/8 SCREW/WSHR/NUT	ST.STL
	H4077–2	4	2	LOWER BEAMS	STEEL
	H4077–1	3	1	CROSS–PIECE	STEEL
	H4076–1	2	1	PLATE	STEEL
	–	1	4	WHEEL	NOTE 1.

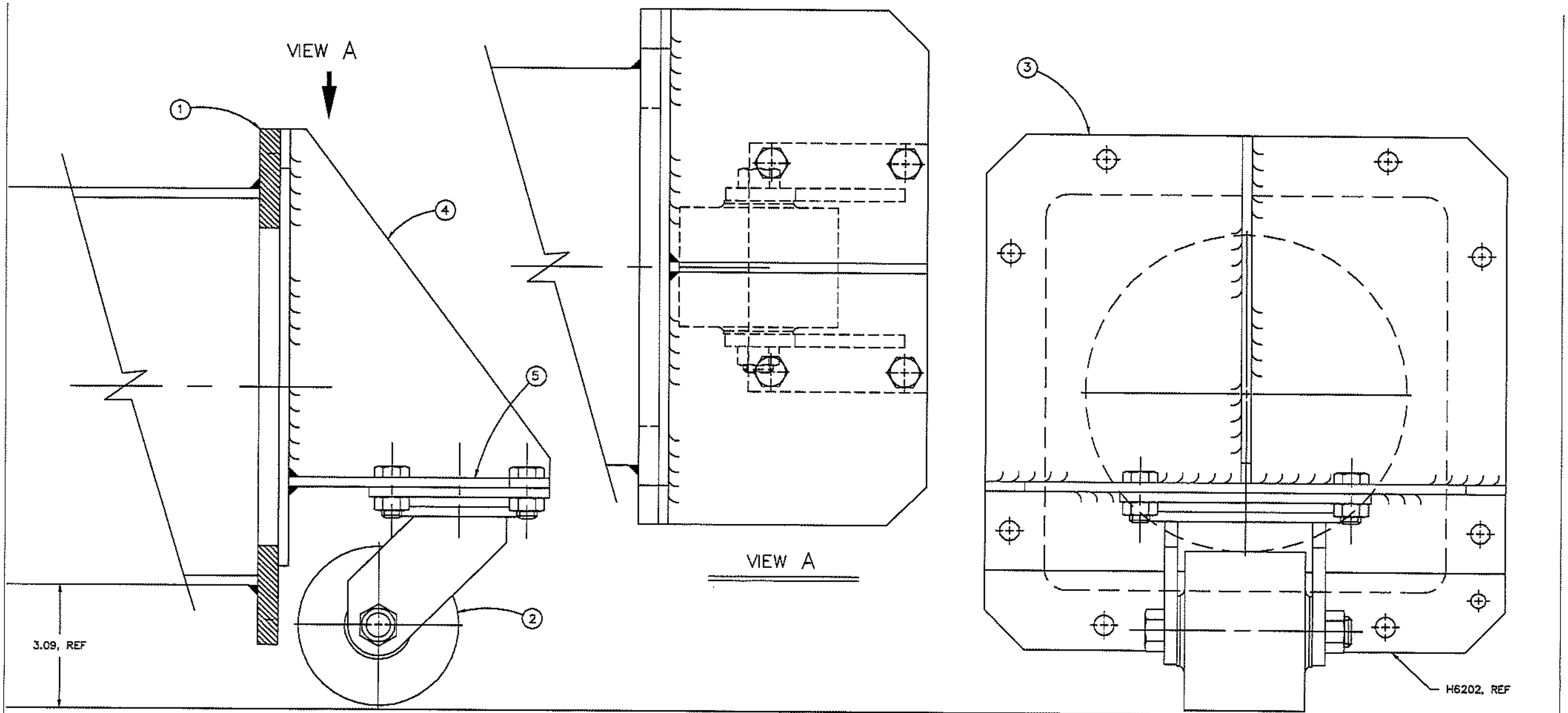
1/4

A	6 17 82	j.o.		UPDATE TO AS–BUILT CONDITION.
B	1 28 83	j.o.		23 WIDE WAS 24. ADD STIFFENING TUB
C	2 18 83	j.o.		ADD 2 HOLES FOR EYES AND STRAPS.

KECK/HIRES
CROSS DISPERSER CART
ASSEMBLY

j.o. 3 18 82

H4075.C



⊖1 CASTER ASSEMBLY

3 REQ'D
ALBION #81-CA-04501
4ØX3 SEMI-STEEL WHEELS
CAPACITY: 1650 LBS
SWIVEL STYLE
⚠ POWDER COAT WHITE

H6606-3	5	1	CASTER MOUNT	STEEL
H6606-2	4	1	SUPPORT	STEEL
H6606-1	3	1	MTG PLT	STEEL
—	2	1	CASTERS	
H6202	1	2	FLANGE	STEEL

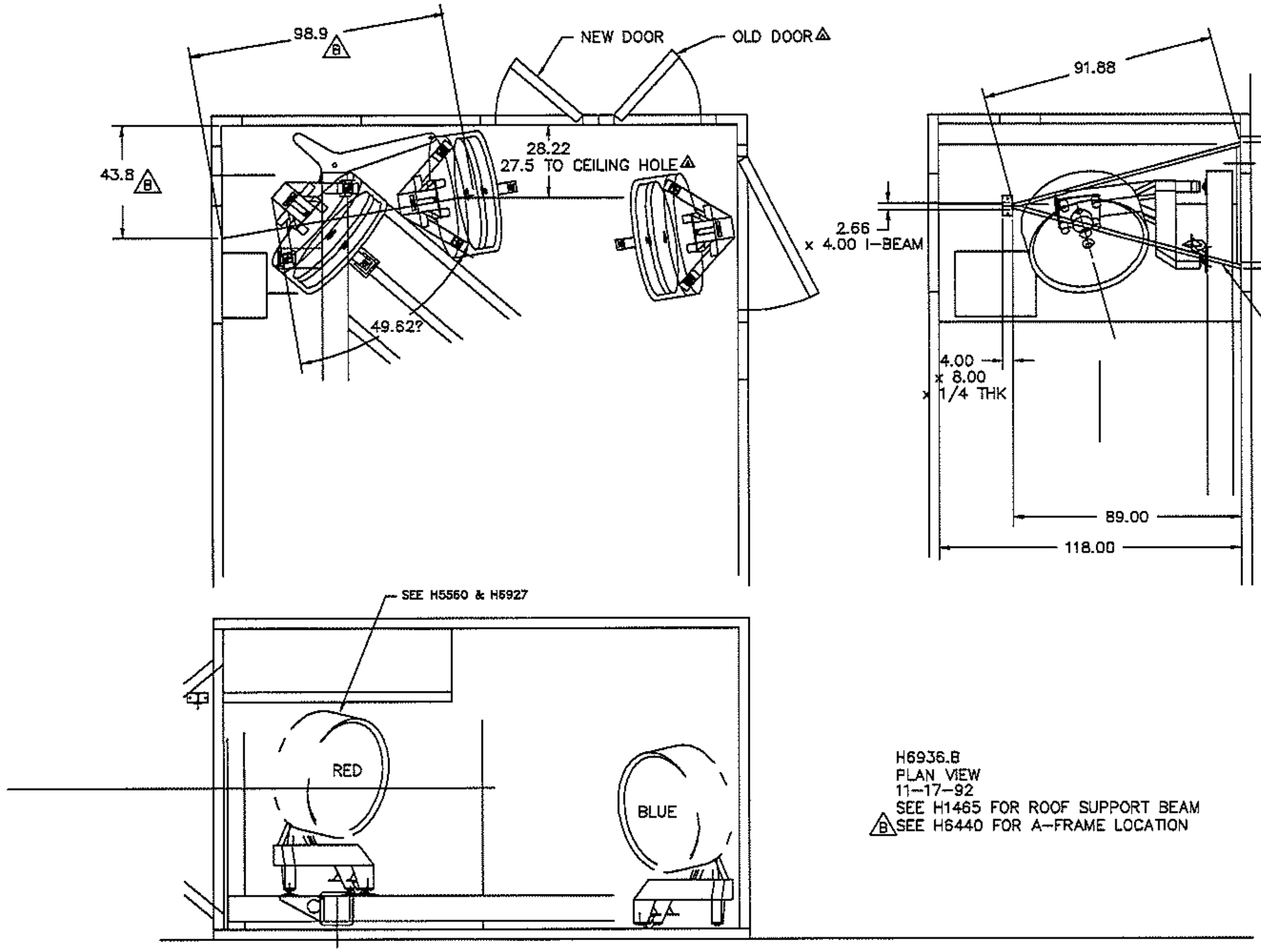
A | 8 8 92 | J.o. | | ADD PAINT NOTE.

FULL

KECK/HIRES
CASTERS
ASSEMBLY

J.o. 12 4 89

H6605.A



H6936.B
PLAN VIEW
11-17-92
SEE H1465 FOR ROOF SUPPORT BEAM
B SEE H6440 FOR A-FRAME LOCATION

.05

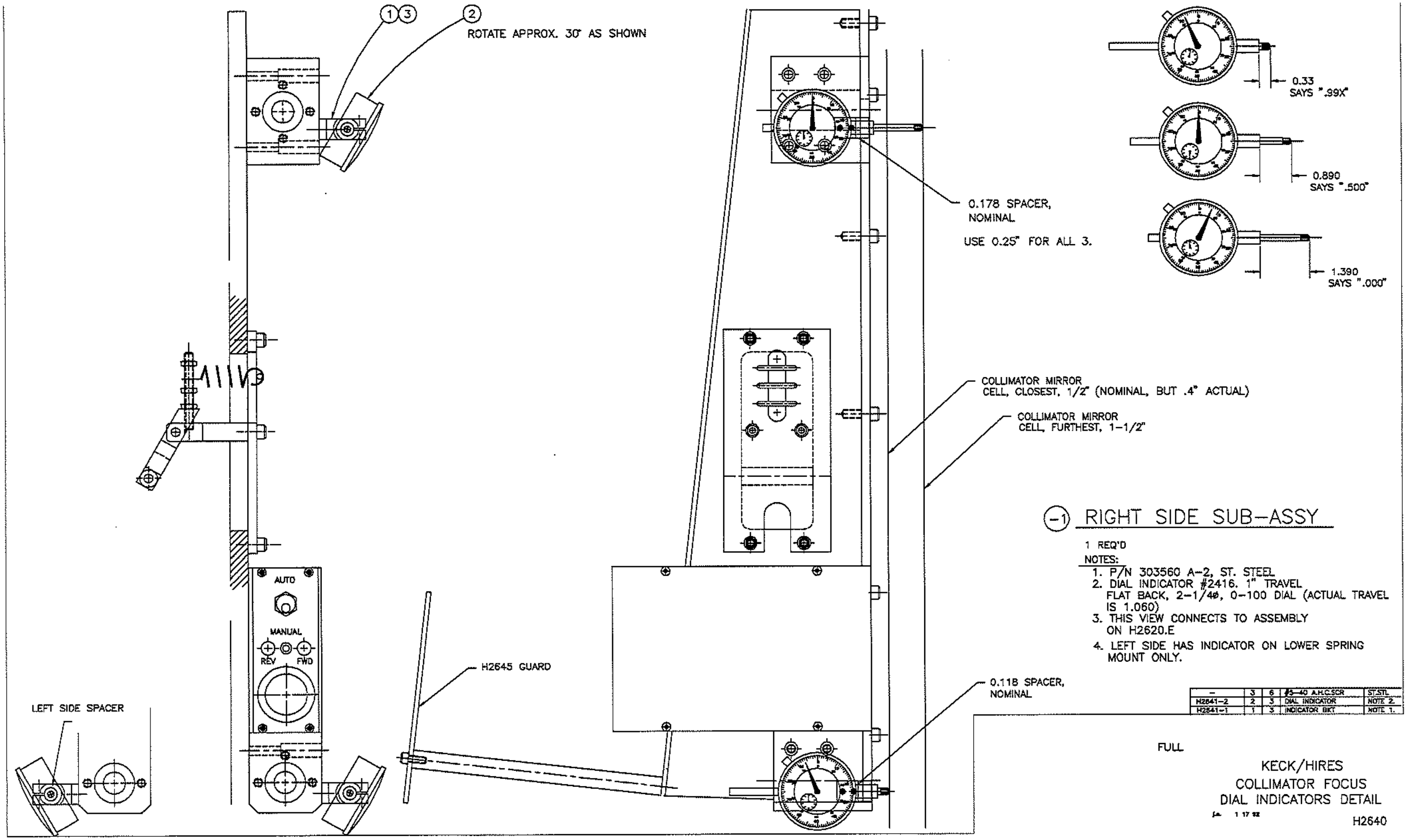
B | 5 13 93 | J.D. | MOVE I-BEAM

KECK/HIRES
CAMERA MIRROR LIFT
LAYOUT

H6936.B

Appendix I List of Drawings — Re-Aluminizing and Re-Aligning

1. H2640 Collimator Focus, Dial Indicator Detail
2. H5420 Hextek (Camera Mirror) Aluminizing Fixture Assembly
3. H6500 Alignment Scenario
4. H6510 Alignment Telescope Fixture, Rear
5. H6530 Alignment Telescope Fixture, Front
6. H6560 Alignment Target, Echelle Pivot



⊖1 RIGHT SIDE SUB-ASSY

1 REQ'D

NOTES:

1. P/N 303560 A-2, ST. STEEL
2. DIAL INDICATOR #2416. 1" TRAVEL FLAT BACK, 2-1/4ø, 0-100 DIAL (ACTUAL TRAVEL IS 1.060)
3. THIS VIEW CONNECTS TO ASSEMBLY ON H2620.E
4. LEFT SIDE HAS INDICATOR ON LOWER SPRING MOUNT ONLY.

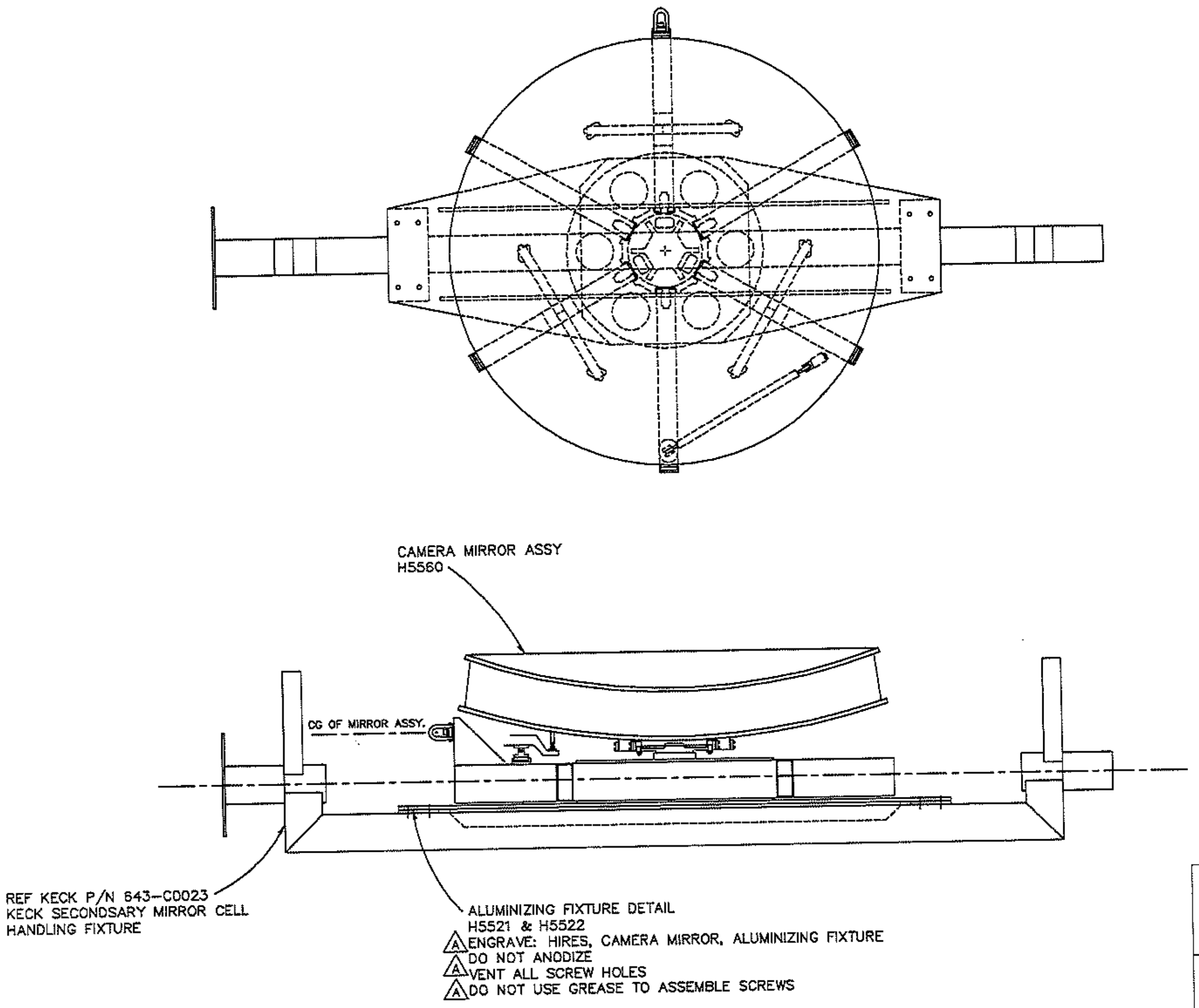
–	3	6	#5–40 A.H.C.SCR	ST.STL.
H2641–2	2	3	DIAL INDICATOR	NOTE 2.
H2641–1	1	3	INDICATOR BKT	NOTE 1.

FULL

KECK/HIRES
COLLIMATOR FOCUS
DIAL INDICATORS DETAIL

1 17 92

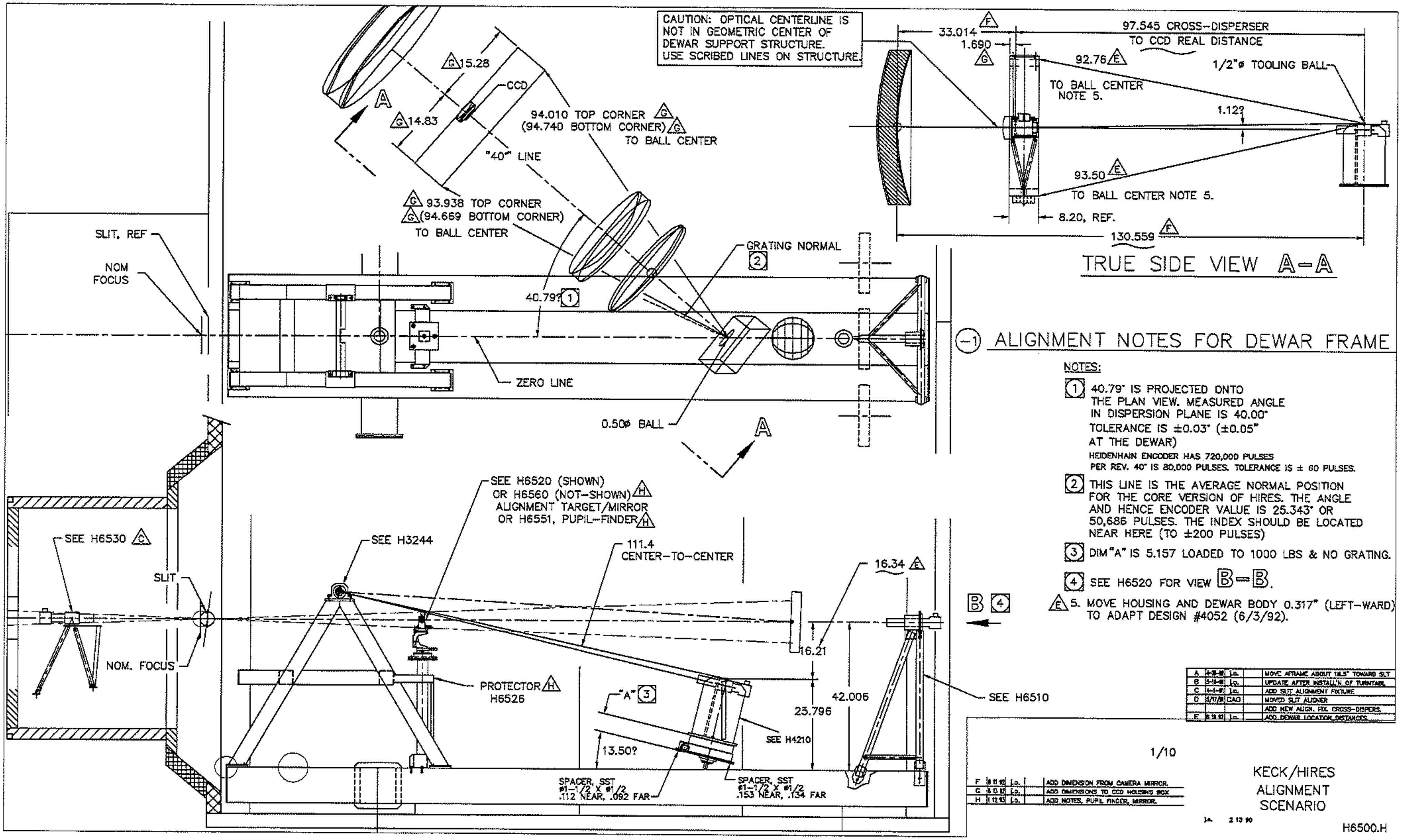
H2640



.2

A | 2 13 93 | j.c. | | ADD NOTES, MODIFY SUB-TITLE.

KECK/HIRES
CAMERA MIRROR
△A ALUMINIZING FIXTURE
E.C.S. 08/22/92
C.A.D. 8/25/92
H5420.A



㊀ ALIGNMENT NOTES FOR DEWAR FRAME

NOTES:

1. 40.79° IS PROJECTED ONTO THE PLAN VIEW. MEASURED ANGLE IN DISPERSION PLANE IS 40.00° TOLERANCE IS ±0.03° (±0.05" AT THE DEWAR)
   HEIDENHAIN ENCODER HAS 720,000 PULSES PER REV. 40° IS 80,000 PULSES. TOLERANCE IS ± 60 PULSES.
2. THIS LINE IS THE AVERAGE NORMAL POSITION FOR THE CORE VERSION OF HIRES. THE ANGLE AND HENCE ENCODER VALUE IS 25.343° OR 50,686 PULSES. THE INDEX SHOULD BE LOCATED NEAR HERE (TO ±200 PULSES)
3. DIM "A" IS 5.157 LOADED TO 1000 LBS & NO GRATING.
4. SEE H6520 FOR VIEW B–B.

E 5. MOVE HOUSING AND DEWAR BODY 0.317" (LEFT-WARD) TO ADAPT DESIGN #4052 (6/3/92).

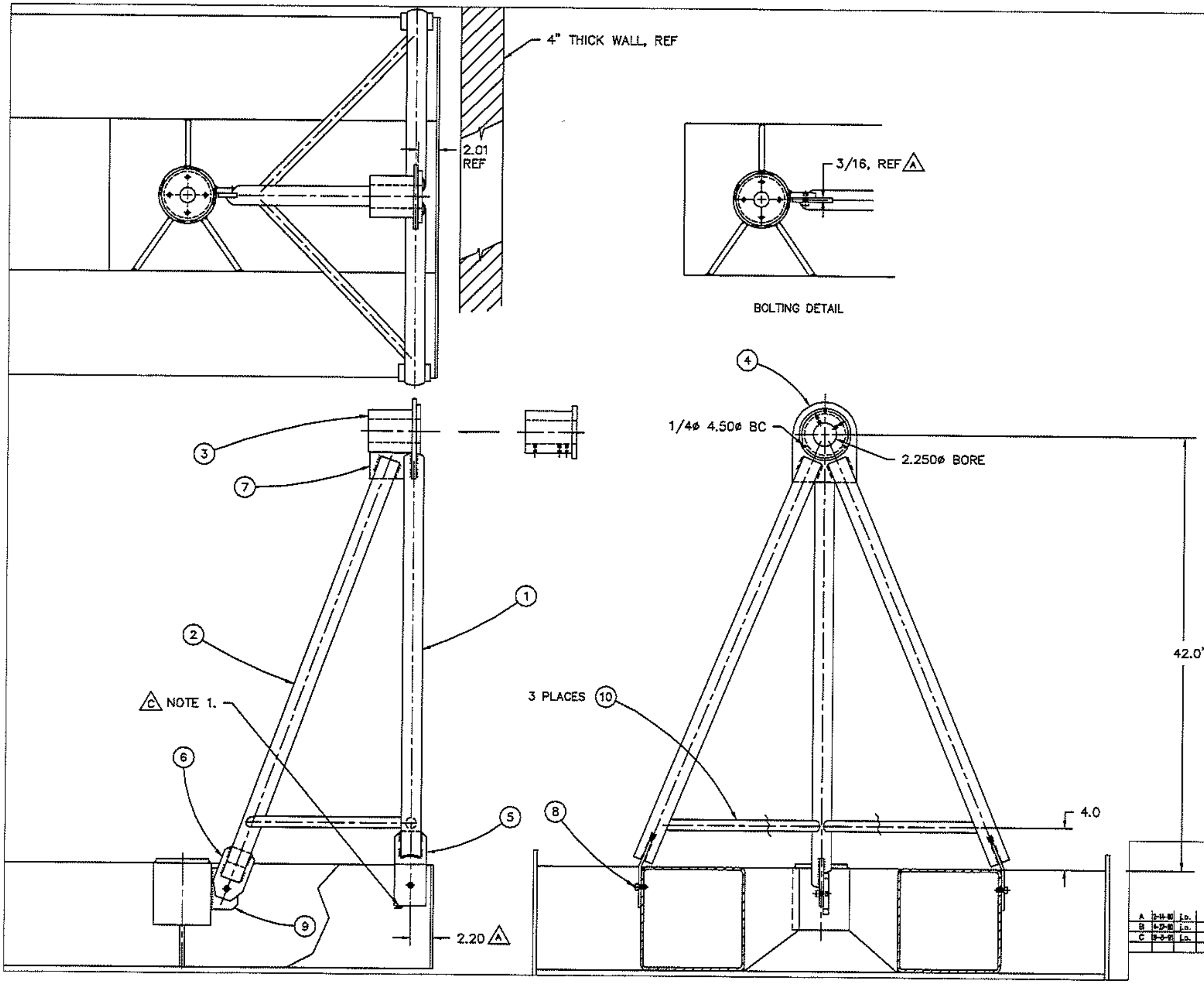
A	[illegible]	j.a.		MOVE AFRAME ABOUT 18.5" TOWARD SLIT
B	[illegible]	j.a.		UPDATE AFTER INSTALL'N OF TURNTABL
C	[illegible]	j.a.		ADD SLIT ALIGNMENT FIXTURE
D	[illegible]	CAD		MOVED SLIT ALIGNER
				ADD NEW ALIGN. FIX. CROSS-DISPERS.
E	[illegible]	j.a.		ADD DEWAR LOCATION DISTANCES
F	8 11 92	j.a.		ADD DIMENSION FROM CAMERA MIRROR.
G	8 13 92	j.a.		ADD DIMENSIONS TO CCD HOUSING BOX
H	1 12 93	j.a.		ADD NOTES, PUPIL FINDER, MIRROR.

1/10

KECK/HIRES
ALIGNMENT
SCENARIO

j.a. 2 13 90

H6500.H



⊖1 ALIGNMENT FIXTURE

1 REQ'D
STEEL WELDMENT
SANDBLAST BEFORE PAINTING B
PAINT: POWDER PAINT, WHITE
NOTES:
C 1. WELD EACH OF THE 3 LEGS AFTER SLIT FRAME IS PINNED.

	–	10	3	TIES, AS REQ'D	3/4 IPS
	H6513–1	9	1	OFFSET TAB	STL
	–	8	3	3/8 AL HD SOC CAP SCR	ST STL
	H6512–4	7	1	WEB	STL
	H6512–3	6	1	FRONT TANG	STL
	H6512–2	5	2	SIDE TANG	STL
	H6512–1	4	1	MOUNTING PLATE	STL
C	H6512–5	3	1	ALIGNMENT ADAPTER	ALUM
	H6511–2	2	1	LOCKING LEG	STL
	H6511–1	1	2	BRACING LEG	STL

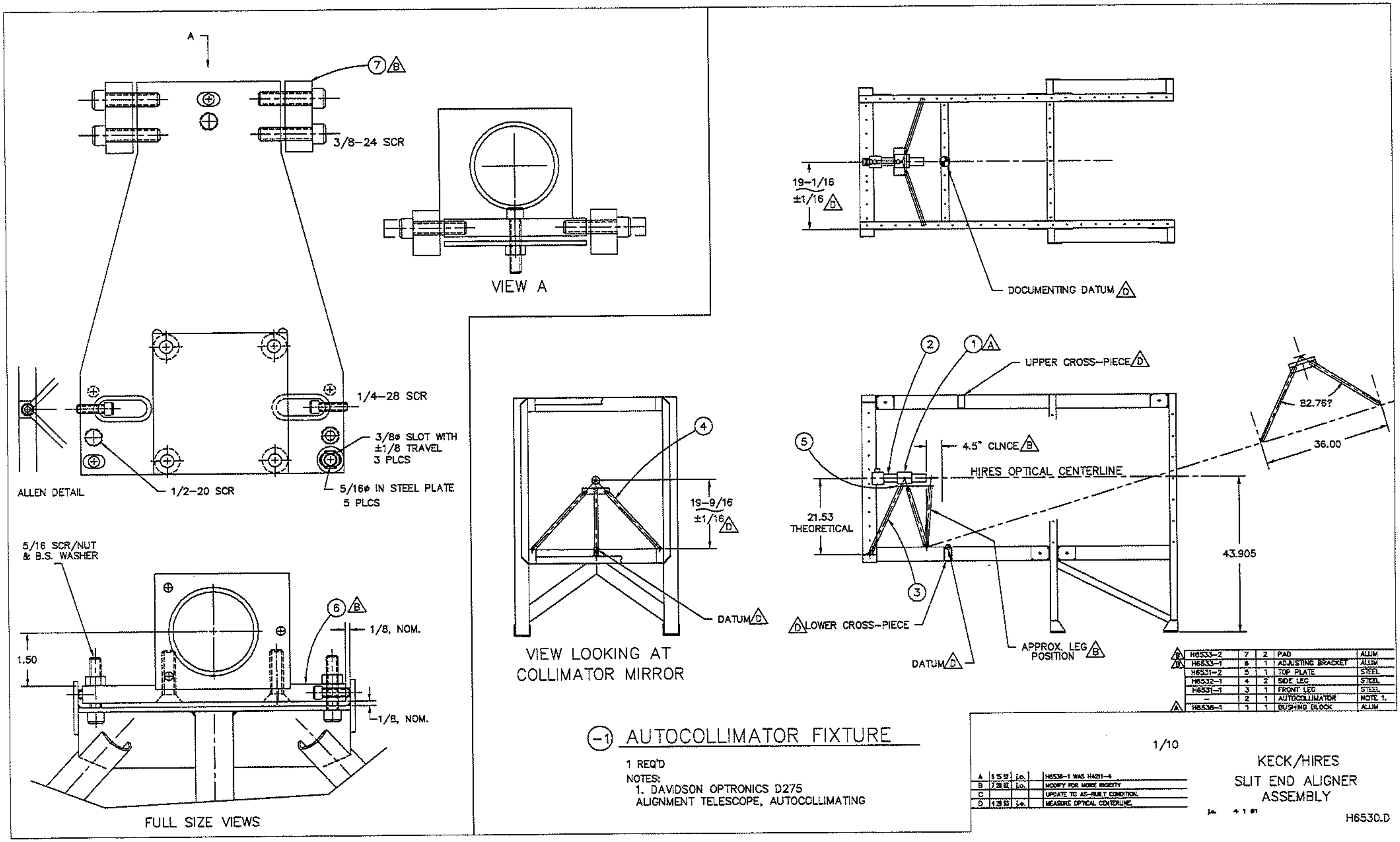
1/4

A	2-11-90	j.o.		ADD DIM, MODIFY VIEW.
B	4-27-90	j.o.		AS BUILT.
C	9-3-91	j.o.		ADD WELD NOTE, PERMANENT FIXTURE.
				PART H6512–5 WAS H2403–1.

KECK/HIRES
ALIGNMENT FIXTURE
ASSEMBLY

j.o. 1 25 90

H6510.C



B	H6533-2	7	2	PAD	ALUM
B	H6533-1	6	1	ADJUSTING BRACKET	ALUM
	H6531-2	5	1	TOP PLATE	STEEL
	H6532-1	4	2	SIDE LEG	STEEL
	H6531-1	3	1	FRONT LEG	STEEL
	–	2	1	AUTOCOLLIMATOR	NOTE 1.
A	H6536-1	1	1	BUSHING BLOCK	ALUM

-1 AUTOCOLLIMATOR FIXTURE

1 REQ'D

NOTES:
1. DAVIDSON OPTRONICS D275
ALIGNMENT TELESCOPE, AUTOCOLLIMATING

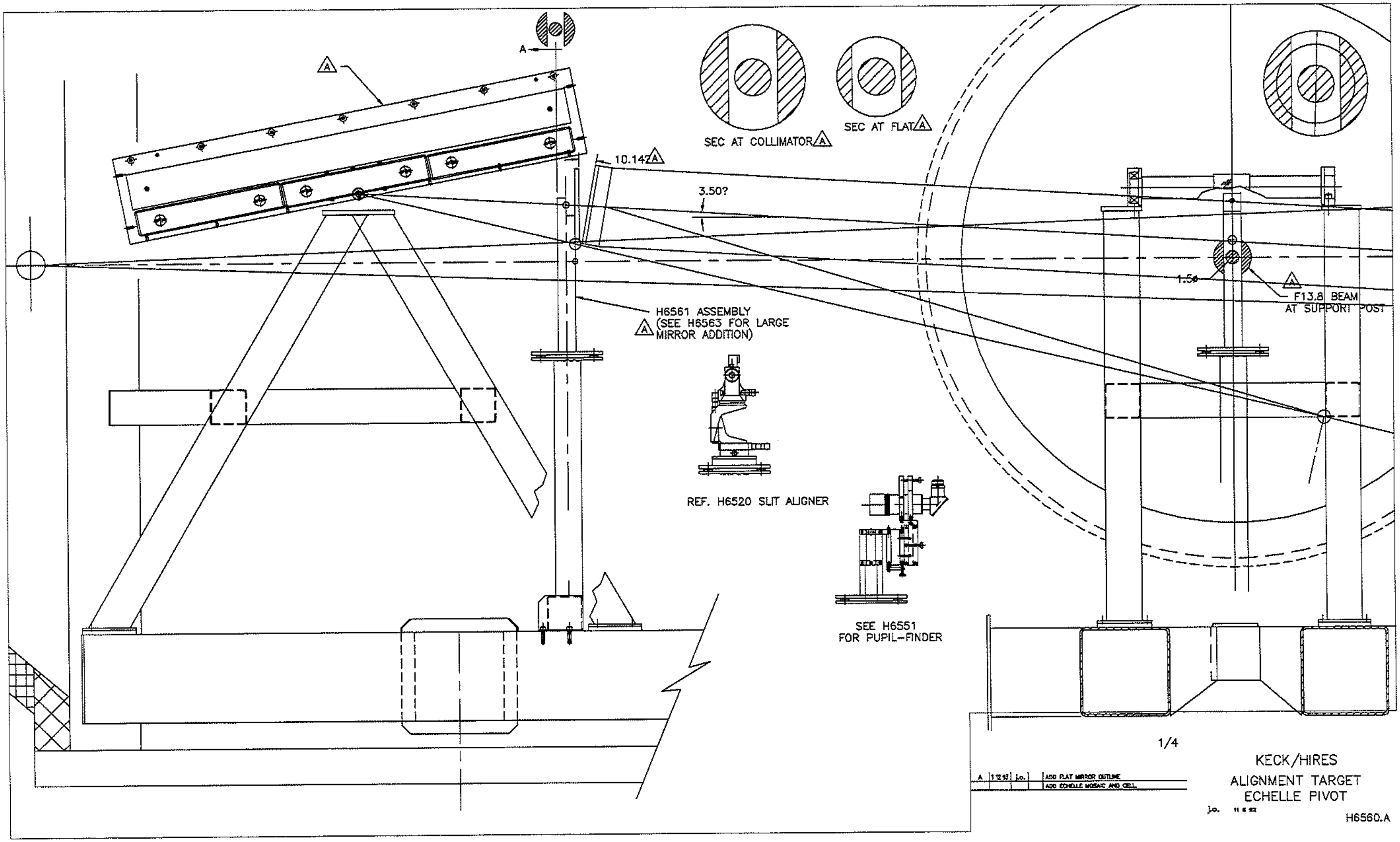
1/10

A	6 15 92	j.o.		H6536-1 WAS H4211-4
B	7 20 92	j.o.		MODIFY FOR MORE RIGIDITY
C				UPDATE TO AS-BUILT CONDITION.
D	4 28 93	j.o.		MEASURE OPTICAL CENTERLINE.

KECK/HIRES
SLIT END ALIGNER
ASSEMBLY

j.o. 4 1 91

H6530.D



A	1 12 93	j.o.		ADD FLAT MIRROR OUTLINE
				ADD ECHELLE MOSAIC AND CELL

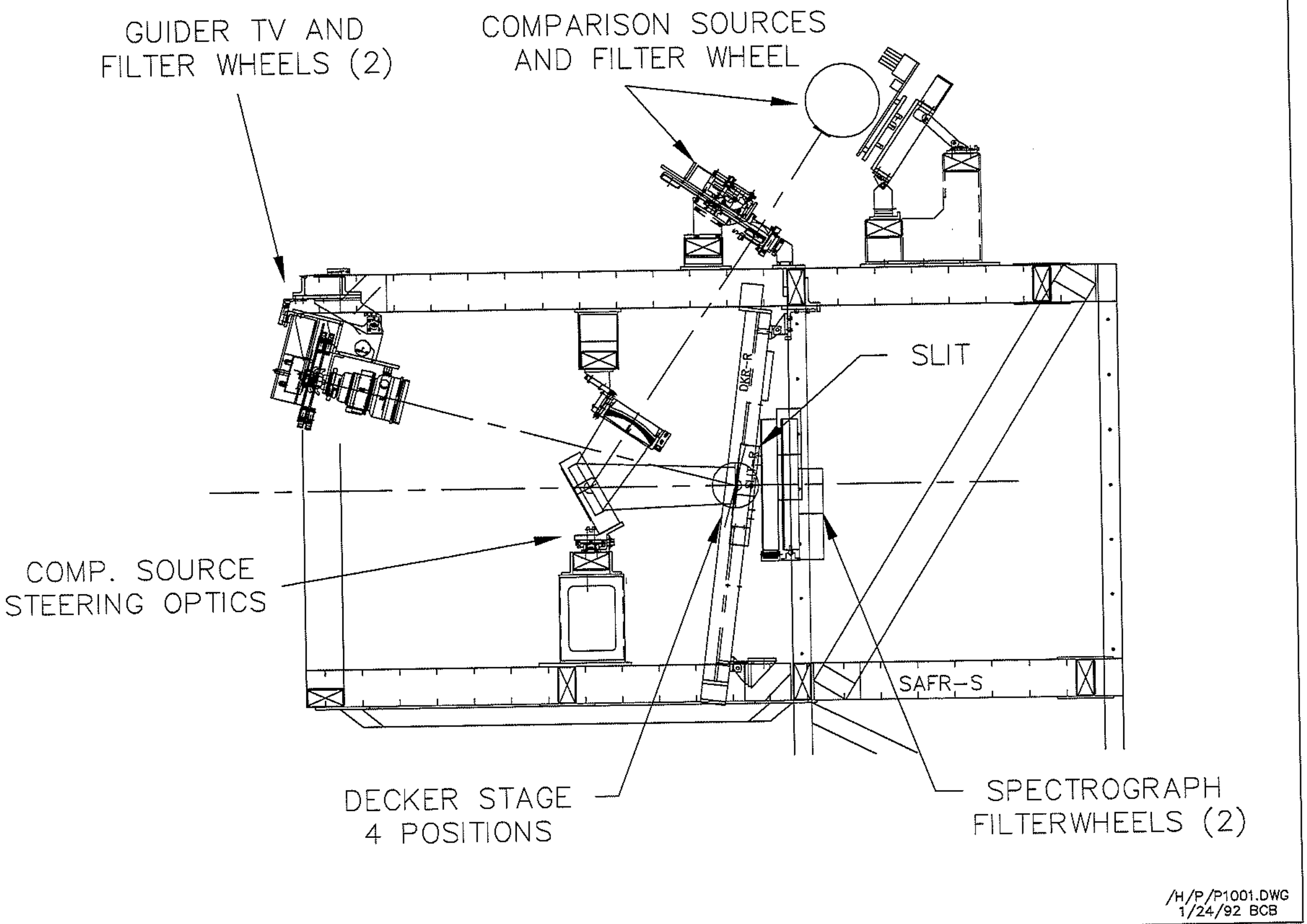
KECK/HIRES
ALIGNMENT TARGET
ECHELLE PIVOT
j.o. 11 6 92
H6560.A

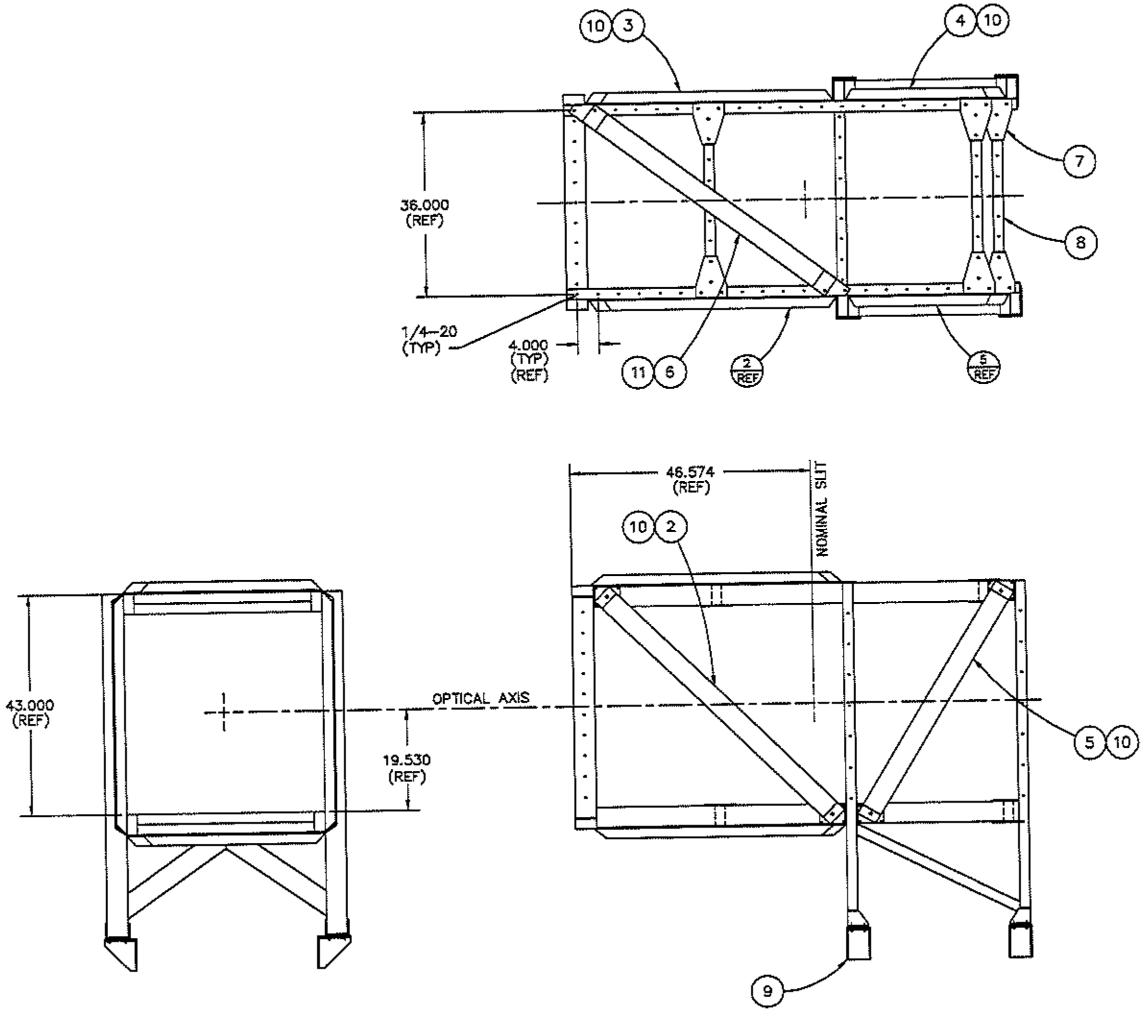
Appendix J List of Drawings — Other Comments

1.

Appendix K List of Drawings — Slit Area

1. P1001 Slit Area Overview and Layout
2. H6711 Slit Area Structure Sub-Assembly


GUIDER TV AND
FILTER WHEELS (2)
COMPARISON SOURCES
AND FILTER WHEEL
SLIT
DKR-R
SLIT-R
COMP. SOURCE
STEERING OPTICS
SAFR-S
DECKER STAGE
4 POSITIONS
SPECTROGRAPH
FILTERWHEELS (2)
/H/P/P1001.DWG
1/24/92 BCB



NOTES:

1. POWDER PAINT: FULLER O'BRIEN FLAT BLACK EFB 534-SO.

H6716-8	11	4	END PLATE	STEEL
H6716-6	10	8	END PLATE	STEEL
H6715-1	9	4	SUPPORT WELD	C1018
H6714-3	8	6	ADJ X-MEMBER	STEEL
H6719-5	7	16	MOUNTING PLATE	C1018
H6712-9	6	2	TRANSVERSE NOSE DIAG WELD	STEEL
H6712-4	5	1	UPPER LEG DIAG WELD	STEEL
H6712-3	4	1	UPPER LEG DIAG WELD	STEEL
H6712-2	3	1	NOSE DIAGONAL WELD	STEEL
H6712-1	2	1	NOSE DIAGONAL WELD	STEEL
H6710-1	1	1	WELD ASSEMBLY	STEEL

1/10

A	7/10/90	CAO		UPDATE PER AS BUILT
B	7/10/90	CAO		UPDATE PER AS BUILT
C	7/27/90	CAO		UPDATE PER AS BUILT
D	8/30/90	CAO		ADDED NOTE 1.

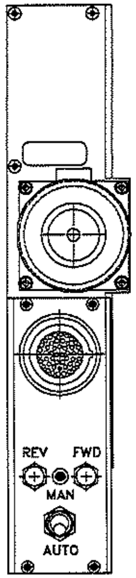
KECK/HIRES
SLIT AREA STRUCTURE
ASSEMBLY

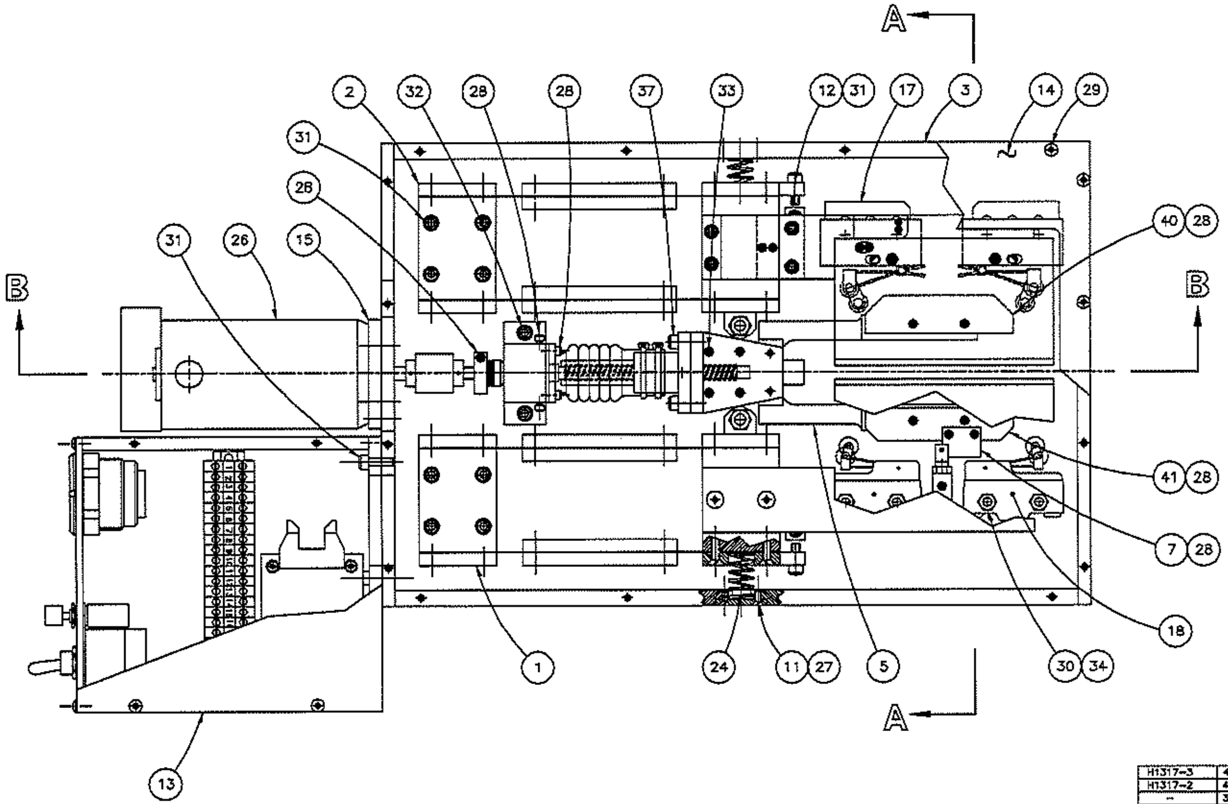
E.C.B. 5/1/90
C.A.G. 5/21/90

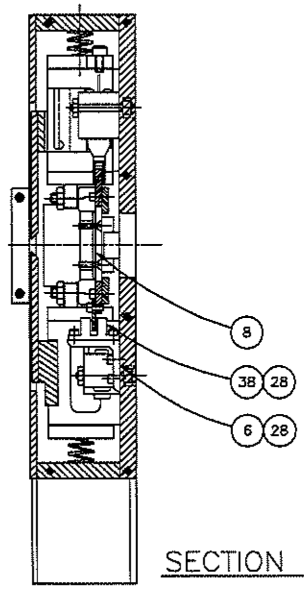
H6711.D

Appendix L List of Drawings — Slit Assembly

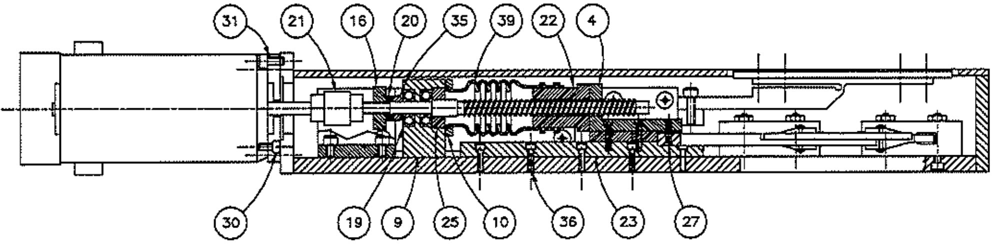
1. H1324 Slit Assembly
2. H1326 Slit Drive Schematic Information
3. H1322 Slit Jaw / Spring Assembly







SECTION A–A



SECTION B–B

① SLIT ASSEMBLY

1 REQ'D

NOTES:

1. BERG CG1-25
2. MICRO DT-2RV22-A7
3. MICRO BZ-2RW822-A2
4. SKF 626-2RS
5. ASSOCIATED B0500-018-5
6. THK MBF-0802-168LC3
7. THK RSR12-M-UUC1+
8. LEE LC-038G-6
9. GALIL 50/1000 (SEE H2623)
10. KEYWAY ADDED

H1317-3	41	1	TRIGGER, LIMIT SWITCH	ALUM
H1317-2	40	1	TRIGGER, LIMIT SWITCH	ALUM
–	39	1	BOOT	
–	38	1	OPTICAL SWITCH	
–	37	2	SCR, SHCS, M4	
–	36	5	SCR, SHCS, M3	
H1319-3	35	1	SPACER	SST
–	34	8	NUT, HEX, 6-32 UNC	
–	33	4	SCR, SHCS, M2.6	
–	32	2	SCR, SHCS, 10-32 UNF	
–	31	6	SCR, SHCS, 8-32 UNC	
–	30	12	SCR, SHCS, 6-32 UNC	
–	29	16	SCR, FHSCS, 5-40 UNC	
–	28	17	SCR, SHCS, 4-40 UNC	
–	27	8	SCR, FHSCS, 4-40 UNC	
H2623-1	26	1	MOTOR/ENCODER	NOTE 9.
H1313-8	25	1	BRAKE	ALUM
–	24	2	SPRING	NOTE 8.
H1313-6	23	1	BALL SLIDE	NOTE 7.
H1319-2	22	1	BALL SCREW, MODIFIED	NOTE 6.
–	21	1	COUPLING	NOTE 10.
–	20	4	BELLVILLE SPRING WASHER	NOTE 5.
–	19	2	BEARING	NOTE 4.
–	18	2	LIMIT SWITCH, SOFT	NOTE 3.
–	17	2	LIMIT SWITCH, HARD	NOTE 2.
H1313-7	16	1	COLLAR, MODIFIED	NOTE 1.
H1112-1	15	1	ADAPTOR, NEMA 23	ALUM
H1319-1	14	1	COVER	ALUM
H1316-1	13	1	JUNCTION BOX	
H1313-4	12	2	STOP	ALUM
H1313-5	11	2	TENSION PLATE	ALUM
H1313-2	10	1	RETAINER RING	ALUM
H1313-1	9	1	BEARING SUPPORT	ALUM
H1312-7	8	1	SPACER	ALUM
H1312-6	7	1	TRIGGER	ALUM
H1312-4	6	1	FIDUCIAL BRACKET	ALUM
H1312-3	5	1	LEVER	ALUM
H1312-1	4	1	WEDGE	ALUM
H1321-1	3	1	HOUSING ASSY	
H1322-1	2	1	SLIT JAW/SPRING ASSY	
H1323-1	1	1	SLIT JAW/SPRING ASSY	

FULL

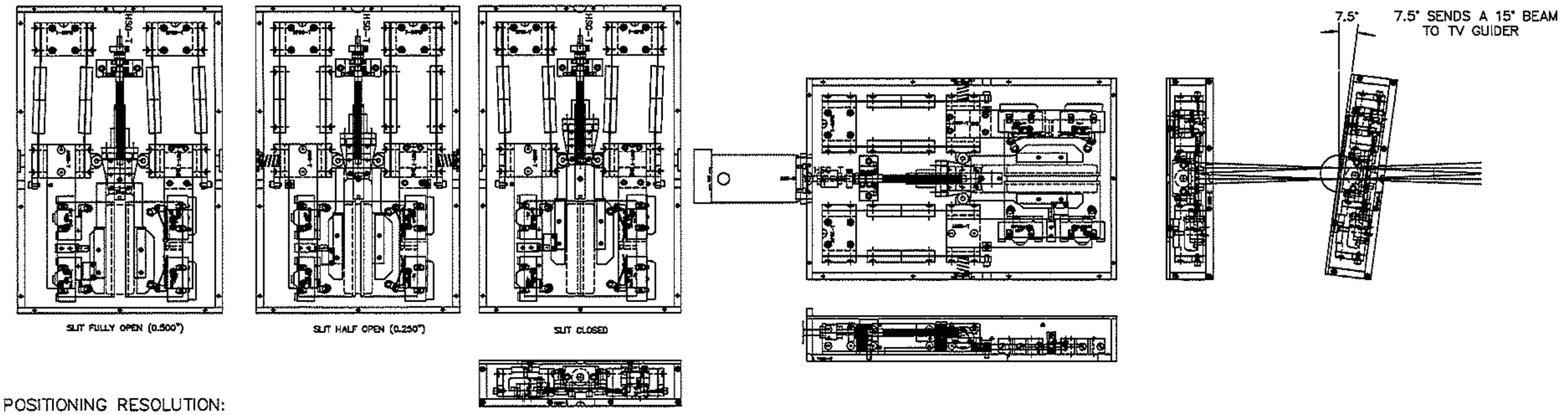
A	[illegible]	C.S.		CHANGED ITEM 13
B	2/8/00	C.S.		MULTI CHANGES
C	1/5/00	CAO		ADDED PART NO. TO ITEM 26
D	1/22/01			ROTATED LIMIT SWITCHES
E	[illegible]	CAO		CLUTCH INFO. PENDING

KECK/HIRES
SLIT
ASSEMBLY

S.C.B. [illegible]
C.A.O. 07/14/99

H1324.E

SLIT ASSEMBLY SHOWN 1/2 SIZE



THEORETICAL POSITIONING RESOLUTION:

MOTOR ENCODER	4000 CTS./REV.
BALL SCREW (THK MBF 08)	2mm/REV.
DRIVE RAMP	1 IN 5 SLOPE (20%)

△A MEANING: MOVE WEDGE 1mm AND SLIT WIDTH OPENS 0.2mm PER JAW OR 0.4mm TOTAL – REALLY 2 IN 5 SLOPE OR 40%

2mm/REV X 1 REV/4000CTS = 0.0005 mm/CT

0.0005 mm/CT X 0.2 SLOPE X 2 JAWS = 0.0002mm/CT

IF SERVO LOOP IS GOOD TO 2 COUNTS,
RESOLUTION IS 0.4 MICRONS

RESOLUTION AND REPEATABILITY HAVE BEEN TESTED TO 0.0005" MECHANICALLY.
BETTER TESTING WILL BE PERFORMED WITH THE GUIDER CCD TV.

