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SUPERSEDING
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MILITARY SPECIFICATION
LIQUID PROPELLANT ROCKET ENGINE LR 64
FOR AQM - 37A MISSILE TARGET SYSTEM

This specification has been approved by the
Naval Air Systems Command, Department of the Navy

1. SCOPE

1.1 Scope. This specification establishes the requirements for the performance, manufacture, testing, acceptance and packaging of the Liquid Propellant Rocket Engine LR64.

2 APPLICABLE DOCUMENTS

* 2.1 Government-furnished Documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATI0NS

Federal

D-D-1271 Diethylenetriamine, Technical

(Activities outside the Federal Government may obtain copies of Federal Specifications and Standards as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20492.)

(Single copies. of this specification and other product specifications required by activities outside the Federal Government for bidding purpose.s are available without charge at the General Services Adminis - tration Regional Offices in Boston, New York, Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, Seattle, and Washington, D. C.)

(Federal Government activities may obtain copies of Federal Specifications and Standards and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

SPECIFICATIONS

MILITARY

MIL-P-116	Preservation, Methods of
MIL-P-7354	Propellant, Nitric Acid
MIL-P-l9834	Plates, Identification, Metal Foil, Adhesive Backed
MIL-C-23661	C artridge, Impulse, Mk 45 Mod O
MIL-E-25366	Electric and Electronic Equipment and Systems, Guided Missile, Installation of, General Specification for
MIL-D-25604	Propellant, Uns-DimethylhydrazMe
MIL-P-27401	Propellant, Pressurizing Agent, Nitrogen

Weapons Specification

WS-4613	Safety Requirements, Minimum, for Targe Guided Missiles

STANDARDS

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U. S. Military Property

STANDARDS (Cont'd)

Military

MIL-STD-292	Ballistic Nomenclature, Rocket Static Tests
MIL-STD-721	Definitions of Effectiveness, Terms for Reliability, Maintainability, Human Factors, and Safety
* MIL-STD-889	Dissimilar Metals

DRAWINGS

Naval Air Systems Command

BuWeps Dwg 2522505	Rocket Engine LR64 for AQM-37A Missile Target, Coordination Control Drawing
NAVAIR Dwg 589 AS1OO	Fitting, Propellant Valve, Shear

(When requesting any of the applicable documents, refer to both title and number. All requests should be made via the cognizant Government inspector. Copies of this specification and other unclassified specifications and drawings required by contractors in connection with specific procurement functions should be obtained upon application to the Commanding Officer, Naval Supply Depot (Code 1051), 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120. All other documents should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other documents. The following documents form a part of this specification to the extent specified herein Unless otherwise indicated the issue in effect on the date of invitation for bids shall apply.

National Bureau of Standards

Handbook H-28	Screw Thread Standards for Federal Services

National Advisory Committee on Aeronautics

Report No. 1235	Standard Atmosphere

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.)

3 REQUIREMENTS

3.1 Description. The LR64 Liquid Propellant Rocket Engine, consists of a propulsion unit, a cartridge actuated multipurpose nitrogen valve, a cartridge actuated oxidizer valve and shear fitting, a cartridge actuated fuel valve and shear fitting, and two nitrogen check valves.

3.1.1 Propulsion Unit. The propulsion unit consists of a booster thrust chamber, a sustainer thrust chamber, a propellant flow selector valve, a cartridge actuated booster shut-off valve, a thrust mount, and miscellaneous fittings and tubing.

3.1.2 Associated Equipment. Associated with the LR64 Rocket Engine (but not a Part of it) are a fuel tank, an oxidizer tank, a nitrogen tank, impulse cartridges, burst diaphragms and holders, engine section structure. air launch structure, lines, and fittings.

3.1.3 Operation. The LR64 Rocket Engine is prepared for flight by installation of impulse cartridges in the nitrogen, oxidizer, fuel and booster shut off valves. The nitrogen tank is charged to 3, 000 psig and the desired engine thrust level is selected on the propellant flow selector valve, The engine. start sequence is initiated shortly after launch by action of the target's programmer. The nitrogen valve is opened and the stored gas flows through the nitrogen pressure regulator to pressurize the propellant tanks. Upon actuation of the shear fittings in the propellant valves, the pressurized propellants flow from the propellant tanks through the propellant flow selector valve into the thrust chambers. The hypergolic propellents ignite on contact. Propellant flow to the booster thrust chamber is shut off by energizing the impulse cartridge in the booster shut off valve as a function of missile target velocity.

3.2 Preproduction sample. Unless otherwise specified in the contract or purhase order, each contractor who has not previously been approved as a qualified producer of the rocket engine shall manufacture a sample lot of 15 rocket engines (or a greater number when a design proposed in the opinion of the Government requires a Preflight Rating Test (PFRT) and Qualification Program) using the methods, processes and equipment proposed for production. The preproduction engines shall meet the requirements of 3.3.3.4 and 3.5 of this specification when tested in

3.2 (Cont'd)

accordance with Section 4, at an activity designated by the procuring activity for the purpose of demonstrating that the production equipment methods and criteria proposed are suitable and will yield rocket engines meeting the requirements of this specification. No production equipments or lot samples shall be delivered prior to the approval of the prepro - duction samples.

3.2.1 Qualified producer. In the event of interruption of production by a previously qualified producer, the procuring activity shall, unless otherwise specified in the contract or purchase order, require test of additional preproduction rocket engines in number as specified in the contract prior to the resumption of production. Any production by the contractor prior to the approval of the preproduction lot shall be at the contractor's risk.

3.3 General requirements.

* 3.3.1 Construction and dimensions. The rocket engine shall be constructed in strict conformance to Naval Air Systems Command (NAVAIR) Drawings 2522505 and 589 AS100.

