7 June 1960

N65-81318

ABMA

June 1960 ~~Report Nr.~~ DLMT-TN-46-60

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PRESERVATION, SHIPMENT & RECOVERY OF THE SATURN BOOSTER

By

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SATURN HISTORY DOCUMENT
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RQ8-20035

ABSTRACT

Simultaneously with each phase of SATURN design, studies were made to determine the most practical procedures for shipping and recovering the SATURN Booster. These procedures are, in effect, now established and the required equipment and facilities are being procured as scheduled.

The purpose of this report is to present the shipping and recovery procedures for the SATURN Booster as established by the participating Branches and Laboratories.

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INTRODUCTION:

Considerable effort has been expended on the individual phases of the SATURN Booster shipment and recovery operations. Simultaneously, efforts were directed toward obtaining equipment and facilities required for each operation. Procedures have been established for the many phases of water recovery. Procurement of equipment and facilities to effect shipment from MSFC to AMR has been programmed.

The report describes the individual operations - preservation, shipment, recovery and return shipment. Each phase of these operations is outlined presenting procedures, facilities, equipment and other pertinent information.

SATURN Booster shipment is detailed from final checkout at SA&R Laboratory to arrival at AMR. SATURN Booster recovery includes all the principle phases of operation from water impact until return shipment to Redstone Arsenal.

The information contained within this report is based on studies made as recommended in Report Nr. DLMT 4-59, "SATURN (JUNO V) Water Recovery Feasibility Study".

DISCUSSION:

The two principal topics presented within this discussion are, preservation, shipment of the Booster from RSA to CCMTA and recovery, including return shipment to RSA. Although many phases of each topic are similar, each will be considered separately in the following discussion.

SECTION I. SATURN BOOSTER PRESERVATION AND SHIPMENT:

A. Preservation:

A preservation system has been developed for the SATURN Booster to prevent internal corrosion and deterioration after fabrication and final checkout is completed. This system will provide protection from the environmental elements and physical protection to the extent that excessive differential pressures will be eliminated upon the container skin due to temperature and barometric pressure changes during shipment. Physical protection will be accomplished by preferential handling of the transporter and Booster. The applied preservation system was designed to assure delivery of the missile to AMR in the same state as when the system is installed.

Since the container structures of the missile cannot withstand the external pressures that may be encountered during shipment due to temperature and barometric pressure changes without causing possible damage, the SATURN missile requires some type of equalizing or venting device. This required venting is to be accomplished with a small desiccator breather (See Figure 1, Detail A) which, besides reducing differential pressures, also has the functions of maintaining a non-corrosive atmosphere (30 to 40 per cent relative humidity) and filters the entering air (Removes dust and any foreign matter).

The desiccator breathers (Two required) will be installed on the LOX Container Nr. 1 manhole and the Fuel Container Nr. 1 manhole after final checkout and purging prior to shipment. Prior to installing the desiccator breathers, the missile tanks will be purged with dry air or nitrogen. The regular manhole cover that is removed will be packaged and shipped separately if they cannot be secured to the missile without causing any damage. These manhole covers will again be installed when the desiccator breathers are removed at AMR.

Protective form-fitting endcovers will be installed on the forward and aft shrouds of the Booster assembly to help seal against moisture, dust and other air contaminates. They will be fabricated from either a nylon vinyl or neoprene coated nylon material. For ease of installation, the forward and aft endcovers will be composed of three and four sections respectively which can be joined together with slide fasteners. Access can be obtained to the tail and 2nd stage adapter sections through provided openings without removing the endcovers. Humidity indicators will be installed in the endcovers. Desiccant static charges (See Figure 1, Detail B) will be placed within the compartments

