26p.

NSP-63-106
11 Oct 1963

N64-25571
CODE-1 CAT. 27
NASA CR-56833

Third RIFT Manufacturing Engineering Working Group Meeting
Progress of RIFT Manufacturing Plan, Volume 1

MANUFACTURING OPERATIONS

OTS PRICE
XEROX $ 2.60 ph
MICROFILM $

Prepared Under Contract No. NAS 8-5600

NUCLEAR SPACE PROGRAMS – LOCKHEED MISSILES & SPACE COMPANY
Sunnyvale, California

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PROGRESS OF RIFT MANUFACTURING PLAN – VOLUME 1, MANUFACTURING OPERATIONS

The first edition of the RIFT Manufacturing Plan, Volume 1, concerning Manufacturing Operations was published approximately nine months ago. Volume 2, The Manufacturing Development Plan, Volume 3, The Experimental Tool Program, and Volume 4, Assembly Facility Activation Plan, had been submitted earlier in accordance with the negotiated program data submittal document schedule and hence, for reasons of expediency, were divorced from the parent Manufacturing Operations volume. Volume 5 of the series concerns The Cryogenic Insulation Plan and only recently has been submitted to NASA for review and comment.

The Manufacturing Operations volume, considered as the "basic plan," was first conceived during the proposal stages of the program and was, in turn, updated and submitted as stated earlier. As a means of introduction, it was primarily written to acquaint MSFC personnel with the overall Saturn Nuclear Stage Program and, more specifically, to outline RIFT Manufacturing's translation of the stage and developmental hardware conceptual design in terms of fabrication, assembly, tooling, handling, and testing.

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Since initial publication of the Plan, the endeavor has been made to keep pace with the changes in Stage Design concepts and at the same time attempt to stay abreast of the progress made at Marshall as well as at other Saturn contractor facilities where tool manufacture, qualification, and hardware fabrication are now in progress. There is a great deal to gain from visits to Marshall and other Saturn V facilities, as well as from the experiences others are now having with respect to the tooling, material, and process requirements of large spacecraft fabrication.

In contrast to the great amount of activity now going on here and elsewhere on the Saturn V stages, the RIFT Program is still more than a year away from the start of detail design of the earliest major tooling. Based on current schedules, installation of the first assembly tool in the Moffett Field hangar is not expected to start until January 1966.

In the ensuing months we are anticipating a marked increase in Engineering design activity. As design concepts are refined, this, of course, will be revealed with increased detail in forthcoming revisions to the Manufacturing Plan.

To date, the LH_2 tank design is much the same as shown during the May 22nd Working Group Meeting, with one exception; a reduction in diameter of the aft bulkhead access cover which, in turn, has had an impact on the Manufacturing Plan. The approach to the problems involved will be discussed in succeeding paragraphs of this publication.

The tank cylinder, as presently described, consists of four hoops or barrel sections of external, integrally stiffened panels machined from 2-in. plate stock. Recent engineering compression-load tests, using representative 10-ft-square sections of the tank wall, have been very encouraging. Although the tests thus far completed are inconclusive, it is believed that the integrally stiffened configuration, in one form or another, will be used for the RIFT Tank Cylinder.

The fore and aft bulkheads of the LH_2 tank, except for the aforementioned reduction in size of the aft access, are unchanged.

With respect to some of the details of bulkhead fabrication, personnel in Manufacturing are committed to resume study of gore panel fabrication techniques. The forming methods eventually chosen will have a bearing on the number of individual gores in each bulkhead. An increase in the number of gores would be required, if for example, the parts were formed by conventional stretch methods, since available press capacity would then become the controlling factor.

At the present time the fore and aft tank skirts are basically the same integrally stiffened structures as the tank cylinder. In all probability this concept will be abandoned in favor of either mechanically fastened, conventional skin and stringer construction or by low-density sandwich structure. A machined, integrally stiffened structure, although light in weight, is expensive; and, since tight sealing of gas and liquid is not necessary (as in the tank cylinder), the material and fabrication costs become prohibitive. Manufacturing also intends to participate with Engineering in a development program using Lockalloy, a new beryllium-aluminum alloy which shows great promise, due to its high modulus and low density.

Although the material is in short supply at this time, candidate structures components for Lockalloy on the S-N stage (RIFT) include, in addition to the tank skirts, the nose fairing, the interstage, and the thrust structure.

Regardless of the final material selection, it is reasonable to predict that the tank skirt structure will more closely resemble interstage rather than tank wall construction. This could lead to the possibility of using a multipurpose assembly fixture capable of manufacturing either skirts or interstages in lieu of our present plan of utilizing the same tooling for both skirts and tank barrels.

Among the changes in tank configuration of vital concern to Manufacturing was the recent reduction in size from 48 to 30 inches of the aft bulkhead access opening.