* 3.3.2 Materials. Unless otherwise specified in the contract or purchase order, all materials entering into the final assembly of the rocket engine shall conform strictly to the applicable specification. Materials which are not covered by specification or which are not specifically designated herein shall be of the best quality, of the lightest practicable weight consistent with strength and durability, and entirely suited to the purpose for which intended under all conditions of test and sertice operation.

3.3.2.1 Substitute materials. Recommendations concerning the use of a superior substitute for any part of material specified herein shall be accompanied by a description of the proposed substitute and the reasons therefore, together with evidence to substantiate any claim as to its suitability. At the discretion of NAVAIR, test samples may be required to prove the suitability of the proposed substitute.

3.3.2.2 Magnesium. The use of magnesium shall require the specific approval of NAVAIR or its appointed agency.

3.3.2.3 Flammable materials. Materials which will support combustion or which are capable of causing an explosion, except for the propellant and cartridges, shall not be used.

3.3.2.4 Toxic materials. Materials, except the propellant, which may produce harmful toxic or corrosive effects under conditions encountered in the Naval Service shall not be used.

* 3.3.2.5 Dissimilar metals. The use of dissimilar metals shall be governed by the requirements of MIL-STD-889.

3.3.3 Moisture, fungus and corrosion. The rocket engine shall be moisture, fungus and corrosion resistant as required by MIL-E-25366.

3.3.4 Protective coatings and surface treatments. The protective coatings and surface treatments used for the protection of the rocket engine shall be suitable for the propellants and gases used and for the environmental conditions to which the rocket engine will be subjected. Materials and protective treatments used shall be satisfactory both for corrosion and stress corrosion cracking behavior.

3.3.5 Marking. Marking shall conform to the requirements of MIL-STD-130.

3.3.5.1 Nameplates. Nameplates shall conform to the requirements of MIL-P-19834, Type I.

3.3.5.2 Serial numbers. Each rocket engine assembly shall bear a serial number which will be assigned by the Government Inspector upon request, or as specified in the contract or purchase order.

3.3.6 Threads. Unless otherwise specified, all threads shall be in accordance with the National Bureau of Standards Handbook H-28. The class and fit for threads shall be as specified on applicable drawings, and the NOT-GO gaging practice shall be as set forth in the aforementioned Handbook H-28 and the Supplement thereto.

3.3.7 Interchangeability. The following parts of the rocket interchangeable as defined in MIL-STD-721:

3.3.7 (Cont'd)

Booster shutoff valve
Multipurpose nitrogen valve
Nitrogen check valve - oxidizer system
Nitrogen check valve - fuel system
Oxidizer valve & shear fitting
Fuel valve & shear fitting
Miscellaneous fittings and tubing

3.3.8 Weight. The weight of the rocket engine, as defined in 3.1, shall be 22 pounds ± 1 pound.

3.4 Performance requirements.

3.4.1 Rocket engine performance requirements. The rocket engine shall conform to the requirements specified in Table I when supplied with the quantity and type of fuel and oxidizer specified in 3.4.2.

3.4.1.1 Rocket engine thrust control. Thrust controls shall be provided so that engine thrust may be set as shown in Tables H and III.

3.4.2 Propellant.

3.4.2.1 Oxidizer. The oxidizer shall be inhibited red fuming nitric acid (IRFNA) conforming to MIL-P-7254, Type IIIB. 211.3 pounds ± pounds shall be used to meet the requirements of Table I.

3.4.2.2 Fuel. The fuel (MAF-4, Hydyne) shall be a blend of 6 0% ± 1% unsymmetrical dimethylhydrazine by weight conforming to MIL-D-25604, and the remainder by difference of diethylenetriamine conforming to D-D-1271. 70.8 pounds ± 1 pound shall be used to meet the requirements of Table I.

3.4.2.2.1 Specific Gravity. The specific gravity of the fuel at 60 degrees (°)/60° Fahrenheit (F) shall be 0.859 ± 0.003.

3.4.3 Propellant pressurizing agent. The propellant pressurizing agent shall be nitrogen conforming to MIL-P-27401.

TABLE I

ENGINE PERFORMANCE REQUIREMENTS*
450 Psig Propellant Tank Pressure

1. Both chambers operating

a.	Orifice selection	Booster #4, Sustainer #2	
b.	Boost thrust (Extrapolated to 35,000 ft)	631 lbs ±10%	
c.	Specific impulse, Isp	231 lbf-sec./lbm, nominal, instantaneous	
d.	Total flow rate	2.73 lb/sec., nominal	(see 6.4.3)
e.	Propellant weight mixture ratio (O/F)	3.0 nominal	
f.	Run duration	59 sec. nominal	
g.	Impulse, Total	37,229 lbf-sec./lbm ±10%	

Upon delivery of the specified impulse in paragraph 1 the booster shutoff valve shall be used to shut down the booster chamber. The sustainer chamber shall continue operation and shall meet the following requirements:

2. Sustainer chamber operating

a.	Orifice selection	Booster #4, Sustainer #2
b.	Sustain thrust (Extrapolated to 70,000 ft.)	106 Ibs +10% - 5%
c.	Specific impulse, Isp	262 Ibf-see./lbm, nominal, instantaneous
d.	Total flow rate	0.405 lb/see., nominal
e.	Propellant weight mixture ratio (0/F)	3.0 nominal
f.	Run duration	280 sec., minimum
g.	Impulse, Total	28,296 lbf-sec./lbm ± 10%

* Engine performance shall be contingent upon propellants being supplied to the propellant flow selector valve at the following pressures:

		Oxidizer	Fuel
1.	Boost phase	380 psia ± 3.57%	407 psia ± 3.5%
2.	Sustainer phase	448 psia ± 3.5%	448 psia ± 3.5%

NOTE : Engine performance shall normally be verified by conducting engine tests at the test site conditions and extrapolating the data theoretically to specified altitudes based on atmosphere of NACA Report No. 1235. Actual altitude tests may be conducted at the discretion of the Government.

