

**MASTER**

NTO-M-15037

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Attention: A. Schaff, Jr.

Subject: E/STS-2&3 Activation Guide, Preliminary Issue

Dear Mr. Rice:

Attached is the Preliminary Issue of the E/STS-2&3 Activation Guide. If further information concerning this document is required, please contact Mr. R. G. Staker or Mr. A. W. Magnusson.

Sincerely yours,

N. E. Erickson
N. E. Erickson, Manager
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AWM:NEE:jj

Attachment: E/STS-2&3 Activation Guide,
Preliminary Issue

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PRELIMINARY

E/STS 2&3 ACTIVATION GUIDE

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Abstract

This document describes the various activities shown on the E/STS-2&3 activation guide network, Figure 1, and represents the initial NTO effort in support of the major E/STS-2&3 activation activities. It is NTO's intent to upgrade this document from time to time as designs and guidelines change or become firm.

Logic for the conduct of the various activities has been based on ETS-1 activation experience and backup references have been included for similar ETS-1 activities where applicable. The information contained herein is based on available information and may not reflect the most current E/STS-2&3 concepts.

One of the purposes of this document is to identify the special test equipment (STE) requirements for facility activation. These articles, in addition to major requirements, are to be found under the activity heading "Requirements". Preliminary sketches of major STE have also been included to supplement the written description and generally acquaint the reader with these concepts.

ACTIVITY

B O D - ALL ACTIVITIES

Summary

Buy-Off-Date (BOD) is the formal acceptance by the operating contractor of the systems from the construction contractor. Upon BOD it is expected that the system will be ready, without further construction or maintenance effort, for the first identified activity. The effectiveness of BOD is dependent primarily upon the adequacy of the construction specifications and the construction followup. It is assumed that the following action will be taken to minimize the problems encountered after BOD, such as rebuilding and/or recleaning systems, and hence minimize the costs (monetary and time) of correcting system deficiencies:

- a) Specifications will be prepared in such a manner that the appropriate construction standards are a requirement on the contractor. Included in this category are rigid Quality Control and workmanship standards such as:
 1. Detailed welding standards, non-destructive testing requirements, and acceptance standards for the non-destructive test results.
 2. Pipe fit-up requirements, especially at mating flanges or joints to assure proper system integrity.

3. Pipe mounting requirements to assure adequate tie-down
4. Cleanliness requirements to assure adequate precautions are taken during construction, and final verification of cleanliness upon completion of construction.

The specifications, should be reviewed by the operating contractor to ensure that operational considerations are factored into the design.

- b) Construction followup of the contractors effort will be in sufficient detail to insure that the requirements of the specifications are satisfied. A thorough quality inspection program will be instituted to assure strict compliance with the specifications. Operating contractor personnel will be intimately involved in the followup effort to ensure that when corrective action is needed, it is taken by the construction contractor and that operating personnel are fully aware of construction history.
- c) The operating contractor will generate acceptance test procedures to provide maximum assurance of complete check-out and to minimize any duplication of checkout effort before and after BOD. The results of acceptance testing will be thoroughly documented and reviewed by operations personnel to insure that acceptance testing requirements are satisfied.
- d) Premature BOD will not occur in order to meet construction schedules at the later expense of activation schedule.
- e) Facility performance (fluid systems) specifications to which the facility is designed will be compatible with initial test specifications.

Activity

" Initial Fill and Simulated Duct Flow Tests "

I. Summary

This test will be conducted to gain system information on and operating characteristics of the water supply and return line installation. Specific objectives are:

1. Valve dynamic performance under load
2. Cavitation suppression techniques
3. Effect on shield and steam generator water supply pressure at duct full flow conditions

II. Requirements

1. Duct Simulator (series of multi-holed orifice plates)
2. SGS and Shield Flow Simulator (fixed orifices)
3. Special Purpose Diagnostic Instrumentation (water hammer effects)
4. Controls Trailer

III. References

- | | | |
|------------------------------|---|------------|
| 1. IF-1 Test Report | - | NTO-S-005 |
| 2. IF-2 Test Report | - | NTO-R-009 |
| 3. IF-3 Test Report | - | NTO-R-0041 |
| 4. IF-4 Test Report | - | NTO-R-0098 |
| 5. Pulsation Controls Report | - | R-177 |

ACTIVITY

"DUCT WATER FLOW TESTS"

I. SUMMARY

This activity will demonstrate the Duct operation performance, determine the variation from design for the purpose of final adjustment water flow rate through the several paths. A secondary objective is to optimize fill and drain flow control procedures plus entire system checkout.

II. REQUIREMENTS

- A. Permanent Instrumentation Installed
- B. Temporary Diagnostic Measurement Devices
- C. Permanent Control System Installed

III. BACKUP REFERENCES

- A. Test Specification RN-S-0127, Phase II
- B. Test Description NTO-I-0137
- C. Control Room Procedure NTO-M-13160
- D. Final Report NTO-R-0106

ACTIVITY

SHIELDS: "WATER FLOW TESTS"

I. SUMMARY

This activity covers the checkout of the shield water system. The shields will be filled with water (no boron) using the mixing stations and circulating water pumps. The pumps will be used to transfer water from shield to shield and also to circulate the water in the lower and intermediate shields, using simulated signals to the control valves to verify proper heat exchanger operation. Transient conditions resulting from simulated failure of a circulating water pump will be determined, using all possible pump combinations.

In a separate checkout, the satisfactory operation of the chemical mixing stations will be verified, using prescribed chemicals. The effluent water will be analyzed to verify proper chemical concentrations.

II. REQUIREMENTS

- A. Shield and Shield Water Systems Completed
- B. Facility Water Supply
- C. Permanent or Temporary Controls and Instrumentation
- D. Pump Power

II. (Continued)

E. Limited Supply of Orthoboric Acid and Borax

F. Facilities for Chemical Analysis

G. Storage or Disposal of Limited Quantities of Borated Water

III. BACKUP REFERENCES

ACTIVITY

SHIELDS: "MECHANICAL SEAL AND LEAK TEST"

I. SUMMARY

This activity covers the verification of the shield positioning equipment operation, the integrity of the mechanical seals, and a leak check of the Engine Test Compartment (ETC). The shields will be positioned, seal make-up completed, and the Duct will be sealed off with a test plug. The ETC will be evacuated using temporary vacuum pumps and all seals will be checked for leakage. The shield seals will be broken and the shield will be repositioned to simulate preparation for engine removal.

II. REQUIREMENTS

- A. Shield Construction Completed
- B. Test Plug
- C. Temporary High Capacity Vacuum Pumps
- D. Shield Water Supply
- E. Shield Gas Purge Supply
- F. Simulated Lower Tank Structure

III. BACKUP REFERENCES

- A. Procedure for ETC Mechanical, Seal and Leak Test (NTO-I-0165)

ACTIVITY

SHIELDS: "GN₂ PURGE TESTS"

I. SUMMARY

This activity covers the nitrogen purge tests of the Engine Test Compartment (ETC) to determine the optimum method of GN₂ purge for inerting the ETC and Duct. The operation of the H₂/O₂ analyzers will be checked and the location of the probes will be optimized. The GN₂ will be released into the ETC, discharged through the exhaust duct and released to atmosphere.

