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IV-1

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

PROGRAM SUBMISSION

FY-1968

SPACE VEHICLE SYSTEMS, SRT

CODE 124
(OART)

Prepared by
Research Program Office
R-EO-R

March 15, 1967

National Aeronautics and Space Administration

NASA

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CODE 124
(OART)

SPACE VEHICLE SYSTEMS, SRT
SUMMARY
(Thousands of $)

CODE	TITLE	FY-68 REQUIREMENTS	FY-68 GUIDELINES
124	Space Vehicle Systems, SRT	4,946	4,260
124-08	Spacecraft Structures	920	830
124-09	Space Vehicle Environmental Factors	1,831	1,550
124-10	Launch Vehicle Aerothermodynamics	810	720
124-11	Launch Vehicle Structures	1,285	1,070
124-12	Space Vehicle Design Criteria	100	90

Requirements by Task Area:

124-08		124-09		124-10		124-11		124-12	
-08	920	-01	1,047	-01	135	-01	700	-03	100
		-02	235	-02	375	-04	180		
		-04	65	-04	300	-05	385		
		-05	484			-08	20		

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-08		Spacecraft Structures				
	08	Cryogenic Storage				
		01 Environmental Testing of Lightweight Multilayer Insulations	P&VE	0	1	-
		02 Thermal Protection System Optimization Study for Cryogenic Propellants on Interplanetary Space Vehicles	P&VE	75	2	3
		03 Development of Manufacturing Technology for Application of High Performance Insulation	ME	100	3	4
		04 Insulation Development for Liquid Hydrogen Tankage	P&VE	0	4	-
		05 Cryogenic Insulation Research	P&VE	0	5	-
		06 Development of High Performance Insulation Systems	P&VE	0	6	-
		07 Thermal Design Criteria for Inflatable Solar Shields	P&VE	100	7	1
		08 Development of High Performance Insulation System Compatible with Modular Nuclear Vehicles	P&VE	425	8	2
		09 Development of Advanced Materials for Integrated Tank Insulation Systems for the Long-Term Storage of Cryogens in Space	P&VE	200	9	6
		10 Application of High Performance Insulation to Large Conical Support Structures	ME	20	10	5
			Total	920		

CODE	TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09	Space Vehicle Environmental Factors				
01	High Energy Radiation Effects and Shielding				
01	Electron Shielding Studies	RP	145	11	2
03	Scaling Laws for Superconducting Magnets	RP	0	12	-
08	Shielding Data Generation and Calculation Techniques	RP	0	13	-
10	Investigation of Supercurrent Instabilities in Type II Superconductors	RP	60	14	13
13	Evaluation of Simulated Radiation Shields	RP	15	15	7
14	Research on Applications of Superconductivity to Active Radiation Shielding Problems	RP	25	16	8
15	Charged Particle Motion in Magnetic Fields	RP	0	17	-
17	Plasma Shielding Studies	RP	150	18	4
18	Cross Section Calculations and the Study of Space Vehicle Radiation Shielding	RP	0	19	-
20	Space Radiation Effects on Materials	P&VE	0	20	-
21	Experimental Investigation of Advanced Superconducting Magnets	RP	75	21	9
22	Investigation of Factors Limiting Construction of Superconducting Magnets for Space Shielding	RP	0	22	-

CODE			TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09			Space Vehicle Environmental Factors				
	01		High Energy Radiation Effects and Shielding (Cont'd)				
		23	Analysis of Radiation Effects on Composite Structures	RP	25	23	11
		24	Mapping of Satellite Orbits in Radiation Belts and Dose Calculations	RP	0	24	-
		25	Investigation of the Combined Effects of Space Environmental Parameters on Space Vehicle Materials	P&VE	60	25	6
		26	Investigation of Electron Interaction in Matter	RP	85	26	5
		28	Study of Magnetic Flux Flow and Superconductor Stabilization	RP	75	27	10
		29	Study of Charged Particle Motions in Magnetic Radiation Shielding Fields	RP	40	28	12
		30	Analysis of High Energy Proton and Charged Particle Transport and Secondary Particle Protection	RP	250	29	1
		31	Theoretical Calculation of Electron Bremsstrahlung Cross Sections	RP	0	30	-
		32	Analytical Studies of the Penetration of Electrons through Matter	RP	42	31	3
				Total	1047		

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09		Space Vehicle Environmental Factors				
	02	Meteoroid Environment and Impact Hazard				
		03 Electro-Chemical Micro-meteoroid Penetration	RP	0	32	-
		06 Electromagnetic Hyper-velocity Gun Development for Meteoroid Simulation	RP	0	33	-
		07 Canadian Meteor Data Analysis	RP	0	34	-
		12 Experimental Hyper-velocity Impact Research (Transient Phenomena From Strong Shocks in Solids)	RP	0	35	-
		15 Meteoroid Detector Devel-opment and Calibration	RP	0	36	-
		17 Theoretical Impact Cal-culations	RP	50	37	2
		19 Development of A Hyper-velocity Facility	RP	70	38	1
		21 Meteoroid Field Patterns	RP	0	39	-
		23 Experimental Hypervelocity Impact Research (Advanced Accelerator Concepts)	RP	25	40	4
		26 Experimental Hypervelocity Impact Research Program	RP	90	41	3
		Total		235		

CODE	TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09	Space Vehicle Environmental Factors				
04	High Vacuum Technology				
06	Laboratory Study of Surface Effects on Astronomical Optical Surfaces	RP	65	42	1

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09		Space Vehicle Environmental Factors				
	05	Thermal Radiation Effects and Temperature Control (Cont'd)				
		20 Analysis and Correlation of Known Thermal Interface Conductance-Experimental	RP	0	53	-
		21 Theoretical Thermal Similitude Studies	RP	0	54	-
		24 Transient Thermal Contact Resistance	RP	18	55	8
		26 Development of Space-Stable Thermal-Control Coatings (Paints with Low Solar Absorptance/ Emittance Ratio)	RP	110	56	4
		27 Solar-Radiation-Induced Damage to Optical Properties of ZnO Type Pigments	RP	100	57	5
		29 Study of In Situ Degradation of Thermal Control Surfaces	RP	52	58	2
		30 Study of the Radiative Emissivity of Metals - b. Experimental	RP	0	59	-
		32 Effects of Solar Wind on Thermal Control Surfaces	RP	10	60	7
		34 Limitations in Thermal Similitude	RP	60	61	1
		35 Synthesis and Evaluation of New High Temperature Polymers for Coating Applications	P&VE	0	62	-

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-09		Space Vehicle Environmental Factors				
	05	Thermal Radiation Effects and Temperature Control (Cont'd)				
		37 Radiative Heat Flux Measurement Using Semiconducting Thermoelectric Devices	RP	0	63	-
		38 Ultraviolet Flight Instrumentation Study	RP	0	64	-
		Total		484		

CODE	TITLE	LAB	FUNDS	PAGE	PRIORITY
124-10	Launch Vehicle Aerothermodynamics				
01	Aerodynamic Forces, Steady Loads, Stability and Control				
05	Experimental Evaluation of Reynolds Number Effects on Body of Revolution Viscous Cross-Flow Phenomena	AERO	0	65	-
06	Aerodynamic Properties of Exhaust Plumes	AERO	30	66	1
08	Stability Derivatives of Slowly Oscillating Bodies of Revolution in Supersonic Flow	AERO	0	67	-
09	Panel Flutter Aerodynamics	AERO	0	68	-
10	Theoretical Foundations for a Quantitative Investigation of the Aerodynamic Heat Transfer to Yawing Cones in Supersonic Flight	AERO	0	69	-
11	Conical Flow Tables with Diagrams for Mach Numbers Between 1 and 25, Semi-Apex Angles Between 5 and 45°, and Specific Heat Ratios 5/3, 7/5, 4/3, 5/4	AERO	0	70	-
12	Experimental Modeling of Apollo-Saturn Hypersonic Aerodynamic Flow Fields	AERO	0	71	-
13	Study of Theoretical Methods as Applied to Steady Aerodynamic Analysis of Saturn Vehicle Shapes	AERO	0	72	-

CODE	TITLE	LAB	FUNDS	PAGE	PRIORITY
124-10	Launch Vehicle Aerothermodynamics				
01	Aerodynamic Forces, Steady Loads, Stability and Control (Cont'd)				
21	Numerical Solution of Special Flow Problems for Saturn Vehicles	AERO	0	80	-
22	Study to Evaluate Flow Coefficients for Flat Plate Outlets Discharging Transverse to an External Stream	AERO	0	81	-
23	Aerodynamic Characteristics of Hammerhead Shrouds	AERO	40	82	3
24	Inhomogeneous Properties of H_2O_2 and CO_2 (Aerodynamic Properties of Exhaust Plumes)	AERO	0	83	-
25	Experimental Measurements Using the Laser Doppler Velocity Instrument	AERO	15	84	4
26	Vortex Model Representing Atmospheric Turbulence	AERO	50	85	2
	Total		135		

CODE			TITLE	LAB	FUNDS	PAGE	PRIORITY
124-10			Launch Vehicle Aerothermodynamics				
	02		Vehicle and Base Heating				
		01	Base Flow and Separation Studies	AERO	0	86	-
		02	Analytical Investigation of Plume Afterburning	AERO	0	87	-
		04	Research Related to Application of Shock Tube Techniques to the Study of Base Thermal Environment of Rocket-Propelled Vehicles (Base Heating Research)	AERO	100	88	3
		05	Radiation of Gases	P&VE	0	89	-
		06	Calculation of Three-Dimensional Interaction Regions in Multi-Rocket Vehicles	AERO	0	90	-
		07	Recirculation of Gases Along the Base	AERO	40	91	4
		09	Base Flow and Separation Studies	AERO	50	92	5
		10	Study of Numerical Solution of Special Flow Problems for Saturn Vehicles	AERO	0	93	-
		11	Short Duration Base Heating Model Research	AERO	50	94	1
		12	Analysis of Ablator Effects on RF Attenuation	AERO	0	95	-
		13	Precursor Radiation Effects on High Enthalpy Gas Streams	AERO	0	96	-

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-10		Launch Vehicle Aerothermodynamics				
	02	Vehicle and Base Heating (Cont'd)				
		14 Study on Exhaust Plume Radiation Predictions	AERO	35	97	2
		15 Reacting Gas Flows	AERO	50	98	6
		16 Optical Measurement of Multi-Plume Interaction	AERO	50	99	7
		Total		375		

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-10		Launch Vehicle Aerothermodynamics				
	04	Acoustic Noise Propagation				
		01 Aerodynamic Noise Research	AERO	60	100	2
		02 Study of Absorption of Low Audio Frequency Energy in the Atmospheric Media	P&VE	0	101	-
		06 Investigation of Noise Generation Mechanisms of Deflected and Undeflected Supersonic Rocket Exhaust	AERO	40	102	6
		08 Investigation of Atmospheric Influences on Far-Field Sound Propagation Predictions (Sound Propagation Predictions)	AERO	50	103	3
		09 Sound Propagation and Acoustical Danger Points	AERO	0	104	-
		10 Acoustic Model Studies of Rocket Exhaust Flows	AERO	0	105	-
		11 Evaluation of the Acoustic Sources of Background Noise in Wind Tunnel Facilities	AERO	50	106	1
		13 Acoustic Scale Model Tests of High Speed Flows	AERO	0	107	-
		14 Sound and Shear Wave Interaction with Oblique Shock Fronts	AERO	15	108	5
		15 Delineation of Ground Attenuation Effects on Measured Acoustic Spectra	AERO	50	109	4
		16 Investigation of the Noise Produced in the High Entropy Regions of a Hot Rocket Exhaust Stream	AERO	35	110	7
		Total		300		

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-11		Launch Vehicle Structures				
	01	Advanced Structure/Material Concepts (Cont'd)				
		38 Development of Materials and Materials Application Concepts for Joint Use as Cryogenic Insulation and Micrometeorite Bumpers	P&VE	300	132	2
		39 Structure - Thermal Insulation - Meteoroid Protection Integration	P&VE	150	133	7
		Total		700		

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-11		Launch Vehicle Structures				
	04	Structural Loads				
		03 High Resoultion Wind Measuring Systems Evaluation	AERO	0	134	-
		06 Low Altitude Wind and Temperature Profile Study	AERO	0	135	-
		09 Analysis of Detailed Vertical Wind Profiles	AERO	50	136	2
		12 Effect of Shock Induced Separation on Vehicle Dynamics	AERO	40	137	4
		13 Theoretical Analysis of Meteorological Tower Data	AERO	50	138	1
		14 Analysis of Relationship Between Micro-, Messo-, and Synoptic-Scale Meteorological Parameters	AERO	0	139	-
		18 Development of Low Level Turbulence Models	AERO	0	140	-
		19 Atmospheric Measuring Technique and Research Studies	AERO	0	141	-
		20 Comparison of Wind Measuring Instruments (Anemometers)	AERO	0	142	-
		21 Development of Panel Flutter Criteria for Launch Vehicles	AERO	40	143	3
		Total		180		

CODE			TITLE	LAB	FUNDS	PAGE	PRIORITY
124-11			Launch Vehicle Structures				
	05		Structural Dynamics				
		02	Establishment of Guidelines for Random and Sinusoidal Vibration Correlation	P&VE	40	144	4
		07	Theoretical Research on the Pressure Distribution on Nonspinning Multistage Spacecraft Performing Bending Oscillations	AERO	0	145	-
		08	Axial Transmissibility Characteristics of Typical Rocket Vehicle Structures	P&VE	75	146	1
		10	Study of Non-Linear Dynamic Behavior of Liquids in Cylindrical Elastic Container	P&VE	0	147	-
		12	Three-Dimensional Analysis of Launch Vehicles Including Shell Degrees of Freedom	AERO	0	148	-
		13	Nonlinear Dynamic Analysis of Structures	AERO	25	149	7
		15	Response of an Elastic Space Vehicle to Random Disturbances	AERO	30	150	9
		17	Studies of Liquid Behavior in Randomly Excited Rigid Tanks	P&VE	0	151	-
		19	Study of the Solution of Nonlinear Algebraic Equations	AERO	0	152	-
		21	Fuel Sloshing Studies (Optimal Design of Slosh Baffles)	AERO	0	153	-

CODE		TITLE	LAB	FUNDS	PAGE	PRIORITY
124-11		Launch Vehicle Structures				
	05	Structural Dynamics (Cont'd)				
		40 Use of Scale Models to Determine the Structural Dynamic Characteristics of Spacecraft	AERO	30	165	2
		41 Dynamics of Inflatable Shell Structures	AERO	25	166	3
		42 Sensitivity Analysis of Saturn V Elastic Boosters	AERO	25	167	5
		43 Cross Beam Analyses of, Deflected and Undeflected, Clustered Supersonic Jets	AERO	40	168	6
		44 Dynamic Stability of a Fuel Tank Subjected to Steady Loading and Oscillational Excitation	AERO	35	169	8
		Total			385	
	06	Structural Mechanics				
		06 Theoretical and Experimental Investigation of Shear Lag in Stiffened Shells and the Stress Analysis of Cone Frustrums and Segments	P&VE	0	170	-
		07 Study of Stability of Unpressurized Shell Structures Under Static Loading	P&VE	0	171	-
		08 Buckling Tests of Eccentrically Stiffened Cylinders	P&VE	0	172	-
	08	Cryogenic Storage				
		02 Slosh Damping in Low g	AERO	20	173	1
		Total		20		

CODE	TITLE	LAB	FUNDS	PAGE	PRIORITY
124-12	Space Vehicle Design Criteria				
03	Environment Criteria (Cont'd)				
15	Environmental Design Criteria Studies (Space)	AERO	50	186	2
18	Planetary Surface Models for Mobility Design Criteria	AERO	0	187	-
20	Meteoroid Technology for Design Criteria	AERO	0	188	-
21	Extension of Knowledge of Solar Cycle Characteristics	AERO	0	189	-
22	Environment Design Criteria Studies (Space)- Sunspot Predictions	AERO	0	190	-
23	A Construction of Probability Envelopes for Flux-Energy Spectra	AERO	0	191	-
04	Stability, Guidance and Control Design Criteria				
01	Design Criteria for Control of Space Vehicles During Launch Phase of Flight	AERO	0	192	-
02	Design Criteria for Flight Evaluation	AERO	0	193	-
03	Design Criteria for Guidance, Flight Mechanics and Trajectory Optimization	AERO	0	194	-
04	Design Criteria for Aerodynamic Analysis of Launch Vehicles	AERO	0	195	-
	Total		100		

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006890	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	PRT U WORK U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-01-62	No Change

11. TITLE:
(U) Environmental Testing of Lightweight Multilayer Insulations

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	08 66	06 67	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
D. Inter-Agency	b. NUMBER H-13248A a. DATE 08 66 c. TYPE J. C. d. AMOUNT $70,000	PRIOR FY— 67	0.1	-
		CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: AFMDC (MDTO)
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Holloman AFB, New Mexico 88330
R-P&VE-SAA	INVESTIGATORS PRINCIPAL: Loukota, R. D., Maj.
RESP. INDIV: Nevins, C. D. Everitt, J. M.	ASSOCIATE:
TEL: (FTS)205-876-0269 (FTS)205-876-9068	TEL: Comm, 505-473-6511 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS:
Cryogenic Insulation, Dynamic Testing, Sled Testing

24. (U) OBJECTIVE: a. Problem: To determine the ability of fragile multilayer insulations (for cryogenic tankage) to withstand a rocket launch dynamic environment.

b. Application: Spacecraft cryogenic propellant tankage contained within an aerodynamic shroud.

c. Multilayer insulation and their attachment methods pose a serious design problem due to the high vibration, acoustic, and longitudinal acceleration environments.

25. (U) APPROACH: A full-scale, 105-inch diameter cryogenic tank will be insulated, placed in a shrouded rocket sled, pre-chilled with liquid nitrogen and accelerated to the maximum expected level of a Saturn V launch. Vibration and acoustic levels from the rocket sled will also be present.

26. (U) PROGRESS: a. Reporting interval: August 24, 1966 to February 15, 1967.

b. The rocket sled has been transferred from the Naval Ordnance Test Station to Holloman AFB. Modifications of the sled to fit the Holloman track are in progress. All instrumentation requirements have been agreed upon.

c. This is a continuation of the work begun in April 1964 with the Naval Ordnance Test Station on H-71480.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Spacecraft Structures	NEXT FY— 69	-	-
35. TASK AREA: Cryogenic Storage			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965 O 795 048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U	U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-02-62	124-11-01-02-62

11. TITLE: (U) Thermal Protection System Optimization Study for Cryogenic Propellants on Interplanetary Space Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
01600 Spacecraft Launch Vehicles 016700 Thermodynamics, 014700 Rocket Propellants	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT				18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	NAS8-11161	a. DATE	06 65	PRIOR FY— 67	0.2	-
B. Contract	c. TYPE	M. CPFF	d. AMOUNT	$105,933	CURRENT FY—68	0.2	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Middleton, R. L., R-P&VE-PTP TEL. 205-876-7848 (FTS)	NAME: General Dynamics ADDRESS: Fort Worth Div., Fort Worth, Texas INVESTIGATORS PRINCIPAL: Goodwin, D. W. ASSOCIATE: Stevens, R. A. TEL: 817-732-4811/Ext. 3713 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

subcooled and slush propellant, solar shields, reliquefaction, high performance insulation

24. (U) OBJECTIVE: The objective of the study is to establish thermal design and integration criteria for storage of cryogenic propellants on typical earth orbital and cislunar space vehicles and missions. The study will consider various class vehicles, as shown in item 25 and must establish all thermal protection system trade-off criteria, system integration aspects, and systems optimization concepts for the specified missions. The missions include: extended earth orbital operations, lunar landing and ferry missions, and earth synchronous orbit.

25. (U) APPROACH: The effectiveness of various thermal and propellant control and conditioning systems will be established through analytical techniques. The study will utilize, but not be limited to the analytical techniques, systems criteria and applicable parameteric data which was generated in the current NAS8-11161 interplanetary vehicle contract. All applicable thermal control concepts will be analyzed for earth orbital/cislunar operation on various vehicles ranging from small chemically powered stages (approximately 5000 lb LH_2, 25000 lb LOX) to the modular nuclear vehicle concept (approximately 200,000 to 250,000 lbs. LH_2) and large orbital launch propellant storage facilities.

26. (U) PROGRESS: The feasibility of storing cryogenic propellants has been analytically established for interplanetary space missions in the current work in NAS8-11161 which is approximately 50% completed. The results to date indicate significant advantages for slush hydrogen and triple point oxygen, the requirement for "High Performance" insulation and an extreme dependence upon the particular mission.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	75
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY68	-	75
34. SUB PROGRAM	Spacecraft Structures	NEXT FY— 69	-	-
35. TASK AREA	Cryogenic Storage			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. REVISED RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U U	N/A	GA	A. Work Unit

10a. PROJECT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-03-62	124-11-01-13-62

11. TITLE

(U) Development of Manufacturing Technology for Application of High Performance Insulation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016300 Structural Engrg. 01590 Spacecraft	09 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY 67	0.2	--
	c. TYPE d. AMOUNT	CURRENT FY 68	2.0	--

19. GOVT LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV	Yates, I. C.	Wood, C. C.
TLE	R-ME-A	R-P&VE-PT
TEL	205-876-6827 (FTS)	205-876-7758 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS:

Same as 19.

INVESTIGATORS PRINCIPAL ASSOCIATE

TLE: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24. (U) OBJECTIVE: a. Problem - To develop manufacturing techniques and processes to apply high performance multilayer insulation to tanks of various sizes for long duration storage of cryogenic fluids in space vehicles.

b. Application - Manufacturing techniques and processes developed will be applicable to advanced space vehicles for orbital, lunar, and planetary flight in which cryogenic storage duration may range up to one year or longer.

25.

c. This work unit is designed to support design activities and is a continuation of the support of the approved work unit for FY-67, "Development of High Performance Insulation Systems," 124-08-08-06-62.

