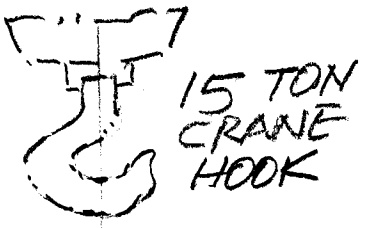
4.1 LIFTING ARRANGEMENT – ALTERNATIVE METHOD

4.1.1 ARRANGEMENT SCHEMATIC



$G \simeq 1950$ [lbs]

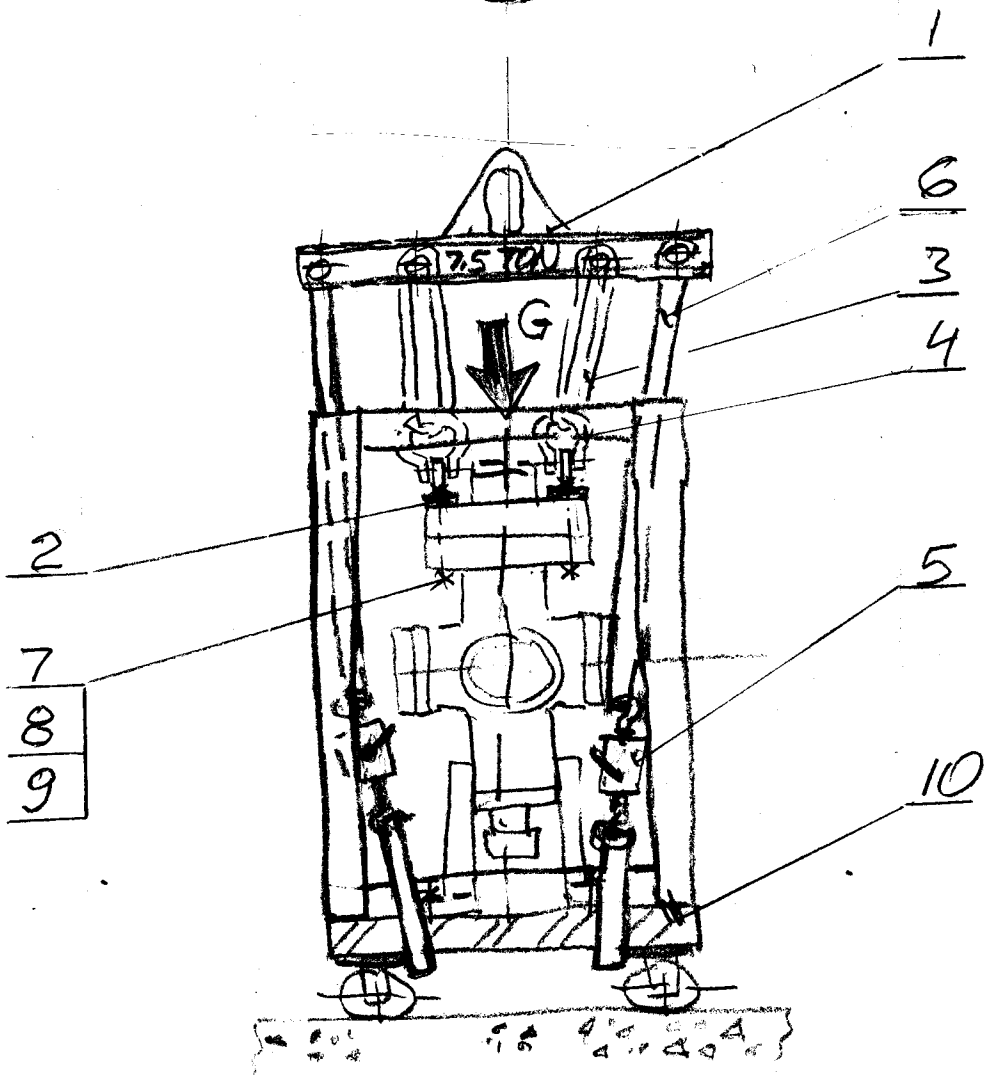


FIG. 2

4.1.2 PARTS;

1. LIFTING FIXTURE - CAPACITY 7.5 TON SKETCH @SZ 12.28.04
2. TOP LIFTER — PART OF SKETCH @SZ 12.28.04
3. SLING - (2 TON - RATED CAP. - MIN.) (2) REQ'D
4. SHACKLE - 5/8" DIA. PIN 2 TON CAP. - MINIMUM (2) REQ'D
5. PULLER - 2 TON CAP. - MIN.
6. SLING - (2 TON CAP. - MIN.)
7. CAP SCREW 1 1/8"-7 UNC, 6 1/2" LG. GRADE 5 PLAIN STEEL HEX. HEAD "Mc MASTER", PART NO: 91283A151
8. SPRING LOCK WASHER 1 1/8" - SCREW SIZE, 1.847 O.D. 1.153 I.D. 0.281 THICK "Mc MASTER", PART NO: 91101A039
9. HEX NUT 1 1/8"-7 UNC, GRADE 2 PLAIN STEEL "McMASTER" CAT. NO: 90494A139
10. "UNISTRUT - INSTALLATION CART" — ASSEMBLY; WEIGHT ≈ 450 [LBS]

4.1.3 DESCRIPTION

THE 1 LITER BUBBLE CHAMBER APPARATUS IS BOLTED TO THE STEEL PLATE OF THE "UNISTRUT-INSTALLATION CART" ASSEMBLY (ITEM 10) FIG. 2. DUE TO UNKNOWN RATING OF THE CONNECTION OF THE BASE PLATE TO SUPPORTIVE LEGS, THE HANDLING WILL INCORPORATE TWO PARTS:

a) APPARATUS ITSELF (~1500 lbs)

b) "UNISTRUT INSTALLATION CART" ASSEMBLY (~450 lbs)

TO CARRY THE LOAD OF "APPARATUS", (2) "TOP LIFTERS" WILL BE BOLTED ON THE TOP FLANGE AS SHOWN ON FIG. 2.

THE INSTALLATION CART WILL BE SUSPENDED FROM THE 7.5 TON LIFTING FIXTURE BY USE OF (2) SLINGS, ITEM 6, AND PULLERS, ITEM 5.

PROPER VERTICAL ORIENTATION HAS TO BE CHECKED AND ADJUSTED BEFORE START UP OF THE TRANSPORTING INTO THE SHAFT.

THE SIMILAR STEPS WILL APPLY FOR TRANSPORTING, AS DESCRIBED IN PREVIOUS SECTIONS OF THIS ELLABORATE.

4.1.4 DETERMINE THE GOVERNING STRESSES

4.1.4.1 SHEAR IN PLANES a-a, b-b

4.1.4.1.1 DUE TO SUDDEN STOP 2(g) CASE, WILL APPLY, g - gravity acceleration

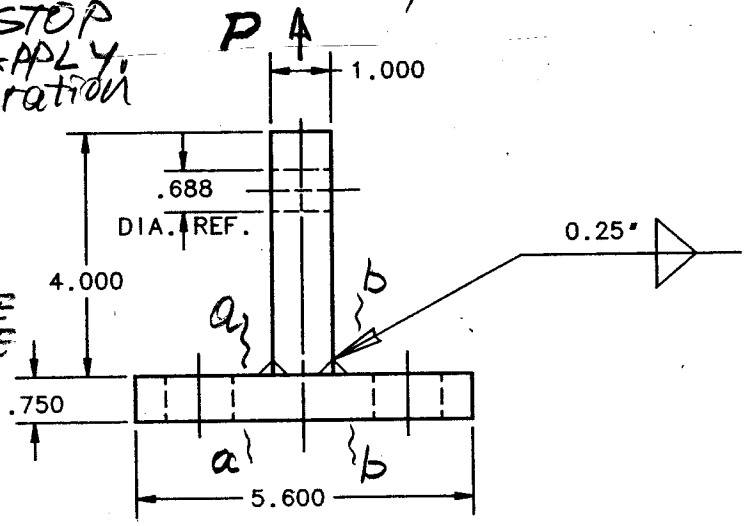
$$P = \frac{1950}{2} \times 2 = 1950$$

P_T – TEST LOAD/SINGLE FIXTURE

$$P_T = 1950 \times (1.25)$$

$$P_T = 2437.5$$

$$P_T \approx 2440 \text{ [lbs]}$$



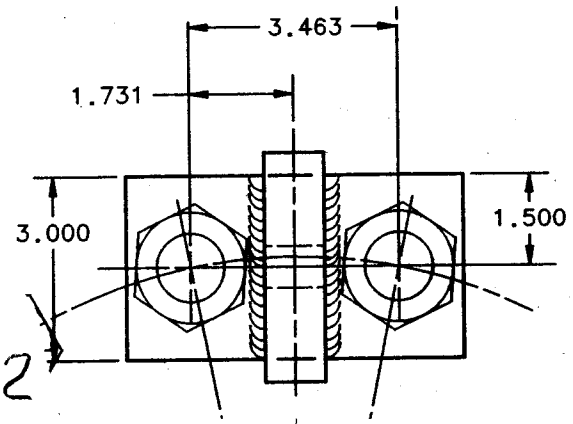


FIG. 3

SHEAR $\tau = \frac{P_T}{A}$

$A = 0.75(3)2$

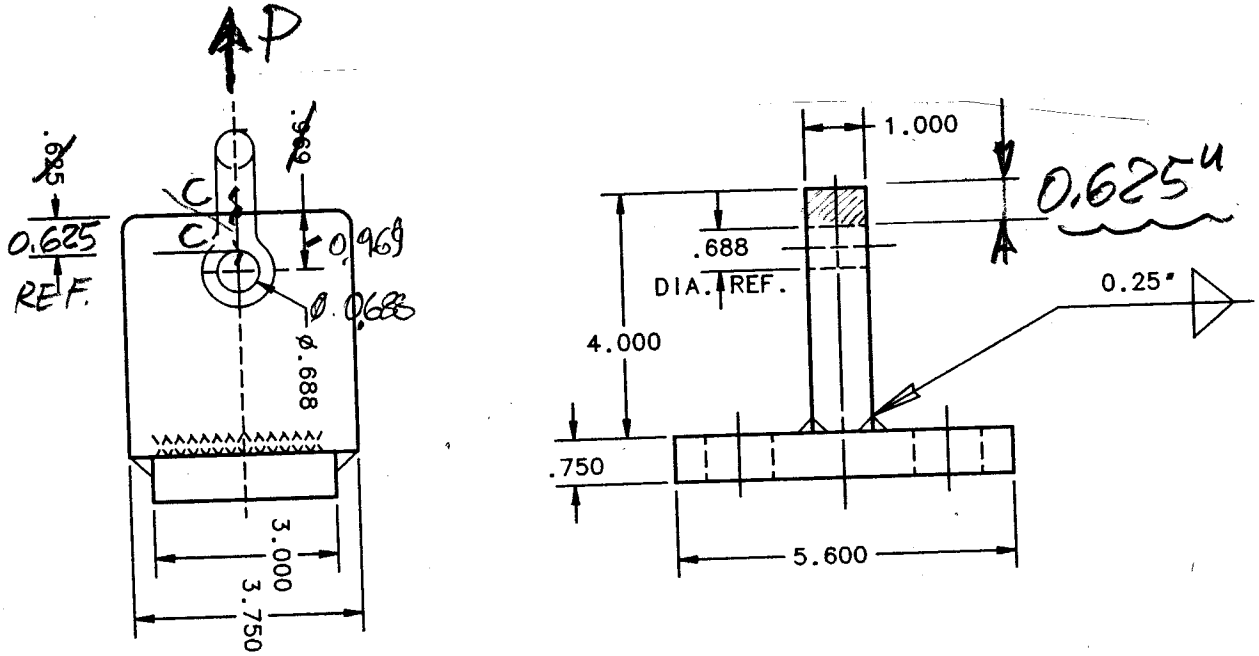
$A = 4.5 \text{ [in}^2\text{]}$

$$\tau = \frac{2440}{4.5}$$

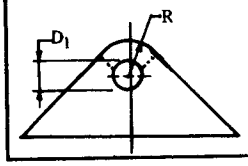
$$\tau \approx 542.2 \text{ [psi]}$$

O.K.

4.1.4.2 STRESS IN THE SECTION C-C AS MARKED IN FIG. 4



*Assuming shear load only thru the minimum section, the required thickness may be calculated by the formula:



$$t = \frac{P}{2S\ (R\text{-}D_1/2)}$$

where t = required thickness of lug, in.
P = load, lbs.
S = allowable shear stress, psi.

See page 440 for design of weld and length of lug.

$t = 1^{in}$

$D_1 = 5/8" + 1/32$

$D_1 = 0.656"$

$P = P_T = 2,440.$ [lbs]

D_1 — AS FABRICATED AT MAB.

$$R = \frac{0.656}{2} + 0.625$$

$$R \sim 0.953$$

$$1 = \frac{2440}{2S\left(0.953 - \frac{0.656}{2}\right)}$$

$$1 = \frac{2440}{2S\,(0.625)}$$

$$1.25\,S = 2{,}440.$$

$$S = \frac{2440}{1.25}$$

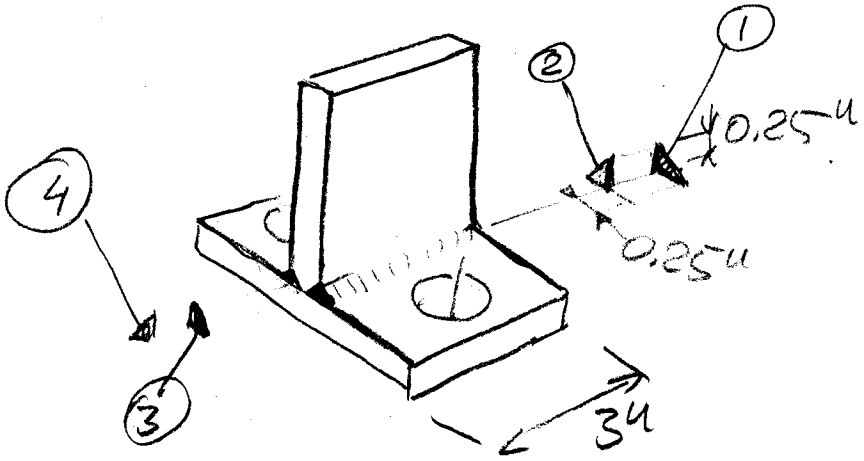
$$S = 1{,}952.\ [psi]$$

0.K.

4.1.4.3 CHECK THE REQUIRED SIZE OF WELDMENT

TOP LIFTER AS WELDED

(4) 0.25" Δ, 3" LG.



REF. [ ]

For weld proportions used in practice, this variation may be neglected. In a parallel weld, the maximum shear stress is across the throat of the weld where the area is $0.707t$. Hence the shear stress on the side of the weld is 0.707 times $s_{s,\max}$, and the permissible load per linear inch is $0.707t$ times 11,500, or $8{,}130t$ lb. This is the same capacity as that found for a normal weld. However, when the external forces are not collinear, there will be bending in the weld and the permissible load should be reduced 20 per cent to $6{,}400t$. This value has been used in computing the values in Table 28.

