OPTICAL TECHNOLOGY DIVISION
OPTO-MECHANICAL DESIGN ENGINEERING

ME-45
2 August 1971

TO: Distribution

FROM: L. B. Molaskey

SUBJECT: Recovery of RV #3 - Meeting at MWC, 7/30/71

The following is a report on the meeting held at MWC in support of the planning for the recovery of RV #3 from the ocean floor.

Attendees:

L. B. Molaskey	SSC
[redacted]	HQS
	MWC
	MWC
	MWC
	MWC
	EK

Agenda:

Although no formal agenda was provided it was agreed to review the detail plans discussed at HQS (to bring MWC up to date) and to provide whatever new data had been generated or obtained to date. Also to discuss possible methods for attaching the payload to the recovery hook or cable.

Discussion:

MWC's refined estimate of the impact conditions are:

A. Velocity at impact 450 ft/sec
450 (.6818) = 306.81 miles/hr.

B. Shock at impact 2600 Gs

C. Weight at start of descent in water 1051 pounds

D. Buoyant weight at sea level 550 pounds total

E. Buoyant weight of payload less RV = 246 to 270 pounds

MWC's Estimate of Impact conditions, cont.

F. Calculated descent rate in water (terminal velocity) V_t = 10 to 18 ft/sec (MWC); 11.5 ft/sec (SSC). These rates are based on assuming a spherical shape in the water and drag coefficients - Reynolds number relationships derived from the data provided in Attachment I. (Reference: Boundary Layer Theory - Dr. Hermann Schlichting - 1960, McGraw-Hill Book Co., Inc.)

G. Kenetic Energy = $1/2\ MV^2$
assuming w = 1051 #

V_t = 14 ft/sec

$$E = \frac{1}{2} \frac{(1051)}{32.2} (14)^2 = 3210 \text{ ft \#}$$

H. Descent time approximation (assuming constant V_t from surface to the bottom which is understood to be "over simplification" of the real case)

$$T = \frac{D}{V} = \frac{14,400}{14(60)} = 17.2 \text{ minutes}$$

I. Sequence of structural failure:

At ≈ 30G Takeup Beryllium Shaft broke at both ends separating the payload from its mounting in the RV structure.

At ≈ 50G The heat shield broke away from pressure canister.

At ≈ 300G The pressure canister buckles (a cross sectional profile of the pressure canister is provided in Attachment II.)

At ≈ 2600G The pressure canister is assumed to be "hydro-dynamically molded" to the payload in the nose of R.V. Consensus of opinion is that the R.V. and payload will be all in one piece with holes or tares in the pressure canister.

Considerable discussion was held on how to attach the lifting cable to the R.V. on the bottom. MWC indicated that the parachute bridle (See Attachment III), similar to observed failures during the development program, would have separated at the apex leaving three individual straps, with loose ends, attached to the R.V. structure. They also pointed out that there was little chance of any remaining

load path from the RV aft structure to the TU since the beryllium shaft undoubtedly broke. The use of a net, which could be laid on the ocean floor with long cables to the primary hook was discussed. The manipulator could be used to roll or lift the payload into the net and attach the rings on the net cables to the lifting hook. See Attachment IV.

It was suggested that Vise-grip type pliers or clamps on the end of cables be used to attach to the parachute bridle. This was discarded because of the lack of load path within the RV and the complexity of activating so small a component.

A plunger inserted into the drogue mortar hole was suggested and rejected because of the same type of problems.

The primary choice is to use a mechanism similar to a "hay hook" which is secured to the lifting cable and when activated would surround the entire payload providing a basket to lift the unit. See Attachment V and Va.

The net and "hay hook" approaches will be discussed with the operations people (U.S. Navy) for their comments and suggestions. The question of who will supply the hardware involved is still open at this time.

The container to be used to transport the recovered payload also presents somewhat of a problem. Ideally it should be large enough to contain the payload package, the lifting apparatus, and the transfer net and canvas (Ref. ME-44, dated 27 July 71). It must be light and water tight and capable of being transported by aircraft and truck. A size restriction, imposed by EK, was identified. It must be able to pass through a door 71 inches wide and 81 inches high. Attachment VI shows the approximate size and weight of such a container.

