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CONTRACT NO. NAS9-11063

FINAL DESIGN DOCUMENT

FOR

SPACE CABIN ENVIRONMENTAL LABORATORY

MAY 15, 1971

To

NASA/MANNED SPACECRAFT CENTER
Facility and Laboratory Support Branch
Houston, Texas 77058

VACUDYNE CORPORATION
375 East Joe Orr Road
Chicago Heights, Illinois 60411

CR-115007

UNITED STATES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

SPECIFICATIONS

FOR

ENVIRONMENTAL LABORATORY

TEST CHAMBER COMPLEX

PREVENTIVE MEDICINE DIVISION

SPECIFICATION NO. 9-11063

MAY 15, 1971

TABLE OF CONTENTS

SECTION 1 -- SCOPE & DESCRIPTION

1.01 SCOPE:

This specification covers all requirements for furnishing all necessary labor and materials to design, fabricate, deliver, install and test a complete Environmental Laboratory Test Chamber Complex. The chamber complex shall be installed at the Manned Spacecraft Center, Houston, Texas.

1.02 APPLICABLE DOCUMENTS:

The following documents of the issue and effect on the date of invitation for bids or request for proposal form a part of this specification to the extent specified herein:

a) FEDERAL AND MILITARY DOCUMENTS

SPECIFICATIONS

Military

MIL-N-22759B	Wiring Specifications
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment, General Specification 4
MIL-H-46855	Human Engineering Requirements For Military Systems, Equipment Facilities
MIL-R-8202D	Diluter Demand Regulator

STANDARDS

Federal

FED-STD-595	Colors

Military

MIL-STD-785	Reliability Program For System Equipment, Development and Production

PUBLICATIONS

Military

MIL-HDBK-472 Maintainability Predictions

NASA

MSC Safety Manual Part 7 Man-Rating Requirements MSCI8825.2 Dated May 15, 1967, Revision No. 8.

SPD-3 Safety Program Directive No. 3, Safety Guide-Lines for Man-Rating Altitude Chambers

MSCI8825.2 Dated May 15, 1967

b) OTHER PUBLICATIONS

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue and effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASME Boiler And Pressure Vessel Code, Section VIII, Unfired Pressure Vessels (1968 Ed.)

ELECTRONIC INDUSTRIES ASSOCIATION

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA No. 70	Standard of National Fire Protection Association (National Electric Code) Except where equipment specified is not commercially available.
NFPA No. 565	Standard of National Fire Protection Association (Non-flammable Medical Gas Systems)
NFPA No. 56E-T	Tentative Standard For Hypobaric Facilities
NFPA No. 56D	Standard For Hyperbaric Facilities
NFPA No. 13	Sprinkler Systems
NFPA No. 15	Water Spray Fixed Systems

AMERICAN STANDARDS ASSOCIATION

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

JOINT INDUSTRY CONFERENCE

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

NATIONAL ELECTRIC SAFETY CODE

1.03 GENERAL DESCRIPTION:

a) The Test Chamber Complex shall consist of the following:

(1) Environmental Laboratory Hypobaric Chamber.

(2) Master Control Console

(3) Oxygen Supply and Control System

(4) Carbon Dioxide Scrubbing System

(5) Gas Conditioning System

(6) Vacuum Control System

(7) Fire Protection System

(8) Communication System

(9) Gas Sterilization System

b) The test chamber shall be a right parallelpiped configuration with double wall construction and divided into two compartments, cell No. 1, man lock, and cell No. 2, test cell, with inside dimensions 10' long x 8' wide x 8' high and 20' long x 8' wide x 8' high respectively. The entire chamber shall be insulated to reduce the heat load when the chamber is being operated at low temperatures. The test cell complex shall be completely equipped with analyzing, read-out display, and control equipment to regulate the following:

(1) Concentration of oxygen

(2) Concentration of carbon dioxide

(3) Total pressure

(4) Differential pressure

(5) Temperature

(6) Humidity

The man lock shall be equipped for manual operation only of the concentration of oxygen, the concentration of carbon dioxide, and the total and differential pressures.

c) The space cabin environmental laboratory will be used to evaluate the affects of space environmental parameters on host systems in a closed ecological system.

d) The test chamber complex shall be "Man-Rated" and designed for high hypobaric operation, 100% oxygen concentration, and "Fail-Safe" operation.

e) The equipment furnished with the chamber complex shall require only normal maintenance and minor parts replacement during their life time expectancy.

1.04 DESIGN:

a) The work under this contract shall conform to the drawings listed below and these specifications. The basic system requirements and schematics shown on the drawings must be developed by the Contractor to meet the performance specified herein.

DRAWING	TITLE	LATEST DATE
J70291	General Facility	4/5/71
J70292	Building Arrangement	4/5/71
J70293	Chamber General Arrangement	4/5/71
J70294	Internal Arrangement Plan and Lateral Cross Section	4/5/71
J70295	Internal Arrangement Longitudinal Cross Section	4/5/71
J70296	Control Console Arrangement	4/5/71
J70297	CO_2 and O_2 System Schematic	4/5/71
J70298	Gas Conditioning Schematic	4/5/71
J70299	Pressure System Schematic	4/5/71

b) The following drawings are for reference only. They contain information for the contractor in carrying out the work, but shall not be interpreted as defining, limiting or extending the scope or details of the work to be done under this contract.

DRAWING	TITLE	LATEST DATE

c) All materials including lubricants and gaskets which will be exposed to the chamber atmosphere either inside the chamber or in equipment through which the chamber atmosphere passes shall be either non-flammable or self-extinguishing when ignition is attempted in an atmosphere of 100% oxygen. All equipment exposed to chamber atmosphere must be designed for exposure to ammonia vapor.

d) All electrical parts exposed to the chamber atmosphere shall conform to the requirements for operation in 100% oxygen concentration.

e) Welding of the chamber shell and liner and all fabricated components subjected to pressure stresses shall be in accordance with Unfired Pressure Vessels, Section VIII, ASME Boiler and Pressure Vessel Code.

f) NASA MSC will furnish the following facilities:

(1) Building for test chamber complex

(2) Building penetrations and trenches for pipes and conduits

(3) Foundations for chamber and machinery

(4) Step and ramp to chamber floor level

(5) Utilities as follows located per reference drawing in Section 1.04 (b)

(a) Electrical

120 Volts 1 Ø 60 Hz.
208 Volts 3 Ø 60 Hz.
480 Volts 3 Ø 60 Hz.

(b) Water

40 PSIG @ 70°F

(c) Air

100 PSIG dried and filtered to meet NASA breathing air requirements

(d) Steam

15 PSIG Saturated

1.05 REQUIRED INFORMATION SUPPLIED BY CONTRACTOR:

a) The Contractor shall prepare and submit to the Contracting Officer on a monthly basis, during the design phase of the contract, a progress report

showing progress on salient features of the work, giving, in percentages, the parts thereof completed at the time, and submitting prints of each drawing and each sketch, started or completed, upon which he has been working during the one month period. These prints shall be clearly dated and marked "Progress Print". Prints of the work "As Is" will serve the purpose. Progress reports and prints shall be submitted in quadruplicate.

b) Within 90 days after award of contract, the contractor shall furnish the following information in quadruplicate, for review by the contracting officer:

(1) Detailed design calculations for

(a) The shell, liner and reinforcing members

(b) Sizing of vacuum pumps

(c) The chamber heat load including sizing of the dryer, humidifier, heat exchangers and blower for the air conditioning and ventilating system. The design calculations shall show the basic design assumptions. Where symbols and abbreviations are used, adequate notes shall explain their meaning. Calculations shall be in detail to support the final design.

(d) The test cell carbon dioxide scrubbing system design.

c) Within 120 days after award of contract, the Contractor shall submit, in septuplicate, detailed construction drawings to review by the Contracting Officer. Approval or submission of drawings does not relieve Contractor of responsibility for meeting specifications.

d) In accordance with paragraph 2-20(c) the Contractor shall submit data for all machinery, equipment, materials and articles which he intends to furnish. One copy of the submittal material will be returned to the Contractor with Government action indicated. If the Contractor requires more than one copy of the submittal material, he shall submit as many additional copies as he requires with a request that the appropriate number be returned.

e) In addition to the manuals required for each item of equipment in paragraph 2-20(d), the Contractor shall furnish six (6) copies of an operation maintenance manual. These manuals shall list operating procedures for the test cells. The manual shall be hard-bound and indexed, and shall be constructed as to permit easy insertion of additions.

1.06 INSTALLATION:

a) The test chamber complex shall be installed in building in area of Manned Spacecraft Center, Texas. The building is located as shown on the attached facilities map. The Contractor's drawings shall show size and location of loads imposed upon the building by the chamber and

associated equipment. See reference drawing in paragraph 1.04 (b) for floor loading limitations.

b) Utilities for use during construction phase of this chamber will be available as indicated in paragraph 1.04 (f). If desired by the Contractor, initial set-up and testing of the chamber complex may be made at the Contractor's plant. In any event, final acceptance will be based upon the tests performed at Manned Spacecraft Center as specified under paragraph 3-18 Testing.

c) All work to be done under these specifications shall be completed within 365 calendar days after date of receipt of notice to proceed.

d) Whenever work is to be done in close proximity to or when connections are to be made into NASA existing systems, the Contractor shall not proceed with the work until granted permission by the assigned inspector.

e) The wage rates applicable to this area of installation shall be in accordance with the attached U.S. Department of Labor as applied to contract for construction to be formed at the NASA Manned Spacecraft Center, Houston, Texas.

SECTION 2 - STANDARD CONDITIONS AND REQUIREMENTS

Table of Contents

2-20. Materials and Equipment (Continued)
- c) Approval Required
- d) Instructions and Parts

2-21. Samples

2-22. Scrap and Spoil Materials to be Removed

2-23. Clean-Up
- a) Periods
- b) Disposal

2-24. Contract Changes Procedure

2-25. Expediting

2-26. Final Inspection

2-27. Safety and Health
- a) Safety Provisions
- b) Procedures
- c) Record
- d) Corrective Action
- e) Special Provisions
- f) Responsibility

2-28. Government Review of Announcements

SECTION 2 - STANDARD CONDITIONS AND REQUIREMENTS

2-01. Scope:

a) This section contains general requirements governing procedures and practices to be followed in the execution of this work.

2-02. Addressing Correspondence:

a) Correspondence and data enclosed therewith shall be furnished in QUADRUPLICATE, except drawings by the Contractor, as specified in paragraph 3-19 herein, which shall be submitted in SEPTUPLICATE. All correspondence shall be clearly marked with the Government contract number and addressed to:

Representative of the Contracting Officer
National Aeronautics and Space Administration
Manned Space Center
Houston, Texas 77058

2-03. Definitions:

a) Wherever in these specifications or upon the drawings the words "directed," "required," "permitted," "necessary," "ordered," "designated," or words of like import are used, it shall be understood to mean that such is to be by the Contracting Officer or his authorized representative. Similarly, the words "approved," "acceptable," "satisfactory," or words of like import, shall be understood to be that of the Contracting Officer or his authorized representative.

b) Wherever in these specifications the Contractor is called upon to install or erect equipment or materials, he shall also furnish such equipment or materials, unless it is specifically stated that they will be provided by others. Likewise, wherever in the specifications the Contractor is called upon to furnish or to provide equipment or materials, he shall also install or erect the same, unless it is specifically stated that they will be installed or erected by others. The Government will not furnish any labor, materials or supplies unless specifically provided for in these specifications.

2-04. Inspection:

a) The work shall be conducted under the general cognizance of the Contracting Officer, working through the Chief Inspector, who will assign inspectors to the work with authority to insure strict compliance with the terms of the contract. No inspector or any other Government employee is authorized to waive or change any provisions of the specifications without written authorization from the Contracting Officer nor shall the presence or absence of an inspector relieve the Contractor from any requirement of the Contract.

2.05. Working Hours:

a) Except as necessary and specifically approved to meet the requirements of paragraph 2-13 (b), the Contractor's working hours shall conform to the regular working hours of the NASA Inspection Section. Should the Contractor desire to work outside of these hours, he shall make written request in advance, and obtain approval from the Contracting Officer. No work shall be performed without such approval except for safeguarding life or property. Emergency deviations may be authorized by the NASA Inspector on the job. Inspectors will be assigned on the basis of working schedules submitted and approved as provided in paragraph 2-13 (a). Regular working hours of the NASA Inspection Section are 7:00 A.M. to 3:30 P.M. Monday through Friday, with the following National Holidays excepted:

New Year's Day -- January 1
Washington's Birthday -- 3rd Monday in February
Memorial Day -- Last Monday in May
Independence Day -- July 4
Labor Day -- First Monday in September
Columbus Day - 2nd Monday in October
Veterans Day - 4th Monday in October
Thanksgiving Day -- Fourth Thursday in November
Christmas Day -- December 25

When any of the above Holidays fall on Saturday, the preceding Friday will be a non-work day. When any of the above Holidays fall on Sunday, the following Monday is a non-work day.

b) The Contractor shall give timely notice to the Chief Inspector of the date when the contract work will begin at the site.

c) Should the Contractor suspend work at any time before the contract is completed, he shall notify the Chief Inspector and shall not again resume work without notifying the Chief Inspector in advance.

2.06. Identification Badges:

a) Contractors and subcontractor shall report to the Chief Inspector upon their arrival at the site to begin work and shall also report to the Chief Inspector upon completion of work at the site. At all times while on Government property, Contractors, subcontractors, their employees and agents shall wear badges which will be issued by the NASA Contract Badge and Pass Office. Badges shall be issued only between the hours of 7:00 A.M. and 4:30 P.M. Monday through Friday. Contractors will be held accountable for these badges and immediately after completion of the work they shall be returned to the NASA Contract Badge and Pass Office.

2-07. Contractor's Temporary Buildings:

a) The Contractor shall construct and maintain at the project site such field offices, shops, storehouses, or other temporary buildings as the specifications require or he finds necessary for his operations.

b) Contractor's temporary field office and other temporary buildings shall be of neat design and workmanship. Factory-built trailers in good repair will be acceptable. Contractor's temporary buildings shall be located at points designated by the Chief Inspector, shall be maintained in an orderly manner, and shall be promptly removed at the completion of the contract. Approval of design shall be obtained from the Contracting Officer before erection begins.

2-08. Handling of Materials and Equipment:

a) All shipments shall be addressed to the Contractor and the Contractor shall be responsible for their receipt and handling at the site.

b) Structural and reinforcing steel, lumber, millwork, and other materials and equipment shall be stored above ground on racks or platforms, free from contact with the soil, and adequately covered to protect them against rusting, dirt, water, chemicals or any injury of any kind which would, in the opinion of the Contracting Officer, impair their value for use in the work.

2-09. Use of Space:

a) The extent and limits of the work shall be as located and shown on the drawings, as herein specified, or as described in the bid invitation. All permanent and temporary building operations and work shall be strictly confined to the limits shown or described, or as designated by the Contracting Officer. Possible contract bidders shall be allowed to visit the site prior to bidding.

b) The Contractor will be permitted to use, free of charge, unoccupied space which is owned and controlled by the Government and which the Contracting Officer is able to place at his disposal. The Contractor shall promptly vacate any such space if ordered by the Contracting Officer to do so.

2-10. Traffic Facilities:

a) The Contractor shall use only the established roadways and such temporary roadways on the premises as may be authorized by the Contracting Officer. When it is necessary to cross curbing or sidewalks, secure bridges shall be constructed across them, and at the completion of all work such bridges shall be removed.

b) Should the Contractor's operations result in deposition of dirt or other debris on paved areas or in buildings, he shall clean such facilities at such intervals and in such manner as will prevent the formation of undesirable quantities of mud or dust, or the creation of any other nuisance.

c) The Contractor shall make his own arrangements for use of private or public road, rail or marine facilities.

2-11. Utilities:

a) Water, in such quantities as may be actually required for the work, will be furnished by the Government without charge. The Contractor shall make all necessary connections to the existing water mains, shall furnish all equipment, and shall run the water lines required by him, connecting at points and following routes approved by the Contracting Officer.

Lines shall be installed and maintained in a sanitary and watertight manner, and shall be removed and capped at the completion of the contract, without additional cost to the Government.

b) The Government will furnish electric power for general construction purposes, with a maximum demand of 25 kilowatts, without cost to the Contractor. This electrical energy will be made available to the Contractor from the NASA distribution system at the nearest location where such capacity is available, and at the option of the Contracting Officer will be supplied at 3-phase, 4-wire, 120/208 volts or 3-wire 440 volts. The Contractor shall provide a disconnect switch, suitably protected from the weather, and fused for 75 amps or less, at the delivery point designated. The Government will connect the supply to the switch provided. All temporary lines extended from the disconnect switch shall be furnished at the Contractor's expense and shall be installed and maintained in a safe and workmanlike manner. All temporary lines and the disconnect switch shall be removed by the Contractor, at his expense, at the completion of the contract. This electrical energy is provided for lighting, motor-driven construction equipment, heaters for humidity control of equipment and machinery and general construction purposes.

c) Any interruption of utilities or services that would interfere with the operation of a facility will be permitted only on week-ends between the hours of 12:00 midnight Friday and 10:00 P.M. on the following Sunday. Permission to make such an interruption shall be requested in writing at least 2 days before the week-end when it is to occur. The Contracting Officer may at his option permit interruptions at other times when the situation so warrants.

d) The Contractor shall provide and maintain, in accordance with the rules and regulations laid down by the Contracting Officer, all necessary sanitary conveniences for use by his employees, and their use shall be strictly enforced. Prior to completion of all work, all such sanitary conveniences shall be removed and the premises left clean and in first-class condition.

e) The Contractor shall provide all necessary temporary heat.

f) The Government will provide no telephone service for Contractor's use. In accordance with NASA regulations and Telephone Company requirements and after consultation with a designated representative of the LRC, Administrative Services Division, General Services Section, Telecommunications Office, the Contractor may make arrangements for the installation and maintenance of telephone service and for removal of same upon completion of the contract.

2-12. Protection and Repair:

a) Existing services shall be maintained, so far as practicable, without interruption, or, if interrupted by the Contractor's operations, shall be promptly restored without cost to the Government.

b) Where the contract work is to be connected to existing buildings or other construction, the Contractor shall do such repairs, touch-up painting, etc., as may be necessary to leave the completed work in a neat and orderly condition.

2-13. Program of Construction:

a) The Contractor shall, within thirty days after date of receipt of Notice to Proceed, prepare and submit to the Contracting Officer, for approval, a practical and feasible schedule, showing the sequence in which he proposes to carry on the work, the date on which he will start significant milestones and the contemplated date for completing each. The divisions of work reported on schedule shall be major systems, subsystems, assemblies and/or subassemblies. The milestones for each division of work will normally consist of design, design approval, procurement or subcontract, manufacture, plant

assembly and test, delivery to site, installation, checkout and acceptance. The Contractor shall submit copies of schedule in accordance with the instructions printed on the form prescribed for that purpose available from the Contracting Officer. The schedule will be updated and re-submitted by air mail on a four week cycle to be established by the Contracting Officer. In addition, schedule changes, such as completion and/or rescheduling of milestones, will be reported on the submittal date, via telephone, to the Contracting Officer, or his designated representative. Any change in the program schedule shall not alter or extend the completion date of the contract.

b) The Contractor shall furnish sufficient forces, construction plant, and equipment, and shall work such hours, including night shifts, overtime operations, Saturday and Sunday as may be necessary to insure the prosecution of the work in accordance with the approved progress schedule. If, in the opinion of the Contracting Officer, the Contractor falls behind the progress schedule, the Contractor shall take such steps as may be necessary to improve his progress, and the Contracting Officer may require him to increase overtime operations, the number of shifts, days of work, or the amount of construction plant, all without additional cost to the Government.

c) Failure of the Contractor to comply with the requirements of the Contracting Officer under this provision shall be grounds for determination by the Contracting Officer that the Contractor is not prosecuting the work with such diligence as will insure completion within the time specified. Upon such determination, the Contracting Officer may terminate the Contractor's rights to proceed with the work, or any separable part thereof, in accordance with the clause entitled "Termination for Default-Damages for Delay-Time Extensions" of the General Provisions.

2-14. Price Breakdown:

a) Promptly upon award of contract, the Contractor shall submit a price breakdown in accordance with the applicable provisions of the Contract General Provisions.

2-15. Subcontractors:

a) The Contractor shall be responsible for familiarizing each of his subcontractors with all aspects of the contract affecting each subcontractor, respectively, and shall be responsible for co-ordinating the work of his subcontractors to prevent any interference or omission whatsoever. NASA shall approve all subcontractors.

2-16. Lines and Grades:

a) The Contractor shall lay out his work. He shall be responsible for the correctness of measurements and shall verify the figures on drawings before laying out the work.

2-17. Contract Drawings and Specifications:

a) A maximum of 10 complete sets of contract drawings and specifications will be furnished by the Government to the Contractor without charge promptly after award.

2-18. Specifications:

a) Wherever in the various sections of these specifications, material or equipment to be furnished or work to be done is required to conform to Federal Specifications, ASTM, AISC, SAE, or any other generally recognized authority, the latest revised edition of such specification in effect on the date of opening of bids shall apply.

b) Copies of the following specifications may be obtained upon application addressed as follows:

Federal Specifications

General Services Administrator
Region 3
7th and D St. SW
Washington, D.C. 20024

Superintendent of Documents
Government Printing Office
Washington, D.C. 20401

Navy Department of Joint Army-Navy Specifications

Bureau of Supplies and Accounts
Navy Department
Washington, D.C. 20360

Military Specifications

Commander, Air Development Center
Wright-Patterson Air Force Base
Ohio 45433

Commanding Officer
U. S. Naval Supply Depot
5801 Tabor Avenue
Philadelphia, Pennsylvania 19120

2-19. Drawings by Contractor:

a) The Contractor shall prepare all design drawings, working drawings, shop drawings, and detail drawings necessary to enable him to fabricate and erect all parts of the work and to enable the Contracting Officer to check its conformity with the contract drawings and specifications, or to satisfy the Contracting Officer that all parts can be fabricated or erected as required.

b) On all work requiring preparation of drawings by the Contractor and submittal of such drawings to the Contracting Officer for review, such drawings shall be submitted for review before construction or fabrication covered thereby is started. Prints shall be submitted in SEPTUPLICATE, and in such sequence that the Contracting Officer will have all information necessary for checking. All drawings shall be clearly marked with the Government's contract number.

c) The Contractor shall not proceed with any construction that may be affected in any manner by equipment located therein, until equipment layouts, showing all components, with dimensions and necessary clearances have been reviewed by the Contracting Officer.

d) Where electrical details are omitted from or are not fully shown on contract drawings, the Contractor shall prepare one-line, elementary, connection, interconnection, outline and erection drawings. Wherever applicable, devices shall be designated by Standard ASA symbols and function numbers.

(1) One-Line Diagrams shall indicate by means of single lines and simplified symbols the paths and component parts of electric circuits or systems of circuits. All items shall be clearly labeled to indicate ratings and use in the system.

(2) Elementary Diagrams shall indicate in straight-line form, without regard for physical relationship, all circuits and elements of equipment and associated apparatus.

(3) Connection Diagrams shall indicate the relations and connections of devices and apparatus of circuits or groups of circuits. They shall show the general physical layout of all electrical controls, with all internal wiring, devices, terminal strips, connections, etc. Typical wiring digrams will not be accepted.

(4) Interconnection Diagrams shall indicate the complete connections between associated units of equipment. Internal equipment connections shall be omitted. For simple installations, the connection and interconnection drawings may be combined on a single drawing.

(5) Outline Drawings shall indicate the overall physical features, dimensions, ratings, and weights of equipment.

(6) Erection Drawings shall indicate equipment arrangement, including elevations, sections, and enlarged details showing methods of construction and installation necessary for proper operation of the systems and equipment.

e). The Government shall furnish the Contractor a sufficient number of 22 by 34 inch sheets of "Herculene Mylar" film for use under this contract; so far as practicable the Contractor shall use this size sheet. The Contractor shall separate the drawings into two catagories; mechanical and electrical. The appropriate drawing numbers shall be issued by the Contracting Officer. At the end of the contract, the Contractor shall turn over the original drawings to the Contracting Officer.

f) The Contracting Officer will promptly after receipt of prints of drawings for review, return one copy to the Contractor marked "Reviewed", "Reviewed with corrections as noted", or "Returned for correction" to be interpreted as follows:

(1) Prints marked "Reviewed" authorize the Contractor to proceed with the work covered by such drawings.

(2) Prints marked "Reviewed with corrections as noted" authorize the Contractor to proceed with the work covered by such drawings with corrections indicated thereon. Upon receipt of prints marked "Reviewed with corrections as noted", the Contractor shall make the necessary revisions and submit six prints for the Contracting Officer's distribution. Additional review of such revised drawings by the Contracting Officer is not required.

(3) Prints marked "Returned for correction" require the Contractor to make the necessary corrections and revisions on the drawings and to resubmit prints for review in the same routine as before. The Contracting Officer will examine and return such prints as promptly as practicable.

(4) If the Contractor feels that the corrections and revisions required under subparagraphs (2) and (3) above are a change in the contract requirements, he shall promptly inform the Contracting Officer and shall not proceed with the affected work until he has received further instructions from the Contracting Officer.

g) If, at any time before completion of the work, changes are made necessitating the revision of previously reviewed drawings, the Contractor shall make such revisions and shall resubmit the drawings for review in accordance with the above instructions.

h) Unless otherwise provided, all connections necessary to properly complete the work under this contract shall be designed and completed in a satisfactory manner by the Contractor. This shall apply with equal force to details not shown or specified, but necessary to make indicated alterations or additions to any existing structure or to provide any connection for any future additions indicated on drawings or specified herein. All parts designed by the Contractor shall be amply strong to withstand, without excessive deflection, any loads or pressures to which they are likely to be subjected and to develop the strength of the weakest of the members connected. In no case shall the construction be inferior in any way to that shown on the drawings. All designs and details made by the Contractor shall be in accordance with the best standard practice.

i) Where reports of factory tests are required by the specifications, the Contractor shall furnish six copies of such reports, certified by a responsible officer of the Contractor, which shall be subject to review of the Contracting Officer before delivery of the materials or equipment. This review shall not relieve the Contractor of the obligation to meet all the requirements of these specifications.

j) Review by the Contracting Officer or the Representative of the Contracting Officer of the Contractor's drawings shall not relieve the Contractor of any part of his responsibility to meet all the requirements of the contract, or of the responsibility of the correctness of the Contractor's drawings. The review of drawings by the Contracting Officer, or the Representative of the Contracting Officer shall not be construed as a complete check but will indicate only that the general method of design, work and detailing has been reviewed.

k) The Contractor shall furnish record information and record drawings showing "as built" conditions for all subsurface construction, including utilities, built under this contract.

(1) The Government will provide the Contractor with work prints showing all existing construction, including utilities, as far as they are known, in the area covered by this contract. New construction under this contract will be indicated on these prints. Prints will be accurately to scale and normally without dimensions. The work prints are to provide a means for the Contractor to keep "as built" records. All existing utilities uncovered or exposed by excavation during construction, whether shown on the prints or not, shall be dimensioned and located the same as new utilities. Direction of flow, if any, shall be indicated.

(2) Prior to the completion of the contract, at his request, the Contractor will be furnished reproducibles, from which the work prints were made. He shall transfer thereon all the "as built" data recorded on the work prints, together with the name of the Contractor, the contract number, and a certification, signed and dated by the Contractor's superintendent, that all dimensions are correct. The completed work prints and modified reproducibles shall be returned at the completion of the contract, or as hereinafter provided, in good and printable condition.

(3) The Contractor shall keep the work prints current by recording locations of all construction immediately upon installation and before backfilling over underground work. All plotting shall be accurate. All control dimensions shall be indicated. Where dimensions of new construction have been indicated on the work prints, these shall be crossed out and the "as built" dimensions recorded even if the same as those given.

(4) Locations shall be three-dimensional. Elevations shall be in feet and hundredths, referenced to USHER Datum. Lateral dimensions shall be in feet and inches. Dimensions to subsurface utilities which extend under foundations, buildings, or other construction shall be given to the point of exposure at the surface or to the point of "rise" in concealed construction. ("Surface" shall be considered as the lowest level of basement, first floor or "crawl" space under the construction.) (The foregoing applies to entering or exiting items only. No records will be required for utilities entirely enclosed in construction, or entirely above surface.) Dimensions shall be given from survey lines, major fixed surface points, or points of permanent nature such as road center lines, curb lines, sidewalk edges, building wall, center of manhole covers, fire plugs, etc. Building foundation, and manhole locations shall be those used by the engineer in the layout for control of construction, and normally shall be to center lines or edges. Manhole or pit dimensions shall include the invert or bottom elevation in addition to the top or cover elevation. Invert elevation shall be given to flow line, if present; otherwise it shall be to the bottom of the manhole or pit with separate information for sump, if present. Dimensions shall be recorded for all changes in direction, slope, or type of run, as well as valves, tees, elbows, fire plugs, cleanouts, manholes, and similar features. For circular utilities, horizontal dimensions shall be to center lines; diameters shall be recorded, and invert or top elevations shall be designated. For rectangular utilities, horizontal dimensions shall be to center lines, and width shall be given. Elevations shall be recorded for both the top and bottom. Construction layout control dimensions shall be taken and location shall be recorded and checked for completeness of record before backfilling. Accuracy of dimensions shall be as follows:

Location:

Buildings, roads, foundations, manholes and similar items to construction accuracy.

Elevations:

Buildings, roads, foundations, sanitary and storm sewers, manhole covers, catch basins and similar items to plus or minus 0.05 foot.

Duct banks, trenches, water lines, etc., to plus or minus 0.1 foot.

(5) On contracts running more than 9 months, the Contracting Officer may request progress prints at intervals of 6 months. These progress prints shall consist of prints from the work prints supplied the Contractor, as corrected to date of submittal.

2-20. Materials and Equipment:

a) Where equipment specified by manufacturer's designation requires modification to fully meet contract requirements, such modification shall be made by the Contractor without additional cost to the Government.

b) Where two or more types of equipment or materials are specified without indication of preference, it shall be optional with the Contractor which one is used, but the same type shall be used throughout.

c) All required equipment and material data, including location and function, shall be furnished to the Contracting Officer, in sextuplicate, for approval. Submittals shall be on standard letter-size, or larger, sheets. Machinery, equipment, materials, and articles furnished without such approval shall be at the risk of subsequent rejection, and will not be considered in computing partial payments.

d) Prior to delivery of each major item of equipment, the Contractor shall, unless otherwise directed, submit 10 copies of an instruction manual for each, containing the following information as a minimum:

(1) Description, including ratings, construction details, bearing and lubrication details, dimensions, weights, location of any internal pressure of temperature devices, etc.

(2) Erection and disassembly instructions.

(3) Operating instructions, including temperature limitations, lubrication recommendations and operating procedures.

(4) Instructions for maintenance, inspection, cleaning and adjustment.

(5) List of repair parts, including description and catalog numbers of each piece.

(6) Test reports and characteristic data.

2-21. Samples:

a) The Contracting Officer may request, and the Contractor shall promptly submit for approval before installation, samples of any materials to be used in the work. Samples shall be furnished without additional cost to the Government, properly marked with the contract number, brand name, trade mark or trade name, and accompanied by a letter of transmittal clearly listing the samples submitted. All materials used in the work shall conform to approved samples.

2-22. Scrap and Spoil Materials to be Removed:

a) Scrap materials removed under this contract and not specified for reuse or for return to the Government shall be removed from the premises or may be destroyed or wasted in a manner approved by the Contracting Officer.

b) Soil excavation not specified to be reused under this contract in the construction shall be disposed of in one or more of the areas shown on the Facilities Map; or, if not shown, then within a two-mile radius of the construction site as directed by the Contracting Officer. Soil shall be leveled to provide a reasonably flat surface free of depressions.

2-23. Clean-up:

a) At intervals during the progress of the work, and at the completion of the contract, the Contractor shall clean up the site and accesses thereto, and shall dispose of debris. Debris shall not be allowed at any time to accumulate in such a manner as to constitute an unsightly condition or a fire or other hazard.

b) If no suitable disposal areas are available near the construction site, the Contractor shall remove debris from the Government reservation and dispose of it without additional cost to the Government.

2-24. Contract Changes Procedure:

a) Generally a supplemental agreement setting forth the changed work and the adjustment in price and time shall be issued before commencement of the changed work. Only where time is not available and the changed work must proceed may the change be initiated by a change order, which will set forth the scope of the change and will state that the adjustment will be made at an early date. A supplemental agreement will be issued as soon as sufficient cost data becomes available to enable final prices to be determined and agreed upon. In no event will "after-the-fact" pricing be allowed or approved.

2-25. Expediting:

a) The Contractor shall submit to the Contracting Officer timely reports showing the status of any orders or subcontractors which may delay or are delaying the overall contract schedule. Order status reports shall include:

(1) Contract or order number, date submitted to the supplier, date accepted by the supplier, supplier's name and address.

(2) Delivery date needed to meet contract schedule.

(3) Delivery date agreed to by the supplier, and any subsequent changes in that date.

(4) Reasons, if known, for changes in delivery dates.

(5) Effect which latest promised delivery date will have on the contract schedule.

(6) Resume of Contractor's efforts to bring the promised delivery date in line with the requirements of the contract schedule, including efforts made to place the order or subcontract with other suppliers.

2-26. Final Inspection:

a) On completion of the work, the Contractor shall give written notice to the Contracting Officer of his readiness for final tests and inspection.

2-27. Safety and Health:

a) In order to provide safety controls for protection to the life and health of employees and other persons; for prevention of damage to property, materials, supplies, and equipment; and for avoidance of work interruptions in the performance of the contract; the Contractor will comply with the provisions of the Manual of Accident Prevention of the A. G. C. A. Further, the Contractor shall take or cause to be taken such additional safety measures as the Contracting Officer may determine to be reasonably necessary provided, that if compliance with such additional safety measures results in a material increase in the cost or time of performance of the contract, an equitable adjustment will be made in accordance with the clause of this contract entitled "Changes."

b) During the performance of work under this contract, the Contractor shall comply with all procedures prescribed by the Contracting Officer for the control and safety of persons visiting the job site and will comply with such requirements to prevent accidents as may be prescribed by the Contracting Officer. All work at the site on electrical, air, steam or fluid driven mechanisms shall conform to applicable safety regulations of NASA which include a safety tag-out procedure to prevent unauthorized operation of such equipment.

c) The Contractor will maintain an accurate record of, and will report to the Contracting Officer in such manner as the Contracting Officer may prescribe all accidents and incidents resulting in death, traumatic injury, occupational disease, and/or damage to property, materials, supplies and equipment incident to work performed under the contract.

d) The Contracting Officer will notify the Contractor of any noncompliance with the provisions of this clause and corrective action to be taken. The Contractor shall, after receipt of such notice, immediately take such corrective action. (Such notice, when delivered to the Contractor or his representative at the site of the work, shall be deemed sufficient for the purpose.) If the Contractor fails or refuses to comply promptly the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop work shall be the subject or claim for extension of time or for costs or damages by the Contractor.

e) In addition, the Contractor will comply with the following special provisions where applicable:

(1) All welding and cutting operations under the scope of this contract shall be done in accordance with nationally recognized good practice. The current publications of the American Welding Society, 345 East 47th Street, New York 17, New York, International Acetylene Association, 270 Park Avenue, New York, New York, and the National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass., shall be used as a minimum standard of nationally recognized safety procedures in welding and cutting.

(2) The Contractor shall provide the necessary methods of fire extinguishment and fire prevention and before operations begin, will clear all welding and cutting operations with the Contracting Officer's representative.

(3) Upon completion of any burning, welding, or cutting operation, the Contractor will provide a workman to remain at the site for one hour. This workman will make a thorough inspection of the area for possible sources of latent combustion. Any unsafe conditions shall be reported to the NASA Manned Spacecraft Center Fire Department for their investigation.

(4) During questionable operations the Contracting Officer may request a standby by the NASA Manned Spacecraft Center Fire Department. However, this does not relieve the Contractor of his responsibility of welding and cutting safety.

(5) Open fires and heating devices. The use of open-flame heating devices will not be allowed except by special permission of the Contracting Officer. Such permission will not be granted unless the Contractor has taken all reasonable precautions to make such devices safe. Burning trash on the job site will not be allowed unless specific approval is granted for each incident by the Contracting Officer. Approval for the use of open fires and open-flame heating devices will in no way relieve the Contractor from the responsibility of any damage incurred because of such fires.

