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AEC RESEARCH AND DEVELOPMENT REPORT

MASTER

Y-1574

Metals, Ceramics, and
Materials

ISOSTATIC PRESSING BAG MATERIALS

Compiled By

J. L. Williams

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

**UNION
CARBIDE**

OAK RIDGE Y-12 PLANT
P. O. Box Y
OAK RIDGE, TENNESSEE 37830

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Date Issued: March 10, 1967

Report Number Y-1574

Metals, Ceramics, and Materials
TID-4500

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Y-12 PLANT

Contract W-7405-eng-26
With the US Atomic Energy Commission

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Oak Ridge, Tennessee

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INTRODUCTION

Elastomeric bags (molds) for containing powders intended for pressing in liquid pressing media at high pressure in an isostatic pressure vessel are generally fabricated from either unvulcanized natural gum rubber or from polyvinyl plastisols. In either case a suitable mold form must be used. Such a form is usually fabricated from aluminum. Its exact geometry depends on the product desired from the pressing operation. Also, it should be recognized that procedures for fabricating elastomers are variable, and suitable products can be made even though wide latitude is allowed in the control of the processing parameters.

The procedures presented here are examples of usable processes representative of standard practices in the rubber and plastic industries.

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MOLD MATERIALS AND FORMING METHOD

GUM RUBBER

Gum rubber bags are fabricated by laying sheets of calendered, unvulcanized material on an aluminum mold form. Joints are made in two ways: as a reinforced butt joint or as a nonreinforced bevel joint.

Unvulcanized gum rubber is cut either with scissors, if a standard square edge is desired, or with a very sharp knife if a skiving cut is necessary. Lubrication with water facilitates cutting with the knife.

Unvulcanized gum rubber, purchased from commercial rubber companies to a specification which has been devised to cover the most important parameters, is received in rolls. This material should be stored on racks to prevent damage and in a refrigerated enclosure to prevent degradation from premature partial vulcanization. Temperatures which have been found acceptable are in the range of 35 to 40° F.

The Y-12 specification for gum rubber is identified by the number YMS-101 (see Appendix A). Because procedures for vulcanizing rubber may differ slightly from vendor to vendor, the specifications call for test batches to be supplied in advance from each new bidder. Some consultation may also be necessary with a new vendor before his product can be successfully adapted to bag making.

Vulcanization is accomplished in a steam autoclave. The autoclave used in Y-12 was purchased to Specification YS-663 (Appendix B). Although determination of the correct curing pressure is generally done empirically, depending on the particular rubber used and the finished properties desired, the nominal curing pressure is 50 psig. The time parameter is a function of both the geometry of the mold and thickness of the rubber.

The most usual type of isostatically pressed product for which a gum rubber bag would be used is a right cylinder. The principal points in a generalized procedure for making such a bag are described in the sections that follow.

Fabrication Procedure

Aluminum Form - The aluminum form is made as a hollow (roll formed and welded) right cylinder to which a flat bottom has been attached by welding. The exterior of the form should be smooth and free from deep scratches or dents. Welds should be ground smooth and flush with the exterior of the form.

Bag Components - The final bag will be in two parts: the bag itself and a cover. Both are hollow right cylinders, formed separately on the same aluminum form.

Fabrication - Fabrication procedures for both parts of the bag are the same except that the cylindrical length of the cover is shorter than for the bag. The ratio of the length of the cover to the length of the bag may vary considerably depending on the diameter, the full length, and the length-to-diameter ratio of the bag mold. The minimum cover length should allow for about a three-inch overlap for sealing after loading.

The following general steps are used to fabricate a bag (or a bag cover):

1. Remove the rubber from the refrigerator and allow it to warm to room temperature.
2. Cut a sheet of rubber from the roll for the bottom of the bag. Remove the "holland" (cloth) backing from the rubber and wash the rubber with a suitable solvent. Benzene is a solvent which is often used, but it creates a fire hazard. It has been found that any of several grades of commercial, inhibited methyl chloroform can be successfully employed. This material is procured with Specification 03-AD-001 (Appendix C).
3. Place the rubber on the form with the tacky side down. Do not trap any air between the rubber and the form.
4. Trim the rubber to fit the bottom of the form. Cut the edges with a 45-degree bevel with the slope toward the center of the mold. If a butt joint is desired, the rubber can be trimmed to the exact size of the form.
5. Cut a sheet (or sheets) of rubber from the roll of a size suitable to form the side of the bag. Remove the holland backing and wash the rubber with solvent.
6. Wrap the rubber around the side of the mold. Be sure to remove all air between the rubber and the mold. Trim the side seam on the mold so that the rubber will be under a slight tension when the edges are joined together.
7. Trim the surplus rubber from the top and bottom of the mold. If a bevel joint is being made, the bottom edge of the side rubber should have been beveled to 45 degrees before wrapping. Also, the mating edges along the length of the cylinder should be beveled to fit. In a butt joint it is necessary only to make sure the square ends meet fairly well.
8. Activate the joint edges with solvent, allow time for them to become very tacky, and press together. Various sizes of hand-operated rollers are available, some with knurled edges, that facilitate applying pressure to assure a complete sealing of the beveled joints. Butt joints are activated and pressed together, but receive the additional treatment described in Step 9.

