INCH-POUND

MIL-DTL-82901A(OS)
13 May 2002
SUPERSEDING
MIL-E-82901
28 February 1996
Amendment 1
8 April 1997

DETAIL SPECIFICATION

EXPLOSIVE, PLASTIC-BONDED, CAST PBXN-110

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

1. SCOPE

1.1 Scope. This specification covers the requirements for two types of cast PBXN-110 plastic-bonded explosive (see 6.1).

1.2 Classification. The plastic-bonded explosive covered by this specification will be of the following types:

Type I	Polymethylene polyphenylisocyanate cured
Type II	Isophorone diisocyanate cured

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents specified in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Indian Head Division, Naval Surface Warfare Center, Standardization Branch (Code 4230F) 101 Strauss Avenue, Indian Head, MD 20640-5035 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by sending a letter.

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SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-L-3061	Lecithin
MIL-DTL-45444	HMX
DOD-D-82727	Dibutyltin Dilaurate
DOD-M-82730	4,4-Methylenebis(2,6-Di-Tert-Butylphenol)

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-650	Explosive: Sampling, Inspection and Testing
MIL-STD-1751	Safety and Performance Tests and Qualification of Explosives

(Unless otherwise indicated, copies of military specifications and standards are available from: Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation (see 6.2).

SPECIFICATIONS

NAVAL AIR SYSTEMS COMMAND (CAGE Code 30003)

AS 2328	Isodecyl Pelargonate

NAVAL SEA SYSTEMS COMMAND (CAGE Codes 10001 and 53711)

OS 9804	Ferric Acetylacetonate
WS 16305	Isophorone Diisocyanate
WS 23148	Polybutadiene, Liquid, Hydroxyl-Terminated
WS 22348	Polymethylene Polyphenylisocyanate
WS 22349	Dibutyltin Sulfide

(Application for copies should be addressed to the Commander, Naval Surface Warfare Center, Indian Head Division (Code 4230H), 101 Strauss Avenue, Indian Head, MD 20640-5035.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

CHEMICAL PROPULSION INFORMATION AGENCY

CPIA Publication No. 21 JANNAF Solid Propellant Mechanical Behavior Manual

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(Application for copies should be addressed to the Chemical Propulsion Information Agency, Applied Physics Laboratory, Johns Hopkins University, Johns Hopkins Road, Laurel, MD 20810.)

NORTH ATLANTIC TREATY ORGANIZATION

STANAG 4489	Explosives: Impact Sensitivity Tests
STANAG 4515	Assessing the Thermal Stability of Chemicals by Methods of Thermal Analysis
STANAG 4556	Explosives: Vacuum Stability Tests

(Application for copies should be addressed to NATO/MAS, Bvd Leopold III, 1110 Brussels, BE.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 537	Assessing the Thermal Stability of Chemicals by Methods of Thermal Analysis
ASTM E 831	Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

(Application for copies of ASTMs should be sent to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Approval of new ingredient vendors. When a new vendor of a PBXN-110 ingredient (see table I) is used, the vendor must be approved in accordance with 4.3. A proposed test and evaluation plan shall be submitted to the PBXN-110 Configuration Control Board for review and approval, unless the guidelines provided in section 6 are followed. The PBXN-110 Configuration Control Board shall evaluate the test data and determine acceptance or non-acceptance of the new ingredient vendor based on a comparison to the original PBXN-110 qualification test data.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.4.

3.3 Formulation. The PBXN-110 shall be a plastic-bonded, castable material that uses an elastomeric polymer to incorporate solid powders and thereby produce a flexible, cured explosive. The formulation of explosive PBXN-110 shall comply with the requirements specified in table I (see 6.8).

3.3.1 Cure conditions. The explosive shall be cured at a recommended temperature of between 20 and 50°C until the Shore A hardness meets the requirements of 3.4.

3.3.2 Equivalent ratio. The weight percent of the polybutadiene and the isodecyl pelargonate shall be kept in a ratio of 1:1 $\pm$ 0.05. The weight percent of the polybutadiene and the isocyanate shall be calculated using the following NCO/OH ratio:

Type I - 0.75/1.0 to 0.85/1.0

Type II - 1.0/1.0 to 1.10/1.0

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The NCO/OH ratio shall be calculated using the equivalent weights of materials obtained by chemical analysis using the techniques of 4.6.1 of WS 22348, 4.5.2 of WS 16305, and 4.6.2 of WS 23148. To avoid shelf life problems with component materials, this chemical analysis must be conducted at least every six months on lots of materials being used. The weight percent of each ingredient shall be determined to two significant figures (see 6.5).

