JATO INSTRUCTION MANUAL

FOR THE

MODEL 15KS-1000-A1

AIRCRAFT ROCKET ENGINE

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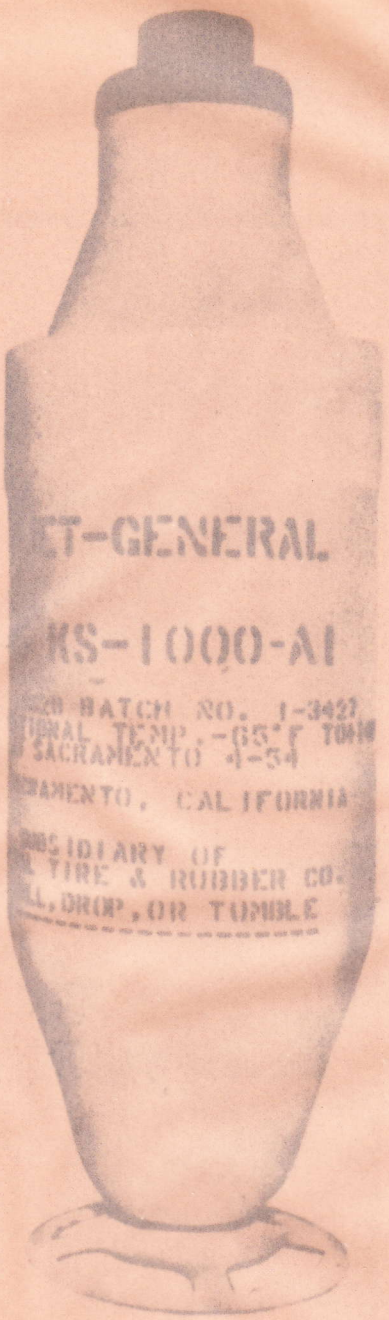
REPORT NO. 997

Aerojet-General CORPORATION

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

AZUSA, CALIFORNIA SACRAMENTO, CALIFORNIA

THE GENERAL TIRE



JATO Rocket Engine 15KS-1000-A1

TABLE OF CONTENTS

SECTION I

INTRODUCTION

1-1. GENERAL

1-2. SCOPE OF HANDBOOK. This handbook is the basic operation and service manual for the 15KS-1000-A1 JATO engine manufactured by the Aerojet-General Corporation, Azusa, California, U.S.A., in accordance with the manufacturer's specification and Civil Aeronautics Administration Engine Type Certification No. 249.

1-3. MODEL DESIGNATION. The model designation, 15KS-1000-A1, is interpreted as follows:

JATO – jet-assisted takeoff
15 – nominal duration of thrust, in seconds, at 60°F (15.6°C)
K – type of propellant
S – solid-propellant grain
1000 – nominal thrust rating, in pounds, at 60°F (15.6°C)
A1 – Model

1-4. PURPOSE OF EQUIPMENT. The 15KS-1000-A1 JATO engine is designed for use during the takeoff of aircraft to augment the basic thrust or to replace power lost due to primary power failure. Limitations on the gross weight, payload, and range of an aircraft imposed by such factors as runway length, air temperature, and runway altitude may be reduced by the use of JATO engines.

1-5. PRINCIPLE OF OPERATION

1-6. The basic principle upon which rocket or JATO engines operate is Newton's third law of motion: "To every action there is an equal and opposite reaction."

1-7. In rocket propulsion, Newton's law is manifested by the action of gases confined in a chamber under pressure and allowed to escape at high velocity through a nozzle. The action of the gases in escaping exerts an equal and opposite reactive force in the JATO engine. The gases are obtained by combustion of the propellant, which is a blend of an oxidizer and a fuel. The oxidizer, which serves as a source of oxygen, permits the engine to operate independently of atmospheric oxygen. For this reason, rocket engine performance is not reduced at higher altitudes.

