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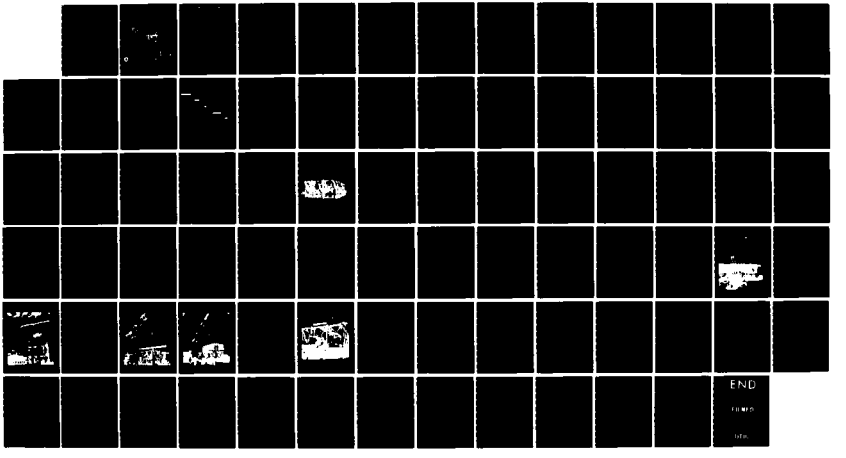

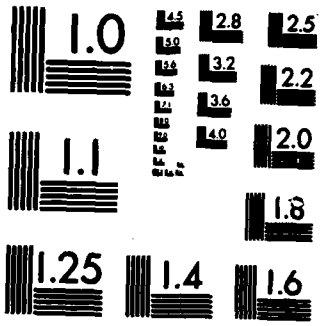

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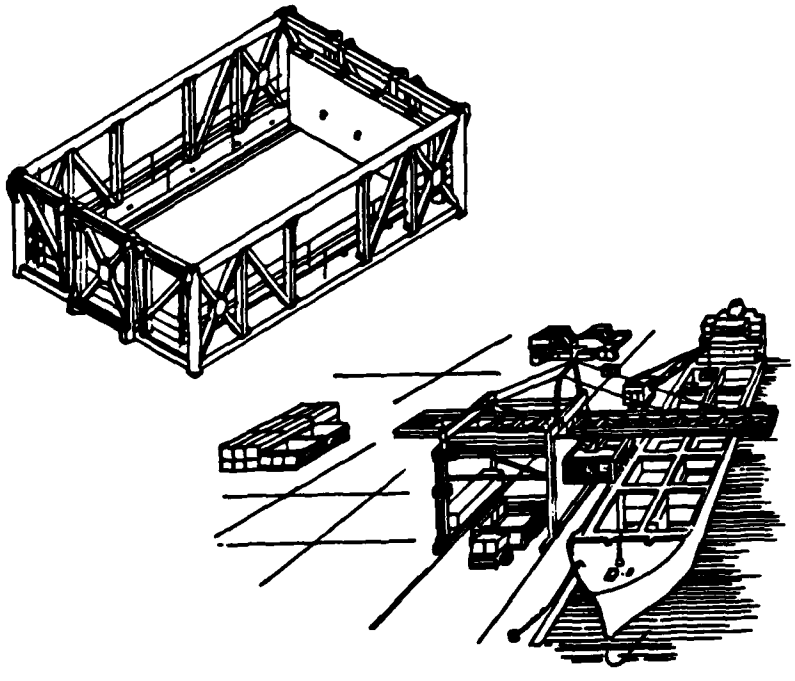
SEA SHED TEST AND EVALUATION PROGRAM
FINAL REPORT



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U.S. Department
of Transportation

**Maritime
Administration**

DEPARTMENT OF THE NAVY

**NAVAL SEA SYSTEMS
COMMAND**

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SEA SHED TEST AND EVALUATION PROGRAM

FINAL REPORT

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16. Abstract (Limit: 200 words)

The purpose of this report is to document the SEA SHED Test and Evaluation Program from design of a removable between deck conversion system for containerships through prototype fabrication to finally, testing in a terminal/simulated shipboard environment. Major subsystems, auxiliary/ancillary equipment, and the compatibility of SEA SHED with existing container handling transport systems was examined through multiple iterations of fundamental cargo handling functions. The report demonstrates the viability of the SEA SHED system to include both facility of fabrication and system performance in accordance with design criteria. A major redesign effort is not indicated. Minor enhancements of specific subsystems are recommended.

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FOREWORD

The SEA SHED Test and Evaluation program successfully demonstrated the viability of the SEA SHED as a much needed solution to the problem of transporting large military equipment and outsize breakbulk cargo.

Under the auspices of the Maritime Administration, U.S. Department of Transportation, and in conjunction with the Naval Sea Systems Command, Information Spectrum, Inc. implemented and managed a research and development effort involving prototype design, fabrication and testing.

As a result of post-fabrication testing, the SEA SHED prototype received American Bureau of Shipping certification.

Following fabrication, four prototype SEA SHEDs underwent extensive operational testing at Military Ocean Terminal Sunny Point, North Carolina. The objective of the Shoreside Test was to obtain performance data on the operation of the SEA SHED, through multiple iterations of basic SEA SHED functions involving multiple loading/unloading and tie-down of military cargo, SEA SHED/container interface, and SEA SHED/ground handling systems interface. From the analysis of test results it was concluded that the SEA SHED prototype achieved the specified parameters. Though shortcomings in subsystem performance were noted during operational testing, they were of a minor nature requiring enhancement rather than major redesign.

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A. BACKGROUND

The movement of military cargo from CONUS to overseas areas is increasingly dependent on systems designed for commercial modularized cargo, a form of transportation handling that offers many advantages from the standpoint of speed, efficiency, and protection from theft and damage. As commercial shippers have adapted to containerized cargo, the number of U.S. flag containerships and modularized capacity has increased while relative breakbulk capacity has declined. (See Figure I-1.) This change has led to potential future deficiencies in total breakbulk capacity to move great quantities of large military equipment and outsize breakbulk cargo in a national emergency.

Recognizing this problem, the U.S. Maritime Administration, U.S. Department of Transportation, jointly with the U.S. Navy Department of Defense, developed the SEA SHED system. (See Figure I-2).

B. PURPOSE

The purpose of this report is to document the development of the SEA SHED 'tween deck conversion system. Specifically, the report will trace the SEA SHED Test and Evaluation Program from its inception through operational testing of four prototype SEA SHEDs to refurbishment in preparation for commercial test operations.

C. SEA SHED DESCRIPTION

The SEA SHED is an insertable 'tween-deck conversion system, designed to provide containerships with the capability of carrying

Figure I-1

U.S. FLAG MERCHANT MARINE

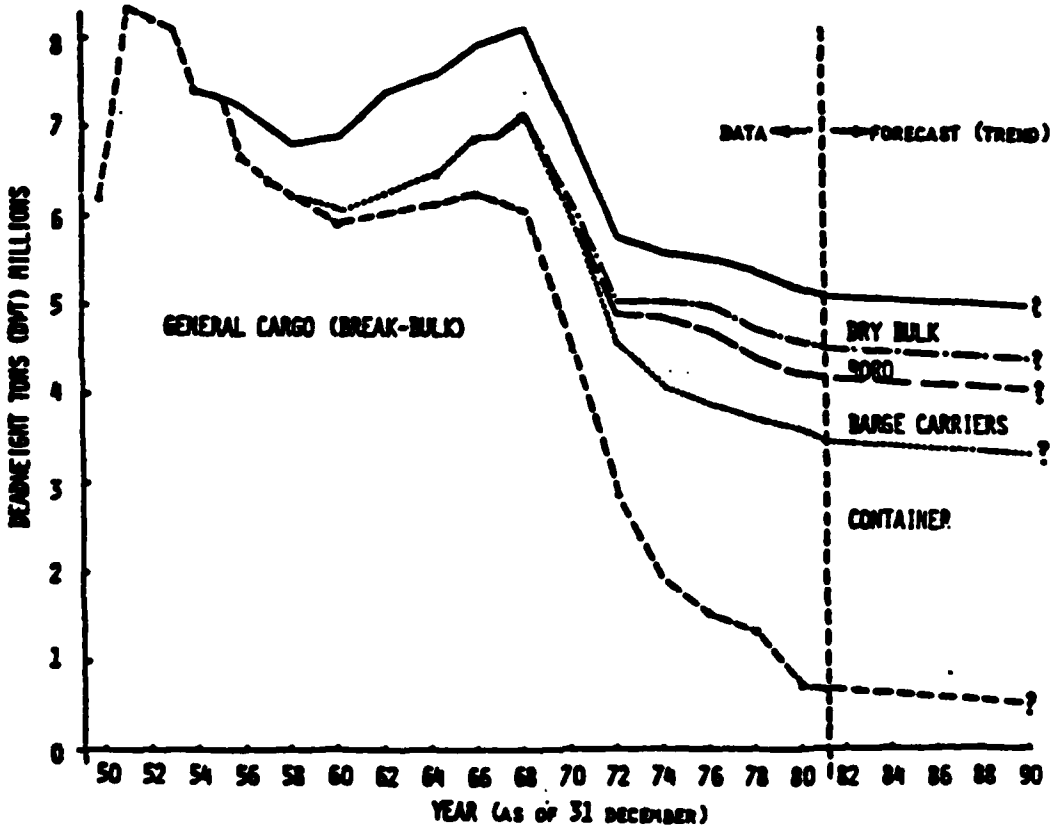
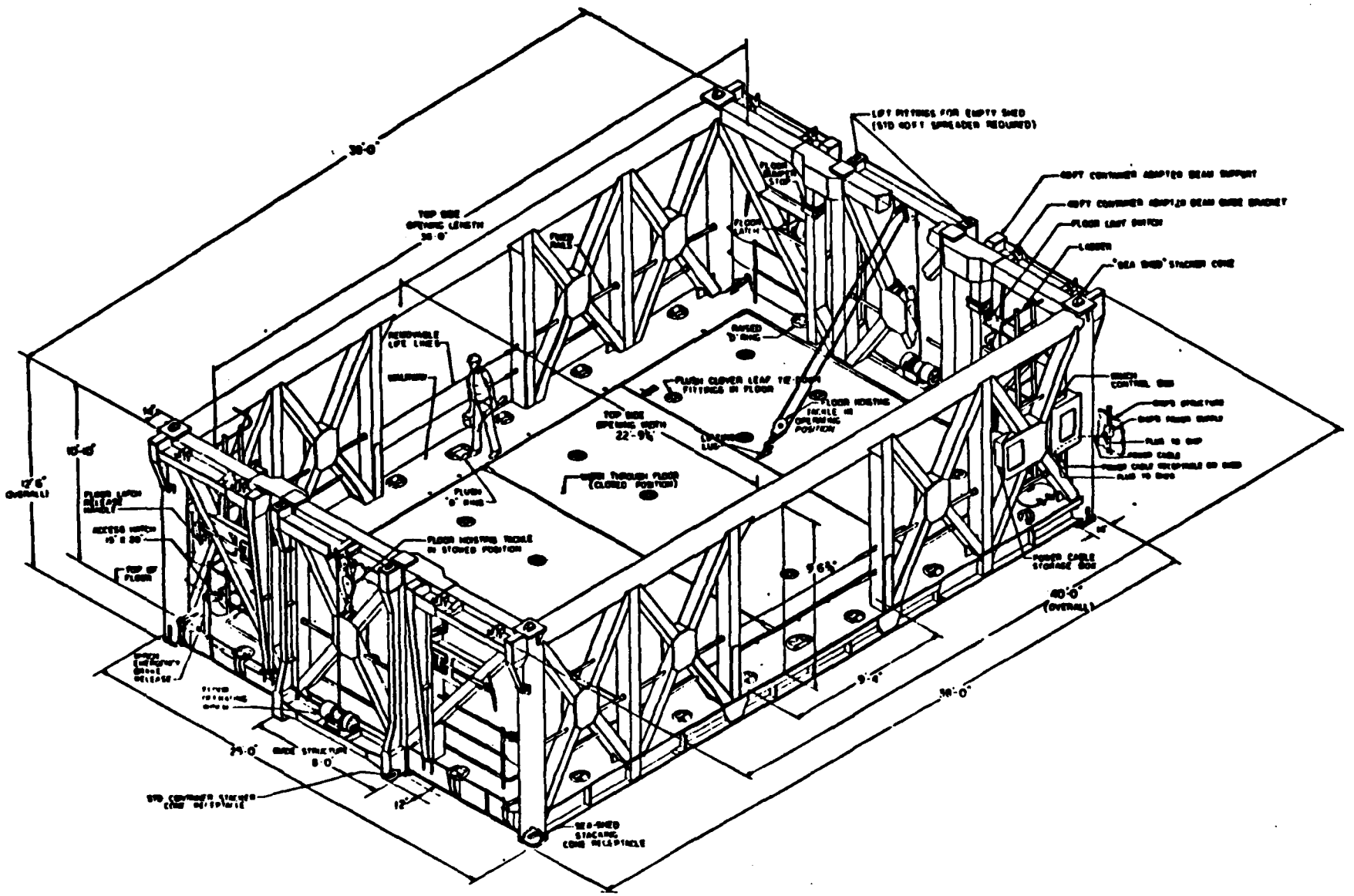


FIGURE I-2

SEA SHED



large military equipment and outsize breakbulk cargo which cannot be containerized. The SEA SHED is a large open-top structure, 40' long by 25' wide by 12' 6" high having a tare weight of 75,000 lbs. and a maximum gross weight of 147 ST. The SEA SHED is designed for insertion into container holds having at least three athwartship cells. (Appendices F and G) Standard container cranes, 40' container spreaders and Chassis are capable of handling empty SEA SHEDs. (See Table I-1.)