PLATE SCALE AT SLIT IS 1.375 ARC-SEC/mm

0.0004mm X 1.375 ARC-SEC/mm = 0.00055 ARC-SEC

SLIT JAWS:

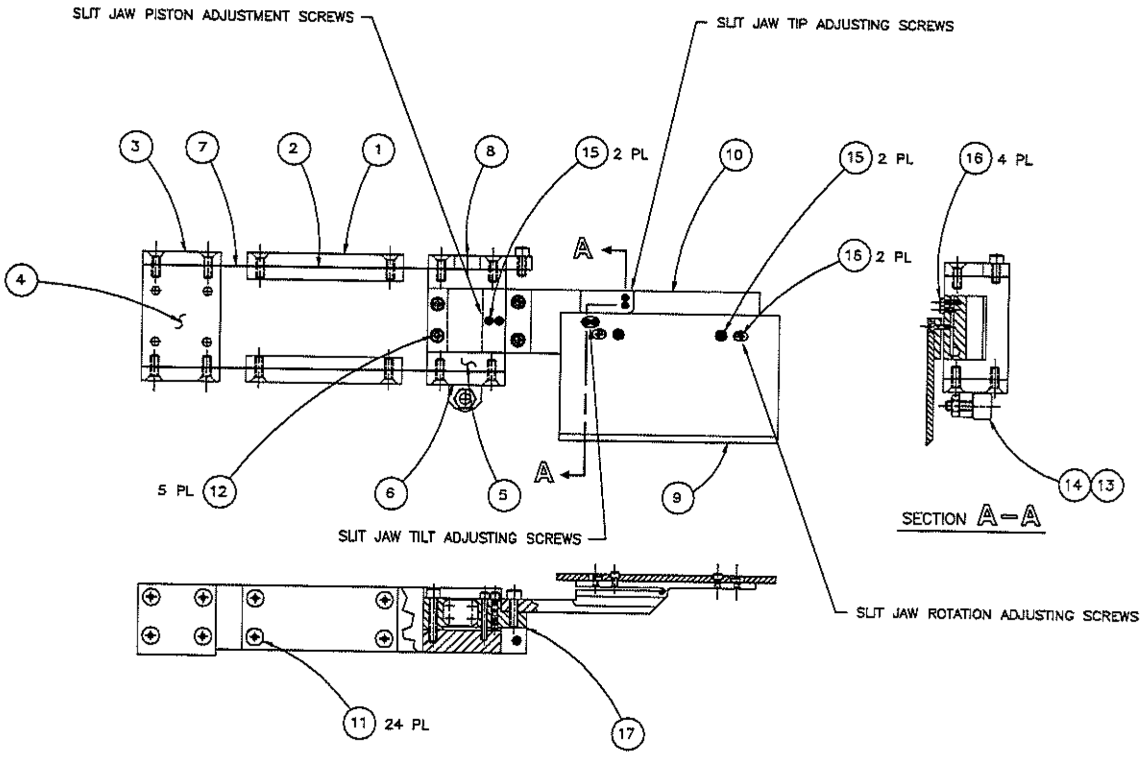
SLIT JAW MATERIAL IS 420 STAINLESS STEEL
JAWS ARE GROUND FLAT MECHANICALLY.
JAWS ARE OPTICALLY POLISHED AND FLAT TO 5 WAVES.

420 STAINLESS STEEL:
CARPENTER TECHNOLOGY
2263 NATIONAL AVE. A
HAYWARD, CA. 94545-1715
800-522-5077

SEE H1424 FOR FULL ASSEMBLY
SEE H6758 FOR SLIT AREA MOUNTINGS
SEE H6760 FOR SLIT MOUNTINGS

A | 4 28 93 | J.C. | ADD NOTE

KECK/HIRES
SLIT ASSY
DATA AND GEAR REDUCTION
04/17/92
H1326.A



⊖1 SLIT JAW/SPRING ASSEMBLY

1 REQ'D

–	17	4	SCR, SHCS, 2–56 UNC	
H1325–3	17	2	JAW MOUNT BASE	
H1325–4	16	2	CAM	
–	15	4	SCR, SHCS, 4–40 UNC	
–	14	1	NUT, HEX 10–32 UNF	
–	13	1	FOLLOWER	[illegible]
–	12	7	SCR, SHCS, 8–32 UNC	
–	11	24	SCR, FHSCS, 8–32 UNC	
H1325–1	10	1	SLIT MOUNT	ALUM
H1312–2	9	1	SLIT JAW	
H1311–8	8	1	END PLATE	ALUM
H1313–3	7	2	SPRING	SPR. ST.
H1311–5	5	1	FOLLOWER PLATE	ALUM
H1325–2	6	1	BASE, SPRING	ALUM
H1311–4	4	1	BASE, SPRING	ALUM
H1311–3	3	2	END PLATE, SPRING	ALUM
H1311–2	2	2	BASE PLATE, SPRING	ALUM
H1311–1	1	2	BASE PLATE, SPRING	ALUM

A. 2/2/90 C.S. MULTI CHANGES

FULL

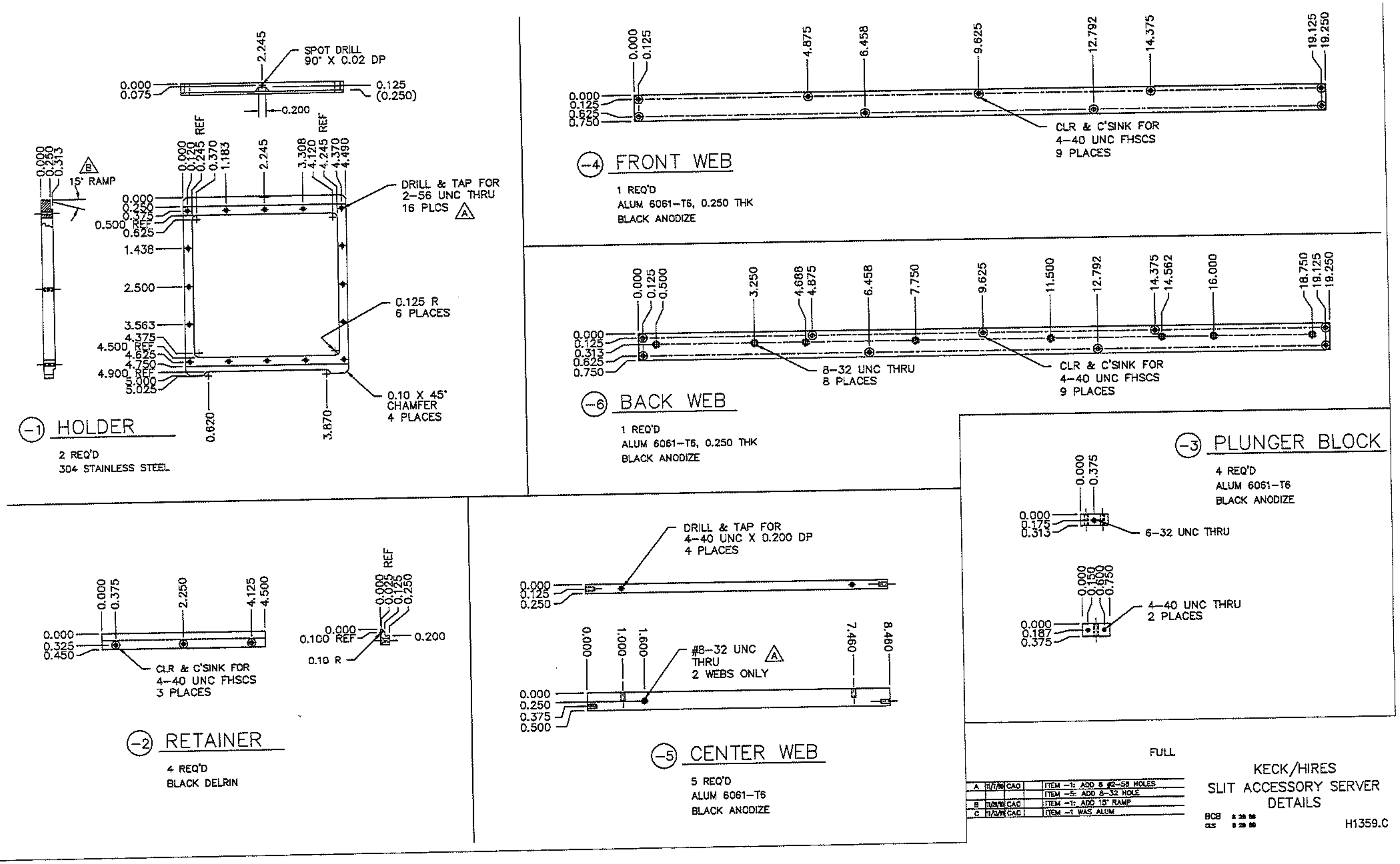
KECK/HIRES
SLIT JAW/
SPRING ASSEMBLY

B.C.B. 08/01/88
C.A.O. 07/06/89

H1322.A

Appendix M List of Drawings — Slit Accessory Server

1. H1359 Details
2. H1388 Decker Plate Blank
3. H1384 Decker Plate #A
4. H1389 Decker Plate #B
5. H1390 Decker Plate #C
6. H1391 Decker Plate #D
7. H1378 Slit Accessory Server Assembly
8. H1387 Slit Accessory Server Drive Schematic
9. H6758 Slit Area Stage Mountings — Assembly
10. H6759 Slit Area Stage Mountings — Details
11. H6760 Slit Area Stage Mountings — Details



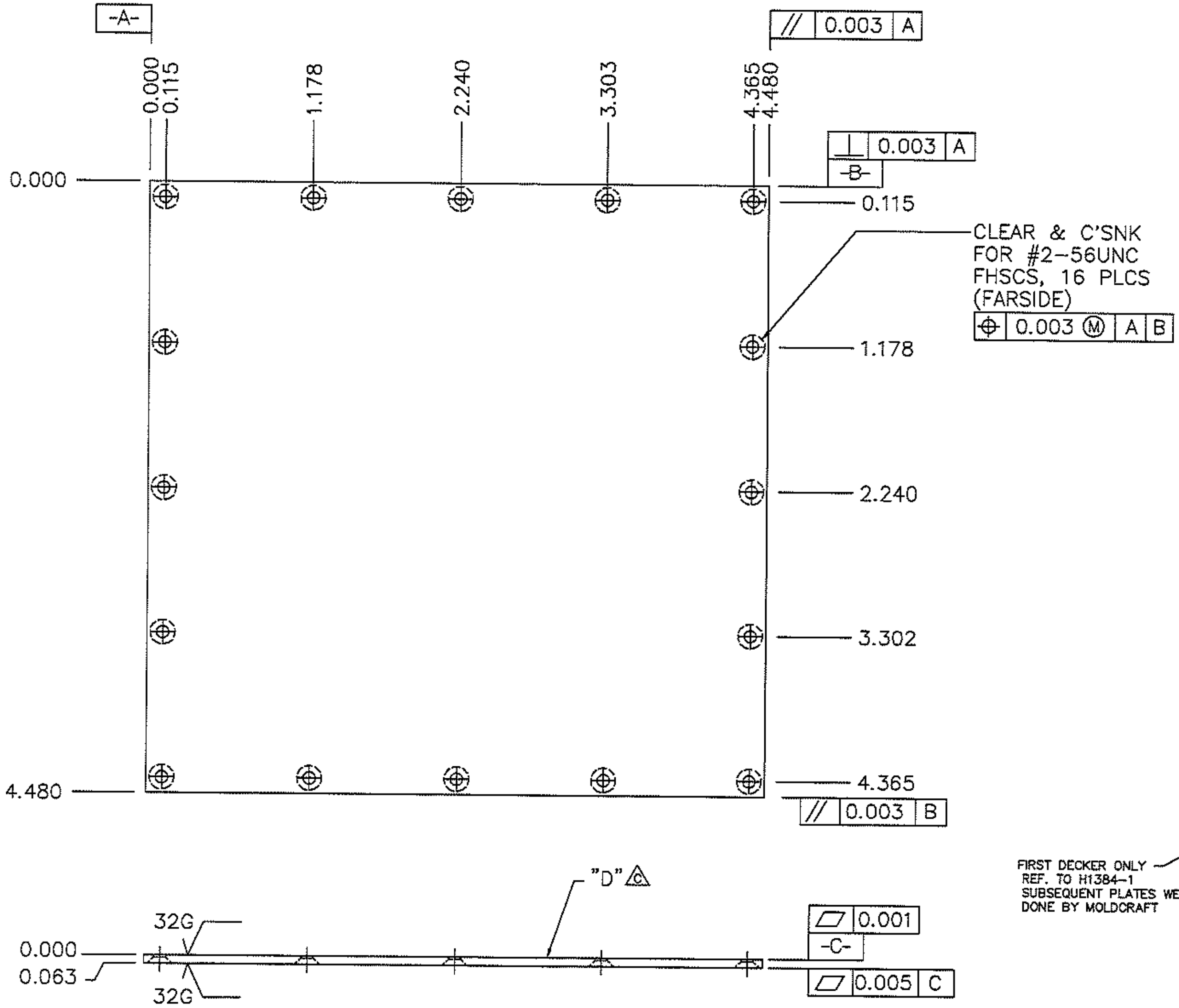
FULL

A	[illegible]	CAO		ITEM –1: ADD 8 #2–56 HOLES
				ITEM –5: ADD 8–32 HOLE
B	[illegible]	CAO		ITEM –1: ADD 15° RAMP
C	[illegible]	CAO		ITEM –1 WAS ALUM

KECK/HIRES
SLIT ACCESSORY SERVER
DETAILS

BCB [illegible]
CLS [illegible]

H1359.C



(-1) DECKER PLATE BLANK

420 ST. STEEL, 0.063 THK.
HARDEN TO RC52 – RC55

△C FABRICATION NOTES:

1. START WITH 3/16" THICK 420 STAINLESS STEEL.
   VENDOR: SIMON METALS, FILMORE, CA
   (805) 524-1801
2. CUT TO 4.480 DIMENSIONS AND PUT IN HOLES (NO C'SNKS)
3. BYINGTON HEAT TREAT TO RC52 TO RC55
   VENDOR: (408) 727-6630
4. DOUBLE DISK GRIND TO 1/16" THICK
   VENDOR: PETERSON GRINDING IN REDWOOD CITY, CA
   (415) 365-4373
5. COUNTERSINK HOLES
6. LICK OPTICAL SHOP TO GRIND SIDE "D"
   WITH 5 MICROGRIT LOOSE ABRASIVE, WET.
7. EDM AT MOLDCRAFT, 1643 S. MAIN ST., MILPITAS, CA
   VENDOR: (408) 945-1058
8. LICK OPTICAL SHOP TO POLISH SIDE "D"
9. NOTE: ALL X.XXX" DIMENSIONS TO BE ± 0.003"
   AND ALL X.XXXX" DIMENSIONS TO BE ±0.0005"

(7. EDM AT MTE, INC. IN SAN JOSE, CA
VENDOR: (408) 227-7040)

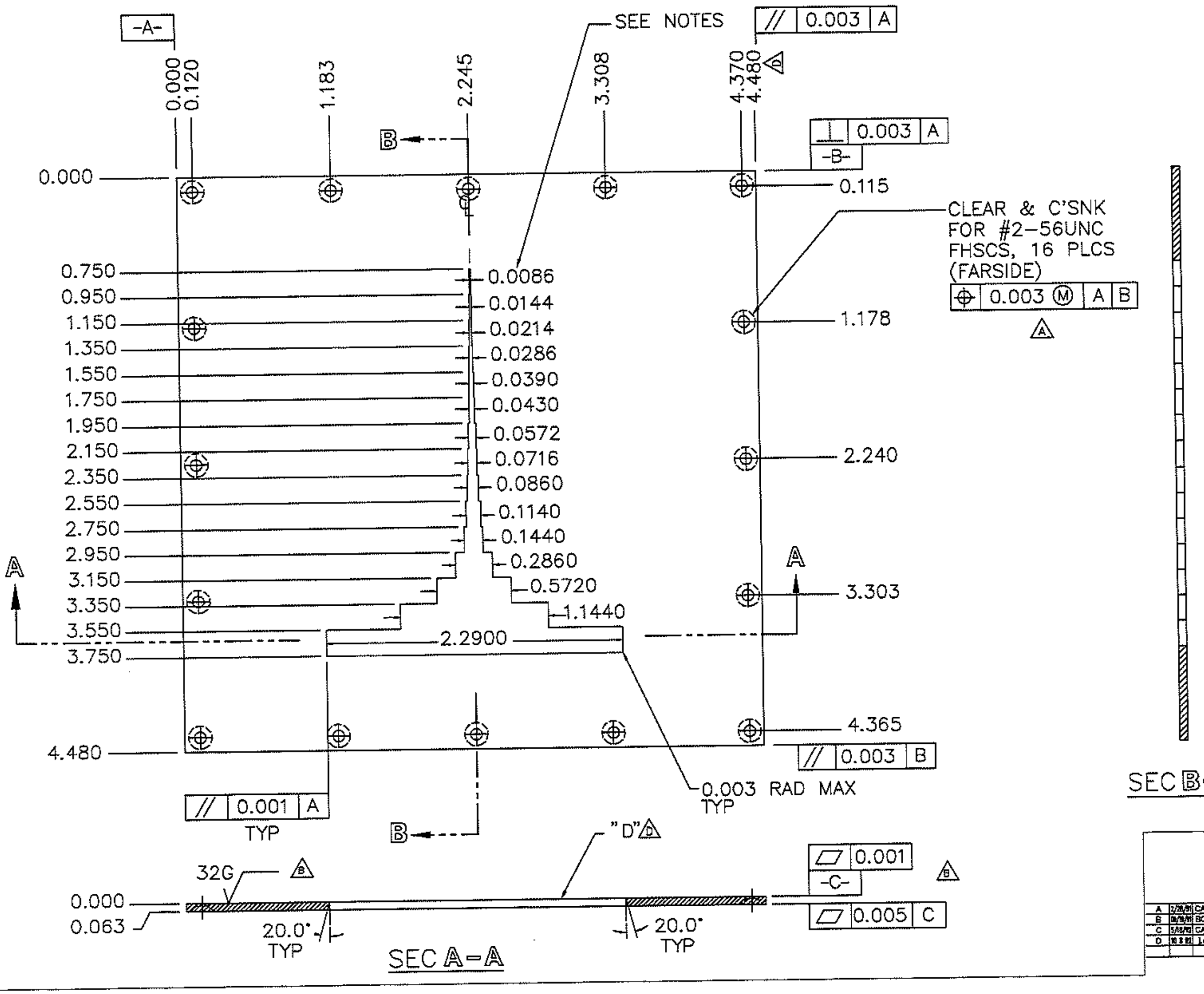
FIRST DECKER ONLY
REF. TO H1384-1
SUBSEQUENT PLATES WERE
DONE BY MOLDCRAFT

3/1

A	7/10/92	CAO		REVISED DIMS PER AS BUILT
B	8/25/92	CAO		ADD MATL HARDEN INFO
C	[illegible]	l.c.		ADD FABRICATION PROCEDURE.

KECK/HIRES
SLIT ACCESSORY SERVER
DECKER PLATE BLANK
BCB 06/13/92
CAO 7/10/92

H1388.C



⊖1 DECKER PLATE #A

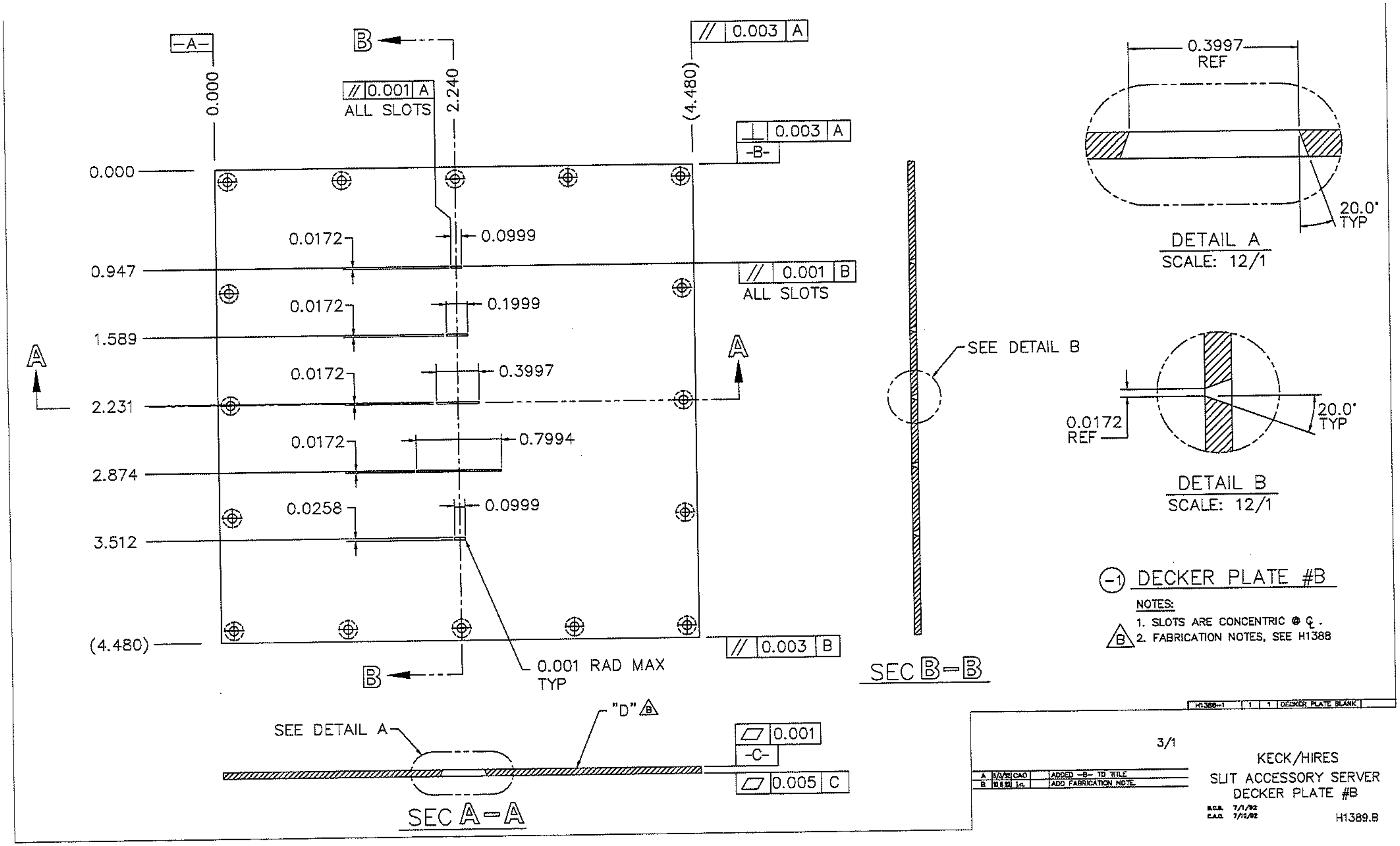
1 REQ'D
420 ST. STEEL, 0.063 THK.

NOTES:
1. SLOTS ARE CONCENTRIC @ ℄.
△D 2. FABRICATION NOTES, SEE H1388

3/1

A	2/28/91	CAO		ADDED 16 C'SNK HOLES
B	[illegible]	BCB		REV. TOLS, ADD SURF. FINISH
C	5/18/92	CAO		REVISED HOLE DIMENSIONS
D	10 8 92	J.c.		ADD FABRICATION NOTE.
				4.480 WAS 4.490.

KECK/HIRES
SLIT ACCESSORY SERVER
DECKER PLATE #A
BCB 02/08/91
CAO 02/07/91
H1384.D



(-1) DECKER PLATE #B

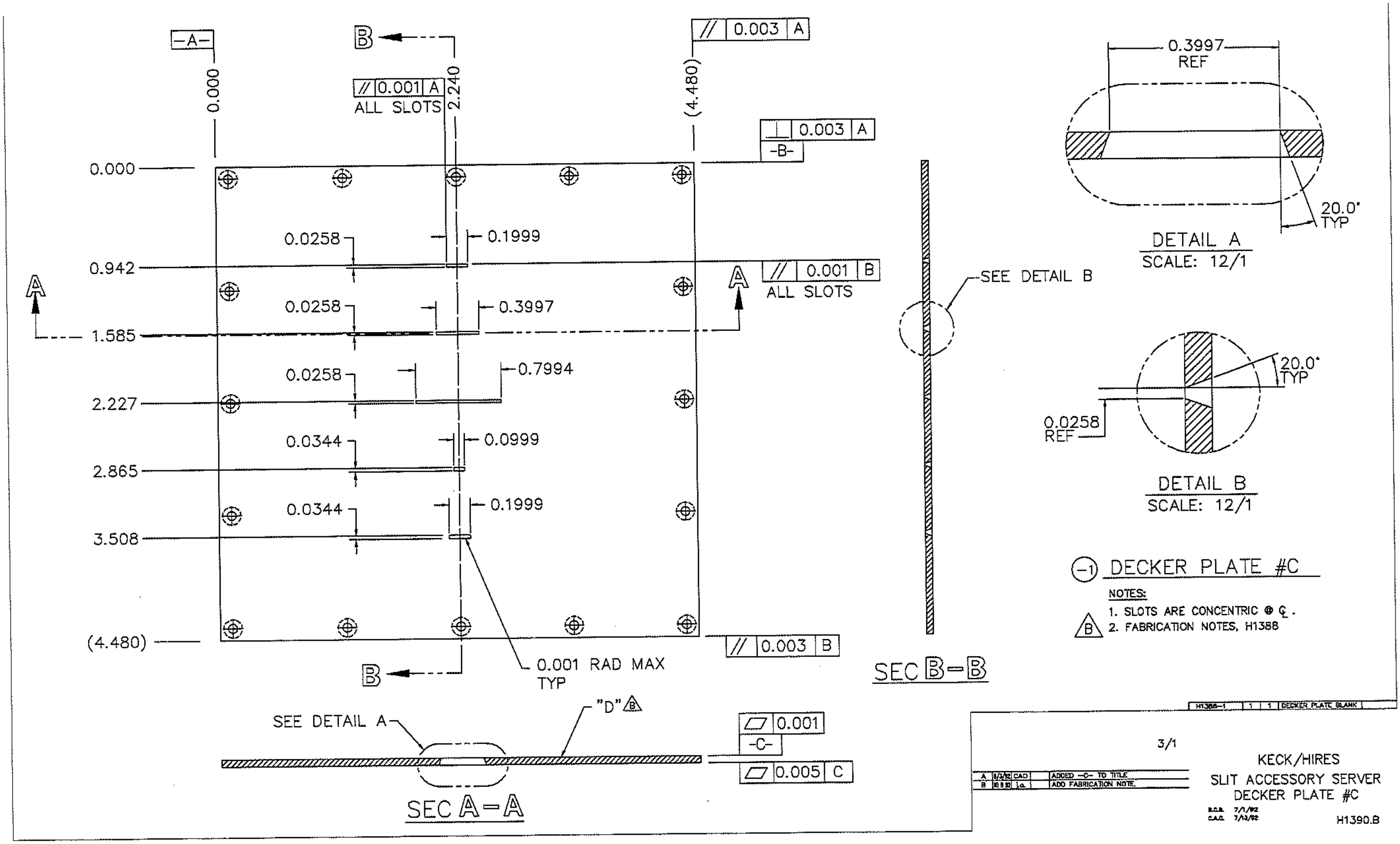
NOTES:
1. SLOTS ARE CONCENTRIC @ ℄.
△B 2. FABRICATION NOTES, SEE H1388

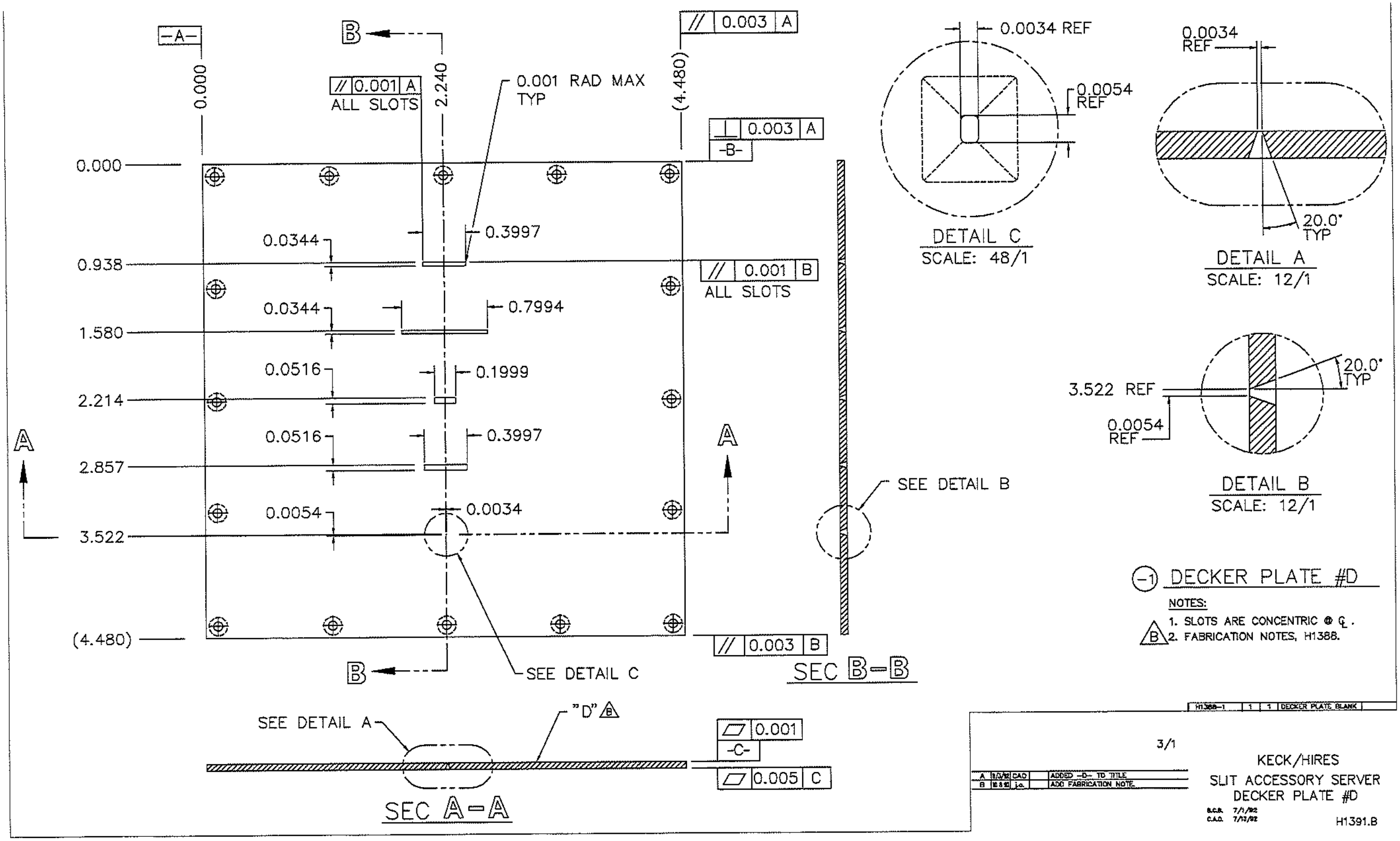
H1388-1	1	1	DECKER PLATE BLANK

3/1

A	8/3/92	CAO		ADDED -B- TO TITLE
B	10 8 92	j.a.		ADD FABRICATION NOTE

KECK/HIRES
SLIT ACCESSORY SERVER
DECKER PLATE #B
R.C.B. 7/1/92
C.A.O. 7/10/92
H1389.B


-A-
0.000
B
// 0.001 A
ALL SLOTS
2.240
(4.480)
// 0.003 A
⊥ 0.003 A
-B-
0.000
0.942
1.585
2.227
2.865
3.508
(4.480)
A
0.0258
0.1999
0.0258
0.3997
0.0258
0.7994
0.0344
0.0999
0.0344
0.1999
A
// 0.001 B
ALL SLOTS
// 0.003 B
B
0.001 RAD MAX
TYP
SEE DETAIL A
"D" B
▱ 0.001
-C-
▱ 0.005 C
SEC A-A
SEE DETAIL B
SEC B-B
0.3997
REF
20.0°
TYP
DETAIL A
SCALE: 12/1
20.0°
TYP
0.0258
REF
DETAIL B
SCALE: 12/1
-1 DECKER PLATE #C
NOTES:
1. SLOTS ARE CONCENTRIC @ ℄.
B 2. FABRICATION NOTES, H1388
H1388-1
1
1
DECKER PLATE BLANK
3/1
A 1/3/92 CAD ADDED -C- TO TITLE
B 10.8.92 j.a. ADD FABRICATION NOTE.
KECK/HIRES
SLIT ACCESSORY SERVER
DECKER PLATE #C
R.C.B. 7/1/92
C.A.C. 7/13/92
H1390.B



① DECKER PLATE #D

NOTES:
1. SLOTS ARE CONCENTRIC @ ℄.
B 2. FABRICATION NOTES, H1388.

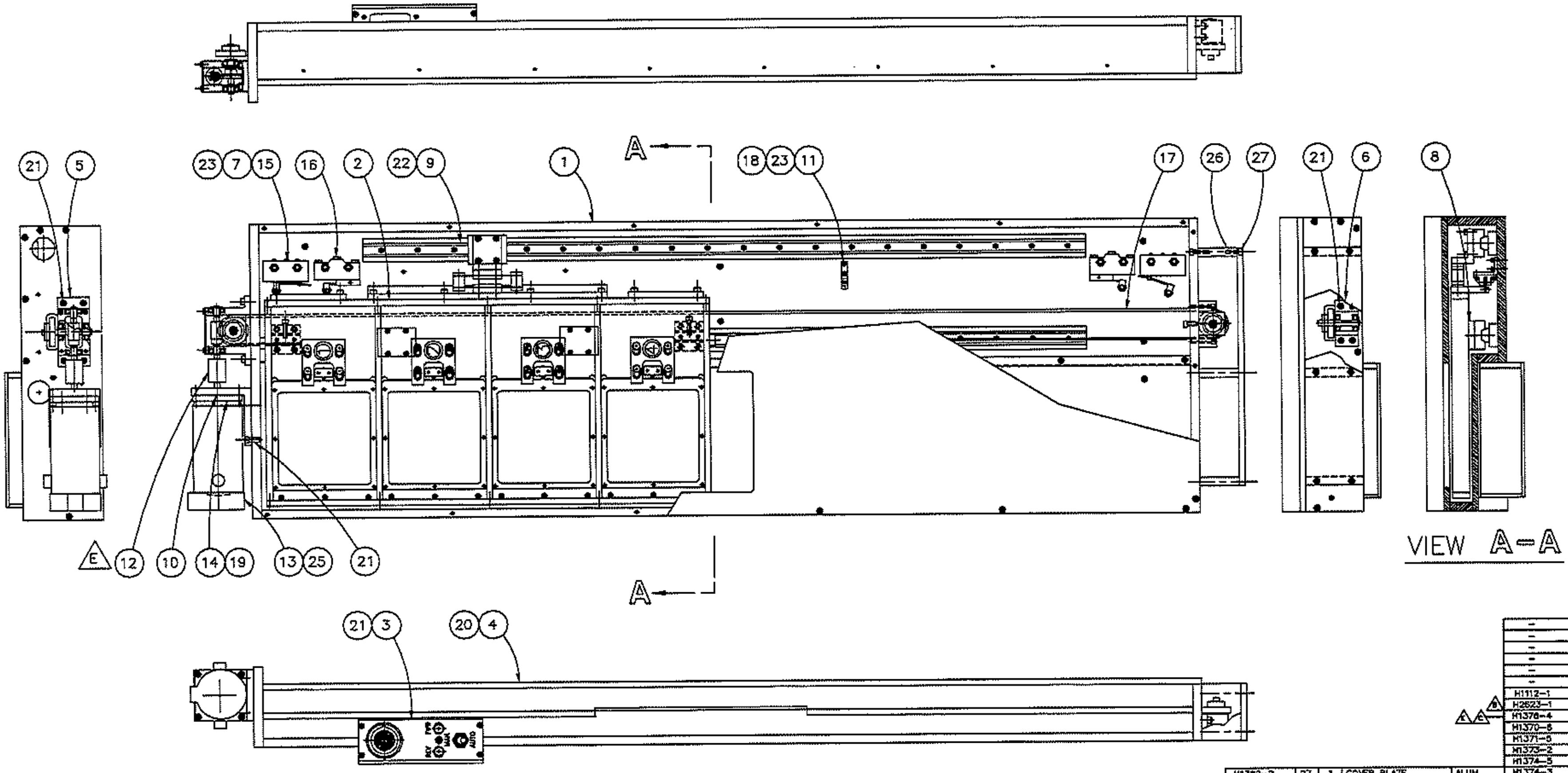
H1388-1 | 1 | 1 | DECKER PLATE BLANK

3/1

A 8/3/92 CAD ADDED -D- TO TITLE
B 10 8 92 j.c. ADD FABRICATION NOTE.

KECK/HIRES
SLIT ACCESSORY SERVER
DECKER PLATE #D
B.C.B. 7/1/92
C.A.D. 7/13/92

H1391.B



⊖1 SLIT ACCESSORY SERVER

1 REQ'D

F NOTES:

1. GALIL 50/1000
2. MICRO, DT-2RV22-A7
3. MICRO, BZ-2RW822-A2
4. HEWLETT PACKARD HED 6000 SERIES

–	20	A/R	SCR, 6-32 UNC LHSCS	
–	19	A/R	SCR, 6-32 UNC SHCS	
–	18	A/R	SCR, 4-40 UNC SHCS	
–	17	1	TIMING BELT BERG	20TB-20
–	16	2	LIMIT SWITCH, SOFT	NOTE 3.
–	15	2	LIMIT SWITCH, HARD	NOTE 2.
H1112-1	14	1	ADAPTOR	NEMA 23
B H2623-1	13	1	MOTOR	NOTE 1.
E C H1376-4	12	1	COUPLING	ST.STL
H1370-6	11	1	BRACKET, FIDUCIAL	ALUM
H1371-5	10	1	BRACKET, MOTOR	ALUM
H1373-2	9	2	SLIDE MODIFIED	
H1374-5	8	1	SLIDE SPACER	ALUM
H1374-3	7	4	SWITCH SPACER	ALUM
H1380-1	6	1	IDLER MOUNT ASSY	
H1379-1	5	1	GEAR BOX ASSY	
H1362-1	4	1	COVER	ALUM
H1316-1	3	1	ELECTRONIC BOX	
H1381-1	2	1	CARRIAGE ASSY	
H1377-1	1	1	HOUSING ASSY	

H1382-2	27	1	COVER PLATE	ALUM
H1382-1	26	3	SUPPORT	ALUM
B H2623-1	25	1	ENCODER	NOTE 4.
–	24	6	HEX NUT, 6-32 UNC	
–	23	1	FIDUCIAL TRW OPB-970-T55	
–	22	A/R	SCR, M3	
–	21	A/R	SCR, 6-32 UNC SHCS	

1/2

A	2/23/90	CAO		ADDED ITEM 26 & 27
B	9-14-90	l.o.		ADD MOTOR/ENCODER PART NUMBER
C	3/5/90	CAO		COUPLER, ITEM 12 WAS H1313-6
D	11/1/90	CAO		ADDED BUMPERS TO CARRIAGE ASSY
E	12/15/92	CAO		REPLACED COUPLING W/ CLUTCH
F	5 13 93	l.o.		MODIFIED COUPLING (KEYWAY ADDED)

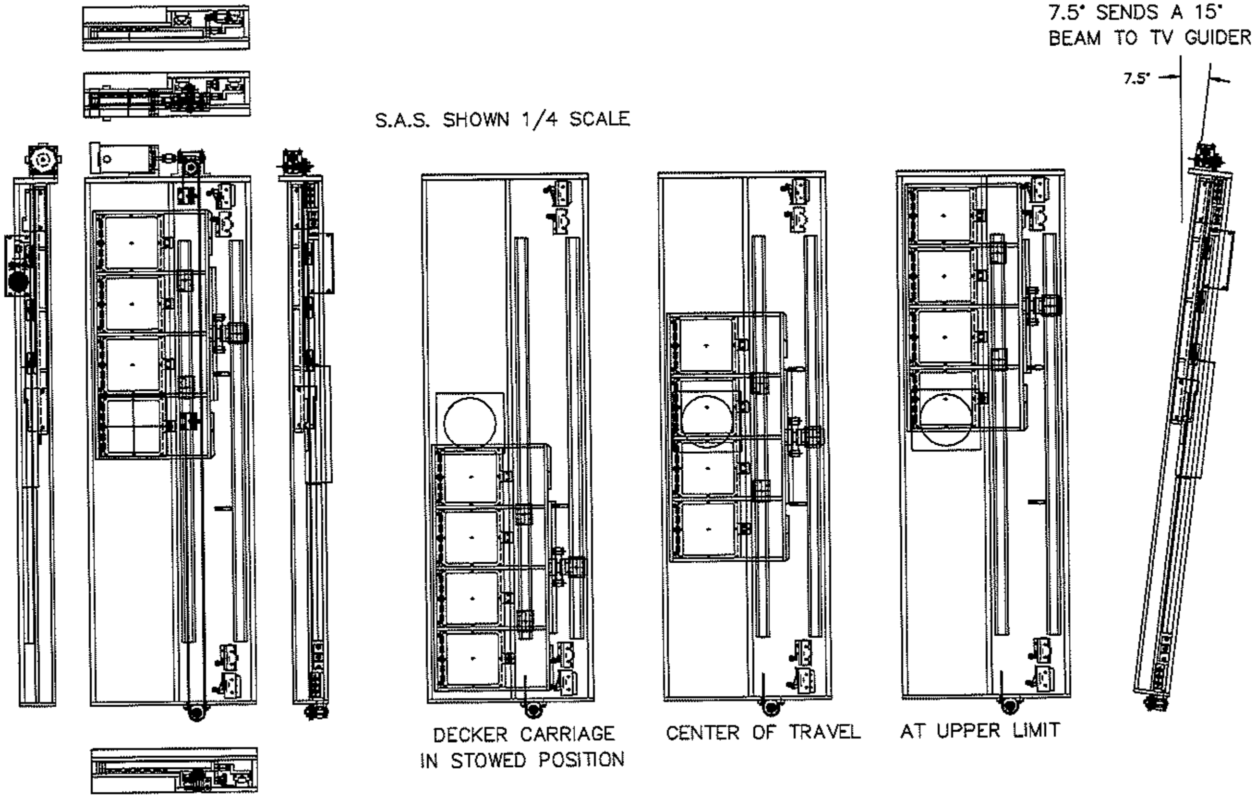
KECK/HIRES
SLIT ACCESSORY SERVER
ASSEMBLY

E.C.B. 08/01/88
C.A.D. 08/12/88

H1378.F

DECKER PLATES:
DECKER PLATE MATERIAL IS 420 STAINLESS STEEL.
PLATES ARE FINE GROUND, THEN EDM MACHINED,
AND OPTICALLY POLISHED TO A FEW WAVES.

420 STAINLESS:
CARPENTER TECHNOLOGY
2263 NATIONAL AVE "A"
HAYWARD, CA 94545-1715
800-522-5077



THEORETICAL POSITIONING RESOLUTION:

MOTOR ENCODER	4000CTS/REV
GEAR BOX REDUCTION	60:1
DRIVE GEAR PITCH RADIUS	0.6366

1 CT X 1 REV/4000 CT X 1 REV OUT/60 REV IN X 2 (.6366)/REV OUT = 0.000016666 INCH

OR 0.000016666 INCH/CT.
OR @ 60,000 CTS/INCH

IF SERVO LOOP IS GOOD TO 2 COUNTS,
RESOLUTION IS 0.00003333 INCHES.

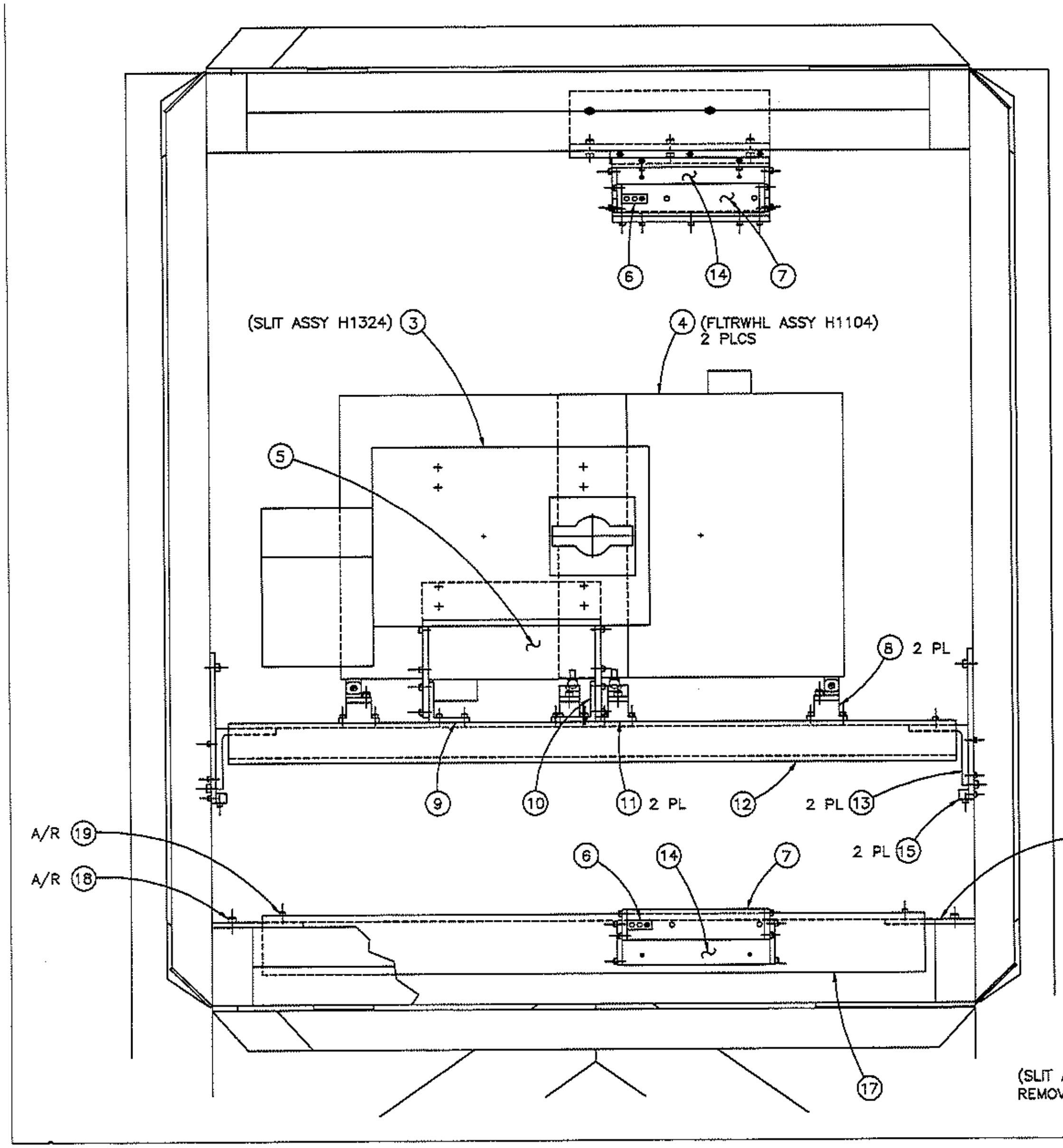
RESOLUTION AND REPEATABILITY HAVE BEEN TESTED MECHANICALLY TO 0.0005 INCHES.
BETTER TESTING WILL BE PERFORMED WITH THE GUIDER CCD TV.

PLATE SCALE AT SLIT ACCESSORY SERVER IS 1.375 ARC-SEC/mm.

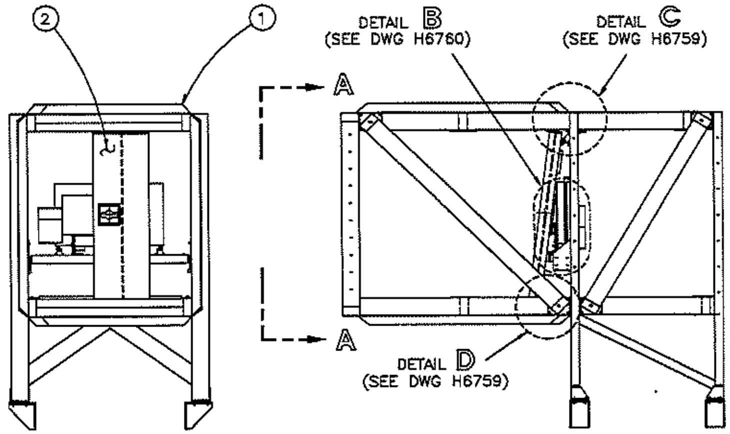
TRAVEL OF CARRIAGE IS 18"
APERTURE PLATES ARE 4.5" X 4.5" X 0.063" THICK
USABLE APERTURE AREA IS 4" X 4"

A | | | UPDATE TO AS-BUILT CONDITION.

KECK/HIRES
SLIT ACCESSORY SERVER
DATA AND GEAR REDUCTIONS
BCS 04/20/92
H1387.A



VIEW A–A
SCALE: NONE
(SLIT ACCESSORY ASSY H1378
REMOVED FOR CLARITY)



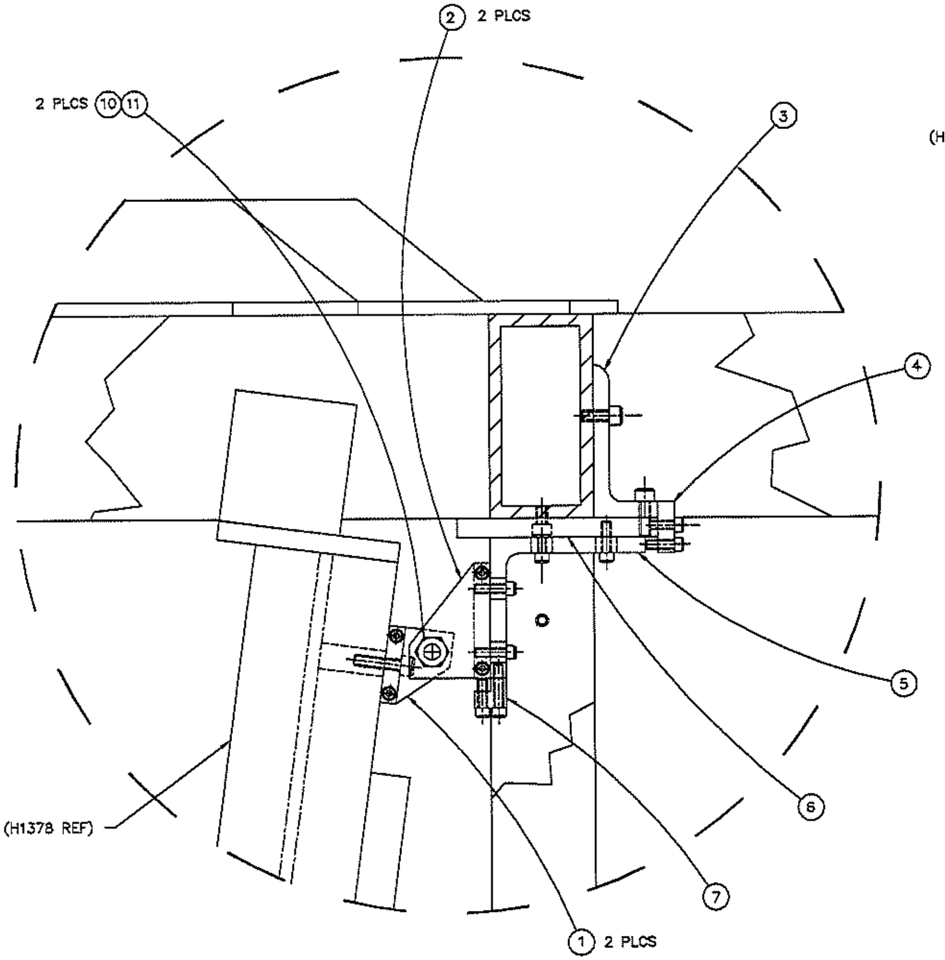
–	19	A/R	SCR, 6-32 UNC SHCS	
–	18	A/R	SCR, 1/4-28 UNF SHCS	
H6754-1	17	1	ANGLE MOUNT	ALUM
H6753-8	16	2	SUPPORT PLATE	ALUM
H6754-2	15	2	ADJUST BAR	ALUM
H6753-3	14	2	S.A.S. MOUNT	ALUM
H6754-4	13	2	ANGLE SUPPORT	ALUM
H6752-1	12	1	SUPPORT	ALUM
H6753-2	11	2	F.W. STAND	ALUM
H6756-1	10	1	ANGLE MOUNT (RIGHT)	ALUM
H6756-2	9	1	ANGLE MOUNT (LEFT)	ALUM
H6753-1	8	2	F.W. STAND	ALUM
H6753-4	7	2	FLANGE (SMALL)	ALUM
H6753-7	6	2	STANDOFF	ALUM
H6756-3	5	1	CROSS SUPPORT	ALUM
H1104	4	2	12 HOLE FLTR WHEEL	ASSY
H1324	3	1	SLIT	ASSY
H1378	2	1	SLIT ACCESSORY	ASSY
H6711	1	1	SLIT AREA STRUCTURE	ST

NOTED

KECK/HIRES
SLIT AREA STAGE MOUNTS
ASSEMBLY

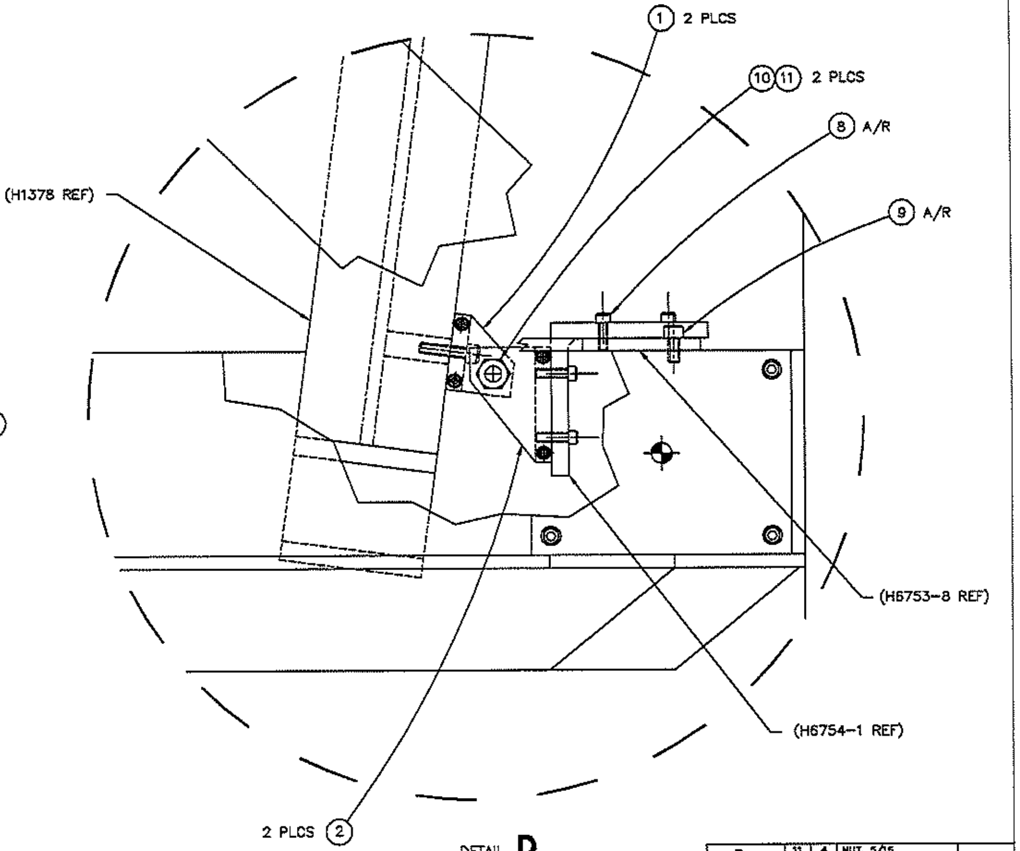
BCB 8/3/90
CS 9/5/90

H6758



DETAIL **C**

(REFERENCE DWG H6758)



DETAIL **D**

(REFERENCE DWG H6758)

