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NOTE: MIL-STD-1362 has been redesignated as a Test Method Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

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(See 6.2)

DEPARTMENT OF DEFENSE
TEST METHOD

PROCEDURES FOR STEAM PURITY MEASUREMENT NAVAL PROPULSION BOILERS

AMSC N/A FSC 4410

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DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Procedures for Steam Purity Measurement Naval Propulsion Boilers

1. This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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CONTENTS

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CONTENTS - Continued

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1. SCOPE

1.1 Purpose. This standard covers the procedure for the determination of steam purity in Naval propulsion boilers.

1.2 Application. The procedure shall be used during acceptance trials of new boilers to determine that the quality assurance requirements for steam purity conform to MIL-B-18381. The procedure shall also be used whenever a Naval propulsion boiler is tested for steam purity.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications. Unless otherwise specified, the following specifications of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-C-17557 - Coolers, Fluid, Industrial, Naval Shipboard (Sample Water Coolers).
MIL-B-18381 - Boilers, Steam, High Pressure, Naval Ship Propulsion.

2.1.2 Other Government publication. The following other Government publication forms a part of this standard to the extent specified herein.

PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
S9086-GX-STM-020/CH 220 V2 - Boiler Water/Feedwater Test and Treatment.

(Copies of specifications and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
D 1066 - Standard Practice for Sampling Steam. (DoD adopted)
D 1125 - Standard Test Methods for Electrical Conductivity and Resistivity of Water. (DoD adopted)
D 1428 - Standard Test Methods for Sodium and Potassium in Water and Water-Formed Deposits in Flame Photometry. (DoD adopted)
D 2791 - Standard Methods for Continuous Determination of Sodium in Water.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
Power Test Code
PTC 19.11 - Water and Steam in the Power Cycle (Purity and Quality, Leak Detection and Measurement).

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.)

AMERICAN IRON AND STEEL INSTITUTE (AISI)
Steel Products Manual - Stainless and Heat Resisting Steels.

(Application for copies should be addressed to the American Iron and Steel Institute, 150 East 42nd Street, New York, NY 10017.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS (Not applicable)

4. GENERAL REQUIREMENTS

4.1 Steam purity. The purity of the steam from the steam drum shall be determined by comparing the sodium content of the steam to that of the boiler water. The steam sodium shall be measured in a continuous, isokinetic sample flow using an electrode specific to the sodium ion. The boiler water sodium shall be derived from the boiler water electrical conductivity.

4.2 Test requirements. In order to meet the requirements of MIL-B-18381, the boiler water total dissolved solids level shall be raised to 1100 ± 50 parts per million (p/m) using disodium phosphate (anhydrous). The sodium levels are monitored at 40, 70, 100, and 120 percent boiler load, and over the water level range given in the applicable boiler specification.

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4.3 Prerequisite. Prior to steam purity testing, the boiler shall be inspected by a NAVSEA-approved boiler inspector to ensure that the installation of the steam drum internals is satisfactory and in accordance with the NAVSEA-approved configuration.

5. DETAILED REQUIREMENTS

5.1 Boiler loading determination. The boiler loading determination is dependent upon the boiler full power oil rate, the number of fuel burners in use, and the burner sprayer plate in use.

5.1.1 Fuel oil pressure. The fuel oil pressure, pound per square inch (lb/in^2), required to obtain the selected boiler loading shall be determined with the aid of table I. The design boiler full power fuel oil rate, pounds per hour (lb/hr), is found in the applicable boiler technical manual.

TABLE I. Fuel oil pressure for selected boiler load.

A	B	C	D	E	F
Full power fuel oil rate (lb/hr)	No. of burners in use	(A/B) Rate per burner (lb/hr)	Boiler load (percent)	(C*D/100%) Rate per burner at load (lb/hr)	Fuel oil pressure (lb/in^2)
			40		
			70		
			100		
			120		

5.2 Water level determination. The steam drum water level shall be determined from the direct reading water gauge normally used for water level control during manual operation. An inch scale, indicating levels above and below normal, shall be attached to the water gauge. The normal water level, with respect to the steam drum center line, shall be accurately determined from the boiler manufacturer's drawings.

