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TOTAL PAGES 228

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MD 59-44

OPERATIONAL DYNA SOAR
RECOVERABLE BOOSTER STUDY
SELECTED BOOSTER

1 March 1959

DYNA SOAR PROGRAM
FOR BOEING AIRPLANE COMPANY
CONTRACT AF33(600)-37706

W. F. Parker
Chief Engineer

NORTH AMERICAN AVIATION, INC.
MISSILE DEVELOPMENT DIVISION

L.N. 60-601
MAY 16 1960

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ENGINES

ROCKET ENGINES

Performance studies on the base point number 1 recoverable booster have resulted in the requirement for a rocket propulsion system in the 950,000 pound thrust class. Bi-propellant propulsion systems capable of this thrust level are as tabulated:

Manufacturer	Designation	Thrust/Chamber-lbs	No. of Chamber Required
Aerojet-General	XLR87-AJ-1	150,000	5 - 6
Aerojet-General	Uprated XLR 87	200,000	4
Rocketdyne	H-1	188,000	4 - 5
Rocketdyne	Uprated H-1	200,000	4
Rocketdyne	E-1	468,000	2
Rocketdyne	Downrated F-1	1,000,000	1

In relative order of importance, the primary considerations in selecting engines for this application were reliability, performance, required modifications, and availability. To meet Dyna Soar requirements, each of the above engines would be subject to specific modifications to include higher design margins commensurate with optimum reliability and performance trade-offs associated with the mission to be accomplished.

On the basis of the above criteria, a cluster of two (2) E-1 engines is considered to be the best engine choice for reasons discussed herein.

The E-1 engine is presently rated at approximately 380,000 pounds of thrust. Indications are that regardless of application funding, Rocketdyne intends to support engine development through PFRT, (tentatively scheduled for early 1961).

To date, E-1 thrust chambers have undergone in excess of 55 tests. A minimum of ten runs have been full mainstage at thrust levels over 300,000 pounds. The Mark 6 turbo-pump has been in development for about five months.

The E-1 concept is to use the static head on propellant tanks for turbo-pump starting. No separate start system is required. This engine is a minimum component system, typical of the new family of Rocketdyne engines.

Designing an uprated E-1 engine (468,000 pounds of thrust) with higher design margins is considered to involve a lower order of magnitude in effort and cost than any of the engines considered. High reliability and compatible availability are felt to be major considerations supporting this selection.

ROCKETDYNE E-1 ENGINE

The Rocketdyne E-1 engine is a single thrust chamber, single turbopump configuration designed to operate at thrust levels up to 500,000 lbs. at sea level on a LOX and RP-1 propellant combination. The specific version of the E-1 for Dyna Soar, will operate at 468,000 lbs. thrust at sea level and, in addition to the improvements of the basic engine configuration, includes structural safety margins and system redundancies in keeping with piloted craft requirements. Two E-1 engines are required for the Dyna Soar booster. E-1 engines for this application can be made available within 28 months from a contract go-ahead. The engine may be developed for operation with storable propellants, N_2O_4 and N_2H_4, within the same time period.

The general engine envelope and design parameters are given in Figure ___.

The tentative sea level performance ratings for the Dyna Soar application are:

Thrust	468,000 lbs.
Specific Impulse	256 sec.
Chamber Pressure	790 psia
Expansion Ratio	12
Throat Area	380 in^2
Mixture Ratio, (Oxidizer/Fuel)	2.25
LOX Pump NPSH	77 ft.
Fuel Pump NPSH	69 ft.

Estimated performance vs. altitude is given in Figure ___.

