

DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150780

INSTALLATION PACKAGE FOR CONCENTRATING SOLAR COLLECTOR PANELS

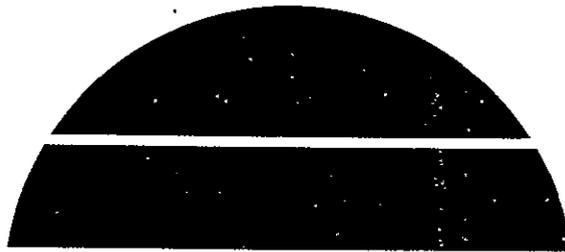
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Northrup, Inc.
302 Nichols Drive
Hutchins, TX 75141

Under Contract NAS8-32251 with

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George C. Marshall Space Flight Center 35812

For the U. S. Department of Energy



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CONCENTRATING SOLAR COLLECTOR PANELS

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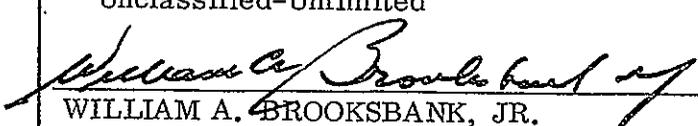
U.S. Department of Energy



Solar Energy

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16. ABSTRACT Northrup, Inc., has developed and delivered 300 square feet of Concentrating Solar Collector (ML Series) and Attitude Control System, under the direction of the National Aeronautics and Space Administration. The "ML Series" Solar Collector Panels comprise a complete package array consisting of collector panels using modified Fresnel Prismatic Lenses for a 10 to 1 concentrating ration, supporting framework, fluid manifolding and tracking drive system, in unassembled components for field erection. The Installation, Operation and Maintenance Manual, Warranty, List of Materials, Sub-Assembly drawings and Final Field Assembly Drawings are included in the package.					
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INSTALLATION OPERATION & MAINTENANCE MANUAL
FOR
NORTHRUP CONCENTRATING SOLAR COLLECTOR PANELS

WITH
INTEGRAL MANIFOLD-FRAME AND SUB-FRAMES

MF-NSC-P "ML" SERIES

MODEL NSC-01-0732

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I.3. List of Materials (cont'd)

required for the array model number. The total number of components, parts and accessories for the array model is the total of those listed for all field sub-assemblies (Drawing Series 01-04-000) depicted on "List of Materials" plus the total of all other parts and components depicted on "List of Materials," not having part or drawing numbers in the 01-05-000 or 01-04-000 series. For convenience, the "List of Materials" also indicates the item number (or letter) for each assembly or part, and references in these instructions are made to these items. Refer to these item numbers (or letters) in "List of Materials" for the appropriate part of drawing number.

II. RECEIVING, UNPACKING, STORAGE, HANDLING AND HOISTING:

1. Receiving: Carefully unload and unpack parts and components as required to inspect and inventory all components, packages and crates. Report any shipping damage in detail to last carrier with copy of report sent to Northrup, Inc. Verify shipment with "List of Materials" herein provided. Report any shortages in writing to Northrup, Inc.
2. Handling: Handle and unload all materials using fork lifts or other material handling equipment, employing standard recommended methods as to prevent damage to equipment. Utilize skids and pallets provided on components to properly lift and transport components.
3. Storing Components: Store in a safe location, in an orderly, sorted arrangement and as follows:
 - a. Open Storage: The following components (except fastening devices for same,) may be stored in the open, properly secured, with access to limited personnel only:

<u>Description</u>	<u>Item</u>
South Wind Bracing	5
Upper North Wind Bracing	6
Inclined Strut	7
Tracking Control Box Mount	8
Idler Pulley Mount	9
Manifold Support	19 thru 32
North Wind Strut	37
North Column	A
Lower North Wind Bracing	B
South Brace	C
South Column Base Angles	D

II.3.b. Receiving (cont'd)

- b. Closed Storage: All other components and fastening devices and loose parts, not listed in "a" above, must be stored in covered dry location, until ready for installation.

4. Hoisting Components:

- a. Framing Components (Items 7, 10, 11, 12, 13, 14, 19 thru 32, 37, A, C, and E): May be hoisted with a crane and a cable sling around palletted bundle of members, or lifted by fork lift to the vicinity of assembly. After de-bundling components, all of these members can easily be handled by one or two persons.
- b. Collector Panels (Item 4): May be hoisted by attaching to the eyebolts in each corner at top of panel with a four rope or cable sling. Care must be exercised in attaching the sling, as to prevent sling members from bearing on lenses.
- c. Other Components: All other components are of such size that will permit handling by one or two persons.

III. INSTALLATION OF FRAMING FOR COLLECTOR PANELS: Relative positions of the various components of the array are as depicted on Drawings 01-05-007, 01-05-122, and 01-05-129. Sequence and method for installation is as follows:

1. Anchor Bolts and Column Bearing Points:

- a. Layout all anchor bolts to dimensions given on "Bolt Setting Plan," 01-05-123, allowing sufficient projections for washers and nuts above base angles. Orientation of array anchor bolts must be as indicated using "true north" and not "magnetic north." (Anchor bolts are not furnished by Northrup, Inc.)
- b. Bolts must be positioned to maintain the tolerances of alignment given on "Bolt Setting Plan." Tolerances for column bearing points can conveniently be maintained by proper field supplied shimming.

2. Sub-Assembly of Framing:

- a. The following members which are spaced 10'-0" on center as shown on Drawing 01-05-007 and shown in Section "CC" of Drawing 01-05-122 are to be assembled as individual units prior to erection of framing:

III.2.a. Installation (cont'd)

- North Column (A)
- Inclined Strut (7)
- North Manifold Support (28) - (32)
- South Manifold Support (19) - (23)
- South Base Angle (D)
- South Brace (C)

b. Assemble these units using the devices as listed below which are included in the bill of material of the field installation drawings for each member. At this time, tighten all of these bolts "finger tight."

Connection at Members	Number Required				
	$\frac{1}{2}$ "x6 $\frac{1}{2}$ " Bolt	$\frac{1}{2}$ " Nut	$\frac{1}{2}$ Lock Washer	$\frac{1}{2}$ " Flat Wash.	Bolt Spacer
(7), (A) and North Manifold Support (28) - (32)	1	1	1	-	One $\frac{1}{2}$ "x4 7/8"
(7), (D) and South Manifold Support (19) - (23)	1	1	1	2*	One $\frac{1}{2}$ "x5"
(C) and South Manifold Support (19) - (23)	1	1	1	-	One $\frac{1}{2}$ "x5 $\frac{1}{4}$ "
(C) and (D)	1	1	1	-	One $\frac{1}{2}$ "x5 3/8"

*Install one washer between each base angle and South manifold support.

III.3. Installation (cont'd)

3. Erection of Framing:

- a. Immediately prior to erection operations, remove the top covers from manifold supports (28) - (32), by removing fastening screws. Retain screws and covers for later installation. Prepare ends of copper manifolds and copper tees for flexible connections for brazing as specified hereinafter. Refer to Drawings 01-05-007 and 01-05-122.
- b. Beginning at the East end of the array, erect the first two sub-assemblies of III, 2 above, and install manifold strut (14) and a North wind strut (37) on the North end between these assemblies, and manifold strut (10) on the South end between these assemblies. Join each end of each manifold strut to each manifold support with four 3/8" x 3/4" bolts, nuts and lock washers, and each North wind strut with two 3/8" x 3/4" bolts, nuts and lock washers at each manifold support.
- c. Install South wind bracing (5), upper North wind bracing (6) and lower North wind bracing (B) between these two East sub-assemblies as shown on assembly drawings for items (5), (6) and (B). Adjust turnbuckles of wind bracing to position these two sub-assemblies in an approximate square and plumb position. Do not tighten lock nuts on turnbuckles.
- d. Continue westward along the array and erect the remaining sub-assemblies of Paragraph III.2 in similar manner as the first two on the East as described in Paragraph III.3.a,b, and c above, and with following additional instructions:
 - (1) Make sure that at each manifold support the proper size copper tee is used as listed and depicted on Drawing 01-05-007. (Tees are shipped as loose parts.)
 - (2) Install manifold struts in the sequence of item numbers depicted, with proper size copper manifold, all as shown and listed on Drawing 01-05-007. All manifold struts are physically marked (10) through (14).
 - (3) When installing manifold struts (10) - (14), install copper pipe manifolds into pipe tees, but do not braze joints until all framing and collector panels have been installed and finally adjusted as described hereinafter.

III.3.d.(4) Installation (cont'd)

- (4) Install wind bracing (5), (6) and (B) only in the bays as shown on Drawing 01-05-007.
- e. Tighten all bolts securely, except the pivot bolt connecting North columns (A), inclined struts (7) and North manifold supports (23) - (32).
- f. Adjust turnbuckles of South wind bracing (5) to square the angle made by the intersection of South manifold supports (19) - (23) and manifold struts (10) - (14) within $\pm 1/8$ " for the length of the South manifold support. Repeat this squaring operation for North manifold supports (28 - (32) and North manifold struts (10) - (14), by adjusting turnbuckles of upper North wind bracing (6). Tighten all lock nuts on turnbuckles after these adjustments and wind bracing is snugged-up tight.

IV. INSTALLATION OF COLLECTOR PANELS (4):

1. Field Sub-Assembly of Collector Panels: Refer to Drawing 01-04-004, and identify North end of collector as having the longer of the two end shafts. Before erecting collector panels, perform the following sub-assembly.
 - a. Install lens by inserting inside grooves on bottom of lenses into the flanges of lens guides, and sliding lens into position, making certain that lenses are parallel to lens guides both vertically and horizontally to prevent stresses and breakage of lens. Position lenses so that they are flush with lens guides on North end only and the pre-drilled holes in lenses are at the North end.
 - b. Install lens retainers 01-06-030 as shown, flush with North end of lenses and lens guides, using two No. 8 x 5/8" self-drilling, self-tapping screws with neoprene washers. Install two No. 6 x 1/2" machine screws, nuts and washers through slotted holes in each lens retainer through pre-drilled holes in lenses as indicated.
 - c. Install pulley on North collector shaft by screwing angle brackets to end of collector panel as indicated.
2. Erection of Collector Panels:

Collector panels must be hoisted by use of four eye bolts as described in Section II.4.b. The South shaft of collector panels must be inserted in the bearings of the South manifold supports (19) - (23) first.

IV.2.a. Installation (cont'd)

- a. It is recommended, that before collector panels are erected, the shafts of the panels and the aligning ball of the bearings be coated with "Never-Seez," manufactured by the Never-Seez Corporation, Broadview, IL 60155, per their recommendations. The aligning ball should be rotated at an angle to the shaft's axis while applying this lubricant to insure full coverage.
- b. The South collector shafts must be inserted into bearings on the South manifold supports (19 - (23) before the North shafts are inserted. Hoisting must be by use of the four eye bolts as described in Section II.4.b. For convenience, the aligning ball of the South bearing may be adjusted to position the bearing at the proper angle for landing the shaft into same.
- c. If the collector height to which the collector panel must be lifted is quite small, a jib pole or cradle frame with chain hoist could be used for hoisting, if collectors were not to be installed on roof of the structure.
- d. When inserting North shaft into bearing, pull the North manifold support (28) - (32) toward the North to allow clearance, and when positioned into bearing push the support South.
- e. Allow the end of the South shaft to extend to face of South manifold support and the end of the North shaft to extend to face the North manifold support. When this is accomplished, the distance between faces of North and South manifold supports should be 11'-7" (139"), and then all set screws of bearings should be tightened securely.
- f. Adjust the turnbuckles of lower North Wind bracing (B) so that at any point along the North end of each collector panel, the distances between the end of collector panel and North manifold strut (10)-(14) is not in variance more than 1/8". After this, snug-up turnbuckles and tighten lock nuts on turnbuckles. Securely tighten pivot bolts mentioned in Paragraph III.3.e. above.
- g. If collectors are to be left overnight or unattended for any period of time before tracking system is installed, they must be temporarily held in place to prevent rotation and damage caused by wind. This may be accomplished by using a heavy nylon cord,

IV.2.g. Installations (cont'd)

making one loop around each collector panel pulley and securing cord tightly at each end of the array. Collector panels should be positioned with the lenses facing down for their protection and to prevent premature energy collection.

- h. Install four manifold end closure plates to the manifold supports, located as shown on Drawing 01-05-007, using four screws in each plate. Refer to field sub-assemblies for items (E), (F) and (G). (E) and (F) plates are for the inlet and outlet to the array and have a hole for these pipes. (G) plates, (two required) are blank plates to cover opening in manifold supports. Install all these plates with weatherstripping adjacent to manifold supports.
- i. Install idler pulley mounts (9) in accordance with drawing 01-04-009 (one on extreme east and one on extreme west north manifold supports). Before installing mounts, it is recommended that the shaft be inserted in bearing with locking collars and pulley be slipped on the shaft to aid in aligning the pulleys parallel and to collector panel pulleys. Install flange stiffeners as indicated. Adjust shafts and pulleys to align with collector pulleys and tighten locking collars, collar set screws and pulley set screws.

V. FIELD PIPING CONNECTIONS: Do not connect or braze any piping connections until the frame work and collector panels have been installed and adjusted as described above. All piping joints within the array and immediately adjacent to the array must be made either by brazing or by pipe threaded connections to withstand a maximum temperature of 600°F.

1. Brazing: Brazing should be by trained and qualified persons using proper cleaning and heating methods recommended by manufactures of the brazing to prevent flux from oxidizing copper.
2. Pipe Threaded Joints: It is recommended that a teflon tape "pipe thread dope" be used on pipe threads, which will withstand the above temperatures.
3. Connections Required, Internal to the Array: Refer to Drawings 01-04-004 and 01-05-122. Perform the following connections, making all brazed connections prior to threaded connections and un-assemble swivels before brazing bleeder connections:
 - a. In each North and South manifold support (28)-(32), braze the tee connection fo copper manifolds with the tee position as shown.
 - b. In each North manifold support (28)-(32) connect a flexible swivel connection which has a 1" x ½" tube connection for bleeder valve) Part #01-09-029, to the collector panel outlet and to the tee connection of copper manifold with the swivel end on collector panel. Also, in each North manifold support, insert bleeder valve assembly, No. 01-03-060, through the grommetted hole in manifold support and braze bleeder valve to the ½" tube on swivel.

V.3.c. Field Piping Connections (cont'd)

- c. In each South manifold support (19) - (28), connect a flexible swivel connection #01-09-130 (without bleeder valve tube) the same as for North manifold supports.
- d. Braze a 3/4" plug into the unused tee connection of northwest and southeast manifold support as shown on manifold end closure drawing (G).
- e. At the fluid outlet (F), braze the assembly to the tee connection in manifold support and install automatic air eliminator as shown on drawing for this item. Air eliminator must be positioned vertically.
- f. At the inlet (E), braze the assembly to tee connection in manifold support and install pressure relief valve as shown for item (E). Pressure relief valve must be installed vertically.

4. Inlet and Outlet Connection to the Array

- a. See Section VI "Purging and Testing, etc" prior to making final inlet and outlet connections.
- b. Braze field system piping to inlet (F) and outlet (G) assemblies as shown for these assemblies.
- c. At the inlet and outlet connections, flexible connections must be provided to allow expansion of manifold piping at the rate of 0.1" for each 10'-0" system piping and is not furnished by the manufacturer. See Application Manual.

VI. PURGING, TESTING & FILLING OF FLUID PIPING:

1. Purging: The array should be thoroughly flushed either before or after connection to the system piping to remove debris that may have accumulated in the piping system. It is recommended this be done prior to connection to system piping as follows:
 - a. Leave outlet open to atmosphere and connect city water to inlet.
 - b. Flush water up through array at the rate of 2.0 GPM for each collector panel for about 15 minutes. While doing this, slowly rotate each collector panel three complete revolutions in each direction. Observe swivels for leaks.

VI.1.c. Purging, etc. (cont'd)

- c. Cap outlet temporarily, and leave city water pressure on system. At each North manifold support (28)-(32) open bleeder valve (by depressing the Valve core) and allow water to flow through each valve for two minutes. Do the same with manual valve on automatic air eliminator valve and pressure relief valve.
- d. Leave cap on outlet for pressure testing system later.

2. Pressure Testing and Drain Down:

- a. Remove city water connection. Install a hydraulic pressure gauge on inlet of array having a range of 150 PSI.
- b. Install a hydraulic (hand operated) pump to inlet down stream from gauge. Pump must have a check valve and a gate at discharge with check valve between pump and gate valve. Connect city water to inlet of pump.
- c. Pump water into array, making sure array is filled with water by opening bleeder valves, automatic vent valve and pressure relief valves, and rotating collectors as in purging above.
- d. Increase pressure to 120 PSI, close gate valve at pump and prove system tight by maintaining this pressure for 24 hours without loss in pressure. During this test period, each collector panel should be rotated three revolutions in each direction at end of each eight-hour interval.
- e. When rotating collector panels, the nylon rope previously installed should be loosen and then re-lightened after rotation.
- f. Prior to releasing pressure after proving system tight, gradually increase pressure until pressure relief valve opens. Check pressure gauge and note that this pressure should be $125 \text{ PSI} \pm 3 \text{ PSI}$. Decrease pressure slowly and allow pressure relief valve to close of its own accord to prove valve works properly.

3. Drain Down after Testing:

- a. Remove hydraulic pressure gauge, hydraulic pump and cap on outlet and begin to drain down of system. Allow array to drain down by gravity flow. Rotate each collector by hand three times. Start at outlet end of array and work towards inlet end. Repeat this step until no more solution flows from outlet pipe. It is advised that a rubber hose be attached to inlet pipe to carry solution away to appropriate site drains. Should

VI.3.a. Purging, etc. (cont'd)

the array be left unconnected from the system piping for an extended period of time, it is recommended that inlet and outlet of the array be temporarily capped to prevent further contamination.

