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MILITARY SPECIFICATION

EXPLOSIVE, PLASTIC-BONDED, CAST PBXN-111

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 the procurement of one type of cast, plastic-bonded explosive, PBXN-111, for use in ordnance.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards 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 supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-R-398	RDX
MIL-A-23950	Aluminum Powder, Spherical
DOD-D-82727	Dibutlytin Dilaurate

STANDARDS

MILITARY

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-650	Explosive: Sampling, Inspection, and Testing

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 8420), 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.

AMSC N/A FSC 1376

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

2.1.2 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).

OTHER GOVERNMENT DOCUMENTS

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 16321	4, 4'-Methylenebis (2,6-Di-Tert-Butylphenol)
WS 18485	Ammonium Perchlorate (For Use in PBX Explosives)
WS 23148	Polybutadiene, Liquid, Hydroxyl-Terminated

(Application for copies should be addressed to the Commander, Naval Surface Warfare Center, Indian Head Division (Code 8410P), 101 Strauss Avenue, Indian Head, MD 20640-5035.)

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 100-199	Transportation

(Application for copies of CFRs should be addressed to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402-0001.)

2.2 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

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

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1744 Water in Liquid Petroleum by Karl Fischer Reagent

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.4.

3.2 Formulation. The PBXN-111 shall be a plastic-bonded, castable material that contains a plastic material used to bond the solid component material to form a flexible explosive. The formulation of explosive PBXN-111 shall comply with the requirements specified in table I (see 6.7).

3.2.1 Cure conditions. The explosive shall be cured at a temperature between 20 and 50°C until a Shore A hardness of at least 20 is measured.

3.2.2 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 an NCO/OH ratio of 1:1 $\pm$ 0.05. The NCO/OH ratio shall be calculated using the equivalent weights of materials obtained by chemical analysis using the techniques of 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 6.4).

3.2.3 Uncured explosive requirements. The uncured explosive shall have a maximum moisture content of 0.05 percent, as determined on a sample of uncured explosive taken before the addition of the isocyanate (see 4.6.6).

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TABLE I. PBXN-111 formulation.

Ingredient	Specification	Nominal % by Weight
Aluminum (Al)	MIL-A-23950	25.0
Ammonium Perchlorate (AP)	WS 18485	43.0
RDX Type B, Class 5	MIL-R-398	8.00 ± 4.00
RDX Type B, Class 1	MIL-R-398	12.00 ± 4.00
Polybutadiene, Liquid Hydroxyl-Terminated	WS 23148	[1]5.70
Isodecyl Pelargonate	AS 2328	[1]5.70
4, 4'-Methylenebis (2,6-Di-Tert-Butylphenol)	WS 16321	0.05 ± 0.01
Isophorone Diisocyanate	WS 16305	[1]0.54
Dibutyltin Dilaurate (DBTDL)	DOD-D-82727	[2]0.004
Ferric Acetylacetonate (FeAA)	OS 9804	[2]0.004

[1] These are nominal values assigned to these component materials. The nominal composition of PBXN-111 was derived using the values of the sample calculations (6.4.1) and the requirements of 3.2.2. Other experimentally determined equivalent weights could result in slightly different weight percent values for these component materials.

[2] Use either DBTDL or FeAA. The weight percent of the catalysts shall be:

Catalyst	Min.	Max.
DBTDL	0.001	0.01
FeAA	0.001	0.01

3.3 Cured explosive requirements. The cured explosive shall meet the requirements of table II (see 6.6).

3.4 Workmanship. The explosive material shall be free from foreign 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. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

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TABLE II. Cured explosive requirements.

Property	Min.	Max.	Test Method
Density at 25°C, g/cc	1.74	1.82	4.6.1
Stress (max.) at 25°C, psi	40	–	4.6.2
Strain, max. stress, at 25°C, %	8	–	4.6.2
Hardness, Shore A, 15 second delay at 25°C	20	–	4.6.3
Vacuum Stability at 100°C (mL gas per g per 48 hours)	–	0.5	4.6.4
% Ammonium Perchlorate (AP)	40	44	4.6.5
% Aluminum (Al)	23	26	4.6.5
% RDX	18	21	4.6.5
% AP + % Al + %RDX [1]	86	89	4.6.5

[1] Values for the % AP, % Al, and % RDX above are to be determined from the average values obtained on triplicate samples using the procedures of 4.6.5.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

a. First article inspection (see 4.4)
b. Quality conformance inspection (see 4.5)

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

4.4 First article inspection. First article inspection shall be performed by the contractor, after award of contract and prior to production, at a location acceptable to the Government. First article inspection shall be performed on samples which have been produced with equipment and procedures normally used in production. Any production prior to acceptance of the first article sample shall be at the contractor's risk.