SATURN BOOSTER PRESERVATION

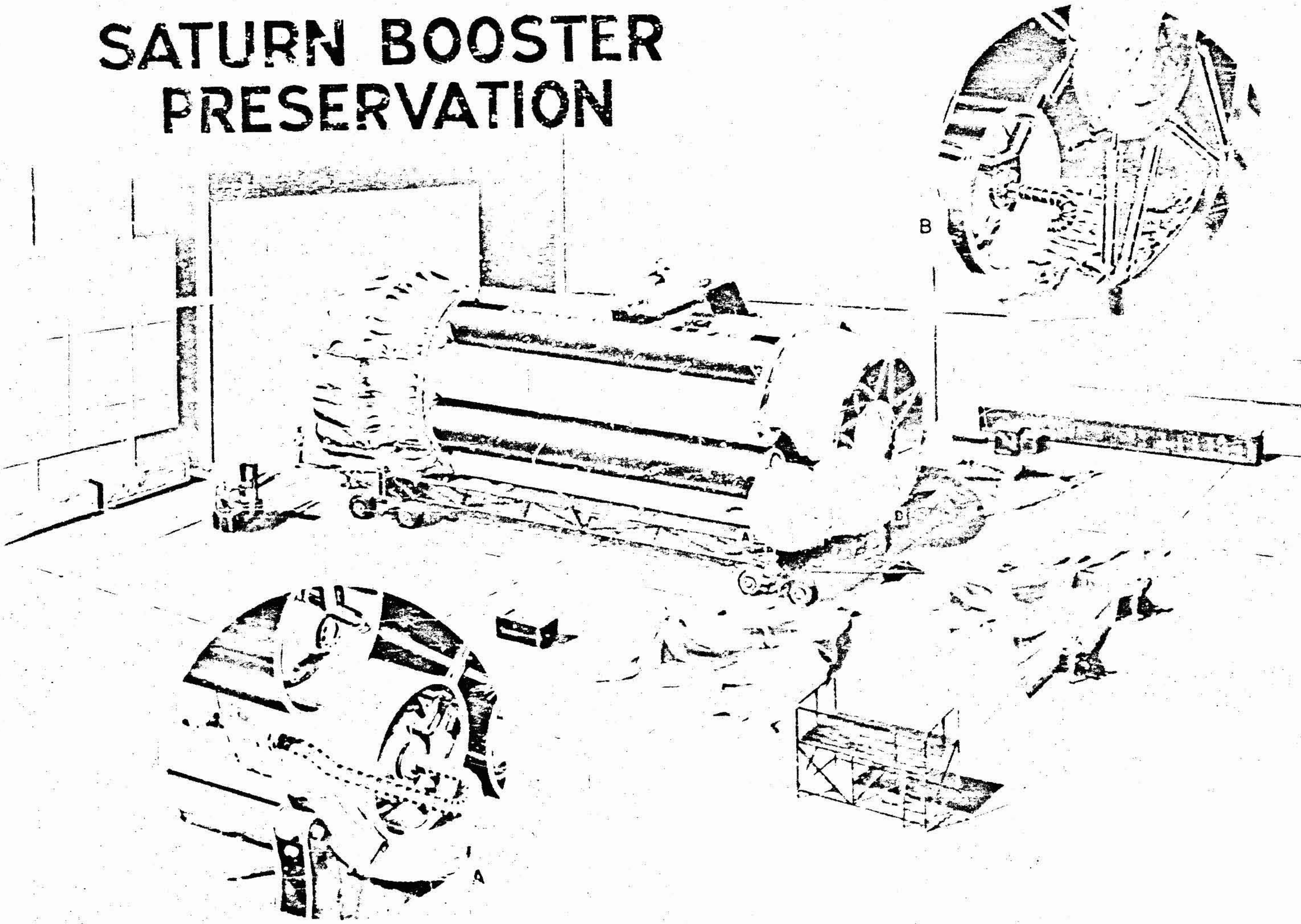


FIGURE 1

sealed by these endcovers. This will assist in preventing accumulation of moisture within these areas and lower the relative humidity to a non-corrosive atmosphere. A light tarpaulin will be available for use in adverse weather conditions (Rain, sleet, snow, etc.) to be used in conjunction with the form-fitting endcovers to protect the area (Container section) between the endcovers.

The above preservation procedures will be adequate to protect the missile during road movements. When the missile is positioned on the barge for the water transport phase or for extended storage, additional preservation equipment is needed to maintain a 30 to 40 per cent relative humidity within the LOX and fuel systems. This equipment consists of two floor desiccator breathers which are positioned and secured to the barge deck along side the missile and are connected in series to the two breathers already installed on the LOX and fuel manholes. A flexible hose will be used to connect the missile manhole breathers to the floor breathers. A portable air dehydrator will be used to reactivate the desiccant in the breathers if necessary. Also, the desiccant static charges may require replacing with reactivated charges. This can be determined by the humidity indicators installed in the breathers and endcovers.

Upon completion of the water transport phase, the floor breathers are disconnected and remain with the barge. After checking the humidity indicators and changing desiccant if necessary, the missile is ready for removal from the barge and continues by road to AMR. At AMR, the remaining preservation materials are removed.

It is estimated that one day will be sufficient time to complete the SATURN Booster preservation.

B. <u>Road Transportation - SA&R Lab to SATURN Dock:</u>

In order to negotiate the eight miles of existing Arsenal roads from SA&R Lab to the SATURN dock site and the approximately 1½ miles of Cape Canaveral road, a transporter is provided. This transporter is depicted in Figure 2 and described briefly below.

The use of the forward and aft assembly jigs as the main support for the transporter answers the operational need for an assembly fixture at any location. The forward and aft assembly rings provide for lateral rotation during the initial assembly of the individual tanks to the cluster. To prevent excessive torsional forces from being transmitted to the missile during transportation, it was decided to use this rotation ability. Truss members which join the forward and aft assembly jigs complete the structural frame of the transporter. The dolly assemblies are attached to the assembly jigs to provide the final mobility requirements of the transporter.