II. REQUIREMENTS

- A. Shield Construction Completed
- B. Simulated Lower Tank Structure
- C. Temporary O₂ Analyzer System
- D. GN₂ Purge Supply

III. BACKUP REFERENCES

- A. Test Description CEP-I - ETC Purge Tests (NTO-I-0144)

Activity

"Component Leak Check and Electromechanical Checkout"

I. Summary

This activity is to insure the integrity of the steam generator components. These preliminary component tests are required for:

1. Pressure Switch calibrations
2. Check Valve functional tests
3. Verification of orifice size and locations
4. Operational verification of proper sequencing
5. Safety System verification

II. Requirements

1. Local control of SGS Control System including cold checkout device (trailer)

III. Reference

1. Test Report, SGS EP-I, NTO-R-0023
 - a. Page 3
 - b. Appendix III Change Requests

Activity

"Steam Generator Water Flow Tests"

I. Summary

This activity covers the Steam Generator Water Flow Tests designed to demonstrate the operational performance of the coolant and injection water flow systems. This test series will accomplish the following objectives:

1. System impedance verification at various flow rates to determine minimum head requirements.
2. Performance evaluation of injection flow control system
3. Evaluation of dynamic water flow forces (water hammer)

II. Requirements

1. Steam line simulator orificed to simulate duct injection impedance
2. Temporary diagnostic instrumentation

III. References

1. Test Report, SGS Development Program, EP-IV - NTO-R-0061, Page 7

Activity

"Steam Generator Idle Tests"

I. Summary

This activity covers the initial firing of the individual steam generator units to accomplish the following objectives:

1. Determine the operating characteristics of the individual steam generator units at idle.
2. Investigate interaction effects of one module on another during multiple module operation.
3. Complete system checkout of propellant supply system with real hardware.
4. Initial checkout of controls and safety circuits under operating conditions.

II. Requirements

1. Over board steam line with orifice to simulate injector back pressure.
2. Block valve in steam line to facilitate system leak and pressure tests.
3. Special purpose diagnostic instrumentation

III. References

1. EP-I Test Specification RN-S-0203
2. Test Description (EP-I) NTO-I-0027
3. Test Report EP-I NTO-R-0033

ACTIVITY

"STEAM GENERATOR COMPLETE SYSTEM CHECKOUT"

I. SUMMARY

A. Individual checkout of each unit at full steam to determine:

1. Proper Unit Operation
2. Determine Proper Mixture Ratio
3. Performance Evaluation

B. Multiple module operation to determine:

1. Interaction Effects During Start-Up and Shutdown
2. Optimum Start-Up and Shutdown Procedure
3. Switching Tests
4. Reliability Tests
5. Duration Tests
6. Off-Design Tests

C. Evaluation of facility steam line to verify design:

1. Starting Shocks
2. High Temperature Warpage
3. Hanger Support and Snubber Systems

II. REQUIREMENTS

A. Overboard Steam Line with Switch-Over Valve to Facility Steam
Line

II. (Continued)

B. Fixed Orifice to Simulate Injection Back Pressure

C. Block Valve to Facilitate Pressure Tests

III. BACKUP REFERENCES

A. Test Report - Steam Generator Development Test Program, EP-II
(NTO-R-0046)

ACTIVITY

"NES GN₂ DEMONSTRATION TESTS"

I. SUMMARY

The Design Demonstration Test Program provides for cold flow testing of the NES at both NERVA design and off-design conditions. These tests will be used to demonstrate the performance of NES prior to its use in supporting the testing of a nuclear engine. Testing at two levels of primary chamber pressure provides assurance that the duct will perform safely over the entire operating range. Testing at off-design conditions verifies that the duct performance is not marginal. The tests will be conducted at NRDS using E/STS-2 Facility (I&C, process water, gas supply system, steam generator, test stand, and permanent engine compartment).

II. REQUIREMENTS

- A. NES Test Device (See Attached Sketch)
- B. Sufficient Storage of GN₂ to Accommodate Flow Demand Profiles
- C. Separate GH₂ Supply for Turbine Exhaust Flow

III. BACKUP REFERENCES

- A. NES Design Demonstration Test Program (RN-S-0137A)
- B. NES Test Specification No. 201
- C. NES Phase I Final Test Report (NTO-R-_____) (In Publication)

ACTIVITY

"NES GH₂ DEMONSTRATION TESTS"

I. Summary

The NES Test Program will be designed to obtain the most information possible from the two test series (GN₂, GH₂).

Test Number I (GN₂) investigates, above the duct "pull-in" point, the effects of excess seal leakage and excess turbine exhaust on NES and ETC performance. Also demonstrated is the ability of the SGS to function as an aerodynamic "check valve" during a simulated engine malfunction shutdown.

Test Number II investigates, above the duct "pull-in" point, the effects of design turbine exhaust and GH₂ primary flow on the NES performance and exhaust plume radiation on the NES and Test Stand.

II. Requirements

1. NES Test Device (See attached sketch)
2. Sufficient storage of GH₂ to accommodate flow demand profiles
3. Separate GH₂ supply for turbine exhaust flow

III. References

1. NES Design Demonstration Test Program - RN-S-0137A
2. NES Test Specification No. 202

ACTIVITY

ALCOHOL TANK V-AL-20: "GN₂ PRESSURE TEST AND PRESSURIZATION AND VENT TESTS"

I. SUMMARY

This activity covers the initial water fill, GN₂ pressure test, and subsequent pressurization and vent tests on the alcohol storage vessel. The tank will be filled with water to the maximum operating level. The tank will be gradually pressurized in steps to 125% of operating pressure, using GN₂ and then reduced to the leak test pressure. Any leaks will be identified and corrected. Following successful leak testing, the pressurization/venting characteristics of the tank will be established. The tank will be dried and left with an inert atmosphere upon completion of this activity.

II. REQUIREMENTS

- A. Temporary Water Supply to Tank
- B. GN₂ Supply Available to Tank
- C. Pressurization and Vent System Operable
- D. Temporary or Local Controls
- E. Tank Drying Capability

III. BACKUP REFERENCES

ACTIVITY

"FIRE PROTECTION SYSTEM, DELUGE ACTIVATION AND CHECKOUT"

I. SUMMARY

This activity includes the initial introduction of water through the various test stand and facility deluge systems; with flow rates, static head pressures, and *HAD automatic trip pressures and temperature rates of rise recorded.

The supply vessel(s) (utility and process water tanks) will be filled, the system valve alignment normal (except for RSV's at deluge valves - shut), the system leak checked (at all flanges, packing glands, joints, etc.), the HAD system response recorded (temperatures, rates of rise) and flow rates per individual deluge system recorded.

II. REQUIREMENTS

- A. Electrical Power
- B. Demineralized Water System Completed
- C. Temporary Flow Meters
- D. Temporary Heat Source for HAD Checkout (Temperature Recorded)

*Heat Actuated Detector

III. BACKUP REFERENCES

- A. Safety Analysis Report
- B. Safety System Control Procedure (NTO-I-0077-5)
- C. Fire Protection System Setup Procedure (NTO-I-0154-1)
- D. Console Setup Checklist (NTO-I-0143)

ACTIVITY

ALCOHOL TANK V-AL-20 : "WATER FLOW TESTS"

I Summary

This activity covers the water flow tests to checkout pumps and piping systems prior to filling the tank with combustible alcohol.

Each pump (three turbine main pumps and one electric auxiliary pump) will be operated at full load conditions. The water will be pumped using the normal alcohol piping and valves to a point as close to the steam generators as is practical. A steam generator simulator will be used to provide realistic flow conditions. Upon completion of this activity the tank and piping will be dried and an inert atmosphere will be left within the system.

II Requirements

- A. Temporary water supply to tank
- B. GN_2 supply available to tank
- C. Pressurization and vent systems operable
- D. Main and auxiliary pumps operable.
- E. Alcohol system completed to vicinity of SG's.
- F. Steam Generator simulator installed
- G. Electric and steam power available for pumps
- H. Alcohol system controls operable.