TABLE II

NOMINAL ENGINE PERFORMANCE CHARACTERISTICS

450 PSIG PRESSURE REGULATOR SETTING

Thrust Setting		Propellant Flow Rate lb/sec.			Thrust lb				Specific Impulse Sec.	
Booster (B)	Sustainer (S)	$\dot{w}_B$	$\dot{w}_S$	$\dot{w}_{TOT}$	F_B (35000 ft)	F_S (35000ft)	F_B (70000 ft)	F_S (70000 ft)	I_{sp} (35000 ft)	I_{sp} (70000 ft)
4	3	2.36	.340	2.700	500	75	582	89	231	249
4	1	2.364	.297	2.661	551	63	583	77	231	248
4	0	2.407		2.407	562		594		233	247
3	3	2.100	.345	2.445	485	76	517	90	229	248
3	2	2.100	.367	2.467	485	82	517	96	230	248
3	1	2.120	.302	2.422	490	65	522	79	229	248
3	0	2.139		2.139	495		527		231	246
2	3	1.40	.367	1.767	310	82	342	96	222	248
2	2	1.40	.390	1.790	310	88	342	103	222	249
2	1	1.42	.320	1.740	315	69	347	84	221	248
2	0	1.445		1.445	321		354		222	245
1	3	.85	.378	1.228	173	85	205	99	210	248
1	2	.85	.400	1.250	173	91	205	105	211	248
1	1	.88	.325	1.205	180	71	212	85	208	246
1	0	.899		.899	185		217		206	241
	3		.390	.390		88		103	226	264
	2		.404	.404		92		106	228	262
	1		.328	.328		72		86	220	262

TABLE III

NOMINAL ENGINE PERFORMANCE CHARACTERISTICS

620 PSIG PRESSURE REGUALTOR SETTING

Thrust Setting Booster (B)	Thrust Setting Sustainer (S)	Propellant Flow Rate lb/sec. $\dot{w}_B$	$\dot{w}_S$	$\dot{w}_{TOT}$	Thrust lb F_B (35000 ft)	F_S (35000 ft)	F_B (7000 ft)	F_S (7000 ft)	Specific Impulse Sec. I_{sp} (35000 ft)	I_{sp} (7000 ft)
4	3	2.912	.444	3.356	688	103	720	117	236	249
4	2	2.912	.450	3.362	688	105	720	119	236	250
4	1	2.912	.368	3.280	688	82	720	97	235	249
4	0	2.95		2.95	697		730		236	247
3	3	2.575	.452	3.027	604	105	636	119	234	249
3	2	2.575	.460	3.035	604	107	636	122	234	250
3	1	2.575	.376	2.951	604	85	636	99	233	249
3	0	2.620		2.620	615		647		235	247
2	3	1.716	.472	2.188	389	111	421	125	229	250
2	2	1.716	.480	2.196	389	113	421	127	229	250
2	1	1.720	.392	2.112	390	89	422	103	227	249
2	0	1.730		1.730	393		425		227	246
1	3	1.05	.478	1.528	223	112	255	126	219	249
1	2	1.05	.485	1.535	223	114	255	128	220	250
1	1	1.05	.395	1.445	223	90	255	104	217	248
1	0	1.06		1.06	225		257		212	242
	3		.500	.500		118		132	236	264
	2		.515	.515		122		136	236	264
	1		.404	.404		92		106	228	262

3.4.4 Ablation. The chamber or throat linings of the propulsion unit shall not ablate so as to emit solid particles exceeding those defined in WS-4613.

3.4.5 Smoke emission. The rocket engine shall not emit smoke or flame from any part of the engine other than from the nozzle exits.

3.4.6 Thrust build-up. The time required to increase the rocket engine thrust from activation of the propellant feed line cartridge operated valves to 90 per cent (%) of rated boost thrust shall be in accordance with Figure 1.

3.4.7 Thrust tail-off. The thrust decay time interval from cut-off of the rocket engine booster chamber thrust to 5% of the rated booster chamber thrust shall be not greater than one and one-half (1-1/2) seconds when operating to the requirements of Table I.

3.4.8 Thrust variation. The rocket engine thrust variation from any source at either booster or sustainer thrust level shall be as specified in Table I when measured in accordance with Figure 2.

3.4.9 Operating range.

3.4.9.1 Temperature range. The. rocket engine shall start, operate and stop over the temperature range from minus (-) 65° F. to plus (+) 140° F.

3.4.9.2 Altitude range. The rocket engine shall start, operate and stop over the altitude range from sea level to 100,000 feet.

3.4.10 Cartridges. The rocket engine shall be started and the booster chamber thrust shall be stopped by the activation of impulse cartridges Mk 45 Mod 0 conforming to MIL-C-23661 which will be Government-furnished equipment.

3.4.11 Leakage. The rocket engine shall not leak propellants when tested at a static pressure of 620 psig minimum.

3.5 Environmental requirements.

3.5.1 Static exposure. The rocket engine shall operate after static exposure at a temperature of +140° F ± 3° F when supplied with propellants at a temperature of +140° F ± 3° F, and after static exposure at a temperature of -65° F ±3° F when supplied with propellants at a temperature of -65° F ±3° F. The rocket engine shall meet the performance requirements of 3.4 after being subjected to the static exposure test of 4.4.3.1.

3.5.2 Temperature cycling. The rocket engine shall meet the requirements of 3.4 after being subjected to the temperature cycling test of 4.4.3.2.

3.5.3 Vibration.

3.5.3.1 Vibration endurance. The rocket engine shall meet the requirements of 3.4 after being tested for a minimum of nine hours as specified in 4.4.3.3.2.