(6) Flammable liquids shall be stored and handled in accordance with the Flammable Liquids Code (No. 30) of the National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass.

(7) Where hydrostatic or other special testing is required under the contract, the Contractor shall submit for approval a complete and detailed testing procedure, and shall not undertake any such testing until the procedure has been approved. No such testing shall be performed without the presence of an NASA Inspector.

(f) Compliance with the provisions of this paragraph (2-27) by subcontractors will be the responsibility of the Contractor.

2-28. Government Review of Announcements:

(a) The Contractor agrees not to make public release of information of any matter pertaining to this contract without NASA clearance prior to publication in any medium or presentation before technical or scientific groups. The Contractor shall insert the provisions of this clause in any subcontract requiring a prior written approval of the Contracting Officer. Requests by subcontractors for clearance from NASA prior to publication in any medium of any

matter pertaining to the subcontract shall be directed to NASA through the Contractor. Requests for clearance will be referred to NASA Manned Spacecraft Center, Office of Public Affairs.

SECTION 3 -- DETAILED REQUIREMENTS - MECHANICAL

3.01 GENERAL:

a) This section covers the technical and mechanical requirements and states the performance required. The Contractor shall furnish all materials and items of equipment, even if not specifically mentioned herein, to meet the system performance as herein specified.

b) The design, construction, and equipment of the facility shall conform in all respects to applicable accepted safety codes and standards of recognized authorities, such as the National Fire Protection Association, the National Electrical Code, ASTM Standards, etc.

c) All electrical equipment and work necessary or incidental to the installation of items covered by this section shall meet the requirements of Section 4, Detailed Requirements - Electrical.

3.02 TEST CHAMBER:

a) The test chamber shall be double wall construction divided by a bulkhead wall into two cells with inside dimensions of 8' wide x 8' high x 10' long and 8' wide x 8' high x 20' long. The inner and outer chambers must be designed to provide a closed ecological system inside

the inner shell or liner. The chamber shell, doors, windows, and all penetrations must be designed for absolute isolation between the inner shell and ambient conditions. There can be positively no cross contamination between the outside and the inner shell. In case of doors and windows, this isolation must be accomplished by double gasketing and reduced pressure between gaskets.

b) The chamber outer shell (called shell) and bulkhead dividing wall shall be fabricated from SA-285, Grade C, carbon steel and shall be designed for both 15 psi vacuum and 15 psig pressure with a maximum metal temperature of 100° Fahrenheit.

The chamber inner shell (called liner) shall be fabricated from SA-240 Type 304L stainless steel and shall be designed for a maximum differential pressure of 25 mm Hg. (millimeters of mercury), with a maximum metal temperature of 100° Fahrenheit.

All chamber areas exposed to the inner chamber atmosphere must be 304L stainless steel.

c) The chamber shell, dividing wall, liner, and supports for the chamber shall be designed in accordance with Section VIII of the ASME Code for Unfired Pressure Vessels (except paragraphs U-1(d) and U-1(d)(4) shall not apply) and the AISC Manual of Steel Construction as applicable. The chamber shell, cell divider, doors, windows and all components within the chamber shall be designed to withstand a dynamic impact pressure of 15 psi evenly distributed

over the outside surface.

d) The chamber shell must be completely sealed against dynamic impact pressure. The liner shall be protected against dynamic forces by equalization of pressures between shell and liner. All joints shall be welded through so that no air can be trapped in the joints. Plates forming a flat surface of the chamber shall be butt welded. The chamber shall be fabricated using full penetration butt welds in the main shell structure, at all corners, and at all nozzle, door and window openings. Structural reinforcing members of the chamber shall be welded to the outside surface of the chamber only. Structural reinforcing members shall not cover any plate weld. The flat surfaces on the inside of the chamber shall be smooth continuous and all butt welds on the inside surface of the chamber liner shall be ground flat and smooth. Welding procedures and welding qualification tests shall be as specified in Section 6 - Welding. Spot radiography is required for the shell welds; radiography shall be in accordance with Section 6 - Welding.

e) Personnel doors shall be designed so that external atmospheric pressure would cause the doors to be forced against the door seals when the test cells are at reduced pressure. The door located in the bulkhead between the two cells shall be designed in a similar manner such that it will be forced against its seal when cell #2 is operating

at a reduced pressure. All doors shall be designed with a locking mechanism which will withstand 15 psig internal pressure and shall be equipped with safety stops to allow the door to come ajar to permit complete pressure equalization before the mechanism is completely disengaged. All doors must be operable from both sides except during positive pressure operations. The necessary penetrations or mechanisms for the door clamping design must be installed in such a way to preclude any possible cross contamination between the outside and the inner shell. The door seal material shall be silicone rubber. All personnel doors shall have a minimum of 7'-0" high x 3'-6" wide. Each door shall contain one 8" view port.

f) The entire chamber shell should be designed to retain the level of vacuum with the vacuum pump isolated from the system with the pressure loss not to exceed 1 mm Hg. per hour. The individual cells leak rate shall not exceed 500 microns per hour.

g) The chamber liner bottom shall serve as the floor of the inner cell and designed to be structurally capable of supporting equipment and personnel necessary for the operation of the chamber for live loading of 300# per square foot.

h) The interior of the chamber shall be #2B finish. All equipment inside the chamber shall be unfinished or treated with a finish which is non-combustible and tested under conditions of at least 1 absolute atmosphere of 100% oxygen.

If sound deadening materials are employed within the chamber, they should be non-combustible.

i) A sufficient number of viewing ports shall be provided in accordance with the reference drawings and must be fabricated with Herculite Tempered glass, or equal, capable of withstanding the design pressure at a 10 to 1 safety ratio.

j) Wherever possible all sources of illumination shall be mounted outside the chamber and arranged to shine through the view ports.

Permanent lighting fixtures installed within the chamber shall comply with requirements of NFPA 70, Article 500, Class 1, Division 1, Group C atmospheres and shall be approved for the maximum vacuum and oxygen concentration within the chamber. A metal plate indicating the maximum atmospheric pressure usage, the maximum oxygen concentration usage, and the normal nominal surface temperature shall be permanently affixed to each fixture.

k) The test chamber shall be man-rated in accordance with NASA/MSC Safety Manual Part 7 "Man-Rating" requirements dated May 15, 1967, revision No. 8 and SPD-3 Safety Program Directive No. 3, Safety Guidelines for "Man-Rating" Altitude Chambers.

l) The chamber shall be designed for 100% gaseous oxygen and shall be free of hydrocarbon contamination as demonstrated by ultra-violet (black light) inspection by NASA inspectors.

m) The chamber shall be provided with rupture or burst discs, or the equivalent, capable of sustaining normal design pressures. These shall be designed to prevent catastrophic failure of the chamber vessel by relieving over pressure conditions caused by rapid gas expansion due to fire or rapid temperature rise. Two safety relief systems shall be provided - one for vacuum operation (760 mm Hg.) and the second for the sterilization operation (see paragraph 3.08).

n) All critical service lines should be routed and protected to preclude damage from any cause other than a catastrophic occurrence. Redundant systems should be adequately separated.

o) The potential and inadvertent connection of inert or asphyxiant gas supplies shall be assessed and eliminated where possible.

3.03 PRESSURE CONTROL SYSTEM:

a) The principle operating modes of the pressure control system shall provide for: (1) reducing to and maintaining a selected absolute pressure independently, in man lock cell No. 1 and test cell No. 2, (2) manual emergency repressurization of each test cell, and (3) maintaining a selected differential pressure between the shell and liner, in both test cells. The pressure control system shall provide the capability of automatically controlling the total and differential pressure of test cell No. 2,

independent of the total and differential pressure in test cell No. 1, between 180 mm HgA and 760 mm HgA; and 0 mm Hg and 25 mm Hg respectively. The pressure control systems shall provide the capability of manual control of the total and differential pressure of man lock cell No. 1 and/or manual equalization with cell No. 2 shell and liner. The total pressure shall be automatically controllable within ± 4 mm Hg (overall system accuracy), and the differential pressure shall be automatically controllable within ± 2 mm Hg of the set point.

b) Two vacuum pumps suitable for pumping 100% gaseous oxygen shall be provided for the pressure control system (see drawing J70299 for typical hook-up schematic) one roughing pump and one trim pump.

(1) The roughing pump shall be a two rotary, water-sealed vacuum pump of conical design with bronze or cast iron bodies, bronze cone, bronze shrouded rotors and steel shaft equipped with teflon packing and lantern glands or mechanical shaft seals. All pump parts in contact with the process vapor shall be supplied and operated in grease-free and oil-free condition to minimize explosive hazard when handling oxygen. The pump shall be either close-coupled or mounted on a base with a coupling drive, coupling guard and motor. The roughing pump shall be capable of 26" Hg vacuum with single stage design and sized for evacuating the chamber from atmospheric

pressure to 180 mm HgA in less than 30 minutes. Factory certified test sheets showing actual pump performance shall be furnished for the pump. The roughing pump shall be furnished with the following accessories:

Vacuum Relief Valve

Water Trap Silencer

Seal Line Flow Control Valve

Seal Line Strainer

Seal Line Solenoid Valve

T.E.F.C. Motor

Discharge Manifold

(2) The trim pump shall be a two rotary, water-sealed vacuum pump of conical, circular-lobe design with all wetted parts of bronze construction and equipped with mechanical shaft seals. All pump parts in contact with the process vapor shall be supplied and operated in grease-free and oil-free condition to minimize explosive hazard when handling oxygen. The pump shall be capable of 27" Hg. vacuum with single stage design and shall be capable of handling evacuating requirements of both total pressure and differential pressure control systems. The pump shall be close coupled to each driver motor. Factory certified test sheets showing actual pump performance shall be furnished for the pump. The trim pump shall be furnished with the following accessories:

Vacuum Relief Valve

Water Trap Silencer

Seal Line Flow Control Valve

Seal Line Strainer

Seal Line Solenoid Valve

T.E.F.C. Motor

c) Each vacuum pump shall be installed strictly in accordance with the manufacturer's recommended procedure. Each vacuum pump's suction line shall be provided with an ultra-high efficiency filter, check valve, and electric actuated shut-off valve.

The ultra-high efficiency filters shall be provided with a manual resterilization cycle utilizing 12% Ethylene Oxide and 88% Dichlorodiflouromethane.

d) The control of the total pressures of each test cell shall be accomplished as shown on drawing J70299. Primary reduction in the pressures shall be accomplished by the roughing vacuum pump as shown. The maximum allowable pump down time from 760 mm HgA to 180 mm HgA for each test cell shall be 30 minutes. In addition one trim vacuum pump shall be required which shall operate continuously during test periods. The total pressure in the test cell No. 2 shall be maintained at the desired set point by automatic control of the trim pump suction line control valve as shown on the referenced drawing. The air inbleed valve should be operated automatically from the same recording

controller which controls the vacuum valve should the total pressure become less than the desired level. The air inbleed valve must be provided with an ultra-high efficiency filter barrier.

e) The control of the differential pressure between the shell and the liner for the test chamber shall be accomplished as shown on the drawing J70299. The differential pressure for cell No. 2 shall be controlled automatically to the desired level by the remote positioning of the control valves, trim pump suction and air inbleed, which are tied into the jacket section. Man lock cell No. 1 differential pressure shall be controlled manually or equalized with cell No. 2 an atmospheric air inbleeding system shall be required to achieve and maintain the total pressure in each test cell to any setting between 180 mm HgA and 760 mm HgA, independent of the total pressure in the other test cell. The system shall be capable of increasing the total pressure in both test cells to 760 mm HgA in less than 20 minutes. Means shall be provided to defuse the in rushing or exhausting air. The control of the inbleed system for cell No. 2 shall be accomplished by automatic remote positioning of the control valve and the overall system tolerance shall be $\pm$ 4 mm Hg. of set point. The cell No. 1 inbleed system shall be accomplished by manual control.

f) Each test cell shall be equipped with emergency repressurization valves as shown on the pressure control schematic. Repressurization from 180 mm HgA to 760 mm HgA shall be accomplished in less than 30 seconds, but the maximum repressurization rate shall not exceed 30 mm Hg per second. The noise level associated with the repressurization shall not exceed 130 decibles, and the dynamic pressure in the test cells shall not exceed 5 lbs. per square foot. The inlets to the valves shall be provided with protective screens; the outlet shall be provided with diverters. A redundent means of emergency repressurization shall be provided.

g) Manual valves shall be located next to all doors to permit pressure equalization between test cells and between the test cells and atmosphere. All manual equalization valves shall be mechanically interlocked in such a way as to permit equalization of the liner concurrently with that of the test cells. Pressure gauges shall be located as shown on the pressure control schematic drawing at all personnel doors to permit the determination of the difference in pressure on each side of the doors to indicate to personnel the hazard of opening a door under a pressure differential.

h) All internal controls shall be located at a display panel. Test cell No. 2 external control console shall be provided with total pressure and differential pressure recorder-controllers (see paragraph 4-14 of Detailed Requirements - Electrical and paragraph 3-14 of this section

for instrument specifications) All instruments and gauges shall be calibrated in mm Hg. absolute.

3.04 VENTILATION AND GAS CONDITIONING SYSTEM:

a) A gas conditioning system shall be provided for test cell No. 2 for the purpose of cooling, heating, circulating, drying, and humidifying the gases in the test cell. The system shall provide for continuous, automatic, and accurate control of the test cell's internal dry bulb and dew point temperatures. The system shall be capable of continuously circulating the interior gases for proper thermal control.

The air handling equipment for the circulating and temperature conditioning system shall be installed inside the chamber and rated for continuous operation at any pressure between 180 mm HgA and 760 mm HgA. The chamber air shall be recirculated from the test cell through a stainless steel plenum located at the top of the cell and then discharged through duct vents back into the cell. Stainless steel fluid to air heat exchangers shall be provided in the plenum for cooling and heating the cell air.

A humidifier shall be furnished for the higher humidity requirements and a desiccant dryer shall be furnished for the lower humidity requirements. The dryer and its air handling equipment shall be installed outside the chamber and rated for continuous operation for all pressure levels.

All instrumentation and associated controls for test cell No. 2 shall be automatic and located outside the chamber

at the external control console. An independent controller-recorder (see Section 4-14 of Detailed Requirements - Electrical) shall operate in conjunction with the dry bulb temperature sensor and with the dew point hygrometer.

The dry bulb temperature of each cell and the dew point temperature of test cell No. 2 shall be displayed continuously at the display panel inside the test cells. The system design shall provide that there be no entrained moisture in the recirculating air to the test cell under operating conditions.

Man lock cell No. 1 temperature and humidity requirements shall be accomplished by manual ventilation using external air.

b) During steady state operation, cell No. 2 ventilation and gas conditioning system shall be designed to meet the following requirements:

(1) The system shall provide for all dry bulb temperatures within the range of 40°F and 100°F, with a tolerance of $\pm$ 1°F.

(2) The system shall provide for all relative humidities between 20 and 80 per cent between 40°F db and 100°F db, with a tolerance of $\pm$ 3 per cent relative humidity.

(3) The following are the heat loads that must be dissipated by the ventilation and gas conditioning system under steady state conditions:

(a) Total sensible heat load in Btuh due to ten men performing light work but not less than 3000 Btuh.

(b) Total latent heat load due to ten men performing light work but not less than 3000 Btuh.

(c) Equipment which emits heat that is a part of the test cell, such as lights, blowers, etc.

(d) External heat load for insulated chamber: It shall be the Contractor's responsibility to determine the external heat load. The temperature of the facility housing the chamber will vary from 70°F db to 90°F db.

c) The temperature conditioning system shall be designed to incorporate the following transient performance requirements:

(1) 40°F db to 100°F db in 180 minutes.

(2) 100°F db to 40°F db in 180 minutes.

d) The temperature gradient shall not exceed 5°F, the maximum variation throughout the working volume of the test cell. The 5° maximum gradient shall be governed by the following conditions:

(1) Measured 1 foot away from interior walls.

(2) Stabilized conditions.

(3) At all dry bulb temperature requirements.

(4) At all pressure requirements.

(5) No electrical equipment heat load.

(6) Lights off.

e) The cooling system shall provide sufficient cooling capacity for the total heat load in the test cell consisting of the various loads as specified in paragraph b) and c) above plus an additional capacity for 12,000 Btuh for future use. The cooling system shall consist of a continuously circulating supply of propylene glycol to the test cell's stainless steel heat exchanger from an external chiller unit.

(1) The Contractor shall furnish and install as shown on general facility drawing a package chiller unit with storage tank, Dunham-Bush Model PCS or approved equal. An excessible hermetic compressor with hot gas by-pass capacity control and suitable for the available electrical characteristics shall be supplied.

The chiller and water cooled condensers shall be of non-ferrous construction using inner-fin on the refrigerant side. The chiller shall be furnished with foamed in place urethane insulation and covered with heavy gauge steel casing. The chilled glycol circuit shall have self-contained galvanized storage tank and bronze body recirculating pump. Tank assembly shall have not less than 2" fiberglass insulation protected by sheet metal panels and all chilled piping shall be covered with insulation and liquid vapor barrier to prevent condensation. A liquid to suction heat exchanger shall be furnished and all components shall be factory assembled, painted, and mounted on a

common steel frame. The chiller unit is to be furnished with:

Magnetic starters for compressor and pump

Dial thermometer indicating the tank temperature

Dual pressure control

Thermostat for freeze protection

Thermostat for storage temperature control

Liquid line sight glass with moisture indicator

Dryer

Expansion valve

Complete wiring including safety interlock between pump and compressor

Refrigerant operating charge

Toggle switch for manual cut-off of compressor

Evaporator pressure regulator

Capacity control.

f) The heating system shall be designed to provide sufficient heating capacity for the total heat load on test cell No. 2 consisting of the various loads as specified above. The heating system design shall be compatible with 100% gaseous oxygen service; any electric resistance type heaters shall be located exterior to the chamber and controlled by a solid state silicone controller rectifier. The heating system shall consist of a continuous circulating supply of a heat transfer fluid from an external heater to a stainless steel heat exchanger in test cell No. 2.

g) The air in test cell No. 2 shall be circulated through the chamber by means of a spark-proof blower which shall be driven from outside the chamber by a drive system capable of meeting the requirements of all the temperature and pressure conditions. The blowers shall discharge the air through a plenum into the working space and the plenum shall be designed to introduce a pressure drop upon the recirculated air, thus enabling a static pressure to build up in the plenum for uniform air distribution. The air shall be exhausted from the working space into a return duct located near the test cell floor where it will be filtered and reconditioned to the proper temperature. The air flow pattern shall be designed so the average velocity will not exceed 200 feet per minute measured at any point at least one foot from the chamber wall. The noise level in the test cells shall not exceed 75 decibels (except during emergency repressurization). The air duct velocity may be adjustable to a maximum of 750 feet per minute at standard conditions in order to meet temperature requirements.

(1) The recirculation blower fan wheel shall be backward inclined, power limiting type of fiberglass construction, and shall safely operate at all system points required by the air distribution system. It shall be tested according to and be licensed to bear the certified rating seal of the Air Moving Conditioning

Association. Basic construction shall be based on the system environment:

For hazardous areas, the minimum requirement shall be AMCA Type "B" spark-proofing (Type C not acceptable).

Where corrosive environments are encountered, all air stream parts shall be constructed of standard metals coated with eight mills of baked epoxy-resin or fiberglass reinforced resin similar to New York Blower Type FPL Fans.

(2) The blower drive shaft mechanical seal shall be designed for the full pressure range and for dry operation. It shall be constructed with stainless steel rotary unit and tungston carbide seal ring insert.

h) The drying system shall be a closed external loop to test cell No. 2 and shall incorporate dessicant type absorbent. The dehumidification bed shall be sized for the following loads:

(1) Transient dehumidification from 93°F dew point to 5°F dew point in 240 minutes at any pressure between 180 mm HgA and 760 mm HgA.

(2) Steady state water vapor load of two thousand mice. The steady state load shall be added to the trancient state load for design system capacity.

The system shall provide for the automatic reactivation of the desiccant bed and where it is necessary to reactivate

a bed during a test period, the switch over to the new bed and reactivation of the spent bed shall be accomplished without aborting the test and without introducing external biological contaminants.

The dehumidification desiccant type absorbent units shall be dual absorber units with molecular sieve desiccant in place, 150 psig maximum design pressure, fully automatic controls with manual override, absorbers interconnected with 4-way teflon lined plug valves for switch over, including lights for indicating preactivation, dial thermometers, and color grade type moisture indicator, and to be furnished with the following safety circuits:

Switch failure alarm circuit,

Heater failure alarm circuit,

High temperature alarm circuit, and

High humidity alarm circuit.

The means by which the chamber atmosphere is circulated thru the desiccant drying beds must be designed to be completely compatible with 100% gaseous oxygen service. The conditioned gas discharged back into the test cell must pass thru a bacteria filter installed in a manner to preclude any bacteriological contamination during replacement.

i) The test cell humidification shall be accomplished with the use of steam supplied by the facility. The steam system shall be properly trapped to insure the use of dry steam for the addition of humidity. The humidification system shall be designed to increase the cell dew point from 5°F to 93°F in

240 minutes at any pressure between 180 mm HgA and 760 mm HgA.

3.05 OXYGEN CONTROL SYSTEM:

a) The oxygen control system shall be capable of providing and maintaining the desired oxygen partial pressure (maximum oxygen concentration shall be 100% at all specified total pressures) manually for man lock No. 1 and automatically for test cell No. 2. The gas analysis system described in paragraph 3.07 shall provide the continuous indication of test cell No. 2 oxygen partial pressure at the test cell external control console and shall have the capability of indicating the man lock oxygen partial pressure when desired. The complete oxygen system shall be rated for 100% oxygen concentration. The control of the oxygen partial pressures shall be accomplished manually or automatically by remotely positioning the pneumatic control valves as shown on drawing No. J70297. The automatic controller for the pneumatic positioning valve for test cell No. 2 shall be as designated in paragraph 4.14 of Detailed Requirements - Electrical. The oxygen control system shall have the capability of increasing the oxygen partial pressure in each test cell from 36 to 760 mm HgA in 120 minutes. Means shall be provided to diffuse the in rushing oxygen.

b) The oxygen supply system shall have the capability of delivering the quantity of oxygen required to raise the

partial pressure of oxygen from 36 to 760 mm HgA as specified in the above paragraph.

c) Test cell No. 2 oxygen flow rate shall be measured by two flow meters in parallel as shown on the above referenced drawing to give continuous indication of the oxygen flow rate. A selector switching arrangement shall be incorporated into the system as shown to provide the capability of reading either flow meter. See paragraph 4.15(e) for detailed oxygen flow meter specifications. A single recorder shall be provided to record the mass flow rates of both the flow meters. The flow meter indicators, mass flow recorder, and selector switch arrangement for the test cell shall be located at the external control console. Indicating lights shall indicate which flow meter is being read.

d) An oxygen breathing system incorporating quick-disconnect connections shall be provided and installed by the contractor as shown on the oxygen system schematic. The regulators for the oxygen breathing system shall be of the diluter demand type and shall meet the specifications as set forth in Military Specification MIL-R-8202D(USAF). The Contractor shall supply oxygen masks (with communication capability) with quick-disconnect connections for attachment to the diluter demand regulators. The breathing oxygen system shall have the capability of continuously supplying make-up oxygen at the total flow rate of all of the diluter demand regulators for a period of 120 minutes. The total flow rate shall consist of the sum of the maximum

expected flow rates of each of the diluter demand regulators as specified in Military Specification MIL-R-8202D(USAF). At least one oxygen mask in each cell shall be provided with sufficient flexible hose to allow movement throughout the entire work area of that cell.

e) NASA furnished oxygen storage bottles:.

(1) The storage bottles for the oxygen supply system and breathing oxygen system shall be furnished by NASA. The furnished oxygen bottles shall be approximately 9" in diameter, shall have a water volume of approximately 2.20 cubic feet, and shall have a maximum storage pressure of 2200 psig. The Contractor shall be responsible for determining the number of bottles required for each of the oxygen systems.

(2) The Contractor shall furnish and install all supplied piping from the storage bottles, including manifolds, regulators, valves, and final connections for the bottles. The support stands with safety chains shall also be furnished and installed by the Contractor. The oxygen header pressures shall be measured and continuously indicated by a pressure transmitter, milliamp meter combination located on the external control console.

(3) The valve outlet connections on the NASA furnished oxygen storage bottles shall be as designated by the American Standard Compressed Gas Cylinder Valve Outlet

and Inlet Connections as sponsored by the Compressed Gas Association:

(a) Oxygen: 0.903" - 14NGO-RH-EXT

Mating assembly: 0.908"-14NGO-RH-INT

3.06 CARBON DIOXIDE CONTROL SYSTEM:

a) The carbon dioxide control system shall be capable of providing and maintaining the desired CO_2 partial pressure in test cell No. 2 only. The gas analysis system as described in paragraph 3.07 shall provide a continuous recording of test cell No. 2 carbon dioxide partial pressure at the test cell external control console and shall have the capability of indicating the man lock carbon dioxide partial pressure when desired. The control of the carbon dioxide partial pressure shall be accomplished automatically by remote positioning of a pneumatic control valve as shown on the carbon dioxide system schematic, drawing No. J70297. The basic controller for the pneumatic conditioning valve shall be as designated in paragraph 4.14 of Detailed Requirements - Electrical.

b) The carbon dioxide system shall have the capability of reducing the carbon dioxide partial pressure to 2 mm Hg and maintaining at that level. The carbon dioxide scrubbing unit shall be sized to maintain the desired carbon dioxide partial pressure in the test cell with a steady state load equivalent to 2000 mice.

c) The carbon dioxide scrubbing system shall consist of an absorption unit, control valve, and instrumentation. The absorption unit shall be designed as a packed column with bacteria-free automatic regeneration of the spent bed and with a positive displacement blower to recirculate the chamber atmosphere thru the absorption unit and back into the test cell thru a bacteria filter. The filter shall be installed so as to preclude any possible bacteriological contamination during replacement. The absorption unit shall be capable of operating with material such as lithium hydroxide or baralyme or some similar material designed specifically for the absorption of carbon dioxide. The system shall be designed such that the absorption material can be easily removed for recharging and the new charge sterilized prior to being put in service.

3.07 GAS ANALYSIS SYSTEM:

a) The gas analysis system shall be provided in order to evaluate and display the partial pressures of oxygen and carbon dioxide in either test cell No. 2 or man lock No. 1. These partial pressures shall be continuously displayed and recorded at the external gas analysis console. The system shall be designed to operate efficiently and accurately at any combination of temperature, humidity, and total pressure previously specified. All sampling pumps to be located outside of the cells and the sample gas shall be dumped to atmosphere thru a bacteria filter.

The gas to be sampled shall be filtered with a high efficiency .3 micron filter as it leaves the chamber and again with a combination liquid separator rated at 10 microns before entering the gas selector panel. It shall be the Contractor's responsibility to determine the quantity of sample gas required by the gas analyzer and to control same.

b) The partial pressure control ranges shall be as follows:

PARAMETER	RANGE	TOLERANCE
pO_2	36 - 760 mm HgA	± 4 mm Hg
pCO_2	0 - 100 mm HgA	± 2 mm Hg

c) The carbon dioxide analyzer shall continuously monitor and display the carbon dioxide partial pressure of either test cell at the external console. A controller - recorder (see paragraph 4-14 of Detailed Requirements - Electrical) shall be required at the external control console for continuous recording of the carbon dioxide partial pressure and automatic control of the pneumatic control valve as shown on drawing J70297. The analyzer shall have a range of 0 to 100 mm HgA of carbon dioxide in a background of oxygen and nitrogen between 180 and 760 mm HgA for the control points. Calibration curves shall be furnished for 180, 380, 570 and 760 mm Hg as carbon dioxide. The analyzer shall have sealed sources, hermetically sealed power switch, and air purge connection on the case. The

analyzer shall be Mine Safety Appliance Company's Lira Model M300 Infrared Analyzer, or equal, and shall include the following characteristics and features:

The analyzer units shall be interrupted type non-dispersive infrared analyzer with dual infrared sources and single pneumatic detector-receiver.

The unit shall operate on the principle of direct deflection.

The speed of response shall be 90% of final reading in 5 seconds.

The zero drift shall be less than 1% of full scale in 24 hours.

The noise level shall be less than 1% of full scale.

Accuracy shall be $\pm$ 1% of full scale and shall be maintained over a temperature range of -20°F to + 120°F db.

The sensitivity shall be $\pm$ 1%.

The repeatability shall be $\pm$ 1/2%.

The millivolt output signal shall be 0 - 100 mv.

The analyzer shall be complete with integral meter displayed in mm HgA.

Calibration shall be achieved by means of a known gas sample.

One complete carbon dioxide analyzer shall be furnished as a spare.

d) The oxygen analyzer shall continuously monitor and display the partial pressure of oxygen in either test cell No. 2 or man lock cell No. 1 at the external control console and at the interior display panels. A controller-recorder (see paragraph 4.14 of Detailed Requirements - Electrical) shall be required at the external console for continuous recording of the oxygen partial pressure and for automatic or manual positioning of the pneumatic control valve as shown on drawing No. J70297. The oxygen analyzer shall be Beckman Instrument Incorporated Model F3M3-1AY, or equal, and shall include the following characteristics and features:

Range:	0-100% oxygen in a background of oxygen and nitrogen between 180 and 760 mm HgA. Calibration curves shall be provided at 180 and 760 mm HgA.
Analyzer Controls:	Consisting of range selector switch and zero and span adjustments located on case door. Air purge connections on the case is required.
Ambient Temperature Limitations:	50° to 110°F, 100 % R.H.
Accuracy:	± 1% of Full Range
Sensitivity:	± 1%
Response Time:	90% in less than 10 seconds from time sample enters instrument.

Output:	0-10 millivolts with integral meter.
Repeatability:	± 1/2%
Method:	The analyzer shall operate exclusively on a paramagnetic principle.
Power:	115 volts, 60 Hz., 150 watts
Special Features:	Fast response, fast flow by-pass

One oxygen analyzer shall be furnished as a spare.

e) The gas analysis sampling system shall be capable of pumping a continuous sample through the analyzers and dumping it to atmosphere. The system shall include:

(1) Diaphragm type sample pump designed with capacity to meet the requirements of the analyzers at all total pressures previously specified.

(2) A back pressure regulator capable of holding the sensor outlet at atmospheric pressure.

(3) Filtration system to properly protect the sensor.

(4) A gas selector panel including flow meters and needle valves manifolded to select and control the zero and span calibration as well as the sample gases.

3.08 STERILIZATION SYSTEM:

The test chamber complex shall be designed with the capability of an industrial gas sterilizer for the purpose of sterilizing the entire interior of the test cells. The design shall incorporate a complete gas sterilization system designed for manual control of the

sterilization cycle using a non-hazardous ethylene oxide mixture. The process cycle shall be the Vacudyne Corporation Standard 12-88, or equal.

3.09 FIRE PROTECTION SYSTEM:

a) The Contractor shall furnish and install a completely independent water fire extinguishing system for each test cell. The fire protection system shall be designed in accordance with the NFPA Standard for Hypobaric Facilities No. 56E-T, NFPA Pamphlet 13, and NFPA Pamphlet 15.

b) The system shall be designed to provide a minimum of 7.5 gallons per minute per square foot of internal chamber floor area. The water supply shall be constantly and fully available and shall not be delayed by starting of fire pumps and should be a minimum of 50 psi pressure. The total quantity of water available for exclusive fire protection of the test cells shall be adequate to furnish at least one minute duration supply (three consecutive 20 second applications at 7.5 gpm rate).

c) The spray nozzles shall be of the high speed design capable of manual as well as automatic activation within one second of sensible flame development. The spray nozzles shall be capable of producing directed full cone patterns and shall be so located to impinge on all surfaces of chamber, equipment and occupants. The spray nozzles shall also be equipped with remotely controlled internal valve mechanisms which will accommodate priming all piping fully with operating standby water pressure.

d) Detection of the fire shall be automatic by using the ultra violet detection system. The detection system shall be capable of disseminating between normal chamber illumination and fire radiation. The detectors shall be so located to constantly provide surveillance of all areas of the chamber, its equipment, and occupants. Electronic devices shall be housed and constructed of materials compatible with the expected atmospheres and ambient pressures. The fire detectors shall operate the solenoid valves relieving the pressure on the pilot control lines and opening the high-speed nozzles thus allowing the water to discharge into the test cells for a period of 20 seconds.

e) Manual facilities for system actuation shall be installed inside and outside of the chamber. These shall be of mechanical or hydraulic type and shall not rely on electrical circuitry for transmissions of actuating signal.

f) A suitable control panel shall be provided to control each fire extinguishing system and shall include the following features and characteristics:

(1) A stand-by power package shall be supplied consisting of triple-charged batteries with sufficient capacity to furnish necessary system operating energy for 24 continuous hours if the charging source should fail. A trouble signal shall sound if the charging source fails.

(2) Detector wiring shall be electrically supervised to determine continuity. Integrity of all components

shall be checked manually with portable or fixed radiation source at each detection device. A disenabling "test" switch shall be provided in the panel to prevent discharge of water from nozzles.

(3) Circuitry to solenoid valves or other remote system actuators shall be equipped with necessary end of line resistors and/or relays to assure maintenance of continuity. An indicating light shall be operated and a trouble signal shall sound a stand-by circuitry fails.

(4) The automatic control system shall provide for double compliments of remote electro-hydraulic or mechanical devices which shall be connected in a redundant manner.

(5) A timer or time delay relay shall be furnished and adjusted to allow actuation of the fire protection system for 20 second consecutive intervals for a one minute period.

(6) Supervisory lights and audible signals shall be provided to monitor position of water supply main control valves.

(7) Audible signals shall be initiated by the control panel upon either the actuation of any flame detector or initiation of water flow into the chamber.

(8) Auxiliary contacts shall be made available to actuate relays or contactors in line and power circuits.

g) Each electro-hydraulic or electro-mechanical control device shall respond in less than 50 milliseconds and they shall be furnished and installed in duplicate so as to provide redundancy operation.

h) The chamber shall be provided with sufficient drains for effective drainage after discharge of the fire system.

i) Interlocking shall be provided so that the vacuum pumps, air conditioning blowers, and all power in the chamber are automatically disconnected upon activation of the fire protection system.

j) Audible signals shall be located exterior to the chamber at the fire protection control panel and at other designated points in the facility to alert all concerned personnel of fire or water flowing in the chamber.

k) A manual extinguishing system shall be provided inside the chamber.

l) All pipes and fittings shall be of the proper size and strength in accordance with the ASA B31.1.

m) Contractor shall furnish all equipment necessary to comply with the above specifications and equipment shall be Underwriters Laboratories approved and Factory Mutual Laboratories approved.

n) All equipment furnished must be compatible with temperature and pressure requirements specified above and 100% gaseous oxygen.

3.10 PNEUMATIC CONTROL VALVES

a) The pneumatic control valves, supplied to meet the requirements of the control system, shall be pneumatic actuated, spring closed, diaphragm valves of stainless steel construction and degreased for oxygen service. They shall be furnished with screwed ends, guided port, single port Micro Flute (equal percentage full characteristic) valve plug with teflon seats, cage construction for ease of assembling inner valve components, and double teflon packing for vacuum service. The actuator shall be sized for 3-15 psig instrument signal with increasing signal to open valve.

The three-way control valves that are required shall be pneumatic actuated, spring returned diaphragm diverting valves constructed of stainless steel and degreased for oxygen service, furnished with screwed ends, guided port, three-way lift V-port (modified parabolic flow characteristic) valve plug, double teflon packing for vacuum service. Actuator sized for 3-15 psig instrument signal, an increasing signal to open bottom port and top port to close, on loss of air supply.

3.11 VALVE POSITIONERS:

a) The electro-pneumatic valve positioners for the control valves described above shall have the following features and characteristics:

Independent Linearity:	Within $\pm$ 1% of output span (valve travel).
Shock and Vibration Effect;	The drift and output due to shock and vibration shall be negligible for accelerations up to 2 Gs for frequencies below 200 Hz.
Adjustments:	Valve stem travel shall be adjustable.
Speed:	A full range change from 3 - 15 psi shall be obtainable in 8 seconds or less.
Air Consumption:	Air consumption shall average .4 scfm or less at mid-stroke. The air pilot shall be closed at upper and lower limits.
Air Supply Pressure:	20 psig
Action:	Direct acting - inverse acting capability
Ambient Temperature Affect:	Ambient temperatures between -40°F and + 150°F shall not affect accuracy.

