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AUTHORITY
FA ltr 3 Sep 1971
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FOREWORD

This Engineering Reference Manual for Propellant Actuated Devices (PAD) is primarily a catalog which provides technical information on over 175 PAD items.

Those items prefixed by an "M" have been type classified as standard and are available as normal production hardware. In addition, certain items are listed that have not reached type classification and are prefixed by an "XM".

In addition, this manual contains a section relating to other specialized activities of the PAD Laboratories such as technical consulting services and Ballistic Testing.
PROPELLANT ACTUATED DEVICE

BACKGROUND HISTORY

In the early 1940's the advent of high speed military aircraft posed the problem of how to get a pilot out of a disabled aircraft, since he could no longer crawl out and manually parachute himself to safety.

For a solution to the problem, the then Army Air Corps looked to the Army Ordnance and it turned to Frankford Arsenal. Thus, commencing in the summer of 1945, Frankford Arsenal collaborated on the design and development of the first ejection seat catapult. Two years later this catapult was standardized as the M1 Personnel Catapult. In 1947, soon after the standardization of the M1 Personnel Catapult, the design and development of the first propellant actuated canopy removers, the M1 and M2, was completed. Later, in 1949 Frankford Arsenal developed the first propellant gas pressure generator source, the M1 initiator. Since then over 175 different Frankford Arsenal propellant actuated devices have been designed, tested, standardized and used in a multitude of aircraft applications.

With the advent of the B-52 Bomber, the requirement for a multicrew, multifunctional integrated escape system necessitated that a different type of propellant actuated device, a thruster, be developed to position seats, unlock hatches, stow steering control columns, and perform other pre-ejection functions. Together with the airframe manufacturers and Air Force Frankford Arsenal designed and developed the first in a series of thrusters designated M1, M2, M3, and M5 in 1951.

Over 3200 American pilots have since been saved by using systems which are in whole or in part operated by Frankford Arsenal propellant actuated devices. Also there is no known record of a systems failure as a result of a Frankford Arsenal developed device.

Frankford Arsenal now supplies the Army, Navy, Air Force, National Aeronautical and Space Administration, Canada and many NATO countries with many of the highly reliable propellant actuated devices used in their Aircraft Emergency Escape Systems.

Advancements in the state-of-art of propellant actuated devices achieved at Frankford Arsenal are evidenced by the issuance of some 180 patents to Arsenal Engineers and Scientists.

This manual contains all propellant actuated devices including those that have not reached type classification status (designated by XM).

Frankford Arsenal is the Army Commodity Center for CAD/PAD and Single Service Procurement Manager for FSC 1377 CAD/PAD. Also, Frankford Arsenal has agreements with the Air Force on Logistic Support (AOAMA) and Research and Development (ASD).
PAD BALLISTICS LABORATORIES

The PAD Ballistics Laboratories are devoted to the mission responsibility of maintaining the state-of-the-art and the entire product life cycle from concept through fielding. The ballistic test and evaluation complex consists of a large variety of special fixtures which permit simultaneity of testing several items ranging in size from squibs to personnel rockets containing 10 lb. of propellant. The fixtures vary to allow for that of static or gas generator type firing thru the type used to simulate “G” fields or opposing constant resistive forces to both vertical and horizontal track-carriage type. Chambers for heating and cooling items under test are also available.

The complex is amply equipped with the latest data acquisition systems and closed circuit TV for viewing tests in progress and tapes for instant TV replay.

The complex occupies over 15,000 sq. ft. of floor space.

The following is a brief resume of some of the equipment:

a. A 150 ft. vertical tower with tracks and carriages. The carriages are designed for incremental weight increases to 1200 lb. and an acceleration of 30 g's with the maximum weight

b. Eight complete data acquisition systems with concomitant transducers for measuring thrust, velocity, acceleration, travel, time, pressure, and temperature.

c. Over forty-five special fixtures for ballistic testing of items containing up to 10 lb. of propellant. These fixtures provide opposing masses and forces, static ballistic testing, temperature conditioning, hi-vacuum, dynamic, and static testing of seals.

d. A 125 ft. vertical tower with tracks and carriages used to simulate various masses which PAD must accelerate.
TECHNICAL CONSULTING SERVICES

Frankford Arsenal provides technical assistance and consulting in the field of PAD and Ordnance Engineering to other Government Agencies and their Contractors.

To mention a few, in the past, Frankford Arsenal engineers and scientists have provided such consulting services to U.S. Air Force ASD, BSD (AVCO and General Electric), Atomic Energy Commission (Sandia Base), AVMC, & NLABS.
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INITIATORS

Initiators are designed primarily to supply gas pressure to operate firing mechanisms of other propellant actuated devices, and they may also be used as sources of energy to operate piston devices such as safety-belt releases and safety pin extractors. All initiators were developed to contain the gas pressure, that is to function at "locked-shut" condition.
INITIATOR, CARTRIDGE ACTUATED, M3A1C

DATA

1. Weight of Assembly ........................................... 0.9 lb.
2. Actuation Method ................................................. Mechanical
3. Actuation Force .................................................. 40 lbs.
4. Operating Temperature Limits ................................. -65°F to +200°F

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70°F
INITIATOR, CARTRIDGE ACTUATED, M5A2

DATA

1. Weight of Assembly .................................. 0.9 lb.
2. Actuation Method ..................................... Gas
3. Actuation Pressure ..................................... 1000 psi (minimum)
4. Operating Temperature Limits .......................... -65°F to +200°F.

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN\(^3\)
FLEXIBLE HOSE MIL-H-25579-4
70°F
INITIATOR, CARTRIDGE ACTUATED, M8

DATA

1. Weight of Assembly .................................. 3.2 lbs.
2. Actuation Method ..................................... Mechanical
3. Actuation Force ........................................ 40 lbs.
4. Operating Temperature Limits .......................... $-65^\circ F$ to $+200^\circ F$

TYPICAL PERFORMANCE

The M8 initiator will deliver a peak pressure of 1000 psi ($-65^\circ F$) to 3000 psi ($200^\circ F$) at the end of a 30-foot flexible hose (MS28741-4)
INITIATOR, CARTRIDGE ACTUATED, M9

DATA

1. Weight of Assembly .................................. 3.2 lb.
2. Actuation Method ...................................... Gas
3. Actuation Pressure .................................... 1000 psi (minimum)
4. Operating Temperature Limits ........................... -65°F to +200°F

TYPICAL PERFORMANCE

The M9 initiator will deliver a peak pressure of 1000 psi (-65°F) to 3000 psi (200°F) at the end of a 30-foot flexible hose (MS28741-4).
INITIATOR, CARTRIDGE ACTUATED, DELAY
(Miniature Type)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
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<tr>
<td>M14</td>
<td>5.2825</td>
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<tr>
<td>M16</td>
<td>5.2825</td>
<td>B</td>
<td>3</td>
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<tr>
<td>M54</td>
<td>5.2825</td>
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<tr>
<td>M89</td>
<td>5.167</td>
<td>B</td>
<td>5</td>
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DATA

1. Weight of Assembly .......................... 0.35 lb.
2. Actuation Method ............................ Mechanical
3. Actuation Force ............................. 40 lbs.
4. Operating Temperature Limits ............... -65°F to +200°F
INITIATOR, CARTRIDGE ACTUATED, DELAY (Cont'd.)
M14, M16, M54, And M89
(Miniature Type)

TYPICAL PERFORMANCE (GRAPH A)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F

TYPICAL PERFORMANCE (GRAPH B)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F
INITIATOR, CARTRIDGE ACTUATED, DELAY, M15
(Miniature Type)

DATA

1. Weight of Assembly ........................................ 0.39 lb.
2. Actuation Method ........................................... Gas
3. Actuation Pressure .......................................... 1000 psi (minimum)
4. Operating Temperature Limits .............................. -65°F to +200°F
5. Delay Time .................................................... 3 sec.