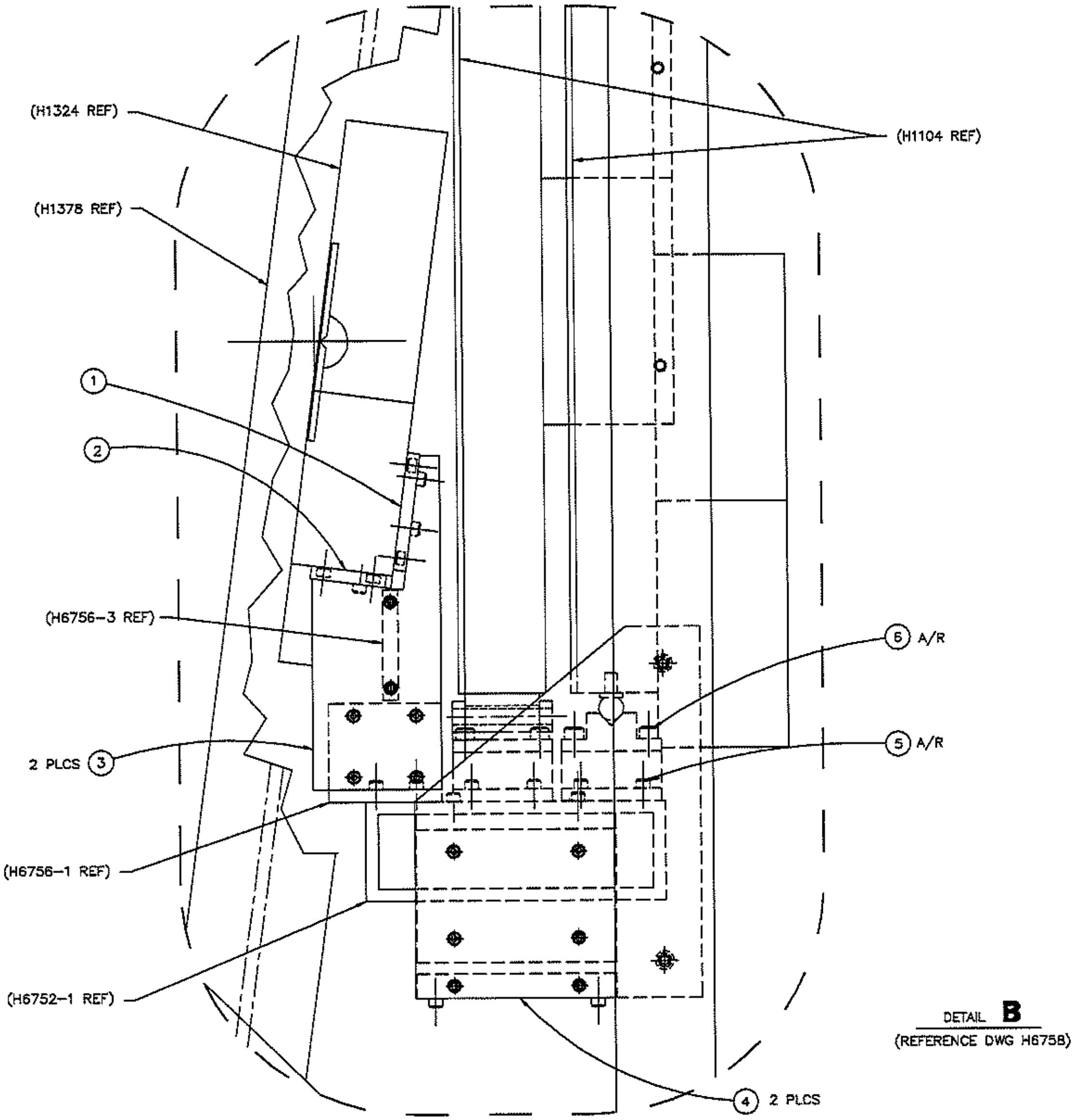
–	11	4	NUT, 5/16	
–	10	4	SCR, SHLDR 5/16 X 1/2	
–	9	A/R	SCR, 1/4–28 UNF SHCS	
–	8	A/R	SCR, 8–32 UNC SHCS	
H6755–2	7	1	ADJUST BAR (ANGLE)	ALUM
H6752–2	6	1	S.A.S. MOUNT	ALUM
H6755–3	5	1	ANGLE MOUNT (SHORT)	ALUM
H6755–1	4	1	ADJUST BAR	ALUM
H6756–4	3	1	ANGLE MOUNT	ALUM
H6753–5	2	4	ANGLE BRACKET (LG)	ALUM
H6753–5	1	4	ANGLE BRACKET (SM)	ALUM

FULL

KECK/HIRES
SLIT AREA STAGE MOUNTS
ASSEMBLY DETAILS

BCB 8/4/90
CS 9/5/90

H6759



DETAIL **B**
(REFERENCE DWG H6758)

--	6	A/R	SCR, 1/4-28 UNF SHCS	
--	5	A/R	SCR, 8-32 UNC SHCS	
H6754-3	4	2	SIDE SUPPORT	ALUM
H6756-4	3	2	SIDE SUPPORT	ALUM
H6756-5	2	1	MOUNT SUPPORT (SM)	ALUM
H6756-6	1	1	MOUNT SUPPORT (LG)	ALUM

FULL

KECK/HIRES
SLIT AREA STAGE MOUNTS
DETAILS

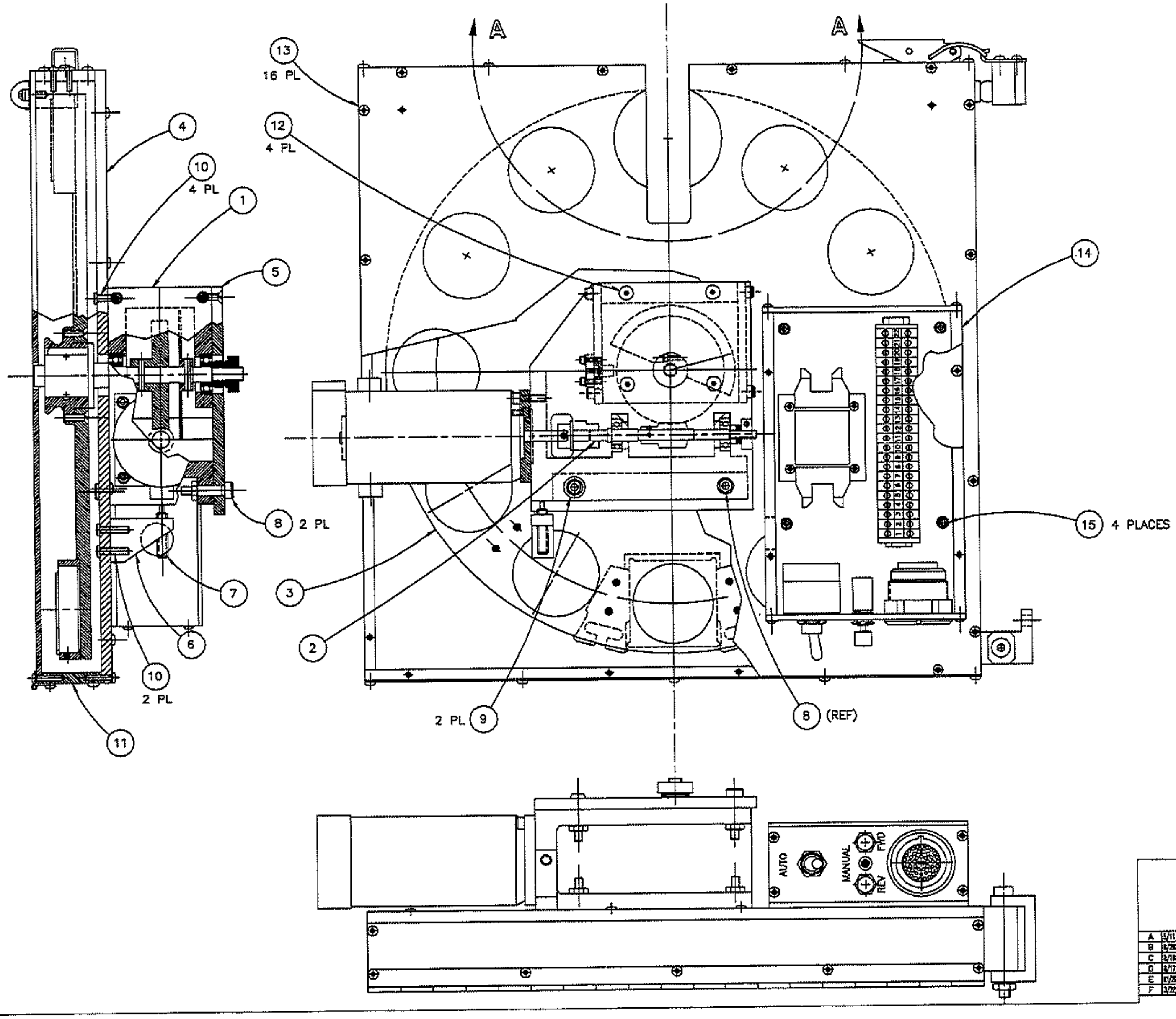
BCB 8/4/90
CS 9/8/90

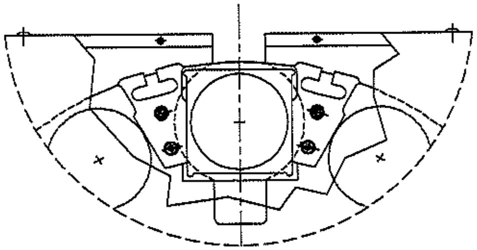
H6760

Appendix N List of Drawings — Filterwheels

1. H1104 12–Position Filterwheel Assembly
2. H1115 Filterwheel
3. H1114 Filterwheel Drive Schematic
4. H1110 Filterwheel Drive Motor Assembly
5. H6758 Slit Area Stage Mountings — Assembly
6. H6760 Slit Area Stage Mountings — Details

G	[illegible] J.o.		UPDATE, ADD PART NAME





VIEW A–A

(–1) 12 HOLE FILTERWHEEL △G

NOTES:

–	15	4	SCR, SHCS, 8–32UNC X .50LG	
H1138–1	14	1	JUNCTION BOX ASSY	
–	13	16	SCR, BHSCS, 5–40UNC X .62LG	
–	12	4	SCR, FHSCS, 8–32UNC X .50LG	
H1136–1	11	1	HOUSING	
–	10	6	SCR, LHSCS, 8–32UNC X .62LG	
–	9	2	SCR, LHSCS, 1/4–28UNF X 1.0LG	
–	8	2	SHOULDER SCREW 1/4 DIA X .62 LG.	
–	7	1	VLIER PLUNGER	
H1133–4	6	1	BRACKET	ALUM
H1133–2	5	1	TOP PLATE	ALUM
H1130–1	4	1	BACK PLATE	ALUM
H1115–1	3	1	WHEEL ASSY	
H1110–1	2	1	WORM DRIVE ASSY	
H1105–1	1	1	HUB & AXLE ASSY	

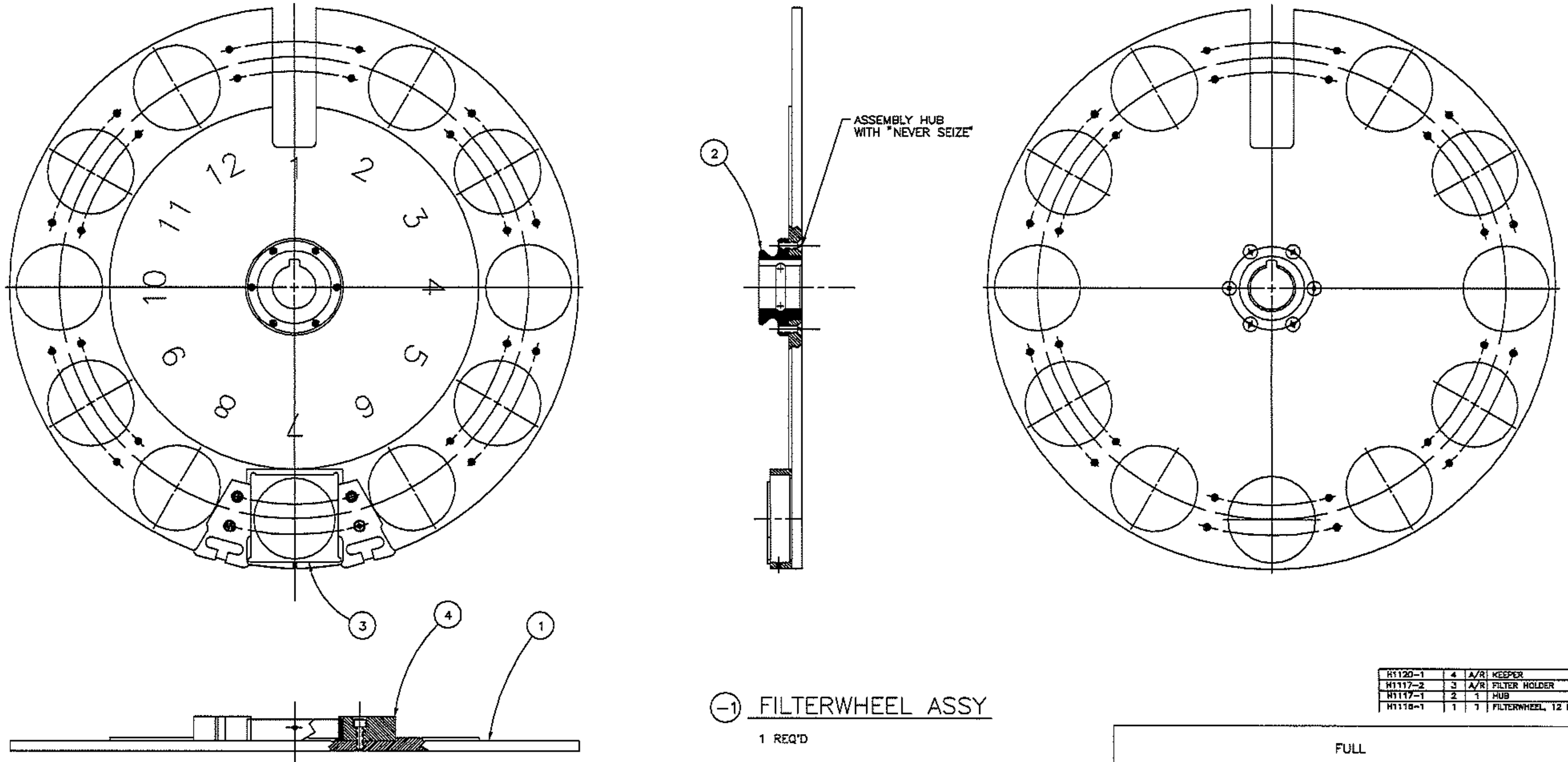
FULL

A	5/11/[illegible]	CAD	BCB	UPDATE
B	8/26/[illegible]	CLS	BCB	ADDED ITEMS 14 THRU 17
C	2/18/[illegible]	CAD		UPDATE
D	4/17/[illegible]	CLS	BCB	ADDED VIEW A–A
E	11/29/[illegible]	CAD		REVISED H1110
F	3/22/[illegible]	CLS		REV TO AS–BUILT

KECK/HIRES
FILTERWHEEL, 12 HOLE
FILTERWHEEL ASSY

B.C.B. 12/10/88
C.A.D. 01/31/89

H1104.G



(-1) FILTERWHEEL ASSY

1 REQ'D

H1120-1	4	A/R	KEEPER	ALUM
H1117-2	3	A/R	FILTER HOLDER	ALUM
H1117-1	2	1	HUB	ALUM
H1116-1	1	1	FILTERWHEEL, 12 HOLE	ALUM

FULL

B	[illegible]	CAO		DESIGN REVIEW UPDATE
C	3/21/[illegible]	CLS		REV TO AS-BUILT
D	11/7/90	CAO		ADDED ENGRAVED NUMBERS
E	[illegible]	j.o.		GENERAL REV & UPDATE

KECK/HIRES
FILTERWHEEL, 12 HOLE
FILTERWHEEL ASSY

S.C.S. 12 06 88
C.A.D. 01 30 89

H1115.E

THEORETICAL POSITIONING RESOLUTION:

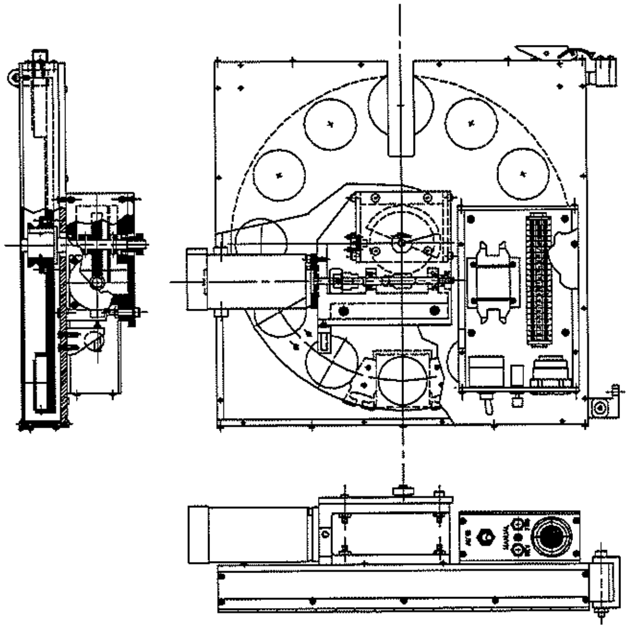
MOTOR ENCODER	4000 CTS./REV
GEAR REDUCTION	30:1
FILTER POSITIONS	12 (12/REV)

1 CT X 1 REV/4000 CTS X 1 REV OUT/30 REV IN X 360°/REV = 0.003°
OR 0.003°/CT
OR 333 CTS/DEGREE

ACTUAL RESOLUTION IS DOMINATED BY FREE PLAY BETWEEN THE HUB AND THE FILTERWHEEL.

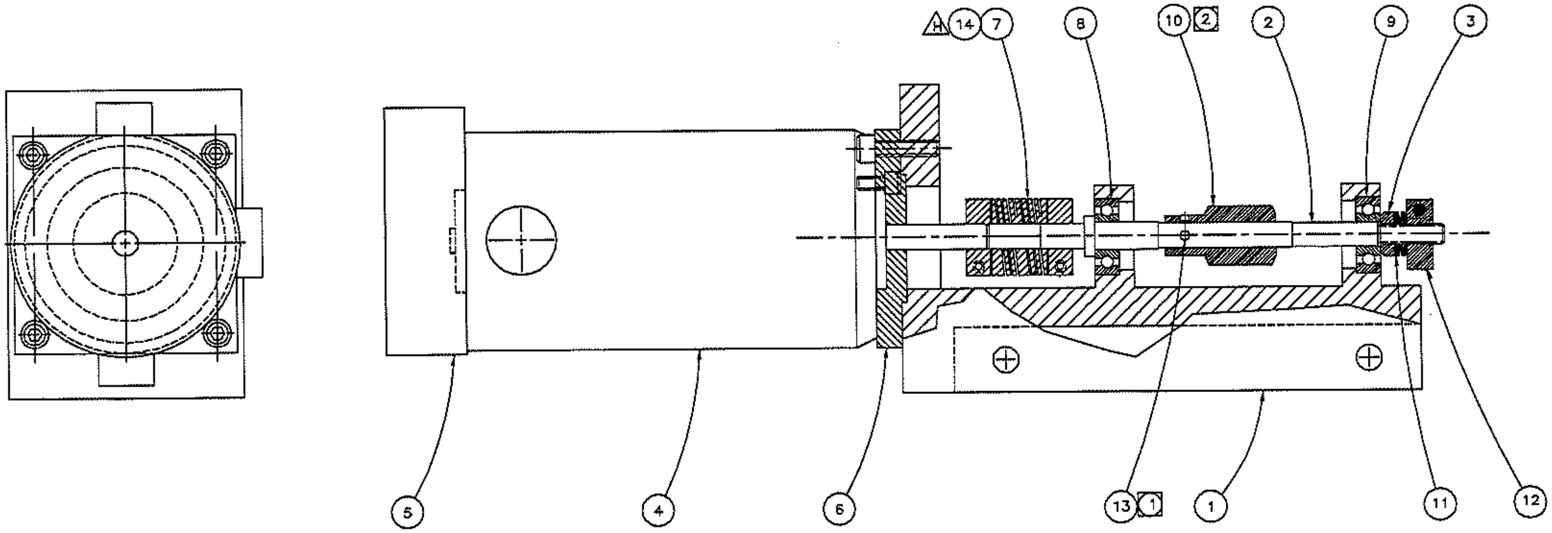
FILTER HOLDER IS H1117-2, AND WILL HOLD A 2" DIA. OR 2" SQUARE FILTER.
FILTER THICKNESS CAN BE AT LEAST 0.400" IN THIS HOLDER.
THICKER FILTERS WILL REQUIRE A CUSTOM HOLDER.

FILTERWHEEL ASSY. SHOWN 1/2 SCALE



A | 8 18 13 | J.O. | GENERAL REVISION.

KECK/HIRES
FILTERWHEEL, 12 HOLE
DATA AND GEAR REDUCTION
BCB 04/20/92
H1114.A



-1 WORM DRIVE ASSY

1 REQ'D

NOTES:

1 PIN GEAR IN PLACE AFTER ASSEMBLY AND ALIGNMENT.

2 LUBRICATE WITH NYEGEL.

1. GALIL #50/1000. SEE H2623-1
2. HEWLETT-PACKARD HEDS-6000 SERIES
3. BERG #C041S-1 WITH KEYWAY ADDED
4. SKF #607-2RS
5. SKF #626-2RS
6. BERG #W24S-4D
7. BELLEVILLE SPRING WASHER #B0437-016-S

H	–	14	2	1/16 KEY	SST
	–	13	1	SPRING PIN, .[illegible] X [illegible] L	SST
	H1112-2	12	1	COLLAR CLAMP	
H	–	11	4	SPRING WASHERS	NOTE 7.
	H1111-4	10	1	WORM, MODIFIED	NOTE 6.
	–	9	1	BALL BEARING	NOTE 5.
	–	8	1	BALL BEARING	NOTE 4.
H	–	7	1	COUPLING, MODIFIED	NOTE 3.
	H1112-1	6	1	MOUNTING PLATE	
H	–	5	1	ENCODER, 58mm DIA	NOTE 2.
H	–	4	1	MOTOR	NOTE 1.
	H1111-3	3	1	SPACER	SST
	H1111-2	2	1	SHAFT	SST
	H1111-1	1	1	WORM CARRIER	ALUM

2/1

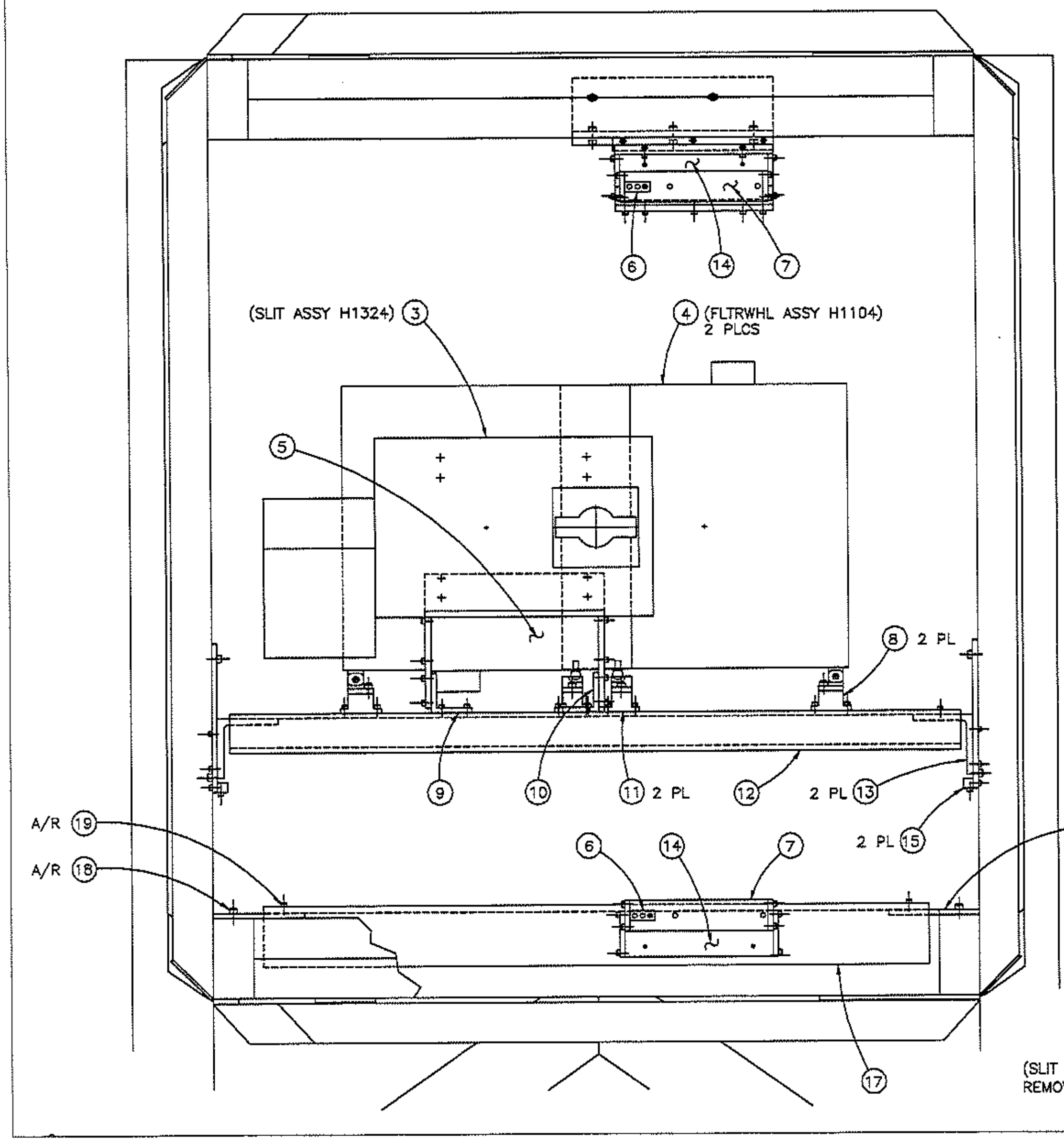
H	3.3.93	j.o.			MOVE NOTES, WERE IN PARTSLIST.
					ADD KEYWAY TO COUPLING, 1/16 KEYS

B	[illegible]	CAO		DESIGN REVIEW UPDATE
C	[illegible]	CAO		UPDATE
D	[illegible]	CAO		ADDED #1.250 C'BORE
E	[illegible]	CAO		UPDATE PER DESIGN REVIEW 5/90
F	[illegible]	CAO		ADDED NEW COUPLING
G	2/3/93	CAO		UPDATE PER AS BUILT

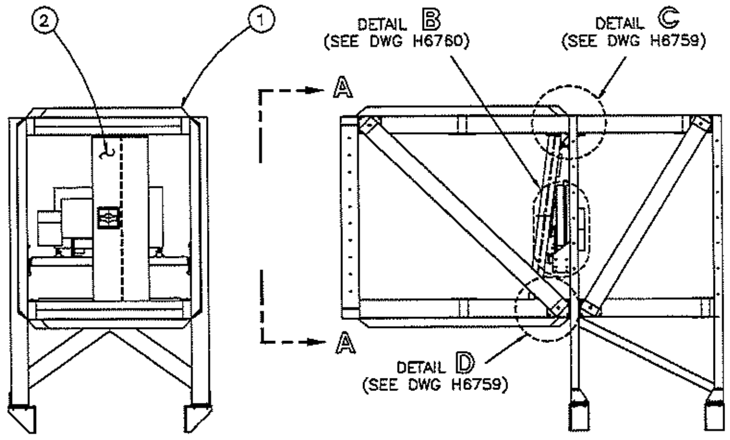
KECK/HIRES
FILTERWHEEL, 12 HOLE
WORM DRIVE ASSY

B.C.B. 12/06/89
C.A.D. 01/30/90

H1110.H



VIEW A–A
SCALE: NONE
(SLIT ACCESSORY ASSY H1378
REMOVED FOR CLARITY)

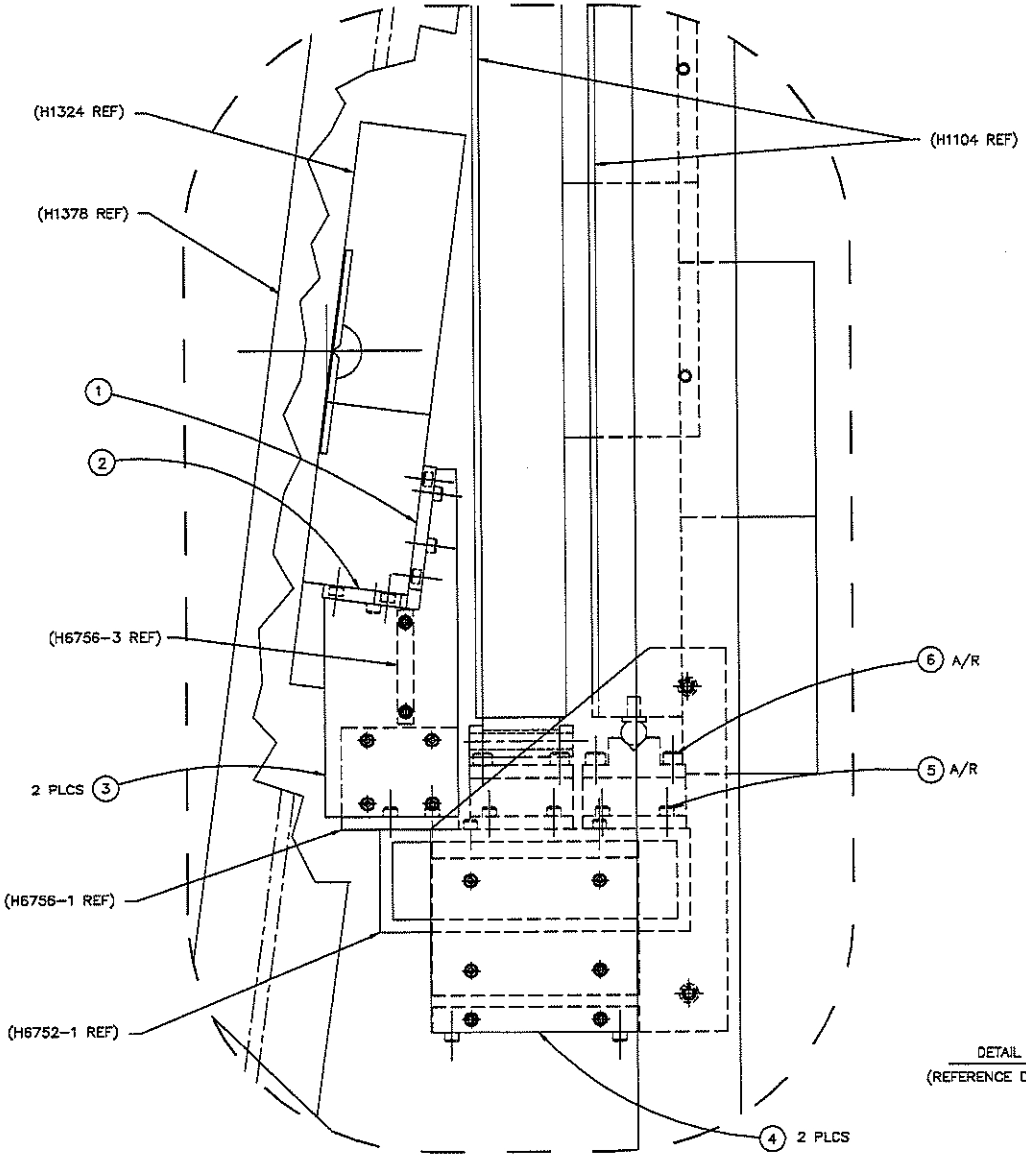


–	19	A/R	SCR, 6–32 UNC SHCS	
–	18	A/R	SCR, 1/4–28 UNF SHCS	
H6754–1	17	1	ANGLE MOUNT	ALUM
H6753–6	16	2	SUPPORT PLATE	ALUM
H6754–2	15	2	ADJUST BAR	ALUM
H6753–3	14	2	S.A.S. MOUNT	ALUM
H6754–4	13	2	ANGLE SUPPORT	ALUM
H6752–1	12	1	SUPPORT	ALUM
H6753–2	11	2	F.W. STAND	ALUM
H6756–1	10	1	ANGLE MOUNT (RIGHT)	ALUM
H6756–2	9	1	ANGLE MOUNT (LEFT)	ALUM
H6753–1	8	2	F.W. STAND	ALUM
H6753–4	7	2	FLANGE (SMALL)	ALUM
H6753–7	6	2	STANDOFF	ALUM
H6756–3	5	1	CROSS SUPPORT	ALUM
H1104	4	2	12 HOLE FLTR WHEEL	ASSY
H1324	3	1	SLIT	ASSY
H1378	2	1	SLIT ACCESSORY	ASSY
H6711	1	1	SLIT AREA STRUCTURE	ST

NOTED

KECK/HIRES
SLIT AREA STAGE MOUNTS
ASSEMBLY

BCB 8/3/90
CS 8/5/90
H6758



DETAIL **B**
(REFERENCE DWG H6758)

–	6	A/R	SCR, 1/4-28 UNF SHCS	
–	5	A/R	SCR, 8-32 UNC SHCS	
H6754-3	4	2	SIDE SUPPORT	ALUM
H6756-4	3	2	SIDE SUPPORT	ALUM
H6756-5	2	1	MOUNT SUPPORT (SM)	ALUM
H6756-6	1	1	MOUNT SUPPORT (LG)	ALUM

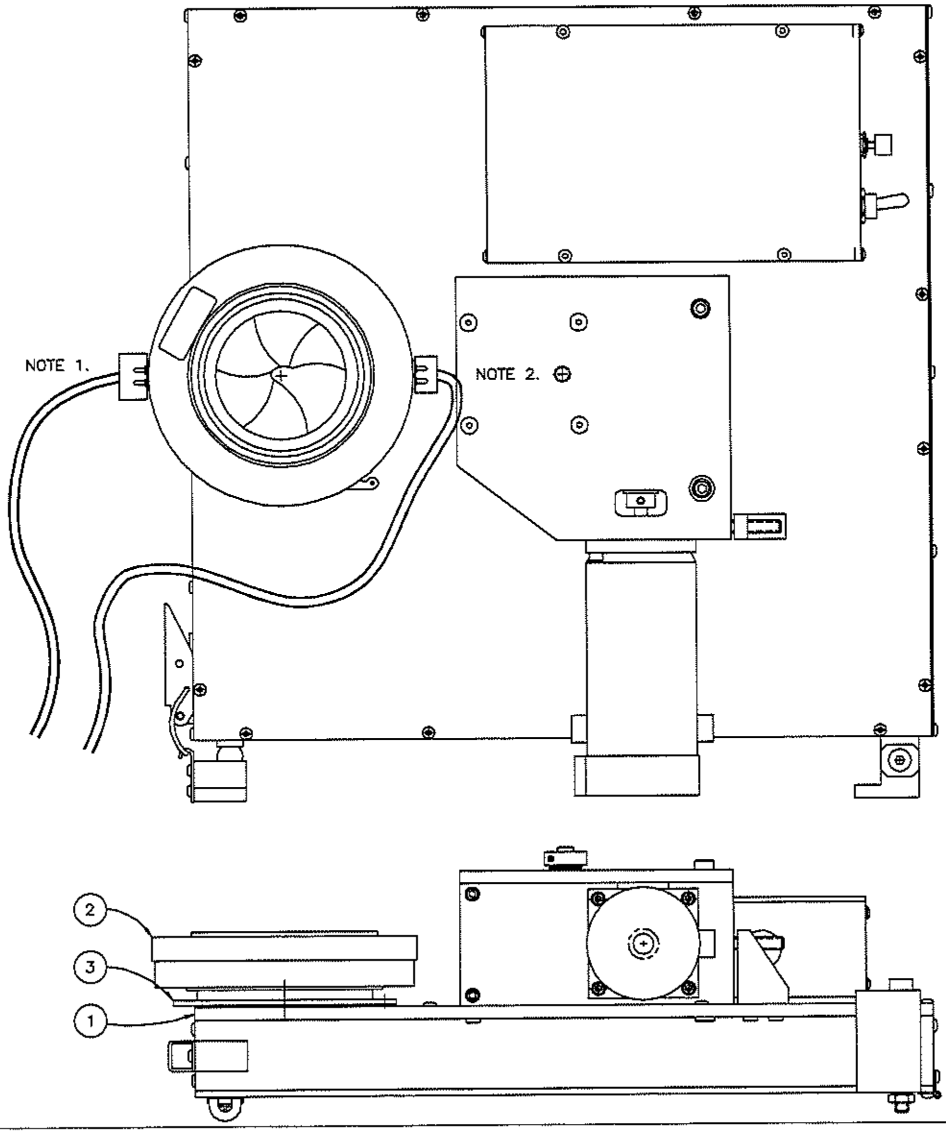
FULL

KECK/HIRES
SLIT AREA STAGE MOUNTS
DETAILS

BCB 8/4/90
CS 8/8/90

H6760

Appendix O List of Drawings — Shutter



㊀ SHUTTER

1 REQ'D

NOTES:

A 1. ACTUATE SOLENOID.
A 2. SENSE (REED SWITCH)

H1202-1	3	1	SHUTTER MOUNTING FLANGE	ALUM
H1201-1	2	1	ILEX ELECTRONIC SHUTTER	
H1113-1	1	1	FILTERWHEEL ASSY	

FULL

A | 5 13 93 | j.o. | ADD SENSE AND ACTUATE WIRING.

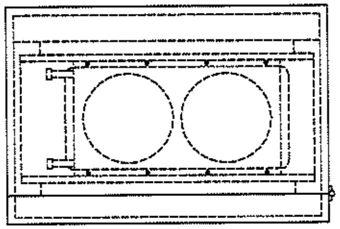
KECK/HIRES
FILTERWHEEL W/ SHUTTER
ASSEMBLY

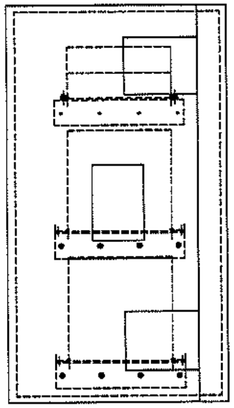
B.C.B. 12 10 80
D.A.O. 07 29 92

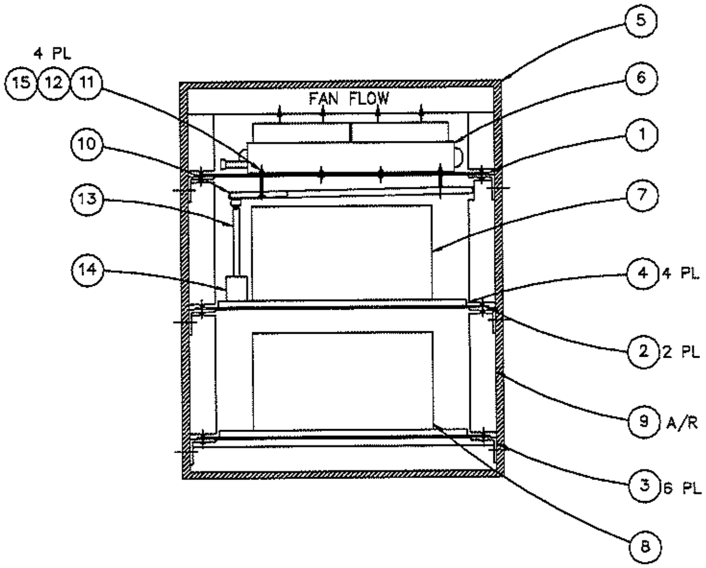
H1203.A

Appendix P List of Drawings — TV Autoguider

1. H1401 TV Cooling Assembly
2. H1406 TV Cooling Installation Details
3. P1003 HIRES GUIDER FORMAT
4. H8105 Lens Drive Assembly
5. H8119 Lens Drive Schematic
6. H8326 8–Position Filterwheel Assembly
7. H8325 Filterwheel
8. H1110 Filterwheel Drive Motor Assembly
9. H8001 TV Guider Assembly
10. H8002 TV Guider Mount Assembly







(-1) T.V. COOLING ASSEMBLY

1 REQ'D

NOTE:

1. LYTRON INC.
   DRAGON COURT
   WOBURN, MA 01801
   617-933-7300

2. WARD-BAGBY PLASTICS
   1310 PIPER DR.
   MILPITAS, CA
   409-262-2111

3. WIRING & PLUMBING HOLES
   LOCATED AS REQ'D.

–	15	4	NUT, #8-32	
–	14	1	CONTAINER	
–	13	A/R	TUBE, 1/2" RED	SILICON
–	12	4	O-RING	
–	11	4	FL. HD. SCR. #8-32	BRASS
H1406-1	10	1	CONDENSATION TRAP	ALUM
–	9	A/R	INSULATION	[illegible]
–	8	1	COOLANT RECIRC.	[illegible]
–	7	1	CAMERA ELECTRONICS	[illegible]
–	6	1	HEAT EXCHANGER	[illegible]
H1402-5	5	1	CONTAINER	
H1402-4	4	4	LIP	ALUM
H1402-3	3	6	BRACKET	EXTREN
H1402-2	2	2	SHELF	ALUM
H1402-1	1	1	SHELF	ALUM

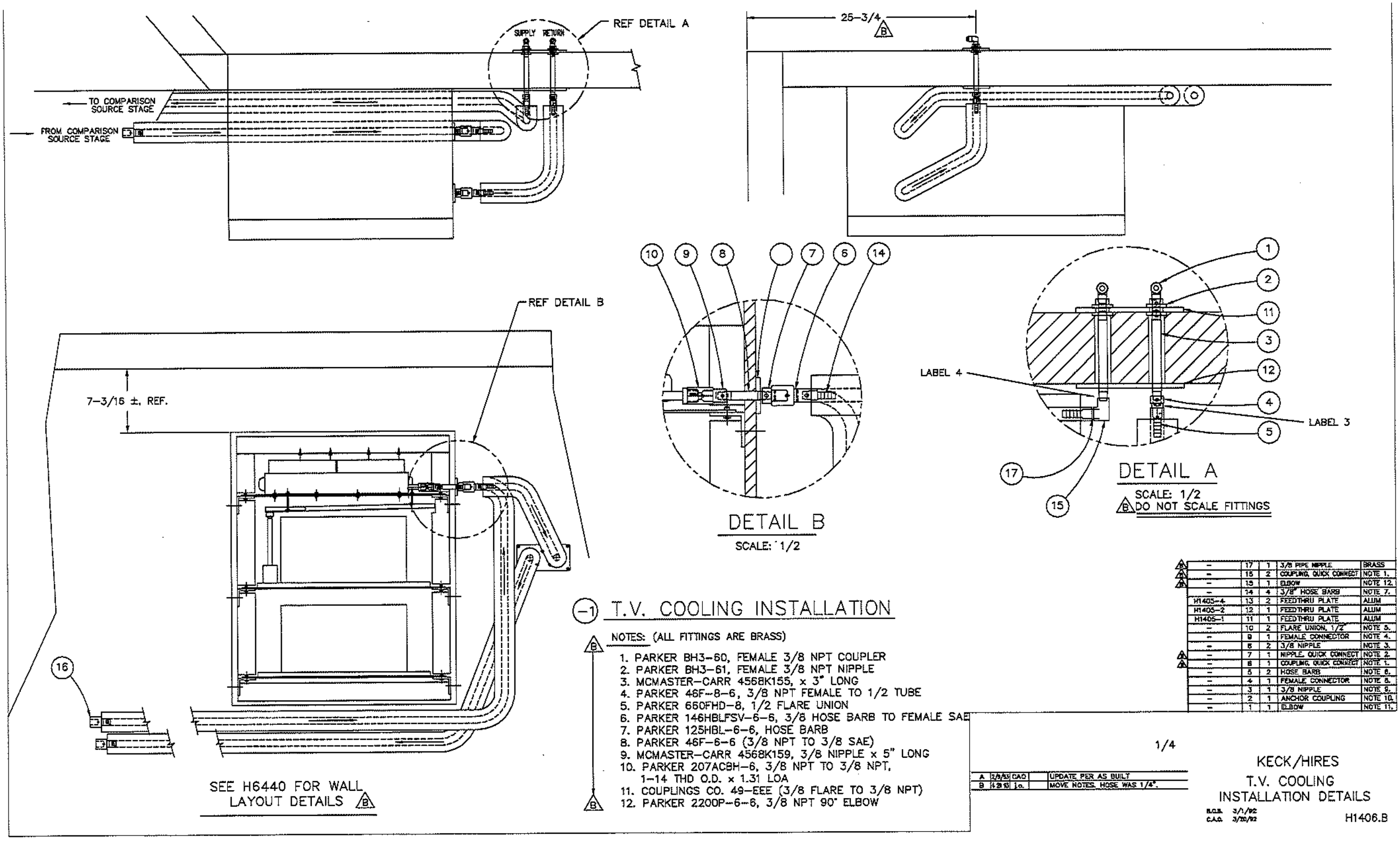
1/4

A	2/9/93	CAO		ADDED ITEMS 10–15

KECK/HIRES
T.V. COOLING
ASSEMBLY

B.C.B. 12/1/91
C.A.O. 12/10/91

H1401.A



-1 T.V. COOLING INSTALLATION

B NOTES: (ALL FITTINGS ARE BRASS)

1. PARKER BH3-60, FEMALE 3/8 NPT COUPLER
2. PARKER BH3-61, FEMALE 3/8 NPT NIPPLE
3. MCMASTER-CARR 4568K155, x 3" LONG
4. PARKER 46F-8-6, 3/8 NPT FEMALE TO 1/2 TUBE
5. PARKER 660FHD-8, 1/2 FLARE UNION
6. PARKER 146HBLFSV-6-6, 3/8 HOSE BARB TO FEMALE SAE
7. PARKER 125HBL-6-6, HOSE BARB
8. PARKER 46F-6-6 (3/8 NPT TO 3/8 SAE)
9. MCMASTER-CARR 4568K159, 3/8 NIPPLE x 5" LONG
10. PARKER 207ACBH-6, 3/8 NPT TO 3/8 NPT, 1-14 THD O.D. x 1.31 LOA
11. COUPLINGS CO. 49-EEE (3/8 FLARE TO 3/8 NPT)
12. PARKER 2200P-6-6, 3/8 NPT 90° ELBOW

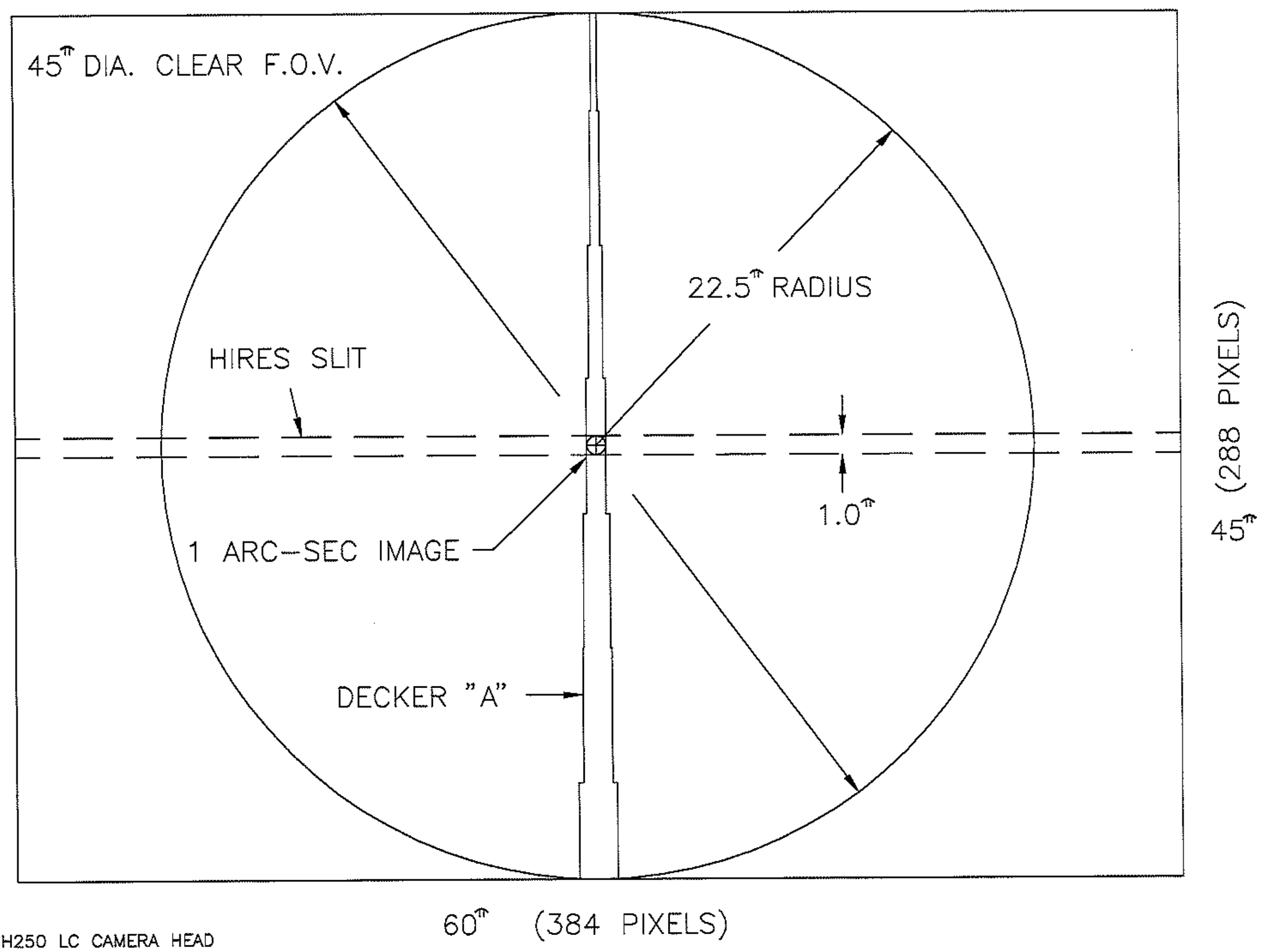
B

B	–	17	1	3/8 PIPE NIPPLE	BRASS
B	–	16	2	COUPLING, QUICK CONNECT	NOTE 1.
B	–	15	1	ELBOW	NOTE 12.
	–	14	4	3/8" HOSE BARB	NOTE 7.
	H1405-4	13	2	FEEDTHRU PLATE	ALUM
	H1405-2	12	1	FEEDTHRU PLATE	ALUM
	H1405-1	11	1	FEEDTHRU PLATE	ALUM
	–	10	2	FLARE UNION, 1/2"	NOTE 5.
	–	9	1	FEMALE CONNECTOR	NOTE 4.
	–	8	2	3/8 NIPPLE	NOTE 3.
B	–	7	1	NIPPLE, QUICK CONNECT	NOTE 2.
B	–	6	1	COUPLING, QUICK CONNECT	NOTE 1.
	–	5	2	HOSE BARB	NOTE 6.
	–	4	1	FEMALE CONNECTOR	NOTE 8.
	–	3	1	3/8 NIPPLE	NOTE 9.
	–	2	1	ANCHOR COUPLING	NOTE 10.
	–	1	1	ELBOW	NOTE 11.

1/4

A	2/9/93	CAO		UPDATE PER AS BUILT
B	1/28/10	J.O.		MOVE NOTES. HOSE WAS 1/4".

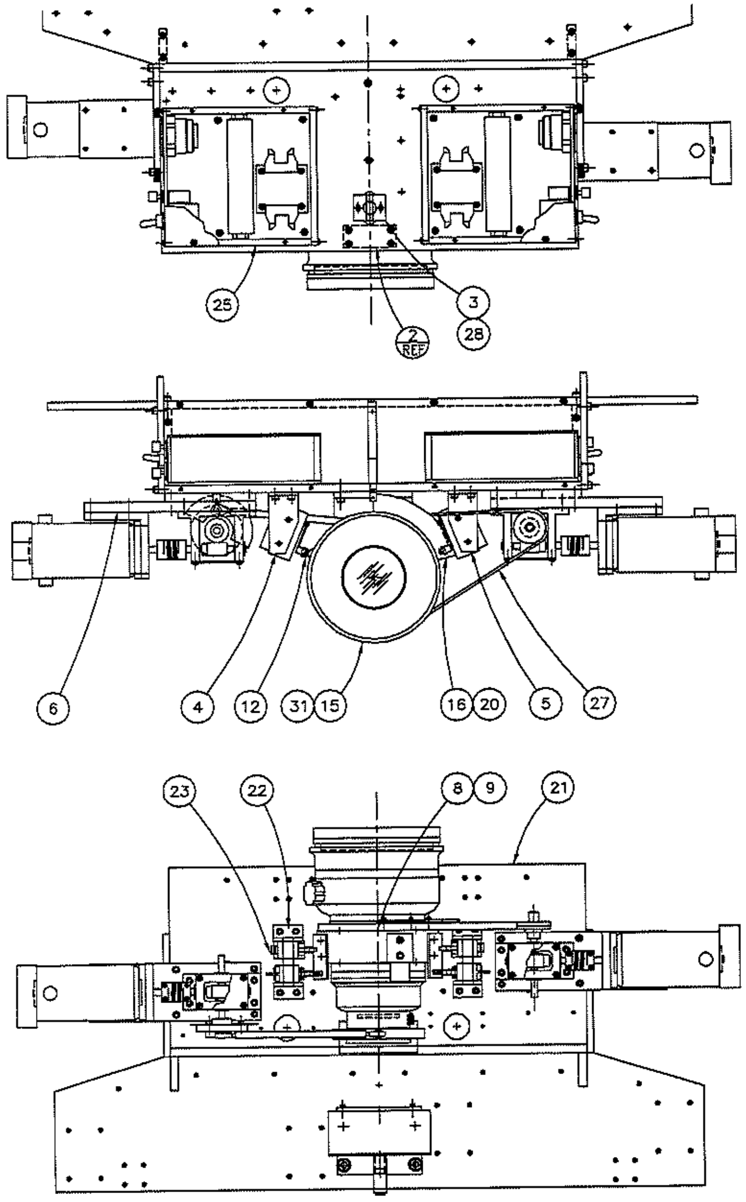
KECK/HIRES
T.V. COOLING
INSTALLATION DETAILS
R.C.B. 3/1/92
C.A.O. 3/20/92
H1406.B

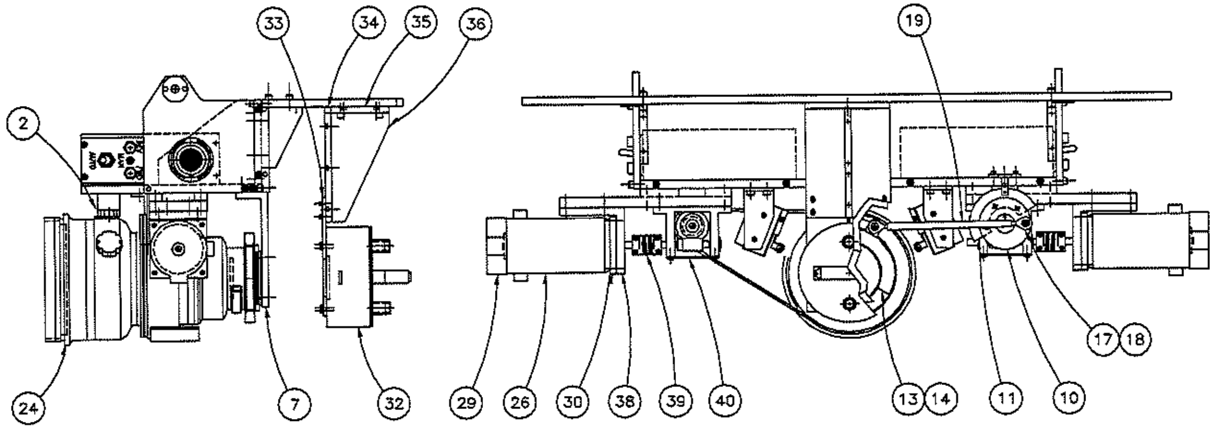


HIRES GUIDER FORMAT

PHOTOMETRICS CH250 LC CAMERA HEAD
THOMSON TH7883 CCD, 23μ PIXELS
1.379″/mm AT SLIT
6.78″+/- 0.26″/mm AT TV CCD
0.156″+/- 0.006″/PIXEL

/H/PSTUFF/P1003.DWG
4/16/92 BCB





-1 TV LENS DRIVE

1 REQ'D

H1379-1	40	2	GEAR BOX ASSY	
H1378-4	39	2	COUPLING, BERG MOD	
H1371-1	38	2	BRACKET, MOTOR	ALUM
H8111-3	37	1	TRIGGER	ALUM
H8118-2	36	1	WEB	ALUM
H8118-1	35	1	PLATE	ALUM
H8117-2	34	1	PLATE	ALUM
H8117-1	33	1	MTG. PLATE - LC CAMERA HEAD	ALUM
H8203-1	32	1	LC CAMERA HEAD	
-	31	1	TIMING BELT, BERG	
H1112-1	30	2	ADAPTER, NEMA 23	
H2623-1	29	2	ENCODER, 56mm DIA	
-	28	2	FIDUCIAL	
H8113-4	27	1	TIMING BELT PULLEY, MOD	
H2623-1	26	2	MOTOR, GALIL 50/1000	
H1316-1	25	2	JUNCTION BOX ASSY	
H8158-1	24	1	LENS, CANON 200mm	
-	23	2	LIMIT SWITCH	
-	22	2	LIMIT SWITCH	
H8116-1	21	1	MOUNTING PLATE ASSY	ALUM
H8115-6	20	3	SPACER	ALUM
H8115-5	19	1	LINK SHAFT	ALUM
H8115-4	18	1	NUT	SST
H8115-3	17	2	BALL END LINK	ALUM
H8115-2	16	1	FIDUCIAL DISC	ALUM
H8115-1	15	1	GEAR, MODIFIED BERG 20TM4-72	
H8114-2	14	1	APERTURE RING CLAMP	ALUM
H8114-1	13	1	APERTURE RING CLAMP	ALUM
H8113-3	12	1	RAMP, LIMIT SWITCH	ALUM
H8113-2	11	1	FIDUCIAL DISC	ALUM
H8113-1	10	1	APERTURE DRIVE	ALUM
H8112-2	9	1	FOCUS RING CLAMP	ALUM
H8112-1	8	1	FOCUS RING CLAMP	ALUM
H8111-2	7	1	LENS BRACKET	ALUM
H8111-1	6	2	MOTOR MNT, ADAPTER	ALUM
H8106-5	5	2	LIMIT SWITCH BRKT, RIGHT	ALUM
H8106-4	4	2	LIMIT SWITCH BRKT, LEFT	ALUM
H8106-3	3	1	FIDUCIAL BRKT, FOCUS	ALUM
H8106-2	2	1	LENS ADAPTOR MOUNT	ALUM
	1			

1/2

A	5/30/93	CAD		REVISED & REDRAWN
B	1 18 93	J.o.		GENERAL UPDATING.

