CERTIFICATE

By Authority Of
THE UNITED STATES OF AMERICA
Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

Document Name: ANSI N14.1: Packaging of Uranium Hexafluoride for Transport

CFR Section(s): 49 CFR 173.420(a)(1)

Standards Body: American National Standards Institute

APPROVED

Official Incorporator:
THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

ANSI®
N14.1-2001
Revision of ANSI N14.1-1995

American National Standard
for Nuclear Materials –

Uranium Hexafluoride – Packaging for Transport

Secretariat

Institute of Nuclear Materials Management

Approved February 1, 2001

American National Standards Institute, Inc.

American National Standard

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgement of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

American National Standards Institute, Inc.
11 West 42nd Street, New York, NY 10036

Printed in the United States of America

Contents

Foreword (This foreword is not part of American National Standard ANSI N14.1-2001.)

This standard was developed under the procedures of the American National Standards Institute by Subcommittee N14-8 (later changed to N14-1) of Accredited Standards Committee N14 on Transportation of Fissile and Radioactive Materials. The secretariat of N14 is presently held by the Institute of Nuclear Materials Management. At the time this standard was being developed, it was held by the American Insurance Association.

The N14 Committee has the following scope:

Standards for the packaging and transportation of fissile and radioactive materials but not including movement or handling during processing and manufacturing operations.

Packaging of uranium hexafluoride (UF_6) for transport is an essential part of a safe and economical nuclear industry. This standard presents information on UF_6 cylinders, valves, protective packages, and shipping.

The packaging and transport of UF_6 is subject to regulation by government agencies having jurisdiction over packaging and transport. This standard does not take precedence over applicable U.S. Nuclear Regulatory Commission (NRC), U.S. Department of Energy (DOE), U.S. Department of Transportation (DOT), or other governmental regulations.

This standard covers only those standard cylinders that meet all of the acceptance criteria for UF_6 handling and is recommended for all new cylinder construction. Cylinders currently in service and not in accordance with this standard are acceptable for continued use, provided that they are inspected, tested, and maintained so as to comply with the intent of this standard and are used within their original design limitations.

It should be noted that some technical regulatory material has been restated in this standard. It was determined by the subcommittee that this is appropriate and convenient and would assist the user of the standard. For more detailed information, the user is encouraged to use the appropriate regulatory document.

Suggestions for improvement of this standard will be welcome. They should be sent to the Institute of Nuclear Materials Management, 60 Revere Drive, Suite 500, Northbrook, IL 60062.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Transportation of Fissile and Radioactive Materials, N14. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time this revision of the standard was approved, the N14 Committee had the following members:

John W. Arendt, Chair
Rick Rawl, Vice Chair
L. Paul Crawford, Secretary

Organization Represented	*Name of Representative*
American Insurance Service Group	S.M. Fastman
American Nuclear Society	D.M. Dawson
American Society for Testing and Materials	Alexander M. Perritt
Atomic Industrial Committee on Transportation	H. Walchli
Center for Devices and Radiological Health	E. Tupin
	C.P. Froom (Alt.)

Organization Represented	*Name of Representative*
Conference of Radiation Control	William Pitchford
Contract Traffic Managers Association	Max D. Ruska
	Randy Walker(Alt.)
Factory Mutual System	P.H. Dobson
Health Physics Society	Kevin Nelson
Institute of Nuclear Materials Management	J.W. Arendt
International Association of Chiefs of Police	R.H. Sostkowki
International Atomic Energy Agency	H.A. Selling
Military Traffic Management Command	C.E. Radford
	H.H. Yeager (Alt.)
U.S. Coast Guard	Emmanuel Pfersich
U.S. Department of Energy	M.E. Wangler
	Mona F. Williams(Alt.)
U.S. Department of Transportation	Richard Boyle
U.S. Environmental Protection Agency	J. Scott Telofski
U.S. Nuclear Regulatory Commission	C.R. Chappell
	E.P. Easton (Alt.)
	D. Westman (Alt.)

Individual Members

M. E. Bennett
Dr. E. Bentz
R. Best
G. Burbidge
A. E. Castagnacci
C. A. Caves
John M. Cece
J. R. Clark
A. Colburn
Daren Condrey
William M. Crawford
M. Elizabeth Darrough
P. E. Eggers
Phillip Eyre
F. Falci
Fred Ferate
L. D. Fischer
C. Fisher
D. Fisher
R. E. Glass
Donna Goertzen
P. C. Gregory
A. W. Grella
R. M. Grenier
R. T. Haelsig
Cynthia Hilton
J. Hummer
L. Jackson
B. Jody, Jr.
G. Blair Johnson
Jim R. Johnston
Kelvin J. Kelkenberg
T. A. Kerr
C. Kilian
Mike Krzaniak
W. H. Lake
R. Lesco
R. E. Luna
Ella McNeil
Manfred Neven
R. I. Newman
D. J. Nolan
Dr. J. J. Oras (Alt.)
R. W. Peterson
Paul J. Pomares
R. Pope
R. R. Rawl
P. C. Rieke
R. Ryan
F. A. Seiler
A. Spiegelman
W. C. Stoddart
Richard A. Swedberg
D. C. Thomas
R. H. Towell
G. A. Townes
P. Turula
R. Vaughn
J. M. Viebrock
B. H. Wakeman
S. F. Wawrzaszek
Alan Zimmer

Subcommittee N14.1 on Packaging of Uranium Hexafluoride, which developed this revision, had the following members:

R. I. Reynolds, Chair
J. H. Alderson
W. M. Arnold
R. E. Stein
R. Boelens
R. D. Clark
R. H. Dyer
T. Davis
R. B. Pope
N. A. Kent
N. L. Osgood
R. H. Towell
P. C. Rieke
R. Boyle
B. Jody, Jr.
G. McRae
R. Michelhaugh
D. R. Polland
W. A. Pryor
R. R. Rawl
T. Rummel
J. Stewart
J. B. Turner
M. E. Wangler
D. J. Warriner
W. M. Crawford

American National Standard for Nuclear Materials –

Uranium Hexafluoride – Packaging for Transport

1 Scope and Purpose

1.1 Scope

This standard provides criteria for packaging of uranium hexafluoride (UF_6) for transport. It includes specific information on design and fabrication requirements for the procurement of new UF_6 packagings. This standard also defines the requirements for in-service inspections, cleanliness, and maintenance for packagings in service. Packagings currently in service and not specifically defined in this standard are acceptable for use, provided they are used within their original design limitations and are inspected, tested, and maintained so as to comply with the intent of this standard. Also included are cylinder loadings, shipping details, and requirements for valves and valve protectors.

1.2 Purpose

This standard is intended to provide guidance and criteria for shipment of UF_6. It will assist in providing for compatibility of UF_6 packaging among different users within the nuclear industry.

2 Normative references

The following standards and references contain provisions, which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards and references are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards and references indicated below.

ANSI N14.30-1992, *Nuclear Materials- Semi-Trailers Employed in the Highway Transport of Weight-Concentrated Radioactive Loads- Design, Fabrication, and Maintenance.*

ANSI/ASME *Boiler and Pressure Vessel Code 1998*

ANSI/ASME B1.1-1989, *Unified Inch Screw Threads (UN and UNR Thread Form)*[*]

ANSI/ASME B1.5-1997, *Acme Screw Threads*

ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch)*

ANSI/ASME B16.11-1996, *Forged Steel Fittings, Socket-Welding and Threaded*

ANSI/ASME NQA-1-2000, *Quality Assurance Program Requirements for Nuclear Facilities*

ANSI/AWS A5.1-1991 (R1999), *Specification for Covered Carbon Steel Arc Welding Electrodes*

ANSI/AWS A5.8-1992, *Specification for Filler Metals for Brazing*

ANSI/AWS A5.14-97, *Specification for Nickel and Nickel Alloy Bare Welding Electrodes and Rods*

ANSI/AWS A5.17-97, *Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding*

---

* The 1989 edition of this standard is available in archive format. Although the standard was administratively withdrawn it has been submitted as a new standard and is currently undergoing the approval process.

ANSI/AWS A5.18-1993, *Specification for Carbon Steel Filler Metals for Gas-Shielded Arc Welding*

ANSI/AWS D1.1-1998, *Structural Welding Code-Steel*

ANSI/CGA V-1-1994, *Compressed Gas Cylinder Valve Outlet and Inlet Connections*

ASTM A20/A20M-97, *Specification for General Requirements for Steel Plates for Pressure Vessels*

ASTM A36-2000, *Specifications for Structural Steel*[1)]

ASTM A53-B-98, *Specification for Black and Hot-Dipped, Zinc Coated Welded and Seamless Steel Pipe*

ASTM A105/A105M-98, *Specification for Carbon Steel Forgings for Piping Components*[1)]

ASTM A108-95, *Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality*[1)]

ASTM A131-94, *Specification for Structural Steel for Ships*[1)]

ASME SA-240, *Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels*

ASTM A285-90, *Specification for Carbon Steel Low and Intermediate-Tensile Strength Pressure Vessel Plates*[1)]

ASTM A370-97, *Methods and Definitions for Mechanical Testing of Steel Products*[1)]

ASTM A516-90, *Specification for Carbon Steel Pressure Vessel Plates for Moderate-and Lower-Temperature Service*[1)]

ASTM A570-98, *Specification for Hot-Rolled Carbon Steel Sheets and Strip, Structural Quality*[1)]

ASTM A575-96, *Specification for Merchant Quality Hot-Rolled Carbon Steel Bars*[1)]

ASTM B32-96, *Specification for Solder Metal*[1)]

ASTM B127-98, *Specification for Nickel-Copper Alloy Plate, Sheet, and Strip*[1)]

ASTM 150-98, *Specification for Aluminum Bronze Rod, Bar, and Shapes*[1)]

ASTM 160-93, *Specification for Nickel Rod and Bar*[1)]

ASTM 161-93, *Specification for Nickel Seamless Pipe and Tube*[1)]

ASTM 162-93, *Specification for Nickel Plate, Sheet, and Strip*[1)]

ASTM B164-98, *Specification for Nickel-Copper Alloy Rod and Bar*[1)]

ASTM B165-93, *Specification for Nickel-Copper Alloy Seamless Pipe and Tube*[1)]

ASTM B249-94, *Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes*[1)]

ASTM B366-98, *Specification for Factory-Made Wrought Nickel and Nickel-Alloy Welding Fittings*[1)]

AWS B2.1-98, *Welding Procedure and Performance Qualification* [2)]

[1] Standards for protection against radiation. Title 10, code of Federal Regulations, Part 20, Washington D.C.: Government Printing Office, January 1, 1999.[3)]

[1)] Available from ASTM 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

[2)] Available from American Welding Society, 550 N. LeJeune Rd., Miami, FL 33135.

[3)] Available from Superintendent of Documents, P.O> Box 371954, Pittsburgh, PA 15250

[2] Special nuclear materials. Title 10, code of Federal Regulations, Part 70, Washington D.C.: Government Printing Office, January 1, 1993.[3)]

[3] Packaging and transportation of radioactive material. Title 10, Code of Federal Regulation, Part 71, Washington D.C.: Government Printing Office, January 1, 1999.[3)]

[4] Radioactive materials; definitions. Title 49, Code of Federal Regulation, Part 173.403, Washington D.C.: Government Printing Office, October 1, 1998. [3)]

[5] Regulations applying to shippers. Title 49, Code of Federal Regulations, Part 173, Washington D.C.: Government Printing Office, October 1, 1998[3)]

[6] Shipper container specifications. Title 49, Code of Federal Regulations, Part 178, Washington D.C.: Government Printing Office, October 1, 1999[3)]

[7] Regulations for the safe transport of radioactive materials. Vienna: International Atomic Energy Agency, No. ST-1, 1996. [4)]

[8] Fissile materials, general requirements. Title 49, CFR, Part 173.451, Washington D.C.: Government Printing Office, October 1, 1998.[3)]

[9] Certificate of compliance, USA/6553/AF. Nuclear Regulatory Commission, Washington, D.C. 20545, latest revision.

[10] IAEA Competent Authority Certification for Fissile Radioactive Materials, Package Design Certificate USA/0411/AF, Revision 4, September 24, 1993.[5)]

[11] The UF_6 Manual Good Handling Practices for Uranium Hexafluoride, January 1999. United States Enrichment Corporation[6)]

[12] Directory of certificate of compliance for radioactive material packages, NUREG-0383.[7)]

[13] DOT 7A Type A Certification document, Test and Evaluation Document for DOT 7A Type A Packaging, DOE/RL-96-57.[7)]

3 Definitions

The definitions below are of a restricted nature for the purpose of this standard.

Terms defined in Title 10, code of Federal Regulations (CFR), Parts 20 [1],[8)] 70 [2], and 71[3], and in Title 49, CFR, Part 173.403[4] have the same meaning when used in this standard.

3.1 Becquerel: The SI unit of radioactivity. One becquerel = 1 disintegration per second.

3.2 Clean cylinder: A cylinder that has been previously used and has been cleaned to remove residual quantities of uranium and other contaminants.

3.3 Curie (Ci): The special unit of radioactivity. One curie equals 3.7x10(10) disintegrations per second = 3.7x10(10) becquerels (Bq). (A method for calculating the activity level in cylinders of UF_6 is provided in Appendix C.)

3.4 Cylinder tare weight: The weight of the clean cylinder including the valve(s) and plug(s) at an internal pressure of 6 psia or less.

[4)] Available from Bernan Associates, UNIPUB, Inc., 46 11-F Assembly Dr., Lanham, MD 20706-4391.

[5)] Available from U.S. Department of Transportation, Washington, DC 20590.

[6)] Available from the United States Enrichment Corporation, Two Democracy Center, 6903 Rockledge Dr., Bethesda, MD 20817, Attention: Vice President of Production.

[7)] Available from The Department of Energy, Packaging Certification Staff, 19901 Germantown Rd., Germantown, MD 20874. Telephone 301-353-5394.

[8)] Numbers in brackets refer to corresponding numbers in clause 2, Normative references.

3.5 DOT specification container: A container whose design has been specified by the U.S. Department of Transportation (DOT) in 49 CFR Part 173 and whose use is limited by the terms and conditions of the specification and provisions in 49 CFR Part 178. DOT Specification containers are authorized for use by NRC licensees by general license provisions in 10 CFR Part 71.

3.6 Empty cylinder: A cylinder containing a residual amount of UF_6 and nonvolatile reaction products of uranium (heel) in quantities less than those specified in 8.1.2. This definition should not be confused with the category of empty packaging used in 49 CFR 173.428.

3.7 Fabricator: One who manufactures, repairs, or modifies a packaging.

3.8 Fissile material: UF_6 containing uranium that has more uranium-235 than the naturally occurring distribution of uranium isotopes. Note : UF_6 that is fissile material but is enriched to a maximum of one weight percent U-235, or is limited to a maximum 15 grams of fissile radionuclides (U-233, U-235, Pu-238, Pu239, and Pu-241) per package is considered fissile excepted material.

3.9 Fissile excepted material: UF_6 containing uranium that is enriched to a maximum of 1 weight percent U-235, with a total plutonium and uranium-233 content up to 1 percent of the mass of uranium-235, or UF_6 that is limited to a maximum of 15 grams of fissile radionuclides (U-233, U-235, Pu-238, Pu-239, and Pu-241) per package..

3.10 Heel: A residual amount of UF_6 and nonvolatile reaction products of uranium.

3.11 Low-specific-activity material: Unirradiated UF_6 that is classified as non-fissile or fissile excepted material.

3.12 MDMT: Minimum design metal temperature to meet ASME Code requirements.

3.13 MAWP: Maximum allowable working pressure permitted by ASME Code requirements.

3.14 New cylinder: An unused cylinder that has been cleaned to remove fabrication debris.

3.15 Non-fissile material: Unirradiated UF_6 composed of natural or depleted uranium.

3.16 Normal-form radioactive material: A radioactive material that has not been demonstrated to qualify as special-form radioactive material. UF_6 is classified as a normal-form material.

3.17 Owner: The individual, agency, contractor, company, or corporation that carries title to, or will carry title to, the packaging during its use.

3.18 Packaging: A container to be used for the transport of UF_6, including the outer protective packaging when utilized.

3.19 Outer protective packaging (overpack): Outer packaging used for fire and impact protection for cylinders containing fissile UF_6.

3.20 Qualified inspector: An individual who has passed the written examination sponsored by the National Board of Boiler and Pressure Vessel Inspectors, and holds a current certificate of competency, or other competent inspector designated by the cylinder owner's inspection authority.

3.21 Shall, should, and may: The word "shall" denotes a requirement, the word "should" denotes a recommendation, and the word "may" denotes permission, neither a requirement nor a recommendation. Conformance with this standard means that all operations are performed in accordance with its requirements but not necessarily with its recommendations.

3.22 Shipper: One who offers the package of UF_6 for transport.

3.23 Transport index: (for domestic shipments in the United States to meet DOT requirements). The dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:

1) For non-fissile or fissile excepted packages, the number is determined by multiplying the maximum radiation level in milliSieverts per hour at one meter (3.3 feet) from the external surface of the package by 100, which is equivalent to the maximum radiation level in millirem per hour at one meter (3.3 feet); or

2) For fissile material packages, the number is determined by multiplying the maximum radiation level in milliSieverts per hour at one meter (3.3 feet) from the external surface of the package by 100, which is equivalent to the maximum radiation level in millirem per hour at one meter (3.3 feet); or, for criticality control purposes, the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever number is larger.

3.24 Type-A quantity of radioactive material: A quantity of radioactive material, the aggregate radioactivity of which does not exceed A2 for normal form radioactive material, where A2 is given in table A-1 of 10 CFR Part 71 or in 49 CFR 173.435.

3.25 Type-B quantity of radioactive material: A quantity of radioactive material greater than that of a type-A quantity.

3.26 Unirradiated UF_6: UF_6 that has not been recycled from prior use in a nuclear power reactor.

4 Quality Assurance

The licensee-user shall have a documented quality assurance (QA) program that meets the applicable criteria of the Code of Federal Regulations, Subpart H, Title 10, CFR, Part 71 [3] or ANSI/ASME NQA-1-1994, at least for those quality-related activities associated with procurement, maintenance, repair, and use of the cylinder and the protective packaging. The licensee-user shall ensure that all parties meet the applicable QA requirements in Subpart H, Title 10, CFR, Part 71 to ensure that the product or service supplied meets the requirements of this standard. Certain quality-related activities (design, fabrication, inspection, testing, modification, and the like) may be satisfied by obtaining certificates from cylinder and package suppliers (fabricators) stating that their activities were conducted in accordance with a QA program that meets the requirements of the Code of Federal Regulations Subpart H, Title 10, CFR, Part 71.

5 Packaging Requirements

5.1 General Packaging Requirements

UF_6 is packaged for transport in cylinders meeting the inspection, testing, and in-service requirements of this standard and is shipped:

1) In bare cylinders that incorporate a feature, such as a unique seal that, while intact, will be evidence that the package has not been illicitly opened, and that qualify as "strong, tight packages" for low specific activity material transport in accordance with 49 CFR 173.427; or

2) In bare cylinders that incorporate a feature, such as a unique seal that, while intact, will be evidence that the package has not been illicitly opened, and that qualify as DOT Specification 7A packages; or

3) In cylinders in outer protective packaging that meet DOT Specification 20 PF or 21 PF or are authorized by NRC or DOE certificates of compliance or IAEA certificate of competent authority. The outside of each package shall incorporate a feature, such as a unique seal that, while intact, will be evidence that the package has not been illicitly opened.

5.2 Packaging for Low Specific Activity UF_6.

5.2.1 Non-exclusive Use Shipments

Non-fissile and fissile-excepted UF_6 (i.e., natural and depleted uranium, and uranium enriched to a maximum 1.0 weight percent U-235), when transported in less than truckload quanities (non-

exclusive use), shall be packaged in accordance with 49 CFR 173.415(a). The packaging shall meet the additional requirements of 49 CFR 173.420, Uranium Hexafluoride (fissile, fissile excepted and non-fissile). Cylinders covered by this standard qualify as DOT Specification 7A packagings. Test results and certification information for these cylinders may be found in report Test and Evaluation Document for DOT Specification 7A Type A Packaging, DOE/RL-96-57.

5.2.2 Exclusive Use Shipments

Non-fissile and fissile-excepted UF_6 are excepted from specification packaging requirements when transported as exclusive use and meeting the other requirements of 49 CFR 173.427(b)(3). The UF_6 shall be packaged in cylinders covered by this standard. These cylinders satisfy the strong, tight packaging requirements of 49 CFR 173.427(b)(3). The packaging shall meet the additional requirements of 49 CFR 173.420, Uranium Hexafluoride (fissile, fissile excepted and non-fissile).

5.3 Packaging for UF_6 Enriched Greater than 1.0 wt% 235U

UF_6 enriched to greater than 1.0 wt% shall be packaged in accordance with the DOT regulations of Title 49 CFR Parts 173 [5] and 178 [6] or in other NRC or DOE certified package designs. These packages consist of an inner UF_6 cylinder, excluding Type 48G and 48H, which are limited to 1.0 wt% assay or less, plus an outer protective package, except for "heels," which may be transported in bare cylinders. The acceptable amount of "heel" (residual uranium) in bare cylinders is defined in 8.1.2.

5.4 Physical Condition of UF_6

UF_6 shall be shipped only after it has solidified and the vapor pressure of the cylinder has been measured to be below 1 atm, and the measured purity of the cylinder contents is within specification. (It should be noted that solid UF_6 is a heavy crystalline mass that is readily sublimed at room temperature. "Cracking" sounds sometimes emanate from large UF_6 cylinders as the ambient temperature changes.)

5.5 Standard UF_6 Cylinders

Standard UF_6 cylinder data are shown in Table 1. Table 1 provides requirements for cylinders currently in service. Cylinders listed in Table 1 that are not specifically defined in this standard are acceptable for continued use, provided they are inspected, tested, and maintained in accordance with the intent of this standard and the requirements stated in Table 1.

6 Cylinders

6.1 Design and Fabrication

6.1.1 General

Design, fabrication, inspection, testing, and cleaning of UF_6 cylinders shall be as specified in 6.4 through 6.15. Design conditions and materials specified therein for pressure containing portions of the cylinders shall be adhered to. The –40 degree F minimum transport temperature specified in the standard for some cylinders is to assure impact resistance of the shell and heads in the event of an accident in a cold climate in order to comply with the transport regulatory requirements. Since the pressure in the cylinder is below atmospheric at subzero temperatures, the minimum transport temperature is not a requirement of the ANSI/ASME Boiler and Pressure Vessel Code.

The manufacturer shall be notified concerning quality assurance and his/her participation therein.

In order to minimize points of leakage, it is desirable to install only one valve and one plug. However, if additional valves or plugs are deemed necessary by the purchaser, they may be provided if they are installed in accordance with the requirements specified in 6.10.6, 6.11.6, 6.12.6, and 6.13.6. Cylinder, valve, and valve protector details are given in Figures 1 through 13.

Table 1 - Standard UF_6 Cylinder Data

Model Number	Nominal Diameter (in)	Material of Construction	Minimum Volume Ft^3	Approximate Tare Weight (Without Valve Protector) (lb)	Maximum Enrichment Wt% ^{235}U	Maximum Fill Lmit (lb UF_6)
1S	1.5	Nickel or Nickel-copper alloy[a]	0.0053	1.75	100	1.0[b]
2S	3.5	Nickel or Nickel-copper alloy[a]	0.0254	4.2	100	4.9[b]
5A	5	Nickel or Nickel-copper alloy[a]	0.284	55	100	54.9[b]
5B	5	Nickel	0.284	55	100	54.9[b]
8A	8	Nickel or Nickel-copper alloy[a]	1.319	120	12.5	255[b]
12A[c]	12	Nickel	2.38	185	5	460[b]
12B	12	Nickel or Nickel-copper alloy[a]	2.38	185	5	460[b]
30B[d]	30	Steel	26	1400	5[e]	5020[b]
48A[f]	48	Steel	108.9	4500	4.5[e]	21030[b]
48X	48	Steel	108.9	4500	4.5[e]	21030[b]
48F[f]	48	Steel	140	5200	4.5[e]	27030[b]
48Y	48	Steel	142.7	5200	4.5[e]	27560[b]
48T[g]	48	Steel	107.2	2450	1	20700[b]
48O[g]	48	Steel	135	2650	1	26070[h]
48OM[g] Allied	48	Steel	140	3050	1	27030[h]
48OM[g]	48	Steel	135	2650	1	26070[h]
48H[g]	48	Steel	140	3250	1	27030[h]
48HX[g] 48G	48	Steel	139	2650	1	26840[h]

[a] For example, Monel or the equivalent.

[b] Fill limits are based on 250°F maximum UF_6 temperature (203.3 lb UF_6 per ft^3), certified minimum internal volumes for all cylinders, and a minimum cylinder ullage of 5%. These operating limits apply to UF_6 with a minimum purity of 99.5%. More restrictive measures are required if additional impurities are present. This maximum temperature shall not be exceeded. It should be noted that initial cylinder heating may result in localized pressures above a normal UF_6 vapor pressure. This may be evidenced by an audible bumping similar to a water hammer.

[c] This cylinder is presently in service. New procurement should be model 12B.

[d] This cylinder replaces the Model-30A cylinder, which has a fill limit of 4950 pounds.

[e] These maximum enrichments require moderation control equivalent to a UF_6 purity of 99.5%. Without moderation control the maximum permissible enrichment is 1.0 wt% ^{235}U.

[f] Cylinder 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

[g] This cylinder is similar to design to the 48G in that their design conditions are based on 100 psig at 235°F.

[h] Fill limits are based on 250°F maximum UF_6 temperature and minimum UF_6 purity of 99.5%. The allowable fill limit for tails UF_6 with a minimum UF_6 purity of 99.5% may be higher but shall not result in a cylinder ullage or less than 5% when heated to the cylinder design temperature of 235°F based on the actual certified volume.

6.1.2 Reports, Certification, and Records

For each cylinder fabricated in accordance with this standard, the manufacturer shall supply to purchaser and to the National Board of Boiler and Pressure Vessel Inspectors, copies of the Manufacturer's Data Report, Form U-1 or U-1A, as provided in Section VIII, Division 1, of the ANSI/ASME Code.

The manufacturer shall provide for the purchaser (1) a copy of the "as built" drawing pertaining to the cylinder or cylinders involved and (2) one copy of each radiograph, properly identified with the cylinder and location to which it applies.

The manufacturer shall measure the actual water capacity of each cylinder, and shall certify to the purchaser the water weight in pounds at a temperature of 60°F. This weight shall be accurate to the percentage specified for each type cylinder in 6.4 through 6.13. For a cylinder to be acceptable, the quotient of the certified water weight divided by 62.37 (the weight in pounds of 1 ft^3 of water at 60°F) shall not be less than the minimum capacity specified in the design conditions (see 6.4 through 6.13). The certified water capacity shall also be stamped on the cylinder as part of the nameplate data, except that the 1S and 2S cylinders are exempt from this capacity stamping requirement.

The cylinder tare weight shall be established before the new cylinder is placed in service. The purchaser is responsible for performing this function, but may by agreement, have the manufacturer perform this function.

The manufacturer shall retain fabrication and inspection records in accordance with Section VIII, Division 1 of the ANSI/ASME Boiler and Pressure Vessel Code. The purchaser shall retain the copies of the Manufacturer's Data Report, drawings, and certifications on file in accordance with regulatory requirements. Radiographs and other related papers shall be retained for a minimum of 5 years. The documents shall be transferred with the cylinder upon change of ownership.

6.2 Cleanliness

6.2.1 New Cylinders

New cylinders shall meet the cleanliness requirements of 6.4 through 6.15. The cleaning procedure to be used shall be described in detail to the cylinder fabricator. A cleaning method is provided in Appendix A.

CAUTION

The cleanliness of UF_6 cylinders is of serious concern to the nuclear industry, since the reaction of UF_6 with hydrocarbon oils and some other impurities is quite vigorous and can result in serious explosions. The purity of the UF_6 contained can also be appreciably affected.

6.2.2 In-Service Cylinders

Cylinders containing residual quantities of UF_6 may require cleaning prior to refilling to ensure product purity and also when maintenance or hydrostatic testing is performed. An example of a decontamination method for large cylinders, which contained enriched UF_6<5 wt%235U, is provided in Appendix B. A similar procedure with modifications can be used for smaller cylinders.

6.2.3 Cylinder Outer Surfaces

Cylinder surfaces shall be monitored and cleaned when required to meet applicable contamination limits (see 49 CFR 173.443).

6.3 Services Inspections, Tests, and Maintenance

6.3.1 Routine Operational Inspections

All UF_6 cylinders shall be routinely examined as received and prior to sampling, withdrawal, filling, or shipping to ensure that they remain in a safe, usable condition. Leakage, cracks, excessive distortion, bent or broken valves or plugs, broken or torn stiffening rings or skirts, or other conditions that may affect the safe use of the cylinder shall warrant appropriate precautions, including removing the cylinder from service until the defective condition is satisfactorily corrected. Questionable conditions should be referred to a qualified inspector for evaluation and for recommendations concerning use,

repair, or condemnation of the cylinder in question. Some examples of acceptable and unacceptable damage are shown in Appendix F.

6.3.2 Periodic Inspections and Tests

All cylinders shall be periodically inspected and tested throughout their service life at intervals not to exceed 5 years, except that cylinders already filled prior to the 5-year expiration date need not be tested until the cylinder has been emptied. However, cylinders that have not been inspected and tested within the required 5-year period shall not be refilled until they are properly reinspected, retested, and restamped. Prior to shipment, cylinders that have not been recertified within the 5-year requirement shall be visually inspected for degradation of the cylinder wall. Any questionable conditions should be investigated further, including ultrasonic wall thickness measurements, if appropriate. The periodic inspection shall consist of an internal and external examination of the cylinder by a qualified inspector along with a hydrostatic strength test of the type set forth in Section VIII, Division 1, of the ANSI/ASME Code, and an air leak test. The hydrostatic test shall be applied at a pressure equal to the original test pressure. Prior to the air test, all couplings from which valves or plugs were removed shall be thoroughly inspected. The air test shall be applied after valves and plugs have been installed in the cylinder. All valves shall meet the current design requirements, including tinning. All plugs shall meet the original or current design requirements including tinning. After testing, the cylinder may have the outer shell cleaned and repainted. At each 5-year recertification the cylinder should have the tare weight reestablished. Cylinders that pass the periodic inspection and tests shall be restamped with the month and year in which the hydrostatic test was performed. This stamping shall be placed in close proximity to the previous or original stamping and shall expire on the last day of the stamped month. Records of periodic inspections and tests shall be retained by the cylinder owner for a period of 5 years or until a subsequent period inspection and test have been performed and recorded.

A UF_6 cylinder shall be removed from service (for repair or replacement) when it is found to contain leaks, corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that, in the opinion of the qualified inspector, render it unsafe or unserviceable in its existing condition.