The capability of the SEA SHED to function as a 'tween-deck conversion system is made possible using a "work-through" floor. The floor, which is biparting, is composed of two bi-panel folding sections; the external panel of each section is hinged and connected to the SEA SHED main frame. The actuation of the floor section is by a self-contained electromechanical winch or by crane activated emergency rigging.

SEA SHEDs, being dimensionally based upon multiples of standard ISO containers, may be stacked up to four-high in three athwartship container cells. Cargo is then loaded through the open "work-through" floors and secured in the bottom SEA SHED in a stack. The process is then repeated at each level.

The SEA SHED system also includes adapter beams, which are positioned on top of the upper SEA SHED which allows standard 40-foot containers to be stacked on top of the SEA SHEDs.

The Test and Evaluation program schedule (see Figure I-3 and Appendix A) consisted of the design of the SEA SHED system, the fabrication of four prototype SEA SHEDs, and an Operational

TABLE I-1
SEA SHED CHARACTERISTICS

(WITH SOLID, HINGED, WORK THROUGH FLOOR)

- DIMENSIONS, OVERALL
  - 40'0" LENGTH (L)
  - 25'0" WIDTH (W)
  - 10'10" CLEAR HEIGHT FOR CARGO
  - 12'6" MAXIMUM OVERALL HEIGHT EXCLUDING STACKER CONES
  - 30'0" (L) x 18'0" (W) CLEAR OPENING FOR FLOOR

- TARE WEIGHT
  - 75,000 LBS

- CAPACITY
  - 220,000 LBS

- LOADING REQUIREMENTS
  - UNIFORM LOAD: 495 LBS/FT^2
  - LOCAL LOAD: 185 LBS/IN^2 OVER FOOT PRINT OF 14" (L) x 4" (W) AND LOCAL LOAD OF M-1 TANK

- TIE DOWN FITTINGS
  - 70,000 LB CAPACITY, CLOVER LEAF TYPE AND D-RING TYPE, FLUSH MOUNTED
  - 24 CLOVER LEAF TYPE AND 24 D-RING TYPE

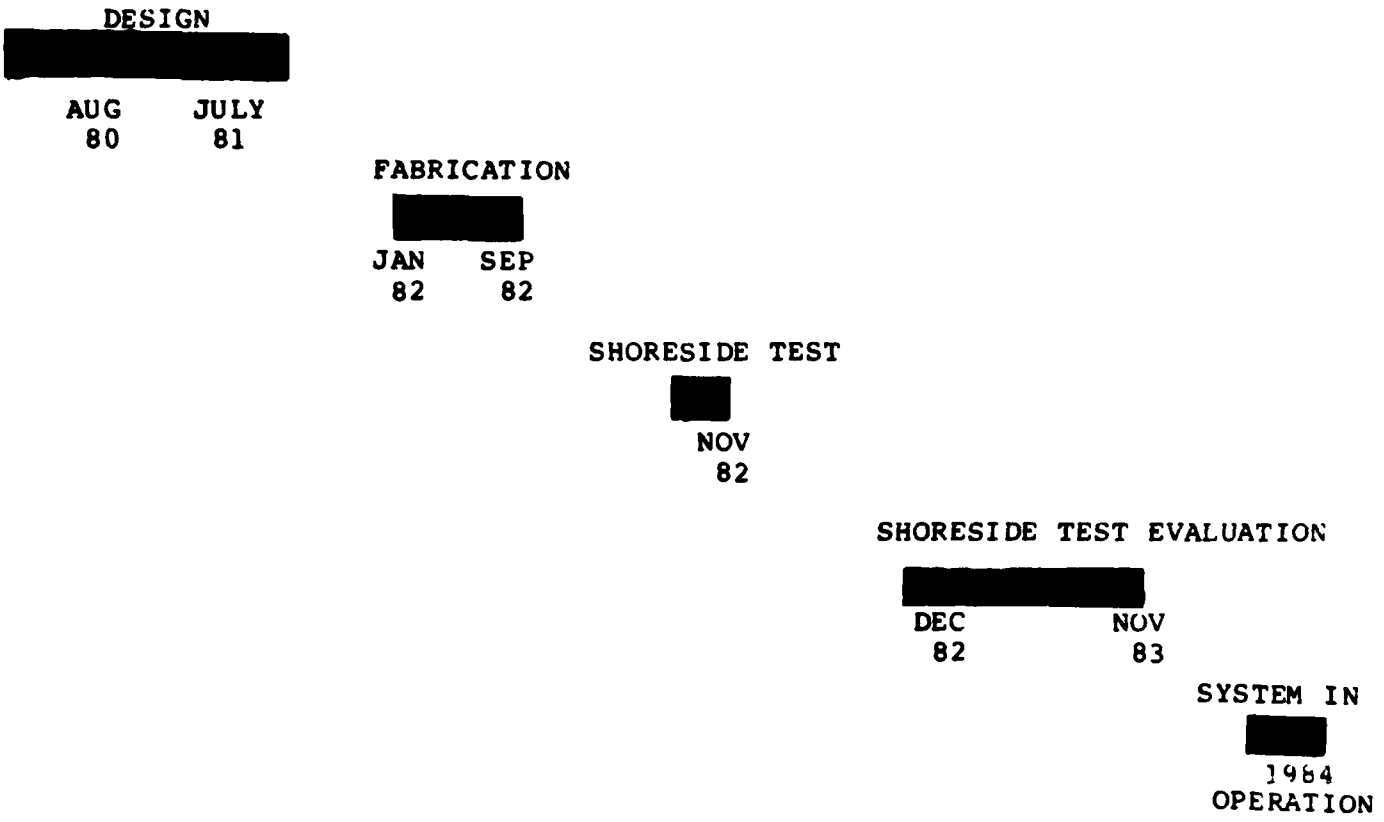
- ACTUATION
  - ELECTRIC POWERED WINCH AND BRAKE WITH MANUAL EMERGENCY BACKUP RIGGING ACTIVATED BY AN EXTERNAL WHIP

- POWER REQUIREMENT
  - 450 VOLT, 3 PHASE, 60 HERTZ SHIPS SERVICE POWER VIA NEW DISTRIBUTION PANEL TO TWO MOTOR CONTROLLERS

- CONSTRUCTION
  - STEEL

FIGURE I-3

SEA SHED TEST AND EVALUATION SCHEDULE



(Shoreside) test conducted at a military ocean terminal. Further Pierside and At-Sea testing using a representative commercial containership is currently in progress.

D. PROGRAM OBJECTIVES

The general objective of the SEA SHED Test and Evaluation Program was to design, fabricate, test, demonstrate and evaluate the operation and performance of the SEA SHED and its major subsystems in terminal and simulated shipboard environments. Due to the limited technical risk inherent in the system the Developmental Test and Evaluation and Operational Test and Evaluation were combined into one Test and Evaluation Program (see Appendix B). The objectives of the Test and Evaluation were:

- Demonstrate proper functioning, integrity and conformity with performance requirements.
- Demonstrate conformance with the electrical, vibration, shock, and safety specification requirements.
- Demonstrate performance of the work through floors.
- Evaluate installation and check out procedures of the SEA SHEDs.
- Evaluate the availability, accessibility, and functioning of the tie down devices.
- Determine if the average cargo handler is capable of operating the system or if he requires special training and instruction.
- Evaluate the accessibility and functioning of the access trunks.

- Determine, through time and motion studies, the loading time factor.
- Demonstrate the SEA SHED compatibility with pierside cranes.
- Determine the storage and ground handling requirements within terminal facilities and if there is a requirement for special devices or equipment.

The initial design of the SEA SHED prototype (See Appendix C) called for the open-top structure with "work-through" floor as currently designed. However, the structure was to have enclosed sides with sliding doors for the side openings. With the addition of a roof structure, the SHED was envisioned as having a secondary role as a shoreside storage facility. Upon further examination of the design it was determined that this "cadillac" version would be too heavy to be handled by existing container cranes.

This lead to the "austere" SEA SHED design, eliminating the requirement for a shoreside storage function, and the associated enclosed configuration. The austere design (see Appendix D) called for an open-truss construction using tubular members, where possible, to reduce weight. Specific design modifications included:

- An open truss construction and elimination of wall paneling and sliding doors.
- Retention of side openings.
- Stacking cones providing a more stable configuration for a two- or more high stack.

- Eight foot adapter beams allowing 40' ISO containers to be stacked on top of SEA SHEDs.
- Eight individual support points distributing weight of SEA SHED in proximity to reinforced hard points near container cell guides.
- Elimination of a hydraulic buttress system.
- Elimination of internal wiring for lighting.

E. SCOPE

The scope of this report covers the entire SEA SHED Test and Evaluation Program to include the evolution of the SEA SHED design, the selection of subcontractors, the prototype fabrication process to include ABS certification testing, and the actual operational testing of four prototypes.

F. CONDUCT OF THE PROGRAM (See Appendix A for Chronology)

1. SEA SHED Coordination Committee

The SEA SHED Coordination Committee was established to assist the Maritime Administration's Contracting Officer's Technical Representative in defining the operational requirements for the SEA SHED system, translating these anticipated requirements into proposed design criteria, and to provide an effective mechanism for coordinating the location, equipment and personnel required for operation testing.

The Committee membership comprised representatives from the following agencies:

- Maritime Administration (MAR 770),
- Department of Defense (OSD MRA&L).

- Office of the Chief of Naval Operations (OP 423).
- Naval Sea Systems Command (PMS 377K).
- Department of the Army (DALO-TSM-P).
- Military Sealift Command.
- Military Transportation Management Command.
- Information Spectrum, Inc.
- M. Rosenblatt and Son, Inc.

2. Participant Responsibilities

- Maritime Administration (MarAd), U.S. Department of Transportation, provided program management.
- Naval Sea Systems Command (NAVSEA) coordinated Department of Defense support.
- Information Spectrum, Inc. (ISI) was prime contractor for design, fabrication and testing and also provided program management support services, to including test control and data collection personnel during the Shoreside Test.
- M. Rosenblatt & Son, Inc. (MR&S) designed the prototype SEA SHED and provided engineering technical services during fabrication and testing.
- American Bureau of Shipping (ABS) provided technical assistance during development of the test agenda and provided an on-site representative during certification testing.
- TRACOR Marine fabricated and tested four prototype SEA SHEDs.

- Transmission Technology, Inc. developed electromechanical winches for operation of SEA SHED "work-through" floors.
- John Roberts, P.E. provided instrumentation during post-fabrication shop testing.
- The Military Ocean Terminal, Sunny Point, North Carolina (MOTSU) provided terminal facilities including a container gantry crane and operator, an electrician, railroad cars and a locomotive, office space, and general administrative support.
- The 119th Terminal Service Company, 7th Transportation Group, Ft. Eustis, Va. provided approximately 45 active duty Army personnel and organic equipment to perform cargo handling and maintenance operations during the test.
- The North Carolina Army National Guard provided representative vehicles and equipment for test cargo.

3. Tasks

The major task areas of the Test and Evaluation Program include:

- SEA SHED Design.
- SOURCE SELECTION (SEA SHED prototype fabrication agency).
- SEA SHED Fabrication:
  - Construction and delivery of four finished, serviceable SEA SHEDs to the shoreside test area.
  - Non-destructive testing of the SEA SHED.

- American Bureau of Shipping (ABS) certification of the SEA SHED system.

- Shoreside Testing.

4. Summary of Program Results

- Successful development of SEA SHED design drawings (Appendices C and D).

- ABS approval of SEA SHED design drawings (Appendices C and D).
- Successful fabrication of four prototype SEA SHEDS.
- Successful completion of post-fabrication shop testing demonstrates conformance of prototype with design criteria (Appendices L and M).
- Successful completion of ABS testing of prototype SEA SHEDs (Appendices L and M).
- ABS certification of the SEA SHED system (Appendix K).
- Successful completion of operational testing in a terminal/ simulated shipboard environment (Appendices P and Q).
- Successful completion of the entire program within cost.