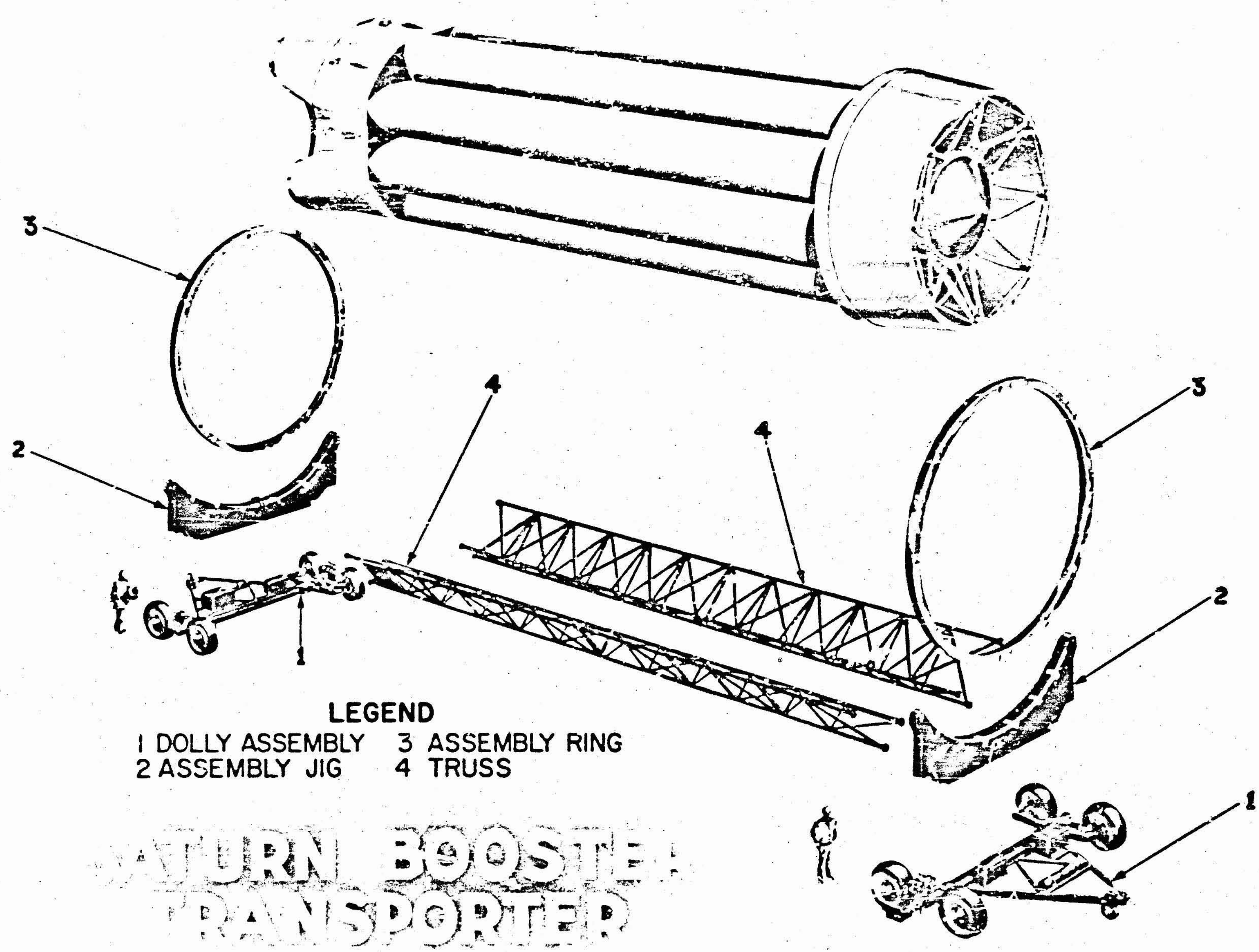

3
2
4
4
3
2
1
1
LEGEND
1 DOLLY ASSEMBLY 3 ASSEMBLY RING
2 ASSEMBLY JIG 4 TRUSS
ATURN BOOSTE
RANSPORTER

Figure 2

In order to meet the wheel loads as established, the dolly assemblies consist of two identical units, each having a walking beam supported by tandem aircraft tires. In all, eight wheels are used with tire pressures no greater than 90 psi being required. A steering panel control and driver are required for each set of dollies. This provides the capability of independent steering and braking. Steering commands are given through inter-communication head sets worn by the drivers.

The tow is made by a draw bar connecting the forward dolly assembly and the M-26 tractor (See Figure 3). During road movements, the speed of tow is kept at a maximum of 5 miles per hour. Although the transporter has capabilities of higher speeds, such speeds are unwarranted.

There is no suitable storage available for the SATURN Booster at the dock site other than the SATURN barge. It is therefore imperative that all possible barge loading preparations be completed prior to movement from SA&R Lab.

Upon notification that all preparations are complete, road transportation of the SATURN Booster will commence along the selected route from SA&R Lab to the SATURN dock site. All traffic along this route will be controlled during the move to insure prompt and safe delivery. It is estimated that a crew of eight can negotiate the eight mile route within two hours.

C. Barge Loading:

To complete the transportation system between the road network and waterways, a dock facility is necessary both at Redstone Arsenal and Cape Canaveral. A roll-on/roll-off concept evolved as the most feasible system to provide this requirement. A barge loading facility is to be built which will effect the road to barge movement (See Figure 4). Since the Tennessee River level has a seasonal fluctuation and a variable current, a dredge slip is to be provided at Redstone. The barge will be capable of being ballasted by either end to augment the variation in river level. In this way, a river height fluctuation of 8½ feet can be accommodated. The situation at the Cape is much simplified, since the water level is stable within six inches, with practically no current. The dock facility at the Cape will be similar with the exception that a slip will not be required.

Prior to arrival of the Booster at the RSA dock site, the barge will be securely tied into loading position. Also, the steel ramps which span from dock to barge will be set into place and other necessary loading preparations will be made.