Cylinders shall no longer be used in UF_6 service when their shell thicknesses have decreased below the following values as interpreted by the National Board Inspection Code, ANSI-NB-23 criteria:

Cylinder Model	Min. Thickness (Inches)
1S	1/16
2S	1/16
5A	1/8
5B	1/8
8A	1/8
12A and B	3/16
30B	5/16
48A,F,X,and Y	½
48T,O,OM, OM allied, HX,H, and G	¼

NOTE - Cylinders 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

6.3.3 Cylinder Maintenance

Cylinder repairs and alterations are authorized provided: (1) they meet the approval of the inspector; (2) they comply with the design, material, fabrication, and welding qualification requirements of the ANSI/ASME Code, Section VIII, Division 1, and Section IX, Welding and Brazing Qualifications, for unfired pressure vessels; and (3) they do not deviated from the intent of this standard.

Welded repairs or alterations to ASME code stamped pressure vessel parts shall be required to be conducted by organizations holding a current "R" Stamp from the National Board Inspection Code, ANSI-NB-23, unless specifically approved by the NBIC Jurisdictional Authority.

Such repairs shall also be inspected and accepted by a qualified inspector in accordance with the fabrication inspection requirements in Section VIII, Division 1, of the ANSI/ASME Code.

Repairs or alterations to pressure parts shall be followed by a hydrostatic strength test. Plug or valve replacements should be followed by air leak tests. Repairs to structural attachments will not require pressure or leak tests of the cylinder unless repair of torn or deformed areas of pressure-containing materials is involved.

6.3.4 Reuse of Cylinder Valves

Valves that are removed from cylinders may be reused only after refurbishment to ensure the used valve meets the testing requirements of 6.14 or 6.15, as appropriate. New valves or newly refurbished valves may have the inspection and refurbishment limited to the inlet threads if the valve is removed from the cylinder because of leakage around the inlet threads. This applies only to valves during the initial installation test. Valves that will not pass in service, shipment, or storage tests must be used only after complete refurbishment. The packing shall be replaced and all parts inspected for damage. The refurbishment shall be performed in accordance with a documented quality control plan.

6.3.5 Retorque of Used Cylinder Valve Packing Nut

The packing nut of cylinder valves procured in accordance with 6.14 or 6.15 may be retorqued to stop leakage. The torque applied to the packing nut should be a minimum amount required to stop the leak but shall not exceed 100 ft-lb. Valves that require more than 100 ft-lb retorque to stop leakage shall not be heated. These cylinders shall require a valve change or replacement of the packing and/or packing nut prior to use in feed, withdrawal, or shipment. The replaced packing shall be new packing as described in 6.14 or 6.15, as appropriate, and shall be retorqued in accordance with 6.14 or 6.15, as appropriate. An adjustable or indicating torque wrench shall be required for retorquing.

6.4 1S Cylinder (see Figure 1)

6.4.1 Design and Fabrication

The cylinder shall be nickel or monel construction with a minimum wall thickness of 1/16 inch in accordance with Section VIII of the ASME/ASME Boiler and Pressure Vessel Code. One end shall contain a ¼-inch NPT female connection threaded in accordance with ANSI/ASME B1.20.1. The design pressure shall be 25 psig external and 200 psig internal. The design temperature shall be from –40°F to 250°F. The minimum volume shall be 9.16 in^3.

6.4.2 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Cylinder*, Nickel, ASTM B162 or Monel, ASTM B127, UNS N04400.

2) Adaptors

   a) Brass ASTM B16 or nickel ASTM B 160, with tube socket weld male connector to accommodate 3/8-inch O.D. tubing on one end and with male ¼-inch NPT threads on the other end. Cajon Part No. B-6TSW-1-4 or approved equal.

   b) Cajon connector, nickel-copper alloy, ASTM B164, male flare, ½-inch to 3/8-inch O.D.T socket, or an approved equivalent.

3) *Valve.* Nickel copper alloy Monel 400, diaphragm sealed, Hoke Part No. 4618N4M straight welded, Hoke Part No. 46-13-N4M straight, or an approved equivalent.

4) *Brazing Alloys.* ANSI/AWS A5.8, AWS classification BAg-7 or BAg-8.

6.4.3 Marking

The following data shall be lightly stamped on the valve end of the cylinder using 1/8-inch characters. Care shall be taken to prevent cylinder deformation.

1) Model 1S
2) MAWP 200 psig at 250°F.
3) MDMT -40° at 200 psig
4) Manufacturer's identification
5) Owner's identification symbol and serial number (not to exceed four digits)
6) 1 lb UF_6 max
7) Date of manufacture

6.4.4 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. Surfaces shall be left dry , clean, bright, and free of contamination. When cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.4.5 Valve Installation and Leak Test

The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted by the ANSI/ASME Code Section VIII, Division 1.

Care shall be taken to keep the valve body cool when the adaptors are silver brazed onto the inlet and outlet connections. The valve and connections shall be clean, dry, and free of contamination before the valve is threaded into the cylinder. Thread lubricants may be used, provided they are compatible with UF_6.

Following the valve installation, the cylinder shall be pressured with air at 100 psig and all connections, including the valve seat and packing shall be leak tested using Carbona Soapless lather or approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, these requirements shall be the responsibility of the purchaser.

6.4.6 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard and Section VIII of the ANSI/ASME Code. The manufacturer shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder, and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.5 2S Cylinder (see Figure 2)

6.5.1 Design, Fabrication, Testing, and Inspection

The design pressure shall be 25 psig external and 200 psig internal. The design temperature shall be from -40° to 250°F. The minimum volume shall be 44 in^3. Construction shall meet requirements of the Section VIII of the ANSI/ASME Boiler and Pressure Vessel Code.

6.5.2 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Cylinder*, Nickel, ASTM B-162 or Monel, ASTM B-127, UNS N04400.

2) Adaptors

a) Brass ASTM B16 or nickel ASTM B160 with tube socket weld male connector to accommodate 3/8-inch O.D. tubing on one end and male 3/8-inch NPT threads on the other end, Cajon Part No. B-6TSW-1-6, or an approved equal.

b) Connector, brass ASTM B 16, ½-inch by ¼-inch half flare, Eastman Part No. 48F08X04, or an approved equal.

3) *Valve.* Nickel-copper alloy Monel 400, diaphragm sealed, Hoke Part No. 4628N4M angle, 4618N4M straight, 46-23-N4M angle, 46-13-N4M straight, or an approved equal.

4) *Brazing Alloys.* ANSI/AWS A.5.8, AWS classification BAg-7 or BAg-8.

6.5.3 Cylinder Marking

The following information shall be stamped on the cylinder using 1/8-inch characters:

1) Model 2S
2) MAWP 200 psig at 250°F
3) MDMT -40°F at 200psig
4) Manufacturer's identification
5) Owner's identification symbol and serial number (not to exceed four digits)
6) 4.9 lb or 2222 g UF_6 max
7) Date of manufacture

6.5.4 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. Surfaces shall be left dry, clean, bright, and free of all contamination. When cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.5.5 Valve Installation and Leak Test

The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted by the ANSI/ASME Code. Care shall be taken to keep the valve body cool when the adaptors are silver brazed onto the inlet and outlet connections. The valve and connections shall be clean, dry, and free of contamination before the valve is threaded into the cylinder. Thread lubricants may be used providing they are compatible with UF_6.

Following the valve installation, the cylinder shall be pressured with air at 100 psig, and all connectors, including the valve seat and packing, shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, these requirements shall be the responsibility of the purchaser.

6.5.6 Reporting and Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all the requirements of this Standard and Section VIII of the ANSI/ASME Boiler and Pressure Vessel Code. The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ±0.1%.

6.6 5B Cylinder (See figure 3)

6.6.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.

2) *Design Temperature.* -40°F to 250°F.

3) *Minimum Transport* Temperature. -40°F.

4) Minimum Volume. 0.284 ft^3.

6.6.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1, of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders shall be National Board registered. All welders and welding procedures (brazing included) shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

6.6.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code. Locations of spots shall be at the circumferential head-to-shell weldment, alternating ends for successive cylinders. The weld defects indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for porosity defects, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.6.4 Testing

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME code and a retest shall follow.

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packaging) shall be tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.6.5 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Shell.* Nickel pipe, schedule 40, ASTM B161.

2) *Heads.* Nickel weld cap, semi-ellipsoidal with 2:1 axis ratio, schedule 40, ASTM B366, grade WPN.

3) *Foot ring.* Nickel-copper alloy pipe, Schedule 40, ASTM B165.

4) *Neck Ring.* Nickel-copper alloy pipe, Schedule 80, ASTM B165.

5) *Valve Protector Cap.* Carbon steel pipe, Schedule 80, ASTM A53, Grade B; carbon steel plate, ASTM A 285, Grade C; ASTM A575, Grade 1008-1020 (handles).

6) *Dip Pipe.* Nickel-copper alloy. ASTM B165, 5/8-inch O.D. x 0.065-inch wall.

7) *Valves.* See Figure 11 and 6.14

8) *Couplings.* Nickel, ¾-inch, 3000 pound, ASTM B 161, in accordance with ANSI B16.11-1980, except threaded with ¾-inch 14 NGT threads.

9) *Dip Pipe Tab.* Nickel-copper alloy, ¼-inch thick, ASTM B 127.

10) *Handles and Support Ring.* Nickel-copper alloy rod, ASTM B 164, Class A, and nickel-copper alloy pipe, Schedule 80, ASTM B 165.

11) *Nameplate* (See Figure 13(a)). Nickel-copper alloy, 20 gage, ASTM B 127.

12) Filler Metal

    a) Brazing ANSI/AWS A5.8(BAg-7)

    b) Welding ANSI/AWS A5.14 (ERNi-1, ERNiCu-7)

6.6.6 Valve Installation

In general, the valve shall be disassembled and cleaned before brazing and installation. The dip pipe shall be silver brazed to the applicable valve. Valve bodies shall be installed in the coupling with a thread engagement of 7 minimum and 12 maximum. The valve bodies shall be silver brazed to couplings before reassembly of the valve.

6.6.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(a). The following data shall be stamped on the nameplate in characters a minimum of 5/32- inch high:

1) ASME Code and National Board Stamping

2) MAWP 200 psig at 250°F.

3) MDMT -40°F at 200 psig

4) Model 5B

5) Owner's name or identification symbol and serial number 5N (plus four digits)

6) Tare wt._____lb.

7) Water cap._____lb.

8) Max. net wt. Pure UF_6 54.9 lb. or 24,947 g

9) Date of manufacture

6.6.8 Cleaning

After welding and hydrostatic testing are completed, the inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. Surfaces shall be left clean, bright, and free of all contamination. When cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.6.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ±0.1%.

6.7 8A Cylinder (See Figure 4)

6.7.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.

2) *Design Temperature.* -40°F to 250°F.

3) Minimum Transport Temperature. -40°F.

4) Minimum Volume. 1.32ft^3.

6.7.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1 of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders shall be National Board registered. All welders and welding procedures (brazing included) shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

6.7.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code. Locations of spots shall be at the junctions of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld defects indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for porosity defects, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.7.4 Testing

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code, and a retest shall follow;

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.7.5 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Shell.* Nickel-copper alloy plate, ASTM B127.

2) *Heads.* Nickel-copper alloy ASTM B 127, ellipsoidal, 2:1 ratio with 2-inch straight flange.

3) *Foot Ring and Head Ring.* Nickel-copper alloy plate, ASTM B 127.

4) *Neck Ring.* Nickel-copper alloy pipe, Schedule 80, ASTM B 165.

5) *Valve Protector Cap.* Steel pipe, ASTM A53, Grade B, Schedule 80; carbon steel plate, ASTM A285, Grade C.

6) *Dip Pipe.* Monel, ASTM B165, 5/8-inch O.D. x 0.065-inch wall.

7) *Valves.* See Figure 11 and 6.14.

8) *Couplings.* Nickel, ¾-inch, 3000-pound, ASTM B161, in accordance with ANSI B 16.11-1980, except threaded with ¾-inch-14 NGT threads.

9) *Dip Pipe Tab.* Nickel-copper alloy, ¼-inch thick, ASTM B127.

10) Filler Metal

   a) Brazing ANSI/AWS A5.8 (BAg-7).

   b) Welding ANSI/AWS A5.14 (ERNi-1, ERNiCu-7)

11) *Nameplate* (See Figure 13 (a)). Nickel-copper alloy, 20 gage, ASTM B127.

6.7.6 Valve Installation

In general, the valves shall be disassembled and cleaned before brazing and installation. The dip pipe shall be silver brazed to the applicable valve. Valve bodies shall be installed in the couplings

with a thread engagement of 7 minimum and 12 maximum. The valve bodies shall be silver brazed to couplings before reassembly of the valves.

6.7.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(a). The following data shall be stamped on the nameplate in characters a minimum of 5/32-inch high:

1) ASME Code and National Board Stamping
2) MAWP 200 psig at 250°F.
3) MDMT -40°F at 200 psig.
4) Model 8A
5) Owner's name or identification symbol and serial number (not to exceed four digits)
6) Tare wt. _____lb.
7) Water Cap. _____lb.
8) Max. net wt. Pure UF_6 255lb.

6.7.8 Cleaning

After welding and hydrostatic testing are completed, the inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt moisture, and other foreign matter. Surfaces shall be left clean, bright, and free of all contamination. When the cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.7.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measure volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.8 12A Cylinder

Reference deleted. Use 12B Cylinder described in 6.9.

6.9 12 B Cylinder. (See figure 6)

6.9.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.
2) *Design Temperature.* -40°F to 250°F.
3) *Minimum Transport Temperature.* -40°F.
4) *Minimum Volume.* 2.38 ft^3.

6.9.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1, of the ANSI/ASME Code, and shall be ASME Code stamped. The cylinder shall be National Board registered. All welders and welding procedures (brazing included) shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

6.9.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code. Locations of spots shall be at the junctions of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The

weld defects indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for porosity defects, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.9.4 Testing

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code, and retest shall follow;

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.9.5 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Shell.* Nickel-copper alloy plate, ASTM B127.

2) *Heads.* Nickel-copper alloy ASTM B127, ellipsoidal, 2:1 ratio with 2-inch straight flange.

3) *Foot Ring and Head Ring.* Nickel-copper alloy plate, ASTM B127.

4) *Neck Ring.* Nickel-copper alloy pipe, Schedule 80, ASTM B165.

5) *Valve Protector Cap.* Steel pipe, ASTM A53, Grade B, Schedule 80, carbon steel plate, ASTM A285, Grade C.

6) *Dip Pipe.* Nickel-copper Alloy, ASTM B165, 5/8-inch O.D. x 0.065-inch wall.

7) *Valves.* See Figure 11 and 6.14

8) *Couplings.* Nickel, ¾-inch, 3000-pound, ASTM B161, in accordance with ANSI B16.11-1980, except threaded with ¾-inch-14 NGT threads.

9) *Dip Pipe Tab.* Nickel-copper alloy, ¼-inch thick, ASTM B127.

10) *Filler Metal*

   a) Brazing ANSI/AWS A5.8 (BAg-7).

   b) Welding ANSI/AWS A5.14 (ERNi-1, ERNiCu-7).

11) *Nameplate* (See Figure 13(a)). Nickel-copper alloy, 20 gage, ASTM B127.

6.9.6 Valve Installation

In general, the valves shall be disassembled and cleaned before brazing and installation. The dip pipe shall be silver brazed to the applicable valve. Valve bodies shall be installed in the couplings with a thread engagement of 7 minimum and 12 maximum. The valve bodies shall be silver brazed to couplings before reassembly of the valves.

6.9.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(a). The following data shall be stamped on the nameplate in characters a minimum of 5/32 inch high:

1) ASME Code and National Board Stamping

2) MAWP 200 psig at 250°F.

3) MDMT -40°F at 200 psig.

4) Model 12B

5) Owner's name and identification symbol and serial number (not to exceed four digits)

6) Tare wt. _____lb.

7) Water Cap. _____lb.

8) Max. net wt. Pure UF_6 460lb.

9) Date of manufacture.

6.9.8 Cleaning

After welding and hydrostatic testing are completed, the inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt moisture, and other foreign matter. Surfaces shall be left clean, bright, and free of all contamination. When the cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.9.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.10 30B Cylinder (See Figure 7)

6.10.1. Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.

2) *Design Temperature.* -20°F to 250°F.

3) *Minimum Transport Temp.* -40°F.

4) *Minimum Volume.* 26 ft3.

6.10.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1, of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders shall be National Board registered. All welders and welding procedures (brazing included) shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

At least one test weld representing each welding procedure to be used in the fabrication of the cylinder shall be impact tested. These impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM A370 for the type and grade of steel to be used in fabrication of the cylinder. The results shall meet acceptance criteria listed in ASTM A20 for the type and grade of steel used and shall be submitted to, and approved by, the purchaser prior to cylinder fabrication.

6.10.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code using a fine-grain X-ray film (Kodak Type AA, or a purchaser-approved equivalent). Unless otherwise directed by the ASME Code inspector, locations of the spot shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld imperfections indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for rounded indications, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.10.4 Testing

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code, and retest shall follow;

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.10.5 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Cylinder.* Cylinder shell, heads, backup bars, and skirts shall conform to ASTM A516, Grade 55, 60, 65, or 70 steel and shall be normalized. ASTM A36 normalized steel may be substituted for the backing rings only. All steel shall be charpy v-notch impact tested and meet the charpy impact requirements as stated in ASTM A20. An alternate material for the shell steel is plate steel in the coil form meeting all requirements for ASTM A516 steel. Coil steel shall meet charpy impact acceptance criteria listed for normalized ASTM A516 plate in ASTM A20.

2) *Seal Loop.* Steel, ASTM A36.

3) *Pipe Plug.* Upset forged, extruded or extruded and drawn aluminum bronze, UNS C61300, conforming to ASTM B150. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1. The actual number of effective threads on the plug shall be stamped on the head of the plug as shown in Figure 7.

NOTE - The number of effective threads is the number of threads that are capable of providing reasonable engagement in mating threads. These are the number of threads that appear visually to be nominally sized threads to an operator/inspector. Although the number of ineffective threads caused by the runout of the threading operation varies, nominally the first effective thread is approximately one thread length down the plug from the end of the scratch left by the runout of the thread machining operation on the plug head end. After visually determining the first effective thread at the lead end, the threads are counted down to the end of the plug. The stamping of the number of effective threads on the head of the plug is provided to aid users in determining the number of threads engaged. For old cylinders without this stamping or as an additional check, other methods such as dimensional measurements with ultrasonic measurements that provide assurance that the plug is properly engaged are also acceptable.

After machining, plugs shall be stress relieved for 1 hour at 800°F plus or minus 10 degrees F.

4) *Valve.* See Figure 12 and 6.15.

5) *Couplings.* 1-inch, half-coupling, 6000-pound, forged steel, ASTM A105, ANSI B 16.11, modified. Threads 1-inch, 11-1/2 NPT. Tapped threads shall be free of all burrs, gouges, scratches, and the like.

NOTE - ASTM A106 Grade C may be used in lieu of ASTM A105.

6) *Solder.* ASTM B32 with a minimum tin content of 45% such as alloy SN50.

7) *Solder Flux.* Phosphoric acid.

8) *Nameplate* (see Figure 13(b)). Stainless steel, 13 to 20-gage, ASME SA-240, Type 304 or 304L.

9) *Valve Protector.* Weldable carbon steel with a minimum tensile strength of 45,000 lbs/in^2 and a maximum carbon content of 0.26% such as ASTM A-36 steel.

10) *Filler Metal.* ASME approved filler metal such as ANSI/AWS A5.1, A5.17, or A5.18.

6.10.6 Valve and Plug Installation

In general, the valves shall be disassembled and cleaned before installation. The valve and plug inlet threads shall be tinned with a thin uniform coating of the specified solder. A valve thread engagement of 7 minimum and 12 maximum shall be obtained by using a minimum of 200 and maximum of 400 foot-pounds of wrench torque applied to the valve body only. The plug thread engagement of 5 minimum and 8 maximum shall be obtained using a minimum of 150 and maximum of 650-ft-lb of torque. An indicating torque wrench shall be used for valve and plug installation. The valve and plug couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed, the coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

6.10.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(b). The following data shall be stamped on the nameplate in characters a minimum of 5/32 inch high:

1) ASME Code and National Board Stamping
2) MAWP 200 psig at 250°F.
3) MDMT -20°F at 200 psig. Minimum transport temperature -40 degrees F
4) Model 30B
5) Owner's name or identification symbol and serial number (not to exceed four digits)
6) Tare wt._____lb. Or kg.
7) Water Cap._____lb. Or kg.
8) Max. net wt. Pure UF_6 5020 lb.
9) Month and year of manufacture

6.10.8 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. The surfaces shall be left clean, dry, and free of all contamination. The cylinders shall be purged with filtered dry air to a maximum dew point of -30°F. When the cylinders are purchased without valves, the openings shall be sealed with threaded plugs.

6.10.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders. The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.11 48X Cylinder (see Figure 8)

6.11.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.
2) *Design Temperature.* -20°F to 250°F.
3) *Minimum Transport Temperature.* -40°F.
4) *Minimum Volume.* 108.9 ft^3.

6.11.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1 of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders shall be National Board registered. All welders and welding procedures shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified. At least one test weld representing each welding procedure to be used in the fabrication of the cylinders shall be impact tested. Test plates, including those for the appendages, shall have butt-type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the material, and one face of the specimen shall be within 1/16-inch of the surface of the material. For A516 steel, these impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM A370 for Charpy V-Notch tests. The results shall meet the acceptance criteria listed in ASTM A20 for the grade of A516 steel used. For A131 Grade-E steel, the Charpy V-Notch impact tests and acceptance criteria shall be as specified in ASTM A131. The test results shall be submitted to, and approved by, the purchaser prior to cylinder fabrication.

6.11.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code using a fine-grain X-ray film (Kodak Type AA, or a purchaser-approved equivalent). Unless otherwise directed by the ANSI/ASME Code inspector, locations of the spot shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld defects indicated by the radiographs shall not exceed those permitted by Section UW-52 of the ANSI/ASME Code, except for rounded indications, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.11.4 Testing

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code and a retest shall follow.

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.11.5 Materials

The material used in the fabrication of new cylinders shall meet the following requirements:

1) *Cylinder.* Cylinder shell, heads, lifting lugs, stiffening rings, backup bars, and skirts shall conform to ASTM A516, Grade 55, 60, 65, or 70 steel, meeting heat treatment and supplementary requirement S5. ASTM A36 normalized steel may be substituted for the backing rings only. ASTM A131, Grade E normalized steel may be used for the stiffening rings only. All steel shall be Charpy V-notch impact tested and meet the charpy impact requirements as stated in ASTM A20. The cylinder shell steel shall have an additional requirement on the practice used to make the shell steel. Shell steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.01%. The cylinder shell steel shall have an additional Charpy V-notch impact test requirement in addition to the standard Charpy test requirement of ASTM A516 supplementary requirement S5. The shell steel shall meet an additional Charpy V-notch transverse average impact strength of 55 ft/lbs minimum when tested at a temperature not to exceed 150°F. Each individual Charpy V-notch transverse impact value shall be not less than 47 ft/lbs. All test results shall be furnished to the purchaser.

An alternate material for the shell steel is plate steel in the coil form meeting all the requirements for ASTM A516 steel. Charpy impact tests shall be required in accordance with ASTM A20. Coil steel shall meet charpy impact acceptance criteria listed for normalized ASTM A516

plate in ASTM A20. The coil steel shall have an additional requirement on the practice used to make the steel. The coil steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.010%. An additional set of Charpy impact tests are required on the coil steel. The Charpy tests shall be conducted in accordance with ASTM A20 with the long axis of the Charpy V-notch specimen oriented transverse to the final direction of rolling. The acceptance criteria shall not be less than 55 foot-pounds when tested at a temperature not to exceed 150°F.

2) *Valve.* See Figure 12 and 6.15

3) *Pipe Plug.* Upset forged, extruded or extruded and drawn aluminum bronze UNS C61300, conforming to ASTM B150. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1-1983. The actual number of effective threads on the plug shall be stamped on the head of the plug as shown in Figure 8.

NOTE - The number of effective threads is the number of threads that are capable of providing reasonable engagement in mating threads. These are the number of threads that appear visually to be nominally sized threads to an operator/inspector. Although the number of ineffective threads caused by the runout of the threading operation varies, nominally the first effective thread is approximately one thread length down the plug from the end of the scratch left by the runout of the thread machining operation on the plug head end. After visually determining the first effective thread at the head end, the threads are counted down to the end of the plug. The stamping of the number of effective threads on the head of the plug is provided to aid users in determining the number of threads engaged. For old cylinders without this stamping or as an additional check, other methods such as dimensional measurements with ultrasonic measurements that provide assurance that the plug is properly engaged are also acceptable.

After machining, the plugs shall be stress relieved for 1 hour at 800°F plus or minus 10 degrees F.

4) *Couplings.* Forged steel conforming to ASTM A105; 1-inch half-couplings, 6000-pound ANSI B16.11.Threads shall be 1" NPT.

Couplings shall be counterbored as detailed in Figure 8 (see also 6.11.6).

NOTE - ASTM A106 Grade C may be used in lieu of ASTM A105.

5) *Solder.* ASTM B32, with a minimum tin content of 45% such as alloy SN50.

6) *Nameplate* (see Figure 13 [c]). Stainless steel, 13-gage to 20 gage, ASME SA-240, Type 304 or 304L.

7) *Valve Guard.* Weldable carbon steel with a minimum tensile strength of 45,000 lbs/in^2 and a maximum carbon content of 0.26% such as ASTM A-36 steel. The set screw shall be carbon steel bar, ASTM A108, Grade 1095 or 1045.

6.11.6 Valve and Plug Installation

The valves shall be supplied to the purchaser with the threads already tinned with a thin uniform coating of the solder specified in 6.11.5 above, or may be purchased without tinning to be tinned with the specified solder by the purchaser. The dimensions of the valve are shown in Figure 12. The threaded portion of the valve that will be installed in the cylinder coupling is cut with approximately 13 or 14 complete threads.

Plugs and couplings shall be furnished by the seller. Plug threads shall be tinned with a thin uniform coating of the solder specified in 6.11.5. The 1-inch, 6000-pound half-coupling into which the valve and plug are to be installed shall be threaded as specified in 6.11.7. Couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to the coupling is accomplished. After welding is completed, the coupling should be allowed to cool before removal of pipe nipple. A 1-inch 11-1/2 NGT tap may be used only if necessary for a light chase.

The valve thread engagement shall be obtained using a minimum of 200 and a maximum of 400 foot-pounds of wrench torque. The plug thread engagement shall be obtained using a minimum of 150 and a maximum of 650 foot-pounds of wrench torque. The torque wrench shall be applied to the valve body and not to the bonnet nut. An indicating torque wrench shall be used for valve

and plug installation. No material of any kind other than the specified solder shall be used on the threads to facilitate installation. A minimum of 7 and a maximum of 12 valve threads shall be engaged. For the plug, a minimum of 5 and a maximum of 8 threads shall be engaged.

6.11.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(c). The following data shall be stamped on the nameplate in characters a minimum of 1/4-inch high:

1) ASME Code and National Board Stamping
2) MAWP 200 psig at 250°F.
3) MDMT -20°F at 200 psig.
4) Minimum transport temp -40°F
5) Model 48X
6) Owner's name or identification symbol and serial number (not to exceed four digits)
7) Tare wt. _____lb.
8) Water Cap. _____lb.
9) Max. net wt. Pure UF_6 21030lb.
10) Month and year of manufacture.

6.11.8 Cleaning

The inside of the cylinders shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. The surfaces shall be left clean, dry, and free of all contamination. The cylinders shall be purged with filtered dry air to a maximum dew point of -30°F. When the cylinders are purchased without valves, the openings shall be sealed with threaded plugs.

6.11.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ±0.1%.

6.12 48Y Cylinder (See Figure 9)

6.12.1 Design conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.
2) *Design Temperature.* -20°F to 250°F.
3) *Minimum Transport Temp.* -40°F.
4) *Minimum Volume.* 142.7 ft^3.

6.12.2 Fabrication

Cylinders shall be fabricated in accordance with the latest edition of Section VIII, Division 1, of the ANSI/ASME Code and shall be ASME Code stamped. The cylinder shall be National Board registered. All welders and welding procedures shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

At least one test weld representing each welding procedure to be used in the fabrication of the cylinder shall be impact tested. Test plates, including those for the appendages, shall have butt-

type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the material, and one face of the specimen shall be within 1/16-inch of the surface of the material. For ASTM A516 steel, these impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM-370 for Charpy V-notch tests. The results shall meet acceptance criteria listed in ASTM A20 for the grade of A516 steel used. For A131 Grade-E steel, the Charpy V-notch impact tests and acceptance criteria shall be as specified in ASTM A131. The test results shall be submitted to, and approved by, the purchaser prior to cylinder fabrication.

6.12.3 Radiography

A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code using a fine-grain X-ray film (Kodak Type AA, or a purchaser-approved equivalent). Unless otherwise directed by the ANSI/ASME Code inspector, locations of the spot shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld defects indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for rounded indications, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.12.4 Testing.

1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure should then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code and retest shall follow.

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.12.5 Materials.

1) *Cylinder.* Cylinder shell, heads, lifting lugs, stiffening rings, backup bars, and skirts shall conform to ASTM A516, Grade 55,60,65, or 70 steel, meeting heat treatment and supplementary requirement S5. ASTM A36 normalized steel may be substituted for the backing rings only. ASTM A131, Grade E, normalized steel may be used for the stiffening rings only. All steel shall be Charpy V-notch impact tested and meet the charpy impact requirements as stated in ASTM A20. The cylinder shell steel shall have an additional requirement on the practice used to make the shell steel. Shell steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.01%. The cylinder shell steel shall have an additional Charpy V-notch impact test requirement of ASTM A516 supplementary requirement S5. The shell steel shall meet an additional Charpy V-notch transverse average impact Strength of 55 ft/lbs minimum when tested at a temperature not to exceed 150°F. Each individual Charpy V-notch transverse impact value shall be not less than 47 ft/lbs. All test results shall be furnished to the purchaser.

An alternate material for the shell steel is plate steel in the coil form meeting all the requirements for ASTM A516 steel. Charpy impact test shall be required in accordance with ASTM A 20. Coil steel shall meet charpy impact acceptance criteria listed for normalized ASTM A516 plate in ASTM A20. The coil steel shall have an additional requirement on the practice used to make the steel. The coil steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.010%. An additional set of Charpy impact tests are required on the coil steel. The charpy tests shall be conducted in accordance with ASTM A20 with the long axis of the charpy V-notch specimen oriented transverse to the final direction of rolling. The acceptance criteria shall not be less than 55 foot-pounds when tested at a temperature not to exceed 150°F.