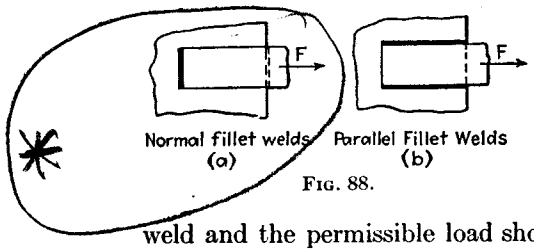


FIG. 88.

TABLE 28.—ALLOWABLE LOADS ON MILD-STEEL FILLET WELDS

Size of weld, in.	Allowable static load per linear inch of weld, lb			
	Bare welding rod		Shielded arc	
	Normal weld	Parallel weld	Normal weld	Parallel weld
1/8 by 1/8	1,000	800	1,250	1,000
3/16 by 3/16	1,500	1,200	1,875	1,500
1/4 by 1/4	2,000	1,600	2,500	2,000
5/16 by 5/16	2,500	2,000	3,125	2,500
3/8 by 3/8	3,000	2,400	3,750	3,000
1/2 by 1/2	4,000	3,200	5,000	4,000
5/8 by 5/8	5,000	4,000	6,250	5,000
3/4 by 3/4	6,000	4,800	7,500	6,000

THE APPLIED TYPES, AS FABRICATED ARE O.K.

5022TA

4.2

BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers:

FNAL Site No/ _____ (If applicable) Div. Specific No. 155 (If applicable) Asset No. _____ (If applicable)

ASME B30.20 Group: (check one)
- [ ] Group I — Structural and Mechanical Lifting Devices
- [ ] Group II — Vacuum Lifting Devices
- [ ] Group III — Magnets, Close Proximity Operated
- [ ] Group IV — Magnets, Remote Operated

Device Name or Description: TOP LIFTER

Device was (check all applicable)
- [ ] Purchased from a Commercial Lifting Device Manufacturer. Mfg Name _____
- [X] Designed and Built at Fermilab SEE DWG. MC-435219...
- [ ] Designed by Fermilab and Built by a Vendor. Assy drawing number _____
- [ ] Provided by a User or other Laboratory
- [ ] Other: Describe _____

Engineering Note Prepared by ANDREW SZYMULANSKI Date FEB. 2. 2005

Engineering Note Reviewed by _____ Date _____

Lifting Device Data:

Capacity 1,000. [lbs]

Fixture Weight 7.8 [lbs]

Service: [X] normal [ ] heavy [ ] severe (refer to B30.20 for definitions)

Duty Cycle _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency _____

Rated Load Test by FNAL (if applicable) Date 2/4/05 Load 3,656. [lbs]

[ ] Check if Load Test was by Vendor and attach the certificate

Satisfactory Load Test Witnessed by: OTTO ALVAREZ ANDREW SZYMULANSKI

Signature (of Load Test Witness) 2258 5935

Notes or Special Information:
- SEE PAGES 31, THROUGH 37 FOR CALCULATIONS; PAGE 39, 40 FOR TEST ARRANGEMENT AND LIFTING DEVICE (TOP LIFTER) ASSEMBLY DWG.
- THIS DOCUMENT IS A PART OF THE ENGINEERING NOTE: "1 LITER BUBBLE CHAMBER INSTALLATION IN THE "MINOS" DETECTOR HALL MD-ENG-075

1 LITER BUBBLE CHAMBER, "TOP LIFTER" TEST ARRANGEMENT

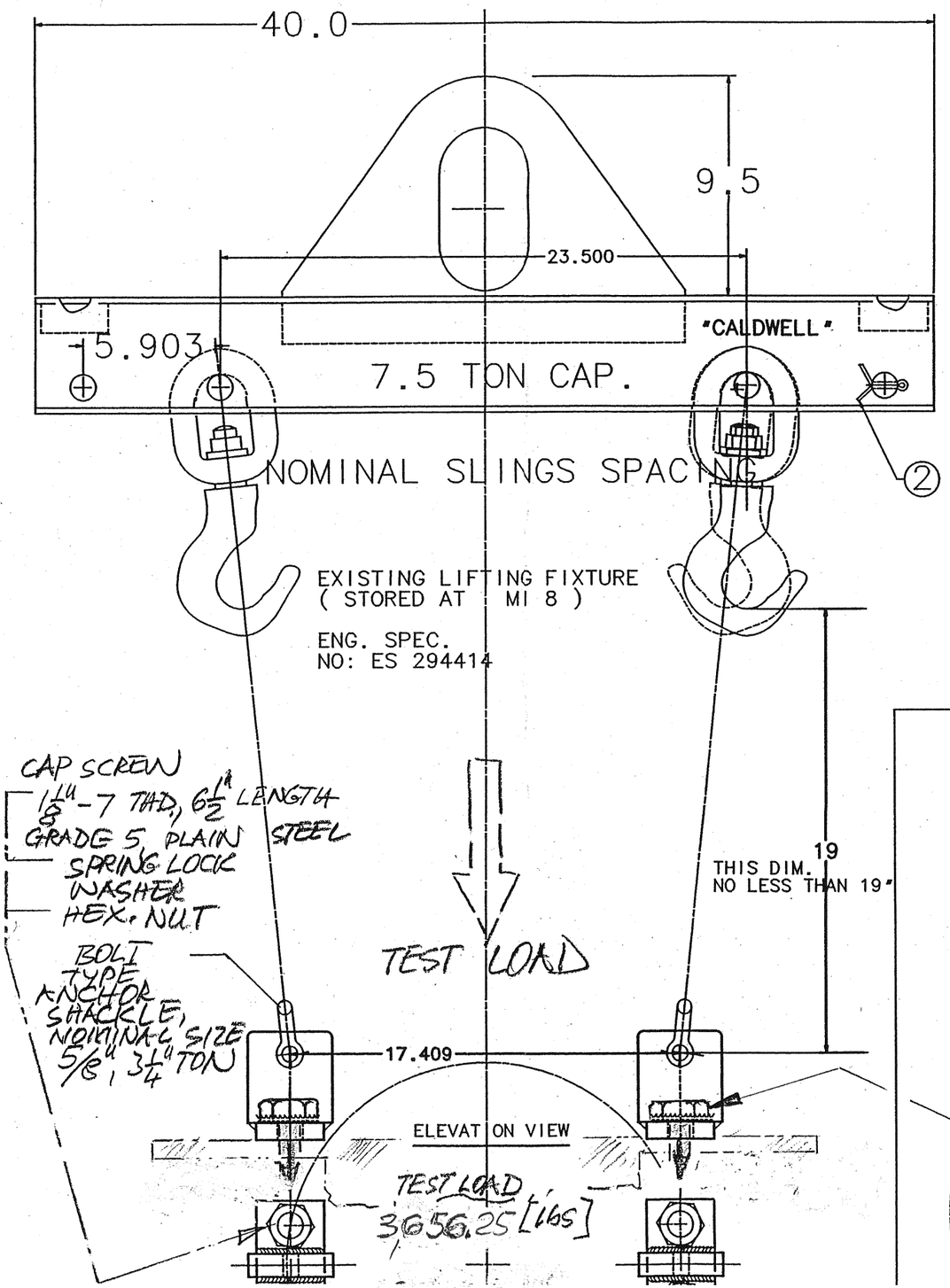
SKETCH: ASZ 01.24.05

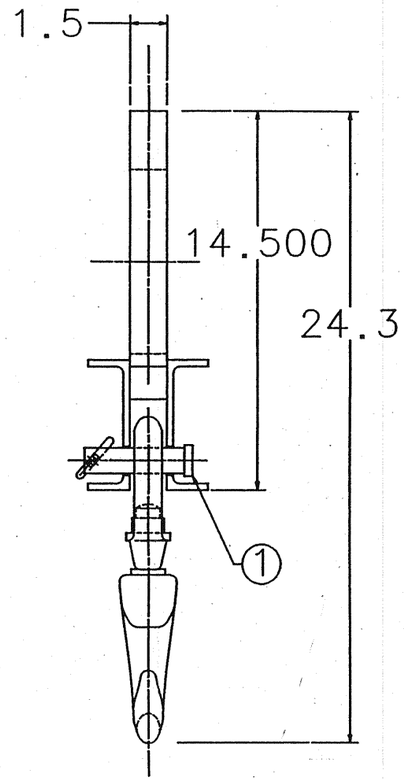
TECHNICAL CRITERIA

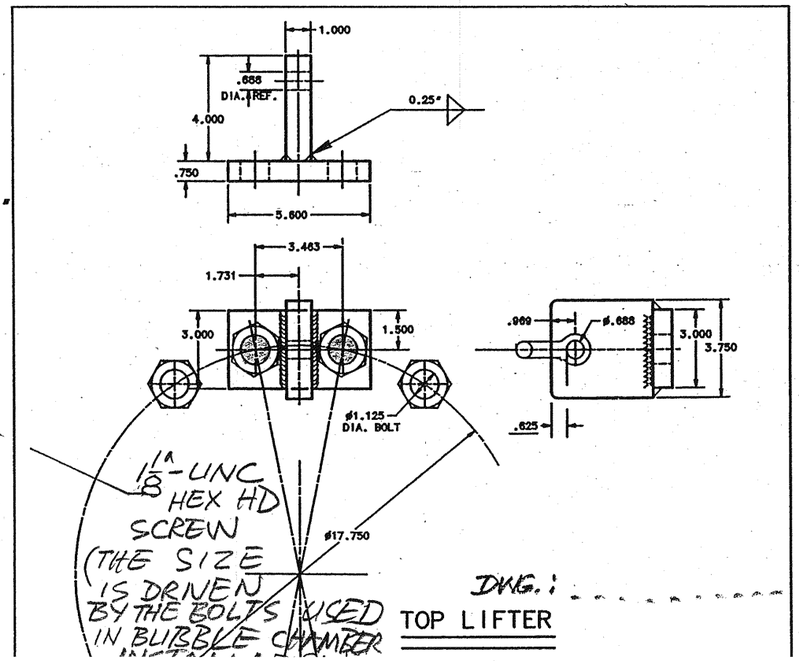
- WEIGHT OF TRANSPORTED OBJECT: G = 1,950. [lbs]
- ASSUMED DECELLERATION IMPACT (SUDDEN STOPPAGE) - 1.5g [g - gravity acceleration]
- TEST LOAD = (1.5) G (1.25)

  WHERE: 1.25 = FERMILAB STANDARD NUMBER FOR STATIC LOAD TESTS

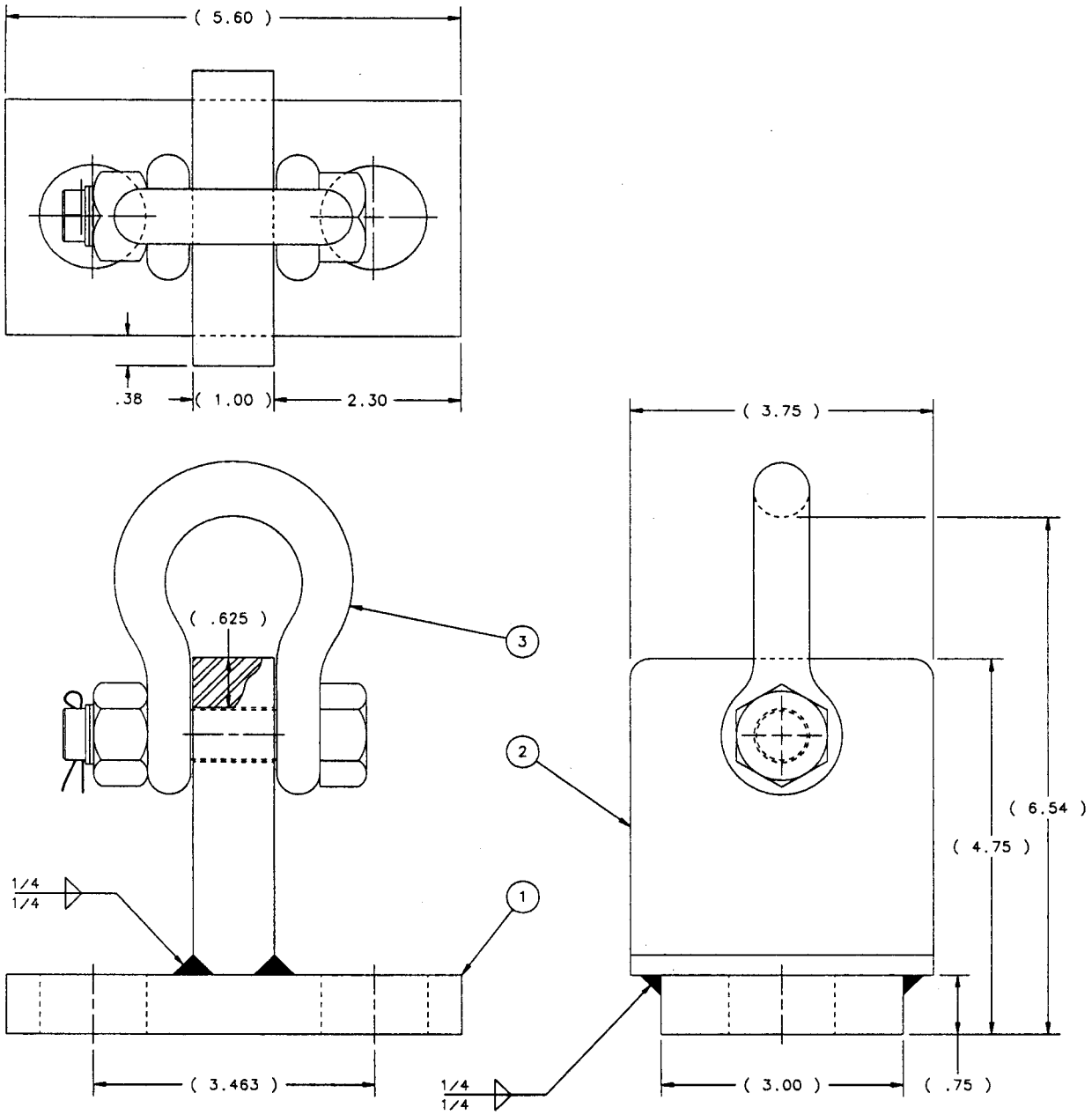
TEST LOAD = 3656.25 [lbs]







REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
3	COML	SHACKLE, BOLT TYPE ANCHOR, CROSBY 5/8 NOM. SIZE, 3.25 TON CAP. #1019490	1
2	MB-435218	PLATE	1
1	MB-435217	PLATE	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	A.SZYMULANSKI	28-JAN-2005
.XX	.XXX	ANGLES	DRAWN	V.MAJDANSKI	28-JAN-2005
± .03	± ---	± ---	CHECKED		
			APPROVED		

1. BREAK ALL SHARP EDGES .015 MAX.
2. DO NOT SCALE DRAWING.
3. DIMENSIONS BASED UPON ASME Y14.5M-1994
4. MAX. ALL MACH. SURFACES 125
5. DRAWING UNITS: U.S. INCH