3. 5.3.2 Vibration endurance life test. The rocket engine shall be tested as specified in 4.4.3.3.3.

3.6 Reliability. The probability of successful operation of the rocket engine shall be not less than O.975 at the 80 per cent confidence level.

3.7 Safety. The Liquid Propellant Rocket Engine LR64 shall meet the minimum safety requirements of WS-4613.

3.8 Cleanliness. All components and assemblies of the rocket engine shall be free from burrs, sharp edges, scratches, chips, grease, oil and other foreign material which could result in malfunction of the rocket engine or components, or which could be a safety hazard in handling.

3.9 Workmanship. The rocket engine, including all parts and assemblies, shall be constructed and finished in a manner to assure compliance with all requirements of this specification. Part icular attention shall be paid to marking of parts and assemblies, to plating, machine screw assemblage, welding and brazing where applicable. The standards of workmanship exhibited in any approved preproduction sample, subject to any qualification stated in the

3.9 (Cont'd)

Government's notice of approval, shall be determinative of the requirements of the contract relative to workmanship insofar as not specifically covered by applicable specifications.

4 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or puchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to the prescribed requirements.

4* 2 Classification of examinations and tests. Examinations and tests of the rocket engine shall be classified as follows:

a. Preproduction Test	4.4
b. Quality Conformance Test	4.5
c. Production Monitoring Test	4.3.3
d. Reliability Test	4.6

4.3 Sampling.

4.3.1 Preproduction sample. The preproduction sample, manufactured in accordance with 3.2, shall consist of not less than 15 rocket engines.

4.3.2 Quality conformance sample. One rocket engine shall be randomly selected from each group of 21 production rocket engines as the sample for the quality conformance test. The engine selected shall not be considered as a deliverable production unit. Examination and test records of the quality conformance sample shall be maintained and shall be available to the procuring activity.

4.3.2.1 Quality Verification Test Data Report. Each quality conformance sample tested in accordance with 4.5.4.1, shall be logged on the Quality Verification Test (QVT) data report depicted in Figure 3.

4.3.3 Production monitoring sample. AQM-37A missile targets, including the LR64 rocket engine and associated equipment (see 3.1) will be selected from the accepted target production lot, in number determined and flight tested by the Government, as the production monitoring sample.

4.3.4 Reliability sample. The reliability sample shall consist of the entire quality conformance sample and shall meet the requirements of 3.6.

4.4 Preproduction tests. The preproduction sample, after having satisfactorily passed the examinations listed in 4.5.1, shall be subjected to the tests specified in Table IV.

TABLE W

Test	No. of Units	Paragraph
Static exposure	5	4.4.3.1
Temperature cycling	8	4.4.3.2
Vibration endurance	1	4.4.3.3.2
Vibration endurance life	1	4.4.3.3.3

4.4.1 Test conditions. Except as specifically required under the tests of 4.4.3, ambient test conditions shall be as follows:

a. Temperature	+10°F to +125° F
b. Humidity	Up to 95 percent relative maxim
c. Altitude	Normal ground
d. Vibration	None

4.4.2 Test equipment and setup. The designated testing activity shall furnish and maintain all necessary test equipment and facilities and personnel for performing all preproduction tests. The test equipment and facilities shall be adequate in quantity, and unless definite requirements are specified, shall be of sufficient accuracy and quality to permit performance of the required preproduction tests.

4.4.2.1 Preproduction test data report. The contractor shall submit all data recorded in conducting preproduction tests to the procuring activity for review and approval. The preproduction test data report shall include, but not necessarily be limited to the following:

a. Description of tests.
b. Photographs and description of methods and equipment.
c. Chronological history of tests.
d. Analysis of results.
e. Conclusions.
f. Recommendations.
g. Reduced data.
h. True copies of recorded data.
i. Calibration data.
j. Performance evaluations with respect to specifications.

4.4.3 Preproduction test Procedures.

4.4.3.1 Static exposure.

a. Two rocket engines and the propellants shall be subjected to an equilibrium temperature of -65° F ±3° F for 96 hours and without warming up then static fired at -65° F. Results of the firing shall indicate compliance with the requirements of 3.4.

b. Three rocket engines and the propellants shall be subjected to an equilibrium temperature of +140° F ± 3° F for 96 hours and then static fired at +140° F. The results of the firing shall indicate compliance with the requirements of 3.4.

4.4.3.2 Temperature cycling. Four rocket engines and the propellants shall be subjected to each of the equilibrium temperature levels, ±3° F, listed below for a minimum of 2 hours at each level.

Number of Units	Temperatures
4	-65°F. +140°F. -65°F.
4	+140°F. -65°F. +140°F.

4.4.3.2 (Cont'd)

At the conclusion of each temperature cycling series, the rocket engine and the propellants shall be stabliz ed at the final cycle temperature and shall then be static fired. The results of the firing shall indicate compliance with the requirements of 3.4.

4.4.3.3 Vibration. Vibration tests shall be performed on the following components of two rocket engines. The propulsion unit, the multi-purpose nitrogen valve, the oxidizer valve and shear fitting, the fuel valve and shear fitting, and the two nitrogen check valves shall each be attached to its respective rigid fixture capable of transmitting the vibration conditions specified herein. Attachment of each component listed above to its respective fixture shall be made through the service mounting which represents dynamically the most adverse service mounting possible. The amplitude of applied vibration shall be monitored on each test fixture near the component's mounting points.