2) *Valve.* See Figure 12 and 6.15.

3) *Pipe Plug.* Upset forged, extruded, or extruded and drawn aluminum bronze UNS C61300 conforming to ASTM B150. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1-1983. The actual number of effective threads on the plug shall be stamped on the head of the plug as shown in Figure 9.

NOTE - The number of effective threads is the number of threads that are capable of providing reasonable engagement in mating threads. These are the number of threads that appear visually to be nominally sized threads to an operator/inspector. Although the number of ineffective threads caused by the runout of the threading operation varies, nominally, the first effective thread is approximately one thread length down the plug from the end of the scratch left by the runout of the thread machining operation on the plug head end. After visually determining the first effective thread at the head end, the threads are counted down to the end of the plug. The stamping of the number of effective threads on the head of the plug is provided to aid users in determining the number of threads engaged. For old cylinders without this stamping or as an additional check, other methods such as dimensional measurements with ultrasonic measurements that provide assurance that the plug is properly engaged are also acceptable.

After machining, the plugs shall be stress relieved for 1 hour at 800°F plus or minus 10 degrees F.

4) *Couplings.* Forged steel conforming to ASTM A105; 1-inch half-coupling, 6000-lb, conforming to ANSI B 16.11-1980, modified. Threads shall be 1" NPT. Couplings shall be counterbored as detailed in Figure 9 (see also 6.12.6).

NOTE - ASTM A106 Grade C may be used in lieu of ASTM A105.

5) *Solder.* ASTM B32 with a minimum tin content of 45% such as alloy SN50.

6) *Nameplate* (see Figure 13[c]). Stainless steel, 13-gage to 20 gage, ASME SA-240 Type 304 or 304L.

7) *Valve Guard.* Weldable carbon steel with a minimum tensile strength of 45,000 lbs./in^2 and a maximum carbon content of 0.26% such as ASTM A-20. The set screw shall be carbon steel bar, ASTM A108, Grade 1095 or 1045.

6.12.6 Valve and Plug Installation

The valves shall be supplied to the purchaser with the threads already tinned with a thin uniform coating of the solder specified in 6.11.5, or may be purchased without tinning to be tinned with the specified solder by the purchaser. The dimensions of the valve are shown in Figure 12. The threaded portion of the valve that will be installed in the cylinder coupling is cut with approximately 13 or 14 complete threads.

Plugs and couplings shall be furnished by the seller. Plug threads shall be tinned with a thin uniform coating of the solder specified in 6.11.5, before installation. The 1-inch, 6000-pound half-coupling into which the valve and plug are to be installed shall be threaded as specified in 6.12.5. Couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed, the coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

The valve thread engagement shall be obtained using a minimum of 200 and a maximum of 400 foot-pounds of wrench torque. The plug thread engagement shall be obtained using a minimum of 150 and a maximum of 650 foot-pounds of wrench torque. The torque wrench shall be applied to the valve body and not to the bonnet nut. An indicating torque wrench shall be used for valve and plug installation. No material of any kind other than the specified solder shall be used on the threads to facilitate installation. A minimum of 7 and a maximum of 12 valve threads shall be engaged. For the plug, a minimum of 5 and a maximum of 8 threads shall be engaged.

6.12.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(c). The following data shall be stamped on the nameplate in characters a minimum of 1/4-inch high:

1) ASME Code and National Board Stamping.
2) MAWP 200 psig at 250°F.
3) MDMT -20°F at 200 psig.
4) Minimum transport temperature -40°F.
5) Model 48Y
6) Owner's name or identification symbol and serial number (not to exceed four digits)
7) Tare wt._____lb.
8) Water Cap._____lb.
9) Max. net wt. Pure UF_6 27560 lb.
10) Month and Year of manufacture

6.12.8 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. The surfaces shall be left clean, dry, and free of all contamination. The cylinders shall be purged with filtered dry air to a maximum dew point of -30°F. When the cylinders are purchased without valves, the openings shall be sealed with threaded plugs.

6.12.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders. The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.13 48G Cylinder (See Figure 10)

6.13.1 Design Conditions

1) *Design Pressure.* 25 psig external and 100 psig internal.
2) *Design Temperature.* -20°F to 235°F
3) *Minimum Transport Temperature.* -40°F
4) *Minimum Volume.* 139 ft^3

6.13.2 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Division 1 of the ANSI/ASME Code and shall be ASME Code-stamped. Cylinders shall be National Board registered. All welders and welding procedures shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified. At least one test weld representing each welding procedure to be used in the fabrication of the cylinders shall be impact tested. Test plates, including those for the appendages, shall have butt-type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the material, and one face of the specimen shall be within 1/16-inch of the surface of the material. For ASTM A516 steel, these impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM A370 for Charpy V-Notch tests. The results shall meet the acceptance criteria listed in ASTM

A20 for the grade of A516 steel used. For A131 Grade-E steel, the Charpy V-Notch impact tests and acceptance criteria shall be as specified in ASTM A131. The test results shall be submitted to, and approved by, the purchaser prior to cylinder fabrication.

6.13.3 Radiography

A minimum of one spot X-ray examination per cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code using a fine-grain X-ray film (Kodak Type AA, or a purchaser-approved equivalent). Unless otherwise directed by the ANSI/ASME Code inspector, locations of the spot shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld defects indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for rounded indications, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.13.4 Testing

1) The cylinder shall be hydrostatically pressured to 200 psig, and the pressure shall be maintained at 200 psig while the cylinder is inspected for leaks. Leaks are not permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code and a retest shall follow.

2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. The sensitivity of this test is 10^{-3} atmospheres •cc/sec. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.13.5 Materials

The materials used in the fabrication of new cylinders shall meet the following requirements:

1) *Cylinder.* Cylinder shell, heads, lifting, lugs, stiffening rings, backup bars, and skirts shall conform to ASTM A516, Grade 55, 60, 65, or 70 steel, meeting heat treatment and supplementary requirement S5. ASTM A36 normalized steel may be substituted for the backing rings only. ASTM A131, Grade E normalized steel may be used for the stiffening rings only. All steel shall be Charpy V-notch impact tested and meet the charpy impact requirements as stated in ASTM A20. The cylinder shell steel shall have an additional requirement on the practice used to make the shell steel. Shell steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.01%. The cylinder shell steel shall have an additional Charpy V-notch impact test requirement in addition to the standard Charpy test requirement of ASTM A516 supplementary requirement S5. The shell steel shall meet an additional Charpy V-notch transverse average impact strength of 55 ft/lbs minimum when tested at a temperature not to exceed 150°F. Each individual Charpy V-notch transverse impact value shall be not less than 47 ft/lbs. All test results shall be furnished to the purchaser.

An alternate material for the shell steel is plate steel in the coil form meeting all the requirements for ASTM A516 steel. Charpy impact tests shall be required in accordance with ASTM A20. Coil steel shall meet charpy impact acceptance criteria listed for normalized ASTM A516 plate in ASTM A20. The coil steel shall have an additional requirement on the practice used to make the steel. The coil steel shall be made by a low sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.010%. An additional set of charpy impact tests are required on the coil steel. The charpy tests shall be conducted in accordance with ASTM A20 with the long axis of the charpy V-notch specimen oriented transverse to the final direction of rolling. The acceptance criteria shall not be less than 55 foot-pounds when tested at a temperature less than 150°F.

2) *Valve.* See Figure 12 and 6.15.

3) *Pipe Plug.* Upset forged, extruded, or extruded and drawn aluminum bronze UNS C61300 conforming to ASTM B150. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1-1983. The actual number of effective threads on the plug shall be stamped on the head of the plug as shown in Figure 10.

NOTE - The number of effective threads is the number of threads that are capable of providing reasonable engagement in mating threads. These are the number of threads that appear visually to be nominally sized threads to an operator/inspector. Although the number of ineffective threads caused by the runout of the threading operation varies, nominally the first effective thread is approximately one thread length down the plug from the end of the scratch left by the runout of the thread machining operation on the plug head end. After visually determining the first effective thread at the head end, the threads are counted down to the end of the plug. The stamping of the number of effective threads on the head of the plug is provided to aid users in determining the number of threads engaged. For old cylinders without this stamping or as an additional check, other methods such as dimensional measurements with ultrasonic measurements that provide assurance that the plug is properly engaged are also acceptable.

After machining, the plugs shall be stress relieved for 1 hour at 800°F plus or minus 10 degrees F.

4) *Couplings.* Forged steel conforming to ASTM A105; 1-inch half-coupling, 6000-pound, conforming to ANSI B16.11-1980. Threads shall be 1" NPT. Couplings shall be counterbored as detailed in Figure 10. (See also 6.13.6)

NOTE - ASTM A106 Grade C may be used in lieu of ASTM A105.

5) *Solder.* ASTM B32 with a minimum tin content of 45% such as alloy SN50.

6) *Nameplate* (see Figure 13[d]). Stainless steel, 13-gage to 20 gage, ASME SA-240, Type 304 or 304L.

7) *Valve Guard.* Weldable carbon steel with a minimum tensile strength of 45,000 lbs./in^2 and a maximum carbon content of 0.26% such as ASTM A-36. The set screw shall be carbon steel bar, ASTM A108, Grade 1095 or 1045.

6.13.6 Valve and Plug Installation

The valves shall be supplied to the purchaser with the threads already tinned with a thin uniform coating of the solder specified in 6.11.5, or may be purchased without tinning to be tinned with the specified solder by the purchaser. The 1-inch, 6000-pound half-coupling into which the valve and plug are to be installed shall be threaded as specified in 6.12.5. Couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

Plugs and couplings shall be furnished by the seller. Plug threads shall be tinned with a thin uniform coating of the solder specified in 6.11.5 before installation. The 1-inch, 6000-pound half-coupling into which the valve and plug are to be installed shall be threaded as specified in 6.12.5. Couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed the coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

The valve thread engagement shall be obtained using a minimum of 200 and a maximum of 400 foot-pounds of wrench torque. The plug thread engagement shall be obtained using a minimum of 150 and a maximum of 650 foot-pounds of wrench torque. This torque range gives assurance that the valve will not be inadvertently screwed out during cylinder use and that damage will not occur during installation. The torque wrench shall be applied to the valve body and not to the bonnet nut. An indicating torque wrench shall be used for valve and plug installation. No material of any kind other than the specified solder shall be used on the threads to facilitate installation. A minimum of 7 and a maximum of 12 valve threads shall be engaged. For the plug, a minimum of 5 and a maximum of 8 threads shall be engaged.

6.13.7 Cylinder Marking

Cylinder nameplates shall contain the information as described in Figure 13(d). The following data shall be stamped on the nameplate in characters a minimum of 1/4-inch high:

1) ASME Code and National Board Stamping.

2) MAWP 100 psig at 235°F.

3) MDMT -20°F at 100 psig.

4) Minimum transport temperature. -40°F.

5) Model 48G

6) Owner's name or identification symbol and serial number.

7) Tare wt._____lb.

8) Water Cap._____lb.

9) Max. net wt. Pure UF_6 26840 lb.

10) Month and year of manufacture.

6.13.8 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. The surfaces shall be left clean, dry, and free of all contamination. The cylinders shall be purged with filtered dry air to a maximum dew point of -30°F. When the cylinders are purchased without valves, the openings shall be sealed with threaded plugs.

6.13.9 Certification

The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinder.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.14 Cylinder valve 50 (3/4 Inch) See Figure 11.

6.14.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.

2) *Design Temperature.* -40°F to 250°F.

3) *Medium.* UF_6.

6.14.2 Material Specifications

1) *Body, Part 1.* Forging, aluminum bronze CDA alloy 636.

2) *Packing Nut*, Part 3; Port Cap, Part 4. Acceptable materials are (1) bar aluminum bronze, CDA alloy 636, stress relieved at 700°F plus or minus 10 degrees F for 1 hour, surface hardness of the bar stock after stress relieving shall not exceed Rockwell B85 nor be less than B70, mechanical properties after stress relieving shall be: ultimate tensile 45,000 psi minimum yield strength (0.5% extension) 25,000 psi minimum, elongation in 2 inches 30% minimum; (2) nickel copper alloy, ASTM B164, NO4400, stress relieved at 1100°F plus or minus 10 degrees F for 1 hour to meet ASTM B164 mechanical properties for hot-worked, stress relieved material; or (3) bar aluminum bronze, ASTM B150, C61300, stress relieved at 800°F plus or minus 10 degrees F for 1 hour and meeting the ASTM B150 mechanical property requirements for C61300 stress relieved material.

3) *Packing Follower*, Part 5; Packing Ring, Part 7. Acceptable materials are (1) bar aluminum bronze, CDA alloy 636, stress relieved at 700°F plus or minus 10 degrees F for 1 hour, surface hardness of the bar stock after stress relieving shall not exceed Rockwell B85 nor be less than B70, mechanical properties after stress relieving shall be: ultimate strength 45,000 psi minimum, yield strength (0.5% extension) 25,000 psi minimum, elongation in 2 inches 30% minimum, or (2) bar aluminum bronze, ASTM B150, C61300, stress relieved at 800°F plus or minus 10 degrees F for 1 hour and meeting the ASTM B150 mechanical property requirements for C61300 stress relieved material.

4) *Stem.* Part 2. Bar, monel, ASTM B164, Class A or B, cold drawn and stress relieved to 1025°F plus or minus 10 degrees F for 1-1/2 hours.

5) *Packing,* Part 6; Cap Gasket, Part 8. Teflon, 100% Virgin TFE (unfilled).

6) *Fluorinated Lubricant.* Occidental-Hooker HO-125 or the equivalent.

7) CDA alloy 636 has the following chemical composition limits by weight percent:

Element	Percentage
Copper and the sum of other named elements	99.5 min
Lead	0.03 max
Tin	0.20 max
Iron	0.10 max
Silicon	0.7-1.3
Aluminum	3.0-4.0
Nickel	0.15 max
Zinc	0.35 max
Arsenic	0.15 max

The valve body shall be forged and shall contain no laps, seams, porosity, or other objectionable forging defects. The seller's name and a forging identification symbol, traceable to the heat number(s) from which the forgings were produced, shall be forged or stamped into the body. Forgings shall be cleaned to a bright smooth finish and shall have the die-flash removed. Surface defects shall not be masked by blasting or by any other mechanical means.

6.14.3 Material certification Requirements

The seller shall require the manufacturer(s) of aluminum bronze materials to furnish mill certification, including the results of tests to determine the chemical composition, tensile strength, yield strength, and hardness of the materials. The tests shall be conducted in accordance with the applicable test methods referenced in ASTM B249.

Mill test reports shall be obtained for each separate lot of material produced by a different mill manufacturing process or of a different size, such as forging stock, as-extruded bar, and rolled and tempered (stress-relieved) bar. The mill test reports shall include heat numbers from which the manufactured products were produced. In addition, each pour shall be analyzed for its chemical composition and the results reported to the purchaser.

The seller shall obtain a manufacturer's certification that the Monel material supplied has been manufactured and tested in accordance with ASTM B164. The seller shall submit certification in writing that all materials requiring mill certification in 6.14.2 conform to the specification requirements.

6.14.4 Manufacturing Requirements

All parts shall conform to the dimensional requirements of Figure 11. In addition to the specific requirements of the drawing, acceptable practices such as deburring, breaking corners, and the like shall be used in the machining and finishing of parts. Close control over the manufacture of threaded elements shall be maintained to meet the Figure 11 requirement. Threads shall conform to applicable American National Standards for manufacturing and gaging, modified as necessary to conform to Figure 11. The applicable standards are ANSI/CGA V-1-1987 for tapered NGT inlet and outlet threads, ANSI/ASME B1.5-1988 for Acme threads, and ANSI/ASME B1.1-1989 for the packing gland threads.

Packing nuts shall be stress-relieved after completion of finish machining at 700°F ± 10°F for CDA 636 material, 1100°F ± 10°F for ASTM B164 material, or 800°F ± 10°F for ASTM B150, C61300 material for a minimum of 1 hour. Surface hardness measurements of packing nuts after stress relieving may be made on the top of the nut as shown in Figure 11.

6.14.5 Cleaning

Prior to assembly, all parts, including the valve bodies, shall be cleaned to remove all traces of machining lubricants, metal chips, oxide film, and other foreign substances. A chlorinated-hydrocarbon, solvent-degreasing procedure is acceptable for removal of lubricants.

6.14.6 Tinning. (Optional: To Be Specified by Purchaser)

Prior to assembly, one valve body out of each fifty shall be selected at random for shipment without tinning. The remaining bodies shall have the tapered inlet thread tinned over its full length with a uniform coating of tin-lead solder, ASTM B32 with a minimum tin content of 45% such as alloy SN50. The thread roots shall be filled approximately half full. The tinning flux used shall be suitable for use with the aluminum bronze alloy. The composition of the solder in the pot shall be certified correct prior to its use. Tinning shall be accomplished by dipping the tapered thread into a pot of solder maintained at the proper temperature. The tinning temperature range shall be included in the seller's proposed procedures and submitted for approval. The inlet shall be plugged to prevent entry of solder or flux into the port, or solder and flux entering the port shall be completely removed. The body shall be preheated prior to dipping. Excess solder shall be removed and the valve allowed to cool without quenching before the flux residue is removed. All traces of the flux shall be removed.

6.14.7 Assembly

Parts shall be assembled as shown in Figure 11. Cleanliness control shall be exercised to ensure that parts and assemblies are not contaminated during or after assembly. Care shall be exercised during assembly to avoid damage to the threaded elements and to ensure that all packing parts, including a full complement of packing, are installed. During assembly, a very light coat of fluorinated lubricant shall be carefully applied only to the Acme thread of the stem and to the tapered surface of the stem. No lubricant shall be used on any of the other components.

After the packing parts have been installed and with the valve stem fully closed, the packing nut shall be tightened to compress the packing. Only a six-point socket wrench shall be used to apply or break the torque on the nut. The wrench shall be manually operated only. The initial packing compaction shall be in the range of 100 to 110 foot-pounds as measured by an indicating torque wrench. The use of an impact wrench shall not be permitted.

6.14.8 Testing

CAUTION

Air pressure tests shall be applied with extreme caution to prevent personal injury. Pressure shall be raised slowly to the test pressure. The valve packing nut, cap, and body threads shall not be tightened with the valve at high pressure. The pressure shall be bled off before any components are retightened, and the test pressure shall be restored slowly. The air pressure source shall be valved off when the test pressure is attained.

Each valve shall be pressure tested for leak-tightness, as follows:

1) On a test bench of fixture, couple the ¾-inch, 14-NGT inlet to a high-pressure air source, oil free or filtered for elimination of oil.

2) Open and close the valve stem twice, using not more than 10 foot-pounds torque, to seat the valve. An adjustable or indicating torque wrench shall be used. The application of excessive torque will damage the valves and is cause for rejection.

3) Pressure test for seat leakage at 400 psig by bubble bottle, by striking a soap bubble across the face of the valve outlet, or by immersing the valve in water. No leakage shall be permitted. The valve stem shall not be overtorqued to stop a leak.

4) If no seat leakage is found, bleed off the pressure, cap the outlet securely, and open the valve approximately halfway. Pressure test the entire valve to 400 psig. No leakage shall be permitted past the stem, around the cap or packing nut, or through the body, as determined by application of the soap test solution all over the exterior of the valve or by immersion in water.

5) If leakage at the stem or at either cap occurs, the corresponding packing or gasket may be retightened (see "caution" above) and the test repeated. Excessive force shall not be used in an attempt to eliminate the leak. The maximum torque permitted to retighten the packing nut is 110 foot-pounds and to retighten the port cap is 50 ft-lb. An adjustable or indicating torque wrench shall be used for retorquing. Valves that show leakage at the juncture of the packing nut, cap, or coupling threads with the body threads shall be carefully examined for possible porosity in the valve body in the threaded areas. Parts showing any evidence of porosity shall not be used.

6) Valves that fail to pass either pressure test shall be removed from the test fixture and immediately segregated and tagged to prevent mixing with acceptable valves. Valves rejected owing to packing leaks may have the packing replaced and be retested.

7) After a valve has been tested and found acceptable, and while it is still coupled to the test fixture, any soap solution shall be washed off completely with water and the valve blown dry. A semi-permanent mark shall be made on the cap to indicate acceptance.

6.14.9 Packing

Each valve shall be packaged in an individual carton together with a protective packing material to fill voids in the carton and afford protection during shipment and handling. Each carton shall be identified with the lot number appearing on the inspection report. Individual valve cartons shall be placed in containers for shipment, and a copy of the inspection report shall be placed inside each shipping container. Each shipping container shall be sturdily constructed to prevent damage to the contents during shipping. Each shipping container shall be identified with the purchase order number and lot number, in addition to the purchaser's name and address.

6.14.10 Certification

The manufacturer shall certify in writing to the purchaser that the valves comply with all fabrication, test, and cleanliness requirements specified in this standard.

6.15 Cylinder Valve 51 (1 inch) (See Figure 12)

6.15.1 Design Conditions

1) *Design Pressure.* 25 psig external and 200 psig internal.

2) *Design Temperature.* -40°F to 250°F.

3) *Medium.* UF_6.

6.15.2 Material Specifications

1) *Body, Part 1.* Forging, aluminum bronze CDA alloy 636.

2) *Packing Nut, Part 3.* Acceptable materials are (1) Nickel copper alloy, ASTM B164, NO4400, stress relieved at 1100°F plus or minus 10 degrees F for 1 hour to meet ASTM B164 mechanical properties for hot-worked, stress-relieved material; or (2) bar aluminum bronze, ASTM B150, C61300, stress relieved at 800°F plus or minus 10 degrees F for 1 hour and meeting the ASTM B150 mechanical property requirements for C61300 stress-relieved material.

3) *Port Cap,* Part 4. Acceptable materials are (1) bar aluminum bronze, CDA alloy 636. stress relieved at 700°F plus or minus 10 degrees F for 1 hour, surface hardness of the bar

stock after stress relieving shall not exceed Rockwell B85 nor be less than B70, mechanical properties after stress relieving shall be: ultimate tensile strength 45,000 psi minimum, yield strength (0.5% extension) 25,000 psi minimum, elongation in 2 inches 30% minimum; (2) nickel copper alloy, ASTM B164, NO4400, stress relieved at 1100°F plus or minus 10 degrees F for 1 hour to meet ASTM B164 mechanical properties for hot-worked, stress-relieved material; or (3) bar aluminum bronze, ASTM B150, C61300, stress relieved at 800°F plus or minus 10 degrees F for 1 hour and meeting the ASTM B150 mechanical property requirements for C61300 stress-relieved material.

4) *Packing Follower*, Part 5; Packing Ring, Part 7. Acceptable materials are (1) bar aluminum bronze, CDA alloy 636, stress relieved at 700°F plus or minus 10 degrees F for 1 hour, surface hardness of the bar stock after stress relieving shall not exceed Rockwell B85 nor be less than B70, mechanical properties after stress relieving shall be: ultimate strength 45,000 psi minimum, yield strength (0.5% extension) 25,000 psi minimum, elongation in 2 inches 30% minimum; or (2) bar aluminum bronze, ASTM B150, C61300, stress relieved at 800°F plus or minus 10 degrees F for 1 hour and meeting the ASTM B150 mechanical property requirements for C61300 stress relieved material.

5) *Stem*, Part 2. Bar, monel, ASTM B164, Class A or B, cold drawn and stress relieved to 1025°F plus or minus 10 degrees F for 1-1/2 hours.

6) *Packing*, Part 6; Cap Gasket, Part 8. Teflon, 100% Virgin TFE (unfilled)

7) *Solder*. Tin-lead, ASTM B32 with a minimum tin content of 45% such as alloy SN50.

8) *Fluorinated Lubricant*. Occidental-Hooker HO-125 or the equivalent.

CDA alloy 636 has the following composition limits, except that the lead content has been modified as noted:

Element	Percentage
Copper and the sum of other named elements	99.5 min
Lead	0.03 max
Tin	0.20 max
Iron	0.10 max
Silicon	0.7-1.3
Aluminum	3.0-4.0
Nickel	0.15 max
Zinc	0.35 max
Arsenic	0.15 max

Each individual pour shall meet these composition limits.

The valve body shall be forged and shall contain no laps, seams, porosity, or other objectionable defects. The data shown in Figure 12 plus a forging identification symbol, traceable to the heat number(s) from which the forgings were produced, shall be forged, stamped, or engraved into the body. Forgings shall be cleaned to a bright or matte finish and shall have the die-flash removed. No mechanical finishing of the valve body (such as buffing, peeling, grinding, or blasting) shall be permitted.

6.15.3 Material Certification Requirements

The seller shall require the manufacturer(s) of aluminum bronze materials to furnish mill certification, including the results of tests to determine the chemical composition, tensile strength, yield strength, and hardness of the materials. The tests shall be conducted in accordance with the

applicable test methods referenced in ASTM B249. Mill test reports shall be obtained for each separate lot of material produced by a different mill manufacturing process or of a different size, such as forging stock, as-extruded bar, and rolled and tempered (stress-relieved) bar. The mill test reports shall include heat numbers from which the manufactured products were produced.

Mill test reports shall be obtained for each separate lot of material produced by a different mill manufacturing process or of a different size, such as forging stock, as-extruded bar, and rolled and tempered (stress-relieved) bar. The mill test reports shall include heat numbers from which the manufactured products were produced.

The seller shall obtain a manufacturer's certification that the Monel material supplied has been manufactured and tested in accordance with ASTM B164. The seller shall submit certification in writing that all materials requiring mill certification in 6.15.2 conform to the specification requirements.

6.15.4 Manufacturing Requirements

All parts shall conform to the dimensional requirements of Figure 12. In addition to the specific requirements of the drawing, acceptable practices such as deburring, breaking corners, and the like shall be used in the machining and finishing of parts. Close control over the manufacture of threaded elements shall be maintained to meet the drawing requirements. Threads shall conform to applicable American National Standards for manufacturing and gaging, modified as necessary to conform to the drawing. The applicable standards are ANSI/CGA V-1 for tapered NGT thread, ANSI/ASME B1.5 for Acme threads and ANSI/ASME B1.1 for the straight threads.

Packing nuts shall be stress-relieved after completion of finish machining at 1100°F ± 10°F for ASTM B164 material, or 800°F ± 10°F for ASTM B150, C61300 material for a minimum of 1 hour.

6.15.5 Cleaning

Prior to tinning, the valve bodies shall be degreased. Prior to assembly, all parts, including valve bodies, shall be cleaned to remove all traces of machining lubricants, metal chips, and other foreign substances. A chlorinated-hydrocarbon, solvent-degreasing procedure is acceptable for removal of lubricants..

6.15.6 Tinning

Unless specifically waived by the purchaser, one valve body out of every fifty shall be selected at random prior to assembly for purchaser inspection of the inlet threads. If required and not inspected by the purchaser at the manufacturer's facility, the valve shall be shipped without tinning. The remaining bodies shall have the tapered inlet thread tinned over its full length with a uniform coating of tin-lead solder, ASTM B32 with a minimum tin content of 45% such as alloy SN50. The thread roots shall be filled approximately half full. The tinning flux used shall be suitable for use with the aluminum bronze alloy. The composition of the solder in the pot shall be verified as meeting specification prior to its use. Tinning shall be accomplished by dipping the tapered thread into a pot of solder maintained at the proper temperature. The tinning temperature range shall be included in the seller's proposed procedures and submitted for approval. The inlet shall be plugged to prevent entry of solder or flux into the port, or solder and flux entering the port shall be completely removed. The body shall be preheated prior to dipping. Excess solder shall be removed and the valve allowed to cool without quenching before the flux residue is removed. All traces of the flux shall be removed.

6.15.7 Assembly

Parts shall be assembled as shown in Figure 12. Cleanliness control shall be exercised to ensure that parts and assemblies are not contaminated during or after assembly. Care shall be exercised during assembly to avoid damage to the threaded elements and to ensure that all packing parts, including a full complement of packing, are installed. During assembly, a very light coat of fluorinated lubricant shall be carefully applied only to the ACME thread of the stem, the tapered surface of the stem, and the packing nut thread.

After the packing parts have been installed and with the valve stem fully closed, the packing nut shall be tightened to compress the packing. Only a six-point socket wrench shall be used to apply or break the torque on the nut. The torque for initial packing compaction shall be in the range of 120 to 150 foot-pounds as measured by an indicating torque wrench. After the packing has been compressed, the top surface of the packing nut shall be flush with, or be not more than 3/32-inch below, the shoulder of the wrench grip of the stem. Variations outside this range indicate improper packing of nonconforming parts and the deficiency shall be corrected.

6.15.8 Testing

CAUTION

Air pressure tests shall be applied with extreme caution to prevent personal injury. Pressure shall be raised slowly to the test pressure. The valve packing nut, cap, and body threads shall not be tightened with the valve at high pressure. The pressure shall be bled off before any components are retightened, and the test pressure shall be restored slowly. The air pressure source shall be valved off when the test pressure is attained.

Each valve shall be pressure tested for leak-tightness, as follows:

1) On a test bench or fixture, couple the 1-inch, 11-1/2 NGT inlet port to a pressure source of clean dry nitrogen, oil free air, or air filtered for the elimination of oil.

2) Open and close the valve stem twice, using not more than 55 foot-pounds torque, to seat the valve. The use of an adjustable or indicating torque wrench is required. The application of excessive torque will damage the valves and is cause for rejection.

3) Pressure test for seat leakage at 400 psig by bubble bottle, by striking a soap bubble across the face of the valve outlet, or by immersing the valve in water. No leakage shall be permitted. The valve stem shall not be overtorqued to stop a leak.

4) If no seat leakage is found, bleed off the pressure, cap the outlet securely, and open the valve approximately halfway. Pressure test the entire valve to 400 psig. No leakage shall be permitted past the stem, around the cap or packing nut, or through the body, as determined by application of the soap test solution all over the exterior of the valve or by immersion in water.

5) If leakage at the stem or at either cap occurs, the corresponding packing or gasket may be retightened (see "caution" above) and the test repeated. Excessive force shall not be used in an attempt to eliminate the leak. The maximum torque permitted to retighten the packing nut is 150 foot-pounds and to retighten the port cap is 50 foot-pounds. An adjustable or indicating torque wrench shall be used for retorquing. Valves that show leakage at the juncture of the packing nut, cap, or coupling threads with the body threads shall be carefully examined for possible porosity in the valve body in the threaded areas. Parts showing any evidence of porosity shall not be used.

6) Valves that fail to pass either pressure test shall be removed from the test fixture and immediately segregated and tagged to prevent mixing with acceptable valves. Valves rejected due to packing leaks or cap gasket leaks may be repacked or have the cap gasket replaced and retested.

7) After a valve has been tested and found acceptable, and while it is still coupled to the test fixture, any soap solution shall be washed off completely with water and the valve blown dry. A semi-permanent mark shall be made on the cap to indicate acceptance.