II. DESIGN

MR&S began design work on the "austere" version of the prototype SEA SHED on December 10, 1980.

MR&S completed the adapter beam design and the design for the emergency activation mechanism by the end of January 1981. At this same time 85% of the main frame design was completed. The primary activation mechanism for the "work-through" floor remained under consideration. Two options, hydraulic and electromechanical, were examined. It was decided that if neither option was determined to be decisively superior, two of each type would be fabricated for testing during the T&E phase. Subsequently, it was decided that in terms of both availability and complexity of the system, the electromechanical winch was the preferred system and was specified for all four prototypes. During the period January through April 1981 MR&S continued development of SEA SHED design drawings. MR&S delivered unchecked design drawings to MarAd and NAVSEA for review in April. MR&S also developed a non-destructive test specification package which the fabricator would then be required to perform and arrange for American Bureau of Shipping (ABS) certification.

During May 1981 MR&S published a Stress Analysis of the SEA SHED design (See Appendix E). This initial analysis was distributed to members of the SEA SHED Coordination Committee for review and comment. An initial technical review of both the SEA SHED design

drawings and stress analysis was conducted on June 3, 1981. A second review was conducted on July 16, 1981. Both reviews were conducted by ISI, MarAd and NAVSEA Technical representatives. It was agreed that the stress analysis demonstrated that the SEA SHED design meets or exceeds ABS structural criteria.

On August 4, 1981, MR&S received approval of the SEA SHED Test Agenda from ABS.

During October 1981 both MarAd and NAVSEA completed their final technical review of the SEA SHED design drawings and announced their approval. Final design drawings were then submitted to ABS for review and approval. MarAd and NAVSEA representatives signed the final design drawings on November 2, 1981.

III. SOLICITATION

A. SOLICITATION

During November 1980 ISI prepared Requests for Information (RFIs) for the SEA SHED Test and Evaluation Program. RFIs were directed to potential fabricators, test and evaluation agencies and film documentation agencies. All RFIs were reviewed and approved by the Department of Commerce prior to publication in the December 19, 1980 issue of the Commerce Business Daily. The fabrication RFI addressed construction, inspection, testing, certification, and transportation of four prototype SEA SHEDs and two pair of adapter beams. The T&E RFI solicited responses from agencies capable of designing test procedures, planning and supervising operational tests and evaluating and reporting the results. The film documentation RFI required the capability to film SEA SHED events such as fabrication, transportation, and shoreside, pierside, and at-sea testing. Film editing to meet the Department of Defense (DOD) standards for documentary films, was also required.

Responses to all three categories were numerous and of high quality. On 30 January 1981, the Contracting Officer's Technical Representative (COTR) and ISI representatives reviewed and evaluated all responses. Those firms passing this initial screening were designated qualified bidders and eligible to receive Requests for Proposal in their respective categories.

During March preparation began on RFPs in both the Test and Evaluation and fabrication categories. The RFP for a documentary film was deleted to reduce program costs. Efforts were begun to identify a government agency with the capability to produce a short documentary film.

During the period of March through June 1981 RFPs in the Test and Evaluation and fabrication area were prepared by ISI. RFPs were reviewed by both MarAd and NAVSEA representatives and approved. RFPs were sent to all firms on the Qualified Bidders List on June 23, 1981. A bidders conference was scheduled for July 1, with closing of bidding at 1630 EDST, July 24, 1981.

As a more logical approach it was agreed to change responsibility for instrumentation for Shop/ABS testing from the T&E agency to the fabricator. It was necessary to modify both RFPs and, as a result, an extension of the bidding was granted until 1630 EDST August 14, 1981.

B. SOURCE SELECTION

With the publication of the RFIs, ISI began the development of Source Selection Criteria for all categories. It was agreed that the source selection criteria would not rigidly adhere to the selection criteria regularly used by MarAd but would also incorporate criteria deemed appropriate to the uniqueness of the SEA SHED Test and Evaluation Program.

April 1981 witnessed 75% completion of the fabrication bid package. It was agreed at this time that MR&S, the SEA SHED design agency, would develop non-destructive test specifications to be provided to the selected fabrication agency. These tests would be performed in concert with ABS approved tests which were required for certification of the prototype SEA SHED.

During April, ISI began examination of alternatives to privately produced SEA SHED documentary films as an effort to reduce costs to the program. Accordingly, NAVSEA representatives explored the possibility of producing a documentary film through the David Taylor Naval Ship Research and Development Center (DTNSRDC).

Also, during April the draft Test and Evaluation Request for Proposal was completed.

On June 23, 1981, both fabrication and Test and Evaluation Requests for Proposal were sent to firms on the respective Qualified Bidder's List.

Bidding was scheduled to end at 1630 EDST July 24, 1981. It was anticipated that a two-week evaluation period would follow. During this period the top three qualifying firms in each category would be selected. These selected firms would receive requests for best and final offers.

On July 1, 1981, the ISI sponsored bidder's conference convened as previously scheduled. Attendees were briefed on the purpose and scope of the SEA SHED Test and Evaluation Program. This was followed by a question and answer session concerning the RFPs.

The SEA SHED Coordination Committee decision to change subcontractor responsibility for test instrumentation required subsequent revision of the RFP. Bidding on both fabrication and T&E subcontracts was extended until 1630 EDST August 14, 1981. Upon the close of bidding, the Source Selection Committee, whose membership comprised the COTR (MarAd) and representatives from NAVSEA and ISI, received copies of all proposals for evaluation.

C. CONTRACT AWARD

During the period August 14, 1981 to September 4, 1981, the Source Selection Committee evaluated all proposals submitted in both the fabrication and T&E categories.

On September 4, 1981, the Source Selection Committee membership completed their evaluations and prepared recommendations concerning both fabrication and T&E proposals. It was agreed that TRACOR Marine of Port Everglades, Florida had presented the best proposal in the fabrication category. At NAVSEA's request, award of the fabrication contract was deferred until NAVSEA could complete a final technical review of the design drawings and ABS comments concerning the proposed manufacturer's test agenda.

T&E proposals indicated an optimum cost range of $305-431,000 for conducting the Test and Evaluation. In view of a shortfall in budgeted funding, ISI began to develop alternatives to the T&E schedule. It was agreed that the At-Sea portion of the testing phase would be deferred until a later test program to reduce costs associated with both test ship operation and test instrumentation.

Further examination of the T&E matrix was required when the Department of the Army identified costs associated with their support of the T&E to be $211.8K, an increase of $44K over DA's initial estimate. During April 1982, DA provided a final cost estimate of $132K.

Based upon projected T&E agency costs, Army support costs and costs for activation/deactivation and operation of a test ship, it was decided that the T&E RFP would be rescinded. ISI was tasked to plan and direct land-based (Shoreside) testing. Sea-based testing comprising both the Pierside and At-Sea tests was deferred.

Upon NAVSEA concurrence of MarAd/ISI evaluations/recommendations of fabrication proposals, ISI awarded TRACOR Marine, Inc. the fabrication contract on January 20, 1982.

IV. FABRICATION

A. FABRICATION

Tracor Marine began fabrication of the four prototype SEA SHEDs on February 24, 1982.

During the period February - July Tracor fabricated the first prototype SEA SHED. In the process of inspecting the unit, it was noted that the columns of the main frame had been incorrectly fabricated. Tracor removed and rewelded all column corner joints. This corrective action was approved by the ABS on-site representative. Upon completion of the first SEA SHED it was noted that the top and bottom plates of the support columns were skewed or cupped and in several cases tolerance variance exceeded 3/16". To correct this problem, all columns not conforming to tolerances had to be machined to a level, parallel surface and shimmed to within acceptable tolerance limits. As a result of the difficulties in achieving tolerances on the support columns, MarAd directed that additional stress analyses (Appendix H) and column stacking tests be performed to determine the effects of column gaps on the SEA SHED structure.

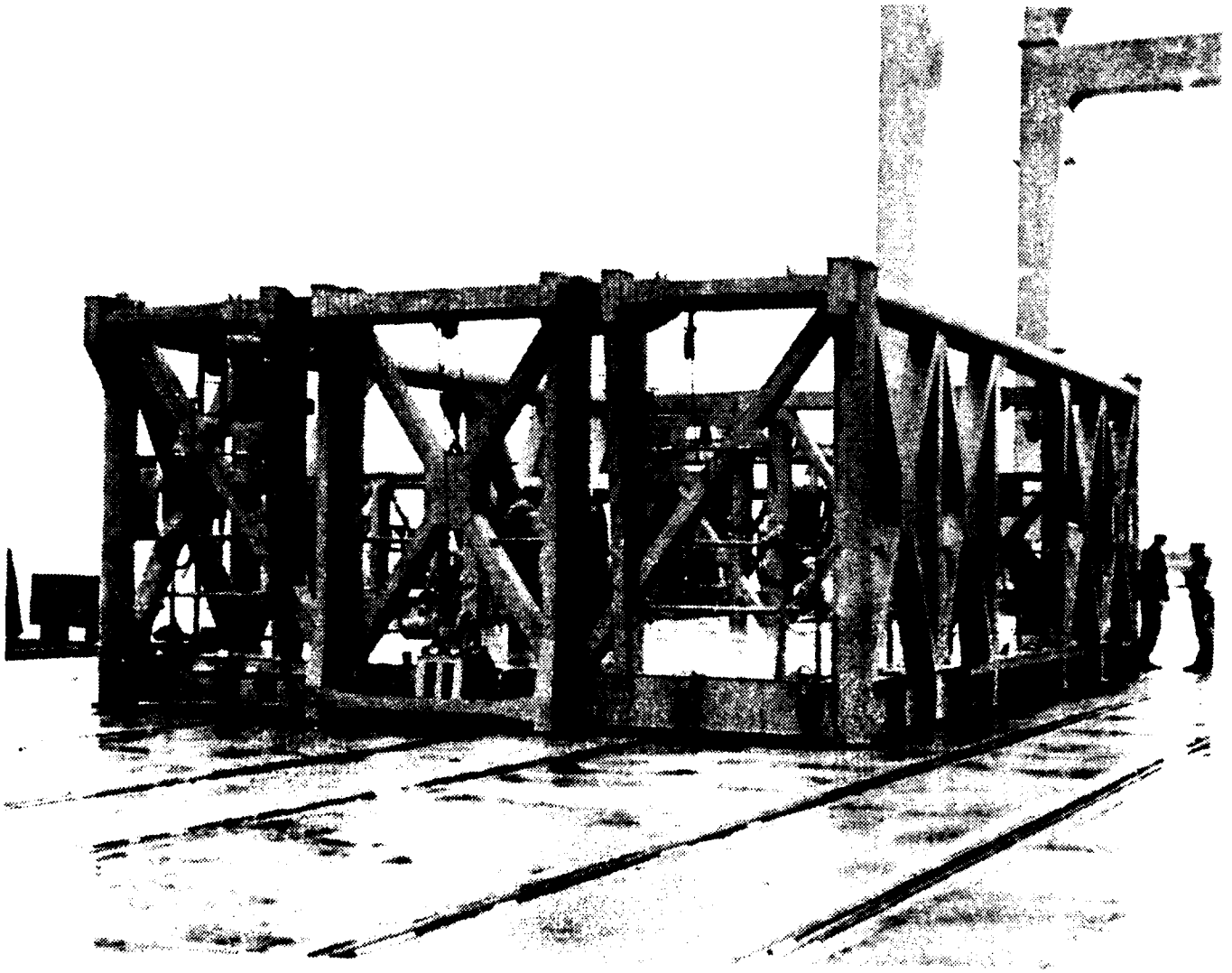
B. AMERICAN BUREAU OF SHIPPING (ABS) CERTIFICATION

A major objective of the SEA SHED Test and Evaluation program was to obtain American Bureau of Shipping (ABS) Certification of the SEA SHED system. (Appendix J)

ISI coordinated with ABS to obtain their assistance in developing an appropriate series of test events, successful completion of which would result in certification. For purposes of certification

FIGURE IV-1

PROTOTYPE SEA SHED



ABS agreed to consider the SEA SHED system as a container system. M. Rosenblatt and Son, Inc., the SEA SHED design agency was tasked to develop ABS test specifications. These specifications were initially submitted by MR&S during May 1981 for ABS review and comment. MR&S then prepared a revised series of test specifications incorporating ABS comments and recommendations. ABS approved the test specification package on August 4, 1981. MR&S in turn submitted the test specification package to ISI for inclusion in the Request for Proposal to fabrication agencies. The selected fabrication agency, Tracor Marine, Inc., was required to develop an ABS Test Plan (Appendix I) from the approved test specification package. This ABS Test Plan specifically detailed the individual tests proposed by Tracor to determine whether the prototype SEA SHED system conformed to the criteria established in the specification package. Included in the agenda were the requirements for test equipment and special test fixtures. The test plan was reviewed by ISI.