4.4.3.3.1 Resonance survey. A resonance survey shall be conducted on each component (listed in 4.4.3.3) of two rocket engines. Vibratory accelerations not greater than 3 g's shall be applied successively along each of the axes noted below:

a. Parallel with the longitudinal axis of the unit
b. Along an axis perpendicular to the longitudinal axis
c. Along an axis perpendicular to both (a) and (b)

Each component (listed in 4.4.3.3) shall be vibrated throughout the frequency range of 20 cps through 1200 cps by slowly varying the frequency over a one-hour period. If required by available test equipment, the tests may be conducted in stages. All resonant frequencies shall be recorded for use in 4. 4.3.3.2 and 4.4.3.3.3.

4.4.3.3.2 Vibration endurance. Following the resonance survey, 4.4.3.3.1, each component of one rocket engine (listed in 4.4.3.3) shall be vibrated for a total of three hours in each of the frequency bands noted below. This three hour period shall be divided equally between the three axes noted in 4.4.3.3.1.

The frequency bands and associated acceleration input levels shall be as follows:

a. 20 to 60 CpS	Nine (9) g's
b. 60 to 500 CpS	Three (3) g's
c. 500 to 1200 Cps	One (1) g

In each axis and in each frequency band the test time shall be divided equally between those resonances recorded in the test of 4.4.3.3.1 in that axis and frequency band. Where no resonances were noted in that axis and frequency band, the frequency shall be continuously varied over the band frequency for the duration of the vibration in that axis. Frequency control shall be automatic and may be either linear or logarithmic. At the conclusion of the test, the components comprising one rocket engine shall be static fired at the rated thrust for the duration shown in Table I. Results of the firing shall indicate compliance with the requirements of 3.4.

4.4.3.3.3 Vibration endurance life test. Each component comprising the second rocket engine subjected to the resonance survey, 4.4.3.3.1, shall be subjected to the endurance life test. The endurance life shall be established by repeating the vibration tests of 4.4.3.3.2 (total time element of 9 hours) until damage is visible or a total time of 45 hours is reached, whichever occurs first. If the components (listed in 4.4.3.3) are undamaged at the completion of the test, the second rocket engine comprised of these components shall be static fired at the rated thrust in compliance with Table I and the results recorded for comparison with the requirements of 3.4. Should any of the components of the rocket engine (listed in 4.4.3.3) show visible damage before completion of 45 hours of test, details on the nature and time of damage shall be recorded.

4.4.4 Acceptance criteria. Unless otherwise specified in the contract or purchase order, preproduction evaluation samples shall be approved on the basis of compliance with this specification and all applicable drawing and specification requirements.

4.4.4 (Cont'd)

Failure of one or more engines to comply with any of these requirements shall be cause for rejection of the preproduction test sample.

4.5 Quality conformance tests and examinations.
Each sample, selected in accordance with 4.3.2, shall be subjected to examinations and tests as follows:

* 4.5.1 Examinations

	Requirement
a. Construction and dimensions	3.3.1
b. Materials	3.3.2
c. Moisture, fungus and corrosion	3.3.3
d. Protective coatings and surface treatments	3.3.4
e. Marking	3.3.5
f. Threads	3.3.6
g. Interchangeability	3.3.7
h. Weight	3.3.8
i. Cleanliness	3.8
j. Workmanship	3.9

* 4.5.2 Tests.

a. Rocket engine performance	4. 5.4.1
b. Ablation	4.5.4.2
c. Smoke emission	4.5.4.3
d. Thrust build-up	4.5.4.4
e. Thrust tail-off	4.5.4.5
f. Thrust variation	4.5.4.6
g. Operating range	4.5.4.7
h. Leakage	4.5.5

* 4.5.2.1 Test conditions. Tests of the rocket engine, unless otherwise Specified, shall be conducted under the following ambinet conditions:

a.	Temperature	+l0° F to +125° F
b.	Humidity	Up to 95 percent relative maximum
c.	Altitude	Normal ground

4.5.3 Test equipment and setup. The contractor shall furnish and maintain all necessary test equipment and facilities and personnel for performing all quality conformance inspections The test equipment shall be adequate in quality and, unless definite requirements are specified, shall be of sufficient accuracy and quality to permit the performance of the required inspections.

4.5.3.1 Gages. The contractor shall provide himself with whatever gages are necessary and adequate to insure that the material to which this specification applies will meet the dimensional requirements shown on the applicable drawings.

4.5.4 Quality conformance inspection procedures.

4.5.4.1 Rocket engine performance. Each sample rocket engine, selected in accordance with 4.3.2, when supplied with propellants and pressurizing agent conforming to 3.4.2 and 3.4.3, respectively, shall be static fired to demonstrate compliance with the requirements of T able 1.

4.5.4.2 Ablation. Following the test of 4.5.4.1, the rocket engine shall be examined to determine that the requirements of 3.4.4 have been demonstrated.

4.5.4.3 Smoke emission. During the test of 4.5.4.1, the rocket engine shall be observed to determine that the requirements of 3. 4.5 have been demonstrated.

4.5.4.4 Thrust build-up. The trace of the thrust curve taken during the test of 4. 5.4.1 shall be examined to determine that the requirements of 3.4.6 have been demonstrated.

4.5.4.5 Thrust tail-off. The trace of the thrust curve taken during the test of 4.5, 4.1 shall be examined to determine that the requirements of 3.4.7 have been demonstrated.

4.5.4.6 Thrust variation. Slices as specified in 4.5.4.6.1 and 4. 5.4.6.2 shall be cut through the trace of the thrust curve taken during the test of 4, 5. 4.1 and examined to determine that the requirements of 3.4.8 have been demonstrated.

4.5.4.6.1 Boost thrust slice time. The boost thrust slice shall be taken at any time during an average stabilized portion of the interval from 20 to 40 seconds after activation of the propellant feed line cartridge operated valves. (See Figure 2).

