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## Characteristics of JAX Gun Propellant

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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.

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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.<sup>1</sup> To increase the energy, cyclotrimethylenetrinitramine (RDX) has been added to JA2 during manufacture.<sup>2, 3</sup> 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 diameter<sup>2</sup> of 7.5  $\mu\text{m}$ . The more recent manufacture used nominal 4- $\mu\text{m}$  recrystallized RDX from Dupont Corporation.<sup>3</sup> 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.<sup>2</sup> 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<br>J/g | Flame Temp<br>K | Impetus/ $(\gamma - 1)$<br>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.<sup>4</sup> 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,<sup>5</sup> 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.<sup>6, 7, 8, 9</sup> 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.<sup>10</sup>

Two methods of fracture evaluation were used to characterize the JAX materials. The first was the drop weight mechanical properties test (DWMPT)<sup>6, 7</sup> 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)<sup>8, 9</sup> 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<sup>-1</sup>. 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.

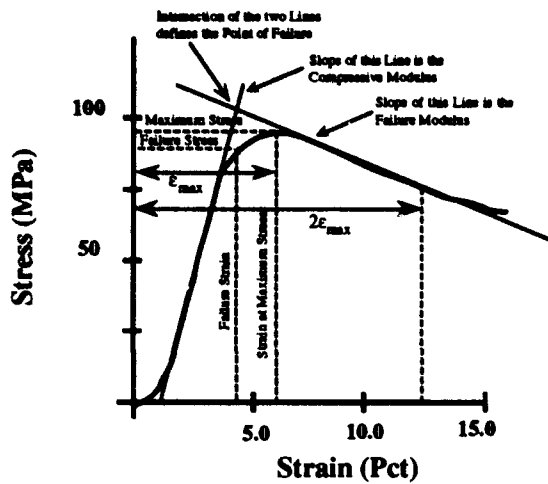


Figure 1. Mechanical Parameters Illustrated

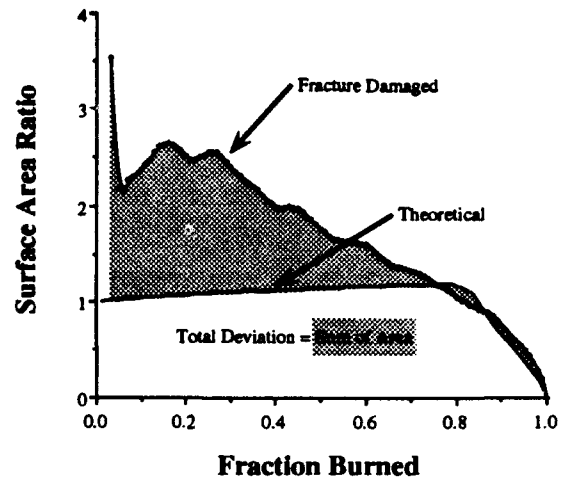
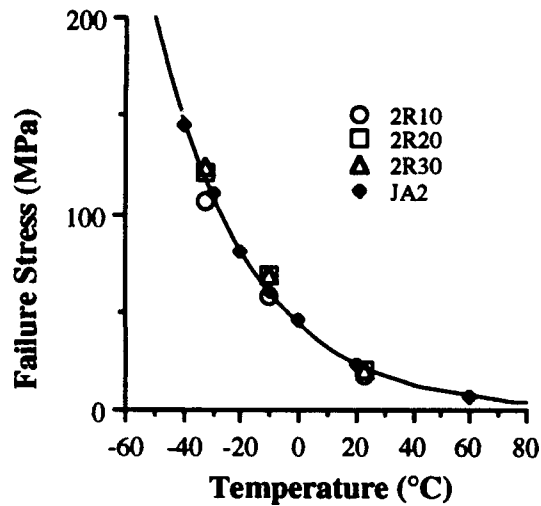
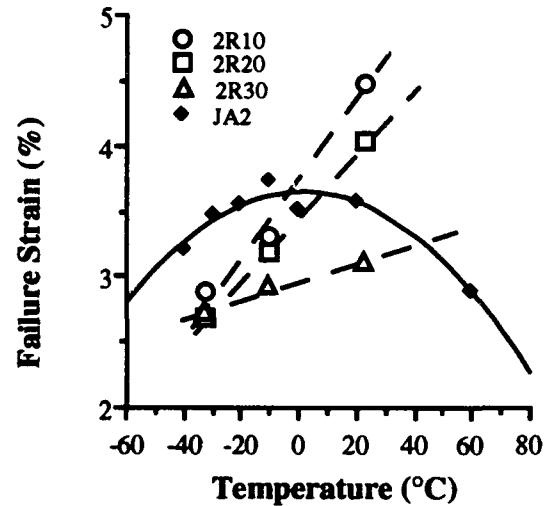


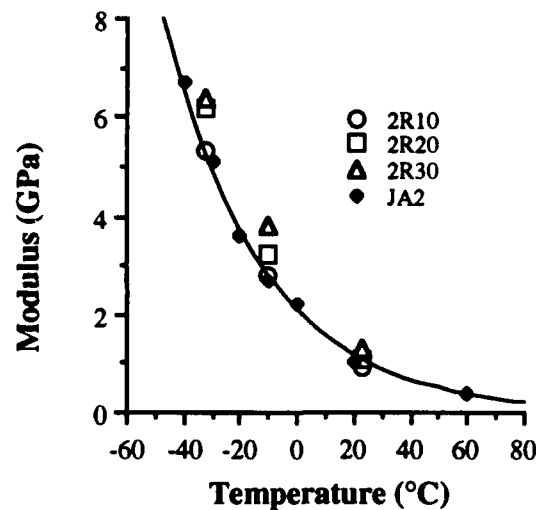
Figure 2. The Total Deviation Parameter



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 analysis<sup>11</sup> 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

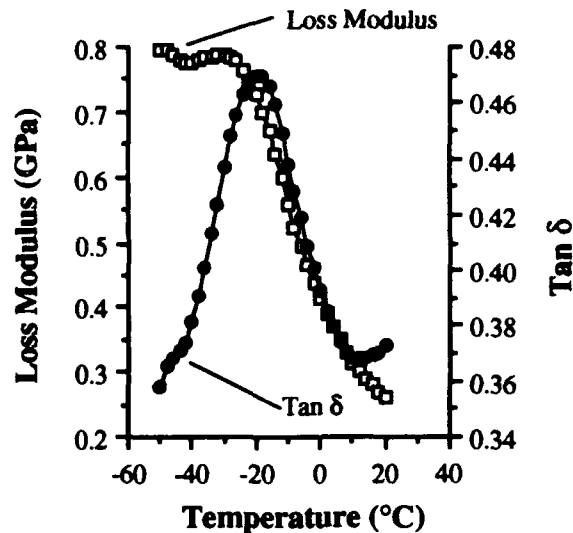


Figure 4. DMA Data for JA2 Which Indicate Glass Transition Temperature Region

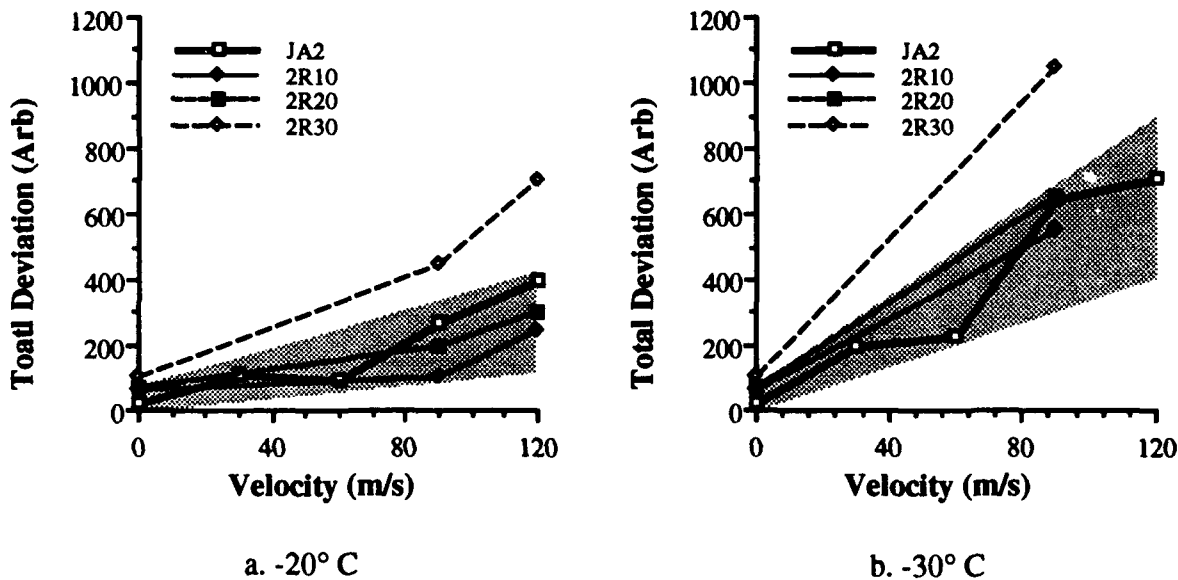


Figure 5. Total Deviation vs Impact Velocity for Gas Gun Impact Test

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,<sup>12</sup> 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).

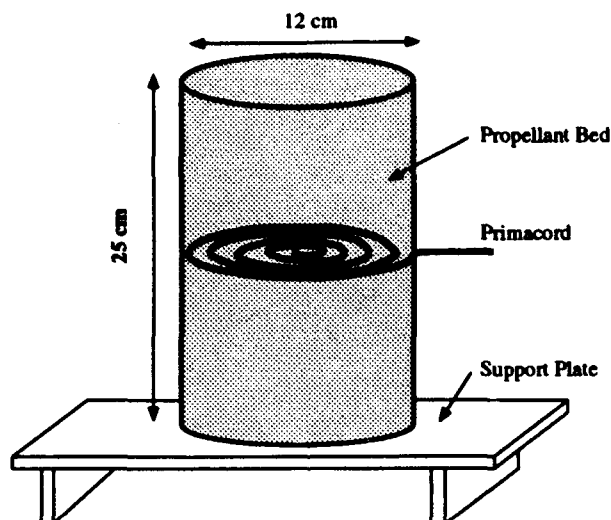


Figure 6. PrimaCord Shock Initiation Test Setup

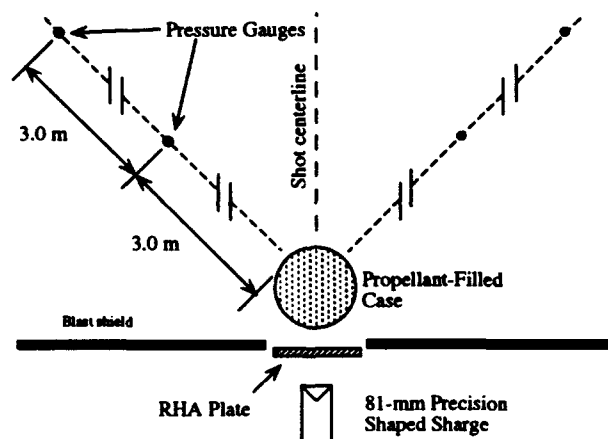


Figure 7. Schematic Diagram of the Air Blast Experiment

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.<sup>2</sup>

These tests indicated a violent response for 2R30 and mild responses for 2R10 and 2R20.<sup>2</sup> 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  $45^\circ$  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

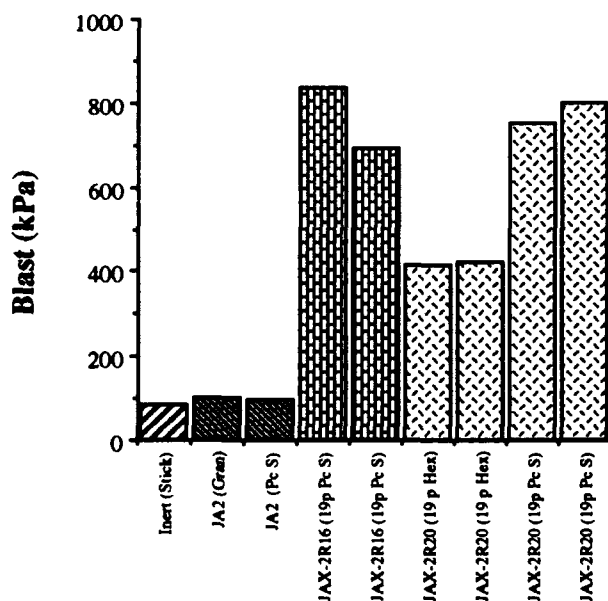


Figure 8. Air Blast Pressure at 3.0 m

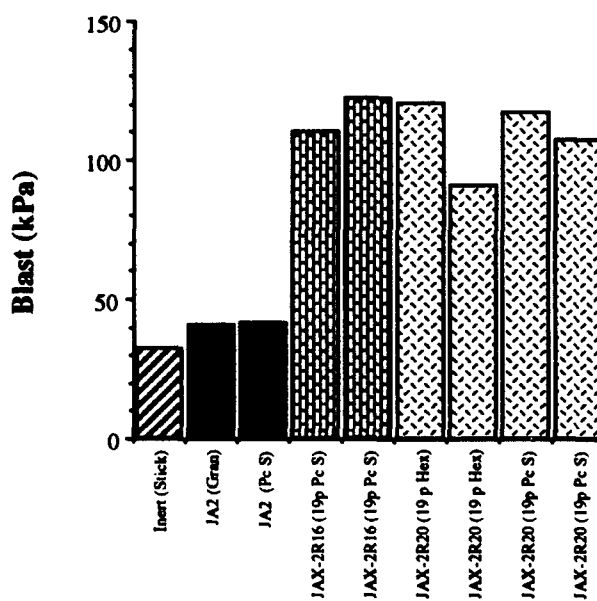


Figure 9. Air Blast Pressure at 6.1 m

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<br>RAD00M0015102<br>RAD792-32<br>HCL87A010-002<br>HCL87A010-002<br>HCL86H003-009<br>HCL86H003-009<br>HCL86H003-009<br>HCL86H003-009 | Inert (Stick)              | 7            | 3.5       | 82.7                   | No Data | 82.7    | 5.4                       |
| S-NG711903  |                                                                                                                                               | JA2 (Gran)                 | 7            | 4.1       | 124.0                  | 87.5    | 99.2    | 4.7                       |
| S-NG716702  |                                                                                                                                               | JA2 (Pc S)                 | 19           | 4.8       | 96.5                   | 99.2    | 97.8    | 4.8                       |
| S-NG716203  |                                                                                                                                               | JAX-2R16 (19p Pc S)        | 19           | 4.9       | 654.6                  | 1005.9  | 834     | 1.9                       |
| S-NG716703  |                                                                                                                                               | JAX-2R16 (19p Pc S)        | 19           | 5.3       | 792.4                  | 592.5   | 692     | 1.9                       |
| S-NG711902  |                                                                                                                                               | JAX-2R20 (19 p Hex)        | 19           | 3.9       | 441.0                  | 385.8   | 413     | 2.1                       |
| S-NG716901  |                                                                                                                                               | JAX-2R20 (19 p Hex)        | 19           | 3.9       | 430.6                  | 413.4   | 422     | 2.2                       |
| S-NG716903  |                                                                                                                                               | JAX-2R20 (19p Pc S)        | 19           | 4.8       | 778.6                  | 723.5   | 751     | 1.9                       |
| S-NG716302  |                                                                                                                                               | 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<br>RAD00M0015102<br>RAD792-32<br>HCL87A010-002<br>HCL87A010-002<br>HCL86H003-009<br>HCL86H003-009<br>HCL86H003-009                  | Inert (Stick)              | 7            | 3.5       | 33.1                   | 32.4    | 32.7    | 12.9                      |
| S-NG711903  |                                                                                                                                               | JA2 (Gran)                 | 7            | 4.1       | 41.3                   | 40.0    | 40.7    | 12.0                      |
| S-NG716702  |                                                                                                                                               | JA2 (Pc S)                 | 19           | 4.8       | 48.2                   | 34.5    | 41.3    | 11.0                      |
| S-NG716203  |                                                                                                                                               | JAX-2R16 (19p Pc S)        | 19           | 4.9       | 117.1                  | 103.4   | 110.2   | 7.1                       |
| S-NG716703  |                                                                                                                                               | JAX-2R16 (19p Pc S)        | 19           | 5.3       | 158.5                  | 86.1    | 122.3   | 6.9                       |
| S-NG711902  |                                                                                                                                               | JAX-2R20 (19 p Hex)        | 19           | 3.9       | 124.0                  | 117.1   | 120.6   | 7.5                       |
| S-NG716901  |                                                                                                                                               | JAX-2R20 (19 p Hex)        | 19           | 3.9       | 89.6                   | 92.3    | 90.9    | 7.7                       |
| S-NG716903  |                                                                                                                                               | JAX-2R20 (19p Pc S)        | 19           | 4.8       | 130.9                  | 103.4   | 117.1   | 6.7                       |
| S-NG716302  |                                                                                                                                               | JAX-2R20 (19p Pc S)        | 19           | 5.0       | 103.4                  | 111.6   | 107.5   | 6.7                       |

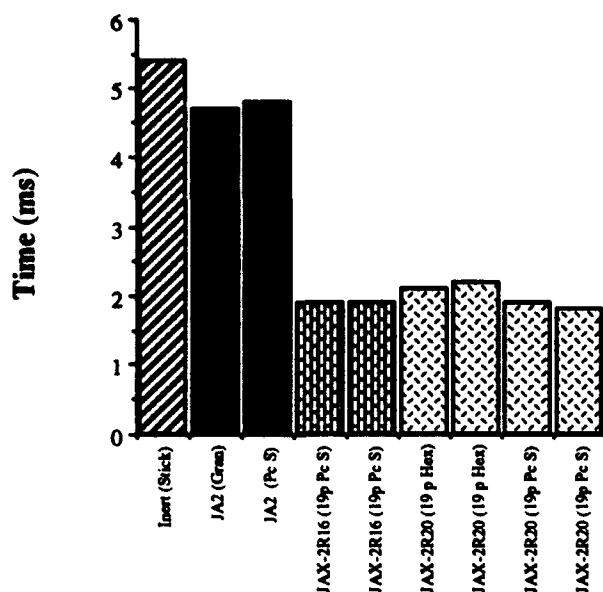


Figure 10. Air Blast Arrival Time at 3.0 m

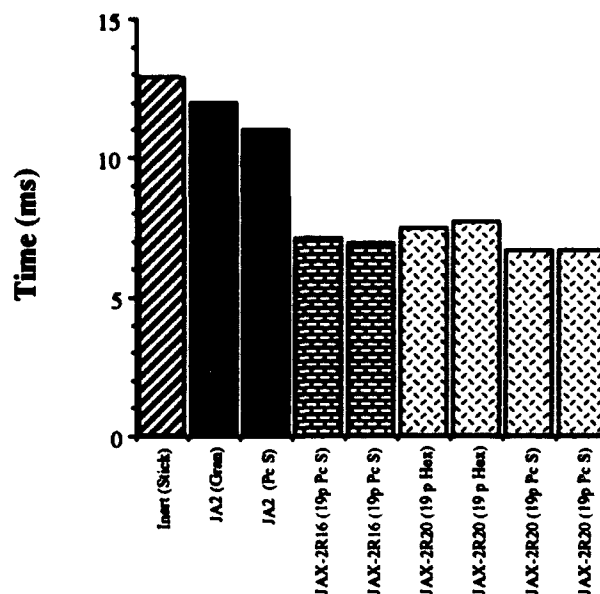


Figure 11. Air Blast Arrival Time at 6.1 m

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.<sup>14, 15</sup> 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),

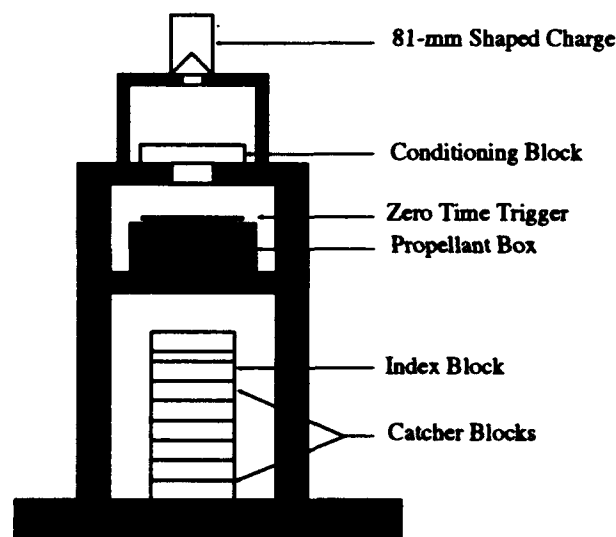


Figure 12. Schematic of the Shock Velocity Experiment

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:

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

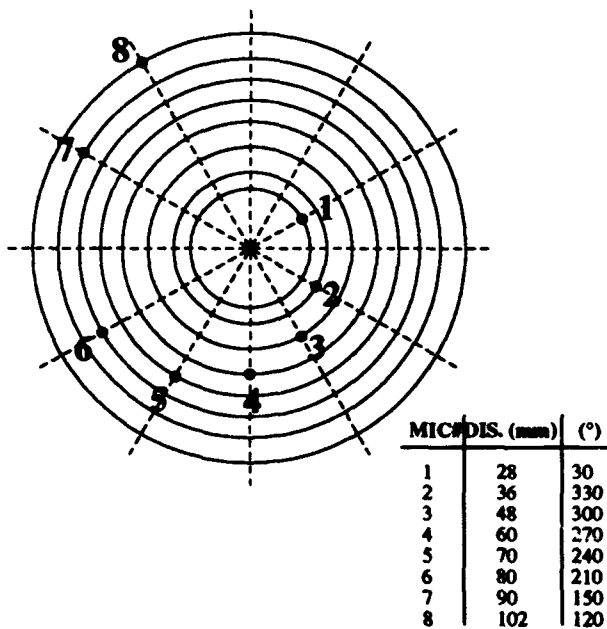


Figure 13. Schematic of Microphone Locations

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<br>(mm) | Shots |      |                   |      |      |      |      |                       | Sigma |
|------------------|-------|------|-------------------|------|------|------|------|-----------------------|-------|
|                  | 16    | 17   | Average<br>16, 17 | 36   | 41   | 43   | 44   | Average<br>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.<sup>16</sup> 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:

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

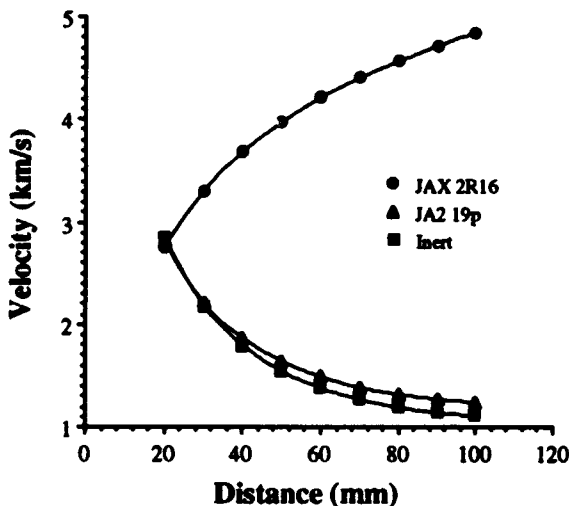


Figure 14. Shock Velocity Data for JA2 and JAX

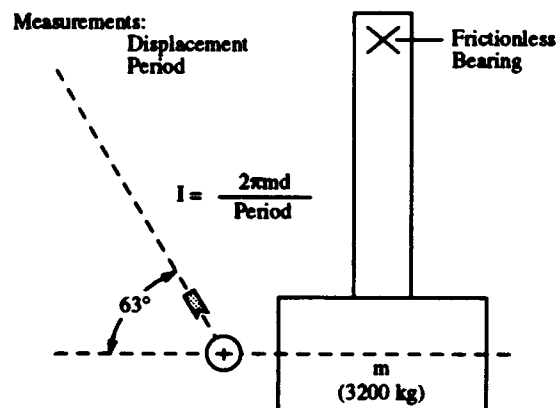


Figure 15. Schematic of the Impulse Pendulum Test

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          |

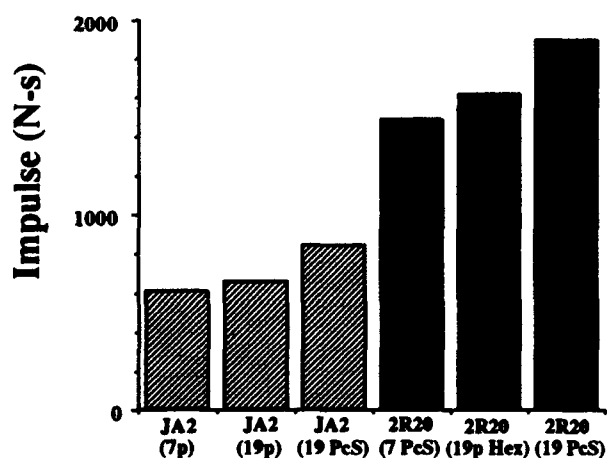


Figure 16. Impulse Pendulum Data for 2.3-kg Quantities of JA2 and JAX

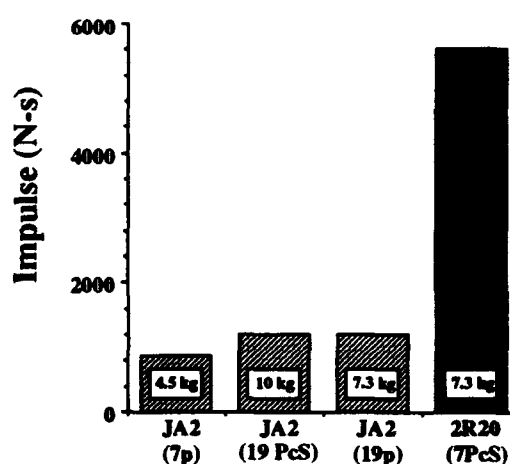


Figure 17. Impulse Pendulum Data for Various Amounts of JA2 and JAX

### 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.

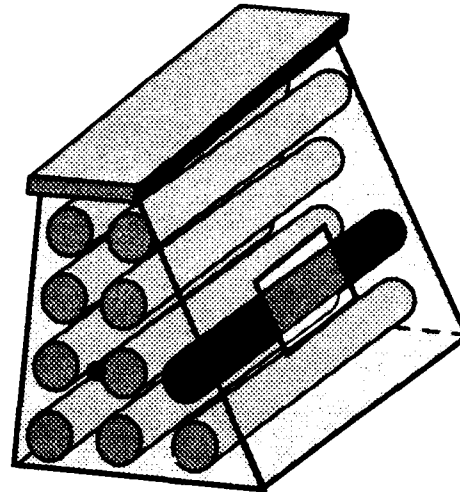


Figure 18. Schematic of the Ten-Round Staged Compartment Test  
(The target round is darkened.)

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.<sup>17</sup>

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 |

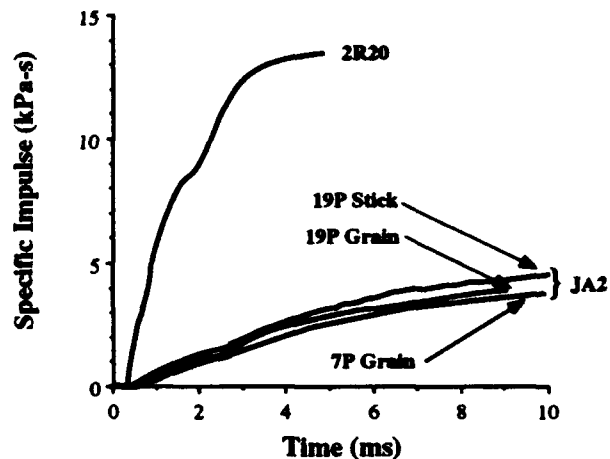


Figure 19. Staged Compartment Test Results for 2.3-kg Quantities of JAX and JA2

#### 4. JAX MORPHOLOGY

##### 4.1 SEM Background.

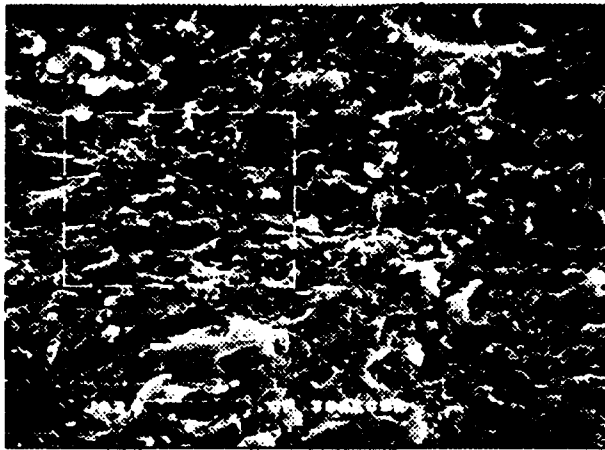
The physical arrangement of the processed material is very important to propellant performance. Defects such as voids, cracks, agglomerates, or foreign material can have a deleterious effect on the programmed burning of the charge by changing the mass generation rate of the propellant. This is done by 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.<sup>5</sup>

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.

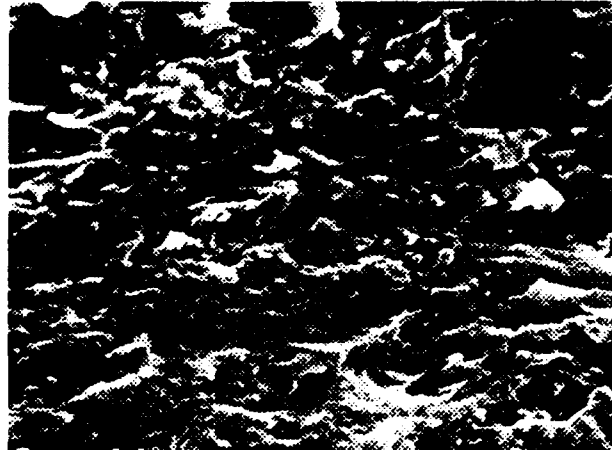
Figure 20 shows micrographs of the cold-fractured surface of typical JA2 propellant and is presented as a basis for comparison. JA2 is a thermoplastic elastomer that undergoes a transition from mostly plastic to brittle behavior at about  $-20^{\circ}\text{C}$  at deformation rates on the order of  $100\text{ s}^{-1}$  (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  $\mu\text{m}$

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



10  $\mu\text{m}$

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.

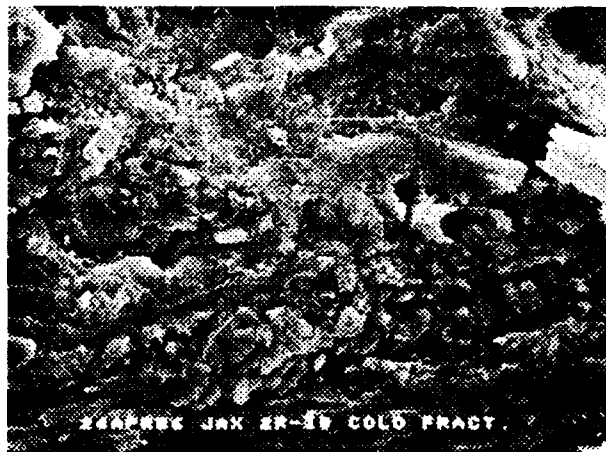
#### 4.3 SEM's of JAX Grains.

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  $\mu\text{m}$

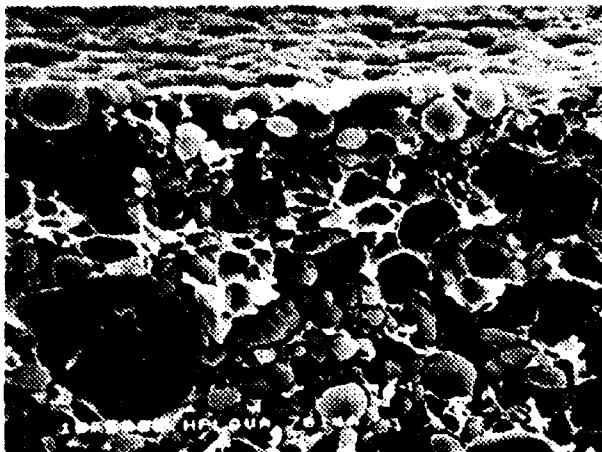
a.  $\approx 400\text{X}$



10  $\mu\text{m}$

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

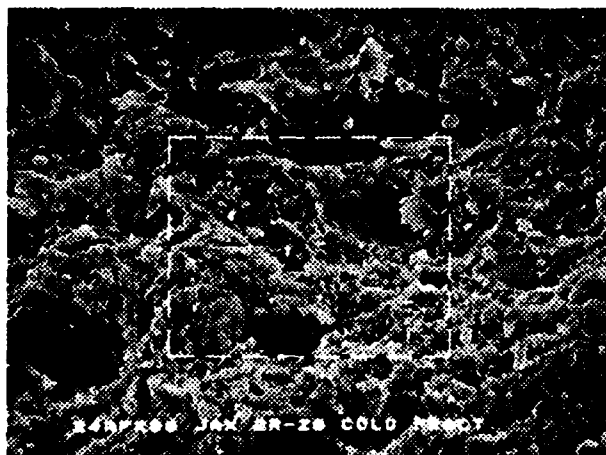
only unusual feature is that the particle size of the RDX is considerably smaller than expected. The distribution of particle sizes that was added to make JAX, and that typically appears in nitramine base propellants, has most of the particles within a range of 2 to 20 μm. Figure 22 shows an example 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.

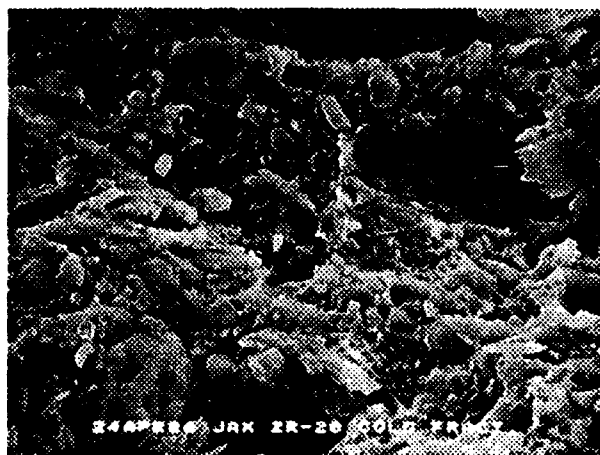
Micrographs of the 30% filled JAX propellant are presented in Figure 24. There are similar changes due to the increased concentration of RDX as were noted in Figure 23. There are more particles present and an even rougher surface. The major difference noted here is that the RDX size distribution seems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



20 μm

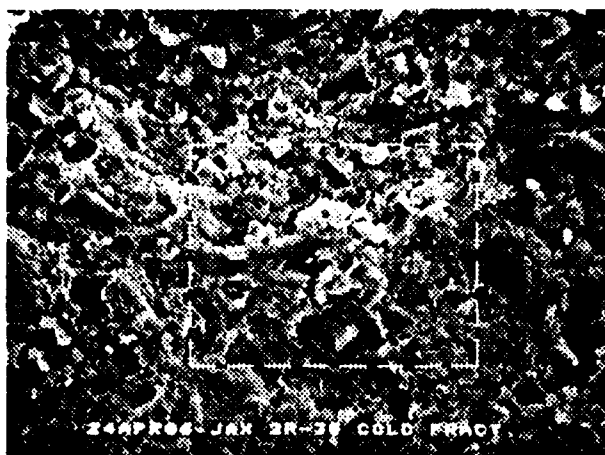
a. ≈400X



10 μm

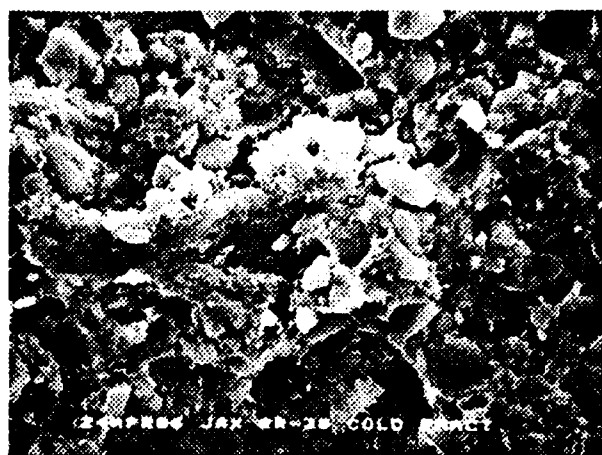
b. ≈800X

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



20 μm

a. ≈400X

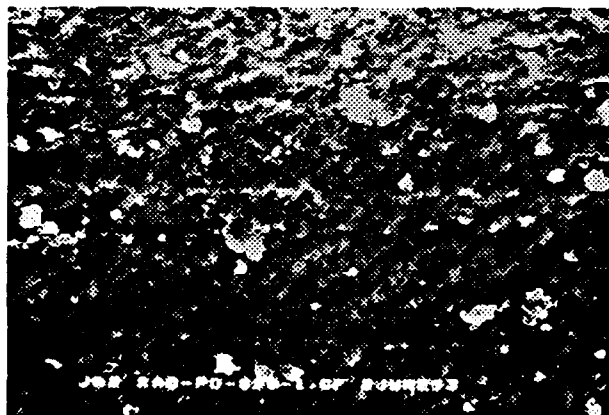


10 μm

b. ≈800X

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

at the Radford Army Ammunition Plant in February 1993.<sup>3</sup> 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 μm

a. JA2 (≈400X)



20 μm

b. JAX-1 with RDX Crystals (≈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.

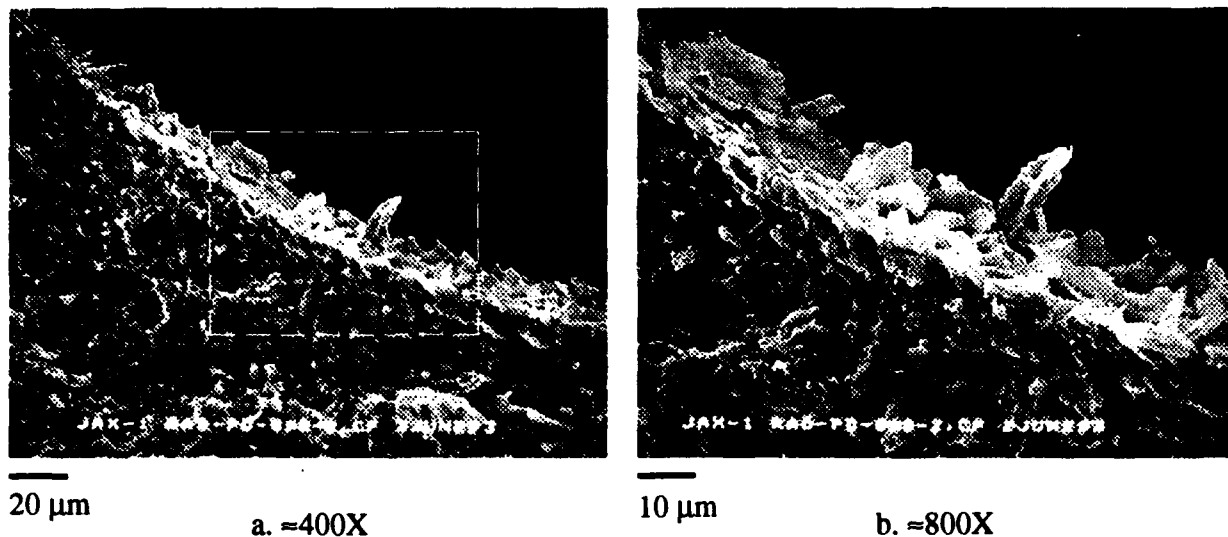


Figure 26. Micrographs of the Inner Perforation Surface of JAX-1 Shown in Figure 11b Cold-Fractured in the Radial Direction

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.<sup>18</sup> The software included Kramers-Kronig transformations to correct spectral distortions. For both spectra, 32 scans were collected with a resolution of 8 cm<sup>-1</sup>. The scans are shown in Figure 28.

