DESIGN AND FABRICATION OF PROTOTYPE
PRIMARY NaK LOOP VALVE SETS

FOLDER 2: BUSINESS MANAGEMENT AND COSTS

A Proposal to
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Proposal NR69053

24 June 1969

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AEROJET-GENERAL CORPORATION
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I. INTRODUCTION AND SUMMARY

A. RESPONSE TO REQUEST FOR PROPOSAL

This proposal is submitted in response to Request for Proposal No. 438468, dated 27 May 1969, from the Power Procurement Section of the NASA Lewis Research Center, to design, fabricate and test Primary NaK Loop (PNL) valves for use in ground testing of the SNAP-8 Power Conversion System.

Aerojet is uniquely qualified to participate in the proposed program because of its extensive experience in valve development, liquid metals and related nuclear applications.

The proposed program is organized to take maximum advantage of the related technology programs conducted by Aerojet such as:

- Liquid Metal Fast Breeder Reactor Valve Technology Program
- Alkali Metals Program
- NERVA Nuclear Rocket Development Program and the more than five hundred types of electrical, electromechanical and mechanical valves and controls designed and developed over the past twenty-five years.

The Nuclear Division of the Aerojet-General Corporation proposes to accomplish the program objectives delineated in the RFP by conducting the following program:

- a thirty (30) day preliminary design task
- a ninety (90) day detail design task
- a one hundred-eighty (180) day fabrication and test task

I, A, Response to Request for Proposal (cont.)

Schedular compression could be achieved if the latter tasks were allowed to proceed concurrent with approvals and authorization were granted when appropriate for the procurement of long lead time components.

The proposed program is in compliance with the technical requirements of the RFP and no exceptions are taken. However, we do wish to document our concern that the magnitude of the pressure differential (in the startup/shutdown mode) available to operate the valve in a self-actuating manner is in question. Further analysis will be required to resolve this question. For this reason the alternate concept included uses a supplementary energy source for actuation. An electric motor is proposed. The use of this supplementary energy source for actuation will have an effect on component reliability that will require evaluation with particular consideration given to the high thermal and radiation environment.

Exception is taken to the schedule for completion of Task II. Although every effort will be made to meet the specified schedule, Aerojet cannot realistically commit itself to completion of Task II 90 calendar days after the date of the contract when authorization to proceed with Task II can be withheld up to 45 calendar days. We would welcome the opportunity to discuss this subject with you to clarify any misunderstanding on our part or investigate an alternate approach that would satisfy your schedule requirements.

A cost-plus-fixed-fee contract is contemplated.

Aerojet-General has a long-standing and a special interest in technology offering a potential for reducing costs. It has successfully participated in numerous contractual and Company-sponsored technology programs having this aim as a major objective. Aerojet-General is in full compliance with the objectives of the NASA Contractor Cost Reduction Program

I, A, Response to Request for Proposal (cont.)

as approved by the NASA Cost Reduction Board. This is evidenced by the letter and certificate included as Appendix A of this folder.

In addition to its broad, pertinent technological experience, Aerojet-General proposes a functional team of available, highly-qualified specialists to accomplish this effort. The total nuclear capabilities and experience of Aerojet will be applied to the Primary NaK Loop Valve Program. Mr. R. L. Murray, as manager, will bring to the program 14 years of engineering experience, the last thirteen of which have been at Aerojet in increasingly important assignments. His most recent position was as project manager of Contract SNPC-35, recently completed on schedule and within budget. This three-year, \$12,000,000 incentive contract included the design, development, testing, and delivery to the Los Alamos Scientific Laboratory of the largest nuclear rocket nozzles produced to date.

The appointment of Mr. E. A. Shearer as Project Engineer will ensure that Aerojet's valve design and development experience will be fully integrated into the proposed program. Mr. Shearer has 17 years of valve and control systems experience. During his 13 years with Aerojet, he has directed the design and development of major critical control systems on Titan I, Titan II, Gemini, M-1, and Transtage engines. His most recent assignment was as project engineer of an all-metal, multi-propellant compatible, electric motor-actuated valve for future deep-space engines.

In selecting the project organization for the proposed program, Aerojet-General has drawn personnel from both its Nuclear and Liquid Rocket organizations. This will assure the application of a broad gamut of technical knowledge and recent valve technology experience to successfully satisfy the proposed program objectives.

I, A, Response to Request for Proposal (cont.)

The proposed Prototype Primary NaK Loop Valve-Development Program will be conducted on a project basis. Aerojet-General experience has demonstrated that streamlined project management utilizing a central management-technical-administrative team results in effective control over the technical, financial, and schedule requirements of a program. Project management also will facilitate the ease of communication with the NASA Lewis Research Center as well as the implementation of any new technical, financial, or administrative requirements mutually worked out with the NASA Lewis Research Center. In addition, the project management technique permits the use of specialized staff personnel from diverse technical and scientific disciplines as required. This assures that highly specialized talent is utilized on a practical economic basis.

A basic precept of Aerojet-General management philosophy is that the assignment of total program responsibility is accompanied by the delegation of total program authority. Not only does this strengthen the project management concept but it also will assure a positive and prompt response to NASA Lewis Research Center direction. The specific program controls and reporting systems are described in Section II,D of this folder. They have been evolved as a result of experience and have been repeatedly demonstrated to be effective.

The unequivocal delegation of authority and the uncomplicated, direct lines of management control assure firm program direction, quick response to changing requirements, and the immediate interest of Corporate Management as well as their continuing support. The selective staffing of the proposed study and its placement within the Sacramento Facility organization is evidence that Aerojet-General recognizes the significance of the NASA project. Further, each member of the proposed functional team has

I, A, Response to Request for Proposal (cont.)

participated in the preparation of this proposal and is fully aware of the program objectives. Each team member has a sense of direct and personal responsibility as well as an active involvement in the effort.

Upon receipt of the award, Aerojet-General will implement this program at its Sacramento Facility, Sacramento, California, which is organized, staffed, and equipped to accomplish this specific type of work both efficiently and economically. All of the facilities required to conduct the program are available without interference with existing programs.

The proposal consists of two folders. Folder 1 is the Technical Proposal. This is Folder 2, the Business Management and Costs Proposal. Both folders follow the instructions contained in the Request for Proposal and provide all of the information requested therein.

B. COST SUMMARY

Estimated Cost	\$224,684
Fixed Fee	\$ 20,222
Total Estimated Costs and Fee	\$244,906

C. VALIDITY SPAN

This proposal is valid until 22 September 1969. However, a starting date of 1 August 1969 has been assumed.

I, Introduction and Summary (cont.)

D. PROPOSAL CORRESPONDENCE

Correspondence regarding this proposal should be addressed to:

Aerojet-General Corporation
P.O. Box 15847
Sacramento, California 95813
Attention: Mr. F. Basque
(Telephone: 916 - 355-5605)

E. AEROJET-GENERAL PERSONNEL AUTHORIZED TO CONDUCT
NEGOTIATIONS

The following personnel are authorized to conduct contractual negotiations as representatives of the Aerojet-General Corporation:

Mr. G. L. Ryland	Mr. F. R. Basque
Telephone: A/C 916, 355-6063	Telephone: A/C 916, 355-5605

Both of the above Contract Representatives can be reached at the following mailing address:

Aerojet-General Corporation
P.O. Box 15847
Sacramento, California 95813

II. PROGRAM MANAGEMENT

A. AEROJET-GENERAL MANAGEMENT STRUCTURE

1. Corporate Management and Intra-Company Relationships

Aerojet-General is incorporated under the laws of the State of Ohio and maintains its corporate headquarters at El Monte, California. Mr. R. I. McKenzie is President and a Member of the Board of Directors. He directs the overall operation of the company, its principal operating plants, and its subsidiaries (see Figure No. 1). Corporate policy is to make each of these entities available to support a particular project on an "as-required" basis at the request of the individual program manager.

2. Nuclear Rocket Operations

The proposed program will be conducted at Aerojet-General's Sacramento Facility by the Nuclear Rocket Operations organization, which is under the direction of Dr. W. O. Wetmore, Manager, and D. E. Price, Assistant Manager (see Figure No. 2). Dr. Wetmore reports directly to Dr. C. C. Ross, the Senior Vice President and General Manager of the Nuclear Division.

3. Nuclear Rocket Operations Special Projects Department

The primary NaK loop (PNL) development program will be under the direction of the Special Projects Office of Nuclear Rocket Operations (see Figure No. 3). This department is headed by D. Holzman and organized on a project basis. The direct line of communication from the office to the Manager of Nuclear Rocket Operations will assure management support and attention to this program on a continuous basis. In addition, the Liquid Metal Fast Breeder Reactor Valve (LMFBR) program also reports to the Special Projects Office and technology from this program will be of substantial benefit to the PNL program.

Figure 1. Corporate Organization

NUCLEAR DIVISION
NUCLEAR ROCKET OPERATIONS
ORGANIZATION CHART

APPROVED
W O Wetmore
[Signature]

ISSUE DATE: 1 MAY 1969
CANCELS AND SUPERSEDES
CHART DATED 10 MARCH 1969

Figure 2. Nuclear Rocket Operations

Figure 3. Nuclear Rocket Operations Special Projects Office

II, Program Management (cont.)

B. PNL VALVE DESIGN-DEVELOPMENT PROGRAM MANAGEMENT STRUCTURE

The program will be organized on a project basis with key personnel assigned to the program on a full-time basis as required (see Figure No. 4). Support personnel will be assigned in accordance with program needs.

The project manager, R. L. Murray, will report to D. Holzman, Manager of the Special Projects Office, and will devote his time to the coordination, and direction of the program to ensure that program objectives and schedules are fulfilled within budget constraints.

As Project Engineer, E. A. Shearer will be responsible for the technical management and direction of the program within the scope of the approved plan and budget. All work authorizations for engineering, fabrication, testing, and support activities will be subject to his approval. In addition, he will maintain a close liaison with Lewis Research Center counterpart to assure the expeditious interchange of information.

The valve design effort will be the responsibility of J. Dever while A. Smith will have full-time responsibility for valve development.

Senior technical specialists in the areas of nuclear analysis, thermal analysis, fluid analysis, structural analysis, and materials and processes currently participating in the LMFBR valve technology program will be utilized to supervise work in the proposed program. Resumes of these personnel are included.

Figure 4. Prototype Primary NaK Loop Valve Development Program Functional Team

II, B, PNL Valve Design-Development Program Management Structure (cont.)

Contract representative for the program will be F. R. Basque who will serve as the central point for all formal contractual communications with the Lewis Research Center. Any departure from the formal agreement will be negotiated through the contract representative who will be responsible for interpreting contractual requirements and furnishing this information to the Aerojet-General organizations involved. In addition, he will monitor formal technical submittals to ensure that they are fully responsive to contract requirements. All requests for changes that originate with the Lewis Research Center will be promptly coordinated with appropriate Aerojet-General personnel. All notices of changes that are formally negotiated will be formally prepared. The necessary authorization and instructions will be distributed to the appropriate organizations.

II, Program Management (cont.)

C. KEY PERSONNEL

NAME: R. L. Murray
PROPOSED ASSIGNMENT: Project Manager
TIME ALLOCATED: 20%
CURRENT RESPONSIBILITY: Project Manager, Liquid Metal Fast Breeder
Reactor (LMFBR) Valve Technology Program

This function involves the responsibility for ensuring that the technical, schedular, fiscal, and contractual aspects of the program are performed in an effective manner and to the satisfaction of the customer.

EXPERIENCE:

Mr. Murray joined Aerojet in 1955 as a design engineer and participated in a number of design and development tasks associated with liquid rocket thrust chamber assemblies. In 1963, Mr. Murray joined the NERVA program as a design supervisor in the thrust chamber department. In 1967, he became Project Manager of Contract SNPC-35, Phoebus-2 nozzle design and development. This contract was successfully completed with the delivery of nozzles to Los Alamos Scientific Laboratory. Since October 1968, Mr. Murray has served as Project Manager of Contract AT(30-1)-4026, LMFBR program.

EDUCATION:

B.S., Mechanical Engineering, 1954, Tri-State College.

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II, C, Key Personnel (cont.)

NAME: E. A. Shearer
PROPOSED ASSIGNMENT: Project Engineer
TIME ALLOCATED: 50%
CURRENT RESPONSIBILITY: Supervisor, Special Projects Section

In this capacity, Mr. Shearer has the responsibility for the design and development of advanced design sodium valves for the LMFBR program.

EXPERIENCE:

Mr. Shearer joined Aerojet-General in 1956 as a project engineer. He was responsible for the development of hot-gas and propellant controls for the pump-drive assemblies of Titan I and Titan II engines. Later, as Manager of the Mechanical Controls Department, he directed the design and development of all valves, mechanical controls, and seal programs for Titan II, Gemini, NERVA, and the M-1 engine programs. More recently, he was responsible for the design and development of the all-metal bipropellant valve for future deep-space engines.

Prior to joining Aerojet-General, Mr. Shearer was with the W. R. Whittaker Co. where he was responsible for the design, development, testing, and production of aircraft valves.

EDUCATION:

B.S., Mechanical Engineering, 1950, University of California.

Proposal NR69053, Folder 2

II, C, Key Personnel (cont.)

NAME: J. E. Dever
PROPOSED ASSIGNMENT: Valve Design
TIME ALLOCATED: 100% during the design phase and as required
during the remaining program
CURRENT RESPONSIBILITY: Design Engineer, Liquid Rocket Division
Engineering Department

EXPERIENCE:

Mr. Dever joined Aerojet-General in 1955. He has participated in the design and development of valves and control elements for the Titan, M-1, Transtage, and NERVA engines. He was also responsible for the design of the electrically actuated, all-metal liquid fluorine valve for advanced space systems. In his most recent assignment, he was responsible for the design of a pneumatic operated shutoff valve compatible with fluorinated oxidizers in space vehicles.

EDUCATION:

B.S., Mechanical Engineering, 1968, Sacramento State College.

II, C, Key Personnel (cont.)