6.15.9 Packaging. Unless specifically waived by the purchaser, one untinned valve shall be sent with each lot consisting of fifty valves or less for thread inspection by the purchaser, unless this inspection was performed by the purchaser at the manufacturer's facility. As far as possible, all valves in one lot shall be sent in a single shipment. Each valve shall be packaged in an individual carton together with a protective packing material to fill the voids in the carton and afford protection during shipment and handling. Each carton shall be identified with the lot number appearing on the inspection report, and the cartons containing untinned valves shall be identified.

Individual cartons shall be placed in a common container for shipment, and a copy of the inspection report shall be placed inside the shipping container. The shipping container shall be sturdily constructed to prevent damage to the contents during shipping. The shipping container shall be identified with the purchase order number and lot number, in addition to the purchaser's name and address.

6.15.10 Certification. The manufacturer shall certify in writing to the purchaser that the valves comply with all fabrication, test, and cleanliness requirements specified in this standard.

7. Outer Protective Packagings

7.1 General

Outer protective packagings are essential for the protection of cylinders against the release of UF_6 enriched to more than 1 wt % from puncture or fire should a transportation accident occur. A breach of the cylinder could allow uncontrolled geometrics of enriched UF_6 which could result in a criticality incident. Proper maintenance of the outer protective packaging is essential so that the integrity of the package as fire and shock resistant housing will be assured. The outer protective packaging shall be kept structurally sound, provide a tight seal between the cover and base and be protected from damage to the insulation by moisture. The minimum inspection and maintenance requirements are listed in 7.4.

7.2 Design

7.2.1 Design Certification

Outer protective packaging for the transport of non-LSA enriched UF_6 shall be designed and fabricated in accordance with the appropriate specification in 49 CFR, Part 178 [6] or in accordance with the requirements of an NRC or DOE Certificate of Compliance.

7.2.2 NRC Certified Outer Protective Packaging Designs

A listing of NRC certified designs can be found in the Directory of Certificates of Compliance for Radioactive Material Packages, NUREG-0383.

7.3 Fabrication

7.3.1 Manufacturer's Qualifications

All outer protective packagings, including DOT specification or DOE or NRC approved designs, shall be fabricated in accordance with an NRC approved quality assurance plan meeting the requirements of 10 CFT 71, Subpart H or ANSI/ASME NQA-1c and ANSI/ASME NQA-1, or both. Prior to fabrication, a specific quality assurance plan shall be prepared for the manufacture of the protective packaging to be fabricated. The specific quality assurance plan shall meet the requirements of and be approved by NRC, DOE, or other regulatory body having jurisdiction of the procurement.

7.3.2 Fabrication Tests and Certifications

The manufacturer shall fabricate the outer protective packaging in accordance with 49 CFR, Part 178 [6] or drawing approved in an NRC or DOE Certificate of Compliance. The manufacturer shall provide a certificate for the weight of each completed packaging. The tare weight shall also appear on the packaging nameplate. The scales used for the weight certificate shall be accurate to ±0.1%. All welding shall be performed by ANSI/AWS or ANSI/ASME code qualified welders qualified in accordance with Section IX for the ANSI/ASME Boiler and Pressure Vessel Code or Section 5 of the ANSI/AWS D1.1. The manufacturer shall provide the owner with certifications of weld procedures, welder qualifications and other certifications necessary to confirm that the packaging meets the requirements of 49 CFR Part 178 and ANSI N14.1. The owner shall retain copies of all certifications and other manufacturing data furnished by the manufacturer throughout the use or ownership of the protective packaging.

7.4 In-Service Inspections and Maintenance.

7.4.1 Routine Operational Inspection

The outer protective packaging shall be inspected by each shipper or by an agent of the shipper in accordance with written inspection procedures prior to each use to ensure its integrity. The inspection shall be documented on an inspection form prepared specifically for each type of outer protective packaging used. The following shall be cause for further investigation or removal from service for repair: excessive warping, distortion, or other damage of the liner or shell that would prevent a tight closure of the package, allow excessive clearance from the inner container with the liner, reduce the assembly fastener strength of the container, reduce the thermal insulation thickness in any area or otherwise make the integrity of the outer protective package questionable as a fire and shock resistant housing. The outer protective packaging shall also be inspected for evidence of leakage of water into the packaging. Any evidence of water leakage shall require an investigation of the packaging to determine the amount of water present in the packaging. The packaging may be required to have the weight recertified if found necessary by the investigation. The water shall be removed prior to repair of the outer protective packaging. Any nonconforming conditions found by the qualified inspector shall be referred to personnel designated by the shipper to evaluate for the use, repair, or condemnation of protective packaging. The representative of the shipper shall contact the owner and user of the protective packaging for recommendations concerning any repair or modification of the packaging.

7.4.2 Periodic Inspections, Tests, and Recertification

In addition to the routine inspections performed prior to each use, each protective packaging shall be recertified every 5 years. This recertification shall include the inspections specified in 7.4.1 and detailed inspection for degradation of welds and the presence of rusting of the protective packaging. Welds shall receive a full visual inspection for the presence of cracks. Any weld defect shall be repaired in accordance with 7.4.3 prior to returning the protective packaging to service. Any questionable condition of a weld shall be subject to further examination, such as dye penetration testing, to assure that no cracks are present. Outer protective packaging shall receive a full visual inspection for rusting and the presence of corrosion. This inspection shall include assurance that corrosion has not reduced the skin wall thickness by 10% of the nominal thickness. When visual inspection cannot assure sufficient wall thickness, other examinations shall be utilized, such as ultrasonic testing, to assure acceptability.

7.4.3 Repairs. All repairs shall be performed by competent sources. All repairs that require welding shall be made by welders who are qualified in accordance with Section IX of the ANSI/ASME Boiler and Pressure Vessel Code or Section 5 of the ANSI/AWS D1.1. The repair shop shall provide certification of weld procedures and welder qualifications. Any repairs that required partial or total replacement of the insulation shall be performed in accordance with an NRC approved quality assurance plan meeting the requirements of 10 CFR 71, Subpart H or ANSI/ASME NQA-1, or both. Caution should be exercised to perform welding in a manner that does not damage adjacent thermal insulation or wood material by charring. Any repairs that result in a significant weight change should be cause for recertification of total outer protective packaging weight.

8 Shipping

8.1 Cylinders

8.1.1 Full Cylinders

Full cylinders to be shipped shall be packaged as specified in clause 5 and when shipped by truck should be shipped on semi-trailers meeting the requirements of ANSI N14.30.

8.1.2 Empty Cylinders. Empty cylinders with valve protection may be shipped without outer protective packaging provided the residual quantities ("heels") of uranium, considered to be in the form of UF_6 are not exceeded as follows:

Cylinder Model #	Heel (lb)	Heel (kg)	Max. ^{235}U, wt%
5A or 5B	0.1	0.045	100.00
8A	0.5	0.227	12.50
12A or 12B	1.0	0.454	5.00
30B*	25.0	11.3	5.00
48A^ or 48X	50.0	22.7	4.50
48F^ or 48Y	50.0	22.7	4.50
48G or 48H	50.0	22.7	1.00
48O, 48OM			
Allied or 48T	50.0	22.7	1.00

* This cylinder replaces the 30A cylinder. The 30A cylinder has the same heel and maximum ^{235}U limit as the 30B.

^ Cylinder 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

8.1.3 Cylinders

Clean cylinders, including new cylinders may be shipped with no special precautions other than those used in normal operations, provided the shipper is confident that no residual contamination remains in the cylinder that has specific activity that exceeds 0.002μ Ci/g (which would classify it as a radioactive material in accordance with 49 CFR 173.403). If this condition cannot be assured, the cylinder shall be shipped in accordance with 49 CFR 173.427 or clause 5 of this standard and applicable DOT regulations. All bare cylinders shall incorporate a feature such as a seal that, while intact, shall provide assurance that the package has not been illicitly opened.

8.2 Valve Protectors and Seals

Valve protectors shall be used on all cylinders (except new and cleaned ones) that are not contained in an outer protective package during shipment. All UF_6 packages when shipped shall incorporate a feature, such as a seal which, while intact, shall provide assurance that the package has not been illicitly opened.

8.3 Labeling

Packages shall be shipped in accordance with 5.2.1 (nonexclusive use LSA Material shipment) and 49 CFR 172.403. The package label shall be selected in accordance with 8.3.1 through 8.3.4.

8.3.1 Radioactive White-I Label

The white-I label shall be used for radiation not exceeding 0.5 millirem per hour at any point on the external surface of the package. The white label is not authorized for Fissile Class II packages.

8.3.2 Radioactive Yellow-II Label

The yellow-II label shall be used for packages exceeding the white-I limits but which have radiation levels not exceeding 50 millirem/hour at the package surface or a transport index exceeding 1.0.

8.3.3 Radioactive Yellow-III Label

The yellow-III label shall be used for packages exceeding the yellow-II limits, that is, with radiation levels exceeding 50 millrem/hour at the package surface or a transport index exceeding 1.0.

8.3.4 Corrosive Labels

Corrosive labels shall be applied to all packages containing UF_6 except those transported in accordance with 5.2.2. (exclusive use LSA shipments) or 8.1.3 (when the cylinder is sufficiently clean to be classed nonradioactive or is shipped in accordance with 49 CFR 173.428 for empty packaging).

8.4 Placarding

8.4.1 Radioactive Placards

"Radioactive" placards shall be displayed on all conveyances transporting uranium hexafluoride in accordance with 5.2.2, and on all conveyances transporting a package labeled "Radioactive Yellow-III."

8.4.2 Corrosive Placards

"Corrosive" placards shall be displayed on all conveyances transporting UF_6 for which the gross weight of UF_6 plus packaging exceeds 1000 pounds.

8.5 Marking

8.5.1 Low Specific Activity UF_6 in Less Than Truckload (Nonexclusive Use) Conditions

Cylinders transported in accordance with 5.2.1 shall be marked with:

1) USA DOT 7A Type A
2) Radioactive material
3) Uranium hexafluoride, low specific activity.
4) UN 2978
5) Name and address of consignor or consignee
6) Gross weight

8.5.2 Low Specific Activity UF_6 Under Exclusive Use Conditions

Cylinders transported in accordance with 5.2.2 shall be marked "RADIOACTIVE-LSA" in accordance with 49 CFR 173.427(a) (6) (vi).

8.5.3 Marking of Packages of UF_6 Enriched to Greater Than 1 wt% ^{235}U

Packages used to transport UF_6 enriched to greater than 1 wt% ^{235} U shall be marked as follows as specified in the applicable NRC certificate of compliance or DOT/IAEA competent authority certificate and DOT regulations:

1) Bare cylinders containing "heels" shall comply with 8.5.1.
    a) USA DOT 7A Type A
    b) Radioactive material
    c) Uranium hexafluoride, fissile
    d) UN 2977
    e) Name and address of consignor or consignee.
    f) Gross weight

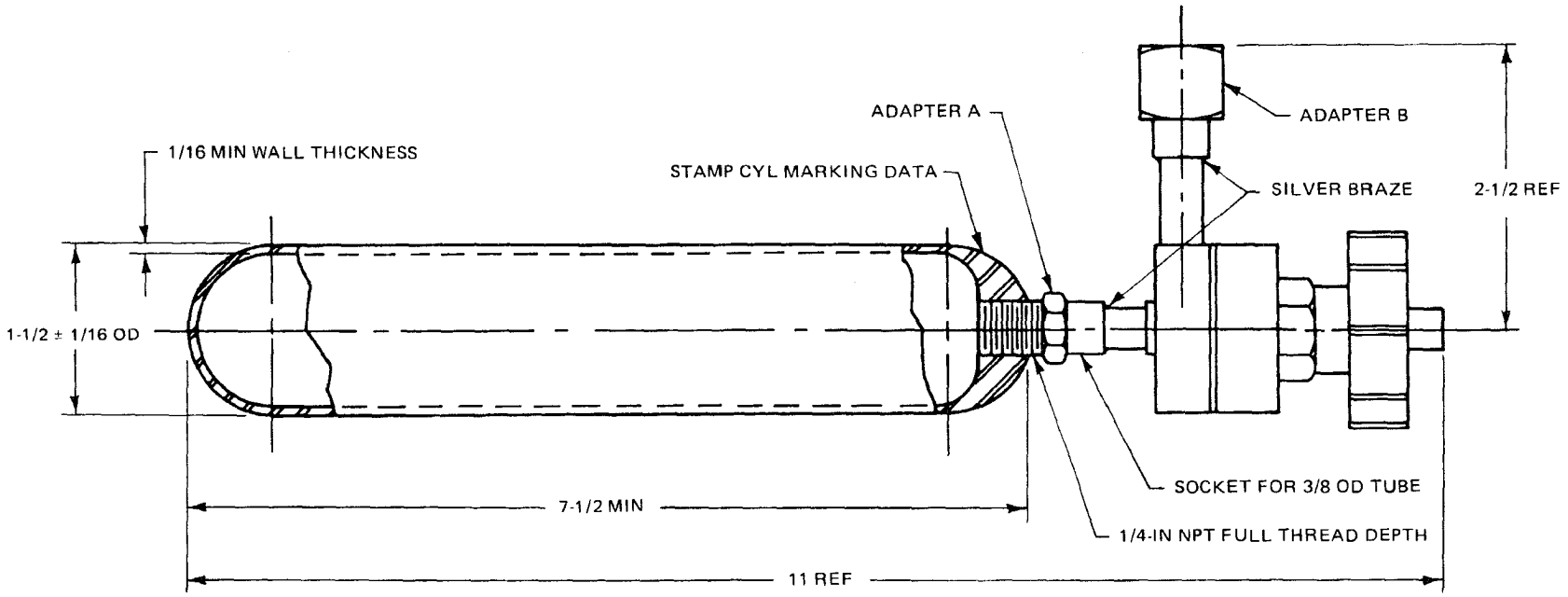
2) DOT specification outer protective packages shall be marked with the DOT specification number in conjunction with "USA-DOT-" (for example, "USA-DOT-21PF-1B").

3) NRC and DOE certified outer protective package designs and DOT specification outer protective packages that will be exported shall be marked with the package design identification number, such as "USA/9196/AF"

4) All outer protective packages shall be marked per DOT regulations:
    a) Uranium hexafluoride, fissile
    b) UN 2977
    c) Name and address of consignor or consignee
    d) Gross weight
    e) Type A

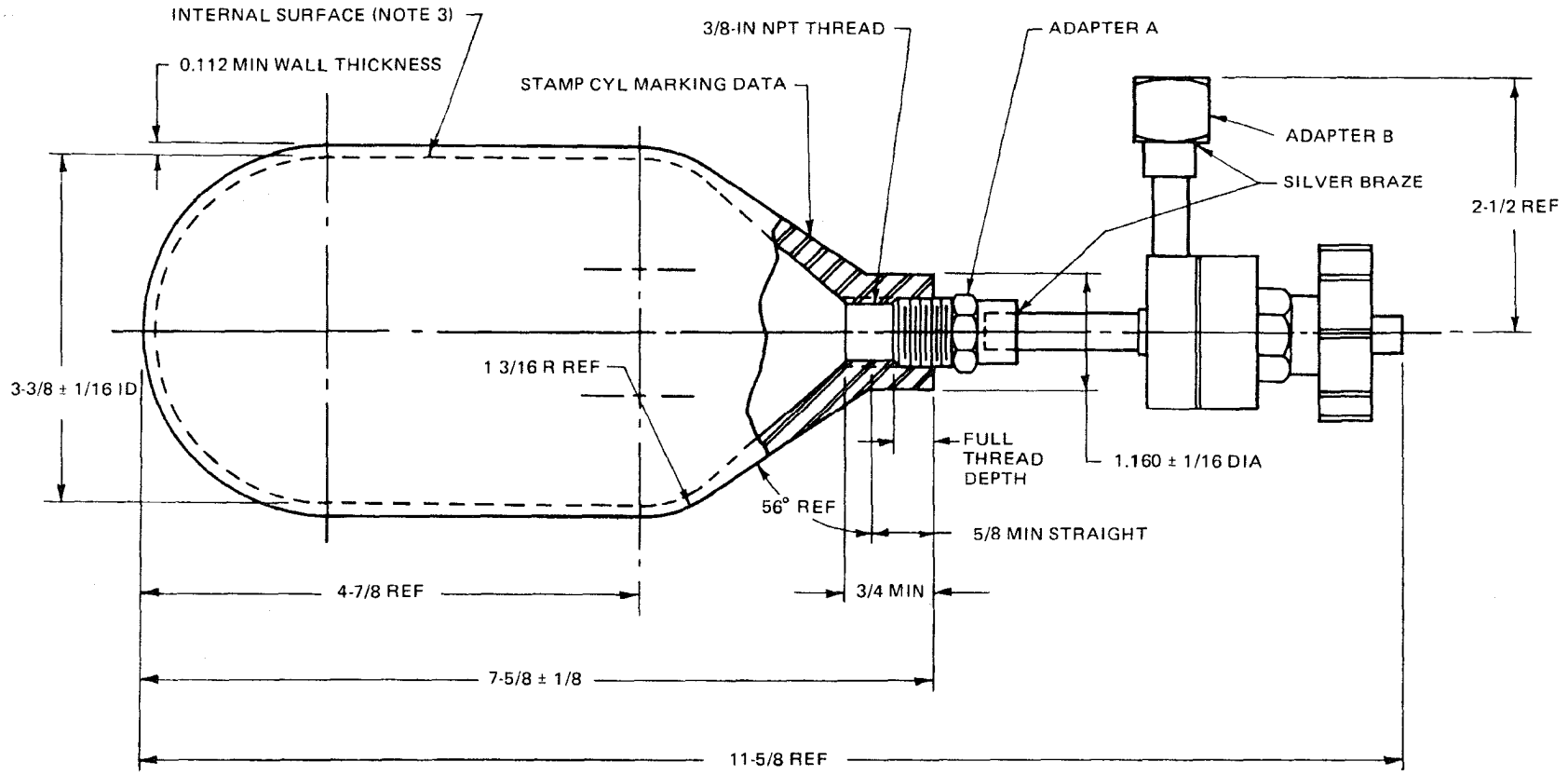
8.6 Shipping Papers

Complete transportation documentation (shipping) papers shall accompany each shipment. All of the information required by the DOT regulations (49 CFR Part 172, Subpart C) shall be included.



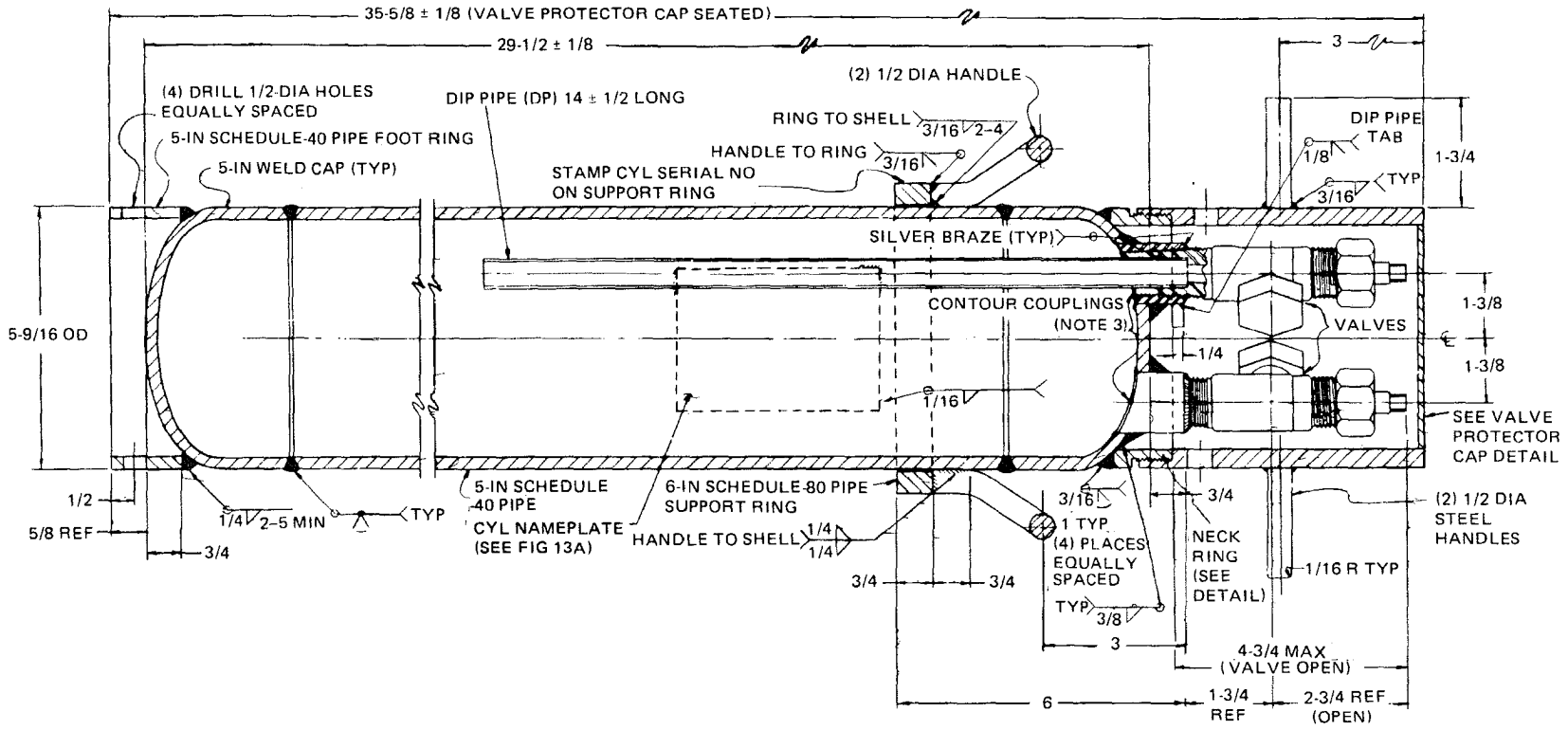
NOTES:
(1) All dimensions are in inches.
(2) Modify the valve to fit the end connections shown.

Figure 1 - UF_6 Cylinder 1S (See 6.4)



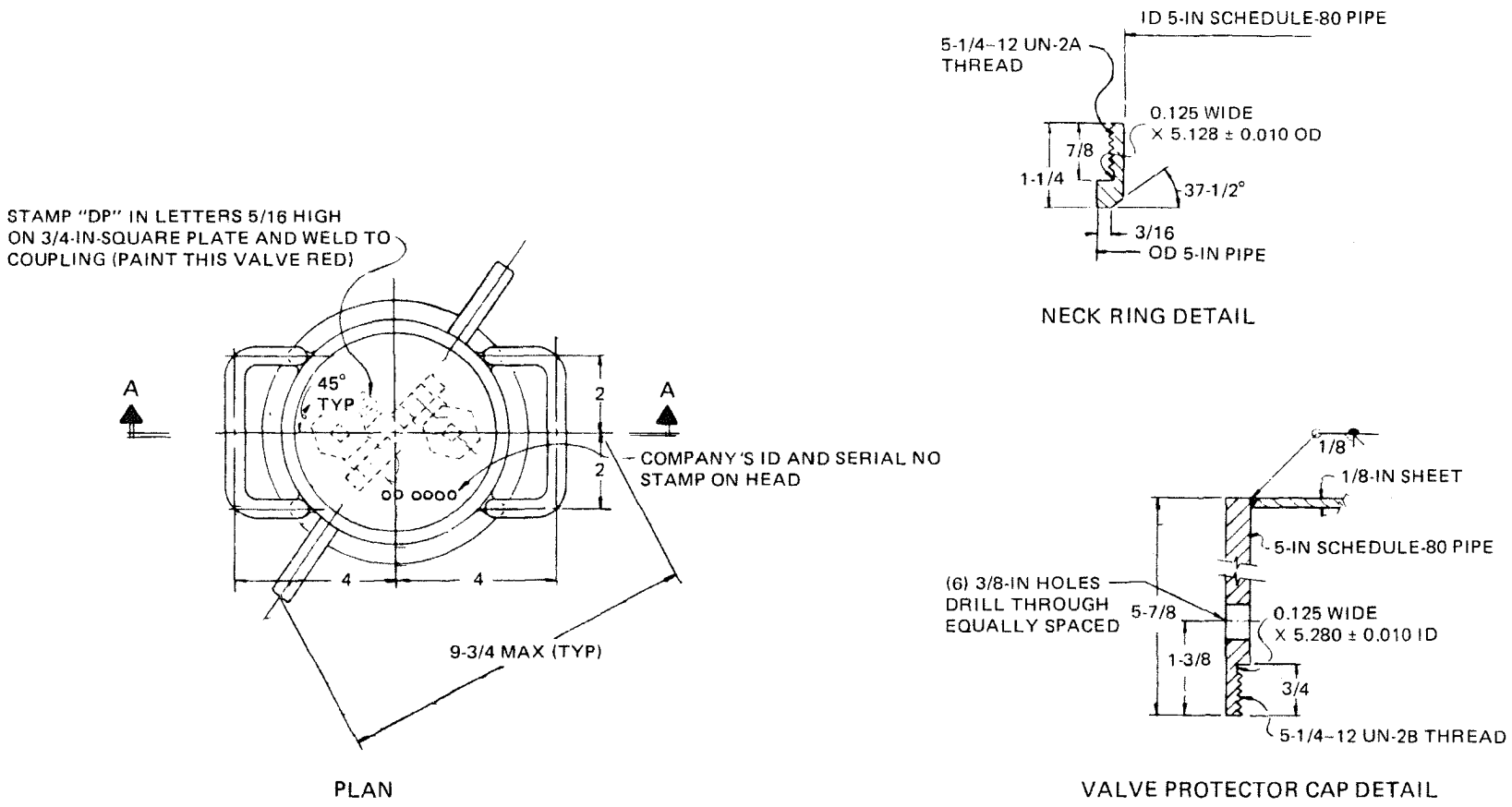
NOTES:
(1) All dimensions are in inches.
(2) Modify the valve to fit the end connections shown.
(3) Internal surfaces shall be free of cracks, fissures, or folds. Smooth ripples incident to forming will be permitted.

Figure 2 - UF_6 Cylinder 2S (See 6.5)



SECTION A-A

Figure 3 - UF_6 Cylinder 5B (See 6.6) *(continued)*



NOTES:
(1) All dimensions are in inches.
(2) Dimensional tolerances are ±1/16 inch unless otherwise indicated. Angular tolerances are ±2°.
(3) Contour couplings shall be flush or concave to the pipe cap inner surface.

Figure 3 - *(concluded)*

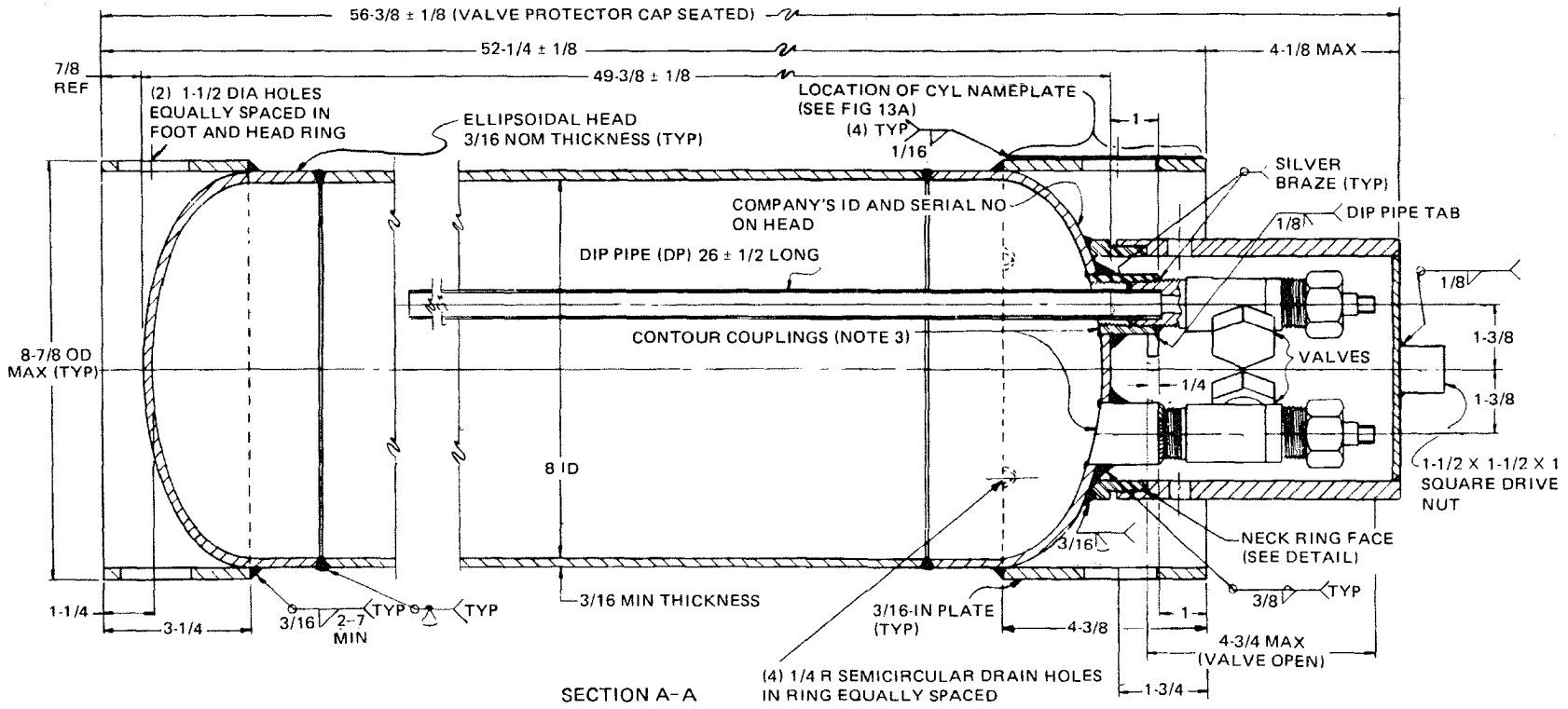
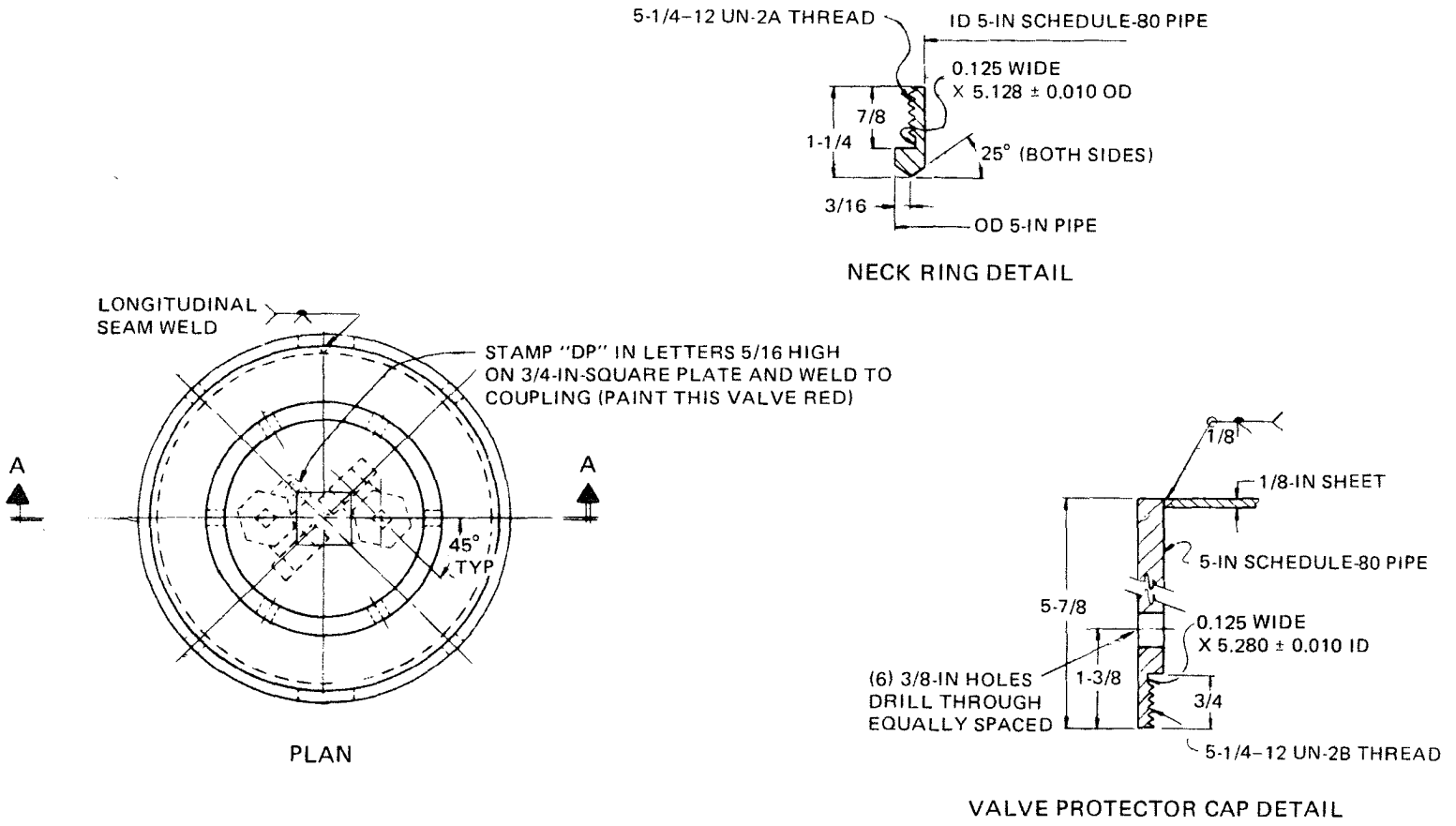


Figure 4 - UF_6 Cylinder 8A (See 6.7) *(continued)*



NOTES:
(1) All dimensions are in inches.
(2) Dimensional tolerance are ±1/16 inch unless otherwise indicated. Angular tolerances are ±2°.
(3) Contour couplings shall be flush or concave to the pipe cap inner surface.

