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DESIGN REPORT

FOR THE
HANFORD K EAST
AND
K WEST BASIN

MCO LOADING SYSTEM

Volume 1

Design Documentation
Revision 0

June 6, 1997

Report Number: 444-R-01

Prepared For:

Duke Engineering & Services, Hanford
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444-R-01

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ommitted from HNF-SD-SNF-DR-004

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ACRONYMS

AC	Alternating Current
ALARA	As Low As Reasonably Achievable
CCTV	Closed Circuit Television
CRT	Cathode Ray Tube
DESH	Duke Engineering & Services, Inc., Hanford
FSO	Full Scale Output
GARM	Grapple Anti-Release Mechanism
GECM	Grapple Extension Compliance Mechanism
LVDT	Linear Variable Differential Transducer
MCO	Multi-Canister Overpack
MMI	Man-Machine Interface
NAC	Nuclear Assurance Corporation International, Inc.
PLC	Programmable Logic Controller
VCR	Video Cassette Recorder
WHC	Westinghouse Hanford Corporation

INTRODUCTION

Duke Engineering and Services Hanford Company has issued contract MCB-SLB-A01129 to NAC International for final design of the K-Basin Multi-Canister Overpack (MCO) Loading System. The scope of service performed under this contract has been directed by the Statement of Work, HNF-SD-SNF-SOW-009. The final design scope develops the system concept design, presented in report "Conceptual Design Report for the Hanford K East and K West Basin MCO Loading System" E-15278, into a final design package. Project deliverables include a design report documenting mechanical and control systems for fabrication. This report includes the following project deliverables:

1. General Arrangement Drawing
2. MCO Loading System / Contamination Pail System Interface Drawings
3. Control Equipment General Arrangement Drawings
4. Detail Drawings
5. Assembly Drawings
6. Installation Drawings
7. System Design Description
8. Failure Modes and Recovery Plans
9. Operational Description
10. Stress Analysis
11. Catalog Cuts
12. Certified Materials Test Report Listing
13. Design Basis Codes and Standards
14. Cost Estimate
15. Schedule

Design Report No. 444-R-01 has been prepared in four volumes. Volume 1 presents items 1 through 13. For convenience of the reader, Volume 2 and Volume 3 present design drawings and catalog cuts discussed in Volume 1. Volume 4 presents cost estimates and fabrication schedule information as required by items 14 and 15 of the project deliverables.

The MCO Loading System is a semi-automated mechanical system for transfer of fueled baskets from the fueled basket queue located adjacent to the South Loadout Pit channel entrance into the MCO. It has been classified as a General Service (non-safety) system, (Reference 8.6). Design of the system permits remote operator control minimizing exposure to high radiation areas supporting site ALARA objectives.

System operation begins with the placement of a fueled basket into the loadout pit channel shuttle cart using the perimeter monorail system and basket handling equipment. Following verification of proper loading, the shuttle cart is transported through the loadout pit transfer channel to the shuttle cart unload location in the loadout pit. Once the operator verifies that the shuttle cart and fueled basket are in their proper location, a ball screw mast with basket grapple is lowered into the basket and secured. The basket is then raised to an elevation that clears the MCO, moved and centered with the MCO loading position, and lowered into the MCO. Following confirmation that the basket is properly positioned into the MCO, the ball screw mast is extracted and returned to the shuttle unload basket pickup point to retrieve the next basket.

While the ball screw mast picks the fueled basket from the shuttle cart and placed it into the MCO, the shuttle cart returns to the load position adjacent to the fueled basket queue. When the system equipment returns to the original start location, the load cycle is ready for the next basket load cycle. Repeating the load cycle for a predetermined number of cycles completes MCO loading. Once the MCO is loaded the MCO shield plug is retrieved and positioned into the MCO.

1.0 FINAL DESIGN DRAWINGS

Six different drawing types have been developed as part of the final design work scope. These sets of drawings include: 1) Equipment General Arrangement Drawings; 2) MCO Loading System/Contamination Pail System Interface Drawings; 3) Control Equipment General Arrangement Drawings; 4) Detail Drawings; 5) Assembly Drawings; and 6) Installation Drawings. Drawings have been assembled as Appendix E under separate cover, Volume 2, for convenience of the reader.

1.1 Equipment General Arrangement Drawings

General arrangement drawings integrating K-Basin facility structure, K-Basin Loadout Pit Operations Equipment, and the MCO Loading System have been prepared to insure interference is not created when the two new hardware systems are installed into the existing facility. This set of drawings presents the MCO Loading System in different operation positions which provide an envelope for Loadout Pit operations. Both side and plan views validate operation free of interferences.

1.2 MCO Loading System/Contamination Pail System Interface Drawings

Drawings have been prepared for the interface components between the MCO Loading System and the K-Basin Operations Equipment. These components include: 1) a set of alignment tooling that protects the MCO top lip and MCO shield plug threads when loading the fueled baskets into the MCO and setting the shield plug in place; 2) Contamination (Immersion) Pail/ Immersion Pail Support Structure Base Plate horizontal alignment components; and 3) Shield Plug drain tube alignment reach tool.

1.3 Control Equipment General Arrangement Drawings

General arrangement drawings of the MCO Loading System Controls have been completed defining the two control stations, one located at the basin viewing area and one located at the remote viewing area. Control panel layout drawings, field wiring and a power schematic for each station is also included.

1.4 Detail Drawings

Details of the MCO Loading System have been prepared, including:

- Shuttle drive cylinder mounted spring compliance cable pulleys
- Shuttle segmented overhead vertical supports
- Shuttle seismic restraints
- Mast ball nut, ball screw, disc brake, motor mount

- Gantry spur gear drive system, frame assembly weldments, guide shafts

1.5 Assembly Drawings

Assembly drawings of the shuttle, gantry and mast include the shuttle frame, carriage guide wheels, and basket fixture, the structural layout for the gantry, and the orientation of the drive belt, brake, ball nut, grease seals and thrust bearings of the mast.

1.6 Installation Drawings

MCO Loading System support requirements and restraining devices for the mast, shuttle and gantry are shown in the installation drawings. This includes overhead support beams, seismic restraints and pneumatic requirements for the shuttle, gantry mounting requirements, and mast/grapple interface requirements.

The shuttle may be installed independent of the gantry/mast. Overlap in all component travel is provided to assist in installation alignment.

2.0 MCO LOADING SYSTEM DESCRIPTION

Figure 2.1 presents an integrated systems general arrangement for the MCO loading system with the loadout pit operations equipment as to be installed in the K-Basin South Loadout Pit facility.

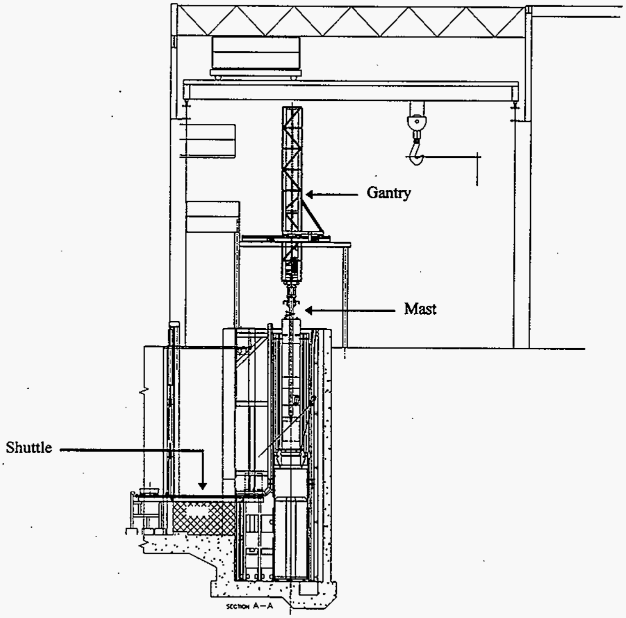


Figure 2.1

2.1 Transfer Equipment System Description

The MCO Loading System is divided into five sets of components:

(1) One (1) queue shuttle, which carries the spent fuel basket from the K-Basin basket queue to the basket unload location in the loadout pit,
(2) One (1) single motion extending mast with grapple, which lifts the basket from the shuttle and places the basket into the MCO,

(3) One (1) single axis bridge gantry which traverses the mast from the shuttle unload position to the MCO load position,
(4) MCO shield plug insertion tooling, and
(5) Guide Tooling for baskets as they are positioned in the MCO.

2.1.1 Shuttle (Reference Drawing 444-300 and Figure 2.2)

The shuttle is a linear motion device with approximately eleven feet and six inches (11'-6") travel. It will transport the 3200 pound (maximum) MCO basket from the fuel basket queue to the basket unload position in the loadout pit for subsequent MCO loading process. The shuttle cart utilizes corrosion resistant linear motion rollers on parallel rails. The rails are suspended from a structural steel framework anchored to the operations floor. This framework spans the transfer canal without interference with existing structures. Control of the shuttle carriage load and unload positioning is provided by shock absorbers and adjustable "hard stops".

After the shuttle carriage is manually loaded with a basket from the K-Basin queue, an underwater camera is used to verify fuel does not extend above the basket seating surface. To minimize operator radiation exposure during movement of the basket queue to the shuttle carriage, reduce MCO Loading System cycle time requirements, and operate within the system height limitations, basket gauging which verifies the fuel basket fits into the MCO is completed before the basket is moved to the shuttle carriage.

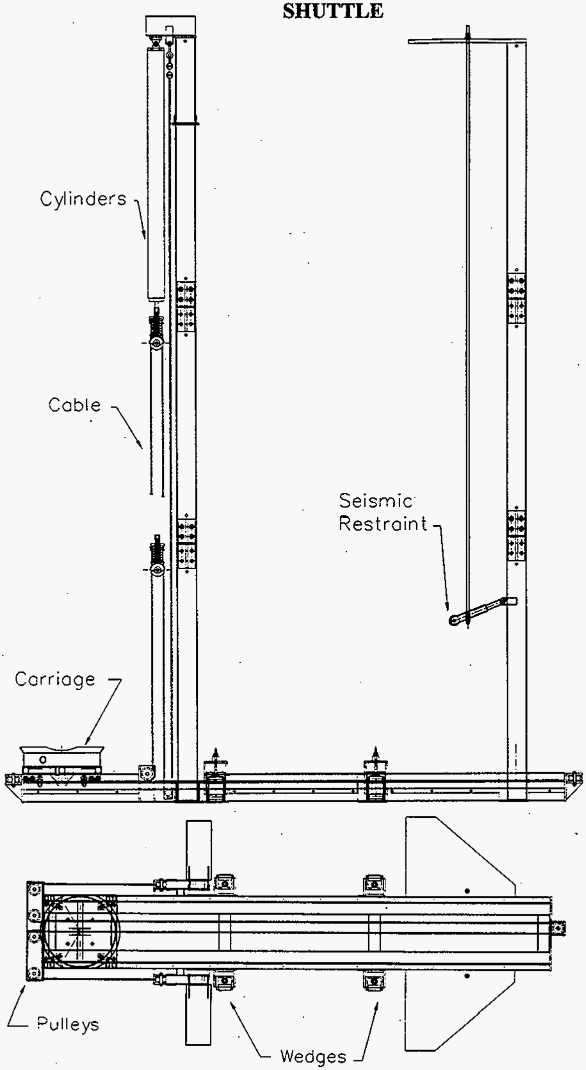
A summary of the shuttle height limitations may be itemized as follows, with the remaining vertical allowable distance listed to the right:

1. The maximum basket lifting height is 5'4" .... 5'4"
2. The shuttle must be positioned over the 3'8" high exclusion area .... 1'8"
3. The design height of the shuttle frame is 11.25" .... 8.75"
4. A clearance of 3" is required between the basket base and top of carriage ...... 5.75"
5. A pilot distance of 1.75" is required for basket loading .... 4.00"

Therefore, only 4" of the full 23.17" basket height may be gauged by the shuttle.

After placing the basket onto the shuttle carriage, the shuttle indexes the carriage to the unload position in the loadout pit. The shuttle drive system is a pneumatic controlled, fixed length cable connected to a power cylinder on opposite sides of the shuttle carriage. The shuttle carriage is fixed to the cable in the center of system travel. Upon activation, one cylinder retracts, the opposite cylinder extends and the carriage is pulled by the cable to one end of the shuttle rail, against hard stops. The pneumatic cylinders are located external to the pool with only cylinder rods exposed to the water. The cable, pulleys and other shuttle drive system equipment is permanently located beneath the water surface. The cylinder rods are immediately sleeved by the cylinders as they are raised from the pool surface, minimizing radiation exposure from airborne contamination.

Figure 2.2
SHUTTLE



Horizontal seismic restraints are attached to the sides of the shuttle cart guide rails to eliminate dynamic response of the shuttle structural system. These seismic restraints, once positioned at the time of system installation, are passive and transfer seismically initiated forces to the adjacent basin concrete structures.

2.1.2 Mast and Grapple

The mast and grapple (Figure 2.3) lifts the fuel basket from the shuttle, supports the basket as the gantry traverses to the center of the MCO load position, and lowers the basket to predefined positions in the MCO.

The mast is a linear guided ball screw drive device (Figure 2.4) which picks the MCO fueled basket from the shuttle unload position and places it into the MCO. The ball screw is driven by a 1.5 horse power servo motor and controller for infinitely programmable positioning capabilities. The mast incorporates a Grapple Extension Compliance Mechanism (GECM) device connected to a Linear Variable Differential Transducer (LVDT). The GECM provides compensation to the extending mast by allowing the column to retract up to two inches before the assembly will be exposed to compressive loading. Position feedback monitoring of mast load is provided by the LVDT. Receiving a signal which indicates system loading outside of normal limits will stop all mast motion.

A video camera mounted at the base of the mast focuses on the grapple. The grapple is pneumatically operated by a cylinder mounted in the GECM. The mast video camera provides monitoring of all grapple operations and a full view of the fuel basket.

In addition to the grapple locked load design, a Grapple Anti-Release Mechanism (GARM) limits grapple operations to directed operator action. Prior to achieving a grapple release, operation procedures require verification that:

a) the mast assembly is properly positioned;
b) the compliance device has retracted properly;
c) the LVDT and monitor verifies all equipment locations.

Figure 2.3
MAST AND GRAPPLE

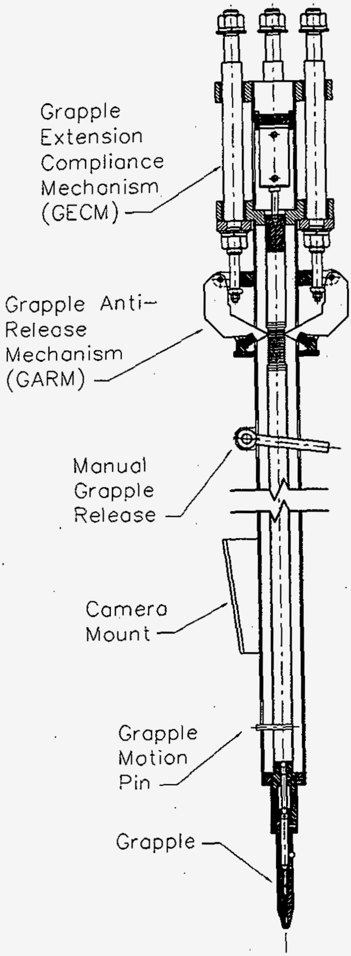
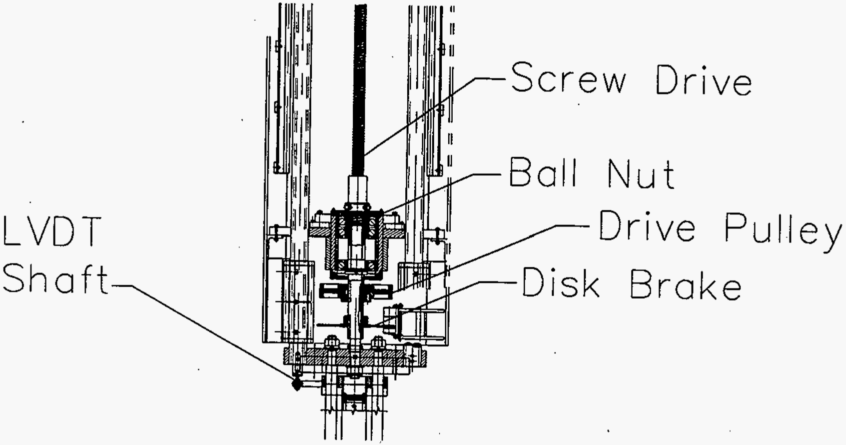


Figure 2.4
BALL SCREW DRIVE DEVICE



When the mast reaches a preprogrammed point for basket positioning in the MCO, the following sequence occurs to open the grapple and release the basket:

1. Mast descends 1 ¼" travel after initial no load signal.
2. Grapple anti-release mechanism (GARM) starts to disengage.
3. Mast descends ¼" more to totally disengage anti release mechanism.
4. Record 1 ½" total travel on LVDT.
5. No load on load cell.
6. Verify height position on controls
7. Verify visually using monitor and grapple pin.
8. Open grapple.

Steps 1-5 occur automatically using system controls; steps 6 and 7 are manually activated. Step 8 may be manually activated using a push button (following successful completion of all preceding sequential stops) or automatic.

2.1.3 Gantry

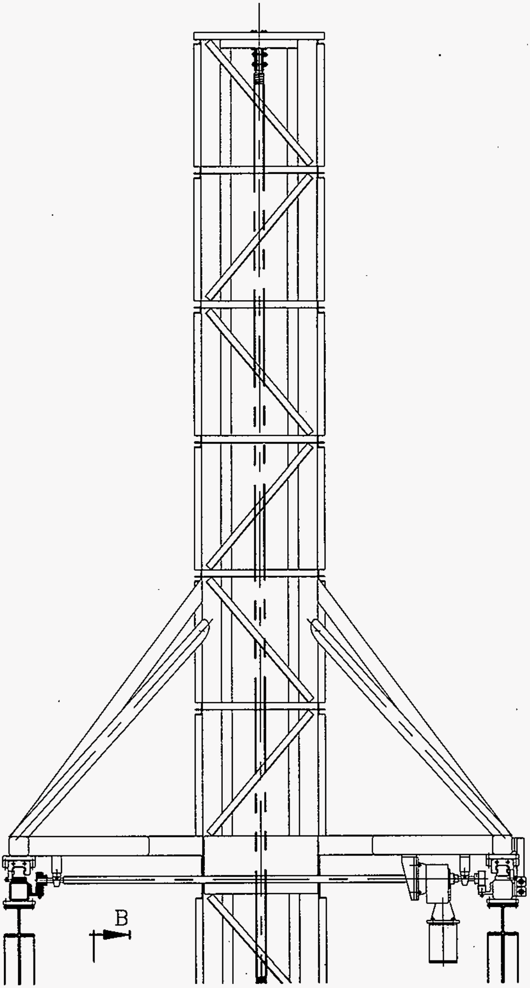
The gantry (Figure 2.5) provides the mast transport cycle from the shuttle unload position to the MCO loading position and returns the mast to the shuttle unload position after placing the basket in the MCO.

The single axis bridge gantry is a linear motion device mounted on facility structural steel extending parallel to the loadout pit fuel transfer canal from mezzanine support columns. The travel of the gantry is approximately four feet axially along the centerline of the canal. Drive motion is provided by a rack and pinion gear linear bearing arrangement. The gantry motion control is provided by a ¼ horse power motor drive with a 8:1 gear reducer and limit switch controlled stops.

2.1.4 Shield Plug Insertion Tooling

Part of the MCO Loading System integration with other K-Basin systems is provided with incorporation of the MCO shield plug placement into the MCO following basket loading. The shield plug insertion tooling provides an interface between the K-Basin auxiliary crane and the MCO shield plug. After successful installation is verified by a video camera mounted near the MCO entrance, the operator will manually disengage the tool from the shield plug using a 'j' hook reach tool.

Figure 2.5
GANTRY



2.1.5 Guide Tooling

A combination Basket Guide and Retainer/Shield Plug Guide are inserted at the MCO entrance to protect the hardware and align the fuel baskets during loading process.

The MCO Basket Guide is used to protect the MCO internal shield plug retainer threads and seating surface as baskets are inserted.

The MCO Retainer/Shield Plug Guide pilots the shield plug into an aligned position and protects the top edge of the MCO during the placement of the shield plug in the final position.

2.2 System Operational Controls

The MCO loading control system has two control stations, one located at the basin viewing area and one located at a remote viewing area (Reference Figure 2.6). System operations and CCTV camera control and viewing are performed at the basin control station. CCTV camera viewing and recording are performed at the remote viewing control station.

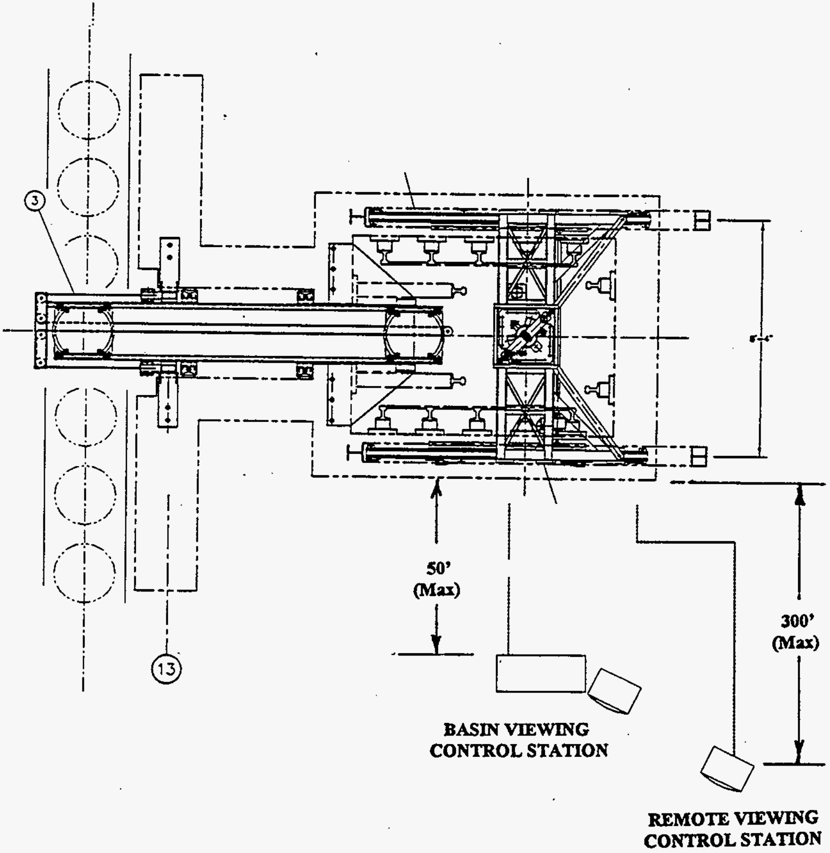
The basin viewing control station consists of two skid mounted cabinets. One cabinet controls basket loading and associated functions, and contains the following components: PLC, CRT-based man-machine interface, motion controller, servo drive with power supply and transformer, and safety shutdown and supervisor override hardware. The second control cabinet contains the CCTV cameral control and viewing hardware. It consists of the following components: three camera controllers with pan and tilt and zoom capability; one camera controller with fixed optics; two monitors; and two four signal video switchers.

All process operations are performed from the control console located at the basin viewing area. The CRT-based man-machine interface (MMI) is used to send commands to and receive the status from the MCO Loading System. The MMI provides continuous display of the system status. A graphic display of the loaded baskets is shown. Safety shutdown and supervisor override functions are hardwired.

All wiring and control equipment shall comply with the National Electric Code, ANSI/NFPA 70. All components are selected for 100% duty cycle as specified in Article 310.

The CCTV camera viewing system will be provided for process step verification by the operator and for maintenance and checkout. Four cameras will be provided. They will be positioned to view the shuttle loading area, the shuttle unloading area, the top of the MCO, and grapple end of the mast.

Figure 2.6
CONTROL EQUIPMENT GENERAL ARRANGEMENT



The mast CCTV camera is the only control component which will receive any significant radiation exposure. Over the lifetime of the MCO Loading System it will receive no more than 20% of the maximum allowable dose for a standard non-radiation hardened industrial CCD color camera. Therefore a standard non-radiation hardened industrial CCD color camera has been selected for this and all four locations.

The remote viewing control station is located in a non contaminated area. It contains CCTV camera viewing and recording hardware. It consists of one fixed control cabinet that contains the following components: one monitor, one VCR, one character generator, and one four signal video switch. This system can view and record any one of the four camera signals independent of the basin viewing system.

Further description and maintenance requirements on the System Controls and Logic requirements are discussed in Appendix B.

2.3 Facility Interfaces

The MCO Loading System is supported by the following facility interfaces:

120 VAC 1 Ø
460 VAC 3 Ø
100 psi, 10-20 cfm, non -lubricated air

2.4 System Check Point Assessment

Table 2.4-1 identifies operator checkpoints and provides descriptions of the verification activities at various points in the MCO Loading Process.

Table 2.4-1
Operator Checkpoints

Operator Checkpoint	**MCO Loading Step Identifier (Reference Table 4.0-1)**	**Operator Verification Activities**
1	1	Verify equipment positions
2	3	Verify that the cart is loaded
3	5	Verify cart in unload position
4	6	Verify gantry/bridge in shuttle unload position
5	7 and 8	Operator selects basket type and number of baskets to be unloaded
6	9	Verify grapple in unlocked position
7	14 and 15	Verify grapple in locked position Verify that load on mast is correct Verify grapple engagement
8	16	Verify mast position in full up operation
9	22	Verify bridge position over MCO
10	27 & 28	Confirm basket location in MCO
11	29	Verify grapple in unlocked position
12	31	Verify "dead load" on mast

2.5 Basket Lift Height

The gantry mast has a fixed maximum elevation of -8'6" relative to the operations floor at 0.0. At this elevation, the ballscrew, guide tubes and slide bottom are at the mechanical end of travel (Reference Drawing 444-211, Rev. 0). This fixed elevation meets the -8'-0" basket lift height limit defined in Reference 8.1, Section 4.2.2.

2.6 Manpower Requirements

The majority of the MCO loading operation is automated such that minimum staff intervention is required. One operator may successfully survey all monitors and control the MCO loading operation at the main control station. Placement of the shield plug is the most labor intensive sequence. Using tooling provided with this system, shield plug insertion is accomplished with two (2) operators, meeting the requirement of Reference 8.1 Section 4.2.3.

2.7 Equipment Sensors/Control Features

Specification WHC-S-0546, Rev. O-A, section 4.2.6, states "The MCO Loading System shall include engineered features that preclude damage to the MCO, cask, and immersion pail container during the basket loading and shield plug insertion operations." To support this requirement, the following features are included:

2.7.1 Load Cells

Three (3) load cells are directly mounted in the line of force for the mast and grapple to continuously monitor operating loads during the complete fuel baskets handling operations. These three load cells provide the ability to:

- Verify fuel baskets have been successfully gripped. Following grapple activation, the basket is lifted approximately one inch and temporarily held in position. The load cells are automatically checked for feedback measurements falling within a predetermined range. If the load cells do not provide acceptable measurements or are not equivalent within an acceptable range, the system will be halted.

- Identify extraneous/unplanned loads on the mast. Following verification that the fuel baskets have been successfully gripped, the load cells are "zeroed out." As the basket begins to rise, traverse to and lowered into the MCO, the load cells continuously monitor the operational load. At any time, if a load is measured that exceeds a predetermined limit, the basket motion will be halted.

2.7.2 LVDT

One (1) LVDT is directly linked to the mast compliance device to provide positioning feedback as the mast performs the load and unload operations.

2.7.3 Video Cameras

Four (4) video cameras with lights are strategically located to provide visual monitoring capability for the following processes:

- shuttle load;
- shuttle unload;
- MCO load;
- all mast end of arm tooling operations.

2.7.4 Electric Fail Safe Brake on Bridge Gantry Motor

The bridge gantry traverses the mast (and basket) from the shuttle unload to the MCO. To prevent loss in position the gantry drive motor includes a fail safe break which will automatically lock the motor in position during any power failure or outage.

2.7.5 Electric Caliper Fail Safe Brake on Screw

The drive screw powers the mast (and basket) through all motions and is controlled by a 1.5 horse power servo drive motor and caliper brake. To prevent uncontrolled descent in the mast (and basket), the caliper brake includes fail safe features that lock the drive screw in position if any outages occur.

2.7.6 Switch and Roller-Follower on Mast Drive Belt

A drive belt provides the interface between the mast ball screw and motor. A spring mounted roller connected to a limit switch constantly rides the mast drive belt to prevent the ball screw from dropping in case of belt breakage. If the belt broke, the roller will fall inward and the limit switch would immediately activate the caliper brake, locking the mast in position. This system is provided to add safety to operations even though the drive belt exceeds operating/safety requirements for this application several times over.

2.7.7 Dual Ball Path in the Ball Nut

The drive screw ball nut bearings cycle through the screw thread and grooves in the nut as it turns, driving the screw vertically upward or downward. A second complete set of bearings riding in a separate groove provides backup. If bearing leakage occurred, this second set of bearings will prevent an uncontrolled fall.

2.7.8 Back-Up Limit Switches

The shuttle and gantry drive are non servo, fixed position indexing devices. The shuttle and gantry cycle positions are set using limit switches. To provide additional safety, each limit switch is backed up by a second limit switch slightly offset from the primary limit switch, followed by hard stops.

2.7.9 GECM (Grapple Extension Compliance Mechanism)

A GECM (Grapple Extension Compliance Mechanism) provides continuous monitoring of system operations. Off normal operation is instantly identified activating system interrupt features.

2.7.10 Manual Overrides

Manual overrides are provided on the shuttle, mast, gantry, and grapple systems permitting operations to interface in the event of equipment failure. The mast and gantry may be operated independent of the primary driving system by inserting a drill motor. The shuttle may be manually driven by a reach tool. The grapple may be manually activated by special tooling accessing the grapple release mechanism.

2.8 Quality Control

Per Reference 8.6, "The Multi-Canister Overpack Loading System has been classified as a General Service (non-safety) system. Design control has been implemented through independent checking and verification of the design and engineering calculations.

2.9 Reliability Analysis

The following table identifies system component operation life, including Design Limits and Mean-Time-To-Repair (MTTR) for the control system components, sensors, and actuators. Data has been obtained from manufacturers where available.

ITEM #	DESCRIPTION	DESIGN LIMITS	MTTR (Hrs.)
1	PLC	90,000	6
2	Servo/resolver	45,000	8
3	Bridge motor	60,000	8
4	Control relays	>100,000 hours	2
5	Power supply	40,000	4
6	Limit switches	>100,000 hours	2
7	LVDT	40,000	4
8	Load cells	40,000	4
9	Misc. Switches	>40,000 hours	2
10	Cables	>100,000	8
11	Annunciator	40,000	4
12	CCTV camera	10,000	25
13	Camera controls	50,000	10
14	CCTV monitor	10,000	10
15	CCTV VTR	5,000	20

2.10 Maintenance Requirements

The MCO Loading System has been designed to provide a high degree of system reliability with minimal maintenance, using easily replaceable equipment where maintenance may be required. The shuttle drive system consisting of a cable, pulleys and two pneumatic cylinders has no maintenance requirements. The gantry drive system is a dual rack and spur gear system capable of significantly faster speeds, cycle times and loads than required for MCO loading. The stainless steel ball screw, guide shafts and grapple interface tooling are designed for operation in the K-Basin water.

It is recommended that conformation of the control equipment set points be subject to periodic evaluation to assure proper system operation. This maintenance will consist of checks on the digital inputs, digital outputs, analog inputs, and motion control inputs & outputs. The following table provides recommendations for maintenance checkout/calibration of the control equipment.

DEVICE	MAINTENANCE/CALIBRATION PROCEDURE	FREQUENCY
Emergency Stop	Depress E-Stop. Check for removal of 120 VAC control power and for deenergization of all control outputs.	Monthly
Primary & backup limit switches	Manually activate each limit switch one at a time Verify that the control system indicates activation of the appropriate limit switch.	Annually
Supervisory override switch	Activate override switch. Verify that the control system indicates activation of the override switch input.	Annually
Bridge motor	In the MANUAL operational mode activate the bridge motor TRAVEL & RETURN outputs. Verify that the bridge moves in the appropriate direction.	Annually
Alarm beacon	In the MANUAL operational mode activate the alarm output. Verify that the beacon alarm is activated visually and audibly.	Monthly
Load cells	In the MANUAL mode backup the GECM until the load cells are all unloaded (i.e., read a nominal zero output). Check for a zero output on each load cell. Then activate the shunt calibration resistor for each load cell. Check for the correct output from each load cell (should be a nominal 80% of FSO)	Quarterly
Load cells	Replace one of the 3 load cells with a calibrated load cell (secondary standard). Apply two loads to the load cells (nominally 20% & 80% of full scale load) and compare the outputs of the two existing load cells with the secondary standard. Any imbalance in the load cells should be taken into account.	Annually
LVDT	With no backup of the GECM check for zero output from the LVDT. Then in the MANUAL operational mode backup the GECM to a nominal 80% of its FSO. Compare the LVDT output with a dimensional measurement of the actual LVDT travel.	Annually
Mast motor/resolver	In the MANUAL operational mode move the mast an incremental distance. Compare the amount of movement indicated by the control system with a dimensional measurement of the actual mast travel.	Annually

2.11 Lubrication Requirements

The MCO Loading System has been designed for minimal lubrication, eliminating foreign material in the K-Basin water while supporting system operation requirements. As identified below, materials for the main wear surfaces (shuttle rollers, ball screw and gantry spur gear/rack) have been selected to operate without lubrication.

Device	Lubrication Specifications
Shuttle Rollers	Corrosion resistant wheel and shaft with non lubricating bearings; 440C roller with graphite bushing riding on 400C hardened stainless steel.
Mast Screw Drive	Grease seals are mounted at the ball nut. No other lubricant is required.
Gantry Spur Gear and Rack	No lubricant required.

2.12 Equipment Interface/Installation/Assembly Clearances

All components of the MCO Loading System have been designed to accommodate installation limitations in the K-Basin East and West structures.

2.12.1 Shuttle Installation

The shuttle hardware is to be mounted directly above the exclusion area in the K-Basin fuel transfer canal The shuttle is suspended from the operating floor and supported laterally using the basin walls for load bearing surfaces. To accommodate limited ceiling clearance, the suspension arms are segmented rectangular tubing sequentially bolted together as the shuttle is lowered into the basin.

To compensate for possible variation in dimensions and provide lateral support, adjustable wedges are welded to the side of the shuttle. Following vertical positioning and anchorage of the shuttle, the wedges are expanded using a reach tool to laterally fix the shuttle against the K-Basin walls.

2.12.2 Gantry Installation

Site structure provides two beams extending from WF 6 @ 15.5 columns with it's top surface eleven foot, one inch (11' 1") from the floor and one hundred inches (100") center to center to support the gantry.

2.12.3 Component Travel Overlap

An evaluation of Facility Interfaces is shown in Table 2.12-1 below. The shuttle, gantry and mast extension travel include additional stroke distance to compensate for installation/assembly tolerance requirements. Programming positions for the shuttle and gantry to accommodate any additional stroke requirements is provided by adjustable position limit switches. Extended stroke in the mast is provided by program adjustments.

Table 2.12-1
Evaluation Of Facility Interfaces

WHC-S-0546 Section	**WHC-S-0546 Requirement**	**Interface Evaluation**	
6.2.1	Existing Monorail System	Existing monorail system will **not** be integrated into the MCO Loading System design.	
6.2.2	Existing Basin Structures	The MCO Loading System design will utilize site provided structure over the loadout pit.	
6.2.3	Loadout Pit & Transfer Channel	a	Integrating with current design of immersion pail system using adapter components
		b	Accommodates existing equipment in transfer canal.
6.2.4	Transfer Bay Crane/Auxiliary Crane	a	Tooling is provided with the MCO system to integrate with the auxiliary crane, providing interface with the shield plug for placement into the MCO.
		b	The MCO Gantry will retract against the bay mezzanine, providing clearance for the crane block and MCO during MCO loading.

An evaluation of the MCO Loading System interfaces with the fuel retrieval system and MCO baskets relative to system specifications is provided in Table 2.12-2. Specific elevation requirements have been revised as this design contract was completed, with final dimensions as defined per drawing SK-1-80220, Rev. F. The shuttle is positioned over the exclusion area (3'8') and below the maximum basket lifting height (5'4").

Table 2.12-2
Evaluation Of Fuel Retrieval System & MCO Basket Interfaces

WHC-S-0546 Section	**WHC-S-0546 Requirement**	**Interface Evaluation**
6.3.1	Fuel Retrieval System Interface	The shuttle system is designed to interface with the fuel basket queue at appropriate elevations. Seismic restraints and queue loading height limits have been included in the design.
6.3.2	MCO Basket Size Variables	The shuttle and mast will accommodate all specified basket dimensions.

An evaluation of the MCO Loading System interfaces with the loadout pit equipment is provided in Table 2.12-3.

Table 2.12-3
Evaluation Of Loadout Pit Equipment Interfaces

WHC-S-0546 *Section*	**WHC-S-0546 *Requirement***	**Interface Evaluation**
6.3.3	Gauging fuel baskets to ensure MCO loading within specified limits.	Due to the elevation of the shuttle and the operational limit maintaining the fuel basket below -8.0', the MCO gauging operation is limited to the fuel queue.
6.3.3	MCO Shielding	MCO has been designed with two (2) adapters to protect MCO seal flange, MCO shield plug nut threads, and overall MCO opening during loading. These adapters are termed the "Basket Funnel Guide" and the "Shield Plug Guide".
6.3.4	Transportation System	The MCO Loading System is fully integrated with the loadout pit operations equipment.
6.3.5	MCO Shield Plug Insertion	The MCO Loading System includes tooling to interface the shield plug to the auxiliary crane and remotely disconnect from the shield plug following shield plug placement.

3.0 FAILURE MODES & SYSTEM RECOVERY PLANS

The following procedures are listed as hypothetical cases for failure modes and system recovery.

Table 3.0-1 Failure Modes & System Recovery Features

Failure Mode	**Failure Mode Description**	**System Recovery Feature**	
1	Basket fails to fit into shuttle	Examine basket handling using pan and tilt capabilities of camera mounted at shuttle load and correct as needed. If basket still does not fit, return basket to storage area and record discrepancies.	
2	Shuttle does not operate or binds	a	Remove basket from carriage and return to queue.
		b	Evaluate shuttle pneumatic system and controls, cycling carriage if possible to identify binding
		c	Check all accessible features of the shuttle drive system.
		d	Manually move carriage to "cart removal position" and lift from shuttle.
		e	Check all guide wheels, bearings and wear areas for binding.
		f	With carriage removed, cycle cylinders, cabling for correct operation. Check installation components including wedges, seismic restraints, support channels.
		g	Correct or replace defective component.
3	Mast fails to lift basket or stops in the basket lifting cycle	a	Observe all monitoring features of mast including LVDT's, load cells and video camera to determine source of problem.
		b	Manually lower the basket to the shuttle.
		c	Manually release the grapple.
		d	Manually raise the mast to the full up position.
		e	Correct, service or replace the defective component.
4	Bridge/gantry fails to move or stops while in transit with a basket	a	Observe all monitoring features of mast including LVDT's, load cells and video camera to determine source of problem.
		b	Manually move the gantry to the shuttle unload position.
		c	Lower/return the basket to the shuttle.
		d	Raise the mast to the full up position.
		e	Correct or replace the defective component.
5	Mast fails while lowering basket into the MCO	a	Observe all monitoring features of mast including LVDT's, load cells and video cameras to determine source of problem.
		b	Manually raise the mast to the full up position
		c	Manually move the gantry to the shuttle unload position
		d	Manually lower basket to shuttle
		e	Manually release the basket to the shuttle
		f	Manually raise the mast to the full up position
		g	Correct or replace the defective component.

Table 3.0-1 Failure Modes & System Recovery Features (Continued)

Failure Mode	Failure Mode Description	System Recovery Feature	
6	Grapple fails to release the basket	a	Observe all monitoring features of mast including LVDT's, load cells and video cameras to determine source of problem.
		b	Select the combination of manual and powered steps to return the basket to the shuttle.
		c	Manually raise the mast to the full up position.
		d	Correct or replace the defective component.
7	Shuttle cylinder pressure is gone.	a	No change in cylinder position will occur because they are tied by a single cable. (If the carriage is moving during pressure outage, all motion will stop.) If a cylinder drops, pulley guards will keep excess cable aligned.
		b	Examine all cylinder plumbing for leakage.
		c	Manually move carriage to shuttle load or unload position (if needed) using external pressure supply.
8	Shuttle cable breaks	a	Determine accessibility of cable break relative to pulley system and carriage. If broken ends of cable are inaccessible, shuttle must be removed and a new cable must be installed.
		b	If accessible, using a reach tool, retrieve broken end of cable.
		c	Splice new cable to failed cable at break closest to a cylinder.
		d	Reel one end of failed cable backward though pulley system using accessible part of failed cable, thereby simultaneously lacing new cable through a portion of pulley system.
		e	Manually remove carriage. Attach opposite end of new cable to second segment of failed cable.
		f	Reel opposite end of failed cable backward through pulley system, thereby lacing new cable through remaining portion of pulley system.
		g	Return carriage to shuttle.
9	Load cells do not "zero out" at basket "resting" position.	a	Observe grapple positioning using video camera and monitor.
		b	Raise basket to home position.
		c	Check operating parameters and test load cells. Observe MCO loading history based on recordings of previously loaded baskets for reasons of discrepancy.
		d	The basket may be unloaded with out load cell "zero out" using the supervisor-key lock mode.

4.0 SYSTEM OPERATIONAL DESCRIPTION/SEQUENCING

The following table outlines sequential steps for cycling one spent fuel basket from the loading queue to the MCO. Estimated cycle times for each step are in parenthesis following the text describing that step. Component speeds used to estimate each operation requiring system operation are as follows:

Mast	1"/second
Gantry	0.4"/second
Shuttle	1.1"/second

Table 4.0-1 MCO Loading Sequence

Step Identifier	Operational Task (estimated cycle time in minutes follows each task for estimated cycle time—section 4.1 and dosage estimate—section 4.2).
1	Verify initial positions with video cameras. Cart at Load Position; Mast retracted; Gantry in Store Position; (All positions have limit switches and back-up switches). (.5)
2	Load basket from queue.
3	Cart Loaded—verify with camera. (.5)
4	Actuate shuttle cart, cart moves to unload position;(2)
5	Verify cart position with cameras.(.25)
6	Mast home position verified with camera. (.25)
7	Select program for basket type.(.5)
8	Select number of baskets to be loaded in the MCO. (.5)
9	"0" the LVDT (occurs automatically); check the manual grapple indicator with mast camera. (.5)
10	Extend mast to basket. (0)
11	Mast extends to predetermined position plus slight back-up of the GECM, (grapple extension compliance mechanism) (1.0 inch)(3)
12	Energize the grapple cylinder. (.5)
13	Grapple anti locking, locks automatically.(0)
14	Verify grapple with camera and observe grapple manual position indicator,
15	Retract mast for approximately 1-inch, verify with load cell that load is appropriate.(.5)
16	Retract basket to-(8ft-6in) level, (hard stop at 8ft-5in) (3)
17	Actuate shuttle, cart returns to shuttle load position (internal cycle time).
18	Verify mast position with encoder readout from screw, (All PLC controlled readouts have battery back-up in case of power loss)(.5)
19	Verify that MCO is in place (externally completed).
20	Energize bridge-move function, moves to MCO load position (.5).
21	Bridge stops at switch—backed up by a hard stop (2).
22	Verify bridge location (.5).
23	Energize down movement of mast (steps 23, 24, 25 & 26—3.3 minutes)
24	Watch with camera looking at MCO
25	Monitor load cell readout carefully.
26	Mast descends to preset point, plus slight back-up of GEMC (1.5 inch).
27	Monitor load cell - Confirm proper basket nesting.(.5)

28	Verify basket location. Touch screen monitor will show exact basket position. (.5)
29	Release grapple, verify with manual grapple position indicator.(.5)
30	Retract mast 2-inches. (.5)
31	Verify "dead load" (approx. 1400#) with the load cell readout, (If the load cell is not "dead load" the system reverts to "supervisor-keylock mode") (.5)
32	Continue retraction of mast to home position. (3.3)
33	Return bridge to home position. (2)

4.1 MCO Load Cycle Time

Loading of a single basket into the MCO is depicted in the timeline presented in Table 4.1-1. The timeline is based on conservative estimates and does not account for overlapping action sequences.

Component travel speeds used to estimate each loading sequence are as follows:

Mast	1"/second
Gantry	0.4"/second
Shuttle	1.1"/second

Table 4.1-1
Single Basket MCO Loading Timeline

Loading Sequence Action	Time (minutes)	Cumulative (minutes)
Shuttle Basket Loading	external to cycle time	
Shuttle travel	3	3
Mast extension	5	8
Grapple activation and verification	1	9
Basket raised 1", verification	0.5	9.5
Mast raised to upper location	3	12.5
Bridge translation	3.5	16
Basket lowered into MCO	3.3	19.3
Grapple release, verification	2.5	21.8
Mast retraction	3.3	25.1
Shuttle and bridge return	3.5	28.6

Based on the timeline presented above, a six (6) basket MCO installation would be completed in less than 3 hours, allowing an hour for shield plug placement interval to maintain the cycle time at the 4 hour maximum limit defined in Specification WHC-S-0546, Rev. D, section 4.2.3, 8.1.1.

Consideration of parallel operations for the shuttle and MCO loading, and reduced mast extension as each basket is loaded results in a further reduction in cycle time.

4.2 Operator Dose Exposure

Operator dose for the MCO Loading System incorporates all sequential automatic operations following manual basket loading at the shuttle queue up to manual loading of the shield plug.

The location of the control station has been defined as corridor 7 of K-Basin East and West with a background dose of less than 0.5 mrem/hr. Therefore, normal operation will not expose the operator to any average dose field greater than 0.5 mrem/hr.

The total cycle time for a single basket loading process is (Reference Table 4.1-1):

shuttle index : 3 minutes
mast extension : 5 minutes
grapple activation : 1.5 minutes
mast extension basket lift to -8'6" : 3 minutes
gantry index : 3.5 minutes
basket descent : 3.3 minutes
grapple release : 2.5 minutes
mast retraction : 3.3 minutes
shuttle and bridge return : 3.5 minutes

Therefore, total cycle time to load one basket is approximately 28.6 minutes, excluding manual shuttle loading and shield plug placement.

Assuming six (6) baskets per MCO,

28.6 minutes/basket x 6 baskets = 171.6 minutes/MCO = 2.86 hours/MCO
0.5 mrem/hr x 2.86 hrs = 1.43 mrem total dose per operator/shift

Therefore, the average operator dose rate based on loading one MCO per 4 hour load cycle is

$$\frac{1.43\text{ mrem}}{4\text{ hrs}} = 0.36\text{ mrem / hr}\text{ , which satisfies the average dose rate limit}$$

of 0.5 mrem/hr as stated in Section 4.2.4, Specification WHC-S-096, Rev. O-C.

5.0 STRESS ANALYSIS

5.1 Criteria

Structural load path design criteria for both the Shuttle and Mast/Ganty has been based on the following documents:

1. ANSI N14.6-1993, section 4.2.1, Stress Design Factors. Stress developed from three times the load must be less than the minimum tensile yield strength and stress developed from five times the load must be less than the ultimate tensile strength of load path materials.

2. ASME B30.16-1993, Overhead Hoists (Underhung), the Mast and Gantry satisfy construction requirements of section 16.1.2.1 (c) which states "the static stress calculated for the rated load shall not exceed 20% of the average ultimate material strength."

3. "Standard Arch-Civil Design Criteria - Design Loads for Facilities " SDC 4.1, section 3.2 is applicable loading criteria for the shuttle structure.

5.2 Stress Analysis Results

A summary table of resultant stress in load path members is shown below.

Calculations are presented in Appendix E.

Table 5-1
Summary of Stress Analysis
Shuttle

Drawing Number	Item No.	Component	Load Condition	Design Check	Calculated Stress psi	Allowable Stress psi	M.S.
444-304	2, 20 AND 21	COMPOSITE RAIL BEAMS	NORMAL	AXIAL AND BENDING	16696	18000	0.07
444-304	2, 20 AND 21	COMPOSITE RAIL BEAMS	NORMAL	SHEAR	5533	12000	0.54
444-304	2, 20 AND 21	COMPOSITE RAIL BEAMS	SEISMIC	AXIAL AND BENDING	23775	30600	0.22
444-304	2, 20 AND 21	COMPOSITE RAIL BEAMS	SEISMIC	SHEAR	11348	16800	0.32

Table 5-1 (continued)
Summary of Stress Analysis
Shuttle

Drawing Number	Item No.	Component	Load Condition	Design Check	Calculated Stress psi	Allowable Stress psi	M.S.
444-309	4 THRU 8	VERTICAL SUPPORTS	NORMAL	AXIAL AND BENDING	4778	18000	0.73
444-309	4 THRU 8	VERTICAL SUPPORTS	SEISMIC	AXIAL AND BENDING	16126	30600	0.47
444-309	4 THRU 8	VERTICAL SUPPORTS	SEISMIC	AISC COMBINED	0.51 (EQUATION 1.6.2)	1.0	0.49
444-310 444-309	1 4 THRU 8	SPLICE IN VERTICAL SUPPORT	SEISMIC	AXIAL AND BENDING	5108 (LOAD)	7886 (LOAD)	0.35
444-310	6	LONGITUDINAL SEISMIC RESTRAINT	SEISMIC	AXIAL	1741	16150	0.89
444-303	1 AND 7 TO 11	LATERAL SEISMIC RESTRAINT	SEISMIC	SHEAR	3090	16800	0.82
444-302	3	FLOOR PLATE	NORMAL	BENDING	12243	22500	0.46
444-302	4 AND 5	CART SUPPORT TUBES	NORMAL	BENDING	8355	18000	0.54
444-300	20	ROD	NORMAL	AXIAL	936 (LOAD)	7952 (LOAD)	0.88

Table 5-2
Summary of Stress Analysis
Shuttle Weld Sizing

Drawing Number	Item No.	Component	Load Condition	Design Check	Weld Size Required inch	Weld Size Provided inch	M.S.
444-310	7 TO 8	VERTICAL SUPPORT TO ANCHORAGE	SEISMIC	SHEAR	0.066	0.1875	0.65
444-309 444-304	4 THRU 7 TO 2, 20 AND 21	VERTICAL SUPPORT TO COMPOSITE RAIL BEAM	SEISMIC	SHEAR	0.11	0.1875	0.41
444-302	4 TO 5	CART SUPPORT TUBE JOINT	NORMAL	SHEAR	0.01	0.1875	0.95

Table 5-3
Summary of Stress Analysis
Mast

Drawing Number	Item No.	Component	Load Condition	Design Check	Calculated Stress psi	Allowable Stress psi	M.S.
444-215	1	MAST VERTICALS	LIFTING	AXIAL	4759	11600	0.59
444-215	2,3,30 AND 36	DIAGONAL BRACE	LIFTING	AXIAL	7019	11600	0.39
444-215	5	OUTRIGGER HORIZ.	NORMAL	AXIAL	406	11600	0.97
444-215	6	OUTRIGGER DIAG.	NORMAL	AXIAL	844	11600	0.93
444-215	39	SUPPORT ANGLE	NORMAL	BENDING	5559	11600	0.52
444-215	12,16 AND 32	MAST HORIZONTALS	NORMAL	AXIAL	2767	11600	0.76
444-215	17	TOP HORIZONTAL	LIFTING	BENDING	6524	11600	0.44
444-215	20	PLATE 1/4"	NORMAL	AXIAL	1458	11600	0.87
444-211	13	MOUNTING PLATE	NORMAL	BENDING	4283	11600	0.63

Table 5-3 (Continued)
Summary of Stress Analysis
Mast

Drawing Number	Item No.	Component	Load Condition	Design Check	Calculated Stress psi	Allowable Stress psi	M.S.
444-232	23	LUG	NORMAL	BENDING	3641	10000	0.64
444-220	2	GANTRY RAIL TUBES	NORMAL	BENDING	7739	11600	0.33
444-232	22 AND 23	LUG TO SHAFT	NORMAL	SHEAR	2421	10000	0.76

Table 5-4
Summary of Stress Analysis
Mast Weld Sizing

Drawing Number	Item No.	Component	Load Condition	Design Check	Weld Size Required inch	Weld Size Provided inch	M.S.
444-215	16 TO 1	MAST HORIZ. TO MAST VERTICAL	NORMAL	SHEAR	0.0157	0.1875	0.92
444-215	6 TO 5 AND 6 TO 1	OUTRIGGER DIAG. TO MAST VERT. AND TO OUTRIGGER HORIZ.	NORMAL	SHEAR	0.0375	0.1875	0.80
444-215	20 TO 1	PLATE TO MAST VERTICAL	NORMAL	SHEAR	0.016	0.1875	0.91
444-215	5 TO 1	OUTRIGGER HORIZ. TO MAST VERTICAL	NORMAL	SHEAR	0.0209	0.1875	0.89
444-215	2 TO 1	DIAGONAL BRACE TO MAST VERTICAL	LIFTING	SHEAR	0.159	0.1875	0.15
444-215	39 TO 1	SUPPORT ANGLE TO MAST VERTICAL	NORMAL	SHEAR	0.0167	0.1875	0.91
444-215	17 TO 1	TOP HORIZONTAL TO MAST VERTICAL	LIFTING	SHEAR	0.072	0.1875	0.62

5.2.1 Anchorage Loads Summary

The following information is a summary of anchorage loads for the gantry/mast and shuttle.

5.2.1.1 Gantry/Mast

The reaction dead load (Rdl) is four hundred thirty pounds (430lbs.).

The reaction live load (Rll) is three thousand nine hundred two pounds (3902lbs.).

In addition to the above vertical loads, appropriate criteria must be applied for impact, lateral and longitudinal forces to produce maximum load requirements on the support steel. Finally, to prevent unacceptable support beam deflection, the minimum moment of inertia for each support beam is two hundred forty eight inches^4 (248 in.^{4}) to provide alignment at critical pick up locations.

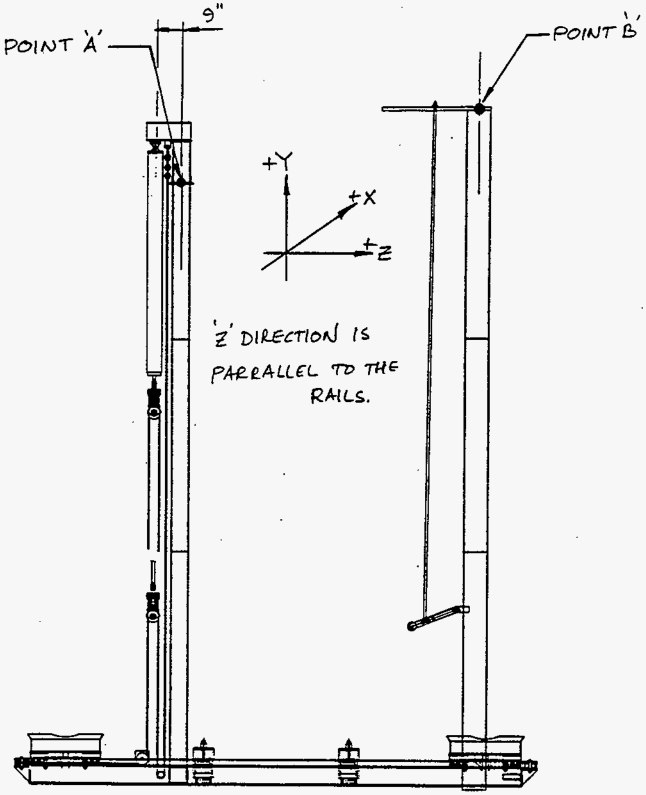
5.2.1.2 Shuttle

Points 'A' and 'B' on Figure 5-1 represent anchorage load locations for the MCO Loading System Shuttle. A summary of loads and moments at these points for normal and seismic conditions is shown below:

	FY	MX	MZ	Load Case
Point 'A'	4280 down 377 up	3105	9838	Normal
	4029 down	--	+-15171	Seismic
Point 'B'	3935 up 377 down	--	+-9838	Normal
	4029 down 285 up	+-392	+-15171	Seismic

Loads are in pounds and moments are in in-lbs. Directions and locations of load and load points are defined on Figure 5-1.

Figure 5-1
Shuttle Anchorage Load Points



6.0 CERTIFIED MATERIALS AND TEST REPORT

The MCO Loading System is defined as general service equipment and will not require certified materials and test reports as traceable documentation. However, NAC experience with fabrication of systems similar to the MCO Loading System has provided material certification records for load path components.

A sample test certificate typically provided as part of the raw material procurement documentation is presented in Appendix D.

7.0 DESIGN BASIS CODES AND STANDARDS

Design documents defined in Specification WHC-S-0546, Revision 0-C, Sections 2.1 have been reviewed with respect to MCO Loading System application.

A summary of compliance to the MCO Loading System design is provided below.

10CFR835, Occupational Radiation Protection

10CFR835 provides rules that establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from conduct of DOE activities. Part 835 delineates requirements for establishing:

- Radiation Protection Programs - Subpart B
- Standards for Internal and External Exposure - Subpart C
- Monitoring (exposure) in the Workplace - Subpart E
- Entry Control Programs - Subpart F
- Posting and Labeling - Subpart G
- Records - Subpart H
- Reports to Individuals - Subpart I
- Radiation Safety Training - Subpart J
- Design and Control - Subpart K
- Releases of Materials and Equipment From Radiological Areas - Subpart L
- Accidents and Emergencies - Subpart N

Implementation of these requirements is the responsibility of the operator, except for Subpart K - Design and Control. This subpart does not provide detailed requirements for design but emphasizes that ALARA principles be considered in the design. In adhering to ALARA principles, the MCO Loading System has been designed to minimize operating times and maximize the distance between personnel and radioactive sources.

29CFR1910.179, Overhead and Gantry Cranes
(Listed as 10CFR1910.179 in Design Specification)

29CFR1910.179 applies to overhead and gantry cranes including semigantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics. 29CFR1910.179(a) defines the terms applicable to this section. A crane is defined as a machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine. The bridge and mast of the MCO Loading System function as a crane and therefore are required to meet the requirements of 29CFR1910.179. The following list identifies the requirements of 29CFR1910.179 that are applicable to the MCO Loading System:

- 29CFR1910.179(b), General Requirements
  - The bridge and mast meet the design specifications of ANSI B30.2.0-1967, Overhead and Gantry Cranes.
  - The crane shall have the rated load marked on each side of the crane.
  - Clearances of 3" overhead and 2" laterally from obstructions shall be maintained.
- 29CFR1910.179(e), Stops, Bumpers, Rail Sweeps, and Guards
  - Bridge bumpers, or other automatic equivalent means, shall be provided to decelerate the unloaded crane in less than 3ft/sec^2 when travelling at 20% rated load speed.
  - The bumpers shall have sufficient energy absorbing capacity to stop the crane when traveling at 40% of rated load speed.
  - Guards are provided for moving parts in accordance with (e)(6) when these parts present a hazard during normal operations.
- 29CFR1910.179(f), Brakes
  - The hoisting mechanism is provided with a holding brake.
  - A control brake is provided for the hoisting mechanism to prevent overspeeding.
- 29CFR1910.179(g), Electrical Equipment, Voltage, enclosures, controllers, resistors, switches are designed in accordance with the requirements of this paragraph.
- 29CFR1910.179(i), Warning Device, A warning signal shall be provided for the bridge and mast.

- The following paragraphs of 29CFR1910.179 are the responsibility of the operator:

  - 29CFR1910.179(j), Inspection
  - 29CFR1910.179(k), Testing
  - 29CFR1910.179(l), Maintenance
  - 29CFR1910.179(n), Handling the Load
  - 29CFR1910.179(o), Other Requirements (pertaining to ladders, cabs, and fire extinguishers

The following paragraphs are not applicable to the MCO Loading System because the system does not contain the following type of components:

- 29CFR1910.179(c), Cabs
- 29CFR1910.179(d), Footwalks and Ladders
- 29CFR1910.179(h), Hoisting Equipment (requirements pertain to sheaves, ropes, equalizers, and hooks which are not part of the MCO Loading System)
- 29CFR1910.179(m), Rope Inspection

DOE-RL, 1993, "Standard Arch-Civil Design Criteria - Design Loads for Facilities", SDC 4.1, Rev 12, U. S. Department of Energy

The MCO Loading System is classified as a General Service (non-safety) system. Section 3.2 of SDC 4.1 covering safety class 3 structures, component and systems has been applied to the gantry and mast. The shuttle is in the zone of influence to a safety class 1 component, and has been analyzed and designed to requirements of section 3.2.2.6, which includes analysis and design requirements for structural failure that may compromise the structural integrity of the safety class 1 (or 2) item. Constraints for this analysis include 'g' factors from figure 3, page 29.

ANSI/AWS D1.1 -1995, Structural Welding Code - Steel

ANSI/AWS D1.1 contains requirements for fabricating welded steel structures. Chapter 1 - General Requirements provides information regarding the code and its use. Chapter 2 - Design of Welded Connections provides criteria for designing various types of weld joints. The MCO Loading System welded joints comply with the criteria provided in this chapter as well as the applicable design specification. The Fabrication Specification shall impose or reference the requirements of Chapter 3 - Prequalification of WPS's, Chapter 4 - Qualification (of welding procedures and welders), Chapter 5 - Fabrication, and Chapter 6 - Inspection. Chapter 7 - Stud Welding, and Chapter 8, Strengthening and Repairing Existing Structures are not applicable to the scope of work.

ANSI/AWS D14.1-1985,
Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ANSI/AWS D14.1 applies to the welding of principal structural weldments and primary welds of cranes and overhead material handling machinery and equipment. Chapter 3, Allowable Stresses, requires the stresses in the crane to meet the requirements of design specifications such as AISC, ASME, CMAA, or MMA. In accordance with this criteria, the MCO Loading System is being designed to conform to the AISC requirements. The configuration of the welded joints is consistent with the requirements and criteria listed in Chapter 4, Weld Joint Design.

The Fabrication Specification shall reference the requirements of Chapter 5 - Workmanship, Chapter 6 - Processes and Filler Metals, Chapter 7 - Qualification (of welding procedures and welders), Chapter 8 - Weld Quality and Inspection, Chapter 9 - Field Weld Repair and Modification, and Chapter 10 - Repair and Correction of Discontinuities.

AWS QC1-96, Standard for AWS Certification of Welding Inspectors

AWS QC1 establishes the requirements for AWS certification of welding inspectors. Welds for the MCO Loading System are qualified and inspected in accordance with AWS D1.1, Structural Welding Code - Steel, or AWS D14.1, Specification for Welding Industrial and Mill Cranes, which impose the requirements of AWS QC1. Personnel responsible for inspecting these welds shall be certified in accordance with this AWS QC1. This requirement for inspector qualification shall be delineated in the fabrication specification for the MCO Loading System.

ASME B30.11-1993, Monorails and Underhung Cranes

ASME B30.11 applies to underhung cranes whose end trucks operate on the bottom flange of a runway track section, and to carriers (trolleys) operating on single track monorail systems. The MCO loading System consists of a single axis bridge gantry and a single motion extending mast with a grapple. The bridge gantry slides on top of a two rails using linear bearing devices. The grapple is a stationary structure mounted to a telescoping mast to connect to the fuel baskets. Because neither the gantry nor mast are underhung configurations, ASME B30.11 is not applicable to these devices.

However, various sections of ASME B30.11 will be used as guidance for the design, testing, and fabrication of the bridge gantry. These items include:

- Welding procedures and welding operator qualifications shall conform to ANSI/AWS D14.1 or ANSI/AWS D1.1 (Section 11-1.3.4)
- Exposed and moving parts that may present a hazard shall be guarded (Section 11-1.7)
- Electrical equipment shall comply with Article 610 of ANSI/NFPA 70. (Section 11-1.9)
- Inspection criteria and procedures shall be developed using Section 11-2.1 as guidance.
- Testing procedures shall be developed using Section 11-2.2 as guidance.
- Maintenance procedures shall be developed using Section 11-2.3 as guidance.

ASME B30.16-1993, Overhead Hoists (Underhung)

ASME B30.16 applies to hoists that are actuated by a hand chain, utilizing a chain as the lifting medium, and electric or air-powered hoists using either a chain or rope as the lifting medium. The MCO Loading System mast uses a ball screw driven linear guided device to lift the canisters. The lifting system does not use chains or wire ropes. Therefore, ASME B30.16 is not applicable to the devices.

However, various sections of ASME B30.16 will be used as guidance for the design, testing, and fabrication of the mast and grapple devices. These items include:

- Electrical equipment shall comply with Article 610 of ANSI/NFPA 70, (Section 16-1.2.2).
- The electrical power for controls shall not exceed 150 VAC (Section 16-1.2.3) and the controls enclosure shall be selected in accordance with ANSI/NEMA ICS6 (Section 16-1.3.3).
- Partial or complete interruption of the power supply during operation shall not result in uncontrollable motion of the load (Section 16-1.2.15)
- Inspection criteria and procedures shall be developed using Section 16-2.1 as guidance.
- Testing procedures shall be developed using Section 16-2.2 as guidance.
- Maintenance procedures shall be developed using Section 11-2.3 as guidance.

NFPA 70 - 1996, National Electric Code

NFPA 70 contains provisions considered necessary for safety from hazards arising from the use of electricity. The power and controls for the MCO Loading System are designed in accordance with the general rules of NFPA 70 with particular attention given to Article 610, Cranes and Hoists. Wiring shall comply with Part B of Article 610 with respect to wiring method, terminal fittings, types of conductors, and rating and size of conductor. The applicable parts of Part C, Contact Conductors, and Part D, Disconnecting Means, shall be implemented. The controls shall be designed in accordance with the applicable parts of Part F. Overcurrent protection shall be provided in accordance with Part E. Grounding shall be in accordance with Part G.

ASME Y14.5-1994, Dimensioning and Tolerancing
ASME Y14.5.1-1994, Mathematical Definition of Dimensioning and Tolerancing Principles

ASME Y14.5 establishes uniform practices for stating and interpreting dimensioning and tolerancing and related requirements for use on engineering drawings. ASME Y14.5.1 provides the mathematical explanation of the principles in ASME Y14.5. The design drawings are developed using decimal inch dimensioning in accordance with Paragraph 1.6.2, and the dimensions are shown in accordance with Paragraphs 1.7, Application of Dimensions, 1.8, Dimensioning Features, and 1.9, Location of Features. Tolerances for the dimensions identified are expressed by a general tolerance block referring to all dimensions on the drawing, unless otherwise noted. This approach is consistent with tolerancing criteria identified in Paragraph 2.2.1(e).

WHC, 1995, Field Verified Measurements of 30 Ton Bridge Crane Travel in 105 KE and 105 KW Transfer Bay Area, WHC-SD-SNF-002

WHC, 1995, Performance Specification of SNF Path Forward Cask and Transportation System, WHC-S-0396

WHC-S-0396 specifies requirements for the MCO cask transportation system. The MCO Loading System will operate previous, adjacent to and comply with the MCO cask transportation system. Specifications describing space limitations of the facility and MCO loading/unloading requirements have been included in the MCO Loading System design.

8.0 REFERENCES

8.1 Westinghouse Hanford Company
Specification No. WHC-S-0546, Revision 0-D.
"Specification For SNF K East and K West MCO Loading System"

8.2. Westinghouse Hanford Company
Statement Of Work No. HNF-SD-SNF-SOW-009, Revision 0.
"Statement of Work for MCO Loading System Final Design".

8.3 NAC International, Inc.
Document 444-S-01, Revision 0
"Design Specification for the MCO Loading System for Duke Engineering & Services, Hanford"

8.4 NAC International, Inc.
Document E-15278
"Conceptual Design Report for the Hanford K East and K West Basin MCO Loading System"

8.5 Duke Engineering and Services, Hanford
Fax Transmittal 4/11/97, 07:51 AM, S. Brisbin

8.6 Duke Engineering and Services, Hanford Document 97-SCB-044, 5/28/97, S. Boothe

8.7 ANSI 14.6-1993, American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More.

Appendix A

Specification-Report Requirement Matrix

SPECIFICATION - REPORT REQUIREMENT MATRIX

SPECIFICATION SECTION	SPECIFICATION REQUIREMENT	DESIGN REPORT CROSS-REFERENCE
4.2.1,8.2.3	Recovery features which allow for fueled basket to be moved into MCO or back to queue to facilitate repairs to failed equipment. Also, allows for remote disengagement and removal of all tools and equipment from fueled basket.	2.7.9, 4.0
4.2.2	Basket lift height not to exceed -8'-0"	2.5
4.2.3, 8.1.1	MCO load cycle time not to exceed 4 hours.	4.1
4.2.4, 8.2.1, 8.2.4	Operators shall not be exposed to dose field in excess of an average 0.5 mrem/hr for the 4 hour loading cycle.	4.2
4.2.5	Load cycle shall be accomplished with staff not exceeding two (2) operators.	2.6
4.2.6	Loading system design shall include features that preclude damage to MCO, cask, immersion pail during basket loading and shield plug insertion.	2.7,2.1.5
4.2.7	CCTV system which provides for operator to remotely monitor critical operations.	2.2, 2.7.3
4.2.8	Loading system shall provide a grapple that enables operators to remotely engage and release baskets.	2.7.9
4.2.9.1	Fueled basket verification of dimensions.	2.1.1
4.2.9.2	Loaded basket verification of position.	2.1.2
4.2.9.3	MCO shield plug verification of placement.	2.1.4
5.1	If monorail hoists used, determine track capacity.	Not Applicable
5.2.1	Wiring and equipment shall comply with National Electric Code.	2.2.1
5.2.2	Electrical supply shall be controlled by lockable switch.	Drawings 444-400 444-401
5.2.3	Remote viewing control station located outside contaminated environment.	2.2.1
5.3	Drives shall have manual overrides	Drawing 444-200
5.4	Existing handling equipment and shop services shall be used where possible.	As Applicable
5.5	Manual tools shall have standard connection features, be light weight. Tools used in pool shall be solid, or have drain or vent holes.	As Applicable
6.0	Equipment requiring support from existing steel shall be identified, along with the dead and live weight information.	Drawing 444-101

SPECIFICATION - REPORT REQUIREMENT MATRIX (CONTINUED)

SPECIFICATION SECTION	SPECIFICATION REQUIREMENT	DESIGN REPORT CROSS-REFERENCE
6.0	Equipment located underwater shall be secured by means of mechanical stops in lieu of anchor bolts. Should be designed for seismic loads.	Drawing 444-101
6.2.1	Define interfaces with existing monorail.	Not Applicable
6.2.2	Define interfaces with existing basin structures.	2.12 and Dwg. 444-101, 444-000
6.2.3	Define interfaces with loadout pit and transfer channel.	2.12 and Dwg. 444-101, 444-000
6.2.3.1	Define interfaces with K-Basin water.	2.12 and Dwg. 444-101, 444-000
6.2.4	Define interfaces with transfer bay crane.	2.12 and Dwg. 444-101, 444-000
6.3.1	Define interfaces with fuel retrieval system.	2.12 and Dwg. 444-101, 444-000
6.3.2	Define interfaces with MCO baskets.	2.12 and Dwg. 444-101 & 444-000
6.3.3	Define interfaces with MCO	2.12 and Dwg. 444-101, 444-201, 444-000
6.3.4	Define interfaces with SNF Transportation System	2.12 and Dwg.444-000
6.4	Installed equipment shall be equipped with rigging support points.	Analyzed Sling Points
7.1	Design and procurement schedule shall be provided.	Volume 4
7.2	Welding and Inspection Codes and Procedures identified to be incorporated.	7.0
8.1.2	Equipment shall be tested prior to delivery.	Fabrication Specification
8.1.3	Total fuel shipment shall be complete within two (2) years of first shipment date.	4.0
8.2.2	Shall be designed to withstand earthquake. Components which can cause damage to Class 1 structures or components shall be designed with tiedown points.	5.0
8.2.5	Design life of five (5) years.	2.9
8.2.6	CCTV and other equipment which is more cost effective to replace need not be radiation hardened.	2.2
8.2.6	Components shall minimize maintenance and testing, shall use standard replacement parts.	2.9
8.2.6	Failure of any one component shall not reduce design life or reduce the capabilities of the MCO loading system.	3.0

SPECIFICATION - REPORT REQUIREMENT MATRIX (CONTINUED)

SPECIFICATION SECTION	SPECIFICATION REQUIREMENT	DESIGN REPORT CROSS-REFERENCE
8.2.6	All equipment must be designed for permanent lubrication.	2.11
8.2.7	All equipment must be able to withstand contamination.	Applied
8.2.8	Number of threaded fastener sizes should be minimized.	Applied
8.2.10	Equipment shall not see significant corrosion effects.	Applied
Statement of Work, 4.1	Transfer equipment general arrangement drawing	Dwg. 444-000
Statement of Work, 4.3	Control equipment general arrangement drawing.	Figure 2.5

Appendix B

Control and Logic
Description and Maintenance Requirements

1.0 CONTROL SYSTEM HARDWARE

1.1 Control Stations

The MCO loading control system includes two control stations, one located at the basin viewing area and one located at a remote viewing area. All system operations and CCTV camera control and viewing will be performed at the basin viewing control station. CCTV camera viewing and recording will be performed at the remote viewing control station, located in corridor 7.

1.1.1 CCTV Camera Basin Viewing Control Station

The basin viewing control station consists of two skid mounted control cabinets on casters for limited mobility. One control cabinet will contain all the controls for performing basket loading and associated functions. It will contain the following components: PLC, CRT-based man-machine interface, motion controller, servo drive with power supply and transformer, and safety shutdown and supervisor override hardware. The second control cabinet will contain the CCTV cameral control and viewing hardware. It will consist of the following components: three (3) camera controllers with pan & tilt and zoom capability, one camera controller with fixed optics, two monitors, and two four signal video switchers.

1.1.2 CCTV Camera Remote Viewing Control Station

The CCTV camera remote viewing control station is located in a non contaminated area and contains CCTV camera viewing and recording hardware. This cabinet consists of one fixed control cabinet and one monitor, one VCR, one character generator, and one four signal video switcher. This system can view and record any one of the four camera signals independent of the basin viewing system.

1.2 Field Mounted Controls

The field mounted control hardware consists of the following system actuators and sensors:

DEVICE	Qty.	SENSOR/ ACTUATOR
Servo motor with 8:1 gearbox (for mast)	1	Actuator
AC gear motor (for bridge)	1	Actuator
Load cell with integral signal conditioning	3	Sensor
LVDT with field mounted signal conditioning	1	Sensor
Limit switch	9	Sensor

2.0 MCO LOADING OPERATIONAL MODES

The control system has two distinct modes of operation, a MAINTENANCE mode and a LOAD mode. The limited access MAINTENANCE mode permits engineering and maintenance personnel access to basic system operations with minimal interlocking. The maintenance mode is used for debugging, setup, and calibration. This mode will be password protected. All MCO loading operations are performed in the LOAD mode.

2.1 Load Mode

Within the LOAD mode there are three operating modes: MANUAL, SEMI-AUTOMATIC, and AUTOMATIC. The control commands are hierarchical in nature with the SEMI-AUTOMATIC mode commands constructed from the MANUAL mode command set and the AUTOMATIC mode commands constructed from the SEMI-AUTOMATIC mode command set.

The nomenclature for the positions of each mechanical subsystem are defined below. For the shuttle operation, the fuel basket is placed into the shuttle at the LOAD station and is picked up by the extended mast at the UNLOAD station. The bridge crane has three positions. The crane is stored at the STORE position. The fuel basket is received from the shuttle at the SHUTTLE position and is placed into the MCO at the MCO position. The mast is extended and retracted to vertically move the fuel basket from the shuttle to the MCO.

The control system is designed to support each movement of the basket from the load station through final placement in the MCO. Interlocks are provided which require operator activation before continuing operations. System design prevents damage to loadout pit operations equipment and a radiation or safety hazard for operational personnel. The status of every actuator and sensor is displayed on the control panel. Feedback sensors are provided for all actuators. System alarming is triggered if a commanded movement does not occur within a predetermined period of time.

2.1.1 Manual Mode

All MANUAL mode movements with appropriate interlocking will be supported. The operator will be allowed to make most movement commands. An exception is the grapple release with an attached basket and a load on the load cells. Releasing the grapple without the basket properly seated in the MCO or shuttle carriage basket could cause basket damage. Grapple Release with load will require two independent requests -- one by the operator and one by the operator's supervisor. The operator's request will consist of input of the operator's ID number. The supervisor's request will consist of a key operated switch along with input of the supervisor's ID number. After both of these conditions have been met, a GRAPPLE RELEASE request will be processed by the control system.

The following MANUAL operations are supported by the control system.

1. SHUTTLE TRAVEL JOG [from LOAD to UNLOAD position]
2. SHUTTLE RETURN JOG [from UNLOAD to LOAD position]
3. BRIDGE TRAVEL JOG [from STORE to SHUTTLE to MCO position]
4. BRIDGE RETURN JOG [from MCO to SHUTTLE to STORE position]
5. MAST EXTENSION JOG
6. MAST RETRACTION JOG
7. MAST GOTO COMMANDED POSITION
8. GRAPPLE ACTIVATION
9. GRAPPLE RELEASE

2.1.2 Semi-Automatic Mode

SEMI-AUTOMATIC operations consist of logical sets of motions for each actuator in the system. These operations are fully interlocked. System HOME position is defined as: shuttle at LOAD position, bridge at SHUTTLE position, mast at BASKET PICKUP RETRACTION position. The BASKET PICKUP RETRACTION position is the maximum (highest) mast assembly elevation the system can attain.

The following SEMI-AUTOMATIC operations will be supported by the control system. Operations 1-12 are sequential loading requirements. Operations 13-19 are additional controlled moves for maintenance, recovery or calibration.

1. SHUTTLE TRAVEL [from LOAD to UNLOAD position]
2. MAST SHUTTLE BASKET PICKUP EXTENSION
3. GRAPPLE ACTIVATION
4. GRAPPLE ACTIVATION VERIFICATION
5. MAST SHUTTLE BASKET PICKUP RETRACTION
6. SHUTTLE RETURN [from UNLOAD to LOAD position]
7. BRIDGE TRAVEL [from SHUTTLE to MCO position]
8. MAST MCO BASKET PROGRAMMED RELEASE EXTENSION
9. GRAPPLE RELEASE
10. GRAPPLE RELEASE VERIFICATION
11. MAST MCO BASKET RELEASE RETRACTION
12. BRIDGE RETURN [from MCO to SHUTTLE position]
13. BRIDGE STORE [from SHUTTLE to STORE position]
14. BRIDGE STORE RETURN [from STORE to SHUTTLE position]
15. MAST MCO BASKET PICKUP EXTENSION
16. MAST POSITION CALIBRATION (retraction to maximum elevation)
17. MAST MCO BASKET LOW SPEED EXTENSION
18. HOME SYSTEM

19. MAST SHUTTLE BASKET PROGRAMMED RELEASE EXTENSION

The GRAPPLE RELEASE will free a basket in the MCO after the load cells have been unloaded and the compliance LVDT indicates "X" inches of backup travel (X is the predetermined MCO loading configuration set point monitored by the Grapple Extension Compliance Mechanism [GECM] release set point).