Each of the contractors were asked to check the availability of such a container.

Additional operating constraints concerning the container, suggested by EK, were:

A. The temperature should be maintained below 80°F at all times - no constraint on low temperature.

B. A drain plug is required. (EK plans to save the water for use during despooling.)

C. It should be capable of being transported by hand truck in the despooling facility or have its' own wheels.

In the dark despooling room the container will be emptied and the sea water saved for use in the despooling operation to keep the stack wet. The payload will be lifted out of the container, the canvas and lifting apparatus removed and the unit set up for disassembly.

It is expected that all the pyros in the RV will have fired or will be otherwise safe.

Other related data, reported here for the record, was also discussed. The data is listed as follows:

A. It is estimated to require 3,000 pounds force to lift the payload out of the water.

B. The heat shield, during a test, experienced 310G when impacting the water at 156 ft/sec.

C. The takeup shaft broke on the keyway side at 30G in the water impact test.

D. The flight recovery sequence is illustrated in Attachment VII.

E. The latest schedule, predicated on the availability of the search ship, is that the search will start the first week in October.

The next phase of the effort will be to review progress to date with the operations people and to provide additional data on light levels at the transfer depth. Also, investigation of potential shipping containers is required.

A summary of the hardware requirements is as follows:

A. Attachment fixture to fix the payload to the lift cable.

B. Transfer net and light shield for lifting the payload out of the water.

C. Shipping Container.

D. Disassembly stands and tools for the despooling operation (EK supplied).

L. B. Molaskey

LBM/cb
cc: M. F. Maguire (w. encs.)
H. Robertson "
R. W. Jones "
C. Karatzas "
P. Petty "
R. Roylance "
J. Braddon "

ATTACHMENT(1

Fig. 1.6 reproduces photographs of the stream-lines about circular cylinders in oil taken by F. Homann [6]. They give a good idea of the changes in the field of flow associated with various Reynolds numbers. For small Reynolds numbers the wake is laminar, but at increasing Reynolds numbers at first very regular vortex patterns,

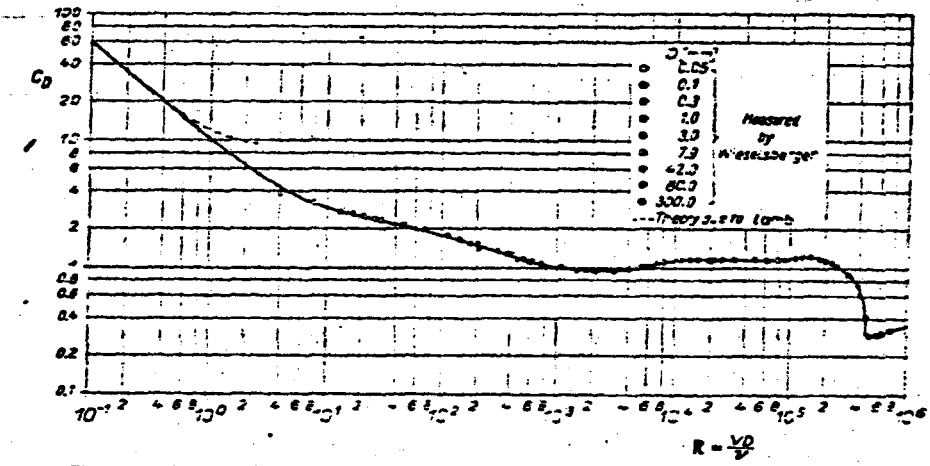


Fig. 1.4. Drag coefficient for circular cylinders as a function of the Reynolds number