DESIGN EVOLUTION OF TANK ACCESS OPENING

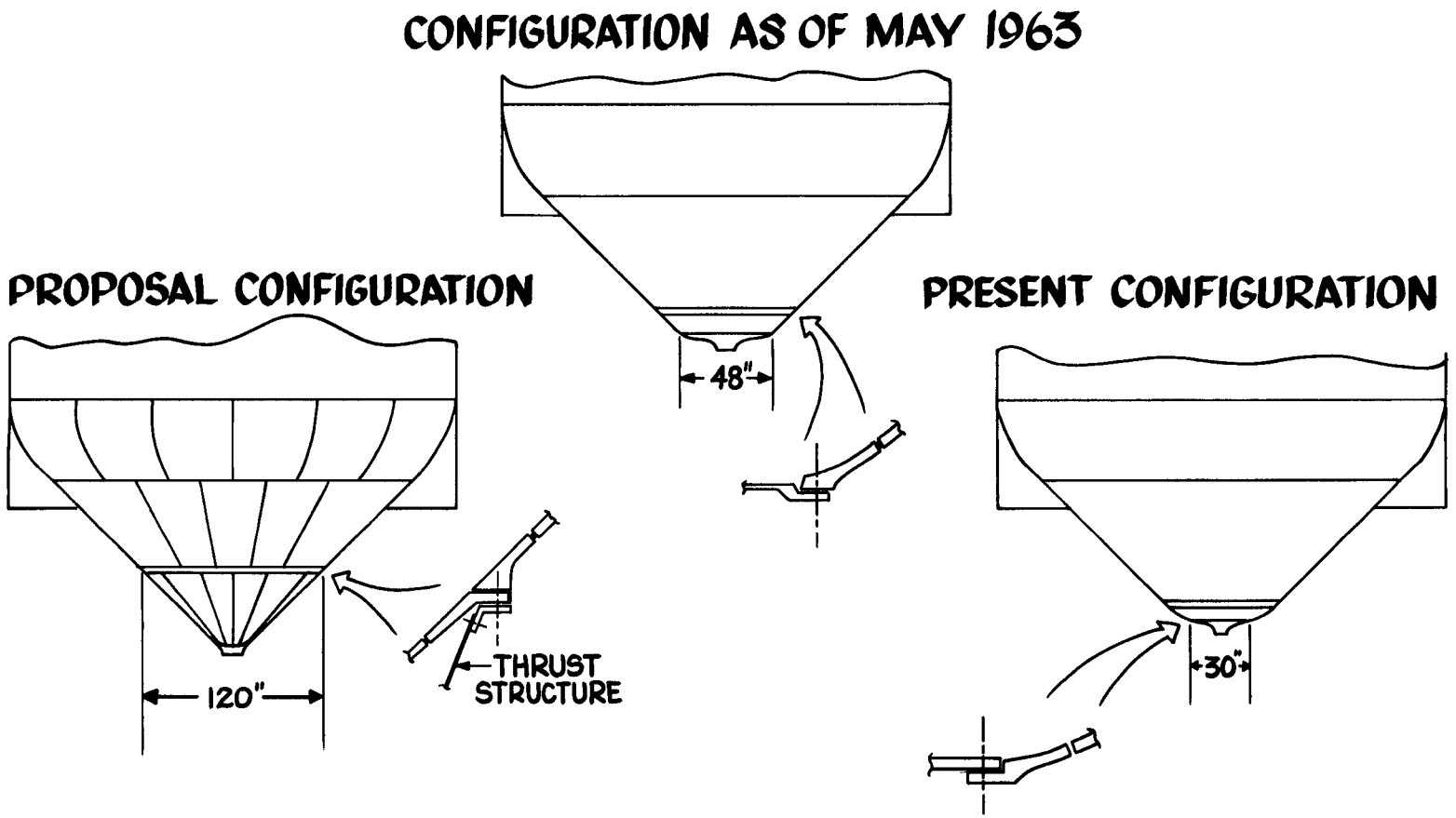
The tank-bottom configuration, at the time the RIFT proposal was being prepared, included a 120-in. removable conical aft closure attached to the tank by means of a circular tension bolt pattern with holes threaded into the tank-bottom flange. The same bolts were intended to serve for attachment of the engine thrust structure.

About a year ago Stage Design resumed detail analysis of the thrust structure arrangement in an effort to provide an uninterrupted load path from the engine into the tank structure. As an outgrowth of the resulting design improvement, an elliptical tank bottom was proposed, replacing the conical bottom. Recognizing the problems involved in sealing the tank openings against escape of LH_2, the access opening was then reduced in size to 48 in.

A study was conducted at that time, and it was then determined, from a manufacturing point-of-view, to allow the minimum access of 48 in. The study was based on the existing tooling concepts of using a telescoping mast arrangement, coming up through the tank opening, and, with retractable platforms, providing convenient working access to the inside of the tank at all levels during installation of instrumentation, insulation, and equipment.

More recent concern by Engineering over the anticipated LH_2 sealing problems has since forced further reduction in size of the access opening from 48 in. to the presently proposed 30 in. At the same time the cover was shown with an internal mating face.

DESIGN EVOLUTION OF TANK ACCESS OPENING



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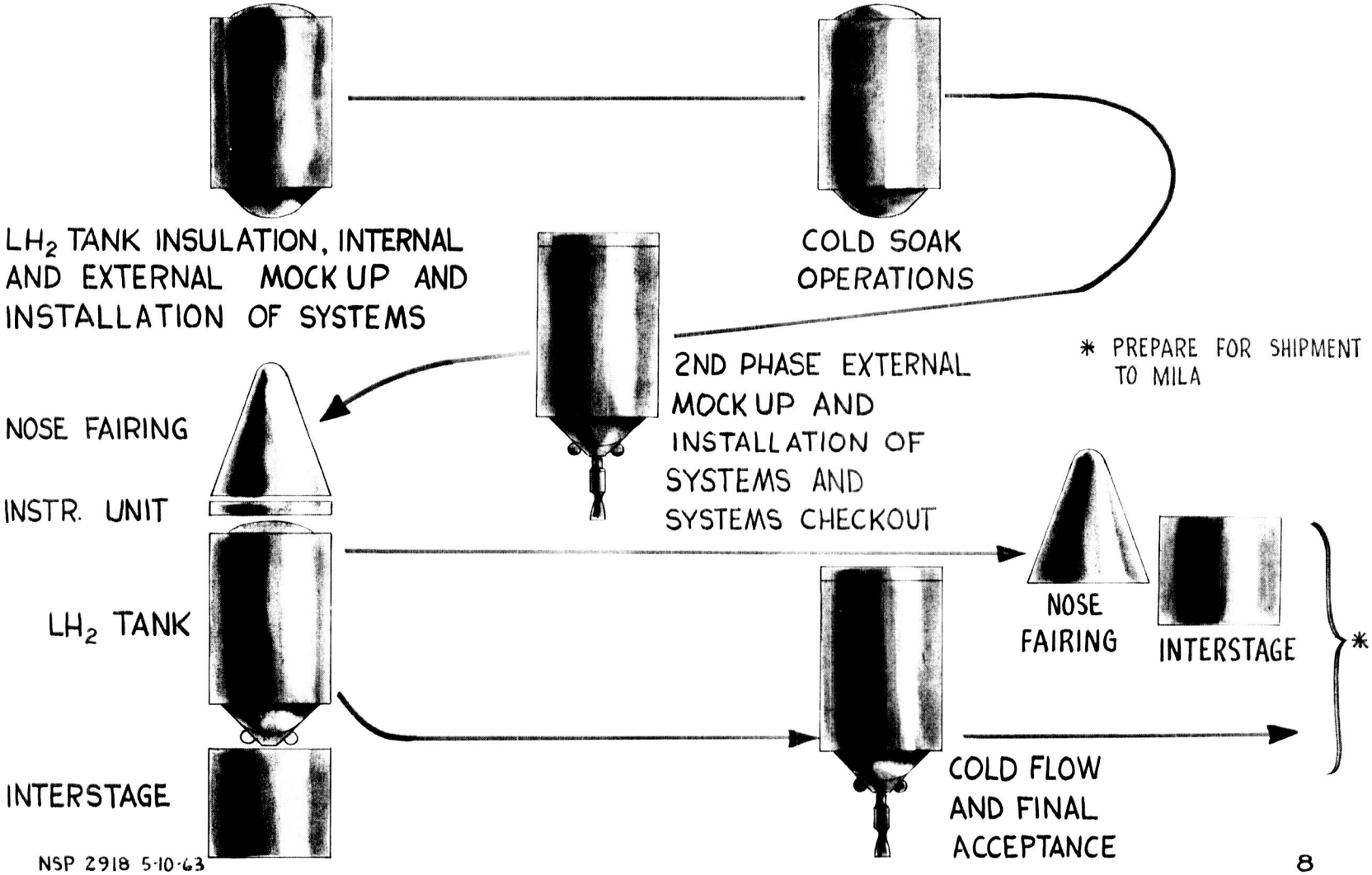
FINAL ASSEMBLY SEQUENCE