The BRIDGE STORE operation moves the bridge to the location mast removed from the loadout pit operating equipment. The bridge is moved to the store location when a cask is being loaded and unloaded from the immersion pail.. Before AUTOMATIC mode operation either a HOME SYSTEM or a BRIDGE STORE RETURN command would be issued to return the bridge to its HOME position.

The MAST MCO BASKET PICKUP EXTENSION and the MAST SHUTTLE BASKET PROGRAMMED RELEASE EXTENSION commands, in addition to other SEMI-AUTOMATIC mode commands, will allow for the unloading of a fuel basket from the MCO to the shuttle.

2.1.3 Automatic Mode

The AUTOMATIC mode will consist of the full loading of one MCO. It utilizes many of the SEMI-AUTOMATIC operations in a programmed sequence. The conditions for initiating this mode are mast positioning system in calibration and system at HOME. As the MCO is loaded the control system keeps track of the number of baskets loaded and the position of the top basket in the MCO. At specified steps in the AUTOMATIC loading process the operator will be required to confirm the successful completion of an operation. Normally, the operator would visually verify with the appropriate TV camera that an operation had been completed successfully and that there were no alarms.

If the load cells indicate an off normal load when loading a basket into the MCO at the programmed basket release height, the control system will issue an alarm. The operator will **NOT** be allowed to jog the mast down to release the basket. Jogging the mast down and completing the MAST BASKET PROGRAMMED RELEASE EXTENSION operation to unload the load cells, prior to releasing the grapple, will require two independent requests -- one by the operator and one by the operator's supervisor. The operator's request will consist of input of the operator's ID number. The supervisor's request will consist of a key operated switch along with input of the supervisor's ID number. Isolating system operation when off normal loads are detected permits administrative procedures to be implemented which define root cause and prevent system damage.

The following AUTOMATIC operations are supported by the control system.

1. LOAD MCO
2. LOAD BASKET
3. SUSPEND LOAD BASKET
4. CONTINUE LOAD BASKET
5. ABORT LOAD BASKET

With an empty MCO in place, the operator would issue a LOAD MCO command. Then each time a basket is to be loaded into the MCO the LOAD BASKET command would be issued. The SUSPEND LOAD BASKET and CONTINUE LOAD BASKET commands allow the operator to suspend and continue the AUTOMATIC sequence as needed. The ABORT LOAD BASKET command allows the operator to abort an AUTOMATIC sequence if serious problems arise.

2.1.3.1 MCO Loading

The operator confirms the system is at HOME position and enters the basket type and number of baskets to be loaded. The control system prevents the operator from loading more baskets than can be placed in the MCO. The operator then issues the LOAD BASKET command to initiate loading a basket into the MCO. The following SEMI-AUTOMATIC operations would then be performed in order with full interlocking:

1. SHUTTLE TRAVEL [from basket LOAD to UNLOAD position]
3. MAST BASKET PICKUP EXTENSION
4. GRAPPLE ACTIVATION
5. GRAPPLE ACTIVATION VERIFICATION
6. MAST BASKET PICKUP RETRACTION
7. BRIDGE TRAVEL [from SHUTTLE to MCO position]
8. SHUTTLE RETURN [from UNLOAD to LOAD position]
9. MAST BASKET PROGRAMMED RELEASE EXTENSION
10. GRAPPLE RELEASE

11. GRAPPLE RELEASE VERIFICATION
12. MAST BASKET RELEASE RETRACTION
13. BRIDGE RETURN [from MCO to SHUTTLE position]

Following operations, the system is back at the HOME position and ready to load the next basket. The control system maintains the number of baskets loaded and the position of the top basket. This information is displayed on the operator's console in both text form and graphically. When the next basket is ready at the shuttle loading station, the operator issues the LOAD BASKET command and the AUTOMATIC sequence to load a basket into the MCO is repeated.

2.2 Maintenance Mode

The maintenance mode can only be entered by receipt of a valid password from authorized personnel. Minimal system interlocking is activated for this mode of operation. The following basic operations can be performed in this mode.

1. SHUTTLE TRAVEL [from LOAD to UNLOAD position]
2. SHUTTLE RETURN [from UNLOAD to LOAD position]
3. BRIDGE TRAVEL [from SHUTTLE to MCO position]
4. BRIDGE RETURN [from MCO to SHUTTLE position]
3. BRIDGE TRAVEL JOG [from SHUTTLE to MCO position]
4. BRIDGE RETURN JOG [from MCO to SHUTTLE position]
5. MAST EXTENSION JOG
6. MAST RETRACTION JOG
7. GRAPPLE ACTIVATION
8. GRAPPLE ACTIVATION VERIFICATION
9. GRAPPLE RELEASE
10. GRAPPLE RELEASE VERIFICATION
11. SYSTEM PARAMETER ENTRY/MODIFICATION
    a. Load cell underload setpoint (initially dead load + 80% of basket load).
    b. Load cell overload setpoint (initially 6000 lb.).
    c. GECM backup grapple engagement travel set point (initially 1.0")
    d. Dwell time at each AUTOMATIC operational step.
    e. The AUTOMATIC steps requiring visual verification and confirmation by the operator.

A number of system parameters are fixed by design and are not anticipated to change throughout the service life of the system. The following parameters will be hard coded into the software:

a. Mast drive linear calibration [counts/inch of linear travel] (524,280 counts/in)
b. GECM backup grapple disengagement travel set point (initially 1.5")

c. Height dimension for each basket type.
d. Allowable basket configurations for loading.
e. Mast calibration elevations [basket loading elevation, bridge traverse elevation, maximum raised elevation (which can not be exceeded mechanically), and MCO internal bottom elevation].
f. Nominal basket load for each basket type.

2.3 Control Functions

All LOAD and MAINTENANCE operations are performed from the control console located at the basin viewing area. A CRT-based man-machine interface (MMI) is used to send commands to and receive the status from the MCO Loading System. The MMI provides continuous display of the system status. A graphic display of the loaded baskets are shown. Safety shutdown and supervisor override functions are hardwired.

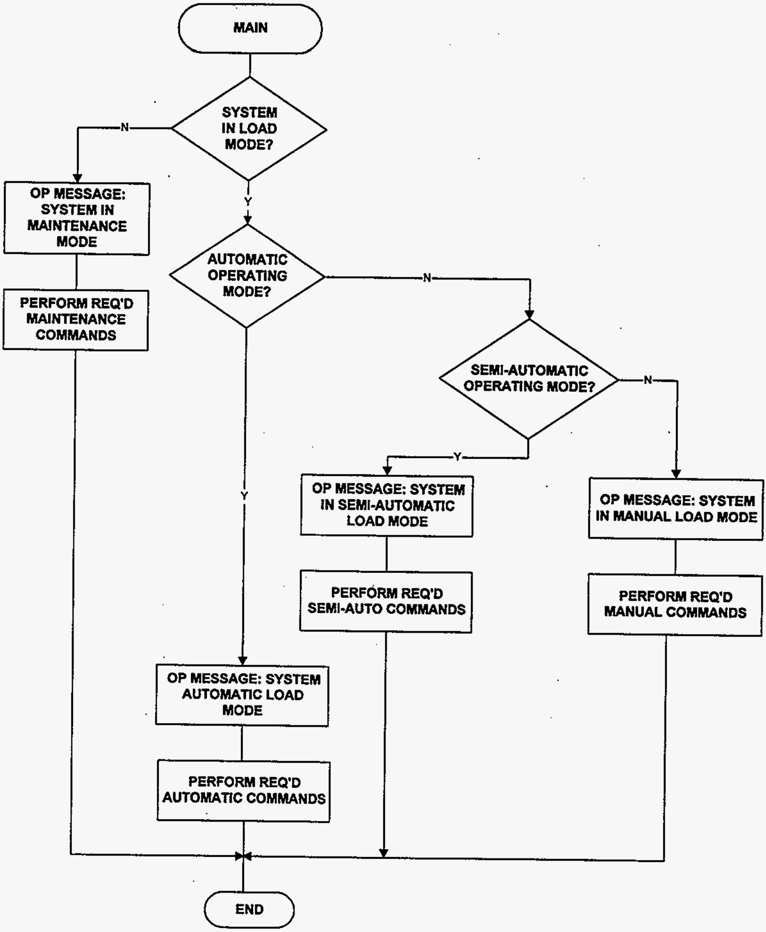
A CCTV camera viewing system provides process step verification by the operator for system maintenance and system testing. Four cameras are positioned to provide visual monitoring of the shuttle loading area, the shuttle unloading area, the top of the MCO, and grapple end of the mast.

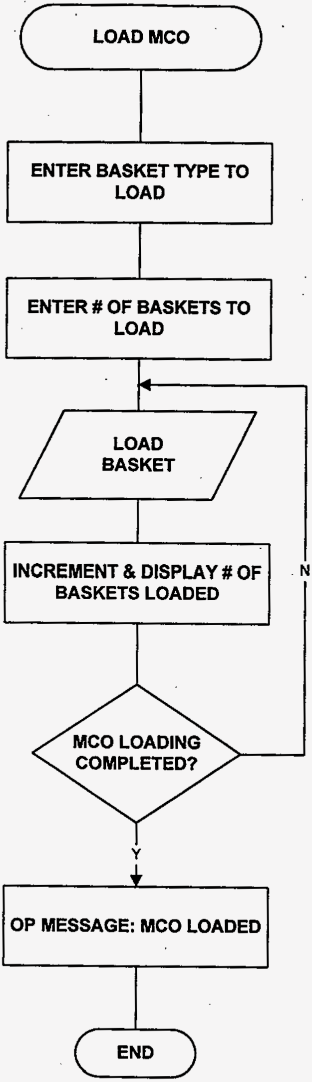
3.0 OPERATIONAL MODE ALARM CONDITIONS

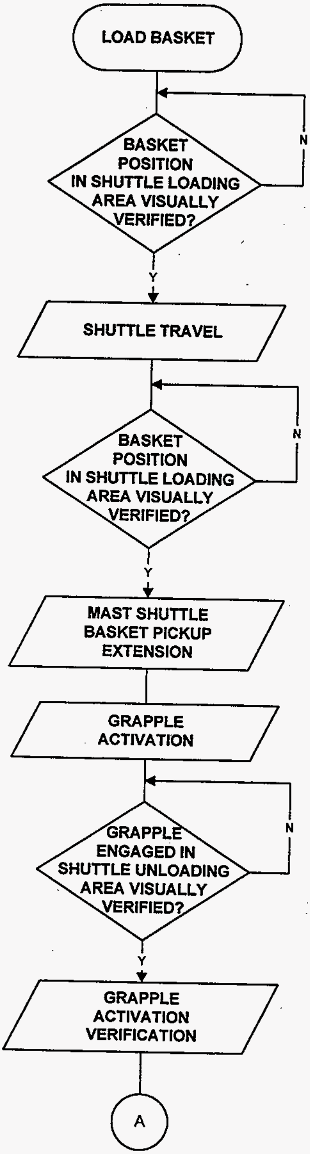
During setup, maintenance, and normal operating conditions, abnormal events resulting in alarms will occur. Control system hardware and software are designed to properly react to these events. No movements or actions are allowed which cause damage to equipment or create a radiation or safety hazard for operational personnel. The operator is notified when any alarm condition occurs or if a command results in an alarm condition. There are two types of alarms, motion and procedure alarms. Motion alarms are those which occur while the system is in transit from one position to another. This type of alarm condition will usually result from malfunctioning actuators or sensors or improperly calibrated or set sensors. A procedure alarm will occur if the system is requested to perform an illegal or unauthorized action. Examples of such actions are: attempting to place more baskets in an MCO than it can contain and automatically trying to jog the mast down to a lower position when the "resting place" for a basket is below its anticipated ("programmed") position.

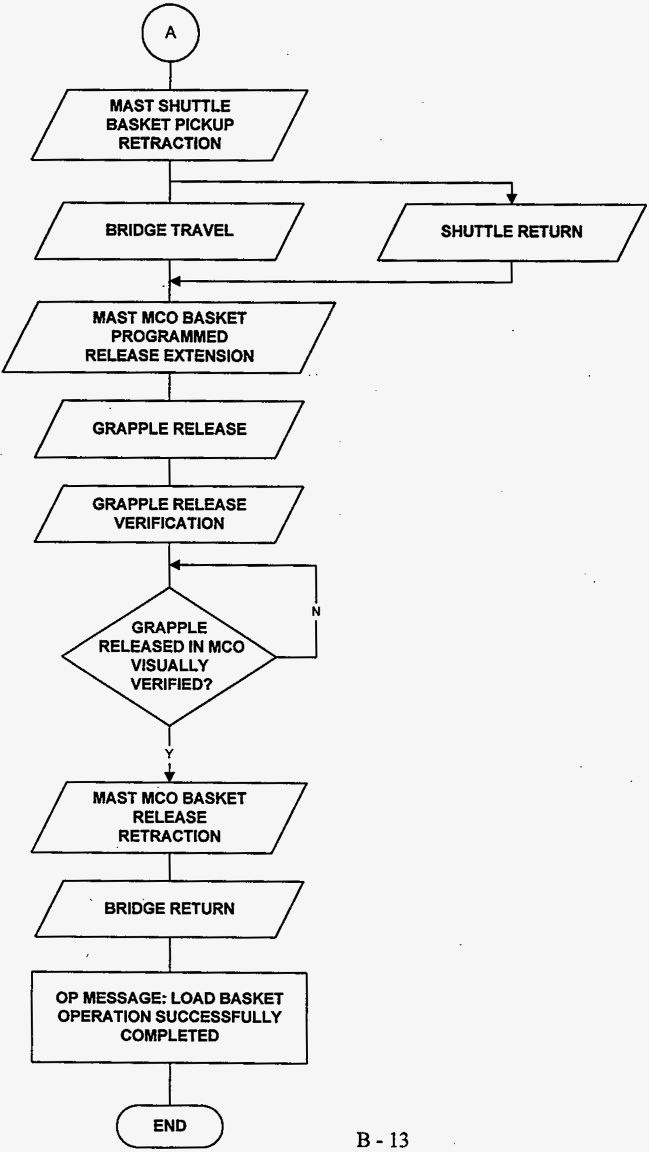
An initial list of possible alarm conditions is given below. Additional alarm conditions may be added to the list during the system fabrication and software design phase of the project.

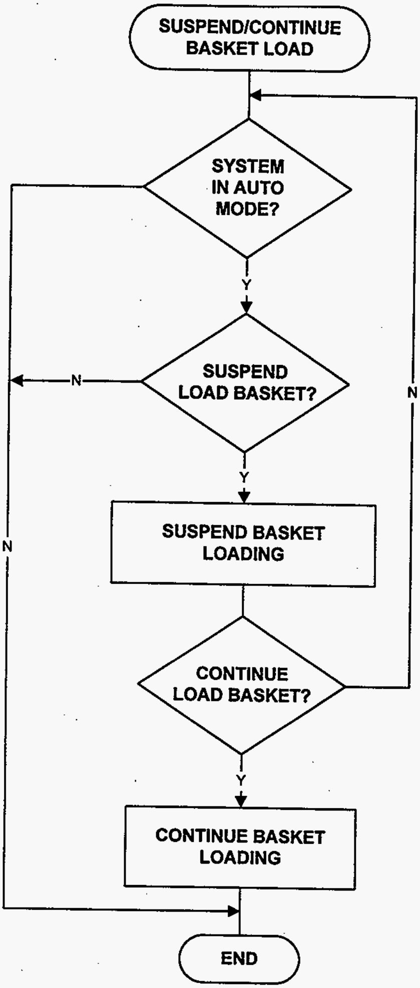
#	ALARM CONDITION	ALARM TYPE
1	SHUTTLE	MOTION
2	MAST	MOTION
3	BRIDGE MOTION	MOTION
4	GRAPPLE ACTIVATION	MOTION
5	GRAPPLE RELEASE	MOTION
6	BASKET PROGRAMMED RELEASE	MOTION
7	LOAD CELL(S) UNLOADED (WHEN SHOULD BE LOADED)	MOTION/PROCEDURE
8	IMPROPER BASKET TYPE/NUMBER COMBINATION	PROCEDURE
9	BRIDGE MOVEMENT NOT ALLOWED WHILE MAST IS EXTENDED	MOTION/PROCEDURE
10	SYSTEM NOT AT HOME	PROCEDURE

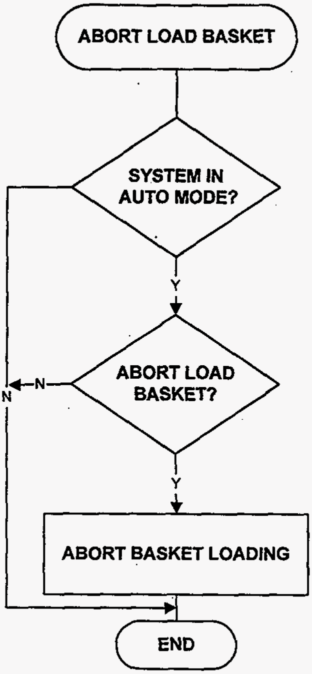

MAIN
SYSTEM IN LOAD MODE?
N
Y
OP MESSAGE: SYSTEM IN MAINTENANCE MODE
PERFORM REQ'D MAINTENANCE COMMANDS
AUTOMATIC OPERATING MODE?
N
Y
SEMI-AUTOMATIC OPERATING MODE?
N
Y
OP MESSAGE: SYSTEM IN SEMI-AUTOMATIC LOAD MODE
PERFORM REQ'D SEMI-AUTO COMMANDS
OP MESSAGE: SYSTEM IN MANUAL LOAD MODE
PERFORM REQ'D MANUAL COMMANDS
OP MESSAGE: SYSTEM AUTOMATIC LOAD MODE
PERFORM REQ'D AUTOMATIC COMMANDS
END

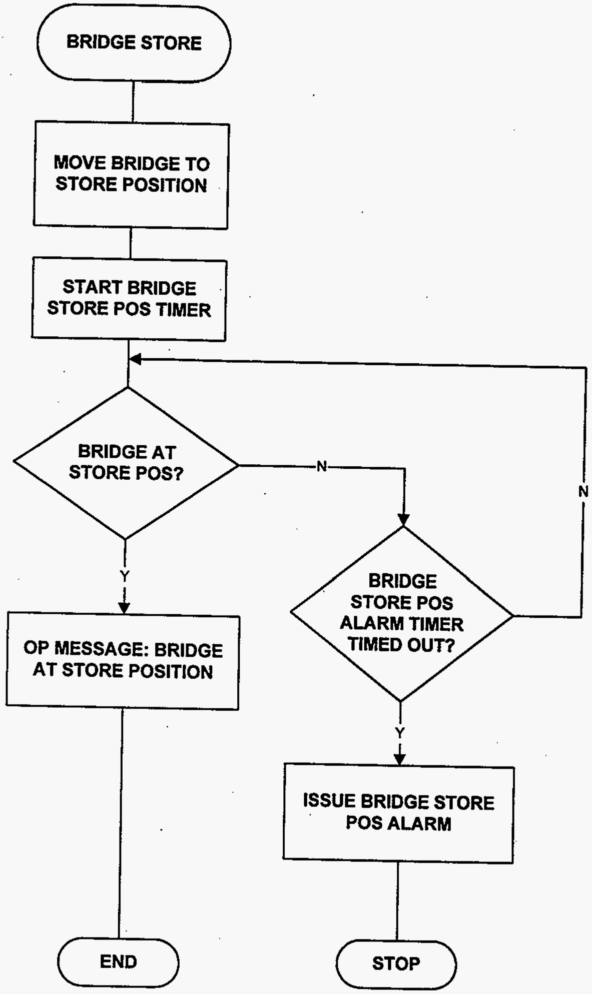

LOAD MCO
ENTER BASKET TYPE TO LOAD
ENTER # OF BASKETS TO LOAD
LOAD BASKET
INCREMENT & DISPLAY # OF BASKETS LOADED
N
MCO LOADING COMPLETED?
Y
OP MESSAGE: MCO LOADED
END

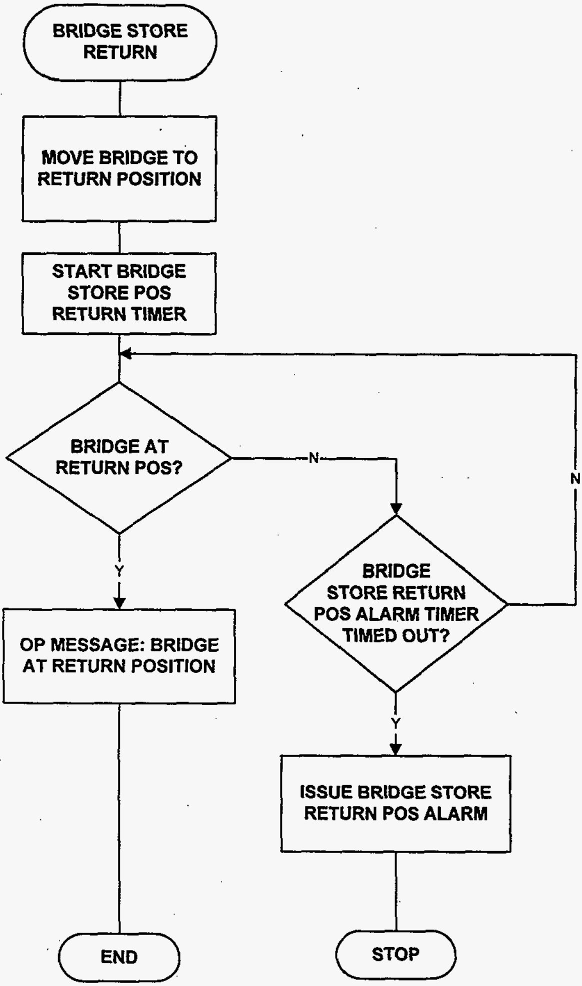

LOAD BASKET
BASKET POSITION IN SHUTTLE LOADING AREA VISUALLY VERIFIED?
N
Y
SHUTTLE TRAVEL
BASKET POSITION IN SHUTTLE LOADING AREA VISUALLY VERIFIED?
N
Y
MAST SHUTTLE BASKET PICKUP EXTENSION
GRAPPLE ACTIVATION
GRAPPLE ENGAGED IN SHUTTLE UNLOADING AREA VISUALLY VERIFIED?
N
Y
GRAPPLE ACTIVATION VERIFICATION
A

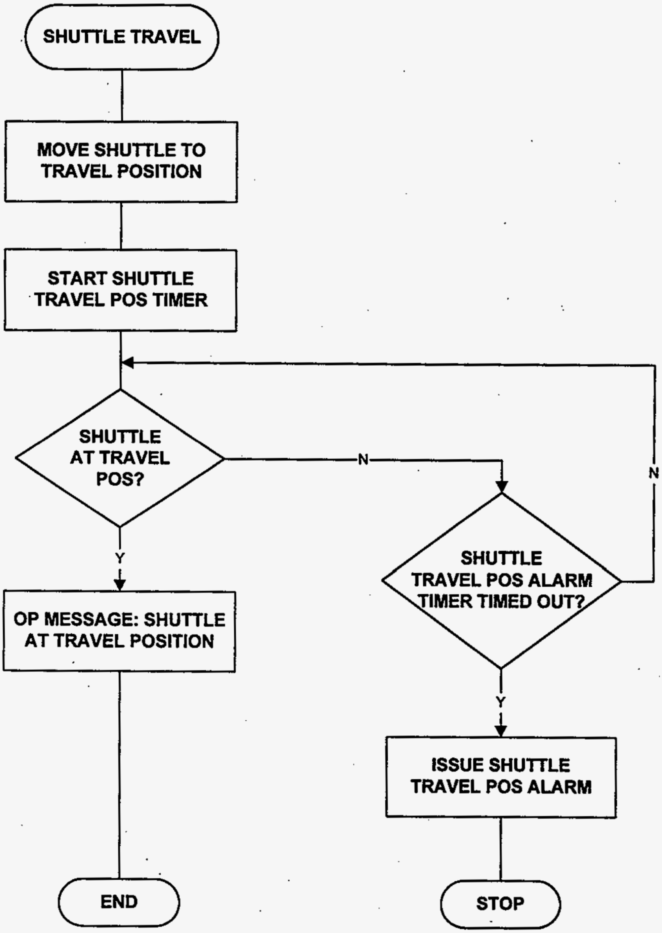

A
MAST SHUTTLE BASKET PICKUP RETRACTION
BRIDGE TRAVEL
SHUTTLE RETURN
MAST MCO BASKET PROGRAMMED RELEASE EXTENSION
GRAPPLE RELEASE
GRAPPLE RELEASE VERIFICATION
N
GRAPPLE RELEASED IN MCO VISUALLY VERIFIED?
Y
MAST MCO BASKET RELEASE RETRACTION
BRIDGE RETURN
OP MESSAGE: LOAD BASKET OPERATION SUCCESSFULLY COMPLETED
END

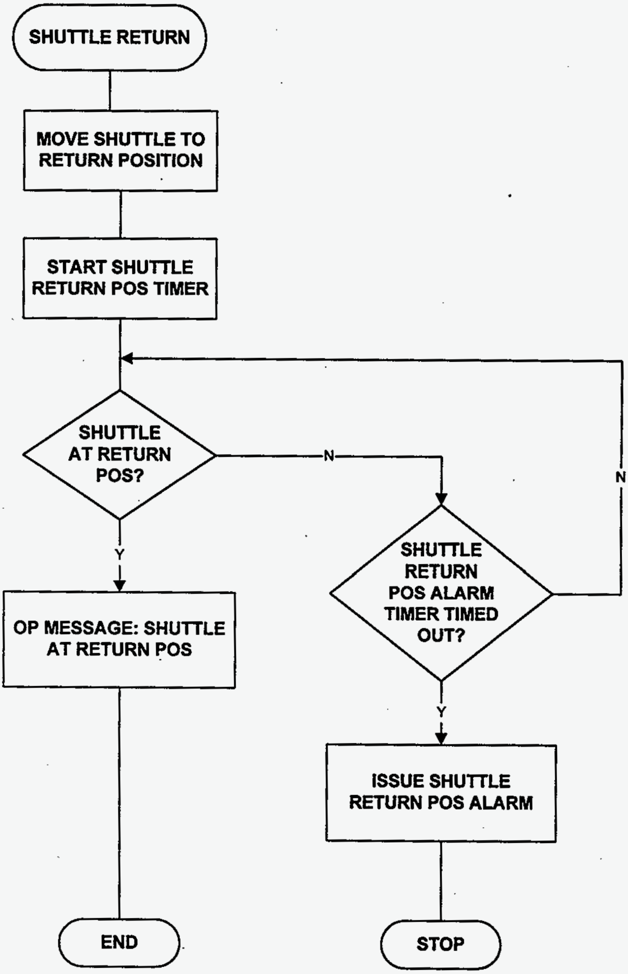

SUSPEND/CONTINUE BASKET LOAD
SYSTEM IN AUTO MODE?
Y
N
SUSPEND LOAD BASKET?
N
Y
SUSPEND BASKET LOADING
CONTINUE LOAD BASKET?
N
Y
CONTINUE BASKET LOADING
N
END

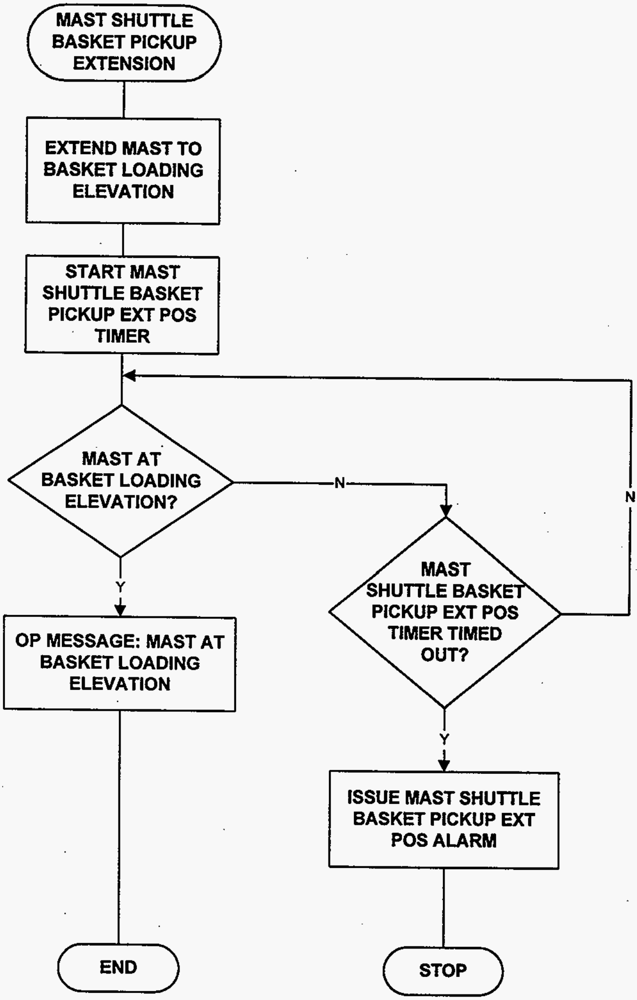

ABORT LOAD BASKET
SYSTEM IN AUTO MODE?
Y
ABORT LOAD BASKET?
N
N
Y
ABORT BASKET LOADING
END

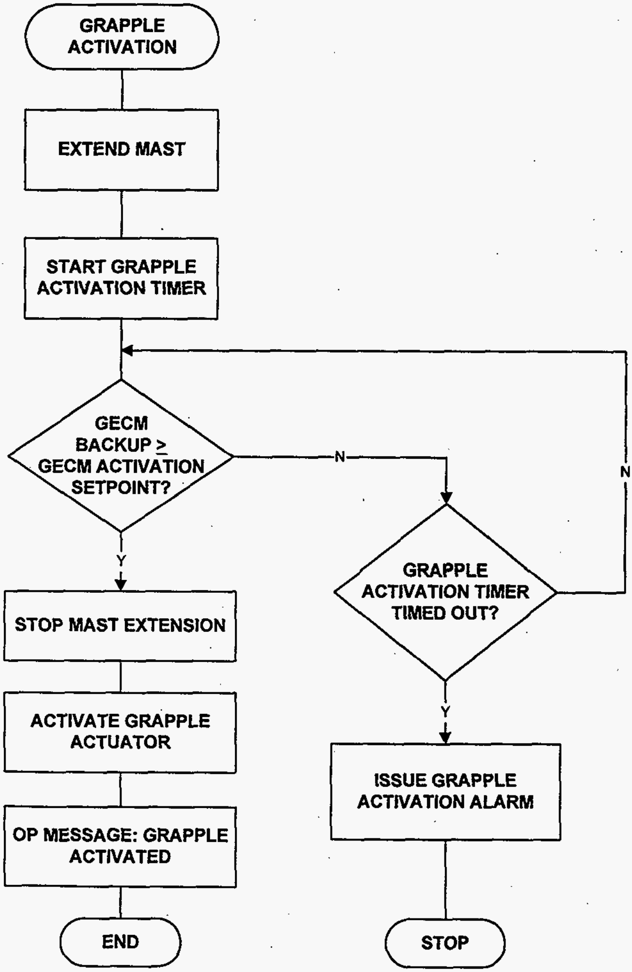

BRIDGE STORE
MOVE BRIDGE TO STORE POSITION
START BRIDGE STORE POS TIMER
BRIDGE AT STORE POS?
N
Y
BRIDGE STORE POS ALARM TIMER TIMED OUT?
N
Y
OP MESSAGE: BRIDGE AT STORE POSITION
ISSUE BRIDGE STORE POS ALARM
END
STOP

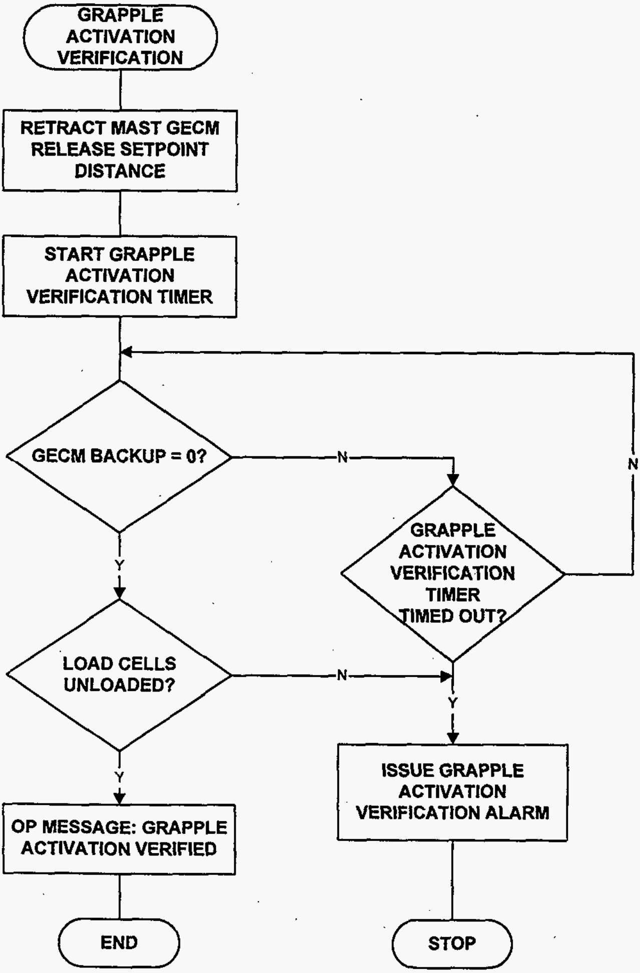

BRIDGE STORE RETURN
MOVE BRIDGE TO RETURN POSITION
START BRIDGE STORE POS RETURN TIMER
BRIDGE AT RETURN POS?
N
Y
OP MESSAGE: BRIDGE AT RETURN POSITION
BRIDGE STORE RETURN POS ALARM TIMER TIMED OUT?
N
Y
ISSUE BRIDGE STORE RETURN POS ALARM
END
STOP

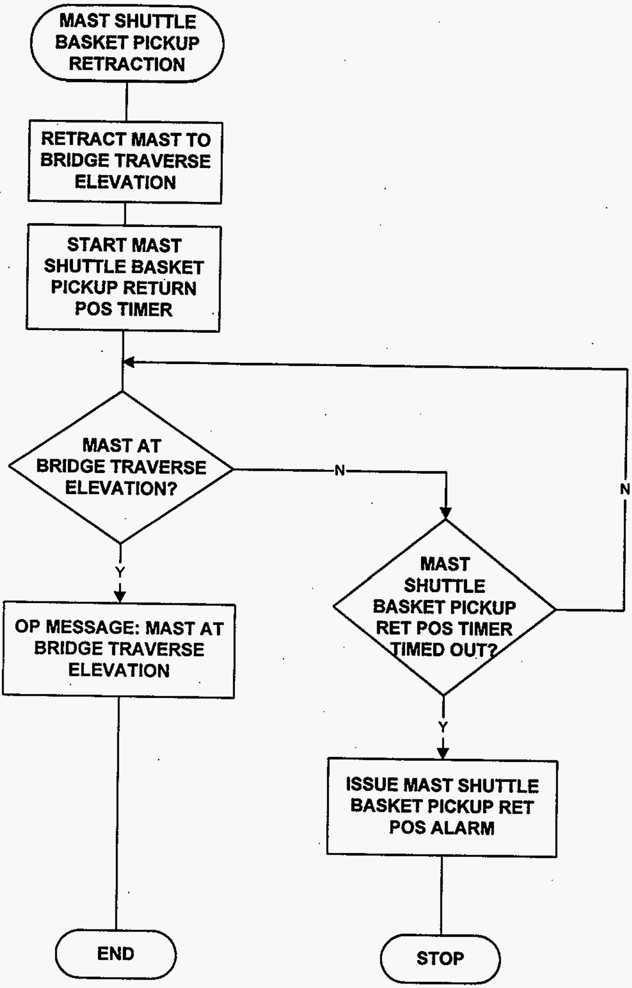

SHUTTLE TRAVEL
MOVE SHUTTLE TO TRAVEL POSITION
START SHUTTLE TRAVEL POS TIMER
SHUTTLE AT TRAVEL POS?
N
Y
SHUTTLE TRAVEL POS ALARM TIMER TIMED OUT?
N
Y
OP MESSAGE: SHUTTLE AT TRAVEL POSITION
ISSUE SHUTTLE TRAVEL POS ALARM
END
STOP

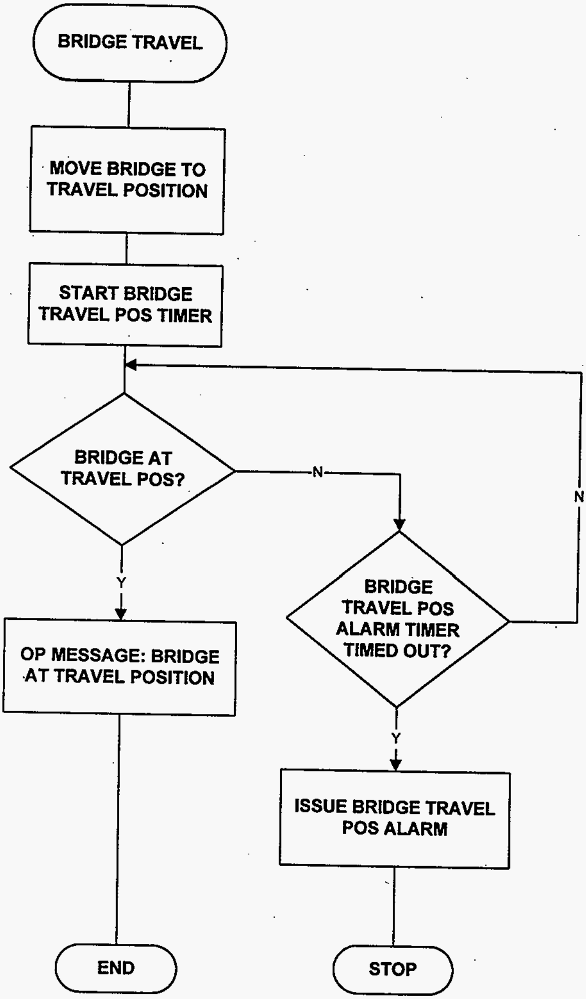

SHUTTLE RETURN
MOVE SHUTTLE TO RETURN POSITION
START SHUTTLE RETURN POS TIMER
SHUTTLE AT RETURN POS?
N
Y
OP MESSAGE: SHUTTLE AT RETURN POS
SHUTTLE RETURN POS ALARM TIMER TIMED OUT?
N
Y
ISSUE SHUTTLE RETURN POS ALARM
END
STOP

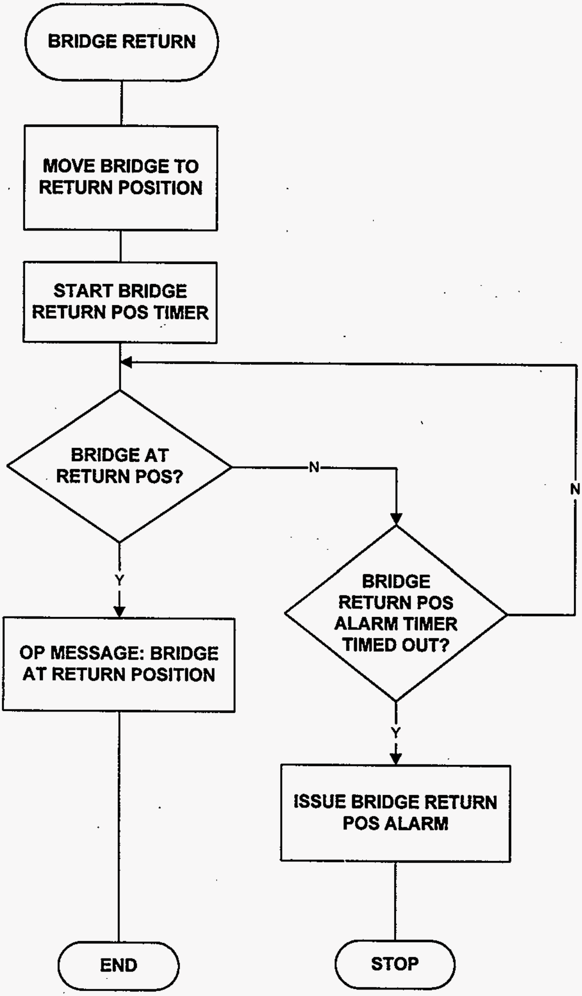

MAST SHUTTLE BASKET PICKUP EXTENSION
EXTEND MAST TO BASKET LOADING ELEVATION
START MAST SHUTTLE BASKET PICKUP EXT POS TIMER
MAST AT BASKET LOADING ELEVATION?
N
Y
OP MESSAGE: MAST AT BASKET LOADING ELEVATION
MAST SHUTTLE BASKET PICKUP EXT POS TIMER TIMED OUT?
N
Y
ISSUE MAST SHUTTLE BASKET PICKUP EXT POS ALARM
END
STOP

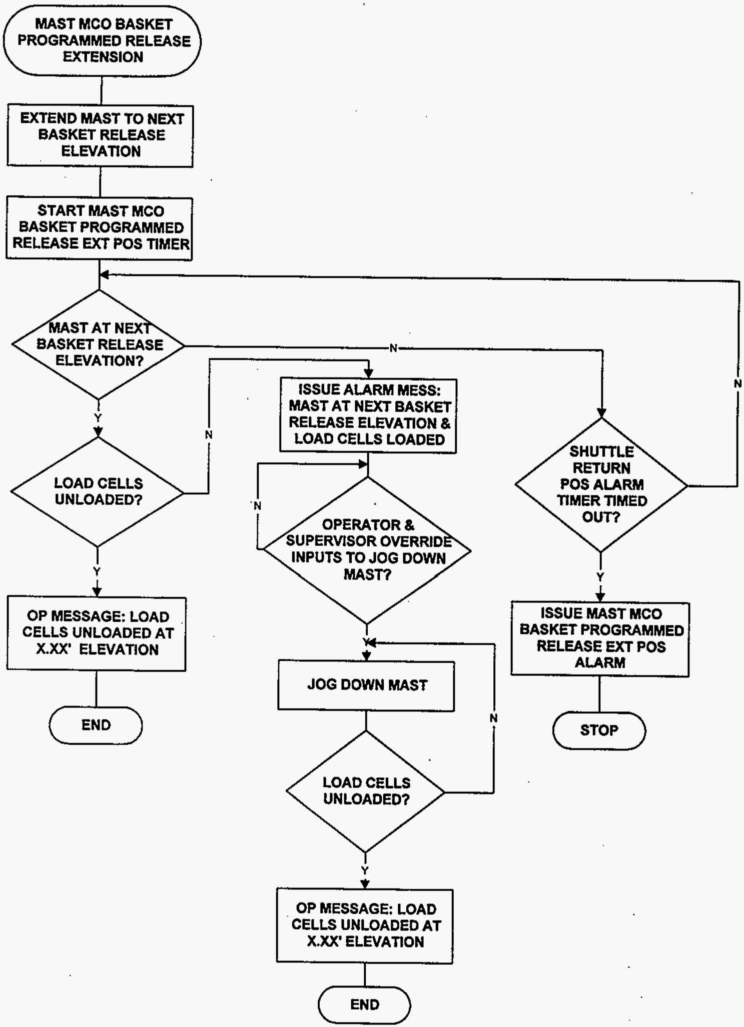

GRAPPLE ACTIVATION
EXTEND MAST
START GRAPPLE ACTIVATION TIMER
GECM BACKUP ≥ GECM ACTIVATION SETPOINT?
N
Y
STOP MAST EXTENSION
ACTIVATE GRAPPLE ACTUATOR
OP MESSAGE: GRAPPLE ACTIVATED
END
GRAPPLE ACTIVATION TIMER TIMED OUT?
N
Y
ISSUE GRAPPLE ACTIVATION ALARM
STOP

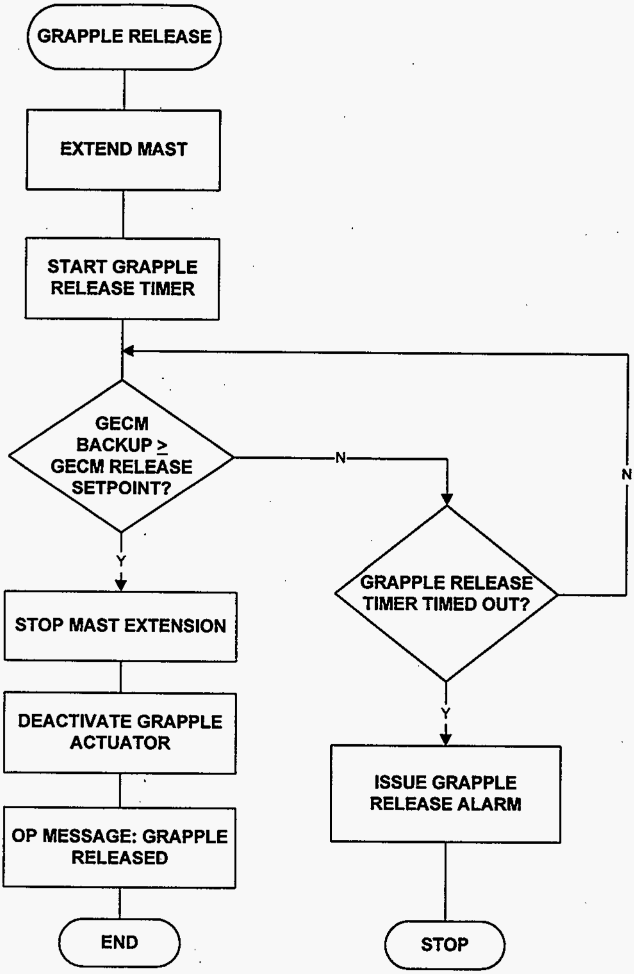

GRAPPLE ACTIVATION VERIFICATION
RETRACT MAST GECM RELEASE SETPOINT DISTANCE
START GRAPPLE ACTIVATION VERIFICATION TIMER
GECM BACKUP = 0?
N
Y
GRAPPLE ACTIVATION VERIFICATION TIMER TIMED OUT?
N
LOAD CELLS UNLOADED?
N
Y
Y
OP MESSAGE: GRAPPLE ACTIVATION VERIFIED
ISSUE GRAPPLE ACTIVATION VERIFICATION ALARM
END
STOP

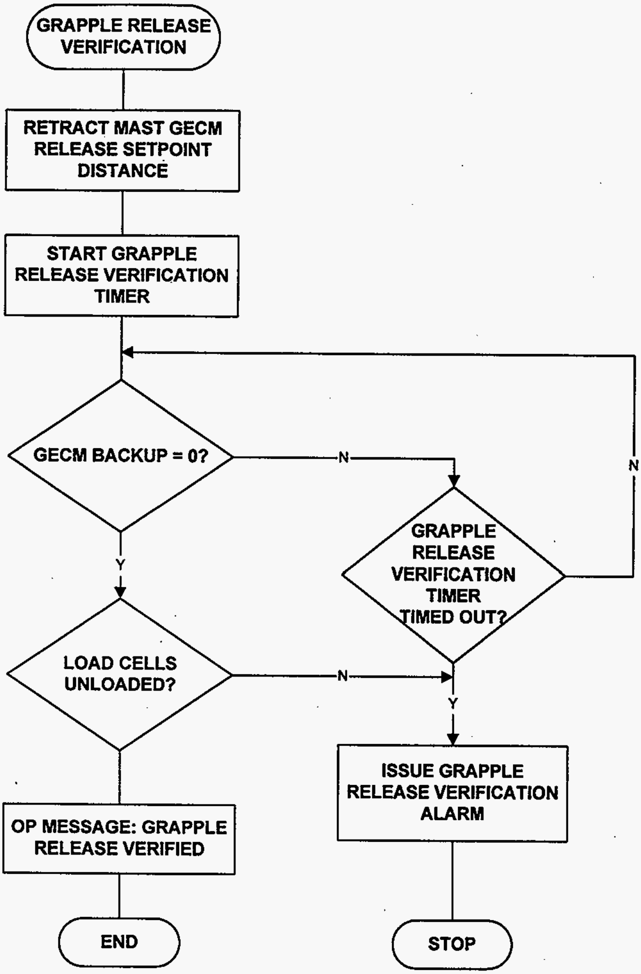

MAST SHUTTLE BASKET PICKUP RETRACTION
RETRACT MAST TO BRIDGE TRAVERSE ELEVATION
START MAST SHUTTLE BASKET PICKUP RETURN POS TIMER
MAST AT BRIDGE TRAVERSE ELEVATION?
N
Y
OP MESSAGE: MAST AT BRIDGE TRAVERSE ELEVATION
END
MAST SHUTTLE BASKET PICKUP RET POS TIMER TIMED OUT?
N
Y
ISSUE MAST SHUTTLE BASKET PICKUP RET POS ALARM
STOP

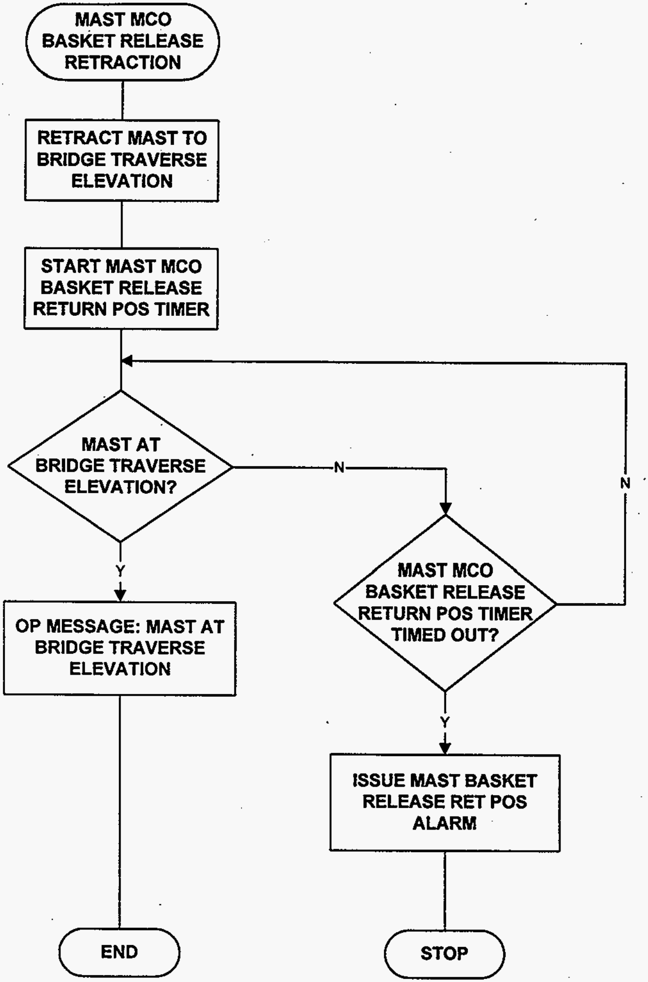

BRIDGE TRAVEL
MOVE BRIDGE TO TRAVEL POSITION
START BRIDGE TRAVEL POS TIMER
BRIDGE AT TRAVEL POS?
N
Y
OP MESSAGE: BRIDGE AT TRAVEL POSITION
BRIDGE TRAVEL POS ALARM TIMER TIMED OUT?
N
Y
ISSUE BRIDGE TRAVEL POS ALARM
END
STOP

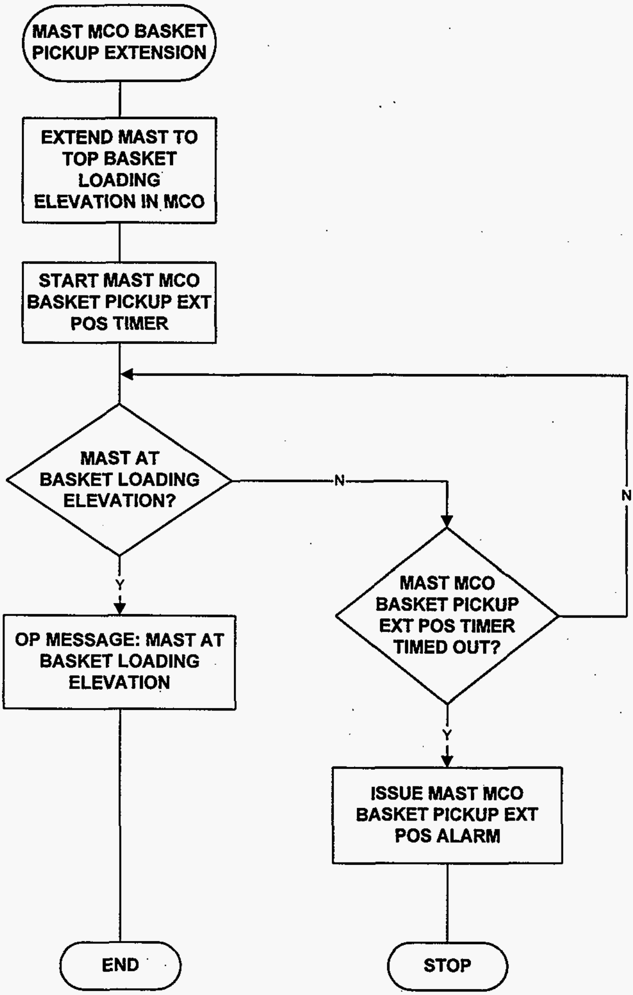

BRIDGE RETURN
MOVE BRIDGE TO RETURN POSITION
START BRIDGE RETURN POS TIMER
BRIDGE AT RETURN POS?
N
Y
OP MESSAGE: BRIDGE AT RETURN POSITION
BRIDGE RETURN POS ALARM TIMER TIMED OUT?
N
Y
ISSUE BRIDGE RETURN POS ALARM
END
STOP

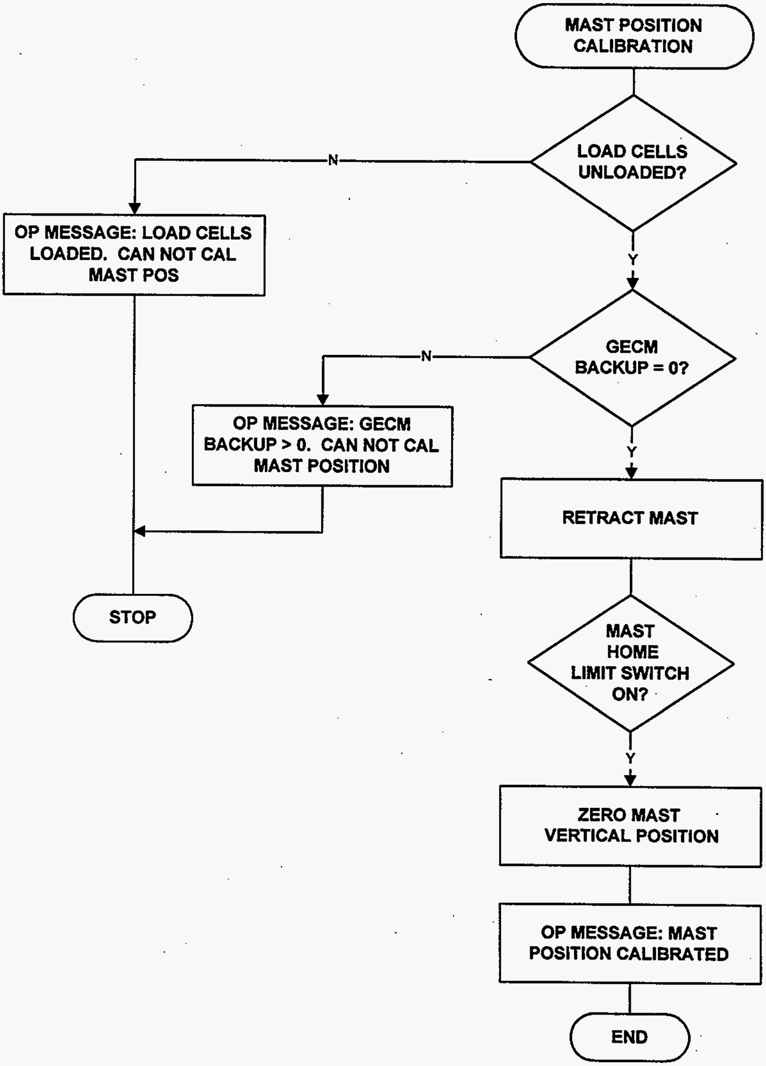

MAST MCO BASKET PROGRAMMED RELEASE EXTENSION
EXTEND MAST TO NEXT BASKET RELEASE ELEVATION
START MAST MCO BASKET PROGRAMMED RELEASE EXT POS TIMER
MAST AT NEXT BASKET RELEASE ELEVATION?
N
Y
LOAD CELLS UNLOADED?
N
Y
OP MESSAGE: LOAD CELLS UNLOADED AT X.XX' ELEVATION
END
ISSUE ALARM MESS: MAST AT NEXT BASKET RELEASE ELEVATION & LOAD CELLS LOADED
N
OPERATOR & SUPERVISOR OVERRIDE INPUTS TO JOG DOWN MAST?
Y
JOG DOWN MAST
N
LOAD CELLS UNLOADED?
Y
OP MESSAGE: LOAD CELLS UNLOADED AT X.XX' ELEVATION
END
SHUTTLE RETURN POS ALARM TIMER TIMED OUT?
N
Y
ISSUE MAST MCO BASKET PROGRAMMED RELEASE EXT POS ALARM
STOP

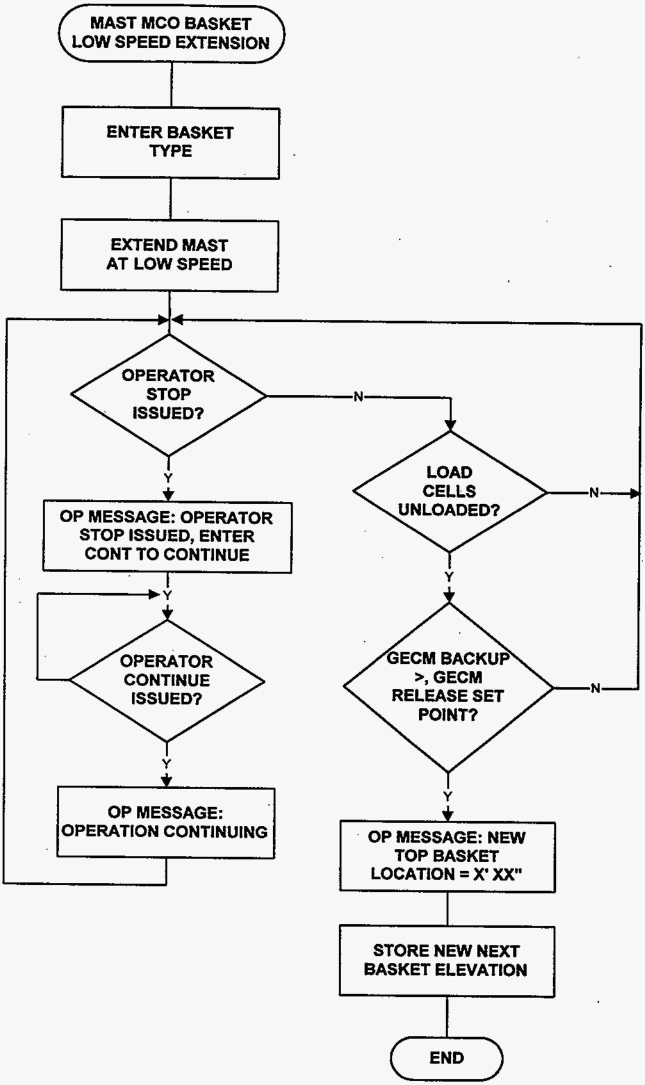

GRAPPLE RELEASE
EXTEND MAST
START GRAPPLE RELEASE TIMER
GECM BACKUP ≥ GECM RELEASE SETPOINT?
N
Y
STOP MAST EXTENSION
DEACTIVATE GRAPPLE ACTUATOR
OP MESSAGE: GRAPPLE RELEASED
END
GRAPPLE RELEASE TIMER TIMED OUT?
N
Y
ISSUE GRAPPLE RELEASE ALARM
STOP

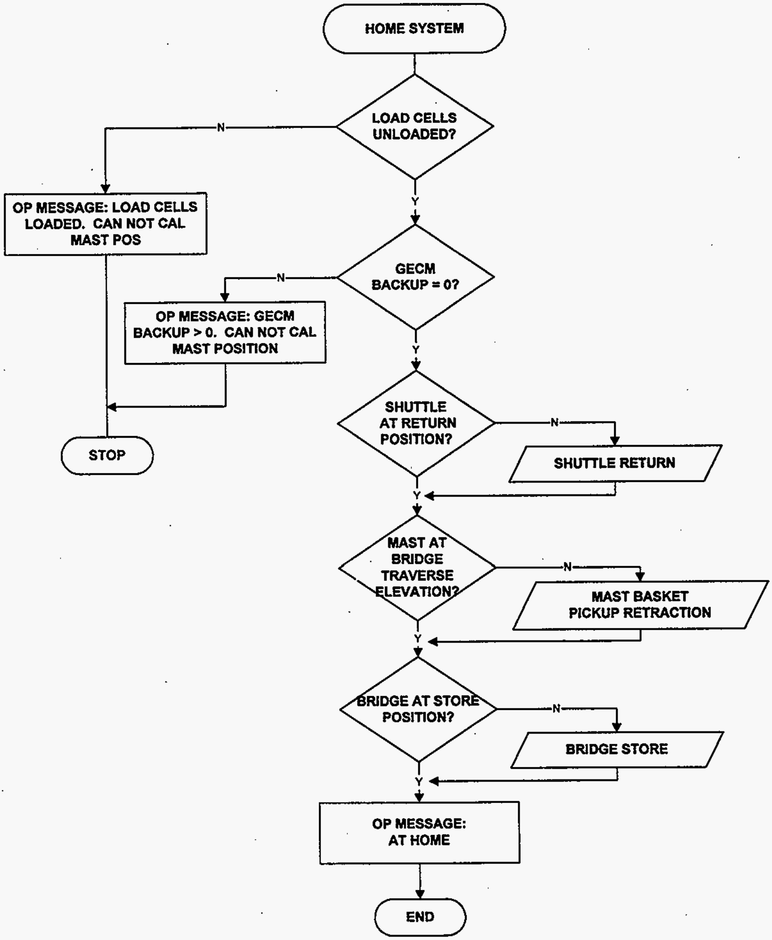

GRAPPLE RELEASE VERIFICATION
RETRACT MAST GECM RELEASE SETPOINT DISTANCE
START GRAPPLE RELEASE VERIFICATION TIMER
GECM BACKUP = 0?
N
N
GRAPPLE RELEASE VERIFICATION TIMER TIMED OUT?
Y
LOAD CELLS UNLOADED?
N
Y
ISSUE GRAPPLE RELEASE VERIFICATION ALARM
OP MESSAGE: GRAPPLE RELEASE VERIFIED
END
STOP

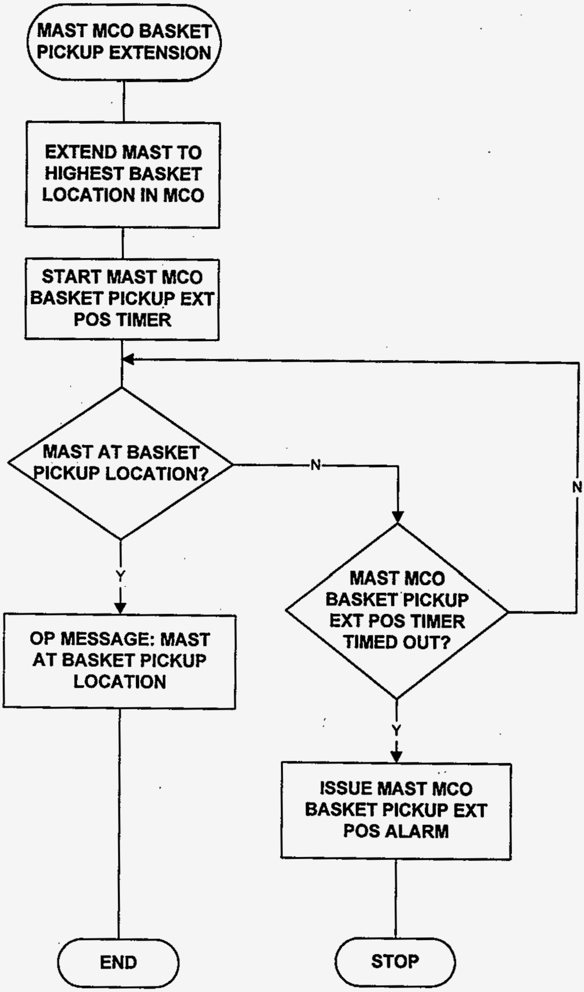

MAST MCO BASKET RELEASE RETRACTION
RETRACT MAST TO BRIDGE TRAVERSE ELEVATION
START MAST MCO BASKET RELEASE RETURN POS TIMER
MAST AT BRIDGE TRAVERSE ELEVATION?
N
Y
OP MESSAGE: MAST AT BRIDGE TRAVERSE ELEVATION
END
MAST MCO BASKET RELEASE RETURN POS TIMER TIMED OUT?
N
Y
ISSUE MAST BASKET RELEASE RET POS ALARM
STOP

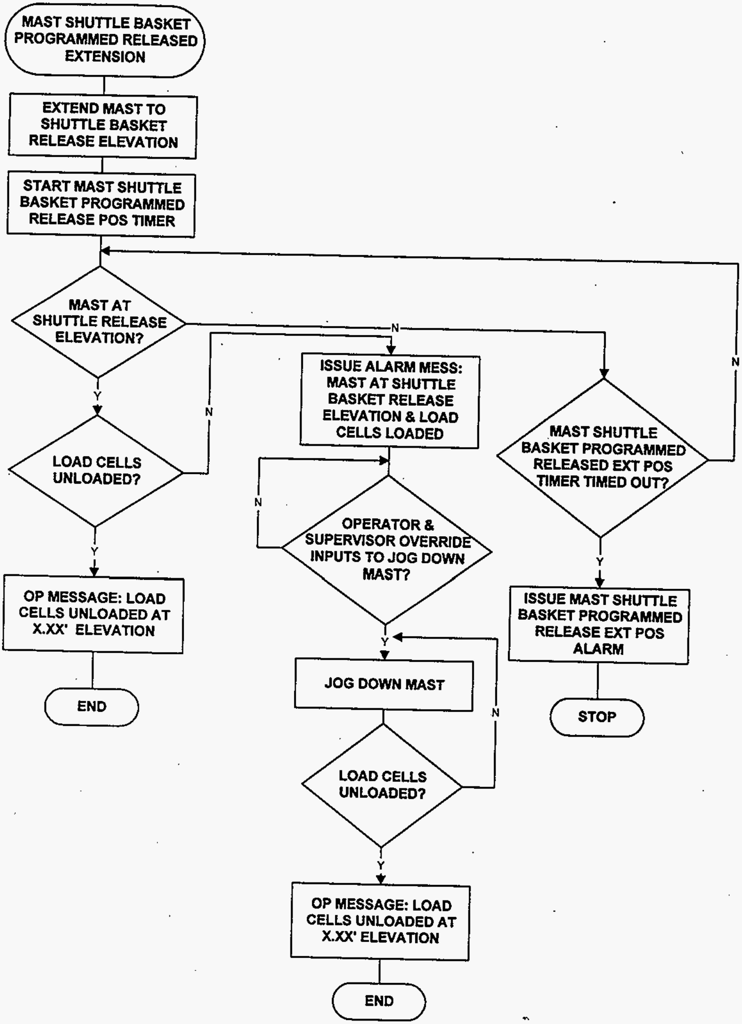

MAST MCO BASKET PICKUP EXTENSION
EXTEND MAST TO TOP BASKET LOADING ELEVATION IN MCO
START MAST MCO BASKET PICKUP EXT POS TIMER
MAST AT BASKET LOADING ELEVATION?
N
Y
OP MESSAGE: MAST AT BASKET LOADING ELEVATION
MAST MCO BASKET PICKUP EXT POS TIMER TIMED OUT?
N
Y
ISSUE MAST MCO BASKET PICKUP EXT POS ALARM
END
STOP


MAST POSITION CALIBRATION
LOAD CELLS UNLOADED?
N
OP MESSAGE: LOAD CELLS LOADED. CAN NOT CAL MAST POS
Y
GECM BACKUP = 0?
N
OP MESSAGE: GECM BACKUP > 0. CAN NOT CAL MAST POSITION
Y
RETRACT MAST
STOP
MAST HOME LIMIT SWITCH ON?
Y
ZERO MAST VERTICAL POSITION
OP MESSAGE: MAST POSITION CALIBRATED
END


MAST MCO BASKET LOW SPEED EXTENSION
ENTER BASKET TYPE
EXTEND MAST AT LOW SPEED
OPERATOR STOP ISSUED?
N
Y
OP MESSAGE: OPERATOR STOP ISSUED, ENTER CONT TO CONTINUE
Y
OPERATOR CONTINUE ISSUED?
Y
OP MESSAGE: OPERATION CONTINUING
LOAD CELLS UNLOADED?
N
Y
GECM BACKUP >, GECM RELEASE SET POINT?
N
Y
OP MESSAGE: NEW TOP BASKET LOCATION = X' XX"
STORE NEW NEXT BASKET ELEVATION
END


HOME SYSTEM
LOAD CELLS UNLOADED?
N
Y
OP MESSAGE: LOAD CELLS LOADED. CAN NOT CAL MAST POS
GECM BACKUP = 0?
N
Y
OP MESSAGE: GECM BACKUP > 0. CAN NOT CAL MAST POSITION
STOP
SHUTTLE AT RETURN POSITION?
N
SHUTTLE RETURN
Y
MAST AT BRIDGE TRAVERSE ELEVATION?
N
MAST BASKET PICKUP RETRACTION
Y
BRIDGE AT STORE POSITION?
N
BRIDGE STORE
Y
OP MESSAGE: AT HOME
END


MAST MCO BASKET PICKUP EXTENSION
EXTEND MAST TO HIGHEST BASKET LOCATION IN MCO
START MAST MCO BASKET PICKUP EXT POS TIMER
MAST AT BASKET PICKUP LOCATION?
N
Y
OP MESSAGE: MAST AT BASKET PICKUP LOCATION
MAST MCO BASKET PICKUP EXT POS TIMER TIMED OUT?
N
Y
ISSUE MAST MCO BASKET PICKUP EXT POS ALARM
END
STOP


MAST SHUTTLE BASKET PROGRAMMED RELEASED EXTENSION
EXTEND MAST TO SHUTTLE BASKET RELEASE ELEVATION
START MAST SHUTTLE BASKET PROGRAMMED RELEASE POS TIMER
MAST AT SHUTTLE RELEASE ELEVATION?
N
Y
LOAD CELLS UNLOADED?
N
Y
OP MESSAGE: LOAD CELLS UNLOADED AT X.XX' ELEVATION
END
ISSUE ALARM MESS: MAST AT SHUTTLE BASKET RELEASE ELEVATION & LOAD CELLS LOADED
N
OPERATOR & SUPERVISOR OVERRIDE INPUTS TO JOG DOWN MAST?
Y
JOG DOWN MAST
N
LOAD CELLS UNLOADED?
Y
OP MESSAGE: LOAD CELLS UNLOADED AT X.XX' ELEVATION
END
MAST SHUTTLE BASKET PROGRAMMED RELEASED EXT POS TIMER TIMED OUT?
N
Y
ISSUE MAST SHUTTLE BASKET PROGRAMMED RELEASE EXT POS ALARM
STOP

Appendix C

Design Review Checklist

MCO Loading System
Design Review Checklist

ITEM	REVIEW CONSIDERATION	YES/NO	REMARKS
1	Does the MLS provide recovery features that allow the fueled basket to be moved into the MCO, removed from the MCO, or moved back to the fueled basket queue, as required to facilitate repairs to the failed equipment?	Yes	Section 2.7.9
2	Do recovery features provide for remote disengagement and removal of all tools and equipment from the fueled basket?	Yes	Section 2.7.9
3	Does the device used to lift the baskets up, over, and into the MCO provide a physical means to preclude the ability to raise the fuel to a height such that the top of the basket is lifted to an elevation above the -8'-0" level, relative to a floor level of 0'-0"?	Yes	Section 2.5
4	Does the MLS allow an MCO to be loaded and the shield plug to be installed within 4 hours (consider only activities performed by this system)?	Yes	Section 4.1
5	Is the MLS designed such that loading can be accomplished with operators exposed to a dose field not exceeding and average of 0.5 mrem/hr for the loading cycle?	Yes	Section 4.2
6	Is the MLS designed such that the load cycle can be accomplished with an operator staff not greater than two operators?	Yes	Section 4.2
7	Does the MLS include engineered features that preclude damage to the MCO, cask, and immersion pail container during the basket loading and shield plug insertion operations?	Yes	Section 2.7, 2.1.5
8	Is a CCTV system provided to allow operators to remotely monitor and verify MLS operations?	Yes	Section 2.2.1

ITEM	REVIEW CONSIDERATION	YES/NO	REMARKS
9	Does the CCTV system include at least two 14-in. color video monitors (on inside the basin and one in a non contaminated area), a video recorder, and an overlay generator?	Yes	Appendix B, Page B-2, Dwg 444-405
10	Does the design include support stands for the viewing system equipment?	Yes	Dwg 444-401
11	Is a NEMA 12 video console equipped with a rack mounted camera (motor) and light controller, light power supplies, and a video select switch provided for the basin viewing station?	Yes	Volume 3
12	Does the grapple system include an emergency release system to disengage the grapple from the basket in the event that the remote system fails?	Yes	Dwg 444-201
13	Does the grapple system allow visual confirmation of grapple engagement status?	Yes	Dwg 444-200, 444-000
14	Does the grapple system design preclude unintentionally releasing a fueled basket?	Yes	Section 2.1.2, Dwg. 444-201
15	Does the grapple system design accommodate a fueled basket having an unbalance equivalent to the removal of nine fuel assemblies?	Yes	2700 lb @ 1.5 inch off center
16	Does the MLS provide a means to verify the diameter of the fueled basket accommodates loading in the MCO and to visually verifying that the basket configuration is correct and fuel is positioned within the basket to allow proper nesting and stacking within the MCO, to verify that loaded baskets are positioned properly to allow successive loading operation to be successfully completed, and to verify that the shield plug is properly inserted into the MCO.	Yes	Section 2.1, Section 2.7.3, Dwg 444-000
17	Does the design include a means to ensure the shield plug orientation is acceptable for future processing?	Yes	Section 2.7.3, Dwg 444-000
18	Does the equipment used to lift a fueled basket and place it into the MCO preclude spilling the contents of the basket into the MCO during normal operations and in the event of equipment failure?	Yes	Section 2.7.2, 2.7.3, 2.7.1

ITEM	REVIEW CONSIDERATION	YES/NO	REMARKS
19	Does the MLS accommodate an electrical supply of 480 VAC or 460 VAC, three phase?	Yes	Section 2.3
20	Are drive units equipped with manual overrides?	Yes	Section 2.7.9
21	Are components that have potential to damage safety class components include features to preclude damage to safety class components?	Yes	Section 2.1.1
22	Is the MLS designed to minimize maintenance and testing?	Yes	Maintenance Chart, Section 2.9
23	Does the MLS design incorporate standard replacement parts to the extent practical?	Yes	Maintenance Chart, Section 2.9
24	Does the MLS design include the capability to perform periodic maintenance to prolong the effective lifetime at a minimum cost and downtime?	Yes	Maintenance Chart, Section 2.9
25	Are components designed to be permanently lubricated to the extent possible?	Yes	Section 2.11
26	Are there any interface problems?	No	Section 2.12
27	Can the equipment be readily assembled/disassembled as designed?	Yes	Installation Drawing
28	Are the specified materials compatible with each other and the environmental conditions to which the materials will be exposed?	Yes	Stainless Steel & Coated Carbon Steel
29	Is the design reproducible by a conventional means?	Yes	All Drawings on ACAD 13
30	Are stresses within design limits?	Yes	Reference Section 5
31	Are mechanical tolerances within the limits of normal shop practice?	Yes	Reference Section 7
32	Are assembly clearances adequate?	Yes	Design Drawings
33	Can the system be stored for extended periods of time without degrading effects?	Yes	Storage for extended periods

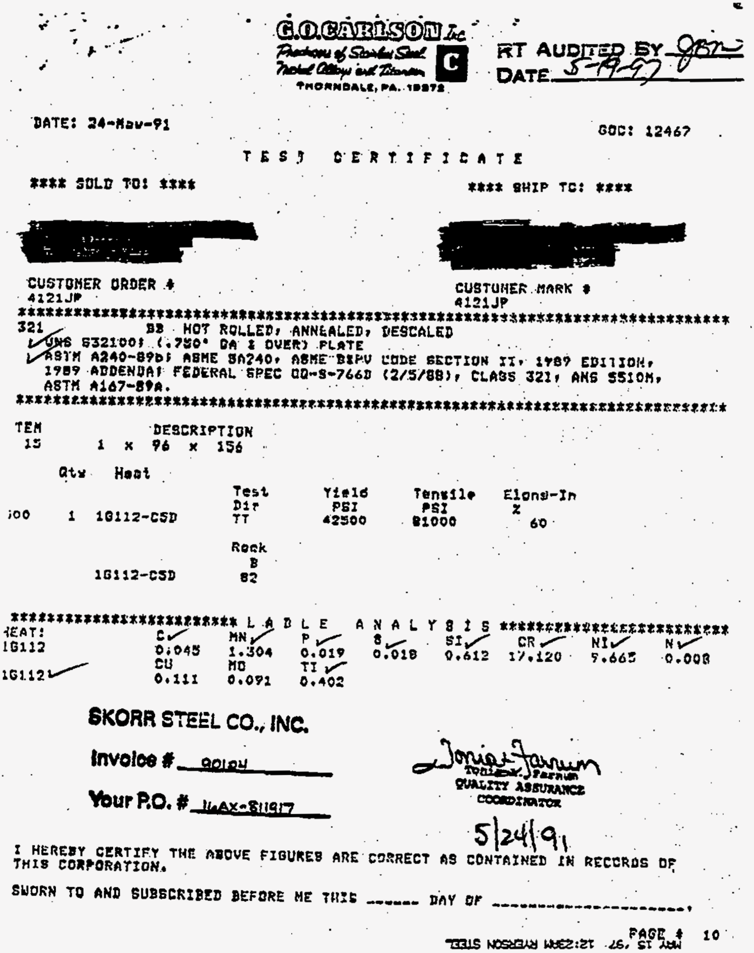
ITEM	REVIEW CONSIDERATION	YES/NO	REMARKS
34	Does the design meet all established safety requirements?	Yes	Section 2.8
35	Have necessary features been provided to maintain personnel radiation exposure as low as reasonably achievable?	Yes	Section 4.2
36	Have welding, bolting, and joining methods been adequately specified?	Yes	Section 7 Design Drawings
37	Is the system operable?	Yes	Testing and system operation are part of fabrication procedures
38	Are all indication lights and electrical controls considered fail-safe?	Yes	Reference Appendix B

Appendix D

Sample Material Test Certificate

Appendix D

A sample Test Certificate is shown below and on the following page, identifying yield strength, tensile strength and elongation for UNS321 hot rolled steel.