NAME: A. D. Wilcox
PROPOSED ASSIGNMENT: Nuclear Analysis
TIME ALLOCATED: Consultant
CURRENT RESPONSIBILITY: Nuclear-Radiation-Transport Analysis in
NERVA Studies

Nuclear-radiation-transport analysis in NERVA studies, including radiation, mapping, engine-component heating rates, shielding, and neutron activation. The techniques used include discrete-ordinate S_N neutron and gamma transport, point-kernel, and Monte Carlo.

EXPERIENCE:

Mr. Wilcox joined Aerojet-General in 1964. As a senior nuclear engineer he has performed radiation analyses for NERVA models including proposed ETS-1 modifications, FFTF shielding studies, several conceptual designs for NERVA pressure vessels and thrust structures, and Phoebux-2 nozzle design.

From 1962 to 1964 he served as a nuclear specialist for Ling-Temco Vought, participating in reactor kinetics and reactor-core criticality studies for the SLAM (Nuclear Ramjet) project. From 1954 to 1962 he was a senior engineer for General Electric, conducting reactor-controls design for a nuclear-propelled aircraft.

EDUCATION:

B.S., Engineering Physics, 1953, South Dakota State
M.S., Physics, 1954, South Dakota State
Oak Ridge School of Reactor Technology, 1958

II, C, Key Personnel (cont.)

NAME: W. R. Thompson
PROPOSED ASSIGNMENT: Thermal Analysis
TIME ALLOCATED: 10%
CURRENT RESPONSIBILITY: Supervision of NERVA Facility Thermodynamic Analysis

EXPERIENCE:

Mr. Thompson joined Aerojet-General in 1955. He presently provides analytical support for design, activation, and operation of rocket-test-stand complexes in both Nevada and Sacramento, including heat transfers, fluid dynamics, and combustion processes. He also provides support for the design of components for advanced power reactor systems, including heat-transfer analyses of heat exchangers for the FFTF fuel-handling machine and steady-state and transient heat-transfer studies for large sodium valves for the LMFBR program. From 1964 to 1965 he was Supervisor of applied research for the NERVA program. From 1955 to 1964 he served as Assistant Head of the Thermodynamics Department, Advanced Research Division, analyzing heat-transfer and liquid-propellant-flow studies for the Titan and Rover programs.

From 1949 to 1955 he was a staff engineer for the Denver Research Institute, University of Denver where he participated in research studies under government and industry contract.

EDUCATION:

B.S., Chemical Engineering, 1948, University of Denver
M.S., Chemical Engineering, 1954, University of Denver

II, C, Key Personnel (cont.)

PUBLICATIONS:

Design and Development of a Test Facility for the Disposal of Hydrogen at High Flow Rates, Advances in Cryogenic Engineering, Volume 12, page 207, 1967 (with C. S. Boncore).

Nozzle Tube Wall Temperature Measurement by Radiometric Techniques, J. Spacecraft and Rockets, Volume 3 (7), pp 1144-5, 1966 (with E. L. Geery, J. H. Beveridge, and W. J. Helm).

Heat Transfer Characteristics of Cryogenic Hydrogen at High Heat Fluxes and Pressures from 800 to 1200 psia, Paper No. 66-581, presented at the AIAA Second Propulsion Joint Specialists Conference, June 13-17, 1966, (with E. L. Geery).

Heat Transfer to Cryogenic Hydrogen at Supercritical Pressures, Paper J-5, Advances in Cryogenic Engineering, Volume 7, pp 391-400, 1962 (with E. L. Geery).

Theory of Pneumatic Dilution Calorimetric Probe, ARS Journal 32(2), pp 257-8, 1962 (with R. B. Edmonson and A. L. Hines).

Ignition Characteristics of Metals and Alloys, ARS Journal 31(7), pp 917-23, 1961 (with L. E. Dean).

Thermal Extraction and Solution of Oil Shale Kerogen, Ind. Eng. Chem., 50 pp 359-64, 1958 (with C. H. Prien).

II, C, Key Personnel (cont.)

NAME: A. L. Smith
PROPOSED ASSIGNMENT: Valve Development
TIME ALLOCATED: 100% Throughout Program
CURRENT RESPONSIBILITY: Development Engineer, Apollo Service Propulsion
System Controls, Controls Engineering

EXPERIENCE:

From 1960 to present, Aerojet-General Corporation. When he joined Aerojet, Mr. Smith was assigned to the development of fluid controls for various rocket propulsion systems. This involved work with a wide variety of devices, including check and relief valves, filters, seals, hydraulic servo-actuation systems, hot-gas valves, and associated laboratory test equipment and facilities. Later, his assignments included development work on liquid-hydrogen valves, squib-operated hot-gas valves, and pneumatic controllers used in early NERVA project activities. He was assigned to the Apollo SPS engine program in 1964 and, since that time, has been intimately involved in design, development, and fabrication of all components of the bipropellant-valve assembly and its independent, self-contained, actuation subsystems. This assignment has included work on ball valves, check valves, relief valves, solenoid valves, regulators, fill and vent valves, pressure tanks, drive mechanisms, and associated hardware for both hydraulic and pneumatic fluids.

Prior to 1960, Cadillac Gage Company. Mr. Smith participated in design and development of pneumatic and hydraulic servo controls.

Mr. Smith is a Registered Mechanical Engineer in the State of California.

II, C, Key Personnel (cont.)

EDUCATION:

Mr. Smith received his Bachelor of Science Degree in Aeronautical Engineering from California State Polytechnic College in 1959.

II, C, Key Personnel (cont.)

NAME: G. B. Hurr
PROPOSED ASSIGNMENT: Fluid Analysis
TIME ALLOCATED: 10%
CURRENT RESPONSIBILITY: Senior Engineer in Fluid Dynamics

Senior Engineer in fluid dynamics and presently responsible for fluid analysis for Atomic Energy Commissions LMFBR Valve Technology Program. His recent assignments included such tasks as boundary layer investigations, nozzle contour optimization, and developing design techniques for plug and forced deflection nozzles.

EXPERIENCE:

From 1957 to present, Aerojet-General Corporation. Mr. Hurr joined Aerojet as a design engineer in the Polaris project and was responsible for designing solid-propellant grains of various configurations to achieve the desired performance characteristics.

In 1961, he was assigned to the Aerophysics Department to perform work in the field of gas dynamics, including experimental work in the Aerophysics Laboratory. From 1965 to 1967, he was assigned to the Heat-Transfer Section of the ARES project, where he was responsible for heat-transfer analysis of hardware components such as the turbine, stator, and combustion-chamber housing. He was also involved in the heat-transfer aspects of regenerative- and film-cooling techniques used in the ARES program.

II, C, Key Personnel (cont.)

EDUCATION:

B.S., Chemical Engineering, 1957, Purdue University

M.S., Mechanical Engineering, 1968, Sacramento State College

PUBLICATIONS:

Co-author of Annular Flow Nozzles for Solid Propellant Rockets, presented at Proceedings of Fourth Annual Solid Propellant Rocket Conference of the American Rocket Society, 1 February 1963.

II, C, Key Personnel (cont.)

NAME: C. E. Dixon
PROPOSED ASSIGNMENT: Materials and Processes
TIME ALLOCATED: 5%
CURRENT RESPONSIBILITY: Supervisor, NRO Advanced Materials Group

EXPERIENCE:

Dr. Dixon joined Aerojet-General in 1963. He is responsible for evaluating all phases of material research and development in the NERVA program. Assignments include reactor-materials liaison with the Westinghouse Astronuclear Laboratory and cryogenic and high-temperature irradiation research in structural alloys, polymers, and elastomers.

Earlier (1951 - 1953) he was employed by Atomics International where he conducted radiation-damage research on materials, research and development of high-temperature reactor materials (with emphasis on graphite and refractory oxides), and basic research on lattice imperfections and the mechanical properties of materials.

EDUCATION:

B.S., Physics, 1942, Washington State University
M.S., Physics, 1948, Washington State University
D.Sc., Physics, 1951, Carnegie Institute of Technology

II, C, Key Personnel (cont.)

PUBLICATIONS:

Cryogenic Radiation Effects on NERVA Structural Materials, ASTM Publication STP 426 (ASTM, 1967), page 625

Cryogenic Radiation Damage in Structural Polymers, Transactions, American Nuclear Society, November 1966

High Temperature Radiation Embrittlement of Hastelloy X, Inconel 625 and AISI 347, Transactions, American Nuclear Society, June 1967

Radiation Effects of High Energy Electrons in Metals, Progress in Nuclear Energy, Series V, Volume 2 - Metallurgy and Fuels (Pergamon Press, 1959), page 475

Generalities of Radiation Damage, Reactor Handbook, Volume I, Materials, (Interscience 1960) page 40

Internal Friction and Shear Modulus of Thorium at High Temperatures Proc. of 2nd Nuclear Engineering and Science Conference, Paper 57-NESC-6, 1957

Interstitial and Vacancy Migration in Copper and Cu_3Au , Acta Metallurgica, Volume 2, page 636, 1954

II, C, Key Personnel (cont.)

NAME: R. T. Reid
PROPOSED ASSIGNMENT: Structural Analysis
TIME ALLOCATED: 10%
CURRENT RESPONSIBILITY: Section Head, NRO Structures

EXPERIENCE:

1962 to present, Aerojet-General Corporation: As Section Head, NRO Structures, currently responsible for NERVA STE/Facility. Previously, during LOFT Feasibility Study, as Engineering Specialist in charge of Structures Department effort, had cognizance for coordination of analysis, customer liaison, and overall program management.

At Von Karman Center, Oceanic Products Division, as Section Supervisor, Stress and Dynamics, was responsible for supervision of structures effort associated with Mark-46 Torpedo Program.

At request of Aerojet-General Corporation and East Los Angeles College, instructed on the staff of East Los Angeles College of Engineering from 1964 to 1966.

Other Aerojet projects on which Mr. Reid has worked are as follows:

SADEYE Project: Responsible for development of loads criteria, design parameters (shock, vibration, thermal effects), and materials selection as well as cognizance for establishing and conducting test programs and designing test fixtures.

II, C, Key Personnel (cont.)

Mk 46 Explorer: Cognizance for establishing parameters for dynamic and vibratory testing, evaluating results, and recommending design improvements.

Project Sea Horse: Responsible for developing design to modify a corporal missile for water launch and subsequent retrieval.

SNAP 8: Assisted in the structural design and material selection for airframe, secondary heat exchanger (boiler and condenser) and turbine power unit.

1960 to 1962, North American Aviation: As Design Engineer "A" on Saturn S-II Project, developed structure and determined loads to be transferred from engine to lower airframe structure. Responsible for structural integrity of engine support area. On Apollo Project, developed structure and determined loads to be transferred from top of S-II structure to Apollo attachment. In Flight Test Department, performed data reduction and evaluated photography, oscillographs, and flight-test equipment.

1954 to 1960, Menasco Manufacturing Company: As Structures Project Engineer, was responsible for structural integrity of all component parts of nose landing gear for F102, F106 and T11 aircraft and was responsible for testing procedures.

EDUCATION:

B.S. Aeronautical Engineering, 1962, Northrop Institute of Technology.

II, Program Management (cont.)

D. PROGRAM CONTROLS

The existing Aerojet-General program control practices and procedures will be applied as applicable in the proposed program. This system provides for the three major areas of program control; technical adequacy, schedules, and cost. All project personnel are oriented to continuously evaluate and improve performance in relationship to these considerations. The Project Manager has the following formal management tools at his disposal for monitoring this performance.

<u>Control Area</u>	<u>Management Tool</u>	<u>Function</u>
Technical Adequacy	Master Program Plan	Task definition.
	Work Authorization	Detailed effort/responsibility definition. Initiates actual work effort.
	Configuration Control	Documentation of designs and restraint in changes.
	Quality Control	Conformance of hardware to design requirements.
	Program Progress Reviews	Engineering, manufacturing, and test status against technical objectives.
	Program Management Information System (PMIS)	Formal technical status reporting up through corporate level.
	Advisory Board	Management evaluation of technical progress against adequacy for satisfying over-technical objectives.
	Customer Liaison	Response to Customer technical requirements.

II, D, Program Controls (cont.)

<u>Control Area</u>	<u>Management Tool</u>	<u>Function</u>
Schedule	Master Program Plan	Task-time definition.
	Milestone Schedules	Major program goals defined.
	Master Program Budget	Time-phased cost objectives.
	Internal Progress Reports	Subtask progress against over-all planned program.
	Program Management Information System (PMIS)	Formal schedule status reporting up through corporate level.
	Advisory Board	Management evaluation of schedule progress against adequacy to satisfy over-all program schedule.
	Customer Liaison	Response to Customer schedule requirements.
Cost	Master Program Budget	Allocation of resources/establishment of cost objectives.
	Work Breakdown Structure	Establishment of basic work/cost system.
	Work Authorization	Establishment of detailed subtask and item budgets.
	Cost Accounting	Collection of actual costs.
	Cost Control Reporting	Data for actual cost performance evaluation.
	Program Management Information System (PMIS)	Formal cost status reporting up through corporate level.
	Advisory Board	Management evaluation of expenditure against actual technical and schedule accomplishment.
	Customer Liaison	Response to customer cost requirements.

II, D, Program Controls (cont.)

Each of these primary areas of project control is discussed in the subsequent paragraphs.

1. Technical Adequacy

The project management system currently applied to rocket engine technology programs at Aerojet-General provides for diligent monitoring and complete control of the technical aspects of this proposed program. Basic control of the technical effort is through the medium of the work authorization procedures that are expanded to a broad pyramid-like base by secondary work authorizations which provide for the detailed subtasks (i.e., short-period component engineering, fabrication, and testing). Additionally, these documents serve as the basis for opening and closing cost accounts.

The communication of technical status and problems has been streamlined through the use of the Program Management Information System (PMIS), wherein the reporting formally moves up through appropriate management levels and the attention of highly experienced, technically-oriented managers is directed toward problem areas. In this way, problems are identified to management as soon as they are anticipated or occur and appropriate corrective action is directed toward rapid resolution. The talents of specialized engineering groups and consultants are utilized as required to solve problems.