Upon arrival of the Booster at the RSA dock site, the M-26 tractor will be disconnected and removed from the immediate area (See Figure 4). A double drum, continuous cable winch, is then attached to the transporter. A portable winch control box is provided for more

SATURN TRANSPORTER AND TRACTOR

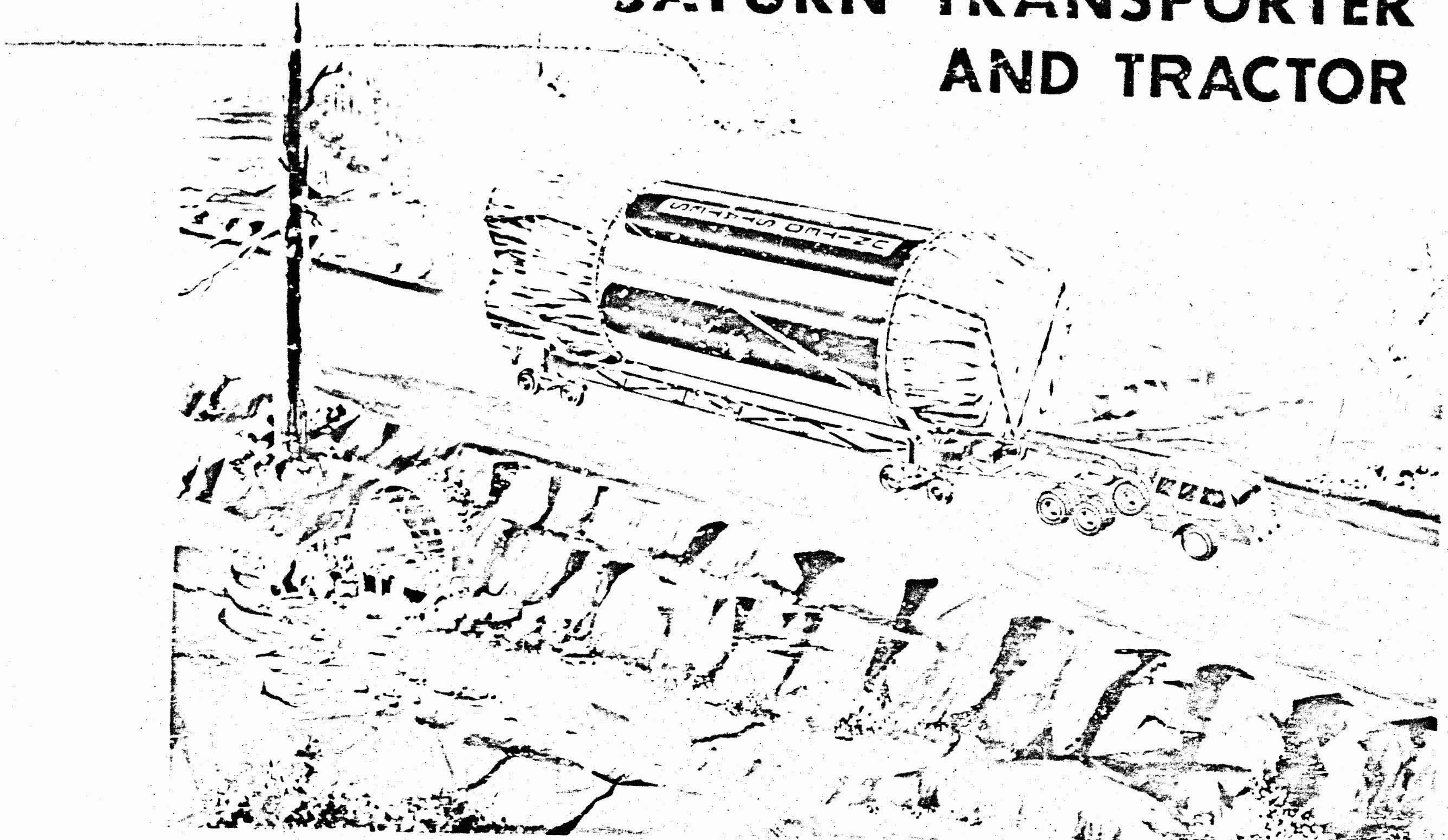
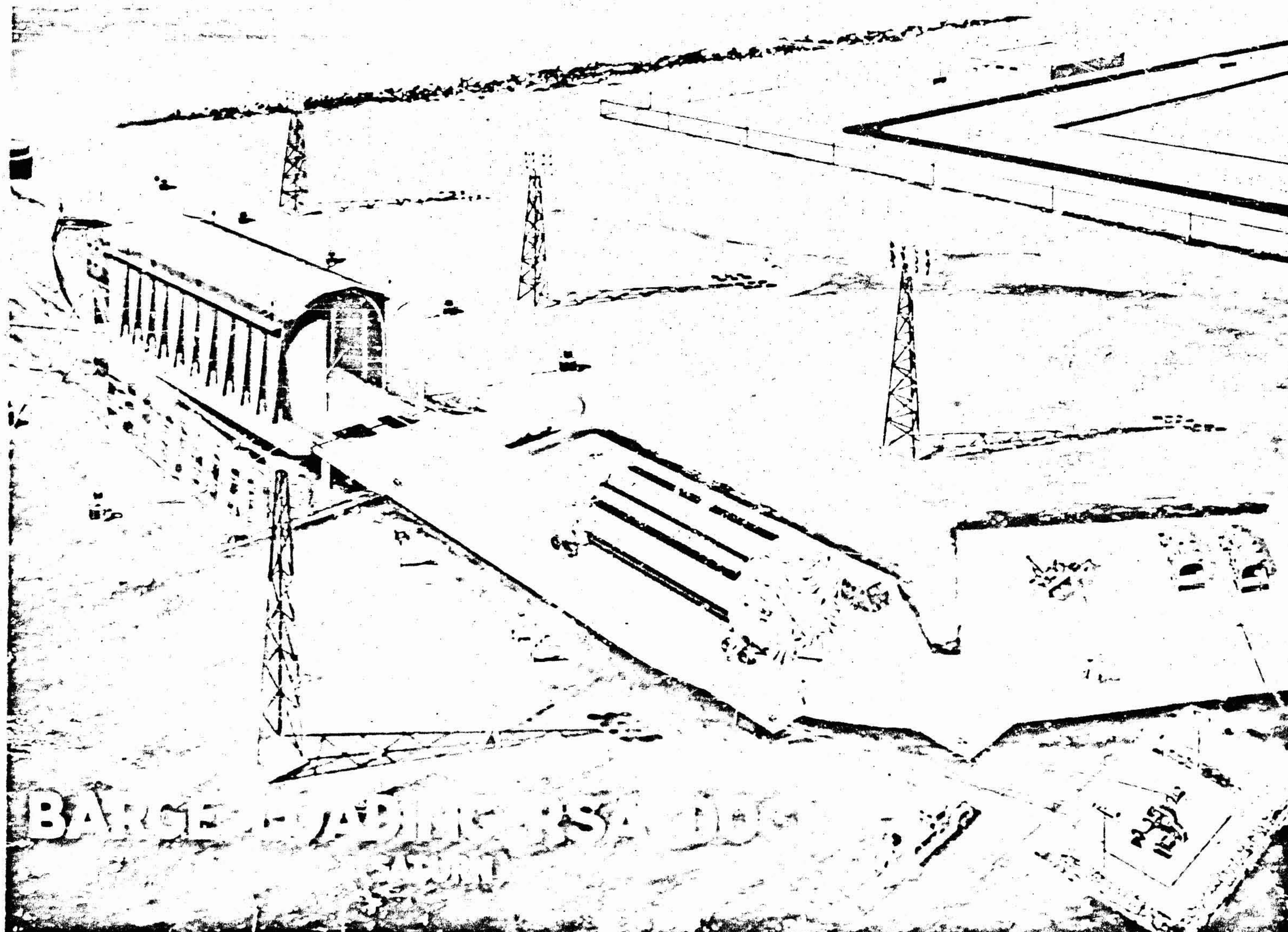