G.O.CARLSON Inc
Producers of Stainless Steel
Nickel Alloys and Titanium
THORNDALE, PA. 19372

RT AUDITED BY JBm
DATE 5-19-97

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DATE: 24-May-91                                                GOC: 12467

                        T E S T   C E R T I F I C A T E

**** SOLD TO: ****                               **** SHIP TO: ****

[redacted]                                       [redacted]

CUSTOMER ORDER #                                 CUSTOMER MARK #
4121JP                                           4121JP
*****************************************************************************
321            BB  HOT ROLLED, ANNEALED, DESCALED
 ✓UNS S32100; (.750" DA & OVER) PLATE
 ✓ASTM A240-89b; ASME SA240, ASME B&PV CODE SECTION II, 1989 EDITION,
  1989 ADDENDA; FEDERAL SPEC QQ-S-766D (2/5/88), CLASS 321, AMS 5510M,
  ASTM A167-89A.
*****************************************************************************
TEM            DESCRIPTION
 15       1  x  96  x  156

     Qty   Heat
                         Test       Yield      Tensile    Elong-In
                         Dir         PSI        PSI          %
;00    1  1G112-CSD      TT         42500      81000          60

                         Rock
                          B
          1G112-CSD       82

************************** L A D L E   A N A L Y S I S **************************
HEAT:
1G112               C✓       MN✓      P✓       S✓       SI✓      CR✓      NI✓      N✓
                    0.045    1.304    0.019    0.018    0.612    17.120   9.665    0.008
                    CU       MO       TI✓
1G112✓              0.111    0.091    0.402
```

SKORR STEEL CO., INC.

Invoice # 90104

Your P.O. # 11AX-811917

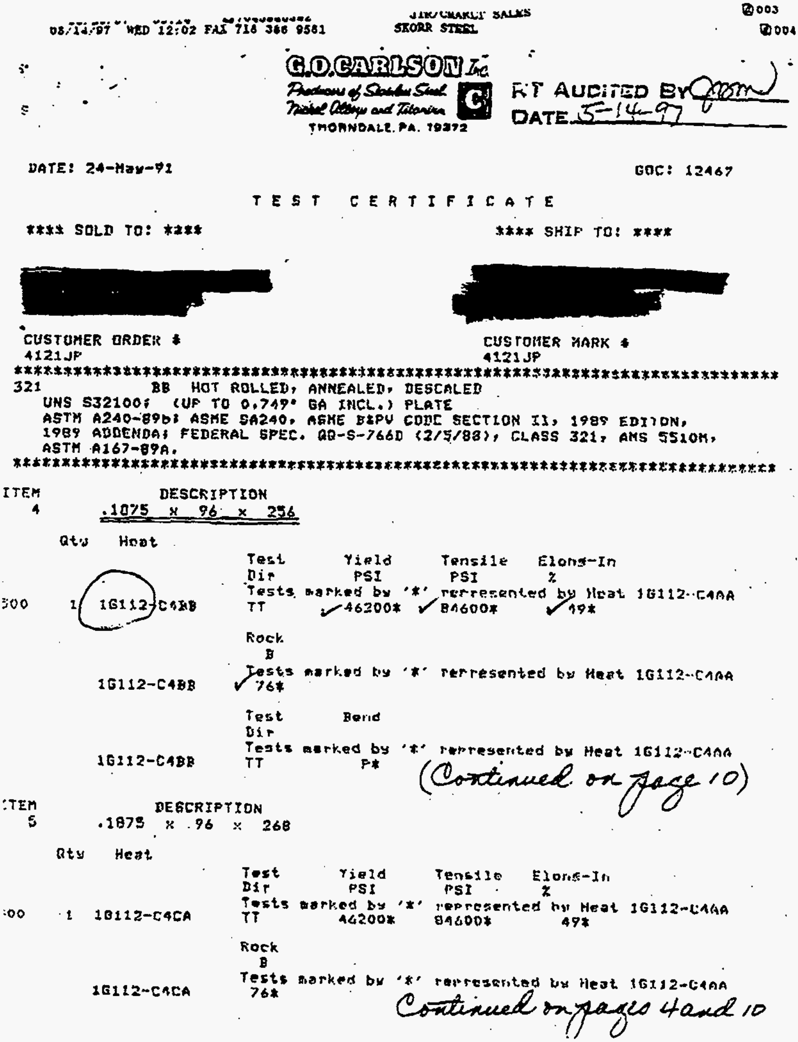
Tonia Farnum
TONIA K. FARNUM
QUALITY ASSURANCE
COORDINATOR

5/24/91

```
I HEREBY CERTIFY THE ABOVE FIGURES ARE CORRECT AS CONTAINED IN RECORDS OF
THIS CORPORATION.