3.12 PRESSURE GAUGES:

a) All pressure gauges located at the test chamber itself shall be direct reading bourdon type pressure gauges. These gauges shall be absolute or differential pressure gauges as listed on drawing No. J70292.

b) The absolute pressure gauges shall have the following features and characteristics:

Dial Size:	6" diameter
Accuracy:	0.33% of full scale range
Sensitivity:	0.20% of full scale range
Range:	As required by operating pressures specified
Dial Calibration:	Millimeters of mercury absolute

c) The differential pressure gauges shall be bourdon type direct reading type gauges. These gauges shall have the following features and characteristics:

Dial Size:	6" diameter
Accuracy:	0.33% of full scale
Sensitivity:	0.20% of full scale
Range:	As required by operating pressures specified
Dial Calibration:	Millimeters of mercury

d) All remote pressure gauges used in conjunction with the control systems shall be in accordance with paragraph 4.15(f) of Detailed Requirements - Electrical.

3.13 FEED-THROUGH CONNECTIONS:

a) The Contractor shall supply spare feed-through connections for future use by NASA. Spare electrical feed-throughs specified under paragraph 4.04(h) of the electrical section shall be furnished. Spare fluid feed-through connections shall be provided on the flanges as

shown on drawing No. J70293. The spare connections shall be plugged off at the feed-through flange (exterior to the vessel). The following sizes and number of spare fluid feed-through connections shall be provided by the Contractor:

PIPE SIZE	NUMBER REQUIRED
2"	4
1"	4
½"	12
¼"	16

3.14 SAFETY RELIEF DEVICES:

a) The chamber cells shall be provided with rupture or burst discs, or the equivalent, capable of sustaining normal design pressures for hyperbaric testing conditions but also capable of relieving at 10 psig during the sterilization cycle. These shall be designed to prevent catastrophic failure of the chamber vessel by relieving over pressure conditions caused by rapid gas expansion due to fire or rapid temperature rise. The safety relief devices shall also have sufficient capacity to pass the maximum flow that the oxygen pressure regulating valves could pass if they should fail in the "wide-open" position with the storage bottles at maximum storage pressure.

Means shall be provided to protect cells against over pressure during a testing period to prevent a test abort.

3.15 DETAILED PIPING SYSTEM REQUIREMENTS

a) All pressure piping shall be designed and fabricated in accordance with ASA Code for Pressure Piping (ASA-B31.1). All piping for pressures above 25 psig shall be ASTM A106, Grade A or B or A312, Grade TP304. All welded joints in the system including pipe joints and welds in manufactured components to be operated at pressures above 125 psig shall be 100% radiographed in accordance with Section 6 - Welding of the Specifications. All pressure piping above 125 psig shall be hydrostatic tested to 1.5 times the maximum expected system working pressure. All defects shall be noted, repaired, and then retested.

b) All vacuum piping shall be ASTM A106, Grade A or B or A312, Grade TP304. All joints in vacuum and pressure piping larger than 2" shall be butt welded. All loose mill scale, weld slag and all other foreign matter shall be removed from piping before installation. All vacuum piping shall be leak checked by pressurizing with air to 20 psi and applying a soap solution to all welds and joints. All leaks shall be repaired and then retested. Filters, pumps and vibration isolators shall be isolated from the system during pressure tests.

c) All piping materials must be compatible with the atmosphere to which they are exposed. All piping either carrying 100% gaseous oxygen or exposed to it shall be constructed of 304 stainless steel and properly degreased.

3.16 EQUIPMENT FOUNDATIONS AND SUPPORTS:

a) NASA shall furnish and install foundations, pads, reinforcing steel and anchor bolts, if required, otherwise Contractor shall furnish equipment anchor devices. Contractor shall furnish washers, nuts, grout, leveling devices, piping supports, and apparatus as required for equipment and piping provided under this contract.

b) Grout shall be of the non-shrinking type.

c) Cutting of the existing concrete floor shall be avoided.

3.17 PAINTING:

a) All ferrous surfaces shall be painted. Other materials used shall be painted if required for preservation purposes or if it is a material which is normally painted. Materials such as stainless steel, glass, aluminum, rubber, etc. which are not normally painted shall not be painted.

b) Surfaces to be painted shall be thoroughly cleaned and dry prior to painting. Ferrous metal surfaces shall be free from rust, loose mill scale or other foreign matter prior to painting.

c) The paint shall dry solidly without running streaking, or sagging.

d) All ferrous surfaces shall be primed with one coat of Pittsburg Zinc Chromate Ironoxide Primer No. 17-6 or equal and two finish coats of Pittsburg "A lavax Machinery Enamel" or equal in the following colors as designated in Federal Standard No. 595 "Colors":

ITEM	COLOR NUMBER
Surfaces inside of test shell (Fire Retardant)	24516
Outside surfaces of shell	1520
Piping outside of shell	Coded
Electrical conduit	Shall Match Surroundings

e) For all piping and tubing the name of fluid and direction of flow shall be indicated every 10 feet using black enamel lettering at easily visible points and at all valves and at points where piping or tubing pass through walls (both sides of wall).

f) Contractor shall touch-up all painted surfaces that have been damaged.

3.18 TESTING:

a) All tests shall be witnessed by a representative of the Contracting Officer. The Contracting Officer shall be notified in writing at least 2 weeks prior to all tests.

b) The following final acceptance tests shall be conducted by the Contractor at his plant prior to shipment.

(1) Each cell must be subjected to a separate pneumatic pressure test. Pressure tests shall be in accordance with paragraph UG-98(f) of Section VIII of the ASME Code for Unfired Pressure Vessels.

(2) The pressure in both cells must be reduced to 1 mm HgA and held for a period of 60 minutes with no detectable change in pressure.

c) The following final acceptance tests shall be conducted by the Contractor after the chamber complex has been completely assembled at Manned Spacecraft Center.

(1) The pressure in test cell No. 2 shall be reduced from 760 mm HgA to 180 mm HgA in 30 minutes; the oxygen system shall be pressurized up to the last valve before entering the test cell. All vacuum pumps shall be valved off and the test cell pressure shall be observed for a period of one hour. If the pressure rise in the test cell is greater than 1 mm Hg the test cell shall be brought up to atmospheric pressure, location of the leak shall be determined, repair shall be made in accordance with the requirements of the ASME Code for Unfired Pressure Vessels, and the chamber shall be retested until it will hold the vacuum within the limits described above for a period of one hour. During this test the bulkhead door shall be closed.

(2) Test cell No. 2 shall be tested again in accordance with the procedure described above under paragraph 3.18 (c)(1) except that the bulkhead door shall be open.

(3) Both cells shall be pressurized to 1140 mm HgA with check relief plugged and observed for a period of one hour. If the pressure loss in the cells is greater than 1 mm Hg the test cell shall be brought to atmospheric pressure, location of the leaks shall be determined, repairs shall be made in accordance with the

requirements of the ASME Code for Unfired Pressure Vessels, and the chamber shall be retested until it will hold the pressure within the limits described above for a period of one hour.

(4) Pressure in test cell No. 2 shall be reduced to 180 mm HgA. The temperature within the test cell shall be increased to 100°F db and 93°F dew point; this condition shall be maintained automatically within specified toleranced for one hour. The humidity within the test cell shall be then decreased in less than 4 hours to 5°F dew point and the temperatures within the test cell shall be decreased in less than 3 hours to 40°F db; this condition shall be maintained automatically within specified tolerances for one hour (during three hour pull down and one hour steady state period the Contractor shall continuously simulate the sensible heat load specified under paragraphs 3.04(3)(a and b) in both test cells. The temperature and humidity in the test cell shall then be increased in less than 4 hours to 100°F db and 93°F dew point.

(5) The total pressure in test cell No. 2 shall be reduced to 180 mm HgA. The partial pressures of oxygen and carbon dioxide shall be controlled at 90 mm HgA and 2 mm HgA respectively and shall be maintained within the specified tolerances for a period of 30 minutes. The carbon dioxide load shall be supplied from bottles if not from the host systems.

d) In the event the equipment supplied under this contract does not function properly in accordance with these specifications, the Contractor shall at no additional cost to the Government, make any necessary changes, alterations, redesigns, or any necessary operations to insure that the equipment functions in accordance with these specifications. The Government will then again witness the operation of the equipment for proper functioning.

e) The Contractor shall furnish all the necessary equipment and services necessary to conduct all tests unless otherwise specified herein. All blanks, plugs, and caps required for testing shall be turned over to the Government at the completion of the tests.

SECTION 4 -- DETAILED REQUIREMENTS - ELECTRICAL

4.01 SCOPE:

a) This section covers the detailed electrical requirements for designing, furnishing and installing electrical equipment and controls necessary or incidental for the operation of the test chamber complex.

b) Included in the work are the following general items:

(1) Electrical circuits

(2) Electrical diagrams

(3) Thermocouple panels

(4) Conduit

(5) Chamber lighting and receptacles

(6) Auxiliary electrical equipment

(7) Electric generator

(8) Fire alarm and protection system

(9) Controls

(10) Control panels

(11) Instrumentation

(12) Communication system

c) The Contractor shall furnish and install all wiring associated with the test chamber complex and its auxiliary equipment.

4.02 GENERAL REQUIREMENTS:

a) Each item of material and equipment shall be of the best quality obtainable for the purpose intended and shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. The materials, wiring and equipment shall be designed and built in accordance with the latest and best practices of the electrical industry, and shall conform to Federal Specifications and to the Standards of the National Electrical Manufacturers Association, American Standards Association, National Electrical Code, Joint Industry Conference Electrical Standards, Institute of Electrical and Electronics Engineers and National Electrical Safety Code, wherever they apply. Wherever specific requirements are not described, the National Electrical Code shall apply for work performed under these specifications.

4.03 ELECTRICAL CIRCUITS - GENERAL:

a) All electrical equipment and circuits associated with the test chamber, whether within or outside of the chamber, shall have a minimum of 2 independent sources of electric power, one to be fed from a prime motor-driven generator set located on the premises of the facility. The specifications for the generator are given in paragraph 4.10 of this section.

b) The electrical circuits contained within the chamber and all permanent lighting, within or outside of the chamber, and all circuits used for communication and alarm systems shall be connected to the emergency electrical system.

c) The emergency power supply generator shall be so installed and connected so that all circuits and equipment will be automatically restored to operation within 10 seconds after interruption of the normal power source.

d) All electrical equipment installed or used in the test chamber shall be explosion proof design and rated Class 1, Division 1, Group C at the highest oxygen partial pressure and lowest total pressure attainable in the chamber.

e) All electrical circuits serving equipment located adjacent to, or in the vicinity of, the test chamber shall be installed to prevent water from interferring with the operation of the equipment should the facility sprinkling system be activated. It is mandatory that all above circuits

be protected from exposure to water from the sprinkler system protecting the chamber housing in the event of a fire in the vicinity of the chamber while it is in operation.

f) All electrical circuits contained within the chamber shall be supplied from an ungrounded electrical system, fed from isolating transformers located outside the chamber, and equipped with a ground - contact indicator with appropriate signal lamps.

g) Each ungrounded circuit within or partially within the chamber shall be controlled by a switch outside the enclosure having a disconnecting pull for each conductor.

h) All electrical equipment shall be grounded in accordance with the National Electrical Code.

4.04 ELECTRICAL CIRCUITS - WIRING:

a) All electrical wiring installed in the test chamber shall comply with the requirements of the National Electrical Code, Article 500, Class 1, Division 1.

b) All conductors shall be of the type, size, and voltage rating as environmental conditions dictate but unless otherwise specified should not be smaller than No. 14 AWG or rated less than 600 volts.

c) Wire and cable shall have Class B stranding as specified by ASTM designation B8, Table 2.

d) All conductors inside the test chamber shall have teflon insulation type TFE, MIL-W-22759B (WEP) and derated 25% of the allowable current capacity. All conductors inside the test chamber shall be installed in rigid conduit.

All other conductors, unless otherwise specified, for circuits rated 600 volts or less where ambient temperatures do not exceed 40°C shall be Type THW or RHW insulation approved by Underwriters' Laboratories.

e) All outgoing wiring from control panels, cabinets, and terminal boxes shall be terminated on terminal blocks. Terminal blocks for 460 volt and 120 volt power and control wiring shall be General Electric Company Type ED-5, or equal. Terminal blocks for shielded cables and other small gauge wiring between electronic equipment and devices shall be Cinch-Jones No. 14, or equal, unless otherwise specified. Terminal blocks located inside the test cells shall have teflon/or ceramic insulating material.

f) Wiring in back of control panels or chassis shall be a minimum of 14 AWG stranded for nominal 115 volt control circuits. For control circuits less than a nominal 115 volts wire size No. 16 or 18 AWG stranded, if compatible with circuit in which used, will be acceptable. Wiring shall be Type TA, SIS or silicone rubber and glass sprayed insulated for 600 volts service. All wiring to be extended from the control panel or chassis shall be brought to terminal blocks properly marked. The thermocouple leads shall be run directly to the termination without intermediate connections excepting chamber penetration.

g) Wiring between units of electronics equipment and devices which may be affected by pick up from power and control

wiring shall be shielded and shall be run in conduit separate from other wiring. Signal wires used need not be governed by requirements (b) (c) (d) above but shall not in any case be smaller than No. 20 AWG, and shall be insulated with 600 volts minimum.

h) Instrumentation and power penetration plugs shall be provided in separate ports, as indicated on drawing J70293. The design of the penetration plugs must incorporate the requirement to withstand pressure on both sides. A minimum of 20% spare instrumentation and power penetration plugs shall be provided.

i) All conductors originating from distribution panels shall be color coded in accordance with the National Electrical Code. The color coding shall be as follows:

CONDUCTOR	208V/120V	480V/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White
Ground Only	Green	

Control wiring, except in cables, shall be other colors.

j) In addition to instrumentation and the power penetration plugs and cables necessary for the operation of the test chamber complex, the Contractor shall furnish and install the following brand and model number, or equal, thermocouple penetration plugs, main connectors, and cables:

(1) Test Cell No. 2

(a) Copper Constantan Thermocouple with 36-#20 AWG leads per plug;

Deutsch-DM 5623-37-37PP - penetration plug, one required

Deutsch-13084-37-37-S-5020 - connector inside, one required

Deutsch-DS07-37-37-S-509 - connector outside, one required

(2) A thermocouple terminal panel shall be provided in test cell No. 2 and external control console for the termination of the thermocouples specified above. The thermocouple panel located at the external control console shall be Curtis Type "GFT" feed-through terminal blocks, or equal. The thermocouple panel shall have sufficient terminals to accommodate each conductor. Each conductor shall be soldered to an individual feed-through identified with a phenolic nameplate lettering to be no smaller than 3/16" in height. The thermocouple terminal panel installed at the external control console should be easily accessible behind an enclosure door. The panel installed inside the test cell shall be located on one long wall. The thermocouple terminal panel enclosure inside the cell shall be of all welded construction with teflon seals for cover openings or penetrations.

4.05 ELECTRICAL CIRCUIT WIRING DIAGRAMS:

a) The electrical diagrams must be in accordance with provisions of Section 2, paragraph 2.19(d).

4.06 CONDUIT:

a) All electrical wiring installed in the test chamber shall comply with the requirements of the National Electrical Code, Article 500, Class 1, Division 1. All conduit shall be threaded rigid metal or Type MI cable with termination fittings approved for the location. All boxes, fittings and joints shall be explosion proof.

b) All other conduit, unless otherwise specified, 2- inch and under that run in dry locations shall be galvanized or sherardized electric metalic tubing; and all conduit over 2" shall be rigid steel, galvanized or sherardized, threaded, with reamed ends and neat bends. Vertical conduits where exposed shall be plumbed and neatly arranged. Bushings shall be provided on the ends of all conduits, and all conduit shall be securely fastened to boxes with lock nuts and bushings.

c) Conduits shall be securely clamped and supported at 10 - feet intervals with pipe hanger devices or galvanized one hole pipe straps and at intervals of not over 12 - inches from each change in direction.

d) Conduit shall be installed where it is readily accessible. Exposed conduit shall be run as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced.

e) All conduits shall be protected against damage and the entrance of foreign matter during construction.

f) Conduit sizes shall be in accordance with the National Electrical Code requirements for the number and size of wires to be carried by the conduit. No conduit, however, shall be smaller than 3/4 - inch except 1/2 - inch flexible conduit with bonding wire may be used for devices having 1/2 - inch hubs.

4.07 POWER SOURCES:

a) All power shall be obtained from existing panel boards and where existing spare breakers are not adequate, they shall be replaced with the correct size and type as the circuits dictate. Existing panel boards are as follows:

VOLTAGE	PANEL BOARD NO.	LOCATION
460, 60 Hz, 3 Ø, 3 Wire		
208, 60 Hz, 3 Ø, 4 Wire		
120, 60 Hz, 1 Ø		

b) Panel board circuit breakers furnished by the Contractor shall be in accordance with the following specifications:

(1) All 120/208 panel board circuit breakers shall be rated nominally 125/250 volts d.c. and 120/240 volts a.c. All 480 volt power circuit breakers shall be rated 600 volt a.c.

(2) Circuit breakers shall have inverse-time characteristics so that tripping will be prevented on momentary overloads but will occur before dangerous heating is produced.

(3) Mechanism shall trip free from the handle so that contacts cannot be held closed against short circuits or abnormal overloads. Automatic tripping shall be distinguished from the manual on and off by visible means.

(4) Breakers shall have quick-make and quick-break action whether operated manually or automatically. Breakers shall be mechanically and electrically suitable for frequent operations as switches at rated current.

(5) Each breaker shall have an identification number and rating permanently and prominently attached.

(6) All circuit breakers shall be Westinghouse No - Fuse De-ion circuit breakers, or equal, and shall conform to the requirements of Federal Specification W-C-375a. All breakers shall be capable of safely interrupting all loads up to and including the maximum interrupting ratings listed below:

: Size :res	Frame Type	Trip Amperes	Poles	Nominal Voltage	Asymmetrical Interrupting Ratings (Amp) Based on NEMA
)0	E	15-100	1,2,3	120/240 a.c.	7,500 at 240 V.
)0	FA	15-100	2,3	600 a.c.	15,000 at 480 V. 20,000 at 240 V.
:5	JA	70-225	2,3	600 a.c.	20,000 at 480 V. 25,000 at 240 V.

4.08 CHAMBER LIGHTING AND RECEPTACLES:

a) Test cells 1 and 2 shall be provided with work lighting of at least 100 foot candles at 30" above floor level over the entire floor area. The lighting fixtures if installed inside the chamber shall be explosion proof as per National Electrical Code, Group C, Class 1, Division 1.

b) The following receptacles connected to their respective power source shall be provided and identified by voltage, phase, and cycles, with phenolic nameplates with lettering no smaller than 3/16 - inch high. Receptacles shall be explosion proof as per National Electrical Code, Group C, Class 1, Division 1.

(1) Eight, 120 volt, single phase, 60 Hz, 20 amperes, 3-wire receptacles for cell No. 1.

(2) Four, 120 volt, single phase, 60 Hz, 20 amperes, 3-wire receptacles for cell No. 2.

(3) All receptacles shall be mounted 48 - inches above floor and shall be supplied with mating plugs.

4.09 AUXILIARY ELECTRICAL EQUIPMENT:

a) Voltages for a.c. equipment shall be as follows:

HORSEPOWER RATING	PHASE	OPERATING VOLTAGE
½ or less	1 or 3	120 or 230/460 dual
½ thru 100	3	230/460 dual

b) Motors furnished shall be designed and constructed in accordance with the standardization rules of the AIEE and NEMA and shall be single or polyphase (as required), squirrel cage, induction type of ample size and adequate rating and speed to operate their respective connected loads without exceeding the allowable temperature rise for the class of insulation used. Ratings shall be on full load basis and not on a service factor. Motors shall have the class of insulation, frame and enclosure required by location and design duty.

c) Refrigeration compressor motors shall be suitable for operation on only 460 volt, 3 phase source.

d) Overcurrent protected devices shall comply with the requirements of NFPA No. 70, Article 240, and shall be installed outside of, and adjacent to, the chamber. Equipment used inside the chamber may have its own individual overcurrent devices incorporated within the equipment, provided this device is approved for Class 1, Division 1, Group C atmospheres at the maximum vacuum and oxygen concentration attainable. Each circuit shall have its own individual overcurrent protection.

e) Controllers shall be furnished for all loads as follows:

(1) For single-phase motors, thermal/motor switches, or equal.

(2) For three-phase motors operating at 230/460 volts, magnetically operated across-the-line starters with manual reset, inverse-time thermo-overload relays and under voltage protection or release as required by the control circuits.

f) Control and indicating devices associated with each controller shall be provided in accordance with approved control circuits.

g) Reduced voltage control shall be employed for all equipment operated on line voltage in excess of nominal 120 volts. The control circuit voltage will be nominal 120 volts, or less, obtainable from a separate, suitably rated control transformer, furnished with each starter enclosure. Each transformer shall have an isolated secondary winding with a voltage rating of 115 volts. Control circuits shall be fused on the operating side and grounded on the coil side.

h) Auxiliary relays in control circuits shall have sufficient contacts to meet all control requirements. At least one extra contact shall be provided on each control relay. Coils shall be suitable for continuous operation from the voltage of the associated control circuit. Contacts shall be self-aligning with no adjustment required, and shall have sufficient rating to safely carry the imposed loads without burning or pitting of contacts.

i) Control devices such as limit switches, pressure switches, control switches, etc., shall have accurate repeat performance, long flexure life, high electrical capacity and long contact life. They shall be adequately rated for the control circuits with which they are associated and shall have sufficient number of contacts to meet the performance requirements.

j) Push button controls shall be rated 250 volt minimum and sufficient in quantity for the duty intended, and sha be properly inscribed as regards to the function and the applied circuits. Where a push button control station is located remotely from the item controlled, it shall be identified by an engraved laminated phenolic nameplate describing the item controlled and securely fastened to the control station.

k) Solenoid operated valves shall be suitable for the mechanical use intended. Coils shall be rated for continuous operation on 120 volts a.c. except the solenoid operated valves for the fire protection system shall operate on 24 volts d.c. Each solenoid shall be incased in a housing suitable for conduit connection.

l) Electrical equipment inside the test cells, such as relays, switches and solenoids, unless otherwise specified, shall be hermetically sealed. Open wire terminations, solder lugs, terminal blocks and connections shall be potted with a suitable material.

4.10 EMERGENCY POWER GENERATOR:

a) The Contractor shall provide an emergency power generator and associated control equipment described in this specification.

b) General:

The emergency power generator shall be a complete natural gas engine-generator set having a stand-by rating with sufficient capacity to operate both test cells simultaneously. It shall be a Kurz and Root Co. Model KG plus accessories and equipment as called for herein, or approved equal. The voltage regulator and generator shall be of one manufacture and tested together at its design rating and speed prior to assembly to the engine to insure compatibility of electrical components. The unit shall be assembled and tested prior to shipment to the Contractor. This test shall include loading at 1/4, 1/2, 3/4, and full load. The test shall include operation tests of all control and safety devices on the unit.

The generator set shall consist of a natural gas engine, direct connected to a brushless a.c. generator with a brushless exciter and a unit-mounted generator control panel mounted to the a.c. generator. Automatic controls shall be furnished to start the unit and automatically transfer the normal load to the generator within 10 seconds of power failure.

c) Engine:

The engine shall be natural gas fuel, naturally aspirated, 4-cycle, water cooled with mounted radiator and water pump. The horsepower rating shall be compatible with the required generator load. Intake and exhaust valves shall be heat resistant alloy steel. Full pressure lubrication shall be supplied by a gear oil pump. The engine shall have an oil filter with replaceable element. Engine speed shall be governed by a mechanical governor to maintain alternator frequency within 3 cycles from no load to full load alternator output. The engine shall have a 24 volt, d.c. battery charging generator and voltage regulator. Starting shall be by 24 volt electric starter.

d) Engine Controls:

The electric plant controls shall include a start-stop selector switch, high water temperature, low oil pressure, and over speed shutdown with signal light and alarm terminal shall also be provided as safety devices.

e) Generator:

The a.c. generator shall be of the revolving field, 4-pull brushless type, a solid state S.C.R. voltage regulator. It shall have a NEMA rating for 480 volts, 3 phase, 3 wire, 60 Hz., with a capacity equal to the total design load of the chamber. It shall be rated class "F" insulation, 90°C rise over 40°C ambient, and shall be capable of operating at stand-by rating of rated load with non-injurious heating and shall be attached

rigidly to the engine fly wheel housing and driven by means of a steel disc type flexible coupling. Generator shall have 12 leads capable of reconnection to other voltages in the future, if desired.

f) Unit:

The engine-generator plus radiator shall be mounted on a steel sub-base which is suitable for installation on a concrete foundation. The generator set shall be provided with vibration isolators of the type, quantity and size recommended by the manufacturer between the engine-generator set sub-base and the concrete foundation.

g) Controls:

The generator control panel shall be unit shock mounted and shall include an a.c. volt meter, a.c. ammeter, molded case circuit breaker, static S.C.R. voltage regulation, voltage adjusting reostat start-stop control, unit wiring, current transformers and terminals for load connection. Steady state regulation shall be 1/10% from no load to full load and the instantaneous voltage dip shall be not more than 13% upon application of full load at rated power factor. The voltage shall recover to 100% within 500 milliseconds. Also include elapse time meter, frequency meter, and phase selector switch.

The panels shall also include frequency meter, hour meter, 200 ampere molded case circuit breaker, cycle type automatic cranking controls, four safety shutdown indicating lights, and panel light.

h) Equipment:

The battery for the engine starting system shall be 24 volt d.c. dry charged with the battery electrolyte furnished along with the generator set separately. The battery shall be unit mounted along with battery cables. A residential exhaust silencer and flexible connection shall be furnished. The fuel system for the engine shall include a 24 volt d.c. solenoid valve, gas regulator, and flexible connection. Provide a battery trickle charger 120 volt a.c. imput with amp ammeter, automatic regulator, and automatic "start disconnect" relay.

i) Conditions:

The manufacturer shall submit four copies of outline dimension drawings of the generator set plus wiring diagrams.

The Contractor shall run a test on the generator set upon completion of installation and shall include operation of generator set at 3/4 and stand-by load ratings for a period of not less than 2 hours each, after suitable operations have been established. Manufacturer shall have a published warranty to be supplied with the unit.

The manufacturer shall warranty all equipment for stand-by service for a period of one year from the date of acceptance by the Contractor.

4.11 FIRE ALARM AND PROTECTION SYSTEM:

a) A fire alarm associated with the fire protection system shall be provided for each test cell, designed to operate from 24 volt d.c. rectified 120 volt a.c. source, and shall be capable of automatically operating from the emergency 24 volt d.c. battery supply in the event of 120 volt a.c. power failure.

b) Detection of fire shall be automatic using an ultra violet system. The detection system shall be capable of disseminating between normal chamber illumination and fire radiation. Detectors shall be so located to constantly provide surveillance of all areas of the chamber, its equipment and occupants. Electronic devices shall be housed and constructed of materials compatible with accepted atmospheres and ambient pressure and shall be designed in accordance with National Electrical Code, Division 1, Class 1, Group C. The automatic function shall have a manual override located at the external control consoles.

c) The fire alarm system shall be as described in the mechanical section paragraph 3.09.

d) Manual activation of fire system from inside and outside of chamber shall be provided. Fire alarm bells shall be provided for each test cell and shall be 10" in diameter, rust-proof, finished in red lacquer, and of the vibrating type. In addition, two normally open and two normally closed contacts shall be provided for a remote alarm device. The alarm system shall include a red light atop each test cell to indicate the alarm circuit is activated. The light shall be Russell and

Stoll Company Catalog No. VLP-6344-A-4 or equal.

e) The fire alarm system wiring shall be run in a separate conduit system and shall be entirely independent of all other systems.

f) Interlocking shall be provided that will stop all vacuum pumps and the ventilating system when the fire protection system is activated.

4.12 OXYGEN ALARM:

a) An oxygen alarm buzzer system shall be provided for each test cell, designed to operate from 24 volt d.c. battery supply in the event of 120 volts a.c. power failure

b) The oxygen alarm system shall operate in conjunction with the oxygen analysis system and shall be activated when an oxygen concentration exceeds the pre-desired set point. The alarm system shall be provided with a manual override located on each external control console and a blue light (Russell & Stoll Co. Catalog VLP-6344A-V or equal), mounted atop each test cell adjacent to the fire alarm light to indicate that the alarm circuit is activated.

4.13 EXTERNAL CONTROL CONSOLE:

a) All controls and equipment necessary for the operation of the test chamber shall be mounted in control panel enclosures bolted together to form an enclosure assembly as shown on drawing J70296. The sloped front enclosures shall be at 90° to

the vertical enclosures and shall have a maximum height of 43 - inches, and end panel enclosures may have a height of 78 - inches. Each enclosure shall be of sheet steel construction and with front bolted panels and hinged rear doors. The panel enclosures shall be Emcor modular enclosures as manufactured by Ingersoll Products, Division of Borg-Warner, or equal. The color of all panel enclosures and accessories shall match the sample number blank as specified in Federal Standards No. 595 - Colors.

b) The control components shall be assembled in the control consoles and wired to terminal strips at the Contractor's plant. They shall be suitable for final installation at the site without requiring disassembly for shipment.

c) All control and indicating devices mounted on or in the external control console shall be identified with phenolic nameplates with lettering 3/16 inch in height.

d) The external control console shall have controls and monitoring instrumentation for the operation of test cell 2, and any other incidental or necessary controls and instrumentation for the operator of the test chamber.

4.14 CONTROLS:

a) The test chamber complex and all its support equipment shall be controlled from the external control console and/or test cells as indicated on the drawings and as spelled out in this specification. The systems shall be controlled and the performance monitored from these locations.

b) The main switch shall be provided on the external control console for the test cell to disconnect the control power of the system.

c) All control systems and safety interlocks shall be designed for "fail-safe" operation.

d) The vacuum pump shall be interlocked with the sealing water flow, so that insufficient water flow will prevent operation of the vacuum pumps. Indicating lights shall be installed on the external control console to indicate insufficient water flow.

4.15 INSTRUMENTATION:

a) Recorder-Controllers

(1) Six recorder-controllers shall be furnished and installed on the external control console for test cell No. 2.

(2) The recorder-controllers shall record and control the temperature, humidity, total pressure, liner differential pressure, oxygen, and carbon dioxide partial pressure of the test cell. The humidity recorder-controller shall operate in conjunction with the dew point hygrometer specified in this section, the pressure recorder-controller shall operate in conjunction with the remote precision pressure gauges as specified in this section, and the oxygen and carbon dioxide recorder-controller shall operate in conjunction with the oxygen and carbon dioxide analyzers respectively. Temperature, humidity, total pressure, differential pressure, oxygen

partial pressure, and carbon dioxide partial pressure shall be automatically controlled. The oxygen partial pressure and the carbon dioxide partial pressure controllers shall be capable of manual control as well.

(3) The recorder-controllers shall include a strip-chart recorder, electric proportional control, adjustable range unit, and an I/P transducer and shall be in accordance with the following specifications:

(a) Strip-Chart Recorder

(1) Actuators shall be potentiometric providing a measurement of 0 - 10 millivolts.

(2) A span step response time of one second or less shall be supplied.

(3) Strip chart papers shall have a calibrated width of 6" and be 120 ft. long. Recorder shall have a basic speed of 30"/Hr. and change gears shall be supplied for speeds of 1/2 and 2 times basic speeds.

(4) Pen assemblies shall be remote reservoir, capillary type.

(5) Scale shall be calibrated length of 6" with black numerals on white background and shall have a red pointer.

(6) Set-point index on indicator scale shall be supplied.

(7) Measuring slide-wire shall be a circular type, precision wound, mounted in a shielded compartment on a swivel drive.

(8) Constant voltage circuit shall be zenor diode regulated.

(9) Calibrated accuracy shall be $\pm$ 0.3% of span.

(10) Ambient temperature limits shall be 16°F to 140°F.

(11) Dead ban shall be 0.1% or less.

(12) Source impedance range shall be 0 - 200 K.

(13) Shall operate from 100 to 130 volts a.c., 60 Hz., single phase electrical source and shall be equipped with American Standard 3-wire plug and cord.

(14) Accessories shall include a minimum of 8 oz. of ink, and mounting accessories.

(15) Chart paper range and quantity shall be as specified in paragraph 4.15(c).

(b) Current Proportional Control:

(1) The unit shall be an all-transistorized current proportioning controller and shall provide 4 to 20 ma d.c. current output. The output shall be capable of operating with a low resistance of 0 to 1500 ohms.

(2) Proportioning resistor shall be 100% of full scale.

(3) Unit shall be adjustable from 0.5 to 500%. Adjustment switch shall permit proportional band adjustment without upset of the controller output.

(4) Reset time shall be adjustable from 0.02 to 100 repeats per minute in 11 steps and off position.

(5) Rate time shall be adjustable from 0.01 - 10 minutes with interval switch to provide true 0 rate time, permitting operation as a 2-mode controller.

(6) Automatic to manual switching shall be supplied.

(7) Output meter on front of unit shall be provided.

(c) Adjustable Range Unit

(1) This unit shall be capable of rapidly changing the above recorders range or span without interrupting operation and without changing measuring circuit modules or range cards.

(2) Range shall be 0 - 2 mv to 0 - 5 volts.

(3) Unit shall have suppression capability. Suppression voltage shall be displayed with normal decimal point, located by marker lamps.

(4) Calibrated system accuracy when used with a recorder shall be at least 0.25% of span.

(5) Output impedance shall be 25000 ohms.

(6) The unit shall require 107 to 127 volts a.c., 60 Hz, single phase electrical source and shall be equipped with American Standard 3-wire plug and cord.

(d) I/P Transducer

(1) Unit shall convert voltage signals into standard pneumatic signals.

(2) Unit shall have accuracy of $\pm$ 0.25% of span.

(3) Unit shall have fine and coarse adjustments.

(4) Standard wall mounting brackets shall be supplied.

(5) Imput to unit shall be 4- 20 ma d.c.

(6) Output of unit shall be 3- 15 psig.

(7) Speed of response shall be 0.5 seconds for 98% response to a 50% step change in imput with output dead-ended.

(8) Required air supply shall be 20 psig $\pm$ 2 psig (filtered).

(9) Internal imput resistance shall be nominal 400 ohms.

b) Recorders

(1) One recorder as specified in paragraph 4.15 (a) (1) (a) shall be furnished and installed on the external control console to record the flow rate in liters per minute of oxygen to test cell No. 2, and shall operate

in conjunction with the mass-flow meters specified in this section paragraph. A selector switch as shown on the oxygen system schematic shall be furnished to select the output signal of either mass-flow meter to be supplied to the recorder. Indicating lights shall be installed on the console to indicate which flow is being recorded.

c) Recorders' Range

(1) All strip-chart recorders shall be furnished with range as follows:

Recorder	Range	Units	Divisions Full Scale
Temperature	0 - 120	°F	100
Humidity	0 - 120	°F	100
Pressure (total)	0 - 1500	MM HgA	100
Pressure (Differential)	0 - 50	MM HgA	100
Pressure (Oxygen pp)	0 - 100		100
Pressure (Carbon Dioxide pp)	0 - 100	MM HgA	100
Flow (Oxygen)	0 - 10 0 - 100	Liters/Min. Liters/Min.	100 100

d) Hygrometer

A dew point hygrometer shall be installed to monitor the dew point temperature of test cell No. 2. The hygrometer shall be EG&G, Environmental Equipment Division Model 992-C1-T1, or equal, and shall have the following features and characteristics:

(1) The dew point depression capability shall vary linearly from + 105°F @ 120°F ambient air temperatures to 65°F @ 0°F ambient air temperature.

(2) Maximum condensation air shall be $\pm$ 0.3°F between a dew point temperature of + 120°F and +32°F; $\pm$ 0.6°F between a dew point of +32°F and +0°F. Maximum system air using calibration data shall be $\pm$ 1.0°F between +120 and +32°F; $\pm$ 2.0°F between +32 and 0°F.

(3) Cooling rate to reach 100% of a 3.0 F degree downward step change in dew point temperature within the range of +120°F to +32°F shall be one second, and within the range of +32°F to 0°F shall be 1.8 seconds.

(4) Repeatability shall be $\pm$ 0.3°F for a constant sample.