5.3 Boiler water chemistry adjustment. The level of total dissolved solids in the boiler water shall be increased to 1100 ± 50 p/m with disodium phosphate to meet the requirements of MIL-B-18381. This level of dissolved solids corresponds to a boiler water conductivity of 1500 ± 100 micromhos per centimeter (mho/cm). Prior to the start of the disodium phosphate addition, the boiler shall be steaming with stable water chemistry and no indications of contamination in accordance with NAVSEA S9086-GX-STM-020/CH 220 V2. The boiler load shall be between 40 and 70 percent to assure rapid circulation of the disodium phosphate.

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5.3.1 Disodium phosphate addition. The boiler water volume for chemical treatment and the procedures for sampling and chemical addition shall be in accordance with NAVSEA S9086-GX-STM-020/CH 220 V2. The addition of disodium phosphate shall be discontinued if difficulty is found in raising the conductivity because of excessive carryover, chemical hideout, or other problems. The procedure for increasing the total dissolved solids level shall be as follows:

(a) Sample the boiler water and test for conductivity in accordance with 5.7.1.
(b) Calculate the amount of disodium phosphate required using:

$$W = \frac{(C' - C)}{k} \times V/1000$$

Where:

W = ounces of anhydrous disodium phosphate
C' = desired conductivity, µmho/cm
C = measured conductivity, µmho/cm
k = factor giving the increase in conductivity caused by 1 ounce disodium phosphate per 1000 gallons water (10 µmho/cm increase per ounce per 1000 gallons)
V = boiler water volume, gallons

(c) Add the calculated amount of disodium phosphate or 80 ounces, whichever is less, to the boiler.
(d) Obtain another sample of the boiler water 30 minutes after the addition and test for conductivity.
(e) Repeat steps (b) through (d) until the conductivity is 1500 ± 100 µmho/cm.

5.3.2 Maintenance of boiler water chemistry. All adjustments of boiler water conditions shall be performed and the conditions stabilized prior to the actual test run. Excess dissolved solids shall be controlled by surface blowdown. Once the conductivity is within the specified range, it is not necessary that this range be maintained throughout the test. However, if contamination occurs the tests shall be secured and the contamination corrected. The boiler water conditions shall be readjusted prior to starting the test again. The boiler water chloride shall be tested hourly during the test to monitor for contamination.

5.4 Saturated steam sample equipment installation. The steam sampling equipment and its installation described herein approach an isokinetic steam sample flow which results in representative sampling of the saturated steam. The equipment and installation shall be in accordance with ASTM D 1066 and ASME PTC 19.11 using a multiport sample nozzle. An overall flow diagram is shown on figure 1.

5.4.1 Steam sample nozzle. The design of the steam sample nozzle is dependent on the steam line size, the rate of steam flow, and the sample flow. A four-port nozzle shall be used for steam lines with an inside diameter (id) of 2 to 6 inches. A six-port nozzle shall be used for steam lines with an id greater than 6 inches. The location of the ports in the two nozzle types shall be as shown on figure 2.

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5.4.1.1 Port diameter. The diameter of the ports for a sample flow at full power of 66 pounds per hour (lb/hr) (500 milliliters per minute (mL/min)) shall be calculated as follows:

$$d = \sqrt{\frac{fD^2}{NF}}$$

Where:

d = diameter of the ports, inch
f = sample flow at full power, lb/hr
D = id of the steam line, inches
N = number of ports in the nozzle
F = steam flow at full power, lb/hr

5.4.1.2 Minimum port diameter. The minimum port diameter shall be 0.0625 inch. If the calculated diameter is less than 0.0625 inch, a port size of 0.0625 inch shall be used, and the sample flow shall be increased. The new boiler full power sample flow shall be calculated by using the formula in 5.4.1.1 and multiplying by 7.57 to convert lb/hr to mL/min. If this sample flow is greater than the sample cooler capacity, the number of ports may be reduced and the required sample flow recalculated.