SECTION II

DESCRIPTION

2-1. GENERAL

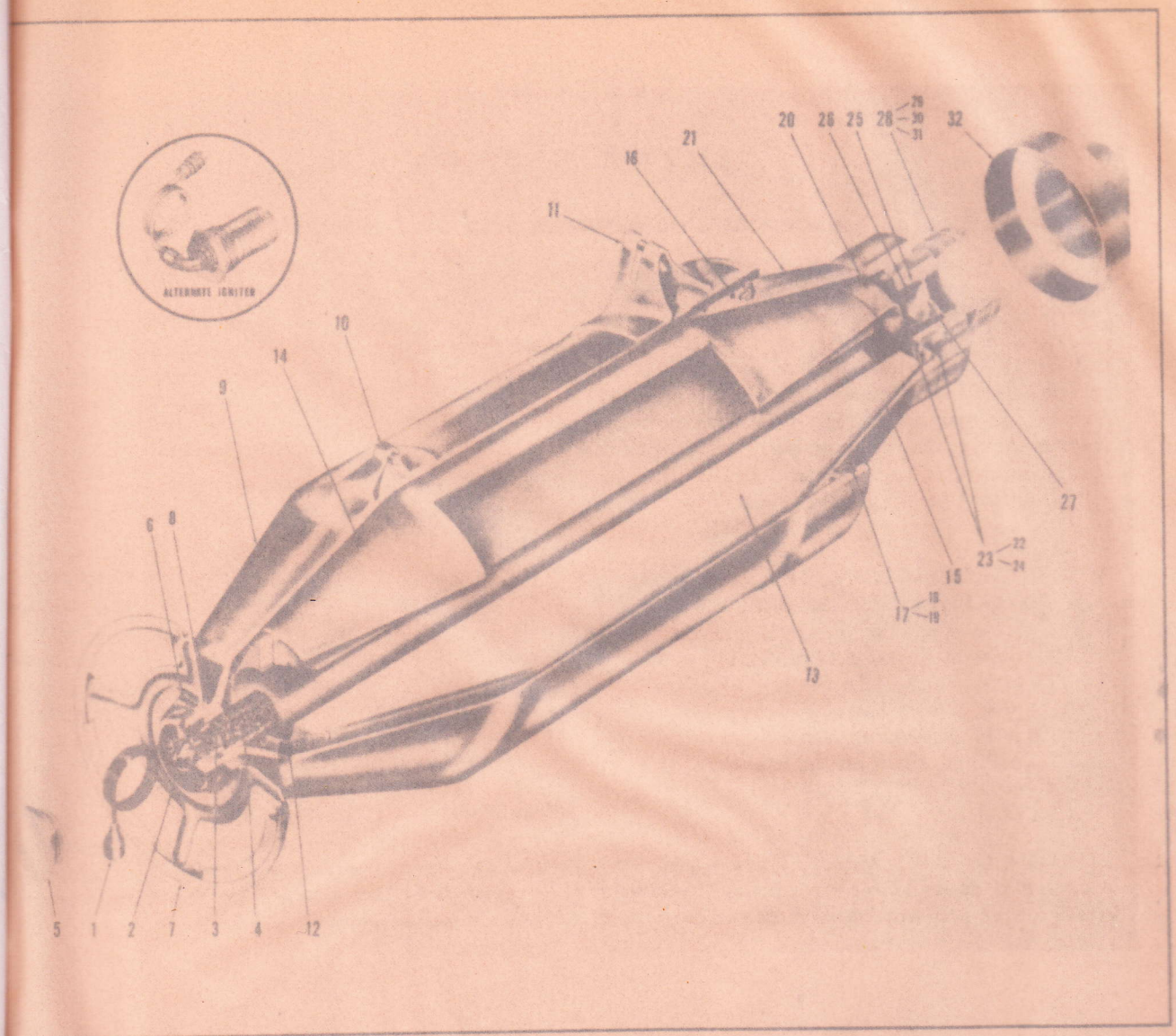
2-2. The 15KS-1000-A1 JATO engine is essentially a steel pressure vessel containing a propellant charge (or grain). An igniter assembly is provided at the forward end of the unit and the aft end contains the exhaust nozzle as well as a safety pressure release assembly. Attachment to the aircraft is accomplished by two welded steel lug assemblies designed for 3-point mounting.

2-3. DESCRIPTION

2-4. PRINCIPAL COMPONENTS.

Note

Figure 2-1 is a ¾ cut-away view showing the principal components. In addition, the Illustrated Parts Breakdown (Appendix B) contains an exploded view illustration of the JATO engine. For purposes of clarity, like components of both illustrations have the same key numbers.



1. Igniter Cable Assembly
2. Igniter Adapter
3. Igniter Powder Case
4. Igniter Basket Assembly
5. Plastic Shipping Cap
6. Handle Nut
7. Handle
8. Handle Washer
9. Chamber Assembly
10. Forward Mounting Lug
11. Aft Mounting Lug
12. Grain Spacer (sponge rubber)
13. Propellant Grain
14. Chamber Insulator (boot and baffle)
15. Aft Cap Felt
16. O-Ring Seal
17. Retaining Ring
18. Snap Ring Clips
19. Screw
20. Safety Diaphragm Deflector Cone
21. Aft Cap Chamber
22. Aft Cap Ring
23. Diaphragm Assembly
24. Diaphragm Insulating Washer
25. Nozzle Retainer Insert
26. Nozzle Insert
27. Weather Seal
28. Nozzle Body
29. Nozzle Retainer Lug
30. Screw
31. Spring Lockwasher
32. Nozzle Cover

Figure 2-1. Cutaway View of JATO Rocket Engine 15KS-1000-A1

The 15KS-1000-A1 JATO consists of a chamber assembly (9) and an aft-cap assembly (21) which together make up the pressure vessel and contain the slotted propellant grain. A plastic, T-shaped insulating boot and gas-flow baffle plate (14) is inserted into the slot, and projects into the bore of the propellant grain. The propellant grain, as shown in Figure 2-1, is turned clockwise 180 degrees to show the boot-baffle plate.) A plastic safety-diaphragm deflector cone (20) is fitted over the aft end of the propellant grain. The aft-cap assembly houses the nozzle assembly (25, 26, 28) through which flow the gases produced by the burning propellant grain. The aft-cap assembly also contains a pressure-release diaphragm having an annular ring of small ports (22, 23, 24). The igniter assembly (1, 2, 3, 4) is inserted into the threaded boss on the forward end of the chamber. Two mounting assemblies (10, 11) are welded to the chamber for attachment to the aircraft. A handle stand (7) is located on the forward end of the chamber for convenience in handling and vertical storage, and may be removed, if desired.