Shown here is the final assembly sequence of a typical flight S-N stage. The operations displayed begin following hydrostatic tests and internal cleaning of the LH_2 tank. The first station of the final assembly line has been planned to accommodate all of the instrumentation, insulation, and equipment installations required inside of the tank.

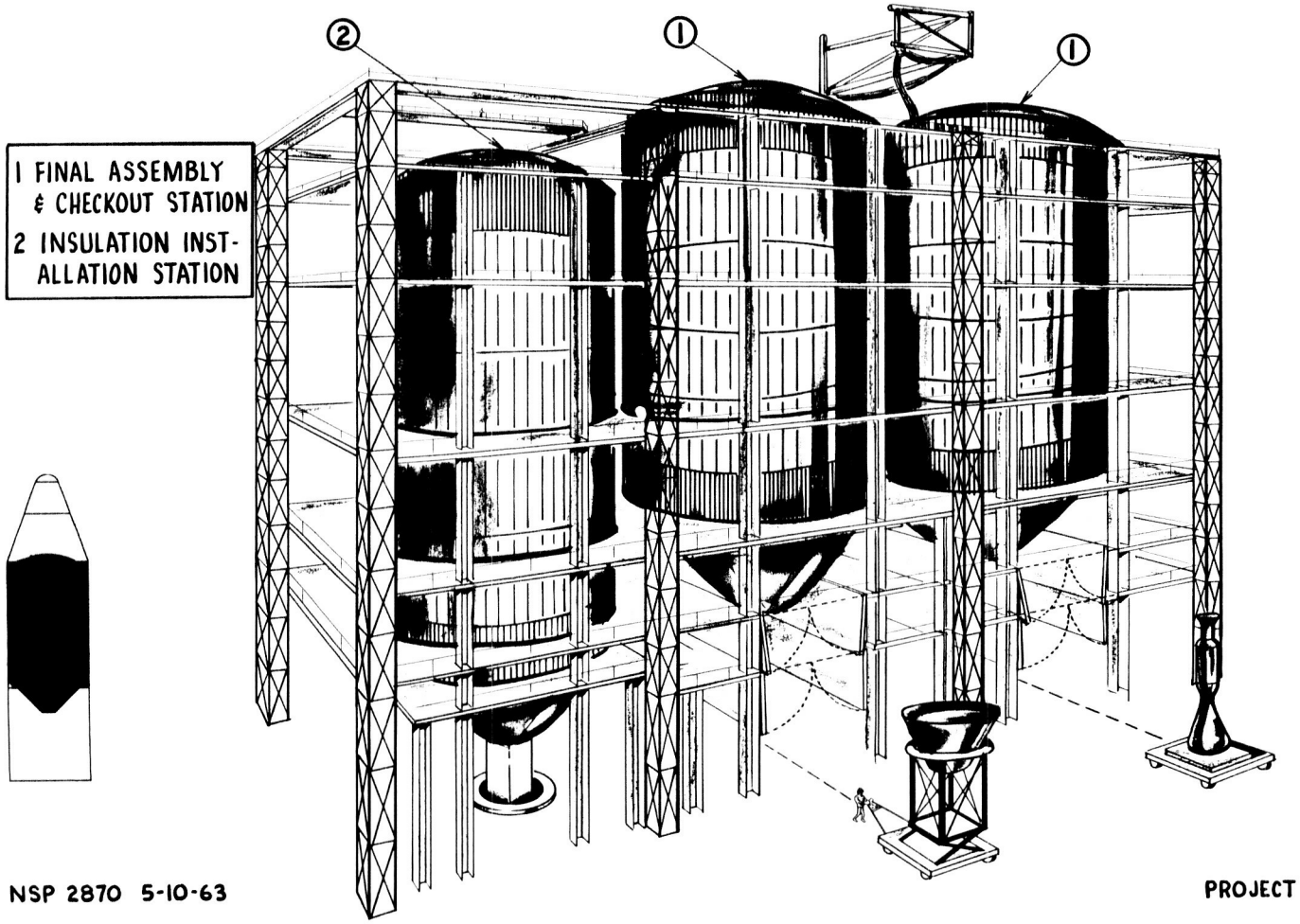
FINAL ASSEMBLY SEQUENCE



INSULATION INSTALLATION, FINAL ASSEMBLY & SYSTEMS CHECKOUT

Three separate though interconnected work stations are provided in final assembly, with the tank being supported in a vertical attitude in each of these stations and resting upon a structural ring arrangement which simulates the joint geometry of the mating interstage assembly. As can be seen here, the elevating work platform is to be provided for only the first station of the three-station final assembly line. It is expected that a certain amount of unplanned activity such as repairs, modifications, or inspection, necessary once the tank left this station, might be accomplished by lowering workmen on a "Bosun's" chair arrangement through the upper 48-in. opening.

