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Characteristics of JAX Gun Propellant

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13. ABSTRACT (Maximum 200 words) To increase the performance of 120-mm kinetic energy tank rounds, propellant made by adding up to 30% ground RDX to JA2 (JAX) has been manufactured and tested. While the performance goals of the JAX were met, its response to shaped charge jet attack in several different vulnerability tests was much more violent than that of JA2 alone. This unexpected violent response of JAX propellants has been documented. In the attempt to understand the mechanism responsible for this response, the deposition of dry crystalline RDX on exposed JAX surfaces was discovered. This crystalline formation was detected during a routine morphological examination using a scanning electron microscope, and the crystals were identified by Fourier transform infrared (FTIR) surface Microreflectance. A wicking mechanism has been proposed to explain this phenomenon. Thermal, chemical, aging, and morphological investigations were performed to substantiate this mechanism. The information gathered indicates that the RDX deposition process occurs in all JAX propellant and may occur in other JAX-like materials. Since JAX undergoes continuous morphological change with temperature and time, there are important safety implications for the storage and handling of these materials, as well as questions concerning their subsequent suitability for use in weapon systems. It was also found that standard safety tests do not indicate the presence of the deposited RDX. All of these findings are documented and the implications are discussed.				
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M. Leadore performed all mechanical properties testing of the propellants. C. Gillich used the scanning electron microscope to discover the white "powder" within the perforations of the JAX grains, and produced, cataloged, and performed initial analysis for the recent micrographs used in this study.

R. Pesce-Rodriguez used her skill with the Fourier transform infrared (FTIR) microscope to determine that the "powder" seen on the JAX propellant surface was a nitramine. In addition, she performed the solubility experiments of RDX and HMX in DEGDN. We extend many thanks to her for allowing us to use her unpublished results. Thanks are also due to F. Robbins for allowing us to remark on his studies with PARAPLEX G59, and to W. J. Worrell and B. M. Riggleman of Hercules (Radford) for supplying information contained in Reference 21.

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1. INTRODUCTION

Methods have been and are being sought to increase the lethality of a kinetic energy (KE) tank round. One approach is to increase the rod's velocity by increasing the energy available to the round. This is most readily accomplished, at least in principle, by increasing the energy of the propellant.

The propellant of choice in several prior tank ammunition applications has been JA2. It is made from nitrocellulose (NC), nitroglycerine (NG), and diethylene glycol dinitrate (DEGDN) in relative amounts of roughly 60%, 15%, and 25%, respectively. JA2 has a nominal impetus of 1150 J/g, as computed from the BLAKE code.¹ To increase the energy, cyclotrimethylenetrinitramine (RDX) has been added to JA2 during manufacture.^{2, 3} The computed increase in the impetus, flame temperature, and the chemical energy, which is the impetus divided by $(\gamma - 1)$, is given in Table 1. The common, generic name for JA2 propellant with RDX added is JAX. A common name for a specific amount of RDX added to JA2, say B%, is 2RB. For example, 10% RDX added is given the designation 2R10. This is the nomenclature used in Table 1.

JAX has been made with nominal RDX additions ranging from 6.5 to 30% by weight. The RDX used in the earlier manufacture of JAX was fluid energy milled and had particles with a mean diameter² of 7.5 μm . The more recent manufacture used nominal 4- μm recrystallized RDX from Dupont Corporation.³ The JAX referred to in this report is generally the earlier manufactured material. For the same propellant formulation, more stick propellant than granular propellant can be placed into a fixed volume gun chamber; thus, the JAX had been made in both granular and partially cut stick (PcS) geometries. The sticks were kerfed, or cut part way through at selected linear intervals along the stick, to relieve the internal pressure when the propellant began burning.

Performance increases were realized.² However, the response of JAX to the unplanned stimulus of a shaped charge jet was violent, approaching, or, in some cases, perhaps sustaining a detonative event. Because JA2 itself usually just burns in such tests, the violent response was not anticipated. In addition, other propellants, e.g., XM39 and M43, have been formulated with several times the RDX loading of the JAXs and in similar tests, they responded less violently to the shaped charge

Table 1. BLAKE Computations for JA2 and Selected JAXs

Formula	Impetus J/g	Flame Temp K	Impetus/ $(\gamma - 1)$ J/g
JA2	1153	3448	5130
2R6.5	1168	3489	5194
2R10	1175	3509	5225
2R12	1179	3520	5240
2R16	1187	3541	5273
2R17.5	1189	3548	5283
2R20	1194	3560	5302
2R30	1209	3602	5367

attacks.⁴ Thus, the question is raised: what happens to the JA2 when the addition of even small amounts of RDX is observed to change the vulnerability response from burning to detonative?

In an effort to address this question, several test results are reviewed. First, the mechanical fracture response of JAX relative to JA2 is discussed. Second, the results of a number of vulnerability tests that demonstrate the different vulnerability responses of JA2 and JAX are reviewed. Third, JAX is characterized by the now standard propellant characterization techniques,⁵ the results were not anticipated and their interpretation consumes the latter half of this report.

2. THE FRACTURE RESPONSE OF JAX

2.1 Mechanical Response Testing.

Three lots of JAX propellant were produced in 1985 and had fracture response evaluations performed with methods that were in use during that period.^{6, 7, 8, 9} The mechanical parameters reported are the results of those tests. These results have been shown to agree with results gathered from improved procedures and equipment subsequently developed to expand the scope and quality of fracture response measurement. This section is based on an unpublished technology transfer report.¹⁰

Two methods of fracture evaluation were used to characterize the JAX materials. The first was the drop weight mechanical properties test (DWMPT)^{6, 7} that provides high-rate, uniaxial, compressive loading to individual grains from which the propellant modulus, failure stress, failure strain, etc., are determined at various temperatures (-50° C to 60° C). These parameters are illustrated in Figure 1. This test characterized the uniaxial response of standard test grains and can indicate fracture response differences in materials. The second method was the gas gun impact test (GGIT)^{8, 9} with surface area analysis performed using the damaged grains. In this latter test, a single grain is damaged by a single impact at a controlled velocity, orientation, and temperature. After several grains are damaged, the grain and any of its shards are collected and burned in a small closed bomb. The pressure-time data is reduced using burning rates established for undamaged grains. From this, a surface area vs fraction burned profile is generated that reveals the nature and degree of the fracture damage suffered during impact, as shown in Figure 2. The fracture susceptibility is quantified by summing the difference between the damaged-grain fracture profile and the profile predicted for the undamaged grain, which is represented by the shaded area in the plot. These two procedures provide mechanical and fracture response information that can be used to indicate propellant fracture susceptibility.

DWMPT and GGIT procedures were performed using JAX propellant under conditions similar to those used for previously tested JA2 propellant. DWMPT procedures were conducted at 20, -10, and -32° C at a strain rate of about 200 s⁻¹. Modulus, failure stress, and failure strain vs temperature results are shown in Figure 3. The JA2 results (solid diamonds) are connected by a smooth curve.

The JAX data in Figures 3a and 3c tend to lie on or above the JA2 line. Also, the JAX data tend to be ranked at a given temperature, the larger values corresponding to specimens with more RDX filler.

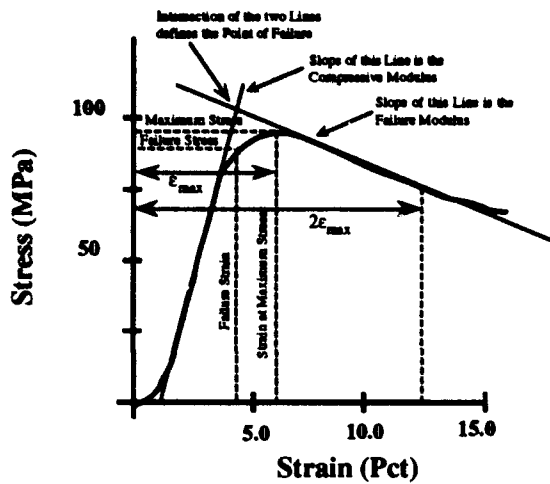


Figure 1. Mechanical Parameters Illustrated

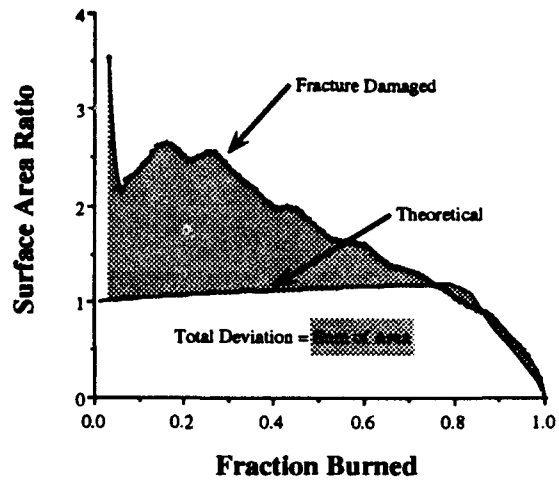
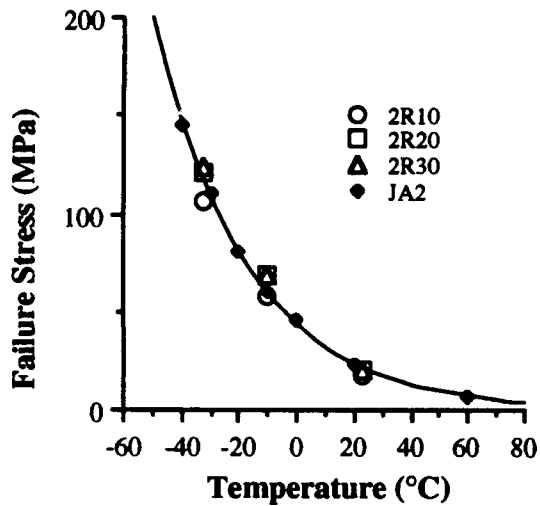
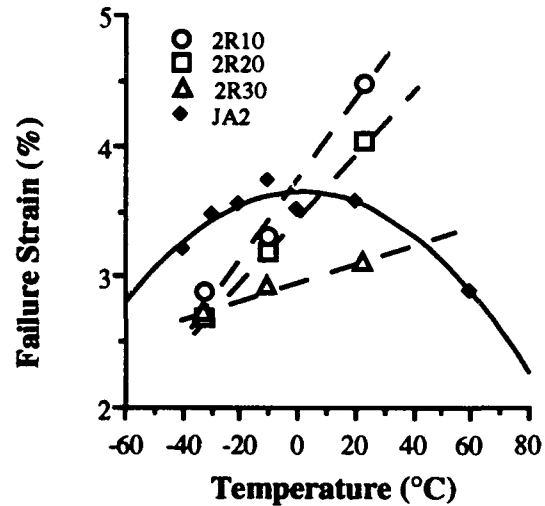


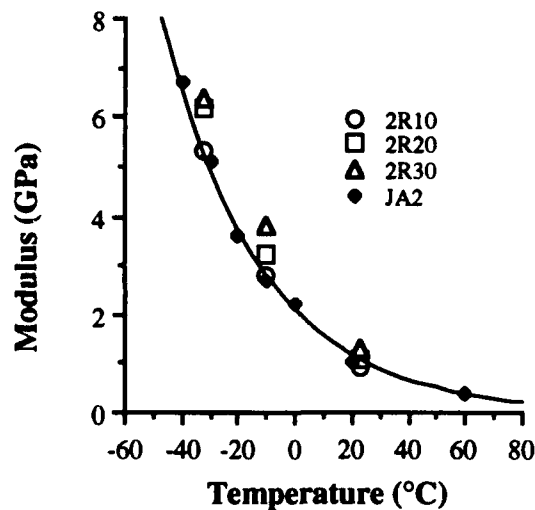
Figure 2. The Total Deviation Parameter



a. Failure Stress vs Temperature



b. Failure Strain vs Temperature



c. Modulus vs Temperature

Figure 3. Mechanical Response Results

The JA2 failure strain curve of Figure 3b decreases in both directions from 0° C. In the lower-temperature direction, the increased brittleness causes failure at lower strain; in the higher-temperature direction, the rapidly increasing softness causes plastic failure, also at lower strain. (Results from dynamic mechanical analysis¹¹ indicate that glass transition occurs at or slightly below -20° C. See Figure 4.)

Figure 3b shows that the JAX propellants do not soften as JA2 but maintain a brittle character over the temperature range tested. 2R10 and 2R20 exhibit similar slopes, while 2R30 has a much shallower one. Again, the magnitude of the strain at failure tends to be ranked with the level of RDX filler used in the JAX. Looked at another way, the addition of the RDX filler reduces (or possibly eliminates) the gross thermoplastic-flow characteristics of the JA2 propellant at higher temperatures and extends the brittle characteristics of the JAX into the higher temperature regimes.

The GGIT procedure was carried out at three velocity-temperature matrix points for the three JAX formulations. For JAX propellant at -20° C, grain fracture was observed to begin at about 110 m/s, so velocities of 90 and 120 m/s were chosen as two of the matrix points. At -30° C, the third matrix point was selected. The results of these tests and ones previously completed for JA2 are shown in Figure 5. The total deviation (defined earlier, see Figure 2) is an arbitrary scale that measures the

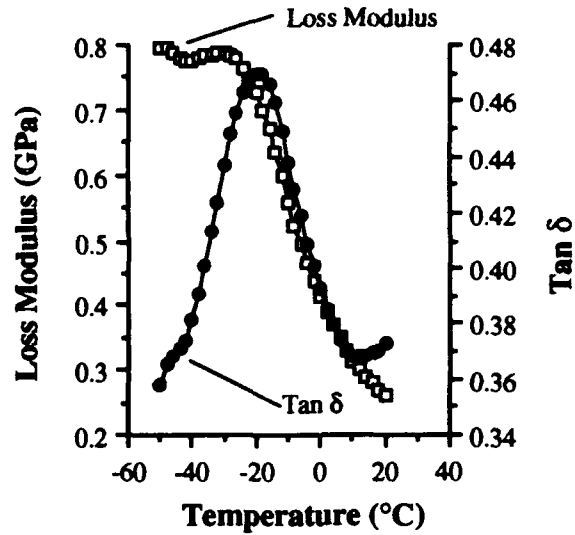


Figure 4. DMA Data for JA2 Which Indicate Glass Transition Temperature Region

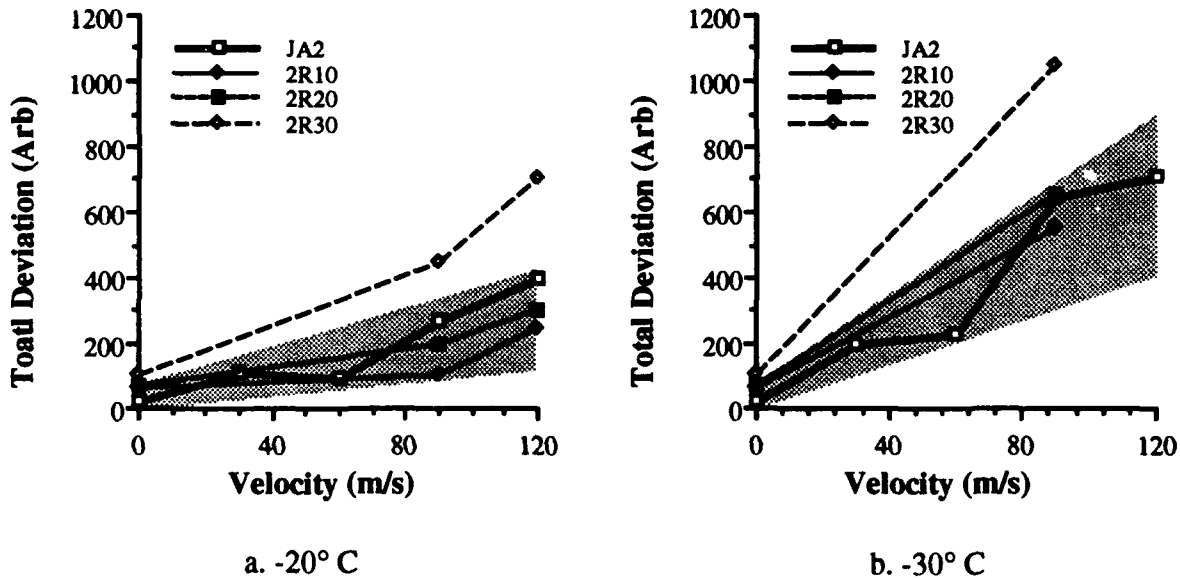


Figure 5. Total Deviation vs Impact Velocity for Gas Gun Impact Test

degree that the damaged grain surface-area profile deviates from the profile predicted for undamaged grains. Closed bomb results for undamaged grains, when subject to this analysis, produce total deviations that average about 45 with a range between 30 and about 100. Significant grain fracture is thought to have occurred when values near 200 result. The comparison of fracture damage and fracture susceptibility via the total deviation is made by noting differences in this parameter at similar impact conditions.

Figure 5 shows several things that are evident:

- 1) As the RDX content of the JAX increases, the fracture susceptibility increases.
- 2) The fracture susceptibilities of the 10% and 20% RDX compositions of JAX are similar to each other and comparable to JA2. (The shaded area indicates the range of JA2-like behavior.)
- 3) The 30% RDX composition has a significantly greater fracture susceptibility than JA2 at both -20 and -30° C.
- 4) These results are self-consistent and consistent with DWMPT results.

2.2 JAX Fracture Response Conclusions.

The mechanical properties and fracture response of JAX were measured under conditions that were thought to show the greatest differences between JA2 and JAX. Measurements showed that at RDX levels near or below 20%, JAX mechanical response was not significantly different from JA2, and may, in fact, have been slightly better (see Figure 5a). At RDX levels near 30%, the DWMPT mechanical response indicated the increase in brittleness would result in the creation of significant fracture-generated surface. This observation was confirmed in GGIT fracture susceptibility tests. JAX with 30% RDX had significantly greater fracture-induced surface area than did JA2, 2R10, or 2R20 under similar impact conditions.

These tests indicate that JAX propellant up to an RDX content of about 20% should not suffer worse fracture-related performance loss or vulnerability susceptibility than JA2, as long as the stress environments are equivalent. At RDX levels of 30% and greater, JAX can be expected to have significantly worse fracture-related performance and vulnerability responses than does JA2 under the conditions in these experiments. This does not say that a JAX propellant cannot be designed to give satisfactory performance under normal interior ballistic conditions. However, when conditions deviate from normal (such as localized ignition at low temperature, or shaped-charge jet interaction) and grain fracture occurs, a JAX propellant can be expected to have a more severe fracture response than JA2. Since JA2 has been shown to be a thermoplastic elastomer with time-temperature equivalence,¹² failure strain results indicate that as the strain rate of the deformation increases, the divergence in mechanical response between JA2 and JAX should increase. That is, as the interaction rates increase, JAX should show an increasingly greater level of brittle response when compared to JA2 (see Figure 3b).

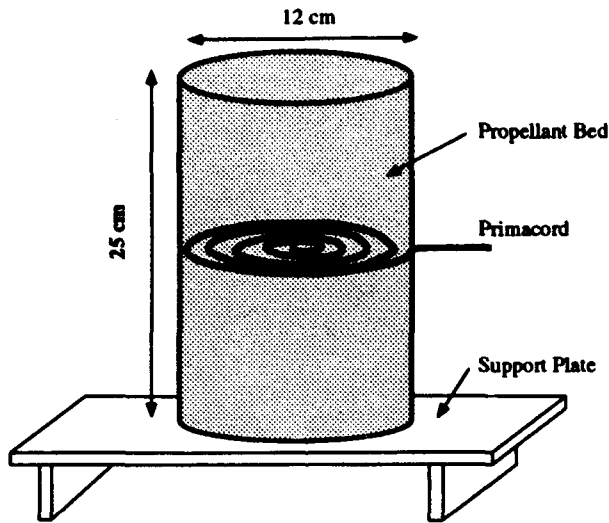


Figure 6. PrimaCord Shock Initiation Test Setup

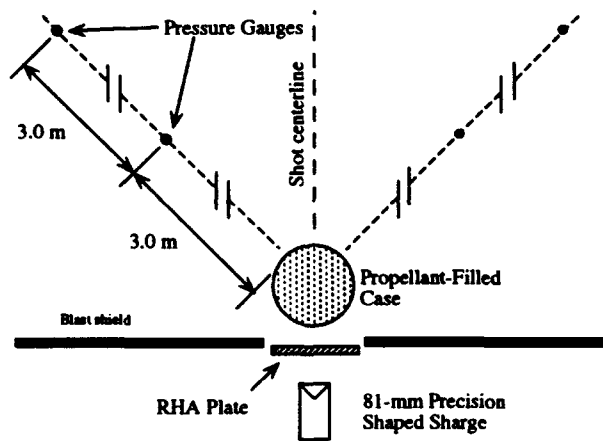


Figure 7. Schematic Diagram of the Air Blast Experiment

RHA (not shown). The Primacord is ignited and the propellant reacts. If the 10-mm support plate is destroyed, a detonative event is indicated and usually indentations can be found in the base plate.²

These tests indicated a violent response for 2R30 and mild responses for 2R10 and 2R20.² These results are consistent with the findings of the fracture response tests of JAX discussed in Section 2. The JAX formulation 2R30 was eliminated from further consideration.

3.2 The Air Blast Test.

A schematic of the test configuration for the air blast measurements is found in Figure 7. An 81-mm BRL precision shaped charge jet is conditioned by a 25-mm RHA plate at a distance of 2 cone

3. VULNERABILITY TESTS: DESCRIPTION AND RESULTS

Several vulnerability tests had been performed using these early JAXs as the test propellant. In this section, these tests and their results are outlined in rough chronological order: 1) the Primacord shock initiation test, 2) the air blast test, 3) the shock velocity test, 4) the impulse pendulum test, and 5) the staged compartment test.

3.1 The Primacord Shock Initiation Test.

This test has been designed to rank new propellant formulations by their relative response to explosive shock initiation. It is a simple "go" or "no-go" screening test designed to eliminate those propellants with a demonstrably poor vulnerability response.

Figure 6 shows a schematic of the Primacord shock initiation test setup. A 250-mm section of a 120-mm combustible case is filled halfway with granular propellant. A predetermined length of Primacord, with a mass of about typically 32 g, is coiled and placed on top of the propellant bed. A short length of cord extends through the wall of the case to accommodate the igniter. The case is filled to the top with propellant that is held in place by sealing the case with gun tape. The case is placed on a 305-mm by 610-mm section of 10-mm rolled homogeneous armor (RHA) plate supported by two plates of 51-mm RHA which, in turn, rest upon a large 51-mm section of

diameters (CD). (This standoff distance has been selected because the jet is thought to have well-defined characteristics [for example diameter, velocity, and length] at this distance.) The conditioned jet proceeds through and interacts with the propellant. The shock wave produced by the jet-propellant interaction is detected by in-ground pressure gages that are located along radii 45° on either side of the jet center line. The pressure gages are situated in lead shields sunk into ground. The entire test area had been graded and leveled. The data consists of time of arrival of the shock and the pressure measured at a given location. For comments on the difficulty of obtaining reliable data from this type of test, see Reference 13.