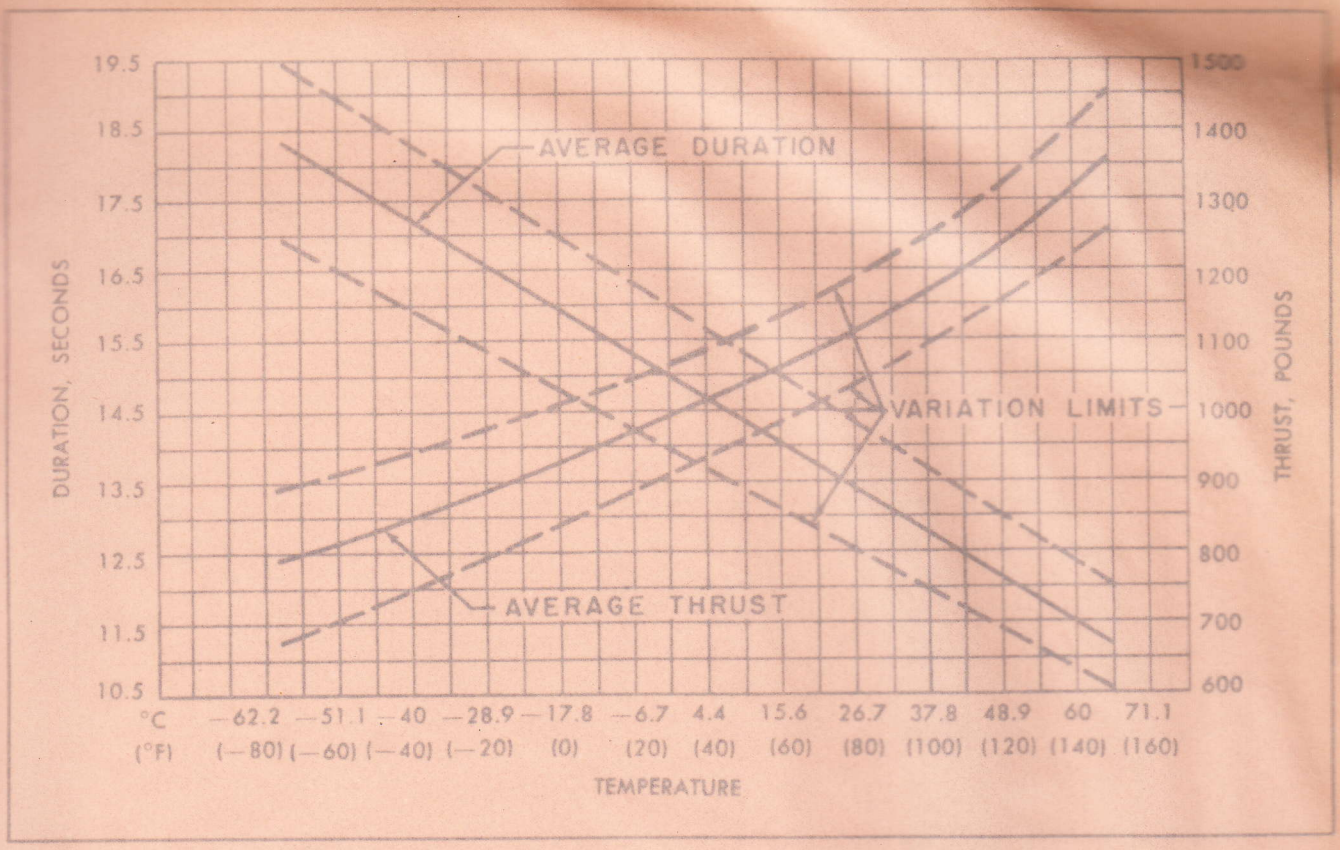


Figure 2-2. Effect of Temperature on JATO Rocket Engine Performance

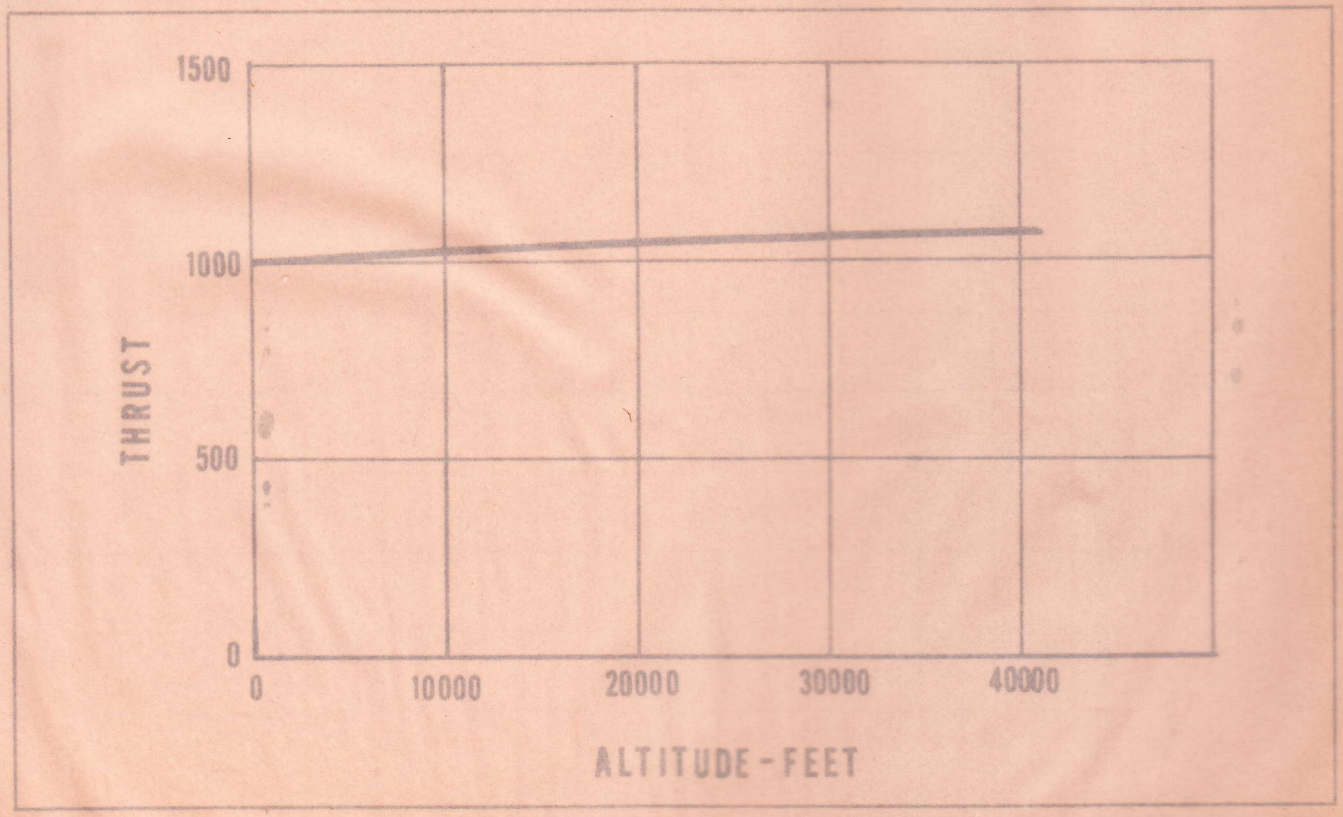
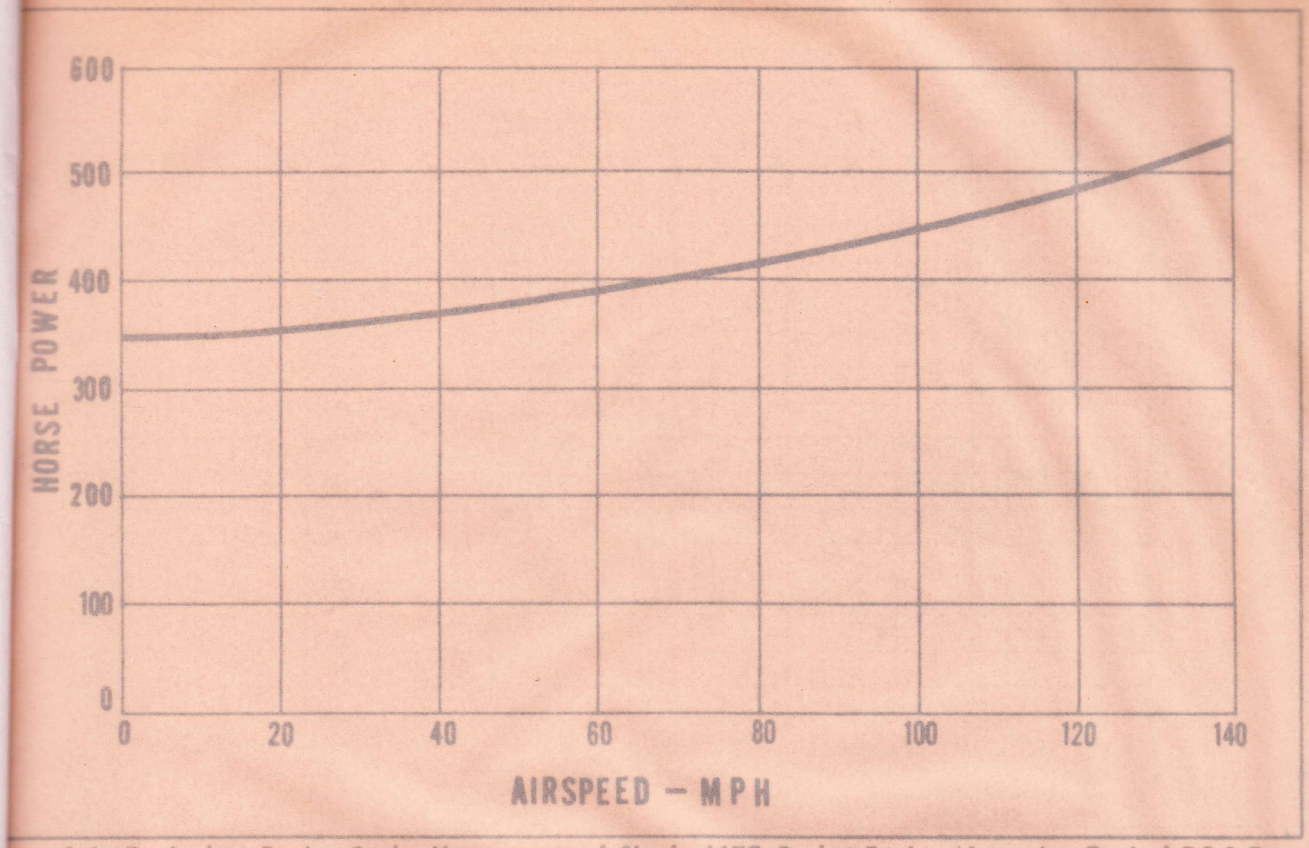


Figure 2-3. Effect of Altitude on Thrust



ure 2-4. Equivalent Engine Brake Horsepower of Single JATO Rocket Engine (Assuming Typical DC-3 Type Engine-Propeller Performance)