Figure 4 - *(concluded)*

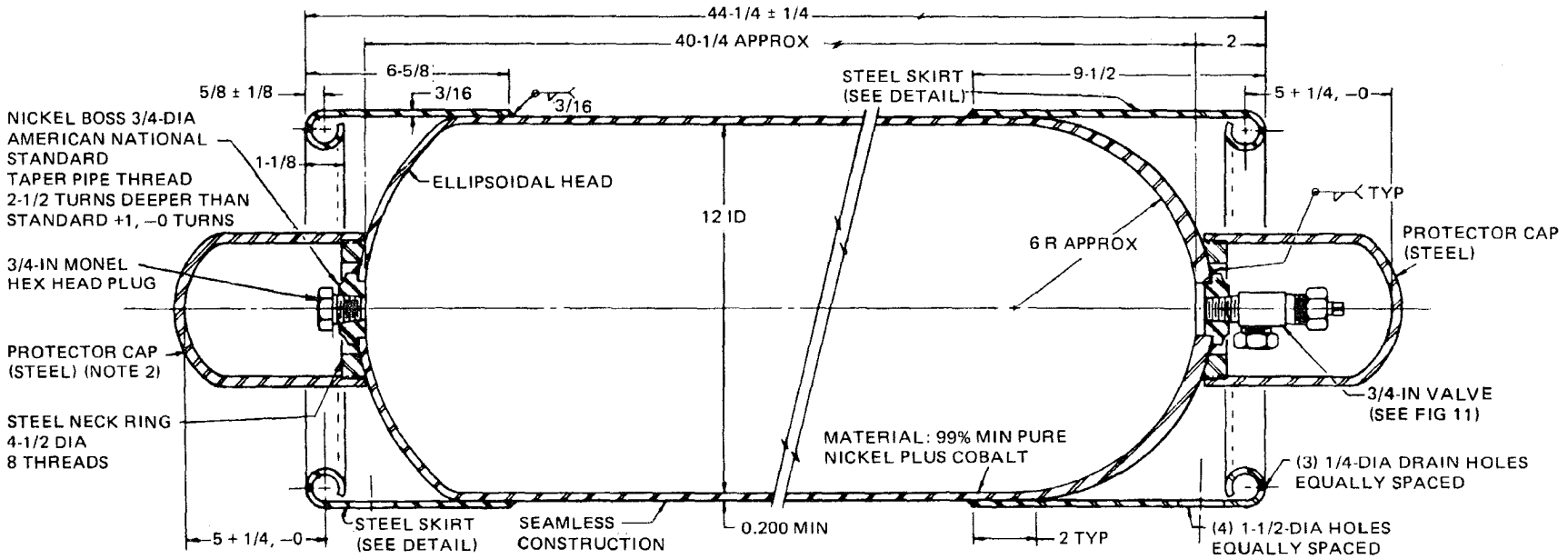
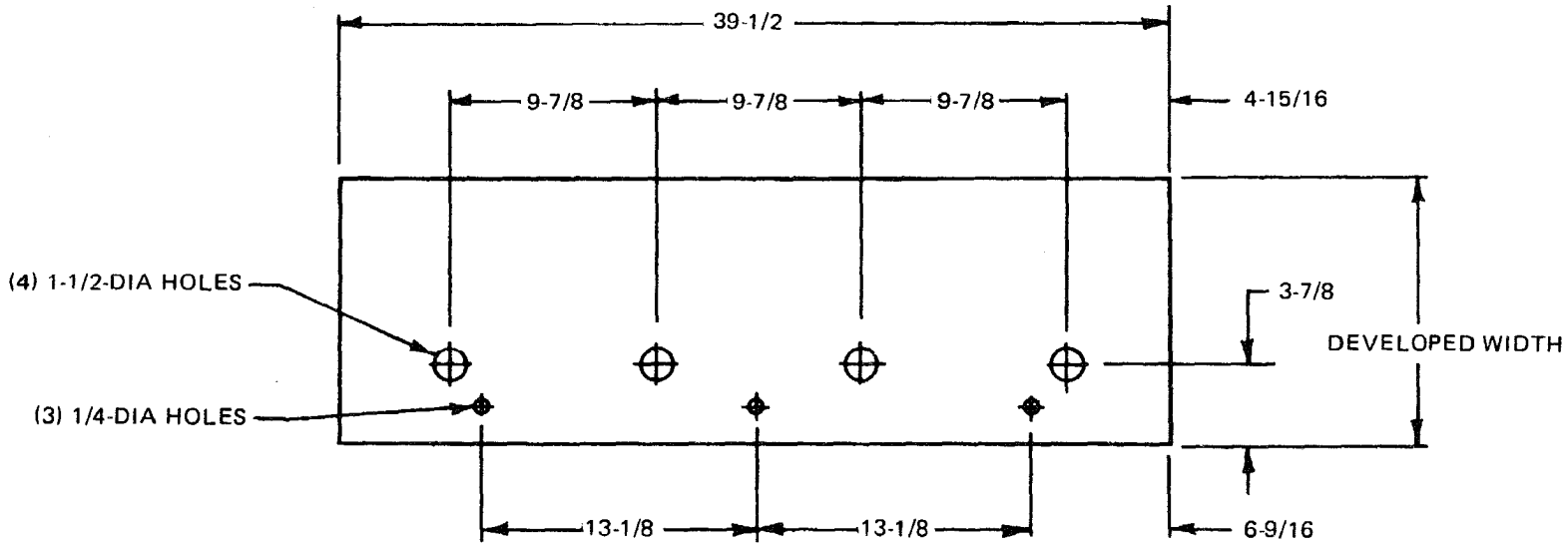


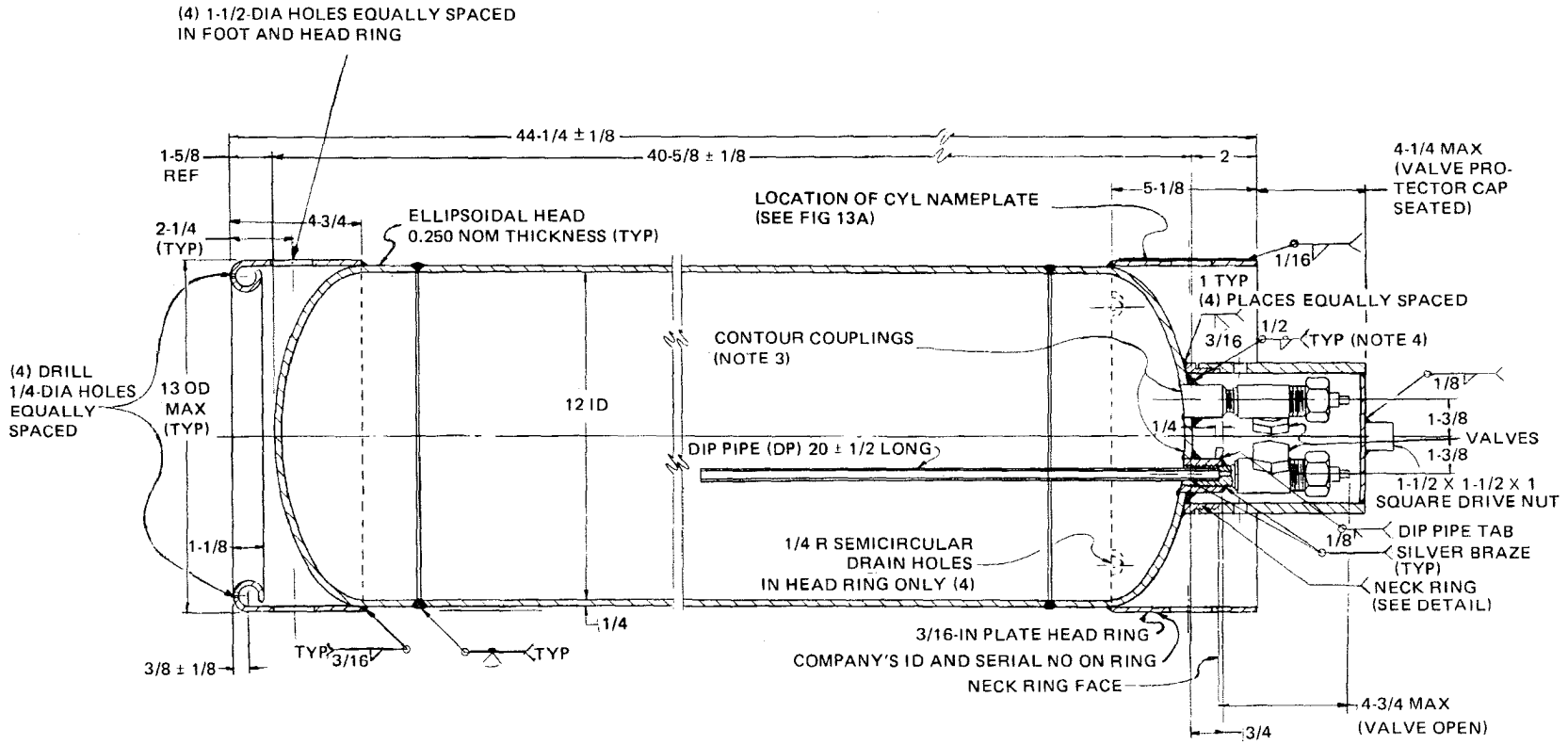
Figure 5 - UF_6 Cylinder 12A (Deleted) (See 6.8) *(continued)*



SKIRT DETAIL

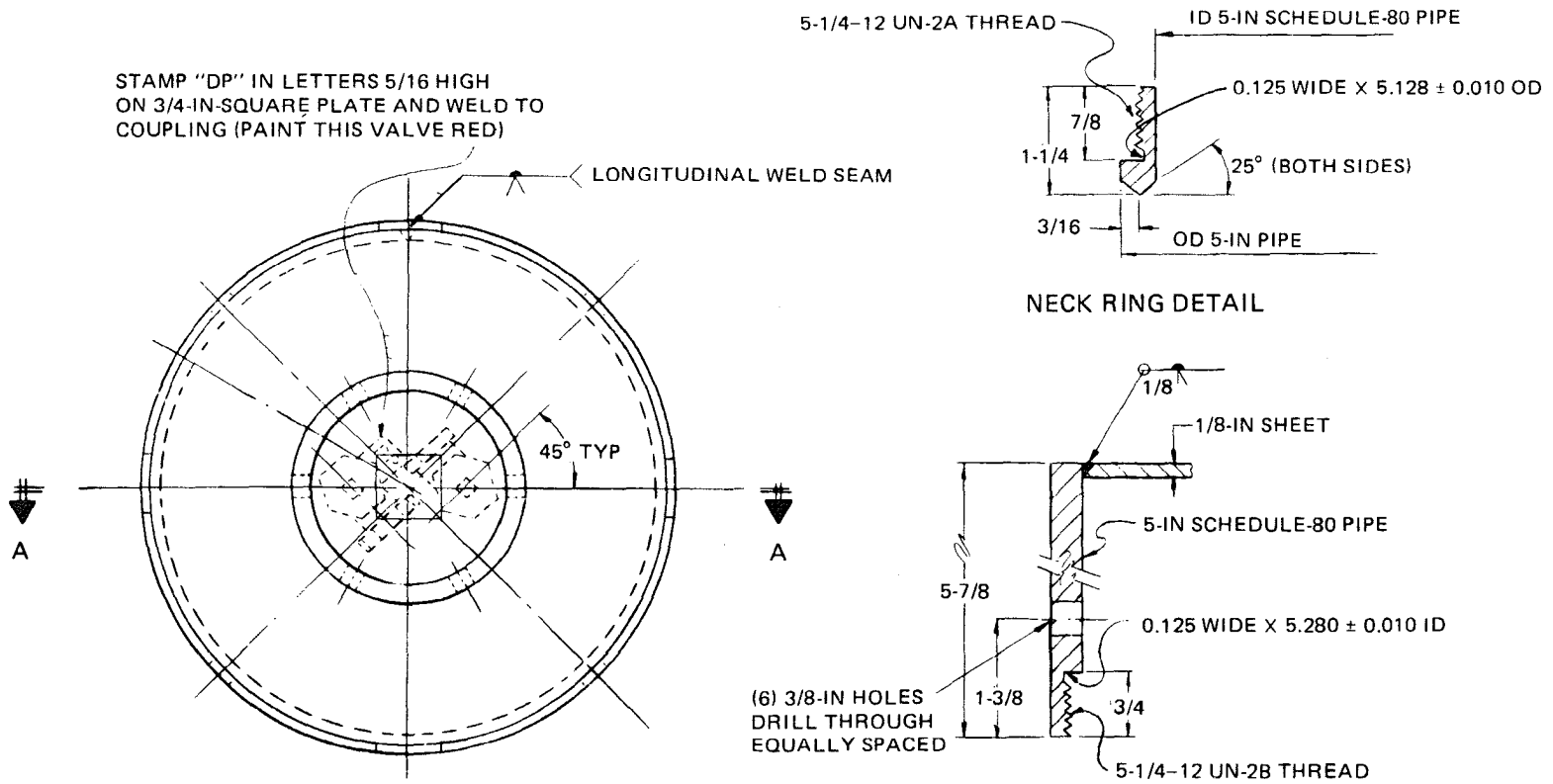
NOTES:
(1) All dimensions are in inches.
(2) Use flat-type cap on this end when shipping with protective package.

Figure 5 - *(concluded)*



SECTION A-A

Figure 6 - UF_6 Cylinder 12B (See 6.9) *(continued)*



NOTES:
(1) All dimensions are in inches.
(2) Dimensional tolerances are ±1/16 inch unless otherwise indicated. Angular tolerances are ±2°.
(3) Contour couplings shall be flush or concave to the cylinder head inner surface.
(4) Grind neck ring at weld interference.

Figure 6 - *(concluded)*

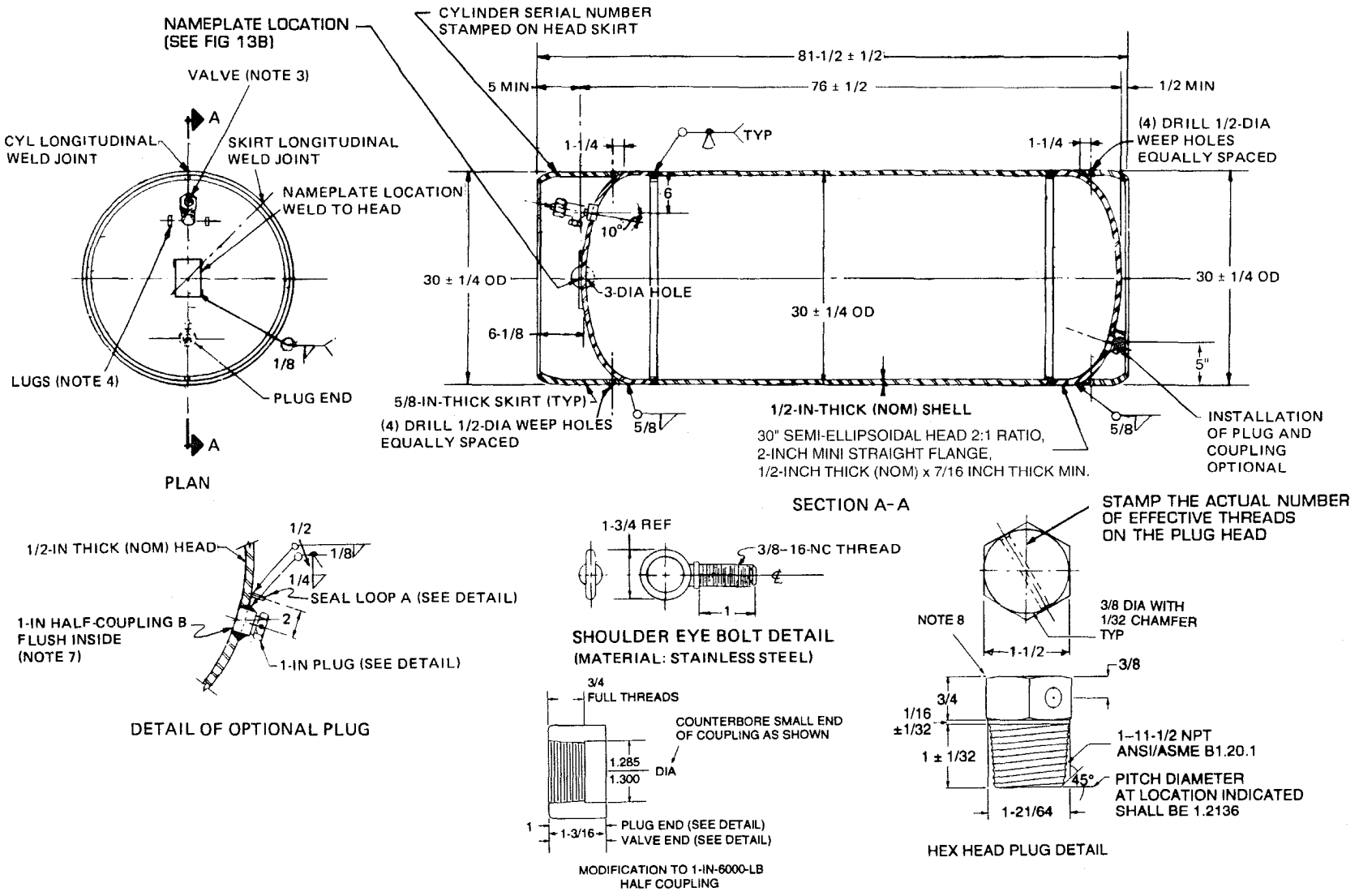
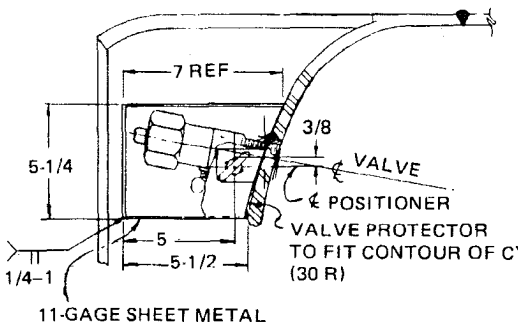
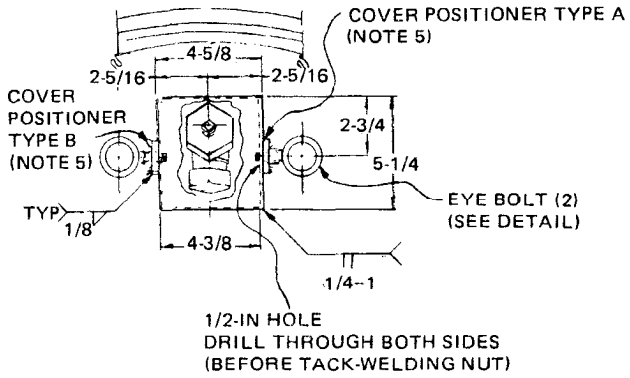
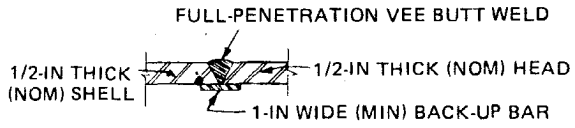


Figure 7 - UF_6 Cylinder 30B (See 6.10) *(continued)*

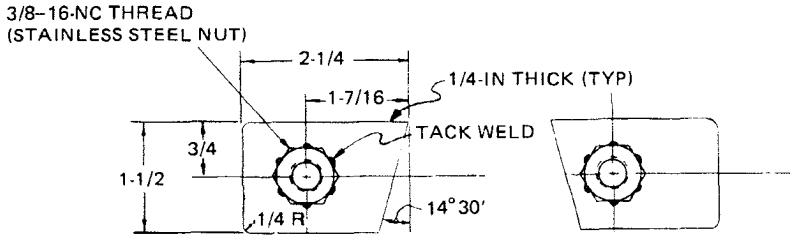




VALVE PROTECTOR DETAILS

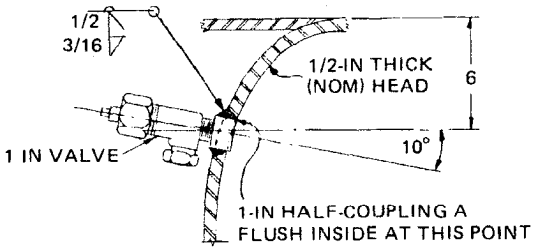


SUGGESTED HEAD-TO-SHELL SEAM

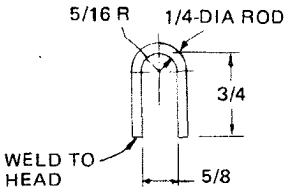


COVER POSITIONER
TYPE A

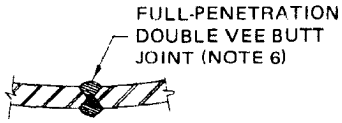
COVER POSITIONER
TYPE B
(OPPOSITE HAND)



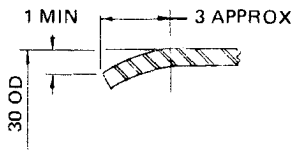
VALVE



SEAL LOOP A



SUGGESTED LONGITUDINAL
SHELL SEAM



STANDARD CHIME RING DETAIL

NOTES:

(1) All dimensions are in inches.

(2) Dimensional tolerances are ±1/16 inch other than thickness unless otherwise indicated. Angular tolerances are ±2°.

(3) Install the valve under the longitudinal weld joint of the cylinder. The valve outlet shall line up on the centerline of the cylinder as shown.

(4) Weld the lugs for the valve protector to the head.

(5) Cover positioner types A and B shall be parallel to each other and accurately located on the cylinder before welding in place. The sheet metal cover may be used as a locating jig.

(6) Locate on vertical centerline at top.

(7) Loop may be provided on top of the plug for sealing as an option to drilling a hole in the plug.

(8) If the cylinder is fabricated using the spiral weld process, start the sprial weld 2" below the horizontal center line.

Figure 7 - *(concluded)*

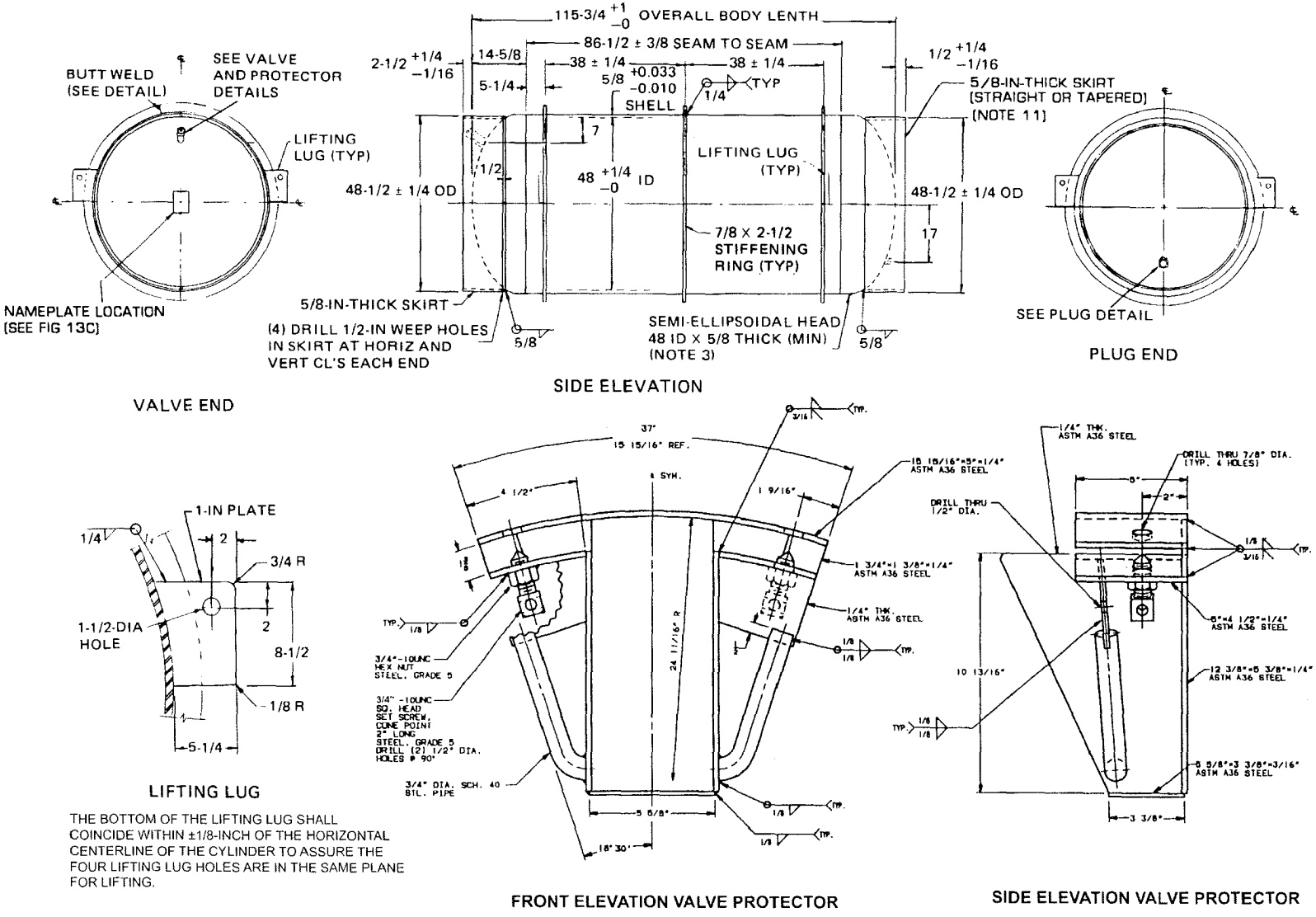
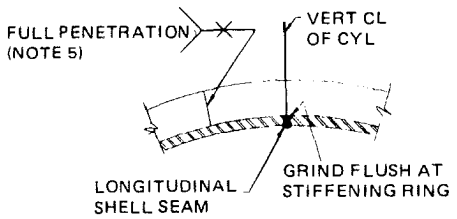
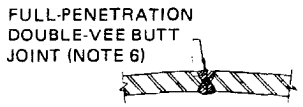


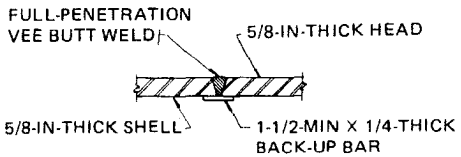
Figure 8 - UF_6 Cylinder 48X (See 6.11) *(continued)*



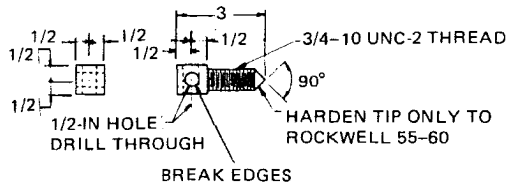
JOINT WELD IN STIFFENING RING



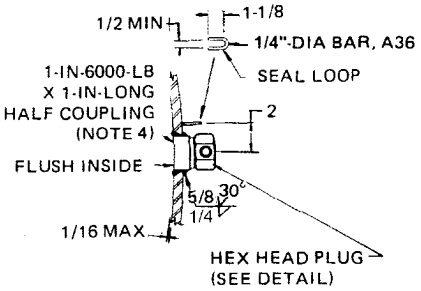
LONGITUDINAL SHELL SEAM



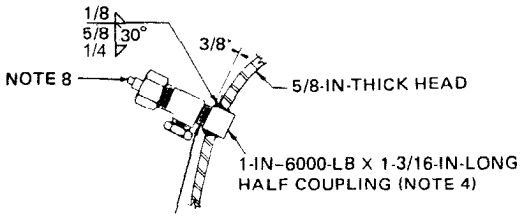
SUGGESTED HEAD-TO-SHELL SEAM



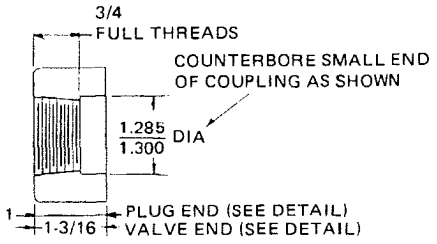
SET SCREW DETAIL



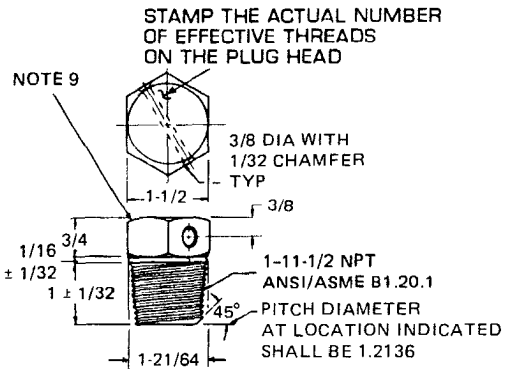
PLUG DETAIL



VALVE DETAIL



MODIFICATION TO 1-IN-6000-LB
HALF COUPLING



HEX HEAD PLUG DETAIL
(NOTE 10)

NOTES

(1) All dimensions are in inches.