Table 2 shows data for an inert material, JA2 in both granular and PcS geometries, and a number of JAXs. The upper section of this table refers to the data taken at the 3.0-m locations while the lower section refer to those data taken at the 6.1-m locations. The left most column identifies the Range 10 shot number; the second and third columns identify the propellant used; the fourth and fifth columns tell the geometry (granular or partially cut stick) and the perforation (7 or 19). The sixth column shows the weight of each propellant in kilograms. The next columns display the results. Pressure values measured along the left (L) and right (R) legs, as well as the average (A) of both legs are show in columns 7, 8 and 9, respectively, in Table 2. The right most column shows the average arrival time of the shock.

Figures 8 and 9 graphically display the average air blast results for the different propellants. The JA2 responses are slightly greater than the inert material response. On the other hand, the JAXs give a more violent response.

Figures 10 and 11 show the air blast arrival times. The inert material exhibits the longest times (i.e., slowest shock wave, which in this case must be due only to the shaped charge jet itself). The arrival time for the JA2 propellants is slightly faster. The JAXs, however, all show significantly

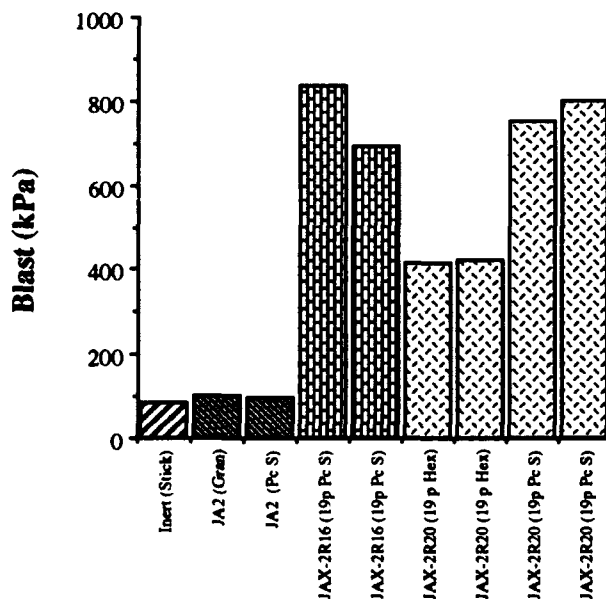


Figure 8. Air Blast Pressure at 3.0 m

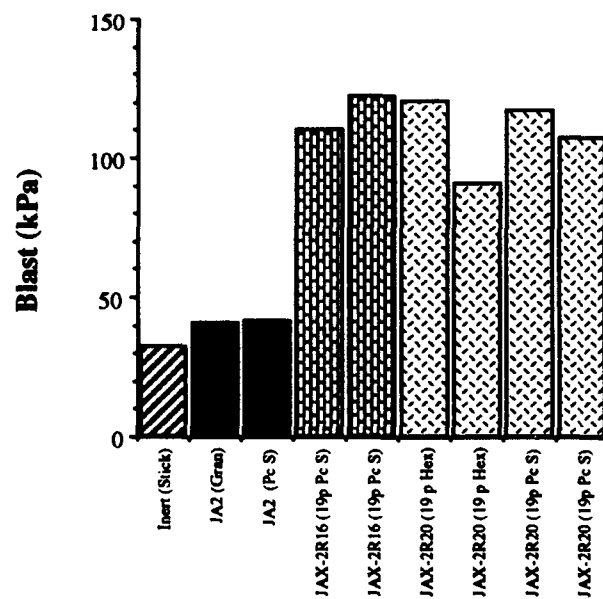


Figure 9. Air Blast Pressure at 6.1 m

Table 2. 3.0 and 6.1-m Air Blast Data

Shot Number	Lot Number	Propellant Name (geometry)	Number Perfs	Mass (kg)	3.0-m Blast Line (kPa)			3.0-m Arrival Time (msec)
					Left	Right	Average	
S-NG711901	Orange EC	Inert (Stick)	7	3.5	82.7	No Data	82.7	5.4
S-NG711903	RAD00M0015102	JA2 (Gran)	7	4.1	124.0	87.5	99.2	4.7
S-NG716702	RAD792-32	JA2 (Pc S)	19	4.8	96.5	99.2	97.8	4.8
S-NG716203	HCL87A010-002	JAX-2R16 (19p Pc S)	19	4.9	654.6	1005.9	834	1.9
S-NG716703	HCL87A010-002	JAX-2R16 (19p Pc S)	19	5.3	792.4	592.5	692	1.9
S-NG711902	HCL86H003-009	JAX-2R20 (19 p Hex)	19	3.9	441.0	385.8	413	2.1
S-NG716901	HCL86H003-009	JAX-2R20 (19 p Hex)	19	3.9	430.6	413.4	422	2.2
S-NG716903	HCL86H003-009	JAX-2R20 (19p Pc S)	19	4.8	778.6	723.5	751	1.9
S-NG716302	HCL86H003-009	JAX-2R20 (19p Pc S)	19	5.0	792.4	806.1	799	1.8
Shot Number	Lot Number	Propellant Name (geometry)	Number Perfs	Mass (kg)	6.1-m Blast Line (kPa)			6.1-m Arrival Time (msec)
					Left	Right	Average	
S-NG711901	Orange EC	Inert (Stick)	7	3.5	33.1	32.4	32.7	12.9
S-NG711903	RAD00M0015102	JA2 (Gran)	7	4.1	41.3	40.0	40.7	12.0
S-NG716702	RAD792-32	JA2 (Pc S)	19	4.8	48.2	34.5	41.3	11.0
S-NG716203	HCL87A010-002	JAX-2R16 (19p Pc S)	19	4.9	117.1	103.4	110.2	7.1
S-NG716703	HCL87A010-002	JAX-2R16 (19p Pc S)	19	5.3	158.5	86.1	122.3	6.9
S-NG711902	HCL86H003-009	JAX-2R20 (19 p Hex)	19	3.9	124.0	117.1	120.6	7.5
S-NG716901	HCL86H003-009	JAX-2R20 (19 p Hex)	19	3.9	89.6	92.3	90.9	7.7
S-NG716903	HCL86H003-009	JAX-2R20 (19p Pc S)	19	4.8	130.9	103.4	117.1	6.7
S-NG716302	HCL86H003-009	JAX-2R20 (19p Pc S)	19	5.0	103.4	111.6	107.5	6.7

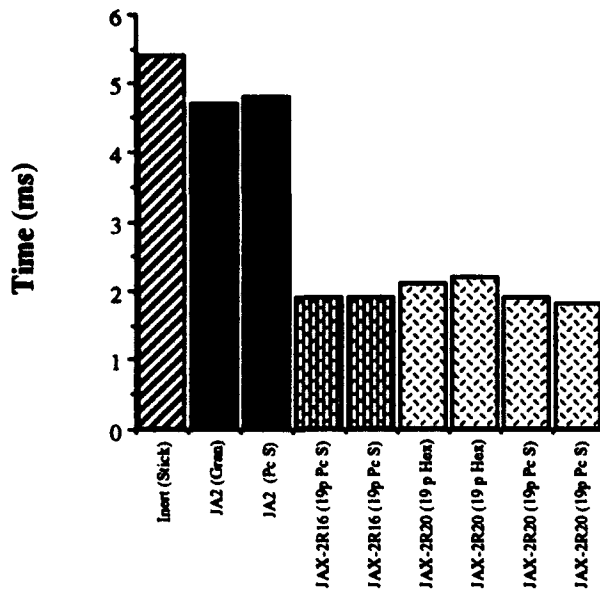


Figure 10. Air Blast Arrival Time at 3.0 m

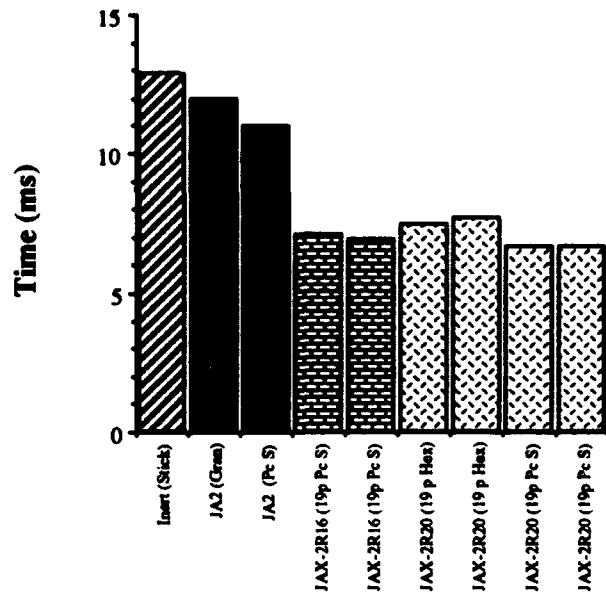


Figure 11. Air Blast Arrival Time at 6.1 m

faster arrival times, again indicative of a more violent reaction.

3.3 The Shock Velocity Test.

Figure 12 shows a schematic of the shock velocity test.^{14, 15} An 81-mm BRL precision shaped charge is aimed at the center of the box of propellant. The shaped charge is fired, the jet is formed, and is conditioned by 51 mm of RHA. It then strikes the trigger plate and interacts with the propellant within the wooden box. Any residual jet is captured by the stack of RHA blocks. At a position 80 mm from the upper surface of the catcher blocks, the upper surface of the third RHA block was indexed to obtain a measure of the actual center-line of the jet. The 2R16 19-perforation stick JAX was broken at the kerfs to provide "grains" with an L/D about unity.

The wooden propellant box is made 250-mm square and 80-mm deep. In the vertical center plane of this box (i.e., 40 mm below the trigger,

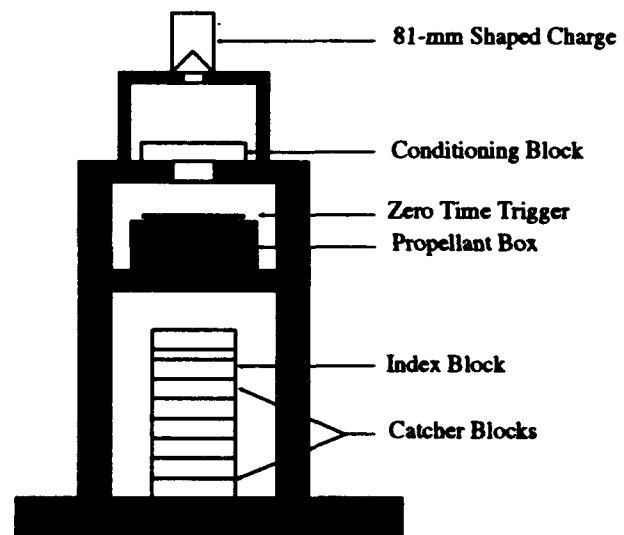


Figure 12. Schematic of the Shock Velocity Experiment

Table 3. Shock Velocity Coefficients

Shot Number	Propellant Name	Lot Number	A	B	C
16	INERT	WEP	-10.50	0.35	25.70
17	INERT	WEP	-6.19	0.21	16.40
36	2R16	HCL-87A-010-002	7.39	0.08	-10.60
41	JA2-19p	RADPE-792-11	-6.41	0.22	17.30
43	JA2-19p	RADPE-792-11	-7.61	0.26	19.60
44	JA2-19p	RADPE-792-11	-6.97	0.24	18.50

eight sacrificial microphones are positioned at progressively increasing radii from the center (see Figure 13). The microphones are located on radii 28 mm to 102 mm from the center of the box. The shock front from the propellant-jet interaction passes through the propellant bed and is sequentially detected by the microphones. Since the location of each microphone is known, the basic data consists of time of arrival of the shock front vs location. Differentiation provides velocity vs time information.

Table 3 identifies the lot numbers for several propellants, their shot numbers, and their coefficients in the empirical formula:

$$\text{shock velocity (km/s)} = A + Bd^{+0.5} + Cd^{-0.25}. \quad (1)$$

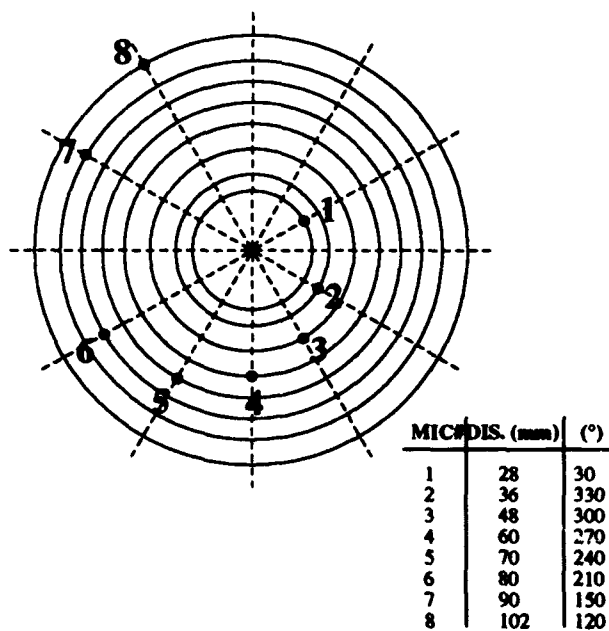


Figure 13. Schematic of Microphone Locations

Equation (1) has been used to compute the information in Table 4 for shots 16, 17, 36, 41, 43, and 44. The average of shots 16 and 17 (the inert shots) and the average of 41, 43, and 44 (the JA2 shots) are also shown in Table 4. The sigma column is the standard deviation of the three JA2 shots.

Figure 14 shows the shock velocity of the average inert, the average JA2 and the 2R16 plotted against distance from the center of the box. The inert material and JA2 propellant show a shock with monotonically decreasing velocity. By contrast, the 2R16 JAX exhibits an accelerating velocity with distance. These results clearly indicate that the response of the JAX is more violent and of a different nature than the response of the JA2.

Table 4. Shock Velocities (km/s) as a Function of Distance

Distance (mm)	Shots								Average 41, 43, 44	Sigma
	16	17	Average 16, 17	36	41	43	44			
20	3.21	2.50	2.85	2.75	2.75	2.82	2.85	2.81	0.05	
30	2.40	1.96	2.18	3.30	2.18	2.18	2.24	2.20	0.04	
40	1.93	1.66	1.79	3.69	1.86	1.82	1.89	1.86	0.04	
50	1.63	1.46	1.54	3.97	1.64	1.60	1.67	1.64	0.04	
60	1.44	1.33	1.38	4.21	1.50	1.44	1.54	1.49	0.05	
70	1.31	1.23	1.27	4.40	1.41	1.33	1.42	1.39	0.05	
80	1.22	1.17	1.19	4.56	1.34	1.26	1.36	1.32	0.05	
90	1.16	1.12	1.14	4.71	1.28	1.22	1.32	1.27	0.05	
100	1.12	1.10	1.11	4.84	1.26	1.18	1.28	1.24	0.05	

3.4 The Impulse Pendulum Test.

Figure 15 shows a schematic of the impulse pendulum test apparatus.¹⁶ In this test, propellants are placed in a cardboard shipping container, nominally 150 mm in diameter and 520 mm long. The attack path is diagonally through the center of mass of the propellant and placed at a convenient angle (but constant) so that the jet will miss the pendulum bob. The attack is by unconditioned bare Viper placed 2 cone diameters away from the propellant charge. The shock wave, produced by the interaction of the Viper's jet and the candidate propellant, impinges upon the nearby pendulum bob of massive weight. The distance between the propellant tube and the pendulum face is 305 mm. The displacement and the period of the pendulum are measured directly and the total impulse delivered to the pendulum is calculated from the following formula:

$$\text{Impulse} = 2\pi [\text{Mass} \times \text{Displacement}/\text{Period}]. \quad (2)$$

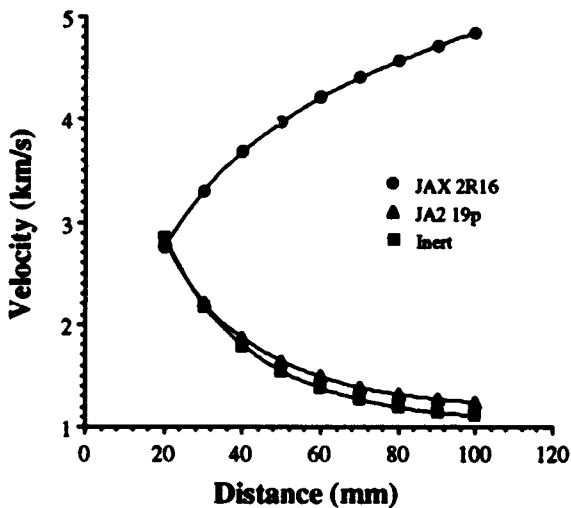


Figure 14. Shock Velocity Data for JA2 and JAX

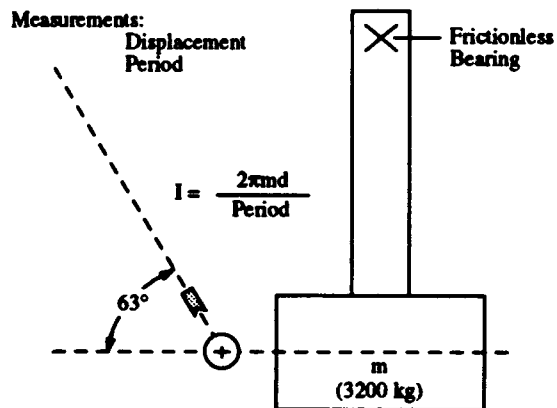


Figure 15. Schematic of the Impulse Pendulum Test

The contribution of the shaped charge itself is determined by shooting into a cardboard container filled with sand. This contribution is small and subtracted from the calculated impulse to obtain the impulse due to the jet-propellant interaction alone. Results are ranked in a relative fashion.

Table 5 identifies the propellant, the shot number, and the net impulse in N-s. The table is divided according to whether the weight of propellant tested was 2.3 kg or greater than 2.3 kg. Figure 16 shows the results for the 2.3-kg tests. Again, it is evident that 2R20, either in the granular or stick geometry, exhibits a greater response than the JA2. The results in Figure 17 are even more dramatic. Here JA2 at the 7.3-kg and 10-kg levels has about five times lower response than the 2R20 at the 7.3-kg level. This is further evidence that the JAX responds in fundamentally different fashion relative to JA2.

Table 5. Impulse Pendulum Data

Propellant Name (type)	Mass (kg)	Lot Number	Shot Number	Impulse (N-s)
JA2 (7p)	2.3	RAD-84G-001-S176	88-10	612
JA2 (19p)	2.3	RAD-PE-792-11	88-11	657
JA2 (19 PcS)	2.3	RAD-PE-792-33	88-30	843
JAX 2R20 (7p PcS)	2.3	HCL-86C-006-004	88-27	1484
JAX 2R20 (19 p Hex)	2.3	HCL-86H-003-009	88-13	1618
JAX 2R20 (19p PcS)	2.3	HCL-86C-004-001	88-14	1896
JA2 (7p)	4.5	RAD-84G-001-S176	88-25	872
JA2 (19 PcS)	10.	RAD-PE-792-33	88-28	1201
JA2 (19p)	7.3	RAD-PE-753-10	88-26	1208
JAX 2R20 (7p PcS)	7.3	HCL-86C-006-004	88-29	5614

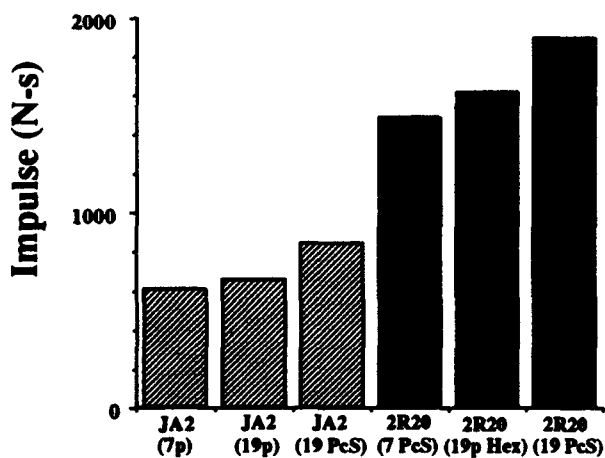


Figure 16. Impulse Pendulum Data for 2.3-kg Quantities of JA2 and JAX

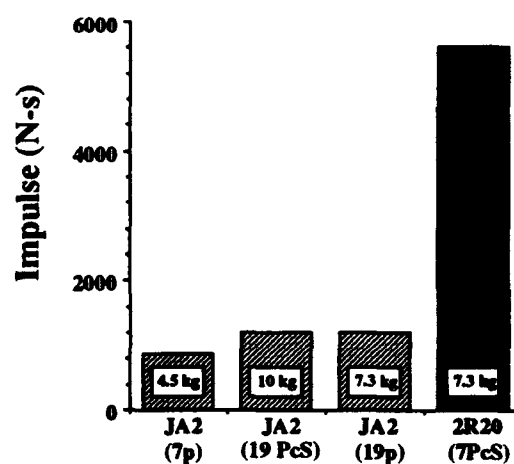


Figure 17. Impulse Pendulum Data for Various Amounts of JA2 and JAX

3.5 The Staged Compartment Test.

These tests characterize the relative response of candidate propellants in confined quarters that simulate the volume of the stowage compartment of an M1 tank. The apparatus used in this test is shown in Figure 18 and is capable of holding ten rounds of sleeved 105-mm ammunition. However, in these experiments, 2.3 kg of propellant are placed in a cardboard tube and blocked with wood. This tube is then located within a standard aluminum stowage sleeve that is placed in the test apparatus on the second tier from the bottom, in front of the hole cut into the angled face of the armor. Only the sleeved 2.3-kg propellant charge is in the compartment. The threat is an 81-mm BRL precision shaped charge located at standoff of 2 CDs (not shown). The jet passes through 25 mm of RHA that is backed by 13 mm of Isodamp. The conditioning armor pack (not shown) is located against the slant wall of the compartment and the jet is aimed at the center of mass of the propellant. Two mounts for Kistler gages (calibrated to 13-MPa peak pressure) are located in both end walls of the compartment, in a plane parallel to the direction of the shaped charge jet attack. These gages provide (duplicate) pressure vs time data. The pressure-time curve is integrated (up to 10 ms) to provide specific impulse vs time information.

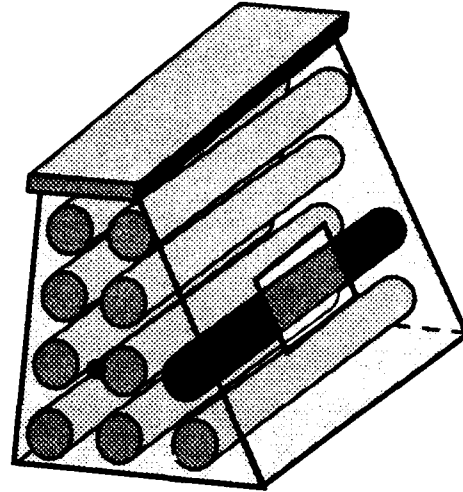


Figure 18. Schematic of the Ten-Round Staged Compartment Test (The target round is darkened.)