INSULATION INSTALLATION, FINAL ASSEMBLY & SYSTEMS CHECKOUT



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PROJECT TOOL

TANK INSULATION INSTALLATION

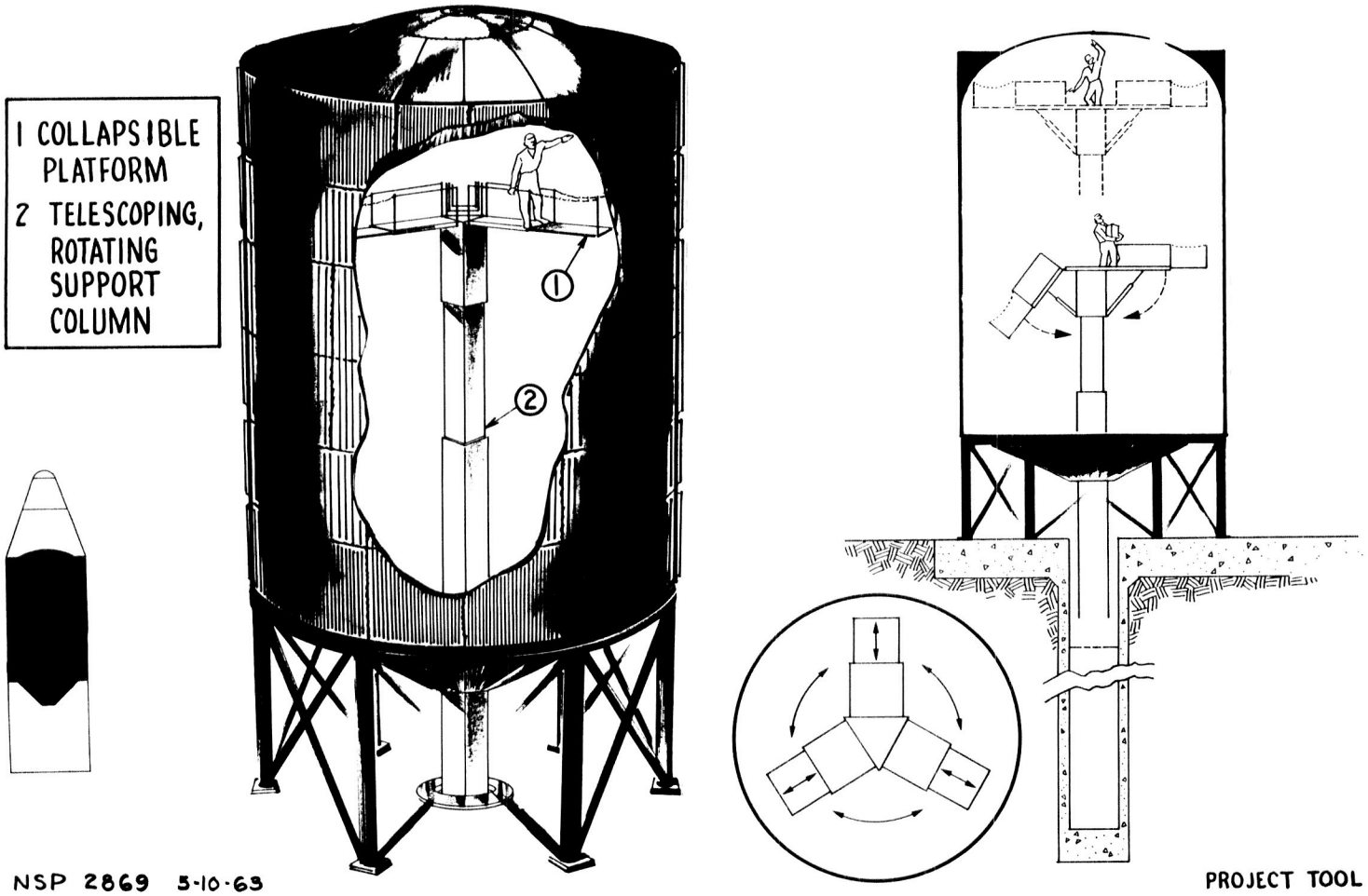
Shown here in more detail is the elevating platform arrangement as originally planned. The telescoping box structure enters the tank through the aft access. This concept, though not particularly unique, could be a rather costly affair, due to safety restrictions, elevator provisions for personnel and parts, air conditioning, heating and power sources (all self-contained). An expenditure for such a rig for more than one of the final assembly stations is, therefore, deemed inadvisable at this time. With this compromise extensive work activity was limited to one physical location in the assembly line, and a possible "homemade, do-it-yourself" bottleneck was thus created.

Still concerned over the difficulty in overcoming the LH_2 sealing problem, Stage Design, as mentioned earlier, then decided to reduce the diameter of the aft bulkhead opening to 30 in.

When first confronted with this proposal, it was evident that the original concept for supporting the platform from below was no longer feasible. At least it appeared that any structure of the telescoping variety that also met all safety regulations could not be designed and yet pass through this 30-in. opening. Since the diameter of the opening at the top of the tank still remained 48 in., two alternate possibilities were considered:

- Insulating the tank in an inverted position without change in the original tooling concepts
- Devising a retractable platform-type of construction entering the tank through the top 48-in. opening