(U) APPROACH: Manufacturing techniques and processes will be developed to evaluate preliminary design concepts applied to calorimeters, test tanks, and test fixtures in a progressive development program to form the basis for design concepts to be applied to 105 inch diameter tanks for complete thermal and structural testing.

26. (U) PROGRESS: Manufacturing technology has been developed for the insulation of reduced scale tanks for short duration storage of liquid hydrogen in space. Development is in progress on applications for large tanks for long term storage.

27	28. REQUESTING AGENCY	29. PROJECT PROG. CODE	30.

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Fabrication of Tooling (50) Materials (50)	PRIOR FY 67	--	--
	CURRENT FY 68	100	--
	NEXT FY 69	100	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Spacecraft Structures
35. TASK AREA	Cryogenic Storage

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C. Terminated (16 04 66)	U~~T~~ U~~NK~~	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER CODE: 124-08-08-04-62

10b. PRIOR NUMBER CODE: 124-11-01-22-62

11. TITLE:

(U) Insulation Development for Liquid Hydrogen Tankage

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	09 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	2.0	-
	c. TYPE d. AMOUNT	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Nevins, C. D., R-P&VE-SAA

TEL: FTS 205-876-0269

20. PERFORMING ORGANIZATION

NAME:

ADDRESS: Same as 19

INVESTIGATORS PRINCIPAL:

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Cryogenic Insulation, Spacecraft Propellant Tankage

24.

Objective: (U) The objective of this program is to investigate, design and determine the structural and thermal performance of insulation concepts for cryogenic tankage. Emphasis will be placed on non-integral liquid hydrogen tankage requiring storage times in space of 30 days.

25. Approach: (U) This program will include the development of basic cryogenic tankage, insulation systems, and associated hardware necessary for the satisfactory performance be pursued through concept definition, component test design, full-scale insulation system design, fabrication assistance, and test surveillance. Promising systems will undergo detailed investigation of problem areas and necessary re-design to improve performance. Associated hardware development, dissimilar metal joining, propellant line gaskets, low conductivity structural supports, flexible vacuum jackets, etc. will also be pursued.

26. Progress: (U) Program was included in: "Environmental testing of lightweight multilayer insulation (124-08-08-01-62).

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM: Spacecraft Structures	NEXT FY— 69	-	-
35. TASK AREA: Cryogenic Storage			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Completed (15 03 66)	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER CODE	10b. PRIOR NUMBER CODE
124-08-08-05-62	(103-11-01-0007-62) (908-20-06-03-62) 124-11-01-27-62 (FY-67)

11. TITLE:

(U) Cryogenic Insulation Research

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-11397 a. DATE 06 64	PRIOR FY— 67	01	-
B. Contract	c. TYPE CPFF d. AMOUNT $356,494	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Martin Marietta Corp.
ADDRESS: Huntsville, Ala. 35812	ADDRESS: Baltimore, Md. 21203
	INVESTIGATORS PRINCIPAL: Crawford, R. F.
RESP. INDIV.: Nevins, C. D. R-P&VE-SA	ASSOCIATE:
TEL: (FTS) 205-876-0269	TEL: 301-687-3800 TYPE: Comm

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Commercial Cryogenic Storage Vessels	N/A

23. KEYWORDS

Cryogenic Insulation, Space Storage

24.

Objective: (U) a. Problem: To design a high performance insulation system suitable for withstanding a rocket vehicle environment.

b. Application: Spacecraft with cryogen storage for up to 30 days and where the storage vessel is protected by an aerodynamic shroud.

c. High performance insulations are, as a class, notoriously fragile. The rigors of a rocket vehicle launch environment must be withstood without significant degradation of insulative properties.

26. Approach: (U) A specimen tank with a lenticular shape is used to screen different systems of high performance insulations. The thermal and structural environments to be encountered in a typical rocket vehicle launch will be simulated in the order in which they occur. Post test analyses will conclude whether a particular insulation system is suitable for spacecraft design.

Progress: (U) a. Reporting Interval: August 15, 1966 to February 15, 1967

b. The program was completed during the reporting interval and the final report has been published. General results of the program indicate that preevacuated systems are currently quite unreliable and that helium purged systems need more effort to reduce the space evacuation time.

26.

c. Final technical report published: NASA CR-61162 "Cryogenic Insulation Research," January 23, 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Spacecraft Structures
35. TASK AREA	Cryogenic Storage

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U RPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-06-62	908-20-02-04-62

11. TITLE:
(U) Development of High Performance Insulation Systems

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006900 Fluid Mech. 016700 Thermodynamics	11 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	4.0	-
		CURRENT FY - 68	4.0	-

19. GOVT. LAB./INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Wood, C. C., R-P&VE-PT RESP. INDIV. Randolph, W. O., R-P&VE-PTE TEL: (FTS)205-876-7758, 205-876-7719	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS:
Insulation, Cryogenic, Multifoil, Equipment, Materials

24. (U) OBJECTIVE: a. Problem: To continue, until completed, development of flight worthy high performance insulation systems including all insulation penetration such as structural supports, piping penetration, electrical connectors and manhole covers for cryogenic and non-cryogenic vessels with storage and stay times up to 60 days.

b. Application: The use of high performance insulation has been studied and found to be a requirement on most cryogenic vehicles in orbit for more than about six hours. Additionally, high performance insulation has been considered
25. desirable for application to such vehicles as the Multiple Docking Adapter, the Apollo Telescope Mount, and some of the Apollo Application Program Flight Experiments. Studies involving reliquefaction, and slush necessitate development of superinsulation. Ultimate application will be on future manned vehicles.

(U) APPROACH: Continue development of light weight-low thermal conductivity helium purged insulation systems. Next objective is to modify an existing tank system with more typical flight type hardware and structural supports and up-grade system design. Analytical studies will be performed and verified with component and scale tests.

26. (U) PROGRESS: Analytical studies are being performed now. When complete, some component tests will be performed to provide basic data. Design will be complete in about six months. Fabrication and testing will be completed in the next fiscal year.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY— 67	100	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Spacecraft Structures	NEXT FY— 69	-	-
35. TASK AREA: Cryogenic Storage			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U / U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-07-62	908-20-02-05-62

11. TITLE:

(U) Thermal Design Criteria for Inflatable Solar Shields

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
C16700 Thermodynamics - 015900 Spacecraft	06 67	05 69	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT a. DATE / b. NUMBER / c. TYPE / d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	c. TYPE Pending	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Vaniman, J. L., R-P&VE-PTP TEL: 205-876-7812 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Cryogenics

24. (U) OBJECTIVE: Establish through analytical and experimental programs design criteria mandatory for development of inflatable solar shields as a thermal environmental control system for long term storage of cryogenics in space for space vehicles such as Nuclear Modules, S-IVB, etc.

25. (U) APPROACH: Design criteria shall be established through experimental testing and supporting analytical studies in three primary areas: (1) thermal, (2) structural, and (3) operational performance. Thermal and structural properties data will be established in a materials test program in which the combined simulated space environments of vacuum, cryo-temperatures, and radiation will determine synergistic effects on material properties. Optical properties degradation will be experimentally established and the impact on system temperatures and associated thermal performance will be analytically determined. Selection of materials most suitable for solar shield applications will be based on criteria from these laboratory test programs.

26. (U) PROGRESS: Mission studies have been completed under contract NAS8-11161 where solar shields were considered for typical hydrogen fueled interplanetary vehicles. The results have indicated the propellant storage penalties can be reduced by approximately 40% for a Mars braking stage. This saving indicates further development as proposed by this work unit on solar shields for space vehicle applications.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	125
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	100
34. SUB PROGRAM: Spacecraft Structures	NEXT FY — 69	-	-
35. TASK AREA: Cryogenic Storage			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U RPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-08-62	908 -20-02-06-62

11. TITLE: (U) Development of High Performance Insulation System Compatible with Modular Nuclear Vehicles

12. SCIENTIFIC OR TECH AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Fluid Mech 006900, Thermodynamics 016700	04 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	a. DATE; b. NUMBER; c. TYPE Pending; d. AMOUNT	PRIOR FY— 67	4.0	-
		CURRENT FY — 68	4.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Wood, C. C., R-P&VE-PT RESP. INDIV. Randolph, W. O., R-P&VE-PTE TEL. 205-876-7758 or 876-7719	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Insulation, Cryogenic, Multifoil, Equipment, Materials

24.

(U) Objective: Studies have considered a Mars landing mission utilizing a number of Nuclear Modules assembled in Earth orbit for Earth escape, Mars braking, and Mars escape propulsion. It is apparent that the requirement will exist in the early 1970's for a high performance insulation system capable of storage of 230,000 pounds of liquid hydrogen for 350 days with a propellant boiloff not to exceed 5 per cent. This will require a superior insulation system with thicknesses greater than those investigated under current technology programs.

25.

(U) Approach: To continue investigation of the practical problems and development of a high performance insulation system compatible with the configuration and mission of a Modular Nuclear Vehicle. The FY 67 effort is to culminate in an insulation material and system design with limited component testing. Additional effort is required to perform the identified component sub-scale and sub-assembly testing that is required to validate analytical results and insulation systems concepts.

26. (U) Progress: Analysis to define insulation design requirements and conceptual design is to be accomplished by the FY 67 effort. Identified component and subsystems tests are to be performed in late FY 68. Sub-scale systems test will follow these component tests resulting in insulation system selection/verification.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SRT GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	300
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	425
34. SUB PROGRAM: Spacecraft Structures	NEXT FY 69	-	300
35. TASK AREA: Cryogenic Storage			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U / U	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08- 09-62	N/A

11. TITLE: (U) Development of Advanced Materials for Integrated Tank Insulation Systems for the Long-Term Storage of Cryogens in Space

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
004100 composite mtrls. 013100 plastics	11 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY– 67	0.2	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Stuckey, J. M., R-P&VE-MNM TEL 205-876-5904 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: This program will be directed toward advanced combinations of high performance multilayer insulation with tank features providing the thermodynamic utilization of boil-off gas to minimize structural support and piping heat leak and thus obtain improved insulation performance. The target performance level for a totally or semi-passive system is 90 per cent liquid hydrogen availability after four months orbital storage in S-IVB scale tankage.

25. (U) Approach: To achieve these goals, it is expected that a high performance multilayer insulation will be mated integrally with a tankage and support system developed specifically to accomodate the type of insulation. Various other features are contemplated to utilize the boiloff gas and/or interpose a gas film resistance over most of the tank internal surface which would minimize heat leakage into the tank. The feasibility of venting boil-off through a sealed cell insulation layer immediately beneath the multilayer insulation surrounding the tank will also be considered.

26. (U) Progress: N/A

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY– 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY – 68	-	200
34. SUB PROGRAM	Spacecraft Structures	NEXT FY – 69	-	300
35. TASK AREA	Cryogenic Storage			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U (RPT) U (WUK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-08-08-10-62	N/A

11. TITLE:
(U) Application of High Performance Insulation to Large Conical Support Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016300 Structural Engrg. 01590 Spacecraft	06 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE; b. NUMBER Pending; c. TYPE; d. AMOUNT	PRIOR FY - 67	--	--
		CURRENT FY - 68	0.3	--

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Not selected
RESP. INDIV: Yates, I. C., R-ME-A	INVESTIGATORS PRINCIPAL:
TEL: 205-876-6827 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24. (U) OBJECTIVE: a. Problem - To develop manufacturing techniques for applying high performance insulation to large conical support structures for long duration cryogenic storage.

b. Application - Manufacturing techniques and processes developed will be applicable to advanced space vehicles requiring long duration cryogenic storage capability.

25. c. This work unit will provide for the evaluation of new concepts, materials and fabrication techniques for the insulation of low heat leak conical support structures, and to identify gaps in technology for further research.

(U) APPROACH: Preliminary manufacturing plans will be developed for the application of new insulation materials to the 200 inch diameter Torus Tank using new concepts and fabrication techniques. The Torus Tank has a large fiberglass conical support structure similar to that proposed for many advanced vehicles. Concepts will be developed and
26. applied to portions of the tank and support structure for evaluation. The most promising concepts will be applied to the entire tank and support structure for manufacturing producibility analysis in a later phase.

(U) PROGRESS: Preliminary design concepts for insulating large tanks having a conical support structure have been proposed by many contractors and NASA organizations, but have not been evaluated on a large scale. A study was intiated in FY-67 under 124-11-01-24-62 to develop concepts for the application of high performance insulation to a torous tank and will be continued on this work unit.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. [illegible] CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY - 67	--	--
CURRENT FY - 68	--	20
NEXT FY - 69	100	--

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Spacecraft Structures
35. TASK AREA	Cryogenic Storage

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 002987	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change(15 08 66)	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-01-62	No Change

11. TITLE:
(U) Electron Shielding Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
012300 Part. Physics 013800 Rad. Shielding & Protect.	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-11304 DATE 06 64	PRIOR FY— 67	-	150
	c. TYPE M. CPFF d. AMOUNT $ 521,803	CURRENT FY—68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Edmonson, Dr. N., R-RP-N TEL: 205-876-4126 (FTS)	NAME: General Atomics Div./General Dynamics ADDRESS: P. O. Box 608 San Diego, California 92112 INVESTIGATORS PRINCIPAL: Jupiter, C. P. & Scalletar, R. S ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Electron Engineering Shielding, Alloy Compound, Composite Bremsstrahlung

24. (U) Objective: a. Problem: Electron beams in the energy range 1-10 MeV will be directed against alloys, compounds and targets of composite materials to obtain secondary electron and bremsstrahlung spectra. Non-normal incidence on targets will be stressed. Targets of complex gemetric structure will be studied. b. Application: To obtain information for engineering design of shields for space vehicles. (Experimental results will be analytically studied)

25. (U) Approach: Electron beams will be supplied by a linear accelerator capable of supplying high density electron beams up to 94 MeV in energy. Experimental results will be analyzed by methods developed by Theoretical Physics groups at General Atomic.

26. (U) Progress: An extensive experimental and theoretical program has been carried out under the current contract. Last report on a quarterly basis was for period ending 9/30/66. Material studied are aluminum, beryllium, copper or tin, and gold. Theoretical analysis has been carried out in parallel with experimental work. Work has stressed basic information.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	150
	CURRENT FY—68	-	145
	NEXT FY—69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects and Shielding

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002988	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	B. Completed (28-11-66)	R_{AU} U_{RK}	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-03-62	No Change

11. TITLE:
(U) Scaling Laws for Superconducting Magnets

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Rad. Shielding 013800; 015700, Solid State Physics	04 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
D. Inter-Agency	b. NUMBER H76798	a. DATE 04 64	PRIOR FY 67	0.2	-
	c. TYPE Z.IA	d. AMOUNT 130,000	CURRENT FY 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Oak Ridge National Laboratories
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Oak Ridge, Tennessee
RESP. INDIV. Urban, E.W., R-RP-N	INVESTIGATORS PRINCIPAL: Gauster, W.F.
TEL: 205-876-4126 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	AEC

23. KEYWORDS
Superconducting Magnets; Active Shielding; Radiation Shields

24.
(U) Objective: To study the very non-linear scaling laws of superconducting magnets to permit prediction of large volume high field magnet operation from characteristics of smaller, less expensive solenoids. The large number of variables (conductor type geometry, and metallurgical history; temperature effects, etc.) in a high field magnet preclude meaningful extrapolation of experimental data to permit evaluation of the ultimate capabilities of superconducting magnets as components of radiation shield for spacecraft.

25.
(U) Approach: A simulation technique developed in the prior work will be used whereby large diameter, small cross section superconducting magnets (sample coils) are tested under conditions of magnetic field, thermal control, current, etc., which normally cannot be controlled directly by the experimentor. Thus, important effects and interactions can be isolated and more easily interpreted. For correlation with these results other experiments with well defined and controllable superconducting units, such as short wire samples or cylinders, will be performed.

26.
(U) Progress: Effort has been expended on testing with large diameter, small cross section sample coils constructed from various superconducting materials of different cross sections. Observations include quenching currents and fields, flux motion, persistent performance, magnetic field scanning, remanant fields, and heat transfer. Tests have been correlated in the light of published basic research. This effort was completed in November of 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY - 69	-	-
35. TASK AREA	High-Energy Radiation Effects and Shielding			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 002989

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-03-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-08-62	No Change

11. TITLE:
(U) Shielding Data Generation and Calculation Techniques

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Rad. Shielding	04 64	N/A	N/A

16. PROCURE METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11164 a. DATE 04 64	PRIOR FY 67	0.3	-
	c. TYPE M.CPFF d. AMOUNT $125,834	CURRENT FY 68	0.3	-

19. GOVT LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

Burrell, M.O.
RESP. INDIV: Stern, H.E., R-RP-N
TEL: 205-876-1891 (FTS)

20. PERFORMING ORGANIZATION

NAME: Lockheed-Georgia
ADDRESS: Marietta, Georgia

INVESTIGATORS PRINCIPAL: Hill, C.W.
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION
N/A

22. COORDINATION
N/A

23. KEYWORDS
Space Shielding, Changed Particle Shielding

24.
(U) Objective: a. Problem: To improve space shielding computation methods and computer codes for calculating the effects of charged particles. b. Application: Realistic estimates of the dose rates within space vehicles to be expected from charged particles in the natural and artificial earth belts and from solar flares are essential for the planning and evaluation of orbital and planetary space missions. Further refinement of the methods, calculations for specific missions, and additional help in developing an in-house computational capability in this area at MSFC are now indi-
25. cated.

(U) Approach: Emphasis will be placed on the prediction of charged particle dose rates to be encountered on near earth and lunar trajectories. The latest cross section data for production of secondaries will be incorporated in the existing codes which will also be modified for compatability with the new generation of computers at MSFC.

26. (U) Progress: Work under previous related contracts has resulted in the development of useful calculational procedures for determining charged particle incident fluxes on specified trajectories and subsequent transport and secondary production in complex geometries. There has been six reports published by Lockheed in the above areas during the past six months. A final report is due in March 1967 for their latest research in electron and bremsstrahlung transport methods.

Note: This effort is presently being continued by FY-66 funds. Funds for FY-68 were not requested because of funding guideline limitations.

27	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SUB CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	50

33. UNIQUE PROJECT: Space Vehicle Systems, SRT
34. SUB PROGRAM: Space Vehicle Environmental Factors
35. TASK AREA: High Energy Radiation Effects and Shielding

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 002990

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U (Mgt) U (Work)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-10-62	No Change

11. TITLE: (U) Investigation of Supercurrent Instabilities in Type II Superconductors

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Rad. Shielding 015700, Solid State Physics;	05 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20552 a. DATE 12 65 c. TYPE M. CPFF d. AMOUNT $68,712	PRIOR FY 67	0.1	-
		CURRENT FY 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Urban, E.W., R-RP-N TEL 205-876-4126 (FTS)	NAME: North American Aviation ADDRESS: P. O. Box 309 Canoga, Calif. 91304 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Superconducting Magnets; Active Shielding

24. (U) Objective: a. Problem: To isolate and eliminate factors limiting the construction of large, high fields superconducting magnets for use in active shielding of spacecraft. b. Application: The understanding of supercurrent instabilities in superconducting magnets is a primary goal.

25. (U) Approach: Supercurrent instabilities, which seriously limits the performance of high field superconducting magnets, will be studied in the light of detailed measurements of the Lorentz force acting on pinning centers. The Lorentz force will be studied as a function of applied magnetic field, temperature, type of superconductor, and the metallurgical microstructure of the material.

26. (U) Progress: Short sample properties of NbTi have been completely studied as a function of metallurgical history, magnetic field, and temperature. This knowledge should be applied to other materials.
No funds for this work unit were used in FY-67; the work reported is based on FY-66 funds for contract NAS8-20552 which will be completed by February 7, 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	60
	NEXT FY 69	-	80

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects and Shielding

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 002992	
4. DATE OF RESUME: 15-03-67	5. KIND OF RESUME: D. Change (15-08-66)	6. SECURITY: U RPT U WRK	7. REGRADING: N/A	8. RELEASE LIMITATION: GA	9. LEVEL OF RESUME: A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-01-13-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE:

(U) Evaluation of Simulated Radiation Shields

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Radiation Shielding & Protection	06 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE c. TYPE d. AMOUNT	PRIOR FY— 67	0.6	-
		CURRENT FY— 68	0.6	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
RESP. INDIV.: Potter, R. A., R-RP-N	INVESTIGATORS PRINCIPAL:
TEL: 205-876-8036(FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: a. Problem: To determine the shielding effectiveness of an integral space vehicle. b. Application: The gamma ray probe technique can determine within an order of magnitude the number of electrons contained in a path through any portion of a space vehicle without any damage to the vehicle. c. Discussion: The principles of the gamma ray probe have been treated theoretically; a laboratory effort should be completed to determine; (1) angular dependence (2) size, shape and type of detector, (3) effect of collimation and/or energy discrimination and (4) the effect of various shield materials.

(U) Approach: Slabs of various shielding materials normally found on a space vehicle will be placed between a source of gamma radiation in energy range of 0.6 mev to 1.5 mev and a radiation detector (Na I or Li drifted Ge). Counts are recorded for a time t, the shield removed and counts again record for time t, the ratio of the counts is a measure of the electrons in the shield between source and detector. Parameters include varying (1) source energy, (2) detector size, shape and type, (3) shield location and Z. (4) Obtaining the unscattered spectra by collimation and energy discrimination.