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70°F
**INITIATOR, CARTRIDGE ACTUATED, DELAY**

**DATA**

1. Weight of Assembly .................. 0.9 lb.
2. Actuation Method .................. Gas
3. Actuation Pressure .................. 1000 psi (minimum)
4. Operating Temperature Limits ......... \(-63^\circ F \) to \(+200^\circ F\)

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<tr>
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<th>TYPICAL PERFORMANCE GRAPH</th>
<th>DELAY TIME (seconds)</th>
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INITIATOR, CARTRIDGE ACTUATED, DELAY (Cont'd.)
M6A1, M10, M25, M31, M33, M42, and M44

TYPICAL PERFORMANCE (GRAPH A)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F

TYPICAL PERFORMANCE (GRAPH B)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F
INITIATOR, CARTRIDGE ACTUATED, DELAY

<table>
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DATA

1. Weight of Assembly ............... 1.0 lb.
2. Actuation Method ................. Mechanical
3. Actuation Force ................. 40 lbs. (minimum)
4. Operating Temperature Limit ........ -65°F to +200°F
INITIATOR, CARTRIDGE ACTUATED, DELAY (Cont'd.)
M4, M12A1, M30A1, M32A1, M43A1, M45A1, And M49A1

TYPICAL PERFORMANCE (GRAPH A)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F

TYPICAL PERFORMANCE (GRAPH B)

GAGE CHAMBER VOL. = .062 IN$^3$
FLEXIBLE HOSE MIL-H-25579-4
70° F
INITIATOR, CARTRIDGE ACTUATED, M28
(Miniature Type)

DATA
1. Weight of Assembly ....................... 0.3 lb.
2. Actuation Method ......................... Gas
3. Actuation Pressure ....................... 1000 psi (minimum)
4. Operating Temperature Limits ........ -65°F to +200°F

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 in³
FLEXIBLE HOSE MIL-H-25579-4
70°F
INITIATOR, CARTRIDGE ACTUATED, M29

DATA

1. Weight of Assembly .................................. 1.75 lbs.
2. Actuation Method ...................................... Gas w/Manual Override
3. Actuation:
   Pressure ............................................. 1000 psi (minimum)
   Initiator Pin Preload ............................... 40 lbs.
4. Operating Temperature Limit ...................... -65°F to 200°F

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70° F

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HOSE LENGTH (FT)

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<td>12</td>
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</tbody>
</table>
INITIATOR, CARTRIDGE ACTUATED, DELAY, M52
(Miniature Type)

DATA
1. Weight of Assembly ......................... 0.39 lb.
2. Actuation Method ......................... Mechanical
3. Actuation Force ........................... 40 lbs.
4. Operating Temperature Limits ........... -65°F to +200°F
5. Delay Time ............................... 5 sec.

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = 0.062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70°F

PRESSURE (PSI x 1000)

HOSE LENGTH (FT)
INITIATOR, CARTRIDGE ACTUATED, M86
(Miniature Type)

DATA

1. Weight of Assembly ........................................ 0.3 lb.
2. Actuation Method ............................................ Mechanical
3. Actuation Force ................................................ 40 lbs.
4. Operating Temperature Limits .............................. -65°F to +200°F.

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70° F
INITIATOR, CARTRIDGE ACTUATED
(Miniature Type, Non-Delay)

DESIGNATION | DIMENSION "L" (Max.) | TYPICAL PERFORMANCE GRAPH
--- | --- | ---
M27 | 4.1575 | B
M87 | 4.033 | B

DATA
1. Weight of Assembly .................. 0.33 lbs.
2. Actuation Method .................... Mechanical
3. Actuation Force ..................... 40 lbs.
4. Operating Temperature Limits ........ -65°F to +200°F

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70°F

HOSE LENGTH (FT)

PRESSURE (PSI x 1000)

1-17
INITIATOR, CARTRIDGE ACTUATED, DELAY, M51, M88
(Miniature Type)

5.1435 MAX

3/4-16 UNF-3A

7/16-20 UNF-3A

.866 MAX DIA

7/16-20 UNF-3B
FOR M88 ONLY
INITIATOR, CARTRIDGE ACTUATED, DELAY, M51 and M88 (Cont'd)

(Miniature Type)

DATA

1. Weight of Assembly ......................................... 0.39 lb.
2. Actuation Method ........................................... Gas
3. Actuation Pressure ......................................... 1000 psi (minimum)
4. Operating Temperature Limits .............................. -650 F to +2000 F
5. Delay Time .................................................. 2 sec.

TYPICAL PERFORMANCE

GAGE CHAMBER VOL. = .062 IN³
FLEXIBLE HOSE MIL-H-25579-4
70° F
DATA

1. Weight of Assembly ................... 3.2 lbs.
2. Actuation Method ...................... Gas
3. Actuation Pressure ..................... 1000 psi (minimum)
4. Operating Temperature Limits .......... −65°F to +200°F
5. The M80 initiator is a scaled M9 type initiator which restricts Toxic
gas leakage to prevent atmospheric contamination.

TYPICAL PERFORMANCE

In the temperature range of −65°F to +160°F the M80 initiator will deliver a peak pressure of
1000 to 3000 psi at the end of a 30-foot flexible hose (MS28741-4).
This miniaturized (saving in weight and space) initiator is a device designed to supply gas pressure to operate the firing mechanism of other cartridge actuated devices. It incorporates an integral extractor with a manual override, in case of malfunction of the gas operated mechanism.
INITIATOR, CARTRIDGE ACTUATED, XM111

DATA

1. Weight of Assembly .......................... 4.0 Ounces
2. Actuation Force ......................... 17 to 25 Pounds Pull
3. Operating Temperature Limits .......... -65 to +200°F

TYPICAL PERFORMANCE

This sub-miniature initiator is for use in mechanically actuated pad systems requiring gas pressure at the end of specific lengths of AN-4 hose. The initiator is designed for bracket or bulkhead mounting (Bracket Mounting Illustrated).
INITIATOR, PROPELLANT ACTUATED, XM112

DATA
1. Weight of Assembly .................. 3.3 Ounces
2. No Fire ............................... 1.0 Amp/1.0 Watt, 5 min.
3. Recommended Firing Current .......... 5.0 Amp.
4. Operating Temperature Limits ........ -65°F to +200°F.

TYPICAL PERFORMANCE

This sub-miniature initiator is for use in electrically actuated pad systems requiring gas pressure at the end of various lengths of AN-4 hose. The initiator is held in position by a hold clamp. (Not shown).
DATA

1. Weight ............................................... 1/2 Ounce
2. Delay Time(s) ................................. Can be supplied in
                          0.3, 0.5, 0.7, 1.0, 1.5,
                          2.0 Sec.
3. Operating Temp. Limits ...................... -65 to 200°F

This sub-miniature initiator is used in combination with the X111 Initiator firing head and the XM104 Initiator. The XM113 Initiator is used as a replacement for delay initiation where the hose length does not exceed 15 feet in length.
INITIATOR, CARTRIDGE ACTUATED, M-104 (SUB-MINIATURE)

DATA
1. Weight of Assembly .................. 400 grams
2. Operating Temperature Limits ........... -65°F to +200°F.

TYPICAL PERFORMANCE

This initiator is installed in a hose line to act as a pressure booster and is an expendable gas initiator, reduced in size, simpler in construction, and more economical to produce than those presently used in aircraft escape systems.
CATAPULTS

The catapult is a propellant actuated device developed for emergency ejection of a seat-man combination from high speed aircraft. Rocket-assisted catapults sustain thrust to increase ejection height without exceeding personnel acceleration maximums.
CATAPULT, AIRCRAFT EJECTION SEAT, M1A1

DATA

1. Stroke ........................................... 66.0 in.
2. Weight (total assembly) ....................... 8.2 lbs.
3. Propelled Weight ................................ 300.0 lbs.
4. Temperature Limits .............................. −65°F to +160°F
5. Max Acceleration (at 70°F) .................... 20.0 g.
6. Velocity, min (at 70°F) .......................... 60.0 fps.
7. Max. Rate of Change of Acceleration (at 70°F) 170.0 g/sec.
8. Firing method ................................... Mechanical Actuation
9. Stroke Time (at 70°F) ........................... 0.220 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

ACCELERATION - G

TIME (MS)

2-2
CATAPULT, AIRCRAFT EJECTION SEAT, TRAINING, M2

DATA

1. Stroke ........................................ 60.0 in.
2. Weight (total assembly) .................... 13.0 lbs.
3. Propelled Weight .............................. 300.0 lbs.
4. Temperature Limits ........................... -65°F to +160°F
5. Max Acceleration (at 70°F) ............... 12.0 g.
6. Velocity, min (at 70°F) .................... 38 fps.
7. Max Rate of Change of Accel (at 70°F) ... 150 g/sec.
8. Firing Method ................................ Mechanical Actuation
9. Stroke Time (at 70°F) ...................... 0.210 s ± 2%

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

ACCELERATION - G

TIME (MS)
CATAPULT, AIRCRAFT EJECTION SEAT, M3A1

DATA

1. Stroke ........................................... 88.0 in.
2. Weight (total assembly) ......................... 24.9 lbs.
3. Propelled Weight ................................. 350.0 lbs.
4. Temperature Limits .............................. -65°F to +160°F
5. Max Accel. (at 70°F) ............................ 20.0 g.
6. Velocity, min. (at 70°F) ....................... 77.0 fps.
7. Max Rate of Change of Accel (at 70°F) ....... 180.0 g/sec.
8. Firing Method: ..................................... Gas Actuation
9. Stroke Time (at 70°F) ........................... 0.240 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 350 LB

ACCELERATION - G

TIME (MS)
CATAPULT, AIRCRAFT EJECTION SEAT, M4A1

DATA

1. Stroke ........................................... 45.0 in.
2. Weight (total assembly) ....................... 6.7 lbs.
3. Propelled Weight .................................. 325.0 lbs.
4. Temperature Limits .............................. -65°F to +160°F
5. Max Accel (at 70°F) ............................ 12.5 g.
6. Velocity, min. (at 70°F) ....................... 38.0 fps.
7. Max rate of change of Accel (at 70°F) ....... 100.0 g/sec.
8. Firing Method ..................................... Gas Actuation
9. Stroke Time (at 70°F) ......................... 0.240 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 325 LB

ACCELERATION - G

TIME (MS)
CATAPULT, AIRCRAFT EJECTION SEAT, M5A1

DATA

1. Stroke ........................................ 66.0 in.
2. Weight (total Assy) .......................... 8.2 lbs.
3. Propelled Weight ............................. 300.0 lbs.
4. Temperature limits .......................... $-65^\circ F$ to $+160^\circ F$
5. Max Accel (at 70$^\circ F$) ................. 20.0 g.
6. Velocity, min (at 70$^\circ F$) ............... 60 fps.
7. Max rate of change of accel (at 70$^\circ F$) .... 170.0 g/sec.