TABLE I. PBXN-110 formulation.

Ingredient	Specification	Percent by Weight	
		Type I	Type II
HMX, Grade B, Class 3	MIL-DTL-45444	[1]66.0	[1]66.0
HMX, Grade B, Class 2	MIL-DTL-45444	[1]22.0	[1]22.0
Polybutadiene, linear, hydroxyl-terminated	WS 23148	[2]5.378	[2]5.365
Isodecyl pelargonate	AS 2328	[2]5.378	[2]5.365
4, 4'-Methylenebis(2,6-di-tert-butylphenol)	DOD-M-82730[3]	0.05 ± 0.005	0.05 ± 0.005
Lecithin	MIL-L-3061	0.70 ± 0.05	0.70 ± 0.05
Polymethylene polyphenylisocyanate	WS 22348 Type I	[2]0.494	--
Isophorone diisocyanate	WS 16305	--	[2]0.510
Dibutyltin dilaurate (DBTDL)	DOD-D-82727	--	[4]0.01
Ferric acetylacetonate (FeAA)	OS 9804	--	[4]0.0015
Dibutyltin sulfide (DBTS)	WS 22349	--	[4]0.10

1 The weight ratio of the HMX Class 3 to HMX Class 2 is nominally 3:1. To accommodate lot-to-lot variations in the HMX classes (see 6.6), this weight percent ratio is allowed to vary from a minimum of 1:1 to a maximum of 8.78:1. These ratios will result in the following minimum and maximum weight percentages:

Ingredient	Min.	Max.
HMX Class 3	44.0	79.0
HMX Class 2	9.0	44.0

in such a way that the total HMX content remains between 86 percent and 89 percent (see 3.3).

2 These are nominal values assigned to these component materials. The nominal composition of PBXN-110, Type I and Type II, was derived using the values of the sample calculations (6.5.1) and the requirements of 3.3.2. Actual weight percents of these materials must be calculated in accordance with 3.3.2 using experimentally determined equivalent weights.

3 Exception to DOD-M-82730: The maximum melting point requirement for 4,4'-Methylenebis(2,6-di-tert-butylphenol) shall not apply.

4 Use either DBTDL, FeAA, or DBTS. The tolerances on the weight percent of the catalysts shall be:

Catalyst	Min.	Max.
DBTDL	0.002	0.02
FeAA	0.001	0.02
DBTS	0.03	0.30

3.4 Cured explosive requirements. The cured explosive shall meet the requirements of table II when tested in accordance with section 4 (see 6.7).

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TABLE II. Cured explosive requirements.

Property	Type I		Type II		Test Method
	Min.	Max.	Min.	Max.	
Density at 25°C (g/cc)	1.62	1.70	1.62	1.70	4.6.1
Stress, max., at 25°C (psi)	20	--	20	--	4.6.2
Strain, max. stress at 25°C (%)	10	--	9	--	4.6.2
Hardness, Shore A, 15 second delay at 25°C	15	--	20	--	4.6.3
Vacuum stability at 100°C (mL gas per g per 48 hours)	--	0.4	--	0.4	4.6.4
Average composition, % HMX	86	89	86	89	4.6.5

3.5 Thermal stability (first article only). The thermal stability of cured PBXN-110 shall be tested in accordance with 4.6.6.

3.6 Workmanship. The explosive material shall be free from contamination with extraneous materials and manufactured in a manner to assure compliance with this specification. The sample shall then be evaluated to determine acceptability and the approved standards of workmanship will thereby become a minimum requirement for all units offered for acceptance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.4)
b. Conformance inspection (see 4.5)

4.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the applicable inspection paragraph.

4.3 Approval of new ingredient vendors. When a new vendor of a PBXN-110 ingredient (see table I) is proposed for use, the ingredient shall be evaluated in PBXN-110 according to an approved test plan. Section 6.8 provides guidance on this test plan. Alternate test plans may be used if approved by the PBXN-110 Configuration Control Board. Further, the government reserves the right to require re-approval of an ingredient vendor who makes a major change to their process or has not produced the material for over one year. Sufficient material from each of the number of lots of the ingredient, as specified in table III, shall be forwarded to the activity designated by the procuring activity so that a batch or batches of PBXN-110 can be made and tested as specified in table III. The approval evaluation batch or batches may be smaller in size than that used in production. The PBXN-110 Configuration Control Board shall review the ingredient test results and determine whether the sample is approved or rejected. Approved ingredient vendors are listed in section 6.9.