FIGURE 3

60-326



FIGURE

reliable and closer control over movement. The two transporter drivers, the winch controlmen and two or three lookouts will then proceed to negotiate the transporter within the barge. As the forward wheels of the transporter cross onto the barge, re-ballasting will be required before the rear wheels are allowed to cross, demanding an approximate ten minutes delay. The Booster is then positioned into the storage compartment in conformance to guide lines painted on the deck. Chocking and tie-down will then proceed immediately.

Once the SATURN Booster is safely tied down within the barge (See Figure 5), instrumentation and preservation equipment for water transportation must be immediately attached. This will include:

1. Explosive sensers.
2. Humidity indicators.
3. Pressure indicators.
4. Temperature indicators.
5. Vibration and other shock test equipment.
6. Additional breathing equipment to LOX and fuel systems.

It is estimated that six to eight hours will be required to complete the barge loading.

D. <u>Water Transportation - RSA to CCMTA</u>.

The SATURN barge is, except for propulsion, a self-sufficient vessel capable of numerous functions (See Figure 5). Many of these functions are depicted in Figure 4 and pointed out in the following discussion.

At the aft end of the SATURN storage compartment, an additional storage area of approximately 900 square feet is available. This are may be used to considerable advantage to ship equipment such as large and bulky "support equipment". Additional "missile breathing equipment" is located at the forward end of the compartment. This equipment, which controls the humidity within the Booster's LOX and fuel systems, must receive regular inspection and servicing of its desiccant charge.

An instrumentation compartment is located immediately forward of the storage compartment on the main deck. The prime purpose of this compartment is to maintain constant instrument check on the SATURN