4. Final Hook-Up and Filling of System:

- a. System piping should be purged, flushed and free of foreign material and debris prior to connecting to the array, by standard methods applicable to the system.
- b. If the array is to be protected from freezing, the system should have provisions for adding anti-freeze solution. Approximate percentages for industrial grade ethylene glycol for freezing protection is given in the table below. If other types of anti-freeze solutions are used, they should be used per manufacturer's recommendations and assure that they are compatible with "O" rings and valves seats in system. See Application Manual for volume of system and anti-freeze limitations. In mild climates, not subject to frequent freezing, fluid may be circulated during non-solar hours, by means of proper temperature sensing and controls.
- c. Connect system piping per Paragraph V.4. Add proper amount of anti-freeze and fill system through water make-up system. Bleed valves and rotate collectors in similar manner as described for purging and testing above, to eliminate air in system.

<u>FREEZING TEMPERATURE °F</u>	<u>%ETHYLENE GLYCOL</u>
16	20
10	25
0	33
-12	40
-34	50
-62	60

VII. INSULATION OF PIPING:

1. All piping with the collector array, between the East faces of the East manifold supports and the West faces of West manifold supports, except those portions within the top of each manifold support, (19)-(23) and (28)-(32), as indicated on Field Drawings 01-04-004 and 01-05-122, are factory insulated. After piping system has been proven tight as above, fill these top cavities with the pouring insulation supplied. Fill all voids around piping thoroughly by rodding with a wooden dowel. It is not necessary to compact this insulation but it is extremely important that all voids are filled. Each manifold support requires 0.30 Ft³ or 0.6 lbs of insulation. Amount listed in "List of Materials" allows wastage over this amount.

VIII. INSTALLATION OF TRACKING SYSTEM:

The following instructions described methods of installing tracking system and cable arrangement. They do not include adjustments in system or start-up procedures described hereinafter. It is recommended that final installation of the cable drive assembly (H) and sensor attachment (J) not be made until the system is fully connected and fluid is circulating in the array.

1. Tracking Control Box (I): This unit is shipped completely assembled as shown on Drawing 01-03-069 as one unit. It is also fitted with sufficient cable to extend to next bay on East and West side of the control box, with a cable thimble and cable clamp on each end, ready to install turnbuckles.
2. Control Box Mount Assembly (8): Remove screws from control box cover and remove from control box. Install East and West control box mounts and control box with accessories and fasteners as indicated on Drawing 01-04-008. Locate this assembly in the array as indicated for Item (1) on Drawing 01-05-007.
3. Cable Drive Assembly (H): Refer to Drawing 01-04-072. Strike pins extending out bottom of power screw housing of control box should be at equal distance away from control box when shipped from factory. If not, loosen the set screw on motor sprocket, and rotate chain and large sprocket to equalize these distances. Tighten "set screw." Facing the tracking box and collector panel pulleys from the South (looking North) as viewed on Drawings 01-04-066 through 01-04-076, perform the following:

VIII.3.a. Installation of Tracking (cont'd)

- a. Remove temporary nylon rope securing the collector panels. Adjust all turnbuckles to 90% full extended length. Remove all pulley cable clamps at top of all collector pulleys.
- b. Attach a turnbuckle through cable thimbles on each of the cables extending out of control box.
- c. Thread West cable under adjacent West collector panel pulley and over its top in a clockwise rotation.
- d. Thread East cable under adjacent East collector panel pulley and over its top in a counter clockwise rotation.
- e. Let these two cables hang loose.
- f. Unroll cable from the reel, laying it reasonably straight. Attach a cable thimble and clamp to one end. Attach the West turnbuckle to this end.
- g. Extend cable to next West collector pulley, loop under the bottom and around pulley in clockwise direction. Continue westward to and around each collector pulley in same manner.
- h. After looping around extreme West collector pulley, loop around West idler pulley in a counter clockwise rotation.
- i. Extend cable back, eastward, (threading through two idler cable supports) (01-03-082) to bottom of East Idler pulley and around pulley in a counter clockwise direction.
- j. Continue, cable westward under and around East collector pulley in a clockwise rotation and around all other collector pulleys in same manner until the collector pulley East of control box has been reached.
- k. Loop end of cable through eye of East turnbuckle, stretch cable tight by hand, pulling end of cable eastward, and mark proper position for cable thimble.
- l. Install a cable thimble and clamp at the marked position and attach to East turnbuckle. It is suggested that any surplus cable be allowed to remain until all adjustments have been made.
- m. Tighten turnbuckles to remove slack in cable, but not tight enough that collector panels cannot be rotated slowly by hand, allowing cable to slip around pulleys.

VIII.3.n. Installation of Tracking (cont'd)

- n. Position all collector panels by hand to solar noon position (bottom of collector panel parallel to manifold struts (10)-(14).
 - o. Install an idler cable support on north manifold support (29) and (33), with two self-drilling, self-tapping screws. Position these so that they hold cable in line with cable at bottom of east and west idler pulleys.
 - p. Tighten turnbuckles so that idler cable has less than $\frac{1}{2}$ " SAG between supports.
 - q. Recheck position of collector panels to solar noon and install pulley cable clamps over the cable on each collector pulley, securing them tight.
4. Sensor Attachment Assembly (J): Install solar sensor on extreme East collector panel, centered on the East lens and install wiring of sensor as indicated to bottom of control box, as indicated, through grommeted hole and connect the black, orange, and blue wires to the corresponding color wires in the box with wire nuts. Tie-off any surplus wire with plastic wire ties (provided in box) to prevent interference with mechanism in control box. See tracking control box wiring diagram 01-02-016
5. Power Supply to Control Box: Provided a 120V, AC, 60HZ power supply to junction box on bottom of tracking control in accordance with National Electrical Code or local governing codes in force for the particular locality. This supply must have a ground continuity wire connected to grounding lug in junction box. Connect the hot leg of power supply to black wire in box and the neutral wire to the white wire in junction. If desired, a toggle disconnect switch may be installed in this junction box, to open the hot leg of power supply for convenience in servicing the tracking system. Full load current of tracking system is 0.50 amps or , 60 watts power consumption.

IX. START-UP OF SYSTEM:

- 1. Piping system must be fully connected as described herein before and flowing at proper rate (see Application Manual) before tracking system in energized.
- 2. It is preferable to perform alignment of collector panels from one to two hours before or after solar noon. After installing tracking system as described in Paragraph VIII, energize tracking motor and allow system drives collector panels westward for a few seconds and then is off for about 45 to 60 seconds.

IX.3. Start-Up of System (Cont'd)

3. While system is tracking the sun, observe focal point (concentrated light beam) of the lens below solar sensor. Rotate solar sensor by loosening and tightening nut on positioning bracket so that focal point is centered on absorber tubes. . Observe this condition for at least 15 minutes making adjustments if required to be certain it is focused and is tracking the sun properly.
4. In making adjustments of solar sensor as above, it should be remembered that if the focal point is East of the absorber tubes, a rotation of the sensor to move its top toward the East will move the focal point West toward the absorber tube, and visa versa.
5. After this panel is focused and tracking properly, adjust all other collector panels in the array (one at a time) by slightly decreasing tension on cable, loosening pulley cable clamp, rotating collector panel to proper focus (allowing cable to slip around pulley), and firmly re-tightening cable clamp and replacing tension on cable.

X. MAINTENANCE

The following routine maintenance should be performed:

1. Lenses (Cleaning of exterior)

- a. Interval - on a "as required basis," per visual inspection, and especially after adverse weather conditions.
- b. Cleaning procedure - clean lenses, when collectors are in a vertical position, by washing with a fine hose spray and washing with a mild, non-abrasive detergent, rinse and dry with a soft (non-linting), dry cloth. When completely dry, coat exterior with a 0.25% solution of detergent (one ounce detergent to 13 quarts water) with a sponge or clean cloth which has been immersed in this solution and let dry by dust-free air. This will destaticize lens to help preclude dust attraction. Due to its chemical consistency, "Orvus K" has been found to be a safe and suitable detergent for the above process. It may be purchased from Hampden Color & Chemical Co., 126 Memorial Dr., Springfield, Mass. 01101, (413/732-2112). Since ordinary household detergents are changed chemically for improved household use, these should be used only after a thorough analysis has been made to insure no detrimental effects to acrylic lens.

2. Lubrication

a. Interval

- (1) Every 90 days for control box chain. All other control box parts do not require lubrication.
- (2) Bearings are the lubricated for life type and have no grease fittings and require no additional lubrication while in use.

b. Procedure

- (1) Control box chain - lubricate chain with a lubricant that penetrates, demoisturizes, and prevents rust (i.e., Browning Chain Lube #CLI56).

3. Cable Tension & Condition

- a. Interval - check cable tension and condition every 30 days and after adverse weather.
- b. Procedure: check to see that sag in idler cable does not exceed $\frac{1}{2}$ ". Should sag exceed $\frac{1}{2}$ ", refer to

X.3.b. Cable Tension (cont'd)

installation instructions, Page 12, Paragraph VIII.1 for tensioning of cable. Check cable for strand breakage (fraying) replace if wearing is evident.

4. Fasteners Check

- a. Interval - every 60 days and after adverse weather.
- b. Procedure - Using appropriate tools, check all nut and bolt combinations at frame bearing flanges. Check all pulley set screws, self-tapping screws and housing fasteners. All fasteners to be hand tight. Caution - do not over tighten, stripping out of or breakage of fastener may occur.

5. Exterior Finish

- a. Interval - check every six months.
- b. Procedure - check for and locate areas of rust or rust scale. These areas should be treated with a zinc rich paint similar to Z.R.C., applied and used according to manufacturer's specifications. All galvanized metal products will in time oxidize leaving a white film on surface. This is not detrimental to the metal and does not require refinishing.

6. Valve Check

- a. Interval - check bleeder valve, swivels, air vent, and pressure relief valve every 30 days.
- b. Procedure
 - (1) Visually and physically check swivel for leakage. Replace entire assembly if leaking is present.
 - (2) Check pressure relief valve by lifting handle on unit and manually release pressure.
 - (3) Check bleeder valve manually by depressing valve core briefly.
 - (4) Air vent is to be checked visually, looking for fluid leakage at air vent cap (small) on top of unit. Should leakage be present, unscrew air vent cap and push in valve core allowing fluid to flow out. This will flush out valve seat. Next, pull out slightly on valve stem to dislodge any foreign matter. Repeat if necessary. If problem persists replace unit.

7. Leak Check

- a. Interval - every 30 days.
- b. Procedure - check all connections at manifolds, North and South, check inlet and outlet connections to arrays.

X.7.b. Leak Check (cont'd)

Check collector housing for internal leakage by visual examination of collector's South end seams. Replace or repair items at leak location after shutting down and draining down system. If leakage is not readily accessible, consult factory for method of repair or replacement.

8. System Anchorage Check

- a. Interval - every 60 days or after adverse weather conditions.
- b. Procedure - visually and physically check anchorage devices for looseness, crack development and/or deformity at all anchorage points. Should a problem exist, consult facility's structural engineering representative.

- XI. CODES AND REGULATIONS: Instructions and directions given herein are considered to be minimum standards. Requirements of any codes or laws in force, governing this type of installation, shall take precedence over these instructions should they conflict; however, approval to make these deviations must be approved by Northrup. Inc.
- XII. WARRANTY: Warranty Certificates shipped with each order of collectors is limited warranty which states that the components of the Northrup Solar System will be free from defects in material and workmanship for a period of 18 months from date of shipment from factory or 12 months from installation date, whichever occurs first.

LIST OF MATERIALS

LIST OF MATERIALS

DATE: 1-16-76

NORTHROP CONCENTRATING SOLAR
COLLECTOR PANELS, MF-NSC-P "ML" SERIES

REV: B 1-16-78

NO. 01-05-076MODEL NSC-01-0732

PAGE 1 OF 2

ITEM	QTY.	DRAWING OR PART NUMBER	DESCRIPTION
1	1	01-03-069	Tracking Control Box Assembly
4	7	01-04-004	Collector Panel Assembly
5	3	01-04-005	South Wind Bracing Assembly
6	3	01-04-006	Upper North Wind Bracing Assembly
7	7	01-04-007	Inclined Strut Assembly
8	1	01-04-008	Tracking Control Box Mount Assembly
9	2	01-04-009	Idler Pulley Mount Assembly
10	2	01-04-010	Manifold Strut Assembly 3/4" cu Manifold
11	2	01-04-011	Manifold Strut Assembly 3/4" cu Manifold
12	2	01-04-012	Manifold Strut Assembly 1" cu Manifold
13	2	01-04-013	Manifold Strut Assembly 1" cu Manifold
14	4	01-04-014	Manifold Strut Assembly 1 1/4" cu Manifold
19	2	01-03-002	South Manifold Support 3/4" x 3/4" connection
20	1	01-03-003	South Manifold Support 1" x 3/4" connection
21	1	01-03-004	South Manifold Support 1" x 1" connection
22	1	01-03-005	South Manifold Support 1 1/4" x 1" connection
23	2	01-03-006	South Manifold Support 1 1/4" x 1 1/4" connection
28	2	01-03-023	North Manifold Support (w/Bleeder) 3/4 x 3/4
29	1	01-03-024	North Manifold Support (w/Bleeder) 1 x 3/4
30	1	01-03-025	North Manifold Support (w/Bleeder) 1 x 1
31	1	01-03-026	North Manifold Support (w/Bleeder) 1 1/4 x 1
32	2	01-03-027	North Manifold Support (w/Bleeder) 1 1/4 x 1 1/4
37	6	01-04-024	North Wind Strut Assembly
A	7	01-03-032	North Column Assembly 32° Tilt Angle

LIST OF MATERIALS

DATE: 1-16-76

NORTHROP CONCENTRATING SOLAR
COLLECTOR PANELS, MF-NSC-P "ML" SERIES

REV: B 1-16-78

NO. 01-05-076

MODEL NSC-01-0732

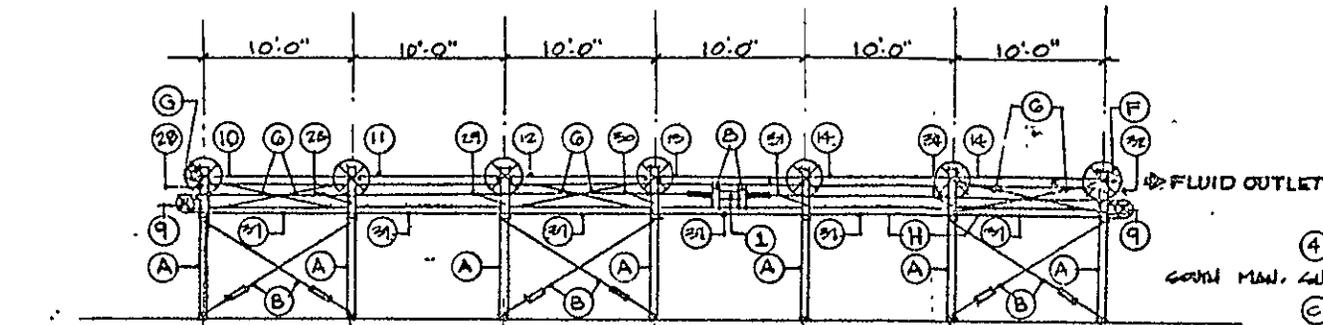
PAGE 2 OF 2

ITEM	QTY.	DRAWING OR PART NUMBER	DESCRIPTION
B	3	01-04-035	Lower North Wind Bracing Assmb. 32° Tilt Angle
C	7	01-04-044	South Brace Assembly 32° Tilt Angle
D	14	01-07-003	South Column Base Ls
E	1	01-04-057	Fluid Inlet Assembly 1 1/4" Manifold
F	1	01-04-062	Fluid Outlet Assembly 1 1/4" Manifold
G	2	01-04-065	Manifold End Closure 3/4"
H	1	01-04-072	Cable Drive Assemble 7 Collector Panels
I	5 ft ³	01-13-003	Loose Fill Insulation (1 bag - 7.5 ft. ³)
J	1	01-04-077	Sensor Attachment Assembly

FINAL FIELD ASSEMBLY DRAWINGS

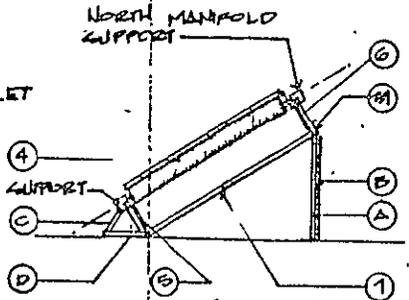
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FIELD ASSEMBLY "ML" SERIES COLLECTORS MODEL NSC-01-0732
 NORTHROP, INCORPORATED 802 INDEPENDENCE DRIVE, MCKINNEY, TEXAS 75141
 DWN FW CANK 9-29-77 REV B
 01-05-007