While it is the Project Manager who has the complete responsibility for all aspects of the program, it is the Project Engineer who implements the daily functions which provide the successful technical achievement of program objectives.

The basic elements of the technical review cycle that are used to assure technical adequacy of a program as well as to pin-point problem areas in a timely manner can be briefly summarized as follows:

II, D, Program Controls (cont.)

- The Project Engineer holds weekly status assessment meetings with his assigned engineers. In addition, special meetings are held as required with individual engineers should any problem necessitate it.
- The Project Manager meets with the Project Engineer each week for a comprehensive review of the program status. The Project Manager also is continuously available to lend technical support and initiate immediate action where needed to resolve problem areas.
- The Project Manager submits formal (PMIS) biweekly reports for the program to the Nuclear Rocket Operations Special Projects Manager, Mr. D. Holzman.
- Nuclear Rocket Operations top management is kept apprised of the program technical adequacy through weekly Management Review meetings.

In addition to the above, the existing procedures provide for the establishment of Advisory Boards, Design Review Committees, Critical Experimental Reviews, Test Critiques, and Customer Review/Approval Meetings, or such other review cycles as deemed appropriate for a particular program.

2. Schedule Control

The program plan provides over-all schedule information, establishing the time-phased requirements for accomplishing milestones. Master program schedules are developed by the Project Manager and his cognizant functional managers in consent with the Customer or subject to such approval. These master schedules reflect the work breakdown structure and permit ready correlations between schedule performance and cost performance.

II, D, Program Controls (cont.)

Schedule control is maintained at the appropriate management levels by means of continuous verification of performance and accomplishment in relationship to the master program plan, the appropriate milestone charts, and the contractual schedule for deliverable items (i.e., hardware and documentation).

The program schedule is monitored similarly to the system used to assure technical adequacy. The Project Engineer holds his weekly meetings and he meets weekly with the Project Manager. The latter also submits formal biweekly reports concerning the program by means of the Program Information System (PMIS). This system is patterned after the highly successful reporting method used in the Polaris Program and is based upon visual presentations. A series of charts is used to interrelate various aspects of program management, including schedules, cost, technical progress, and problem areas. In this way, incipient problem areas are pin-pointed and appropriate remedial action is undertaken without delay.

PMIS charts are prepared for each program in the Sacramento Facility and reviewed at regularly scheduled interviews by facility and operational management. Following this review at the Sacramento Facility, the PMIS charts are forwarded to corporate headquarters at El Monte, where the Sacramento information is posted to summary charts maintained there. This assures that any problem area, real or potential, is brought to the attention of corporate management for appropriate resolution by corporate officers if necessary.

The use of the PMIS system in the proposed program will assure the NASA/Lewis Research Center that this effort will receive attention at all levels of management. This is the same system that has proven itself to be successful in major programs such as Titan, Polaris, Minuteman, and NERVA. It also has been applied to technology programs and company-funded efforts with equal success.

II, D, Program Controls (cont.)

3. Cost Control

The system of cost control and cost reporting in use at Aerojet-General is designed to provide timely and comprehensive budgetary status information for all programs to the program, facility, and corporate management. Actual cost control is exercised by the Project Manager using the standard practices and procedures described below. His cognizant engineering and support personnel are held fully accountable for meeting their milestones within budgetary limitations.

Budgets are established in terms of manpower, material, and computer costs. The cost accounting system accumulates charges against the cost accounts (work breakdown structure) on a weekly basis. These weekly charges are monitored (similarly to the system used for technical adequacy and schedule control) against the master budgets to uncover any areas requiring action to preclude potential overexpenditures. In addition, total costs are related to accomplishment. Commitments in excess of specified budgeted amounts cannot be made without the approval of the Program Manager. A discussion of the mechanics of this system follows.

A program master budget is prepared concurrently with a proposal. It reflects estimates against the work breakdown structure and is appropriately adjusted based upon the results of contract negotiations. The revised budget becomes the frame of reference for program cost control.

Manpower is controlled by establishing time-phased manpower ceilings for the functional organizations. These ceilings, which are based upon original program needs, are adjusted periodically to reflect any reallocation of resources if required. Weekly manpower reports provide early indications of manpower variances and permit prompt remedial action. All changes

II, D, Program Controls (cont.)

in manpower requirements are subject to prior approval of the Program Manager. Close attention also is given to changes in labor rate trends that indicate labor mix variances.

Time-phased material commitment plans, which indicate the items to be procured, are maintained on a current basis. Changes in planned material requirements are subject to prior approval of the Project Manager with regard to both the type and amount of material involved. Reporting of cost as well as schedule performance by major subcontractors is required to enable the monitoring of performance consistent with the over-all Aerojet-General control system.

Time-spread budgets are prepared for computer service charges. Computer service report requests require project engineering approval and computer programming services are subject to Project Management authorization. Computer applications are routinely scrutinized to assure efficient utilization.

A cost accumulation system is used to provide maximum cost control as well as to respond to normal contract cost reporting requirements. This enables computerized summation at the task, subtask, and item indenture levels as well as by organizational functions. This capability allows a management review of organization cost performance relative to budgets. It permits the responsibility for variances to be fixed and direct remedial action to be initiated. Further, data for the analysis of costs of contract item is readily segregable to determine the value of work performed. The estimated cost-to-complete and the actual cost data are accumulated by using identical cost codes; this enables a simplified, combined summarization and comparison.

II, D, Program Controls (cont.)

The work order is the prime authorization for the performance of contractual effort within the Sacramento Facility. This work order is issued by the Contract Administrator and it clearly defines the scope of work to be performed. It also identifies the first six digits of the nine-digit work order numbering system in use at Aerojet-General. The first four digits serve to identify the specific contract and remain unchanged throughout the course of the program. The fifth and sixth digits identify the operational or functional area being authorized to perform the specific work delineated on the work order. These areas operate within an allocated budget in connection with the work requested. These project budgets are prepared by the program control personnel and are subject to the approval of the Project Manager.

Specific tasks within a general operational or functional area are identified by means of secondary work authorizations which are issued by the project office and whereon the last three digits (the release group) of the nine-digit work order number are identified. These secondary work authorizations specify a particular effort as well as budgetary limitations and time schedule requirements. The following three types of forms are used within this grouping.

a. General Work Authorization

Issued to procure general support (i.e., drafting, documentation, structural and stress analysis, as well as fiscal or material control), tool design (tooling and equipment as well as changes thereto), and testing(test stand preparation, activation, hardware, installation and removal, environmental testing, instrumentation, data engineering, data reduction, and specific testing).

II, D, Program Controls (cont.)

b. Interplant Work Authorization

Issued by the Project Office to authorize specific work in another Aerojet-General Corporation Facility.

c. Requisitions

These include In-Plant Fabrication and/or Purchasing/ Subcontracting.

The following five reports are the basic ones processed to provide budgetary status information and assist the Project Manager in assuring adequate cost control.

- The Program Cost Reports include commitment reports, the Project Manager's cost report, the work order cost report, and the responsible organization cost report.

- The Weekly Commitment Report is issued on the fourth day following the reporting period. It presents a comparison of funded, budgeted, and committed amounts for the week being reported as well as the over-all status of the contract from its initiation to the date of the report.

- The Project Manager's Cost Report is issued monthly. It shows the cumulative commitments from the inception of the contract as well as budget data through the end of the month by both work order and contract total. Budget variances also are shown at both the work order and total contract levels.

- There is both a Weekly and a Monthly Work Order Cost Report is issued. The weekly report is available on the fifth working day following the report period, and the monthly report is issued on the eighth

II, D, Program Controls (cont.)

working day following the end of the accounting month. The budgetary status of each release group is shown both incrementally and cumulatively. In the weekly report, a budget variance is shown against the total, whereas in the monthly report, budget variances are shown at both the release group and work order total levels.

- The Responsible Organization Cost Report also is issued as a weekly and as a monthly report. The weekly report is issued on the fifth working day following the report period and the monthly report is issued on the eighth working day following the end of the accounting month. It shows cumulative commitments by organization and authorizations for each work charge number and release group total. Budgets through the current month, variances from the budget, and total authorizations are shown at the release group level. In the weekly report, incremental commitments are shown by organization for each charge number, the total for each work charge number, and the release group total.

These project cost reports are subject to continuous monitoring by appropriate management levels. In addition, the graphic-type PMIS charts are prepared and kept current to reflect program budgetary status. Undesirable economic trends become readily apparent early enough to permit corrective action to be most effective. Variances between planned accomplishment and planned expense are promptly investigated. The problem is isolated, clearly defined, a solution is evolved, and corrective action is implemented.

Reporting the fiscal status of programs conducted at Aerojet-General is based upon the described internal cost reporting technique. It permits complete fiscal information to be relayed in a timely manner, thereby assuring the Procuring Agency that it is fully-informed regarding the program budgetary status at all times.

III. FACILITIES AND EQUIPMENT

A. CORPORATE INVESTMENT IN FACILITIES

The Aerojet-General Corporation has invested more than 82 million dollars in facilities at the Sacramento Facility, which also represents a government investment of more than 132 million dollars. These facilities support NASA, Air Force, Navy, and Army programs and would contribute to the PNL program.

Administrative and engineering personnel are located in the main administrative area building complex. Office space of approximately 650,000 square feet is available for engineers engaged in the development of rocket propulsion systems and for personnel manning the administrative support functions. These facilities are located close to manufacturing shops, computer facilities, laboratories, and the technical library. The facilities also include: roads, railroads, and utilities; publication facilities; cafeteria; medical dispensary, and fire and facility security protection.

B. ENGINEERING FACILITIES

1. Computer Facilities

Of particular interest to the PNL program are the digital computing facilities (a partial view is shown in Figure No. 5) which are equipped with an IBM 360 Model 65, an IBM 360 Model 67, an IBM Model 30, and an 1130 digital computer.

The IBM 360, Model 65, digital computer is used to solve problems relative to the development of rotating machinery, nozzle design and evaluation, fluid flow, injector design, and heat transfer. It has a 512,000-byte memory system, four 2311 disk drives, a 15-tape drive, and a 0.75-microsec cycle. It is supported by a 2540 card reader punch which punches cards at the

Figure 5. Digital Computer Facilities

III, B, Engineering Facilities (cont.)

rate of 300 cards per minute and has a card reading speed of 1000 cards per minute. Also in support is a 1403 printer which prints at the rate of 1100 lines per minute.

The IBM 360 Model 67 computer differs only slightly from the IBM 360, Model 65, in that it is tailored to time-sharing capabilities. Programs created on the Model 65 can be run on the Model 67 with a slight increase in running time.

Off-line requirements are handled with an IBM 360, Model 30, computer driving three 1403 print, five 2400 tape drives, and a 2540 card reader punch. It has an 8000-byte memory and a 2.5-microsec cycle time. A second Model 30 has five 2400 tape drives, two 2311 disk units, one 2671/1012 paper-tape punch, one 1403 printer, one 2540 card reader punch, and a 16,000-byte memory.

An 1130 digital computer also is available to prove concepts and theory before their inclusion into the large programs that are to be run on the IBM 360, Model 65, computer. The 1130 computer will punch 100 cards per minute, read 400 cards per minute, and print 900 lines per minute. This machine has an 18-microsec access time.

A library has been compiled of more than 1200 operational engineering and scientific programs developed since operations were initiated.

In addition, an analog computing facility is available for the solution of large-scale scientific and engineering problems. This facility is composed of two, fully-expanded Comcor CI 5000's, two EAI 231 R's, two EAI 131 R's, and an EAI 24D consisting of 1700 operational amplifiers with associated nonlinear equipment (e.g., multipliers, function generators, and resolvers).

III, B, Engineering Facilities (cont.)

Digital logic also is available. Two automatic digital input-output systems also are available to facilitate computer checkout.

2. Technical Library

Aerojet-General maintains a well-equipped technical library with collections covering the fields of mathematics, physical sciences, engineering, rocketry, and aerospace technology. Materials in other fields (e.g., accounting and business) are acquired as needed. Figure No. 6 shows a portion of this library.

Holdings include more than 25,000 books, 3,000 bound periodicals, and 100,000 technical reports. The library subscribes to 700 technical journals and has excellent working relationships with many large research libraries for interlibrary loans. In addition to its collection of printed reports, the library maintains files of NASA microforms and other microfilms.

A comprehensive collection of vendor catalog information is maintained on microfilm for the use of design engineers. The visual search microfilm file, together with a reader-printer, is available to locate and reproduce pages of product information.

Military and federal specifications, standards, military manuals, technical orders, and regulations also are handled by the library. Extensive files are maintained. New military and governmental agency publications are distributed as they are received.

The library has indexed in depth all the external and internal technical reports in its collection. This literature retrieval system is stored on magnetic tape and used on an IBM 7094 computer. A literature search

Figure 6. Technical Library

III, B, Engineering Facilities (cont.)

on the computer can accommodate 52 separate coordinations at a time. In addition to this local capability, the corporate technical information center at the Von Karman Center provides a source for ready access to all technical information located at any of the Aerojet-General facilities.

3. Laboratories

The Sacramento Facility provides the complete laboratory capabilities necessary for research and development programs. The available laboratories, listed below, house the most modern types of equipment and are staffed by trained research personnel in each particular field of research.

- Aerophysics Laboratory
- Analytical Chemistry Laboratory
- Cryogenics Laboratory
- Dynamics Laboratory
- Engineering R&D Laboratories:
 - Component Evaluation Laboratory
 - Controls System Laboratory*
 - Electrical/Electronic Systems Laboratory*
- Environmental Laboratory*
- Fuel and Combustion Chemistry Laboratories
- Materials Research and Development Laboratory*
- Metals and Plastics Laboratories
- Photoelastic Laboratory
- Research Physics Laboratory
- Structures Laboratory*
- Vibration Laboratories*

*Described in Section III,D of this Folder.

III, Facilities and Equipment (cont.)

C. MANUFACTURING FACILITIES

1. Advanced Technology Shop

The facilities of the advanced technology shop (a view of which is shown on Figure No. 7) will be used for fabrication of hardware for the prototype primary NaK loop valve development program.

