T10/SNA -- 239

NUCLEAR DIVISION

C002-DS090135-F1

ENGINEERING DESIGN SHEET SPECIFICATION

PERFORMANCE/DESIGN AND
PRODUCT CONFIRMATION REQUIREMENTS

FOR
PUMP DISCHARGE LINE

FORMING A PART OF
CEI NUMBER 090290A

MAJOR

PRELIMINARY PROPOSAL ISSUE

DATED 12-15-69

FOR REVIEW ONLY. DO NOT IMPLEMENT.

AEROJET-GENERAL CORPORATION

SACRAMENTO, CALIFORNIA

TECHNICAL DOCUMENT CENTER
Nuclear Rocket Operations

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

DOC. NO. 14-1969

AGCS 0120-48

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

AEROJET-GENERAL CORPORATION

CODE IDENT. NO. 05824

Data Item Identification
No. C002-DS-90135-F1

Design Sheet
Component Specification No. DS-90135

Part I of Two Parts
Page - 1 of 14

PERFORMANCE/DESIGN AND QUALIFICATION REQUIREMENTS

for

PUMP DISCHARGE LINE

Replace page(s) with the latest revised page(s) noted below. Revised paragraph(s) are identified with the latest revision letter (or number) in the margin.

	REV LTR
Page	DATE
No.	ECP

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

CLASSIFICATION CATEGORY	
UNCLASSIFIED	
CLASSIFYING OFFICER	DATE

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

5

1. SCOPE

1.1 Scope.- This specification establishes the performance, design, test, and qualification requirements for equipment identified as pump discharge lines (PDL). The PDL transports propellant from the turbopump discharge to the nozzle torus inlet and to the inlet of the structural support coolant line.

2. APPLICABLE DOCUMENTS

2.1 Aerojet-General Corporation Documents.- The following documents, of the latest issue, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced herein and other detailed content of Sections 3, 4, 5, and 10 the detailed requirements of Sections 3, 4, 5, and 10 shall be considered a superseding requirement.

SPECIFICATIONS

EC-90218

Propellant Feed System

CP-90290

Engine, NERVA 75K, Full Flow

DRAWINGS

1136390

Engine Layout

3. REQUIREMENTS

3.1 Performance.- Except as otherwise specified herein, performance requirements for this equipment shall be in accordance with EC-90218, Propellant Feed Subsystem, of which this equipment is a part. The PDL shall be capable of meeting these requirements within the environmental conditions specified in 3.1.2.4.

3.1.1 Functional Characteristics. - The PDL shall transport propellant from the turbopump discharge to the nozzle torus inlet and to the inlet of the Structural Support Coolant Line (SSCL).

3.1.1.1 Propellant Flow. - The propellant characteristics of the PDL shall be as shown on Table I.

3.1.1.2 Pressure Drop. -

3.1.1.2.1 Design Point. - The allowable pressure drop of the PDL at the engine nominal design state point conditions shall be as shown on Table II.

3.1.1.2.2 Symmetry, Pressure Drop. - The allowable variation in the pressure drop specified, from the line inlet to the pump discharge check valve (PDKV) inlet, shall not be greater than 20% between that line interfacing with TPA #1 and that line interfacing with TPA #2.

3.1.1.3 Structural Support. -

3.1.1.3.1 Pump Discharge Check Valve (PDKV) Support. - The PDL shall provide structural support for the PDKV. This support shall serve to prevent dynamic amplification which would prevent proper valve operation.

3.1.1.3.2 Instrumentation. - The PDL shall provide mounting capability for all instrumentation transducers.

3.1.2 Operability. -

3.1.2.1 Reliability. - The reliability of the PDL, including joints, shall be a minimum of 0.999978 apportioned into subcategories as shown in Table III.

3.1.2.2 Maintainability.- The time required for manual removal of the PDL upper segment or the PDL lower segment shall not exceed one hour. The time required to manually install the upper or lower segments shall not exceed three hours, not including leak check. The time limitation for remote removal and replacement shall be six hours.

3.1.2.2.1 Maintenance and Repair Cycles.- There shall be no periodic maintenance required on the PDL.

3.1.2.2.2 Service and Access.-

3.1.2.2.2.1 Checkout.- The PDL joints shall be capable of being leak checked subsequent to installation, within three hours.