(U) Progress: All required electronic equipment has been purchased, received, and checked out. Studies have been completed for steady state condition using Na I crystal detectors. It was determined that the photo tube temperature must be maintained to within plus or minus two degrees to maintain the peaks within ten Kev. Solid state, Li drifted Ge detectors are presently being used with energy resolution of less than 80 Kev FW HM for the 1.33 Mev gamma ray from a cobalt 60 source.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	6	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	15	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY— 69	5	-
35. TASK AREA	High Energy Radiation Effects and Shielding			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004282

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-14-62	No Change

11. TITLE:

(U) Research on Applications of Superconductivity to Active Radiation Shielding Problems

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015700 Solid State Phys;013800 Rad.Shielding	11 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE c. TYPE d. AMOUNT	PRIOR FY– 67	0.5	-
		CURRENT FY 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
RESP. INDIV. Urban, E.W., R-RP-N	INVESTIGATOR'S PRINCIPAL: Same as 19
TEL. 205-876-4126 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective; a. Problem: To permit the in-house evaluation of techniques developed under contract toward advancement of the state-of-the-art of superconducting magnets for space shielding applications. b. Application: To perform original research on the application of superconductivity to active radiation shielding problems, and to permit contract supervisors to remain more completely abreast of research problems of stable high field superconducting magnets.

25.

(U) Approach: In parallel with the efforts of contractors, stability problems of short samples and coil are being investigated. Magnetization test with cylindrical sample of superconductors will be conducted to investigate flux jumps and flux penning strengths.

26.

(U) Progress: Initial experiments on short sample characteristics of superconductor and magnetization test have been performed. These measurements are being correlated with the theoretical results from contractors. New experiments are planned to extend observations to higher magnetic fields and temperatures above and below 4.2°K.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
High field superconducting magnet 20,000; high purity & controlled metallurgical history materials 2,; diagnostic	PRIOR FY– 67	19	-
	CURRENT FY 68	25	-
	NEXT FY 69	20	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects & Shielding

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 004283	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-15-62	No Change

11. TITLE:
(U) Charged Particle Motion in Magnetic Fields

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800, Radiation Shielding; 012300, Particle Physics	08 62	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A; a. DATE; c. TYPE; d. AMOUNT	PRIOR FY—67	-	-
		CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Urban, E. W., R-RP-N TEL: 205-876-4126 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) Objective: a. Problem: To determine the general characteristics of charged particle motion in a variety of magnetic field systems, particularly those with axial symmetry. b. Application: By the techniques so derived magnetic configuration may be classified as to their effectiveness in excluding charged particles.

25. (U) Approach: Analytic techniques developed earlier will be applied to promising or interesting magnetic geometries to determine their shielding characteristics; such geometries may include thin and thick solenoids, torroids, and various field combinations such as dipole plus solenoid, etc. The methods of mathematical physics will be applied in the search for new analytic techniques.

26. (U) Progress: Due to an educational leave of absence, the principle investigator did no research on this topic in FY-67; however, research will continue in FY-68.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA: High Energy Radiation Effects and Shielding			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 005263

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-17-62	No Change

11. TITLE:

(U) Plasma Shielding Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Radiation Shielding & Protection	03 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER NAS8-20310 a. DATE 03 66	PRIOR FY - 67	-	136
B. Contract	c. TYPE CPFF d. AMOUNT $284,481	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Avco-Everett Research Laboratory
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Everett, Massachusetts
	INVESTIGATORS PRINCIPAL: Dr. Levy, Richard
	ASSOCIATE: Dr. Jones, Sargent
RESP. INDIV.: Wood, Lawrence H., R-RP-N	TEL: 617-389-3000 TYPE:
TEL: 205-876-1629 (FTS)	

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Plasma Space Radiation Shield, Magnetic Field

24.

(U) Objective: a. Problem: To develop an efficient, low weight plasma space radiation shield. b. Application: Superior manned spacecraft designs. c. Discussion: The "Plasma" radiation shields offers the possibility of employing a magnetic field to produce an electrostatic radiation shield. Such a shield is potentially an order of magnitude lighter than bulk shielding.

25. (U) Approach: The development of a plasma radiation shield references a coordinated approach involving theoretical analyses pertaining to the feasibility of the shield, e.g. investigation of possible instabilities, and experimental verification of theoretical analyses. Specific experiments involve laboratory simulation of the basic torroidal geometry via an inverted torroid and will lead to tests of a scale model shield in a large vacuum chamber.

26. (U) Progress: The contract was extended, effective January 1, 1967 until January, 1968. Theoretical analyses have thus far shown the plasma shield to be quite stable. Experimental studies performed in a torroid with a one meter major diameter and a 10 cm minor diameter have developed potentials up to 100 kv.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	136
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	150
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY - 69	-	200
35. TASK AREA: High Energy Radiation Effects and Shielding			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 005264

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	C.Terminated(15 08 66)	RPT U WRK U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-18-62	No Change

11. TITLE:
(U) Cross Section Calculations and the Study of Space Vehicle Radiation Shielding

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
High Energy Radiation Effects:Cross Sec.	10 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-18007 a. DATE 06 66	PRIOR FY— 67	-	-
	c. TYPE CPFF d. AMOUNT $49,996	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Union Carbide Research Institute
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Tarrytown, New York
RESP. INDIV. Edmonson, Dr. N., R-RP-N	INVESTIGATORS PRINCIPAL: Dr. Zerby,C.D., Industrial Research
TEL: 205-876-4126 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
(U) Objective: a. Problem: To develop an accurate theoretical method for computing electron bremsstrahlung cross sections. b. Application: Accurate values of bremsstrahlung cross sections to give more accurate space shielding designs. c. Discussion: Values of bremsstrahlung cross sections calculated by existing methods are as much as 55% different from measured values.

25.
(U) Approach: The existing methods use plane wave expansions for the various wavefunctions involved in this problem. The present method uses spherically wave expansions which are much more realistic physically.

26.
(U) Progress: A computation code has been formulated and is now being tested in the MSFC Computation Laboratory. The final report on this contract is in preparation. The contract will not be extended.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects and Shielding

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1. | 2. GOVT. ACCESSION | 3. AGENCY ACCESSION: NR 006891

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U (RPT) U (WRK)	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-01-20-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE: (U) Space Radiation Effects on Materials

12. SCIENTIFIC OR TECH. AREA: Coatings 003600, Particle Physics 012300, Composites 004100

13. START DATE: 06 63 | 14. CRIT. COMPL. DATE: N/A | 15. FUNDING AGENCY: N/A

16. PROCURE. METHOD: N/A

17. CONTRACT/GRANT: a. DATE b. NUMBER c. TYPE N/A d. AMOUNT

18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
PRIOR FY— 67	4.0	-
CURRENT FY - 68	3.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Gause, R. L., R-P&VE-MER

TEL: 205-876-4589 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS: Same as 19

INVESTIGATORS PRINCIPAL:

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Engineering Materials, Coastings, Radiation Effects, Polymers

24. (U) OBJECTIVE: To determine the applicability of various materials, such as passive thermal control coatings, dielectrics, sealants, etc., to spacecraft, payloads, and advanced stages, and to provide some insight into the mechanisms of radiation degradation in polymeric materials.

(U) APPROACH: Materials specimens are exposed to ultraviolet and/or charged particle radiation, vacuum, and various temperatures (elevated and cryogenic). Property tests are generally made in-situ through the use of specially designed equipment. Irradiations are made with a 2 Mev Van de Graaff accelerator and a high intensity ultraviolet source and can be made singularly or simultaneously.

(U) PROGRESS: The integrating sphere and associated spectrometer system required for in-situ measurements are being mated to the requisite optical coupling system. The irradiation chamber has been modified to allow the ion accelerator beam to enter through one port at an incident angle of 15^{o} to the normal of the sample and the solar simulator beam to enter through a second port also at an incident angle of 15^{o}. This modification is necessary to overcome equipment problems encountered in superimposing the two beams normal to the specimen. The complete system is being assembled currently in the Ion Accelerator Facility.

27. | 28. REQUESTING AGENCY | 29. PROJECT CROSS CODE | 30. SRT CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY— 67	-	-
CURRENT FY 68	-	-
NEXT FY— 69	-	-

33. UNIQUE PROJECT: Space Vehicle Systems, SRT

34. SUB PROGRAM: Space Vehicle Environmental Factors

35. TASK AREA: High Energy Radiation Effects and Shielding

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Prev. 2/6/26 blank col 5: DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006892

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-01-21-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE: (U) Experimental Investigation of Advanced Superconducting Magnets

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015700, Solid State Physics; 013800 Shielding Rad.	05 63	N/A	N/A

16. PROCUR. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE 11 66			
	b. NUMBER NAS8-21037	PRIOR FY-- 67	0.1	69
	c. TYPE CPFF d. AMOUNT $68,216	CURRENT FY-- 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV: Urban, E. W., R-RP-N

TEL: 205-876-4126

20. PERFORMING ORGANIZATION

NAME: Avco-Everett Research Laboratory

ADDRESS: Everett, Mass.

INVESTIGATORS PRINCIPAL: Dr. Stekly, Z.J.J.

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS:

Superconducting Magnets, active shielding

24. (U) Objective: a. Problem: To isolate and eliminate factors limiting the construction of large, high field superconducting magnets for use in active shielding of spacecraft. b. Application: To understand problems associated with operation of large-cross-section superconductors in magnets and supercurrent instabilities in coils.

25. (U) Approach: Research will continue on operation and stabilization problems of large volume, high field superconducting coils. Research will be concentrated in the study of the following factors on the behavior of superconducting magnets: various substrate ratios, behavior over wide temperature ranges, and the effects of cooling passage size.

26. (U) Progress: A detailed study of the current transfer and current sharing between superconductor and copper stabilizer has been made. This analysis will help in determining critical values of important superconducting parameters (e.g. current and substrate ratios). Magnetization and current density properties of superconducting strip have been experimentally investigated, and the results have been applied to the design and testing of strip-superconducting magnets. NAS8-5279 completed and work being continued on NAS8-21037.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY-- 67	-	69
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-- 68	-	75
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY-- 69	-	80
35. TASK AREA: High Energy Radiation Effects and Shielding			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006893

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	C.Terminated (15 08 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-22-62	124-09-01-10-62

11. TITLE: (U) Investigation of Factors Limiting Construction of Superconducting Magnets for Space Shielding

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015700, Solid State Physics; 013800 Rad. Shielding	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-11272	a. DATE 06 64	PRIOR FY–67	0.1	0*
B. Contract	c. TYPE M. CPFF	d. AMOUNT $123,185	CURRENT FY – 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: RCA-Applied Research
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Camden, New Jersey
RESP. INDIV. Urban, E. W., R-RP-N	INVESTIGATORS PRINCIPAL: Gandolfo, D.
TEL 205-876-4126 (FTS)	ASSOCIATE: Harper, C.
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Superconducting Magnets, Active Shielding

24.

(U) Objective: b. Problem: To isolate and eliminate factors limiting the construction of large, high field superconducting magnets for use in active shielding of spacecraft. b. Application: The understanding of supercurrent instabilities in superconductors.

25.

(U) Approach: Research has been directed toward understanding the relationship between flux flow and superconductor instabilities. An A.C. magnetic field was superimposed on D.C. bias field, and the affects of frequency, wave form, and amplitude were observed inside various samples.

(U) Progress: Experiments on the penetration of the A.C. magnetic field into the various superconductors have been completed. This method can be used to measure the penning strength of various type II superconductors.

* Note: Contract on FY-66 funds expired October 1966. Due to the lack of FY-67 funds, contract was not renewed.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY 69	-	-
35. TASK AREA: High Energy Radiation Effects and Shielding			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006894

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15 08 66)	RPT U WRK U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-23-62	No Change

11. TITLE:

(U) Analysis of Radiation Effects of Composite Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013900 Radio Activity 013800 Radiation Shielding & Protection	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-21050 DATE 12 66	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT $34,956	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Lockheed-Georgia Company
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Dawsonville, Georgia
RESP. INDIV. Stern, Henry E., R-RP-N	INVESTIGATORS PRINCIPAL: Gamble, R. L.
TEL 205-876-3542 (FTS)	ASSOCIATE: Vaughn, C.
	TEL: 404-424-9411 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Electrons, capacitor discharge, voltage breakdown

24 (U) Objective: a. Problem: To determine the mechanism and characteristics of voltage breakdown in dielectric material caused by electron charge storage. b. Application: The discharge of Pegasus capacitor panels under the effects of electron bombardment in the earth's radiation belts and to other discharge phenomena which may pose significant problems in spacecraft operations.

25 (U) Approach: Work in this area has comprised the irradiation of Pegasus capacitor panels, using a specially constructed strontium yttruim source. Experiments have been carried out in an environmental chamber with temperatures down to about -65°C and a vacuum 10^{-6} Torr. Principal instrumentation is an oscilloscope with camera to record pulse size and slope and a timing circuit under contract NAS8-21050, especially designed movable shield is being constructed to allow a varible electron source strength, and the temperature will be cycled. More realistic Pegasus circuiting will also be employed. In addition to experiments using entire panels, smaller capacitors will be etched out to determine the areas of discharge involved in the pulses. Upon completion
26 of this work, it is hoped that further studies can be performed to inprove the understanding of the fundamental properties of electron-produced discharge.

(U) Progress: Work under NAS8-20206 has been completed, and a final report received. A large number of pulses were observed at low temperatures of fractional voltage magnitude, although none appeared at room temperatures. A theoretical treatment of the discharge phenomena was also presented.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	25
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY— 69	-	25
35. TASK AREA	High-Energy Radiation Effects & Shielding			

William G. Johnson

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AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006895	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-09-66)	U RPT U WORK	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-24-62	N/A

11. TITLE:

(U) Mapping of Satellite Orbits in Radiation Belts and Dose Calculations

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Radiation Shielding		N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	1.0	-
		CURRENT FY—68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Burrell, M. O., R-RP-N RESP. INDIV. Wright, J. J. , R-RP-N TEL: 205-876-1891 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: a. Problem: To develop computer codes which will provide the integrated electron or proton fluxes encountered by an orbiting spacecraft in the earth's magnetic field. b. Application: Codes are to be developed to calculate the radiation loses inside spaceships as the craft traverses the belts of radiation.

(U) Approach: The orbital parameters of a satellite will be specified in sufficient detail to locate the spaceship as a function of the three orientation elements (longitude of the node, the inclination, and the argument of perigee) and the three-dimensional elements (semimajor axis, eccentricity, and time of perigee passed). From the above parameters the longitude, the latitude and the distance from the earth will be converted into B-L coordinates which are used to specify the radiation flux and energy spectra as a function of position in space. A forty-nine term expansion will be used for the earth's magnetic field. It is hoped that simple radiation transport models can be developed which will provide a continuous dose rate calculation from protons and electrons inside a spacecraft.

(U) Progress: The above work has been completed and publication of the work has been made. The computer codes developed are available to NASA and contractor personnel. Extended effort is being expanded to modify the program to treat special problems such as modifying solar flare spectrum in earth's magnetic field.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY—67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY 69	-	-
35. TASK AREA	High Energy Radiation Effects and Shielding			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U (GPT) U (WRA)	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-01-25-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE: Investigation of the Combined Effects of Space Environmental Parameters on Space Vehicle Materials

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600 Coatings 013800 Radiation	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20210 (M.) DATE 06 65 c. TYPE M. CPFF d. AMOUNT. 96,564	PRIOR FY - 67 CURRENT FY - 68	0.3 0.3	- -

19. GOVT LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV. Gause, R. L., R-P&VE-ME

TEL: 205-876-0011 (FTS)

20. PERFORMING ORGANIZATION

NAME: Hughes Aircraft Company

ADDRESS: Culver City, California

INVESTIGATORS PRINCIPAL ASSOCIATE: Escoffery, C.

TEL: 213-391-0711 Ext. 231 TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Thermal Control Coatings, Radiation Environment

24. (U) OBJECTIVE: The objectives of this work unit are to study the in-vacuo behavior of selected space vehicle materials in various radiation environments and to establish theoretical models which adequately describe the radiation damage mechanism. Primary emphasis will be on the evaluation of the effects of UV and solar wind environments on thermal control coatings for use on interplanetary spacecraft.

25. (U) APPROACH: Materials are exposed to a vacuum-radiation-temperature environment. In-situ measurements of pertinent properties are made as a function of the incident radiation. Synergistic effects will be revealed by comparing the effects of separate environments. Selected material systems are studied to develop theoretical models which describe the damage mechanism. Analytical means will be devised to aid in defining the chemical processes and structure changes that occur.

26. (U) PROGRESS: The first year's effort on this program involved the development of the unique experiment apparatus required. The second year's program currently is underway. Materials have been obtained and are presently being evaluated. A detailed description of the work done during the first year is given the Hughes Aircraft Company annual report.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUBJECT CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	—	50
CURRENT FY 68	—	60
NEXT FY 69	—	45

33. UNIQUE PROJECT: Space Vehicle Systems, SRT

34. SUB PROGRAM: Space Vehicle Environmental Factors

35. TASK AREA: High Energy Radiation Effects and Shielding

William G. Johnson

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Replaces previous edition

U.S. GOVERNMENT PRINTING OFFICE 1967

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-26-62	No Change

11. TITLE:

(U) Investigation of Electron Interaction in Matter

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
012300 Particle Physics 013800 Rad. Shielding & Protection	10 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE 02 67 b. NUMBER NAS8-21055 c. TYPE M. CPFF d. AMOUNT $78,711	PRIOR FY– 67	-	79
		CURRENT FY– 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Edmonson, Dr. N., R-RP-N TEL. 205-876-4126	NAME: LTV Research Center ADDRESS: P.O. Box 5907 Dallas, Texas 75222 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Electron, bremsstrahlung space shielding alloys, compounds composite materials

24. (U) Objective: a. Problem: Electron interactions with compounds, alloys, and composite materials will be studied. b. Application: Will contribute to the solution of engineering problems in shielding space equipment and personnel from electrons in space non-normal target impact and complex target configurations will be used.

25. (U) Approach: Controlled electron beams in the energy range 3 MeV furnished by a Van deGraaff accelerator will be directed against targets selected in accordance with the above description. Secondary electron spectra and bremsstrahlung will be measured. Dose rates will be measured.

26. (U) Progress: This work will continue research being carried out by the contractor on secondary electron spectra, bremsstrahlung spectra and cross sections for these interactions. Previous work has stressed measurement of fundamental quantities. Continuation will stress data for direct application in space shielding engineering design. NASw-1385 has been completed and work is being continued under NAS8-21055.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SET GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	79
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	85
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY– 69	-	-
35. TASK AREA: High-Energy Radiation Effects and Shielding			

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(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (12 09 66)	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-28-62	N/A

11. TITLE:
(U) Study of Magnetic Flux Flow and Superconductor Stabilization

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Rad. Shielding 015700 Solid State Phys.	11 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	a. DATE		PRIOR FY— 67	0.1	68
B. Contract	H-29278A	02 67		CURRENT FY - 68	0.1	—
	c. TYPE Y. C.	d. AMOUNT	68,000			

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Lacy, L.L., R-RP-N TEL. 205-876-4126 (FTS)	NAME: Oak Ridge National Laboratory ADDRESS: Oak Ridge, Tennessee INVESTIGATORS PRINCIPAL: Gauster, W. F. ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Superconducting Magnets; Active Shielding; Radiation Shields

24.
(U) Objective: a. Problem: To study magnetic flux flow in type II superconductors and relate the flux flow to instabilities in large, high field superconducting magnets. b. Application: The specification of the most effective, reliable, and light-weight technique for stabilizing large, high current, superconducting magnets for space applications.

25.
(U) Approach: Research will be directed toward a theoretical and experimental study of flux motion and supercurrent instabilities in thick and thin wall cylindrical superconducting samples. Furthermore, attempts will be made to correlate the flux motion and supercurrent instabilities with the metallurgical properties of the superconductor. Research will also continue on the study of flux and current behavior and stability properties of short samples and coils.

26.
(U) Progress: The contractor was only recently selected and research should begin by February 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	-	68
	CURRENT FY—68	-	75
	NEXT FY— 69	-	80

33. UNIQUE PROJECT	Space Environmental Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects & Shielding

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (12 09 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-29-62	N/A

11. TITLE:
(U) Study of Charged Particle Motions in Magnetic Radiation Shielding Fields

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Rad. 015700 Solid State Phys. 013800 Shielding	11 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-21048 a. DATE 02 67	PRIOR FY-67	0.1	30
	c. TYPE M. CPFF d. AMOUNT $29,774	CURRENT FY-- 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Urban, E. W., R-RP-N TEL: 205-876-4126 (FTS)	NAME: Northrop Corporation ADDRESS: Hawthorne, Calif. INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Charged Particle Motion, Stormertron, Active Shielding

24. (U) Objective: a. Problem: To study theoretically and experimentally charged particle shielding capabilities of various magnetic systems exposed to isotropic and non-isotropic charged particle distributions. b. Application: The evaluation of active space vehicle radiation shields by experimental (Stormertron) techniques.

25. (U) Approach: The Stormertron techniques involves placing a model of the active shield in a space simulation chamber and bombarding the shielding model with electrons. The relative distribution of electrons can then be mapped by using phosphoresence screens and fluorescence gases. Models of active shields to be tested are those with single and multiple current turn loops.

26. (U) Progress: An initial development contract was only recently awarded; however, data has already been recorded on a point dipole shielding model using both gas and screens. After the data has been reduced, it will be compared with the theoretical studies performed in-house and by the contractor.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY--67	-	30
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY-68	-	40
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY-- 69	-	40
35. TASK AREA	High Energy Radiation Effects and Shielding			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	A. New (Proposed)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01- 30-62	N/A

11. TITLE:
(U) Analysis of High Energy Proton & Charged Particle Transport & Secondary Particle Protection

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015700 Solid State Physics	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER Pending c. TYPE a. DATE d. AMOUNT	PRIOR FY-- 67	-	-
		CURRENT FY 68	0.4	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Burrell, M.O., R-RP-N TEL 205-876-1891 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) Objective: a. Problem: To perform analytical studies on the transport of high energy protons in materials, the production of secondary particles through interactions, and the subsequent transport of the secondaries. b. Application: The protection of personnel and equipment against radiations to be encountered on near-earth and extended space missions.

25. (U) Approach: Sophisticated nuclear models will be used to predict particle interactions, resulting in loss of energy and the production of new particles or gamma rays. These will be coupled with Nonte Carlo or statistical estimation technique to calculate the particle transport through material. Results will be expressed in a form applicable to shielding calculations and will be compared with appropriate experimental data.