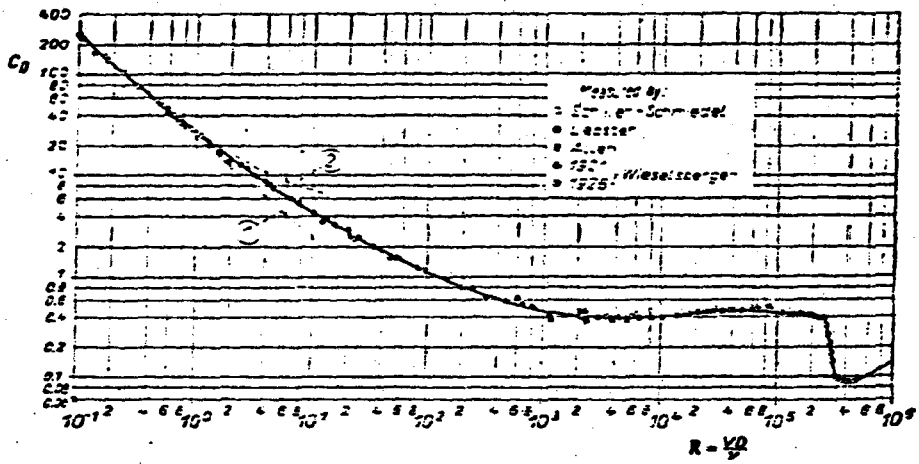
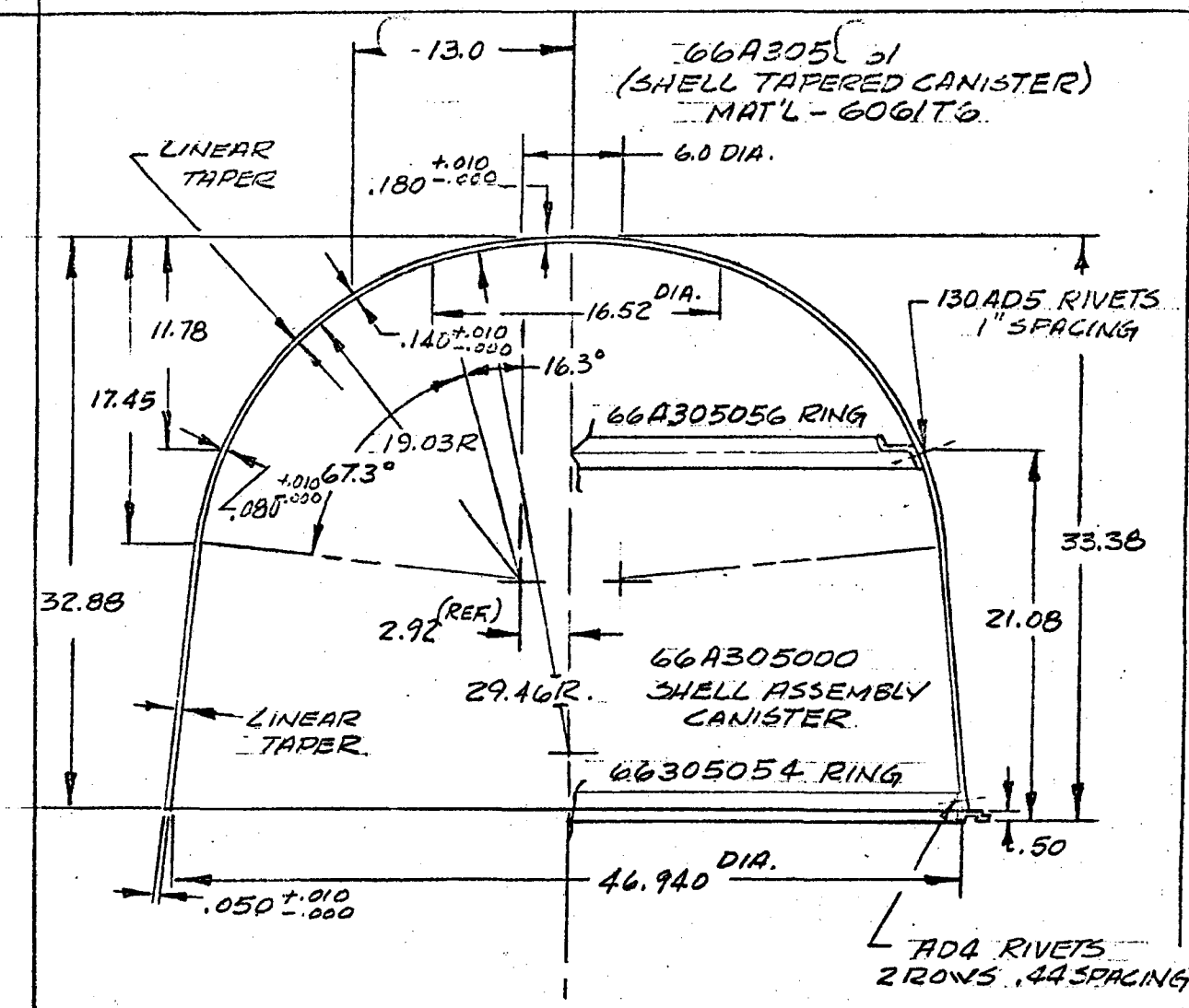