ISI submitted the proposed test plan to ABS for review and comment during November 1981. The test plan was submitted "blind", i.e., no indication of the preparing agency, per ABS' request. Upon review by ABS, ISI returned the test plan to Tracor for revision in accordance with ABS comments. The test plan was then resubmitted and received final approval.

In anticipation of operational requirements, the fully loaded SEA SHED was designed to sustain the following loading configurations:

- Three fully loaded SEA SHEDs stacked upon the base SEA SHED.
- Twelve fully load 40' containers, three abreast and four high, stacked atop the base SEA SHED.
- A SEA SHED/40' container mix, whose combined weight does not exceed the weight of four fully loaded SEA SHEDs.

In its final form the test plan described specific test events, which after successful completion, demonstrated that the combined static and dynamic loads anticipated in actual service are within the design capabilities of SEA SHED as stated above.

Seven specific test events were performed in accordance with the test plan. All testing was performed under the on-site supervision of a local ABS representative. In addition, both ISI and MR&S representatives were present to provide further technical assistance. The final ABS Test Report comprises Appendix J of this report.

The following provides a description of each test event:

1. Test No. 1: Floor Loading

A base frame was placed on a concrete platen to support the SEA SHED. There were eight raised and leveled support pads, four on each transverse beam. Four pads incorporated stacker cones and supported the corners of the SEA SHED. The other four were dimensionally matched to their respective mating surfaces between the corner supports on the narrow ends of the SEA SHED. The design of the base frame allowed the lower longitudinal structure of the SEA SHED to deflect under load in the longitudinal direction.

Water was used to uniformly load the 791 square feet of floor area. A container was constructed to hold 54,784 gallons of water to give a uniform floor loading of 578 pounds per square foot.

No deflection was observed.

2. Test No. 2: Column Loading - Shed Stacking

Upon completion of Test #1, and without removing the uniformly distributed test load material, the upper truss of the test fixture was lowered into position by a crane.

The lower ends of the four pipe columns were pinned to clevises in the lower support beams. Adapter plates were placed at the two corner columns and bearing plates on the two intermediate columns. At each of the four support points, a 150-ton hydraulic jack was placed between the bearing plates on the SEA SHED columns and the centerline of the lower flange of the test fixture beam. Each of the four cylinders exerted a force of 196,560 pounds against its respective column.

The loads were applied for an interval of five minutes without deformation of the columns.

3. Test No. 3: Column Loading - Container Stacking

The adapter beams were placed in position on the loading points on the two outside cells of the SEA SHED. Floor loading material used in the previous test was not removed. The upper truss of the test fixture was placed over the center line of the adapter beams. The hydraulic jack and a pad was placed between the

lower flange of the truss and the adapter beam. The pad seated on the adapter beam had a plane area equal to the standard container corner fitting. One pair of columns was tested at a time, with the required force applied five times.

The first test consisted of applying two forces of 120,960 pounds concentric with the vertical axes of the apertures in the adapter beam. The calibrated pressure gauges in the hydraulic line were used to determine the correct force for each cylinder. The load was applied for a period of five minutes.

The sequence of force application was concentric first, followed by four eccentric applications of force. The pads were offset 1" laterally and 1 1/2" longitudinally with respect to the center of the apertures. In all cases the force was applied at the center of the pads. Each application of force was applied for a period of five minutes.

After testing both pairs of columns on the outside cells, the same test was applied to the center cell, with the exception that no adapter beam was used in this location.

During and upon completion of each stacking test, the structural members were examined and measured for deformation and abnormality. Neither deformation nor abnormality was observed in the structural members.

4. Test No. 4: Lifting

The water used in Tests 1-3 was removed until the total weight of the loaded SEA SHED equaled 134,400 pounds as determined

by calculation and measurement. A 100-ton crane was used to attach a container spreader assembly to the SEA SHED lifting sockets. The SEA SHED was then lifted vertically in order to minimize the acceleration or deceleration forces being applied. The SEA SHED was successfully suspended for not less than five minutes and then lowered to its original position.

5. Test No. 5: Floor Strength (Concentrated)

a) Industrial Truck

The SEA SHED in the tare weight condition was placed on 8 supports (no load cells) in a horizontal plane with the base structure able to deflect in the longitudinal direction. A fork lift was used to make at least seven longitudinal passes. (A pass was defined as the test vehicle entering the container, traversing its entire length, and leaving the container.) Each pass was executed at a different location on the floor (from the 'edges', for shear, to the center of the floor, for bending). A forklift with a front axle loading of 12,000 pounds (including the weight of the vehicle) or 6,000 pounds per wheel was used. Rubber tires with a footprint of 7" x 3-1/8" and a maximum center-to-center distance of 35" were used. A single wheel loading area of 22 square inches with a single wheel pressure of 271 psi was also used. No shearing or bending was observed.

b) Cargo Truck

Next the floor was loaded to simulate stowage of two fully loaded M125 10-ton 6x6 U.S. Army trucks standing side by side. Each front axle was loaded to 13,700 pounds and each

rear axle was loaded to 25,800 pounds. Again, no bending was observed.

6. Test No. 6: Tie Downs

The test load for each tie down was 448,000 pounds divided by the number of recessed cloverleaf tie downs (42). The test load was 10,667 pounds. A portable test rig was designed using a level, pin joint, and a standard cloverleaf locking device. The locking device was suspended from the center of the beam, or lever, and a 3-ton hydraulic jack placed under the free end of the lever. Using the 2:1 mechanical advantage of the lever, a force of approximately 6 tons was applied to the tie down. A calibrated guage in the hydraulic line to the jack registered the pressure exerted This test was performed on each tie down. No failure was observed.

7. Test No. 7: Ladders

One ladder rung, chosen arbitrarily, of each ladder was tested with a load equal to 440 pounds. A half-ton chain "come-along" was shackled to an eye at the base of the ladder in a plane normal to the rungs. A tensiometer was hooked to the mid point of the rung and secured to the hook on the "come-along" and a force of 440 pounds applied using the ratchet lever. No deformation was observed in the ladder rungs tested.

Based upon successful completion of the test events described above, ABS certified the SEA SHED system (Appendix K).

C. SHOP TESTS

As a major part of the fabrication effort, Tracor Marine was tasked to conduct a series of non-destructive tests, whose successful completion would demonstrate prototype SEA SHED structural conformance with design criteria.

M. Rosenblatt and Son, Inc. was initially tasked by ISI to develop nondestructive testing specifications. The shop test scenario subsequently developed was reviewed and approved by both MarAd and NAVSEA technical representatives.

The shop test scenario was included in the Request for Proposal submitted to all fabrication agencies on the Qualified Bidders List.

Based upon the MR&S shop test scenario, Tracor Marine developed a detailed Shop Test Plan (Appendix L) describing test events, with supporting test fixtures.

Testing was performed by Tracor at its shipyard facilities at Port Everglades, Florida, site of SEA SHED fabrication. Testing was conducted under the supervision of Information Spectrum, Inc. Representatives of MR&S were present to provide technical assistance.

Tracor divided their shop testing effort into two major subareas as follows:

- Structural Testing, included:
  - Racking (SEA SHED support) - Transverse.
  - Racking (SEA SHED support) - Longitudinal.
  - Racking (container support) - Transverse.

- **Non Structural Testing, included:**
  - **Weighing/lifting.**
  - **Floor actuation.**
  - **SEA SHED/container trailer interface.**

The following provides a description of the individual shop tests:

1. Structural Testing

Structural Testing was conducted upon completion of the ABS Test agenda and certification. The SEA SHED, previously instrumented for ABS structural testing, remained instrumented and was subjected to the following non-destructive tests.

a. Racking Test (Transverse)

The SEA SHED was placed on the eight level support pads corresponding to the eight weight support points of the SEA SHED. The four corner pads, outfitted with cones, engaged the bottommost SEA SHED corner sockets to provide stability. The hydraulic system was placed against each of the two stacker cones. The water column was then reduced until a gross total weight of 378,500 pounds was achieved. At this time the hydraulic system exerted the requisite 102,000 pounds against each of the two stacker cones. No permanent deformation was observed.

b. Racking Test (Longitudinal)

With the SEA SHED positioned in the same configuration as the Transverse Racking Test and with the same uniformly distributed floor load, a 73,000 pounds load was

exerted on two stacker cones simultaneously from the same direction. No permanent deformation was observed.

c. Racking Test (Container Support) Transverse

The modified requirement for this test called for applying 33,600 pounds on each column. The prescribed weight was applied against the container support column. No permanent deformation of the column was observed.

2. Non-Structural Testing

a. Container Trailer Interface

This test demonstrated the compatability of the SEA SHED with a representative tractor truck/semi-trailer normally used to transport 40' ISO containers. Using a crane equipped with a 40' spreader bar, the SEA SHED was positioned on the semi-trailer so that container fittings on the underside of the SEA SHED engaged the cone fittings on the semi-trailer. The cone locks were then engaged and the spreader bar was removed. The tractor truck was then hooked up to the semi-trailer to insure that no interference existed between the tractor and the SHED. The process was repeated with the SHED orientation on the trailer reversed. No problems were encountered during installation/removal of the SEA SHED, nor was damage caused to the semi-trailer during the process.

b. Lifting/Weighing

Lifting/Weighing of the SEA SHED prototypes was conducted on two occasions. The first instance involved the first prototype SEA SHED to complete fabrication. Lifting/Weighing required a standard container spreader, whose weight had been previously determined to be 7,950 pounds a crane and a tensiometer calibrated/certified to 100,000 pounds. The spreader was locked into position on top of the SEA SHED. The tensiometer, in turn, was placed between the spreader hook and the crane's hook. The SEA SHED was raised approximately 1' above the ground. The tensiometer indicated a weight of 74,500 pounds for the SEA SHED and spreader or a tare weight of 64,500 pounds for the SEA SHED alone. The second weighing involved all four completed prototypes prior to delivery to Sunny Point. Two load cells were used to verify the weights of each SEA SHED. A Dillon Dynamometer was attached to the crane hook in order to provide a direct measurement of total SEA SHED/spreader bar tare weight. A second load cell, as an integral part of the crane, was used to verify the tare weight indicated by the Dillon unit. Each SEA SHED was lifted and weighed twice. Each SEA SHED had a tare weight of approximately 75,000 pounds.

c. Floor Actuation Test

Upon completion of painting and outfitting the first prototype SEA SHED, it underwent floor actuation testing.

With the floor in the closed position and the hoisting match block disconnected from the floor, a tension load cell was installed between the match block and floor lifting lug. The load cell had a minimum capacity of 20,000 lbs. The winch was then actuated to reel in the winch cable until all slack was removed. The winch was then used to open the floor to a half-open position, then closed. The procedure was repeated for both sides of the work-through floor. No failure occurred during the operation of the winches. No failure occurred during operation of the floor.

The second phase of floor actuation testing examined the functioning of the floor limit switch, floor latch release lever. Again the floors were actuated to the fully open position with observations made on the performance of each item. No failures were observed.

D. ADDITIONAL SHOP TESTING (Appendices N and O)

The performance of additional shop testing was directed by the Contracting Officer's Technical Representative to determine whether the combined static and dynamic loads anticipated in service are within both the design and production capabilities. This determination was required in order to resolve the issue of fabrication tolerances between the four vertical columns on the end frame. It was felt by the fabricator and design agency representatives that SEA SHED fabrication could be expedited and associated costs reduced, if end column tolerances could be safely increased from 1/32" to 1/8" or 3/16".

It was agreed that the fabricator would conduct the additional testing on the first prototype SEA SHED to complete initial ABS/Shop Testing. The following shop tests were performed:

1. Floor Loading

Four corner column bottom support pads were placed on the lower truss weldments. Four stacker cones were placed on top of these pads. The SEA SHED was then positioned on top of the four stacker cones. The two center column pads were then placed on the lower truss weldments in such a manner that a 1/8" gap was left between the bottom of the center columns and the top of the shim pad. The water container was reinstalled and filled to a height of 11'-9".

2. Column Loading/SEA SHED Stacking

This test was conducted with the water level the same as in the Floor Loading test. The 1/8" shim was placed upon the top of the center column pads. Bearing pads were placed on top of the two intermediate columns. Cylinder support pads were then placed on top of the corner columns. In turn four hydraulic cylinders were placed on top of the cylinder support pads and a force of 196,560 pounds or 6198.67 PSI was exerted. The 1/8" shims were then replaced with 1/16" shims and again the cylinders simultaneously exerted a force of 6198.67 PSI on each corner column. The load was maintained for five minutes. It was observed that the 3/16" gap remained open.