9. Cut a strip of 1/32-inch rubber, treat as in Step 2, activate it with solvent, allow it to become tacky, and apply it as a backup strip to all butt joints. Roll with a suitably sized roller to assure sealing.
10. Backup all beveled joints with a 2-inch-wide strip of plastic (vinyl or polyethylene) pressure-sensitive tape. This tape will be removed after vulcanization is completed.
11. Wrap the rubber bag with single strips of 2-inch-wide plastic tape at intervals of about 6 to 10 inches (or less with short bags) to insure that the rubber does not separate from the form during vulcanization.
12. Place the assembly, open end down, on the grate inside the vulcanizer.
13. Close the vulcanizer and apply steam pressure. As a general criterion, 1/8-inch-thick rubber will require about 1 1/2 hours for curing while 1/4-inch material will require two hours.
14. Remove the plastic tape from the bag immediately after removal from the vulcanizer. If the bag is allowed to cool, removal of the tape is difficult.
15. Strip the rubber bag from the aluminum form after cooling to room temperature. Usually a jet of compressed air is used to facilitate removal.

Rubber can also be vulcanized in a completely enclosed compression-type mold. Such a mold should be filled completely with pieces of activated rubber which are cut to fit. The curing pressure in the autoclave is the same as for unconfined mold forms, and time is again a function of the geometry and size. Compression molds are made of relatively thick aluminum and must be designed to allow for several vent holes at strategic locations. The rubber which extrudes through these holes during curing can be cut off after cooling.

Gum rubber isostatic pressing bags are usually sealed with a rubber cement. A commercial product can be procured, but it is convenient to make a cement in the bag fabrication area through the simple process of dissolving scraps of unvulcanized rubber in some of the solvent used in the shop.

POLYVINYL PLASTISOL

Polyvinyl plastisol is a more useful elastomer for fabricating isostatic pressing bag molds than gum rubber because a greater variety of shapes can be made, because the bags can be fabricated to closer tolerances (thus providing the means for a more economical use of powder in the pressing step), and because the bags will withstand more pressure runs since polyvinyl is considerably more resistant to the liquid pressing medium and rough handling than gum rubber.

Polyvinyl plastisols are defined^(a) as a vinyl dispersion of resins in nonaqueous liquids consisting of plasticizers which do not dissolve the resin at ordinary temperatures. Such materials can be converted to a tough, rubbery film by heating to above 350° F. A report has been written that gives a description of the testing methods and quality considerations.^(b) The specification used in Y-12 for the purchase of polyvinyl plastisol is YMS-102 (Appendix D).

Plastisol is usually cured in a forced-air, recirculation-type electric furnace. The equipment in use at Y-12 was purchased on Specification YS-1240 (Appendix E).

Isostatic pressing molds (or bags) are made from polyvinyl plastisol formulations by three methods, described in the sections that follow.

Fabrication Procedure

Casting - Thick-walled (1/2 to 1") bags are made by pouring the plastisol into the annular space between two heavy-walled (1/2 to 3/4") aluminum shells and fusing the plastisol. The molds are subjected to considerable pressure because the molds are closed; small extrusion holes at the top are the only means of pressure relief. The plastisol is fused at 375° F in a forced-air, recirculation-type electric oven. The fusing time is governed by the bag size and is judged by noting the appearance of the extrusions. The molds are cooled to room temperature and dismantled. Bag lids are cast in a similar manner. These bags have a useful life of several hundred pressure cycles and are discarded when the plasticizer is leached from the bags and they lose their flexibility.

Dip Molding - This is the most economical method of bag fabrication because of cheaper tooling, shorter fabrication time, and lower raw material usage. Bags are dip molded by lowering a heated mold into the plastisol and withdrawing it after a predetermined time. Since the unfused plastisol is exposed on the exterior surface, the molds are supported in the oven by hanging. The steps in the procedure are:

1. Coat the mold with a thin film of a suitable mold-release agent.
2. Heat the mold between 350 and 375° F, depending on the mold thickness and the desired bag thickness.
3. Lower the mold into the plastisol at about 72 inches/min.

(a) Plastics Engineering Handbook (Society of the Plastics Industry, Inc), Third Edition, Reinhold Publishing Company, New York (1960).

(b) Schmitt, C. R.; Polyvinyl Plastisol Quality Study, Y-1508, Union Carbide Corporation-Nuclear Division, Y-12 Plant, Oak Ridge, Tennessee; to be issued.

4. Leave the mold submerged in the plastisol for a short period of time, depending on the desired thickness.
5. Withdraw the mold at about 72 inches/min.
6. Heat the coated mold at 375° F for about one hour to fuse the plastisol. The heating period will vary according to the bag thickness.
7. Cool to room temperature and strip the bag from the mold.

Bag molds for dip molding are normally fabricated from 1/4-inch-thick (minimum) aluminum. For small-diameter cylinders (4 inches maximum diameter) solid bar can be used. The aluminum must be nonporous and should have a surface finish of 16 microinches rms or better.

Pour Molding - This method is similar to dip molding but is used primarily for shapes that cannot be readily dipped. The procedure is identical to dip molding except the plastisol is poured over the heated mold. The heat gels the plastisol and forms a thin layer that adheres to the mold. Two or three pours are normally required to make a bag. The pour molds are usually made from solid aluminum billets so that they will retain enough heat to gel each pour.

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APPENDIX A

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SPECIFICATION FOR UNVULCANIZED RUBBER

UNION CARBIDE NUCLEAR CO.