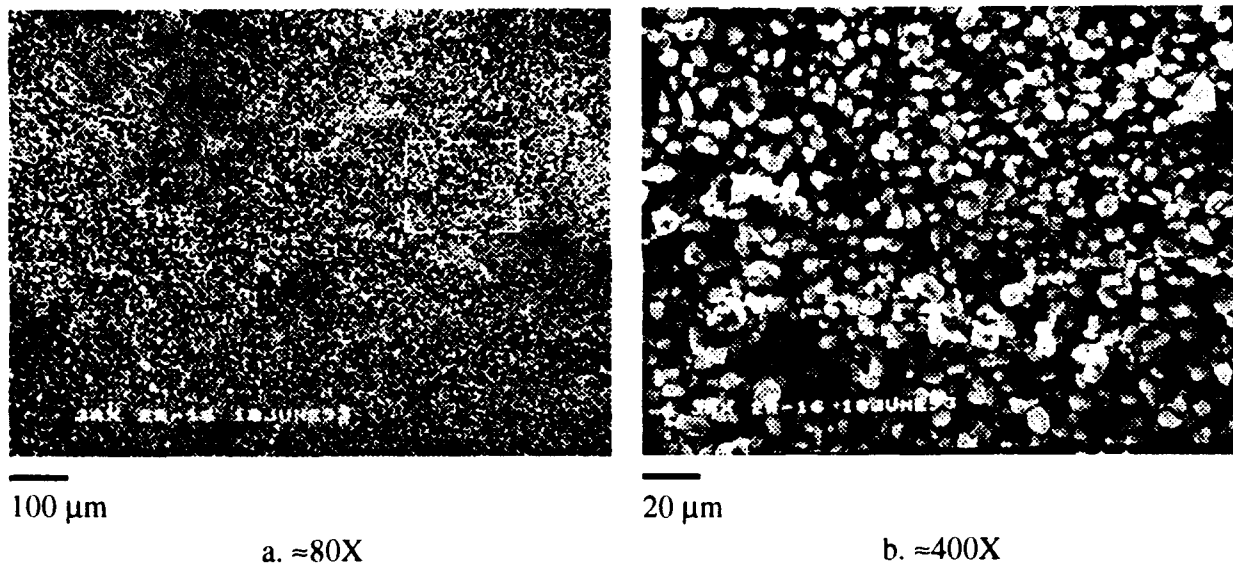


Figure 27. Micrographs of the Exterior Surface of 2R-16 JAX Propellant after 7-Year Storage

Attention is drawn to the ordinate of Figure 28 in the region between 1500 and 1700  $\text{cm}^{-1}$ . From other spectra (not shown), an RDX spectral signature lies at about 1600  $\text{cm}^{-1}$  and an NC spectral signature lies at about 1660  $\text{cm}^{-1}$ . In the upper scan labeled "Bulk Surface of JAX" (Figure 28), we see the NC spectral signature at 1660  $\text{cm}^{-1}$ , but little or no indication of an RDX spectral signature at 1600  $\text{cm}^{-1}$ . On the other hand, the lower scan, labeled "Perforation Surface of JAX" (Figure 28), we do find the RDX spectral signature at about 1600  $\text{cm}^{-1}$ . The shape of the derived NC spectral signature at about 1660  $\text{cm}^{-1}$  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.<sup>3</sup> Thus, if heating were to accelerate the RDX deposition, all JAX materials should have RDX crystal growths on their external surfaces after manufacture.

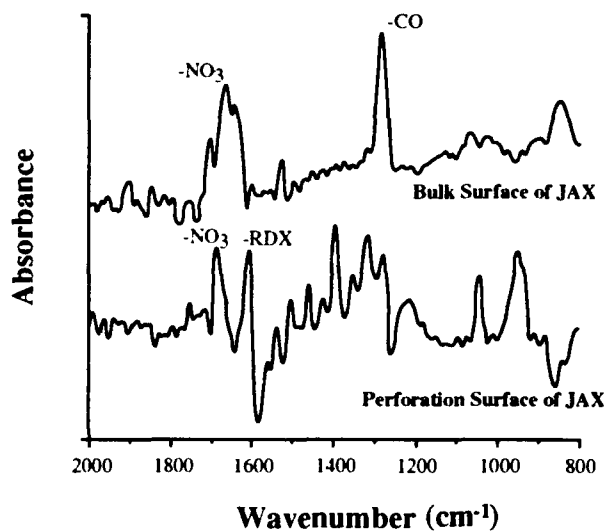


Figure 28. Microreflectance FTIR Spectra of JAX Surfaces

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.<sup>19</sup>

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 materials<sup>20</sup> over

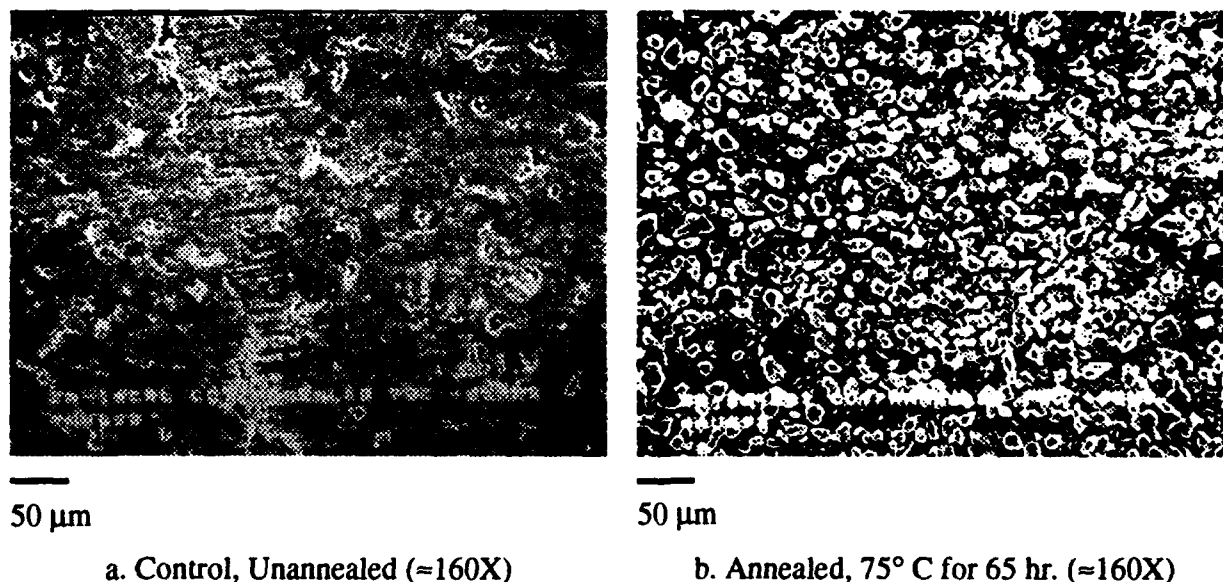


Figure 29. Micrographs of the Cut Surface of 2R-16 JAX Propellant

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

| Propellant Specimen | (%Wt. Loss)              |                          |
|---------------------|--------------------------|--------------------------|
|                     | T= 60° C<br>t = 1000 min | T= 100° C<br>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<br>(° C) | Vapor Pressure<br>(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 HMX<sup>20</sup> 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<br>phosphoramide | 16               | 1.4  | b   | 11      |
| Dimethyl<br>acetamide       | 33               | c    | b   | ---     |
| Dimethyl<br>formamide       | 37               | c    | b   | ---     |
| Dimethyl<br>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.<sup>3</sup> 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 noted<sup>21</sup> 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.<sup>21</sup>

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.<sup>21</sup> 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 RDX<sup>21</sup>) 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.<sup>22</sup> 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 | 450 Pounds                                                                                                                                                                                                                                                                                                                |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
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| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 | Moneywell Subcontract 947092                                                                                                                                                                                                                                                                                              |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| B95089; 95091; 95092                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 | <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>ENTRANCE CONCENT</th> <th>IN BRANCH</th> <th>STABILITY (RANGE)</th> </tr> <tr> <td>RAW 13.11</td> <td></td> <td></td> </tr> <tr> <td>RAW 13.07</td> <td></td> <td></td> </tr> <tr> <td>AVE 13.10</td> <td>45+</td> <td>10+</td> </tr> </table> |                              | ENTRANCE CONCENT                | IN BRANCH   | STABILITY (RANGE)            | RAW 13.11                    |                                |  | RAW 13.07                    |  |             | AVE 13.10       | 45+               | 10+            |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| ENTRANCE CONCENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | IN BRANCH       | STABILITY (RANGE)                                                                                                                                                                                                                                                                                                         |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| RAW 13.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                                                                                                                                                                                                                                                                           |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| RAW 13.07                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                                                                                                                                                                                                                                                                                                           |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| AVE 13.10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 45+             | 10+                                                                                                                                                                                                                                                                                                                       |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                                                                                                                                                                                                                                                                                                           |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| <b>PROCESS-DRYING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                                                                                                                                                                                                                                                                                                                           |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| Amblen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Amblen          | Load Forced Air Dry                                                                                                                                                                                                                                                                                                       |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| Amblen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 110°F           | Increase temperature to 110 ± 5°F                                                                                                                                                                                                                                                                                         |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| 110°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 110°F           | Hold at temperature                                                                                                                                                                                                                                                                                                       |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| 110°F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Amblen          | Cool down for sampling                                                                                                                                                                                                                                                                                                    |                              |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="3">PROPELLANT COMPOSITION</th> <th colspan="3">TESTS OF FINISHED PROPELLANT</th> <th colspan="2">STABILITY AND PHYSICAL TESTS</th> </tr> <tr> <th>CONSTITUENT</th> <th>PERCENT FORMULA</th> <th>PERCENT TOLERANCE</th> <th>PERCENT ACTUAL</th> <th></th> <th>FORMULA</th> <th>ACTUAL</th> </tr> <tr> <td>Nitrocellulose</td> <td>N/A</td> <td>N/A</td> <td>50.62</td> <td>HEAT TEST @ 120°C</td> <td>CC 40'</td> <td>CC 60'+</td> </tr> <tr> <td>Nitroglycerin</td> <td>N/A</td> <td>N/A</td> <td>11.45</td> <td>No Fumes</td> <td>NF 1 hr</td> <td>NF 1 hr</td> </tr> <tr> <td>DEGDN</td> <td>N/A</td> <td>N/A</td> <td>19.24</td> <td>FORM OF PROPELLANT</td> <td></td> <td></td> </tr> <tr> <td>Akardite II</td> <td>N/A</td> <td>N/A</td> <td>0.71</td> <td>HOE (cal/cm)</td> <td>N/A</td> <td>1163</td> </tr> <tr> <td>Magnesium Oxide</td> <td>N/A</td> <td>N/A</td> <td>0.05</td> <td>Abs. Dens. (g/cc)</td> <td>N/A</td> <td>1.61</td> </tr> <tr> <td>Graphite</td> <td>N/A</td> <td>N/A</td> <td>0.05</td> <td>Talenti:</td> <td></td> <td></td> </tr> <tr> <td>RDY</td> <td>N/A</td> <td>N/A</td> <td>17.78</td> <td>Slope @ 100 mm Hg</td> <td>51.0 mm/min</td> <td>.349</td> </tr> <tr> <td>Ash</td> <td>N/A</td> <td>N/A</td> <td>0.09</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Moisture</td> <td>0.5</td> <td>±0.3</td> <td>0.2</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Methylene Cl Solubility</td> <td>N/A</td> <td>N/A</td> <td>31.40</td> <td></td> <td></td> <td></td> </tr> </table> |                 |                                                                                                                                                                                                                                                                                                                           |                              | PROPELLANT COMPOSITION          |             |                              | TESTS OF FINISHED PROPELLANT |                                |  | STABILITY AND PHYSICAL TESTS |  | CONSTITUENT | PERCENT FORMULA | PERCENT TOLERANCE | PERCENT ACTUAL |  | 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 |       |        | Akardite 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 | Talenti: |      |        | RDY | N/A  | N/A  | 17.78 | Slope @ 100 mm Hg | 51.0 mm/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 |  |  |  |
| PROPELLANT COMPOSITION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                                                                                                                                                                                                                                                                                                                           | TESTS OF FINISHED PROPELLANT |                                 |             | STABILITY AND PHYSICAL TESTS |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| CONSTITUENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PERCENT FORMULA | PERCENT TOLERANCE                                                                                                                                                                                                                                                                                                         | PERCENT ACTUAL               |                                 | 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              |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| Akardite 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                         | Talenti:                        |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| RDY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | N/A             | N/A                                                                                                                                                                                                                                                                                                                       | 17.78                        | Slope @ 100 mm Hg               | 51.0 mm/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                        |                                 |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">CLOSED BOMB</th> <th colspan="4">PROPELLANT DIMENSIONS (Inches)</th> </tr> <tr> <th>LOT NUMBER</th> <th>TEMP °F</th> <th>INITIAL WEIGHT</th> <th>FINAL WEIGHT</th> <th></th> <th>SPRINKLER</th> <th>DR</th> <th>FINISHED</th> </tr> <tr> <td>RT</td> <td>-40</td> <td>90.97</td> <td>101.69</td> <td>UNDER RJ</td> <td>N/A</td> <td>.648</td> <td>.656</td> </tr> <tr> <td></td> <td>+90</td> <td>92.47</td> <td>103.43</td> <td>QUARTER DI</td> <td>N/A</td> <td>.620</td> <td>.601</td> </tr> <tr> <td></td> <td>+145</td> <td>96.81</td> <td>106.25</td> <td>PERI DIA DI</td> <td>N/A</td> <td>.027</td> <td>.027</td> </tr> <tr> <td>STANDARD</td> <td>S-231</td> <td>90</td> <td>100.00</td> <td>Web Ave</td> <td>N/A</td> <td>.082</td> <td>.079</td> </tr> <tr> <td colspan="4" rowspan="6"> REMARKS:<br/><br/> 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. </td> <td>Inner</td> <td>N/A</td> <td>.088</td> <td>.078</td> </tr> <tr> <td>Middle</td> <td>N/A</td> <td>.091</td> <td>.076</td> </tr> <tr> <td>Outer</td> <td>N/A</td> <td>.067</td> <td>.082</td> </tr> <tr> <td>End of Extrusion / 1st 500 lb B</td> <td>N/A</td> <td></td> <td>2.77</td> </tr> <tr> <td>at Web Ave</td> <td>N/A</td> <td>1.05</td> <td>1.09</td> </tr> <tr> <td>End</td> <td>N/A</td> <td>22.96</td> <td>22.69</td> </tr> </table>                                                                                                                   |                 |                                                                                                                                                                                                                                                                                                                           |                              | CLOSED BOMB                     |             |                              |                              | PROPELLANT DIMENSIONS (Inches) |  |                              |  | LOT NUMBER  | TEMP °F         | INITIAL WEIGHT    | FINAL WEIGHT   |  | SPRINKLER | DR     | FINISHED       | RT  | -40 | 90.97 | 101.69            | UNDER RJ | N/A     | .648          | .656 |     | +90   | 92.47    | 103.43  | QUARTER DI | N/A   | .620 | .601 |       | +145               | 96.81 | 106.25 | PERI DIA DI | N/A | .027 | .027 | STANDARD     | S-231 | 90   | 100.00          | Web Ave | N/A | .082 | .079              | REMARKS:<br><br>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 | Middle | N/A | .091 | .076 | Outer | N/A               | .067        | .082 | End of Extrusion / 1st 500 lb B | N/A |     | 2.77 | at Web Ave | N/A | 1.05 | 1.09     | End | N/A  | 22.96 | 22.69 |  |  |                         |     |     |       |  |  |  |
| CLOSED BOMB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                                                                                                                                                                                                                                                                                                           |                              | PROPELLANT DIMENSIONS (Inches)  |             |                              |                              |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| LOT NUMBER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | TEMP °F         | INITIAL WEIGHT                                                                                                                                                                                                                                                                                                            | FINAL WEIGHT                 |                                 | SPRINKLER   | DR                           | FINISHED                     |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| RT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -40             | 90.97                                                                                                                                                                                                                                                                                                                     | 101.69                       | UNDER RJ                        | N/A         | .648                         | .656                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | +90             | 92.47                                                                                                                                                                                                                                                                                                                     | 103.43                       | QUARTER DI                      | N/A         | .620                         | .601                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | +145            | 96.81                                                                                                                                                                                                                                                                                                                     | 106.25                       | PERI DIA DI                     | N/A         | .027                         | .027                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| STANDARD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | S-231           | 90                                                                                                                                                                                                                                                                                                                        | 100.00                       | Web Ave                         | N/A         | .082                         | .079                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
| REMARKS:<br><br>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                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                                                                                                                                                                                                                                                                                           |                              | Middle                          | N/A         | .091                         | .076                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                                                                                                                                                                                                                                                                                           |                              | Outer                           | N/A         | .067                         | .082                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                                                                                                                                                                                                                                                                                           |                              | End of Extrusion / 1st 500 lb B | N/A         |                              | 2.77                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                                                                                                                                                                                                                                                                                           |                              | at Web Ave                      | N/A         | 1.05                         | 1.09                         |                                |  |                              |  |             |                 |                   |                |  |           |        |                |     |     |       |                   |          |         |               |      |     |       |          |         |            |       |      |      |       |                    |       |        |             |     |      |      |              |       |      |                 |         |     |      |                   |                                                                                                                                         |      |          |     |       |      |          |      |        |     |      |      |       |                   |             |      |                                 |     |     |      |            |     |      |          |     |      |       |       |  |  |                         |     |     |       |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                                                                                                                                                                                                                                                                                                           |                              | End                             | 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

DNX

HCL86H003-008

## PROPELLANT DESCRIPTION SHEET

EXEMPT-PARA 7-28  
AR 335-15

|                                                              |                                                               |
|--------------------------------------------------------------|---------------------------------------------------------------|
| COMPOSITION<br>2R20, 19 Perf Hexagonal Granular              | LOT NUMBER<br>HCL06H063-005                                   |
| SPECIFICATION<br>Honeywell Multics 6FB 086-057 & 6FB 086-081 | PACKED AMOUNT<br>488 Pounds                                   |
| MFG AT<br>RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.        | CONTRACT NUMBER<br>Honeywell Subcontract 947092, KE, T45X 110 |

|                                                  |                                                               |                                            |                                          |
|--------------------------------------------------|---------------------------------------------------------------|--------------------------------------------|------------------------------------------|
| ACCEPTED BLEND NUMBERS<br>B95085; B95091; B95092 | NITROGEN CONTENT<br>MAX 13.13 %<br>MIN 13.07 %<br>AVG 13.10 % | AT STARCH<br>(65.3°C)<br>MIN<br>MIN<br>MIN | STABILITY (134.5°C)<br>MIN<br>MIN<br>MIN |
|                                                  |                                                               | 45+ MIN                                    | 30+ MIN                                  |
|                                                  |                                                               | EXPLOSION NR                               |                                          |