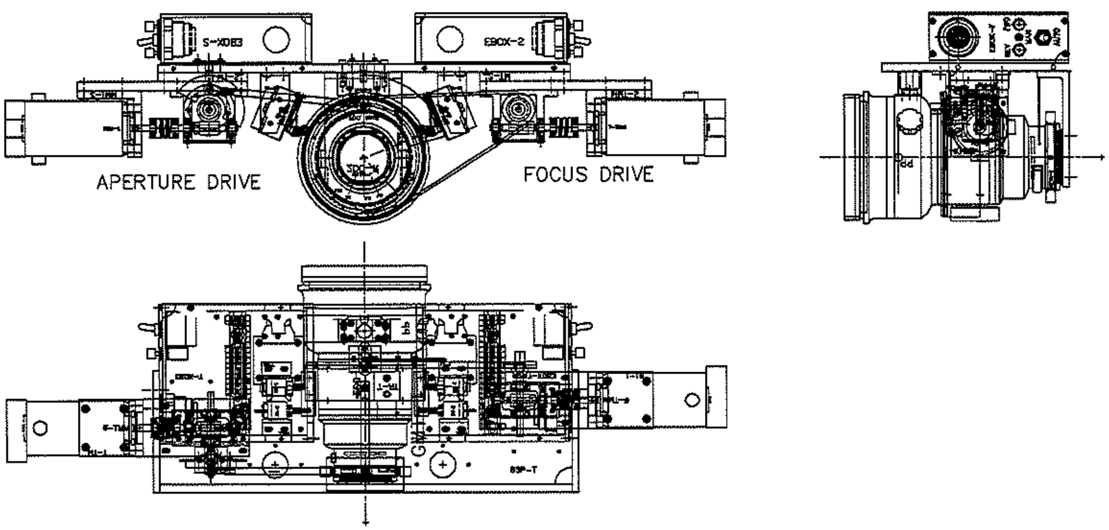
KECK/HIRES
LENS DRIVE
ASSEMBLY

B.C.B. 12/01/90
C.A.C. 1/16/91

H8105.B

POSITIONING OF LENS APERTURE AND FOCUS:

LENS DRIVES SHOWN 1/2 SCALE

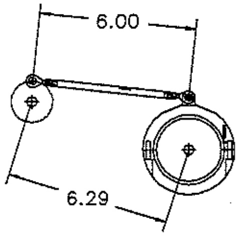


APERTURE DRIVE:

MOTOR ENCODER	4000 CTS/REV
GEAR BOX	60:1 REDUCTION
BELL CRANK RADIUS	0.800
LENS CRANK RADIUS	2.050
APERTURE RING TRAVEL	46°

CRANK ARM IS 6" LONG.

ONE REVOLUTION OF THE BELL CRANK RING WILL COVER THE FULL APERTURE RANGE FROM F/1.8 TO F/22. THE RATIO IS NOT LINEAR AND SETTINGS WILL COME FROM A LOOK-UP TABLE.
THE BELL CRANK DRIVE ALLOWS THE FULL RANGE OF APERTURE SETTINGS WITHOUT THE POSIBILITY OF OVER-RUNNING THE BUILT-IN TRAVEL LIMITS.



FOCUS DRIVE:

MOTOR ENCODER	4000 CTS/REV
GEAR BOX	60:1 REDUCTION
TIMING BELT REDUCTION	72 T : 20 T (4.5863 P.D. TO 1.2732 P.D.) = 3.602:1
FOCUS RING TRAVEL	136°

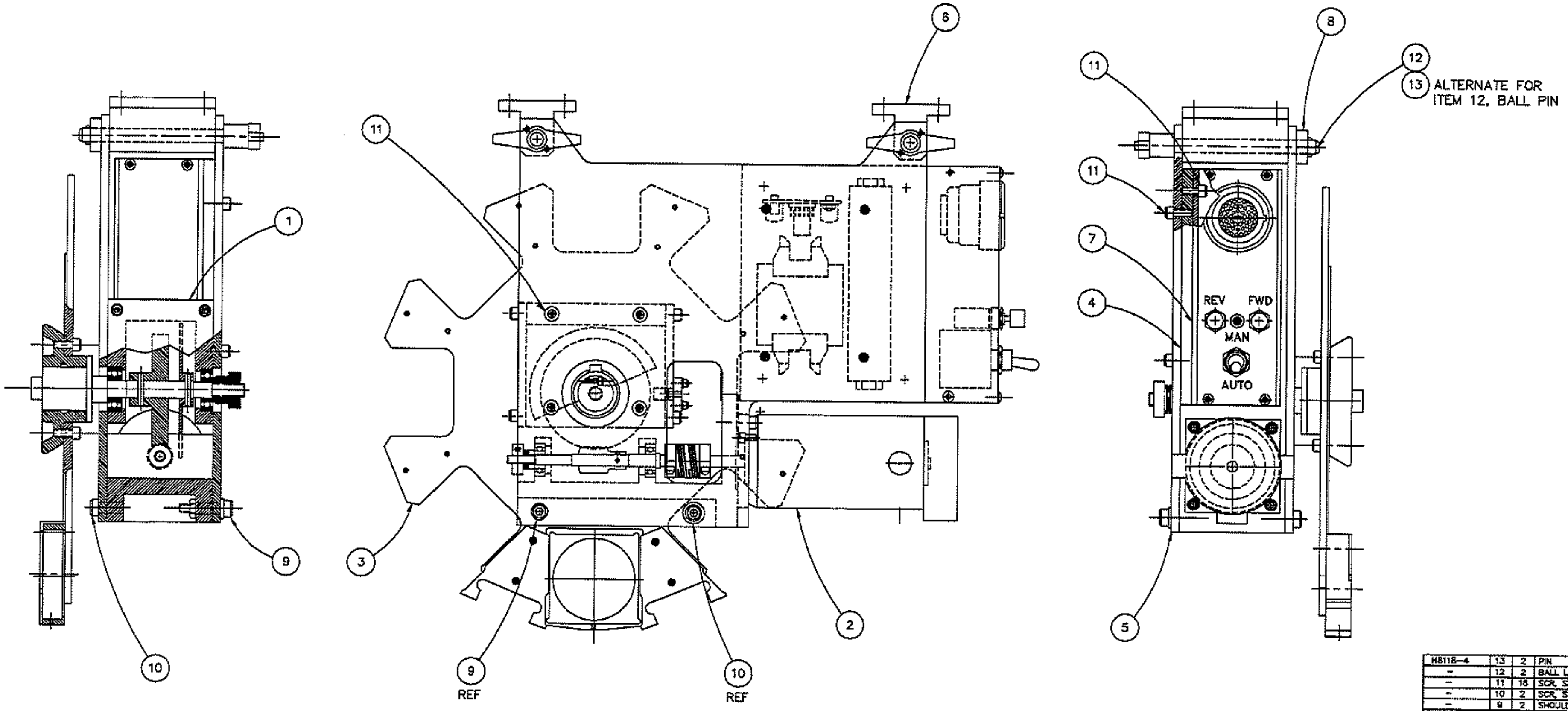
1 CT X 1 REV/4000 CTS X 1 REV OUT/60 REV IN X 1/3.6 X 360°/REV = 0.0004166°
OR 0.0004166°/CT.
OR 2400 CTS/DEG.

FOCUS RANGE IS XX TO INFINITY.
FOCUS TRAVEL IS LIMITED BY HARDWARE AND SOFTWARE LIMIT SWITCHES.

1/2

A 11 19 92 Lo. ADD BELL CRANK DIAGRAM

KECK/HIRES
LENS DRIVES
DATA AND GEAR REDUCTIONS
BCB 04/21/92
H8119.A



(-1) FILTER WHEEL ASSEMBLY

2 REQ'D

H8118-4	13	2	PIN	SST
-	12	2	BALL LOCK PIN, 0.312	[illegible]
-	11	16	SCR, SHCS, 8-32 UNC	
-	10	2	SCR, SHCS, 1/4-28 UNF	
-	9	2	SHOULDER SCREW 1/4 DIA X .62 LG	
H8324-2	6	2	SPACER	ALUM
H1316-1	7	1	JUNCTION BOX ASSY	
H8322-2	6	2	MOUNTING BLOCK	ALUM
H8321-2	5	1	MOUNTING PLATE	ALUM
H8321-2	4	2	MOUNTING PLATE	ALUM
H8325-1	3	1	FILTER WHEEL SUB-ASSY	
H1110-1	2	1	WORM DRIVE ASSY	
H1105-1	1	1	HUB & AXLE ASSY	

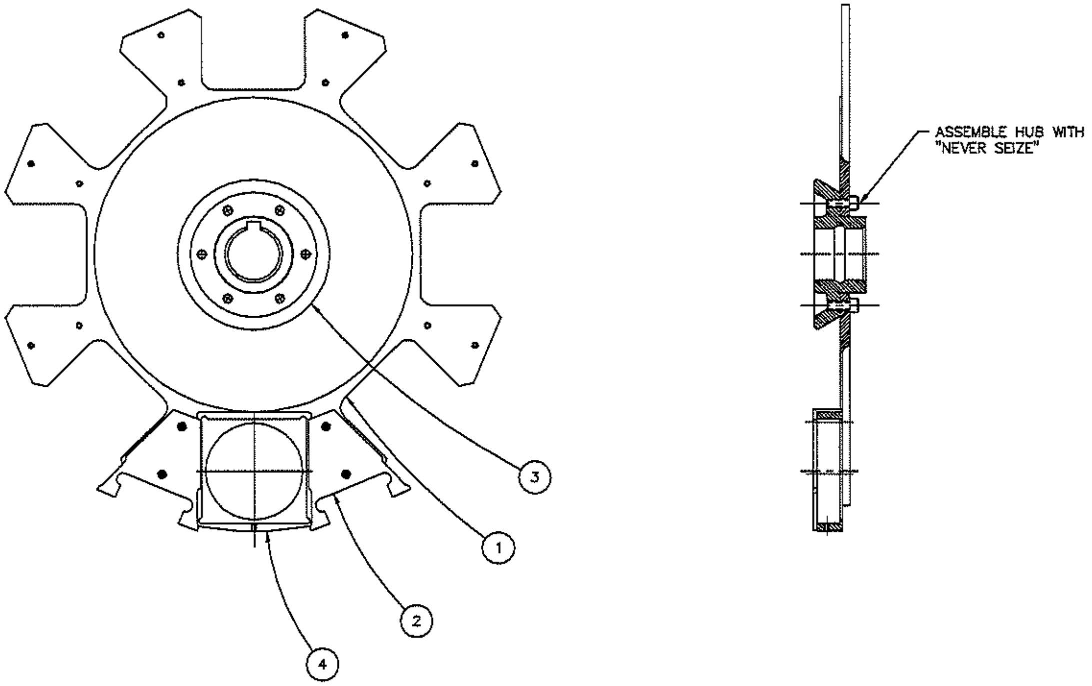
FULL

B	8/1/92	CAO		ADDED ITEM 12 AS ALTERNATE

KECK/HIRES
FILTERWHEEL, 8 HOLE
ASSEMBLY

E.C.B. 11/01/90
C.A.O. 12/03/90

H8326.B



(−1) FILTER WHEEL SUB–ASSEMBLY

2 REQ'D

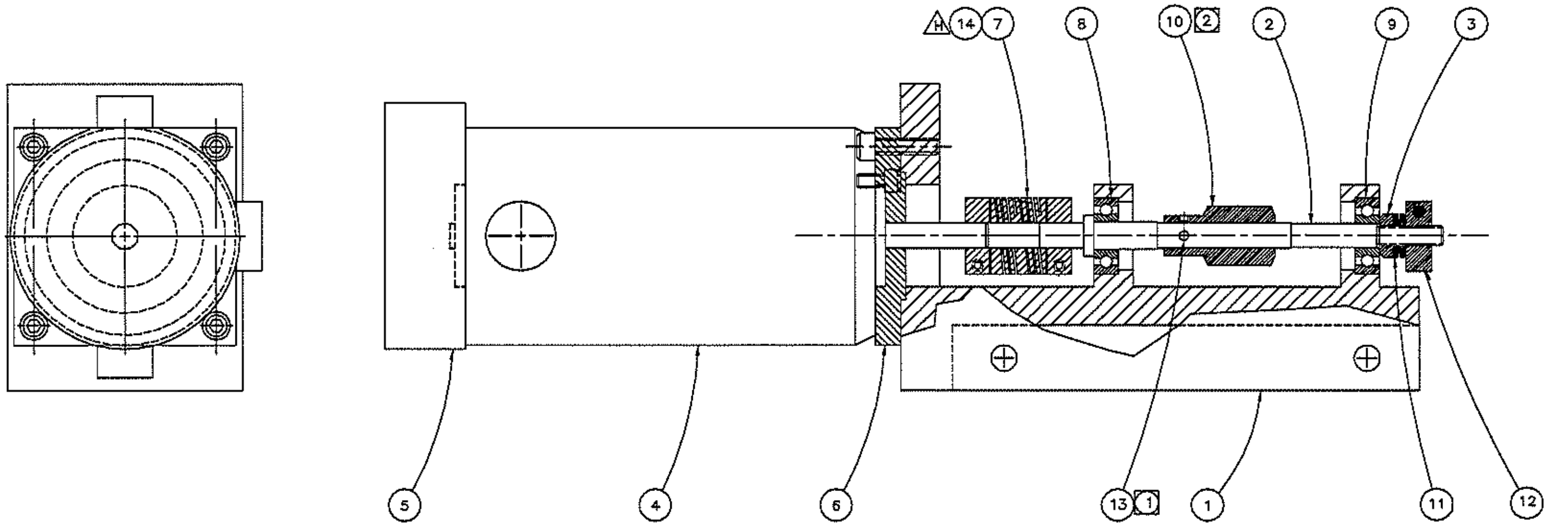
H1117–2	4	8	FILTER HOLDER	ALUM
H8324–1	3	1	HUB	ALUM
H8323–1	2	8	KEEPER	DELRIN
H8322–1	1	1	FILTER WHEEL	ALUM

FULL

KECK/HIRES
FILTERWHEEL, 8 HOLE
SUB–ASSEMBLY

B.C.B. 11/01/90
C.A.C. 12/02/90

H8325



⊖1 WORM DRIVE ASSY

1 REQ'D

NOTES:

$\boxed{1}$ PIN GEAR IN PLACE AFTER ASSEMBLY AND ALIGNMENT.

$\boxed{2}$ LUBRICATE WITH NYEGEL.

1. GALIL #50/1000. SEE H2623-1
2. HEWLETT-PACKARD HEDS-6000 SERIES
3. BERG #CO41S-1 WITH KEYWAY ADDED
4. SKF #607-2RS
5. SKF #626-2RS
6. BERG #W24S-4D
7. BELLEVILLE SPRING WASHER #B0437-016-S

–	14	2	1/16 KEY	SST
–	13	1	SPRING PIN, [illegible]	SST
H1112-2	12	1	COLLAR CLAMP	
–	11	4	SPRING WASHERS	NOTE 7.
H1111-4	10	1	WORM, MODIFIED	NOTE 6.
–	9	1	BALL BEARING	NOTE 5.
–	8	1	BALL BEARING	NOTE 4.
–	7	1	COUPLING, MODIFIED	NOTE 3.
H1112-1	6	1	MOUNTING PLATE	
–	5	1	ENCODER, 56mm DIA	NOTE 2.
–	4	1	MOTOR	NOTE 1.
H1111-3	3	1	SPACER	SST
H1111-2	2	1	SHAFT	SST
H1111-1	1	1	WORM CARRIER	ALUM

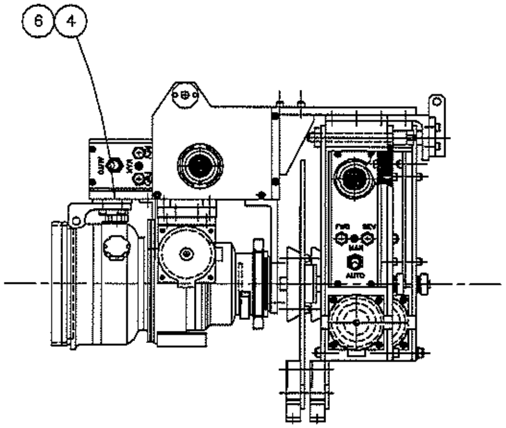
2/1

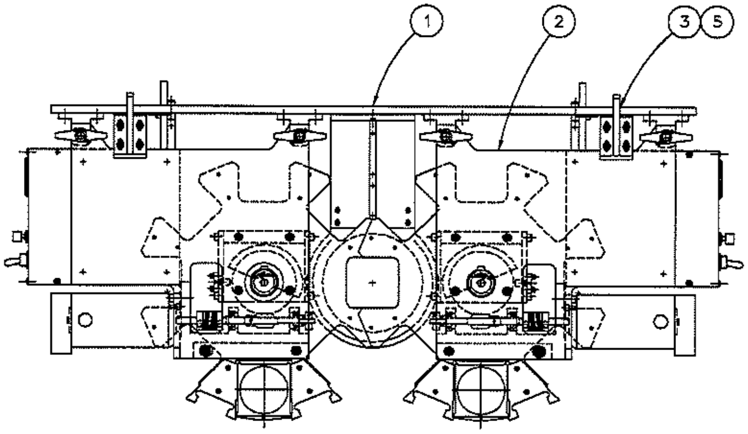
B	[illegible]	CAO		DESIGN REVIEW UPDATE
C	[illegible]	CAO		UPDATE
D	[illegible]	CAO		ADDED ⌀1.250 C'BORE
E	[illegible]	CAO		UPDATE PER DESIGN REVIEW 5/90
F	[illegible]	CAO		ADDED NEW COUPLING
G	2/3/93	CAO		UPDATE PER AS BUILT
H	3 3 95	J.o.		MOVE NOTES. WERE IN PARTSLIST.
				ADD KEYWAY TO COUPLING, 1/16 KEYS

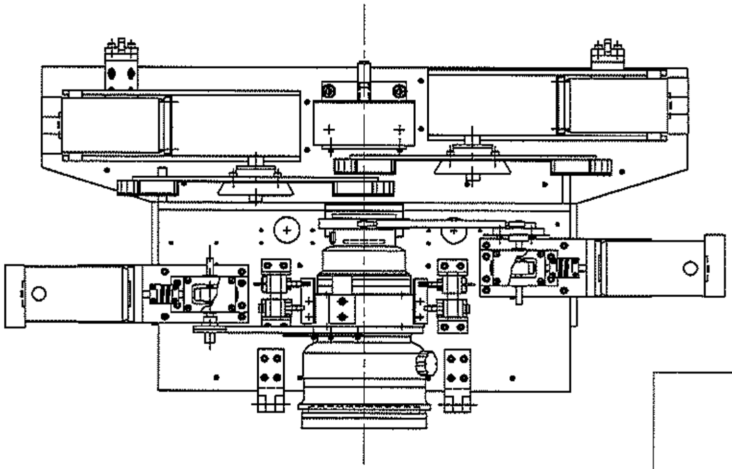
KECK/HIRES
FILTERWHEEL, 12 HOLE
WORM DRIVE ASSY

B.C.B. 12/08/88
C.A.O. 01/30/88

H1110.H







(-1) T.V. GUIDER ASSEMBLY

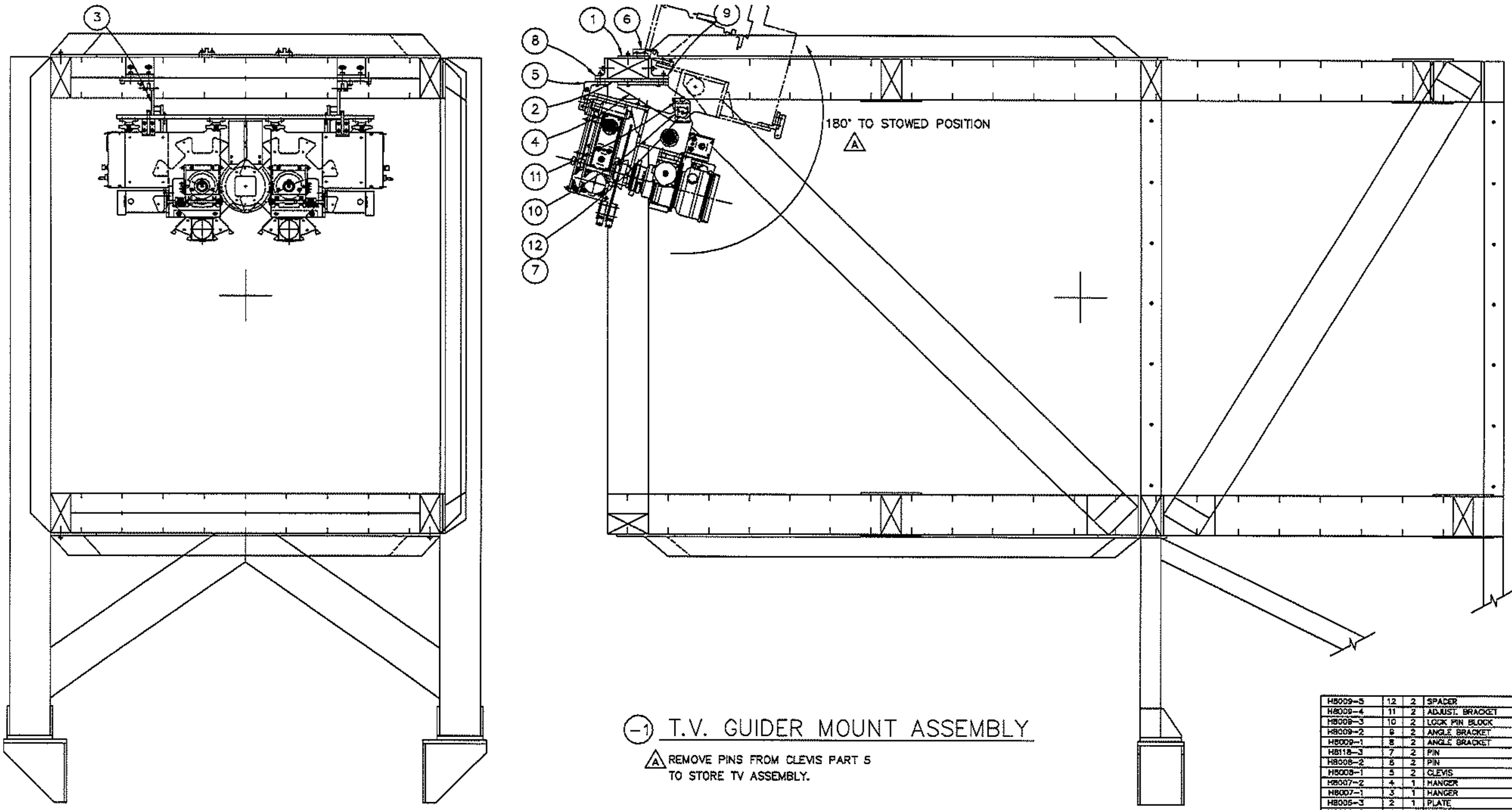
H8008-3	6	2	CLEVIS SPACER	ALUM
H8008-2	5	2	PIN	ALUM
H8006-1	4	2	CLEVIS	ALUM
H8006-1	3	2	ANGLE BRACKET	ALUM
H8326-1	2	2	8 HOLE FILTERWHEEL ASSY	
H8105-1	1	1	LENS DRIVE ASSEMBLY	

1/2

KECK/HIRES
T.V. GUIDER
ASSEMBLY

R.C.B. 5/1/92
C.A.C. 5/27/92

H8001



⊖1 T.V. GUIDER MOUNT ASSEMBLY

A REMOVE PINS FROM CLEVIS PART 5
TO STORE TV ASSEMBLY.

H8009-5	12	2	SPACER	ALUM
H8009-4	11	2	ADJUST. BRACKET	ALUM
H8009-3	10	2	LOCK PIN BLOCK	ALUM
H8009-2	9	2	ANGLE BRACKET	ALUM
H8009-1	8	2	ANGLE BRACKET	ALUM
H8118-3	7	2	PIN	SST
H8008-2	6	2	PIN	ALUM
H8008-1	5	2	CLEVIS	ALUM
H8007-2	4	1	HANGER	ALUM
H8007-1	3	1	HANGER	ALUM
H8006-3	2	1	PLATE	ALUM
H8006-2	1	1	PLATE	ALUM

1/4

A 3 8 93 L.O. ADD STOWED OUTLINE.

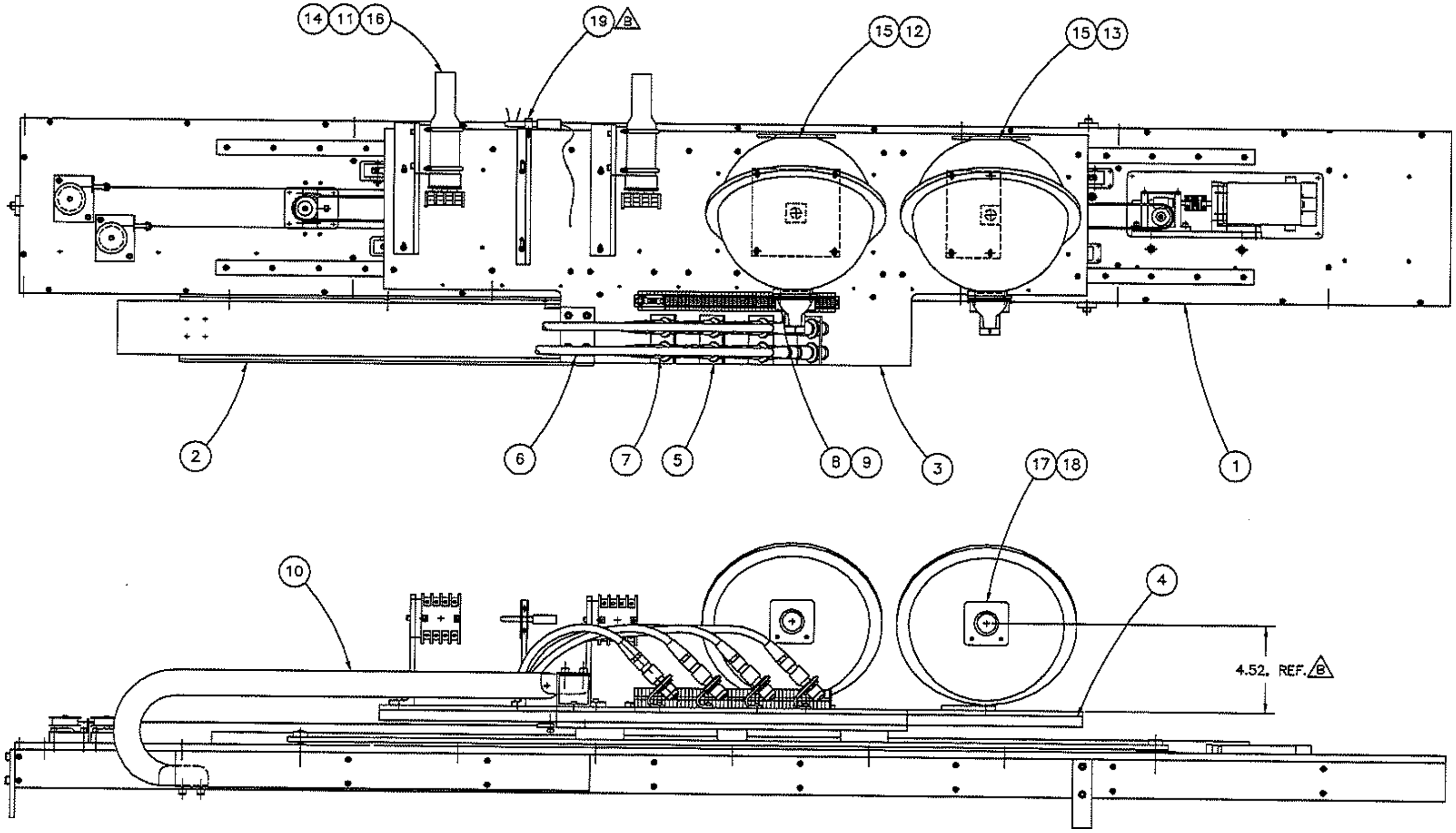
KECK/HIRES
T.V. GUIDER
MOUNT ASSEBLY

B.C.B. 3/1/92
C.A.O. 5/29/92

H8002.A

Appendix Q List of Drawings — Comparison Source System

1. H1620 Comparison Source Stage Assembly
2. H1622 Stage Schematic
3. H1618 Comp. Source Stage Mounting Surface Layout
4. H1688 Enclosure Assembly
5. H1701 Comp. Source Stage Filterwheel Assembly
6. H1706 Comp. Source Stage Filterwheel Mounting
7. H1655 Comp. Source Optics (Epps 3940)
8. H1657 Comp. Source Optics Stop Layout
9. H1812 Comp. Source Optics 2" Lens Cell Mount
10. H1816 Comp. Source Optics 6" Lens Cell Mount
11. H1814 Comp. Source Optics 6" Flat Mirror Mount



⊖1 COMPARISON SOURCE STAGE ASSEMBLY

1 REQ'D

NOTES:

1. BULBTRONICS #MR 16 "ENZ"
VENDOR:
BULBTRONICS
P.O. BOX 306
FARMINGDALE, N.Y.
11735
800-654-8542

2. I.S.T.C. #WL32809
VENDOR:
I.S.T.C.
WESTINGHOUSE CIRCLE
HORSEHEADS, N.Y.
14845
607-796-3349

3. LABSPHERE #US-080-SF
VENDOR:
LABSPHERE
P.O. BOX 70
NORTH SUTTON, N.H.
03260
603-927-4266

4. "E-CHAIN" #25-3-055-0
W/ BRACKETS 200-1 AND 200-2
5. PHOENIX TERMINAL RAIL CONTACT
#NS15, #14-01-68-2
6. PHOENIX TERMINAL CONTACT
#MKB2.5/E, #14-14-00-6

B	H1623-1	19	1	TEST LAMP ASSY	
	H1503-1	18	2	BULB HOLDER	ALUM
C	H1505-1	17	2	PROJECTOR LAMP	NOTE 1.
	H1506-1	16	2	HOLLOW CATHODE	NOTE 2.
C	H1507-1	15	2	SPHERE	NOTE 3.
	H1502-4	14	2	HOLLOW CATHODE BRACKET	ALUM
	H1502-3	13	1	MOUNTING PLATE, SPHERE	ALUM
	H1502-2	12	1	MOUNTING PLATE, SPHERE	ALUM
	H1502-1	11	2	MOUNTING, HOLLOW CATHODE	ALUM
C	–	10	1	CABLE	NOTE 4.
	–	9	1	TERMINAL, RAIL	NOTE 5.
C	–	8	1	TERMINAL	NOTE 6.
	–	7	8	CONNECTOR, LEMO 3B	
	H1619-3	6	1	BRACKET MOUNT	ALUM
	H1619-2	5	4	CONNECTOR BRACKET	ALUM
	H1619-1	4	2	RAIL	ALUM
	H1618-1	3	1	MOUNTING PLATE	ALUM
	H1608-3	2	1	CABLE WRAP BRACKET	ALUM
	H1612-1	1	1	COMPARISON SOURCE STAGE	SUB-ASSY

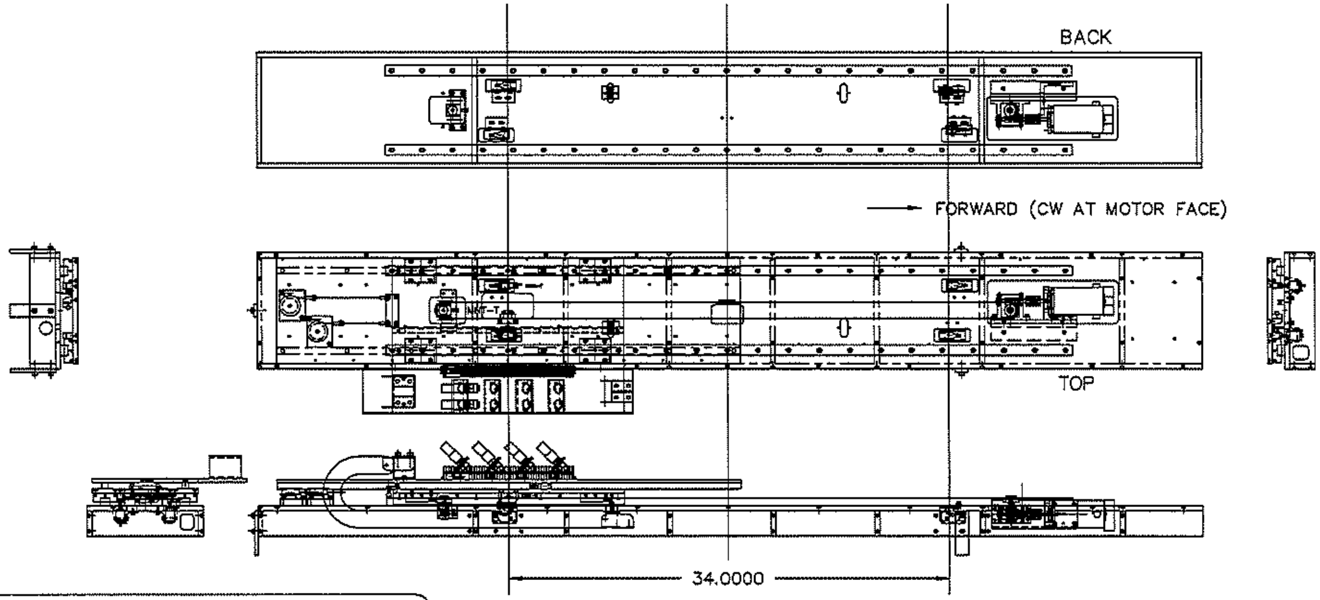
.4

A	2/8/91	CAD		UPDATE
B	1 12 93	J.c.		ADD TEST SOURCE, HG LAMP
C	1 25 93	J.c.		MOVE ELEC. BOX, NOTES.

KECK/HIRES
COMPARISON SOURCE STAGE
ASSEMBLY

S.C.B. 7/1/90
C.A.D. 2/8/91

H1620.C



CALIBRATION SOURCE STAGE SHOWN 1/4 SCALE

THEORETICAL POSITIONING RESOLUTION:

MOTOR ENCODER	4000 CTS/REV
GEAR BOX	60:1 REDUCTION
DRIVE GEAR PITCH RADIUS	0.6366

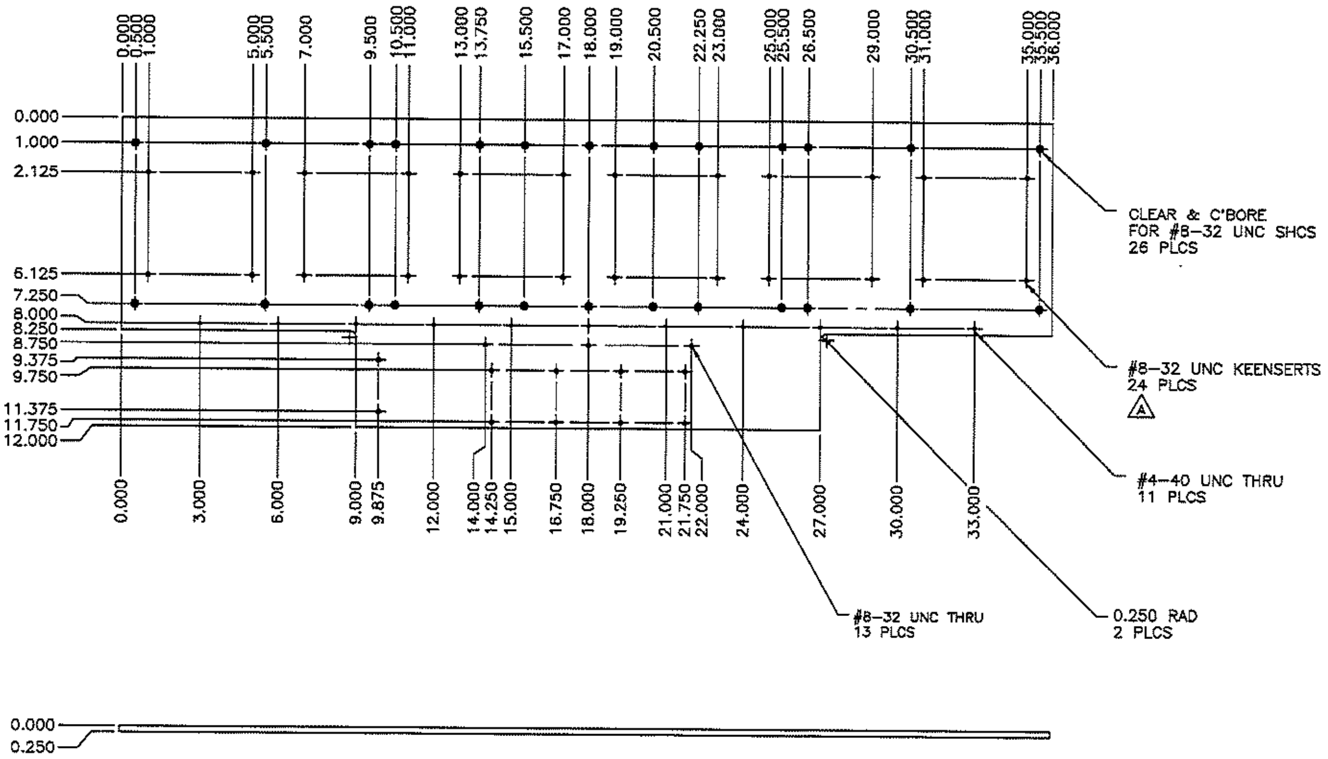
1 CT. X 1 REV/4000 CT X 1 REV OUT/60 REV IN X 2(pi)(0.6366) = 0.000016666 INCH
OR 0.000016666 INCH/CT
OR @ 60,000 CT/INCH

IF SERVO LOOP IS GOOD TO 2 COUNTS,
RESOLUTION IS 0.00003333 INCHES.

RESOLUTION AND REPEATABILITY HAVE BEEN TESTED MECHANICALLY TO 0.0005 INCHES.

TOTAL TRAVEL IS 34 INCHES. MOUNTING PLATFORM IS 8" X 36".
MOUNTING PLATFORM HOLE PATTERN IS ON H1618, 6 SETS OF 4" X 4" #8-32 HOLES
H1620 SHOWS STAGE WITH INTEGRATING SPHERES AND HOLLOW CATHODES INSTALLED.

KECK/HIRES
COMP. SOURCES STAGE
DATA AND GEAR REDUCTION
E.C.E. 04/20/92
H1622



(-1) MOUNTING PLATE

1 REQ'D
ALUM., 6061-T651 TOOLING PLATE
BLACK ANODIZE
FINISH: $\overset{63}{\surd}$

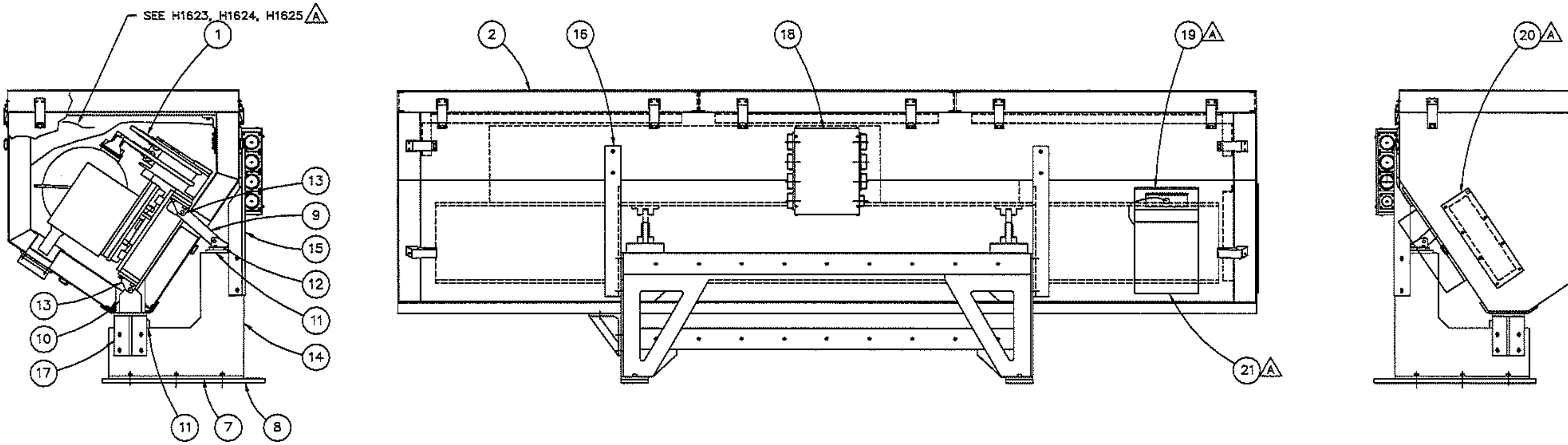
1/2

A	[illegible]	CAO		#8 KEENSERTS WERE THD HOLES
B	[illegible]	j.a.		GENERAL UPDATING.

KECK/HIRES
COMP. SOURCE STAGE
SOURCE MOUNT L/O

B.C.B. 11-13-90
C.A.C. 11/14/90

H1618.B



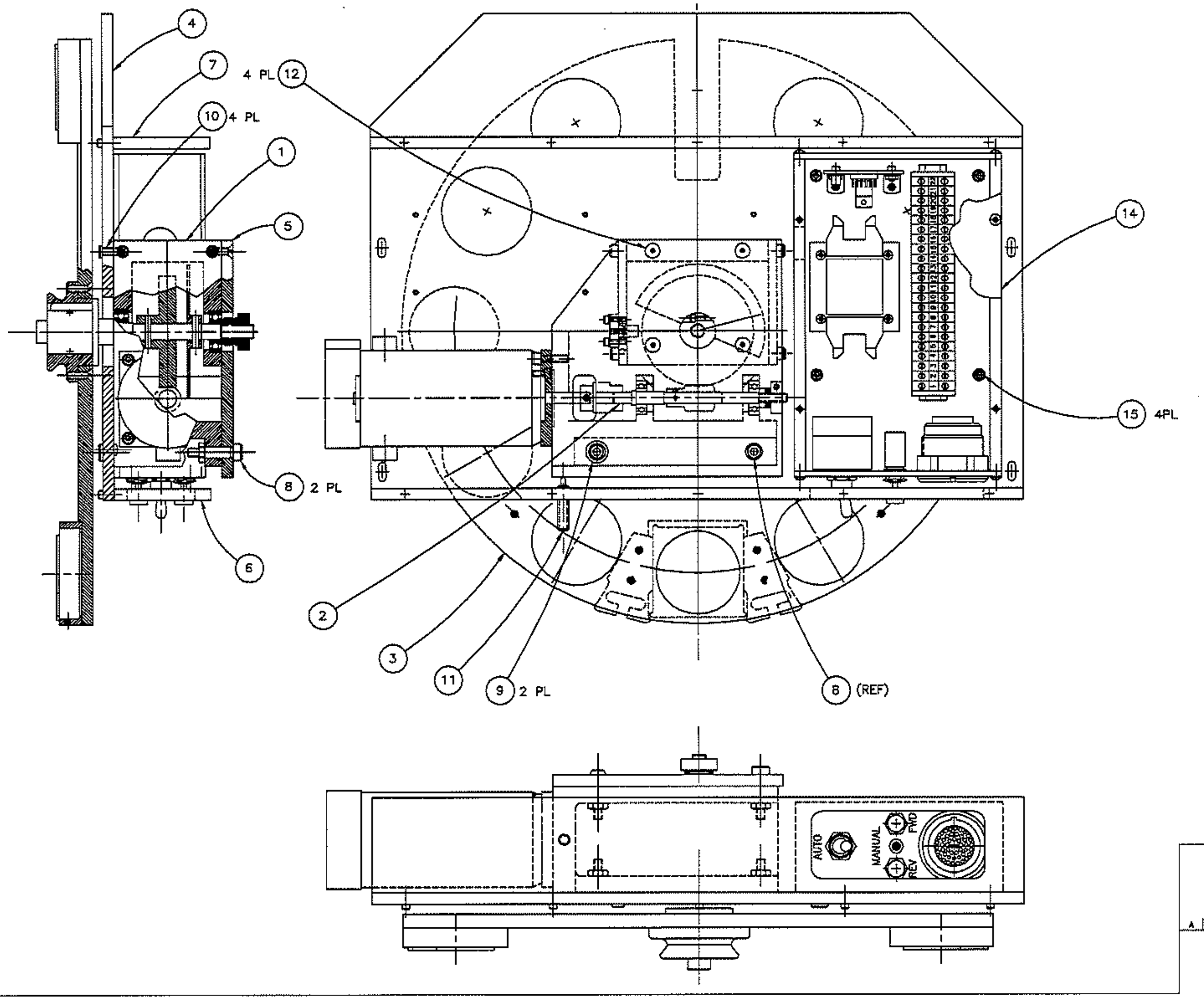
(-1) COMPARISON SOURCE STAGE/ENCLOSURE ASSEMBLY

A	H1618-1	21	1	JUNCTION BOX	ASSY
A	H1682-1	20	1	END PLATE MOD	
A	H1686-1	19	1	MOUNT PLATE	ALUM
	H1691-1	18	1	EBOX ASSY	
	H6767-3	17	2	BRACKET	ALUM
	H6767-2	16	1	BRACKET	ALUM
	H6767-1	15	1	BRACKET	ALUM
	H6766-1	14	1	MOUNTING WELDMENT	STEEL
	H6765-3	13	4	BRACKET	ALUM
	H6765-2	12	2	BRACKET	ALUM
	H6765-1	11	4	MOUNT	ALUM
	H6764-2	10	2	MOUNT	SST
	H6764-1	9	2	LINK	SST
	H6763-2	8	2	BASE PLATE	STEEL
	H6763-1	7	2	BASE PLATE	STEEL
	H1680-1	2	1	COMP SOURCE STAGE ENCLOSURE ASSY	
	H1620-1	1	1	COMPARISON SOURCE STAGE ASSY	

1/4

A | 2 28 93 | J.D. | | MOVE ELECTRONICS BOX, ADD COOLING.

KECK/HIRES
COMPARISON SOURCE STAGE
STAGE/ENCLOSURE ASSY
B.C.B. 1/1/92
C.A.D. 1/17/92
H1688.A



~	15	4	SCR, SHCS, 6~32UNC	X .50LG
H1138-1	14	1	JUNCTION BOX ASSY	
–	13	10	SCR, SHCS, 4–40UNC	X .50 LG
–	12	4	SCR, FHSCS, 6–32UNC	X .50LG
–	11	1	VLIER PLUNGER	
–	10	4	SCR, LHSCS, 6–32UNC	X .62LG
–	9	2	SCR, LHSCS, 1/4–28UNF X 1.0L	
–	8	2	SHOULDER SCREW 1/4	DIA X .62 LG
H1703–2	7	1	SIDE PLATE	ALUM
H1703–1	6	1	SIDE PLATE	ALUM
H1133–2	5	1	TOP PLATE	ALUM
H1702–1	4	1	MOUNTING PLATE	ALUM
H1115–1	3	1	WHEEL ASSY	
H1110–1	2	1	WORM DRIVE ASSY	
H1105–1	1	1	HUB & AXLE ASSY	

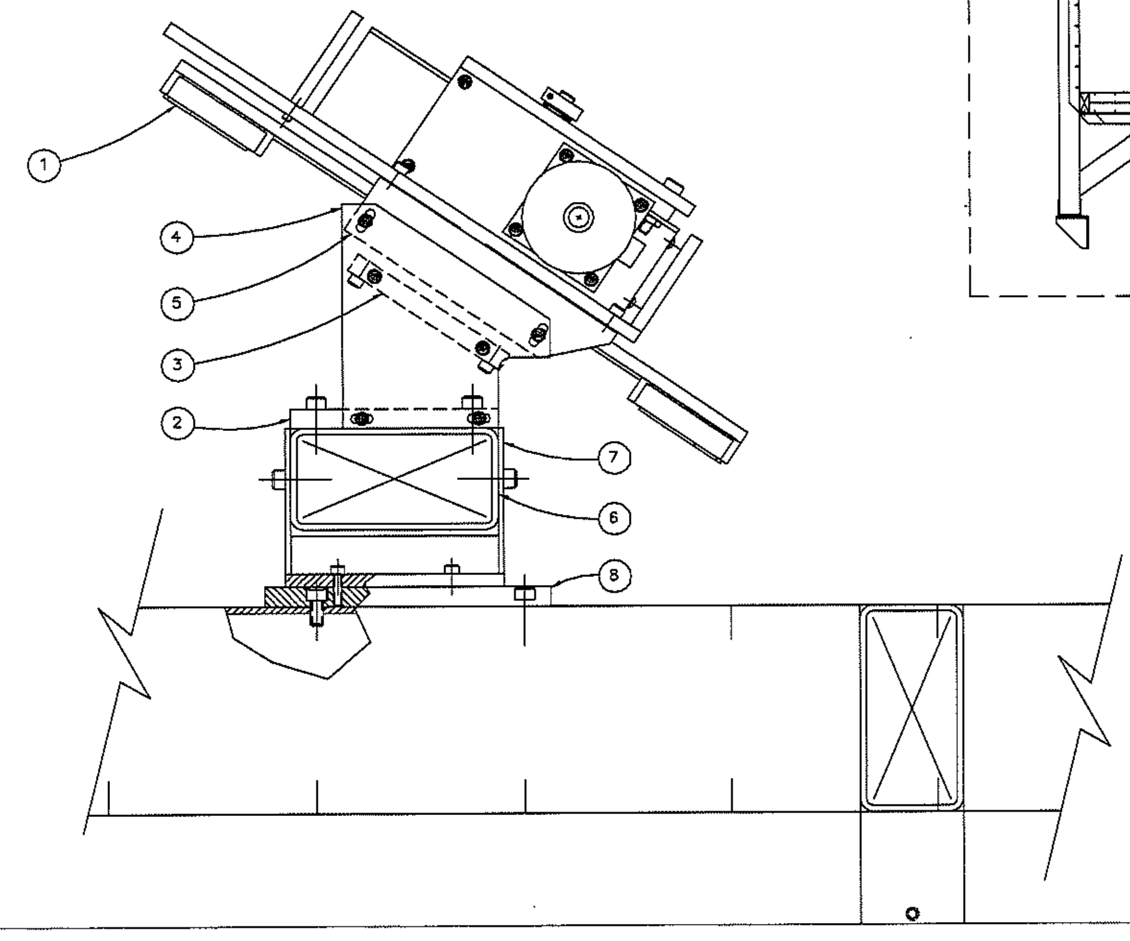
FULL

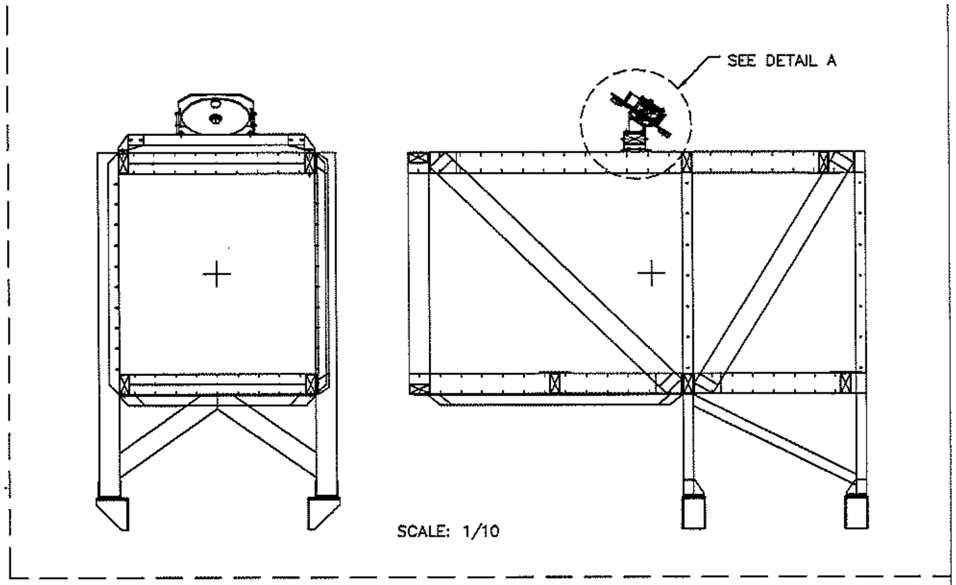
A | 3 8 93 | J.D. | | UPDATE

KECK/HIRES
COMPARISON SOURCE STAGE
FILTERWHEEL ASSY

B.C.B. 6/1/91
C.A.O. 8/16/91

H1701.A





(–1) FILTERWHEEL MOUNT ASSY

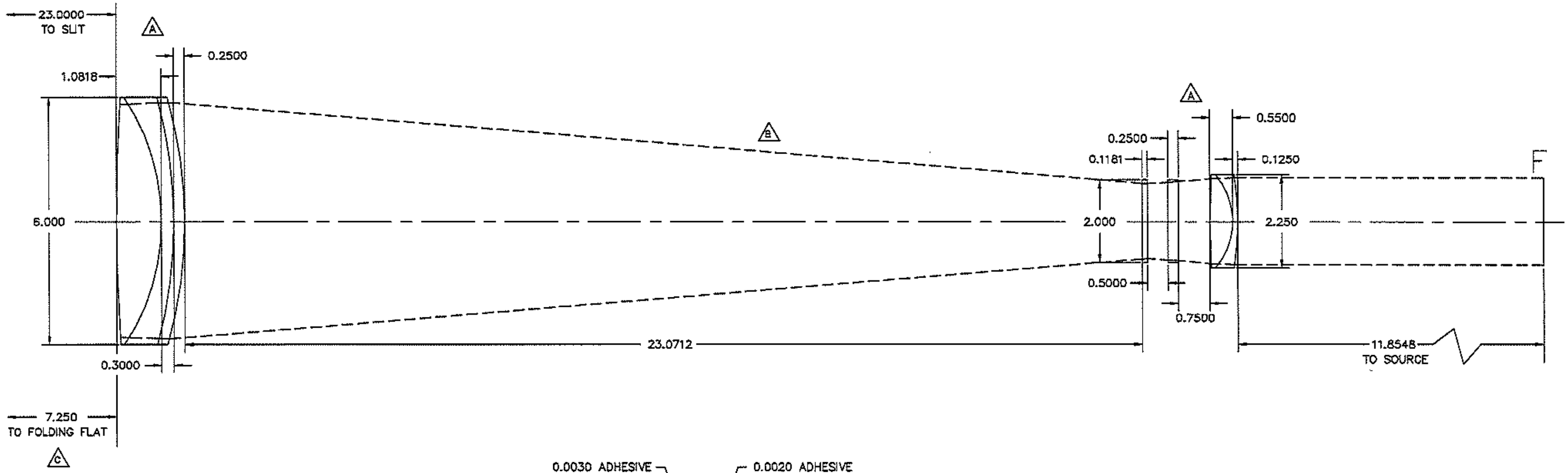
1 REQ'D

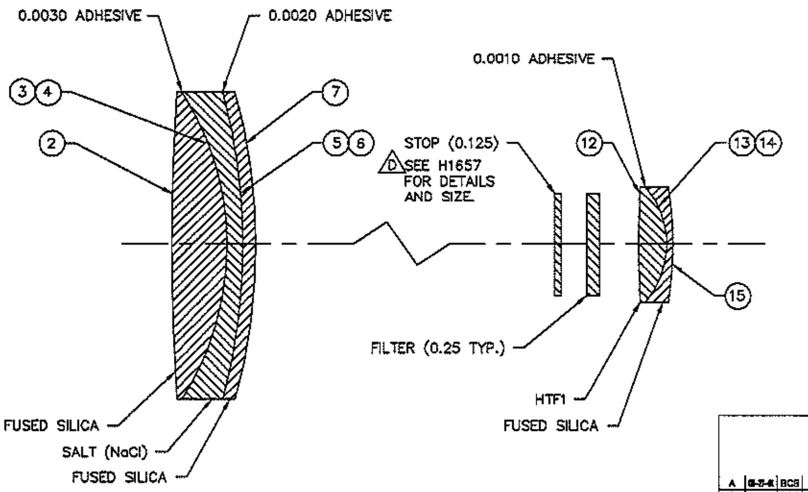
H6776-3	8	2	BASE	STL
H6777-1	7	2	BRACKET MOUNT ASSY	
H6776-1	6	1	HORIZONTAL	STL
H1704-4	5	2	STAGE MOUNT	ALUM
H1704-3	4	2	BRACKET	ALUM
H1704-2	3	2	ADJUSTMENT PLATE	ALUM
H1704-1	2	2	BRACKET BASE	ALUM
H1701-1	1	1	FILTERWHEEL ASSY	

FULL

A | 8 B 93 | L.O. | | UPDATE.

KECK/HIRES
COMPARISON SOURCE STAGE
FILTERWHEEL MOUNT ASSY
B.C.B. 7/1/92
C.A.D. 7/31/92
H1706.A





SURFACE	RADIUS	MIN. DIA.	DIAMETER
2	46.1614	5.645	6
3	5.4993	5.647	6
4	5.5023	5.647	6
5	11.5470	5.710	6
6	11.5490	5.710	6
7	11.4181	5.725	6
STOP	STOP	1.833	2
FILTER	FILTER	1.820	2
12	18.4049	2.054	2.25
13	1.7297	2.070	2.25
14	1.7307	2.070	2.25
15	6.6457	2.107	2.25

A

NOTE:

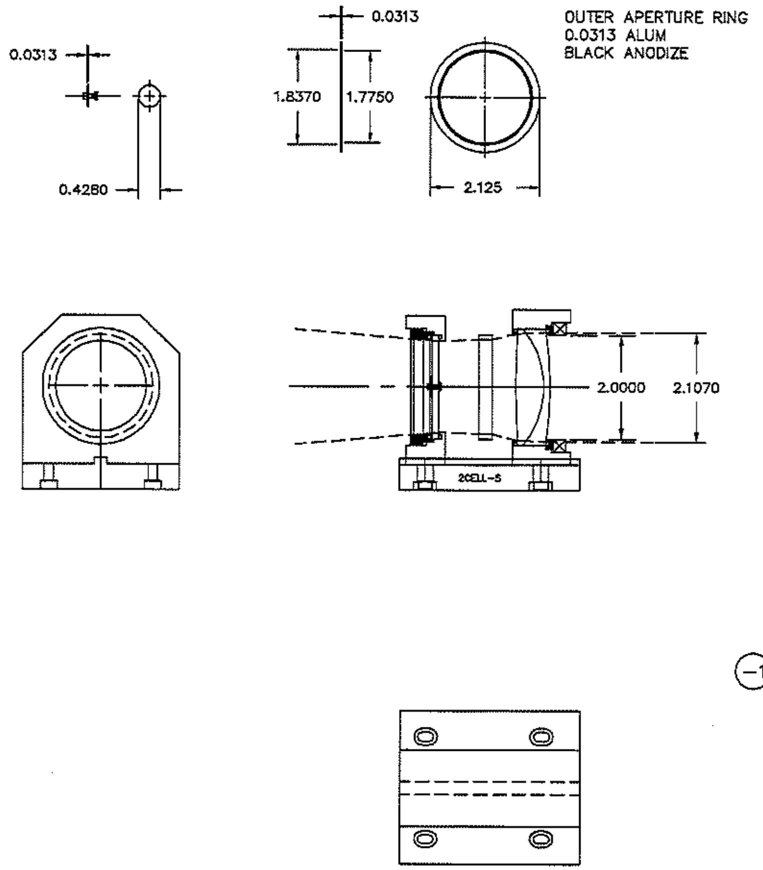
FOUR PLACE DIMENSIONS ARE ROUNDED FROM NINE PLACE RECIPROCAL OUTPUT OF THE EPPS "OARSA" RUN #3940, 05-01-91.