SWORN TO AND SUBSCRIBED BEFORE ME THIS ______ DAY OF ______________________,

                                                             PAGE #   10
                                   MAY 15 '97 12:23PM RYERSON STEEL
```



05/14/97 WED 12:02 FAX 718 366 9561 SKORR STEEL @003

@004

G.O.CARLSON Inc.
Producers of Stainless Steel
Nickel Alloys and Titanium
THORNDALE, PA. 19372

RT AUDITED BY
DATE 5-14-97

DATE: 24-May-91

GOC: 12467

TEST CERTIFICATE

**** SOLD TO: **** [redacted]

**** SHIP TO: **** [redacted]

CUSTOMER ORDER #
4121JP

CUSTOMER MARK #
4121JP

****

321 BB HOT ROLLED, ANNEALED, DESCALED
UNS S32100; (UP TO 0.749" GA INCL.) PLATE
ASTM A240-89b; ASME SA240, ASME B&PV CODE SECTION II, 1989 EDITION,
1989 ADDENDA; FEDERAL SPEC. QQ-S-766D (2/5/88), CLASS 321, AMS 5510M,
ASTM A167-89A.

****

ITEM 4 DESCRIPTION .1875 x 96 x 256

Qty Heat

500 1 1G112-C4BB

Test Dir	Yield PSI	Tensile PSI	Elong-In %
Tests marked by '*' represented by Heat 1G112-C4AA			
TT	✓ 46200*	✓ 84600*	✓ 49*

1G112-C4BB

Rock B
✓ Tests marked by '*' represented by Heat 1G112-C4AA
✓ 76*

1G112-C4BB

Test Dir	Bend
Tests marked by '*' represented by Heat 1G112-C4AA	
TT	P*

(Continued on page 10)

ITEM 5 DESCRIPTION .1875 x 96 x 268

Qty Heat

500 1 1G112-C4CA

Test Dir	Yield PSI	Tensile PSI	Elong-In %
Tests marked by '*' represented by Heat 1G112-C4AA			
TT	46200*	84600*	49*

1G112-C4CA

Rock B
Tests marked by '*' represented by Heat 1G112-C4AA
76*

Continued on pages 4 and 10

Appendix E

Stress Analyses

Appendix E

The following pages detail stress analysis calculations for the MCO Loading System.

The analysis has been divided into two sets:

1. Structural Evaluation of Gantry/Mast for MCO Loading System.
2. Structural Evaluation of the Shuttle Supporting Structure for the MCO Loading System.

NAC INTERNATIONAL

CALCULATION PACKAGE COVER SHEET

Work Request/Calculation No: EF444-20-01

Page 1 of 44

PROJECT NAME: MCO LOADING SYSTEM PROJECT

CLIENT: WESTINGHOUSE HANFORD COMPANY

CALCULATION TITLE:

STRUCTURAL EVALUATION OF SHUTTLE SUPPORTING STRUCTURE FOR MCO LOADING SYSTEM.

PROBLEM STATEMENT OR OBJECTIVE OF THE CALCULATION:

THIS CALCULATION EVALUATES SHUTTLE SUPPORTING STRUCTURE FOR HANFORD K-EAST AND K-WEST BASIN MCO LOADING SYSTEM FOR ITS STRUCTURAL ADEQUACY PER SPECIFICATION WHC-S-0546 REV. 0 AND NAC DOCUMENT NO. 444-S-01 REV. 0.

Document Revision	Affected Pages	Revision Description	Name and Initials Of Preparers & Checkers	Project Manager Approval/Date
0	1 THRU 44	ORIGINAL ISSUE	RAMESH PATEL RP 6-4-97 LeRoy Bishop LB 6/4/97	Thomas A Danner 6/4/97

INDEPENDENT DESIGN VERIFICATION CHECK SHEET

Work Request/Calculation No: EF444-20.01 Revision 0

Scope Of Analysis File: THIS CALCULATION EVALUATES SHUTTLE SUPPORTING STRUCURE FOR ITS STRUCTURAL ADEQUACY USING REQUIREMENT OF WHC-S-0540 R/0

Review Methodology:
Check Of Calculations
Alternate Analyses —
Other (Explain) —

Confirm That The Work Request / Calculation Package Reviewed Includes:

1. Statement of Purpose
2. Defined Method of Analysis
3. Listing of Assumptions
4. Detailed Analysis Record
5. Statement of Conclusions / Recommendations (if applicable)

Step	Activities	Verification Yes	No	N/A	Comments
1	For the scope of the defined analysis:				
	A. Are the required data input complete?	✓			
	1. Material properties	✓			
	2. Geometry (drawing reference)	✓			
	3. Loading source term *If a supporting analysis is required to define the load state, has it been defined?*	✓			
	B. Are boundary conditions acceptable?	✓			
2	Is the method of analysis adequate for the defined scope?	✓			
3	Is the worst case loading/configuration documented?	✓			
4	Are the acceptance criteria defined and complete?	✓			
5	Has all concurrent loading been considered?	✓			
6	Are analyses consistent with previous work for method and approach?			✓	NEW CALC PKG.
7	Are the records for input and output complete?	✓			
8	Is traceability to verified software complete?			✓	NO SOFTWARE USED
9	Is the statement of conclusions and recommendations complete and acceptable for the project and objectives of the defined purpose?	✓			

LeRoy Bishop
Reviewer (Name/Signature)

6/4/97
Date

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1.0 INTRODUCTION / PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO EVALUATE THE SHUTTLE SUPPORTING SYSTEM FOR HANFORD K-EAST & K-WEST BASIN MCO LOADING SYSTEM FOR ITS STRUCTURAL ADEQUACY PER SPECIFICATION WHC-S-0546 REV-0 AND NAC DOCUMENT NO. 444-S-01 REV.0.

- DWG # 444-300 REV.0, SHUTTLE ASSEMBLY, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82911
- DWG # 444-301 REV-0, CART ASSEMBLY, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82912
- DWG # 444-302 REV-0 CART WELDMENT, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82913
- DWG # 444-303 REV.0 WEDGE ASSEMBLY, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82914
- DWG # 444-304 REV.0 RAILS AND SUPPORT, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82915
- DWG # 444-306 REV.0 SEISMIC RESTRAINT, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82917
- DWG # 444-309 REV0 UPPER MOUNTS, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82920
- DWG # 444-310 REV0 UPPER MOUNTS, MCO LOADING SYSTEM
  WHC DWG NO: H-1-82920 & 82921.

2.0 METHOD OF ANALYSIS

HAND CALCULATIONS USING CLASSIC TEXT BOOK SOLUTIONS ARE USED TO STRUCTURALLY EVALUATE ALL APPLICABLE ITEMS. ACTUAL STRESSES ARE THEN COMPARED AGAINST AISC-ASD CODE ALLOWABLES AND INCREASED ALLOWABLE FACTORS USED PER DIRECTION SPECIFIED IN REFERENCE NO. 6F.

3.0 ASSUMPTIONS / DESIGN INPUTS

THERE ARE NO UNVERIFIED ASSUMPTIONS WITHIN THIS CALCULATION.

MATERIAL PROPERTIES

TP304 S.S. STEEL $F_u = 75000$ PSI $\nu = 0.305$

$F_y = 30000$ PSI. $E = 27.6 \times 10^6$ PSI. $\rho_s = 0.288$ #/IN^3.

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4.0 ANALYSIS DETAIL

Using SDC 4.1, the Shuttle is classified as Class 3: however, it is in close proximity to a Class 1 item, therefore the applicable criteria is Class 3 over 1. Using Figure 3 in SDC 4.1 the maximum g value is 0.42 with 5% damping. This is the design acceleration with no importance factor or other factor having to be applied. The vertical acceleration shall be 2/3 of the horizontal acceleration resulting in a vertical acceleration of 0.28g. The horizontal acceleration shall be applied in each orthogonal direction as well as the vertical acceleration simultaneously. SRSS shall be used to combine stresses.

The allowable stress for the seismic design loads shall be as follows:

Shear allowable = 1.4 times normal AISC allowable

Allowable for all other stresses = 1.7 times normal AISC allowable

DETERMINATION OF WEIGHT FOR SHUTTLE CART.

REF DWG# 444-302 REV.0.

ITEM. DESCRIPTION

① RIGHT HAND BRACKET : QTY 2
PLATE 3.5×6×0.75 WT = 2×3.5×6×.75×.288 = 9 LBS

② LEFT HAND BRACKET QTY 2
PLATE 3.5×6×0.75. WT = 2×3.5×6×.75×.288 = 9 LBS.

③ FLOOR PLATE 1/4"×24"×24" QTY. 1
WT = 0.25×24×24×.288 = 41.47 LBS.

④ TS 2×2×1/4 24" LG QTY 2
WT = 5.41 #/' × $\frac{24}{12}$ × 2 = 21.6 LBS

⑤ TS 2×2×1/4 × 20" LG QTY 1
WT = 5.41 × $\frac{20}{12}$ = 9 LBS

⑥ SLEEVE PLATE VERTICAL 1/4" THICK, 4" LONG, 24"ϕ QTY 1.
WT = π × 24 × 4 × .25 × .288 = 21.7 LBS.

⑦ FLAIR PLATE 1/4" THICK, 2" LONG USE 26"ϕ CONS. QTY. 1
WT = π × 26 × 2 × .25 × .288 = 11.76 LBS.

⑧ CABLE RETAINER 3/4×5×2 QTY 2
WT = 2×.75×5×2×.288 = 4.32 LBS

TOTAL WT (ITEM 1 THRU 8) = 127.85 LBS.

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SHUTTLE CART WT. CONTD

ITEM DESCRIPTION

⑨ GUSSET PLATE 1/4×4.5×7 QTY. 2
AREA (4.5×7 − 2×2 − 2×1)×2 = 51 IN²
WT = 0.25×51×.288 = 3.7 LBS

⑩ TS 2×2×1/4 ×24" LG QTY. 2
WT= 5.41 × 24×2 ÷ 2 = 21.64 LBS.

⑪ SAME AS ITEM. 1

⑫ ROLLER MOUNT PLATE QTY 4 2×2×1/2
WT= 4× 2×2× 1/2 ×.288 = 2.34 LBS.

REF DWG# 444-301 SHT. 1 REV. 0

①&② WELDMENT

③ ROLLER QTY 12 1½"OD × 1.25" LG
WT= (π×1.25 ×.25×1.25× 12 ×.288 = 4.24#

④ FLANGE BUSHING QTY 24, 3/4"Φ NOMINAL ID GRAPHITE
EST. 2 LBS

⑤ SHOULDER SCREW QTY 8 1¼"Φ
MCMC-90298A847 WT= 12 LBS

⑥⑧ FLAT WASHER WT. 1# EST QTY. 24

⑦ SHOULDER SCREW QTY 4 1¼"Φ WT. 6 LBS

⑨ CASTLE NUT
⑩ COTTER PIN } QTY 24 WT. 2# EST

TOTAL WT = 54.9# THIS PAGE
∴ TOTAL SHUTTLE WT = 182.75#

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DETERMINATION OF WEIGHTS FOR WEDGE.

— REF. DWG # 444-303 REV.0

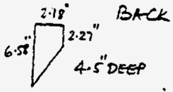
ITEM	DESCRIPTION
①	WELDMENT
②	BACK PLATES 1/2 × 6 × 9.5 QTY. 4 WT = 0.5×6×9.5×0.288×4 = 32.83 LBS ←
③	TOP PLATES 1/2 × 5.63 × 7 QTY. 4 WT = 0.5 × 5.63 × 7 × 0.288 × 4 = 22.7 LBS ←
④	SIDE PLATS 1/2 × 5.13 × 9.5 QTY 8 WT = 0.5 × 5.13 × 9.5 × 0.288 × 8 = 56.14 LBS. ←
⑤	PUSH BAR 2"Φ ROD 6" LG $WT = \pi/4 \times 2^2 \times 6 \times 0.288 = 5.42$ LBS ←
⑥	DRIVE BOSS (THREADED) 2"Φ × 1.5" LG QTY 4. WITH 3/4"Φ HOLE $WT = \pi/4 (2^2 - .75^2) \times 1.5 \times .288 \times 4 = 4.67$ LBS ←
⑦	WEDGE BODY

TOP SECTION 1.19 × 4.03 × 5.5 QTY 4

WT = 1.19 × 4.03 × 5.5 × .288 × 4 = 30.39 LBS

SIDE SECTION 1/2 × 1.85 × 6.58 QTY. 8

WT = 0.5 × 1.85 × 6.58 × .288 × 8 = 14 LBS



BACK SECTION 2.18" × 6.58" × 4.5" CUT AS SHOWN QTY. 4

$$WT = \frac{(2.27+6.58)}{2} \times 2.18 \times 4.5 \times .288 \times 4 = 50.0 \text{ LBS}$$

∴ WEDGE BODY TOTAL WEIGHT = 94.39 ←

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WEDGE WEIGHTS CONTD.

ITEM. DESCRIPTION

⑧ ROLLERS 2"Φ 4"LG QTY 8

$WT = \pi/4 \times 2^2 \times 4 \times 0.288 \times 8 = 28.95$ LBS.

⑨ ROLLER SHAFT QTY 8 WEIGHT INCLUDED IN ITEM 8

⑩ SET SCREWS QTY 16 WT 1 LBS EST.

⑪ WEAR PLATE 1/2 × 4.5 × 5 QTY 4

$WT = 0.5 \times 4.5 \times 5 \times 0.288 \times 4 = 12.96$ LBS

⑫ DRIVE SCREW 1 1/2"Φ BAR QTY 4

$WT = \pi/4 \times 1.5^2 \times 8.1 \times 0.288 \times 4 = 16.49$ LBS

⑬ JAM NUT 3/4 QTY 4 WT 1 LB EST.

⑭ FLAT HEAD SCREWS QTY 8 WT 0.5 LBS EST. CONS.

TOTAL WEIGHTS (ITEM ① THRU ⑭) = 277 LBS

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FRAME AND RAIL WEIGHT

REF. DWG # 444-304 REV.0

ITEM DESCRIPTION

① RAIL TUBE TS 6×2×1/4 ×164.5" LG QTY.2

WT = 2×12.21×164.5 ÷12 = 334.56 LBS

② SUPPORT TUBE TS 4×4×1/4 ×164.5" LG QTY.2

WT = 2×12.21×164.5 ÷12 = 334.56 LBS

③ CROSS TUBES TS 2×4×1/4 ×1'-0 LG QTY 4

WT = 8.81×4 = 35.24 LBS

TOTAL WT = 704.36 LBS

VERTICAL SUPPORT ASSEMBLY

TS 6×3× 1/4×18.72 LG QTY 4

WT = 4×13.91×18.72 = 1042 LBS

REF DWG 444-306 REV.0

① WELDMENT

② BAR 1.5×2.75×10.25 QTY 2

WT = 1.5×2.75×10.25 ×.288 ×2 = 24.35 LBS

③ SIDE PLATE 1/2× 2 BAR QTY 4

WT = 0.5×2×11.5× 0.288×4 = 13.25 LBS

④ PIVOT PIN 3/4"⌀ WT. INCLUDED IN ITEM 2

⑤ THRU ⑧ MISC WT QTY.2 15 LBS EST.

THEREFORE TOTAL WT. FOR VERT. SUPT = 1095 LBS.

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DETERMINATION OF SPRING WEIGHT

REF. DWG # 444-305 REV. 0

ITEM DESCRIPTION

① BOTTOM PLATE $\frac{1}{2} \times 4.5 \times 4.5$ QTY 4.

$WT = 0.5 \times 4.5 \times 4.5 \times .288 \times 4 = 11.67$ LBS

② MID PLATE $\frac{1}{4} \times 3.75\phi$ QTY. 2

$WT = \pi/4 \times 3.75^2 \times .288 \times 2 = 6.36$ LBS

③ UPPER TUBE $3\frac{1}{2}''\phi \times 0.25''$ WALL QTY. 2

$WT = \pi/4 \times (3.5^2 - 3^2) \times 5 \times .288 \times 2 = 7.35$ LBS

④ PULLEY $4''\phi \times 1.25$ QTY. 2

$WT = \pi/4 \times 4^2 \times 1.25 \times .288 \times 2 = 9$ LBS CONS.

⑤ PIN $1''\phi \times 3.88$ LG QTY. 2

$WT = \pi/4 \times 1^2 \times 3.88 \times 0.288 \times 2 = 1.76$ LBS

⑥ CAP $4\frac{1}{4}''\phi$ BAR QTY. 2

$WT = \left\{\pi/4(4.25^2 - 3.25^2) \times 1.63 + \pi/4 \times 4.25^2 \times .5\right\} \times .288 \times 2$

$= 9.6$ LBS

⑦ PLUNGE PLATE ¼ PL QTY. 2 WT 1 LB EST

⑧ COTTER PIN $1/16''\phi \times 1\frac{1}{2}''$ LG QTY 4. WT = NEGLIGIBLE

⑨ SPRING CENTURY 73156 QTY 2 $WT = 20 \times 2 = 40$ LBS

⑩,⑪ 10 SET SCREW 11 FLANGED BUSHING EST. 3 LBS

⑫ BODY WELDMENT

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SPRING WEIGHT CONTD

ITEM	DESCRIPTION
⑬	PLUNGER WELDMENT
⑭	PLUNGER ROD 1½"⌀ BAR 8"LG QTY 2
	WT = $\pi/4 \times 1.5^2 \times 8 \times 0.288 \times 2 \quad = 8.14$ LBS.

TOTAL WT OF SPRING COMPONENTS ITEM # 1 THRU 14 = 97.88 LBS.

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LIST OF WEIGHTS

				WTS USED IN CALCULATION
①	SHUTTLE CART	183 LBS		250 LBS
②	FRAME & RAIL COMPONENTS	704 LBS	1679 LBS	2400 LBS
③	SPRINGS	98 LBS		
④	REEVING SYSTEM	600 LBS		
⑤	WEDGES	277 LBS		
⑥	VERTICAL SUPPORTS	1095 LBS		1300 LBS.

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LIST OF SHUTTLE WEIGHTS.

1)	SHUTTLE CART	250 LBS	MOVEABLE
2)	FRAME, RAIL COMPONENTS SPRINGS, REEVING SYSTEM AND WEDGES	2400 LBS	UNIFORM. DISTR.
3)	VERTICAL SUPPORTS	1300 LBS	CONCERNTRATED.

LOADS ARE DEFINED IN 3 CO-ORDINATE DIRECTIONS

VERTICAL —— DL + LL + SEISMIC
LATERAL ——→ SEISMIC
LONGITUDINAL —→ SEISMIC
} REF 6-F

LATERAL & LONGITUDINAL SEISMIC ACCELERATIONS ARE 0.42g.
VERTICAL SEISMIC ACCELERATION IS $^2/_3$ X HORI ACC^n = 0.28g

SEISMIC CONDITION IN ALL THREE DIRECTION OCCUR SIMULTANEOUSLY.

THE SYSTEM IS ALSO SUBJECTED TO A NORMAL LOAD CASE OF

VERTICAL (DL + LL + IMPACT) IMPACT 25%
LATERAL 20 % OF MOVEABLE LOAD
LONGITUDINAL 10 % OF MOVABLE LOAD

LIVE LOAD = 3200 LBS (FUEL WT)
THIS LOAD IS CARRIED BY SHUTTLE.

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VERTICAL SEISMIC CONDITION.

VERT. LOAD ON A SINGLE RAIL IS

A) HALF WT OF FRAME, RAIL COMPONENTS, SPRINGS REEVING SYSTEM AND WEDGES

DL = 2400/2 = 1200 LBS UNIF. DIST LOAD.

\+ VERTICAL SEISMIC ACC'N OF 0.28 g.

SEISMIC = 0.28 (1200) = 336 # UNIF. DIST. LOAD.

B) HALF WT OF SHUTTLE CART (250 LBS) AND SHUTTLE LOAD

$$LL. = \frac{250+3200}{2} = 1725 \text{ LBS.}$$ MOVEABLE

\+ SEISMIC = 0.28 (1725) = 483 LB MOVEABLE

LATERAL LOAD ON A SINGLE RAIL IS 'x' DIRECTION

- WT OF FRAME, RAIL COMPONENTS, SPRINGS, REEVING SYSTEM AND WEDGES, PLUS HALF THE SUPPORT WEIGHT MULTIPLIED BY LATERAL SEISMIC ACCELERATION.

0.42 (2400 + 650) = 1281 LBS (UNIFORM DIST)

NOTE: SUPPORT WEIGHT IS TREATED AS UNIFORM LOAD SINCE THIS WILL PRODUCE MAXIMUM MOMENT IN RAIL SYSTEM

- WEIGHT OF SHUTTLE CART (250 LBS) AND SHUTTLE LOAD (3200 LBS) MULTIPLIED BY LATERAL SEISMIC ACCELERATION

0.42 (250 + 3200) = 1449 LBS MOVEABLE.

<u>LONGITUDINAL LOAD ON A SINGLE RAIL IS</u> HALF THE WEIGHT OF THE SHUTTLE (250 LBS) AND SHUTTLE LOAD (3200 LBS) PLUS HALF THE WEIGHT OF THE FRAME, RAIL COMPONENTS, SPRINGS, REEVING SYSTEM AND WEDGES (2050 LBS) MULTIPLIED BY LONGITUDINAL SEISMIC ACCELERATION.

$$\frac{0.42\,(250+3200+2400)}{2} = 1229\ \#.$$

NORMAL LOAD CONDITION

VERT. LOAD ON A SINGLE RAIL IS

- HALF THE WEIGHT OF FRAME, RAIL COMPONENTS, SPRINGS, REEVING SYSTEM AND WEDGES

$DL = 2400/2 = 1200$ LB (UNIFORM DIST)

- HALF THE WEIGHT OF SHUTTLE CART (250 LBS) AND SHUTTLE LOAD (3200 LBS)

$LL = \frac{250+3200}{2} = 1725$ LBS MOVABLE

PLUS IMPACT OF 25 %

IMPACT $= 0.25\,(1725) = 431$ LBS MOVEABLE

LATERAL LOAD ON A SINGLE RAIL IS

WT. OF MOVEABLE LOAD, SHUTTLE CART (250 LBS) AND SHUTTLE LOAD (3200 LBS) MULTIPLIED BY 20 %

$\therefore$ LATERAL $= 0.20\,(250+3200) = 690$ LBS MOVABLE

LONGITUDINAL LOAD ON A SINGLE RAIL IS

- HALF THE WEIGHT OF THE SHUTTLE (250 LBS) AND SHUTTLE LOAD (3200 LBS); MOVEABLE LOADS MULLTIPLIED BY 10 %

LONGITUDINAL $= 10\,\%\,(250+3200) = 345$ LBS.

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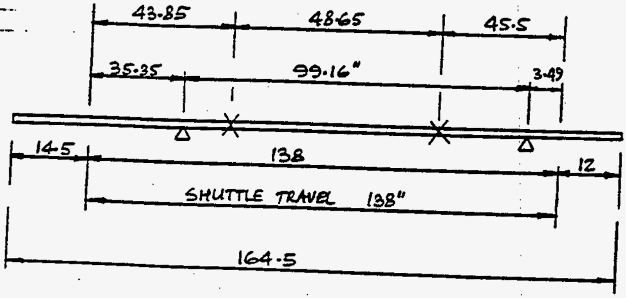
SUPPORT LOCATIONS



△ VERTICAL SUPPORT

× LATERAL RESTRAINT

UNIFORM DISTRIBUTED LOADS WILL BE TAKEN OVER 164.5"
MOVEABLE LOADS MAY BE LOCATED ANYWHERE IN THE SHUTTLE TRAVEL.

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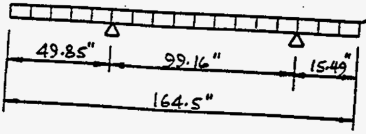
VERTICAL LOAD CASE

DETERMINE SHEAR FORCE & MOMENT ON TS 6x2x1/4
DUE TO 1) UNIFORM LOAD OF 1200 LBS
2) POINT LOAD 1725 # @ CRITICAL LOCATION.

1) UNIFORM LOAD 1200 LBS.

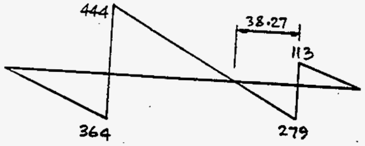


$W = \frac{1200}{164.5} = 7.29$ #/IN.

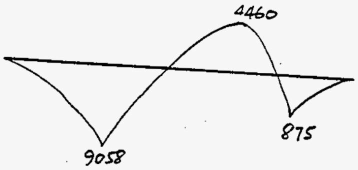
$\Sigma ML = 0 = 99.16\ R_R - 1200\left(\frac{164.5}{2} - 49.85\right)$

$\therefore R_R = 392$ LBS.

$RL = 1200 - 392 = 808$ LBS.



SHEAR FORCE DIAGRAM



MOMENT DIAGRAM

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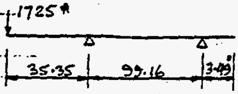
2) POINT LOAD 1725# MOVEABLE.



$R_{L\,MAX} = 1725(35.35 + 99.16)/99.16$

$= 2340\#$

$R_{R\,MIN} = 2340 - 1725$

$= 615$ UPLIFT

$M_{MAX} = 1725 \times 35.35$

$= 60979$ ''#

NOTE: CANTILEVER LEFT SECTION IS CRITICAL FOR MOMENT SINCE ITS LENGTH EXCEEDS 0.25 TIMES SIMPLY SUPTD. SECTION.

MULTIPLY BOTH 1) & 2) RESULTS BY VERTICAL SEISMIC ACC^{N} AND ADD THEM TO OBTAIN VERTICAL SEISMIC LOAD ACTING ON TS 6x2x1/4

DL + LL + SEISMIC VERT

$M_{MAX} = 9058 \times 1.28 + 60979 \times 1.28 = 89647$ ''#

$R_{MAX} = 808 \times 1.28 + 2340 \times 1.28 = 4029\#$

$R_{MIN} = 615 \times 1.28 - 392 \times 1.28 = 285\#$ UPLIFT.

$V_{MAX} = 444 \times 1.28 + 1725 \times 1.28 = 2776\#$

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VERTICAL LOAD WITH 25% IMPACT FACTOR FOR LIVE LOAD.

DL + LL + IMPACT.

$M_{MAX} = 9058 + 60979 \times 1.25 = 85282$ ''#

$R_{MAX} = (808 + 2340) \times 1.25 = 3935$ # CONS

$R_{MIN} = 615 \times 1.25 - 392 = 377$ # UPLIFT.

$V_{MAX} = (444 + 1725) \times 1.25 = 2711$ # CONS.

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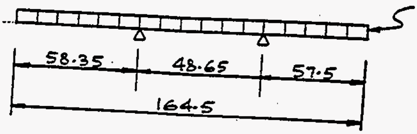
HORIZONTAL LOAD CASE   LATERAL 'X' DIRECTION.

DETERMINE SHEAR FORCE & MOMENT ON TS 6X2X1/4
DUE TO 1) UNIFORM LOAD OF 1281 LBS
2) POINT LOAD 1449 LBS @ CRITICAL LOCATION

1) UNIFORM LOAD 1281 LBS.

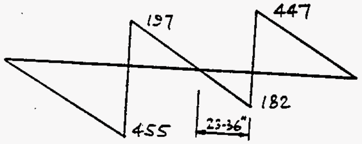


$W = \frac{1281}{164.5} = 7.79 \ \#/\text{IN}$

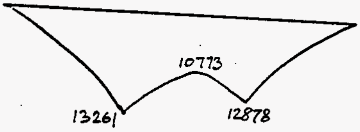
$\Sigma M_L = 0 = 48.65 R_R - 1281 \left(\frac{164.5}{2} - 58.35 \right)$

$\therefore R_R = 629$ LBS

$R_L = 1281 - 629 = 652$ LBS.



SHEAR FORCE DIAGRAM



MOMENT DIAGRAM

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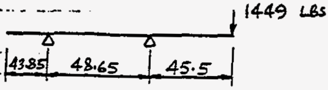
2). POINT LOAD HORIZONTAL $H = 1449$ LBS.



$R_{H\ MAX} = 1449\ (45.5 + 48.65) / 48.65 = 2804$ LBS

$R_{H\ MIN} = 2804 - 1449 = 1355$ LBS

$M_{H\ MAX} = 1449 \times 45.5 = 65930$ "#

NOTE: CANTILEVER RIGHT SECTION IS CRITICAL FOR MOMENT SINCE ITS LENGTH EXCEEDS 0.25 TIMES THE SIMPLY SUPPORTED SECTION

ADD RESULTS FROM 1) & 2) TO OBTAIN TOTAL HORI. LOAD ACTING ON TS 6x2x1/4

<u>DL + LL + SEIS. HORI.</u>

$M_{H\ MAX} = 13261 + 65930 = 79191$ "# CONS.

$R_{H\ MAX} = 652 + 2804 = 3456$ LBS

$V_{H\ MAX} = 455 + 1449 = 1904$ LBS CONS.

<u>LATERAL NORMAL IS 20% OF MOVEABLE LOAD</u> (SINGLE RAIL)

$M_{H\ MAX} = 0.2\ (250 + 3200) \times 45.5 = 31395$ "#

$R_{H\ MAX} = 0.2\ (250 + 3200) \times (45.5 + 48.65) / 48.65 = 1335$ LBS.

$V_{H\ MAX} = 0.2\ (250 + 3200) = 690$ LBS.

<u>LONGITUDINAL LOAD CASE</u> (SINGLE RAIL LOAD)

P_H SEISMIC $= 0.42\ (250 + 3200 + 2400) / 2 = 1229$ LBS

P_H NORMAL $= 10\%$ MOVABLE LOAD $= 0.1\ (250 + 3200) / 2 = 173$ LBS

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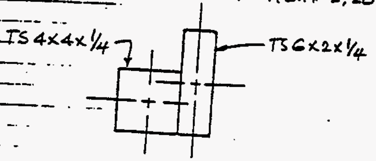
DETERMINE COMPOSITE SECTION PROPERTIES OF TS 4x4 & TS 6x2 (COMPOSITE RAIL BEAMS ITEM# 2, 20 & 21 DWG # ~~444~~-304 REV.0)



SECTION	AREA(A)	IX	IY	X	Y	AX	AY
TS 6x2	3.59	13.8	2.31	0	0	0	0
TS 4x4	3.59	8.22	8.22	3	1	10.77	3.59
SUM	7.18	22.02	10.53			10.77	3.59

$\bar{X} = 10.77 / 7.18 = 1.5 \text{ IN}; \quad \bar{Y} = 3.59 / 7.18 = 0.5 \text{ IN}$

$I_X = 22.02 + 3.59 (0.5^2 + 0.5^2) \doteq 23.8 \text{ IN}^4$

$I_Y = 10.53 + 3.59 (1.5^2 + 1.5^2) = 26.7 \text{ IN}^4$

$S_X = 23.8 / 3.5 = 6.8 \text{ IN}^3$

$S_Y = 26.7 / 3.5 = 7.6 \text{ IN}^3$

$A = 7.18 \text{ IN}^2$

$r_X = (I_X / A)^{1/2} = \left(\frac{23.8}{7.18} \right)^{1/2} = 1.82 \text{ IN}$

$r_Y = (I_Y / A)^{1/2} = \left(\frac{26.7}{7.18} \right)^{1/2} = 1.93 \text{ IN.}$

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CHECK TS 6X2 COMPOSITE SECTION FOR NORMAL LOAD CASE.

DL + LL + IMPACT

$M_X = 85282$ "#
$V_X = 2711$ LBS
$M_Y = 31395$ "#
$V_Y = 690$ LBS
$P = 173$ LBS. AXIAL.

COMPOSITE SECTION PROPERTIES

$S_X = 6.8$ IN³ ; $S_Y = 7.6$ IN³
$A = 7.18$ IN² ; $r_X = 1.82$ IN
$r_Y = 1.93$ IN. REF 6-B

CHECK BENDING STRESS

$$f_{bX} = M_X/S_X = 85282/6.8 = 12541 \text{ psi.}$$

$$f_{bY} = M_Y/S_Y = 31395/7.6 = 4131 \text{ psi.}$$

$$f_a = P/A = 173/7.18 = 24 \text{ PSI.}$$ INSIGNIFICANT.

TOTAL STRESSES $= 12541 + 4131 + 24 = 16696 < 0.6 \times 30000$
18000 PSI F_y SS STEEL

CHECK SHEAR STRESS

$$f_{vX} = \frac{V_X}{A} = \frac{2711}{2 \times .25 \times 6} = 905 \text{ PSI.}$$

USE ONLY WEB AREA OF TS 6x2x1/4 CONSERVATIVELY

$$f_{vY} = \frac{V_Y}{A} = \frac{690}{2 \times .25} = 1380 \text{ PSI}$$

USE ONLY TOP FLANGE AREA OF TS 6x2x1/4 CONSERVATIVELY

TORSIONAL SHEAR STRESS CHECK ON NEXT PAGE.

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SHEAR STRESS DUE TO TORSION. (NORMAL CASE)

TORSION = 1.5 × VERT. LOAD + 3.5 × HORI. LOAD

VERT. LOAD = 1200 # + 1725 × 1.25
= 3356 LBS

TOTAL VERT. LOAD AND IMPACT FACTOR APPLIED TO MOVEABLE LOAD.

HORI. LOAD = 690 LBS

T = 1.5 × 3356 + 3.5 × 690
= 7449 ''#

$$\tau = \frac{T \times C}{J}$$

T = 7449 ''# ; C = 3 IN ; J = 6.88 IN⁴
TS 6x2 ONLY

$$= \frac{7449 \times 3}{6.88}$$

= 3248 PSI.

THEREFORE TOTAL SHEAR STRESSES ARE

905 + 1380 + 3248 = 5533 PSI. < 0.4 × 30000 PSI ← Fy SS STEEL.

THEREFORE COMPOSITE SECTION (TS6x2 & TS 4x4) IS ADEQUATE FOR NORMAL LOAD CASE.

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CHECK TS 6x2 COMPOSITE SECTION FOR SEISMIC LOAD CASE

DL+LL+ SEISMIC

$Mx = 89647$ in#

$Vx = 2776$ LBS

$My = 79191$ in#

$Vy = 1904$ LBS

$P_{AXIAL} = 1229$ LBS.

COMPOSITE SECTION PROPERTIES

$Sx = 6.8\ IN^3$; $Sy = 7.6\ IN^3$

$A = 7.18\ IN^2$; $r_x = 1.82$ IN

$r_y = 1.93$ IN.

CHECK BENDING STRESS

$f_{bx} = M_x/S_x = 89647/6.8 = 13183$ PSI

$f_{by} = M_y/S_y = 79191/7.6 = 10420$ PSI

$f_a = P/A = 1229/7.18 = 171$ PSI INSIGNIFICANT.

TOTAL STRESSES $= 13183 + 10421 + 171 = 23775$ PSI. $< 1.7 \times .6 \times F_y$
$= 30600$ PSI.
$F_y = 30000$ PSI.
FOR SS STEEL

CHECK SHEAR STRESS

$f_{vx} = \frac{V_x}{A} = \frac{2776}{2 \times .25 \times 6} = 925$ PSI. USE ONLY WEB AREA OF TS 6x2x1/4 CONSERVATIVELY

$f_{vy} = \frac{V_y}{A} = \frac{1904}{2 \times .25} = 3808$ PSI. USE ONLY TOP FLANGE AREA OF TS 6x2x1/4 CONSERVATIVELY

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SHEAR STRESS DUE TO TORSION (SEISMIC CASE)

TORSION = 1.5 × VERT. LOAD + 3.5 × HORI. LOAD.

VERT. SEIS. = 1200 × 1.28 + 1725 × 1.28 = 3744 LBS

HORI. SEIS = 1281 + 1449 = 2730 LBS

TORSION = 1.5 × 3744 + 3.5 × 2730

= 15171 "#

$$\tau = \frac{T \times c}{J}$$

T = 15171 "# ; C = 3 IN ; J = 6.88 IN^4

TS6x2 ONLY.

$$= \frac{15171 \times 3}{6.88}$$

= 6615 psi

THEREFORE TOTAL SHEAR STRESSES ARE

925 + 3808 + 6615 = 11348 psi < 1.4 × 0.4 × 30000 = 16800 psi.

THEREFORE COMPOSITE SECTION (TS 6x2 & TS 4x4) IS ADEQUATE FOR SEISMIC LOAD CASE.

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LOADS ON LATERAL SEISMIC RESTRAINTS. ('X' DIRECTION)

$R_{H\,MAX} = 3456$ LBS	DL + LL + SEISMIC	SEISMIC CASE
$R_{H\,MAX} = 1335$ LBS	DL + LL	NORMAL CASE

SEISMIC CONDITION GOVERNS OVER NORMAL CONDITION.

LOADS ON LONGITUDINAL SEISMIC RESTRAINTS ('Z' DIRECTION)

$P_H = 1229$ LBS	DL + LL + SEISMIC	SEISMIC CASE
$P_H = 173$ LBS	DL+LL	NORMAL CASE

SEISMIC CONDITION GOVERNS OVER NORMAL CONDITION.

LOADS ON VERTICAL SUPPORTS ('Y' DIRECTION)

$R_{MAX} = 4029$ LBS	DL+LL+ SEISMIC VERT.
$R_{MIN} = 285$ LBS (UPLIFT)	DL+LL+ SEIS. VERT.
$R_{MAX} = 3935$ LBS	DL+LL+ IMPACT
$R_{MIN} = 377$ LBS (UPLIFT)	DL+LL+IMPACT.

FOR DESIGN PURPOSE. USE $R = 4029^*$ & -377^* AND NORMAL ALLOWABLE CONSERVATIVELY.

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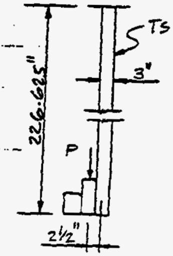
<u>DESIGN OF VERTICAL SUPPORTS</u> (ITEM #4,5,6 & 7 DWG # 444-303 REV.0)

TWO VERTICAL SUPPORTS RESISTS ONLY VERTICAL LOAD AND TWO VERTICAL SUPPORTS RESISTS BOTH VERTICAL AND LONGITUDINAL LOAD.

VERTICAL LOAD RANGES BETWEEN 4029 LBS (DOWNWARDS) TO -377 LBS (UPWARDS) CONSERVATIVELY



$A = 4.09\ \text{IN}^2$; $S_x = 5.98\ \text{IN}^3$; $S_y = 4.0\ \text{IN}^3$

$r_x = 2.09\ \text{IN}$; $r_y = 1.21\ \text{IN.}$

$P = 4029\ \#$

MOMENT $= 4029 \times 2.5 = 10073$ IN.#

OR

MOMENT = 15171 "# TORSION FOR RAIL SECTION.

$$\frac{K \cdot \ell}{r_y} = \frac{1.0 \times 223.6}{1.21} = 184.8 \Rightarrow F_a = 4360 \times \frac{30}{36} = 3633\ \text{Psi}$$

$$f_b = \frac{M}{S} = \frac{15171}{4.0} = 3793\ \text{Psi.} < 0.75 \times 30000\ \text{Psi.}$$

22500 Psi.

$$f_a = P/A = \frac{4029}{4.09} = 985\ \text{Psi} < F_a$$

OK FOR UPLIFT COMP. LOAD.

TOTAL STRESSES = 3793 + 985 = 4778 PSI.

$< 0.6 \times 30000$ PSI.

18000 PSI.

THEREFORE, TWO VERTICAL SUPPORTS RESISTING ONLY VERTICAL LOADS ARE ADEQUATE FOR ALL LOAD CONDITIONS.

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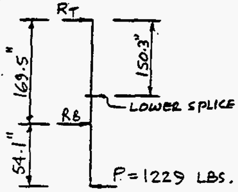
DESIGN OF VERTICAL SUPPORTS CONTD.

CHECK TWO VERTICAL SUPPORTS RESISTING VERTICAL AND LONGITUDINAL LOADS

THESE TWO VERTICAL SUPPORTS RESISTING LONGITUDINAL LOAD IN ADDITION TO PREVIOUSLY QUALIFIED VERTICAL SUPPORTS FOR VERTICAL LOADS ONLY. THEREFORE EVALUATE STRESSES WITH LONGITUDINAL LOAD AND COMBINE THEM WITH PREVIOUS STRESSES.



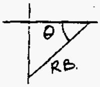
$R_B = \frac{223.6}{169.5}\overset{PG\ 23}{(1229)} = 1621$ LBS

$R_T = 1229 - 1621 = -392$ LBS

MOMENT = 1229 × 54.1 = 66489 "#

(STRONG AXIS MOMENT)

RB RESTRAINT MECHANISM CAN BE AT ANY ANGLE 8° TO 30° FROM HORIZONTAL POSITION.



THEREFORE, FORCE IN RB LINK COULD BE

$R_B = 1621 / \cos 30 = 1872$ #

THIS INDUCES AN ADDITIONAL AXIAL FORCE IN TS6X3

$= R_B \times \sin 30 = 936$ LBS.

$f_b = \frac{M}{S} = \frac{66489}{5.98} = 11119$ PSi.

$f_a = (\underbrace{4029 + 936}_{4965}) \div 4.09 = 1214$ PSi.

TOTAL STRESSES $= 3793 + 11119 + 1214 = 16126 < 1.7 \times 0.6 \times 30000$

$= 30{,}600$ PSi ∴ ok.

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DESIGN OF VERTICAL SUPPORT CONTD.

$$f_a = \frac{377+936}{4.09} = 321 \text{ psi}$$

$$\frac{Kl}{r_{min}} = \frac{1.0 \times 223.6}{1.21} = 184.8 \Rightarrow F_a = 4360 \times \frac{30}{36} = 3633 \text{ psi}$$

$$F_a = 1.7 \times 3633 = 6176 \text{ psi.}$$

$$f_a/F_a = 321/6176 = 0.052 < 0.15$$

COMBINED AXIAL & BENDING STRESS INTERACTION RATIO WILL BE

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$$= 0.052 + \frac{11119}{1.7 \times 18000} + \frac{3793}{1.7 \times 22500}$$

$$= 0.51 < 1.0$$

THEREFORE, TWO VERTICAL SUPPORTS RESISTING VERTICAL & LONGITUDINAL LOADS ARE ADEQUATE FOR ALL LOADING CONDITIONS

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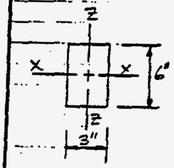
CHECK WELDS (VERTICAL SUPPORT TO ANCHORAGE)

VERTICAL SUPPORT THAT RESISTS LONGITUDINAL LOAD IS CRITICAL FOR SUPPORT MEMBERS.



F_Y = TENSION = 377 + 936 = 1313 #

M_Z = 15171 "# & F_Z = 512 #

WELD PROPERTIES

$A_W = 2(6+3) = 18$ IN. $S_{WZ} = 6 \times 3 + \frac{3^2}{3} = 21$ IN^2

FORCE IN WELD PER INCH

$$= \left\{ \left(\frac{F_Y}{A_W} + \frac{M_Z}{S_{WZ}} \right)^2 + \left(\frac{F_Z}{A_W} \right)^2 \right\}^{1/2}$$

$$= \left\{ \left(\frac{1313}{18} + \frac{15171}{21} \right)^2 + \left(\frac{512}{18} \right)^2 \right\}^{1/2}$$

$= 796$ #

WELD SIZE REQ'D $= 796 / 0.4 \times 30000$ ← F_y FOR S.S. STEEL

$= 0.066$ IN. ∴ PROVIDE 3/16" FILLET WELD ALL AROUND

∴ WELD IS o/k

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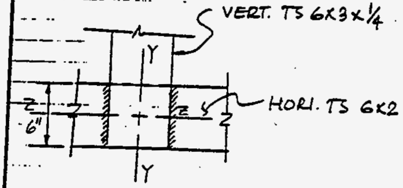
CHECK WELD CONNECTION BETWEEN TS 6X3 & TS 6X2 (RAIL SUPT)



(VERTICAL SUPPORT TO COMPOSITE RAIL BEAM)

$F_Y = 4029$ # ; $F_Z = 1229$ # ; $M_Z = 15171$ "#

WELD PROPERTIES

$A_W = 6 \times 2 = 12$ IN ; $S_{WZ} = 6^2/3 = 12$ IN^2

FORCE ON WELD PER INCH

$$= \left\{ \left(\frac{F_Y}{A_W} \right)^2 + \left(\frac{M_Z}{S_{WZ}} \right)^2 + \left(\frac{F_Z}{A_W} \right)^2 \right\}^{1/2}$$

$$= \left\{ \left(\frac{4029}{12} \right)^2 + \left(\frac{15171}{12} \right)^2 + \left(\frac{1229}{12} \right)^2 \right\}^{1/2}$$

$= 1312$ #/IN.

WELD SIZE REQD $= 1312 \div (.4 \times 30000)$ — Fy FOR S.S. STEEL

$= 0.11$ IN.

THEREFORE PROVIDE FLARE BEVEL & 3/16" FILLET WELD ON BOTH SIDES.

∴ WELD IS OK

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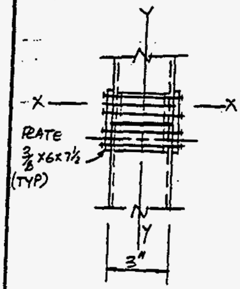
CHECK SPLICE JOINT IN VERTICAL TS 6X3X1/4
(ITEM #1 DWG# 444-310 R/0 ; ITEM# 4,5,6,7 & 8 DWG# 444-309 R/0)



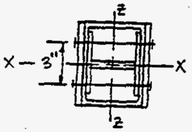
AXIAL LOAD = 4965 # (PG 31)

MOMENT 'X' = 392 x 150.3 = 58918 "# — LOCATION OF LOWER SPLICE FROM TOP (392 ↳ RT PG #31)

MOMENT 'Z' = 15171 "# WEAK AXIS (PG #28)

CHECK SHEAR PIN

SHEAR DUE TO AXIAL = $\frac{4965}{8}$ = 621 LBS



SHEAR DUE TO MX = $\frac{58918}{4 \times 3}$ = 4910 LBS.

SHEAR DUE TO MZ = $\frac{15171}{4 \times 3}$ = 1264 LBS.

THEREFORE RESULTENT SHEAR = $(621^2 + 4910^2 + 1264^2)^{1/2}$

= 5108 #

USE 4 - BOLTS 3/4"ϕ STAINLESS STEEL BOLTS Fu = 75000 PSI.

ALLOW SHEAR FOR BOLT = 0.17 x .4418 x 75000 x 1.4 = 7886 #
↳ INCR. ALLOW. FACTOR

CHECK BEARING STRESS IN TS 6X3 $P/A = \frac{5108}{.75 \times .625}$ = 10897 PSI.
(1/4" TS 6x3 + 3/8" PLATE)

ALLOW BEARING STRESS = 0.9 Fy = 0.9 x 30000 = 27000 PSI.

ACT. STRESS < ALLOW BEARING STRESS

∴ CONNECTION IS ADEQUATE

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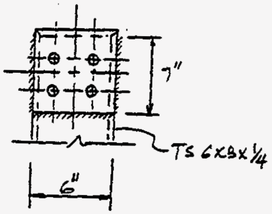
Project: MCO LOADING SYSTEM	Checked By: M	Date: 6/4/97	Page 35 of 44

CHECK WELD BETWEEN PLATE 3/8×6×7½ TO TS 6×8×1/4.



AS PER PAGE # 35
RESULTENT SHEAR LOAD ON
EACH BOLT = 5108#

TOTAL SHEAR LOAD = 5108×4
= 20432 #

TOTAL WELD LENGTH
= 2×7+6 = 20 IN. (A_w)

FORCE ON WELD PER INCH $= \frac{P}{A_w} = \frac{20432}{20}$
= 1022 #/IN.

THEREFORE WELD SIZE REQ'D = 1022 ÷ (0.4×30000)
└ Fy S.S. STEEL
= 0.085 IN.

∴ PROVIDE 3/16" FILLET WELD ON FLAT TO FLAT &
FLARE BEVEL ON FLAT TO CURVED SURFACE ∴ WELD OK

CHECK 3/4"φ S.S. STEEL ROD (ITEM # 20 DWG # 444-300 REV.0)

VERTICAL COMPONENT OF RB (REF PG # 31) = RB Sin 30 = 936#

ALLOW TENSION FOR 3/4"φ = 0.4418×0.6×30000 = 7952# > 936#.

∴ 3/4"φ S.S STEEL ROD IS ADEQUATE

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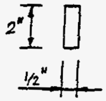
CHECK SEISMIC RESTRAINT (REF. DWG # 444-310 REV-0. ITEM # 6)
LONGITUDINAL 'Z' DIRN.

LENGTH OF RESTRAINT = 4.5 + 11.61 REF. DWG # 444-306 REV.0
= 16.11 IN.



$r_{min} = 0.288675 \times d$ → THICKNESS REF 6B.

$= 0.288675 \times 0.5$

$= 0.1443$ IN.

REF 6B PG. 5.74

$$Kl/r_{min} = \frac{1.0 \times 16.11}{0.1443} = 111.6 \Rightarrow F_a = 11400 \times \frac{30}{36} = 9500 \text{ PSi}$$

$$F_a = 1.7^{*} \times 9500 = 16150 \text{ PSi}$$

ACTUAL STRESS $= P/A$

$P = 3482 \div 2 = 1741$ #

$= \frac{1741}{2 \times 0.5}$

SINCE TWO PLATES ARE TAKING LOAD

* INCREASED ALLOW. FACTOR

$= 1741$ PSi

< 16150 PSi. ∴ SEISMIC RESTRAINT OK

CHECK SEISMIC RESTRAINT IN 'X' DIRN (REF. DWG # 444-303 R/0. ITEM # 1 & 7 TO 11)
LATERAL SEISMIC RESTRAINT.

THIS WEDGE BLOCK ASSEMBLY IS BEARING AGAINST CONCRETE STRUCTURE. THE BLOCK IS SUBJECTED TO A MAXIMUM LOAD OF (1281 + 1449) = 2730 # (SEISMIC LOAD)

SHEAR PIN IS 3/4" φ

$$\text{SHEAR STRESS} = \frac{2730}{2 \times \pi/4 \times .75^2} = 3090 \text{ PSi}.$$

DOUBLE SHEAR

ALLOW SHEAR STRESS $= 0.4 \times 30000 \times 1.4$ — INCR. ALLOW FACTOR
$= 16,800$ PSi. >> 3090 PSi. ∴ LAT. 'X' RES. IS OK.

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CHECK 1/4"×24"×24" PLATE & TS 2×2×1/4 UNDER THE BASKET CART PLATE (FLOOR ITEM #3 DWG # 444-302 REV.0)

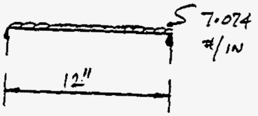
FUEL WEIGHT = 3200 LBS.

BASKET DIA = 24"ϕ

UNIFORM LOAD ON 1/4" THICK PLATE

$$= \frac{3200}{\pi/4 \times 24^2} = 7.074 \ \#/IN^2$$

CONSIDER 1" WIDTH OF PLATE SPANNING 12" BET^N TUBES 2×2×1/4



$$MAX.\ MOM = \frac{wl^2}{8} = \frac{7.074 \times 12^2}{8}$$

$$= 127.33 \ IN\ \#$$

$$SECT.\ MODULUS\ \ S = \frac{bd^2}{6} = \frac{1.0 \times .25^2}{6} = 0.0104 \ IN^3$$

$$f_b = \frac{M}{S} = \frac{127.33}{0.0104} = 12243 \ PSI. < 0.75 \times 30000 \ PSI. = 22500 \ PSI.$$

∴ 1/4" ×24×24 PLATE IS OK.

CHECK TS 2×2×1/4 CART SUPPORT TUBES (SQUARE TUBES ITEM 4 & 5 DWG # 444-302 R/0)

SPAN = 24" POINT LOAD = 3200/2 = 1600 #

$$SIMPLY\ SUPPORTED\ BEAM\ MOMENT = Pl/4 = \frac{1600 \times 24}{6} = 6400 \ "\#$$

$$f_b = \frac{M}{S} = \frac{6400}{0.766} = 8355 \ PSI. < 0.6 \times 30000 \ PSI. = 18000 \ PSI$$

$$SHEAR\ STRESS\ IS\ \ \frac{1600/2}{0.25 \times 2 \times 2} = 800 \ PSI\ \ CON. < 0.4 \times 30000 \ PSI = 12000 \ PSI.$$

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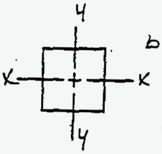
BENDING & SHEAR STRESSES ARE OK $\therefore$ TS 2×2×1/4 ARE OK

CHECK WELDING BET^N TUBES (CART SUPPORT TUBE JOINT)

HORIZONTAL CENTER PIECE TS 2×2×1/4



$b = d = 2''$ $F_y = \frac{1600}{2} = 800$ LBS

WELD PROPERTIES

A_w = LENGTH = 2×4 = 8"

LOAD / IN OF WELD PER INCH

= 800/8

= 100 #

WELD SIZE REQ'D = 100 ÷ (.4×30000)

Fy S.S. STEEL

= 0.01 IN.

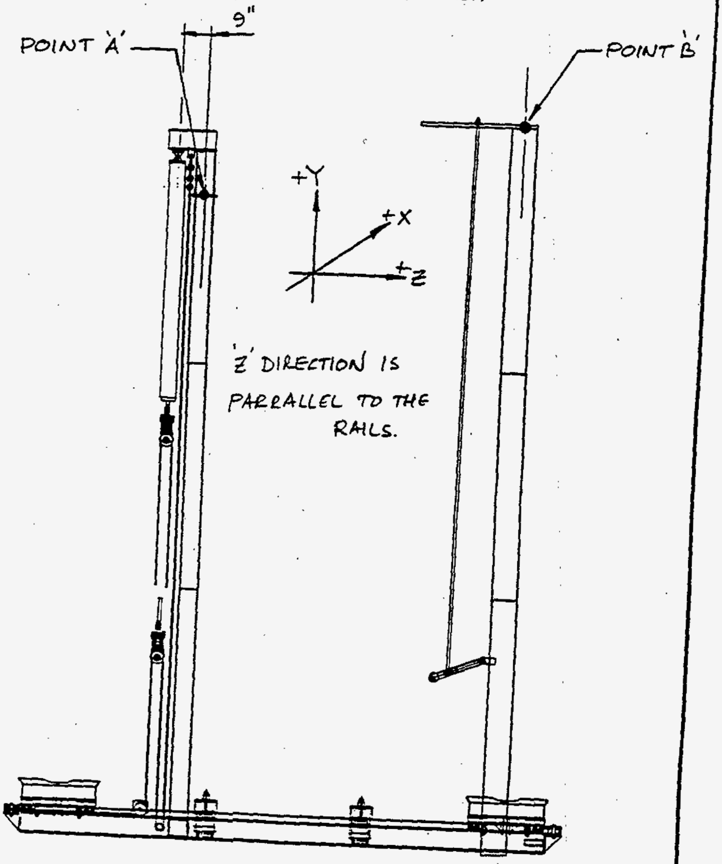
PROVIDE FLARE BEVEL WELD ON FLAT TO CURVED SURFACES & 3/16" FILLET WELD ON FLAT TO FLAT SURFACES.

THEREFORE WELDS ARE OK.

SEISMIC CASE.

DUE TO SEISMIC FACTOR OF 0.28g VERTICAL LOAD ON BASKET PLATE & TS2×2×1/4 WILL INCREASE BY 1.28. BUT ALLOWABLE FOR MATERIAL WILL ALSO INCREASE BY 1.7. THEREFORE, SEISMIC CASE IS NOT GOVERNING AND HENCE NOT ANALYZED.

ANCHORAGES AT POINT 'A' & 'B' SHALL BE DESIGNED BY DES-H.
LOADS ARE TABULATED ON FOLLOWING SHEET.



'Z' DIRECTION IS PARRALLEL TO THE RAILS.

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SUMMARY OF REACTIONS FOR VERTICAL SUPPORTS

	FY	MX	MZ	LOAD CASE
POINT 'A'	4280 ↓ 377 ↑	± 3105 (SEE NOTE 2)	±9838	NORMAL
	4029 ↓ 285 ↑	–	±15171	SEISMIC

	FY	FZ	MZ	
POINT 'B'	3935 ↑ 377 ↓	–	±9838	NORMAL
	4029 ↓ 285 ↑	±392	± 15171	SEISMIC

NOTES 1) LOADS ARE IN POUNDS & MOMENTS IN IN. LBS
DIRECTIONS & LOCATIONS OF LOAD & LOAD POINTS
ARE DEFINED ON PAGE #

2) MX AT POINT 'A' CART + FUEL WT = 250 + 3200 = 3450#.
LOAD ON THE REEVING SYSTEM WILL BE APPROX. 10% OF
MOVING LOAD. = 0.1 × 3450 = 345 #
$MX_A = 9 \times 345 = 3105$ "#
(REEVING LD)
FY = 3935 ↓ + 345 ↓ = 4280 ↓ / 377 ↑

3) MZ NORMAL POINT 'A' & B = 3935 × 2.5 = 9838 "#.

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5.0 SUMMARY OF RESULTS/CONCLUSIONS

Summary of Stress Analysis

Drawing Number	Item No. (PER DWG)	Component	Load Condition	Design Check	Calculated Stress	Allowable Stress	M.S.	Reference Page
444-304	2. 20 AND 21	COMPOSITE RAIL BEAMS	NORMAL	AXIAL AND BENDING	16696	18000	0.07	25
444-304	2. 20 AND 21	COMPOSITE RAIL BEAMS	NORMAL	SHEAR	5533	12000	0.54	26
444-304	2. 20 AND 21	COMPOSITE RAIL BEAMS	SEISMIC	AXIAL AND BENDING	23775	30600	0.22	27
444-304	2. 20 AND 21	COMPOSITE RAIL BEAMS	SEISMIC	SHEAR	11348	16800	0.32	28
444-309	4 THRU 8	VERTICAL SUPPORTS	NORMAL	AXIAL AND BENDING	4778	18000	0.73	30
444-309	4 THRU 8	VERTICAL SUPPORTS	SEISMIC	AXIAL AND BENDING	16126	30600	0.47	31
444-309	4 THRU 8	VERTICAL SUPPORTS	SEISMIC	AISC COMBINED	0.51 (EQUATION 1.6.2)	1.0	0.49	32
444-310 444-309	1 4 THRU 8	SPLICE IN VERTICAL SUPPORT	SEISMIC	AXIAL AND BENDING	5106 (LOAD)	7886 (LOAD)	0.35	35
444-310	6	LONGITUDINAL SEISMIC RESTRAINT	SEISMIC	AXIAL	1741	16150	0.89	37
444-303	1 AND 7 TO 11	LATERAL SEISMIC RESTRAINT	SEISMIC	SHEAR	3090	16800	0.82	37
444-302	3	FLOOR PLATE	NORMAL	BENDING	12243	22500	0.46	38
444-302	4 AND 5	CART SUPPORT TUBES	NORMAL	BENDING	8355	18000	0.54	38
444-300	20	ROD	NORMAL	AXIAL	936 (LOAD)	7852 (LOAD)	0.88	36

SUMMARY OF RESULTS/CONCLUSIONS (cont.)

Summary of Stress Analysis

Drawing Number	Item No. (PER DWG)	Component	Load Condition	Design Check	Weld Size Required	Weld Size Provided	M.S.	Reference Page
444-310	7 TO 8	VERTICAL SUPPORT TO ANCHORAGE	SEISMIC	SHEAR	0.066	0.1875	0.65	33
444-309 444-304	4 THRU 7 TO 2, 20 AND 21	VERTICAL SUPPORT TO COMPOSITE RAIL IBEAM	SEISMIC	SHEAR	0.11	0.1875	0.41	34
444-302	4 TO 5	CART SUPPORT TUBE JOINT	NORMAL	SHEAR	0.01	0.1875	0.95	39

CONCLUSION : THE STRUCTURAL DESIGN OF SHUTTLE MEETS ALL OF THE APPLICABLE DESIGN CRITERIA AND CODE REQUIREMENTS. THEREFORE, THE DESIGN IS ADEQUATE AND HENCE ACCEPTABLE.

NAC International Inc.	Prepared By: RP	Date: 6-4-97	WRR No. EF444-20-01
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6.0 REFERENCES

A) DESIGN SPECIFICATION WHC-S-0546 REV-0 AND NAC DOCUMENT NO. 444-S-01 REV.0

B) AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC-ASD MANUAL OF STEEL CONSTRUCTION, 9TH EDITION.

C) DESIGN OF WELDED STRUCTURES BY O.W. BLODGETT 8TH ED. PUBLISHED BY THE JAMES F. LINCOLN ARC WELDING FOUNDATION

D) AWS D1.1 1994, AMERICAN WELDING SOCIETY, STRUCTURAL WELDING CODE STEEL

E) STANDARD ARCH-CIVIL DESIGN CRITERIA SDC-4.1 REV.12

F) LETTER NO. 97-SCB-045 FROM DE & S HANFORD INC, 5-30-97

G
- DWG # 444-300 REV.0 SHUTTLE ASSEMBLY, MCO LOADING SYSTEM WHC DWG NO: H-1-82911
- DWG # 444-301 REV-0 CART ASSEMBLY, MCO LOADING SYSTEM WHC DWG NO: H-1-82912
- DWG # 444-302 REV.0 CART WELDMENT, MCO LOADING SYSTEM WHC DWG NO: H-1-82913
- DWG# 444-303 REV.0 WEDGE ASSEMBLY, MCO LOADING SYSTEM WHC DWG NO: H-1-82914
- DWG # 444-304 REV.0 RAILS AND SUPPORT, MCO LOADING SYSTEM WHC DWG NO: H-1-82915
- DWG # 444-306 REV0 SEISMIC RESTRAINT, MCO LOADING SYSTEM WHC DWG NO: H-1-82917
- DWG # 444-309 REV.0 UPPER MOUNTS, MCO LOADING SYSTEM WHC DWG NO: H-1-82920
- DWG # 444-310 REV.0 UPPER MOUNTS, MCO LOADING SYSTEM WHC DWG NO: H-1-82920 & 82921.