## MANUFACTURE OF SOLVENTLESS PROPELLANT

|                           |                 |
|---------------------------|-----------------|
| PERCENTAGE REMIX TO WHOLE |                 |
| TEMPERATURE °<br>FROM TO  | PROCESS- DRYING |
| 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             | *TALIANI           | ≤1.0 HE/BB                   |           |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.05             |                    | MIN 21100mm                  | 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 SENSITV (g/cc) | N/A                          | 11.61     |
| MOISTURE                    | N/A             | N/A                          | 0.2              |                    |                              |           |
| METHYLENE CI SOLUBILITY     | N/A             | N/A                          | 31.40            |                    |                              |           |

| TESTED 80MB                  |         | PROPELLANT DIMENSIONS (INCHES) |               |
|------------------------------|---------|--------------------------------|---------------|
| LOT NUMBER                   | TEMP °F | PARAMETER                      | SPECIFICATION |
|                              |         | LENGTH (L)                     | N/A           |
|                              |         | DIAMETER (D)                   | N/A           |
|                              |         | PERF. DIA. (d)                 | N/A           |
| STANDARD                     | 100.00% | WEB AVG.                       | N/A           |
| REMARKS<br>NO DATA AVAILABLE |         | MIN                            | N/A           |
|                              |         | MID                            | N/A           |
|                              |         | OUTER                          | N/A           |
|                              |         | WEB DIFF                       | N/A           |
|                              |         | SD in % of                     | N/A           |
|                              |         | WEB AVG.                       | N/A           |
|                              |         | SD                             | N/A           |
|                              |         | OD                             | N/A           |

|                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------|
| TYPE OF PACKING CONTAINER<br>FIBER DRUMS: MIL-STD-652D                                                                   |
| REMARKS<br>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. SIMMONS, PROGRAM MANAGER |
|-------------------------------------|--------------------------------|

|                                             |  |                              |  |
|---------------------------------------------|--|------------------------------|--|
| N/A                                         |  | 47 Pounds                    |  |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. |  | Honeywell Subcontract 947092 |  |
| 95089; 95091; 95092                         |  | NITROCELLULOSE               |  |
| NITROGEN CONTENT                            |  | STABILITY (24 HRS)           |  |
| MAX 13.13 %                                 |  | MIN 13.07 %                  |  |
| AVG 13.10 %                                 |  | 65+ 70+                      |  |

| MANUFACTURE OF SOLVENTLESS PROPELLANT |         |                                   |   |
|---------------------------------------|---------|-----------------------------------|---|
| PROCESS-DRYING                        |         |                                   |   |
| 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 ANALYSIS | PERCENT ANALYSIS             | 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 |             |                              |  |  |
| Akardic II              | N/A             | N/A              | 0.71                         | HOF (cal/gr)       | 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:           |             |                              |  |  |
| 37Y                     | N/A             | N/A              | 17.78                        | Slope @ 100mmHg    | 51.0 mm/min | .349                         |  |  |
| 3sh                     | 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 | 90% DPT | 100% DPT | 101.69 | LENGTH IN                      | DIAMETER IN | WEIGHT | DATE  |  |
| 827                                                                                                                                | -40     | 90.97   | 101.69   |        | N/A                            | .660        | .670   |       |  |
|                                                                                                                                    | +90     | 92.47   | 103.43   |        | N/A                            | .639        | .617   |       |  |
|                                                                                                                                    | +145    | 96.81   | 104.25   |        | N/A                            | .020        | .021   |       |  |
| STANDARD                                                                                                                           | S-231   | 90      | 100 DPT  | 101.69 | Web Ave                        | N/A         | .090   | .086  |  |
| REMARKS<br>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   | .091  |  |
|                                                                                                                                    |         |         |          |        | Middle                         | N/A         | .099   | .078  |  |
|                                                                                                                                    |         |         |          |        | Outer                          | N/A         | .0655  | .090  |  |
|                                                                                                                                    |         |         |          |        | Web Ave                        | N/A         |        | 6.66  |  |
|                                                                                                                                    |         |         |          |        | Web Ave                        | N/A         | 1.03   | 1.09  |  |
|                                                                                                                                    |         |         |          |        | Web Ave                        | N/A         | 31.95  | 29.18 |  |

|                                                                                                                          |  |
|--------------------------------------------------------------------------------------------------------------------------|--|
| TYPE OF PACKING CONTAINER Fiber Drum: 652 D                                                                              |  |
| REMARKS<br>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 4CLB6H003-010 |
|------------------------|--------------------|

|                                                             |                              |
|-------------------------------------------------------------|------------------------------|
| COMPOSITION 2R10, 19 Perf. Hexagonal Granular               | DA LOT NUMBER HCL86H003-013  |
| DESCRIPTION Multics GER 086-323, 5/27/86                    | PACKED AMOUNT 173 Pounds     |
| MANUFACTURED BY RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER Honeywell    |
|                                                             | Subcontract 973525, Task III |

| ACCEPTED BOND NUMBERS  | NITROGEN CONTENT | EU STARCH (MAGN) | STABILITY (254.5°C) |
|------------------------|------------------|------------------|---------------------|
| B95089; B95091; B95092 | MAX 13.13 %      | MIN              |                     |
|                        | MIN 13.07 %      | MIN              |                     |
|                        | AVG 13.10 %      | 45+ MIN          | 30+                 |
|                        |                  |                  | EXPLOSION           |

### MANUFACTURE OF SOLVENTLESS PROPELLANT

| TEMPERATURE |    | PROCESS-DRYING | DAYS | HOURS |
|-------------|----|----------------|------|-------|
| FROM        | TO |                |      |       |
|             |    |                |      |       |
|             |    |                |      |       |
|             |    |                |      |       |
|             |    |                |      |       |

| PROPELLANT COMPOSITION  |                    | TESTS OF FINISHED PROPELLANT |                     |                    | STABILITY AND PHYSICAL TESTS |         |  |
|-------------------------|--------------------|------------------------------|---------------------|--------------------|------------------------------|---------|--|
| CONSTITUENT             | PERCENT<br>FORMULA | PERCENT<br>TOLERANCE         | PERCENT<br>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/cm³)      | 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                 |                    |                              | 0.5C±   |  |
| Methylene Cl Solubility | N/A                | N/A                          | 34.28               |                    |                              |         |  |
|                         |                    |                              |                     |                    |                              |         |  |
|                         |                    |                              |                     |                    |                              |         |  |

| MILITARY                                                                                                                                                   |            |         |                   |                   | PROPELLANT IN FIBER DRUM |               |       |          |                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|-------------------|-------------------|--------------------------|---------------|-------|----------|-----------------------------|
|                                                                                                                                                            | LOT NUMBER | TEMP °F | RELATIVE HUMIDITY | RELATIVE HUMIDITY |                          | SPECIFICATION | DE    | FINISHED |                             |
| TEST                                                                                                                                                       |            |         |                   |                   |                          |               |       |          |                             |
|                                                                                                                                                            | -013       | -40     | 105.45            | 104.19            | LENGTH (L)               | N/A           | .715  | .715     |                             |
|                                                                                                                                                            | -013       | +90     | 119.89            | 105.02            | DIAMETER (D)             | N/A           | .639  | .610     |                             |
|                                                                                                                                                            | -013       | +145    | 123.47            | 104.86            | PERF. DIA. (D)           | N/A           | .024  | .022     |                             |
| STANDARD                                                                                                                                                   | 472-138    | 90      | 100.00%           | 102.00%           | Web Avg.                 | N/A           | .088  | .084     | DATE                        |
| REMARKS:<br>The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138.<br><br>700cc bomb @ 0.10 gm/cc loading density. |            |         |                   |                   | Inner                    | N/A           | .104  | .092     | PACKED 8/86                 |
|                                                                                                                                                            |            |         |                   |                   | Middle                   | N/A           | .096  | .080     | SAMPLED 8/86                |
|                                                                                                                                                            |            |         |                   |                   | Outer                    | N/A           | .064  | .079     | TEST FINISHED 8/86          |
|                                                                                                                                                            |            |         |                   |                   | Web Avg.                 | N/A           | .073  | 6.76     | OFFERED 9/11/86             |
|                                                                                                                                                            |            |         |                   |                   | LD                       | N/A           |       | 1.17     | DISCUSSION SHEETS FORWARDED |
|                                                                                                                                                            |            |         |                   |                   | Od                       | 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*

SIGNATURE OF PROGRAM MANAGER  
R. L. SIMONS, PROGRAM MANAGER *R. L. Simons*

# PROPELLANT DESCRIPTION SHEET

1-82 235-15

|                                                     |                              |
|-----------------------------------------------------|------------------------------|
| COMPOSITION 2R10, 19 Perf. Hexagonal Granular       | SAFETY NUMBER HCL86H003-014  |
| INSPECTION Multics GER 086-323, 5/27/86             | PACKS WEIGHT 768 Pounds      |
| DATE 21 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER Honeywell    |
|                                                     | Subcontract 973525, Task III |

## NITROCELLULOSE

| ACCEPTED BRAND NUMBERS | NITROGEN CONTENT | SI STARCH (ALL %) | STABILITY (24.5°C) |
|------------------------|------------------|-------------------|--------------------|
| B95089; B95091; B95092 | MAX 13.13 %      | MIN               | MIN                |
|                        | MIN 13.07 %      | MIN               | MIN                |
|                        | AVE 13.10 %      | 45+               | 30+                |
|                        |                  |                   | EXPLOSION          |

## MANUFACTURE OF SOLVENTLESS PROPELLANT

| TEMPERATURE FROM | TO | PROCESS-DRYING | DAYS | HOURS |
|------------------|----|----------------|------|-------|
|                  |    |                |      |       |
|                  |    |                |      |       |
|                  |    |                |      |       |
|                  |    |                |      |       |
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|                  |    |                |      |       |
|                  |    |                |      |       |
|                  |    |                |      |       |

| PROPELLANT COMPOSITION  |                 | TESTS OF FINISHED PROPELLANT |                  |                    | STABILITY AND PHYSICAL TESTS |          |  |
|-------------------------|-----------------|------------------------------|------------------|--------------------|------------------------------|----------|--|
| CONSTITUENT             | PERCENT FORMULA | PERCENT TOLERANCE            | PERCENT MEASURED |                    | NO. 1                        | 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/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             | Talenti:           |                              |          |  |
| 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            |                    |                              |          |  |
|                         |                 |                              |                  |                    |                              |          |  |

| TESTED FOR                                                                                                                                                |            |         |                   |                   | TESTED FOR                                 |              |       |          | DATES                       |         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|-------------------|-------------------|--------------------------------------------|--------------|-------|----------|-----------------------------|---------|
|                                                                                                                                                           | LOT NUMBER | TEMP °F | RELATIVE HUMIDITY | RELATIVE HUMIDITY |                                            | SP. ORGATION | DR    | FINISHED |                             |         |
| TEST                                                                                                                                                      | -014       | -40     | 105.45            | 104.19            |                                            |              |       |          |                             |         |
|                                                                                                                                                           | -014       | +90     | 119.89            | 105.02            | LENGTH (L)                                 | N/A          | .709  | .710     |                             |         |
|                                                                                                                                                           | -014       | +145    | 123.47            | 104.86            | DIAMETER (D)                               | N/A          | .639  | .615     |                             |         |
|                                                                                                                                                           |            |         |                   |                   | PERF. DIA. (D)                             | N/A          | .020  | .022     | DATES                       |         |
| STANDARD                                                                                                                                                  | 472-138    | 90      | 100.00%           | 100.00%           | Web Avg.                                   | N/A          | .090  | .085     |                             |         |
| REMARKS<br>The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138.<br><br>700cc bomb @ 0.10 gm/cc loading density. |            |         |                   |                   | Inner                                      | N/A          | .106  | .092     | PACKED                      | 8/86    |
|                                                                                                                                                           |            |         |                   |                   | Middle                                     | N/A          | .099  | .079     | SAMPLED                     | 8/86    |
|                                                                                                                                                           |            |         |                   |                   | Outer                                      | N/A          | .0655 | .086     | TEST FINISHED               | 8/86    |
|                                                                                                                                                           |            |         |                   |                   | Web Thickness / Ind. Dev. to % of Web Avg. | N/A          |       | 7.04     | COVERED                     | 9/11/86 |
|                                                                                                                                                           |            |         |                   |                   | LD                                         | N/A          | 1.11  | 1.15     | DISCUSSION SHEETS FORWARDED |         |
|                                                                                                                                                           |            |         |                   |                   | 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 *DW Kirkpatrick*

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

# PROPELLANT DESCRIPTION SHEET

AR 335-15

|                                                     |                              |
|-----------------------------------------------------|------------------------------|
| COMPOSITION 2R10, 19 Perf. Hexagonal Granular       | DA LOT NUMBER HCL86H003-015  |
| DESCRIPTION Multics GER 086-123, 5/27/86            | PACKED AMOUNT 440 Pounds     |
| DATE 41 RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER 80549011     |
|                                                     | Subcontract 973525, Task III |

## NITROCELLULOSE

|                                                  |                  |                            |                    |
|--------------------------------------------------|------------------|----------------------------|--------------------|
| ACCEPTED BLIND NUMBERS<br>B95089, B95091, B95092 | NITROGEN CONTENT | WJ RASH (M/L) <sup>2</sup> | STABILITY (30.5°C) |
|                                                  | MAX 13.13 %      |                            |                    |
|                                                  | MIN 13.07 %      |                            |                    |
|                                                  | AVE 13.10 %      | 45+                        | 30+                |
|                                                  |                  |                            | EXPLOSION          |

## MANUFACTURE OF SOLVENTLESS PROPELLANT

| TEMPERATURE | PROCESS-DRYING | DATE | MOVT |
|-------------|----------------|------|------|
| FROM        | TO             |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |
|             |                |      |      |

| 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'    |
| 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 (cal/gm)                 | N/A       |
| Magnesium Oxide         | N/A                          | N/A               | 0.06             | Abs. Dens. (g/cc)            | N/A       |
| Graphite                | N/A                          | N/A               | 0.05             | Italiani:                    |           |
| RDX                     | N/A                          | N/A               | 10.52            | Slope @ 100mmHg              | 1.0mm/min |
| Ash                     | N/A                          | N/A               | 0.10             |                              |           |
| Moisture                | N/A                          | N/A               | 0.4              |                              |           |
| Methylene Cl Solubility | N/A                          | N/A               | 34.28            |                              |           |
|                         |                              |                   |                  |                              |           |
|                         |                              |                   |                  |                              |           |
|                         |                              |                   |                  |                              |           |

| LOT NUMBER                                                                                                                                                | TEMP °F  | RELATIVE HUMIDITY | RELATIVE MOISTURE | STORAGE        | DE               | FINISHED | DATE |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|-------------------|----------------|------------------|----------|------|
| TEST -015                                                                                                                                                 | -40      | 105.45            | 104.19            |                |                  |          |      |
| -015                                                                                                                                                      | +90      | 119.89            | 105.02            | LENGTH (L)     | N/A              | 732      | 735  |
| -015                                                                                                                                                      | +145     | 123.47            | 104.86            | DIAMETER (D)   | N/A              | 700      | 654  |
|                                                                                                                                                           |          |                   |                   | PERF. DIA. (D) | N/A              | .020     | .022 |
| STANDARD 472-138                                                                                                                                          | 90       | 100.00%           | 100.00%           | Web Avg.       | N/A              | .100     | .089 |
| REMARKS<br>The 2R10 was in sheet form (7.5" x .125" x .085") fired against the XM829 standard PE 472-138.<br><br>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     |      |
|                                                                                                                                                           | Web Avg. | N/A               | .114              | 4.84           | OFFERED          | 9/11/86  |      |
|                                                                                                                                                           | 10       | N/A               | 1.05              | 1.12           | DESCRIPTION SENT |          |      |
|                                                                                                                                                           | 35       | N/A               | 29.44             | FORWARDED      |                  |          |      |

|                           |                  |
|---------------------------|------------------|
| 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 <i>DH Kirkpatrick</i> | R. E. SIMONS <i>R. E. Simons</i> |
|------------------------------------------|-----------------------------------------|----------------------------------|

| SPECIFICATION 2R-20 19 Perf Stick<br>N/A<br>RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                     |                  | BCL86C004-001 ✓<br>500 Pounds<br>Honeywell Subcontract 932077                   |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------|------------------|---------------------------------------------------------------------------------|-------------------------------------|--------------------------------------------------------------------|--|----------------|--|--|------|------|------|----|-------|--|--|---------|---------|---------------------|--|--|---------|-------|-----------------------------------|--|--|-------|-------|---------------------|--|---|-------|---------|------------------------|--|--|
| RECEIVED BOMB NUMBER<br>95058: 95059: 95060                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                     |                  | NITROCELLULOSE<br>NITROGEN CONTENT<br>MAX 13.15 %<br>MIN 13.08 %<br>AVE 13.11 % |                                     | IN BATCH (94.9°C)<br>45+<br>STABILITY (94.9°C)<br>30+<br>EXPLOSION |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                     |                  |                                                                                 |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="3">PROCESS-DRYING</th> <th>DATE</th> <th>TEST</th> </tr> <tr> <td>From</td> <td>To</td> <td>Notes</td> <td></td> <td></td> </tr> <tr> <td>Ambient</td> <td>Ambient</td> <td>Load Forced Air Dry</td> <td></td> <td></td> </tr> <tr> <td>Ambient</td> <td>110°F</td> <td>Increase temperature to 110 ± 5°F</td> <td></td> <td></td> </tr> <tr> <td>110°F</td> <td>110°F</td> <td>Hold at temperature</td> <td></td> <td>4</td> </tr> <tr> <td>110°F</td> <td>Ambient</td> <td>Cool down for sampling</td> <td></td> <td></td> </tr> </table> |                 |                                     |                  |                                                                                 |                                     |                                                                    |  | PROCESS-DRYING |  |  | DATE | TEST | From | To | Notes |  |  | 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 |  |  |
| PROCESS-DRYING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |                                     | DATE             | TEST                                                                            |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| From                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To              | Notes                               |                  |                                                                                 |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| 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              |                  |                                                                                 |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| <b>PROPELLANT COMPOSITION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 | <b>TESTS OF FINISHED PROPELLANT</b> |                  |                                                                                 | <b>STABILITY AND PHYSICAL TESTS</b> |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| CONSTITUENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PERCENT FORMULA | PERCENT TOLERANCE                   | PERCENT MEASURED | TEST                                                                            | 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                                                              |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| Add II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | N/A             | N/A                                 | 0.64             | HOE (cal/gm)                                                                    | 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             | Talenti:                                                                        |                                     |                                                                    |  |                |  |  |      |      |      |    |       |  |  |         |         |                     |  |  |         |       |                                   |  |  |       |       |                     |  |   |       |         |                        |  |  |
| 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** | | | | **PROPELLANT DIMENSIONS (Inches)** | | | |
| LOT NUMBER | TEMP °F | RELATIVE HUMIDITY | RELATIVE FORCE | DESCRIPTION | DI | THICKNESS | DATE |
| WFI | -40 | 102.99 | 104.97 | LENGTH (L) | N/A | 8.0 |  |
|  | +90 | 118.06 | 106.86 | DIAMETER (DI) | N/A | .700 |  |
|  | +145 | 121.83 | 106.92 | PERF. DIA. (DI) | N/A | .021 |  |
| STANDARD | PF-472-138 | +90 | 100.00% | Web T | N/A | .113 |  |
| 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 |  |
| Web O | N/A | .077 |  |
| Web A | N/A | .099 |  |
| Web B | N/A |  |  |
| Web C | N/A | 6.67 |  |
| Web D | N/A | 11.43 |  |
|  |  |  |  | Web E | 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 | | | | Development Engineer   D.W. Kirkpatrick  *D. W. Kirkpatrick* | | | |

44 FOUR

Honeywell Subcontract 932077

| INSTRUMENT CONTROL | IN RANGE<br>(24.5°C) | RADIANTY (24.5°C) |
|--------------------|----------------------|-------------------|
| MAX 13.15          | MAX                  | MAX               |
| MIN 13.08          | MIN                  | MIN               |
| 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               |
| 110°F  | Ambien | Cool down for sampling            |

### PROPELLANT COMPOSITION

## TESTS OF FINISHED PROPELLANT

### STABILITY AND CRITICAL POINTS

| CONSTITUENT     | PERCENT<br>BY WEIGHT | PERCENT<br>BY VOLUME | PERCENT<br>BY WEIGHT | TEST METHOD              | FORMULA     | ACTUAL  |
|-----------------|----------------------|----------------------|----------------------|--------------------------|-------------|---------|
| Nitrocellulose  | N/A                  | N/A                  | 42.70                | HEAT SET @ 120°C         | CC 40'      | CC 60'4 |
| Nitroglycerin   | N/A                  | N/A                  | 13.12                | No Puffs                 | NF 1 hr     | NF 1 hr |
| DEGDN           | N/A                  | N/A                  | 23.16                | FORM OF PROPELLANT       |             |         |
| Alardit II      | N/A                  | N/A                  | 0.64                 | MOF (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                 | Tallent:                 |             |         |
| RDX (ground)    | 20                   | N/A                  | 20.30                | Slope @ 100mmHg          | 51.0 mm/min | *       |
|                 |                      |                      |                      | * pressure did not reach |             |         |
| Moisture        | N/A                  | N/A                  |                      | 100 mm Hg                |             |         |
| Ash             | N/A                  | N/A                  | 0.10                 |                          |             |         |

**TELEPHONE RECORDS - 10-608**

| TEST     | TEST NUMBER | TIME OF TEST | INITIALS | DATE    | TEST      | TEST NUMBER | TIME OF TEST | INITIALS | DATE                      |
|----------|-------------|--------------|----------|---------|-----------|-------------|--------------|----------|---------------------------|
|          |             |              |          |         |           |             |              |          |                           |
|          |             | -40          | 102.99   | 104.97  | UNION (A) | N/A         | 2.75         | 2.68     |                           |
|          |             | +90          | 118.06   | 106.86  | UNION (B) | N/A         | 700          | .678     |                           |
|          |             | +145         | 121.83   | 106.92  | UNION (C) | N/A         | .021         | .023     |                           |
| STANDARD | PE-472-138  | +90          | 100.00%  | 100.00% | Web Y     | N/A         | 113          | .092     | DATE                      |
|          |             |              |          |         | Web M     | N/A         | 108          | .087     | PACKED 3/86               |
|          |             |              |          |         | Web O     | N/A         | .077         | .104     | SAMPLED 3/86              |
|          |             |              |          |         | Web A     | N/A         | .099         | .094     | TEST RESULTS 3/86         |
|          |             |              |          |         | Web B     | N/A         |              | 6.67     | GRAPHED                   |
|          |             |              |          |         | Web C     | N/A         | 3.93         | 3.95     | DILUTION FACTOR FORWARDED |
|          |             |              |          |         | 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**