(2) All tolerances are ±1/16 inch other than thickness unless otherwise indicated.

(3) Shall be in accordance with UG-32-D of the ANSI/ASME Code with 2-inch straight flange (both ends).

(4) Shall be in accordance with ASTM A105, 1-11-1/2 NPT. Chase threads after welding. Modify prior to installation as shown in detail.

(5) Locate joint near top between lifting lugs.

(6) Locate on vertical centerline at top.

(7) Fillet welds shall be in accordance with 3.6 of ANSI/AWS D1.1-90 in addition to the requirements of the ANSI/AMSE Code, Division 1, Section VIII.

(8) Install valve perpendicular to head tangent and orient the valve outlet downward as shown on the vertical centerline of the cylinder.

(9) Loop may be provided on top of the plug for sealing as an option to drilling a hole in plug.

(10) 1-1/2-11-1/2 NPT plug and plug coupling may be used as an option to the 1-11-1/2 NPT plug.

(11) A 20° tapered skirt may be used in lieu of the straight skirt shown on the plug end of the cylinder.

(12) If the cylinder is fabricated using the spiral weld process, start the spiral weld 2" below the horizontal center line.

Figure 8 - *(concluded)*

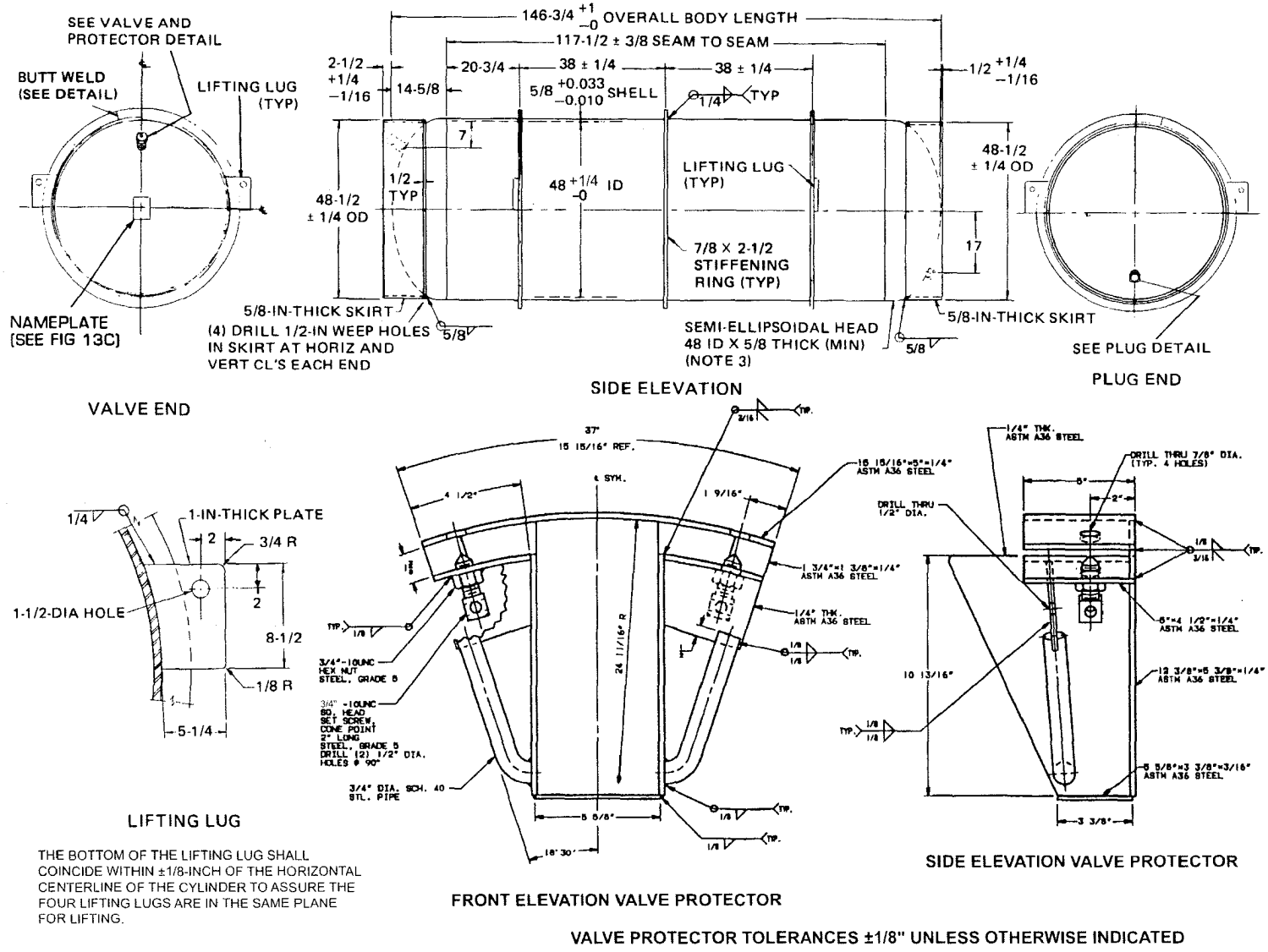
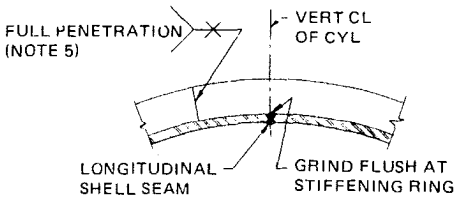
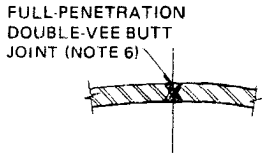


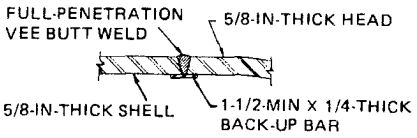
Figure 9 - UF_6 Cylinder 48Y (See 6.12) *(continued)*



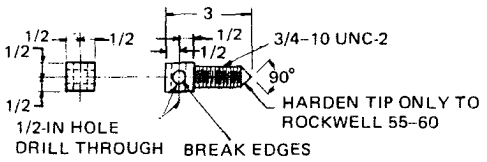
JOINT WELD IN
STIFFENING RING



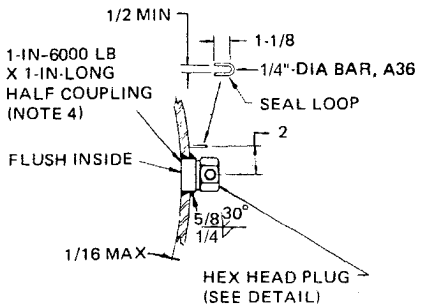
LONGITUDINAL SHELL SEAM



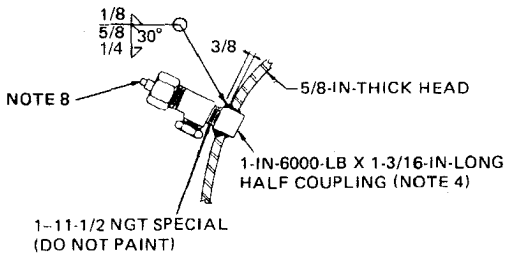
SUGGESTED HEAD-TO-SHELL SEAM



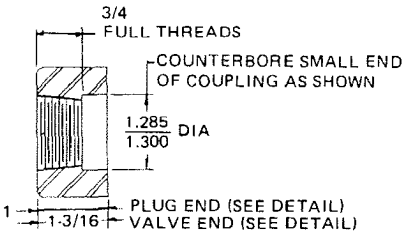
SET SCREW DETAIL



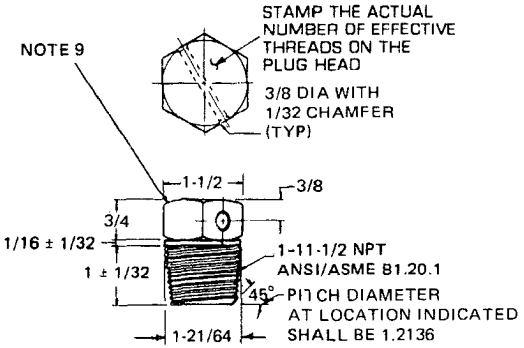
PLUG DETAIL



VALVE DETAIL



MODIFICATION TO
1-IN-6000-LB HALF COUPLING



HEX HEAD PLUG DETAIL
(NOTE 10)

NOTES:

(1) All dimensions are in inches.

(2) All tolerances are ±1/16 inch other than thickness unless otherwise indicated.

(3) Shall be in accordance with UG-32-D of the ANSI/ASME Code with 2-inch straight flange (both ends).

(4) Shall be in accordance with ASTM A105, 1-11-1/2 NPT. Chase threads after welding. Modify prior to installation as shown in detail.

(5) Locate joint near top between lifting lugs.

(6) Locate on vertical centerline at top.

(7) Fillet welds shall be in accordance with 3.6 of ANSI/AWS D1.1-90, in addition to the requirements of the ANSI/ASME Code, Division 1, Section VIII.

(8) Install valve perpendicular to head tangent and orient the valve outlet downward as shown on the vertical centerline of the cylinder.

(9) Loop may be provided on top of the plug for sealing as an option to drilling a hole in the plug.

(10) 1-1/2-11-1/2 NPT plug and plug coupling may be used as an option to the 1-11-1/2 NPT plug.

(11) If the cylinder is fabricated using the spiral weld process, start the sprial weld 2" below the horizontal center line.

(12) A 20° tapered skirt may be used in lieu of the straight skirt shown on the plug end of the cylinder.

Figure 9 - *(concluded)*

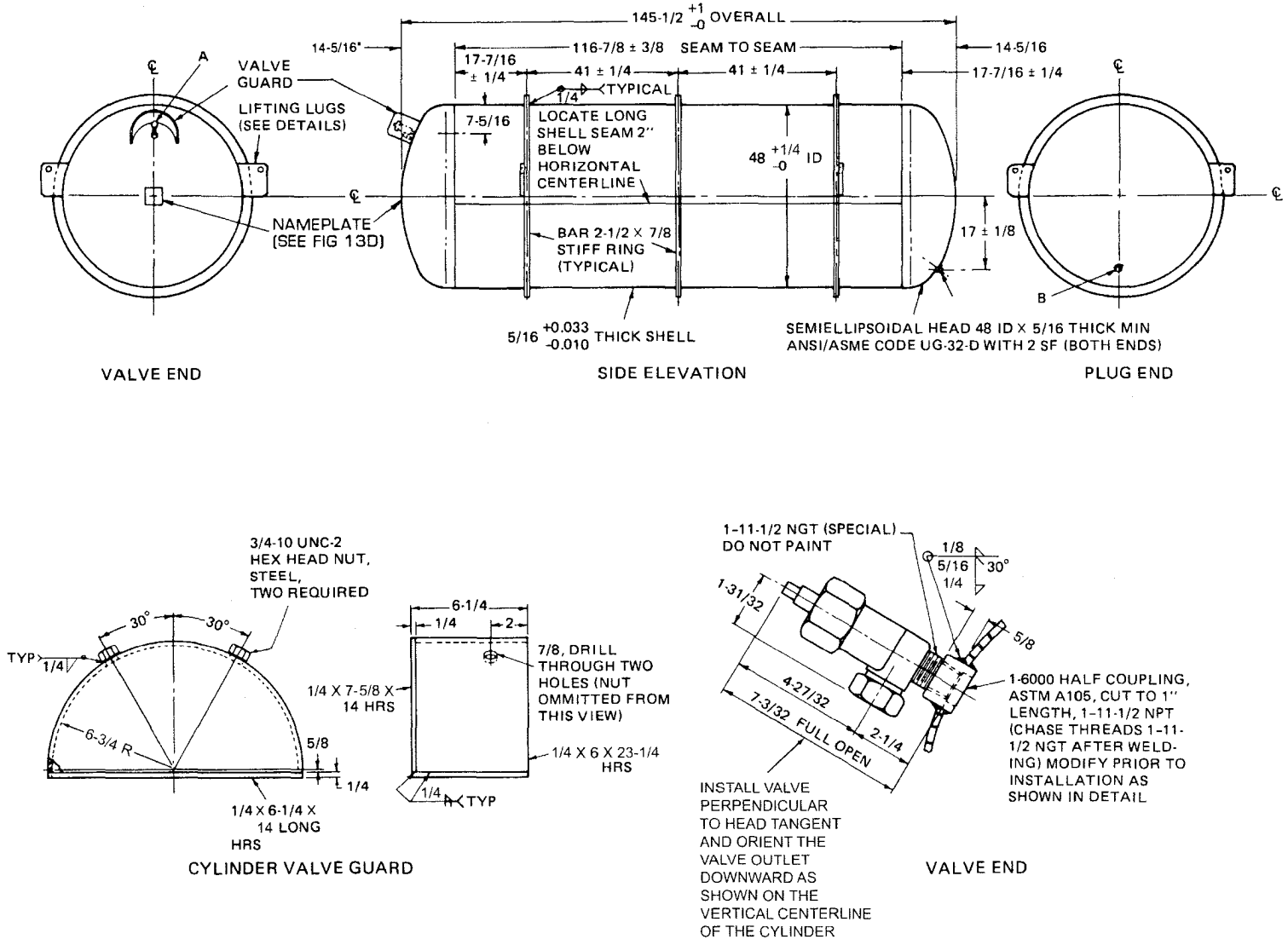
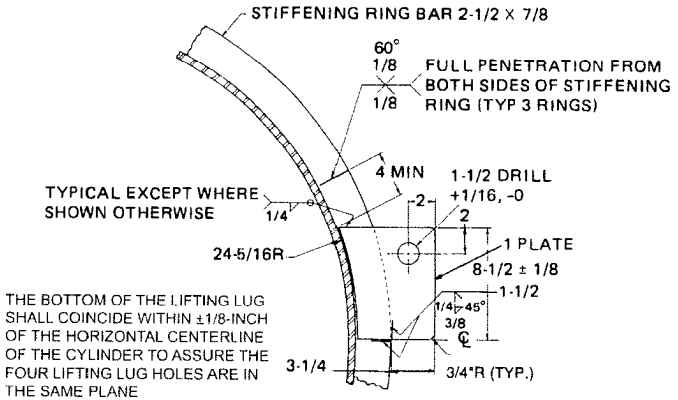
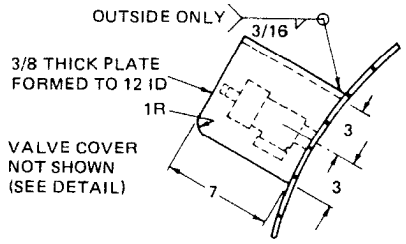


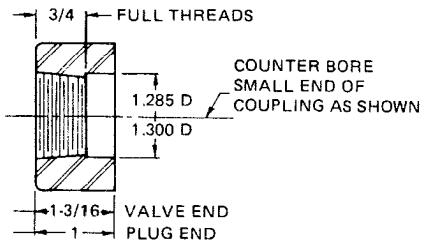
Figure 10 - UF_6 Cylinder 48G (See 6.13) *(continued)*



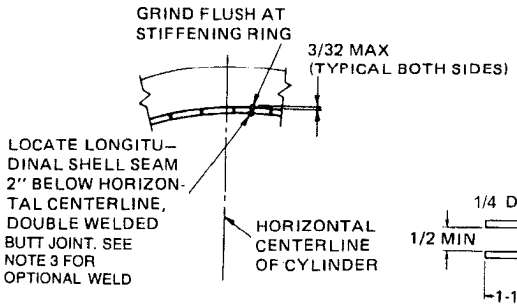
LIFTING LUG DETAIL



VALVE GUARD

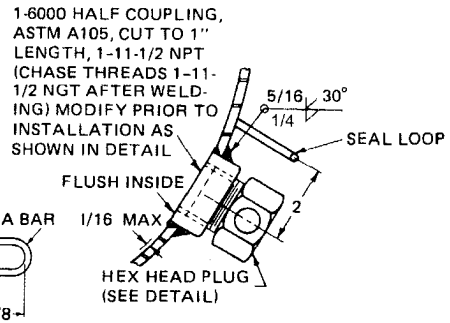


MODIFICATION TO 1-6000 HALF COUPLING

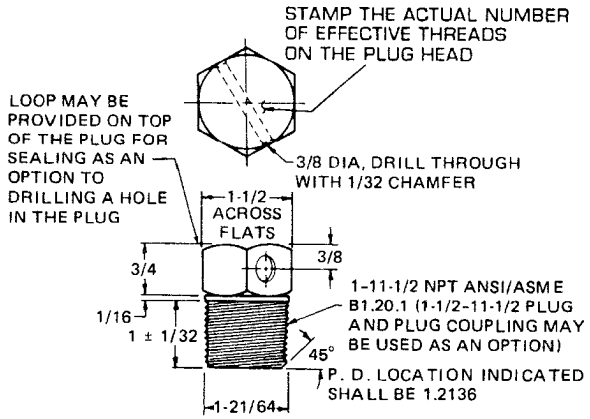


LONGITUDINAL SHELL SEAM

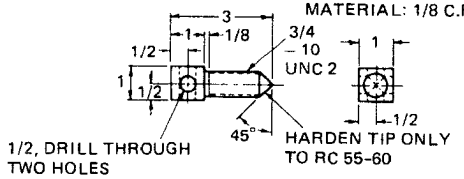
SEAL LOOP



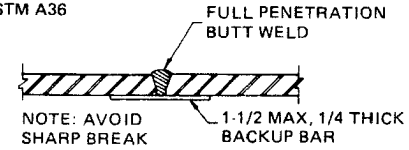
PLUG END



DETAIL – HEX HEAD PLUG
MATERIAL: ALUMINUM BRONZE CDA ALLOY 613, UPSET FORGED, EXTRUDED, OR EXTRUDED AND DRAWN



SET SCREW
MATERIAL: CARBON STEEL BAR ASTM A108, GRADE 1095



SUGGESTED HEAD TO SHELL SEAM

NOTES:
(1) All dimensions are in inches.
(2) Fillet welds shall be in accordance with 3.6 of ANSI/AWS D1.1-90 and the ANSI/ASME Code, Division I, Section VIII.
(3) If the cylinder is fabricated using the spiral process, start the spiral weld 2" below the horizontal centerline.

Figure 10 - *(concluded)*

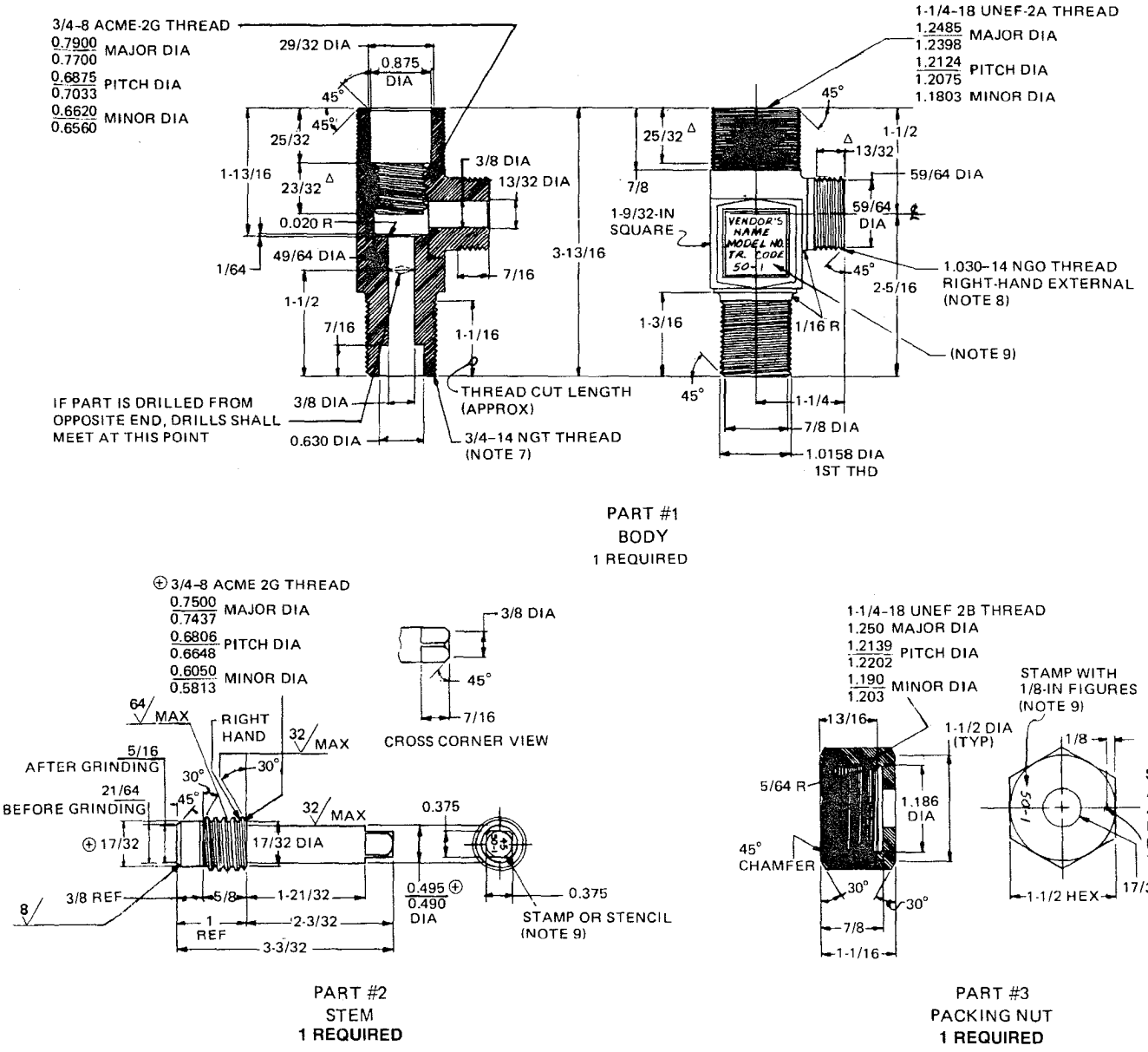
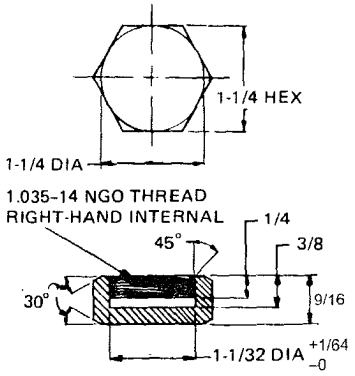
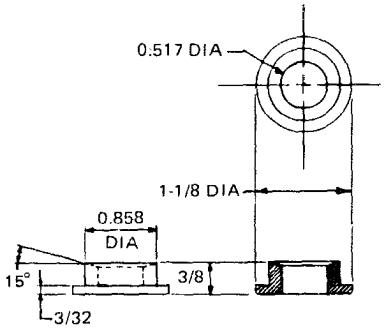


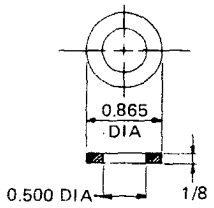
Figure 11 - UF_6 Cylinder 50 (3/4 Inch) (See 6.14) *(continued)*



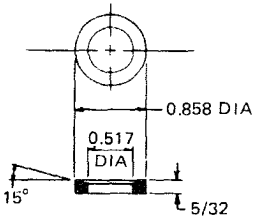
PART #4
CAP
1 REQUIRED



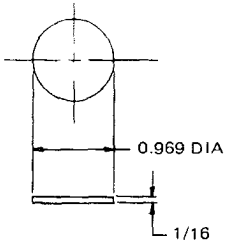
PART #5
PACKING FOLLOWER
1 REQUIRED



PART #6
PACKING
5 REQUIRED



PART #7
PACKING RING
1 REQUIRED



PART #8
CAP GASKET
1 REQUIRED

NOTES:

(1) All dimensions are in inches.

(2) Fractional tolerances shall be ±1/64 inch, decimal tolerances shall be ±0.005 inch and angular tolerances shall be ±1-1/2° unless otherwise indicated.

(3) The service pressure is 200 psig at 250°F.

(4) All machined surfaces shall be finished to 63 microinches unless otherwise indicated. Remove all burrs and break all sharp corners.

(5) Valves shall be manufactured, tested, inspected, identified, and packaged in accordance with 6.14.

(6) Materials of construction and certification shall be in accordance with 6.14.

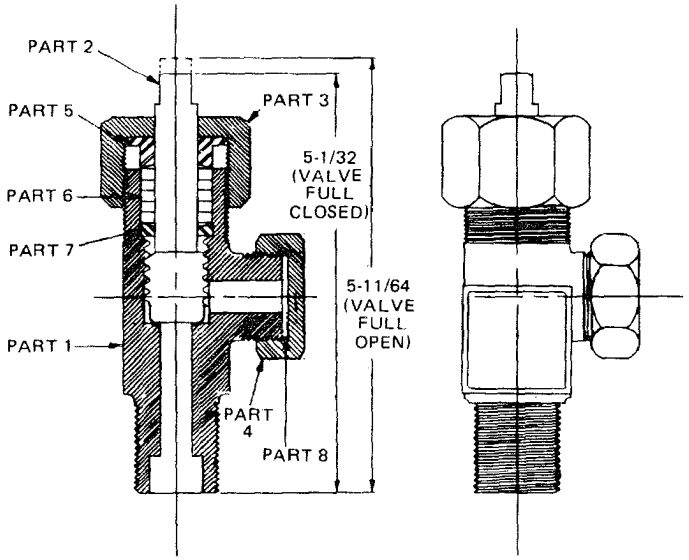
(7) This thread shall conform to ANSI/CGA V-1-1987 (two turns undersize, 14 full threads required minimum).

(8) This thread shall conform to ANSI/CGA V-1-1987.

(9) Stamp, forge, or engrave the vendor's name, the vendor's model number and trackability code, and the valve number and revision number (latest revision) in 1/8-in letters. The valve numbers and revision number shall also appear on the packing nut and stem.

(10) Diameters marked with the symbol ⊕ shall be concentric with each other within 0.002-inch TIR.

(11) Dimensions marked with the symbol Δ indicate the length of perfect threads.



ASSEMBLY

Figure 11 - *(concluded)*

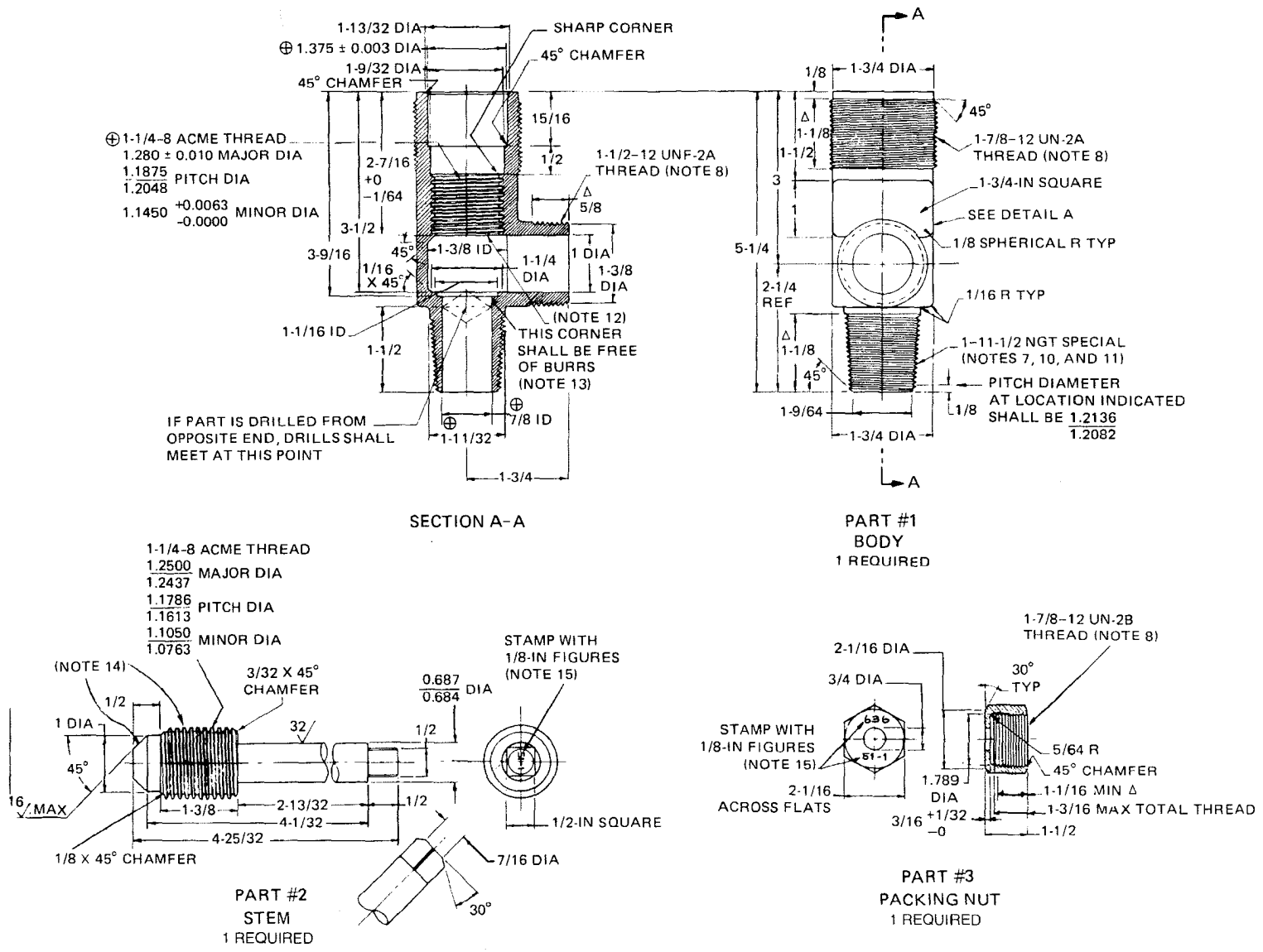
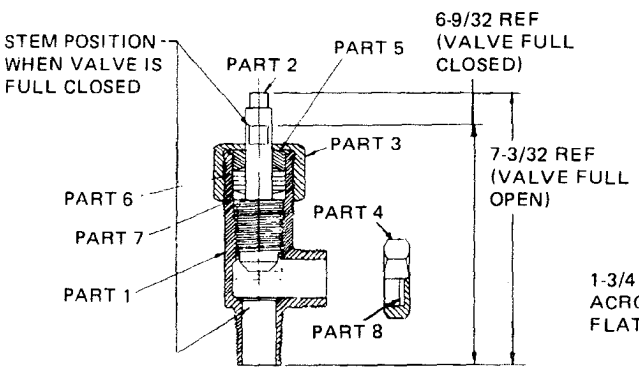
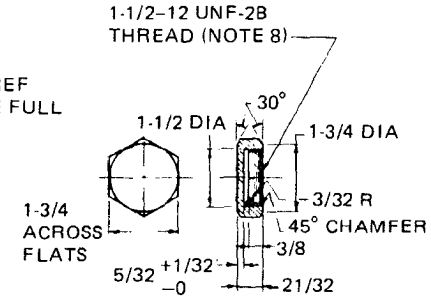


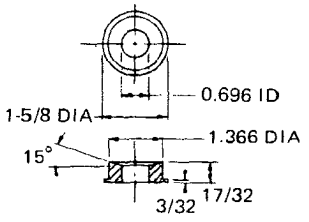
Figure 12 - UF_6 Cylinder Valve 51 (1 inch) (See 6.15) *(continued)*



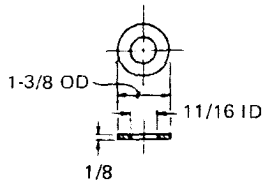
ASSEMBLY



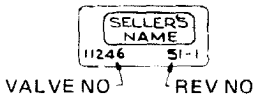
PART #4
CAP
1 REQUIRED



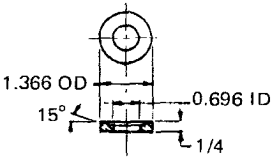
PART #5
PACKING FOLLOWER
1 REQUIRED



PART #6
PACKING
4 REQUIRED



DETAIL A
(NOTE 15)



PART #7
PACKING RING
1 REQUIRED

PART #8
CAP GASKET
1 REQUIRED

NOTES:

(1) All dimensions are in inches.