26. (U) Progress: During the past six years, the Oak Ridge National Laboratory has been carrying out an extensive effort, under NASA contract, to study high energy proton and neutron interactions and transport. The work has comprised both analytical techniques and experimental work performed with several different accelerators. An extensive amount of experimental data has been obtained and some quite useful calculational models have been developed. This resume is intended to cover an extension of the analytical portion of the work currently under contract from OART.
NOTE: This work unit has been highly recommended and concurred by Mr. Art Reetz of Headquarters.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	250
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems , SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects and Shielding

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	A. New (Proposed)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01-31-62	N/A

11. TITLE:
Theoretical Calculation of Electron Bremsstrahlung Cross Sections

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Solid State Physics 015700	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A c. TYPE d. AMOUNT a. DATE	PRIOR FY 67	—	-
		CURRENT FY 68	2.5	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Edmonson, Dr. N., R-RP-N TEL 876-4126 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATOR& PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Quantum electrodynamics, bremsstrahlung, electron

24. (U) Objective: a. Problem: To develop accurate analytical methods for computing the bremsstrahlung cross sections for electron interactions with materials.
b. Application: Results have application in protection of personnel and equipment in earth's natural and artificial radiation belts.

25. (U) Approach: Advanced methods in relativistic quantum field theory and electrodynamics will be employed using sophisticated numerical methods and advanced computing machines to generate electron bremstrahlung cross sections. These results will be compared with available experimental measurements.

26. (U) Progress: This is the first resume on this work.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	High Energy Radiation Effects and Shielding

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U T U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-01 -32-62	N/A

11. TITLE

(U) Analytical Studies of the Penetration of Electrons through Matter

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
012300 Particle Physics 013800 Radiation Shielding& Protection	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER Pending a. DATE c. TYPE d. AMOUNT	PRIOR FY 67	-	-
		CURRENT FY 68	0 .2	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Edmonson, Dr. N., R-RP-N TEL. 205-876-4126 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Bremsstrahlung, Electrons

24. (U) Objective: a. Problem: Penetration of electrons and bremsstrahlung through matter. b. Application: Methods will be developed and calculations performed for the penetration of electrons and bremsstrahlung through matter.

25. (U) Approach: Monte Carlo methods will be developed and calculations performed for the penetration of electrons with energies up to 10 MeV through various materials. Range straggling, thick target bremsstrahlung production and multilayer slab geometries will be included

26. (U) Progress: This contract has been carried as a NASA Headquarters Contract R-80 under the above stated title. It has been under the direction of Dr. Martin J. Berger of National Bureau of Standards. It is now being transferred to MSFC and will be under the direction of Research Projects Laboratory. Dr. Berger will present an invited paper on the work through 1966 and 1967 to date at the American Nuclear Society Meeting in San Diego in June, 1967. Some other publications from this program are: (1) Berger, Martin J. and Seltzer, Stephen M., "Tables of Energy Losses and Ranges of Electrons and Positrons - NASA SP-3012, 1964 (2) Barkas, Walter H. and Berger, Martin J., "Tables of Energy Losses and Ranges of Heavy Charged Particles" - NASA SP-3013, 1964 (3) Berger, M. J. and Seltzer, S.M., "Results of Some Recent Transport Calculations for Electrons and Bremsstrahlung", Proceedings of the Second Symposium on Protection Against Radiations in Space - NASA SP-71, 1965.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	42
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY 69	-	50
35. TASK AREA: High-Energy Radiation Effects and Shielding			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	B. Completed (30-04-64)	(U) PRT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-03-62	No Change

11. TITLE:
(U) Electro-Chemical Micrometeoroid Penetration Detector

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
01000 Meteorology	05 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20194 a. DATE 05 65	PRIOR FY-- 67	0.3	5
	c. TYPE M. CPFF d. AMOUNT $74,252	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Northrop Space Laboratories
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Huntsville, Alabama
	INVESTIGATORS PRINCIPAL:
RESP. INDIV: Dr. Hudson, O.K., R-RP-S	ASSOCIATE:
TEL: 205-876-1387 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: a. Problem: The objective of this work is to determine the feasibility of using Electro-Chemical Micrometeoroid Penetration Detectors in future lunar and planetary programs. b. Application: These detectors are thought to offer distinct advantages over other detectors which have been tested in laboratory and aboard space vehicles. Such a meteoroid detector would be employed to determine the hazard to men and equipment located on the lunar surface. c. Discussion: It
25. would be utilized as a safety-warning device aboard all spacecraft of the future to indicate penetration of critical areas.

(U) Approach: This detector concept was presented to the Meteoroid Technology Advisory Working Group in July 1964 and received favorable comments. Evaluation including impact investigations will be made on a meteoroid detector which would have the form of the capacitor detector presently used on the Pegasus Satellites, but in which the dielectric would be replaced by a thin layer of microspheres filled with a volatile, ionic chemical. When such a structure is penetrated, the volatile,
26. ionic material would be released causing a short circuit in the capacitor-type geometry. The short circuit condition would persist until the material had evaporated into space.

(U) Progress: The work to be performed under this task has been satisfactorily completed under Contract NAS8-20194 with Northrop.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	5
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY -	-	-
35. TASK AREA: Meteoroid Environment and Impact Hazard			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006896	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Completed (30-04-64)	U	U	N/A	GA	A-Work Unit

10a. CURRENT NUMBER CODE	10b. PRIOR NUMBER/CODE
124-09-02-06-62	No Change

11. TITLE:
(U) Electromagnetic Hypervelocity Gun Development for Meteoroid Simulation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Physics 005500, 013600, 015700	06-63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-11174	a. DATE 06 64	PRIOR FY— 67	0.3	-
B. Contract	c. TYPE M.CPFF	d. AMOUNT 245,279	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Aerojet-General Nucleonics
ADDRESS: Huntsville, Alabama 35812	ADDRESS: P.O. Box 77 San Ramon, California
	INVESTIGATORS PRINCIPAL: R. L. Chapman
RESP. INDIV: Dr. O. K. Hudson, R-RP-J	ASSOCIATE:
TEL: 205-876-1387 (FTS)	TEL: 415-837-5311 x774 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
See Below

24. Objective: (U) The objective of this work is to increase the velocities of simulated meteoroid particles in the laboratory to at least 15Km/sec. This is necessary to correlate hypervelocity impacts in the laboratory with flight experiments. Present day theory of hypervelocity impact is based on data obtained at velocities which border on the hypervelocity regime (which can be nominally placed at the velocity of sound in structural metals - about 6 Km/Sec). No data currently exists which may be used to predict the effects of meteoroid impacts upon space vehicles; a simple computation indicates that meteoroids will have velocities ranging between 11 and 80 Km/sec.

25. Approach: (U) Two techniques of particle acceleration using magnetic fields have been investigated by analytical and laboratory methods. One method has had the feasibility tested and found lacking; the other method is the subject of this work. Here an extraordinary magnetic field is produced momentarily by rapid compression of a static magnetic field using chemical explosives; a gradient introduced by the geometry of the field is used to directly accelerate the particle. A velocity well in excess of 20 Km/sec is theoretically possible.

26. Progress: (U) The work to be performed under this task has been satisfactorily completed under Contract NAS8-11174 with Aerojet General.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA	Meteoroid Environment and Impact Hazard			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

2. GOVT ACCESSION	3. AGENCY ACCESSION
	NR 003010

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-07-62	No Change

11. TITLE:
(U) Canadian Meteor Data Analysis

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002000 Astronomy	11 62	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER H-41974	a. DATE 11 62	PRIOR FY— 67	0.1	20
B. Contract	c. TYPE C	d. AMOUNT $ 65,000	CURRENT FY -68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV.: Clifton, Stuart, R-RP-P
TEL: 205-876-2595 (FTS)

20. PERFORMING ORGANIZATION
NAME: Radio & Electrical Engineering Division
ADDRESS: National Research Council of Canada
Ottawa 2, Canada
INVESTIGATORS PRINCIPAL: Dr. Millman, Peter M.
ASSOCIATE: Dr. McIntosh, Bruce A.
TEL: 613-232-8211 x3-2490 TYPE:

21. TECHNOLOGY UTILIZATION
N/A

22. COORDINATION
N/A

23. KEYWORDS

24.
(U) Objective: a. Problem: To determine the diurnal and yearly variations in the meteoroid environment. b. Application: Improved definition of the Meteoroid environment. c. Discussion: The equipment used in this experiment has been in continuous operation since 1957. This set of data is unique and offers the only present chance for observing long term variations in the meteoroid environment. It also provides an excellent data set for comparison to satellite results.

25. (U) Approach: Data from the radar for recent months are being reduced. Older data are being analyzed for diurnal, yearly, and other periodic variations in flux. Comparisons are being made between these data and other data taken at NRC, as well as with Pegasus data.

26. (U) Progress: Collection and analysis of meteoroid data is continuing. It has been well established that the variation of meteoroid rates repeats in a yearly cycle. Data collection will continue to the next sun spot maximum so that a complete solar activity cycle will be covered. Annual, monthly, and diurnal variations of the meteoroid rates are being investigated and rates are being compared from northern and southern hemispheres in the next sun spot cycle. Data have been supplied to MSFC for comparison with the Pegasus data and to MSC for use in meteor shower investigations. Funds for FY-68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY— 67	-	20
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY— 69	-	20
35. TASK AREA	Meteoroid Environment and Impact Hazard			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 003012	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change(15-03-66)	U U	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-12-62	No Change

11. TITLE: (U) Experimental Hypervelocity Impact Research (Transient Phenomena from Strong Shocks in Solids)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Physics 005500, 013600, 015700	01 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20345 a. DATE 01 66	PRIOR FY-- 67	0.1	50
	c. TYPE M, CPFF d. AMOUNT $130,368	CURRENT FY - 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Naumann, R. J.,R-RP-P TEL: 205-876-2595 (FTS)	NAME: Hayes International ADDRESS: Huntsville, Alabama INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) Objective: a. Problem: To develop a thorough understanding of the behavior of matter under shock compression. Application: Meteoroid sensor concepts, instrumentation for impact measurements.

25. (U) Approach: To design a meaningful experiment, it is necessary to develop a theoretical model to guide the measurement program. Effects under consideration are conducting states in dielectrics, polarization of non-piezo dielectrics, equation of state of porous solids, release temperature and entropy change, vaporization, a nd ionization phenomena.

26. (U) Progress: A one-dimensional model has been constructed for prediction of the onset of conduction band overlap in dielectrics. Hydrocodes have been developed for prediction of material state during compression and expansion. Design of pertinent experiments are underway.
Funds for FY-68 were not requested because of funding guidelines limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY-- 67	-	50
	CURRENT FY 68	-	-
	NEXT FY-- 69	-	30

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Meteoroid Environment and Impact Hazard

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 003015

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-03-66)	U RPT U WRK	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-15-62	No Change

11. TITLE

(U) Meteoroid Detector Development and Calibration

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Astronomy 002000	03 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-21115 c. TYPE M, CPFF d. AMOUNT 49,990 e. DATE 03 67	PRIOR FY— 67	0.2	50
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: North American Aviation, Inc.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: 12214 Lake Wood Boulevard, Downey, California 90241
RESP. INDIV. Dozier, Dr. J. B. R-RP-P	INVESTIGATORS PRINCIPAL: Scully, C. N.
TEL. 205-876-1936	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
(U) Objective: a. Problem: To provide adequate hypervelocity impact testing of detector panels and related target materials. b. Application: To determine the effective thickness in terms of penetration in semi-infinite targets and to correlate spacecraft meteoroid data with impact of known mass and velocity particles.

25.
(U) Approach: Hypervelocity impact testing employing particles of several types of materials, and appropriate masses, utilizing velocities up to the maximum available with emphasis on thin sheet threshold velocities will be contracted until such facilities may be available in-house. Functional tests and calibration of various detectors including Pegasus panels, Explorer 23 pressure cells, and S-IVB tankage with IR detectors will be conducted.

26.
(U) Progress: A contract (NAS8-20053) with North American Aviation has been completed and the final technical report is being prepared. This aspect of the study has not been abandoned bu t plans are to seek a contract to continue the applicable portions of the study.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
N/A	PRIOR FY—67	-	50
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY68	-	-
34. SUB PROGRAM: Space Vehicles Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA: Meteoroid Environment and Impact Hazard			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

2. GRANT ACCESSION	3. AGENCY ACCESSION
	NR 006897

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-17-52	No Change

11. TITLE

(U) Theoretical Impact Calculations

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Physics 006400, 015600, 016700	09 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCE'S EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20235 a. DATE 06 65	PRIOR FY 67	0.5	—
	c. TYPE M.CPFF d. AMOUNT $135,910	CURRENT FY 68	0.5	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Shock Hydrodynamic Corp.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Sherman Oaks, California
RESP. INDIV.: Naumann, R. J. R-RP-P	INVESTIGATORS PRINCIPAL: Bjork, R. L.
TEL: 205-876-2595 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: a. Problem: To utilize existing programs and to develop sophisticated codes to describe the complex phenomena of meteoroid impact for use in design of meteoroid protection and for analyzing meteoroid measurements. b. Application: Meteoroid Protection and definition of environment.

25. (U) Approach: Programs have been developed to integrate the equations of motion describing the impact process. Equation of State data and contributive relations for a variety of materials exist and it is now possible to describe certain features of meteoroid impact with reasonable accuracy. The results are being checked against experimental measurements wherever possible. Additional cases will be computed from existing programs and new programs will be developed to incorporate more detail into the calculations.

26. (U) Progress: Particle-in-cell and Eulerain techniques have been developed for the treatment of a porous meteoroid striking an arbitrary target. Strength effects have recently been incorporated to provide a late-time description where pressures have fallen to the point that material strength is important. For the first time, ultimate crater dimensions can be predicted. Currently, various failure criteria are being incorporated to enable prediction of incipient failure and ballistic limit of finite sheets. A limited number of cases of engineering design interest are being computed in the present program. Experimental data is being generated under another contract to compare with these results.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SRT GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	100
	CURRENT FY 68	-	50
	NEXT FY 69	-	50

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Meteoroid Environment and Impact Hazard

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION
		NR 004285

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (07-11-66)	U RPT U WRK	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-19-62	No Change

11. TITLE:

(U) Development of a Hypervelocity Facility

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Astronomy - 002000	09 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	1.0	-
	c. TYPE d. AMOUNT	CURRENT FY - 68	1.0	—

19. GOVT LAB INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
RESP. INDIV.: Espy, P. N., Naumann, R.J. R-RP-P	INVESTIGATORS PRINCIPAL: Same as 19
TEL: 205-876-2595 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.

(U) Objective: a, Problem: To develop instrumentation for determining projectile mass velocity and integrety and for diagnostic measurement of impact phenomena such as ejecta distribution and state, emission of radiation, and charge separation. To optimize and improve range performance. b. Application: Meteoroid simulation.

(U) Approach: An optical in-flight photometer will be constructed to collect and analyze light scattered from the projectile. An image converter framing camera will be used to photograph the projectile in flight and to observe transient impact phenomena. The same image converter camera operated in streak mode used with a spectrograph will provide time resolved spectra. A mass spectrometer will be used to analyze ionized ejecta material. A diffusion pump to evaluate the chamber to 10^{-6} Torr will be used to minimize interaction of the ejecta with ambient atmosphere.

(U) Progress: The light gas gun range is presently operative and is being used in applications of an engineering nature that do not require elaborate instrumentation. The plasma rail gun has proven its feasibility and is being scaled up to utilize increased energy input. It should be available in July. Sufficient experience has been gained with our existing range to now be able to undertake more elaborate experiments of type that are presently being contracted.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	48	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	70	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	30	-
35. TASK AREA: Meteoroid Environment and Impact Hazard			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004287

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-21-62	No Change

11. TITLE:

(U) Meteoroid Field Patterns

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002100 Astrophysics	04 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Hale, D. P., Wright, J.J. R-RP-N TEL 205-876-4513 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Meteoroid Flux, Ejection Dynamics

24.

(U) Objective: a. Problem: To perform theoretical analysis of the possible patterns of launch meteoric flux about attractive centers, and the dynamical behavior of orbiting material upon experiencing brief impulses. b. Application: This study has application in the ejection of material from an orbiting spacecraft.

25.

(U) Approach: Application of celestrial mechanics to an ensemble of particles bound to an attractive center, and to the problem of arbitrary injection at any point about the center.

26.

(U) Progress: Research completed upon two papers dealing respectively with the delineation of the regions in which there can be flux, and with the behavior of ejected material. An attempt is in progress to apply theory to the Leonid Stream of Nov., 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	-	-
	CURRENT FY68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Meteoroid Environment and Impact Hazard

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006899

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-02-23-62	No Change

11. TITLE:
(U) Experimental Hypervelocity Impact Research (Advanced Accelerator Concepts)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Physics 006400, 012200, 01300	03 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20352 a. DA 06 66	PRIOR FY— 67	0.1	-
	c. TYPE M.CPFF d. AMOUNT $24,044	CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Physics International
ADDRESS: Huntsville, Alabama 35812	ADDRESS: San Leandro, California
RESP. INDIV. Naumann, R. J. R-RP-P	INVESTIGATORS PRINCIPAL: Dr. Ford
TEL. 205-876-2595 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
(U) Objective: a. Problem: To explore advanced concepts for acceleration of material to hypervelocities. b. Application: Meteoroid simulation.

25.
(U) Approach: In the past, research on other programs has suggested techniques for generating extreme pressures and energy densities or for accelerating gasses to extreme velocities. Such capabilities are of interest for possible accelerator concepts and have in some cases lead to useful accelerators such as the plasma rail gun. It is desirable to continue to explore promising concepts by means of modest feasability studies aimed at producing particles with velocity in excess of 20 km/sec.

(U) Progress: Previous work has explored an explosively compressed magnetic field, which was found to b e unfeasable because of the difficulty of maintaining projectile integrity and the high cost per shot, and the plasma rail gun which produced a useful accelerator. Explosive evaporation of electron beam deposition is presently being studied. Much effort has gone into the problem of focusing the energy into a small area. Feasibility of the approach has not yet been determined.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	25
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	25
35. TASK AREA: Meteoroid Environment and Impact Hazard			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION
		NR 006902

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	A. New	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-02-26-62

10b. PRIOR NUMBER/CODE: 124-09-02-12-62

11. TITLE: (U) Experimental Hypervelocity Impact Research Program

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Physics 006400, 012200, 001300	05 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER NAS8-20337 DAT 06 66	PRIOR FY-- 67	0.1	—
B. Contract	c. TYPE M.CPFF d. AMOUNT $100,000	CURRENT FY 68	1.0	—

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Naumann, R. J., R-RP-P

TEL.: 205-876-2595(FTS)

20. PERFORMING ORGANIZATION

NAME: IIT Research Institute

ADDRESS: Chicago, Illinois

INVESTIGATOR'S PRINCIPAL:

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Hypervelocity Impact

24. (U) Objective: a. Problem: To provide basic data on shock propogation, pressure profiles, crater growth, rear surface deformation, rupture phenomena, ejecta momenta field, change separation and photon emission that can be checked against theoretical calculations to improve basic understanding of impact phenomena and indicate those observables that might prove useful for advanced sensor concepts. b. Application: Provide basic understanding of impact phenomena useful to development of sensors and protective design.

25. (U) Approach: Techniques for measurement of the above have been developed both in-house and under previous contract. It is now possible to utilize our in-house facility to perform some of this work at greatly reduced cost and with increased control and flexibility. However, certain measurements require specialized range capabilities and instrumentation that is not yet available in-house. A limited number of tests in contractor ranges will be required to complete program goals.

26. (U) Progress: The in-house facility is operational and limited work has been performed on measurement of shock propogation, ejecta momenta field, and change separation. IIT has developed techniques for measurement of shock arrival times and rear surface deformation and is currently making such measurements in support of our theoretical effort. Also IIT has perfected methods of launching very small intact spheres for calibration of Pegasus detector panels.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT: Gun parts, material, electronic instrumentation, PM tubes, Optical filters

32. FUNDS ($ K)	IN HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	20	70
NEXT FY 69	20	70

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Meteoroid Environment and Impact Hazard

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	A. New (Proposed)	U RPT U WRK	N/A	DC	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-04- 06-62	N/A

11. TITLE:
(U) Laboratory Study of Surface Effects on Astronomical Optical Surfaces

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Astrophysics - 002100; Optics-012000; Elec. & Magnetism - 012000	04 67	04 69	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER Pending a. DATE c. TYPE d. AMOUNT	PRIOR FY-- 67	-	-
		CURRENT FY - 68	2.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 Moore, W.W., R-RP-P RESP. INDIV. Williams, J., R-RP-P TEL 205-876-1936 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Astronomical Optical Surfaces; Contaminants Deposition; Large Spacecraft

(U) Objective: a. Problem: To study under laboratory vacuum conditions the effects of desposition of simulated spacecraft environments on astronomical optical surfaces. b. Application: To provide empirical data indicative of probable space flight effects and also to provide other information needed in the development of an associated flight experiment package. c. Discussion: This investigation would expose a complete series of selected astronomical optical surfaces to a vacuum environment having a source of simulated spacecraft effluences. A method would be developed in-house for applying various electromagnetic potentials to the surfaces and studies then made of the deposition effects as system parameters are varied.

(U) Approach: Expose astronomical optical samples such as lenses, mirrors, prisms, gratings, slits, etc. to a vacuum chamber simulating spacecraft orbital altitudes and environments. These samples would be studied for surface effects as variations are made in systems parameters such as surface, electrical potential, surface temperature, chamber temperature and pressure, environment composition, electromagnetic fields and radiations, etc. It is expected this effort would be made easier to execute through a co-investigation between: (1) In-house laboratory facilities where the experimental techniques are being developed; and (2) various scientific groups connected with the execution of ATM type missions. These groups will provide the necessary samples as well as theri requirements.