Table 6 identifies the propellants tested in the staged compartment apparatus. The testing of JA2 propellant took place on February 11, 1988, while the testing of 2R20 propellant took place on April 12, 1988. Figure 19 shows the computed impulse plotted against time for the four propellants listed in Table 6. It is obvious that the JA2 response is about five times lower than the JAX response.

3.6 Summary of JAX Vulnerability Testing.

The mechanical properties tests, even at low temperatures, did not show an obvious correlation with the vulnerability tests that involved shaped charge jets interacting with the JAX propellant bed. This is not surprising since the role that mechanical properties play has been shown to be secondary to that of chemistry.¹⁷

All five tests discussed previously show that the response of JAX is fundamentally different from the response of JA2. Since JAX is manufactured by adding 30% RDX (or less) to JA2, the question arises: What is the specific mechanism that causes JA2 to go from a low response propellant, one that generally mimics the inert material response, to the violent response observed for the JAXs? The remainder of this report discusses how we began to address this question and what was found.

Table 6. Staged Compartment Propellants

Propellant	Lot#
2R20	HCL-88C-006-004
JA2 19P STICK	RAD-PE-792-33
JA2 19P GRAN	RAD-PE-792-11
JA2 7P GRAN	RAD-PE-001-S176

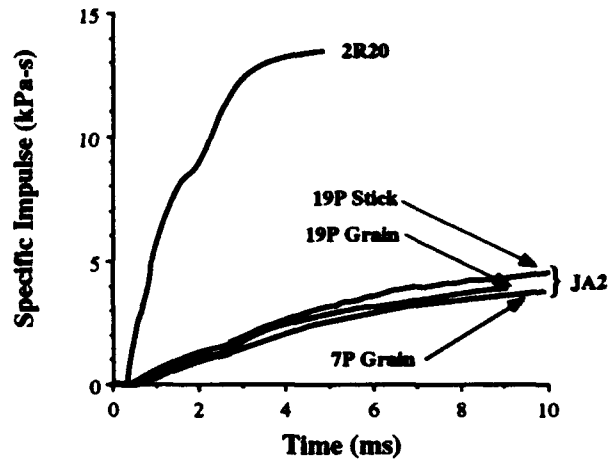


Figure 19. Staged Compartment Test Results for 2.3-kg Quantities of JAX and JA2

4. JAX MORPHOLOGY

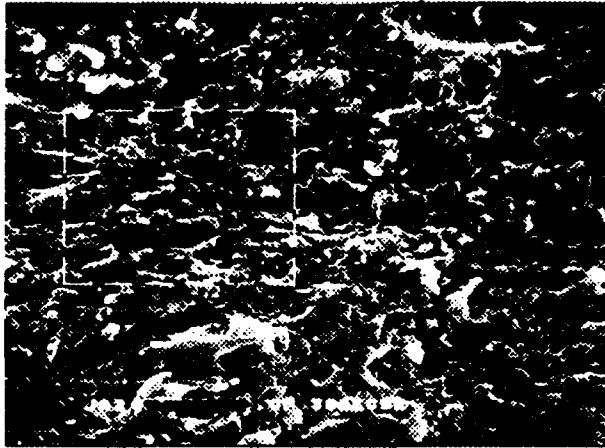
4.1 SEM Background.

The physical arrangement of the processed material is very important to propellant performance. Defects such as voids, cracks, agglomerates, or foreign material can have a deleterious effect on the programmed burning of the charge by changing the mass generation rate of the propellant. This is done by supplying augmented surface area directly or through the resulting fracture, or by simply changing the intrinsic burning rate of the propellant. For this reason, scanning electron microscopy (SEM) has been adopted as a standard method of detecting these defects. Each propellant lot undergoing investigation is examined by SEM to ensure that the structure has its intended integrity. SEM micrographs are also used to assure that there are no processing problems, such as poor mixing of materials. Information may be uncovered during a routine SEM morphological screening examination that would alert researchers to potential performance problems and could eliminate or redirect subsequent testing.⁵

Therefore, undamaged specimens of each type of JAX propellant were cold fractured at dry ice temperatures. The low-temperature fracture reduces the possibility of introducing artifacts into the structure. Since cracks propagate through the material by a path of least resistance and defects usually supply a lower resistance pathway, the likelihood that a crack will encounter a defect (if it exists) as it propagates is enhanced. This process results in more defects being exposed at the fracture surface than would be represented in random sectioning of the specimen. Conversely, if no defects are seen on the newly exposed surface, it is likely that the defect population is small.

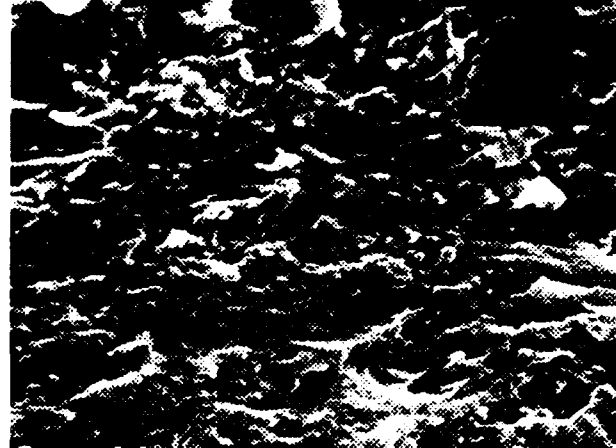
4.2 SEM's of JA2 Grains.

Figure 20 shows micrographs of the cold-fractured surface of typical JA2 propellant and is presented as a basis for comparison. JA2 is a thermoplastic elastomer that undergoes a transition from mostly plastic to brittle behavior at about -20°C at deformation rates on the order of 100 s^{-1} (see Figure 4). The typical JA2 cold-fracture surface is smooth, indicating brittle fracture. Some nitrocellulose (NC) is observed because the high nitration level (13.1%) of the NC prevents all of the fiber from dissolving in the plasticizer. Other propellants that use lower levels of nitration (12.6%)



10 μm

a. $\approx 700\text{X}$



10 μm

b. $\approx 2000\text{X}$

Figure 20. Micrographs of the Cold-Fractured Surface of JA2 Propellant

have the NC completely dissolved and do not show exposed fibers. The only other notable feature in typical JA2 propellant is the presence of very small ($0.5 - 2 \mu\text{m}$) particles distributed throughout the propellant. Their identity has not been established. They could be very fine carbon black, which is an added ingredient, or they could be small particles of MgO that are added during mixing to aid in the extrusion process. In any case, they seem to be found throughout the material.

4.3 SEM's of JAX Grains.

Figure 21 shows micrographs of 2R10, a JAX propellant. RDX particles that are less than $5 \mu\text{m}$ in diameter are observed in these micrographs. The surface is not as smooth as the JA2 surface in Figure 20, but other JA2-like features are present, such as NC fibers and very small particles. The



20 μm

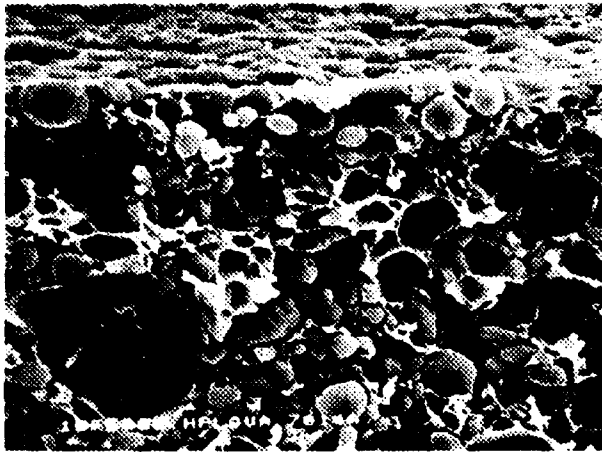
a. $\approx 400\text{X}$



10 μm

b. $\approx 800\text{X}$

Figure 21. Micrographs of the Cold-Fractured Surface of 2R-10 JAX Propellant



10 μm (≈800X)

Figure 22. Nitramine Base Propellant with RDX in the 2 - 20 μm Particle Size Range

only unusual feature is that the particle size of the RDX is considerably smaller than expected. The distribution of particle sizes that was added to make JAX, and that typically appears in nitramine base propellants, has most of the particles within a range of 2 to 20 μm. Figure 22 shows an example of a nitramine base propellant. It has 76% RDX filler that falls within the 2-20 μm range. This range is representative of the RDX particles size distribution expected in the JAX specimen but was not observed.

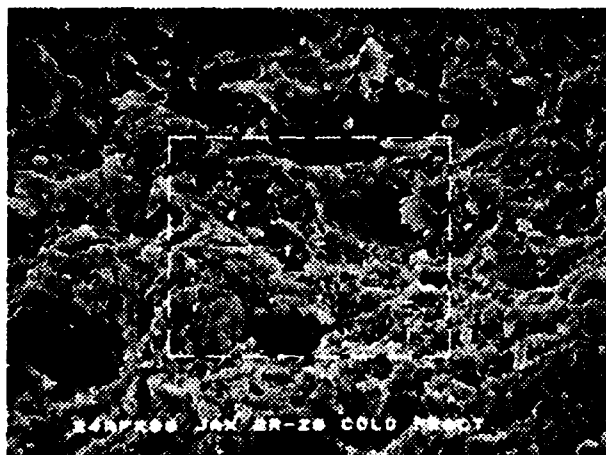
Micrographs of JAX propellant with 20% RDX filler are found in Figure 23. As expected the number density of particles is greater, but the particle size is still about 5 μm. The fracture surface is rougher than the 2R10 surface (see

Figure 21). This was caused by the greater number of particles (i.e., defect locations) diffusing the path of the crack during the specimen preparation.

Micrographs of the 30% filled JAX propellant are presented in Figure 24. There are similar changes due to the increased concentration of RDX as were noted in Figure 23. There are more particles present and an even rougher surface. The major difference noted here is that the RDX size distribution seems to be more in line with what was expected.

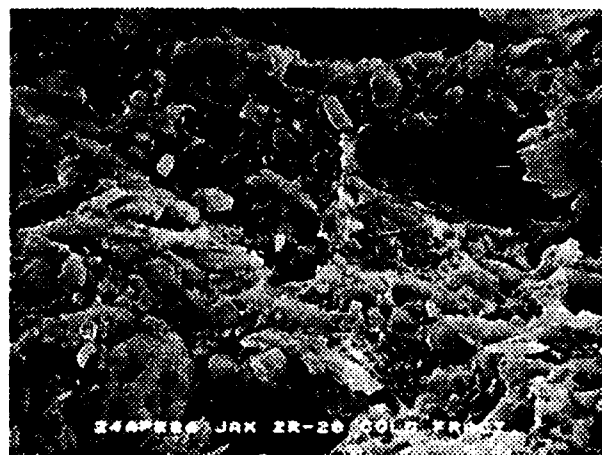
The observations made for these three lots of JAX propellant are significant and consistent when considered in light of information that was gathered when a more recent production of JAX propellant was made. The JAX micrographs presented in Figures 22, 23, and 24 were taken when the propellant was first delivered in the Spring of 1986. A more recent production was manufactured

Micrographs of JAX propellant with 20% RDX filler are found in Figure 23. As expected the number density of particles is greater, but the particle size is still about 5 μm. The fracture surface is rougher than the 2R10 surface (see



20 μm

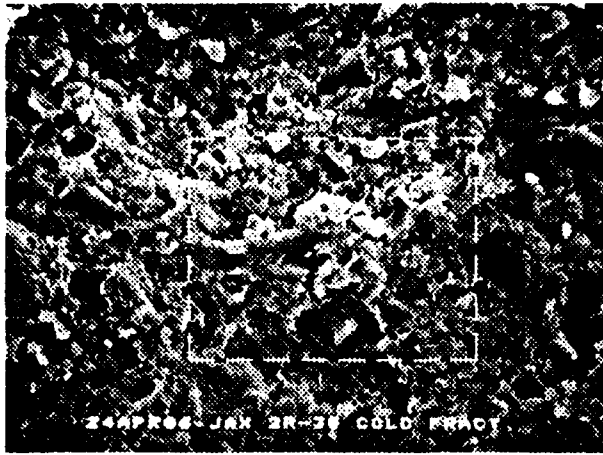
a. ≈400X



10 μm

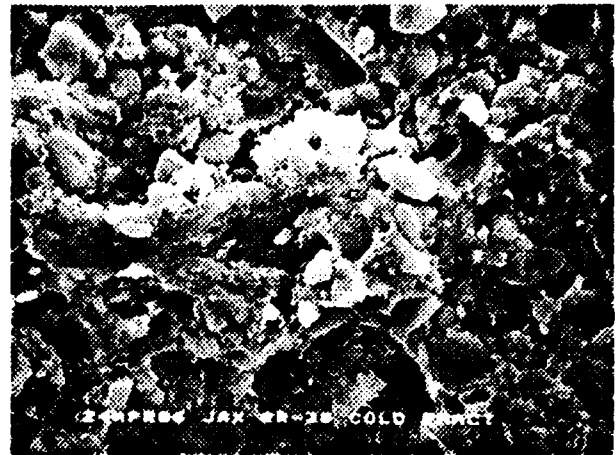
b. ≈800X

Figure 23. Micrographs of the Cold-Fractured Surface of 2R-20 JAX Propellant



20 μ m

a. \approx 400X

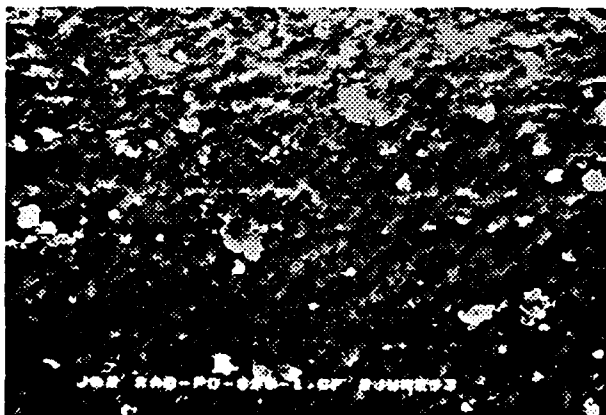


10 μ m

b. \approx 800X

Figure 24. Micrographs of the Cold-Fractured Surface of 2R-30 JAX Propellant

at the Radford Army Ammunition Plant in February 1993.³ The objective in making the newer JAX had been to test the effects of using recrystallized RDX rather than fluid-energy-milled RDX in a JAX composition. This lot was received for routine morphological testing and was cold fractured to investigate the structure. Crystals were observed covering the surfaces of the perforation walls. These observations had not been made with any previous lot of JAX. However, the only surfaces that were investigated using the earlier propellant were cold-fracture surfaces. Micrographs of early lots were inspected for similar observations, but there were no portions of micrographs that showed perforation surfaces of sufficient magnification to confirm the presence of crystals growth. Figure 25 shows a comparison between a JA2 perforation surface and the corresponding surface of a 2R7.7 JAX grain. All perforations showed similar crystal structure. All areas of every perforation showed evidence of crystal growth.



20 μ m

a. JA2 (\approx 400X)



20 μ m

b. JAX-1 with RDX Crystals (\approx 400X)

Figure 25. Micrographs of the Inner Perforation Surface of JA2 and JAX-1 Propellants

To understand the physical nature of the deposition process, the specimen used in Figure 25 was cold fractured along the radial direction of the grain. This provided an orthogonal view from the one presented in that figure, and provided an opportunity to observe the extent of the crystal growth.

Figure 26 shows the radial fracture surface. Attention is called to the whiter band of material that sits on the gray bulk of the propellant grain. It is clear that the crystals reside only on the extrusion surface. There is no extension of the crystals below a sharp line of demarcation, the extruded perforation surface.

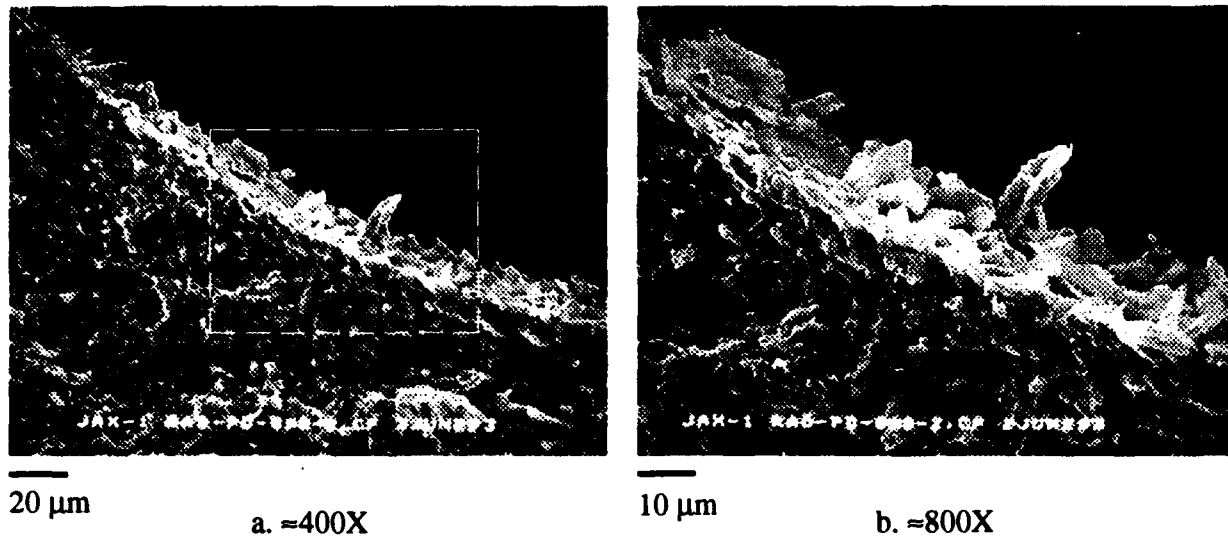


Figure 26. Micrographs of the Inner Perforation Surface of JAX-1 Shown in Figure 11b Cold-Fractured in the Radial Direction

The more recent lots of JAX were not the only ones to exhibit this crystallization phenomenon. The JAX propellant that was studied in 1986 (2R10, 2R20, 2R30, and 2R16) was still in storage in the magazine. It had been undisturbed for 7 years and was retrieved to see if this crystal growth could be seen in the perforations. When the ungraphited 2R16 JAX propellant was brought to the laboratory, a white "powder" was visible on its outside surfaces. Specimens of whole grains were prepared for SEM analysis and micrographs of the outside surface of the grain appear in Figure 27. Since the crystals must have appeared after extrusion, and since the crystals seem to appear upon annealing or long-term storage, the deposition mechanism is likely to be precipitation after transportation to the surface by means of solution.

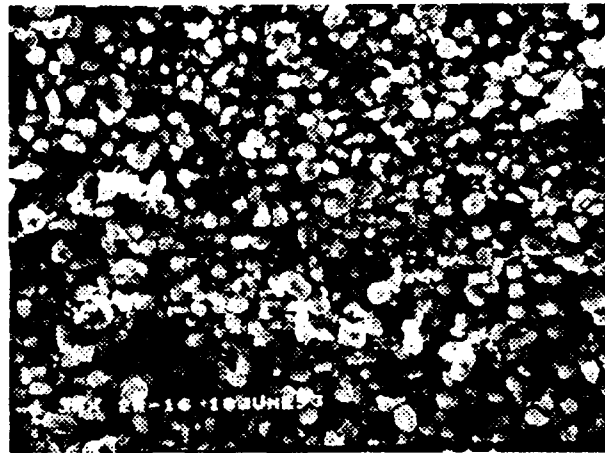
4.4 Crystal Identification.

Positive identification of these crystals was needed and was obtained. The identification strategy consisted of 1) examining the surface of the perforations, where the crystals had been detected; and 2) examining the bulk material, away from external surfaces, as a control. The microreflectance-FTIR spectra of the JAX surfaces (see Figure 25b) were obtained using a Mattson Polaris FTIR spectrometer and a Spectra-Tech IR-Plan infrared microscope with a MCT detector.¹⁸ The software included Kramers-Kronig transformations to correct spectral distortions. For both spectra, 32 scans were collected with a resolution of 8 cm^{-1} . The scans are shown in Figure 28.



100 μm

a. $\approx 80\text{X}$



20 μm

b. $\approx 400\text{X}$

Figure 27. Micrographs of the Exterior Surface of 2R-16 JAX Propellant after 7-Year Storage

Attention is drawn to the ordinate of Figure 28 in the region between 1500 and 1700 cm^{-1} . From other spectra (not shown), an RDX spectral signature lies at about 1600 cm^{-1} and an NC spectral signature lies at about 1660 cm^{-1} . In the upper scan labeled "Bulk Surface of JAX" (Figure 28), we see the NC spectral signature at 1660 cm^{-1} , but little or no indication of an RDX spectral signature at 1600 cm^{-1} . On the other hand, the lower scan, labeled "Perforation Surface of JAX" (Figure 28), we do find the RDX spectral signature at about 1600 cm^{-1} . The shape of the derived NC spectral signature at about 1660 cm^{-1} is distorted. This results from a failure of the Kramers-Kronig transformation to perfectly compensate for the specular reflection of the crystals on the surface.

The crystals were positively identified as nitramines and we concluded that they were recrystallized RDX. With the information thus far it was hypothesized that some type of migration process was occurring that resulted in the deposition of RDX on the exterior surfaces of JAX propellants.

4.5 The Formation of Crystals on JAX Surfaces.

Processing records indicated that annealing of the propellant was performed for 6 hours at 43° C after extrusion and cutting to relieve residual grain stress. Annealing is routinely performed as a part of JA2 processing, and was included in the JAX processing.³ Thus, if heating were to accelerate the RDX deposition, all JAX materials should have RDX crystal growths on their external surfaces after manufacture.

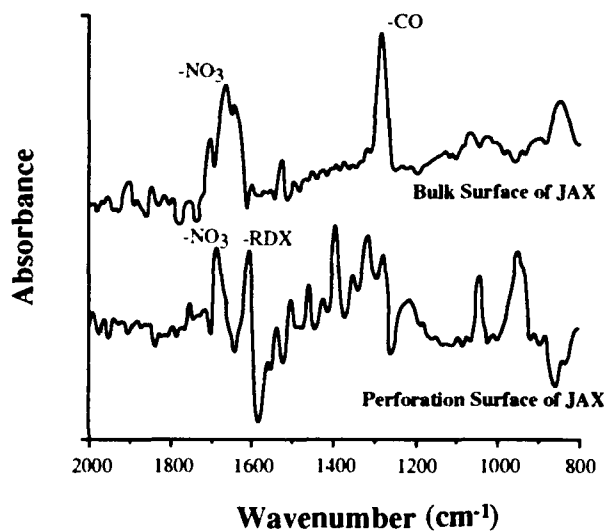


Figure 28. Microreflectance FTIR Spectra of JAX Surfaces

After annealing, the grains are tumbled to apply a graphite coating that aids in loading operations and increases packing density. We infer that the newer grains had the RDX removed from exposed outside surfaces during the tumbling process. This explains why crystals were found only within the perforations for the recently produced JAX. Grains stored for extended periods of time either were exposed to high temperatures (storage history is unknown) or the solution that transports the RDX to the surface had sufficient time to form these crystals after slowly evaporating.