FULL

A	[illegible]	BCB	ADD FORTH DECIMAL PLACE TO DIMS.
B	[illegible]	BCB	ADD EXTREME RAYS
C	[illegible]	BCB	ADD DIMENSIONS
D	[illegible]	[illegible]	ADD STOP NOTE (H1657 DRAWING REF.)

KECK/HIRES
COMP. SOURCE OPTICS
EPPS #3940 (5-1-91)
B.C.B. 07/01/91

H1655.D



(-1) DETAIL OF STOP

1 REQ'D B

FULL

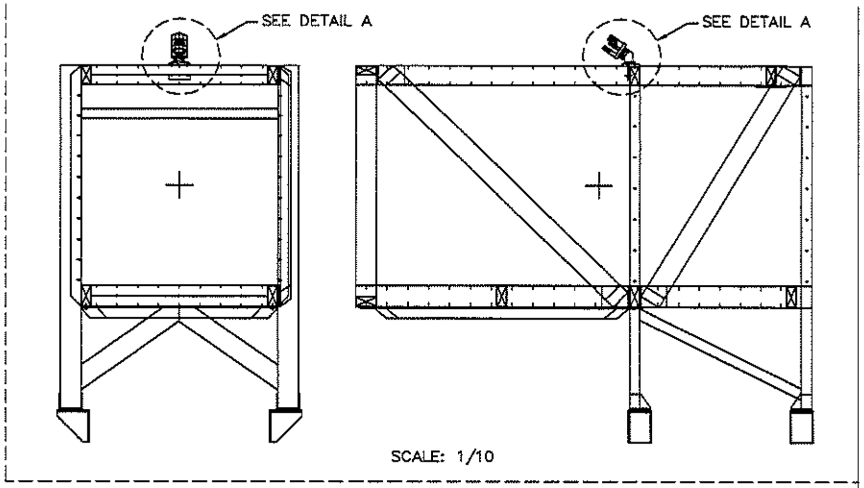
B	1 19 93	l.o.		CLEAN-UP. REF FROM H1655 OPTICAL LAYOUT. REMOVE LAYOUT FROM THIS DRAWING.

CHANGE A IS UNKNOWN

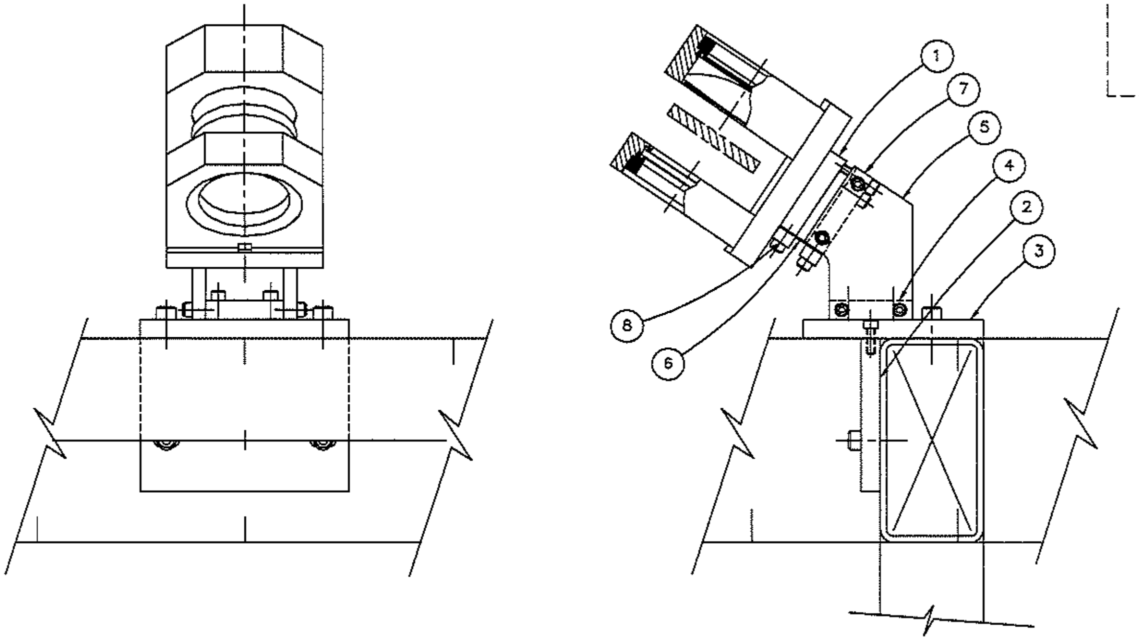
KECK/HIRES
COMP. SOURCE OPTICS
STOP L/O

B.C.B. 08/21/92

H1657.B



SCALE: 1/10



DETAIL A
SCALE: FULL

㊀ 2" LENS CELL MOUNT ASSY

1 REQ'D

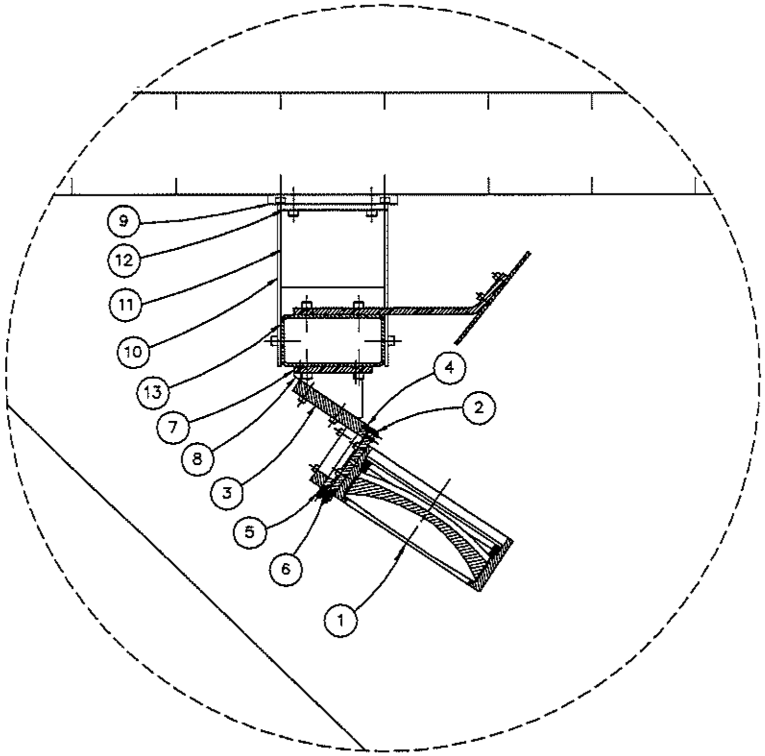
H1809-3	8	2	CLAMP	ALUM
H1809-2	7	1	MOUNT, LOWER	ALUM
H1809-1	6	1	SPRING	STEEL
H1808-4	5	4	SUPPORT	ALUM
H1808-3	4	1	RIB	ALUM
H1808-2	3	1	MOUNTING PLATE	ALUM
H1808-1	2	1	MOUNTING PLATE	ALUM
H1811-1	1	1	2" LENS CELL ASSY	

NOTED

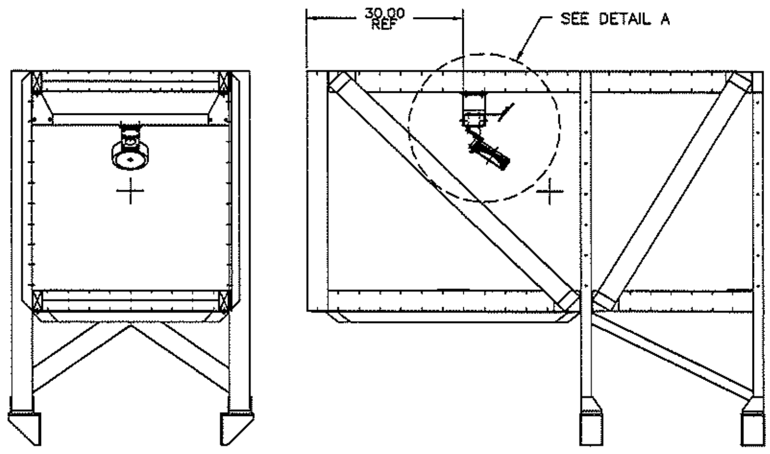
KECK/HIRES
CALIBRATION OPTICS
2" LENS CELL MOUNT ASSY

E.C.B. 6/1/91
C.A.C. 5/1/92

H1812



DETAIL A
SCALE: 1/2



SCALE: 1/10

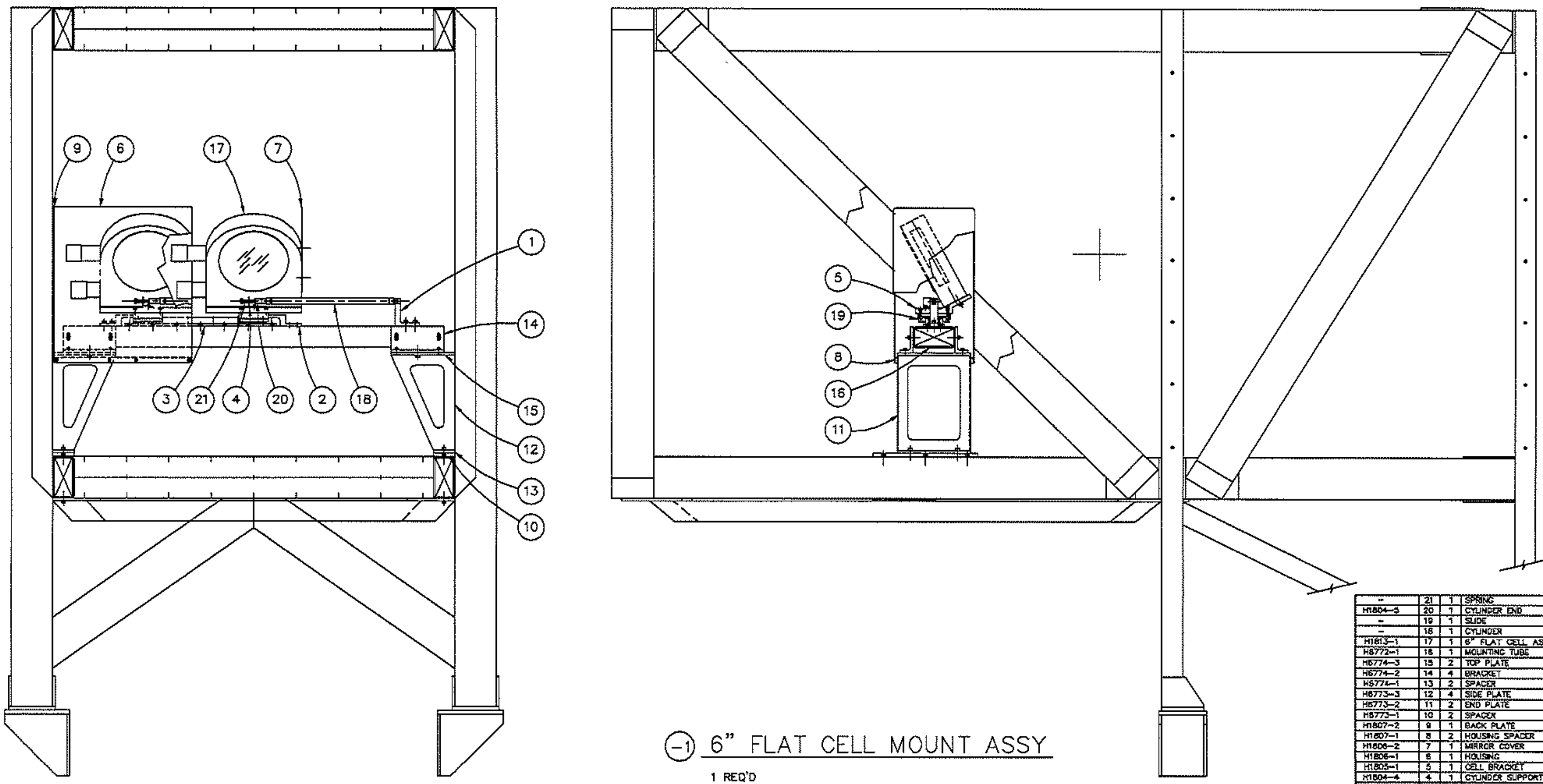
⊖1 6" LENS CELL MOUNT ASSY

1 REQ'D

H6771-1	13	1	MOUNTING TUBE	STEEL
H6770-4	12	2	MOUNTING PLATE	STEEL
H6770-3	11	4	SIDE PLATE	STEEL
H6770-2	10	2	BACK PLATE	STEEL
H6770-1	9	2	MOUNTING PLATE	STEEL
H1803-2	8	2	MOUNTING PLATE	ALUM
H1803-1	7	1	MOUNTING PLATE	ALUM
H1800-5	6	1	SPRING	STEEL
H1800-4	5	2	CLAMP	ALUM
H1800-3	4	1	MOUNT, UPPER	ALUM
H1800-2	3	1	BRACKET	ALUM
H1800-1	2	1	MOUNT, LOWER	ALUM
H1815-1	1	1	6" LENS CELL ASSY	

1/4

KECK/HIRES
CALIBRATION OPTICS
6" LENS CELL MOUNT ASSY
E.C.B. 8/1/91
C.A.D. 3/11/92
H1816



(-1) 6" FLAT CELL MOUNT ASSY

1 REQ'D

–	21	1	SPRING	STEEL
H1804-5	20	1	CYLINDER END	SST
–	19	1	SLIDE	
–	18	1	CYLINDER	
H1813-1	17	1	6" FLAT CELL ASSY	
H6772-1	16	1	MOUNTING TUBE	STEEL
H6774-3	15	2	TOP PLATE	STEEL
H6774-2	14	4	BRACKET	ALUM
H6774-1	13	2	SPACER	STEEL
H6773-3	12	4	SIDE PLATE	STEEL
H6773-2	11	2	END PLATE	STEEL
H6773-1	10	2	SPACER	STEEL
H1807-2	9	1	BACK PLATE	ALUM
H1807-1	8	2	HOUSING SPACER	ALUM
H1806-2	7	1	MIRROR COVER	ALUM
H1806-1	6	1	HOUSING	ALUM
H1805-1	5	1	CELL BRACKET	ALUM
H1804-4	4	1	CYLINDER SUPPORT	ALUM
H1804-3	3	1	SPACER	STEEL
H1804-2	2	2	STOP	ALUM
H1804-1	1	1	CYLINDER BRACKET	ALUM

1/4

A	1/17/92	CAO		ADDED ITEMS 20 & 21

KECK/HIRES
CALIBRATION OPTICS
6" FLAT CELL MOUNT ASSY

E.C.B. 8/1/91
C.A.O. 5/4/92

H1814.A

Appendix R List of Drawings — Iodine Cell Stage

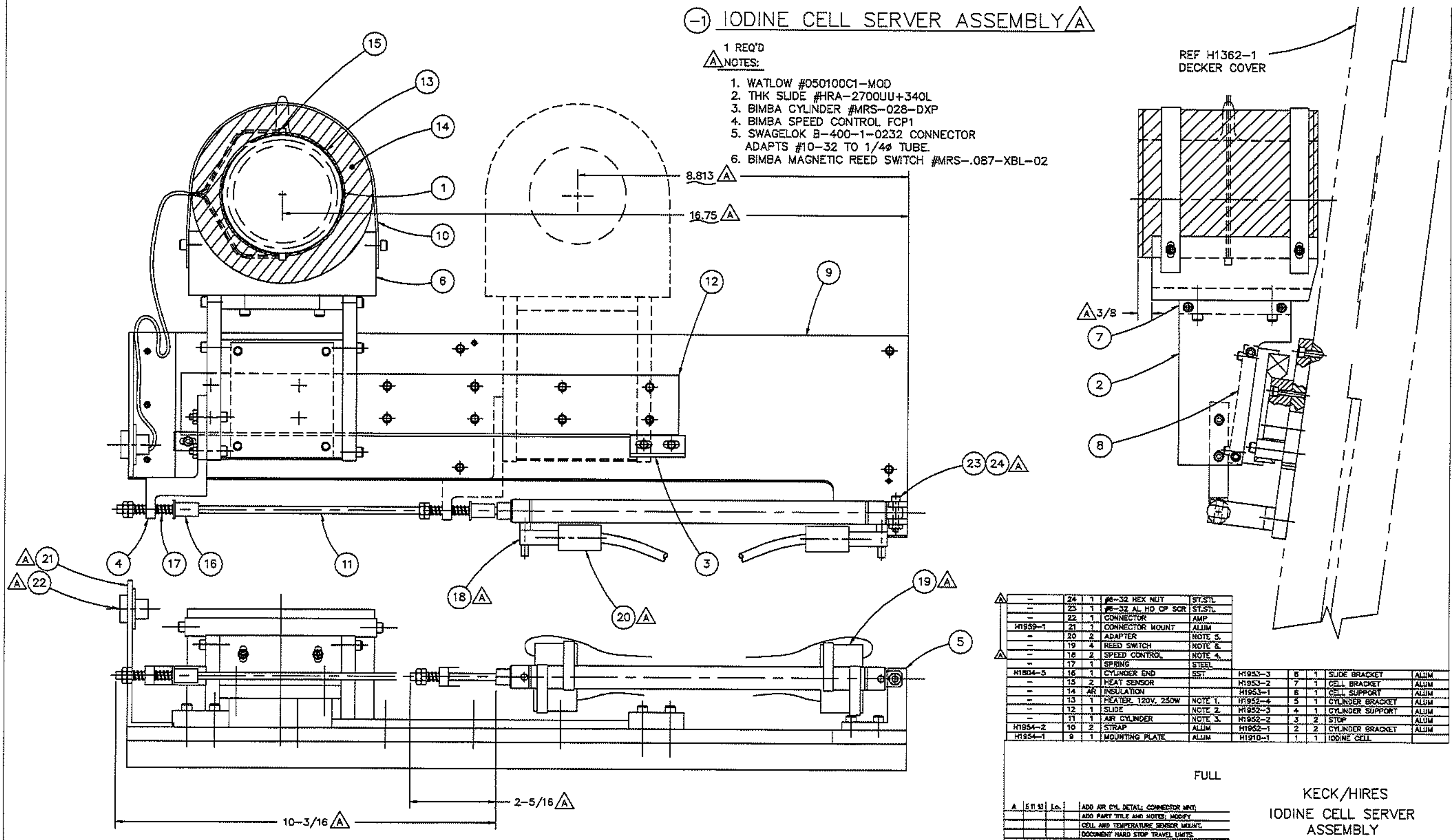
1. H1955 Iodine Cell Server Assembly

(-1) IODINE CELL SERVER ASSEMBLY A

1 REQ'D

A NOTES:

1. WATLOW #050100C1-MOD
2. THK SLIDE #HRA-2700UU+340L
3. BIMBA CYLINDER #MRS-028-DXP
4. BIMBA SPEED CONTROL FCP1
5. SWAGELOK B-400-1-0232 CONNECTOR ADAPTS #10-32 TO 1/4ø TUBE.
6. BIMBA MAGNETIC REED SWITCH #MRS-.087-XBL-02



–	24	1	#8-32 HEX NUT	ST.STL
–	23	1	#6-32 AL HD CP SCR	ST.STL
–	22	1	CONNECTOR	AMP
H1959-1	21	1	CONNECTOR MOUNT	ALUM
–	20	2	ADAPTER	NOTE 5.
–	19	4	REED SWITCH	NOTE 6.
–	18	2	SPEED CONTROL	NOTE 4.
–	17	1	SPRING	STEEL
H1804-5	16	1	CYLINDER END	SST
–	15	2	HEAT SENSOR	
–	14	AR	INSULATION	
–	13	1	HEATER, 120V, 250W	NOTE 1.
–	12	1	SLIDE	NOTE 2.
–	11	1	AIR CYLINDER	NOTE 3.
H1954-2	10	2	STRAP	ALUM
H1954-1	9	1	MOUNTING PLATE	ALUM
H1953-3	8	1	SLIDE BRACKET	ALUM
H1953-2	7	1	CELL BRACKET	ALUM
H1953-1	6	1	CELL SUPPORT	ALUM
H1952-4	5	1	CYLINDER BRACKET	ALUM
H1952-3	4	1	CYLINDER SUPPORT	ALUM
H1952-2	3	2	STOP	ALUM
H1952-1	2	2	CYLINDER BRACKET	ALUM
H1910-1	1	1	IODINE CELL	

FULL

A	5 11 93	Lo.		ADD AIR CYL DETAIL; CONNECTOR MNT;
				ADD PART TITLE AND NOTES; MODIFY
				CELL AND TEMPERATURE SENSOR MOUNT.
				DOCUMENT HARD STOP TRAVEL LIMITS.

KECK/HIRES
IODINE CELL SERVER
ASSEMBLY

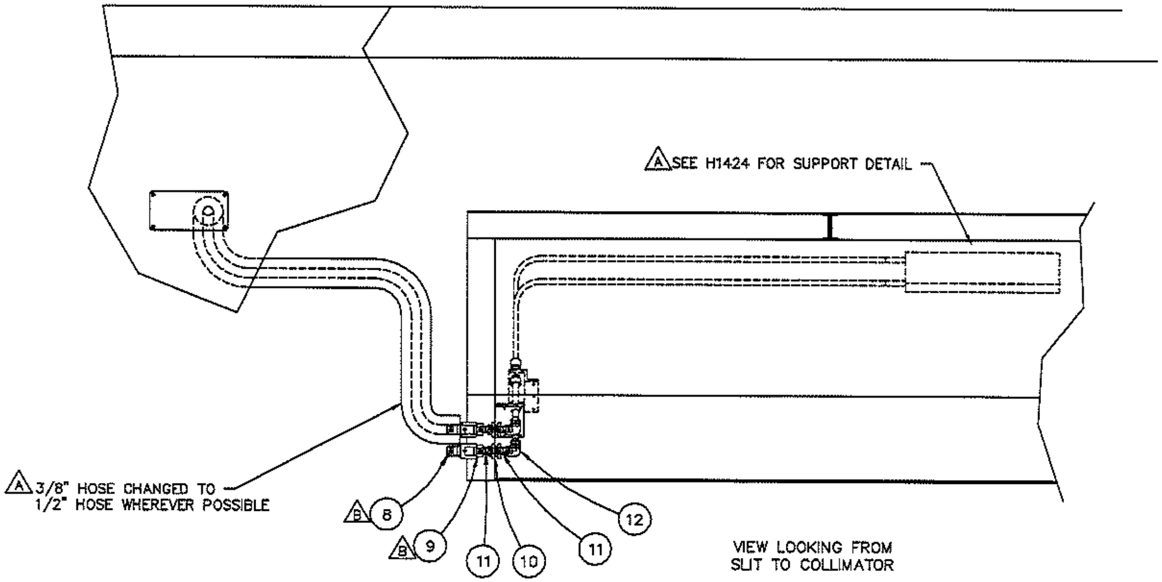
E.C.B. 7/1/92
C.A.C. 7/9/92

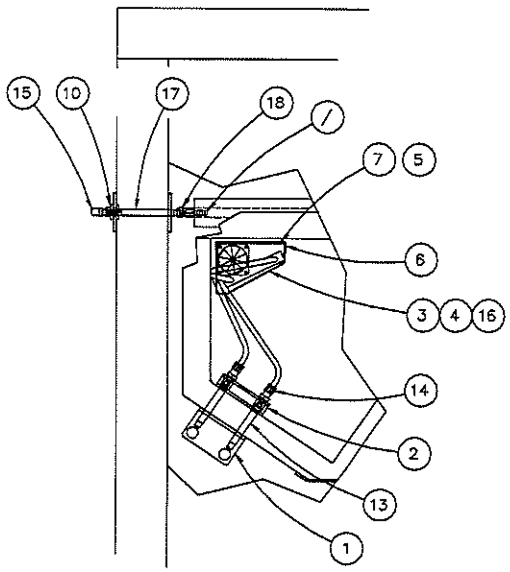
H1955.A

Appendix S List of Drawings — Slit Area Collimation

Appendix T List of Drawings — Instrument Cooling System

1. H1423 Comparison Source Stage Cooling Details
2. H1406 TV Cooling Details
3. H1411 Vault Cooling Details
4. H1432 Cooling System Control Panel
5. H1450 Cooling System Installation
6. H1462 CCD Electronics Cooling
7. H1463 CCD Cooling Installation Details





(-1) COOLING SYSTEM

1 REQ'D

NOTES:

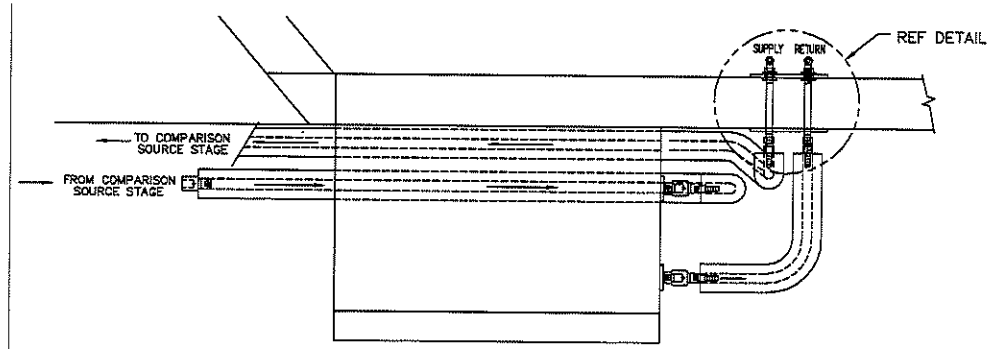
1. PARKER 46F-6-4
2. MCMASTER-CARR 4568F139
3. COMAIR-ROTRON FS24B3/031157
4. PARKER 48F-6-4
5. SWAGELOCK SS-600-71-4
6. MCMASTER-CARR 4568K137
7. PARKER 2200P-4-4
8. MCMASTER-CARR 4568K131
9. PARKER 207ACBH5-4
10. △B PARKER BH3-61
11. △A△B PARKER BH3-60

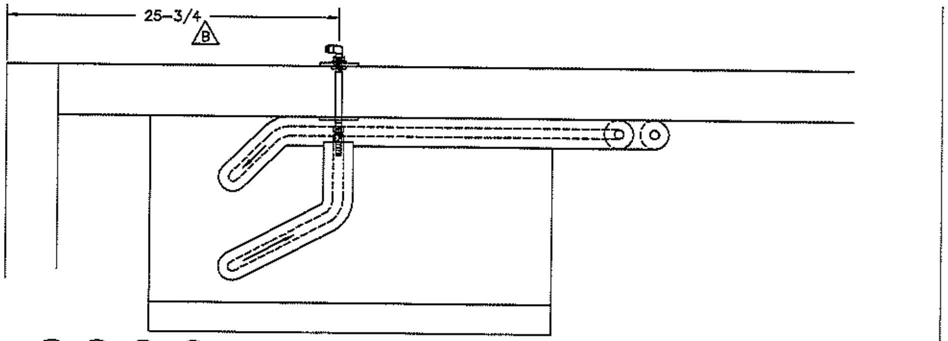
–	19	1	HOSE BARB	
–	18	1	FEMALE CONN	NOTE 1.
–	17	1	NIPPLE, 5" LG	NOTE 2.
–	16	2	FAN	NOTE 3.
–	15	1	MALE COUPLING,	NOTE 4.
–	14	2	BULKHD CONN, FEMALE	NOTE 5.
–	13	2	NIPPLE, 4" LG	NOTE 6.
–	12	2	ELBOW, 1/4"	NOTE 7.
–	11	4	NIPPLE, 7/8" LG	NOTE 8.
–	10	3	ANCHOR COUPLING	NOTE 9.
–	9	2	NIPPLE, QUICK DISCONNECT	NOTE 10.
–	8	2	COUPLING, QUICK DISCONNECT	NOTE 11.
H1422-4	7	1	COVER	ALUM
H1422-3	6	2	HANGER	ALUM
H1422-2	5	2	SPACER	ALUM
H1422-1	4	2	FAN MOUNTING PLATE	ALUM
H1421-1	3	1	PLENUM	ALUM
H1420-2	2	1	BRACKET	ALUM
H1420-1	1	1	BRACKET	ALUM

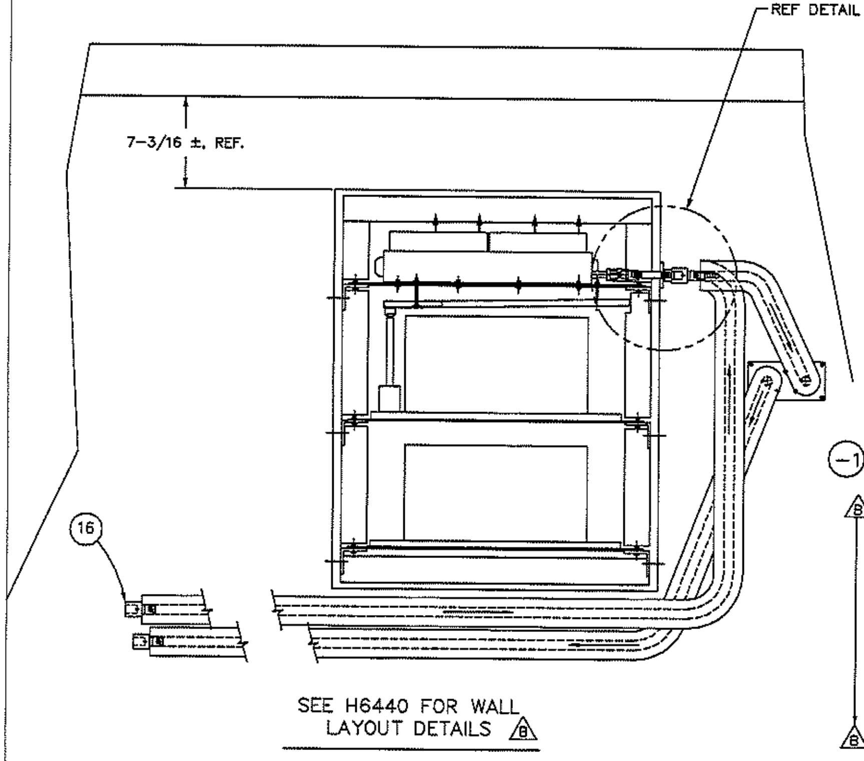
1/4

A	2 25 93	j.o.		ADD NOTE, CROSS-BAR, MOVE NOTES.
B	4 28 93	j.o.		BH3-60 WAS BH2-60, ETC.

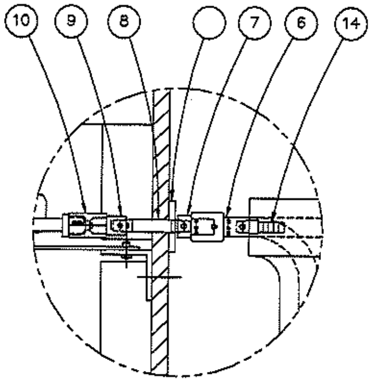
KECK/HIRES
COMPARISON SOURCE STAGE
COOLING INSTALLATION DETAILS
R.C.B. 3/1/92
C.A.C. 3/23/92
H1423.B





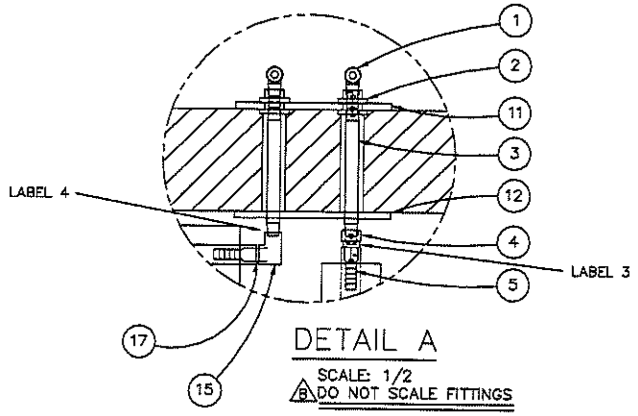


SEE H6440 FOR WALL
LAYOUT DETAILS B



DETAIL B

SCALE: 1/2



DETAIL A

SCALE: 1/2
B DO NOT SCALE FITTINGS

①1 T.V. COOLING INSTALLATION

NOTES: (ALL FITTINGS ARE BRASS)

B
1. PARKER BH3-60, FEMALE 3/8 NPT COUPLER
2. PARKER BH3-61, FEMALE 3/8 NPT NIPPLE
3. MCMASTER-CARR 4568K155, x 3" LONG
4. PARKER 46F-8-6, 3/8 NPT FEMALE TO 1/2 TUBE
5. PARKER 660FHD-8, 1/2 FLARE UNION
6. PARKER 146HBLFSV-6-6, 3/8 HOSE BARB TO FEMALE SAE
7. PARKER 125HBL-6-6, HOSE BARB
8. PARKER 46F-6-6 (3/8 NPT TO 3/8 SAE)
9. MCMASTER-CARR 4568K159, 3/8 NIPPLE x 5" LONG
10. PARKER 207ACBH-6, 3/8 NPT TO 3/8 NPT, 1-14 THD O.D. x 1.31 LOA
11. COUPLINGS CO. 49-EEE (3/8 FLARE TO 3/8 NPT)
12. PARKER 2200P-6-6, 3/8 NPT 90° ELBOW
B

B	-	17	1	3/8 PIPE NIPPLE	BRASS
B	-	16	2	COUPLING, QUICK CONNECT	NOTE 1.
B	-	15	1	ELBOW	NOTE 12.
	-	14	4	3/8" HOSE BARB	NOTE 7.
	H1405-4	13	2	FEEDTHRU PLATE	ALUM
	H1405-2	12	1	FEEDTHRU PLATE	ALUM
	H1406-1	11	1	FEEDTHRU PLATE	ALUM
	-	10	2	FLARE UNION, 1/2"	NOTE 5.
	-	9	1	FEMALE CONNECTOR	NOTE 4.
	-	8	2	3/8 NIPPLE	NOTE 3.
B	-	7	1	NIPPLE, QUICK CONNECT	NOTE 2.
B	-	6	1	COUPLING, QUICK CONNECT	NOTE 1.
	-	5	2	HOSE BARB	NOTE 6.
	-	4	1	FEMALE CONNECTOR	NOTE 8.
	-	3	1	3/8 NIPPLE	NOTE 9.
	-	2	1	ANCHOR COUPLING	NOTE 10.
	-	1	1	ELBOW	NOTE 11.

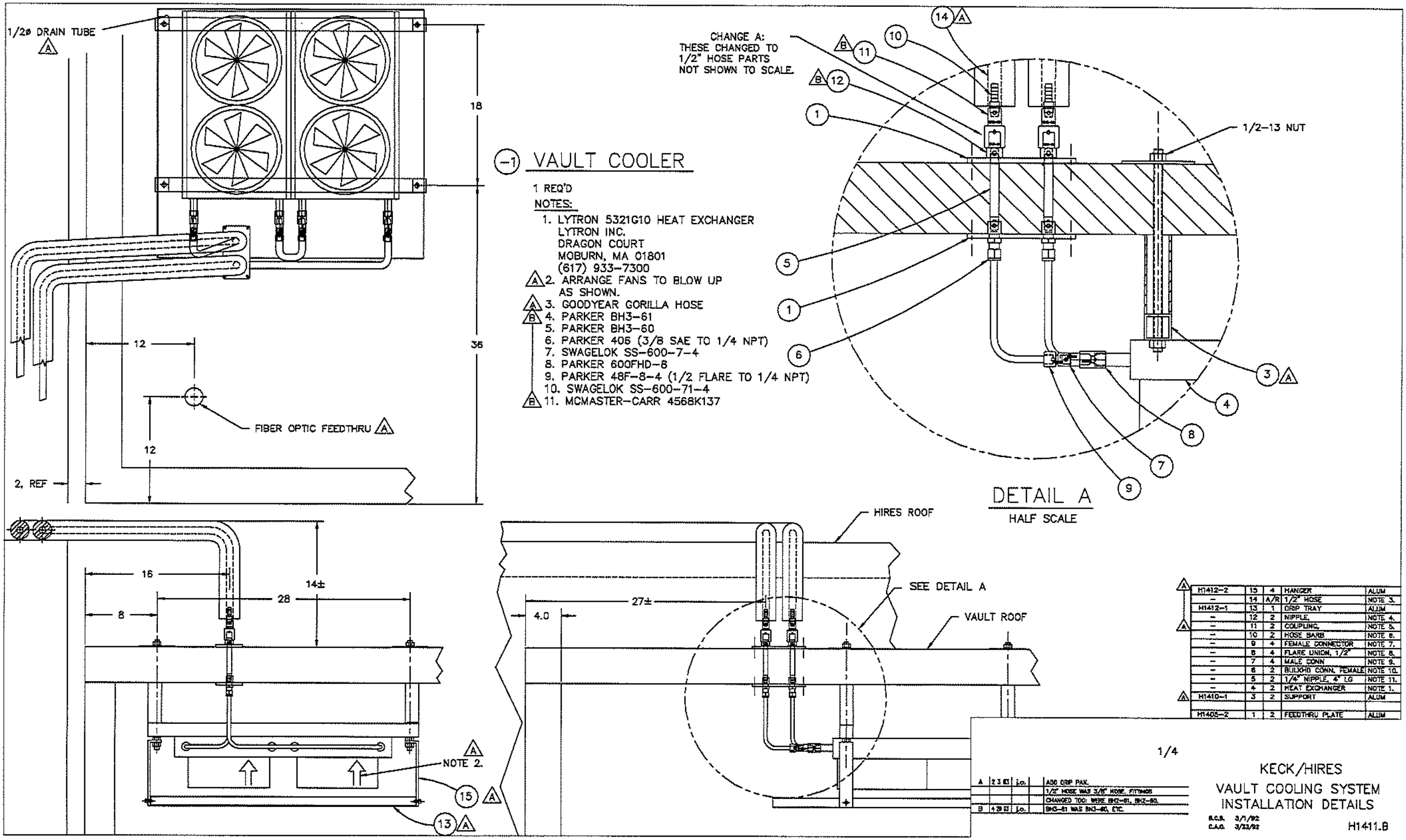
1/4

A	2/9/93	CAO		UPDATE PER AS BUILT
B	4/21/93	j.a.		MOVE NOTES. HOSE WAS 1/4".

KECK/HIRES
T.V. COOLING
INSTALLATION DETAILS

B.C.B. 3/1/92
C.A.O. 3/20/92

H1406.B



⊖1 VAULT COOLER

1 REQ'D

NOTES:

1. LYTRON 5321G10 HEAT EXCHANGER
   LYTRON INC.
   DRAGON COURT
   MOBURN, MA 01801
   (617) 933-7300
2. A ARRANGE FANS TO BLOW UP AS SHOWN.
3. A GOODYEAR GORILLA HOSE
4. B PARKER BH3-61
5. PARKER BH3-60
6. PARKER 406 (3/8 SAE TO 1/4 NPT)
7. SWAGELOK SS-600-7-4
8. PARKER 600FHD-8
9. PARKER 48F-8-4 (1/2 FLARE TO 1/4 NPT)
10. SWAGELOK SS-600-71-4
11. B MCMASTER-CARR 4568K137

DETAIL A

HALF SCALE

A	H1412-2	15	4	HANGER	ALUM
	–	14	A/R	1/2" HOSE	NOTE 3.
	H1412-1	13	1	DRIP TRAY	ALUM
	–	12	2	NIPPLE,	NOTE 4.
A	–	11	2	COUPLING,	NOTE 5.
	–	10	2	HOSE BARB	NOTE 6.
	–	9	4	FEMALE CONNECTOR	NOTE 7.
	–	8	4	FLARE UNION, 1/2"	NOTE 8.
	–	7	4	MALE CONN	NOTE 9.
	–	6	2	BULKHD CONN, FEMALE	NOTE 10.
	–	5	2	1/4" NIPPLE, 4" LG	NOTE 11.
	–	4	2	HEAT EXCHANGER	NOTE 1.
A	H1410-1	3	2	SUPPORT	ALUM
	H1405-2	1	2	FEEDTHRU PLATE	ALUM

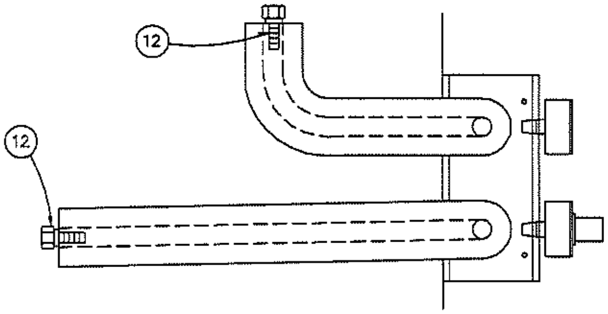
1/4

A	2 3 93	j.o.		ADD DRIP PAN.
				1/2" HOSE WAS 3/8" HOSE, FITTINGS
				CHANGED TOO: WERE BHZ-61, BHZ-60.
B	4 29 93	j.o.		BH3-61 WAS BH3-60, ETC.

KECK/HIRES
VAULT COOLING SYSTEM
INSTALLATION DETAILS

B.C.B. 3/1/92
C.A.G. 3/23/92

H1411.B

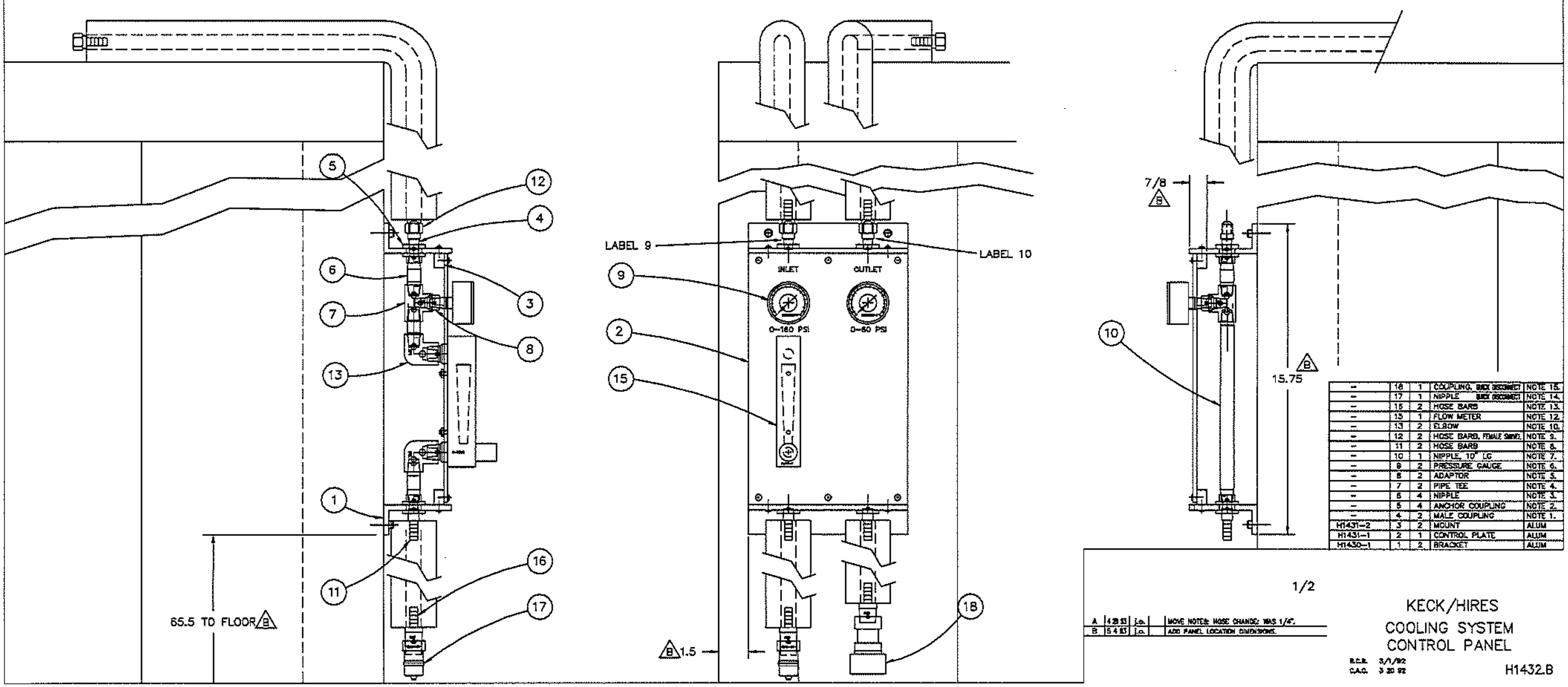


(-1) CONTROL PANEL COOLING SYSTEM

△A NOTES:

1. PARKER 48F-6-6, 3/8 MALE NPT TO 45° FLARE
2. PARKER 207ACBH-6, 3/8 NPT TO 3/8 NPT
   1-14 THD O.D. x 1.31 LOA
3. MCMASTER-CARR 4568K152, 3/8 NPT NIPPLE x 1-1/2 LG
4. PARKER 1203P-6, 3/8 NPT "T"
5. PARKER BUSHING, 209P-4-6
6. MCMASTER-CARR 4000K54, 1/4 NPT PRESSURE GAGE
7. MCMASTER-CARR 4568K165, 3/8 NPT NIPPLE, 10" LOA
   MODIFY TO FIT.
8. PARKER 125HBL-6-6, 3/8 NPT TO 3/8 TUBE
9. PARKER 146HBLFSV-6-6, 3/8 NPT TO 45° SWIVEL,
   5/8-18 STRAIGHT THREADS
10. PARKER 2200P-6-8, 3/8 NPT TO 1/2 NPT 90° ELBOW
12. COLE-PALMER L-03285-18
    BLOCK-TYPE FLOWMETER WITH VALVE, 75mm SCALE.
13. PARKER 125HBL-6-8, 1/2 NPT MALE TO 3/8 HOSE BARB
14. PARKER BH4-61, 1/2 NPT FEMALE, NIPPLE
15. PARKER BH4-60, 1/2 NPT FEMALE, COUPLER
    ALL FITTINGS ARE BRASS.

DO NOT SCALE FITTINGS.



–	18	1	COUPLING, QUICK DISCONNECT	NOTE 15.
–	17	1	NIPPLE QUICK DISCONNECT	NOTE 14.
–	16	2	HOSE BARB	NOTE 13.
–	15	1	FLOW METER	NOTE 12.
–	13	2	ELBOW	NOTE 10.
–	12	2	HOSE BARB, FEMALE SWVL.	NOTE 9.
–	11	2	HOSE BARB	NOTE 8.
–	10	1	NIPPLE, 10" LG	NOTE 7.
–	9	2	PRESSURE GAUGE	NOTE 6.
–	8	2	ADAPTOR	NOTE 5.
–	7	2	PIPE TEE	NOTE 4.
–	6	4	NIPPLE	NOTE 3.
–	5	4	ANCHOR COUPLING	NOTE 2.
–	4	2	MALE COUPLING	NOTE 1.
H1431-2	3	2	MOUNT	ALUM
H1431-1	2	1	CONTROL PLATE	ALUM
H1430-1	1	2	BRACKET	ALUM

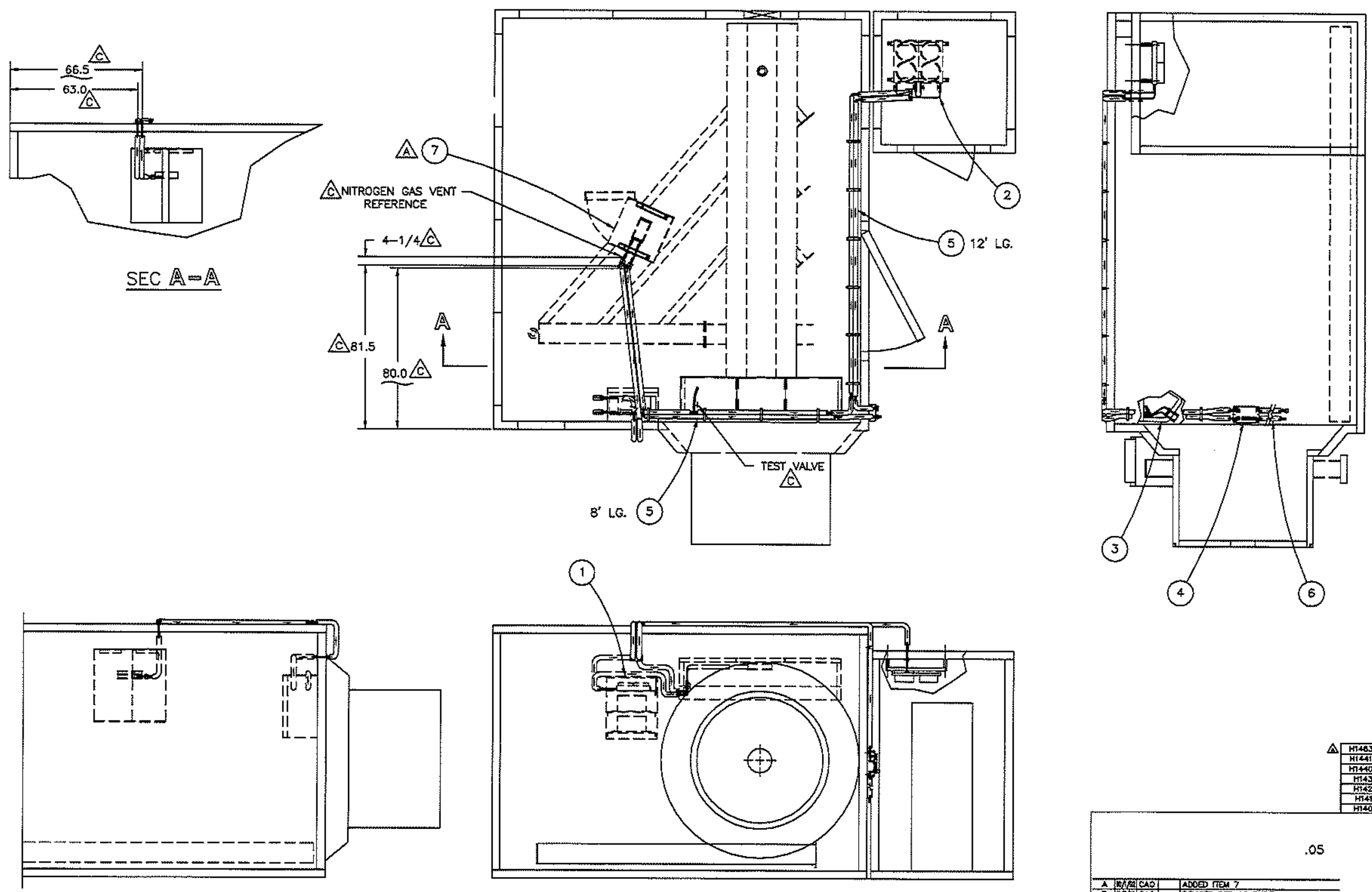
1/2

A	4 28 93	J.o.		MOVE NOTES; HOSE CHANGE; WAS 1/4".
B	5 4 93	J.o.		ADD PANEL LOCATION DIMENSIONS.

KECK/HIRES
COOLING SYSTEM
CONTROL PANEL

R.C.B. 3/1/92
C.A.O. 3 20 92

H1432.B



△A	H1463–1	7	1	CCD COOLING SYSTEM	
	H1441–1	6	A/R	HOSE ASSY	
	H1440–1	5	4	COOLANT TUBE	
	H1432	4	1	CONTROL PANEL COOL SYSTEM	
	H1423	3	1	CCS COOL. SYSTEM	
	H1411	2	1	VAULT COOL. SYSTEM	
	H1406	1	1	T.V. COOL. SYSTEM	

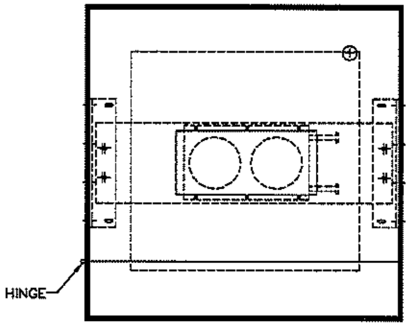
.05

A	10/1/92	CAO		ADDED ITEM 7
B	11/5/92	CAO		REVISED PER AS BUILT
C	4-29-10	J.o.		ADD CEILING HOLE DIMENSIONS.

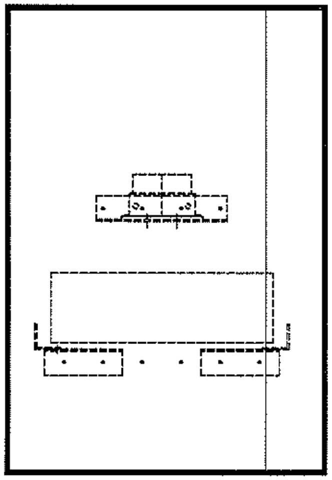
KECK/HIRES
COOLING SYSTEM
INSTALLATION

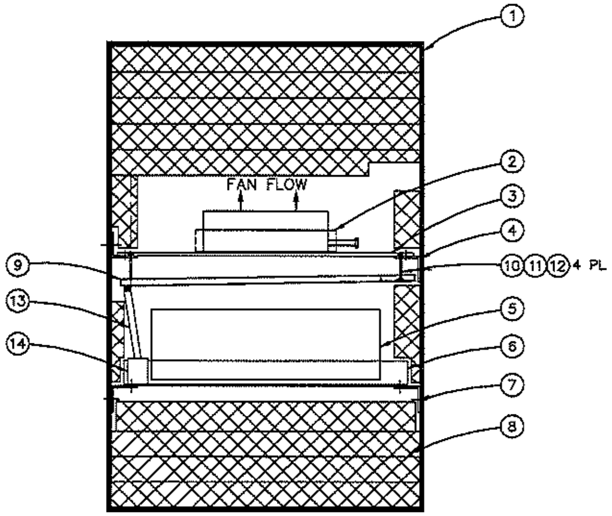
B.C.B. 3/1/92
C.A.D. 3/20/92

H1450.C



TOP VIEW





(-1) CCD ELECTRONICS COOLING ASSY

NOTES:

1. LYTRON INC.
   DRAGON CT
   WOBURN, MA 01801
   617/933/7300

2. WARD-BRAGBY PLASTICS
   1310 PIPER DR.
   MILPITAS, CA
   408/262/2111

3. WIRING AND PLUMBING HOLES
   LOCATED AS REQ'D.

4. INSULATION THICKNESS, 2-1/4".

–	14	1	CONTAINER	
–	13	A/R	TUBE, 1/2" RED	SILICON
–	12	4	NUT, #8-32	
–	11	4	O-RING	
–	10	4	#8-32 FL. HD. SCREW	BRASS
H1471-1	9	1	CONDENSATION TRAP	ALUM
–	8	A/R	INSULATION	
H1461-4	7	4	BRACKET	ALUM
H1461-3	6	2	BRACKET	ALUM
–	5	1	CCD ELECTRONICS	
H1461-2	4	2	BRACKET	ALUM
H1461-1	3	1	SHELF	ALUM
LYT 5121C	2	1	HEAT EXCHANGER	
–	1	1	CONTAINER	

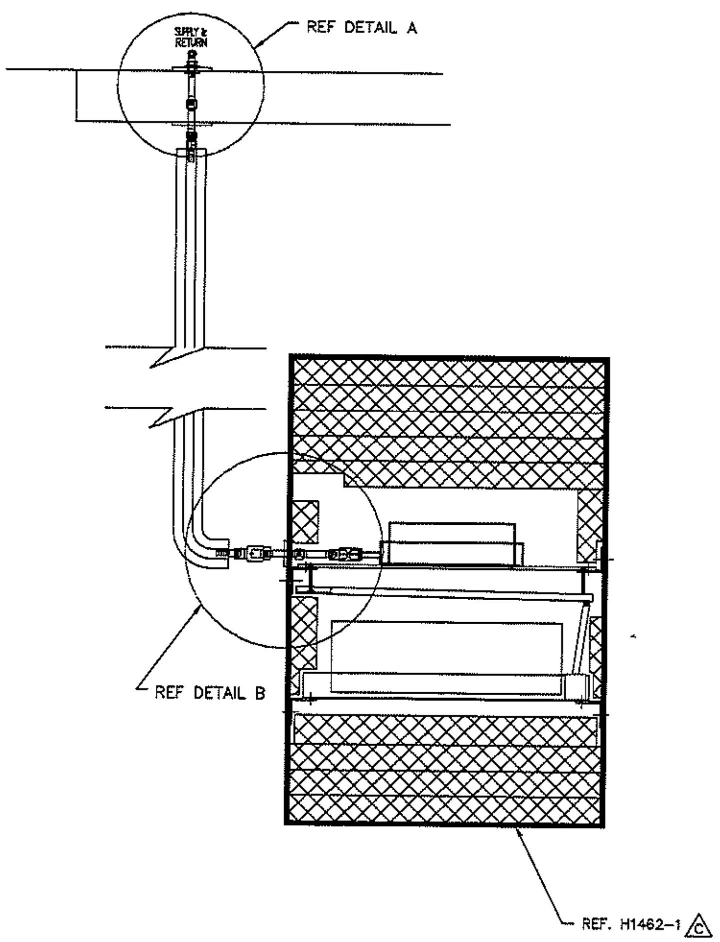
1/4

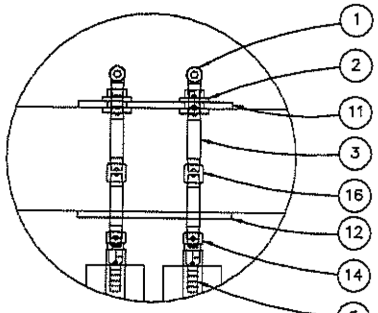
A	11/3/92	CAO		REVISED PER AS BUILT
B	3/9/93			ADDED ITEMS 9-15.
C	4 28 10	l.o.		REMOVE ITEM 15, ADD FIBER OPTIC
				FEEDTHRU HOLE.