4.4 First article inspection.

4.4.1 First article inspection. The first article sample shall be manufactured using the same process, procedures, and ingredient vendors proposed for production, and inspected for the requirements of 3.4 and 3.5. This sample shall be tested in accordance with the test procedures specified in 4.6.1 through 4.6.6

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prior to the start of production. Failure of the first article sample to pass this inspection shall be cause for rejection of the first article sample. Any production prior to acceptance of the first article sample is at the risk of the contractor.

4.4.2 First article sample. The sample shall consist of two sets of representative explosive material selected from a minimum batch size of 225 kilograms. A sample set shall contain approximately 2000 g of explosive. A set shall be composed of two specimens of explosive, one selected from the first third of the batch another separate specimen selected from the final third of the batch. A batch is defined as that quantity of material that has been subjected to one or more chemical or physical processes (or combination thereof) in a single mix intended to produce a desired product having substantially uniform characteristics.

4.5 Conformance inspection. Conformance inspection shall consist of the tests specified in 4.6.1 through 4.6.5. The quality conformance sample shall be the same as that of 4.4.2 except that it shall consist of one set. Uncured material for analysis shall be selected from the same containers from which the cast samples are poured. Explosive failing to meet any of the requirements of 3.4 when tested in accordance with 4.6.1 through 4.6.5 shall be classified defective, resulting in the rejection of the batch from which it was obtained.

4.5.1 Sample identification. Each explosive sample container and specimen shall be marked with the following information:

a. Complete explosive designation
b. Lot number
c. Weight of the lot
d. Manufacturer's name and plant designation
e. Contract number
f. Date of manufacture and sampling

4.5.2 Lot Size. An inspection lot of PBXN-110 is equal to one batch as defined in 4.4.2.

4.6 Test methods. All explosive specimens used in the tests of 4.6.1 through 4.6.5.1 and 4.6.6 shall be cured to a constant Shore A hardness meeting the requirements of 3.3.1.

4.6.1 Density.

4.6.1.1 Samples. Density shall be determined on two samples cut from two separate cured test specimens (one sample taken from the beginning of the pour and one sample taken from the end of the pour). Each sample should weigh between 10 and 20 g.

4.6.1.2 Density determination. The density of the sample shall be determined on an analytical balance equipped for underwater weighing. The sample shall be weighed to an accuracy of 0.1 milligram, first in air then in water.

4.6.1.3 Density calculation. The density shall be calculated according to the following formula:

$$D = \frac{W_a}{W_a - W_b} \, x \, D_w$$

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Where:

D = Density of test sample, g/cc
D_w = Density of water at test temperature, g/cc
W_a = Weight of test sample in air, g
W_b = Weight of test sample in water, g

4.6.1.4 Failure. If a sample selected for density fails to meet the requirements of table II, another sample shall be taken from the same section of mix and tested. If the second sample meets the density requirement, the batch shall be considered to meet the density requirements of this specification.

4.6.2 Stress and strain at maximum stress. Stress and strain at maximum stress shall be determined in accordance with JANNAF Solid Propellant Mechanical Behavior Manual, CPIA Publication No. 21, Section 4.3.2, Uniaxial Tensile Tests at Constant Strain Rate (tentative standard), Nov. 1970. Class C testing shall be used except final specimens may be die cut from the half-inch slices from the bulk sample. The specimens for testing may be selected from the first third of the batch or the final third when sampled as described in 4.4.2.

4.6.3 Shore A hardness test (15-second delay).

4.6.3.1 Sample. The explosive of 4.6.1 in a suitable form as in 4.6.1.1 shall be tested for Shore A hardness. Any sample which exhibits bleeding at the surface at the end of the cure period shall not be tested.

4.6.3.2 Shore A hardness determination. The hardness of the cured material shall be determined using a Type A-2 durometer together with a constant load operating stand (Code DRCL). The total weight of dead weight, holding screw, and durometer shall be 1065 g. Test specimen shall be placed under the durometer pointer with the pointer resting on the surface of the sample. Release the lock called a "Pawl." Do not permit the point to shock the sample. Record the instrument dial reading 15 seconds after release. Use a stopwatch to measure the time. Determine three values each on the top and bottom of the specimen. Report the average of the top average and the bottom average as the test value.