5.4.1.3 Construction and installation. The nozzle shall be fabricated from AISI type 321 or 347 corrosion resistant tubing, 0.500 inch outside diameter (od) by 0.065 inch wall. The nozzle shall be constructed as shown on figures 2 and 3 and installed as shown on figure 4. The controlling dimensions, A and G (see figure 2), shall be obtained for each specific installation as shown on figure 4. The longitudinal mark shall provide a positioning reference to ensure that the ports of the installed nozzle face directly upstream. A transverse witness mark shall be inscribed on the nozzle at a reference point for laterally positioning the nozzle such that the center line of the nozzle ports will coincide with the center line of the steam line. The nozzle shall be located in the saturated steam line within one to four steam line diameters of the steam drum. Alternate locations shall be approved by NAVSEA.

5.4.2 Sample line. The sample line shall be of AISI type 316L corrosion resistant tubing, 1/4 inch od by 0.035 inch wall. The total length of sample line shall be as short as practical. The sample line shall have a gradual slope down from the sample nozzle to its connection with the cooler. The sample line shall be installed in such a manner as to prevent accidental contact with the hot line. Signs shall be placed to indicate the danger of burns. The length of the line from the sample cooler to the sodium analyzer shall be as short as possible.

5.4.3 Sample cooler. The sample cooler shall be a boiler water sample cooler, type I of MIL-C-17557. The cooler shall be mounted vertically at a height such that there is a downward flow to the sodium analyzer. The sample shall enter the top of the cooler and exit the bottom. The coolant shall be fresh water, if a sufficient quantity is available. Sea water shall be the alternate coolant. The coolant flow shall be counter to the sample flow.

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There shall be no valves or restrictions in the coolant exit line. There shall be a valved bypass line installed after the cooler before the inlet to the sodium analyzer. The cooler and the analyzer shall be secured in such a manner that the ship's movement will not shift them.

5.4.4 Sample flow meter. A sample flow meter may be installed in the sample line immediately after the sample cooler. An alternate sample flow measurement may be performed by measuring the sample by-pass flow in a graduated cylinder for a time and adding the bypass flow rate to the sodium analyzer flow rate.

5.5 Steam sample flow rate. The sample flow shall be isokinetic in order to obtain a representative steam condensate sample. Table II gives the sample flow rates for the port diameter calculated in accordance with 5.4.1 that will approach the isokinetic condition for the various boiler loads. If the sample flow has been calculated in accordance with 5.4.1.2, the required total sample flow to approach the isokinetic condition shall be determined by multiplying the calculated total sample flow at full power by the percent boiler load. The sample flow rate to the analyzer is set by the instrument manufacturer. The desired total sample flow shall be obtained by setting the flow to the analyzer and then adjusting the bypass flow rate.

TABLE II. Sample flow rate requirements.

Boiler load (percent)	Total sample flow rate (mL/min)
40	200
70	350
100	500
120	600

5.6 Monitoring steam condensate for sodium. The sodium concentration of the continuously flowing steam condensate sample shall be monitored and determined by means of a process sodium ion selective electrode in accordance with ASTM D 2791 and the instrument instructions. Sodium ion electrodes require that the sample pH be greater than 10 to prevent hydrogen ion interference. The method for increasing the pH of the sample depends on the instrument in use. The pH of the sample shall be increased according to the instrument manufacturer's instructions.

5.6.1 Procedure.

5.6.1.1 Laboratory check out. Prior to shipboard installation, the process sodium ion analyzer shall be pre-checked in the laboratory in accordance with the manufacturer's instructions. The pre-check shall include conditioning of the electrodes, calibration and standardization of the meter, and flushing of the analyzer with demineralized water.

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5.6.1.2 Initiation of sample flow. With the boiler steaming at normal water level and at 50 percent or less of boiler load, a flow of steam condensate sample shall be started as follows:

(a) Secure the sample inlet valve to the analyzer.
(b) Initiate a full flow of cooling water through the sample cooler.
(c) Open the valve controlling the sample line bypass.
(d) Open the sample line root valve.
(e) Flush the sample line and cooler until the water flashes to steam or a full flow has been established for 5 minutes. If a flowmeter is installed after the cooler, it shall be bypassed or removed prior to the steam flush.
(f) Reduce the flow with the bypass valve to about 200 mL/min and flush for 1 hour.
(g) With the analyzer bypass valve open, crack open the sample inlet valve to the analyzer and adjust to the required flow rate. The sample temperature shall be maintained at less than 100 degrees Fahrenheit (°F) throughout the test. The electrode is damaged by high sample temperatures.
(h) Check the pH of the sample at the analyzer drain to assure the sample pH is at least 10.
(i) Flush the analyzer for at least 1 hour.
(j) Secure the sample flow to the instrument and calibrate the instrument with 1.00 p/m sodium standard solution.
(k) Restart the flow of sample to the analyzer.
(l) Recalibrate the instrument at least every 8 hours or whenever erratic readings are obtained.
(m) If the meter goes off scale because of excessive carryover, the actual level may be determined by recalibrating with a higher standard.
(n) Upon completion of the test, flush the instrument with demineralized water.

5.7 Determination of sodium in boiler water. The sodium concentration of a boiler water sample shall be calculated from the electrical conductivity of the boiler water using the conversion factor specified in table III. The boiler water sodium may also be determined by specific ion electrode in accordance with ASTM D 2791.

TABLE III. Factor to convert boiler water conductivity to p/m sodium.

Conductivity (µmho/cm)	Factor (p/m per µmho/cm)
0-499	0.18
500-999	0.20
1000 or more	0.22

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5.7.1 Boiler water electrical conductivity. The electrical conductivity in µmho/cm of each boiler water sample shall be measured in accordance with ASTM D 1125.

5.8 General procedure. The general procedure for the actual test runs shall be initiated after the following conditions have been obtained:

(a) Boiler water agenda conditions.
(b) Steam condensate sodium monitoring equipment stabilized and calibrated.

The completed run will consume 6 to 9 hours once the foregoing conditions have been established. It will require 2 to 3 hours after the boiler is on the line to establish conditions. The total time will be 8 to 12 hours for the complete test. Three to 4 hours are required to install the portable items of the sampling and monitoring equipment prior to the actual trial.

5.8.1 Test procedure. The steam purity is measured at boiler loads of 40, 70, 100 and 120 percent and at water levels of minus 3 inches, normal and plus 3 inches. The test shall be conducted at each boiler load as follows:

(a) Assure a flow of coolant to the boiler water sample cooler. Flush the cooler at a high sampling rate for 5 minutes or until the sample flashes to steam. Reduce the sample flow and maintain a flow throughout the test. The boiler water sample temperature shall be less than 100°F.
(b) Establish the boiler load.
(c) Establish the water level at minus 3 inches.
(d) Note the time that the boiler load and water level are obtained, then wait 5 minutes for the boiler chemistry to stabilize.
(e) Collect a 1 quart boiler water sample.
(f) As soon as the boiler water sample is obtained, read and record the steam sodium.
(g) Test the boiler water sample for conductivity and record the result. Determine the boiler water sodium using the appropriate factor and calculate the percent steam purity, record these results.
(h) Repeat steps (d) through (g) at normal and plus 3 inches water level.
(i) Reduce the water level to normal prior to changing load.

5.9 Confirmation of shipboard test results. A sample of steam condensate and of boiler water shall be reserved at each boiler rate at the normal water level. In addition, three samples of steam condensate and one of boiler water shall be retained whenever the level of sodium in the steam condensate sample indicates that the steam purity is less than the requirement. The samples shall be obtained in new polyethylene bottles. The bottles shall be prepared for use by filling with reagent grade water and allowing to soak for 24 hours. The samples shall be held for analysis at a laboratory for sodium concentration by flame photometry in accordance with ASTM D 1428. The laboratory test results shall serve to confirm the shipboard results.

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5.10 Recording of results. A record of the results shall be maintained. The chronological maintenance of results shall be logged as shown on figure 5.

5.11 Boiler care after tests. Upon completion of the tests, the boiler shall be secured, cooled, dumped and flushed with feedwater, including the superheater. Upon completion of the flushing, the boiler shall be freshly filled, treated, and then lit off. If it is not practical to do the foregoing, the steaming boiler shall be given a series of surface blowdowns in accordance with NAVSEA S9086-GX-STM-020/CH 220 V2. The superheater shall be flushed with feedwater as soon as practical.