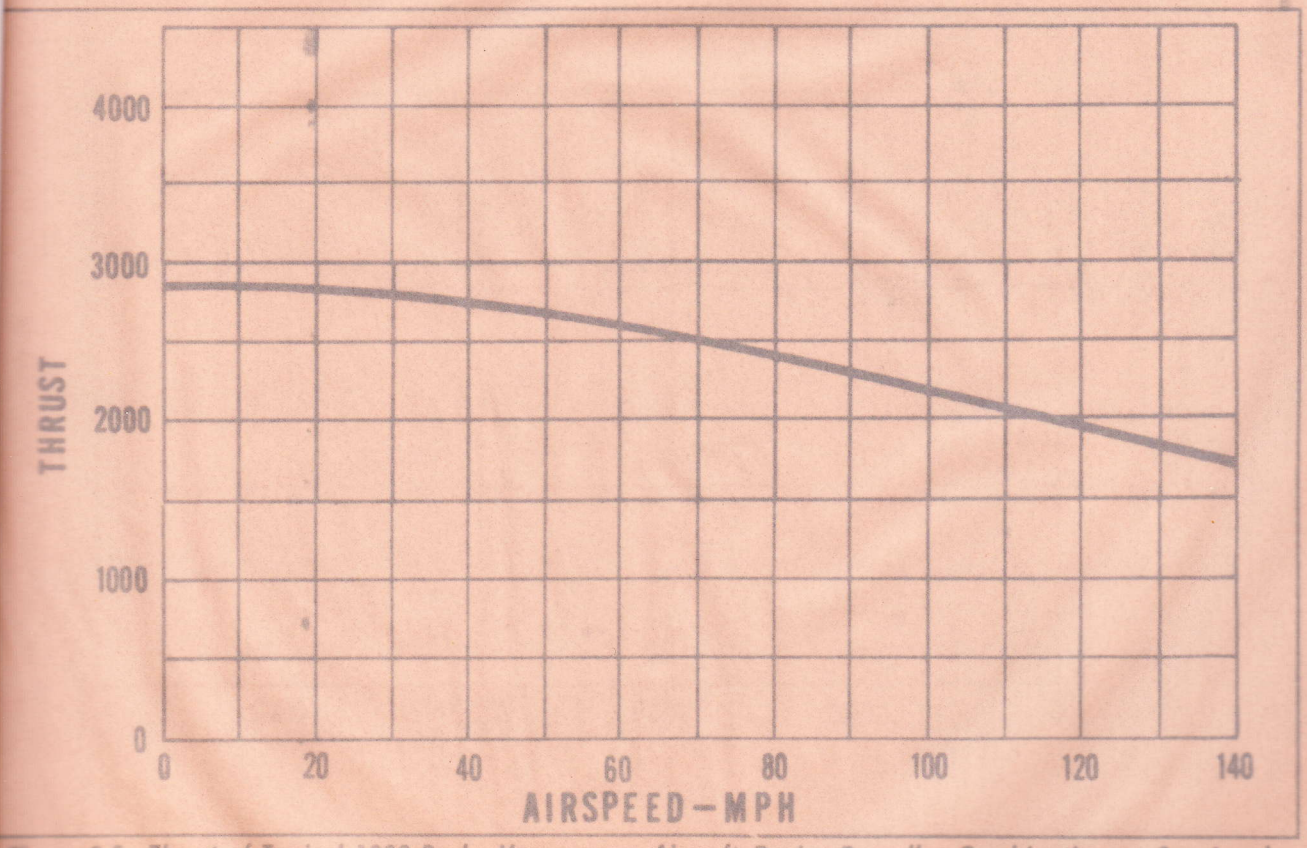


Figure 2-5. Thrust of Typical 1000 Brake Horsepower Aircraft Engine-Propeller Combination at Sea Level (Computed from 1200 Horsepower Engines in DC-3 Type Aircraft)

2-5. WEIGHTS AND DIMENSIONS. Pertinent nominal data on the 15KS-1000-A1 JATO are as follows:

Loaded weight (before firing)	144 lb
Expended weight (after firing)	72 lb
Length	33.45 in.
Diameter (largest cylindrical section)	10.30 in.

2-6. PERFORMANCE CHARACTERISTICS

2-7. NOMINAL PERFORMANCE. The 15KS-1000-A1 is designed to deliver 1000 lb thrust for 15 seconds at sea level when fired at a propellant temperature of 60°F (15.6°C). The maximum ignition interval for the unit does not exceed 0.5 seconds over the operating range.

2-8. PERFORMANCE RANGE. Performance is affected by the temperature of the JATO propellant grain (not ambient temperature) as shown in Figure 2-2. In an extreme case, such as removal from a warm storage area to an airplane standing outdoors in subzero weather, it may take as long as 20 hours for the entire propellant charge to reach a new ambient temperature. Performance is essentialy unaffected (actually improves slightly) by the decreased atmospheric pressure at increasing altitudes (see figure 2-3).

2-9. COMPARATIVE PERFORMANCE. Figures 2-4 and 2-5 have been included to provide approximate means for comparing the effects on aircraft performance of the JATO engine with that of a typical reciprocating engine-propeller combination. The curves of reciprocating engine-propeller performance are not exact for any given installation, but can be considered to be typical for aircraft in the multi-engine 200 m.p.h. category.

2-10. OPERATING LIMITS

2-11. TEMPERATURES. Operating and storage temperatures should be maintained between —65 to +140°F (—53.9 to +60°C). A JATO engine which has been stored at temperatures outside the specified range may suffer damage which cannot be found by the inspection outlined in Appendix A; therefore, any engine subjected to temperatures outside the specified values must not be used.