OAK RIDGE, TENNESSEE

Y-12 Plant

Y-12 Interim Specification
No. YMS-101

Date of Original Issue: 7-17-56

MATERIALS SPECIFICATION

RUBBER, NATURAL GUM, UNVULCANIZED

1. SCOPE AND CLASSIFICATION:
 - 1.1 SCOPE. This specification covers requirements for unvulcanized natural gum rubber for use in general plant operations.
 - 1.2 CLASSIFICATION. The material covered by this specification shall be unvulcanized, pure gum rubber. It shall be uncolored and compounded without inert fillers or diluents.
2. APPLICABLE SPECIFICATIONS, STANDARDS AND OTHER SPECIFICATIONS:
 - 2.1 FEDERAL SPECIFICATIONS. None.
 - 2.2 OTHER SPECIFICATIONS. None.
3. REQUIREMENTS:
 - 3.1 MATERIAL. The material shall be unvulcanized pure gum rubber. It shall be uncolored and compounded without inert fillers or diluents.
 - 3.2 HARDNESS. The compound shall be designed for vulcanization in steam autoclaves, on forms or in molds, into components of 35 ± 5 durometer Shore A hardness.
 - 3.3 TENSILE STRENGTH. The tensile strength of the material, when vulcanized under ASTM test conditions (ASTM-D412-41T), shall average 3450 psi. The minimum value shall be 3000 psi.
 - 3.4 TEAR STRENGTH. The tear strength of the material, when vulcanized under ASTM test conditions (ASTM-D624-48T), shall average 280 pounds/inch. The minimum value shall be 250 pounds/inch.
 - 3.5 MODULUS. The modulus of the material, when vulcanized under ASTM test conditions, shall average 400 psi at 500%. (ASTM-D412-41T).

Y-12 Interim Specification
No. YMS-101

Materials Specification
Rubber, Natural Gum, Unvulcanized

- 3.6 ELONGATION AT BREAK. The percent elongation at break of the material, when vulcanized under ASTM test methods, shall average 780. The minimum shall be 750 percent. (ASTM-D412-41T)
- 3.7 RATIO OF NEW TO RECLAIMED RUBBER. The ratio of new rubber to reclaimed rubber included in the compound shall not be lower than 100 to 1.
- 3.8 PERCENT OF RUBBER IN COMPOUND. The percent by weight of pure rubber included in the compound shall not be lower than 92.0.
- 3.9 PHYSICAL CONDITION. The unvulcanized material shall be evenly calandered, smooth both sides, and shall be handled through the compounding and calendering operations in a manner such that no dimples and imperfections are visible in the finished surfaces.
- 3.10 SIZES. Material shall be 36" wide. Thickness tolerances on various sizes shall be as shown in the following table:

Table I.

Thickness Tolerances

<u>Nominal Thickness</u>	<u>Permissible Tolerances</u>
1/4"	± .015"
1/8"	± .008"
1/16"	± .004"
1/32"	± .004"

4. SAMPLING, INSPECTION, AND TEST PROCEDURES:
- 4.1 SAMPLES. Prior to award of contract the supplier shall submit one production-lot sample to the buyer for testing purposes. Each such sample shall consist of from 50 to 100 pounds of 36" X 1/8" compound, and shall be accompanied by two copies of certified test results for the tests outlined in Sections 3.2 through 3.8.
- 4.2 The buyer reserves the right to reject any lot of material which does not meet the minimum requirements outlined in Sections 3.2 through 3.8.
- 4.3 Each shipment is subject to inspection on delivery for compliance with this specification, and other requirements as specified on the purchase order.

Y-12 Interim Specification
No. YMS-101

Materials Specification
Rubber, Natural Gum, Unvulcanized

5. PACKAGING AND SHIPPING:

- 5.1 PACKAGING. The material shall be holland-backed and shall be packaged on rolls which are supported inside wooden crates in such a manner that imperfections due to handling in shipment are minimized.
- 5.2 IDENTIFICATION. Each wooden crate shall be marked with the manufacturer's name, address, and catalog number, the applicable UCNC purchase order number, the size of the material, and the net weight of the material. Each crate shall contain a lot ticket which bears, in addition to the above information, the vendors lot number and the date of compounding.

6. NOTES:

- 6.1 BID EVALUATION. In addition to price and to meeting of physical tests, the buyer will take the following into consideration in evaluating proposals:

The performance of a sample of the vendor's product in service in the buyers process.

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SPECIFICATION FOR STEAM AUTOCLAVE

UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
Y-12 ENGINEERING DIVISION

Issued: March 16, 1959

Job Specification Number YS-663

Specification For: DIRECT STEAM HEATED AUTOCLAVE

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YS-663

I. SCOPE

This specification covers the design, fabrication, test, inspection and delivery of a direct steam heated autoclave to be used for vulcanizing raw natural rubber.

II. REFERENCES

Tank and Drum Data Sheet FTD-663
ASME Boiler and Pressure Vessel Code
ASTM Standards

III. DESIGN SPECIFICATIONS

A. Requirements

1. General Design

This equipment shall meet the requirements as outlined in the Tank and Drum Data Sheet FTD-663. Fabrication of the vessel shall be in accordance with Section VIII, ASME Code for Unfired Pressure Vessels.

The vessel shall have a hydraulically operated, quick opening cover of external bayonet lug type or equivalent. The cover when opened shall allow full overhead access to load a maximum size rubber mold.

The hydraulic equipment shall be furnished complete including internal relief valve, cylinders, pump with drive, valves and interconnecting tubing. The equipment shall be mounted to the vessel or furnished with base suitable for floor mounting.

2. Test and Inspection

The vessel shall be tested and inspected in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. The vessel shall be code stamped and completed Manufacturer's Data Report, Form U-1 shall be furnished.

UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
Y-12 PLANT, OAK RIDGE, TENNESSEE

TANK AND DRUM DATA SHEET

Page 1 of 1

BM or Spec. No. YS-663

Title DIRECT STEAM HEATED AUTOCLAVE
Application Vulcanizing Raw Rubber
Location _____
No. Required 1 Spares in Total None

Data Sheet No. FTD 663-1
Work Order No. _____
Building No. _____
By _____ Chkd. _____ Appd. _____ Date _____

Equipment Numbers	Rev..	Revision Description	By	Appd.	Date
None					

Process Fluid Steam, Superheated
Sp Gr _____ Conc _____
Oper psig 70 Design psig 70
Oper Temp. °F 316 Design Temp. °F 480
Corrosion Allowance in _____ .062
Oper Volume Gal. Approx. 1400
Vessel O D 72 in.
Length, Tang to Tang 72 in.
Heat Transfer _____ Agitation _____
Materials of Construction:
Heads ASTM A-256 Gr. B Firebox
Shell ASTM A-256 Gr. B Firebox
Nozzles ASTM A-181 Any Gr.
Flanges & Covers ASTM A-181 Gr. I
Bolts ASTM A-491 Nuts ASTM A-194 Gr. 2
Gaskets Asbestos
Internal Baffles etc _____
Internal Piping _____
External Lugs etc _____
Supports ASTM A-7
Vessel Lining _____
Insulation _____
Type of Head (top) ASME F & D
Type of Head (bottom) ASME F & D
Type of Supports External Lugs
Lifting Lugs Special Opening Device
Manhole Flg. Rating & Facing _____
Nozzle Flg. Rating & Facing 150 lb. R.F.
Outside Finish As Rolled
Inside Finish As Rolled
Vessel Weight lbs _____
Hydrostatic Test psig _____
Code ASME, Section VIII
Stress Relieved _____
Radiographed _____
Stamped U Stamped Required
Witness Test Required No
Inspection By Code Inspector

SKETCH:

TYP. SUPPORT, 4
REQ'D. EA. SPAC-
ED @ 90°

ORIENTATION

Nozzle	Size & Type	Purpose
A	2" Flanged	Steam Inlet
B	1" Flanged	Condensate
C	2" Flanged	Pressure Relief
D	1/2" Screwed	Pressure Gauge
E	3/4" Screwed	Temp. Bulb
F	2" Flanged	Spare

Space marked with an asterisk (*) refers to furnish the information.

REQUEST FOR MANUFACTURER'S DATA

Date: March 16, 1959BM No. Spec. No. YS-663

W. O. No. _____

Page 1 Of 1

Equipment No. _____ Building No. _____ Room No. _____

Operating Division _____

Brief Description of Equipment Direct Steam Heated Autoclave

The seller shall furnish the information outlined below. Each item of information shall be identified with the purchasers P. O. number.

MANUFACTURERS' DATA REQUESTED

DRAWINGS AND DATA DESCRIPTION REQUIRED	WITH BID CHECK (✓)	FOR APPROVAL	CERTIFIED COPIES
1. Warranty (includes all guarantees, bonds, etc., specified in purchase orders and contracts, and furnished by contractors and vendors).			
2. Material Specifications and/or Certifications.			5
3. Operating Data and/or Performance Specifications (including flow characteristics).			
4. Manufacturers' Data and Test Reports (Manufacturers' tests before shipment. Additional to Item 3 above).			5
5. Heat Charts.			
6. Welding Procedures.			
7. Parts Lists, Parts Drawings.			
8. Outline Dimension Drawings.	2	5	11 or R
9. Assembly Drawings.			
10. Detail Drawings, Mechanical.		5	11 or R
11. Detail Electrical Drawings, and Electrical Wiring and Schematic Diagrams.			
12. Instructions (Installation, Operation, Maintenance, Lubrication).		5	11 or R
13. Other			

GENERAL NOTES:

- a. Within (2) weeks after award of contract the Seller shall furnish the required number of data and drawings "For Approval" as outlined in the table above. Subsequent revisions shall also be approved.
- b. "Certified Correct" data and drawings are required within (2) weeks after return of "For Approval" data and drawings.

REQUISITIONER

APPENDIX C

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SPECIFICATION FOR METHYL CHLOROFORM

APPROVED FOR
INTERIM USE
IN PROCUREMENT *WCA*

03-AD-001
January 12, 1956
Page 1 of 4

An Interim
**MATERIALS SPECIFICATION¹ OF
UNION CARBIDE NUCLEAR COMPANY**
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
U. S. Government Contract W-7405-eng-26

1,1,1,-TRICHLOROETHANE (METHYL CHLOROFORM), STABILIZED, COMMERCIAL

1. SCOPE AND CLASSIFICATION

1.1 This specification covers inhibited 1,1,1,-trichloroethane, stabilized especially for aluminum 24S-T, copper and 50-50 lead-tin solder. This product is intended for cold degreasing of metals, and cleaning of electrical and general equipment; a substitute for more toxic compounds such as carbon tetrachloride. (See 6.2 Field use)

2. APPLICABLE SPECIFICATIONS, STANDARDS AND OTHER PUBLICATIONS

2.1 Federal Specification VV-L-791 and ASTM Methods are applicable as specified.

3. REQUIREMENTS

3.1 Material. The 1,1,1,-trichloroethane shall be stable for aluminum 24S-T, copper and 50-50 lead-tin solder at the solvents' boiling temperature at atmospheric pressure.

3.2 Physical Requirements. The material shall conform to the requirements shown in Table I.

TABLE I - Physical Requirements

: Acidity (as HCL)	0.001% (maximum)	:
: Flash point	None (Cleveland Open Cup Method)	:
: Fire point	None (Cleveland Open Cup Method)	:
: Max. allowable concentration		:
: in the air	500 ppm	:
: Water	100 ppm (maximum)	:
: Non-volatile material	0.001% maximum (by weight)	:
: Boiling range at 760 mm. Hg,		:
: IBP-DP	70° - 88° C	:
: Color	Clear (APHA 15)	:
: Odor	None to mildly sweet	:
: Specific gravity at 25/25° C	1.312 - 1.321	:

(The material shall not contain more than 6 percent 1,1,2,-trichloroethane)

3.3 Acceptability. An acceptable material will satisfactorily pass all of the tests listed in Section 4.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

¹ For use by installations in Oak Ridge, Tennessee and Paducah, Kentucky operated for the U. S. Atomic Energy Commission.