TANK INSULATION
INSTALLATION



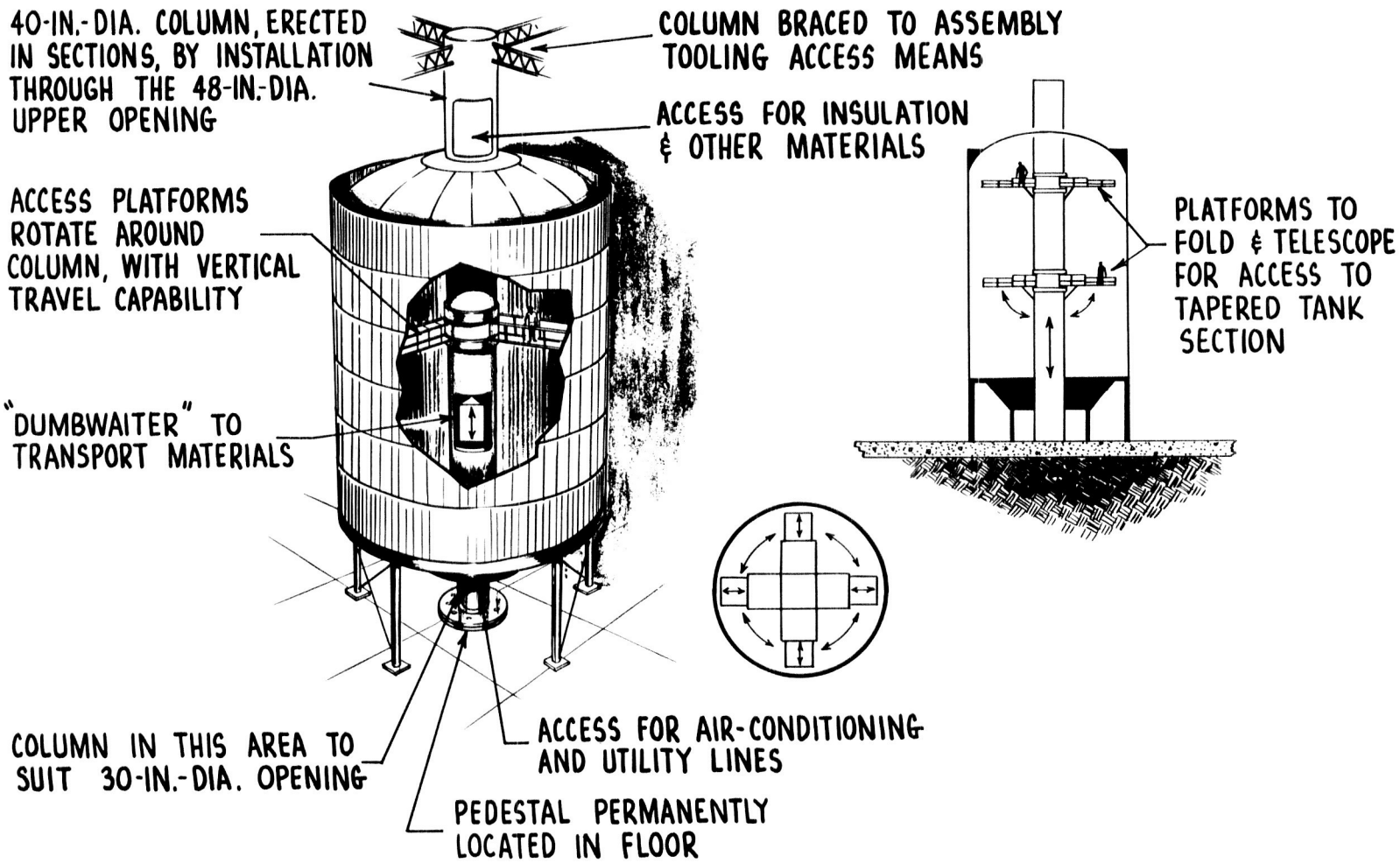
A CONCEPT OF TANK INSULATION INSTALLATION

This figure depicts a current concept; the same general idea of a structural mast with retractable platforms, as first proposed, with the main difference being that the device now enters the tank through the top rather than through the bottom. Certain advantages over the original plan soon became obvious. It was found that the new concept, with no requirement for an underground pit, would be less costly.

The hollow mast, as shown, can be assembled in sections and lowered into the tank from the top. The bottom end of the mast is pinned into a floor-mounted plate, while the upper end is stabilized by braces tied to the vertical jig structure. Access to the tank is gained through the sidewall of the mast, which has openings at the top and bottom as well as from within the tank for passage of personnel, equipment, and the insulating tiles. This arrangement provides added versatility, too, in that the mast can be used in connection with any of the final assembly work stations or, if the occasion arises, while the tank is being cleaned prior to and following insulation, as well as during any unforeseen modifications which may be necessary.

This presentation has attempted to give some of the paramount problems and achievements so far encountered with the design and ultimate construction of the S-N stage (RIFT). It will be a number of months before the metal-cutting stage is reached. At the present time Engineering personnel are studying various related concepts, and much of their activity is still in the analysis phase. With an increasing degree of design activity indicated, Manufacturing soon will be more deeply involved in the details. The latest results of these concept studies will be given through future updatings of the Manufacturing Plan and Manufacturing Working Group Meetings.

A CONCEPT OF TANK INSULATION INSTALLATION



NSP 3269 9-25-63

1 BACKGROUND AND OBJECTIVES

The two welded compression-test-panel assemblies are of a curved, integrally stiffened skin construction representating Stage Design's earlier concepts of the RIFT LH_2 tank barrel-panel configuration.

The individual panels, two each with longitudinal measurements of 95 in. and 119 in., respectively, were machined in the flat from 2.00-in.-thick 2219-T87 aluminum. These four panels are of identical cross section and width (109 in.) and have been contoured to a constant 198-in. radius. The machining and contouring of these panels was performed by the Lockheed-California Company at Burbank.

Following fabrication, the individual panels were delivered to RIFT Test Operations and, in turn, were subjected to the first in a succession of compression-load tests. These tests were conducted at the University of California at Berkeley.

The second phase of the test schedule calls for the same two sets of panels (95 in. and 119 in. long, respectively,) to be delivered to Berkeley, and again compression-tested – this time in the larger, double-width configuration.

The panel welding will be accomplished by RIFT Development Manufacturing, utilizing equipment already in operation or on order and tooling presently in the process of design and manufacture.