2R-20 19 perf stick HCL BG 004-002

Development Engineer  
D.W. Kirkpatrick

D. W. Gubert





|                                                             |  |                              |  |
|-------------------------------------------------------------|--|------------------------------|--|
| SPECIFICATION N/A                                           |  | WEIGHT 60 Pounds             |  |
| MANUFACTURED BY RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. |  | HONEYWELL Subcontract 932077 |  |
| NITROCELLULOSE                                              |  |                              |  |
| RECEIVED DATE 05058: 05059: 05060                           |  | STABILITY (30+°C)            |  |
|                                                             |  | EXPLOSION                    |  |

## MANUFACTURE OF SOLVENTLESS PROPELLANT

| PROCESS-DRYING |         |                                   | DATE |
|----------------|---------|-----------------------------------|------|
| TEMP           | TIME    | REMARKS                           | NO.  |
| 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 ANALYSIS             | PERCENT ACTUAL | 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           | Talenti:                 |                              |         |
| 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 |     |       |       | DATE                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|-------------------|-------------------|-----------------------|-----|-------|-------|--------------------------|
| TEST                                                                                                                                                    | LOT NUMBER | TEMP °F | RELATIVE HUMIDITY | RELATIVE PRESSURE | DESCRIPTION           | DI  | DI    | DI    |                          |
|                                                                                                                                                         |            | -40     | 102.99            | 104.97            | LENGTH (IN)           | N/A | 15.0  | 15.0  |                          |
|                                                                                                                                                         |            | +90     | 118.06            | 106.86            | DIAMETER (IN)         | N/A | 395   | 391   |                          |
|                                                                                                                                                         |            | +145    | 121.83            | 106.92            | PERF. DIA (IN)        | N/A | .025  | .0277 |                          |
| STANDARD                                                                                                                                                | PP-472-138 | +90     | 106.00%           | 106.00%           | Weight                |     |       |       |                          |
| 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  | PACKED 3/86              |
|                                                                                                                                                         |            |         |                   |                   | Outer                 | N/A | .082  | .077  | SAMPLE 3/86              |
|                                                                                                                                                         |            |         |                   |                   | Ave.                  | N/A | .082  | .077  | TEST RESULTS 3/86        |
|                                                                                                                                                         |            |         |                   |                   | Wt. of Propellant     | N/A | 1.22  | .04   | OTHER                    |
|                                                                                                                                                         |            |         |                   |                   | Wt. of Wax            | N/A | 37.97 | 38.36 | STRENGTH TESTS FORWARDED |
|                                                                                                                                                         |            |         |                   |                   | Wt. of Wax            | 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                              | UNCLASIFIED                                  |
| DESCRIPTION N/A                                             | WEIGHT 30 Pounds                             |
| MANUFACTURED BY RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER Honeywell Subcontract 932077 |
| NITROCELLULOSE                                              |                                              |
| RECEIVED DATE 9505R: 95059: 95060                           | STABILITY (30-5°C)                           |
| INTERMEDIATE CONTENT                                        | STABILITY (30-5°C)                           |
| MAX 13.15                                                   | MIN 13.08                                    |
| MAX 13.11                                                   | MIN 13.08                                    |
| AVE 13.11                                                   | MIN 13.08                                    |
| 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 FORMULA              | PERCENT FORMULA | FORMULA                      | ACTUAL    |
| Nitrocellulose         | N/A             | N/A                          | 42.70           | WEAT TEST @ 120°C            | CC 60'±   |
| 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            | Tallini:                     | 1.62      |
| RDX (ground)           | 20              | N/A                          | 20.30           | Slope @ 100mmHg              | 1.0mm/min |
|                        |                 |                              |                 | * pressure did not reach     |           |
| Moisture               | N/A             | N/A                          |                 | 100mmHg                      |           |
| Ash                    | N/A             | N/A                          | 0.10            |                              |           |

| CLOSED BOMB                                                                                                                                                |            | PROPELLANT DIMENSIONS (inches) |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------|-------------|
| LOT NUMBER                                                                                                                                                 | TEMP °F    | DIAMETER (in)                  | LENGTH (in) |
| 48                                                                                                                                                         | -40        | 102.99                         | 104.97      |
|                                                                                                                                                            | +90        | 118.06                         | 106.86      |
|                                                                                                                                                            | +145       | 121.83                         | 106.92      |
| STANDARD                                                                                                                                                   | PF-472-138 | +90                            | 100.00%     |
| REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085".<br>700 cc bomb with a 0.1 gm/cc loading density. |            | Inner                          | N/A         |
|                                                                                                                                                            |            | Outer                          | N/A         |
|                                                                                                                                                            |            | Ave.                           | N/A         |
|                                                                                                                                                            |            | Net Wt. (g)                    | N/A         |
|                                                                                                                                                            |            | Net Wt. (lb)                   | N/A         |
|                                                                                                                                                            |            | Net Wt. (oz)                   | N/A         |

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

|                                             |  |                              |  |
|---------------------------------------------|--|------------------------------|--|
| 2R-20 7 Port Stick                          |  | WEIGHT 30 pounds             |  |
| N/A                                         |  | Honeywell Subcontract 932077 |  |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. |  |                              |  |
| NITROCELLULOSE                              |  |                              |  |
| R9505R: 95059: 95060                        |  | NITROGEN CONTENT             |  |
|                                             |  | BY GRAIN (MAX %)             |  |
|                                             |  | MAX 13.15 %                  |  |
|                                             |  | MIN 13.08 %                  |  |
|                                             |  | AVE 13.11 %                  |  |
|                                             |  | 45+ %                        |  |
|                                             |  | 30+ %                        |  |
|                                             |  | LITROGEN                     |  |
| MANUFACTURE OF SOLVENTLESS PROPELLANT       |  |                              |  |

| PROCESS-DRYING |         |                                   | DAY | MO |
|----------------|---------|-----------------------------------|-----|----|
| 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 | PURITY TOLERANCE             | PURITY MAXIMUM | FORMULA                      | ACTUAL     |
| Nitrocellulose         | N/A            | N/A                          | 42.70          | HEAT TST @ 120°C             | CC 40'     |
| Nitroglycerin          | N/A            | N/A                          | 13.12          | No Fumes                     | NF 1 hr    |
| DEGDN                  | N/A            | N/A                          | 23.16          | ROCK OF PROPELLANT           |            |
| Akardit II             | N/A            | N/A                          | 0.64           | HOF (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           | 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                                                                                                                                                |            |                        |                     | PROPELLANT DIMENSIONS (INCHES) |     |          |                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------|---------------------|--------------------------------|-----|----------|-------------------|
| LOT NUMBER                                                                                                                                                 | TEMP °F    | INITIAL PRESSURE (PSI) | INITIAL VOLUME (CC) | DESCRIPTION                    | OR  | FINISHED | DATE              |
| N/A                                                                                                                                                        | -40        | 102.99                 | 104.97              | LENGTH (L)                     | N/A | 15.0     |                   |
|                                                                                                                                                            | +90        | 118.06                 | 106.86              | DIAMETER (D)                   | N/A | .471     |                   |
|                                                                                                                                                            | +145       | 121.83                 | 106.92              | WEIGHT (W)                     | N/A | .025     |                   |
| STANDARD                                                                                                                                                   | PF-472-138 | +90                    | 102.99              | Web                            |     |          |                   |
| REMARKS: These are the closed bomb results for carpet rolls cut to strips of dimensions 7.5"x.125"x.085".<br>700 cc bomb with a 0.1 gm/cc loading density. |            |                        |                     | Inner                          | N/A | .104     | PACKED 3/86       |
|                                                                                                                                                            |            |                        |                     | Outer                          | N/A | .096     | LAMPED 3/86       |
|                                                                                                                                                            |            |                        |                     | Ave.                           | N/A | .100     | TEST RESULTS 3/86 |
|                                                                                                                                                            |            |                        |                     | Net Weight                     | N/A | -8.33    | COILED            |
|                                                                                                                                                            |            |                        |                     | Net Weight                     | N/A | 31.85    | DISSEMINATION     |
|                                                                                                                                                            |            |                        |                     | Net Weight                     | N/A | 18.84    | 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 \_\_\_\_\_ Development Engineer  
 D.W. Kirkpatrick  
 D.W. Kirkpatrick

2R-20 19 Perf Stick

NET WEIGHT 399 pounds

N/A

BADFORD ARMY AMMUNITION PLANT, BADFORD, VA.

Honeywell Subcontract 932077

NITROCELLULOSE

RECEIVED DATE NUMBER  
95058: 95059: 95060

| INITIAL CONTENT | BY BRANCH | STABILITY (24.5°C) |
|-----------------|-----------|--------------------|
| RAW 13.15       | RAW       | RAW                |
| RAW 13.08       | RAW       | RAW                |
| AVE 13.11       | 45+       | 30+                |
|                 |           | EXPLOSION          |

MANUFACTURE OF SOLVENTLESS PROPELLANT

PROCESS-DRYING

|         |         |                                   |
|---------|---------|-----------------------------------|
| 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 MEASURED | TEST METHOD        | FORMULA   | ACTUAL  |
|-----------------|-----------------|-------------------|------------------|--------------------|-----------|---------|
| Nitrocellulose  | N/A             | N/A               | 42.68            | WEAT TEST @ 120°C  | CC 40'    | CC 40'± |
| 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             | Tallant:           |           |         |
| BDX (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               |                  |                    |           |         |

TEST DATA

PROPELLANT DIMENSIONS (inches)

| TEST     | LOT NUMBER                                                                                                                                     | TEMP °F | INITIAL WEIGHT | RELATIVE HUMIDITY | SPECIFICATION  | RE  | FINISHED | DATE |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------------|-------------------|----------------|-----|----------|------|
|          |                                                                                                                                                | -40     | 113.55         | 105.86            | LENGTH (L)     | N/A | 8.0      | 8.0  |
|          |                                                                                                                                                | +90     | 123.05         | 107.30            | DIAMETER (D)   | N/A | .700     | .675 |
|          |                                                                                                                                                | +145    | 124.88         | 106.28            | PERF. DIA. (H) | 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 |
|          |                                                                                                                                                |         |                |                   | Web O          | N/A | .077     | .093 |
|          |                                                                                                                                                |         |                |                   | Web A          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web B          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web C          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web D          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web E          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web F          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web G          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web H          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web I          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web J          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web K          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web L          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web M          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web N          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web O          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web P          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web Q          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web R          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web S          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web T          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web U          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web V          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web W          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web X          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web Y          | N/A | .099     | .095 |
|          |                                                                                                                                                |         |                |                   | Web Z          | N/A | .099     | .095 |

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



|                                                                                                                                                                                                                                                                                     |                 |                                                                     |                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------------|------------------------------|
| 25-20 19 Perf Stick                                                                                                                                                                                                                                                                 |                 | 31 Pounds                                                           |                              |
| N/A                                                                                                                                                                                                                                                                                 |                 | Honeywell Subcontract 932077                                        |                              |
| <b>NITROCELLULOSE</b>                                                                                                                                                                                                                                                               |                 |                                                                     |                              |
| RECEIVED LAB NUMBER<br>895058; 95059; 95060                                                                                                                                                                                                                                         |                 | NITROGEN CONTENT                                                    | STABILITY (24Hr)             |
|                                                                                                                                                                                                                                                                                     |                 | MAX 13.15 %                                                         | 30+                          |
|                                                                                                                                                                                                                                                                                     |                 | MIN 13.08 %                                                         |                              |
|                                                                                                                                                                                                                                                                                     |                 | AVG 13.11 %                                                         |                              |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                                                                                                                                                                        |                 |                                                                     |                              |
| <b>PROCESS-DRYING</b>                                                                                                                                                                                                                                                               |                 |                                                                     |                              |
| From                                                                                                                                                                                                                                                                                | To              | Load Forced Air Dry                                                 | Days                         |
| Ambient                                                                                                                                                                                                                                                                             | Ambient         | Increase temperature to 110 ± 5°F                                   |                              |
| 110°F                                                                                                                                                                                                                                                                               | 110°F           | Hold at temperature                                                 | 4                            |
| 110°F                                                                                                                                                                                                                                                                               | Ambient         | Cool down for sampling                                              |                              |
| <b>PROPELLANT COMPOSITION</b>                                                                                                                                                                                                                                                       |                 | <b>TESTS OF FINISHED PROPELLANT</b>                                 |                              |
| CONSTITUENT                                                                                                                                                                                                                                                                         | PERCENT FORMULA | PERCENT ANALYSIS                                                    | STABILITY AND PHYSICAL TESTS |
| Nitrocellulose                                                                                                                                                                                                                                                                      | N/A             | 42.68                                                               | HEAT TEST @ 120°C CC 40'     |
| Nitroglycerin                                                                                                                                                                                                                                                                       | N/A             | 13.48                                                               | No Fumes NF 1 hr             |
| 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:                     |
| BDX (class I)                                                                                                                                                                                                                                                                       | 20              | 20.92                                                               | Slope @ 100mmHg              |
| Moisture                                                                                                                                                                                                                                                                            | N/A             | 0.10                                                                | 31.0mm/min                   |
| Ash                                                                                                                                                                                                                                                                                 | N/A             |                                                                     | 0.260                        |
| <b>FINISHED BOMB</b>                                                                                                                                                                                                                                                                |                 | <b>PROPELLANT DIMENSIONS (inches)</b>                               |                              |
| LOT NUMBER                                                                                                                                                                                                                                                                          | TEMP °F         | WEIGHT G/CM <sup>3</sup>                                            | RELATIVE DENSITY             |
| 40                                                                                                                                                                                                                                                                                  | 113.53          | 105.86                                                              |                              |
| 90                                                                                                                                                                                                                                                                                  | 123.05          | 107.30                                                              |                              |
| 145                                                                                                                                                                                                                                                                                 | 124.88          | 106.28                                                              |                              |
| STANDARD                                                                                                                                                                                                                                                                            | PE-472-138      | 90                                                                  | 106.00%                      |
| <b>REMARKS</b><br>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 (in)                                                         | 1.6                          |
|                                                                                                                                                                                                                                                                                     |                 | DIAMETER (in)                                                       | .675                         |
|                                                                                                                                                                                                                                                                                     |                 | PERF. DIA (in)                                                      | .022                         |
|                                                                                                                                                                                                                                                                                     |                 | Web I                                                               | .113                         |
|                                                                                                                                                                                                                                                                                     |                 | Web M                                                               | .108                         |
|                                                                                                                                                                                                                                                                                     |                 | Web O                                                               | .077                         |
|                                                                                                                                                                                                                                                                                     |                 | Web A                                                               | .099                         |
|                                                                                                                                                                                                                                                                                     |                 | Web B                                                               | .095                         |
|                                                                                                                                                                                                                                                                                     |                 | Web C                                                               | 4.95                         |
|                                                                                                                                                                                                                                                                                     |                 | Web D                                                               | 2.29                         |
|                                                                                                                                                                                                                                                                                     |                 | Web E                                                               | 33.33                        |
|                                                                                                                                                                                                                                                                                     |                 | Web F                                                               | 30.68                        |
| TYPE OF PACKING CONTAINER Wood Box No. 327041, Barrier Bag No. 327041, Carton No. 327146<br>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<br>D.W. Kirkpatrick<br><i>D.W. Kirkpatrick</i> |                              |

SPECIFICATION N/A

PROCESS 30 FUMES

RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.

CONTRACT NUMBER  
Honeywell Subcontract 932077

## NITROCELLULOSE

ACCEPTED CASE NUMBER

895058; 93059; 95060

NITROGEN CONTENT

ID STAGE  
(HLS °C)

STABILITY (HLS °C)

MAX 13.15 %

MIN

MIN

MIN 13.08 %

MIN

MIN

AVE 13.11 %

45+

30+

EXPLOSION

## MANUFACTURE OF SOLVENTLESS PROPELLANT

| TEMPERATURE |         | PROCESS-DRYING                    |  | TIME |       |
|-------------|---------|-----------------------------------|--|------|-------|
| FROM        | TO      |                                   |  | DAYS | HOURS |
| 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 ANALYSIS             | PERCENT ANALYSIS |                    | 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/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             | Tallent:           |                              |         |
| 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 PRESSURE | INITIAL WEIGHT |                                   | SPOTGON | DE    | FINISHED |
| N/A                                                                                                                                                       |            |                  |                | LENGTH (L)                        | N/A     | 15.0  | 15.0     |
|                                                                                                                                                           | -40        | 113.53           | 105.86         | DIAMETER (D)                      | N/A     | .395  | .387     |
|                                                                                                                                                           | +90        | 123.05           | 107.30         | WEIGHT (W)                        | N/A     | .025  | .026     |
|                                                                                                                                                           | +145       | 124.88           | 106.28         |                                   |         |       |          |
| STANDARD                                                                                                                                                  | PE-472-138 | +90              | 113.00         | 106.00                            | Weight  |       |          |
| REMARKS<br>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     |
|                                                                                                                                                           |            |                  |                | Outer                             | N/A     | .082  | .077     |
|                                                                                                                                                           |            |                  |                | Ave                               | N/A     | .082  | .077     |
|                                                                                                                                                           |            |                  |                | Wt of 1000 ft of 7.3"x.125"x.085" | N/A     | 2.22  | -1.51    |
|                                                                                                                                                           |            |                  |                | LD                                | N/A     | 37.97 | 38.76    |
|                                                                                                                                                           |            |                  |                | SD                                | N/A     | 15.80 | 14.88    |
|                                                                                                                                                           |            |                  |                | DATE                              |         |       |          |
|                                                                                                                                                           |            |                  |                | PACKED 3/86                       |         |       |          |
|                                                                                                                                                           |            |                  |                | SAMPLED 3/86                      |         |       |          |
|                                                                                                                                                           |            |                  |                | TEST FINISHED 3/86                |         |       |          |
|                                                                                                                                                           |            |                  |                | COPIED                            |         |       |          |
|                                                                                                                                                           |            |                  |                | STATION DATA 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