As stated earlier, the annealing step in the processing of JAX suggests that heat might promote the RDX formation. We devised a simple test of this proposal. Specimens of JAX (2R16) were cut at 21° C (not cold-fractured) to expose fresh surface area that contained no crystals. One half of the grain was placed into an oven at 75° C for 65 hours. The other was placed within a laboratory hood at room temperature. After 23 hours the propellant specimens were removed from the annealing oven and inspected; crystals were observed on the surfaces. The control showed no sign of crystal formation. The samples were returned to the oven and the hood and after 65 hours they were again examined using the SEM. There was about the same number density of RDX crystals on the heated samples as there was after 23 hours, but the crystals were larger. The SEM results for heated and control samples after 65 hours are shown in Figure 29.

4.6 The Role of DEGDN.

Evidence from thermogravimetric analysis experiments shows large weight losses (13.5 to 19%) for JA2 upon exposure to elevated temperatures. Table 7 shows the weight loss observed for the propellants JA2, M30, and M43 upon exposure to 60° C for 1000 minutes and upon exposure to 100° C for 360 minutes.¹⁹

The candidates responsible for this relatively large weight loss observed for JA2 are the plasticizers DEGDN or NG. Table 8 shows the vapor pressure for these two neat materials²⁰ over

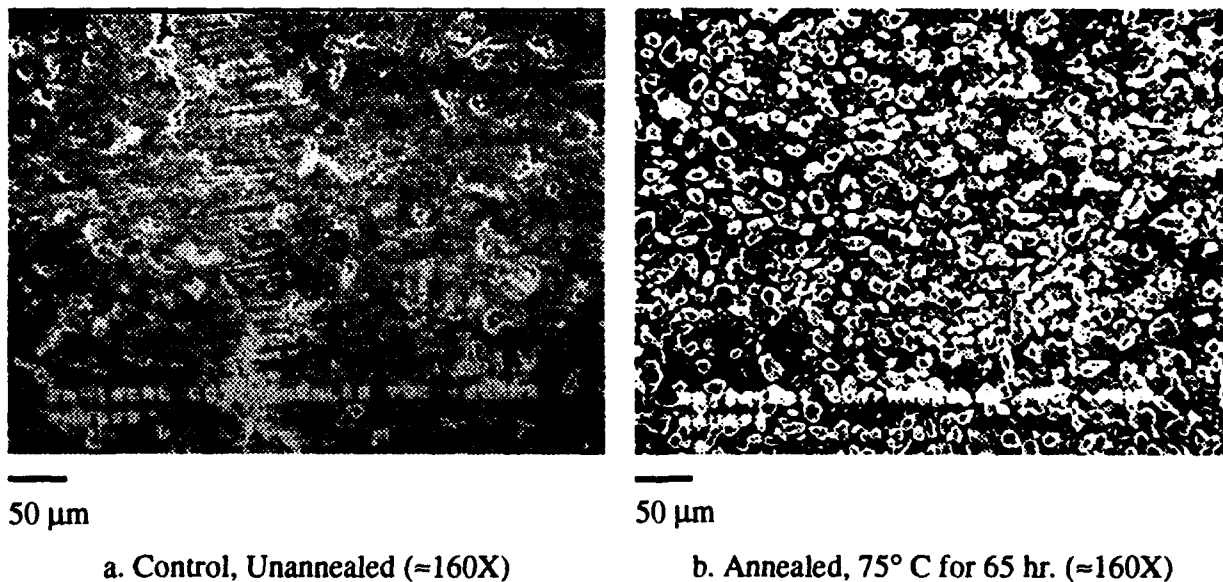


Figure 29. Micrographs of the Cut Surface of 2R-16 JAX Propellant

Table 7. Thermogravimetric Analysis for JA2, M30 and M43 at 60° C and 100° C

Propellant Specimen	(%Wt. Loss)	
	T= 60° C	T= 100° C
	t = 1000 min	t = 360 min
JA2	13.5	19
M30	7.5	12
M43	1.5	3

Table 8. Vapor Pressures of Neat DEGDN and NG

Temperature (° C)	Vapor Pressure (Pa)	
	DEGDN	NG
20	0.48	0.20
25	0.78	0.24
40	no data	1.00
45	no data	1.72
60	17.3	8.00

the temperature range 20° to 60° C. The neat vapor pressure of DEGDN is significantly greater than that of NG, a factor of 2 at 60° C, and the weight percentage of DEGDN is almost a factor of 2 greater than the weight percentage of NG in the formulation of JA2. These two ratios lead us to focus our attention on DEGDN as the principal solvent for the transport of RDX in the JAXs.

The next question concerns the solubility of RDX in DEGDN itself. Table 9 shows the available data for the solubility of RDX and HMX²⁰ at 25° C. The data are ranked according to the value of the absolute solubility of RDX. This value ranges from a low of 2.3 g/100 g solvent to a high of 41 g/100 g solvent. The absolute solubility of RDX in neat DEGDN has the lowest value.

Since DEGDN is about 25 wt% of JA2, and since 6 to 30 wt% of RDX is added to the JA2, the solution of dissolved RDX in the DEGDN and NG within the JAX propellant is very likely saturated.

4.7 The RDX Deposition Process.

The measurable solubility of RDX in DEGDN and high vapor pressures for DEGDN strongly supports the following deposition process.

When RDX is added to the JA2 propellant, it dissolves to form a saturated solution in the propellant plasticizers. This accounts for smaller than expected particle sizes observed in morphology investigations, especially at lower concentrations of RDX. The high vapor pressure of DEGDN causes rapid vaporization of the plasticizer at all exposed propellant surfaces. During annealing, this process is accelerated (and the solubility of RDX may be greater) causing rapid loss of plasticizer and transport of RDX from the interior to the exterior surfaces. As the plasticizer vaporizes, the dissolved RDX precipitates and is deposited on the surface. Once crystals are formed on the surface, the tendency to enlarge existing crystals would take precedence over the creation of new sites, as is usually the case when solids precipitate from saturated solutions. This was observed in the most recent annealing experiments (see Section 4.5). The effect of this process is to remove RDX from the bulk of the grain and deposit RDX crystals on the exterior surfaces.

Table 9. Solubility of RDX and HMX in DEGDN at 25° C

Solvent	RDX	HMX	Ref	RDX/HMX
	(g/100g Solvent)			
DEGDN	2.3	<0.2	a	>11
Acetonitrile	5.5	2.0	b	2.8
Cyclohexanone	7.7	1.0	b	7.7
Acetone	8.2	2.8	b	2.9
Butyrolactone	14	12	b	1.2
Hexamethyl phosphoramidate	16	1.4	b	11
Dimethyl acetamide	33	c	b	---
Dimethyl formamide	37	c	b	---
Dimethyl sulfoxide	41	57	b	0.7

a) Reference 18
b) CPIA/M3 "Solid Propellant Ingredients Manual" Nov 1989. RDX values from Unit 16, p15 of 21; HMX values from Unit 15, p16 of 22.
c) Shortly after the HMX dissolves, precipitation of solvate crystals occurs.

5. SAFETY IMPLICATIONS

Some of the final processing steps in the manufacture of JAX are conducted at elevated temperatures.³ First, there is the "even-speed operation" conducted at 68° C that prepares the dough for carpet rolling. Second, the carpet rolls are conditioned at 66° C for a minimum of 30 hours. Finally after extrusion, trays of cut propellant are annealed for 6 hours at a temperature of 43° C. If our proposed mechanism for the precipitation of RDX on exposed propellant surfaces is correct, then it is likely that recrystallized RDX is formed in one or more of these processing steps. Thus, the recrystallized RDX constitutes a potential safety hazard even during its manufacture.

It is also noted²¹ that "Microscopic examination of 2R12 and 2R16 propellant carpet rolls in storage at Radford (since 1986) confirmed the presence of unbound (recrystallized) RDX on the propellant surface."

We have noted in section 4.5 that the recrystallized RDX is likely to be mechanically loosened from the exposed exterior surfaces of JAX propellant. This was confirmed when recrystallized RDX

Table 10. Sensitivity Initiation Characteristics for JAX, JA2 and Neat RDX

Sample	Production Date	Total Volatiles (%)	RDX Content		Sample Thickness (mm)	Impact (cm)	Sliding Friction* (MPa)	Electrostatic Discharge (J)	Thermal Initiation (°C)
			Particle Size (μ)	(%)					
2R12	Apr-86	0.05	47	12	2.46	80	390	≥9.5	198
2R16	Apr-86	<0.01	7.5	16	2.54	64	464	≥9.5	194
2R20	Feb-86	0.14	100	20	2.41	80	503	≥9.5	no data
JA2	Oct-86	0.30	0	0	2.46	80	617	≥9.5	195
neat RDX		dry	7.5	100	0.18-0.38	13-26	200-293	0.026-0.065	no data
neat RDX		dry	47	100	0.38-0.45	51	170	0.065	no data
neat RDX		dry	100	100	0.28-0.36	26-64	170-345	0.13-0.26	no data

* at 244 cm/s

was easily removed from 2R12 and 2R16 carpet rolls in experiments at Radford by scraping the propellant surfaces with a spatula.²¹

This RDX crystal growth and subsequent separation from the propellant introduce safety concerns during propellant moving and handling operations that are not well understood. These concerns arise during sample inspection, the finishing phases in the JAX manufacturing process, and propellant shipment and storage.

Recent safety testing of several JAXs, JA2, and neat RDX has been done.²¹ These results for threshold initiation levels are presented in Table 10. (In the table, threshold initiation level is defined as that level above which initiation can occur, and is established by 20 consecutive failures at the stated level. Initiation was determined by infrared detection of decomposition gases.) These data show little or no change in the initiation level among the JAXs as measured by electrostatic or thermal ignition. The differences in the JAX initiation values for impact and sliding friction were judged not significant. The report concludes that for all practical purposes the JAX initiation levels are comparable to the JA2 values. Table 10 also shows that dry, neat RDX is more easily initiated by impact, friction, and electrostatic discharge than either JA2 or the JAX propellants listed.

There are two implications that can be drawn from these data. First, the recrystallized RDX, when mechanically freed from the JAX, may either remain airborne and diffuse, or be convectively transported, thereby contaminating shipping or storage containers. The precise safety implications have not been quantified, but the data in Table 10 suggest a prudent caution since the loose RDX poses an increased safety hazard. Second, the fact that these safety tests showed no differences between JA2 and JAX (with or without surface RDX²¹) suggests that these tests cannot be used to predict or determine the level of recrystallized RDX present. To make this determination, a time-temperature study of the rate of formation of recrystallized RDX on the JAX propellant surfaces would have to be undertaken, perhaps as a function of the weight percentage of RDX. Once this relationship is determined, the temperature history of the JAX propellants would have to be recorded and evaluated to properly assess the current state of recrystallization. The increased hazard due to the evolution of loose RDX would also have to be determined.

Two considerations raise questions that may be significant, but are currently not resolvable. The first deals with the RDX deposition process at annealing and upper-extreme storage temperatures. The data in Table 8 show that the relationship between the vapor pressure and temperature is Arrhenius in nature. Thus, at elevated temperatures, the vapor pressures will continue to rapidly increase. However, the solubility of RDX in the propellant plasticizers is not known at higher temperatures. If the solubility is significantly larger and works in concert with the higher vapor pressure, the deposition rate will be markedly increased as the temperature rises. The second consideration concerns the deposition rate and is chemical in nature. Our interest has been focused on the role of DEGDN because of: 1) its higher vapor pressure (Table 8) and greater concentration relative to NG; and 2) the greater thermogravimetric weight loss experienced by JA2 relative to M30 (Table 7). Nevertheless, the role that NG plays in the RDX transport process is not clear. In addition, the mixture of DEGDN and NG that forms the JA2 plasticizer may have properties different from the properties of the neat components. Most of the information needed to address these concerns is not known. Two tacit assumptions were used throughout this analysis: 1) dramatic changes in the solubility of RDX with temperature were not considered; and 2) the vapor pressure of the plasticizer mixture would be an interpolation of the neat constituent values. If additional processes or chemical changes were introduced when the plasticizers were mixed, other explanations for these observations become possible. However, the mechanism, as presented, is qualitatively consistent with the information and physical data contained in this report.

In conclusion, the mechanism for the precipitation of RDX discussed in section 4.7 *produces a dynamically changing structure on the surfaces of and within JAX propellants. Since JAXs can undergo morphological changes with time and temperature, and since the standard safety tests are not predictors of the changing state of a JAX propellant, the continued manufacture and use of JAXs as they are currently formulated and processed is not recommended.*

6. OPTIONAL STRATEGIES TO RDX ADDITION

6.1 Solid Fills.

RDX is not the only energetic solid oxidizer that could be tried in the manufacture of a JAX-like propellant. Table 9 shows that the relative solubility of HMX in neat DEGDN is more than an order of magnitude lower than that of the RDX's solubility. While this is encouraging, this low value is no guarantee that HMX would not show a similar crystallization phenomenon. Recourse must be made to experimentation. Other solid oxidizers could also be tried.

6.2 Use of Less Volatile Plasticizer.

The DEGDN could either be replaced with a less volatile plasticizer or an inhibitor could be added to DEGDN to retard its migration. In this last regard, some experimentation with PARAPLEX G59, a viscous, high molecular weight hydrocarbon, has shown some success.²² Approximately 10 wt% of G59 had been added to a recently manufactured nominal 2R20 JAX. The grains were exposed to testing as described in section 4.5, except that the heating at 75° C was continued for 120 hours. These grains were examined by SEM, as described in section 4.3, and analyzed by FTIR, as described in section 4.4. No crystalline RDX was observed on the exposed outer surfaces.

7. SUMMARY

The original goal of this investigation, to determine the mechanism(s) by which the vulnerability response of JAX was so much greater than that of JA2, was not reached. It may be that the raw crystalline RDX observed on the external JAX surfaces contributes to this increased violent response but it is not the only possible mechanism, and in no way has it been demonstrated. For example, the implication that RDX enters into solution in the DEGDN may also provide a mechanism for the increase violent response of the JAXs observed in the vulnerability tests.

During the course of routine investigations on JAX propellant, raw RDX crystals were found deposited on the external surfaces of all JAX grains examined. A mechanism for this deposition was hypothesized and tested, and found to be consistent with all data at hand. Safety implications of the deposition process were pointed out and some general approaches to mitigating or circumventing the RDX crystallization were suggested.

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APPENDIX A

JAX Propellant Description Sheets

Lot Numbers:

HCL86H003-008
HCL86H003-009
HCL86H003-010
HCL86H003-013
HCL86H003-014
HCL86H003-015

HCL86C004-001
HCL86C004-002
HCL86C004-003
HCL86C004-004
HCL86C004-005
HCL86C004-006

HCL86C006-001
HCL86C006-002

HCL86C006-003
HCL86C006-004
HCL86C006-005

HCL86H008-001
HCL86H008-002
HCL86H008-003
HCL86H008-004
HCL86H008-005
HCL86H008-006
HCL86H008-007
HCL86H008-008

HCL87A010-002
HCL87A010-004
HCL87A010-005

HCL87A010-006
HCL87C010-007
HCL87C010-008
HCL87C010-009
HCL87C010-010
HCL87C010-011
HCL87C010-012
HCL87C010-013
HCL87C010-014
HCL87B010-015

RAD-PD-090-1(JA2)
RAD-PD-090-2
RAD-PD-090-3
RAD-PD-090-4

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N/A
RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.
 450 Pounds
 Honeywell Subcontract 947092

RECEIVED DATE NUMBER B95089; 95091; 95092		NITROCELLULOSE 13.13 13.07 13.10	STABILITY (PARTS) 45+ 10+
--	--	---	---------------------------------

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			DATE	TIME
Ambient	Ambient	Load Forced Air Dry		
Ambient	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		
110°F	Ambient	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT ALLOWED		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.62	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardic II	N/A	N/A	0.71	HOE (cal/cm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Taliansi:		
RDX	N/A	N/A	17.78	Slope @ 100=HR	51.00' min	.349
Ash	N/A	N/A	0.09			
Moisture	0.5	±0.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)				
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT		SPONGERON	DR	FINISHED		
RT	-40	90.97	101.69	LENGTH (L)	N/A	.648	.656		
	+90	92.47	103.43	DIA (TYPE B)	N/A	.620	.601		
	+145	96.81	106.25	WEB DIA (W)	N/A	.027	.027		
STANDARD	S-231	90	100.00	Web Ave	N/A	.082	.079	DATE	
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.					Inner	N/A	.088	.078	PACKED 8/86
					Middle	N/A	.091	.076	MARKED 8/86
					Outer	N/A	.067	.082	TEST PERIOD 8/86
					of 1000 grains / 100 cc in 827 form	N/A		2.77	OFFICE
					of 1000 grains / 100 cc in 827 form	N/A		1.05	1.09
				of	N/A	22.96	22.69		

TYPE OF PACKING CONTAINER Fiber Drum: 652 D
 REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

2R-20 19 part granular
 DWX
 HCL86H003-008

PROPELLANT DESCRIPTION SHEET

EXEMPT-PARA 7-28
AR 335-15

COMPOSITION ZR20, 19 Perf Hexagonal Granular	LOT NUMBER NCL06H063-005
SPECIFICATION Honeywell Multics 6FB 086-057 & 6FB 086-081	PACKED AMOUNT 488 Pounds
MFG AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 947092, KE, 745X 110

NITROCELLULOSE			
ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	AI STARCH (65.3°C)	STABILITY (134.5°C)
B95089; B95091; B95092	MAX 13.13 %	MIN	MIN
	MIN 13.07 %	MIN	MIN
	AVG 13.10 %	45+ MIN	30+ MIN
		EXPLOSION	NR

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURES °		PERCENTAGE REMIX TO WHOLE	TIME
FROM	TO	PROCESS- DRYING	DAYS HOURS
		N/A	

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 HOUR	NF 1 HOUR
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		
AKARBIT II	N/A	N/A	0.71	*ITALIAN	≤1.0 HE/BB	
MAGNESIUM OXIDE	N/A	N/A	0.25		MIN 21000MI	0.349
GRAPHITE	N/A	N/A	0.05	NOE (cal/gm)	N/A	11783
RDX	N/A	N/A	17.78			
ASH	N/A	N/A	0.09	ABS DENSITY (g/cc)	N/A	1.61
MOISTURE	N/A	N/A	0.2			
METHYLENE CL SOLUBILITY	N/A	N/A	31.40			

FINISHED PROPELLANT DIMENSIONS (INCHES)

TEST	LOT NUMBER	TEMP °F	PERCENT	PARAMETER	SPECIFICATION	DIE	FINISHED	SPEC	ACTUAL	
				LENGTH (L)	N/A	0.660	10.666			
				DIAMETER (D)	N/A	0.639	10.612			
				PERF. DIA. (d)	N/A	0.024	10.024			
STANDARD			100.00%	WED AVG.	N/A	0.088	10.084			
REMARKS NO DATA AVAILABLE				LONG	N/A	0.104	10.054	PACKED	8/86	
				MIDDLE	N/A	0.096	10.080	SAMPLED	8/86	
				QUICK	N/A	0.064	10.079	TEST FINISHED	8/86	
				WED DIFF /						
				SD in % of					CHIEFS	
				WED AVG.	N/A		1.53	11.09	DESCRIPTION SHEETS FORWARDED	9/30/86
				D:D	N/A	26.62	125.96			

TYPE OF PACKING CONTAINER **FIBER DRUMS: MIL-STD-652D**

REMARKS
Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

D. W. KIRKPATRICK, PROCESS ENGINEER R. L. SIMONS, PROGRAM MANAGER

N/A

47 Pounds

RAAFORD ARMY AMMUNITION PLANT, RADFORD, VA.

Nonever-11 Subcontract 947092

NITROCELLULOSE

95089; 95091; 95092

WATER CONTENT	BY GRADE (AS SHD)	STABILITY (AS SHD)
MAX 13.13 %		
MIN 13.07 %		
Avg 13.10 %	45+	10+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

TEMPERATURE	DRYING	REMARKS
Ambient	Ambient	Load Forced Air Dry
Ambient	110°F	Increase temperature to 110 ± 5°F
110°F	110°F	Hold at temperature
110°F	Ambient	Cool down for sampling

TESTS OF FINISHED PROPELLANT

STABILITY AND PHYSICAL TESTS

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT	STABILITY AND PHYSICAL TESTS			
CONSTITUENT	TESTY FORMULA	TESTY RANGE	TESTY VALUE	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 60'
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT	
Akardic II	N/A	N/A	0.71	HOE (cal/gr)	N/A
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A
Graphite	N/A	N/A	0.05	Talant:	
Zn	N/A	N/A	17.78	Slope @ 100mmHg	51.0 min
ash	N/A	N/A	0.09		
Moisture	0.5	±0.3	0.2		
Methylene Cl Solubility	N/A	N/A	31.40		

CLOSED BOMB

PROPELLANT DIMENSIONS (inches)

LOT NO.	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	DESCRIPTION	WEIGHT	WEIGHT
87	-40	90.97	101.69	LENGTH (L)	N/A	.660
	+90	92.67	103.43	DIA (D)	N/A	.639
	+145	96.81	106.25	WEB (W)	N/A	.020
STANDARD	90	100.00%	100.00%	Web Ave	N/A	.090
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.				Inner	N/A	.106
				Middle	N/A	.099
				Outer	N/A	.0655
				at Web Ave	N/A	6.66
				at Web Ave	N/A	1.03
			at Web Ave	N/A	31.95	29.18

TYPE OF PACKING CONTAINER Fiber Drum: 652 D

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

2R-20 19 part granular

part HCL B6H003-010

COMPOSITION 2R10, 19 Perf. Hexagonal Granular DA LOT NUMBER RCL86H003-013
 SPECIFICATION Multics GER 086-323, 5/27/86 PACKED AMOUNT 173 Pounds
 MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. CONTRACT NUMBER none/yes/ Subcontract 973525, Task III

NITROCELLULOSE

ACCEPTED BRAND NUMBERS	NITROGEN CONTENT	SI STARCH (ALL °C)	STABILITY (25-35 °C)
B95089; B95091; B95092	MAX 13.13 %	MIN	
	MIN 13.07 %	MIN	
	AVE 13.10 %	45+ MIN	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

TEMPERATURE FROM	TO	DAYS	HOURS

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	FORMULA	ACTUAL	
Nitrocellulose	N/A	N/A	55.09	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	12.68	No Fumes	NF 1 hr	NF 1 Hr
DEGDN	N/A	N/A	20.99	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.61	NOF (cal/gm)	N/A	1156
Magnesium Oxide	N/A	N/A	0.06	Ads. Dens. (g/cc)	N/A	1.60
Graphite	N/A	N/A	0.05	Italiani:		0.353
RDX	N/A	N/A	10.52	Slope @ 100mmHg	1.0/min	
Ash	N/A	N/A	0.10			
Moisture	N/A	N/A	0.4			
Methylene Cl Solubility	N/A	N/A	34.28			

MIXED BUNCH

LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE HUMIDITY	SPECIFICATION	DE	FINISHED	DATE
-013	-40	105.45	104.19	LENGTH (L)	N/A	.715	
-013	+90	119.89	105.02	DIAMETER (D)	N/A	.639	
-013	+145	123.47	104.86	PERF. DIA. (M)	N/A	.024	
STANDARD 472-138	90	100.00%	102.00%	Web Avg.	N/A	.088	
REMARKS The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138. 700cc bomb @ 0.10 gm/cc loading density.				Inner	N/A	.104	PACKED 8/86
				Middle	N/A	.096	SAMPLED 8/86
				Outer	N/A	.064	TEST RAN 8/86
				See Drawing / Int. Dev. in E of Web Avg.	N/A	.213	OFFERED 9/11/86
				LD	N/A	1.17	DESCRIPTION SHEETS FORWARDED
				DW	N/A	26.62	27.55

TYPE OF PACKING CONTAINER Fiber Drum: 652D

REMARKS
Candelilla wax was used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE
 D. W. KIRKPATRICK *D.W. Kirkpatrick*
 R. L. SIMONS, PROGRAM MANAGER *R.L. Simons*

PROPELLANT DESCRIPTION SHEET

AR 222-18

COMPOSITION 2R10, 19 Perf. Hexagonal Granular	SAFETY NUMBER HCLB6H003-014
INSPECTION Multics GER 086-323, 5/27/86	PACKS WEIGHT 768 Pounds
MANUFACTURER RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Subcontract 973525, Task III

ACCEPTED BRAND NUMBERS	NITROGEN CONTENT		SI STARCH (ALL %)	STABILITY (30±°C)
	MAX	MIN		
B95089; B95091; B95092	13.13	13.07	45+	30+
				EXPLOSION

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE FROM	TEMPERATURE TO	PROCESS-DRYING	DAYS	
			DAY	NIGHT

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
	CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT REASBEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	55.09	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	12.68	No Fumes	NF 1 hr	NF 1 Hr.
DEGDN	N/A	N/A	20.99	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.61	ROF (cal/cm)	N/A	1156
Magnesium Oxide	N/A	N/A	0.06	Abs. Dens. (g/cc)	N/A	1.60
Graphite	N/A	N/A	0.05	Talioni:		
RDX	N/A	N/A	10.52	Slope @ 100mmHg	1.0cm/min	0.353
Ash	N/A	N/A	0.10			
Moisture	N/A	N/A	0.4			
Methylene Cl Solubility	N/A	N/A	34.28			

TEST	LOT NUMBER	TEMP °F	QUALITY (G/CM ³)	RELATIVE DENSITY	SPECIFICATION			DATES
					UNIFORMITY	DR	FINISHED	
	-014	-40	105.45	104.19				
	-014	+90	119.89	105.02	DIAMETER (DI)	N/A	.709	.710
	-014	+145	123.47	104.86	DIAMETER (DI)	N/A	.639	.615
					PERF. DIA. (DI)	N/A	.020	.022
STANDARD	472-138	90	100.00%	100.00%	Web Avg.	N/A	.090	.085
REMARKS The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138. 700cc bomb @ 0.10 gm/cc loading density.					Inner	N/A	.106	.092
					Middle	N/A	.099	.079
					Outer	N/A	.0655	.086
					Web Thickness / 2nd. Dev. to % of Web Avg.	N/A		7.04
					LD	N/A	1.11	1.15
				DD	N/A	81.95	27.95	

TYPE OF PACKING CONTAINER Fiber Drum: 652D

REMARKS Candelilla wax was used as a lubricant during extrusion and may be present in the propellant in trace amounts. The physical dimensions of this lot are a weighted average of sublots A and B.