This shop is unique in that special procedures, facilities, and personnel are utilized to meet the fabrication needs of exploratory research and advanced development programs. Staffed with skilled machinists, the shop can produce unique experimental hardware from a sketch or a print. The routing of hardware through work stations, inspection, and manufacturing processes is accomplished by indicating the sequential station number on shop orders.

The shop has been in existence since 1963. It has achieved quality fabrication of one-of-a-kind experimental hardware at substantial savings in cost per machine hour on a unit basis as compared with production-mode fabrication. Work produced in this shop is competitive with "outside" concerns in cost and has been equal or superior in quality. Actual machining is started within one day after the release of the shop-order package containing the routing, drawings, quality control instructions, hydraulic testing instructions, and material.

The shop occupies approximately 10,000 square feet. It is equipped with general-purpose machine tools and equipment, including lathes, milling machines, horizontal and vertical boring machines, drills, grinders, shapers, hones, and sawing and filing machines. Internal production control, assembly, dispatch, and stores areas also are provided.

Figure 7. Advanced Technology Shop

III, C, Manufacturing Facilities (cont.)

The overall manufacturing capabilities of the Sacramento Facility, as well as those of other Aerojet Facilities also are available to support fabrication requirements. The manufacturing complex consists of: four major shop buildings with one million feet of floor space; a foundry; a heat treat facility; laboratory support operations; and a machine shop.

The shops are specifically designed for high-volume production of precision parts and assemblies from all major alloys and plastics. The Sacramento Facility offers a manufacturing capability of impressive versatility and accomplishment as evidenced by the receipt of two Air Force awards for Zero Defects. Figure No. 8 is a montage of this manufacturing complex.

2. Cleaning, Decontamination, and Assembly

Cleaning and decontamination facilities include a vapor degreaser, acid flushing, passivating, hot and cold rinse, ultrasonic cleaning, and a Freon flushing station. All are serviced by a polyethylene packaging and sealing area. A Class 100,000 clean room, the main component of this facility, has airlocks and temperature and humidity control equipment. Operating personnel are required to wear special clothing to prevent contamination: accessibility is controlled.

The precision assembly area has a controlled atmosphere of a Class 100,000 level. Assembly stands in this area are mounted on static block foundations to isolate assembly operations from vibration. Atmospheric temperature is controlled to maintain the exacting conditions required for assembling hardware to extraordinarily close tolerances. All supply air is passed through absolute filters and several complete air changes are made each hour. Access to the assembly area is through airlocks and special clothing is mandatory for operating personnel. Air samples are taken continuously and the

Numerical control speeds Polaris production—Aerojet technician observes numerically controlled machining of an inert part for the Navy Polaris Fleet Ballistic Missile on a Giddings and Lewis 3-D milling machine. The new process is being used at Aerojet-General Corporation's Solid Rocket Plant near Sacramento, California. Aerojet designed, developed and is producing both the first and second stage solid fuel power plants for Polaris.

A process for applying a zirconium oxide ceramic coating has been available for several years, and it is now used for the high-temperature protection of the exposed surface of nozzle components.

Metals joining is a specialty at Aerojet—A technician is joining the tube bundle of a Titan first stage chamber to the forward flange prior to furnace brazing to tube bundle to obtain a gas-tight assembly. Thin-wall stainless-steel tubing is assembled on a solid mandrel swaged to obtain the tube clearances not to exceed 0.002 in. prior to weld attachment of forward, aft, and intermediate restraining bands. This high-quality workmanship has resulted in the outstanding success of the Titan and Gemini programs.

Incorporated within the foundry is a complete pattern-making shop for direct foundry support.

General view of the extensive Manufacturing Machine Shop. A Titan second stage combustion chamber is being machined in the foreground. This chamber is fabricated of stainless alloys starting with thin wall tubes, furnace brazed into a gas tight assembly, with TIG welded forward, aft and intermediate ring attachments. The forward chamber is wire wrap reinforced and coated with epoxy.

Figure 8. Sacramento Facility Manufacturing Complex

III, C, Manufacturing Facilities (cont.)

particle count is maintained at the levels required by Specification FED-STD-209 for the Class 100,000 clean room.

3. Hydraulics Laboratory

Calibration, proof pressure, and static leakage tests are conducted in this facility which is equipped with the necessary hydraulic and pneumatic equipment, controls, and instrumentation for testing rocket engine components, subassemblies, and the assemblies. All technical phases of the laboratory operation, the work performed, the tooling, and the procedures are under the direction of hydraulic and process engineers.

Available equipment includes high-flow and low-flow water facilities for calibration checks. Quality-control surveillance is maintained during all tests to assure against sump water contamination. The sump for water-flow work is continually filtered to minimize contamination. This filtration system is capable of screening particles down to 10 microns in size while maintaining the flow rates and pressures required to test components and assemblies.

The laboratory is equipped with 13 static test benches for proof and leak tests. The test media can be either gaseous nitrogen or water. Stations are also available for conducting proof and leak tests with helium. By utilizing a helium leak detector, this facility can be used for weldment leak tests of components. When incompressible fluids are required, the test media can be liquid nitrogen, hydraulic oil, RP-1, or filtered and treated water. Available instrumentation is of the instantaneous recording type, capable of indicating transient conditions in milliseconds. The laboratory also contains a battery of dehydrators, utilizing heat and vacuum, to dry component parts and assemblies after hydraulic testing.

III, C, Manufacturing Facilities (cont.)

4. X-Ray Facilities

Three buildings are devoted exclusively to high-energy X-ray inspection, with traveling cranes and elevator/turntables capable of handling loads to 40,000 lb. In addition to a wide variety of low-energy equipment, major equipment includes:

One 25-million electron volt betatron

Two 10-mev linear accelerators

One 2-mev Van deGraaf generator

Three cobalt 60 "cameras" each in excess of 1,000 curies

The experience of X-ray operators and interpreters includes work with virtually all metals, nonmetals, and composites which are capable of being effectively inspected through radiography.

5. Quality Control

The quality control operation is organized and staffed to perform inspections and tests of all parts, components, and assemblies to ensure that all articles conform to applicable drawings and specifications with respect to workmanship, finish, construction, functional performance, interchangeability, and identification. Tests and inspections include receiving, processing, fabrication, assembly, test, and shipping.

Primary and secondary laboratories are used to inspect and certify various measuring devices at established intervals to maintain control over equipment and special processes (i.e., plating, anodizing, radiography, magnetic particle, penetrant, heat treating, and welding). Tools and gages are initially checked and periodically rechecked and recalibrated to ensure accuracy and the interchangeability of end items.

III, C, Manufacturing Facilities (cont.)

a. Receiving Inspection

All incoming raw materials, machined parts, and standard hardware are checked for adherence to applicable procurement drawings and specifications. Available dimensional inspection facilities include surface plates, rotary tables, a special measuring machine, various hardness and spring testers, optical comparators, as well as miscellaneous hand-measuring tools and gages.

A complete nondestruction inspection section is available. It is equipped with ultrasonic systems, eddy current, zyglo fluorescent penetrants, magnetic particle units, and X-ray equipment (175 kv to 2 Mev).

b. Process Inspection

In-process quality control is maintained through the use of inspection stations strategically located throughout the manufacturing, assembly, laboratory, and test areas to facilitate inspection of in-process components, subassemblies, and final assemblies. The major stations include:

- Decontamination
- Dye penetrant and magnetic particle
- Electrical assembly and checkout
- Failure analysis
- First-article and casting layout
- Gage cribs
- Hydrotest
- Precision inspection
- Secondary-gage inspection laboratory
- Sheet metal

III, C, Manufacturing Facilities (cont.)

- Tool inspection
- Weld inspection
- X-ray and ultrasonic

c. Measurement Standards Laboratory

The Measurement Standards Laboratory serves as the Sacramento Facility Primary Standards Laboratory. It provides a common reference for all calibration and measurements within the facility and assures the traceability of all such measurements to the National Bureau of Standards. It also coordinates measurement requirements and problems with the bureau. The laboratory provides a common reference for coordinating both administrative and technical procedures between the various secondary calibration laboratories (i.e., indication of calibration status, calibration records, and calibration procedures) and for interpreting as well as coordinating customer calibration requirements.

D. TEST FACILITIES

1. Engineering R&D Laboratories

These laboratories consist of a three-laboratory complex: components evaluation; controls systems; and electrical-electronic systems. All inspection, test, measuring, and instrumentation equipment in these laboratories are subject to a rigorously-enforced calibration recall system to ensure that they conform to the required accuracies and national standards.

a. Control Systems Laboratory

This laboratory, a partial view of which is shown in Figure No. 9, was established to develop controls system components for

Figure 9. View of Controls Systems Laboratory

III, D, Test Facilities (cont.)

advanced rocket engines. Since 1956, it has contributed significantly to the development of propulsion systems for programs such as Gemini, Transtage, Apollo, M-1, and NERVA. The laboratory is staffed with engineers and technicians who are trained to conduct development testing and evaluation programs for valves, seals, and actuating mechanisms.

The laboratory is divided into several areas, each of which houses specialized equipment for a particular phase of the assembly, development, and testing of mechanical controls. Leak, proof, functional and water flow tests will be conducted in the laboratory.

Gaseous nitrogen for seal-leakage testing is available from a liquid-to-gas converter system at pressures to 3200 psig. A helium system also is available for seal-leakage testing using a cascade system with pressures to 6000 psig.

This laboratory includes a machine shop where development hardware is modified and new configurations developed. The shop, which is equipped with appropriate machine tools (i.e., lathe, mill, drill presses, power shutoff saw, grinders, gas welders, arc welder, and tube bender), also provides support for test system build-up.

Special burst chambers are available for the burst, proof, and leak testing of valves, seals, and actuators with both liquids and gases. Water-flow bench facilities also are available for flow, leak, proof, and burst testing. The mechanical-pump-fed system has a pressure capability of 1500 psi and a flow capability in excess of 500 gpm. Additionally, the laboratory includes a fully-enclosed, positive pressure, filtered-air clean room which is used for assembly, disassembly, and testing of components where control of airborne contamination is required to satisfy Federal Standard 209,

III, D, Test Facilities (cont.)

Class 100,000. There is also a Level G assembly clean room which contains laminar flow benches and an ultrasonic cleaner.

b. Electrical/Electronic Systems Laboratory

This laboratory is equipped for the testing, evaluation, and qualification of experimental prototype and deliverable components and subsystems. Breadboard systems are assembled and tested and experimental components are developed to meet special program requirements. Typical of these are engine thrust controls, ignition systems, malfunction detection systems, engine sequence and protective controls, and ground support equipment. The laboratory is equipped to perform precision voltage, current, and frequency measurements.

A separate facility is available for the development and operation of electro-mechanical servo systems. This facility is equipped with special test equipment to provide input signals to, and analyze signals from, servo-actuated systems. Signal analysis equipment has the capability to measure, compute, and record data pertinent to transient analysis, velocity error, position error, and frequency response testing.

2. Static Acceleration

Static acceleration testing will be conducted in Environmental Test Zone D-8. This facility is equipped with a Schaevitz B-8-A centrifuge (see Figure No. 10) having the following specifications:

Figure 10. Centrifuge; Environmental Test Zone D-8

III, D, Test Facilities (cont.)

<u>Test Space</u>	<u>Capability</u>
End each arm	Maximum rpm 280
2 ft	Maximum "g" load, 75 g's
2 ft	Maximum "g" lb, 2000
18-in.	Maximum weight, 100 lb
	Maximum deviation of load center-of-gravity from vertical axis of rotating platform is 3.5-in.
Chamber:	
9 ft dia	Nominal radius of gyration is 34-in.
3 ft deep	Six pressure sources 18 instrument, power, and control circuits (slip-ring)

3. Materials Research and Development Laboratory

This laboratory provides services to the Sacramento Facility in the use of nontoxic, nonexplosive, structural and nonstructural, insulative, and refractory materials. Specimen preparation and testing is accomplished by technicians skilled in the use of the processing and testing equipment.

4. Structures Laboratory

The structural tests conducted in this laboratory vary from simple hydraulic tests and single-load applications without instrumentation to full-scale flight simulation tests involving internal pressure, axial compression, shear, bending, and aerodynamic heating -- all programmed within their proper sequence. A total of 456 channels of data can be recorded simultaneously.

Available are test fixtures that are capable of providing reacting tension or compression loads of 300,000 lb, horizontal loads of

III, D, Test Facilities (cont.)

150,000 lb, and axial bending moments of 6,000,000 in.-lb. A structural steel enclosure can retain 4,000,000 ft-lb of stored electric energy. The pressurization system is capable of pressurizing with oil to 4400 psi at 19.2 gal/min and with water to 2000 psi to 50 gal/min. An extensive environmental testing laboratory is also available.

All data developed in the laboratory can be recorded on magnetic tape. Through the use of data-processing techniques, these recordings can either be time-base expanded or time-base contracted by a maximum factor of 160,000:1. With specialized electronic data analysis, equipment data and the time-base analysis of transient data (i.e., high-frequency responses) can be established.

5. Vibration and Shock

Vibration and shock testing will be accomplished in the Test Zone G Laboratory, which has the following equipment capabilities:

<u>Exciter Model No.</u>	<u>Force, lb Sine, Peak</u>	<u>Force lb Random rms</u>	<u>Max Frequency (Hz)</u>	<u>Displacement Inches</u>
MBC 70 (2)	7,000	5,000	2,000	0.5
MBC 60	6,000	4,200	5,000	1.0
MBC 125	10,000	8,000	2,000	1.0

Instrumentation Channels:

24 Accelerometer amplifier
 12 Strain-gage channels
 14 Track tape recorder
 12 Channel Visicorder
 25 Channel Dymec
 18 Tie-line to G-Area control room

III, D, Test Facilities (cont.)

Figure No. 11 shows one of the vibrators being prepared for testing. Figure No. 12 shows the vibrator control console.

6. Acoustic Noise Test Facility (Wyle Laboratories)

The high-intensity acoustic fatigue test facility is capable of an overall output of 20,000 acoustic watts with an accompanying sound pressure level of 165 db. The basic facility consists of a noise generator, an initial expansion horn, a constant area parallel incidence test section, a second expansion horn, and anechoic termination or reverberation chamber. The facility is designed to operate either with a broad-band siren or a random/sine wave air-modulated driver.