III Backup References

None

ACTIVITY

ALCOHOL TANK V-AL-20: "ALCOHOL FILL AND FLOW VERIFICATION TESTS"

I. SUMMARY

This activity covers the initial alcohol fill and flow tests on the alcohol system. The tank will be filled with alcohol and all tank instrumentation will be checked. Each pump will be operated at full load conditions. All three main pumps will be operated at normal load and system transients caused by simulated single pump failure will be determined. The alcohol will be pumped using the normal alcohol piping and valves to a point as close to the steam generators as is practical. A steam generator simulator will be used to provide realistic flow conditions and alcohol disposal facilities. Upon completion of this activity, the system will be left in the normal lay-up conditions.

II. REQUIREMENTS

- A. Alcohol Supply
- B. System Construction Completed, Including Pressurization Supply, Instrumentation and Controls.
- C. Steam Generator Simulator (Including Alcohol Disposal Facilities) Installed.
- D. Steam and Electric Power

III. BACKUP REFERENCES

ACTIVITY

"LOX TANK V-LO-19: GN₂ PRESSURE TESTS"

I. SUMMARY

This activity covers the GN₂ pressure test on the liquid oxygen storage vessel. The vacuum jackets associated with these systems will be pumped down to operating pressure and the jackets and pumping system will be checked for operational characteristics and integrity. The tank will be gradually pressurized in steps to 125% of operating pressure using GN₂ and then reduced to the leak test pressure. Any leaks will be identified and corrected. After successful leak testing, the tank will be vented and left with an inert atmosphere.

II. REQUIREMENTS

A. GN₂ Supply Available to Tank

III. BACKUP REFERENCES

None

ACTIVITY

LOX TANK V-LO-19 : "LN₂ CRYOSHOCK AND LEAK TEST"

I Summary

This activity covers the initial cryoshock (LN₂) of the LOX storage vessel and cold leak test of the vessel and associated systems.

The storage vessel will be chilled and filled to approximately 10% following pulldown of the vacuum annulus. The self-pressurization system will be checked out using LN₂. All mechanical fittings in the dewar, fill and pressurization systems will be torque checked and the systems drained. While the dewar and associated systems are cold, a GN₂/GHe mixture will be introduced and the systems will be leak tested. The system will then be vented.

II Requirements

1. Electrical power
2. Vacuum pumps
3. LN₂ source
4. GN₂ source
5. He source
6. He leak detectors
7. Temporary I&C equipment

III Backup References

None

ACTIVITY

"LOX TANK V-LO-19 : LN₂ FLOW TESTS TO SGS INTERFACE"

I Summary

This activity covers the LN₂ flow tests to checkout pumps and piping systems prior to filling the tank with liquid oxygen.

The tank will be filled with LN₂ and pressurized to normal operating pressures using the self pressurization system.

Each pump (three turbine main pumps and one electric auxiliary pump) will be operated at full load conditions. The LN₂ will be pumped using the normal LO₂ piping and valves to a point as close to the steam generators as is practical. A steam generator simulator will be used to provide realistic flow conditions.

Upon completion of this activity, the tank and piping will be drained and an inert atmosphere will be left within the system.

II Requirements

1. LN₂ supply to tank.
2. Pressurization and vent systems operable.
3. Main and auxiliary pumps operable.
4. LO₂ system completed to vicinity of SG's.
5. Steam generator simulator installed.
6. Electric and steam power available for pumps.
7. LO₂ controls operable.

III Backup References

None

ACTIVITY

"LOX TANK V-LO-19: LOX FILL AND FLOW VERIFICATION TESTS"

I. SUMMARY

This activity covers the initial LOX fill and flow verification tests on the LOX system. The tank will be filled with LOX and all tank instrumentation will be checked. Each pump will be operated at full load conditions. All three main pumps will be operated at normal load and system transients caused by simulated single pump failure will be determined. The LOX will be pumped using the normal LOX piping and valves to a point as close to the steam generators as is practical. A steam generator^{SIMULATOR} will be used to provide realistic flow conditions. Upon completion of this activity, the system will be left in normal lay-up conditions.

II. REQUIREMENTS

- A. LOX Supply
- B. System Construction Completed Including Instrumentation and Controls
- C. Steam Generator Simulator Installed
- D. Steam and Electric Power

III. BACKUP REFERENCES

ACTIVITY

"INITIAL SITE CHECKOUT OF NGTM"

I. SUMMARY

This activity concerns itself with the initial site checkout of the NGTM prior to installation in the E/STS-2 Test Stand. These activities cover the following:

- A. Inspection
- B. Instrumentation Installation and Checkout (Megger Instrumentation and Power Bus)
- C. Functional Component Checkout (Valves, pressure switches, etc.)

II. REQUIREMENTS

- A. Inspection Building
- B. Portable Electronic Checkout Devices

III. BACKUP REFERENCES

- A. MAD Procedures P-1 through P-9

ACTIVITY

"NGTM PRESSURE TESTS"

I. SUMMARY

This activity covers the initial pressurization tests of the NGTM using the facility pressurization control system. It is anticipated that the initial pressurization fluid will be GN₂ with 10% helium. The objectives of this test are:

- A. Checkout NGTM Pressurization and Vent Systems
- B. Leak Check of Umbilical Connections
- C. Leak Check of PSOV and/or the Engine/MPT Interface

II. REQUIREMENTS

- A. TSCS Controls System
- B. PSOV Operable or a Blind Flange at Engine/MPT Interface

III. BACKUP REFERENCES

- A. FEP-III Phase 2 Test Description
- B. FEP-III Final Report

ACTIVITY

"EP-2: TRANSFER AND LOADING EXERCISE TO NGTM AND CHECKOUT OF EMERGENCY DRAIN"

I. SUMMARY

This activity covers the initial LH₂ transfer exercises to the NGTM and verification of the emergency drain operation.

With the storage and pressurization dewars filled, the pressurization dewar will be self-pressurized and pressurization of the storage dewar via the heat exchanger will be accomplished. When adequate pressure has been established in the storage dewar, LH₂ transfer operations to the NGTM will be established. NGTM level and temperature data will be verified and the heat loss characteristics of the NGTM will be verified. Transfer line chilling data will be obtained relative to future topping exercises. This FEP will be concluded by performing out-flow tests through the NGTM emergency drain system.

II. REQUIREMENTS

- | | |
|-----------------------|-------------------------------------|
| 1) CP Consoles | 6) Fire Protection System |
| 2) CP I&C | 7) H ₂ Alarm System |
| 3) CP Data System | 8) O ₂ Detectors |
| 4) GHe Bottles | 9) Emergency Drain Overboard System |
| 5) Flares & Burn Pond | 10) Hot Water System |

III. BACKUP REFERENCES

- 1) FEP-III Test Description: Liquid Hydrogen System Tests (NTO-I-0136)

ACTIVITY

"EP-3: RATED FLOW TESTS OF NGTM AND TOPPING"

I. SUMMARY

This activity covers the NGTM flow and topping tests.

With the NGTM filled, temperature rise-rate tests will be conducted at various ullage pressures and transfer function exercises will be conducted on the pressure/vent system. Flow tests will then be conducted at minimum and maximum rates, with and without topping, through the engine simulator. Fluid samples will be taken during flow testing to establish cleanliness levels and system integrity through the remote connector verified.

II. REQUIREMENTS

- 1) CP Consoles.
- 2) CP I&C.
- 3) CP Data System.
- 4) Engine Simulator (control valve, associated piping and burn-off system).
- 5) H₂ Alarm System.
- 6) O₂ Detectors.
- 7) Fire Protection System.
- 8) GHe.
- 9) Hot Water System.