(5) Unit shall be capable of measuring dew point temperatures from +120°F to 0°F.

(6) Sample temperature variation from measured dew point temperature to +140°F shall not change the instruments measurement.

(7) Sample gases of oxygen, nitrogen, helium, carbon dioxide, and hydrogen in a breathable atmosphere shall not affect measurement.

(8) The hygrometer shall be able to operate in a pressure environment varying from 760 mm HgA to 180 mm HgA without affecting the instruments measurement. The sample flow rate variation shall not affect the measurement. Instrument ambient temperatures from 40 to 125°F shall not affect measurement.

(9) Heat sink shall be a thermoelectric heat pump.

(10) Operation shall be automatic and shall require no operator.

(11) The dew point temperature shall be sensed with an aged precision thermostat and a platinum resistance thermometer. The platinum resistance thermometers output shall be converted to 0-10 millivolts, d.c., at 200 ohms maximum independence.

(12) Instrument shall be supplied with a meter indicator which will convert the resistance change of the thermostat to a dew point in degrees F meter range from 0° to 120°F.

(13) System shall contain heaters and a manual on-off switch to prevent condensation within the instrument when measuring dew points from ambient temperatures to 120°F. These heaters shall be thermostatically controlled to prevent overheating of the instrument.

(14) System shall include the sensor, control unit, power supply, required blowers and indicator.

(15) Maximum power requirement shall be 120 watts, using 115 volts, 60 Hz., and shall be equipped with an American Standard 3-wire plug and cord.

(16) Instrument shall be rack mounted and all controls shall be easily accessible.

(17) Three copies of the air curve of the accuracy in $\pm$ F° versus the dew point temperature from a dew point

of +120°F to +0°F shall be included with this system. Calibration data or curves for all other readout such as meters in partial pressure, dew point, etc., shall be included.

(18) The sample system shall be provided by the Contractor capable of operating with gases at pressures ranging from 760 mm HgA to 180 mm HgA. The sample pumps shall have a separate electrical on-off switch. Sample pumps shall have a maximum noise level of 60 decibels. The pumps shall inject no contamination into the sample lines and shall not affect measurement due to pressure modulation.

A second complete hygrometer shall be furnished as a spare.

e) Flow Meters

(1) The oxygen flow meters shall be Hastings HF Series mass flow meters, or equal, and shall have the following characteristics and features:

(a)	Power:	110 V. a.c., 60 Hz, 115 Watts
(b)	Temperatures:	Ambient temperatures from 40°F to 120°F
(c)	Sensitivity:	Down to 1/2% of full scale
(d)	Response Time:	5 seconds
(e)	Repeatability:	1 %
(f)	Working Pressure:	5 psia to 250 psia

(g) Principle of Operation: The mass flow meters shall operate on the principle of an electrically heated tube and an arrangement of the thermocouples to measure differential cooling caused by the gas passing through the tube. Thermoelectric elements shall generate a d.c. voltage proportional to the mass flow of the gas through the tube. There shall be no fragile elements projecting into the stream.

(2) The flow meters shall have the following ranges:

Flow Meter #1 - 0 to 10 liters/minute

Flow Meter #2 - 0 to 100 liters/minute

(3) The flow meters shall be calibrated prior to installation. The flow meters shall be linear.

f) Precision Pressure Gauge

(1) The remote precision pressure gauges shall be Texas Instruments, Inc. Model 145 Fused Quartz precision pressure gauges, or equal, and shall have the following features and characteristics:

(a) Resolution:

0.001% of full scale

(b) Repeatability:

0.0017% of full scale

(c) Operating Temperature Range:

50 - 100°F

(d) Power Requirements:

120 Volts a.c., 130 Watts

(e) Tilt Sensitivity:

Maximum 0.0005% of full scale range per degree of tilt.

(f) Slew Rate: (100° Burdon Tube Deflection)

2.1 minutes

(g) Temperature Sensitivity:

Less than .0005% of full scale per degree C ambient temperature change

(h) Range:

0 - 1270 mm HgA

4.16 COMMUNICATION SYSTEM:

a) Two audio communication systems shall be provided for each test cell.

(1) System 1 shall include a master station on the external control console and a respective slave in the test cell. The slave shall originate as well as receive calls and shall be capable of communicating with the master, hands-free. The slave shall be explosion proof talk-back type speakers in accordance with the National Electrical Code, Division 1, Class Group C. The intercommunication amplification center shall provide at least 6 stations with annunciators

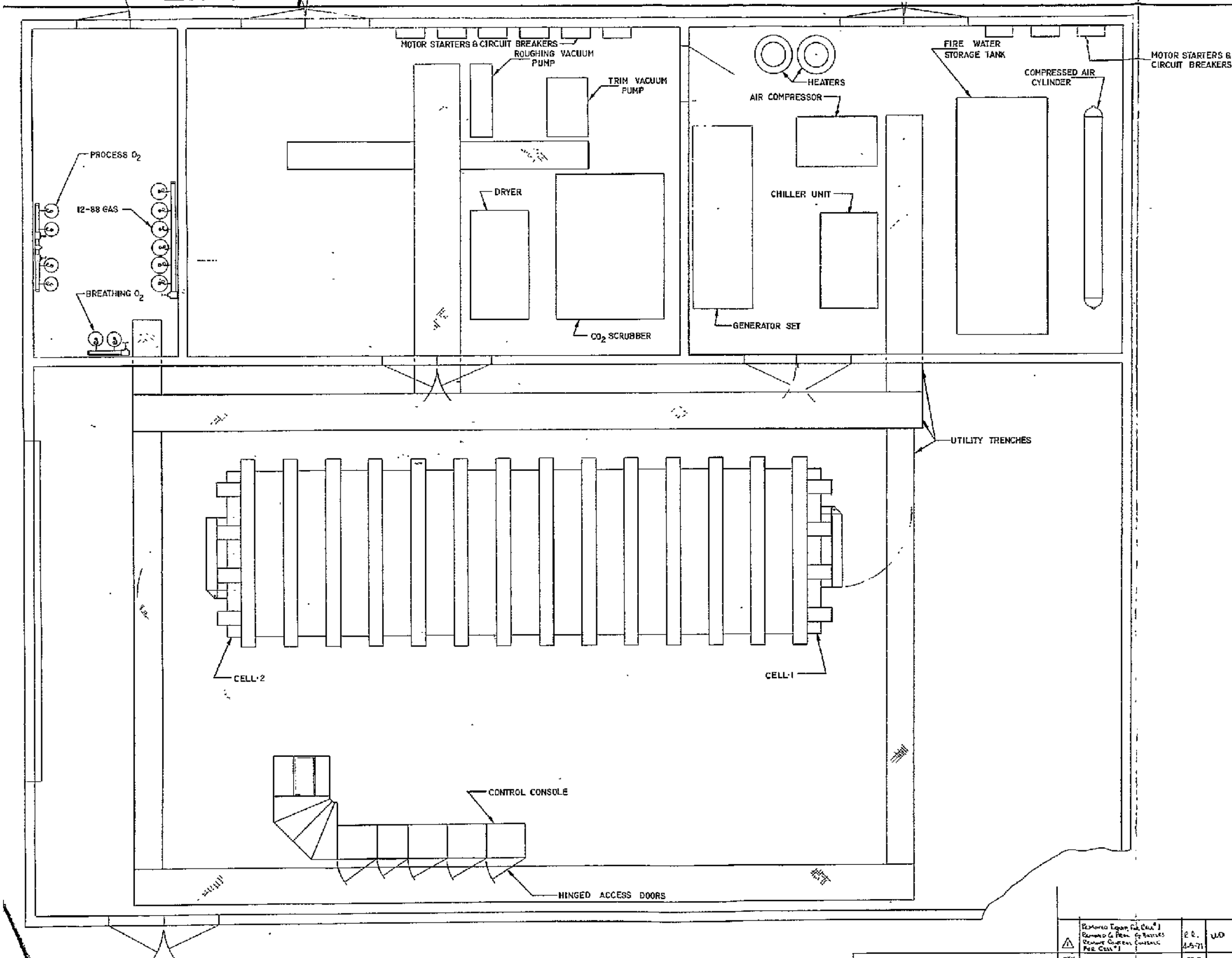
and a three position talk/listen control for private remote reply and talk flexibility.

(2) System 2 shall include head-band -- headsets (2 ear) with mask microphones (supplied with oxygen mask) for chamber internal use, speaker for provisions for private conversation for external use, and central amplification system. Two headset stations shall be provided on each long wall of the test cells. The headset channel will be common talk with all stations, and independent of system 1. The head-band headsets shall be Roanwell Model RHM-2 Type III, or equal. The master amplification system shall have the capability of hands free talk, push to talk, or private talk.

(3) The amplifiers for the communication systems shall be of solid state design to operate normally from 120 volts, 60 Hz. supply. At least one of the communication system amplifiers shall have provisions to provide for a tape recording.

FOLDOUT FRAME 1

FOLDOUT FRAME 2



TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS.
FRACTIONAL ± 1/64"
DECIMAL ± .005
ANGULAR ± 0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ± 0°-2' OR ±.005 IN 12 INCHES
CONCENTRICITY. T.I.R. = ½ OF TOLERANCE ON DIAMETER.

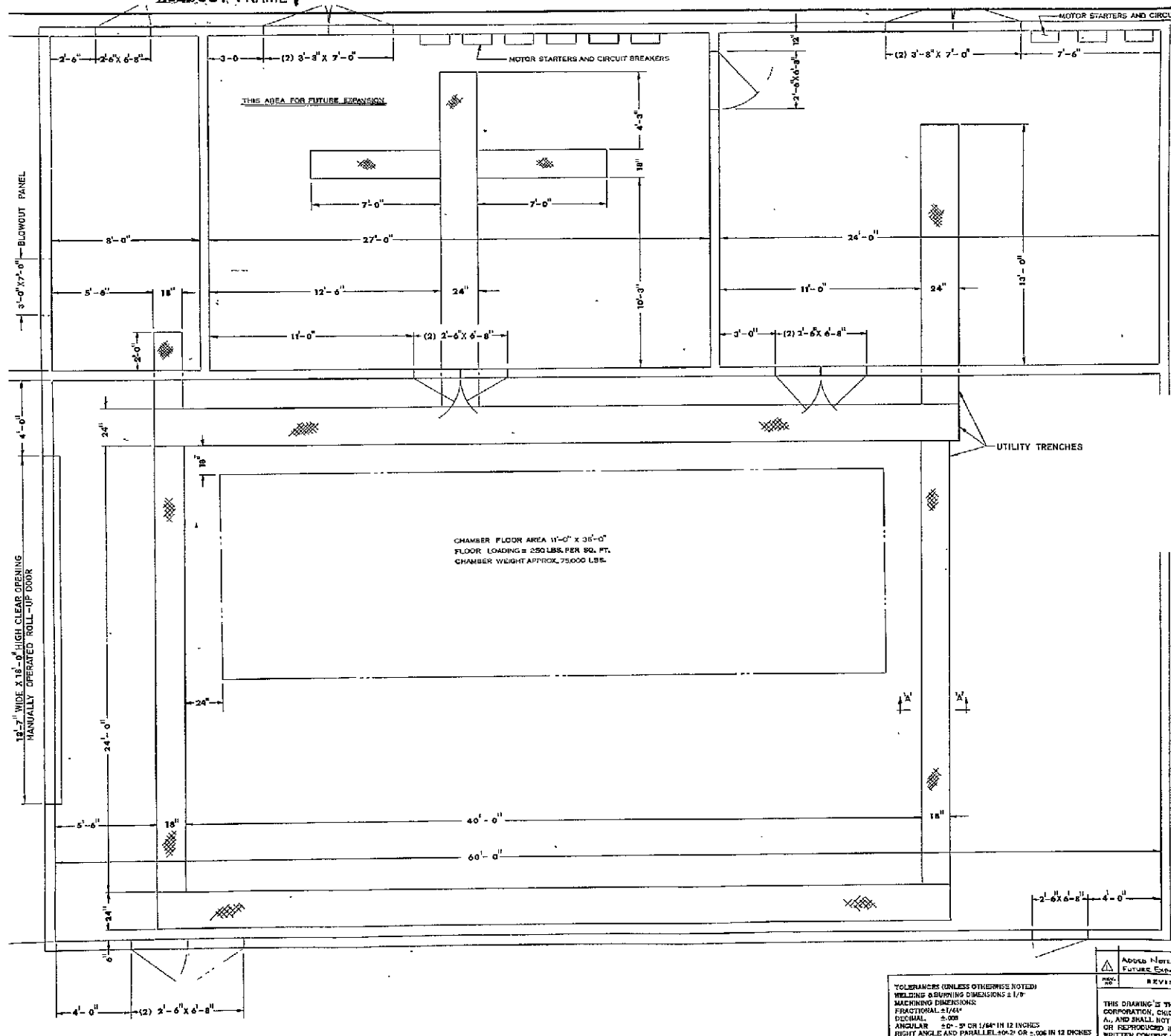
REV NO	REVISIONS	BY & DATE	CHKD
1	Removed Equip. For Cell #1 Removed & Relo. O_2 Bottles Remove Control Console For Cell #1	R.D. 4-5-71	W.D.

VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: GENERAL FACILITY
CUSTOMER: NASA MANNED SPACECRAFT CENTER FACILITY AND LABORATORY SUPPORT BRANCH
DRAWN: R D
DATE: FEB 19, 1971
CHECKED: W D
SCALE: NONE
TRACED:
APPROVED:
DWG. NO. J70-29-1

FOLDOUT FRAME 1

FOLDOUT FRAME 2



UTILITY REQUIREMENTS

ELECTRICITY

480 V	3 phase	60 hz	200 amps	
208 v	3 phase	60 hz	60 amps	4 wire
120 v	1 phase	60 hz	100 amps	

WATER

75 GPH @ 70°F

SEWAGE

75 GPH

STEAM

15 lb. per hr. @ 15 PSIG

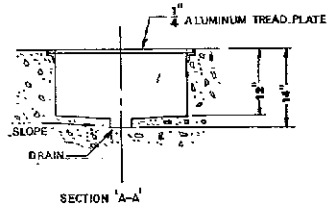
NATURAL GAS

314 cu. ft. per min.

AIR

100 SCFM @22 PSIG

NOTE: Chamber room clear height 20'-0" under girders. All other rooms to have 12'-0" clear height.



The room or rooms housing the hypobaric chamber and service equipment, shall be for the exclusive use of the hypobaric operation and shall have an automatic sprinkler system installed in accordance with NFPA No. 13, Installation of Sprinkler Systems.

The room housing the hypobaric chamber shall be vented sufficiently to the outside or be equipped with blow-in panelling so that the execution of the emergency "dump" procedure will not disrupt the integrety of the walls of the building.

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS:
FRACTIONAL ±1/64"
DECIMAL ±.005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0° 2' OR ±.005 IN 12 INCHES
CONCENTRICITY, T.I.R. = ½ OF TOLERANCE ON DIAMETER.

REV NO	REVISIONS	BY & DATE	CHKD
1	ADDED NOTE FOR FUTURE EXPANSION	G.D. 6-25-71	WD

VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: BUILDING ARRANGEMENT

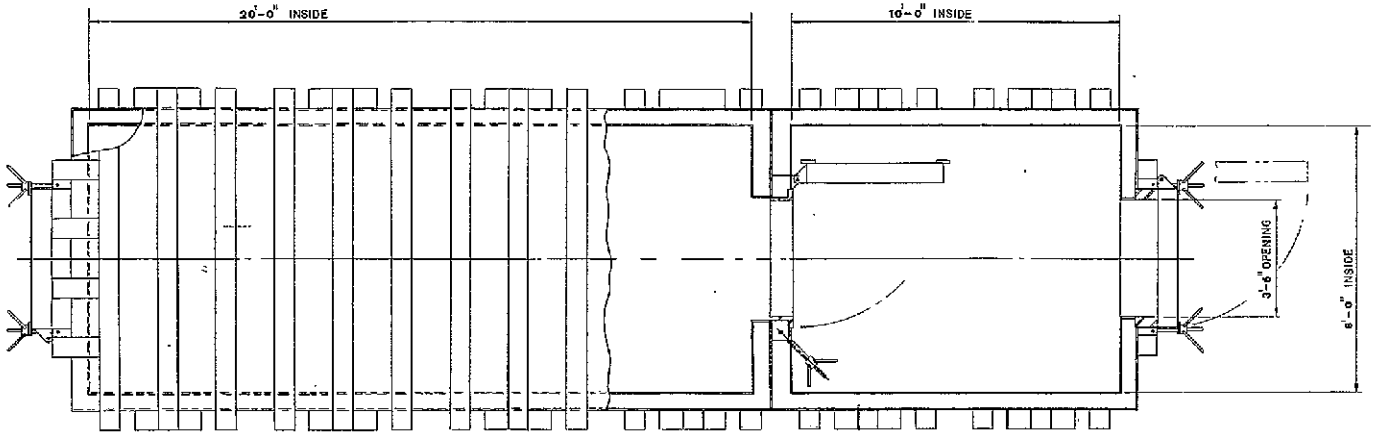
CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

DRAWN	R.D.	DATE	MAR. 1, 1971
CHECKED	W.Q.	SCALE	NONE
TRACED		APPROVED	

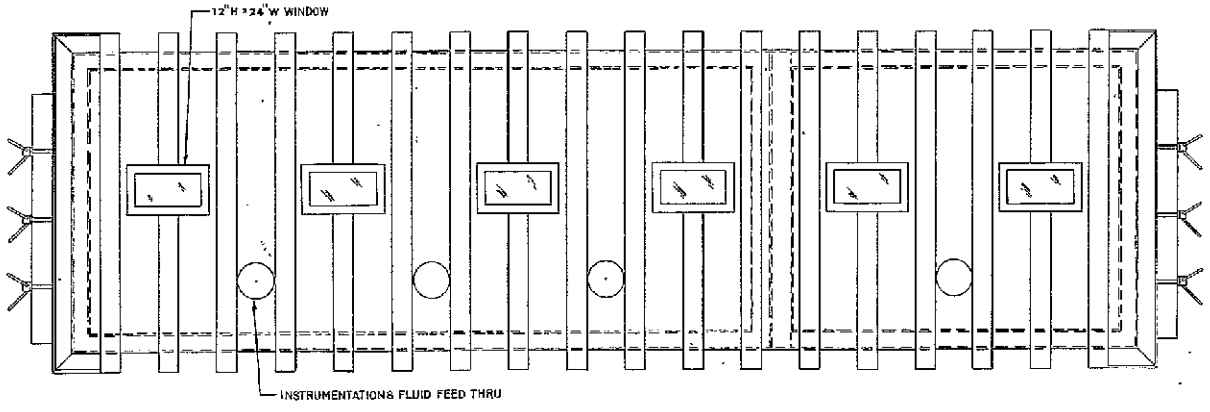
DWG. NO. J70-29-2

FOLDOUT FRAME 1

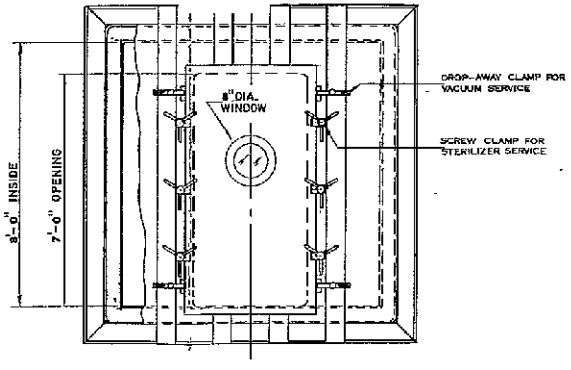
FOLDOUT FRAME 2



PLAN VIEW



SIDE ELEVATION



END ELEVATION

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURRING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS.
FRACTIONAL ±1/64"
DECIMAL ± .005
ANGULAR 1.0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ± 2' OR ± .005 IN 12 INCHES
CONCENTRICITY, TIR = ½ OF TOLERANCE ON DIAMETER

REV NO	REVISIONS	BY & DATE	CHKD
⚠	Enlarged Window & Inner Door, Added Drop Away Clamps	RD 4-5-71	W/D

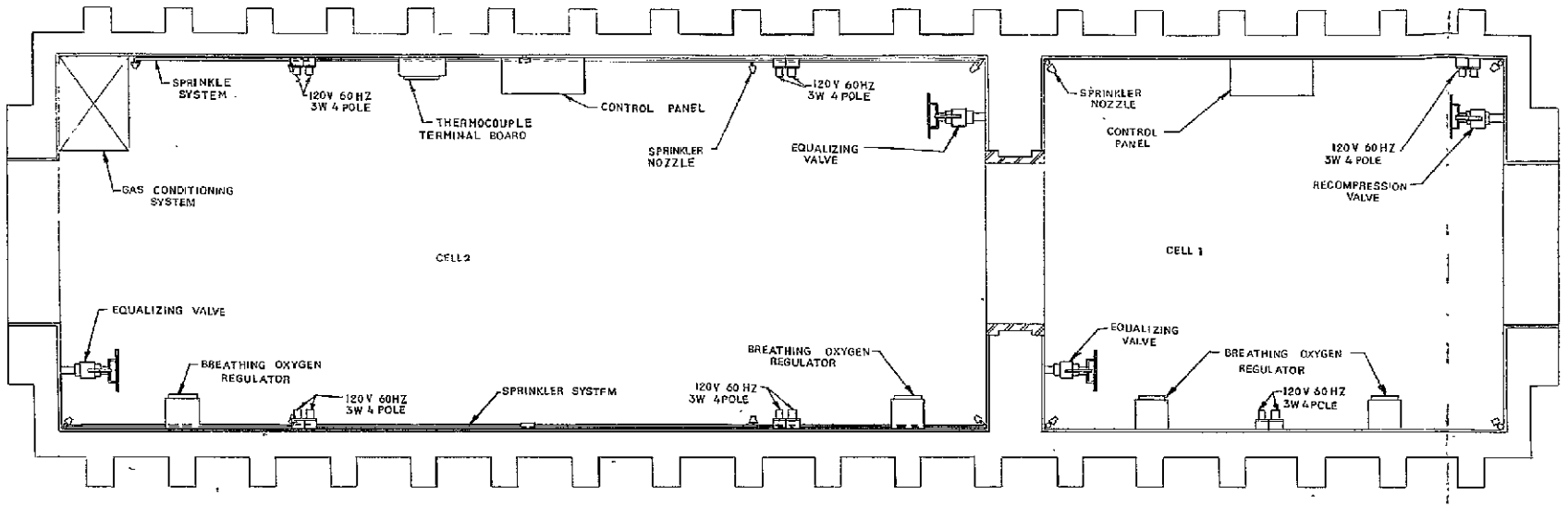
VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: Chamber General Arrangement
CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

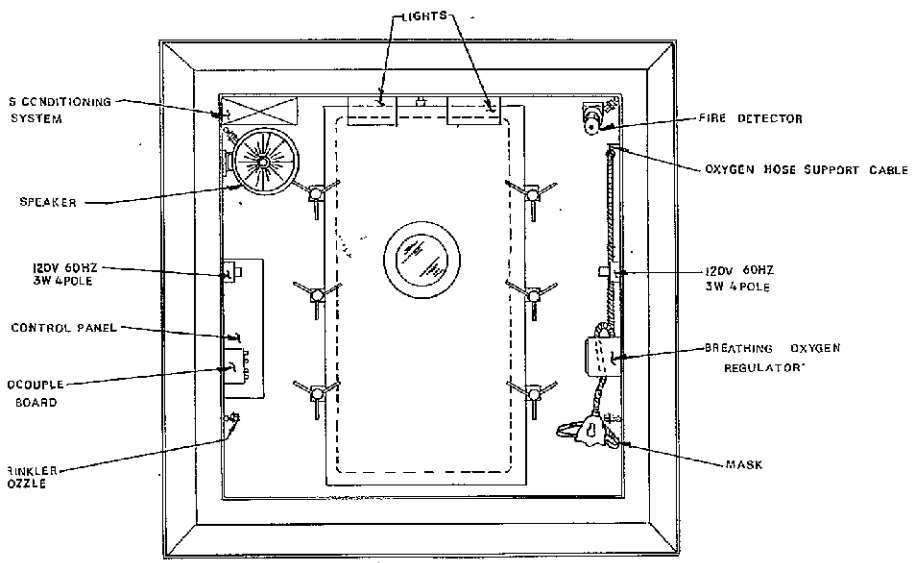
DRAWN	DATE	DWG. NO.
R D.	MAR. 2, 1971	J70-29-3
CHECKED W. D	SCALE NONE	
TRACED	APPROVED	

FOLDOUT FRAME 1

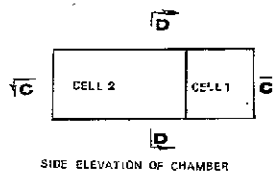
FOLDOUT FRAME 2



SECTION "C-C"



SECTION "D-D"



SIDE ELEVATION OF CHAMBER

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS.
FRACTIONAL ±1/64"
DECIMAL ± .005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0°-2' OR ± .005 IN 12 INCHES
CONCENTRICITY T I R = ½ OF TOLERANCE ON DIAMETER

REV. NO.	REVISIONS	BY & DATE	CHKD
1	ADDED THERMOCOUPLE TERMINAL BOARD IN CELL 2	MEW 4-15-71	WD

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VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

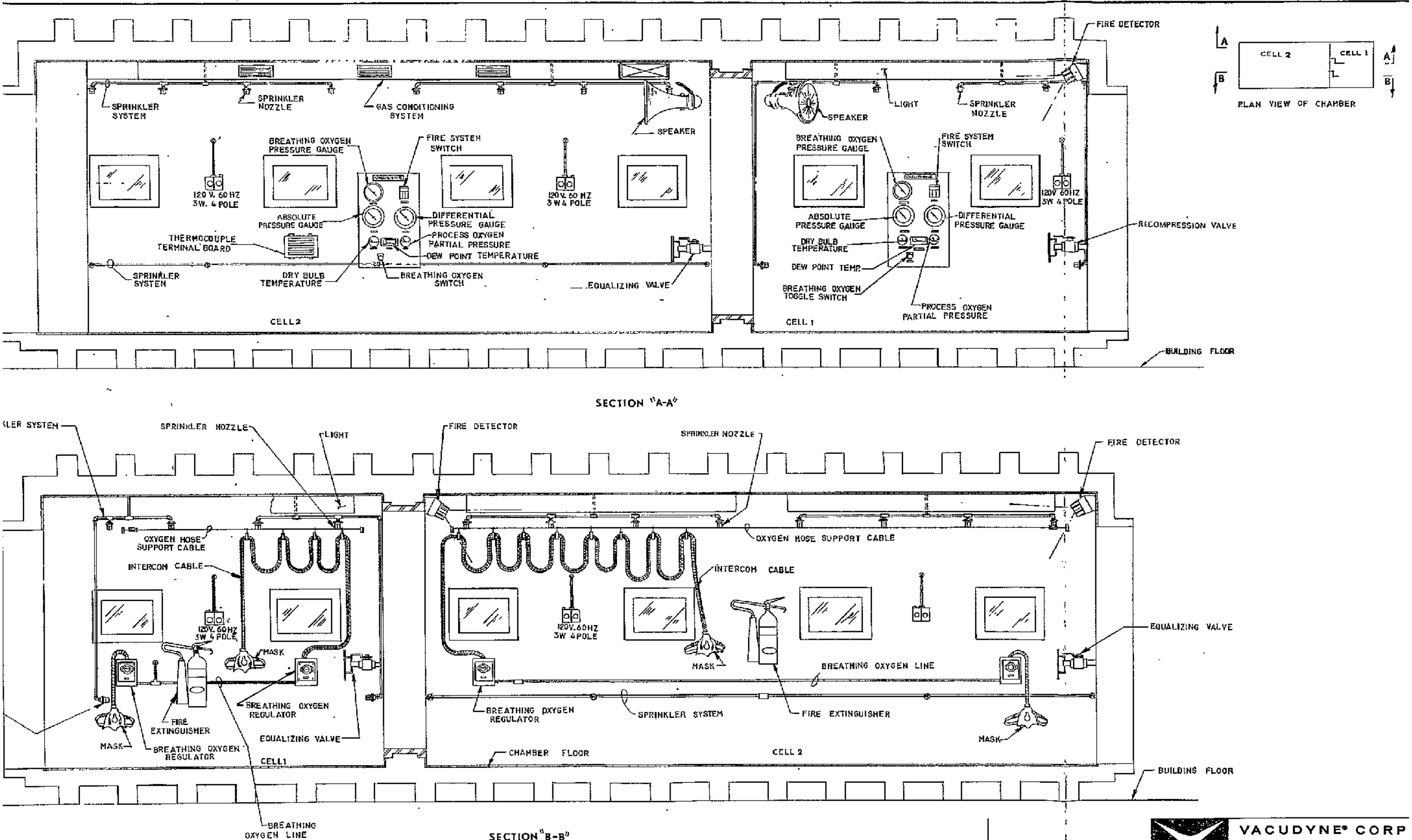
PART NAME: INTERNAL ARRANGEMENT PLAN AND LATERAL CROSS SECTION

CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

DRAWN	DATE	DWG. NO.
MEW	3-5-71	J70-29-4
CHECKED: WD	SCALE: NONE	
TRACED	APPROVED	

FOLDOUT FRAME 1

FOLDOUT FRAME 2



TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS.
FRACTIONAL ±1/64"
DECIMAL ± .005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0°-2' OR ± .006 IN 12 INCHES
CONCENTRICITY. T I R. = ½ OF TOLERANCE ON DIAMETER

REV NO	REVISIONS	BY & DATE	CHKD
1	REMOVED THERMOCOUPLE TERMINAL BOARD IN CELL #1	1-5-71	WD

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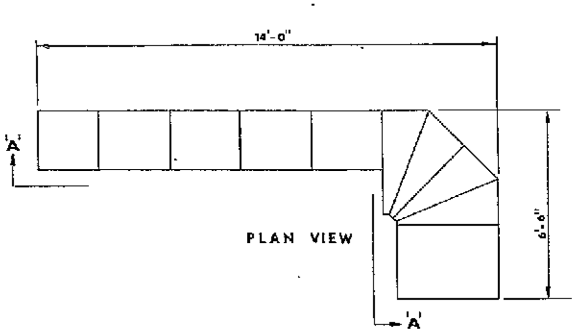
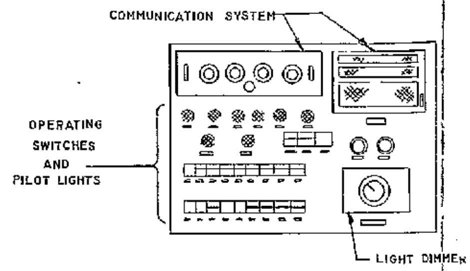
VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

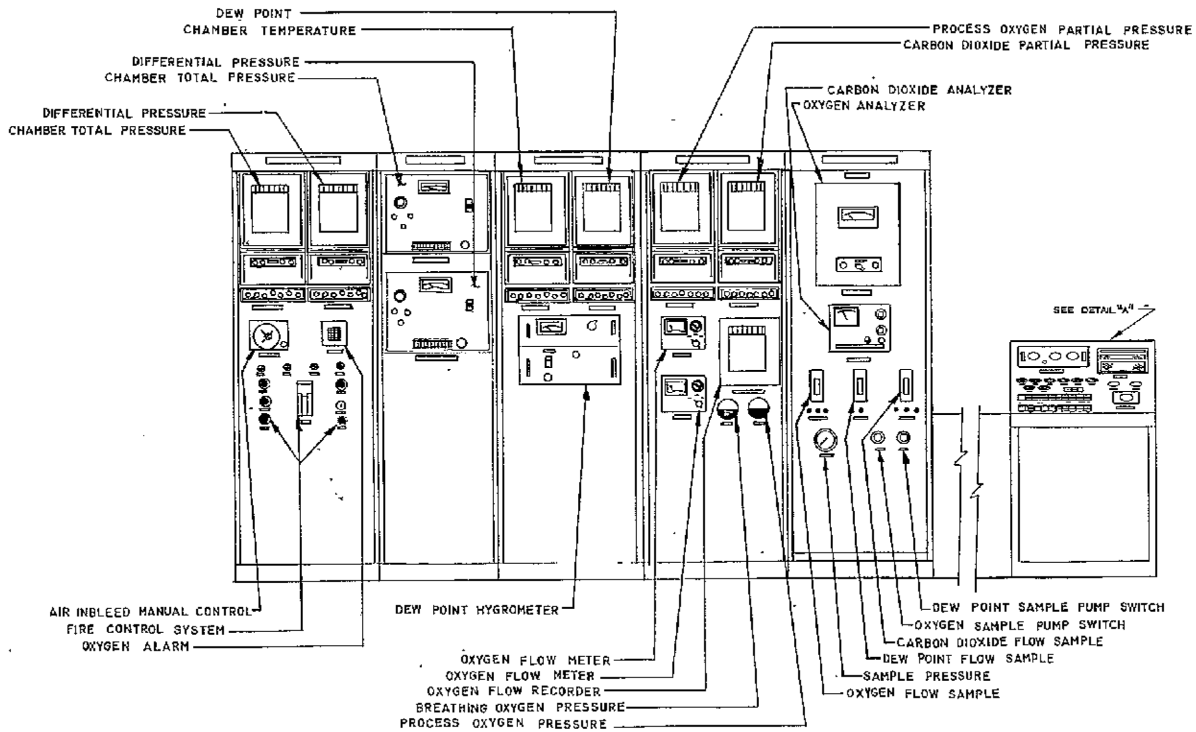
PART NAME	INTERNAL ARRANGEMENT LONGITUDINAL CROSS SECTION
CUSTOMER	NASA MANNED SPACECRAFT FACILITY AND LABORATORY SUPPORT BRANCH
DRAWN	MEW
DATE	3-3-71
CHECKED	W. D.
SCALE	NONE
TRACED	
APPROVED	
DWG. NO.	J70-29-5



PLAN VIEW



DETAIL "A"



VIEW "A-A"

30

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS:
FRACTIONAL ±1/64"
DECIMAL ± .005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0°-3' OR ± .005 IN 12 INCHES
CONCENTRICITY T I R = ½ OF TOLERANCE ON DIAMETER

REV NO	REVISIONS	BY & DATE	CHKD
2	Moved Desk Console To Right Hand Side	4-26-71	WD
1	Removed Control Panels From Cell	4/5/71	WP

VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: CONTROL CONSOLE ARRANGEMENT
CUSTOMER: NASA MANNED SPACECRAFT CENTER FACILITY AND LABORATORY SUPPORT BRANCH
DRAWN: M EW
DATE: MARCH 2, 1971
CHECKED: W D
SCALE: NONE
TRACED:
APPROVED:
DWG. NO. J70-29-6

FOLDOUT FRAME 1

FOLDOUT FRAME 2

NOTE:

ters shall be displayed in millimeters of mercury, absolute.
as otherwise noted.

ygen for the system will meet the dryness and purity
ements of military specification MIL-O-27210.

le CO_2 fire extinguishers will be furnished and installed
contractor.

ctor shall furnish and install all manifolds (including
erated isolation valves) for the various gas supply fields.
ctor shall furnish all caps, plugs and other equipment and
as necessary for hydrostatic testing.

supply field for the emergency system shall not be connected
oxygen partial pressure supply field.