The large 100,000 cubic foot reverberation room is used to test complete segments of aerospace vehicles to overcome the otherwise insurmountable problems associated with the simulation of boundary conditions when partial structures are tested. Further, its high modal density of greater than one mode/cps above 25 cps makes it an ideal diffuse room for basic research as well as environmental simulation.

Complete instrumentation, recording, and calibration facilities are available. All calibrations are performed using instrumentation whose calibration is traceable to the National Bureau of Standards. Also, basic facilities for free-field reciprocity and other calibrations of microphones are available for clients.

Figure 11. Vibrator Being Prepared for Testing

Figure 12. Vibration Control Console, Test Zone G Laboratory

III, D, Test Facilities (cont.)

7. Test Data Acquisition, Processing, and Analysis

a. Data Services Processing Methods and Equipment

(1) Digital Test Data Acquisition and Processing

Raw, commutated digital test data from all test zones are recorded on magnetic tape at the centrally-located test area IBM-360 computer system, which simultaneously processes the test data through an engineering units time history listing and computer/plotter formatted tapes. Extended performance calculations for components and engine balance test data are then developed using this IBM-360 system. Cal-Comp programmed automatic plotters are used in conjunction with the IBM-360 computer system to provide a graphic presentation of recorded parameters and performance functions versus time within a few hours after a test has been completed.

(2) Analog Test Data Acquisitions

Raw analog test data is recorded on strip charts, oscillograph recorders, and on the dynamic data tape recording system. The dynamic data magnetic tape recorded data are presented on a high speed oscillograph and/or in a high sampling rate digital listing format.

b. Test Data Presentations

(1) Digital Data

Each of the following units of measure is within the capabilities of the engineering units conversion program:

III, D, Test Facilities (cont.)

Pressure	psi, psig, psia
Temperature	°F, °R
Flow Rates	gps, gpm, lb/sec (H ₂ O)
Load	lb
Speed	rpm
Torque	in.-lb
Angles	degrees
Valve Movement	degrees, percentage
Electrical	volts, amperes

The digital listing point frequency can be varied from every recorded sample to one sample per test. It can also be varied within the test duration. Data can be tabulated prior to Fire Switch-One and subsequent to Fire Switch-Two as well as during the test.

The digital data can be summarized over 40 time intervals, three of which can be over-lapping. Additional processing is needed if more than three over-lapping intervals are desired.

(2) Analog Data

The oscillograph records can be identified at any specific time during the test duration by light break number, parameter call-out, and magnitude scaling.

The Brown and Sanborn records are used for "quick-look" purposes and for verification of the digital data.

III, D, Test Facilities (cont.)

(3) Test Data Sheet

Summarized measured and performance data can be processed with the IBM-360 computer system by modifying existing computer programs.

Control times can be reduced from the analog records.

Transient impulse information for analysis of the start and shutdown transient characteristics can be obtained from the transient impulse program.

(4) Plotted Data Capabilities

Measured test data versus time, or parameter versus parameter, can be plotted using a Cal-Comp plotter in conjunction with the IBM-360 computer system. Inch or centimeter paper can be used for presentation. The length of the plot is variable with a maximum of 17 parameters per plot. Any portion of the test can be expanded or the entire test contracted and plotted. Split scale plots are also available. Performance test data could also be plotted automatically if existing computer programs were appropriately modified.

(5) Dynamic Data Capabilities

Seven pressures, accelerometers, or combinations can be played back on a high speed oscillograph record from the dynamic data tape. This information can also be presented in the same formats as the normal digital data if desired. However, band pass information, frequency definition, and effective playback speed as well as end-use of data must be specified. Spectral density tabulations and plots are also available if requested.

III, D, Test Facilities (cont.)

(6) Data Storage

All original engine and component test records as well as data are readily available. Test data can be stored on magnetic tape for rapid, economical automatic tape use for statistical analysis and the data can be grouped by any categories selected.

III, Facilities and Equipment (cont.)

E. USE OF GOVERNMENT-OWNED FACILITIES AND EQUIPMENT

In estimating the cost of this proposed program, it has been assumed that the Government will grant authorization for rent-free, non-interference use of Government-owned facilities and equipment located at the Aerojet-General Sacramento Facility. The specific items are identified below. A utilization study of the indicated facilities and equipment shows that the proposed program falls within the anticipated contract expiration dates of the existing contractual programs indicated. A written request has been submitted to the cognizant contracting officer asking for concurrence with such use. Past experience as well as verbal inquiry indicates that there are no anticipated problem areas in obtaining owning contracts agreement for its use in the proposed program.

ADVANCED TECHNOLOGY SHOP
BUILDING 20004

<u>Item</u>	<u>Owning Contract</u>
Engine Lathe	AF 33(600)-29926
Universal Mill	
Bridgeport Mill	
Heliarc Automatic Welder	
Welding Positioner	
Cleaning and Degreasing Equipment	

HYDRAULICS LABORATORY
BUILDING 20002

Flow Test Station	AF 33(600)-29926
Proof and Leak Test Station	

Proposal NR69053, Folder 2

III, E, Use of Government-Owned Facilities and Equipment (cont.)

DATA PROCESSING CENTER
BUILDING 3308

<u>Item</u>	<u>Owning Contract</u>
Digital Data System	AF 33(600)-29926
Converter System	AF 33(600)-29926
Digital Data Recording System	AF 33(600)-29926

VALVE SHOP
BUILDING 3409

Lathe, Bench, 10-in.	AF 33(600)-29926
Drilling Machine	AF 33(600)-29926
Hacksaw	AF 33(600)-29926

TRANSDUCER LABORATORY
BUILDING 3308

Temperature Test Chambers	AF 33(600)-29926
Load Cell	AF 33(600)-29926
Manometers	AF 33(600)-29926
Mueller Bridge	AF 33(600)-29926

INSTRUMENTATION SHOP
BUILDING 3308

Low Frequency Generator	AF 33(600)-37850
Oscilloscope, Visicord, 36 Channel	AF 33(600)-37850

INSTRUMENTATION SHOP
BUILDING 3308

Modulator, Dual Analyzer	N00030-66-C-0223
Square Wave Generator, Oscilloscope	N00030-66-C-0223

Proposal NR69053, Folder 2

III, E, Use of Government-Owned Facilities and Equipment (cont.)

CONTROL SYSTEMS LABORATORY
BUILDING 2002

<u>Item</u>	<u>Owning Contract</u>
Bench Lathe	N00030-66-C-0223

TRANSDUCER LABORATORY
BUILDING 3308

Multigage Calibration Unit	F04688-67-A-0001
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RESEARCH PHYSICS LABORATORY
BUILDING 3004

Patchboard, Rear Frame, and Spring Assembly	NAS 7-141(F)
Instrumentation Bay Group	NAS 7-141(F)
Isolation Transformer	NAS 7-141(F)
Instrumentation Bay	NAS 7-141(F)
Digital Converter System	NAS 7-141(F)

CONTROL SYSTEMS LABORATORY
BUILDING 2002

Burst Chamber	NAS 7-141(F)
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STRUCTURAL TEST FACILITY S-1
BUILDING 46025

Structural test building with static and dynamic	N00030-66-C-0223
test frame, testing fixtures, controls and related	AF 33(600)-37850
equipment such as amplifiers, voltage regulators	AF 04-694-C67-0005
and motor generator	AF 33(600)-29926

III, E, Use of Government-Owned Facilities and Equipment (cont.)

STATIC ACCELERATION TESTING
TEST ZONE D-8

<u>Item</u>	<u>Owning Contract</u>
Centrifuge System, including drive unit, slip rings, and supporting equipment	AF 33(600)-29926

VIBRATION TEST FACILITY
TEST ZONE G

Data Acquisition System, consisting of tape recorder visicorder, oscillograph, Dymec system, amplifiers, analyzer and oscillators, strain gage systems	AF 33(600)-29926 AF 33(600)-37850
Vibration System, consisting of exciters, control consoles, amplifier and slip tables	NAS 7-141(F) Part 1 AF 33(600)-29926
High Pressure Gaseous Nitrogen Storage System, including seven (7) each 156,000 SCF, 3500 psig receivers and associated piping and vent system. Also two (2) each 13,200-gallon, 35 psig LN ₂ storage vessels with three (3) each pumps, vaporizers, piping and valving	AF 33(600)-29926
Test Services, Machine Shop Equipment, such as power cut-off saw, lathe, welding equipment, drill press, etc.	AF 33(600)-29926

III, E, Use of Government-Owned Facilities and Equipment (cont.)

OSCILLOGRAPH PROCESSING SHOP
BUILDING 3306

<u>Item</u>	<u>Owning Contract</u>
Oscillograph processing shop equipment, including wide film/paper processors, folding machine, oscillograph processor, hypo recovery unit	AF 33(600)-29926

DATA PROCESSING CENTER
BUILDING 3308

Instrumentation data processing and analyzing equipment including on-line recording tape transports, tape switching cabinet, plotters, printers, data buffer and tape gapper, and analog-to-digital converter	AF 33(600)-29926 NAS 7-141 Part 1
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TRANSDUCER LABORATORY
BUILDING 3308

Laboratory Equipment, including temperature test chambers, environmental chambers, dryer, lathe, welding equipment, microscopes, oscilloscopes, and related items	AF 33(600)-29926 AF 33(600)-37850 N00030-66-C-0223
Load Cell Calibration Equipment, including load cell calibration systems, calibrators, and associated items. Also force multiplication system with controls and related equipment	AF 33(600)-29926 AF 33(600)-37850 NAS 7-141(F) Part 1 N00030-66-C-0223
Accelerometer Calibration Equipment, including shaker, rotary accelerator, and related items	N00030-66-C-0223 AF 33(600)-29926

III, E, Use of Government-Owned Facilities and Equipment (cont.)

TRANSDUCER LABORATORY
BUILDING 3308

<u>Item</u>	<u>Owning Contract</u>
Pressure Transducer Test and Calibration Equipment, including pressure transducer test system with console, switching unit, differential pressure indicators, temperature chambers, and associated equipment (pressure intensifier, manometer system, multigage calibration units)	AF 04(695)-730 AF 33(600)-29926 F04-688-67-A-0001
Temperature Calibration Equipment, including cryostat and components, variable and constant temperature baths, and associated equipment	
Deadweight Standard Equipment, consisting of deadweight testers and associated equipment	AF 33(600)-29926
Shock Tube Pressure Generator System, including shock tube, control panel, and associated items	AF 04(695)-941
Sinusoidal Pressure System, including carrier generator, tracking filter, X-Y recorder, and related equipment	AF 04(694)-734
Instrumentation Diagnostic System and components	AF 04(695)-941

Proposal NR69053, Folder 2

III, E, Use of Government-Owned Facilities and Equipment (cont.)

INSTRUMENTATION SHOP
BUILDING 3308

<u>Item</u>	<u>Owning Contract</u>
Instrumentation Shop Calibration, Repair and Fabrication Equipment, including recorders, testers, simulators, resistance and temperature bridges, oscilloscope and associated pre-amplifiers, electronic counters, potentiometers, system calibrators, power, signal, and function generators, voltage, regulator, and associated shop equipment	AF 33(600)-29926 AF 33(600)-37850
Instrumentation Measurement and Test Equipment, such as oscilloscope, DC voltage standard, digital voltmeter and time measurement equipment	F04-688-67-A-0001
Instrument Measurement and Test Equipment, such as precision capacitors, power supplies, calibrators and associated equipment	NAS 7-141(F) Part 1 (NERVA Support)
Square Wave Generator, Oscilloscope	N00030-66-C-0223

ELECTRICAL FABRICATION AND REPAIR SHOP
BUILDING 3409

Electrical Fabrication and Repair Shop Equipment, including cable, checker, time checker, relay checker, power supply, meters, and associated components	AF 33(600)-29926
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III, E, Use of Government-Owned Facilities and Equipment (cont.)

VALVE SHOP
BUILDING 3409

<u>Item</u>	<u>Owning Contract</u>
Valve Repair, Testing, Cleaning and Assembly Shop	AF 33(600)-29926
Equipment, including lathes, grinders, pumps and	N00030-66-C-0223
similar associated equipment, a spectrophotometer,	AF 33(600)-37850
an ultrasonic cleaning unit, and a dehydrator	SNP-1

TEST OPERATIONS MACHINE SHOP
BUILDING 4621

Machine Tools and Related Equipment, including	N00030-66-C-0223
milling machines, shaper, lathes, drill machine,	AF 33(600)-29926
grinders, saw and filing machine and welders	AF 33(600)-37850

POOLED COMPONENTS

In addition to major systems heretofore listed, use	AF 04(695)-197
of Special Test Equipment Instrumentation components	AF 04(695)-730
such as recorders, oscillators, power supplies, timers,	F04-688-67-A-0001
counters, meters and calibrators belonging to the	AF 04(600)-37850
listed contracts is also required. These items of	NAS 9-150
equipment are subject to frequent periodic move because	SNP-1
of recalibration requirements. Use of the items among	AF 04(695)-941
various Government contracts permits reduced inven-	NAS 7-141(F) Part 1
tories to the economic benefit of the Government.	(NERVA Support)

IV. COSTS

A. PROPOSAL COST ELEMENTS

1. Direct Labor Rates

The method for estimating direct labor costs is based upon departmental average wage rates for employees in the Nuclear Rocket Operations and pool average wage rates for employees in the supporting organizations participating in the proposed work at the Sacramento Facility. The least-square trendline of average wage rates is calculated to determine the adjustment of rates. A trendline is placed through the actual average rates and projected forward. These trendline rates include provision for an anticipated change during the period of contract performance, including union negotiations, merit, promotion, and cost-of-living considerations.

A midpoint month is determined for each proposal and this point is found on the trendline. The proposed labor costs then are based upon the wage rates at this point. The midpoint month of a proposed program is that month during which one-half of the total proposed labor hours will have been expended.

The wage rates used in this proposal were calculated as described above and are listed on the Wage Rate Adjustment Worksheet, next page.