2-12. ALTITUDE. The 15KS-1000-A1 JATO igniter should not be exposed to altitudes above 35,000 feet.

2-13. VIBRATION. Prolonged or extreme vibration beyond that encountered in normal operation may be harmful to the engine.

2-14. STORAGE LIFE. The 15KS-1000-A1 JATO engine may be stored for a maximum of two years from date stenciled on the engine chamber.

2-15. OPERATING LIFE. The JATO engine is designed to be carried on the aircraft ready for use for a period of 500 hours of logged flight time or one year, whichever first occurs. Engines approaching the above limitation should be used for flight training or demonstration purposes. This serves to maintain pilot proficiency, and eliminates the necessity for ground disposal of the propellant and igniter.

SECTION III
OPERATION

3-1. OPERATION

3-2. IGNITION. Engines are ignited by closing the JATO firing switch located in the pilot's compartment.

3-3. THRUST. Thrust is produced immediately and smoothly and engine operation is characterized by a noise similar to a turbojet. The exhaust flame is bright blue with a column of hot gases beyond the visible flame pattern similar to that of a turbojet. No smoke is visible except when relative humidity is 80 percent or greater. At the end of burning, cessation of thrust is smooth and abrupt. Burning of internal residue such as the rubber shock pads will normally result in a puff of black smoke at the end of burning which may be noticeable to observers outside the aircraft. In some cases, residual material may continue to burn slowly for 2 or 3 minutes, producing a small licking flame at the exhaust nozzle.

3-4. PRESSURE-RELEASE DIAPHRAGM ACTUATION. The safety diaphragm release assembly is designed to provide the chamber with a safety valve to relieve excessive pressures resulting from mishandling or exposure to abnormal conditions. When a safety-release diaphragm is actuated forward thrust continues; however, its magnitude and the duration may vary.

3-5. NON-IGNITION. If the JATO engine fails to ignite, the probable cause is a defective aircraft JATO electrical system. After landing, disconnect the igniter wire and remove the igniter. Check the aircraft firing circuit and repair if defective.

WARNING

If the igniter has fired, but the JATO engine has not operated, do not attempt to refire the JATO. Remove the expended igniter and dispose of the engine according to applicable Aerojet-General Service Bulletins.

3-6. FORCED LANDINGS. In addition to their primary purpose as a source of standby power in the event of power loss during takeoff, the JATO engines may be used to advantage during landings resulting from power losses en route. They may permit the selection of a more advantageous landing spot or provide the necessary reserve power for a go-around after a missed approach. However, it is recommended that the JATO units be fired, if practicable, prior to a wheels-up landing.

3-7. POST OPERATION PROCEDURES. After any JATO operation it is recommended that the aircraft surfaces which have been exposed to the JATO engine exhaust be thoroughly washed down with water.

SECTION IV
STORAGE AND HANDLING

4-1. GENERAL

4-2. Information on the storage and handling provisions for the 15KS-1000-A1 JATO engine and its igniter for the majority of normally encountered conditions is contained below. In general, the engine should be stored and shipped in accordance with current regulations covering ICC Class B Jet Thrust Units, and the igniter in accordance with current regulations covering ICC Class B Jet Thrust Unit Igniters.

4-3. SHIPPING CONDITION

4-4. The 15KS-1000-A1 JATO engines are factory-assembled for shipment as complete units except for the igniter assemblies, which are packed in watertight cans and may be shipped in separate packages when JATOs are shipped palletized. Prior to palletizing or crating, the engines are sealed against moisture with a forward and aft shipping seal. The engines may be shipped in a pallet assembly containing 12 units or less, or in individual crates. These pallets are designed for static loads three high, although one pallet high is recommended for shipment.

4-5. STORAGE AND HANDLING

4-6. UNASSEMBLED. During all warehouse storage or prolonged storage on or near the aircraft, keep the igniter in its sealed factory shipping container and the original plastic shipping plug in the igniter boss of the engine. If an engine is being returned to storage, after having been mounted on an airplane, store the igniter in its original factory container. Tape container shut and, if possible, use new desiccant bag. Use *only* the original type plastic cover in the igniter boss. Do not insert desiccant or other foreign objects in the chamber.

4-7. ATTACHED TO AIRCRAFT. An aircraft with JATO engines attached and ready to fire is not subject to any new or different handling or storage requirements. Personnel should stand clear of JATO exhaust areas in the same manner as avoiding propellers or turbojet exhausts.

4-8. JATO HANDLING. JATO engines are not sensitive to incidental shocks of normal warehouse and shipping. However, if the engine is dropped from a height exceeding 12 inches, it must be rejected.

4-9. IGNITER HANDLING. The uninstalled igniter is somewhat more delicate mechanically than the rest of the JATO engine. Accordingly, more care should be exercised in handling.

SECTION V

INSPECTION

5-1. INSPECTION

5-2. PERSONNEL. All inspection of the JATO engine must be made only by personnel approved by the manufacturer.

WARNING

Do not apply heat to JATO engines or igniters. Electric or other power tools must not be used on JATO engines. Avoid any source of sparks. Disconnect the igniter wire from the aircraft terminal prior to any inspection. Remove the igniter before any internal inspection, before working on the aircraft in the JATO exhaust area, or before removing the engine from the aircraft. Replace the igniter with the plastic shipping cover as soon as possible.

5-3. INTERVALS. Shortly before installing the engine on the aircraft, visually inspect for any damage incurred during shipment and storage. Engines installed on aircraft must be inspected every 90 days or after 100 hours flying time, whichever first occurs, in accordance with Appendix A.

