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DEVELOPMENT OF XM144 HAND-HELD GROUND SIGNAL SERIES

SEYMOUR LOPATIN

JUNE 1963

OMS 5530.12.548F

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PICATINNY ARSENAL
DOVER, NEW JERSEY

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Seymour Lopatin

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Feltman Research Laboratories
Picatinny Arsenal
Dover, N. J.

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Approved:
J. Klonick
for J. SAGE
Chief, Pyrotechnics
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I. SUMMARY

This report has been prepared to assist in the analysis of the XM-Series Hand-Held Signals which were developed by Picatinny Arsenal, Dover, New Jersey. The analysis is to be made during a ST Review to be held at Picatinny Arsenal on 2 July 1963. The report contains a summary of major events in the development of the signals from time of program initiation to the present, pertinent materiel, physical, operational, and performance characteristics, comparisons of several types of signals and other significant information, data, and documents.

II. INTRODUCTION

Preliminary efforts at Picatinny Arsenal on the design of the XM144 Hand-Held Ground Signal Series was authorized and commenced October 1959. Full scale development was authorized and initiated by OTCM 37402, dated 26 May 1960. This OTCM was prepared on the basis of the military characteristics presented in USCONARC File 0019U1-6049, dated 10 March 1959, and called for the development of the following family of fourteen signals:

1. Signal, Illumination, Ground, Parachute
    - a. Green Star, XM144
    - b. Red Star, XM145
    - c. White Star, XM146
2. Signal, Illumination, Ground, Cluster
    - a. Green Star, XM147
    - b. Red Star, XM148
    - c. White Star, XM149
3. Signal, Smoke, Ground, Parachute
    - a. Green, XM150
    - b. Red, XM151

c. Yellow, XM152

d. Violet (No numerical designation assigned)

4. Signal, Smoke, Ground, Streamer

a. Green, XM153

b. Red, XM154

c. Yellow, XM155

d. Violet (No numerical designation assigned)

Other recommendations for the initiation of the development of the XM144 Signal Series are recorded in the following correspondence:

1. USCONARC letter 00/8-10156-0U0, dated 30 July 1958, referring to USA, Arctic Test Board Project No. ATB 457.

2. OCO letter ORDTS 00/8-13538-0U0, dated 22 October 1958, referring to USCONARC letter 00/8-12814-0U0.

3. OCO letter ORDTS 00/800-33231, dated 3 December 1958, referring to the USA Infantry Board, letter 00/8U1-33120, dated 24 November 1958.

4. OCO letter ORDTS 00/9-1383-0U0, dated 3 February 1959, referring to USCONARC letter 00/9-794-0U0, dated 5 January 1959.

5. OCO letter ORDTS 00/9-5586-0U0, dated 14 May 1959, referring to USCONARC file 00/9-5297-0U0, dated 20 April 1959.

6. OCO letter ORDTS 00/9U1-12655, dated 7 October 1959, referring to USA Arctic Test Board Report of Test of Project No. ATB 259, dated 26 August 1959.

In 1947, the Army Field Forces conducted a limited evaluation of hand-held rocket-type signals for employment in visual ground-to ground and ground-to-air signaling and to provide temporary close-in illumination for individuals and small units. They concluded that signals which did not require a weapon or special projector were a decided improvement over standard signals that were weapon launched. Military characteristics for these signals were approved in 1948 and revised in 1950. After the initial service testing in 1952, the fin-stabilized T71 Signal Series were classified standard and designated the M125

Signal Series. At approximately the same time, the initiation of development of additional signals, the T133 Signal Series, completed the family.

In 1954, erratic flight performance of the M127 White Star Parachute Signal caused the suspension from issue of all types of hand-held signals. In subsequent testing, however, certain lots of modified standard-type signals have been found acceptable for Army use on an interim basis. Efforts are continuing to complete the modification of all signals in the family to make them acceptable on an interim basis.

The new family of signals (XM144 Signal Series) was designed to alleviate many of the deficiencies now occurring in the M125 and T133 Signal Series (e.g. erratic flight and spark trails at launch) by utilizing spin stabilization and new advances in the fields of solid rocket propellants and pyrotechnic compositions.

III. PROGRAM HISTORY

1. Initial Design Concepts (October 1959)

Development of the XM144 Series Signals was initiated because of USCONARC's desire for a signal that would eliminate such major deficiencies of the Standard M125 and T133 Signal Series as erratic flight, position-disclosing smoke and spark trails at launch, and low altitude of functioning. The advantages of the new signal series were to include improved flight stability, elimination of the smoke and luminous trails at launch, increased height of burst, increased flare burning times, and improved color definition of all illuminant and smoke components.

In order to improve the flight stability, increase the height of burst, and eliminate the smoke and luminous trails at launch, it was decided to utilize the spin stabilization principle of flight instead of the fin stabilization principle presently used for the standard signals. In addition to providing the necessary thrust required for satisfactory stabilization, the rocket motor would incorporate a high energy double-base propellant exhausting through two small canted nozzles which would eliminate the smoke and spark trails at launch. The standard signals were propelled by a black powder motor which is responsible for the objectionable smoke and spark trails. A further advantage of the high energy double-base

propellant was that it would permit a reduction in the motor length, thereby providing more space for the message component. The propellant grain was designed to meet the following criteria:

a. Highest possible propellant loading density and total impulse with minimum size and weight.

b. Highest energy standard smokeless propellant.

c. Easiest configuration for ignition.

d. Burning time between 1 and 2 seconds, consistent with above considerations and with reasonable size nozzle throat diameter.

High Energy N-12 Propellant was selected because it is a standard propellant manufactured in large quantities for a large variety of rocket systems. The solid end burning cylinder configuration was chosen because it offered maximum loading density and, therefore, maximum total impulse in a minimum of space. It also gave rise to a strategic position for the exposed propellant surface to be impringed upon by the hot gases of the expulsion charge for ignition. These factors as well as the high energy level of the propellant facilitated ignition. The propellant surface area of this configuration required nozzle throat diameters of reasonable size consistent with a good mass rate of discharge. The burning time resulting from the combination of all above factors was nearly ideal. Absolute neutrality of burning was also characteristic of the design and made for efficient operation.

Various signal designs were studied, their physical dimensions being governed by the operational characteristics established by USCONARC. It was finally decided to design the signals so that they could be fired from the same launcher-igniter assembly used for the M131 Red Star Distress Signal which had previously proven satisfactory. The selection of the M131 Launcher-Igniter Assembly was also governed by the method of firing, which was not considered objectionable, as was the method of firing the standard M125 Signals. In addition, the final design was based on the need for a signal which would produce the desired characteristics of flight when fired from the launcher assembly. These characteristics would be produced by the M131 Launcher-Igniter Assembly.

The basic design established for the parachute and cluster signal was a two-stage unit, the first stage consisting of the rocket motor and signal body, and the second stage consisting of the message component. Initial spin required for launch stability of the signals

was expected to be obtained by two aluminum pins located 180 degrees apart which would ride in the grooves of the launcher. The launcher-igniter assembly would contain an expelling charge which would simultaneously expel the signal with the velocity required for stability and ignite the rocket motor. The rocket motor would then burn for the time required to attain an average height of 750 feet. After burnout, the propellant would ignite a delay column which would burn for the time required to reach apex of flight. At apex, delay burnout would occur and ignite an expelling charge which would simultaneously ignite and expel the message component. The basic design of the smoke streamer signals consisted of a single-stage unit which would emit smoke from launch to ground return. The smoke composition would be pressed directly into the signal body and be ignited by two strands of quickmatch, which in turn would be ignited by the expelling charge.

With respect to the illuminant and smoke producing components, it was decided to conduct an extensive investigation designed to provide the best signal elements that the state of art could produce.

The basic parachute design previously established for similar signals was expected to function satisfactorily in the new series signals.

2. Picatinny Arsenal Test Program, ED Phase (April 1960-June 1961)

a. Rocket Seizure in Launcher Tube and Design Changes. During initial testing, 5 of 17 signals failed to eject from the launcher tubes. Examination of the malfunctioning signals showed that the signal body guide pins were riding out of the launcher rifling grooves, causing the signal rocket to jam in the launcher tube. To eliminate this condition, a special jig was designed to insert the two guide pins equally deep and obtain a constant surface-to-surface dimension (1.556-.004 inch). The pins were located in the same transverse plane on 180° centers. Further, an additional preventive measure was taken by utilizing guide pins manufactured from softer material. Since the launcher tube was considerably harder than the pins, they could not cut through the rifling grooves even if not positioned properly. Originally, 17S-T4 aluminum guide pins were used. By annealing these pins dead soft, the malfunction rate was reduced to 2 signals of 666 tested. Replacing the 17S-T4 aluminum pins with 2S-H18 aluminum pins completely solved the problem, no malfunctions occurring in tests of 817 signals.

b. Parachute Modifications. Repeated failures of

parachutes to properly deploy upon ejection from the signal rocket assembly at the zenith of flight prompted a static ejection test program. An available 50-foot observation tower was utilized; the test items were mounted in a rigid fixture and fired from the top platform. For the parachute design with a ballistic failure rate of 66% (41 parachute failures of 62 tested), all parachutes functioned satisfactorily when tested statically. From this data and previous data provided by the M125 Series Signal and M131 Signal programs, it was concluded that the rapid spin of the signal at apex was the major cause of failure. Various approaches to the problem was attempted and an eventual solution was reached by pleating the canopy to permit more rapid deployment, replacing the asbestos riser by a beaded metal chain to prevent the spin of the pyrotechnic component from being transmitted to the parachute, and packing the parachute into a cloth bag to delay parachute deployment until the burning pyrotechnic element is clear of the parachute. Of 112 signals tested incorporating the new parachute design, 6 parachutes malfunctioned. However, four of these malfunctions were due to mechanical failures such as the separation of the shroud from the canopy, thereby causing the canopy to collapse, and the breaking of the static line attaching the parachute bag to the signal body, thus preventing the bag from releasing the parachute.

c. Premature "Message" Ejection and Its Correction. On occasion, the gases produced by the propellant grain leaked around the delay column threads, causing ignition of the black powder expelling charge, resulting in premature explusion of the "message" component. This problem was solved by increasing the number of female threads in the rocket motor closure head resulting in a greater thread engagement and a tighter gas seal.

d. Rocket Motor Improvements. One of the parameters required for successful flight was that propellant grain ignition must be accomplished within 0.09 second of firing. To meet this requirement, an igniter assist was required for successful grain ignition. The igniter assist initially selected was composed of four strands of Eimite and four strands of Benite. This device functioned marginally, 30 of 400 signals tested exhibiting delayed or non-ignition of the propellant grain. Examination of the "non-ignition" grains showed that the Benite failed to ignite. Increasing the ignitability of the Benite by coating each strand with a very ignitable first fire slurry significantly reduced the number of delayed or non-ignitions to 11 of 630 signals tested. The problem was eventually solved by relocating the position of the Benite on the grain, eliminating the four strands of Eimite, and completely coating the exposed surface of the grain with a 0.035-inch-thick layer of first fire slurry. Of 470 rounds tested,

no delayed or non-ignitions have occurred. Static tests have indicated an ignition delay of 0.03 second, well below the maximum requirement of 0.09 second.

e. Star Cluster Rework. Star clusters utilizing newly developed compositions were initially designed to resemble the clusters used in the Standard M125 Signal Series. When tested in the XM144 Signal Series, however, the clusters burned erratically and their burning time was considerably below the minimum requirement of six seconds. Since the cluster burned satisfactorily when tested in the M125 Signal Series, it was deduced that the spin imparted to the clusters by the new signal series was harming their burning characteristics. Various approaches to develop satisfactory burning clusters were attempted, including the following: direct pressing of the composition into paper cases, pre-pelleting and subsequent insertion into paper cases, varying the compositions and dimensions of the pellets, varying the internal surface coating of the paper cases, and redesigning the cluster assemblies to allow for directional burning. Of 180 signals incorporating clusters containing one or more of the above modifications, all failed to function properly. A solution was eventually reached by pre-pelleting and inhibiting each pellet by wrapping it with glass cloth thermosetting electrical tape in place of the kraft paper cases previously used. Of 150 signals tested, all of the newly designed star clusters functioned properly, burning for approximately 8 seconds. The failure of the rocket assembly to eject all five star clusters was solved by increasing the black powder expeling charge from 0.8 gram to 2.0 grams and inserting a gas check assembly between the expelling charge and star clusters.

f. Preliminary Environmental Tests. Prior to the shipment of ET quantities of signals to Aberdeen Proving Ground, a total of 265 signals incorporating all the design features of the ET signals were tested locally after being subjected to the following environmental conditions: ambient temperature, -65°F; + 160°F; transportation-vibration; temperature-humidity cycling and fired at -65°F, ambient and + 160°F; and simulated air drop. The signals subjected to temperature-humidity cycling and fired at -65°F were tested statically. All other signals were tested ballistically. Test results revealed no deleterious effects of the above test conditions on the functioning characteristics of the signals. In addition, 20 signals were subjected to jolt, jumble, and 40-ft drop tests. These signals were not fired but failed safe as required.

3. ED-ET Review Meeting (September 1960). In accordance with OCTI 200-2-59, dated 14 January 1959, a Materiel Research and Development Review covering the MX144 Signal Series was held at

Picatinny Arsenal on 21 September 1960. In addition to various Arsenal personnel, representatives from the following agencies were in attendance: Office, Chief of Ordnance; U. S. Army Infantry Board; Headquarters, Ordnance Special Weapons-Ammunition Command; and Ordnance Ammunition Command.

The purpose of the meeting was to determine the acceptability of the design of the XM144 Signal Series prior to their release for final Engineering Testing at the various proving grounds. This decision was to be based upon its ability to meet the requirements listed in the Military Characteristics.

Detailed reports and documents discussing the local test results and describing the functioning characteristics of the signals were presented by representatives of Picatinny Arsenal. These reports showed that:

a. Engineering design activities on the XM144 Signal (not including smoke streamer signals) series had been completed and the item could be released for Engineering Tests.

b. Rounds for Engineering Tests could be delivered to Aberdeen Proving Ground by 15 Nov 1960.

c. The Engineering Design phase of the Smoke Streamer Signals would be completed by 31 December 1960.

d. A number of signals containing a modified igniter assembly incorporating a squeeze type firing mechanism in place of the pull cord mechanism would be hand fired at Aberdeen Proving Ground.

As a result of the demonstration and the discussions held during the meeting, the various attendees were requested to give their opinion as to the acceptability of the item and their recommendations. In all cases, those present indicated that they believed the item was satisfactory for shipment to the various proving grounds to complete the ET phase.

4. First Aberdeen Proving Ground Test Program, ET Phase (July 1961 to August 1961).

a. Test Objective. To determine whether the signals meet the Military Characteristics established by OTCM 37402, dated 26 May 1960 (Appendix I). Various numbers of each of the fourteen signals evaluated were subjected to a battery of safety field tests which included water immersion, temperature-humidity, constant

temperature (ambient, + 160°F and -65°F) and transportation-vibration.

b. Test Results. Summaries of the test results and round-by-round data were tabulated in Aberdeen Proving Ground Report No. DPS-375.

c. Proving Ground Comments and Conclusions.

(1) The color of the smoke and stars was as prescribed exception for the white star, which had a yellow tinge.

(2) The series of signals XM144 through XM-Violet (parachute), when subjected to a 28-day temperature-humidity test and fired at -65°F, showed a tendency for the rocket motor to blow up.

(3) The XM146 Signal failed to ignite after being subjected to + 160°F for an extended period.

(4) The average altitude of function for the star cluster was less than 675 feet.

(5) The average altitude of function of the star cluster when fired at an angle of 45 degrees was less than 400 feet.

(6) The angle of functioning from the vertical, of the star clusters, exceeded 10 degrees.

(7) Erratic flights were obtained for the star clusters and the smoke streamers.

(8) The parachutes would not release properly from the parachute bag.

(9) The flash at the launching position was visible at night from an altitude of 6,000 feet and a distance of 5 miles. Ground observers noted flash from a distance of 1,000 yards.

(10) The XM Signals Series did not meet all Military Requirements.

5. First ST Review Meeting (September 1961). The first ST Review meeting was held at Picatinny Arsenal in September 1961. In addition to representatives from various segments of Picatinny

Arsenal, other government agencies were in attendance. The latter included Office, Chief of Ordnance, Aberdeen Proving Ground, U. S. Army Infantry Board, and Ordnance Special Weapons-Ammunition Command Headquarters.

A review was made that explained the operational characteristics of the signals, with particular emphasis on the component parts which performed poorly during Engineering Test at Aberdeen Proving Ground. These were summarized according to the type of malfunction, the number of rounds tested at Picatinny Arsenal and Aberdeen Proving Ground, and the total number of malfunctions occurring at each installation.

The types of deficiencies noted at APG included the following:

a. Parachute malfunctions (25 of 323 signals)

b. Candle non-ignition at 160°F (29 of 130 signals)

c. Delay non-ignition at 160°F (4 of 70 signals)

d. Rocket motor blows at -65°F after temperature-humidity cycling (10 of 16 signals)

e. Poor ignition qualities of propellant grain (50 of 240 signals).

f. White star candle separation (14 of 44 signals)

The reasons for each of the above malfunctions and the modifications required to prevent them were discussed. As reported, th only malfunction not satisfactorily resolved at the time of the review was the motor blows at -65°F after temperature-humidity cycling. However, the approaches being taken to resolve the motor blow problem were discussed.

At the end of the meeting all attendees agreed that the ST shipment of the signals would be delayed three months to permit a retest at Aberdeen Proving Ground. It was recommended that the signals be reworked to correct the existing deficiencies and that additional samples be furnished for further testing, specifically under the test conditions at which the deficiencies occurred. The test program outlined was to enable APG to recommend all the rounds for service test based on successful completion of the retest.

It was also agreed that all signals designated for

Environmental Testing at Yuma Test Activity and Fort Wainwright be recalled. These signals would be replaced by an equal number containing the latest modifications.

Because of the poor visibility of the smoke streamer signals to aircraft observers, Picatinny Arsenal recommended that the Military Requirements for these signals be modified to allow for a denser smoke trail which could be produced by a faster burning smoke composition. It was stressed that this would limit the smoke production from launch to apex (the requirement called for smoke from launch to ground return). Signals containing this modification would be included in the APG retest. Tentative agreement on this was reached.

6. Second Aberdeen Proving Ground Test Program, ET Phase (December 1961).

a. Test Objective. To determine the acceptability of the XM Signal Series, based on the testing of a number of signals of one type from each of the four groups.

b. Design Improvements Since Last Test.

(1) Rocket Motor. Initial Aberdeen Proving Ground tests of the smoke parachute and star parachute signals produced 10 rocket motor explosions in the 16 signals tested at -65°F after 28 days of temperature-humidity cycling. These malfunctions occurred only after the rounds were subjected to the above test conditions. Subsequent investigation at Picatinny Arsenal indicated that the O ring, which was incorporated to protect the exposed upper face of the grain from being prematurely ignited, did not provide a proper gas seal after the round was cycled and fired at -65°F. Consequently, the exposed face of the grain designed to ignite the delay column after burnout was prematurely ignited. The pressure produced by the propellant grain burning on two surfaces was too great for the metal parts to withstand, and the motor blows resulted. This problem was solved by redesigning the motor assembly to eliminate the dual function of the propellant grain, that is, to propel the signal and also serve as part of the delay train. The grain was redesigned to provide for propulsion only by inhibiting its upper face. The motor was redesigned by plugging the opening previously provided for the delay column and incorporating quickmatch to ignite the delay independently of the grain. A total of 24 rounds containing this latest modification were cycled and tested at -65°F at Picatinny Arsenal. All rounds functioned successfully.

(2) Launcher Recoil. Throughout the development of the XM Signal Series, various methods of firing were considered in an

attempt to minimize the effect of recoil on the flight performance of the signals. Two methods were eventually evaluated, the first being the standard firing technique previously developed for the M131 Red Star Distress Signal. This method required for the signal to be held in one hand while the other hand fired the signal by pulling a lanyard. An alternate method was to adapt a squeeze-type mechanism to the signal to enable the firer to grasp the signal with two hands at the time of firing. Evaluation of both methods at Aberdeen Proving Ground did not indicate either method to be superior. Subsequently, it was found that by knurling the outside surface of the launcher tube, the ability of using personnel at Picatinny Arsenal to grip the launcher during firing was so improved as to make the standard firing method superior to the squeeze-type method. Three of five signals utilizing the squeeze-type method recoiled out of the firer's hands. No loss of signals occurred with the knurled-lanyard type. Hence, no further design change was considered.

(3) Flight Characteristics. In an attempt to simplify the application of the igniter assist to the propellant grain, the Benite was replaced by an equivalent weight of black powder (Grade A-7) blended directly into the slurry. This modified igniter assist, which was satisfactorily proven out as reliable at Picatinny Arsenal, was applied to the grains of all star-cluster and smoke-streamer signals shipped to Aberdeen Proving Ground. An investigation of the cause of the erratic flights at Aberdeen Proving Ground indicated that the homogeneity of the slurry was poor due to segregation of the black powder ingredient. This resulted in a poor functioning igniter assist which caused excessive ignition delays of the propellant grain and resulted in the high incidence of erratic flights. Since sufficient time was not available to refine the blending techniques required to maintain the slurry at uniform consistency, it was decided to revert to the previous igniter assist system of Benite plus first fire slurry.

(4) Parachute. Of the 25 parachute malfunctions occurring during the first Engineering Testing at Aberdeen Proving Ground, approximately 90% were due to one of the following causes: parachutes not being released by their cloth bag housings because the static line attaching the bag to the signal body either pulls out of the bag or breaks; and separation of the parachute shroud lines from the canopy at time of opening, causing the parachute to collapse. These problems were rectified by increasing the size of the bag, permitting easier exit of the parachute and improved sewing technique of the shroud lines to the canopy and static line to the bag. Of the 100 rounds tested at Picatinny Arsenal containing this modified parachute assembly, only 2 failed to function properly. Neither of these failures was caused by any of the malfunctions described above.

One failure was the result of the candle colliding with the parachute's canopy; the other was the result of the shroud lines wrapping themselves around the canopy. From past experience with similar designs, a small percentage of malfunctions of these types were expected as a result of chance alone, consequently no effort was directed towards their solution.

(5) Candle Ignition. The first test results at the Proving Ground on the illuminant parachute signals conditioned at 160°F showed that 13 of 29 candles failed to ignite. Investigation of the problem at Picatinny Arsenal revealed the cause to be the diffusing of wax from the case coating into the first fire, rendering it inert. The solution of this problem was found in substituting a relatively high melting point mixture of paraffin wax and polyethylene in place of the paraffin wax previously used. Of the 33 rounds subsequently tested at Picatinny Arsenal, no failures occurred.

(6) Candle Assembly. The use of filter paper as a flare case provided a flare whose candlepower was more than 50% greater than flares with similar compositions in kraft paper cases. However, the filter paper burned too fast, permitting the last increment of the flare composition to fall free. This malfunction, which occurred with 14 of the 44 flares tested at Aberdeen Proving Ground, was eliminated by cementing the last increment of composition to the anchor plate with epoxy resin. Of the 89 flares tested at Picatinny Arsenal which contained this latest improvement, no malfunctions were encountered.

(7) Streamer Visibility. During the Service Test Review Meeting of 7 Sep 1961, the poor visibility to aircraft observers of streamer signals emitting smoke from launch to ground return in compliance with the Military Characteristics was discussed. Picatinny Arsenal recommended that the signals be modified to allow for a denser smoke trail by utilizing faster burning smoke compositions. It was pointed out that this change would limit the smoke production from launch to apex whereas the requirement called for smoke from launch to ground return. All attendees at the meeting concurred with this recommendation and agreed to include this modification in the streamer signals manufactured for the retest.

c. Test Results. Summaries of the test results and round-by-round data were tabulated in Aberdeen Proving Ground Report No. DPS-479 .

d. Proving Ground Conclusions. The XM Signal Series failed to meet the military requirements because of low altitude of functioning, parachute failures, and unstable flights.

e. Proving Ground Recommendations. It was recommended that, after the signals were reworked, additional signals of each of the types XM146, XM149, XM151, and XM153 be submitted for retest. These signals would be hand fired at ambient temperature.

7. Third Aberdeen Proving Ground Test Program, ET Phase (February 1962).

a. Test Objective. To determine the acceptability of the XM Signal Series based primarily on the altitudes of functioning of a number of signals from one type of each group.

b. Background. A test to supplement the original engineering test plan had been conducted at Aberdeen Proving Ground. Test results showed the major deficiency of the signals to be low altitudes of function when hand fired. A conference was held by representatives of the Proving Ground and Picatinny Arsenal to consider the cause and remedy for the low altitudes of function. It was decided to increase the length of the rocket motor grain and to submit an additional number of signals to Aberdeen Proving Ground for test to determine if the increase would enable the signal to attain the prescribed altitude when fired by hand. The grain length was increased from 1.0 inch to 1.1 inch for the XM146, XM149, and XM153 signals, and from 0.9 inch to 1.0 inch for the XM151 signals.

c. Test Results. Summaries of the test results and round-by-round data were tabulated in Aberdeen Proving Ground Report No. DPS-555. In addition it was noted that the smoke streamers, which were redesigned to emit smoke from launch to apex, were not visible from an altitude of 2,000 feet and from a distance of 2.5 miles. Observations were made both looking toward the sun and with the sun at the observer's back.

d. Proving Ground Conclusions.

(1) The XM149 White Star Cluster Signal met all the military requirements except those of the environmental test, which had not been conducted at the time, but would be in the summer of 1962 and winter of 1962-1963. The same conclusion applied to the XM151 Red Parachute Smoke Signal.

(2) The XM153 Green Streamer Smoke Signal, as modified by Picatinny Arsenal (smoke from launch to apex), was not visible to air observers as required. It met the other military

requirements, except those of the environmental test, which had not been conducted but would be performed as noted above.

(3) The XM146 White Star Parachute Signal did not meet the military requirements because of candle ignition failures, parachute failures, and "message" ejection failure.

(4) The angle of function from vertical exceeded 10 degrees because the firer had not held the signal erect.

e. Proving Ground Recommendations.

(1) The XM147, XM148, and XM149 Star Cluster Signals, the XM150, XM151, XM152, and XM-Violet Parachute Smoke Signals, and the XM153, XM154, XM155, and XM-Violet Streamer Smoke Signals should be released for service test prior to conducting the environmental test.

(2) The XM153, XM154, XM155, and XM-Violet Streamer Smoke Signals, as modified, should only be released to the user for an evaluation test prior to conducting the environmental test.

(3) The XM144, XM145, and XM146 Star Parachute Signals should be reworked. A closer inspection should be made of the assembly and the reworked items should then be resubmitted for further test.

8. Fourth Aberdeen Proving Ground Test Program, ET Phase (March 1962).

a. Test Objective. To determine the acceptability of the XM144, XM145, and XM146 Star Parachute Signals.

b. Design Improvements Since Last Test.

(1) Candle-Parachute Assembly Ejection. One possible explanation for the failure of the candle-parachute assembly to eject was that the paper disc confining the black powder expelling charge broke during transportation, allowing the charge to leak out. The paper disc material was thereby changed from onion skin with a minimum burst strength of 12 points to artesian bond with a minimum burst strength of 37 points. Of the 120 rounds tested at Picatinny Arsenal containing this new paper disc, all functioned properly. Prior to firing, these rounds were subjected to transportation-vibration.

(2) Parachute. In an attempt to improve the

functioning reliability of the parachute, the canopy assembly was modified by increasing the width of the pleats (pocket bands) from 1 inch to $1\frac{1}{4}$ inch. It was anticipated that this change would permit the parachute to deploy more rapidly after ejection. Of the 73 rounds tested at Picatinny Arsenal containing this modified parachute assembly, only one parachute failed to function properly. This failure was a result of the flare colliding with the parachute.

(3) Candle Ignition. From the evidence available, a conclusive reason for the occurrence of candle non-ignitions could not be established. On the basis of similar deficiencies occurring for comparable systems, however, it was decided that the failure of the first fire to ignite might have been due to improper blending of the composition. As a result, a new lot of candles was manufactured, using extreme care in the blending and loading of the first fire composition. Of the 140 rounds tested at Picatinny Arsenal containing this new lot of candles, all functioned properly.

c. Test Results. Summaries of the test results and round-by-round data were tabulated in Aberdeen Proving Ground Report No. DPS-558.

d. Proving Ground Conclusions. The Star Parachute Signals failed to meet the military requirements because of parachute failures, low altitude of functioning, ejection failures, and candle-parachute separations.

e. Proving Ground Recommendations. As the deficiencies still existed in the signals that were tested, it was recommended that the star parachute signals should be reworked, maintaining closer inspection at assembly. Further, after reworking, the signals should be resubmitted for test.

9. Fifth Aberdeen Proving Ground Test ET Phase (May 1962)

a. Test Objective. To determine the acceptability of the XM144, XM145, and XM146 Star Parachute Signals.

b. Design Improvements Since Last Test.

(1) Candle-Parachute Assembly Ejection. Investigation of the problem at Picatinny Arsenal indicated that the failure of the candle-parachute assembly to eject was related to the black powder expelling charge. The weight of expelling charge, although sufficient for the old motor design, was found to be too small for the current design due to the loss of gas pressure through

the motor end of the signal. To compensate for this loss of pressure, the charge weight was increased from 0.8 grams to 1.2 grams. Of the 100 rounds tested at Picatinny Arsenal containing this new charge weight, all had satisfactory ejections.