Firing Method ................................ Gas Actuation

Stroke Time (at 70$^\circ F$) ................. 0.220 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB
CATAPULT, AIRCRAFT EJECTION SEAT, TRAINING, M6A1

DATA

1. Stroke ............................................. 21.0 in.
2. Weight (total Assembly) .................. 31.5 lbs.
3. Propelled weight ......................... 300.0 lbs.
4. Temperature Limits ..................... 40°F to 125°F
5. Max accel (at 70°F) .................. 8.5 g.
6. Firing Method ................................. Mechanical Actuation
7. Stroke Time (at 70°F) .......... 0.163 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

ACCELERATION - G

125°F
70°F
60°F

TIME (MS)

0 20 40 60 80 100 120 140 160
CATAPULT, AIRCRAFT EJECTION SEAT, M8

DATA

1. Weight (total assembly) ........................................ 27.0 lbs.
2. Propelled Weight .................................................. 350.0 lbs.
3. Temperature Limits ............................................... -65° to +160° F

CATAPULT (BOOSTER SECTION)

1. Stroke ............................................................. 40 in.
2. Max Acceleration (at 70°F) ..................................... 20.0 g.
3. Velocity, minimum (at 70°F) .................................. 40.0 fps.
4. Max Rate of Change of Acceleration (at 70°F) ............. 300.0 g/sec.
5. Stroke Time (at 70°F) ........................................... 0.175 sec.
6. Firing Method .................................................... Gas Actuation

ROCKET (SUSTAINER SECTION)

1. Action Time, max (at 70°F) .................................... 0.400 sec.
2. Impulse (resultant at 70°F) ................................... 1200 lb-sec.
3. Pressure, max .................................................... 4600 psi.
4. Ignition Delay, max (at 70°F) ................................. 0.012 sec.
5. Nozzle Angle ........................................................ 37° 30'
CATAPULT, AIRCRAFT EJECTION SEAT, M9

DATA
1. Weight (total Assembly) ........................................... 24.0 lbs.
2. Propelled Weight .................................................. 350 lbs.
3. Temperature Limits .............................................. -65°F to +160°F

CATAPULT (BOOSTER SECTION)
2. Max. Accel. (at 70°F) ................................................ 20.0 g.
3. Velocity, minimum (at 70°F) ...................................... 40.0 fps.
4. Max. Rate of Change of Accel. (at 70°F) .................. 300 g/sec.
5. Stroke Time (at 70°F) ............................................... 0.160 sec.
6. Firing Method .......................................................... Gas Actuation

ROCKET (SUSTAINER SECTION)
1. Action Time, max. (at 70°F) ...................................... 0.350 sec.
2. Impulse (resultant at 70°F) ...................................... 1100 lb-sec.
3. Pressure, max. ......................................................... 4600 psi.
4. Ignition Delay, max. (at 70°F) ................................. 0.012 sec.
5. Nozzle Angle ............................................................. 47°30'

TYPICAL PERFORMANCE

NOZZLE ANGLE 47° 30'
PROPELLED WEIGHT = 350 LB
**CATAPULT, AIRCRAFT EJECTION SEAT, M10**

![Diagram of a catapult with dimensions and data points]

**DATA**

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<th>Number</th>
<th>Description</th>
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<td>1</td>
<td>Weight (Total Assy)</td>
<td>26.0 lbs.</td>
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<td>Propelled Weight</td>
<td>400.0 lbs.</td>
</tr>
<tr>
<td>3</td>
<td>Temperature Limits</td>
<td>-65°F to +160°F</td>
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**CATAPULT (BOOSTER SECTION)**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Value</th>
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<tr>
<td>1</td>
<td>Stroke</td>
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<td>Max. Acceleration (at 70°F)</td>
<td>20.0 g.</td>
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<td>Velocity, minimum (at 70°F)</td>
<td>40.0 fps.</td>
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<td>4</td>
<td>Max. Rate of Change of Acceleration (at 70°F)</td>
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</tr>
<tr>
<td>5</td>
<td>Stroke time (at 70°F)</td>
<td>0.155 sec.</td>
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<td>6</td>
<td>Firing Method</td>
<td>Gas Actuation</td>
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**ROCKET (SUSTAINER SECTION)**

<table>
<thead>
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<th>Description</th>
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<tr>
<td>1</td>
<td>Action Time, max. (at 70°F)</td>
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</tr>
<tr>
<td>2</td>
<td>Impulse (resultant, at 70°F)</td>
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<td>3</td>
<td>Pressure, max.</td>
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<td>4</td>
<td>Ignition Delay, max. (at 70°F)</td>
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</tr>
<tr>
<td>5</td>
<td>Nozzle Angle</td>
<td>36° 20'</td>
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</tbody>
</table>

**TYPICAL PERFORMANCE**

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<th>Acceleration</th>
<th>Time (MS)</th>
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<tr>
<td>10</td>
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<td>20</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
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*NOZZLE ANGLE 36° 20' STANDARD PROPELLED WEIGHT 400 LB*
CATAPULT, AIRCRAFT EJECTION SEAT
For Use As Specified In Table Below

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>STROKE (in.)</th>
<th>NOZZLE ANGLE</th>
<th>PROPELLED MASS (lb.)</th>
<th>VEL. (MIN) AT SEPARATION (ft/sec.)</th>
<th>IMPULSE TOTAL lb. sec</th>
<th>ACCEL. (MAX G) AT 70°F (lbs.)</th>
<th>ASSEM. WEIGHT lbs.</th>
</tr>
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<tbody>
<tr>
<td>XM12</td>
<td>40</td>
<td>45.0</td>
<td>350</td>
<td>42.</td>
<td>1800</td>
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<tr>
<td>XM13</td>
<td>36</td>
<td>36° 20°</td>
<td>220</td>
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<td>1400</td>
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<td>1800</td>
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<tr>
<td>XM22</td>
<td>33-1/2</td>
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<td>XM23</td>
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<td>350</td>
<td>40.</td>
<td>1620</td>
<td>12</td>
<td>23</td>
</tr>
</tbody>
</table>

OTHER DATA

1. Operating Temperature Limits: -65°F to +165°F.
2. Firing Method: Gas* (Equivalent (1000 psi-advisory) to that delivered by an M3 type initiator).

The catapult is a propellant actuated device developed for emergency ejection of seat-man combination from high speed aircraft. The rocket component provides the additional thrust required to achieve safe "off-the-deck" escape capability.
CATAPULT, AIRCRAFT EJECTION SEAT (Cont'd)
XM 12, XM 13, XM 18, M 19, XM 20, XM 21, XM 22, and XM 23

DIMENSIONAL DATA

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>A (in.)</th>
<th>B (in.)</th>
<th>C (in.)</th>
<th>D (in.)</th>
<th>E (in.)</th>
<th>F (in.)</th>
<th>G (in.)</th>
<th>H (in.)</th>
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<tr>
<td>XM12</td>
<td>50-1/8</td>
<td>3-1/8</td>
<td>3-3/16</td>
<td>2-7/8</td>
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<td>2.4</td>
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<td>M19</td>
<td>45-7/8</td>
<td>3-1/8</td>
<td>3-3/16</td>
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<td>9/16, 5/8</td>
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<td>XM22</td>
<td>39.</td>
<td>3.</td>
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<td>2-7/8</td>
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<td>XM23</td>
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<td>3.</td>
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<td>2-7/8</td>
<td>4-13/16</td>
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<td>9/16, 5/8</td>
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</tr>
</tbody>
</table>
CATAPULT, AIRCRAFT EJECTION SEAT
For Use As Shown In Table Below

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>STROKE (in.)</th>
<th>NOZZLE ANGLE</th>
<th>PROPELLED MASS (lb.)</th>
<th>VEL. (MIN) AT SEPARATION (ft/sec.)</th>
<th>IMPULSE TOTAL lb. sec.</th>
<th>ACCEL. MAX. G AT 70° F.</th>
<th>ASSEM. WEIGHT lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>XM26</td>
<td>34.0</td>
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<td>410</td>
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<td>2200.</td>
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<td>30.</td>
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DIMENSIONAL DATA

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>A (in.)</th>
<th>B (in.)</th>
<th>C (in.)</th>
<th>D (in.)</th>
<th>E (in.)</th>
<th>F (in.)</th>
<th>G (in.)</th>
<th>H (in.)</th>
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</table>
CATAPULT, AIRCRAFT EJECTION SEAT (Cont'd)
XM25, XM26, and XM30

TYPICAL PERFORMANCE

THrust along unit Centerline 4800 lb MAX (TYPICAL)
ACCELERATION 10.4g (TYPICAL)
CATAPULT PRESSURE 6480 PSI MAX (TYPICAL)
ROCKET PRESSURE 3500 PSI (TYPICAL)

CATAPULT IGNITION  ROCKET IGNITION

ACTION (TIME)

OTHER DATA

1. Operating temperatute limits ........ -65 °F to +160 °F
2. Firing method ....................... Gas*
3. This type item can be supplied with parts to provide a nozzle angle adjustable from 0° to 50°.
4. Left-hand dimension "C" = 3-1/4. Right-hand dimension "C" is same as dimension "D".
* Equivalent (1000 psi - advisory) to that delivered by an M3 type initiator.