4.6.4 Vacuum stability test. The vacuum stability test procedure shall be as described in MIL-STD-650, Method 503.1.1 except sample size shall be at least 0.2 g. Sample shall be cut into small cubes with a maximum size of 3 millimeters before being placed in the vacuum stability test tube. Two samples, one from each section of the batch, shall be tested.

4.6.4.1 Alternate vacuum stability test. Vacuum thermal stability test by the pressure transducer method may be conducted in accordance with STANAG 4556.

4.6.5 HMX analysis.

4.6.5.1 Detailed analytical procedure, cured PBXN-110. Weighed samples of cured material shall be extracted with carbon tetrachloride (CCl_4) and the residue dried and weighed (loss in weight = CCl_4 extractables). The residue shall then be extracted with hot dimethylsulfoxide (DMSO), dried and weighed (loss in weight = HMX). The remaining residue weight is the amount of binder or polymer.

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a. Cut sample into thin strips. Weigh 2.0 to 2.5 g of the thin strips to the nearest 0.1 mg into a 100-mL beaker.

b. Add 40 mL of CCl_4 and continuously stir the solution for 15 minutes.

c. Filter the solution through a weighed, medium porosity, sintered-glass crucible, and quantitatively transfer the residue to the crucible.

d. Dry the crucible plus residue at 100°C to a constant weight.

e. Quantitatively transfer the residue to a 100-mL beaker.

f. Add 30 mL of hot DMSO (60 to 70°C). Heat the solution for 15 minutes with constant stirring.

g. Filter off the DMSO through a previously weighed glass crucible.

h. Repeat step f.

i. Repeat step g.

j. Repeat step f (total volume of hot DMSO = 90 mL). Mash the sample residue with a flat-tipped stirring rod to release any trapped HMX-DMSO from the polymer matrix.

k. Filter quantitatively solid and solution through the previously weighed crucible. Mash residue with a flat-tipped stirring rod.

1. Wash residue at least 10 times with 20 mL of water and dry at 100°C to a constant weight.

Calculations:

$$\%\ HMX = \frac{B - C}{A}\ x\ 100$$

$$\%\ Binder = \frac{C}{A}\ x\ 100$$

$$\%\ CCl_4\ extractables = \frac{A - B}{A}\ x\ 100$$

Where:

A = Initial weight of PBXN-110

B = Weight of residue after CCl_4 extraction

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C = Weight of residue after DMSO extraction, polymer, or binder weight

4.6.5.2 Alternate test procedure, uncured PBXN-110.

a. Determine the HMX content of uncured PBXN-110 in duplicate on each of the two test specimens from a set of 4.5.1. Weigh a 2-gram sample of uncured explosive to an accuracy of 0.1 mg on an analytical balance prior to beginning polymerization. Place the weighed sample into a tared, 30-mL, fine porosity, sintered-glass filtering crucible. A glass stirring rod is to be included in the tare weight of the crucible.

b. Extract the sample at ambient temperature using a vacuum filtrator with five portions of 10 mL each of reagent grade methylene chloride saturated with HMX. The extractions should have a stirring time of approximately 1 minute each with the vacuum off while stirring.

c. Dry the sample for 30 minutes at 90 to 100°C, cool, and weigh.

d. Calculate percent HMX:

$$\% HMX = \frac{A - B}{C} x\ 100$$

Where:

A = Weight of crucible plus residue, g

B = Weight of crucible, g

C = Weight of sample, g

4.6.6 Thermal stability. Test in accordance with MIL-STD-1751, Method 1071; ASTM E 537; or STANAG 4515.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

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6.1 Intended use. PBXN-110 is a high-energy explosive intended for use in ordnance. PBXN-110, Type II is the preferred composition for general use. The material has been formulated to provide a longer pot life, i.e., time between the end of mixing and the time when the material can no longer be cast into a warhead to give a high-quality charge because of its high viscosity increase. PBXN-110, Type I has a shorter pot life but is equivalent to Type II with respect to sensitivity and performance properties. The material can be used in place of Type II for applications not requiring a long pot life, if isophorone diisocyanate is not available. Since PBXN-110 is designed for military ordnance, there is no commercial application.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).

c. Activity to receive new ingredient vendor samples for approval tests (see 3.1)

d. Whether first article inspection is required (see 3.2).

e. Packaging requirements (see section 5 and 6.11)

f. That the safety precaution requirements of the "Contractor's Safety Manual for Ammunition, Explosives, and Related Dangerous Material," DOD 4145.26M, are applicable. NOTE: When this specification is used as part of the description of work to be accomplished by a Government activity, the safety precaution requirements of "Ammunition and Explosives Ashore," OP 5, are applicable.