2R20 7 port stick

HCL86C006-004 ✓

Development Engineer  
D.W. Kirkpatrick

D.W. Kirkpatrick



|                                                                                                                                                                                         |                 |                                                                                                                                                                                                                                                           |                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| N/A                                                                                                                                                                                     |                 | 45 Pounds                                                                                                                                                                                                                                                 |                  |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                                                                             |                 | Moneywell Subcontract 932077                                                                                                                                                                                                                              |                  |
| NITROCELLULOSE                                                                                                                                                                          |                 |                                                                                                                                                                                                                                                           |                  |
| 95058: 95059: 95060                                                                                                                                                                     |                 | NITROGEN CONTENT<br>MAX 13.15 %<br>MIN 13.08 %<br>AVE 13.11 %                                                                                                                                                                                             |                  |
|                                                                                                                                                                                         |                 | IN POUCH<br>45+                                                                                                                                                                                                                                           |                  |
|                                                                                                                                                                                         |                 | STABILITY (30.5°C)<br>30+                                                                                                                                                                                                                                 |                  |
| MANUFACTURE OF SOLVENTLESS PROPELLANT                                                                                                                                                   |                 |                                                                                                                                                                                                                                                           |                  |
| PROCESS-DRYING                                                                                                                                                                          |                 |                                                                                                                                                                                                                                                           |                  |
| Ambient                                                                                                                                                                                 |                 | Load Forced Air Dry                                                                                                                                                                                                                                       |                  |
| Ambient 110°F                                                                                                                                                                           |                 | Increase temperature to 110 ± 5°F                                                                                                                                                                                                                         |                  |
| 110°F                                                                                                                                                                                   |                 | Hold at temperature                                                                                                                                                                                                                                       |                  |
| 110°F                                                                                                                                                                                   |                 | Cool down for sampling                                                                                                                                                                                                                                    |                  |
| TESTS OF FINISHED PROPELLANT                                                                                                                                                            |                 |                                                                                                                                                                                                                                                           |                  |
| PROPELLANT COMPOSITION                                                                                                                                                                  |                 | STABILITY AND PHYSICAL TESTS                                                                                                                                                                                                                              |                  |
| CONSTITUENT                                                                                                                                                                             | PERCENT FORMULA | PERCENT TOLERANCE                                                                                                                                                                                                                                         | PERCENT MEASURED |
| Nitrocellulose                                                                                                                                                                          | N/A             | N/A                                                                                                                                                                                                                                                       | 42.68            |
| Nitroglycerin                                                                                                                                                                           | N/A             | N/A                                                                                                                                                                                                                                                       | 13.48            |
| DEGDN                                                                                                                                                                                   | N/A             | N/A                                                                                                                                                                                                                                                       | 22.08            |
| Akardit II                                                                                                                                                                              | N/A             | N/A                                                                                                                                                                                                                                                       | 0.77             |
| Magnesium Oxide                                                                                                                                                                         | N/A             | N/A                                                                                                                                                                                                                                                       | 0.03             |
| Graphite                                                                                                                                                                                | N/A             | N/A                                                                                                                                                                                                                                                       | 0.04             |
| RDY (class T)                                                                                                                                                                           | 20              | N/A                                                                                                                                                                                                                                                       | 20.92            |
| Moisture                                                                                                                                                                                | N/A             | N/A                                                                                                                                                                                                                                                       | 0.10             |
| Ash                                                                                                                                                                                     | N/A             | N/A                                                                                                                                                                                                                                                       |                  |
| FORMULA                                                                                                                                                                                 |                 | ACTUAL                                                                                                                                                                                                                                                    |                  |
| CC 40'                                                                                                                                                                                  |                 | CC 60'                                                                                                                                                                                                                                                    |                  |
| NF 1 hr                                                                                                                                                                                 |                 | NF 1 hr                                                                                                                                                                                                                                                   |                  |
| FORM OF PROPELLANT                                                                                                                                                                      |                 |                                                                                                                                                                                                                                                           |                  |
| HOF (cal/cm)                                                                                                                                                                            |                 | N/A                                                                                                                                                                                                                                                       |                  |
| Abs. Dens. (g/cc)                                                                                                                                                                       |                 | N/A                                                                                                                                                                                                                                                       |                  |
| Tallini:                                                                                                                                                                                |                 |                                                                                                                                                                                                                                                           |                  |
| Slope @ 100mmHg                                                                                                                                                                         |                 | 1.0mm/min                                                                                                                                                                                                                                                 |                  |
|                                                                                                                                                                                         |                 | 0.260                                                                                                                                                                                                                                                     |                  |
| CLOSED BOMB                                                                                                                                                                             |                 |                                                                                                                                                                                                                                                           |                  |
| LOT NUMBER                                                                                                                                                                              | TEMP °F         | INITIAL G/C                                                                                                                                                                                                                                               | FINAL G/C        |
|                                                                                                                                                                                         | -40             | 113.53                                                                                                                                                                                                                                                    | 105.86           |
|                                                                                                                                                                                         | +90             | 123.05                                                                                                                                                                                                                                                    | 107.30           |
|                                                                                                                                                                                         | +145            | 124.88                                                                                                                                                                                                                                                    | 106.28           |
| STANDARD                                                                                                                                                                                | PE-472-138      | +90                                                                                                                                                                                                                                                       | 106.00%          |
| 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.                                                                                                            |                  |
|                                                                                                                                                                                         |                 | SPECIFICATION<br>LENGTH (IN) N/A 15.0 15.0<br>DIAMETER (IN) N/A .471 .462<br>PIST DIA (IN) N/A .025 .025<br>Webe<br>Inner N/A .104 .101<br>Outer N/A .096 .093<br>Ave. N/A .100 .097<br>N/A N/A -8.33 -8.23<br>N/A N/A 31.85 32.47<br>N/A N/A 18.84 18.57 |                  |
|                                                                                                                                                                                         |                 | DATE<br>PACKED 3/86<br>SAMPLED 3/86<br>TEST FINISHED 3/86<br>DISPATCHED 3/86<br>DISPATCHED 3/86                                                                                                                                                           |                  |
| TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Cartron 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. |                 |                                                                                                                                                                                                                                                           |                  |

|                                                                                                                                                                  |                                                                                                                  |                                                                                                                                |                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>DESCRIPTION</b> 2R-20 19 Perf Stick (JAX)                                                                                                                     |                                                                                                                  | <b>DA FORM NUMBER</b> NCL86H008-001                                                                                            |                                                                                                             |
| <b>OPERATION</b> N/A                                                                                                                                             |                                                                                                                  | <b>PACKING WEIGHT</b> 700 Pounds                                                                                               |                                                                                                             |
| <b>MANUFACTURED AT</b> RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                               |                                                                                                                  | <b>CONTRACT NUMBER</b> Honeywell Subcontract 932077                                                                            |                                                                                                             |
| <b>INITIALS</b>                                                                                                                                                  |                                                                                                                  |                                                                                                                                |                                                                                                             |
| <b>RECEIVED DATE NUMBER</b><br>895089; 95091; 95092                                                                                                              |                                                                                                                  | <b>INITIAL CONTENT</b><br>MAX 13.13<br>MIN 13.07<br>AVG 13.10                                                                  | <b>STANDARD (MAX)</b><br>45+<br>30+                                                                         |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                                                     |                                                                                                                  |                                                                                                                                |                                                                                                             |
| <b>PROCESS-DRYING</b>                                                                                                                                            |                                                                                                                  |                                                                                                                                |                                                                                                             |
| <b>AMBIENT</b> Ambient<br>110°F 110°F<br>110°F 110°F<br>110°F Ambient                                                                                            | <b>LOAD FORCED AIR DRY</b><br>Increase temperature to 110 ± 5°F<br>Hold at temperature<br>Cool down for sampling |                                                                                                                                |                                                                                                             |
| <b>PROPELLANT COMPOSITION</b>                                                                                                                                    |                                                                                                                  | <b>TESTS OF FINISHED PROPELLANT</b>                                                                                            |                                                                                                             |
| <b>CONSTITUENT</b><br>Nitrocellulose<br>Nitroglycerin<br>DEGDN<br>Alardit II<br>Magnesium Oxide<br>Graphite<br>RDX<br>Ash<br>Moisture<br>Methylene Cl Solubility | <b>PERCENT FORMULA</b><br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>0.5<br>N/A                            | <b>PERCENT TOLERANCE</b><br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>±0.3<br>N/A                                       | <b>PERCENT MEASURED</b><br>50.64<br>11.45<br>19.24<br>0.71<br>0.05<br>0.05<br>17.78<br>0.09<br>0.2<br>31.40 |
|                                                                                                                                                                  |                                                                                                                  | <b>STABILITY AND PHYSICAL TESTS</b>                                                                                            |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>HEAT TEST @ 120°C</b><br>No Fumes<br>FORM OF PROPELLANT<br>HOF (cal/cm)<br>Abs. Dens. (g/cc)<br>Taliani:<br>Slope @ 100mmHg | <b>FORMULA</b><br>CC 40'<br>NF 1 hr<br>N/A<br>N/A<br>Si. 0mm/min                                            |
|                                                                                                                                                                  |                                                                                                                  | <b>ACTUAL</b><br>CC 60'+<br>NF 1 hr<br>1163<br>1.61<br>.349                                                                    |                                                                                                             |
| <b>CLOSED BOMB</b>                                                                                                                                               |                                                                                                                  | <b>PROPELLANT DIMENSIONS (Inches)</b>                                                                                          |                                                                                                             |
| <b>LOT NUMBER</b><br>TEST<br>STANDARD S-231                                                                                                                      | <b>TEMP °F</b><br>-40<br>+90<br>+145<br>90                                                                       | <b>INITIAL WEIGHT</b><br>90.97<br>92.47<br>96.81<br>100.00                                                                     | <b>FINAL WEIGHT</b><br>101.69<br>103.43<br>104.25<br>100.00                                                 |
| <b>REMARKS</b><br><br>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.                    |                                                                                                                  | <b>SPORCATION</b><br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A<br>N/A                                                             | <b>DR</b><br>8.0<br>.700<br>.023<br>.099<br>.115<br>.106<br>.075<br>9.57<br>11.43<br>30.43                  |
|                                                                                                                                                                  |                                                                                                                  | <b>RIMMED</b><br>8.0<br>.683<br>.024<br>.094<br>.093<br>.081<br>.107<br>11.71<br>28.21                                         | <b>DATE</b><br>8/86<br>8/86<br>8/86<br>8/86<br>8/86<br>8/86<br>8/86<br>8/86<br>8/86<br>8/86                 |
|                                                                                                                                                                  |                                                                                                                  | <b>PACKED</b> 8/86                                                                                                             |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>SAMPLED</b> 8/86                                                                                                            |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>TEST FINISHED</b> 8/86                                                                                                      |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>COPIED</b>                                                                                                                  |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>DISCUSSION SHEET</b>                                                                                                        |                                                                                                             |
|                                                                                                                                                                  |                                                                                                                  | <b>FORWARDED</b>                                                                                                               |                                                                                                             |
| <b>TYPE OF PACKING CONTAINER</b> Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146                                                                  |                                                                                                                  |                                                                                                                                |                                                                                                             |
| <b>REMARKS</b><br>Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.                                  |                                                                                                                  |                                                                                                                                |                                                                                                             |

|                                                                                                                         |                 |                                   |                   |
|-------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------|-------------------|
| N/A                                                                                                                     |                 | 72 Pounds                         |                   |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                             |                 | Honeywell Subcontract 932077      |                   |
| B95089; 95091; 95092                                                                                                    |                 | NITROCELLULOSE                    |                   |
| NITROGEN CONTENT                                                                                                        |                 | NITROGEN                          |                   |
| 13.13                                                                                                                   |                 | 13.07                             |                   |
| 13.10                                                                                                                   |                 | 45+                               |                   |
| 30+                                                                                                                     |                 | NITROGEN                          |                   |
| MANUFACTURE OF SOLVENTLESS PROPELLANT                                                                                   |                 |                                   |                   |
| PROCESS-DRYING                                                                                                          |                 |                                   |                   |
| Ambient                                                                                                                 |                 | Load Forced Air Dr.               |                   |
| 110°F                                                                                                                   |                 | Increase temperature to 110 ± 5°F |                   |
| 110°F                                                                                                                   |                 | Hold at temperature               |                   |
| 110°F                                                                                                                   |                 | Cool down for sampling            |                   |
| TESTS OF FINISHED PROPELLANT                                                                                            |                 |                                   |                   |
| PROPELLANT COMPOSITION                                                                                                  |                 | STABILITY AND PHYSICAL TESTS      |                   |
| CONSTITUENT                                                                                                             | PERCENT FORMULA | PERCENT TOLUENE                   | PERCENT DIABASE   |
| Nitrocellulose                                                                                                          | N/A             | N/A                               | 50.64             |
| Nitroglycerin                                                                                                           | N/A             | N/A                               | 11.45             |
| DEGDN                                                                                                                   | N/A             | N/A                               | 19.24             |
| Akardir II                                                                                                              | N/A             | N/A                               | 0.71              |
| Magnesium Oxide                                                                                                         | N/A             | N/A                               | 0.05              |
| Graphite                                                                                                                | N/A             | N/A                               | 0.05              |
| RDY                                                                                                                     | N/A             | N/A                               | 17.78             |
| Ash                                                                                                                     | N/A             | N/A                               | 0.09              |
| Moisture                                                                                                                | 0.5             | ±0.3                              | 0.2               |
| Methylene Cl Solubility                                                                                                 | N/A             | N/A                               | 31.40             |
| HEAT TEST @ 120°C                                                                                                       |                 | FORMULA                           |                   |
| No Fumes                                                                                                                |                 | CC 40'                            |                   |
| FORM OF PROPELLANT                                                                                                      |                 | NF 1 hr                           |                   |
| HOF (cal/cm)                                                                                                            |                 | N/A                               |                   |
| Abs. Dens. (g/cc)                                                                                                       |                 | N/A                               |                   |
| Talliani:                                                                                                               |                 | 1163                              |                   |
| Slope @ 100mmHg                                                                                                         |                 | 1.61                              |                   |
| S1.0cc/min                                                                                                              |                 | .349                              |                   |
| CLOSED BOMB                                                                                                             |                 |                                   |                   |
| LOT NUMBER                                                                                                              | TEMP °F         | RELATIVE HUMIDITY                 | RELATIVE HUMIDITY |
| -40                                                                                                                     | 90.97           | 101.69                            |                   |
| +90                                                                                                                     | 92.47           | 103.43                            |                   |
| +145                                                                                                                    | 96.81           | 104.25                            |                   |
| STANDARD                                                                                                                | 5-231           | 90                                | 100.00            |
| REMARKS                                                                                                                 |                 | PROPELLANT DIMENSIONS (Inches)    |                   |
| 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. |                 | SPORCATION                        | DE                |
|                                                                                                                         |                 | Inner                             | N/A               |
|                                                                                                                         |                 | Middle                            | N/A               |
|                                                                                                                         |                 | Outer                             | N/A               |
|                                                                                                                         |                 | Web Ave                           | N/A               |
|                                                                                                                         |                 | Inner                             | N/A               |
|                                                                                                                         |                 | Middle                            | N/A               |
|                                                                                                                         |                 | Outer                             | N/A               |
| DATE                                                                                                                    |                 | PACKED 8/86                       |                   |
| DATE                                                                                                                    |                 | SAMPLED 8/86                      |                   |
| DATE                                                                                                                    |                 | TEST FINISHED 8/86                |                   |
| DATE                                                                                                                    |                 | COMPLETED                         |                   |
| DATE                                                                                                                    |                 | SECTION DATA 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.   |                 |                                   |                   |

|                                                                                                                                          |         |          |         |                                             |              |                   |  |
|------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|---------|---------------------------------------------|--------------|-------------------|--|
| SPECIFICATION N/A                                                                                                                        |         |          |         | WEIGHT 78 Pounds                            |              |                   |  |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                              |         |          |         | CONTACT NUMBER Honeywell Subcontract 932077 |              |                   |  |
| <b>NITROCELLULOSE</b>                                                                                                                    |         |          |         |                                             |              |                   |  |
| RECEIVED DATE NUMBER 895089; 95091; 95092                                                                                                |         |          |         | NITROGEN CONTENT                            |              | STABILITY (240°C) |  |
|                                                                                                                                          |         |          |         | NAD 13.13                                   |              | NAD 13.07         |  |
|                                                                                                                                          |         |          |         | NAD 13.10                                   |              | 45+ 30+           |  |
|                                                                                                                                          |         |          |         |                                             |              | EXPLOSION         |  |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                             |         |          |         |                                             |              |                   |  |
| <b>PROCESS-DRYING</b>                                                                                                                    |         |          |         |                                             |              |                   |  |
| Ambient                                                                                                                                  |         | Ambient  |         | Lead 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                      |              |                   |  |
|                                                                                                                                          |         |          |         |                                             |              |                   |  |
|                                                                                                                                          |         |          |         |                                             |              |                   |  |
| <b>TESTS OF FINISHED PROPELLANT</b>                                                                                                      |         |          |         |                                             |              |                   |  |
| PROPELLANT COMPOSITION                                                                                                                   |         |          |         | STABILITY AND PHYSICAL TESTS                |              |                   |  |
| CONSTITUENT                                                                                                                              | PERCENT | PERCENT  | PERCENT | 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                          |              |                   |  |
| 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    | Tallent:                                    |              |                   |  |
| ROX                                                                                                                                      | N/A     | N/A      | 17.78   | Slope @ 100mmHg                             | 21.0mmHg     | 349               |  |
| Ash                                                                                                                                      | N/A     | N/A      | 0.09    |                                             |              |                   |  |
| Moisture                                                                                                                                 | 0.5     | 20.3     | 0.2     |                                             |              |                   |  |
| Methylene Cl Solubility                                                                                                                  | N/A     | N/A      | 31.60   |                                             |              |                   |  |
|                                                                                                                                          |         |          |         |                                             |              |                   |  |
| <b>PROPELLANT DIMENSIONS (INCHES)</b>                                                                                                    |         |          |         |                                             |              |                   |  |
| LOT NUMBER                                                                                                                               | TEMP °F | DIAMETER | LENGTH  | SPECIFICATION                               | IN           | OUTER             |  |
| 827                                                                                                                                      | -40     | 90.97    | 101.69  | LENGTH IN                                   | N/A          | 1.6               |  |
|                                                                                                                                          | -90     | 92.47    | 103.43  | DIAMETER IN                                 | N/A          | .700              |  |
|                                                                                                                                          | +145    | 96.81    | 104.25  | DIAMETER OUT                                | N/A          | .023              |  |
| STANDARD                                                                                                                                 | 5-231   | 90       | 100.00% | Web Ave                                     | N/A          | .099              |  |
| <b>REMARKS</b><br>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              |  |
|                                                                                                                                          |         |          |         | Middle                                      | N/A          | .106              |  |
|                                                                                                                                          |         |          |         | Outer                                       | N/A          | .075              |  |
|                                                                                                                                          |         |          |         | Web Ave                                     | N/A          | 9.57              |  |
|                                                                                                                                          |         |          |         | Web Ave                                     | N/A          | 2.29              |  |
|                                                                                                                                          |         |          |         | Web Ave                                     | N/A          | 30.43             |  |
|                                                                                                                                          |         |          |         | DATE                                        | PACKED 8/86  |                   |  |
|                                                                                                                                          |         |          |         | DATE                                        | SAMPLED 8/86 |                   |  |
|                                                                                                                                          |         |          |         | DATE                                        | TESTED 8/86  |                   |  |
|                                                                                                                                          |         |          |         | DATE                                        | OVERSEEN     |                   |  |
|                                                                                                                                          |         |          |         | DATE                                        | EXCEPTIONS   |                   |  |
|                                                                                                                                          |         |          |         | DATE                                        | FORWARDED    |                   |  |
| TYPE OF PACKING CONTAINER Wood Box No. 327043, Barrier Bag No. 327041, Carton No. 327146                                                 |         |          |         |                                             |              |                   |  |
| <b>REMARKS</b><br>Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.          |         |          |         |                                             |              |                   |  |
|                                                                                                                                          |         |          |         |                                             |              |                   |  |
|                                                                                                                                          |         |          |         |                                             |              |                   |  |

| 2R-20 19 Perf Strick (TAX)                                                                                              |                   | NCL86H008-004                     |                    |
|-------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------------|--------------------|
| N/A                                                                                                                     |                   | 324 Pounds                        |                    |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                             |                   | None; null Subcontract 932077     |                    |
| B95089; 95091; 95092                                                                                                    |                   | NITROCELLULOSE                    |                    |
|                                                                                                                         |                   | NITROGEN CONTENT                  |                    |
|                                                                                                                         |                   | BY GRAIN                          |                    |
|                                                                                                                         |                   | STABILITY (MOISTURE)              |                    |
|                                                                                                                         |                   | BAS 13.13 %                       |                    |
|                                                                                                                         |                   | BSI 13.07 %                       |                    |
|                                                                                                                         |                   | AVE 13.10 %                       |                    |
|                                                                                                                         |                   | 45+ %                             |                    |
|                                                                                                                         |                   | 30+                               |                    |
|                                                                                                                         |                   | EXPLOSION                         |                    |
| MANUFACTURE OF SOLVENTLESS PROPELLANT                                                                                   |                   |                                   |                    |
| PROCESS-DRYING                                                                                                          |                   |                                   |                    |
| 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                                                                                            |                   |                                   |                    |
| PROPELLANT COMPOSITION                                                                                                  |                   | STABILITY AND PHYSICAL TESTS      |                    |
| CONSTITUENT                                                                                                             | PURCHASER FORMULA | RECEIVER TOLERANCE                | PHYSICAL PROPERTY  |
| Nitrocellulose                                                                                                          | N/A               | N/A                               | HEAT SET @ 120°C   |
| Nitroglycerin                                                                                                           | N/A               | N/A                               | No Fumes           |
| DEGDN                                                                                                                   | N/A               | N/A                               | FORM OF PROPELLANT |
| Akardite II                                                                                                             | N/A               | N/A                               | HOF (cal/cm)       |
| Magnesium Oxide                                                                                                         | N/A               | N/A                               | Abs. Dens. (g/cc)  |
| Graphite                                                                                                                | N/A               | N/A                               | Taliansi:          |
| RDX                                                                                                                     | N/A               | N/A                               | Slope @ 100mmHg    |
| Ash                                                                                                                     | N/A               | N/A                               |                    |
| Moisture                                                                                                                | 0.5               | ±0.3                              |                    |
| Methylene Cl Solubility                                                                                                 | N/A               | N/A                               |                    |
| CLOSED BOMB                                                                                                             |                   | PROPELLANT DIMENSIONS (Inches)    |                    |
| LOT NUMBER                                                                                                              | TEMP °F           | BURN RATE INCHES/SEC              | BURN TIME SECS     |
| 827                                                                                                                     | -40               | 90.97                             | 101.69             |
|                                                                                                                         | +90               | 92.47                             | 103.43             |
|                                                                                                                         | +145              | 96.81                             | 104.25             |
| STANDARD S-231                                                                                                          | 90                | 100.00%                           | 100.00%            |
| REMARKS                                                                                                                 |                   | DATE                              |                    |
| 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. |                   | PACKED 8/86                       |                    |
|                                                                                                                         |                   | SAMPLED 8/86                      |                    |
|                                                                                                                         |                   | TEST FINISHED 8/86                |                    |
|                                                                                                                         |                   | OFFICE                            |                    |
|                                                                                                                         |                   | SIZING/PAINT DATA FOR WAREHOUSE   |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web Ave N/A .073 .074             |                    |
|                                                                                                                         |                   | Inner N/A .074 .058               |                    |
|                                                                                                                         |                   | Middle N/A .073 .069              |                    |
|                                                                                                                         |                   | Outer N/A .072 .094               |                    |
|                                                                                                                         |                   | Web                               |                    |