4.5.4.6.2 Sustainer thrust slice time. The sustainer thrust slice shall be taken at any time during an average stabilized portion of the interval from 170 to 230 seconds after activation of the propellant feed line cartridge operated valves. (See Figure 2). If the sustainer chamber thrust varies more than 5% in the interval from 80 to 339 seconds after activation of the propellant feed line cartridge operated valves, or in the interval from 80 seconds to the beginning of final decline, whichever is less, a data slice shall be taken at maximum and minimum sustainer thrust in the 170 to 230 second interval and the average shall constitute the accepted reading. (See Figure 2).

4.5.4.7 Operating range.

4.5.4.7.1 Temperature range. Ten % of the sample rocket engines, selected in accordance with 4.3.2, shall undergo the test of 4.5.4.1 when fired at a stabilized temperature of -65° F ± 3° F. Ten % of the sample rocket engines, selected in accordance with 4.3.2, shall undergo the test of 4.5.4.1 when fired at a stabilized temperature of +140° F ± 3° F. The propellants shall be stabilized at the same temperature that the rocket engine has been stabilized. The rocket engines shall fire at both temperatures and the propellant shall sustain burning until the end of the firing run as calculated for the specific temperature of firing.

4.5.4.7.2 Altitude range. Data resulting from the tests of 4.5.4.1 shall be extrapolated theoretically to the design altitude

4.5.4.7.2 (Cont'd)

based upon atmosphere of NACA Report No. 1235. Calcuated thrust shall fall within the thrust requirements of Table I.

4.5.5 Leakage. The rocket engine of 3.1 shall be visually examined. for leakage of propellant prior to and during the test of 4.5.2 (See Table I.)

4.6 Reliability tests. The rocket engine reliability requirements of 3.6 shall be satisfied upon satisfactory conformance of the sample selected in accordance with 4.3.4 to the static firing tests of 4.5.4.1, and the corrective action of 4.8 in the event of a rejection.

4.7 Rejections.

4.7.1 Quality conformance sample rejection. The failure of any quality conformance sample (4.3.2) to pass the inspection and test outlined in this specification shall cause conditional rejection of all rocket engines represented by that sample, and all subsequent lots, subject to corrective action and retest (4.8).

4.7.1.1 Performance rejection. In the event the quality conformance sample performs outside the limits specified in the QVT Data Report (4.3.2.1), the lot represented by the QVT sample shall be considered conditionally rejected. Analysis of the limit(s) exceeded shall be prepared and submitted to the procuring agency for lot acceptance or lot rejection directions,

4.7.2 Salvaged pieces. Any piece(s) from a rejection rocket engine may be salvaged for use subject to approval by the procuring agency, providing each salvaged piece is inspected and is found to be in complete accordance with the requirements of this specification and the associated drawings and specifications.

4.8 Corrective action and retest.

4.8.1 Corrective action. In the event any sample representing a quality conformance lot fails to pass the inspection and tests outlined herein, the supplier may have the opportunity of

4.8.1 (Cont'd)

resubmitting to retest another sample, selected at random by the Naval Inspector, that represents the rejected lot after the completion of the following corrective action:

a. Determine the cause of failure.
b. Take the necessary action to correct or eliminate the defect from the lot and subsequent lots.
c. Submit to the procuring agency for approval the proposed corrective action to prevent recurrence of the defect.

4.8.2 Retest. After compliance with the corrective action specified in 4.7.1 and approval by the procuring agency, retest of the sample of the affected lot shall be consummated. Should the sample pass the required tests, the lot represented thereby shall be considered acceptable. Should the sample fail, the entire lot represented thereby shall be rejected.

4.9 Test plans, methods, and procedures. The test plans, test methods and procedures, and data reduction methods to be used for all tests specified herein (see 4.2) shall be prepared by the contractor and submitted to the procuring agency for acceptance no later than 2 months prior to delivery of the preproduction test articles or production articles if delivery of the preproduction test articles is waived.

These procedures and methods shall specify, in addition to the details of the tests to be performed, all facilities, test equipment, instrumentation, and test personnel qualifications required for the conducting of all tests.

5 PREPARATION FOR DELIVERY

5.1 Preservation and packaging.

5.1.1 Level A.

5.1.1.1 Cleaning, drying and preservative application shall be in accordance with selected method of MIL-P-116 (see 6.2).

5.1.1.2 Unit packaging. One rocket engine shall be packaged in the container supplied as Government Furnished Equipment (see 6.2).

5.1.2 Level C.

5.1.2.1 Cleaning, drying and preservative application shall be in accordance with selected method of MIL-P-116 (see 6.2).

5.1.2.2 Unit packaging. One rocket engine shall be packaged to afford protection against damage during direct shipment from the supply source to the first receiving activity for immediate use. The shipping container shall comply with the rules and regulations applicable to the mode of transportation.

5.2 Packing.

5. 2.1 Level A.

5.2.1.1 Containers shall be packed or palletized to afford adequate protection during shipment, handling, indeterminate storage and world-wide distribution.

5.2.2 Level C.

5.2.2.1 The rocket engine packaged in accordance with 5.1.2.2 shall be packed or palletized to afford protection against damage during direct shipment from the supply source to the first receiving activity for immediate use. The pack shall comply with the rules and regulations applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required by the contract or purchase order, unit packages, intermediate packages, and shipping containers shall be marked in accordance with the requirements of MIL -ST D-129.

6 NOTES

6.1 Intended use. The Liquid Propellant Rocket Engine LR64 covered by this specification is intended for use in the AQM-37A missile target.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.
b. The number of rocket engines to be provided.
c. The number of preproduction rocket engines to be provided (see 3.2).
d. Technical data, if any, specified in the contract or purchase order.
e. All options or deviations (see 3.2.1).
f. Test plans, methods, and procedures (see 4.9).
g. Preproduction test data report (see 4.4.2.1).
h. Quality Verification Test Data Reports (see 4.3.2.1).