Legend

ntrolled from inside of test cell

splayed inside of test cell

ternal console displayed

ternal Console Controlled

witch

ntroller

corder

ster

reen Pilot Light

ed Pilot Light

essure Transducer

hut Off Valve

neumatic Controlled Valve

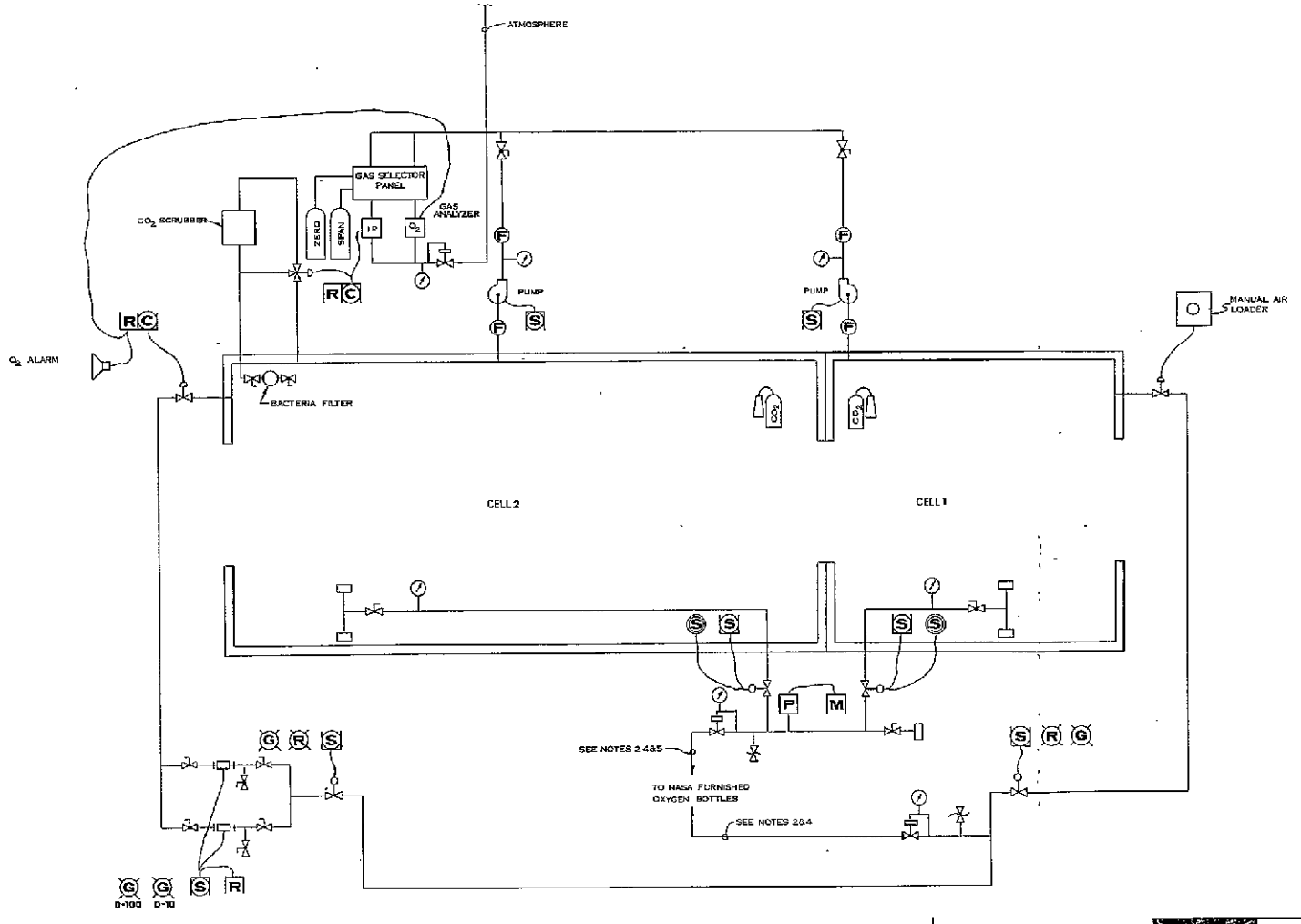
lectrically Controlled Valve

essure Reducing Valve

low Meter

ifferential Pressure Gauge

bsolute Pressure Gauge



TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS:
FRACTIONAL ±1/64"
DECIMAL ± .005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL 10'-2" OR ± .006 IN 12 INCHES
CONCENTRICITY T I R = ½ OF TOLERANCE ON DIAMETER

REV NO	REVISIONS	BY & DATE	CHKD
△	Removed Instrument Control From Cell #1 Tied to Wire Cell #2 Control	R.D. 4-6-71	WD

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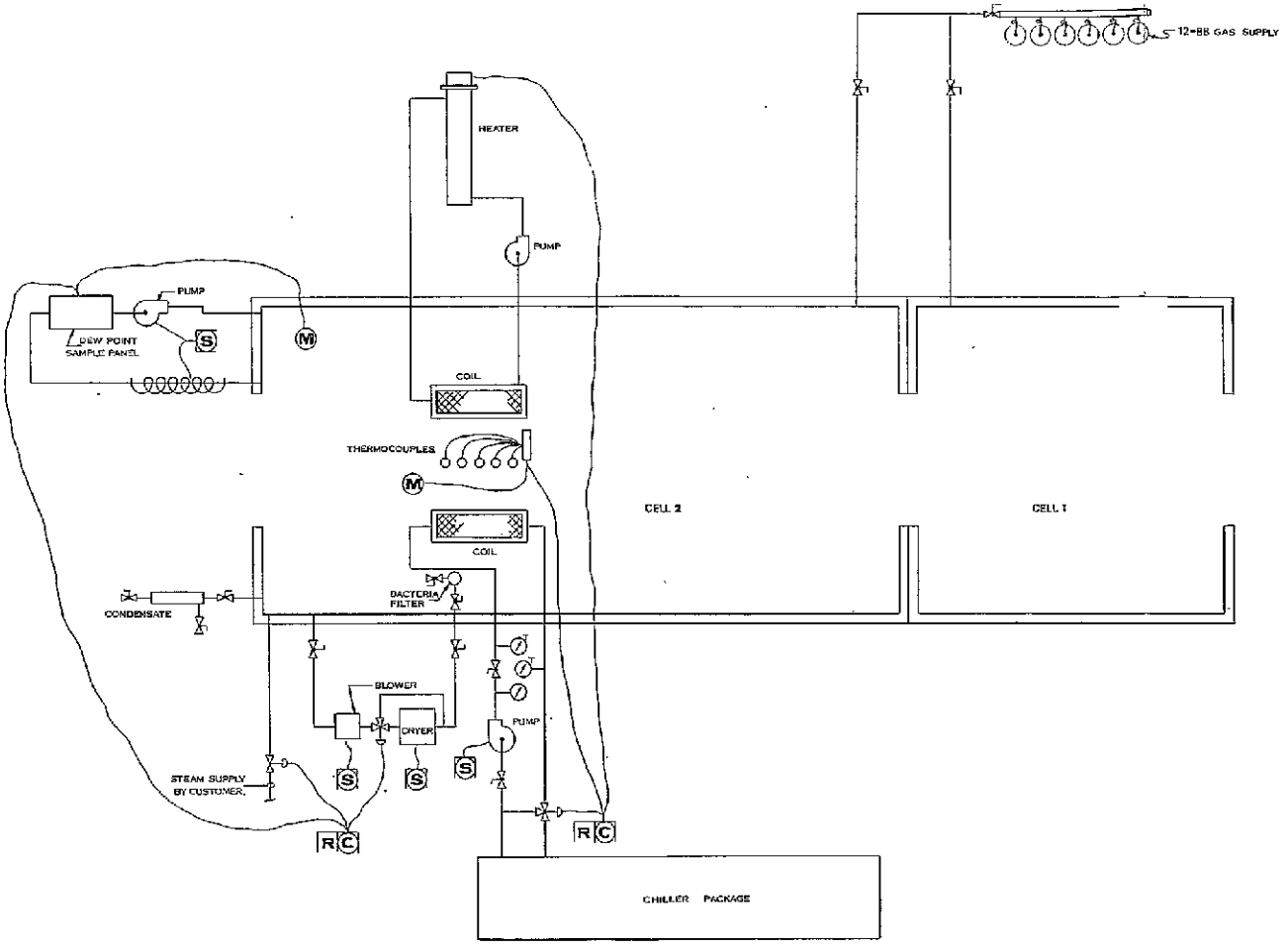
VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: CO_2 & O_2 SYSTEM SCHEMATIC

CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

DRAWN	DATE	DWG. NO.
R D	MARCH 12 1971	J70-29-7
CHECKED: W D	SCALE: NONE	
TRACED	APPROVED	



Legend

Isplayed Inside of Test Cell

xternal Console Displayed

xternal Console Controlled

witch

ontroller

ecorder

ther

ifferential Pressure Gauge

ermometer

hut Off Valve

neumatically Controlled Valve

lectrically Controlled Valve

REV. NO.	REVISIONS	BY & DATE	CHKD
A	ADDED VALVE & FILTER ADDED SPECIFICATIONS CHG	R.D. 4-23-71	WD
B	REMOVED GAS CONDITIONING FROM CELL 1.	R.D. 5-5-71	WD

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BURNING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS
FRACTIONAL ± 1/64"
DECIMAL ± .005
ANGULAR ± 0° - 30' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0°-20' OR ± .005 IN 12 INCHES
CONCENTRICITY, T I R. = ½ OF TOLERANCE ON DIAMETER

VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: Gas Conditioning System Schematic

CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

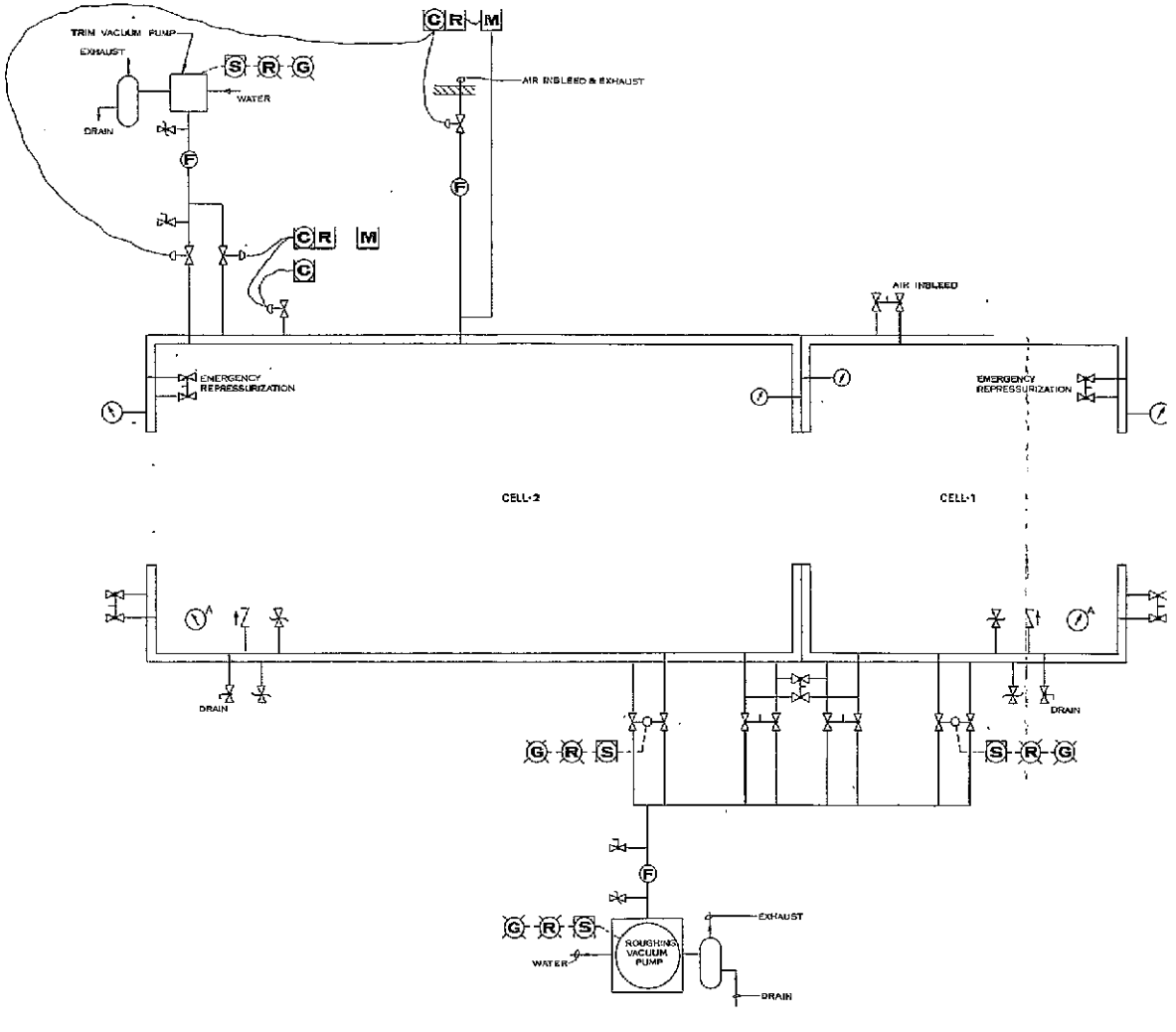
DRAWN	DATE	DWG. NO.
R. D.	MARCH 16 1971	J70-29-8
CHECKED W. D.	SCALE NONE	
TRACED	APPROVED	

FOLDOUT FRAME 1

FOLDOUT FRAME 2

L indicating lights shall be located at the respective test
LL external control console except the indicating lights for
cuum pumps shall be located at both the respective external
trol console and at the respective pump.

l meters s'all be displayed in millimeters of mercury absolute.



Legend

External Console Displayed

External Console Controlled

Switch

Controller

Recorder

Meter

Green Pilot Light

Red Pilot Light

Filter

Shut Off Valve

Pneumatically Controlled Valve

Electrically Controlled Valve

Relief Valve

Check Valve

Differential Pressure Gauge

Absolute Pressure Gauge

REV NO.	REVISIONS	BY & DATE	CHKD
1	Eliminate Vacuum Pump & Individual Control System for Cell #1	P.P. 4-5-71	WD

TOLERANCES (UNLESS OTHERWISE NOTED)
WELDING & BRAZING DIMENSIONS ± 1/8"
MACHINING DIMENSIONS:
FRACTIONAL ± 1/64"
DECIMAL ± .005
ANGULAR ±0° - 5' OR 1/64" IN 12 INCHES
RIGHT ANGLE AND PARALLEL ±0°-2' OR ± .005 IN 12 INCHES
CONCENTRICITY. T.I.R. = ½ OF TOLERANCE ON DIAMETER

VACUDYNE® CORP
CHICAGO HEIGHTS, ILL.

PART NAME: PRESSURE SYSTEM SCHEMATIC

CUSTOMER: NASA MANNED SPACECRAFT CENTER
FACILITY AND LABORATORY SUPPORT BRANCH

DRAWN	DATE	DWG. NO.
R.D.	MARCH 10,1971	J70-29-9
CHECKED: WD	SCALE: NONE	
TRACED	APPROVED	

SECTION 6 - WELDING

6 -01. Scope:

(a) Under this section the Contractor shall do all welding, either in the shop or in the field, including the furnishing of all plant, equipment, tools, services and materials, and performing all operations necessary for or incidental to a complete project in accordance with the plans and these specifications.

6 -02. General:

(a) TERMINOLOGY: Welding terms used in this specifications sha be interpreted according to the American Welding Society definitions.

(b) WELDING SYMBOLS: The American Welding Society standard welding symbols shall be used on all drawings prepared by the Contractor.

(c) All welding processes shall be done in accordance with the specifications and best practice recommendations of the American Welding Society and the American Society of Mechanical Engineers.

(d) PROCESSES: Unless otherwise called for on the drawings or in these specifications, all fusion welding shall be done by either the metallic arc or the gas process. The metallic arc processes shall utilize either AC or DC current, consistent with the type weldment being formed. Gas welding shall be done by the oxyacetylene process.

6 -03. Process and Operator Qualification:

(a) Except where specifically excepted by other provisions of these specifications, welding processes shall be qualified in accordance with the "Standard Qualification Procedure" of the American Welding Society or the ASME, whichever is applicable. The Contracting Officer reserves the right to require that test specimens be made in the presence of an authorized representative of the Government, and that such test specimens be tested by an approved testing laboratory.

(b) All welding operators shall be qualified under the provisions of the "Standard Qualification Procedure" of the American Welding Society, or the ASME, or under an equivalent qualification test approved in advance by the Contracting Officer. In addition to the above requirements, all tests shall be performed on test pieces in positions and with clearances equivalent to those actually encountered in construction. If a test weld fails to meet requirements, an immediate retest of two test welds shall be made, and each test weld shall pass. Failure in the immediate retest will require that the welder be retested after further practice or training, and a complete set of test welds shall be made.

(c) For welding to be performed at other than LRC, the Contracting Officer may, at his option, accept certification from an approved testing agency that each operator has satisfactorily performed the required tests and has been engaged in the process of welding within a period of three months prior to the contract date. Operators shall be permitted to make only those types of weldments for which each is specifically qualified.

6-04. Equipment:

(a) Equipment used in the metallic arc fusion welding process shall be manufactured in accordance with NEMA standards. Power equipment shall be equipped with voltmeters, ammeters or voltammeters, except that detachable test meters may be used in lieu of permanently attached equipment. Meters shall have been tested and calibrated within 6 months of the date of award of contract and shall thereafter be retested at regular intervals not exceeding 6 months. Suitable devices shall be employed for regulating and maintaining voltage and current compatible with the weldments being made. Welding leads shall be of sizes recommended by the American Welding Society for the particular length and current used. Electrode holders, cable splices and ground clamps shall be securely fastened to their leads. Acetylene generators shall not be used on the Government reservation.

6-05. Safety Measures:

(a) In addition to ordinary precautions against fire and other accidents normally associated with welding, the Contractor shall consult with the Contracting Officer to acquaint himself with any unusual hazards in the vicinity of work to be performed and shall take such additional precautions as the Contracting Officer may consider necessary to safeguard personnel and property.

6-06. Oxygen and Air-Arc Cutting and Flame Gouging:

(a) Oxygen or air-arc cutting will be permitted on steels with ladle analysis of alloying agents not exceeding those listed below, where the cut edge is not incorporated in the weldment:

MN-0 percent; Si-4 percent; Cr-5 percent; Ni-7 percent; Mo-5 percent; W-14 percent; Cu-2 percent; Al-9 percent; P.S. Va-unlimited.

Steels with higher content of alloying agents may be cut, provided the technique and processes to be used are specifically approved in advance by the Contracting Officer.

(b) Oxygen or air-arc cutting of faces to be welded will be permitted only on carbon steels have a ladle analysis of 0.35 percent carbon and less.

(c) Machine oxygen or air-arc cutting shall be used wherever practicable in cutting material one-half inch or greater in thickness.

(d) Oxygen or air-arc cut surfaces on material not to be incorporated in a welded joint shall exhibit surfaces reasonably smooth, free of under-cutting or melting of top edge. Oxygen or air-arc cut surfaces to be welded shall not contain gouges or other irregularities which might produce defective bond in the completed weldment. Large uncut corners will not be permitted.

(e) Flame gouging will be permitted only on carbon steels with a ladle analysis of 0.35 carbon and less, and on such steels only for the following operations:

(1) Removal of the root of the original weld on a butt welded joint.

(2) Removal of defective weld metal and temporary tack welds.

(3) Edge preparation for U, J and V butt and corner welds.

(f) Air-arc cutting and flame gouging shall be done with tips especially designed for that purpose

6 -07. Weld Metal:

(a) Iron and steel arc-welding electrodes shall be of the heavy coated type and shall conform to ASTM Serial Designation A233. Low hydrogen electrodes of Classification E-70 through E-120 shall be used with steels having a higher tensile strength than the electrodes listed under A-233.

(b) Iron and steel gas welding rods shall conform to ASTM Designation A251.

(c) Aluminum and aluminum alloy metal arc-welding electrodes shall conform to ASTM Designation B184.

(d) Corrosion resisting chromium and chromium-nickel steel welding electrodes shall conform to ASTM Designation A298.

(e) Welding rods and electrodes shall be selected on a usability basis consistent with the specifications given in paragraphs 6-07(a), (b), (c) and (d) above. Weld metal shall have essentially the same composition and characteristics as the parent (base) metal, and shall be approved in advance by the Contracting Officer.

(f) Except where specifically called for on the drawings or in these specifications, no metal filler or other material except deposited weld metal will be permitted in a weldment.

6 -08. Joint Preparation:

(a) Surfaces to be welded shall be free from rust, scale, water, oil, dirt, paint and other foreign material except that a light coat of rust preventing preservative which will not be detrimental to the finished weld need not be removed. These surfaces shall be thoroughly dried and maintained dry during welding operation.

(b) Slag adhering to oxygen or air-arc cut edges shall be removed prior to welding these edges. Joint surfaces shall be smooth, uniform and free from fins, tears and other defects.

(c) The welding edges of plates may be universal mill edges or may be prepared by shearing, machining, chipping or mechanically guided oxygen or air-arc cutting, except that edges of irregular shape may be prepared by manually guided oxygen cutting.

(d) Shearing shall not be employed for butt joints in material more than one-half inch in thickness. Shearing may be employed for lap joints in material of any thickness.

6-09. Procedure:

(a) Before any welding is begun on any particular section of the structure, or any assembly thereof, the Contractor shall submit a general welding procedure for the approval of the Contracting Officer. Detailed welding procedures may be required for all work, and shall be submitted for all weldments of major structural importance. Where pre-heat and post-heat treatments are to be used, the procedure shall include complete treatment to be followed.

(b) The actual welding of structures and of all parts entering into their construction shall be done in such a manner that the magnitude and extent of residual or locked-up stresses in the welds and structural member will be reduced to a minimum.

(c) Butt welds in structural members shall be made before those members are permanently fastened in place. Where circumstances make it impracticable to comply with the above requirement, the Contracting Officer may approve the use of an un-strapped butt, which is not free to move and which may be welded, provided its members are unsecured on either side of the joint for a distance of at least twelve inches, and are bowed sufficiently to allow for shrinkage.

(d) Riveting within the area affected by the heat of welding shall be done after the welding is completed, unless otherwise specifically approved by the Contracting Officer.

(e) Continuous lines of welding shall be made by the back-step, cascade, wandering, block or other approved sequence, in order to reduce local heating and resultant warping. Welding shall progress symmetrically so that the shrinkage on both sides of the structure will be equalized.

(f) Flat plate structures supported and/or stiffened by intersecting systems of rolled or built-up sections shall be assembled in such sequence that welding of joints between support and/or stiffener members proceeds substantially ahead of the adjacent joints between plate members or between plates and support and/or stiffener members.

(g) Seam welds shall not be carried beyond unwelded intersecting butt or butt lap joints until the latter have been welded, unless specifically approved by the Contracting Officer.

(h) In order to insure adherence to the specified tolerances, it may be necessary to provide extra length and width on certain plates and shapes to allow for shrinkage. Check measurements shall be made frequently during construction, and all possible corrective measures shall be taken.

(i) Longitudinal joints in plates shall be staggered or separated a minimum of 5 times the thickness of the thicker plate joined.

(j) Parts to be joined by fillet welds shall be brought into as close contact as practicable, and in no event shall be separated by more than 3/16 inch. If the separation is 1/16 inch or greater, the size of the fillet weld shall be increased by the amount of the separation. The separation between faying surfaces of lap joints and of butt joints landing on a backing structure shall not exceed 1/16 inch. The fit of the joints produced by contact surfaces which are not sealed by welds throughout their length shall be sufficiently close to exclude water after the required painting.

(k) Abutting parts to be joined by butt welds shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignments, except as permitted by paragraph 6-09(1) below, departure from the theoretical alignment shall not exceed 10 percent of the thickness of the thinner part joined, or 1/8 inch, whichever is less. In correcting misalgnment in such cases, the parts shall not be drawn into a slope greater than two degrees (7/16 inch in 12 inches).

(l) For circumferential joints in tunnel plates and pressure vessels the alignment tolerances shall be, except as otherwise specified, as follows:

For plates less than 1/4 inch in thickness . . . 1/16 inch

For plates 1/4 inch to 3/4 inch in thickness . . 25 percent of plate thickness

For plates 3/4 inch to 1-1/2 inches in thickness.. 3/16 inch

For plates over 1-1/2 inch in thickness . . 12-1/2 percent of plate thickness, but not to exceed 1/4 inch

(m) Members to be welded shall be held in correct position by bolts, clamps, wedges, guy lines, struts, or other suitable devices, or by tack welds, until welding has been completed, except that bolts shall not be used with pressure vessels. Bolts shall be located in such a manner that they are not detrimental to the functioning of the completed structure. Wherever practicable, holes for erection bolts shall be restricted to clip angles and secondary members. Such fastening devices as may be used shall be adequate to insure safety during assembly. Suitable allowances shall be made for warpage and shrinkage. Where, in the opinion of the Contracting Officer, erection bolts or tack welds are detrimental to the finished appearance or functioning of the completed structure they shall be removed and the holes thus exposed shall be repaired in the same manner as that described in paragraph 6 -13(j).

(n) Defective, cracked or brokentack welds or welds not of the same quality or not made by the same procedure as the completed weld shall be removed before final welding.

(o) No welding of any kind shall be done when the temperature of the base metal is lower than zero degrees Fahrenheit. At temperatures between 32 degrees and zero degrees Fahrenheit, the surface of all areas within 3 inches of the point where a weld is to be started shall be heated to a temperature at least warm to the hand before welding is started.

(p) When welds are being made in parts where thicknesses of more than 1-1/2 inches are involved, the base metal adjacent to the welding shall be heated to a temperature of not less than 70 degrees Fahrenheit.

(q) Welding shall not be done when snow is falling on the surfaces to be welded, or when they are wet, ice coated, or exposed to high wind.

6 -10. Technique of Arc Welding:

(a) Welding current shall conform with respect to voltage and amperage (and polarity if direct current is used) to the recommendations of the manufacturer of the electrode being used, as indicated in the instructions included with each container of electrodes. Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances attending the work.

(b) The electrode manipulation during welding shall be such as to insure that:

(1) The base metal is in a fused state when the filler metal makes contact with it.

(2) The weld metal does not overflow upon any unfused base metal.

(3) The base metal is not undercut along the weld edges.

(4) The flowing metal floats slag, oxides and gas bubbles to the surface behind the advancing pool.

The current shall be adjusted or the electrode size changed, if necessary, to insure conformance with these requirements.

(c) Electrode sizes shall not exceed the following:

(1) Passes following the root pass in flat position welds: 1/4 inch

(2) Horizontal fillet welds: 3/16 inch

(3) All other welds: 3/16 inch

(d) Fillet welds made in one pass shall not exceed the following:

(1) Vertical welds made upward: 1/2 inch

(2) All others: 5/16 inch

(e) Weld metal built up behind the advancing arc shall not exceed the following thicknesses:

(1) Single pass fillet weld) As specified in
(2) Root pass of a multi-pass fillet weld) paragraph 6-10 (d) above

(3) Root pass of a butt weld: 1/4 inch

(4) All others: 1/8 inch

(f) Each time the arc is started, the electrode travel shall be delayed until base metal fusion at the starting point is assured. At the completion of a pass, the electrode travel shall be delayed sufficiently to fill the arc crater. After

every interruption of the arc, except at completion of a pass, the arc shall be restarted ahead of the previous deposit and then moved back to fill the crater. Alternative techniques which will insure complete filling of the crater, complete fusion between the new and old deposits and base metal at the point of junction, and complete resultant continuity of weld will be permitted, with the approval of the Contracting Officer.

(g) Before welding over previously deposited weld metal, all traces of slag shall be removed from the deposit by chipping, if necessary, and the deposit and adjoining base metal shall be wire-brushed until clean at all points. This requirement shall apply not only to successive layers, but also to successive beads and to the overlapping area wherever a junction is made on starting a new electrode, but shall not apply to the making of plug and slot welds deposited in the flat position.

(h) In making plug and slot welds the metal may be deposited by a continuous manipulation of the electrodes which will keep the slag molten and floating on the top of the pool. The technique used shall be such as to insure the deposition of sound weld metal, free from any slag inclusions and shrinkage cracks.

6-11. Technique of Gas Welding:

(a) The welding flame shall be either neutral or slightly reducing, as appropriate for the work. The size of the inner cone or cones shall be regulated to suit the thickness of the base metal, the criterion being heat production at a rate which maintains a quiet pool of molten metal and causes fusion of the filler metal with both base metal parts. The orifice of the welding tip shall be clean at all times. An irregular or unsymmetrical inner cone shall be taken as evidence that the tip needs cleaning or repair.

(b) The size of the welding rod shall be suited to the base metal thickness, the size of the pool of molten metal to be maintained, and the size of the inner cone or inner cones of the welding flame or flames, the criterion for correct welding rod size being that it permits maintaining a welding pool of the required size in a quiet molten state.

(c) When starting a weld, the base metal shall be heated to a dull red for a distance of 1 to 2 inches along the joint before filler metal is added. Whenever welding is interrupted, this preheating shall be repeated before resuming addition of filler metal.

(d) The welding torch and the welding rod shall be manipulated in such a manner as to maintain a pool of molten weld metal, without concentrating the heat sufficiently to burn or otherwise injure the base metal or weld metal. The end of the welding rod shall be kept within the pool of molten metal at all times during welding. Special care shall be exercised to avoid disturbance of the rear edge of the pool and thereby to avoid slag becoming entrapped in the molten metal. Either backhand or forehand technique may be employed. The weld shall be formed by advancing the welding rod and flame and thereby advancing the pool of molten metal and allowing the metal at the rear end of the pool to freeze progressively. The flame shall be alternately advanced and retracted in such manner as to preheat the base metal surfaces ahead of the advancing pool of metal, to a state of surface fusion. The manipulation shall be such as to prevent the pool from overflowing the base metal which has not yet melted at its surface. When welding in vertical and overhead positions the pool of molten metal shall not be so deep as to flow out of bounds or overflow upon unfused base metal. Special care shall be exercised to maintain the pool in a sufficiently liquid state to avoid entrapping surface oxides or slag in the weld metal.

(e) When making fillet welds in the horizontal position, the flame shall be directed more against the horizontal face than against the vertical face. The welding rod and flame shall be manipulated so as to insure thorough fusion at the root.

(f) When making butt welds in the flat position, the welding rod and flame shall be manipulated in such a manner that the base metal at the root is fused slightly in advance of the higher positions of the walls, in order that the pool of molten metal shall not overflow into the root in advance of the point at which the base metal is fused.

(g) The welding operator shall not carry a deeper pool of molten metal than he can effectively control. A weld larger than can be formed with continuous and effective control of the pool shall be made in two or more layers.

(h) In multi-layer welding the several layers may be made successively, completing each layer before starting the next, or may be made by the "step" method. When the "step" method is employed, the length of each step need be only sufficient to provide a solid foundation of weld metal for the superimposed layer, except that if annealing

of the underlying layers is desired the length of each step shall be sufficient so that the starting end thereof will cool to at least a black heat before metal is deposited thereon.

6-12. Details of Welds:

(a) The size and shape of fillet welds and the amount of reinforcement of groove welds shall be checked by a gage similar to that shown in Figure (16), or of equivalent design specifically approved by the Contracting Officer.

(b) Fillet welds 3/8 inch size or smaller shall not vary from the specified size, at any point, by more than one gauge size, and variations shall not exceed the gage limits of the specified size over any length exceeding six inches, nor over total lengths exceeding one-fourth the length of the weld. Fillet welds 7/16 inch size or larger shall not vary beyond the gage limits of the specified size at any point.

(c) Exposed faces of welds shall be made reasonably smooth and regular, shall conform as closely as practicable to design requirements, and shall not at any place be inside the intended cross sections.

(d) Before starting welding on the back side of a complete penetration butt weld, the initial layer shall be gouged or chipped out, except that welds produced with the aid of backing material or welded from both sides in square edged material 5/16 inch or less in thickness and having a root opening less than half the thickness of the thinner part need not be gouged or chipped out. Butt welds made with the use of a backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips may be removed by means of gas cutting, after welding is completed, provided no injury is done to the base and weld metal and provided the weld surface is left flush or slightly convex, with full throat thickness.

(e) To insure soundness, the ends of butt welds carrying stresses approaching the maximum allowable working stress shall be extended past the edges of the parts joined, by means of short extension bars providing a similar joint preparation and having a width not less than the thickness of the thicker part joined. If extension bars are removed upon completion

of the weld, the ends of the weld shall be left smooth and flush with the edges of the abutting parts. The extension bars may be omitted on metal 3/4 inch or less in thickness if the ends of the butt weld are chipped or cut down to solid metal, and side welds are applied to fill out the ends to the same reinforcement as the faces of the weld.

(f) Welds shall not be dressed, smoothed, or finished for the purpose of improving their appearance unless specifically called for in these specifications or on the contract drawings.

(g) Where any welded material, either temporary or permanent, is removed from surfaces exposed to view, and is not to be replaced, the areas so exposed shall be made as smooth as the unwelded surrounding structure. In locations not exposed to view, weld metal shall be removed when such weld metal constitutes a hazard to personnel or to equipment. In removing welding material, care shall be employed not to tear out or gouge the base metal. Such holes or undercutting as may result shall be filled by welding.

(h) When grinding or chipping welds, care shall be taken to avoid undercutting or nicking the surface of the plate in the vicinity of the weld.

(i) Slag and spatter adhering to the weld deposit and contiguous material shall be carefully removed, and the surface of the completed weldment shall be painted or coated as soon as practicable after the weld metal has been deposited and the weldment has been inspected and approved by the Contracting Officer.

6-13. Corrections and Repairs to Welds:

(a) Removal or part or all of the weld, or a portion of the base metal, for the purpose of correcting defects as specified below, shall be effected by chipping, machining, grinding, gas or air-arc cutting or gouging. Cutting shall not be performed on a member while under stress, except that detail cutting to correct minor errors may be done if the removal of metal does not reduce the strength below design requirements.

(b) Defective or unsound welds shall be corrected either by removing and replacing the welds, or as follows:

(1) EXCESSIVE CONVEXITY - Reduce to size by removal of excess weld metal.

(2) SHRINKAGE CRACKS, CRACKS IN BASE METAL, CRATERS, BLOWHOLES AND EXCESSIVE POROSITY - Remove defective portions of base and weld metal down to sound metal, and deposit additional weld metal.

(3) UNDERCUTTING, UNDERSIZE AND EXCESSIVE CONCAVITY - Clean and deposit additional weld metal.

(4) OVERLAPPING AND LACK OF FUSION - Remove and replace the weld.

(5) SLAG INCLUSIONS - Remove those parts of the weld containing slag, and fill with weld metal.

(6) REMOVAL OF ADJACENT BASE METAL DURING WELDING - Clean and form full size by depositing additional weld metal.

(c) Wherever corrections necessitate the depositing of additional weld metal, an electrode or welding rod of a size not exceeding 5/32 inch shall be used.

(d) A cracked weld shall be removed throughout its length, unless by the use of acid etching, magnetic inspection, radiographing or other equally positive means the extent of the crack can be ascertained to be limited, in which case sound weld metal two inches or more beyond each end of the crack need not be removed.

(e) In removing defective parts of a weld, the gas gouging, chipping or grinding shall not extend into the base metal any substantial amount beyond the depth of weld penetration, unless cracks or other defects exist in the base metal. The weld or base metal shall not be nicked or under cut in chipping, grinding or gas gougning.

(f) Where work performed subsequent to the making of a deficient weld has rendered the weld inaccessible or has caused conditions which would make the correction of the deficiency dangerous or ineffectual, said conditions shall be mitigated by removal of welds or members or both, if necessary, before making the corrections, or else the deficiency shall be compensated by additional work according to an approved revised design.

(g) Caulking of welds will not be permitted.

(h) Before adding weld metal or rewelding, the surfaces shall be thoroughly cleaned.

(i) Improperly fitted or misaligned parts may be cut apart and rewelded. Members distorted by the heat of welding may be straightened by mechanical means or by the carefully supervised application of limited amount of heat. Such areas shall not be heated to more than 1200 degrees Fahrenheit (a dull red color). Under no circumstances shall heated portions be quenched. Parts shall be substantially unloaded before heating for straightening.

(j) Holes in welded joints left by the removal of trepanned plug specimens, and holes made to provide access for radiographic inspection shall be closed by one of the following methods:

(1) Insert and weld in special plugs, some acceptable types of which are shown in Figure 17. Type (a) is adapted to welding from both sides and shall be used wherever practicable. Types (b) or (c) shall be used when access is possible from only one side. The diameter of the filler plug shall be such as to make a snug fit in the hole to be filled. Each layer of weld metal shall be thoroughly peened, as deposited, to reduce residual stresses. The 1/4 inch holes in the center of the plugs as shown in Figure 17 may afterwards be closed by any reasonable method. Plain plugs without holes may be used.

(2) Fill the hole completely with weld metal. If the thickne of the thinner plate is less than 1/3 of the diameter of the hole, a backing plate shall be tack welded on the inside of the shell over the opening, and the opening shall be closed by welding from the outside only. If the thickness of the thinner plate is between one-third and two-thirds the diameter of the hole, the weld metal shall be applied from both sides, without the use of a backing plate. Fillet welds, where cut, shall be re-built.