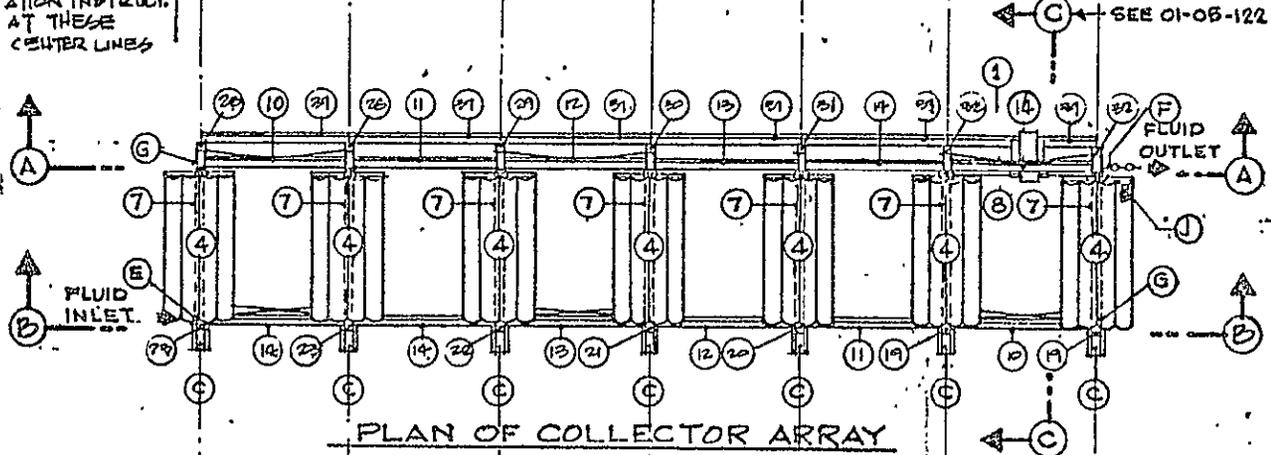


ELEVATION A-A
LOOKING NORTH-PARALLEL
TO TILT ANGLE

SUB-ASSEMBLY
PARAGRAPH III,
2 OF INSTALL-
ATION INSTRUCT.
AT THESE
CENTER LINES



SECTION REF 01-05-122



PLAN OF COLLECTOR ARRAY

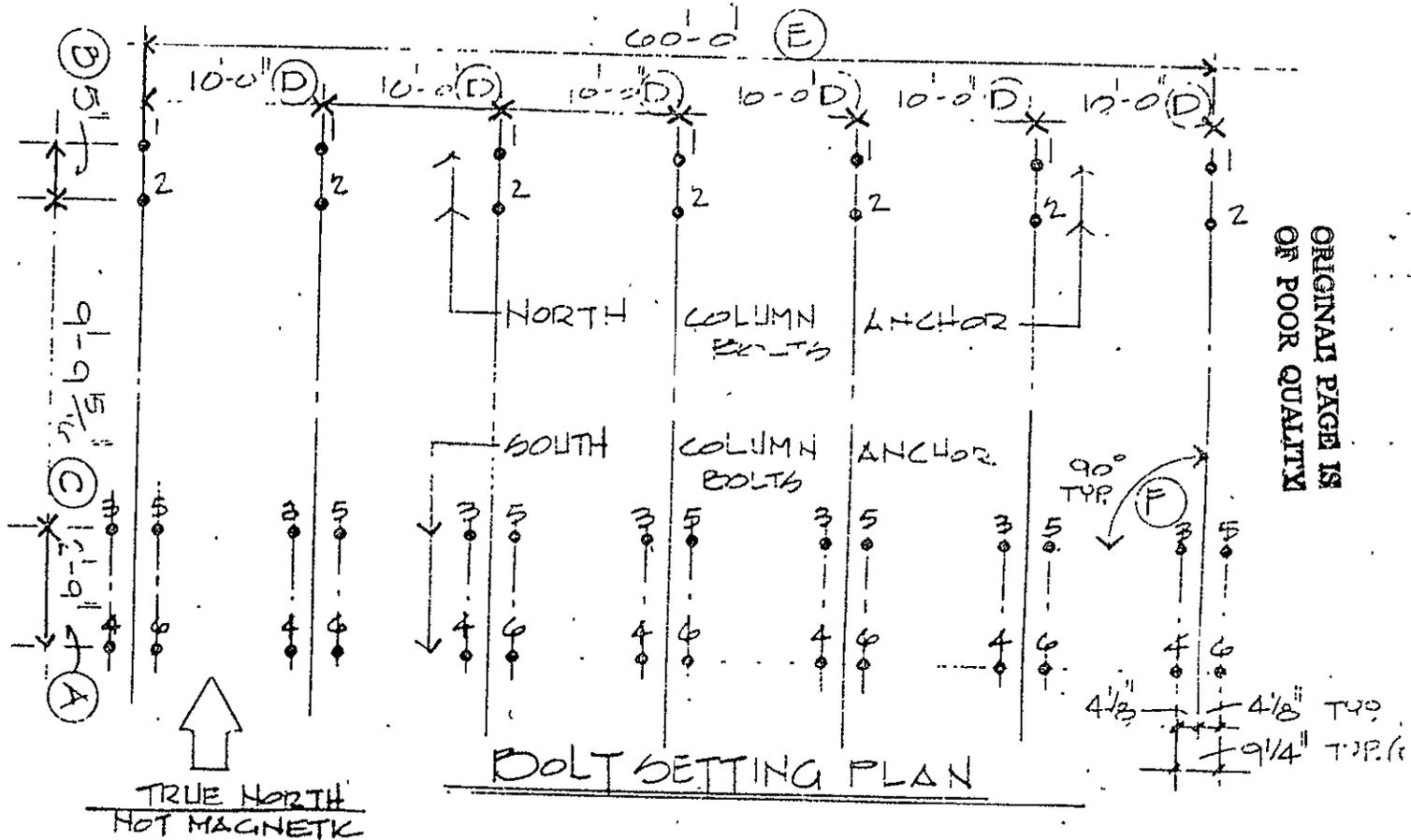
ITEM	DESCRIPTION
1	Tracking Control Box Assembly
4	Collector Panel Assembly
5	South Wind Bracing Assembly
6	Upper North Wind Bracing Assembly
7	Inclined Strut Assembly
8	Tracking Control Box Mount Assembly
9	Idle Pulley Mount Assembly
10	Manifold Strut Assembly 3/4" cu Manifold
11	Manifold Strut Assembly 3/4" cu Manifold
12	Manifold Strut Assembly 1" cu Manifold
13	Manifold Strut Assembly 1" cu Manifold
14	Manifold Strut Assembly 1 1/4" cu Manifold
19	South Manifold Support 2 1/4" x 2 1/4" collector
20	South Manifold Support 2 1/4" x 2 1/4"
21	South Manifold Support 1 1/4" x 1 1/4"
22	South Manifold Support 1 1/4" x 1 1/4"
23	South Manifold Support 1 1/4" x 1 1/4"
28	North Manifold Support 2 1/4" x 2 1/4"
29	North Manifold Support 1 1/4" x 3/4"
30	North Manifold Support 1 1/4" x 1 1/4"
31	North Manifold Support 1 1/4" x 1 1/4"
32	North Manifold Support 1 1/4" x 1 1/4"
37	North Wind Strut Assembly
A	North Column Assembly
B	Lower North Wind Bracing Ansbm.
C	South Brace Assembly 32° Tilt Angle
D	South Column Base Ls
E	Fluid Inlet Assembly 1 1/4" Manifold
F	Fluid Outlet Assembly 1 1/4" Manifold
G	Manifold End Closure
H	Cable Drive Assembly 7 Coll. Panels
I	Loose Fill Insulation (1 bag-7.5ft. 3"
J	Sensor Attachment Assembly

REVISIONS
 A REVISION ON # 11-4-77 FJW/eb
 B GEN. REVISIONS 1-5-77 eb
 C GEN. REVISIONS 2-24-78 ba

NOFERTERRIDE

BOLT SETTING PLAN

01-05-123
 DRN b4 DR
 5-5-78 REV



PERMISSIBLE VARIATIONS FROM CENTER LINE DIMENSIONS OF BOLT SETTING PLAN.

- * (A) $\pm 1/32''$
- * (B) $\pm 1/32''$
- (C) $\pm 1/2''$
- (D) $\pm 1/2''$
- (E) $\pm 1/2''$
- (F) $\pm 1/2$ DEGREE
- * (G) $\pm 1/32''$

* BASED ON USING 1/2" DIA. ANCHOR BOLTS

PERMISSIBLE VARIATIONS IN COLUMN BOLT POINTS FROM ONE LEVEL PLANE.

ALONG N-S ϕ BETWEEN BOLTS 1 & 2	$\pm 1/2$
ALONG E-W ϕ BETWEEN ANY TWO SETS OF ADJACENT BOLTS 1 & 2	$\pm 1/2$
ALONG N-S ϕ BETWEEN BOLTS 3 & 4	$\pm 1/2$
ALONG N-S ϕ BETWEEN BOLTS 5 & 6	$\pm 1/2$
ALONG E-W ϕ BETWEEN BOLTS 3 & 5	$\pm 1/3$
ALONG E-W ϕ BETWEEN BOLTS 4 & 6	$\pm 1/3$
ALONG E-W ϕ BETWEEN ANY TWO SETS OF ADJACENT BOLTS 3 & 5 OR 4 & 6	$\pm 1/4$

STATUS	NO. REQ'D	PART NUMBER	DESCRIPTION
2		0k-06-136	Tracking Motor
2		01-10-002	Potted PC Board
2		01-10-009	P/C Board Receptacle
2		01-10-004	Transformer
1		01-10-005	Capacitor
2		01-10-003	Relays
2		01-10-008	Relay Socket
2		01-17-120	Sprocket 1 3/4" Bore
1		01-17-119	Sprocket 3/8" Bore
2		01-17-118	Bearing 1 3/4", Acme Power Screw
1		01-17-121	Chain No. 35 3/8 Pitch
1		01-06-126	Limit Switch
2		01-18-010	Power Screw & Nut Assembly
1		01-04-066 through 01-04-076	Cable (Specify Part No.)
2		01-18-014	Cable Guide
2		01-03-049	Collector Panel Housing
2		01-02-029	Flexible Hose Assembly North
2		01-02-030	Flexible Hose Assembly South
1		01-09-002	Pressure Relief Valve
1		01-09-024	Schrader Valve
1		01-09-001	Auto Vent Air Eliminator (Maid-O-Mist)
1		01-17-016	Bearing 1 1/2" Collector Panel
1		01-17-053	Bearing 1 1/4, Idler Pulleys
1		01-17-009	Pulley Idler 12 Nom.
2		01-02-027	Pulley, Collector, Assembly 29" Nom.
2		01-02-001	Lens
2		01-03-051	Lens End Closure Assembly

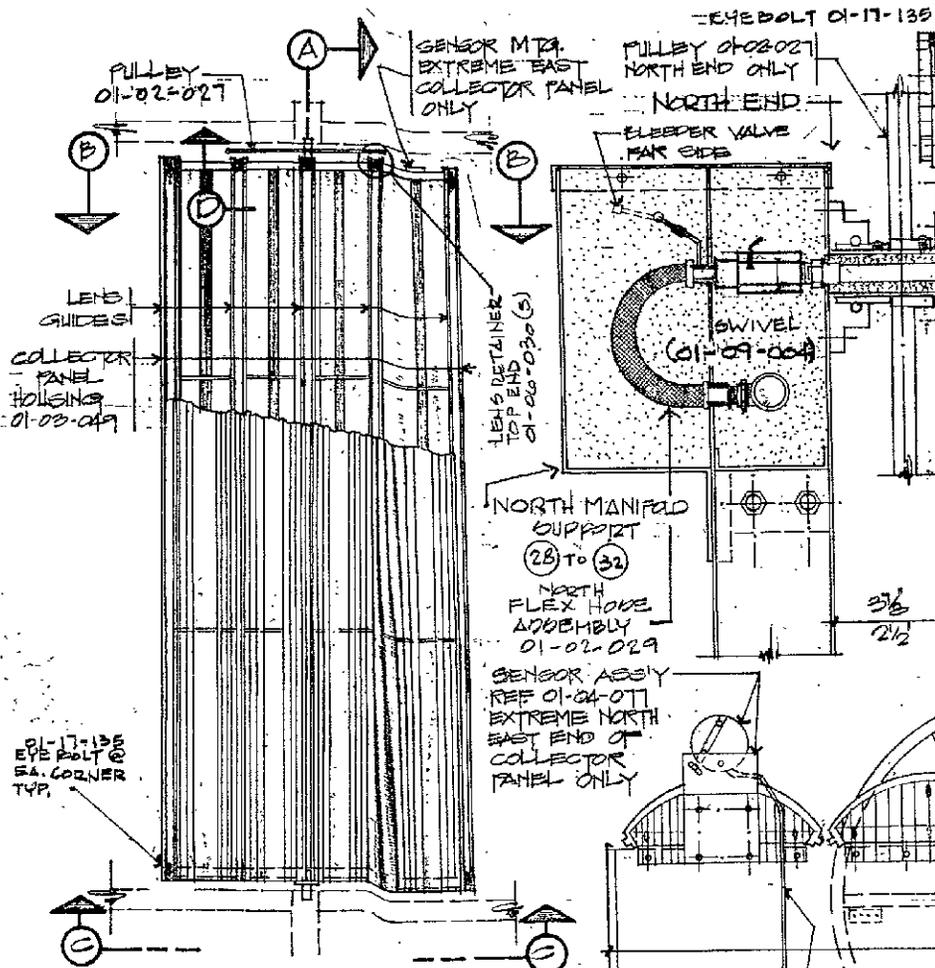
NORTHROP

NORTHROP, INCORPORATED 302 Nichols Drive, Hutchins, Texas 75141

Spare Parts List
"ML" Series
Model NSC-01-0732

01-05-124	CK
DRS	BG
5/3/78	REJ

· FIELD SUB-ASSEMBLY DRAWINGS



LIST OF MATERIALS

No.	Req'd	PN	Description
1		01-03-049	Collector Panel Housing
1		01-03-051	LENS END CLOSURE ASSY
1		01-02-027	PULLEY ASSEMBLY
50		01-17-008	Self-Drilling, Self Tapping Screw No. 8x1/2" x 32
3		01-06-030	Lens Retainer -
6		01-17-081	# 6 X 1/2 SCREW C.N. HD.
6		01-17-022	# 6 HEX NUT
6		01-17-083	# 6 STAR LOCK WASHER
4		01-02-021	LENSES
6		01-17-130	2 D # 8 X 1/2 SCREW W/ HEX STAR WASHER
1		01-17-135	2" DIA. EYE BOLT.

NOTE: SEE INSTALLATION INSTRUCTIONS FOR ASSEMBLY PROCEDURE.

SOLE OUT FRAME

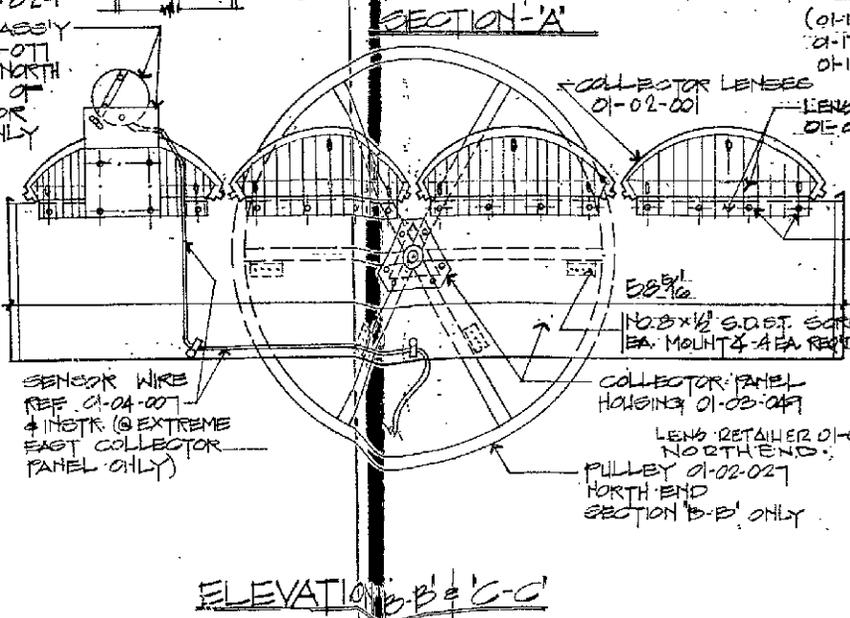
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PLAN OF COLLECTOR PANEL
(LOOKING DOWN PERPENDICULAR TO TILT Z)