These average wage rate and trendline projection methods are approved by the Air Force Plant Representative's Office (Ref: Aerojet-General Corporation letters to the AFPRO, 22 October 1968 and 30 January 1969, subject: "Revision to Average Wage Rates for Proposal Purposes").

WAGE RATE ADJUSTMENT WORKSHEET

AGCS 0520-10 (REV. 10-67)

PROPOSAL NUMBER

NR69053

VOLUME

2

SECTION

IV

PAGE

OF

TASK/END ITEM/ASSY.

SUB TASK/COMPONENT

PLANT

POOL

FISCAL YEAR

NEXT SUMMARY REFERENCE

SALARY EXEMPT						POOL	HOURLY & SALARY NONEXEMPT				
MID POINT MONTH	ADJ. BASE RATE \$	SHIFT DIFF. \$	E.W.W. \$	FIELD PAY \$	ADJ. RATE \$		MID POINT MONTH	ADJ. BASE RATE \$	FIELD PAY \$	ADJ. RATE \$	O.T. PREMIUM RATE \$
Feb 70					6.65	NRO 7110				4.31	
Feb 70					7.84	7300				3.54	
					7.65	7730	Feb 70			4.43	
Feb 70					6.12	7780	Feb 70			4.90	
					7.26	7830				4.61	
					7.24	LRD				4.58	
					6.75	Mfg				4.70	

PERIOD OF PERFORMANCE

1 July 1969 through 31 August 1970

JUSTIFICATION

IV, A, Proposal Cost Elements (cont.)

2. Midpoint Determination

The Midpoint Determination Schedule shows the period of performance, total manhours proposed, and the proposal midpoint (see next page).

3. Overhead Rates

Each year, Aerojet-General submits a forecast of direct labor overhead, material burden, as well as General and Administrative expenses for the ensuing year. These rates, which are reviewed by both the Air Force Plant Representative's Office and the resident Defense Contract Audit Agency, are subsequently negotiated. These negotiated rates become the effective overhead rate for proposals.

Overhead rates for work to be accomplished during Aerojet's Fiscal Year 1969 and 1970 and beyond were submitted to the Air Force Plant Representative's Office on 7 January 1969. These rates are as follows:

<u>Description</u>	<u>Applied to</u>	<u>FY 1969</u> <u>%</u>	<u>FY 1970</u> <u>%</u>
Manufacturing Division			
DLO	1100/1200	215.9	220.6
G&A		10.4	9.4
Liquid Rocket Division			
DLO	9500/9600	144.5	146.5
G&A		15.78	15.96
Nuclear Rocket Operations			
DLO	2400/7100/ 7300/7700/ 7800	113.9	113.9
G&A		10.6	10.6
Material Burden		7.9	7.5

IV, A, Proposal Cost Elements (cont.)

4. Manhours to Equivalent Men Conversion Rates

In this proposal, the equivalent men per month are calculated on the basis of the following productive hours per month. They are calculated, audited, and published by the Aerojet-General Controller, Sacramento Facility.

MIDPOINT DETERMINATION

PERIOD OF PERFORMANCE - 1 Aug 1969 through 31 Oct 1970

TOTAL MANHOURS PROPOSED - 11,983

50% OF TOTAL MANHOURS - 5,992

PROPOSAL MIDPOINT - February 1970

<u>Year</u>	<u>Period</u>	<u>Incremental Manhours</u>	<u>Cumulative Manhours</u>
1969	Aug	863	863
	Sep	229	1,092
	Oct	864	1,956
	Nov	1,567	3,523
	Dec	789	4,312
1970	Jan	1,000	5,312
	Feb	1,075	6,387
	Mar	1,446	7,833
	Apr	1,225	9,058
	May	1,660	10,718
	Jun	757	11,475
	Jul	273	11,748
	Aug	53	11,801
	Sep	43	11,844
	Oct	139	11,983

IV, A, Proposal Cost Elements (cont.)

<u>Month</u>	<u>Productive Manhours</u>	<u>Month</u>	<u>Productive Manhours</u>
August	178	March	152
September	145	April	145
October	150	May	181
November	174	June	136
December	150	July	132
January	155	August	178
February	148	September	145
		October	150

5. Computer Rates

The rates for the Computing Sciences Department are established, audited, and published by the Aerojet-General Controller, Sacramento Facility. These rates include direct charges and allocated overhead for the Computing Sciences Department. (Ref: Memorandum, Controller to Operation and Department Managers, dated 22 January 1969, subject: "Cost Distribution-Computing Sciences Revised Rate Schedule" and Aerojet-General Letter to the AFPRO, dated 8 January 1969, subject: "Test Data Processing Rate per Hour for Proposal Preparation.")

<u>Cost Center</u>	<u>Description</u>	<u>Rate per Hour FY 1969 and Beyond</u>
1	System Analysis/Development	13.25
2	Computer Programming	10.25
A	Key Punch/Verify	6.10
B	Computer Support (EAM)	18.00
C	IBM 1130 Computer	20.00
D	360/30 Computers - Peripheral Support	70.00
K	360/65 Operating System	325.00
	Test Computer (Department 9500)	
	AGC FY 1969	115.00
	AGC FY 1970	120.00

IV, Costs (cont.)

B. CONTRACT PRICING PROPOSAL (DD Form 633-4)

DD Form 633-4 presents the costs and fee for accomplishing all tasks in the program plan.

C. PROPOSED R&D CONTRACT ESTIMATE (NASA-C-162a)

The cost detail for the proposed program is shown on Form NASA C-162a.

D. PROPOSED R&D CONTRACT ESTIMATE - DETAIL OF RATED COSTS (NASA-C-162b)

The estimated labor costs are shown on the NASA-C-162b form by the Aerojet-General Sacramento Departments that will accomplish the work tasks and subtasks. The rates used are as discussed in Section IV,A,1 of this folder. The burden and G&A rates used are discussed in Section IV,A,3.

E. ESTIMATED FUNDING REQUIREMENTS (NASA-C-163)

The estimated funding requirements are based upon an anticipated commitment basis with the estimated costs shown in the period when it is estimated that the costs will be committed.

F. DIRECT LABOR BREAKDOWN AND COST DISTRIBUTION

Cost distribution is detailed on Form AGCS 0520-12. The direct labor departmental breakdown shown is by salary and hourly hours in relationship to task.

DEPARTMENT OF DEFENSE CONTRACT PRICING PROPOSAL (RESEARCH AND DEVELOPMENT)				Form Approved Budget Bureau No 22-R100	
This form is for use when (i) submission of cost or pricing data (see ASPR 3-807.3) is required and (ii) substitution for the DD Form 633 is authorized by the contracting officer				PAGE NO	NO OF PAGES
NAME OF OFFEROR Aerojet-General Corporation		SUPPLIES AND/OR SERVICES TO BE FURNISHED Design and Fabrication of Prototype Primary NaK Loop Valve Sets			
HOME OFFICE ADDRESS (Include ZIP Code) Post Office Box 15847 Sacramento, Calif. 95813					
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Nuclear Rocket Operations, Sacramento Facility		TOTAL AMOUNT OF PROPOSAL \$ 244,906	GOVT SOLICITATION NO 438468		
DETAIL DESCRIPTION OF COST ELEMENTS					
1 DIRECT MATERIAL (Itemize on Exhibit A)			EST COST (\$)	TOTAL EST COST ¹	REFER. 2 ENCE
a PURCHASED PARTS					
b SUBCONTRACTED ITEMS			13,604		
c OTHER (1) RAW MATERIAL			972		
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL				14,576	
2 MATERIAL OVERHEAD ³ (Rate % X \$ base =)				1,093	
3 DIRECT LABOR (Specify)		ESTIMATED HOURS	RATE/ HOUR	EST COST (\$)	
NRO		3,259		20,378	
LRO		6,289		39,928	
Mfg		2,435		11,445	
TOTAL DIRECT LABOR				71,751	
4 LABOR OVERHEAD (Specify department or cost center) ³		O.H. RATE	X BASE =	EST COST (\$)	
NRO				23,207	
LRO				58,261	
Mfg				25,248	
TOTAL LABOR OVERHEAD				106,716	
5 SPECIAL TESTING (Including field work at Government installations)				EST COST (\$)	
TOTAL SPECIAL TESTING					
6 SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)					
7 TRAVEL (If direct charge) (Give details on attached Schedule)				EST COST (\$)	
a TRANSPORTATION					
b PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL					
8 CONSULTANTS (Identify purpose rate)				EST COST (\$)	
TOTAL CONSULTANTS					
9 OTHER DIRECT COSTS (Itemize on Exhibit A)					4,643
TOTAL DIRECT COST AND OVERHEAD					198,779
11 GENERAL AND ADMINISTRATIVE EXPENSE (Rate % of cost element Nos					25,905
12 ROYALTIES ⁴					224,684
TOTAL ESTIMATED COST					
14 FEE OR PROFIT					20,222
TOTAL ESTIMATED COST AND FEE OR PROFIT					244,906
This proposal is submitted for use in connection with and in response to (Describe RFP, etc.)					
RFP No. 438,468, NASA LeRC					
and reflects our best estimates as of this date in accordance with the instructions to offerors and the footnotes which follow					
TYPED NAME AND TITLE G. L. Ryland, Manager Administration, Nuclear Division			SIGNATURE		
NAME OF FIRM Aerojet-General Corporation			DATE OF SUBMISSION June 20, 1969		

Proposal NR69053, Folder 2

[illegible]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED R&D CONTRACT ESTIMATE

(Submit with DD Form 633)

Page 1 of 2

INSTRUCTIONS: Submit an estimate for the total contract and for each task or other logical subdivision of work. Phase each estimate by annual or other time periods for which separate estimating or quoting rates have been negotiated or established.

RFP NO

438468

OFFEROR (Name)

Aerojet-General Corporation

COST ELEMENTS		Task				REFERENCE
		I	II	III	IV	
Direct Labor	Hours					
	Engineering	842	3,240	4,393	1,073	
	Manufacturing			2,435		
Direct Labor	Cost					
	Engineering	5,710	21,215	26,383	6,998	
	Manufacturing			11,445		
Labor Overhead	Engineering	7,768	27,318	37,749	8,633	
	Manufacturing			25,248		
Direct Material	Purchased parts					
	Subcontracted items			13,604		
	Raw material			972		
	Standard Commercial items					
	Interdivisional transfers (at other than cost)					
Material Overhead				1,093		
Interdivisional transfers at cost						
Other Direct Costs	Travel & per diem					
	Computer		1,125		750	
	Consultants					
	Publishing Costs				2,768	
Subtotals		13,478	49,658	116,494	19,149	
General and administrative expense		1,951	6,561	15,084	2,309	
Royalties						
Subtotals		15,429	56,219	131,578	21,458	
Fee or Profit						
Total Price						

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED R&D CONTRACT ESTIMATE

(Submit with DD Form 633)

Page 2 of 2

INSTRUCTIONS: Submit an estimate for the total contract and for each task or other logical subdivision of work. Phase each estimate by annual or other time periods for which separate estimating or quoting rates have been negotiated or established.

RFP NO

438468

OFFEROR (Name)

Aerojet-General Corporation

COST ELEMENTS						REFERENCE
		TOTALS				
Direct Labor	Hours	Engineering	9,548			
		Manufacturing	2,435			
Direct Labor	Cost	Engineering	60,306			
		Manufacturing	11,445			
Labor Overhead		Engineering	81,468			
		Manufacturing	25,248			
Direct Material		Purchased parts				
		Subcontracted items	13,604			
		Raw material	972			
		Standard Commercial items				
		Interdivisional transfers (at other than cost)				
Material Overhead			1,093			
Interdivisional transfers at cost						
Other Direct Costs		Travel & per diem				
		Computer	1,875			
		Consultants				
		Publishing Costs	2,768			
Subtotals			198,779			
General and administrative expense			25,905			
Royalties						
Subtotals			224,684			
Fee or Profit			20,222			
Total Price			244,906			

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED R&D CONTRACT ESTIMATE - DETAIL OF RATED COSTS
(Submit with DD Form 633)

Page 1 of 2

INSTRUCTIONS: Submit this form to provide detail of the rated costs (labor, computer, overhead, G&A, etc) which have been included in form NASA-C-162a.

OFFEROR (Name)

Aerojet-General Corporation

RFP NO.

438468

COST ELEMENT AND CATEGORIES												
	Task I			Task II			Task III			Task IV		
	HOURS/ BASE	RATE	COST	HOURS BASE	RATE	COST	HOURS/ BASE	RATE	COST	HOURS/ BASE	RATE	COST
Direct Labor												
<u>NRO</u> Sal	150		1,144	1,192		8,266	266		1,627	714		4,749
Hr1	89		436	576		2,823	232		1,137	40		196
<u>LRD</u> Sal	514		3,722	1,272		9,211	2,173		15,732	223		1,614
Hr1	89		408	200		915	1,722		7,887	96		439
<u>Mfg</u> Sal												
Hr1							2,435		11,445			
Totals	842		5,710	3,240		21,215	6,828		37,828	1,073		6,998
DLO												
NRO			1,800			12,634			3,148			5,625
LRD			5,968			14,684			34,601			3,008
Mfg									25,248			
Totals			7,768			27,318			62,997			8,633
Materials												
Material O.P.									14,576			
Material Burden									1,093			
Computer						1,125						750
ODC												2,768
Subtotals			13,478			49,658			116,494			19,149
G&A Expense												
NRO			358			2,638			2,177			1,501
LRD			1,593			3,927			9,458			808
Mfg									3,449			
Total Costs			15,429			56,219			131,578			21,458

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PROPOSED R&D CONTRACT ESTIMATE - DETAIL OF RATED COSTS
(Submit with DD Form 633)

Page 2 of 2

INSTRUCTIONS: Submit this form to provide detail of the rated costs (labor, computer, overhead, G&A, etc.) which have been included in form NASA-C-162a.

OFFEROR (Name)

Aerojet-General Corporation

RFP NO.