|                                             |  |                              |                   |
|---------------------------------------------|--|------------------------------|-------------------|
| SPECIFICATION N/A                           |  | PACKAGE WEIGHT 44 Pounds     |                   |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. |  | CONTRACT NUMBER              |                   |
| 95089; 95091; 95092                         |  | Honeywell Subcontract 932077 |                   |
| NITROCELLULOSE                              |  |                              |                   |
| NITROGEN CONTENT                            |  | IN GRAIN (AS IS)             | STABILITY (AS IS) |
| GRAIN 13.13 %                               |  | GRAIN 13.07 %                | GRAIN 13.10 %     |
| GRAIN 13.10 %                               |  | GRAIN 45+                    | GRAIN 30+         |
| MANUFACTURE OF SOLVENTLESS PROPELLANT       |  |                              |                   |

| PROCESS-DRYING |         | DAY                               | TEMP |
|----------------|---------|-----------------------------------|------|
| 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 ANALYSIS             | PERCENT REJECTED | TEST METHOD        | FORMULA                      | REMARKS |
| 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             | Taliansi:          |                              |         |
| 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                                                                                                                        |         |                  |                |         | PROPELLANT DIMENSIONS (Inches) |     |       |       |
|------------------------------------------------------------------------------------------------------------------------------------|---------|------------------|----------------|---------|--------------------------------|-----|-------|-------|
| LOT NUMBER                                                                                                                         | TEMP °F | INITIAL PRESSURE | FINAL PRESSURE | TIME    | DESCRIPTION                    | IN  | OUTER | DATE  |
| 827                                                                                                                                | -40     | 90.97            | 101.69         |         | LENGTH IN                      | N/A | 2.68  | 2.68  |
|                                                                                                                                    | +90     | 92.47            | 103.43         |         | DIAMETER IN                    | N/A | .700  | .684  |
|                                                                                                                                    | +145    | 96.81            | 104.25         |         | PER DIA IN                     | N/A | .054  | .048  |
| STANDARD                                                                                                                           | S-231   | 90               | 100.00%        | 100.00% | Web Ave                        | N/A | .073  | .074  |
| REMARKS<br>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 |       |       |
|                                                                                                                                    |         |                  |                |         | Web Ave                        | N/A | 3.83  | 3.92  |
|                                                                                                                                    |         |                  |                |         | Web Ave                        | 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



|                                                                                                                                    |                  |                                                                                 |                                                                   |                                                                                                         |              |           |       |
|------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------|-----------|-------|
| Description 2R-20 7 Perf Granular<br>Specification N/A<br>Made at RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                      |                  | Net Weight 209 Pounds<br>Contract Number Honeywell Subcontract 932077           |                                                                   |                                                                                                         |              |           |       |
| Lot Numbers 895089; 95091; 95092                                                                                                   |                  | Nitrocellulose<br>Moisture Content<br>Max 13.13 %<br>Min 13.07 %<br>Avg 13.10 % | GUN STRENGTH (PSI)<br>45+<br>BRASITT (2543°C)<br>30+<br>EXPLOSION |                                                                                                         |              |           |       |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                                                                                       |                  |                                                                                 |                                                                   |                                                                                                         |              |           |       |
| <b>PROCESS-DRYING</b>                                                                                                              |                  |                                                                                 |                                                                   |                                                                                                         |              |           |       |
| Temp                                                                                                                               | Atmos            | Process                                                                         | Remarks                                                           |                                                                                                         |              |           |       |
| 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                                                          |                                                                   |                                                                                                         |              |           |       |
| <b>PROPELLANT COMPOSITION</b>                                                                                                      |                  | <b>TESTS OF FINISHED PROPELLANT</b>                                             | <b>STABILITY AND PHYSICAL TESTS</b>                               |                                                                                                         |              |           |       |
| CONSTITUENT                                                                                                                        | PERCENT GRANULAR | PERCENT SOLUBLE                                                                 | PERCENT MEASURED                                                  | TEST                                                                                                    | 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                                                             | SOFTENING POINT                                                                                         |              |           |       |
| 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. 0.07/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                                                             |                                                                                                         |              |           |       |
| <b>FIXED DATA</b>                                                                                                                  |                  | <b>PROPELLANT DIMENSIONS (Inches)</b>                                           |                                                                   |                                                                                                         |              |           |       |
| LOT NUMBER                                                                                                                         | TEMP °F          | INITIAL WEIGHT                                                                  | FINAL WEIGHT                                                      | SPONGERON                                                                                               | IN           | THICKNESS |       |
| WF                                                                                                                                 | -40              | 90.97                                                                           | 101.69                                                            | Length in                                                                                               | N/A          | .539      | .547  |
|                                                                                                                                    | +90              | 92.47                                                                           | 103.43                                                            | Diameter in                                                                                             | N/A          | .355      | .354  |
|                                                                                                                                    | +145             | 96.87                                                                           | 104.25                                                            | Perf Dia in                                                                                             | N/A          | .023      | .022  |
| STANDARD                                                                                                                           | S-231            | 90                                                                              | 100.00%                                                           | Web Avg                                                                                                 | N/A          | .072      | .072  |
| REMARKS<br>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  |
|                                                                                                                                    |                  |                                                                                 |                                                                   | Outer                                                                                                   | N/A          | .0725     | .077  |
|                                                                                                                                    |                  |                                                                                 |                                                                   | Web Thickness                                                                                           | N/A          |           | 13.10 |
|                                                                                                                                    |                  |                                                                                 |                                                                   | Web                                                                                                     | N/A          | 1.52      | 1.54  |
|                                                                                                                                    |                  |                                                                                 |                                                                   | Web                                                                                                     | N/A          | 15.43     | 16.34 |
| TYPE OF PACKING CONTAINER Fiber Drum; 652 D                                                                                        |                  |                                                                                 |                                                                   | DATE<br>PACKED 8/86<br>SAMPLED 8/86<br>TEST FINISHED 8/86<br>SHIPPED 8/86<br>SKELETON WEIGHTS FORWARDED |              |           |       |
| REMARKS<br>Candelilla wax is used as a lubricant during extrusion and may be present in the propellant in trace amounts.           |                  |                                                                                 |                                                                   |                                                                                                         |              |           |       |



|                                             |  |                              |  |
|---------------------------------------------|--|------------------------------|--|
| DESCRIPTION                                 |  | WEIGHT                       |  |
| N/A                                         |  | 300 Pounds                   |  |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. |  | HONEYWELL Subcontract 932077 |  |
| MTC 0000000000                              |  |                              |  |
| RECEIPT AND NUMBER                          |  | NITROGEN CONTENT             |  |
| 895089; 95091; 95092                        |  | IN PAGES                     |  |
|                                             |  | (SEE PAGE)                   |  |
|                                             |  | STABILITY (SEE PAGE)         |  |
|                                             |  | MAX 13.13 %                  |  |
|                                             |  | MIN 13.07 %                  |  |
|                                             |  | AVE 13.10 %                  |  |
|                                             |  | 45+ %                        |  |
|                                             |  | 30+ %                        |  |
|                                             |  | EXPLOSION                    |  |

## MANUFACTURE OF SOLVENTLESS PROPELLANT

| Drying Schedule |         | PROCESS-DRYING                    | DATE | MOIST |
|-----------------|---------|-----------------------------------|------|-------|
| 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 MAXIMUM |                    | 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            | 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:           |                              |         |
| SDX                     | 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           |                    |                              |         |
|                         |                 |                              |                 |                    |                              |         |

| TEST DATA                                                                                                                               |            |         |                   |                  | PRODUCTION TESTS |               |       |         | RECORD |                           |
|-----------------------------------------------------------------------------------------------------------------------------------------|------------|---------|-------------------|------------------|------------------|---------------|-------|---------|--------|---------------------------|
| REF                                                                                                                                     | LOT NUMBER | TEMP °F | INITIAL<br>CHARGE | INITIAL<br>FORCE |                  | SPECIFICATION | GR    | REMARKS |        |                           |
|                                                                                                                                         |            | -40     | 90.97             | 101.69           | LENGTH (L)       | N/A           | 15.0  | 15.0    |        |                           |
|                                                                                                                                         |            | +90     | 92.47             | 103.43           | DIAMETER (D)     | N/A           | .355  | .354    | 02133  |                           |
|                                                                                                                                         |            | +145    | 96.81             | 104.25           | PERF DIA (L)     | N/A           | .023  | .022    |        |                           |
| STANDARD                                                                                                                                | S-231      | 90      | 90.00             | 100.00           | Web Avg          | N/A           | .072  | .072    |        | DATE                      |
| REMARKS:<br><br>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    |        | PACKED 8/86               |
|                                                                                                                                         |            |         |                   |                  | Outer            | N/A           | .0725 | .077    |        | SAMPLED 8/86              |
|                                                                                                                                         |            |         |                   |                  |                  |               |       |         |        | TEST FINISHED             |
|                                                                                                                                         |            |         |                   |                  |                  |               |       |         |        | 8/86                      |
|                                                                                                                                         |            |         |                   |                  |                  |               |       |         |        | DISCUSSION DATA FORWARDED |
|                                                                                                                                         |            |         |                   |                  | Web Avg          | N/A           |       | 13.10   |        |                           |
|                                                                                                                                         |            |         |                   |                  | LD               | N/A           | 42.25 | 42.37   |        |                           |
|                                                                                                                                         |            |         |                   |                  | GR               | 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. 1259

**QWST  
LTC**

## PROPELLANT DESCRIPTION SHEET

EXEMPT- PARA 7-2a  
AS 212-11

|              |                                             |                 |                              |
|--------------|---------------------------------------------|-----------------|------------------------------|
| COMPOSITION  | 2R-16 19 Perf Stick                         | DA LOT NUMBER   | HCL87A010-002                |
| MANUFACTURER | Honeywell Multica GFR 087-002R              | PACKED AMOUNT   | 105 Pounds                   |
| MPG AT       | RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER | Honeywell Subcontract 932077 |

|                                   |  |                  |           |                      |
|-----------------------------------|--|------------------|-----------|----------------------|
| NITROCELLULOSE                    |  | NITROGEN CONTENT | NI STARCH | STABILITY (24-48 °C) |
| 95078: 95079: 95080: 95081: 95082 |  | MAX _____ %      | _____ %   | _____ %              |
|                                   |  | MIN _____ %      | _____ %   | _____ %              |
|                                   |  | AVG 13.11 %      | 45+       | 30+ %                |
|                                   |  |                  |           | EXPLOSION _____ %    |

| MANUFACTURE OF SOLVENTLESS PROPELLANT |     | DATE                    | TIME |
|---------------------------------------|-----|-------------------------|------|
| FROM                                  | TO  |                         |      |
| 210                                   | 215 | Differential Rolling    | 20   |
| 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                          | 47.65            | HEAT             | cc 40'                       | cc 60'+ |
| NITROGLYCERIN               | N/A             | N/A                          | 13.10            | NO FUMES         | NY 1 Hr                      | NY 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             | USE cal/cm       | N/A                          | -1162   |
| WAX (0.09 %)                | N/A             | N/A                          | 16.15            |                  |                              |         |
| TOTAL                       |                 |                              | 100.00           | ASS 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   | TWO   | THREE                       |
|                                                                                        |            | -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  | N/A                         |
| STANDARD                                                                               | C-231      | +90     | 100.00 | 100.00%          | Web Ave.                       | N/A           | .099  | .097  |                             |
| REMARKS<br>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  | CHIEF                       |
|                                                                                        |            |         |        |                  | L:D                            | N/A           | 11.43 | 11.59 | DESCRIPTION SHEET 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. Lufkin

J. W. Lufkin

# PROPELLANT DESCRIPTION SHEET

EXEMPT-PARA 7-2a  
AS 231-11

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

## ACCEPTED BRAND NAMES NITROCELLULOSE

|                      |                                                               |                                           |                                                     |                  |
|----------------------|---------------------------------------------------------------|-------------------------------------------|-----------------------------------------------------|------------------|
| B95089; 95091; 95092 | NITROGEN CONTENT<br>MAX 13.13 %<br>MIN 13.07 %<br>AVG 13.10 % | W STARCH<br>MAX 45+<br>MIN 45+<br>AVG 45+ | STABILITY (24.5°C)<br>MAX 30+<br>MIN 30+<br>AVG 30+ | EXPLOSION<br>YES |
|----------------------|---------------------------------------------------------------|-------------------------------------------|-----------------------------------------------------|------------------|

| MANUFACTURE OF SOLVENTLESS PROPELLANT |     |                         | MINUTE | SECOND |
|---------------------------------------|-----|-------------------------|--------|--------|
| 210                                   | 215 | Blending                | 20     | -      |
| 145                                   | 155 | Differential Rolling    | -      | 140    |
| 150                                   | 160 | Evanspeed Rolling       | -      | -      |
| 145                                   | 155 | 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             | *TALIANI                     | 21.8 Hz/mm   | .349    |  |                              |  |
| MAGNESIUM OXIDE             | N/A             | N/A               | 0.05             |                              | 1000 21100mm |         |  |                              |  |
| GRAPHITE                    | N/A             | N/A               | 0.05             | NOE 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 | RQ     | RELATIVE DENSITY | PARAMETER                      | SPECIFICATION | ONE   | TWO   | THREE |
|                                                                                                                                    |            | -40     | 90.97  | 101.69           | LENGTH (L)                     | N/A           | 8.0   | 8.0   | N/A   |
|                                                                                                                                    |            | +90     | 92.47  | 103.43           | DIAMETER (D)                   | N/A           | .700  | .690  | N/A   |
|                                                                                                                                    |            | +145    | 96.81  | 104.25           | PERF. DIA. (d)                 | N/A           | .023  | .021  | N/A   |
| 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  |       |
|                                                                                                                                    |            |         |        |                  | Middle                         | N/A           | .108  | .086  |       |
|                                                                                                                                    |            |         |        |                  | Inner                          | N/A           | .115  | .103  |       |
|                                                                                                                                    |            |         |        |                  | Web Diff                       | N/A           | N/A   | 7.95  |       |
|                                                                                                                                    |            |         |        |                  | L:D                            | N/A           | 11.43 | 11.59 |       |
|                                                                                                                                    |            |         |        |                  | D:d                            | N/A           | 30.43 | 28.2  |       |

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* Program Manager *John D. 9 Feb 87*

# PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL, SYMBOL  
EXEMPT-PARA 7-2a  
OF 221-11

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

|                                               |                                                               |                              |                                               |
|-----------------------------------------------|---------------------------------------------------------------|------------------------------|-----------------------------------------------|
| ACCEPTED BOMB NUMBERS<br>B95089; 95091; 95092 | NITROGEN CONTENT<br>MAX 13.13 %<br>MIN 13.07 %<br>AVG 13.10 % | DI STARCH<br>(ALL °C)<br>45+ | STABILITY (24.5 °C)<br>30+<br>EXPLOSION - MES |
|-----------------------------------------------|---------------------------------------------------------------|------------------------------|-----------------------------------------------|

| TEMPERATURE |     |                         | MANUFACTURE OF SOLVENTLESS PROPELLANT |  | TIME   |        |
|-------------|-----|-------------------------|---------------------------------------|--|--------|--------|
| FROM        | TO  |                         |                                       |  | 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    | -      |

| 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            |                  |                              |         |  |
| ACARDIT II                  | N/A             | N/A                          | 0.71             | "ITALIAN"        | 21.8 g/gm                    | .349    |  |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.05             |                  | glass 2180mm                 |         |  |
| 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             | Form of Prop.    | Cyl                          | Cyl     |  |
| Methylene Cl Solubility     | N/A             | N/A                          | 31.40            | No. of Perfs     | 19                           | 19      |  |

| CLOSED BOMB                                                                                                                        |            |         |        | PROPELLANT DIMENSIONS inches |                |               |       | SUB DIV. n % of Mean Dimensions |                    |        |
|------------------------------------------------------------------------------------------------------------------------------------|------------|---------|--------|------------------------------|----------------|---------------|-------|---------------------------------|--------------------|--------|
| TEST                                                                                                                               | LOT NUMBER | TEMP °F | RO     | RELATIVE DENSITY             | PARAMETER      | SPECIFICATION | DE    | 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  | .686                            | N/A                | .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                            |                    |        |
| 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                            | DATES 1/87         |        |
|                                                                                                                                    |            |         |        |                              | Middle         | N/A           | .107  | .100                            | PACKED 1/87        |        |
|                                                                                                                                    |            |         |        |                              | Inner          | N/A           | .116  | .102                            | SAMPLED 1/87       |        |
|                                                                                                                                    |            |         |        |                              | Web Diff       | N/A           | N/A   | 5.34                            | TEST FINISHED 1/87 |        |
|                                                                                                                                    |            |         |        |                              | L:D            | N/A           | 11.43 | 11.66                           | OFFERED            |        |
|                                                                                                                                    |            |         |        | D:d                          | N/A            | 30.43         | 32.15 | DESCRIPTION SHEETS FORWARDED    |                    |        |

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 *P. W. X. [Signature]* Program Manager *[Signature]* 9 FEB 87

# PROPELLANT DESCRIPTION SHEET

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

## ACCEPTED BLIND NUMBERS NITROCELLULOSE

|                      |                  |                    |                      |
|----------------------|------------------|--------------------|----------------------|
| B95089; 95091; 95092 | NITROGEN CONTENT | NI STARCH (AT 5°C) | STABILITY (30±5°C)   |
|                      | MAX _____ %      | _____ MG/L         | _____ MG/L           |
|                      | MIN _____ %      | _____ MG/L         | _____ MG/L           |
|                      | AVE 13.10 %      | 45+ MG/L           | 30+ MG/L             |
|                      |                  |                    | EXPLOSION _____ MG/L |

| TEMPERATURE |     | MANUFACTURE OF SOLVENTLESS PROPELLANT | TIME    |         |
|-------------|-----|---------------------------------------|---------|---------|
| FROM        | TO  |                                       | MINUTES | SECONDS |
| -           | -   | Blending                              | 20      | -       |
| 210         | 215 | Differential Rolling                  | -       | 140     |
| 145         | 155 | Evanspeed 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             | 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                          | 31.40            |                    |                              |         |

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

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. Gumpert*

*W. R. Thomas*

ARRCOM FORM 214 R 10 AUG 77

# PROPELLANT DESCRIPTION SHEET

FORM 1-77

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

|                                              |       |                |                   |
|----------------------------------------------|-------|----------------|-------------------|
| ACCEPTED BRAND NAMES<br>B95089; 95091; 95092 |       | NITROCELLULOSE |                   |
| NITROGEN CONTENT                             |       | STARCH (M.J.%) | STABILITY (240°C) |
| MAX                                          | 8     | MAX            | 8                 |
| MIN                                          | 8     | MAX            | 8                 |
| AVE                                          | 13.10 | MAX            | 30+               |
|                                              |       | EXPLOSION      | NR2               |

| TEMPERATURE |     |                         | MANUFACTURE OF SOLVENTLESS PROPELLANT |  | STABILITY |     |
|-------------|-----|-------------------------|---------------------------------------|--|-----------|-----|
| FROM        | TO  |                         |                                       |  | MIN       | MAX |
| -           | -   | 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           | EL.8 g/cm                    | .349    |  |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.05             |                    | 1000 BTU/HR                  |         |  |
| 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                          | 31.60            |                    |                              |         |  |

| CLOSED BOMB                                                                                                                        |            |         |        |               | PROPELLANT DIMENSIONS (INCHES) |               |       |          |                              |
|------------------------------------------------------------------------------------------------------------------------------------|------------|---------|--------|---------------|--------------------------------|---------------|-------|----------|------------------------------|
| TEST                                                                                                                               | LOT NUMBER | TEMP °F | RQ     | RELATIVE SCPI | PARAMETER                      | SPECIFICATION | SEE   | FINISHED | DATE                         |
|                                                                                                                                    |            | -40     | 90.97  | 101.69        | LENGTH (L)                     | N/A           | 4.75  | 4.78     | N/A                          |
|                                                                                                                                    |            | +90     | 92.47  | 103.43        | DIAMETER (D)                   | N/A           | .700  | .690     | N/A                          |
|                                                                                                                                    |            | +145    | 96.81  | 106.25        | PERF. DIA. (M)                 | N/A           | .023  | .021     | N/A                          |
| STANDARD                                                                                                                           | S-231      | +90     | 100.00 | 100.00        | Web Ave.                       | N/A           | .099  | .097     | DATE                         |
| 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  