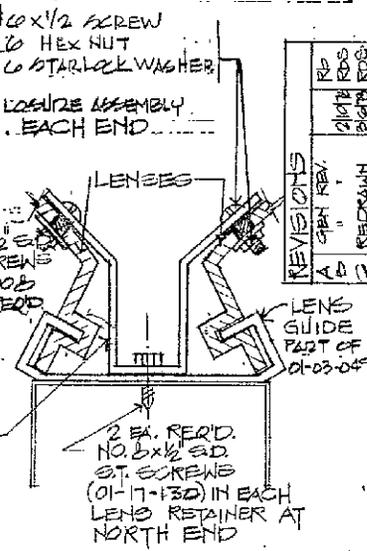
NET AREA OF COLLECTOR PANEL = 43 FT²

SOLE OUT FRAME

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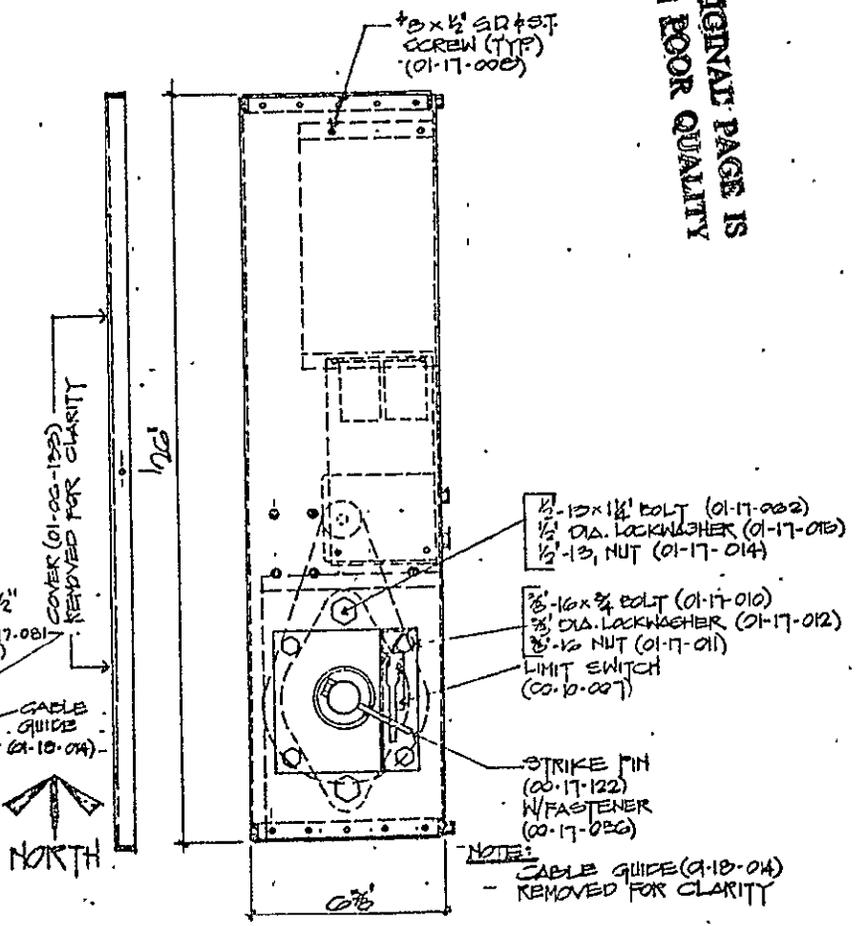
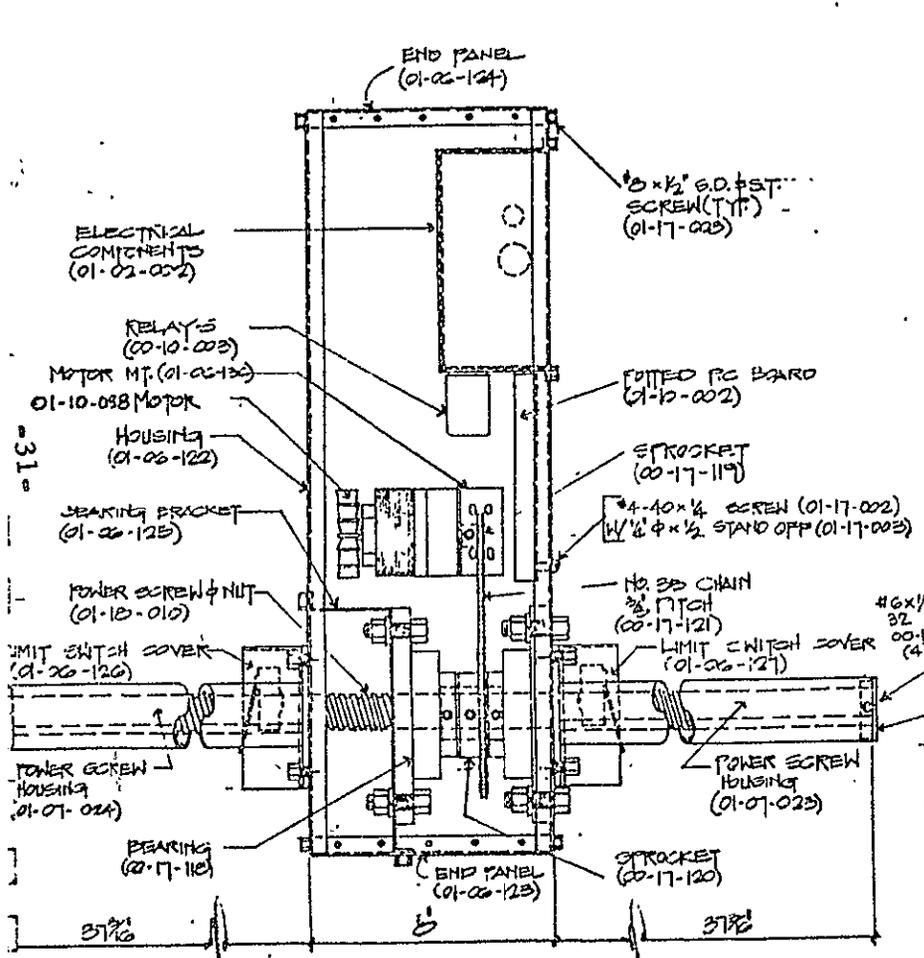
ELEVATION B-B' & C-C'



SECTION 'D'

REV	DATE	BY	CHKD	REASON
1				
2				

01-04-004
 DATE: FA
 DRAWN: FA
 CHECKED: FA
 REVISIONS: 4
 FIELD SUB-ASSEMBLY COLLECTOR PANEL 'ML' SERIES
 7-2017
 NORTHROP
 NORTHROP, INCORPORATED 302 Nichols Drive, Hughes, Texas 75141



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TRACKING CONTROL BOX

01-03-007	REV	DATE
001 RDS	01-15-70	101
002	01-15-70	101

TRACKING CONTROL BOX
SHOP ASSEMBLY

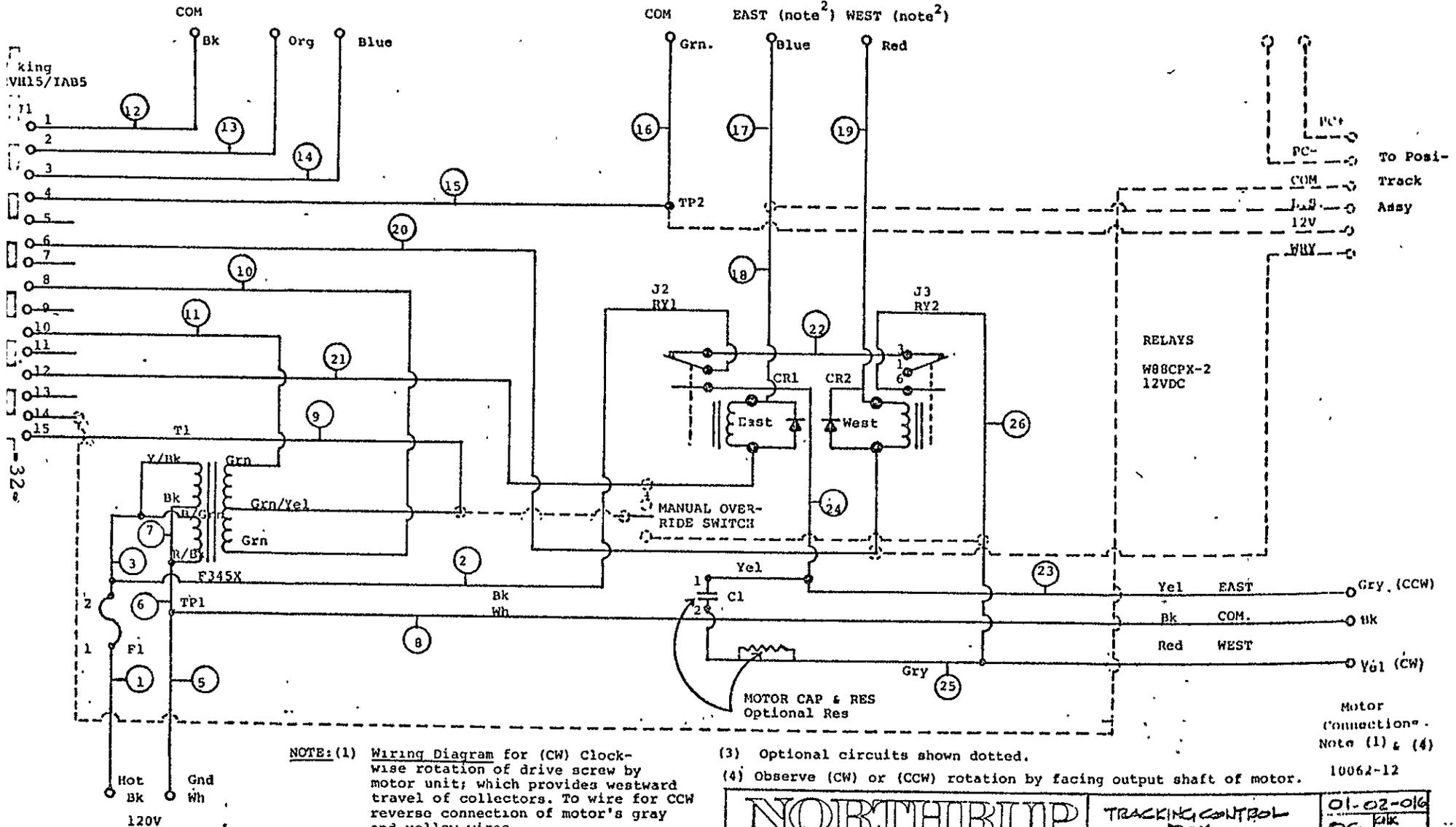
NORMAN ROUP

NORMAN INCORPORATED 302 NICHOLS DRIVE TULSA, OKLA. 74114

SOLAR CELL ASSEMBLY

LIMIT SWITCHES

TO POSI-TRACK SOLAR CELL



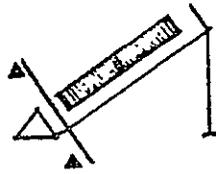
NOTE: (1) Wiring Diagram for (CW) Clock-wise rotation of drive screw by motor unit; which provides westward travel of collectors. To wire for CCW reverse connection of motor's gray and yellow wires.

(2) Limit switch @ this end of control box.

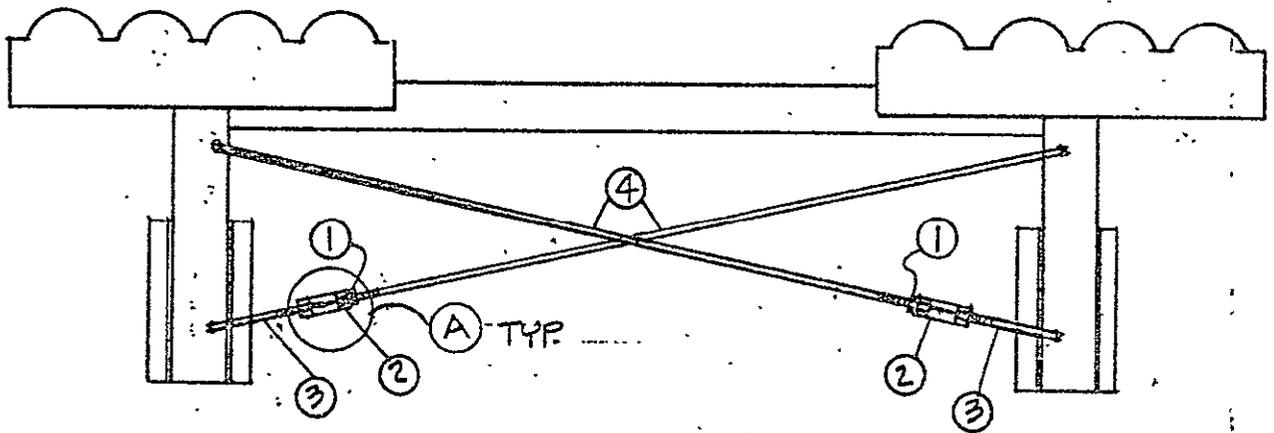
(3) Optional circuits shown dotted.
 (4) Observe (CW) or (CCW) rotation by facing output shaft of motor.

Motor connections - Note (1) & (4)
 10062-12

<h1 style="margin: 0;">NORTHROP</h1> <p style="font-size: small; margin: 0;">NORTHROP, INCORPORATED 532 Nichols Drive, Hutchins, Texas 75141</p>	TRACKING CONTROL BOX	01-02-016
	WIRING DIAGRAM	OG FHK
		10-26-77 REV. -

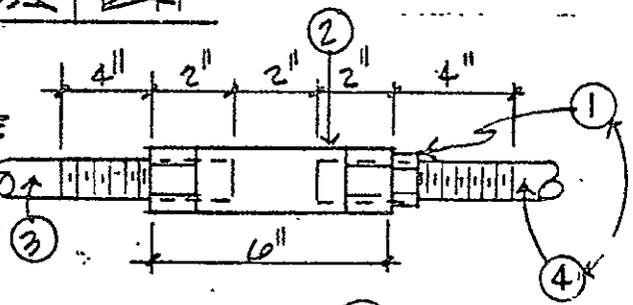


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ELEVATION

NOTE: COUPLE TURNBUCKLE
AND WIND BRACE
ENDS PER DETAIL-
A AND INSTALL PER
FIELD ASSEMBLY
INSTR.



DETAIL A

BILL OF MATERIALS

- ① 01-17-011 3/8" HEX NUT (2)
- ② 01-17-017 3/8" I.D. X 6" TURNBUCKLE (2)
- ③ 01-17-098 2'-0" LOWER WIND BRACE (2)
- ④ 01-17-101 7'-10" UPPER WIND BRACE (2)

FIELD ASSEMBLY INSTR.

INSERT EACH END OF ASSEMBLY
INTO PROVIDED HOLES. USE
ONLY THOSE HOLES TO THE INSIDE
OF RAY TO BE BRACED.
ADJUST TURNBUCKLE TO TIGHTEN,
SNUGLY.

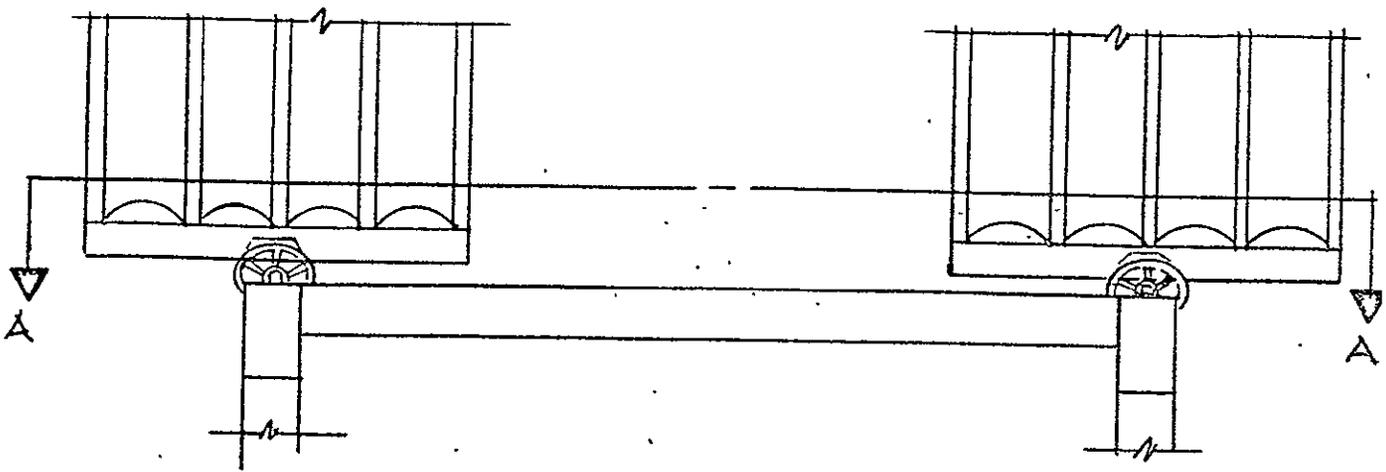
REVISED 3-2-78

NORTHROP

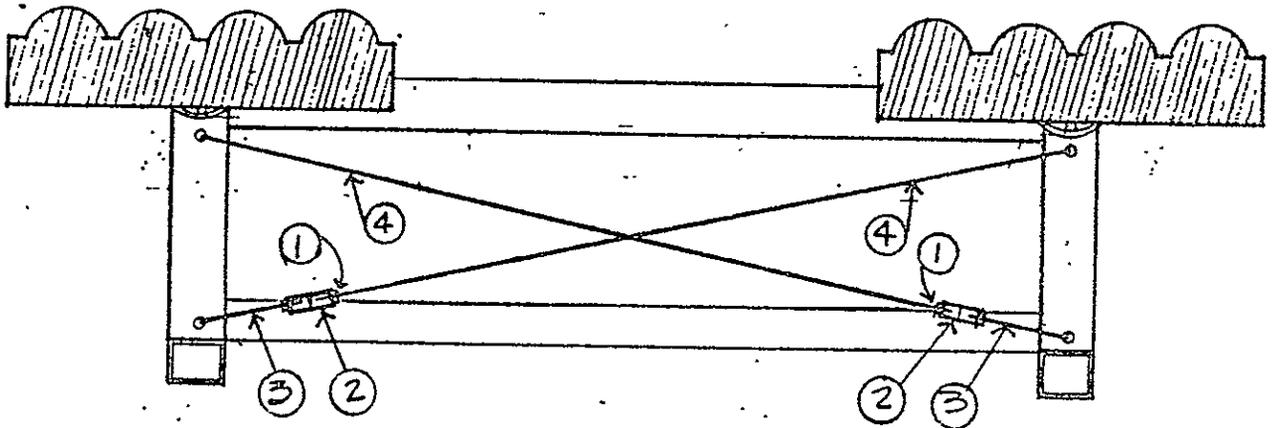
NORTHROP, INCORPORATED 302 Nichols Drive, Hutchins, Texas 75141

SOUTH
WIND BRACING

⑤	01-04-005	
	DRN b9	CHK
	2-2-78	REV A



PARTIAL PLAN
NORTH-END



SECTION A-A

BILL OF MATERIALS:

- ① 01-17-011 3/8" ϕ HEXNUT (2)
- ② 01-17-077 3/8" I.D. X 6" TURNBUCKLE (2)
- ③ 01-17-098 LOWER WIND BRACE, 2'-0" (2)
- ④ 01-17-100 UPPER WIND BRACE, 7'-10" (2)

FIELD ASSEMBLY INSTRUCTIONS

REF. DWG 01-04-005, INSTR.
AND DETAIL (A).