USED ON

MATERIAL: SEE PARTS LIST ABOVE

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

1 LITER BUBBLE CHAMBER-COUPP LIFTING FIXTURE ASSEMBLY

SCALE	DRAWING NUMBER	SHEET	REV
FULL	9219.000-MC-435219		

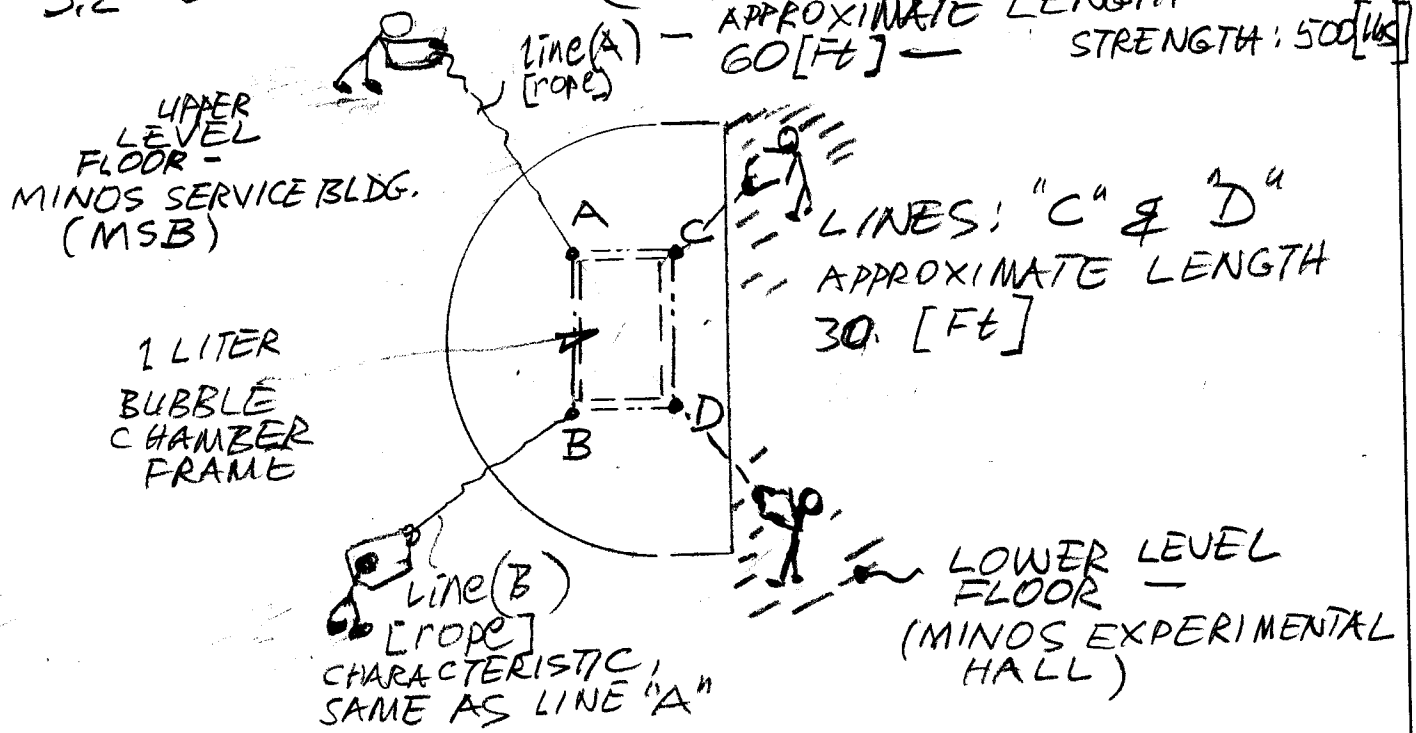
CREATED WITH : Ideas9m3 | GROUP: PPD/MECHANICAL DEPARTMENT

5. WORK PLAN / HAZARD ANALYSIS

5.1 WORK DESCRIPTION

THE 1 LITER BUBBLE CHAMBER APPARATUS ASSEMBLY WILL BE UNLOADED IN "MINOS" — SERVICE BLDG. MAIN FLOOR, CRANE SERVICED AREA.
THE COMPONENTS ARE SPECIFIED / TABULATED, ON SKETCH @SZ 12.29.04.
THE DRAWING SHOWS THE ARRANGEMENT, GEOMETRY, AND TORQUING DATA FOR (4) BOLTS ENGAGING "LIFTING EARS".
THE PROCEDURE FOR SETTING UP OF THE SLINGS, AND THE APPARATUS ASSEMBLY IS SPECIFIED IN SUBSECTION 4. OF THIS ELABORATION.

5.2 CONTROL LINES (ROPES).

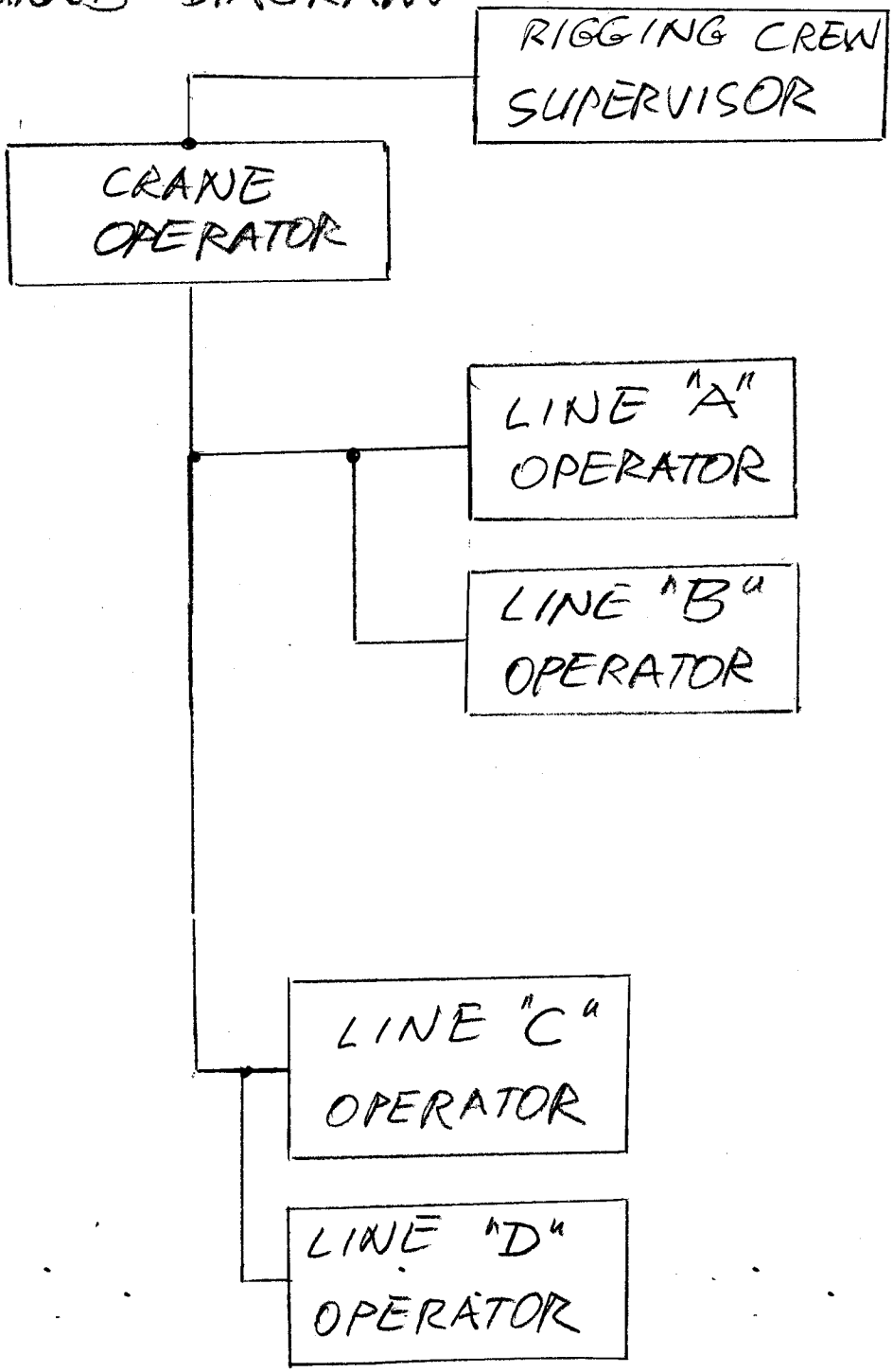


THE LINES, WILL BE USED DURING HANDLING OPERATION.
FIRST AT THE LIFT UP STAGE, TO CONTROL THE OBJECT ORIENTATION, AND MANIPULATION DURING LOWERING IT INTO THE SHAFT.
THIS STAGE WILL BE CONTROLLED BY (2) "A" AND "B" LINES.
THE OBJECT WILL BE LOWERED, SHORTENING AT THE SAME TIME THE "USABLE" LENGTH OF THE LINES. AT RIGHT TIME, SIGNALED BY THE CRANE OPERATOR, THE LOWER LEVEL OPERATORS ("MINOS" EXPERMENTAL HALL) WILL ENGAGE LINES "C" AND "D", CONTROLLING THE ORIENTATION OF THE OBJECT.
THE LINES MUST BE CONTINUOUSLY IN SLIGHT TENSION DURING THE TIME OF LOWERING.

5.3 SAFEGUARDING

THE UPPER LEVEL FLOOR OBSERVERS MUST HAVE CONTINUOUS CONTACT, WITH LOWER LEVEL FLOOR, LINES (C, D) OPERATORS. REQUIRED ACTION, HAS TO INVOLVE CRANE OPERATOR, SERVICE PERSONS OF LINE "A", "B", "C" AND "D".
THE COMMUNICATION WILL BE DONE BY THE USE OF TWO WAY RADIOS BETWEEN "MS/B" CRANE OPERATOR AND THE "MINOS EXPERIMENTAL FLOOR" SERVICEMAN "C" OR "D"

5.3.1 COMMAND DIAGRAM



5.3.2 POTENTIAL ENERGY ISSUE.

Flammable Gas Hazard		Approves work in Flammable Gas Class 1 or 2 areas.	Any use of flammable gas or mixtures	Notify	Approves all Flammable Gas installations

Table 2 continues.

Hazard	Designated PPD Approver threshold *(Who Approves)*	Department Head	ES&H Review for use as part of an Experiment	PPD ES&H Department	Division Head
Hazardous and Toxic Substances		Approves direct handling written procedure in advance of work	Any toxic / hazardous materials planned or used	Approves all abatement work.	Notify for Direct Handling & Abatement.
Hydraulic Systems	Fermilab designed or modified systems require review. *(PPD Engineering Approver)*	Notify			
Lasers	Any work with a Class 3b or higher laser. *(Laser Safety Officer in ES&H)*	Notify	Use of any laser	Notify	Notify
Machining and Grinding				Approves any work with hazardous materials.	Notify for work with hazardous materials.
Magnetic Field Hazards	Fringe fields over 1 kilogauss in air extending over 1 cubic foot. Potential mechanical movements due to magnetic fields. *(PPD Engineering Approver)*	Notify		Any time average exposure of people to 300 or more Gauss	
Mechanical Equipment	Work with a mechanical system that has the potential to release stored energy in excess of 60,000 foot-pounds. *(PPD Engineering Approver)* Work with unguarded rotating machinery. *(PPD Engineering Approver)*	Notify Notify	over 3 tons supported above floor over 10 tons Moves faster than 5 feet per second	 Notify	Always notify. Must approve if potential energy release is above 500,000 ft-lbs.
Noise Hazards				Approves if more than 8 hrs work in an area above 85 dbA.	Notify
Other Work Environments	Continuous work in temperatures above 86 degrees F or below -25 degrees F. *(Immediate Supervisor)*	Notify			
Oxygen Deficiency Hazard	Work in ODH-1 areas. *(Immediate Supervisors)*	Approves work in any area classified as ODH-2 or higher	Any use of oxygen displacing gases	Notify for ODH-2 work.	
Pressure or Vacuum Vessels and Systems	All pressure vessels and vacuum vessels require an engineering review. *(PPD Engineering Approver)*	Notify	Review of all vessels	Notify	Following test, approves operation of all pressurized systems >200 SCFH & all vacuum systems > 35 cubic feet
Radiation	Work in a High Radiation Area, on Class 2-5 objects, with activated liquids, depleted U_2, or contaminated objects, requires a Rad Work Permit (RWP). *(PPD Radiation Safety Officer)*	Notify	Any sources or rad. materials used, sources embedded in detectors	Notify ES&H Section and PPD ES&H before moving a source to another building.	Notify -------
Repetitive Motion or	All repetitive assembly work				

5.3.2.1 "H" VALUE FOR POTENTIAL ENERGY EQUATION DISTANCE BETWEEN ("MSB" FLOOR) BOTTOM LINE OF THE LIFTED OBJECT AND THE FLOOR LINE OF THE "MINOS" EXPERIMENTAL HALL,

$H = 752 - 406$ (SEE: SKETCH asz 12.16.04)

$H = 346$ [Ft]'

POTENTIAL ENERGY

$W = G \cdot [H]$

G - WEIGHT OF LOWERED OBJECT

$W = 1499 [346]$

$W = 518,654$ [Ft lbs]

1L BUBBLE CHEMBER ASSEMBLY WEIGHT = 1499 [lbs]

* $W > 500,000$ [Ft lbs]

* DIVISION HEAD HAS TO BE NOTIFIED ABOUT HANDLING & ABATEMENT

5.4 WORK DESCRIPTION – 1 TON CAPACITY GANTRY

THE GANTRY ASSEMBLY IS SHOWN ON: SKETCH @SZ 11.16.04
THE UNIT COMPRISES (3) ESSENTIAL PARTS:

a) (2) ROLLING SUPPORT ASSEMBLIES

b) (1) "BEAM" ASSEMBLY

CONSIDERING SAFETY ASPECT, THE GOOD WAY TO TRANSPORT THE UNIT, WILL BE BY TRANSPORTING INDIVIDUAL ASSEMBLIES TRANSPORTING WHOLE ASSEMBLY IS POSSIBLE ALSO. IN THIS CASE HOWEVER THE LOOSE PINS MUST BE REPLACED BY THE SAME DIAMETER MACHINE BOLTS, WITH LOCK SPRINGS AND LOCK NUTS.

THE POTENTIAL ENERGY OF THE OBJECT IS BELOW 500,000 [lbs Ft].
THE STEPS OF HANDLING SHOULD BE SIMILAR TO THAT COVER BY SUBSECTION 4, OF THIS ELABORATION.

5.5 SIGNATURE LIST OF WORKERS INVOLVED IN THE TASK OF HANDLING / TRANSPORTATION OF THE 1 LITER BUBBLE CHAMBER ASSEMBLY AND RELATED EQUIPMENT NEEDED FOR THIS -

SIGNATURE LIST OF WORKERS INVOLVED IN THIS TASK

My supervisor has reviewed this Work Plan & Hazard Analysis with me and I understand the hazards and required precautionary actions. I will follow the requirements of this plan or notify my supervisor if I am unable to do so.