KECK/HIRES
CCD ELECTRONICS COOLING
ASSEMBLY

mjk 8/20/92

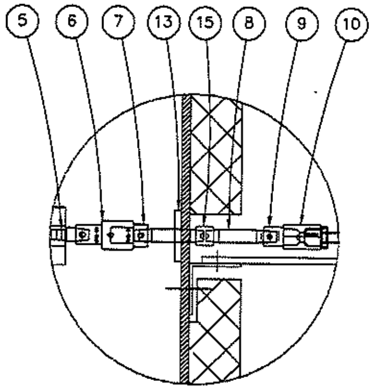
H1462.C





DETAIL A

SCALE: 1/2
VIEW IS 90° FROM ORIGINAL



DETAIL B

SCALE: 1/2

(-1) CCD COOLING INSTALLATION

NOTES:

1. ITEM 14, 4 EA. USED TO CONNECT TO EXISTING COOLING SYSTEM, SEE H1450.
2. NOT TO SCALE.

–	16	2	1/2 COUPLING	
–	15	2	3/8 COUPLING	
–	14	6	SWIVEL HOSE BARB 1/2"	
H1460-4	13	2	FEEDTHRU PLATE	ALUM
H1460-2	12	1	FEEDTHRU PLATE	ALUM
H1460-1	11	1	FEEDTHRU PLATE	ALUM
–	10	2	FLARE UNION, 3/8	
–	9	2	F'MALE C'NCTOR,3/8	
–	8	4	3/8" NIPPLE, 2.50 LG	
–	7	2	3/8 NIPPLE, QUICK DISCONNECT	
–	6	2	3/8 COUPLG, QUICK DISCONNECT	
–	5	2	HOSE BARB, 1/2" TO 1/2" NPTM	
–	4	2	FEMALE CONN 1/2 NPT TO 1/2 SAE	
–	3	4	1/2" NIPPLE, 2.50 LG	
–	2	2	1/2 ANCHOR COUPLING	
–	1	2	ELBOW, 1/2 FLARE TO 1/2 NPT	

NTS

A	11/5/92	CAO		REVISED PER AS BUILT
B	2/3/93	CAO		UPDATE PER AS BUILT
C	4-28-93	j.a.		REMOVE FIBER OPTIC BKT. ADD NOTE.

KECK/HIRES
CCD COOLING
INSTALLATION DETAILS

mjk 9/25/92

H1463.C

Appendix U List of Drawings — Camera Mirror

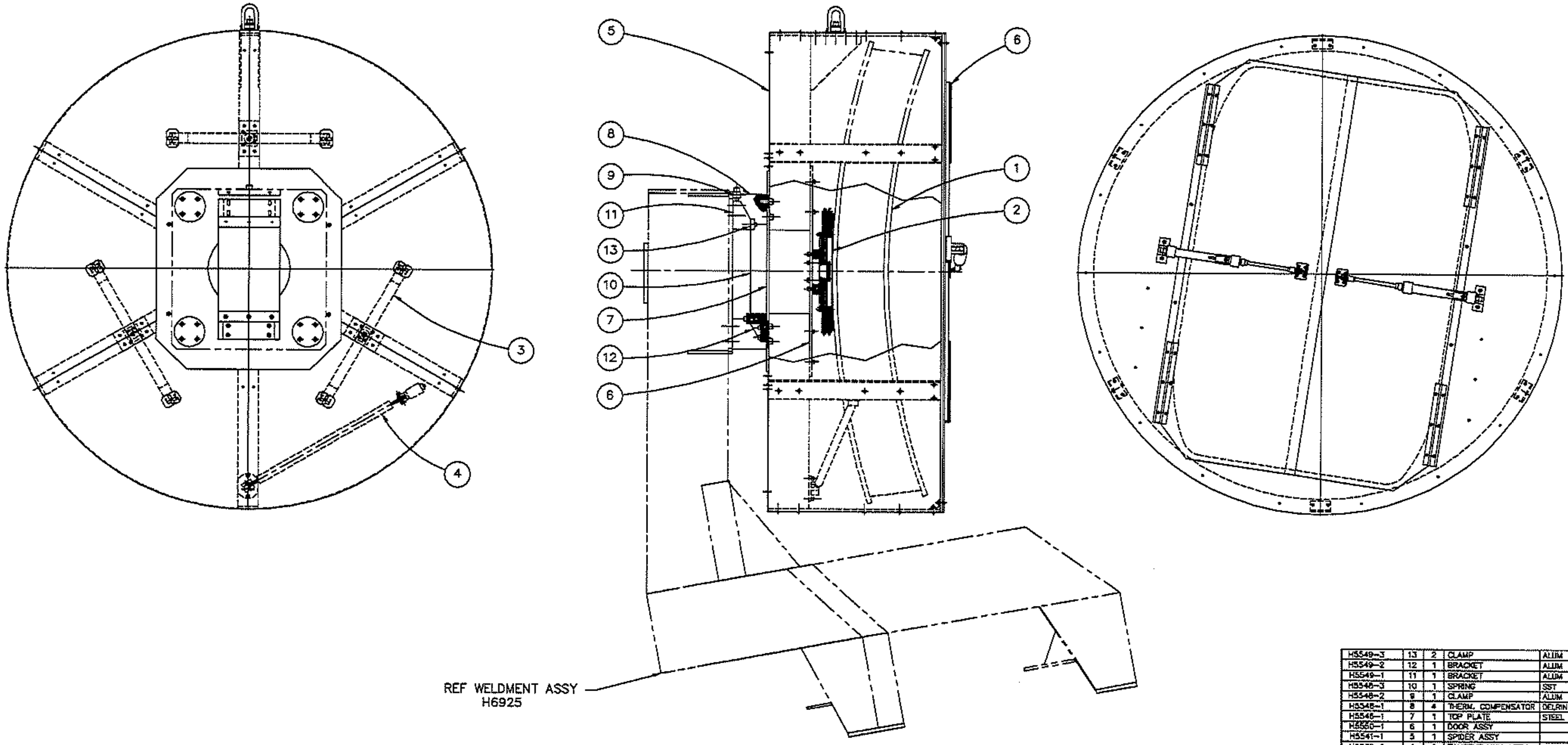
1. H5000 Locating Tree
2. H5560 Camera Mirror Cell Assembly
3. H5530 Camera Mirror Cell, Radial Support Sub-Assembly
4. H5550 Door Assembly
5. H5380 Pneumatic Control Panel
6. H5514 Radial Support Load Testing
7. H5537 Axial Support Details
8. H5536 Axial Support Details
9. H5539 Torsional Link Assembly
10. H5824 Horizontal Mirror Testing
11. H5825 10° Mirror Testing (As Used in HIRES)
12. Figure 1: Half Model Showing 3 Axial Supports
13. Figure 2: Half Model — ANSYS Model
14. Figure 3: Deflection Contours and Clear Aperture

H5000		THIS DRAWING
H5016		CELL DOOR VS. DEWAR CLEARANCE
H5100		OPEN
H5200		CORRECTOR TOOLING
	H5210	CORRECTOR TOOLS
	H5214	CAMERA MIRROR TOOLS
H5300		CORRECTOR CELLS AND SUPPORT STRUCTURE
	H5303	CORRECTOR BASE ASSY (ISOMETRIC)
	H5314	CORRECTOR CELL TOOLING L/O
	H5324	MENISCUS CORRECTOR CELL ASSY
	H5328	CORRECTOR CELL AXIAL SUPPORT ASSY'S
	H5324	MEN. CORR. DOOR ASSY
	H5349	BICONVEX CORRECTOR CELL ASSY
	H5363	CORRECTOR CELL ASSEMBLY FIXTURE
	H5370	BI-FOLDING DOOR ASSEMBLY
H5400		CAMERA MIRROR AND TOOLING
	H5401	CAMERA MIRROR L/O
	H5409	CAMERA MIRROR SUPPORT ASSY (FOR STRASBAUGH)
	H5411	CAMERA MIRROR 25" LAP (STRASBAUGH)
	H5412	CAM. MIRROR 30" LAP (STRASBAUGH)
	H5415	CAM. MIRROR (HEXTEK DRAWING)
	H5420	BEAM1 RAYTRACE AT CAMERA PLANE
	H5421	BEAM1 RAYTRACE OF TELESCOPE AND HIRES
H5500		CAMERA MIRROR CELL
	H5530	CAM. MIRROR RADIAL SUPPORT ASSY.
	H5536	CAM. MIRROR AXIAL SUPPORT ASSY.
	H5539	CAM. MIRROR TANGENT LINK ASSY.
	H5541	CAM. MIRROR CELL SPIDER ASSY.
	H550	CAM MIRROR DOOR ASSY.
H5600		FIELD FLATTENER
	H56XX	
H5700		OPEN
H5800		FABRICATION AND TEST TOOLING
	H5807	OPTICS PALET L/O
H5900		FEA MODELS AND TEST
(H4532		CROSS DISPERSER DOORS VS BIFOLDING DOOR CLEARANCE)

KECK/HIRES
SUPERCAMERA
LOCATING TREE

BCB 04/18/92

H5000



H5549-3	13	2	CLAMP	ALUM
H5549-2	12	1	BRACKET	ALUM
H5549-1	11	1	BRACKET	ALUM
H5548-3	10	1	SPRING	SST
H5548-2	9	1	CLAMP	ALUM
H5548-1	8	4	THERM. COMPENSATOR	DELRIN
H5546-1	7	1	TOP PLATE	STEEL
H5550-1	6	1	DOOR ASSY	
H5541-1	5	1	SPIDER ASSY	
H5539-1	4	1	TANGENT LINK ASSY	
H5536-1	3	1	AXIAL SUPPORT ASSY	
H5530-1	2	1	RADIAL SUPPORT ASSY	
H5400-1	1	1	HEXTEK MIRROR	

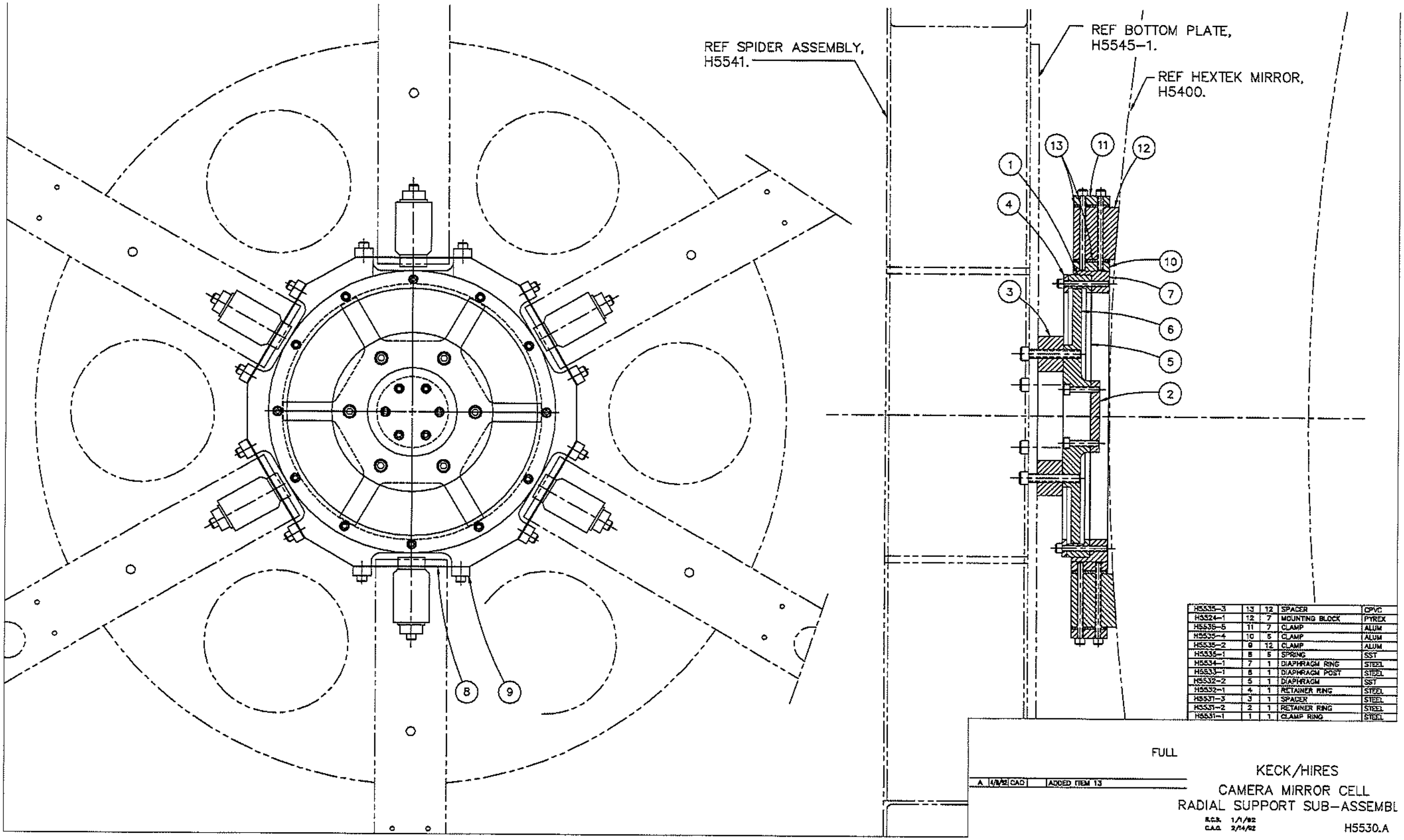
(-1) CAMERA MIRROR CELL ASSEMBLY

1/4

KECK/HIRES
CAMERA MIRROR
CELL ASSEMBLY

R.C.B. 1/1/92
C.A.C. 4/23/92

H5560



H5535-3	13	12	SPACER	CPVC
H5524-1	12	7	MOUNTING BLOCK	PYREX
H5535-5	11	7	CLAMP	ALUM
H5535-4	10	6	CLAMP	ALUM
H5535-2	9	12	CLAMP	ALUM
H5535-1	8	6	SPRING	SST
H5534-1	7	1	DIAPHRAGM RING	STEEL
H5533-1	6	1	DIAPHRAGM POST	STEEL
H5532-2	5	1	DIAPHRAGM	SST
H5532-1	4	1	RETAINER RING	STEEL
H5531-3	3	1	SPACER	STEEL
H5531-2	2	1	RETAINER RING	STEEL
H5531-1	1	1	CLAMP RING	STEEL

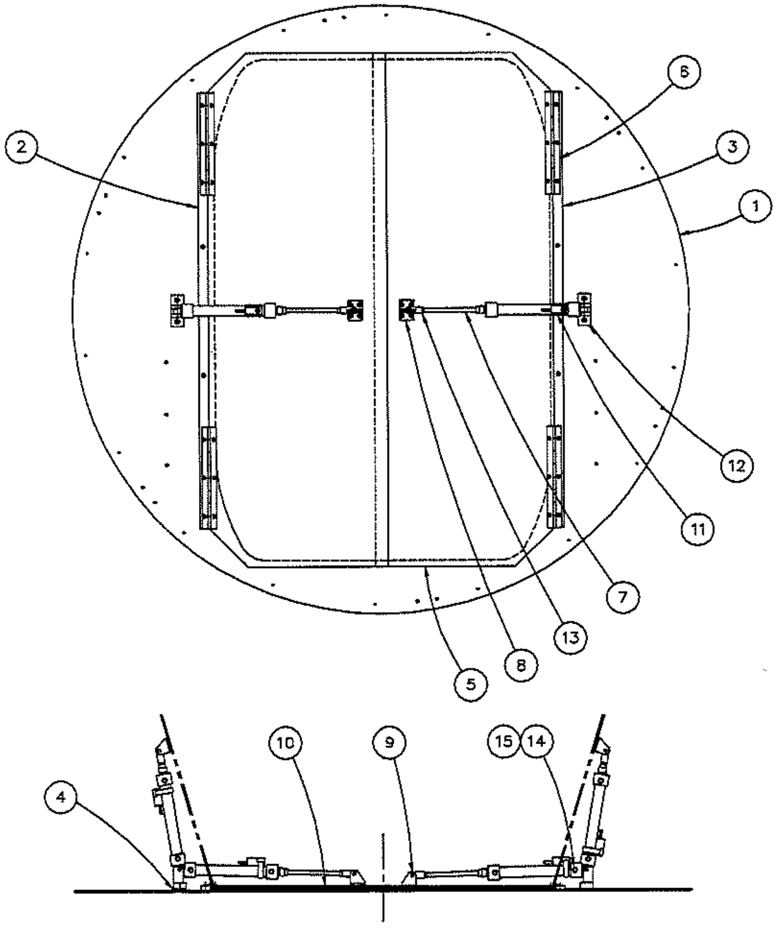
FULL

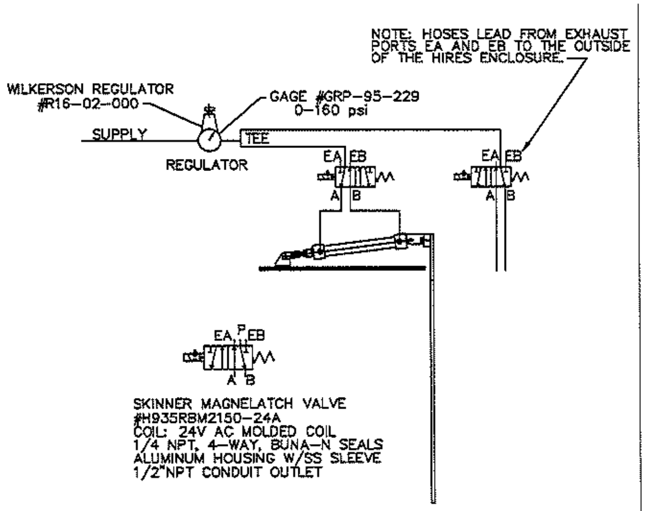
A	4/8/92	CAD		ADDED ITEM 13

KECK/HIRES
CAMERA MIRROR CELL
RADIAL SUPPORT SUB-ASSEMBL

R.C.B. 1/1/92
C.A.D. 2/14/92

H5530.A





SPEED CONTROL DETAIL
BIMBA #FCP2, 1/8 NPT.
PORT MOUNTED
FLOW CONTROL

(-1) DOOR ASSEMBLY

1 REQ'D

NOTES:

1. CELLULAR URETHANE, #4701-01-20125-1604
   WITH ADCHEM #256 ADHESIVE.
   BOYD CORP.
   2209 FAIRVIEW DR.
   CERES, CA 95307
2. BIMBA #MRS-044-DXF.
3. BIMBA #D-166-3.
4. BIMBA #MRS-087-XBL-04.
   144" LEADS, FITS 3/4" CYLINDER.
5. BIMBA #D-167.
6. BIMBA #FCP2, 1/8 NPT.
7. SWAGELOK FITTING, #B-400-1-2 (1/8 NPT).
8. SWAGELOK FITTING, #B-400-1-4.
9. REFERENCE DRAWING H4750 FOR PNEUMATIC DIAGRAMS.

–	16	A/R	1/4 TUBE TO 1/4 NPT	NOTE 8.
–	15	A/R	1/4 TUBE TO 1/8 NPT	NOTE 7.
–	14	4	SPEED CONTROL VALVE	NOTE 6.
H2302-5	13	2PR	BRACKET	NOTE 5.
H5333-3	12	2	STAND	ALUM
–	11	2	SWITCH	NOTE 4.
–	10	2	GASKET, FOAM	NOTE 1.
–	9	2	PIN, 1.0 X 0.22ø	SST
H2302-4	8	2	ROD CLEVIS	NOTE 3.
H2302-3	7	2	BIMBA AIR CYLINDER	NOTE 2.
–	6	4	HINGE STRIP	ALUM
H5553-1	5	2	DOOR	ALUM
H5552-3	4	1	CYLINDER SPACER	ALUM
H5552-1	3	1	HINGE SPACER, .250 THK	ALUM
H5552-1	2	1	HINGE SPACER, .375 THK	ALUM
H5551-1	1	1	FRONT PLATE	ALUM

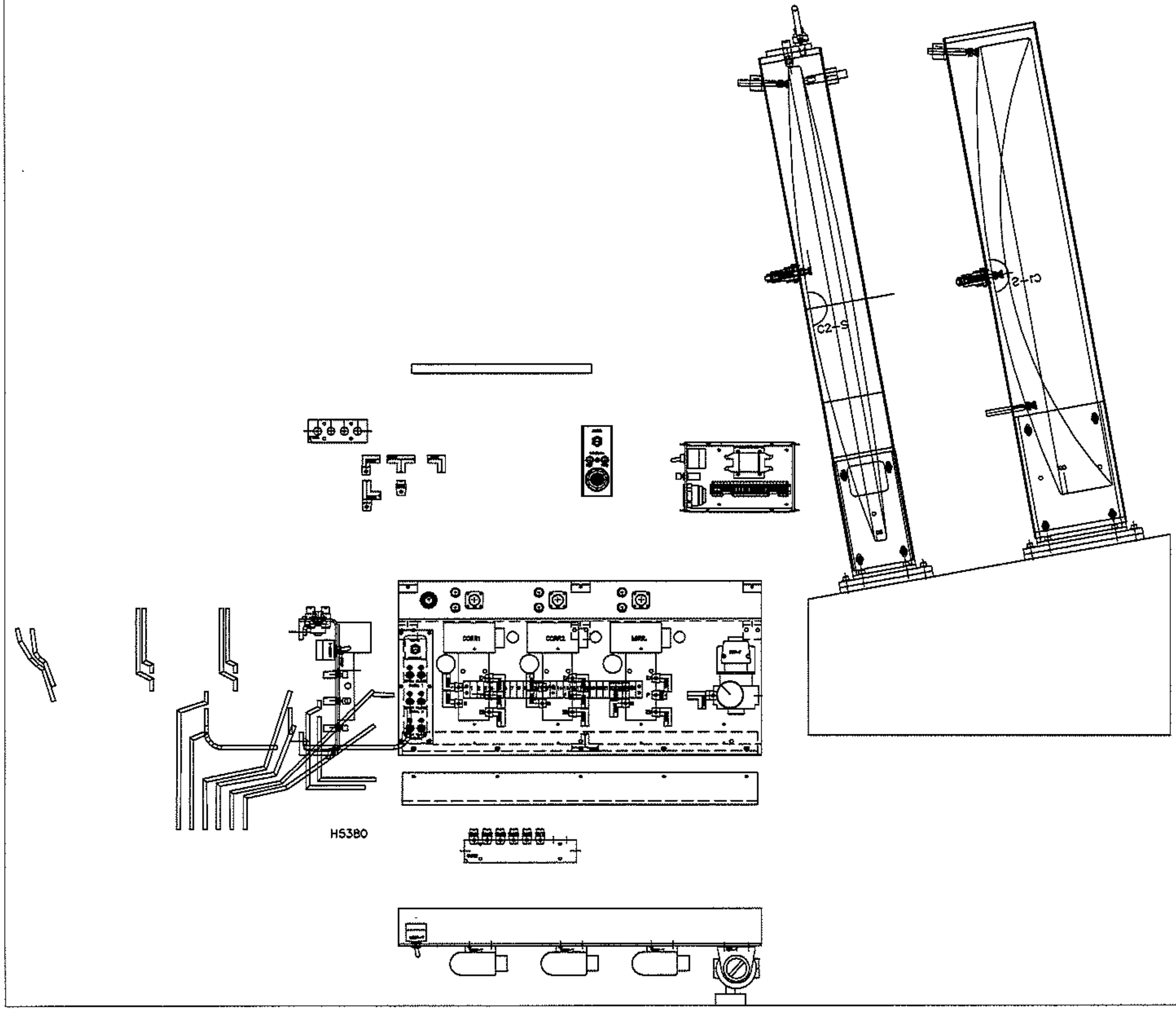
1/4

A	3/18/92	CAO		ITEM 12 WAS H2302-2
B	4/10/92	CAO		REV NOTE 1.

KECK/HIRES
CAMERA MIRROR CELL
DOOR ASSEMBLY

S.C.B. 01-10-92
C.A.O. 2/20/92

H5550.B

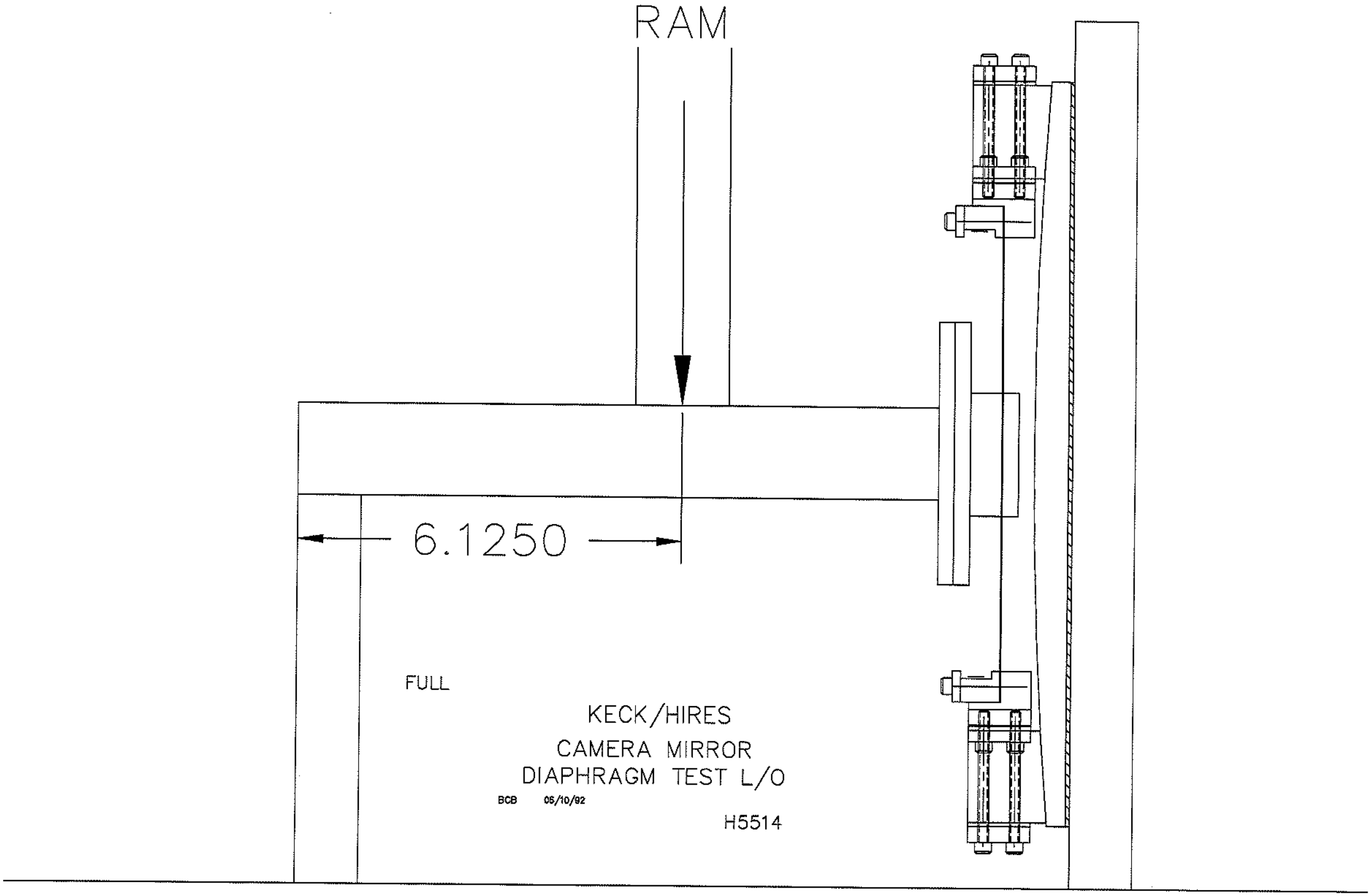


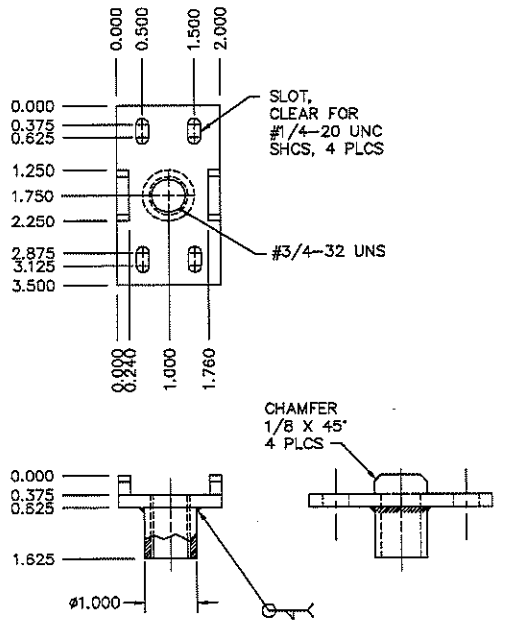
N/A

A	1/28/93	JO		REORGANIZED FOR PRINTING

KECK/HIRES
CORRECTOR CELLS
AIR SYSTEM LAYOUT
BCB 2 19 92

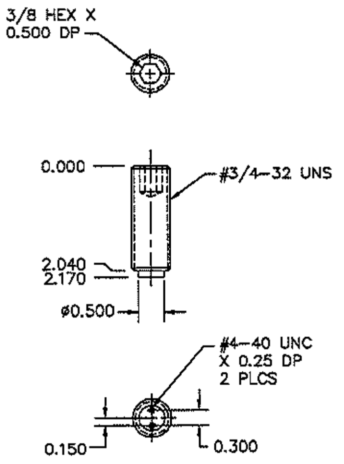
H5380.A


RAM
6.1250
FULL
KECK/HIRES
CAMERA MIRROR
DIAPHRAGM TEST L/O
BCB 05/10/92
H5514



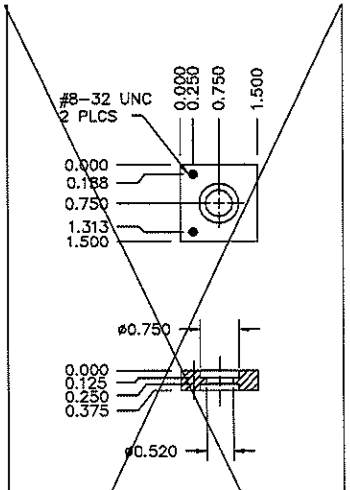
-1 BEAM SUPPORT

3 REQ'D PER CELL
STAINLESS STEEL



-2 AXIAL ADJUSTER

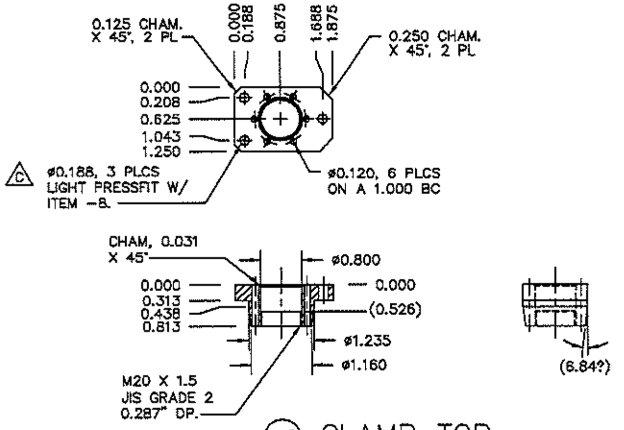
3 REQ'D PER CELL
BRASS



~~-4 PIVOT BASE~~

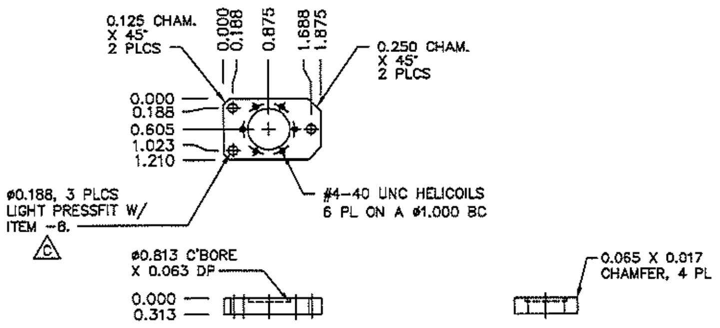
~~3 REQ'D PER CELL~~
~~ALUMINUM, 6061-T6~~
~~BLACK ANODIZE~~

OBS.



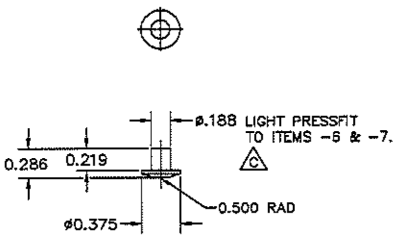
-6 CLAMP TOP

7 REQ'D PER CELL
BLACK DELRIN



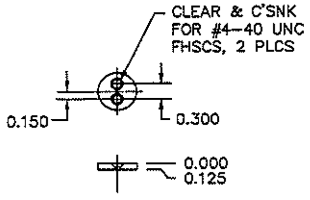
-7 CLAMP BASE

7 REQ'D PER CELL
BLACK DELRIN



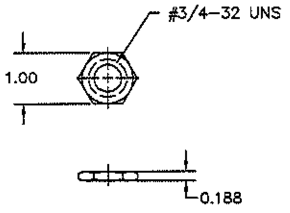
-8 BUTTON

42 REQ'D
DELRIN
SCALE: 2/1



-3 CAP

3 REQ'D PER CELL
ALUMINUM, 6061-T6
BLACK ANODIZE



-5 NUT

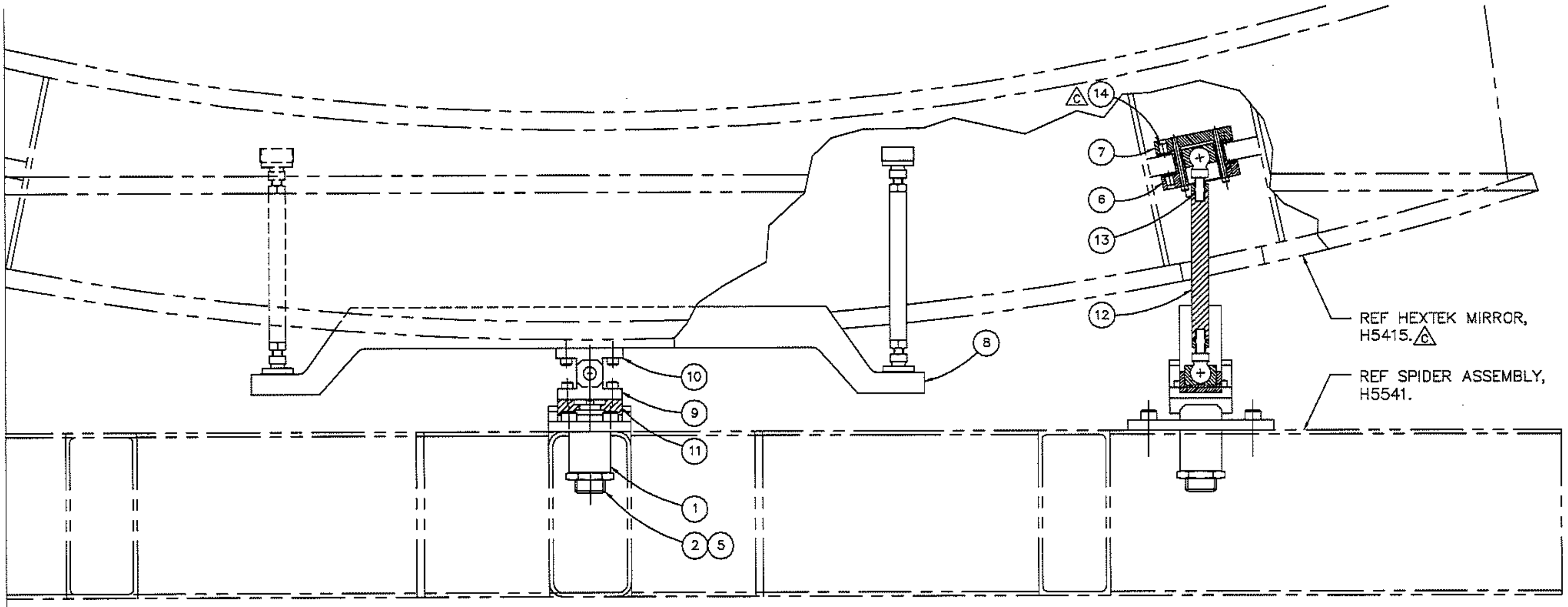
3 REQ'D PER ASSY
304 STAINLESS STEEL

A	3/28/92	CAO		REVISED ITEMS 6 & 7
B	4/7/92	CAO		REVISED ITEMS 6 & 7
C	4/6/93	CAO		CORRECT SCALE ITEM -8

KECK/HIRES
CAMERA MIRROR CELL
AXIAL SUPPORT DETAILS

B.C.B. 1/1/92
C.A.O. 1/24/92

H5537.C



(-1) AXIAL SUPPORT SUB-ASSEMBLY

△C	H5537-8	14	36	BUTTON	DELRIN
	-	13	6	LINK BALL TYPE TBS-6	"THK"
	H5538-5	12	6	SHAFT	SST
	H5538-4	11	3	PIVOT SWIVEL	ALUM
	H5538-3	10	3	PIVOT BLOCK	ALUM
	H5538-2	9	3	PIVOT BASE	ALUM
	H5538-1	8	3	ARM	ALUM
	H5537-7	7	6	CLAMP BASE	DELRIN
	H5537-6	6	6	CLAMP	DELRIN
	H5537-5	5	3	NUT	SST
	H5537-4	4	3	SPRING BASE	ALUM
	H5537-3	3	3	CAP	ALUM
	H5537-2	2	3	AXIAL ADJUSTER	BRASS
	H5537-1	1	3	BEAM SUPPORT	SST

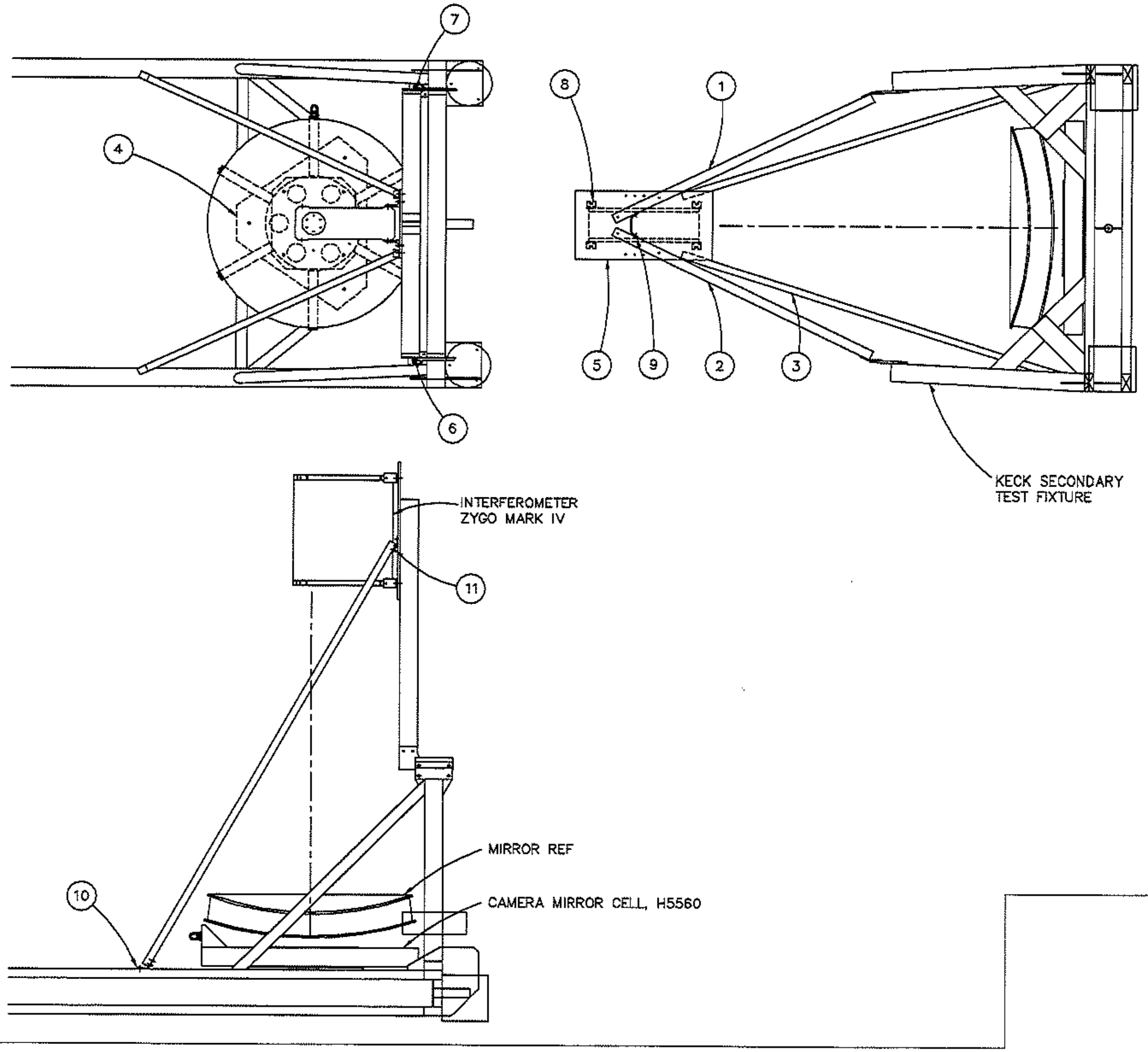
FULL

A	1/28/92	CAO		REVISED & REDRAWN
B	5/12/92	CAO		REVISED & REDRAWN
C	1 28 93	j.o.		ADD PART 14; H5415 WAS H5400.

KECK/HIRES
CAMERA MIRROR CELL
AXIAL SUPPORT ASSY

S.C.R. 1/1/92
C.A.O. 1/24/92

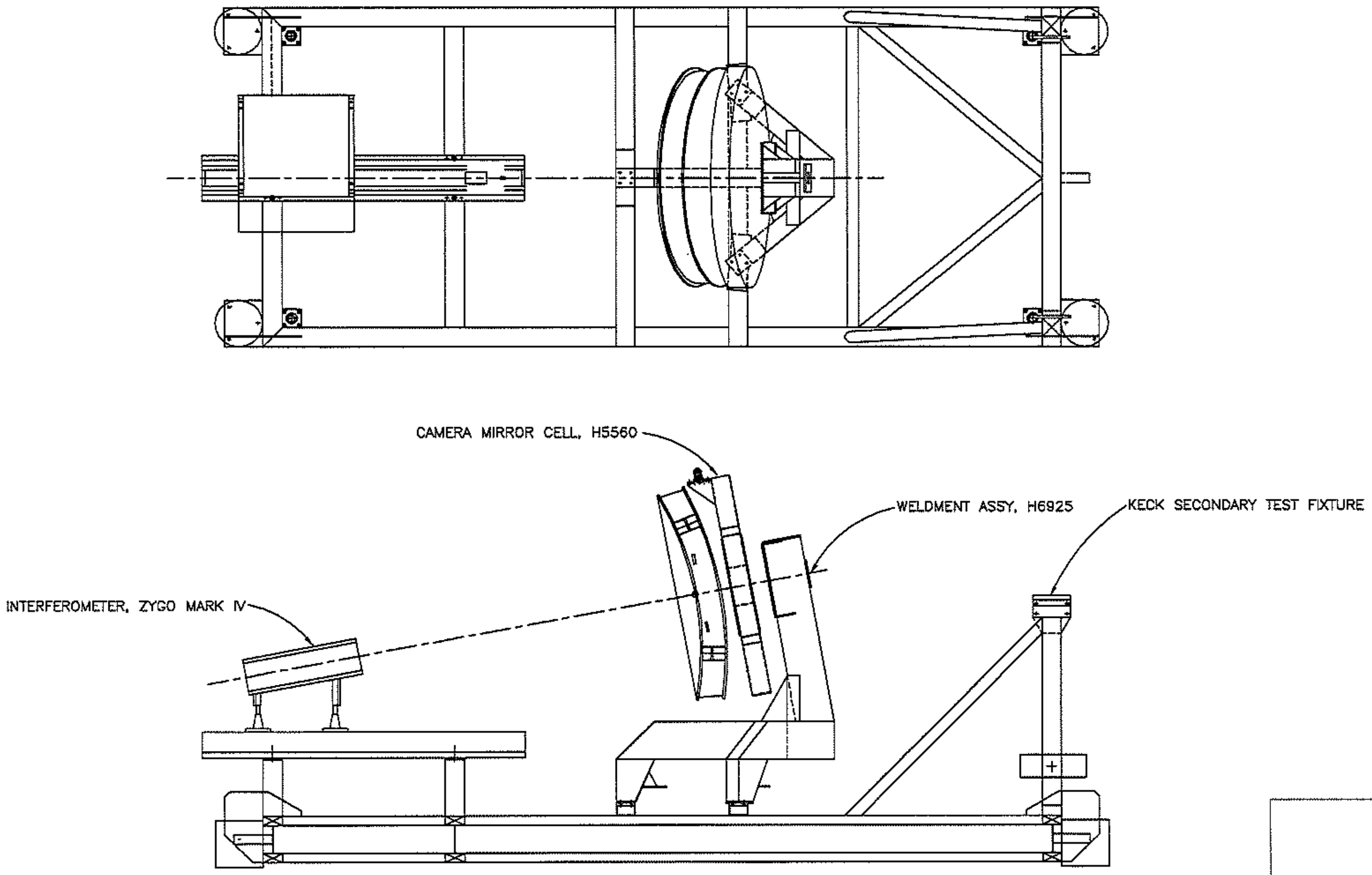
H5536.C



H5823–4	11	2	BRACKET	ALUM
H5823–3	10	2	BRACKET	ALUM
H5823–2	9	1	BRACKET	ALUM
H5823–1	8	4	BRACKET	ALUM
H5822–3	7	1	BRACKET	ALUM
H5822–2	6	1	BRACKET	ALUM
H5822–1	5	1	MOUNTING PLATE	ALUM
H5821–2	4	1	MOUNTING PLATE	ALUM
H5821–1	3	2	STRUT	STEEL
H5820–2	2	1	POST	STEEL
H5820–1	1	1	POST	STEEL

.1

KECK/HIRES
CAMERA MIRROR
HORIZONTAL TEST ASSY
B.C.B. 4/14/92
G.A.G. 4/17/92
H5824



.1

KECK/HIRES
CAMERA MIRROR
10° TEST ASSY

E.C.B. 7/1/92
C.A.G. 8/5/92

H5825

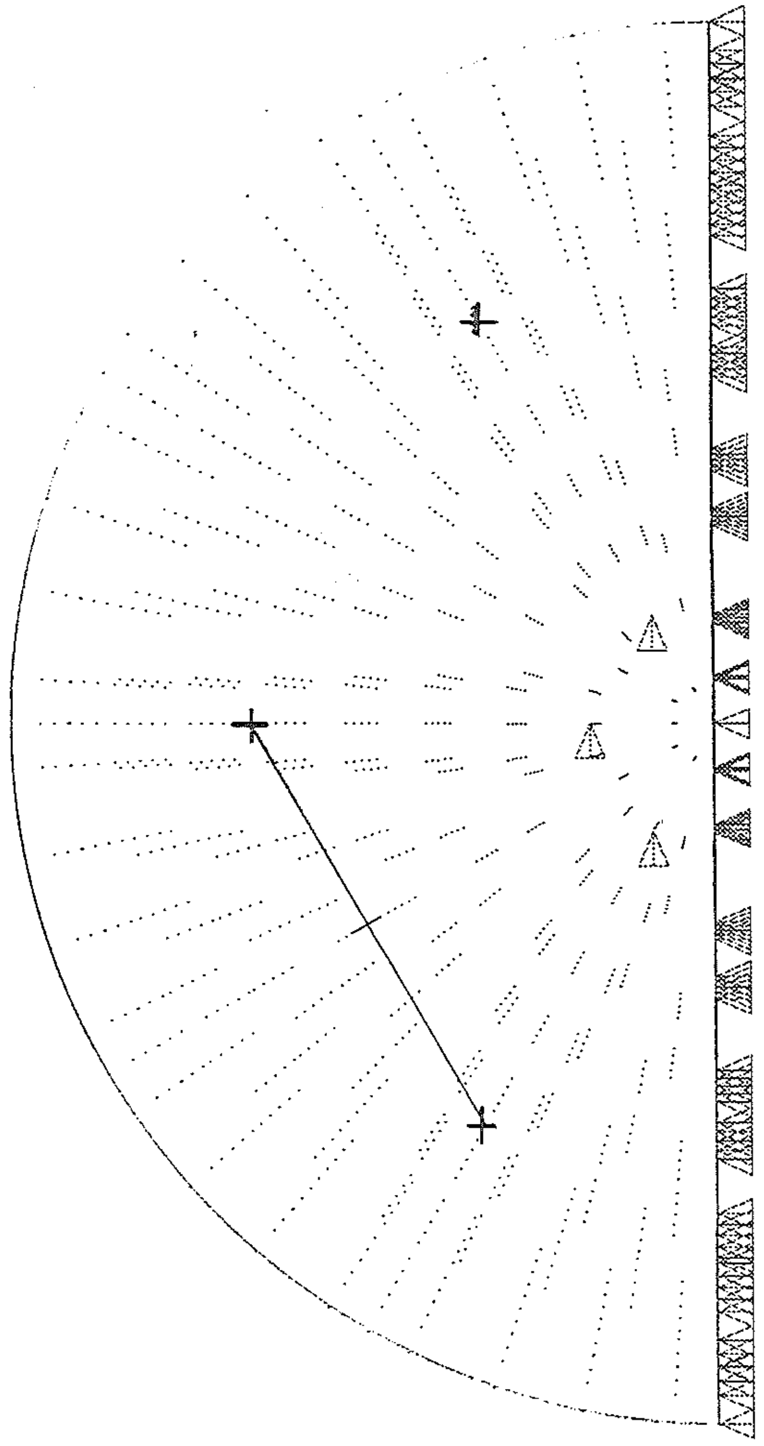

1
ANSYS 4.4A
JUL 22 1992
15:44:32
PLOT NO. 2
POST1 NODES
ZV =-1
DIST=24.962
XF =11.346
ZF =65.418
FACE HIDDEN
POST1 NODES
TDIS
ZV =-1
DIST=24.962
XF =11.346
ZF =65.418
FACE HIDDEN
POST1 ELEMENTS
TYPE NUM
TDIS
CAMERA MIRROR V16

FIGURE 1

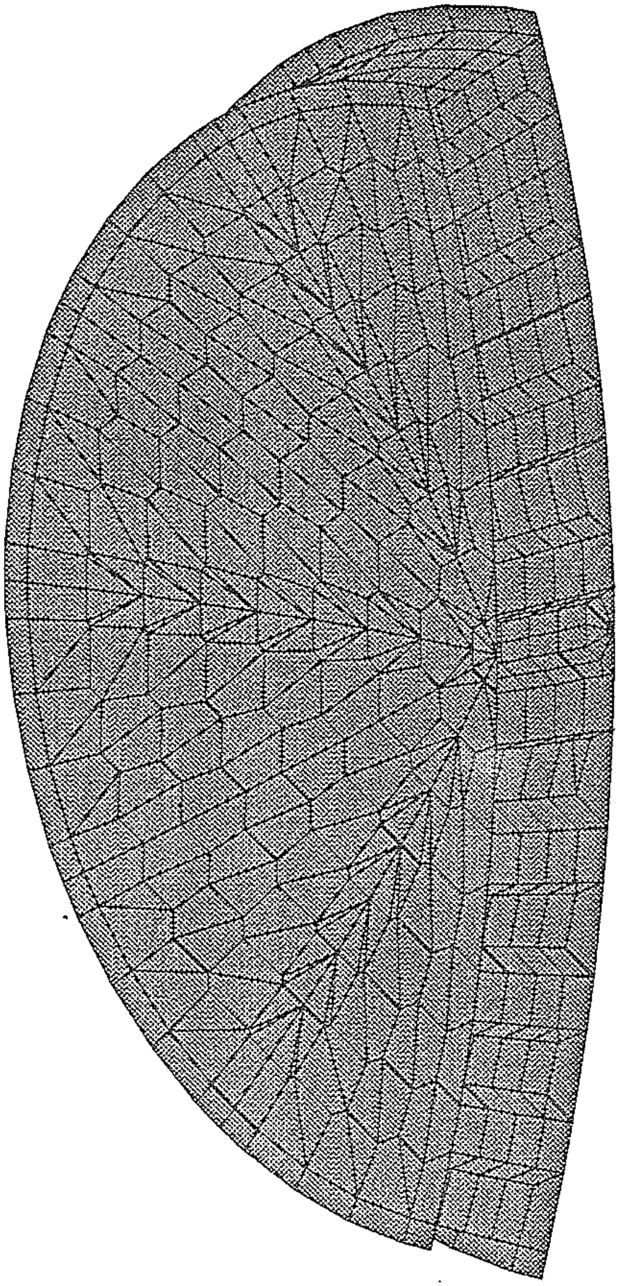

1
ANSYS 4.4A
AUG 10 1992
13:31:36
PLOT NO. 1
POST1 ELEMENTS
TYPE NUM
XV =-1
YV =0.3
ZV =-1
DIST=26.997
XF =11.346
ZF =65.418
FACE HIDDEN
CAMERA MIRROR V16

FIGURE 2

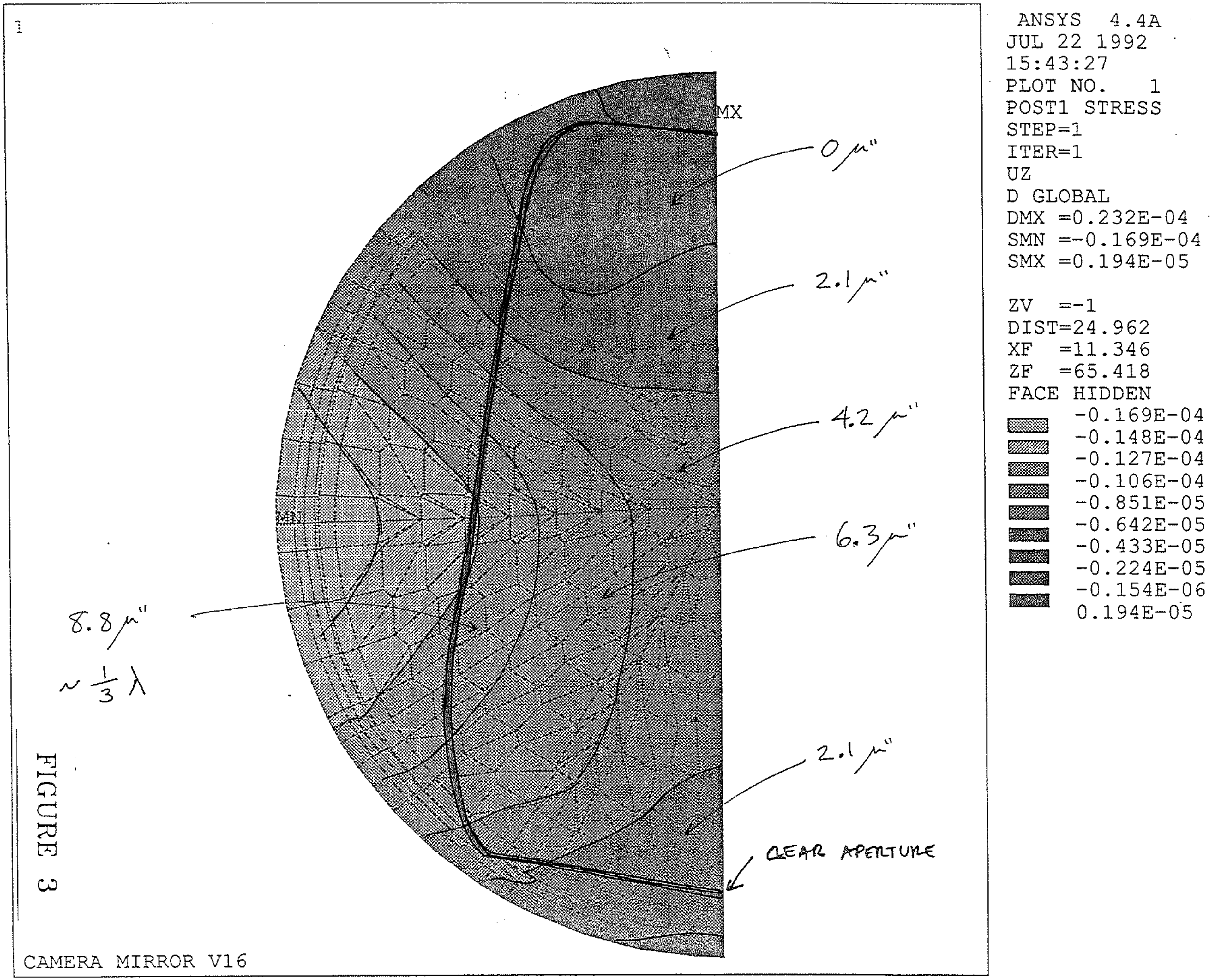
1
ANSYS 4.4A
JUL 22 1992
15:43:27
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=1
UZ
D GLOBAL
DMX =0.232E-04
SMN =-0.169E-04
SMX =0.194E-05
ZV =-1
DIST=24.962
XF =11.346
ZF =65.418
FACE HIDDEN
-0.169E-04
-0.148E-04
-0.127E-04
-0.106E-04
-0.851E-05
-0.642E-05
-0.433E-05
-0.224E-05
-0.154E-06
0.194E-05
MX
MN
0 µ"
2.1 µ"
4.2 µ"
6.3 µ"
8.8 µ"
~ 1/3 λ
2.1 µ"
CLEAR APERTURE
CAMERA MIRROR V16