438468

COST ELEMENT AND CATEGORIES												
	Totals											
	HOURS/ BASE	RATE	COST	HOURS/ BASE	RATE	COST	HOURS/ BASE	RATE	COST	HOURS/ BASE	RATE	COST
<u>Direct Labor</u>												
<u>NRO</u> Sal	2,322		15,786									
Hrl	937		4,592									
<u>LRD</u> Sal	4,182		30,279									
Hrl	2,107		9,649									
<u>Mfg</u> Sal												
Hrl	435		11,445									
Totals	11,983		71,751									
<u>DLO</u>												
NRO			23,207									
LRD			58,261									
Mfg			25,248									
Totals			106,716									
<u>Materials</u>												
Mat'l & O.P.			14,576									
Mat'l Burden			1,093									
<u>Computer</u>			1,875									
<u>ODC</u>			2,768									
<u>Subtotals</u>			198,779									
<u>G&A Expense</u>												
NRO			6,670									
LRD			15,786									
Mfg			3,449									
<u>Total Costs</u>			224,684									

ESTIMATED FUNDING REQUIREMENTS		
RFP NO.:	OFFERER:	
C-257216	Aerojet-General Corporation	
PERIOD	AMOUNT	
	QUARTER	FISCAL YEAR
FISCAL YEAR ENDING JUNE 30, 19 <u>70</u> :		
JULY - SEPTEMBER	22,110	
OCTOBER - DECEMBER	61,223	
JANUARY - MARCH	83,628	
APRIL - JUNE	67,453	234,414
FISCAL YEAR ENDING JUNE 30, 19 <u>71</u> :		
JULY - SEPTEMBER	7,365	
OCTOBER - DECEMBER	3,127	
JANUARY - MARCH		
APRIL - JUNE		10,492
FISCAL YEAR ENDING JUNE 30, 19 ____ :		
JULY - SEPTEMBER		
OCTOBER - DECEMBER		
JANUARY - MARCH		
APRIL - JUNE		
FISCAL YEAR ENDING JUNE 30, 19 ____ :		
JULY - SEPTEMBER		
OCTOBER - DECEMBER		
JANUARY - MARCH		
APRIL - JUNE		
FISCAL YEAR ENDING JUNE 30, 19 ____ :		
JULY - SEPTEMBER		
OCTOBER - DECEMBER		
JANUARY - MARCH		
APRIL - JUNE		
FISCAL YEAR ENDING JUNE 30, 19 ____ :		
JULY - SEPTEMBER		
OCTOBER - DECEMBER		
JANUARY - MARCH		
APRIL - JUNE		
GRAND TOTAL		244,906

TIMEPHASE SUMMARY

AGCS 0520 12 REV 1 69

TASK END TEM ASS

PROPOSAL NUMBER
NR69053, Folder 2

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SUB TASK COMPONENT

FAC L

FOO

FISCAL YEAR

NEXT SUMMARY REFERENCE

Task	DESCRIPTION	1		2		3		4		5		6		7		8		9		10		11		12		Subtask	
		SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH	SH	HH
I	Preliminary																										
	Design	635	178	29																						664	178
II	Detailed Design			117	40	705	115	1097	421	545	200															2464	776
						Comp \$ 750		Comp \$ 375																		Comp \$ 1125	
III	Fab and Test																									2439	4389
													315	640	318	713	355	1047	452	730	656	954	343	305		Mat'l/OP 14576	
													Mat'l/OP 13539						Mat'l/OP 324		713						
IV	Reports	50		43		44		49		44		45		44		44		43		50		109		167	106	732	106
		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 214		Comp/ODC 510		Comp/ODC 2864	
	Summary Inc	685	178	189	40	749	115	1146	421	589	200	360	640	362	713	399	1047	495	730	706	954	452	305	167	106	6299	5449
	Cum	863		1092		1956		3523		4312		5312		6387		7833		9058		10718		11475		11748		11748	
	Matl + OP \$											13539						324		713						14576	
	Comp + O.D.C \$	214		214		964		589		214		214		214		214		214		214		214		510		3989	

TIMEPHASE SUMMARY

AGCS 0520 12 REV. 69

ASK END TEM ASS

R O P O A N B
NR69053, Folder 2

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POOL

F SCAL YEAR

NEX S UMAN REFERENCE

Task	DESCRIPTION	13		14		15										TOTAL	
		SH	HH	SH	HH	SH	HH									SH	HH
I	Preliminary																
	Design															664	178
II	Detailed Design															2464	776
																Comp \$	1125
III	Fab and Test															2439	4389
																Mat'l/OP	14576
IV	Reports	53		43		109	30									937	136
		Comp/ODC		Comp/ODC		Comp/ODC										Comp/ODC	3518
		50		50		554											
	Summary Inc	55		43		109	30									6504	5479
	Cum	11801		11844		11983											11983
	Mat'l + OP \$																14576
	Comp. + ODC \$	50		50		554											4643

IV, Costs (cont.)

G. MAN-LOADING SCHEDULES

The cumulative estimated costs (exclusive of fee) and manhours are shown by month (see next page) for the total program and each of the following specified tasks:

- Task I - Preliminary Design
- Task II - Detail Design
- Task III - Fabrication and Test
- Task IV - Reports

H. EXCESS COSTS ASSOCIATED WITH PROVIDING REQUESTED FINANCIAL DATA

The financial data required is available in Aerojet's existing accounting structure and excess costs for providing this information is not anticipated.

Manhours and Dollars vs Time x Task

<u>Task</u>	<u>Description</u>	<u>Elmt</u>	<u>Avg</u>	<u>Sept</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sept</u>	<u>Oct</u>
I	Prelim. Design	Cum Mhr Cum \$	813 14835	842 15429													
II	Detailed Design	Cum Mhr Cum \$		157 2919	977 18446	2495 43597	3240 56219										
III	Fab and Test	Cum Mhr Cum \$						955 32741	1986 50403	3388 73919	4570 93669	6180 120751	6828 131578				
IV	Reports	Cum Mhr Cum \$	50 1022	93 1936	137 2866	186 3874	230 4804	275 5748	319 6678	363 7608	406 8522	456 9544	565 11833	838 16808	891 17783	934 18590	1073 21458
	TOTAL PROGRAM	Cum Mhr Cum \$	863 15857	1092 20284	1956 36741	3523 62900	4312 76452	5312 110137	6387 128729	7833 133175	9058 173839	10718 201943	11475 215059	11748 220034	11801 221009	11844 221816	11983 224684

V. AEROJET-GENERAL PERFORMANCE IN RELATED PROCUREMENTS

Following are the requested data on five (5) government contracts received during the last three (3) years involving research and development work in the areas of valve design, fabrication, testing and related fields. All of these contracts represent current, on-going, cost type programs and completions are estimated within the contractual schedules.

1. a. Contract No.: NAS 9-8317 Type: CPFF
 b. Title: Rocket Engine Valve Improvement Program
 c. Agency: NASA, Manned Space Center, Houston, Texas
 d. Cost and Fee: \$500,000
 e. Start and Completion: June 28, 1969 - December 31, 1970
 f. Work Description: Design, fabricate and test valves for the
 Apollo Service Propulsion System Bipropellant
 Valve improvement program.

2. a. Contract No.: NAS 3-12035 Type: CPFF
 b. Title: Space Storable Oxidizer Valve
 c. Agency: NASA, LeRC, Cleveland, Ohio
 d. Cost and Fee: \$124,745
 e. Start and Completion: March 14, 1969 - March 14, 1970
 f. Work Description: Design, fabricate and test a flight weight
 liquid florine shutoff valve.

3. a. Contract No.: AT(04-3)-728 Type: CPFF
 b. Title: Liquid Metal Fast Breeder Reactor Fuel
 Handling System
 c. Agency: U.S. AEC, San Francisco Operations Office
 d. Cost and Fee: \$310,352. (Interim funding and fee through
 June 1969)
 e. Start and Completion: September 9, 1968 - June 30, 1969 (Continuous)
 f. Work Description: Provide all necessary facilities, equipment
 and personnel for research, development
 evaluation, reporting, consulting and
 allied services in the PNL fuel handling
 system for liquid metal fast breeder reactors.

Proposal NR69053, Folder 2

V, Aerojet-General Performance in Related Procurements (cont.)

4.
 - a. Contract No.: AT(30-1)-4026 Type: CPFF
 - b. Title: LMFBR Large Valve Technology Development
 - c. Agency: U.S. AEC, San Francisco Operations Office
 - d. Cost and Fee: \$198,911 (Interim funding and fee through August 1969.)
 - e. Start and Completion: October 15, 1968 - August 31, 1969 (Continuous)
 - f. Work Description: Develop, fabricate, list large isolation, check and flow valves for use in liquid sodium environments for the Liquid Metal Fast Breeder Reactor Program.

5.
 - a. Contract No.: SNP-1 Type: CPFF
 - b. Title: R&D to produce a Nuclear Powered Rocket Engine
 - c. Agency: AEC-NASA - Space Nuclear Propulsion Office
 - d. Cost and Fee:
 - e. Start and Completion: July 15, 1961 - Continuous
 - f. Work Description: Provide the necessary research, development, and testing to produce a Nuclear Powered Rocket Engine System. This effort includes the development of a Turbine Powered Control Valve for hot hydrogen and nuclear environments.

VI. SUPPLEMENTAL INFORMATION

Aerojet-General is incorporated under the laws of the State of Ohio and maintains its corporate headquarters in El Monte, California. The Sacramento Facility currently employs approximately 6,000 persons in research, development, and production programs for both governmental agencies and commercial organizations. The most recent Corporate financial statement is included as Appendix B.

A. AEROJET-GENERAL ACCOUNTING SYSTEMS, POLICIES, AND PROCEDURES

The accounting policies and procedures of Aerojet-General are reviewed and approved periodically by the Defense Contract Audit Agency and the Air Force Administrative Contracting Officer. It is assumed that this will satisfy the accounting requirements for the proposed contract.

In accordance with the provisions of ASPR 3-903.3, the Aerojet-General purchasing system is reviewed and approved by the resident DCAA auditor and the resident Air Force Administrative Contracting Officer. It is assumed that this system will fulfill all requirements of the contract relative to obtaining prior approval of subcontracts and purchase orders.

B. ROYALTIES

No royalty payments or royalty fees are included in this proposal.

C. LOCATION OF WORK

It is anticipated that the work involved in this proposed program will be performed at the Aerojet-General Sacramento Facility.

VI, Supplemental Information (cont.)

D. INITIATION OF WORK

Should it be considered expedient, work can be initiated in the proposed program upon the basis of a teletype notice of award, letter contract, or other interim contractual authority to proceed.

E. OVERTIME

No overtime is included in or planned for this program.

F. LOCAL AUDIT AND ADMINISTRATIVE AGENCY

Branch offices of the Defense Contract Audit Agency and the Air Force Plant Representative are located at Aerojet-General's Sacramento Facility. They can be reached at the following addresses:

Air Force Plant Representative
Air Force Contract Management
Division (AFSC)
Aerojet-General Corporation
Post Office Box 15846
Sacramento, California 95813
Telephone: A/C 916, 355-1000

Defense Contract Audit Agency
c/o Aerojet-General Corporation
Post Office Box 15846
Sacramento, California 95813
Attn: A. W. Hara
Telephone: A/C 916, 355-5813

G. INVENTIONS MADE UNDER CONTRACTOR'S INDEPENDENT RESEARCH AND DEVELOPMENT PROGRAMS

It is requested that the clause authorized by NASA Procurement Regulation 9.101-7 be placed in any resulting contract.

VI, Supplemental Information (cont.)

H. CONTRACTUAL PROCEDURES

The Aerojet-General Corporation has extensive experience in the administration of Government contracts. In the proposed program, no need is foreseen for any deviation from the established standard procedures.

I. MAKE-OR-BUY

Aerojet-General has detailed policies and procedures governing make-or-buy. Corporate Standard Practice Instruction (SPI) C-09-03 provides basic policy guidance and establishes a Corporate Make-or-Buy Review Committee charged with reviewing and revising corporate policy as well as auditing plant make-or-buy programs.

Sacramento Facility Standard Practice Instruction K-06-12 establishes the responsibilities and procedures for implementing the corporate policy. In general, the policy provides that available Aerojet-General resources will be utilized in the fullest extent practicable for Aerojet-General designed parts, assemblies, and processes, but that commercially-available items will not normally be manufactured in-plant. The SPI's also provide that contractual make-or-buy obligations take precedence.

Appropriate make-or-buy decisions will be made by Mr. Shearer, the Aerojet-General Project Engineer in accordance with SPI K-06-12. In each instance, estimates of price, quality, and delivery times will be obtained from qualified vendors who have demonstrated related experience as well as from the Aerojet-General Manufacturing Division. The make-or-buy decision will be based upon a critical evaluation of these estimates.

VI, Supplemental Information (cont.)

J. SUBCONTRACTING

Aerojet-General maintains a comprehensive set of Standard Practice Instructions covering all aspects of procurement. These SPI's are supported and implemented by the Procurement and Material Procedures Manual. The purchasing system is reviewed periodically and is currently approved by the Chief of the Contract Administration Division, Air Force Plant Representative Office.

In addition, Aerojet-General maintains a Small Business/Labor Surplus Area Subcontracting Program. The small Business Specialist of the Naval Ordnance Systems Command reviewed and approved this program in May 1966 and has recommended a plus factor when computing fee or profit based upon the weighted guidelines method.

In the proposed program, any necessary make-or-buy decisions will be made by Mr. Shearer, the Aerojet-General Project Engineer. These decisions will be made in accordance with the existing policies and procedures. In each instance, estimates of price, quality, and delivery times will be obtained from qualified Aerojet-General vendors having demonstrated related experience. The make-or-buy decision will be based upon a critical evaluation of these estimates.

K. COST REDUCTION PROGRAM

Aerojet-General is in full compliance with the objectives of the NASA Contractor Cost Reduction Program as approved by the NASA Cost Reduction Board. This is evidenced by the letter and certificate included as Appendix A of this folder.

VI, Supplemental Information (cont.)