03-AD-001
Page 2 of 4

4.1 Sampling. A suitable sample of 1,1,1,-trichloroethane shall consist of blended equal portions from containers randomly selected from each lot of material and sufficient in amount to determine conformance with this specification. A lot shall consist of all material produced under substantially the same conditions and offered for delivery at the same time. Sampling shall be in accordance with method 8001.2 of Federal Specification VV-L-791. (Which specifies ASTM D270-53T Sampling Petroleum and Petroleum Products)

4.2 Inspection. Each filled container may be examined for defects of construction of container and closure, for evidence of leakage, and for unsatisfactory markings. Any noted defect may be cause for rejection of the entire lot offered for delivery.

4.3 Tests. The following tests are recognized for determining conformance to requirements of Section 3.

4.3.1 Fire and Flash Point. The fire and flash point shall be determined in accordance with ASTM Designation D92-52. The results shall be as specified in 3.2.

4.3.2 Boiling Range (Distillation Test). The initial boiling point and boiling range shall be determined in accordance with ASTM Designation D1078-49T.

4.3.3 Non-Volatile Material. The non-volatile matter shall be determined in accordance with ASTM Designation D268-53.

4.3.4 Acidity. The acidity shall be determined in accordance with ASTM Designation D268-53. The titration shall be with alcoholic 0.1 N sodium hydroxide. Bromthymol Blue shall be used as the indicator.

4.3.5 Water. The water content shall be determined by electrometric titration with Karl Fischer reagent, as specified in Method 3253 of Federal Specification VV-L-791.

4.3.6 Stability. Prepare a 1/2 by 3 inch panel of aluminum alloy 24S-T. Polish with emery cloth, wash with soap and water and rinse thoroughly with distilled water. Wash with acetone and allow to dry in air. Place the dry panel in a 125 milliliter Erlenmeyer flask which has a 24/40 ground glass neck. Add 50 milliliters of 1,1,1,-trichloroethane, stabilized, attach a reflux condenser, and reflux the sample for five (5) hours. Allow to cool and examine the panel. There shall be no evidence of corrosion of the aluminum.

Repeat this test using copper and 50-50 lead-tin solder.

4.3.7 Allowable Concentration in Air. The following test is recognized for determining the Maximum Allowable Concentration in air:

A glasswall chamber or similar chamber having a capacity of approximately 200 liters shall be used. A constant air flow shall be maintained through the chamber and the air metered at the rate of 20 liters per minute through a Precision Wet Testmeter, or other suitable device such as an accurately calibrated rotometer. The vapor concentration shall be obtained by metering the material at a constant

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rate into a suitable container for complete volatilization into the main air flow. The apparatus used may consist of a burette discharging into a Phipps and Bird glass Nebulizer, or by another suitable device such as a gear driven syringe pump apparatus, into a volatilization flask. A minimum of heat shall be applied at the point of addition to effect complete volatilization. A group of 10 rats (5 of each sex) shall be introduced into the chamber and observed for a period of 7 hours. All of the rats shall be healthy albino rats and shall weigh approximately 200 grams each. The concentration in the chamber shall be 10,000 ppm by volume (55 mg. of material per liter of air calculated at 25° C. and 760 mm. Hg). At the end of 7 hours, all animals shall be alive and at least one of the animals shall not be comatose at the end of 3 hours.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Packing. Unless otherwise specified, the material shall be packaged in 5 and 55 gallon drums. The packing shall be such as to insure acceptance and safe delivery by common carriers, at the lowest rate, to the point of delivery called for in the contract or purchase order.

5.2 Labeling. In subject commodity the presence of an ingredient covered by labeling requirement of the Manufacturing Chemists Association, Inc., shall be indicated on the label in conformance with such requirements.

5.3 Shipping Container. Each container shall be marked with the following information:

Vendor's name
Descriptive name of item
Purchase order number
Letter release number (if any)

6. NOTES

6.1 Contractual Requirements. Certification requirements, submission of buyer's samples and other contractual matters will be detailed in the invitation to bid and purchase order as required.

6.2 Field Use

6.2.1 Use on Metals. 1,1,1,-trichloroethane is a chlorinated solvent stabilized principally for cold degreasing of 24S-T aluminum used in the aircraft industry. It can be reactive with certain metals under certain conditions. This specification requires proof of its stability with copper and 50-50 lead-tin solder. This solvent can logically be expected to be stable in the presence of ferrous alloys, stainless steels, lead, tin, nickel, inconel, brass, bronze and monel and other metals and alloys below aluminum 24S-T in the electromotive series (See Langes' Handbook of Chemistry, 8th Ed., Page 1250, "An Electromotive Series of Metals and Alloys".) This solvent can logically be expected to exhibit some reactivity in contact with aluminum 52SH, 4S, 3S, 2S, 53S-T, alclad, cadmium, zinc, galvanized products, magnesium and magnesium alloys.

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6.2.2 Re-distillation in Use. At the time this specification was prepared one vendor recommended the following procedures when re-distillation is involved.

6.2.2.1 Steam injection at end of distillation is recommended to carry over portions of the stabilizers which have not volatilized.

6.2.2.2 Mixing of reclaimed solvent with equal parts of virgin solvent is recommended if at all practicable.

APPENDIX D

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SPECIFICATION FOR POLYVINYL PLASTISOL

UNION CARBIDE NUCLEAR CO.