The objectives of this program are:

- To perform the welding, setup, and checking of the 95- and 119-in. curved compression panels as described by Stage Design Drawing Nos. 6900275 and 6900274 and under controlled conditions meeting the requirements of NSP Specification 6540023
- To develop the necessary techniques, procedures, tooling, and equipment and conduct a planned program of tests and evaluations preliminary to welding the subject panels

2 GENERAL DESCRIPTION OF WORK

Weld Development

- Fabrication of 6 test panels 0.326 in. by 24 in. by 120 in. machined from 0.375 2219-T87 material
- Welding of the above (Item A) into four 48-in. by 120-in. distortion-test and two destructive-test panel assemblies
- Test and evaluation of the above (Item B)
- Fabrication of two 20-in. by 120-in. integrally stiffened, curved test panels machined from 2.00 2219-T87 material
- Welding of the above (Item D) into one 40-in. by 120-in. distortion-test panel assembly

Compression Test Panels

- Assembly, welding and setup, checking and straightening of the 6900275 (95 in. by 218 in.) panel
- Assembly, welding and setup, checking and straightening of the 6900274 (119 in. by 218 in.) panel

Miscellaneous

- Complete documentation of all developmental, assembly, and welding operations, including test results, specimens, and pertinent data

3 MANUFACTURING SEQUENCE

Hardware delivery, as shown on the sequence chart for ESDP large-panel weld development (Fig. 6) is contingent upon successful execution of a series of developmental activities. These activities, for ease of reporting and for the convenience of readjustment, are grouped into five chronological phases (Fig. 6) as follows:

Phase I

Fabrication. Machining and preparation of material for:

- Weld procedure development and flat-distortion-test panels

- Destructive tests – tensile-test and bend-test panels
- Curved, integrally stiffened specimens

Inspection and rework of the 6900107-1 panels to meet drawing dimensional requirements.

Tooling. Design and manufacture as required to support weld development and the pre-weld setup, and inspection of the 6900107-1 and 6900101-1 panels.

Handling Equipment. Design and manufacture for single-panel (119 in. by 109 in.) capability.

Phase IIA

Weld Development. Flat panels, 0.326 in. by 48 in. by 120 in. (6 required).

Test and Evaluation. Radiographic specimens and tensile- and bend-test specimens.

Inspection. Setup and squaring of 6900107-1 and 6900101-1 panels.

Tooling. Design and manufacture as required to support assembly and welding of the 6900275 (95 in.) and 6900274 (119 in.) panels.

Handling Equipment. Design and manufacture for dual-panel (119 in. by 218 in.) capability.

Phase IIB

Weld Development. Flat, machined, integrally stiffened curved specimen panels, 0.326 in. thick (edge) by 40 in. wide by 120 in. long.

Inspection and Evaluation. Radiographic, distortion, and shrinkage measurements.

Phase III

Assembly. Welding, checking, and profiling of 6900274 (119 in.) compression-test panel.

Delivery and Test.

Phase IV

Assembly. Welding, checking, and profiling of 6900275 (95 in.) compression-test panel.

Delivery and Test.

4 FACILITIES AND EQUIPMENT

Execution of the foregoing program of development and manufacture will utilize existing and/or planned facilities and equipment as follows:

Fabrication of Detail Parts

- Phase I flat-panel machining and processing (Outside Production)
- Phase I curved, integrally stiffened specimen panels, machining, and processing (CALAC)
- Phase IIA coupon machining and processing to conduct the tensile and bend tests (Central Manufacturing)
- In-process cleaning as required (Central Manufacturing)

Pre-Weld Setup and Inspection

- Phase I setup and dimensional check of 6900107-1 (119 in. by 109 in.) panels (CALAC)
- Phase IIA setup, dimensional check of 6900107-1 (119 in. by 109 in.) and 6900101-1 (95 in. by 109 in.) panels utilizing "project" check fixture to be located in RIFT Development Manufacturing, Building 303 (Moffett Field hangar)

Development, Assembly, and Welding

Phases IIA and IIB weld development and Phases III and IV fusion welding of the 6900275 (95 in.) and 6900274 (119 in.) ESDP curved, compression-test panels utilizing:

- Existing Sciaky automatic fusion welder and associated LMSC appurtenances, i.e., weld traveler located in RIFT Development Manufacturing, Building 303
- Lockheed modified airline stake fixture

Postweld Setup and Inspection

Phases III and IV setup, dimensional check, and profiling of 6900275 (95 in.) and 6900274 (119 in.) curved, compression-test panels utilizing the experimental weld fixture (as adapted).

5 RESPONSIBILITIES

RIFT Development Manufacturing

Preparation of all essential documentation, execution of weld development, and assembly of the compression-test panels as described in the foregoing paragraphs. This is to include tool designs and tooling, documentation and recording of the developmental and manufacturing processes used, assimilation and recording of in-process test data, and initiation of all procurement action as required.

Central Manufacturing

Detail fabrication support as required.