3.1.2.2.2.2 Removal.- The PDL shall be both manually and remotely removable from the engine assembly in two segments as follows: (a) Upper segment consisting of that length from the two PDL inlets to the PDKV outlet and (b) Lower segment consisting of that length from the PDL aluminum segment inlet to the nozzle inlet. The two segments shall be as shown in Figure 1.

3.1.2.3 Useful Life.- The PDL shall have a minimum useful life of 9 years, allocated as follows:

(a) Rated operating life	
Time, minutes, minimum	600
Cycles, maximum	60
(b) Non-rated operating life	
(1) Transient and in-flight checkout, minutes	2400
(2) Acceptance-thermal cycles from ambient to operating and back to ambient temperature	20

(c) Non-operating life

(1) Engine assembly to launch pad (less ground storage), months	6
(2) Launch pad, months	6
(3) Space storage (includes (a) and (b)), years	3
(4) Ground storage, years	5

3.1.2.4 Environmental.- The natural environments and the loads experienced by the PDL shall be as specified in EC-90218 in addition to the following:

3.1.2.4.1 Turbopump Dynamic Output.- The PDL shall be capable of accepting the turbopump dynamic output.

3.1.2.4.2 Nozzle Dynamic Output.- The PDL shall be capable of accepting the nozzle dynamic output.

3.1.2.4.3 Imposed Movements.- The PDL shall be capable of accepting all relative movements of the turbopump and nozzle without creating harmful loadings on the interfacing components or harmful stresses within the line. All relative movements shall include all tolerances due to fabrication and assembly and all motion due to applied loads and thermal changes.

3.1.2.4.4 Nuclear.- The PDL shall be capable of functioning within the nuclear environments of Table IV.

3.1.2.5 Transportability.- The PDL shall be capable of meeting the transportability requirements specified in EC-90218.

3.1.2.6 Human Performance.- The PDL shall be capable of meeting the human performance requirements specified in EC-90218.

3.1.2.7 Safety.- The PDL shall be capable of complying with all the safety requirements specified in EC-90218.

3.2 CEI Definition.- Not applicable.

3.3 Design and Construction.- Except as otherwise specified herein, design and construction of the PDL shall be in accordance with EC-90218, of which this line is a part.

3.3.1 General Design Features.-

3.3.1.1 Joints.-

3.3.1.1.1 Remote Joints.- Remote joints shall be capable of assembly and disassembly by means of either a manipulator or a remote power or signal source in order to permit the human operator to be protected from the NERVA radiation environment. All remote joints shall be also capable of assembly and disassembly by manual means by unprotected personnel.

3.3.1.1.2 Permanent Joints.- Permanent joints shall not contain a static seal to prevent leakage at the interface but shall be permanently bonded as by welding, brazing, or soldering.

3.3.1.2 Envelope.- The total envelope occupied by the line shall be as shown on Figure 1 and drawing 1136390.

3.3.1.3 Weight.- The line total weight, not including the remote joint capability shall be as shown on Figure 1.

3.3.1.4 Loads.- Thermal loads created by the line at its inlet shall be as specified in Table V.

3.3.1.5 Stiffness.-

3.3.1.5.1 Allowable.- The allowable stiffness of the PDL at its inlet, shall be as specified in Table VI.

3.3.1.5.2 Symmetry.- The allowable variation in the stiffness specified above between the #1 TPA flange and the #2 TPA flange shall not be greater than 20%.

3.3.1.6 Leakage.- The allowable leakage of static seal flange joints for the flight engine shall be 1×10^{-1} scc/sec/in diameter nominal at a test pressure of 50 psi with helium. Leakage shall be disposed of in such a manner that it will not cause a safety hazard.

3.3.1.7 Contamination.- The allowable contamination shall be as specified in CP-90290. Design of all lines, bellows, and subcomponents shall be such as to minimize the existence of entrapped areas which cannot be visually inspected for contaminants.

3.3.1.8 Nuclear Shielding.- Secondary nuclear shielding shall be provided as part of the PDL in the segment routed around the disk shield. The secondary shield shall consist of material having a thickness of 0.25 inches with a density of 0.3 lbs/cu.in., shaped to the contour of the PDL.