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4.4.1 First article sample. The sample shall consist of two sets of representative explosive material selected from a minimum batch of 225 kg after isocyanate has been added. A set shall contain approximately 2000 g of explosive. A set shall be composed of two specimens of explosive, the first selected from the first third of the batch and 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) intended to produce a desired product having substantially uniform characteristics.

4.4.2 Inspection routine. Material from one of the two sample sets from the batch shall be subjected to the tests specified in 4.6. The second sample set shall be forwarded to the procuring activity in a form suitable for the tests specified in 4.6. Failure to meet the requirements of this specification shall be cause for rejection of the first article sample.

4.5 Quality conformance inspection. Quality conformance inspection shall consist of the tests specified in 4.6.1, 4.6.3, and 4.6.5.

4.5.1 Sample. The quality conformance sample shall be the same as that of 4.4.1, 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. Explosives failing to meet any of the requirements shall be classed as defective and shall be cause for rejection of the batch from which it was obtained.

4.5.1.1 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

4.6 Test methods. All explosive specimens used in the tests of 4.6.1 through 4.6.6 shall be cured to a constant Shore A hardness meeting the requirements of 3.2.1.

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 weighing in a liquid medium. The sample shall be weighed to an accuracy of 0.1 mg, first in air then in hexane.

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

$$D = \frac{W_a}{W_a - W_b} \times D_H$$

Where:

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

4.6.1.4 Failure. If one 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 requirement of this specification. If the second sample fails to meet the density requirement, then the batch shall be considered unacceptable.

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, Nov. 1970. Class C testing shall be used; however, 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 4.4.1.

4.6.3 Shore A hardness test.

4.6.3.1 Sample. The explosive of 4.5.1 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 (15 seconds) determination. The hardness of the cured material shall be determined using a Type A-2 durometer, with a maximum dial indicator or hand, together with a constant-load operating stand (Code DRCL). The total weight of the dead weight, holding screw, and durometer shall be 1065 g. The 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 the 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 that the sample size shall be at least 0.2 g. The sample shall be cut into small cubes with a maximum size of 3 mm before being placed in the vacuum stability test tube. Two samples, one from each section of the batch, shall be tested.

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4.6.5 Ammonium perchlorate, aluminum, and RDX analysis.

4.6.5.1 Sample preparation.

4.6.5.1.1 Sample preparation procedure for cured PBXN-111.

a. Gently rub a small block of PBXN-111 across the face of a nonconductive, flat, wooden abrader to obtain 1.0 to 2.0 g of prepared sample. This procedure shall be carried out behind a safety shield. Proper handling shall be practiced in accordance with local safety instructions (see 6.7).

b. For cured PBXN-111, an accurate chemical analysis can be made using abraded PBXN-111 samples which have the majority (at least 80% by number) of the abraded particles less than 1.2 mm in size.

4.6.5.1.2 Sample preparation procedure for uncured PBXN-111. Collect 1.0 to 2.0 g of uncured PBXN-111 in a tared, 30-mL, medium porosity fritted glass filtering crucible.

4.6.5.2 Test procedure, cured and uncured PBXN-111. Weighed samples of cured and uncured PBXN-111 material are extracted with n-heptane, and the residue is dried and weighed. The loss in weight is equivalent to the amount of n-heptane extractables (weight % n-Heptane extractable). The remaining residue shall then be extracted with water, dried, and weighed. The loss in weight is equivalent to the amount of ammonium perchlorate (weight % AP) in the sample. The material is subsequently extracted with acetone, dried, and weighed. The loss in weight is equivalent to the amount of RDX and HMX present in the sample (weight % RDX/HMX). Finally, the remaining material is treated with HCl, washed with water, dried, and weighed. The loss in weight is equivalent to the amount of aluminum in the sample (weight % Al). The remaining solid residue is the amount of cross-linked polymeric material in the sample.