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE
D. W. KIRKPATRICK *D W Kirkpatrick*

SIGNATURE OF PROGRAM MANAGER
R L SIMMONS
R. L. SIMMONS, PROGRAM MANAGER

PROPELLANT DESCRIPTION SHEET

AR 335-15

COMPOSITION: 2R10, 19 Perf. Hexagonal Granular	DA LOT NUMBER: HCL86H003-015
DESCRIPTION: Multics GER 086-323, 5/27/86	PACKED AMOUNT: 440 Pounds
DATE AT: RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER: 40549001 Subcontract 973525, Task III

NITROCELLULOSE

ACCEPTED BUND NUMBERS B95089; B95091; B95092	NITROGEN CONTENT	SI RANGE (ALL °C)	STABILITY (20±°C)
	MAX 13.13 %		
	MIN 13.07 %		
	AVG 13.10 %	45+	30+
			EXPLOSION

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE °C	FROM	TO	PROCESS-DRYING	DAYS	
				DAY	MO/HT

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	55.09	HEAT TEST @ 120°C	CC 60' +
Nitroglycerin	N/A	N/A	12.68	No Fumes	NF 1 hr
DEGDN	N/A	N/A	20.99	FORM OF PROPELLANT	
Akardit II	N/A	N/A	0.61	HOF (cc/gm)	N/A 1156
Magnesium Oxide	N/A	N/A	0.06	Abs. Dens. (g/cc)	N/A 1.60
Graphite	N/A	N/A	0.05	Italiani:	
RDX	N/A	N/A	10.52	Slope @ 100 mm Hg	1.0/min 0.353
Ash	N/A	N/A	0.10		
Moisture	N/A	N/A	0.4		
Methylene Cl Solubility	N/A	N/A	34.28		

TEST	LOT NUMBER	TEMP °C	RELATIVE HUMIDITY	RELATIVE HUMIDITY	SPECIFICATION	DE	FINISHED	DATE
	-015	-40	105.45	104.19	N/A	.732	.735	
	-015	+90	119.89	105.02	N/A	.700	.654	
	-015	+145	123.47	104.86	N/A	.020	.022	
STANDARD	472-138	90	100.00%	100.00%	Web Avg.	.100	.089	
REMARKS The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138. 700cc bomb @ 0.10 gm/cc loading density.	Inner	N/A	.116	.094				PACKED 8/86
	Middle	N/A	.108	.083				SAMPLED 8/86
	Outer	N/A	.077	.091				TEST PERFORMED 8/86
	Use Difference / Std. Dev. in % of Web Avg.	N/A	14.25	4.84				OFFERED 9/11/86
	LD	N/A	1.05	1.12				DESCRIPTION BESTS FORWARDED
Std	N/A	.35	29.44					

TYPE OF PACKING CONTAINER: Fiber Drum: 652D

REMARKS
Candelilla wax was used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE
D. H. KIRKPATRICK *DH Kirkpatrick* | R. E. SIMONS *R. E. SIMONS*

QUANTITY	2R-20 19 Perf Stick	NSN NUMBER	NCL86C004-001 ✓
WEIGHT	N/A	WEIGHT RANGE	500 Pounds
MANUFACTURER	BADFORD ARMY AMMUNITION PLANT, BADFORD, VA.	CONTACT NUMBER	Honeywell Subcontract 932077
NITROCELLULOSE			
RECEIVED BOMB NUMBER	95058: 95059: 95060	WATEROOR CONTENT	BY BATCH (MAX. 8°C)
		MAX 13.15 %	
		MIN 13.08 %	
		AVE 13.11 %	45+ 30+
MANUFACTURE OF SOLVENTLESS PROPELLANT			

TEMPERATURE		PROCESS-DRYING	TIME
FROM	TO		DAYS
Ambient	Ambient	Load Forced Air Dry	
Ambient	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambient	Cool down for sampling	

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT REJECTED		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.70	HEAT TEST @ 120°C	CC 40'	CC 60'4
Nitroglycerin	N/A	N/A	13.12	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	23.16	FORM OF PROPELLANT		
Adit II	N/A	N/A	0.64	HOE (cal/gm)	N/A	1166
Sodium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.05	Talenti:		
RDX (ground)	20	N/A	20.30	Slope @ 100mmHg	51.0mm/min	*
				* pressure did not reach		
Moisture	N/A	N/A		100 mm Hg		
Ash	N/A	N/A	0.10			

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)			
LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE FORCE		SPECIFICATION	DI	FINISHED	
	-40	102.99	104.97	LENGTH (L)	N/A	8.0	8.0	
	+90	118.06	106.86	DIAMETER (DI)	N/A	.700	.678	
	+145	121.83	106.92	WEB (WA 60)	N/A	.021	.023	
STANDARD	PF-472-138	+90	100.0%	100.0%	Web T	N/A	.113	.092
REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.					Web M	N/A	.108	.087
					Web O	N/A	.077	.104
					Web A	N/A	.099	.094
					Web B	N/A		6.67
					Web C	N/A	11.43	11.80
					Web D	N/A	33.33	29.75

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by *[Signature]* Development Engineer
D.W. Kirkpatrick
[Signature] D. W. Kirkpatrick

N/A

20 FOUND

RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.

Contract No. Honeywell Subcontract 932077

NITROCELLULOSE

95058: 95059: 95060

EXPLOSION CONTENT	DIAPHRAGM (MILS)	STABILITY (DAYS @ 30°C)
MAX 13.15		
MIN 13.08		
Avg 13.11	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambien	Cool down for sampling	

PROPELLANT COMPOSITION TESTS OF FINISHED PROPELLANT STABILITY AND PHYSICAL TESTS

CONSTITUENT	PERCENT FORMULA	PERCENT ANALYSIS	PERCENT ANALYSIS	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.70	STABILITY @ 120°C	CC 40'
Nitroglycerin	N/A	N/A	13.12	No Fumes	NF 1 hr
DEGDN	N/A	N/A	23.16	FORM OF PROPELLANT	
Akardix II	N/A	N/A	0.64	HOE (cal/cm)	N/A
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A
Graphite	N/A	N/A	0.05	Tallini:	
RDX (ground)	20	N/A	20.30	Slope @ 100mmHg	21.0 g/in *
				* pressure did not reach	
Moisture	N/A	N/A		100 mm Hg	
Ash	N/A	N/A	0.10		

CLOSED BOMB PROPELLANT DIMENSIONS (inches)

LOT NUMBER	TEMP °F	INITIAL LENGTH	FINAL LENGTH	DESCRIPTION	DR	DRMIN	DATE
WF	-40	102.99	104.97	UNFINISHED	N/A	2.75	
	+90	118.06	106.86	DIAMETER (D)	N/A	.700	
	+145	121.83	106.92	WEB DIA (W)	N/A	.021	
STANDARD	PF-472-138	+90	108.07	Web T	N/A	.113	
				Web M	N/A	.108	PACKED 3/86
				Web O	N/A	.077	SAMPLED 3/86
				Web A	N/A	.099	TEST FOLLOWED 3/86
				Web B	N/A	6.67	FORMED
				Web C	N/A	3.93	DESCRIPTION SHEETS FORWARDED
				Web D	N/A	33.33	

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by *2R-20 (9 pref stick)* HCL 06 C004-002

Development Engineer
D.W. Kirkpatrick
D.W. Kirkpatrick

DESCRIPTION: N/A WEIGHT: 65 Pounds

LOCATION: RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. CONTRACT NUMBER: Honeywell Subcontract 932077

NITROCELLULOSE		STRENGTH (CC-TEST)	IN GRADE (GALS/G)	STABILITY (GALS/G)
95058	95059	95060		

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			DAY	HOUR
Ambien	Ambien	Load Forced Air Dry		
Ambien	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambien	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT ANALYSIS	PERCENT ANALYSIS	FORMULA	ACTUAL	
Nitrocellulose	N/A	N/A	42.70	MAX TEST @ 120°C	CC 40'	
Nitroglycerin	N/A	N/A	13.12	No Fumes	NF 1 hr	
DEGDN	N/A	N/A	23.16	FORM OF PROPELLANT		
Akardis II	N/A	N/A	0.64	NOF (cal/cm)	N/A	
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	
Graphite	N/A	N/A	0.05	Talenti:		
BDX (ground)	20	N/A	20.30	Slope @ 100mmHg	51.0mm/min *	
				* pressure did not reach		
Moisture	N/A	N/A		100 mm Hg		
Ash	N/A	N/A	0.10			

CLOSED BOMB				PROPELLANT DIMENSIONS (Inches)			
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	DESCRIPTION	DN	DN	DATE
	-40	102.99	104.97	LENGTH (L)	N/A	1.6	
	+90	118.06	106.86	DIAMETER (D)	N/A	.700	
	+145	121.83	106.92	PERF. DIA (P)	N/A	.021	
STANDARD	PF-472-138	+90	104.00	Web T	N/A	.113	
				Web M	N/A	.108	PACKED 3/86
				Web O	N/A	.077	SAMPLED 3/86
				Web A	N/A	.099	TEST NUMBER 3/86
				Web B	N/A		DN
				Web C	N/A	6.67	DESCRIPTION SHEET FORWARDED
				Web D	N/A	2.29	
				Web E	N/A	33.33	

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candellilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by: *2R-20 19 putstick* ACL 80C 004-003
 Development Engineer: *D.W. Kirkpatrick*
D.W. Kirkpatrick

DESCRIPTION N/A	WEIGHT 60 Pounds												
MANUFACTURER RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	PROPERTY NUMBER Honeywell Subcontract 932077												
NITROCELLULOSE													
RECEIVED DATE 95058: 95059: 95060	<table border="1"> <tr> <th>WET WEIGHT</th> <th>WET MOISTURE</th> <th>STABILITY (30+°C)</th> </tr> <tr> <td>BAR 13.15</td> <td>BAR</td> <td>BAR</td> </tr> <tr> <td>BAR 13.08</td> <td>BAR</td> <td>BAR</td> </tr> <tr> <td>Avg 13.11</td> <td>45+</td> <td>30+</td> </tr> </table>	WET WEIGHT	WET MOISTURE	STABILITY (30+°C)	BAR 13.15	BAR	BAR	BAR 13.08	BAR	BAR	Avg 13.11	45+	30+
WET WEIGHT	WET MOISTURE	STABILITY (30+°C)											
BAR 13.15	BAR	BAR											
BAR 13.08	BAR	BAR											
Avg 13.11	45+	30+											

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			TIME
TEMP °F	MOISTURE	REMARKS	RECIPIENT
Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambien	Cool down for sampling	

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT BY WEIGHT	PERCENT BY WEIGHT	PERCENT BY WEIGHT	FORMULA	ACTUAL	
Nitrocellulose	N/A	N/A	42.70	GRAV TEST @ 120°C	CC 40'	
Nitroglycerin	N/A	N/A	13.12	No Fumes	NF 1 hr	
DEGDN	N/A	N/A	23.16	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.64	HOE (cal/cm)	N/A	
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	
Graphite	N/A	N/A	0.05	Talioni:		
BDX (ground)	20	N/A	20.30	Slope @ 100mmHg	1.0mm/min *	
				* pressure did not reach		
Moisture	N/A	N/A		100 mm Hg		
Ash	N/A	N/A	0.10			

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)			
TEST	LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE PRESSURE	DESCRIPTION	DI	DI	DI
		-40	102.99	104.97	LENGTH (L)	N/A	15.0	15.0
		+90	118.06	106.86	DIAMETER (D)	N/A	395	391
		+145	121.83	106.92	PROP. DIA (P)	N/A	.025	.0277
STANDARD	PP-472-138	+90	100.0%	100.0%	Web			
REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.					Inner	N/A	.081	.077
					Outer	N/A	.082	.077
					Ave.	N/A	.082	.077
					Wt of Propellant Per Sq. In. of Web Area	N/A	1.22	.04
					LD	N/A	37.97	38.36
SD	N/A	15.8	14.65					

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327061, Carton No. 327146

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by _____ Development Engineer
 D.W. Kirkpatrick
D. W. Kirkpatrick

COMPOSITION 2R-20 7 Perf Stick
 N/A
RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.
 NITROCELLULOSE
 HONEYWELL Subcontract 932077

RECEIVED DATE NUMBER 95058: 95059: 95060	EXTRUSION CONTENT MAX 13.15 MIN 13.08 AVG 13.11	STRENGTH (PSI) 45+	STABILITY (DAYS @ 25°C) 30+
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MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			STABILITY	TEST
Ambient	Ambient	Load Forced Air Dry		
Ambient	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambient	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT PROPELLANT	PERCENT RESIDUE	TEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.70	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.12	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	23.16	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.64	HOE (cal/cm)	N/A	1166
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.05	Taliansi:		
RDX (ground)	20	N/A	20.30	Slope @ 100mmHg	1.0mm/min	*
				* pressure did not reach 100mmHg		
Moisture	N/A	N/A				
Ash	N/A	N/A	0.10			

CLOSED BOMB					PROPELLANT DIMENSIONS (inches)				
LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE PRESSURE		SPONGERON	DE	FINISHED		
58	-40	102.99	104.97	LENGTH (L)	N/A	15.0	15.0		
	+90	118.06	106.86	DIAMETER (D)	N/A	.430	.422		
	+145	121.83	106.92	PERF. DIA (P)	N/A	.025	.026		
STANDARD	PF-472-138	+90	100.00%	100.00%	Web			DATE	
REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.					Inner	N/A	.093	.086	PACKED 3/86
					Outer	N/A	.087	.088	SAMPLED 3/86
					Ave.	N/A	.090	.087	TEST NUMBER 3/86
					Net Weight of Wax in Bomb	N/A	-6.90	2.57	GRAIN
					W	N/A	34.88	35.54	DIRECTION BLENDS FORWARDED
D	N/A	17.20	16.23						

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327145

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by: *[Signature]* Development Engineer
 D.W. Kirkpatrick
 P.W. Schubert

2R-20 7 Port Stick

DESCRIPTION: N/A

WEIGHT: 30 pounds

CONTRACT NUMBER: Honeywell Subcontract 932077

MANUFACTURED AT: RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.

COMPOSITION: NITROCELLULOSE

LOT NUMBERS: 9505R, 9505S, 95060

INITIATION CONTENT	IN RANGE (90.8%)	STABILITY (90.8%)
MAX 13.15		
MIN 13.08		
Avg 13.11	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

TEMPERATURE	MOISTURE	PROCESS	TIME
Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambien	Cool down for sampling	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT ANALYSIS	STABILITY AND PHYSICAL TESTS	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.70	HEAT WT @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.12	No PUFES	NF 1 hr	NF 1 hr
PEGDN	N/A	N/A	23.16	ROCK OF PROPELLANT		
Akardit II	N/A	N/A	0.64	HOF (cal/cm)	N/A	1166
Magnesium Oxide	N/A	N/A	0.03	Abs. dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.05	Tellani:		
RDX (ground)	20	N/A	20.30	Slope @ 100mmHg	±1.0mm/min	*
				* pressure did not reach		
Moisture	N/A	N/A		100 mm Hg		
Ash	N/A	N/A	0.10			

CLOSED BOMB

LOT NUMBER	TEMP °F	INITIAL PRESSURE (PSI)	FINAL PRESSURE (PSI)	WEIGHT (G)	WEIGHT (G)	WEIGHT (G)	WEIGHT (G)	DATE
N/A								
	-40	102.99	104.97	15.0	15.0			
	+90	118.06	106.86	471	462			
	+145	121.83	106.92	025	025			
STANDARD	PF-472-138	+90						

PROPELLANT DIMENSIONS (INCH)

DESCRIPTION	OR	MIN	MAX
Length (L)	N/A	15.0	15.0
Diameter (D)	N/A	.471	.462
Web Dia (W)	N/A	.025	.025
Web			
Inner	N/A	.104	.101
Outer	N/A	.096	.093
Ave.	N/A	.100	.097
Δ of Density	N/A	-8.33	-8.23
Δ of Weight	N/A	31.85	32.47
Δ of	N/A	18.84	18.48

REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.

DATE: 3/86

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by: *[Signature]* Development Engineer
D.W. Kirkpatrick

2R-20 19 Perf Stick NITROCELLULOSE

WEIGHT 399 pounds

BAADFORD ARMY AMMUNITION PLANT, BAADFORD, VA. Honeywell Subcontract 932077

RECEIVED BOMB NUMBER

RECEIVED BOMB NUMBER	NITROGEN CONTENT	STANDARD DEVIATION	STABILITY (245°C)
95058: 95059: 95060	MAX 13.15		
	MIN 13.08		
	AVE 13.11	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

TEMPERATURE	MOISTURE	PROCESS
Ambient	Ambient	Load Forced Air Dry
110°F	110°F	Increase temperature to 110 ± 5°F
110°F	110°F	Hold at temperature
110°F	Ambient	Cool down for sampling

PROPELLANT COMPOSITION TESTS OF FINISHED PROPELLANT STABILITY AND PHYSICAL TESTS

CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT FINISHED	TEST METHOD	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.68	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.48	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	22.08	FORM OF PROPELLANT		
Akardic II	N/A	N/A	0.77	HOE (cal/gm)	N/A	1161
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.06	Talenti:		
RDX (class I)	20	N/A	20.92	Slope @ 100mmHg	±1.0%/min	0.260
Moisture	N/A	N/A	0.10			
Ash	N/A	N/A				

FINISHED CARPET PROPELLANT DIMENSIONS (INCH)

LOT NUMBER	TEMP °F	DIAMETER (IN)	LENGTH (IN)	WEIGHT (LB)	SPERICATION	RE	FINISH	DATE	
	-40	113.55	105.86		N/A	8.0	8.0		
	+90	123.05	107.30		N/A	.700	.675		
	+145	124.88	106.28		N/A	.021	.022		
STANDARD	PE-472-138	+90	106.00	106.00	Web I	N/A	.113	.102	
REMARKS	These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.				Web M	N/A	.108	.090	PACKED 3/86
					Web O	N/A	.077	.093	SAMPLES 3/86
					Web A	N/A	.099	.095	TEST RESULTS 3/86
					Web B	N/A	.	4.95	GRAIN
					Web C	N/A	11.43	11.85	DISCREPANCY REPORT FORWARDED
					N/A	33.33	30.68		

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by Development Engineer D.W. Kirkpatrick
D.W. Kirkpatrick

PREPARED BY: N/A
 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.
 CONTRACT NUMBER: Honeywell Subcontract 932077

ACCEPTED SAMPLE NUMBERS		NITROGEN CONTENT	DI STARCH (M.L.%)	STABILITY (30-35°C)
R9505B; 95059; 95060		MAX 13.15 %		
		MIN 13.08 %		
		AVG 13.11 %	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			DATE	TEST
Ambien	Ambien	Load Forced Air Dry		
Ambien	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambien	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT ANALYZED		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	62.68	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.48	No Fumes	NF 1 hr	NF 1 hr
DECDN	N/A	N/A	22.08	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.77	HOF (cal/cm)	N/A	1161
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.04	Tellani:		
RDX (class I)	20	N/A	20.92	Slope @ 100mmHg	21.0mm/min	0.260
Moisture	N/A	N/A	0.10			
Ash	N/A	N/A				

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)				
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT		DESCRIPTION	DE	RMED		
WT	-40	113.53	105.86	LENGTH (L)	N/A	2.75	2.67		
	+90	123.05	107.30	DIAMETER (D)	N/A	.700	.675		
	+145	124.88	106.28	WEB DIA (W)	N/A	.021	.022		
STANDARD	PE-472-138	+90	108.00%	108.00%	Web I	N/A	.113	.102	
REMARKS	These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.				Web M	N/A	.108	.090	PACKED 3/86
					Web O	N/A	.077	.093	SAMPLED 3/86
					Web A	N/A	.099	.095	TEST FINISHED 3/86
					Web B	N/A		4.95	COINED
					Web C	N/A	3.93	3.96	DISSECTION TESTS FORWARDED
					Web D	N/A	33.33	30.68	

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by: *2R-20 19 part stick HCL 86C006-002*
 Development Engineer: *D.W. Kirkpatrick*
D.W. Kirkpatrick

DESCRIPTION 25-20 19 Perf Stick		WEIGHT 31 Pounds		
SPECIFICATION N/A		CONTRACT NUMBER Honeywell Subcontract 932077		
MATERIAL NITROCELLULOSE				
REPTD LAB NUMBERS 895058; 95059; 95060		NITROGEN CONTENT	STABILITY (24Hr @ 120°C)	
		MAX 13.15 %	EXPLOSION	
		MIN 13.08 %		
		AVG 13.11 %	30+	
MANUFACTURE OF SOLVENTLESS PROPELLANT				
PROCESS-DRYING		DRY	MOIST	
Ambien	Ambien	Load Forced Air Dry		
Ambien	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		
110°F	Ambien	Cool down for sampling		
PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT		
CONSTITUENT	PERCENT FORMULA	PERCENT ANALYSIS	STABILITY AND PHYSICAL TESTS	
Nitrocellulose	N/A	42.68	HEAT TEST @ 120°C	
Nitroglycerin	N/A	13.68	No Fumes	
DECDN	N/A	22.08	FORM OF PROPELLANT	
Alaridic II	N/A	0.77	HOF (cal/cm)	
Magnesium Oxide	N/A	0.03	Abs. Dens. (g/cc)	
Graphite	N/A	0.04	Talenti:	
RDX (class I)	20	20.92	Slope @ 100mmHg	
Moisture	N/A	0.10	SI. Com/min	
Ash	N/A		0.260	
FINISHED FORM		PROPELLANT DIMENSIONS (inches)		
LOT NUMBER	TEMP °F	WEIGHT (g)	RELATIVE MOIST	
	-40	113.53	105.86	
	+90	123.05	107.30	
	+145	124.88	106.28	
STANDARD	PE-472-138	+90	108.00%	
REMARKS These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.	LENGTH (L)	SPORCATION	DE	FINISHED
	DIAMETER (Ø)	N/A	1.6	1.6
	PERF. DIA (Ø)	N/A	.700	.675
	Web I	N/A	.021	.022
	Web M	N/A	.113	.102
	Web O	N/A	.108	.090
Web A	N/A	.077	.093	
Web B	N/A	.099	.095	
Web C	N/A		4.95	
Web D	N/A	2.29	2.37	
Web E	N/A	33.33	30.68	
TYPE OF PACKING CONTAINER		DATE		
Wood Box No. 327041, Barrier Bag No. 327041, Carton No. 327146		PACKED 3/86		
REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.		SAMPLED 3/86		
		TEST NUMBER 3/86		
		COPIED		
		SECTION BLENDS FORWARDED		
Signed by		Development Engineer D.W. Kirkpatrick		
		<i>D.W. Kirkpatrick</i>		

PREPARED BY: N/A
 CONTRACT NUMBER: Honeywell Subcontract 932077

RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.