6.3 Approval of new ingredient vendors. With respect to vendors of PBXN-110 ingredients requiring approval, awards will be made to contractors who propose to use only ingredient vendors which are, at the time of award of contract, approved for inclusion in 6.9 whether or not such vendors have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have their ingredient vendors that they propose to use tested for approval in order that they may be eligible to be awarded contracts or purchase orders for the product covered by this specification. Information pertaining to approval of PBXN-110 ingredient vendors may be obtained from Indian Head Division, Naval Surface Warfare Center, Yorktown Detachment, PO Drawer 160, Yorktown, VA 23691-0160.

6.4 First article. When a first article inspection is required, the contracting officer should provide specific guidance to offerors whether the sample(s) should be a preproduction sample, a first article sample, a first production sample, a sample selected from the first production batches, standard production sample(s) from the contractor’s current inventory (see 3.2) and the number of samples to be tested as specified in 4.4.2. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely

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on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.5 Equivalent ratio. The following method is used to calculate the weight percent of polybutadiene, isodecyl pelargonate, and isocyanate:

Given:

The hydroxyl value of the polybutadiene = A, meq/g
The weight of equivalent of the polybutadiene = 1000/A, g/eq
The weight of equivalent of the isocyanate = B, g/eq

Step 1: Determine the weight in grams of isocyanate required to react with each gram of polybutadiene. This is accomplished using the following formula:

$$X = \frac{BR}{1000 / A}$$

Where:

X = Weight in grams of isocyanate per gram of polybutadiene
R = Mole ratio of isocyanate to polybutadiene

Step 2: Since the polybutadiene and the isodecyl pelargonate are in a 1:1 ratio, the weight percents of polybutadiene, isodecyl pelargonate, and isocyanate are in a 1:1:x ratio. The weight percent of isocyanate is equal to (X/(2 + X)) x 100, and likewise, the weight percent of polybutadiene and isodecyl pelargonate would be equal to 1/(2 + X) x 100, in the binder

Step 3: Since 11.25 percent of the Type I and 11.24 percent of the Type II explosive composition is made of these three ingredients , then:

1. Weight percent of polybutadiene in the two types of explosives is as follows:

Polybutadiene in Type I explosive = $\frac{100}{(2 + X)}$ (0.1125)

Polybutadiene in Type II explosive = $\frac{100}{(2 + X)}$ (0.1124)

2. Weight percent of isodecyl pelargonate in the two types of explosives is as follows:

Isodecyl pelargonate in Type I explosive = $\frac{100}{(2 + X)}$ (0.1125)

Isodecyl pelargonate in Type II explosive = $\frac{100}{(2 + X)}$ (0.1124)

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3. Weight percent of isocyanate in the two types of explosives is as follows:

Isocyanate in Type I explosive = $\frac{100X}{(2 + X)}$ (0.1125)

Isocyanate in Type II explosive = $\frac{100X}{(2 + X)}$ (0.1124)

6.5.1 Sample calculation for PBXN-110.

6.5.1.1 Type I.

Given:

The hydroxyl value of the polybutadiene = A = 0.84 meq/g
The weight equivalent of the polybutadiene 1000/hydroxyl value = 1190.48 g/eq
The weight equivalent of the isocyanate = B = 137.4 g/eq
NCO/OH ratio = R = 0.80

Using the values given above and the procedures outlined in 6.5, the following is computed:

$$X = \frac{(137.4)(0.8)}{1190.48} = 0.92\ g\ isocyanate/g\ polybutadiene$$

$$\frac{100}{2 + 0.092}(0.1125) = 5.378\%\ polybutadiene$$

The weight percent of the polybutadiene is calculated using Step 3-1 of 6.5 as follows:
And likewise, the weight percent of the isodecyl pelargonate using Step 3-2 of 6.5 is:

$$\frac{100}{2 + 0.092}(0.1125) = 5.378\%\ isodecyl\ pelargonate$$

Finally, the weight percent of isocyanate is determined using Step 3-3 of 6.5 giving the following:

$$\frac{(100)(0.092)}{2 + 0.092}(0.1125) = 0.495\%\ isocyanate$$

6.5.1.2 Type II.

Given:

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The hydroxyl value of the polybutadiene = A = 0.84 meq/g
The weight equivalent of the polybutadiene 1000/hydroxyl value = 1190.48 g/eq
The weight equivalent of the isocyanate = B = 113.65 g/eq
NCO to OH ratio = R = 1.0