Three copies of the Quality Verification Test Data Report (QVT) shall be forwarded to NAVAIRSYSCOM/AIR-53512 after each static firing.

i. QVT performance rejection analysis (see 4.7.1.1).
j. Corrective action proposals (see 4.8.1).
k. Selection of levels of packaging and packing (see 5.1, 5.2).
l. Preservation methods (see 5.1.1.1, 5.1.2.1).
m. Source of GFE containers if required.
n. Request for use of substitute parts or materials (see 3.3.2.1).

6.3 Conflicting requirements. Conflicting requirements between this specification and any specifications, publications or drawings listed herein should be referred in writing to the procuring activity or its designated agent for interpretation or clarification.

6.4 Definitions. Definitions concerning ballistic nomenclature as contained in MIL-STD-292 are applicable.

6.4.1 Level A. The degree of preservation, packaging and packing which will afford adequate protection against corrosion, deterioration and physical damage during handling, shipment, indeterminate storage and world-wide distribution.

6.4.2 Level C. The degree of preservation, packaging and packing which will afford adequate protection against corrosion, deterioration and physical damage during shipment from supply source to the first receiving activity for immediate use. This level may conform to supplier's commercial practice when such meets the requirements of this level.

6.4.3 Nominal. For the purpose of this specification, the word nominal shall refer to design objectives.

6.5 Changes. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made, This is done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationships to the previous issue.

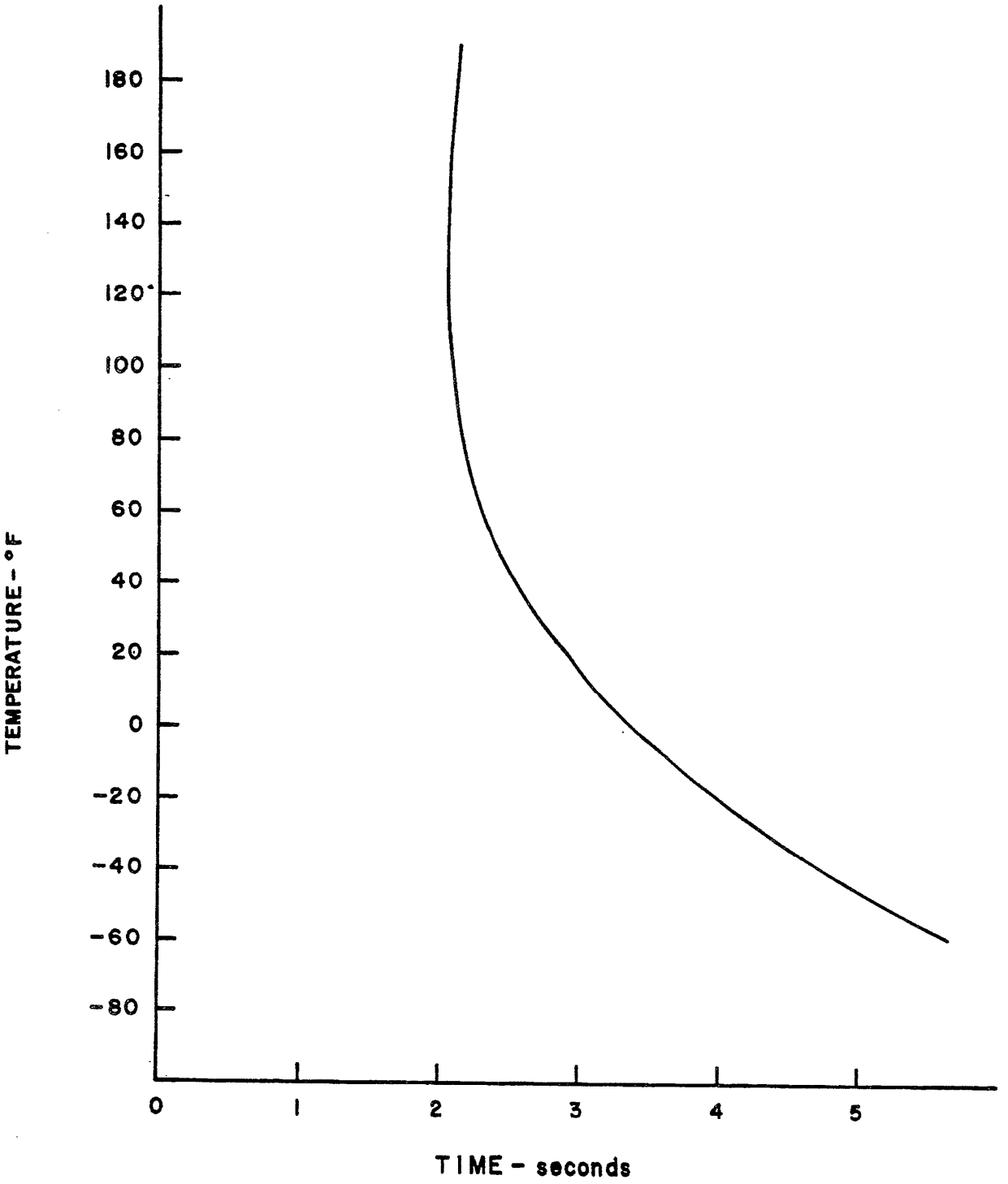

FIGURE 1. LR 64 ROCKET ENGINE:
MINIMUM TIME FROM ACTIVATION OF THE SQUIB OPERATED PROPELLANT VALVES
TO 90% OF RATED THRUST VERSUS TEMPERATURE