4.6.5.2.1 Detailed analytical procedure for cured and uncured PBXN-111.

a. Weigh 1.0 to 2.0 g of the prepared PBXN-111 sample to the nearest 0.1 mg (sample weight A) in a tared, 30-mL, medium porosity fritted glass filtering crucible (sample weight A + crucible weight = B).

b. Add 25 mL of n-heptane at ambient temperature to the contents of the crucible, letting the solvent filter unaided through the crucible into a 30-mL beaker. Wait for approximately 10 minutes, then filter off the remaining solvent using a vacuum filtrator.

c. Repeat step "b" until a total of 100 mL of n-heptane has been added in 25-mL increments.

WARNING

Solvent vapors are hazardous. Proper handling and disposal shall be practiced in accordance with local safety instructions and Material Safety Data Sheets (MSDS).

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d. Dry the crucible at 80 to 90°C to a constant weight. Cool the crucible and contents in a desiccator to room temperature and weigh (weight C).

e. Calculate the total weight % of n-heptane extractables as follows:

$$\%\ n\text{-}heptane\ extractables = \frac{B - C}{A} \times 100$$

where:

A = Weight of sample, g
B = Weight of crucible plus sample before n-heptane extraction, g
C = Weight of crucible plus residue after n-heptane extraction, g

f. Add 25 mL of distilled water at ambient temperature to the contents of the crucible, letting the solvent filter unaided through the crucible into a 30-mL beaker. Wait for approximately 10 minutes, then filter off the remaining solvent using a vacuum filtrator.

g. Repeat step "f" until a total of 100 mL of distilled water has been added in 25-mL increments.

h. Dry the crucible at 80 to 90°C to a constant weight. Cool the crucible and contents in a desiccator to room temperature and weigh (weight D).

i. Calculate the weight % of ammonium perchlorate (AP) as follows:

$$\%\ AP = \frac{C - D}{A} \times 100$$

where:

A = Weight of sample, g
C = Weight of crucible plus residue before water extraction, g
D = Weight of crucible plus residue after water extraction, g

NOTE: If the weight % of AP is less than expected, repeat steps "f" and "h." This additional step may be repeated an additional two times, as necessary.

j. Add 25 mL of acetone at ambient temperature to the contents of the crucible, letting the solvent filter unaided through the crucible into a 30-mL beaker. Wait for approximately 10 minutes, then filter off the remaining solvent using a vacuum filtrator.

k. Repeat step "j" until a total of 100 mL of acetone has been added in 25-mL increments.

l. Dry the crucible at 80 to 90°C to a constant weight. Cool the crucible and contents in a desiccator to room temperature and weigh (weight E).

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m. Calculate the weight % of RDX (and HMX) as follows:

$$\% \ RDX = \frac{D - E}{A} \times 100$$

where:

A = Weight of sample, g
D = Weight of crucible plus residue before acetone extraction, g
E = Weight of crucible plus residue after acetone extraction, g

NOTE: If the weight % of RDX is less than expected, repeat steps "j" and "l." This additional step may be repeated an additional two times, as necessary.

n. To the remaining contents in the crucible, carefully add 2 to 4 mL of 3N HCl. After the reaction has subsided, add small increments of 6N HCl to the crucible until all aluminum (Al) has reacted. This is indicated by the absence of bubbles being formed.

NOTE: Do not leave the sample in contact with the acid solution for more than 24 hours. Loss of polymer will likely occur.

o. Rinse the contents of the crucible with a total of 100 mL of distilled water to remove traces of the acid. Filter using a vacuum filtrator.

p. Dry the crucible at 80 to 90°C to a constant weight. Cool the crucible and contents in a desiccator to room temperature and weigh (weight F).

q. Calculate the weight % of Al as follows:

$$\% \ Al = \frac{E - F}{A} \times 100$$

where:
A = Weight of sample, g
E = Weight of crucible plus residue before HCl extraction, g
F = Weight of crucible plus residue after HCl extraction, g

r. Calculate the weight % of polymer as follows:

$$\% \ Polymer = \frac{F - T}{A} \times 100$$

where:
F = Weight of crucible plus residue after HCl extraction, g
T = Tare weight of crucible with glass stirring rod, g
A = Weight of sample, g

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4.6.6 Moisture content. The moisture content shall be determined in accordance with ASTM D 1744 to verify conformance to 3.2.3.