III. BACKUP REFERENCES

- 1) ETS-1 Activation Specification (NTO-I-0094).
- 2) FEP-III Test Description: Liquid Hydrogen System Tests (NTO-I-0136)

ACTIVITY

LH₂ STORAGE AND PRESSURIZATION DEWARS

"GN₂ LEAK TEST"

I. SUMMARY

This activity covers the GN₂ leak test of the LH₂ storage and pressurization dewars, fill systems and heat exchangers.

The LH₂ dewars, fill systems, and heat exchangers will be pressurized to 75% of the operating pressure and then reduced to their respective leak test pressure settings with GN₂. The pressure holding capability of each valve will be demonstrated and a system leak test performed in preparation for the LN₂ cryo shock and cold leak-tests. The vacuum jackets associated with these systems will be pumped down to operating pressure and the jackets and pumping system will be checked for operational characteristics and integrity. A blow down of the dewars will be conducted through the fill system to verify system cleanliness.

II. REQUIREMENTS

- A. Electrical Power
- B. GN₂ Trailers
- C. Leak Detectors (sonic type)
- D. Temporary I&C Equipment
- E. Contaminant Trap or Target

ACTIVITY

LH₂ STORAGE AND PRESSURIZATION DEWARS: "INSTALL & CHECKOUT INSTRUMENTATION"

I. SUMMARY

This activity covers the installation and checkout of the permanent and temporary transducers on the storage and pressurization dewars.

The permanent and temporary transducers will be installed along with the mounting brackets, rakes etc. Associated wiring will be run and integrated with the temporary I&C checkout equipment as required. Various resistance and continuity checks will be performed and calibrations made where applicable. Functional checks will be performed on all valves.

II. REQUIREMENTS

- A. Electrical Power
- B. Scaffolding
- C. Temporary I&C Checkout Equipment
- D. Temporary Control System

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)

ACTIVITY

LH₂ STORAGE AND PRESSURIZATION DEWARS: "LN₂ CRYO SHOCK AND LEAK TEST"

I. SUMMARY

This activity covers the initial cryo-shock (LN₂) of the LH₂ Storage and Pressurization Dewars and cold leak-test of these systems.

The subject dewars will be chilled and filled to approximately 10% following pulldown of the vacuum annuli. The pressurization dewar will be pressurized (checking out the self-pressurization system) with GN₂ to the pressure required to chilldown the heat exchangers. At this point, the LH₂ vaporizer will be functionally checked with LN₂. All mechanical fittings in the dewars, fill, and heat exchanger systems will be torque checked and the systems drained. While the dewars and associated systems are cold, a GN₂/He mixture will be introduced and the systems will be leak tested. The systems will then be evacuated and inerted for the subsequent H₂ operations.

II. REQUIPEMENTS

1. Electrical Power
2. Vacuum Pumps
3. LN₂ Source (tankers or dewar)
4. He Source (trailer or tank farm)
5. GN₂ Source (trailers or LN₂ vaporizer)
6. He Leak Detectors
7. Temporary I&C Equipment

III. BACKUP REFERENCES

1. ETS-1 Activation
2. LN₂ Loading of V-5001 and Cryogenic Leak Tests (NFO-I-0153)

ACTIVITY

LH₂ STORAGE AND PRESSURIZATION SYSTEMS: "LH₂ VAPORIZER CHECKOUT WITH LH₂"

I. SUMMARY

This activity covers the checkout of the LH₂ vaporizer pumping characteristics.

Conduct of this activity requires that the pressurization dewar contains LH₂ and can be accomplished concurrent with "Initial LH₂ Fill and Pressurization System Checkout". Following chilldown of the LH₂ vaporizer supply system, the pumping operations will be initiated. Pumping rate will be established by comparing initial GH₂ storage pressure with final GH₂ storage pressure. The system will be checked for leakage and operation of all valves, pressure, and temperature switches will be verified.

II. REQUIREMENTS

- A. C.P. Consoles
- B. LH₂ in Pressurization Dewar
- C. Leak Detector
- D. Fire Protection System
- E. H₂ Alarm System

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094).

ACTIVITY

HIGH PRESSURE LH₂ DEWARS: "INSTALL AND CHECKOUT INSTRUMENTATION"

I. SUMMARY

This activity covers the installation and checkout of the permanent and temporary transducers on the high pressure LH₂ dewars.

The permanent and temporary transducers will be installed along with the mounting brackets, rakes, etc. Associated wiring will be run and integrated with the temporary I&C checkout equipment as required. Various resistance and continuity checks will be performed and calibrations made where applicable. Functional checks will be performed on all valves.

II. REQUIREMENTS

- A. Electrical Power
- B. Scaffolding
- C. Temporary I&C Checkout Equipment
- D. Temporary Control System

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)

ACTIVITY

HIGH PRESSURE LH₂ DEWARS: "GN₂ LEAK TEST"

I. SUMMARY

This activity covers the GN₂ Leak Check of the High Pressure Dewars.

The LH₂ dewars and fill systems will be pressurized to 75% of the operating pressure and then reduced to their respective leak test pressure settings with GN₂. The pressure holding capability of each valve will be demonstrated and a system leak test performed in preparation for the LN₂ Cryo Shock and Cold Leak Tests. The vacuum jackets associated with these systems will be pumped down to operating pressure and the jackets and pumping system will be checked for operational characteristics and integrity. A blow-down of the dewars will be conducted through the fill system to verify system cleanliness.

II. REQUIREMENTS

- A. Electrical Power
- B. GN₂ Trailers
- C. Leak Detectors (Sonic type)
- D. Temporary I&C Equipment
- E. Contaminant Trap or Target

ACTIVITY

HIGH PRESSURE LH₂ DEWARS: "LN₂ CRYO-SHOCK AND LEAK TEST"

I. SUMMARY

This activity covers the initial cryo-shock (LN₂) of the high pressure dewars and cold leak test of these systems.

The vacuum annuli of the high pressure dewars and associated systems will be pulled down to operating pressure and the dewars will be chilled and filled to approximately ____%. The dewars will be pressurized and LN₂ transferred to the NGTM interface. All mechanical fittings in the dewars and associated systems will be torque-checked and the systems drained. While the dewars and associated systems are cold, a GN₂/GHe mixture will be introduced and the systems will be leak tested. The systems will then be evacuated and inerted for the subsequent H₂ operations.

II. REQUIREMENTS

- A. Electrical Power
- B. Vacuum Pumps
- C. LN₂ Source (Tankers or Dewar)
- D. He Source (Trailer or Tank Farm)
- E. GN₂ Source (Trailers or LN₂ Vaporizer)
- F. GH₂ Source (Trailers or LH₂ Vaporizer)
- G. He Leak Detectors
- H. Temporary I&C Equipment

III. BACKUP REFERENCES

A. ETS-1 Activation

B. LN₂ Loading of V-5001 and Cryogenic Leak Tests (NTO-I-0153)

ACTIVITY

GAS STORAGE BOTTLES: "PRESSURE & LEAK TEST"

I. SUMMARY

This activity covers functional checkout of the valves and pressure/leak test of the GH_2 , GHe and GN_2 fill and storage systems.

All valves in the gas fill and storage systems will be operationally checked. Following above, each gas bottle will be pressurized to its respective operating pressure using GN_2 , plus GHe (90% GN_2 /10% GHe). The pressure will then be reduced and the fill and storage systems leak checked. The pressure-holding capability of each valve will be demonstrated during the above operations. A blowdown of all bottles will be conducted (through the fill system) to verify system cleanliness.

II. REQUIREMENTS

- A. Electrical Power
- B. GN_2 Source (Trailers or LN_2 Vaporizer)
- C. GHe Trailer
- D. He Leak Detectors
- E. Temporary I&C Equipment
- F. Contaminant Trap or Target

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0015)

Activity

LN₂ Dewars: "Install & Checkout Instrumentation"

I. Summary

This activity covers the installation of the permanent and temporary transducers on the LN₂ dewars; integration of the transducers with the Temporary I & C Checkout Equipment; and electrical, mechanical and functional checks to be conducted prior to GN₂ testing.