The catapult is a propellant actuated device developed for emergency ejection of seat-man combination from high speed aircraft. The rocket component provides the additional thrust required to achieve safe "off-the-deck" escape capability.
This catapult is a gun-launched rocket seat ejection device used to eject a seat-man combination from high speed aircraft.
CATAPULT, AIRCRAFT EJECTION SEAT, XM-36

DATA

1. Weight of Assembly .................. 20 lb.
2. Function Time ...................... 450 ms.
4. Thrust (maximum) .................... 5000 lb.
5. Velocity (max. at separation) ...... 50 ft./sec.
6. Operating Temperature Limits ...... \(-65^\circ F \) to \(+200^\circ F\)
7. Ejected Weight ...................... 383 lb.
8. Nozzle angle ......................... As determined

This catapult is a cartridge actuated device designed for emergency ejection of a seat-man combination from high speed aircraft.
CATAPULT AIRCRAFT, EJECTION SEAT, XM-38

DATA

1. Weight of Assembly .................. 35 lb. (Estimated)
2. Stroke ............................. 34 in. (Booster only)
3. Impulse .............................. 1100 lb.-sec. (Rocket only)
4. Nozzle Angle Adjustment Range ...... 38° 50' to 52° 0'
5. Velocity (max. at separation) ...... 48 ft./sec.
6. Operating Temperature Limits ...... -65°F. to +165°F.
7. Ejected Weight ...................... 383 lb. (50 Percentile man)

This catapult is a cartridge actuated device designed for emergency ejection of a seat-man combination from the F-5/T-38 Aircraft.
XM-39 ROCKET CATAPULT

DATA

1. Weight of Assembly ........................................ 19.5 lbs.
2. Stroke ....................................................... 34 in. (Booster only)
3. Impulse ..................................................... 1140 lb.-sec. (Rocket only)
4. Nozzle Angle ............................................. 60° (other positions as req’d)
5. Velocity (max. at separation) .......................... 52 ft./sec.
6. Operating Temp. Limits ................................ -65°F to +200°F
7. Ejected Weight ........................................... 363 lb. (50 percentile man)

TYPICAL PERFORMANCE

This catapult is designed for use in the advanced concept ejection seat (ACES) and is initiated by dual electric apollo standard initiators. It is also easily adaptable for gas initiation.
THRUSTERS

The thruster is a propellant actuated device principally developed to serve as a source of energy to move a weight or overcome a resistive force such as position the seat in an aircraft or unlock a canopy prior to ejection of the crewman. Thrusters are designed as a closed ballistic system so that the piston does not separate under the range of operating conditions including "lock-shut" and "no-load" firings.

Some thrusters have provisions to bypass the gas to initiate another PAD unit during or after power stroke of the piston. In yet another type of thruster the unit is oil damped for controlled thrust, velocity, acceleration, or rate of change of acceleration.
THRUSTER, M1A2

DATA
1. Average Peak Thrust ...................... 6000 lbs.
2. Completed Stroke ......................... 2 in. (min.)
3. Average Stroke Time ..................... 0.009 sec.
4. Assembled Weight ....................... 3.2 lbs.
5. Propelled Weight, Horizontal .......... 20 lbs.
6. Firing Method ............................... Propellant Gas
7. Temperature Limits ................. -65°F to +200°F
8. Restraining Force ....................... 1000 lbs. @ .00 in. stroke; 6000 lbs. @ .25 in. stroke

TYPICAL PERFORMANCE

20 POUND WEIGHT PROPELLED HORIZONTALLY
4 SHEAR PINS
DATA

1. Average Peak Thrust w/Seat in Horizontal Position @ 70°F ......... 6170 lbs.
2. Completed Stroke .............. 5.7 in.
3. Velocity, Maximum ............. 12 ft/sec.
4. Assembled Weight ............. 4.0 lbs.
5. Propelled Weight, Horizontal .......... 300 lbs.
6. Firing Method .............. Propellant Gas
7. Temperature Limits ............. -65°F to +200°F
8. Average Stroke Time w/Seat in Horizontal Position @ 70°F ............. .410 sec.

TYPICAL PERFORMANCE

300 POUND WEIGHT HORIZONTAL COMPRESSION DAMPER ORIFICE, 12" DIAM
DATA
1. Average Peak Thrust Under Normal Load @ 70°F ........................................ 1660 lbs.
2. Completed Stroke ................................................................. 1-1/2 in., min.
3. Assembled Weight .......................................................... 1.0 lbs.
4. Propelled Weight, Vertical ........................................... 550 lbs.
5. Firing bore ............................................................... Propellant Gas
6. Temperature Limits .............................................................. -69°F to 200°F
7. By-Pass Pressure @ 70°F Under Normal Load at the End of 4 Ft. Length of #4 Hose ........ 600 psi, min.
8. Average Stroke Time ...................................................... .090 sec.

TYPICAL PERFORMANCE

550 POUND WEIGHT PROPELLED VERTICALLY UPWARD

END OF STROKE

DISCHARGE THROUGH GAS PORT

THRU5T (LBS)

0 500 1000 1500 2000

TIME (MS)

0 10 20 30 40 50 60 70 80 90 100 110 120

160° F
70° F
-65° F
THRUSTER, M5A2

DATA

1. Average Peak Thrust Under Normal Load @ 70°F ... 6670 lbs.
2. Completed Stroke ........................................... 5.0 in.
3. Average Stroke Time Under Normal Load @ 70°F ... .075 sec.
4. Assembled Weight ........................................... 3.6 lbs.
5. Propelled Weight, Horizontal ................................ 500 lbs.
6. Firing Method ................................................. Propellant Gas
7. Temperature Limits ......................................... -65°F to +200°F
8. Restraining Forces ......................................... 4000 lbs. @ .0 inches of stroke
       ................................................. 1000 lbs. @ .5 inches of stroke

TYPICAL PERFORMANCE

510 POUND WEIGHT PROPELLED HORIZONTALLY
2 SHEAR PINS

THrust (LBS x 1000)

0 10 20 30 40 50 60 70 80 90

TIME (MS)

160°F 70°F -65°F

END OF STROKE

-160°F -70°F -65°F
DATA

1. Average Peak Thrust Under Load @ 70°F ........ 1100 lbs.
2. Completed Stroke ........................................ 1.5 in.
3. Assembled Weight ........................................ 1.0 lbs.
4. Propelled Weight, Horizontal ......................... 60 lbs.
5. Firing Method ............................................. Propellant Gas
6. Temperature Limits ....................................... -65°F to +200°F
7. Restraining Force ....................................... 400 lbs.

TYPICAL PERFORMANCE

![Graph showing typical performance with axes for thrust (lbs) and time (ms)]
DATA

1. Average Peak Thrust Under Normal Load @ 70°F .......................... 1600 lbs.
2. Complete Stroke ........................................ 2.5 in.
3. Average Stroke Time ..................................... .070 sec.
4. Assembled Weight ........................................ 1.08 lbs.
5. Propelled Weight, Horizontal ......................... 11.6 lbs.
6. Firing Method ............................................ Propellant Gas
7. Temperature Limits ...................................... -65°F to +200°F
8. Restraining Force ....................................... 500 lbs.

TYPICAL PERFORMANCE

THRUSS (LBS)

<table>
<thead>
<tr>
<th>TIME (MS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

70°F
THRUSTER, M9

DATA
1. Average Peak Thrust Under Load @ 70°F ................. 2600 lbs.
2. Completed Stroke .................................. 3.6 in. (min.)
3. Operating Time .................................... .080 sec.
4. Assembled Weight .................................. 1.0 lb.
5. Propelled Weight, Horizontal ...................... 50 lbs.
6. Firing Method ....................................... Propellant Gas
7. Temperature Limits .................................. -65°F to 200°F
8. Restraining Force ................................... 500 lbs.
9. By-Pass Pressure Under Normal Load at the End of 42 Inch Length of #4 Hose .... 1000 psi (min.)