(3) For butt joints where the thickness of the thinner plate at the joint does not exceed 7/8 inch, chip a groove on one side of the plate each way along the seam from the hole. The groove at the opening shall have sufficient width to provide a taper to the bottom of the hole, and the length of the groove on each side of the opening shall have a slope of approximately 1 to 3. Use a backing plate on the side opposite that on which the chipping is done or a thin disk (not over 1/8 inch thick) at the bottom of the hole and fill the groove and the hole with weld metal.

4) For butt joints, and for plates of any thickness, chip a groove on both sides of the plate each way along the seam from the hole. The groove at the opening shall have sufficient width to provide a taper to the middle of the plate, and the length of the groove on each side of the opening shall have a slope of approximately 1 to 3. Place a thin disk (not over 1/8 inch thick) in the hole at the middle of the plate and fill the groove and the hole on both sides with weld metal.

(k) Holes in welded joints left by the removal of spherical segmen specimens shall be closed by filling the opening completely with weld metal, working from one side only and using a backing plate where necessary. Rebuild fillets where cut.

(l) Where gas welding is used, the area surrounding the holes referred to in paragraphs6-13(j) and (k) shall be preheated to approximately 400 degrees Fahrenheit prior to welding.

(m) Galvanized surfaces damaged by welding shall be repaired by the application of zinc by one of the following processes:

(1) Metal spray (wire or powder)

(2) Electro-brush plating

(3) Hot application of commercially pure zinc

Welds and damaged surfaces on assemblies to be galvanized after weldings shall be cleaned by sandblasting.

(n) Surfaces on which all mill scale has been previously removed shall have all scale resulting from welding removed.

6-14. Peening and Chipping:

(a) Where required, multiple-layer welds may be peened with light blows from a power hammer, using an elongated round nosed tool, except that the first and last layers shall not be peened. Peening shall be done after the weld has cooled to a temperature warm to the hand, and after the slag has been removed. Peening shall be done only by experienced workmen and care shall be exercised to prevent scaling, flaking, rupturing of the weld or excessive strain-hardening due to over peening.

(b) Groove welds to be welded from both sides shall have the root weld chipped out to sound metal after sufficient weld metal has been deposited on one side of the joint and before any welding is done on the opposite side of the joint, as indicated by figures (1) through (14), inclusive. A round nosed tool having a radius of not less than 3/16 inch shall be used for such chipping.

6-15. Preheating:

(a) Welded joints in carbon-molybdenum steel and in carbon steel having a carbon content in excess of 0.35 percent with a nominal plate thickness of 1/2-inch or greater shall be preheated adjacent to the welding zone to a temperature of not less than 400 degrees Fahrenheit. Preheating may be accomplished by any suitable method, providing it is uniform and the temperature is maintained during the actual welding operation.

6-16. Thermal Stress Relief:

(a) The operation of relieving residual stresses in carbon and low-alloy steel structures by heating shall be carried out by one of the following methods:

(1) Heating the structure as a whole in an enclosed furnace. This method is preferable and should be used whenever practicable.

(2) Heating the structure in two heats in a furnace, provided the overlap of the heated sections of the structure is at least 5 feet. When this method is used that portion outside of the furnace shall be protected so that the temperature gradient is not harmful.

(3) Heating small sections and/or portions of structures to stress relieve longitudinal joints or complicated welded details before joining together to make the completed structure. When stress relieving of the entire structure is required, and it is not practicable to stress relieve the completed structure as a whole or in two heats, as described above, any circumferential joints not previously stress relieved may be stress relieved after the completion of the structure by heating uniformly a circumferential band having a minimum width of each side of the welded joint of 6 times the plate thickness, or the portion outside the furnace shall be protected so that the temperature gradient is not harmful. This procedure may also be used in the stress relieving of portions of structures after repairs.

(4) Heating the structure internally, if the structure is a vessel, pipe or other compatible type, by any appropriate means and with the use of adequate indicating and recording temperature devices to aid in the control and maintenance of uniform distribution of temperature in the structure wall. Previous to this operation the structure shall be fully enclosed with insulating material, or the permanent insulation may be installed, provided it is suitable for the required temperature. In this process the internal pressure shall be kept as low as practicable, but shall not exceed 50 percent of the maximum allowable working pressure at the highest metal temperature expected during the stress relieving period.

(5) Nozzles or other welded attachments for which stress relief is required may be locally stress relieved by heating uniformly a circumferential band around the entire structure in such a manner that the entire band is brought up to the temperature and held for the time specified in this paragraph for stress relieving. The circumferential band shall include the nozzle or welded attachment and shall extend at least 6 times the plate thickness beyond the welding which connects the nozzle or other attachment to the structure. The portion of the structure outside of the circumferentia band shall be protected so that the temperature gradie is not harmful.

(6) Induction heating in the case of welded circumferential joints in piping and tubing, the width of the heated band shall be at least three times the width of the widest part of the welding groove, but in no case less than twice the width of the weld reinforcement.

(b) In any of these methods the stress relieving shall be carried out as follows:

(1) The furnace shall be of such design that the flame cannot impinge directly on the structure to be heated, at any point, and that the temperature variation, within the position being heated can, during the holding period, be maintained within a range of 150 degrees Fahrenheit. The furnace atmosphere shall be so controlled as to avoid excessive oxidation of the surface of the structure.

(2) At the time the structure or part is placed in the furnace, the furnace temperature shall not exceed 600 degrees Fahrenheit.

(3) The temperature of the furnace shall be raised to such a point that the temperature of the structure of part reaches a minimum of 1100 degrees Fahrenheit, at such a rate that the variation of temperature within any 15-foot interval of length of the structure or part being heated does not at any time exceed 250 degrees Fahrenheit. In no case shall the rate of heating be greater than 400 degrees Fahrenheit per hour, or 400 degrees Fahrenheit per hour divided by the maximum metal thickness in inches, whichever is less.

(4) The temperature shall be maintained at a minimum of 1100 degrees Fahrenheit for a period of one hour for each inch of maximum metal thickness, except as specified in paragraph 6-16(b)(6) below.

(5) The structure or part shall be cooled from the maximum down to 600 degrees Fahrenheit in a closed furnace or cooling chamber at a maximum rate of 500 degrees Fahrenheit per hour, or 500 degrees Fahrenheit per hour divided by the maximum metal thickness in inches, whichever is less. Below 600 degrees Fahrenheit the structure or part may be cooled in still air.

(6) Where stress relieving at 1100 degrees Fahrenheit is impracticable, lower temperatures may be used and the holding time increased in accordance with the following schedule:

Metal Temperature (Degrees Fahrenheit)	Holding Time (Hours per inch of metal thickness)
1100	1
1050	2
1000	3
950	5
[illegible]	10

(Intermediate temperatures and holding times may be determined by straight line interpolation.)

(c) Minimum temperature shall be taken to mean the actual minimum temperature of any part of the plate material of the structure as determined by thermocouples attached thereto.

(d) Stress relieving of structures or parts shall include all connections attached by fusion welding, except that small scattered fusion welded connections added to the structure subsequent to stress-relieving need not themselves be stress relieved if:

(1) The diameter of the opening cut in the structure wall for the attachment does not exceed 2 inches.

(2) Neither inside nor outside attachment weld exceeds 3/8 inch in throat dimension.

(3) The connection is not so placed as to form a ligament in the shell, the efficiency of which affects the shell thickness.

(e) When a structure is to be stress relieved, all welded attachments for supporting the vessel shall be stress relieved with the vessel after attachment, except as otherwise provided in paragraph 6-16(f).

(f) Supporting members such as angles and plates outside or inside the structure, when attached by welds having a throat thickness greater than 3/8 inch for circumferential welds, and 1/4 inch for longitudinal welds, shall be attached before stress relieving of the structure, if stress relieving is required.

(g) When rewelding or alterations requiring additional welding have been made on new structures which have been stress relieved, those structures shall again be stress relieved, except as permitted by paragraph 6-16(d).

(h) Stress relieving, when required, shall be done before hydrostatic test, if any. A preliminary hydrostatic test to reveal leaks prior to the stress relieving operation is permissible.

(i) For structures fabricated of materials for which the procedures given in paragraph 6-16(a) and (b) are not suitable, the procedures to be followed in stress relieving shall be determined by the fabricator in consultation with the manufacturer of the materials, and shall be approved in advance by the Contracting Officer.

6-17. Inspection:

(a) All welding shall be subject to inspection by the Contracting Officer who shall have full access at all times to the welded work and shall be provided with facilities for the inspection thereof. The Contractin Officer shall be notified in advance of any welding operations, and shall be furnished with complete detail drawings showing size, length, type and disposition of welds to be made. He may require each welding operator to have an identifying stamp or mark with which to identify all work done by him.

(b) For the purpose of maintaining a general high quality of work, all welders shall be tested and certified by LRC on their first job at LRC. LRC will not recognize any other agency certification. Any welder holding a LRC certification will be permitted to perform on the certified type of welding for any Contractor performing work at LRC. Any welder shall be required to requalify only under any of the following conditions.

(1) When he has not engaged in welding for 90 days or longer.
(2) He has performed no work at LRC for 90 days or longer.
(3) When in the opinion of the Contracting Officer the welder's work is questionable, or when it is thought to be necessary to check his experience and ability to perform satisfactory welding of the type called for in the specifications.

(c) The technique for radiographic examination of welded joints, described paragraph 5-11, and the acceptability of weldments thus examined shall be a described in paragraph UW-51, Rules for Construction of Unfired Pressure Vessels, of the ASME unless specified otherwise. The technique for radiographic examination of the shell welds, described in paragraph 5-02(a) and the acceptability of weldments thus examined shall be as described in paragraph UW-52. The Contractor shall submit to the Contracting Officer for approval, the procedure detailing the steps he proposes to employ in making all radiographs, in particular the type, size and strength of the source, penetrometer information to include location in respect to source, penetrometer number, thickness of shims and the shim material; also the type, number and size of films for each size and type of welded joint. The procedure shall include a code acceptable method of permanently markin each weld joint. Sketches shall be prepared showing all welds to be radiographed and the corresponding marking of each shall be indicated thereon. The sketches shall be submitted with the films for identificatio and record purposes. No film will be accepted for interpretation unless the sketches have been submitted and approved. Prior to the completion of the contract, the Contractor shall submit an "as built" drawing showing al welds for which radiographs were submitted and approved. The welds as sho on the drawing shall be identified in the same manner as the corresponding radiographs. Notwithstanding the provisions of paragraph 3-02 as amended, all radiographs shall be submitted directly to or addressed to the Inspection Office. All radiographs will be examined, interpreted, and approved by the Chief Inspector. When submitting radiographs for inspection, the Contractor will certify that to the best of his knowledge and belief the welds do meet the criteria of acceptability as provided by the terms of the contract. In the event of a dispute as to

whether or not a weld is acceptable, the weld will be cut out in a manner approved by the Government in the presence of an Inspector with the area in question preserved. In the event of a dispute as to whether or not a radiographs is acceptable, the Contractor shall retake the x-ray and submit both the retake and the rejected film to the Inspection Office. The retake will be identified with the prefix "R" and numbered whether it is the first, second, etc. retake.

(d) Magnetic-powder testing and sonic testing of weldments may be performed at the discretion of the Contracting Officer and at Government expense and may form the basis for rejection of weldments.

6-18. Provisions Applicable Only to Building Construction:

(a) The term "Building Construction" shall be interpreted to include all low carbon steel structures, and low carbon steel supports and other appurtenances to pressure vessels and pipes which are not specifically covered in paragraphs 6-19 and 6-20.

(b) Except as otherwise specifically noted in these specificatic or on the drawings, the AISC Code of Standard Practice and Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings shall apply to all work under these specifications.

(c) In new work, rivets or bolts in combination with welds shall not be considered as sharing the stress, and welds shall be provided to carry the entire stress for which the connection is designed. In making alterations to structures, existing rivets may be considered as carrying stresses resulting from existing dead loads, and welding shall be provided to carry all additional stress.

(d) Permissible Unit Stresses:

(1) Welded joints shall be proportioned so that the stresses caused therein by the loads specified on the drawings or in these specifications shall not exceed the following values:

a. Tension, compression or shear on a section through the throat of butt welds: same as corresponding allowable stress for base metal.

b. Shear on a section through the throat of fillet welds, or on faying surface area of plug or slot welds: 13,600 pounds per square inch.

Fiber stresses due to bending shall not exceed the values prescribed above for tension and compression, respectively. Stress in a fillet weld shall be considered as shear on the throat, for any direction of the applied stress. Plug or slot welds shall not be ascribed any value in resistance to stress other than shear.

(2) In the case of fillet welds subjected to both shear and bending stresses, the maximum unit stress resulting from the combination shall not exceed that allowed for shear in paragraph 6-18(d)(1).

(3) Where, under paragraph 6-18(b) of these specifications, an increase in unit stresses is allowed for stresses due to combination of loads, or to secondary or erection stresses, a corresponding increase shall be applied to the allowable unit stresses in welds.

(e) Effective Sizes:

(1) The effective area of a butt or fillet weld shall be considered as the effective length of weld times the effective throat thickness.

(2) The effective shearing area of a plug or slot weld shall be considered as the nominal cross-sectional area of the hole or slot, in the plane of the faying surface.

(3) The effective areas of fillet welds in holes and slots shall be computed as specified in paragraph 6-18(e)(1) for fillet welds, using for the effective length the length along the center line of the weld through the center of the plane through the throat. In the case of overlapping fillets, the area thus computed shall not exceed the nominal cross-sectional area of the hole or slot.

(4) The effective length of a fillet weld shall be the overall length of the full size fillet, including returns.

(5) The effective length of a butt weld, when the ends of the weld are made as specified in paragraph 6-12(e), shall be the width of the parts joined. A transverse skewed butt weld shall not be assumed to be longer than the width of the joint or piece perpendicular to the direction of stress.

(6) The effective throat thickness of a fillet weld shall be the shortest distance from the root to the face of the diagrammatic weld.

(7) The effective throat thickness of a complete-penetration butt weld shall be the thickness of the thinner part joined.

(8) The effective throat thickness of an incomplete-penetration butt weld shall, for design purposes, be considered as reduced in accordance with the provisions of paragraph 6-18(f)(3), hereinafter.

(f) **Details of Welded Joints:**

(1) Framing connections of beams, girders and columns shall be of types compatible with the type construction used. Connections shall be designed for the degree of restraint indicated on the drawings, or elsewhere in these specifications. Where typical details for framing connections are not given on the drawings, proposed typical details shall be submitted to the Contracting Officer for approval before preparing shop drawings of the framing.

(2) Procedure qualification tests will not be required for complete-penetration butt welds in joints made in accordance with Figures (1) through (10), numbers B-2 through 5, B-11 through 20, B-31, B-32, B-41 through 44, B-61, B-62, C-2, C-12, C-14, C-15, C-19, C-21, C-32, C-42, C-45, C-49 through 51, C-54, C-55, C-62, T-14, T-32, T-44, T-46, T-48, and T-62.

(3) Incomplete-penetration butt welds may be used on joints made in accordance with Figures (1) through (10), numbers B-1, C-1, C-11, C-14, C-17, C-20, C-41, C-44, C-48, and T-42, provided:

a. Penetration is as nearly complete as the method of welding will permit.

b. If designed to carry calculated tensile stress, the joint is restrained to prevent any rotation which might result from the eccentricity of the weld with respect to the welded parts.

c. If designed to carry any calculated stress, the efficiency of the joint is reduced as follows: B-1 and C-1 to 50 percent; C-14, C-17, C-20, C-41, C-44, C-48, T-42 to 75 percent; C-11 to 85 percent.

(g) **Fillet Welds:**

(1) Fillet welds may be used without procedure qualification tests.

(2) The relation between weld size and the maximum thickness of material on which various sizes of load carrying fillet weld may be used shall be in accordance with the following table:

Nominal size of fillet weld (Inches)	Maximum thickness of part (Inches)
3/16	1/2
1/4	3/4
5/16	1-1/4
3/8	2
1/2	6
5/8	Over 6

The maximum nominal size of fillet weld applied to a nominally square edge of a plate or section shall be 1/16 inch less than the nominal thickness of the edge, and the nominal size of fillet weld used along the toe of an angle or the edge of a rounded or sloping flange shall not exceed three-fourths the nominal edge thickness of the sloping flange; except that when required by the design conditions and specifically designated on the drawings, fillet welds equal in size to the edge of a plate or rolled section may be used, provided the weld is built out in such a manner as to insure full throat thickness, full fusion area and no injury to the base metal that will reduce its thickness adjacent to the weld.

(3) The ratio of the effective length to the nominal effective size of a load carrying fillet weld, as used in strength computations, shall be not less than 4 to 1.

(4) If longitudinal fillet welds are used alone in end connections, the length of each fillet weld shall be not less than the perpendicular distance between them. The transverse spacing of longitudinal fillet welds used in end connections shall not exceed 8 inches, unless end transverse welds or intermediate plug or slot welds are used.

(5) Intermediate fillet welds may be used to transfer calculated stress across a joint of faying surfaces when the strength required is less than that developed by a continuous fillet weld of the smallest practical

size. The effective length of any segment of intermittent fillet weld shall be not less than four times the weld size, with a minimum of 1-1/2 inches. The ratio of the clear spacing between the effective lengths of such segments at the edges of plates and unsupported edges of rolled shapes carrying calculated stress and the thickness of the thinner part joined shall not exceed the following:

For compression: 16 to 1

For tension: 24 to 1

The clear spacing shall in no case be more than 12 inches. The effective length of longitudinal fillet welds at the ends of built-up members shall be not less than the width of the component part joined.

(6) The minimum width of laps, on lap joints, shall be five times the thickness of the thinner part joined and not less than one inch. Lap joints joining plates or bars subjected to axial stress shall be double fillet welded, except where deflection of the lapped parts is sufficiently restrained to prevent opening of the joint under maximum loading.

(7) Side or end fillet welds terminating at ends or sides, respectively, of parts or members shall, wherever practicable, be returned continuously around corners for a distance not less than twice the nominal size of the weld. This provision shall apply to side and top fillet welds connecting brackets, beam seats and similar connections at the tension side of such connections on the plane about which bending moments are computed. End returns shall be indicated on the detail drawings.

(8) Fillet welds in holes or slots may be used to transmit shear in lap joints or to prevent the buckling or separation of lapped parts. Such fillet welds may overlap, subject to the provisions of paragraph 6-18(a)(3).

(h) Plug and Slot Welds:

(1) Plug or slot welds may be used in plates not more than one inch thick, where subjected principally to shearing stresses, or where needed to prevent buckling or lapped parts.

(2) The transverse spacing between slots shall not exceed 8 inches unless the design otherwise prevents excessive transverse bending in the connection.

(3) If the material is not over 5/8 inch in thickness, the hole shall be filled with weld metal approximately flush with the surface of the part; if the material is over 5/8 inch in thickness, the hole shall be filled with weld metal to at least 5/8 inch in depth.

(4) Holes for plug welds shall be circular. The diameter of the hole shall not be less than the thickness of the part containing the hole plus 5/16 inch, rounded to the next greater odd sixteenth. It shall not be greater th three times the thickness of the weld metal.

(5) The width of slot shall be not less than the above-specified diameter for plug welds. The maximum length of slot shall not exceed 10 times the thickness of the part containing the slot.

(6) The ends of slots shall be semicircular or shall have the corners rounded to a radius not less than the thickness of the part containing the slot.

(i) Eccentricity:

(1) In designing welded joints, adequate provisions shall be made for bending stresses due to eccentricity, if any, in the disposition and section of base metal parts and in the location and types of welded joints.

(j) Combination of Welds:

(1) If two or more of the general types of weld (butt, fillet, plug, slot) are combined in a single joint, th effective capacity of each shall be separately compute with reference to the axis of the group, in order to determine the allowable capacity of the combination.

(k) Stitch Welds: If two or more plates or rolled shapes are used to build up a member, sufficient stitch welding (of t fillet, plug or slot type) shall be provided to make the parts act in unison. Except where transfer of calculated stress between the parts joined requires closer spacing, such stitch welding shall be as fo[illegible]

(1) For plates, the longitudinal clear spacing between stitch welds shall not exceed that specified in paragraph 6-18(g)(4) and the transverse spacing shall not exceed 32 times the thickness of the thinner of the plates joined.

(2) For members composed of two or more rolled shapes, in contact with another, the longitudinal spacing of stitch welds shall not exceed 24 inches or the limits described in paragraph 6-18(k)(3).

(3) For members composed of rolled shapes, separated one from the other by a gusset plate, the component parts shall be stitched together at intervals such that the critical ratio, l/r for each component between stitching, shall not exceed three-fourths the critical ratio for the whole member.

(l) Girders and Beams:

Girders shall be proportioned by their moments of inertia. Butt welded splices shall be complete penetration butt welds. If the flanges are spliced, the splices shall either develop the full effective strength of the material or they shall develop the strength required by the total stresses, calculated on the assumption that all live and impact loads are increased 15 percent, but in no case shall such strength developed be less than 50 percent of the effective strength of the material spliced.

(m) Connections of Tension and Compression Members in Trusses:

Welded connections at ends of tension or compression members in trusses shall develop either the full effective strength of the material or the strength required by total stresses, calculated on the assumption that all live and impact loads are increased 15 percent, but in no case shall such strength developed be less than 50 percent of the effective strength of the material connected.

(n) Milled Joints in Compression Members:

(1) Where compression members are in full-milled bearing on base plates, and where full-milled tier-building columns are spliced there shall be sufficient welding to hold all parts securely in place.

(2) Where other compression members are spliced by full-milled bearing, the splice material and its welding shall be arranged to hold all parts in line and shall be proportioned for 50 percent of the computed stress.

(3) All the foregoing joints shall be proportioned to resist any tension that would be developed by specified wind forces acting in conjunction with 75 percent of the calculated dead load without live load, or with full dead load and full live load, whichever produces the greater tension.

(o) Filler Plates:

Fillers of less than 1/4 inch thickness shall not be used to transfer stress, but shall be trimmed flush with the welded edges of the stress-carrying element and the sizes of the welds along the edges shall be increased over the required sizes by an amount equal to the thickness of the filler.

(p) Heat Treating:

Preheating and thermal stress relief shall be used in building construction only where specifically required by the contract.

(q) Inspection:

(1) Inspection shall be as outlined in paragraph 6-17, except that radiographic examination of weldments shall not be required.

(r) Galvanized Members:

Where the zinc coating on galvanized members has been destroyed either by welding, cutting or drilling such coating shall be replaced after assembly by the use of either galvanizing stick or powder similar and equal to those manufactured by the American Solder and Flux Company.

6-19. Provisions Applicable only to Pressure Vessels:

(a) Part UW, requirements for welded pressure vessels of carbon and low alloy steel, of the ASME Rules for Construction of Unfired Pressure Vessels shall be applicable to all work

under these specifications, except that the provisions of paragraph 6-01 through 6-17 of these specifications and of the paragraphs below shall supplement and take precedenc over affected portions of these rules.

(b) Qualification of welding procedure shall be performed as specified under paragraph 6-03(a).

(c) Forge, pressure and submerged arc welding shall be used onl with the specific approval of the Contracting Officer.

(d) Profiles and details of welds shall conform to Figures (1) through (15).

(e) Within the restrictions provided in paragraph 6-19(a), complete or spot radiographing, or sectioning or a combinat of both may be required at the option of the Contracting Officer. Where spot radiographing, sectioning or a combination of both is used, at least one spot shall be examined for every 50 feet of weld.

(f) Where joint efficiencies require complete radiographing, pressure vessels shall bear the stamp of the ASME.

(g) Where the vessel or piping is 30 inches or more in diameter or is fabricated from steel listed under a pressure vessel classification, Section VIII of the ASME Code for Unfired Pressure Vessels shall govern, except as modified by specific provisions of these specifications.

(h) Where reinforcement is required for a nozzle, the reinforcement pad shall be welded to the vessel before welding in the nozzle.

(i) Where joints require stress relieving, the vessel thickness shall be designed to the allowable stress for the weld material.

(j) All individual pieces shall be permanently marked to permit ready identification and correlation with the mill reports.

(k) Fabrication drawings, including marks on each piece for identification with the mill reports, shall be submitted for approval.

(l) Where radiographing is specified, and stress relieving is required, radiographing shall be done after stress relieving.

6-20. Provisions Applicable Only to Piping System:

(a) Welded joints in pressure piping shall be designed and fabricated in accordance with paragraph 5-11(a), except that the provisions of paragraphs 6-01 through 6-17 of these specifications and the paragraphs below shall supplement and take precedence over affected portions of the referenced ASA Code.

(b) All welded joints, including socket welds and welds in manufactured components, for any working pressure above 125, shall be 100 percent radiographically inspected in accordance with paragraph 6-17(f). See Section 5, paragraph 5-11(a).

(c) Inspection of joints shall be as prescribed in paragraph 6-17, Inspection. Trepanned plug or spherical segment specimens shall be taken as directed in paragraph 6-17, if deemed necessary by the Contracting Officer to determine the extent of a defect and shall be removed at no additional cost to the Government, or, at the option of the Contractor, the weld shall be removed throughout this entire length.

(d) Approved backing rings shall be used at all butt weld piping connections not requiring radiographic inspection. Backing rings shall be knock-off spacer type. Consumable type inserts, ARCOS EB Type A, or equal, shall be used at all butt weld piping connections requiring radiographic inspection.

(e) Backing gas inside all welds requiring radiographic inspection shall be Argon.

(f) Pipe welding shall conform to Figure 18.

6-21. Brazing and Soldering:

(a) All brazing and soldering shall be performed in accordance with Section 7 - Brazing and Silver Soldering.

DESIGN DATA FOR GROOVE BUTT JOINTS

IMPORTANT—NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1— THIS JOINT SHALL NOT BE USED WHEN ROOT OF WELD IS SUBJECT TO TENSION BENDING.

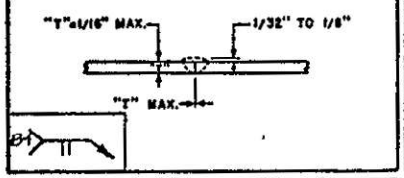
NOTE 2— ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE IS WELDED.

NOTE 3— BACKING STRAP SHALL BE REMOVED & ROOT OF WELD CHIPPED OUT TO SOUND METAL & REWELDED

NOTE 4— DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED

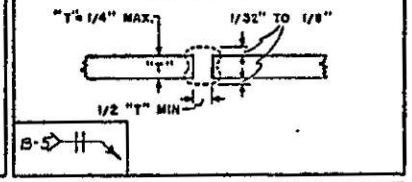
B-1. SQUARE – BUTT JOINT, WELDED ONE SIDE

(SEE NOTE 1)

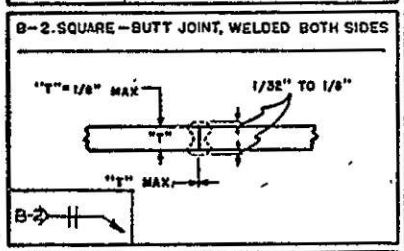


B-5. OPEN SQ.-BUTT JOINT, WELDED BOTH SIDES

(SEE NOTE 2)

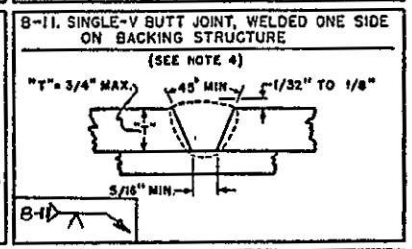


B-2. SQUARE – BUTT JOINT, WELDED BOTH SIDES

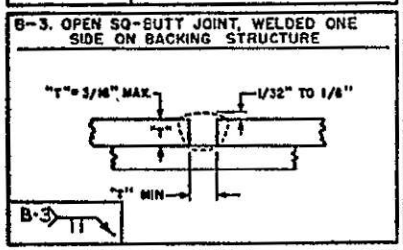


B-11. SINGLE-V BUTT JOINT, WELDED ONE SIDE ON BACKING STRUCTURE

(SEE NOTE 4)

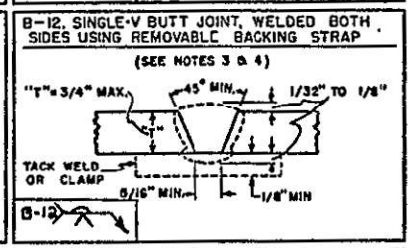


B-3. OPEN SQ-BUTT JOINT, WELDED ONE SIDE ON BACKING STRUCTURE

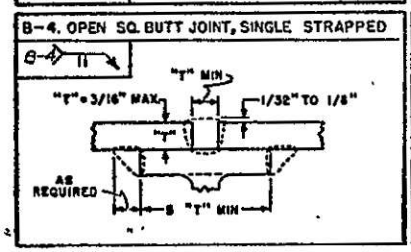


B-12. SINGLE-V BUTT JOINT, WELDED BOTH SIDES USING REMOVABLE BACKING STRAP

(SEE NOTES 3 & 4)



B-4. OPEN SQ. BUTT JOINT, SINGLE STRAPPED



B-13. SINGLE-V BUTT JOINT, SINGLE STRAPPED

(SEE NOTE 4)

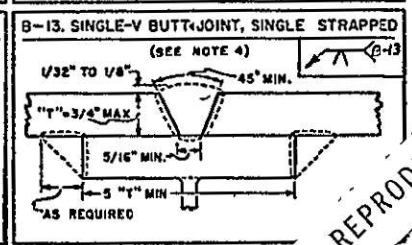


Figure 1.

DESIGN DATA FOR GROOVE BUTT JOINTS

IMPORTANT—NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1— ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

NOTE 2— BACKING STRAP SHALL BE REMOVED AND ROOT OF WELD CHIPPED OUT TO SOUND METAL & REWELDED

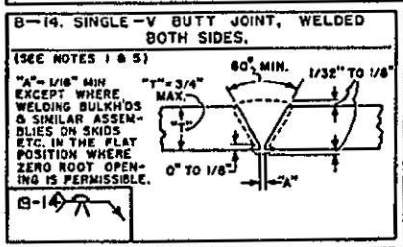
NOTE 3— WHEN THIS JOINT IS USED IN THE FLAT & OVERHEAD POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 6 INCHES TO THE EDGE OF THE BEVELED PLATE. WHEN THE JOINT IS USED IN THE HORIZONTAL & VERTICAL POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE

NOTE 4— THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY. WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45°

NOTE 5— DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED.

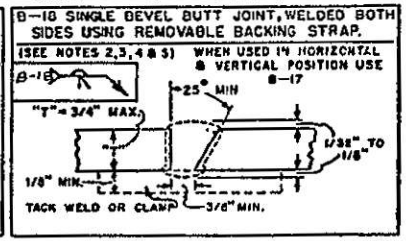
B-14. SINGLE-V BUTT JOINT, WELDED BOTH SIDES.

(SEE NOTES 1 & 5)



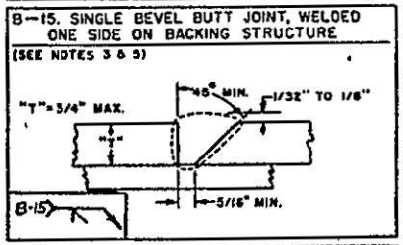
B-18 SINGLE BEVEL BUTT JOINT, WELDED BOTH SIDES USING REMOVABLE BACKING STRAP.

(SEE NOTES 2,3,4 & 5) WHEN USED IN HORIZONTAL & VERTICAL POSITION USE B-17



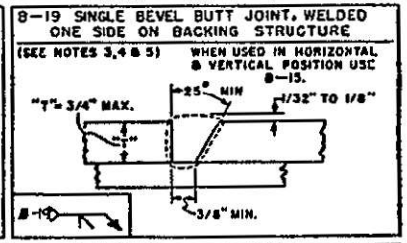
B-15. SINGLE BEVEL BUTT JOINT, WELDED ONE SIDE ON BACKING STRUCTURE

(SEE NOTES 3 & 5)



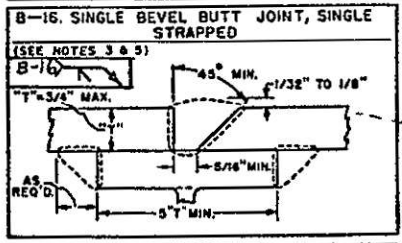
B-19 SINGLE BEVEL BUTT JOINT, WELDED ONE SIDE ON BACKING STRUCTURE

(SEE NOTES 3,4 & 5) WHEN USED IN HORIZONTAL & VERTICAL POSITION USE B-15.



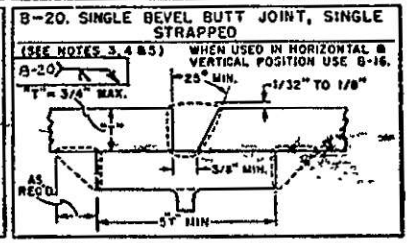
B-16. SINGLE BEVEL BUTT JOINT, SINGLE STRAPPED

(SEE NOTES 3 & 5)



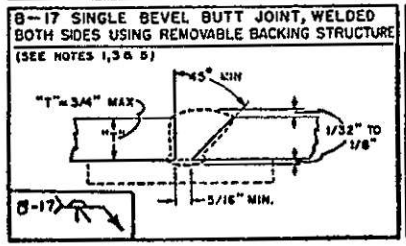
B-20. SINGLE BEVEL BUTT JOINT, SINGLE STRAPPED

(SEE NOTES 3,4 & 5) WHEN USED IN HORIZONTAL & VERTICAL POSITION USE B-16.



B-17 SINGLE BEVEL BUTT JOINT, WELDED BOTH SIDES USING REMOVABLE BACKING STRUCTURE

(SEE NOTES 1,3 & 5)



B-31 DOUBLE V BUTT JOINT.

(SEE NOTES 1 & 5)

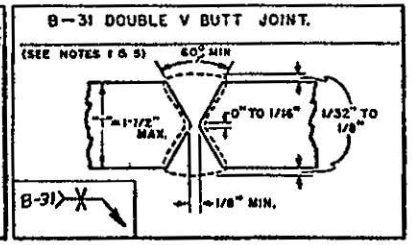


Figure 2.

DESIGN DATA FOR GROOVE BUTT JOINTS

IMPORTANT- NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1- ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

NOTE 2- BACKING STRAP SHALL BE REMOVED AND ROOT OF WELD CHIPPED OUT TO SOUND METAL & REWELDED.

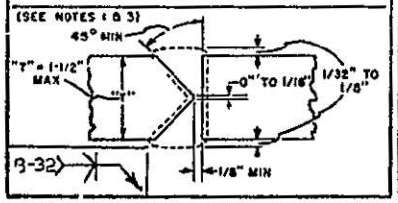
NOTE 3- WHEN THIS JOINT IS USED IN THE FLAT & OVERHEAD POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 6 INCHES TO THE EDGE OF THE BEVELED PLATE WHEN THE JOINT IS USED IN THE HORIZONTAL & VERTICAL POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE.

NOTE 4- THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY. WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45.

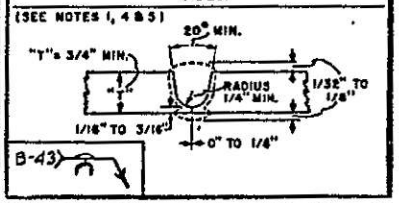
NOTE 5- DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE LESS FOR JOINTS INDICATED

NOTE 6- ROOT EDGES SHALL BE INDEPENDENTLY FUSED TO THE BACKING STRUCTURE WITH 5/32" DIA. ELECTRODE.

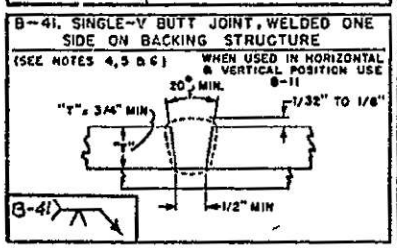
B-32. DOUBLE BEVEL BUTT JOINT



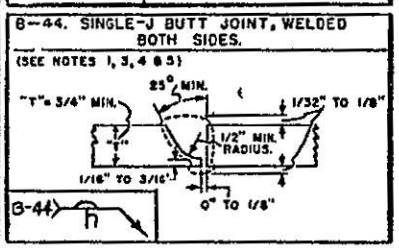
B-43. SINGLE-U BUTT JOINT, WELDED BOTH SIDES.