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|                                                                                                                                    |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |
|------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------|------------------|--------------------|----------------|---------------|-------|----------|-------------------------------------------------------------------------------------------------------|--------|
| COMPOSITION                                                                                                                        |                 | DA LOT NUMBER                |                  |                    |                |               |       |          |                                                                                                       |        |
| 2R-20 14 Perf Stick                                                                                                                |                 | HCL87C010-009                |                  |                    |                |               |       |          |                                                                                                       |        |
| SPECIFICATION                                                                                                                      |                 | PACKED AMOUNT                |                  |                    |                |               |       |          |                                                                                                       |        |
| Honeywell Mullica GER 087-029                                                                                                      |                 | 54 Pounds                    |                  |                    |                |               |       |          |                                                                                                       |        |
| BAG #1                                                                                                                             |                 | CONTRACT NUMBER              |                  |                    |                |               |       |          |                                                                                                       |        |
| RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.                                                                                        |                 | Honeywell Subcontract 932077 |                  |                    |                |               |       |          |                                                                                                       |        |
| ACCEPTED BRAND NAMES NITROCELLULOSE                                                                                                |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |
| B95089; 95091; 95092                                                                                                               |                 | NITROGEN CONTENT             |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MAX 13.13 %                  |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MIN 13.07 %                  |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | AVG 13.10 %                  |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | BI STARCH (MJJ °C)           |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MAX                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MIN                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | 45+                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | STABILITY (30.4.5 °C)        |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MAX                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | MIN                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | 30+                          |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | EXPLOSION                    |                  |                    |                |               |       |          |                                                                                                       |        |
|                                                                                                                                    |                 | YES                          |                  |                    |                |               |       |          |                                                                                                       |        |
| TEMPERATURE MANUFACTURE OF SOLVENTLESS PROPELLANT                                                                                  |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |
| TEMPERATURE                                                                                                                        | TIME            | PROCESS                      | REMARKS          |                    |                |               |       |          |                                                                                                       |        |
| -                                                                                                                                  | -               | 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/cc      | .349          |       |          |                                                                                                       |        |
| MAGNESIUM OXIDE                                                                                                                    | N/A             | N/A                          | 0.05             |                    | Stops 2180mm   |               |       |          |                                                                                                       |        |
| 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                          | 31.40            |                    |                |               |       |          |                                                                                                       |        |
| CLOSED BOMB PROPELLANT DIMENSIONS (inches)                                                                                         |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |
| TEST                                                                                                                               | LOT NUMBER      | TEMP °F                      | RQ               | RELATIVE DENSITY   | PARAMETER      | SPECIFICATION | DE    | FINISHED | SPEC                                                                                                  | 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. (D) | N/A           | .023  | .021     |                                                                                                       |        |
| STANDARD                                                                                                                           | S-231           | +90                          | 100.00           | 100.00%            | Web Ave.       | N/A           | .099  | .097     | DATES<br>PACKED 1/87<br>SAMPLED 1/87<br>TEST FINISHED 1/87<br>OFFERED<br>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           | .075  | .104     |                                                                                                       |        |
|                                                                                                                                    |                 |                              |                  |                    | Middle         | N/A           | .108  | .086     |                                                                                                       |        |
|                                                                                                                                    |                 |                              |                  |                    | Inner          | N/A           | .115  | .103     |                                                                                                       |        |
|                                                                                                                                    |                 |                              |                  |                    | Web Diff       | N/A           | N/A   | 7.95     |                                                                                                       |        |
|                                                                                                                                    |                 |                              |                  |                    | L:D            | N/A           | 3.00  | 3.09     |                                                                                                       |        |
|                                                                                                                                    |                 |                              |                  |                    | 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                                                                                                  |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |
| <div style="display: flex; justify-content: space-between;"> <div><i>P W Suberter</i></div> <div><i>W R Thomas</i></div> </div>    |                 |                              |                  |                    |                |               |       |          |                                                                                                       |        |



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# PROPELLANT DESCRIPTION SHEET

|                                                                |                                                 |
|----------------------------------------------------------------|-------------------------------------------------|
| COMPOSITION<br>2R-20 19 Perf Stick                             | DA LOT NUMBER<br>HCTA/C010-012                  |
| SPECIFICATION<br>Moneywell Multica GFR 087-029                 | PACKED AMOUNT<br>60 Pounds                      |
| MANUFACTURED AT<br>RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER<br>Moneywell Subcontract 932077 |

## ACCEPTED GRADE NOMENCLATURE: NITROCELLULOSE

|                      |                  |           |                   |
|----------------------|------------------|-----------|-------------------|
| B95089; 95091; 95092 | NITROGEN CONTENT | DI STARCH | DIAMETER (34.8°C) |
|                      | MAX 13.13 %      | —         | —                 |
|                      | MIN 13.07 %      | —         | —                 |
|                      | AVG 13.10 %      | 45+       | 30+               |
|                      |                  |           | EXPLOSION —       |

| TEMPERATURE |      |                         | MANUFACTURE OF SOLVENTLESS PROPELLANT |      | RESULTS |      |
|-------------|------|-------------------------|---------------------------------------|------|---------|------|
| TEMP        | TIME | TEMP                    | TIME                                  | TEMP | TIME    | TEMP |
| 210         | 215  | Blending                | 20                                    | 210  | 215     | 210  |
| 145         | 155  | Differential Rolling    | —                                     | —    | —       | —    |
| 150         | 160  | Even-speed Rolling      | —                                     | —    | —       | —    |
| 145         | 155  | Extrusion - Carpet Roll | —                                     | —    | —       | —    |
| 110         | 110  | Extrusion - Die         | —                                     | —    | —       | —    |
|             |      | 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             | *ITALIANI          | 21.8 Hg/mm                   | .349    |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.05             |                    | slope 21100mm                |         |
| GRAPHITE                    | N/A             | N/A                          | 0.05             | SEE 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 ERROR | PARAMETER                      | SPECIFICATION | DE    | FINISHED | DATE                         |
|             |                                                                                                                            | +40     | 90.97  | 101.69         | LENGTH (L)                     | N/A           | 2.70  | 2.71     | N/A                          |
|             |                                                                                                                            | +90     | 92.47  | 103.43         | DIAMETER (D)                   | N/A           | .700  | .686     | N/A                          |
|             |                                                                                                                            | +145    | 96.81  | 104.25         | PERF. DIA. (d)                 | N/A           | .023  | .021     | N/A                          |
| STANDARD    | C-231                                                                                                                      | +90     | 100.00 | 100.00         | Web Ave.                       | N/A           | .099  | .097     | DATE                         |
| 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                  |
|             |                                                                                                                            |         |        |                | 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           | 3.86  | 3.95     | 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 Suber*

*W. B. Hennes*

... 01 221 - 2

ADDENDUM FORM 214 R 10 AUG 77

# PROPELLANT DESCRIPTION SHEET

|                                                        |                                                 |
|--------------------------------------------------------|-------------------------------------------------|
| COMPOSITION<br>2R-20 19 Perf Stick                     | DA LOT NUMBER<br>HCLST 010-014                  |
| PERFORMANCE<br>Moneysell Multica GFR 087-029           | PACKED AMOUNT<br>25 Pounds                      |
| MADE AT<br>RADFORD ARMY AMMUNITION PLANT, RADFORD, VA. | CONTRACT NUMBER<br>Moneysell Subcontract 932077 |

## ACCEPTED NAME NUMBERS NITROCELLULOSE

|                      |                                                               |                                            |                                                            |
|----------------------|---------------------------------------------------------------|--------------------------------------------|------------------------------------------------------------|
| B95089; 95091; 95092 | NITROGEN CONTENT<br>MAX 13.13 %<br>MIN 13.07 %<br>AVG 13.10 % | DI STARCH<br>(ML/100)<br>MAX<br>MIN<br>AVG | STABILITY (24 H°)<br>MAX<br>MIN<br>AVG<br>30+<br>EXPLOSION |
|----------------------|---------------------------------------------------------------|--------------------------------------------|------------------------------------------------------------|

| TEMPERATURE | TIME | MANUFACTURE OF SOLVENTLESS PROPELLANT | ACTUAL | THEORY |
|-------------|------|---------------------------------------|--------|--------|
| 210         | 215  | Blending                              | 20     | -      |
| 145         | 155  | Differential Rolling                  | -      | 140    |
| 150         | 160  | Evenspeed Rolling                     | -      | -      |
| 145         | 155  | Extrusion - Carpet Roll               | -      | -      |
| 110         | 110  | 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            | HEAT               | 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           | 21.8 Bg/mm                   | .349    |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.05             |                    | slight stiction              |         |
| GRAPHITE                    | N/A             | N/A                          | 0.05             | BSE cal/gr         | N/A                          | 1163    |
| RDY                         | 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 | DATE                         |
|                                                                                                                                       |            | -40     | 90.97  | 101.69         | LENGTH (L)                     | N/A           | 1.60  | 1.61     | N/A                          |
|                                                                                                                                       |            | +90     | 92.47  | 103.43         | DIAMETER (D)                   | N/A           | .700  | .686     | N/A                          |
|                                                                                                                                       |            | +145    | 96.81  | 104.25         | PERF. DIA. (D)                 | N/A           | .023  | .021     | N/A                          |
| STANDARD                                                                                                                              | S-231      | +90     | 100.00 | 100.00         | Web Ave.                       | N/A           | .099  | .097     | DATE                         |
| REMARKS<br>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                  |
|                                                                                                                                       |            |         |        |                | 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           | 2.29  | 2.35     | 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 Shugart*  
*U. L. Shugart*

# PROPELLANT DESCRIPTION SHEET

AL 221-11

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

|                                                |                |                                                               |                                                  |                                                           |                   |
|------------------------------------------------|----------------|---------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------|-------------------|
| ACCEPTED GRADE NUMBERS<br>B95088, 95059, 95060 | NITROCELLULOSE | NITROGEN CONTENT<br>MAX _____ %<br>MIN _____ %<br>AVG 13.11 % | DI STARCH<br>MAX _____ %<br>MIN _____ %<br>45+ % | STABILITY (24 Hrs)<br>MAX _____ %<br>MIN _____ %<br>30+ % | EXPLOSION _____ % |
|------------------------------------------------|----------------|---------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------|-------------------|

| VIBRATORY |     | MANUFACTURE OF SOLVENTLESS PROPELLANT |  | STABILITY |       |
|-----------|-----|---------------------------------------|--|-----------|-------|
| TYPE      | TO  |                                       |  | MONTHS    | YEARS |
| -         | -   | 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 TOLFRANCY            | 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 XX                  | N/A             | N/A                          | 0.64             | *ITALIANI             | 31.8 g/cc                    |             |
| MAGNESIUM OXIDE             | N/A             | N/A                          | 0.03             |                       | 1000 g/cc                    | *           |
| 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) |               |     |          |                                 |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|--------|-------------------|--------------------------------|---------------|-----|----------|---------------------------------|--------|
|                                                                                                                                                                     | LOT NUMBER | TEMP °F | RQ     | RELATIVE HUMIDITY |                                |               |     |          | NO DIV or % of Major Dimensions |        |
| TEST                                                                                                                                                                |            |         |        |                   | 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 (D)                   | N/A           | N/A | 4        | N/A                             | N/A    |
|                                                                                                                                                                     |            | +145    | 121.83 | 106.92            | PERF. DIA. (d)                 | N/A           | N/A | N/A      |                                 |        |
| STANDARD                                                                                                                                                            | PE-472-138 | +90     | 100.00 | 100.00%           |                                |               |     |          | DATES                           |        |
| REMARKS<br>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                         |        |
|                                                                                                                                                                     |            |         |        |                   |                                |               |     |          | DESCRIPTION SHEETS FORWARDED    |        |
|                                                                                                                                                                     |            |         |        |                   | L:D                            | N/A           | N/A | 1        |                                 |        |
|                                                                                                                                                                     |            |         |        |                   | 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 Hennes*

# 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-590-1

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-Z-0001

## NITROCELLULOSE

| ACCEPTED BLEND NUMBERS      | NITROGEN CONTENT | KI STARCH<br>(65.5°C) | STABILITY<br>(34.5°C) |
|-----------------------------|------------------|-----------------------|-----------------------|
| BB 95539, BB 95540, BB95541 | MAX 13.17 %      | 45- MINS              | 30- MINS              |
|                             | MIN 13.06        | 45- MINS              | 30- MINS              |
|                             | AVG 13.13        | 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   |
|                                                              |         |                    |                | PERF (in.)   | 0.027 NOM | 0.026 | 0.026    |                                |        |
| STD-71136                                                    |         | 100.00             | 100.00         | WEB (avg)    | 0.109 NOM | ---   | 0.113    | Dates                          |        |
|                                                              |         |                    |                | WEB (inner)  | INFO      | ---   | 0.120    | PACKED 11-92                   |        |
| REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY |         |                    |                | WEB (middle) | INFO      | ---   | 0.111    | SAMPLED 11-92                  |        |
|                                                              |         |                    |                | WEB (outer)  | INFO      | ---   | 0.106    | TEST FINISHED 12-92            |        |
|                                                              |         |                    |                | L/D          | INFO      | ---   | 0.908    | OFFERED 1-93                   |        |
|                                                              |         |                    |                | D/d          | INFO      | ---   | 30.69    | DESCRIPTION SHEETS FORWARDED   |        |
|                                                              |         |                    |                | WEB (diff %) | 15 MAX    | ---   | 4.04     |                                |        |

REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY

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

D. ZEOLI

*Danny Zeoli*

SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE

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: DAAA09-91-2-0001

## NITROCELLULOSE

| ACCEPTED BLEND NUMBERS     | NITROGEN CONTENT | KI STARCH<br>(65.5°C) | STABILITY<br>(134.5°C) |
|----------------------------|------------------|-----------------------|------------------------|
| BB 95539, BB95540, BB95541 | MAX 13.17%       | 45+ MINS              | 30+ MINS               |
|                            | MIN 13.06        | 45+ MINS              | 30+ MINS               |
|                            | AVG 13.13        | 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              | 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 |              |           |       |          | Uniformity by<br>and Deviation, % |                                 |
|--------------|---------|--------------------|----------------|--------------|-----------|-------|----------|-----------------------------------|---------------------------------|
| RAD-PD-090-2 | -90     | 81.6               | 101.1          |              | SPEC      | DIE   | FINISHED | SPEC                              | ACTUAL                          |
|              |         |                    |                | 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    |                                   |                                 |
| STD-71136    |         | 100.00             | 100.00         | WEB (avg)    | 0.109 NOM | ---   | 0.114    |                                   | Dates                           |
|              |         |                    |                | 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<br>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<br>EXEMPT FAPA 7-2a<br>AP 335-15  |           |          |                                |
|----------------------------------------------------------------------|-----------------|--------------------------|------------------|---------------------------------------|----------------------------------------------------------|-----------|----------|--------------------------------|
| COMPOSITION: PROPELLANT JAX-2 13-PERF HEX GRANULAR                   |                 |                          |                  |                                       | LOT NUMBER: RAD-PD-090-3                                 |           |          |                                |
| SPECIFICATION: DDT-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                        |           |          |                                |
| <b>NITROCELLULOSE</b>                                                |                 |                          |                  |                                       |                                                          |           |          |                                |
| ACCEPTED BLEND NUMBERS                                               |                 | NITROGEN CONTENT         |                  | KI STARCH<br>65.5°C                   | STABILITY<br>134.5°C                                     |           |          |                                |
| BB 95539, BB 95540, BB 95541                                         |                 | MAX 13.17%               |                  | 45+ MINS                              | 30+ MINS                                                 |           |          |                                |
|                                                                      |                 | MIN 13.06                |                  | 45+ MINS                              | 30+ MINS                                                 |           |          |                                |
|                                                                      |                 | AVG 13.10                |                  | 45+ MINS                              | 30+ MINS                                                 |           |          |                                |
|                                                                      |                 |                          |                  | EXPLOSION HRS                         |                                                          |           |          |                                |
| <b>MANUFACTURE OF SOLVENTLESS PROPELLANT</b>                         |                 |                          |                  |                                       |                                                          |           |          |                                |
| TEMPERATURE, °F                                                      |                 | PROCESS - DRYING         |                  |                                       |                                                          | TIME      |          |                                |
| FROM                                                                 | TO              |                          |                  |                                       |                                                          | DAYS      | HOURS    |                                |
| 145                                                                  | 155             | CARPET ROLL AT EXTRUSION |                  |                                       |                                                          |           |          |                                |
| 160                                                                  | 170             | EXTRUSION DIE            |                  |                                       |                                                          |           |          |                                |
| 105                                                                  | 115             | ANNEAL                   |                  |                                       |                                                          |           |          |                                |
| <b>TEST OF FINISHED PROPELLANT</b>                                   |                 |                          |                  |                                       |                                                          |           |          |                                |
| 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            |                                       |                                                          |           |          |                                |
| Akardit II                                                           | 0.61            | NOM.                     | 0.68             | HOE (cal/g)                           | Info                                                     | 1144      |          |                                |
| Magnesium oxide                                                      | 0.04            | NOM.                     | 0.05             | 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              |                                       |                                                          |           |          |                                |
| <b>CLOSED BOMB</b>                                                   |                 |                          |                  | <b>PROPELLANT DIMENSIONS (INCHES)</b> |                                                          |           |          |                                |
| Lot Number                                                           | Temp °F         | Relative Quickness       | Relative Force   |                                       |                                                          |           |          | Uniformity by Std Deviation, % |
| RAD-PD-090-3                                                         | -90             | 81.1                     | 101.7            |                                       | SPEC                                                     | DIE       | FINISHED | SPEC                           |
|                                                                      |                 |                          |                  | LENGTH in.                            | 0.75 NOM                                                 | ---       | 0.760    | ---                            |
|                                                                      |                 |                          |                  | O.D. in.                              | 0.789 NOM                                                | 0.834     | 0.810    | ---                            |
|                                                                      |                 |                          |                  | 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                  |
|                                                                      |                 |                          |                  | 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     |                                |
| REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY         |                 |                          |                  |                                       |                                                          |           |          |                                |
| 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 <i>Danny Zeoli</i>                                          |                 |                          |                  |                                       | C. N. HALL                                               |           |          |                                |

# PROPELLANT DESCRIPTION SHEET

REPORTS CONTROL SYSTEM  
EXEMPT PARA 7-2a  
AR 555-15

COMPOSITION: PROPELLANT JAX-2 19-PERF HEX GRANULAR

DOT NUMBER: RAD-PD-C90-4

SPECIFICATION: DOD-P-64037B: DPEER RELEASE NO. 135-90, 747-92

PACKED AMOUNT: 100 pounds

MANUFACTURED: RADFORD ARMY AMMUNITION PLANT, RADFORD VIRGINIA 24141

CONTRACT NUMBER: DAAAC9-91-D-0001

## NITROCELLULOSE

| ACCEPTED BLEND NUMBERS       | NITROGEN CONTENT | KI STARCH<br>65.5% C | STABILITY<br>134.5% C |
|------------------------------|------------------|----------------------|-----------------------|
| BB 95539, BB 95540, BB 95541 | MAX 13.17%       | 45- MINS             | 30- MINS              |
|                              | MIN 13.05%       | 45- MINS             | 30- MINS              |
|                              | AVG 13.13%       | 45- MINS             | 30- 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    | ---                            | 1.55   |
|                                                              |         |                    |                | 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                          |        |
|                                                              |         |                    |                | WEB (inner)  | INFO      | ---   | 0.110    | PACKED 11-92                   |        |
| REMARKS: FIRED IN A 700 CC BOMB AT 0.20 G/CC LOADING DENSITY |         |                    |                | 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

THIS LOT MEETS SPECIFICATION REQUIREMENTS

SIGNATURE OF CONTRACTOR'S REPRESENTATIVE

SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE

D. ZEOLI

*Danny Zeoli*

C. N. HALL

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