Name (print)	ID#	Signature	Date

REFERENCES

1. STANDARD HANDBOOK OF FASTENING AND JOINING
SECOND EDITION
BY: ROBERT O. PARMLEY

2. THE ENGINEER'S MANUAL
BY: RALPH G. HUDSON, S.B.,

3. FORMULAS FOR STRESS AND STRAIN
SIXTH EDITION
R.J. ROARK AND WARREN C. YOUNG

4. DESIGN OF WELDMENTS
BY:
OMER W. BLODGETT

5. DESIGN OF MACHINE MEMBERS
BY: ALEX VALLANCE
V.L. DOUGHTIE
THIRD EDITION

REF.

PPD Implementation of Integrated Safety Management (ISM) and Fermilab ES&H Manual (FESHM) Chapter 2060

Contents:

PPD Implementation
of
Integrated Safety Management (ISM)
and
Fermilab ES&H Manual (FESHM) Chapter 2060

I. Introduction

This document describes the PPD Implementation of ISM and FESHM 2060.

Within PPD our focus is work planning. A hazard analysis and mitigation of the hazards is a natural part of this planning. Approval of the work and notification of supervisors about work plans is the standard procedure. A review of completed work to improve future work should be a part of our standard practice. Throughout the rest of this document, the term **"Work Plan/Hazard Analysis"** will be used to summarize this process.

This implementation is not intended to challenge the competence of trained and experienced people. We are working towards safety performance at a new level where more eyes on the hazards and mitigation of the hazards are needed to find and avoid the more exotic problems. We also need to be alert for accident situations stemming from several ordinary hazards working in concert. "More eyes" includes writing Work Plan/Hazard Analysis, having the written plan reviewed by experts in some cases, having every individual on a work team read and sign the written plan, and having the approved written plan distributed to the next level in line management.

This implementation is intended to follow FESHM 2060. Instead of references to FESHM chapters or to CFR (Code of Federal Regulations), this PPD document attempts to collect the full set of FESHM 2060 guidance and other special PPD concerns in terms of simple phrases for easy everyday reference.

II. Object

This document provides guidance on the following:

- **When is a written Work Plan/Hazard Analysis required and who writes it?**
- **When must a written Work Plan/Hazard Analysis be reviewed and who reviews it?**
- **When should line management be notified about Work Plans/Hazard Analyses?**

Generally, we all fall into two categories:

- **Developers of Work Plans/Hazard Analyses, including:**
  - Individual workers,
    recognizing that we all act in this capacity each day.
  - Supervisors, Group Leaders, Task Managers for T&M and Fixed Price work, and Detector Sub-project Managers.
    - Usually a team of individuals and supervisors will collaborate to write a Work Plan/Hazard Analysis.
    - Supervisors have a special responsibility to ensure that Work Plans/Hazard Analyses are written when required by this document.
- **Reviewers of Work Plans/ Hazard Analyses, including:**
  - Task Managers for T&M or Fixed Price work
  - Service Contract Coordinators
  - PPD Approvers (defined in Section IV below)
  - PPD Department Heads
  - PPD Project Managers
  - PPD ES&H Review Committees
  - PPD Division Head or designee

Deleted: -

III. Responsibilities of Individuals

- "Line Management Responsibility for Safety" includes everyone in the division. We are all part of the "line". It is expected that individuals will follow the Integrated Safety Management (ISM) core functions for **every** task. These functions are:

  - Define the work
  - Analyze the hazards associated with the task(s)
  - Take action to mitigate those hazards
  - Perform the work within the hazard controls
  - Provide feedback to allow improvements

  In your daily work, you should use these five core functions as your work guide.

- **PPD requires a written Work Plan/Hazard Analysis for employee tasks if:**

  - **Your task involves two or more of the hazards in Table 1.**

    Note: your judgement is required. For example, PPD does not expect a full written hazard analysis if you are working on a ladder 6 feet above the floor and there is an electrical outlet nearby (this is not an electrical hazard). PPD does expect a full written hazard analysis if you are modifying a pressurized system from a ladder position 6 feet above the floor.

    If there are two hazards due to faulty equipment, e.g. a frayed electrical cord, PPD expects you to fix the hazard before beginning the task. Do not write a hazard analysis.

    Contact your supervisor for help if you have questions.

  - **Your task involves one of the PPD High Level hazards in Table 1.**

    Note: your judgement is required. PPD expects you to be on alert for all hazards. PPD does not expect you to consider every potential hazard as a "high hazard". Contact your supervisor for help if you have questions.

  - **Your task involves construction or decommissioning activities as described in FESHM 7010** "SUBCONTRACTOR CONSTRUCTION SAFETY PROGRAM"

- You should work with your supervisor to develop a written Work Plans/Hazard Analysis when required. Usually a team of individuals and a supervisor will collaborate to write the document.

- You should read and sign the Work Plan/Hazard Analysis before performing the task.

Table 1. List of Hazards and thresholds indicating "high-level" hazards faced by individuals in PPD.

Hazard (If your task has TWO hazards, write a Work Plan/Hazard Analysis)	**"High-Level" Hazards** (If your task has ONE high-level hazard, write a Work Plan/Hazard Analysis)
Chemicals Use of materials that are flammable, combustible, corrosive, reactive, toxic, caustic, or poisonous. Use of any material that because of the quantity and/or manner it is being used is hazardous to the health of the worker. Occasional use of small amounts (500 ml) of consumer products or other chemicals available from the stockroom. Any work with new chemicals synthesized at Fermilab.	Work with solvents, reactive or corrosive chemicals in large amounts or in a poorly ventilated area. Work with poisonous chemicals (e.g. plating solutions containing cyanide). Work with highly reactive chemicals (e.g. battery acids, metal cleaning solutions containing a high % of hydrofluoric acid). Work with known carcinogens or cancer-suspect agents (e.g. benzene, methylene chloride, chloroform, etc.). Any work with explosive chemicals.
Computers in Systems that Protect People, Property, or the Environment Always a high level hazard	Computers used as an essential element of any system that is necessary to protect people from serious harm, to protect the environment from significant impact, or to protect property the loss of which would have a serious impact on our mission. Programmable logic controllers would require a review.
Confined Space Work Work in a space that has limited or restricted means for entry or exit. Work in a "Non-Permit Required Confined Space" or a reclassified "Permit Required Confined Space"	Entry into a "Permit Required Confined Space"
Crane, Hoist, & Forklift Use Any material handling using these types of equipment (e.g. "standard" crane or forklift operations where a load is being lifted within the rated capacity using approved lifting fixtures and devices).	Work where exceptional care is required due to size, shape, or close installation tolerance of a particular load. Lifts involving prototype or non-approved lifting devices and fixtures.
Cryogenic Equipment or Systems Working with solids, liquids, or gases colder than -150 C.	Working with more than 200 liters of cryogenic material.
Decommissioning & Dismantling Removing only a single piece of utilization equipment	Removing utilities or services from a building or experiment at the end of its life cycle Dismantling experiments and removing walls are high level hazards
Electrical Power Tasks during which workers are likely to be exposed to voltages, currents, or stored electrical energy of sufficient magnitude and duration to startle or injure if shocking, arcing, sparking, or heating should occur. 130 VAC or less line to neutral or ground, and primary current is limited to 30 amperes or less by circuit breakers or fuses.	Work activities near or on exposed electrical conductors, circuits, or equipment that are or may be energized and where there is a potential for arcing, flash burns, electrical burns, or arc blast. Any work on an AC electrical power distribution system. All "hot" work (work on energized electrical systems). Work on capacitors with stored energy in electrical distribution systems.
Electronics Work involving a single electrical source, where voltages present in the equipment exceeds 50 volts or the secondary voltages are not individually power limited to 50 volt-amperes or less. Any work with non-commercial electronics or with electronics modified at Fermilab, particularly in the prototype stage.	Work activities near or on exposed electrical conductors, circuits, or equipment that are or may be energized and where there is a potential for arcing, flash burns, electrical burns, or arc blast. First-time, unattended operation of non-commercial electronics or with electronics modified at Fermilab.
Environmental Work that will generate a WASTE product with a chemical that has a flash point below 140 degrees F, a pH below 2, a pH greater than 12.5, or which contains any toxic substance (see MSDS).	Any work that will generate more than 5 gallons of regulated waste. Any work with chemicals where a spill is possible and likely to get into the environment (e.g. drain or ditch nearby). Work that will generate a mixed (radioactive + regulated) waste.
Excavation and Digging Trenching or excavation less then 4 feet in depth.	Digging deeper than 4 feet. Digging into a radiation shield berm. Any excavation that could become a confined space due to changing conditions. Any digging (even by hand) where utilities or unsanitary conditions may be encountered.
Fall Exposure Work from a ladder at 6 feet or more above the floor. Work from a scissors lift. Work on low slope roofs (less than 4" rise in 12" horizontal).	Work at 6 feet above floor without guardrails. Work from an articulating lift device (e.g. a "cherry picker" or similar lift). Work on high slope roofs. Any new use of scaffolding, including erection of the scaffolding.
"First time use" of new equipment Potential hazard with any first time use of mechanical or electrical Equipment if a significant injury could occur. Consider ergonomic issues. Ergonomic issues are described in the "repetitive motion" box.	First time production work with new equipment designed or modified at Fermilab if a significant injury or property damage potential exists. Examples: start of production with a large new mechanical machine is a high hazard, but starting use of a small low-power printed circuit board is not.
Flammable Gas Areas Flammable gas areas are classified by fire risk and must be reviewed to determine the risk class (unreviewed areas are Class 2). **Risk Class 0**: risk of small local flash fire **Risk Class I**: Risk of a local fire **Risk Class II**: Risk of a general fire	Work in a Flammable Gas Risk Class 1 or Class 2 Areas that could cause a local or general fire. All un-reviewed Flammable Gas Risk areas are Class 2.

Hazard (If your task has TWO hazards, write a Work Plan/Hazard Analysis)	**PPD "High-Level" Hazards** (If your task has ONE high-level hazard, write a Work Plan/Hazard Analysis)
Hydraulic and Pneumatic Systems ("Fluids such as oil, water, air, etc.) Any hydraulic or pneumatic system that leaks. Connecting hoses or lines to pressurized oil, water, or air systems. Pressure washing operations or power sprayers.	Any work where a sudden uncontrolled release (failure) of pressure could result in injury (e.g. people working around a heavy object supported hydraulically could get "caught between"). Modifying or reconfiguring hydraulic or pneumatic systems. Operating hydraulic cutters.
Lasers Laser systems can present electrical, chemical, and eye or skin hazards from intense visible light. Lasers are classified on a scale of 1 (safe) to 4 (dangerous).	Work with a Class 3b or higher laser- Requires Laser Safety Officer approval, eye examination and training.
Machining and Grinding Work requiring an unusual or awkward position (e.g. overhead grinding, etc.). Any work that generates sparks.	Machining or grinding hazardous materials such as lead, uranium, etc. Removal of structural welds on large weldments (fall hazard may result). Machinery operated without appropriate guards.
Magnetic Fields Magnetic fields as low as 2.5 gauss can cause cardiac pacemakers, metallic implants, and other medical devices to function improperly.	Work in > 2.5 gauss field if personnel are fitted with cardiac pacemakers or metallic implants Work near any area with a fringe field of more than 1 kilogauss. Any time averaged exposure of people to 300 gauss or more. Any situation were ferrous objects can be subject to magnetic forces causing sudden or unexpected movement into the magnetic field.
Mechanical Equipment Tasks involving the potential release of stored energy through falling, rotating, or other unplanned movement. Work on or near computer actuated mechanical equipment.	Any unusual arrangement of heavy objects. Other mechanical stored energy hazards (e.g. springs). Work in an area where personnel can be caught between moving objects. Work near unguarded rotating shafts. Work with a mechanical system that has the potential to release stored energy that could cause considerable damage or injury. Work with a mechanical system that has the potential to release stored energy in excess of 60,000 foot-pounds. Examples: 30 tons at 1 foot off the floor or 3 tons at 10 feet off the floor.
Noise Hazards Eight hours of work in an environment where you must raise your voice (but not shout) to be heard from a distance of 3 feet.	Two hours of work per day in an environment where it is necessary to shout in order to be heard from a distance of 3 feet. Work that exceeds a posted noise hazard limitation. (Typically 8 hrs @ 85 dbA).
Other Work Environments Nuisance dust from general cleaning, sweeping, or windy conditions. Work in areas of excessive heat or cold.	Exposure to animal feces during clean-up operations (birds, rodents, raccoons, etc.) Prolonged work in temperatures above 86 degrees F or below -25 degrees F.
Oxygen Deficiency (ODH) Areas Work in an ODH-Class 1 area (training, oxygen monitor, respirator and medical approval required) Classes range from 0 (no hazard) to 4 (high hazard SCBA required)	Working in a posted ODH Class 2 area or above. (training, oxygen monitor, respirator, multiple personnel in continuous communication and medical approval required)
Pressure or Vacuum Vessels and Systems Modifying a pressure or vacuum system. Unusual or rare operation of a pressure or vacuum system.	Work with gas systems having a pressure greater than 15 psi. or fluid systems greater then 150 psi. Work with a vacuum chamber > 35 ft^3 and larger than 12" in diameter. Work with thin vacuum windows greater than 12 inches in diameter.
Prototype development work New process may present unexpected hazards that need to be evaluated	Moving from small-scale prototype development to large-scale production may require repetitive activities that result in strains or injuries
Radiation Work on Class 1 < 1mR/hr or Class 2 < 10mR/hr radioactive items. Using radioactive sources.	Work in a High Radiation Area, Very High Rad Area, or Contamination Area. Work with Class 3, 4, or 5 items, contaminated items, or radioactive liquids. Direct handling or exposure to depleted uranium. Moving sources between buildings. Work that will generate a mixed (radioactive + regulated) waste.
Repetitive Motion or Ergonomically Challenging Tasks Any work at an inappropriately designed computer workstation. Assembly work with repetitive motion tasks (less than 4 hours at a time) Work conducted from awkward positions - stooping, twisting, stretching, etc. Routine and/or infrequent movement of equipment or office items such as wastebaskets, boxes of photocopier paper, computers and monitors, bottles of drinking water, etc. Lifting unusually shaped objects.	Assembly work requiring motions repeated continuously for 4 consecutive hours. Jobs that may aggravate a pre-existing medical condition. Assembly jobs that have caused previous repetitive injuries. Change in normal daily routines involving the above situations.
Underground Enclosures Work in any underground enclosure <50 feet with only one exit. CDF and D0 collision halls are not considered hazardous when cryogenics and gases are not present.	Work in any space > 50 feet below grade level and only one exit. Training for entry to perform routine task can be uses instead of a JHA. The Minos Experimental Hall and MiniBooNE would require training or HA.
Welding, flame cutting, brazing, open flame work Welding work in an area where passers-by can see the arc.	Any flame cutting on an existing structure.
Work in spaces controlled by other Divisions This includes all Collision Halls. See High Hazard section.	Always considered a high hazard until analyzed to determine if the severity of an incident would have serious impact on operations.