5-4. TOOLS. A safety flashlight and a 2-inch open end wrench are the only tools required for inspection. The use of extension lights, mirrors, etc., inside the JATO engine is forbidden.

5-5. PROCEDURE. Refer to Appendix A for inspection procedure instructions.

SECTION VI

INSTALLATION

6-1. MOUNTING

6-2. Mount the JATO engine on the aircraft as follows:

a. Remove paint or rust from at least one pin of the JATO engine attaching lugs to insure adequate electrical ground for the ignition current.

b. Lift the JATO engine into position and attach by its mounting lugs to the aircraft attachment fittings. Make certain that the engine is securely locked in position.

c. Remove the shipping cap from the igniter boss of the chamber assembly. At this point, care should be taken to open the aircraft arming switch and double-check the electrical circuit to determine that *no voltage* remains in the line, as described in Appendix A.

d. Insert the igniter assembly in the igniter boss and tighten with a hand wrench.

e. Connect the igniter wire to the aircraft terminal.

WARNING

When the igniter wire is connected to the aircraft, all personnel must stay clear of the area aft of the exhaust nozzle. When JATO engines are in operation, exhaust gases of high temperature and velocity are emitted from the nozzle.

6-3. REMOVAL

6-4. Remove the JATO engine from the aircraft as follows:

a. Disconnect the igniter wire from the aircraft terminal.

b. Remove the igniter and return it to its shipping container.

c. Insert the plastic shipping cap in the igniter boss.

d. Remove the JATO engine.

Note

In the case of removing expended units, check to determine that the metal parts are not hot from the recent firing. Dispose of used metal parts per applicable Aerojet-General Service Bulletins.

APPENDIX A

INSPECTION CHECK-OFF LIST

I. As received from factory, check items A-1 through A-5 and B-1 through B-3.

II. Before installation, check items A-1 through A-9, B-3 through B-8, and C-1 through C-5.

III. At 100-hour inspection periods, check items A-3 through A-12, B-3 through B-8, and C-4 through C-6.

General Note: Inspection Disposition:

(a) Reject

(b) Perform additional inspection

(c) Take corrective action

When more than one disposition letter follows an item, the seriousness of the condition will determine the necessary disposition.

A. JATO CHAMBER AND SHIPPING CONTAINERS

1. Shipping crates or pallets for evidence of mishandling, dropping, immersion, excessive heat or vibration (a).....

2. Plastic shipping caps:
   Missing (b & c)..... Damaged (b & c)..... Loose (c).....

3. Evidence of dropping or impacts of other objects on JATO chamber (a).....

4. Rust on JATO chamber Heavy (a)..... Light (b & c).....

5. Nozzle protecting cover
   Missing (b & c)..... Damaged (b & c)..... Loose (b & c).....

6. Nozzle weather seal Broken or missing (a).....

7. Nozzle retaining lugs and bolts
   Damaged (a)..... Missing (a)..... Loose (b & c).....

8. Snap ring retaining clips and screws
   Damaged (a)..... Missing (a)..... Loose (c).....

9. Damage to diaphragm protector visible through pressure release ports (a).....

10. Loose pieces or foreign objects inside chamber (a).....

WARNING: A *safety* flashlight is to be used for all interior inspections. Do *not* insert flashlight or other objects into chamber bore.

11. Moisture or water inside chamber (a).....

12. Cracks, chips or other damage to propellant grain (a).....

NOTE: Slight chipping of the sharp edge between the propellant bore and the ends normally occurs in processing and does not affect operation.