(U) Progress: To date this task area has been thoroughly studied by this group. In addition the Ball Brothers Research Corporation problem definition study is indicating the significant contamination problem will likely be depositing of heavier particles onto optical surfaces. The techniques and equipment generated for the ATM Contamination Definition Program will be used in this task.

27	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Optical Surfaces Deposition & Plating Analysis Equipment	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	50	15
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY-- 69	35	-
35. TASK AREA: High Vacuum Technology			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	B. Completed (30 04 64	H PT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-03-62	No Change

11. TITLE:
(U) Study of Interfacial Thermal Contact Conductance

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	03 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER NAS8-11247 c. DATE 03 64	PRIOR FY— 67	-	-
B. Contract	c. TYPE M, CPFF d. AMOUNT 89,220	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: General Electric Co.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: P. O. Box 8555 Philadelphia 1, Pa.
RESP. INDIV: Atkins, Harry L. R-RP-T	INVESTIGATORS PRINCIPAL:
TEL: 205-876-8701 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
(U) Objective: To measure the thermal and electrical contact conductance of selected spacecraft materials in a vacuum environment. As an added feature thermal and electrical bulk conductivity measurements were made.

25.

26.
(U) Progress: The program has been completed and a final report has been issued. The report contains the experimental data that was the objective mentioned above. In addition some theoretical analyses were performed. The work will be presented in a national symposium this year.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects & Temperature Control

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 003060	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15 08 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-04-62	No Change

11. TITLE:
(U) Study of the Radiative Emissivity of Metals - a. Theoretical

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20365 a. DA 06 66	PRIOR FY– 67	0.2	-
	c. TYPE M.CPFF d. AMOUNT 39,464	CURRENT FY– 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Schocken, Klaus, R-RP-T TEL 205-876-3391 (FTS)	NAME: P.E.C. Research Associates ADDRESS: 1001 Mapleton Street Boulder, Colorado INVESTIGATORS PRINCIPAL: Dr. Ashby, Neil ASSOCIATE: Dr. Burkhard, D. G. TEL: 303-442-6015 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Emissivity, Absorptivity

24.
(U) Objective: a. Problem: To calculate theoretically the emissivities and absorptivities of solid materials, including the numerical computation of emissivity as a function of angle of emission, wavelength, and polarization for selected materials. b. Application: The results may be used to good effect in perturbation calculations of emissivity and absorptivity. c. Discussion: The absorptivities of metallic sodium are computed. In addition, similar calculations are performed for semi-conductors. The calculations include the case where the semi-conductors are doped with impurities. In a metal at the longer wavelengths, an incident plane electromagnetic wave is nearly totally reflected. Good zeroth-order wave functions then correspond to perfectly reflected waves exterior to the metal and to exponentially attenuated waves in the metal's interior.
(U) Approach: In order to perform the calculation, the wave functions for the valence and conduction electron bands are required. In an extensive search through the literature no such functions were found. Therefore, these functions have to be evaluated first. Some cases are presently studied where magnetic interactions are included, or electric quadrupole moments of the solid, or wavelength dependence of the optical mode polarization density.
(U) Progress: A complete orthonormal set of basis functions, appropriate for use in perturbation calculations of emissivity and absorptivity has been developed. The functions are applicable to metals, insulators, and certain semi-conductors. Previously the basis functions were used to perform detailed calculations of the spectral emissivity of aluminum. Now the calculations on optical absorption by semi-conductors have been completed. The final results of the computation of the absorptivities of metallic sodium agree better with the experimental values than any other published theory. An attempt is made to explain the absorption structure of gold due to direct transitions of electrons. Funds for FY-68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY– 67	-	36
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY– 69	-	-
35. TASK AREA	Thermal Radiation Effects and Temperature Control			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
65-03-07	C. Complete (01 04 65)	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-05-62	No Change

11. TITLE:
(U) Directionally Reflective Surface Study

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 - Thermodynamics	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11273 a. DATE 06 64	PRIOR FY— 67	—	—
	c. TYPE M. CPFF d. AMOUNT 62,917	CURRENT FY— 68	—	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Ling-Temco-Vought
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Dallas, Texas
RESP. INDIV: Miller, E.R., R-RP-T	INVESTIGATORS PRINCIPAL: Cox, Ray
TEL: 205-876-4861 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Scattering, directional reflectance

24. (U) Objective: Conduct theoretical and laboratory experimental studies on surfaces whose reflectance by scattering is directional with angle of incidence.

25. (U) Approach: Fiber optics plates closely approximating the theoretical models are used to compare theoretical and experimental directional backscattering in the Rayleigh Gans domain. Theoretical backscattering predictions are also made for dielectric cylinders in the Rayleight domain.

26. (U) Progress: Theoretical backscattering cross-sections have been calculated using a IBM 7090 computer. The experimental directional reflectance of the fiber-optics. models has been measured. Good correlation in directional reflectance has been obtained, however, the magnitude of the measured directional reflectance is less than predicted. This is attributed to larger diameter cylinders than anticipated.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA: Thermal Radiation Effects & Temperature Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 003061

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	B. Complete (01 04 65)	U RPT U WORK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-08-62	No Change

11. TITLE:

(U) Study of Micrometeoroid Damage to Thermal Control Materials

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600 - Coatings 016700 - Thermodynamics; 012000 - Optics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-18015 a. DATE 06 66 c. TYPE M.CPFF d. AMOUNT $18,650	PRIOR FY– 67	-	-
		CURRENT FY– 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Miller, Edgar R. R-RP-T TEL: 205-876-4861 (FTS)	NAME: Texas Nuclear Corp. ADDRESS: P.O. Box 9267 Allandale, Sta. Austin, Texas 78756 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Optical properties; Meteoroids; Thermal control surfaces

24. (U) Objective: a. Problem: Thermal control surfaces on spacecraft may have their optical properties altered under continued bombardment of micrometeoroids. The degradation may not only be in the form of lowered reflectivity but may effect the coating performance by altering its specular characteristics. Not only thermal control surfaces are involved, but also optical components such as windows, lens, and mirrors. b. Application: Proper simulation of meteoroid craters to develop an analytical optical scattering model would allow designers to allow for degradation where unavoidable or to compensate where necessary.

25. (U) Approach: Actual simulation of micrometeoroid bombardment has proven expensive due to the amount of time required to sufficiently damage a sample for subsequent optical measurements. Since crater size and shapes have essentially been determined from previous studies, it is now feasible to create craters artifically in samples for the optical studies. Several means may be used in this approach such as chemical etching, charged particle bombardment (sputtering or vaporizing) and laser vaporization. Artificially cratering lends itself more readily to mathematical treatment of results of optical measurement since size, shape, and distribution can be controlled.

26. (U) Progress: Several metallic samples have been bombarded with simulated meteoroids and attempts were made to accurately determine the resultant optical properties. However, due to the problems discussed above the prospects are dim to develop a satisfactory analytical model under the present contract (NAS8-18015).

NOTE: Work under NAS8-20646 and 20120 has been completed under this task.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY– 67	-	-
	CURRENT FY 68	-	-
	NEXT FY– 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	C. Completed (01 04 65) U WH		N/A	FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-13-62	No Change

11. TITLE:

(U) Thermal Design Studies (thermal similitude) Applicable to Spacecraft

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	02 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-5270 a. DATE 02 64	PRIOR FY-- 67	-	—
	c. TYPE J. C. d. AMOUNT $123,177	CURRENT FY - 68	-	—

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: University of Alabama
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Tuscaloosa, Alabama 35486
	INVESTIGATORS PRINCIPAL: Matheny, Dr. J.D.
RESP. INDIV. Watkins, J. R., R-RP-T	ASSOCIATE:
TEL: 205-876-7264 (FTS)	TEL: 205-752-7441, x829 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) Objective: a. Problem: To study the application of the principles of similitude and dimensional analysis to transient thermal energy exchange. b. Application; Established an applied method of measurement of radiative geometry factors.

25. (U) Approach: Most of the analysis is done in-house and the experimental work is done by contract as an extension of the analysis. For other radiative and/or conductive transfer, a computer program based upon the algebraic theory is used and the applicable differential equations for the transient case are used as the basis whenever the equations can be written. The results are then used in thermal scaling experiments.

(U) Progress: Difficulty was encountered in some of the eight basis Disk-Stem-Disk modeling configurations. Some of this is inherent in the problem, where ratio limits were found in time scaling. The exact limits are not yet established, but it appears that ratios smaller than 1/10 will be extremely difficult to incorporate. All testing 26. is not complete for the originally planned eight cases, so comparisons can not be made meaningful at this time. The tests for some of the cases have been completed satisfactorily. Design and construction was completed for the analog photoreader for geometry factor determination. The device saves considerable labor in the use of the parabolic mirror/camera system. A prototype direct acquisitions view factor device was constructed and evaluated. As a result, the method is thought to be useful. A refined system would take into account the sensitivity of the location of the photometer head in the chamber.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY – 67	-	-
	CURRENT FY 68	-	-
	NEXT FY – 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects & Temperature Control

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
4. DATE OF RESUME: 15 03 67	5. KIND OF RESUME: B. Completed(01 04 65)	6. SECURITY: U RPT U WRK	7. REGRADING: N/A	8. RELEASE LIMITATION: GA/FO	9. LEVEL OF RESUME: A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-15-62	No change

11. TITLE:
(U) Development of Techniques for Measuring Thermal Diffusivity

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
012700 Physical chemistry	06 65	04 66	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11891 a. DATE 06 65	PRIOR FY-- 67	0.2	-
	c. TYPE M. CPFF d. AMOUNT $54,725	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV.: Austin, J. G., Jr., R-P&VE-MCP
TEL: 205-876-6815 (FTS)

20. PERFORMING ORGANIZATION
NAME: Battelle Memorial Institute
ADDRESS: 505 King Avenue
Columbus, Ohio 43201
INVESTIGATORS PRINCIPAL: Deem, H.
ASSOCIATE: McCann, R.
TEL: 614-299-3151 TYPE: Commercial

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Diffusivity apparatus, thermal properties

24.
(U) OBJECTIVE:

a. Problem: - To develop an apparatus and techniques capable of measuring thermal diffusivity of solid materials over a temperature range from 200°C to 2000°C.

b. Application: - The thermal evaluation of materials for high temperature application.

25. (U) APPROACH - As thermal diffusivity is an instantaneous property which measures the ability of a material to absorb heat, a transient measurement technique was devised. In this method the front surface of a thin disc sample was pulsed with a quantity of energy from a crystal laser. The temperature profile of the rear surface was recorded and analyzed to determine diffusivity.

26. (U) PROGRESS

a. The development and qualification of a fully equipped working apparatus capable of measuring thermal diffusivity of metals, plastics, reinforced plastics, ceramics, and composites over a temperature range from 200°C to 2000°C.

b. Manuals describing the technique of measurement and methods of calculation for each class of materials.

27	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY-- 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 003062	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15 08 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-16-62	No Change

11. TITLE:
(U) Thermal Similitude Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20411 DATE 06 66	PRIOR FY— 67	0.3	-
	c. TYPE M.CPFF d. AMOUNT $69,924	CURRENT FY - 68	0.3	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Lockheed Missiles & Space Co.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Palo Alto, Calif. 90488
	INVESTIGATORS PRINCIPAL: Rolling, R.E.
RESP. INDIV.: Jones, B.P.; Watkins, J.R., R-RP-T	ASSOCIATE:
TEL: 205-876-3391 (FTS)	TEL: 415-324-3311 x45430 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Thermal similitude, spacecraft, transient thermal modeling, thermal scale modeling

24.
(U) Objective: a. Problem: To demonstrate that prototype thermal design information can be obtained by use of scaled models and to determine the feasibility and develop criteria for using principles of similarity. b. Application: Experimentally determine the transient thermal/structural behavior of space telescopes.

25.
(U) Approach: The work will be accomplished in two phases: (1) Analysis to define the modeling criteria for the thermal/structural distortion affecting the usefulness and accuracy of the telescope system. (2) Design, fabrication, and test of experimental scaled thermal/structural models.

26.
(U) Progress: Previously reported work summarized in final contract report, "Thermal Scale Modeling in A Simulated Space Environment", LMSC N-05-66-1, June 66, (R.E. Rolling), "Experimental Results in Thermal Similitude", MSFC Research Achievement Review Reports, Vol. 2, No. 2, Feb 1967, (B. Jones), and "Theory of Thermal Similitude with Application to Spacecraft - A Survey", Astronantica Acta, Vol 12, No. 4, 1966 (B. Jones). Analysis has started to determine modeling criteria for thermal/structural properties of optical space telescope. NAS8-11152 was completed March 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY — 67	-	24
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	60
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	60
35. TASK AREA: Thermal Radiation Effects & Temperature Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004289	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-17-62	No Change

11. TITLE:
(U) Spectral Reflectance and Infrared Detection Under Cryogenic Conditions

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	01 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
D. Inter-Agency	b. NUMBER H-2153A a. DATE 10 65 c. TYPE ZIA d. AMOUNT $80,000	PRIOR FY— 67	0.1	40
		CURRENT FY 68	0.1	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Schocken, Klaus, R-RP-T TEL: 205-876-3391 (FTS)	NAME: National Bureau of Standards ADDRESS: Boulder, Colorado INVESTIGATORS PRINCIPAL: Dr. Kropschot, R. H. ASSOCIATE: TEL: 303-442-2161 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Emissivity, Reflectivity, Cryogenic Conditions

24. (U) Objective: a. Problem: To investigate the spectral reflectance of metallic surfaces and the absorptivity of selected transparent materials under cryogenic environments. b. Application: The information obtained will insure optimum performance of the space vehicle by controlling temperature variations. c. Discussion: Only a very limited amount of spectral reflectivity data under cryogenic environments have been produced. New techniques and new equipment make it possible to obtain and improve accuracy in spectral reflectance and transmittance in the far infrared region. Commer-
25. cial spectrometers can now be used to span the wavelength spectrum from 4000 angstroems to 700 microns. A vacuum grating spectrometer could be used to at least 300 microns. (U) Approach: Measurements of spectral reflectance on moderate reflectors will be completed, including commercial alloys, solar cells, and certain semiconductors. Spectral absorptances from 1 to 715 microns of gold, silver, aluminum, copper, and other materials of interest will be measured.

26. (U) Progress: Two samples of ultra-high vacuum deposited gold on glass substrates have been prepared. These samples are now used to test the repeatability of the reflectance apparatus. The samples are mounted, one as test sample and one as reference, and the detector signal compared with, respectively, test sample and reference in position. The detector signals are in agreement by 3%; it is expected that this figure can be reduced to less than 1%.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	40
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	40
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	40
35. TASK AREA: Thermal Radiation Effects & Temperature Control			

William G. Johnny

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004290	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-18-62	No Change

11. TITLE: (U) Theory of Thermal and Electrical Conductivity in Bulk Material and at the Interface of Solid Conducting Specimens

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	01 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20126 a. DATE 01 66 c. TYPE M. CPFF d. AMOUNT $34,150	PRIOR FY- 67	0.1	-
		CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Schocken, Klaus, R-RP-T TEL: 205-876-3391 (FTS)	NAME: P.E.C. Research Associates ADDRESS: 1001 Mapleton Street Boulder, Colorado 80302 INVESTIGATORS PRINCIPAL: Dr. Ashby, Neil ASSOCIATE: TEL: 303-442-6015 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Heat Conduction, Surface Definition

24. (U) Objective: a. Problem: To develop a description from basic principles of the heat transfer across a metallic interface for two general surfaces for various degrees of contact. b. Application: The investigation into the possibility of directional effects will be continued and extended, to determine under what conditions and for what substances such effects can be expected to occur. c. Discussion: The study will be extended to several new aspects of the basic transfer mechanism, as the contact of like and unlike materials. The materials being studied are metals, dielectrics, semi-metals, semi-conductors, and liquids.

25. (U) Approach: For metals, the electronic contribution is an important part of the thermal transfer across an interface. The coefficients for reflection and transmission of electrons across a potential barrier will be calculated, which represents the boundary between two dissimilar materials. The effect of phonon contributions to the energy transfer will be investigated. Also coupled equations of motion for the electron and phonon systems in the two media will be investigated, with appropriate boundary conditions at the interface. The contact potential difference between the dissimilar materials will be taken into account. The energy transfer at a metal-liquid helium interface is studied.

26. An attempt is made to understand the effect of surface oxide contaminants or dielectric layers at the surface.

(U) Progress: The directional effects in the heat flow at the interface between dissimilar metals have been studied. The process of thermal conduction by electrons through an oxide layer between two dissimilar metals has been analyzed, and the contention that directional effects exist has been shown to be in error. The calculations by Moon & Keller have been shown to be in error; they do not prove that directional effect exists. At this time it has not been determined if a correct calculation will give results of a directional effect or no directional effect.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY- 67	-	35
	CURRENT FY 68	-	34
	NEXT FY-- 69	-	34

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change 01-04-65	RPT U WRK U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-19-62	No Change

11. TITLE:

(U) Use of Thermal Models For Environmental Testing

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 - Thermodynamics	04 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER H-71483	a. DATE 04 64	PRIOR FY— 67	0.2	-
D. Inter-Agency	c. TYPE ZIA	d. AMOUNT $30,000	CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Arnold Engineering Dev. Center
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Arnold Air Force Station, Tenn. 37389
	INVESTIGATORS PRINCIPAL:
RESP. INDIV: Harrison, James K., R-RP-T	ASSOCIATE:
TEL: 205-876-3391 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Thermal Similitude

24 (U) OBJECTIVE: a. Problem: To confirm by experiment the theoretical validity of dimensional analysis and similitude as applied to the thermal behavior of materials in a hard vacuum. Also to investigate the practical problems associated with such an endeavor. b. Application: Thermal behavior of materials in a hard vacuum.

(U) APPROACH: The initial experiments will involve only radiative exchange between three isothermal bodies (flat plate, sphere, and cylinder). All external surfaces 25 will be black and diffuse. Heat is supplied by an electrical resistor heater installed inside the flat plate. The heater is cycled (on 2 hours and off 2 hours) for 6 hours to insure transient conditions. Scaling of gross dimensions from prototype to model will be 2 to 1. Second phase experiments will be similar to the initial experiments and will include conductive exchange as well as radiative exchange.

(U) PROGRESS: One set of prototype/model experiments has been completed. Conditions were as described above for the initial experiments. The temperature correlation, from prototype to model, for corresponding locations and times for the flat 26 plate and cylinder was reasonably good. For the sphere the correlation was poor. Extreme temperature gradients were present over the surface of the sphere and are blamed for the poor correlation. The experiment will be performed again and a concerted effort will be made to eliminate the temperature gradients.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SRT GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY-68	-	-
	NEXT FY -69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects & Temperature Control

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	C. Terminate (01 04 65)	U_T U_{WK}	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-20-62	No Change

11. TITLE:

(U) Analysis and Correlation of Known Thermal Interface Conductance-Experimental

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 - Thermodynamics		N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Atkins, Harry L., R-RP-T TEL. 205-876-8701 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Heat transfer, resistance, conductance-contact, interface, joints

24 (U) OBJECTIVE: At present no acceptable theory is available for the prediction of thermal interface conductance. Two approaches would be (1) development of a theoretical heat transport equation and (2) correlation of available information in terms of dimensionless generalized parameters. This proposed program concerns the latter. It is felt by taking this approach in conjunction with No. (1) above (submitted as a separate resume) it will supplement the theoretical study and give guide-
25 lines as to what should be measured in the current experimental programs of NASA and industry. Past programs along this line have been reasonably successful in predicting their measured experimental results for specialized contacting surfaces. However, no general correlation exists which brings together all the known data.

(U) APPROACH: All available data would be reviewed in terms of the many parameters affecting thermal contact conductance. By reviewing the procedures by which the data was taken, the parameters measured and the materials considered, an attempt will be made to analyze the cause for the wide spread in data. Thus findings from
26 this approach in terms of generalized dimensionless parameters can be compared with those derived from a theoretical program. In addition, the two working in conjunction might shed light on mutual difficulties. This effort is being terminated due to it being done under a NASA Contract and also a Headquarters Contract.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	-	-
	CURRENT FY—68	-	-
	NEXT FY—69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects & Temperature Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	B. Completed(01 04 65)	U (PT) U (WRK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-21-62	No Change

11. TITLE:
(U) Theoretical Thermal Similitude Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 - Thermodynamics	N/A	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY-- 67	0.2	—
		CURRENT FY - 68	0.2	—

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Watkins, J.R., R-RP-T TEL: 205-876-7265 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) Objective: a. Problem: To establish a basis for thermal scale modeling and prove the feasibility of using scaled models to predict the transient thermal behavior of spacecraft in a simulated space environment. b. Application: Thermal design, analysis, and testing of scientific payloads.

25. (U) Approach: The differential equations and pi theoram methods were used to derive the modeling laws. Using these modeling laws, experiments were designed and conducted to maintain the modeling laws from prototype to model.Thermal tests were run for the prototype configuration. Then tests were conducted on the model to experimentally verify how well the model predicted the thermal behavior of the prototype.

26. (U) Progress: The above objectives were satisfactorily achieved, using the approach indicated. Two contractor and two in-house reports have been written in connection with this effort.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY — 67	—	—
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY — 68	—	—
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY — 69	—	—
35. TASK AREA	Thermal Radiation Effects & Temperature Control			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 005265

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (28 09 65)	U - U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-24-62	No Change

11. TITLE:

(U) Transient Thermal Contact Resistance

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
A. Grant	a. DATE 06 66 b. NUMBER NsG-711 c. TYPE d. AMOUNT $17,250	PRIOR FY- 67	-	-
		CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Schocken, Klaus, R-RP-T TEL: 205-876-3391 (FTS)	NAME: Southern Methodist University ADDRESS: Dallas, Texas INVESTIGATORS PRINCIPAL: Harold Blum ASSOCIATE: TEL: 214-363-5611 Ext 635 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Heat Conduction, Surface, Contact

24. (U) Objective: a. Problem: To study heat transfer across surfaces in contact under transient conditions. b. Application: Transient conditions include those where the contact resistance remains constant and the thermal environment is varied, where the thermal environment remains constant and the contact resistance is varied, and combinations of both cases. c. Discussion: Previously a computation was made of how long it takes the system to approach a new equilibrium condition in the one-dimensional case after subjecting it to a step function by a change in contact pressure, change in source temperature, or change in ambient pressure. The experimental data are in agreement with the predicted values. The agreement is more close if the predicted time is longer.