REVISED 3-1-78.

NORTHROP

NORTHROP, INCORPORATED 302 Nichols Drive, Hutchins, Texas 75141

UPPER NORTH
WIND BRACING.

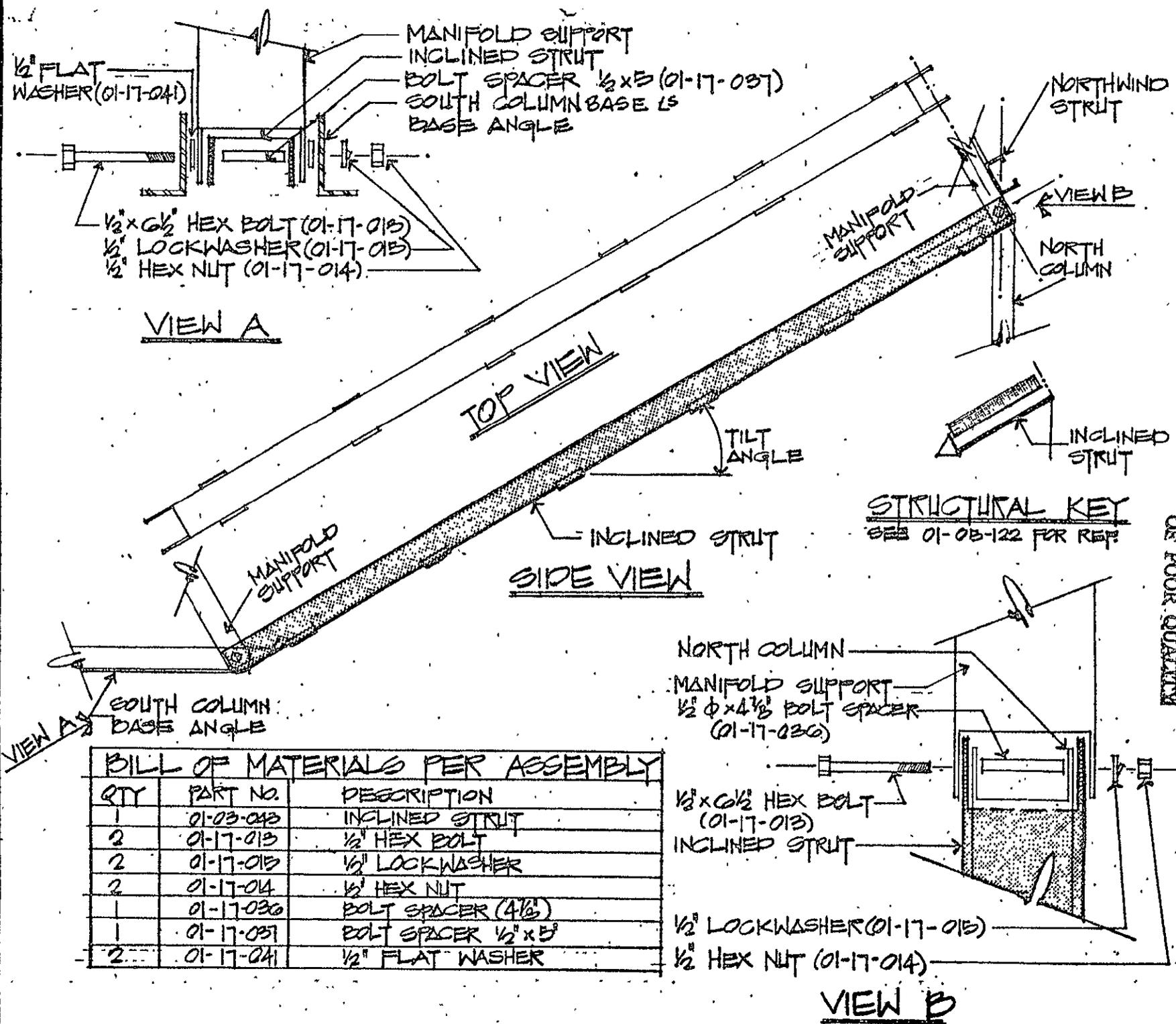
01-04-006	
DRN	CHK
bq	
2-2-78	REV A

⑥

NORRTHROP

INCLINED STRUT

01-04-007	DRN	CHK
8-2-18	ROS	RP
	REV	

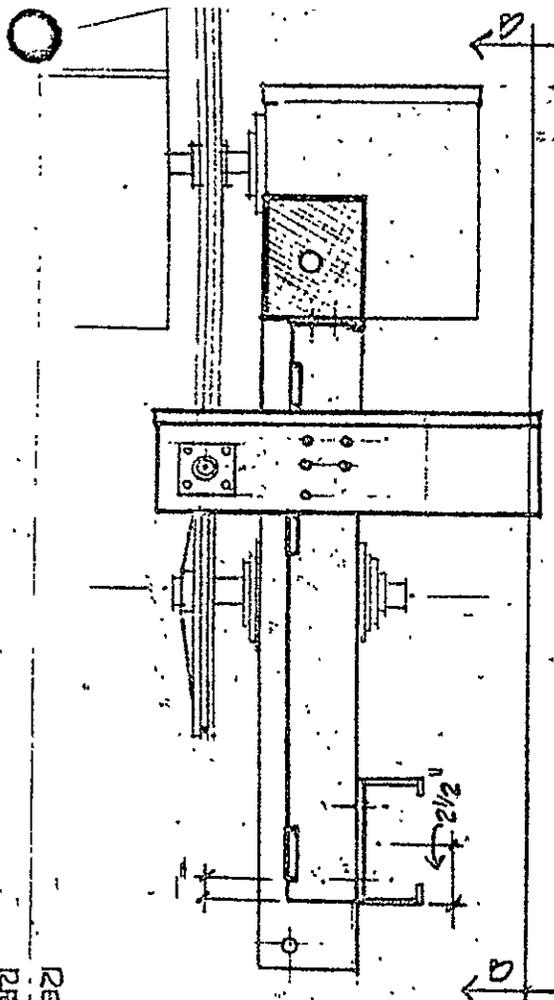


BILL OF MATERIALS PER ASSEMBLY

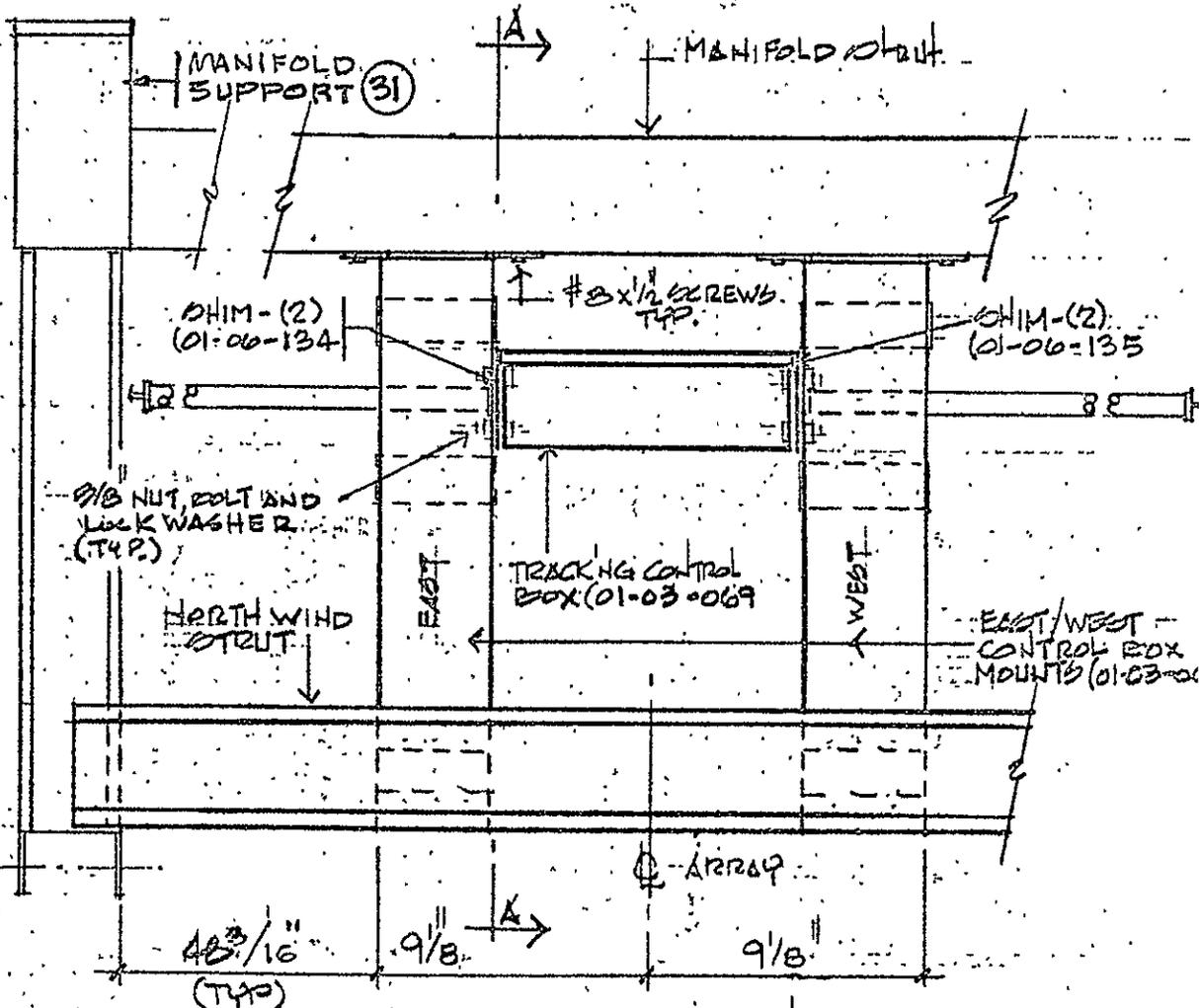
QTY	PART NO.	DESCRIPTION
1	01-03-043	INCLINED STRUT
2	01-17-013	1/2" HEX BOLT
2	01-17-015	1/2" LOCKWASHER
2	01-17-014	1/2" HEX NUT
1	01-17-036	BOLT SPACER (4 1/8")
1	01-17-037	BOLT SPACER 1/2" x 5"
2	01-17-041	1/2" FLAT WASHER

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REVISION - A REDRAWN 1-31-78 RDS
REVISION - B REDRAWN 3-21-78 by



RECT. A-A
LOOKING WEST



ELEVATION B-B
@ NORTH END, LOOKING SOUTH

BILL OF MATERIALS PER ASSEMBLY		
QTY	PART NO	DESCRIPTION
2	01-03-066	CONTROL BOX MOUNT
20	01-17-003	#3 6.D. 6T. HEX SCREW
2	01-06-134	SHIM - EAST 5 HOLES
2	01-06-135	SHIM - WEST 4 HOLES
6	01-17-010	3/8" HEX BOLT X 3/4"
6	01-17-011	3/8" HEX NUT
6	01-17-012	3/8" LOCK WASHER

ASSEMBLY PROCEDURE

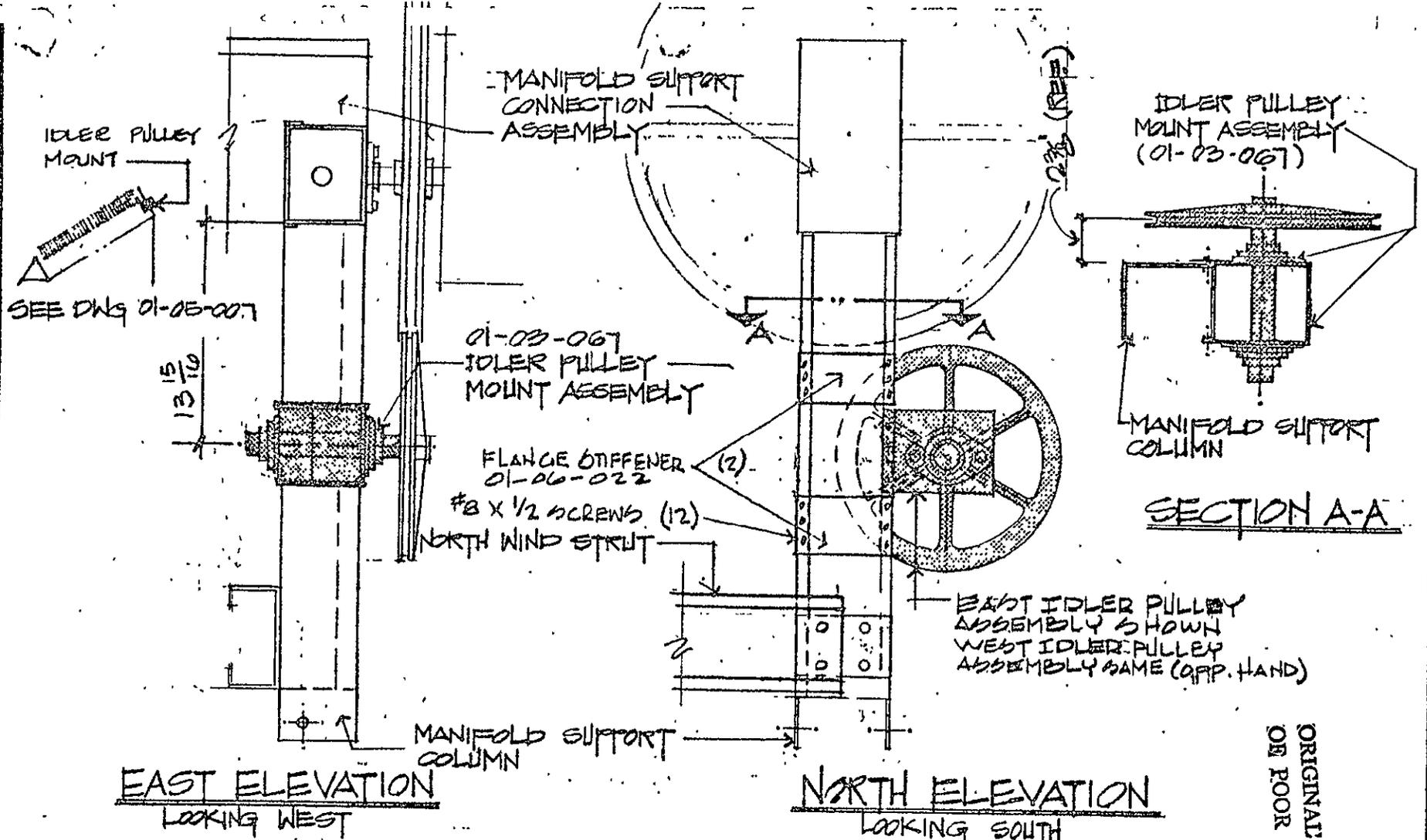
1. LOCATE CONTROL BOX MOUNTS (01-03-066) SPECIFIED DISTANCE EA. SIDE OF ARRAY CENTER LINE, FLUSH WITH BOTT. OF NORTH WIND STRUT.
2. MOUNT TRACKING CONTROL BOX (01-03-069) USING 3/8" DIA. BOLTS, NUT AND WASHERS PROVIDED.
3. REF. DWG. 01-05-007 FOR LOCATION OF TRACKING CONTROL BOX (1) AND MOUNTS (3)

WORKSHIP INFORMATION 205 Wilson Pike Madison Tenn 37137

NORRIMHURUP

IDLER PULLEY MOUNT
 FIELD SUB-ASSEMBLY

DRN RPS
 CHK RB
 REV



BILL OF MATERIALS PER ASSEMBLY

QTY	PART NO.	DESCRIPTION
1	01-03-067	IDLER PULLEY ASSY.
1	01-17-009	PULLEY
1	01-18-009	1/4" SHAFT
28	01-17-008	#8 3/4" HEX SCREW
2	01-17-054	1/4" LOCKING COLLARS
2	01-06-022	FLANGE STIFFENER