3. Column Loading/Container Stacking

A container adapter beam was placed on one of the SEA SHED outside cells. Two pads were then centered concentric with the vertical axis of the apertures of the adapter beam. Hydraulic cylinders were placed on top of the two pads. The 1/16" shim was replaced with a 1/8" shim creating a 1/8" gap. A load of 120,960 lbs. or 3814.56 PSI was applied to each of the columns for a period of five minutes. It was observed that the 1/8" gap remained open. This process was then repeated on the other outside cell.

4. Racking Transverse

The upper corner columns of the SEA SHED were prepared by welding channel welds for the spacer bars. The base of each stacker cone was welded to the top of the corner pads. Finally the bottom of the corner support pads were welded to the top of the lower truss.

Next the racking frame was positioned so that the two outside pipe columns were placed directly across the web centers of the lower truss. Two cylinders were placed into the supports on top of the outer pipe columns of the racking frames. A force of 3216.65 PSI was exerted with readings taken during both the build-up and drop in pressure. The 3/16" gap obtained during the column loading test served as the gap during this test. The test was then repeated on the opposite end of the SEA SHED.

5. Racking Longitudinal

With the water level and gap the same as in the Racking Transverse Test, the racking frame was positioned for longitudinal

racking. The interface plates were connected with the two intermediate columns center to center. Cylinders were placed into the supports on top of the intermediate columns and a force of 73,000 pounds or 2302.1 psi were exerted against the cones of the outer supports. The cylinders were then positioned onto the inner cylinder supports of the Racking Frame and the test repeated. No permanent deformation was observed.

6. Racking Longitudinal

In this test the racking frame was engaged with the SEA SHED. Two cylinders were positioned on the outer cylinder supports and two were positioned in the intermediate supports. The cylinders were then used to apply 20,000 lbs. or 630.71 psi against the outer surface of the container support columns. Following this, the racking frame and cylinder setup were moved to the far end in the same configuration as before. Again each cylinder exerted a force of 20,000 pounds against the outer surface of the container support columns. No permanent deformation was observed.

V. OPERATIONAL TESTING

A. TEST PLANNING

The test planning phase encompassed development of the Test and Evaluation Master Plan (Appendix B); identification of an appropriate test site, test equipment/personnel assets; and finally, development of a detailed test plan for Shoreside Testing (Appendix P).

During September 1980 ISI began preparation of the draft SEA SHED Test and Evaluation Master Plan (TEMP). The TEMP is derived from those agreements on program responsibility reached between MarAd and Navy and formalized in the Memorandum of Understanding dated September 1980. In addition, the TEMP identified the specific program tasks, established responsibilities, and provided the description and operational requirements for the prototype SEA SHED System. The TEMP also identified program assumptions and test and evaluation objectives. The TEMP described a two phase program. The first phase encompassed those efforts concerned with SEA SHED prototype design; solicitation and award of fabrication, film documentation, and T&E agency contracts; prototype fabrication and finally Shoreside testing.

Testing planned for Phase I included both post-fabrication Shop/ABS certification testing and the land-based (Shoreside) operational testing. Shop/ABS testing would be performed by the fabricator at the fabrication facility to ensure prototype conformance with design criteria. ABS testing, also performed by the

fabricator, would demonstrate the structural integrity of the SEA SHED System.

Shoreside Testing would encompass those land-based tests designed to confirm the operational performance of the SEA SHED system and major subsystems. In addition, the interface between the prototype and container cranes and ground handling systems would be examined.

The final draft TEMP was presented to the Coordination Committee membership for review/comment. The review was completed during February 1981. The final TEMP, incorporating MarAd/DOD comments was published in March 1981.

Beginning in February 1981, MarAd began efforts to identify an appropriate government-controlled ocean terminal to serve as a test site. The TEMP called for a government-controlled terminal as a means of reducing costs associated with usage of terminal facilities and equipment. MarAd identified Military Ocean Terminal, Sunny Point (MOTSU), North Carolina. MOTSU is the only government-controlled terminal on the east coast with a 50 ton capacity container gantry crane. In addition, the schedule is such that testing would not interfere with normal terminal operations.

Though a government-controlled ocean terminal was specified in the TEMP, MarAd tasked ISI to perform a cost analysis comparing costs associated with the use of MOTSU with costs associated with use of a representative commercial port. ISI conducted a site survey at the Port of Baltimore. Results of the survey confirmed that while

the Port of Baltimore possessed the facilities/equipment necessary to support SEA SHED T&E, cost to the government would far exceed costs incurred at a military ocean terminal. In addition, competition with port operations for available facilities and equipment would preclude timely conduct of testing.

A second planning area was the identification of DOD resources (equipment and personnel) required to support the test. Personnel included cargo handlers and equipment (crane) operators. Test cargo equipment requirements encompassed representative military equipment items ranging in size from a 1/4 ton jeep to an M88 Tank Recovery Vehicle.

B. TEST COORDINATION

Test coordination encompassed those efforts made to obtain use of an appropriate test-site, to ensure the availability of DOD-provided resources including both equipment and personnel, and finally, the development of those agreements on test participant responsibilities and interrelationships as finalized in the detailed test plan.

During February 1980 MarAd tasked ISI to provide input identifying specific equipment requirements for the T&E program. This information was incorporated into a formal MarAd request to OPNAV to initiate tasking through DOD-channels. In addition to equipment requirements, MarAd specifically requested that MOTSU be designated as the test site, and that terminal service company personnel from Ft. Eustis, Va. be provided as cargo handling personnel.

Initial response to the OPNAV tasking was received during June 1981. Deputy Chief of Staff for Logistics (DCSLOG) indicated several reservations concerning availability of Army equipment either from active Army units, the National Guard or from depot stocks. However, DCSLOG indicated that no challenge would be raised as to the use of MOTSU as a test site. As a result of this response OSD began researching the availability of Marine Corps personnel and equipment assets. Paralleling this effort OPNAV reiterated its initial request to DCSLOG with further clarification of the nature of the SEA SHED T&E.

During the period April - September 1981 coordination efforts clarified the nature of the SEA SHED T&E and emphasized the importance of DA participation in the program. This effort culminated in the September 3, 1981 meeting sponsored by U. S. Army Operational Test and Evaluation Agency (OTEA). At this meeting ISI personnel presented the SEA SHED briefing. Discussions followed in which Army support requirements were identified. The feasibility of providing support was examined and tentative dates for the Shoreside Test were established. A follow-up meeting was conducted on February 5, 1982 at which time estimated costs associated with Army support were examined. The Army estimate of support costs indicated a major increase. Consequently, a reexamination of the T&E matrix identified potential changes which could reduce program costs.

During October 1982, MarAd and ISI representatives conducted final on-site coordination with Amry representatives at MOTSU and Ft. Eustis. Discussions at MOTSU with the host installation POC covered identification of the test site, availability of installation-provided support/facilities and discussion of the detailed test plan. At Ft. Eustis, MarAd and ISI representatives met to finalize availability of mobile cranes and cargo handling personnel. The MOTSU POC was in attendance to discuss administrative procedures governing Terminal Service Company personnel participating in the test.

C. TEST CONDUCT

The Test Directorate began operations at MOTSU on October 25, 1982. The period from October 25, 1982 to November 1, 1982 was utilized as an administrative period for effecting last minute, on-site coordination with the Host Installation POC. During this time the four prototype SEA SHEDs were offloaded from the barges and positioned in the designated test area. Test Directorate and Host Installation personnel positioned military equipment which was designed as test cargo and was provided by the North Carolina National Guard. In addition, mobile cranes provided by Ft. Eustis were assembled and positioned.

Test Directorate personnel instructed officers and NCOs from the 119th Terminal Service Company, Ft. Eustis in the operation and maintenance of the prototype SEA SHED. The NCOs and soldiers of the 119th Terminal Service Company provided the cargo handling personnel during the actual testing. Based upon this instruction and information contained in the draft operators manual and maintenance manual, NCOs were in turn required to develop lesson plans and instruct junior enlisted personnel.

Upon completion of instruction, Army cargo handling personnel, under Test Directorate supervision, performed "dry runs" of representative test events. This demonstrated both the effectiveness of instruction and the degree of individual comprehension.

Actual testing commenced on November 1, 1982. The sequence of test events was designed to progressively examine the loading, unloading and tying down of representative military cargo in SEA SHEDS

Figure V-1

ARMY MOBILE CRANE STACKING SEA SHEDS USING 40' CONTAINER SPREADER

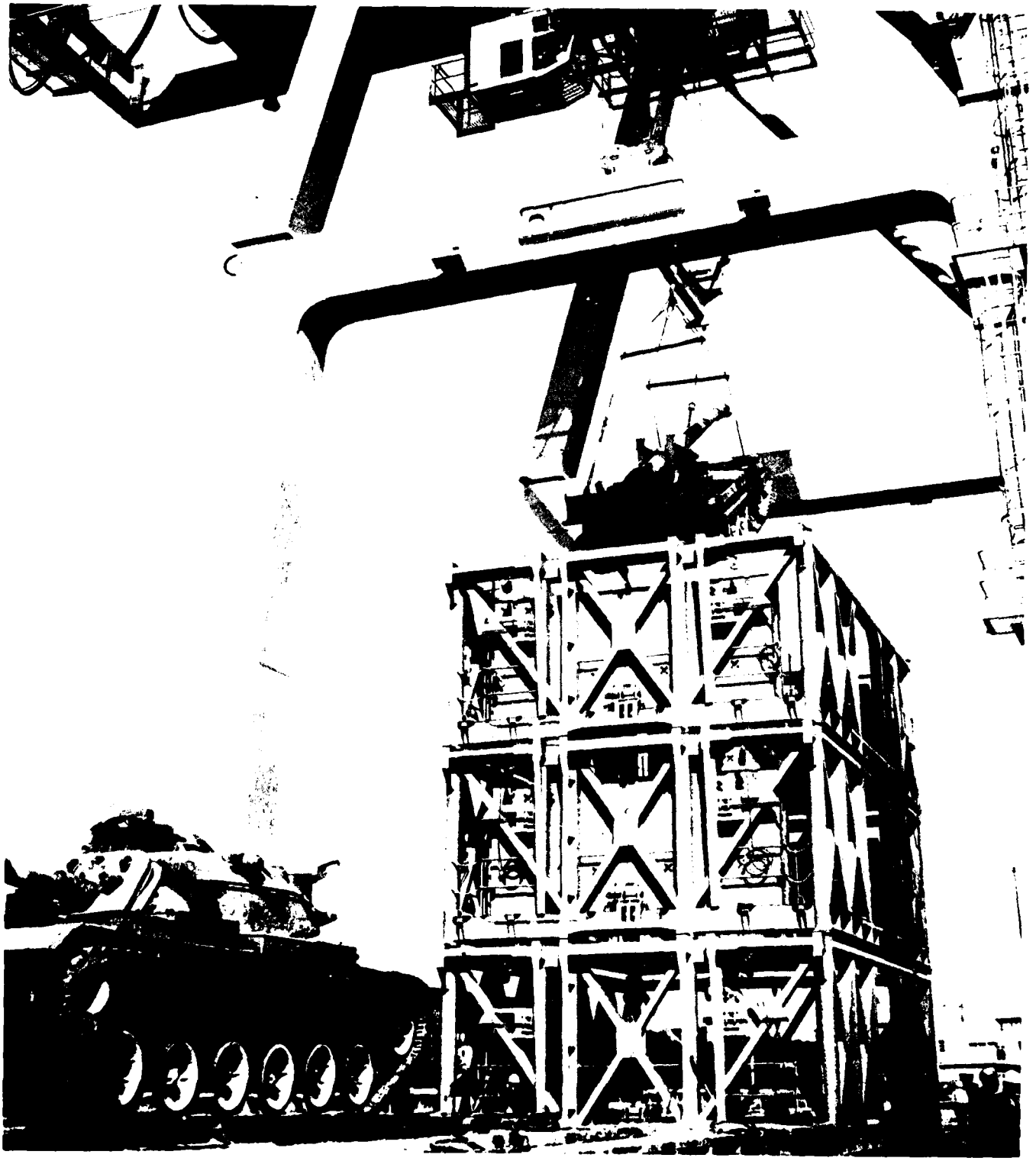
stacked one to three high. The SEA SHED at each stack level was loaded to its maximum extent. Data was recorded on individual subtasks, addressing the critical and other operational issues as identified in Section 1.0 of the Shoreside Detailed Test Plan (Appendix Q).