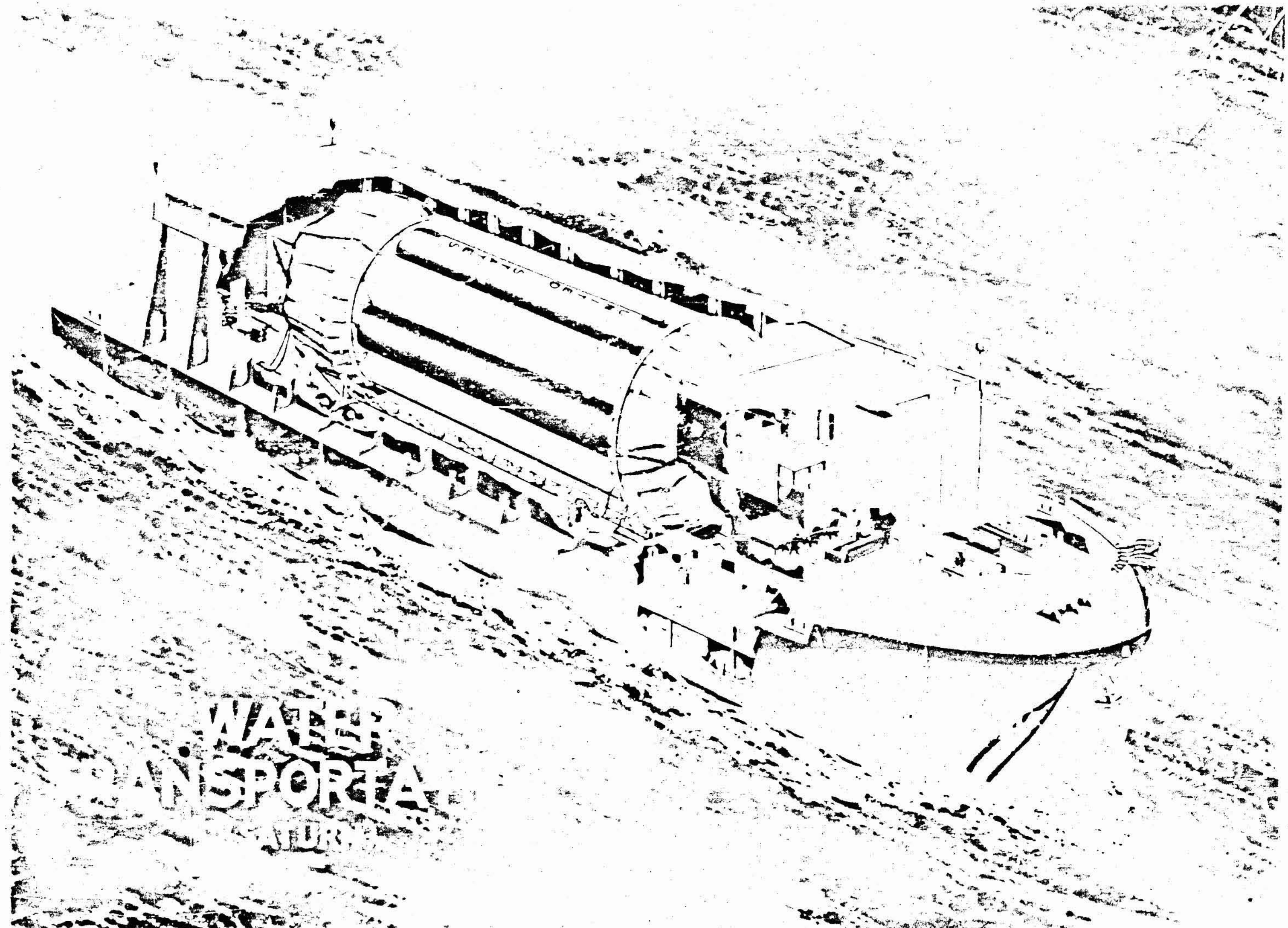


FIGURE 5

Booster. Also housed in this compartment is radio equipment to provide contact with RSA and CCMTA as well as inland and coastal weather stations.

Below the radio compartment is the "Pump and Generator Room". Housed in this compartment along with various pumps, are two diesel driven 60 cycle AC generators to supply necessary current for lighting and power. A diesel fuel supply of at least thirty days will be provided for these generators.

A work shop on the main deck is available for any emergency or temporary repairs to the barge or Booster "support equipment". This work shop will be conveniently available during the return trip to RSA following Booster recovery.

Above the main deck, complete berthing for ten men is provided, together with showers, galley and stores having a full thirty day capacity.

There is only one route available from RSA to New Orleans, Louisiana, as shown in Figure 6. This route follows the Tennessee, Ohio and Mississippi Rivers to New Orleans. From this point to the Cape, three routes are available, but the most advantageous at the present appears to be as follows:

The Gulf Intercoastal Waterway from New Orleans east for a distance of 350 miles to St. Georges Sound. The Gulf of Mexico is then entered for a distance of 281 miles to San Carlos Bay, 20 miles southwest of Fort Myers, Florida. From this point, the Okeechobee Waterway is followed across Florida for 147 miles to Stuart, Florida. From here, the Florida Intercoastal Waterway leads for 138 miles to the Canveral Barge Canal.

The total distance from RSA to CCMTA is approximately 2200 miles which will require an estimated three weeks to traverse. Only 281 miles are considered "sea miles". This route is never more than 50 miles from shore and a few hours from shelter.

E. Barge Unloading - CCMTA:

Barge unloading at the Cape is similar to the loading operation at RSA, but simplified due to only a six inch fluctuation in water level as compared to about an 8½ foot fluctuation on the Tennessee River. Very little ballasting will be required to position the barge for the unloading operation.

The rear winch of the M-26 tractor (CCMTA facility) will be employed to unload the Booster from the barge (See Figure 6, Detail 2). When this is accomplished, the winch will be disconnected and the M-26 tractor will then be used as towing vehicle for road transportation to Complex 34.