Following installation of the transducers, associated brackets and wiring, various resistance and continuity checks will be performed. Calibrations will be performed and all valves will be functionally checked.

II. Requirements

- A. Electrical Power
- B. Scaffolding
- C. I & C calibration equipment for pressure, temperature and level transducers.
- D. Temporary control system.

III. Backup References

- A. ETS-1 Activation Specification (HTO-I-0094)

ACTIVITY

LH₂ DEWARS: "GH₂ LEAK TEST"

I. SUMMARY

This activity covers the GH₂ Leak Test of the LH₂ dewars and fill systems.

The LH₂ dewars and associated sub-systems (Self --pressurization, Fill & Heat Exchanger Systems) will be pressurized to 75% of the operating pressure and then reduced to their respective leak-test pressure settings with GH₂. The pressure-holding capability of each valve will be demonstrated and a system leak test performed in preparation for the cryogenic shock and cold leak tests. The vacuum jackets associated with these systems will be pumped down to operating pressure and the jackets and pumping system will be checked for operational characteristics and integrity. A blowdown of the dewars will be conducted through the fill system to verify system cleanliness.

II. REQUIREMENTS

- A. Electrical power
- B. GH₂ trailers
- C. Leak detectors (sonic-type)
- D. Temporary I & C Equipment
- E. Contaminant trap or target

Activity

LN₂ Dewars: "LN₂ Cryo. Shock & Pressure Test"

I. Summary

This activity covers the initial introduction of LN₂ to the LN₂ dewars and pressure testing at low temperature.

The LN₂ dewars will be chilled and filled (approximately 10%) and allowed to soak, following pull-down of the vacuum annulus. The primary dewar self-pressurization system will be checked and the dewar pressurized sufficiently to chilldown the LN₂ heat exchanger. All mechanical fittings in the fill, storage and associated systems will be torque checked and the system drained. While the systems are cold, GN₂ with a trace of He will be introduced and the systems leak-checked.

II. Requirements

- A. Electrical power
- B. Vacuum pump
- C. LN₂ tanker(s)
- D. He leak detectors
- E. He trailer
- F. GN₂ trailer
- G. Temporary I & C Equipment

III Backup References

- A. ETS-1 Activation Specification (NTO-I-0015)
- B. LN₂ Loading of V-5001 and Cryogenic Leak Tests (NTO-I-0153) Typical

Activity

LN₂ Dewars: "LN₂ Fill"

I. Summary

This activity covers the LN₂ fill test of the LN₂ dewars.

Both dewars will be filled to the 50% level (approx.) and allowed to soak. Evaporization-loss tests will be conducted to evaluate the insulating characteristics of the vacuum jackets and level/temperature data will be verified insofar as possible. Pressure/vent characteristics of the dewars will be established. The remaining LN₂ will subsequently be used for the LN₂ vaporizer checkout. A torque check of all mechanical fittings will be repeated.

II. Requirements

- A. Electrical power
- B. Vacuum pump
- C. LN₂ tankers
- D. GN₂ source (trailers)
- E. Gas flowmeters (evaporation-loss test)
- F. Temporary I & C equipment

III Backup References

- A. ETS-1 activation specification (NTO-R-0015)
- B. Checkout of LH₂ system using LN₂ (NTO-I-0020), typical

ACTIVITY

"INSTALLATION OF FACILITY COOLDOWN SIMULATOR"

I. SUMMARY

This activity concerns the installation and checkout of the Facility Cooldown Simulator. The simulator is an arrangement of pipes and valves to simulate engine back pressures at varying flow rates and chamber temperatures. The simulator should be a permanent facility installation to permit checkout of the LH₂, GH₂, GN₂, GHe cooldown piping and associated control systems independent of the NGTM or shield activities.

II. REQUIREMENTS

See Sketch

III. BACKUP REFERENCES

A. ETS-1 Flow Simulator

ACTIVITY

LN₂ DEWARS: "FEP-I: CHILL & FILL TO NGTM INTERFACE AND FLOW TESTS

I. SUMMARY

This activity covers the initial cooldown flow tests of the LN₂ dewar systems to a point upstream of the NGTM umbilical.

Following a functional check of the valves and a GN₂ leak check of the cooldown systems, the LN₂ dewars will be filled and verification of the level and temperature measurements established. Individually, the dewars will be pressurized and the respective cooldown systems chilled and flow tested. Pressure/vent characteristics will be verified. Primary dewar self pressurization system operation will be verified and the LN₂ heat exchanger operation will be established. The systems will be flow-tested through the facility cooldown flow simulator at various ullage pressures and control valve settings to simulated engine impedances. Fluid samples will be taken to determine system cleanliness levels. Following the flow tests, the cooldown systems will be drained and charged with a GN₂/GHe mixture and "cold" leak tests will be conducted. A torque-check of all mechanical fittings in the cooldown systems will be conducted.

II. REQUIREMENTS

- A. C. P. Consoles
- B. C. P. I&C
- C. C. P. Data System
- D. LN₂ Tankers
- E. He Leak Detectors
- F. Facility Cooldown Flow Simulator
- G. GN₂ Storage System
- H. GHe Storage System
- I. Flow Measurement Devices

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-I Test Description (NTO-I-0129)

ACTIVITY

GAS STORAGE BOTTLES: "FEP-II: GASEOUS SYSTEM FLOW TESTS to NGTM INTERFACE"

I. SUMMARY

This activity covers the initial checkout of the GH₂ and GHe cooldown systems to a point upstream of the NGTM umbilical.

The GH₂ and GHe storage systems will be charged to operating pressure and the cooldown systems will then be individually flow tested through the Facility Cooldown Flow Simulator. Tests will be conducted at various flow rates and back-pressure settings. Control valve responses will be established and preliminary transfer-function data obtained.

II. REQUIREMENTS

- | | |
|---------------------|--|
| A. C.P. Consoles | E. LH ₂ Vaporizer |
| B. C.P. I&C | F. Facility Cooldown Flow Simulator |
| C. C.P. Data System | G. Oscillator (Control Valve Frequency Response Tests) |

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-II Test Description: Gaseous Cooldown Systems Tests (NTO-I-0131)

ACTIVITY

HIGH PRESSURE LH₂ DEWARS:

"FEP-III: INITIAL LH₂ FILL AND FLOW TESTS TO NGTM INTERFACE"

I. SUMMARY

This activity covers the initial LH₂ Fill and Cooldown Flow Tests to a point upstream of the NGTM Interface.

The vacuum annuli will be pulled down to operating pressure and the dewars chilled and filled. A checkout will be conducted of the temperature and level measurement instrumentation. Pressure/vent characteristics will be established and transfer function data will be taken. The cooldown line to the Facility Cooldown Flow Simulator will be chilled and flow tests conducted. Response and transfer function data will be taken at various ullage pressures, control valve settings and impedances.

II. REQUIREMENTS

- A. C.P. Consoles
- B. C.P. I&C
- C. C.P. Data System
- D. LH₂ Tankers
- E. GH₂ Source
- F. GHe Source
- G. Oscillator (Control Valve Frequency Response Tests)

II. (Continued)

- H. Flares (As required)
- I. Fire Protection System
- J. H₂ Alarm System
- K. O₂ Detectors
- L. Facility Cooldown Flow Simulator

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-III Test Description: Liquid Hydrogen System Tests
(NTO-I-0136).