Using the values given above and the procedures outlined in 6.5, the following is computed:

$$X = \frac{(113.65)(1.0)}{1190.48} = 0.095 \text{ g isocyanate/g polybutadiene}$$

The weight percent of the polybutadiene is now (Step 3-1):

$$\frac{100}{2 + 0.095}(0.1124) = 5.365\% \text{ polybutadiene}$$

And likewise the weight percent of the isodecyl pelargonate is (Step 3-2):

$$\frac{100}{2 + 0.095}(0.1124) = 5.365\% \text{ isodecyl pelargonate}$$

And the weight percent isocyanate is (Step 3-3):

$$\frac{(100)(0.095)}{2 + 0.095}(0.1124) = 0.510\% \text{ isocyanate}$$

6.6 HMX batches. HMX batches as received tend to vary considerably from batch to batch. It is therefore recommended that a 1-gallon (6-kg), or smaller, batch of PBXN-110 be processed and the initial mix viscosity determined for all new batches of HMX. If the initial viscosity is excessive (greater than 10 kp) thus reducing the mix pot life, then the following techniques may be tried in order to reduce the mix viscosity and/or increase pot life:

a. Shift the HMX3/HMX2 ratio from 3:1 to a ratio containing more or less Class 2 HMX.

b. To maximize pot life, the mix temperature should be kept at 25°C or less. In addition, the catalyst level can be reduced to a lower level but one which is compatible with the limits established in 3.4.

c. Reduce the total HMX content to 87 percent.

6.7 Moisture content. To obtain proper physical properties in the cured explosive, the moisture content of the component raw materials and the moisture content of the uncured explosive should be less

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than 0.05 percent. The moisture content can be determined by using MIL-STD-650, Method 101.4.1. In order to meet the stress and strain property requirements of 3.4, these property measurements should be made soon after meeting the Shore A hardness requirements of 3.4.

6.8 Test and evaluation plan for approving new ingredient vendors. Table III provides guidance on those tests and test methods deemed necessary for approving a new ingredient vendor. The extent of testing recommended depends on the ingredient. Some programs may want to add system level testing for their application.

6.9 PBXN-110 ingredient approved vendors.

6.9.1 HMX approved vendor(s).

Holston Defense Corporation Holston Army Ammunition Plant 4509 West Stone Drive Kingsport, TN 37660	CAGE Code 1D893 (Holston Defense Corporation is no longer a supplier, but previously produced material may be available.)
Bofors Explosives AB S-691 86 Karlskoga Sweden	CAGE Code S9784
DYNO ASA Postboks 779, Sentrum N-0106 Oslo, Norway	CAGE Code N0093
BAE Systems, Ordnance Systems Inc. 4509 West Stone Dr Kingsport, TN 37660-9982	CAGE Code 1LF48

6.9.1.1 HMX vendor approval test report references.

SMPO Pub 021000, *Foreign Source HMX Study Test Report*, J. W. Black III and E. O'Connor, NSWCDD, December 2000

IHTR 2332, *Evaluation of Foreign Source HMX in PBXN-110 Explosive*, Karen S. Burrows and Nancy C. Johnson, NSWCIHD, 2 April 2001

NSWCIHD ltr 8010 Ser 2411D/993 of 31 July 2001, Subj: Approval of BAE Systems, Ordnance Systems Inc. (OSI), as a Supplier for HMX, Classes 2 and 3 for PBXN-110

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TABLE III. Approval tests for new ingredient vendors.