TYPICAL PERFORMANCE

LOAD PROPELLED HORIZONTALLY
50-POUND WEIGHT
500-POUND RESISTIVE FORCE

THRUST (LBS x 1000)

TIME (MS)

3.8
DATA

1. Average Peak Thrust Under Normal Load
   @ 70°F ........................................ 2272 lbs.
2. Completed Stroke ................................ 5.75 in.
3. Assembled Weight ................................ .95 lbs.
4. Propelled Weight, Radially ....................... 45 lbs.
5. Firing Method .................................. Propellant Gas
6. Temperature Limits .............................. -65°F to +200°F
7. Average velocity of propelled mass .......... 5 rad/sec.

TYPICAL PERFORMANCE

<table>
<thead>
<tr>
<th>TIME (MS)</th>
<th>THRUST (LBS)</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
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<tr>
<td>4</td>
<td>1000</td>
</tr>
<tr>
<td>6</td>
<td>1500</td>
</tr>
<tr>
<td>8</td>
<td>2000-2500</td>
</tr>
<tr>
<td>10</td>
<td>1500</td>
</tr>
<tr>
<td>12</td>
<td>1000</td>
</tr>
<tr>
<td>14</td>
<td>500</td>
</tr>
</tbody>
</table>

3.9
THRUSTER, M13

DATA

1. Thrust Under Load @ 70°F ........................................ 2700 lbs.
2. Completed Stroke .................................................. 2.86 in., max.
3. Assembled Weight .................................................. 1.07 lbs.
4. Propelled Weight, Vertical ....................................... 70 lbs.
5. Firing Method ...................................................... Propellant Gas
6. Temperature Limits ................................................ -65°F to +200°F
7. By-Pass Pressure Under Load @ 6 Foot of #4 Hose .............. 1000 lbs., min.
8. Restraining Force ................................................... 2000 lbs. @ "0" inches of stroke

TYPICAL PERFORMANCE

THrust (LBS × 1000)

TIME (MS)
THRUSTER, CARTRIDGE ACTUATED, XM-14

DATA

1. Firing Cycle .......................... 25 rounds minimum, without maintenance.
2. Stroke .................................. 11 in. (max.)
3. Projectile Chambering Velocity ....... 10 to 20 fps.
4. Piston return .......................... Manually repositioned
5. Recharging Rate ....................... 3 to 4 rounds per minute.
6. Operating Temperature ............... $-65^\circ F$ to $+200^\circ F$
7. Life Expectancy ........................ 500 to 1000 cycles (design)

The XM-14 Thruster provides the ramming force necessary to drive a 95 pound projectile a distance of 61 inches into the breech of the 155 mm. Howitzer used in the T-196 Tank.

3-11
## THRUSTER, M15

![Diagram of THRUSTER, M15](image)

### DATA

1. Approximate Thrust: 6700 lbs.
3. Assembled Weight: 5.0 lbs.
4. Firing Method: Propellant Gas
5. Temperature Limits: -65°F to +200°F
7. Operating Time @ -65°F: 500 ms
8. Oil Damped

### TYPICAL PERFORMANCE

![Graph of TYPICAL PERFORMANCE](image)
THRUSTER, M16

DATA
1. Approximate Peak Thrust ........... 200 lbs.
2. Completed Stroke .................. 3.137 max.
3. Assembled Weight .................. 1.6 lbs.
4. Firing Method ...................... Propellant Gas
5. Temperature Limits .............. -65°F to +200°F
7. Oil Damped

TYPICAL PERFORMANCE

![Graph showing oil and gas pressure over time](image)

- OIL PRESSURE
- GAS PRESSURE

TIME (MS)
THRUSTER, M17

DATA

1. Average Peak Thrust Under Load
   @ 165°F .................................. 1600 lbs.
4. Assembled Weight .......................... 13.0 lbs.
5. Firing Method ............................ Propellant Gas
6. Temperature Limits ...................... -65°F to +200°F
7. Propelled Weight, Horizontal .......... 350 lbs.
9. Oil Damped

TYPICAL PERFORMANCE

PROPELLED WEIGHT 350 LB
RESISTIVE FORCE 525 LB

TIME (MS)
THRUSTER, M-18

**DATA**

1. Average Thrust Under Load @ +165°F ........ 1600 lbs.
2. Completed Stroke ................................ 9-1/2 in.
4. Assembled Weight ................................ 12 lbs.
5. Firing Method ................................... Propellant Gas
6. Temperature Limits .............................. -65°F to +200°F
7. Propelled Weight ................................ 350 lbs.
8. Retaining Force ................................. 525 lbs.
9. Oil Damped. ..........................
THRUSTER, M19

DATA
1. Peak Thrust Under Load @ 70°F. .......... 1470 lbs.
2. Completed Stroke .................... 2.86 in.
3. Assembled Weight .................... 1.07 lbs.
4. Propelled Weight ..................... 75 lbs.
5. Firing Method ......................... Propellant Gas
6. Temperature Limits ................... -65°F to +200°F
7. By-Pass Pressure Under Load @ 15 Feet
   6 Inch Length of #4 Hose ............... 1000 psi (min.)
8. Restraining Force ...................... 25 lbs. @ "0" inch stroke,
    500 lbs. @ "2.4" inch stroke

TYPICAL PERFORMANCE

TEMPERATURE 70°F

THRUST (LBS)

TIME (MS)

3-16
THRUSTER, M20A1

DATA

1. Average Peak Thrust Under Normal Load
   @ 70°F. .................................. 5877 lbs.
2. Completed Stroke ........................ 5.0 in.
3. Average Stroke Time ................... .046 sec.
4. Assembled Weight ...................... 3.6 lbs.
5. Propelled Weight, Horizontal ....... 50 lbs.
6. Firing Method .......................... Propellant Gas
7. Temperature Limits ................... -65°F to +200°F
8. Restraining Force ..................... 3000 lbs.

TYPICAL PERFORMANCE

THrust (lbs x 1000)

TIME (MS)
THRUSTER, CARTRIDGE ACTUATED, XM-26

DATA

1. Average Peak Thrust Under Normal Load @ 70°F - 4400 lbs.
2. Completed Stroke - 4.95 in.
3. Assembled Weight - 1.0 lb.
5. Firing Method - Gas
6. Operating Temperature Limits - -65°F thru +200°F.

TYPICAL PERFORMANCE

This thruster is a cartridge actuated device used, in pairs, to remove the F104 aircraft canopy.

3-18
REMOVERS

The remover is a propellant actuated device developed primarily to jettison the canopies from aircraft prior to emergency personnel ejection.
REMOVER, AIRCRAFT CANOPY, M1A3

DATA

1. Stroke ............................................. 23.3 in.
2. Weight (total assy) ............................... 2.1 lbs.
3. Propelled Weight .................................. 300 lbs.
4. Temperature Limits ............................... -65°F to +200°F
5. Velocity, min. (at 70°F) ......................... 20.0 fps.
6. Thrust, min (at 70°F) ............................. 2800 lbs.
7. Stroke Time (at 70°F) .................. 0.135 sec.
8. Firing Method ........................................
   Gas Actuation of the M1A1 Firing Pin Release, which releases M1A3 Remover Firing Pin

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

THRU-LBS

TIME (MS)
DATA

1. Stroke ........................................... 26.0 in.
2. Weight ........................................... 4.4 lbs.
3. Propelled Weight .............................. 300 lbs.
4. Temperature Limits ........................... -65°F to 200°F
5. Velocity, min. (at 70°F) ....................... 20.5 fps.
6. Thrust, min. (at 70°F) ......................... 2600 lbs.
7. Stroke Time (at 70°F) .......................... 0.150 sec.
8. Firing Method .................................. Mechanical

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

![Graph showing typical performance]

TIME (MS)

THRUST - LBS

0 20 40 60 80 100 120 140 160

2000 3000 4000
REMOVER, AIRCRAFT CANOPY, M3A1

DATA

1. Stroke ........................................ 26.0 in.
2. Weight (total assy) ......................... 4.4 lbs.
3. Propelled Weight ......................... 300 lbs.
4. Temperature Limits .................. -65°F to +200°F
5. Velocity, min (at 70°F) ........ 20.5 fps.
6. Thrust, min (at 70°F) ........ 2600 lbs.
7. Stroke Time (at 70°F) ........ 0.150 sec.
8. Firing Method .................. Gas

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB
DATA

1. Stroke ........................................ 19.0 in.
2. Weight (total assy.) ......................... 3.84 lbs.
3. Propelled Weight ......................... 300 lbs.
4. Temperature Limits ....................... -65°F to +200°F
5. Velocity, min (at 70°F) ................. 20 fps.
6. Thrust, min (at 70°F) ................ 2800 lbs.
7. Stroke Time (at 70°F) ........ 0.114 sec.
8. Firing Method .................. Gas