5. PACKAGING

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

5.2 Packing. The material, packaged as specified in 5.1, shall be packed to ensure carrier acceptance and safe delivery to the destination at the lowest applicable rate.

5.3 Marking.

5.3.1 Special marking. Precautionary and safety markings shall be in accordance with 49 CFR 171-179.

5.3.2 Normal marking. In addition to any special marking required by the contract or purchase order, all container markings shall be in accordance with MIL-STD-129.

6. NOTES

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

6.1 Intended Use. PBXN-111 is a high-energy explosive intended for use in ordnance.

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 2.1.1 and 2.1.2).

c. Desired completeness and availability of inspection records, including data cards. Use a DOD Form 1423 with appropriate Data Item Description (Form DD 1664).

d. Type and degree of contractor quality assurance system required.

e. Whether or not the test samples required are included in the material ordered.

f. Testing activities designated by the procuring agency to perform tests.

g. Level of preservation and packaging required.

h. 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.

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6.3 First article. When a first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.4.1. 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 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.

6.4 PBXN-111 composition. The following method is used to calculate the weight percent of the components of PBXN-111. The weight percent (W) of each component is as follows:

$$W_T = W_{RI} + W_{RV} + W_{AP} + W_{Al} + W_{po} + W_{pl} + W_{ao} + W_I + W_C \quad [1]$$

The total weight percent of the PBXN-111 composition (W_T) is 100%.

$$W_T = 100\ \% = W_S + W_B \quad [2]$$

where

W_{RI} = Weight % of RDX Class I
W_{RV} = Weight % of RDX Class V
W_R = Weight % of total RDX = $W_{RI} + W_{RV}$
W_{AP} = Weight % of ammonium perchlorate (AP)
W_{Al} = Weight % of aluminum powder (Al)
W_{po} = Weight % of R-45 HTPB polymer
W_{pl} = Weight % of IDP plasticizer
W_{ao} = Weight % of antioxidant
W_I = Weight % of IPDI isocyanate
W_C = Weight % of catalyst
W_S = Weight % of solids (RDX + AP + Al)
W_B = Weight % of binder ingredients

To calculate the weight percentages of the PBXN-111 ingredients, first select the amount of weight percents of the solids, i.e., the RDX, AP, and Al:

$$W_S = \text{Weight \% of solids (RDX + AP + Al)} = W_R + W_{AP} + W_{Al} \quad [3]$$

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The nominal values of these components from table I are:

$W_R = 20\%$
$W_{AP} = 43\%$
$W_{Al} = 25\%$

Using these nominal values, the nominal value of the weight percent solids is:

$$W_S = W_R + W_{AP} + W_{Al} = 88\% \quad [4]$$

The weight percent of the binder ingredients from Equation [2] is:

$$W_B = W_T - W_S = 100\% - W_S \quad [5]$$

$$= W_{po} + W_{pl} + W_{ao} + W_I + W_C \quad [6]$$

Using the nominal percent for the solids, the nominal weight percent of the binder is $W_B = 12\%$. The weight percent of the Ethyl 702 antioxidant is:

$$W_{ao} = 0.05 \pm 0.01$$

The type (either DBTDL or FeAA) and weight percent of the catalyst can be chosen within the limits established in 3.3. The DBTDL catalyst is recommended. With the selection of the weight percents of the antioxidant (W_{ao}) and the catalyst (W_C) selected, the remaining binder components (the HTPB polymer resin, the plasticizer, and the IDPI) using equation [6] have a weight percent of:

$$W_{po} + W_{pl} + W_I = W_B - W_C - W_{ao} \quad [7]$$

The IDP plasticizer content is held in a 1:1 $\pm$ 0.05 ratio to the HTPB polymer content:

$$m_{pl}/m_{po} = 1.0 \pm 0.05$$

$$m_{pl} = a\, m_{po} \quad [8]$$

where: $a = 1.0 \pm 0.05$

The HTPB polymer content is given by:

$$m_{po} = (W_B - W_C - W_{ao})/(1 + a + (ABR/1000)) \quad [9]$$

where: A = Hydroxyl value of the R-45 HTPB polymer (intrinsic chemical property of the R-45 polymer)
B = Weight equivalent of the IPDI isocyanate (intrinsic chemical property of IPDI isocyanate polymer)
R = NCO:OH ratio (from 3.2.2) = 1.0 ± 0.05