- DWG # 444-305 REV.0 CABLE MOUNT-CYLINDER, MCO LOADING SYSTEM WHC DWG NO: H-1-82916
- DWG # 444-307 REV-0 CABLE RETURN, MCO LOADING SYSTEM WHC DWG # H-1-82918
- DWG # 444-308 REV.0 CABLE RETURN, MCO LOADING SYSTEM WHC DWG NO: H-1-82919

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NAC INTERNATIONAL

CALCULATION PACKAGE COVER SHEET

Work Request/Calculation No: EF444-20-02

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PROJECT NAME: MCO LOADING SYSTEM PROJECT

CLIENT: WESTINGHOUSE HANFORD COMPANY

CALCULATION TITLE:

STRUCTURAL EVALUATION OF GANTRY / MAST FOR MCO LOADING SYSTEM

PROBLEM STATEMENT OR OBJECTIVE OF THE CALCULATION:

THIS CALCULATION EVALUATES GANTRY / MAST FOR HANFORD K EAST AND K WEST BASIN MCO LOADING SYSTEM FOR STRUCTURAL ADEQUACY PER SPECIFICATION WHC-S-0546 REV. 0 AND NAC DOCUMENT # 444-S-01 R/0

Document Revision	Affected Pages	Revision Description	Name and Initials Of Preparers & Checkers	Project Manager Approval/Date
0	1 THR 70	ORIGINAL ISSUE	RAMESH PATEL RP 6-4-97 LEROY BISHOP LB 6/4/97	Thomas A [illegible] 6-4-97

INDEPENDENT DESIGN VERIFICATION CHECK SHEET

Work Request/Calculation No: EF444-20-02 Revision 0

Scope Of Analysis File: THIS CALCULATION EVALUATES GANTRY / MAST SYSTEM FOR ITS STRUCTURAL ADEQUACY USING THE REQUIREMENTS OF WHC-S-054040

Review Methodology:
- Check Of Calculations Mb
- Alternate Analyses —
- Other (Explain) —

Confirm That The Work Request / Calculation Package Reviewed Includes:

1. Statement of Purpose Mb
2. Defined Method of Analysis Mb
3. Listing of Assumptions Mb
4. Detailed Analysis Record Mb
5. Statement of Conclusions / Recommendations (if applicable) Mb

Step	Activities	Verification Yes	Verification No	Verification N/A	Comments
1	For the scope of the defined analysis:				
	A. Are the required data input complete?	✓			
	1. Material properties	✓			
	2. Geometry (drawing reference)	✓			
	3. Loading source term	✓			
	If a supporting analysis is required to define the load state, has it been defined?				
	B. Are boundary conditions acceptable?	✓			
2	Is the method of analysis adequate for the defined scope?	✓			
3	Is the worst case loading/configuration documented?	✓			
4	Are the acceptance criteria defined and complete?	✓			
5	Has all concurrent loading been considered?	✓			
6	Are analyses consistent with previous work for method and approach?			✓	NEW CALC PKG
7	Are the records for input and output complete?	✓			
8	Is traceability to verified software complete?	✓			CAT 3 ONLY
9	Is the statement of conclusions and recommendations complete and acceptable for the project and objectives of the defined purpose?	✓			

LeRoy Bishop
Reviewer (Name/Signature)

6/4/97
Date

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2.0	METHODS OF ANALYSIS	4
3.0	ASSUMPTIONS / DESIGN INPUTS	4
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1.0 INTRODUCTION / PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO EVALUATE THE GANTRY / MAST FOR HANFORD K EAST AND K WEST BASIN MCO LOADING SYSTEM FOR ITS STRUCTURAL ADEQUACY PER SPECIFICATION WHC-S-0546 REV.0 AND NAC DOCUMENT NO. 444-S-01 REV.0

REF. DWG # 444-215 REV.0 MAST WELDMENT, MCO LOADING SYSTEM
WHC DWG NO: H-1-82892

- DWG # 444-211 REV.0 GUIDE SUBASSEMBLY, MCO LOADING SYSTEM
WHC DWG NO: H-1-82889
- DWG # 444-232 REV.0 DRIVE SUB ASSEMBLY, MCO LOADING SYSTEM
WHC DWG NO: H-1-82903
- DWG # 444-220 REV.0 RAIL SUBASSEMBLY, MCO LOADING SYSTEM
WHC- DWG NO: H-1-82890

2.0 METHOD OF ANALYSIS

HAND CALCULATIONS USING CLASSIC TEXT BOOK SOLUTIONS ARE USED TO STRUCTURALLY EVALUATE ALL APPLICABLE ITEMS. ACTUAL STRESSES ARE THEN COMPARED AGAINST AISC-ASD CODE ALLOWABLE STRESSES. LOTUS 1-2-3 RELEASE 4 IS USED TO TABULATE WEIGHTS AND DETERMINE THE C.G. (CENTER OF GRAVITY)

3.0 ASSUMPTIONS / DESIGN INPUTS

THERE ARE NO UNVERIFIED ASSUMPTIONS WITHIN THIS CALCULATION. ALLOWABLE STRUCTURAL STRESSES ARE USED PER AISC-ASD MANUAL, REF # 6G AND REF # 6H.

MATERIAL PROPERTIES.	TP304 S.S. STEEL
ASTM A-36	$F_Y = 30000$ PSI
$F_Y = 36000$ psi	$F_U = 75000$ PSI
$F_U = 58000$ PSI	$E = 27.6 \times 10^6$ PSI
$E = 29 \times 10^6$ PSI	$\nu = 0.305$
$\rho_s = 0.288$ #/IN^3.	$\rho_s = 0.288$ #/IN^3

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4.0 ANALYSIS DETAIL

This structure is classified as non-safety equipment and therefore no seismic analysis is required. The structure shall be designed to resist dead and live load only.

The following seven pages are spread sheets summarizing the weight and CG location for various configurations. Sketches following the spread sheets identify the items tabulated with a detail tabulation of item weight and location following.

NOTE The individual item numbers used for the CG location determination are not the same as the material item numbers shown on the drawings.

SPREAD SHEET FOR CG LOCATION FOR MAST AND GANTRY WITH MAST UP

ITEM #/DESCRIPTION	SIZE	WEIGHT	X	Wx	Y	Wy	Z	Wz
1 BASE CROSS TUBES	4 EA TS4X4X.25X53.75	146	0	0	7	1022	0	0
2 BASE LATERAL ANGLES	2 EA L1.5X1.5X.188X17	5.1	0	0	7	35.7	0	0
3 BASE DIAGONAL ANGLES	2 EA L1.5X1.5X.188X32.6	9.8	0	0	7	68.6	0	0
4 BASE LATERAL TUBES	2 EA TS4X4X.25X22	44.77	0	0	7	313.39	20.277	907.801
5 BASE LONGITUDINAL TUBES	2 EA TS4X4X.25X53.5	108.89	0	0	7	762.23	15	1633.35
6 MAST VERTICAL ANGLES	4 EA L4X4X.25X232.5	511.5	0	0	60.05	30715.6	0	0
7 MAST HORIZ TUBES	TS 3X3X.188X100	61.83	0	0	174.6	10795.5	0	0
8 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	146.25	2237.63	0	0
9 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	118.65	1815.35	0	0
10 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	91.05	1393.07	0	0
11 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	63.45	970.785	0	0
12 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	35.85	548.505	0	0
13 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-28.85	-441.41	0	0
14 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-55.45	-848.39	0	0
15 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	160.05	3156.19	0	0
16 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	132.45	2611.91	0	0
17 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	104.85	2067.64	0	0
18 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	77.25	1523.37	0	0
19 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	49.65	979.098	0	0
20 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	22.05	434.826	0	0
21 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-15.65	-308.65	0	0
22 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-42.15	-831.2	0	0
23 MAST DIAG BRACE WELDMENT	TS4X3X.25&L1.5x1.5x.188	308.65	0	0	36.6	11294.7	0	0
24 SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
25 SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
26 GANTRY MOTOR & GEAR BOX		96	-37.66	-3615.4	-4.75	-456	13.75	1320
27 DRIVE SHAFT	1.437 DIA X 73.78	34	0	0	0	0	13.75	467.5
28 GANTRY BEARINGS		184	0	0	2.962	545.008	12.78	2351.52
32 SCREW DRIVE MOTOR & GEAR HEAD		110	18.551	2040.6	-35	-3850	-4	-440
33 MOTOR BRACKET BASE	1.5X14X3	16.13	12.125	195.576	-36.86	-594.55	-4	-64.52
34 MOTOR BRACKET SIDES	.25PL AREA 82.27	11.96	15	179.4	-37.5	-448.5	-4	-47.84
35 MOTOR BRACKET BOTTOM	1.5X10.21X3	11.76	17.1	201.096	-44.11	-518.73	-4	-47.04
36 MOTOR PULLEY		15.1	18.55	280.105	-46.371	-700.2	-4	-60.4
37 VERT RAIL SUPPORT	4EA	22.4	0	0	78.375	1755.6	0	0
38 VERTICAL RAILS	2EA 1.000DIAX183.25	86	0	0	78.375	6740.25	0	0
39 SCREW DRIVE BRNG SUPPORT	PL 1.5X22.5X22.5	170.8	0	0	-38.25	-6533.1	0	0
40 SCREW DRIVE BRNG SUPPORT	L1/4X3X.375	84.68	0	0	-37.38	-3165.2	0	0
41 BALL NUT		8.25	0	0	-38.9	-321	0	0
42 DRIVE SHAFT	APPROX 110 CU IN	49.44	0	0	-37.25	-1841.6	0	0
43 TOP BEARINGS	QTY 2	29.74	0	0	-34.75	-1033.4	0	0
44 BRNG HOUSING MOUNTING LUG	AREA 6.0 THICK 1.0	1.7	0	0	-33.5	-56.95	0	0
45 LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46 BEARING SPACER	7.880ODX4.880X4L	20.33	0	0	-38.67	-786.16	0	0
47 BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.89	0	0
48 BRAKE DISK	14ODX.375	16.4	0	0	-51.14	-838.7	0	0
49 DRIVE PULLEY		29.8	0	0	-46.371	-1381.8	0	0
50 BOTTOM HOUSING CAP	10.8ODX2.75IDX.8625	13.88	0	0	-43.84	-608.5	0	0
51 HOUSING	10.8ODX7.774IDX10.57	134.39	0	0	-37.82	-5082.7	0	0
52 TOP HOUSING CAP	10.8ODX4.84IDX.64	18.07	0	0	-32.21	-582.03	0	0
53 VERT GUIDE TUBE BEARING	2EA SIDE	53.26	0	0	-48.5	-2583.1	0	0
54 ANTI-ROTATION SPLINE		9	0	0	170	1530	0	0
55 VERT GUIDE TUBES	80MMX10MM TUBEX235	255	0	0	57.5	14662.5	0	0
56 UPPER TIE BAR	AREA 91 THICK 3.25	85.2	0	0	173.375	14771.6	0	0
57 LOWER TIE BAR	AREA 144 THICK 3	124.4	0	0	-58.5	-7277.4	0	0
58 OVER TRAVEL GUIDES	1.2DIAX2THK 2EA	110.4	0	0	-49	-5409.6	0	0
59 UPPER INNER TUBE	2ODX1.875IDX11	1.23	0	0	-61.25	-75.338	0	0
60 AIR CYLINDER		2.5	0	0	-67	-167.5	0	0
61 INNER TUBE ADJUSTER	2DIAX4.9LONG	4.25	0	0	-88.88	-377.74	0	0
62 OVER TRAVEL RODS	.2DIAX24.875X4 RODS	60	0	0	-67	-4020	0	0
63 LVDT TUBE & HARDWARE	1.75ODX1.687IDX222.08	13	-7.43	-96.59	-61	-793	-7.43	-96.59
64 LOWER INNER TUBE	2ODX1.875IDX138.61	15	0	0	-160.74	-2411.1	0	0
65 OUTER TUBE	4.5ODX4IDX170.42	163.6	0	0	-145.21	-23756	0	0
66 MCO GRAPPLE	1.625DIAX17LONG	10	0	0	-237.5	-2375	0	0
67 BALL SCREW		201.46	0	0	154.85	31196.5	0	0
68 CAMERA AND MOUNTING		10	0	0	-219.75	-2197.5	0	0
69 FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-85.125	-1276.88	0	0
72 DIAGONAL BRACE TUBES	3 DIA X .25 X 83.37X 2EA	93.6	0	0	36.6	3425.76	27.5	2574
73 OUTRIGGER PLATES LOWER	PL 3X8.5X3.5 QTY 4	13.1	0	0	9.25	121.175	0	0
74 OUTRIGGER PLATES UPPER	PL 5X7.25X6 QTY 4	25.1	0	0	62.7	1573.77	0	0
75 SHAFT BRACKET	PL .5	17.84	-30.75	-548.58	0.6	10.704	13.75	245.3
76 PLATE UNDER TS4X4X.25	PL .5X6 7X7.3 QTY 6	42.26	0	0	4.75	200.735	12.78	540.083
77 TIE BAR	24 LG QTY 2	100	0	0	4.293	429.3	18.5	1850
78 ENCLOSURE PLATES	PL .125x24X25.1 QTY 4	86.75	0	0	-41.4	-3591.5	0	0
79 OUTRIGGER DIAGONAL PLATES	PL .5X6.5X5 QTY 2	9.26	0	0	9.25	85.66	39.5	365.72
80 MACHINE PLATE		113.78	0	0	-48.7	-5541.1	0	0
TOTAL								
	WEIGHT	4373.01		-1363.9		52915		11517.9
	CG COORDINATES WITH SCREW IN FULL UP POSITION	X =	-0.311881	Y =		12.1004	Z =	2.63388
ITEMS NOT USED IN CG CALC FOR MAST								
29 GANTRY RAIL	22.5KG/MX144IN LG QTY	181	0	0	20	3620	24	4344
30 RACK GEAR	1.5X1.38X48 QTY 2	56.2	0	0	10.2	573.24	24	1348.8
31 RACK SUPPORT ANGLE	L3X3X.5X108 QTY 2	168.2	0	0	0	0	24	4036.8
70 GANTRY RAIL SUPPORT PAD	BAR .875X3X108	163.3	0	0	0.4377	71.5021	24	3919.2
71 GANTRY RAIL TUBES	TS4X4X.312X117 QTY 2	288	0	0	-2	-576	16.784	4833.79
TOTAL								
	WEIGHT	856.7		0		3688.74		18482.4
	CG COORDINATES	X =	0	Y =		4.30584	Z =	21.5714

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SPREAD SHEET FOR CG LOCATION FOR MAST AND GANTRY WITH MAST DOWN

ITEM NO	DESCRIPTION	SIZE	WEIGHT	IX	WIx	IY	WIy	IZ	WIz
1	BASE CROSS TUBES	4 EA TS4X4X.25X23.75	146	0	0	7	1022	0	0
2	BASE LATERAL ANGLES	2 EA L1.5X1.5X.188X17	5.1	0	0	7	35.7	0	0
3	BASE DIAGONAL ANGLES	2 EA L1.5X1.5X.188X32.6	9.8	0	0	7	68.6	0	0
4	BASE LATERAL TUBES	2 EA TS4X4X.25X22	44.77	0	0	7	313.39	20.277	907.801
5	BASE LONGITUDINAL TUBES	2 EA TS4X4X.25X33.5	109.89	0	0	7	769.23	15	1648.35
6	MAST VERTICAL ANGLES	4 EA L4X4X.25X232.5	511.5	0	0	60.05	30715.6	0	0
7	MAST HORIZ TUBES	TS 3X3X.188X108	61.83	0	0	174.6	10795.5	0	0
8	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	146.25	2237.63	0	0
9	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	118.65	1815.35	0	0
10	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	91.05	1393.07	0	0
11	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	63.45	970.785	0	0
12	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	35.85	548.505	0	0
13	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-28.85	-441.41	0	0
14	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-55.45	-848.39	0	0
15	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	160.05	3156.19	0	0
16	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	132.45	2611.91	0	0
17	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	104.85	2067.64	0	0
18	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	77.25	1523.37	0	0
19	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	49.65	979.098	0	0
20	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	22.05	434.826	0	0
21	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-15.65	-308.65	0	0
22	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-42.15	-831.21	0	0
23	MAST DIAG BRACE WELDMENT	TS4X3X.25&L1.5x1.5x.188	322.88	0	0	34.8	11234.7	0	0
24	SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
25	SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
26	GANTRY MOTOR & GEAR BOX		96	-37.88	-3636.5	-4.75	-456	13.75	1320
27	DRIVE SHAFT	1.437 DIA X 73.75	34	0	0	0	0	13.75	467.5
28	GANTRY BEARINGS		184	0	0	2.966	545.688	12.78	2351.52
32	SCREW DRIVE MOTOR & GEAR HEAD		110	18.55	2040.5	-36	-3960	-4	-440
33	MOTOR BRACKET BASE	.5X14X8	16.13	12.125	195.576	-36.88	-594.86	-4	-64.52
34	MOTOR BRACKET SIDES	.25PL AREA 80.27	11.96	15	179.4	-37.5	-448.5	-4	-47.84
35	MOTOR BRACKET BOTTOM	.5X10.21X8	11.76	17.1	201.096	-44.11	-518.73	-4	-47.04
36	MOTOR PULLEY		15.1	18.55	280.105	-46.371	-700.2	-4	-60.4
37	VERT RAIL SUPPORT	4EA	22.4	0	0	78.375	1755.6	0	0
38	VERTICAL RAILS	2EA 1.000DIAX183.25	86	0	0	78.375	6740.25	0	0
39	SCREW DRIVE BRNG SUPPORT P	PL 1.5X22.5X22.5	170.8	0	0	-33.25	-5680.7	0	0
40	SCREW DRIVE BRNG SUPPORT	L3X3X.375	56.08	0	0	-37.58	-2108.2	0	0
41	BALL NUT		8.25	0	0	-39	-321	0	0
42	DRIVE SHAFT	APPROX 110 CU IN	48.44	0	0	-37.25	-1841.8	0	0
43	TOP BEARINGS	QTY 2	29.74	0	0	-34.78	-1034.4	0	0
44	BRNG HOUSING MOUNTING LUG	AREA 6.0 THKS 1.0	1.7	0	0	-33.5	-56.95	0	0
45	LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46	BEARING SPACER	7.880ODX6.880X4L	20.33	0	0	-37.78	-768.14	0	0
47	BOTTOM BEARING	QTY 1	14.87	0	0	-41.82	-621.86	0	0
48	BRAKE DISK	14.0OD X.375	10.4	0	0	-41.14	-428.7	0	0
49	DRIVE PULLEY		29.8	0	0	-46.371	-1381.8	0	0
50	BOTTOM HOUSING CAP	10.80OD X2.75ID X.625	13.68	0	0	-43.84	-599.7	0	0
51	HOUSING	10.80OD X7.774ID X10.87	134.38	0	0	-37.82	-5085.7	0	0
52	TOP HOUSING CAP	10.80OD X4.84ID X.84	18.07	0	0	-32.21	-582.03	0	0
53	VERT GUIDE TUBE BEARING	2EA SIDE	53.36	0	0	-48.5	-2588	0	0
54	ANTI-ROTATION SPLINE		9	0	0	-20	-180	0	0
55	VERT GUIDE TUBES	40MMX16MM TUBEX225	255	0	0	-132.5	-33788	0	0
56	UPPER TIE BAR	AREA 81 THKS 3.25	85.2	0	0	-16.625	-1414.5	0	0
57	LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-248.5	-30913	0	0
58	OVER TRAVEL GUIDES	12DIAX2THK 2EA	118.4	0	0	-259	-30666	0	0
59	UPPER INNER TUBE	2.0OD X1.875ID X11	1.23	0	0	-271.25	-333.64	0	0
60	AIR CYLINDER		2.5	0	0	-257	-642.5	0	0
61	INNER TUBE ADJUSTER	2DIAX4.5LONG	4.25	0	0	-278.88	-1185.2	0	0
62	OVER TRAVEL RODS	2DIAX24.875X4 RODS	88	0	0	-257	-22616	0	0
63	LVDT TUBE & HARDWARE	1.750OD X1.687ID X222.66	13	-7.43	-96.59	-251	-3263	-7.43	-96.59
64	LOWER INNER TUBE	2.0OD X1.875ID X138.81	15	0	0	-390.74	-5861.1	0	0
65	OUTER TUBE	4.500OD X4ID X170.42	163.8	0	0	-335.21	-54907	0	0
66	MCO GRAPPLE	1.625DIA X17LONG	10	0	0	-427.5	-4275	0	0
67	BALL SCREW		201.45	0	0	-35.15	-7081	0	0
68	CAMERA AND MOUNTING		10	0	0	-408.75	-4087.5	0	0
69	FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-275.13	-4126.9	0	0
72	DIAGONAL BRACE TUBES	3 DIA X .25 X 63.37X 2EA	83.6	0	0	38.6	3425.78	27.8	2324
73	OUTRIGGER PLATES LOWER	PL .5X8 5X3.5 QTY 4	13.1	0	0	9.25	121.175	0	0
74	OUTRIGGER PLATES UPPER	PL .5X7.25X4 QTY 4	25.1	0	0	62.7	1573.77	0	0
75	SHAFT BRACKET	PL .5	17.84	-30.75	-548.58	0.6	10.704	13.75	245.3
76	PLATE UNDER TS4X4X.25	PL .5X6 7X7.5 QTY 6	42.26	0	0	4.75	200.735	12.78	540.083
77	TIE BAR	24 LG QTY 2	100	0	0	4.293	429.3	18.5	1850
78	ENCLOSURE PLATES	PL .125X24X25 1 QTY 4	66.75	0	0	-41.4	-2763.5	0	0
79	OUTRIGGER DIAGONAL PLATES	PL .5X8 5X5 QTY 2	9.36	0	0	9.25	86.58	38.5	360.36
80	MACHINE PLATE		113.78	0	0	-40.7	-4441.6	0	0
	TOTAL		4373.61		-1363.9		-167898		11517.6
		WEIGHT							
	CG COORDINATES	WITH SCREW IN FULL DOWN POSITION	IX =		-0.31187	IY =	-38.388	IZ =	2.63336
	ITEMS NOT USED IN CG CALC FOR MAST								
29	GANTRY RAIL	22.9KG/MX144IN LG QTY	181	0	0	20	3620	24	4344
30	RACK GEAR	1.5X1.38X48 QTY 2	56.2	0	0	10.2	573.24	24	1348.8
31	RACK SUPPORT ANGLE	L3X3X.5X108 QTY 2	166.7	0	0	0	0	24	4000.8
70	GANTRY RAIL SUPPORT PAD	BAR .875X3X108	163.3	0	0	0.437	71.3621	24	3919.2
71	GANTRY RAIL TUBES	TS4X4X.312X117 QTY 2	289	0	0	-2	-578	16.704	4680.66
	TOTAL		836.2		0		3686.6		18293.4
		WEIGHT							
	CG COORDINATES		IX =		0	IY =	4.4088	IZ =	21.8754

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SPREAD SHEET FOR CG LOCATION FOR MAST AND GANTRY WITH MAST DOWN AND LOAD

ITEM NO	DESCRIPTION	SIZE	WEIGHT	X	Wx	Y	Wy	Z	Wz
1	BASE CROSS TUBES	4 EA TS4X4X.25X35.75	146	0	0	7	1022	0	0
2	BASE LATERAL ANGLES	2 EA L1.5X1.5X.188X17	5.1	0	0	7	35.7	0	0
3	BASE DIAGONAL ANGLES	2 EA L1.5X1.5X.188X32.6	9.8	0	0	7	68.6	0	0
4	BASE LATERAL TUBES	2 EA TS4X4X.25X22	44.77	0	0	7	313.39	20.277	907.801
5	BASE LONGITUDINAL TUBES	2 EA TS4X4X.25X53.5	109.89	0	0	7	769.23	15	1648.35
6	MAST VERTICAL ANGLES	4 EA L4X4X.25X222.5	511.5	0	0	60.05	30715.6	0	0
7	MAST HORIZ TUBES	TS 3X3X.188X108	61.83	0	0	174.6	10795.5	0	0
8	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	146.25	2237.63	0	0
9	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	118.65	1815.35	0	0
10	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	91.05	1393.07	0	0
11	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	63.45	970.785	0	0
12	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	35.85	548.505	0	0
13	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-28.85	-441.41	0	0
14	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-45.45	-695.39	0	0
15	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	160.05	3156.19	0	0
16	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	132.45	2611.91	0	0
17	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	104.85	2067.64	0	0
18	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	77.25	1523.37	0	0
19	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	49.65	979.098	0	0
20	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	22.05	434.826	0	0
21	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-15.65	-308.62	0	0
22	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-42.15	-831.2	0	0
23	MAST DIAG BRACE WELDMENT	TS4X3X.25&L1.5x1.5x.188	300.95	0	0	38.6	11616.7	0	0
24	SIDE PLATES	1.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
25	SIDE PLATES	1.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
26	GANTRY MOTOR & GEAR BOX		88	-37.68	-3315.4	-4.75	-418	13.75	1210
27	DRIVE SHAFT	1.437 DIA X 73.76	34	0	0	0	0	13.75	467.5
28	GANTRY BEARINGS		184	0	0	2.962	545.008	12.78	2351.52
32	SCREW DRIVE MOTOR & GEAR HEAD		110	18.85	2073.5	-35	-3850	-4	-440
33	MOTOR BRACKET BASE	1.5X14X8	16.13	12.125	195.576	-38.88	[illegible]	-4	-64.52
34	MOTOR BRACKET SIDES	.25PL AREA 60.27	11.88	15	178.2	-37.5	-445.5	-4	-47.52
35	MOTOR BRACKET BOTTOM	.5X10.211X8	11.76	17.11	201.2136	-44.11	-518.73	-4	-47.04
36	MOTOR PULLEY		15.1	18.85	284.635	-46.371	-700.2	-4	-60.4
37	VERT RAIL SUPPORT	4EA	22.4	0	0	78.375	1755.6	0	0
38	VERTICAL RAILS	2EA 1.00DIAX183.25	88	0	0	78.375	4040.35	0	0
39	SCREW DRIVE BRNG SUPPORT	PL 1.5X22.5X22.5	170.81	0	0	-35.25	-6020.7	0	0
40	SCREW DRIVE BRNG SUPPORT	L4X3X.375	84.68	0	0	-37.38	-3165.3	0	0
41	BALL NUT		8.35	0	0	-30	-251	0	0
42	DRIVE SHAFT	APPROX 110 CU IN	40.44	0	0	-37.25	-1641.6	0	0
43	TOP BEARINGS	QTY 2	28.74	0	0	-34.78	-1034.4	0	0
44	BRNG HOUSING MOUNTING LUG	AREA 8.0 THKS 1.0	17	0	0	-33.5	-569.5	0	0
45	LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46	BEARING SPACER	7.880DIA 6IDX4L	20.35	0	0	-38.67	-786.9	0	0
47	BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.89	0	0
48	BRAKE DISK	14ODX.375	16.4	0	0	-51.14	-838.7	0	0
49	DRIVE PULLEY		28.8	0	0	-48.371	-1393.1	0	0
50	BOTTOM HOUSING CAP	10.8ODX2.75IDX.8625	13.88	0	0	-43.84	-608.5	0	0
51	HOUSING	10.8ODX7.774IDX10.37	134.38	0	0	-37.82	-5082.3	0	0
52	TOP HOUSING CAP	10.8ODX4.64IDX.84	18.07	0	0	-32.21	-582.03	0	0
53	VERT GUIDE TUBE BEARING	2EA SIDE	53.56	0	0	-46.51	-2491.1	0	0
54	ANTI-ROTATION SPLINE		9	0	0	-20	-180	0	0
55	VERT GUIDE TUBES	80MMX10MM TUBE2X255	255	0	0	-132.5	-33788	0	0
56	UPPER TIE BAR	AREA 91 THKS 3.25	85.2	0	0	-16.625	-1416.5	0	0
57	LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-248.5	-30913	0	0
58	OVER TRAVEL GUIDES	12DIAX.2THK 2EA	118.4	0	0	-260	-30784	0	0
59	UPPER INNER TUBE	2ODX1.875IDX11	1.25	0	0	-271.25	-339.06	0	0
60	AIR CYLINDER		2.5	0	0	-257	-642.5	0	0
61	INNER TUBE ADJUSTER	2DIAX4.8LONG	4.25	0	0	-278.88	-1185.2	0	0
62	OVER TRAVEL RODS	2DIAX24.875x4 RODS	88	0	0	-257	-22616	0	0
63	LVDT TUBE & HARDWARE	1.75ODX1.887IDX222.68	13	-7.43	-96.59	-251	-3263	-7.43	-96.59
64	LOWER INNER TUBE	2ODX1.875IDX138.81	15	0	0	-290.74	-4361.1	0	0
65	OUTER TUBE	4.5ODX4IDX170.42	183.8	0	0	-243.78	-44807	0	0
66	MCO GRAPPLE		10	0	0	-427.5	-4275	0	0
67	BALL SCREW	1.625DIAX17LONG	201.45	0	0	-35.15	-7081	0	0
68	CAMERA AND MOUNTING		10	0	0	-408.75	-4087.5	0	0
69	FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-275.13	-4126.9	0	0
72	DIAGONAL BRACE TUBES	3 DIA X .35 X 63.37X 2EA	93.6	0	0	36.6	3425.76	27.5	2574
73	OUTRIGGER PLATES LOWER	PL 5X8 5X3.5 QTY 4	13.1	0	0	9.25	121.175	0	0
74	OUTRIGGER PLATES UPPER	PL 5X7.25X8 QTY 4	25.1	0	0	62.7	1573.77	0	0
75	SHAFT BRACKET	PL .5	17.84	-30.75	-548.58	0.6	10.704	13.75	245.3
76	PLATE UNDER TS4X4X.25	PL 5X8 7X7.3 QTY 8	42.26	0	0	4.75	200.735	12.78	540.083
77	TIE BAR	24 LG QTY 2	100	0	0	4.293	429.3	18.5	1850
78	ENCLOSURE PLATES	PL .125x24x25 1 QTY 4	86.75	0	0	-41.4	-3591.5	0	0
79	OUTRIGGER DIAGONAL PLATES	PL 5X8 5X3 QTY 2	9.36	0	0	9.25	86.58	38.5	360.36
80	MACHINE PLATE		113.78	0	0	-40.7	-4641.6	0	0
	LOADED BASKET		3200	0	0			0	0
	TOTAL		7373.81		-1393.6		[illegible]		11617.8
		WEIGHT							
	CG COORDINATES WITH SCREW IN FULL DOWN POSITION		X =	-0.18901	Y =	-31.514	Z =	1.57555	
	ITEMS NOT USED IN CG CALC FOR MAST								
29	GANTRY RAIL	22 800MMX144mm LG QTY	181	0	0	20	3620	24	4344
30	RACK GEAR	1.5X1.38X48 QTY 2	56.2	0	0	10.2	573.24	24	1348.8
31	RACK SUPPORT ANGLE	L3X3X.5X108 QTY 2	169.2	0	0	0	0	24	4060.8
70	GANTRY RAIL SUPPORT PAD	BAR .875X3X108	163.3	0	0	0.437	71.3621	24	3919.2
71	GANTRY RAIL TUBES	TS4X4X.3125X117 QTY 2	288	0	0	-2	-576	16.784	4830.89
	TOTAL		858.7		0		3688.6		18503.4
		WEIGHT							
	CG COORDINATES		X =	0	Y =	4.29554	Z =	21.5474	

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SPREAD SHEET FOR CG LOCATION FOR MAST AND GANTRY WITH MAST DOWN AND LOAD WITH MAXIMUM ECCENTRICITY

ITEM NO/DESCRIPTION	SIZE	WEIGHT	X	wx	Y	wy	Z	wz
1 BASE CROSS TUBES	4 EA TS4X4X.25X33.75	146	0	0	7	1022	0	0
2 BASE LATERAL ANGLES	2 EA L1.5X1.5X.188X17	5.1	0	0	7	35.7	0	0
3 BASE DIAGONAL ANGLES	2 EA L1.5X1.5X.188X32.6	9.8	0	0	7	68.6	0	0
4 BASE LATERAL TUBES	2 EA TS4X4X.25X22	44.77	0	0	7	313.39	20.277	907.801
5 BASE LONGITUDINAL TUBES	2 EA TS4X4X.25X53.5	109.89	0	0	7	769.23	15	1648.35
6 MAST VERTICAL ANGLES	4 EA L4X4X.25X222.5	511.5	0	0	60.05	30715.6	0	0
7 MAST HORIZ TUBES	TS 3X3X.188X100	61.85	0	0	174.6	10798.5	0	0
8 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	146.25	2237.63	0	0
9 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	118.65	1815.35	0	0
10 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	91.05	1393.07	0	0
11 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	63.45	970.785	0	0
12 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	35.85	548.505	0	0
13 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-28.85	-441.41	0	0
14 MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-44.45	-448.39	0	0
15 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	160.05	3156.18	0	0
16 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	132.45	2611.91	0	0
17 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	104.85	2067.64	0	0
18 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	77.25	1523.37	0	0
19 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	49.65	979.098	0	0
20 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	22.05	434.826	0	0
21 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-15.65	-308.65	0	0
22 MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-42.15	-831.2	0	0
23 MAST DIAG BRACE WELDMENT	TS4X3X.25&L1.5x1.5x.188	392.82	0	0	28.6	11234.7	0	0
24 SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
25 SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
26 GANTRY MOTOR & GEAR BOX		95	-38.06	-3615.4	-4.75	-451	13.75	1306
27 DRIVE SHAFT	1.437 DIA X 73.78	34	0	0	0	0	13.75	467.5
28 GANTRY BEARINGS		184	0	0	2.902	545.059	12.75	2361.83
32 SCREW DRIVE MOTOR & GEAR HEAD		110	18.65	2051.5	-35	-3850	-4	-440
33 MOTOR BRACKET BASE	.5X14X8	16.13	12.125	195.576	-30.66	-494.55	-4	-64.52
34 MOTOR BRACKET SIDES	.25PL AREA 60.27	11.96	15	179.4	-37.5	-448.5	-4	-47.84
35 MOTOR BRACKET BOTTOM	.5X10.21X8	11.76	17.1	201.096	-44.11	-518.73	-4	-47.04
36 MOTOR PULLEY		15.11	18.55	280.105	-46.371	-700.2	-4	-60.4
37 VERT RAIL SUPPORT	4EA	22.4	0	0	78.375	1755.6	0	0
38 VERTICAL RAILS	2EA 1.000DIAX183.25	86	0	0	78.375	6740.25	0	0
39 SCREW DRIVE BRNG SUPPORT	PL 1.5X22.5X22.5	170.8	0	0	-35.25	-6020.7	0	0
40 SCREW DRIVE BRNG SUPPORT	L5.40OX.375	84.08	0	0	-37.65	-3165.5	0	0
41 BALL NUT		6.25	0	0	-37	-231	0	0
42 DRIVE SHAFT	APPROX 110 CU IN	40.44	0	0	-37.25	-1041.6	0	0
43 TOP BEARINGS	QTY 2	29.74	0	0	-34.78	-1034.4	0	0
44 BRNG HOUSING MOUNTING LUG	AREA 6.0 THKS 1.0	1.7	0	0	-33.5	-56.95	0	0
45 LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46 BEARING SPACER	[illegible]	20.33	0	0	-38.67	-786.16	0	0
47 BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.88	0	0
48 BRAKE DISK	14ODX.375	16.4	0	0	-41.14	-674.7	0	0
49 DRIVE PULLEY		29.8	0	0	-46.371	-1381.8	0	0
50 BOTTOM HOUSING CAP	10.500X2.75IDX.625	13.66	0	0	-43.84	-598.8	0	0
51 HOUSING	10.500X7.774IDX10.37	134.38	0	0	-37.82	-5082.7	0	0
52 TOP HOUSING CAP	10.500X4.84IDX.84	18.07	0	0	-32.21	-582.03	0	0
53 VERT GUIDE TUBE BEARING	2EA SIDE	63.26	0	0	-48.5	-3068.1	0	0
54 ANTI-ROTATION SPLINE		9	0	0	-20	-180	0	0
55 VERT GUIDE TUBES	80MMX10MM TUBEX225	255	0	0	-132.5	-33788	0	0
56 UPPER TIE BAR	AREA 91 THKS 3.25	85.2	0	0	-16.625	-1416.5	0	0
57 LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-248.5	-30913	0	0
58 OVER TRAVEL GUIDES	12DIAX2THK 2EA	118.4	0	0	-259	-30666	0	0
59 UPPER INNER TUBE	2.00X1.875IDX11	1.23	0	0	-271.25	-333.64	0	0
60 AIR CYLINDER		2.5	0	0	-257	-642.5	0	0
61 INNER TUBE ADJUSTER	2DIAX4.8LONG	4.25	0	0	-270.88	-1165.2	0	0
62 OVER TRAVEL RODS	2DIAX24.875X4 RODS	88	0	0	-257	-22616	0	0
63 LVDT TUBE & HARDWARE	1.750OX1.687IDX222.08	13	-7.43	-96.59	-251	-3263	-7.43	-96.59
64 LOWER INNER TUBE	2.00X1.875IDX130.61	15	0	0	-350.74	-5261.1	0	0
65 OUTER TUBE	4.500X4IDX170.42	163.8	0	0	-335.21	-54907	0	0
66 MCO GRAPPLE	1.625DIAX17LONG	10	0	0	-427.5	-4275	0	0
67 BALL SCREW		201.46	0	0	-35.15	-7081	0	0
68 CAMERA AND MOUNTING		10	0	0	-408.75	-4087.5	0	0
69 FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-275.13	-4126.9	0	0
72 DIAGONAL BRACE TUBES	3 DIA X .25 X 63.37X 2EA	93.6	0	0	36.6	3425.76	27.5	2574
73 OUTRIGGER PLATES LOWER	PL.5X8.5X3.5 QTY 4	13.1	0	0	9.25	121.175	0	0
74 OUTRIGGER PLATES UPPER	PL.5X7.25X8 QTY 4	25.1	0	0	62.7	1573.77	0	0
75 SHAFT BRACKET	PL.5	17.84	-30.75	-548.58	0.6	10.704	13.75	245.3
76 PLATE UNDER TS4X4X.25	PL.5X8 7X7.3 QTY 8	42.26	0	0	4.75	200.735	12.78	540.083
77 TIE BAR	24 LG QTY 2	100	0	0	-4.283	-428.3	18.5	1850
78 ENCLOSURE PLATES	PL.125x24X25.1 QTY 4	68.75	0	0	-41.4	-2846.3	0	0
79 OUTRIGGER DIAGONAL PLATES	PL.5X8.5X5 QTY 2	8.28	0	0	9.25	76.59	30.5	252.54
80 MACHINE PLATE		113.79	0	0	-40.7	-4641.6	0	0
LOADED BASKET		2700					1.5	4050
TOTAL								
		7073.81		-1363.9		-159169		16627.9
		WEIGHT						
	CG COORDINATES WITH SCREW IN FULL DOWN POSITION	X =		-0.1928 Y =		-22.5 Z =		2.35079

ITEMS NOT USED IN CG CALC FOR MAST	SIZE	WEIGHT	X	wx	Y	wy	Z	wz
29 GANTRY RAIL	22.5X.5DIAX144IN LG QTY	181	0	0	20	3620	24	4344
30 RACK GEAR	1.5X1.38X46 QTY 2	56.3	0	0	10.2	573.24	24	1348.8
31 RACK SUPPORT ANGLE	L3X3X.5X100 QTY 2	168.2	0	0	0	0	24	4080.0
70 GANTRY RAIL SUPPORT PAD	BAR .875X3X100	163.5	0	0	0.437	71.3821	24	3910.2
71 GANTRY RAIL TUBES	TS4X4X.312X117 QTY 2	380	0	0	-1	-378	18.784	4960.68
TOTAL								
		948.7		0		3886.6		18523.4
		WEIGHT						
	CG COORDINATES	X =		0 Y =		4.09624 Z =		21.8714

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SPREAD SHEET FOR CG LOCATION FOR MAST AND GANTRY IN SHIPPING CONFIGURATION

ITEM N	DESCRIPTION	SIZE	WEIGHT	X	Mx	Y	My	Z	Mz
1	BASE CROSS TUBES	4 EA TS4X4X.25X35.75	146	0	0	7	1022	0	0
2	BASE LATERAL ANGLES	2 EA L1.5X1.5X.188X17	5.1	0	0	7	35.7	0	0
3	BASE DIAGONAL ANGLES	2 EA L1.5X1.5X.188X32.6	9.8	0	0	7	68.6	0	0
4	BASE LATERAL TUBES	2 EA TS4X4X.25X22	44.77	0	0	7	313.39	20.277	907.801
5	BASE LONGITUDINAL TUBES	2 EA TS4X4X.25X53.5	109.89	0	0	7	769.23	15	1648.35
6	MAST VERTICAL ANGLES	4 EA L4X4X.25X232.5	511.5	0	0	60.05	30715.6	0	0
7	MAST HORIZ TUBES	TS 3X3X.188X108	61.83	0	0	174.6	10795.5	0	0
8	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	146.25	2237.63	0	0
9	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	118.65	1815.35	0	0
10	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	91.05	1393.07	0	0
11	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	63.45	970.785	0	0
12	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	35.85	548.505	0	0
13	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-28.85	-441.41	0	0
14	MAST HORIZ ANGLES	L 1.5X1.5X.188X102	15.3	0	0	-55.45	-848.39	0	0
15	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	160.05	3156.19	0	0
16	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	132.45	2611.91	0	0
17	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	104.85	2067.64	0	0
18	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	77.25	1523.37	0	0
19	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	49.65	979.098	0	0
20	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	22.05	434.826	0	0
21	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-15.55	-306.65	0	0
22	MAST DIAG ANGLES	L 1.5X1.5X.188X131.47	19.72	0	0	-42.15	-831.2	0	0
23	MAST DIAG BRACE WELDMENT	TS4X3X.25&L1.5x1.5x.18	306.96	0	0	36.6	11234.7	0	0
24	SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
25	SIDE PLATES	.25X23.5X12 2EA	40.61	0	0	3	121.83	0	0
26	GANTRY MOTOR & GEAR BOX		96	-37.66	-3615.4	-4.75	-456	13.75	1320
27	DRIVE SHAFT	1.437 DIA X 73.78	34	0	0	0	0	13.75	467.5
32	SCREW DRIVE MOTOR & GEAR HEAD		110	18.55	2040.5	-35	-3850	-4	-440
33	MOTOR BRACKET BASE	.5X14X8	16.13	12.125	195.576	-36.86	-594.55	-4	-64.52
34	MOTOR BRACKET SIDES	.25PL AREA 60.27	11.96	15	179.4	-37.5	-448.5	-4	-47.84
35	MOTOR BRACKET BOTTOM	.5X10.211X8	11.76	17.1	201.096	-44.11	-518.73	-4	-47.04
36	MOTOR PULLEY		15.1	18.55	280.105	-46.371	-700.2	-4	-60.4
37	VERT RAIL SUPPORT	4EA	22.4	0	0	78.375	1755.6	0	0
38	VERTICAL RAILS	2EA 1.00DIAX193.25	86	0	0	78.375	6740.25	0	0
39	SCREW DRIVE BRNG SUPPORT	PL 1.5X22.5X22.5	170.8	0	0	-35.25	-6020.7	0	0
40	SCREW DRIVE BRNG SUPPORT	L4X3X.375	58.08	0	0	-37.28	-2165.2	0	0
41	BALL NUT		8.25	0	0	-28	-231	0	0
42	DRIVE SHAFT	APPROX 110 CU IN	49.44	0	0	-37.25	-1841.6	0	0
43	TOP BEARINGS	QTY 2	29.74	0	0	-34.78	-1034.4	0	0
44	BRNG HOUSING MOUNTING LUG	AREA 6.0 THKS 1.0	1.7	0	0	-33.5	-56.95	0	0
45	LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46	BEARING SPACER	7.88ODX6.8IDX4L	20.33	0	0	-38.67	-786.16	0	0
47	BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.89	0	0
48	BRAKE DISK	14ODX.375	16.4	0	0	-51.14	-838.7	0	0
49	DRIVE PULLEY		29.8	0	0	-46.371	-1381.9	0	0
50	BOTTOM HOUSING CAP	10.8ODX2.75IDX.5625	13.88	0	0	-43.84	-608.5	0	0
51	HOUSING	10.8ODX7.774IDX10.57	134.38	0	0	-37.92	-5095.7	0	0
52	TOP HOUSING CAP	10.8ODX4.64IDX.84	18.07	0	0	-32.21	-582.03	0	0
53	VERT GUIDE TUBE BEARING	2EA SIDE	53.26	0	0	-48.5	-2583.1	0	0
54	ANTI-ROTATION SPLINE		9	0	0	170	1530	0	0
55	VERT GUIDE TUBES	80MMX10MM TUBEX235	255	0	0	57.5	14662.5	0	0
56	UPPER TIE BAR	AREA 91 THKS 3.25	85.2	0	0	173.375	14771.6	0	0
57	LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-58.5	-7277.4	0	0
63	LVDT TUBE & HARDWARE	1.75ODX1.687IDX222.06	13	-7.43	-96.59	-61	-793	-7.43	-96.59
67	BALL SCREW		201.45	0	0	154.85	31194.5	0	0
72	DIAGONAL BRACE TUBES	3 DIA X .25 X 63.37X 2EA	93.6	0	0	36.6	3425.76	27.5	2574
73	OUTRIGGER PLATES LOWER	PL.5X6.5X3.5 QTY 4	13.1	0	0	9.25	121.175	0	0
74	OUTRIGGER PLATES UPPER	PL.5X7.25X6 QTY 4	25.1	0	0	62.7	1573.77	0	0
75	SHAFT BRACKET	PL .5	17.84	-30.75	-548.58	0.6	10.704	13.75	245.3
76	PLATE UNDER TS4X4X.25	PL.5X6.7X7.3 QTY 6	42.26	0	0	4.75	200.735	12.78	540.083
77	TIE BAR	24 LG QTY 2	100	0	0	4.293	429.3	18.5	1850
78	ENCLOSURE PLATES	PL.125x24X25.1 QTY 4	86.75	0	0	-41.4	-3591.5	0	0
79	OUTRIGGER DIAGONAL PLATES	PL.5X6.5X5 QTY 2	9.36	0	0	9.25	86.58	39.5	369.72
80	MACHINE PLATE		113.79	0	0	-48.7	-5541.6	0	0
	TOTAL		3781.63		-1363.9		99136.8		9186.36
			WEIGHT						
		CG COORDINATES WITH SCREW IN FULL UP POSITION AND SHIPPING CONFIGURATION		X =	-0.3626	Y =	26.3547	Z =	2.43681

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SPREAD SHEET FOR CG LOCATION FOR SUPPORT PLATE LOAD

ITEM N	DESCRIPTION	SIZE	WEIGHT	X	Mx	Y	My	Z	Mz
41	BALL NUT		8.25	0	0	-28	-231	0	0
42	DRIVE SHAFT	APPROX 110 CU IN	49.44	0	0	-37.25	-1841.6	0	0
43	TOP BEARINGS	QTY 2	29.74	0	0	-34.78	-1034.4	0	0
44	BRNG HOUSING MOUNTING LUG	AREA 6.0 THKS 1.0	1.7	0	0	-33.5	-56.95	0	0
45	LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46	BEARING SPACER	7.85ODX6.8IDX4L	20.33	0	0	-38.67	-786.16	0	0
47	BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.89	0	0
48	BRAKE DISK	14ODX.375	16.4	0	0	-51.14	-838.7	0	0
49	DRIVE PULLEY		29.8	0	0	-46.371	-1381.9	0	0
50	BOTTOM HOUSING CAP	10.8ODX2.75IDX.5625	13.88	0	0	-43.84	-608.5	0	0
51	HOUSING	10.8ODX7.774IDX10.57	134.38	0	0	-37.92	-5095.7	0	0
52	TOP HOUSING CAP	10.8ODX4.64IDX.84	18.07	0	0	-32.21	-582.03	0	0
54	ANTI-ROTATION SPLINE		9	0	0	-20	-180	0	0
55	VERT GUIDE TUBES	80MMX10MM TUBEX235	255	0	0	-132.5	-33788	0	0
56	UPPER TIE BAR	AREA 91 THKS 3.25	85.2	0	0	-16.625	-1416.5	0	0
57	LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-248.5	-30913	0	0
58	OVER TRAVEL GUIDES	12DIAX2THK 2EA	118.4	0	0	-259	-30666	0	0
59	UPPER INNER TUBE	2ODX1.875IDX11	1.23	0	0	-271.25	-333.64	0	0
60	AIR CYLINDER		2.5	0	0	-257	-642.5	0	0
61	INNER TUBE ADJUSTER	2DIAX4.9LONG	4.25	0	0	-278.88	-1185.2	0	0
62	OVER TRAVEL RODS	2DIAX24.875X4 RODS	88	0	0	-257	-22616	0	0
63	LVDT TUBE & HARDWARE	1.75ODX1.687IDX222.06	13	-7.43	-96.59	-251	-3263	-7.43	-96.59
64	LOWER INNER TUBE	2ODX1.875IDX138.81	15	0	0	-350.74	-5261.1	0	0
65	OUTER TUBE	4.5ODX4IDX170.42	163.8	0	0	-335.21	-54907	0	0
66	MCO GRAPPLE	1.625DIAX17LONG	10	0	0	-427.5	-4275	0	0
67	BALL SCREW		201.45	0	0	-35.15	-7081	0	0
68	CAMERA AND MOUNTING		10	0	0	-409.75	-4097.5	0	0
69	FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-275.13	-4126.9	0	0
	LOAD		3200					0	0
	TOTAL		4660.59		-96.59		-218067		-96.59
			WEIGHT						
		CG COORDINATES		X =	-0.0207	Y =	-46.794	Z =	-0.0207
		WITH SCREW IN FULL DOWN POSITION							

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SPREAD SHEET FOR CG LOCATION FOR SUPPORT PLATE LOAD WITH MAXIMUM ECCENTRICITY

ITEM N	DESCRIPTION	SIZE	WEIGHT	X	Mx	Y	My	Z	Mz
41	BALL NUT		8.25	0	0	-28	-231	0	0
42	DRIVE SHAFT	APPROX 110 CU IN	49.44	0	0	-37.25	-1841.6	0	0
43	TOP BEARINGS	QTY 2	29.74	0	0	-34.78	-1034.4	0	0
44	BRNG HOUSING MOUNTING LUG	AREA 6.0 THKS 1.0	1.7	0	0	-33.5	-56.95	0	0
45	LOAD CELLS	2.5 LB EA QTY 3	7.5	0	0	-34.5	-258.75	0	0
46	BEARING SPACER	7.88ODX5.8IDX4L	20.33	0	0	-38.67	-786.16	0	0
47	BOTTOM BEARING	QTY 1	14.87	0	0	-41.62	-618.89	0	0
48	BRAKE DISK	14ODX.375	16.4	0	0	-51.14	-838.7	0	0
49	DRIVE PULLEY		29.8	0	0	-46.371	-1381.9	0	0
50	BOTTOM HOUSING CAP	10.8ODX2.75IDX.5625	13.88	0	0	-43.84	-608.5	0	0
51	HOUSING	10.8ODX7.774IDX10.57	134.38	0	0	-37.92	-5095.7	0	0
52	TOP HOUSING CAP	10.8ODX4.64IDX.84	18.07	0	0	-32.21	-582.03	0	0
54	ANTI-ROTATION SPLINE		9	0	0	-20	-180	0	0
55	VERT GUIDE TUBES	80MMX10MM TUBEX235	255	0	0	-132.5	-33788	0	0
56	UPPER TIE BAR	AREA 91 THKS 3.25	85.2	0	0	-16.625	-1416.5	0	0
57	LOWER TIE BAR	AREA 144 THKS 3	124.4	0	0	-248.5	-30913	0	0
58	OVER TRAVEL GUIDES	12DIAX2THK 2EA	118.4	0	0	-259	-30666	0	0
59	UPPER INNER TUBE	2ODX1.875IDX11	1.23	0	0	-271.25	-333.64	0	0
60	AIR CYLINDER		2.5	0	0	-257	-642.5	0	0
61	INNER TUBE ADJUSTER	2DIAX4.9LONG	4.25	0	0	-278.88	-1185.2	0	0
62	OVER TRAVEL RODS	2DIAX24.875X4 RODS	88	0	0	-257	-22616	0	0
63	LVDT TUBE & HARDWARE	1.75ODX1.687IDX222.06	13	-7.43	-96.59	-251	-3263	-7.43	-96.59
64	LOWER INNER TUBE	2ODX1.875IDX138.61	15	0	0	-350.74	-5261.1	0	0
65	OUTER TUBE	4.5ODX4IDX170.42	163.8	0	0	-335.21	-54907	0	0
66	MCO GRAPPLE	1.625DIAX17LONG	10	0	0	-427.5	-4275	0	0
67	BALL SCREW		201.45	0	0	-35.15	-7081	0	0
68	CAMERA AND MOUNTING		10	0	0	-409.75	-4097.5	0	0
69	FAIL SAFE LATCHES	AREA 21 THK .5 (4)PLCS	15	0	0	-275.13	-4126.9	0	0
	LOAD		2700					-1.5	-4050
	TOTAL		4150.59		-96.59		-218087		-4146.6
		WEIGHT							
		CG COORDINATES	X =	-0.0232	Y =	-52.417	Z =	-0.9966	
		WITH SCREW IN FULL DOWN POSITION							

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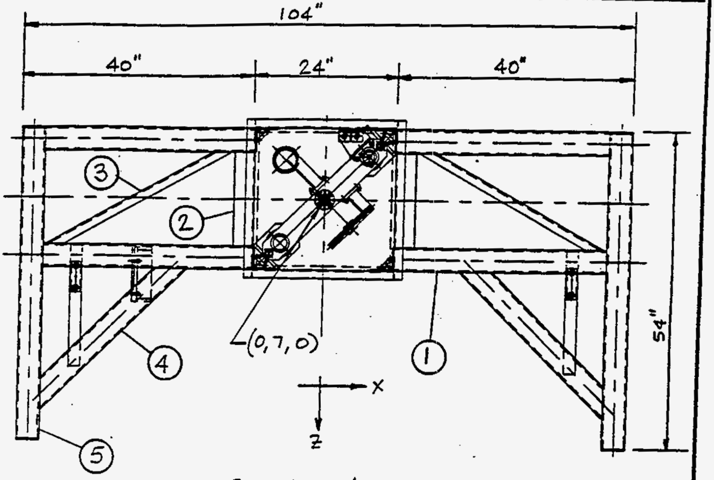
COMPONENTS WEIGHTS & C.G. DETERMINATION



PLAN VIEW
ITEM # 1 THR' 5

CENTER LINE OF THESE ITEMS IS 7 IN. ABOVE 0-0 BASE LINE.