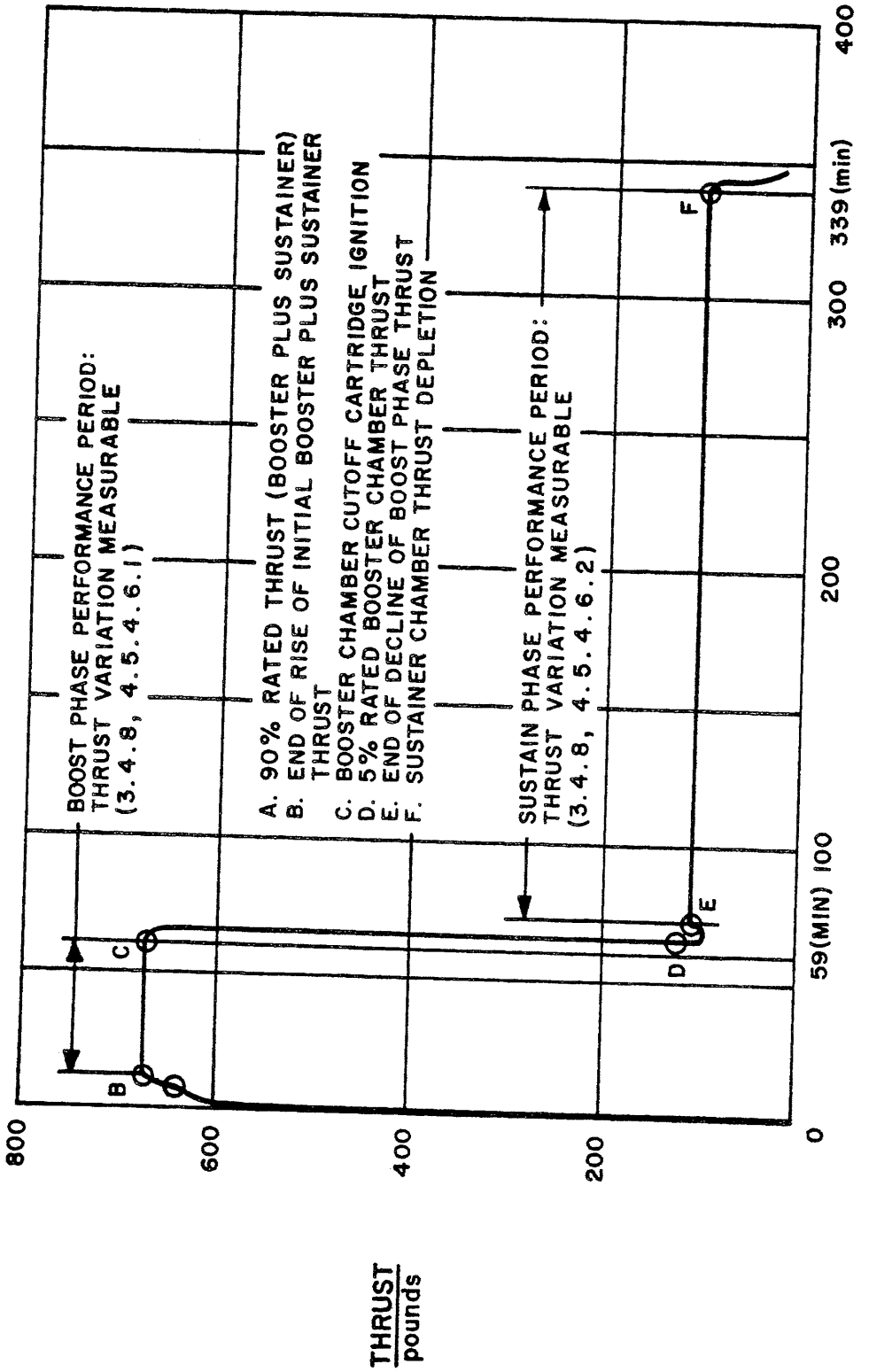

FIGURE 2. LR 64 ROCKET ENGINE:
PERIODS FOR MEASURING THRUST VARIATION

FIGURE.3. QUALITY VERIFICATION TEST DATA
LR64 ROCKET ENGINE

CONTRACT NUMBER _____

QVT ENGINE SERIAL NUMBER _____ (JVT DATE _____

PRODUCTION EFFECTIVITY SERIAL NUMBERS _____ Thru _____

	BOOST PHASE	SUSTAIN PHASE
THRUST		
SPEC.	631± 10% LBS	106 +10% −5% LBS
QVT	_____	_____
SPECIFIC IMPULSE		
SPEC.	231 SECONDS	262 SECONDS
QVT	_____	_____
MIXTURE RATIO		
SPEC.	3.0 o/f	3.0 o/f
QVT	_____	_____
RUN DURATION		
SPEC.	59 SECONDS	280 SECONDS
QVT	_____	_____
IMPULSE		
SPEC.	37,229LB-SEC ± 5%	28, 296LB-SEC ± 10%
QVT	_____	_____
AMBIENT TEMPERATURE		
SPEC	+10°F TO + 125°F	
QVT	_____	

APPENDIX 1

CONTRACTOR FURNISHED EQUIPMENT

The following equipments shall be furnished by the contractor and shall be interchangeable in accordance with 3.3.7.

Item No.	Quantity	DescriPtion	Identification (Mfg. & Part No.)
1	1	Multipurpose (Mutifunc-tion) Nitrogen Valve	
2	1	Oxidizer Valve & Shear Fitting	
3	1	Fuel Valve & Shear Fitting	
4	2	Nitrogen Check Valve	
5	1	Propellant Flow Selector Valve Assembly	

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 1119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification ir procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION
MIL-L-23822C(AS) LIQUID PROPELLANT ROCKET ENGINE LR64 FOR AQM-37A MISSILE TARGET SYSTEM

ORGANIZATION *(Of submitter)*	CITY AND STATE

CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

DD FORM 1 APR 63 1426

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