New Vendor's Ingredient: / TEST	HMX, Grade B, Class 2	HMX, Grade B, Class 3	HTPB	PAPI or IPDI	IDP	DBTDL, or FeAA, or DBTS	Antioxidant	Lecithin	TEST METHOD
PBXN-110 Spec. Analysis	XX	XX	X	X	X	X	X	X	Test in accordance with 4.6.1 through 4.6.5.
Processing Evaluation	XX	XX	X	X	X	X	X	X	Prepare a PBXN-110 batch at least two pounds in size. Fill a 500-mL beaker with PBXN-110 immediately following the end of mix. Measure the viscosity with a t-spindle viscometer and helipath stand at the end of mix and every half hour for a minimum of 5 hours. Record and report the viscosity data along with the viscometer type, spindle type and speed used, choosing the correct types and speeds for PBXN-110. Keep the sample at constant temperature (20 ± 2°C) throughout the evaluation.
Shock Sensitivity	XX	XX							Test a cured PBXN-110 sample in accordance with MIL-STD-1751, Method 1041.
Impact Sensitivity	X	X							Test a cured PBXN-110 sample in accordance with MIL-STD-1751, Method 1012, or Rotter impact sensitivity test may be conducted in accordance with STANAG 4489. Concurrently test an RDX Type II Class 5 sample as a standard.
Friction Sensitivity	X	X							Test a cured PBXN-110 sample in accordance with MIL-STD-1751, Method 1021 or 1024, with an RDX Type II Class 5 sample as a standard.
ESD Sensitivity	X	X							Test a cured PBXN-110 sample in accordance with MIL-STD-1751, Method 1031 or 1033, with an RDX, Type II, Class 5 or PETN sample as a standard.
Thermal Stability (DSC)	X	X	X	X					Test a cured PBXN-110 sample in accordance with 4.6.6.
Critical Diameter	X	X							Test a cured PBXN-110 sample in accordance with MIL-STD-1751, Method 1091.
Thermal Expansion	X	X	X	X					Test a cured PBXN-110 sample in accordance with ASTM E 831.
Aging (6 mos. @ 70 C)									Age the PBXN-110 samples for the aging tests listed below for six months at 70°C. The PBXN-110 Configuration Control Board may allow a shorter aging period on a case-by-case basis, pending review of the ingredient vendor change. Conduct the following tests on cured PBXN-110 at the beginning and end of aging (note exceptions). Where more than one test method may be used, use the same test method for both tests (before and after aging).
VTS	X	X	X	X	X		X		Test in accordance with 4.6.4.
Composition			X	X	X				Test in accordance with 4.6.5.
Mechanical Properties (Stress/Strain)			X	X	X		X		Test in accordance with 4.6.2. Test at 0, 3 and 6 months.
Thermal Stability (DSC)	X	X	X	X	X		X		Test in accordance with 4.6.6.
Impact Sensitivity	X	X							Test in accordance with MIL-STD-1751, Method 1012, or Rotter impact sensitivity test may be conducted in accordance with STANAG 4489. Concurrently test an RDX Type II Class 5 sample as a standard.
Friction Sensitivity	X	X							Test in accordance with MIL-STD-1751, Method 1021 or 1024, with an RDX Type II Class 5 sample as a standard.
ESD Sensitivity	X	X							Test in accordance with MIL-STD-1751, Method 1031 or 1033, with an RDX, Type II, Class 5 sample as a standard.
Shock Sensitivity	X	X							Test in accordance with MIL-STD-1751, Method 1041.

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Table III Legend:

X = number of lots to evaluate in PBXN-110
HTPB = Polybutadiene, linear, hydroxyl-terminated
PAPI = Polymethylene polyphenylisocyanate
IPDI = Isophorone diisocyanate
IDP = Isodecyl pelargonate
DBTDL = Dibutyltin dilaurate
FeAA = Ferric acetylacetonate
DBTS = Dibutyltin sulfide
Antioxidant = 4,4'-Methylenebis(2,6-di-tert-butylphenol)

6.9.2 Polybutadiene, linear, hydroxyl-terminated approved vendor(s).

Atofina Chemical Incorporated	CAGE Code 86460
(Formerly Elf Atochem Incorporated	
and Arco Chemical Company)	Product Identification:
2000 Market Street	PolyBD R45HT, R45M or R45HTLO
Philadelphia, PA 19103	
1-800-328-2811	Plant Location: Channel View, TX 77530

6.9.3 Isodecyl pelargonate approved vendor(s).

Cognis Corporation	CAGE Code 0JS01
(Formerly Henkel; Corp & Emery Industries)	
5051 Estecreek Drive	Product Identification:
Cincinnati, OH 45232-1446	Emery 2911 (formerly Emolein 2911)
1-800-543-7370	Plant: Cincinnati, OH

6.9.4 4,4'-Methylenebis(2,6-di-tert-butylphenol) approved vendor(s).