All test exercises were based on accepted military and commercial doctrine and procedures. Data and information pertaining to maintenance and human factors were collected throughout all exercises. The following exercises were performed during the Shoreside Test:

- Multiple Stacking of SEA SHEDs from One to Three High. These exercises were designed to simulate typical shipboard configurations and thus provide data to:
  - Determine whether the "work-through" floor subsystem functions, and if so, whether it functions within the required five-minute cycle time.
  - Evaluate the capacity of shoreside cranes and associated lifting devices to load and stack SEA SHEDs in a simulated shipboard configuration.
  - Determine whether clearance through open "work-through" floors is sufficient for loading varied mixes of military equipment.
  - Evaluate the availability, accessibility and functioning of tie-down devices.
  - Determine whether auxiliary and emergency equipment functions according to design.
  - Determine through time-motion studies the loading time factor.

Figure V-2

CONTAINER GANTRY CRANE LOADING HOWITZER IN SEA SHEDS THREE-HIGH



- Determine storage requirements for ancillary and auxiliary equipment.
- Determine use times and requirements for special devices and equipment.
- Evaluate installation and checkout procedures.

- Multiple Stacking of Containers on SEA SHEDs Using the System Adaptor Beams. These exercises were designed to determine whether ISO containers stack easily and in accordance with design criteria.
- Multiple Loadings of the SEA SHED onto Ground Handling Systems. These exercises were designed to provide data to:
  - Assess the capability of existing and specially designed ground handling systems to safely transport SEA SHEDs in a terminal environment.
  - Determine ground handling times and any special requirements for terminal facilities.
- Transferring Palletized Cargo by Forklift Between Two Side-by-Side SEA SHEDs. This exercise was designed to determine times, tolerances, and capabilities for transfer of palletized cargo by forklift between two side-by-side SEA SHEDs.

Due to significant maintenance-related problems affecting the Army-provided 250-ton capacity mobile crane, it was agreed that the 50-ton capacity PACECO gantry crane of the host installation would be used instead. Testing resumed, examining one-, two-, and three-high stacked configurations with a limit on total stack weight (both SEA SHEDs and cargo) of 150 STONS. This weight limitation

Figure V-3

SEA SHED CONTAINER ADAPTER BEAMS

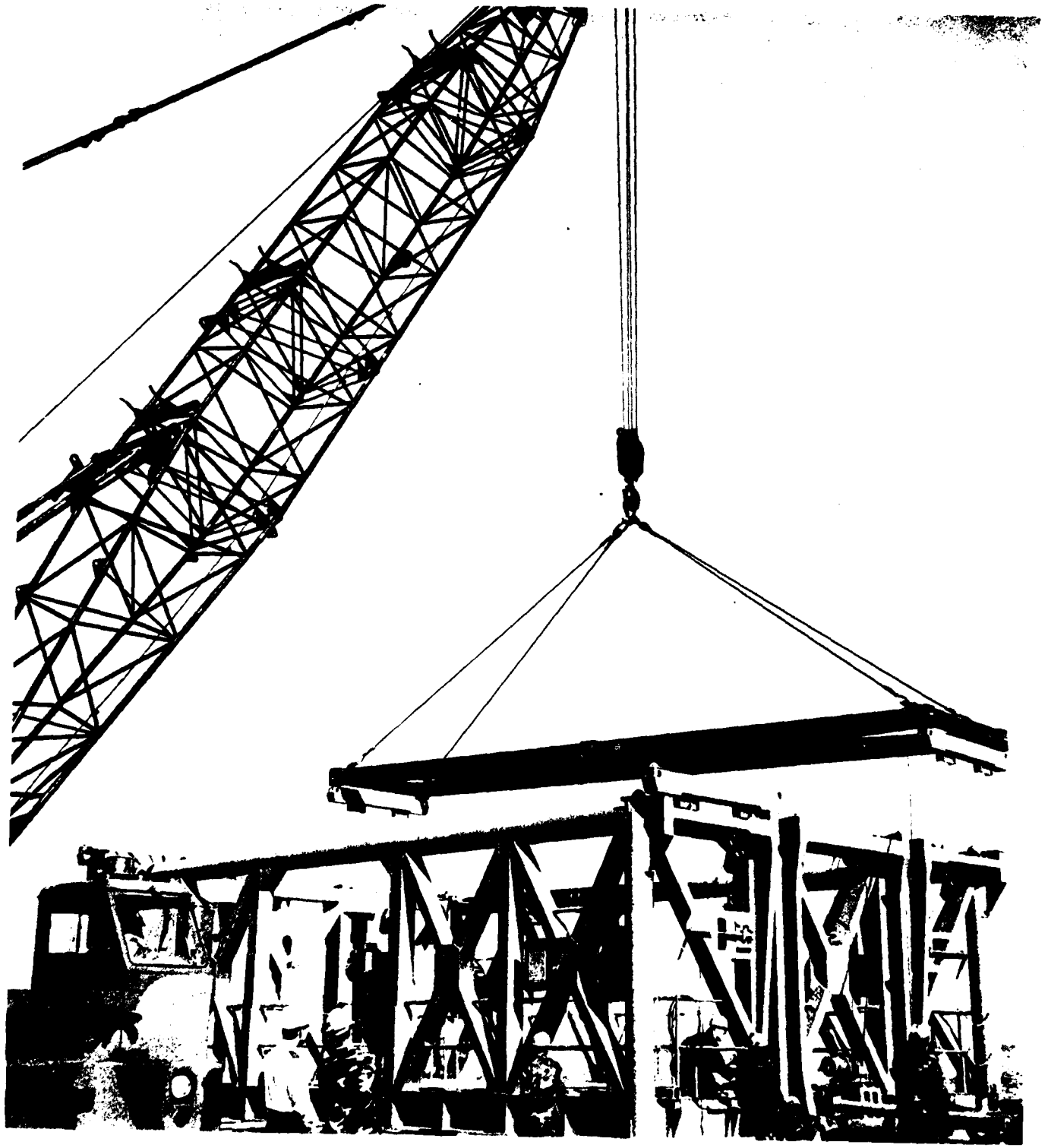
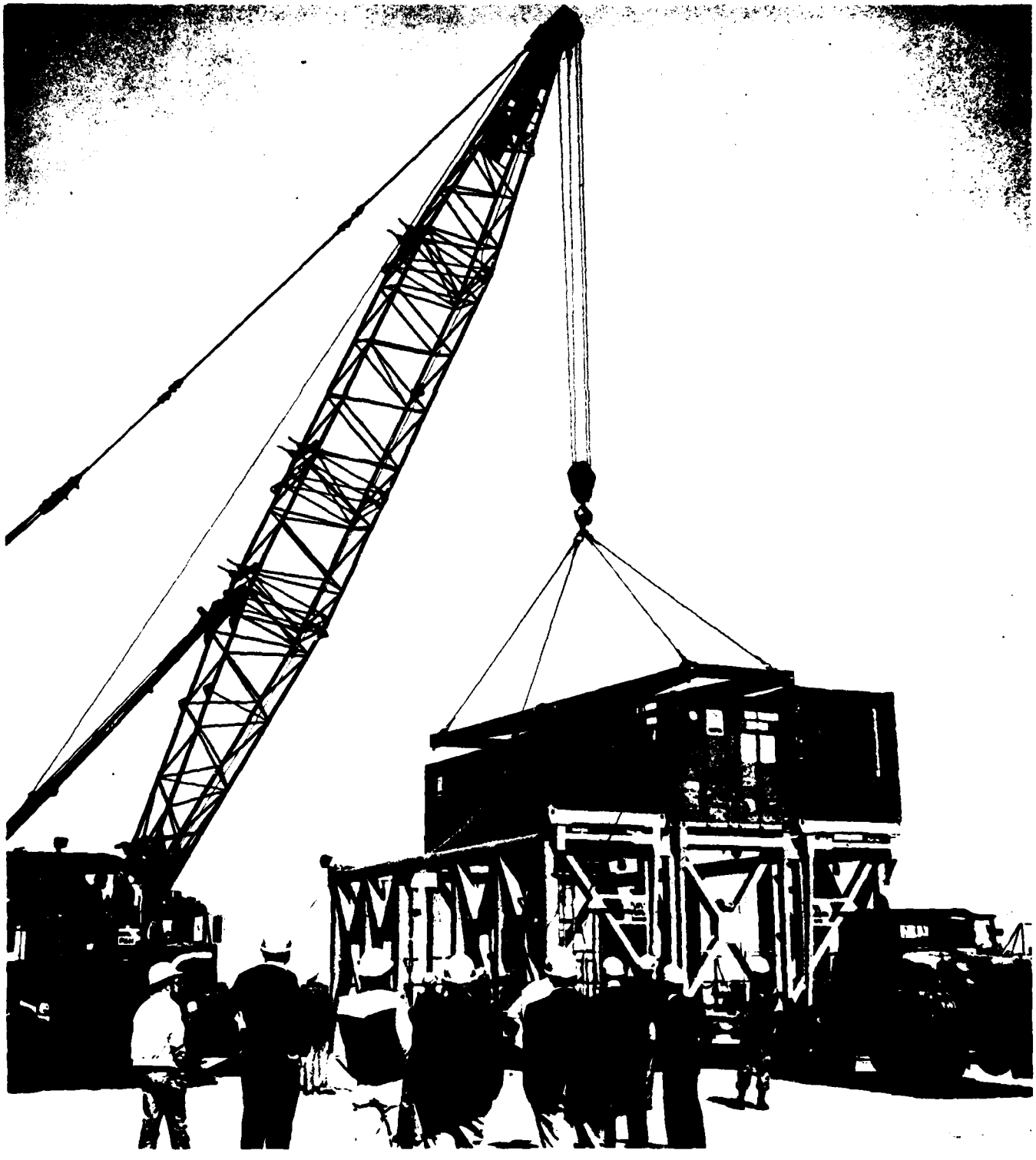


Figure V-4

STACKING 40' CONTAINERS ON SEA SHED USING CONTAINER ADAPTER BEAMS

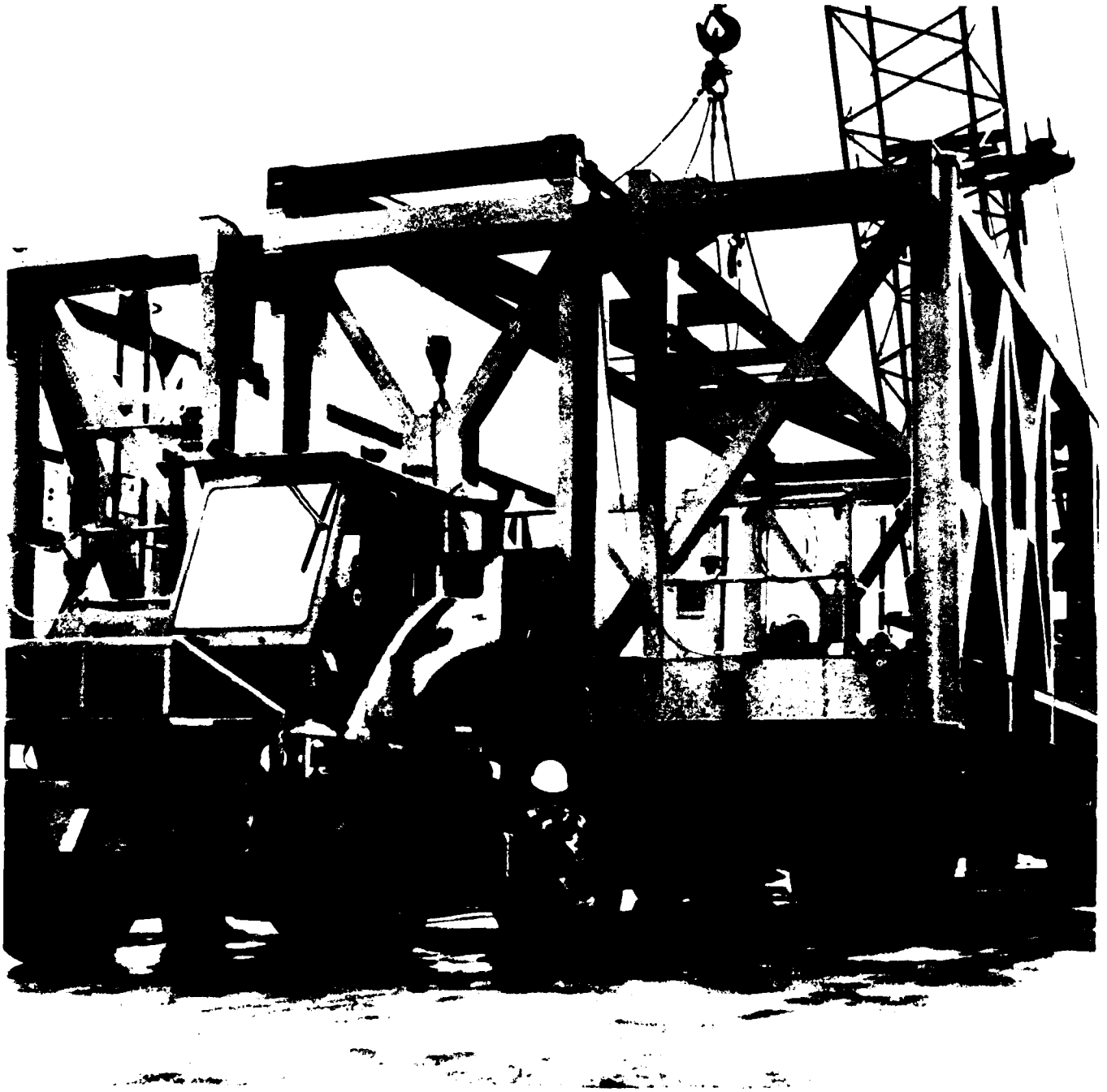


was imposed by the load bearing capacity of the wharf in the vicinity of the PACECO cranes and prevented accomplishment of the four-high stack configuration.