25. (U) Approach: The following activities are to be performed: (1) In addition to stainless steel, the experiments are to be continued with other materials (Armco iron, aluminum, other types of steels). Also other surface conditions will be used. (2) The temperature drop across the contact and the time of the occurrence of its maximum will be brought in relation with the contact conductance. (3) The theoretical work on the 2 - dimensional case will be continued and will be made more general by allowing for internal generation of heat.

26. (U) Progress: Most of the effort was concerned with obtaining data for studies with one-dimensional systems. While the analysis of the results and the performance of new experiments continue, the results indicate that the analytical studies previously reported can be used for the prediction of transient effects. The studies of heat transfer across surfaces in contact for two-dimensional heat flow show that the program which was developed previously is accurate.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	18
34. SUB PROGRAM	Space Vehicle Environmental Factors	NEXT FY 69	-	-
35. TASK AREA	Thermal Radiation Effects and Temperature Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006903	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	RPT U WRK U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-26-62	No Change

11. TITLE: (U) Development of Space-Stable Thermal-Control Coatings (Paints with low Solar Absorptance/Emittance Ratios)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Materials/Coatings 003600 Physics/Thermodynamics 016700	05 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-5379 a. DATE 05 63 c. TYPE M. CPFF d. AMOUNT (P)233,522	PRIOR FY– 67	0.6	50
		CURRENT FY – 68	0.6	-

19. GOVT. LAB./INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Gates, D. W., R-RP-T TEL. 205-876-4040 (FTS)	NAME: IIT Research Institute ADDRESS: 10 West 35th Street Chicago, Illinois 60616 INVESTIGATORS PRINCIPAL: Zerlaut, G. A. ASSOCIATE: TEL: 312-CA5-9630, Ext. 5074 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS Thermal control coatings, space stable, low alpha, low alpha/epsilon ratio, low solar absorptance/emittance ratio

24. (U) Objective: a. Problem: To obtain space-stable thermal-control coatings with as low a solar absorptance. b. Application: These coatings are desired to be easily applied and suitable for use on large space vehicles.

25. (U) Approach: Three major efforts are simultaneously pursued: pigment screening (synthesis of new materials, preparation of existing materials, treatments to improve stability); vehicle studies (selection by screening existing vehicles, modification of presently available vehicles, construction of new polymers); systems evaluation (sample testing both in simulated environment and preparation of samples for flight experiments, delineation of insitu testing requirements, application techniques, combined environment, mechanical as well as optical properties, new test equipment and procedures, coordination of test results so that valid comparisons may be made).

26. (U) Progress: Infrared anomoly has been defined; alkali silicate treatment for ZnO developed (S-13 G); vehicle investigation yielded a superior material than here-to-fore available; better pigment than ZnO and method of producing same found; IRIF (In Situ Reflectometer/Irradiation Facility) designed and built for multiple sample insitu simulation and measurement of optical properties; surface state of pigments elucidated with emphasis on stability of porcelain enamels.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	908-20

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
IRIF (In Situ Reflectometer/Irradiation Facility)	PRIOR FY 67	-	52
	CURRENT FY 68	-	110
	NEXT FY 69	-	110

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects & Temperature Control

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006904	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15 08 66)	U U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-27-62	No Change

11. TITLE:

(U) Solar-Radiation-Induced Damage To Optical Properties of ZnO Type Pigments

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600-Coatings 015700 - Solid State Physics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-18114 a. DATE 06 66 c. TYPE A.F PF d. AMOUNT $54,000	PRIOR FY— 67	1.5	-
		CURRENT FY — 68	1.5	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Arnett, Gary M., R-RP-T TEL 205-876-3314 (FTS)	NAME: Lockheed Missiles & Space Co. ADDRESS: Research Laboratories 3251 Hanover St., Palo Alto, Calif. INVESTIGATORS PRINCIPAL: Dr. Greenberg, S. A. ASSOCIATE: Mr. MacMillian, H. F. TEL: 415-324-3311 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

(U) Objective: a. Problem: Coatings, utilized for thermal control of spacecraft, are subject to degradation of their radiometric properties when exposed to the solar- ultraviolet radiation. b. Application: Elucidating the basic damage mechanism will allow more accurate laboratory simulation of solar UV effect on coatings and also will allow materials experts to improve on coating systems. c. Discussion: As flight mission time increases or as missions are flown closer to the sun, the need for a more stable control coating becomes very critical.

25.
(U) Approach: When conducting a basic research study such as this, one must start with the simpilist, best definedsystem available. Because the pigment of a coating determines the basic optical properties of a coating and because ZnO is one of the more promising pigments now available, it becomes the logical starting point. In the beginning of this program it was carefully considered that results of this program would be directly applicable to basic research initiated on other coating pigments and systems. This consideration has been conclusively demonstrated as being true. Other NASA centers and other Government agencies are now using the results obtained thus far in this program for studying other coating systems and have found them to be of extreme value.
26.
(U) Progress: The first phase of this program (Contract NAS8-11266) produced (a) discovery of anomalous infared bleeching on cettain ZnO pigmented coatings (dictating revision of lab. procedures when conducting studies of this nature);(b) Preliminary damage mechanism model ("A Model for Extraterrestrial Solar Degradation of ZnO", IEEE Transactions, Vol. AES-2, No. 3, PP332-336, May 66). The second phase of this program (Contract NAS8-18114,) is producing experimental and theoretical results needed for refinement and better understanding of the degradation processes and model. The third phase proposed will concentrate on a limited amount of lab experiments as dictated by theoretical considerations which prove necessary in producing a conclusive and realistic damage mechanism model.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
Luminescence attachment & chambers 10K, sampl matl. 2K; Low temp dewars 10K, misc. 3K	PRIOR FY 67	39	42
	CURRENT FY 68	25	75
	NEXT FY 69	10	35

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006905	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
03-09-67	D. Change (30 09 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-29-62	N/A

11. TITLE:

(U) Study of In Situ Degradation of Thermal Control Surfaces

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600 - Coatings 016700 - Thermodynamics; 012000 - Optics	03 67	N/A	NA

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-21074 a. DATE 03 67	PRIOR FY— 67	0.5	40
B. Contract	c. TYPE M. CPFF d. AMOUNT 42,400	CURRENT FY - 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Miller, Edgar R. R-RP-T TEL: 205-876-4861 (FTS)	NAME: IIT Research Institute ADDRESS: 10 West 35th Street Chicago, Illinois 60616 INVESTIGATORS PRINCIPAL: Zerlout, G. A. ASSOCIATE: Gilligan, J. B. TEL: 312 CA-9630 Ext. 5074 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	Warren Keller; Conrad Mook, OART, RV-1

23. KEYWORDS

Optical Properties; Optical Measurements; Thermal Control Surfaces

24. (U) OBJECTIVE: Thermal control surfaces optical properties have been shown to be altered considerably under the space environments including solar electromagnetic radiation and thermal vacuum. The results is an increase in optical absorption and/or directional properties over the solar spectrum region. In situ measurements have been shown to be a necessity for a very sensitive degradation which is, to a large degree, reversible upon exposure to atmosphere. This degradation alone can change the total solar absorptance by as much as 50%. It is thought at this time the "in situ degradation" is due to photodesorption of oxygen from the pigment surfaces. The exact process is not known however, and very little data exists on the nature of in situ degradation in real coating systems.

25. (U) APPROACH: A thorough laboratory study of typical coating systems and their components is needed to define the in situ degradation problem. The study will include solar radiation simulation in vacuo, in situ degradation measurements, bleaching measurements using various gases, and the effects of temperature and temperature cycling to further the basic model of in situ degradation.

26. (U) PROGRESS: Detailed and basic studies have been performed on the environmental effects on the optical properties of thermal control surfaces on both contractual and in-house basis by R-RP-T, including the problems of in situ measurement: NAS8-11269, NAS8-11149, NAS8-11266, NAS8-5379. In-house instrumentation includes bench and portable integrating sphere spectroreflectometers and a special bidirectional spectroreflectometer with an environmental effects chamber on order for in situ property determinations.

27.	28. REQUESTING AGENCY	29. INTER-CENTER SUPPORT	30. CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Inert or vacuum glove box - 10 K Photomicrograph facility - 5 K; Portable emittometer - 7 K	PRIOR FY - 67	-	40
	CURRENT FY 68	22	30
	NEXT FY — 69	10	30

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

NASA FORM 1122 (AUGUST 64)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006906	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-08-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-30-62	No Change

11. TITLE:

(U) Study of the Radiative Emissivity of Metals - b. Experimental

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	01 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20123 a. DAT 01 66	PRIOR FY— 67	0.1	-
	c. TYPE M.CPFF d. AMOUNT $26,000	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: P.E.C. Research Associates
ADDRESS: Huntsville, Alabama 35812	ADDRESS: 1001 Mapleton Street Boulder, Colorado
	INVESTIGATORS PRINCIPAL: Dr. Ashby, Neil
	ASSOCIATE: Dr. Burkhard, C. G.
RESP. INDIV. Schocken, Klaus, R-RP-T	
TEL: 205-876-3391 (FTS)	TEL: 303-442-6015 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Emissivity, Absorptivity, Stefan-Boltzmann Law

24. (U) Objective: It is the purpose of the contract to measure the deviation from the classical Stefan-Boltzmann law for a surface radiating to its surroundings at a lower temperature. A new theory by Ashby predicts deviation up to 7%.

25. (U) Approach: The experiment involves a metal sphere or cylinder heated electrically to a temperature above that of its environment. The emissivity-absorptivity ratio of a metal sphere deviates most from the classical value when the temperature of the sphere is less than the temperature of the environmental radiation. It is possible to have this arrangement and to solve the problem of maintaining constant temperatures by using boiling liquids at constant pressure. The inner sphere (the sample) should be kept at 88°K with liquid nitrogen, and the outer sphere at 373°K with steam. A measurement of the rate at which the nitrogen boils off would give the power absorption

26. of the sphere. Preliminary plans for the experimental setup have been begun along with an investigation of corrections such as the heat exchange with the escaping gas, the heat conduction of the necessary tubing, etc.

(U) Progress: The contract was let on January 7, 1966. Preliminary plans for the experimental set-up have been begun along with an investigation of corrections such as the heat exchange with the escaping gas, the heat conduction of the necessary tubing, etc.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM: Space Vehicle Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA: Thermal Radiation Effects and Temperature Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006908	
4. DATE OF RESUME 15-03-67	5. KIND OF RESUME D. Change (15-08-66)	6. SECURITY U RPT U WRK	7. REGRADING N/A	8. RELEASE LIMITATION GA	9. LEVEL OF RESUME A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-32-62	No Change

11. TITLE:
(U) Effects of Solar Wind on Thermal Control Surfaces

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600-Coatings 016700 Thrmdynmcs; 012200 Prtcl Acclratrs	07 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A; a. DATE; c. TYPE; d. AMOUNT	PRIOR FY– 67	0.5	12
		CURRENT FY 68	0.5	–

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Miller, E.R., R-RP-T TEL: 205-876-4861 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same As 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Solar Wind Effects; Thermal Control Surfaces; Optical Properties

24. (U) Objective: a. Problem: Thermal control surfaces have been shown to be optically degraded when subjected to charged particle bombardment of energies and particle type simulating those of the solar wind. b. Application: To determine whether this damage may be significant for some missions, especially when the effects of combined environments are not known (synergistic effects) The effects of rapid bleaching must be ascertained upon exposure to the atmosphere.

(U) Approach: Low energy charged particle simulation will be accomplished with a singly ionized gas accelerator using the available in situ environmental effects chamber and bidirectional reflectometer. Investigations of synergistic effects with ultraviolet and charge particles will be made in high vacuum. Detailed optical property measurements will be performed in situ with the bidirectional reflectometer. Parametric studies of particle type, flux, and energy will be performed.

(U) Progress: Investigations have been performed on several current thermal control surfaces. The damage seen on these surfaces depends on the coating constituents and is proportional to the particle energy and integrated flux. It was found that helium ions caused the most severe damage to ZnO pigmented coatings (NAS8-11269). A singly charged ion source is being purchased from Texas Nuclear Inc. to perform in-house studies on various thermal control surfaces utilizing the available equipment listed above. Work has been completed under Contract NAS8-11269.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. GRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Misc. funds for operation; Recorders, Repairs Maintenance, Replacement, etc.	PRIOR FY 67	20	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	10	-
34. SUB PROGRAM: Space Vehicle Environmental Effects	NEXT FY 69	10	-
35. TASK AREA: Thermal Radiation Effects and Temperature Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006911	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (10 11 66)	U U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-34-62	No Change

11. TITLE:

(U) Limitations in Thermal Similitude

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics	03 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER Pending a. DATE	PRIOR FY– 67	0.2	–
	c. TYPE d. AMOUNT	CURRENT FY– 68	0.2	–

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATORS PRINCIPAL: Not Selected
RESP. INDIV: Jones, B.P., R-RP-T	ASSOCIATE:
TEL: 205-876-3391 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Scale Modeling, Thermal Control, Prototype Thermal Behavior

24. (U) Objective: a. Problem: To establish some of the inherent limitations of scale modeling. b. Application: A method for predicting complex prototype thermal behavior. c. Discussion: A large number of problem areas of remodeling will be experienced and the limitations of modeling, especially with regard to over size scaling, will be established when considering those areas.

25. (U) Approach: Both analytical and laboratory experiments may be used to establish these thermal scale modeling limitations. Consideration will be given to difficult radiative/conductive interchange geometries, use of multi-layer insulations, thermal gradient restrictions, variable material thermal properties, extreme temperature scaling, material substitutions, limits of time scaling in transient problems, extreme geometric distortion, and other such problems.

26. (U) Progress: Studies have shown that transient scale modeling is a reasonable way of predicting prototype thermal behavior for 1/4 and 1/2 scale models. Inherent limitations of the scale modeling method has not been defined. An RFQ is presently out to industry.

NOTE: This work unit is related to 124-09-05-16-62.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
N/A	PRIOR FY 67	–	66
	CURRENT FY 68	–	60
	NEXT FY 69	–	60

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation and Temperature Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006912	
4. DATE OF RESUME 1[illegible] 03 67	5. KIND OF RESUME B. Completed	6. SECURITY U PPT U WORK	7. REGRADING N/A	8. RELEASE LIMITATION GA/FO	9. LEVEL OF RESUME A. Work Unit

10a. CURRENT NUMBER/CODE: 124-09-05-35-62

10b. PRIOR NUMBER/CODE: (103-11-07-24-62) (933-32-01-02-62)

11. TITLE: (U) Synthesis and Evaluation of New High Temperature Polymers for Coating Applications

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003600 coatings, 012100 organic chem., 913100 plastics	06 64	67	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11338 DATE 06 64 c. TYPE M. CPFF d. AMOUNT (P) 77,550	PRIOR FY 67	0.2	-
		CURRENT FY 68	-	-

19. GOVT LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV: Hobbs, L. M., R-P&VE-MNP
TEL: 205-876-0366 (FTS)

20. PERFORMING ORGANIZATION
NAME: Midwest Research Institute
ADDRESS: 425 Volker Avenue
Kansas City, Missouri 64110
INVESTIGATORS PRINCIPAL: Breed, L. W.
ASSOCIATE: Elliott, R. L., Whitehead, M. E.
TEL: 816-LO-1-0202 TYPE:

21. TECHNOLOGY UTILIZATION: chemical process

22. COORDINATION: N/A

23. KEYWORDS: Coatings, elastomers, polymers

24. (U) OBJECTIVE: - The major objective is the synthesis and evaluation of new organic and semiorganic polymers for the preparation of films and coatings that are resistant to radiation, vacuum, and high temperature. Particularly, it is desired to develop compositions which are both thermally resistant and readily processable in the form of films and coatings.

25. (U) APPROACH: In previous work the contractor has appraised some ten compositions of various chemical structure which appeared to be the most promising for polymers possessing the desired combination of properties. In the present work, unit the polyarylenesiloxane structures are being appraised in order to identify the composition which possesses the optimum construction of thermal resistance and low temperature flexibility.

26. (U) PROGRESS: A new polyarylenesiloxane, prepared by the reaction of bis(p-hydroxydimethylsilphenyl)ether with heptamethyl-1-azo-3,5-dioxa-2,4,6-trisilacyclohexane, possesses a desirable combination of properties which point to uses, such as the current application of silicone coatings on the S-IVB stage. The product is high in molecular weight, readily processable, stable to rapid heating to 480°C, and is flexible at -80°C. The work is summarized in Technical Summary Report "Synthesis and Evaluation of New High Temperature Polymers for Coating Applications" NAS8-11339, L. W. Breed, R. L. Elliott, L. M. McDonough, W. H. Burton, and M. E. Whitehead, Midwest Research Institute, November 2, 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE 933-32	30. [illegible] CROSS CODE 103-11

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	-

33. UNIQUE PROJEC	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (15-03-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-37-62	125-24-01-05-62

11. TITLE:
(U) Radiative Heat Flux Measurement Using Semiconducting Thermoelectric Devices

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 - Thermodynamics	08 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER Pending a. DATE c. TYPE d. AMOUNT	PRIOR FY— 67	-	-
		CURRENT FY—68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 R-RP-T RESP. INDIV.: Schafer, C.F./Bannister, T. C., TEL. 205-876-3314 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Semiconducting Thermoelectric devices; radiometer; Peltier Effect

24.
(U) Objective: a. Problem: Development of an isothermal radiometric measuring device utilizing a semiconducting temperature control system for the detector, and having the capability of measuring thermal fluxes over the range of 10-250 milliwatts/CM^2 with an accuracy of ± 5%. This device will make use of the Peltier effect to maintain a constant temperature in the sensing element. b. Application: The radiometer will be used in a spacecraft thermal control coatings experiment and could find application on spacecraft for measurement of electromagnetic radiation fluxes in space (e.g., the solar constant, planetary albedo and infrared radiation.

25.
(U) Approach: The approach consists of these phases: (1) Design and fabrication of breadboard radiometer utilizing an available commercial semiconducting thermoelectric device; (2) laboratory studies of the thermophysical properties of the devices and of the accuracy and response of the breadboard system; and (3) studies of the function of the system under simulated space environmental conditions.

26.
(U) Progress: After a feasibility study of applying commercially available thermoelectric devices to this use, a request for quotations was issued for the design and fabrication of a laboratory prototype system. This work unit has been discussed with Mr. Mook and Dr. Menzel, OART Headquarters.

NOTE: FY-68 funds were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	3	30
	CURRENT FY-68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Environmental Factors
35. TASK AREA	Thermal Radiation Effects and Temperature Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change(15-03-66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-09-05-38-62	125-24-01-06-62

11. TITLE:

(U) Ultraviolet Flight Instrumentation Study

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002100 Astrophysics	10 66	10 67	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.4	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Arnett, Gary M., R-RP-T TEL: 205-876-3314 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Ultraviolet, Flight, Instrumentation

24.

(U) Objective: a. Problem: To conduct an instrumentation study to elucidate which experiment parameters are realistic and if desired data is feasible from an instrumentation point of view. b. Application: Thermal control coatings. c. Discussion: Studies throughout various NASA laboratories during the past year have indicated that the electromagnetic irradiation damage to outer-skins and thermal control coatings of spacecraft is highly wavelength dependent. Further studies also indicate that present data on the absolute intensity of the solar spectrum between 1150A and 4000A is not sufficient to allow laboratory simulation, therefore, adequate explanation, is required in order to control this phenomena.

(U) Approach: During the past year studies have concentrated on answering the following 3 questions: (a) what are the requirements of chemists and solid state physicists in the field of developing stable thermal control coatings in connection with defining the intensity of the solar UV spectrum (b) Is the existing data sufficient for these requirements and (c) If existing data is not sufficient(studies have indicated that it is not), suggest experimental parameters for making desirable flight measurements. The previous 3 areas of study have indicated the measurements are necessary and have suggested preliminary guidelines for instrumentation which is required.

(U) Progress: As outlined above, studies have proceeded to a point where the environment which must be measured, and to what tolerances, has been defined. It is now necessary to initiate an instrumentation study to determine if flight instrumentation can measure this environment and how much research and development of the instrumentation is necessary to accomplish the goals. This work unit has been discussed with Mr. Mook and Dr. Menzel, OART Headquarters.

NOTE: FY-68 funds were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY—67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY68	-	-
34. SUB PROGRAM	Launch Vehicle Environmental Factors	NEXT FY— 69	-	-
35. TASK AREA	Thermal Radiation Effects and Temperature Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 002756	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	RMT U WUK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-05-62	No Change

11. TITLE: (U) Experimental Evaluation of Reynolds Number Effects on Body of Revolution Viscous Cross-Flow Phenomena

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11100 a. DATE 06 65	PRIOR FY— 67	1.0	-
	c. TYPE M.CPFF d. AMOUNT $46,500	CURRENT FY— 68	1.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: LTV Aerospace Corporation
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Dallas 27, Texas 75222
	INVESTIGATOR'S PRINCIPAL: Wolfe, J. A.
RESP. INDIV.: Andrews, C. D., R-AERO-ADE	ASSOCIATE:
TEL: 205 877-8526 (FTS)	TEL: 214 262-3211, Ext. TYPE 3131

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Viscous Cross Flow, Reynolds Number Effects

24. (U) OBJECTIVE-a. Problem: Determine effects of Reynolds numbers on body of revolution viscous cross-flow phenomenon. b. Application: Improved analytical or semi-empirical approaches for more accurate predictions of the nonlinear angle of attack aerodynamic characteristics of large launch vehicles such as Saturn V. c. It is desirable to study the effects of Reynolds numbers on the viscous cross-flow phenomenon in order to obtain realistic extrapolations of wind tunnel data to the full scale flight conditions.