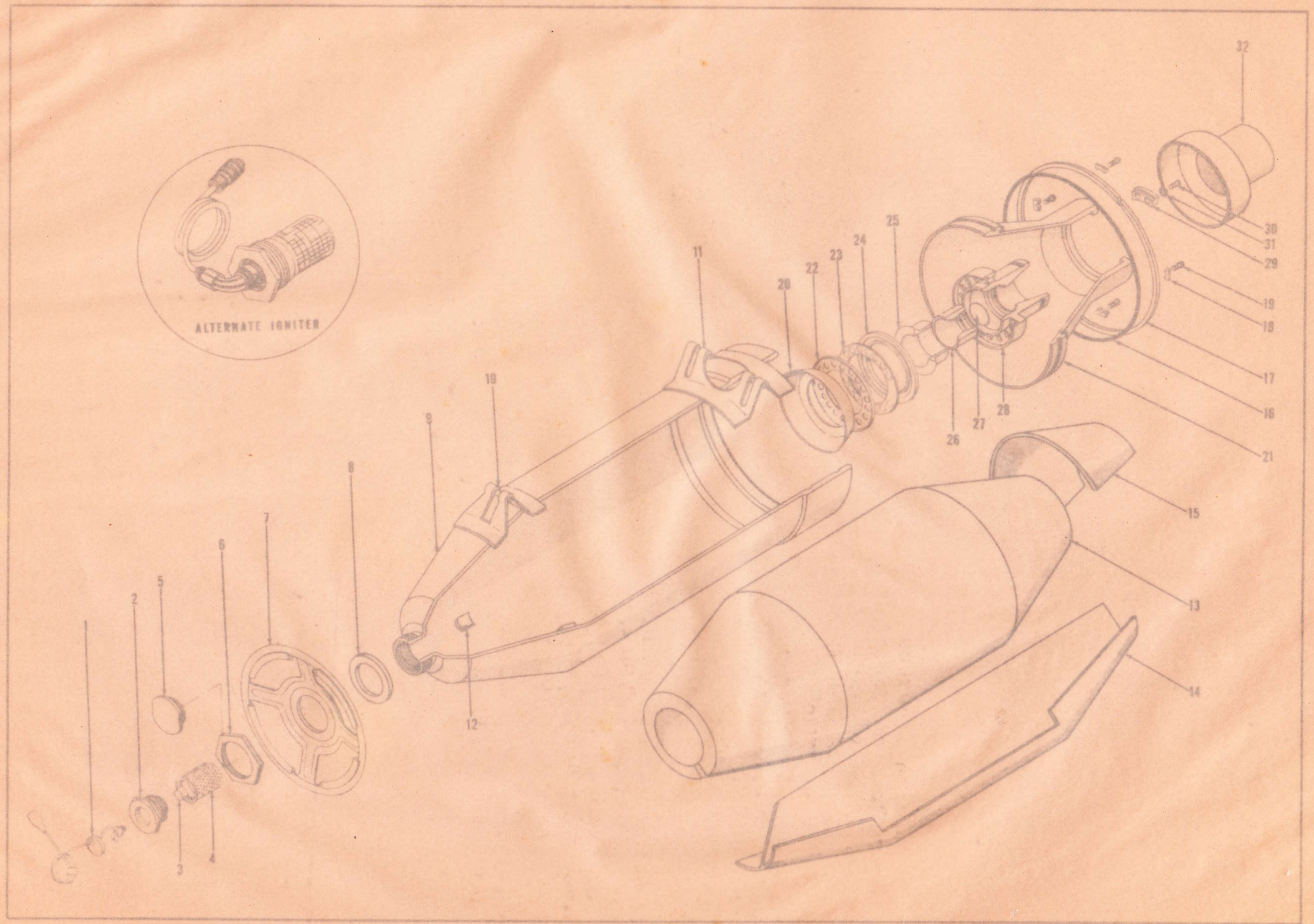
APPENDIX B

ILLUSTRATED PARTS BREAKDOWN

Note

Parts cannot be purchased separately. This list is furnished for identification and inspection purposes only.

Index No.	Description	Units Per Assy
1	CABLE ASSY, Igniter	1
2	ADAPTER, Igniter	1
3	CASE, Powder	1
4	BASKET ASSY, Igniter	1
5	CAP, Shipping	1
6	NUT, Handle	1
7	HANDLE	1
8	WASHER, Handle	1
9	CHAMBER ASSY	1
10	LUG ASSY, Forward Mounting	1
11	LUG ASSY, Aft Mounting	1
12	SPACER, Grain (sponge rubber)	3
13	GRAIN	1
14	INSULATOR, Chamber (boot and baffle)	1
15	FELT, Aft Cap	1
16	SEAL, O-ring	1
17	RING, Snap, Aft Cap Retaining	1
18	CLIP, Snap Ring	4
19	SCREW	4
20	CONE, Safety Diaphragm Deflector	1
21	CHAMBER, Aft Cap	1
22	RING, Aft Cap	1
23	DIAPHRAGM ASSY	1
24	WASHER, Diaphragm Insulating	1
25	INSERT, Retainer, Nozzle	1
26	INSERT, Nozzle	1
27	SEAL, Weather	1
28	BODY, Nozzle	1
29	LUG, Nozzle Retention	2
30	SCREW, Socket Hd., 0.312-24 NF x 1.00 in. lg.	4
31	WASHER, Spring Lock	4
32	COVER, Nozzle	1



Exploded View of JATO Rocket Engine 15KS-1000-A1

CONF. POR [signature]

V°B° [signature]

OPERACION CON JATO

DC-3 C-47	AEROPUERTO ALTO PALENA APN ELEVACION 920' TEMPERATURA STANDARD 13° C FECHA 13 - DICIEMBRE - 1963

L. REAL: 2952'
%G: 0

OBSTACULO: DE 120' a 6.348' DEL CABEZAL DE PARTIDA (27)

NOTA: OPERACION NO AUTORIZADA PARA PISTAS CON AGUA, SLUSH, NIEVE, HIELO O REBLANDECIDAS.

FLAP : 0°

MAX. AUTORIZADO T. OFF G.W. 26.200

DESPEGUE	VIENTO	DIRECCION MAGNETICA DE LAS PISTAS						
		09/27						
	40	↑						
	30	26.200 S/R						
	20	26.200 29°C						
	15	26.200 22°C						
	10	25.900 13°C						
	5	25.000 13°C						
	0	24.300 13°C						
	- 5	N.A						
	-10	N.A						

CORRECCION POR TEMPERATURA: Por cada °C sobre temperatura crítica indicada reste 126 libras del peso máximo autorizado con el casillero correspondiente.

ATERRIZAJE	VIENTO	USO REGULAR FULL FLAP MAX. AUTORIZADO LAND. G.W. 26.000 DIRECCION MAGNETICA DE LAS PISTAS						USO ALTERNATIVA FULL FLAP MAX. AUTORIZADO LAN. G.W. 26.000 DIRECCION MAGNETICA DE LAS PISTAS					
		09/27						09/27					
	30	↑						↑					
	20												
	15	26.000						26.000					
	10	25.600						25.600					
	5	25.200						25.200					
	0	24.800						24.800					
	- 5	N.A						N.A					
	-10	N.A						N.A					

E

NOTA: PESO MAXIMO DE ATERRIZAJE CALCULADO COMO ALTERNATIVA (70%) POR REQUERIMIENTOS METEOROLOGICOS.