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The IPDI isocyanate weight percent is given by:

$$W_I = (ABR/1000)\, W_{ao} \qquad [10]$$

6.4.1 Sample calculation for PBXN-111. This calculation will be made using nominal values of the components in the equations and procedures given in 6.4. Selecting the nominal values for the RDX, AP, and Al powders:

$W_{RI} = 12\%$
$W_{RV} = 8\%$
$W_R = 20\%$ $(= W_{RI} + W_{RV})$
$W_{AP} = 43\%$
$W_{Al} = 25\%$

then the weight percent of the binder is:

$$W_B = 12\%$$

The nominal weight percent of the Ethyl 702 antioxidant is:

$$W_{ao} = 0.05\%$$

Choosing the DBTDL catalyst at the nominal percent

$$W_C = 0.004\%$$

Then the remaining binder components (the HTPB polymer resin, the plasticizer, and the IPDI) using equation [7] have a weight percent of:

$$W_{po} + W_{pl} + W_I = W_B - W_C - W_{ao} = 12 - 0.004 - 0.05 = 11.9496\% \qquad [7]$$

The nominal IDP plasticizer/HTPB polymer ratio of 1.00 will be used. Thus, the value of "a" in equation [8] is 1.00

$$W_{pl} = a\, W_{po} = W_{po} \qquad [8]$$

The R-45HT HTPB polymer hydroxyl value and the weight equivalent of the IPDI isocyanate nominal value are based upon chemical analysis of the respective materials, or are from the respective commercial vendor product bulletins.

A = Hydroxyl value of the R-45HT HTPB polymer = 0.85
B = Weight equivalent of the IPDI isocyanate = 111.60
R = NCO:OH ratio (from 3.2.2) = 1.0

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Using these values in equation [9], the R-45HT HTPB polymer weight percent is:

$$W_{po} = (W_B - W_C - W_{ao})/(1 + a + (ABR/1000)) \quad [9]$$

$$= (11.9496)/(1 + 1 + ((0.85)\ (111.60)\ (1))/1000)$$

$$= (11.9496)/(2 + 0.09486) = 5.704\%$$

From equation [8], the plasticizer weight percent is:

$$W_{pl} = aW_{po} = W_{po} = 5.704\%$$

From equation [10], the IPDI isocyanate weight percent is given by:

$$W_I = (ABR/1000)\ m_{po} = [(0.85)\ (111.60)\ (1)]/1000\ m_{po} = (0.09486)\ (5.704\%) = 0.541\%$$

The calculation is now complete. The calculated PBXN-111 composition is:

RDX Class I:	$W_{RI} = 12\ \%$
RDX Class V:	$W_{RV} = 8\ \%$
AP:	$W_{AP} = 43\ \%$
Al:	$W_{Al} = 25\ \%$
R-45HT:	$W_{po} = 5.704\ \%$
Emery 2911:	$W_{pl} = 5.704\ \%$
Ethyl-702:	$W_{ao} = 0.05\ \%$
IPDI:	$W_I = 0.541\ \%$
DBTDL:	$W_C = 0.004\ \%$
Total composition:	100%

6.5 Materials. Materials which have been used to successfully formulate PBXN-111 are the following:

a. Polybutadiene, liquid, hydroxyl-terminated is available from Elf Atochem as PolyBD R45HT and R45M.

b. Isodecyl pelargonate is available from Emery Industries as Emery 2911.

c. 4,4'-Methylenebis (2,6-Di-Tert-Butylphenol) is available from Ethyl Corp. as Ethyl 702.

d. Isophorone diisocyanate is available from Huls America as IPDI.

e. RDX Class I and V is available from Holston Defense Corporation, Holston Army Ammunition Plant.

f. Ammonium perchlorate, regular, Class I, Ordnance grade is available from Kerr-Mcgee Chemical Corporation.

g. Dibutyltin dilaurate (DBTDL) is available from CasChem, Inc. as COTIN 200 catalyst.