Fig. 1.5. Drag coefficient for spheres as a function of the Reynolds number
Curve (1): Stokes' theory, eqn. (6.10); curve (2): Oseen's theory, eqn. (6.13)



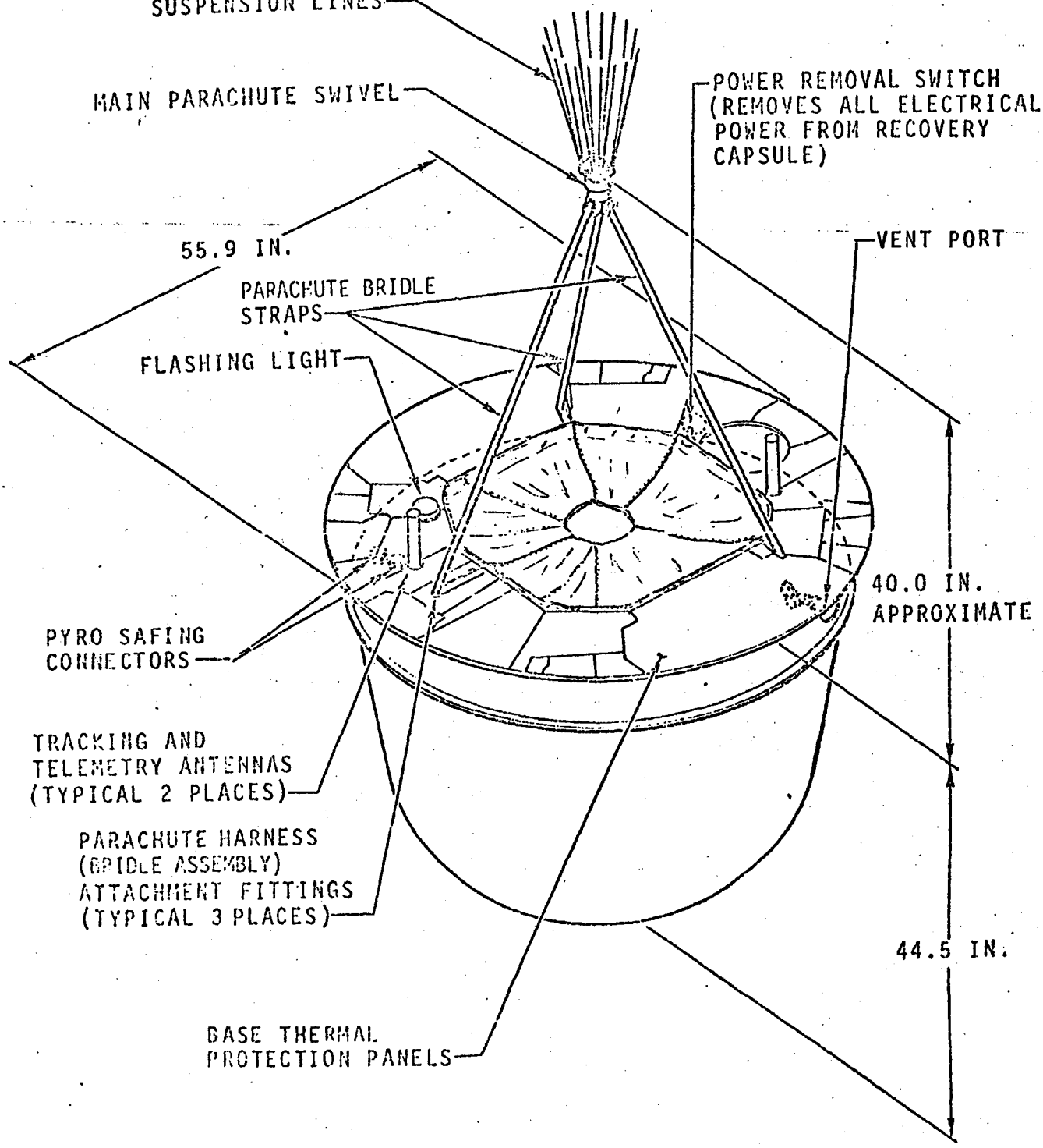
CRITICAL AREAS:

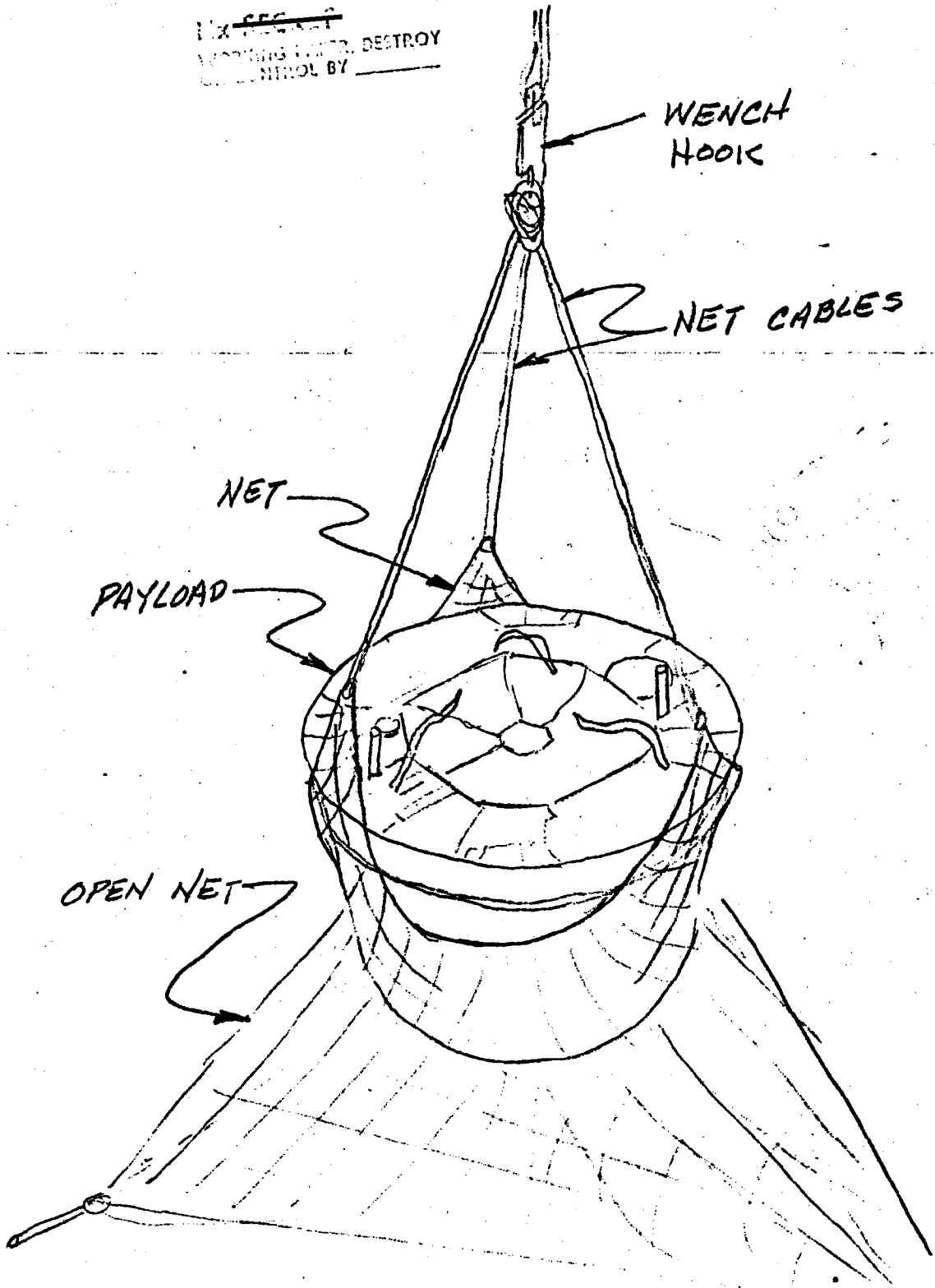
NONE - WATER IMPACT
SHEAR BUCKLING IN SHELL FROM RING LOADS
AXIAL COMPRESSION IN SHELL AT BASE