ACTIVITY

FEP IV

LH₂ STORAGE & PRESSURIZATION DEWARS:

"INITIAL LH₂ FILL & PRESSURIZATION SYSTEM CHECKOUT"

I. SUMMARY

This activity covers the initial fill operations of the LH₂ storage and pressurization dewars and checkout of the heat exchanger and self-pressurization systems.

The subject dewars will be chilled and filled with LH₂ and a checkout conducted of dewar temperature and level measurement instrumentation. The pressurization dewar will be checked for pressure/vent characteristics using the self-pressurization system and pressurized to provide flow to the heat exchangers. Heat exchanger operations will be conducted and pressure/vent tests conducted on the storage dewar. Transfer function tests will be conducted on the pressure/vent systems where applicable.

II. REQUIREMENTS

1. C.P. Consoles
2. C.P. I&C
3. C.P. Data System
4. LH₂ Tankers
5. GHe Source
6. GH₂ Storage

7. Oscillator (Control Valve Frequency Response Tests)
8. Flares (as required) During Venting Operations.
9. Fire Protection System
10. H₂ Alarm System
11. O₂ Detectors
12. Hot Water System

III. BACKUP REFERENCES

1. ETS-1 Activation Specification (NTO-I-0094).
2. FEP-III Test Description: Liquid Hydrogen System Tests (NTO-I-0136).

ACTIVITY

"FEP-V: COMBINED EMERGENCY COOLDOWN TESTS TO NGTM INTERFACE"

I. SUMMARY

This activity covers the integrated flow tests of all the cooldown systems, to a point upstream of the NGTM umbilical.

The vacuum annuli will be pumped down to operating pressure on the high pressure LH₂ dewar and the LN₂ dewars. These dewars and the bottle farm will be filled to capacity. LH₂ and LN₂ cooldown system chilldown and chill-holding techniques will be verified. Flow Tests of liquid and gaseous systems will be conducted in accordance with the cooldown sequences. Fluid interaction, responses and transfer function data will be obtained.

II. REQUIREMENTS

- | | |
|------------------------------|--|
| A. C.P. Consoles | H. LN ₂ Vaporizer |
| B. C.P. I&C | I. Hot Water System |
| C. C.P. Data System | J. Flares, as required |
| D. LN ₂ Tankers | K. Fire Protection System |
| E. LH ₂ Tankers | L. H ₂ Alarm System |
| F. GHe Trailers | M. O ₂ Detectors |
| G. LH ₂ Vaporizer | N. Facility Checkout Device (Control valve, flare and associated piping) |

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-IV Test Description: Integrated Cooldown Systems Flow Tests (NTO-I-0171)

ACTIVITY

"INSTALL ENGINE FLOW SIMULATOR"

I. SUMMARY

This activity covers the installation and checkout of the engine flow simulator.

Following the installation of the NGTM in E/STS-2, the engine flow simulator will be mated to the remote interface. The engine simulator will mate with all fluid systems providing the NE and will permit back-pressure control of the various systems to be tested. All I&C associated with the engine simulator will be checked out and calibrated. All fluid systems will individually be pressurized to operating pressure with a GN₂/He mixture and reduce to the leak test setting. Leak tests will be performed to evaluate system integrity and, specifically, remote-connector pressure holding capability. The systems will then be inerted, as applicable, in preparation for flow testing.

II. REQUIREMENTS

- A. Hoisting Equipment
- B. Temporary Flare System (From the Facility Cooldown Flow Simulator)
- C. GN₂ Source
- D. GHe Source

II. (Continued)

E. He Leak Detectors

F. Temporary I&C

III. BACKUP REFERENCES

ACTIVITY

"FEP-VI: AUXILIARY SYSTEMS CHECKOUT"

I. SUMMARY

This activity covers the checkout of the auxiliary engine systems using the Engine Flow Simulator.

The various pneumatic/actuation systems will be flow-tested to NE requirements. Pressure, temperature, flow and response-rate data will be taken as required.

II. REQUIREMENTS

- A. C.P. Consoles
- B. C.P. I&C
- C. C. P. Data System
- D. GHe Source
- E. GN₂ Source
- F. GH₂ Source
- G. H₂ Alarm System
- H. O₂ Detectors
- I. Fire Protection System
- J. Flare Systems (As required)
- K. Engine Simulator

III. BACKUP REFERENCES

ACTIVITY

"FEP-VII: LN₂ COOLDOWN SYSTEM CHECKOUT WITH ENGINE SIMULATOR"

I. SUMMARY

This activity covers the LN₂ cooldown flow verification tests of the low and high pressure systems through the Engine Simulator.

The LH₂ Cooldown systems will individually be chilled and flow tested.

Optimum chilldown and chill-holding techniques will be established and flow system dynamics will be established to simulated engine impedance.

Fluid samples will be taken to determine system cleanliness levels.

Following the flow tests, the cooldown system will be drained and charged with a GN₂/GHe mixture and "cold" leak tests will be conducted.

II. REQUIREMENTS

- A. C. P. Consoles
- B. C. P. I&C
- C. C. P. Data System
- D. LN₂ Tankers
- E. GN₂ Storage System
- F. GHe Storage System
- G. Hot Water System
- H. He Leak Detectors
- I. Engine Simulator

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-I Test Description (NTO-I-0129)

ACTIVITY

GAS STORAGE BOTTLES: "FEP-VIII: GASEOUS COOLDOWN SYSTEMS

CHECKOUT WITH ENGINE SIMULATOR"

I. SUMMARY

This activity covers the GH_2 and GHe cooldown systems flow-verification tests through the Engine Simulator.

The Bottle Farm will be charged to capacity and the gaseous cooldown systems will be individually flow tested. Tests will be conducted at various flow rates to the simulated engine impedance. Transfer function and response data will be obtained and fluid samples will be taken to verify system cleanliness levels.

II. REQUIREMENTS

- | | |
|--------------------------|--|
| A. C.P. Consoles | E. GH_2 Source (LH_2 Vaporizer) |
| B. C.P. I&C | F. He Leak Detectors |
| C. C.P. Data System | G. Engine Simulator |
| D. GHe Trailers | H. Oscillator (Control Valve Frequency Response Tests) |

III. BACKUP REFERENCE

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-II Test Description: Gaseous Cooldown Systems Tests (NTO-I-0131)

ACTIVITY

"FEP-IX: EMERGENCY LH₂ COOLDOWN SYSTEM TESTS WITH ENGINE SIMULATOR"

I. SUMMARY

This activity covers the LH₂ cooldown system flow-verification tests through the Engine Simulator.

The LH₂ cooldown dewar will be filled and chilldown/chill-holding tests to the cooldown line will be conducted. The Engine Simulator will then be chilled and flow tests will be conducted. Response and transfer function data will be taken at various ullage pressures and control valve settings to the simulated engine impedance.

II. REQUIREMENTS

- A. C.P. Consoles
- B. C.P. I&C
- C. C.P. Data System
- D. GHe Bottles
- E. GH₂ Bottles
- F. GN₂ Bottles
- G. H₂ Alarm System
- H. O₂ Detectors
- I. Fire Protection System

II. (Continued)

J. Flare Systems (As required)

K. Oscillator (Control Valve Frequency Response Tests)

L. Engine Simulator

III. BACKUP REFERENCES

A. ETS-1 Activation Specification (NTO-I-0094)

B. FEP-III Test Description: Liquid Hydrogen Systems Tests
(NTO-I-0136)

ACTIVITY

"FEP-X: COMBINED COOLDOWN SYSTEMS TESTS WITH ENGINE SIMULATOR"

I. SUMMARY

This activity covers the integrated cooldown systems flow-verification tests through the Engine Simulator.

The LN₂ and LH₂ dewars and bottle farm will be filled to capacity and flow tests will be conducted simulating the engine cooldown sequences. Chill-holding techniques will be verified and fluid interactions, responses and transfer function data will be obtained.