L. ZERO DEFECTS PROGRAM

Aerojet-General has been an active participant in the Government's Zero Defects Program since 1964. A number of citations have been awarded to Aerojet-General in recognition of its achievements. These include the Air Force Participation and Achievement Awards. In addition, Aerojet-General has been given the Air Force Craftsmanship Award which represents the highest attainable recognition in the Zero Defects Program.

M. NON-SEGREGATED FACILITIES

Aerojet-General is fully compliant with the Government requirements concerning non-segregated facilities.

N. SAFETY AND HEALTH

Aerojet-General maintains comprehensive standards concerning safety and health for the various operational aspects of its Sacramento Facility. The NASA Lewis Research Center is familiar with these practices, especially as pertains to testing and the handling of hazardous propellants. In the proposed program, the testing medium will be water and the procedures to be applied do not impose any potential for safety and/or health hazards. Consequently, the existing standard safety and health practices will be applied throughout the program without deviation.

APPENDIX A

COST REDUCTION PROGRAM CERTIFICATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

OCT 28 1965

Mr. William E. Zisch
President
Aerojet-General Corporation
9191 East Flair Drive
El Monte, California

Dear Mr. Zisch:

In recognition of the cooperation which Aerojet-General has shown in establishing a cost reduction program approved by the NASA Cost Reduction Board, we are enclosing a formal citation.

The members of NASA General Management join with Dr. Silverstein in thanking you for your very excellent efforts. You have our permission to make appropriate internal dissemination of this approval of your Program.

We will look forward to your continued personal support in our effort to achieve economy and efficiency in the Space Program.

Sincerely yours,

James E. Webb
Administrator

Enclosure

National Aeronautics and Space Administration
Recognition of Cost Reduction Participation

Presented to

Aerojet-General Corporation

*In acknowledgment of the establishment of a formal
Cost Reduction Program and for Participation in
the NASA Contractor Cost Reduction Program*

October 28, 1965

Date

James E. Webb
Administrator

APPENDIX B

AEROJET-GENERAL CORPORATION
FINANCIAL STATEMENT

Financial Statements

CONSOLIDATED BALANCE SHEET

NOVEMBER 30, 1968 AND 1967

ASSETS		1968	1967
Current assets			
Cash and short term securities		\$ 12 383 000	\$ 10 095 000
Accounts and notes receivable, including unbilled amounts of \$26,457,000 in 1968 and \$35,785,000 in 1967 —			
United States Government		58,310 000	61 163 000
Other, including \$10,856,000 income tax refund in 1967		6,390,000	15,444,000
Inventories, less progress payments of \$89,084,000 in 1968 and \$86,779,000 in 1967 which are secured by lien (Note B)		78 166 000	63 153 000
		<u>155,249,000</u>	<u>149,855,000</u>
Property, plant and equipment, at cost less accumulated depreciation of \$116,539,000 in 1968 and \$102,833,000 in 1967 (Note C)		89,235 000	89 388 000
Investments and advances, at cost		4,449,000	4,216 000
Deferred charges		3,938 000	3 903 000
Intangible assets (Note A)		2,881 000	2 881 000
		<u>\$255 752 000</u>	<u>\$250 243 000</u>

LIABILITIES

Current liabilities			
Notes payable to banks		\$ 25,000,000	\$ 25,000,000
Instalments on long term debt		1,895,000	2,018 000
Accounts payable, accrued wages, interest, etc		67,687,000	69 396 000
Federal income taxes		7 720 000	878 000
		<u>102,302,000</u>	<u>97,292 000</u>
Long term debt, less current instalments (Note D)		30,051,000	32 284 000
Shareholders' equity			
Common stock — \$1 par value			
Authorized — 12,000,000 shares (Note E)			
Outstanding — 4,766,595 shares		4,767 000	4,767,000
Other capital		36,990,000	36 990 000
Retained earnings, per accompanying statement (Note D)		83 125 000	80 392 000
		<u>124,882,000</u>	<u>122,149,000</u>
Less cost of shares in treasury, 51,528 in 1968 and 51,490 in 1967		1 483 000	1 482 000
		<u>123 399 000</u>	<u>120 667 000</u>
		<u>\$255 752 000</u>	<u>\$250 243 000</u>

STATEMENT OF CONSOLIDATED INCOME

YEARS ENDED NOVEMBER 30 1968 AND 1967

	1968	1967
Net sales	\$444,803,000	\$443,804,000
Interest, dividends and other income, less other expenses	<u>1 490,000</u>	<u>745,000</u>
	446,293,000	444,549,000
Cost and expenses		
Cost of sales, administrative and general expenses, excluding items shown below	400,103,000	434,612,000
Taxes other than federal income taxes	13,093,000	14,202,000
Depreciation	15,973,000	14,342,000
Interest	<u>3 676 000</u>	<u>2,839,000</u>
	432,845,000	465,995,000
Income (loss) before federal taxes on income	13,448,000	(21,446,000)
Provision for federal taxes on income (refund in 1967), including investment tax credit of \$1 100,000 in 1968 and \$800,000 in 1967	<u>6,000 000</u>	<u>(11,200 000)</u>
Net income (loss) for year	<u>\$ 7 448 000</u>	<u>(\$ 10,246,000)</u>
Net income (loss) per share of common stock	<u>\$1 58</u>	<u>(\$2 17)</u>

CONSOLIDATED STATEMENT OF RETAINED EARNINGS

YEARS ENDED NOVEMBER 30 1968 AND 1967

	1968	1967
Balance at beginning of year	\$ 80,392,000	\$ 95,359,000
Net income (loss) for year	7,448,000	(10,246,000)
Cash dividends on common stock (\$1 per share)	<u>(4,715,000)</u>	<u>(4,721,000)</u>
Balance at end of year (Note D)	<u>\$ 83,125 000</u>	<u>\$ 80,392,000</u>

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

NOTE A: The consolidated financial statements include the accounts of the company and all of its subsidiary companies. Intangible assets (\$2,881,000) represent the excess of consideration given over the underlying equity at dates of acquisition of a subsidiary subsequently merged into the company.

NOTE B: Inventories are stated generally at the lower of average cost or market. Work in process on fixed-price and fixed-price incentive type contracts is stated at the total of direct costs and overhead applicable thereto, less the estimated average cost of deliveries based on the estimated total cost of each contract at completion. To the extent that estimated total contract costs, determined as above, are expected to exceed total sales price, charges are made to current earnings, with a related reduction in work in process to estimated realizable value.

Under cost type contracts, charges are made to cost of sales when applicable costs are incurred and the related sales include such costs to the extent considered reimbursable, together with applicable fees based on the percentage of contract completion.

NOTE C: The investment in property, plant and equipment, at cost, is summarized below:

	1968	1967
Land	\$ 13,023,000	\$ 13,091,000
Land improvements	13,679,000	13,619,000
Buildings and structures	63,462,000	62,675,000
Machinery and equipment	98,707,000	84,187,000
Office furniture and equipment	10,651,000	10,604,000
Transportation equipment	2,643,000	2,624,000
Leasehold improvements	1,624,000	1,590,000
Construction in progress	1,985,000	3,831,000
	<u>205,774,000</u>	<u>192,221,000</u>
Less — Accumulated depreciation	<u>116,539,000</u>	<u>102,833,000</u>
	<u>\$ 89,235,000</u>	<u>\$ 89,388,000</u>

Depreciation is generally provided on the declining balance method over the estimated service lives of the properties

NOTE D: Long term debt, less current instalments:

	1968	1967
5 ³ / ₄ % subordinated sinking fund promissory notes due 1970 to 1983	\$ 14,000,000	\$ 15,000,000
5 ¹ / ₄ % sinking fund debentures due 1970 to 1981	11,800,000	12,600,000
Other	4,251,000	4,684,000
	<u>\$ 30,051,000</u>	<u>\$ 32,284,000</u>

Under the most restrictive provisions of the trust indentures for the debentures and of the long term loan agreements, approximately \$34,000,000 of retained earnings at November 30, 1968 is not under restriction as to cash dividends on common stock.

NOTE E: At November 30, 1968, options for 86,626 shares of the company's common stock granted at market prices ranging from \$25.40 to \$34.50 were outstanding, of which 62,698 were exercisable. During fiscal year 1968, options for 500 shares were granted and options for 12,477 shares were canceled. There were 23,000 unoptioned shares available for future grants at November 30, 1968.

NOTE F: The company and its subsidiaries have several pension plans covering substantially all of their employees. Total pension cost accrued for the year was \$900,000. The company's policy is to fund only those pension costs accrued which will be required to keep the plans qualified under the Internal Revenue Code. During the year the treatment of actuarial gains and losses was changed from recognizing all such gains currently to an averaging method which, together with other changes in actuarial assumptions, had the effect of decreasing net income for the year by approximately \$200,000.

NOTE G: Substantially all of the company's business is with the United States Government and is subject to price redetermination and renegotiation. Provision has been made for estimated refunds under price redetermination provisions of the contracts. All renegotiation proceedings on a consolidated basis with The General Tire & Rubber Company and subsidiaries for 1966 and prior years have been concluded; in the opinion of management no refund will be required from Aerojet-General for 1967 and 1968.

NOTE H: Minimum annual rentals under noncancelable leases, excluding obligations for taxes, insurance and certain other expenses, for fiscal years ended November 30 are as follows: \$3,400,000 for 1969, \$2,700,000 for 1970, \$1,000,000 for 1971, \$500,000 for 1972, \$100,000 for 1973, and \$200,000 in total for the period 1974 through 1978.

**CONSOLIDATED STATEMENT OF SOURCE
AND APPLICATION OF FUNDS**

YEARS ENDED NOVEMBER 30, 1968 AND 1967

	1968	1967
SOURCE:		
Operations —		
Net income (loss) for year	\$ 7,448,000	(\$10,246,000)
Depreciation	<u>15,973,000</u>	<u>14,342,000</u>
	23,421,000	4,096,000
Increase in long term debt		2,884,000
Other items, net		<u>817,000</u>
	<u>23,421,000</u>	<u>7,797,000</u>
APPLICATION:		
Cash dividends to shareholders	4,715,000	4,721,000
Property additions, net	15,820,000	24,147,000
Reduction in long term debt	2,233,000	
Other items, net	<u>269,000</u>	
	<u>23,037,000</u>	<u>28,868,000</u>
DIFFERENCE — increase (decrease) in working capital	<u>\$ 384,000</u>	<u>(\$21,071,000)</u>

OPINION OF INDEPENDENT ACCOUNTANTS

PRICE WATERHOUSE & Co.

606 SOUTH OLIVE STREET
LOS ANGELES 90014

January 17, 1969

To the Board of Directors and Shareholders
of Aerojet-General Corporation

We have examined the November 30, 1968 consolidated financial statements of Aerojet-General Corporation and its subsidiaries. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances. It was not practicable to obtain confirmation of certain receivables from the United States Government by direct correspondence, but we satisfied ourselves as to these amounts by application of other auditing procedures.

In our opinion, the accompanying balance sheet, statement of income, and statements of retained earnings and source and application of funds present fairly the consolidated financial position of Aerojet-General Corporation and its subsidiaries at November 30, 1968, the consolidated results of their operations and the supplementary information on funds for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Price Waterhouse & Co.

APPENDIX C

CONTRACTUAL REPRESENTATIONS

ATTACHMENT A

REPRESENTATIONS, CERTIFICATIONS, AND ACKNOWLEDGMENTS

The Offeror represents and certifies as part of his offer that: (Check or complete all applicable boxes or blocks.)

1. SMALL BUSINESS

He ☐ is, ☒ is not, a small business concern. If offeror is a small business concern and is not the manufacturer of the supplies offered, he also represents that all supplies to be furnished hereunder ☐ will, ☒ will not, be manufactured or produced by a small business concern in the United States, its possessions, or Puerto Rico.

2. REGULAR DEALER-MANUFACTURER (Applicable only to supply contracts exceeding \$10,000)

He is a ☐ regular dealer in, ☒ manufacturer of, the supplies offered.

3. CONTINGENT FEE

(a) He ☐ has, ☒ has not, employed or retained any company or person (other than a full-time, bona fide employee working solely for the offeror) to solicit or secure this contract, and (b) he ☐ has, ☒ has not, paid or agreed to pay any company or person (other than a full-time bona fide employee working solely for the offeror) any fee, commission, percentage, or brokerage fee contingent upon or resulting from the award of this contract; and agrees to furnish information relating to (a) and (b) above, as requested by the Contracting Officer. (For interpretation of the representation, including the term "bona fide employee", see Code of Federal Regulations, Title 41, Subpart 1-1.5.)

4. TYPE OF BUSINESS ORGANIZATION

He operates as ☐ an individual, ☐ a partnership, ☐ a non-profit organization, ☒ a corporation, incorporated under the laws of the State of Ohio.

(a) If a small business concern, Contractor represents that it ☐ has, ☐ has not, previously been denied a Small Business Certificate of Competency by the Small Business Administration.

(b) If Contractor is a regular dealer, it also represents that all supplies to be furnished hereunder ☐ will, ☐ will not, be manufactured or produced in the United States, its possessions, or Puerto Rico, by a small business manufacturer or producer.

5. EQUAL OPPORTUNITY

He ☒ has, ☐ has not, participated in a previous contract or subcontract subject either to the Equal Opportunity Clause herein or the clause originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114, or clause in Executive Order No. 11246 as amended by Executive Order No. 11375; that he ☒ has, ☐ has not, filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards. (The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause.)

6. PLACE OF PERFORMANCE (Walsh-Healey Act)

If this offer is \$10,000. or more the offeror shall provide, in the space provided below, the name and location (city and state) of the plant or place of business where the item(s) will be produced or supplied from stock or where the service will be performed.

Aerojet-General Corporation

Name of Plant

Sacramento, California

City and State

7. BUY AMERICAN CERTIFICATE

The offeror hereby certifies that each end product, except the end products listed below, is a domestic source end product (as defined in the clause entitled "Buy American Act"); and that components of unknown origin have been considered to have been mined, produced, or manufactured outside the United States.

Excluded End Products	Country of Origin
None	

Aerojet-General Corporation
(Name of company or individual)

(Signature)
G. L. Ryland, Manager
Administration, Nuclear Division
(Typed name and title)