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB

THRUST - LBS

TIME (MS)
DATA

1. Stroke .......................................................... 19.0 in.
2. Weight (total assy) ........................................... 3.84 lbs.
3. Propelled Weight ............................................. 1000 lbs.
4. Temperature Limits .......................................... -65°F to +200°F
5. Velocity, min (at 70°F) .......................................... 10 fps.
6. Thrust, min (at 70°F) ........................................... 4500 lbs.
7. Firing Method ................................................ Gas
REMOVER, AIRCRAFT CANOPY, M8

DATA
1. Weight (Total Assy) ....................................... 22.5 lbs.
2. Temperature Limits ....................................... -65°F to +200°F

ELECTRO-MECHANICAL
1. Electric Power ............................................. 28 Volt D.C. System
2. Operating Voltage Limit ................................. 18 to 29 Volts
3. Operating Loads
   Overload ..................................................... 250 lbs. (tension) to
   Normal Load .............................................. 680 lbs. (compression)
   Overload ..................................................... 380 lbs. (compression)
   Overload ..................................................... 430 lbs (tension) to
   Normal Load .............................................. 940 lbs. (tension)
4. Extension or Retraction Time ............................ 15 sec. max; 5 sec. min.
5. Clutch Engage Time, max .................................. 0.500 sec.
6. Clutch Disengage Time, max .............................. 0.500 sec.
7. Cinch-Down Load ......................................... 1000 to 1450 lbs.
8. Stroke ....................................................... 8.38 to 9.38 in.

The M8 Remover combines a unique electro-mechanical means for a normal canopy operation with a ballistic charge for emergency jettisoning.
REMOVER, AIRCRAFT CANOPY, M8 (Cont'd)

BALLISTIC

1. Stroke ........................................ 12.0 in.
2. Propelled Weight ............................ 350 lbs.
3. Velocity min. (at 70°F) .................... 24.0 fps.
4. Peak Thrust (at 70°F) ...................... 5400 lbs.
5. Firing Method ................................. Gas
6. Stroke Time (at 70°F) ...................... 0.150 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 350 LB.
The M9 Remover combines a unique electro-mechanical means for a normal canopy operation with a ballistic charge for emergency jettisoning.
REMOVER, AIRCRAFT CANOPY, M9 (Cont’d)

BALLISTIC

1. Stroke ...................................................... 27.0 in.
2. Propelled Weight ................................. 300 lbs.
3. Velocity, minimum (at 70°F) ................. 33.0 fps.
4. Peak Thrust (at 70°F) ......................... 6000 lbs.
5. Firing Method ........................................... Gas
6. Stroke Time (at 70°F) ........................... 0.090 sec.

TYPICAL PERFORMANCE

PROPELLED WEIGHT 300 LB
CUTTER

The cutter is a propellant actuated device principally developed to cut or sever either a bundle of electrical coaxial cables, electrical wires, nylon reefing line, wire rope, rod, pipe and similar items. Cutters are classified in accordance with the following characteristics: (1) Method of Actuation - mechanical or gas pressure, and (2) Function Time - nondelay or delay.
CUTTER
(For Use As Specified In Table Below)

![Diagram of Cutter]

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>IGNITION ELEMENT UTILIZED</th>
<th>ASSEMBLED WEIGHT (oz.)</th>
<th>CABLE DIA. (in.)</th>
<th>LENGTH L (in.)</th>
<th>DIA. D (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XM6</td>
<td>M55</td>
<td>1.12</td>
<td>3/16</td>
<td>2-5/16</td>
<td>11/16</td>
</tr>
<tr>
<td>XM20</td>
<td>M21</td>
<td>1.12</td>
<td>3/16</td>
<td>2-5/16</td>
<td>11/16</td>
</tr>
</tbody>
</table>

DATA

1. Operating Temperature Limits ............ -65°F. to +200°F.
2. Firing Method ............ Electric Ignition Element

These cutters are electrically initiated devices designed to cut wire rope, rod, pipe and similar items. They are also suitable for use under water.
CUTTER
(For Use As Specified In Table Below)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>ASSEMBLED WEIGHT (oz.)</th>
<th>CABLE DIA. (in.)</th>
<th>LENGTH L (in.)</th>
<th>DIA. D (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XM7</td>
<td>1.12</td>
<td>3/16</td>
<td>2-5/16</td>
<td>11/16</td>
</tr>
</tbody>
</table>

DATA

1. Operating Temperature Limits ............. -65°F. to +200°F.
2. Firing Method ............................ Gas*

*Equivalent (3500 psi-advisory) to that delivered by an M27 type initiator.

These cutters are actuated by gas from another cartridge actuated device and designed to cut wire rope, rod, pipe and similar items. They are also suitable for use under water.
CUTTER, M8

DATA

1. Stroke .............................................. 1.25 inches
2. Assembled Weight .................................. 75 lbs.
3. Blades average depth of penetration into anvil when fired at 70°F ........... 0.004 inches
4. Firing Method ...................................... Gas
5. Temperature Limits ................................... -65°F to +200°F
6. Material Severed:
   Cable Assembly ..................................... .060 inch thick vinyl sheath around 9 RG-62 A/U Coax Cables (MIL-C-17/30)
   Wire Bundle ........................................ .060 inch thick vinyl sheath around 27 strands #22 wire (MIL-W-8777)
                                                   6 strands #18 wire (MIL-W-8777)
                                                   8 strands #20 wire (MIL-W-12349)

The M8 Cutter is a cartridge actuated device designed to sever either a bundle of electrical coaxial cables or electrical wires. The blade of the cutter is coated to prevent shorting as the blade passes through the cables or wires. The M8 Cutter is installed on the F-106B aircraft and the part number is 10520566.
CUTTER, REEFING LINE
(For Use As Specified In Table Below)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>CARTRIDGE, DELAY</th>
<th>FUNCTION, TIME</th>
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</thead>
<tbody>
<tr>
<td>XM-14</td>
<td>XM-134</td>
<td>1 sec.</td>
</tr>
<tr>
<td>XM-15</td>
<td>XM-135</td>
<td>2 sec.</td>
</tr>
<tr>
<td>XM-16</td>
<td>XM-136</td>
<td>4 sec.</td>
</tr>
<tr>
<td>XM-17</td>
<td>XM-137</td>
<td>6 sec.</td>
</tr>
<tr>
<td>XM-18</td>
<td>XM-138</td>
<td>8 sec.</td>
</tr>
<tr>
<td>XM-19</td>
<td>XM-139</td>
<td>10 sec.</td>
</tr>
</tbody>
</table>

DATA

1. Weight of Assembly .............. 0.9 lb.
2. Operating Temperature Limits ....... -90°F to 200°F

These cutters are designed to sever 2 strands of 6000 lb. test nylon reefing line.
CUTTER, CARTRIDGE ACTUATED, FOR USE WITH CARTRIDGE, DELAY, AS SPECIFIED IN TABLE BELOW

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>CARTRIDGE, DELAY</th>
<th>FUNCTION, TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>XM-26</td>
<td>XM-234</td>
<td>2 SEC</td>
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<tr>
<td>XM-27</td>
<td>XM-235</td>
<td>4 SEC</td>
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<td>XM-28</td>
<td>XM-236</td>
<td>6 SEC</td>
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<tr>
<td>XM-29</td>
<td>XM-237</td>
<td>8 SEC</td>
</tr>
<tr>
<td>XM-30</td>
<td>XM-238</td>
<td>10 SEC</td>
</tr>
</tbody>
</table>

DATA

1. Weight of Assembly ................... 0.1 lb.
2. Operating Temperature Limits .......... -90° F. to +200° F.

These cutters are designed to sever 2 strands of 1000 lb. test nylon reefing line.
CUTTERS, CABLE/REEFING LINE WITH CARTRIDGE, DELAY

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>CARTRIDGE, DELAY</th>
<th>FUNCTION TIME</th>
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</thead>
<tbody>
<tr>
<td>M9</td>
<td>XM129</td>
<td>2 SEC</td>
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<tr>
<td>XM10</td>
<td>XM130</td>
<td>4 SEC</td>
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<tr>
<td>XM11</td>
<td>XM131</td>
<td>6 SEC</td>
</tr>
<tr>
<td>XM12</td>
<td>XM132</td>
<td>8 SEC</td>
</tr>
<tr>
<td>M13</td>
<td>XM133</td>
<td>10 SEC</td>
</tr>
</tbody>
</table>

DATA

1. Assembly Weight ............................................ 4.0 Ounces
2. Temperature Limits. ........................................... -95°F to +250°F
3. Firing Method ............................................. Mechanical
4. Shock ......................................................... 750 g
5. Acceleration ................................................ 400 g
6. Material Severed ........................................... Two 1/2-inch 1000 lb tubular nylon lines

The M9 Cutter is a component part of an aerial delivery system for cargo and drone recovery. Its purpose is to sever cords or wires. It consists of an XM129 Delay Cartridge which is fired mechanically by applying a force to a cable or lanyard.
CUTTER, REEFING LINE, XM24

DATA

1. Assembly Weight ................................ 2.5 oz.
2. Operating Temperature Limits .......... -65°F to 200°F
3. Firing Method ................................. Mechanical
4. Time Delay .................................. 2 seconds
5. Material Severed ......................... One 1000 lb. nylon line

This unit was developed for use in initiating timely disreefing of the main recovery chute used with the B58 capsule escape systems.
The M22 Cutter is a component part of an aerial delivery system for cargo and drone recovery. The purpose is to sever cords or wires, and it consists of a delay cartridge which is fired mechanically by applying a force to a lanyard.
The M21 Cutter is a component part of an aerial delivery system for cargo and drone recovery. The purpose is to sever cords or wires and it consists of a delay cartridge which is fired mechanically by applying a force to a lanyard.
MILD DETONATING CORD SYSTEM

There are four basic methods that could be used to transfer the primary initiation stimulus to each PAD associated with any given system. They are mechanical, gas, electric and explosive. Usually a combination of two or more of the methods are used in a system. This is a description of a mechanically initiated explosive system.