6. NOTES

6.1 Subject term (key word) listing.

Boiler loading determination
Boiler water chemistry adjustment
Fuel oil pressure
Steam purity
Water level determination

6.2 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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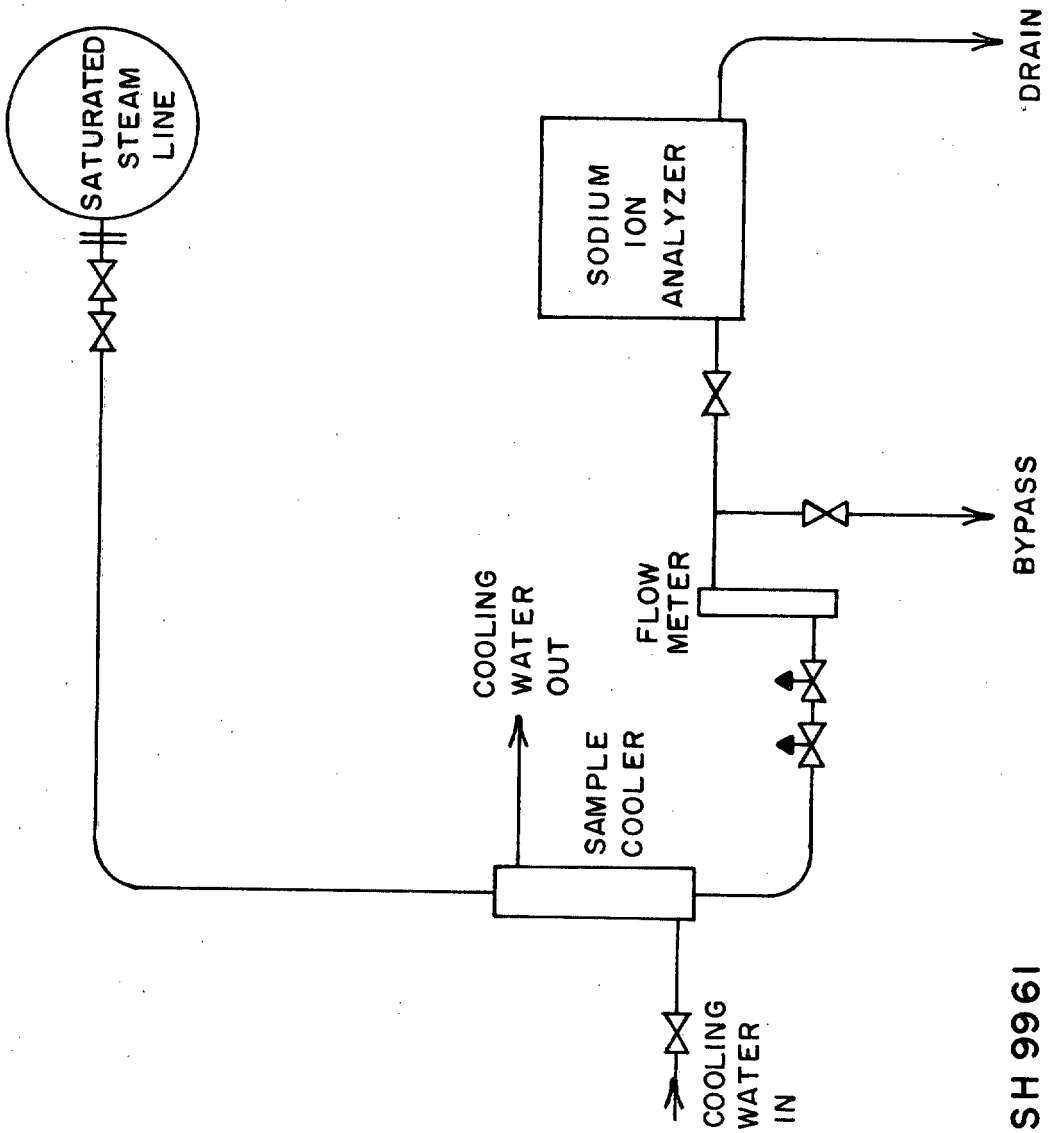

FIGURE 1. Flow diagram.