REVISION

REV	DESCRIPTION	DATE	BY
A	REDRAWN	2-1-78	RDS
B	"	3-25-78	09

IDLER PULLEY MOUNT FIELD SUB-ASSEMBLY

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9

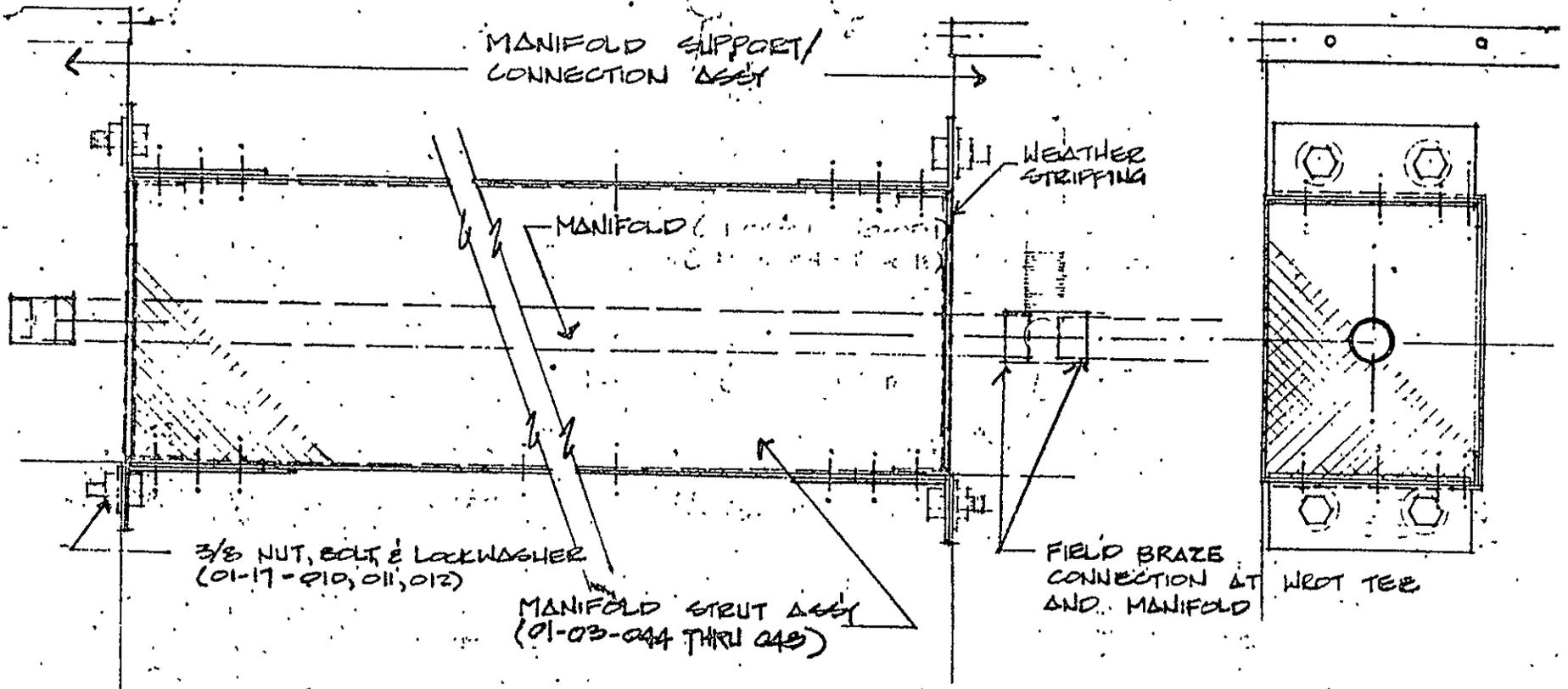
NORTHROP

-38-

FIELD

MANIFOLD STRUT

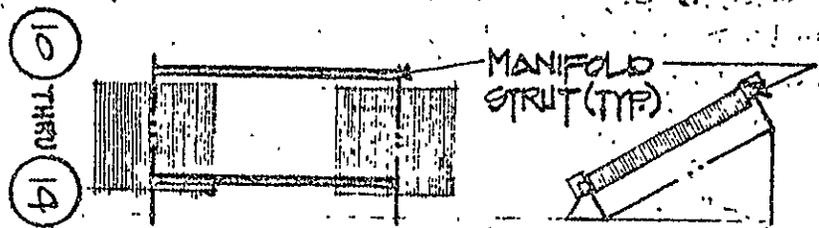
ASSY



BILL OF MATERIALS PER ASSEMBLY		
QTY	PART/ASSEMBLY #	DESCRIPTION
1	01-03-***	MANIFOLD STRUT ASSY
8	01-17-010	3/8 BOLT X
8	01-17-011	3/8 NUT
8	01-17-012	3/8 LOCKWASHER

REVISION			
A	GEN. REV.	2-1-76	RDS

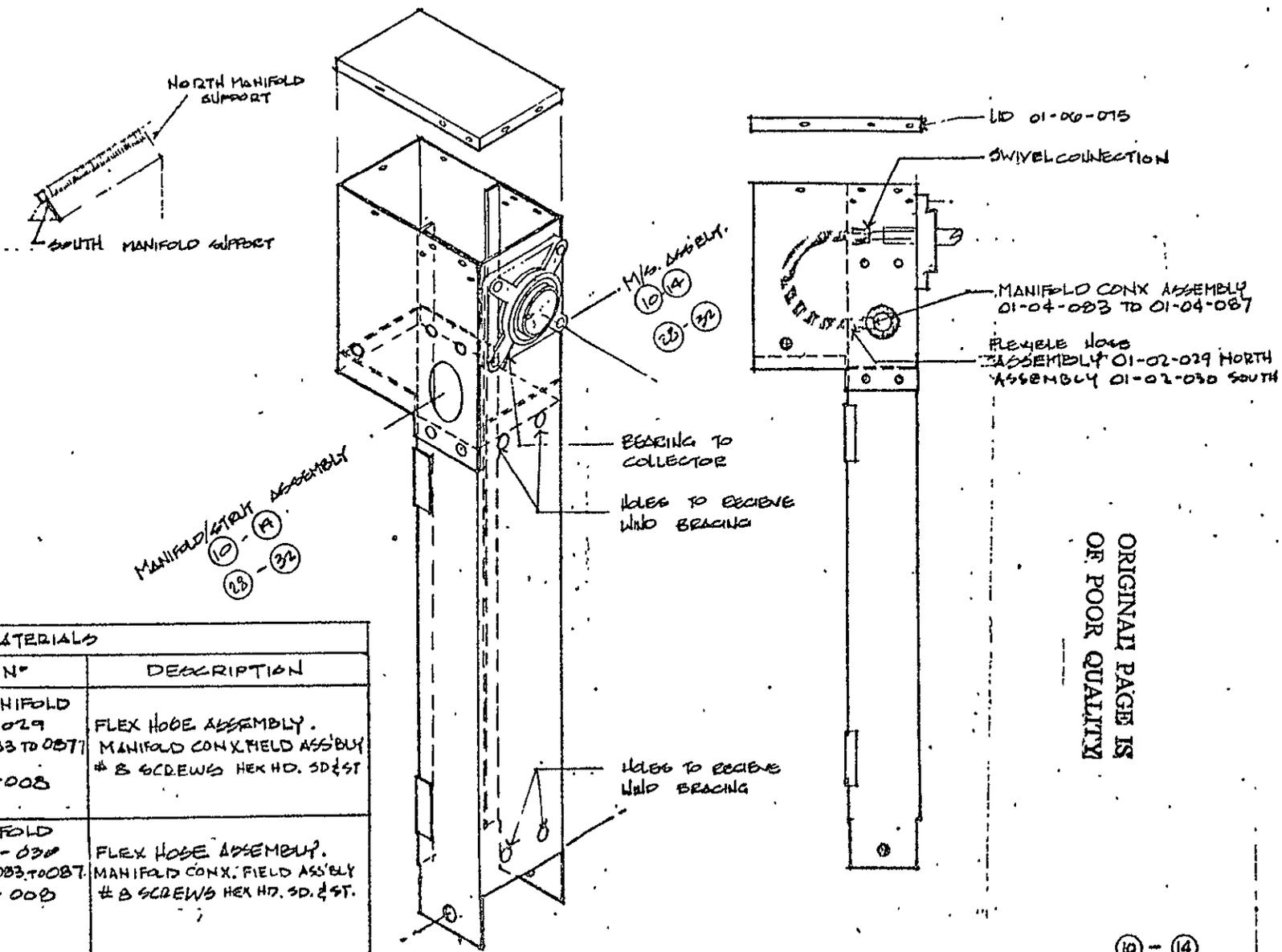
** 01-03-044 THRU-048



MANIFOLD STRUT 10-14
FIELD ASSEMBLY

SEE DWG. 01-03-001

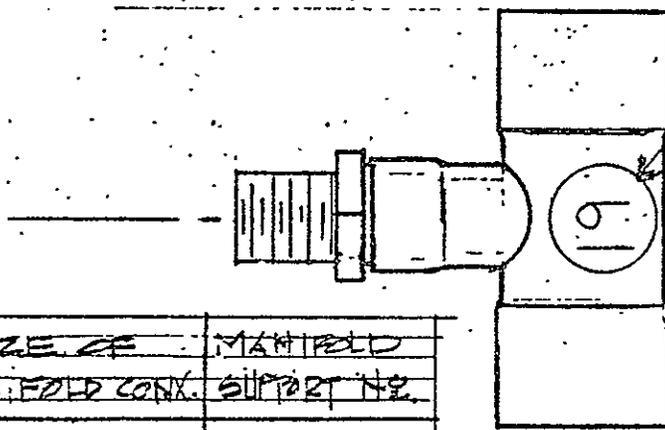
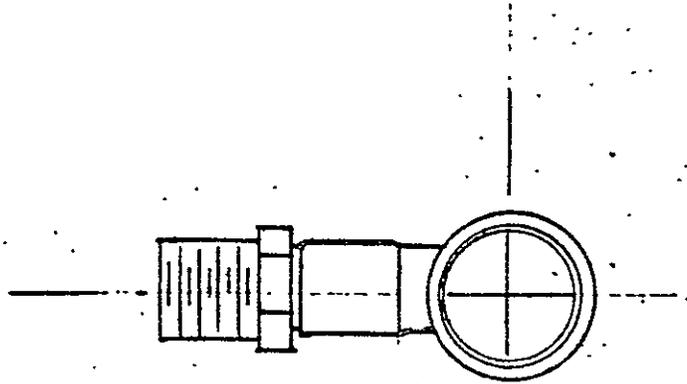
DRN	RLP	CHK	12/14
10-17-77		REV	



BILL OF MATERIALS		
QTY	PART N°	DESCRIPTION
(NORTH) MANIFOLD		
1	01-02-029	FLEX HOSE ASSEMBLY.
1	01-04-083 TO 087	MANIFOLD CONX. FIELD ASS'BY
9	01-17-008	# 8 SCREWS HEX HD. SD. ST.
(SOUTH) MANIFOLD		
1	01-02-030	FLEX HOSE ASSEMBLY.
1	01-04-083 TO 087	MANIFOLD CONX. FIELD ASS'BY
9	01-17-008	# 8 SCREWS HEX HD. SD. ST.

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(6) - (14)
(28) - (52)
(01-04-088)



MANIFOLD
SUPPORT NO
1E

QTY	PART NO.	SIZE OF	MANIFOLD
	FIELD ASSEMBLY	MANIFOLD CONX.	SUPPORT NO.
2	01-04-083	3/4 X 3/4	9
1	01-04-084	1 X 3/4	20
1	01-04-085	1 X 1	21
1	01-04-086	1/4 X 1	22
2	01-04-087	1/4 X 1/4	23
2	01-04-088	3/4 X 3/4	28
1	01-04-084	1 X 3/4	29
1	01-04-085	1 X 1	30
1	01-04-086	1/4 X 1	31
2	01-04-087	1/4 X 1/4	32

10 - 14

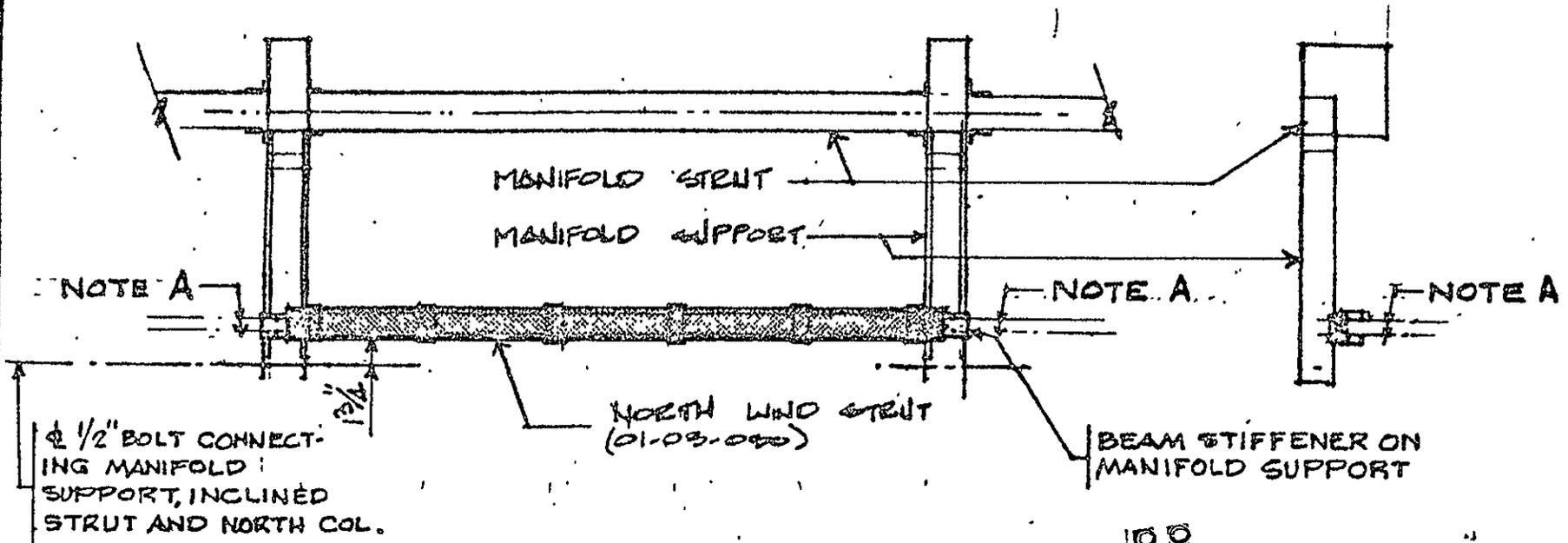
28 - 32

01-04-083

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MANIFOLD CONX. FIELD ASSEMBLY
 DRN by CR
 5-1-78 REV

NORTHROP



NOTE A: ϕ 1/2" BOLT CONNECTING MANIFOLD SUPPORT, INCLINED STRUT AND NORTH COL.

NORTH WIND STRUT (01-03-050)

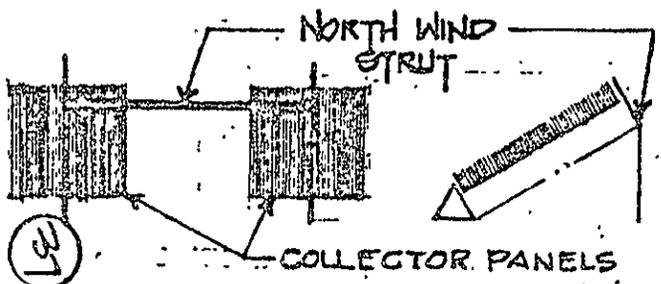
BEAM STIFFENER ON MANIFOLD SUPPORT

NORTH ELEVATION LOOKING SOUTH

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NOTE A:

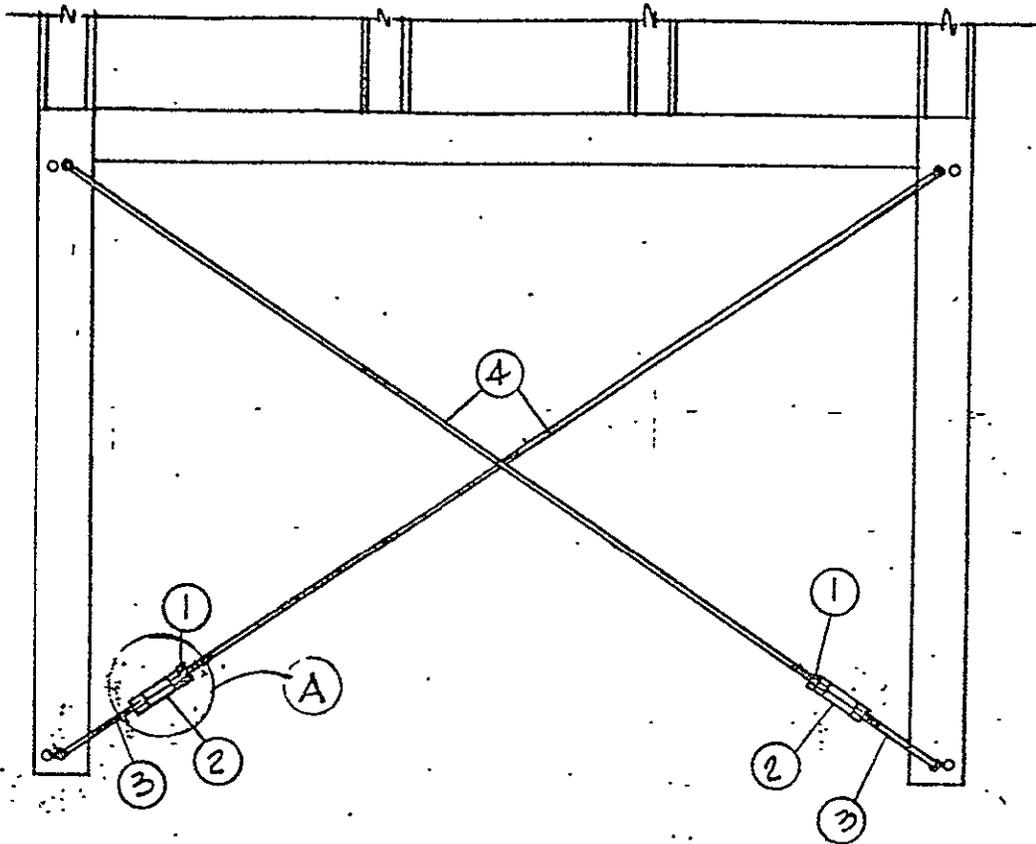
INSTALL NORTH WIND STRUT WITH $3/8" \times 3/4"$ BOLTS THRU STRUT INTO HOLES IN BEAM STIFFENER WITH $2-3/8"$ FLAT WASHERS BTW STRUT & BM STIFFENER, AND WITH LOCK WASHER & NUT ON SOUTH FACE OF BM STIFFENER.