NITROCELLULOSE

ACCEPTED GROSS WEIGHTS	NITROGEN CONTENT	ID GRADE (MILS)	STABILITY (243°C)
895058; 95059; 95060	MAX 13.15 %		
	MIN 13.08 %		
	Avg 13.11 %	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE	MOISTURE	PROCESS-DRYING	DAY	HOUR
Ambient	Ambient	Load Forced Air Dry		
Ambient	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambient	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PURITY FORMULA	PERCENT NITROGEN	NITROGEN GRAINAGE	TEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.68	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.48	No Fumes	NE 1 hr	NE 1 hr
DEGN	N/A	N/A	22.08	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.77	HOE (cal/cm)	N/A	1161
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.04	Talenti:		
RDX (class I)	20	N/A	20.92	Slope @ 100mmHg	31.0cm/min	0.260
Moisture	N/A	N/A	0.10			
Ash	N/A	N/A				

CLOSED BOMB				PROPELLANT DIMENSIONS (INCHES)				
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	DESCRIPTION	DI	FINISHED	DATE	
N/A	-40	113.53	105.86	LENGTH (L)	N/A	15.0		
	+90	123.05	107.30	DIAMETER (D)	N/A	.387		
	+145	124.88	106.28	REF. DIA. (R)	N/A	.025		
STANDARD	PE-472-138	+90	123.05	Weight				
REMARKS	These are the closed bomb results for carpet rolls cut to strips of dimensions 7.3"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.			Inner	N/A	.081	.078	PACKED 3/86
				Outer	N/A	.082	.077	SAMPLED 3/86
				Ave	N/A	.082	.077	TEST FINISHED 3/86
				Wt of Propellant / Wt of Wax @ 100 mmHg	N/A	2.22	-1.51	GRAINAGE
				LD	N/A	37.97	38.76	DIRECTION DATA FORWARDED
				Std	N/A	15.80	14.88	

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candellilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by: 2R20 7 part stick HCL 86C006-004 ✓ *[Signature]*
 Development Engineer
 D.W. Kirkpatrick
[Signature]

PROPELLANT 2R-20 7: Perf Stick
 WEIGHT 45 Pounds

CONTRACT NUMBER Honeywell Subcontract 932077
 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.

NITROCELLULOSE

RECEIVED AND NUMBER	NITROGEN CONTENT	IN GRADE (98.5%)	STABILITY (90.5°C)
95058; 95059; 95060	MAX 13.15 %		
	MIN 13.08 %		
	AVG 13.11 %	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE	MOISTURE	PROCESS-DRYING	DATE	LOGS
Ambient	Ambient	Load Forced Air Dry		
Ambient	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambient	Cool down for sampling		

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT NOMINAL	PERCENT TOLERANCE	PERCENT ACTUAL		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	42.68	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	13.48	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	22.08	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.77	HOF (cal/gm)	N/A	1161
Magnesium Oxide	N/A	N/A	0.03	Abs. Dens. (g/cc)	N/A	1.62
Graphite	N/A	N/A	0.04	Talanti:		
RDX (class I)	20	N/A	20.92	Slope @ 100mmHg	31.0mm/min	0.260
Moisture	N/A	N/A	0.10			
Ash	N/A	N/A				

CLOSED BOMB					PROPELLANT DIMENSIONS (INCHES)			
LOT NUMBER	TEMP °F	INITIAL WEIGHT (G)	FINAL WEIGHT (G)	REMARKS	SPECIFICATION	ON	RIMMED	DATE
	-40	113.53	105.86		LENGTH (L)	N/A	15.0	15.0
	+90	123.05	107.30		DIAMETER (Ø)	N/A	.471	.462
	+145	124.88	106.28		PERI DIA (Ø)	N/A	.025	.025
STANDARD	PE-472-138	+90	100.00%	100.00%	Web			
REMARKS These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085". 700 cc bomb with a 0.1 gm/cc loading density.	Inner	N/A	.104	.101				PACKED 3/86
	Outer	N/A	.096	.093				SAMPLED 3/86
	Ave	N/A	.100	.097				TEST FINISHED 3/86
	Web Thickness / 100 sq. in. of Web Area	N/A	-8.33	-8.23				GRAINED
	Wd	N/A	31.85	32.47				DIRECTION BERTS FORWARDED

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts. Propellant composition results are from analysis of carpet rolls.

Signed by *[Signature]* Development Engineer
 D.W. Kirkpatrick
[Signature] D. W. Kirkpatrick

REVISIONS	2R-20 19 Perf Stick (JAX)	DA FORM NUMBER	NCLB6H008-001
DESCRIPTION	N/A	PACKING WEIGHT	700 Pounds
MANUFACTURER	BADFORD ARMY AMMUNITION PLANT, BADFORD, VA.	CONTRACT NUMBER	Honeywell Subcontract 932077
NITROCELLULOSE			
ACCEPTED LOTS NUMBERS	895089; 95091; 95092	NITROGEN CONTENT	BY GRADE (AS IS %)
		MAX 13.13 %	
		MIN 13.07 %	
		AVE 13.10 %	45+ 30+
MANUFACTURE OF SOLVENTLESS PROPELLANT			

HONEYWELL		PROCESS-DRYING		DATE	USER
Ambient	Ambient	Load Forced Air Dry			
Ambient	110°F	Increase temperature to 110 ± 5°F			
110°F	110°F	Hold at temperature			4
110°F	Ambient	Cool down for sampling			

PROPELLANT COMPOSITION			TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TEST METHOD	FORMULA	ACTUAL	
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+	
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr	
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT			
Alardit II	N/A	N/A	0.71	HOF (cal/cm)	N/A	1163	
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61	
Graphite	N/A	N/A	0.05	Italiani:			
RDX	N/A	N/A	17.78	Slope @ 100mmHg	Si. Qm/min	.349	
Ash	N/A	N/A	0.09				
Moisture	0.5	±0.3	0.2				
Methylene Cl Solubility	N/A	N/A	31.40				

CLOSED BOMB					PROPELLANT DIMENSIONS (INCHES)				
TEST	LOT NUMBER	TEMP °F	RELATIVE CRACKNESS	RELATIVE FORCE	DESCRIPTION	DR	FINISHED	DATE	
		-40	90.97	101.69	LENGTH (L)	N/A	8.0	8/86	
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	8/86	
		+145	96.81	104.25	PERF DIA (P)	N/A	.023	8/86	
STANDARD	S-231	90	100.00%	100.00%	Web Ave	N/A	.099	8/86	
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.					Inner	N/A	.115	8/86	
					Middle	N/A	.106	8/86	
					Outer	N/A	.075	8/86	
					Web Ave	N/A	9.57	8/86	
					LD	N/A	11.43	11.71	8/86
					DR	N/A	30.43	28.21	8/86

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWK J.V. [Signature] 20 AUG 86

N/A		WEIGHT 72 Pounds	
RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.		HONEYWELL Subcontract 932077	
NIROCELLULOSE			
B95089; 95091; 95092		NITROGEN CONTENT MAX 13.13 % MIN 13.07 % AVE 13.10 %	STABILITY (MS 8°C) 45+ 30+ STABILITY (MS 8°C)
MANUFACTURE OF SOLVENTLESS PROPELLANT			

TEMPERATURE		PROCESS-DRYING	TIME	MOISTURE
Ambien	Ambien	Load Forced Air Dr.		
Ambien	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		4
110°F	Ambien	Cool down for sampling		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT ANALYSED	TEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardir II	N/A	N/A	0.71	HOF (cal/cm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Taliani:		
RDY	N/A	N/A	17.78	Slope @ 100mmHg	51.0cc/min	.349
Ash	N/A	N/A	0.09			
Moisture	0.5	±0.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)				
LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE FORCE		SPERATION	DI	THICK		
827	-40	90.97	101.69	LENGTH (L)	N/A	2.68	2.70		
	+90	92.47	103.43	DIAMETER (D)	N/A	.700	.683		
	+145	96.81	104.25	PER DIA (P)	N/A	.023	.024		
STANDARD	S-231	90	100.00	Web Ave	N/A	.099	.094	DATE	
REMARKS	The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.				Inner	N/A	.115	.093	PACKED 8/86
					Middle	N/A	.106	.081	SAMPLED 8/86
					Outer	N/A	.075	.107	TEST FINISHED 8/86
					Web Ave	N/A		9.57	OPENED
					LD	N/A	3.83	3.95	SELECTION DATA FORWARDED
				DI	N/A	30.43	28.21		

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWZ

PROPELLANT N/A WEIGHT AMOUNT 78 Pounds
 CONTACT NUMBER Honeywell Subcontract 932077
 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.
 NITROCELLULOSE

RECEIVED BOMB NUMBER 895089; 95091; 95092	NITROGEN CONTENT	IN RANGE	STABILITY (30±°C)
	max 13.13 %		
	min 13.07 %		
	ave 13.10 %	45±	30±
			EXPLOSION

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE		PROCESS-DRYING	TIME
FROM	TO		DAYS
Ambien	Ambien	Lead Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	6
110°F	Ambien	Cool down for sampling	

PROPELLANT COMPOSITION			TESTS OF FINISHED PROPELLANT		STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT ANALYSIS	PERCENT ANALYSIS		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardic II	N/A	N/A	0.71	HOE (cal/cm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Talioni:		
RDY	N/A	N/A	17.78	Slope @ 100mmHg	21.0m/gm	349
Ash	N/A	N/A	0.09			
Moisture	0.5	30.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.60			

STABILITY DATA				PROPELLANT DIMENSIONS (RECOR)				
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT		SPERIFICATION	IN	FINISHED	
REF	-40	90.97	101.69	LENGTH IN	N/A	1.6	1.6	
	-90	92.47	103.43	DIA AT THE	N/A	.700	.683	
	+145	96.81	104.25	PER DIA. IN	N/A	.023	.024	
STANDARD	5-231	90	100.00%	100.00%	Web Ave	N/A	.099	.094
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb, 0.1 gm/cc loading density.					Inner	N/A	.115	.093
					Middle	N/A	.106	.081
					Outer	N/A	.075	.107
					Web Thickness	N/A		9.57
					Web	N/A	2.29	2.34
					End	N/A	30.43	28.21

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWR
JCH

2R-20 19 Perf Strick (TAX) NCL86N008-004
 N/A 324 Pounds
BADFORD ARMY AMMUNITION PLANT, BADFORD, VA. Nonexpend Subcontract 932077

ACCEPTED LOTS NUMBERS	INITIALS	STRENGTH	STABILITY (240°C)
895089; 95091; 95092		NAB 13.13 DB 13.07 AVE 13.10	45+ 30+ EXPLOSION

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE	MOISTURE	PROCESS-DRYING	TEST
Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambien	Cool down for sampling	

PROPELLANT COMPOSITION			TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLUENE	PERCENT AIR-DRY	TEST	FORMULA	ACTUAL	
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+	
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr	
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT			
Akardit II	N/A	N/A	0.73	HOE (cal/cm)	N/A	1163	
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61	
Graphite	N/A	N/A	0.05	Taliani:			
RDX	N/A	N/A	17.78	Slope @ 100mmHg	1.0 cm/min	.349	
Ash	N/A	N/A	0.09				
Moisture	0.5	±0.3	0.2				
Methylene Cl Solubility	N/A	N/A	31.40				

CLOSED BOMB				PROPELLANT DIMENSIONS (Inches)			
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	DESCRIPTION	DI	DI	DI
827	-40	90.97	101.69	LENGTH	N/A	8.0	8.0
	+90	92.47	103.43	DIAMETER	N/A	.700	.684
	+145	96.81	104.25	PER DIA	N/A	.054	.048
STANDARD	S-231	90	100.00%	Web Ave	N/A	.073	.074
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.				Inner	N/A	.074	.058
				Middle	N/A	.073	.069
				Outer	N/A	.072	.094
				Web Ave	N/A		.777
				DI	N/A	11.43	11.70
				DI	N/A	12.96	14.25

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWK
 XXX

PROPELLANT: N/A
 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.
 WEIGHT: 44 Pounds
 CONTRACT NUMBER: Housong 11 Subcontract 932077

INTERCELLULOSE

ACCEPTED BOMB NUMBERS	INITIATION CONTENT	IS BRANCH (MA 8°)	INITIATION (MA 8°)
895089; 95091; 95092	BAR 13.13		
	BB 13.07		
	AVE 13.10	45+	70+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

TEMPERATURE	TIME	PROCESS	REMARKS
Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	6
110°F	Ambien	Cool down for sampling	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT POLYMER	PERCENT RESIDUE	TEST METHOD	FORMULA	RESULT
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.71	HOF (cal/cm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Taliani:		
30X	N/A	N/A	17.78	Slope @ 100mmHg	21.0mm/min	.349
ash	N/A	N/A	0.09			
Moisture	0.5	±0.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB TESTS

LOT NUMBER	TEMP °F	RELATIVE HUMIDITY	RELATIVE FORCE	DESCRIPTION	WE	WEHED	DATE
827	-40	90.97	101.69	LENGTH DI	N/A	2.68	
	+90	92.47	103.43	DIA AT 100	N/A	.684	
	+145	96.81	104.25	PER DIA 100	N/A	.048	
STANDARD	90	100.00%	100.00%	Web Ave	N/A	.073	
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.				Inner	N/A	.074	PACKED 8/86
				Middle	N/A	.073	SAMPLED 8/86
				Outer	N/A	.072	TEST RESULTS 8/86
				Web Ave	N/A		COPIED
			LD	N/A	3.83	3.92	DILUTION DATA FORWARDED
			WD	N/A	12.96	14.25	

TYPE OF PACKING CONTAINER: Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DW 9
LJ

PROPELLANT	N/A	PACKED AMOUNT	750 Pounds
MANUFACTURED AT	BADFORD ARMY AMMUNITION PLANT, BADFORD, VA.	CONTRACT NUMBER	Honeywell Subcontract 932077
ACCEPTED CASE NUMBERS	95089; 95091; 95092	WETTED CONTENT	NO STARCH NO SUGAR
		MAX 13.13 %	NO
		MIN 13.07 %	NO
		Avg 13.10 %	45+ NO
			10+ NO
			EXPLOSION NO

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			TEST	TEST
Ambient	Ambient	Load Forced Air Dry		
Ambient	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		
110°F	Ambient	Cool down for sampling		

PROPELLANT COMPOSITION	TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT ANALYSED	TEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardit II	N/A	N/A	0.71	HOE (cal/gm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Talenti:		
RDX	N/A	N/A	17.78	Slope @ 100mmHg	1.00/min	.349
Ash	N/A	N/A	0.09			
Moisture	0.5	±0.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

See

CLOSED BOMB					PROPELLANT DIMENSIONS (in: 100g)								
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	RESIDUE	DESCRIPTION	DIAM	LENGTH	DATE					
REF	-40	90.97	101.69										
	+90	92.47	103.43		LENGTH	N/A	15.0	15.0					
	+145	96.81	106.25		DIAMETER @1	N/A	.395	.39					
					PER DIA @1	N/A	.024	.027					
STANDARD	S-231	90	100.00%	100.00%	Web Avg	N/A	.081	.078					
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.					Inner	N/A	.0805	.076	PACKED 8/86				
					Outer	N/A	.0815	.080				SAMPLED 8/86	
													TEST NUMBER 8/86
													WEIGHT
													DIAMETER - DIETS FORWARDED

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWZ
LS

DESCRIPTION 2R-20 7 Perf Granular	NET WEIGHT 209 Pounds
CLASSIFICATION N/A	CONTACT NUMBER Honeywell Subcontract 932077
MANUFACTURED BY RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	
NITROCELLULOSE	
LOT NUMBER 895089; 95091; 95092	WATER CONTENT BY GRAVIMETRY (100°C) MAX 13.13 % MIN 13.07 % AVE 13.10 %
	STABILITY (24 HRS) 30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING			DATE
Temp	Atmos	Notes	
Ambien	Ambien	Load Forced Air Dry	
Ambien	110°F	Increase temperature to 110 ± 5°F	
110°F	110°F	Hold at temperature	4
110°F	Ambien	Cool down for sampling	

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT GRANULA	PERCENT RESIDUE	PERCENT RESIDUE	TEST	FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAVY MET @ 120°C	CC 40'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	ROCK OF PROPELLANT		
Akardit II	N/A	N/A	0.71	HOF (cal/cm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Taliansi:		
RDY	N/A	N/A	17.78	Slope @ 100mmHg	Si. 0.05/mic	.349
Ash	N/A	N/A	0.09			
Moisture	0.5	30.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

FINISHED BOMB					PROPELLANT DIMENSIONS (inches)				DATE
LOT NUMBER	TEMP °F	INITIAL WEIGHT	FINAL WEIGHT	RESIDUE	LENGTH (L)	DIAMETER (D)	WEIGHT	STANDARD	
WF	-40	90.97	101.69		N/A	N/A	.539	.547	
	+90	92.47	103.43		N/A	N/A	.355	.354	
	+145	96.81	104.25		N/A	N/A	.023	.022	
STANDARD	S-231	90	100.00	100.00	Web Avg	N/A	.072	.072	8/86
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.					Inner	N/A	.0715	.068	SAMPLED 8/86
					Outer	N/A	.0725	.077	TEST FINISHED 8/86
					Web Avg	N/A		13.10	GRAINED 8/86
					LD	N/A	1.52	1.54	STRENGTH TESTS FORWARDED
				OD	N/A	15.43	16.34		

TYPE OF PACKING CONTAINER: Fiber Drum; 652 D

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWK
JFK

2R-20 7 Perf Stick (7AX)

NCL 848008-008

DESCRIPTION N/A	WEIGHT 300 Pounds
MANUFACTURED BY RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	ORDER NUMBER Honeywell Subcontract 932077

ACCEPTED LOT NUMBERS 895089; 95091; 95092		NITROGEN CONTENT	IN RANGE (MAX)	STABILITY (30-45°C)
		MAX 13.13 %		
		MIN 13.07 %		
		AVG 13.10 %	45+	30+

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE		PROCESS-DRYING	TIME	REMARKS
Ambien	Ambien	Load Forced Air Dry		
Ambien	110°F	Increase temperature to 110 ± 5°F		
110°F	110°F	Hold at temperature		
110°F	Ambien	Cool down for sampling		

PROPELLANT COMPOSITION			TESTS OF FINISHED PROPELLANT		STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT REPROD		FORMULA	ACTUAL
Nitrocellulose	N/A	N/A	50.64	HEAT TEST @ 120°C	CC 60'	CC 60'+
Nitroglycerin	N/A	N/A	11.45	No Fumes	NF 1 hr	NF 1 hr
DEGDN	N/A	N/A	19.24	FORM OF PROPELLANT		
Akardic II	N/A	N/A	0.71	HOF (cal/gm)	N/A	1163
Magnesium Oxide	N/A	N/A	0.05	Abs. Dens. (g/cc)	N/A	1.61
Graphite	N/A	N/A	0.05	Taliani:		
ADX	N/A	N/A	17.78	Slope @ 100mmHg	El. 0.02/min	.349
Ash	N/A	N/A	0.09			
Moisture	0.5	±0.3	0.2			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB				PROPELLANT DIMENSIONS (INCH)			
LOT NUMBER	TEMP °F	INITIAL WEIGHT	INITIAL FORCE	LENGTH (L)	DIAMETER (D)	WEIGHT (W)	REMARKS
827	-40	90.97	101.69				
	+90	92.47	103.43				
	+145	96.81	104.25				
STANDARD	S-231	90	100.00				
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700 cc bomb, 0.1 gm/cc loading density.				LENGTH (L)	N/A	15.0	15.0
				DIAMETER (D)	N/A	.355	.354
				WEIGHT (W)	N/A	.023	.022
				Web Avg	N/A	.072	.072
				Inner	N/A	.0715	.068
				Outer	N/A	.0725	.077
				Weight of Propellant	N/A	13.10	
				Weight of Wax	N/A	42.25	42.37
				Weight of Wax	N/A	15.43	16.34

TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

DWSK
ETC

PROPELLANT DESCRIPTION SHEET

EXEMPT CODED, SYMBOL
EXEMPT-PARA 7-2a
AS 222-11

COMPOSITION 2R-16 19 Perf Stick	DA LOT NUMBER HCL87A010-002
SPECIFICATION Honeywell Multica GER 087-002R	PACKED AMOUNT 105 Pounds
MFG AT RAFORD ARMY AMMUNITION PLANT, RAFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BRAND NAMES: NITROCELLULOSE		
95078: 95079: 95080: 95081: 95082	NITROGEN CONTENT	STABILITY (30-45 °C)
	MAX _____ %	_____ MMSL
	MIN _____ %	_____ MMSL
	AVG 13.11 %	30+ MMSL
		EXPLOSION _____ MMSL

MANUFACTURE OF SOLVENTLESS PROPELLANT		DRUMS	TRUCKS
From	To		
-	-	20	-
210	215	-	130
145	155	-	-
150	160	-	-
145	155	-	-
110	110	240	-

PROPELLANT COMPOSITION			TESTS OF FINISHED PROPELLANT		STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PIC-11 TOLERANCE	PERCENT ANALYSIS	TESTS	FORMULA	ACTUAL
HYDROCELLULOSE	N/A	N/A	47.65	HEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	13.10	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	22.21			
BARBIT XX	N/A	N/A	0.75			
MAGNESIUM OXIDE	N/A	N/A	0.08			
GRAPHITE	N/A	N/A	0.06	MOE cal/cm	N/A	1162
MOI (0.09 %)	N/A	N/A	16.15			
TOTAL			100.00	APP DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20	Form of Prop.	Cyl	Cyl
				No. of Perfs	19	19

CLOSED BOMB					PROPELLANT DIMENSIONS (INCHES)				
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE PERCENT	PARAMETER	SPECIFICATION	ONE	FINISHED	NO. DIV. ± % of Mean Dimension
		-40	95.32	103.83	LENGTH (L)	N/A	8.0	8.0	N/A
		+90	107.20	104.83	DIAMETER (D)	N/A	.700	.690	N/A
		+145	107.67	104.03	PERF. DIA. (d)	N/A	.023	.021	
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097	
REMARKS The closed bomb was shot using carpet roll cut into 7.5"x.125"x.09" strips.					Outer	N/A	.075	.104	PACKED 1/87
					Middle	N/A	.108	.086	SAMPLED 1/87
					Inner	N/A	.115	.103	TEST FINISHED 1/87
					Web Diff.	N/A	N/A	7.95	CONVLS
					L:D	N/A	11.43	11.59	DESCRIPTION SHEETS FORWARDED
				D:d	N/A	30.43	28.21		

TYPE OF PACKING CONTAINER: Carton 327310; Barrier Bag 327041; Wood Box 327311

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer: *D. W. Substant*

DATE: *20 FEB 83*

PROPELLANT DESCRIPTION SHEET

REPORT COVERED BY
EXEMPT-PARA 7-2a
AS 221-11

COMPOSITION 2R-20 19 Perf Stick	BA LOT NUMBER HCL87A010-004
SPECIFICATION Honeywell Mulica GFR 087-002R	PACKED AMOUNT 672 Pounds
MFG AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BRAND NUMBERS		
NITROCELLULOSE		
B95089; 95091; 95092	NITROGEN CONTENT	EI STARCH (ALL °C)
	MAX <u>13.13</u> %	_____
	MIN <u>13.07</u> %	_____
	AVG <u>13.10</u> %	45+
		STABILITY (30.5 °C)

		EXPLOSION _____

MANUFACTURE OF SOLVENTLESS PROPELLANT			(min)	(sec)
TEST	TD	Description	MINUTE	SECOND
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rolling	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

TESTS OF FINISHED PROPELLANT				STABILITY AND PHYSICAL TESTS		
PROPELLANT COMPOSITION	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	52.54	N/A	50.64	HEAT	cc 40'	cc 60'+
NITROGLYCERIN	11.43	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	19.24	N/A	19.24			
PERMANGANATE	0.71	N/A	0.71	*TALIANI	21.8 Hz/mm	.349
MAGNESIUM OXIDE	0.05	N/A	0.05		Blow at 1000mm	
GRAPHITE	0.05	N/A	0.05	MBE cal/gm	N/A	1163
RDX	17.78	N/A	17.78			
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09	Form of Prop.	Cyl	Cyl
Methylene Cl Solubility	N/A	N/A	31.40	No. of Perfs	19	19

CLOSED BOMB				PROPELLANT DIMENSIONS (inches)						
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DIE	FINISHED	SPEC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	8.0	8.0	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.690	N/A	N/A
		+145	96.81	104.25	PERF. DIA. (W)	N/A	.023	.021		
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.087		
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.075	.104	DATE	57-7
					Middle	N/A	.108	.086	PACKED	1/87
					Inner	N/A	.115	.103	SAMPLED	1/87
					Web Diff	N/A	N/A	7.95	TEST FINISHED	1/87
					L:D	N/A	11.43	11.59	OFFERED	
				D:d	N/A	30.43	28.2	DESCRIPTION SHEETS FORWARDED		

TYPE OF PACKING CONTAINER **Carton 327310; Barrier Bag 327041; Wood Box 327311**

REMARKS
Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer: *D. W. Substant*
 SIGNATURE OF Program Manager: *[Signature]* 9 Feb 87

PROPELLANT DESCRIPTION SHEET

REPORT CONTROL SYMBOL
EXEMPT-PARA 7-2a
OF 221-11

COMPOSITION 2R-20 19 Perf Stick	DA LOT NUMBER HCL87A010-005
SPECIFICATION Honeywell Multica GFB 087-002R	PACKED AMOUNT 672 Pounds
MFG AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BLIND NUMBERS			NITROCELLULOSE		
B95089; 95091; 95092			NITROGEN CONTENT	W STARCH (ALS °C)	STABILITY (24-5 °C)
			MAX <u>13.13</u> %	MIN	MIN
			MIN <u>13.07</u> %	MAX	MIN
			AVG <u>13.10</u> %	45+	30+ MIN
					EXPLOSION

TEMPERATURE		MANUFACTURE OF SOLVENTLESS PROPELLANT	TIME	
From	To		MIN	SECONDS
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rolling	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL	
NITROCELLULOSE	N/A	N/A	50.64	HEAT	CC 40'	CC 60'+	
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr	
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24				
BARBIT II	N/A	N/A	0.71	"ITALIAN"	21.0 g/gm	.349	
MAGNESIUM OXIDE	N/A	N/A	0.05		glass 210000		
GRAPHITE	N/A	N/A	0.05	BUE cal/gm	N/A	1163	
RDX	N/A	N/A	17.78				
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61	
Moisture	N/A	N/A	0.20				
Ash	N/A	N/A	0.09	Form of Prop.	Cyl	Cyl	
Methylene Cl Solubility	N/A	N/A	31.40	No. of Perfs	19	19	

CLOSED BOMB				PROPELLANT DIMENSIONS (inches)						
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DE	FINISHED	SUB DIV. % of Mean Dimension	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	8.0	8.0	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.686	N/A	1.93
		+145	96.81	104.25	PERF. DIA. (d)	N/A	.023	.021		
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097	DATES 1/77-3 PACKED 1/87 SAMPLED 1/87 TEST FINISHED 1/87 OFFERED DESCRIPTION SHEETS FORWARDED	
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.074	.090		
					Middle	N/A	.107	.100		
					Inner	N/A	.116	.102		
					Web Diff	N/A	N/A	5.34		
					L:D	N/A	11.43	11.66		
					D:d	N/A	30.43	32.15		

TYPE OF PACKING CONTAINER **Carton 327049 ; Barrier Bag 327202 ; Wood Box 327068**

REMARKS
Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer <i>D. W. K. [Signature]</i>	Program Manager <i>[Signature]</i> 9 FEB 87
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PROPELLANT DESCRIPTION SHEET

COMPOSITION 2R-20 7 Perf Stick	DA LOT NUMBER HCL87A010-006
SPECIFICATION Honeywell Multrica GFB 087-029	PACKED AMOUNT 175 Pounds
400 AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BLIND NUMBERS NITROCELLULOSE

B95089; 95091; 95092	NITROGEN CONTENT	KI STARCH (AT 5°C)	STABILITY (30±5°C)
	MAX _____ %	_____ MBSL	_____ MBSL
	MIN _____ %	_____ MBSL	_____ MBSL
	AVG <u>13.10</u> %	<u>45+</u> MBSL	<u>30+</u> MBSL
			EXPLOSION _____ MBS

TEMPERATURE			MANUFACTURE OF SOLVENTLESS PROPELLANT		TIME	
FROM	TO		MINUTES	SECONDS		
-	-	Blending	20	-		
210	215	Differential Rolling	-	140		
145	155	Evenspeed Rolling	-	-		
150	160	Extrusion - Carpet Roll	-	-		
145	155	Extrusion - Die	-	-		
110	110	Annealing	240	-		

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL	
NITROCELLULOSE	N/A	N/A	50.64	HEAT	cc 40'	cc 60'+	
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr	
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl	
BARBIT II	N/A	N/A	0.71	*TALIANI	21.0 Hg/mm	.349	
MAGNESIUM OXIDE	N/A	N/A	0.05		Slope at 100mm		
GRAPHITE	N/A	N/A	0.05	BBE cal/gm	N/A	1163	
RDX	N/A	N/A	17.78				
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61	
Moisture	N/A	N/A	0.20				
Ash	N/A	N/A	0.09				
Methylene Cl Solubility	N/A	N/A	31.40				

CLOSED BOMB					PROPELLANT DIMENSIONS (inches)					
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DI	FINISHED	SPEC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	3.0	3.0	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.395	.386	N/A	1.57
		+145	96.81	104.25	PERF. DIA. (d)	N/A	.025	.026		
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.080	.077	DATES PACKED 1/87 SAMPLED 1/87 TEST FINISHED 1/87 OFFERED DESCRIPTION SHEETS FORWARDED	
					Outer	N/A	.081	.081		
					Inner	N/A	.080	.073		
					Web Diff	N/A	N/A	10.44		
					L:d	N/A	20.25	20.72		
					D:d	N/A	15.80	14.70		

TYPE OF PACKING CONTAINER Carton 327049 ; Barrier Bag 327202 ; Wood Box 327088

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer <i>D. W. Gumpert</i>	<i>W. R. Thomas</i>
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PROPELLANT DESCRIPTION SHEET

FORM 1000-10
AT 221-10

COMPOSITION 2R-20 19 Perf Stick	DA MDI NUMBER HCL87C010-007
SPECIFICATION Honeywell Multica GER 087-029	PACKED AMOUNT 53 Pounds
MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BOMB NUMBERS			NITROCELLULOSE		
B95089; 95091; 95092			NITROGEN CONTENT	STARCH (M.L.%)	STABILITY (240°C)
			MAX _____ %	MIN _____ %	MIN _____ %
			MIN _____ %	MAX _____ %	MAX _____ %
			AVG 13.10 %	45+	30+
					EXPLOSION _____ %

TEMPERATURE			MANUFACTURE OF SOLVENTLESS PROPELLANT		
FIR	IN				
-	-		Blending		20
210	215		Differential Rolling		140
145	155		Evenspeed Rollline		
150	160		Extrusion - Carpet Roll		
145	155		Extrusion - Die		
110	110		Annealing		240

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL	
NITROCELLULOSE	N/A	N/A	50.64	WEAT	cc 40'	cc 60'+	
NITROGLYCERIN	N/A	N/A	11.45	BO FUMES	NF 1 Hr	NF 1 Hr	
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl	
BARBIT II	N/A	N/A	0.71	*TALIANI	SI.0 Gt/MB	.349	
MAGNESIUM OXIDE	N/A	N/A	0.05		Slope 0100000		
GRAPHITE	N/A	N/A	0.05	BOE cal/gm	N/A	1163	
RDX	N/A	N/A	17.78				
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61	
Moisture	N/A	N/A	0.20				
Ash	N/A	N/A	0.09				
Methylene Cl Solubility	N/A	N/A	31.60				

CLOSED BOMB					PROPELLANT DIMENSIONS (Inches)					
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE FORCE	PARAMETER	SPECIFICATION	DIE	FINISHED	S&W Dev. or R. of Meas. Dimensions	
									SPEC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	4.75	4.78	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.690	N/A	N/A
		+145	96.81	104.25	PERF. DIA. (M)	N/A	.023	.021		
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097	DATES	
REMARKS: The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.075	.104	PACKED 1/87	
					Middle	N/A	.108	.086	SAMPLED 1/87	
					Inner	N/A	.115	.103	TEST FINISHED 1/87	
					Web Diff.	N/A	N/A	7.95	OFFERED	
					L:D	N/A		6.93	DESCRIPTION SHEETS FORWARDED	
				D:d	N/A		30.43	28.21		

TYPE OF PACKING CONTAINER: Carton 327310; Barrier Bag 327041; Wood Box 327311

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer



PROPELLANT DESCRIPTION SHEET

AL 211-11

COMPOSITION 2R-20 14 Perf Stick	DA LOT NUMBER HCL87C010-008
SPECIFICATION Honeywell Mulica GER DR7-029	PACKED AMOUNT 67 Pounds
MPD AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED NAME NUMBER			NITROCELLULOSE		
895089; 95091; 95092			NITROGEN CONTENT	GI STARCH	STABILITY (24.5°C)
			MAX _____ %	_____ MG/L	_____ MG/L
			MIN _____ %	_____ MG/L	_____ MG/L
			AVG <u>13.10</u> %	<u>43+</u> MG/L	<u>30+</u> MG/L
					EXPLOSION _____ MG/L

MANUFACTURE OF SOLVENTLESS PROPELLANT			TIME	TEMP
		Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rollline	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-



PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TEST	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	WEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
BARBIT II	N/A	N/A	0.71	*ITALIANI	El.8 Gg/MB	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		Slips 2100MB	
GRAPHITE	N/A	N/A	0.05	BOE cal/cm	N/A	1163
RDX	N/A	N/A	17.78			
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (INCHES)					
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE ERROR	PARAMETER	SPECIFICATION	DE	FINISHED	SPC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	2.70	2.71	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.690	N/A	N/A
		+145	96.81	106.25	PERF. DIA (M)	N/A	.023	.021		
STANDARD	5-731	+90	100.00	100.00%	Web Ave.	N/A	.099	.097		
					Outer	N/A	.075	.104		PACKED 1/87
					Middle	N/A	.108	.086		SAMPLED 1/87
					Inner	N/A	.115	.103		TEST FINISHED 1/87
					Web Diff	N/A	N/A	7.95		OFFERED
					L:D	N/A	3.86	3.93		DESCRIPTION SHEETS FORWARDED
					D:d	N/A	30.43	28.21		

TYPE OF PACKING CONTAINER: Carton 327310; Barrier Bag 327041; Wood Box 327311

REMARKS: The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.

REMARKS: Candellilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer



COMPOSITION 2R-20 19 Perf Stick	DA (DI) NUMBER HCL87C010-009
SPECIFICATION Honeywell Mullica GER 087-029	PACKED AMOUNT 54 Pounds
NO 41 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BRAND NAMES NITROCELLULOSE		
B95089; 95091; 95092	NITROGEN CONTENT MAX 13.13 % MIN 13.07 % AVG 13.10 %	DI STARCH 64.3 J°C MINL MINL MINL 45+
		STABILITY (24.5°C) MINL MINL MINL 30+ MINL EXPLOSION MINL

TEMPERATURE		MANUFACTURE OF SOLVENTLESS PROPELLANT	TIME	
HR	YR		MINUTE	SECOND
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rollline	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	WEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
BARBIT II	N/A	N/A	0.71	TALIANI	21.8 g/cm	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		Stops 2100mm	
GRAPHITE	N/A	N/A	0.05	BOE cal/cm	N/A	1163
RDX	N/A	N/A	17.78			
	TOTAL		100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (inches)					
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE (CC/G)	PARAMETER	SPECIFICATION	DE	FINISHED	SPC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	2.10	2.13	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.690	N/A	N/A
		+145	96.81	104.25	PERF. DIA. (M)	N/A	.023	.021		
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097	DATES	
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.075	.104	PACKED 1/87	
					Middle	N/A	.108	.086	SAMPLED 1/87	
					Inner	N/A	.115	.103	TEST FINISHED 1/87	
					Web Diff	N/A	N/A	7.95	OFFERED	
					L:D	N/A	3.00	3.09	DESCRIPTION SHEETS FORWARDED	
D:d	N/A	30.43	28.21							

TYPE OF PACKING CONTAINER Carton 327310; Barrier Bag 327041; Wood Box 327311

REMARKS Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
P W Schubert *W R Thomas*

PROPELLANT DESCRIPTION SHEET

COMPOSITION 2R-2U 19 Perf Stick	DA (DI) NUMBER HCL87C010-010
PREPARATION Honeywell Mullica GFR 007-029	PACKED AMOUNT 34 Pounds
MFG AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED STANDARDS		NITROCELLULOSE																				
B95089; 95091; 95092		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2">NITROGEN CONTENT</th> <th>DI STARCH (66.5°C)</th> <th>STABILITY (24.5°C)</th> </tr> <tr> <td>MAX</td> <td>8</td> <td>MDLL</td> <td>MINIS</td> </tr> <tr> <td>MIN</td> <td>8</td> <td>MDLL</td> <td>MDML</td> </tr> <tr> <td>AVG</td> <td>13.10</td> <td>45+</td> <td>MDLL</td> </tr> <tr> <td colspan="3"></td> <td>EXPLOSION</td> </tr> </table>	NITROGEN CONTENT		DI STARCH (66.5°C)	STABILITY (24.5°C)	MAX	8	MDLL	MINIS	MIN	8	MDLL	MDML	AVG	13.10	45+	MDLL				EXPLOSION
NITROGEN CONTENT		DI STARCH (66.5°C)	STABILITY (24.5°C)																			
MAX	8	MDLL	MINIS																			
MIN	8	MDLL	MDML																			
AVG	13.10	45+	MDLL																			
			EXPLOSION																			

MANUFACTURE OF SOLVENTLESS PROPELLANT			MINUTE	SECOND
TEMPERATURE (°F)	TIME (Yr)	Process		
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rollline	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	HEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
BARBIT XI	N/A	N/A	0.71	*ITALIANI	21.0 Bg/mg	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		Slope at 18000	
GRAPHITE	N/A	N/A	0.05	BOE cal/gr	N/A	1163
RDX	N/A	N/A	17.78			
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB				PROPELLANT DIMENSIONS (INCHES)						
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DN	FINISHED	SPC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	1.60	1.61	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.690	N/A	N/A
		+145	96.81	104.25	PREF. DIA. (M)	N/A	.023	.021	DATES	
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097		
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.075	.104	PACKED 1/87	
					Middle	N/A	.108	.086	SAMPLED 1/87	
					Inner	N/A	.115	.103	TEST FINISHED 1/87	
					Web Diff	N/A	N/A	7.95	OFFERED	
					L:d	N/A	2.29	2.33	DESCRIPTION SHEETS FORWARDED	

TYPE OF PACKING CONTAINER: Carton 327310; Barrier Bag 327041; Wood Box 327311

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
D W Schubert
W J R... ..

PROPELLANT DESCRIPTION SHEET

COMPOSITION 2R-20 19 Perf Stick	DA (D) NUMBER HCL87C010-011
SPECIFICATION Honeywell Multica GFR 087-029	PACKED AMOUNT 62 Pounds
MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED LOAD NUMBERS NITROCELLULOSE			
B95089; 95091; 95092	NITROGEN CONTENT	B) STARCH (M.S.) %	STABILITY (24.8°C)
	MAX _____ %	_____ %	_____ %
	MIN _____ %	_____ %	_____ %
	AVG 13.10 %	4.5+ %	30+ %
			EXPLOSION _____ %

MANUFACTURE OF SOLVENTLESS PROPELLANT			REVOLUTIONS	MINUTES
STEP	NO	Description	REV	MIN
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rollline	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL	
NITROCELLULOSE	N/A	N/A	50.64	HEAT	cc 40'	cc 60'+	
NITROGLYCERIN	N/A	N/A	11.45	BB FONTS	NF 1 Hr	NF 1 Hr	
DIETHYLENE GLYCOL DIBIBATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl	
BARBIT XX	N/A	N/A	0.71	*TALIANI	21.8 Bg/mm	.349	
MAGNESIUM OXIDE	N/A	N/A	0.05		Slope at 100mm		
GRAPHITE	N/A	N/A	0.05	BBE cal/cm	N/A	1163	
RDX	N/A	N/A	17.78				
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61	
Moisture	N/A	N/A	0.20				
Ash	N/A	N/A	0.09				
Methylene Cl Solubility	N/A	N/A	31.40				

CLOSED BOMB				PROPELLANT DIMENSIONS (Inches)						
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DE	FINISHED	1/8 Div. or R. of these Dimensions	
									SPEC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	4.75	4.78	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.686	N/A	.93
		+145	96.81	104.25	PERF. DIA. (D)	N/A	.023	.021		
STANDARD	5-731	+90	100.00	100.00%	Web Ave.	N/A	.099	.097		
REMARKS The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.074	.090		PACKED 1/87
					Saddle	N/A	.107	.100		SAMPLED 1/87
					Inner	N/A	.116	.102		TEST FINISHED 1/87
					Web Diff	N/A	N/A	5.34		OFFERED
					L:D	N/A	N/A	6.97		DESCRIPTION SHEETS FORWARDED
					D:d	N/A	30.43	37.15		

TYPE OF PACKING CONTAINER: Carton 327049; Barrier Bag 327202; Wood Box 327088

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
D. W. Shultz
W. B. Thomas

PROPELLANT DESCRIPTION SHEET

COMPOSITION 2R-20 19 Perf Stick	DC LOT NUMBER HCTA/C010-012
SPECIFICATION Moneywell Multrix GFR 087-029	PACKED AMOUNT 60 Pounds
MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Moneywell Subcontract 932077

NITROCELLULOSE			
B95089; 95091; 95092	NITROGEN CONTENT	DI STARCH	DIAMITY (24.0°C)
	MAX 13.13 %	_____	_____
	MIN 13.07 %	_____	_____
	AVG 13.10 %	45+	30+
			EXPLOSION _____

TEMPERATURE			MANUFACTURE OF SOLVENTLESS PROPELLANT		RESULTS	REMARKS
Temp	Time	Notes				
-	-	Blending			20	
210	215	Differential Rolling			-	140
145	155	Evenspeed Rolling			-	-
150	160	Extrusion - Carpet Roll			-	-
145	155	Extrusion - Die			-	-
110	110	Annealing			240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	HEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
AKADIT II	N/A	N/A	0.71	*TALARI	21.0 Bg/DB	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		11000 21100DB	
GRAPHITE	N/A	N/A	0.05	88E cal/gr	N/A	1163
RDX	N/A	N/A	17.78			
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (inches)					
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE SCPEL	PARAMETER	SPECIFICATION	DE	FINISHED	SUB DIV. n R of Meas Dimensions	ACTUAL
		-60	90.97	101.69	LENGTH (L)	N/A	2.70	2.71	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.686	N/A	.93
		+145	96.81	104.25	PERF. DIA (d)	N/A	.023	.021	DATE PACKED 1/87 SAMPLED 1/87 TEST FINISHED 1/87 OFFERED DESCRIPTION SHEETS FORWARDED	
STANDARD	G-231	+90	100.00	100.00Z	Web Ave.	N/A	.099	.097		
					Outer	N/A	.074	.090		
					Middle	N/A	.107	.100		
					Inner	N/A	.116	.102		
					Web Diff.	N/A	N/A	5.34		
					L:d	N/A	3.86	3.95		
					D:d	N/A	30.43	32.15		