II. REQUIREMENTS

- A. C.P. Consoles
- B. C.P. I&C
- C. C.P. Data System
- D. GHe Bottles
- E. GH₂ Bottles
- F. GN₂ Bottles
- G. LN₂ Vaporizer
- H. LH₂ Vaporizer
- I. H₂ Alarm System
- J. O₂ Detectors
- K. Fire Protection System
- L. Flare Systems (As required)

II. (Continued)

- M. Oscillator (Control Valve Frequency Response Tests)
- N. Hot Water System
- O. Engine Simulator

III. BACKUP REFERENCES

- A. ETS-1 Activation Specification (NTO-I-0094)
- B. FEP-IV Test Description: Integrated Cooldown Systems Flow Tests (NTO-I-0171)

FIG. #3
ENGINE SIMULATOR

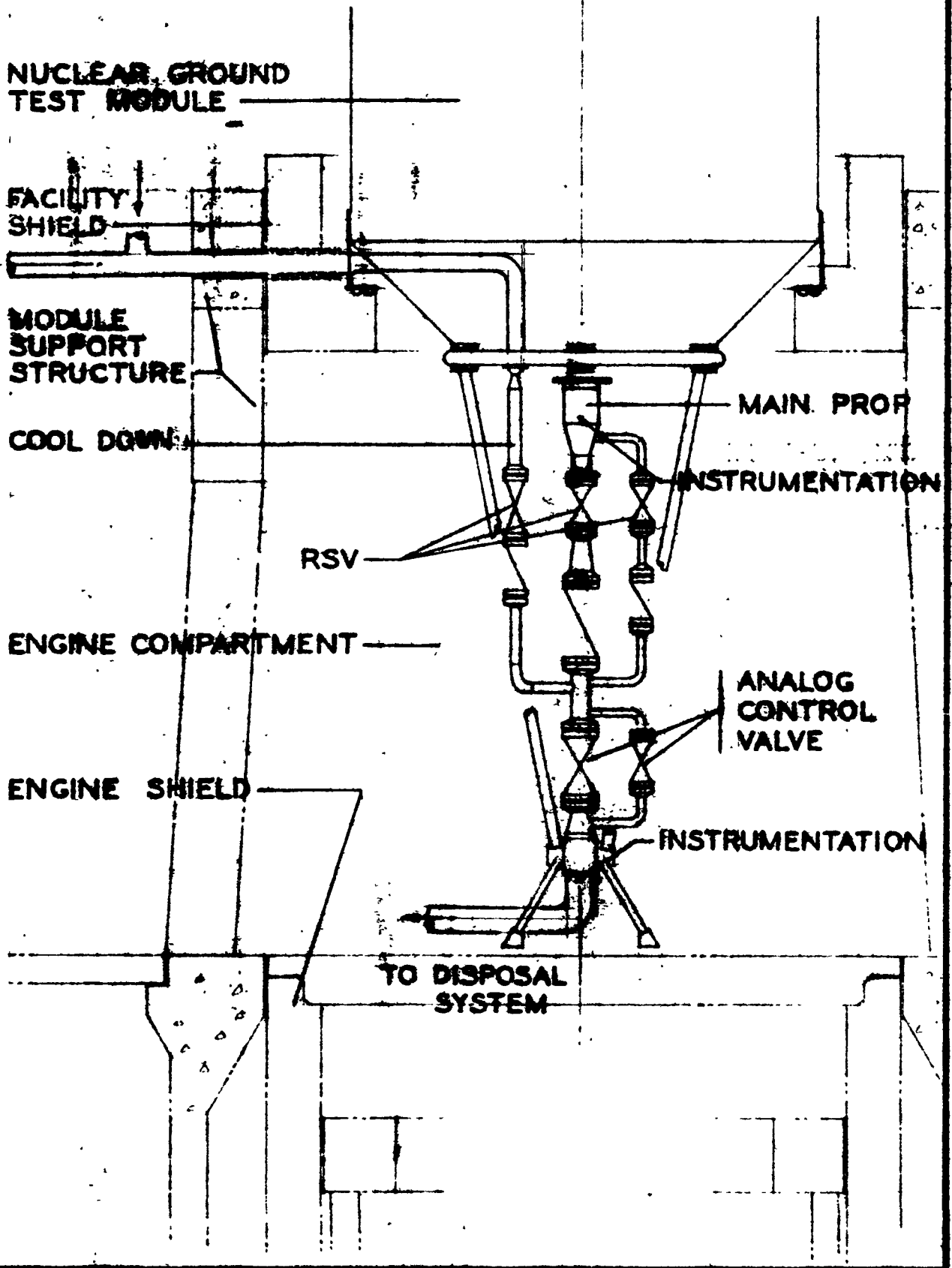


FIG. #2
NES TEST DEVICE

FROM
FLUID
SUPPLY

SIMULATED NGTM

ENGINE COMPARTMENT

SIMULATED
TURBINE
EXHAUST

NES DUCT
COLLAR

NES DUCT
DIFFUSER

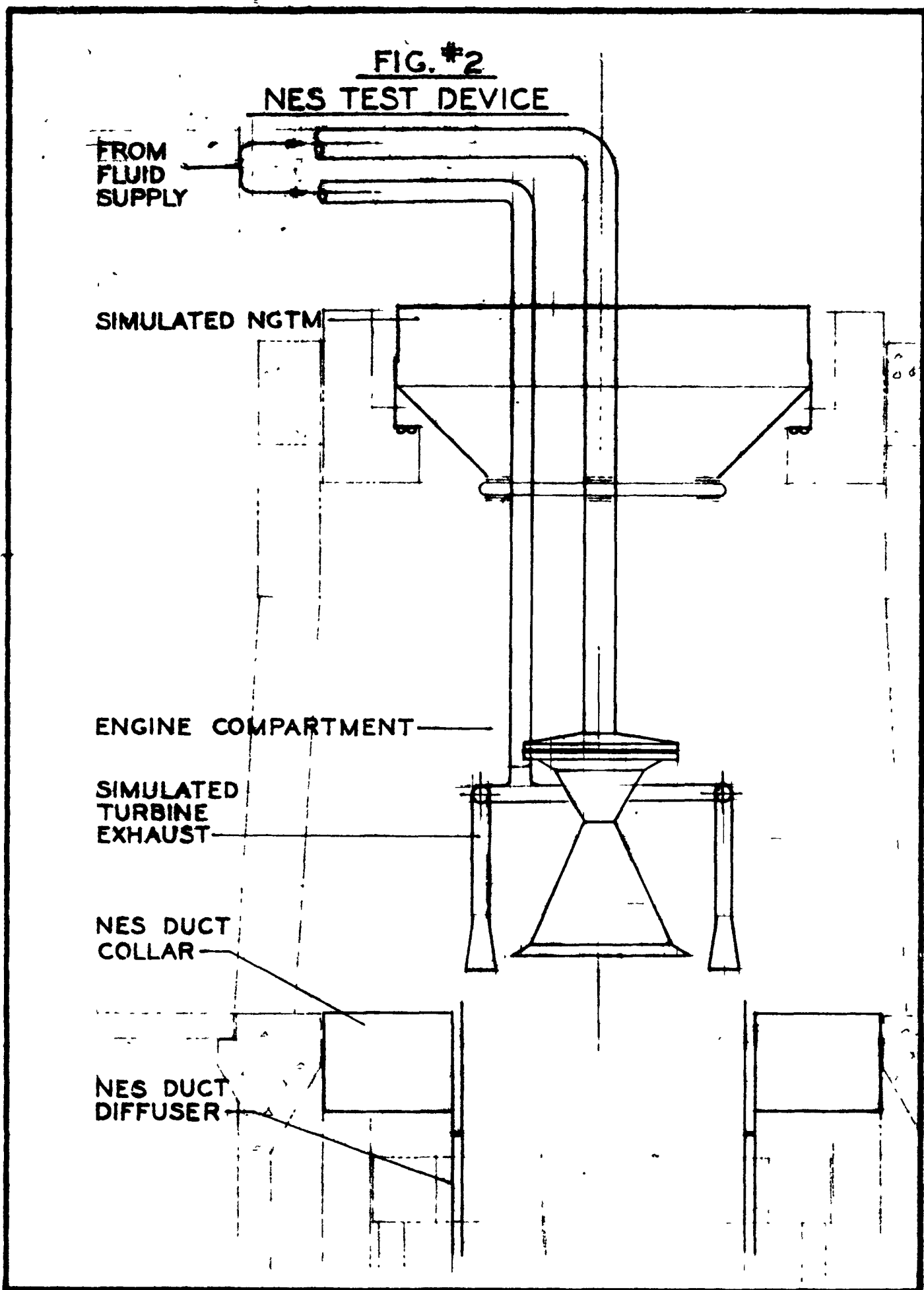
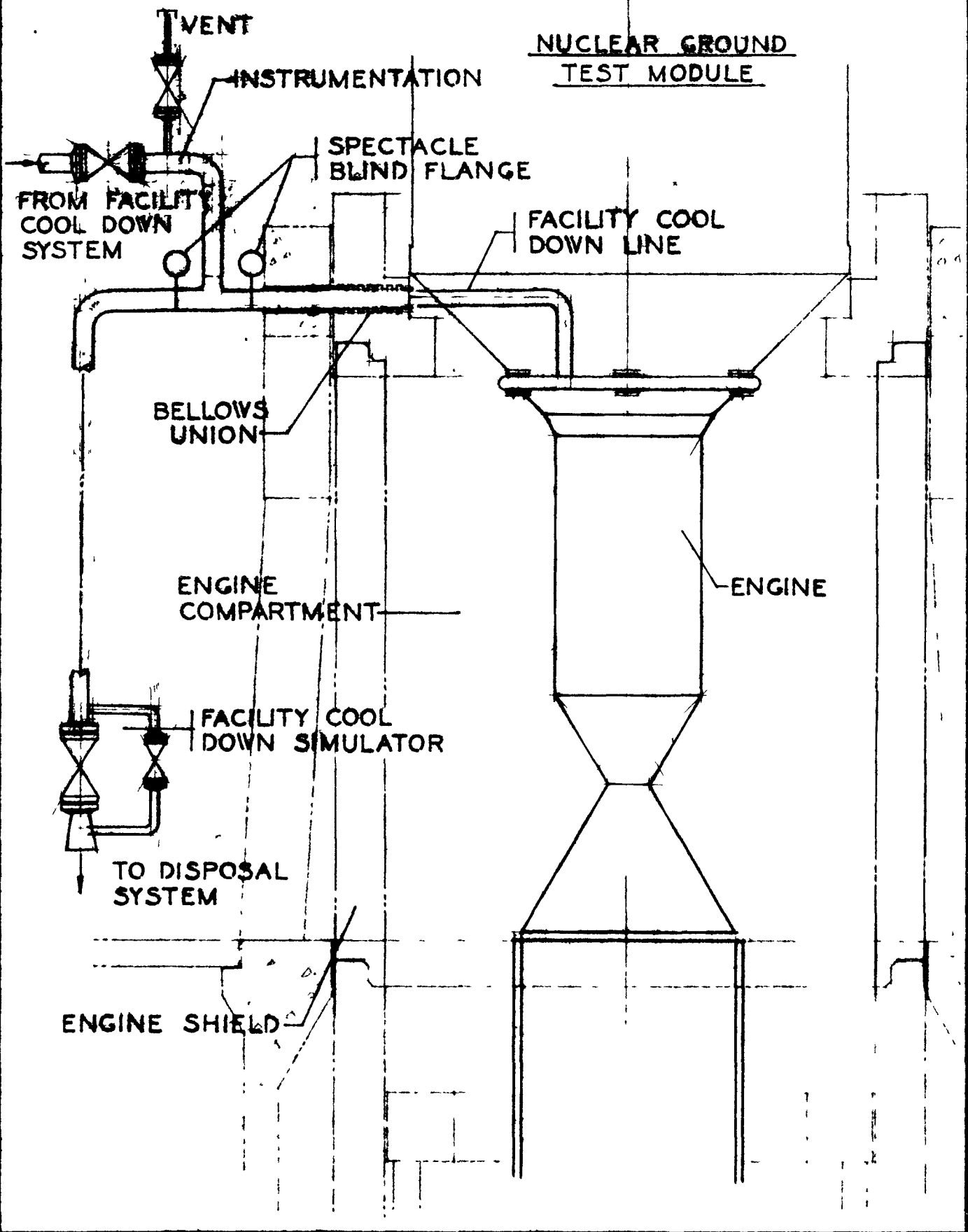


FIG #4
FACILITY SIMULATOR



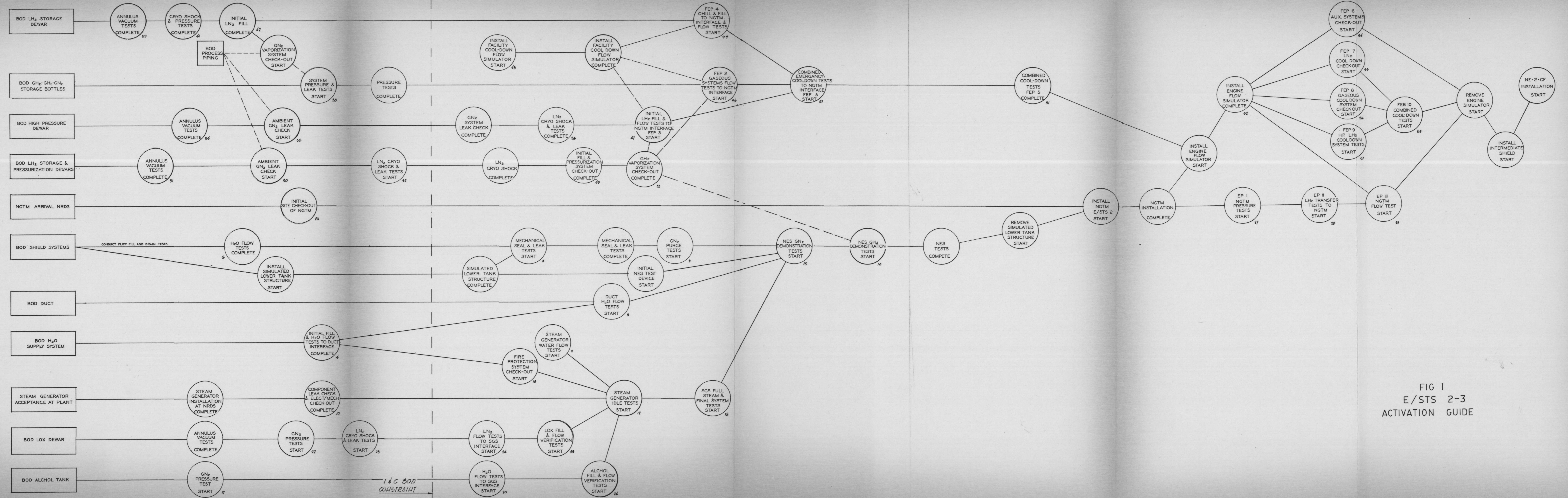


FIG 1
E/STS 2-3
ACTIVATION GUIDE