3.3.2 Selection of Specifications and Standards.- As specified in CP-90290.

3.3.3 Materials, Parts and Processes.- As specified in CP-90290.

3.3.4 Standard and Commercial Parts.- As specified in CP-90290.

3.3.5 Moisture and Fungus Resistance.- As specified in CP-90290.

3.3.6 Corrosion and Metal Parts.- As specified in CP-90290.

3.3.7 Interchangeability and Replaceability.- As specified in CP-90290.

3.3.8 Workmanship.- As specified in CP-90290.

3.3.9 Electromagnetic Interference.- Not Applicable

3.3.10 Identification and Marking.- As specified in CP-90290.

3.3.11 Storage.- The PDL shall be capable of performing as specified herein subsequent to storage while protected from the ground environmental conditions specified in 3.1.2.4 for a period not exceeding the ground storage life specified in 3.1.2.3.

TABLE I

PROPELLANT FLOW CHARACTERISTICS

<u>Inlet Conditions</u>	<u>Normal Operating Mode (Two Pumps)</u>	<u>Malfunction Operating Mode (One Pump)</u>	<u>Specificatio Maximum</u>
Pressure (psia)	1468	1874	2232
Temperature (°R)	61	67	67
Flow Rate (lb/sec)	44.6	89.3	93

<u>Inlet Conditions (to SSCL)</u>	<u>Normal Operating Mode (Two Pumps)</u>	<u>Malfunction Operating Mode (One Pump)</u>	<u>Specificatio Maximum</u>
Pressure (psia)	1426	1721	2193
Temperature (°R)	61	67	68
Flow Rate (lb/sec)	20.6	20	21

Specification No. DS-90135

TABLE II

PRESSURE DROP (psid)

	<u>Normal Operating Mode (Two Pumps)</u>	<u>Malfunction Operating Mode (One Pump)</u>
TPA to PDKV	8 ± 0.6	$25 \begin{smallmatrix} + 1.5 \\ - 0 \end{smallmatrix}$
PDKV to NOZZLE	24 ± 1.7	24 ± 1.7

TABLE III

RELIABILITY APPORTIONMENT

<u>Segment</u>	<u>Reliability</u>
Remote Joints (each)	.999998
Remote Joints (5 total)	.999991
Bellows (each)	.999998
Bellows (6 total)	.999989
Line Segments (Total)	<u>.999998</u>
TOTAL	.999978

TABLE IV

FLIGHT ENGINE - NO - SHIELD - UNPERTURBED

NUCLEAR ENVIRONMENT

Description	Location Station	(in) R	Kerma Rate Rads/Hr	γ Kerma Rads (10 Hr Exp)	In Al γ Heating Rate Btu/in ³ -sec	Thermal Neutron		Fast Neutron		Epy Thermal	
						Flux n/cm ² sec	Fluence n/cm ²	Flux n/cm ² sec	Fluence n/cm ²	Flux n/cm ² sec	Fluence n/cm ²
PDL	82.8	54.8	1.9+7	1.9+8	2.3-3	1.2+11	4.2+15	1.9+12	7.0+16	5.2+12	1.9+17
Bell #1	45.2	49.4	3.8+6	3.8+7	4.7-4	2.9+10	1.0+15	6.3+11	2.3+16	1.6+12	5.8+16
Bell #2	45.2	29.2	2.2+6	2.2+7	2.8-4	1.5+9	5.4+13	1.4+11	5.0+15	1.8+11	6.5+15
Bell #3	55.7	56.5	7.0+6	7.0+7	8.7-4	5.1+10	1.8+15	9.0+11	3.2+16	2.2+12	8.0+16

Specification No. DS-90135

TABLE V
THERMAL LOADS

	<u>Axial Load</u> <u>(lb)</u>	<u>Shear Load</u> <u>(lb)</u>	<u>Bending Moment</u> <u>(lb-in)</u>	<u>Torsion</u> <u>(lb-in)</u>
(a) Nominal	150	500	12000	4000
(b) Maximum	300	1000	24000	8000

TABLE VI
ALLOWABLE STIFFNESS

	<u>K_{Axial}</u> <u>(lb/in)</u>	<u>K_{Shear}</u> <u>(lb/in)</u>	<u>$\frac{M}{\theta}$ Bending</u> <u>(lb-in/deg)</u>	<u>$\frac{M}{\theta}$ Torsion</u> <u>(lb-in/deg)</u>
(a) Nominal	500	500	20000	5000
(b) Maximum	1000	1000	40000	10000

Figure 1

Figure 1 (Continued)