FIGURE 3

Appendix V List of Drawings — Corrector Lenses

1. Figure 1: Finite Element Half Model Showing the Application of Radial Forces
2. Figure 2: Finite Element Contour Plot
3. Figure 3: FEA Contour Plot Showing Clear Aperture of Lens
4. Figure 4: Finite Element Contour Plot
5. Figure 5: FEA Contour Plot Showing Clear Aperture of Lens
6. Figure 9: Interferometer Output, No Forces
7. Figure 11: WISP Output, No Forces
8. Figure 17: Interferometer Output, Optimum Support
9. Figure 18: WISP Output, Optimum Support
10. H0148 Super-Duper III Camera Layout
11. H5000 Locating Tree
12. H5266 Meniscus Lens Sling Assembly
13. H5267 Biconvex Lens Sling Assembly
14. H5324 Meniscus Cell Assembly
15. H5328 Axial Support Details
16. H5349 Bi-Convex Cell Assembly
17. H5363 Lens Installation/Removal Tool
18. H5370 Bi-Fold Door Sub-Assembly
19. H5375 Bi-Fold Door Air Logic
20. H5376 Bi-Fold Door Assembly
21. H5380 Air System Layout
22. H5384 Bi-Convex Lens Installation/Removal Procedure
23. H5385 Meniscus Lens Installation/Removal Procedure
24. H5811 Testing Meniscus Lens
25. H5826 Testing Meniscus Lens at 10°

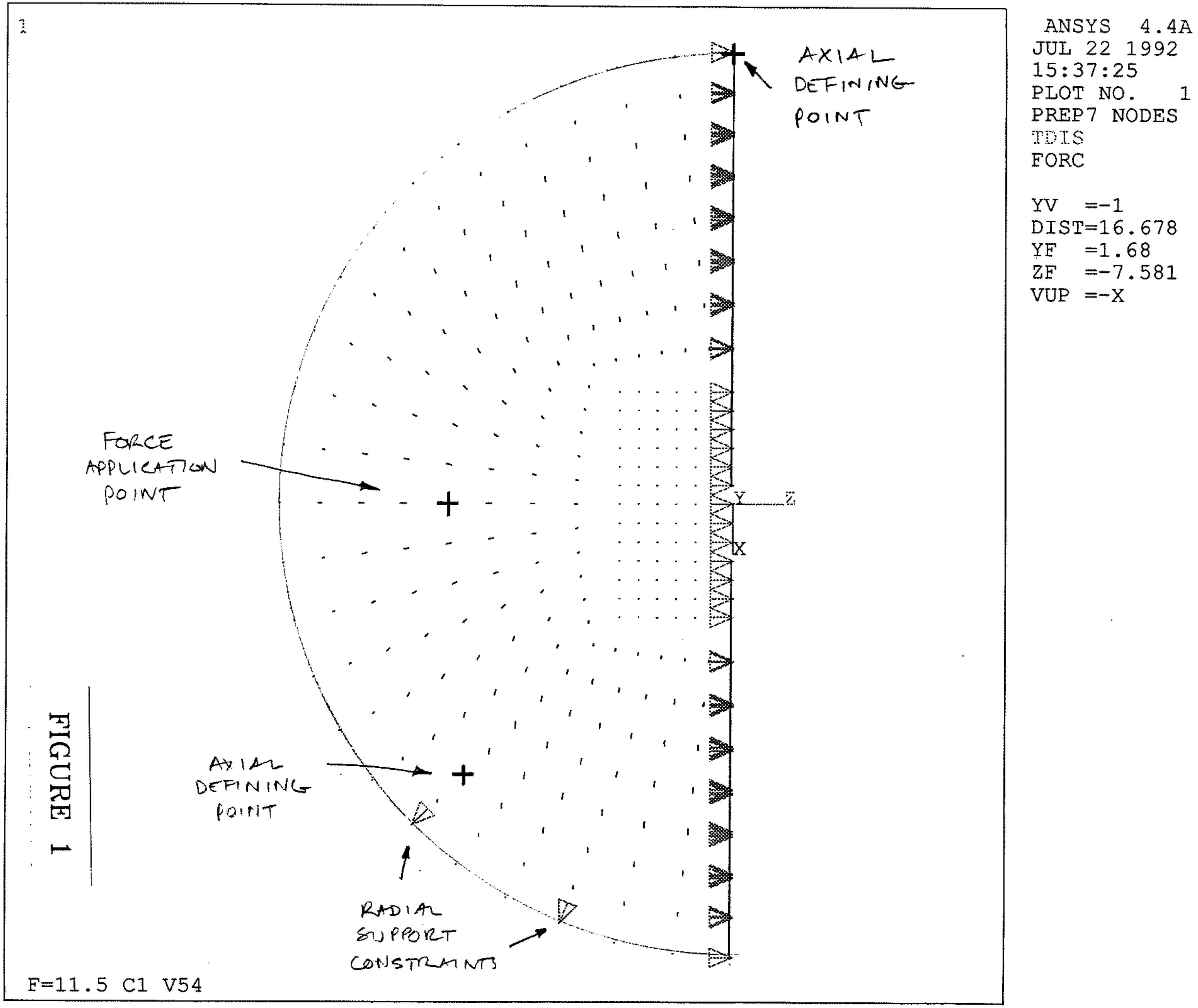

ANSYS 4.4A
JUL 22 1992
15:37:25
PLOT NO. 1
PREP7 NODES
TDIS
FORC
YV =-1
DIST=16.678
YF =1.68
ZF =-7.581
VUP =-X
AXIAL DEFINING POINT
FORCE APPLICATION POINT
AXIAL DEFINING POINT
RADIAL SUPPORT CONSTRAINTS
Y
Z
X
F=11.5 C1 V54

FIGURE 1

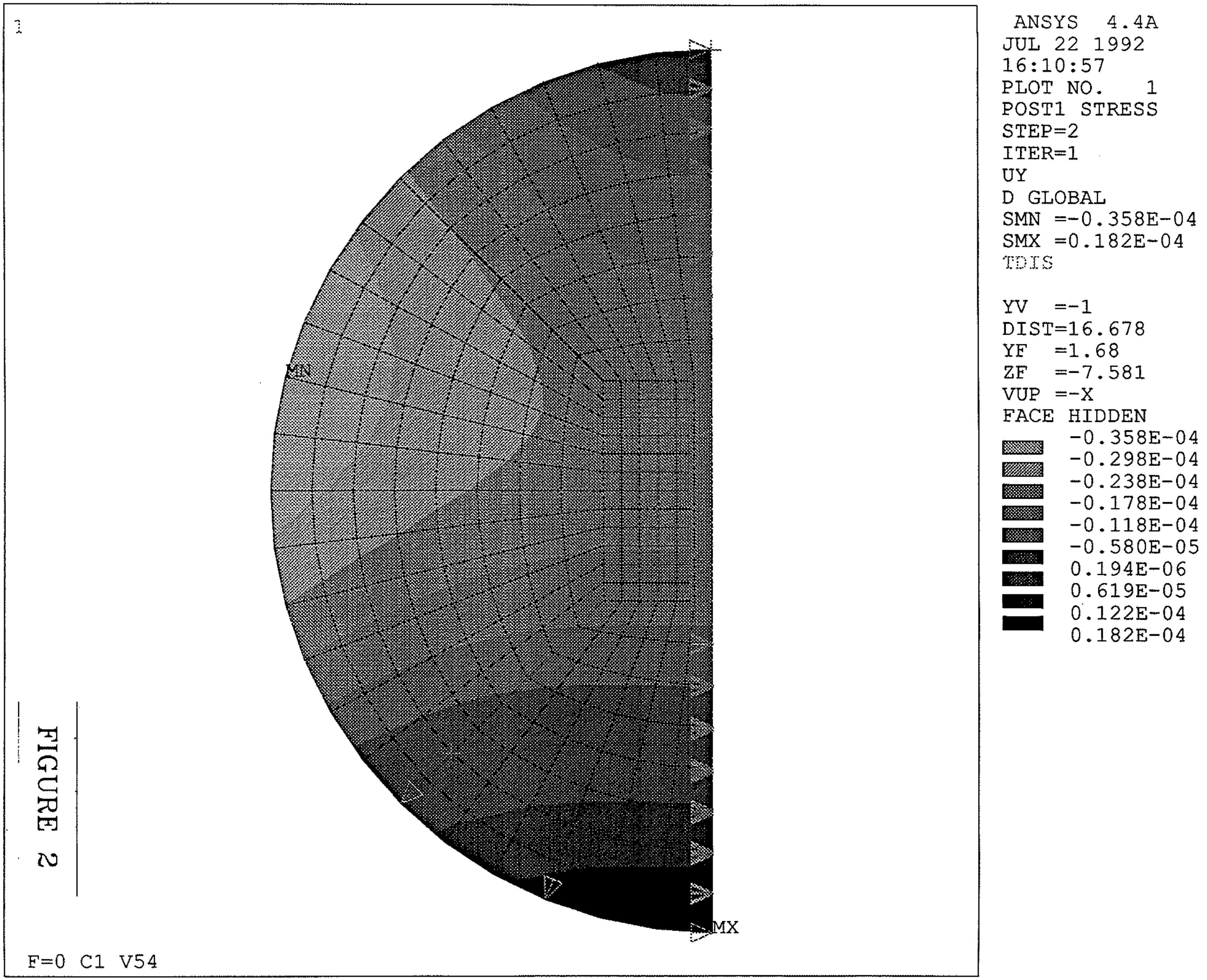
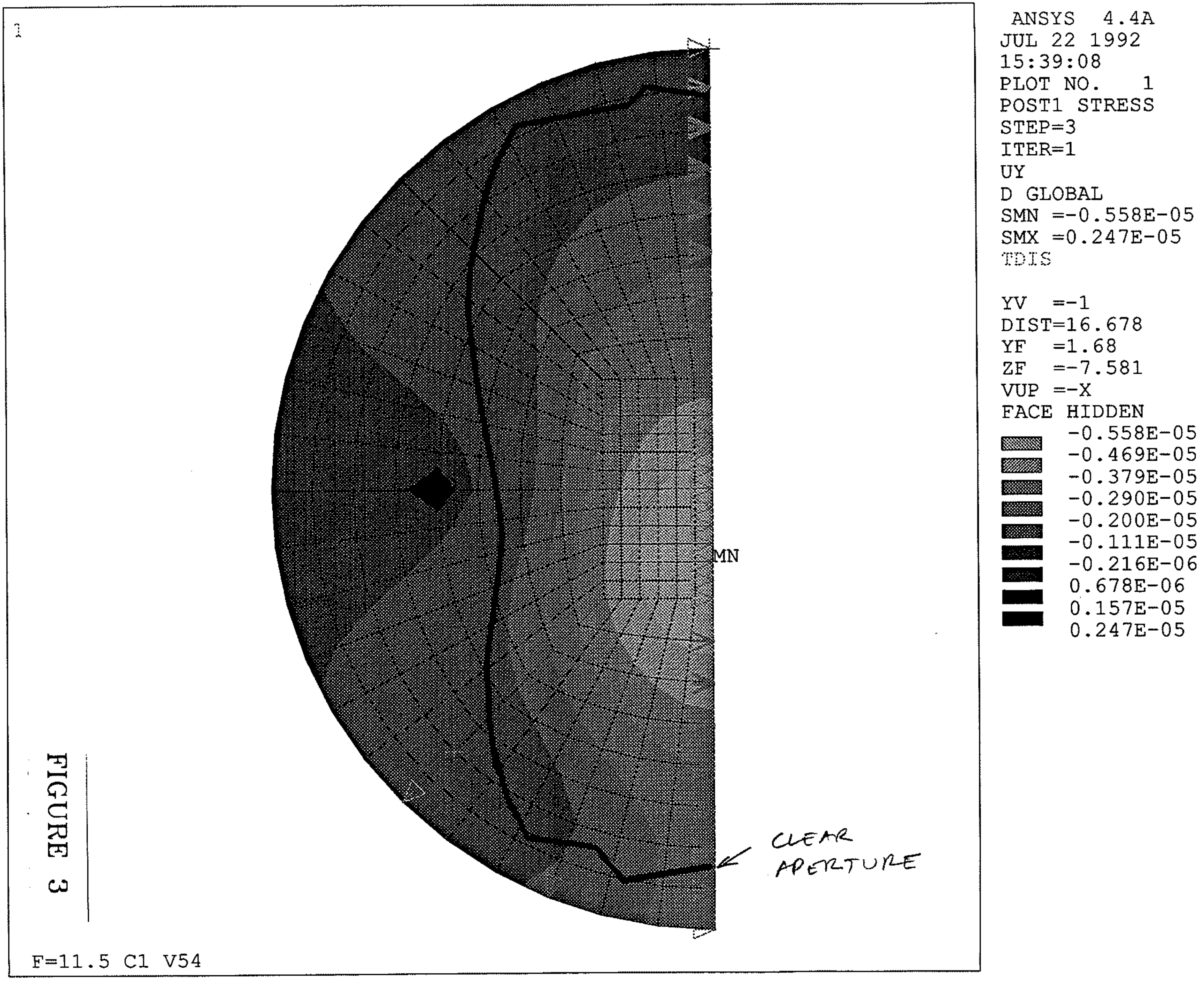

1
ANSYS 4.4A
JUL 22 1992
16:10:57
PLOT NO. 1
POST1 STRESS
STEP=2
ITER=1
UY
D GLOBAL
SMN =-0.358E-04
SMX =0.182E-04
TDIS
YV =-1
DIST=16.678
YF =1.68
ZF =-7.581
VUP =-X
FACE HIDDEN
-0.358E-04
-0.298E-04
-0.238E-04
-0.178E-04
-0.118E-04
-0.580E-05
0.194E-06
0.619E-05
0.122E-04
0.182E-04
MN
MX
F=0 C1 V54

FIGURE 2



CLEAR APERTURE

FIGURE 3

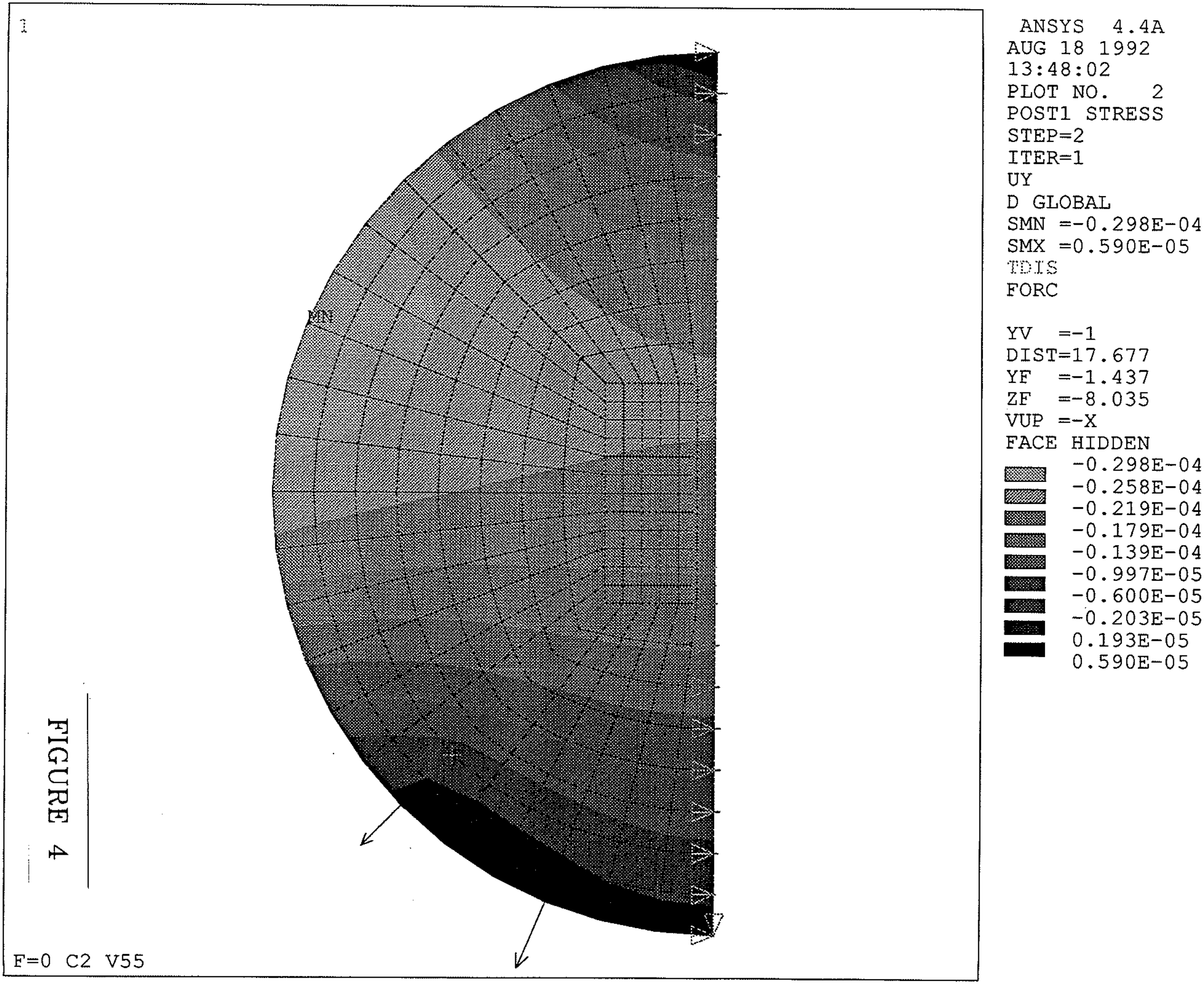

ANSYS 4.4A
AUG 18 1992
13:48:02
PLOT NO. 2
POST1 STRESS
STEP=2
ITER=1
UY
D GLOBAL
SMN =-0.298E-04
SMX =0.590E-05
TDIS
FORC
YV =-1
DIST=17.677
YF =-1.437
ZF =-8.035
VUP =-X
FACE HIDDEN
-0.298E-04
-0.258E-04
-0.219E-04
-0.179E-04
-0.139E-04
-0.997E-05
-0.600E-05
-0.203E-05
0.193E-05
0.590E-05
MN
1
F=0 C2 V55

FIGURE 4

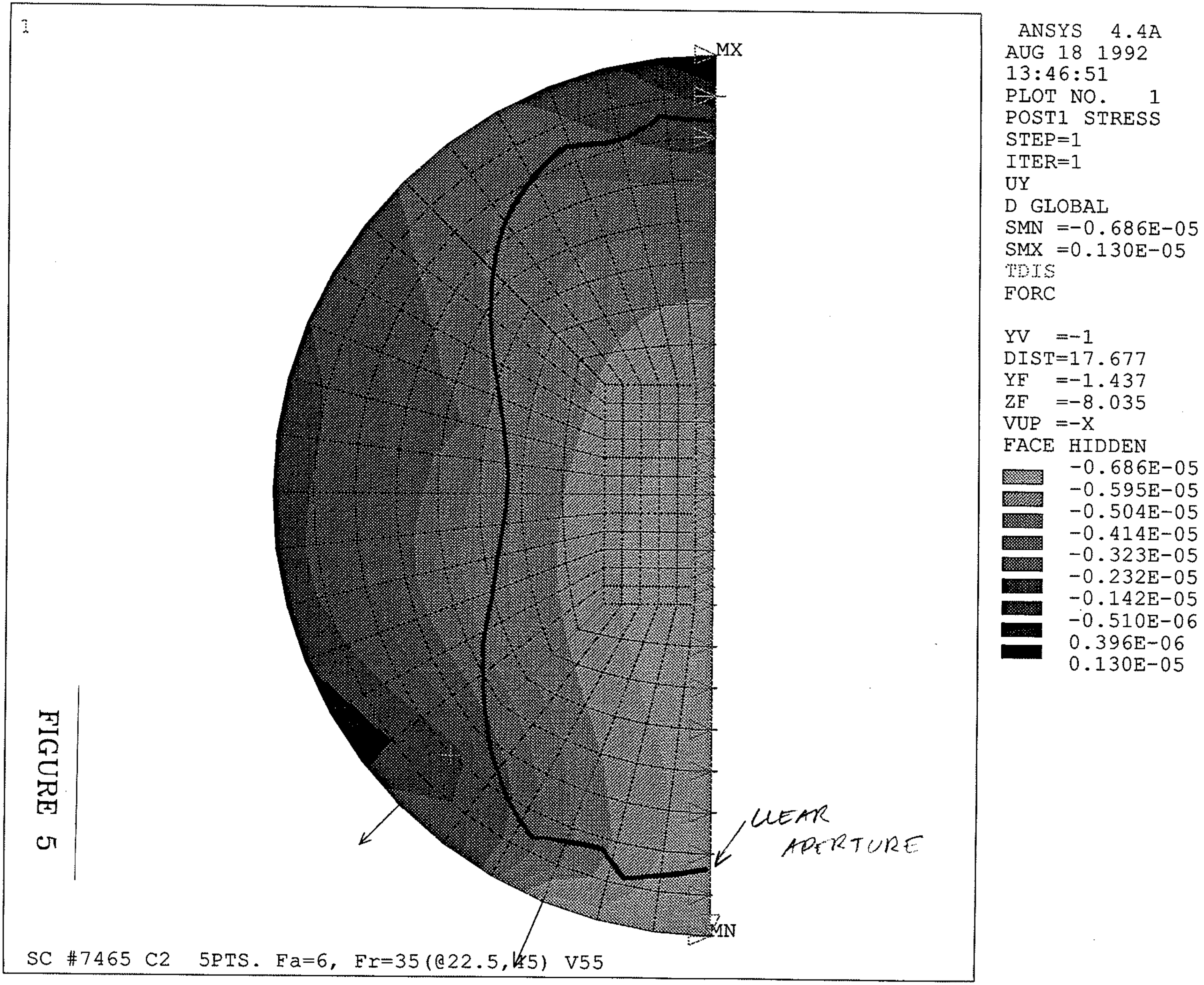

ANSYS 4.4A
AUG 18 1992
13:46:51
PLOT NO. 1
POST1 STRESS
STEP=1
ITER=1
UY
D GLOBAL
SMN =-0.686E-05
SMX =0.130E-05
TDIS
FORC
YV =-1
DIST=17.677
YF =-1.437
ZF =-8.035
VUP =-X
FACE HIDDEN
-0.686E-05
-0.595E-05
-0.504E-05
-0.414E-05
-0.323E-05
-0.232E-05
-0.142E-05
-0.510E-06
0.396E-06
0.130E-05
MX
MN
CLEAR APERTURE
SC #7465 C2 5PTS. Fa=6, Fr=35(@22.5,45) V55

FIGURE 5

Corrector #2 7-17-92

10° Lean

No Tweeking / 3 pt. support

File: CR2NF#1
No Forces

#1

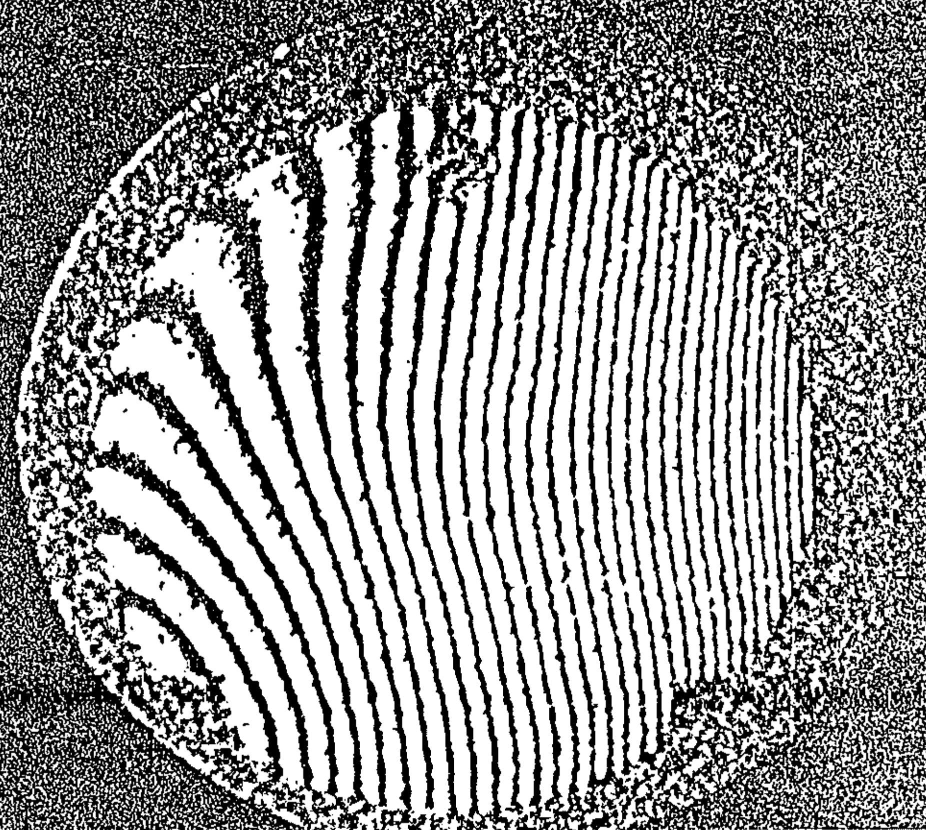


FIGURE 9

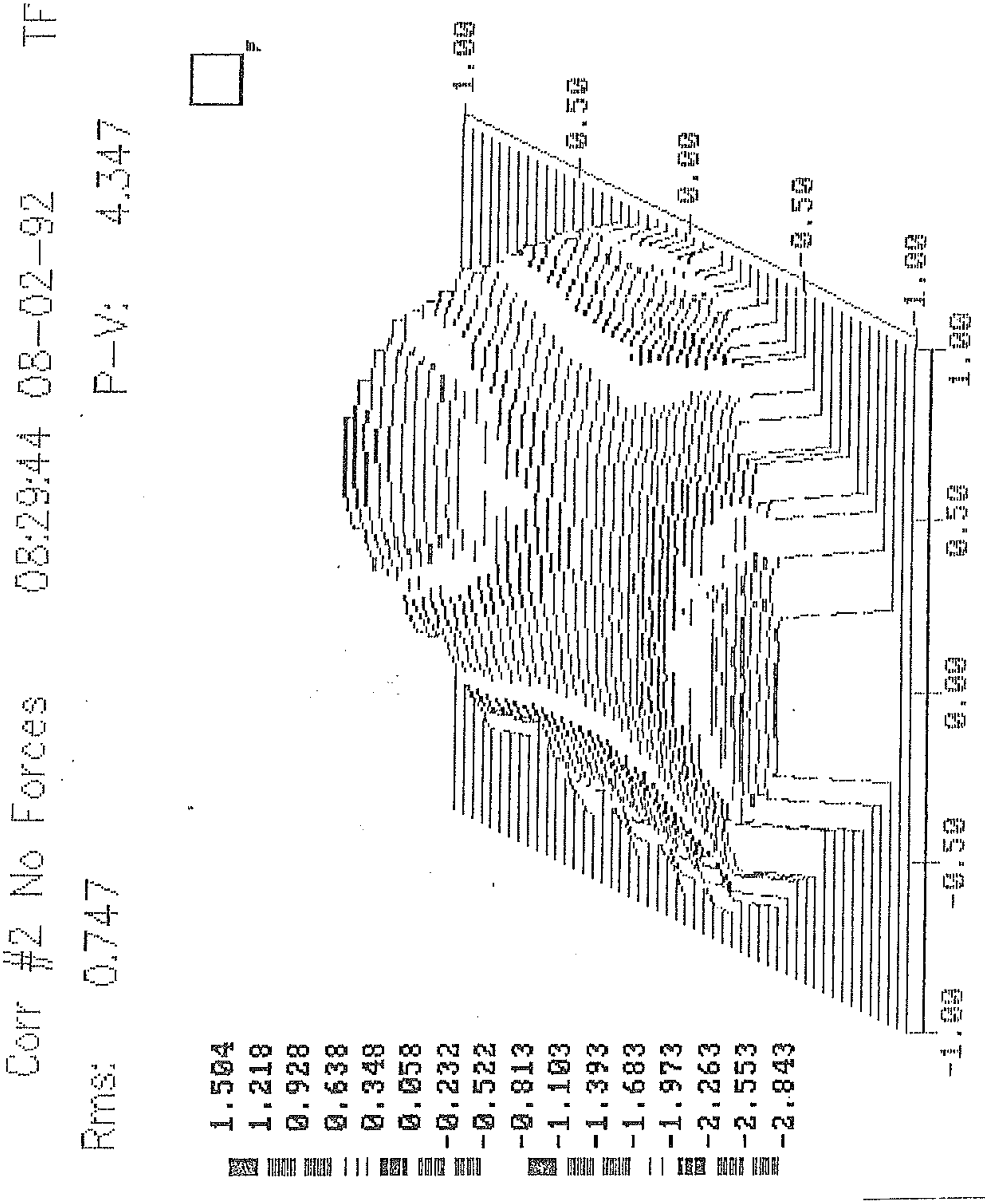
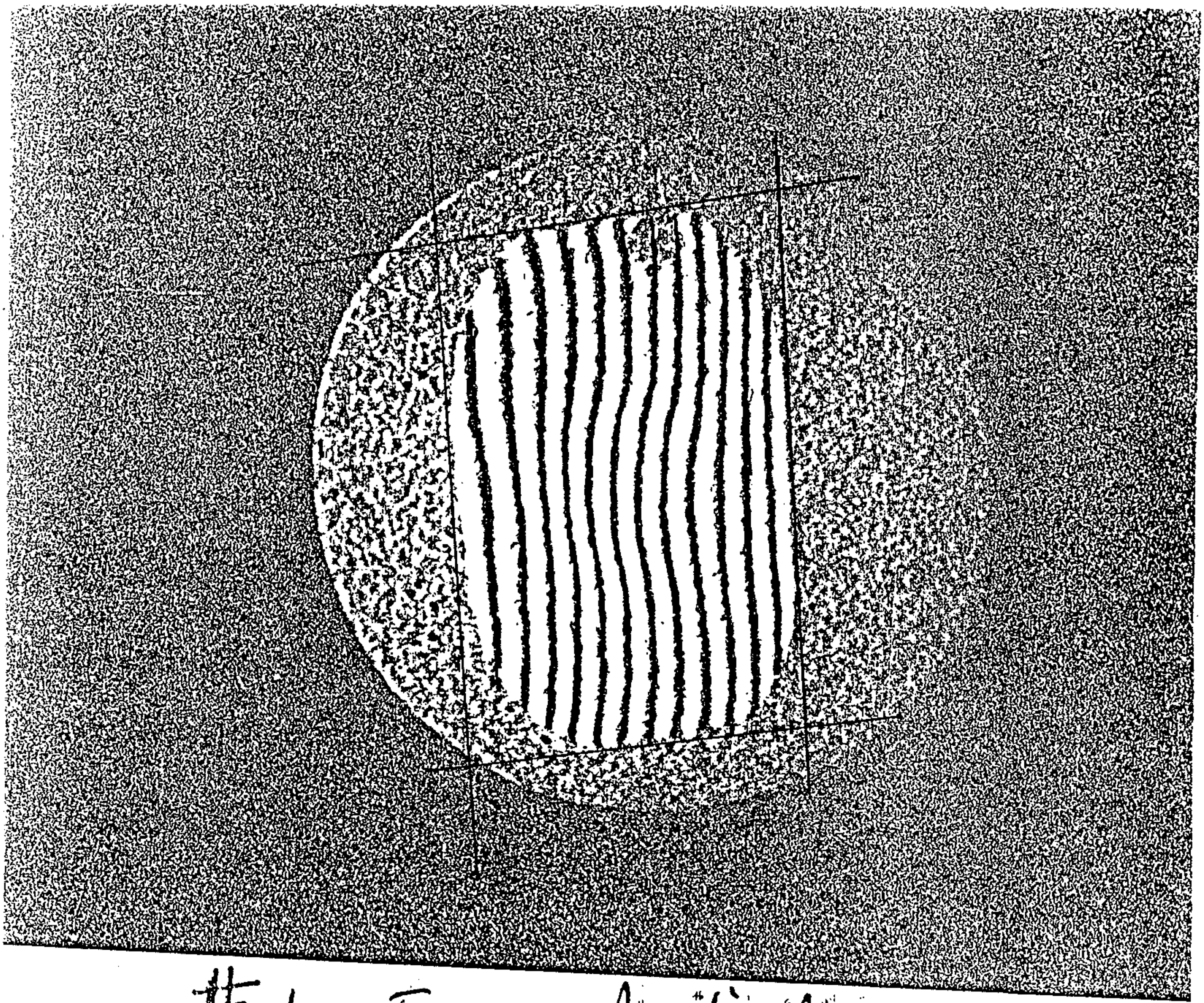

Corr #2 No Forces
08:29:44 08-02-92
TF
Rms: 0.747
P-V: 4.347
1.504
1.218
0.928
0.638
0.348
0.058
-0.232
-0.522
-0.813
-1.103
-1.393
-1.683
-1.973
-2.263
-2.553
-2.843
-1.00
-0.50
0.00
0.50
1.00
1.00
0.50
0.00
-0.50
-1.00

FIGURE 11



#1 Forces Applied 7-20-92

Masked C.A.

Corr. #2

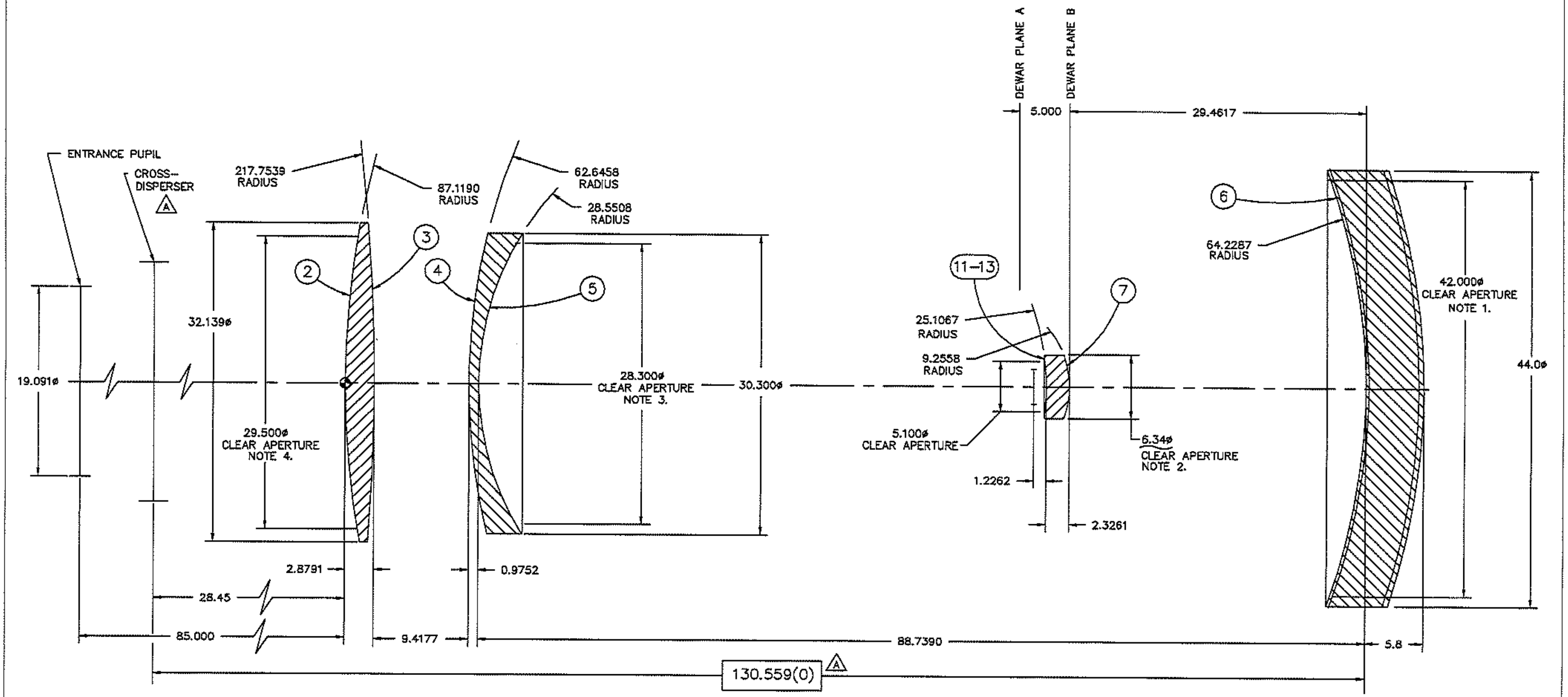
File: CR2FACA1

Final 10° Lean Test
Best Representative
Forces applied.
P-V. = .65λ

FIGURE 17

```
Corr2 Cell Forces CA 06:42:40 07-19-92
OPD data

TERM            RMS FIT        COEFFICIENTS
TILT             0.103       -4.9845       -0.0879
FOCUS            0.097       -4.9897       -0.0828         0.0653
SEIDEL           0.060       -4.8561       -0.0994        -0.1466        -0.3611
                              0.0887        0.1285        -0.0331        -0.1432

                  AMT         ANGLE
TILT             5.113        180.4
FOCUS            0.194
ASTIG            0.744         83.1
COMA             0.398        -14.5
SA3             -0.859

TERMS REMOVED:   TILT   FOCUS

x center      y center      radius
  50.00         50.00        39.81


DATA PTS     WEDGE      PEAK     VALLEY     P-V      RMS     STREHL RATIO
  3096        0.50      0.222    -0.427    0.648    0.103       0.656
```

FIGURE 18



① EPPS DESIGN #4052 (6/3/92)

FINAL "AS-BUILT" PRESCRIPTION
USE WITH R=65.0" CONVEX TEK CCD
T = 0'C
THIS DRAWING REPLACES H0135, SUPER-DUPER II
WHICH WAS EPPS DESIGN #7465 (11/15/90)
THE FLAT FIELD VERSION #4753 IS DRAWING H0149.
B 6.7° FOV (FIELD OF VIEW)

NOTES:
1. 37.603ø CLEAR APERTURE FOR THIS CCD.
SEE H5400-H5405, H5415, H0144 FOR DETAILS
2. 6.34ø C.A. FROM 6.44ø BLANK
SEE H7181 FOR LENS DETAIL
3. 25.90ø C.A.
SEE H0136, H0142, H0145, H0147
4. 27.13ø C.A.
SEE H0136, H0141, H0146

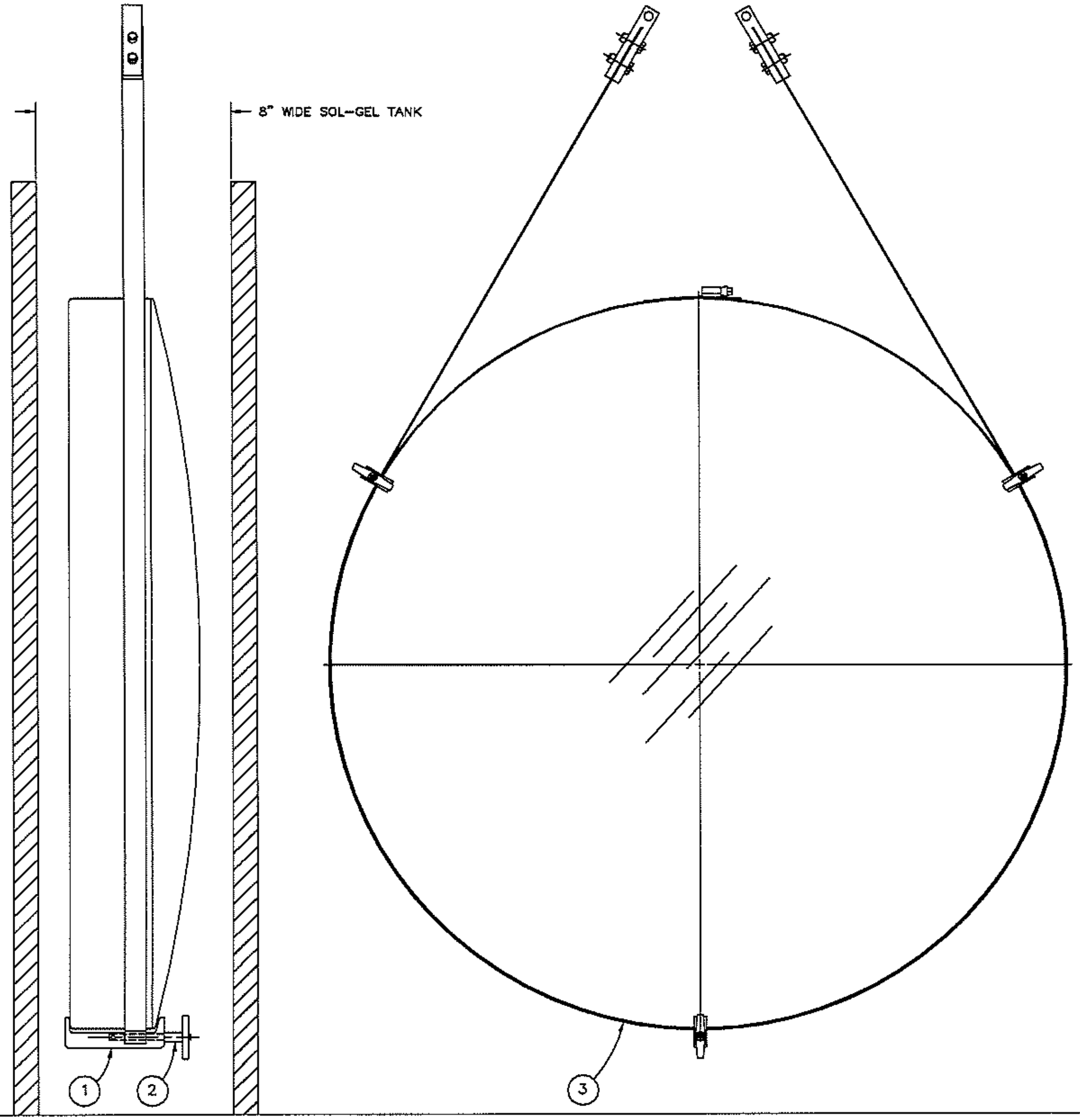
1/4

A	8 11 92	j.o.		ADD DIMENSION TO CROSS-DISPERSER.
B	6 13 93	j.o.		ADD FIELD OF VIEW NOTE.

KECK/HIRES
SUPER-DUPER CAMERA III
AS-BUILT "CURVED FIELD"
H.EPPS 3 92
j.o. 6 5 92
H0148.B

- H5000 THIS DRAWING
- H5016 CELL DOOR VS. DEWAR CLEARANCE
- H5100 OPEN
- H5200 CORRECTOR TOOLING
  - H5210 CORRECTOR TOOLS
  - H5214 CAMERA MIRROR TOOLS
- H5300 CORRECTOR CELLS AND SUPPORT STRUCTURE
  - H5303 CORRECTOR BASE ASSY (ISOMETRIC)
  - H5314 CORRECTOR CELL TOOLING L/O
  - H5324 MENISCUS CORRECTOR CELL ASSY
  - H5328 CORRECTOR CELL AXIAL SUPPORT ASSY'S
  - H5324 MEN. CORR. DOOR ASSY
  - H5349 BICONVEX CORRECTOR CELL ASSY
  - H5363 CORRECTOR CELL ASSEMBLY FIXTURE
  - H5370 BI–FOLDING DOOR ASSEMBLY
- H5400 CAMERA MIRROR AND TOOLING
  - H5401 CAMERA MIRROR L/O
  - H5409 CAMERA MIRROR SUPPORT ASSY (FOR STRASBAUGH)
  - H5411 CAMERA MIRROR 25" LAP (STRASBAUGH)
  - H5412 CAM. MIRROR 30" LAP (STRASBAUGH)
  - H5415 CAM. MIRROR (HEXTEK DRAWING)
  - H5420 BEAM1 RAYTRACE AT CAMERA PLANE
  - H5421 BEAM1 RAYTRACE OF TELESCOPE AND HIRES
- H5500 CAMERA MIRROR CELL
  - H5530 CAM. MIRROR RADIAL SUPPORT ASSY.
  - H5536 CAM. MIRROR AXIAL SUPPORT ASSY.
  - H5539 CAM. MIRROR TANGENT LINK ASSY.
  - H5541 CAM. MIRROR CELL SPIDER ASSY.
  - H550 CAM MIRROR DOOR ASSY.
- H5600 FIELD FLATTENER
  - H56XX
- H5700 OPEN
- H5800 FABRICATION AND TEST TOOLING
  - H5807 OPTICS PALET L/O
- H5900 FEA MODELS AND TEST
- (H4532 CROSS DISPERSER DOORS VS BIFOLDING DOOR CLEARANCE)

KECK/HIRES
SUPERCAMERA
LOCATING TREE
SCB 04/18/92
H5000



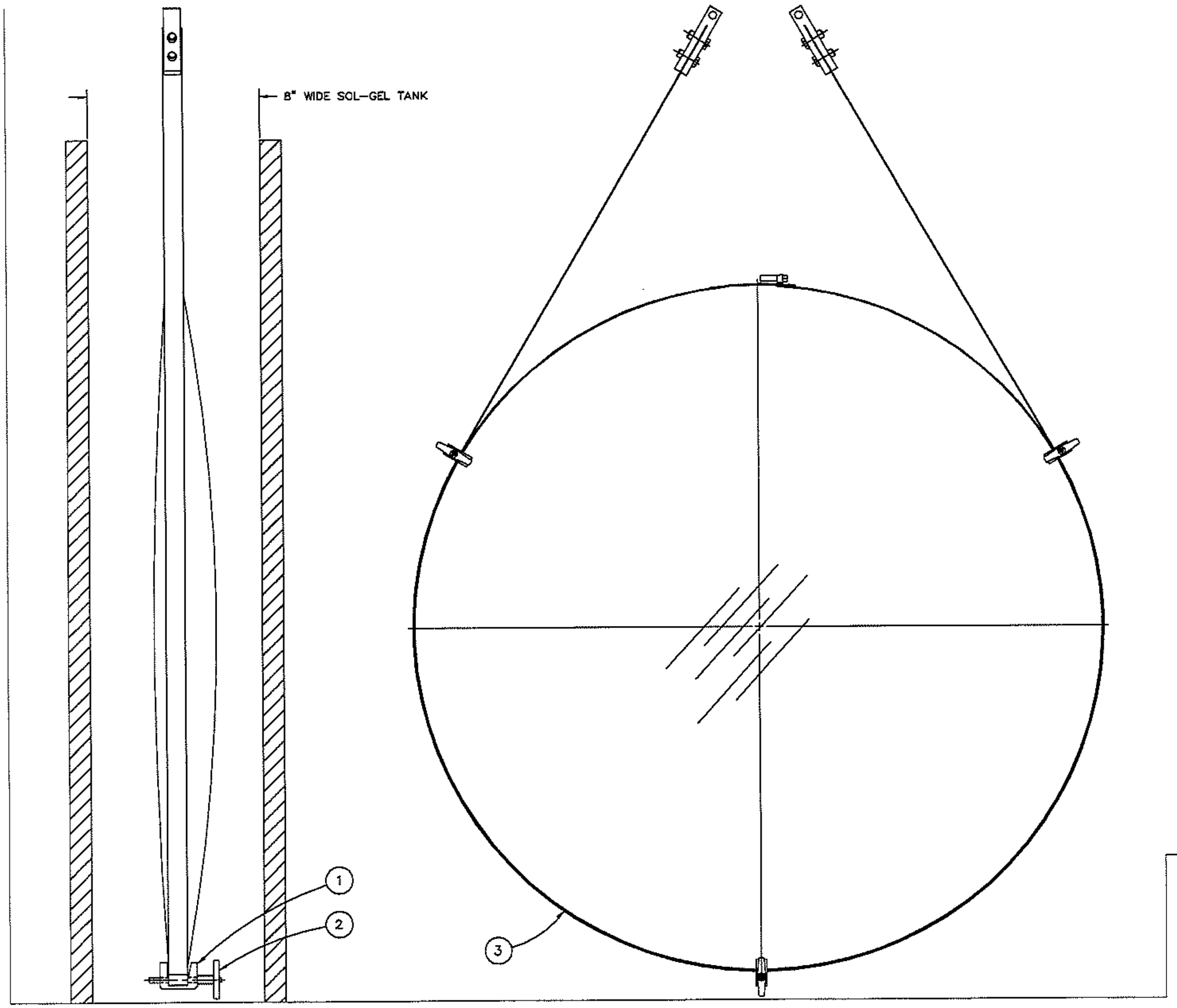
H5264-1	3	1	SLING WELDMENT	SST
–	2	3	PIN	SST
H5261-2	1	3	LOCKING CLIP	ALUM

1/2

KECK/HIRES
MENISCUS LENS
SLING ASSEMBLY

B.C.B. 6/1/92
C.A.C. 6/23/92

H5266



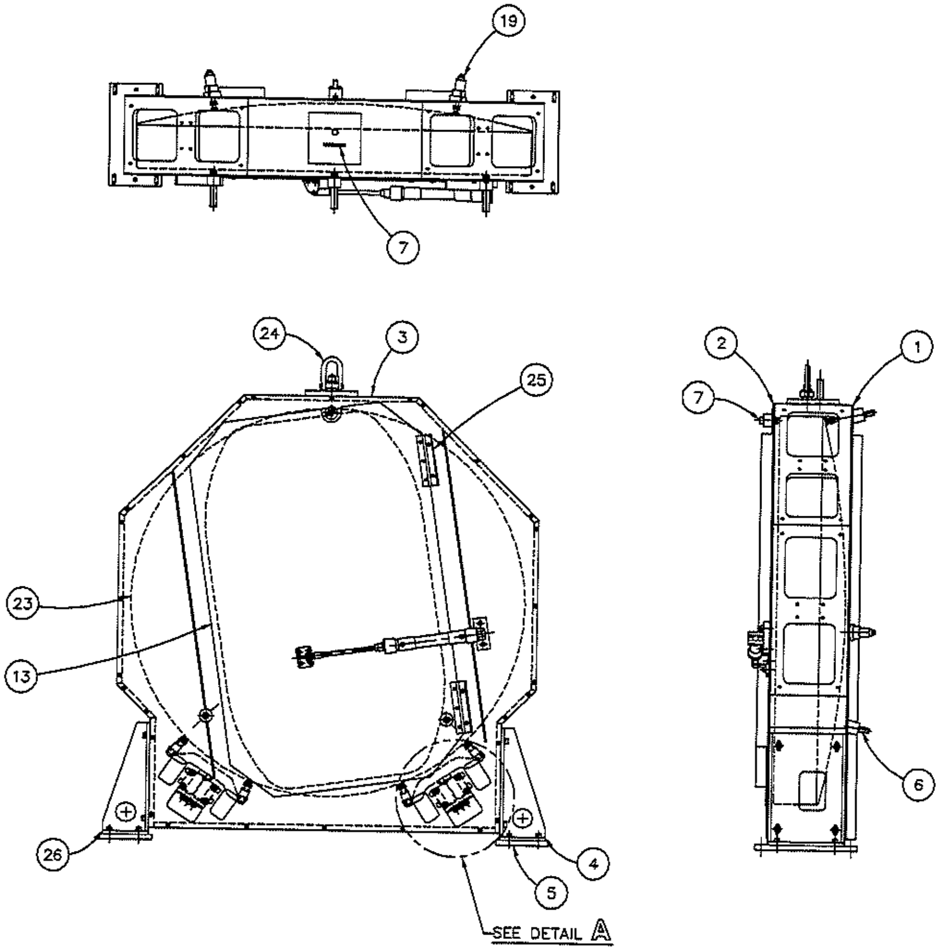
H5265-1	3	1	SLING WELDMENT	SST
--	2	3	PIN	SST
H5261-5	1	3	LOCKING CLIP	ALUM

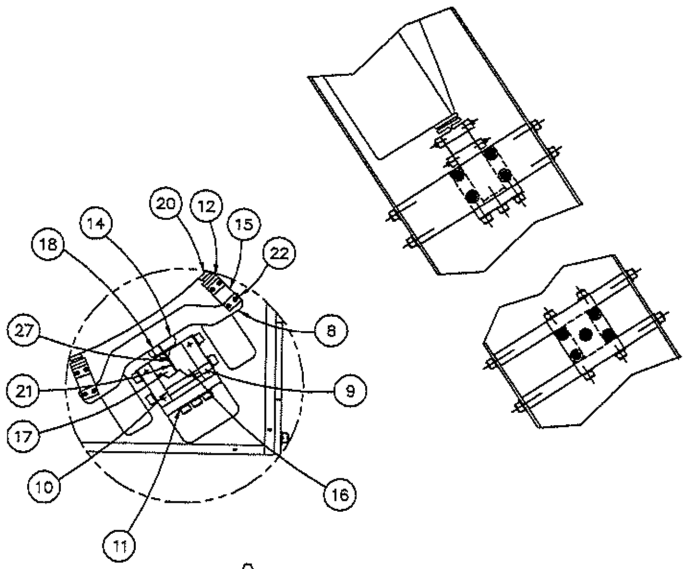
1/2

KECK/HIRES
BICONVEX LENS
SLING ASSEMBLY

R.C.B. 6/1/92
C.A.O. 6/23/92

H5267





DETAIL A

SCALE 1/2
DOOR & BACK PLATE REMOVED
FOR CLARITY

H5335-9	27	2	SPACER	SST					
H5341-2	26	1	CELL MOUNT WELD	STEEL	H5342-1	13	1	DOOR ASSY	
H5333-2	25	2	SPACER	STEEL	H5335-3	12	4	SUPPORT ARM	ST.STEEL
–	24	1	HOIST RING		H5336-2	11	2	BASE PLATE	STEEL
H0142-1	23	1	#7465 CORRECT. LENS	SILICA	H5336-3	10	4	SIDE PLATE	STEEL
H5335-4	22	4	CLAMP	ST.STEEL	H5336-4	9	4	BEAM	STEEL
H5335-8	21	2	SPRING	ST.STEEL	H5336-1	8	2	ROCKER ARM	ALUM
H5335-1	20	4	LENS CONTACT PAD	DELRIN	H5328-2	7	4	RETAINING POINT	
H5328-3	19	2	FORCE POINT		H5328-1	6	3	DEFINING POINT	
H5335-7	18	2	CLAMP	ST.STEEL	H5332-4	5	2	MOUNTING PLATE	STEEL
H5335-6	17	2	CLAMP	ALUM	H5341-1	4	2	CELL MOUNT WELD.	STEEL
H5335-5	16	2	CLAMP	ST.STEEL	H5343-1	3	1	MENISCUS CORRECT CELL WELD	
H5335-2	15	8	SPRING	ST.STEEL	H5339-1	2	1	BACK PLATE WELD.	STEEL
H5336-5	14	2	CLAMP	ALUM	H5338-1	1	1	FRONT PLATE WELD.	STEEL

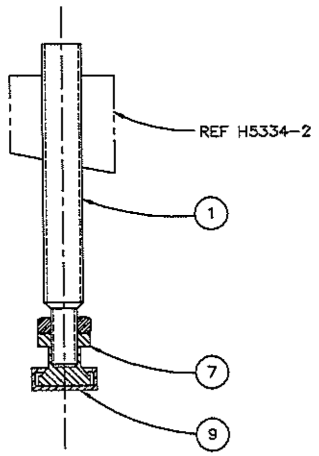
1/4

A	1/7/92	CAO		UPDATE PER AS BUILT
B	5/12/92	CAO		ADDED PARTS 27 & 20

KECK/HIRES
MENISCUS CORRECTOR CELL
ASSEMBLY

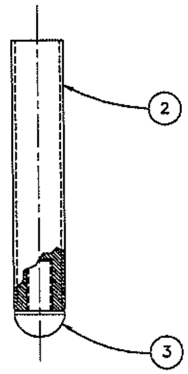
S.C.E. 10/1/91
C.A.D. 11/4/91

H5324.B



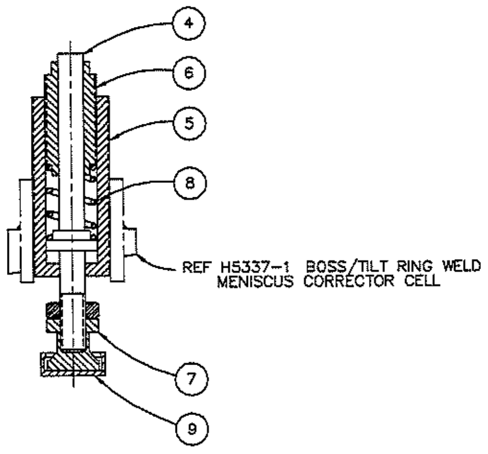
(-1) DEFINING POINT

3 REQ'D – MENISCUS CORRECTOR CELL
3 REQ'D – BICONVEX CORRECTOR CELL



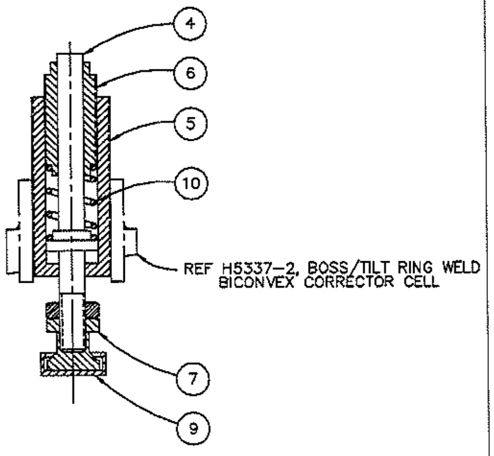
(-2) RETAINING POINT

4 REQ'D – MENISCUS CORRECTOR CELL
4 REQ'D – BICONVEX CORRECTOR CELL



(-3) FORCE POINT

2 REQ'D – MENISCUS CORRECTOR CELL
△c SPRING COMPRESSION = 0.542"
DESIGN FORCE = 11.5 LBS.



(-4) FORCE POINT

2 REQ'D – BICONVEX CORRECTOR CELL
△c SPRING COMPRESSION = 0.540
DESIGN FORCE = 6.0 LBS.

–	10	1	SPRING ALLIED SPRING [illegible]	ST. STEEL
H5334-14	9	1	CAP	TEFLON
–	8	1	SPRING ALLIED SPRING [illegible]	ST. STEEL
–	7	1	TOGGLE PAD [illegible]	
H5334-10	6	1	TENSION ADJUSTER	SST
H5334-7	5	1	BODY	SST
H5334-6	4	1	SHAFT	SST
H5334-5	3	1	BUTTON	DELRIN
H5334-3	2	1	SHAFT	SST
H5334-1	1	1	SHAFT	SST

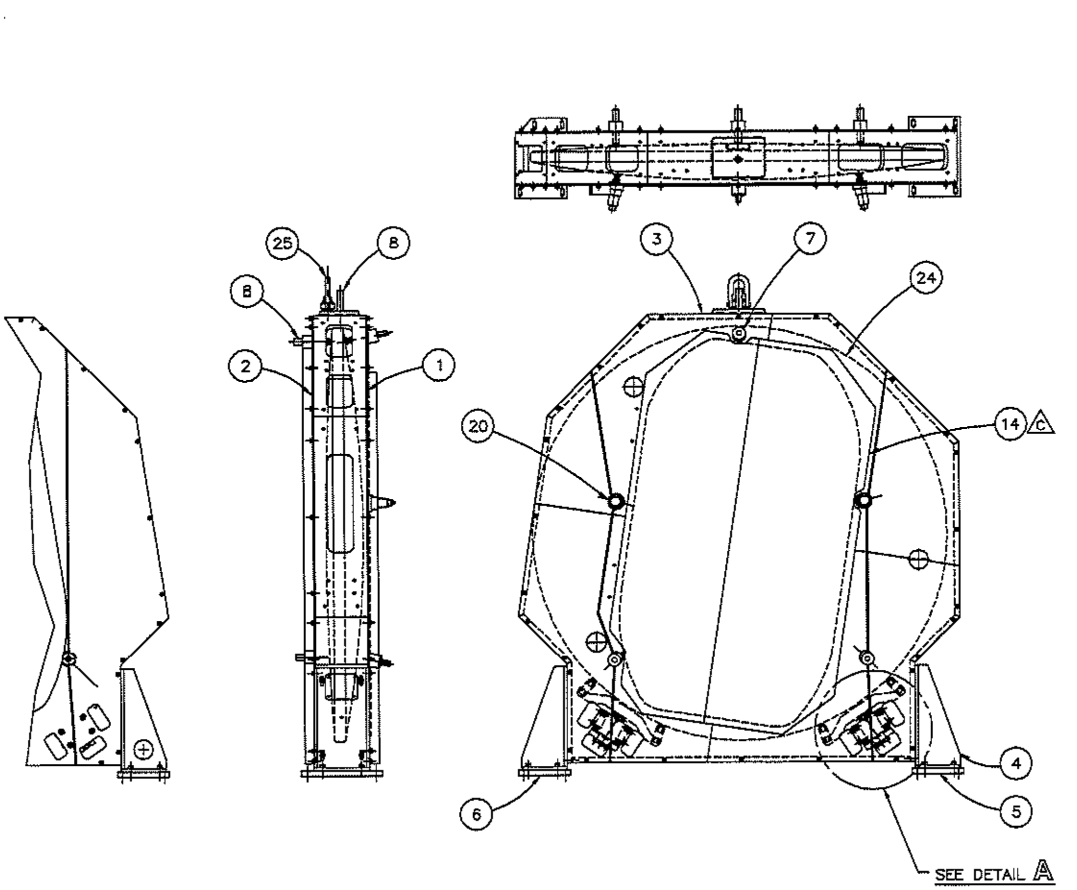
2/1

A	9/30/91	CAO		ADDED ITEM -4
B	7/15/92	CAO		REPLACED TEFLON TAPE W/ CAP
C	9/1/92	BCB		ADDED SPRING AND FORCE DATA

KECK/HIRES
CORRECTOR CELL
AXIAL SUPPORT DETAILS

B.C.B. 9/1/91
C.A.O. 9/18/91

H5328.C

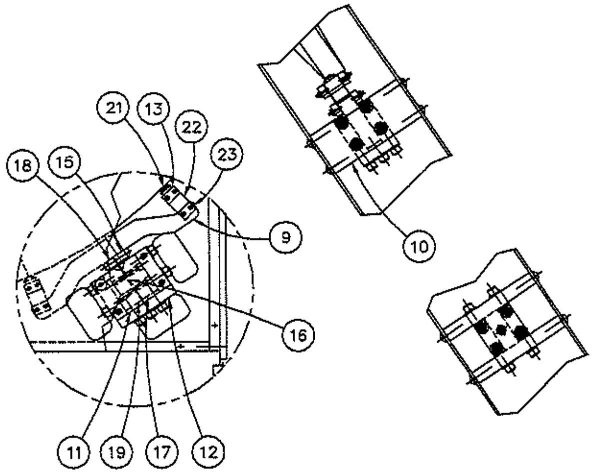


⊖1 BICONVEX CORRECTOR LENS CELL

1 REQ'D

NOTES:

C 1. SEE H5370 AND H5376 FOR OPENER AND CLOSER DETAIL.
C 2. SEE H5383 FOR MANUAL DOOR LATCHES.