TYPE OF PACKING CONTAINER: **Carton 327049 ; Barrier Bag 327202 ; Wood Box 327088**

REMARKS: **Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.**

SIGNATURE OF Development Engineer
D W Subator *W. B. Hennes*

PROPELLANT DESCRIPTION SHEET

AL 311 11

COMPOSITION 2R-20 19 Perf Stick	DA LOT NUMBER RCL87CJ10-013
SPECIFICATION Honeywell Multica GFA 087-029	PACED AMOUNT 58 Pounds
MANUFACTURED AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED BRAND NAMES NITROCELLULOSE		
B95089; 95091; 95092	NITROGEN CONTENT MAX _____ % MIN _____ % AVG <u>13.10</u> %	DI STARCH (AS %) MAX _____ % MIN _____ % AVG _____ %
		STABILITY (24.5°C) MAX _____ % MIN _____ % AVG <u>30+</u> %
		EXPLOSION _____ %

TEMPERATURE	TYPE	MANUFACTURE OF SOLVENTLESS PROPELLANT	PERCENT	PERCENT
-	-	Blending	20	-
210	215	Differential Rolling	-	140
145	155	Evenspeed Rolling	-	-
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MANUFACT	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	MEAT	cc 40'	cc 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
BRADIT II	N/A	N/A	0.71	*ITALIAN	51.8 g/m ³	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		51000 210000	
GRAPHITE	N/A	N/A	0.05	80E cal/cm	N/A	1163
RDX	N/A	N/A	17.78			
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (INCHES)				
TEMP	LOT NUMBER	TEMP °F	RO	RELATIVE DENSITY	PARAMETER	SPECIFICATION	MIN	MAX	TEST DIV. or % of Spec. Dimensions
-40		+90	90.97	101.69	LENGTH (L)	N/A	2.10	2.13	N/A
+90		+145	92.47	103.43	DIAMETER (D)	N/A	.700	.686	N/A
			96.81	106.25	PERF. DIA. (M)	N/A	.023	.021	N/A
					Web Ave.	N/A	.099	.097	RATES
					Outer	N/A	.074	.090	PACKED 1/87
					Middle	N/A	.107	.100	SAMPLED 1/87
					Inner	N/A	.116	.102	TEST FINISHED 1/87
					Web Diff	N/A	N/A	5.34	OFFERED
					L:d	N/A	3.00	3.10	DESCRIPTION SHEETS FORWARDED
					D:d	N/A	30.43	32.15	

TYPE OF PACKING CONTAINER: Carton 327049 ; Barrier Bag 327202 ; Wood Box 327088

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
D W Sherten *W R Thomas*

PROPELLANT DESCRIPTION SHEET

COMPONENTS 2R-20 19 Perf Stick	DA LOT NUMBER HCLBX 010-014
MANUFACTURER MONEYWELL MULTICA GFR 087-029	PACKED AMOUNT 25 Pounds
WFO AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Moneywell Subcontract 932077

ACCEPTED IN THE NAME OF NITROCELLULOSE		
B95089; 95091; 95092	NITROGEN CONTENT MAX 13.13 % MIN 13.07 % AVG 13.10 %	STABILITY (24 H °C) 30+ EXPLOSION

MANUFACTURE OF SOLVENTLESS PROPELLANT			ACTUAL	THEORY
210	215	Blending	20	-
145	155	Differential Rolling	-	140
150	160	Extrusion - Carpet Roll	-	-
145	155	Extrusion - Die	-	-
110	110	Annealing	240	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT OBSERVED	TESTS	FORMULA	ACTUAL
NITROCELLULOSE	N/A	N/A	50.64	WEAT	CC 40'	CC 60'+
NITROGLYCERIN	N/A	N/A	11.45	NO FUMES	NF 1 Hr	NF 1 Hr
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	19.24	FORM OF PROPELLANT		Cyl
BARBIT II	N/A	N/A	0.71	*ITALIANI	21.0 Gg/mm	.349
MAGNESIUM OXIDE	N/A	N/A	0.05		1000 BTU/HR	
GRAPHITE	N/A	N/A	0.05	BSE cal/hr	N/A	1163
BDX	N/A	N/A	17.78			
TOTAL			100.00	ASS DENSITY g/cc	N/A	1.61
Moisture	N/A	N/A	0.20			
Ash	N/A	N/A	0.09			
Methylene Cl Solubility	N/A	N/A	31.40			

CLOSED BOMB					PROPELLANT DIMENSIONS (inches)					
TEST	LOT NUMBER	TEMP °F	RO	RELATIVE SC271	PARAMETER	SPECIFICATION	DE	FINISHED	SPEC	ACTUAL
		-40	90.97	101.69	LENGTH (L)	N/A	1.60	1.61	N/A	N/A
		+90	92.47	103.43	DIAMETER (D)	N/A	.700	.686	N/A	.93
		+145	96.81	104.25	PERF. DIA. (M)	N/A	.023	.021	DATES	
STANDARD	S-231	+90	100.00	100.00%	Web Ave.	N/A	.099	.097	PACKED 1/87	
REMARKS: The closed bomb test used 2R-20 in the 827 form fired against the 827 standard. 700cc bomb with 0.1 gm/cc loading density.					Outer	N/A	.074	.090	SAMPLED 1/87	
					Middle	N/A	.107	.100	TEST FINISHED 1/87	
					Inner	N/A	.116	.102	OFFERED	
					Web Diff	N/A	N/A	5.34	DESCRIPTION SHEETS FORWARDED	
					L:D	N/A	2.29	2.35		
				D:d	N/A	30.43	32.15			

TYPE OF PACKING CONTAINER: Carton 327049; Barrier Bag 327202; Wood Box 327088

REMARKS: Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
D W Sulgaster

U. L. ...

PROPELLANT DESCRIPTION SHEET

AL 221-11

COMPOSITION 2R-20 Carpet Roll	DA LOT NUMBER HCL87B010-015
SPECIFICATION Honeywell Multica GER 087-029	PACKED AMOUNT 55 Pounds
MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.	CONTRACT NUMBER Honeywell Subcontract 932077

ACCEPTED GRADE NUMBERS			NITROCELLULOSE		
B95088, 95059, 95060			NITROGEN CONTENT	DI STARCH	STABILITY (24.5 °C)
			MAX _____ %	_____ %	_____ %
			MIN _____ %	_____ %	_____ %
			AVG 13.11 %	45+ _____ %	30+ _____ %
					EXPLOSION _____ %

VIGILANTLY		MANUFACTURE OF SOLVENTLESS PROPELLANT		RESULTS	
TYPE	NO				
-	-	Blending		20	-
210	215	Differential Rolling		-	-
145	155	Evenspeed Rollline		-	-
-	-	Extrusion - Carpet Roll		-	-
-	-	Extrusion - Die		-	-
-	-	Annealing		-	-

PROPELLANT COMPOSITION		TESTS OF FINISHED PROPELLANT			STABILITY AND PHYSICAL TESTS		
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	TESTS	FORMULA	ACTUAL	
NITROCELLULOSE	N/A	N/A	42.70	MEAT	cc 40'	cc 60'+	
NITROGLYCERIN	N/A	N/A	13.12	BO FUMES	NF 1 Hr	NF 1 Hr	
DIETHYLENE GLYCOL DINITRATE	N/A	N/A	23.16				
ASARBIT X	N/A	N/A	0.64	*ITALIANI	31.8 g/cm		
MAGNESIUM OXIDE	N/A	N/A	0.03		Block 8100mm	*	
GRAPHITE	N/A	N/A	0.05	BOE cal/cm	N/A	1166	
RDX	N/A	N/A	20.30				
TOTAL			100.00	ABS DENSITY g/cc	N/A	1.62	
Moisture	N/A	N/A		Form of Prop.		Carpet Roll	
Ash	N/A	N/A	0.10				
				*Did not reach 100 mm			

CLOSED BOMB				PROPELLANT DIMENSIONS (inches)						
TEST	LOT NUMBER	TEMP °F	RQ	RELATIVE DENSITY	PARAMETER	SPECIFICATION	DE	FINISHED	SPEC	ACTUAL
		-40	102.99	104.97	LENGTH (L)	N/A	N/A	4	N/A	N/A
		+90	118.06	106.86	DIAMETER (Ø)	N/A	N/A	4	N/A	N/A
		+145	121.83	106.92	PERF. DIA. (Ø)	N/A	N/A	N/A		
STANDARD	PE-472-138	+90	100.00	100.00%					DATES	
REMARKS Closed bomb was shot using carpet roll cut into strips (7.5"x.125"x .090") fired against the 829 standard 700 cc bomb using a 0.1 gm/cc loading density.									PACKED	
									SAMPLED	
									TEST FINISHED	
									OFFERED	
									L:D	N/A
				D:d	N/A	N/A	N/A			

TYPE OF PACKING CONTAINER Lever Pack Can

REMARKS
Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.

SIGNATURE OF Development Engineer
D. W. Kirkpatrick
 D. W. Kirkpatrick

W.B. Jones

PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL SYSTEM
EXEMPT PARA 7-2a
AR 335-15

COMPOSITION: PROPELLANT JA-2 19-PERF HEX GRANULAR	LOT NUMBER: RAD-PD-090-1
SPECIFICATION: DCD-P-64035B; ORDER RELEASE NO. 235-92, 7/7/92	PACKED AMOUNT: 75.5 pounds
MANUFACTURED: RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA 24141	CONTRACT NUMBER: DAAA09-91-2-0001

NITROCELLOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH (65.5°C)	STABILITY (34.5°C)
BB 95539, BB 95540, BB95541	MAX <u>13.17</u> %	45- MINS	30- MINS
	MIN <u>13.06</u>	45- MINS	30- MINS
	AVG <u>13.13</u>	45- MINS	30- MINS
			EXPLOSION HRS

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE, °F		PROCESS - DRYING	TIME	
FROM	TO		DAYS	HOURS
145	155	CARPET ROLL AT EXTRUSION		
160	170	EXTRUSION DIE		
105	115	ANNEAL		6

TEST OF FINISHED PROPELLANT

PROPELLANT COMPOSITION				STABILITY AND PHYSICAL TESTS		
Constituent	Percent Formula	Percent Tolerance	Percent Measured	Tests	Formula	Actual
Nitrocellulose	59.50	± 2.00	58.89	Heat test @ 120°C	NCC 60'	CC 60'
Nitroglycerin	14.90	± 1.00	15.54	No fumes	NF 60'	NF 60'
Diethylene glycol dinitrate	24.80	± 1.50	24.78			
Akardit II	0.70	± 0.20	0.71			
Magnesium oxide	0.05	- 0.02	0.03	HOE (cal/g)	1120 Nom.	1115
Graphite	0.05	- 0.02	0.05	Absolute density, g/cc	1.56 min	1.56
Total	100.00		100.00			
Moisture content	0.5	± 0.3	0.3	Form	hexagonal	hexagonal
Ash content	0.3	MAX	0.1	Number of perfs	19	19
Methylene chloride solubles	40.4	± 3.0	41.4			

CLOSED BOMB

PROPELLANT DIMENSIONS (INCHES)

Lot Number	Temp °F	Relative Quickness	Relative Force				Uniformity by Std Deviation, %		
PD-090-1	+90	82.7	99.9	SPEC	DIE	FINISHED	SPEC	ACTUAL	
				LENGTH (in.)	0.75 NOM	---	0.736	6.25 MAX	4.56
				O.D. (in.)	0.789 NOM	0.834	0.811	6.25 MAX	0.93
STD-71136		100.00	100.00	PERF (in.)	0.027 NOM	0.026	0.026		
				WEB (avg)	0.109 NOM	---	0.113		
				WEB (inner)	INFO	---	0.120	Dates	
				WEB (middle)	INFO	---	0.111	PACKED 11-92	
				WEB (outer)	INFO	---	0.106	SAMPLED 11-92	
				L/D	INFO	---	0.908	OFFERED 1-93	
				D/d	INFO	---	30.69	DESCRIPTION SHEETS FORWARDED	
WEB (diff %)	15 MAX	---	4.04						

TYPE OF PACKING CONTAINER: DOT 21-C FIBER DRUM

REMARKS: THIS DRUM CONTAINED NET PROPELLANT WEIGHT OF 75.5 POUNDS

THIS LOT MEETS SPECIFICATION REQUIREMENTS

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE

SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE

D. ZEOLI

Danny Zeoli

C. N. HALL

PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL SYSTEM
EXEMPT PARA 1-2
AR 335-2

COMPOSITION: PROPELLANT JAX-1 19-PERF HEX GRANULAR	LOT NUMBER: RAD-PD-090-2
SPECIFICATION: DGD-P-64035B; ORDER RELEASE NO. 335-92, 7/7/92	PACKED AMOUNT: 92.5 pounds
MANUFACTURED: RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA 24141	CONTRACT NUMBER: DAAA09-91-Z-0001

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH (65.5°C)	STABILITY (134.5°C)
BB 95539, BB95540, BB95541	MAX <u>13.27</u>	<u>45</u> MINS	<u>30</u> MINS
	MIN <u>13.06</u>	<u>45</u> MINS	<u>30</u> MINS
	AVG <u>13.13</u>	<u>45</u> MINS	<u>30</u> MINS
			EXPLOSION HRS

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE, °F		PROCESS - DRYING	TIME	
FROM	TO		DAYS	HOURS
145	155	CARPET ROLL AT EXTRUSION		
160	170	EXTRUSION DIE		
105	115	ANNEAL		6

TEST OF FINISHED PROPELLANT

PROPELLANT COMPOSITION				STABILITY AND PHYSICAL TESTS		
Constituent	Percent Formula	Percent Tolerance	Percent Measured	Tests	Formula	Actual
Nitrocellulose	55.33	NOM.	55.73	Heat test @ 120°C	NCC 60'	CC 60'
Nitroglycerin	13.86	NOM.	14.25	No fumes	NF 60'	NF 60'
Diethylene glycol dinitrate	23.06	NOM.	22.72			
RDX	7.00	NOM.	6.42			
Akardit II	0.65	NOM.	0.74	HOE (cal/g)	Info	1131
Magnesium oxide	0.05	NOM.	0.06	Absolute density, g/cc	Info	1.59
Graphite	0.05	NOM.	0.08			
Total	100.00		100.00	Form	hexagonal	hexagonal
Ash content	0.3	NOM	0.1	Number of perfs	19	19
Methylene chloride solubles	40.4	NOM	42.2			
Moisture content	0.5	NOM	0.3			

CLOSED BOMB

PROPELLANT DIMENSIONS (INCHES)

Lot Number	Temp °F	Relative Quickness	Relative Force	DIMENSIONS			Uniformity by Web Thickness, %		
				SPEC	DIE	FINISHED	SPEC	ACTUAL	
RAD-PD-090-2	-90	81.6	101.1	LENGTH (in.)	0.75 NOM	---	0.746	---	4.42
				O.D. (in.)	0.789 NOM	0.834	0.809	---	0.63
				PERF (in.)	0.027 NOM	0.026	0.026		
				WEB (avg)	0.109 NOM	---	0.114		Dates
REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY				WEB (inner)	INFO	---	0.123		PACKED 11-92
				WEB (middle)	INFO	---	0.111		SAMPLED 11-92
				WEB (outer)	INFO	---	0.108		TEST FINISHED 12-92
				L/D	INFO	---	0.921		OFFERED 1-93
				D/d	INFO	---	30.94		DESCRIPTION SHEETS FORWARDED
				WEB (diff %)	INFO	---	5.08		

TYPE OF PACKING CONTAINER: DOT 21-C FIBER DRUM

REMARKS: THIS DRUM CONTAINED NET PROPELLANT WEIGHT OF 92.5 POUNDS

THIS LOT MEETS SPECIFICATION REQUIREMENTS

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE

SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE

D. ZEOLI *Danny Zeoli*

C. N. HALL

PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL SYSTEM
EXEMPT PARA 1-2a
AR 335-15

COMPOSITION: PROPELLANT JAX-2 19-PERF HEX GRANULAR	LOT NUMBER: RAD-PD-090-3
SPECIFICATION: DOD-P-64035B; ORDER RELEASE NO. 235-92, 7/7/92	PACKED AMOUNT: 100 pounds
MANUFACTURED: RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA 24141	CONTRACT NUMBER: DAAAC9-91-Z-0001

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH 65.5% ¹	STABILITY 134.5% ¹
BB 95539, BB 95540, BB 95541	MAX <u>13.17%</u>	<u>45-</u> MINS	<u>30-</u> MINS
	MIN <u>13.06%</u>	<u>45-</u> MINS	<u>30-</u> MINS
	AVG <u>13.11%</u>	<u>45-</u> MINS	<u>30-</u> MINS
			EXPLOSION HRS

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE, °F		PROCESS - DRYING	TIME	
FROM	TO		DAYS	HOURS
145	155	CARPET ROLL AT EXTRUSION		
160	170	EXTRUSION DIE		
105	115	ANNEAL		

TEST OF FINISHED PROPELLANT

PROPELLANT COMPOSITION				STABILITY AND PHYSICAL TESTS		
Constituent	Percent Formula	Percent Tolerance	Percent Measured	Tests	Formula	Actual
Nitrocellulose	51.77	NOM.	54.48	Heat test @ 120°C	NCC 60'	CC 60'
Nitroglycerin	12.96	NOM.	12.59	No fumes	NF 60'	NF 60'
Diethylene glycol dinitrate	21.58	NOM.	20.07			
RDX	13.00	NOM.	12.10			
Akardat II	0.61	NOM.	0.68	HOE (cal/g)	Info	1144
Magnesium oxide	0.04	NOM.	0.35	Absolute density, g/cc	Info	1.59
Graphite	0.04	NOM.	0.03			
Total	100.00		100.00	Form	hexagonal	hexagonal
Ash content	0.3	NOM	0.1	Number of perfs	19	19
Methylene chloride solubles	40.4	NOM	44.3			
Moisture content	0.5	NOM	0.2			

CLOSED BOMB

PROPELLANT DIMENSIONS (INCHES)

Lot Number	Temp °F	Relative Quickness	Relative Force					Uniformity by Std Deviation, %	
				SPEC	DIE	FINISHED	SPEC	ACTUAL	
RAD-PD-090-3	-90	81.1	101.7	LENGTH in.	0.75 NOM	---	0.760	---	1.90
				O.D. in.	0.789 NOM	0.834	0.810	---	0.70
				PERF in.	0.027 NOM	0.026	0.027		
STD-71136		100.00	100.00	WEB (avg.)	0.109 NOM	---	0.114	Dates	
				WEB (inner)	INFO	---	0.114	PACKED 11-90	
				WEB (middle)	INFO	---	0.108	SAMPLED 11-90	
REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY				WEB (outer)	INFO	---	0.112	TEST FINISHED 11-90	
				L/d	INFO	---	0.938	OFFERED 1-90	
				D/d	INFO	---	30.16	DESCRIPTION SHEETS FORWARDED	
				WEB (diff %)	INFO	---	3.12		

TYPE OF PACKING CONTAINER: DCT 21-C FIBER DRUM

REMARKS: THIS DRUM CONTAINED NET PROPELLANT WEIGHT OF 100 POUNDS

THIS LOT MEETS SPECIFICATION REQUIREMENTS

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE

SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE

D. ZEOLI

Danny Zeoli

C. N. HALL

PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL SYSTEM
EXEMPT PARA 102a
AR 355-15

COMPOSITION: PROPELLANT CAX-2 19-PERF HEX GRANULAR	DOT NUMBER: RAD-PD-C90-4
SPECIFICATION: DOD-P-6403'B; CDEP RELEASE NO. 035-90, 747 92	PACKED AMOUNT: 100 pounds
MANUFACTURED: RADFORD ARMY AMMUNITION PLANT, RADFORD VIRGINIA 24141	CONTRACT NUMBER: DAAA09-91-B-0001

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH 65.5% C	STABILITY 134.5% C
BB 95539, BB 95540, BB 95541	MAX <u>13.178</u>	<u>45</u> MINS	<u>30</u> MINS
	MIN <u>13.055</u>	<u>45</u> MINS	<u>30</u> MINS
	AVG <u>13.113</u>	<u>45</u> MINS	<u>30</u> MINS
			EXPLOSION MRS

MANUFACTURE OF SOLVENTLESS PROPELLANT

TEMPERATURE, °F		PROCESS - DRYING	TIME	
FROM	TO		DAYS	HOURS
145	155	CARPET ROLL AT EXTRUSION		
160	170	EXTRUSION DIE		
105	115	ANNEAL		6

TEST OF FINISHED PROPELLANT

PROPELLANT COMPOSITION				STABILITY AND PHYSICAL TESTS		
Constituent	Percent Formula	Percent Tolerance	Percent Measured	Tests	Formula	Actual
Nitrocellulose	46.38	NOM.	46.65	heat test @ 120°C	NCC 60'	CC 60'
Nitroglycerin	12.11	NOM.	13.54	No fumes	NF 60'	NF 60'
Diethylene glycol dinitrate	20.16	NOM.	21.60			
RDX	16.70	NOM.	17.42			
Akardit II	0.57	NOM.	0.71	HOE (cal/g)	Info	1156
Magnesium oxide	0.04	NOM.	0.03	Absolute density, g/cc	Info	1.60
Graphite	0.04	NOM.	0.05			
Total	100.00		100.00	Form	hexagonal	hexagonal
Ash content	0.3	NOM	0.1	Number of perfs	19	19
Methylene chloride solubles	40.4	NOM	46.7			
Moisture content	0.5	NOM	0.2			

CLOSED BOMB

PROPELLANT DIMENSIONS (INCHES)

Lot Number	Temp °F	Relative Quickness	Relative Force				Uniformity by Std Deviation, %	
RAD-PD-C90-4	+90	79.8	103.1	SPEC	DIE	FINISHED	SPEC	ACTUAL
				LENGTH (in.)	0.75 NOM	---	0.762	---
O.D. (in.)	0.789 NOM	0.834	0.818	---	0.54			
PERF (in.)	0.027 NOM	0.026	0.027					
STD-71136		100.00	100.00	WEB (avg.)	0.109 NOM	---	0.115	Dates
REMARKS: FIRED IN A 100 CC BOMB AT 0.20 G/CC LOADING DENSITY				WEB (inner)	INFO	---	0.110	PACKED 11-92
				WEB (middle)	INFO	---	0.107	SAMPLED 11-92
				WEB (outer)	INFO	---	0.127	TEST FINISHED 10-92
				L/D	INFO	---	0.932	OFFERED 1-93
				D/d	INFO	---	30.82	DESCRIPTION SHEETS FORWARDED
WEB (diff %)	INFO	---	6.94					

TYPE OF PACKING CONTAINER: DOT 21-C FIBER DRUM

REMARKS: THIS DRUM CONTAINED NET PROPELLANT WEIGHT OF 100 POUNDS

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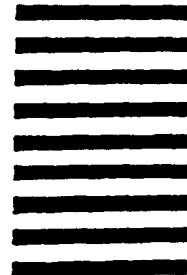
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