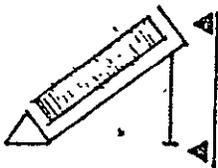
BILL OF MATERIALS		
1	01-03-050	NORTH WIND STRUT
4	01-11-010	BOLT, $3/8" \phi \times 3/4"$ HEX, UNC, ZINC
4	01-11-011	NUT, $3/8" \phi$ HEX, UNC, ZINC
4	01-11-012	LOCKWASHER, $3/8" \phi$, ZINC
8	01-17-072	$3/8"$ FLAT WASHER, ZINC

NORTH WIND STRUT (37)

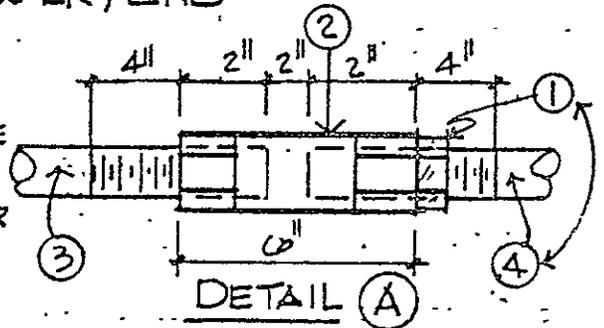
01-04-024	DRN	1-10-78	REV A
	EP		
	CHK	3-24-78	



ELEVATION
NORTH (LOWER) END



NOTE: COUPLE TURNBUCKLE
AND WIND BRACE
ENDS PER DETAIL
A AND INSTALL PER
FIELD ASSEMBLY
INSTR.



BILL OF MATERIALS:

- ① 01-17-011: 3/8" ϕ HEX. NUT. (2)
- ② 01-17-017: 3/8 I.D. X 6" TURNBUCKLE (2)
- ③ 01-17-098: 2" ϕ LOWER WIND BRACE. (2)
- ④ 01-17-099: 9' 4" UPPER WIND BRACE. (2)

FIELD ASSEMBLY INSTR.

INSERT EACH END OF
ASSEMBLY INTO PROVIDED
HOLES. USE ONLY THOSE
HOLES TO THE INSIDE OF
RAY TO PERBRACED.
ADJUST TURNBUCKLE TO
TIGHTEN WIND BRACE, SNUGLY.

REVISED 3-2-78

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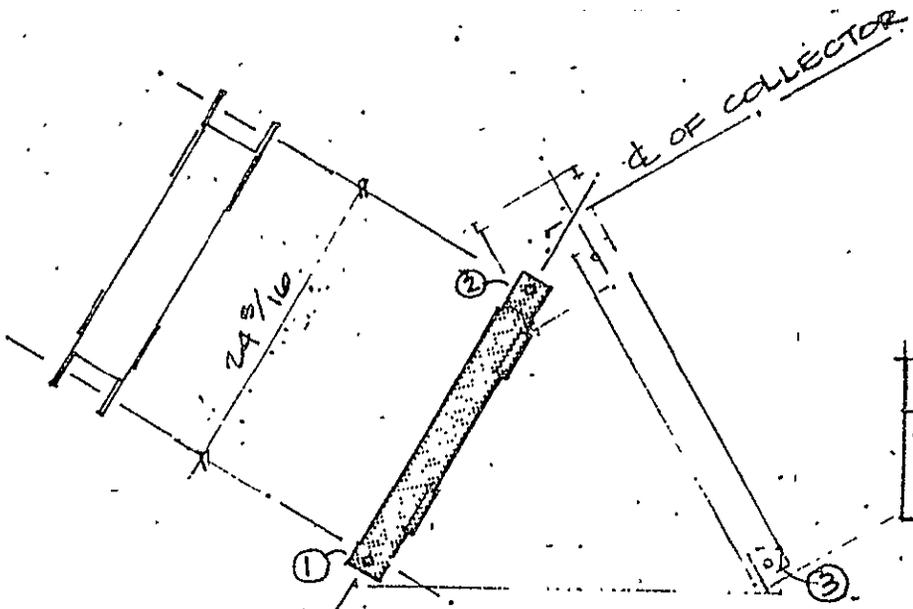
LOWER NORTH
WIND BRACING

01-04-035	
DRN 69	CHK
2-2-78	REV A.

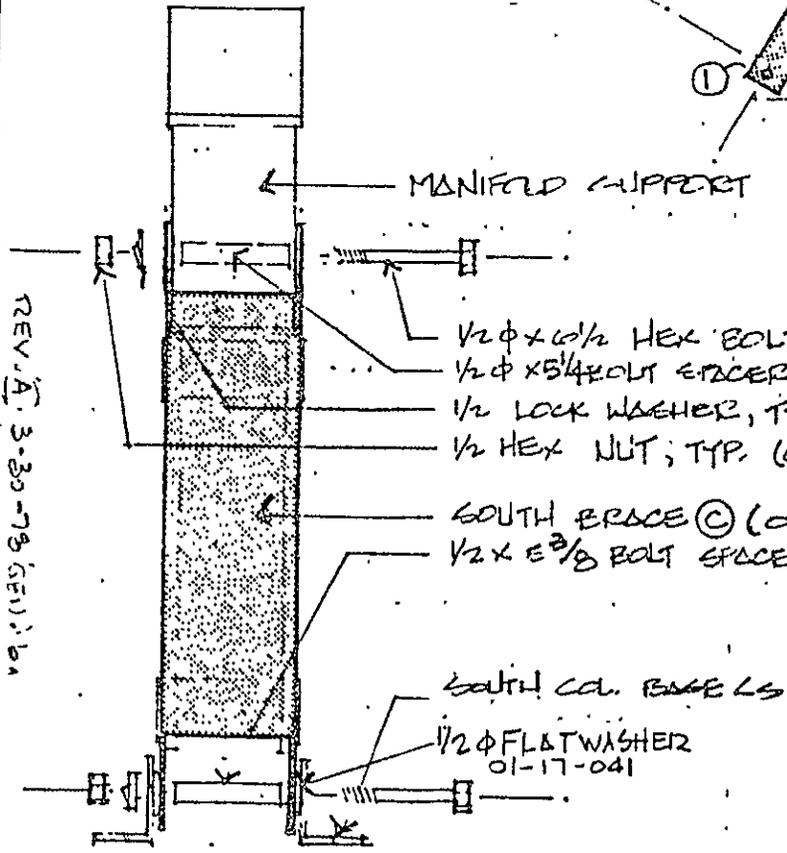
⑧

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REVISIONS			
Δ	SCHEDULES	10-11-77	RE



SIDE VIEW (PROJECTED TOP VIEW)



FRONT VIEW

BILL OF MATERIALS PER ASSEMBLY		
QTY	PART #	DESCRIPTION
1	01-03-012	SOUTH BRACE (C)
1	01-17-029	BOLT SPACER 1/2 x 5 1/4 (2)
1	01-17-031	" " 1/2 x 5 (3)
2	01-17-013	HEX BOLT 1/2 x 6 1/2
2	01-17-015	LOCK WASHER 1/2
2	01-17-014	HEX NUT 1/2
1	01-17-030	BOLT SPACER 1/2 x 5 3/8 (1)
2	01-17-041	1/2 DIA. FLAT WASHER

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SOUTH BRACE
 ASSEMBLY (322)

01-04-044	DRN	EB	CHK
10-4-77	REV	A	

REV. A 3-30-78 (REV) b4

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NORTHROP

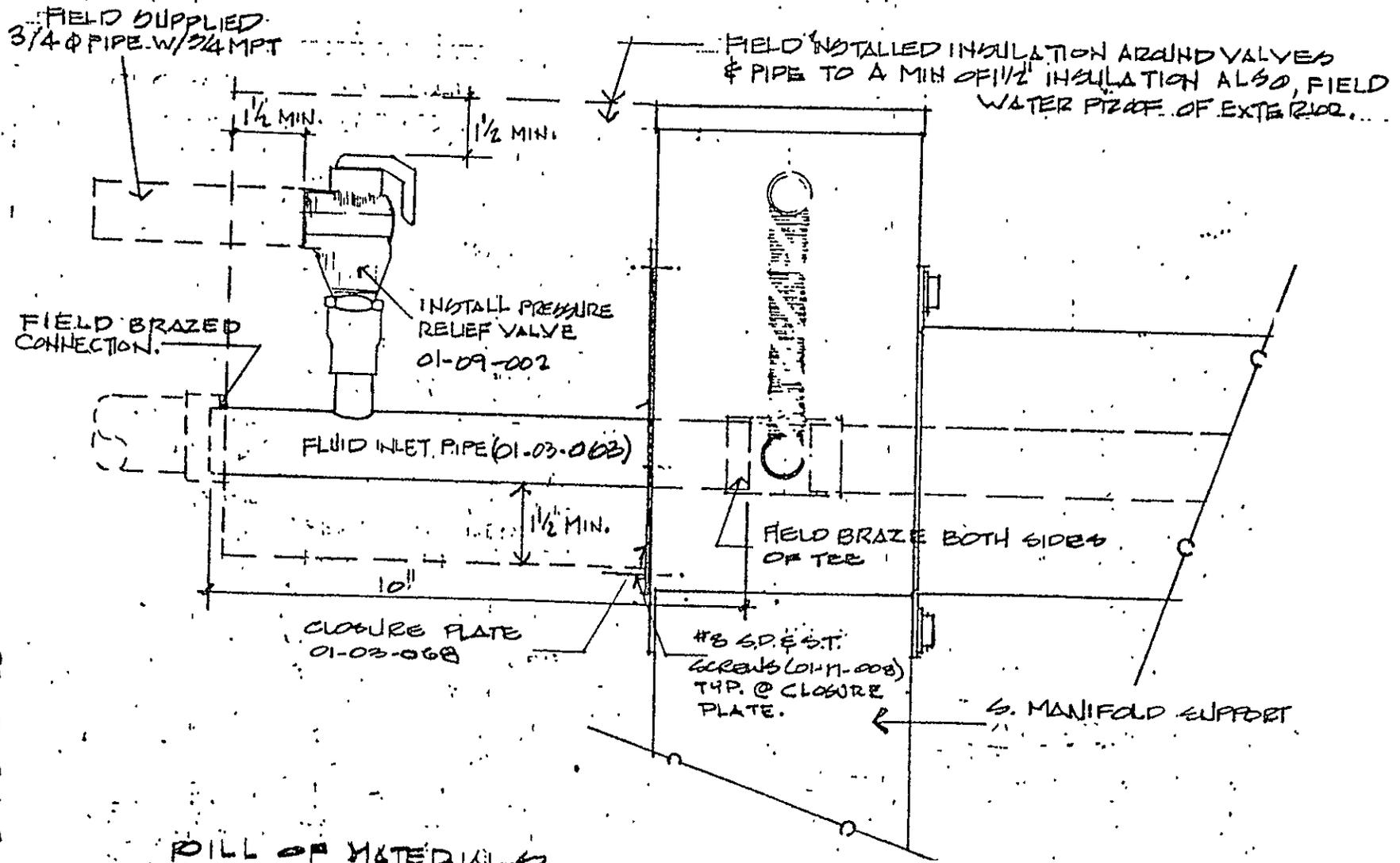
FLUID INLET ASSEMBLY

(E)

11-25-71	DRN	01-04-057
	EP	CHK
	REV	A

REVISED 3-1-78 b9

(E)



BILL OF MATERIALS

QTY.	PART NO	DESCRIPTION
1	01-03-06B	FLUID INLET PIPE MS2P
1	01-09-00B	PRESSURE RELIEF VALVE
1	01-03-06B	CLOSURE PLATE
4	01-11-00B	#8 SCREWS S.D. & S.T.

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INSTALL AUTO-VENT
AIR ELIMINATOR
01-09-001

* INDICATES FIELD BRAZED
CONNECTION

INSTALL INSULATION AROUND VALVES &
PIPE TO PROVIDE A MIN OF 1/2" INSULATION
W/ WATER PROOF EXTERIOR
"FIELD INSTALLED"

CLOSURE PLATE
01-02-006

FIELD CAULK
BETWEEN PIPE & MANIFOLD
CLOSURE PLATE

TEE, FIELD BRAZE
BOTH SIDES

NORTH MANIFOLD SUPPORT

#8 SCREWS
S.D. & S.T.

FIELD APPLIED FLEXIBLE
CONNECTION

* FLUID OUTLET PIPE
01-03-003

* BRAZED CONNECTION

REVISED 3-1-78

BILL OF MATERIALS

QTY	PART NO.	DESCRIPTION
1	01-09-001	AUTO-VENT AIR ELIMINATOR
1	01-03-003	FLUID OUTLET PIPE APPY
1	01-02-006	CLOSURE PLATE
4	01-17-009	#8 SCREWS S.D. & S.T.

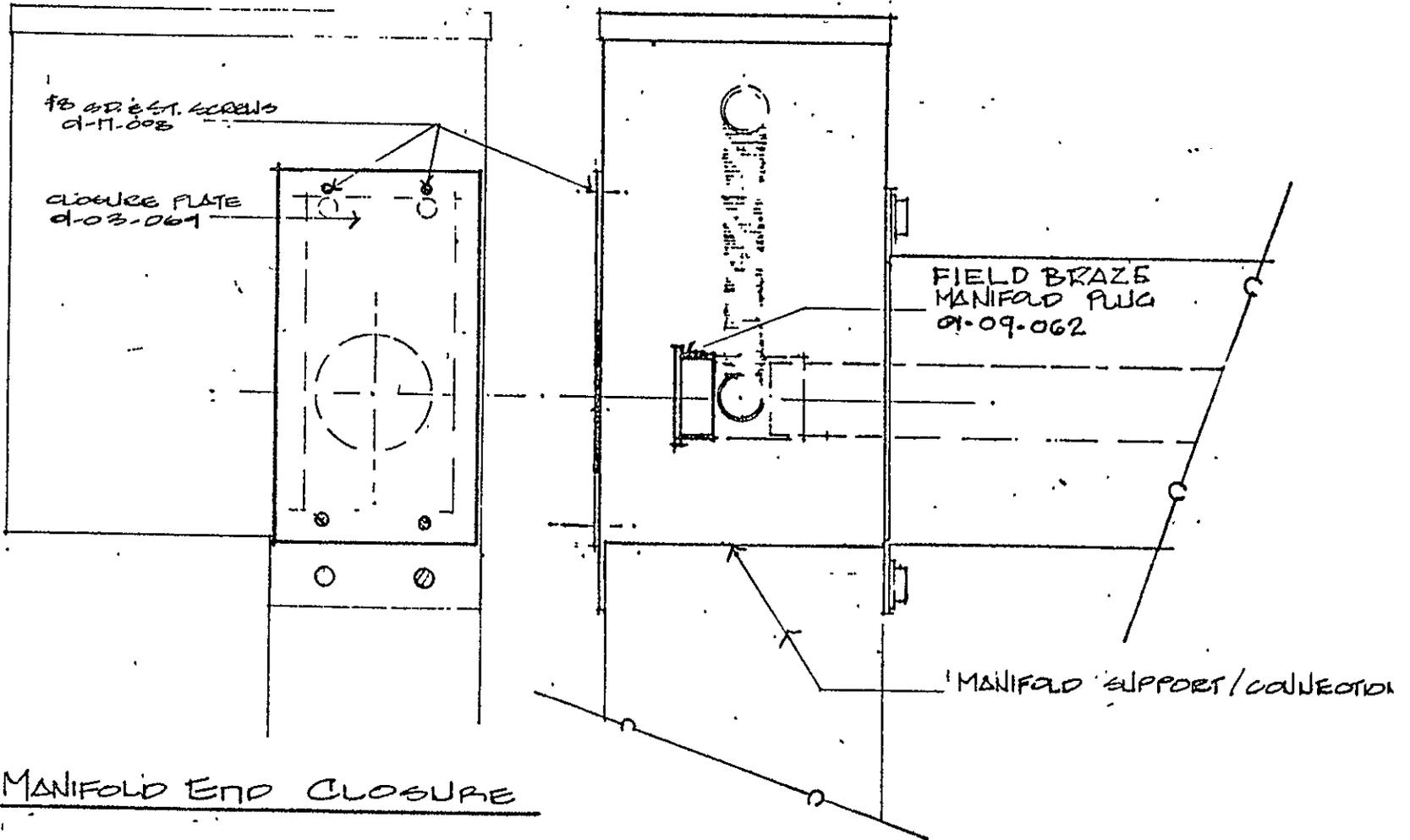
NORTHROP, INCORPORATED 302 Nichols Drive, Houston, Texas 75141

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FLUID OUTLET
ASSEMBLY

01-04-062	DRN	01-04-062
11-4-77	EB	CHK
	REV	A

BILL OF MATERIALS PER ASSEMBLY		
QTY	PART #	DESCRIPTION
1	01-03-073	CLOSURE PLATE
1	01-09-062	PLUG
4	01-11-008	SCREWS #3 1/2 S.D. ST



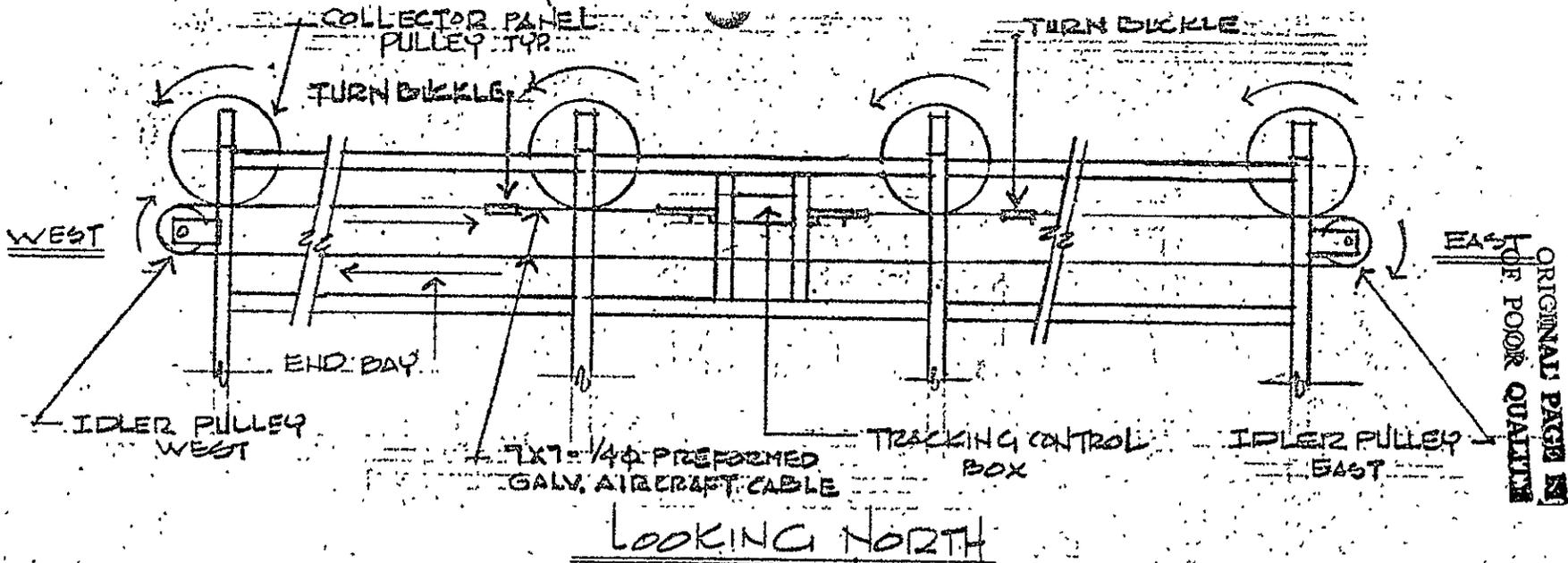
G MANIFOLD END CLOSURE

G

MANIFOLD END CLOSURE **G**

01-04-065	DRN	P.B	CHK
11-3-77	REV		

NORTHROP



NOTE: ARROWS INDICATE CABLE MOVEMENT FOR TRACKING TOWARD THE WEST.