OAK RIDGE, TENNESSEE

Y-12 Plant

Y-12 Interim Specification

Date of Original Issue: 11-26-56

No. YMS - 102

MATERIALS SPECIFICATION

POLYVINYL PLASTISOL

1. SCOPE AND CLASSIFICATION:

- 1.1 SCOPE. This specification covers requirements for compounded polyvinyl chloride for use in general plant operations.
- 1.2 CLASSIFICATION. Material shall be a plastisol compounded principally of polyvinyl chloride and its copolymers, and the necessary plasticizers, lubricants, and stabilizers.

2. APPLICABLE SPECIFICATIONS, STANDARDS AND OTHER SPECIFICATIONS:

- 2.1 FEDERAL SPECIFICATIONS. None
- 2.2 OTHER SPECIFICATIONS. None.

3. REQUIREMENTS.

- 3.1 MATERIAL. The plastisol shall be compounded using a plasticizer which, from the cured product, has a low extractability into mineral oil. The compound shall include appropriate heat and light stabilizers. The compound shall be unpigmented and shall include no filler materials and shall be designed for hot air curing in aluminum molds. A mold release agent shall be included in the compound, if considered desirable by the vendor. The material shall be of uniform composition and so compounded as to conform to the requirements prescribed in these specifications.

Y-12 Interim Specification

No. YMS-102

Materials Specification
Polyvinyl Plastisol

- 3.2 HARDNESS. The compound shall be designed for hot air curing into components of 60 - 5⁺ durometer Shore A hardness. (ASTM-D-676-49T).
- 3.3 TENSILE STRENGTH. The tensile strength of the material after hot air curing under ASTM test conditions shall average 1500 lb./sq.in. The minimum value shall be 1450 lbs./sq.in. (ASTM-D-412-51T).
- 3.4 TEAR STRENGTH. The tear strength of the material after hot air curing under ASTM test conditions shall average 170 lb./in. The minimum value shall be 150 lbs./in. (ASTM K-624-48).
- 3.5 ULTIMATE ELONGATION. The percent elongation at break of the material when hot air cured under ASTM test conditions shall average 400%. The minimum value shall be 350%. (ASTM-D-412-51T).
- 3.6 VISCOSITY. The viscosity of the material shall not exceed 5000 centipoises after 10 weeks storage, using a Brookfield Viscometer.
- 3.7 CHEMICAL COMPOSITION. The vendor shall furnish a sample lot with certified laboratory test results as follows:
1. Percent by weight of resin.
 2. Percent by weight of plasticizer.
 3. Percent by weight of stabilizers.
 4. Percent by weight of mold release agent.
- It shall not be necessary for the vendor to divulge the chemical names of the materials used in the compound.
4. SAMPLING, INSPECTION, AND TEST PROCEDURES.
- 4.1 Prior to the award of contract the supplier shall submit one production lot sample of the material to the buyer for testing. Each sample shall consist of 5 gallons of material, and shall be accompanied by two copies of certified test results as outlined in Section 3.7.

Y-12 Interim Specification

3

No. YMS-102

Materials Specification
Polyvinyl Plastisol

- 4.2 Each shipment is subject to inspection on delivery for compliance with this specification and other requirements as specified in the purchase order.
- 4.3 The buyer reserves the right to reject any lot of material which does not meet the minimum requirements outlined in Sections 3.1 through 3.7.
5. PREPARATION FOR SHIPMENT. The material shall be placed in 55 gallon drums and properly sealed.
- 5.1 IDENTIFICATION. Each drum shall include the suppliers name, address, and catalog number, the applicable UCNC purchase order number, and the net weight of material.
6. NOTES
- 6.1 BID EVALUATION. In addition to price and to meeting of physical tests, the buyer will take the following into consideration in evaluating proposals:
- The performance of the vendors product in service in the buyers process.

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APPENDIX E

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SPECIFICATION FOR ELECTRIC FURNACE

Y-12 Engineering Division

Date April 3, 1963

Specification No. YS - 1240

Work Order No. _____

Specification For: CURING OVEN

TABLE OF CONTENTS

1. Scope
2. Applicable Specifications, Standards, Codes and Drawings
3. Requirements
4. Equipment Number
5. Identification
6. Inspection and Tests
7. Certification of Materials

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1. SCOPE

This specification covers the design and fabrication of an electrical resistance heated curing oven. The oven shall be complete with blower, ductwork, access doors, all permanently attached conduit, wiring, junction boxes and required instrumentation controls.

All oven controls shall be housed in a 24" x 24" x 70" control cubicle. Interconnecting conduit, wiring, contactors and foundations shall be furnished and installed by the Company using the Seller's installation instructions.

2. APPLICABLE SPECIFICATIONS, STANDARDS, CODES AND DRAWINGS:

The latest revision of the following documents shall form a part of this specification insofar as they are applicable:

National Fire Protection Association pamphlet #86 entitled "Class A Ovens and Furnaces".

National Fire Protection Association pamphlet #70 entitled "National Electrical Code".

AIEE

NEMA

Data sheets of this specification

All equipment, valves, instruments and electrical devices shall be Underwriters or Factory Mutual approved and listed, unless such approval is waived by the Company. The Seller shall submit a list of all devices to the Company for approval.

3. REQUIREMENTS

a. Design Conditions

The oven charge will consist of a 900 pound aluminum mold and 400 pounds of (plasticized polyvinyl chloride) material, which is to be heated to 225°C for a period of 20 hours for curing.

b. Oven Construction

- (1) The oven shall be a walk-in type
- (2) The clear working space within the oven shall be 6 feet wide, 6½ feet high, and 6 feet deep.
- (3) The exterior surface of the oven shall be painted with one coat of standard prime and two finish coats of exterior gray Federal Chip #16440.