Ethyl Corporation	CAGE Code 95643
PO Box 2189	
Richmond, VA 23280	Product Identification:
(804) 788-5000	HITECH 4702 formerly Ethyl 702
	Plant: Orangeburg, SC 29115

6.9.5 Lecithin approved vendor(s).

Central Soya Company, Inc	CAGE Code 1S003
PO Box 1400	
Fort Wayne, IN 46801-1400	Product Identification:
(219) 425-5100	Centrophil K, Centrolex F

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AE Staley Mfg. Co.
2501 N. Brush College Road
Decatur, IL 62525
(217) 423-4411

CAGE Code 56488

Product Identification:
Type UF (No longer available)

W. A. Cleary Corporation
1049 Somerset Street
Somerset, NJ 08875
(732) 247-8000

CAGE Code 09533

Product Identification:
B60

American Lecithin Company
115 Hurley Road Unit 2B
Oxford, CT 06478
(203) 626-7100

CAGE Code 7J557

Product Identification:
Alcolec S
Plant: Decatur, Indiana

6.9.6 Polymethylene polyphenylisocyanate approved vendor(s).

The Dow Chemical Company
Customer Information Group
PO Box 1206
Midland, MI 48640-1206
1-800-635-4332

CAGE Code 6K748

Product Identification:
PAPI 4027 (formerly PAPI(R) 27)
Plant: La Porte, TX

6.9.7 Isophorone diisocyanate approved vendor(s).

Degusa/Huls Corporation
Creanova Inc.
(Formerly Huls America Inc.,
Piscataway, New York)
PO Box 889
Mobile, AL
(334) 443-5400
Plant: Theodore, AL

CAGE Code 63182

Product Identification:
Vestanat IPDI

Bayer Corporation
6666 Mykawa Road
Houston, TX 77033

CAGE Code 0KWB1

Product Identification:
Desmodur I

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Marco Chemical Co.
PO Box 2200
Ft Worth, TX 76113

CAGE Code 003M1

Product Identification:
Luxate IM

Nuodex Inc.
New Jersey
(see Degusa/Huls Corporation)

CAGE Code 63182

Product Identification:
HCKL-1697

Huls America Inc.
80 Centennial Ave.
PO Box 456
Piscataway, NY 08855-0456
(201) 980-6800
(see Degusa/Huls Corporation)

CAGE Code 63182

6.9.8 Dibutyltin dilaurate approved vendor(s).

CasChem, Inc
40 Avenue A
Bayonne, NJ 07002
Tel: (201) 858-7900
Fax: (201) 437-2728
1-800-227-2436

CAGE Code 1Y152

Product Identification:
COTIN 200 Catalyst

General Electric
Waterford, NY
(518) 237-3330

CAGE Code 01139

Product Identification
DBT

Air Products and Chemicals Inc.
PO Box 25760
Lehigh Valley, PA 18002
(215) 481-4911

CAGE Code 00742

Product Identification
Metacure T12

Atofina Chemical Incorporated
(Formerly Elf Atochem Incorporated
and Arco Chemical Company)
2000 Market Street
Philadelphia, PA 19103
1-800-328-2811

CAGE Code 86460

Product Identification:
Fascat® 4202 Catalyst

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6.9.9 Ferric acetylacetonate approved vendor(s).

Fischer Scientific (Formerly Eastman-Kodak Corporation) Pittsburgh, PA 1-800-766-7000 or 1-800-227-6701	CAGE Code 11913 Product Identification: 8731
Shepherd Chemical Company 4900 Beech Street Cincinnati, OH 45212 (513) 731-1110	CAGE Code 86968 Product Identification: 1455
Norac Company, Inc. 1700 W. Roosevelt Street Azusa, CA (626) 334-2908	 Product Identification: FeAA
Westco Chemicals, Inc. 6850 Tujunga North Hollywood, CA (323) 877-0077	CAGE Code 4E616 Product Identification: FeAA

6.9.10 Dibutyltin sulfide approved vendor(s).

Pfaltz and Bauer Inc. Waterbury, CT 06708 (203) 574-0047	CAGE Code 93272 Product Identification: DBTS

6.10 Garnet paper. The Garnet A 511 paper, 180-A type used for impact sensitivity testing is available from the Norton Company (1-800-551-4413).

6.11 Packaging.

6.11.1 Packaging. The explosive material should be packaged in accordance with the manufacturer's best commercial practice.

6.11.2 Packing. The material, packaged as specified in 6.11.1, should be packed to ensure carrier acceptance and safe delivery to the destination at the lowest applicable rate.

6.11.3 Special marking. In addition to any special markings required by the contract or purchase order (see 6.2), all container markings should be in accordance with MIL-STD-129.

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6.12 Subject term (key word) listing.

Chemical analysis
Elastomeric polymer
Ordnance

6.13 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Preparing Activity:
Navy - OS
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3. DOCUMENT TITLE
EXPLOSIVE, PLASTIC-BONDED, CAST PBXN-110

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

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