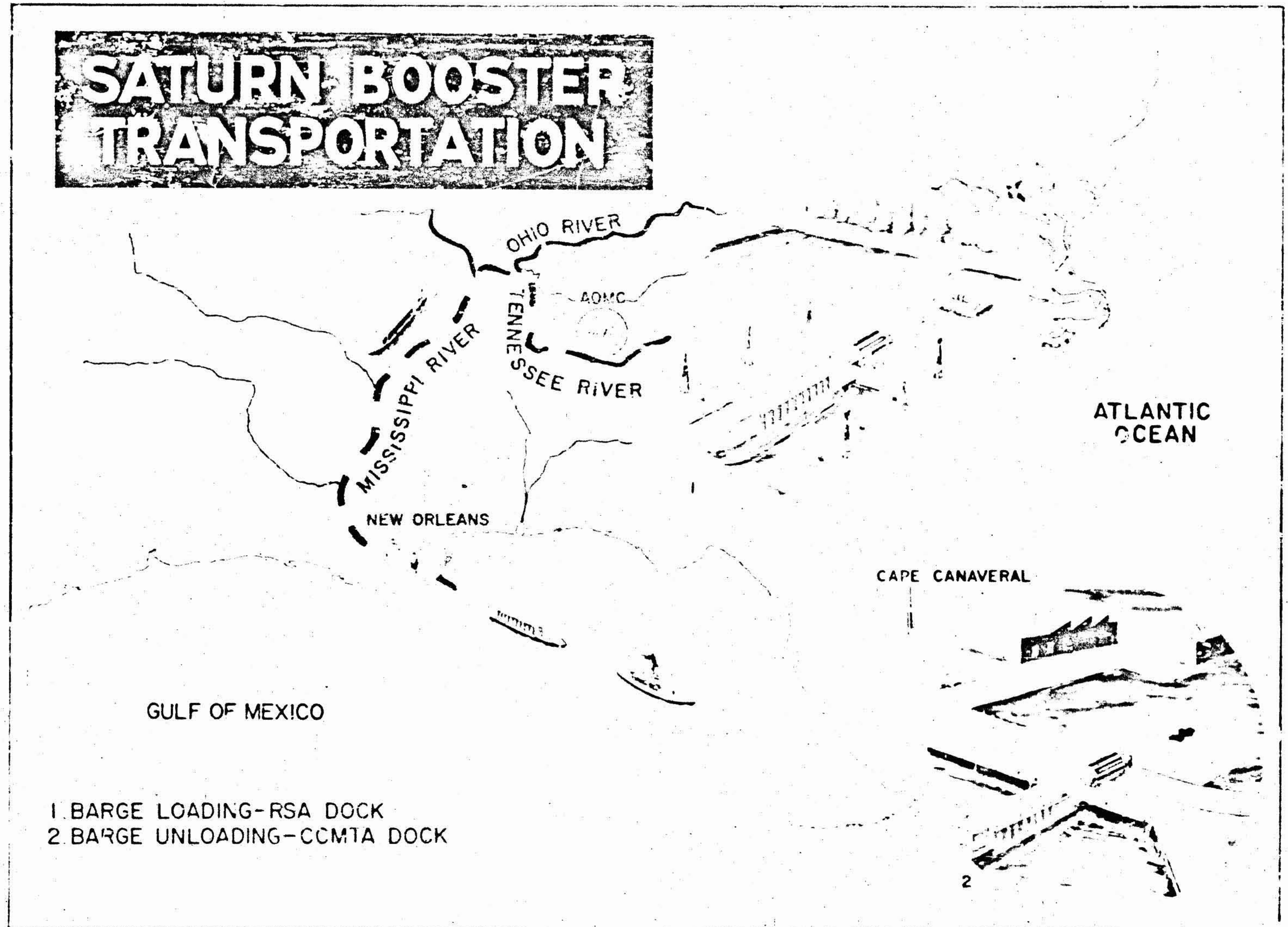

SATURN BOOSTER TRANSPORTATION
OHIO RIVER
AOMC
TENNESSEE RIVER
MISSISSIPPI RIVER
NEW ORLEANS
ATLANTIC OCEAN
CAPE CANAVERAL
GULF OF MEXICO
2
1. BARGE LOADING-RSA DOCK
2. BARGE UNLOADING-CCMTA DOCK

FIGURE 6

The total time required for the unloading operation at the Cape is estimated to be four hours.

SECTION II. SATURN BOOSTER WATER RECOVERY:

The recovery program for the SATURN missile Boosters will be conducted in unison with the U. S. Navy. Recovery methods may vary as the program advances; however, a method is presented which, for the most part, should remain unchanged, with only refinements in procedure being dictated by future knowledge.

The "on-missile" recovery package employs drag and orientation devices together with parachutes and retro-rockets for reducing the terminal velocity sufficiently to minimize damage to the Booster upon impact. Since the impact will be on the ocean, approximately 200 miles from shore, it will be necessary to handle and transport the Booster on the open sea to completely effect recovery. The SATURN will not be fired during inclement weather exceeding a sea state three condition at the predicted point of impact. This can be determined by the extended weather forecast of the impact area.

The following are the necessary sequence of operations in the successful recovery of the Booster (See Figure 7):

A. The Booster will be located by the use of radar and visual observation as well as the computed impact point. Once the Booster has been located and the retrieving operation initiated, immediate visual damage surveillance will be performed while remaining at a safe distance.

B. Once the Booster has been affirmed recoverable, an underwater diving team will advance to the site. The initial task is to remove the destructor unit from the Booster. Additional personnel and equipment will then arrive to assist in the following:

1. Atmospheric venting of the LOX and fuel system.

2. Installation of stabilization equipment.

3. Installation of flotation equipment designed to insure that Booster depth will not exceed limit dictated by recovery ship.

4. Connection of all towing and tag lines.

5. Removal of parachutes which have tended to function as effective sea anchors.

C. In the meanwhile, the other recovery vessels have been proceeding to the impact point. It is anticipated that the accuracy of predicting the impact point will be such that the recovery fleet will be at the pick-up point within a maximum of three hours.

The prime recovery vessel, an LSD, is a ship 458 feet in length with a 72 foot beam having a normal draft of 18 feet. However, the stern of the ship can be ballasted in such a manner as to make the aft most decks become awash (See Figure 7, Detail 1). Thus, the ship can ride in water in such a manner that a depth of about 17 feet of water may be attained within the well. This well is 43 feet wide and the "removeable superstructure" does not place any overhead limits.

Upon arriving at the impact point, the LSD is deployed in such a manner that its stern faces the forward end of the Booster. Then, with the forward attached tow lines, the Booster is winched into the well of the LSD (See Figure 7, Detail 1). The aft section of the LSD well will be padded to cushion any contact between Booster and the ship. The well is then pumped dry as the Booster is positioned upon support drives.