Responsibilities of Supervisors and Group Leaders

- The term "Supervisor" or "Group Leader" within PPD includes Detector Project Managers at all WBS levels and Task Managers of T&M and Fixed Price construction activities. As a supervisor of other employees, you have a special responsibility for safety of those employees. **When you assign work to employees, you are responsible for ensuring that Work Plans/Hazard Analyses are written as required by this document.**

- **You are required** to have a written Work Plan/Job Hazard Analysis for tasks done by your employees if their work passes any of the following thresholds:
  - **The task involves two or more of the hazards in Table 1.**
  - **The task involves one hazard at the "high level" defined in Table 1.**
  - **The task involves at least one hazard from Table 1 with a work crew where individual responsibilities of each crewmember should be clearly spelled out.**
  - **The task is outside of the normal duties and responsibilities for your group and involves one or more hazards from Table 1.**
    (e.g., your group is called to a new area to "help out", or your group is assigned a new permanent and continuing task)
  - **The task involves complex activities of more than one day duration and at least one hazard from Table 1.**
    (You should consider having daily toolbox meetings to review the complexities each day. But this is not required if a simple task is just being repeated every day.)
  - **Any T&M or fixed price construction work you are task managing.**
  - **If, in your judgment, the task is complicated and would be done more safely using a written Work Plan/Hazard analysis, then write one!**

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- **For tasks that recur often,** it is permissible to write a generic Work Plan /Hazard Analysis good for one calendar year. All such generic plans expire on December 31 every year and must be reviewed/amended as needed, and re-approved following the instructions below.

- **You are required to have Work Plans/Hazard Analyses reviewed if the work passes any of the thresholds in Table 2.**
  Table 2 indicates who should do the review, either a designated PPD Approver, a PPD Department Head, a PPD ES&H Review Committee, or the Division Head. If an obvious reviewer cannot be identified, contact the Division Office.

- **If the work is below the thresholds in Table 2, no further approval is required.**

- Once you have a written plan, **you have the following additional responsibilities:**
  - **Discuss the work plan with all involved employees, and get each employee to sign the Work Plan/Hazard Analysis as a record that the job was understood. Post a copy near the work area.**
  - **Keep the Work Plan/Hazard Analysis for your employees on file for one year.**
  - **Provide a copy of the Work Plan/Hazard Analysis up the line in the PPD Line Management as detailed in the PPD Organization chart.**
    See Table 2 for additional guidance. Supervisors provide copies to Group Leaders, and

Group Leaders provide copies to Department Heads. If you have both a department head (e.g. Support Services) and a project leader (e.g. CMS Project), provide a copy to both.

Table 2. Hazard vs. Review Matrix.

Hazard	Designated PPD Approver threshold *(Who Approves)*	Department Head	ES&H Review for use as part of an Experiment	PPD ES&H Department	Division Head
Chemicals	Work with solvents, reactive or corrosive chemicals in large amounts or in a poorly ventilated area. *(Immediate Supervisors)*	Notify		Any work with poisonous, highly reactive, explosive, or carcinogenic chemicals. Work with new chemicals synthesized at Fermilab.	Notify
Computers in Systems that Protect People, Property, or the Environment			Fermilab Senior Computer Security Executive and the Associate Director for Operations Support (ADOS).	Notify	Notify
Confined Space Work				If known hazards require a Confined Space Permit	Notify
Crane, Hoist & Forklift Usage	Below-the-hook lifting devices require review. *(PPD Engineering Approver)*			Notify	Approves unusual use (e.g. outside rated load limit)
Cryogenic Hazards	Any work with more than 200 liters of cryogenic material. *(PPD Engineering Approver)*		Any system with inventory exceeding 200 liters		Approves operation of any system with inventory exceeding 200 liters
Decommissioning & Dismantling		Approves all D&D work		Reviews all D&D work	Notify
Electrical Power	Work on AC electrical power distribution system requires an Electrical Work Permit. *(Electrical Coordinators)*	Notify			Notify Must approve all hot work.
Electronics	If "significant potential" for arcing, flash burns, electrical burns, or arc blast. *(Immediate Supervisors)*	Notify	Systems with non-commercial or modified equipment. Any large capacitor banks.		
Environmental	Any work that will generate greater than 5 gallons of hazardous waste. Any work where a significant spill is possible and likely to get into the environment. *(PPD Senior Safety Officer)*	Notify		Notify	
Excavation and Digging	Excavation permit for any earth removal. *(Task Manager or Construction Coordinator)*	--------- ---------		Notify Permit for any Berm alteration.	-------- Notify
Fall Exposure	Any new scaffolding erection. *(PPD Scaffold Competent Person)*	Notify		Notify	
"First time use" of new equipment	Machines designed or modified for use at Fermilab require an approved procedure before production use. *(PPD Engineering Approver)*	Notify .			Notify

Flammable Gas Hazard		Approves work in Flammable Gas Class 1 or 2 areas.	Any use of flammable gas or mixtures	Notify	Approves all Flammable Gas installations

Table 2 continues.

Hazard	Designated PPD Approver threshold *(Who Approves)*	Department Head	ES&H Review for use as part of an Experiment	PPD ES&H Department	Division Head
Hazardous and Toxic Substances		Approves direct handling written procedure in advance of work	Any toxic / hazardous materials planned or used	Approves all abatement work.	Notify for Direct Handling & Abatement.
Hydraulic Systems	Fermilab designed or modified systems require review. *(PPD Engineering Approver)*	Notify			
Lasers	Any work with a Class 3b or higher laser. *(Laser Safety Officer in ES&H)*	Notify	Use of any laser	Notify	Notify
Machining and Grinding				Approves any work with hazardous materials.	Notify for work with hazardous materials.
Magnetic Field Hazards	Fringe fields over 1 kilogauss in air extending over 1 cubic foot. Potential mechanical movements due to magnetic fields. *(PPD Engineering Approver)*	Notify		Any time average exposure of people to 300 or more Gauss	
Mechanical Equipment	Work with a mechanical system that has the potential to release stored energy in excess of 60,000 foot-pounds. *(PPD Engineering Approver)* Work with unguarded rotating machinery. *(PPD Engineering Approver)*	Notify Notify	over 3 tons supported above floor over 10 tons Moves faster than 5 feet per second	 Notify	Always notify. Must approve if potential energy release is above 500,000 ft-lbs.
Noise Hazards				Approves if more than 8 hrs work in an area above 85 dbA.	Notify
Other Work Environments	Continuous work in temperatures above 86 degrees F or below -25 degrees F. *(Immediate Supervisor)*	Notify			
Oxygen Deficiency Hazard	Work in ODH-1 areas. *(Immediate Supervisors)*	Approves work in any area classified as ODH-2 or higher	Any use of oxygen displacing gases	Notify for ODH-2 work.	
Pressure or Vacuum Vessels and Systems	All pressure vessels and vacuum vessels require an engineering review. *(PPD Engineering Approver)*	Notify	Review of all vessels	Notify	Following test, approves operation of all pressurized systems >200 SCFH & all vacuum systems > 35 cubic feet
Radiation	Work in a High Radiation Area, on Class 2-5 objects, with activated liquids, depleted U_2, or contaminated objects, requires a Rad Work Permit (RWP). *(PPD Radiation Safety Officer)*	Notify	Any sources or rad. materials used, sources embedded in detectors	Notify ES&H Section and PPD ES&H before moving a source to another building.	Notify -------
Repetitive Motion or	All repetitive assembly work				

Ergonomically Challenging Tasks	taking more than 4 hours per day. *(Immediate Supervisor)*	Notify		Notify	
Welding, flame cutting, brazing, open flame work	All work requires a Burn Permit. *(Fermilab Fire Department)*				
Work in space controlled by another division		Notify			Approves all such work.

Responsibilities of PPD Reviewers

- PPD Reviewers of Work Plans/Hazard Analyses include "PPD Approvers" (defined below), PPD Department Heads, Project Managers, ES&H Review Committees, and the Division Head. "PPD Approvers" are appointed by the Division Head and include:
  - Electrical Coordinators,
  - Scaffolding Competent Person,
  - Task Managers,
  - Construction Coordinators,
  - Mechanical Engineering Approvers,
  - Electronics Engineering Approvers,
  - Radiation Safety Officer,
  - Environmental Protection Officer,
  - Senior Safety Officer

  The list appears in http://www-ppd.fnal.gov/esh&bmg_www/Reviewers.htm

You are required to review some Work Plans/Hazard Analyses submitted to you by Supervisors and Group Leaders if they are above the thresholds outlined in Table 2 above. Normally you will approve Work Plans from within your own department. If you are the author of the Work Plan/Hazard Analysis needing review, get someone else to do the review.

- Reviewers are charged with evaluation of the submitted plan within the following guidelines:
  - **Is additional engineering needed to ensure a safe operation?** (Do the appropriate engineering calculations or seek additional engineering advice if you are uncertain.)
  - **Are FESHM Safety Standards and Fermilab requirements being adhered to?**
  - **Is the PPD Environmental Program (PPD_ESH_007) being adhered too?**
  - **Is a multi-hazard analysis complete?**
  - **Have any additional hazards been missed?**
  - **Is the Work Plan understandable?**
  - **Are the roles and responsibilities of the work party clearly defined?**
  - **Who is in charge on the scene and what happens if that person leaves the area?**
  - **Are the people doing the work appropriately skilled and trained for the work?**
  - **Should toolbox meetings be included for complex work continuing over many days?**
  - **Are controls clearly spelled out to mitigate the identified hazards?**
  - **Is the hazard control appropriate for the work being performed?**
  - **Is LOTO mentioned in the plan if it is needed?**
  - **Has proper notification been given to other divisions for work occurring in their space?**

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- If you approve such a Work Plan/Hazard Analysis, you are required to:
  - **Keep a copy on file for one year.**
  - **Give the original signed plan back to the author.**
  - **Provide a copy of the approved Work Plan/Hazard Analysis to your Department Head or Project Leader.** If you have both a department head (e.g. Support Services) and a project leader (CMS Project), provide a copy to both.

- **You may conclude that the Work Plan/Hazard Analysis is below threshold and does not require approval.** If so, note this fact on the plan and return it to the requestor. Keep a copy or your note in your files.

IV. Responsibilities of PPD ES&H Committees

As detailed in PPD_ESH_006, "ES&H Reviews for Experiments", all experiments within PPD shall be subjected to a safety analysis and review by an ES&H Review Panel appointed by the Division Head. Coordinators for the currently active ES&H Review Panels are listed in the current PPD organization chart.

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These Review Panels are the core of the process by which an experiment obtains an Operational Readiness Clearance (ORC) to run the detector or a partial ORC (pORC) to run a part of a detector. The PPD Senior Safety Officer and the Division Head approve all ORCs and pORCs.

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Since much of the work in PPD is on such detectors, the division often uses pORCs as a method of approving and permitting the unattended operation of any apparatus within the jurisdiction of the division. With the adoption of this ISM procedure, pORCs will still continue as a method for Division Head approval when required.

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The guidelines for these Review Panels are similar to the guidelines in Table 2. The differences stem from an "experiment" view vs. a "hazards associated with a task" view. The guidelines from PPD_ESH_006 are reproduced here for easy cross- reference and are summarized in Table 2.

The following are items that shall require an ES&H review. This is not a complete list. Reviews shall be required whenever the Division Head, Project Engineer, system designer or other knowledgeable person so determines. **Note:** All systems must meet all Fermilab safety standards.

Mechanical Hazards: Devices, which meet any of the following criteria:

- Weighs over 3 tons and is supported above the floor
- Exceeds 10 tons in total weight
- Moves at a speed greater than 5 ft/sec
- Costs more than $100,000 to replace
- Includes pressure/vacuum vessels

Computers in Systems that Protect People, Property, or the Environment

- Any computers or programmable logic controllers (PLCs) used in the above system must be approved by the Fermilab Senior Computer Security Executive (CSExec) and the Associate Director for Operations Support (ADOS).

Flammable Gas Systems: Any use of flammable gas and flammable gas mixtures.

Electrical Hazards: Electrical systems which meet any of the following criteria:

- Uses non-commercial or modified commercial equipment.
- Uses non-PREP or modified PREP equipment.
- Any non-commercial low voltage high current or high voltage distribution systems.
- Any equipment with large capacitor banks.

Fire Hazards: Any large combustible items such as large quantities of plastic scintillator, large numbers of cables requiring cable trays.

Oxygen Deficiency Hazards: Use of any oxygen displacing gases such as chamber gas systems, helium bag systems, dry nitrogen, cryogenic magnets or targets.

Cryogenic Hazards: Cryogenic systems for magnets, hydrogen targets, calorimeters, or any cryogenic system with inventory exceeding 200 liters.

Laser Hazards: Lasers of class 3 or higher.

Radiation Hazards: Radioactive sources/materials which will be used. Specify if embedded in detectors.

Toxic Materials: Toxic/hazardous materials planned or used, if the amount exceeds few gallon/pound quantities. Examples include: lithium, beryllium, mercury, lead, uranium, cyanide, PCB's, freons, oils, etc.

V. Forms to use for PPD Work Plans/Hazard Analyses

- PPD written Work Plans / Hazard Analysis will contain the following information:

• **Job name and location** • **Job start and end date** • **A description of the work** • **A list of hazards associated with the work** • **Details on planned mitigation of each hazard** • **The name of the task manager or task supervisor** • **A list of individuals in the work party with each person's role clearly defined** • **The name of the Work Plan/Hazard Analysis author** • **A place for approval by a reviewer if applicable** • **A place for individuals in the work party to sign that they have read and understood the plan** • **Details on notification to other divisions if applicable**

A sample form is attached in Appendix A.

The FESHM 2060 form can be used if the above information is added to the form.

- Other laboratory or PPD forms can serve the same purpose **as long as a Work Plan is included.** If the lab form does not include a Work Plan, a cover letter can be attached. The list of other common forms is shown below.

  - Electrical Work Permit
  - Pressure Vessel Testing permit
  - Radiation Work Permit
  - Confined Space Entry Permit
  - Written Lockout/Tagout Procedure Form
  - Fire Detection/Protection System Disablement Request (>48 hours)
  - Welding and Burning Permit
  - Toxic Material Handling Permit
  - Work Permit and Notification Form (FESHM 2020)
  - FESHM 2060 Hazard Analysis form
  - Other PPD written Procedures.

SIGNATURE LIST OF WORKERS INVOLVED IN THIS TASK

My supervisor has reviewed this Work Plan & Hazard Analysis with me and I understand the hazards and required precautionary actions. I will follow the requirements of this plan or notify my supervisor if I am unable to do so.