FORM M 186-6-6 VELLUM

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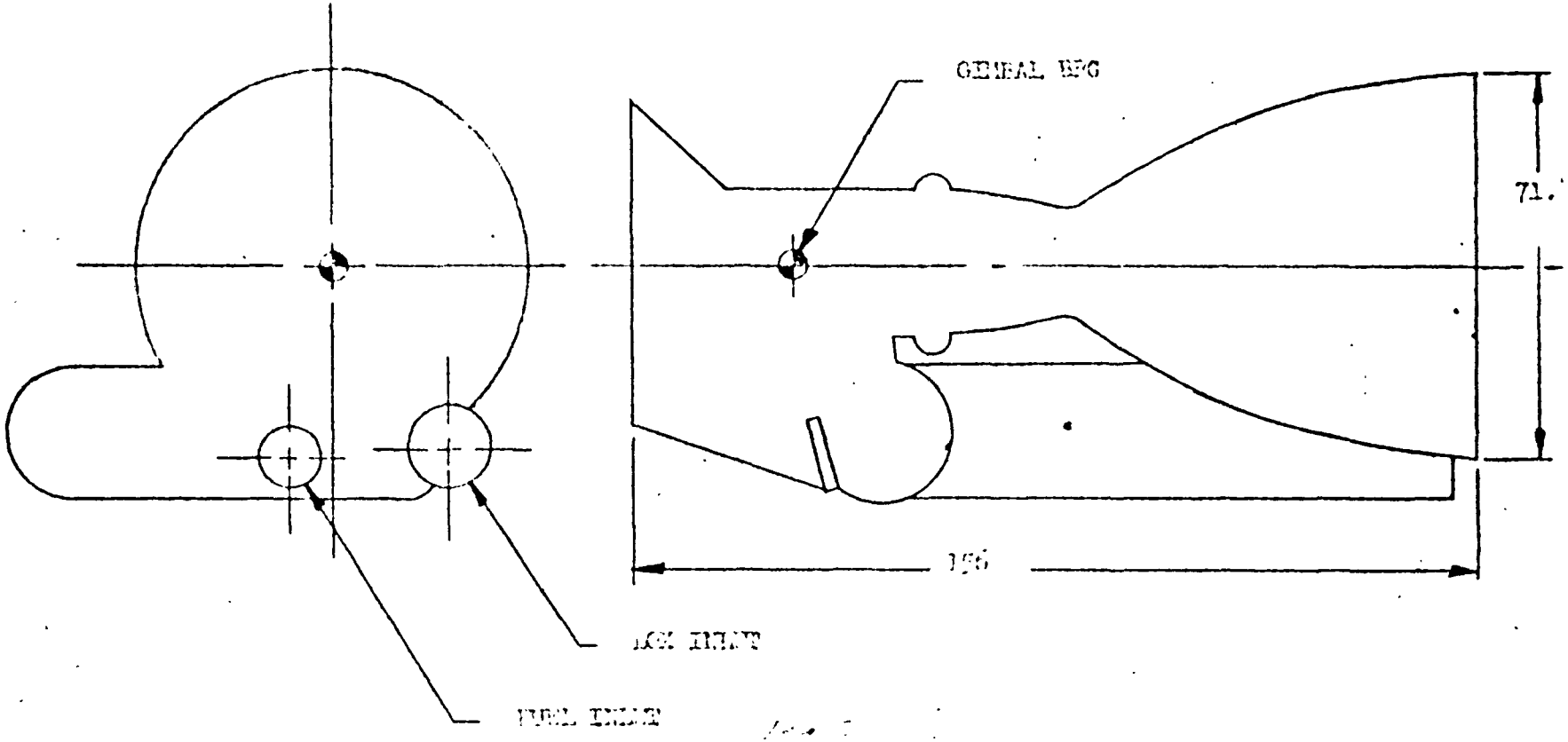
APPROXIMATE ENVELOPE E-1 ENGINE

CHAMBER GIMBAL CAPABILITY = ± 7°
GROSS WET WEIGHT = 4,600 LBS
GROSS DRY WEIGHT = 4,000 LBS
NOTE: WEIGHT ESTIMATES INCLUDE DESIGN SAFETY MARGINS AND SYSTEM REDUNDANCIES FOR PILOTED APPLICATION.



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MISSILE DEVELOPMENT DIVISION

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ESTIMATED PERFORMANCE VS ALTITUDE E-1 ROCKET ENGINE