(2) Parachute It was apparent that the parachute failures were now the most serious deficiency of the star parachute signals. A detailed review of the considerable amount of test data accumulated at Picatinny Arsenal and Aberdeen Proving Ground indicated that the majority of parachute failiures were due to canopy damage caused by the burning candle during ejection. Although the parachute bag was designed to prevent this, it was apparent that additional safeguards would be required. Consequently, it was decided to redesign the candles so that ignition of the illuminant composition was delayed until after the parachute was fully deployed. This was accomplished by recessing the illuminant and first fire composition in the flare case and filling the cavity with a relatively slow burning igniter composition. Ignition of the igniter composition was accomplished by two strands of quickmatch which are imbedded in the igniter composition. The quickmatch was ignited by the black powder expelling charge. Of the 70 rounds tested at Picatinny Arsenal containing the modified candles, only 1 parachute failed to deploy properly.

(3) Parachute-Candle Connection: A deficiency unique only for the white star parachute signals was the separation of the candle from the parachute after satisfactory suspension had occurred. The separation was due to the flame from the candle burning through the bead chain attaching the candle to the parachute. This did not occur for the red or green star signals because of the nature of their flare case material, which tended to confine and directionalize the flame away from the suspension chain. The case material for the red and green flares was 0.070 inch-wall kraft paper; the case material for the white flare was 0.035-inch-wall filter paper. Since the filter paper case was responsible for a 50% improvement in candlepower, the decision to replace it with a kraft paper case was made with considerable reluctance. Of the 100 white star parachute rounds tested at Picatinny Arsenal using the kraft paper cases, no chains were burned through.

c. Test Results. Round-by-round data was tabulated in Aberdeen Proving Ground Report No. DPS-679.

d. Proving Ground Conclusions. The star parachute signals failed to meet the military requirements because of the excessive number of red star parachute signals functioning below 675 feet.

e. Proving Ground Recommendations; Because of the low altitude of function, it was recommended that the red star parachute signals should be reworked and should be inspected more closely at assembly. Further, that after reworking, the signals should be resubmitted for test.

10. Sixth Aberdeen Proving Ground Test Program ET Phase (June 1962).

a. Test Objective. To determine the acceptability of the XM144, XM145, and XM146 Star Parachute Signals based on the altitudes of functioning of the XM145 Red Star Parachute Signal.

b. Test Results. Round-by-round data was tabulated in Aberdeen Proving Ground Report No. DPS-679.

c. Proving Ground Conclusions; The star parachute signals failed to meet the military requirements because the results were inconclusive.

d. Proving Ground Recommendations. Because the results were inconclusive, it was recommended that a larger sample of red star parachute signals be resubmitted for test.

11. Seventh Aberdeen Proving Ground Test Program, ET Phase, (June 1962).

a. Test Objective. To determine the acceptability of the XM144, XM145, and XM146 Star Parachute Signals, based on the altitude of functioning of the XM145 Red Star Parachute Signal and using a 50-round sample.

b. Test Results. Round-by-round data was tabulated in Aberdeen Proving Ground Report No. DPS-679.

c. Proving Ground Conclusions. The functioning characteristics of the star parachute signal were satisfactory except that some of them functioned below the required altitude. Nevertheless the average altitude of functioning was 777 feet when the signals were fired by hand.

d. Proving Ground Recommendations. Since the altitude of function was not critical deficiency, it was recommended that the star parachute signals be released for service test prior to conducting the desert and arctic enviromental tests.

12. Yuma Test Station Summer Enviromental Test Program, ET Phase, (May 1962 to August 1962).

a. Test Objective. To determine the functioning reliability of the XM Series Signals after they were subjected to desert summer enviroment.

b. Test Results. Summaries of the test results and round-by-round data were tabulated in Aberdeen Proving Ground Report No. DPS/OTA-193.

c. Proving Ground Conclusions and Recommendations.

(1) The XM147, XM148, and XM149 Star Cluster Signals and the XM150, XM151, XM152, and XM-Violet Parachute Smoke Signals did not perform reliably under desert summer enviromental conditions. It was recommended that they should be reworked and resubmitted for testing under such conditions.

(2) The XM144, XM145, and XM146 Star Parachute Signals and the XM153, XM154, XM155, and XM-Violet Streamer Smoke Signals did perform reliably under desert summer enviormental conditions. It was recommended that they be considered satisfactory for use under such conditions.

d. Picatinny Arsenal Comments. After a review of the Yuma Test results, the following comments were formulated at Picatinny Arsenal.

Comparison of the test data for all signals indicated that the failure of the star cluster and parachute smoke signals to be considered satisfactory for use under desert summer enviromental conditions was most strongly influenced by the occurrence of premature "message" expulsions for 3 of the 70 rounds tested. It was apparent that the prematures resulted because the hot reaction products from the launch expelling charge and/or quickmatch bypassed the gas seal and ignited the payload and/or payload expelling charge. As designed the payload was protected from these reaction products by a gas seal composed of 2 pressed felt wads and a neoprene disc located at the delay housing. Although the gas seal had functioned successfully in temperate and arctic enviroments, the higher desert temperatures caused higher pressures to be generated by the launch expelling charge and/or quickmatch, thereby reducing the effectiveness of the seal. Previous work with items of similar design indicated that a reliable gas seal effective at the temperature extreme of 160°F can be provided by roll crimping the signal body over a grooved spacer located at the same position as the present spacer.

13. Infantry Board Test Program, ST Phase (June 1962 to October 1962)

a. Test Objective. To determine if (1) the XM Series Signals are suitable for Army use under temperate enviromental conditions, (2) they meet the established military characteristics, and (3) they are suitable replacements for the standard M Series Signals.

b. Test Results. A summary of the test results abstracted from the test report is shown below. A detailed presentation of the test results and the Infantry Board's comments can be found in Project Report No. 2991.

(1) The XM Series Signals were considered satisfactory with respect to physical characteristics, burning time, average visible display times, and the rate of descent of the parachute-suspended message components. The signals were not rendered operationally unusable by exposure to adverse conditions. Functioning of those signals not visibly damaged was apparently not affected adversely by aerial delivery or transport.

(2) Deficiencies and the principal shortcomings noted during the test were as follows:

(a) Twelve of the malfunctions that occurred during the test were considered safety hazards and, therefore, deficiencies. In addition, launcher recoil, the sparks and debris from the signals, and the potential lethal effect of the falling burned-out spin-stabilized tube of all signals were considered excessive.

(b) All signals exceeded the specifications stated in the military characteristics for the average height of burst and the tolerance from the average height of burst. The recoil impulse of the signals was considered excessive. Some of this excessive recoil was caused by the force required to project the message component to the increased average height of burst,.

(c) There was a lack of sharp definition between the colors of some of the signals. Position-disclosing effects of all signals could be seen at the launch site by observers stationed at a distance of 1,000 yards during daylight and 5,200 yards at night. Smoke streamer signals did not emit smoke from launch to ground impact as specified in the military characteristics.

(d) The total of 110 malfunctions (6.4%) which occurred during the tests indicated a lack of reliability.

(e) The signals were deficient in important aspects of human factors engineering. The hermetically sealed containers of the signals were difficult to open. In addition, the users experienced excessive recoil, with attendant sparks and debris, when launching the signals by hand.

c. Infantry Board Conclusions.

(1) The Rocket Type Hand Held Ground Signals are not suitable for Army use under temperate conditions.

(2) The ultimate requirement for a ground signal should be fulfilled by the development of a 40 mm signal cartridge.

d. Infantry Board Recommendations.

(1) The development of the XM Series Signals, should be terminated.

(2) Immediate effort should be directed toward developing a 40 mm signal cartridge for interim use with the M79 Grenade Launcher and ultimately with the Special Purpose Individual Weapon.

e. Picatinny Arsenal Comments. During the Service Tests at Ft. Benning, nine separate Reports of Equipment Failure covering a variety of shortcomings and deficiencies observed during these tests were issued. The deficiencies as recorded and Picatinny Arsenal's comments are shown below. Where practicable, the modifications suggested by Picatinny Arsenal were incorporated in the signals shipped to Ft. Greely, Alaska for arctic winter enviromental tests.

(1) Equipment Failure Report No. 1 stated that breaking of the tear strip made it difficult to open the hermetically sealed containers. A program was initiated to improve the container by substituting a nine-inch-diameter nylon loop for the six-inch-length metal tear strip extension. The nylon loop will make it possible to apply better leverage to the tear strip, thereby facilitating the opening of the container. In addition, this Arsenal initiated an investigation into the possibility of replacing the metal containers with plastic containers, which would be opened by unscrewing a cap from the container body.

(2) Equipment Failure Report No. 2 stated that the spent hardware falling close to the launch position was a safety hazard. During the development of the XM144 Signals Series, major emphasis was placed on reliability, accuracy, and stability of flight in order to deploy the message component in accordance with the requirements established by the Military Characteristics. Only minor consideration was given to the impact area of the spent hardware. If this is considered a safety hazard to troops, the only short range recommendation that can be made to alleviate the problem is to revise the firing instructions to require firing at 20 degrees from the vertical in lieu of the present vertical firings. This would cause the spent hardware to impact approximately 250 feet from the launch area while still meeting the minimum height requirement for vertical firing of 675 feet. Greater increases in the angle of firing from the vertical will cause the hardware to fall further from the launch area. However, the vertical height of functioning would then be less than 675 feet.

(3) Equipment Failure Report No. 3 stated that the position-disclosing effects of this series of signals was a shortcoming. Picatinny Arsenal had previously indicated tha the Military Characteristics requiring the flash of the XM Signal Series to be indiscernible at ranges greater than 1,000 yards could not be met. In addition, it was stated that the signals would be designed to minimize the effects of smoke and flash. This has been accomplished, as shown by a comparison of the smoke and flash resulting from the firing of the XM144 Series and M125 Series. Although the M125 Signal Series produced a smoke and spark trail from launch to a height of approximately 85 feet, the XM Signal Series produced a short duration flash (of the order of milliseconds) having a diameter of less than three feet. Although this flash is discernible at ranges greater than 1,000 yards, its small size and short duration would make it extremely difficult for an observer to determine the range of the firer.

(4) Equipment Failure Report No. 4 stated that the firing instructions affixed to all signal launchers were incomplete and incorrect and, if followed, might cause injury to the firer. The firing instructions were revised to show the firer pictorially the correct procedure to be followed in firing the signal.

(5) Equipment Failure Report No. 5 stated that when the signal was removed from the hermetically sealed containers, the metal caps on the signal sometimes remained in the container. In addition, when the metal cap was removed from the signal, the cork seal on the ejection end sometimes adhered to the cap or falls off the signal because of an apparent lack of glue. Action was taken to prevent the metal caps from sticking in the hermetically sealed container and the pull ring from being wedged in the cap by increasing the inside diameter of the container and decreasing the outside diameter of the pull ring. These changes increased the amount of clearance between the parts in question. Regarding the cork seal adhering to the metal caps, it was believed that insufficient time was allowed for the lacquer seal to thoroughly dry prior to assembly of the caps to the signal. Assembly instructions were revised to provide for a longer drying period. To prevent the cork seal from falling out of the launcher tube, greater care would be taken to insure the application of sufficient lacquer to seal the cork in place. Greater care would also be given to packing the pull cord so that it unraveled properly.

(6) Equipment Failure Report No. 6 stated that excessive recoil was experienced. The recoil transmitted to the firer was the result of the sudden acceleration imparted to the signal by the ejection charge. Measurements of the recoil forces were made during optimization of the expulsion charge in the ET Phase of this program The expulsion charge selected was based on an acceptable level of recoil demonstrated in the previously developed series of hand-held signals. It was considered possible to redesign the ejection charge to reduce recoil below the present level without degrading performance by altering the

quantity and granulation of black powder used, or by introducing other propellant materials in place of the black powder and optimizing the quantity and configuration of ejection propellant. Recent work with nitrocellulose propellants in igniters and ejection systems indicated the wide variation of performance that can be obtained with these materials.

(7) Equipment Failure Report No. 7 stated that a rocket motor blow was experienced when "the ignition system, black powder expelling charge and rocket motor had exploded simultaneously and/or the pins on the signal rocket assembly had wedged into the sides of the signal launcher which caused the rocket motor to burn out in the base of the signal launcher and prior to ejection." The rocket motor design was believed to be basically sound and no evidence of a weak spot in the motor had been adduced by consistency of one type of failure. It was believed that the few failures encountered were attributable to poor quality or poor assembly of the failed item, possibly in combination with each other or with other unusual conditions. The quality control of the parts would be carefully re-examined and improvements would be made in critical areas. It was also recommended that adhesive should be applied to all threaded attachments in the assembly of the item not only to improve the strength of the basic motor but to mitigate the effect of poor assembly.

(8) Equipment Failure Report No. 8 stated that the one of the signals fired prematurely while being removed from the container after a malfunctioning parachute drop. It was recommended that the Military Characteristics requiring "the signals to be safe to handle and fire after drop by malfunctioning parachute provided no visible damage has been sustained" be revised to require only that signals be safe to handle and dispose of. The basis for this recommendation was the signals might have experienced internal damage not visible to the naked eye, thereby creating a hazard to the firer. Further, the requirement that this or any other pyrotechnic item be serviceable after malfunctioning parachute drop was considered technically unsound. For this type of item, the ability to be handled and disposed of was considered a very desirable characteristic.

(9) Equipment Failure Report No. 9 stated that suspension chain breaks caused the parachute flare and parachute smoke "message" components to be separated from the parachute upon ejection from the rocket assembly. Subsequent to the Ft. Benning test, a stronger chain was incorporated in the signals shipped to Ft. Greely. Whereas the suspension chain in Ft. Benning shipment was chrome plated brass with a minimum tensile strength of 45 pounds, the new chain was stainless steel with a minimum tensile strength of 75 pounds. Of the 81 signals tested at Picatinny Arsenal which incorporated the stainless steel chain, no chains broke.

(10) In addition to the aforementioned, Report of Project No. 2991 stated that five dangerously erratic flights were encountered, there was a lack of color definition, and that the smoke streamer signals emit smoke only on ascent.

(a) With respect to the five erratic flights it was understood that they all landed approximately 150 feet from the launcher. Thus they created less of a hazard to the troops than the spent signal body falling from trajectory apex of 750 feet except that the pyrotechnic element was still in the signal or was ejected just before ground impact.

(b) With respect to color definition, this Arsenal had used the best signal elements that the current technology could produce. It was noted that all signals were correctly identified at a range of 2500 yards during the day except one yellow smoke element was mistakenly identified as green. At night all flare signals were correctly identified at a arange of 5200 yards. It was also noted that during the night aerial test all flare signals were correctly identified at a slant range of 5 miles and 5,000 feet altitude.

(c) With respect to the streamer signals emitting smoke only on ascent, it was found during the engineering test that insufficient smoke was produced to effectively mark the whole trajectory. This problem was brought to the attention of a member of the Infantry Board and the Office, Chief of Ordnance and smoke emission on ascent only was informally accepted as the limit of the state of the technology.

14. Ft. Greely Winter Enviromental Test Program, ST Phase (December 1962 - January 1963)

a. Test Objective. To determine if the XM Signal Series are suitable for Army use under arctic winter enviromental conditions.

b. Test Results. The official report covering the arctic winter enviromental tests has not been completed at the time of this report. A preliminary summary of the test results as received from the Arctic Test Board is as follows:

(1) A total of 897 signals were fired at ambient temperatures ranging from minus 51°F to plus 30°F, 879 signals were fixture fired and 18 hand fired. The average height of burst or smoke streamer apex for all types of signals was in excess of 900 feet. No signal that otherwise functioned normally deviated from line of fire more than 10 degrees. No significant difference in performance occurred at either end of the temperature range in which the signals were fired.

(2) A total of six signals malfunctioned at launch. For five of these signals, the igniter assembly separated from the launcher tube at time of firing. The nozzle plate of the sixth signal separated from the motor in or adjacent to the launcher tube. Of the six malfunctions, three of the signal rocket assemblies failed to

eject from the launcher. The three rocket assemblies which left the launcher had extremely erratic flights.

(3) In approximately 10% of the smoke parachute signals fired, the parachutes either failed to eject or failed to deploy. Failures occurred primarily with the violet smoke parachute.

(4) The color of the smoke signals was difficult to ascertain at ranges in excess of 1,500 yards. Green and yellow were easy to confuse. Violet at times appeared black. Illumination signals, howeverl were effective and easy to identify. On one occassion, a red star cluster signal was observed and identified at night by an air observer at a distance of 40 miles.

c. Arctic Test Board Conclusions. Because of the six malfunctions at launch, it was considered that the test signal do not meet the safety requirements of the military characteristics and are not safe, as provided for test, for issue to using troops. In addition, empty message containers of all types of test signals returned to earth with sufficient force to constitute a serious safety hazard to ground personnel.

d. Arctic Test Board Conclusion. The XM Signal Series, as provided for test, are unsuitable for Army use under arctic winter conditions.

e. Picatinny Arsenal Comments

(1) With respect to the igniter assembly and motor nozzle separation, examination of 110 of the unfired signals returned from Ft. Greely disclosed that the threads of two launcher tubes were stripped. This defect apparently occurred during manufacture but was not detected during inspection. Firing of one of these signals resulted in an igniter assembly separation similar to those which occurred at Ft. Greely. Prior to this discovery, an engineering design analysis confirmed the design of all metal parts to be basically sound and capable of withstanding gas pressure far in excess of the normal pressures generated. A reliability engineering analysis showed the reliability of the metal parts in question to approach 100% (99.99+%). All evidence therefore indicated that the few failures may be attributed to faulty parts and/or assembly techniques. Development of more stringent quality control provisions was started to prevent the recurrence of these malfunctions. As an additional safety factor, application of an adhesive to the threaded attachments has been incorporated into the design. This would mitigate the effect of poor assembly.

(2) With respect to the large number of smoke parachute signals which failed to eject the message component, it was believed that this defect was an outgrowth of the motor design changes necessitated by the failure of the original motors to withstand temperature-humidity cycling, and firing at -65°F. As a result of these

design changes, the effectiveness of the motor assembly in preventing excessive gas leakage from the black powder expelling charge was reduced. Comparison of the test data from Ft. Benning, Yuma, Aberdeen, and Ft. Greely indicated that the low ambient temperatures at Ft. Greely tended to increase the amount of leakage, thereby preventing the required pressures necessary for reliable ejection from being attained. The recommendation previously made to eliminate prematures (Engineering Test at Yuma), that is, roll crimping the signal body over a grooved spacer, would eliminate non-ejections by preventing gas leakage through the rear of the signal.

15. U.S. Army Test and Evaluation Command Comments on the Service Tests (January 1963)

The U.S. Army Test and Evaluation Command's comment on the Ft. Benning test results and conclusions and the preliminary Ft. Greely test results are contained in a letter report which was made a part of the Ft. Benning Report on Project No. 2991. The major comments excerpted from the letter were as follows:

(1) "This Headquarters concurs in the report of the U. S. Army Infantry Board, except that development should not be terminated without a review of requirements and consideration of alternatives."

(2) "The reported deficiencies and shortcomings, and those currently observed during winter tests at Ft. Greely, Alaska, are of such a nature as to make procurement inadvisable, if for no other reason than considerations of safety. Specifically, malfunctions in or adjacent to the launching tube must be eliminated or the tube reinforced to withstand such malfunction without potential hazard to the user."

(3) "It is recommended that the comments of the Combat Developments Command be solicited to determine whether the requirements for subject items are still firm, prior to further development."

16. Safety and Reliability Evaluation (March 1963)

During Service Tests of the XM144 Series Signals at Ft. Benning and Ft. Greely a small percentage of launching malfunctions occurred. These malfunctions consisted of motor nozzle separations at Ft. Benning (4 of 1,704 rounds), and motor nozzle and igniter assembly separations at Ft. Greely (1 and 5 respectively, of 897 rounds).

Although the launcher-igniter assembly and rocket motor were originally designed to withstand pressures considerably in excess of the normal pressures generated, the occurrence of the launching malfunctions caused additional experimental and computation work to be conducted. This work gave further evidence that the design of these metal parts was basically sound.

A detailed analysis to determine the reliability (safety) of metal parts security for the launcher-igniter assembly when subjected to the firing pressures developed inside the launcher tube can be

found in Picatinny Arsenal's Quality Assurance Division Report No. CAR 6. This analysis established that reliability of metal parts (launcher tube and igniter assembly) security approaches 100% (99.99+%) if these parts are produced in accordance with present drawings and specifications.

A detailed analysis to determine the reliability (safety) of metal parts security for the rocket motor when subjected to the propellant pressures developed inside the motor can be found in Picatinny Arsenal Quality Assurance Division Report No. CAR 7. This analysis established that if the metal parts (motor head and motor nozzle) are produced in accordance with present drawings and specifications their reliability with respect to shear approaches 100% (99.99+%).

17. Recent Local Findings (April 1963)

In addition to the theoretical analysis, the reliability of metal parts security of the launcher-igniter assembly and rocket motor was experimentally and dimensionally determined. The experimental tests were designed to confirm the calculated results and determine whether poor assembly techniques would result in metal parts failure. The dimensional tests were designed to assure that the metal parts met the drawing and specification requirements.

a. Hydrostatic Tests. To determine the pressure necessary to cause motor failure at different degrees of thread engagement (motor nozzle engaged for full 5 threads, motor nozzle backed off to reduce thread engagement to 4 threads, 3 threads, and 2 threads). The average pressure at which motor nozzle separation occurred were as follows:

(1) Fully engaged, 8300 psi
(2) 4-thread engagement, 7300 psi
(3) 3-thread engagement, 5200 psi
(4) 2-thread engagement, 2500 psi

Since the peak internal pressure generated by the propellant grain is approximately 1700 psi at 70°F, satisfactory functioning may still result under the worst condition, which reduces the thread engagement by 60%. By coating the threads with epoxy resin prior to assembly, the pressure required for separation of the 2-thread-engaged system is increased to 4000 psi, thus providing a reliable safety factor.

b. Function Test No. 1. To determine if a reduction in thread engagement of the igniter assembly will cause separation during firing of signals. The launcher tubes were modified to reduce the thread engagement from the normal 3.85 threads to 1.0 and 2.0 threads. Firing was conducted at -65°F from the fixture previously used at Ft. Greely during Service Tests. All 21 rounds functioned satisfactorily.

c. Functioning Test No. 2. To determine the effect of increasing the black powder expelling charge on the metal parts security of the launcher-igniter assembly. The expelling charge for 32 signals returned from Ft. Greely was increased from the present 1.0 gram to 2.0 grams of Grade A-5 black powder. Firing was conducted at-65°F from the fixture previously used at Ft. Greely. All signals functioned satisfactorily.

d. Functioning Test No. 3. To determine the effect of a finer granulation black powder expelling charge on the metal parts security of the launcher-igniter assembly. The expelling charge for 31 signals returned from Ft. Greely was modified to 1.0 gram Grade A-7 black powder. Firing was conducted at -65°F from the fixture previously used at Ft. Greely. All signals functioned satisfactorily.

e. Metal Parts Inspection: Inspection of 110 unfired signals recalled from Ft. Greely disclosed two signals whose launcher tube threads were stripped, thereby preventing any appreciable thread engegement to the igniter assembly. It was apparent that the threads were stripped during manufacture and were not detected during incoming inspection. Firing of one of these signals produced an igniter assembly separation of the type encountered at Ft. Greely.

f. Conclusions: All findings indicate that the design of the metal parts is basically sound and that they are capable of withstanding pressures considerably in excess of normal. The findings also indicate that the launch malfunctions encountered at Ft. Benning and Ft. Greely can be eliminated by tighter inspection procedures of the metal parts prior to assembly.

18. Second ST Review Meeting (July 1963) As directed by U. S. Army Materiel Command, an In-Process Review (Service Test) will be held at Picatinny Arsenal on 2 July 1963. The review will have the following objectives:

a. Establish those characteristics found deficient during service test which must be corrected prior to type classification.

b. Determine the latest military requirements for signals, namely, hand-held, weapon-launched or both, together with a confirmation of requirements with regard to:

(1) Altitude
(2) Number of colors and types of signature
(3) Smoke streamer characteristics.

c. Establish what must be done to meet the determined requirements.

IV. GENERAL DESCRIPTION

1. Physical Characteristics

The XM144 Series Signals are essentially self-contained, spin stabilized, hand-held, rocket-type, ground-launched pyrotechnics. Each signal consists of three concentric tubes: an outer tube, which is the protective container, a middle tube, which is the launcher tube with an igniter, and an inner tube, which contains the rocket motor and pyrotechnic components (Figures 1, 2, and 3). The protective container is for shipping and storage only, and consequently is never removed until immediately before firing. The middle and inner tubes comprise the signal's complete assembly.

The major units of the star parachute rocket assemblies consist of a parachute assembly, illuminant assembly, delay assembly, rocket motor assembly, and signal body. They differ only in the formulation of their illuminant compositions, which are designed to produce different colors, green, red, white (Figure 4).

The major units of the star cluster rocket assemblies consist of five individual pellets , a delay assembly, rocket motor assembly, and signal body. They differ only in the formulation of their illuminant compositions, which are designed to produce different colors, green, red, and white (Fugure 5).

The major units of the smoke parachute rocket assemblies consist of a parachute assembly, smoke assembly, delay assembly, rocket motor assembly, and signal body. They differ only in the formulation of their smoke compositions, which are designed to produce different colors, green, red, yellow, and violet (Figure 6).

The major units of the smoke streamer rocket assemblies consist of a smoke ignition assembly, smoke composition consolidated in the signal body, and rocket motor assembly (Figure 7).

The physical characteristics of the above assemblies are shown in Table 1.

2. Component Description

a. Launcher and Igniter Assembly. The launcher and igniter assembly previously developed for the M131 Red Star Distress Signal was adapted for use with the XM Series Hand Held Signals (Figures 8 and 9). The igniter assembly incorporates a pull ring firing mechanism and a black powder expelling and igniter charge. Because a smaller expelling charge was used, the cavity was reduced in volume with polyethylene fillers. The black powder charge is ignited by a No. 68 Remington percussion primer which is pressed into the assembly housing. A gas check assembly

located at the base of the launcher tube minimizes gas leakage around the signal body during ejection. The launcher contains two spiral grooves running the length of the tube. Two pins located on the rocket motor ride in these grooves during ejection, creating initial spin of the signal body. This spin is required to provide flight stability of the signal up to the time the rocket motor takes over. The outside surface of the launcher tube is knurled for a length of 5.2 inches at the igniter end to make it easier for using personnel to grip the tube during firing.

b. Rocket Motor. The rocket motor consists of two steel screw-fitter parts, a motor nozzle and a head closure. The motor nozzle contains dual canted nozzles to impart spin to the signal during the burning period of the propellant charge (Figure 10). The head closure functions not only as a closure but also as a spin mechanism for imparting initial spin to the signal by means of pins which protrude through the signal body. In addition, the head closure for the star-parachute, star-cluster, and smoke-parachute signals incorporate a threaded slot for attachment of the delay column (Figures 11 and 12). The propellant charge consists of a single-end-burning HEX-12 double-base propellant grain inhibited at the outer periphery and one end with ethylcellulose. (Figure 13.). Rapid ignition of the propellant grain is accomplished by an igniter assist consisting of two strands of Benite and first fire slurry bonded to the nozzle end of the propellant grain. Functioning of the rocket motor is accomplished when the hot gases from the black powder expulsion charge pass through the nozzle and initiate the igniter assist material. This material in turn ignites the exposed face of the cigarette-type-burning propellant grain.

c. Delay Assembly. The delay assembly (Figure 14) is designed to burn for approximately 5.7 seconds to allow the signal to attain an average height of approximately 770 feet (vertical firing) prior to ejection of the parachute or cluster assemblies. The delay is obtained by a pyrotechnic composition consolidated in an aluminum housing under a pressure of 36,000 pounds per square inch. Igniter composition is located at each end of the delay composition, at one end to assure ignition of the delay and at the other to assure ignition of a black charge. Initiation of the delay train is accomplished by two strands of first-fire-coated quickmatch which are ignited simultaneously with the rocket motor by the launch black powder expelling charge.

d. Rocket Motor Assembly. The rocket motor assemblies incorporated in the star-parachute, star-cluster, and smoke-parachute signals are identical in appearance but differ in the weight of black powder expelling charge and length of propellant grain (Figure 15, Table 1). They are completely assembled prior to insertion into the signal body. Assembly is performed by the following operations in the order listed.

(1) Propellant grain assembly is inserted into closure head.

(2) Motor nozzle is assembled to closure head.

(3) Spacer is secured to delay assembly by staking and cementing.

(4) Neoprene gas check seal and pressed felt gas check wads are placed on the delay column. The purpose of these gas checks is to prevent the signal rocket black powder expelling charge from being prematurely ignited by the hot gases and reaction products produced by the launch expelling charge and quickmatch.

(5) Delay column is assembled to closure head.

(6) Gas check is cemented to spacer.

(7) Black powder expelling charge is inserted into cavity formed by the gas check wad and spacer.

(8) Bond paper disc is cemented to the gas check.

(9) Required length of quickmatch is inserted through opening between delay column and closure head and secured in the required position with permacel tape.