The explosive system utilizes Mild Detonating Cord (MDC) completely confined. The MDC consists of one grain of PETN per linear foot contained on a 0.040 inch diameter flexible lead tubing. The tubing is covered with layers of fabric and plastic material sufficient to dampen and completely contain the resulting products of detonation of the explosive. In addition to resisting rupture, the cord has the advantages of being highly flexible, can readily be coiled in a 1-1/2 inch radius, is resistant to abrasion, and is light weight (0.03 pound per foot). The MDC has an outside diameter of approximately 0.25 inch and a detonating velocity of approximately 23,000 feet per second.

Since MDC is unique, both as to its construction and its physical properties, it does not lend itself to standard assembly methods. The system assembly problem was solved by designing special hardware around the core and covering for the specific purpose of retrofitting existing electrical or gas systems or for new systems.

MDC systems in various types of confining structures are being widely used in such applications as initiating explosive bolts or nuts to release points of attachments, initiating flexible linear shape charge systems for severing attachment structures such as aircraft fuselages, port covers, cutting motor cases, as well as for functioning the various PAD in Aircraft Crew Emergency Escape Systems.

Special MDC hardware has been designed and tested consisting of initiators, time delays, check valves, quick disconnects, and crossover stimulus transfer fittings. Data sheets on these components are included in this section. A simulated prototype system embodying those functions normally expected in an aircraft escape system is illustrated in Figure 1.

The sequence of operation is started by actuating the ejection initiators. One initiator actuates the canopy remover and simultaneously activates the thermal batteries that supply electrical energy to operate the stabilization fins of the capsule. The other two ejection initiators actuate two gas producing initiators generating sufficient gas pressure to fire the delay cartridge which functions the ejection catapult. The canopy may be removed in an emergency by operating the initiator located near the exterior of the aircraft with a lanyard handle located in an access panel outside the aircraft. A check valve prevents the actuation of the thermal batteries. The quick disconnects separate the MDF lines so that the capsule is free of exterior restraints.

The systems are operable over the temperature range of -65° F. to +200° F.
MILD DETONATING CORD

A data sheet of each MDC is presented and a typical MDC actuated ejection system is also illustrated.
MDC ACTUATED EJECTION SYSTEM
This initiator is a device designed to contain a delay element which interrupts the detonating stimulus for a specified time and then initiates the continuation of the stimulus to any desired component. It will function regardless of which end receives the initial stimulus.
This initiator is a device actuated by a pull of from 2 to 35 pounds force. When actuated the output of the initiator is a shock wave of sufficient brisance to detonate the acceptor charge of MDC, thus initiating the transmission of the detonating stimulus.
This Initiator is actuated by a minimum of 500 p.s.i. of gas pressure. When actuated the output of the initiator is a shock wave of sufficient brisance to detonate the acceptor charge of MDC, thus initiating the transmission of the detonating stimulus.
INITIATOR, CARTRIDGE ACTUATED, XM-67

DATA
1. Weight of Assembly .................. 0.068 lb.
2. Function Time ...................... 4 milliseconds
3. Output .............................. 1000 psi in 0.5 cu. in. volume
4. Operating Temperature Limits ........ -65°F. to +200°F.

TYPICAL PERFORMANCE

This initiator is actuated by the shock wave from the MDC donor charge. The output end is threaded so that it can mate with any standard gas actuated pad.
INITIATOR, CARTRIDGE ACTUATED, XM-69

DATA
1. Weight of Assembly .................. 0.070 lb.
2. Function Time ...................... 4 milliseconds
3. Operating Temperature Limits ....... -65°F. to +200°F.

TYPICAL PERFORMANCE

This initiator is actuated by the shock wave from the MDC donor charge. The output end is threaded so that it can mate with any standard gas actuated pad. The MDC enters the initiator perpendicular to the center line of the outlet of the initiator.
DATA
1. Weight of Assembly.................. 0.106 lb.
2. Operating Temperature Limits........ -65° F. to 420° F.

This initiator is a device designed to permit the transfer of a detonating stimulus in one direction only.
DATA
1. Weight of Assembly .................. 0.077 lb.
2. Function Time ........................ 50 microseconds
3. Operating Temperature Limits .......... -100° F. to 350° F.

This booster-fitting is a device designed to transfer a detonating stimulus thru a bulkhead and separate the transmitting lines at the bulkhead.
This booster-fitting is a device designed to transfer a detonating stimulus thru a bulkhead from one MDC line to another.
DATA
1. Weight of Assembly ................ 0.077 lb.
2. Operating Temperature Limits .... -100° F. to +350° F.

This booster-fitting is a device designed to transfer a detonating stimulus from one MDC line to another, situated at a right angle to the donor line.
This booster-fitting is a device designed to transfer a detonating stimulus from one MDC line to two others.
DATA

1. Weight of Assembly .................................. 0.142 lb.
2. Operating Temperature Limits ...................... -100°F to +350°F.

This booster-fitting is a device designed to transfer a detonating stimulus from one MDC line to three others.

6-14
CORD ASSEMBLY, DETONATING, XM-163

DATA
1. Weight of Assembly. .......................... 0.100 for ends plus
   0.0267 lb./ft of cord
2. Function Time ............................... in microseconds
3. Velocity ................................. Approx 21,000 ft/sec.
4. Operating Temperature Limits ............ -100°F. to +350°F.

This cord assembly is designed to receive and transfer a detonating
stimulus from one point to another.
ELECTRICAL IGNITION ELEMENTS AND PULSE GENERATOR

The electrical ignition element is an item principally developed to supply gas pressure (and brisance) to operate firing mechanisms of other propellant actuated devices or initiate an explosive chain reaction of the propelling charge(s) in propellant actuated devices.

The pulse generator is a hand held device designed to generate sufficient electrical energy when squeezed manually to fire electrical ignition elements.

A data sheet for each item is presented.
IGNITION ELEMENT, ELECTRICAL
(For Use As Specified In Table Below)

![Circuit Diagram]

**TWO CIRCUIT MULTIPRONG TYPE**

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>CURRENT RATING (AMP)</th>
<th>RECOMM'D FIRING CURRENT (amps)</th>
<th>BRIDGE WIRE RESISTANCE (ohm)</th>
<th>AVERAGE FUNCTIONING TIME (ms)</th>
<th>PRIMER CHARGE (mg)</th>
<th>BOOSTER CHARGE (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M21</td>
<td>3.5</td>
<td>5.0</td>
<td>0.11 ±0.03</td>
<td>50 ± 3.5A</td>
<td>90. ±5.</td>
<td>60 ±5.</td>
</tr>
<tr>
<td>XM22</td>
<td>3.5</td>
<td>5.0</td>
<td>0.11 ±0.03</td>
<td>50 ± 3.5A</td>
<td>90. ±5.</td>
<td></td>
</tr>
</tbody>
</table>

**DATA**

1. Operating Temperature Limits. . . . . -65°F. to +200°F
2. Assembled Weight (Approximately): M21, 11.5 gm; XM22, 10 gm.
4. AC is Firing Circuit; BD is Checkout Circuit.
5. The threaded section of this element will fit standard gas fittings on propellant actuated devices.
6. Output Approx. 4740 psi in 0.062 in 3 Vol. at 70°F.
7. Functioning Time using 5 amps less than 10ms.