DETAIL A

SCALE 1/2

H5370-1	25	1	BI-FOLDING DOOR	
-	25	1	HOIST RING	
H0141-1	24	1	Ø7455 CORRECT. LENS	SILICA
H5335-4	23	4	CLAMP	ST.STEEL
H5335-2	22	4	SPRING	ST.STEEL
H5335-1	21	2	CONTACT POINT	
H5326-4	20	2	FORCE POINT	
H5361-5	19	2	CLAMP	ST.STEEL
H5361-4	18	2	CLAMP	ALUM
H5361-3	17	2	CLAMP	ST.STEEL
H5361-2	16	2	SPRING	ST.STEEL
H5361-1	15	2	CLAMP	ALUM
	14			
H5358-5	13	2	CONTACT SUPPORT	ST.STEEL
H5358-4	12	2	BASE PLATE	STEEL
H5358-3	11	4	SIDE PLATE	STEEL
H5358-2	10	4	BEAM	STEEL
H5358-1	9	2	ROCKER ARM	ALUM
H5326-2	8	4	RETAINING POINT	
H5328-1	7	3	DEFINING POINT	
H5367-3	6	1	MOUNTING PLATE	STEEL
H5357-2	5	1	MOUNTING PLATE	STEEL
H5364-1	4	2	CELL MOUNT WELD.	STEEL
H5369-1	3	1	BICONVEX CORRECT CELL WELD	
H5366-1	2	1	BACK PLATE WELD.	STEEL
H5365-1	1	1	FRONT PLATE WELD.	STEEL

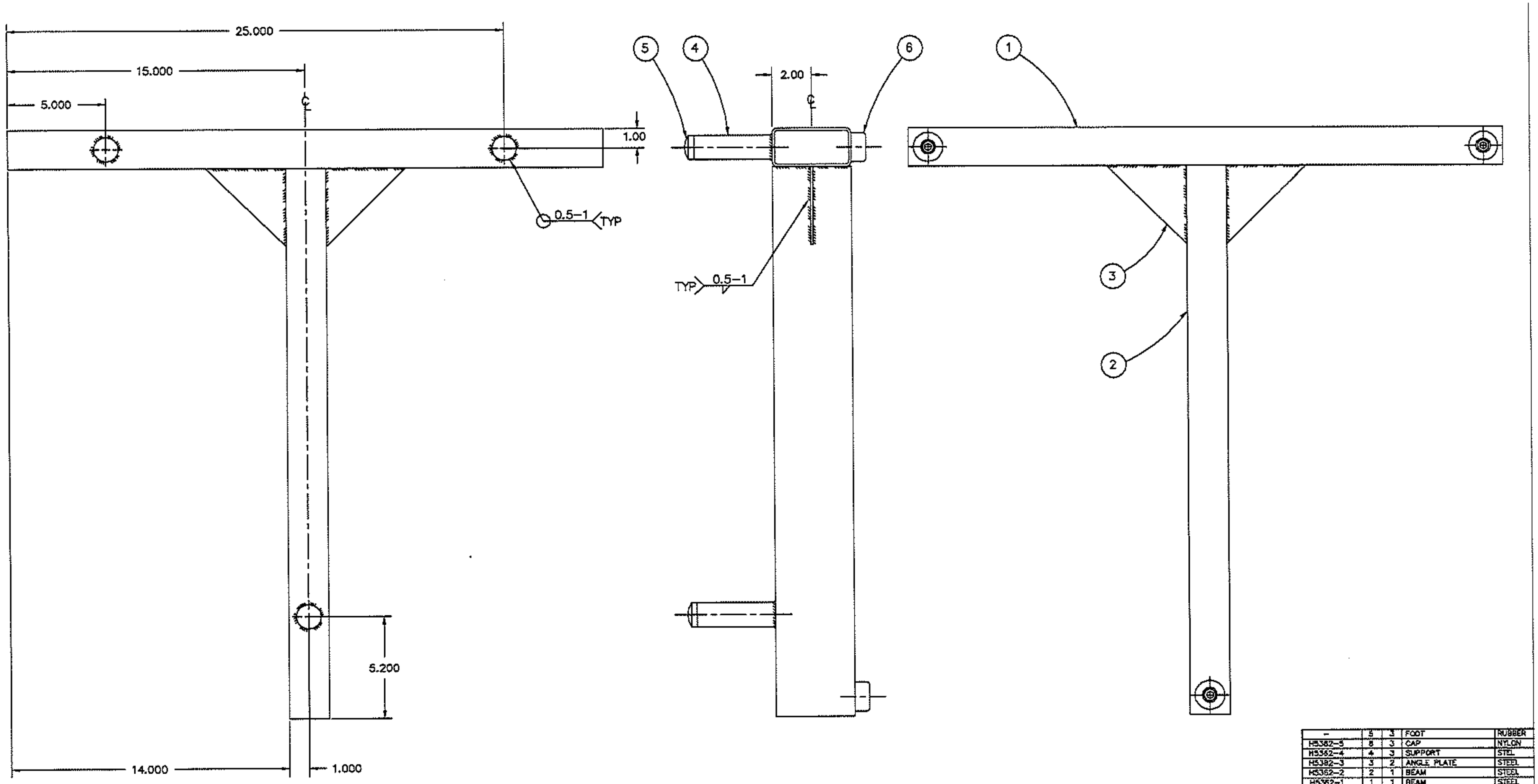
1/4

A	1/7/92	CAO		UPDATE PER AS BUILT
B	5 14 92	CAO		REVISED WITH DOOR MOD.
C	9 8 92	J.a.		REDESIGN BI-FOLD DOOR

KECK/HIRES
BICONVEX CORRECTOR CELL
ASSEMBLY

B.C.B. 8 1 91
C.A.O. 10 23 91

H5349.C



–	5	3	FOOT	RUBBER
H5382–5	6	3	CAP	NYLON
H5362–4	4	3	SUPPORT	STEL
H5382–3	3	2	ANGLE PLATE	STEEL
H5362–2	2	1	BEAM	STEEL
H5362–1	1	1	BEAM	STEEL

⊖1 CORRECTOR TOOL ASSY WELDMENT

1 REQ'D

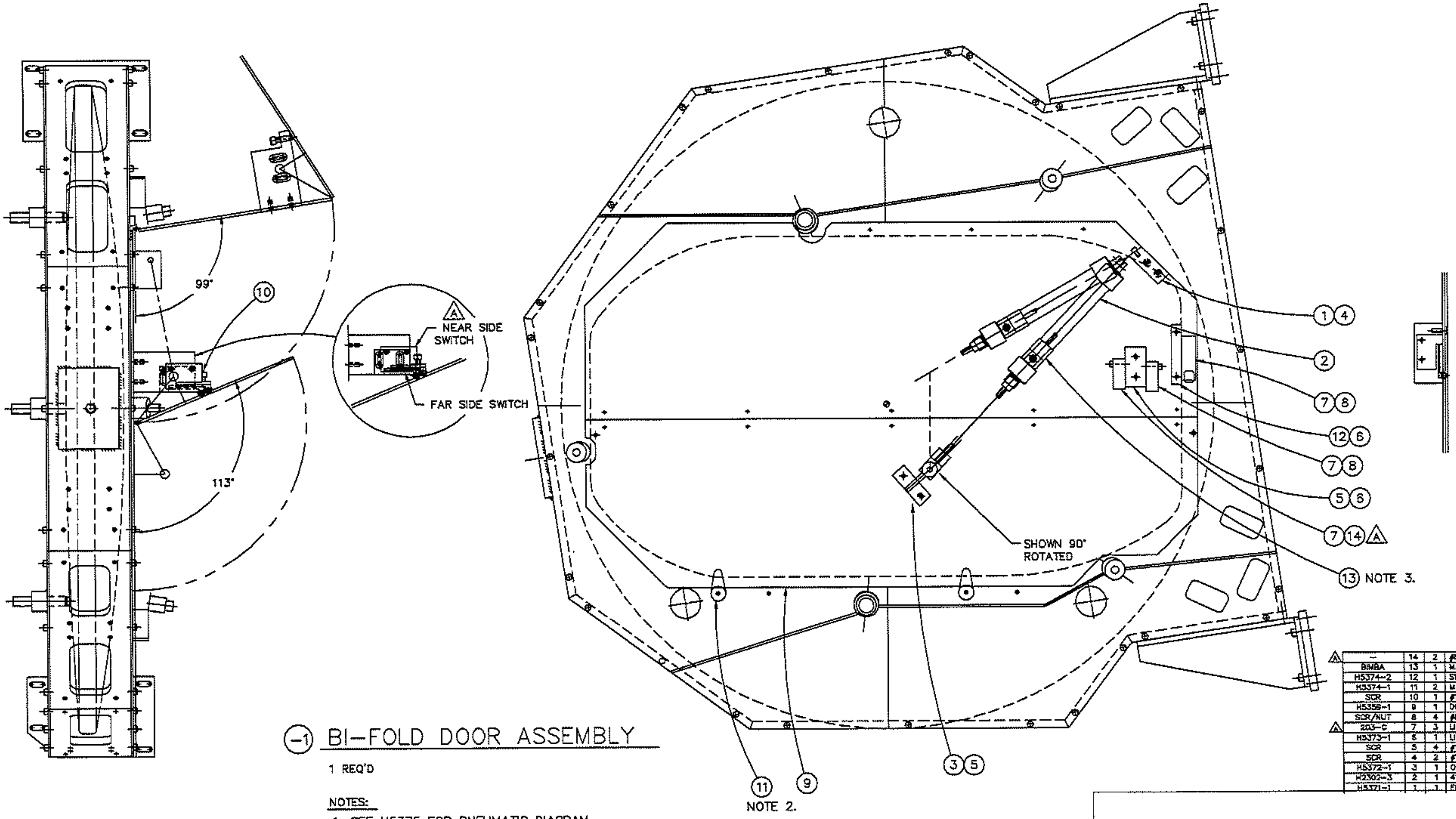
1/2

A	11/8/91	CAO		UPDATE DIMLFAC

KECK/HIRES
CORRECTOR ASSEMBLY TOOL
WELDMENT

S.C.S. 10/1/91
C.A.D. 10/21/91

H5363.A



(-1) BI-FOLD DOOR ASSEMBLY

1 REQ'D

NOTES:

1. SEE H5375 FOR PNEUMATIC DIAGRAM
AND PARTS LIST.
2. SEE H5383 FOR MANUAL LATCH LOCATIONS.
3. THIS SWITCH SENSES CLOSED CONDITION
4. BIMBA SWITCH #MRS-.087-BL-04
5. SEE H5376 FOR SECOND CYLINDER ASSEMBLY

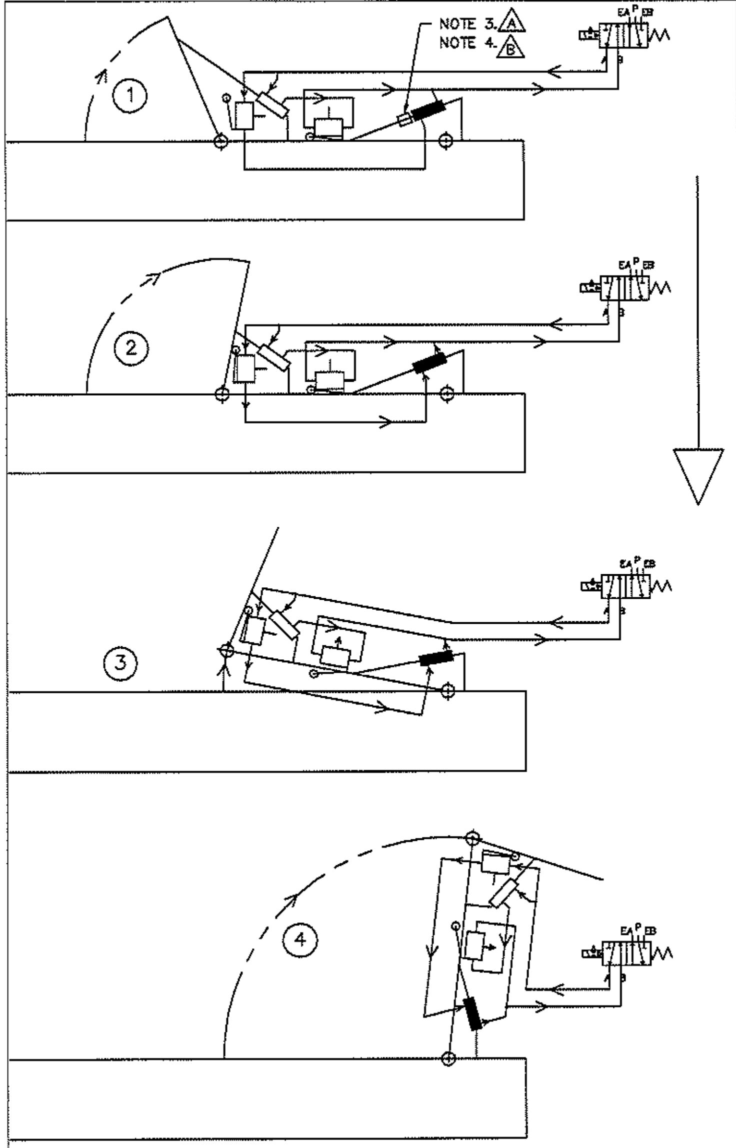
A	—	14	2	#8-32 SCR	ST.STL
	BIMBA	13	1	MAGNETIC REED SWITCH	NOTE 4.
	H5374-2	12	1	SWITCH BRACKET	ALUM
	H5374-1	11	2	MANUAL LOCK	ALUM
	SCR	10	1	#1/4-20 AL HD CAP	ST STL
	H5359-1	9	1	DOOR ASSEMBLY	ALUM
	SCR/NUT	8	4	#8-32 AL HD CP SCR	ST.STL
A	203-C	7	3	LIMIT SWITCH	ARO
	H5373-1	6	1	LIMIT BRACKET	ALUM
	SCR	5	4	#10-32 BUTTON HD	ST.STL
	SCR	4	2	#10-32 FLT HD	ST.STL
	H5372-1	3	1	OPENING SWIVEL	ASSY
	H2302-3	2	1	4" AIR CYLINDER	BIMBA
	H5371-1	1	1	FIXED SWIVEL	ASSY

HALF

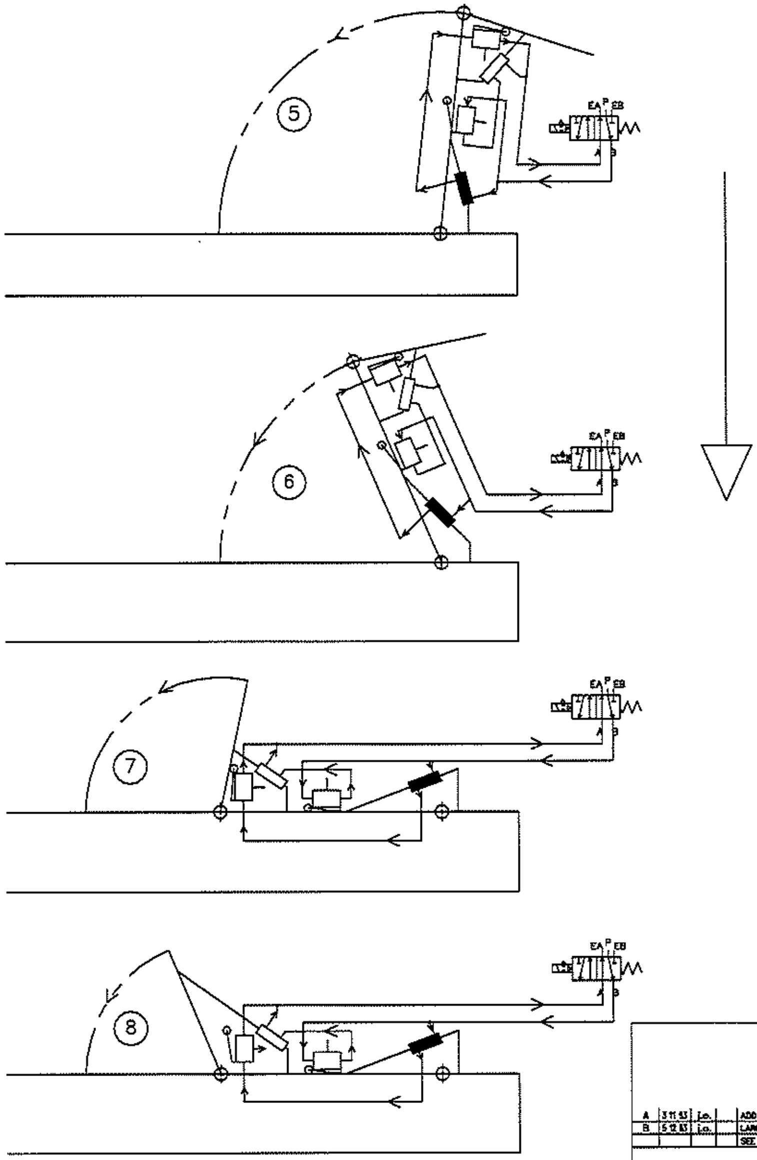
A | 3 11 93 | J.O. | | ADD BRAKE TO DRIVE CYL, PART 2.

KECK/HIRES
CORRECTOR CELL
BI-FOLD DOOR ASSY
J.O.

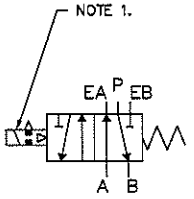
H5370.A



OPENING SEQUENCE



CLOSING SEQUENCE



SKINNER MAGNELATCH VALVE
#H935RBM2150-24A
COIL: 24V AC MOLDED COIL
1/4 NPT, 4-WAY, BUNA-N SEALS
ALUMINUM HOUSING W/SS SLEEVE
1/2"NPT CONDUIT OUTLET

(-1) PNEUMATIC PLAN

OPENING AND CLOSING SEQUENCES

NOTES:

1. LATCHING SOLENOID #CV5-LAAM-F24, SKINNER
   VENDOR:
   ELECT-AIR
   245 SINCLAIR FRONTAGE RD
   MILPITAS, CA 95035
   (408) 262-2252

A 2. ADD ARO SWITCH TO THIS SWITCH POSITION.

A 3. SPRING-OPERATED BRAKE. AIR-RELEASED.

B 4. MAIN DRIVE CYLINDER ADDED. BRAKE WAS NOT NEEDED AND SO WAS REMOVED.

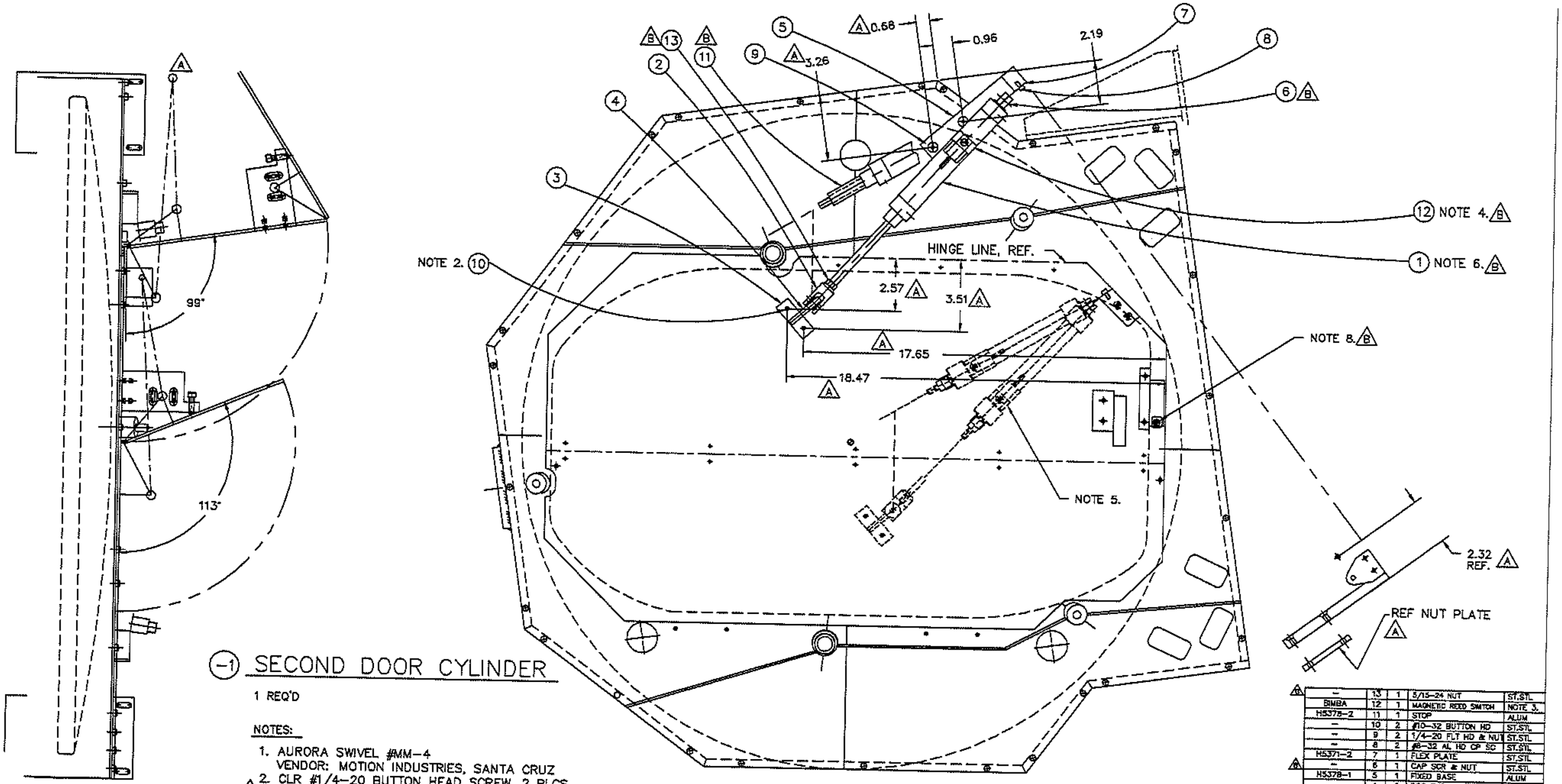
N/A

A	3 11 93	j.o.		ADD BRAKE TO MAIN DRIVE CYLINDER.
B	5 12 93	j.o.		LARGER MAIN DRIVE CYLINDER ADDED.
				SEE NOTE 4.

KECK/HIRES
BI-FOLD DOOR
PNEUMATIC PLAN

j.o. 10 13 92

H5375.B



(-1) SECOND DOOR CYLINDER

1 REQ'D

NOTES:

1. AURORA SWIVEL #MM-4
   VENDOR: MOTION INDUSTRIES, SANTA CRUZ
2. CLR #1/4-20 BUTTON HEAD SCREW, 2 PLCS
B 3. BIMBA SWITCH # MRS-.087-BL-09
4. THIS SWITCH SENSES OPEN CONDITION
5. THIS SWITCH SENSES CLOSED CONDITION
6. 0.035 WIDE SLOT IN CYLINDER TO FIT
   FLEX PLATE, H5371-2
B 7. BIMBA MRS-094-DXP CYLINDER. 0.9 x 50 PSI
   IS 45 LBS (WAS 20 LBS).
B 8. SCREW AND NUT INSTALLED IN CELL TO
   ACTUATE AIR LIMIT SWITCH (APPROX #4 OR #5)

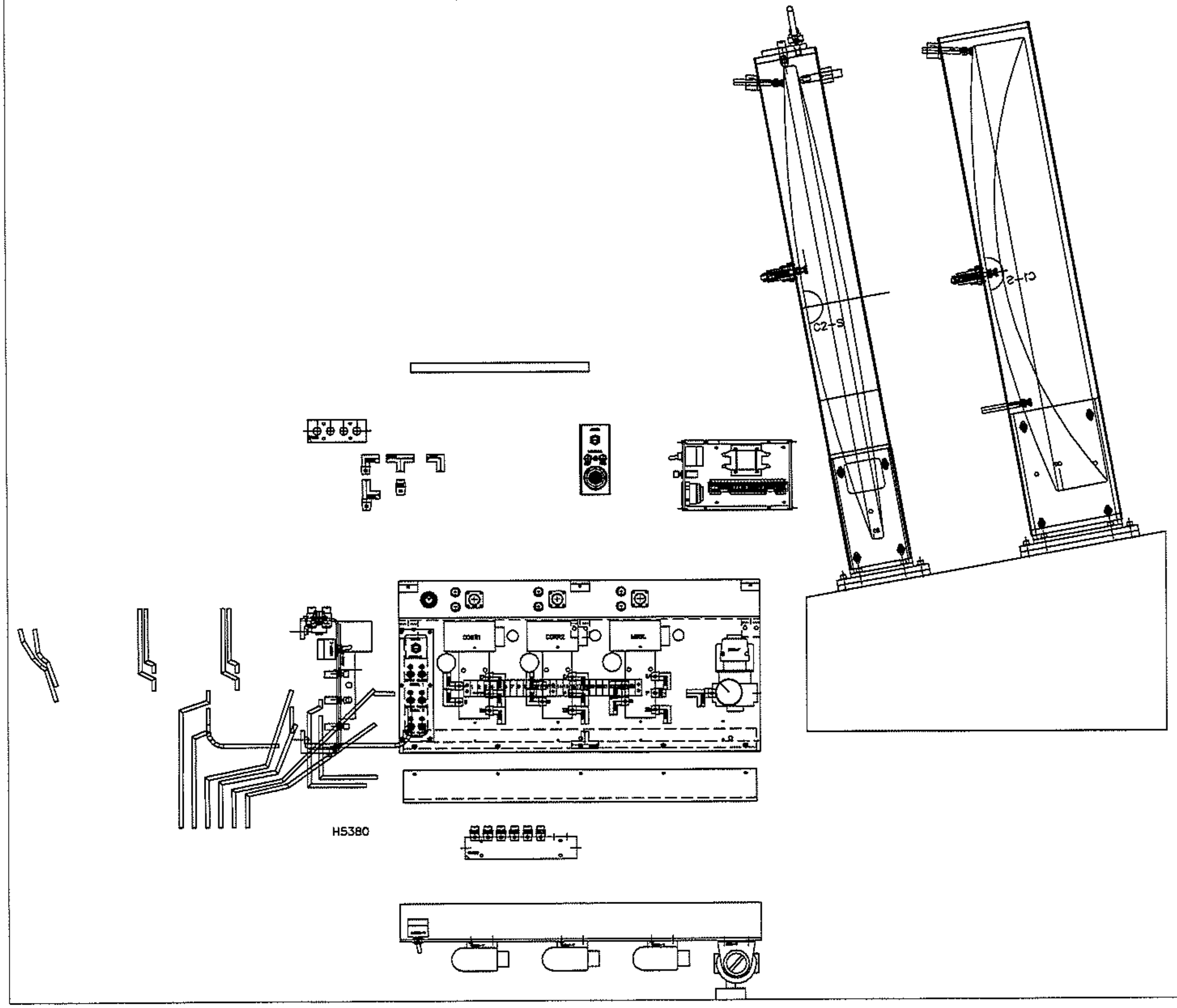
B	–	13	1	5/15-24 NUT	ST.STL
	BIMBA	12	1	MAGNETIC REED SWITCH	NOTE 3.
	H5378-2	11	1	STOP	ALUM
	–	10	2	#10-32 BUTTON HD	ST.STL
	–	9	2	1/4-20 FLT HD & NUT	ST.STL
	–	8	2	#8-32 AL HD CP SC	ST.STL
	H5371-2	7	1	FLEX PLATE	ST.STL
B	–	6	1	CAP SCR & NUT	ST.STL
	H5378-1	5	1	FIXED BASE	ALUM
	–	4	1	ROD END	NOTE 1.
	H5372-3	3	1	THREADED BRACKET	ALUM
	H5372-2	2	1	CLEVIS	ALUM
B	H3702-1	1	1	4" AIR CYLINDER	NOTE 7.

1/2

A	3 12 03	J.O.		2.32 WAS 1.25. ADD BRAKE, PART 13
B	5 12 03	J.O.		PART 1 WAS MRS-044-DXP CYLINDER.

KECK/HIRES
CORRECTOR CELL
SECOND DOOR ASSEMBLY
J.O. 10 14 02

H5376.B



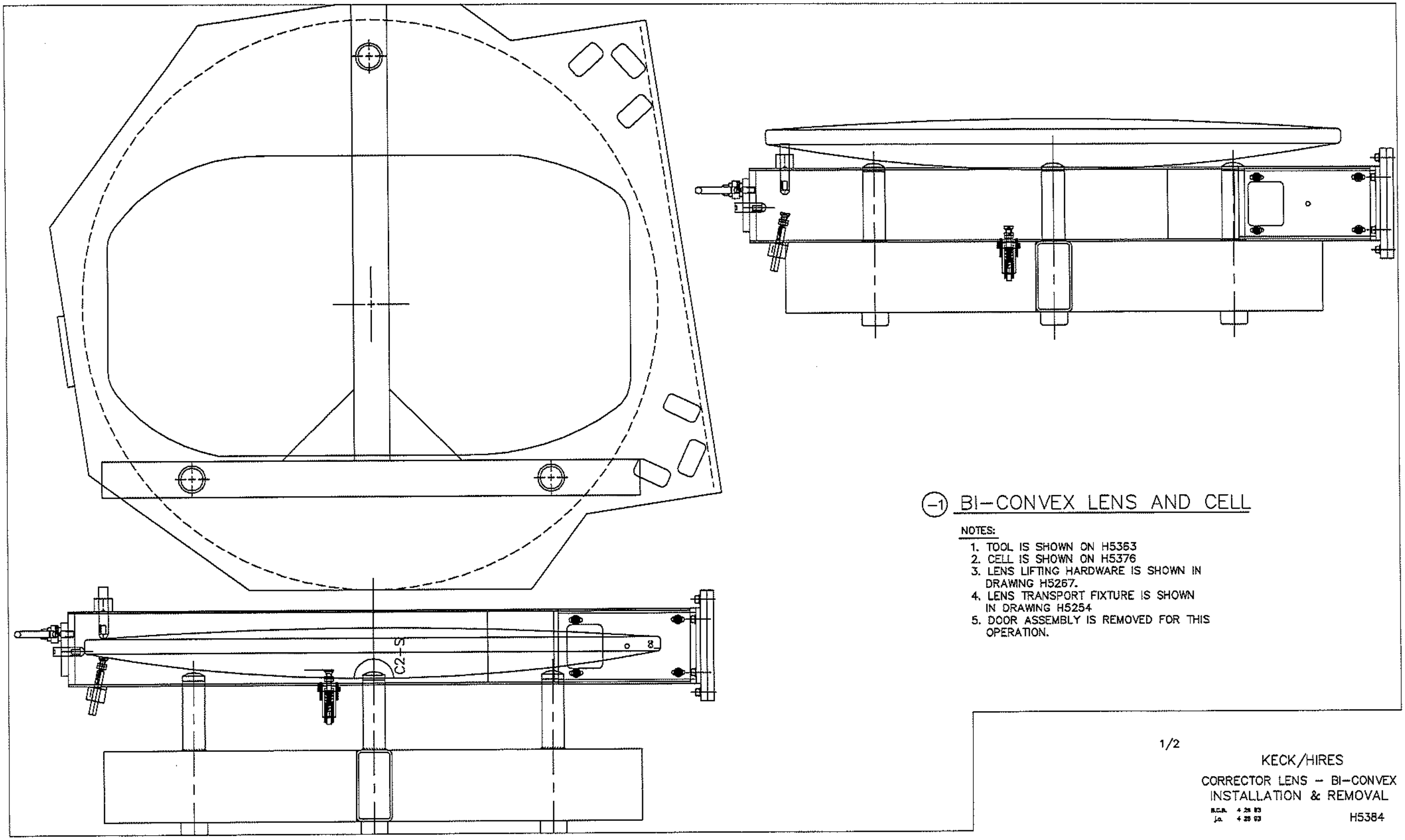
N/A

A	1/28/93	JO		REORGANIZED FOR PRINTING

KECK/HIRES
CORRECTOR CELLS
AIR SYSTEM LAYOUT

BCB 2 18 92

H5380.A



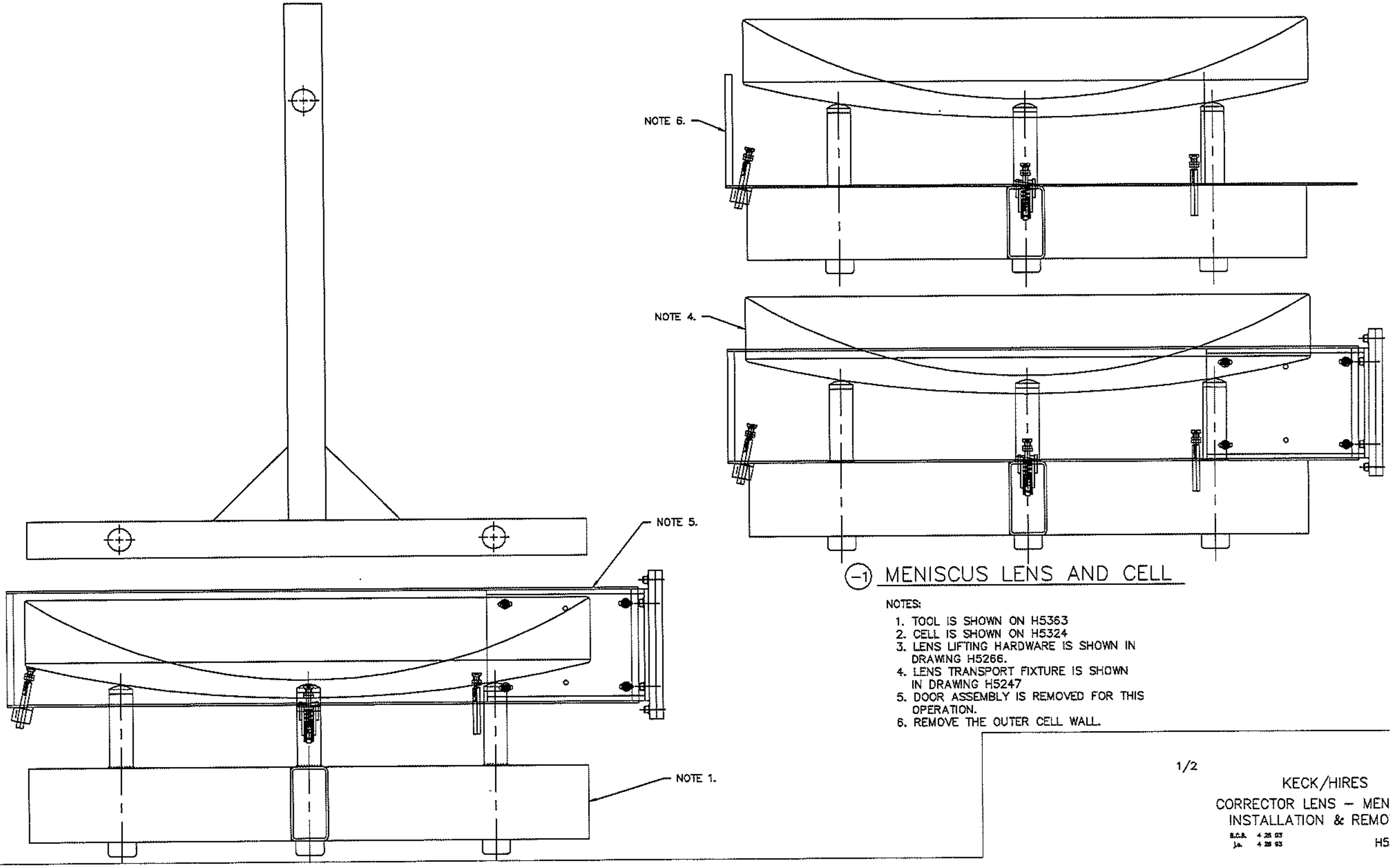
(-1) BI-CONVEX LENS AND CELL

NOTES:

1. TOOL IS SHOWN ON H5363
2. CELL IS SHOWN ON H5376
3. LENS LIFTING HARDWARE IS SHOWN IN DRAWING H5267.
4. LENS TRANSPORT FIXTURE IS SHOWN IN DRAWING H5254
5. DOOR ASSEMBLY IS REMOVED FOR THIS OPERATION.

1/2

KECK/HIRES
CORRECTOR LENS - BI-CONVEX
INSTALLATION & REMOVAL
B.C.B. 4 28 93
J.a. 4 28 93
H5384



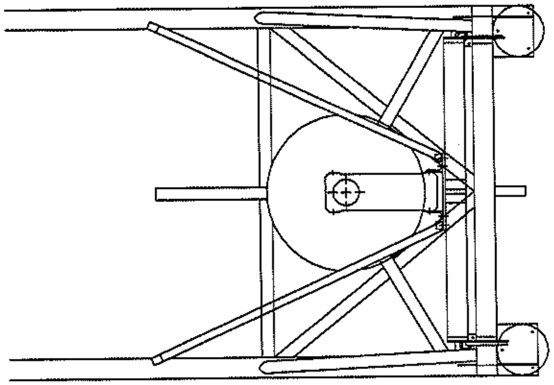
⊖1 MENISCUS LENS AND CELL

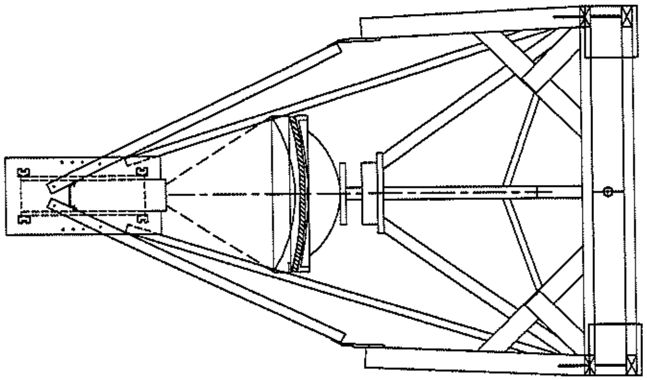
NOTES:

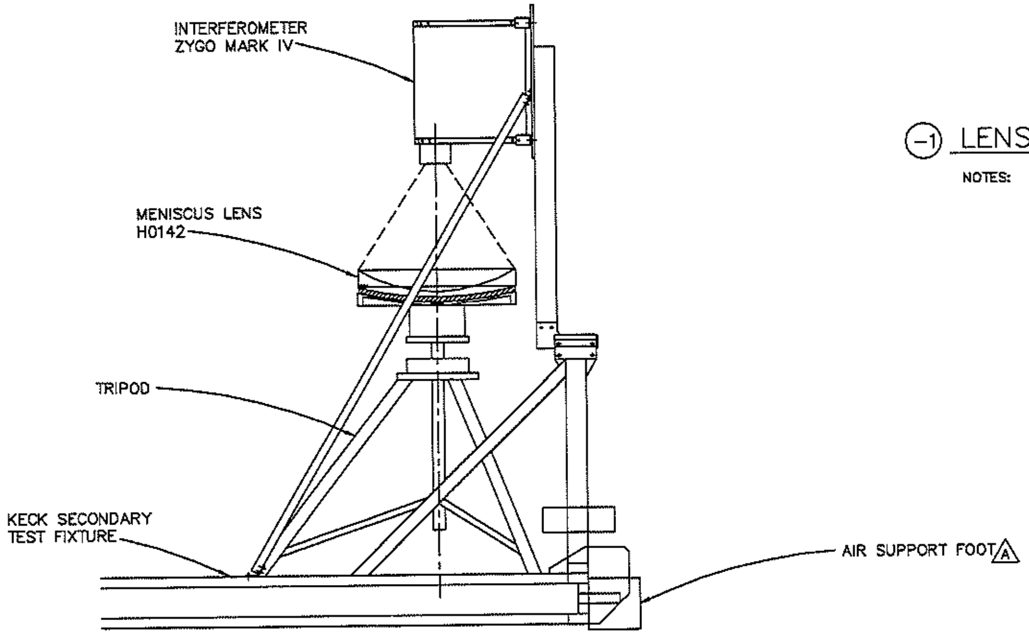
1. TOOL IS SHOWN ON H5363
2. CELL IS SHOWN ON H5324
3. LENS LIFTING HARDWARE IS SHOWN IN DRAWING H5266.
4. LENS TRANSPORT FIXTURE IS SHOWN IN DRAWING H5247
5. DOOR ASSEMBLY IS REMOVED FOR THIS OPERATION.
6. REMOVE THE OUTER CELL WALL.

1/2

KECK/HIRES
CORRECTOR LENS – MENISCUS
INSTALLATION & REMOVAL
B.C.B. 4 26 93
J.A. 4 26 93
H5385







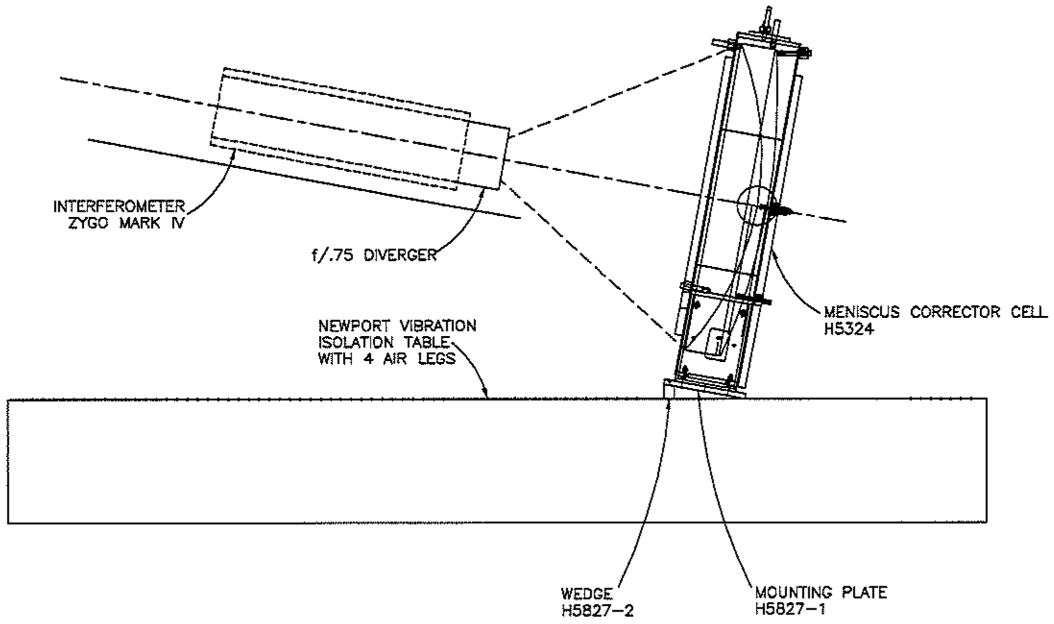
(-1) LENS TEST SETUP

NOTES:

,1

A | 8 18 93 | J.D. | GENERAL REVISION

KECK/HIRES
MENISCUS LENS
HORIZONTAL TEST ASSY
B.C.B. 8/12/92
D.A.C. 8/24/92
H5811.A



.2

A | 8 18 93 | J.C. | GENERAL REVISION.

KECK/HIRES
MENISCUS LENS
10° TEST SET–UP
B.C.B. 8/1/92
C.A.D. 8/24/92
H5826.A

Appendix W HIRES Control Functions

August 1, 1991

HIRES Control Functions
prepared by Jack Osborne
see /u/jack/text/hires17.cf

1. ECHELLE MOSAIC
   - a. 1 DC motor: 50 in-oz minimum, 1000 RPM.
   - b. Rotation limits: (2 primary, 2 secondary)
   - c. Encoder, linear, to measure 1 micron over 100 mm travel. This represents 0.32 arc-sec least count over about 9° total travel.
   - d. An air-operated brake will be required.
   - e. An air-operated cover will be used. (2 limits)
   - f. Dual fiducials using an interrupter in conjunction with stage encoder index track.
   - g. 'Brake off' is a special priviledge requiring a password.
2. CROSS-DISPERSER (Uses a Heidenhain rotary incremental encoder with 3 arc-sec resolution: 10,800 lines with x40 logic = 432,000)
   - a. 1 DC motor: 50 in-oz min, 1000 RPM.
   - b. Encoder interface to Heidenhain electronics driver box is required.
   - c. Limits for about 30 degrees rotation. (2 primary and 2 secondary)
   - d. An air-operated, *user-optional* brake will be required.
   - e. An air-operated cover will be used. (2 limits)
   - f. A dual fiducial system like "ECHELLE MOSAIC" above.
3. CAMERA FOCUS (aka DEWAR FOCUS or DETECTOR FOCUS)
   - a. 1 DC motor: 50 in-oz min, 1000 RPM.
   - b. Linear encoder: position to 5 microns with 140 mm travel.
   - c. Limits: 2 primary and 2 secondary.
   - d. Electric-operated fail-safe brakes will be required.
   - e. A dual fiducial system like "ECHELLE MOSAIC" above.

4. SHUTTER
    - a. Opening solenoid (spring return, so that shutter closes on power failure).
    - b. Magnetic reed switch sensing open condition.
5. DARK SLIDE
    - a. A slow-moving dark cover for the detector. Air cylinder, 2 limits.
6. FILTERS (2 wheels of 12 positions right behind the slit)
    - a. 2 DC motors: 50 in-oz min, 1000 RPM.
    - b. No limits.
    - c. Encode 12 positions each wheel using motor encoder.
    - d. A fiducial will be used for indexing each wheel.
7. TV Guiding
    - a. Focus: DC motor: 50 in-oz min, 1000 RPM.
    - b. Encode using motor encoder.
    - c. Limits: 2 primary and 2 secondary.
    - d. Two filter wheels of 8 positions each. See "FILTERS" above.
    - e. Aperture adjuster: DC motor and f-stop ring; 50 in-oz min, 1000 RPM.
    - f. Shutter (Ilex or equivalent)
8. COMPARISON LIGHTS
    - a. 6-position linear stage; 6" each, moves parallel to slit jaws.
    - b. 1 DC motor: 50 in-oz min, 1000 RPM.
    - c. Limits: 2 primary and 2 secondary.
    - d. Motor encoder is used for each of 6 positions.
    - e. A mirror is positioned by an air cylinder. (2 limits)
9. DECKER SLIDE (aka SLIT ACCESSORY SERVER)
    - a. 4 positions, linear motion.
    - b. DC motor is 50 in-oz min., 1000 RPM.
    - c. Encoding is done by using motor encoder.
    - d. Limits: 2 primary and 2 secondary
10. SLIT
    - a. A bilateral slit will be used. (both sides move, keeping the center fixed)
    - b. DC motor: 50 in-oz min, 1000 RPM.
    - c. Limits: 2 primary and 2 secondary.
    - d. Encoding will measure 0.001" (0.03 arc-sec on the sky), over 0.25" travel (each jaw). (Use the motor encoder to do this.)
11. CAMERA MIRROR (44" diameter) will be stationary.
    - a. Air-operated cover. (2 limits)

12. COLLIMATOR MIRRORS (17" diameter) Red and Blue.
    a. 2-position stage uses 2 air cylinders. Either Red or Blue mirror is "in".
    b. Limits: 2.
    c. Air-operated clamp will be required.
    d. Air-operated covers. (2 limits per cover = 4 limits total) Covers are interlocked, in software, with stage limits so that a cover may be opened only for the "in" position mirror.
    e. User with special password may open mirror cover which is in "out" position.
    f. Focus will be required. (1" travel)
        - DC motor: 50 in-oz min, 1000 RPM.
        - Encoding is via the motor encoder.
        - Limits: 2 primary and 2 secondary.
        - Electric-operated fail-safe brakes will be required.

13. ACCESS PORT TO SEAL HIRES (Near the slit)
    a. Air-operated hinged door. (2 limits)

14. FILTER WHEEL / COMPARISON LIGHTS
    a. 1 DC motor: 50 in-oz min, 1000 RPM.
    b. No limits.
    c. Encode 12 positions with motor encoder.
    d. A fiducial will be used for indexing.

15. LOCAL LOCKOUT
    a. This feature prevents injury to a worker inside the instrument. Lockout status will be visible at all control stations.
    b. The lockout switch is located at the spectrograph and its status should be obvious.

NOTES:

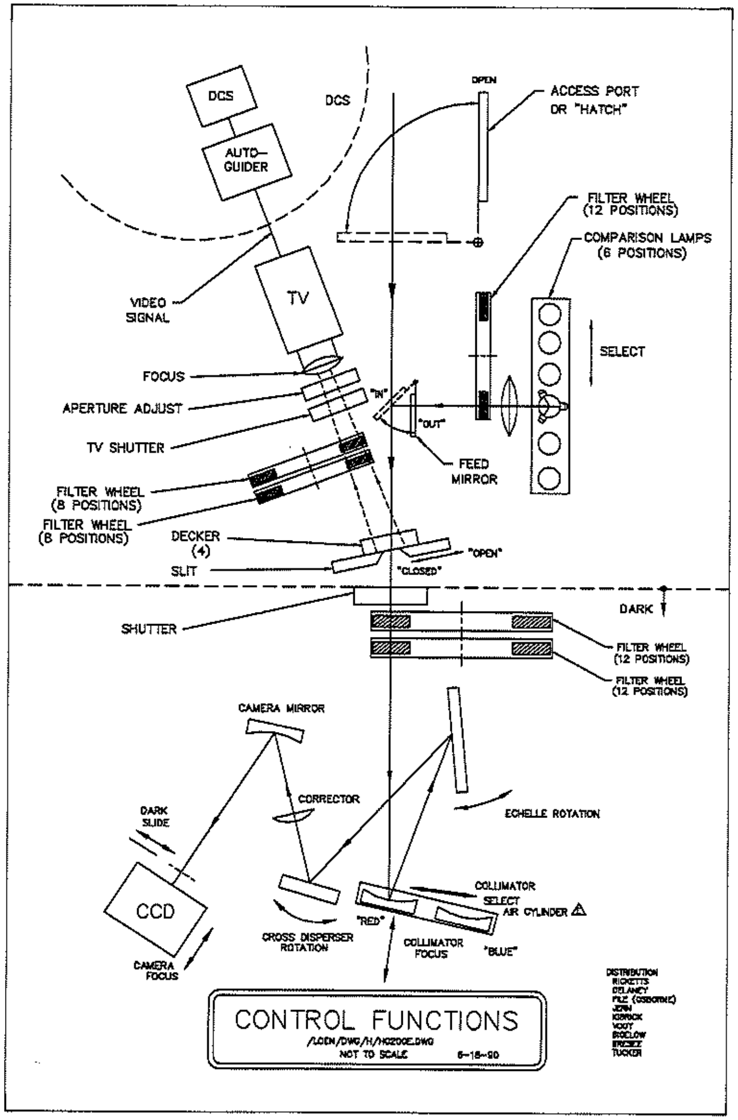
1. Dual fiducials: All moving stations have at least 1 fiducial (an optical interupter) At power-up this indicates which side of center you are. Coarse center-locating is done with this fiducial. A fine fiducial comes with the encoders on the three stages which use separate encoders. Position information then comes from the incremental encoder.
2. The "core" HIRES has no field rotator and so has no need for an X-Y stage for the TV.
3. The TV zoom function will be by "pixel-binning".

4. The 6 comparison source positions could each have up to 3 separate lamps (and lamp controllers). The stage will scan a single source along the slit or be driven to one of 6 pre-selected positions.
5. Limits: Secondary (heavy duty) will be the Microswitch DTE6 enclosed style. All others will be the low current Microswitch BZ style (we usually call these "logic" limits).

= modified or new items since last change.

See also drawing # H0200.E .

Distribution: HIRES file (Osborne)
Vogt
Bigelow
Jern
Kibrick
Ricketts
Delaney
Tucker
Bresee



DISTRIBUTION
RICKETTS
DELANEY
FILE (OSBORNE)
JERN
KIBRICK
VOGT
BIGELOW
BRESEE
TUCKER

CONTROL FUNCTIONS
/LOEN/DWG/H/H0200E.DWG
NOT TO SCALE
6-18-90

NONE

A	8-1-89	j.o.		UPDATE. SHOW SPECTROGRAPH INTERNAL
B	1-17-90	j.o.		MODIFY FOR SOFTWARE DESIGN REVIEW
C	1-17-90	j.o.		MODIFY FOR SOFTWARE DESIGN REVIEW
D	3-19-90	j.o.		REMOVE CAMERA, CORRECTOR CHANGERS.
E	3-1-91	j.o.		8 POS. TV FILTERS WERE 6-POS.
				AIR CYL. DRIVE WAS 1/3 HP MOTOR.

KECK/HIRES
CONTROL FUNCTIONS
SCHEMATIC

Ja 8 15 88

H0200.E

Appendix X Glossary

1. TPI is threads per inch, referring to screws and nuts. 5 TPI means that each revolution advances the nut 1/5 inch or 0.20" per rev.
2. CCD is charge-coupled device referring to the main HIRES Super-Duper Camera detector or the TV guider photo-sensitive detector
3. FEA is Finite Element Analysis. ANSYS is the software used.
4. OPD is Optical Path Difference.
5. Sol-gel is an anti-reflection lens coating..