The smoke streamer signals, which do not incorporate a delay column or signal rocket expelling charge, require only steps (1) and (2) for rocket motor assembly (Figure 16). The rocket motor assemblies are then inserted into their respective signal bodies with the two bosses of the closure heads in line with the two .201-inch-diameter holes located on the signal bodies. A soft aluminum pin is then force fitted into the opening of each boss to the required dimension.

e. Illuminant Composition. Illuminant compositions burning green, red, or white are shown in Figures 17, 18, 19 , and 20 respectively. Identical compositions are used for the red and green flare-type and cluster-type signals. The white burning compositions differ for the flare and cluster type signals.

f. Smoke Composition. Smoke compositions producing green, red, yellow , or violet smokes are shown in Figures 21, 22, 23, and 24 respectively. Identical compositions are used for the smoke parachute and smoke streamer signals.

g. Illuminant Assembly. The illuminant composition is consolidated in a convolute-wound kraft paper case (3.73 inches long by 1.34 inch outside diameter), with bottom case recessed 0.5 inch, under a loading pressure of 7,500 pounds per square inch with a stepped ram. Ignition of the illuminant composition is assured by an outer layer of first fire composition consolidated with the first increment of illuminant composition. Ignition of the first fire composition is accomplished by an ignition charge and a quickmatch assembly, their purpose being to delay ignition of the illuminant composition until the parachute is fully deployed. (Figure 23). A parachute hanger assembly is attached to the case by roll crimping the case over the anchor plate.

h. Cluster Assembly. The illuminant composition is consolidated as individual pellets to the dimensions shown in Fugure 26. In order to meet the required burning time and light characteristics, each pellet is inhibited on the outer periphery with glass cloth thermosetting electrical tape (Figure 27). Each signal contains 5 pellets. Ignition of the illuminant composition is assured by coating all exposed surfaes with a brushable slurry of first fire composition.

i. Smoke-Parachute Canister Assembly. The smoke composition is consolidated in a convolute-wound kraft paper case (3.73 inches long by 1.34 inches outside diameter) under a loading pressure of 4,000 pounds per square inch with a stepped ram. The required smoke cloud is obtained by providing a tapered hole through the center of the composition to allow for radial burning. A fire clay choke at the base of the column physically protects the smoke column and also prevents flaming of the smoke composition (Figure 28). The smoke composition is ignited by coating all exposed surfaces with a first fire slurry. A parachute hanger assembly is attached to the top of the canister by roll crimping the canister over the anchor plate.

j. Smoke Streamer Case Assembly. The smoke composition is consolidated in the aluminum signal body under a loading pressure of 4,000 pounds per square inch with a stepped ram. The required smoke trail is obtained by providing a tapered hole through the center of the composition to allow for radial burning. The burning composition exits through eight 0.375-inch-diameter holes in the signal body, arranged in two rows of four holes located at the base of the smoke charge. A fire clay choke, at the base of the smoke column physically protects the column and also prevents flaming of the smoke composition. Ignition of the smoke composition is accomplished by two strands of first-fire-coated quickmatch running the length of the smoke charge. The quickmatch is ignited by the launch expelling charge. The assembly is closed off at the top by roll crimping the signal body over an aluminum disc and at the base by the rocket motor (Figure 5).

k. Parachute Assembly. A circular-shaped canopy made of nylon cloth with a diameter of 24 inches is used to suspend the illuminating and smoke producing components. The parachute has eight peripheral shroud lines approximately 22 inches long made from nylon cord. To facilitate proper deployment, the canopy is pleated at each point of connection to the shroud lines making a total of eight pleats. All eight shroud lines are joined to a 10-inch-long beaded suspension chain through a coupling. The other end of the suspension chain is joined to the hanger assembly coupling. The parachute is packed in a cloth bag to delay its deployment until after the illuminating or smoke producing component has passed by, thus preventing damage to the canopy or shroud lines by the hot reaction products (Figures 29, 30, and 31)

l. Hanger Assembly. The assembly is attached to the illuminant case or smoke canister by crimping over an anchor plate. The parachute assembly is attached to a coupling anchored to the plate by a cotter pin.

m. Launch Expelling Charge. 1.0 gram of grade A-5 black powder is used to expel the signal rocket assembly rocket assembly from the launcher.

n. Signal Expelling Charge. 1.2 grams of grade A-3 black powder is used to expel the parachute-illuminant assembly from the signal body. 2.0 grams of grade A-3 black powder is used to expel the illuminant cluster assemblies from the signal body. 1.0 gram of grade A-3 black powder is used to expel the parachute-smoke assembly from the signal body.

3. Packing Description

Each signal is hermetically sealed for shipping and storage in an appropriately marked, cylindrical steel shipping container (Figure 32). The signals are shipped and stored in wooden boxes. Each box when fully loaded contains 36 signals, weighs approximately 65 pounds and requires 1.6 cubic feet of space.

4. Operation and Performance Data

a. Preparation for Use.

(1) After each signal is removed from the shipping box, its protective container should be examined for possible damage resulting from transportation and rough handling. No attempt should be made to remove the signal element from a damagedcontainer since a premature firing may result if the pull ring is wedged inside the container. All seriously damaged signals are to be returned to the appropriate Ordnance Ammunition Depot for disposition.

(2) When the signal is to be fired, the container is opened by pulling a centrally located tear strip extension until the tear strip is completely peeled from around the container. The signal is then removed from the divided halves of the container. Since the signal is not waterproof, it is recommended that it be fired immediately after removal from the container.

b. Method of Operation.

(1) After removal from the shipping container, the signal is fired in accordance with the pictorial instructions attached to the launcher tube, (Figure 33). To fire the signal, it is firmly grasped at the knurled section with one hand, while the other hand removes the aluminum cap at each end. The firer is cautioned to hold the signal upright at all times to eliminate any potential hazardous situation if the signal is inadvertently fired. The signal is then

pointed in the desired direction of fire while being held firmly at arms length with the base of the signal at approximately eye level. With the other hand the user grasps the pull ring which is hanging freely, and gently pulls the safety latch to release the striker assembly, thereby firing the primer, which in turn ignites the primary black powder expelling charge. Hot gases from the burning of this charge build up sufficient pressure to expel the signal rocket assembly and ignite the propellant grain and quickmatch strands.

(2) For the star-parachute, star-cluster, and smoke-parachute signals, the burning quickmatch ignites a delay column. After approximately 5.7 seconds, at which time the signal is at the apex of its flight, the delay column burns through and ignites a second expelling charge. This charge performs two functions: it ignites and ejects the message component. The star-cluster, which fall freely, burn for approximately 8 seconds, burnout occurring approximately 200 feet above the launch site when the signal is fired vertically. The star-parachute consist of a parachute-suspended candle which burns for approximately 50 seconds while descending at an average rate of 7 feet per second. The smoke-parachutes consist of a burning smoke charge suspended from a prarchute. Because of the nature and rapidity of burning (approximately 10 seconds duration), a smoke cloud is produced in the immediate area of ejection.

(3) For the smoke-streamer signals, the burning quickmatch ignites the smoke composition which emits a smoke trail from launch to apex of flight.

c. Performance Characteristics. Performance characteristics for the entire family of signals are shown in Table 2. Detailed test data and user comments can be found in the following reports covering all engineering and service tests.

DPS-375, Nov 1961, Aberdeen Proving Ground
DPS-479, Feb 1962, Aberdeen Proving Ground
DPS-555, May 1962, Aberdeen Proving Ground
DPS-558, Jun 1962, Aberdeen Proving Ground
DPS-679, Sep 1962, Aberdeen Proving Ground
Report 2291, U. S. Army Infantry Board
DPS/OTA193, Dec 1962, Aberdeen Proving Ground/Yuma

d. Precautions In Use, Handling and Storage.

(1) Use and Handling.

a. The signals are designed and packed to withstand normal rough handling and will function satisfactorily if reasonable care is exercised in handling them. However, no attempt should be made to remove a signal from a damaged protective container, or to fire a signal from a damaged launcher tube.

(b) Tests have shown that the signals will fail-safe when subjected to a jolt test as per MIL-STD-30C, jumble test as per MIL-STD-301, and after air drop by malfunctioning parachute. It is not recommended, however, that Signals which have undergone these tests should be fired since hidden damage may have been incurred, thereby creating a hazard to the firer.

(c) When the signals are fired, regulations prescribed in AR-385-63 should be followed.

(2) Storage. All signals should be stored in accordance with Ordnance Safety Manual ORD-M7-224 with its supplements and amendments.

(3) Classification. ICC classification for shipping is "SPECIAL FIREWORKS."

5. Comparison of XM144 Signal Series To Other Types of Signals

For purposes of comparison, the ballistic characteristics of the signaling elements for the XM144 Signal Series, M125 Signal Series, M131 Distress Signal, Aircraft Signals and Pen Gun Signals are tabulated in Table 3. Since the tactical requirements for the M131, Aircraft Signals and Pen Gun differ, a direct comparison can only be made between the XM144 and M125 Signal Series.

TABLE 1

PHYSICAL CHARACTERISTICS

MODELS

	Parachute			Cluster			Parachute				Streamer			
	Green Star XM144	Red Star XM145	White Star XM146	Green Star XM147	Red Star XM148	White Star XM149	Green Smoke XM150	Red Smoke XM151	Yellow Smoke XM152	Violet Smoke XM-	Green Smoke XM153	Red Smoke XM154	Yellow Smoke XM155	Violet Smoke XM-
Complete Assembly (w/Steel Shipping container														
Length (inches)	10.66													
Diameter (inches)	1.9													
Weight (lbs)	1.43	1.39	1.40	1.43	1.40	1.40	1.31	1.31	1.31	1.31	1.43	1.43	1.43	1.39
Launcher Assembly														
Material	Aluminum													
Length (inches)	9.85													
Diameter (inches)	1.63													
Weight (lbs)	0.40													
Primer														
Type	Percussion													
Model	Remington Arms No. 68													
Expelling Charge	1.0 gram Grade A-5 Black Powder													
Signal Rocket Assembly														
Weight (lbs)	0.73	0.69	0.70	0.73	0.73	0.70	0.61	0.61	0.61	0.61	0.73	0.73	0.73	0.69
Signal Body														
Material	Aluminum													
Length (inches)	8.7													
Diameter (inches)	1.43													
Pins														
Material	Aluminum													
Rocket Motor														
Material	Steel													
Propellant														
Type	End Burning, Double Base													
Length (inches)	1.15						1.05 (See Note No. 1)				1.15			
Diameter (inches)	.87													

Material	Aluminum			
Length (inches)	8.7			
Diameter (inches)	1.43			

Pins

Material	Aluminum			

Rocket Motor

Material	Steel			

Propellant

Type	End Burning, Double Base			
Length (inches)	1.15	1.05 (See Note No. 1)	1.15	
Diameter (inches)	.87			
Weight (lbs)	.036	.033	.036	

Delay Assembly

Material	Aluminum			

Charges

Lower	50 mgs Igniter Composition, Pressed; Approx. 50 mgs Igniter Comp. buttered to Pressed Igniter Comp.			
Main	3240 mgs Delay Composition Pressed			
Upper	50 Igniter Composition Pressed			

Illuminant or Smoke Assembly

				----See Note No. 2--										
Case Material	Kraft Paper			Glass Tape			Kraft Paper				Aluminum Signal Body			
Charge length (inches)	Approx 2.7			0.86			Approx 3.0				Approx 6.2			
Charge Diameter (inches)	1.2			1.19			1.2				1.35			
Charge Weight (gms)	99	93	87	29	26	25	80	80	82	76	165	165	165	155

Parachute

Material	Nylon		Nylon	
Diameter (inches)	24		24	
Color (See Note No. 3)	Orange		Orange	

Expelling Charge	1.2 gms Grade A-3 Black Powder	2.0 gms Grade A-3 Black Powder	1.0 gm Grade A-3 Black Powder	none

Note No. 1. To be changed to 1.15 length to provide uniform grain length for all signals.

Note No. 2. Each Cluster signal contains 5 assemblies.

Note No. 3. Color of canopy to be charged to approximate color of flare and smoke component.

TABLE 2

BALLISTIC CHARACTERISTICS

	Parachute			Cluster			Parachute				Streamer			
	Green Star XM144	Red Star XM145	White Star XM146	Green Star XM147	Red Star XM148	White Star XM149	Green Smoke XM150	Red Smoke XM151	Yellow Smoke XM152	Violet Smoke XM-	Green Smoke XM153	Red Smoke XM154	Yellow Smoke XM155	Violet Smoke XM-
Average Burning time(Sec)	53	55	48	8.5	8.2	8.5	10.2	10.2	9.6	10.5	7.8	8.5	7.5	7.5
Average Luminous Intensity (Candles)	7600	10,800	45,000	22,000	49,000	90,000								
Color Value	.44	.56		.44	.54									
Average Altitude of Function Fixture Fired,(Ft)	850										920			
Hand Fired, (Ft)	770										825			
Average Recoil, Max.(lbs)	401													
Average Recoil, Mean.(lbs)	236													
Average Action Time of Recoil (Sec.)	.012													
Average Time from Firing to Propellant Grain Ignition (Sec)	0.0296													
Average Muzzle Velocity Fixture Fired, (Ft/Sec)	112													
Hand Fired,(Ft/Sec)	90													
Muzzle Spin:Fixture Fired (RPM)	10,080													
Hand Fired (RPM)	8,100													

TABLE 3

COMPARISON OF VARIOUS SIGNALING DEVICES

Signal Series	Number of Signals	Firing Device	Maximum Altitude of Functioning[1] (Ft)	Star Parachute		Star Cluster[2]		Smoke Parachute		Smoke Streamer
				Burning Time (Sec)	Candle-power (Cdls)	Burning Time (Sec)	Candle-power[3] (Cdls)	Burning Time (Sec)	Smoke Duration (Sec)	Burning Time (Sec)
XM144	14	Hand[4]	750	(G) 53	7,600	(G) 8.5	22,000	(G) 10.2	60	(G) 7.8
				(R) 55	10,800	(R) 8.2	49,000	(R) 10.2	60	(R) 8.5
				(W) 48	45,000	(W) 8.5	90,000	(Y) 9.6	60	(Y) 7.5
								(V) 10.5	60	(V) 7.5
M125	11	Hand	700	(G) 55	16,000	(G) 8.4	15,000	(G) 11.1	60	(G) ---
				(R) 61	7,000	(R) 6.6	35,000	(R) 11.4	60	(R) ---
				(W) 25	50,000	(W) 6.8	43,000			(Y) ---
M131	1	Hand	1500	(R) 30	10,000					
Aircraft	15	Pistol	150			(G) 10	25,000			
						(R) 10	25,000			
						(Y) 10	25,000			
Pen Gun	3	Hand	250			(G) 4	2,500			
						(R) 4	2,500			
						(W) 3	3,500			

1. Fired vertically
2. 5 stars per signal present in XM144 series and M125 series, 1 or 2 stars per signal aircraft series, 1 star per signal in pen gun series.
3. Each individual star.
4. With minor modifications, can be fired from M79 Grenade Launcher.

Code: (G) Green; (R) Red; (W) White; (Y) Yellow; (V) Violet.

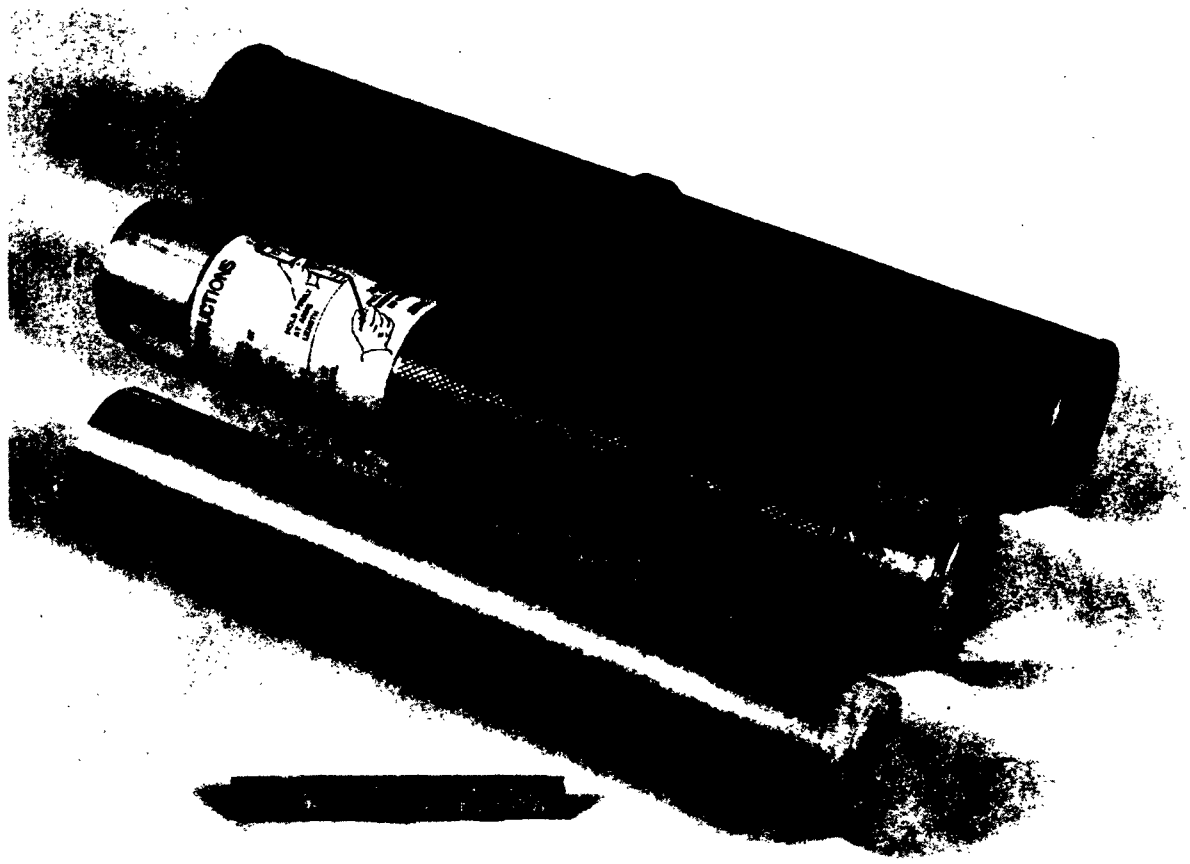


Figure 1 Photo of Shipping Container, Launcher Assembly & Signal Rocket Assembly

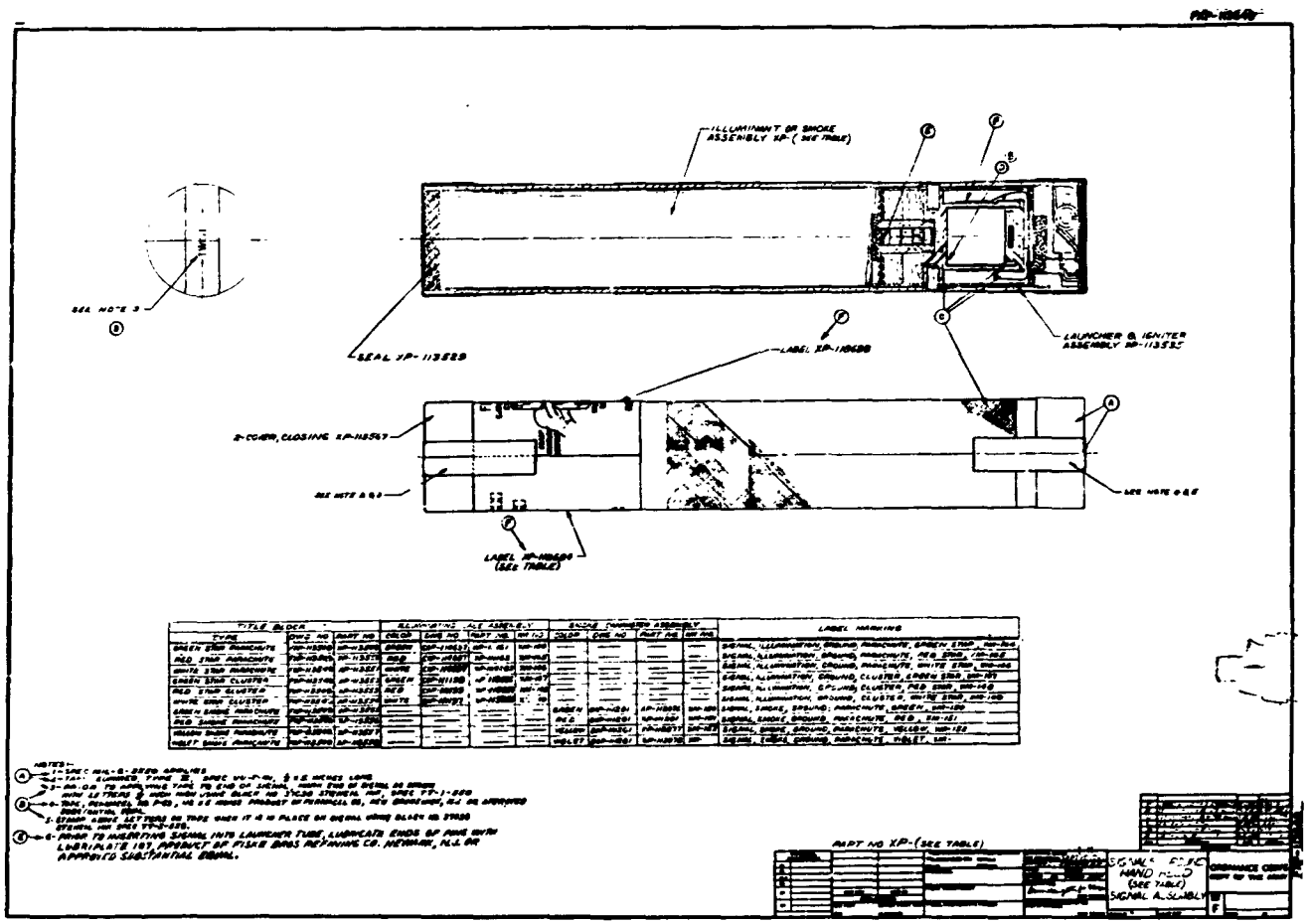

ILLUMINANT OR SMOKE ASSEMBLY XP-(SEE TABLE)
SEAL XP-113529
LABEL XP-110688
LAUNCHER & IGNITER ASSEMBLY XP-113535
2-COVER, CLOSING XP-113567
LABEL XP-110684 (SEE TABLE)
TITLE BLOCK
ILLUMINATING FLARE ASSEMBLY
SMOKE CHAMBER ASSEMBLY
LABEL MARKING
PART NO XP-(SEE TABLE)
SIGNAL ASSEMBLY

Figure 2

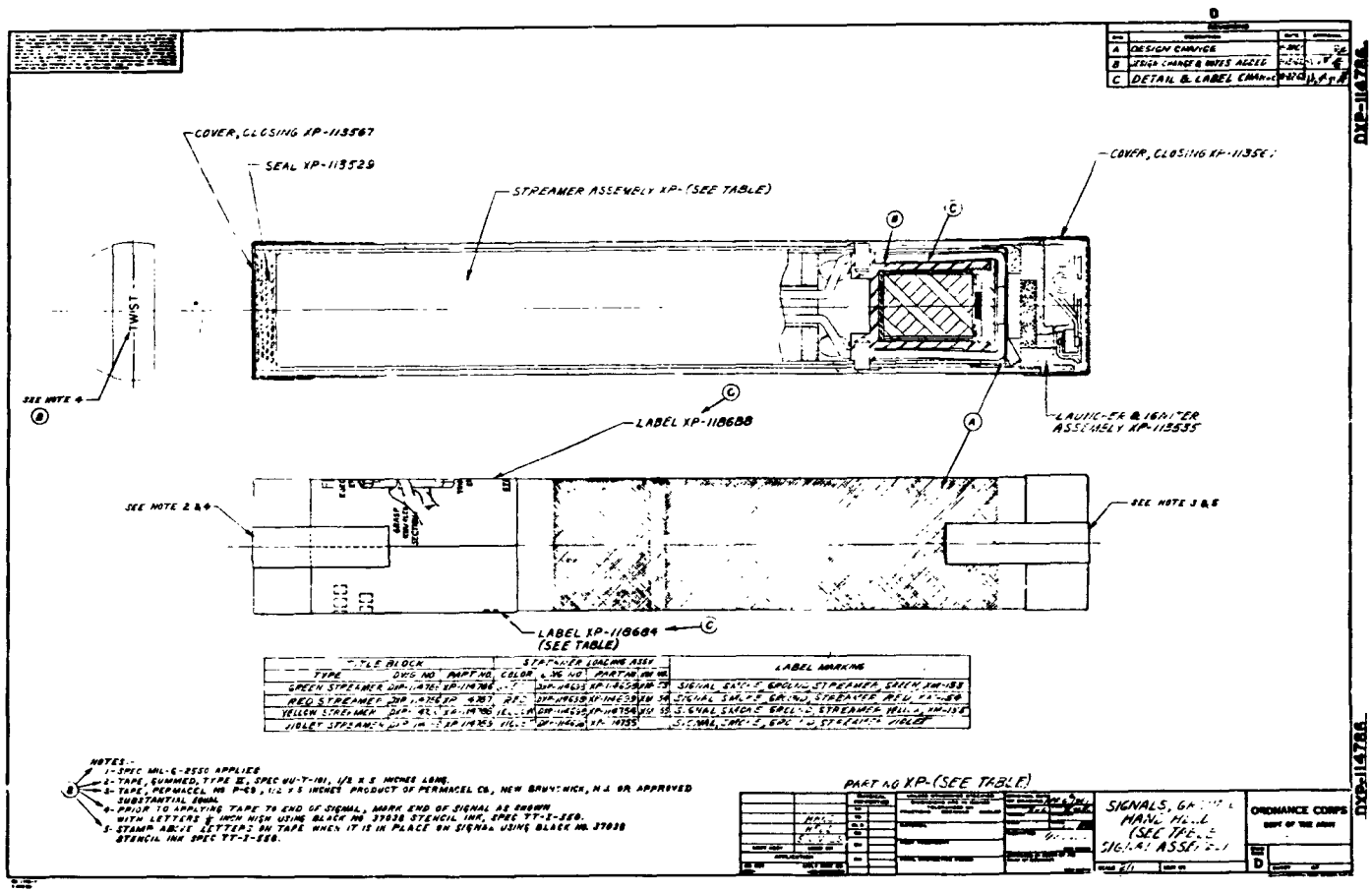

COVER, CLOSING XP-113567
SEAL XP-113529
STREAMER ASSEMBLY XP-(SEE TABLE)
COVER, CLOSING XP-113567
TWIST
SEE NOTE 4
LABEL XP-118688
LAUNCHER & IGNITER ASSEMBLY XP-113535
SEE NOTE 2 & 4
SEE NOTE 3 & 5
LABEL XP-118684 (SEE TABLE)
TITLE BLOCK
STREAMER LOADING ASSY
LABEL MARKING
TYPE
DWG NO
PART NO
COLOR
DWG NO
PART NO
GREEN STREAMER
RED STREAMER
YELLOW STREAMER
VIOLET STREAMER
NOTES:-
1-SPEC MIL-C-2550 APPLIES
2-TAPE, GUMMED, TYPE II, SPEC UU-T-101, 1/2 X 5 INCHES LONG.
3-TAPE, PERMACEL NO P-69, 1/2 X 5 INCHES PRODUCT OF PERMACEL CO, NEW BRUNSWICK, N.J. OR APPROVED SUBSTANTIAL EQUAL
4-PRIOR TO APPLYING TAPE TO END OF SIGNAL, MARK END OF SIGNAL AS SHOWN WITH LETTERS 1/2 INCH HIGH USING BLACK NO 37038 STENCIL INK, SPEC TT-I-550.
5-STAMP ABOVE LETTERS ON TAPE WHEN IT IS IN PLACE ON SIGNAL USING BLACK NO. 37038 STENCIL INK SPEC TT-I-550.
PART NO XP-(SEE TABLE)
SIGNALS, GROUND HAND HELD (SEE TABLE) SIGNAL ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
A DESIGN CHANGE
B DESIGN CHANGE & NOTES ADDED
C DETAIL & LABEL CHANGE
DXP-114786