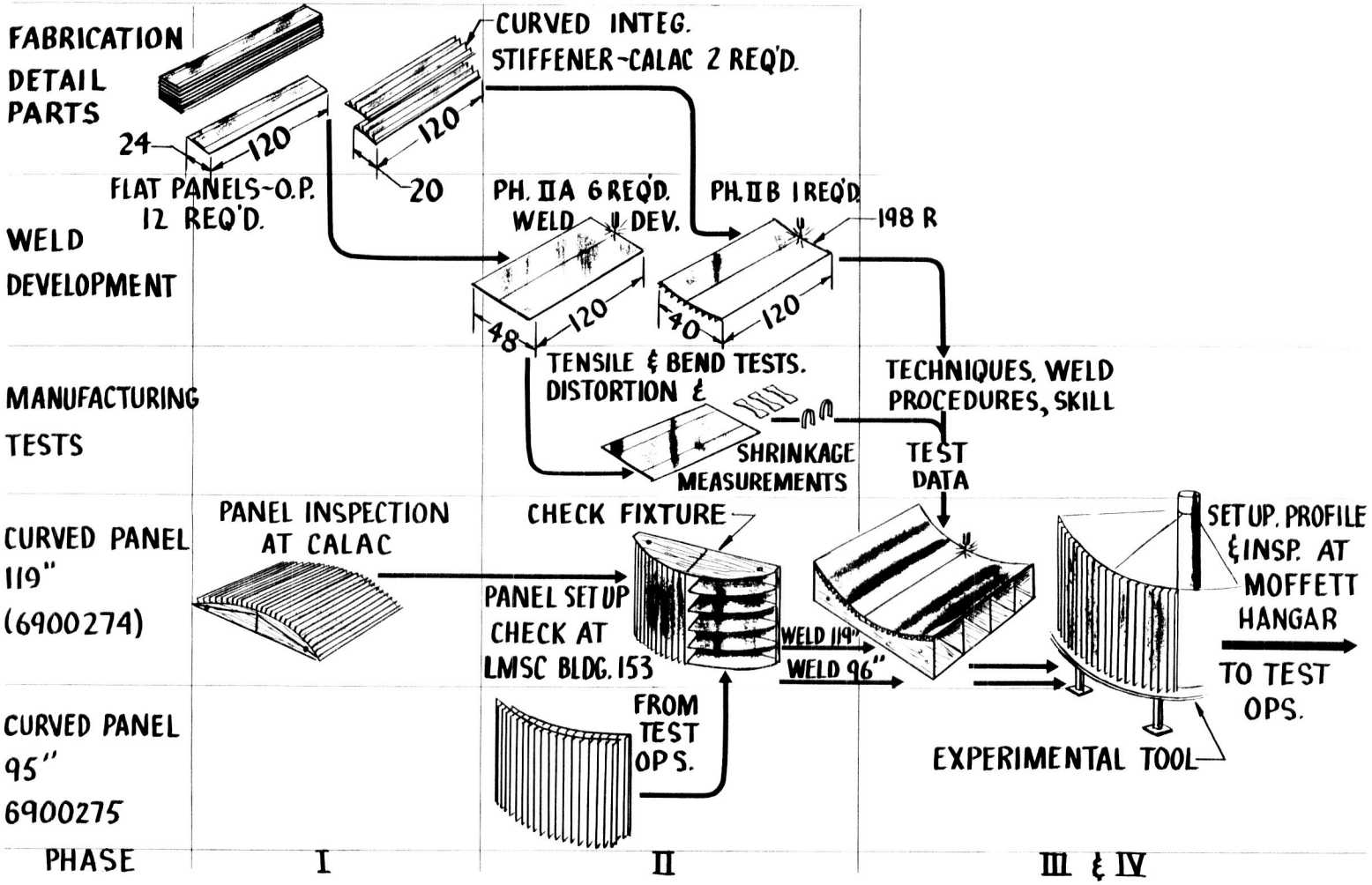
Procurement

Response to all requests for interdivisional and outside manufacturing support as required.

RIFT Quality Assurance

Receiving and in-process inspection as required.