(2) Fractional tolerances shall be ±1/64 inch, decimal tolerances shall be ±0.005 inch, and angular tolerances shall be ±1-1/2° unless otherwise indicated.

(3) The service pressure is 200 psig at 250°F.

(4) All machined surfaces shall be finished to 63 microinches unless otherwise indicated. Remove all burrs and break all sharp corners.

(5) Valves shall be manufactured, tested, inspected, identified, and packaged in accordance with 6.15.

(6) Materials of construction and certification shall be in accordance with 6.15.

(7) This thread shall conform to ANSI/CGA V-1-1987, except that the pitch diameter shall be gaged 1/8-inch from the small end (1-1/2 to 2-1/2 turns undersize, 13 to 14 perfect threads).

(8) These threads shall conform to ANSI/ASME B1.1-1989.

(9) Each valve shall be tested at 400 psig in accordance with 6.15.

(10) 1-inch - 11 - 1/2 NGT thread shall be tinned with a uniform coating of tin-lead ASTM B32 solder with a minimum tin content of 45%, such as alloy SN50.

(11) Cover 1-inch-11-1/2 NGT thread with a cap or similar fitting to protect the threads and keep the valve inlet clean during shipping and storage.

(12) The outlet can be counterbored 1/16-inch deep at this location (with 45° chamfer), if desired, to prevent burr formation.

(13) 0.005 to 0.007 radius or chamfer permitted.

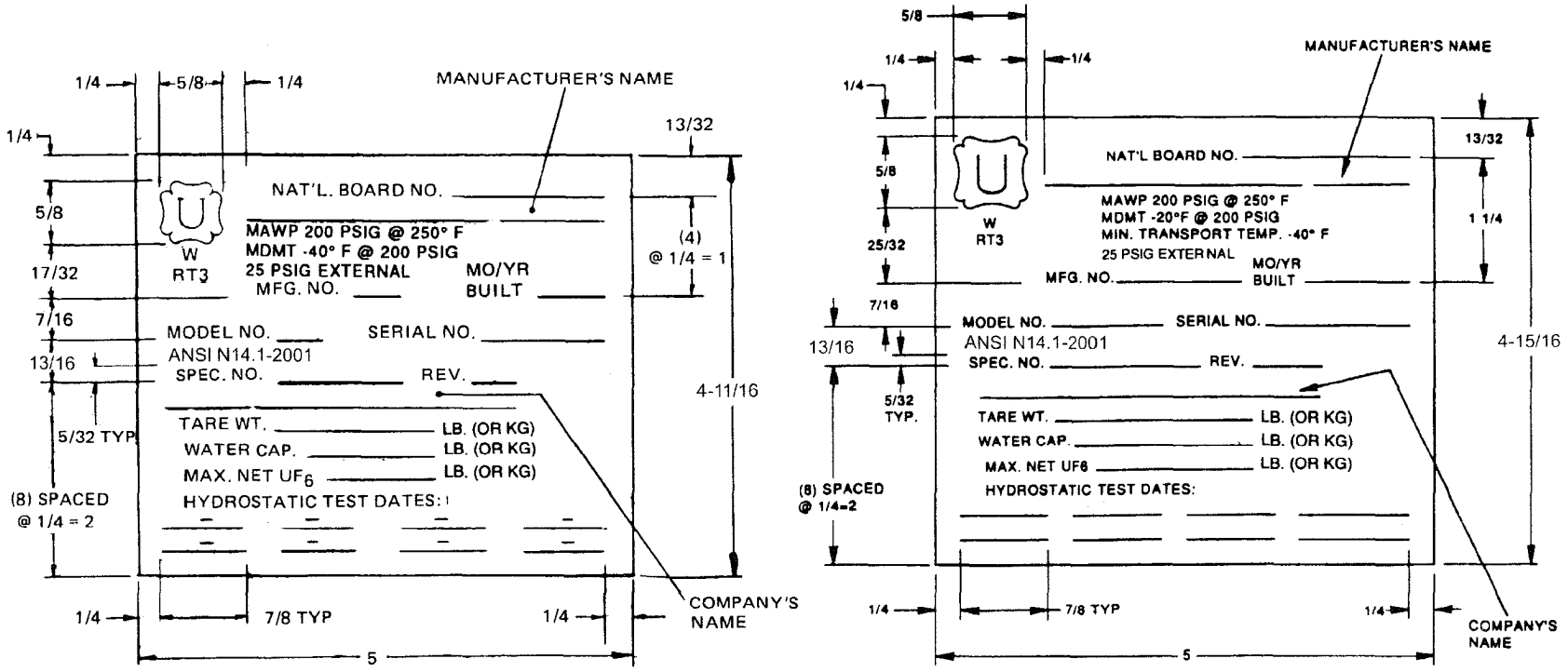
(14) Apply fluorinated lubricant to these surfaces of the stem only.

(15) Stamp, forge, or engrave the seller's name, valve number, and revision number (latest revision) in 1/8-inch figures. The valve number and revision number shall also appear on the packing nut and stem.

(16) Diameters marked with the symbol ≈ shall be concentric with each other to within 0.020-inch TIR.

(17) Dimensions marked with the symbol Δ indicate the length of perfect threads.

Figure 12 - *(concluded)*

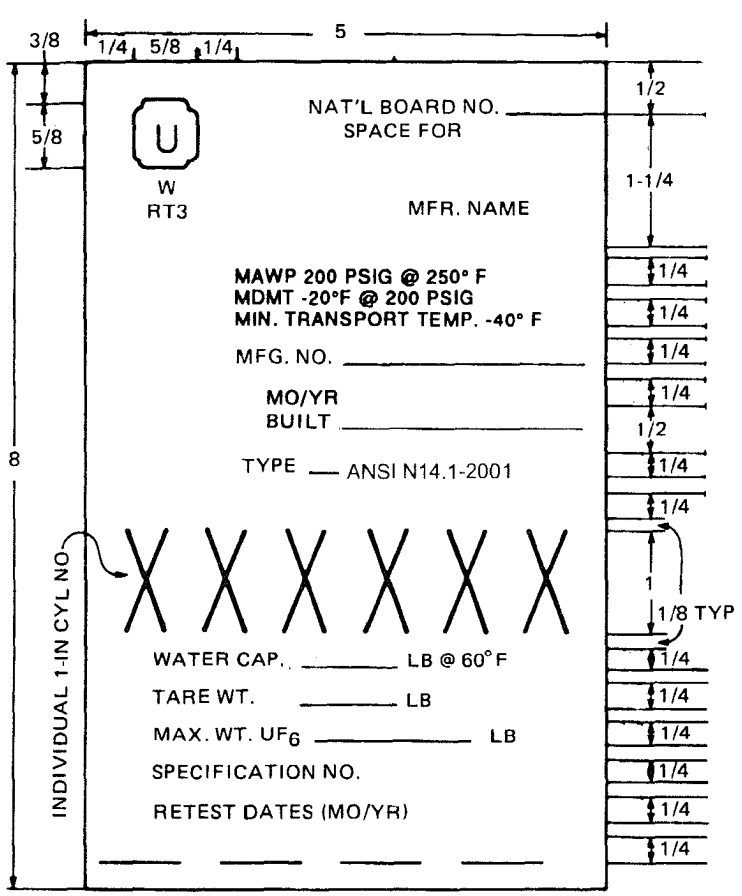


(a) Nameplate for 5B, 8A, and 12B Cylinders

(b) Nameplate for 30B Cylinder

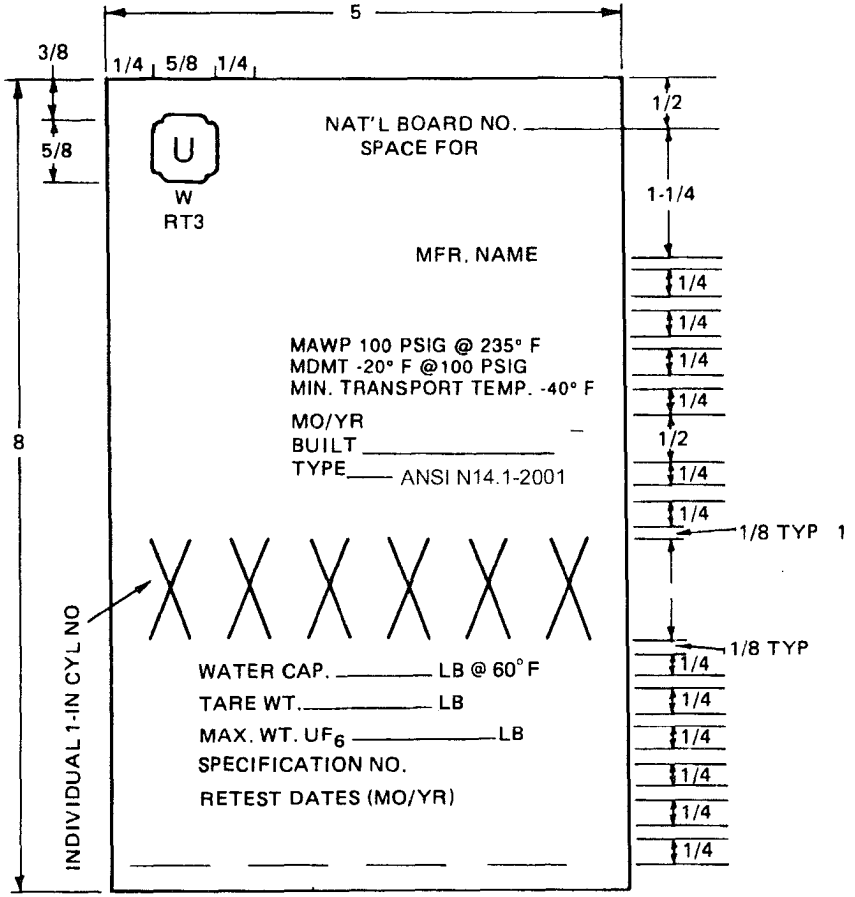
NOTE: Dimensions shown can be varied to provide information required. Nameplate shall be attached by continuous welding

Figure 13 - UF_6 Cylinder Nameplates *(continued)*



NOTE: Dimensions shown can be varied to provide information required. Nameplate shall be attached by continuous welding.

(c) Nameplate for 48X and 48Y Cylinders



(d) Nameplate for 48G Cylinder

Figure 13 - *(concluded)*

Appendix A

Cleaning Procedures for New Cylinders[9)]

The following procedure is suggested for cleaning new cylinders:

1) As late as practicable before assembly of heads to the shell, clean all interior surfaces free of slag, mill scale, weld spatter, and rust.

2) Blow or brush the cylinder free of all loose grit, dust, and the like.

3) Following the welding assembly and hydrostatic testing, degrease the interior of the vessel with an alkali cleaning solution such as Kelite 24D (2 to 4 ounces per gallon), or an approved equivalent. Hold the solution in the vessel at a temperature of 180°F to 200°F for a minimum of 10 minutes.

4) Drain cleaning solution from vessel and thoroughly rinse with clean hot water at 180°F to 200°F.

5) Blow dry immediately with filtered dry air (-40°F dew point or lower). The moisture content of exhaust air from vessel must not exceed -30°F dew point. Measure dew points with an Alnor dew point meter or an approved equivalent.

6) Inspect visually to determine that the cylinder interior is clean, dry, and free of scale and other loose material. A droplight or standard boroscope is suitable for this purpose.

7) Upon completion of the cleaning and drying procedures, install the valve and plug, or plug the openings, as specified.

[9)] Other methods or information may be equally applicable.

Appendix B

Method for Large Cylinder Decontamination for Residual UF_6 Greater than 1.0wt% ^{235}U

CAUTION

Extreme caution and particular attention should be exercised in the cleaning of large cylinders that are geometrically unsafe from a nuclear safety aspect. In the event that these cylinders contain a "heel" larger than the safe mass of ^{235} U at the approved maximum enrichments (Ref. 8.1.2), water must not be added and nuclear safety personnel should be consulted.

B.1 Nuclear Safety Controls

B.1.1 ^{235}U Enrichment. This procedure is limited to:

1) 30-inch diameter cylinders containing less than 5 wt% ^{235} U.

2) 48-inch diameter cylinders containing less than 5 wt% ^{235} U.

B.1.2 Maximum Water Wash. 5 gallons.

B.2 Safety

Proper safety precautions include the wearing of safety glasses; splash goggles or full face mask, as required; and neoprene gloves. Approved respiratory protection should be worn in the event that gas is emitted, and a respirator should be worn when the cylinder is being steamed.

B.3 Cylinder Storage

Place incoming cylinders in an approved nuclear criticality safety storage area.

B.4 Accountability

For uranium accountability purposes, identify collector containers of uranium-bearing solution with tags that contain the following information: (1) cylinder number, (2) material code, and (3) material transfer number.

B.5 Procedure

The following procedure is suggested for decontaminating large cylinders:

1) Checkweigh the cylinders before the wash solution is added.

2) Transfer one cylinder from the approved storage area to the roll stand in the decontamination area.

3) Using Tygon (or the equivalent) hose and fittings as provided, connect the cylinder valve to a container modified to hold no more than 5 gallons of liquid.

4) If the heel weight is less than the specified limits (see 8.1.2), add 5 gallons of water to the container. If the heel weight is greater than these limits, consult nuclear safety personnel for use of boron solution (10 grams boron per liter) for cleaning. The boron content must be certified by the laboratory. Use 1 gallon of the boron solution per 5 pounds of residuals.

CAUTION

Total water content in the cylinder must not exceed 5 gallons except in cases where the neutron absorber is used, or when the ^{235}U enrichment is below 1.0 wt %.

5) Open the cylinder valve slightly. If a positive pressure is experienced, as evidenced by the appearance of bubble in the Tygon (or the equivalent) hose, close the cylinder valve and reduce the internal pressure by spraying the entire cylinder externally with cold water for 10 to 20 minutes.

6) When no positive pressure is evident, open the cylinder valve and allow water or boron solution to enter the cylinder.

7) Close the cylinder valve and disconnect the Tygon (or equivalent) hose.

8) Rotate and tilt the cylinder for 10 minutes to hydrolyze the uranium compounds.

9) Remove the cylinder valve or plug.

10) Using a ½-inch copper tube, siphon the solution into a 1-gallon container. When the container is full, stop siphoning, and immediately transfer the solution from the container, using an individually safe funnel, into an individually safe plastic bottle container in a dolly.

11) Continue siphoning the solution from the cylinder until all solution has been removed, transferring the solution from the container to the plastic bottle as necessary.

12) If no solution can be siphoned from the cylinder after the addition of 5 gallons of water, add 5 gallons of boron solution.

13) Repeat steps (4), (8), (10), and (11) twice more.

14) After the third wash cycle, sample the solution for total uranium concentration.

15) Repeat the 5-gallon-water or boron-solution wash, cylinder rotation, siphoning, and sampling until the uranium concentration is less than 5000 ppm U.

16) Using a boroscope, visually inspect the interior of the cylinder for any accumulations of uranium-bearing compounds.

17) Apply steam to the interior of the cylinder for approximately 2 to 3 hours. Discard steam condensate solution.[10)] Provide local exhaust control to prevent atmospheric contamination.

18) Use the boroscope to ascertain that the cylinder has been completely cleaned.

19) If oil is present, add 2 gallons of Freon-113 (or the equivalent) or trichloroethane, and tilt and rotate the cylinder for approximately 10 minutes. Drain and discard the solvent,[10)] and repeat the washings as many times as necessary to remove all traces of oil.

20) Steam the cylinder for 10 to 20 minutes.

21) Rotate the cylinder and siphon the condensate through the valve opening.

22) Dry the interior of the cylinder with filtered dry air until the moisture content of the air in the cylinder is less than –30 degrees F dew point.

23) Visually inspect the interior of the cylinder with the boroscope to ascertain that the cylinder is clean and dry.

24) Replace the valve, tag the cylinder as being decontaminated, and transfer it to storage.

[10)] Discard solutions in compliance with plant criteria.

Appendix C

Activity of UF_6 Shipping Cylinders

U.S. Department of Transportation and NRC regulations require that the activity of UF_6 shipments be specified. The curie (Ci) is the unit used to specify the activity of the uranium isotopes of interest and is equal to 3.7×10^{10} disintegrations per second.

Uranium hexafluoride may be produced either from unirradiated uranium or from irradiated uranium that may contain small quantities of the ^{232}U and ^{233}U isotopes. The maximum activity that may be anticipated in standard shipping cylinders containing enriched UF_6 prepared from both irradiated and unirradiated uranium is given in Table C1. A convenient graph (see Figure C1) is included for determining the specific activity of UF_6 prepared from irradiated uranium. The maximum anticipated UF_6 specific activity as function of ^{235}U enrichment is indicated by the dashed line.

As a result of long-established usage in internal dose calculations, a curie of recently extracted natural uranium has come to mean 3.7×10^{10} disintegrations per second from ^{238}U, plus 3.7×10^{10} disintegrations per second from ^{234}U, plus 9.0×10^{3} disintegrations per second from ^{235}U. Thus, when this description is applied to natural uranium, 1 curie is equal to 7.5×10^{10} disintegrations per second. As this definition is the result of long-term usage and may not be universal, it is advisable to check the meaning of the activity, in curies, when applied to natural uranium.

Additional discussion of the curie unit and activity determinations relative to UF_6 shipping cylinders may be found in USAEC Report K-L-6252. [11)]

[11)] Newlon, C.E., and Taylor, R.G. Curie determination of Uranium Hexafluoride Shipping Cylinders, USAEC Report K-L-6252. Oak Ridge, Tennessee: Oak Ridge Gaseous Diffusion Plant, Union Carbide Corporation, Nuclear Division, February 10, 1970. Available from National Technical Information Service, U.S. Department of commerce, Springfield, VA 22151.

Table C.1 - Maximum Anticipated Activity Levels in UF_6 Shipping Cylinders

Model Number	Maximum Assay (wt% ^{235}U)	Maximum Net Weight (lb UF_6)	Activity (curies)	
			Irradiated*	Unirradiated
1S	100.0	1.0	0.04	0.03
2S	100.0	4.9	0.18	0.17
5A and B	100.0	55	2.02	1.90
8A	12.5	255	0.71	0.65
12A and B	5.0	460	0.50	0.45
30A	5.0†	4 950	5.40	4.85
30B	5.0†	5 020	5.47	4.92
48A^ and X	4.5†	21 030	20.80	18.70
48F^	4.5†	27 030	26.80	24.10
48Y	4.5†	27 560	27.30	24.50
48F^	Natural	27 030	--	5.60
48Y	Natural	27 560	--	5.70
48T	1.0§	20 700	6.15	5.69
48O	1.0§	26 070	7.74	7.17
48OM Allied	1.0§	27 030	8.07	7.43
48OM	1.0§	26 070	7.74	7.17
48H	1.0§	27 030	8.03	7.43
48HX	1.0§	27 030	8.03	7.43
48G	1.0§	26 840	7.97	7.38

* 0.110 parts ^{232}U plus 500 parts ^{233}U per 10^6 part ^{235}U are considered to be present.

† Moderation control equivalent to 99.5% pure UF_6 is required. Assays greater than 1 wt % may be loaded only if the cylinder and shipping procedures are specifically approved for such higher ^{235}U enrichments by the NRC and DOT.

^ Cylinders 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

§ Cylinders with tails UF_6 will have less activity than shown even though the fill limits for tails cylinders may be slightly higher in accordance with the requirements of 5.5 and Table 1.

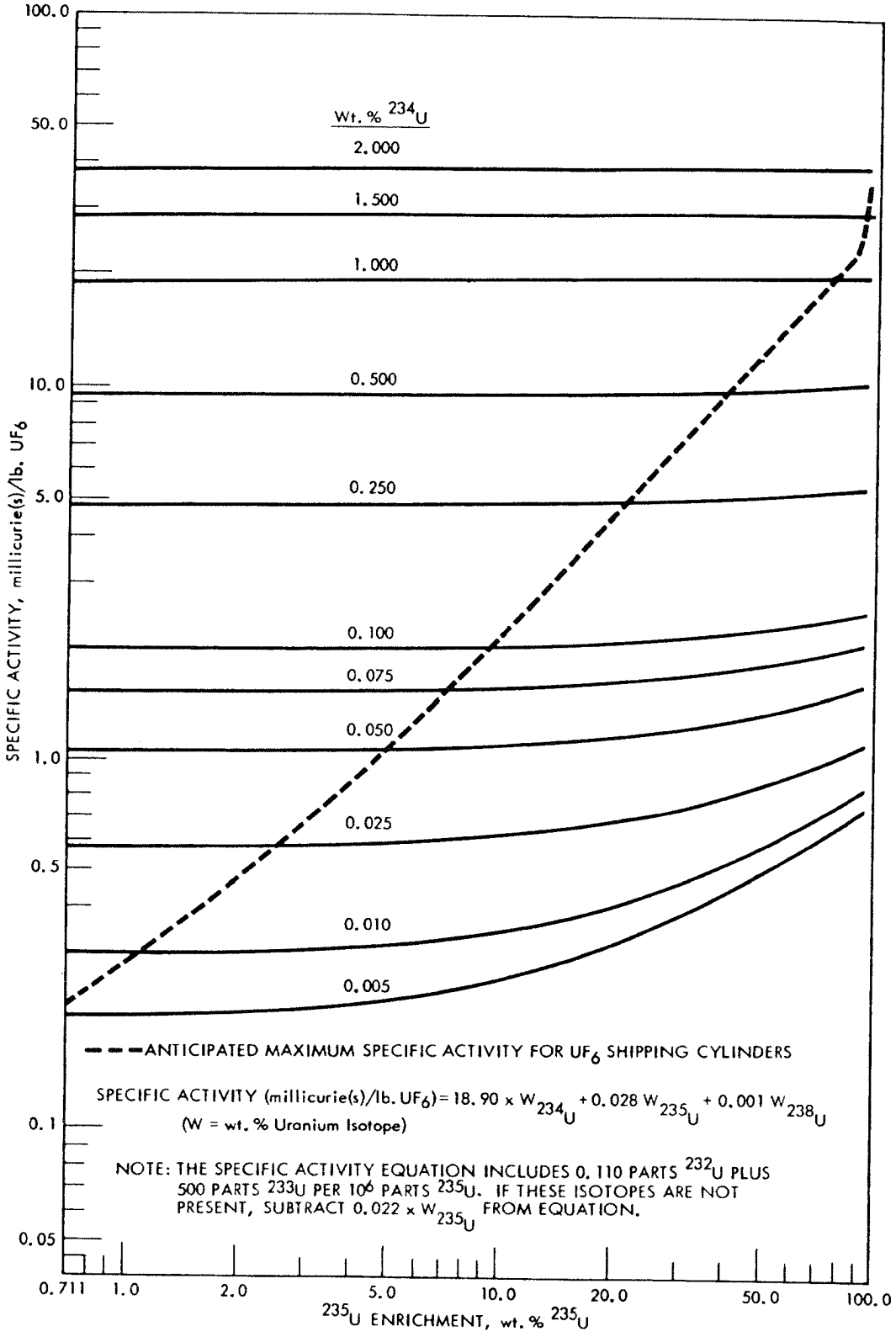


Figure C.1 - Specific Activity of UF_6

Appendix D

Physical Properties of UF_6

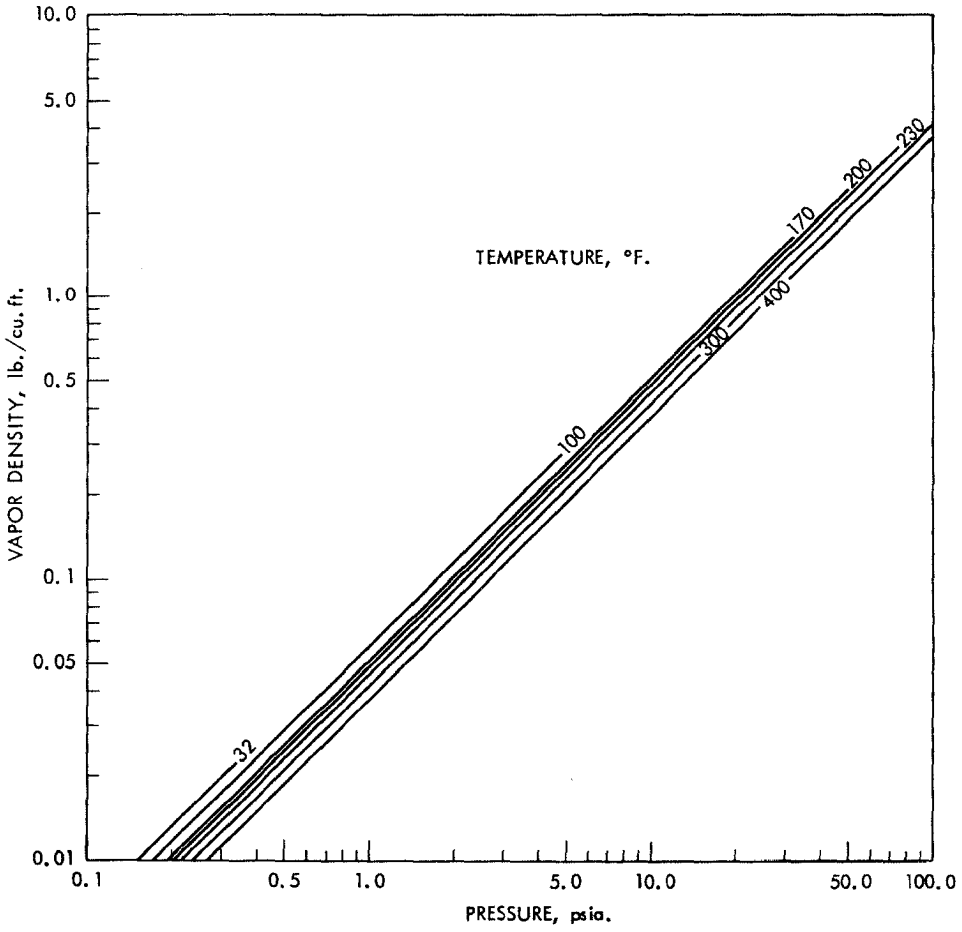


Figure D.1 - Density of Gaseous UF_6

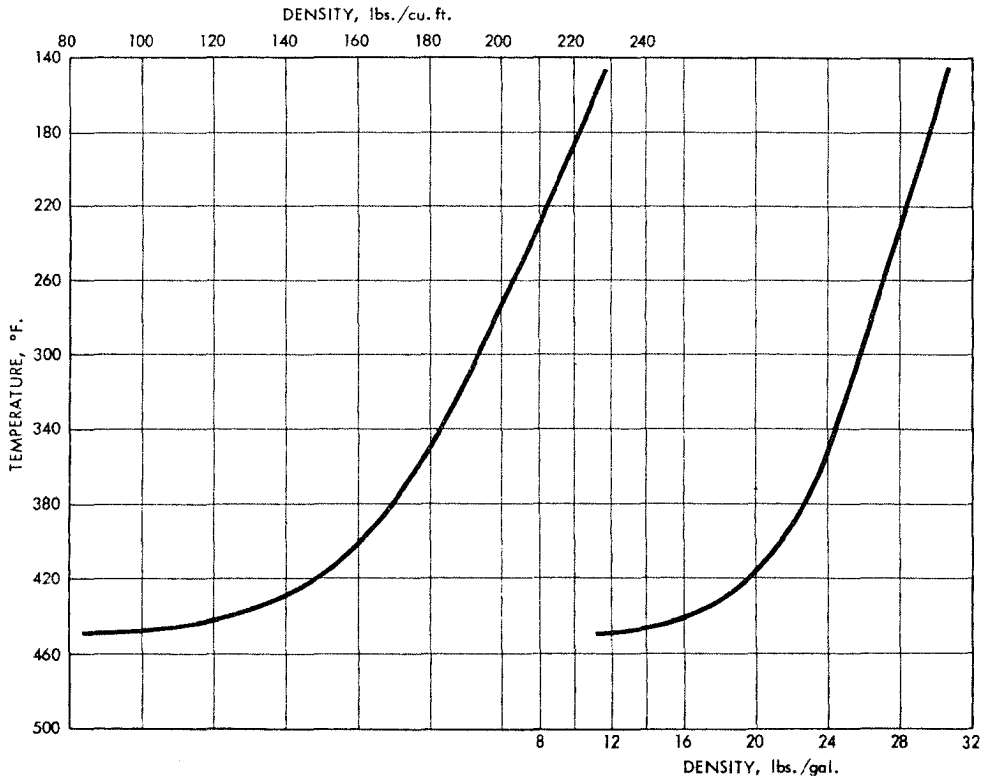


Figure D.2 - Density of Liquid UF_6

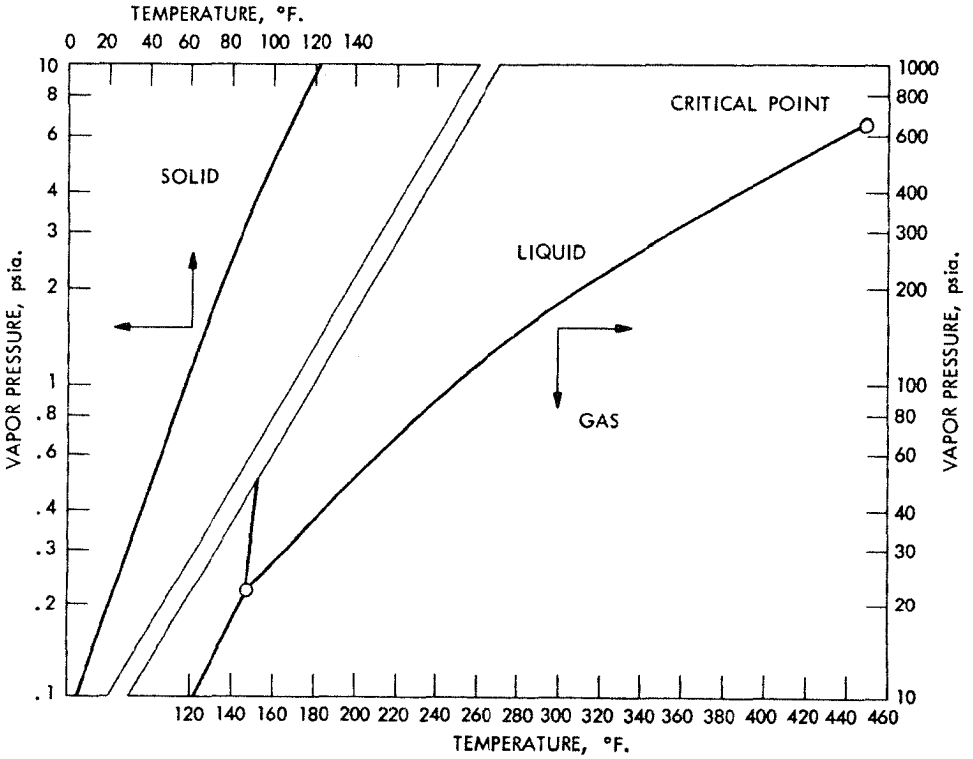


Figure D.3 - Phase Diagram of UF_6

Appendix E

Examples of a Cylinder Procurement Specification

The following example illustrates the type of information that should be included in a typical procurement specification and its presentation.