Figure 3

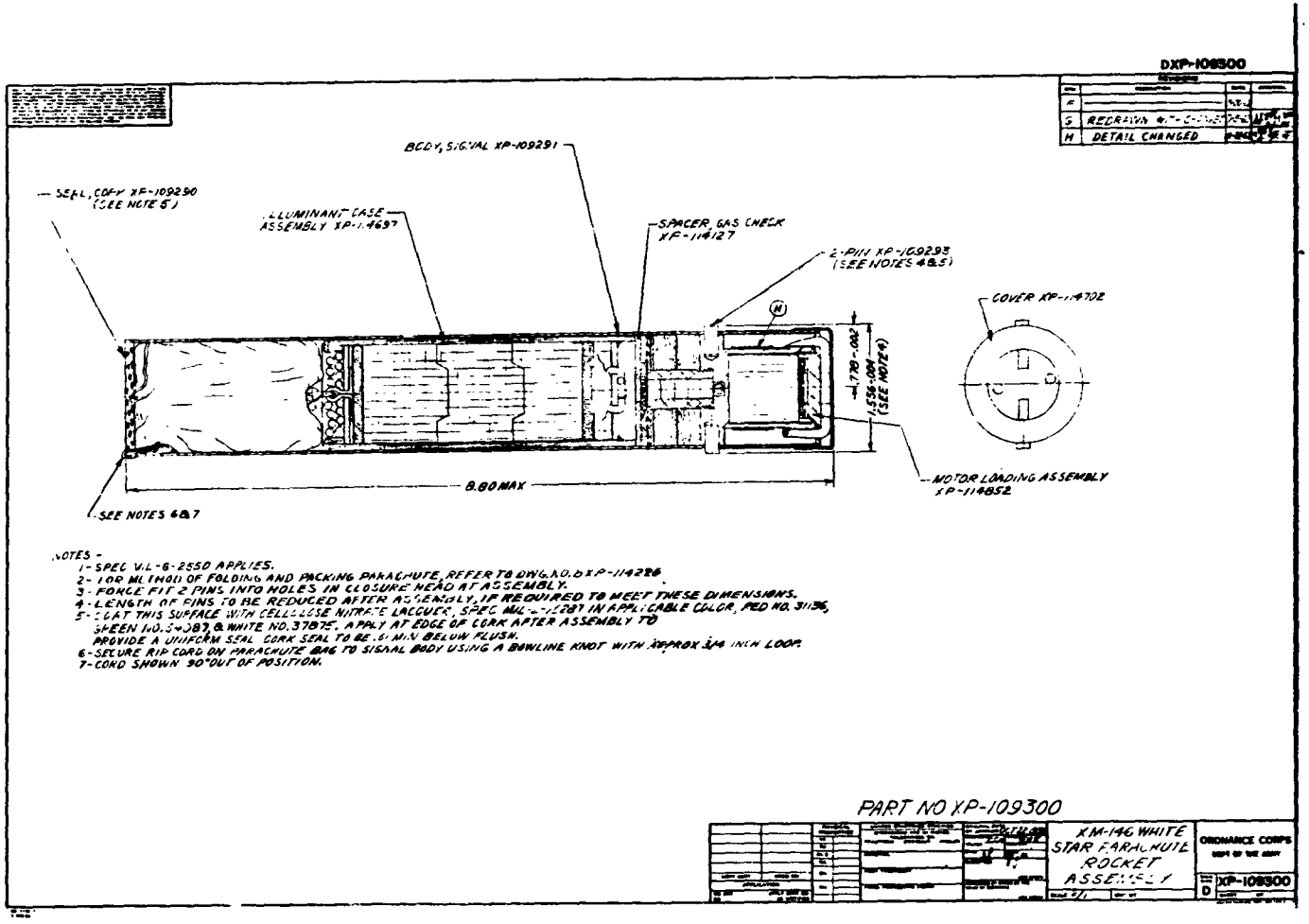

DXP-109300
H DETAIL CHANGED
BODY, SIGNAL XP-109291
SEAL, COPY XP-109290 (SEE NOTE 5)
ILLUMINANT CASE ASSEMBLY XP-114697
SPACER, GAS CHECK XP-114127
2-PIN XP-109293 (SEE NOTES 4&5)
COVER XP-114702
1.780-.002
1.556-.004 (SEE NOTE 4)
8.80 MAX
MOTOR LOADING ASSEMBLY XP-114852
SEE NOTES 6&7
NOTES -
1-SPEC W.L-6-2550 APPLIES.
2-FOR METHOD OF FOLDING AND PACKING PARACHUTE, REFER TO DWG. NO. DXP-114286
3-FORCE FIT 2 PINS INTO HOLES IN CLOSURE HEAD AT ASSEMBLY.
4-LENGTH OF PINS TO BE REDUCED AFTER ASSEMBLY, IF REQUIRED TO MEET THESE DIMENSIONS.
5-COAT THIS SURFACE WITH CELLULOSE NITRATE LACQUER, SPEC MIL-L-10287 IN APPLICABLE COLOR, RED NO. 31136, SHEEN NO. 37038, & WHITE NO. 37875. APPLY AT EDGE OF CORK AFTER ASSEMBLY TO PROVIDE A UNIFORM SEAL. CORK SEAL TO BE 0.01 MIN BELOW FLUSH.
6-SECURE RIP CORD ON PARACHUTE BAG TO SIGNAL BODY USING A BOWLINE KNOT WITH APPROX 3/4 INCH LOOP.
7-CORD SHOWN 90° OUT OF POSITION.
PART NO XP-109300
XM-146 WHITE STAR PARACHUTE ROCKET ASSEMBLY
ORDNANCE CORPS
XP-109300
D

Figure 4

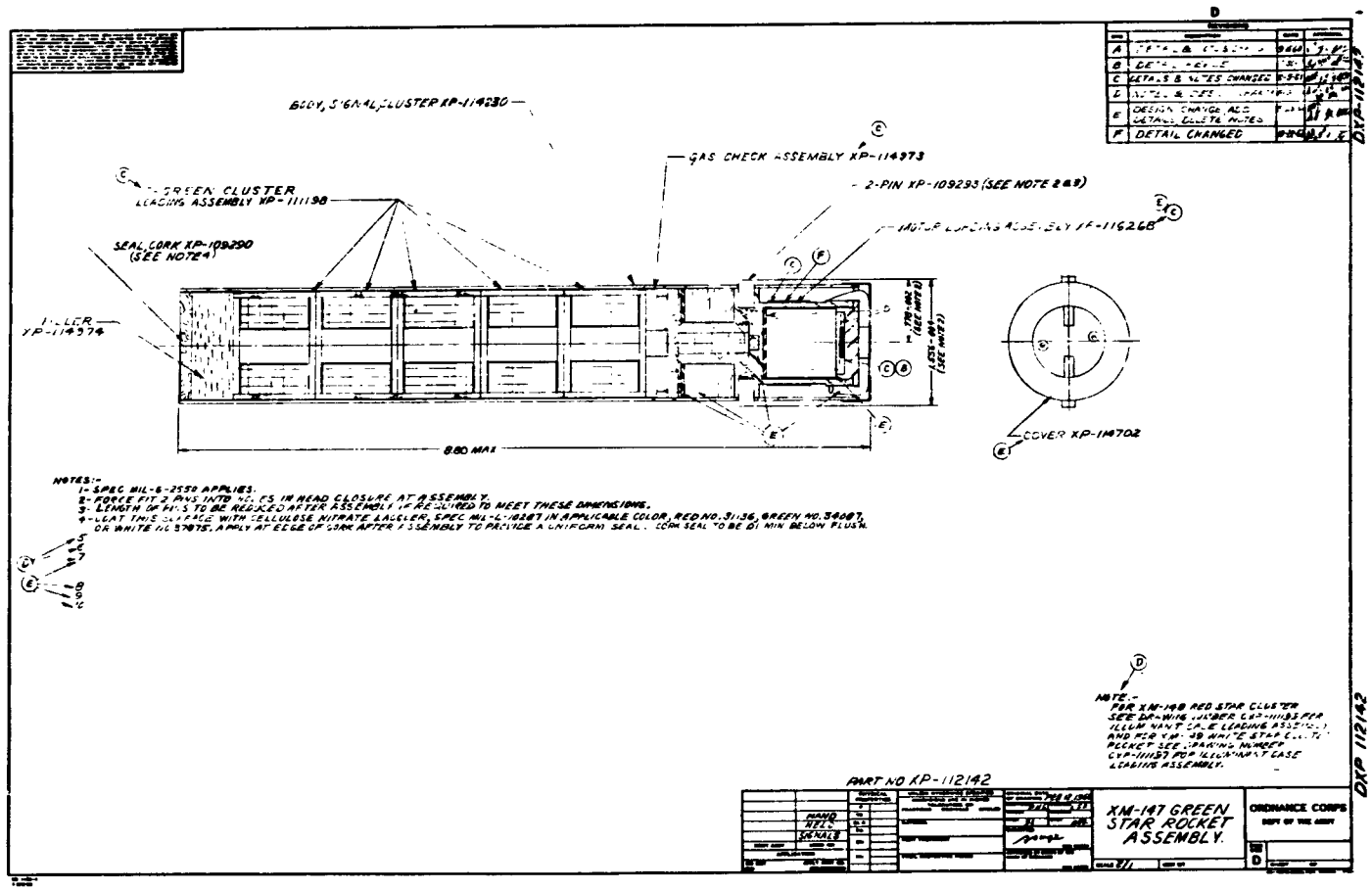

BODY, SIGNAL CLUSTER XP-114230
GAS CHECK ASSEMBLY XP-114973
GREEN CLUSTER LEADING ASSEMBLY XP-111198
2-PIN XP-109293 (SEE NOTE 2 & 3)
SEAL CORK XP-109290 (SEE NOTE 4)
FILLER XP-114974
COVER XP-114702
8.80 MAX
NOTES:-
1- SPEC MIL-C-2550 APPLIES.
2- FORCE FIT 2 PINS INTO HOLES IN HEAD CLOSURE AT ASSEMBLY.
3- LENGTH OF PINS TO BE REDUCED AFTER ASSEMBLY IF RESULTED TO MEET THESE DIMENSIONS.
4- COAT THIS SURFACE WITH CELLULOSE NITRATE LACQUER, SPEC MIL-L-10287 IN APPLICABLE COLOR, RED NO. 31136, GREEN NO. 34087, OR WHITE NO. 37875. APPLY AT EDGE OF CORK AFTER ASSEMBLY TO PROVIDE A UNIFORM SEAL. CORK SEAL TO BE .01 MIN BELOW FLUSH.
NOTE:-
FOR XM-148 RED STAR CLUSTER SEE DRAWING NUMBER CXP-111193 FOR ILLUMINANT CASE LEADING ASSEMBLY AND FOR XM-149 WHITE STAR CLUSTER ROCKET SEE DRAWING NUMBER CXP-111197 FOR ILLUMINANT CASE LEADING ASSEMBLY.
PART NO XP-112142
XM-147 GREEN STAR ROCKET ASSEMBLY.
ORDNANCE CORPS
DEPT OF THE ARMY
DXP 112142

Figure 5

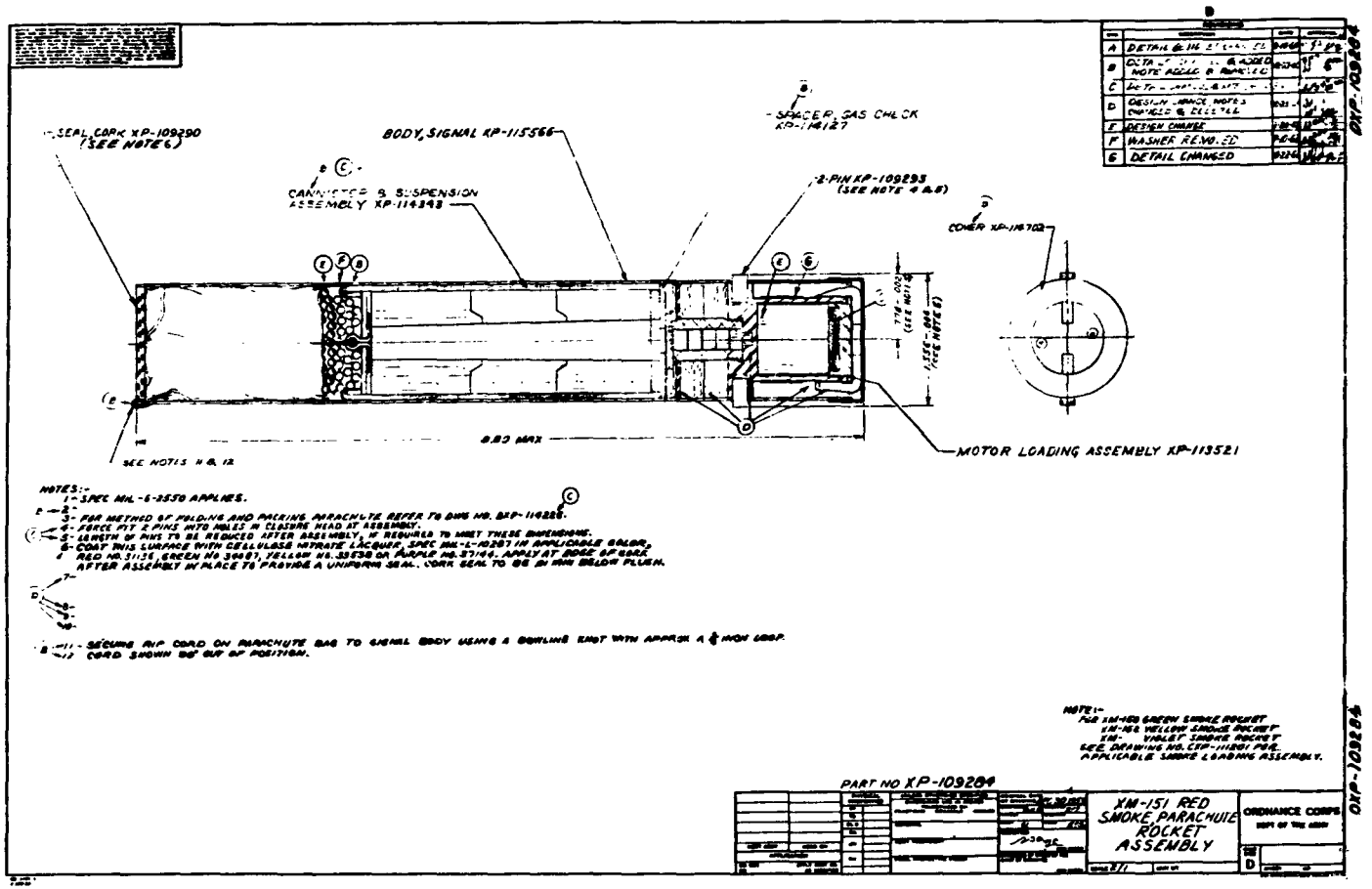
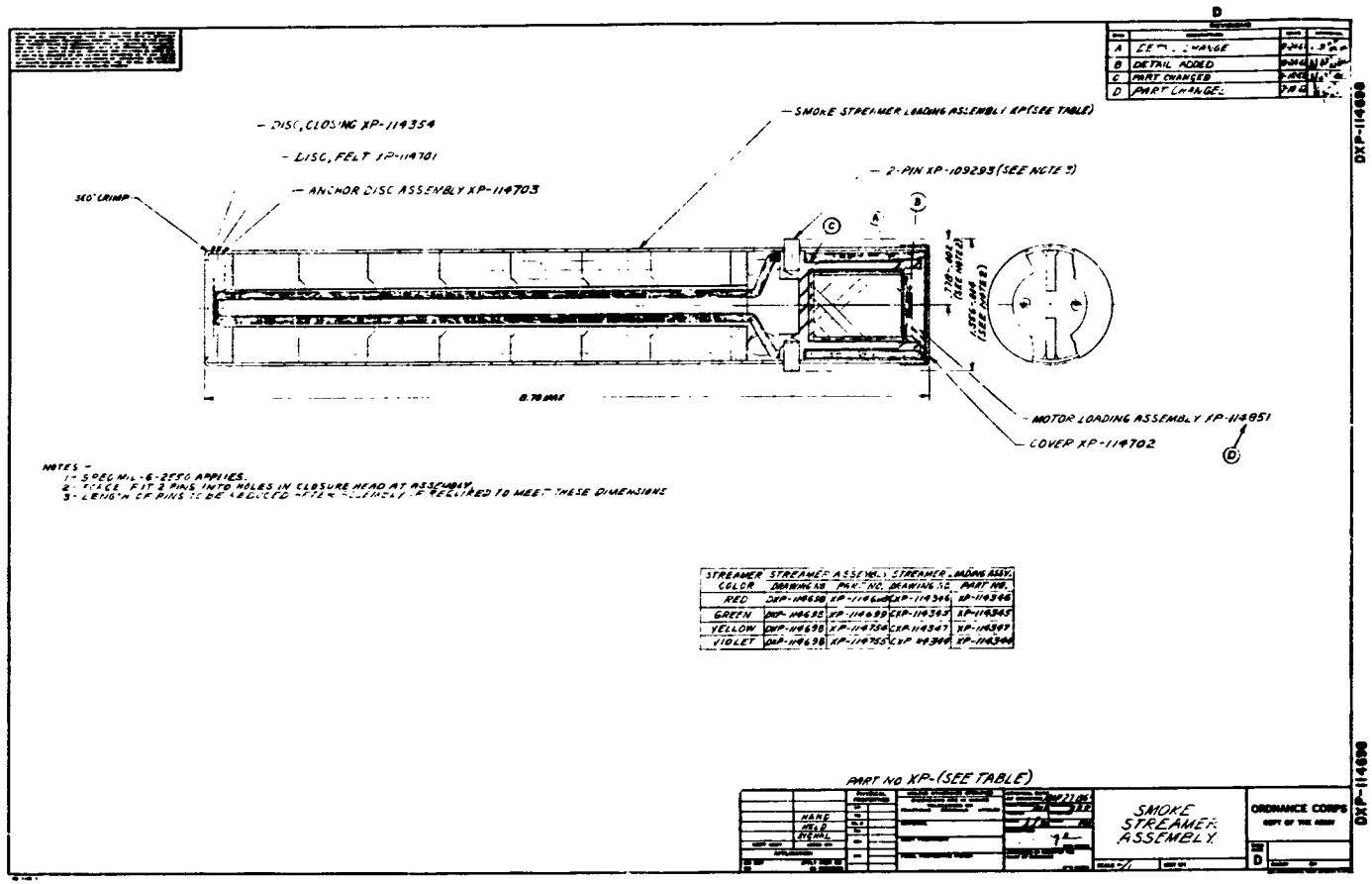

SEAL, CORK XP-109290 (SEE NOTE 6)
BODY, SIGNAL XP-115566
SPACER, GAS CHECK XP-114127
CANNISTER & SUSPENSION ASSEMBLY XP-114343
2-PIN XP-109293 (SEE NOTE 4 & 8)
COVER XP-116702
MOTOR LOADING ASSEMBLY XP-113521
8.80 MAX
SEE NOTES 11 & 12
NOTES:-
1- SPEC MIL-C-3530 APPLIES.
3- FOR METHOD OF FOLDING AND PACKING PARACHUTE REFER TO DWG NO. BXP-114228.
4- FORCE FIT 2 PINS INTO HOLES IN CLOSURE HEAD AT ASSEMBLY.
5- LENGTH OF PINS TO BE REDUCED AFTER ASSEMBLY, IF REQUIRED TO MEET THESE DIMENSIONS.
6- COAT INSIDE SURFACE WITH CELLULOSE NITRATE LACQUER, SPEC MIL-L-10287 IN APPLICABLE COLOR, RED NO. 31136, GREEN NO. 34087, YELLOW NO. 33538 OR PURPLE NO. 37144. APPLY AT BASE OF BORE AFTER ASSEMBLY IN PLACE TO PROVIDE A UNIFORM SEAL. CORK SEAL TO BE 1/8 IN BELOW FLUSH.
11- SECURING RIP CORD ON PARACHUTE BAG TO SIGNAL BODY USING A BOWLINE KNOT WITH APPROX A 1/4 HIGH LOOP.
12- CORD SHOWN 90° OUT OF POSITION.
NOTE:-
FOR XM-150 GREEN SMOKE ROCKET
XM-152 YELLOW SMOKE ROCKET
XM- VIOLET SMOKE ROCKET
SEE DRAWING NO. CFP-111201 FOR APPLICABLE SMOKE LOADING ASSEMBLY.
PART NO XP-109284
XM-151 RED SMOKE PARACHUTE ROCKET ASSEMBLY
ORDNANCE CORPS
D
XP-109284

Figure 6



STREAMER COLOR	STREAMER ASSEMBLY DRAWING NO	STREAMER ASSEMBLY PART NO.	STREAMER LOADING ASSY. DRAWING NO.	STREAMER LOADING ASSY. PART NO.
RED	DXP-114698	XP-114694	DXP-114346	XP-114346
GREEN	DXP-114698	XP-114699	DXP-114347	XP-114345
YELLOW	DXP-114698	XP-114758	DXP-114347	XP-114347
VIOLET	DXP-114698	XP-114755	DXP-114346	XP-114346

Figure 7

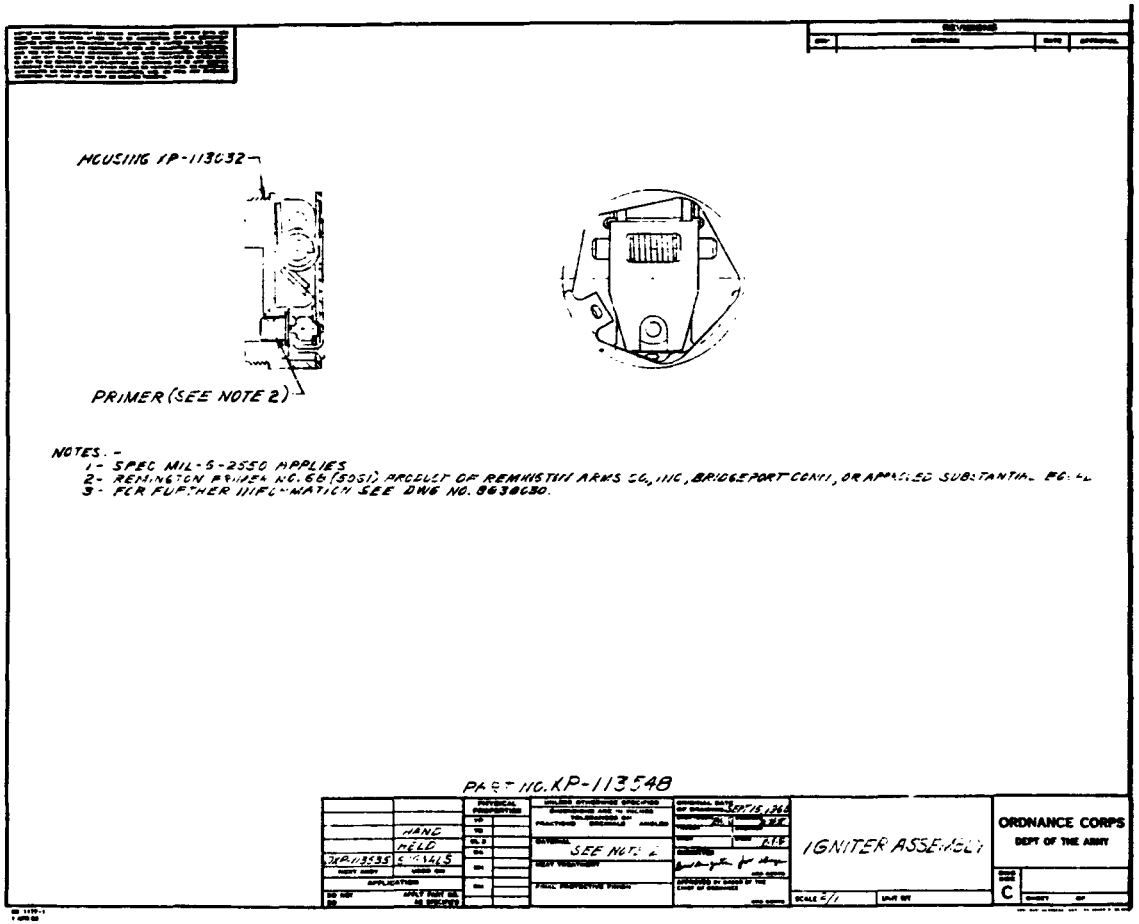

HOUSING KP-113032
PRIMER (SEE NOTE 2)
NOTES. -
1- SPEC MIL-S-2550 APPLIES
2- REMINGTON PRIMER NO. 66 (5051) PRODUCT OF REMINGTON ARMS CO., INC., BRIDGEPORT CONN., OR APPROVED SUBSTANTIAL EQUAL
3- FOR FURTHER INFORMATION SEE DWG NO. 8638030.
PART NO. KP-113548
HAND
HELD
SEE NOTE 2
IGNITER ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
C

Figure 8

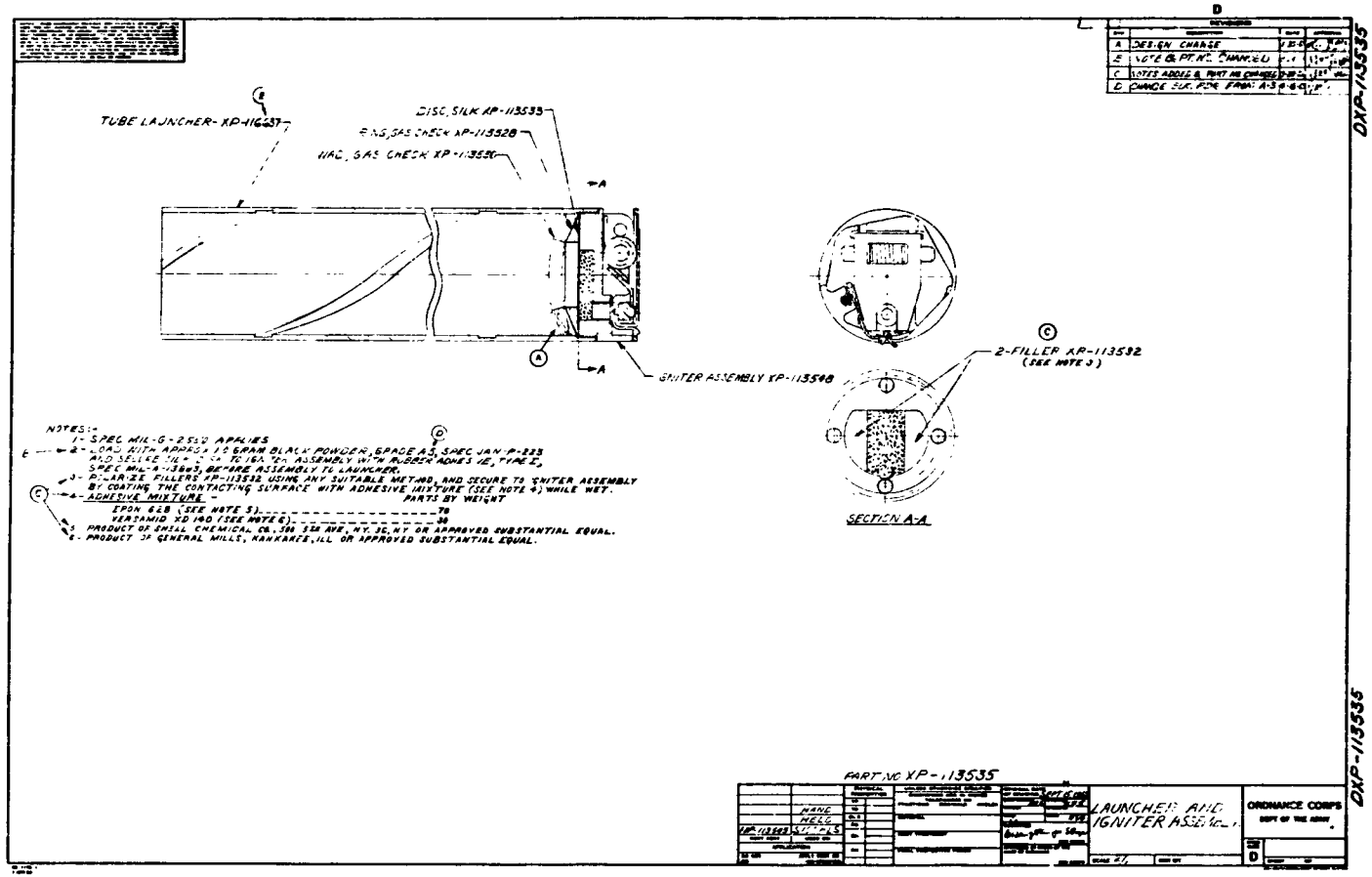

TUBE LAUNCHER- XP-116637
DISC, SILK XP-113533
RING, GAS CHECK XP-113528
WAD, GAS CHECK XP-113530
IGNITER ASSEMBLY XP-113548
2-FILLER XP-113532
(SEE NOTE 3)
SECTION A-A
NOTES:-
1- SPEC MIL-G-2550 APPLIES
2- LOAD WITH APPROX 1.0 GRAM BLACK POWDER, GRADE A5, SPEC JAN-P-223 AND SEEDLE SILK DISC TO IGNITER ASSEMBLY WITH RUBBER ADHESIVE, TYPE I, SPEC MIL-A-13663, BEFORE ASSEMBLY TO LAUNCHER.
3- POLARIZE FILLERS XP-113532 USING ANY SUITABLE METHOD, AND SECURE TO IGNITER ASSEMBLY BY COATING THE CONTACTING SURFACE WITH ADHESIVE MIXTURE (SEE NOTE 4) WHILE WET.
4- ADHESIVE MIXTURE - PARTS BY WEIGHT
EPON 628 (SEE NOTE 5) 70
VERSAMID XD 140 (SEE NOTE 6) 30
5- PRODUCT OF SHELL CHEMICAL CO., 500 5TH AVE, N.Y. 36, N.Y. OR APPROVED SUBSTANTIAL EQUAL.
6- PRODUCT OF GENERAL MILLS, KANKAKEE, ILL OR APPROVED SUBSTANTIAL EQUAL.
A DESIGN CHANGE
B NOTE & PT. NO. CHANGED
C NOTES ADDED & PART NO. CHANGED
D CHANGE SUR. FOR FROM A-3
PART NO XP-113535
LAUNCHER AND IGNITER ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
DXP-113535
DXP-113535