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h. Ferric acetylacetonate (FeAA) is available from Eastman-Kodak Corp. as Kodak #8731.

i. Aluminum is available from the following:

(1) H-5 spherical aluminum powder available from Valimet, Inc.
(2) Alcan X-81 and Alcan X-65 spherical aluminum powder is available from Alcan-Toyo America.

6.6 Viscosity measurement. It is recommended that a viscosity measurement be made of each batch of PBXN-111. Using the materials noted in 6.5, PBXN-111 mix viscosities between 1.5 and 7.5 kilopoise should be obtained at approximately 25°C when measured with a Brookfield viscometer using a TC spindle at 2.5 RPM. These viscosity measurements should be made at 30 ± 5 minutes after the isocyanate cross-linker (IPDI) is added to the mix.

6.7 Nonconductive, flat, wooden abrader. The abrader is made of hardwood (example: oak). The dimensions of the wooden abrader are approximately 64 mm long x 64 mm wide x 18 mm high (see figure 1). Grooves are cut into the wooden abrader. The grooves are 2 mm deep, 1 mm wide, and run across the entire face of the abrader. The center-to-center distance between grooves is approximately 4 mm.

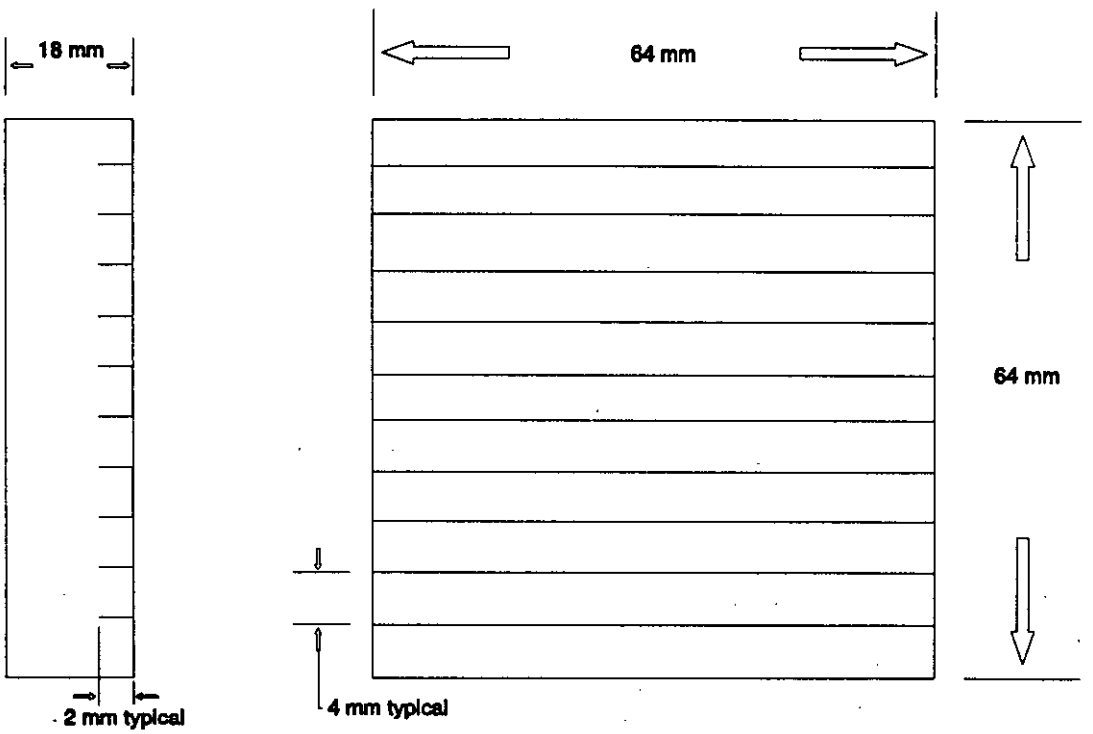

FIGURE 1. Abrader dimensions.

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6.8 Subject term (key word) listing.

Chemical analysis
Elastomeric polymer
Ordnance

Preparing Activity:
Navy - OS
(Project 1377-N480)

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EXPLOSIVE, PLASTIC-BONDED, CAST PBXN-111

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

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8. PREPARING ACTIVITY

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