Concurrent with loading/unloading exercises, the fourth SEA SHED was utilized in testing SEA SHED interface with various ground handling systems. In addition, this SEA SHED was used in tests examining SEA SHED, adapter beam, and container interface. This involved stacking and unstacking standard 40' containers on top of the SEA SHED using the prototype adapter beams.

Figure V-5

ARMY MOBILE CRANE POSITIONING SEA SHED ON 40' FLATBEAD TRAILER



D. TEST RESULTS[1/]

The SEA SHED Shoreside Test addressed those critical and other operational issues pertaining to the performance of the prototype SEA SHED system, including major subsystems and auxiliary equipment. The Shoreside Test examined these issues by conducting multiple iterations of basic SEA SHED system functions in conjunction with normal container handling functions. Table V-1 identifies specific test issues and presents a summary of goals and results.

Based upon the analysis and evaluation of test data the SEA SHED system successfully demonstrated its ability to operate in accordance with design criteria and operational requirements. Analysis of the test data has shown that the SEA SHED system as a whole is compatible with existing terminal operations and container handling equipment. The SEA SHED can be transported using available ground handling systems (forty-foot container chassis and flatbed trailers in conjunction with standard tractors and yard hustlers). Existing commercial port cranes, both gantry and mobile, can successfully handle SEA SHEDs using standard forty-foot container spreader bars.

SEA SHED subsystems were also demonstrated to adhere to design criteria. Major engineering revision of the SEA SHED subsystems is therefore unnecessary. The real-world environment of the Shoreside Test did serve to point out some subsystem shortcomings. The electromechanical winch which activates the work-through floor must

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1/ For a detailed description of test results see the SEA SHED Shoreside Test Report (Appendix Q).

be enhanced to improve its reliability.[1] The location of the tie-down fittings is being reexamined to accommodate a more densely loaded SEA SHED than was previously anticipated. Fixtures must be added to the SEA SHED design to accommodate storage of life lines and stanchions. These are indicative of suggested possible improvements rather than the identification of major deficiencies in the design.[2]

The Shoreside Test proved that operation of the SEA SHED system does not involve operations and functions necessarily unique to the SEA SHED system. Because the system design is derived from existing container systems and existing container handling equipment, the average stevedore can readily understand, and become proficient in, the operation of the system.

The SEA SHED demonstrated its ability to accommodate military cargo ranging in size from a quarter-ton Jeep to a self-propelled eight-inch howitzer and in weight to an M60 tank. It was further demonstrated that, within weight limitations, the floor of the SEA SHED can be loaded with more military equipment than had been anticipated.

A synopsis of performance times for operation of the "work-through" floor using both normal and emergency procedures is depicted in Table V-2.

Table V-3 identifies SEA SHED productivity rates after the

1/ All winches were subsequently refurbished by the manufacturer, replaced and successfully tested aboard the prototype SEA SHEDs.

2/ For a detailed description of suggested system improvements, see Shoreside Test Report (Appendix Q).

TABLE V-1

SUMMARY OF TEST ISSUES, GOALS, AND RESULTS

Test Issues	Test Goal	Observed Performance
Critical		
• "Work-Through" Floor		
(1) Functioning	(1) Adequacy	(1) Satisfactory
(2) Normal Cycle Times	(2) 5 Minutes	(2) See Table 1-1.
• Shoreside Cranes and Lifting Devices Capabilities	Adequacy	Satisfactory
• "Work-Through" Floor Clearance	Adequacy	Satisfactory
• "Work-Through" Floor-Tie-Down Devices	Adequacy	More Needed
• Container Stacking on SEA SHEDs	Compatibility	Satisfactory
• Auxiliary and Emergency Equipment Functions:		
- Lifelines and Stancheons	Adequacy	Satisfactory
- Emergency Rigging for Floor Operation	Adequacy	Satisfactory
- Emergency Winch Brake Release	Adequacy	Satisfactory
Operational		
• Establish Loading/Unloading Productivity	Develop Parameters	See Table 2-1.
• Evaluate Terminal Handling Systems Capabilities:		
- Flatbed Trailer	Compatibility	Satisfactory
- Container Chassis	Compatibility	Satisfactory
- Tow-Bar and Casters	Compatibility	Unsatisfactory
• Prepare Ancillary and Auxiliary Equipment for Storage	Identify Requirements	Completed
• Evaluate Installation and Check-out Procedures	Adequacy	Satisfactory
• Evaluate Manuals for Training Purposes:		
- Operation	Adequacy	Satisfactory
- Maintenance	Adequacy	Partially Satisfactory
• Evaluate Size and Placement of Access Trunks	Adequacy	Satisfactory
• Establish Rigging Productivity	Develop Parameters	See Table 1-1.
• Evaluate Forklift Operations Between SHEDs	Compatibility	Satisfactory

TABLE V-2

OPERATING PERFORMANCE TIMES (MINUTES)

Operation Type	Install Rigs	Operate 1/ Floor	Sub Total (One Side)	Total (Both Sides)
• Normal (SHED's Winch Power)				
Open	2.08	2.79	4.87	4.97
Close	-	2.43	2.43	2.53
Close (Manual Brake Only)	-	2.45	2.45	2.55
• Emergency (External Crane & Whip)				
Open	9.01	3.49	12.50	12.60
Close	4.02	.76	4.78	4.88

1/ Includes a six second lag (.1 minute) to allow for the fact that both floors do not operate simultaneously. Re-wind and stow excluded.

TABLE V-3

SEA SHED PRODUCTIVITY AFTER LEARNING (2-3 ITERATIONS)

TOP SHED

WEIGHT	SIZE	TIME TO LOAD
Heavy	Big	10 1/4 min
Medium (Roadgrader, 28,250#) (Bulldozer D7, 34,669#)	Big	7 1/2 min
Medium (Personnel Carrier, 19,996#)	Small	3 1/2 min
Light (Trailer, 1,500#) (Jeep, 2,380#)	Small	3 min

FOR LOWER SEA SHEDs

Multiply by:

Big and small mix	1.2
Small only	1.5

From the analysis of Shoreside Test data the prototype SEA SHED successfully demonstrated its operational viability as follows:

- The prototype can be effectively and safely transported in a terminal environment using existing, standard ground handling systems.
- Stevedoring personnel can readily assimilate instruction and operate the SEA SHED.
- Existing crane systems, both gantry type and mobile, can handle the SEA SHED.
- Varied mixes of military equipment can be loaded through the work-through floor opening.
- Floor space can be aximized to permit loading of more equipment than previously estimated.
- Deficiencies noted in subsystem performance are of a nature that enhancement rather than major redesign is required.

SECTION VI. TRANSPORTATION, STORAGE, AND REFURBISHMENT

Upon completion of the Shoreside Test, the four prototype SEA SHEDs were prepared for long term storage at MOTSU. Ancillary equipment items (power cables, lifelines and stanchions, winch cables, etc.) were placed in wooden containers for subsequent storage in a MILVAN provided by the host installation.

The SEA SHEDs were loaded on barges for storage.

The eight winches were removed from the SEA SHEDs and returned to the manufacturer (Transmission Technology, Inc.) for refurbishment of the internal winch drum mechanism.

The refurbished winches underwent certification testing at the manufacturer on April 14, 1983. Representatives from ISI and MarAd were present. The refurbished winches were returned to MOTSU during May 23-26, 1983 and reinstalled on the SEA SHEDs. The work through floors of the SEA SHEDs were cycled to test the operation of the winches. Installation and testing was conducted under ISI supervision.

During October 1983 the SEA SHEDs were transported by barge to Norfolk for testing in a commercial environment. Testing is being conducted aboard Farrell Lines ships engaged in Mediterranean service. In preparation for commercial testing, the SEA SHEDs underwent further refurbishment to include:

- Installation of copper sleeves on floor opening wire rope.
- Welding a bead on the floor to indicate (open or closed) floor securing lock position

- Installation of six additional "D"-rings on each SEA SHED.

The above actions were accomplished during the period January 12-24, 1984.

VII. TEST EVALUATION

The SEA SHED Test and Evaluation program has successfully demonstrated the viability of the SEA SHED 'tween deck conversion system for containerships.

The Test and Evaluation program achieved the following goals:

- Identification and definition of a major problem area with growing impact upon both the U.S. Maritime Industry and national defense planning.
- Successful coordination of the resources of MarAd, DOD and private industry to develop a containerization concept as a solution to this problem.
- Successful development of a SEA SHED design addressing operational requirements.
- Fabrication of four prototype SEA SHEDs structurally conforming to the developed design criteria.
- Successful completion of a shop/ABS testing agenda demonstrating structural conformity to design criteria and resulting in ABS certification of the SEA SHED system.
- Successful performance of operational testing in a simulated shipboard environment.

It has also been demonstrated that the SEA SHED design permits fabrication of multiple, uniform units. The fabrication of SEA SHEDs does not require extraordinary materials, fabrication techniques or tooling.

VIII. CONCLUSIONS

From the SEA SHED Test and Evaluation program the following conclusions have been reached:

- The SEA SHED can be produced using state-of-the-art steel fabrication techniques and common, commercially available construction materials.
- Fabrication requirements for the SEA SHED are compatible with existing mass production processes.
- The SEA SHED is not stressed beyond allowable working stresses.
- The SEA SHED subsystems perform in accordance with design criteria.
- The safe operation of the SEA SHED is readily understood by the average cargo handler.
- The SEA SHED is compatible with existing container handling systems.
- The SEA SHED can accept the anticipated range of large military equipment.
- The SEA SHED can accommodate a greater quantity of military equipment than previously anticipated.
- The Final SEA SHED Drawing Package was delivered by MARAD to Naval Sea Systems Command (PMS-377K). NAVSEA determined that the SEA SHED is a viable system and is currently contracting with two vendors for a large number of production units.

IX. RECOMMENDATIONS

As a result of preforming the SEASHED Test and Evaluation program the following recommendations are suggested for SEA SHED improvements:

- Proceed with design enhancements as discussed in detail in the Shoreside Test Report.
- Proceed with sea-based testing (Pierside and At-Sea).
- Conduct sea-based testing in a commercial environment.

X. SEA SHED REPORTS

The following SEA SHED REPORTS are available through the National Technical Information Service:

NTIS NO.	COST	TITLE
1/	-	SEA SHED Executive Summary. February 1980
PB80-216393	$6.00	Vol. 1, SEA SHED Final Report. February 1980
1/	-	Vol. 2, Evaluation of U.S. Flag Containerships for SEA SHED suitability. February 1980
PB80-216401	$10.000	Vol. 3, Concept Feasibility and Operational Analysis. February 1980
1/	-	Vol. 4, Stress Analysis, SEA SHED. February 1980
PB80-216419	$6.00	Vol. 5, The Use of Containerships to Transport a U.S. Army Mechanized Division. June 1980
PB80-216351	$7.00	Vol. 6, The Use of SL-7 containerships to transport a Marine Amphibious Brigade. June 1980
PB81-203648	$8.00	Vol. 7, The Impact of the Introduction of SEA SHED at Ocean Terminals. April 1981
PB84-117134	$20.50	SEA SHED Shoreside Test. October 1983

1/ The Project Executive Summary, and Volumes 2 and 4 were not published. They are available for review at MarAd, Office of Advanced Ship Operation and at Information Spectrum, Inc., Logistics Support and Mobility Department.