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- (4) The oven shall be constructed of noncombustible materials throughout.
- (5) The amount of insulation used in oven panel construction shall be sufficient to prevent the outside surface temperature from exceeding 160°F when ambient temperature is 100°F. Outside design temperature for computing heating requirements for the oven is 0°F.
- (6) Oven structural supports shall be designed with adequate factors of safety at the maximum operating temperatures, consideration being given to the strains imposed by expansion.
- (7) Access doors or openings in adequate number and size shall be provided to facilitate inspection and maintenance.
- (8) The metal enclosure and framework of the oven shall be electrically grounded throughout. Oven conduit, junction boxes, switch enclosures, and blower motor shall be grounded with a bare copper conductor in accordance with table 290-95 of article 250 NEC dated 1959.
- (9) The floor of the oven work chamber shall be a concrete supporting pad which will be furnished by the Company as indicated on Data Sheets 1 and 2 (Pages 7 and 8 of this specification).
- (10) The oven shall have double doors at one end only with a 6 foot wide, 6½ foot high clear opening. The doors shall be electrically interlocked to shut off heaters whenever the doors are open.
- (11) The oven enclosure, junction boxes, and motor shall be designed for outdoor service and meet NEMA type 4 (Water-tight) requirements.

c. Heating System

- (1) The oven shall operate continuously at all levels from 30°C to 225°C
- (2) The oven shall have a minimum of 30 KW heat input capacity.
- (3) The electric heating elements shall be inconel sheathed.
- (4) Power for the heating elements shall be 460 volts, 3 phase, 60 cycles.
- (5) The electrically operated contactors for the oven heaters and blowers shall be supplied and will be remotely located and installed by the Company. All power and control wiring shall be terminated and identified on a terminal block at some convenient location on the oven.

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d. Controls

- (1) All control devices shall operate from a 120 volt, single phase, 60 cycle power source.
- (2) Oven temperature shall be measured with a 14 gauge iron-constantan thermocouple, located in the heated air supply to the oven work chamber. The thermocouple shall be mounted in an open end protection tube, attached to the oven and containing a water-tight thermocouple head. Location of the thermocouple assembly shall be in a position to prevent heating element radiation effects on the temperature measurement and to prevent interference with loading and unloading of the oven charge.
- (3) Oven compartment temperature shall be controlled by a round chart, electronic potentiometer type recording controller, calibrated over the range of 0 to 300°C for iron-constantan thermocouple. Scale and chart of the instrument shall be calibrated 0 to 300°C and the chart speed shall be 24 hours per revolution. The control form shall be two position (On-Off), consisting of two SPDT snap action switches to provide a neutral or zero neutral zone of control. A control index shall be provided at the front of instrument to manually position the control point over the instrument full scale. A failsafe feature shall be included to provide up-scale pen drive on amplifier failure and thermocouple burn-out. The instrument shall have continuous standardization and automatic reference junction compensation. A SPDT snap action type, high temperature switch shall be included in the instrument. Setting of this switch shall be independent of the control index and shall be adjustable over the instrument full scale. An auxiliary relay shall be incorporated in the instrument to provide a contact for shutting off the oven if the instrument balancing motor fuse opens. A $\frac{1}{4}$ " NPT air purge connection shall be provided in the instrument case. The instrument shall be Leeds & Northrup Speedomax H, Model R, Catalog #2-901-061-007-6-024-1-3-42 with special relay or approved equal.
- (4) Two adjustable timers shall be provided in the control circuit. One timer shall be a 7-day operation type which will permit automatic starting and stopping of the oven heating cycle during each 24 hour day and which shall have provision for skipping the operation on Saturday and Sunday or other selected days. The timer shall be International Register's Series T-170 or approved equal. A by-pass switch shall be supplied to permit operation of the oven without the timer contact in the control circuit. The other timer shall be a $\frac{1}{4}$ to 15 hour interval timer, which shall initiate an audible and visible signal to indicate when the selected

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interval time is complete. The timer shall be ATC No. 305A-21-A-01-XX or approved equal. An On-Off (Reset) selector switch shall be provided to start and stop the interval period. In the Off (Reset) position, the timer and "Interval Complete" indication shall be reset. Note: The audible signal requested in Section 3.d.(5) may be utilized as part of this indication.

- (5) An audible and visible alarm shall be included to provide indication of high temperature conditions in the oven compartment. If high temperature occurs, heat to the oven shall be automatically shut off. Provision for silencing the audible signal but leaving the visible signal during alarm conditions shall be included.
- (6) The oven control circuit shall contain a Low-Off-High heat selector switch for close heat control and quick recovery.
- (7) The oven blower and heater contactors shall be electrically interlocked to shut off heaters of power to the blower is interrupted. Controls shall be provided to permit operating the blower with the oven heat off during purging and cooling of the oven.
- (8) A $\frac{1}{4}$ " NPT, 15 pound air line connection, shutoff valve, pressure switch and two flow meters shall be provided on the control cubicle for maintaining a positive air pressure inside the cubicle and the recording controller case. The air pressure switch shall be set at 5 psig and interlocked with the oven control circuit source voltage.
- (9) The two flow meters shall be Schutte-Koerting Fig. #1853, size 4 purge rotameter for an air flow range of .1 to 30 cfm at 10 psig and 70°F or approved equal.

e. Control Cubicle

A self-supporting, dead front, steel control cubicle with hinged front panel shall be supplied for mounting all electrical controls. The cubicle shall meet NEMA 1 requirements. Minimum requirements of items to be mounted on the front panel and identified with nameplates are listed below:

- (1) Oven temperature recorder-controller
- (2) Close heat selector switch
- (3) Start-Stop switches for blower and heaters
- (4) Silence switch for audible alarm signals