Figure 9

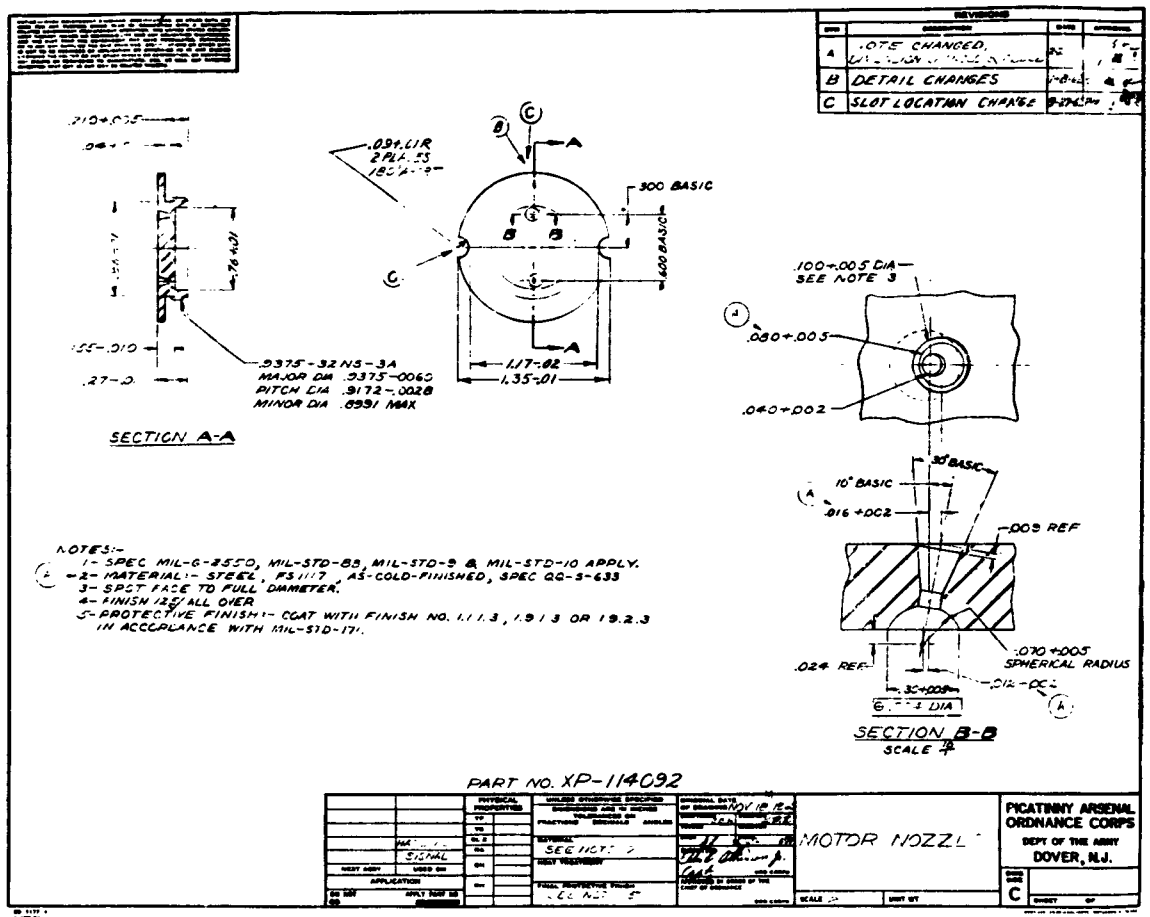

REVISIONS
A NOTE CHANGED.
B DETAIL CHANGES
C SLOT LOCATION CHANGE
.094 LIR
2 PLA. SS
.300 BASIC
.600 BASIC
1.17-.02
1.35-.01
.9375-32 NS-3A
MAJOR DIA .9375-.0060
PITCH DIA .9172-.0028
MINOR DIA .8991 MAX
SECTION A-A
.100+.005 DIA
SEE NOTE 3
.080+.005
.040+.002
30° BASIC
10° BASIC
.016+.002
.003 REF
.070+.005
SPHERICAL RADIUS
.024 REF
SECTION B-B
SCALE
NOTES:-
1- SPEC MIL-G-2550, MIL-STD-88, MIL-STD-9 & MIL-STD-10 APPLY.
2- MATERIAL:- STEEL, FS 1117, AS-COLD-FINISHED, SPEC QQ-S-633
3- SPOT FACE TO FULL DIAMETER.
4- FINISH 125 ALL OVER
5- PROTECTIVE FINISH:- COAT WITH FINISH NO. 1.1.1.3, 1.9.1.3 OR 19.2.3 IN ACCORDANCE WITH MIL-STD-171.
PART NO. XP-114092
SIGNAL
MOTOR NOZZLE
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, N.J.
C

Figure 10

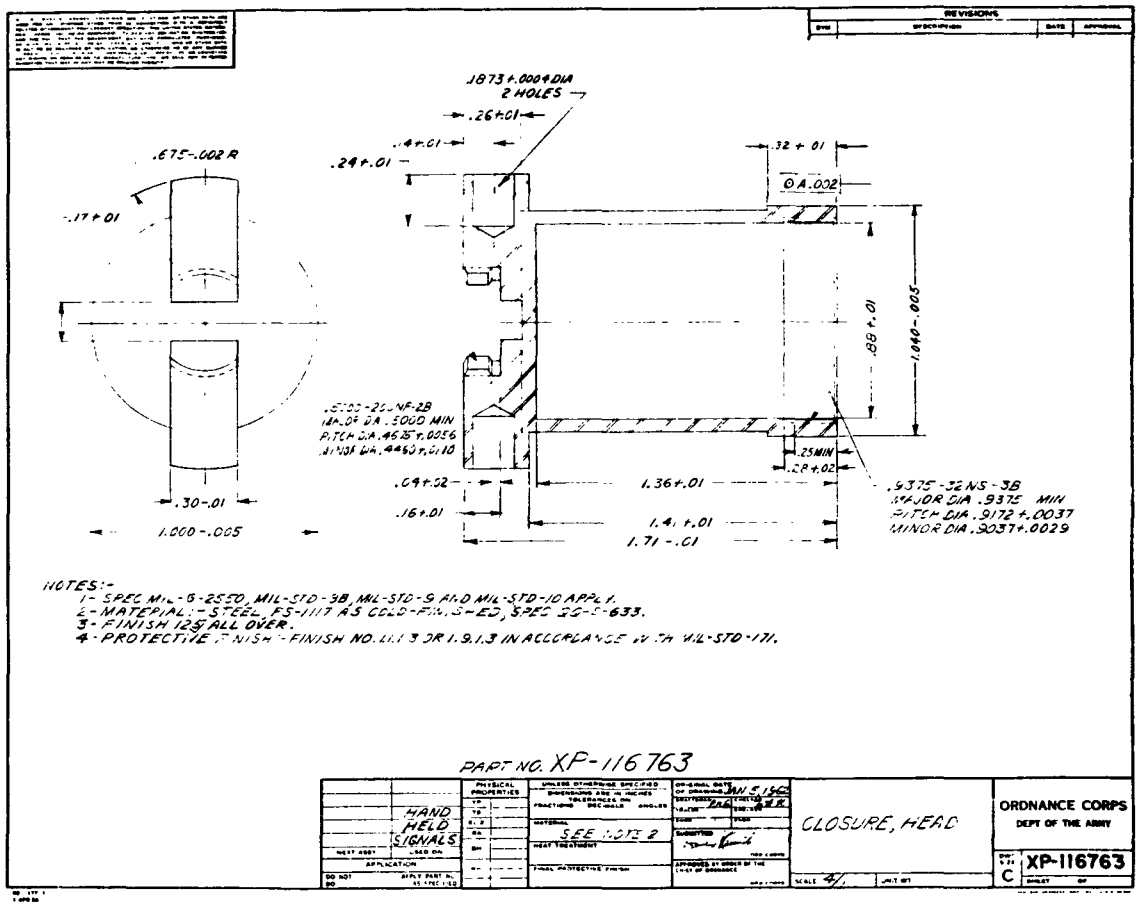

REVISIONS
.1873+.0004 DIA
2 HOLES
.26+.01
.14+.01
.24+.01
.32 + .01
⊙ A .002
.675-.002 R
.17+.01
.88+.01
1.040-.005
.5000-20 UNF-2B
MAJOR DIA .5000 MIN
PITCH DIA .4625+.0056
MINOR DIA .4460+.0010
.25 MIN
.28+.02
.04+.02
1.36+.01
.9375-32 NS-3B
MAJOR DIA .9375 MIN
PITCH DIA .9172+.0037
MINOR DIA .9037+.0029
.30-.01
.16+.01
1.000-.005
1.41+.01
1.71-.01
NOTES:-
1- SPEC MIL-G-2550, MIL-STD-3B, MIL-STD-9 AND MIL-STD-10 APPLY.
2- MATERIAL:- STEEL, FS-1117 AS COLD-FINISHED, SPEC QQ-S-633.
3- FINISH 125 ALL OVER.
4- PROTECTIVE FINISH - FINISH NO. 1.1.3 OR 1.9.1.3 IN ACCORDANCE WITH MIL-STD-171.
PART NO. XP-116763
HAND HELD SIGNALS
SEE NOTE 2
CLOSURE, HEAD
ORDNANCE CORPS
DEPT OF THE ARMY
XP-116763
C

Figure 11

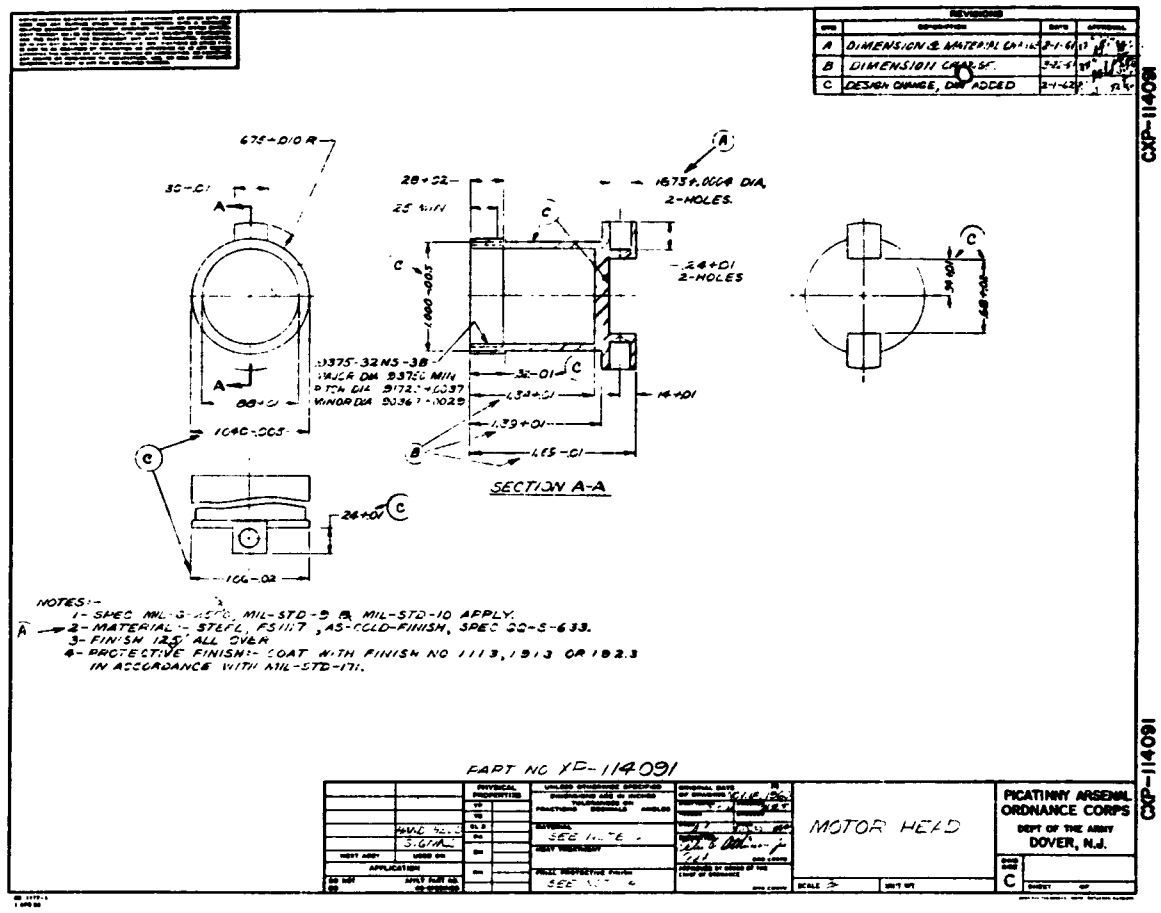

REVISIONS
A DIMENSION & MATERIAL CHANGE
B DIMENSION CHANGE
C DESIGN CHANGE, DIM ADDED
CXP-114091
SECTION A-A
NOTES:-
1- SPEC MIL-S-4570, MIL-STD-9 & MIL-STD-10 APPLY.
2- MATERIAL:- STEEL, FS1117, AS-COLD-FINISH, SPEC QQ-S-633.
3- FINISH 125 ALL OVER
4- PROTECTIVE FINISH:- COAT WITH FINISH NO 1113, 1913 OR 192.3 IN ACCORDANCE WITH MIL-STD-171.
PART NO XP-114091
MOTOR HEAD
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, N.J.
C

Figure 12

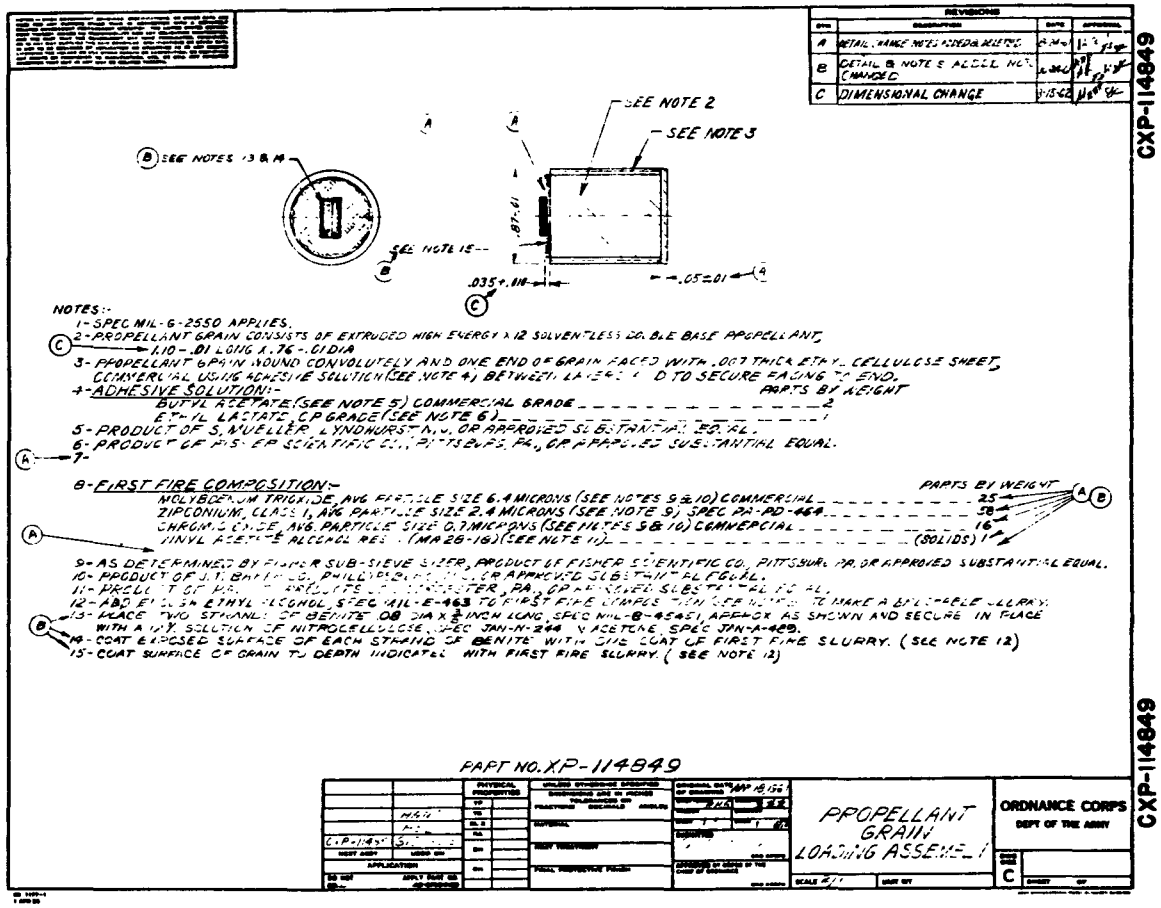

REVISIONS
A DETAIL CHANGE NOTES ADDED & DELETED
B DETAIL & NOTES ADDED NOTE CHANGED
C DIMENSIONAL CHANGE
SEE NOTE 2
SEE NOTE 3
SEE NOTES 13 & 14
SEE NOTE 15
.87±.01
.035+.010
.05±.01
NOTES:-
1-SPEC MIL-G-2550 APPLIES.
2-PROPELLANT GRAIN CONSISTS OF EXTRUDED HIGH ENERGY X 12 SOLVENTLESS DOUBLE BASE PROPELLANT,
1.10-.01 LONG X .76-.01 DIA
3-PROPELLANT GRAIN WOUND CONVOLUTELY AND ONE END OF GRAIN FACED WITH .007 THICK ETHYL CELLULOSE SHEET, COMMERCIAL USING ADHESIVE SOLUTION (SEE NOTE 4) BETWEEN LAYERS AND TO SECURE FACING TO END.
4-ADHESIVE SOLUTION:-
PARTS BY WEIGHT
BUTYL ACETATE (SEE NOTE 5) COMMERCIAL GRADE 2
ETHYL LACTATE, CP GRADE (SEE NOTE 6) 1
5-PRODUCT OF S. MUELLER, LYNDHURST N.J., OR APPROVED SUBSTANTIAL EQUAL.
6-PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.
7-
8-FIRST FIRE COMPOSITION:-
PARTS BY WEIGHT
MOLYBDENUM TRIOXIDE, AVG PARTICLE SIZE 6.4 MICRONS (SEE NOTES 9 & 10) COMMERCIAL 25
ZIRCONIUM, CLASS 1, AVG PARTICLE SIZE 2.4 MICRONS (SEE NOTE 9) SPEC PA-PD-464 58
CHROMIC OXIDE, AVG. PARTICLE SIZE 0.7 MICRONS (SEE NOTES 9 & 10) COMMERCIAL 16
VINYL ACETATE ALCOHOL RESIN (MA 28-18) (SEE NOTE 11) (SOLIDS) 1
9-AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA. OR APPROVED SUBSTANTIAL EQUAL.
10-PRODUCT OF J.T. BAKER CO., PHILLIPSBURG, N.J., OR APPROVED SUBSTANTIAL EQUAL.
11-PRODUCT OF PA. [illegible] PRODUCTS [illegible] LANCASTER, PA., OR APPROVED SUBSTANTIAL EQUAL.
12-ADD ETHYL ALCOHOL, SPEC MIL-E-463 TO FIRST FIRE COMPOSITION (SEE NOTE 8) TO MAKE A BRUSHABLE SLURRY.
13-PLACE TWO STRANDS OF BENITE .08 DIA X 3/8 INCH LONG, SPEC MIL-B-45451, APPROX AS SHOWN AND SECURE IN PLACE WITH A 10% SOLUTION OF NITROCELLULOSE, SPEC JAN-N-244 IN ACETONE, SPEC JAN-A-489.
14-COAT EXPOSED SURFACE OF EACH STRAND OF BENITE WITH ONE COAT OF FIRST FIRE SLURRY. (SEE NOTE 12)
15-COAT SURFACE OF GRAIN TO DEPTH INDICATED WITH FIRST FIRE SLURRY. (SEE NOTE 12)
PART NO. XP-114849
PROPELLANT GRAIN LOADING ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
CXP-114849
CXP-114849

Figure 13

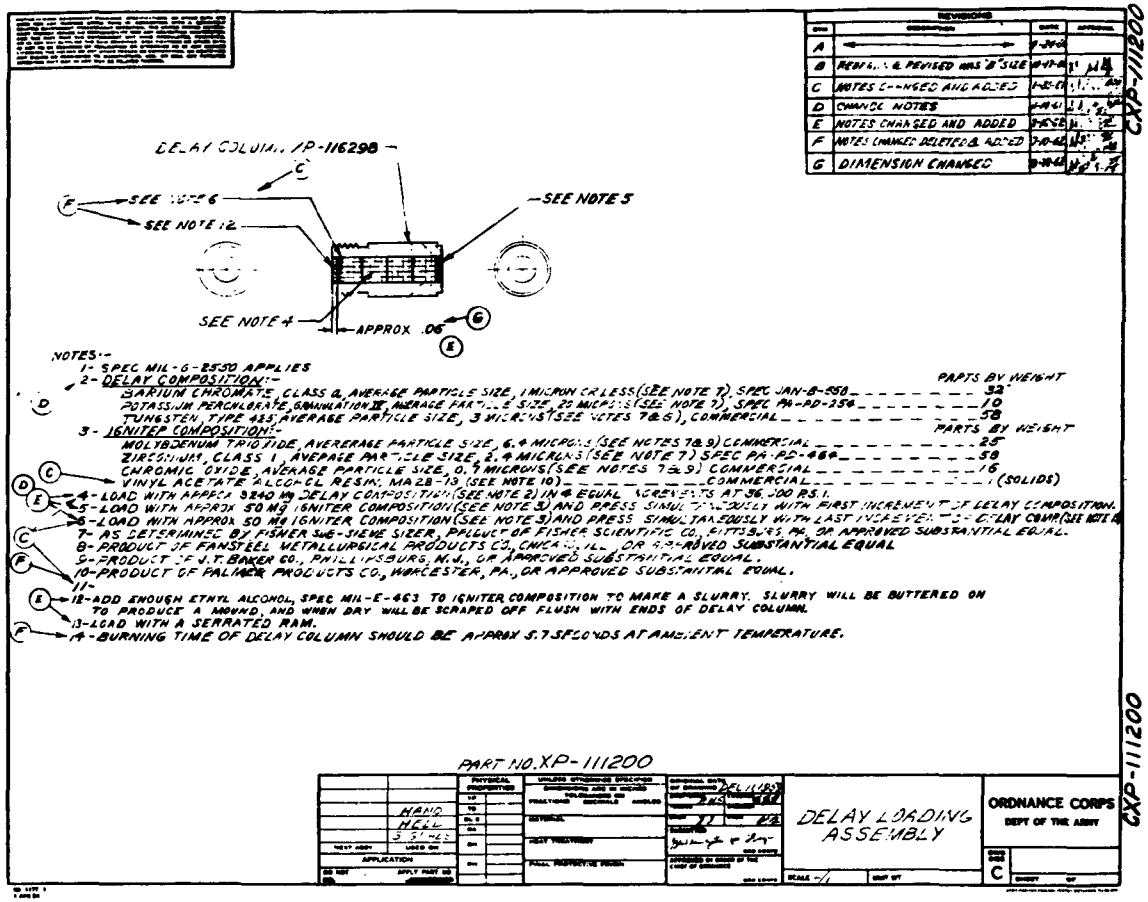

REVISIONS
A
B REDRAWN & REVISED WAS "B" SIZE
C NOTES CHANGED AND ADDED
D CHANGE NOTES
E NOTES CHANGED AND ADDED
F NOTES CHANGED DELETED & ADDED
G DIMENSION CHANGED
DELAY COLUMN XP-116298
SEE NOTE 6
SEE NOTE 12
SEE NOTE 5
SEE NOTE 4
APPROX .06
NOTES:-
1- SPEC MIL-G-2550 APPLIES
2- DELAY COMPOSITION:-
PARTS BY WEIGHT
BARIUM CHROMATE, CLASS a, AVERAGE PARTICLE SIZE, 1 MICRON OR LESS (SEE NOTE 7), SPEC JAN-B-550 32
POTASSIUM PERCHLORATE, GRANULATION IV, AVERAGE PARTICLE SIZE, 20 MICRONS (SEE NOTE 7), SPEC PA-PD-254 10
TUNGSTEN, TYPE 425, AVERAGE PARTICLE SIZE, 3 MICRONS (SEE NOTES 7 & 8), COMMERCIAL 58
3- IGNITER COMPOSITION:-
PARTS BY WEIGHT
MOLYBDENUM TRIOXIDE, AVERERAGE PARTICLE SIZE, 6.4 MICRONS (SEE NOTES 7 & 9) COMMERCIAL 25
ZIRCONIUM, CLASS 1, AVERAGE PARTICLE SIZE, 2.4 MICRONS (SEE NOTE 7) SPEC PA-PD-464 58
CHROMIC OXIDE, AVERAGE PARTICLE SIZE, 0.7 MICRONS (SEE NOTES 7 & 9) COMMERCIAL 16
VINYL ACETATE ALCOHOL RESIN, MA28-73 (SEE NOTE 10) COMMERCIAL 1 (SOLIDS)
4- LOAD WITH APPROX 3240 MG DELAY COMPOSITION (SEE NOTE 2) IN 4 EQUAL INCREMENTS AT 36,000 PSI.
5- LOAD WITH APPROX 50 MG IGNITER COMPOSITION (SEE NOTE 3) AND PRESS SIMULTANEOUSLY WITH FIRST INCREMENT OF DELAY COMPOSITION.
6- LOAD WITH APPROX 50 MG IGNITER COMPOSITION (SEE NOTE 3) AND PRESS SIMULTANEOUSLY WITH LAST INCREMENT OF DELAY COMP (SEE NOTE 4)
7- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA, OR APPROVED SUBSTANTIAL EQUAL.
8- PRODUCT OF FANSTEEL METALLURGICAL PRODUCTS CO., CHICAGO, ILL., OR APPROVED SUBSTANTIAL EQUAL
9- PRODUCT OF J.T. BAKER CO., PHILLIPSBURG, N.J., OR APPROVED SUBSTANTIAL EQUAL.
10- PRODUCT OF PALMER PRODUCTS CO., WORCESTER, PA., OR APPROVED SUBSTANTIAL EQUAL.
11-
12- ADD ENOUGH ETHYL ALCOHOL, SPEC MIL-E-463 TO IGNITER COMPOSITION TO MAKE A SLURRY. SLURRY WILL BE BUTTERED ON TO PRODUCE A MOUND, AND WHEN DRY WILL BE SCRAPED OFF FLUSH WITH ENDS OF DELAY COLUMN.
13- LOAD WITH A SERRATED RAM.
14- BURNING TIME OF DELAY COLUMN SHOULD BE APPROX 5.7 SECONDS AT AMBIENT TEMPERATURE.
PART NO. XP-111200
HAND HELD
DELAY LOADING ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
C
CXP-111200
CXP-111200

Figure 14

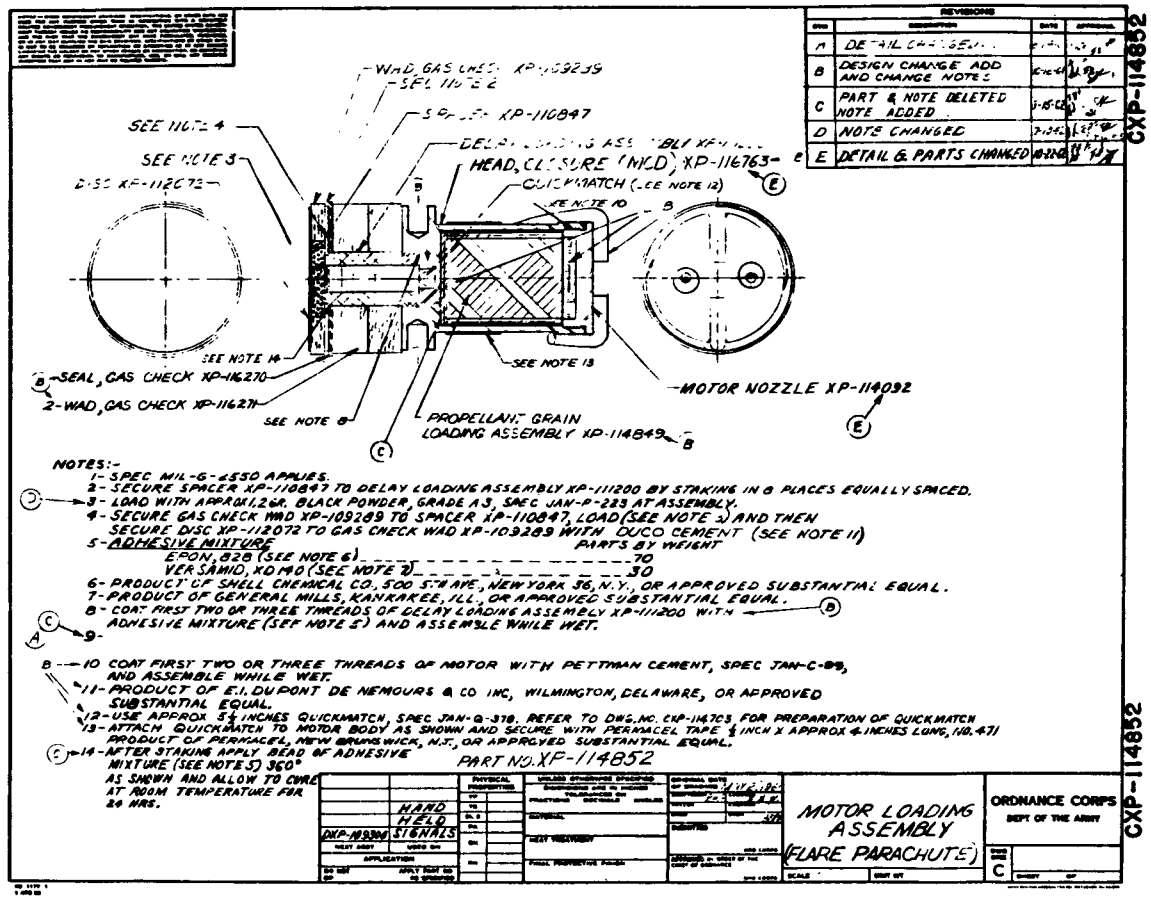

REVISIONS
A DETAIL CHANGES
B DESIGN CHANGE ADD AND CHANGE NOTES
C PART & NOTE DELETED NOTE ADDED
D NOTE CHANGED
E DETAIL & PARTS CHANGED
CXP-114852
WAD, GAS CHECK XP-109289
SEE NOTE 2
SPACER XP-110847
SEE NOTE 4
SEE NOTE 3
DISC XP-112072
DELAY LOADING ASSEMBLY XP-111200
HEAD, CLOSURE (MKD) XP-116763
QUICKMATCH (SEE NOTE 12)
SEE NOTE 10
SEE NOTE 14
SEE NOTE 13
SEAL, GAS CHECK XP-16270
2-WAD, GAS CHECK XP-116271
SEE NOTE 8
PROPELLANT GRAIN LOADING ASSEMBLY XP-114849
MOTOR NOZZLE XP-114092
NOTES:-
1- SPEC MIL-G-4550 APPLIES.
2- SECURE SPACER XP-110847 TO DELAY LOADING ASSEMBLY XP-111200 BY STAKING IN 6 PLACES EQUALLY SPACED.
3- LOAD WITH APPROX 1.26 LB. BLACK POWDER, GRADE A3, SPEC JAN-P-223 AT ASSEMBLY.
4- SECURE GAS CHECK WAD XP-109289 TO SPACER XP-110847, LOAD (SEE NOTE 3) AND THEN SECURE DISC XP-112072 TO GAS CHECK WAD XP-109289 WITH DUCO CEMENT (SEE NOTE 11)
5- ADHESIVE MIXTURE PARTS BY WEIGHT
EPON, 828 (SEE NOTE 6) 70
VERSAMID, XD 140 (SEE NOTE 7) 30
6- PRODUCT OF SHELL CHEMICAL CO., 500 5TH AVE., NEW YORK 36, N.Y., OR APPROVED SUBSTANTIAL EQUAL.
7- PRODUCT OF GENERAL MILLS, KANKAKEE, ILL., OR APPROVED SUBSTANTIAL EQUAL.
8- COAT FIRST TWO OR THREE THREADS OF DELAY LOADING ASSEMBLY XP-111200 WITH ADHESIVE MIXTURE (SEE NOTE 5) AND ASSEMBLE WHILE WET.
9-
10 COAT FIRST TWO OR THREE THREADS OF MOTOR WITH PETTMAN CEMENT, SPEC JAN-C-99, AND ASSEMBLE WHILE WET.
11- PRODUCT OF E.I. DU PONT DE NEMOURS & CO INC, WILMINGTON, DELAWARE, OR APPROVED SUBSTANTIAL EQUAL.
12- USE APPROX 5 1/2 INCHES QUICKMATCH, SPEC JAN-Q-378. REFER TO DWG. NO. CXP-114703 FOR PREPARATION OF QUICKMATCH
13- ATTACH QUICKMATCH TO MOTOR BODY AS SHOWN AND SECURE WITH PERMACEL TAPE 1/2 INCH X APPROX 4 INCHES LONG, NO. 471 PRODUCT OF PERMACEL, NEW BRUNSWICK, N.J., OR APPROVED SUBSTANTIAL EQUAL.
14- AFTER STAKING APPLY BEAD OF ADHESIVE MIXTURE (SEE NOTE 5) 360° AS SHOWN AND ALLOW TO CURE AT ROOM TEMPERATURE FOR 24 HRS.
PART NO. XP-114852
HAND HELD SIGNALS
MOTOR LOADING ASSEMBLY (FLARE PARACHUTE)
ORDNANCE CORPS
DEPT OF THE ARMY
C
CXP-114852