25. (U) APPROACH: The effects of Reynolds number on viscous cross-flow will be studied through the use of various facilities utilizing force and pressure models of various scales.

26. (U) PROGRESS: This report covers the period of August 16 through December 31, 1966. Preliminary plots of normal force coefficients versus angle of attack have been completed for the high Reynolds number data obtained in the LTV 4-foot high speed wind tunnel. These data are being correlated with the MSFC low-to-medium Reynolds number range data. From these data, preliminary parameter plots of normal force coefficient versus Reynolds number at various angles of attack are presently being analysed to determine the Mach number range and angle of attack range where Reynolds number effects are predominant. These areas will then be further investigated by conducting pressure tests to determine the effects of Reynolds number on local flow conditions. An RFQ to this effect has been initiated for these follow-on tests in a high Reynolds number facility. Approximately $25,000 from work unit 124-10-01-05 will be used during this portion of the investigation. The remaining funds will be combined with work unit 124-10-01-20 for tests in the MSFC 14" facility to determine the effects of Reynolds number on local flow conditions in the low-to-medium Reynolds number range.
FY-68 funds were not requested because of funding guideline limitations.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		931-50,932-50 &933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	25
	CURRENT FY— 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004296	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 02 67	D Change 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-06-62	No Change

11. TITLE:
(U) Aerodynamic Properties of Exhaust Plumes

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 014600 Rocket Motors, 016700 Thermodynamics	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-11260 a. DATE 06 64 c. TYPE M. CPFF d. AMOUNT $68,691	PRIOR FY— 67	0.4	--
		CURRENT FY— 68	0.4	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Sims, Joseph L., R-AERO-AM TEL: 205 876-2300 (FTS)	NAME: Northrop Corporation ADDRESS: Norair Division Hawthorne, California INVESTIGATORS PRINCIPAL: Powers, S. A. ASSOCIATE: TEL: 675-4611, Ext 2342 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Computer Program, Flow Field, Exhaust Impingement

24. (U) OBJECTIVE - a. Problem: - To develop a theoretical method, numerical solution techniques, and computer programs for the analysis and calculation of the inviscid three-dimensional supersonic flow field formed by the interaction of multiple rocket engine exhaust flow fields. b. Application: - The computer program will be used to compute gas dynamic results in the interaction region near the vehicle base for use in thermal environments analyses.

25. (U) APPROACH - The analysis of this inviscid flow field is to be accomplished using a three-dimensional method of characteristics.

26. (U) PROGRESS - a. 15 08 66 to 15 02 67. b. Debugging and analysis of the two jet case continues. Currently the problems arising from the intersection of the interaction shock wave and the plume free shock wave are being attacked.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
			103-10

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	--	39
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	--	30
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	--	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006915	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	~~U~~ ~~U~~	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-08-62	No Change

11. TITLE:

(U) Stability Derivatives of Slowly Oscillating Bodies of Revolution in Supersonic Flow

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	01 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.1	-
	c. TYPE d. AMOUNT	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATOR: PRINCIPAL: Same as 19
RESP. INDIV. Beranek, Richard G., R-AERO-AUU	ASSOCIATE:
TEL. 205 877-3217 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Spacecraft, Aircraft	N/A

23. KEYWORDS

Unsteady Aero, Stability Derivatives, Bodies of Revolution, Supersonic Flow

24. (U) OBJECTIVE - a. Problem: - The objective of this study is to derive stability derivatives for slowly oscillating bodies of revolution in supersonic flow using linearized theory and compare these results with experimental data. b. Application: - These results will be used as a basis for estimating space vehicle stability derivatives.

25. (U) APPROACH - Two approaches are being explored (a) an extension of Adam-Sears' quasi-slender body theory to the case of slowly oscillating bodies, (b) an extension of Oswatitch-Erdmann's linearized characteristics method to the case of slowly oscillating bodies.

26. (U) PROGRESS - The theoretical study under part (a) has been completed and a NASA-TN-D has been published. The report is entitled "Quasi-Slender Body Theory for Slowly Oscillating Bodies of Revolution in Supersonic Flow," NASA-TN-D-3440, by M. F. Platzer and G. H. Hoffman. The extension of Oswatitch-Erdmann's Linearized Characteristic method is nearly completed and will be published as a NASA-TN. A wind tunnel program has been initiated in the MSFC 14 x 14 inch wind tunnel. The tests models and balance system are nearly completed and tentative test date has been set for June 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006916

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RAT / WORK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (15 03 66)	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-09-62	No Change

11. TITLE:
(U) Panel Flutter Aerodynamics

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	01 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER / c. TYPE N/A / a. DATE / d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Beranek, Richard G., R-AERO-AUU TEL: 205 877-3217 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Spacecraft, SST Program	ARC

23. KEYWORDS: Panel Flutter, Pressure Distribution, Supersonic Flow, Non-Linear and Boundary Layer Effects

24. (U) OBJECTIVE - a. Problem: - The objectives of this study are to assess boundary layer and transonic flow effects on panel flutter aerodynamics. b. Application: - These results will provide a better basis for developing an analytical panel flutter prediction model.

25. (U) APPROACH - The approach being used is to calculate the nonviscid and viscous flow over wavy-walled surfaces and to compare these solutions with measured pressure distributions. For this purpose wavy-wall models are being machined at MSFC and tested in the ARC 2' transonic wind tunnel. This will provide experimental results on the effects of the waveness on the boundary layer.

26. (U) PROGRESS - During this project period the wind tunnel tests on the wavy wall flutter models at NASA Ames Research Center have been completed. A cursory evaluation of the experimental data collected shows no signs of boundary layer separation on the pressure of strong shocks. The first indication is, therefore, that the quality of the data collected is excellent and that the tests were very successful. Data reduction and evaluation will continue through the next reporting period.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY-68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006917	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B Complete (15 08 66)	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-10-62	No Change

11. TITLE: (U) Theoretical Foundations for a Quantitative Investigation of the Aerodynamic Heat Transfer to Yawing Cones in Supersonic Flight

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	07 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY– 67	0.1	-
		CURRENT FY – 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Krause, Helmut G. R-AERO-T TEL: 205 876-1333 (FTS)	NAME: Same as 19 ADDRESS: INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Calculation of viscous force, moment, and heat flow coefficients for yawing cones	N/A

23. KEYWORDS: Yawing cones, Three-Dimensional Boundary Layer Theory, Viscous Force Moment, and Heat Flow Coefficients

24. (U) OBJECTIVE: a. Problem: The goal is to determine the skin friction coefficients of the meridional and circumferential components of the viscous shear stress at the wall of the yawed cone, furthermore, the viscous drag and viscous lift coefficients, the viscous pitching moment coefficient, and the heat flow coefficient, respectively, the Staton number for a yawed cone. b. Application: Application in Aerodynamics and problems at reentry where the spacecraft under-
25. goes atmospheric oscillations. c. To get the total values the viscous force and moment coefficients have to be combined with the usual pressure force and moment coefficients.

(U) APPROACH: Starting from the equations for the local flow on the surface of a yawing cone in supersonic flight outside the boundary layer, a theory is developed for three-dimensional stationary compressible laminar boundary layer flow on a yawing circular cone in supersonic flight, with heat transfer in the wall. Nineteen new profile functions have to be computed by numerical
26. integration of non-linear second-order differential equations for Pradtl numbers Pr = 1 and 0.72 (air).

(U) PROGRESS: This work is complete and a report will be published.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY– 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY– 69	-	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006918	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B Complete(15 08 66)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-11-62	No Change

11. TITLE: (U) Conical Flow Tables with Diagrams for Mach Numbers Between 1 and 25, Semi-Apex Angles Between 5 and 45°, and Specific Heat Ratios 5/3, 7/5, 4/3, 5/4

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	07 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Krause, Helmut G. R-AERO-T TEL: 205 876-1333 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Supersonic Transport	N/A

23. KEYWORDS

Taylor-Maccoll Differential Equation, Conical Flow Tables

24. (U) OBJECTIVE: a. Problem: To determine velocity components, Mach number, sound velocity, temperature, pressure and density at the surface (outer edge of the boundary layer) of a circular cone in supersonic flight at zero angle of attack with respect to the corresponding free flight values outside the shock wave cone as a function of free flight Mach numbers between 1 and 25, semi-apex angles between 5 and 45°, and specific heat ratios γ = 5/3, 7/5, 4/3, 5/4. b. Application: Application in heat transfer studies to calculate the flow data at the outer edge of the boundary layer. c. Extension of the well-known tables of Kopal and Sims.

25. (U) APPROACH: The well-known Taylor-Maccoll differential equation has to be numerically integrated for the following semi-apex angles of the cone surface; θ_s between 5° and 45° in the free flow Mach number range $1 < M < 25$ with no larger steps than 2 and for the following values γ = 5/3, 7/5, 4/3, 5/4, useful for monatomic diatomic, polyatomic and dissociated gases. Practical graphs, useful in heat transfer calculations, will be prepared.

26. (U) PROGRESS: Tables and graphs are ready. All technical work is complete.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY 69	-	-
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006919	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-12-62	No Change

11. TITLE:
(U) Experimental Modeling of Apollo-Saturn Hypersonic Aerodynamic Flow Fields

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	01 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER a. DATE c. TYPE N/A d. AMOUNT	PRIOR FY-- 67	0.1	-
		CURRENT FY 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Andrews, C. Dale, R-AERO-ADE TEL: 205, 877-8526 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Hypersonic Partial Modeling, Aerodynamic Simulation	Jet Propulsion Laboratory Pasadena, California

23. KEYWORDS
Hypersonic Aerodynamic Modeling, Flow Separation

24. (U) OBJECTIVE - a. Problem: To determine the significant aerothermodynamic parameters controlling hypersonic flow separation and what degree of flow field partial modeling will give valid results for analysis of full scale vehicle aerodynamic characteristics.

b. Application: Successful partial modeling of hypersonic flow fields during scaled model wind tunnel test.

c. Scaled model wind tunnel testing provides a cheap, quick, accurate method of predicting full scale vehicle aerodynamic characteristics. However, complete modeling of the aerodynamic flow fields is impossible for a vehicle as large as Saturn. Successful partial modeling requires recognition of the strong and weak influence factors. Flow separation from the launch escape rocket controls the hypersonic static aerodynamic characteristics of the Apollo-Saturn launch and upper stage configurations. Influence factors controlling this separation will be investigated.

25. (U) APPROACH - Complimentary experimental testing will be conducted to determine effects of local Reynolds number, Mach number, enthalpy level, and model wall temperature on the hypersonic aerodynamic characteristics of the Apollo-Saturn launch vehicle and upper stage configurations.

26. (U) PROGRESS - Results of the experimental tests to determine effects of Mach number, Reynolds number, and heat transfer on the static aerodynamic characteristics of an Apollo-Saturn IB second stage flight configuration are available. Information pertaining to current trajectories has been extracted and used for design criteria. A complete analysis of the available data has been delayed due to higher priority tasks.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		932-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models and Associated Equipment	PRIOR FY 67	—	—
	CURRENT FY 68	—	—
	NEXT FY 69	—	—

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006920

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change	U U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-13-62	No Change

11. TITLE: (U) Study of Theoretical Methods as Applied to Steady Aerodynamic Analysis of Saturn Vehicle Shapes

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	09 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.4	-
	c. TYPE d. AMOUNT	CURRENT FY 68	0.1	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Same as Item # 19
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATORS PRINCIPAL:
RESP. INDIV.: Johnson, Josh D., R-AERO-ADE	ASSOCIATE:
TEL: 205 876-6733 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Theoretical Aerodynamics Applicable to Bodies of Revolution with Varying Cross-Section	N/A

23. KEYWORDS

Theoretical Methods, Bodies of Revolution

24. (U) OBJECTIVE - a. Problem: To refine existing theoretical methods for calculation of aerodynamic data on bodies of revolution at small angles of attack. b. Application: Preliminary design of Saturn-type vehicles. c. Preliminary design of Saturn vehicles require an early estimate of vehicle aerodynamic characteristics. These estimates are required before experimental data are available; therefore, theoretical methods must be used to calculate the aerodynamic data.

25. (U) APPROACH - Detailed experimental static aerodynamic information exists for Saturn vehicle configurations presently in design. Comparisons will be made of these data and predictions from applicable existing analytical methods. Programs being considered include: Second Order Shock Expansion, Modified Newtonian Flow, First and Second Order van Dyke Axial Flow, Kelly's Viscous Cross-Flow and Linearized Theory. Some limitations of these programs as applied to Saturn vehicle shapes will be determined. Empirical modifications will be attempted to optimize these programs for future use.

26. (U) PROGRESS - Due to higher priority work, no progress has been made during this reporting period.

27	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	—	—
	CURRENT FY 68	—	—
	NEXT FY— 69	—	—

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006921

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 08 67	D Change 15 03 66	U (RPT) U (WRK)	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-14-62	No change

11. TITLE: (U) A Parametric Fin Study to Determine Thickness Effects of Delta and Trapezoidal Fin Shapes

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	05 65	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.1	-
	c. TYPE d. AMOUNT	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV.: Blackwell, K. L., R-AERO-ADE
TEL: 205, 876-6733 (FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS: Same as 19
INVESTIGATOR$ PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION Empirical Corrections for Existing Theoretical Fin Programs

22. COORDINATION N/A

23. KEYWORDS
Parametric Fin Thickness Study

24. (U) OBJECTIVE - a. Problem: To determine aerodynamic characteristics for thick fins (5 to 20 percent) with varying planforms. b. Application: The final analyzed experimental data will be used to apply empirical corrections to existing theoretical fin programs. c. In the past, fin or wind studies and tests have been for low thickness ratio wings. However, for space vehicle applications, the factors of weight and structural rigidity based on flutter requirements usually cause the optimum fin thickness ratio to be 10 to 15 percent. The reason for this is the minor effect of fin drag on vehicle performance and the major effect of weight.

25. (U) APPROACH - A parametric study of several fin planform configurations and thickness ratios will be experimentally investigated in the MSFC 14-inch TWT. A force balance, splitter plate, and/or side wall mount will be used to obtain data over a Mach range of 1.10 to 4.96 with angle of attack varying from -4^{o} to $+10^{o}$.

26. (U) PROGRESS - Improved analytical technques for determination of thickness effect on fin aerodynamic efficiency are being studied. Wind tunnel investigations are planned which will provide a verification of these methods. Due to higher priority work, no progress has been made during this reporting period.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498 .

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006922	

4. DATE OF RESUME	5. KIND OF RESUME	SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Complete (15 08 66)	RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-15-62	No Change

11. TITLE: (U) Determination of Scale Effects (Local Reynolds Number) on Negative Spikes in Normal Force Distributions and Local Pressure at Compression and Expansion Corners

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	07 65	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A	a. DATE	PRIOR FY— 67	0.1	-
	c. TYPE	d. AMOUNT	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Same as 19
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
RESP. INDIV.: Nunley, Billy W., R-AERO-ADV	INVESTIGATORS PRINCIPAL:
TEL: 205 876-4909 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Aerodynamic Analysis of Saturn-Type Vehicles	N/A

23. KEYWORDS

Separation, Aerodynamics, Pressure Distribution, Shock Detachment

24. (U) OBJECTIVE - a. Problem: To define the negative spikes in local normal force coefficient distributions. b. Application: To be applied to aerodynamic design of future space vehicles. c. To determine Reynolds number effect on local load distributions at transonic Mach numbers and to determine the local pressures which are necessary when a compartment is being vented for calculating the internal pressure to obtain the resultant loading across the compartment wall.

25. (U) APPROACH - An experimental investigation was conducted employing a pressure instrumented 15° cone-cylinder, 10° frustum-cylinder in the MSFC 14-inch wind tunnel for a Mach range of M = 0.8 to 1.43 and angles of attack from -8° to +8°. The cylindrical section between the cone and cylinder will be varied in length from 0.6 to 3.0 calibers to obtain the necessary Reynolds number variation.

PROGRESS:

26. (U) Pressure and normal force coefficient distributions were defined for three cylindrical lengths, which varied local Reynolds numbers. These data have been plotted and analyzed for each configuration over the Mach number and angle of attack range investigated. Reynolds number effects were evident in both the pressure and normal force distribution. Also, shock locations changed as cylindrical length was varied and the longitudinal displacement of the shock on windward and leeward sides was determined. All possible objectives of the test and analysis have been obtained.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498 .

☆ U.S. GOVERNMENT PRINTING OFFICE: 1965 O 795-048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	
		NR 006923	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (15 03 66)	U NPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-16-62	No Change

11. TITLE:
(U) Effects of a Nonuniform Spanwise Velocity Profile on Fin Efficiency

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	04 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.1	-
	c. TYPE d. AMOUNT	CURRENT FY - 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Same as Item # 19
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
RESP. INDIV.: Blackwell, Kenneth L., R-AERO-ADE	INVESTIGATOR'S PRINCIPAL:
TEL: 205 876-6725 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Fin Aerodynamic Scaling Effects, Aerodynamic Analysis	N/A

23. KEYWORDS
Fin Analytical Methods, Boundary Layer Effects

24. (U) OBJECTIVE - a. Problem: To investigate effects of a nonuniform spanwise velocity profile on the effectiveness of Saturn-type fins.
b. Application: The results will provide both analytical and experimental tools with which to better analyze fin aerodynamic characteristics while operating in non-uniform flow fields.
c. Fins submerged in a thick boundary layer (such as that along a flat plate or vehicle body) will be less efficient, especially in the transonic speed range, than when subjected to a thin boundary layer. Scaling effects such as these occur when applying fin efficiencies, determined by wind tunnel tests, to large Saturn-type vehicles.

25. (U) APPROACH - Results are to be obtained through both analytical and experimental methods. Wind Tunnel tests are to be conducted which will provide effects of various boundary layer characteristics on fin effectiveness. Also, computer programs are to be written which will calculate fin effectiveness for various spanwise velocity profiles. Through analysis of these data, it is hoped that an ability to predict boundary layer effects on fin efficiency will be developed.

26. (U) PROGRESS - A computer program has been written which is capable of computing fin aerodynamic characteristics in a nonuniform flow field. The computation results have not been checked against experimental results. Experiments have been delayed because it has been impossible to obtain necessary hardware. The hardware is expected shortly and testing should be completed by June 1967.

27	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models and Associated Test Equipment	PRIOR FY— 67	-	-
	CURRENT FY— 68	-	-
	NEXT FY — 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006924	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change	U_{RPT} U_{WRK}	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-17-62	No Change

11. TITLE: (U) Study and Refinement of High Angle of Attack Wind Tunnel Model Testing Techniques

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	10 06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY-- 67	0.1	-
	c. TYPE d. AMOUNT	CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as Item # 19
RESP. INDIV.: Walker, Clyde E., R-AERO-ADE	INVESTIGATORS PRINCIPAL:
TEL: 205 876-6725 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
High Angle of Attack Testing, Sting Interference Effects	N/A

23. KEYWORDS

Model-Image Testing, Reflection-Plane Testing, Sidewall Testing, Half-Model Testing

24. (U) OBJECTIVE - a. Problem: Develop a more efficient and more accurate method of obtaining experimental aerodynamic data at high angles of attack.

b. Application: It is anticipated that these techniques may be used to obtain high angle of attack data on reentry bodies, range safety information on vehicle components, and data on models which cannot be adapted to the conventional sting-support-internal balance system.

c. Conventional sting-support-internal balance techniques are presently used for high angle of attack scale model aerodynamic studies. This technique not only requires an excessive amount of hardware, but usually results in data which have been influenced to some extent by sting effects. An attempt to develop an improved high angle of attack testing technique for small conventional wind tunnel facilities will be made.

25. (U) APPROACH - Force data, over a large angle range, will be obtained on a right circular cylinder and a blunted cone utillizing various half-model techniques (i.e., model image, reflection plane, and sidewall). The data will be compared with existing experimental data from sting supported and free flight models and with analytical results. Technical problems include optimizing the windshield and pitch mechanism for the model-image technique, optimizing the spacer thickness for the sidewall technique, eliminating gap effects for the reflection-plane technique, and minimizing separation on the reflection plane.

26. (U) PROGRESS- Phase I of the investigation (reflection-plane) was partially completed in December 1966. Preliminary analysis indicated definite flow separation problems with this technique, however, results at some Mach numbers was very satisfactory. Because of impacted wind tunnel schedules and demands of higher priority work, resumption of this program will tentatively be delayed until July 1967.

27	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SRT GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models and Associated Test Equipment	PRIOR FY - 66	-	-
	CURRENT FY - 67	-	-
	NEXT FY - 68	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006925

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change	U T wU	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-18-62	No Change

11. TITLE: (U) Parametric Study of the Aerodynamic Characteristics of Solid Propellant "Strap-On" Thrust Assist as Applied to Saturn-Class Vehicle

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	04 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.15	-
	c. TYPE d. AMOUNT	CURRENT FY - 68	0.30	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV. Walker, Clyde E., R-AERO-ADE

TEL. 205 876-6725 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS: Same as Item # 19

INVESTIGATORS PRINCIPAL:

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION

Thrust-Assisted Launch Vehicles

22. COORDINATION

N/A

23. KEYWORDS

Strap-Ons, Parallel Staging

24. (U) OBJECTIVE - a. Problem: Determine an optimum arrangement of "strap-on" configurations from the aerodynamic viewpoint for various basic/secondary body combinations.

b. Application: Feasibility studies for uprating basic launch vehicles and for determining an optimum aerodynamic configuration from a wide range of basic/strap-on body combinations.

c. One approach to uprating launch vehicles is through the use of "strap-on" solid propellant thrust assist. In support of these studies, parametric aerodynamic data are needed for various basic/secondary body combinations.