E.1 Scope

The scope should set forth what this particular procurement is trying to accomplish.

E.2 Applicable Codes, Standards, and Drawings

The following are referred to in this Appendix; the applicable portions of the latest revisions of the references form a part of this specification:

ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch)*

ANSI/ASME B16.11-1996, *Forged Fittings, Socket Welding and Threaded*

ANSI/CGA V-1-1994, *Compressed Gas Cylinder Valve Outlet and Inlet Connections*

ANSI/ASTM A20-1997, *Specification for General Requirements for Steel Plates for Pressure Vessels*

ASTM A105-1998, *Specification for Forgings, Carbon Steel, for Piping Components*[1)]

ASTM A108-1995, *Specification for Steel Bars, Carbon, Cold Finished Standard Quality*[1)]

ASTM A131-1994, *Specification for Structural Steel for Ships*[1)]

ASME SA-240 1995, *Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels*

ASTM A285-1990, *Specification for Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength*[1)]

ASTM A370-1997, *Methods and Definitions for Mechanical Testing of Steel Products*[1)]

ASTM A516-1990, *Specification for Carbon Steel Pressure Vessel Plates for Moderate- and Lower- Temperature Service*[1)]

ASTM B32-1996, *Specification for Solder Metal*[1]

ASTM B150-1998, *Specification for Aluminum Bronze Rod, Bar, and Shapes*[1)]

ANSI/ASME *Boiler and Pressure Vessel Code-1998 (referred to as the Code)*

Sec. VIII, Pressure Vessels, Division 1

Sec. IX Welding and Brazing Qualifications

Figure 8, Cylinder, Type 48X

Figure 12, 1-inch Size Valve for UF_6 cylinder

[This illustration is for the Type-48X cylinder with a 1-inch valve. Individual specifications might cite other drawings than the ones in this standard.]

E.3 Specifications

E.3.1 Working Pressure

The cylinder shall be constructed to withstand working pressures of 200 psig internal at 250° F and 25 psig external at 250° F.

E.3.2 Materials of Construction

E.3.2.1 Cylinder

Cylinder shell, heads, lifting lugs, stiffening rings, backing rings, and skirts shall conform to normalized ASTM A516, Grades 55, 60, 65, steel, meeting heat treatment and supplementary requirement S5. The ASTM A516 plate used for shell fabrication shall have an additional requirement on the practice used to make the steel. Shell steel shall be made by a low-sulfur practice with inclusion shape control. The sulfur content shall not exceed 0.010%.

The results of the impact test shall meet the acceptance criteria in ASTM A20 for the grade of A516 steel used. If desired, ASTM A131, Grade-E steel may be used for the stiffening rings. This steel shall meet the Charpy v-notch impact test requirements of ASTM A131. The test results shall be submitted to, and approved by, the company prior to cylinder fabrication.

An additional set of charpy impact tests are required on the shell steel. The long axis of the specimen shall be oriented transverse to the final direction of rolling. The acceptance criteria shall be 55 ft-lbs when tested at a temperature less than 150° F.

E.3.2.2 Pipe Plug

Upset forged, extruded or extruded and drawn aluminum bronze CDA alloy 61300, conforming to ASTM B150. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1. The actual number of effective threads on the plug shall be stamped on the head of the plug. After machining the plugs shall be stress relieved at 800° F plus or minus 10 degrees F.

E.3.2.3 Couplings

Couplings shall be forged steel conforming to ASTM A105, 1-inch half coupling, 6000 lb, conforming to ANSI/ASME B16.11. The couplings shall be 11-1/2 NPT (national pipe thread). Couplings shall be counterbored as described in Figure 8 of ANSI N14.1-2000.

E.3.2.4 Solder

Solder shall be ASTM B32, tin-lead alloy SN50.

E.3.2.5 Nameplate

The nameplate shall be of stainless steel, 13 gage, ASME 240, Type 304L.

E.3.2.6 Valve Guard

The valve guard shall be of carbon steel, ASTM A285, Grade C. The set screw shall be carbon steel bar, ASTM A108, Grade 1095.

E.3.3 Testing

E.3.3.1 Hydrostatic

Each cylinder shall be tested at 400-psig cylinder pressure. The test pressure shall be produced only as permitted by and in accordance with the Code, and the cylinder shall be retested after the repairs are complete.

E.3.3.2 Air

Following the cleaning, hydrostatic testing, drying, and plug and valve installation, pressure each cylinder to 10 psig using filtered dry air (-40° F dew point, as measured with an Alnor dew point meter). Soap test for leaks around the valve and plug threads and then pressure the cylinder to

100 psig. While under 100 psig pressure, all welds and the plug and valve connections shall be soap tested, with no leakage being permitted. Any welded repair shall be followed by reapplication of the hydrostatic test, cleaning, drying, and air test.

E.3.3.3 Vacuum

The cylinder shall be prepared for painting and shipment by reducing the pressure to 20 inch (5 psig) Hg vacuum minimum. An air jet ejector is suggested for this purpose.

E.4. Quality control

E.4.1 Procedures

The seller shall establish and maintain written quality control procedures for manufacture, cleaning, inspection, equipment calibration, and testing to ensure that the finished product meets the requirements of this specification. Such procedures may consist of, or be based on, the seller's written specifications for like practices or shall be developed to meet the requirements of this specification. Industry standards, together with a program of frequent inspection and verification of the seller's adherence to such standards, are acceptable.

E.4.2 Approvals

The seller shall, prior to the start of fabrication, submit copies of the proposed procedures to the company for approval. Changes in approved procedures may not be made during manufacture without prior written approval by the company. The company shall be notified 5 days in advance of the start of fabrication to allow a company representative to witness initial production. The representative shall be permitted access to the manufacturing facilities at any reasonable time to verify that the quality control procedures are being implemented in manufacturing.

E.4.3 Responsibilities

The requirements for certification of materials and control of quality through inspection shall be imposed by the seller on the subcontractors, if any.

E.5 Manufacturing.

E.5.1 Fabrication

Cylinders shall be fabricated in accordance with Section VIII, Pressure Vessels, Division 1, of the latest edition of the ANSI/ASME Boiler and Pressure Vessel code and shall be ASME Code and National Board stamped. All welders and welding procedures shall be qualified in accordance with Section IX, Welding and Brazing Qualifications, of the Code.

At least one test weld, representing each welding procedure to be used in fabrication of the cylinders, shall be impact tested. Test plates, including those for the appendages, shall have butt-type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the materials, and one face of the specimen shall be within 1/16 inch of the surface of the material. For ASTM A516 steel, these impact tests shall be performed in accordance with ASTM A370 for Charpy V-notch tests. The results shall meet the acceptance criteria listed in ASTM A20 for the grade of ASTM A516 steel used. For ASTM A131 Grade-E steel, the Charpy V-notch impact tests and acceptance criteria shall be as specified in ASTM A131 for Grade-E steel. The test result shall be submitted to and approved by the company prior to cylinder fabrication.

E.5.2 X-Ray Examination

A minimum of one spot X-Ray examination for each cylinder shall be made in accordance with Section UW-52 of the Code using a fine-grain X-ray film (Kodak Type AA or a company approved equivalent). Unless otherwise directed by the code inspector, locations of spots shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for succes-

sive cylinders. The weld imperfections indicated by the radio-graphs shall not exceed those permitted by Section UW-52 (except for rounded indications, which shall be required to meet UW-52) of the Code.

E.5.3 Cleaning

The inside of the cylinder shall be thoroughly cleaned of all grease, oil, scale, slag, loose oxides, dirt, moisture, and other foreign contamination, except for a thin coating of iron oxide from hydrotesting. The detailed cleaning procedure proposed shall be submitted for the company's approval before fabrication is started. A signed cleaning certification form for each cylinder shall be submitted to the company.

E.5.4 Valve and Plug Installation

E.5.4.1 Valves shall be supplied to the seller by the company with valve threads already tinned with a thin uniform coating of ASTM B32 alloy SN50 solder. The dimensions of the valve are shown on the referenced drawing. The threaded portion of the valve, which will be installed in the cylinder coupling, is cut with approximately 13 or 14 complete threads.

E.5.4.2 Plugs and couplings shall be furnished by the seller. Plug threads shall be tinned with a thin uniform coating of ASTM B32 alloy 50A solder before installation. The 1-inch, 6000-lb half-coupling into which the valve and plug are to be installed shall be threaded as specified in E3.2.3.

E.5.4.3 The valve and plug couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed, coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

E.5.4.4 The valve thread engagement shall be obtained using a minimum of 200 ft-lb and not more than 400 ft-lb of wrench torque. The plug engagement shall be obtained using a minimum of 150 ft-lb and not more than 650 ft-lb of wrench torque. The torque wrench shall be applied to the valve body and not to the bonnet nut. An indicating torque wrench shall be used for valve and plug installation. No material of any kind, other than the specified solder, shall be used on the threads to facilitate installation. A minimum of 7 and a maximum of 12 valve threads shall be engaged. For the plug, a minimum of 5 and a maximum of 8 threads shall be engaged.

E.5.5 Cylinder Capacity

The seller shall determine the capacity of each cylinder by completely filling the cylinder with water. The weight of water contained in the cylinder and the water temperature shall be recorded. The water capacity at 60° F (62.37 lb of water per ft^3) shall be determined. The cylinder shall have a minimum water capacity (corrected to 60° F) of 6792 lb of water (108.9 ft^3). Upon completion of fabrication, painting, and evacuation of the cylinder, the tare weight of each cylinder shall be determined. The water capacity in pounds of water at 60° F after tare weight shall be stamped on the nameplate of the cylinder. The seller shall submit to the company for approval the procedure for this operation before starting fabrication.

E.5.6 Identification

Each cylinder shall have a stainless steel nameplate, as shown on the referenced drawing, permanently attached to the cylinder. The nameplate shall state the serial number of each cylinder, numbered consecutively, starting with a four-digit number specified by the company.

E.5.7 Painting

After interior cleaning and all testing have been completed, the exterior of the cylinder shall be cleaned and prepared for blasting. Prior to coating the exterior surface of the cylinder, the cylinder shall be blasted to a commercial finish. The blasting shall remove rust, scale, dirt and other foreign materials. The cylinder shall be primed with one coat of zinc chromate Pittsburgh No. 6-204, or an approved equivalent, and painted with one coat of Battleship Gray, Pittsburgh No. 54-307, or an approved equivalent. The valve and nameplate shall be completely masked so that no part is painted.

E.6 Certification

E.6.1 Mill Tests

The seller shall furnish to the company one certified copy of mill test reports, including chemical and physical analysis on each heat of material used in fabricating cylinders. Serial numbers of cylinders shall be identified as to the heat numbers of materials used in the cylinder fabrication.

E.6.2 Inspection and Testing

The seller shall furnish to the company one completed copy of the manufacturer's sheet ASME Form U-1 for each cylinder. The seller shall also furnish to the company certification that each cylinder has passed the air-soap test as specified in E3.3.2.

E.6.3 Capacity Statement

The seller shall submit to the company the calculations used to determine the water capacity of each cylinder.

E6.4 Miscellaneous Certification. The seller shall submit to the company for each cylinder a verification of performance for:

1) E5.2, X-ray Examination

2) E5.3, Cleaning

3) E5.4, Valve and Plug Installation, data indicating the actual torque applied and the actual number of threads showing after installation.

E6.5 Certified Package. The seller shall submit to the company all required certification data as a "package" and identified by the company cylinder number.

E.7 Defect Repair

Repair of all defects whereby the cylinder fails to comply with this specification and the necessary retesting shall be at the seller's expense.

E.8 Acceptance

Final acceptance will be at the designated U.S. DOE plant. Acceptance will be based on (1) review of the seller's certified test reports; (2) visual inspection for workmanship, cleanliness, and the condition of all attachments; (3) dimensional inspection of the cylinder; and (4) vacuum check of the cylinder. Failure to meet any of the preceding requirements shall be cause for rejection of the cylinder.

E.9 Shop Drawings and Manufacturer's Data

The seller shall furnish the company with shop drawings and manufacturer's data as specified on the Manufacturer's Data Required form on the last page of this specification (see Figure E.1). Only after the company's approval shall the seller proceed with fabrication.

MANUFACTURER'S DATA REQUIRED

SPEC. OR DATA SHEET NO. | REV.

PAGE OF

DESCRIPTION AND EQUIPMENT NUMBERS

TYPE 48X UF_6 CYLINDERS

THE SELLER SHALL FURNISH DATA BELOW IN QUANTITIES SHOWN	NUMBER OF COPIES					
				CERTIFIED AS BUILT COPIES		
	With Bids	For Approval	Advanced Engineering	Prints or Brochure	Transparency (Not Folded)	Packed W/ Equipment
OUTLINE DIMENSION DWG. – INCLUDE TOTAL WT. OF EQUIPMENT		3			1	
ASSEMBLY DRAWINGS		3			1	
DETAIL DRAWINGS – MECHANICAL						
FLOW DIAGRAMS						
PANEL WIRING DIAGRAMS						
ELEMENTARY WIRING DIAGRAMS *(According to joint Industrial Council Std.)*						
INTERCONNECTING WIRING DIAGRAMS *(According to Joint Industrial Council Std.)*						
MATERIAL CERTIFICATION					1	
WELDING PROCEDURES		3			1	
OPERATING DATA AND PERFORMANCE CURVES						
TEST REPORTS AND INSPECTION REPORTS					1	
MANUFACTURERS DATA REPORT ON UNFIRED PRESSURE VESSELS *(National Board Certification of Inspection FORM U-1)*					1	
SPARE PARTS LIST – INCLUDING RECOMMENDATIONS FOR 1 YEAR *(Each part is to be described and identified in sufficient detail to permit procurement from the original manufacturer, or from any supplier).*						
OPERATING AND MAINTENANCE INSTRUCTIONS						
LUBRICATION INSTRUCTIONS						
RECOMMENDED PIPING AND INSTRUMENTATION						
INSTALLATION INSTRUCTIONS						
SCHEMATIC OR LOGIC DIAGRAMS *(Each component shall be described and identified in sufficient detail to permit procurement from the original manufacturer, or from any supplier).*						
Proposed Quality Control Procedures		3			1	
Welding Qualifications		3			1	
Certification (X-ray, cleaning, valve and plug installation)						1

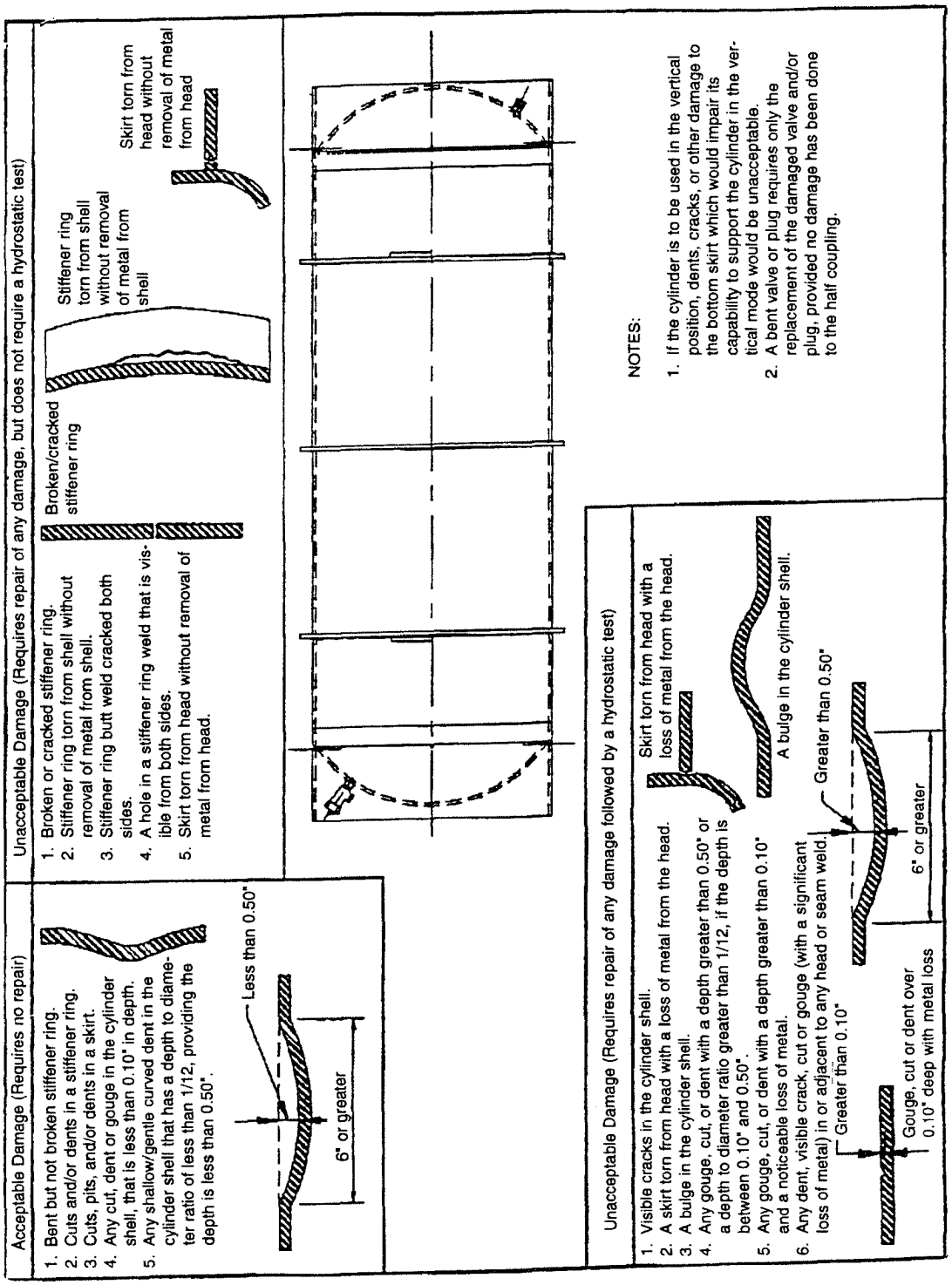
GENERAL NOTES:

1. *Within weeks after award of subcontract the Seller shall furnish the required number of data and drawings "For Approval" and/or "Advance Engineering" as outlined in the table above. Subsequent revisions shall also be approved.*
2. *"Certified Correct" data and drawings are required prior to delivery of equipment and/or material. Each copy of information shall be marked to indicate Company's Purchase Order No., Equipment No. and Manufacturer's Model and Serial No.*

Figure E.1 - Sample of Manufacturer's Data Required Form

Appendix F

Examples of Acceptable and Unacceptable Damage to UF_6 Cylinders



American National Standard

for Nuclear Materials –

Uranium Hexafluoride – Packaging for Transport

Approved: April 3, 2002

Secretariat: Institute of Nuclear Materials Management

This addendum revises the American National Standard ANSI N14.1-2001, *Uranium Hexafluoride - Packaging for Transport*, as defined in the following changes to the standard:

1. *Add the following new section:*

   6.3.6 Cylinder Skirt Holes for 48X and 48Y Alternate Valve Protector. Holes may be drilled into the skirt of existing 48X and 48Y cylinders (as described in Figures 8 and 9, respectively) in accordance with Figure 14 to allow the use of the alternate valve protector detailed in Figure 14.

2. *Add a new item (8) to the Material Sections 6.11.5 and 6.12.5 as follows:*

   (8) Alternate Valve Guard. Aluminum Plate of alloy UNS A96061 meeting the mechanical properties of temper condition T62 as specified in ASTM B209. Plug material aluminum bar of alloy UNS A96061 with mechanical properties of temper condition T6 as specified in ASTM B211 with stainless steel thread insert.

3. *Add a new figure,* Figure 14, which consists of Figure 14, Part 1, of this addendum, "Alternate Valve Protector" and Figure 14, Part 2, of this addendum, "Cylinder Skirt Modification for Alternate Valve Protector".

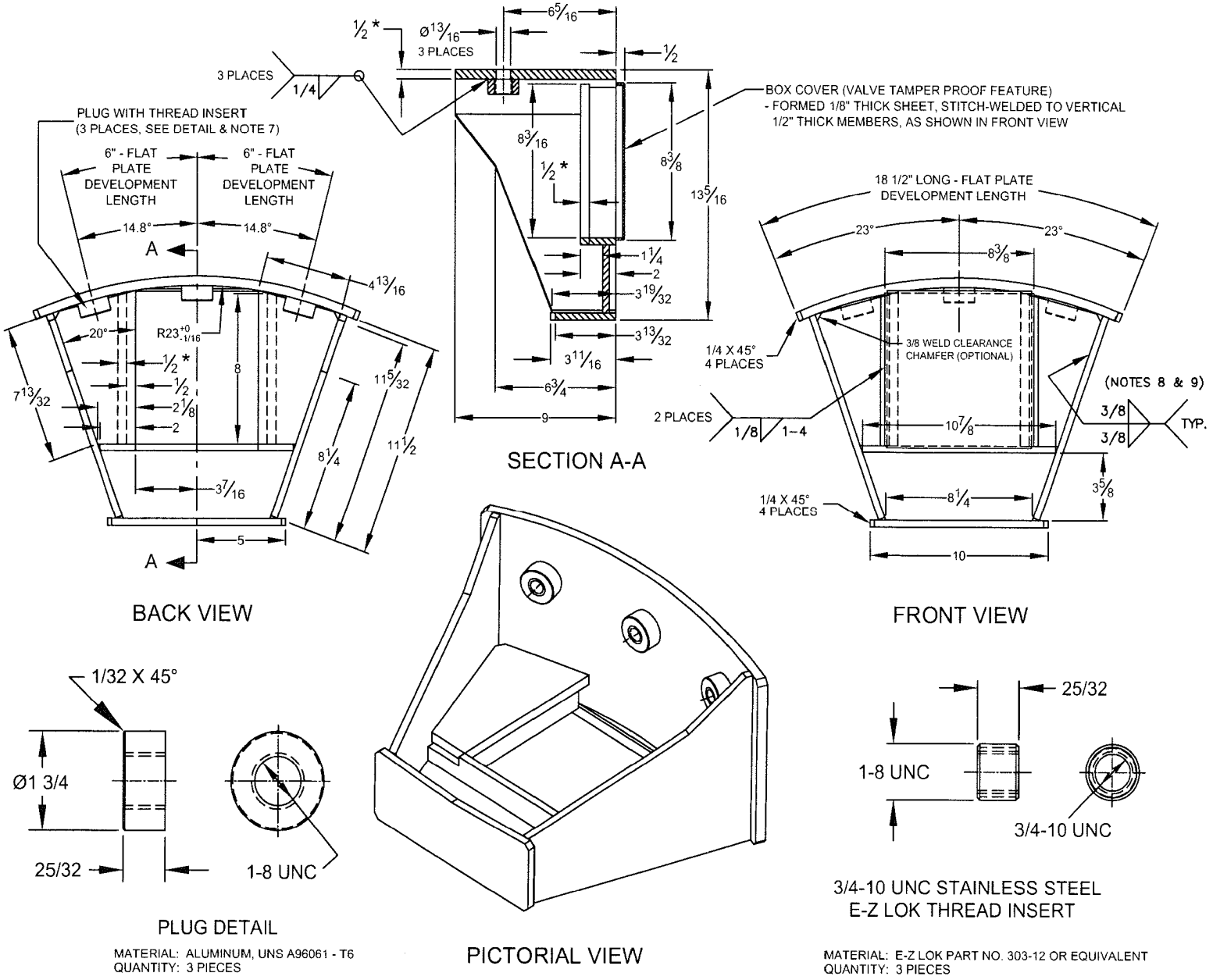
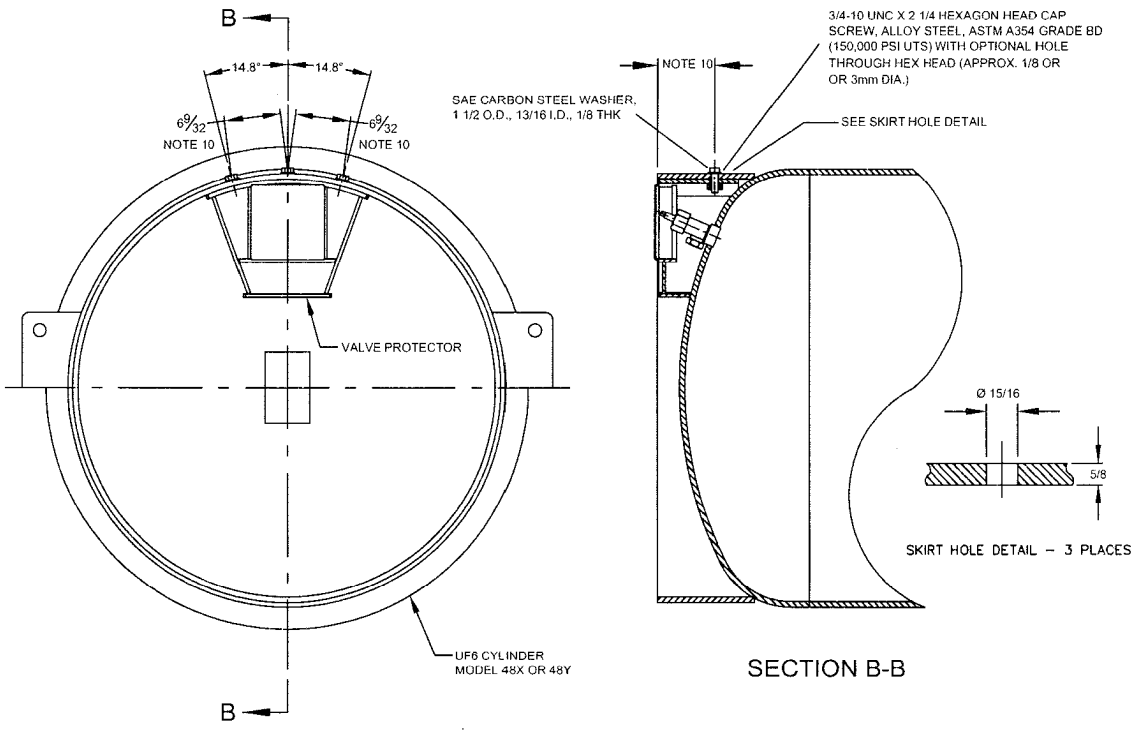


Figure 14 (Part 1) - Alternate Valve Protector



NOTES:

1. All dimensions are in inches. Dimensions with " * " are nominal plate sizes.
2. All tolerances for the Valve Protector components (prior to welding) are ± 1/32" or ± 0.5°, unless otherwise noted.
3. The Valve Protector is symmetrical about its vertical centerline.
4. Materials of construction; Aluminum Plate (3/8" nominal thickness, unless otherwise shown) of alloy UNS A96061 meeting the mechanical properties of temper condition T62 as specified in ASTM B209. Plug material aluminum bar of alloy UNS A96061 with mechanical properties of temper condition T6 as specified in ASTM B211 with stainless steel thread insert. The box cover (valve tamper proof feature) shall be formed from utility grade UNS A93003 H14 aluminum sheet, or equivalent.
5. Existing cylinders may be modified by drilling 3 holes in the skirt, as shown, to allow the Valve Protector to be attached by cap screws.
6. External surface of top, curved plate of Valve Protector shall be free of weld spatter.
7. Thread inserts shall be installed flush against underside of top, curved plate.
8. All joints shall be welded with 3/8" (unless shown otherwise) fillets, both sides which blend smoothly into the parent metal.
9. All filler metal for structural joints shall be AWS A5.10 class ER5356 (UNS A95356) or equivalent which meets the strength requirements of the plate material.
10. Dimension dependent on actual skirt geometry. Dimensions shown are for the nominal skirt OD (48 1/2"). Location of holes, from outer edge of skirt, is relative to each cylinder head surface and must be established using either the Valve Protector or through use of a template or jig.

Figure 14 (Part 2) - Cylinder Skirt Modification for Alternate Valve Protector