Figure 15

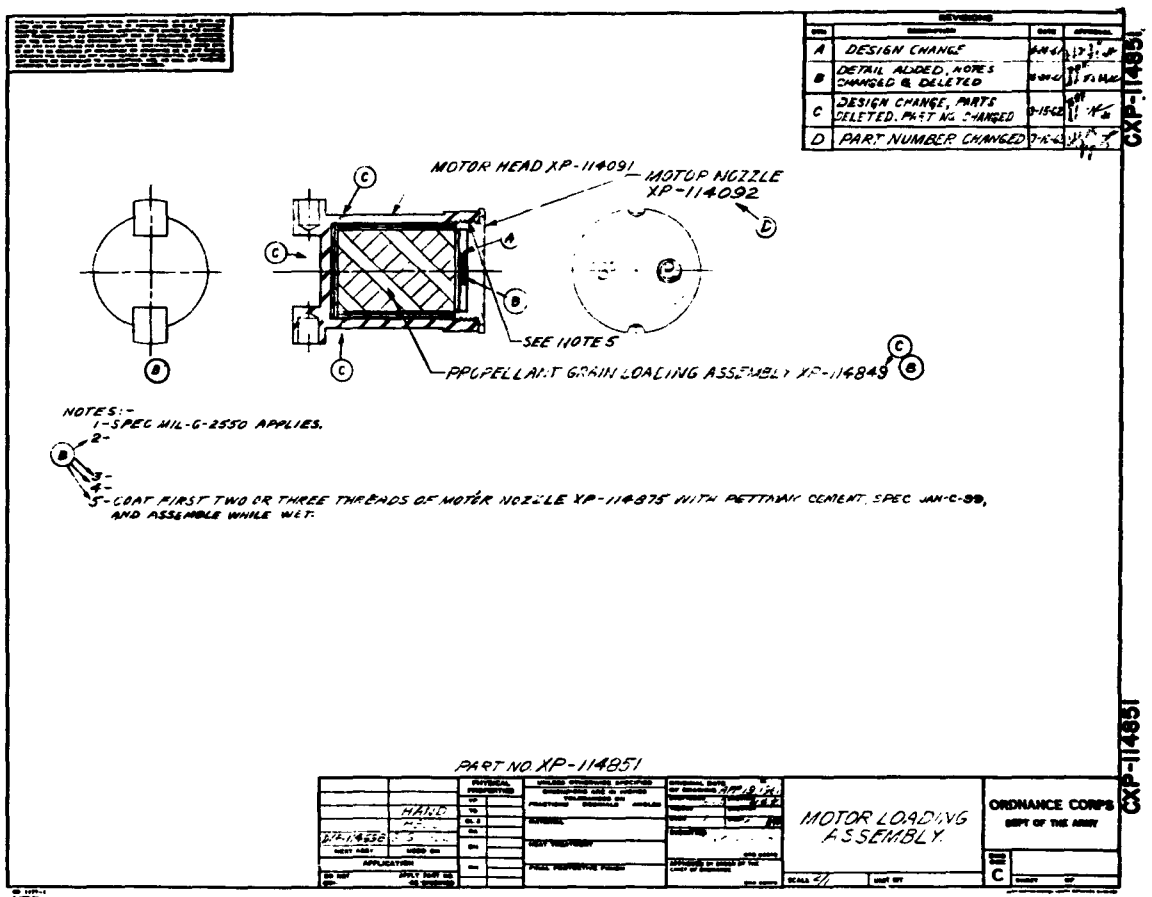

REVISIONS
A DESIGN CHANGE
B DETAIL ADDED, NOTES CHANGED & DELETED
C DESIGN CHANGE, PARTS DELETED. PART NO. CHANGED
D PART NUMBER CHANGED
CXP-114851
MOTOR HEAD XP-114091
MOTOR NOZZLE XP-114092
SEE NOTE 5
PROPELLANT GRAIN LOADING ASSEMBLY XP-114849
NOTES:-
1-SPEC MIL-G-2550 APPLIES.
2-
3-
4-
5-COAT FIRST TWO OR THREE THREADS OF MOTOR NOZZLE XP-114875 WITH PETTMAN CEMENT, SPEC JAN-C-99, AND ASSEMBLE WHILE WET.
PART NO. XP-114851
HAND
MOTOR LOADING ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
SIZE C
CXP-114851

Figure 16

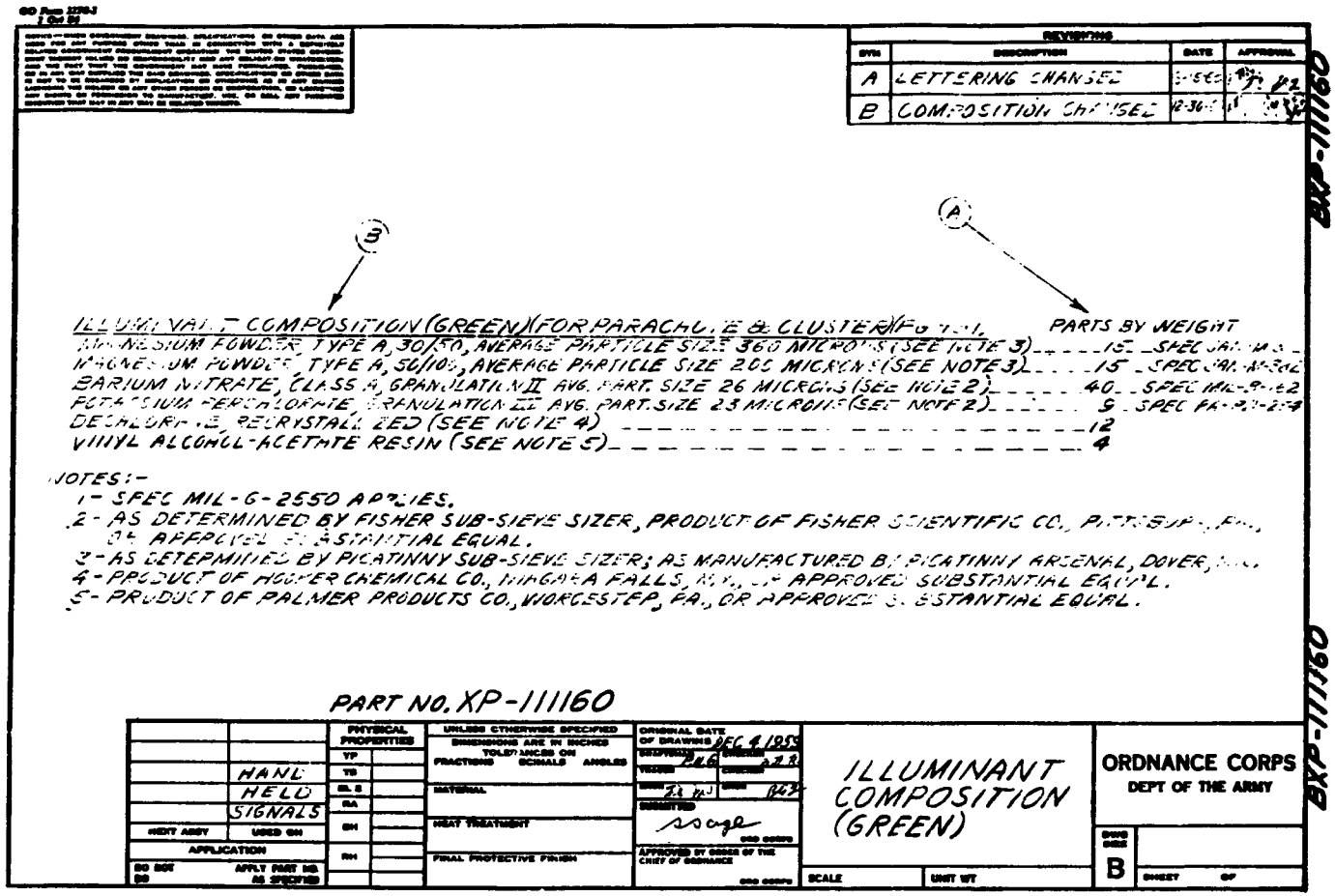

REVISIONS
SYM
DESCRIPTION
DATE
APPROVAL
A
LETTERING CHANGED
B
COMPOSITION CHANGED
ILLUMINANT COMPOSITION (GREEN) (FOR PARACHUTE & CLUSTER)
PARTS BY WEIGHT
MAGNESIUM POWDER, TYPE A, 30/50, AVERAGE PARTICLE SIZE 360 MICRONS (SEE NOTE 3) 15 SPEC
MAGNESIUM POWDER, TYPE A, 50/100, AVERAGE PARTICLE SIZE 205 MICRONS (SEE NOTE 3) 15 SPEC
BARIUM NITRATE, CLASS A, GRANULATION II AVG. PART. SIZE 26 MICRONS (SEE NOTE 2) 40 SPEC
POTASSIUM PERCHLORATE, GRANULATION II AVG. PART. SIZE 23 MICRONS (SEE NOTE 2) 9 SPEC
DECALORATE, RECRYSTALLIZED (SEE NOTE 4) 12
VINYL ALCOHOL-ACETATE RESIN (SEE NOTE 5) 4
NOTES:-
1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURGH, PA., OR APPROVED SUBSTANTIAL EQUAL.
3- AS DETERMINED BY PICATINNY SUB-SIEVE SIZER; AS MANUFACTURED BY PICATINNY ARSENAL, DOVER, N.J.
4- PRODUCT OF HOOKER CHEMICAL CO., NIAGARA FALLS, N.Y., OR APPROVED SUBSTANTIAL EQUAL.
5- PRODUCT OF PALMER PRODUCTS CO., WORCESTER, PA., OR APPROVED SUBSTANTIAL EQUAL.
PART NO. XP-111160
HAND
HELD
SIGNALS
NEXT ASSY
USED ON
APPLICATION
PHYSICAL PROPERTIES
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS
DECIMALS
ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING DEC 4 1959
SUBMITTED
APPROVED BY ORDER OF THE CHIEF OF ORDNANCE
ILLUMINANT COMPOSITION (GREEN)
ORDNANCE CORPS
DEPT OF THE ARMY
SCALE
UNIT WT
B
SHEET
OF
BXP-111160

Figure 17

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	LETTERING CHANGED	[illegible]	[illegible]
B	COMPOSITION CHANGED	2-33-6[illegible]	[illegible]

XP-111159

(B) (A)

ILLUMINANT COMPOSITION (RED) (FR-534) — PARTS BY WEIGHT

MAGNESIUM POWDER, TYPE A, 50/100, AVG. PARTICLE SIZE 200 ± 25 MICRONS (SEE NOTE 3)	29	SPEC JAN-M-382
STRONTIUM NITRATE, GRADE A, AVG. PARTICLE SIZE 34 MICRONS (SEE NOTE 2)	43	SPEC MIL-S-20322
POTASSIUM PERCHLORATE, GRANULATION III, AVG. PART. SIZE 23 MICRONS (SEE NOTE 2)	9	SPEC PA-PD-254
POLYVINYLCHLORIDE, AVG. PARTICLE SIZE 27 MICRONS (SEE NOTE 2)	12	SPEC MIL-P-20307
BINDER COMPOSITION	7	PART NO. XP-111138

NOTES:-

1- SPEC MIL-6-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.
3- AS DETERMINED BY PICATINNY SUB-SIEVE SIZER AS MANUFACTURED BY PICATINNY ARSENAL, DOVER, N.J.

PART NO. XP-111159

HAND HELD SIGNALS	PHYSICAL PROPERTIES: YP, TS, EL 2, RA, BH, BH	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING DEC 4 1959
NEXT ASSY / USED ON		MATERIAL	DRAWN BAG / TRACED / CHECKED / ISSUED soge
APPLICATION		HEAT TREATMENT	APPROVED BY ORDER OF THE CHIEF OF ORDNANCE
DO NOT / DO — APPLY PART NO. AS SPECIFIED		FINAL PROTECTIVE FINISH	

M

ILLUMINANT COMPOSITION (RED)

SCALE | UNIT WT

ORDNANCE CORPS
DEPT OF THE ARMY

SPEC CODE B

SHEET OF

XP-111159

Figure 18

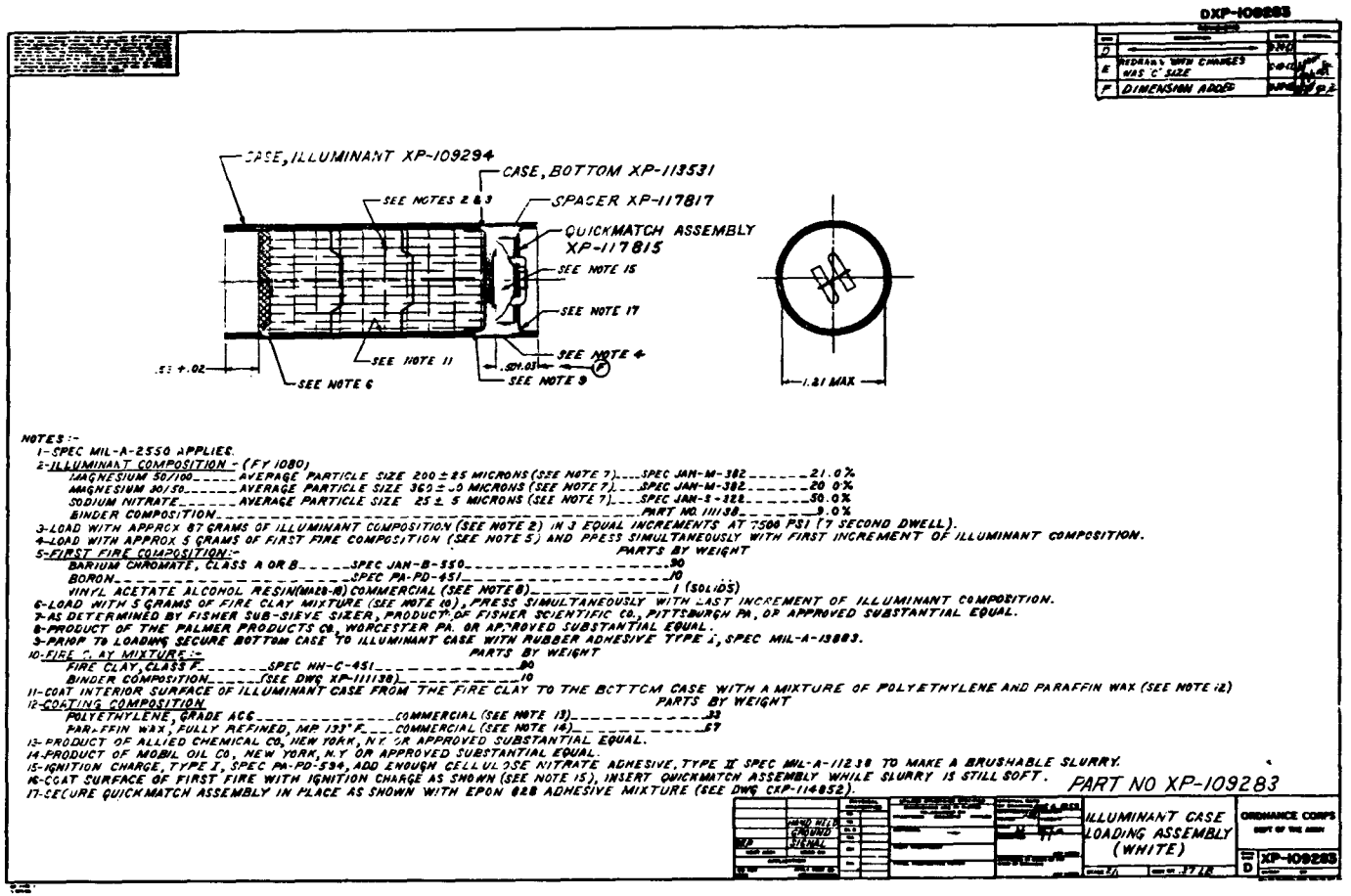

DXP-109283
D
E REDRAWN WITH CHANGES WAS 'C' SIZE
F DIMENSION ADDED
CASE, ILLUMINANT XP-109294
CASE, BOTTOM XP-113531
SEE NOTES 2 & 3
SPACER XP-117817
QUICKMATCH ASSEMBLY XP-117815
SEE NOTE 15
SEE NOTE 17
SEE NOTE 4
SEE NOTE 11
SEE NOTE 6
SEE NOTE 9
1.21 MAX
NOTES:-
1-SPEC MIL-A-2550 APPLIES.
2-ILLUMINANT COMPOSITION - (FY 1080)
MAGNESIUM 50/100 AVERAGE PARTICLE SIZE 200 ± 25 MICRONS (SEE NOTE 7) SPEC JAN-M-382 21.0%
MAGNESIUM 30/50 AVERAGE PARTICLE SIZE 360 ± 50 MICRONS (SEE NOTE 7) SPEC JAN-M-382 20.0%
SODIUM NITRATE AVERAGE PARTICLE SIZE 25 ± 5 MICRONS (SEE NOTE 7) SPEC JAN-S-228 50.0%
BINDER COMPOSITION PART NO. 111138 9.0%
3-LOAD WITH APPROX 87 GRAMS OF ILLUMINANT COMPOSITION (SEE NOTE 2) IN 3 EQUAL INCREMENTS AT 7500 PSI (7 SECOND DWELL).
4-LOAD WITH APPROX 5 GRAMS OF FIRST FIRE COMPOSITION (SEE NOTE 5) AND PRESS SIMULTANEOUSLY WITH FIRST INCREMENT OF ILLUMINANT COMPOSITION.
5-FIRST FIRE COMPOSITION:- PARTS BY WEIGHT
BARIUM CHROMATE, CLASS A OR B SPEC JAN-B-550 90
BORON SPEC PA-PD-451 10
VINYL ACETATE ALCOHOL RESIN (MAEB-B) COMMERCIAL (SEE NOTE 8) 1 (SOLIDS)
6-LOAD WITH 5 GRAMS OF FIRE CLAY MIXTURE (SEE NOTE 10), PRESS SIMULTANEOUSLY WITH LAST INCREMENT OF ILLUMINANT COMPOSITION.
7-AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURGH PA, OR APPROVED SUBSTANTIAL EQUAL.
8-PRODUCT OF THE PALMER PRODUCTS CO, WORCESTER PA. OR APPROVED SUBSTANTIAL EQUAL.
9-PRIOR TO LOADING SECURE BOTTOM CASE TO ILLUMINANT CASE WITH RUBBER ADHESIVE TYPE I, SPEC MIL-A-13883.
10-FIRE CLAY MIXTURE:- PARTS BY WEIGHT
FIRE CLAY, CLASS F SPEC NN-C-451 90
BINDER COMPOSITION (SEE DWG XP-111138) 10
11-COAT INTERIOR SURFACE OF ILLUMINANT CASE FROM THE FIRE CLAY TO THE BOTTOM CASE WITH A MIXTURE OF POLYETHYLENE AND PARAFFIN WAX (SEE NOTE 12)
12-COATING COMPOSITION PARTS BY WEIGHT
POLYETHYLENE, GRADE ACG COMMERCIAL (SEE NOTE 13) 33
PARAFFIN WAX, FULLY REFINED, MP 133°F COMMERCIAL (SEE NOTE 14) 67
13-PRODUCT OF ALLIED CHEMICAL CO, NEW YORK, N.Y. OR APPROVED SUBSTANTIAL EQUAL.
14-PRODUCT OF MOBIL OIL CO, NEW YORK, N.Y OR APPROVED SUBSTANTIAL EQUAL.
15-IGNITION CHARGE, TYPE I, SPEC PA-PD-534, ADD ENOUGH CELLULOSE NITRATE ADHESIVE, TYPE II SPEC MIL-A-11238 TO MAKE A BRUSHABLE SLURRY.
16-COAT SURFACE OF FIRST FIRE WITH IGNITION CHARGE AS SHOWN (SEE NOTE 15), INSERT QUICKMATCH ASSEMBLY WHILE SLURRY IS STILL SOFT.
17-SECURE QUICKMATCH ASSEMBLY IN PLACE AS SHOWN WITH EPON 828 ADHESIVE MIXTURE (SEE DWG CXP-114852).
PART NO XP-109283
ILLUMINANT CASE LOADING ASSEMBLY (WHITE)
ORDNANCE CORPS
XP-109283
D

Figure 19

WHITE ILLUMINANT COMPOSITION (FY-1054)

	PARTS BY WEIGHT	
MAGNESIUM, 50/100, AVG. PART. SIZE 225 ± 25 MICRONS (SEE NOTE 2)	18	SPEC JAN-M-382
MAGNESIUM, 30/50, AVG. PART. SIZE 350 ± 50 MICRONS (SEE NOTE 2)	18	SPEC JAN-M-382
SODIUM NITRATE, AVG. PART. SIZE 20 ± 5 MICRONS (SEE NOTE 3)	40	SPEC JAN-S-322
POTASSIUM PERCHLORATE, GRANULATION III, AVG. PART. SIZE 25 ± 5 MICRONS (SEE NOTE 3)	10	SPEC PA-PD-254
DECHLORANE, RECRYSTALLIZED WHITE, COMMERCIAL (SEE NOTE 4)	4	
BINDER COMPOSITION, PART NO. XP-111138	10	

NOTES:-

1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY PICATINNY SUB-SIEVE SIZER, AS MANUFACTURED BY PICATINNY ARSENAL, DOVER, N.J.
3- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.
4- PRODUCT OF HOOKER CHEMICAL CO., NIAGARA FALLS, N.Y., OR APPROVED SUBSTANTIAL EQUAL.

PART NO. XP-114348

		PHYSICAL PROPERTIES	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES
	HAND	YP	
	HELD	TS	MATERIAL
	SIGNALS	RL S	
NEXT ASSY	USED ON	RA	HEAT TREATMENT
APPLICATION		BH	
DO NOT	APPLY PART NO	RH	FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING FEB 9 1961

SUBMITTED

APPROVED BY ORDER OF THE CHIEF OF ORDNANCE

ILLUMINANT COMPOSITION (WHITE)

SCALE | UNIT WT

ORDNANCE CORPS
DEPT OF THE ARMY

DWG SIZE B | SHEET OF

Figure 20

CO Form 1276-2
1 Oct 64

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	COMPOSITION CHANGED	9.15.60	
B	COMPOSITION CHANGE		

BXP-112079

GREEN SMOKE COMPOSITION (SG 128)

	PARTS BY WEIGHT	
SODIUM BICARBONATE, AVERAGE PARTICLE SIZE 30±5 MICRONS (SEE NOTE 2)	2	SPEC O-S-576
POTASSIUM CHLORATE, AVERAGE PARTICLE SIZE 25±5 MICRONS (SEE NOTE 2)	55	SPEC MIL-P-150
SUGAR, TYPE I(b)2, AVERAGE PARTICLE SIZE 11 MICRONS (SEE NOTE 2)	23	SPEC JJJ-S-791
DYE, INDANTHRENE, GOLDEN YELLOW (SEE NOTE 3)	12	
DYE, 1,4-DI-P-TOLUIDINOANTHRAQUINONE)	28	SPEC MIL-D-3709

NOTES:-
1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.
3- PRODUCT OF GENERAL ANILINE & FILM CORP., NEW YORK 14, N.Y., OR APPROVED SUBSTANTIAL EQUAL.

PART NO. XP-112079

	HAND HELD SIGNALS	PHYSICAL PROPERTIES: TP, TS, RA, DH, RH	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING JAN 29 1960	GREEN SMOKE COMPOSITION
NEXT ASSY	USED ON		MATERIAL	DRAFTSMAN RNB	ORDNANCE CORPS DEPT OF THE ARMY
APPLICATION			HEAT TREATMENT	SUBMITTED soage	DWG SIZE B
DO NOT DO	APPLY PART NO. AS SPECIFIED		FINAL PROTECTIVE FINISH	APPROVED BY ORDER OF THE CHIEF OF ORDNANCE	SCALE / UNIT WT / SHEET OF

BXP-112079

Figure 21

OD Form 1270-1
1 Oct 54

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	COMPOSITION CHANGED	7-15-6[illegible]	[illegible]
B	COMPOSITION CHANGED	8-24-6[illegible]	[illegible]

BXP-111158

RED SMOKE COMPOSITION (SR 78) A B

	PARTS BY WEIGHT	
POTASSIUM CHLORATE, AVERAGE PARTICLE SIZE, 10 MICRONS (SEE NOTE 2)	40	SPEC MIL-P-150
SUGAR, TYPE IB2, AVERAGE PARTICLE SIZE, 11 MICRONS (SEE NOTE 2)	20	SPEC JJ-[illegible]-791
DYE, METHYLAMINOANTHRAQUINONE, GRADE I	40	SPEC MIL-D-3284

NOTES:-
1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.

PART NO. XP-111158

NEXT ASSY	USED ON	PHYSICAL PROPERTIES	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING DEC 4 1953	M
APPLICATION		YP		DRAFTSMAN P.H.G.	RED SMOKE COMPOSITION.
DO NOT DO	APPLY PART NO AS SPECIFIED	TS	MATERIAL	TRACER	
		EL 2		CHECKER	
		RA	HEAT TREATMENT	SUBMITTED ssage ORD CORPS	
		BH		APPROVED BY ORDER OF THE CHIEF OF ORDNANCE ORD CORPS	
		RH	FINAL PROTECTIVE FINISH		

SCALE | UNIT WT

ORDNANCE CORPS
DEPT OF THE ARMY

DWG SIZE B | SHEET OF

BXP-111158

Figure 22

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	COMPOSITION CHANGED	[illegible]	[illegible]
B	COMPOSITION CHANGED	8-24-6	[illegible]

XP-112080

YELLOW SMOKE COMPOSITION (SY115)

	PARTS BY WEIGHT	
SODIUM BICARBONATE, AVERAGE PARTICLE SIZE 35±5 MICRONS (SEE NOTE 2)	8	SPEC O-S-576
POTASSIUM CHLORATE, AVERAGE PARTICLE SIZE 35±5 MICRONS (SEE NOTE 2)	30	SPEC MIL-P-150
SUGAR, TYPE I(A)2	2[illegible]	SPEC JJJ-S-791
DYE, BENZANTHRONE	32	SPEC MIL-B-50074
DYE, INDANTHRENE, G.K., GOLDEN YELLOW (SEE NOTE 3)	15	SPEC MIL-D-50069

NOTES:-
1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG PA., OR APPROVED SUBSTANTIAL EQUAL.
3- PRODUCT OF GENERAL ANILINE & FILM CORP, NEW YORK 14, N.Y., OR APPROVED SUBSTANTIAL EQUAL.

PART NO. XP-112080

HAND HELD SIGNALS		PHYSICAL PROPERTIES	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES
NEXT ASSY	USED ON		MATERIAL
APPLICATION			HEAT TREATMENT
DO NOT USE	APPLY PART NO. AS SPECIFIED		FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING JAN 29 1946

DRAWN P.N.A.