Name (print)	ID#	Signature	Date

Appendix A: PPD Work Plan/Hazard Analysis form

PPD Work Plan / Hazard Analysis

JOB NAME: _____

LOCATION:

ESTIMATED START DATE:

ESTIMATED JOB DURATION OR END DATE:

DESCRIPTION OF WORK:

ASSOCIATED HAZARDS:

1.
2.
…

PLANNED MITIGATION OF HAZARDS:
(match mitigation # to hazard # above)

1.
2.
…

TASK SUPERVISOR: _____ **PHONE:** _____

WORK PARTY (NAMES, TITLES IN THIS TASK):

1.
2.
…

PREPARED BY: _____ **DATE:** _____

APPROVED BY: _____ **DATE:** _____

DETAILS OF NOTIFICATION / APPROVAL BY OTHER DIVISIONS IF REQUIRED

APPARATUS TRANSPORT — BY TRUCK / FEASIBILITY ANALYSIS

FERMILAB

Mechanical Support Departmer
PO Box 500, MS 219
Batavia, IL 60510

APPARATUS TRANSPORT - BY TRUCK!
FEASIBILITY ANALYSIS

* *

FAX COVER SHEET

Date: JAN. 11. 2005

To: ANDREW SONNENSCHEIN

Fax #: 1. 773-834-8279

From: ANDREW SZYMULANSKI

Telephone #: 630. 840-4870

Fax #: 630-840-3694

This fax consists of 10 **page(s) including the fax cover sheet.**

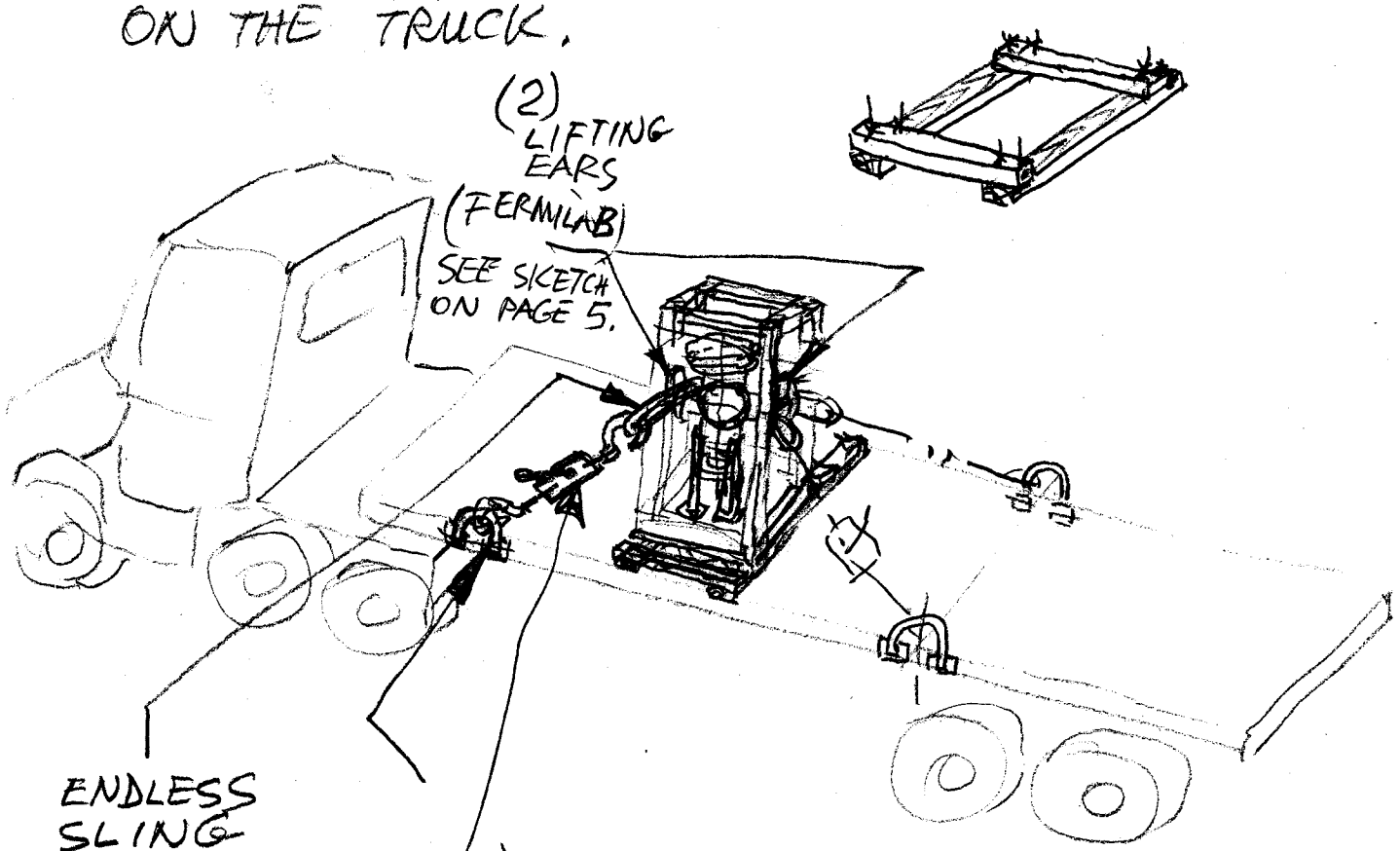
* *

ANDREW,
I HAVE LOOKED AT THE TRANSPORT PROBLEM; THE SKETCH ON THE FOLLOWING PAGE WAS THE BASE FOR THE ANALYSIS.
AT A FINAL STAGE, THERE IS AN PROPOSAL FOR SUPPORT LEG, MODIFICATION (PAGE 9).
THE $2\frac{1}{2} \times 2\frac{1}{2} \times 0.5''$ ANGLE, WILL BE WELDED ONLY TO THE EXISTING $2 \times 2 \times \frac{1}{4}''$ ANGLE IN "FREE" AREA, BUT WITH CONTOUR CONTACT TO THE VESSEL, IN UPPER PART.

REGARDS
ANDREW

JAN, 11, 2005
A.SZ - (1)

ANDREW,
THANKS, FOR THE INFORMATION.
I HAVE ASSUMED GRADE "B" BOLTS IN MY CALCULATIONS; SO THIS IS FINE.
NOW THE RIGGING / TRANSPORT ISSUE.
BELOW IS A SKETCH OF SETTING THE ASSEMBLY ON THE TRUCK.



FIND THE DECELLERATION OF THE TRUCK:

$$S = \frac{v_t^2 - v_0^2}{2a} \qquad v_0 = 0$$

$$S = \frac{v_t^2}{2a}$$

$$2aS = v_t^2$$

$$a = \frac{v_t^2}{2S}$$

ACURA / RS
60 MILES/HR
S = 146 Ft
MFG. DATA

v_t = 60 Miles/HR
1 MILE = 5280 Ft

$v_t = 60(5280)$
$v_t = 316,800,0 \left[\frac{Ft}{Hr}\right]$
$v_t = 88 \left[\frac{Ft}{sec}\right]$

$$a = \frac{(88)^2}{2(146)}$$

$$a = \underline{26,5}$$

$$\frac{\left[\frac{Ft}{sec}\right]^2}{Ft} = \frac{\frac{Ft^2}{sec^2}}{Ft} \left[\frac{Ft}{sec^2}\right]$$

WEIGHT OF THE BUBBLE CHAMBER

$G \approx 1300$ lbs

$G = m \cdot [g]$

g - gravity

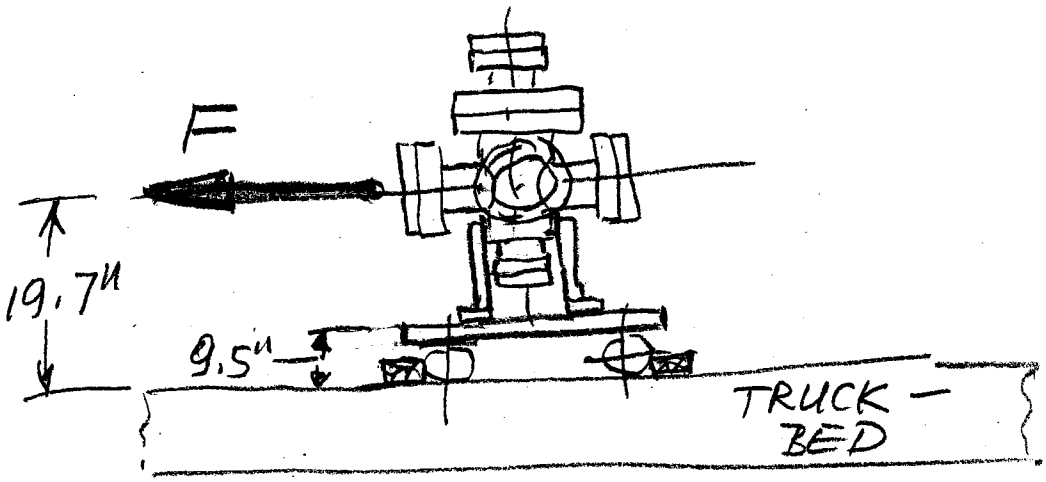
$g = 32.2 \left[\frac{Ft}{sec^2} \right]$

$1300 = m\, g$

$m = \frac{1300}{32.2}$

$m = 40.37$

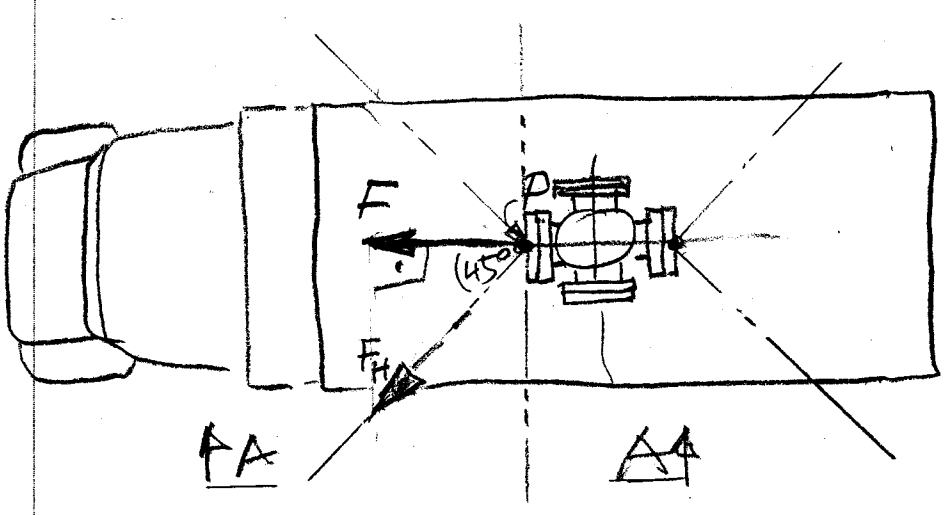
$\frac{lbs}{\left[\frac{Ft}{sec^2} \right]} = \left[\frac{lbs\ sec^2}{Ft} \right]$

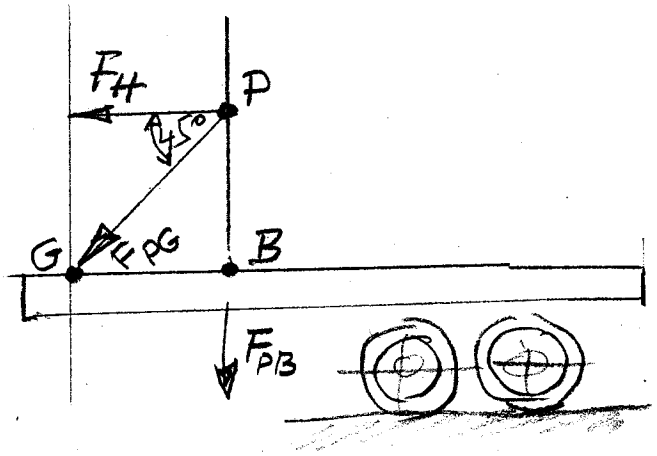


$F = M \cdot a$

$F = (40.37)(26.5)$

$F = 1069.8$ [lbs] $\frac{lbs\ sec^2}{Ft} \cdot \frac{Ft}{sec^2}$





VIEW A-A

$$\frac{F}{F_H} = \cos 45^\circ$$

$$F_H = \frac{F}{\cos 45^\circ}$$

$$PB = 19.7^{4}$$

REF

$$\frac{F_{PB}}{F_{PG}} = \sin 45^\circ$$

$$F_{PG} = \frac{F_{PB}}{\sin 45}$$

$$F_{PG} = \frac{2139.59}{\sin 45}$$

$$F_{PG} = 3025.9 \text{ [lbs]}$$

$$\frac{F_H}{F_{PG}} = \cos 45^\circ$$

$$F_{PG} = \frac{F_H}{\cos 45}$$

$$F_H = 1512.92 \text{ [lbs}$$

$$F_{PG} = 2139.59 \text{ [lbs}$$

FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
		5	~~22~~

SUBJECT: 1 LITER BUBBLE CHAMBER INSTALLATION IN THE "MINOS" DETECTOR HALL

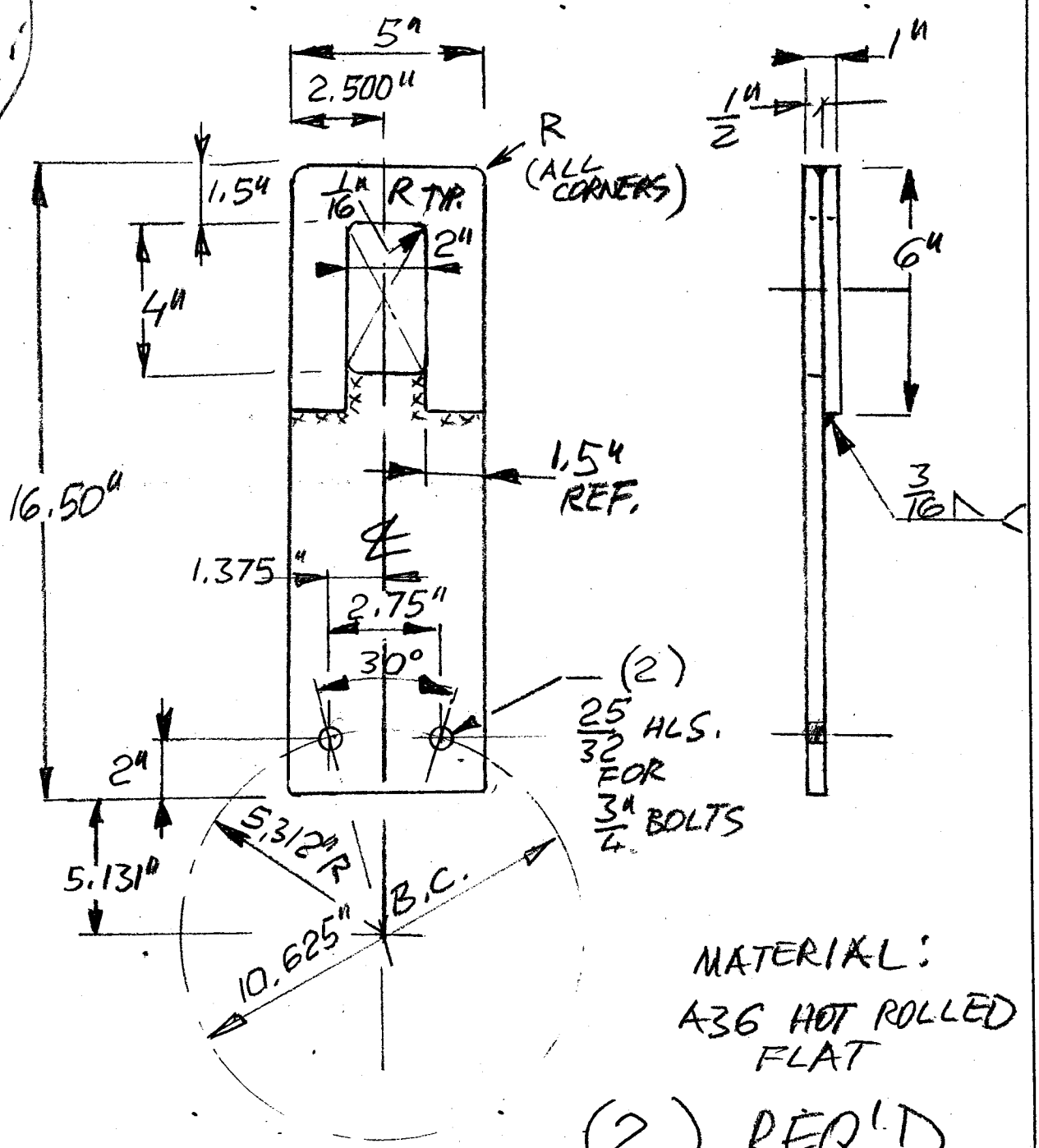
NAME: A. SZYMULANSKI x4870

DATE:

REVISION DATE:

LIFTING EAR

THIS IS IN FABRICATION PROCESS



MATERIAL:
A36 HOT ROLLED FLAT

(2) REQ'D

CAPACITY
1.5 TON

SKETCH ASZ 12.21.04

1. LITER BUBBLE CHAMBER SUPPORT LEGS

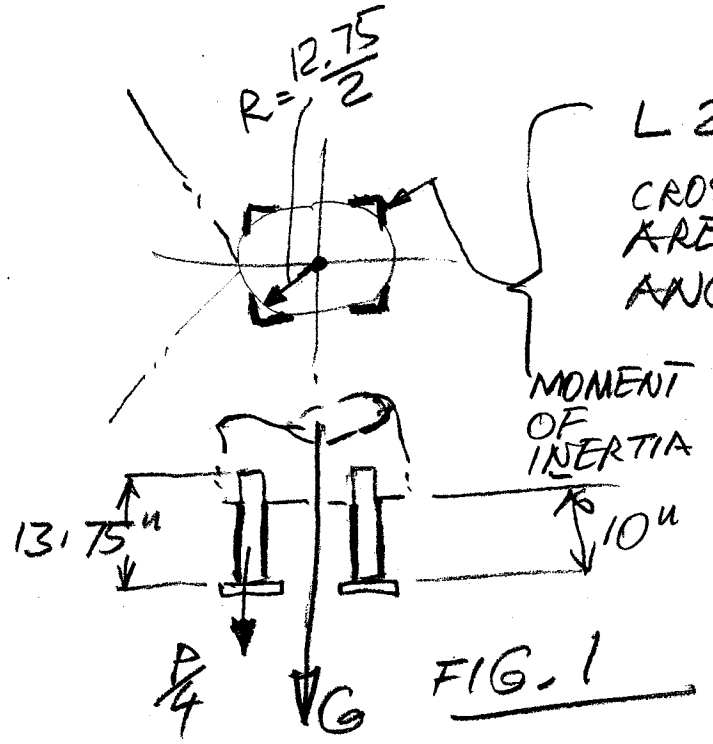


FIG. 1

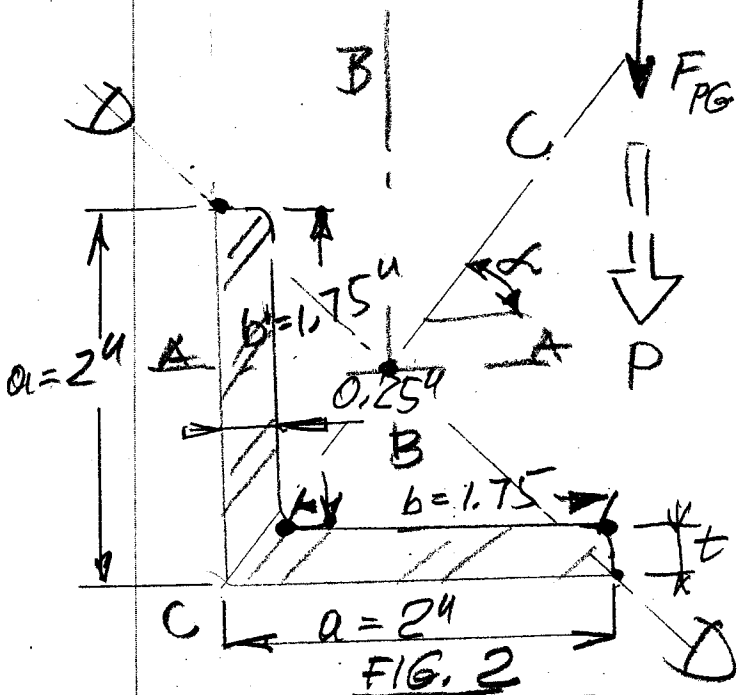


FIG. 2

$$P = F_{PG} + G$$

$$P = 3025,9 + 1300$$

$$P = 4,325,8 \text{ [lbs]}$$

$$\frac{P}{4} = \frac{4,325.8}{4}$$

$$\frac{P}{4} = 1081.5 \text{ [lbs]}$$

BENDING MOMENT AFFECTING EACH SUPPORT LEG

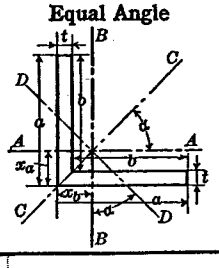
$$M = \frac{P}{4}(R)$$

$$M = 1081.5\left(\frac{12.75}{2}\right)$$

$$M = 6894.3 \text{ [lb in]}$$

MOMENT OF INERTIA

Properties of Various Plane Sections (*Continued*)

Section	Distance to center of gravity, x	Moment of inertia, J*	Radius of gyration, K
Equal Angle 	$x_a = x_b = \frac{a^2 + (a-t)\,t}{2\,(2\,a - t)}$. $[\alpha = 45°]$	$J_{AA} = \frac{t\,(a-x)^3 + a x^3 - a\,(x-t)^3}{3}$. $J_{BB} = J_{AA}$. $J_{CC} = \frac{bt^3 + b^3 t + 3\,a^2 bt + t^4}{12}$. $J_{DD} = \frac{bt^3 + b^3 t + 3\,bt\,(a-4x+2t)^2 + t^4 + 6t^2\,(2x-t)^2}{12}$.	$K = \sqrt{\frac{J}{A}}$.

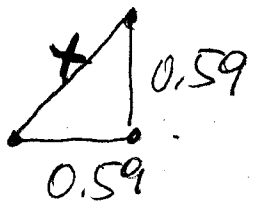
$$J_{DD} = \frac{(1.75)(0.25)^3 + (1.75)^3 0.25 + 3(1.75)(0.25)[2-4x+2\cdot 0.25]^2 + 0.25^4 + 6(0.25)^2 x}{12} \qquad (2x-0.25)^2$$

$$J_{DD} = \frac{0.0273 + 1.33 + 1.31[2-4x+0.5]^2 + 0.0039 + 0.375(2x-0.2}{12}$$

$$x_a = x_b = \frac{(2)^2 + (2-0.25)0.25}{2\,[2\cdot(2) - 0.25]}$$

$$x_a = x_b = \frac{4 + 0.4375}{7.5}$$

$$x_a = x_b = 0.59$$



$$x = \sqrt{0.59^2 + 0.59^2}$$

$$x = 0.836$$

$$J_{DD} = \frac{1.357 + 1.31\left[2-4(0.836)+0.5\right]^2 + 0.0039 + 0.375\left[2(0.836)-0.25\right]^2}{12}$$

$$J_{DD} = \frac{1.357 + 0.933 + 0.0039 + 0.758}{12}$$

$$J_{DD} = 0.255\ [in^4]$$

INTENSITY OF STRESS IN SUPPORTING LEG

$$f = \frac{\frac{P}{4}}{A} + \frac{M(x)}{J}$$

$\frac{P}{4} = 1081.5\ [lbs]$

$A = 0.938\ [in^2]$

$J = J_{DD} = 0.255\ [in^4]$

$x = 0.836\ [in]$

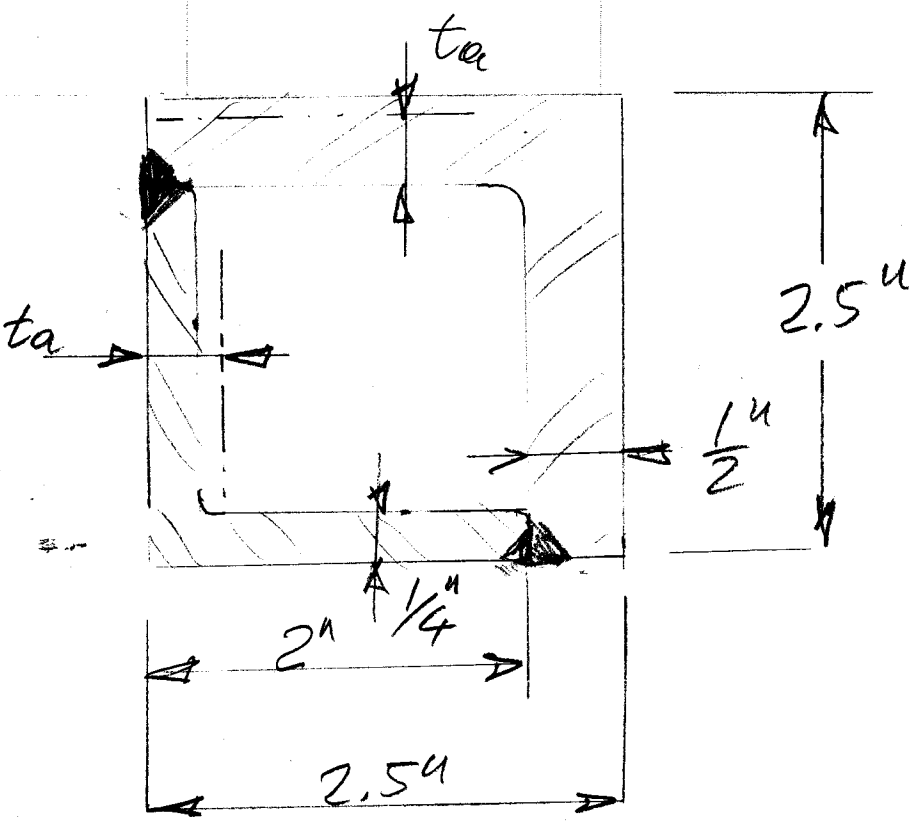
$$f = \frac{1081.5}{0.938} + \frac{6894.3(0.836)}{0.255}$$