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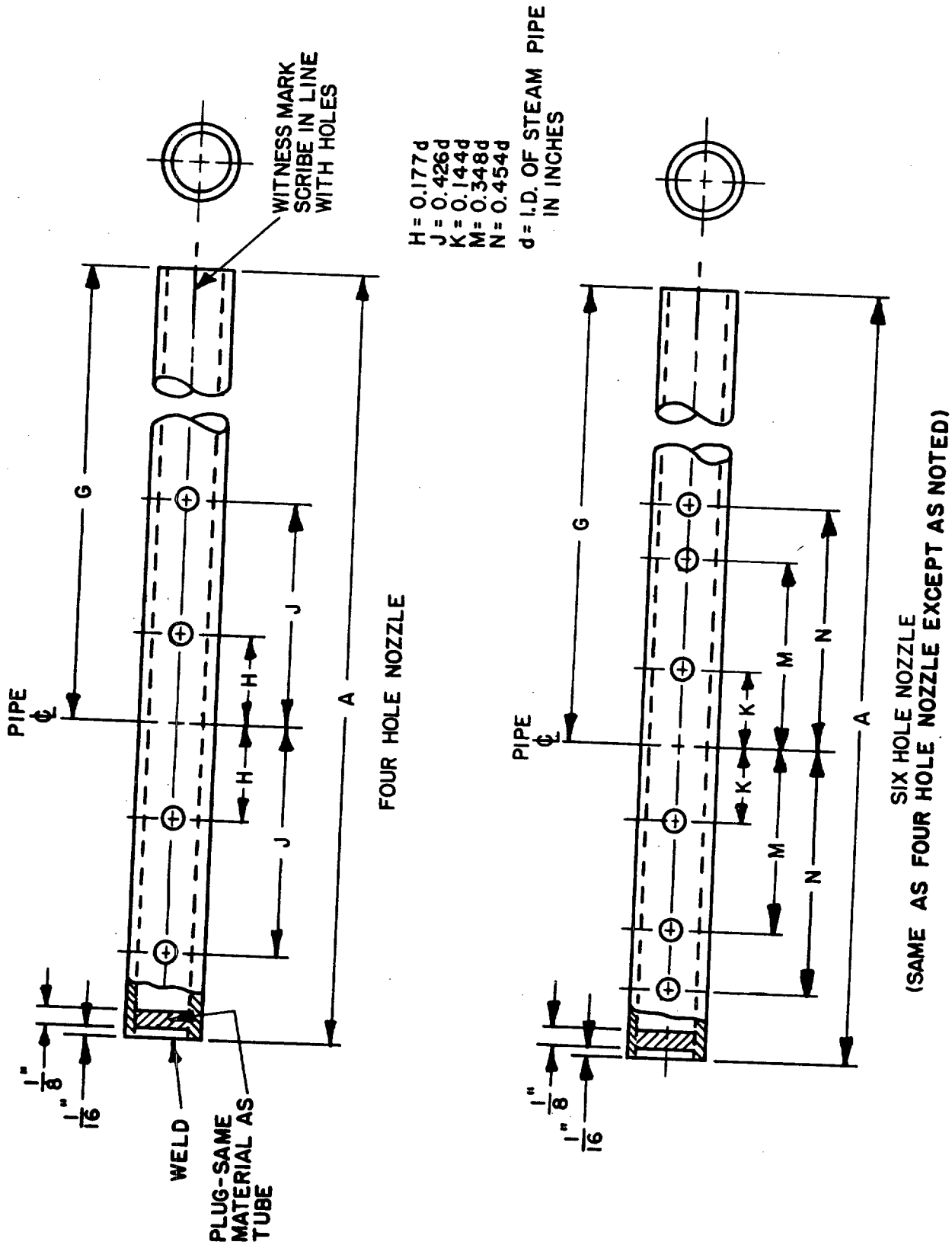
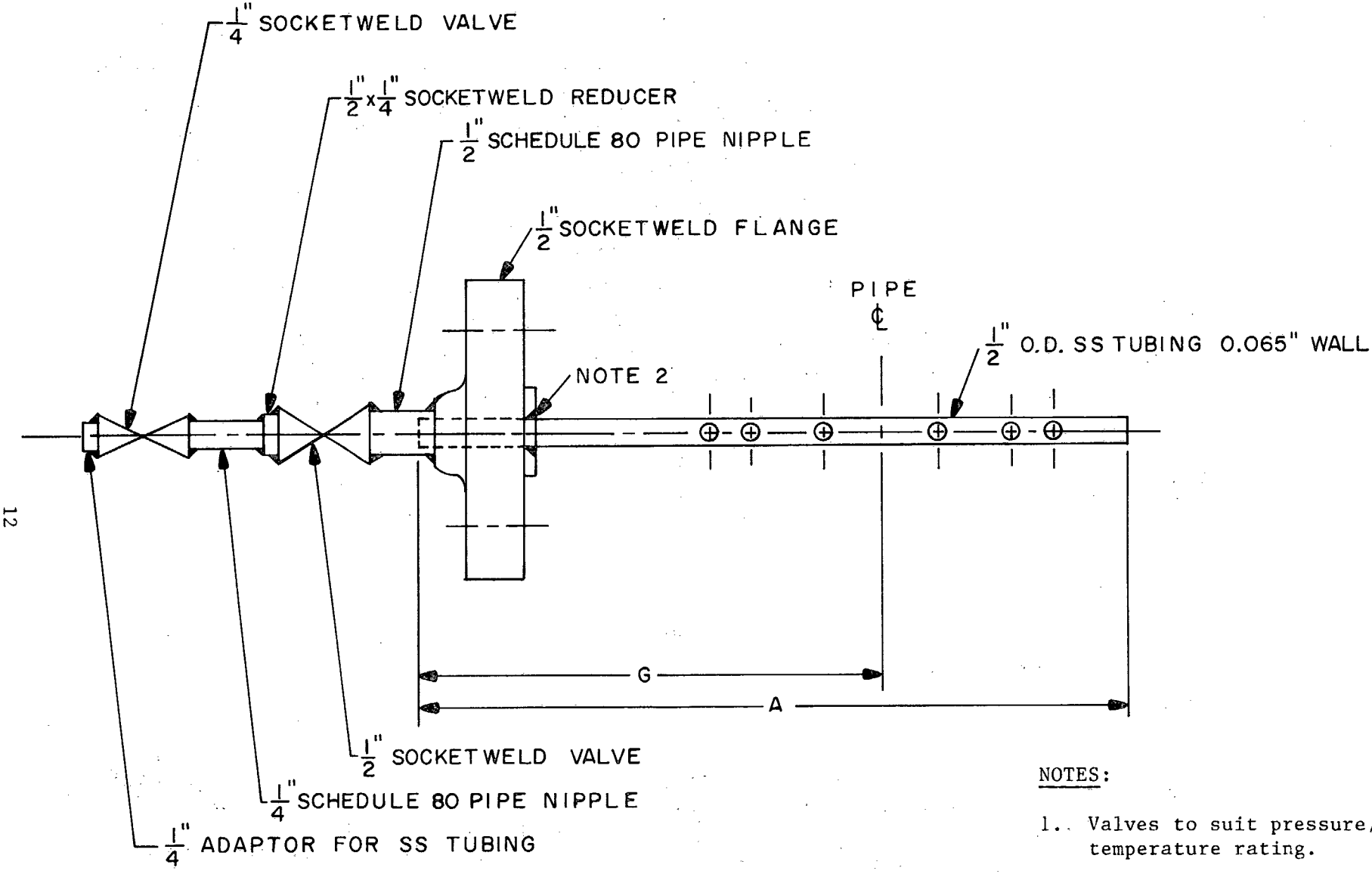