CHECKED

APPROVED BY ORDER OF THE CHIEF OF ORDNANCE

ssage

YELLOW SMOKE COMPOSITION

SCALE | UNIT WT

ORDNANCE CORPS
DEPT OF THE ARMY

DWG CODE B

SHEET OF

XP-112080

Figure 23

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	COMPOSITION CHANGED	5-15-6[illegible]	[illegible]
B	COMPOSITION CHANGE	6-24-6[illegible]	[illegible]

XP-112081

VIOLET SMOKE COMPOSITION (SV-29)

	PARTS BY WEIGHT	
SODIUM BICARBONATE, AVERAGE PARTICLE SIZE 30 ±5 MICRONS (SEE NOTE 2)	1.3	SPEC O-S-576
POTASSIUM CHLORATE, AVERAGE PARTICLE SIZE 25 ±5 MICRONS (SEE NOTE 2)	33.[illegible]	SPEC MIL-P-150
SUGAR, TYPE 182, AVERAGE PARTICLE SIZE 11 MICRONS (SEE NOTE 2)	22.0	SPEC JJJ-S-791
DYE, 1-METHYLAMINOANTHRAQUINONE, GRADE I,	8.5	SPEC MIL-D-3284
DYE, 1,4-DIAMINO-2,3-DIHYDROANTHRAQUINONE	34.0	SPEC MIL-D-3668
ASBESTOS, POWDER, TECH. GRADE, AVERAGE PARTICLE SIZE 15 MICRONS (SEE NOTE 3)	1.2	

NOTES:-
1- SPEC MIL-G-2550 APPLIES.
2- AS DETERMINED BY FISHER SUB-SIEVE SIZER, PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.
3- PRODUCT OF FISHER SCIENTIFIC CO., PITTSBURG, PA., OR APPROVED SUBSTANTIAL EQUAL.

PART NO. XP-112081

HAND HELD SIGNALS	NEXT ASSY	USED ON	
APPLICATION			
DO NOT -DO	APPLY PART NO. RO-[illegible]		

PHYSICAL PROPERTIES: YP, TS, EL 2, RA, BH, RH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL

HEAT TREATMENT

FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING JAN 29 1960

DESIGNED R.A.C. CHECKED

TRACED WAS CHECKED RAS

SUBMITTED [illegible] ORD CORPS

APPROVED BY ORDER OF THE CHIEF OF ORDNANCE ORD CORPS

VIOLET SMOKE COMPOSITION

SCALE | UNIT WT

ORDNANCE CORPS
DEPT OF THE ARMY

ORDNANCE SIZE B

SHEET OF

Figure 24

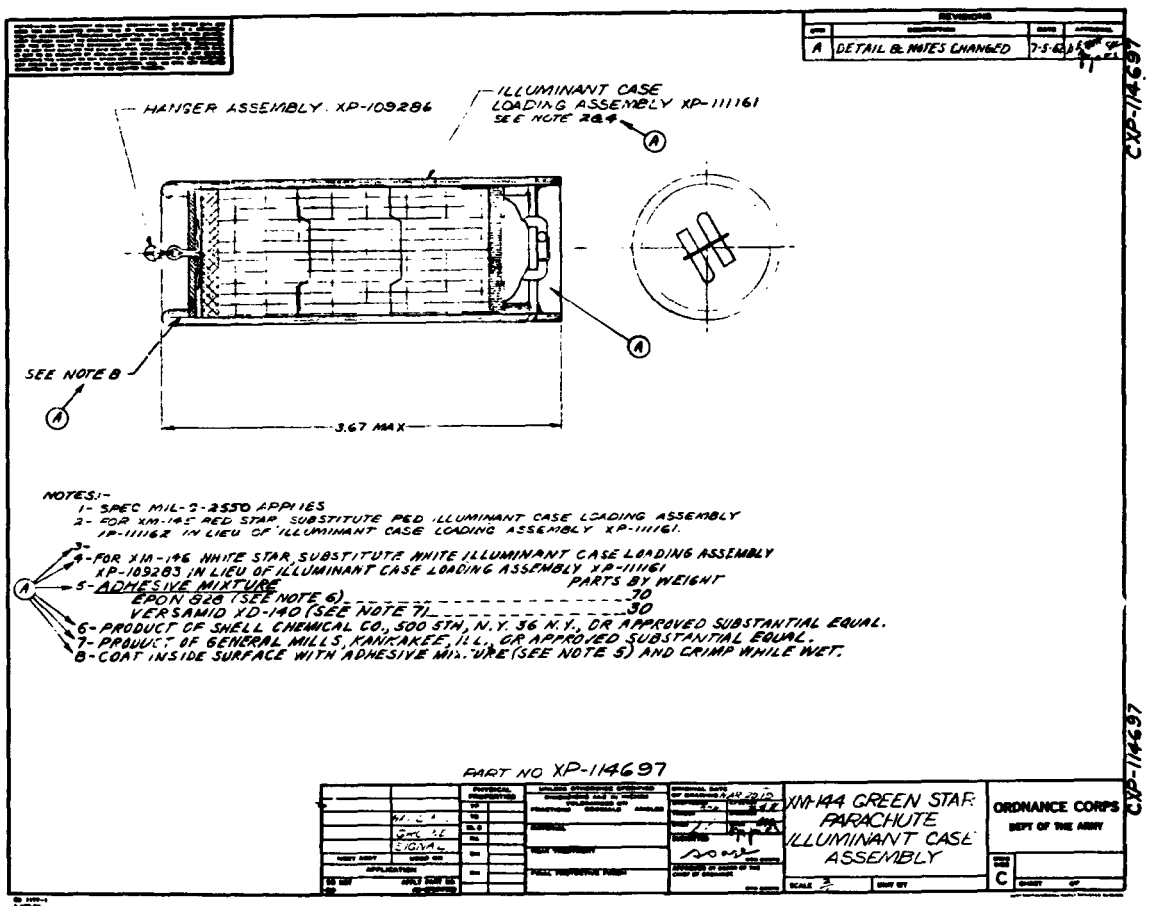

REVISIONS
A DETAIL & NOTES CHANGED
HANGER ASSEMBLY XP-109286
ILLUMINANT CASE LOADING ASSEMBLY XP-111161 SEE NOTE 2&4
SEE NOTE B
3.67 MAX
NOTES:-
1- SPEC MIL-2-2550 APPLIES
2- FOR XM-145 RED STAR, SUBSTITUTE RED ILLUMINANT CASE LOADING ASSEMBLY XP-111162 IN LIEU OF ILLUMINANT CASE LOADING ASSEMBLY XP-111161.
3-
4-FOR XM-146 WHITE STAR, SUBSTITUTE WHITE ILLUMINANT CASE LOADING ASSEMBLY XP-109283 IN LIEU OF ILLUMINANT CASE LOADING ASSEMBLY XP-111161
5-ADHESIVE MIXTURE PARTS BY WEIGHT
EPON 828 (SEE NOTE 6) -70
VERSAMID XD-140 (SEE NOTE 7) -30
6-PRODUCT OF SHELL CHEMICAL CO., 500 5TH, N.Y. 36 N.Y., OR APPROVED SUBSTANTIAL EQUAL.
7-PRODUCT OF GENERAL MILLS, KANKAKEE, ILL. OR APPROVED SUBSTANTIAL EQUAL.
8-COAT INSIDE SURFACE WITH ADHESIVE MIXTURE (SEE NOTE 5) AND CRIMP WHILE WET.
PART NO XP-114697
XM-144 GREEN STAR PARACHUTE ILLUMINANT CASE ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
C
CXP-114697

Figure 25

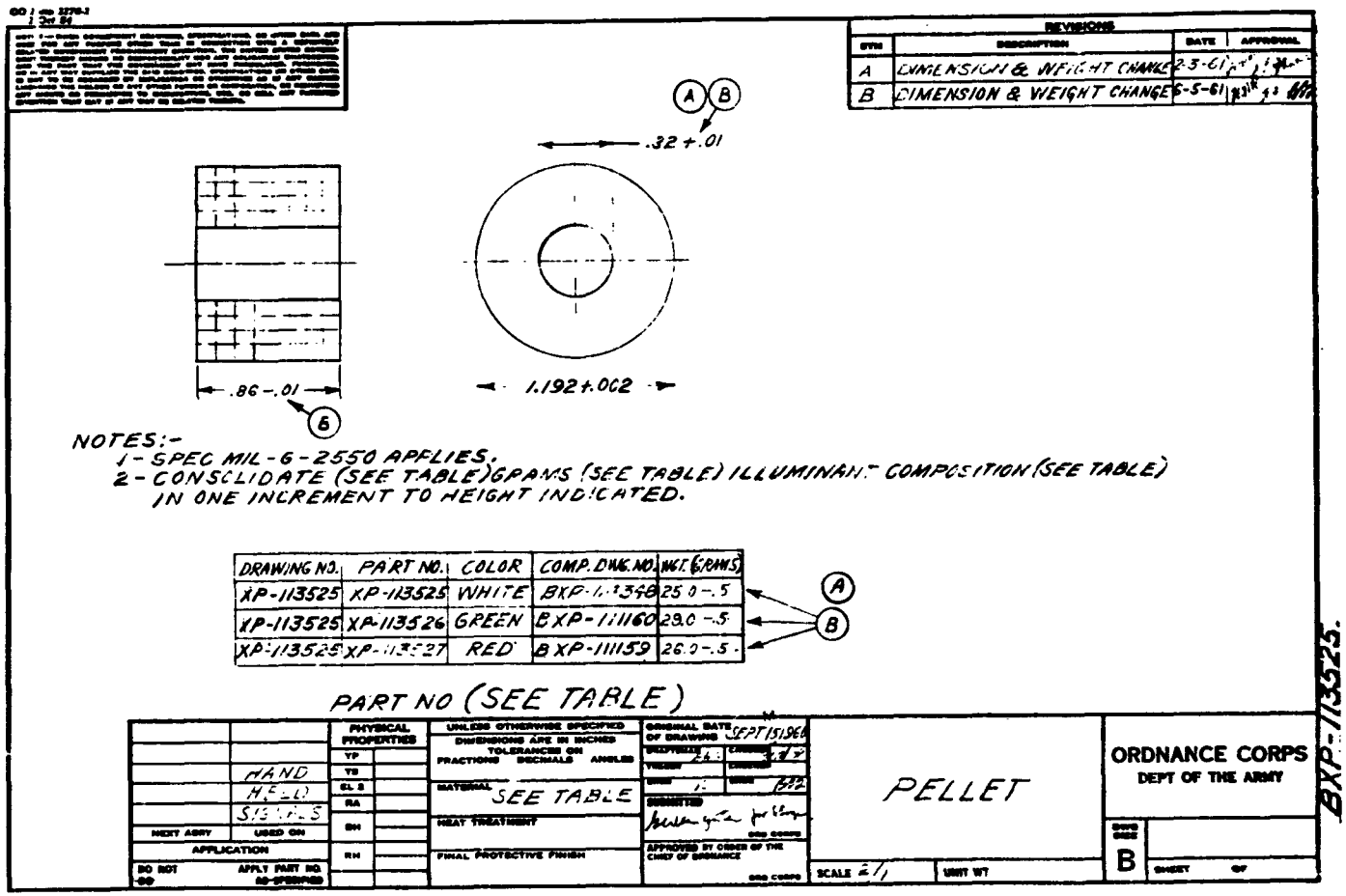

REVISIONS
A DIMENSION & WEIGHT CHANGE 2-3-61
B DIMENSION & WEIGHT CHANGE 6-5-61
.32 +.01
.86 -.01
1.192 +.002
NOTES:-
1 - SPEC MIL-G-2550 APPLIES.
2 - CONSOLIDATE (SEE TABLE) GRAMS (SEE TABLE) ILLUMINANT COMPOSITION (SEE TABLE) IN ONE INCREMENT TO HEIGHT INDICATED.
DRAWING NO. | PART NO. | COLOR | COMP. DWG. NO. | WGT. (G/RWS)
XP-113525 | XP-113525 | WHITE | BXP-111348 | 25.0 -.5
XP-113525 | XP-113526 | GREEN | BXP-111160 | 29.0 -.5
XP-113525 | XP-113527 | RED | BXP-111159 | 26.0 -.5
PART NO (SEE TABLE)
HAND
HELD
SIGNALS
PHYSICAL PROPERTIES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL SEE TABLE
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING SEPT 15, 1960
PELLET
ORDNANCE CORPS
DEPT OF THE ARMY
SCALE 2/1
UNIT WT
B
BXP-113525.

Figure 26

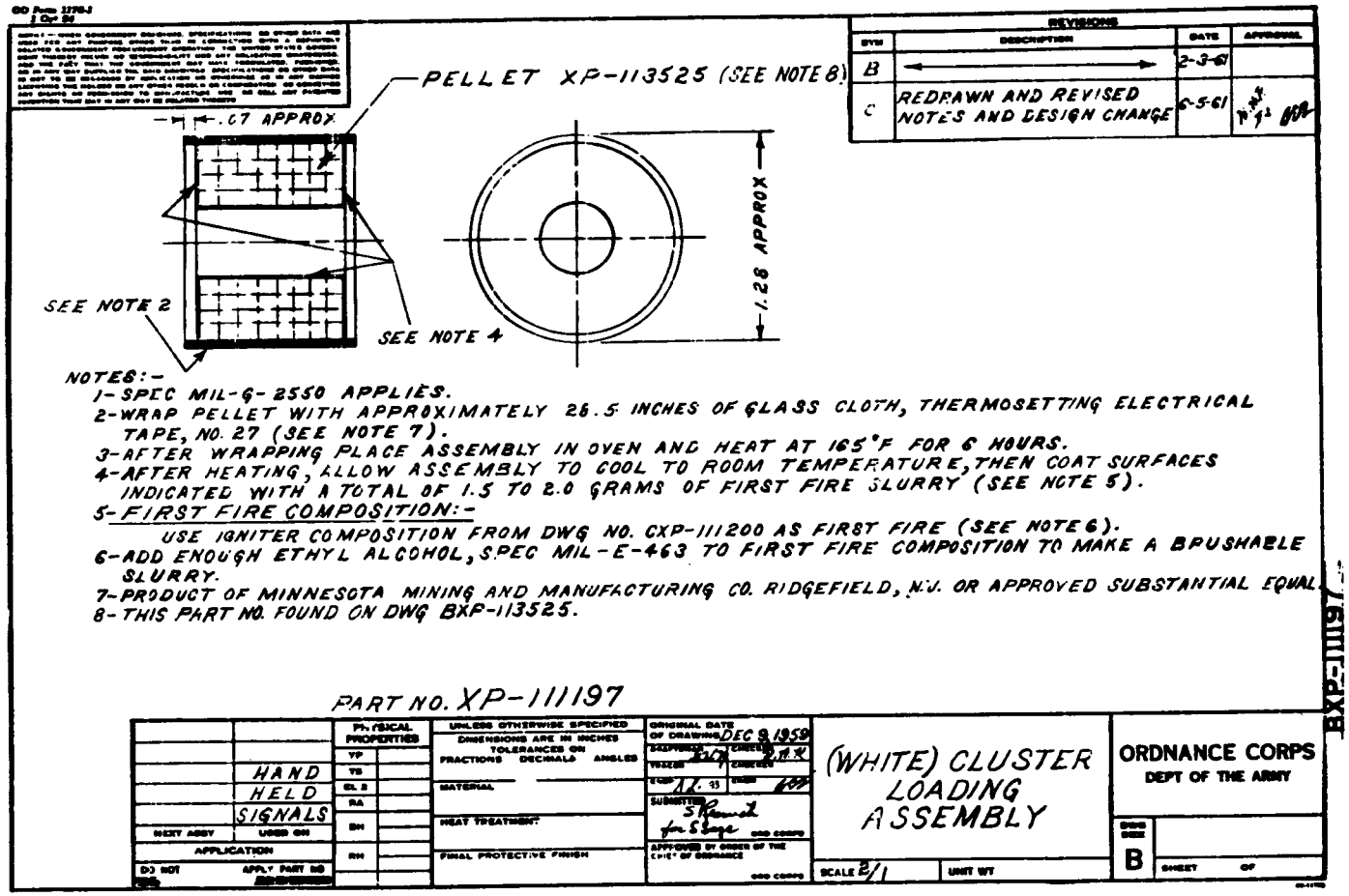

REVISIONS
SYM
DESCRIPTION
DATE
APPROVAL
B
2-3-61
C
REDRAWN AND REVISED NOTES AND DESIGN CHANGE
6-5-61
PELLET XP-113525 (SEE NOTE 8)
.07 APPROX
1.28 APPROX
SEE NOTE 2
SEE NOTE 4
NOTES:-
1-SPEC MIL-G-2550 APPLIES.
2-WRAP PELLET WITH APPROXIMATELY 28.5 INCHES OF GLASS CLOTH, THERMOSETTING ELECTRICAL TAPE, NO. 27 (SEE NOTE 7).
3-AFTER WRAPPING PLACE ASSEMBLY IN OVEN AND HEAT AT 165°F FOR 6 HOURS.
4-AFTER HEATING, ALLOW ASSEMBLY TO COOL TO ROOM TEMPERATURE, THEN COAT SURFACES INDICATED WITH A TOTAL OF 1.5 TO 2.0 GRAMS OF FIRST FIRE SLURRY (SEE NOTE 5).
5-FIRST FIRE COMPOSITION:-
USE IGNITER COMPOSITION FROM DWG NO. CXP-111200 AS FIRST FIRE (SEE NOTE 6).
6-ADD ENOUGH ETHYL ALCOHOL, SPEC MIL-E-463 TO FIRST FIRE COMPOSITION TO MAKE A BRUSHABLE SLURRY.
7-PRODUCT OF MINNESOTA MINING AND MANUFACTURING CO. RIDGEFIELD, N.J. OR APPROVED SUBSTANTIAL EQUAL.
8-THIS PART NO. FOUND ON DWG BXP-113525.
PART NO. XP-111197
HAND HELD SIGNALS
NEXT ASSY
USED ON
APPLICATION
DO NOT
APPLY PART NO
PHYSICAL PROPERTIES
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING DEC 9 1959
(WHITE) CLUSTER LOADING ASSEMBLY
SCALE 2/1
UNIT WT
ORDNANCE CORPS
DEPT OF THE ARMY
B
SHEET
OF
BXP-111197

Figure 27

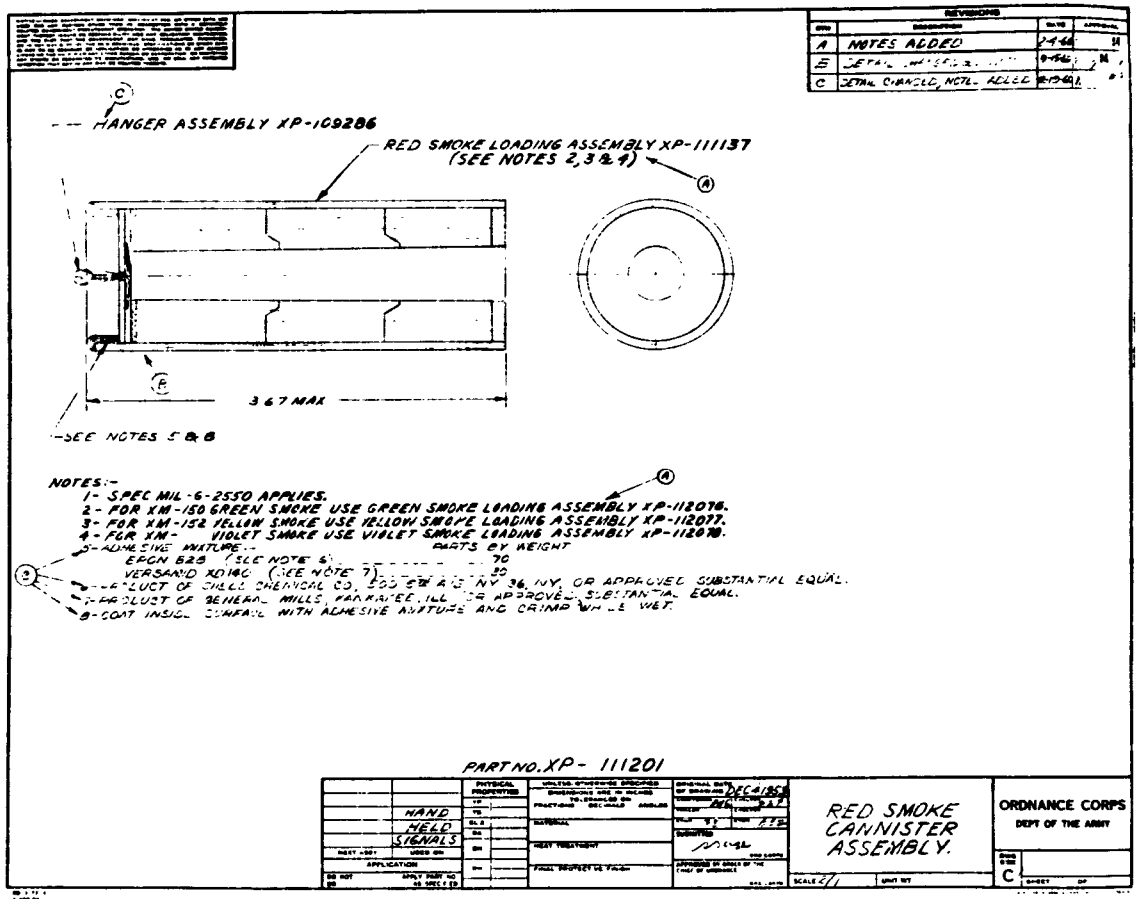

REVISIONS
A NOTES ADDED
C DETAIL CHANGED, NOTE ADDED
HANGER ASSEMBLY XP-109286
RED SMOKE LOADING ASSEMBLY XP-111137
(SEE NOTES 2,3 & 4)
3.67 MAX
SEE NOTES 5 & 6
NOTES:-
1- SPEC MIL-6-2550 APPLIES.
2- FOR XM-150 GREEN SMOKE USE GREEN SMOKE LOADING ASSEMBLY XP-112076.
3- FOR XM-152 YELLOW SMOKE USE YELLOW SMOKE LOADING ASSEMBLY XP-112077.
4- FOR XM- VIOLET SMOKE USE VIOLET SMOKE LOADING ASSEMBLY XP-112078.
5- ADHESIVE MIXTURE:- PARTS BY WEIGHT
EPON 828 (SEE NOTE 6) 70
VERSAMID X0140 (SEE NOTE 7) 30
6- PRODUCT OF SHELL CHEMICAL CO. 500 5TH AVE NY 36, NY. OR APPROVED SUBSTANTIAL EQUAL.
7- PRODUCT OF GENERAL MILLS, FARMINGDALE, ILL. OR APPROVED SUBSTANTIAL EQUAL.
8- COAT INSIDE SURFACE WITH ADHESIVE MIXTURE AND CRIMP WHILE WET.
PART NO. XP- 111201
HAND HELD SIGNALS
RED SMOKE CANNISTER ASSEMBLY.
ORDNANCE CORPS
DEPT OF THE ARMY
C

Figure 28

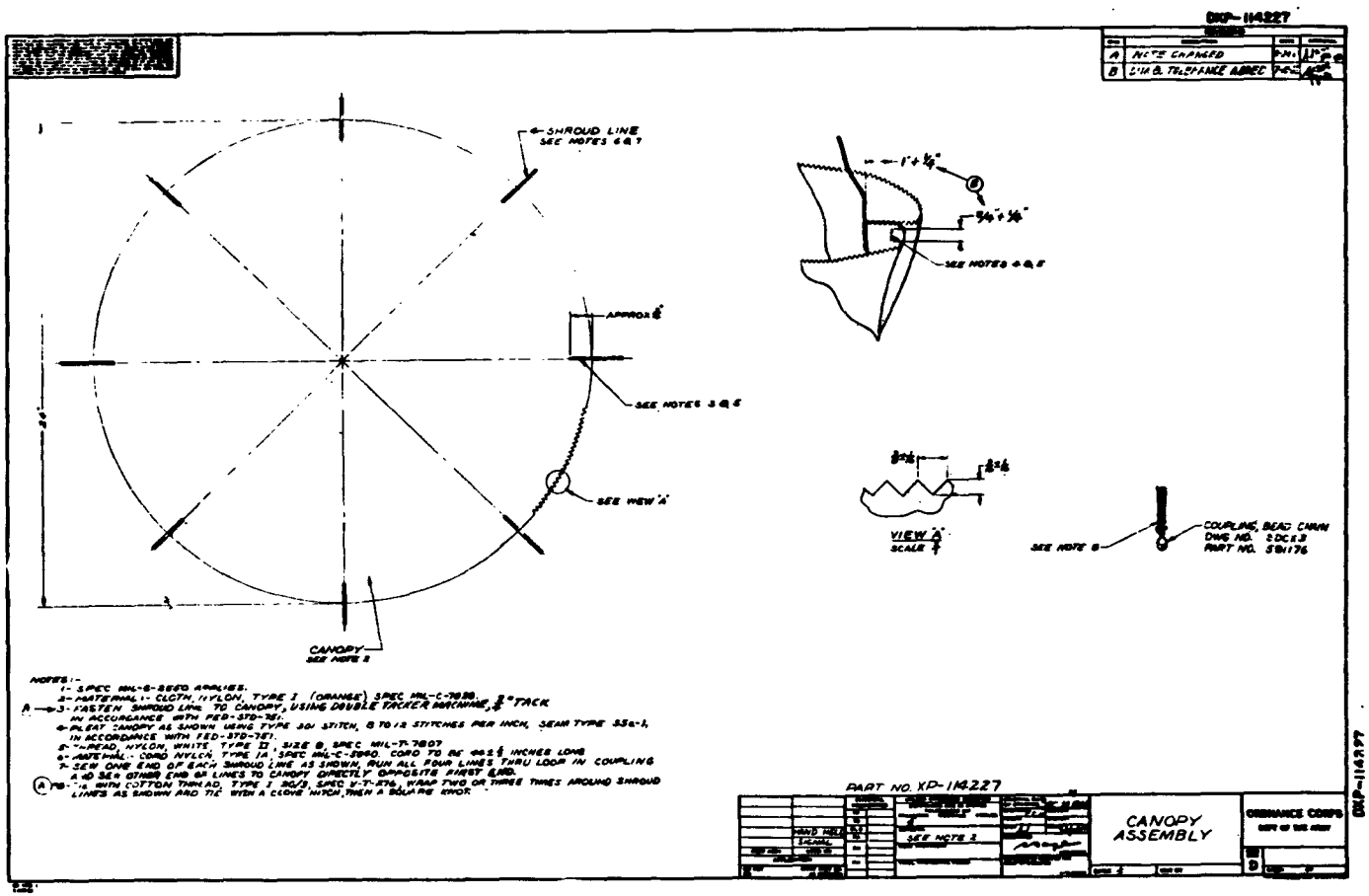

DKP-114227
A NOTE CHANGED
B DIA & TOLERANCE ADDED
SHROUD LINE
SEE NOTES 6 & 7
APPROX
SEE NOTES 3 & 5
SEE VIEW 'A'
CANOPY
SEE NOTE 2
SEE NOTES 4 & 5
VIEW 'A'
SCALE
SEE NOTE 8
COUPLING, BEAD CHAIN
DWG NO. 2DC23
PART NO. 591176
NOTES:-
1- SPEC MIL-S-2650 APPLIES.
2- MATERIAL:- CLOTH, NYLON, TYPE I (ORANGE) SPEC MIL-C-7838.
3- FASTEN SHROUD LINE TO CANOPY, USING DOUBLE TACKER MACHINE, 3/4" TACK IN ACCORDANCE WITH FED-STD-751.
4- PLEAT CANOPY AS SHOWN USING TYPE 301 STITCH, 8 TO 12 STITCHES PER INCH, SEAM TYPE 35a-1, IN ACCORDANCE WITH FED-STD-751.
5- THREAD, NYLON, WHITE, TYPE II, SIZE B, SPEC MIL-T-7807
6- MATERIAL:- CORD NYLON, TYPE IA, SPEC MIL-C-5040. CORD TO BE 44 ± 1/2 INCHES LONG
7- SEW ONE END OF EACH SHROUD LINE AS SHOWN, RUN ALL FOUR LINES THRU LOOP IN COUPLING AND SEW OTHER END OF LINES TO CANOPY DIRECTLY OPPOSITE FIRST END.
8- TIE WITH COTTON THREAD, TYPE I 30/3, SPEC V-T-276, WRAP TWO OR THREE TIMES AROUND SHROUD LINES AS SHOWN AND TIE WITH A CLOVE HITCH, THEN A SQUARE KNOT.
PART NO. XP-114227
SEE NOTE 2
CANOPY ASSEMBLY
ORDNANCE CORPS
DKP-114227