ATTACHMENT II

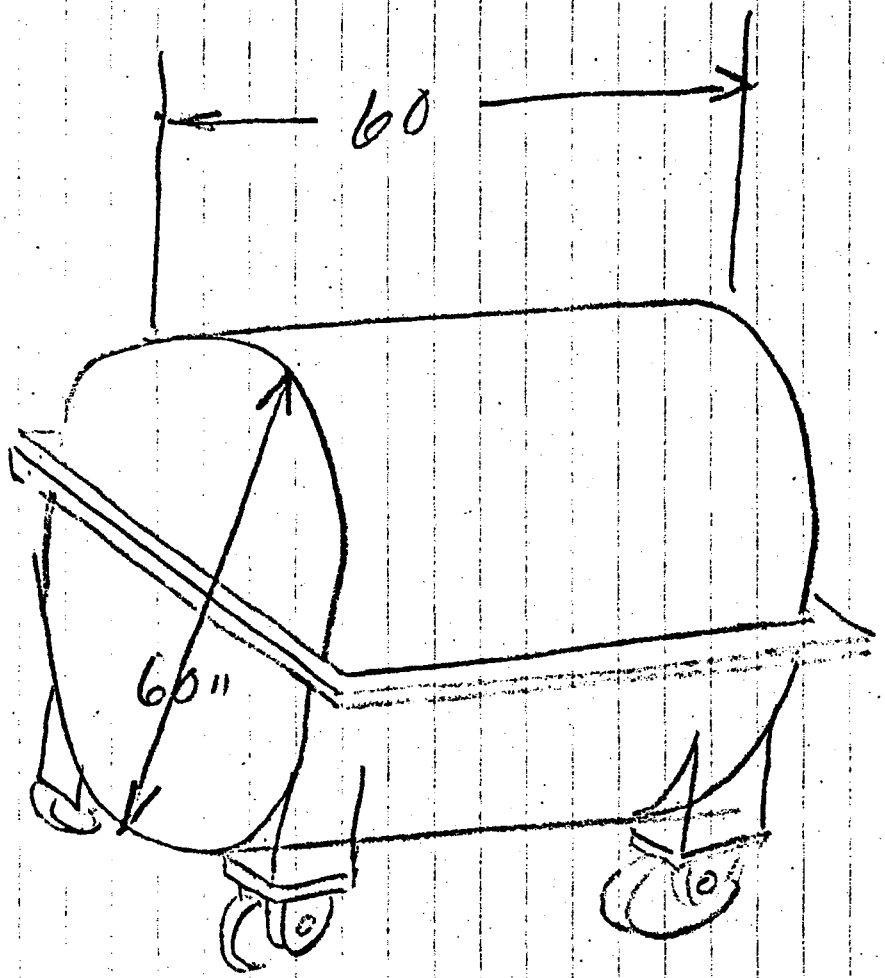
Hx ~~SECRET~~

ATTACHMENT III





ATTACHMENT IV



$V = AL$

$= \pi \cdot 2.5^2 (5)$

$= 98.2 \text{ ft}^3$

Assume Cam = 500#

RV, Hook, Net, Etc = 1300#

WATER ≈ 60 FT³ = 3900

TOTAL = 5,500#

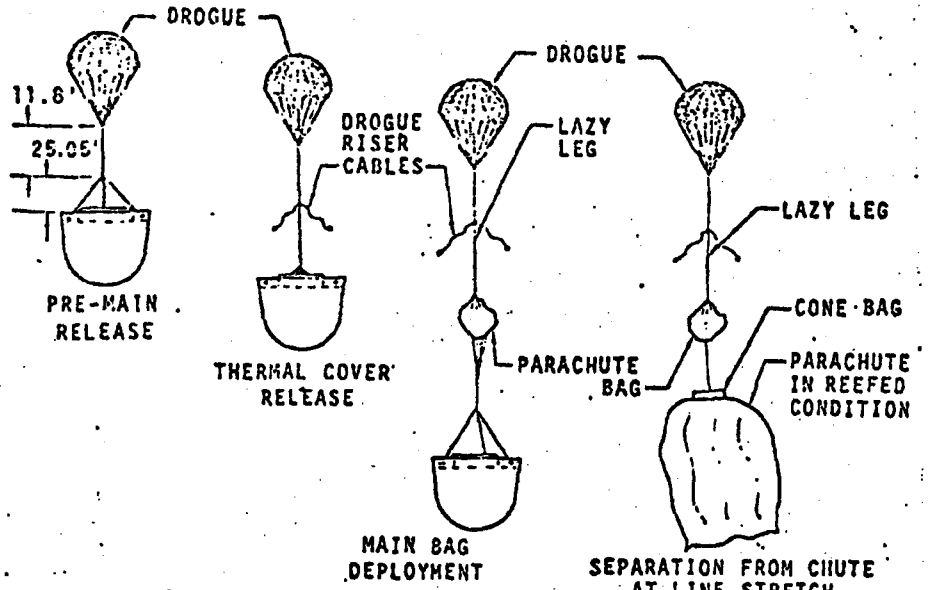
SAY 3 TON

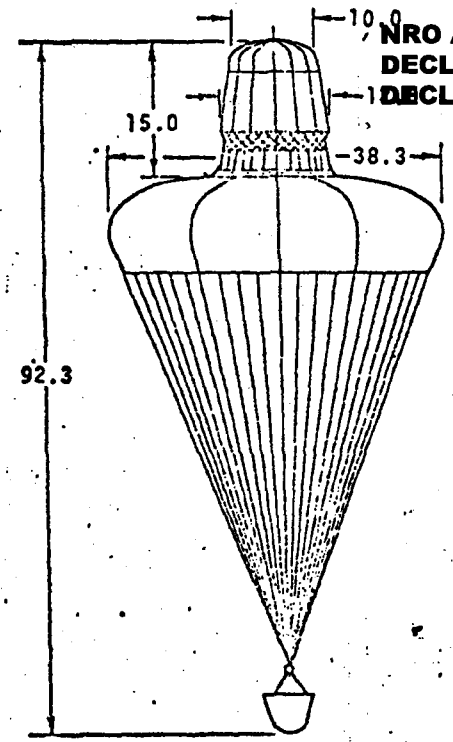
ATTACHMENT VI

Hx ~~SECRET~~

WORKING PAPER, DESTROY OR CONTROL BY _____

MAIN PARACHUTE DEPLOYMENT SEQUENCE





CONICAL EXTENSION
$C_D S$ = 2070 FT^2

MAIN CANOPY:
- NOMINAL DIA Do = 38.3 FT
- VENT DIA. = 7.2 FT
- NO. OF GORES = 56
- REEFING LINE LENGTH = 33.

TARGET CONE:
- TOTAL HEIGHT = 15 FT
- SLOT HEIGHT =
- BASE DIA = 12 FT
- CROWN DIA = 10 FT

SUSPENSION:
- LINE LENGTH = 56.3 FT
- 4 LINES @ 600 LB STRENGTH
- 52 LINES @ 300 LB STRENGTH

RECOVERY SUBSYSTEM