D. With the LSD well dry and the Booster securely tied down, the decontamination operation will commence (See Figure 7, Detail 2).

First, a complete freshwater wash down is employed over all Booster surfaces that have been exposed to salt water. As much water as possible will then be removed with the aid of suction hoses, etc. The LOX and fuel tanks should require no purging but will be vented to desiccant charged "breathing" equipment.

Water displacing compounds are then employed to spray the exterior portions of the engine compartment and within the interior of all engines. These water displacing compounds act as effective preservatives.

Simultaneous to water displacing application, critical or special components such as electronic gear, black boxes and delicate engine components will be closely checked for contamination. Determination will then be made to either leave components "as are" or to remove, decontaminate, preserve, and package for return shipment.

It is recommended that personnel familiar with the Booster and its components should be aboard the LSD to direct and perform these operations.

E. In the meanwhile, the LSD will be enroute to a large port at which a 100 ton lift crane is available. Upon arrival at the port, the overhead of the SATURN barge storage compartment is removed to facilitate transfer of the Booster from within the LSD well to the barge (See Figure 7, Detail 3).

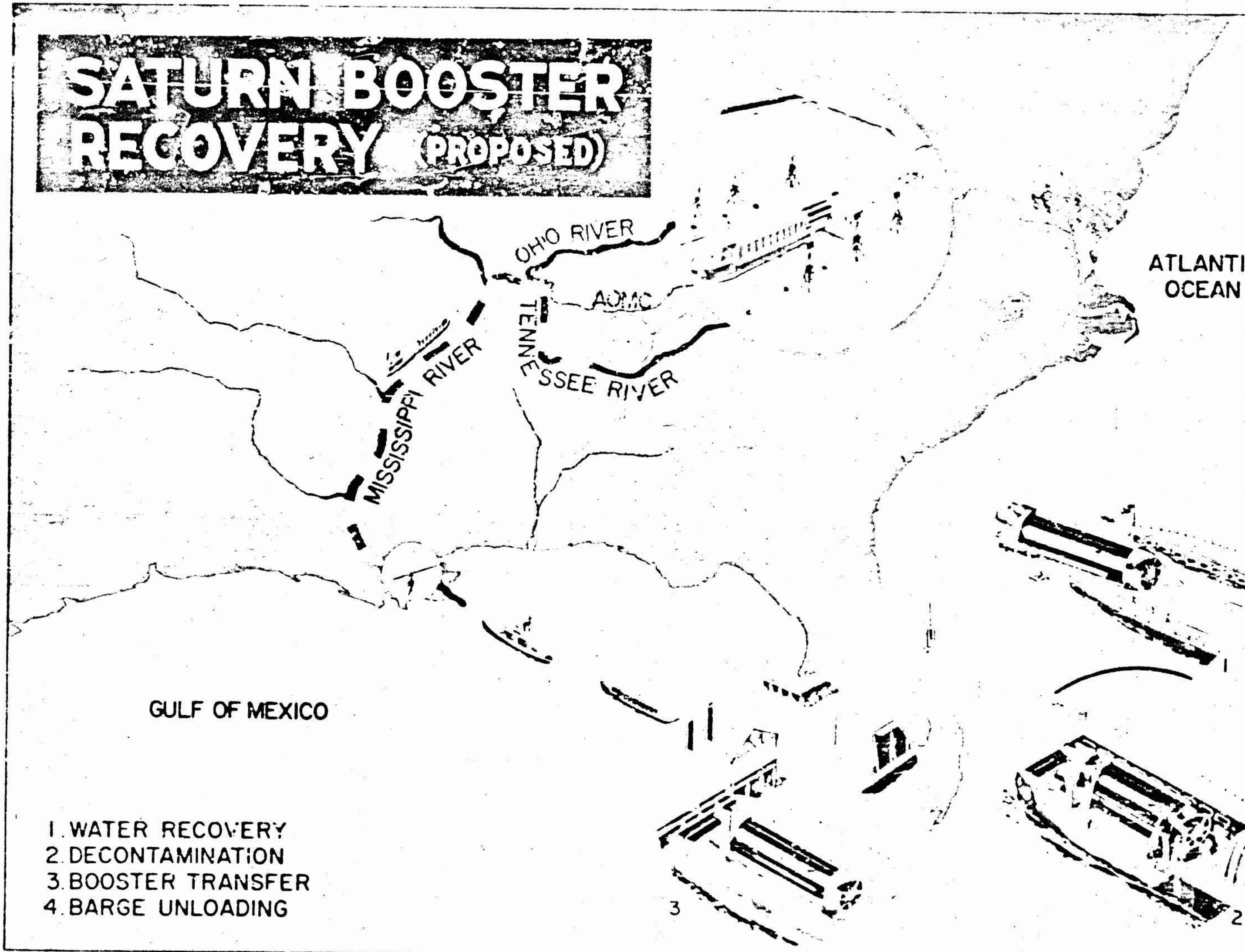

SATURN BOOSTER
RECOVERY (PROPOSED)
OHIO RIVER
AOMC
TENNESSEE RIVER
MISSISSIPPI RIVER
ATLANTIC
OCEAN
GULF OF MEXICO
1. WATER RECOVERY
2. DECONTAMINATION
3. BOOSTER TRANSFER
4. BARGE UNLOADING
1
2
3

FIGURE 7

Return shipment may now be effected in the same manner and via the same route as the initial delivery to the Cape. Upon arrival at RSA, the Booster will be off-loaded and taken to SA&R Lab for reusability analysis.

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