Figure 29

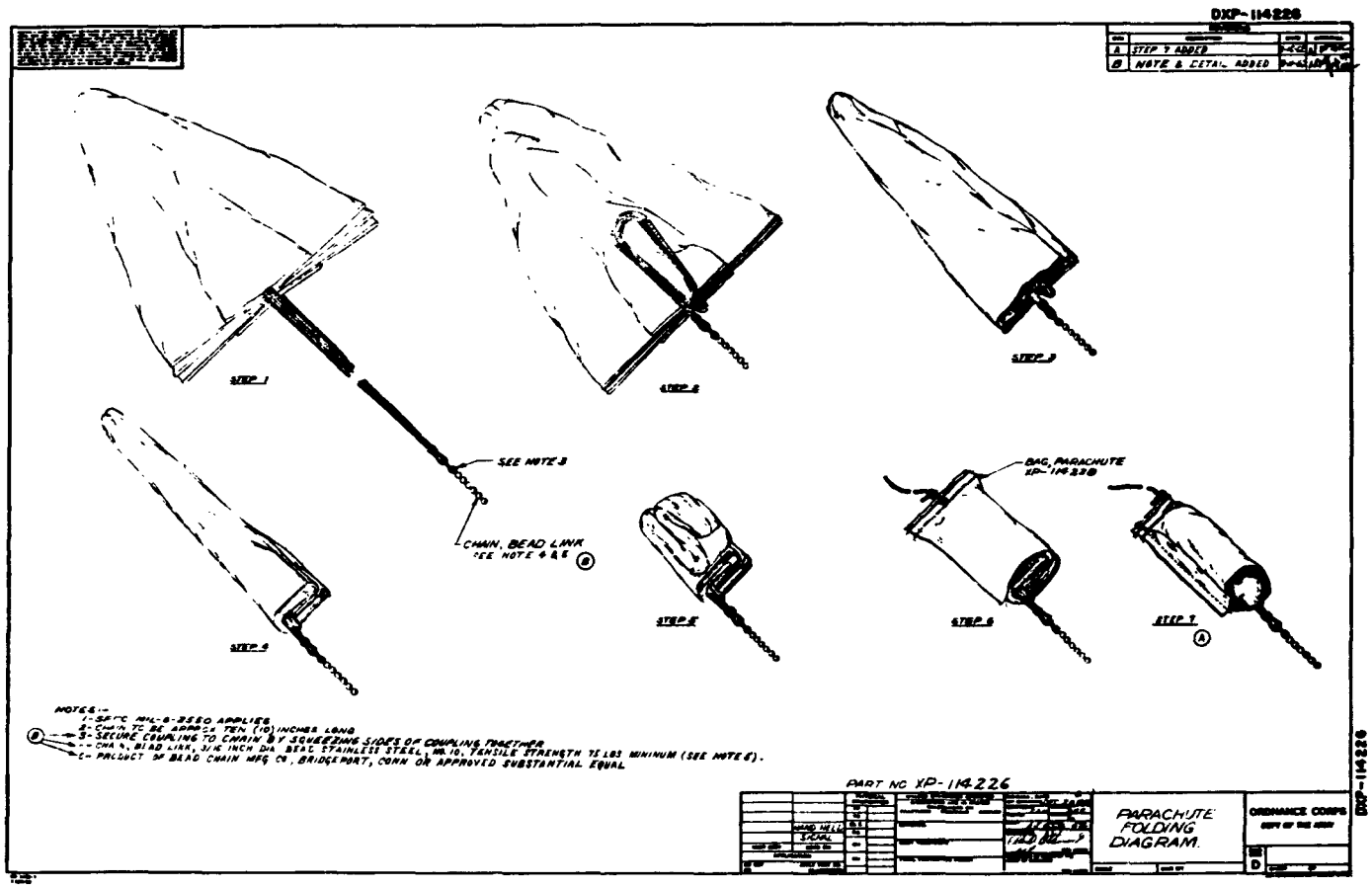

DXP-114226
A STEP 7 ADDED
B NOTE & DETAIL ADDED
STEP 1
STEP 2
STEP 3
STEP 4
STEP 5
STEP 6
STEP 7
SEE NOTE 3
CHAIN, BEAD LINK
SEE NOTE 4 & 5
BAG, PARACHUTE
XP-114228
NOTES:-
1-SPEC MIL-B-2550 APPLIES
2-CHAIN TO BE APPROX TEN (10) INCHES LONG
3-SECURE COUPLING TO CHAIN BY SQUEEZING SIDES OF COUPLING TOGETHER
4-CHAIN, BEAD LINK, 3/16 INCH DIA BEAD STAINLESS STEEL, NO. 10, TENSILE STRENGTH 75 LBS MINIMUM (SEE NOTE 6).
5-PRODUCT OF BEAD CHAIN MFG CO., BRIDGEPORT, CONN OR APPROVED SUBSTANTIAL EQUAL
PART NO XP-114226
PARACHUTE FOLDING DIAGRAM.
ORDNANCE CORPS
DXP-114226

Figure 30

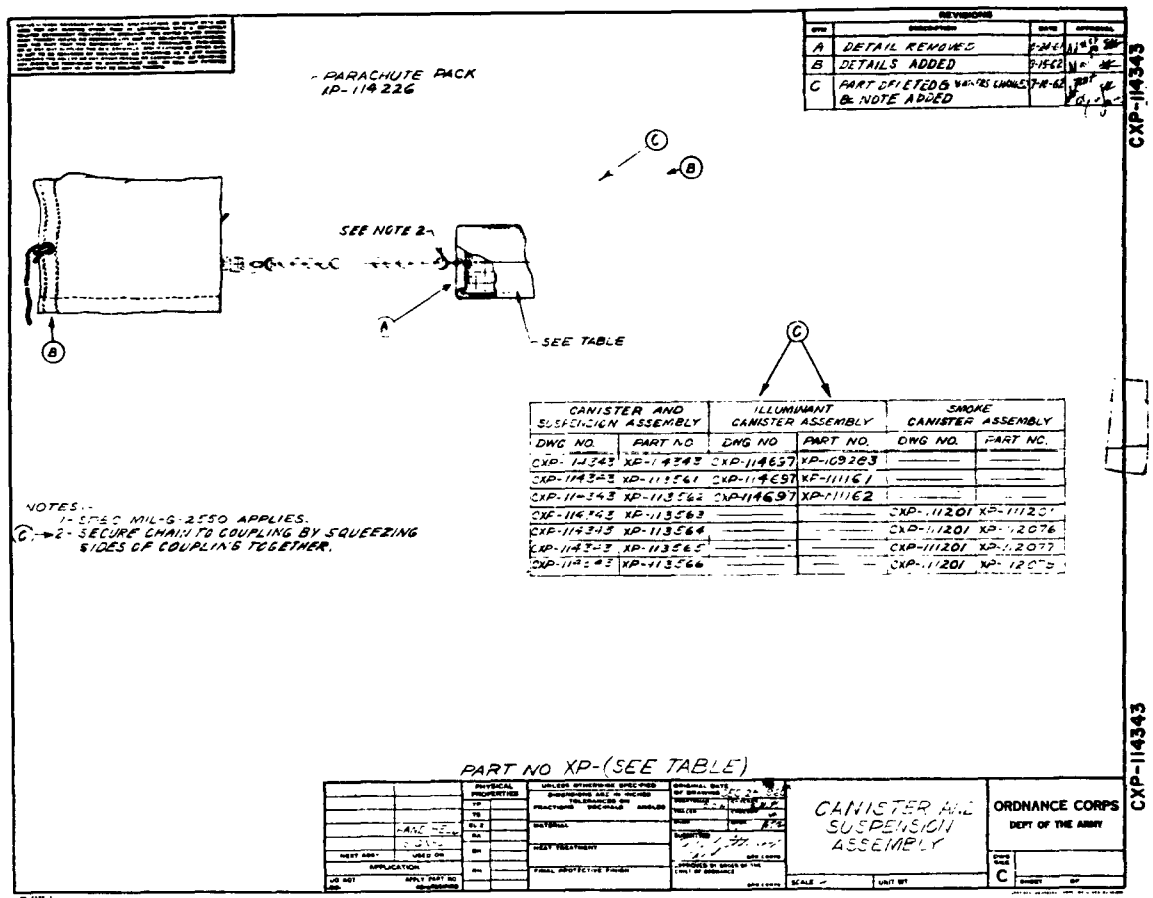

REVISIONS
A DETAIL REMOVED
B DETAILS ADDED
C PART DELETED & NOTE ADDED
PARACHUTE PACK XP-114226
SEE NOTE 2
SEE TABLE
NOTES:
1- SPEC MIL-G-2550 APPLIES.
2- SECURE CHAIN TO COUPLING BY SQUEEZING SIDES OF COUPLING TOGETHER.
CANISTER AND SUSPENSION ASSEMBLY
ILLUMINANT CANISTER ASSEMBLY
SMOKE CANISTER ASSEMBLY
DWG NO.
PART NO.
CXP-114343 XP-114343 CXP-114657 XP-109283
CXP-114343 XP-113561 CXP-114697 XP-111161
CXP-114343 XP-113562 CXP-114697 XP-111162
CXP-114343 XP-113563 CXP-111201 XP-111201
CXP-114343 XP-113564 CXP-111201 XP-112076
CXP-114343 XP-113565 CXP-111201 XP-112077
CXP-114343 XP-113566 CXP-111201 XP-112078
PART NO XP-(SEE TABLE)
CANISTER AND SUSPENSION ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
C
CXP-114343

Figure 31

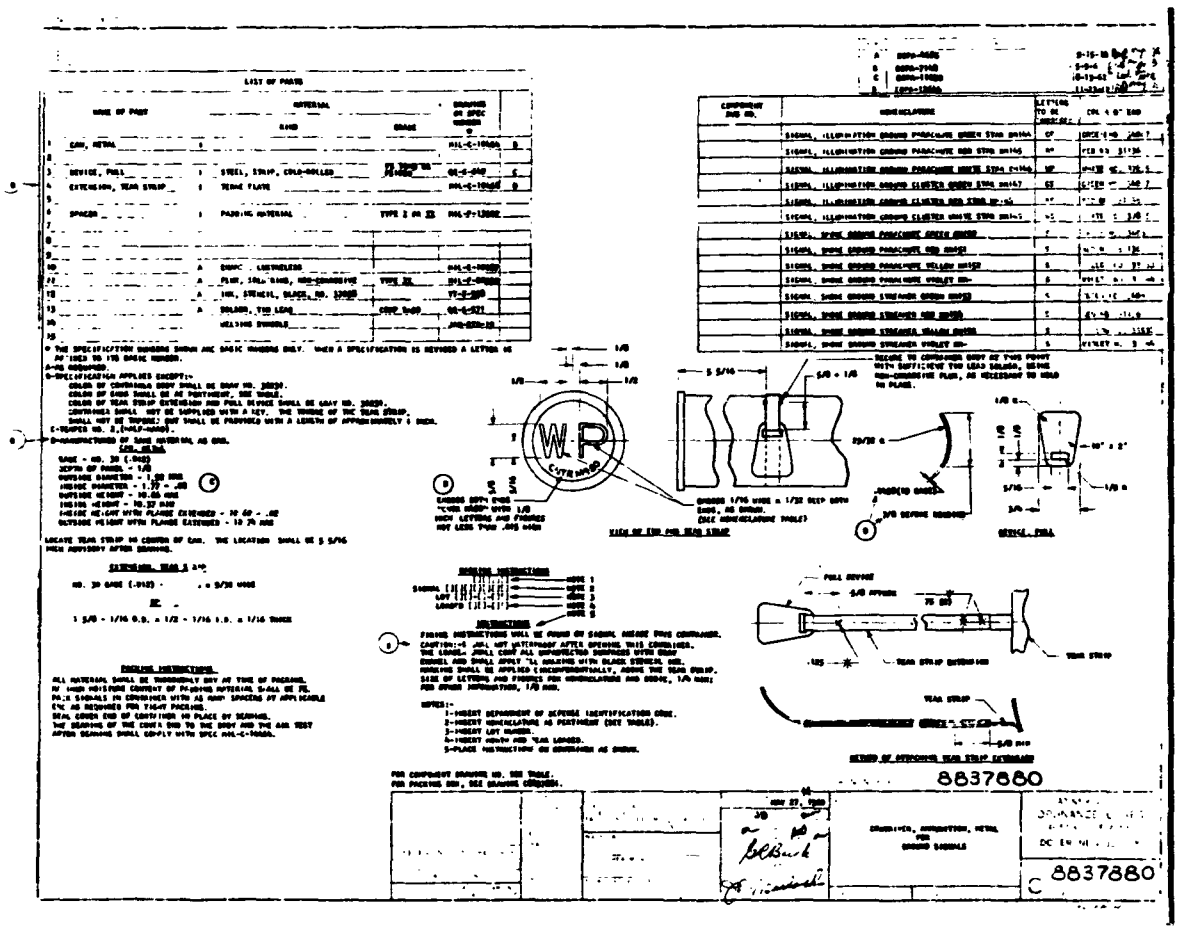


Figure 32

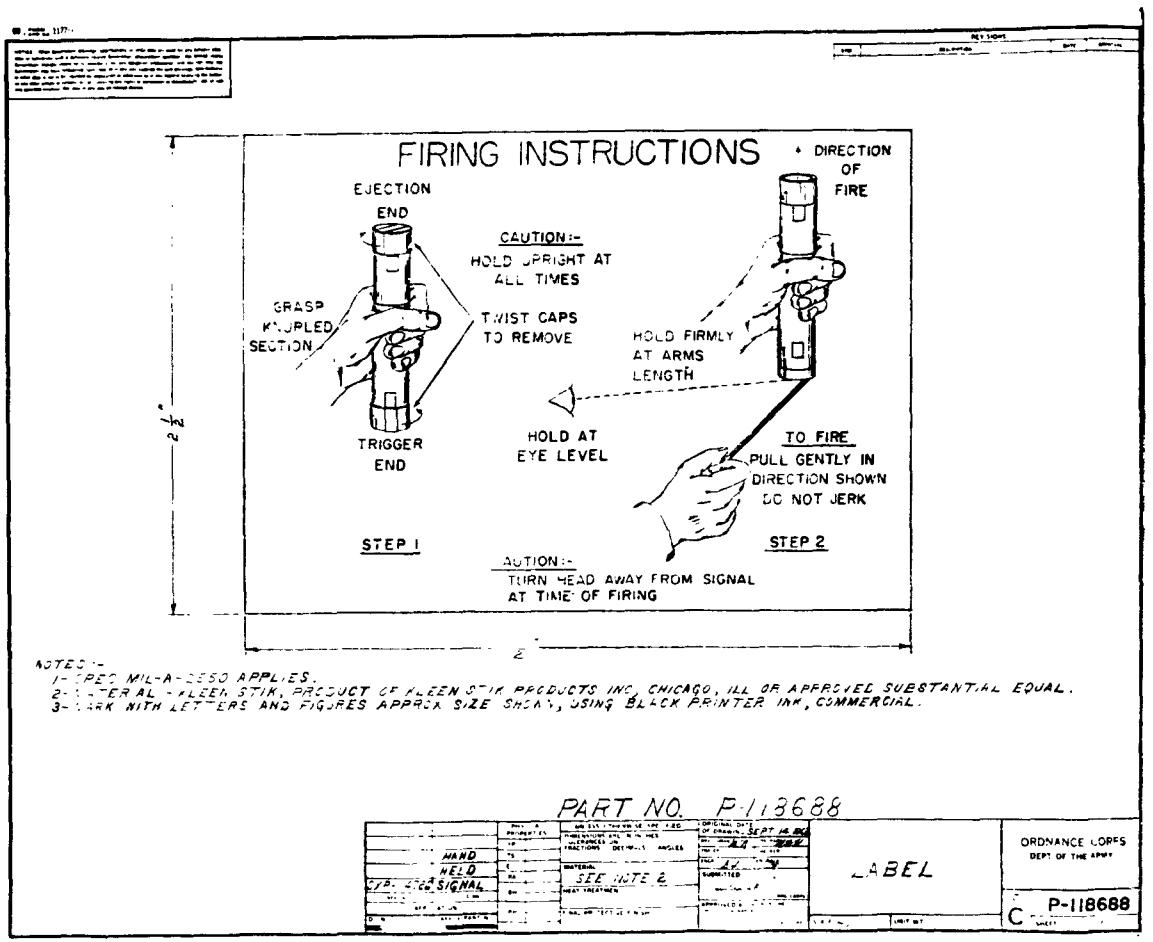

FIRING INSTRUCTIONS
DIRECTION OF FIRE
EJECTION END
CAUTION:-
HOLD UPRIGHT AT ALL TIMES
GRASP KNURLED SECTION
TWIST CAPS TO REMOVE
HOLD FIRMLY AT ARMS LENGTH
TRIGGER END
HOLD AT EYE LEVEL
TO FIRE
PULL GENTLY IN DIRECTION SHOWN DO NOT JERK
STEP 1
STEP 2
CAUTION:-
TURN HEAD AWAY FROM SIGNAL AT TIME OF FIRING
2 1/2"
2"
NOTES:-
1- SPEC MIL-A-2550 APPLIES.
2- LATHER AL - KLEEN STIK, PRODUCT OF KLEEN STIK PRODUCTS INC, CHICAGO, ILL OR APPROVED SUBSTANTIAL EQUAL.
3- MARK WITH LETTERS AND FIGURES APPROX SIZE SHOWN, USING BLACK PRINTER INK, COMMERCIAL.
PART NO. P-118688
HAND HELD SIGNAL
SEE NOTE 2
LABEL
ORDNANCE CORPS
DEPT OF THE ARMY
C
P-118688

Figure 33

APPENDIX A

OTCM 37402
APPROVED 26 MAY 60
DEPARTMENT OF THE ARMY
Office of the Chief of Ordnance

JALlompart/bw/55684

FROM: The Subcommittee on Infantry and Aircraft Weapon Systems

TO: The Ordnance Technical Committee

SUBJECT: SIGNALS, GROUND, HAND-HELD - Initiation of Development and Recording of Military Characteristics - DA Project 504-22-016 (OMS Code 5530.12.548 F).

1. REFERENCES:

a. OTCM 32189 dated 27 May 1948
b. OTCM 33337 dated 9 June 1950
c. Ltr, 10 March 1959, USCONARC to C/R&D, ATDEV-3 400.114/32 (10 March 1959), Subject: USCONARC-Approved Revised Military Characteristics for Signal, Ground, Hand-Held.
d. Ltr, 23 March 1959, from USCONARC to C/R&D subject: Draft Revised MC's for Signals, Ground, Hand-Held, Rocket Type, CRD/D 3664, 00/9UI-5987.

2. DISCUSSION:

a. Reference 1a authorized the initiation of Project 504-022-016 (TS5-5402) for the purpose of developing hand-held rocket type signals.

b. Reference 1b clarified the Military Characteristics originally established for these signals.

c. Reference 1c contained USCONARC-approved revised Military Characteristics for Signal, Ground, Hand-Held, which were approved by C/R&D in reference d.

d. Since the T133 Series Signal currently being developed do not comply with the revised military characteristics, USCONARC recommended that a new development program be established for the purpose of providing a new series of hand-held signal to meet the revised requirement.

e. The requirement for EOD tools and "render safe" procedures for these signals will be carefully considered.

f. In the development of the signals resulting from this project all available technical intelligence will be considered.

g. This project is included in the Fiscal Year 1960 Research and Development Program.

3. RECOMMENDATIONS:

The Subcommittee recommends that:

a. The attached R&D Project Card, DD Form 613, Appendix I, be approved.

b. The following nomenclatures be assigned:

SIGNAL, ILLUMINATION, GROUND: parachute, green star, XM144
SIGNAL, ILLUMINATION, GROUND: parachute, red star, XM145
SIGNAL, ILLUMINATION, GROUND: parachute, white star, XM146

SIGNAL, ILLUMINATION, GROUND: cluster, green star, XM147
SIGNAL, ILLUMINATION, GROUND: cluster, red star, XM148
SIGNAL, ILLUMINATION, GROUND: cluster, white star, XM149

SIGNAL, SMOKE, GROUND: parachute, green, XM150
SIGNAL, SMOKE, GROUND: parachute, red, XM151
SIGNAL, SMOKE, GROUND: parachute, yellow, XM152

SIGNAL, SMOKE, GROUND: streamer, green, XM153
SIGNAL, SMOKE, GROUND: streamer, red, XM154
SIGNAL, SMOKE, GROUND: streamer, yellow, XM155

c. The development of the above signals be conducted under DA Project 504-22-016, OMS 5530.12.548 - Signal, Ground, Hand-Held, Rocket Type, Priority 1A, and Technical Objective LC-10.

d. This OTCM, the subject material, components and related documents be unclassified.

SUBMITTED FOR CONSIDERATION:

S.L. HALL
Col, Ord Corps
Chairman, Subcommittee

APPENDIX B

R&D PROJECT CARD EXTRACTS
4 April 1960

20. Requirement and/or Justification

The Continental Army Command has a requirement for hand-held, rocket type, signals that will attain an average height of 750 feet and be able to maintain normal functioning after prolonged storage and handling in the field. CDOG Reference 939C (2)

21. a. Brief:
The purpose of the development is to provide signals for use of CONARC, which do not require weapons or special adapters for projection. The military characteristics are contained in Inclosure I to this R&D Project Card.

b. Approach:
From available data regarding the standard M131 Hand-Held Distress Signal, the standard M125 Series of ground signals, and the T133 Series of ground signals, establish the basic design of a series of spin stabilized signals, prepared drawings and specifications.

c. Sub-Tasks:
None

d. Other Information:

(1) Fiscal Estimates:

Period	Total Estimates	ARMY RDT&E	ARMY PEMA
FY 1960	270	270	0
FY 1961	270	270	0
Total	650	590	60

(2) Scientific Research: N/A

(3) Standardization Item: The items are included in an international standardization program as reflected by CLSI-1-107-17.

(4) Same or Related Items: None

(5) Critical Material or Limitations: None

(6) Specific Review Points: All phases of development will be reviewed in accordance with OCTI 200-2-59, dated 1 Oct 1959.

e. Background History and Progress:

The Continental Army Command requested that a new series of signals be developed to eliminate the deficiencies of and replace the present standard M125 Series and the T133 Series. The deficiencies to be eliminated are erratic flight, smoke and spark trail, and breaking of tear strips on the packing containers.

f. Future Plans:

(1) To finish the development of the smoke composition; (2) to conduct static tests of the rocket motor; (3) to conduct ballistic tests of all signals; (4) to conduct engineering tests of all signals.

g. References:

(1) First Partial Report of U.S. Army Infantry Board, Project M.2705, Service Test of Signals, Ground, Hand-Held (DA Project 5S04-22-0.6).

(2) Aberdeen Proving Ground Firing Records B-14006-B-14010 covering tests of Hand-Held Rocket Type Ground Signals T113, T134, T135, T137 and T138, dated 17-30 October 1956.

(3) Ltr, 10 Mar 59, USCONARC to C/R&D, ATDEV-3-400:114/32, subject: USCONARC - Approved Revised Military Characteristics for Signals, Ground Hand-Held.

APPENDIX C

USCONARC-APPROVED REVISED MILITARY CHARACTERISTICS
FOR
SIGNALS, GROUND, HAND-HELD

I - GENERAL

1. Requirement

A hand-held device capable of projecting streamer-type, light, and smoke pyrotechnic devices to a height of 750 feet to replace standard projecting devices. This device will be utilized for visual signaling by airborne and other combat troops as personnel assembly aids, site markings, and for ground-to-ground and ground-to-air signaling in combat operations.

2. Operational concept

The signals will be employed by Army ground units for visual ground-to-ground and ground-to-air signaling and to provide temporary close-in illumination for individuals and small units.

3. Organizational concept

The signals will replace those combat signals that require weapons or devices for projection and the current family of rocket-type, hand-held signals.

4. Consideration of tripartite, Navy, Air Force, and Marine Corps development activities

Coordination will be effected with all interested agencies and will include the United States Marine Corps, United Kingdom, and Canada.

5. Feasibility of development

If, during the development phase, it appears to the development agency that the characteristics listed herein require the incorporation of certain impractical features or unnecessarily expensive and complicated components or devices, costly manufacturing methods and processes, critical materials or restrictive specifications which serve as a detriment to the military value of the item, such matters will be brought to the attention of the Chief of Research and Development, Department of the Army, and CONARC Hdqtrs, for careful consideration before incorporation in a final design.

6. Background

a. In 1947 Army Field Forces conducted a limited evaluation of hand-held, rocket-type signals and concluded that pyrotechnics which did not require a weapon or special projector were a decided improvement over

standard signals that were weapon launched. Military characteristics for those signals were approved in 1948 and revised in 1950. After completion of the initial service test in 1952 signals in series T71 through T76 were classified as standard type and designated M125 through M130. Subsequent to classification as standard type of this series of signals, development of additional signals, designated T133 through T138, was initiated.

b. Erratic performance in production lots of the M127 signal (white star parachute) in 1954 led to suspension from issue of all types of hand-held signals. In subsequent testing certain lots of modified standard-type signals have been found acceptable for Army use on an interim-basis. Efforts are continuing to improve performance of the adopted-type signals and to complete development and testing of the remainder of the interim family of hand-held signals at an early date.

c. Those military characteristics supersede those recorded by Ordnance Technical Committee Item No. 32189, 5 May 1948, as revised by Ordnance Technical Committee Item No. 33337, 9 June 1950.

II-OPERATIONAL CHARACTERISTICS

7. Configuration

a. Weight (complete) shall not exceed 1.2 pounds.

b. Length (complete) shall not exceed 9.5 inches.

c. Diameter shall not exceed 2 inches.

8. The signals shall be provided in the following types and colors:

a. Light producing signals:

Red Star Cluster
Green Star Cluster
White Star Cluster
Red Star Parachute
Green Star Parachute
White Star Parachute

b. Smoke producing signals:

Red Smoke Parachute
Green Smoke Parachute
Yellow Smoke Parachute
Red Smoke Streamer
Green Smoke Streamer
Yellow Smoke Streamer
Violet Smoke Parachute
Violet Smoke Streamer

9. Performance

a. The signal shall be capable of projection by hand, without danger to the firer, and without the use of a weapon or special adapter.

b. The noise and recoil produced by firing shall be kept to the minimum possible and shall not cause undue discomfort to the firer.

c. The ignition of the signal element shall begin at approximately the zenith of flight when launched at an angle of approximately 90° from the horizontal, except for smoke streamer-type signals, in which ignition shall begin at the minimum safe distance from the firer.

d. The noise, smoke, and flash resulting from the firing of the signals shall be the minimum practicable, and, excpet for smoke streamer signals, shall make no smoke, flash, or luminous trail which would disclose the position of the firer. It is desirable that smoke and flash produced by firing the signal be indiscernable to ground observers at all ranges in daylight and darkness, and mandatory that they be indiscernable at ranges greater than 1,000 yards (except for Smoke Streamer Signals).

e. Both light and smoke producing signals shall have sharp color definition and be easily distinguishable.

f. Smoke parachute signals shall have a minimum duration of usable visibility of 60 seconds.

g. Flare signals (parachute-type) shall have a minimum burning time of 40 seconds with 60 seconds desired.

h. The White Star Parachute Signal shall be an illuminating flare. It shall produce a white light of a minimum of 45,000 candlepower and have a minimum burning time of 40 seconds. 60,000-100,000 candlepower and 60 seconds burning time is highly desirable. When projected at an elevation of 45°, it shall burst in the air at a horizontal range of between 620 and 790 feet at a height of 500 to 450 feet.

i. Cluster-type signals producing green, red, or white stars shall have a burning time of approximately 8 seconds.

j. Streamer-type signals shall emit green, red, violet, or yellow smoke at a safe distance from the firer and continue to emit smoke to ground impact.

k. Compliance with the visibility and smoke cloud requirement shall be determined in clear weather with wind velocity not greater than 10 miles per hour.

l. Parachute-suspended signals shall not descent at a rate faster than 7 feet per second.

m. The signals shall be stable in flight and shall not depart more than 10° from the intended direction of flight.

n. The signals shall be able to attain an average height of 750 feet when fired vertically. Tolerance in height shall not exceed plus or minus 75 feet.

o. The signals shall be visible and colors distinguishable to an air observer on a clear (with aerial visibility not less than 10 miles) cloudless day against a contrasting background from a height of 6,000 feet at a slant range of 5 miles.

p. The signals shall be safe in storage, transporting, handling, and firing.

q. The signals shall be sufficiently durable to withstand the shocks incurred in parachute delivery when secured to a parachutist and when dropped by parachute in aerial delivery containers, provided normal precautions are taken in packing to protect the signals from undue damage. The signals must be safe to handle and fire after drop by malfunctioning parachute provided no visible damage has been sustained.

r. The signal and signal container must be so designed that the container can be opened and the signal removed and fired by a man wearing cold-weather clothing.

s. Signal performance shall not be dependent on selection and training of firers.

t. Instructions for firing shall be clearly marked on the container or signal.

u. The signal and signal container shall be so marked as to permit easy identification of type and color of signal.

10. Durability and reliability

The signals shall be sufficiently durable to withstand the abuse normally encountered in combat, to include prolonged exposed storage and frequent handling in the field.

III - SPECIAL CHARACTERISTICS

11. Enviromental operating requirements

a. Shall be capable of satisfactory performance under the basic extreme cold weather and extreme hot weather operating conditions as specified in AR 705-15.

b. Shall be capable of safe storage and transportation without permanent impairment of its capabilities from the effects of extreme conditions as specified in subparagraph 7d, AR 705-15, 14 August 1957.

c. Shall be immersion proof to the extent specified in ABC Army Standard Nr 13, 10 April 1952.

12. CBR and atomic requirements

The signals shall be designed to facilitate rapid decontamination from CBR and atomic contamination.

13. Kit requirements - None

14. Maintenance and interchangeability requirements - None. The signals shall be expendable.

15. Human engineering

Human engineering is required.

IV - ORDER OF PRIORITY OF CHARACTERISTICS

16. In case of competing essential characteristics, the developing agency will give priority in the below listed order:

a. Performance
b. Durability and Reliability
c. Weight and bulk
d. Simplicity of operation

V - ITEMS TO BE SUPERSEDED BY THESE ITEMS

17. These signals will supersede the current family of Signals, Ground, Hand-Held, Rocket-Type, and all other combat signals requiring a weapon or special device for projection.