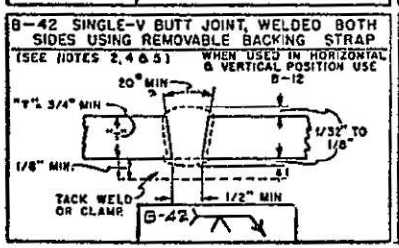
B-41. SINGLE-V BUTT JOINT, WELDED ONE SIDE ON BACKING STRUCTURE



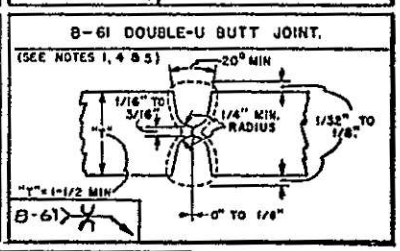
B-44. SINGLE-J BUTT JOINT, WELDED BOTH SIDES.



B-42 SINGLE-V BUTT JOINT, WELDED BOTH SIDES USING REMOVABLE BACKING STRAP



B-61 DOUBLE-U BUTT JOINT.



B-62. DOUBLE-J BUTT JOINT.

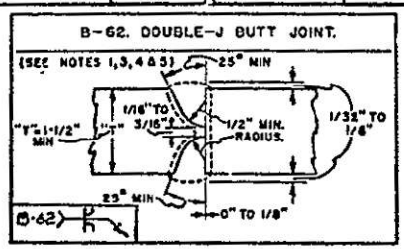


Figure 3.

DESIGN DATA FOR GROOVE CORNER JOINTS

IMPORTANT— NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1- ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED

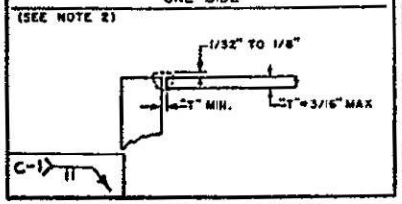
NOTE 2- THIS JOINT SHALL NOT BE USED WHEN ROOT OF WELD IS SUBJECT TO TENSION BENDING

NOTE 3- WHEN THIS JOINT IS USED IN THE FLAT & OVERHEAD POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 6 INCHES TO THE EDGE OF THE BEVELED PLATE. WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE

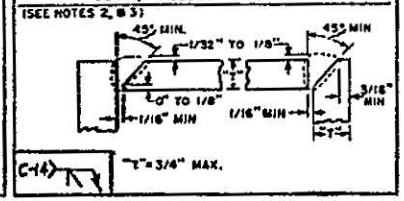
NOTE 4- WHEN THIS JOINT IS USED NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE

NOTE 5- DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED.

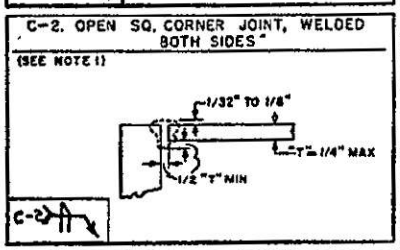
C-1. OPEN SQ. CORNER JOINT, WELDED ONE SIDE



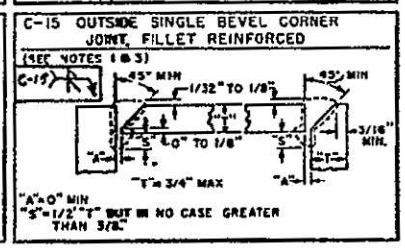
C-14 OUTSIDE SINGLE BEVEL CORNER JOINT, WELDED ONE SIDE



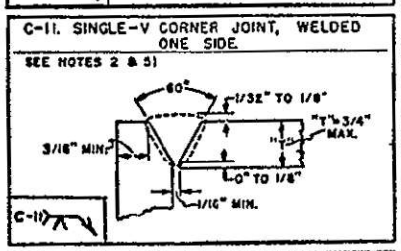
C-2. OPEN SQ. CORNER JOINT, WELDED BOTH SIDES"



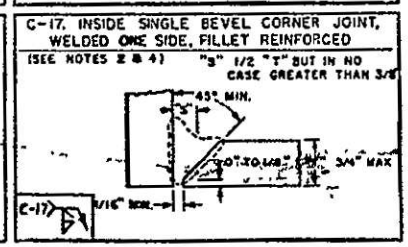
C-15 OUTSIDE SINGLE BEVEL CORNER JOINT, FILLET REINFORCED



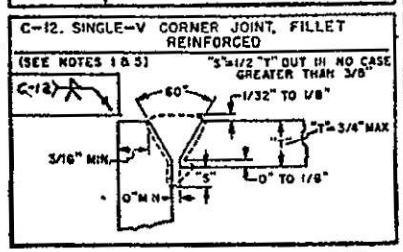
C-11. SINGLE-V CORNER JOINT, WELDED ONE SIDE.



C-17. INSIDE SINGLE BEVEL CORNER JOINT, WELDED ONE SIDE, FILLET REINFORCED



C-12. SINGLE-V CORNER JOINT, FILLET REINFORCED



C-19 INSIDE SINGLE BEVEL CORNER JOINT, WELDED BOTH SIDES, FILLET REINFORCED.

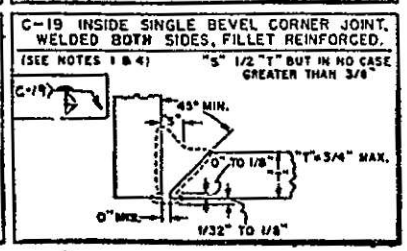


Figure 4.

DESIGN DATA FOR GROOVE CORNER JOINTS

IMPORTANT—NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1—ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED

NOTE 2—THIS JOINT SHALL NOT BE USED WHEN ROOT OF WELD IS SUBJECT TO TENSION BENDING

NOTE 3—WHEN THIS JOINT IS USED IN THE FLAT & OVERHEAD POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 6 INCHES TO THE EDGE OF THE BEVELED PLATE WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE.

NOTE 4—WHEN THIS JOINT IS USED NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE.

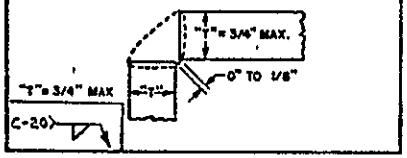
NOTE 5—DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED

NOTE 6—THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY. WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45°

NOTE 7—DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE LESS FOR JOINTS INDICATED

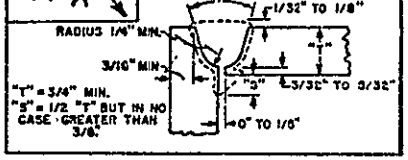
C-20. OUTSIDE SINGLE FILLET WELDED CORNER JOINT.

(SEE NOTES 2 & 5)



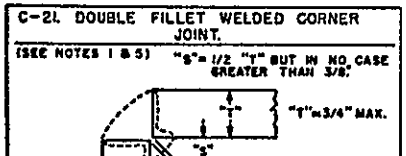
C-42. SINGLE-U CORNER JOINT, FILLET REINFORCED

(SEE NOTES 1, 6 & 7)



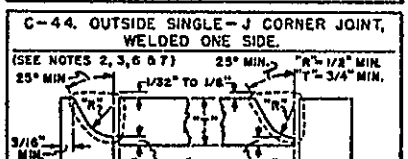
C-21. DOUBLE FILLET WELDED CORNER JOINT.

(SEE NOTES 1 & 5) "S"= 1/2 "T" BUT IN NO CASE GREATER THAN 3/8"



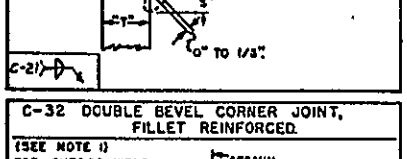
C-44. OUTSIDE SINGLE-J CORNER JOINT, WELDED ONE SIDE.

(SEE NOTES 2, 3, 6 & 7)



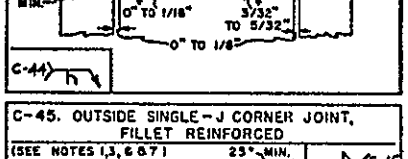
C-32 DOUBLE BEVEL CORNER JOINT, FILLET REINFORCED.

(SEE NOTE 1)



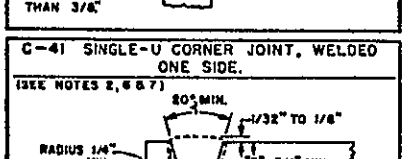
C-45. OUTSIDE SINGLE-J CORNER JOINT, FILLET REINFORCED

(SEE NOTES 1, 3, 6 & 7)



C-41 SINGLE-U CORNER JOINT, WELDED ONE SIDE.

(SEE NOTES 2, 6 & 7)



C-48 INSIDE SINGLE-J CORNER JOINT, WELDED ONE SIDE, FILLET REINFORCED

(SEE NOTES 2, 4, 6 & 7)

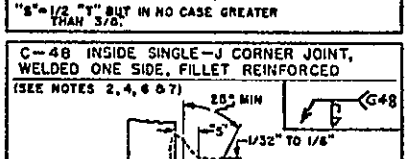


Figure 5.

DESIGN DATA FOR GROOVE CORNER JOINTS

IMPORTANT—NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1—ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED

NOTE 2—BACKING STRAP SHALL BE REMOVED & ROOT OF WELD CHIPPED OUT TO SOUND METAL & REWELDED.

NOTE 3—WHEN THIS JOINT IS USED IN THE FLAT & OVERHEAD POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 6 INCHES TO THE EDGE OF THE BEVELED PLATE WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS OF WELDING NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE.

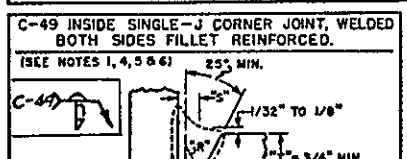
NOTE 4—WHEN THIS JOINT IS USED NO OBSTRUCTION SHALL BE CLOSER THAN 18 INCHES TO THE EDGE OF THE BEVELED PLATE

NOTE 5—DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE LESS FOR JOINT INDICATED.

NOTE 6—THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45°

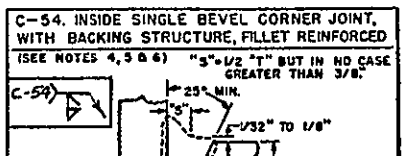
C-49 INSIDE SINGLE-J CORNER JOINT, WELDED BOTH SIDES FILLET REINFORCED.

(SEE NOTES 1, 4, 5 & 6)



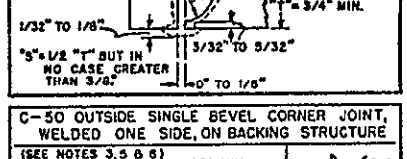
C-54. INSIDE SINGLE BEVEL CORNER JOINT, WITH BACKING STRUCTURE, FILLET REINFORCED

(SEE NOTES 4, 5 & 6) "S"= 1/2 "T" BUT IN NO CASE GREATER THAN 3/8".



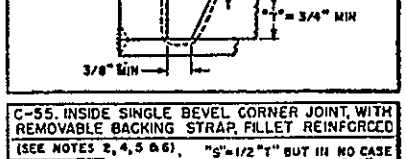
C-50 OUTSIDE SINGLE BEVEL CORNER JOINT, WELDED ONE SIDE, ON BACKING STRUCTURE

(SEE NOTES 3, 5 & 6)



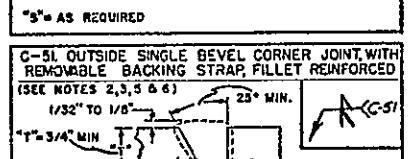
C-55. INSIDE SINGLE BEVEL CORNER JOINT, WITH REMOVABLE BACKING STRAP, FILLET REINFORCED

(SEE NOTES 2, 4, 5 & 6), "S"= 1/2 "T" BUT IN NO CASE GREATER THAN 3/8"



C-51. OUTSIDE SINGLE BEVEL CORNER JOINT, WITH REMOVABLE BACKING STRAP, FILLET REINFORCED

(SEE NOTES 2, 3, 5 & 6)



C-62 DOUBLE-J CORNER JOINT, FILLET REINFORCED.

FOR OUTSIDE WELD SEE NOTE 3 FOR INSIDE WELD SEE NOTE 4

(SEE NOTES 1, 5 & 6)

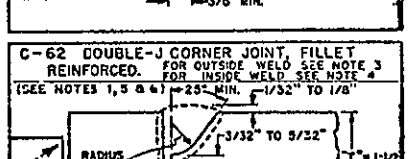


Figure 6.

DESIGN DATA FOR EDGE JOINTS

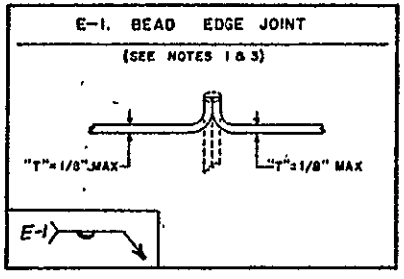
IMPORTANT–NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

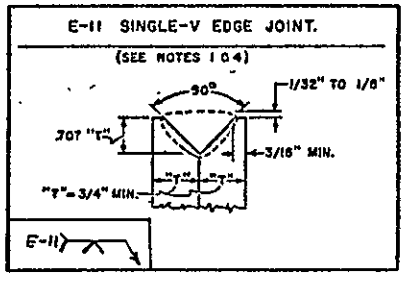
NOTE 1 – THIS JOINT SHALL NOT BE USED WHEN ROOT OF WELD IS SUBJECT TO TENSION BENDING.

NOTE 2 – THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45°.

NOTE 3 – DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED.

NOTE 4 – DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE IF DESIRED, PLATE THICKNESS MAY BE LESS FOR JOINTS INDICATED





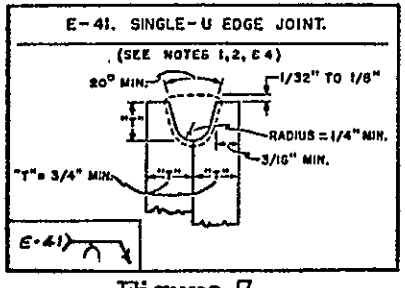


Figure 7.

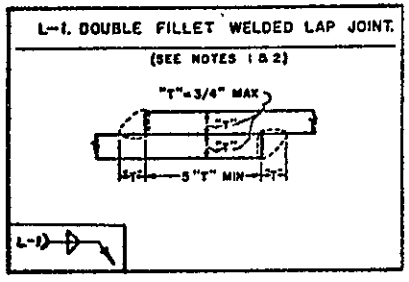
DESIGN DATA FOR LAP JOINTS

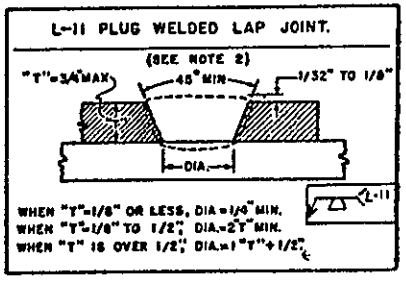
IMPORTANT–NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

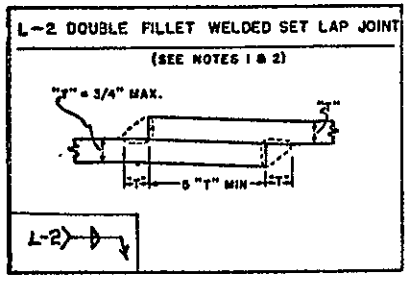
NOTE 1 – THIS JOINT SHALL NOT BE USED ON MEMBERS SUBJECT TO HIGH STRESSES OR COMPRESSION LOADING.

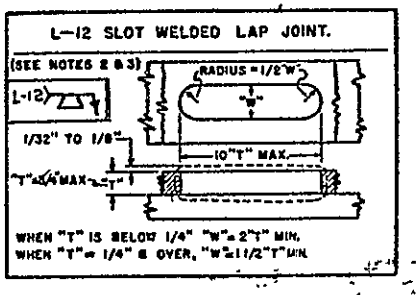
NOTE 2 – DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED.

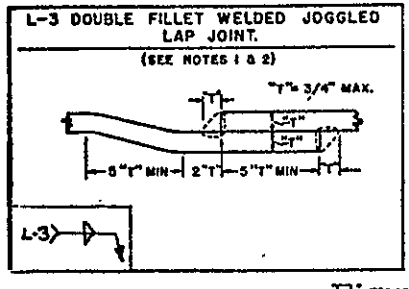
NOTE 3 – SLOT WELDS SHALL BE BEVELED 45° INCLUDED ANGLE WHEN "T" IS LESS THAN 1/2".











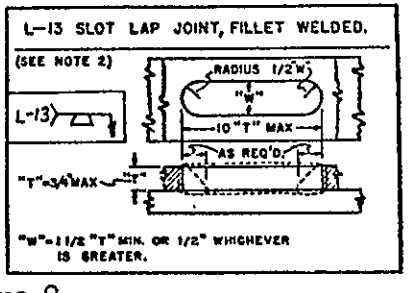


Figure 8.

DESIGN DATA FOR TEE JOINTS

IMPORTANT–NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1– WHERE THE CLEARANCE BETWEEN MEMBERS TO BE JOINED "A" IS GREATER THAN 1/16" THE SIZE OF FILLET WELD SHALL BE THE SIZE SPECIFIED PLUS THE CLEARANCE.

NOTE 2– DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE GREATER FOR JOINTS INDICATED.

NOTE 3– THE MINIMUM LENGTH OF AN INCREMENT SHALL BE 4 TIMES THE SIZE OF THE WELD, BUT IN NO CASE LESS THAN 1 INCH.

NOTE 4– THE MAXIMUM LENGTH OF AN INCREMENT SHALL BE 16 TIMES THE THICKNESS OF THE THINNER MEMBER, BUT IN NO CASE SHALL THIS MAXIMUM EXCEED 6 INCHES.

NOTE 5– THE MAXIMUM CENTER TO CENTER SPACING BETWEEN INCREMENTS SHALL BE 16 TIMES THE THICKNESS OF THE THINNER MEMBER, BUT IN NO CASE SHALL THIS MAXIMUM EXCEED 12 INCHES.

NOTE 6– THE MAXIMUM CENTER TO CENTER SPACING BETWEEN INCREMENTS ON THE SAME SIDE OF THE JOINT SHALL BE 32 TIMES THE THICKNESS OF THE THINNER MEMBER, BUT IN NO CASE SHALL THIS SPACING BETWEEN ADJACENT INCREMENTS ON OPPOSITE SIDES OF THE MEMBER EXCEED 12 INCHES.

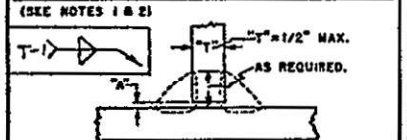
NOTE 7– THIS JOINT SHALL NOT BE USED WHEN ROOT OF WELD IS SUBJECT TO TENSION BENDING.

NOTE 8– WHEN THIS JOINT IS USED NO OBSTRUCTION SHALL BE CLOSER THAN 16 INCHES TO THE EDGE OF THE BEVELED PLATE

NOTE 9– ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

T-1. DOUBLE FILLET WELDED TEE JOINT.

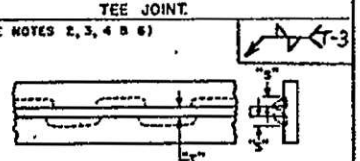
(SEE NOTES 1 & 2)



"A"=0" TO 1/8" FOR STRAIGHT SURFACES.
"A"=0" TO 3/16" FOR CURVED SURFACES.

T-3. STAGGERED INTERMITTENT WELDED TEE JOINT.

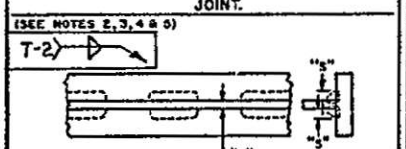
(SEE NOTES 2, 3, 4 & 6)



"T"=1/4" MAX.
"S"="T" MAX.

T-2. CHAIN INTERMITTENT WELDED TEE JOINT.

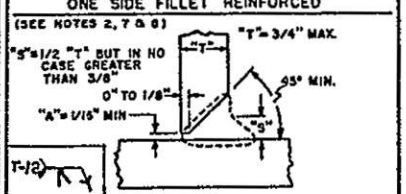
(SEE NOTES 2, 3, 4 & 6)



"T"=1/4" MAX.
"S"="T" MAX.

T-12. SINGLE BEVEL TEE JOINT, WELDED ONE SIDE FILLET REINFORCED

(SEE NOTES 2, 7 & 8)



T-14. SINGLE BEVEL TEE JOINT, WELDED BOTH SIDES, FILLET REINFORCED.

(SEE NOTES 2, 8 & 9)

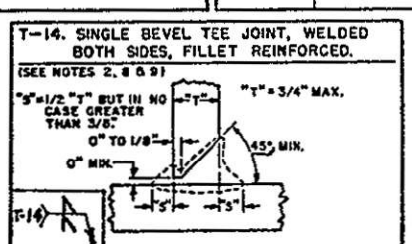


Figure 9.

DESIGN DATA FOR GROOVE TEE JOINTS

IMPORTANT–NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1– ROOT OF WELD SHALL BE CHIPPED OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

NOTE 2– BACKING STRAP SHALL BE REMOVED AND ROOT OF WELD CHIPPED OUT TO SOUND METAL & REWELDED.

NOTE 3– WHEN THIS JOINT IS USED NO OBSTRUCTION SHALL BE CLOSER THAN 16 INCHES TO THE EDGE OF THE BEVELED PLATE.

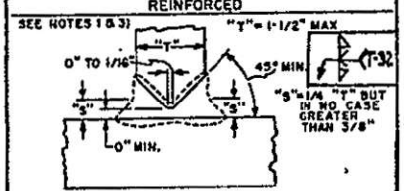
NOTE 4– THIS JOINT SHALL NOT BE USED WHEN ROOT SIDE OF WELD IS SUBJECT TO TENSION BENDING

NOTE 5– THE JOINT AS SHOWN SHALL BE USED IN THE FLAT & OVERHEAD POSITIONS ONLY. WHEN USED IN THE HORIZONTAL & VERTICAL POSITIONS THE INCLUDED ANGLE SHALL NOT BE LESS THAN 45°

NOTE 6– DIMENSION "T" IS PLATE THICKNESS TO WHICH NORMALLY APPLICABLE. IF DESIRED, PLATE THICKNESS MAY BE LESS FOR JOINTS INDICATED

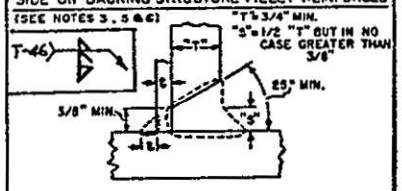
T-32. DOUBLE BEVEL TEE JOINT, FILLET REINFORCED

(SEE NOTES 1 & 3)



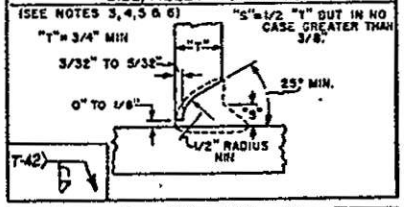
T-46 SINGLE BEVEL TEE JOINT, WELDED ONE SIDE ON BACKING STRUCTURE FILLET REINFORCED

(SEE NOTES 3, 5 & 6)



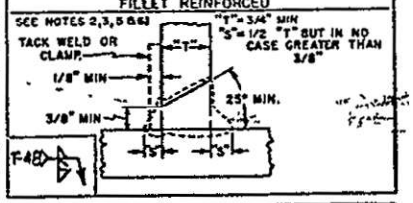
T-42. SINGLE-J TEE JOINT, WELDED ONE SIDE, FILLET REINFORCED

(SEE NOTES 3, 4, 5 & 6)



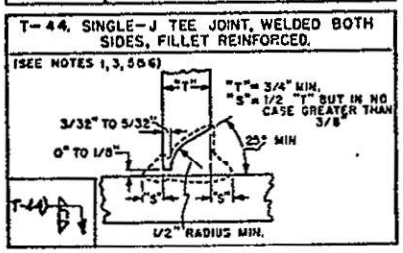
T-48 SINGLE BEVEL TEE JOINT, WITH REMOVABLE BACKING STRAP, WELDED BOTH SIDES, FILLET REINFORCED

(SEE NOTES 2, 3, 5 & 6)



T-44. SINGLE-J TEE JOINT, WELDED BOTH SIDES, FILLET REINFORCED.

(SEE NOTES 1, 3, 5 & 6)



T-62. DOUBLE-J TEE JOINT, FILLET REINFORCED

(SEE NOTES 1, 3, 5 & 6)

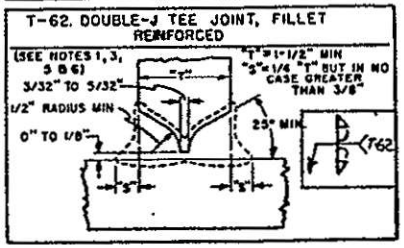
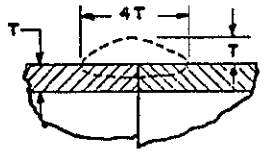


Figure 10.

DESIGN DATA FOR WELDED PIPING

P-1. SQUARE BUTT JOINT, SADDLE WELDED.

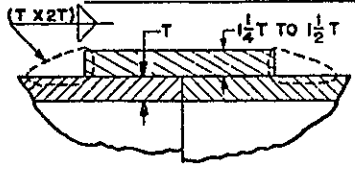


PRESSURE- 50# & LESS FOR ALL SIZES

TEMPERATURE- 212°F MAX. FOR ALL SIZES.

SERVICE- ALL EXCEPT SALT WATER.

P-2. SLIP-ON SLEEVE BUTT JOINT, FILLET WELDED.

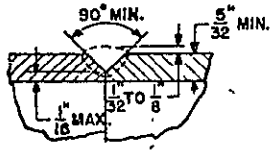


PRESSURE: 150# & LESS, OVER 2" — ALL PRESSURES, 2" & LESS.

TEMPERATURE 212°F. MAX., OVER 2" — ALL TEMPERATURES, 2" & LESS

SERVICE ALL EXCEPT SALT WATER.

P-3. V-BUTT JOINT.

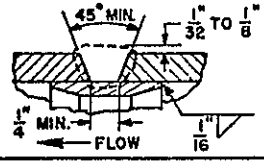


PRESSURE- 150# & LESS

TEMPERATURE: 212°F MAX

SERVICE: ALL EXCEPT SALT WATER.

P-4. V-BUTT JOINT, WELDED ON PLAIN TYPE BACKING RING.

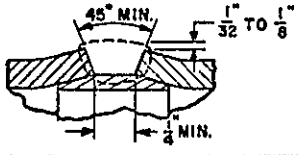


PRESSURE- ALL, 3 1/2" & LARGER.

TEMPERATURE ALL, 3 1/2" & LARGER.

SERVICE- ALL INCLUDING SALT WATER.

P-5. V-BUTT JOINT, WELDED ON FLARED TYPE BACKING RING.



PRESSURE ALL, FOR ALL SIZES

TEMPERATURE- ALL, FOR ALL SIZES.

SERVICE- ALL INCLUDING SALT WATER.

PIPING, FITTING, & BRANCH OUTLET CONNECTIONS

Figure 11.

DESIGN DATA FOR WELDED PIPING

IMPORTANT. NOTES APPLY ONLY TO ILLUSTRATIONS ON WHICH REFERENCED.

NOTE 1 SEE TABLE FOR DIMENSION "L".

NOTE 2. INTERNAL WELD SHALL BE MADE FIRST.

NOTE 3. ROOT OF WELD TO BE CUTOUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

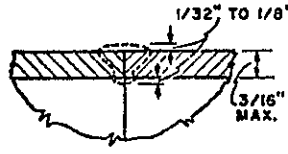
NOTE 4. FOR PIPING 3" & SMALLER INTERNAL REINFORCEMENT SHALL BE MADE FLUSH WITH INSIDE DIAMETER OF PIPING.

NOTE 5 FOR PIPING 2" & SMALLER, NIPPLE DIMENSION "L" SHALL NOT EXCEED 6" MAX.

TABLE FOR DIMENSION "L"
NIPPLE FOR FITTINGS & BRANCH OUTLETS

I.P.S.	L" MAX.
2 1/2"	4"
3"	5"
3 1/2"	6"
4"	7"
5"	8"
6" & UP	10"

P-21. SQUARE BUTT JOINT, WELDED BOTH SIDES.



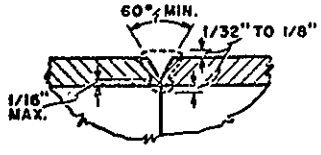
PRESSURE ALL, OVER 2"

TEMPERATURE ALL, OVER 2"

SERVICE ALL INCLUDING SALT WATER.

SEE NOTES 1, 2, 3 & 4.

P-22. V. BUTT JOINT, WELDED BOTH SIDES.



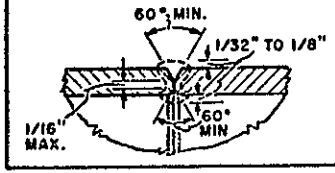
PRESSURE: ALL, OVER 2"

TEMPERATURE: ALL, OVER 2"

SERVICE: ALL INCLUDING SALT WATER.

SEE NOTES 1, 2, 3 & 4

P-23. DOUBLE V. BUTT JOINT, WELDED BOTH SIDES.



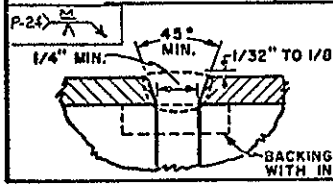
PRESSURE ALL, OVER 2"

TEMPERATURE ALL, OVER 2"

SERVICE: ALL INCLUDING SALT WATER.

SEE NOTES 1, 2, 3 & 4

P-24. V. BUTT JOINT, WELDED ON REMOVABLE BACKING RING.



PRESSURE ALL, FOR ALL SIZES.

TEMPERATURE: ALL, FOR ALL SIZES.

SERVICE: ALL INCLUDING SALT WATER.

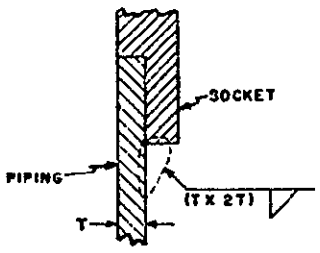
SEE NOTE 5.

FITTING, FLANGE, AND EXTRUDED BRANCH OUTLET CONNECTIONS

Figure 12.

DESIGN DATA FOR WELDED PIPING

P-41. FILLET WELDED SOCKET.

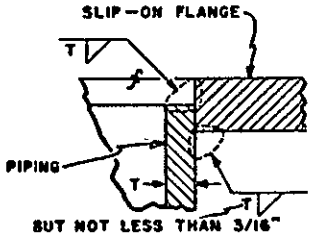


PRESSURE: ALL, 2" & SMALLER

TEMPERATURE: ALL, 2" & SMALLER

SERVICE: ALL EXCEPT SALT WATER

P-42. FILLET WELDED SLIP-ON FLANGE.

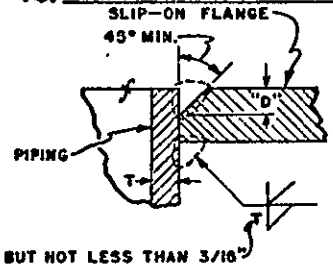


PRESSURE: 150# & LESS FOR ALL SIZES.

TEMPERATURE: 650° F. MAX.

SERVICE: ALL, EXCEPT FERROUS PIPING FOR SALT WATER.

P-43. FILLET & BEVEL WELDED SLIP-ON FLANGE.



LIGHT WEIGHT FLANGES	
"D"	PIPE OR TUBE SIZE
3/16"	THRU 4"
1/4"	5" & 6"
5/16"	7" THRU 10"
3/8"	11" THRU 16"
STANDARD FLANGES	
3/16"	THRU 2"
1/4"	2½" THRU 7"
5/16"	8" THRU 16"

PRESSURE: 150# & LESS FOR ALL SIZES.

TEMPERATURE: 650° F. MAX.

SERVICE: ALL, INCLUDING SALT WATER.

SOCKET & SLIP-ON FLANGE CONNECTIONS

Figure 13.

DESIGN DATA FOR WELDED PIPING

IMPORTANT NOTES APPLY ONLY TO ILLUSTRATION ON WHICH REFERENCED.

NOTE 1. INTERNAL WELD SHALL BE MADE FIRST

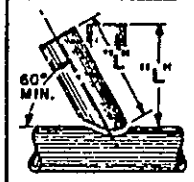
NOTE 2. ROOT OF WELD SHALL BE CUT OUT TO SOUND METAL BEFORE OPPOSITE SIDE OF JOINT IS WELDED.

NOTE 3. FOR PIPING LARGER THAN 2" SEE TABLE FOR DIMENSION "L"

NOTE 4. FOR PIPING 2" & SMALLER, NIPPLE DIMENSION "L" SHALL NOT EXCEED 6" MAX.

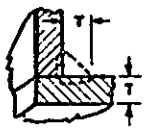
NOTE 5. FOR PIPING 3" & SMALLER, INTERNAL REINFORCEMENT SHALL BE MADE FLUSH WITH INSIDE DIA. OF PIPING.

TABLE FOR DIMENSION "L"
NIPPLE FOR BRANCH OUTLETS



I.P.S.	"L" MAX
2 ½"	4"
3"	5"
3 ½"	6"
4"	7"
5"	8"
6 & UP	10"

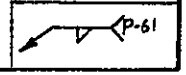
P-61. SQ. BUTT, FILLET WELDED, BRANCH OUTLET CONNECTION.



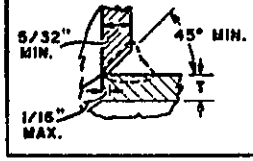
PRESSURE: 50# & LESS, FOR ALL SIZES

TEMPERATURE: 212° F. MAX.

SERVICE: ALL, EXCEPT SALT WATER.



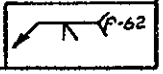
P-62. BEVEL-FILLET REINFORCED, BRANCH OUTLET CONNECTION.



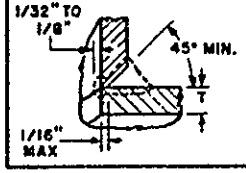
PRESSURE: 150# & LESS

TEMPERATURE: 212° F. MAX.

SERVICE: ALL, EXCEPT SALT WATER.



P-63. BEVEL-NIPPLE OUTLET CONNECTION, WELDED BOTH SIDES.



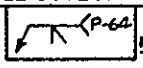
PRESSURE: ALL, OVER 2"

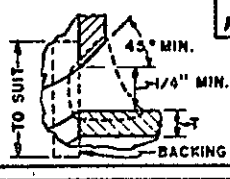
TEMPERATURE: ALL, OVER 2"

SERVICE: ALL, INCLUDING SALT WATER.

SEE NOTES 1,2,3 & 5.

P-64. BEVEL-NIPPLE OUTLET CONNECTION, WELDED TO BACKING RING.





PRESSURE: ALL, FOR ALL SIZES.

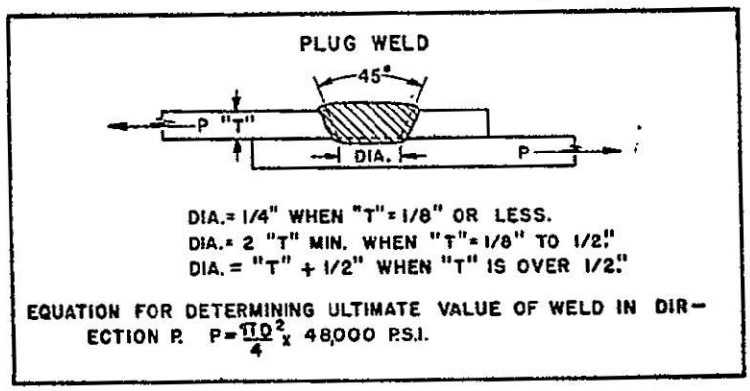
TEMPERATURE: ALL, FOR ALL SIZES.

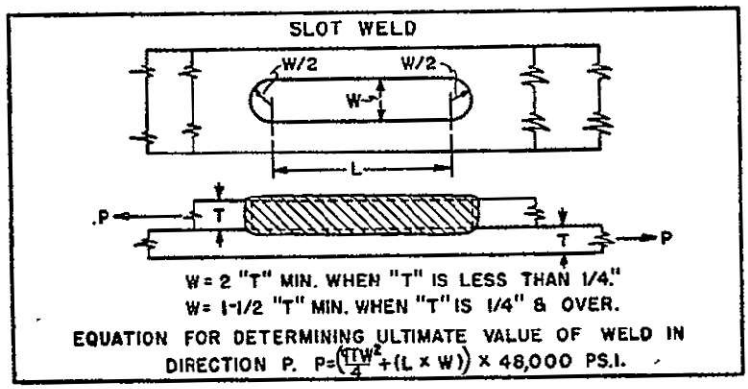
SERVICE: ALL, INCLUDING SALT WATER.