The electrical ignition element is an item having an electrical resistance embedded in a heat combustible composition which, when ignited, generates a gas pressure to actuate a device and/or initiate an explosive chain reaction of the propelling charge(s) in propellant actuated devices.
IGNITION ELEMENT, ELECTRICAL
(For Use As Specified In Table Below)

CIRCUIT DIAGRAM

BAYBAYONET CONNECTOR TYPE (DAGE CBSN 1-317-1 OR EQUAL)

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>CURRENT (AMP.)</th>
<th>RECOMM'D BRIDGEWIRE RESISTANCE (ohms)</th>
<th>AVERAGE FUNCTIONING TIME (ms)</th>
<th>CHARGE WEIGHT (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALL-FIRE @18.V.</td>
<td>NO-FIRE @28.V.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M26</td>
<td>1.5</td>
<td>0.5</td>
<td>3.0</td>
<td>1.0 ±0.3</td>
</tr>
<tr>
<td>M55</td>
<td>3.5</td>
<td>1.5</td>
<td>5.0</td>
<td>0.11 ±0.03</td>
</tr>
<tr>
<td>M56</td>
<td>3.5</td>
<td>1.5</td>
<td>5.0</td>
<td>0.11 ±0.03</td>
</tr>
<tr>
<td>M42</td>
<td>1.5</td>
<td>0.5</td>
<td>3.0</td>
<td>1.0 ±0.3</td>
</tr>
</tbody>
</table>

DATA

1. Operating Temperature Limits . . . . . . . -65°F to +200°F
2. The M series output is similar to #33 percussion primer, except that the M56 output is similar to #26 percussion primer.

The electrical ignition element is an item having an electrical resistance embedded in a heat combustible composition which, when ignited, generates a gas pressure to actuate a device and/or initiate an explosive chain reaction of the propelling charge(s) in propellant actuated devices.
IGNITION ELEMENT, ELECTRICAL, M-47

This electrical ignition element is an item having an electrical resistance embedded in a heat combustible composition which, when ignited, generates a gas pressure to actuate a device and/or initiate an explosive chain reaction of the propelling charge(s) in propellant actuated devices.
PULSE GENERATOR
(For Use As Specified In Table Below)

1. Operating Temperature Limits .............. \(-65^\circ F.\) to \(+200^\circ F.\)

The generator is a manually operated automatically reset device designed to generate sufficient electrical energy to fire specified electric ignition elements used in electrically initiated propellant actuated devices.
PULSE GENERATOR (Cont'd)

TYPICAL TRACE OF PULSE GENERATOR OUTPUT

ENERGY = \frac{VOLTAGE^2 \times TIME (MS)}{RESISTANCE (OHMS)}

E = \frac{NO. UNITS \times UNIT VALUE}{TOTAL RESISTANCE}

1 UNIT = 1 INCH^2 = 4 V^2MS

AREA UNDER CURVE = 7 UNITS

TOTAL RESISTANCE = 0.3 OHMS

E = \frac{7 \times 4}{0.3} = 93.3 MILLIWATT-SECONDS

PLOT OF TYPICAL TRACE AND COMPUTATION OF ENERGY OUTPUT

7-6
GAS GENERATORS

The gas generators are primarily designed to supply gas pressure, for a longer sustained period of time than initiators to initiate, inflate, pressurize or otherwise serve as a self-contained propellant generating system. The items illustrated were designed for a specific purpose; however, gas generators can be designed to deliver propellant gas for a range of times from seconds to minutes. The delivered gas can also be filtered and temperature conditioned if required.
GENERATOR, GAS PRESSURE, XM-14

DATA

1. Weight:
   - Assembly ............... 3-3/4 lbs.
   - Propellant .............. 0.065 lb.
2. Burning Time ............ 1.0 sec.
3. Gas Output:
   - Operating Pressure ..... 1000 psig
   - Temperature ........... 1600°F
4. Operating Temperature Limits ...... -65°F + 200°F

This reusable, self-contained unit consists of two parallel chambers containing identical cartridges. For normal operation, one cartridge is mechanically actuated. The alternate cartridge, for use under certain conditions, has provisions for either gas or mechanical actuation. The cartridges are easily replaced. The generator is easily integrated into a system by means of standard fittings. This gas generator was designed to initiate the prejection system in the capsule of the B-58 aircraft.

8-2
DATA
1. Weight of Assembly .................. 2 lb.
2. Function Time ........................ 10 sec.
3. Gas Output .......................... Produces 5 std. cu. ft. of gas at a bulk temperature of 150° F.
4. Operating Temperature Limits ......... –65° F. to +120° F.

This gas generator is a device designed to inflate a 1-man life raft.
GENERATOR, GAS PRESSURE, XM-20

DATA

1. Weight of Assembly ........................................ 28 lb.
2. Function Time .................................................. 30 sec.
3. Gas Output ...................................................... Produces 80 std. cu. ft. of gas at a bulk temperature of 200°F.
4. Operating Temperature Limits .............................. -65°F to +120°F.

This gas generator is a device designed to inflate a 20-man life raft.
MISCELLANEOUS ITEMS

The following items are not readily identifiable as to the nomenclature of the other propellant actuated devices and as such are listed separately as Miscellaneous items.
This penetration and extraction system is designed to penetrate and seal unexploded ordnance items. It can penetrate and seal items having an internal pressure of plus or minus several atmospheres; 0.040 to 0.750 inches of mild steel and 0.040 to 1.000 inches of aluminum can be penetrated and sealed.
DATA
1. Weight of Assembly .................. 3.25 lb.
2. Function Time ........................ 0.25 sec.
3. Three Revolutions ................... Rotary actuator
5. Operating Temperature Limits ........ -65° F. to +200° F

This power actuated inertia reel is a device designed to take up the personnel shoulder harness to position the pilot prior to ejection.
CARTRIDGE, BOMB EJECTION, CCU-1/B

DATA
1. Weight of Assembly .................................. 30 grams
2. Theoretical Energy ..................................... 5000 ft-lb.
3. Ignition Element ....................................... Electric
4. No Fire Current ........................................ One amp – One watt for 5 min.
5. All Fire Current ......................................... 5 amp applied for 25 ms
6. Operating Temperature Limits ....................... -65° F. to +325° F.
7. Propellant ............................................... 6 grams HMX/polyacrylate, thermal resistant, extremely clean and noncorrosive

TYPICAL PERFORMANCE

This cartridge is a device designed for use on the MAU-12A/B bomb rack, the pressure, thrust, versus time graphs shown represent the energy from two cartridges while ejecting a 500 pound store. The ballistic performance of this cartridge will vary with application.
EJECTOR, PLATFORM, PROPELLANT ACTUATED, XM-3

DATA
1. Weight of Assembly .................. 105 lbs.
2. Function Time .................. 0.040 sec. (40 ms.)
4. Thrust (maximum) .................. 61,000 lbs.
5. Velocity (maximum) .................. 1000 ft./sec.
6. Operating Temperature Limits ........... 70°F. (ambient)
7. Ejected Weight .................. 340 lbs.

ANCILLARY COMPONENTS:
1. Generator, Gas Pressure, Propellant Actuated, XM-23.
2. Cartridge, Impulse, XM-228.

This ejector platform is a force-ejection mechanism used for upward ejection of weapon stores from low flying aircraft at speeds up to mach 2.0.
EJECTOR, PLATFORM, PROPELLANT ACTUATED, XM-3

TYPICAL PRESSURE, TRAVEL, VELOCITY, AND ACCELERATION – TIME PERFORMANCE

TYPICAL PRESSURE, AND VELOCITY – TRAVEL PERFORMANCE
EJECTOR, PARACHUTE, CARTRIDGE ACTUATED, XM-233

DATA
1. Weight of Assembly ........................................ 2.16 lb.
2. Function Time .............................................. 0.040 sec.
3. Stroke .................................................... 16.44 inches
4. Thrust ..................................................... 825 lb.
5. Velocity (at full stroke) ................................. 68 ft/sec.
6. Operating Temperature Limits ...................... -65°F to +200°F.

This ejector is a propellant actuated device specifically designed to ballistically deploy a personnel reserve (T-10 type) parachute.
The M1A1 Firing Pin Release is gas actuated and releases the firing pin for such devices as the M1A3 Remover. It is actuated by gas from another Propellant Actuated Device. The Firing Pin Release is installed in the following aircraft: B-57, F-6, -86, -100, -101, -102, -105, -106, MF-K and T-37. The part number for the M1A1 Release is 94-5-1.
The XM15 Escape Rocket was designed to satisfy the ejection propulsion needs for a single place separable nose emergency crew escape capsule. It was used in the feasibility testing of the separable nose escape concept, the test capsule being based on the F104 aircraft configuration.
ESCAPE ROCKET, XM-15 (Cont'd)

TIME PERFORMANCE

<table>
<thead>
<tr>
<th>OTHER DATA</th>
<th>TARGET</th>
<th>MEAN</th>
<th>$\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrust Max., lbs.</td>
<td>45,000</td>
<td>42,344</td>
<td>901.5</td>
</tr>
<tr>
<td>Total Impulse, lbs. sec.</td>
<td>17,500</td>
<td>17,250</td>
<td>140.5</td>
</tr>
<tr>
<td>Burning Time, sec.</td>
<td>.500</td>
<td>.497</td>
<td>.013</td>
</tr>
<tr>
<td>Thrust Alignment</td>
<td>$49^\circ , 31'$</td>
<td>$49^\circ , 4'$</td>
<td>$0^\circ 2.4'$</td>
</tr>
</tbody>
</table>

*Based on five Static Tests.