FIGURE 2. Nozzle details.

SH 9962



SH 9963

FIGURE 3. Nozzle assembly.

NOTES:

1. Valves to suit pressure/temperature rating.
2. Bevel the raised face of the flange, weld in the nozzle, machine the raised face to remove excess weld and obtain a flat surface.

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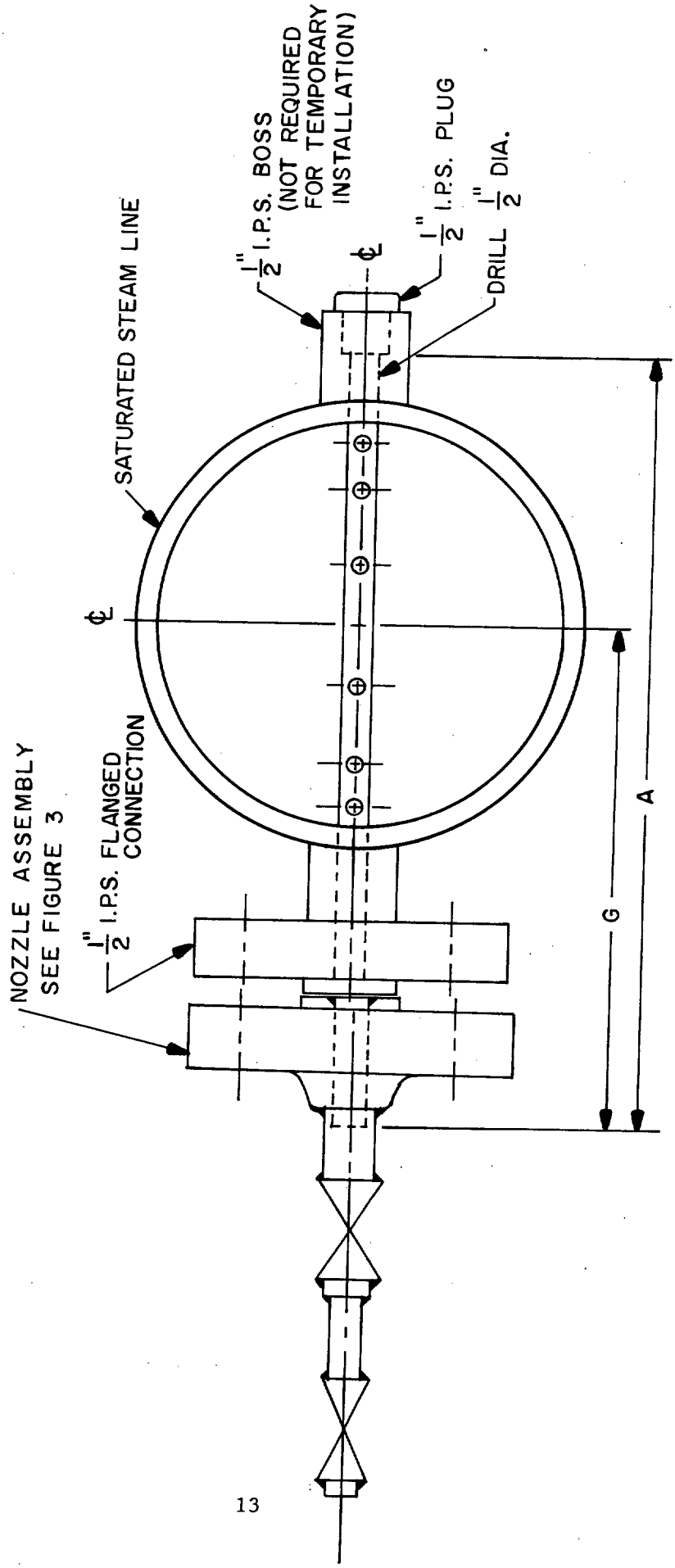

FIGURE 4. Nozzle installation.

SH 9964

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STEAM PURITY TEST DATA

USE _____ BOILER NO. _____ DATE(S) _____

CONVERSION FACTOR: F = p/m SODIUM/μmho/cm

Time	Boiler load, percent	Water level	Boiler water			Steam sodium, p/m	Steam purity, percent
			Chloride, epm	Conductivity, μmho/cm	Sodium p/m		

FIGURE 5. Form for steam purity test data.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-1362A (SH)	PROCEDURES FOR STEAM PURITY MEASUREMENT NAVAL PROPULSION BOILETS

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

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- ☐ USER
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5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
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