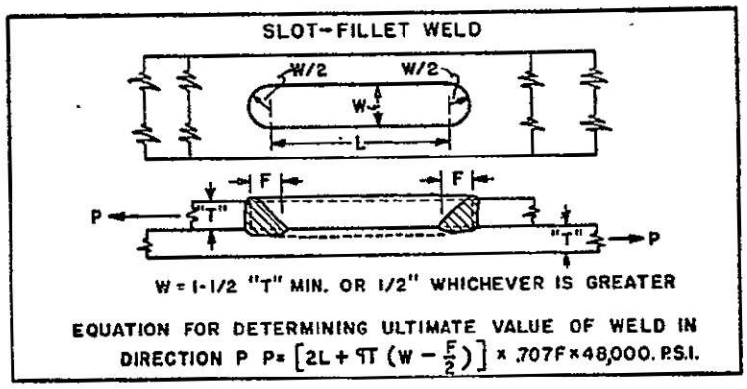
SEE NOTE 4.

BRANCH & NIPPLE OUTLET CONNECTIONS

Figure 14.

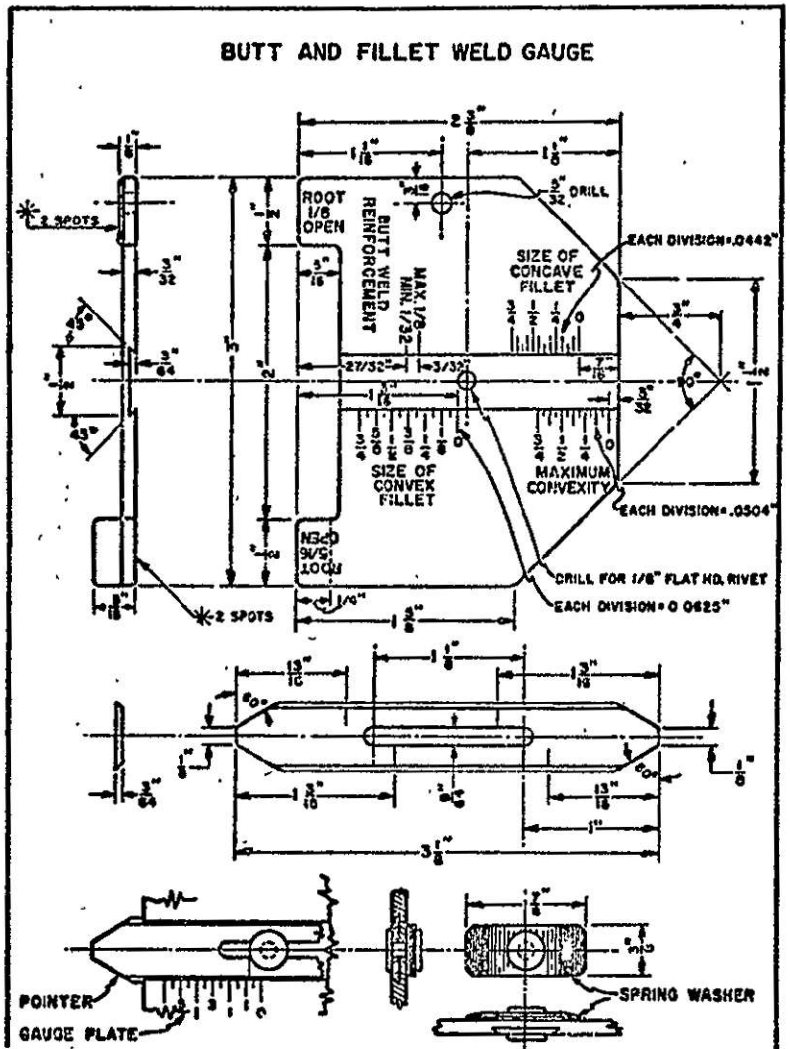






DESIGN DATA FOR SLOT & PLUG WELDS

Figure 15.



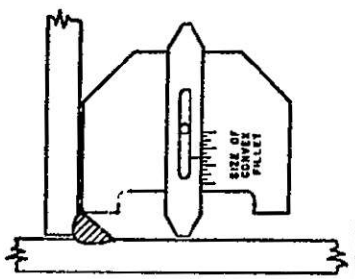
NOTES: 1. All parts of this gauge except washer shall be made of 18-8 stainless steel. Washer shall be made of blue spring steel, cadmium plated.

2. Pointer shall be a "push fit" in gauge plate and shall operate smoothly.

3. All lettering and graduations on gauge shall be made by engraving.

BUTT AND FILLET WELD GAUGE
(INSTRUCTIONS FOR USING)

TO DETERMINE THE SIZE OF A CONVEX FILLET WELD

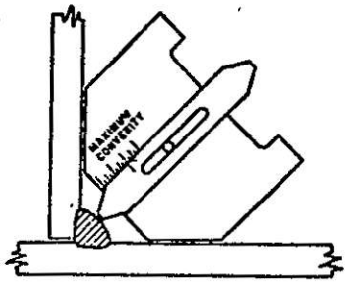


PLACE GAUGE AGAINST THE TOE OF THE SHORTEST LEG OF THE FILLET AND SLIDE POINTER OUT UNTIL IT TOUCHES STRUCTURE AS SHOWN.

READ "SIZE OF CONVEX FILLET" ON FACE OF GAUGE.

SEE GENERAL SPECIFICATIONS FOR INSPECTION OF MATERIAL—APPENDIX VII—WELDING—PART A—SECTION A-I, FIGURE 41.

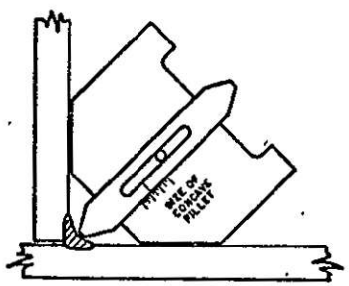
TO CHECK THE PERMISSIBLE TOLERANCE OF CONVEXITY



AFTER THE SIZE OF A CONVEX WELD HAS BEEN DETERMINED, PLACE THE GAUGE AGAINST THE STRUCTURE AND SLIDE POINTER UNTIL IT TOUCHES FACE OF FILLET WELD AS SHOWN.

THE MAXIMUM CONVEXITY SHOULD NOT BE GREATER THAN THAT INDICATED BY "MAXIMUM CONVEXITY" FOR THE SIZE OF FILLET BEING CHECKED.

TO DETERMINE THE SIZE OF A CONCAVE FILLET WELD

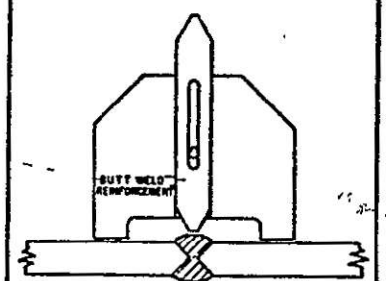


PLACE GAUGE AGAINST STRUCTURE AND SLIDE POINTER OUT UNTIL IT TOUCHES THE FACE OF THE FILLET WELD AS SHOWN.

READ "SIZE OF CONCAVE FILLET" ON FACE OF GAUGE.

SEE GENERAL SPECIFICATIONS FOR INSPECTION OF MATERIAL—APPENDIX VII—WELDING—PART A—SECTION A-I, FIGURE 41.

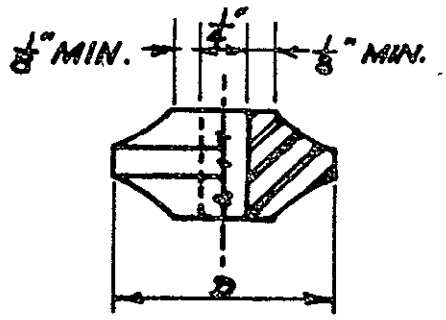
TO CHECK THE PERMISSIBLE TOLERANCE OF REINFORCEMENT



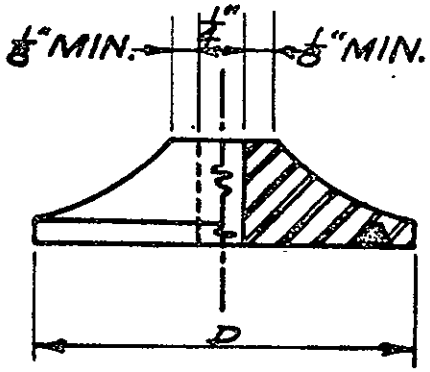
PLACE GAUGE SO THAT REINFORCEMENT WILL COME BETWEEN LEGS OF GAUGE AND SLIDE POINTER OUT UNTIL IT TOUCHES THE FACE OF WELD AS SHOWN.

THE PERMISSIBLE TOLERANCE OF REINFORCEMENT IS THAT INDICATED ON FACE OF GAUGE.

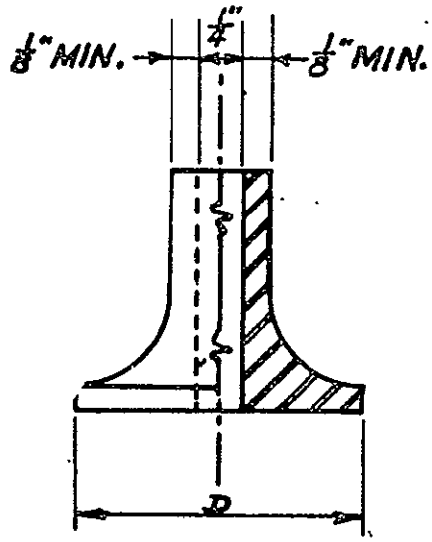
Figure 16



TYPE (a)



TYPE (b)

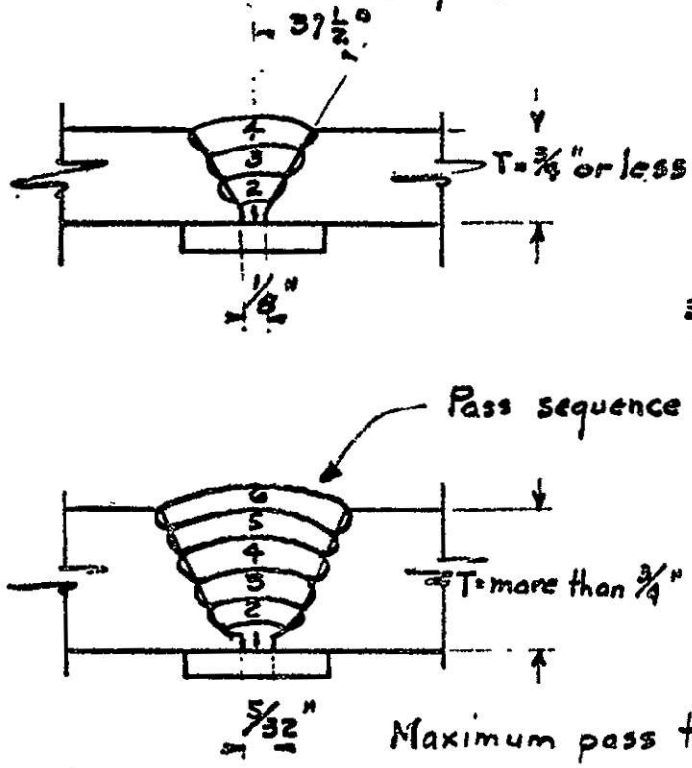


TYPE (c)

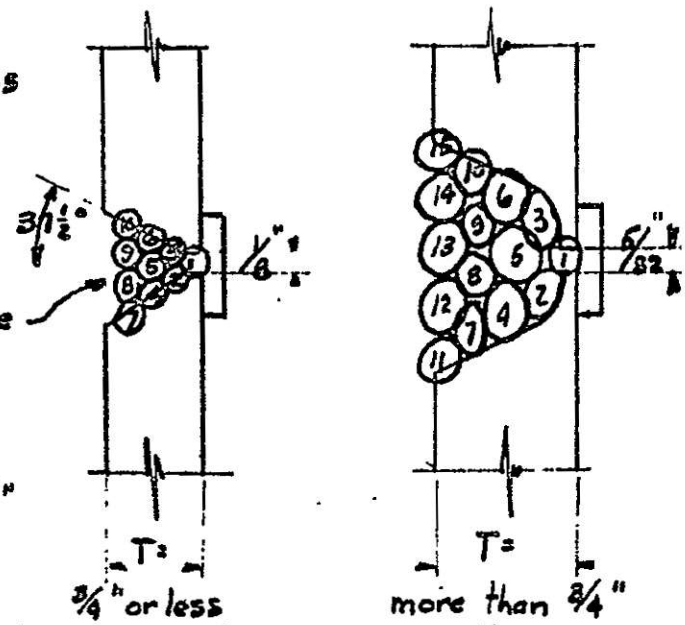
SOME ACCEPTABLE TYPES OF FILLER PLUGS FOR CLOSING HOLES

FIG. 17

Horizontal Pipe



Vertical Pipe



Maximum pass thickness at any point = 5/32"

	Pass Number	
	1	2 or more
Maximum electrode size	1/8"	5/32"
Voltage	22 - 26	22 - 28
Amperage	75 - 125	120 - 170

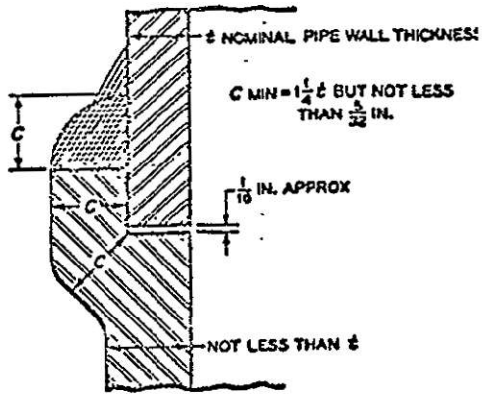
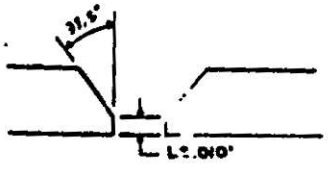
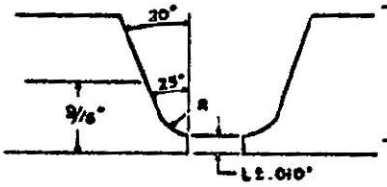


FIG. 7 Minimum Dimensions Required for Socket Weld Fittings

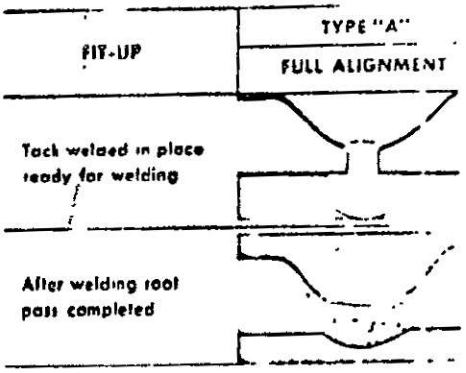
Details of Pipe Welds
Figure 18



under ¼" wall thickness



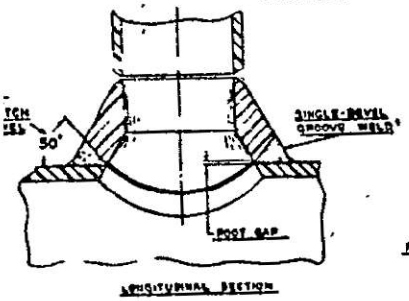
over ¼" wall thickness



TYPE "A"

SIZE	APPLICATION	FIT-UP TOLERANCE
1/8" 5/32"	High Pressure Air piping, and highly controlled applications where rigid fabrication specifications must be met. Requires machining of I.D., bevel and land.	+ 1/32 − 1/32

LONGITUDINAL AND TRANSVERSE SECTIONAL VIEWS OF WELDOLET PROPERLY WELDED[1]



LONGITUDINAL SECTION

FIG 1

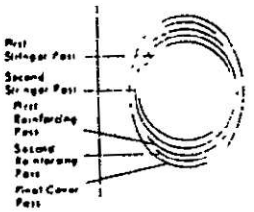
Wide bases or footings of crotch section distribute internal and external stresses.
Gradual changes of section eliminate stress concentration.

TRANSVERSE SECTION

FIG 2

Note the blending of the stub section of the Weldolet to the run pipe to avoid abrupt change in intersection. Throat of weld at this point is designated by the welding bevel.

EXAMPLE OF WELD PASS SEQUENCE



Where the Weldolet saddles on the run pipe the welding bevel provides for a full or complete penetration single-bevel groove weld at match section Fig 1 tapering to a single vee groove weld at the stub section Fig 2.

1 Acceptable proportion for 45° full size and 90° reducing size branch connections ASA B31.1 1955 Code for Pressure Piping.

2 According to American Welding Society Standard A3.0.49 "Welding Terms and Their Definitions" Pps. 13 and 39.

DETAILS OF PIPE WELDS
FIGURE 18

1P

SECTION 7 - BRAZING AND SILVER SOLDERING

7-01. Scope:

(a) Under this section the Contractor shall do all brazing and silver-soldering required on the project.

(b) This section shall apply to operations performed by any trade under these specifications.

7-02. Materials:

(a) Materials not specified on the drawings or in other sections of these specifications shall meet the following minimum standards:

Flux, low melting point silver alloy, brazing	O-F-499
Pipe, brass, seamless, iron-pipe size	WW-P-351
Pipe, copper, seamless	WW-P-377b
Pipe fittings, bronze (screwed), 125-pounds and 250-pounds	WW-P-460
Pipe fittings, bushings, locknuts and plugs, brass or bronze, iron or steel, and aluminum (screwed) 125-pounds and 250-pounds	WW-P-471a
Tubes, condenser and ferrule stock, admiralty	WW-T-756c
Tubes, copper, seamless (general use)	WW-T-775
Tubes, copper, seamless (6,000-psi maximum pressure)	WW-T-797a
Tube, steel, alloy, round, seamless and welded	QQ-T-825
Tube, steel, and open hearth iron, seamless and welded, boiler use	WW-T-731c
Tubing, brass, seamless	WW-T-791
Tubing, copper, seamless (for use with solder-joint or flared-tube fittings)	WW-T-799a
Solder, brazing	QQ-B-650
Solder, silver	QQ-S-561d Class 4

7-03. Workmanship:

(a) General:

(1) Before being permitted to perform any production work, each brazing and silver soldering operator shall have passed the applicable qualification test specified below not earlier than 365 calendar days prior to date of receipt of Notice to Proceed with this contract work. Each operator shall make the joints with the type of equipment and under working conditions that he is to use in production. Where testing is necessary, the Contractor shall direct and supervise the testing of operators and shall bear the expense of conducting these tests. The testing shall be witnessed by a Government Inspector.

(2) The Contractor shall require any operator to repeat these tests when, in the opinion of the Contracting Officer, there is a reasonable doubt of the operator's ability, and any such operator shall not be permitted to resume work until he passes the retest.

(3) All qualification specimens shall be stamped, stenciled, or otherwise indelibly marked with the operator's identification number and other applicable markings sufficient to establish the identity of the specimen.

(4) Operators who are qualified to work with a specific combination of the materials listed below, shall be considered qualified to work with this combination and all other combinations listed below this combination in the same class.

(5) Operators who are to work in the field or outside of the shop shall be required to pass qualification test No. 1. Operators who are qualified under test No. 1 shall be considered qualified under test No. 2.

(6) Operators who are to work in the shop only shall be required to pass qualification test No. 2.

(7) The results of the qualification tests, together with identification data, shall be filed in the office of the NASA Chief Inspector.

(b) Detail Requirements:

(1) Each operator who is to do work at the construction site shall pass qualification tests number 1 as specified below, on the applicable material representing each composition class which he will be required to braze. Operators who are to do work by the face feeding method shall be qualified by that method. Operators who are to do work by the insert method shall be qualified by that method. Operators who are to do work by both face feed and insert methods may be qualified by means of a single specimen, using insert type coupling and face feed type caps. Operators who are to do work on other than standard designed fittings may be required to pass special qualification tests as required by the Contracting Officer.

(c) Materials:

(1) The grade, size and shape of the silver brazing alloy to be used shall conform to the following requirements:

Material	Method	BRAZING ALLOY - QQ-S-561d		
		Class	Size and Shape For Use On	
			Tubing-2" Size & Under	Tubing-2-1/2" Size & Above
"70-30"to"70-30"	Insert	4	As supplied	As supplied
	Face Feed	4	Strip 050"x 1/8" x 20" Wire 1/16" Dia.	Rod 1/8"x 1/8"x 36" Wire 3/32" Dia.
"70-30"to Bronze	Insert	4	As supplied	As supplied
	Face Feed	4	Strip 050"x 1/8"x 20" Wire 1/16" Dia.	Rod 1/8"x 1/8"x 36" Wire 3/32" Dia.
Copper to Bronze	Insert	4	As supplied	As supplied
	Face Feed	4	Strip 050"x 1/8"x 20"	Rod 1/8"x 1/8"x 36"
Copper to Copper	Insert	4	As supplied	As supplied
	Face Feed	4	Strip 050"x 1/8"x 20"	Rod 1/8"x 1/8"x 36"
C.R.S. to C.R.S.	Insert	4	As supplied	As supplied
	Face Feed	4	Wire 1/16" Dia.	Wire 3/32" Dia.
C.R.S. to Steel	Insert	4	As supplied	As supplied
	Face Feed	4	Wire 1/16" Dia.	Wire 3/32" Dia.
Steel to Steel	Insert	4	As supplied	As supplied
	Face Feed	4	Wire 1/16" Dia.	Wire 3/32" Dia.
"70-30" to Steel	Insert	4	As supplied	As supplied
	Face Feed	4	Wire 1/16" Dia.	Wire 3/32" Dia.
Copper to Steel	Insert	4	As supplied	As supplied
	Face Feed	4	Wire 1/16" Dia.	Wire 3/32" Dia.

(2) The combinations of fittings and tubing which are to be used are classified as follows:

Non-Ferrous Class		Ferrous Class	
Tubing	Fittings	Tubing	Fittings
Copper-Nickel Alloy(70:30)	Copper-Nickel Alloy(70:30)	Corrosion Resisting Steel	Corrosion Resistant Steel
Copper-Nickel Alloy(70:30)	Bronze	Corrosion Resisting Steel	Steel
Copper	Bronze	Steel	Steel
Copper	Copper	Copper-Nickel Alloy(70:30)	Steel
		Copper	Steel

(d) Qualification Test Number 1:

(1) Qualification test No. 1 shall consist of silver brazing a specimen prepared in accordance with the requirements of Figures 1 and 2, which, after brazing, shall be subjected to a visual examination of the exterior of the assembly, a hydrostatic test, and a visual examination of the interior of the assembly.

(2) Exterior examination of the joints shall show a complete ring of filler metal between the tube and the outer end of the fitting. Surfaces of the specimen shall be free of globules of filler metal. Fillets, if present, shall be concave, and of the minimum practicable dimension.

(3) Hydrostatic test shall be held for 10-minutes at the pressure indicated below without showing any weeps at the joint.

Tubing	Test Pressure
	(Pounds per sq. inch)
Copper Nickel Alloy (70:30)	1600
Copper	1000
Corrosion Resisting Steel	2700
Steel	3000

(4) If the specimen passes the hydrostatic test, it shall be saw-cut as indicated in Figure 2 and visual examination of the joints shall show complete penetration of the filler metal throughout at least 75-percent of the circumference of the fittings. The presence of at least a metallic stain of silver at the end of the tubing shall be considered as evidence of penetration of the alloy. The stain resulting from the penetration of the flux shall not be considered as penetration. The metallic stain may be differentiated from the flux by its color, which is grayish white. The flux stain is glassy in appearance.

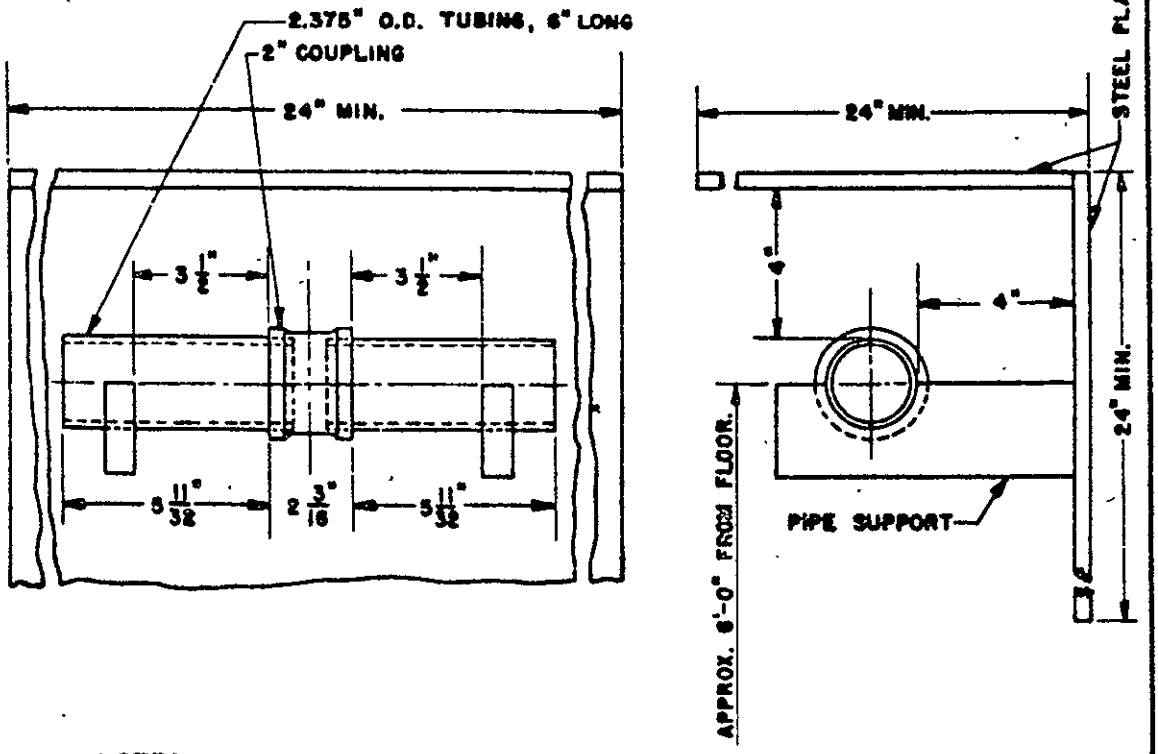
(e) Qualification Test Number 2:

(1) Qualification test No. 2 shall consist of silver brazing a specimen prepared in accordance with the requirements of Figures 3 and 4, which, after brazing, shall be subjected to a visual examination of the exterior of the assembly, a hydrostatic test, and a visual examination of the interior of the assembly.

(2) Exterior examination of the joints shall show a complete ring of filler metal between the tube and the outer end of the fitting. Surfaces of the specimen shall be free of globules of filler metal. Fillets, if present, shall be concave, and of the minimum practicable dimension.

(3) Hydrostatic test shall be the same as for test No. 1.

(4) If the specimen passes the hydrostatic test it shall be cut as indicated in Figure 4 and visual examination of the joints shall show complete penetration of the filler metal throughout at least 75-percent of the circumference of the fittings. (See 7.03(d)(4) above.)



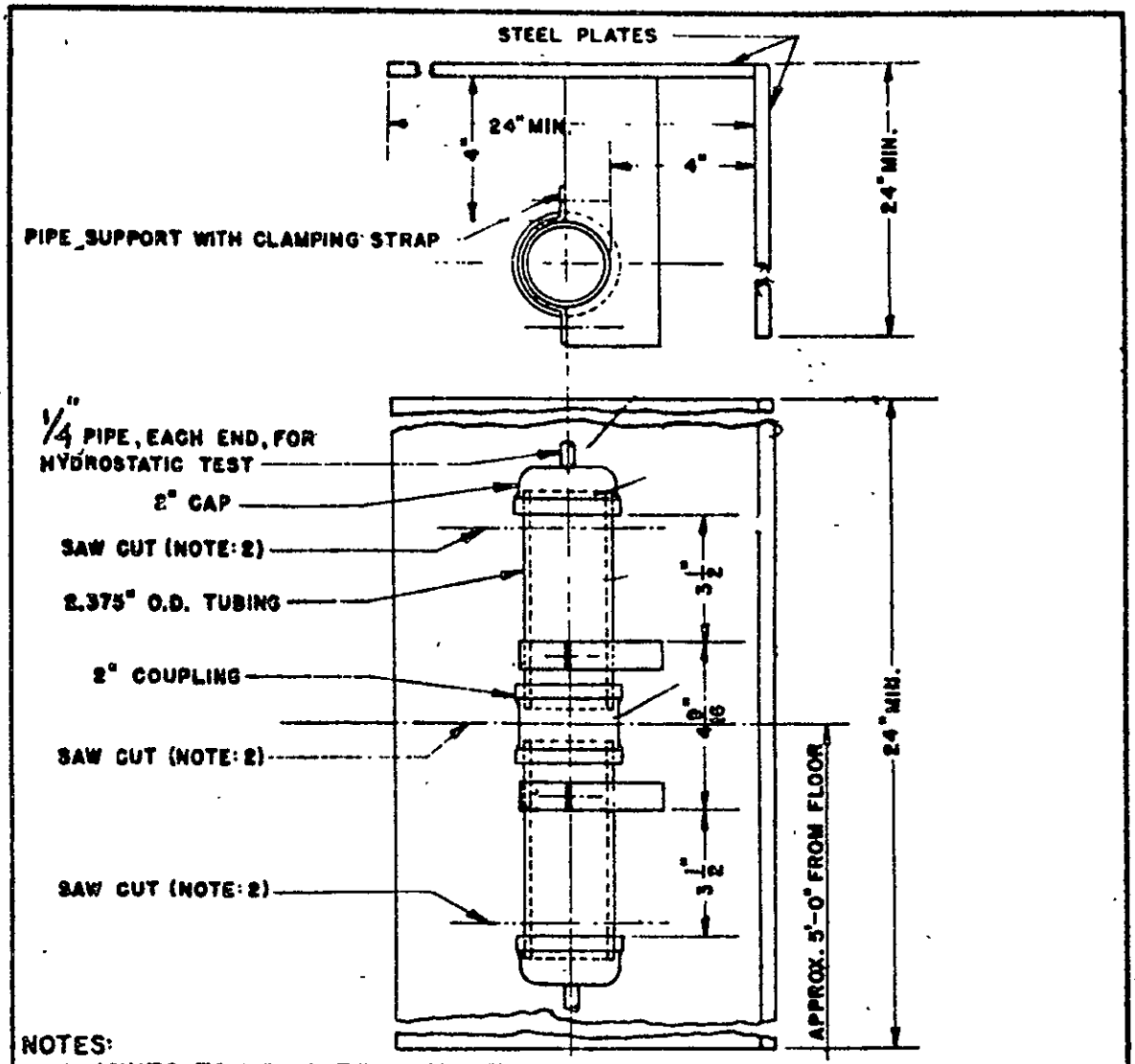
NOTES:

1. JOINTS TO BE BRAZED IN HORIZONTAL POSITION WITHOUT ROTATING THE ASSEMBLY.

2. AFTER JOINTS HAVE BEEN BRAZED IN THE POSITION SHOWN ABOVE SPECIMEN SHALL BE COMPLETED AS SHOWN IN FIGURE 2.

FIG. 1.

QUALIFICATION TEST NO. 1.

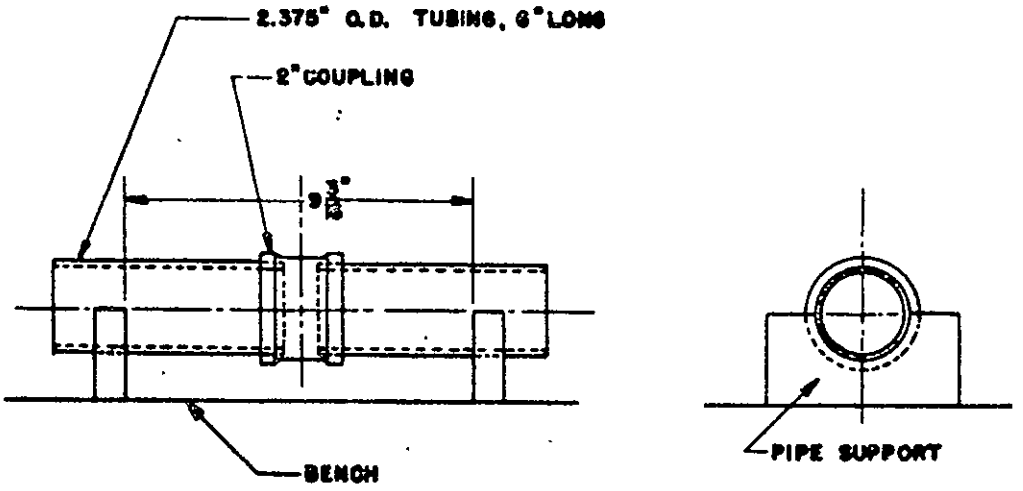


NOTES:

1. JOINTS TO BE BRAZED IN VERTICAL POSITION WITHOUT ROTATING ASSEMBLY.
2. TUBING TO BE CUT FOR VISUAL INSPECTION AFTER HYDROSTATIC TEST.

FIG. 2.

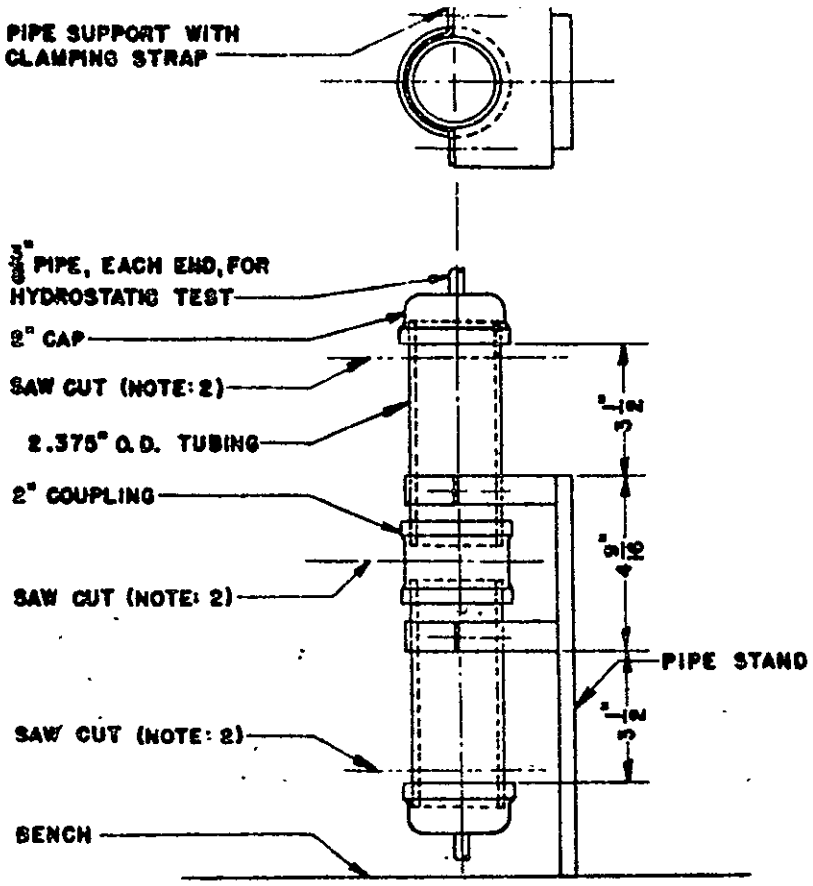
QUALIFICATION TEST NO. 1.



NOTES:

1. JOINTS TO BE BRAZED IN HORIZONTAL POSITION WITHOUT ROTATING THE ASSEMBLY.
2. AFTER JOINTS HAVE BEEN BRAZED IN THE POSITION SHOWN ABOVE SPECIMEN SHALL BE COMPLETED AS SHOWN IN FIGURE 4.

FIG. 3.	QUALIFICATION TEST NO. 2.	



NOTES:

1. JOINTS TO BE BRAZED IN VERTICAL POSITION WITHOUT ROTATING THE ASSEMBLY.
2. TUBING TO BE CUT FOR VISUAL INSPECTION AFTER HYDROSTATIC TEST.

FIG. 4.	QUALIFICATION TEST NO. 2.	

NASA-Langley, 1963