APPENDIX A - CHRONOLOGY

MILESTONE EVENT	DATE
Contract Award FY 80 (Phase I)	15 JUL 1980
Austere SEA SHED Design	17 JUL 1980
CPM Baseline	12 SEP 1980
CPM Revision	24 SEP 1980
Visit to Dundalk Marine Terminal	07 NOV 1980
Draft Temp	09 DEC 1980
Final Draft MarAd-Navy Memorandum of Understanding	09 DEC 1980
Visit to Bethleham Steel Yards, Baltimore, Maryland Tour of Bath Class Vessel	16 DEC 1980
Request for Information Published	19 DEC 1980
Source Selection Procedures Published	15 JAN 1981
Legal Consultant Hired	21 JAN 1981
RFIs Evaluated/Qualified Bidders List Published	30 JAN 1981
MarAd-Navy MOU Signed by Navy	20 FEB 1981
Visit to Military Ocean Terminal Sunny Point, North Carolina	25 FEB 1981
MarAd Letter to OPNAV, Re: Facilities/Equipment Requirements	02 MAR 1981
Temp Published	06 MAR 1981
Maryland State Port Administration Visit/Briefing	09 MAR 1981
MarAd-Navy MOU signed at MarAd	16 MAR 1981
CNO Memorandum to DCSLOG, Re: Army Equipment Requirements	25 MAR 1981
Meeting with DTNSRDC, Re: Doc. Film	01 APR 1981
Design Drawings to MarAd NAVSEA for Technical Review	02 APR 1981

MILESTONE EVENT	DATE
MOTSU Letter to HQDA (Concurrence on tasking as Test Terminal)	20 APR 1981
Stress Analysis to MarAd/NAVSEA for Technical Review	13 May 1981
Technical Review Conference of Design Drawings and Stress Analysis	03 JUN 1981
Mod #1 to ISI Contract Signed	09 JUN 1981
RFPs Distributed and Bidders Conference Announced	23 JUN 1981
MR&S Design Contract Executed	29 JUN 1981
Bidders Conference	01 JUL 1981
Technical Review of Instrumentation Package	03 JUL 1981
MR&S Received A.B.S. Comments on Test Agenda	07 JUL 1981
NAVSEA Review of Stress Analysis/Test Agenda	16 JUL 1981
RFP Amendments, Weld Specifications, Tolerances distributed to Qualified Bidders	23 JUL 1981
Bidders Conference Minutes distributed to all firms on Qualified Bidders List	24 JUL 1981
ABS Approval of Test Agenda	04 AUG 1981
ABS Approval of MarAd-designed Hold Modification	05 AUG 1981
Bidding Closed	14 AUG 1981
Steering Group Meeting	26 AUG 1981
OTEA Briefing	02 SEP 1981
Selection Committee Meeting	03 SEP 1981
SEA SHED Briefing (Marty Fink, NAVSEA)	03 SEP 1981
NAVSEA Approval of T&E Agency	14 SEP 1981
Visit to Tracor Marine	22-23 SEP 1981

MILESTONE EVENT	DATE
Briefing for LCDR Nick Schmitt USN, OASD	05 OCT 1981
Received MR&S Final SEA SHED Design Drawings	13 OCT 1981
NAVSEA Approved Final Design Drawings	26 OCT 1981
MarAd Approved Final Design Drawings	27 OCT 1981
Received ABS Comments on Tracor Test Agenda	28 OCT 1981
SS Design Drawings Signed	02 NOV 1981
Design Drawings to ABS for Review	10 NOV 1981
Request for Best and Final Offer Sent	27 NOV 1981
ABS Approved Final Design Drawings	02 DEC 1981
ABS Approved Design Drawings to MarAd/NAVSEA	07 DEC 1981
ABS Approved Manufacturerer's Test Agenda	09 DEC 1981
Best and Final Negotiations with Tracor	21 DEC 1981
Fabrication Subcontract to MarAd Procurement Division for Review/Approval	29 DEC 1981
Fabrication Subcontract to Ron Corkrey for Review	04 JAN 1982
Award of Fabrication Subcontract	20 JAN 1982
Contract Extension to MarAd Procurement for Review/Approval	28 JAN 1982
Meeting with Marty Fink, NAVSEA Re: T&E Schedule/Army Support	29 JAN 1982
Fabrication Contract Award Announcement to "Maritime Reporter and Engineering News"	29 JAN 1982
T&E Schedule/Army Support Meeting	05 FEB 1982
Tracor ABS Test Agenda Sent to American Bureau of Shipping	10 FEB 1982
ISI/NAVSEA Visit to Tracor Marine	10-11 FEB 1982
Signed Contract Extension from MarAd Procurement	24 FEB 1982

MILESTONE EVENT	DATE
SEA SHED Fabrication Commences "First Steel Cut"	24 FEB 1982
Delivered 40' SEA SHED Status Report to NAVSEA 03R2	23 MAR 1982
DAR #4A Received, Subject PC #18, Controller, MR&S Drawing M13D	5 APR 1982
Informed that "Export Leader" will not be available for Test Ship	09 APR 1982
DCSLOG (TALO-TSM) provided revised Army cost estimate	20 APR 1982
ISI/MarAd Reps met to discuss program funding	4 MAY 1982
ISI/NAVSEA met to discuss T&E Schedule	5 MAY 1982
MarAd requested NAVSEA arrange a SEA SHED T&E Coordination Meeting	7 MAY 1982
ISI Reps visited Tracor Re: ABS/Shop Testing	17-21 MAY 1982
Tracor Marine letter requesting fabrication of Steel Water Containment Structure	18 MAY 1982
Tracor RFI #2 Subject Shop Test #10	25 MAY 1982
Tracor letter requesting four week delay in delivery to MOTSU	25 MAY 1982
ISI, NAVSEA, MarAd, Army Reps met at FT EUSTIS to discuss T&E Schedule/Army support	27 MAY 1982
ISI approval of Tracor request to increase Cost Winch Assembly	28 MAY 1982
Tracor letter Re: Slippage of ABS/Shop Testing to 10 June vice 7 June due to inclement weather	1 JUN 1982
ISI approved request to construct water containment structure	1 JUN 1982

MILESTONE EVENT	DATE
Received Tracor Marines Sequence Chart (ABS/Ship Testing)	2 JUN 1982
Tracor Report of Inclement Weather Delay	3 JUN 1982
Tracor Report of Inclement Weather Delay	8 JUN 1982
Rescinded T&E RFPs	11 JUN 1982
MarAd approves Manual Brake Release Mod to Contract	11 JUN 1982
Received Tracor DAR #5 Re: Lockbolts	14 JUN 1982
ISI approves DAR #5	15 JUN 1982
Tracor Report of Inclement Weather Delay	18 JUN 1982
MarAd consents to Instrumentation Subcontract	18 JUN 1982
Received DAR #7 Re: Controller	22 JUN 1982
Instrumentation Subcontract executed	23 JUN 1982
Caster System Purchase Order executed	30 JUN 1982
Received RFI #4	1 JUL 1982
Received request to approve additional cost Re: Tracor RFI #4	9 JUL 1982
Letter to Tracor (Menghi) Re: RFI #4	14 JUL 1982
Letter to COTR Re: Completion of ABS/Shop Testing and Additional Testing	22 JUL 1982
TRACOR DAR #7 approved	30 JUL 1982
Transmittal of MR&S corrections to MR&S DWG 8086-M120 to Tracor	30 JUL 1982
ISI submitted a Request to Contracting Officer for consent to award Mod #2 to Tracor Contract (Additional tolerance testing)	03 AUG 1982
ISI requested Contracting Officer consent to Mod #1 to John Roberts Contract (Additional Data Collection)	03 AUG 1982

MILESTONE EVENT	DATE
ISI requested Contracting Officer consent to Mod #3 to MR&S Contract (Ship Modifications)	03 AUG 1982
Request for consent to Mod #3 to TRACOR Contract (PADEYES)	03 AUG 1982
Contracting Officer consents to Mod #1 to John Roberts Contract	09 AUG 1982
Request for consent to Mod #2 to John Roberts Contract (Deflection Insrumentation)	10 AUG 1982
Contracting Officer consents to Mod #2 to John Roberts Contract	13 AUG 1982
ISI, MR&S and COTR meet Re: Additional Tolerance Testing/ Stress Analysis and Intrumentation	17 AUG 1982
Mod #1 to John Roberts Contract Executed	17 AUG 1982
Contracting Officer consents to Mod #1 (TOW BAR) and #2 (Additional Testing) to Tracor Contract	17 AUG 1982
Mod #2 (Additional Testing) and Mod #3 (PADEYES) to Tracor Contract executed	17 AUG 1982
Contracting Officer consents to Mod #3 to MR&S Contract (Ship Mods for C-6)	19 AUG 1982
Mod #3 to MR&S Contract executed	19 AUG 1982
Contracting Officer consents to Change Order #5 (Additional Shimming Requirements to Tracor Contract)	19 AUG 1982
Change Order #5 executed	19 AUG 1982
ISI/Tracor meeting Re: Additional Shimming Requirements	19 AUG 1982
ISI/John Roberts meeting Re: Additional Strain Guage requirements	19 AUG 1982
Caster Wheels Shipped from Albion Industries	19 AUG 1982
MarAd locates sources of tie down devices	23 AUG 1982

MILESTONE EVENT	DATE
Change Order #6 (Additional Washers) to Tracor Contract executed	27 AUG 1982
Mod #2 to John Roberts Contract executed	27 AUG 1982
SEA SHED status update/request for new test window to MarAd	27 AUG 1982
Tracor begins shimming of SEA SHED # 2	01 SEP 1982
ISI modified change order #5 (Re: Corner Columns)	03 SEP 1982
ISI Representatives visit Tracor (Re: ABS/Shop Testing and MarAd-directed additional tolerance testing and shimming)	06-15 SEP 1982
Tracor began MarAd-Directed additional tolerance testing	07 SEP 1982
ISI and MarAd reviewed initial detailed test plan for the shoreside test	16 SEP 1982
ISI, MarAd and MR&S representatives visited Tracor to discuss shimming/ prototype delivery	21-23 SEP 1982
ISI requested contracting officer approval to award modification #4 to Tracor Marine (Re: Video Tapes of fabrication/shop testing)	01 OCT 1982
Draft shoreside detailed test plan distribution for review	06 OCT 1982
ABS certified prototype SEA SHEDs	09 OCT 1982
Prototype SEA SHEDs shipped to MOTSU	09 OCT 1982
Prototype SEA SHEDs arrive at MOTSU	13 OCT 1982
ISI/MarAd representatives visit MOTSU to conduct final test coordination	13-14 OCT 1982

MILESTONE EVENT	DATE
ISI/MarAd/MOTSU representatives visit Ft Eustis to conduct final test coordination	15 OCT 1982
Final Shoreside Detailed Test Plan published	22 OCT 1982
Shoreside Test Directorate began operations at MOTSU	25 OCT 1982
On-Site preparation for Shoreside Test	25-31 OCT 1982
SEA SHED Shoreside Test	01-17 NOV 1982
Visitors day (SEA SHED Shoreside Test)	09-10 NOV 1982
MG BRUEN (MTMC) Visited Shoreside Test	15 NOV 1982
ISI requested status of Tracor deliverables	02 DEC 1982
C6 Ship Mods signed at MarAd	06 DEC 1982
ISI/MR&S/MarAd representatives visit Transmission Technology (Re: Winch redesign)	09 DEC 1982
ISI received Tracor's recommendations concerning SEA SHED design changes	15 DEC 1982
NAVSEA requested authorization from the Naval Audiovisual Center for ISI personnel to use their VHS equipment for editing T&E video tapes	16 DEC 1982
ISI submitted modification #4 to MR&S contract providing no-cost extension until May 15, 1983	22 DEC 1982
Modification #4 executed	04 JAN 1983
CO approved transmission tech subcontract Re: Overhaul/refurbishment of winches	27 JAN 1983
ISI requested CO's approval for reallocation of funds to T&E effort	24 FEB 1983
Subcontract with Transmission Technology for winch refurbishment executed	03 MAR 1983

MILESTONE EVENT	DATE
Final SEA SHED Drawing Package - Revision A delivered to PMS-377K	MAR 1983
ISI/MarAd representatives met with commercial containership operators Re: Commercial At-Sea Test	13 APR 1983
ISI/MarAd representatives visited transmission technology to observe certification testing of winches	14 APR 1983
ISI representatives visited MOTSU to supervise replacement/testing of winches on prototype SEA SHEDs	23-26 MAY 1983
ISI submitted draft Shoreside Test Report to MarAd for review.	AUG 1983
ISI submitted Final Shoreside Test Report to MarAd for review.	SEP 1983
ISI submitted Shoreside Test Report to printers.	15 SEP 1983
Shoreside Test Report published.	OCT 1983
Prototype SEA SHEDs brought by barge to Norfolk for refurbishment.	24-26 OCT 1983
Repair and modification of prototype SEA SHEDs accomplished at Norfolk.	12-24 JAN 1984
NIT receives four production SEA SHEDs to store.	19 APR 1984
Production SEA SHEDS stored at NIT and Newport News.	APR-JUL 1984

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