ESDP CURVED-PANEL WELD DEVELOPMENT & MFG. SEQUENCE



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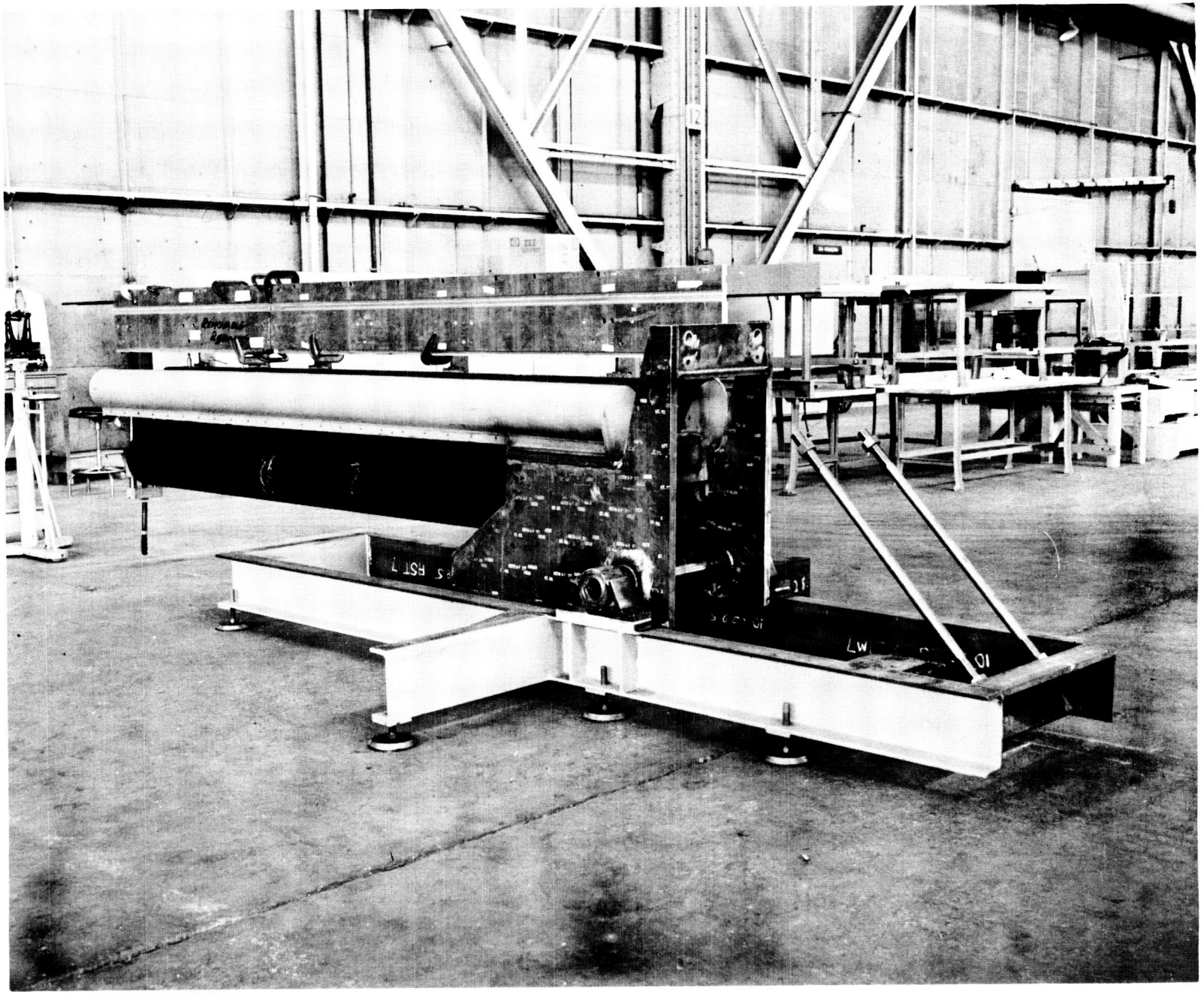
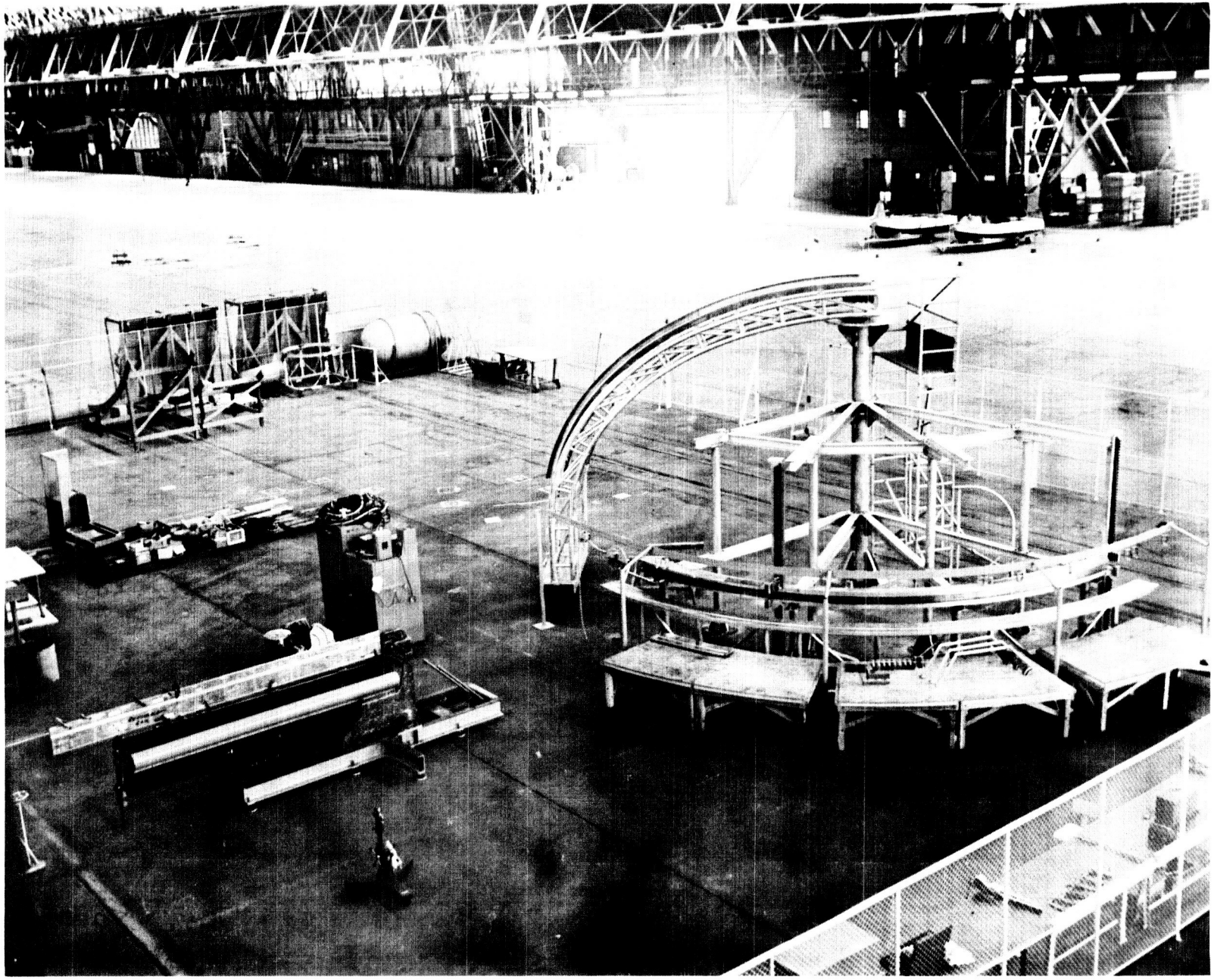
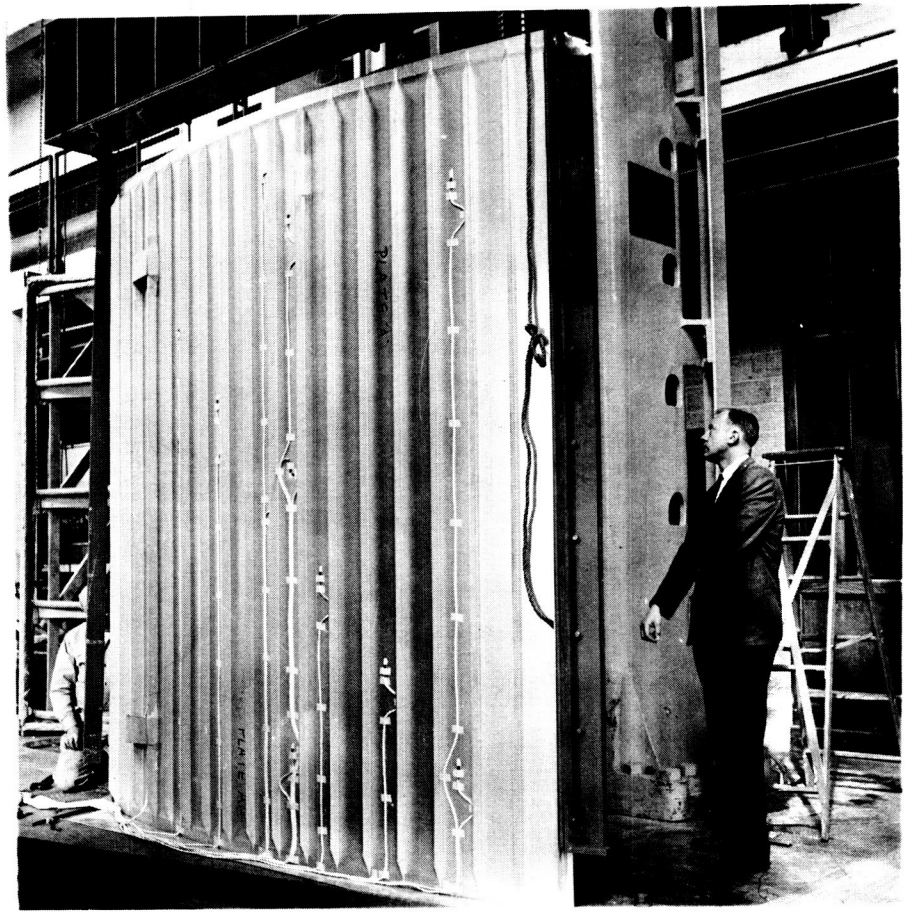




CURVED TANK WALL PANEL (119 IN X 109 IN)



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