$$f = 1152.98 + 22602.4$$

$$f = 23755.4\ [psi]$$

TOO HIGH ∇∇

WE HAVE TO BEEF UP THE CROSS SECTION OF THE SUPPORT LEG



PROPOSED - SUPPORTIVE LEG COMPOSITE WELDMENT

t_a - average thickness

$t_a = 0,375"$

L $2\frac{1}{2} \times 2\frac{1}{2} \times 0,375$

$A = 1.73"$

TOTAL AREA OF COMPOSITE WELDMENT

$A_T = 2A = 3,46 [in^2]$

MOMENT OF INERTIA OF THE COMPOSITE WELDMENT CROSS SECTION

$I \simeq 3.58 [in^4]$

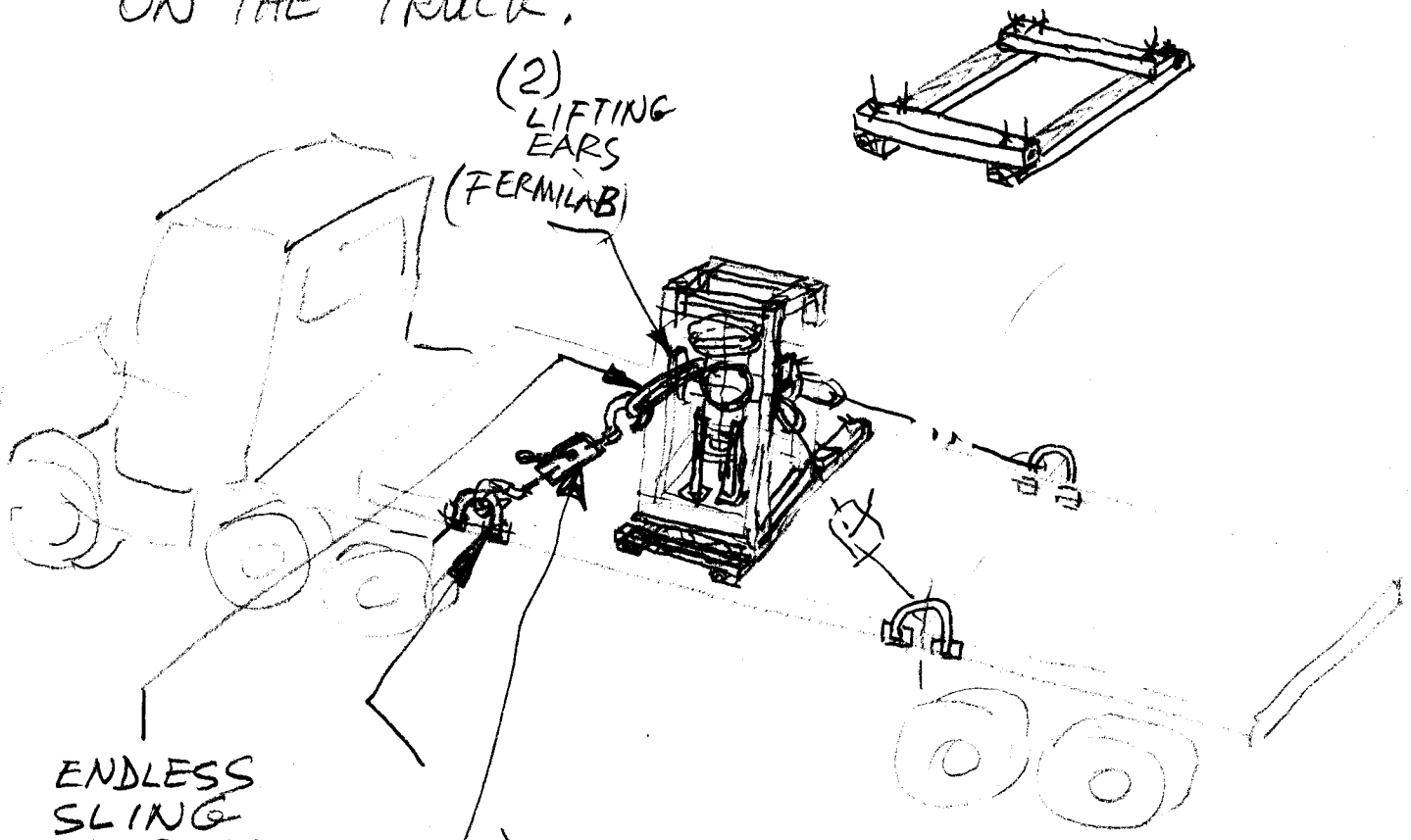
INTENSITY OF STRESS IN SUPPORTING LEG

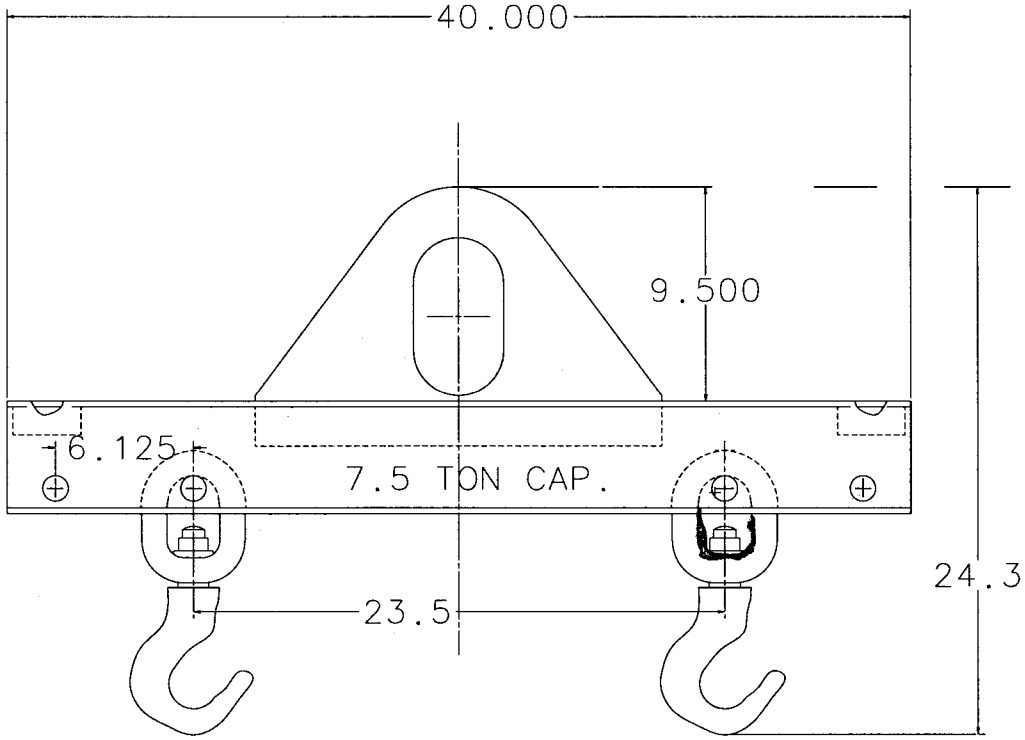
$$f = \frac{1081.5}{1.73} + \frac{6894.3\,(1.25)}{3.58}$$

$$f = 625,14 + 2407.2$$

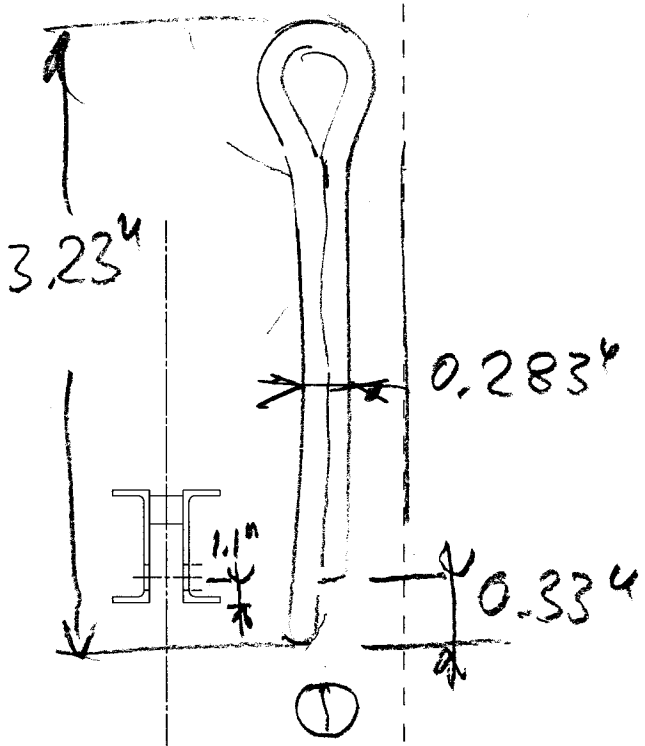
$$f = \underline{3032,36}\ [psi]$$

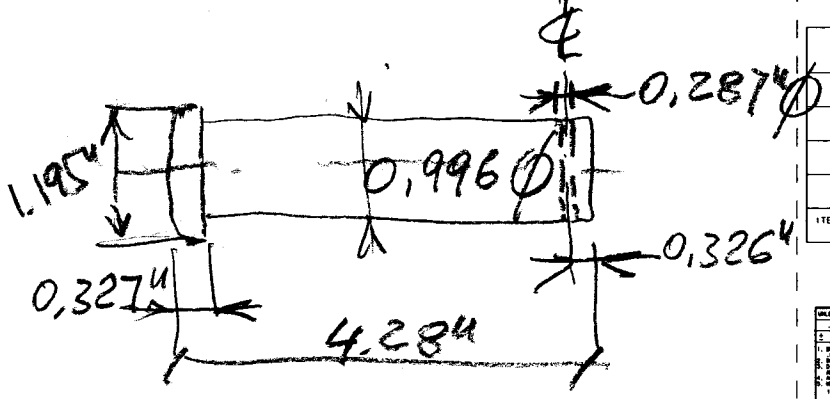
ANDREW,
THANKS FOR THE INFORMATION.
I HAVE ASSUMED GRADE "B" BOLTS IN MY CALCULATIONS; SO THIS IS FINE.
NOW THE RIGGING / TRANSPORT ISSUE.
BELOW IS A SKETCH OF SETTING THE ASSEMBLY ON THE TRUCK.





NOMINAL SLINGS SPACING





ITEM No		Qty

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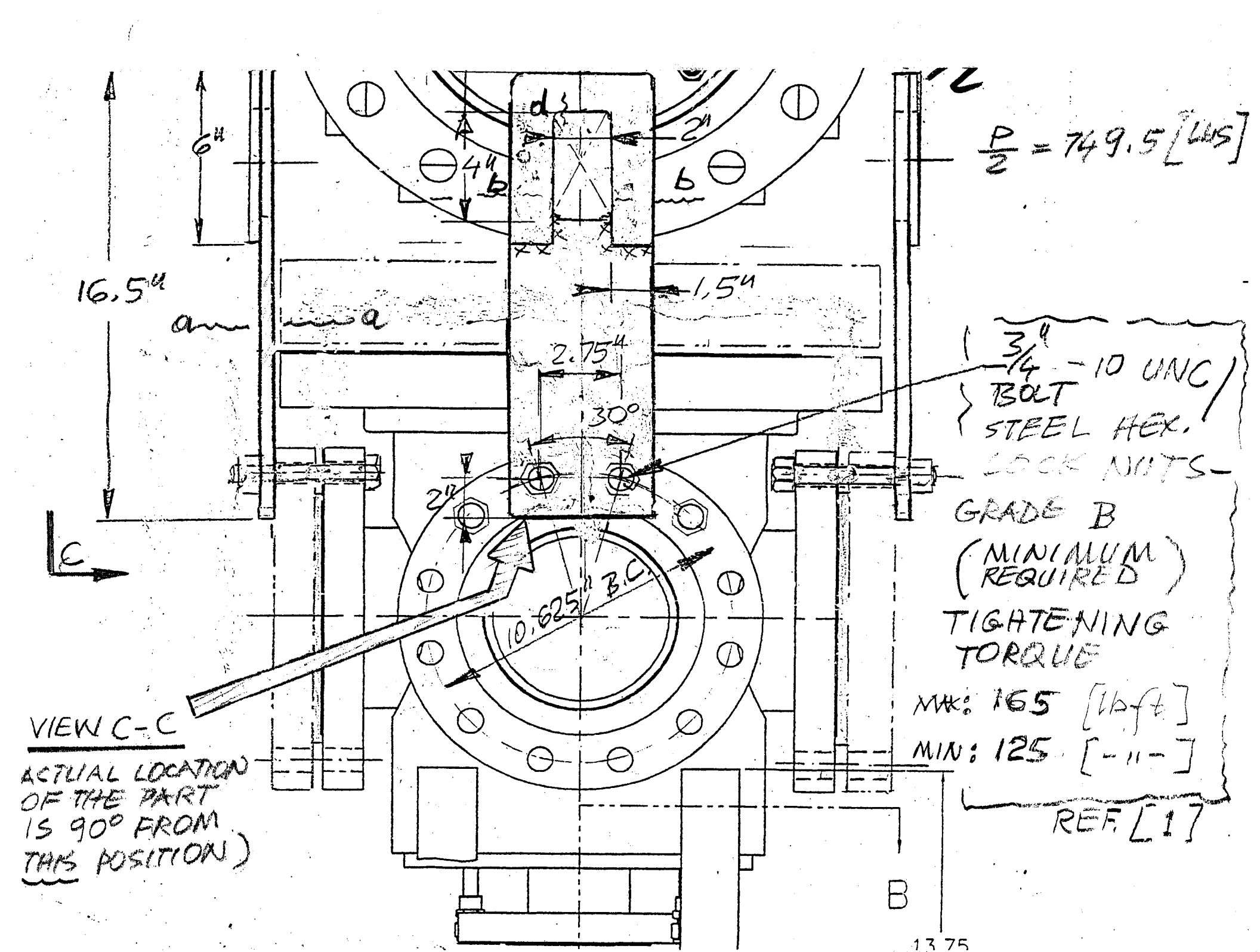
UNITED STATES DEPARTMENT OF ENERGY

NuMIupperrailsworkcell

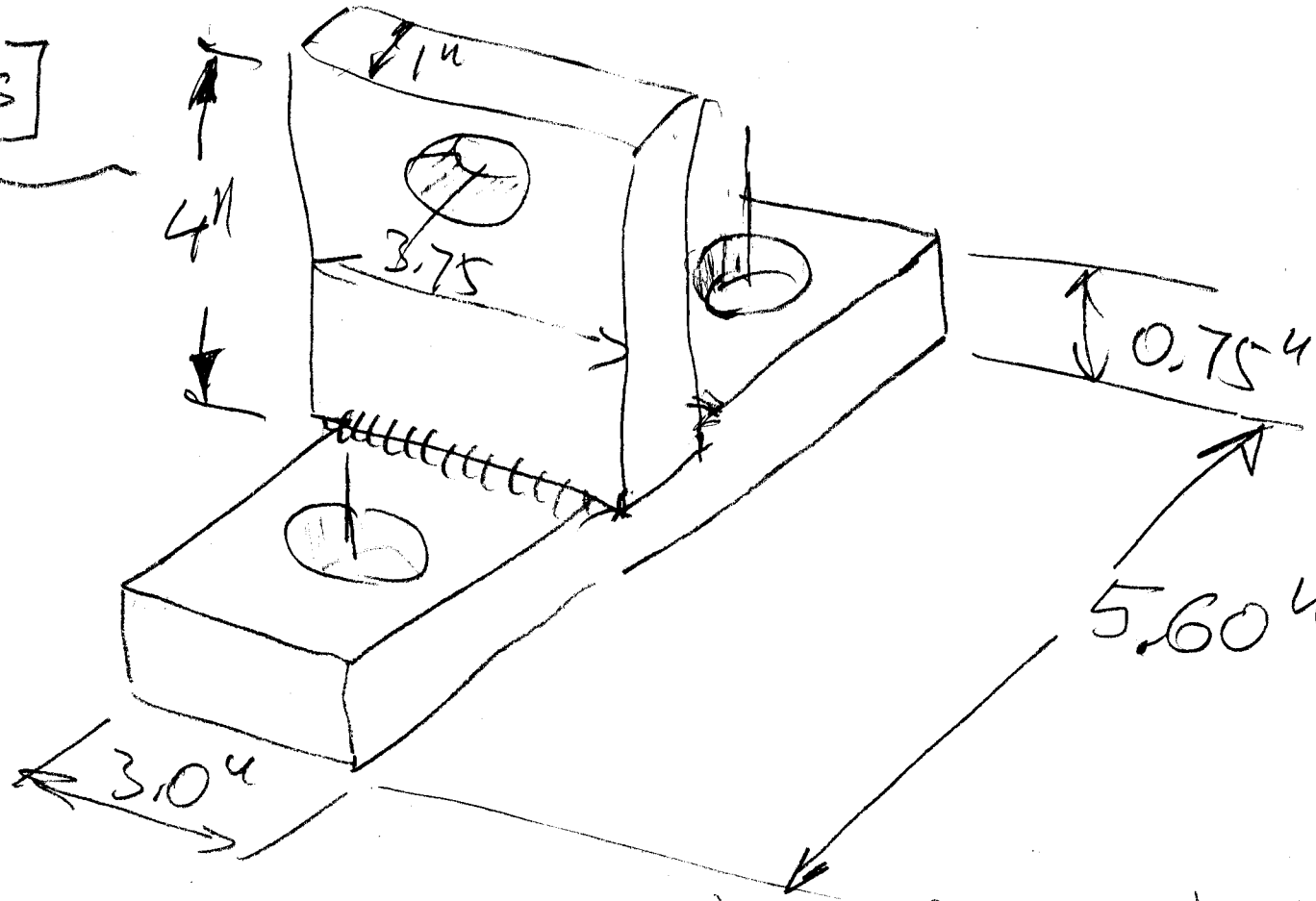
SCALE | DRAWING NUMBER | SHEET 1 OF 1 | REV


6"
4"
2"
16.5"
1.5"
2.75"
30°
2"
10.625" B.C.
$\frac{P}{2} = 749.5$ [LBS]
3/4" - 10 UNC
BOLT
STEEL HEX.
LOCK NUTS
GRADE B
(MINIMUM REQUIRED)
TIGHTENING TORQUE
MAX: 165 [lb-ft]
MIN: 125 [-"-]
REF. [1]
VIEW C-C
ACTUAL LOCATION OF THE PART IS 90° FROM THIS POSITION)
B
13.75

WEIGAT OF THE LIFTING FIXTURE

- SINGLE

$G = 7.8\ [lbs]$



$$V = (3.75)(4)\times(1) + (5.60)\times(3.0)(0.75) - 2\cdot\frac{\pi(1.125)^2}{4}(0.75) - \frac{\pi(0.625)^2}{4}(1)$$

$V = 15 + 12.6 - 1.24 - 0.3$

$V = 25.46$

$\gamma = \frac{G}{V}$

$G = (0.3)(V)$

$G \approx 7.8\ [lbs]$