0'-0" IS CENTER LINE OF DRIVE SHAFT.

ITEM # DESCRIPTION

① TUBE 4×4×1/4 35 3/4" LONG (4) 12.21 #/1, TOTAL WT = 146#
$x = 0$; $y = 7$; $z = 0$ $\quad 4 \times \frac{35.75}{12} \times 12.21 = 146\#$

② BASE LATERAL ANGLES ∠ 1 1/2 × 1 1/2 × 3/16 17" LONG (2) 1.8#/1 WT = 5.1#
$x = 0$; $y = 7$; $z = 0$ $\quad \frac{2 \times 17}{12} \times 1.8 = 5.1\#$

③ BASE DIAGONAL ANGLES ∠ 1 1/2 × 1 1/2 × 3/16 32.63" LONG (2) 1.8#/1
WT = 9.8#
$x = 0$; $y = 7$; $z = 0$ $\quad 2 \times \frac{32.63}{12} \times 1.8 = 9.789\#$

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ITEM	DESCRIPTION
④	BASE LATERAL TUBES TS 4x4x1/4 1'-10" LG (2) 12.21 #/1 WT = 1.833 × 2 × 12.21 = 44.77 # X = 0 ; Y = 7.0" ; Z = 20.277
⑤	BASE LONGI. TUBES TS 4x4x1/4 × 54" LG (2) 12.21 #/1 X = 0" ; Y = 7.0" ; Z = 15" WT = $\frac{54}{12}$ × 12.21 × 2 = 109.89 #

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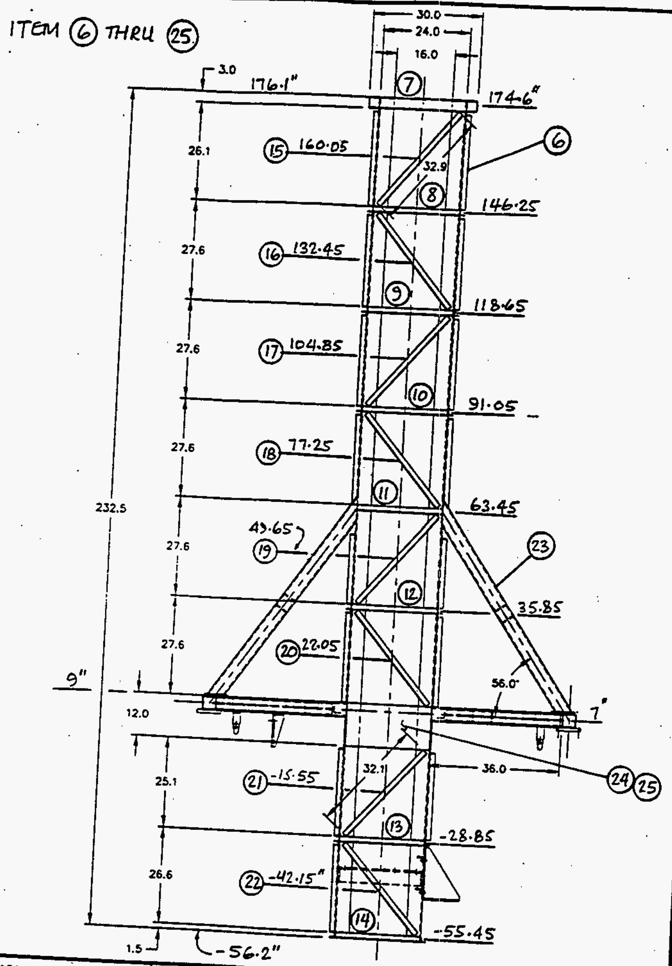

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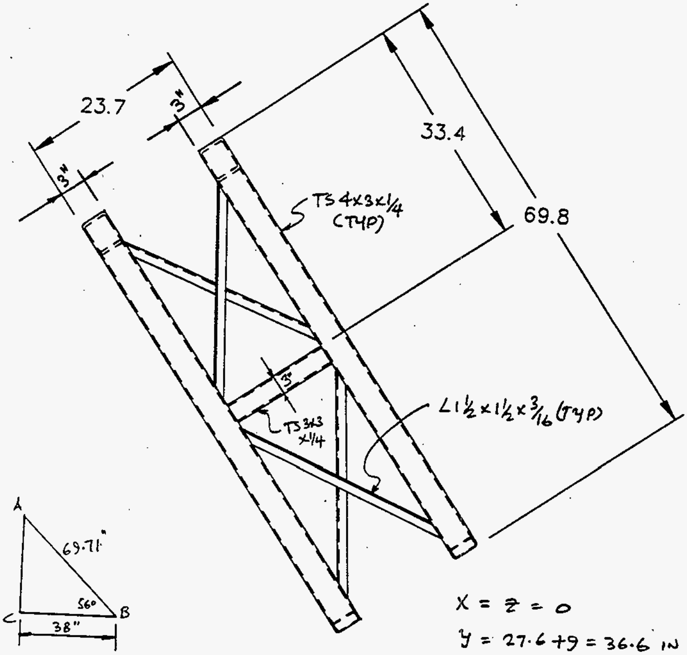
ITEM	DESCRIPTION
⑥	MAST VERT. ∠4×4×1/4 232.5" LG (4) 6.6#/1 WT = 511.5# X = 0 ; Y = 60.05 ; Z = 0 $\frac{4\times232.5}{12}\times6.6=511.5$#
⑦	MAST HORI. TUBES TS 3×3×3/16 27" LG (4) 6.87#/1 WT = 61.83# X = 0 ; Y = 174.6" ; Z = 0 $4\times\frac{27}{12}\times6.87=61.83$#
⑧	MAST HORI. ∠1½×1½×3/16×102" LG 1.8#/1 WT = 15.3# X = 0 ; Y = 146.25" ; Z = 0
⑨	SAME AS ITEM #8 EXCEPT Y = 118.65"
⑩	SAME AS ITEM #8 EXCEPT Y = 91.05
⑪	SAME AS ITEM #8 EXCEPT Y = 63.45
⑫	SAME AS ITEM #8 EXCEPT Y = 35.85
⑬	SAME AS ITEM #8 EXCEPT Y = −28.85
⑭	SAME AS ITEM #8 EXCEPT Y = −55.45
⑮	MAST DIAGONAL ∠1½×1½×3/16 ×181.47 LG 1.8#/1 WT = 19.72# X = 0 ; Y = 160.05" ; Z = 0
⑯	SAME AS ITEM #15 EXCEPT Y = 132.45
⑰	SAME AS ITEM #15 EXCEPT Y = 104.85
⑱	SAME AS ITEM #15 EXCEPT Y = 77.25
⑲	SAME AS ITEM #15 EXCEPT Y = 49.65
⑳	SAME AS ITEM #15 EXCEPT Y = 22.05
㉑	SAME AS ITEM #15 EXCEPT Y = −15.55
㉒	SAME AS ITEM #15 EXCEPT Y = −42.15

ITEM #㉓ MAST DIAGONAL BRACE



X = Z = 0

Y = 27.6 + 9 = 36.6 IN

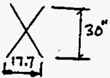
AB - CENTER TO CENTER LENGTH OF TS 4x3x1/4

AB = $38/\cos 56 - 2 = 69.71"$ WT = 10.51 #/1

WT OF TS = $2 \times \frac{69.71}{12} \times 10.51 = 122.1$ #

CENTER TS WT = $\frac{17.7}{12} \times 10.51 = 10.5$ #

4 - ∠1½×1½×3/16



34.8" LG 1.8#/1 WT = $4 \times 1.8 \times \frac{34.8}{12} = 20.88$#

TOTAL WT = $2\,(122.1 + 10.5 + 20.88) = 306.96$#

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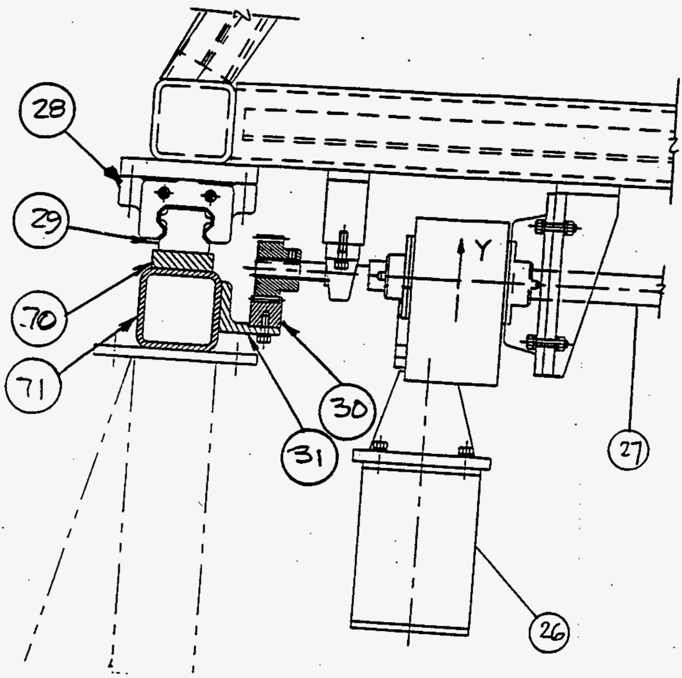
ITEM # ㉖ THRU ㉛, (70) & (71)



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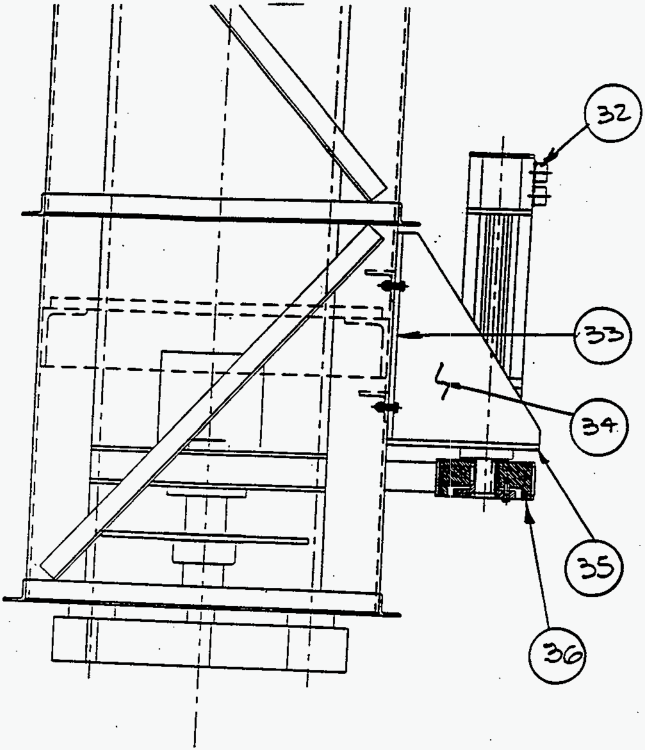
ITEM # ㉜ THRU ㊱



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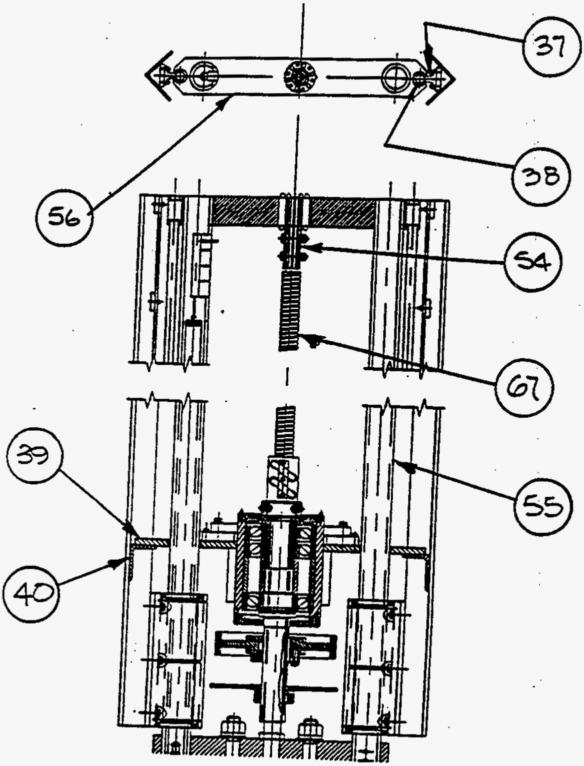
ITEM # ㊲ THRU ㊵, (54) THRU (57) & (67)



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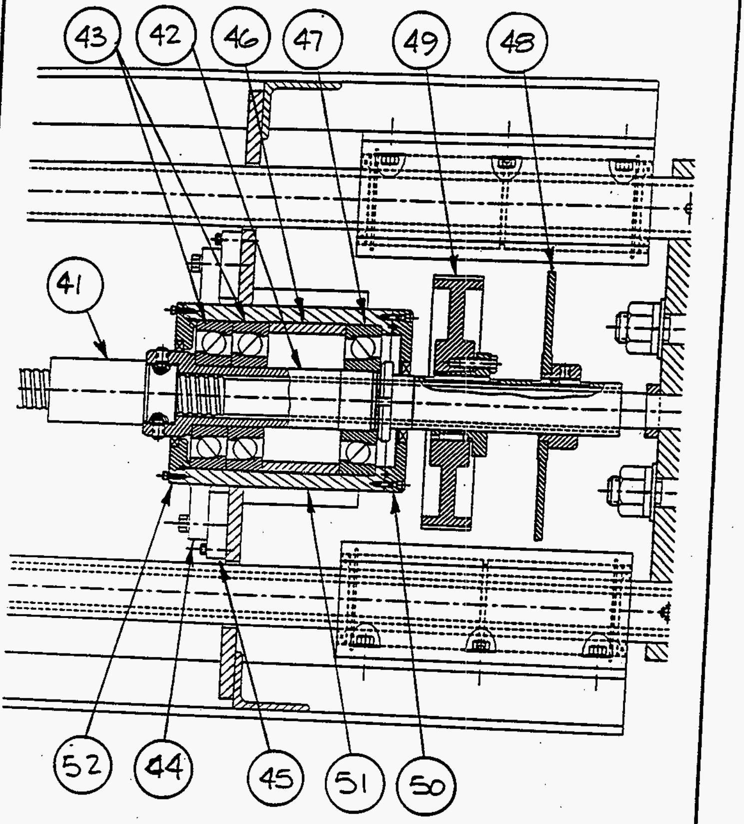
ITEM ㊶ THRU ㊾



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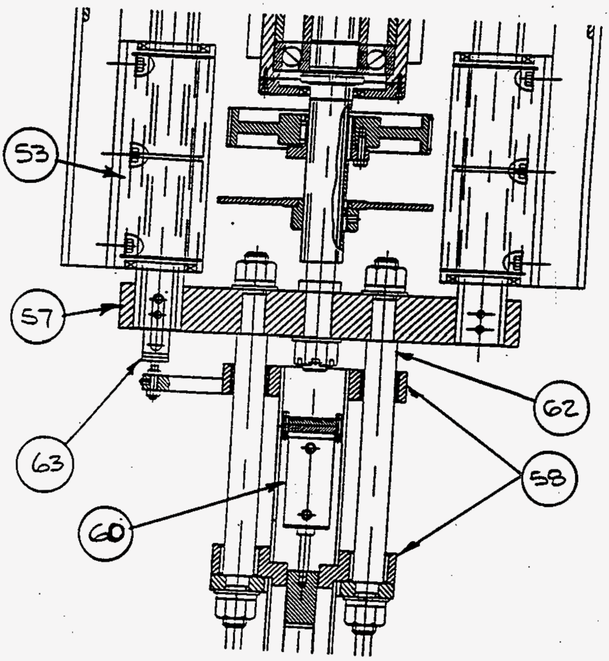
ITEM (53), (57), (58), (60), (62) & (63)



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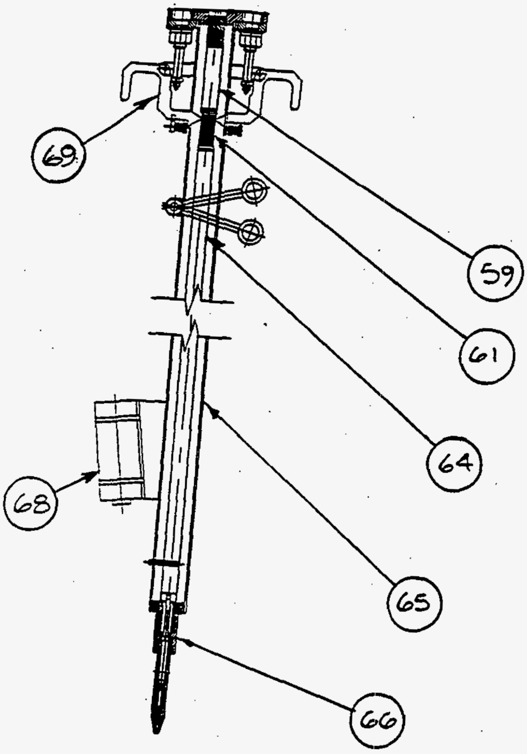
ITEM # ㊾ ⑥① ⑥④ THRU ⑥⑥ ⑥⑧ & ⑥⑨



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ITEM #	DESCRIPTION
㉔	SIDE PLATES 1/4×23.5×12 (2) WT = 2×0.25×23.5×12 ×0.288 = 40.61# X=0 ; Y = 3.0 ; Z = 0
㉕	SAME AS ITEM # 24.
㉖	GANTRY MOTOR & GEAR BOX WT=96# X = -37.66" ; Y = -4.75" ; Z = 13.75"
㉗	DRIVE SHAFT 1.437 DIA×73.78 WT=34# X=0 ; Y = 0 ; Z = 13.75
㉘	GANTRY BEARING WT = 184# X=0 ; Y = 2.962 ; Z = 12.78
㉙*	GANTRY RAIL 22.5Kg/M 144"LG WT=181# X=0 ; Y=20 ; Z= 24
㉚*	RACK GEAR 1.5×1.38×48 QTY 2 WT=56.2# X = 0 ; Y = 10.2 ; Z = 24
㉛*	RACK SUPPORT ANGLE L3×3×.5×108 QTY 2 WT = 169.2 X = Y = 0 Z = 24
㉜	SCREW DRIVE MOTOR & GEAR HEAD WT = 110# EST. X = 18.55 ; Y = -35 ; Z = -4

* THESE ITEMS ARE NOT USED IN CG CALCULATION FOR MAST.

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ITEM DESCRIPTION

㉝ MOTOR BRACKET BASE ½×14×8 0.288 #/IN^3 WT = 16.13#
X = 12.125; Y = −36.86 ; Z = −4
WT = 0.5×14×8 ×.288 = 16.13

㉞ MOTOR BRACKET SIDES ¼" THICK PL A = 80.345 IN^2 QTY. 2.
AREA = (14×10.21) − (9.21×13 ×0.5) = 83.075 IN^2.
WT = 83.075 ×.25 ×.288 ×2 = 11.96#
X = 15 ; Y = −37.5 ; Z = −4

㉟ MOTOR BRACKET BOTTOM ½×10.21 ×8 WT = 11.76#
X = 17.1 ; Y = −44.11 ; Z = −4
WT = .5×10.21×8×.288 = 11.76#

㊱ MOTOR PULLEY WT = 15.1# X = 18.55, Y = −46.371, Z = −4

㊲ VERTICAL RAIL SUPPORTS 4 EA. 5.6# X = Z = 0 Y = 78.375 WT = 22.4#

㊳ VERTICAL RAILS 2 EA 1"Φ ×193.25 43# EA WT = 86# X = Z = 0 Y = 78.375

㊴ SCREW DRIVE BRNG SUPT. PL 22.5 SQ ×1½ THICK
LESS 1 − 10.8"Φ & 2 − 3½"Φ HOLES
AREA = $22.5^2 - \pi/4 \times 10.8^2 - 2 \times \pi/4 \times 3.5^2$ = 395.4 IN^2
WT = 395.4 ×1.5 ×.288 = 170.8 #
X = Z = 0 Y = −35.25 IN

㊵ SCREW DRIVE BRNG SUPT ANGLES L4×3×3/8 8.5 #/FT
2 PC'S 23½" & 2 PC'S 17½" LG TOTAL 82" LG
WT = 82/12 ×8.5 = 58.08#, X = Z = 0 Y = −36.2

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ITEM DESCRIPTION

(41) BALL NUT WT = 8.25 * $y = -28$ $x = z = 0$

(42) DRIVE SHAFT 4.5" OD x 2.1" ID x 13.8" LG

$\pi/4\,(4.5^2 - 2.1^2) \times 13.8 \times .288 = 49.44$ # $y = -37.25$"

$x = z = 0$

(43) TOP BEARINGS TOTAL 2 WT = 14.87 x 2 = 29.74*

$x = z = 0$ $y = -34.78$

(44) BRNG HOUSING MNTG LUG $A = 6$ IN^2 1" THICK WT = 1.7 *

$x = z = 0$ $y = -33.5$

(45) LOAD CELLS (3) 2.5# EA WT = 7.5# $y = -34.5$

$x = z = 0$

(46) BEARING SPACER 6.8" ID x 7.88 OD x 4" LG

1) $\pi/4\,(7.88^2 - 6.88^2) \times .288 \times 4 = 13.35$# $y = -38.67$ IN.

2) $\pi/4\,(4.2^2 - 3.15^2) \times 4 \times .288 = 6.98$* $x = z = 0$

TOTAL WT = 13.35 + 6.98 = 20.33*

(47) BOTTOM BEARING WT = 14.87* $x = z = 0$ $y = -41.62$

(48) BRAKE DISK 14" OD x .375 BEARING 16.4# $y = -51.14$ IN.

$x = z = 0$

(49) DRIVE PULLEY WT 29.8* $y = -46.371$, $x = z = 0$

(50) BOTTOM HOUSING CAP 10.8 OD x 2.75 ID x 9/16

WT = $\pi/4\,(10.8^2 - 2.75^2) \times .5625 \times .288 = 13.88$# $y = -43.84$

$x = z = 0$

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ITEM DESCRIPTION

(51) HOUSING 10.8 OD × 7.774 ID × 10.57" LG

$WT = \pi/4 (10.8^2 - 7.774^2) \times 10.57 \times .288 = 134.38\#$

$x = z = 0$ $y = -37.92$

(52) TOP HOUSING CAP 10.8 OD × 4.64 ID × .84

$WT = \pi/4 (10.8^2 - 4.64^2) \times .84 \times .288 = 18.07\#$ $x = z = 0$ $y = -32.21$

(53) VERT. GUIDE TUBE BEARING

2 BALL BUSHING 8.63# EA.
HOUSING ~18 # EA

} 26.63# PER SIDE

$\therefore WT = 26.63 \times 2 = 53.26\#$ $y = -48.5$, $x = z = 0$

(54) ANTI ROTATION SPINE 9# EST.

$y = 170$ TO -20 $x = z = 0$

(55) VERTICAL GUIDE TUBES 80 MM OD × 70 MM ID × 235 IN LG.

$$WT = \pi/4 \left\{ \underbrace{\left(\frac{80}{25}\right)^2}_{\text{OD IN.}} - \underbrace{\left(\frac{70}{25}\right)^2}_{\text{ID IN}} \right\} \times 235 \times .288 \times \underbrace{2}_{\text{NO. OF TUBES}} = 255\#$$

$y = +57.5$ TO -132.5 ; $x = z = 0$

(56) UPPER TIE BAR AREA 91 IN^2 3.25" THICK.

$WT = 91 \times 3.25 \times .288 = 85.2\#$

$Y = 173.375$ TO -16.625 ; $x = z = 0$

(57) LOWER TIE BAR AREA $= 144''^2$ THICKNESS 3", $x = z = 0$

$Y = -58.5"$ TO $-248.5"$ $WT = 144 \times 3 \times .288 = 124.4\#$

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ITEM DESCRIPTION

(58) OVER TRAVEL GUIDES 12"Φ x 2" 2 EA.
WT = 59.2 # TOTAL 2 ∴ WT = 59.2 x 2 = 118.4 #
y = -69 TO -259 ; x = z = 0

(59) UPPER INNER TUBE 2" OD x 1.875" ID x 11" LG 1.34 #/1
$11/12 \times 1.34 = 1.23$ #
y = -81.25 TO -271.25 ; x = z = 0

(60) AIR CYLINDER WT = 2.5 # EST.
y = -67 TO -257 ; x = z = 0

(61) INNER TUBE ADJUSTER ~2"Φ DIA 4.5" LG
W = 4.25 # y = -88.88 TO -278.88, x = z = 0

(62) OVER TRAVEL RODS 2"Φ x 24.875 LG 4 GUIDES
EACH 22 # TOTAL WT = 22 x 4 = 88 # y = -67 TO -257
x = z = 0

(63) LVDT TUBE & HARDWARE
1.75 OD x 1.687 ID x 222 1/16 WT = 13 #
x = -7.43 ; z = -7.43
y = -61 TO -251 ; x = z = 0

(64) LOWER INNER TUBE 2" OD x 1.875" ID x 138.61 LG
$\pi/4 (2^2 - 1.875^2) \times 138.61 \times .288 = 15$ #
y = -160.74 TO -350.74 ; x = z = 0

(65) OUTER TUBE 4.5" OD x 4" ID x 170.42 LG x = z = 0
$\pi/4 (4.5^2 - 4^2) \times 170.42 \times .288 = 163.8$ # y = -145.21 TO -335.21

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ITEM	DESCRIPTION
⑥⑥	MCO GRAPPLE ~1 5/8"ϕ X17" LG W=10 # y= −237.5 TO −427.5 ; x = z = 0
⑥⑦	BALL SCREW WT = 201.45 # y = 154.85 TO −35.15 ; x = z = 0
⑥⑧	CAMERA & MOUNTING WT = 10# y = −219.75 TO −409.75 x = z = 0
⑥⑨	FAIL SAFE LATCHES AREA 21 THICKNESS 0.5 4-places + HARDWARE WT = 15 # x = 0 z = 0 y = −85.125 TO −275.125
⑦⓪*	GENTRY RAIL SUPPORT PAD 0.875" THICK x 3" WIDE x 108" LG BAR 2 SIDES WT = .875 x 3 x 108 x .288 x 2 = 163.3 # X = 0 ; Y = .437 ; z = 24
⑦①*	GENTRY RAIL TUBES 4x4x 5/16" x 117" LG (2) WT = 14.83 #/1 x (117 ÷ 12) X 2 = 289 # x = 0 ; y = −2 ; z = 16.784

* THESE ITEMS ARE NOT USED IN CG CALCULATION FOR MAST

ITEM	DESCRIPTION
⑦②	DIAGONAL BRACE TUBE (PIPE) 3"ϕ SCH-40 7.8 #/1 $\{(2\times27.6)^2+36^2+27.5^2\}^{1/2} \cong 72$ IN WT = $\frac{72}{12}\times 7.8 = 46.8$ EA 2 SIDE TOTAL = 93.6 # X = 0 IN. y = 36.6 z = 27.5

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ITEM	DESCRIPTION

(73) OUTRIGGER WELDMENT LOWER PLATES FOR TS 4x3x1/4

4- PLATES $\frac{1}{2} \times 6.5 \times 3.5$

$WT = 4 \times \frac{1}{2} \times 6.5 \times 3.5 \times 0.288 = 13.1^{*}$ $\qquad WT = 13.1^{*}$

$x = 0$; $y = 9.25$; $z = 0$

(74) OUTRIGGER WELDMENT UPPER PLATES FOR TS 4x3x1/4

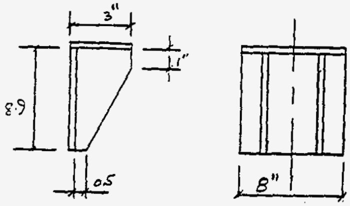
4- PLATES $\frac{1}{2} \times 7.25 \times 6$

$WT = 4 \times \frac{1}{2} \times 7.25 \times 6 \times 0.288 = 25.1^{*}$ $\qquad WT = 25.1^{*}$

$x = 0$; $y = 62.7$; $z = 0$

(75) SHAFT BRACKET 4 - PLATES

1) $\frac{1}{2} \times 3 \times 8$
2) $\frac{1}{2} \times 8 \times 8.9$
3) 2.5×8.9 CUT PLATE AS SHOWN



WEIGHTS

1) $.5 \times 3 \times 8 \times .288 = 3.456^{*}$
2) $.5 \times 8 \times 8.9 \times .288 = 10.25^{*}$

3) $\left\{\left(\underset{22.25}{2.5 \times 8.9}\right) - \left(\underset{7.9}{7.9 \times 2 \times .5}\right)\right\} \times .5 \times 2 \times .288$

$= 4.13^{*}$

TOTAL $WT = 3.456 + 10.25 + 4.13 = 17.84^{*}$

$x = -30.75''$ $\quad y = 0.6''$; $z = 13.75''$

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ITEM DESCRIPTION

(76) PLATES UNDER TS 4×4×1/4 TOTAL - 6

1/2×6.7×7.3 LG WT = 0.5×6.7×7.3×6 ×.288 = 42.26 #

X = 0 ; Y = 4.75 ; Z = 12.78

(77) TIE BAR 2"×3.5"×2'-0 LG (2)

WT = 2 × 2 × 3.5 × 24 × .288 = 96.768 #

X = 0 ; Y = 4.293 ; Z = 18.5"

USE WT = 100 #
TO INCLUDE 2 - PILLOW BLOCK

(78) ENCLOSURE PLATES (4) 1/8×24×25.1" LG.

WT = 0.125 × 24 × 25.1 × .288 × 4 = 86.75 #

X = 0 ; Y = −41.4 ; Z = 0

(79) OUTRIGGER DIAGONAL PLATES (2) 1/2×6.5×5

WT = 0.5× 6.5×5×2×.288 = 9.36 #

X = 0 ; Y = 9.25 ; Z = (27.5+12) = 39.5"

(80) MACHINE PLATES (2) SPACIAL PLATES CUT FROM BAR

CROSS SECTION AREA = 13.17 IN^2 15" LONG.

WT = 13.17 × 15 × 2 × .288 = 113.79 #

X = 0 ; Z = 0 ; Y = −48.7 IN.

BOTTOM OF BAR IS SAME AS BOTTOM OF MAST. VERT. ∠4×4.

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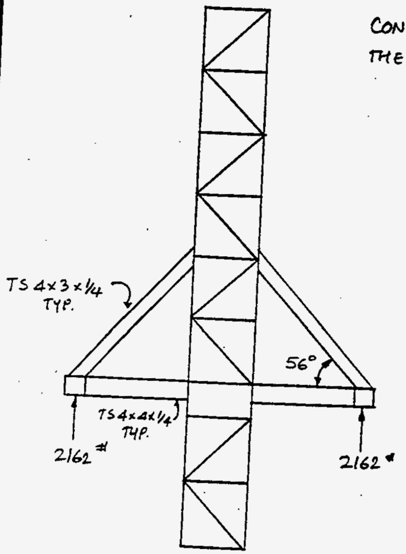
EVALUATION OF MAST & GANTRY CROSS TUBES AND BRACES

WT OF MAST & GANTRY FROM SPREAD SHT = 7574# REF PG# 8
WT. OF LOADED BASKET (3200#) IS INCLUDED IN ABOVE WEIGHT.

CONSIDER FOUR BEARING UNDER THE MAST ARE EVENLY LOADED.

$P_{MAX} = 7574\#$

SEE NEXT PAGE FOR MAXIMUM LOAD ON ANGLE USE THIS LOAD (2162#) ON EACH SIDE CONSERVATIVELY.



ELEVATION VIEW SHOWING LOAD @ ONE BEARING PAIR. TYP. BOTH PAIRS AT MAST.

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FIND A MAX. FORCE IN VERT. ANGLE 4x4x1/4

REF. SPREADSHEET PAGE # 8 FOR CASE # 1

CASE 1 $P_{MAX} = 7574^{\#}$ (FUEL WT 3200# W/O ECC)

VERT. LOAD = 7574# ; $M_X = 1364''^{\#}$; $M_Z = 11518''^{\#}$

$$\text{MAX LOAD ON } \angle 4\times4 = \frac{7574}{4} + \frac{1364}{2\times24} + \frac{11518}{2\times24}$$

$$= 2162^{\#}$$

CASE 2. $P_{MAX} = 7074^{\#}$; $M_x = 1364''^{\#}$; $M_Z = 15568''^{\#}$

REF. SPREADSHEET PAGE # 9 (FUEL WT. 2700 WITH 1.5" ECC)

$$\text{MAX. VERT. ON } \angle 4\times4 = \frac{7074}{4} + \frac{1364}{2\times24} + \frac{15568}{2\times24}$$

$$= 2121^{\#}$$

FROM CASE 1 & 2, LOAD CASE 1 GOVERNS

<u>NOTE</u>: ALLOWABLE STRESSES FOR ALL STRUCTURAL MEMBERS IN THIS CALCULATION USED ARE LOWER OF $\frac{F_y}{3}$ OR $\frac{F_u}{5}$

THEREFORE FOR A-36 MAT'L $\frac{F_u}{5}$ GOVERNS

$$= 58000/5 = 11600 \text{ PSI.}$$

AND FOR STAINLESS STEEL $F_y/3$ GOVERN

$$= 30000/3 = 10000 \text{ PSI.}$$

FOR AXIAL ALLOW USE LOWER OF AISC OR ABOVE ALLOW.

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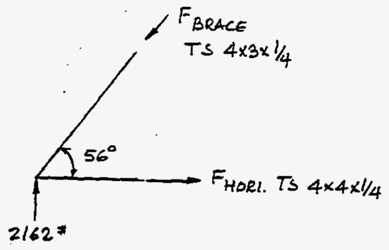

$$\Sigma F_Y = 0 = 2162 - F_{BRACE} \times \sin 56^\circ = 0$$

$$\therefore F_{BRACE} = \frac{2162}{\sin 56}$$

$$= 2608\ \#$$

$$F_{HORI} = F_{BRACE} \times \cos 56$$

$$= 2608 \times \cos 56$$

$$= 1458\ \#$$

CHECK AXIAL STRESS IN BRACE (OUTRIGGER DIAGONAL)
(ITEM #6 DWG 444-215 R/0)

$$f_a = \frac{P}{A} = \frac{2608}{3.09}$$

$P = F_{BRACE} = 2608\ \#$

$A = 3.09\ IN^2$ TS 4x3x1/4

$$= 844\ PSI$$

$$\frac{K\ell}{r_{min}} = \frac{1.0 \times 65.79}{1.15}$$

$\ell = (38^2 + 53.7^2)^{1/2} = 65.79$ IN.

$K = 1.0$

$r_{min} = 1.15$ IN

$$= 57.2$$

$\Rightarrow F_a = 17620$ PSI.

USE $F_a = 11600$ PSI $>> f_a$ $\therefore$ TS 4x3x1/4 IS OK

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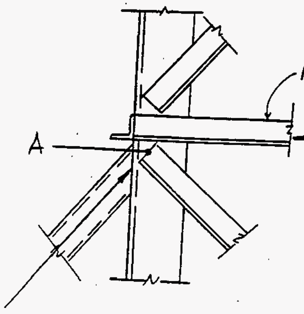
CHECK AXIAL STRESS IN HORI. TS 4×4×1/4 (OUTRIGGER HORIZONTAL)

(ITEM#5 DWG#444-215 R/0)

$$fa = \frac{P}{A} = \frac{1458}{3.59} = 406 \text{ psi.}$$

< 11600 PSI. ∴ ok

∴ HORI. TS 4×4×1/4 ok.



MAST HORIZONTALS (ITEM# 12, 16 & 32 DWG# 444-215 R/0)

CONSIDER THIS HORI. ∠1½×1½×3/16 CARRIES FULL LOAD OF F_{BRACE} HORI. COMPONENT. (CONS.)

HORI. LOAD = 2608 × cos 56

= 1458#

$F_{BRACE} = 2608\#$

$$fa = \frac{P}{A} = \frac{1458}{.527} = 2767 \text{ psi.}$$

$$\frac{Kl}{r_{min}} = \frac{1.0 \times 24}{0.293} = 82$$

⇒ Fa = 15130 psi. USE Fa = 11600 psi
>> fa

∴ ∠1½×1½×3/16 ok.

TENSILE STRESS ON 1/4"×12"×23½" LONG PLATE PLATE 1/4"

AXIAL FORCE IS 1458# (ITEM# 20 DWG# 444-215 R/0)

SAME AS LOAD ON TS 4×4×1/4

$$fa = \frac{P}{A} = \frac{1458}{0.25 \times 4} = 1458 \text{ psi.} < 11600 \text{ psi}$$ ∴ PL IS ok

↳ USE ONLY 4" EFFECTIVE WIDTH. CONS.

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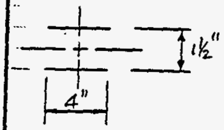
CHECK WELD BETWEEN HORI. ∠1½x1½ AT BRACE & ∠4x4x¼
(MAST HORI. TO MAST VERT)
(ITEM #16 TO ITEM #1 DWG 444-215 R/0)

FORCE IN MEM = 1458 #



USE TWO SIDED 4" LG WELD

WELD LENGTH = 2x4 = 8"

#/IN LOAD = 1458/8

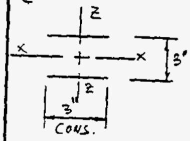
= 182 #/IN

WELD SIZE REQ'D

= 182 ÷ 11600 = 0.0157 IN.

∴ PROVIDE 3/16" FILLET WELD ∴ WELD IS OK

CHECK WELD FOR TS 4x3x¼ BRACE. (ITEM # 6 TO 5 & 6 TO 1
(OUTRIGGER DIA. TO MAST VERT & OUTRIGGER HORIZ) DWG # 444-215 R/0)



FORCE IN BRACE AXIS = 2608 #

HORI. FORCE = 2608 x COS 56 = 1458 #

VERT. FORCE = 2608 x SIN 56 = 2162 #

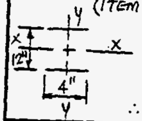
WELD LENGTH = 2x3 = 6 CONS

$$\#/IN = \left\{\left(\frac{1458}{6}\right)^2 + \left(\frac{2162}{6}\right)^2\right\}^{1/2} = 435\ \#/IN$$

WELD SIZE REQ'D = 435 ÷ 11600 = 0.0375 IN

THEREFORE PROVIDE 3/16" FILLET WELD 3" LG. MIN. ∴ WELD IS OK

CHECK WELD FOR 12" DEEP ¼" x 23½" LG PLATES (PLATES TO MAST VERTICAL)
(ITEM # 20 TO 1 DWG # 444-215 R/0)



WELD LENGTH = 4 x 2 = 8" P = 1458 #

#/IN = 1458/8 = 183 # SIZE REQ'D = 183 ÷ 11600
= 0.016 IN

∴ PROVIDE 3/16" FILLET WELD 2 SIDED AND BOTH ENDS. ∴ OK

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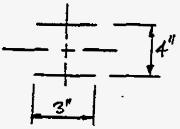
CHECK WELD ON HORIZONTAL TS 4×4×1/4. (OUTRIGGER HORIZONTAL TO MAST VERTICALS)

TENSION LOAD ON TS 4×4 IS ONLY 1458 # (ITEM # 5 TO 1 REF DWG 444-215 R/0)

USE TWO SIDED 3" WELD PATTERN. CONS.



LENGTH OF WELD = 2×3 = 6"

FORCE PER IN = 1458/6

= 243 #

WELD SIZE REQ'D = 243 ÷ 11600

= 0.0209 IN

PROVIDE 3/16" FILLET WELD MIN. 3" LG ON TWO SIDES

∴ WELD IS ADEQUATE

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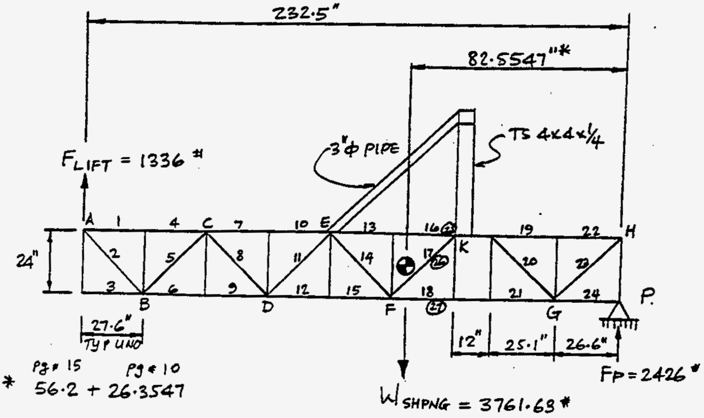
LIFT LOAD FROM HORIZONTAL SHIPPING POSITION.



pg# 15 pg# 10

* 56.2 + 26.3547

TAKING MOMENT ABOUT POINT P

$$F_{LIFT} \times 232.5 - W_{SHPNG} \times 82.5547 = 0$$

$$\therefore F_{LIFT} = \frac{W_{SHPNG} \times 82.5547}{232.5} = \frac{3761.63 \times 82.5547}{232.5}$$

$$= 1336 \text{ LBS}$$

$$F_P = 3761.63 - 1336$$

$$= 2426 \text{ LBS}$$

NOTE : 1) DEAD WT. OF MAST IS NOT CONSIDERED TO FIND FORCES IN TRUSS MEMBER CONSERVATIVELY.

2) ANALYZE TRUSS MEM. FROM EACH END THRU PANEL WHERE CENTROID IS LOCATED.

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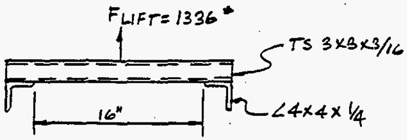
CHECK TS 3x3x3/16 AT LIFT POINT. (TOP HORIZONTAL)



CONSIDER SIMPLY SUPPORTED BEAM

$$\text{MAX. MOM} = \frac{PL}{4} = \frac{1336 \times 24}{4} = 8016 \text{ in.\#}$$

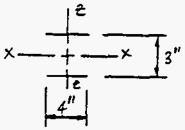
$Fu/5$ GOVERNS OVER $\frac{Fy}{3}$

$$f_b = \frac{M}{S} = \frac{8016}{1.73} = 4634 \text{ PSI} < \frac{Fu}{5} = \frac{58000}{5} = 11600 \text{ PSI.} \quad \therefore \text{ OK}$$

$$\text{CHECK SHEAR STRESS} = \frac{P}{A} = \frac{1336}{2 \times 0.1875 \times 3} = 1188 \text{ PSI.} < 11600 \text{ PSI}$$

STRESSES ARE LOW. ∴ TS 3x3x3/16" IS OK.

CHECK WELD BETWEEN TS 3x3 & ∠4x4. TOP HORIZONTAL TO MAST VERTICAL
(ITEM # 17 TO 1 DWG # 444-215 R/0)
USE HALF MOMENT & HALF FORCE ON ONE SIDE WELD.



$$AW = 4 \times 2 = 8 \text{ IN} \quad \text{CONS.} \quad SW_z = \frac{4^2}{3} = 5.33 \text{ IN}^2$$

$$\text{FORCE ON WELD} = \frac{1336}{2 \times 8} + \frac{8016}{2 \times 5.33} = 835 \text{ \#/IN}$$

$$\text{WELD SIZE REQ'D} = 835 \div 11600 = 0.072 \text{ IN.}$$

$$\frac{Fy}{3} \text{ OR } \overset{\text{CONTROLS}}{\frac{Fu}{5}} = \frac{58000}{5} = 11600 \text{ PSI}$$

THEREFORE PROVIDE FLARE BEVEL WELD 4" LONG. MIN.
AVAL. THROAT = 5/8 t = 0.625 x .1875 = 0.117 IN, ALSO PROVIDE 3/16" FILLET WELD
∴ OK

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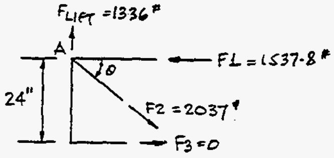
CHECK FORCES IN TRUSS MEMBERS AND EVALUATE STRESS AND BUCKLING.

CONSIDER ALL LOADS CARRIED BY ONE SIDE OF TRUSS CONS. i.e. F_{LIFT} IS NOT DIVIDED BY 2

FORCES IN MEMBERS AT JOINT 'A'



$$\theta_{TYP} = \tan^{-1}\frac{24}{27.62} = 40.98^\circ$$

$$\Sigma M_A = 0 = 24\,F3$$

$$F3 = 0$$

$$\Sigma F_Y = 0 = F_{LIFT} - F2 \sin\theta$$

$$\therefore F2 = \frac{F_{LIFT}}{\sin\theta}$$

$$= \frac{1336}{\sin 40.98^\circ}$$

$$= 2037\ \#$$

$$\Sigma F_X = 0 = F2 \cos\theta - F1$$

$$\therefore F1 = 2037 \times \cos\theta$$

$$= 1537.8\ \#$$

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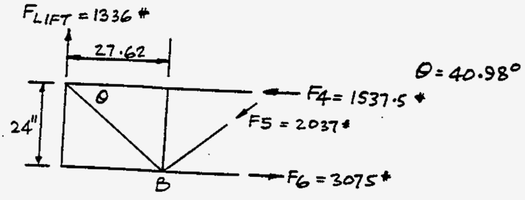
CHECK FORCES IN MEMBERS AT JOINT B.



$$\Sigma M_B = 0 = -27.62 \times F_{LIFT} + 24\,F_4$$
$$= -27.62 \times 1336 + 24\,F4$$
$$\therefore F4 = 1537.5 \text{ \#}$$

$$\Sigma F_Y = 0 = +F_{LIFT} - F5 \times \sin\theta$$
$$= 1336 - F5 \times \sin\theta$$
$$\therefore F5 = 1336/\sin 40.98 = 2037 \text{ \#}$$

$$\Sigma F_X = 0 = -F4 - F5 \times \cos\theta + F6$$
$$\therefore F6 = F4 + F5 \times \cos\theta$$
$$= 1537.5 + 2037 \times \cos 40.98°$$
$$= 3075 \text{ \#}$$

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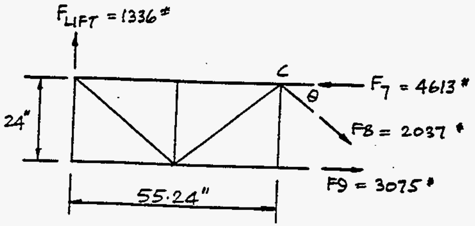
CHECK FORCES IN MEMBERS AT JOINT 'C'



$$\Sigma M_C = 0 = -55.24\ F_{LIFT} + F9 \times 24$$

$$\therefore F9 = \frac{55.24 \times 1336}{24}$$

$$= 3075\ \#$$

$$\Sigma F_Y = 0 = F_{LIFT} - F_8 \sin\theta$$

$$\therefore F_8 = \frac{1336}{\sin\theta}$$

$$= 2037\ \#$$

$$\Sigma F_X = 0 = F9 - F_7 + F8 \cos\theta$$

$$\therefore F7 = F9 + F8 \cos\theta$$

$$= 3075 + 2037 \cos 40.98$$

$$= 4613\ \#$$

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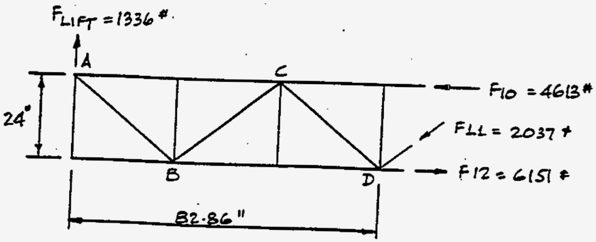
CHECK FORCES IN MEMBERS AT JOINT D



$$\Sigma M_D = 0 = 82.86 \times F_{LIFT} - 24 F_{10}$$

$$\therefore F_{10} = \frac{82.86 \times F_{LIFT}}{24}$$

$$= 4613 \ \#$$

$$\Sigma F_Y = 0 = F_{LIFT} - F_{11} \times \sin\theta$$

$$\therefore F_{11} = \frac{F_{LIFT}}{\sin\theta} = 2037 \ \#$$

$$\Sigma F_X = 0 = F_{12} - F_{11} \times \cos\theta - F_{10}$$

$$\therefore F_{12} = F_{11} \cos\theta + F_{10}$$

$$= 2037 \times \cos 40.98 + 4613$$

$$= 6151 \ \#$$

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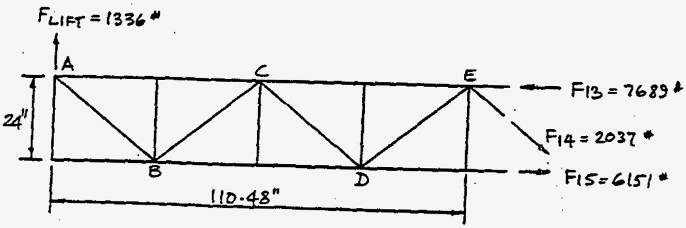
CHECK FORCES IN MEMBERS AT JOINT E



$$\Sigma M_E = 0 = -110.48 \times F_{LIFT} + 24 F_{15}$$

$$\therefore F_{15} = \frac{110.48 \times F_{LIFT}}{24}$$

$$= 6151^{\#}$$

$$\Sigma F_y = 0 = F_{LIFT} - F_{14} \times \sin\theta$$

$$\therefore F_{14} = \frac{F_{LIFT}}{\sin\theta}$$

$$= 2037^{\#}$$

$$\Sigma F_x = 0 = -F_{13} + F_{14} \cos\theta + F_{15}$$

$$\therefore F_{13} = F_{14} \times \cos\theta + F_{15}$$

$$= 2037 \times \cos 40.98 + 6151$$

$$= 7689^{\#}$$

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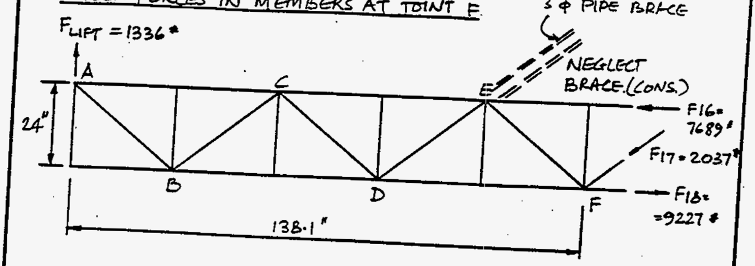
CHECK FORCES IN MEMBERS AT JOINT E



$$\Sigma M_F = 0 = -138.1 \times F_{LIFT} + 24 F_{16}$$

$$\therefore F_{16} = \frac{138.1 \times F_{LIFT}}{24}$$

$$= 7689 \, \# \longleftarrow \text{GOVERNS}$$

$$\Sigma F_Y = 0 = F_{LIFT} - F_{17} \times \sin\theta$$

$$\therefore F_{17} = \frac{F_{LIFT}}{\sin\theta} = 2037 \, \#$$

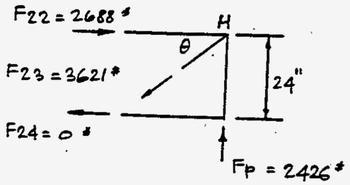
$$\Sigma F_X = 0 = F_{18} - F_{16} - F_{17} \times \cos\theta$$

$$\therefore F_{18} = F_{16} + F_{17} \times \cos\theta$$

$$\therefore F_{18} = 7689 + 2037 \times \cos 40.98$$

$$= 9227 \, \#$$

FORCES IN THE MEMBERS AT JOINT H.



$$\Sigma M_H = 0 = -24\ F4$$

$$\therefore\ F_{24} = 0\ \#$$

$$\theta = TAN^{-1}\frac{24}{26.6} = 42.06°$$

$$\Sigma F_Y = 0 = F_P - F_{23} \times \sin Q$$

$$= 2426 - F23 \times \sin 42.06$$

$$\therefore\ F23 = \frac{2426}{\sin 42.06}$$

$$= 3621\ \#$$

$$\Sigma F_X = 0 = F_{22} - F_{24} - F_{23} \times \cos \theta$$

$$\therefore\ F_{22} = F_{24} + F_{23} \times \cos \theta$$

$$= 3621 \times \cos 42.06$$

$$= 2688\ \#$$

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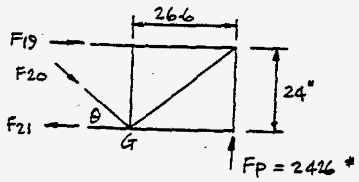
CHECK FORCES IN MEMBERS AT JOINT 'G'



$\Sigma M_G = 26.6\ F_P - 24\ F_{19}$

$\therefore F_{19} = \frac{26.6 \cdot F_P}{24} =$

$= \frac{26.6 \times 2426}{24}$

$= 2689$ #

$\Sigma F_y = 0 = -F_{20} \times \sin\theta + F_P$

$\therefore F_{20} = \frac{F_P}{\sin\theta} = \frac{2426}{\sin 43.72°}$

$= 3510$ #

$\theta = \tan^{-1}\frac{24}{25.1}$

$= 43.72°$

$\Sigma F_x = 0 = F_{19} - F_{21} + F_{20} \times \cos\theta$

$= 2689 - F_{21} + 3510 \times \cos\theta$

$\therefore F_{21} = 2689 + 3510 \times \cos 43.72$

$= 5226$ #

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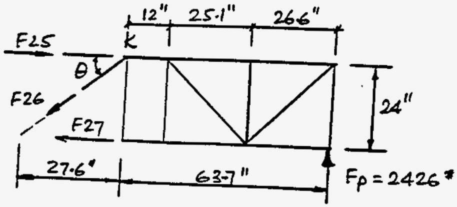
CHECK FORCES IN MEMBERS AT JOINT 'K' FROM RIGHTSIDE REACTION



$$\theta = TAN^{-1} \frac{24}{27.62} = 40.98^\circ$$

$$\Sigma M_K = 0 = FP \times 53 - F_{27} \times 24$$

$$\therefore F_{27} = \frac{2426 \times 63.7}{24} = 6439\#$$

$$\Sigma Y = 0 = FP - F_{26} \times Sin\theta$$

$$\therefore F_{26} = \frac{2426}{Sin\,40.98} = 3699\# \longleftarrow GOVERNS$$

$$\Sigma X = 0 = F25 - F26\,cos\theta - F27$$

$$\therefore F25 = F26\,cos\theta + F27$$

$$= 3699 \times cos\,40.98 + 6439$$

$$= 9232\# \longleftarrow GOVERNS$$

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CHECK STRESSES IN ∠1½×1½ & ∠4×4

1. ∠1½×1½×3/16 (ITEM # 2,3,30 & 36 DWG 444-215 R/0) $P_{MAX} = 3699$, MEM # 26 (DIAGONAL BRACE) PG # 48

$$f_a = \frac{P}{A} = \frac{3699}{0.527} = 7019 \text{ psi}$$

ALLOW STRESS SMALLER OF $\frac{F_y}{3}$ OR $\frac{F_u}{5}$ ↳ GOVERNS

$$\frac{F_u}{5} = 11600 \text{ PSI.}$$

$$\frac{Kl}{r_{min}} = \frac{1.0 \times 32.1}{0.293} = 109.56 \Rightarrow F_a = 11670 \text{ PSI.}$$

∴ USE $F_a = 11600$ PSI > 7019 PSI. ∴ ∠1½×1½×3/16 OK

2. ∠4×4×1/4 (ITEM # 1 DWG 444-215 R/0) $P_{MAX} = 9232$ #   MEM # 25 (MAST VERTICALS) PG # 48

$A = 1.94 \text{ in}^2$ $r_{min} = 0.795$ IN.

$$f_a = \frac{P}{A} = \frac{9232}{1.94} = 4759 \text{ Psi} < 11600 \text{ Psi.}$$

∴ ∠4×4×1/4 OK

$$\frac{Kl}{r_{min}} = \frac{1.0 \times 27.62}{0.795} = 34.74 \Rightarrow F_a = 19580$$

∴ USE 11600 PSI.

THEREFORE. ALL TRUSS MEMBERS ARE ADEQUATE.

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THE FOLLOWING MEMBERS ARE CHECKED TO ENSURE THAT THEY HAVE ADEQUATE STIFFNESS TO BRACE THE TRUSS.

DIAGONAL $\angle 1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$

$L_{MAX} = (33.4^2 + 24^2)^{1/2} = 41.2$ IN.

$\frac{Kl}{r_{min}} = \frac{(1)(41.2)}{0.293} = 141 < 200 \quad \therefore$ OK.

DIAGONAL $\angle 1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ IN HORI. PLANE BETWEEN TS $4 \times 4 \times \frac{1}{2}$

$L_{MAX} = (40^2 + 21^2)^{1/2} = 45$ IN.

$Kl/r_{min} = \frac{(1)(45)}{0.293} = 154'' < 200 \quad \therefore$ OK

3"ϕ SCH 40 PIPE

PIPE LENGTH = 72" PG # 29

$\frac{Kl}{r_{min}} = \frac{(1)(72)}{1.16} = 62$ IN $< 200 \quad \therefore$ OK

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CHECK WELDED CONNECTION FOR BRACE ∠1½ x 1½ x 3/16

DIAGONAL BRACE TO MAST VERTICAL. (ITEM # 2 TO 1 DWG # 444-215 R/0)

MAX. AXIAL LOAD = 3699 #   MEM # 26   PAGE # 48

USE WELD LENGTH OF 1" TWO SIDED

TOTAL WELD LENGTH = 2"

$$\text{WELD FORCE PER INCH} = \frac{3699}{2}$$

$$= 1850\ \#$$

$$\text{WELD SIZE REQ'D} = 1850/11600 \longrightarrow \frac{F_Y}{3} \text{ OR } \frac{F_U}{5} \longrightarrow \text{GOVERNS}$$

$$= 0.159\ \text{IN} \qquad \frac{58000}{5} = 11600\ \text{PSI}$$

THEREFORE PROVIDE 3/16" FILLET WELD
ON TWO SIDES @ EACH END

∴ WELD IS OK

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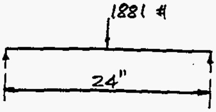
(ITEM # 17 DWG # 444-215 R/0)

STRESSES IN TOP TS 3x3x3/16 DUE TO VERTICAL LIFT. (TOP HORIZONTAL)
CONSIDER LOAD LIFTED AT TWO MID POINTS OF TS 3x3x3/16

LOAD ON EACH TS = 3762/2 = 1881 # (PG # 10)



$$\text{MAX MOM} = \frac{PL}{4} = \frac{1881 \times 24}{4} = 11286 \text{ ''\#}$$

$$f_b = \frac{M}{S} = \frac{11286}{1.73} = 6524 \text{ PSI.}$$

$$< \frac{F_u}{5} = \frac{58000}{5} = 11600 \text{ PSI}$$

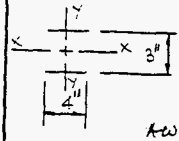
$$\text{OR } \frac{F_Y}{3} = \frac{36000}{3} = 12000 \text{ PSI}$$

CHECK SHEAR STRESS

$$f_v = \frac{1881}{2 \times .1875 \times 3} = 1672 \text{ PSI} < 11600 \text{ PSI ok}$$

∴ TS 3x3x3/16" IS ADEQUATE.

CHECK WELD BETN TS 3x3x3/16 & ∠4x4x1/4
USE HALF LOAD & HALF MOMENT ON WELD



$$F_y = 1881/2 = 941 \text{ \#} \qquad M_z = \frac{11286}{2} = 5643 \text{ ''\#}$$

$$M_x = 1881/2 \times 3 = 2822 \text{ ''\#}$$

$$A_w = 8\text{''} \; ; \; S_{wx} = 4 \times 3 = 12 \text{ IN}^2 \; ; \; J_w = \frac{4^3 + 3 \times 4 \times 3^2}{6} = 28.67 \text{ IN}^3$$

$$\text{FORCE ON WELD} = \left\{ \left(\underset{235}{\frac{2822}{12}}\right)^2 + \left(\underset{118}{\frac{941}{8}} + \underset{394}{\frac{5643 \times 2}{28.67}}\right)^2 + \left(\underset{295}{\frac{5643 \times 1.5}{28.67}}\right)^2 \right\}^{1/2} = 636 \text{ \#/IN.}$$

WELD SIZE REQ'D = 636/11600 = 0.055 IN. LOWER OF $\frac{F_y}{3}$ OR $\frac{F_u}{5}$ ← GOVERNS

PROVIDE FLARE BEVEL & 3/16" FILLET WELD. $\frac{58000}{5} = 11600$ PSI.

∴ WELD IS ok

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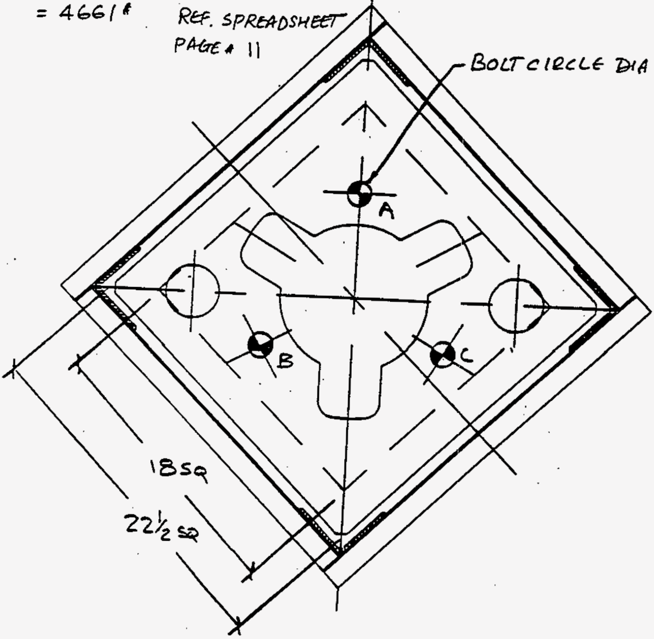
ANALYSIS OF BALL SCREW SUPPORT PLATE (ITEM #13 DWG #444-211 [illegible]) MOUNTING PLATE

1. TOTAL WT OF MAST, BALL SCREW & FUEL BASKET 2700# W/ECC.
   = 4161# REF. SPREADSHEET PAGE # 12

2. TOTAL WT. OF MAST, BALL SCREW & FUEL BASKET 3200# W/O ECC
   = 4661# REF. SPREADSHEET PAGE # 11



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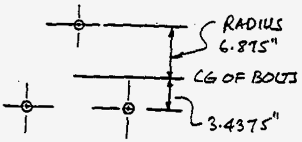
BOLT CIRCLE IS 13.75"

<u>LOAD CASE 1</u> 1" ECC. 2700# FUEL.

DIRECT LOAD @ EACH POINT $= \frac{4161}{3} = 1387$#

ADD'L LOAD DUE TO MOMENT



MOMENT OF INERTIA

$= 1(6.875)^2 + 2(3.4375)^2$

$= 47.27 + 23.63$

$= 70.9$ IN^4

ADD Mx & Mz CONSERVATIVELY 4147+97 = 4244 II#

ADD'L LOAD $= P = \frac{M \times C}{I} = \frac{4244 \times 6.875}{70.9}$

$= 412$#

THEREFORE TOTAL LOAD = 1387+412 = 1799#

<u>LOAD CASE 2</u> NO ECC 3200# FUEL.

LOAD/BOLT = 4661/3 = 1554# < 1799# LOAD CASE 1 GOVERNS.

∴ USE P = 1799# BOLT LOAD.

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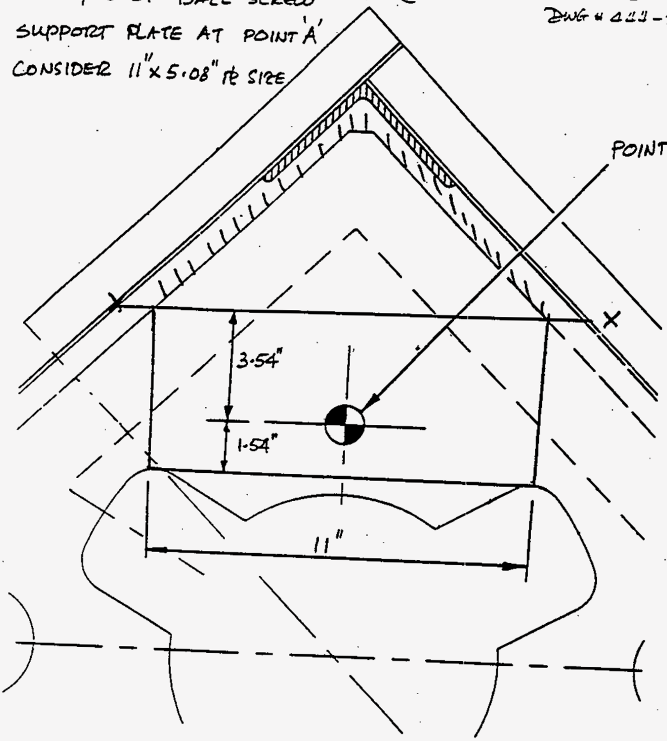
ANALYSIS OF BALL SCREW SUPPORT PLATE AT POINT 'A'

CONSIDER 11" x 5.08" PL SIZE

(MOUNTING PLATE ITEM #13
DWG # 444-211 1/2)



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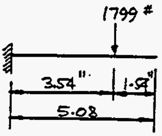
ANALYSIS OF SCREW SUPPORT PLATE AT POINT 'A' (MOUNTING PLATE)
(ITEM # 13 DWG # 444-211 R/0)



← PG# 54

CONSIDER LOAD ACTING @ 3.54" AWAY @ MIDPOINT OF 5.08"x11" PLATE

SECT. MODULUS $S = \frac{bd^2}{6} = \frac{11 \times 1.5^2}{6} = 4.125\ IN^3$

MOMENT $M = 1799 \times 3.54 = 6368$ "#

$f_b = \frac{M}{S} = \frac{6368}{4.125} = 1544$ PSI. < 11600 PSI

MAX. DEFLECTION @ FREE END $\delta = \frac{Pb^2}{6EI}(3l - b)$

REF #

$P = 1799$ #; $l = 5.08"$

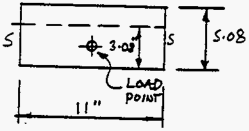
$b = 3.54$ IN.

$I = \frac{11 \times 1.5^3}{12} = 3.09375"$

$$\delta = \frac{1799 \times 3.54^2}{6 \times 29E6 \times 3.09375}(3 \times 5.08 - 3.54)$$

$= 0.00049$ IN.

ALSO CHECK DEFLECTION CONSIDERING BOTH END SIMPLY SUPT'D.



USE 3.08"x11" PLATE STRIP CONS.

$I = \frac{bd^3}{12} = \frac{3.08 \times 1.5^3}{12} = 0.866\ IN^4$

$S = I/c = \frac{0.86625}{0.75} = 1.155\ IN^3$

MOMENT $= \frac{Pl}{4} = \frac{1799 \times 11}{4} = 4947$ "#

$f_b = \frac{M}{S} = \frac{4947}{1.155} = 4283$ PSI. < 11600 PSI.

∴ PL IS ADEQUATE.

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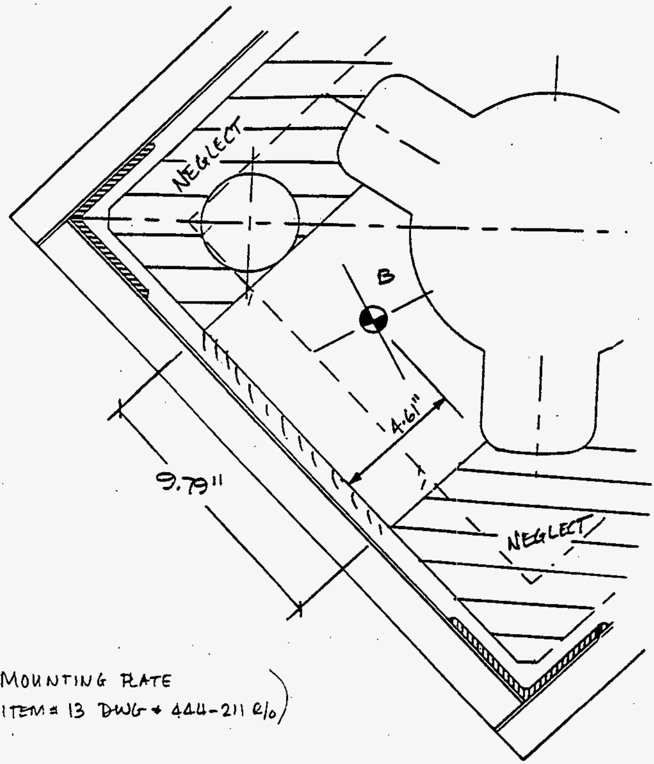
ANALYSIS OF BALL SCREW SUPPORT PLATE AT POINT 'B' & 'C'
BOTH POINTS ARE SYMETRICAL. CONSIDER PLATE'S EFFECTIVE DIMNS. AS SHOWN & NEGLECT REST OF PLATE.



(MOUNTING PLATE
ITEM # 13 DWG # 444-211 R/0)

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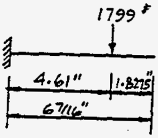
$$\delta_{MAX} = \frac{P\ell^3}{48EI} = \frac{1799 \times 11^3}{48 \times 29E6 \times .866} = 0.0020 \text{ IN}$$

ANALYSIS OF SCREW SUPPORT PLATE AT POINT 'B' & 'C'
(MOUNTING PLATE ITEM # 13 DWG # 444-211 R/0)



CONSIDER LOAD ACTING @ 4.61" AWAY FROM FIXED END AND @ MID POINT OF 6 7/16 × 9.79" PL

SECT. MODULUS $S = \frac{bd^2}{6} = \frac{9.79 \times 1.5^2}{6} = 3.67125 \text{ IN}^3$

MOMENT = 1799 × 4.61 = 8293 in#

BENDING STRESS $f_b = \frac{M}{S} = \frac{8293}{3.67125} = 2259 \text{ PSI} < 11600 \text{ PSI}.$

MAX. DEFLECTION
@ FREE END

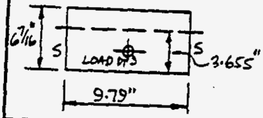
$$\delta = \frac{Pb^2}{6EI}(3\ell - b)$$

$P = 1799\#$ $b = 4.61"$
$\ell = 6.4375"$
$I = \frac{9.79 \times 1.5^3}{12} = 2.7534 \text{ IN}^4$

$$\delta = \frac{1799 \times 4.61^2}{6 \times 29E6 \times 2.7534}(3 \times 6.4375 - 4.61)$$

$= 0.0012$ IN.

ALSO, CHECK DEFLECTION CONSIDERING BOTH END SIMPLY SUPPORTED



USE 3.655" × 9.79" PLATE STRIP CONS.

$I = \frac{bd^3}{12} = \frac{3.655 \times 1.5^3}{12} = 1.028 \text{ IN}^4.$

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SECT. MODULUS $S = \frac{I}{c} = \frac{1.028}{.75}$

$= 1.37 \text{ IN}^3$

MOMENT $= \frac{Pl}{4} = \frac{1799 \times 9.79}{4} = 4403$ #

$f_b = \frac{M}{S} = \frac{4403}{1.37} = 3214$ PSI. < 11600 PSI. ∴ ok

$\delta_{MAX} = \frac{Pl^3}{48\,EI} = \frac{1799 \times 9.79^3}{48 \times 29E6 \times 1.028} = 0.0012$ IN.

STRESSES AND DEFLECTIONS ARE LOW, THEREFORE 1½" PLATE IS OK

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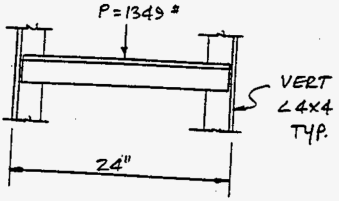
PG# 207

CHECK ∠4x3x3/8 ITEM #40. (SUPPORT ANGLE)
(ITEM# 39 DWG# 444-215 R/0)

MAXIMUM LOAD ON LOAD CELL BASED ON ECCENTRIC LOADING IS 1799 #. THEREFORE MAX. LOAD ON ∠4x3x3/8 COULD BE 1799 x 3/4 = 1349 # (CONS)
PG# 54



APPLY FULL LOAD IN CENTER OF SPAN CONS.

$$\text{MOMENT} = PL/4 = \frac{1349 \times 24}{4}$$

$$= 8096 \text{ ".\#}$$

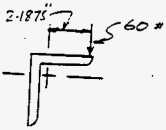
$$f_{b_{\angle 4\times 3}} = \frac{M}{S} = \frac{8096}{1.46} = 5545 \text{ PSI.}$$

$$< 11600 \text{ PSI.}$$

∴ ∠4x3x3/8 OK

ALSO CHECK ∠4x3 WITH UNIFORM LOAD & 1" WIDTH OF TOP FLANGE.

LOAD PER INCH = 1349/22.5 = 60 #
→ SIDE DIMN OF 1½" SUPT. PLATE



MOMENT = 60×2.1875 = 131.25

$$\text{SECT. MODULUS} = \frac{bd^2}{6} = \frac{1 \times .375^2}{6} = 0.02344 \text{ IN}^3$$

$$f_b = M/S = 131.25/0.02344 = 5559 \text{ PSI} < 11600 \text{ PSI.}$$

∴ ∠4x3x3/8 IS ADEQUATE.

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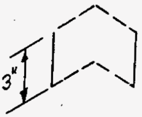
CHECK WELD BETWEEN $\angle 4 \times 3 \times \frac{3}{8}''$ AND VERTICAL $\angle 4 \times 4 \times \frac{1}{4}$ SUPPORT ANGLE TO MAST VERTICALS.

(ITEM # 39 TO 1 REF. DWG# 444-215 R/0)

CONSIDER WELD ONLY ON VERTICAL SIDES CONSERVATIVELY
AT EACH JOINT WELD LENGTH $= 2 \times 3 = 6''$



LOAD @ EACH JOINT IS $4661^{*}/4 = 1165$ # (CONS)

WELD SIZE REQ'D $= \left(\frac{1165}{6}\right) \div 11600$

$= 0.0167$

THEREFORE PROVIDE 3/16" FILLET WELD .OK

* SEE SPREADSHEET PAGE #11.

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CHECK LUG 1.5" DEEP & 2.8" WIDE (ITEM # 23 DWG # 444-232 R/0)

LENGTH OF LUG $L = \frac{13.75}{2} - \frac{9.5}{2} = 2.125$

$$M = 1799\,(2.125) = 3823 \text{ ''\#}$$

$$S = \frac{2.8\,(1.5)^2}{6} = 1.05$$

$$f_b = \frac{M}{S} = \frac{3823}{1.05} = 3641 \text{ PSI} < 10{,}000 \text{ PSI}$$

GOVERN. S.S. STEEL

LOWER OF $\frac{F_y}{3}$ OR $\frac{F_u}{50}$

$\frac{30000}{3}$
$= 10000$ PSI

$$f_v = \frac{1799 \times 1.5}{2.8 \times 1.5} = 643 \text{ PSI} < 10{,}000 \text{ PSI.}$$

$\therefore$ OK

WELD IS 1/2" PARTIAL PENETRATION ON EACH SIDE
(SUPPORT LUG TO SHAFT DWG # 444-232 R/0, ITEM # 23 TO ITEM # 22)

TENSION ON WELD DUE TO MOMENT $= \frac{3823}{1.17} = 3268$ LBS

LENGTH OF WELD IS 2.8" SAME AS LUG'S WIDTH

$$f_T = \frac{3268}{0.5 \times 2.8} = 2334 \text{ PSI}$$

$$f_v = \frac{1799}{(1) \times 2.8} = 643 \text{ PSI.}$$

$$f = \sqrt{f_T^2 + f_v^2}$$

$$= \sqrt{2334^2 + 643^2}$$

$$= 2421 \text{ PSI.} < 10{,}000 \text{ PSI.} \qquad \frac{F_y}{3} = \frac{30000}{3} = 10000 \text{ PSI.}$$

THEREFORE PARTIAL PENETRATION WELD IS ADEQUATE

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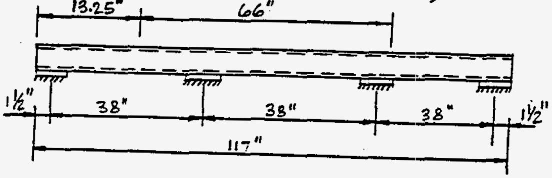
Project: MCO LOADING SYSTEM	Checked By:	Date: 6/4/97	Page 62 of 70

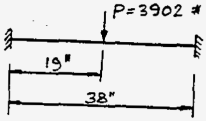
CHECK STRESS & DEFLECTION OF TS 4X4X 5/16 TRACK RAIL SUPPORT
(GANTRY RAIL TUBE ITEM # 2 DWG# 444-220 A/D)



CENTER LINE OF MAST CAN TRANSLATE TO ANY POINT ALONG THE 66" DIMN.

THEREFORE MAXIMUM STRESS & DEFLECTION OCCURS WHEN ℄ OF MAST IS AT MID POINT OF 38" SPAN.

$$P = \frac{7574}{2} \xleftarrow{} \text{PG \# 8} + \frac{11518}{100} \xrightarrow{} \text{M2} = 3902 \,\#$$



$$\text{MAX. MOM} = \frac{P\ell}{4} = \frac{3902 \times 38}{4}$$

$$= 37069 \text{ "\#}$$

$$f_b = \frac{M}{S} = \frac{37069}{4.79} = 7739 \text{ Psi}$$

$$< 11600 \text{ psi}$$

SHEAR STRESS $f_v = \frac{P}{A}$

$$= \frac{3902}{2 \times 4 \times .3125} = 1561 \text{ psi.} \quad < 0.4 \times 36000 \text{ psi}$$

$$14400 \text{ psi.}$$

DEFLECTION $\delta = \frac{P\ell^3}{48EI} = \frac{3902 \times 38^3}{48 \times 29E6 \times 9.58} = 0.016$ IN.

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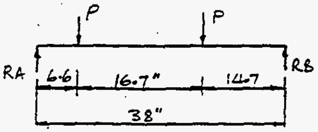
DIFFERENTIAL DEFLECTION CHECK FOR THE STEEL BY OTHER:

WITH MAST AT PICK UP POINT AND EMPTY. THIS IS TO CHECK THE ALIGNMENT AT CRITICAL LOCATION FOR PICK UP

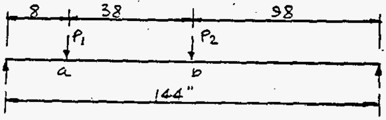


$P = 4374/4 = 1094^{\#}$

PG#6

$R_B = (6.6 \times 1094 + 23.3 \times 1094)/38 = 861^{\#}$ $R_A = 2 \times 1094 - 861 = 1327^{\#}$

FIND THE DEFLECTION FOR STEEL BY OTHERS DUE TO THESE REACTIONS



$P_1 = R_A = 1327^{\#}$

$P_2 = R_B = 861^{\#}$

USE W 8X35, $I = 127\ \mathrm{IN}^4$

USE AISC FORMULA CASE 2 PG # 2-116

$$\Delta_a = \frac{1327\,(8)^2(136)^2}{3 \times 29E6 \times 127 \times 144} + \frac{861 \times 98 \times 8\,(144^2 - 98^2 - 8^2)}{6 \times 29E6 \times 127 \times 144}$$

$= 0.00099 + 0.00235$

$= 0.00334$ IN.

$$\Delta_b = \frac{861 \times 46^2 \times 98^2}{3 \times 29E6 \times 127 \times 144} + \frac{1327 \times 8 \times 98\,(144^2 - 98^2 - 8^2)}{6 \times 29E6 \times 127 \times 144}$$

$= 0.011 + 0.00362$

$= 0.0146$ IN.

$\Delta_{ab} = 0.0146 - 0.00334 = 0.01126$ IN.

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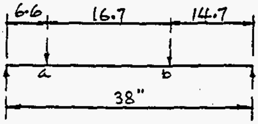
Project: MCO LOADING SYSTEM	Checked By: M	Date: 6/4/97	Page 64 of 70

DIFFERENTIAL DEFLECTION CHECK FOR TS 4×4×5/16



P = 4374/4 = 1094 #

FIND THE DEFLECTION USING AISC FORMULA CASE 2 PG # 2-116

$$\Delta a = \frac{1094 \times 6.6^2 \times 31.4^2}{3 \times 29E6 \times 9.58 \times 38} + \frac{1094 \times 14.7 \times 6.6\,(38^2 - 14.7^2 - 6.6^2)}{6 \times 29E6 \times 9.58 \times 38}$$

$$= 0.00148 + 0.00198$$

$$= 0.00346 \text{ IN.}$$

$$\Delta b = \frac{1094 \times 14.7^2 \times 23.3^2}{3 \times 29E6 \times 9.58 \times 38} + \frac{1094 \times 14.7 \times 6.6\,(38^2 - 14.7^2 - 6.6^2)}{6 \times 29E6 \times 9.58 \times 38}$$

$$= 0.00405 + 0.00198$$

$$= 0.00603 \text{ IN.}$$

$$\Delta_{a\text{-}b} = 0.00603 - 0.00346 = 0.00257''$$

ADD BOTH DIFFERENTIAL DEFLECTION 1) STEEL BY OTHERS & 2) TS 4×4×5/16 = 0.011 + 0.00257 = 0.01357 IN.

DEFLECTION USING $I = 248$ IN^4 W10×45 STEEL BY OTHERS

DIFF DEFLECTION WILL BE $0.01126 \times 127/248 = 0.0058$ IN.

AND TOTAL DEFL = 0.0058 + 0.00257 = 0.00837 IN. (ACCEPTABLE).

THIS STEEL IS TO BE PROVIDED BY OTHERS HOWEVER, MIN. MOMENT OF INERTIA $I = 248$ IN^4 IS REQUIRED.