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- (5) Indicating lights for:
 - (a) Control power on
 - (b) High temperature
 - (c) Interval time completion
- (6) Timers (Mount at Top of Panel)
- (7) Timer switches
- (8) Air purge rotameters

The cabinet shall be completely wired and all wiring for external connection shall terminate at appropriately marked terminal boards.

f. Oven Ventilation

- (1) The oven shall be equipped with a fan or fans to provide a supply of fresh air into the oven.
- (2) An adjustable air control damper shall be provided in the oven fresh air intake and in the exhaust vent.
- (3) Oven fan motors shall not be located inside of the oven or in the exhaust duct.
- (4) Vent duct shall have a weather cap.
- (5) All moving parts shall be guarded to provide mechanical and personnel protection.
- (6) Fresh air intakes outside of the oven shall be protected by screens.
- (7) The fresh air supply for the oven shall be from outdoors and not from inside of the building.
- (8) The temperature at any point within the oven work chamber shall not vary more than $\pm 5^{\circ}\text{C}$ from the oven set control temperature.

g. Services Available

The services available in the general area where the oven is to be installed are as follows:

- (1) Power: 3 phase, 440 volts, 60 cycles, and 1 phase, 120 volts, 60 cycles.
- (2) Instrument Air: 90 psig

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4. EQUIPMENT NUMBER

None

5. IDENTIFICATION

- a. Each assembly shall be plainly and permanently marked, preferably on a nameplate with the manufacturer's or seller's model and serial number. When such marking will impair proper functioning of equipment, use a metal tag. Such assemblies and parts shall be marked for identification.
- b. The Seller shall provide a shipping list itemizing all items by skid or container whether shipped from his plant or a subcontractor's. This list shall accompany or be submitted prior to the first component shipment.

6. INSPECTION AND TESTS

The oven and control cubicle shall be assembled, interconnected and tested by the Seller before shipping. Seller's test shall include a routine operational test to determine correctness of wiring, thermocouple calibration, and effectiveness of oven forced air circulation equipment. The Seller shall notify the Company one week prior to the beginning of the test in order that Company's representative may witness test, or at the option of the Company, certified results of the tests as specified on page 9, item 11, entitled "Test Reports" will be acceptable.

7. CERTIFICATION OF MATERIALS

None

UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
Y-12 PLANT - OAK RIDGE, TENNESSEE

DATA SHEET

TITLE CURING OVEN					SPECIFICATION NO. YS- 1240	
APPLICATION Equipment Location Plan					B/M NO.	
LOCATION					DATA SHEET NO. 1	
					WORK ORDER NO.	
NO. REQUIRED 1	SPARES IN TOTAL 0	BY	CHECKED	APPROVED	DATE 4-4-63	
EQUIPMENT NUMBERS			REV.	REVISION DESCRIPTION		BY APPD. DATE

NOTE:
SECTION "H-H" SHOWN ON DATA SHEET NO. 2

EQUIPMENT LOCATION PLAN

UC-N-480
12 2-611

NOTE: Space marked with an asterisk (*) indicates bidder to furnish the information.

UNION CARBIDE NUCLEAR COMPANY
 DIVISION OF UNION CARBIDE CORPORATION
 Y-12 PLANT - OAK RIDGE, TENNESSEE

DATA SHEET

TITLE CURING OVEN					SPECIFICATION NO. YS-1240	
					B/M NO.	
APPLICATION Section "A-A"					DATA SHEET NO. 2	
					WORK ORDER NO. S-2505	
LOCATION					DATE 4-4-63	
NO. REQUIRED	SPARES IN TOTAL	BY	CHECKED	APPROVED		
EQUIPMENT NUMBERS			REV.	REVISION DESCRIPTION	BY	APPD. DATE

UCN-550
(2 2-61)

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NOTE: Space marked with an asterisk (*) indicates bidder to furnish the information.

UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
Y-12 PLANT - OAK RIDGE, TENNESSEE

EQUIPMENT DESCRIPTION CURING OVEN	SPECIFICATION NO. YS- 1240
EQUIPMENT NO. --	B/M NO.
LOCATION	WORK ORDER NO.
WRITTEN BY	DATE April 3, 1963

MANUFACTURER'S DATA REQUIRED
THE SELLER SHALL FURNISH THE INFORMATION BELOW

INFORMATION	COPIES WITH BIDS	COPIES FOR APP.	CERTIFIED COPIES*
1. Outline Dimension Dwg. - Include total Wt. of Equipment	3	6	1-R
2. Assembly Drawings		6	1-R
3. Detail Drawings - Mechanical		6	1-R
4. Flow Diagrams			
5. Panel Wiring Diagrams		6	1-R
6. Elementary Wiring Diagrams (According to JIC Std.) **	3	6	1-R
7. Interconnecting Wiring Diagrams (According to JIC Std.) **		6	1-R
8. Material Certification			
9. Welding Procedures			
10. Operating Data and Performance Curves			
11. Test Reports (Sect. No. 6 of Specification)			11
12. Spare Parts List (In sufficient detail on each item to order from any supplier)		6	11
13. Operating, Maintenance & Lube Manuals		6	11
14. Recommended Piping and Instrumentation	3	6	1-R
15. Installation Instructions			
16. Small Component List and Description		6	11
17. Operating instructions including operating sequence, shut down emergency procedures and proper cleaning of unit			11

GENERAL NOTES

- Within four weeks after award of subcontract the Seller shall furnish the required number of data and drawings "For Approval" as outlined in the table above. Subsequent revisions shall also be approved.
- "Certified Correct" data and drawings are required within two weeks after return of "For Approval" data and drawings.

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* The required number of data and drawings shall include one reproducible transparency when followed by the symbol "R". Transparencies shall not be folded.
** Joint Industrial Conference.