BILL OF MATERIALS PER ASSEMBLY		
QTY	PART #	DESCRIPTION
2	01-17-099	1/4 CABLE CLAMP
2	01-17-073	1/4 CABLE THIMBLE
1	01-17-035	7x7 1/4 CABLE
2	01-17-074	TURNBUCKLE
2	01-03-032	CABLE GUIDE BRKT*
4	01-17-008	4#8 X 1/2 SD. ST. SCREWS

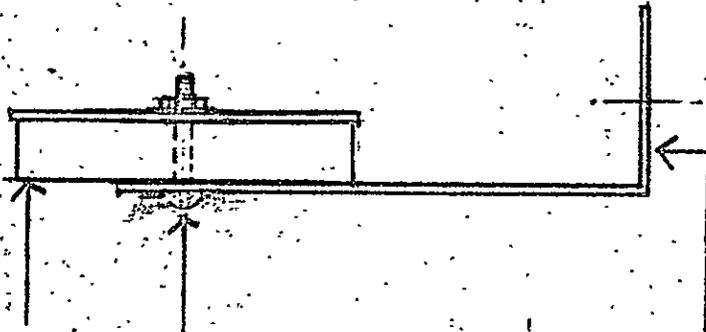
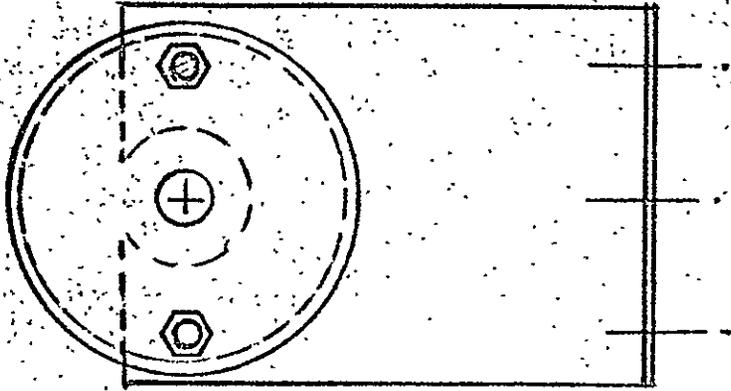
NO. COLLECTOR PANELS	ASSEMBLY #	CABLE LENGTH
1	N/A	N/A
2	01-04-067	41 L.F.
3	01-04-068	63 L.F.
4	01-04-069	96 L.F.
5	01-04-070	124 L.F.
6	01-04-071	151 L.F.
7	01-04-072	179 L.F.
8	01-04-073	206 L.F.
9	01-04-074	234 L.F.
10	01-04-075	262 L.F.
11	01-04-076	289 L.F.

* CABLE GUIDE BRKTS NOT SHOWN ON ELEV. ABOVE. CABLE GUIDE ARE MOUNTED TO MANIFOLD SUPPORTS AND ON LOWER PORTION OF CABLE @ 20" O.C. CENTERS FROM ENDS OF ABAY.

CABLE DRIVE
FIELD SUB-ASSEMBLY (H)

01-04-066	TH21
01-04-076	CHK
REV	REV

REV. A. 2-11-78 GEN BY
B. 2-27-78 GEN BY



- 01-18-004 CABLE GUIDE
- 01-17-022 & 021 #6 RHD. SCREW, WASHER & LOCKWASHER.
- 01-06-173 CABLE GUIDE BRKT.

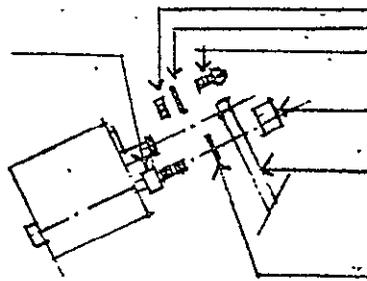
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CABLE GUIDE
BRACKET
ASSEMBLY

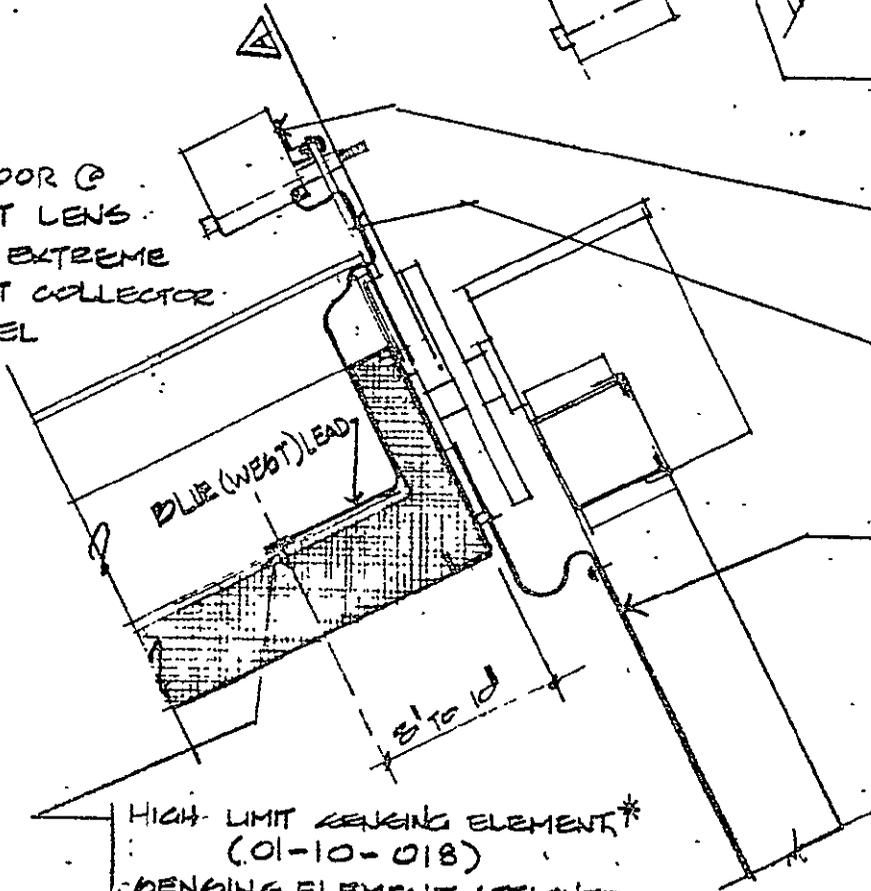
01-03-032	
DRW BG	CHK
DATE 5-20-78	ZEY.

HOLD THIS NUT WHILE
SECURING NUT ON NORTH
SIDE OF BRKT.



- #6-32 HEX NUT 01-17-081
- #6 LOCK WASHER 01-17-082
- #6-32X1/2 RH. HD. 01-17-083
- 1/4 X 20 HEX NUT
(01-17-015)
- SENSOR MTC. BRACKET
(01-06-110)
- 1/4" STAR LOCK WASHER
(01-17-016)

SENSOR @
EAST LENS
OF EXTREME
EAST COLLECTOR
PANEL



SENSOR ASSEMBLY
(01-03-083) INSTALLED
AS NOTED.

MTC. BRACKET - 01-06-110
W/ 4 #8 SCREWS
(01-17-008), SEE
01-04-004

01-10-017,
FACTORY SUPPLIED SENSOR
LEADS, INSTALL PER INSTRUCTIONS.

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HIGH-LIMIT SENSING ELEMENT*
(01-10-018)
SENSING ELEMENT ATTACHED
IN PLANT. SENSING ELEMENT
LEADS ATTACHED IN FIELD.

SENSOR ATTACHMENT - FIELD SUB. ASSEMBLY (J)
REF. 01-04-004

BILL OF MATERIALS PER ASSEMBLY		
QTY	PART #	DESCRIPTION
1	01-17-015	HEX NUT 1/4 X 20
1	01-06-110	SENSOR MTC. BRACKET
1	01-17-016	STAR LOCK WASHER
1	01-03-083	SENSOR ASSEMBLY
4	01-17-008	#8 STD. HT. SCREWS
1	01-17-083	#6 SCREW RH. HD.
1	01-17-081	#6 HEX NUT
1	01-17-082	#6 LOCK WASHER

REF. SECT. (A) ON SH. 2.

* OPTIONAL EQUIPMENT

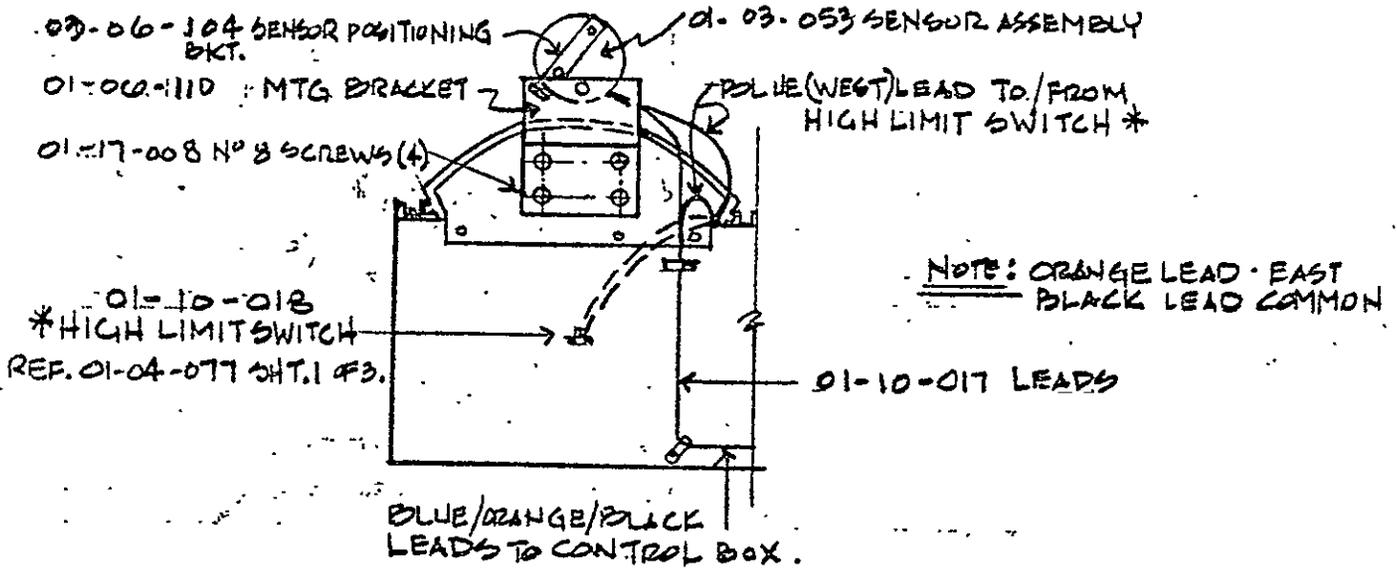
REV. A 1-30-78 by (Gau) SH. 1 OF 3

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SENSOR ATTACHMENT
FIELD SUB-ASSEMBLY

01-04-011	
DRN 20	CHK
11-1-77	REV A



SENSOR ATTACHMENT-FIELD

SUB-ASSEMBLY

REF. 01-04-004

HIGH LIMIT SWITCH -
* OPTIONAL EQUIPMENT.



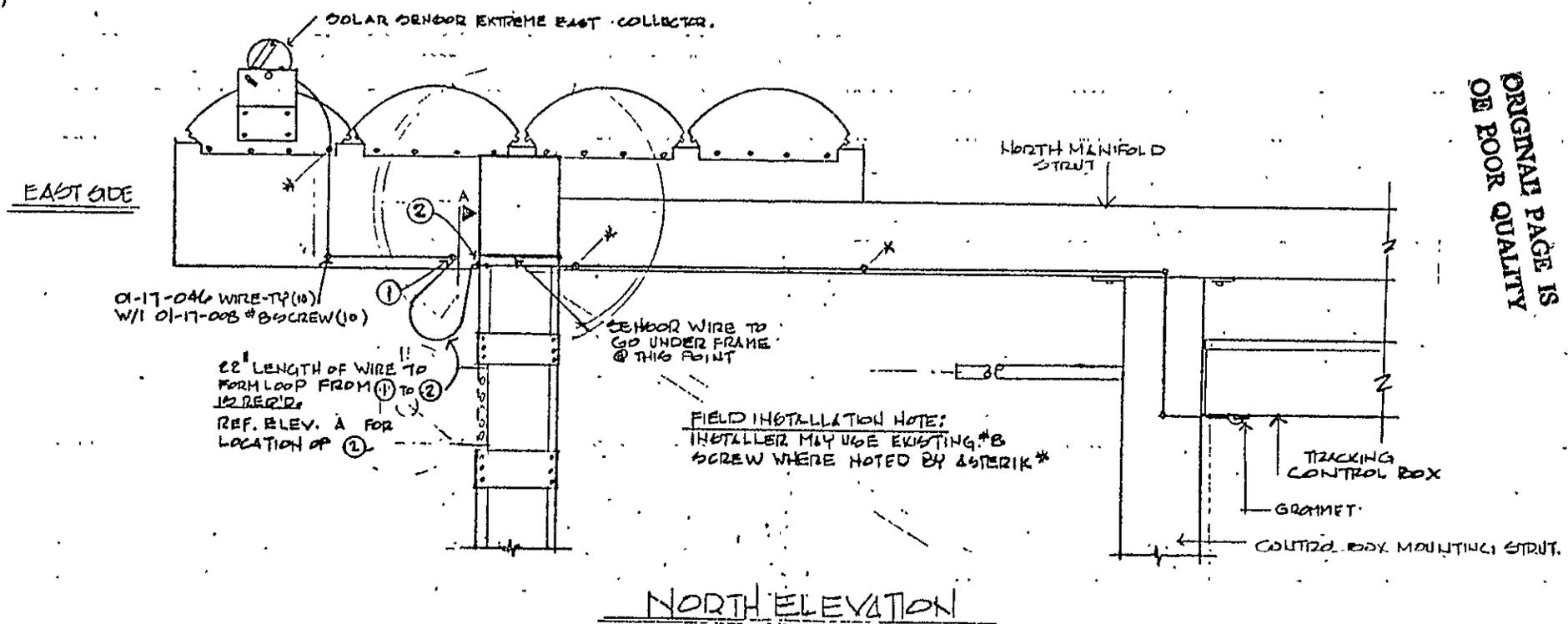
SHT. 2 OF 3

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NORTHROP INCORPORATED 393 Northside Drive, Hawthorne, Texas 78120

SENSOR ATTACHMENT
FIELD SUB-ASSEMBLY

01-04-077	
DRN	CHK
06	RFV

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NORTH ELEVATION

LOOKING SOUTH

01-17-046 WIRE-TY (10)
W/ 01-17-008 #8 SCREW (10)

22" LENGTH OF WIRE TO
FORM LOOP FROM ① TO ②
IN REAR
REF. ELEV. A FOR
LOCATION OF ②

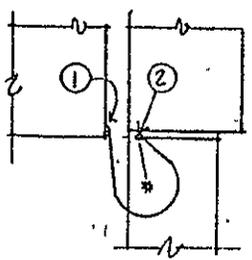
SENSOR WIRE TO
GO UNDER FRAME
@ THIS POINT

FIELD INSTALLATION NOTE:
INSTALLER MAY USE EXISTING #8
SCREW WHERE NOTED BY * & ASTERIK *

NOTE: FIELD INSTALLER TO WIRE SENSOR
WIRES DIRECTLY TO CONTROL
BOX. CONNECTION TO BE MADE
INSIDE OF CONTROL BOX TO
CORRESPONDING LEADS WITH WIRE
NUTS PROVIDED. NO OUTSIDE WIRE
SPICES WILL BE ALLOWED.
SHOULD HIGH LIMIT SWITCH,
OPTIONAL EQUIPMENT, BE USED;
WIRE HIGH LIMIT SWITCH IN SERIES
IN BLUE (WEST) SENSOR LEAD.

REVISIONS:
A. 2-3-76 REDRAWN BY
B. 3-27-78 GEN. REV. BY

SHEET 0073



ELEV. A

NORTHROP <small>NORTHROP, INCORPORATED 200 Hothole Drive, Hawthorne, Texas 75141</small>	SENSOR ATTACHMENT		01-04-077	
	DRN	CHK	BG	REV.
FIELD SUB-ASSEMBLY (WIRING) (1)	