NAC International Inc.	**Prepared By:** RP	**Date:** 6-4-97	**WRR No.** EF444-20-02
Project: MCO LOADING SYSTEM	**Checked By:** M	**Date:** 6/4/97	**Page** 65 **of** 70

DETERMINE THE REACTIONS ON STEEL BY OTHERS

CASE I $P = 7574^{\#}$ $M_z = 11518$ "# PG # 8

$$R = \frac{7574}{2} + \frac{11518}{100}$$

$$R = 3787 + 115$$

$R = 3902$ LBS.

CASE II $P = 7074^{\#}$ $M_z = 15568$ "# PG # 9.

$$R = \frac{7074}{2} + \frac{15568}{100}$$

$= 3693$ LBS.

CASE I GOVERNS $R_u = 3902$ LBS.

DETERMINE D.L.

$R_{DL} = \frac{859}{2} = 430$ LBS CONSERVATIVE

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SUMMARY OF LOAD ON STEEL BY OTHERS

R_{DL} = 430 LBS

R_{LL} = 3902 LBS

THE ABOVE LOADS SHALL BE APPLIED AT ANY SINGLE SUPPORT PAD LOCATION SO AS TO PRODUCE MAXIMUM LOAD IN SUPPORT STEEL.

IN ADDITION TO ABOVE VERTICAL LOADS APPROPRIATE IMPACT, LATERAL AND LONGITUDINAL PERCENTAGE OF THE LOAD SHALL BE APPLIED TO PRODUCE MAXIMUM LOAD ON SUPPORT STEEL THIS STEEL SHALL HAVE A MINIMUM MOMENT OF INERTIA OF 248 IN^4 FOR THE PURPOSE OF ALIGNMENT AT CRITICAL PICK UP LOCATION.

NAC International Inc.	Prepared By: RP	Date: 6-4-97	WRR No. EF444-20-02
Project: MCO LOADING SYSTEM	Checked By:	Date: 6-4-97	Page 67 of 70

5.0 SUMMARY OF RESULTS/CONCLUSIONS

Summary of Stress Analysis

Drawing Number	Item No. (PER DWG)	Component	Load Condition	Design Check	Calculated Stress	Allowable Stress	M.S.	Reference Page
444-215	1	MAST VERTICALS	LIFTING	AXIAL	4759	11600	0.59	49
444-215	2,3,30 AND 36	DIAGONAL BRACE	LIFTING	AXIAL	7019	11600	0.39	49
444-215	5	OUTRIGGER HORIZ.	NORMAL	AXIAL	406	11600	0.97	35
444-215	6	OUTRIGGER DIAG.	NORMAL	AXIAL	844	11600	0.93	34
444-215	39	SUPPORT ANGLE	NORMAL	BENDING	5559	11600	0.52	60
444-215	12,16 AND 32	MAST HORIZONTALS	NORMAL	AXIAL	2767	11600	0.76	35
444-215	17	TOP HORIZONTAL	LIFTING	BENDING	6524	11600	0.44	52
444-215	20	PLATE 1/4"	NORMAL	AXIAL	1458	11600	0.87	35
444-211	13	MOUNTING PLATE	NORMAL	BENDING	4283	11600	0.63	56
444-232	23	LUG	NORMAL	BENDING	3641	10000	0.64	62
444-220	2	GANTRY RAIL TUBES	NORMAL	BENDING	7739	11600	0.33	63
444-232	22 AND 23	LUG TO SHAFT	NORMAL	SHEAR	2421	10000	0.76	62

NAC International Inc.	Prepared By: RP	Date: 6-4-97	WRR No. EF444-20-02
Project: MCO LOADING SYSTEM	Checked By:	Date: 6/4/97	Page 68 of 70

SUMMARY OF RESULTS/CONCLUSIONS (cont.)

Summary of Stress Analysis

Drawing Number	Item No. (PER DWG)	Component	Load Condition	Design Check	Weld Size Required	Weld Size Provided	M.S.	Reference Page
444-215	16 TO 1	MAST HORIZ. TO MAST VERTICAL	NORMAL	SHEAR	0.0157	0.1875	0.92	36
444-215	6 TO 5 AND 6 TO 1	OUTRIGGER DIAG. TO MAST VERT. AND TO OUTRIGGER HORIZ.	NORMAL	SHEAR	0.0375	0.1875	0.80	36
444-215	20 TO 1	PLATE TO MAST VERTICAL	NORMAL	SHEAR	0.016	0.1875	0.91	36
444-215	5 TO 1	OUTRIGGER HORIZ. TO MAST VERTICAL	NORMAL	SHEAR	0.0209	0.1875	0.89	37
444-215	2 TO 1	DIAGONAL BRACE TO MAST VERTICAL	LIFTING	SHEAR	0.159	0.1875	0.15	51
444-215	39 TO 1	SUPPORT ANGLE TO MAST VERTICAL	NORMAL	SHEAR	0.0167	0.1875	0.91	61
444-215	17 TO 1	TOP HORIZONTAL TO MAST VERTICAL	LIFTING	SHEAR	0.072	0.1875	0.62	39

CONCLUSIONS: THE STRUCTURAL DESIGN OF GANTRY / MAST SYSTEM MEETS ALL APPLICABLE DESIGN CRITERIA AND CODES REQUIREMENTS. THEREFORE, THE DESIGN IS ADEQUATE & ACCEPTABLE.

NAC International Inc.	Prepared By: RP	Date: 6-4-97	WRR No. EF444-20-02
Project: MCO LOADING SYSTEM	Checked By: M	Date: 6/4/97	Page 69 of 70

6.0 REFERENCES

A. DESIGN SPECIFICATION WHC-S-0546 REV.0 AND NAC DOCUMENT NO. 444-S-01 REV.0

B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC-ASD MANUAL OF STEEL CONSTRUCTION, 9TH EDITION.

C. DESIGN OF WELDED STRUCTURES BY O.W. BLODGETT 8TH ED. PUBLISHED BY THE JAMES F. LINCOLN ARC WELDING FOUNDATION.

D. AWS. D1.1 1994, AMERICAN WELDING SOCIETY, STRUCTURAL WELDING CODE STEEL.

E. STANDARD ARCH-CIVIL DESIGN CRITERIA SDC-4-1 REV.12

F. LETTER # 97-SCB-045 FROM DE & S HANFORD, INC DATED MAY 30, 1997.

G. OVERHEAD HOIST (UNDERHUNG) ASME B30.16-1993 SAFETY STANDARDS FOR CABLEWAYS, CRANES, DERRICKS, HOISTS, HOOKS. JACKS AND SLINGS

H. AMERICAN NATIONAL STANDARD INSTITUTE ANSI N14.6-1993 SECTION 4.2.1

I 1) DWG# 444-215 R/0. MAST WELDMENT, MCO LOADING SYSTEM
WHC DWG NO: H-1-82892.

2) DWG # 444-211 R/0 GUIDE SUBASSEMBLY, MCO LOADING SYSTEM
WHC DWG NO: H-1-82889.

3) DWG # 444-232 R/0 DRIVE SUBASSEMBLY, MCO LOADING SYSTEM
WHC DWG NO: H-1-82903

4) DWG # 444-220 R/0 RAIL SUBASSEMBLY, MCO LOADING SYSTEM
WHC DWG NO: H-1-82896

NAC International Inc.	Prepared By: RP	Date: 6-4-97	WRR No. EF444-20-02
Project: MCO LOADING SYSTEM	Checked By: M	Date: 6/4/97	Page 70 of 70

DESIGN REPORT

FOR THE
HANFORD K EAST
AND
K WEST BASIN

MCO LOADING SYSTEM

Volume 2

Appendix F - Drawings
Revision 0

June 6, 1997

Report Number: 444-R-01

Prepared For:

Duke Engineering & Services, Hanford
Under Contract Purchase Order
MCB-SLD-A01129

Prepared By:

NAC International, Inc.
655 Engineering Drive
Norcross, Georgia 30092

NAC INTERNATIONAL

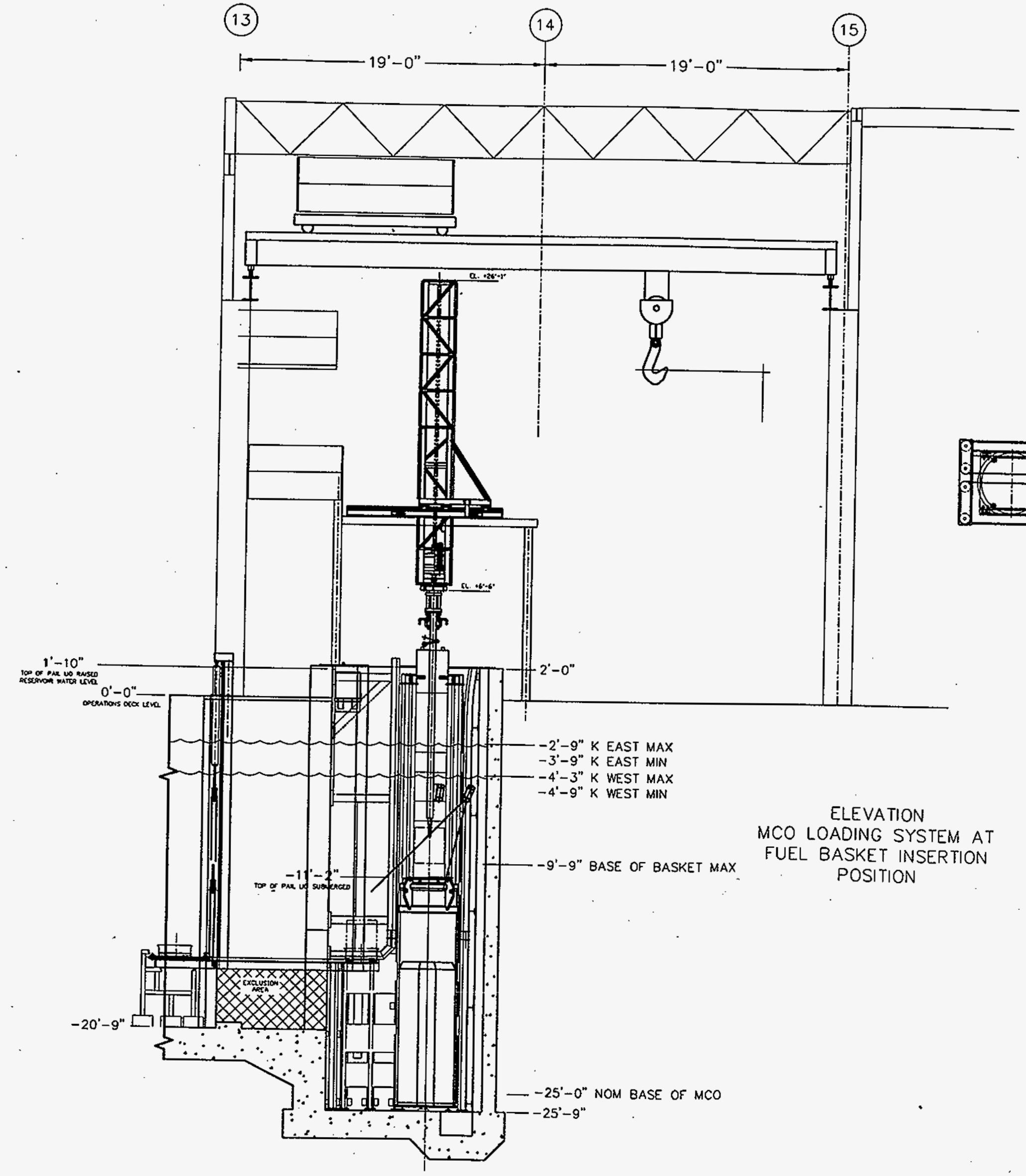
ATLANTA WASHINGTON ZURICH LONDON TOKYO MOSCOW

MCO LOADER SYSTEM DRAWING LIST

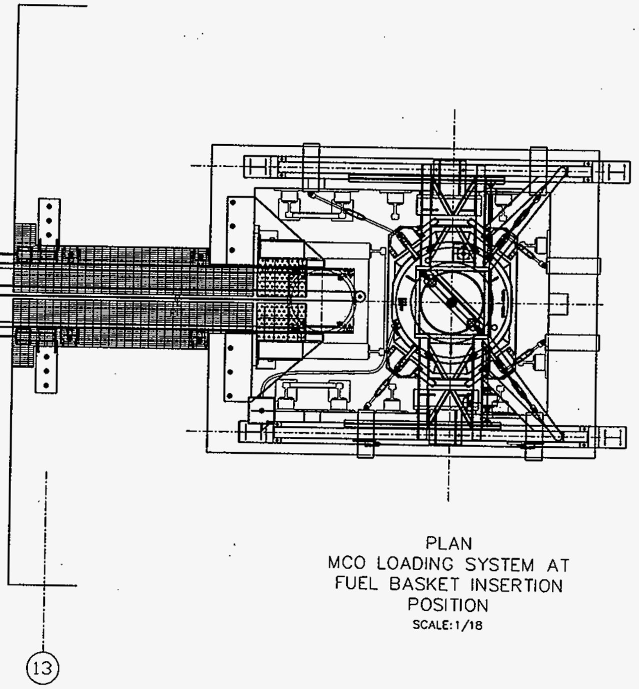
	NAC DWG. NOS.	WEST DWG NOS.
Equipment General Arrangement		
Fuel Basket Insertion	444-000, SHT-1	H-1-82960, SHT-1
Shuttle Pick-Up Position	444-000, SHT-2	H-1-82960, SHT-2
Immersion Pail Handling	444-000, SHT-3	H-1-82960, SHT-3
Installation Layouts		
Plan	444-101, SHT-1	H-1-82887, SHT-1
Elevation	444-101, SHT-	H-1-82887, SHT-2
View AA	444-101, SHT-3	H-1-82887, SHT-3
Shuttle Assembly		
Sheet 1	444-300, SHT-1	H-1-82911, SHT-1
Sheet 2	444-300, SHT-1	H-1-82911, SHT-2
Cart Assembly	444-301	H-1-82912
Cart Weldment	444-302	H-1-82913
Wedge Assembly	444-303	H-1-82914
Rails and Support		
Sheet 1	444-304, SHT-1	H-1-82915, SHT-1
Sheet 2	444-304, SHT-2	H-1-82915, SHT-2
Sheet 3	444-304, SHT-3	H-1-82915, SHT-3
Cable Mount/Cylinder	444-305	H-1-82916
Seismic Restraint Subassembly	444-306	H-1-82917
Cable Return	444-307	H-1-82918
Cable Return	444-308	H-1-82919
Upper Mounts	444-309	H-1-82920
Upper Mounts	444-310	H-1-82921
Return Pulley Assembly	444-311	H-1-82922
Pneumatic Schematic	444-314	H-1-82927
Gantry Assembly		
Sheet 1	444-200, SHT 1	H-1-82895, SHT 1
Sheet 2	444-200, SHT 2	H-1-82895, SHT 2
Sheet 3	444-200, SHT 3	H-1-82895, SHT 3
Grapple Subassembly		
Sheet 1	444-201, SHT 1	H-1-828902, SHT 1
Sheet 2	444-202, SHT 2	H-1-828902, SHT 2
Guide Subassembly		
Sheet 1	444-211, SHT 1	H-1-82889, SHT 1
Sheet 2	444-211, SHT 2	H-1-82889, SHT 2
Sheet 3	444-211, SHT 3	H-1-82889, SHT 3
Mast Weldment		
Sheet 1	444-215, SHT 1	H-1-82892, SHT 1
Sheet 2	444-215, SHT 2	H-1-82892, SHT 2
Sheet 3	444-215, SHT 3	H-1-82892, SHT 3
Rail Subassembly	444-220	H-1-82896

Bridge Drive Subassembly	444-225	H-1-82898
Screw Drive Subassembly		
Sheet 1	444-232, SHT 1	H-1-82903, SHT 1
Sheet 2	444-232, SHT 2	H-1-82903, SHT 2
Control Station Schematic	444-400	H-1-82940
Control Station Cabinet Assembly	444-401	H-1-82941
Control Station Cabinet Wiring Diagram (Sheet 1 & 2)	444-402	H-1-82942
Control System Field Wiring Diagram	444-403	H-1-82943
Field Junction Box Assembly	444-404	H-1-82944
CCTV Basin Viewing Cabinet Ass'y.	444-405	H-1-82945
CCTV Remote Viewing Cabinet Ass'y.	444-406	H-1-82946
CCTV Viewing Power Schematic	444-407	H-1-82947
CCTV Field Wiring Diagram	444-408	H-1-82948
MCO Structure Brace	457-117	
MCO Structure Brace	457-118	
MCO Structure Brace	457-119	

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



ELEVATION
MCO LOADING SYSTEM AT
FUEL BASKET INSERTION
POSITION



PLAN
MCO LOADING SYSTEM AT
FUEL BASKET INSERTION
POSITION
SCALE:1/18

F-3

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

SYM.	GEOMETRY
⏥	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⌖	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

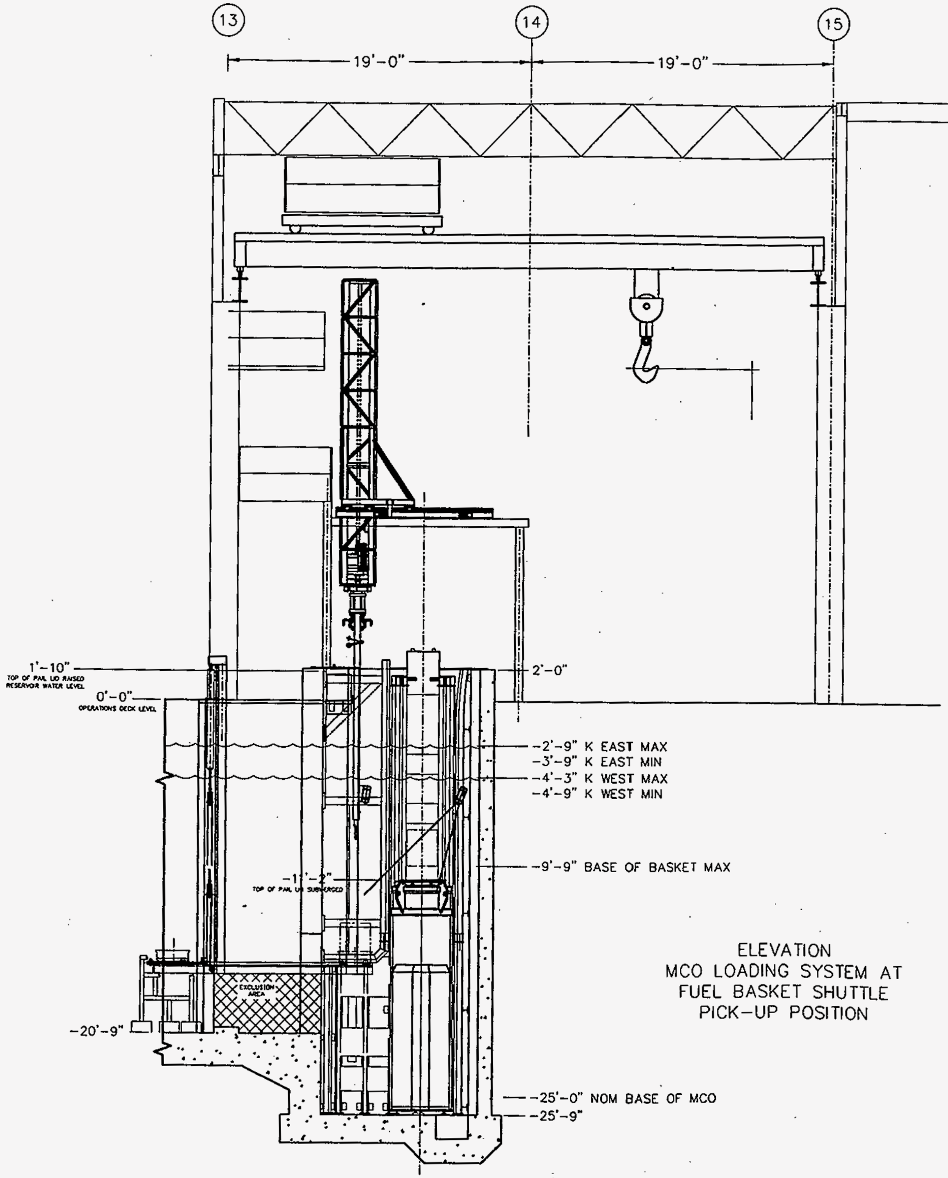
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

GROUP	NAME	DATE
PREPARER	*KC*	*[illegible]*
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

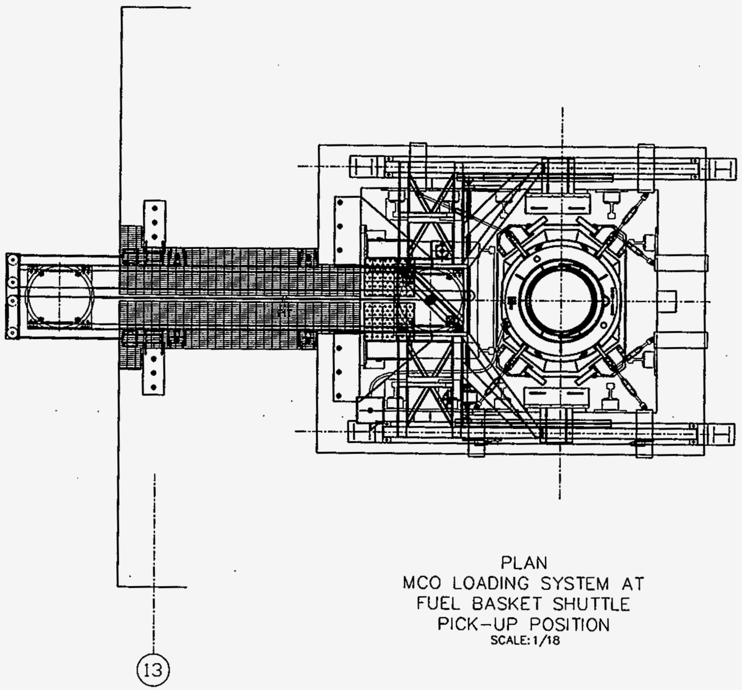
NAC INTERNATIONAL

K BASIN LOADOUT PIT AND
MCO LOADING EQUIPMENT
INTERFACE ARRANGEMENT
WHC DRAWING NO:H-1-82960

PROJECT 444	DESIGN PACKAGE	DRAWING 000	REV 0
SCALE 1/36	EST.WT.	SH 1 OF 3	3:15PM 6-5-97



ELEVATION
MCO LOADING SYSTEM AT
FUEL BASKET SHUTTLE
PICK-UP POSITION



PLAN
MCO LOADING SYSTEM AT
FUEL BASKET SHUTTLE
PICK-UP POSITION
SCALE: 1/18

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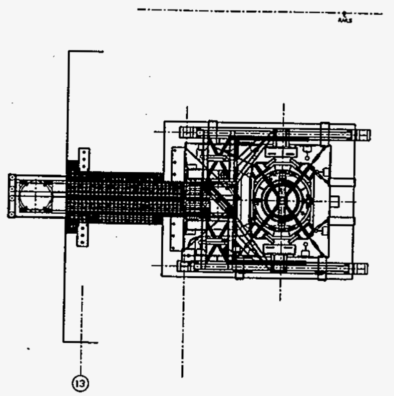
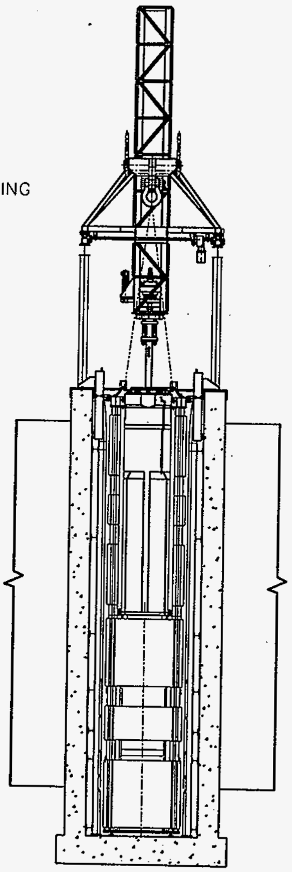
K BASIN LOADOUT PIT AND
MCO LOADING EQUIPMENT
INTERFACE ARRANGEMENT
WHC DRAWING NO: H-1-82960

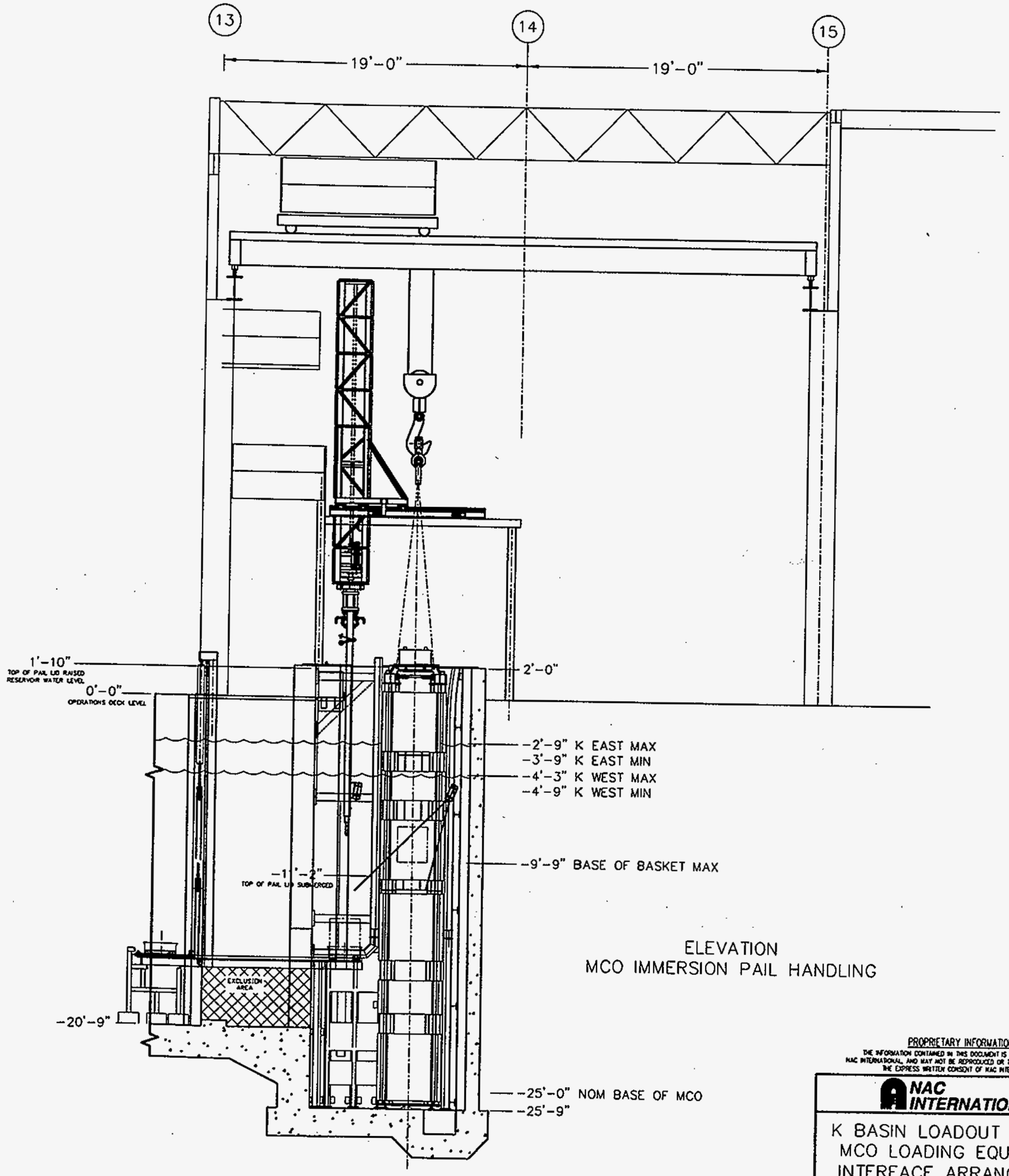
PROJECT 444	DESIGN PACKAGE	DRAWING 000	REV 0
SCALE 1/36	EST. WT.	SH 2 OF 3	3:17PM 6-5-97



PLAN
MCO IMMERSION PAIL HANDLING



FRONT ELEVATION
MCO IMMERSION PAIL HANDLING



ELEVATION
MCO IMMERSION PAIL HANDLING

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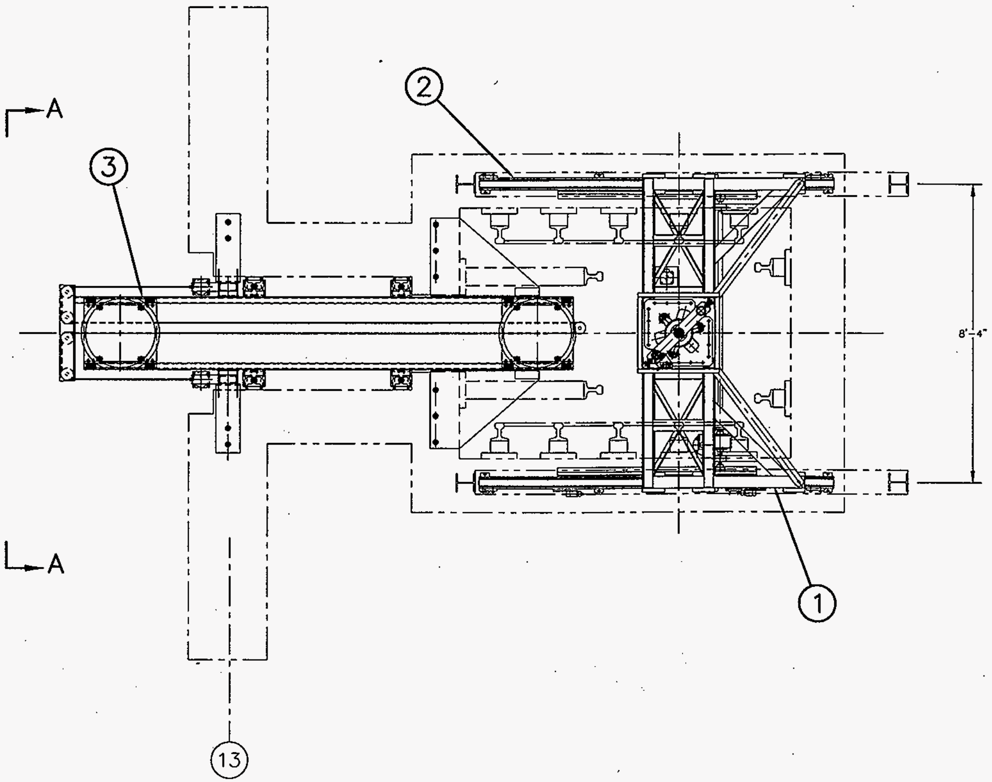
K BASIN LOADOUT PIT AND
MCO LOADING EQUIPMENT
INTERFACE ARRANGEMENT
WHC DRAWING NO:H-1-82960

PROJECT 444	DESIGN PACKAGE	DRAWING 000	REV 0
SCALE 1/36	EST.WT.	SH 3 OF 3	3:19PM 6-5-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE	—	—	—



PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	3	SHUTTLE ASSEMBLY			444-300-99	
		1	2	RAIL SUBASSY			444-220-99	
		1	1	GANTRY ASSEMBLY			444-200-99	
ASSY	ASSY	ASSY						
QUANTITY								

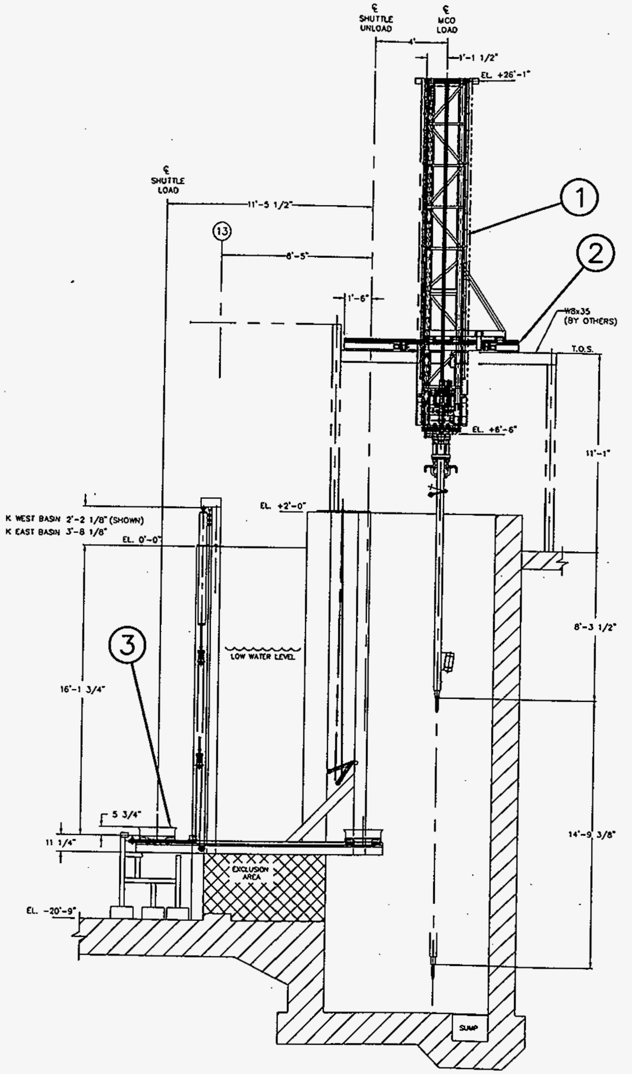
SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
▱	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.	PREPARER	JOC	
—	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
∠	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
⊕	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:				SRU VP		
		DRAWING TYPE:						

NAC INTERNATIONAL

INSTALLATION, PLAN
MCO LOADING SYSTEM
WHC DWG NO: H-1-82887

PROJECT 444	DESIGN PACKAGE	DRAWING 101	REV 0
SCALE 1/16	EST.WT.	SH 1 OF 3	4:26PM 6-4-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01



ELEVATION
VIEW LOOKING SOUTH

PROPRIETARY INFORMATION

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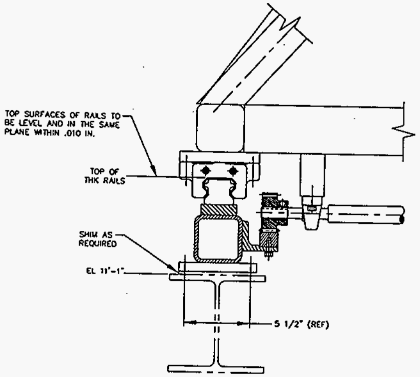
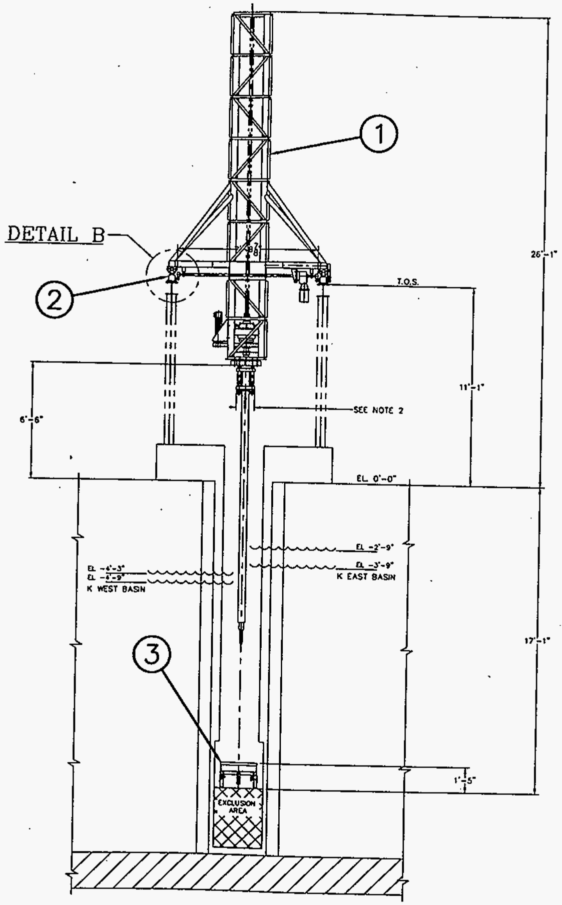
NAC INTERNATIONAL

INSTALLATION, PLAN
MCO LOADING SYSTEM
WHC DWG NO: H-1-82887

PROJECT 444	DESIGN PACKAGE	DRAWING 101	REV 0
SCALE 1/32	EST.WT.	SH 2 OF 3	12:15PM 6-4-97



DETAIL B
SCALE: 1/4
TYP 2 PLACES



VIEW A-A
(ROTATED 90.00° CCW)
VIEW LOOKING WEST

PROPRIETARY INFORMATION
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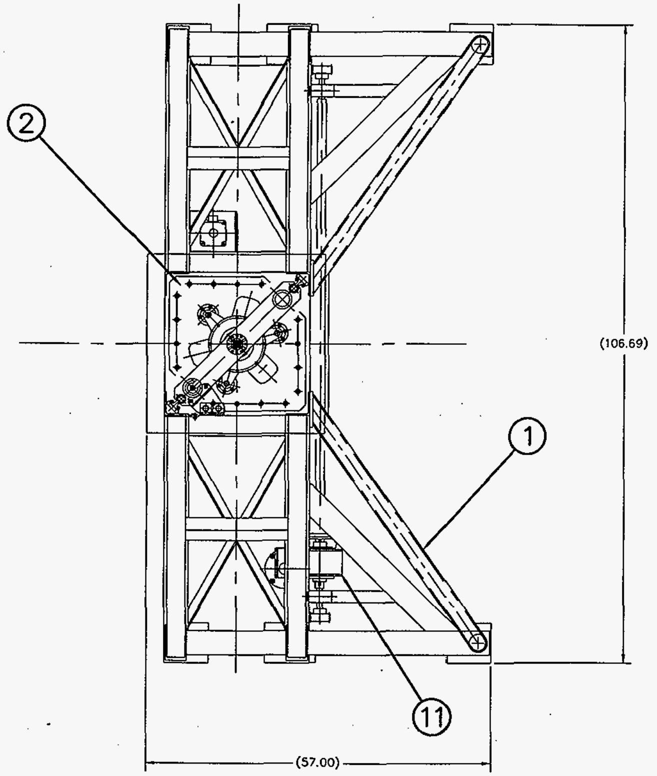
NAC INTERNATIONAL

INSTALLATION, PLAN
MCO LOADING SYSTEM
WHC DWG NO: H-1-82887

PROJECT 444	DESIGN PACKAGE	DRAWING 101	REV 0
SCALE 1/32	EST.WT.	SH 3 OF 3	12:48PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



PLAN VIEW

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
								PLATE/BAR
		1	11	BRIDGE DRIVE ASSY			444-220-99	
		1	10	SENSOR BRACKET			444-215-99	
		1	9	DRIVE PULLEY	ALUMINUM	COML		BROWNING #24XHQ200
		1	8	HEX HD BOLT	304 ST.STL.	ASTM A240		PLATE/BAR
		1	7	DRIVE MOTOR	STEEL	COML		1/4 HP SERVO W/GEARHEAD,BRAKE
		1	6	AIR SPOOL			444-214-99	
		1	5	CABLE SPOOL			444-213-99	
		1	4	DRIVE BELT	NEOPRENE	COML		BROWNING #XH200 7/8" PITCH 2" WIDE
		1	3	DRIVE MOUNT			444-212-99	
		1	2	GUIDE ASSEMBLY			444-211-99	
		1	1	MAST WELDMENT			444-215-99	

QUANTITY

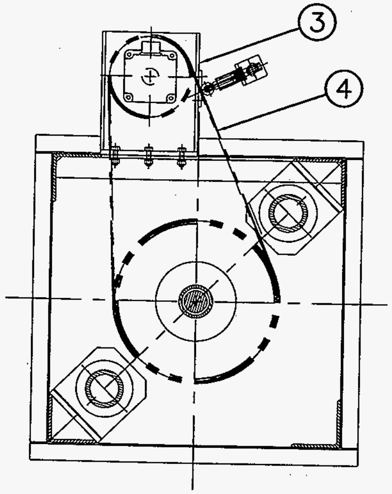
SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
⏥	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER	JOC	
—	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
∠	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
⊕	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:						
		DRAWING TYPE:				SRU VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

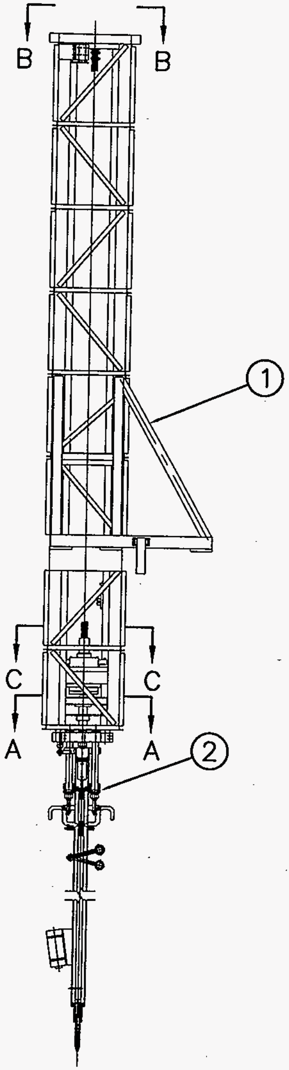
NAC INTERNATIONAL

GANTRY ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82895

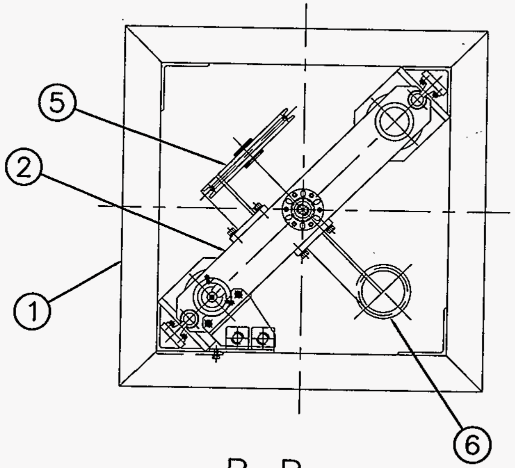
PROJECT 444
DESIGN PACKAGE
DRAWING 200
REV 0
SCALE 1/8
EST.WT.
SH 1 OF 3
10:02AM 6-5-97



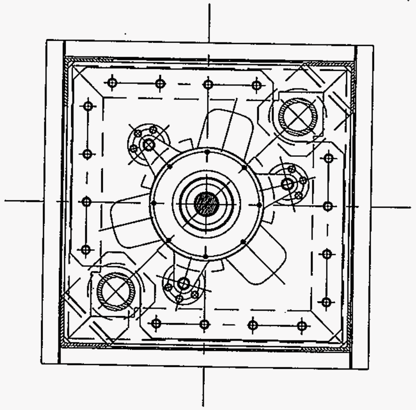
SECTION A—A
SCALE: 1/4



ELEVATION
VIEW LOOKING SOUTH



SECTION B—B
SCALE: 1/4



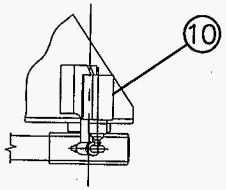
SECTION C—C
SCALE: 1/4

PROPRIETARY INFORMATION

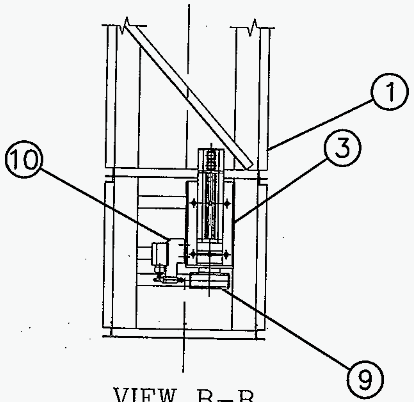
NAC INTERNATIONAL

GANTRY ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82895

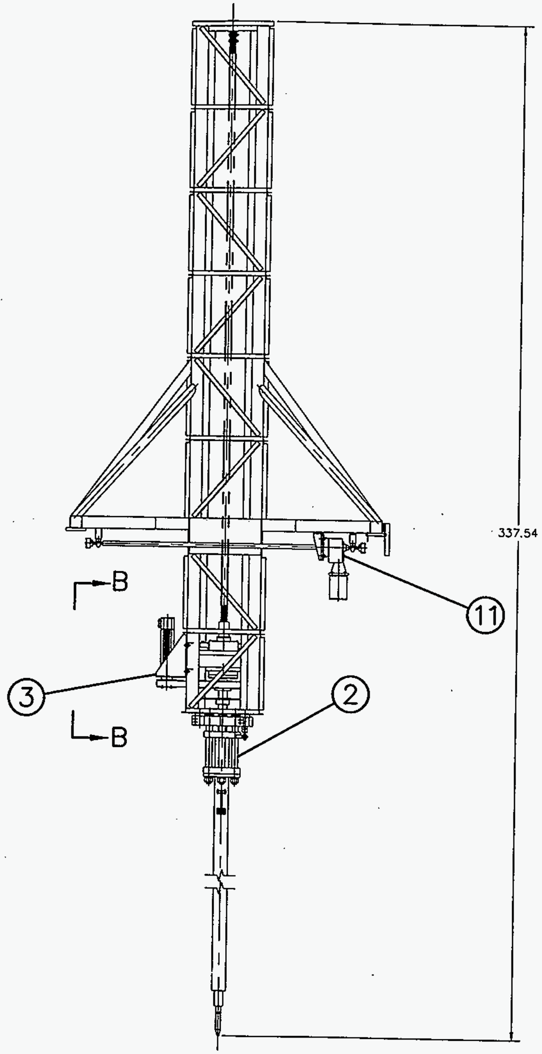
PROJECT 444	DESIGN PACKAGE	DRAWING 200	REV 0
SCALE 1/16	EST.WT.	SH 2 OF 3	10:03AM 6-5-97



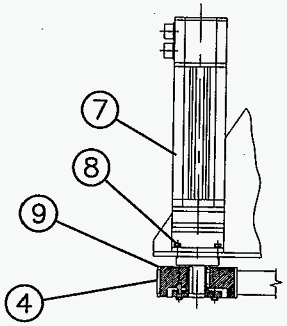
DETAIL C
SCALE: 1/4



VIEW B-B
VIEW LOOKING NORTH
SCALE: 1/8



VIEW A-A
(ROTATED 90.00° CCW)
VIEW LOOKING WEST



DETAIL D
SCALE: 1/4

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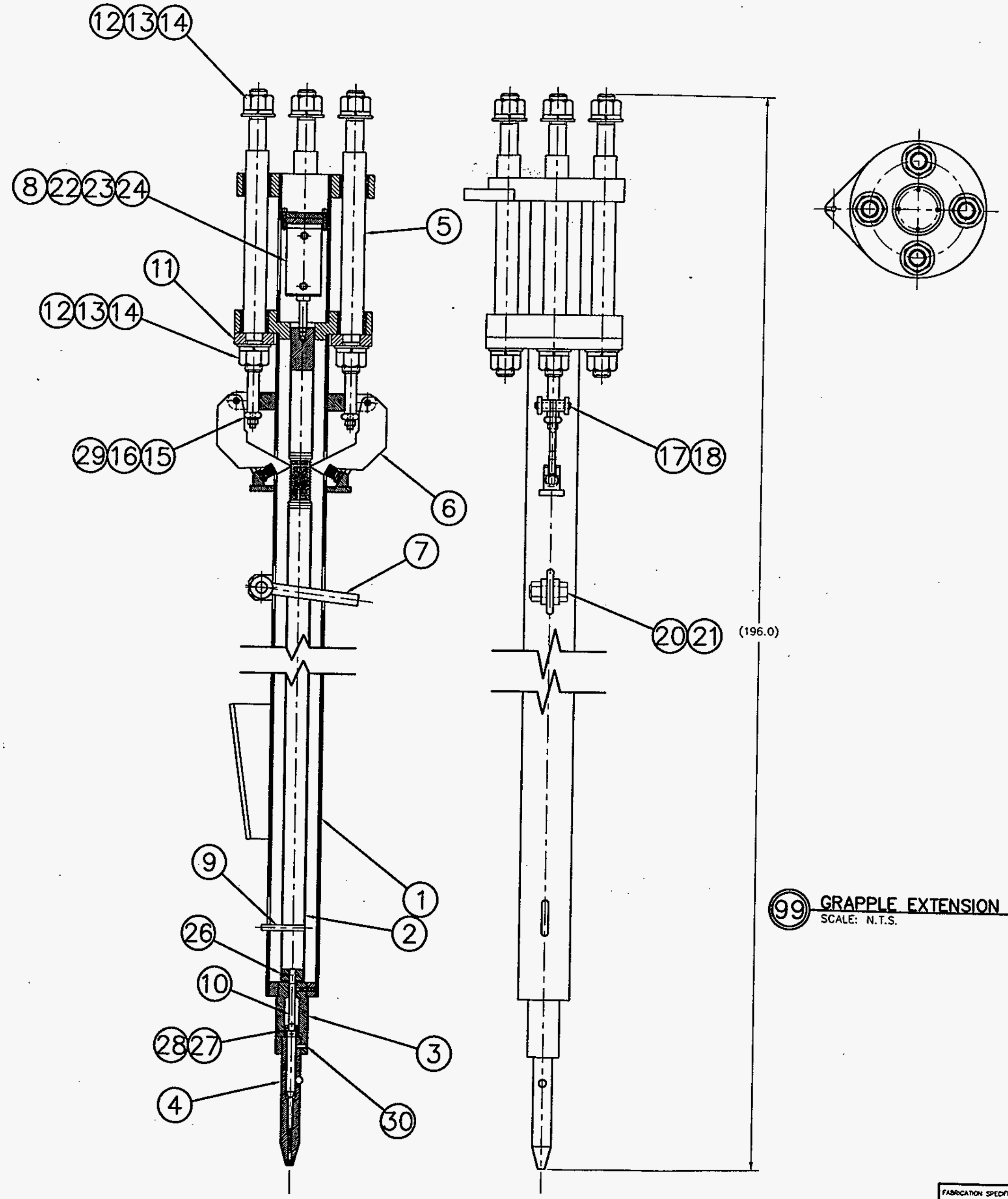
NAC INTERNATIONAL

GANTRY ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82895

PROJECT 444	DESIGN PACKAGE	DRAWING 200	REV 0
SCALE 1/16	EST.WT.	SH 3 OF 3	7:50PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 GRAPPLE EXTENSION ASSEMBLY
SCALE: N.T.S.

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1			48	END	304 ST.STL.	ASTM A276		BAR
1			47	HOUSING	304 ST.STL.	ASTM A511		2 OD X .063 WALL
1			46	LOCKING SLEEVE	304 ST.STL.	ASTM A276		BAR
1			45	HEAD	304 ST.STL.	ASTM A276		BAR
1			44	ACTUATOR TUBE	304 ST.STL.	ASTM A511		2 OD X .063 WALL
	1		43	LUG	304 ST.STL.	ASTM A240		PLATE
	2		42	SPRING HOUSING	304 ST.STL.	ASTM A276		BAR
	2		41	SPRING MOUNT	304 ST.STL.	ASTM A276		BAR
	2		40	BRACE	304 ST.STL.	ASTM A276		BAR
	1		39	CAMERA MOUNT	304 ST.STL.	ASTM A240		PLATE
	1		38	LEVER PIVOT	304 ST.STL.	ASTM A276		BAR
	2		37	PAWL PIVOT	304 ST.STL.	ASTM A276		BAR
	1		36	END GUIDE PLATE	304 ST.STL.	ASTM A240/276		PLATE/BAR
	1		35	CYLINDER MOUNT	304 ST.STL.	ASTM A240/A276		PLATE/BAR
	1		34	CYLINDER HOUSING	304 ST.STL.	ASTM A511		4 1/2 OD X 1/4 WALL
	1		33	GUIDE PLATE	304 ST.STL.	ASTM A240/A276		PLATE/BAR
	1		32	HEAD	304 ST.STL.	ASTM A276		BAR
	1		31	MAIN TUBE	304 ST.STL.	ASTM A511		4 1/2 OD X 1/4 WALL
		1	30	DOWEL PIN	ST.STL.	COML		1/4 X 3/4 LG
		4	29	CAM RING	304 ST.STL.	ASTM A276		BAR
		1	28	SET SCREW	ST.STL.	COML		#10-32 X 3/8 LG
		1	27	ROLL PIN	ST.STL.	COML		1/4 X 1.0 LG
		1	26	SET SCREW	ST.STL.	COML		3/-16UNC-2A X 1.0 LG
		1	25	ROLL PIN	ST.STL.	COML		3/8 DIA X 2 LG
		4	24	HEX HEAD BOLT	ST.STL.	COML		3/8-16UNC-2A X 2.0 LG
		1	23	BASE MOUNT	304 ST.STL.	ASTM A240		PLATE
		1	22	ACTUATOR COUPLING				DESH SUPPLIED
		1	21	NYLOK HEX NUT	ST.STL.	COML		1-8UNC-2B
		1	20	HEX HD BOLT	ST.STL.	COML		1-8UNC-2A X 2.5 LG
		2	19	SPRING	ST.STL.	COML		ASSOCIATED #C0480-045-1000
		4	18	SNAPRING	ST.STL.	COML		WALDES TRUARC #5160-50
		2	17	PIN	304 ST.STL.	ASTM A276		BAR
		2	16	LOCKWASHER	ST.STL.	COML		1/2 DIA
		2	15	HEX NUT	ST.STL.	COML		1/2-13UNC-2B
		8	14	FLATWASHER	ST.STL.	COML		1 1/2 DIA
		8	13	LOCKWASHER	ST.STL.	COML		1 1/2 DIA
		8	12	HEX NUT	ST.STL.	COML		1 1/2-12UNF-2B
		1	11	RETAINER PLATE	304 ST.STL.	ASTM A240		PLATE
		1	10	CONNECTOR	304 ST.STL.	ASTM A276		BAR
		1	9	STROKE INDICATOR	304 ST.STL.	ASTM A276		BAR
		1	8	AIR CYLINDER	ST.STL.	COML		BIMBA
		1	7	MANUAL LEVER	304 ST.STL.	ASTM A276		BAR
		2	6	LOCKING PAWL	17-4PH ST.STL.	ASTM A240		PLATE
		4	5	GUIDE ROD	440C ST.STL.	ASTM A276		BAR
		1	4	GRAPPLE				DESH SUPPLIED
		1	3	GRAPPLE BOSS	304 ST.STL.	ASTM A276		BAR
		1	2	ACTUATOR WELDMT			444-201-97	
		1	1	MAST EXT WELDMT			444-201-98	

QUANTITY

SYM.	GEOMETRY
⏥	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.04
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY: 444-211
DRAWING TYPE: ENGINEERING

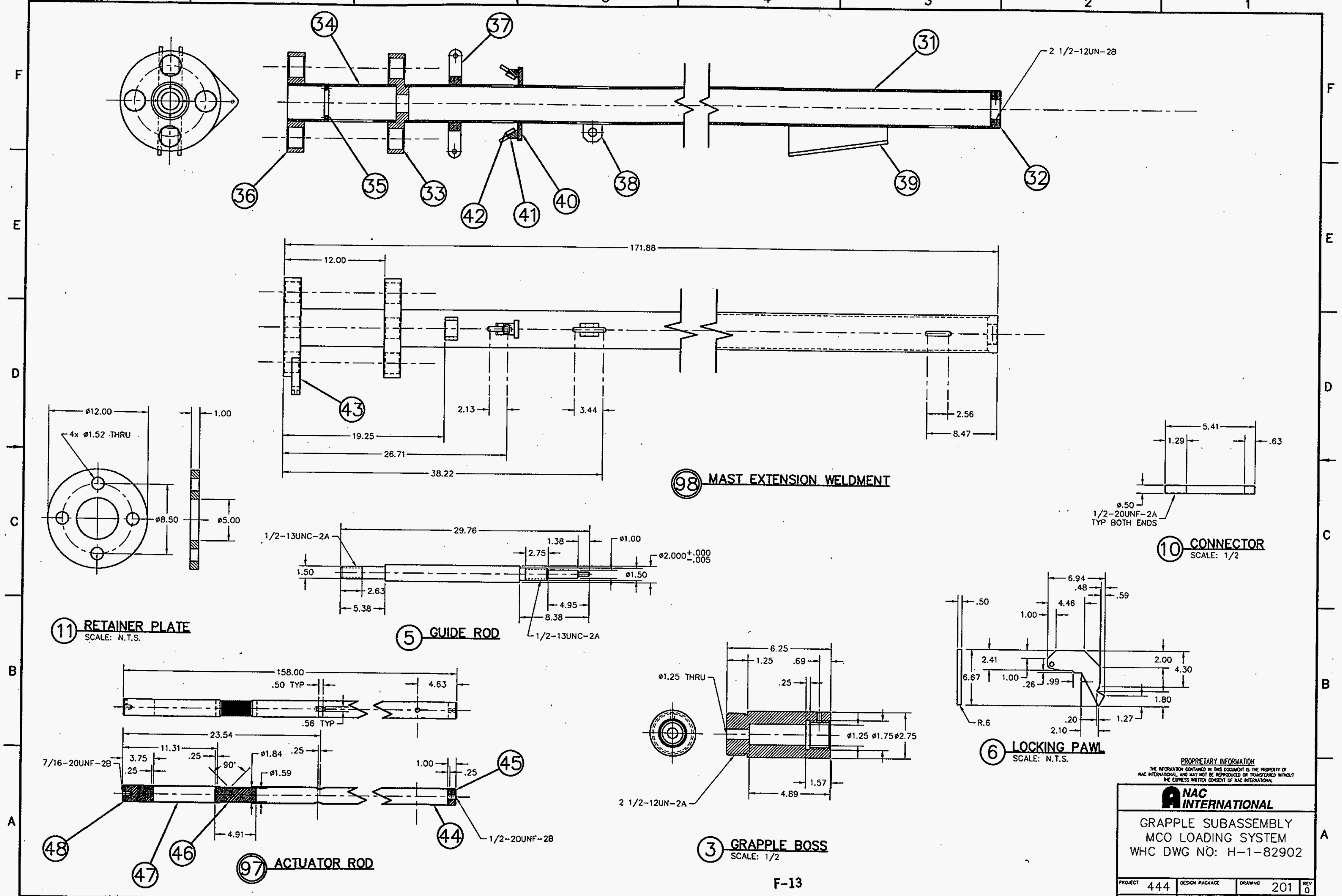
GROUP	NAME	DATE
PREPARER	JDC	6/4/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRU VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

GRAPPLE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82902

PROJECT 444
DESIGN PACKAGE
DRAWING 201
REV 0
SCALE 1/4
EST.WT.
SH 1 OF 2
9:22PM 6-4-97



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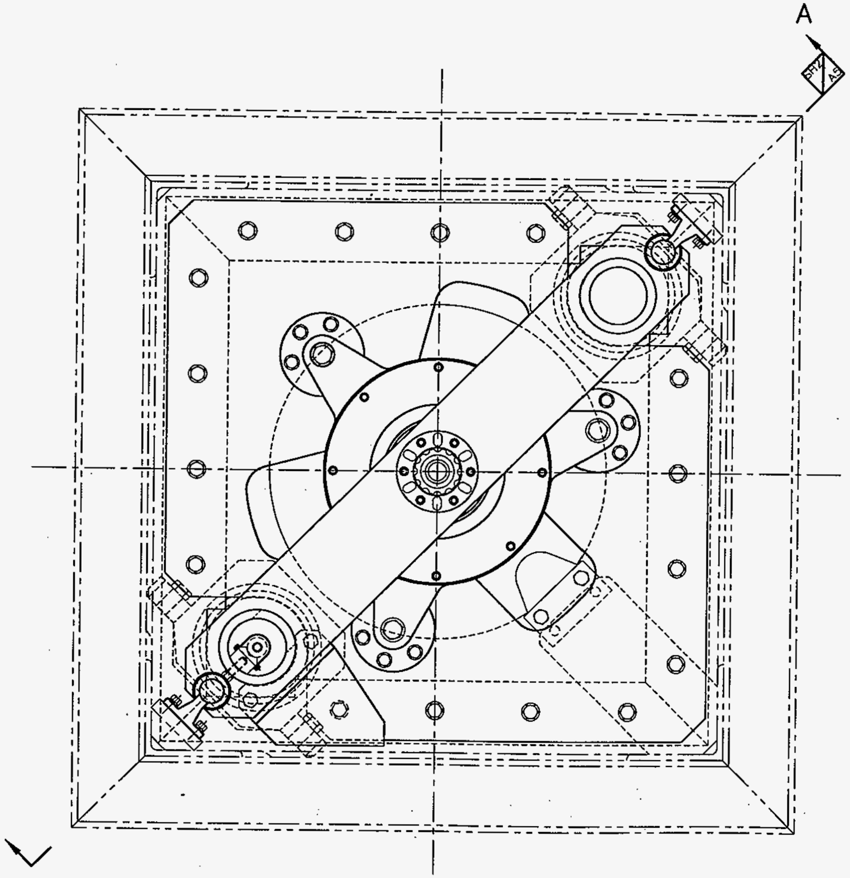
NAC INTERNATIONAL

GRAPPLE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82902

PROJECT 444	DESIGN PACKAGE	DRAWING 201	REV 0
SCALE 1/4	EST.WT.	SH 2 OF 2	9:20PM 8-4-97

NOTES: UNLESS OTHERWISE SPECIFIED
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI/ASME Y14.5M-1994.
2. DIMENSIONS ARE IN INCHES.

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
			1	54	HEX NUT	ST. STL.	COML		#6-32UNC
			1	53	HEX HD SCREW	ST. STL.	COML		#6-32UNC-2A X 6.5 LG
	1			54	TOP	304 ST. STL	ASTM A276		BAR
	1			53	TUBE	304 ST. STL	ASTM A276		1 3/4 TUBE X .035 WALL
	1			52	BASE	304 ST. STL	ASTM A276		BAR
			2	51	HEX BOLT	ST. STL	COML		.312-18 UNC X 7/8 LG
			3	50	LOAD CELL	ST. STL	COML		SENSOTEC NO. AL113DL,2C,30A
			1	49	PUSHROD WELDMENT			444-211-97	ø1.75 X .035 W TUBING
			2	48	HEX NUT	ST. STL	COML		3/8-16 UNC-2B
			2	47	LOCK WASHER	ST. STL	COML		3/8 SCREW SIZE
			2	46	SHOULDER SCREW	ST. STL	COML		3/8-16UNC-2A X 6.5 LG
			1	45	CALIPER, BRAKE		COML		ECB MODEL NO. FS47
			1	44	CLAMP	ST. STL	COML		
			1	43	LVDT	ST. STL	COML		SENSOTEC NO. BY122HQ
			1	42	LOCK WASHER	ST. STL	COML		M5 SCREW SIZE
			1	41	HEX HD CAP SCR	ST. STL	COML		M5 x 0.8 x 10.0 LG
		3		40	GUIDES	304 ST. STL	ASTM A312		10 SCH 80 PIPE
		1		39	BULKHEAD	304 ST. STL	ASTM A240		PLATE
			1	38	LVDT BRACKET	304 ST. STL	ASTM A276		BAR
			40	37	LOCK WASHER	ST. STL	COML		.250 SCREW SIZE
			40	36	HEX HD BOLT	ST. STL	COML		.250-20 UNC-2A X .88 LG
			2	35	SUPPORT RAIL	AL, 6061-T6	COML		STAR NO. 1767-116-00
			2	34	BUSHING SHAFT	ST. STL	COML		STAR NO. 1767-116-00
			4	33	SNAP RING	ST. STL	COML		TRUARC NO.
			2	32	LINEAR BUSHING	ST. STL	COML		STAR NO. 0753-216-30
			1	31	KEY	304 ST. STL	ASTM A276		.500 X .500 X 3.25 LG
			1	30	DOWEL PIN	ST. STL	COML		ø.375 X .50 LG
			1	29	SPLINE OUTER RACE	.	COML		SAGINAW NO. 7828134
			2	28	HEX NUT	ST. STL	COML		.500-13 UNC-2B
			2	27	LOCK WASHER	ST. STL	COML		.500 SCR SIZE
			2	26	HEX HD BOLT	ST. STL	COML		.500-13 UNC-2A X 2.75 LG
			1	25	SPLINE INNER RACE	.	COML		SAGINAW NO. 5706436
			1	24	SPRING PIN	ST. STL	COML		ø.250 X 2.00 LG
			1	23	CASTLE NUT	304 ST. STL	ASTM A276		2.44 HEX STOCK
			1	22	WASHER	304 ST. STL	ASTM A276		3.25 OD X 1.63 ID X .22 THK
			1	21	COLLAR	304 ST. STL	ASTM A276		2.75 OD X 1.75 X ID X .688 THK
			1	20	DRIVE SCREW			444-210-99	
			9	19	LOCK WASHER	ST. STL	COML		.312 SCREW SIZE
			9	18	HEX HD CAP SCR	ST. STL	COML		.3125-18 UNC-2A X 1.50 LG
			1	17	SCR DRV SUBASSY	ST. STL		444-232-99	
			16	16	HEX NUT	ST. STL	COML		.312-18 UNC-2B
			16	15	LOCK WASHER	ST. STL	COML		.312 SCREW SIZE
			16	14	HEX HD BOLT	ST. STL	COML		.312-18 UNC-2A X 2.50 LG
			1	13	MOUNTING PLATE			444-211-98	
			12	12	LOCK WASHER	ST. STL	COML		.500 SCREW SIZE
			12	11	HEX HD CAP SCR	ST. STL	COML		.500-13 UNC-2A X 1.25 LG
			4	10	SNAP RING	ST. STL	COML		
			4	9	LINEAR BUSHING	ST. STL	COML		STAR NO. 0601-080-10
			1	8	LVDT STRAP	304 ST. STL	ASTM A240		SHEET
			2	7	HOUSING	304 ST. STL	ASTM A276		5.75 X 6.00 X 15.00
			1	6	GUIDE TUBE "B"	ALLOY STL	COML		STAR NO. 1001-080-00
			1	5	GUIDE TUBE "A"	ALLOY STL	COML		STAR NO. 1001-080-00
			8	4	SHOULDER SCREW	304 ST. STL	ASTM A276		ø.50 X 3.5 LG
			1	3	SLIDE TOP	304 ST. STL	ASTM A276		3.25 X 4.00 X 27.69
			1	2	SLIDE BOTTOM	304 ST. STL	ASTM A276		3.00 X 9.52 X 25.00
			1	1	GRAPPLE SUBASSY	ST. STL		444-201-99	

QUANTITY

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

F-14

SYM	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE:

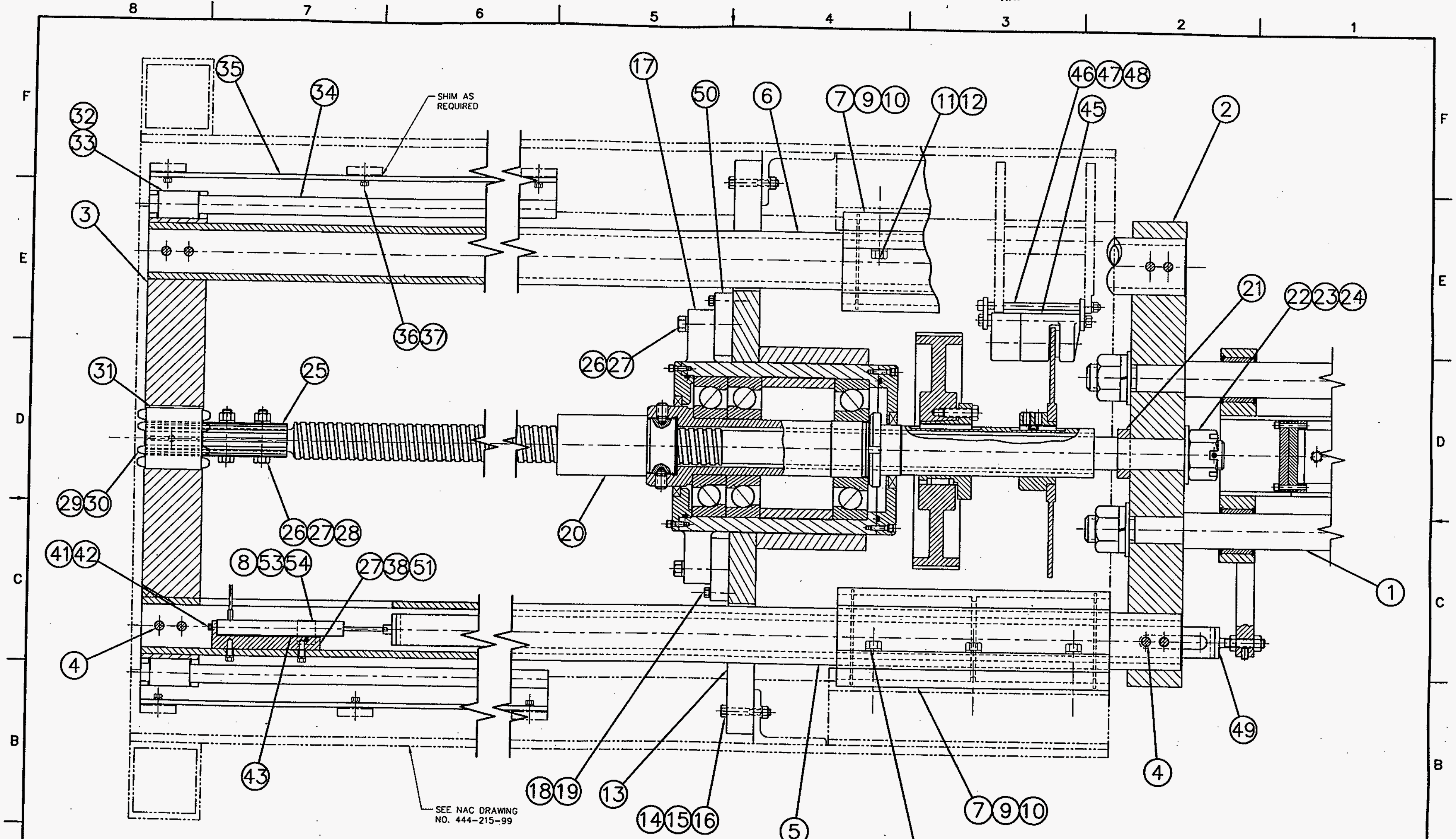
GROUP	NAME	DATE
PREPARER		
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR OF PROJECTS		
LICENSING MANAGER		
QUALITY		
SRV VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

GUIDE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82889

PROJECT 444 | DESIGN PACKAGE | DRAWING 211 | REV 0
SCALE 1/2 | EST.WT. | SH 1 OF 3 | 8:39PM 6-4-97



UP

SECTION A—A $\frac{\text{SH1}}{\text{E5}}$

⑨⑨ GUIDE SUBASSEMBLY

F-15

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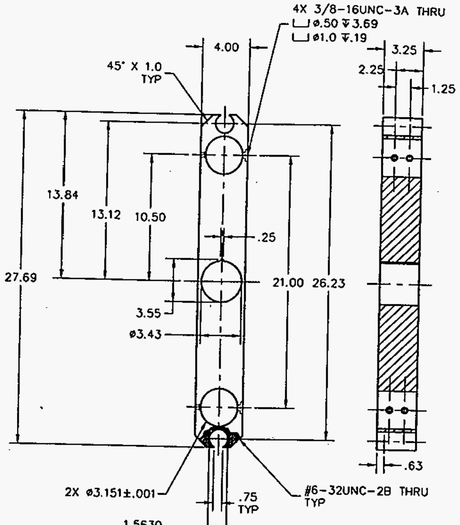
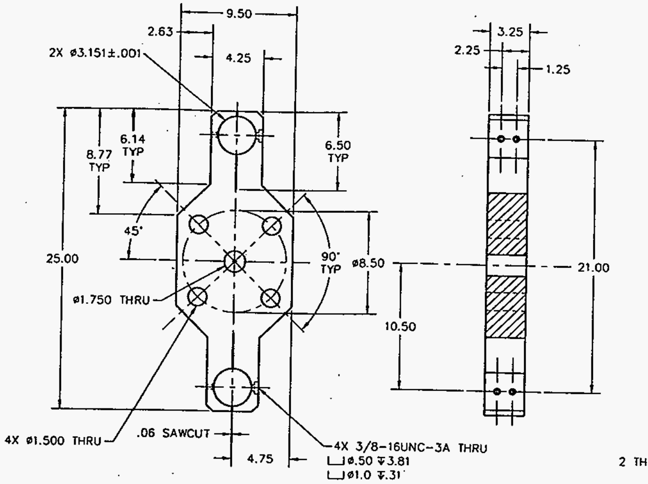
NAC
INTERNATIONAL

GUIDE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82889

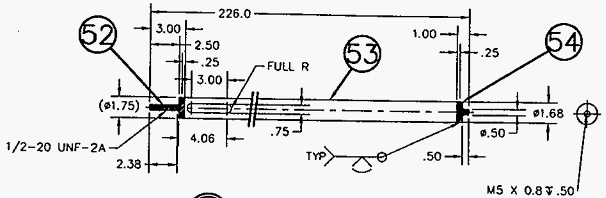
PROJECT 444	DESIGN PACKAGE	DRAWING 211	REV 0
SCALE 1/2	EST.WT.	SH 2 OF 3	8-4-97



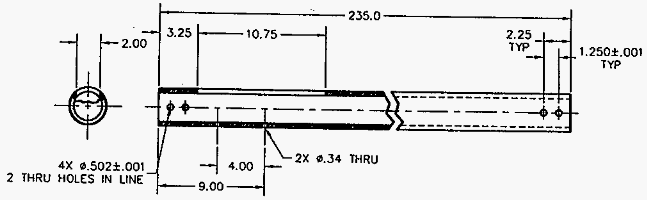
③ TOP SLIDE



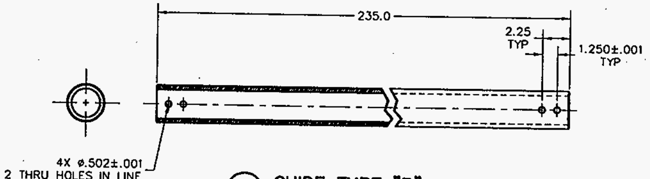
② SLIDE BOTTOM



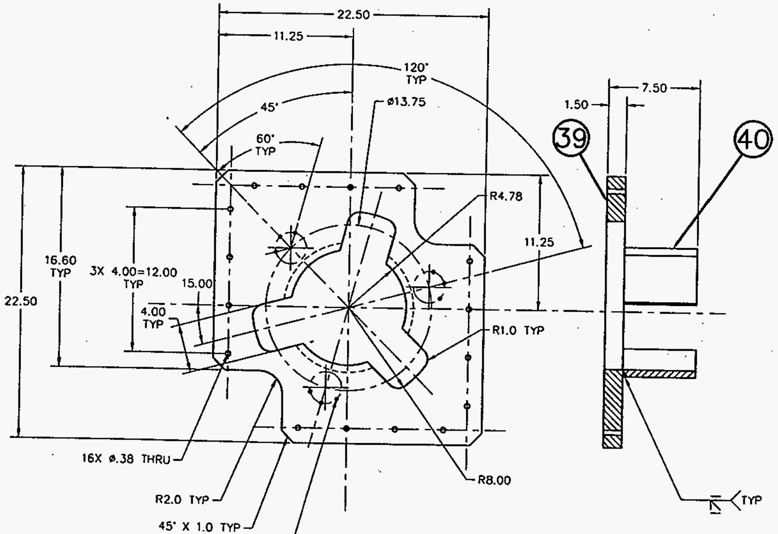
97 PUSHROD WELDMENT



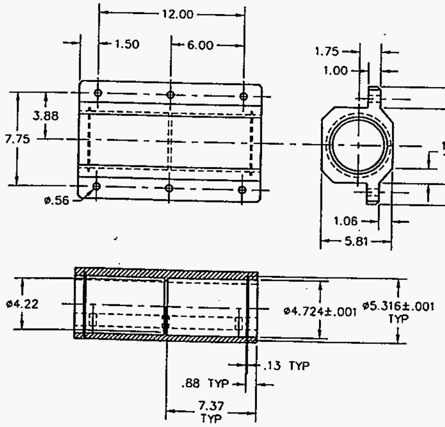
⑤ GUIDE TUBE "A"



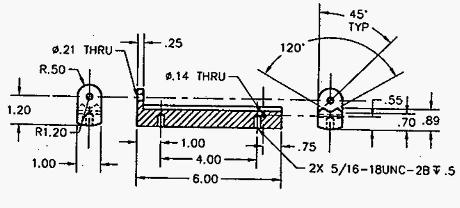
⑥ GUIDE TUBE "B"



98 MOUNTING PLATE



⑦ HOUSING



38 LVDT BRACKET
SCALE: 1/2

PROPRIETARY INFORMATION
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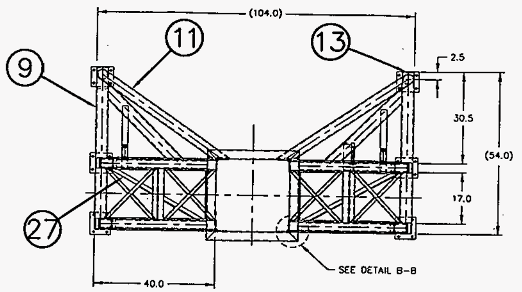
NAC INTERNATIONAL

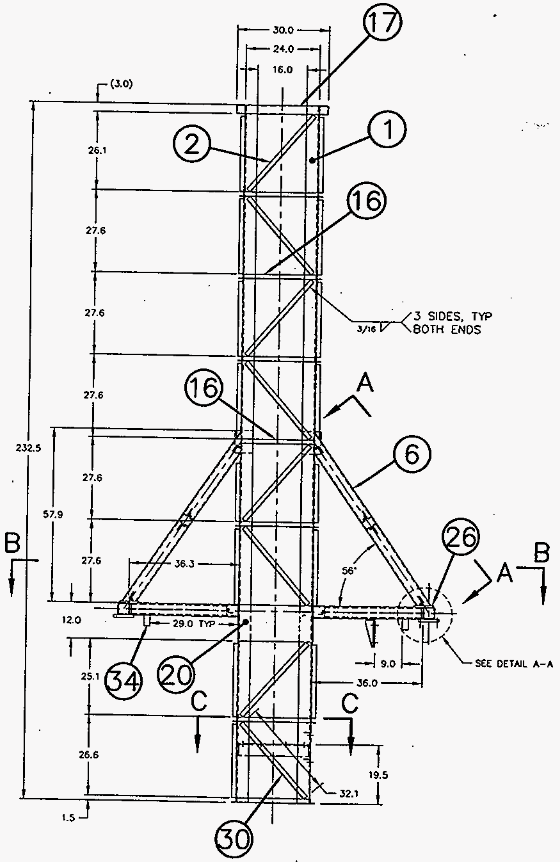
GUIDE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82889

PROJECT 444	DESIGN PACKAGE	DRAWING 211	REV 0
SCALE 1/4	EST.WT.	SH 3 OF 3	R 2RAM 6-4-97

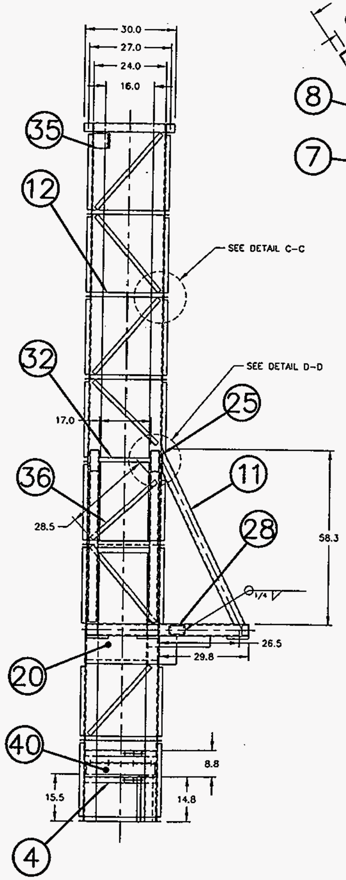
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

NOTES: UNLESS OTHERWISE SPECIFIED
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI/ASME Y14.5M-1994.
2. DIMENSIONS ARE IN INCHES.
3. PERFECT ORIENTATION AT MAXIMUM MATERIAL CONDITION REQUIRED FOR RELATED FEATURES.

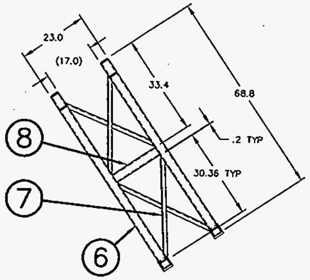




FRONT VIEW



RIGHT VIEW



VIEW A—A

99 MAST WELDMENT

		1	41	SCREW DRIVE BASE			444-215-97	
		1	40	GANTRY STOP ASSY.			444-215-98	
2			39	BASE LEG	CARBON STEEL	ASTM A36		4 X 3 X 3/8 THK WALL RECT. TUBE
	6		38	WASHER	CARBON STEEL	ASTM A36		3/4 SPLIT LOCK WASHER
	6		37	HEX HEAD BOLT	CARBON STEEL	ASTM A36		3/4-10 UNC-2A X 1 1/2 LG
		3	36	DIAGONAL BRACE	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		1	35	BELT DRIVE SUPPORT	CARBON STEEL	ASTM A36		1/2 PLATE
		2	34	PILLOW BLOCK SUPPORT	CARBON STEEL	ASTM A36		3 1/2 X 2 RECT. BAR
		2	33	BRACKET SUPPORT	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		2	32	MAST HORIZONTALS	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
	2		31	STOP PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		7	30	DIAGONAL BRACE	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		2	29	GUIDE MOUNT	CARBON STEEL	ASTM A36		BAR/PLATE
		1	28	STOP SUPPORT BRACKET	CARBON STEEL	ASTM A36		1/2 PLATE
		2	27	CROSS BRACING	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		4	26	PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		2	25	PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		2	24	PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		1	23	PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		1	22	PLATE	CARBON STEEL	ASTM A36		BAR/PLATE
		36	21	PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
		4	20	PLATE	CARBON STEEL	ASTM A36		1/8 SHEET
		2	19	DIAGONAL BRACE	CARBON STEEL	ASTM A36		4 X 4 X 1/4 THK WALL SQ. TUBE
	1		18	STOP	CARBON STEEL	ASTM A36		C3 X 6 CHANNEL
		4	17	TOP HORIZONTALS	CARBON STEEL	ASTM A36		3 X 3 X 3/16 THK WALL SQ. TUBE
		14	16	MAST HORIZONTALS	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		6	15	SUPPORT PLATE	CARBON STEEL	ASTM A36		1/2 PLATE
2		2	14	SUPPORT PLATE	CARBON STEEL	ASTM A36		4 X 3 X 3/8 ANGLE
		4	13	END CAP	CARBON STEEL	ASTM A36		1/2 PLATE
		12	12	MAST HORIZONTALS	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		2	11	DIAGONAL BRACE	CARBON STEEL	ASTM A53		3 IN. SCH. 40 PIPE
		2	10	LATERAL BRACE	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		2	9	OUTRIGGER	CARBON STEEL	ASTM A36		4 X 4 X 1/4 THK WALL SQ. TUBE
		2	8	INTERMEDIATE BRACE	CARBON STEEL	ASTM A36		4 X 4 X 1/4 THK WALL SQ. TUBE
		8	7	DIAGONAL BRACE	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		4	6	OUTRIGGER	CARBON STEEL	ASTM A36		4 X 3 X 1/4 RECT. TUBE
		4	5	OUTRIGGER BRACE	CARBON STEEL	ASTM A36		4 X 4 X 1/4 THK WALL SQ. TUBE
		2	4	ANGLE BRACKET	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
			3	(DELETED)				
		21	2	DIAGONAL BRACE	CARBON STEEL	ASTM A36		1 1/2 X 1 1/2 X 3/16 ANGLE
		4	1	MAST VERTICALS	CARBON STEEL	ASTM A36		4 X 4 X 1/4 ANGLE
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

PROPRIETARY INFORMATION

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SYM.	GEOMETRY
⏥	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY: 444-200

DRAWING TYPE: ENGINEERING

GROUP	NAME	DATE
PREPARER	wmP	6/5/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

NAC INTERNATIONAL

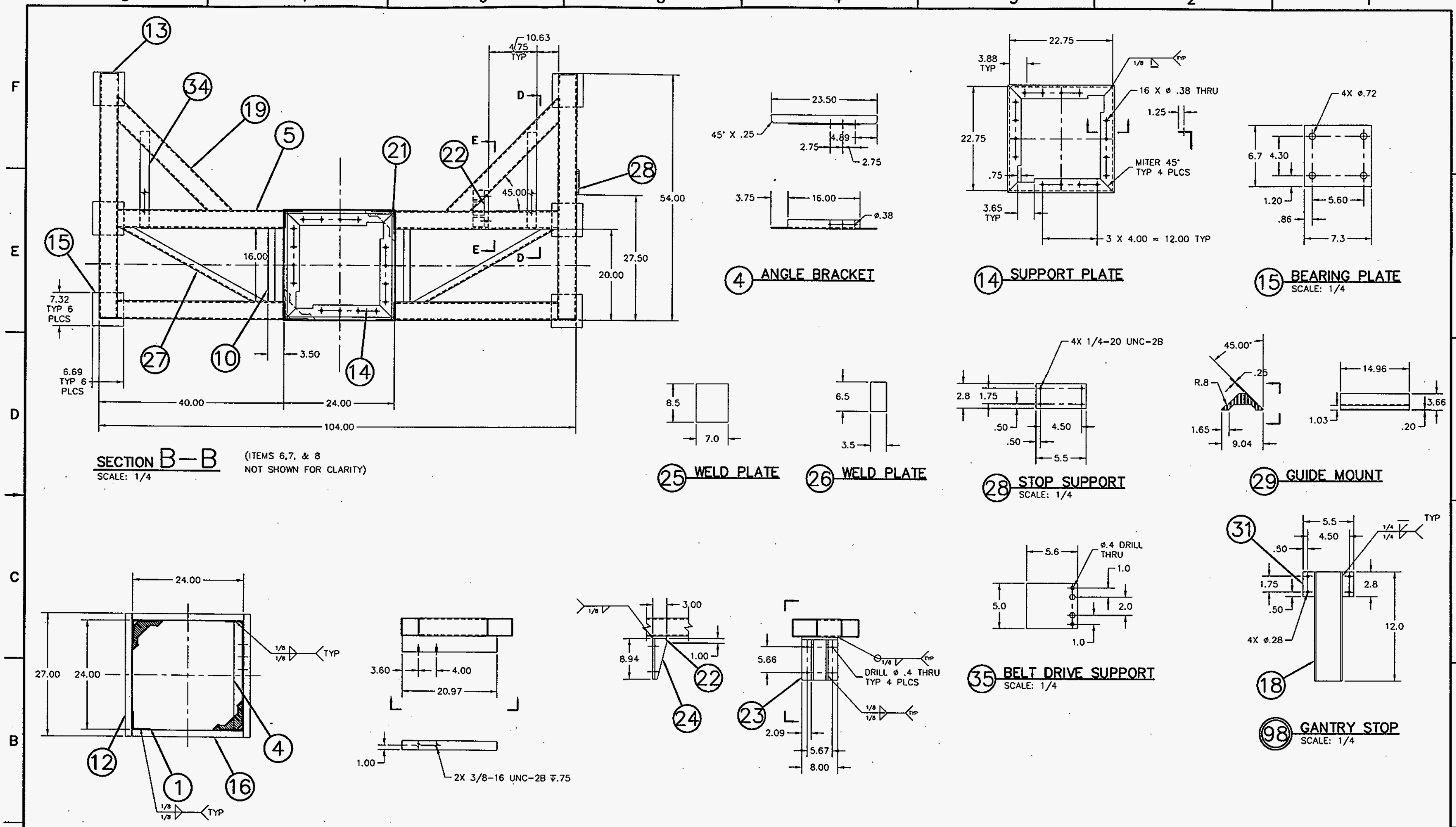
MAST WELDMENT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82892

PROJECT 444 | DESIGN PACKAGE | DRAWING 215 | REV 0
SCALE 1/16 | EST.WT. | SH 1 OF 2 | 3:25PM 6-5-97

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546 ITEM 5
WHC P.O. NO: NCB-SLD-A01129

FABRICATION SPECIFICATION:

DESIGN SPECIFICATION: 440-S-01



PROPRIETARY INFORMATION

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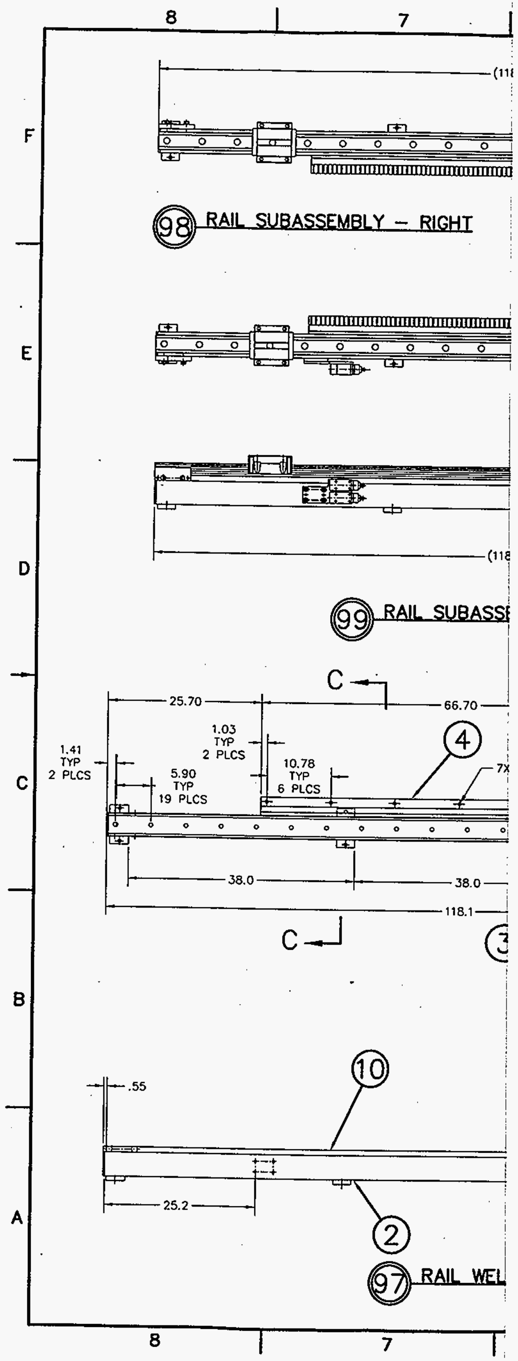
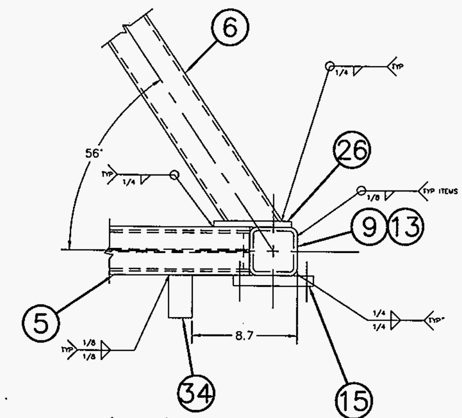
NAC INTERNATIONAL

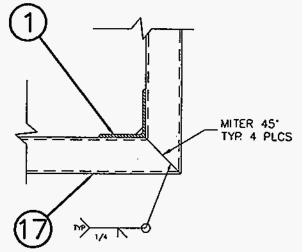
MAST WELDMENT
MCO LOADING SYSTEM
WHC DWG. NO: H-1-82892

PROJECT 444	DESIGN PACKAGE	DRAWING 215	REV 0
SCALE 1/8	EST.WT.	SH 2 OF 3	4:07PM 6-5-97

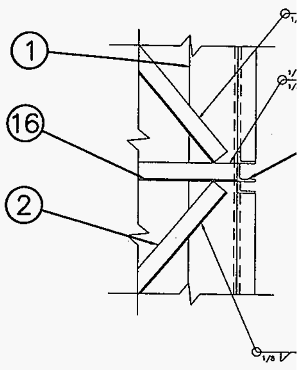




DETAIL A–A
SCALE: 1/4

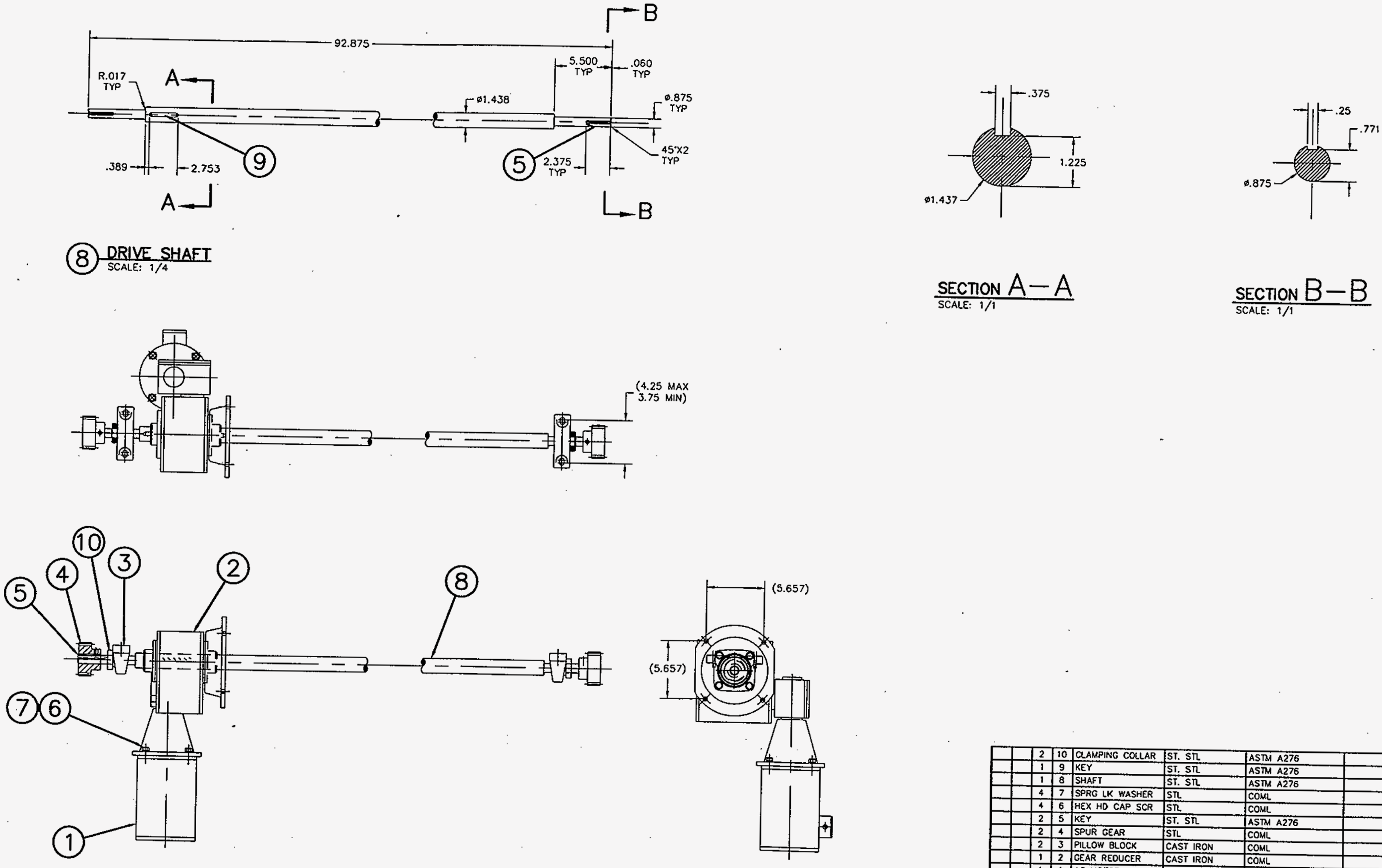


DETAIL B–B
SCALE: 1/4



DETAIL C–C
SCALE: 1/4

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 BRIDGE DRIVE ASSEMBLY
SCALE: 1/4

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		2	10	CLAMPING COLLAR	ST. STL	ASTM A276		BOSTON GEAR 2SC87 ITEM CODE49153
		1	9	KEY	ST. STL	ASTM A276		.375 X 2.75 SQUARE KEY STOCK
		1	8	SHAFT	ST. STL	ASTM A276		STAR 1001-080-00 HOLLOW SHAFT SERIES
		4	7	SPRG LK WASHER	STL	COML		.375 SCREW SIZE
		4	6	HEX HD CAP SCR	STL	COML		.375-16 UNC-2A X 1.00 LG
		2	5	KEY	ST. STL	ASTM A276		.25 X 2.375 SQUARE KEY STOCK
		2	4	SPUR GEAR	STL	COML		BOSTON GEAR # YH24-7/8
		2	3	PILLOW BLOCK	CAST IRON	COML		BOSTON GEAR # SH-7/8
		1	2	GEAR REDUCER	CAST IRON	COML		BOSTON GEAR #SRFWC726-600-VW-B5-G
		1	1	AC MOTOR	STL	COML		BOSTON GEAR #DU-B W/FAILSAFE BRAKE

QUANTITY

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NC8-SLD-A01129

F-21

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
▱	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
∠	ANGULARITY	. 3-12	±.005	6-18	±.03
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
⊕	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY: 444-200
DRAWING TYPE: ENGINEERING

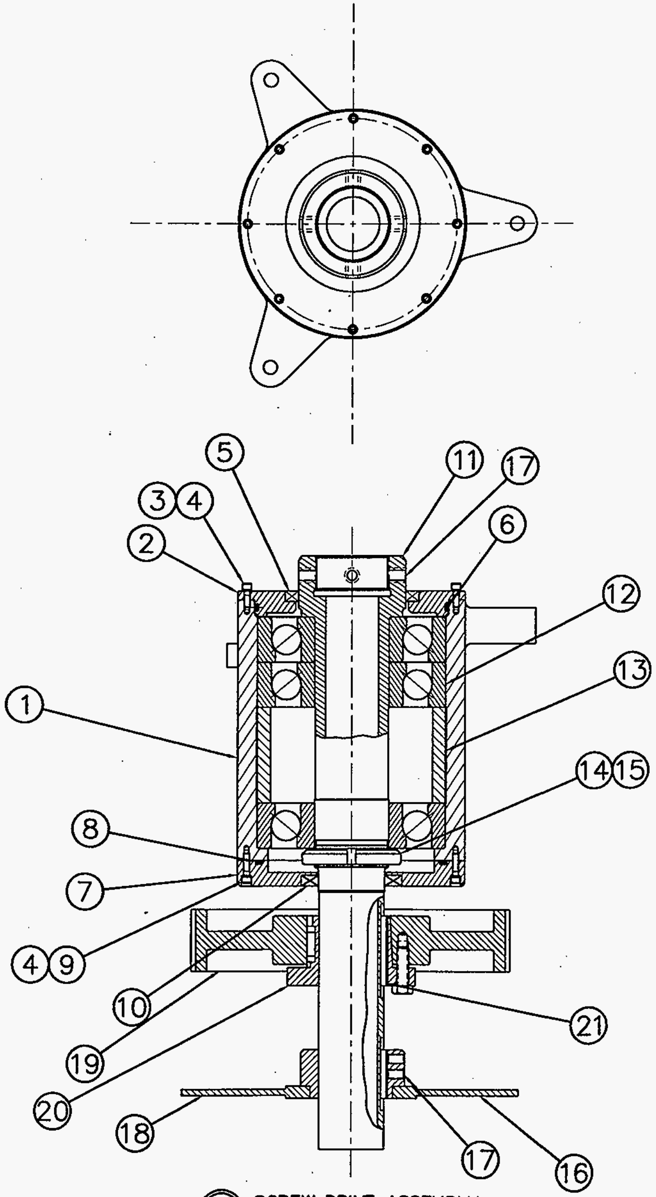
GROUP	NAME	DATE
PREPARER	ACr	6/3/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

NAC INTERNATIONAL

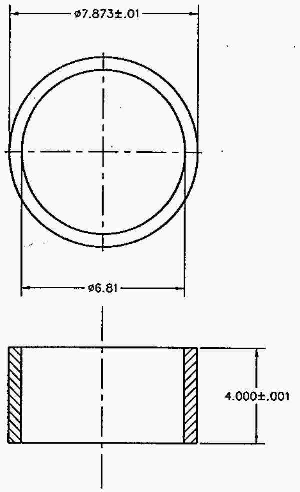
BRIDGE DRIVE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82898

PROJECT 444
DESIGN PACKAGE
DRAWING 225
REV 0
SCALE 1/4
EST.WT.
SH 1 OF 1
8:50PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 SCREW DRIVE ASSEMBLY
SCALE: N.T.S.



13 SPACER

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

96	97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1				27	DISK	440C ST.STL	ASTM A240		PLATE
1				26	HUB	304 ST.STL.	ASTM A276		BAR
	1			25	BODY	440C ST.STL	ASTM A276		BAR
	1			24	HEAD	440C ST.STL.	ASTM A276		BAR
		3		23	LUG	304 ST.STL	ASTM A276		BAR
		1		22	HOUSING	304 ST.STL.	ASTM A743		CENT. CASTING
			1	21	KEY	ST. STL	ASTM A276		.375 X .250 X 2.875 LG
			1	20	TAPER BUSHING	ALUMINUM	COML		ALTERED
			1	19	GEARBELT PULLEY	ALUMINUM	COML		BROWNING NO. 48XHR200
			1	18	KEY	ST. STL	ASTM A276		.375 X .250 X 2.00 LG
			6	17	HEX SOC SET SCR	ST. STL	COML		.375-16 UNC-2A X .75 LG
			1	16	DISK WELDMENT			444-232-96	
			1	15	BRG LOCKWASHER	STEEL	COML		WHITTET-HIGGINS #WMS-19070-163
			1	14	BRG LOCKNUT	STEEL	COML		WHITTET-HIGGINS #MS-19068-163
			1	13	SPACER	304 ST. STL	ASTM A511		8 O.D. TUBE W 3/4 WALL
			3	12	BEARING	STEEL	COML		FAFNIR NO. 7415WN
			1	11	DRIVE SHAFT			444-232-97	
			1	10	SHAFT SEAL	FLUROELASTOMER	COML		CHICAGO-RAWHIDE NO. 28275
			8	9	SOC HD CAP SCR	ST. STL	COML		.250-20 UNC-2A X 1.00 LG
			1	8	O-RING	VITON	COML		PARKER NO. 2-367V747-75
			1	7	BOTTOM FLANGE	304 ST. STL	ASTM A240		PLATE
			1	6	O-RING	VITON	COML		PARKER NO. 2-368V747-75
			1	5	SHAFT SEAL	FLUROELASTOMER	COML		CHICAGO-RAWHIDE NO. 45032
			16	4	LOCK WASHER	ST. STL	COML		.250 SCREW SIZE, HI-COLLAR
			8	3	SOC HD CAP SCR	ST. STL	COML		.250-20 UNC-2A X .75 LG
			1	2	TOP FLANGE	304 ST. STL	ASTM A240		PLATE
			1	1	HOUSING WELDMENT			444-232-98	
ASSY	ASSY	ASSY	ASSY						
QUANTITY									

NAC INTERNATIONAL

DRIVE SUBASSEMBLY
MCO LOADING SYSTEM
WHC DRAWING NO: H-1-82903

SYM.	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

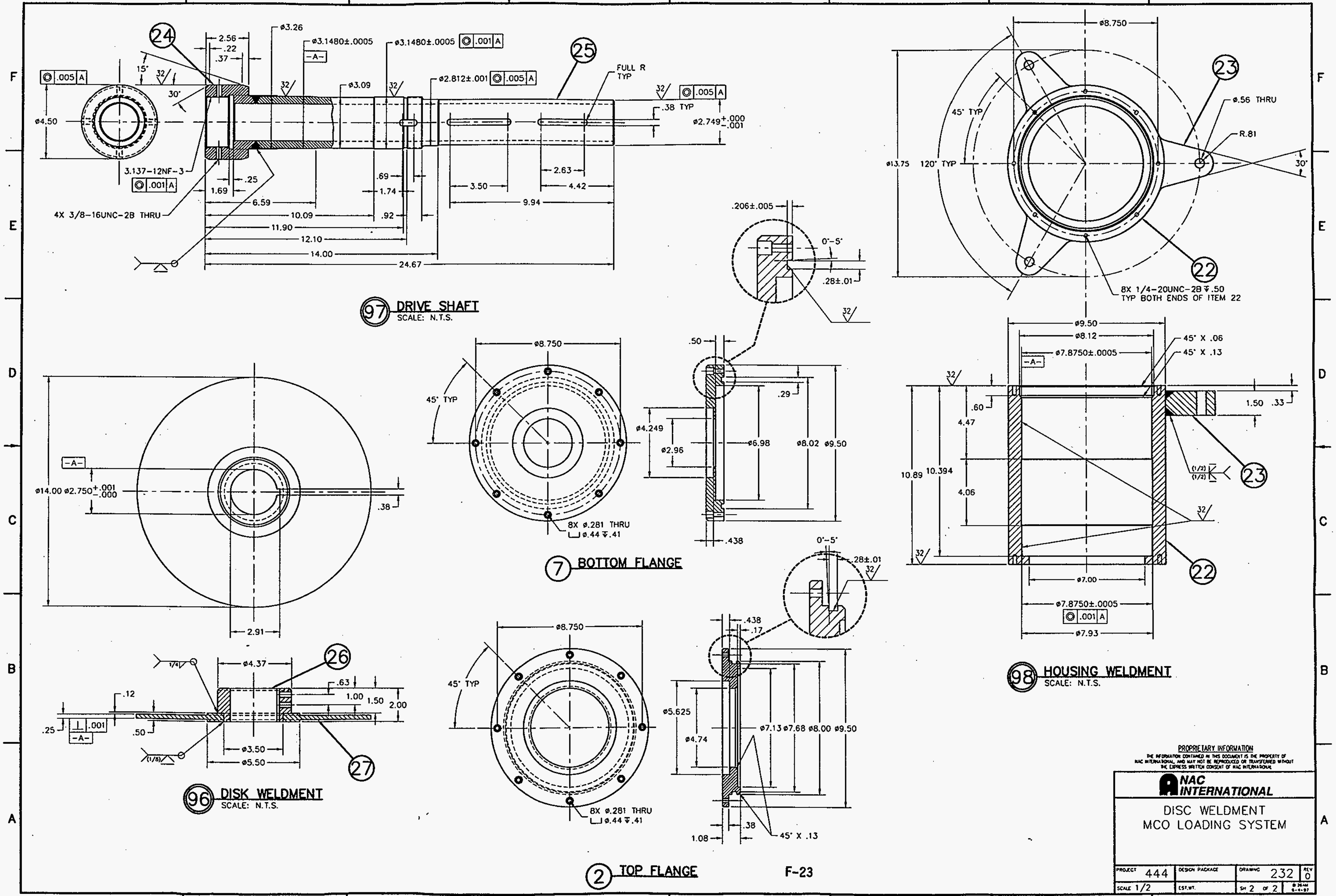
3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY: 444-211
DRAWING TYPE: ENGINEERING

GROUP	NAME	DATE
PREPARER	NAC	6/4/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRU VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

PROJECT 444
DESIGN PACKAGE
DRAWING 232
REV 0
SCALE 1/2
EST.WT.
SH 1 OF 2
8:53PM 6-4-97



97 DRIVE SHAFT
SCALE: N.T.S.

96 DISK WELDMENT
SCALE: N.T.S.

7 BOTTOM FLANGE

2 TOP FLANGE

98 HOUSING WELDMENT
SCALE: N.T.S.

F-23

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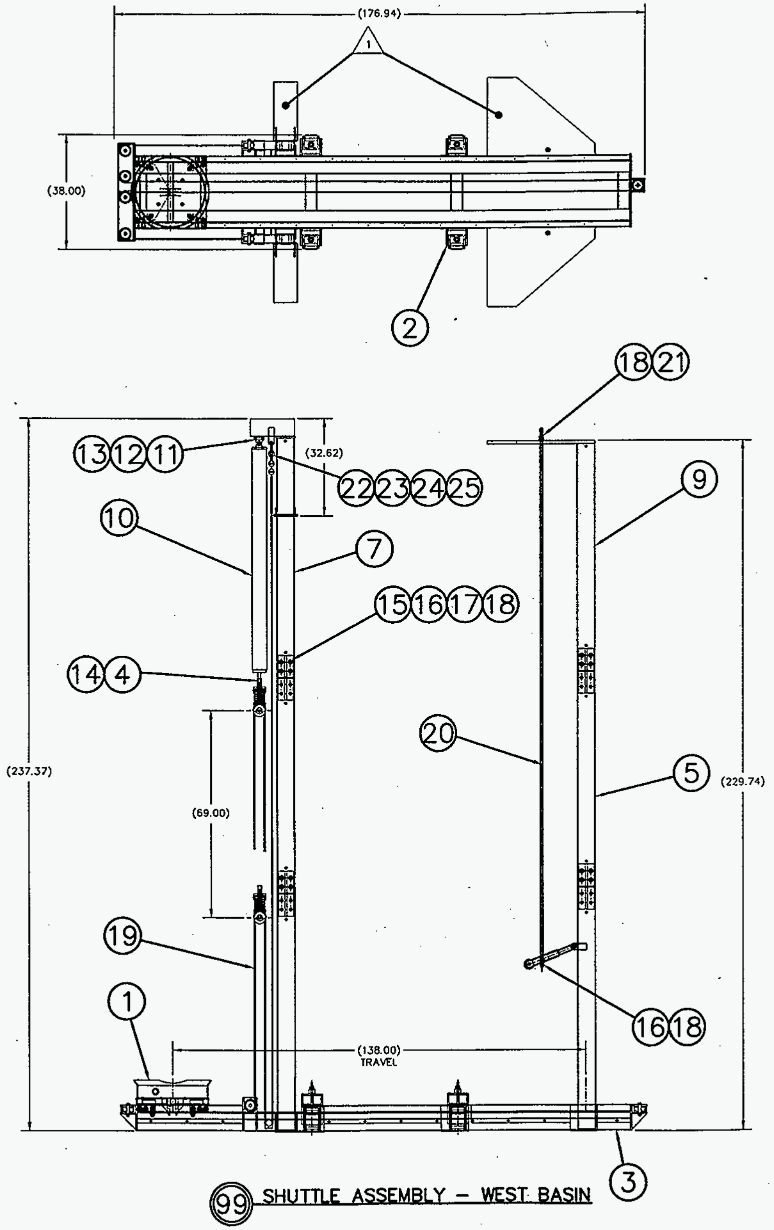
NAC INTERNATIONAL

DISC WELDMENT
MCO LOADING SYSTEM

PROJECT 444	DESIGN PACKAGE	DRAWING 232	REV 0
SCALE 1/2	EST.WT.	SH 2 OF 2	

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 SHUTTLE ASSEMBLY – WEST BASIN

1) NUMBER, SIZE, LOCATION OF BOLTS AND ANCHORAGE TO BE DETERMINED BY HANFORD ENGINEERS USING REATIONS PROVIDED AT ANCHORAGE PLATES.

NOTES

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	1		26	CYL. TUBE RH			444-310-94	
	1		25	CYL. TUBE LH			444-310-93	
	4	4	24	JAM NUT	ST.STL.	COML.		1/2-13UNC-2B
	2	2	24	OPEN THIMBLE	ST.STL.	COML.		3/8 DIA WIRE ROPE
	2	2	23	EYE BOLT	ST.STL.	COML.		1/2 DIA
	4	4	22	WIRE ROPE CLIP	ST.STL.	COML.		CROSBY #1011283
	2	2	21	SPHERICAL WASHER	ST.STL.	COML.		3/4 DIA
	2	2	20	DRAW BAR			444-306-09	
	1	1	19	WIRE ROPE	ST.STL.	COML.		3/8 DIA
	36	36	18	HEX NUT	ST.STL.	COML.		3/4-10UNC-2B
	32	32	17	LOCK WASHER	ST.STL.	COML.		3/4 DIA
	65	65	16	WASHER	ST.STL.	COML.		3/4 DIA
	32	32	15	BOLT	ST.STL.	COML.		3/4-10 X 4 3/4 LONG
	2	2	14	JAM NUT	ST.STL.	COML.		3/4-16UNF-2B
	8	8	13	WASHER	ST.STL.	COML.		??
	8	8	12	BOLT	ST.STL.	COML.		??
	2	2	11	CLEVIS MOUNT ,		COML.		NUMATICS 5 BORE
	2	2	10	AIR CYLINDER	NFPA MP2 STYLE	COML.		NUMATICS (5 X71)-P2 MOUNT
	1	1	9	PLATE/TUBE RH			444-310-96	
	1	1	8	PLATE/TUBE LH			444-310-95	
		1	7	CYL. TUBE RH			444-310-94	
		1	6	CYL. TUBE LH			444-310-93	
	4	4	5	MIDDLE TUBE ASSY			444-310-98	
	2	2	4	CABLE MOUNT-CYL.			444-305-99	
	1	1	3	RAILS AND SUPPORT			444-304-99	
	4	4	2	WEDGE ASSEMBLY			444-303-99	
	1	1	1	CART ASSEMBLY			444-301-99	

QUANTITY

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
	ANGULARITY	3-12	±.005	6-18	±.03
	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06
	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
	CONCENTRICITY	FINISH (✓)-AA-125 MICRO IN		ANGLES ±.5°	
	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

GROUP	NAME	DATE
PREPARER	R Walker	6597
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRU VP		

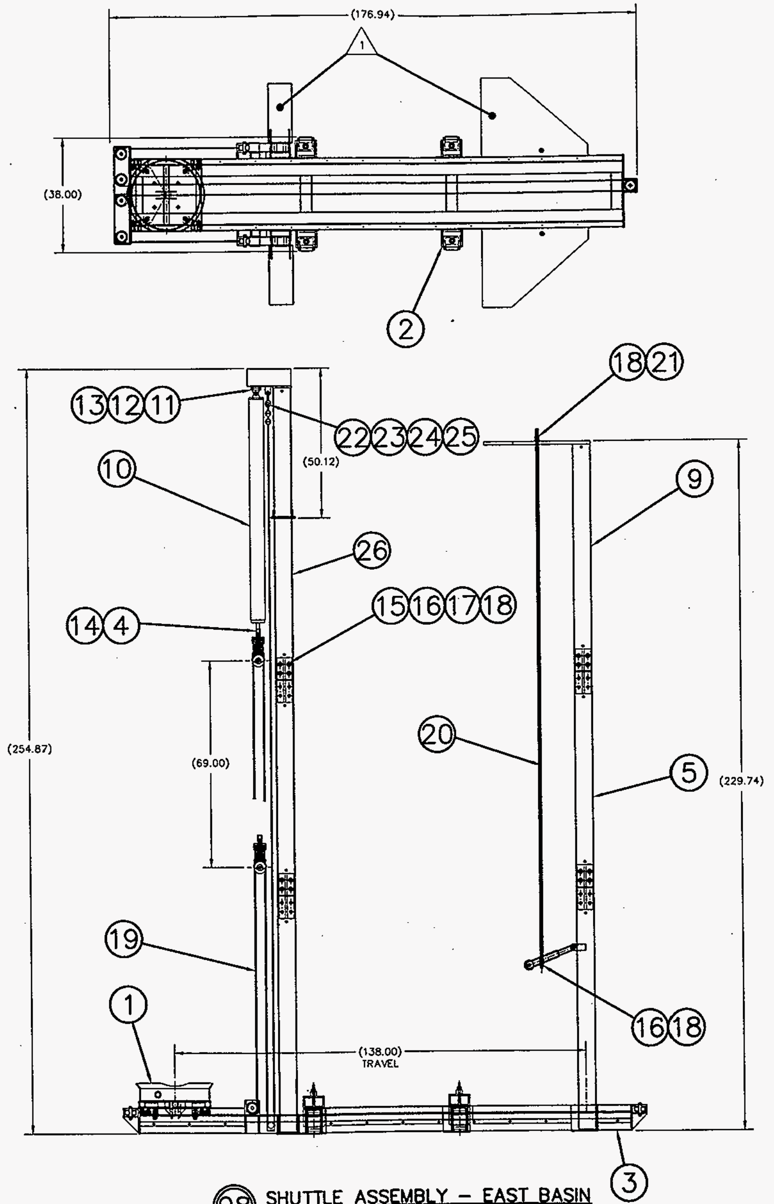
NAC INTERNATIONAL

SHUTTLE ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82911

PROJECT 444
DESIGN PACKAGE
DRAWING 300
REV 0
SCALE 1/16
EST.WT.
SH 1 OF 2
3:15PM 6-5-97

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01



98 SHUTTLE ASSEMBLY - EAST BASIN

PROPRIETARY INFORMATION
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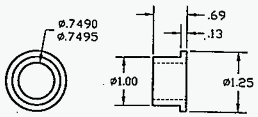
NAC INTERNATIONAL

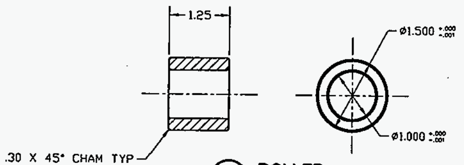
SHUTTLE ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82911

PROJECT 444	DESIGN PACKAGE	DRAWING 300	REV 0
SCALE 1/16	EST.WT.	SH 2 OF 2	3:15PM 6-5-97

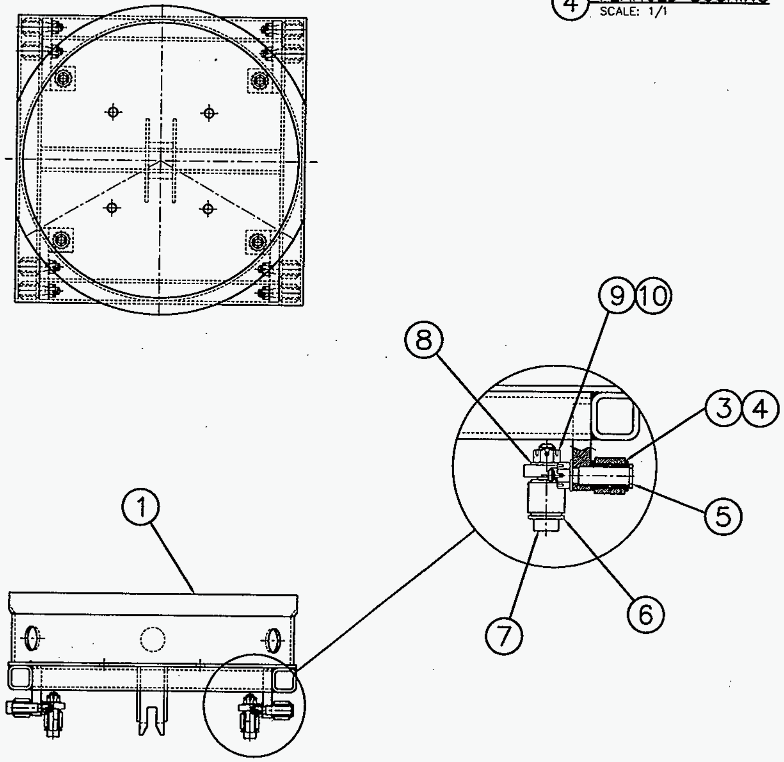
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

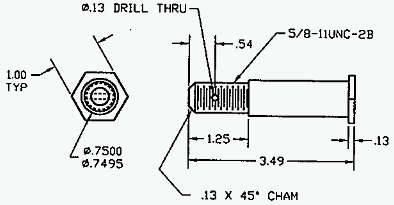


④ FLANGED BUSHING
SCALE: 1/1

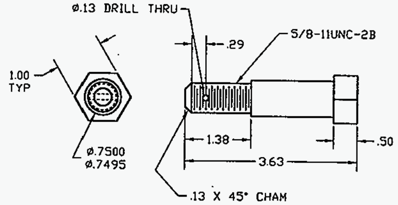


③ ROLLER
SCALE: 1/1





⑤ SHOULDER SCREW
SCALE: 1/1



⑦ SHOULDER SCREW
SCALE: 1/1

		24	10	COTTER PIN	ST.STL.	COML.		DIA 1/8 X 1 1/2
		24	9	CASTLE NUT	ST.STL.	COML.		5/8-11
		24	8	FLAT WASHER	ST.STL.	COML.		DIA 5/8
		4	7	SHOULDER SCREW	440 C ST.STL.	ASTM A276		DIA 1 1/4
		24	6	FLAT WASHER	ST.STL.	COML.		DIA 3/4
		8	5	SHOULDER SCREW	440 C ST.STL.	ASTM A276		DIA 1 1/4
		24	4	FLANGED BUSHING	GRAPHITE	COML.		GRAPHALLOY #317-12
		12	3	ROLLER	440 C ST.STL.	ASTM A276		2 O.D. X 1.25 LG.
			2					
		1	1	CART WELDMENT			444-302-99	
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

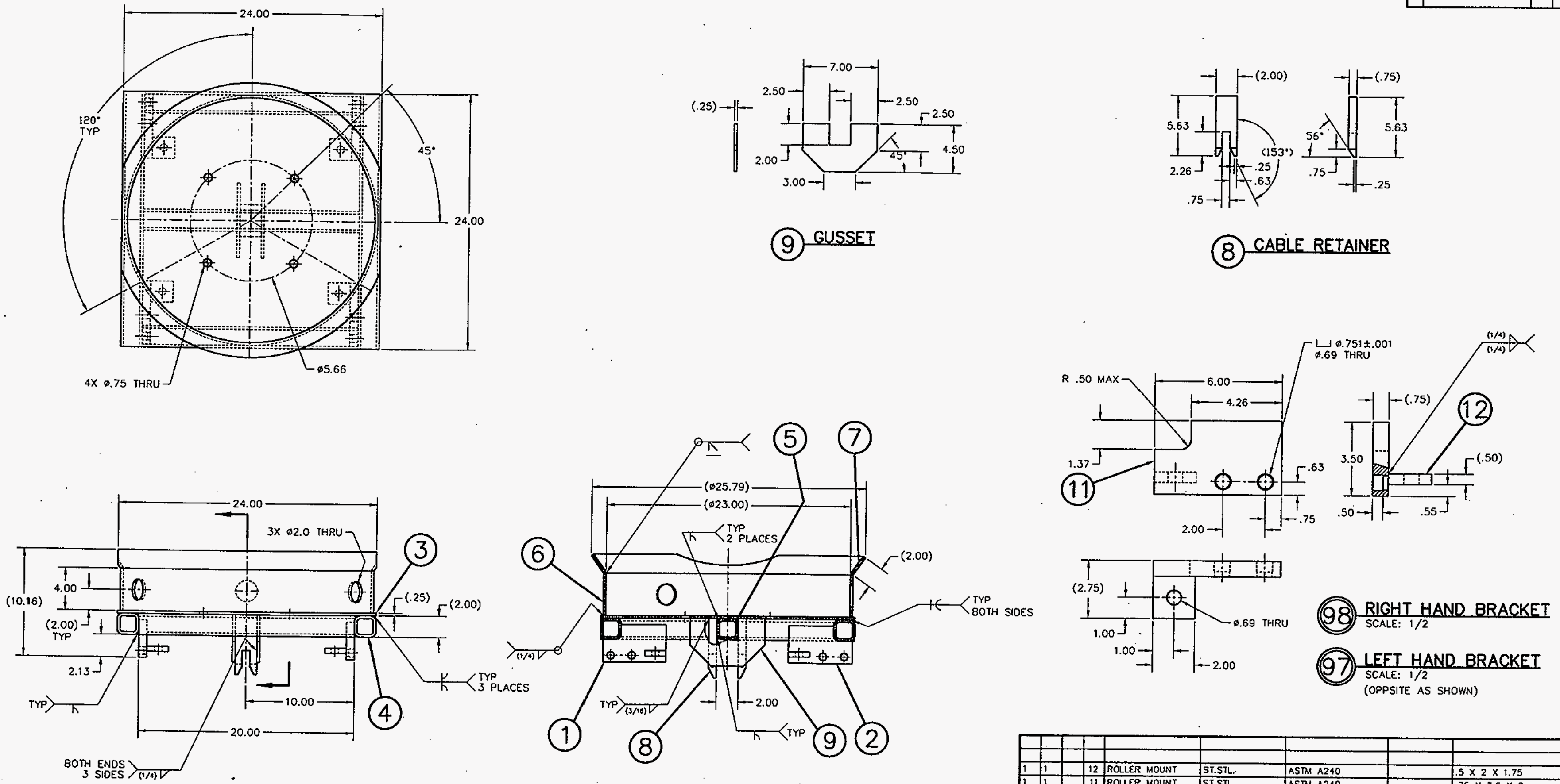
SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
⏥	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER	K Walker	6-5-97
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
∠	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
//	PARALLELISM	1 PLACE DEC. ±.1		FILLETS .015 TO .030		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
⊕	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:						
		DRAWING TYPE:				SBU VP		

NAC INTERNATIONAL

CART ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82912

PROJECT	DESIGN PACKAGE	DRAWING	REV
444		301	0
SCALE 1/4	EST.WT. 185#	SH 1 OF 1	8:29PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1	1		12	ROLLER MOUNT	ST.STL.	ASTM A240		.5 X 2 X 1.75
1	1		11	ROLLER MOUNT	ST.STL.	ASTM A240		.75 X 3.5 X 6
			10					
		2	9	GUSSET	ST.STL.	ASTM A240		.25 X 4.50 X 7.00
		2	8	CABLE RETAINER	ST.STL.	ASTM A240		.75 X 2 X 5.63
		1	7	FLAIR	ST.STL.	ASTM A240		.25 X 2 X 90
		1	6	SLEEVE	ST.STL.	ASTM A240		.25 X 4 X 73
		3	5	SQ. TUBE	ST.STL.	ASTM 544		2 SQ. X .25 WALL X 20
		2	4	SQ. TUBE	ST.STL.	ASTM 554		2 SQ. X .25 WALL X 24
		1	3	FLOOR	ST.STL.	ASTM A240		.25 X 24 SQ.
		2	2	LEFT HAND BRACKET			444-302-97	
		2	1	RIGHT HAND BRACKET			444-302-98	

QUANTITY

NAC INTERNATIONAL

CART WELDMENT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82913

SYM	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE:

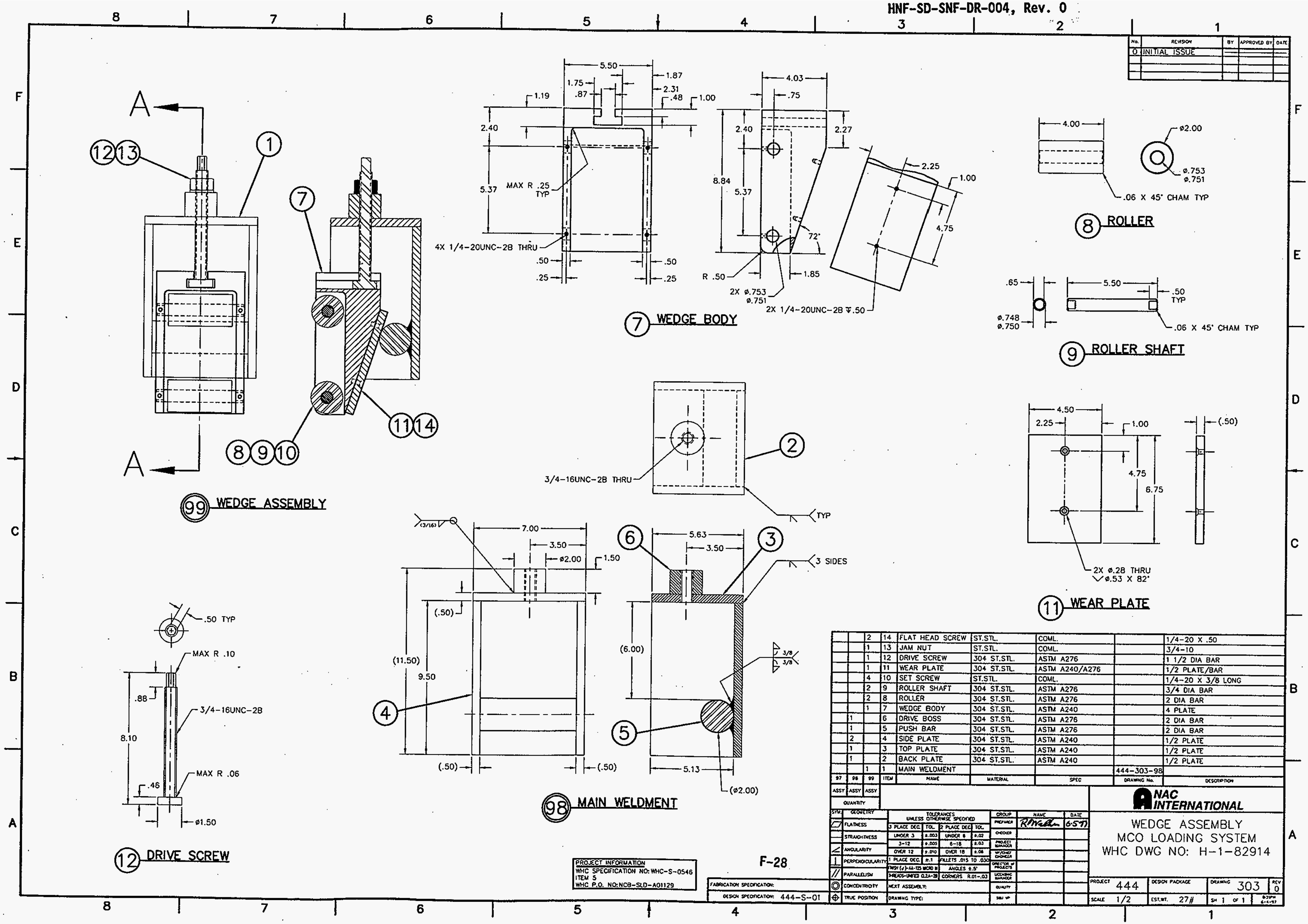
GROUP	NAME	DATE
PREPARER	RWollin	6-5-97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRU VP		

PROJECT 444
DESIGN PACKAGE
DRAWING 302
REV 0
SCALE 1/4
EST.WT.
SH 1 of 1
8:30PM 6-4-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



		2	14	FLAT HEAD SCREW	ST.STL.	COML.		1/4-20 X .50
		1	13	JAM NUT	ST.STL.	COML.		3/4-10
		1	12	DRIVE SCREW	304 ST.STL.	ASTM A276		1 1/2 DIA BAR
		1	11	WEAR PLATE	304 ST.STL.	ASTM A240/A276		1/2 PLATE/BAR
		4	10	SET SCREW	ST.STL.	COML.		1/4-20 X 3/8 LONG
		2	9	ROLLER SHAFT	304 ST.STL.	ASTM A276		3/4 DIA BAR
		2	8	ROLLER	304 ST.STL.	ASTM A276		2 DIA BAR
		1	7	WEDGE BODY	304 ST.STL.	ASTM A240		4 PLATE
	1		6	DRIVE BOSS	304 ST.STL.	ASTM A276		2 DIA BAR
	1		5	PUSH BAR	304 ST.STL.	ASTM A276		2 DIA BAR
	2		4	SIDE PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		3	TOP PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		2	BACK PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
		1	1	MAIN WELDMENT			444-303-98	
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
		3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.			
▱	FLATNESS	UNDER 3	±.003	UNDER 6	±.02	PREPARER	RWalker	6-5-97
	STRAIGHTNESS	3-12	±.005	6-18	±.03	CHECKER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	PROJECT MANAGER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		VP/CHIEF ENGINEER		
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		DIRECTOR of PROJECTS		
		THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		LICENSING MANAGER		
◎	CONCENTRICITY	NEXT ASSEMBLY:				QUALITY		
⊕	TRUE POSITION	DRAWING TYPE:				SRV VP		

NAC INTERNATIONAL

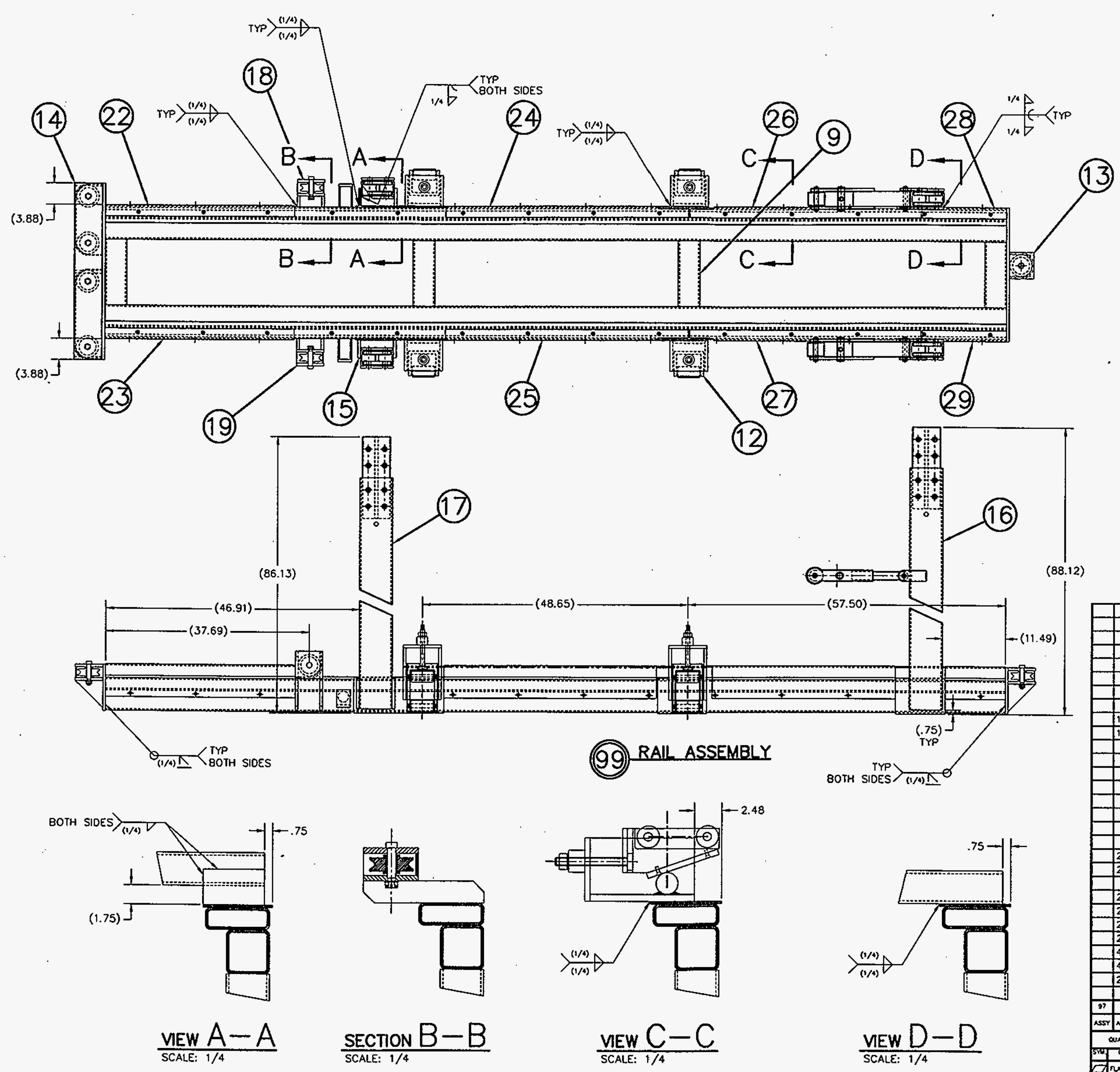
WEDGE ASSEMBLY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82914

PROJECT	DESIGN PACKAGE	DRAWING	REV
444		303	0
SCALE 1/2	EST.WT. 27#	SH 1 OF 1	6-3-97 6-4-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	29	GUARD #4 - RH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	28	GUARD #4 - LH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	27	GUARD #3 - RH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	26	GUARD #3 - LH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	25	GUARD #2 - RH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	24	GUARD #2 - LH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	23	GUARD #1 - RH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	22	GUARD #1 - LH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
	1		21	RAIL TUBE, LH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
	1		20	RAIL TUBE, RH	304 ST.STL.	ASTM A276		2 X 6 X 1/4 WALL
		1	19	PULLEY ASSEMBLY			444-311-99	
		1	18	PULLEY ASSEMBLY			444-311-98	
		2	17	BOTTOM TUBE ASSY			444-310-99	
		2	16	BOTTOM TUBE ASSY			444-310-97	
		4	15	GUSSET	304 ST.STL.	ASTM A240		1/2 PLATE
		1	14	CABLE RETURN			444-307-99	
		1	13	CABLE RETURN			444-308-99	
		4	12	WEDGE ASSEMBLY			444-303-99	
	28		11	BOLT	ST.STL.	COML.		1/4-20 X 1/2
	2		10	HARDENED RAIL	440 C ST.STL.	ASTM A276		3/8 X 2 3/8 BAR
		1	9	SUB-ASSEMBLY			444-304-98	
	2		8	BOTTOM PLATE	304 ST.STL.	ASTM A276		1/2 X 2 1/2 BAR
	2		7	END PLATE	304 ST.STL.	ASTM A276		1/2 X 2 1/2 BAR
	2		6	RETURN ROD	304 ST.STL.	ASTM A276		2 DIA BAR
	2		5	DOUBLER	304 ST.STL.	ASTM A240		1/4 PLATE
	4		4	DOUBLER	304 ST.STL.	ASTM A240		1/4 PLATE
	4		3	CROSS TUBE	304 ST.STL.			2 X 4 X 1/4 WALL
	2		2	SUPPORT TUBE	304 ST.STL.			4 X 4 X 1/4 WALL
			1					

QUANTITY

SYM.	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL.2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE:

GROUP	NAME	DATE
PREPARER	R. Walker	6-5-97
CHECKER		
PROJECT MANAGER		
WVDHO/ ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

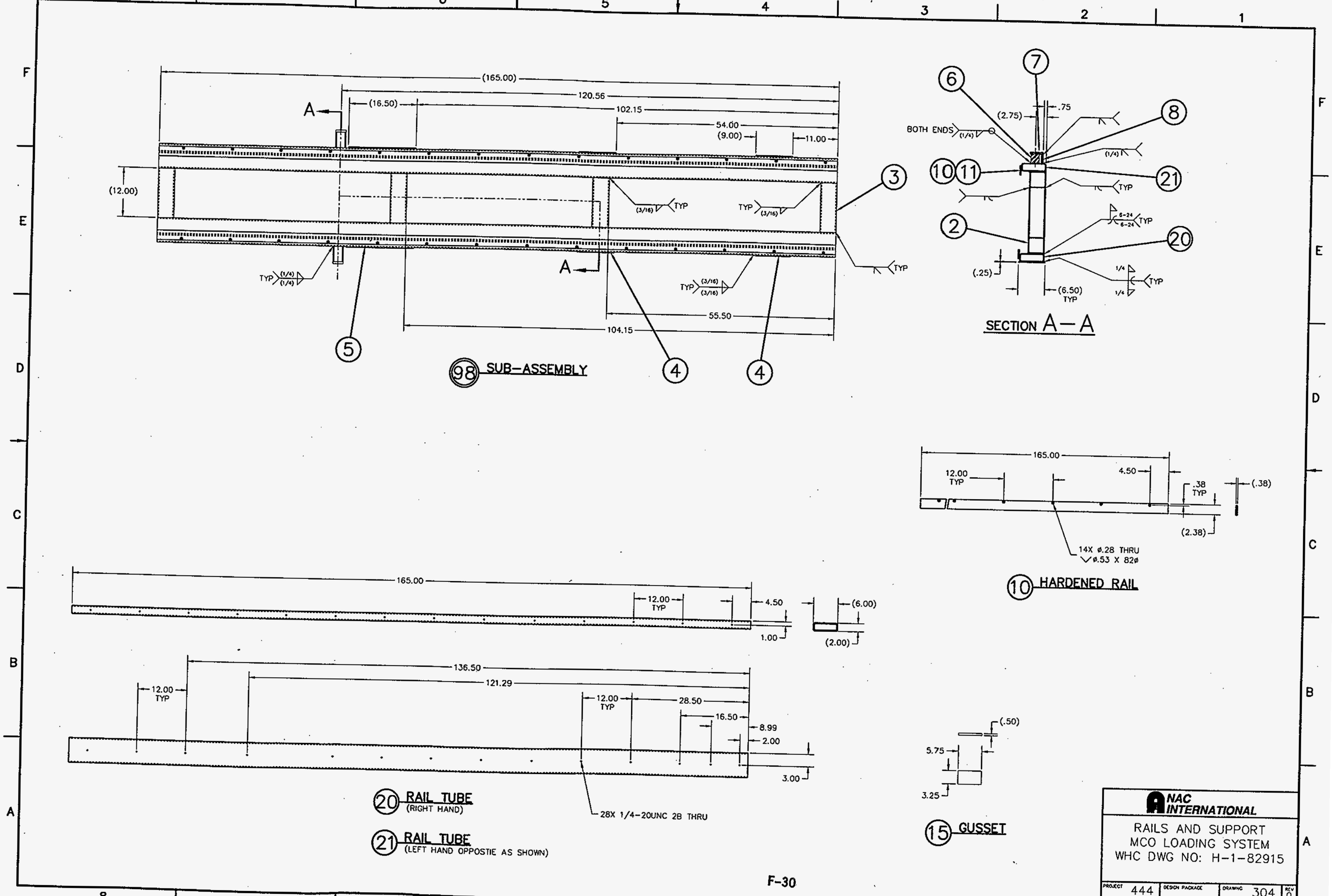
F-29

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

RAILS AND SUPPORT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82915

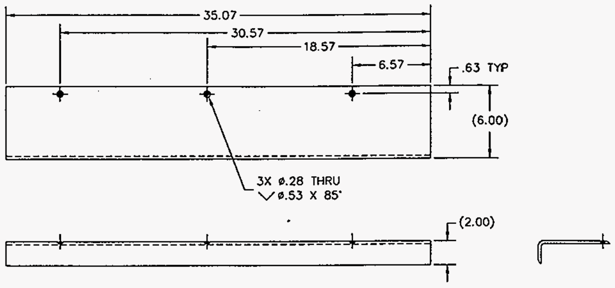
PROJECT 444 | DESIGN PACKAGE | DRAWING 304 | REV 0
SCALE 1/8 | EST.WT. 1,100# | SH 1 OF 3 | 8:32PM 6-4-97



NAC INTERNATIONAL

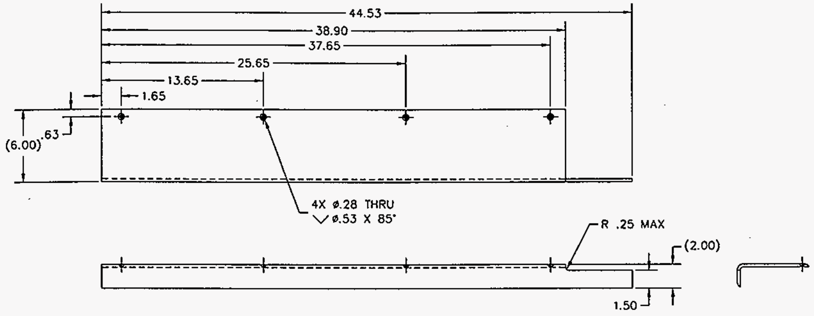
RAILS AND SUPPORT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82915

PROJECT 444	DESIGN PACKAGE	DRAWING 304	REV 0
SCALE 1/8	EST.WT.	SH 2 OF 3	



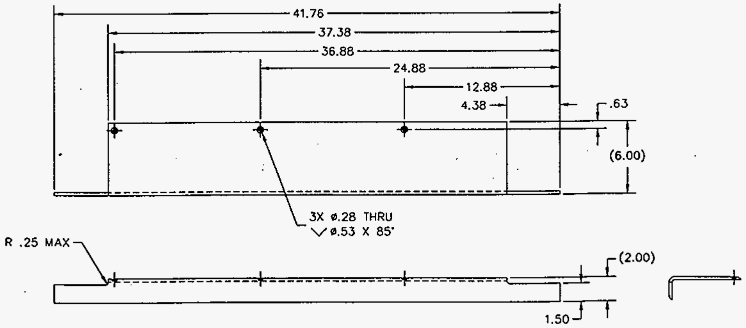
㉒ GUARD #1
(LEFT HAND)

㉓ GUARD #1
(RIGHT HAND–OPPOSITE AS SHOWN)



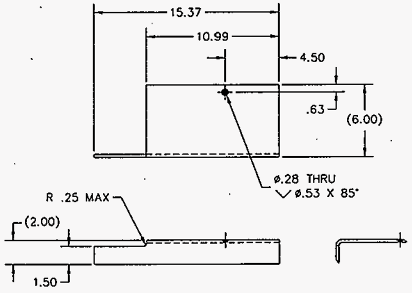
㉔ GUARD #2
(LEFT HAND)

㉕ GUARD #2
(RIGHT HAND–OPPOSITE AS SHOWN)



㉖ GUARD #3
(LEFT HAND)

㉗ GUARD #3
(RIGHT HAND–OPPOSITE AS SHOWN)



㉘ GUARD #4
(LEFT HAND)

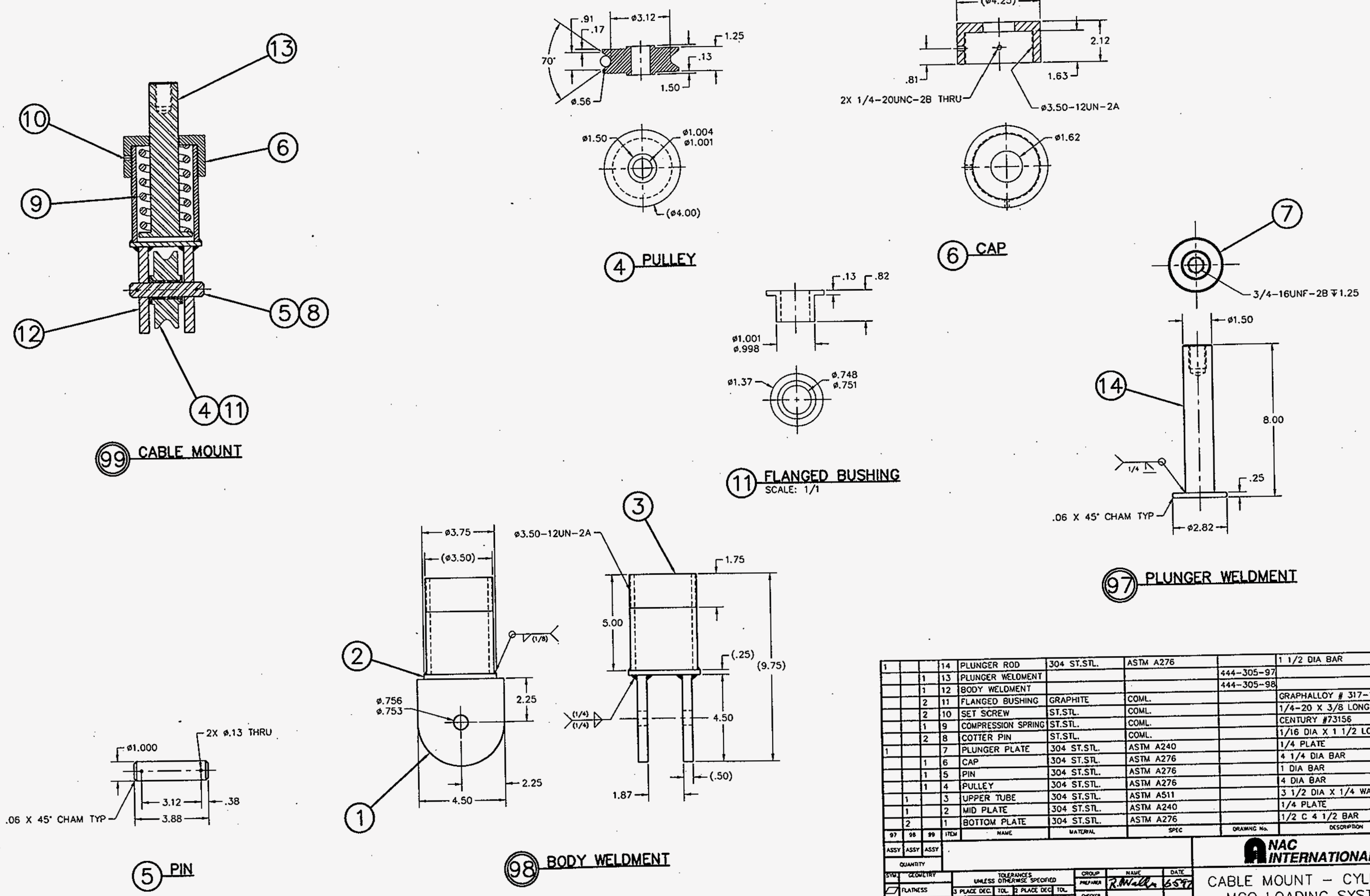
㉙ GUARD #4
(RIGHT HAND–OPPOSITE AS SHOWN)

NAC INTERNATIONAL

RAILS AND SUPPORT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82915

PROJECT 444	DESIGN PACKAGE	DRAWING 304	REV 0
SCALE 1/8	EST.WT.	SH 3 OF 3	

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE	—	—	—



97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1			14	PLUNGER ROD	304 ST.STL.	ASTM A276		1 1/2 DIA BAR
		1	13	PLUNGER WELDMENT			444-305-97	
		1	12	BODY WELDMENT			444-305-98	
		2	11	FLANGED BUSHING	GRAPHITE	COML.		GRAPHALLOY # 317-12
		2	10	SET SCREW	ST.STL.	COML.		1/4-20 X 3/8 LONG
		1	9	COMPRESSION SPRING	ST.STL.	COML.		CENTURY #73156
		2	8	COTTER PIN	ST.STL.	COML.		1/16 DIA X 1 1/2 LONG
1			7	PLUNGER PLATE	304 ST.STL.	ASTM A240		1/4 PLATE
		1	6	CAP	304 ST.STL.	ASTM A276		4 1/4 DIA BAR
		1	5	PIN	304 ST.STL.	ASTM A276		1 DIA BAR
		1	4	PULLEY	304 ST.STL.	ASTM A276		4 DIA BAR
	1		3	UPPER TUBE	304 ST.STL.	ASTM A511		3 1/2 DIA X 1/4 WALL
	1		2	MID PLATE	304 ST.STL.	ASTM A240		1/4 PLATE
	2		1	BOTTOM PLATE	304 ST.STL.	ASTM A276		1/2 C 4 1/2 BAR

QUANTITY

SYM.	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⌖	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FNSH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE:

GROUP	NAME	DATE
PREPARER	R.Walls	6597
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

NAC INTERNATIONAL

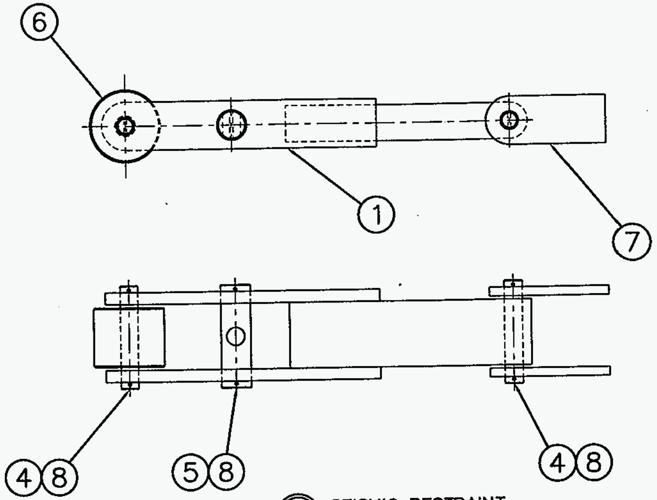
CABLE MOUNT – CYLINDER
MCO LOADING SYSTEM
WHC DWG NO: H-1-82916

PROJECT 444
DESIGN PACKAGE
DRAWING 305
REV 0
SCALE 1/2
EST.WT. 49#
SH 1 OF 1
2:43PM 6-5-97

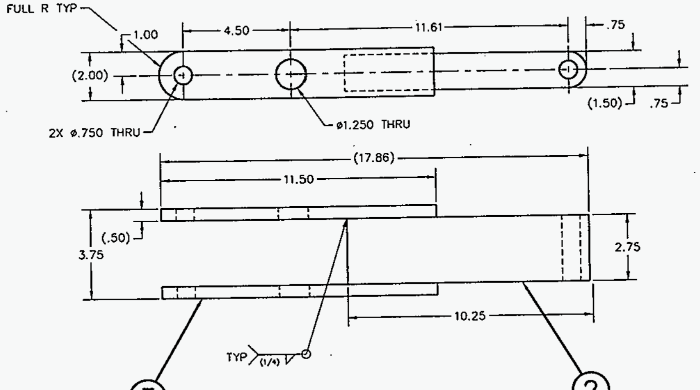
PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLO-A01129

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

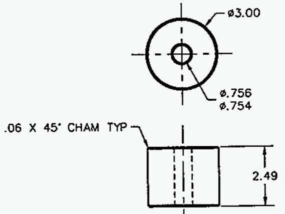
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



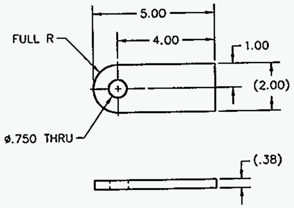
99 SEISMIC RESTRAINT



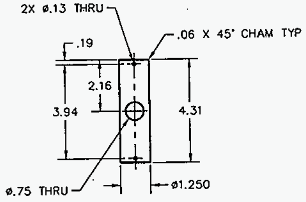
98 BODY WELDMENT



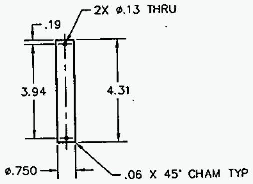
6 ROLLER



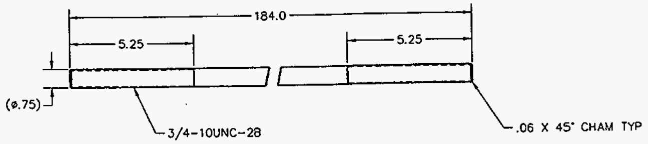
7 MOUNTING TAB



5 ROD MOUNT



4 PIVOT PIN



9 DRAW BAR

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
			9	DRAW BAR	304 ST.STL.	ASTM A276		DIA 3/4
		6	8	COTTER PIN	ST.STL.	COML.		DIA 1/8 X 1 3/4 LONG
		2	7	MOUNTING TAB	304 ST.STL.	ASTM A276		3/8 X 2 BAR
		1	6	ROLLER	304 ST.STL.	ASTM A276		3 DIA BAR
		1	5	ROD MOUNT	304 ST.STL.	ASTM A276		1 1/4 DIA BAR
		2	4	PIVOT PIN	304 ST.STL.	ASTM A276		3/4 DIA BAR
	2		3	SIDE PLATE	304 ST.STL.	ASTM A276		1/2 X 2 BAR
	1		2	BAR	304 ST.STL.	ASTM A276		1 1/2 X 2 3/4 BAR
		1	1	BODY WELDMENT			444-306-98	

QUANTITY

NAC INTERNATIONAL

SEISMIC RESTRAINT
MCO LOADING SYSTEM
WHC DWG NO: H-1-82917

SYM.	GEOMETRY
▱	FLATNESS
	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

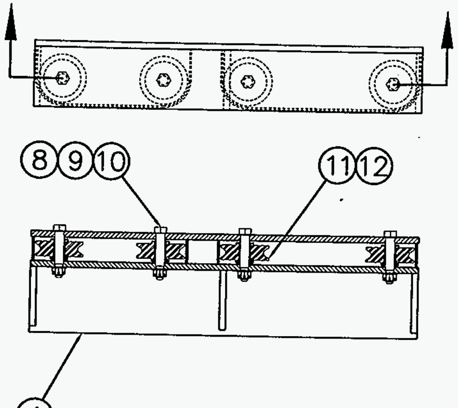
GROUP	NAME	DATE
PREPARER	R Walker	6-5-97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR OF PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

PROJECT	444	DESIGN PACKAGE		DRAWING	306
SCALE	1/2	EST.WT.	27#	SH 1 OF 1	REV 0 3:40PM 6-5-97

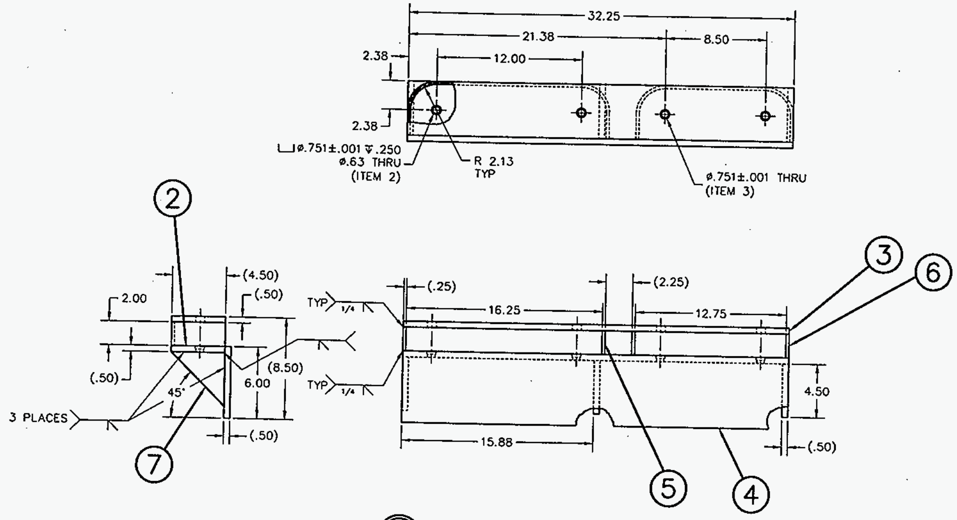
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLO-A01129

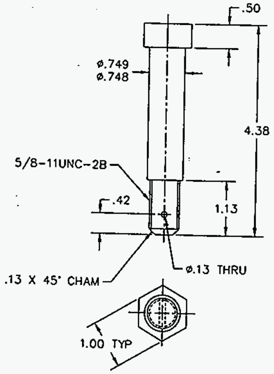
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 CABLE RETURN



98 WELDMENT



8 SHOULDER SCREW
SCALE: 1/1

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		4	12	FLANGED BUSHING			444-305-11	
		4	11	PULLEY			444-305-04	
		4	10	COTTER PIN	ST.STL.	COML.		1/16 DIA X 1 1/2 LONG
		4	9	CASTLE NUT	ST.STL.	COML.		5/8-11
		4	8	SHOULDER SCREW	304 ST.STL.	ASTM A276		1 1/4 DIA BAR
	3		7	GUSSET	304 ST.STL.	ASTM A240		1/2 PLATE
	1		6	SPACER	304 ST.STL.	ASTM A240		1/4 PLATE
	1		5	SPACER	304 ST.STL.	ASTM A240		1/4 PLATE
	1		4	END PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		3	MOUNTING PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		2	MOUNTING PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
		1	1	WELDMENT			444-307-98	

QUANTITY

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
⏥	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER	R. Mully	6597
—	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
∠	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
⊕	TRUE POSITION	THREADS-UNIFIED CLA-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:				SBU VP		
		DRAWING TYPE:						

NAC INTERNATIONAL

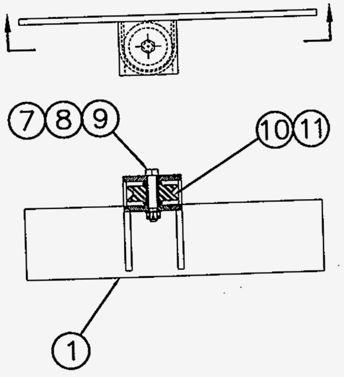
CABLE RETURN
MCO LOADING SYSTEM
WHC DWG NO: H-1-82918

PROJECT 444
DESIGN PACKAGE
DRAWING 307
REV 0
SCALE 1/4
EST.WT. 90#
SH 1 OF 1
3:55PM 6-5-97

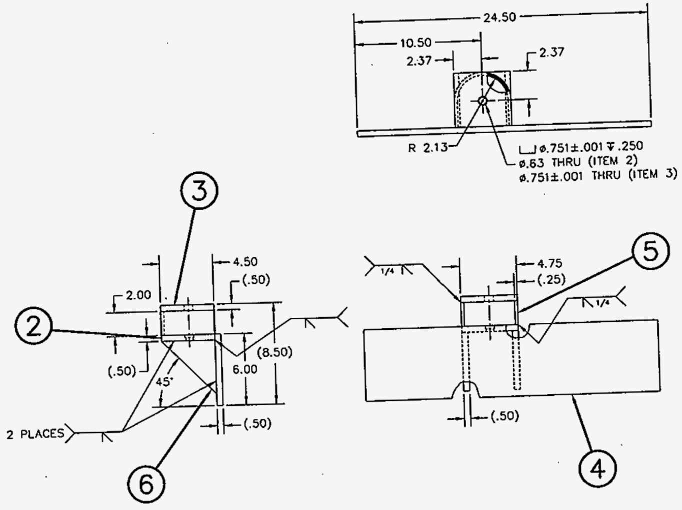
PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



99 CABLE RETURN



98 WELDMENT

		1	11	FLANGED BUSHING			444-307-12	
		1	10	PULLEY			444-307-11	
		1	9	COTTER PIN			444-307-10	
		1	8	CASTLE NUT			444-307-09	
		1	7	SHOULDER SCREW			444-307-08	
	2		6	GUSSET	304 ST.STL.	ASTM A240		1/2 PLATE
	1		5	SPACER	304 ST.STL.	ASTM A240		1/4 PLATE
	1		4	END PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		3	MOUNTING PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
	1		2	MOUNTING PLATE	304 ST.STL.	ASTM A240		1/2 PLATE
		1	1	WELDMENT			444-308-98	
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

NAC INTERNATIONAL

CABLE RETURN
MCO LOADING SYSTEM
WHC DWG NO: H-1-82919

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
▱	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
⏤	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
∠	ANGULARITY	3-12	±.005	6-18	±.03
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
⌖	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE:

GROUP	NAME	DATE
PREPARER	RWalter	6-5-97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

PROJECT 444	DESIGN PACKAGE	DRAWING 308	REV 0
SCALE 1/4	EST.WT. 75#	SH 1 OF 1	8:42PM 6-4-97

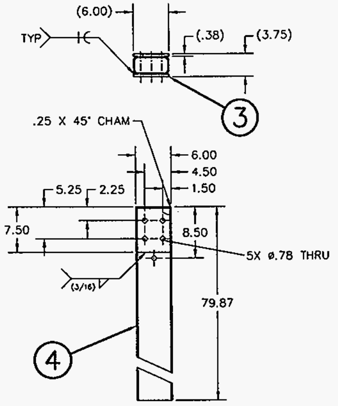
FABRICATION SPECIFICATION:

DESIGN SPECIFICATION: 444-S-01

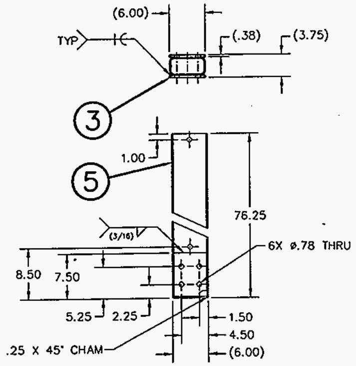
PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

F-35

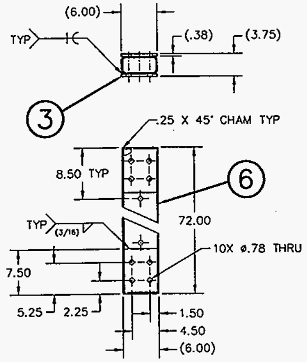
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE	—	—	—



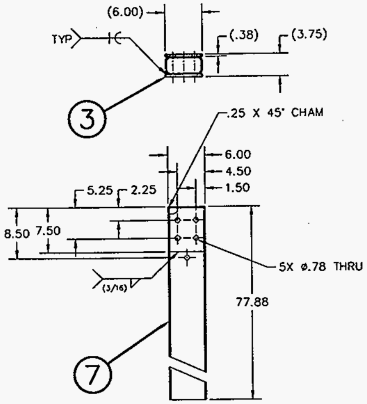
98 **TUBE WELDMENT**
WEIGHT: 102#



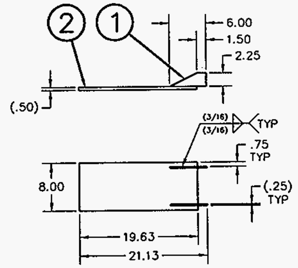
97 **TUBE WELDMENT**
WEIGHT: 98#



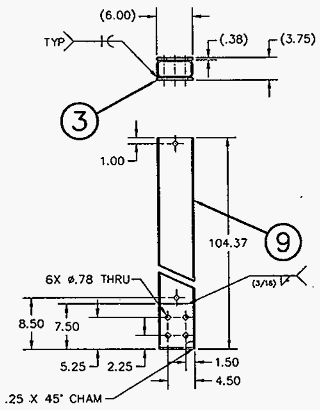
96 **TUBE WELDMENT**
WEIGHT: 103#



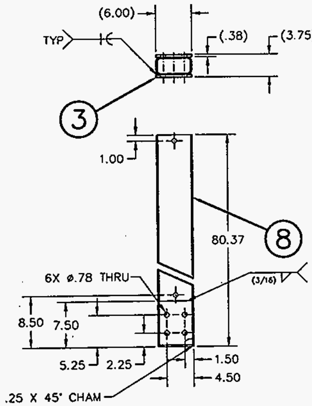
94 **TUBE WELDMENT**
WEIGHT: 100#



△1 99 **MOUNTING GUSSET**
WEIGHT: 25LBS



93 **TUBE WELDMENT**
WEIGHT: 130#



95 **TUBE WELDMENT**
WEIGHT: 102#

94	94	95	96	97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1							9	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
	1						8	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
		1					7	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
			1				6	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
				1			5	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
					1		4	TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
2	2	2	4	2	2		3	DOUBLER PLATE	304 ST.STL.	ASTM A276/A240		3/8 BAR/PLATE
						1	2	MOUNTING PLATE	304 ST.STL.	ASTM A276/A240		1/2 BAR/PLATE
						2	1	PLATE GUSSET	304 ST.STL.	ASTM A276/A240		1/4 BAR/PLATE
				ASSY	ASSY	ASSY						
				QUANTITY								

1) PRELIMINARY PART DESIGN FOR LAYOUT PURPOSES ONLY. FINAL PART DESIGN BY HANFORD ENGINEERING.

NOTES

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLO-A01129

F-36

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
⏥	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.
—	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
		3-12	±.005	6-18	±.03
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
		FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
//	PARALLELISM	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	
◎	CONCENTRICITY	NEXT ASSEMBLY:			
⌖	TRUE POSITION	DRAWING TYPE:			

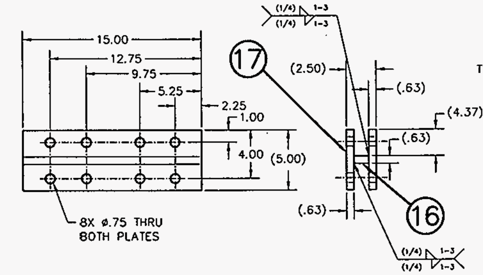
GROUP	NAME	DATE
PREPARER	R. Walker	6-97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SR. VP		

NAC INTERNATIONAL

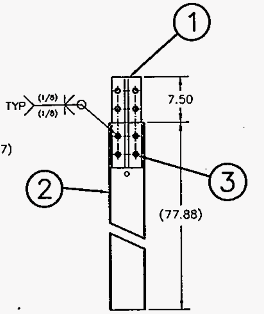
UPPER MOUNTS
MCO LOADING SYSTEM
WHC DWG NO: H-1-82920

PROJECT 444
DESIGN PACKAGE
DRAWING 309
REV 0
SCALE 1/8
EST.WT.
SH 1 OF 1
12:32PM 6-5-97

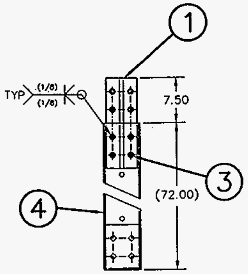
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



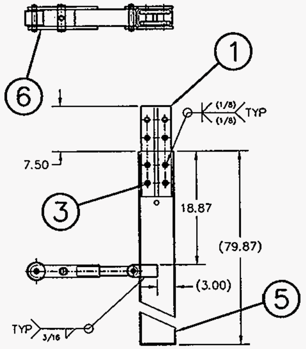
△2 (90) SPLICE BAR
SCALE: 1/4
WEIGHT: 28#



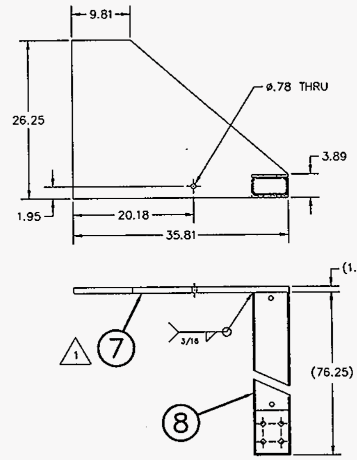
(99) BOTTOM TUBE ASSY
WEIGHT: 130#



(98) MIDDLE TUBE ASSY
WEIGHT: 130#

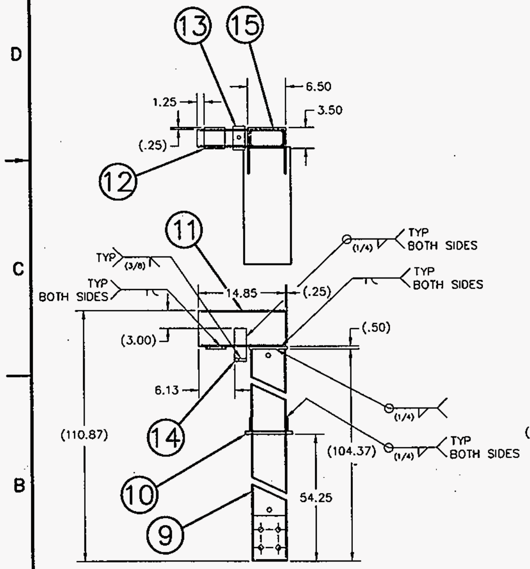


(97) BOTTOM TUBE ASSY
WEIGHT: 140#



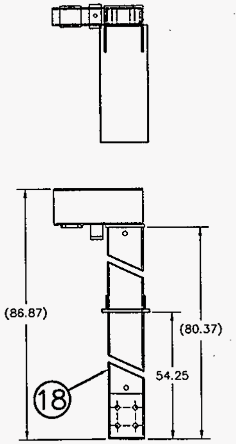
(96) RH ASSEMBLY
WEIGHT: 260#

(95) LH ASSEMBLY
(OPPOSITE AS SHOWN)



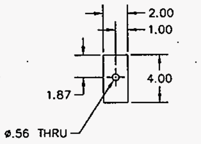
(94) RH ASSEMBLY
(EAST)
WEIGHT: 140#

(93) LH ASSEMBLY
(OPPSITE AS SHOWN)

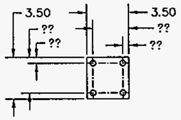


(92) RH ASSEMBLY
(WEST)
WEIGHT: 140#

(91) LH ASSEMBLY
(OPPSITE AS SHOWN)



(13) PLATE
SCALE: 1/4



(12) PLATE
SCALE: 1/4

2) FIT UP WITH ITEMS 2, 4, 5, 8, 9 AND 18.

1) PRELIMINARY PART DESIGN FOR LAYOUT PURPOSES ONLY. FINAL PART DESIGN BY HANFORD ENGINEERING.

NOTES

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

90	91	92	93	94	95	96	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	1	1								18	TUBE WELDMENT			444-309-95	
1										17	PLATE	304 ST.STL.	ASTM A276/240		5/8 BAR/PLATE
1										16	PLATE	304 ST.STL.	ASTM A276/240		5/8 BAR/PLATE
	1	1	1	1						15	PLATE	304 ST.STL.	ASTM A276/240		1/2 BAR/PLATE
	1	1	1	1						14	PLATE	304 ST.STL.	ASTM A276		1/2 X 1 BAR
	2	2	2	2						13	PLATE	304 ST.STL.	ASTM A276		1/2 X 1 BAR
	1	1	1	1						12	CYLINDER MOUNT	304 ST.STL.	ASTM A240		1/2 PLATE
	1	1	1	1						11	TOP TUBE	304 ST.STL.	ASTM A276		3 X 6 X 1/4 WALL
	1	1	1	1						10	MOUNTING GUSSET			444-309-99	
			1	1						9	TUBE WELDMENT			444-309-93	
					1	1				8	TUBE WELDMENT			444-309-97	
					1	1				7	TOP PLATE	304 ST.STL.	ASTM A240		1 PLATE
							1			6	SEISMIC RESTRAINT			444-306-99	
							1			5	TUBE WELDMENT			444-309-98	
								1		4	TUBE WELDMENT			444-309-96	
							4	4	4	3	DOWEL PIN	ST.STL.	COML.		3/4 DIA X 3 3/4 LONG
									1	2	TUBE WELDMENT			444-309-94	
							1	1	1	1	SPLICE BAR			444-310-90	

QUANTITY

SYM.	GEOMETRY
▱	FLATNESS
⏤	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO #		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

GROUP	NAME	DATE
PREPARER	R.Walker	6597
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRV VP		

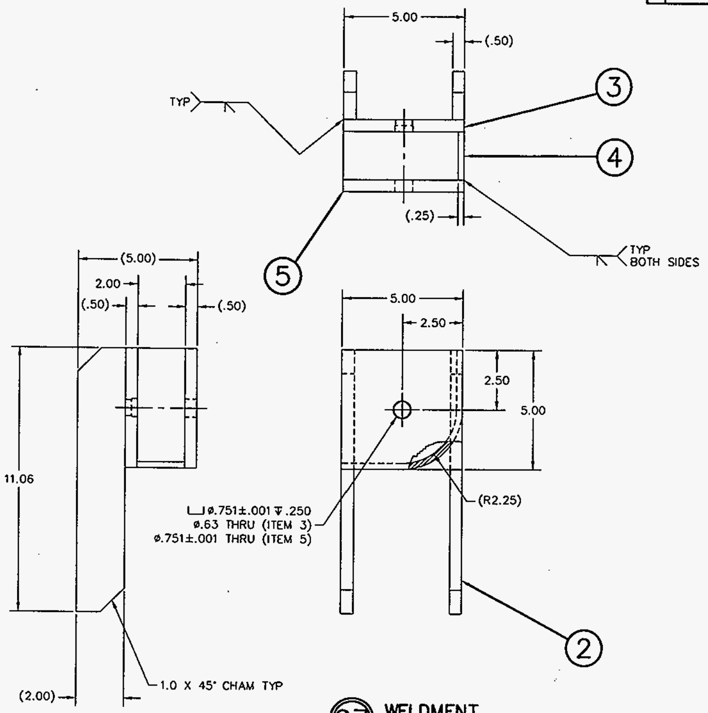
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

UPPER MOUNTS
MCO LOADING SYSTEM
WHC DWG NO: H-1-82921

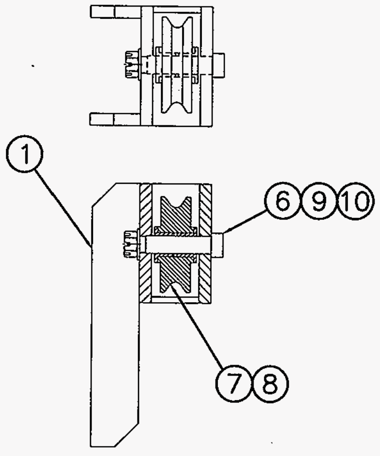
PROJECT 444 | DESIGN PACKAGE | DRAWING 310 | REV 0
SCALE 1/8 | EST.WT. NOTED | SH 1 OF 1 | 3:16PM 6-5-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

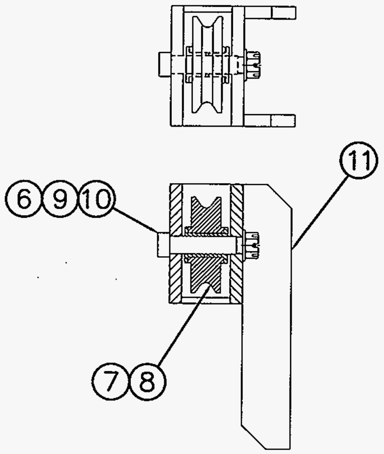


97 **WELDMENT**
(RIGHT HAND)

96 **WELDMENT**
(LEFT HAND-OPPSITE AS SHOWN)



99 **RETURN PULLEY ASSY**
(RIGHT HAND)



98 **RETURN PULLEY ASSY**
(LEFT HAND)

96	97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1		11	WELDMENT-LEFT HAND			444-311-96	
		1	1	10	COTTER PIN			444-307-10	
		1	1	9	CASTLE NUT			444-307-09	
		1	1	8	PULLEY			444-305-04	
		2	2	7	FLANGED BUSHING			444-305-11	
		1	1	6	SHOULDER SCREW			444-307-08	
1	1			5	FRONT PLATE	304 ST.STL.	ASTM A240/A276		1/2 PLATE/BAR
1	1			4	SPACER	304 ST.STL.	ASTM A240/A276		1/4 PLATE/BAR
1	1			3	BACK PLATE	304 ST.STL.	ASTM A240/A276		1/2 PLATE/BAR
2	2			2	MOUNTING PLATE	304 ST.STL.	ASTM A240/A276		1/2 PLATE/BAR
			1	1	WELDMENT-RIGHT HAND			444-311-97	
	ASSY	ASSY	ASSY						
	QUANTITY								

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
		3-12	±.005	6-18	±.03
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
		THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	
◎	CONCENTRICITY	NEXT ASSEMBLY:			
⌖	TRUE POSITION	DRAWING TYPE:			

GROUP	NAME	DATE
PREPARER	R.W. [illegible]	6.5.97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

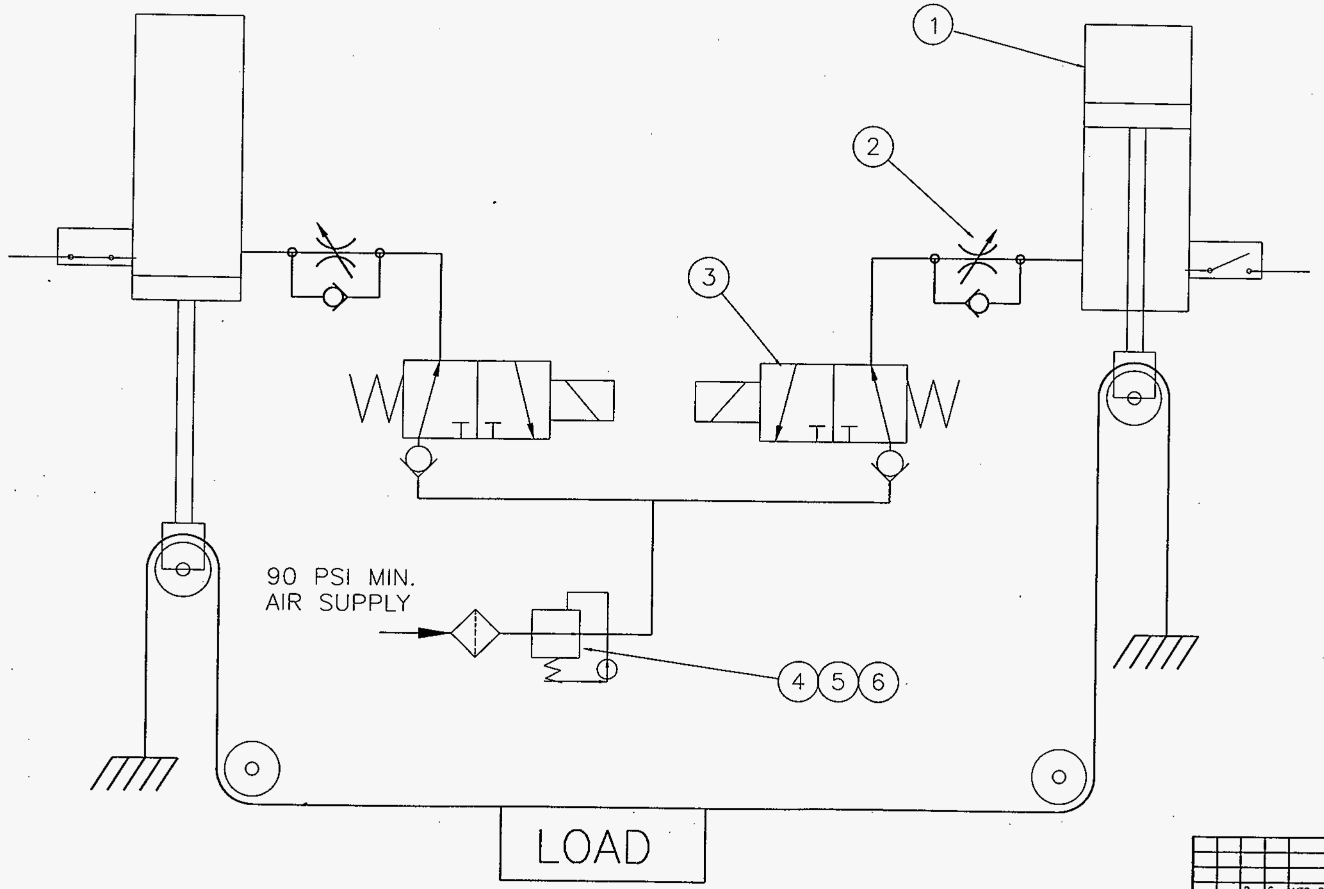
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

RETURN PULLEY ASSY
MCO LOADING SYSTEM
WHC DWG NO: H-1-82922

PROJECT 444	DESIGN PACKAGE	DRAWING 311	REV 0
SCALE 1/2	EST.WT.	SH 1 OF 1	11:38AM 6-5-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLO-A01129

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		2	6	MTG. BRACKET				SCHRADER # BAGD051597-006
		2	5	GAUGE				SCHRADER # BAGD051597-005
		2	4	FILTER/REGULATOR				SCHRADER # BAGD051597-004
		2	3	INLINE VALVE				SCHRADER #BAGD051597-002
		2	2	CHECK VALVE				SCHRADER # BAGD051597-001
		2	1	PNEUMATIC CYLINDER				SCHRADER #BAGO-SA5822x72.00-1.00-P1-V

QUANTITY

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.	PREPARER		
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:				SRU VP		
		DRAWING TYPE:						

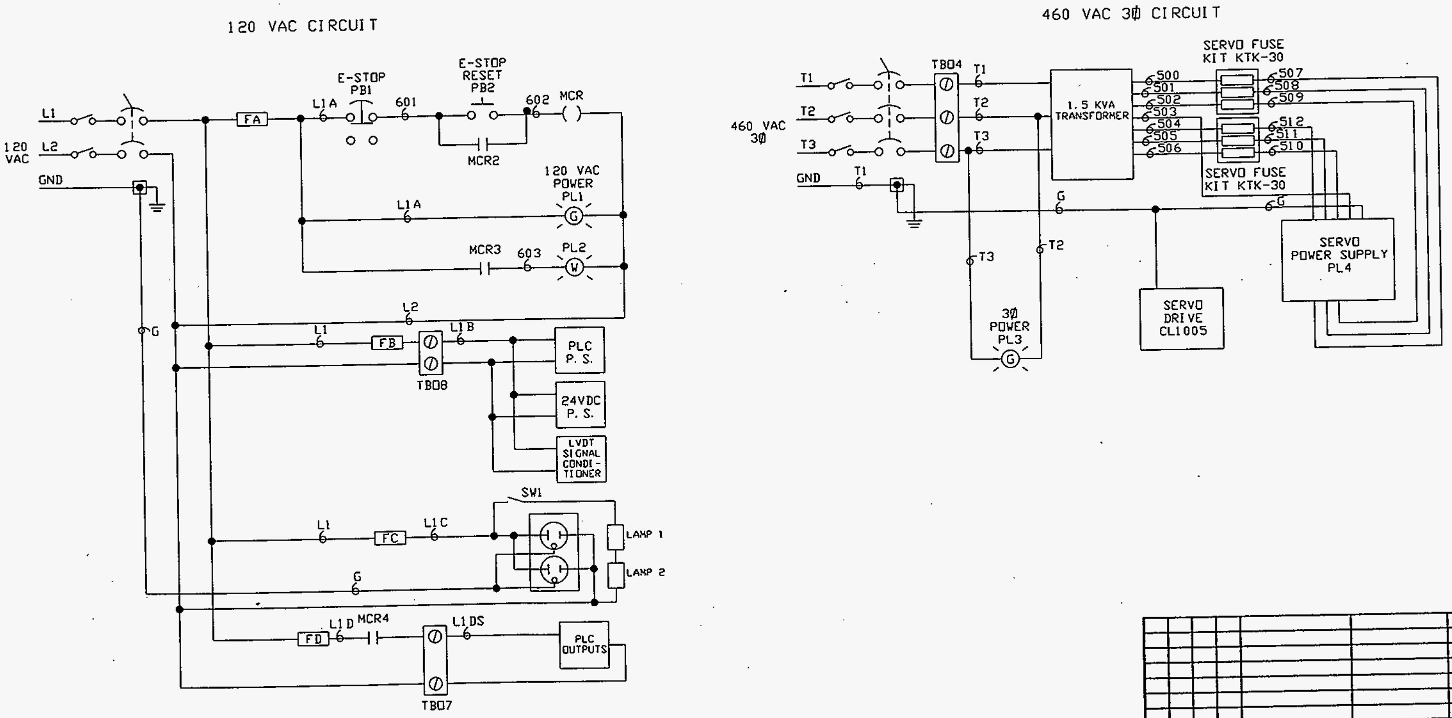
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

SHUTTLE ASSEMBLY,
PNEUMATIC SCHEMATIC
WHC DRAWING NO: H-1-82927

PROJECT 444
DESIGN PACKAGE
DRAWING 314
REV 0
SCALE NONE
EST.WT.
SH 1 OF 1
10:06PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE	—	—	—



PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER		
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
		3-12	±.005	6-18	±.03	PROJECT MANAGER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
		FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
//	PARALLELISM	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
◎	CONCENTRICITY	NEXT ASSEMBLY:				SBU VP		
⊕	TRUE POSITION	DRAWING TYPE:						

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

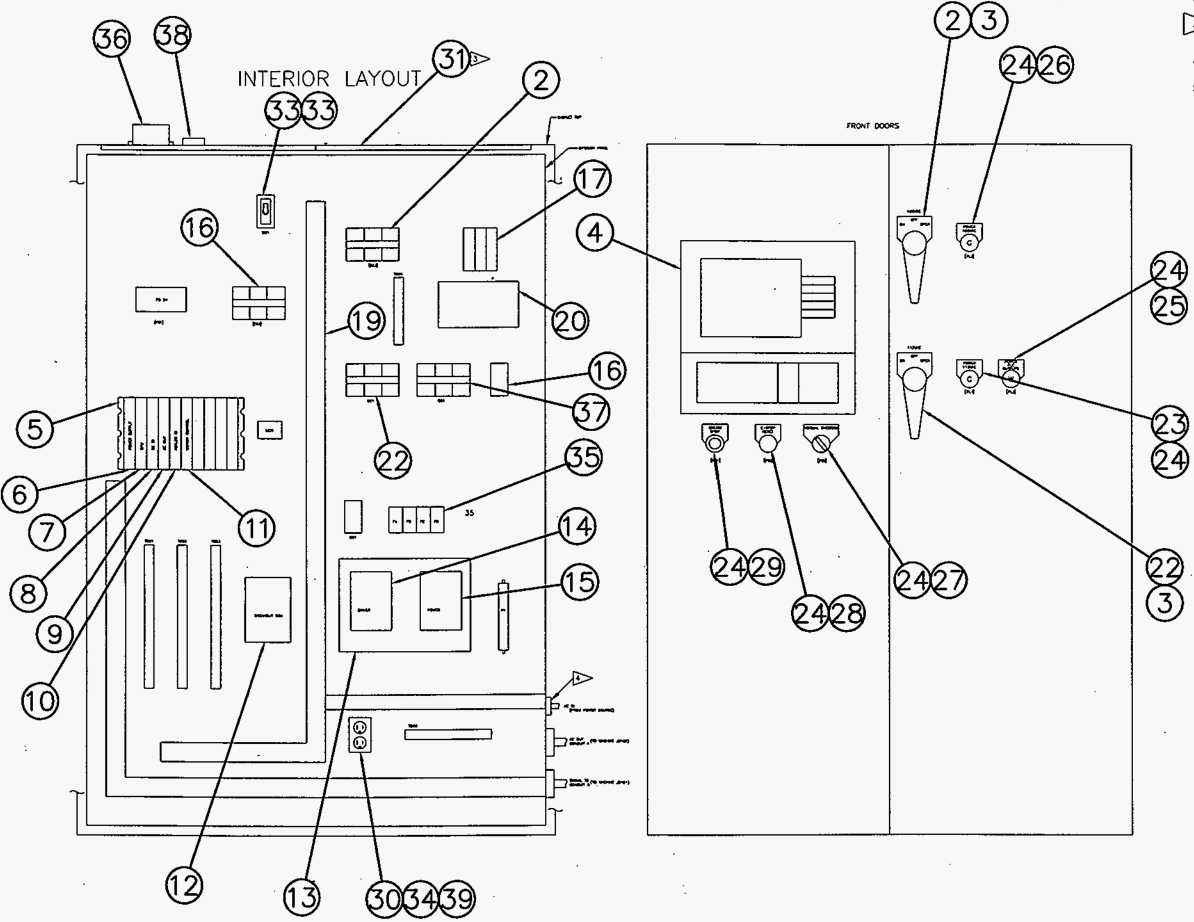
NAC INTERNATIONAL

CONTROL STATION,
POWER SCHEMATIC,
MCO LOADING STATION
WHC DRAWING NO: H-1-82940

PROJECT 444
DESIGN PACKAGE
DRAWING 400
REV 0
SCALE NTS
EST. WT.
SH 1 OF 1
10:10PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

NOTES: UNLESS OTHERWISE SPECIFIED
1. FIELD LOCATE'S MOUNT COMPONENTS APPROXIMATELY AS SHOWN
2. ROUTE AC WIRING SEPERATE FROM SIGNAL WIRING
3. MOUNT FLOURESCENT LAMPS (2 PLCS.) INSIDE CABINET TO TOP UNDERSIDE USING #10-32 HARDWARE
4. ROUTE AC WIRING SEPERATE FROM SIGNAL WIRING
5. [ ] DESIGNATES TO LETTER SET AND CLEAR COVER COAT COMPONENT IDENTIFIER ON THE INSIDE OF CABINET



		1	40	COVER PLATE, OUTLET				RACO 864
		1	39	COVER PLATE, SWITCH				RACO 865
		1	38	HORN				VIBRAHORN 4A967
		1	MCR	RELAY				ALLEN BRADLEY 700-PK400A1
		1	37	BREAKER				ALLEN BRADLEY 1492-CB1G020
		1	36	BEACON				VITALITE 4A961
		3	35	FUSE BLOCK				ALLEN BRADLEY 1492-H7
		1	34	BRACKET				RACO 660
		1	R1	RESISTOR				CHMITE L225J10R
		1	GB1	GROUND BUS				SQUARE D 980MH66
		1	33	SWITCH				LEVITON 1201I W/ BOX
		2	32	LAMP 20V FLOURESCENT				F20T120
		2	31	LAMP HOLDER				POWER PRODUCTS ST120PH
		1	30	AC OUTLET				LEVITON 5-15R
		1	PS1	POWER SUPPLY 24VDC 5A				SOLA SLS-24-048
		1	TB08	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1942-CA1-20
		1	TB07	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-CA1-10
		1	TB06	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-F1-10
		1	TB05	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-F1-10
		1	TB04	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-CA1-10
		1	TB03	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-F1-34
		1	TB02	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-F1-34
		1	TB01	TERMINAL STRIP ASSY				ALLEN-BRADLEY 1492-F1-34-BLUE
		2	29	PUSH BUTTON E-STOP				ALLEN-BRADLEY 800T-FXD24R1
		1	28	PUSH BUTTON ES RESET				ALLEN-BRADLEY 800T-QB10WD1
		1	27	SWITCH				ALLEN-BRADLEY 800T-H31D1
		1	26	PILOT LAMP GREEN				ALLEN-BRADLEY 800T-PTH46G
		1	25	PILOT LAMP WHITE				ALLEN-BRADLEY 800T-QT-10C
		3	24	LEGEND PLATE				ALLEN-BRADLEY 800T-X59
		1	23	PILOT LAMP GREEN				ALLEN-BRADLEY 800TQTH10G
		1	22	DISCONNECT				ALLEN-BRADLEY 1494R-N30
		1	C09	CABLE, PREFAB 3 FT				MODICON 600 MC1
		1	C08	CABLE, PREFAB 3 FT				MODICON AS V920
		20FT	20	TRANSFORMER				MODICON 800-060
		20FT	19	WIRING DUCT W/ COVER				PANDUIT E2X2LG6N
		1	18	FUSE KIT - 10 AMP				MODICON KTK-10
		1	17	FUSE KIT - 30 AMP				MODICON KTK-30
		1	16	CIRCUIT BREAKER				ALLEN-BRADLEY 1492-CB3G030
		1	15	SYNCRO POWER				MODICON DR PLS4 000
		1	14	DRIVER MODULE				MODICON DR 1020 000
		1	13	MOUNTING PANEL				MODICON 110-200
		1	12	BREAKOUT BOX				MODICON 690 MCB 000 00
		1	11	MOTION CONTROL MODULE				MODICON 140 MSC 101 00
		1	10	ANALOG INPUT MODULE				MODICON 140 AVI 030 00
		1	9	AC OUTPUT MODULE				MODICON 140 DAO 840 00
		1	8	DIGITAL INPUT MODULE				MODICON 140 DDI 841 00
		1	7	CPU				MODICON 140 CPU 113 02
		1	6	POWER SUPPLY				MODICON 140 CPS 111 00
		1	5	RACK - 10 SLOT				MODICON 140 XBP 010 00
		1	4	CONTROLLER DISPLAY				MODICON MM PM41 400
		4	3	ROD				ALLEN-BRADLEY 1484R-N4
		2	2	DISCONNECT				ALLEN-BRADLEY 1494R-N60
		1	1	CABINET				COXLINE C-FS7250300AD.MK
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

SYM.	GEOMETRY	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	GROUP	NAME	DATE
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02	PREPARER		
—	STRAIGHTNESS	3-12	±.005	6-18	±.03	CHECKER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	PROJECT MANAGER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		VP/CHIEF ENGINEER		
		FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		DIRECTOR of PROJECTS		
//	PARALLELISM	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		LICENSING MANAGER		
◎	CONCENTRICITY	NEXT ASSEMBLY:				QUALITY		
⌖	TRUE POSITION	DRAWING TYPE:				SBU VP		

TOLERANCES UNLESS OTHERWISE SPECIFIED

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

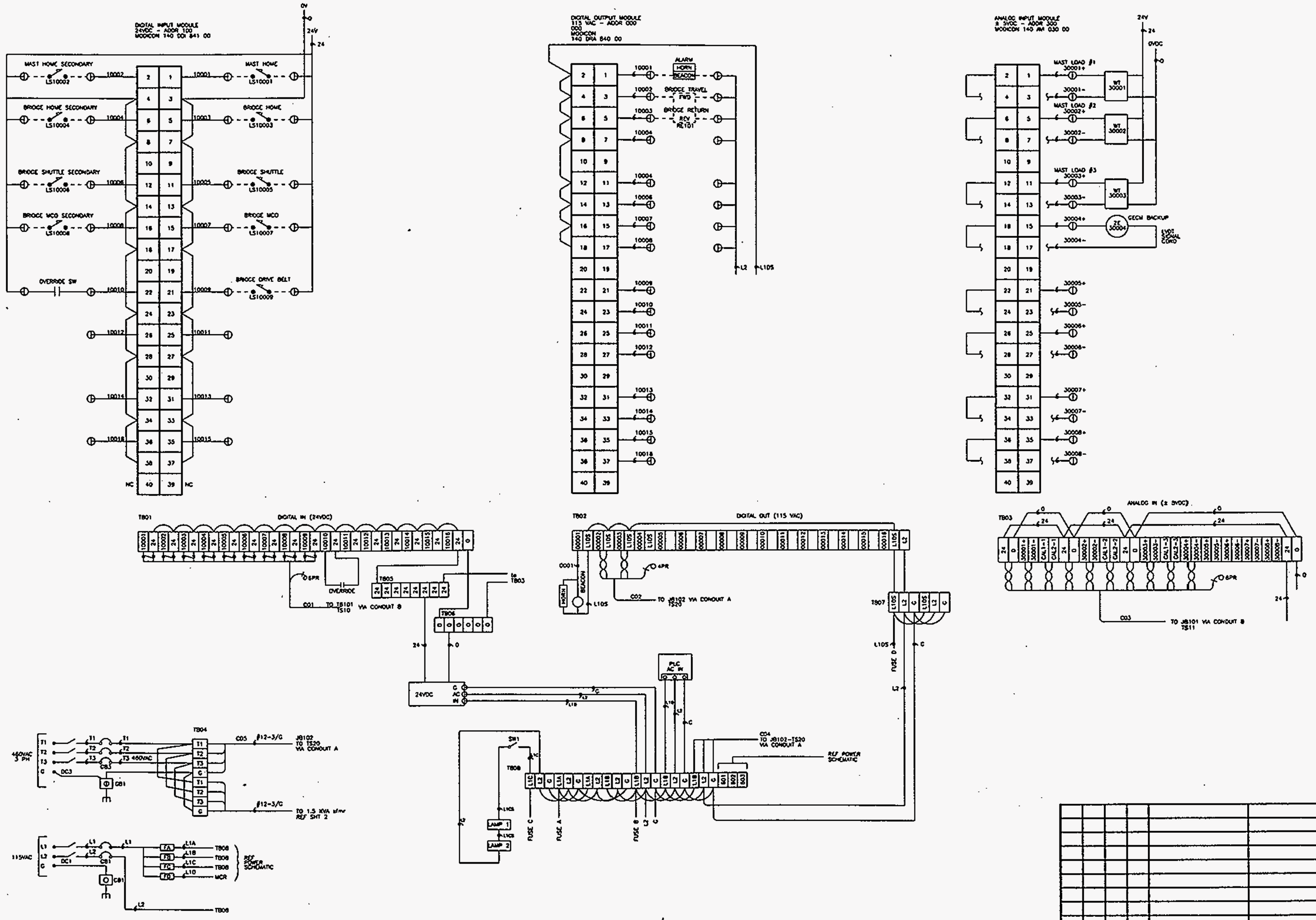
F-41

NAC INTERNATIONAL

CONTROL STATION,
CABINET ASSEMBLY,
MCO LOADING STATION
WHC DRAWING NO:H-1-82941

PROJECT	DESIGN PACKAGE	DRAWING	REV
444		401	0
SCALE	EST.WT.	SH 1 OF 1	9:21AM 6-5-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

F-42

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

SYM.	GEOMETRY
⏥	FLATNESS
	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

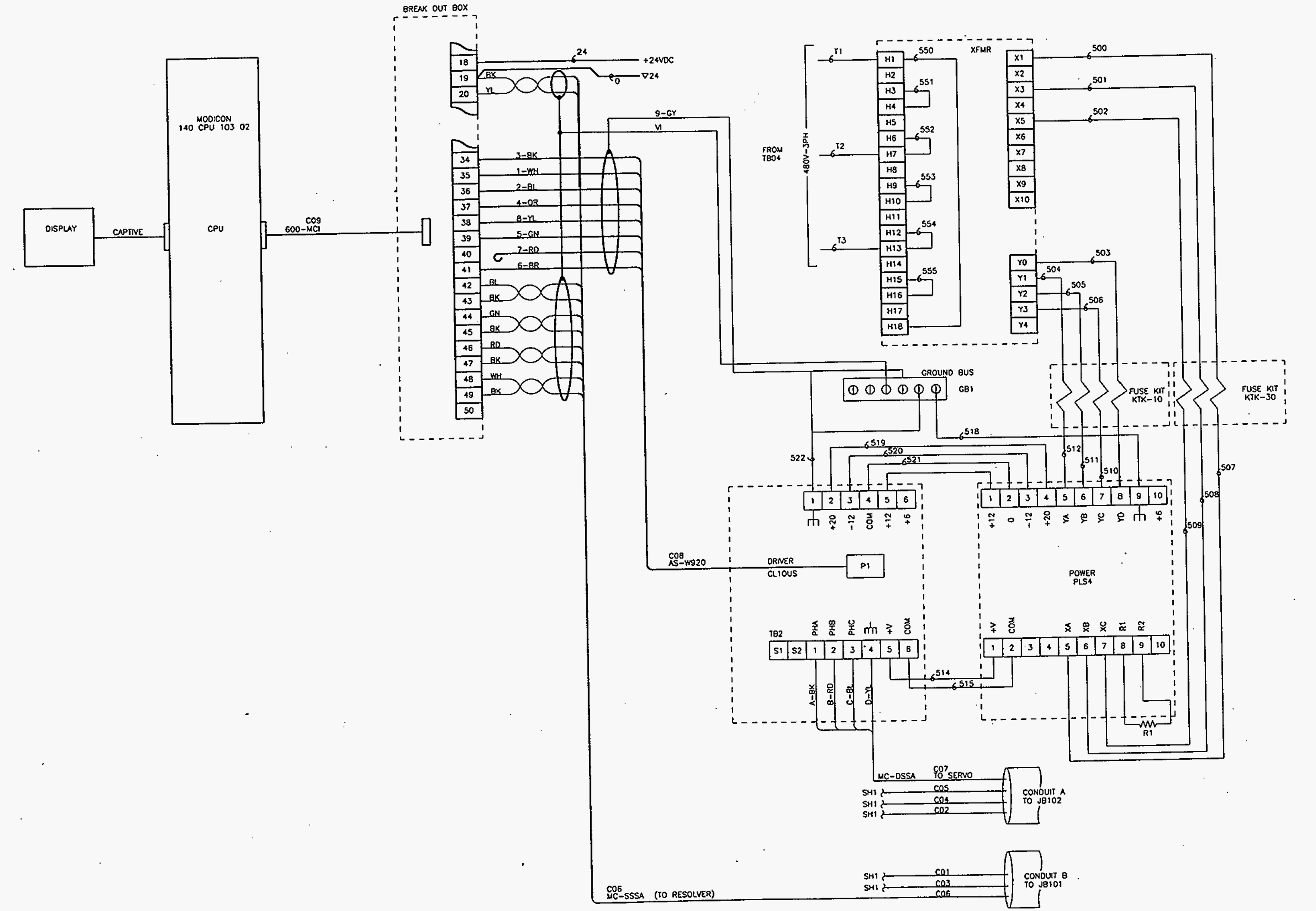
GROUP	NAME	DATE
PREPARER		
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

NAC INTERNATIONAL

CONTROL STATION CABINET
WIRING DIAGRAM
MCO LOADING STATION
WHC DRAWING NO:H-1-82942

PROJECT 444	DESIGN PACKAGE	DRAWING 402	REV 0
SCALE	EST.WT.	SH 1 OF 2	10:47PM 6-4-97

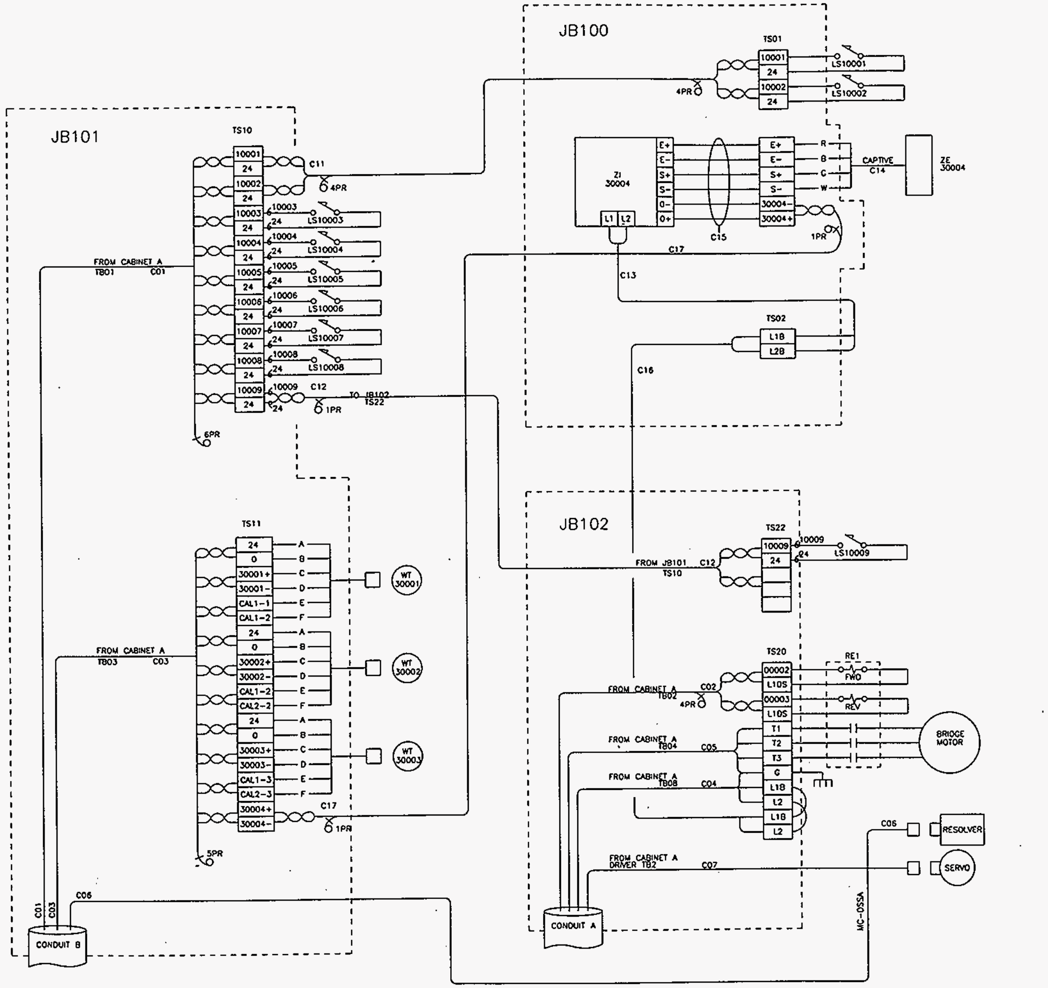


NAC INTERNATIONAL

CONTROL STATION CABINET
WIRING DIAGRAM
MCO LOADING STATION
WHC DRAWING NO: H-1-82942

PROJECT 444	DESIGN PACKAGE	DRAWING 402	REV 0
SCALE	EST. WT.	SH 2 OF 2	10:44PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1			C17	CABLE, 2TP-20FT.				SAME AS C12
1			C16	WIRE,2 STRANDS #18-20FT				SHOP SUPPLY
1			C15	WIRE,6 STRANDS #18-2FT				SHOP SUPPLY
1			C14	CABLE,CAPTIVE,ON LVDT,6FT.				SENSOTEC ASSY
1			C13	WIRE, 2 STRANDS #18-3FT				SHOP SUPPLY
1			C12	CABLE, 2TP-10FT.				BELDEN 9302
1			C11	CABLE, 6TP-20FT.				SAME AS C02
1			C07	CABLE, SERVO-100 FT.				MODICON MC-DSSA
1			C06	CABLE,RESOLVER-100FT				MODICON MC-SSSA
1			C05	ROMAX,#12-2/C-100FT.				WESSEX OR EQUAL
1			C04	ROMAX,#12-3/C-100FT.				WESSEX OR EQUAL
1			C03	CABLE, 6TP-100FT				BELDEN 9306
1			C02	CABLE, 6TP-100FT				BELDEN 9306
1			C01	CABLE, 15TP-100FT				BELDEN 9315
ASSY	ASSY	ASSY						
QUANTITY								

NAC INTERNATIONAL

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
		3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER	S.H.MOORE	5/97
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
	STRAIGHTNESS	3-12	±.005	6-18	±.03	PROJECT MANAGER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		OPERATING MANAGER		
		THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03				
◎	CONCENTRICITY	NEXT ASSEMBLY:				QUALITY		
⊕	TRUE POSITION	DRAWING TYPE:				SRV VP		

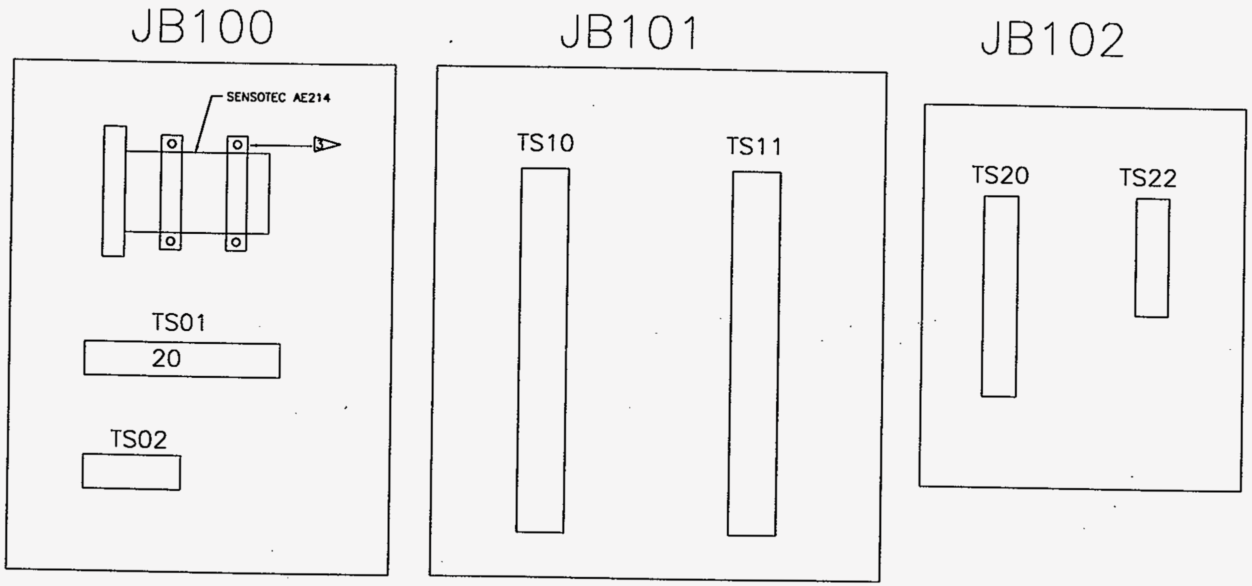
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

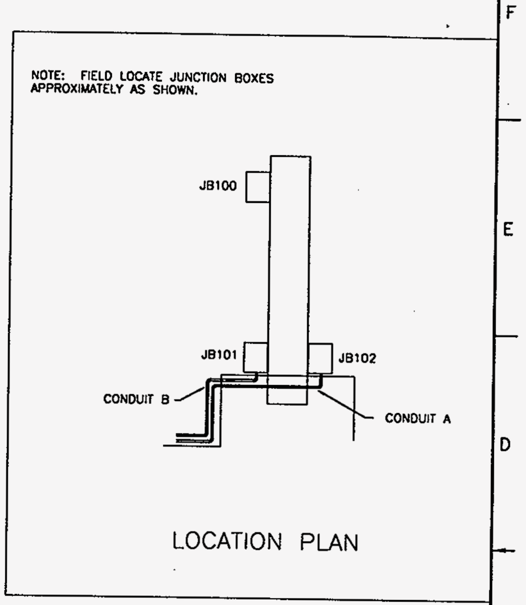
F-44

CONTROL SYSTEM
FIELD WIRING DIAGRAM
MCO LOADING SYSTEM
WHC DRAWING NO: H-1-82943

PROJECT 444	DESIGN PACKAGE	DRAWING 403	REV 0
SCALE	EST.WT.	SH 1 OF 1	11:04PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			




NOTE: FIELD LOCATE JUNCTION BOXES APPROXIMATELY AS SHOWN.

LOCATION PLAN

PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	1	SIGINAL CONDITIONER				SENSOTEC AE214
		1	TS22	TERMINAL STRIP ASS'Y.				AB 1492-CA1-10
		1	TS20	TERMINAL STRIP ASS'Y.				AB 1492-F1-20
		1	JB102	JUNCTION BOX				HAMMOND 1414K
		1	TS11	TERMINAL STRIP ASS'Y.				AB 1492-F1-32
		1	TS10	TERMINAL STRIP ASS'Y.				AB 1492-F1-32
		1	JB101	JUNCTION BOX				HAMMOND 141406
		1	TS02	TERMINAL STRIP ASS'Y.				AB 1492-CA1-10
		1	TS01	TERMINAL STRIP ASS'Y.				AB 1492-F1-20
		1	JB100	JUNCTION BOX				HAMMOND 141406
ASSY	ASSY	ASSY						
QUANTITY								

SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
		3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.			
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02	PREPARER		
—	STRAIGHTNESS	3-12	±.005	6-18	±.03	CHECKER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	PROJECT MANAGER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		VP/CHIEF ENGINEER		
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		LICENSING MANAGER		
⊕	TRUE POSITION	NEXT ASSEMBLY:				QUALITY		
		DRAWING TYPE:				SBU VP		

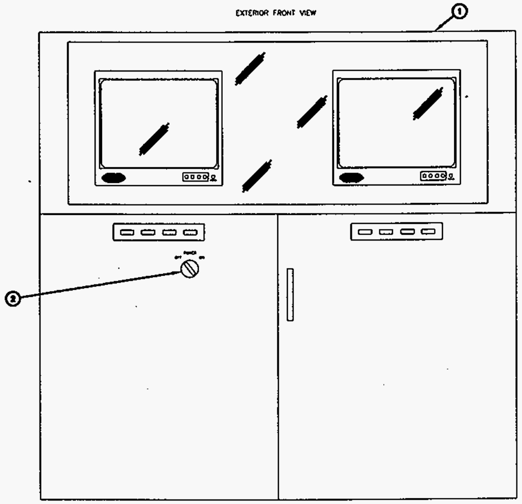
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

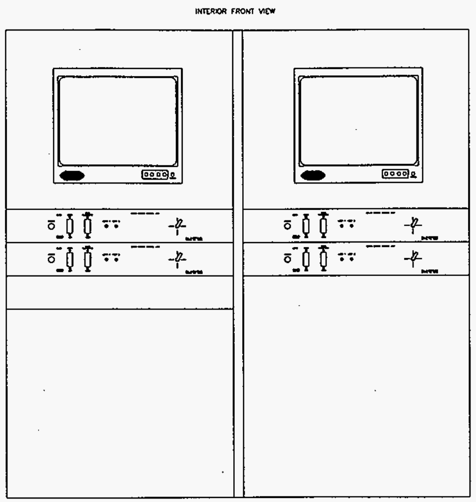
NAC INTERNATIONAL

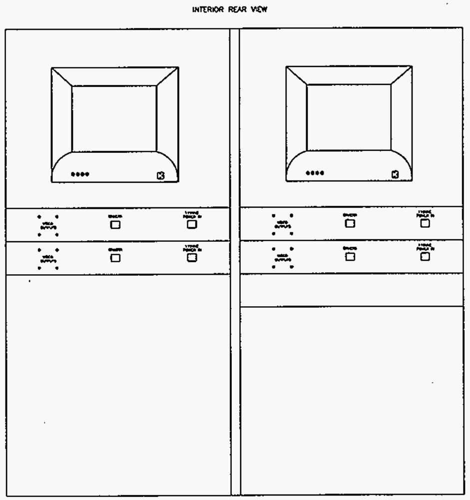
CONTROL SYSTEM
FIELD JUNCTION BOX
ASSEMBLY
WHC DRAWING NO: H-1-82944

PROJECT 444
DESIGN PACKAGE
DRAWING 404
REV 0
SCALE
EST.WT.
SH 1 OF 1
11:02PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE	—	—	—







PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	2	SELECTOR SWITCH				ALEN-BRADLEY 800T-H201
		1	1	ENCLOSURE				COXLINE C-SC485030.MK

QUANTITY

NAC INTERNATIONAL

SYM.	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⌖	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:
DRAWING TYPE:

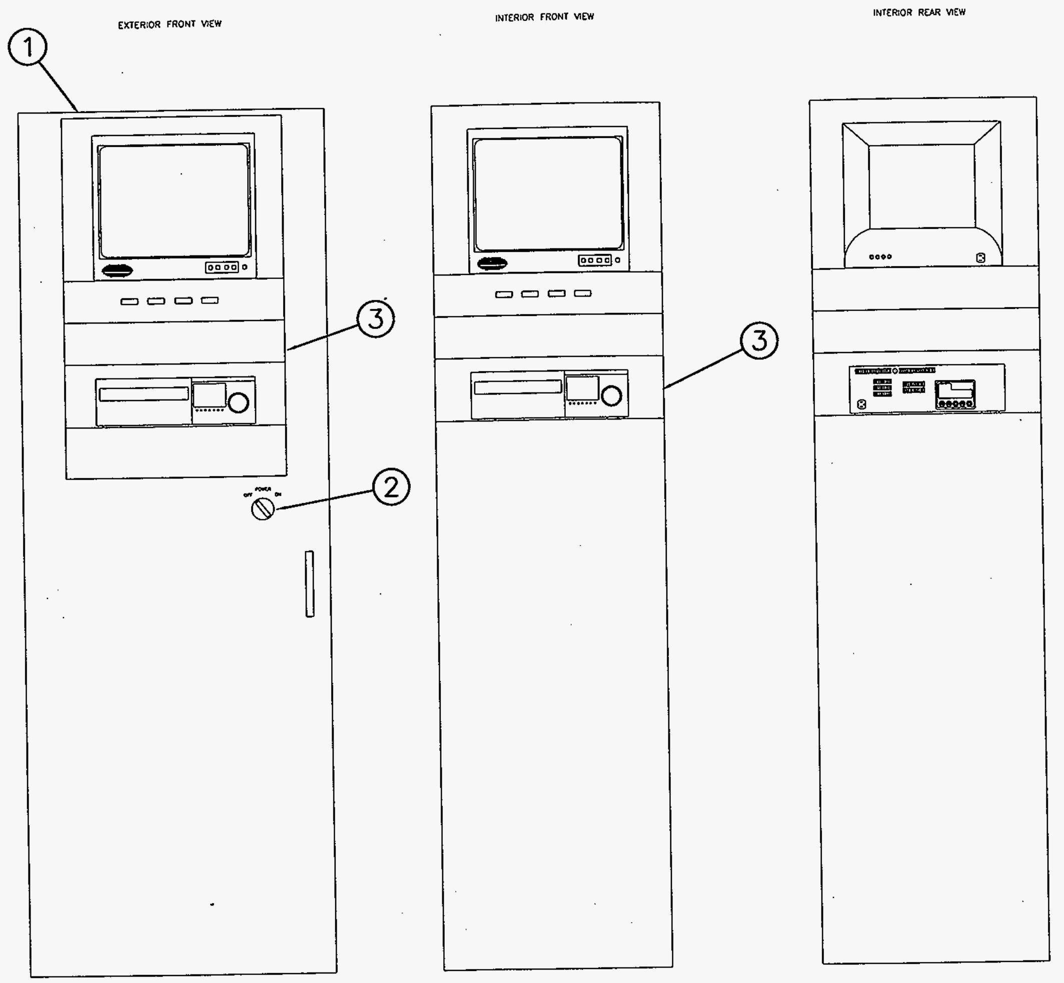
GROUP	NAME	DATE
PREPARER		
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

CCTV BASIN VIEWING STATION
CABINET ASSEMBLY
MCO LOADING STATION
WHC DRAWING NO:H-1-82945

PROJECT 444	DESIGN PACKAGE	DRAWING 405	REV 0
SCALE	EST.WT.	SH 1 OF 1	11:10PM 8-4-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NC8-SLD-A01129

1			3	RACK MOUNT KEYBOARD				R.J. ELECTRONICS RJ-COG-KD
1			2	SELECTOR SWITCH				ALLEN-BRADLEY 800T-H2D1
1			1	ENCLOSURE				COXLINE C-F5722530DA.MK
97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
QUANTITY								

SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
		3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02
—	STRAIGHTNESS	3-12	±.005	6-18	±.03
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
◎	CONCENTRICITY	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	
⊕	TRUE POSITION	NEXT ASSEMBLY:			
		DRAWING TYPE:			

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

GROUP	NAME	DATE
PREPARER	S.P.BAKER	5/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRU VP		

NAC INTERNATIONAL

CCTV REMOTE VIEWING
STATION CABINET ASSEMBLY
MCO LOADING STATION
WHC DRAWING NO: H-1-82946

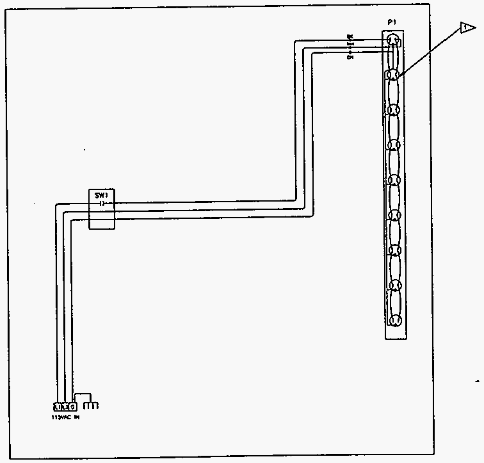
PROJECT 444
DESIGN PACKAGE
DRAWING 406
REV 0
SCALE
EST.WT.
SH 1 OF 1
11:15PM
6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

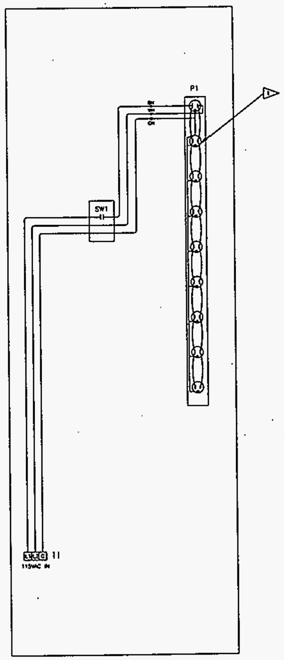
NOTES: UNLESS OTHERWISE SPECIFIED

1. FIELD MOUNT POWER STRIP P1 AND TERMINAL BLOCK TB1 ON PANEL OR SIDEWALL APPROXIMATELY AS SHOWN
2. FOR SW1 LOCATIONS REF CABINET ASSY DRAWINGS

CCTV REMOTE VIEWING STATION



CCTV BASIN VIEWING STATION



PROJECT INFORMATION
WHC SPECIFICATION NO:WHC-S-0546
ITEM 5
WHC P.O. NO:NCB-SLD-A01129

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		2	P1	OUTLET STRIP				WABER 4407
		2	SW1	SWITCH				ALLEN-BRADLEY 800T-H201
		2	TB1	TERMINAL BLOCK ASSY				AB 1492-F1-3
QUANTITY								

NAC INTERNATIONAL

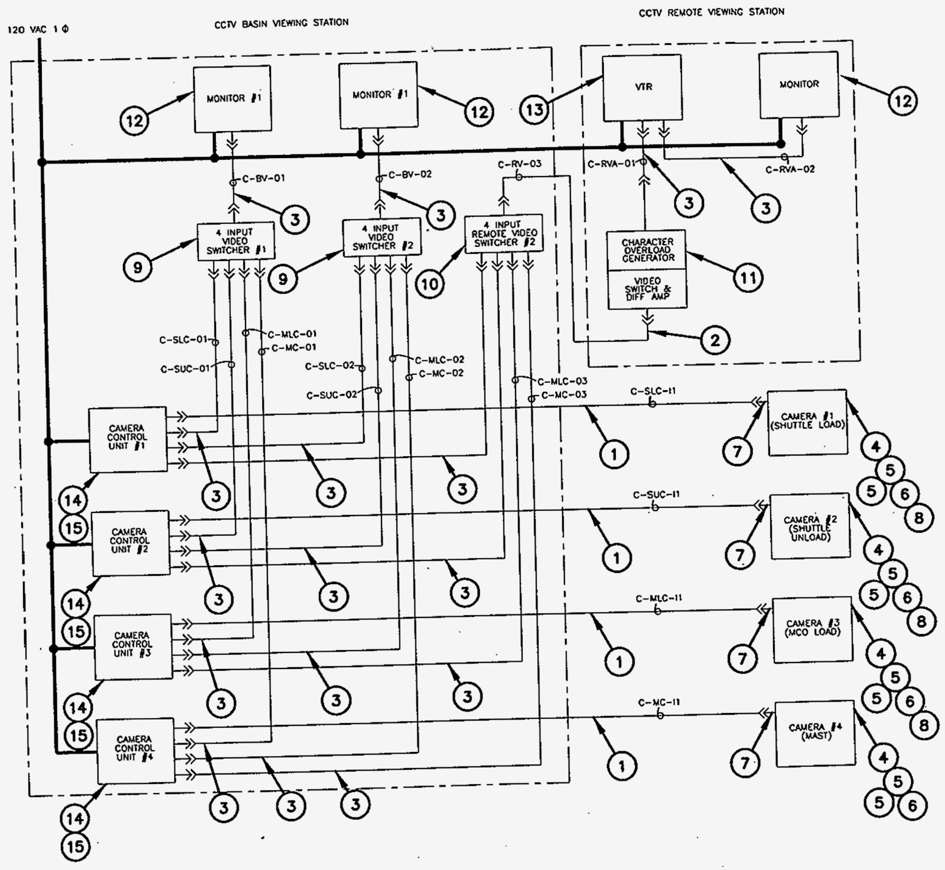
SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
⏥	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER	S.P.BAKER	5/97
—	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
∠	ANGULARITY	3-12	±.005	6-18	±.03	PROJECT MANAGER		
⊥	PERPENDICULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
//	PARALLELISM	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
◎	CONCENTRICITY	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
⊕	TRUE POSITION	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
		NEXT ASSEMBLY:				SRU VP		
		DRAWING TYPE:						

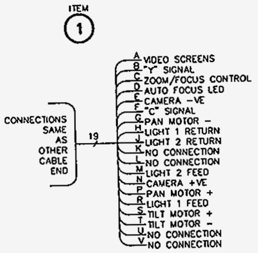
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

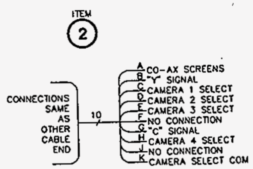
CCTV BASIN/REMOTE VIEWING
STATION POWER SCHEMATIC
MCO LOADING STATION
WHC DRAWING NO:H-1-82947

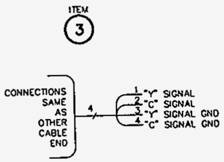
PROJECT	DESIGN PACKAGE	DRAWING	REV
444		407	0
SCALE	EST.WT.	SH 1 OF 1	11:22PM 6-4-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			









97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
4			15	S-VIDEO DIFF. LINE REC.				R.J. ELECTRONICS RJ-DIFF
4			14	CAMERA CONTROL UNIT				R.J. ELECTRONICS CU-2140
1			13	VIDEO TAPE RECORDER				R.J. ELECTRONICS AG1980RM
3			12	MONITOR				R.J. ELECTRONICS SSM-14N1U
1			11	CHAR OVERLAY BOARD				R.J. ELECTRONICS RMS5
1			10	S-VIDEO INPUT SELECTOR				R.J. ELECTRONICS SW4XRC
2			9	S-VIDEO INPUT SELECTOR				R.J. ELECTRONICS SW4XNEMA
3			8	PAN & TILT HEAD				R.J. ELECTRONICS PTE-100
4			7	CONNECTOR SET				R.J. ELECTRONICS RCS-1501-10-DL-PT
4			6	LIGHT CLAMP				R.J. ELECTRONICS CLB-6
8			5	UNDERWATER LIGHT				R.J. ELECTRONICS UL-210-30
4			4	TELEVISION CAMERA				R.J. ELECTRONICS RCS-2100
16			3	S-VIDEO SIGNAL CABLE				R.J. ELECTRONICS Mini-DIN
1			2	REMOTE CAMERA CABLE				R.J. ELECTRONICS R6504A
4			1	BASIN CAMERA CABLE				R.J. ELECTRONICS R6504B
QUANTITY								

PROJECT INFORMATION
WHC SPECIFICATION NO: WHC-S-0546
ITEM 5
WHC P.O. NO: NCB-SLD-A01129

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 444-S-01

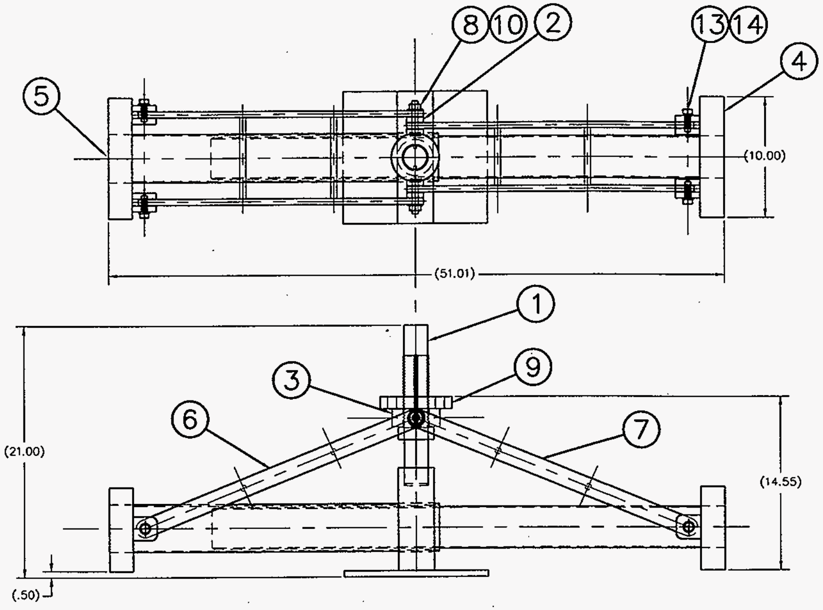
SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
▱	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC	TOL.	PREPARER		
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
		3-12	±.005	6-18	±.03	PROJECT MANAGER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
		THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03		QUALITY		
◎	CONCENTRICITY	NEXT ASSEMBLY:				SBU VP		
⊕	TRUE POSITION	DRAWING TYPE:						

NAC INTERNATIONAL

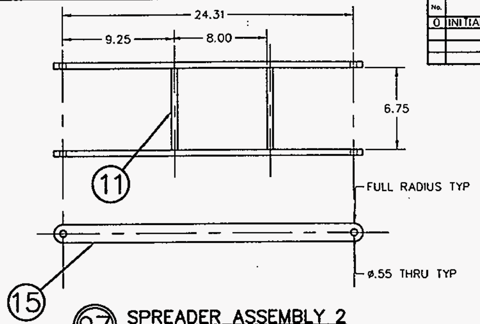
CCTV FIELD WIRING DIAGRAM
MCO LDOAING STATION
WHC DRAWING NO: H-1-82948

PROJECT 444	DESIGN PACKAGE	DRAWING 408	REV 0
SCALE	EST.WT.	SH 1 OF 1	11:27PM 6-4-97

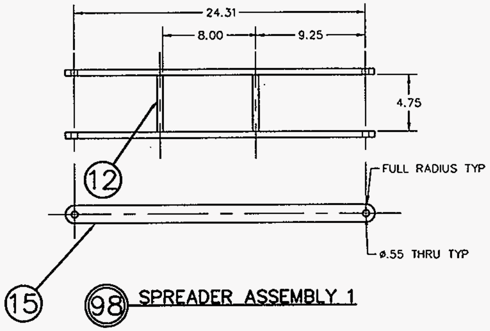
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



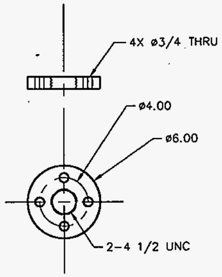
99 MCO STRUCTURE BRACE



97 SPREADER ASSEMBLY 2



98 SPREADER ASSEMBLY 1



9 SCREW COLLAR

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1			15	SPREADER BAR	304 ST. STL.	ASTM SA240		BAR 1/2
		4	14	LOCK WASHER	304 ST. STL.	COML		HELICAL LOCK,HVY X .75 NOM. I.D.
		4	13	HEX HEAD BOLT	304 ST. STL.	COML		3/4-10 UNC X 1.25 LG.
	2		12	STIFFENER	304 ST. STL.	ASTM SA240		ROD 2
2			11	STIFFENER	304 ST. STL.	ASTM SA240		ROD 2
		2	10	HEX HEAD NUT	304 ST. STL.	COML		1/2-13 UNC
		1	9	SCREW COLLAR	304 ST. STL.	COML		PLATE 1
		2	8	LOCK WASHER	304 ST. STL.	COML		HELICAL LOCK,HVY X .50 NOM. I.D.
1			7	SPREADER ASSEMBLY 2			427117-97	
	1		6	SPREADER ASSEMBLY 1			427117-98	
		1	5	BRACE 2 ASSEMBLY			427119-98	
		1	4	BRACE 1 ASSEMBLY			427119-99	
		1	3	SPREADER COLLAR ASSEMBLY			427118-98	
		4	2	BUSHING	304 ST. STL.	ASTM SA240		.755 I.D X 1.40 0.D X .45 THK.
		1	1	SHAFT ASSEMBLY			427118-99	
ASSY	ASSY	ASSY						
QUANTITY								

NAC INTERNATIONAL

SYM.	GEOMETRY
⏥	FLATNESS
	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE: ENGINEERING

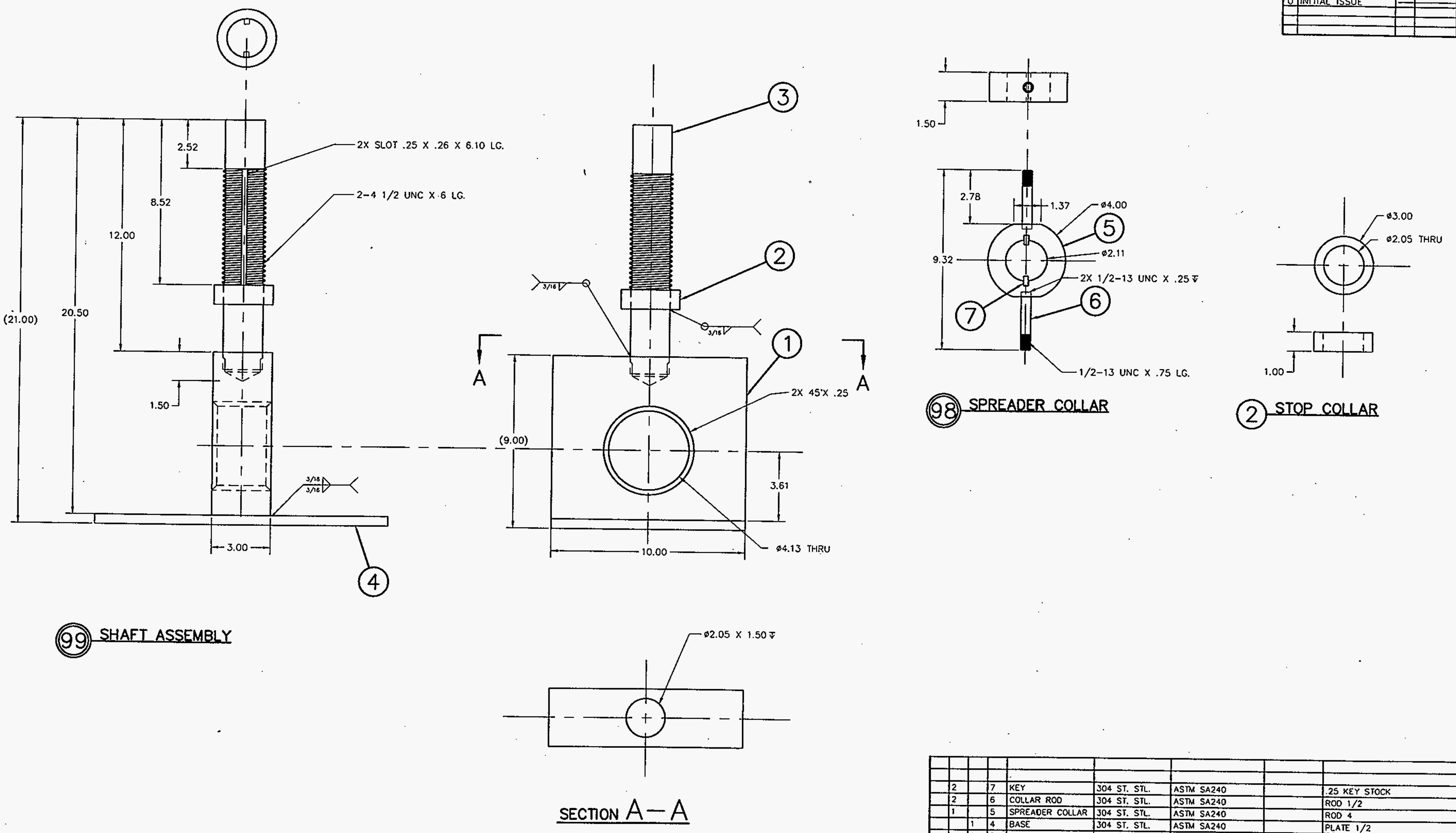
GROUP	NAME	DATE
PREPARER		6/5/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

MCO STRUCTURE BRACE
MCO LOADING SYSTEM

PROJECT 457
DESIGN PACKAGE
DRAWING 117
REV 0
SCALE 1/4
EST.WT.
SH 1 OF 1
4:02PM 6-5-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 457-S-02

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



	2		7	KEY	304 ST. STL.	ASTM SA240		.25 KEY STOCK
	2		6	COLLAR ROD	304 ST. STL.	ASTM SA240		ROD 1/2
	1		5	SPREADER COLLAR	304 ST. STL.	ASTM SA240		ROD 4
		1	4	BASE	304 ST. STL.	ASTM SA240		PLATE 1/2
		1	3	ROD	304 ST. STL.	ASTM SA240		ROD 2
		1	2	STOP COLLAR	304 ST. STL.	ASTM SA240		ROD 3
		1	1	SUPPORT BLOCK	304 ST. STL.	ASTM SA240		PLATE 3
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

NAC INTERNATIONAL

MCO STRUCTURE BRACE
MCO LOADING SYSTEM

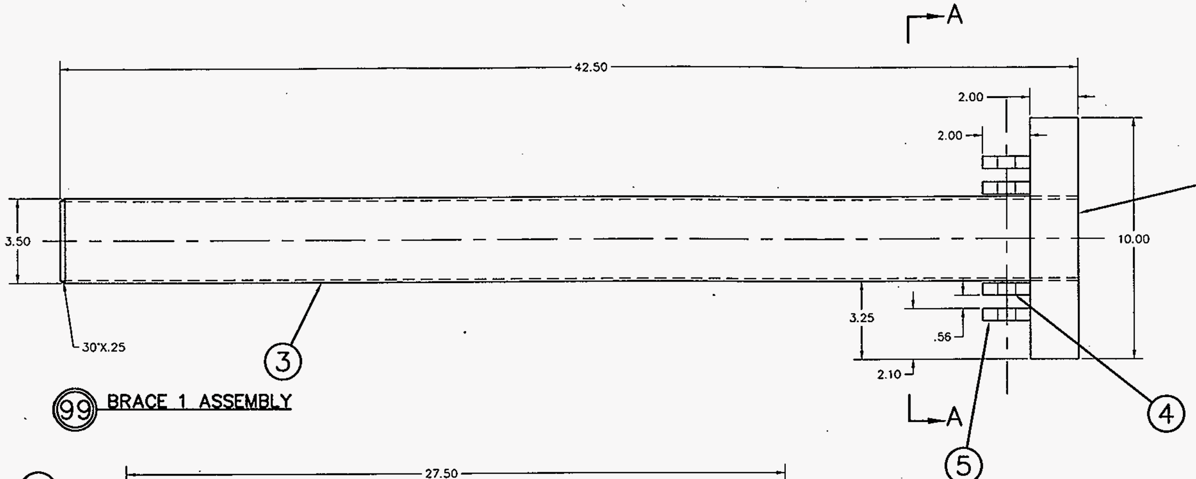
SYM.	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED			
	FLATNESS	3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
	STRAIGHTNESS	UNDER 3	±.003	UNDER 6	±.02
		3-12	±.005	6-18	±.03
	ANGULARITY	OVER 12	±.010	OVER 18	±.06
	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030	
		FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
	PARALLELISM	THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	
	CONCENTRICITY	NEXT ASSEMBLY:			
	TRUE POSITION	DRAWING TYPE: ENGINEERING			

GROUP	NAME	DATE
PREPARER	C.J. Hahn	6/5/97
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR of PROJECTS		
LICENSING MANAGER		
QUALITY		
SRV VP		

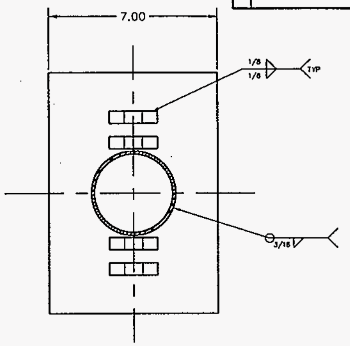
FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 457-S-02

PROJECT 457	DESIGN PACKAGE	DRAWING 118	REV 0
SCALE 1/2	EST.WT.	SH 1 OF 1	4:01PM 6-5-97

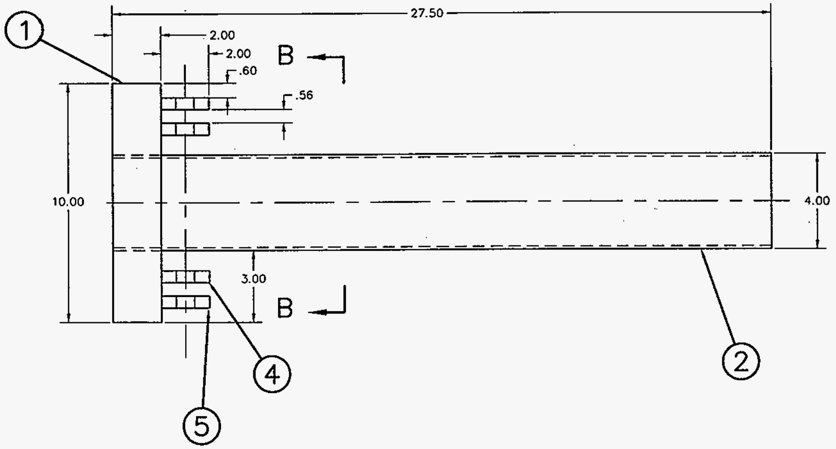
No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



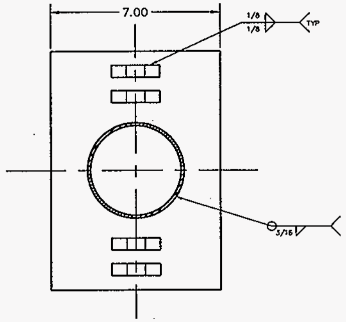
(99) BRACE 1 ASSEMBLY



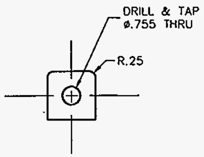
SECTION A—A



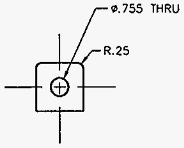
(98) BRACE 2 ASSEMBLY



SECTION B—B



④ CONNECTION PLATE



⑤ CONNECTION PLATE

	2	2	5	CONNECTION PLATE	304 ST. STL.	ASME SA240		PLATE 1/2
	2	2	4	CONNECTION PLATE	304 ST. STL.	ASME SA240		PLATE 1/2
		1	3	BRACE 1 TUBE	304 ST. STL.	ASME SA240		ø3.50 O.D. X .216 WALL TUBE
	1		2	BRACE 2 TUBE	304 ST. STL.	ASME SA240		ø4.00 O.D. X .226 WALL TUBE
	1	1	1	BRACE BASE	304 ST. STL.	ASME SA240		PLATE 2
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

NAC INTERNATIONAL

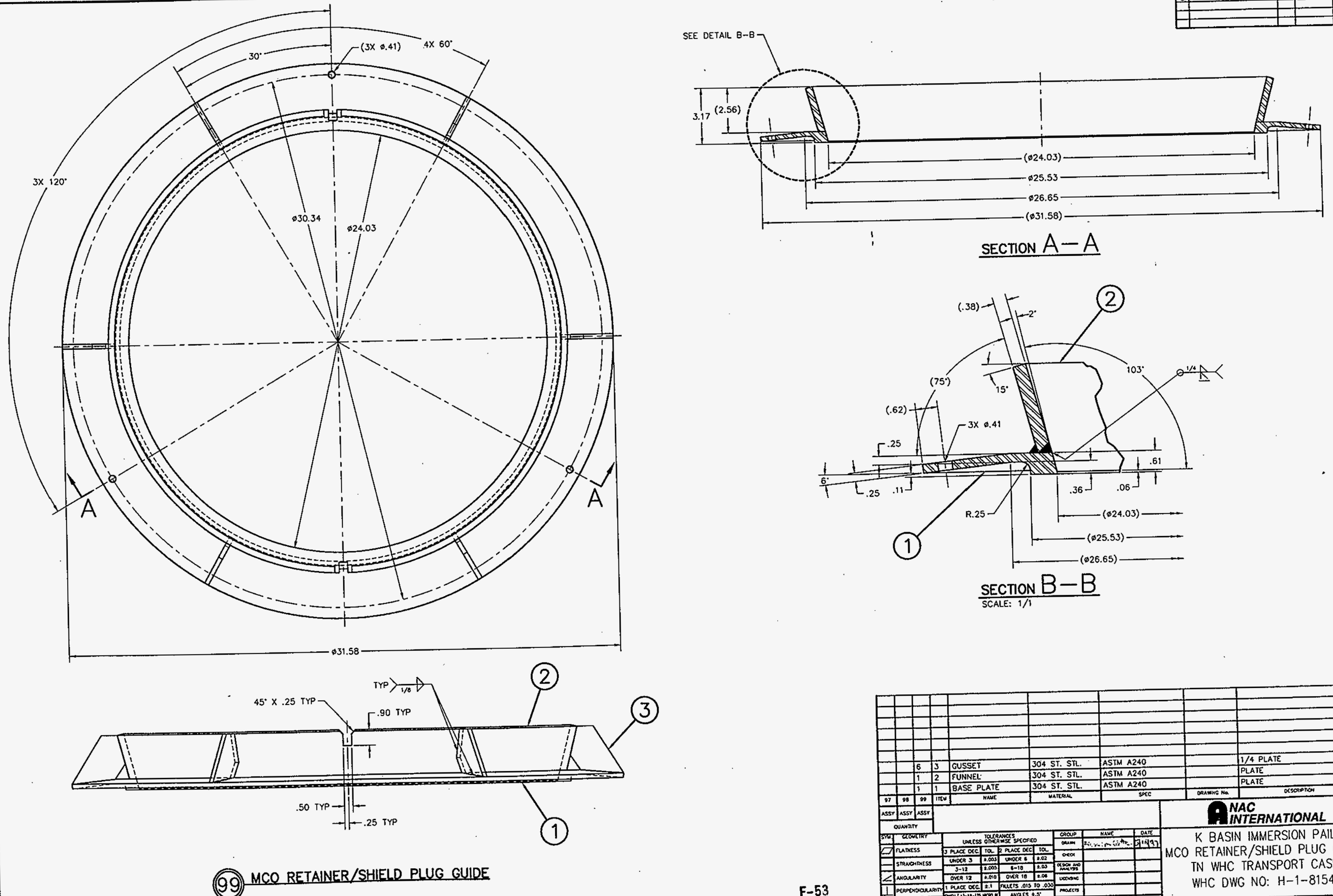
SYM	GEOMETRY	TOLERANCES UNLESS OTHERWISE SPECIFIED				GROUP	NAME	DATE
		3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.	PREPARER		6/5/97
⏥	FLATNESS	UNDER 3	±.003	UNDER 6	±.02	CHECKER		
—	STRAIGHTNESS	3-12	±.005	6-18	±.03	PROJECT MANAGER		
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.06	VP/CHIEF ENGINEER		
⊥	PERPENDICULARITY	1 PLACE DEC.	±.1	FILLETS .015 TO .030		DIRECTOR of PROJECTS		
//	PARALLELISM	FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°		LICENSING MANAGER		
		THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03				
◎	CONCENTRICITY	NEXT ASSEMBLY:				QUALITY		
⌖	TRUE POSITION	DRAWING TYPE: ENGINEERING				SRU VP		

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION: 457-S-02

MCO STRUCTURE BRACE
MCO LOADING SYSTEM

PROJECT 457	DESIGN PACKAGE	DRAWING 119	REV 0
SCALE 1/2	EST.WT.	SH 1 OF 1	4:02PM 6-5-97

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			



		6	3	GUSSET	304 ST. STL.	ASTM A240		1/4 PLATE
		1	2	FUNNEL	304 ST. STL.	ASTM A240		PLATE
		1	1	BASE PLATE	304 ST. STL.	ASTM A240		PLATE
97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
ASSY	ASSY	ASSY						
QUANTITY								

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION:

SYM	GEOMETRY
⏥	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B			
RADIUS CORNERS .015-.030			

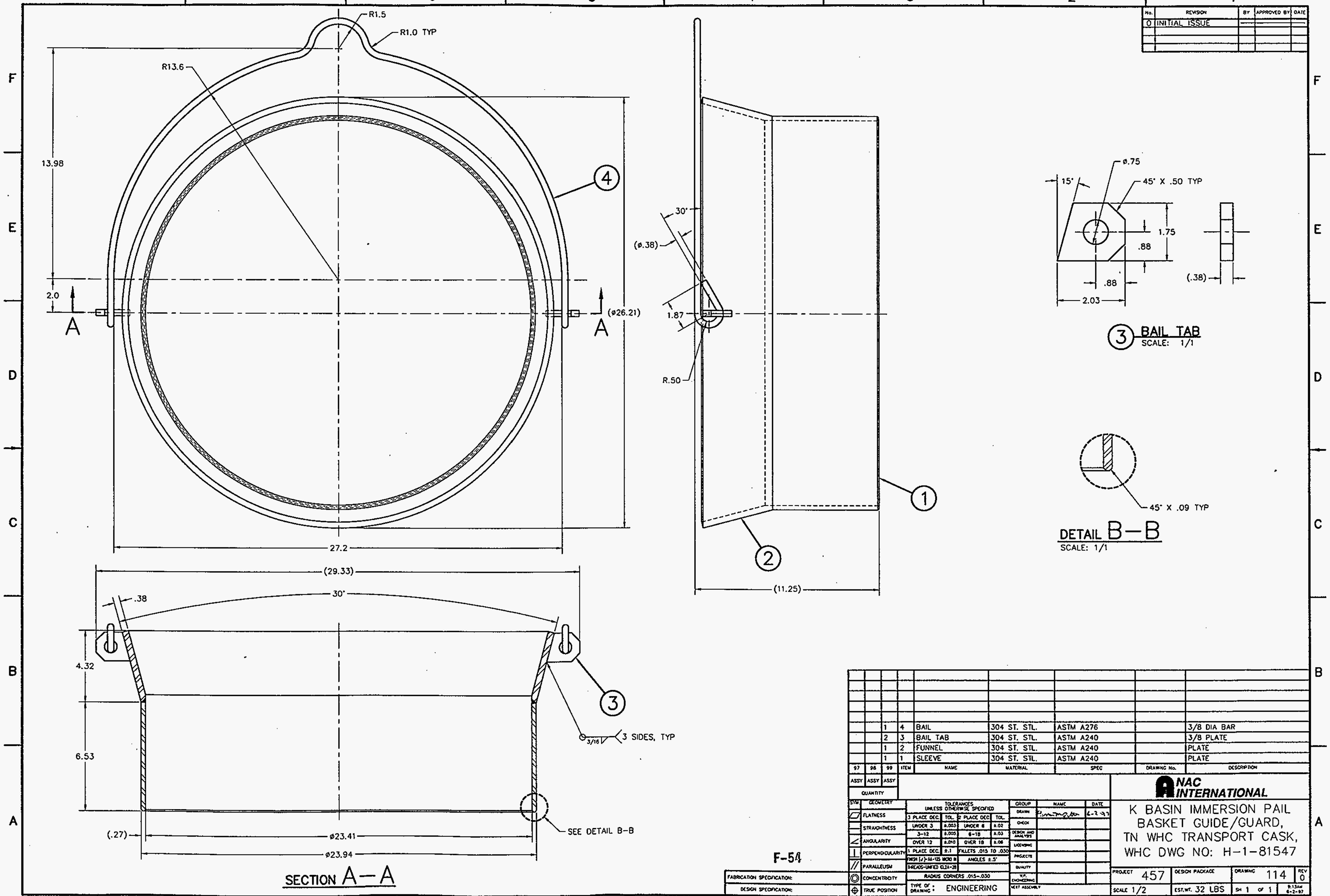
TYPE OF DRAWING: ENGINEERING

GROUP	NAME	DATE
DRAWN	[illegible]	5/1/97
CHECK		
DESIGN AND ANALYSIS		
LICENSING		
PROJECTS		
QUALITY		
V.P. ENGINEERING		
NEXT ASSEMBLY		

NAC INTERNATIONAL

K BASIN IMMERSION PAIL
MCO RETAINER/SHIELD PLUG GUIDE,
TN WHC TRANSPORT CASK,
WHC DWG NO: H-1-81547

PROJECT 457
DESIGN PACKAGE
DRAWING 113
REV 0
SCALE 1/2
EST.WT. 56 LBS
SH 1 OF 2
11:12AM 5-15-97



SECTION A—A

③ BAIL TAB
SCALE: 1/1

DETAIL B—B
SCALE: 1/1

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	4	BAIL	304 ST. STL.	ASTM A276		3/8 DIA BAR
		2	3	BAIL TAB	304 ST. STL.	ASTM A240		3/8 PLATE
		1	2	FUNNEL	304 ST. STL.	ASTM A240		PLATE
		1	1	SLEEVE	304 ST. STL.	ASTM A240		PLATE
ASSY	ASSY	ASSY						
QUANTITY								

SYM	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B			

RADIUS CORNERS .015-.030

TYPE OF DRAWING: ENGINEERING

GROUP	NAME	DATE
DRAWN	Armstrong	6-2-97
CHECK		
DESIGN AND ANALYSIS		
LICENSING		
PROJECTS		
QUALITY		
V.P. ENGINEERING		

NEXT ASSEMBLY

NAC INTERNATIONAL

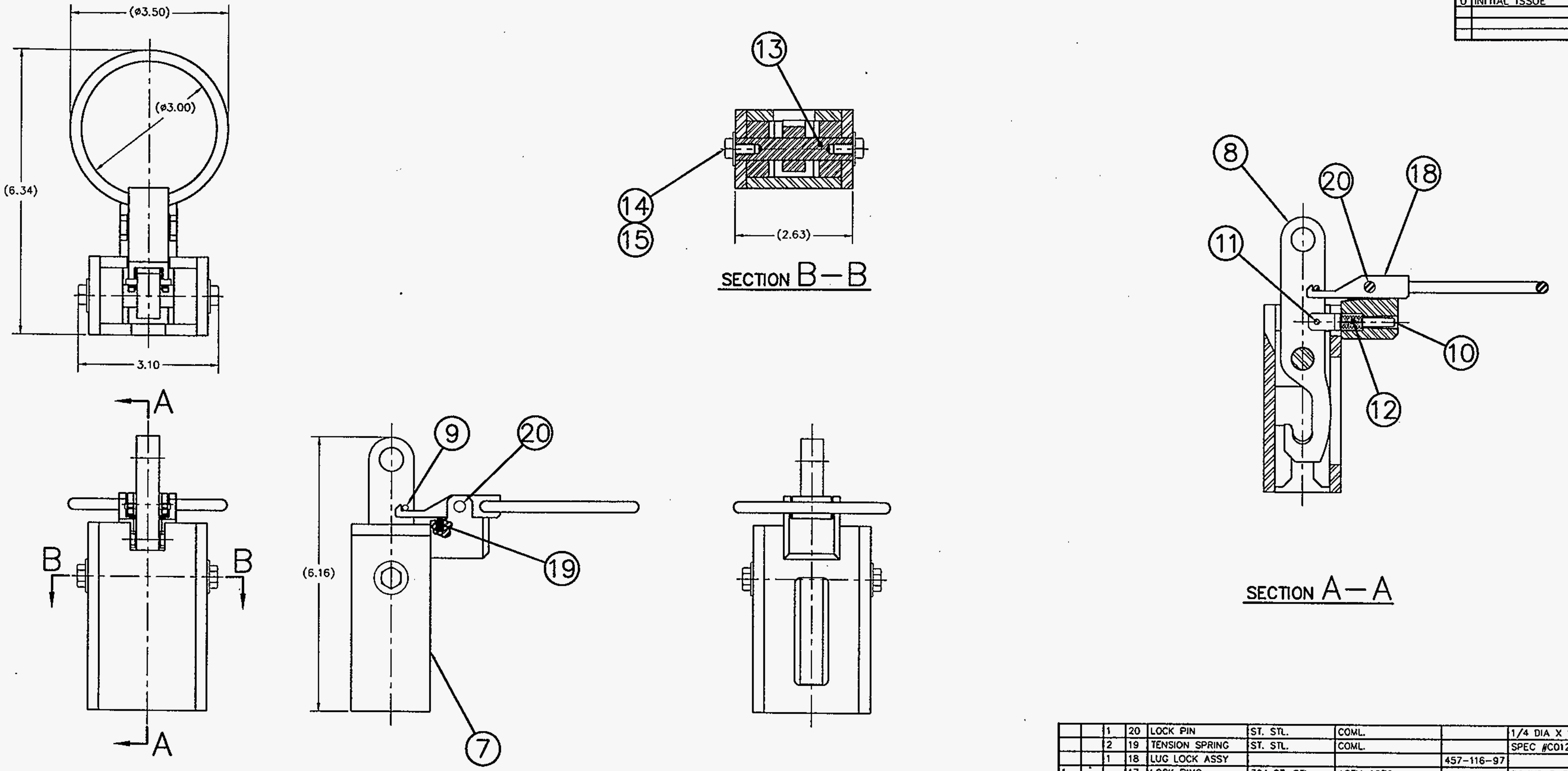
K BASIN IMMERSION PAIL
BASKET GUIDE/GUARD,
TN WHC TRANSPORT CASK,
WHC DWG NO: H-1-81547

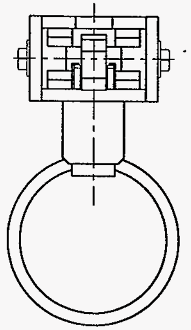
PROJECT 457	DESIGN PACKAGE	DRAWING 114	REV 0
SCALE 1/2	EST.WT. 32 LBS	SH 1 OF 1	9:13AM 6-2-97

FABRICATION SPECIFICATION:
DESIGN SPECIFICATION:

F-54

No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			





97	98	99	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
		1	20	LOCK PIN	ST. STL.	COML.		1/4 DIA X 1 1/4 LG DOWEL PIN
		2	19	TENSION SPRING	ST. STL.	COML.		SPEC #C0120-014-0440S
		1	18	LUG LOCK ASSY			457-116-97	
1			17	LOCK RING	304 ST. STL.	ASTM A276		ROUND BAR
1			16	LUG LOCK	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
		2	15	HEX HD BOLT	ST. STL.	COML.		1/4-20 UNC-2A X 3/8 LG
		2	14	FLAT WASHER	ST. STL.	COML.		MCMASTER-CARR #98019A360
		1	13	PIVOT SHAFT	304 ST. STL.	ASTM A276		ROUND BAR
		1	12	GUIDE SPRING	ST. STL.	COML		SPEC #C0120-014-0440S
		1	11	PIVOT PIN	ST. STL.	COML.		1/8 DIA X 7/8 LG DOWEL PIN
		1	10	GUIDE	304 ST. STL.	ASTM A276		ROUND BAR
		1	9	LOCK PIN	ST. STL.	COML.		1/8 DIA X 1 LG DOWEL PIN
		1	8	LIFT LUG	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
		1	7	LIFT RIG BODY ASSY			457-116-98	
	1		6	BLOCK	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
	1		5	BACK PLATE	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
	1		4	FRONT PLATE	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
	4		3	GUIDE	304 ST. STL.	ASTM A240/A276		SQ BAR/PLATE
	2		2	PIVOT LUG	304 ST. STL.	ASTM A240/A276		SQ BAR/PLATE
	2		1	SIDE PLATE	304 ST. STL.	ASTM A240/A276		FLAT BAR/PLATE
ASSY	ASSY	ASSY						

QUANTITY

PROPRIETARY INFORMATION

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NAC INTERNATIONAL

SYM.	GEOMETRY
▱	FLATNESS
—	STRAIGHTNESS
∠	ANGULARITY
⊥	PERPENDICULARITY
//	PARALLELISM
◎	CONCENTRICITY
⊕	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (√)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY:

DRAWING TYPE: ENGINEERING

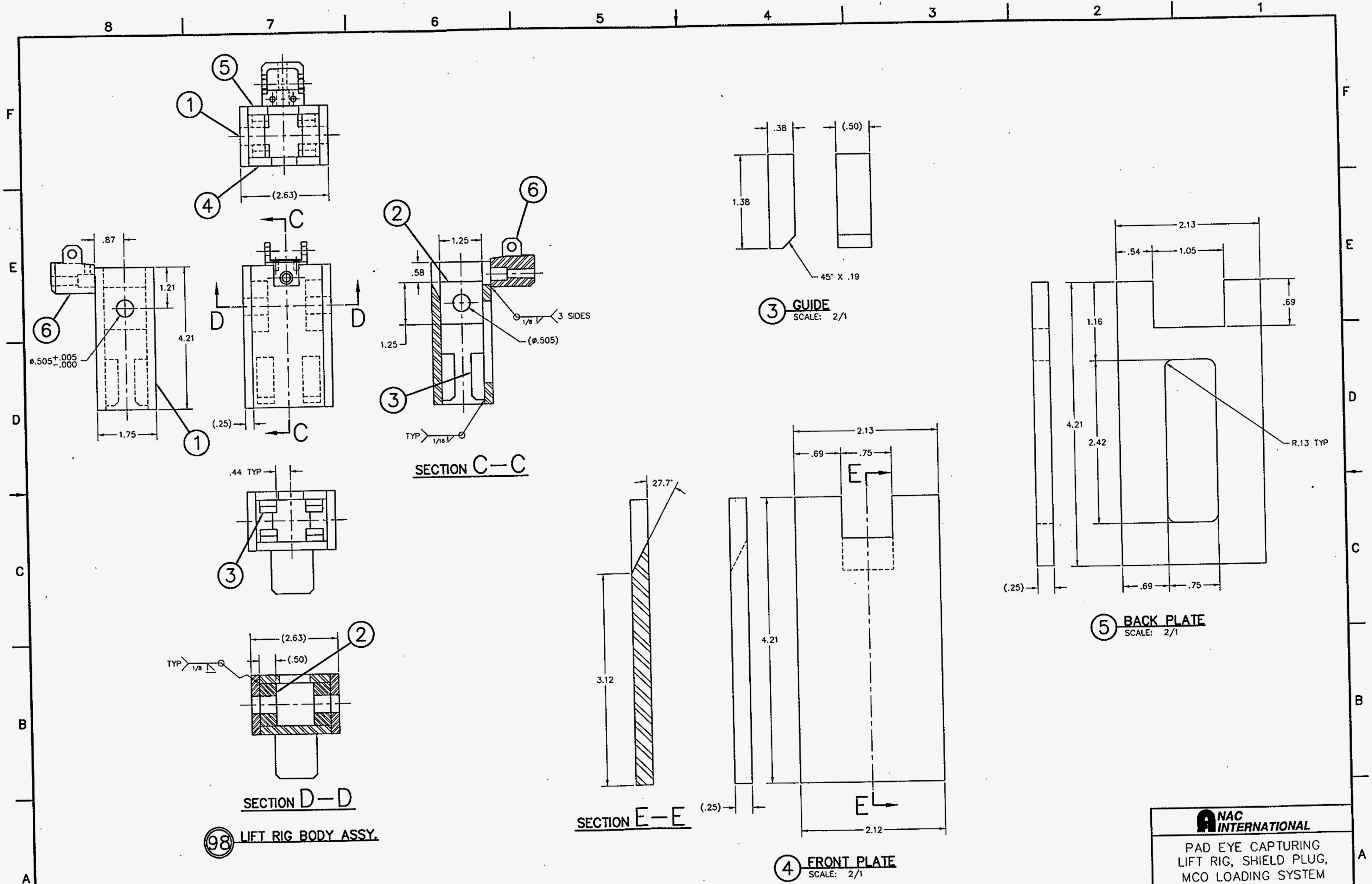
GROUP	NAME	DATE
PREPARER		
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER		
DIRECTOR OF PROJECTS		
LICENSING MANAGER		
QUALITY		
SBU VP		

FABRICATION SPECIFICATION:

DESIGN SPECIFICATION:

PAD EYE CAPTURING LIFT RIG, SHIELD PLUG, MCO LOADING SYSTEM

PROJECT 457
DESIGN PACKAGE
DRAWING 116
REV 0
SCALE 1/1
EST.WT.
SH 1 OF 3
3:38PM 5-28-97



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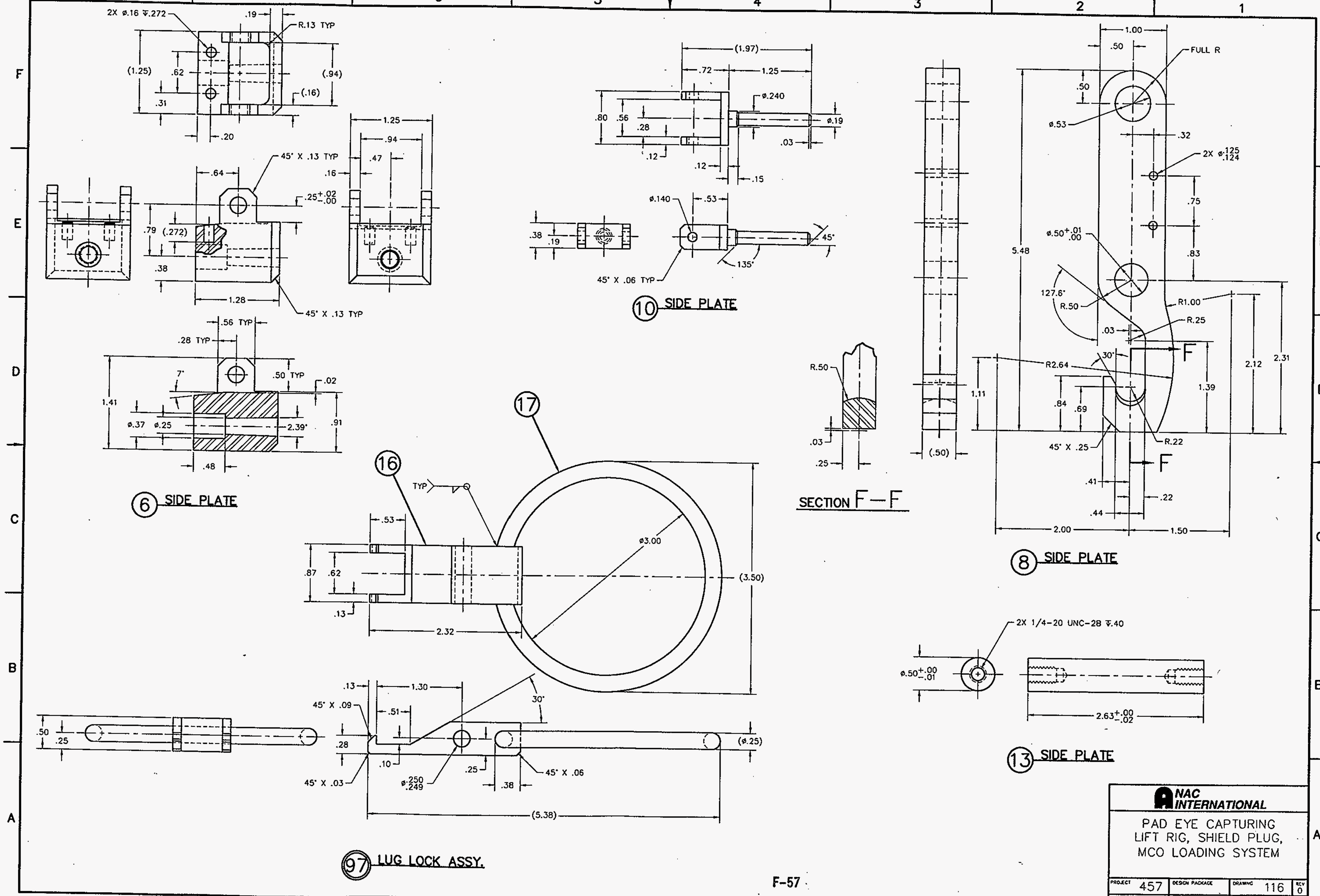
PAD EYE CAPTURING
LIFT RIG, SHIELD PLUG,
MCO LOADING SYSTEM

PROJECT 457	DESIGN PACKAGE	DRAWING 116	REV 0
SCALE 1/1	EST.WT.	SH 2 OF 3	2:41PM 5-28-97



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PAD EYE CAPTURING
LIFT RIG, SHIELD PLUG,
MCO LOADING SYSTEM

PROJECT 457	DESIGN PACKAGE	DRAWING 116	REV 0
SCALE 2/1	EST.WT.	SH 3 OF 3	3-33PV 3-26-97

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