25. (U) APPROACH - Because of the complexity of the aerodynamics, an experimental parametric investigation is believed to be the most practical method of obtaining the desired data. The investigation includes nine separate parameters to be studied in three to five test phases. The results will be reported at the conclusion of each phase, and a summary report will be issued at the completion of the investigation.

26. (U) PROGRESS; Because of impacted wind tunnel schedules and demands of higher priority work, no progress has been made to date. Tentative test date is May 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models and Associated Test Equipment	PRIOR FY - 66	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-67	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY - 68	-	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006926	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	RD U WD U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-19-62	No Change

11. TITLE: (U) Normal Force Characteristics of Right Circular Cylinders of Various Fineness Ratios at 90° Angle of Attack

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY-- 66	-	-
	c. TYPE d. AMOUNT	CURRENT FY - 67	0.2	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as Item # 19
RESP. INDIV.: Walker, Clyde E., R-AERO-ADE	INVESTIGATORS PRINCIPAL:
TEL: 205 876-6725 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Experimental/Theoretical Data Correlation, Range Safety Studies, Re-entry Studies	N/A

23. KEYWORDS: Right Circular Cylinder, 90° Angle of Attack, Cross-Flow Drag Coefficient, Fineness Ratio Effects

24. (U) OBJECTIVE: a. Problem: Determine a value for the ratio of the normal force coefficient of a circular cylinder of finite length to that of a circular cylinder of infinite length for a cylinder normal to the flow over the Mach number range from 0 to 5.0. Also, determine a value for cross-flow drag coefficient based on the same set of data. b. Application: Aid in better correlation of experimental and theoretical aerodynamic data at high angles of attack. c. Theoretical methods presently being used for high angle of attack aerodynamic range safety and reentry studies require empirical values of normal force coefficient ratio and cross-flow drag coefficient. A consistent set of values does not exist over the Mach number range of interest. Therefore, an experimental program to determine these data has been initiated.

25. (U) APPROACH: Normal force data will be obtained for cylinders with fineness ratios (L/D), varying from 2 to 10. The planform area will be held constant for one set of data, and the model diameter will be held constant for another. Reynolds numbers will be held constant. Curves for cross-flow drag coefficient and normal force coefficient ratio will be derived from the data and compared with existing data for each Mach number and fineness ratio where such data are available.

26. (U) PROGRESS: No progress to date due to impacted wind tunnel schedules and more pressing developmental work. Tentative test date: August 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY 66	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 67	-	-
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY 68	-	-
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006927	
4. DATE OF RESUME: 15 03 67	5. KIND OF RESUME: D Change 15 03 66	6. SECURITY: U_{RPT} U_{WRK}	7. REGRADING: N/A	8. RELEASE LIMITATION: GA	9. LEVEL OF RESUME: A Work Unit

10a. CURRENT NUMBER/CODE: 124-10-01-20-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE:
(U)Experimental Investigation of Nonlinear Lift of Bodies with Changing Cross Section

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 006400 Fluid Mechanics	08 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE; b. NUMBER; c. TYPE Pending; d. AMOUNT	PRIOR FY— 67	1.0	-
		CURRENT FY—68	1.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
ALTERNATES: Ramsey, Paul E., R-AERO-ADE
Warmbrod, John D., R-AERO-AM
RESP. INDIV.: Struck, Heinz G., R-AERO-AM
TEL: 205 876-6114 (FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS: Not Selected
INVESTIGATOR'S PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION
Commerical Aircraft Design

22. COORDINATION
N/A

23. KEYWORDS
Experiment, Nonlinear Lift, Vortex Flow, Bodies of Changing Cross Section

24. (U) OBJECTIVE-a. Problem: To determine the separated flow behind bodies of revolution at moderate angles of attack. b. Application: To better predict the aerodynamic loads for the structural design and total forces for flight mechanics.
c. Above certain angles of attack the flow separates at the lee side of bodies of revolution forming two vortices which are connected by a feeding sheet to the boundary layer of the body. The vortices cause a change of the pressure distribution about the body and then an additional total lift contribution. Experimental investigations on bodies with constant cross section have been conducted. However, separated flow
25. field investigations on bodies with changing cross sections, such as cylinder-frustum-cylinder configurations do not exist.
25. (U) APPROACH: A detailed experimental investigation on above mentioned configurations in sub-and supersonic flow is planned. The separated flow field will be surveyed by pressure probes to locate the vortex core and its strength and to determine the influence of cross sectional changes on the vortices.
26. (U) PROGRESS: A request for proposals is being released to contractors for an experimental program to investigate the flow around bodies of revolution with changing
26. cross sections. This program consists of two phases: the first, a complete pressure distribution study on an ogive-cylinder and an ogive-cylinder-frustum-cylinder model for Mach numbers of 0.4 to 1.96. The second phase consists of a pressure probe survey of the vortex system in the wake of an ogive-cylinder-frustum-cylinder body to determine vortex location and strength. The flow will be surveyed at several model longitudinal stations, angular positions around the model, and various distances from the skin at a Mach number of 1.96. These tests will be conducted in the MSFC 14" TWT. This work is being combined with work unit number 124-10-01-05-62 by using funds from both OART work units.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	-	93
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	50
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006928	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U / U	N/A	N/A	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-21-62	No Change

11. TITLE:
(U) Numerical Solution of Special Flow Problems for Saturn Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	08 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT b. NUMBER / c. TYPE / a. DATE / d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	Pending	PRIOR FY— 67	0.2	--
		CURRENT FY— 68	0.2	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Sims, Joseph L. R-AERO-AM TEL. 205 876-2300 (FTS)	NAME: Douglas Aircraft Co., Inc. ADDRESS: Missiles & Space Systems Division Santa Monica, California INVESTIGATORS PRINCIPAL: Xerikos, J. ASSOCIATE: TEL: 213 399-9311,Ext.2635 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Launch Vehicles, Supersonic Transport	N/A

23. KEYWORDS
Flow Fields, Finite Different Methods, Elliptic Equations

24. (U) OBJECTIVE - a. Problem: - To develop techniques for determining the flow field about Saturn type bodies at finite angles of attack in a supersonic free stream. Special emphasis is to be placed on obtaining solutions in mixed supersonic-subsonic flow areas such as blunt noses and expanding frustum sections. b. Application: - The computer programs using these techniques will be used to compute the flow fields around space launch vehicles flying at finite angles of attack.

25. (U) APPROACH - This analysis will use a finite difference solution of the time dependent flow equations. No time dependent forcing function is used and the desired steady state solution is found as an asymptotic time solution. All shock waves occurring in the flow field will be treated as discrete discontinuities.

26. (U) PROGRESS - a. 20 06 66 to 15 03 67. b. Contract negotiations with Douglas Aircraft are underway.

FY-68 funds were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	--	40
	CURRENT FY— 68	--	-
	NEXT FY— 69	--	30

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT ACCESSION	3. AGENCY ACCESSION NR 006929	
4. DATE OF RESUME 15 03 67	5. KIND OF RESUME D-Change 15 08 66	6. SECURITY RPT U WORK U	7. REGRADING N/A	8. RELEASE LIMITATION GA	9. LEVEL OF RESUME A. Work Unit

10a. CURRENT NUMBER/CODE: 124-10-01-22-62

10b. PRIOR NUMBER/CODE: No change

11. TITLE: (U) Study to Evaluate Flow Coefficients for Flat Plate Outlets Discharging Transverse to an External Stream

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20200 DATE 06 65	PRIOR FY– 67	0.6	49
	c. TYPE M. CPFF d. AMOUNT P58,066	CURRENT FY 68	0.6	-

19. GOVT LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

RESP. INDIV. Ramsey, P. E., R-AERO-ADE
TEL. 205 876-6725 (FTS)

20. PERFORMING ORGANIZATION

NAME: Northrop Corporation
ADDRESS: Northrop Space Laboratories
Huntsville, Alabama

INVESTIGATORS PRINCIPAL:
ASSOCIATE: Delaney, Bob
TEL: 205 837-0580, Ext. 267 TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Discharge Coefficients, Boundary Layer

24. (U) OBJECTIVE: a. Problem: To determine discharge coefficients for vent ports operating under simulated flight conditions. b. Application: Provide empirical discharge coefficient data under simulated flight conditions to be used for more accurate predictions of launch vehicle compartment venting characteristics. c. An investigation has been undertaken to evaluate the flow coefficients for narrow slots and to determine the effects of low jet to external mass flow ratios and boundary layer thickness on flow coefficients for flat plate outlets. Data for these conditions are not available; therefore, a wind tunnel test program to cover these areas will provide data which will be used for vent design when space vehicle compartments are vented to the atmosphere during flight.

25. (U) APPROACH - Wind tunnel tests will be conducted in the Ames Research Center's 6x6-foot supersonic facility and the MSFC 14" trisonic wind tunnel. The model consists of a wall mounted flat plate with various inserts containing the test vents. Discharge coefficient data will be obtained for varying jet-to-external mass flow ratios and boundary layer thickness.

26. PROGRESS - Reporting interval is August 15, 1966 to February 15, 1967. The AEC completed fabrication of the model which was shipped to Ames Research Center on October 11, 1966. The model was installed in the 6x6-foot supersonic wind tunnel and the test conducted from November 8 through November 18, 1966. Difficulties with the model and instrumentation prevented all of the test objectives from being reached during the test time allotted. As a result, preparations were begun to conduct a second test at Ames. Model re-design and test planning were started in January, 1967. The present test date at Ames is July 1, 1967. The contract with Northrop is being extended to cover the second testing period and to cover a limited amount of testing in the MSFC 14x14-inch TWT to extend the data obtained from the Ames tests.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE 904-21

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models and Associated Test Equipment	PRIOR FY – 67	-	50
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY 69	-	50
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Controls			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006930

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WHK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
24-10-01-23-62	No Change

11. TITLE:
(U) Aerodynamic Characteristics of Hammerhead Shrouds

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	08 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	-	-
		CURRENT FY—68	0.4	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Dunn, Bob G., R-AERO-ADV TEL: 205 876-4909 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Aerodynamics, Hammerhead

24. (U) OBJECTIVE - a. Problem: To determine the aerodynamic loads and stability and influence on bending moments and control of hammerhead shrouds on launch vehicles. b. Application: Direct input to payload packaging, structural design, and vehicle control studies. Results of this study could be applied to future Saturn V Voyager missions. c. Orbital space stations, nuclear deep space propulsion units, planetary probes, and others can advantageously utilize shrouds larger than the parent boost vehicle. A survey of potential users has indicated a definite need for adequate design data and limitations of such payloads.

25. (U) APPROACH - The contractor shall conduct a study of aerodynamic load distributions for hammerhead shrouds composed of a cone-cylinder-inverse frustum-cylinder. The approach to be used will be through parametric wind tunnel tests to fill areas where data are not available in the literature. Systematic, parametric data will be defined in the Mach number range 0.7 to 2.0. Test data will be supplemented by available theories on the high and low end of the Mach number range. The final curves will be presented as a function of Mach number, cone angle, flare angle, and cylinder lengths.

26. (U) PROGRESS - Only limited experimental data in terms of design parameters and Mach ranges are available. These will be used in conjunction with the present study to establish consistent data appropriate for use in engineering design.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Wind Tunnel Models	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	40
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006931	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Completed 15 08 66	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-24-62	No Change

11. TITLE:
(U) Inhomogeneous Properties of H_2O and CO_2 (Aerodynamic Properties of Exhaust Plumes)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Mechanics, 016700 Thermodynamics, 014600 Rocket Motors	04 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20359 a. DATE 04 66	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT 19,983	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Warner and Swasey
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Flushing, New York
	INVESTIGATORS PRINCIPAL: Tourin, Richard
	ASSOCIATE:
RESP. INDIV.: Huffaker, Robert M., R-AERO-ATP	
TEL: 205-876-0431 (FTS)	TEL: 212-461-4200 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Properties of Exhaust Plumes

24. (U) OBJECTIVE: a. Problem: - To analyze rapid scan spectral radiance measurements on model rocket engines at the Cornell Aeronautical Laboratory. To determine the relative merits of using a 10 cm^{-1}, or 25 cm^{-1} increment for the band model parameters to be used in a radiant heat transfer computer program.

25. (U) APPROACH: Spectral measurements of model rocket engines at Cornell Aeronautical Laboratory have been taken using ethylene-oxygen and hydrogen-oxygen as fuel and oxidizer. Spectral intensity measurements have been made looking at the impingement regions between two engines and at various positions downstream. This date has been evaluated. The effect of spectral interval size on the heat transfer calculation has been studied.

26. (U) PROGRESS: Spectra measurements have been taken on short duration firings at Cornell Aeronautical Laboratory. These data have been reduced and compared with theoretical calculations. The agreement was good. The wavelength increment used in the calculation has been decided to be 25 cm^{-1}. This work unit has been completed.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY— 67	-	-
	CURRENT FY—68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 11 01 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-01-25-62	124-10-01-06-62

11. TITLE:
(U) Experimental Measurements Using the Laser Doppler Velocity Instrument

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
014600 Rockets, 000500 Aerodynamics, 016700 Thermodynamics	07 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
E Contract	b. NUMBER NAS8-21072 c. TYPE J.C. d. AMOUNT P 4,965 DATE 01 67	PRIOR FY67	0.1	5
		CURRENT FY68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Huffaker, Robert M., R-AERO-AT TEL: 205, 876-0431 (FTS)	NAME: Arizona State University ADDRESS: Tempe, Arizona 85281 INVESTIGATORS PRINCIPAL: Logan, Earl ASSOCIATE: TEL: 602 966 3727 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Doppler velocity, exhaust plumes, turbulence

24. (U) OBJECTIVE - a. Problem: - Theoretically predict and experimentally measure the velocity profile and the turbulent properties of model rocket exhaust flows using a laser doppler velocity instrument. b. Application: - An exact velocity history will be obtained for model rocket exhaust flows with local spatial resolution. An accurate measurement of the velocity and of the turbulence in rocket flows will give greater understanding in generating vehicle design criteria where heat transfer and noise generation is of interest.

25. (U) APPROACH. Using the laser doppler velocity instrument and MSFC facilities, measurements will be made on specific model rocket exhaust flows. This data will be evaluated and compared to theories that are available. The principal problem will probably be in developing an appropriate data reduction technique.

26. (U) PROGRESS. Experiments have been outlined using the laser doppler velocity instrument. The measurements are expected to begin in March 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50-02	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY67	-	5
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY68	-	15
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY69	-	40
35. TASK AREA: Aerodynamic Forces, Steady Loads, Stability and Control.			

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 05 67	A. New (Proposed)	U RPT U WRK	N/A	GA	A Work Unit

0a. CURRENT NUMBER/CODE: 124-10-01-26-62

10b. PRIOR NUMBER/CODE:

11. TITLE:
(U) Vortex Model Representing Atmospheric Turbulence

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 006400 Fluid Mechanics, 010000 Meteorology	06 65	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.3	--
		CURRENT FY— 68	0.3	--

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Struck, Heinz G., R-AERO-AM
TEL: 205 876-6114 (FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS:

INVESTIGATORS PRINCIPAL: Not Selected
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION
N/A

22. COORDINATION
N/A

23. KEYWORDS
Vortex Model, Atmospheric Turbulence, Crossed-Beam Technique

24. (U) OBJECTIVE - a. Problem: - To simulate turbulent flow regions as observed in the atmosphere by a large number of modified Rankine vortices randomly distributed in a two-dimensional space. b. Application: - To test the feasibility of sensing atmospheric turbulence by crossed-beam methods and to use this model in connection with the crossed-beam method to predict the weather conditions above launch sites. c. It has been proven that crossed-beam methods are able to determine the statistical flow properties (as turbulence scales and intensities, etc) of turbulent flow fields in wakes where turbulent intensities are rather large compared to the surrounding field and where the observation time is unlimited. Uncertain is whether the method is equally capable of measuring the statistical properties of flow regions with strong background "noise" (generated close to the ground) and therefore longer required observation times which might be limited by nonstationary effects (changing weather). This work will clarify the above posed problem and will help in the proper interpretation of atmospheric turbulence by the crossed-beam method.

25.(U) APPROACH - It is planned to simulate a free turbulent flow field on a digital computer by a finite group of moving modified Rankine vortices to represent the eddy structure of the turbulence. To this hypothetical field the method of the crossed-beam technique will be applied with the goal to predict the statistical properties of the original field. In this respect the hypothetical flow field acts as a "test bed" for the crossed-beam technique.

26.(U) PROGRESS - The vortex model as described has been successfully applied to simulate wake flows by the Institute of Sound and Vibration Research, University of Southhampton, England. In particular, some shear flow results from the vortex model were compared with measured results from air jets and showed quite good agreement.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	--	--
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY— 68	--	50
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY— 69	--	--
35. TASK AREA	Aerodynamic Forces, Steady Loads, Stability and Control			

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1. SUBJECT: Vortex Model Representing Atmospheric Turbulence

2. CODE: 124-10-01-26-02

3. BASIS OF NEED: The desired computer program is needed in conjunction with remote crossed-beam detection devices to study the transfer of kinetic energy between atmospheric motions of a different scale. The optical signals, which describe atmospheric and clear air turbulence above launch tower heights, are often buried in the "noise," which is generated by atmospheric fluctuations close to the ground. The remote detection of atmospheric turbulence then requires large observation times in order to pull the weaker signals, which originate at higher altitudes, out of the noise generated close to the ground. However, the associated mathematical correlation techniques become questionable as soon as the intergration time approaches the time scale of a nonstationary effect such as a change in weather. Our presently developed computer program for the piecewise analysis of long records can cope with non-stationary means but would be questionable, if the time dependant change of the dissipated kinetic energy is transferred to motions of a small scale.

4. APPLICATION: The computer program will be used to extend the present statistical analysis of crossed-beam data to nonstationary processes in the atmosphere, which are characterized by a large and changing energy transfer between motions of a different scale. Crossed-beam methods could be used in turn to experimentally provide initial values and boundary conditions for the simulation for the above processes, in particular, large gusts and clear air turbulence.

5. SPIN OFFS AND APPLICATION: Improvement of numerical methods of weather prediction and provision of crossed-beam data, which are compatible with mathematical prediction models.

6. TOTAL TIME AND EFFORT: This work should be conducted within one year and 50 K dollars are sufficient to cover the cost.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 002767

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C Terminated 15 08 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-01-62	No Change

11. TITLE:
(U) Base Flow and Separation Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 009700 Statistics 016000 Launch Vehicles	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-11299 c. TYPE M. CPFF d. AMOUNT 129,387 e. DATE 06 64	PRIOR FY— 67	0.5	--
		CURRENT FY - 68	--	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Dahm, W. K., R-AERO-A TEL: 205 876-4566 (FTS)	NAME: Litton Industries Applied Science Div. ADDRESS: 2003 East Hennepin Avenue Minneaplois, Minnesota 55413 INVESTIGATORS PRINCIPAL: Larson, Roy ASSOCIATE: Hanson, A. R. TEL: 612 331-4282 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS Turbulence, Reattachment, Acoustics, Base Heating, Convection, Sound Radiation, Hot Wires, Scaling Laws

24. (U) OBJECTIVE - a. Problem: - To study aerodynamic feedback by turbulent convection and sound radiation in base recirculation areas. b. Application: - The simulation and reduction of base heating and base pressure fluctuation through a systematic investigation of scaling laws and turbulence measurements with hot wire systems. c. To verify present hypothesis about the dependence and conditioning of heat flow resistance and production through acoustic resonance and turbulent-shock wave interactions.

25. (U) APPROACH - Using the two-dimensional wind tunnel model the base heat transfer and the time averaged velocity profiles should be measured and compared with analytical estimates at selected base boundary; forebody, and free shear layer traverses covering a wide range of Reynolds numbers. Having completed these mean value measurements, turbulence measurements were to start employing hot wire systems. The completion of the heat transfer measurements and the hot wire investigation will now be continued under a new work unit, code number 124-10-02-09.

26. (U) PROGRESS - The model was transferred to a blowdown tunnel to cover a wide Reynolds number range and to avoid slip flow at the hot wire. Systematic base pressure measurements were reported. The contract was then terminated, because of the high spending rate which made the heat transfer measurements and hot wire calibration studies impossible.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY— 67	--	--
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	--	--
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	--	--
35. TASK AREA: Vehicle and Base Heating			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002768	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-02-62	No Change

11. TITLE:
(U) Analytical Investigation of Plume Afterburning

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 016700 Thermodynamics, 014600 Rocket Motors	03 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-21047 a. DATE 04 67	PRIOR FY— 67	0.1	54
B. Contract	c. TYPE M. CPFF d. AMOUNT $53,498	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: General Applied Science Laboratory
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Merrick & Stewart Avenue Westbury, L. I., New York 11590
	INVESTIGATORS PRINCIPAL: Slutsky, Simon
RESP. INDIV.: Farmer, Richard C., R-AERO-ATB	ASSOCIATE:
TEL: 205-876-2060 (FTS)	TEL: 576-333-6960 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Plume Afterburning, Radiation

24. (U) OBJECTIVE - a. Problem: - To investigate the application of computer programs, which were developed by GASL for describing hydrogen venting phenomena, to describing the thermodynamics of plume afterburning. b. Application: - To calculate radiation to the base of the first stage vehicle. c. Temperature fields of plumes in which afterburning is important will be predicted analytically.

25. (U) APPROACH - Computer programs will be used to describe the temperature field and these temperature fields will be compared with experimental data. Currently hydrogen venting problems are being investigated by GASL under NAS8-2686. These studies will result in computer programs which describe the turbulent mixing and combustion of hydrogen-air streams, kinetics and thermodynamics for RP-1. Air streams used with the same mixing analysis will be added to the programs under this contract.

26. (U) PROGRESS - Two technical reports have been published describing the global chemistry model and the radiation-convection coupling mechanism which have been chosen to represent plume afterburning regions. They are "Mixing and Combustion in the Exhaust Plumes of Rocket Engines Burning RP-1 and LOX," GASL Report #631 and "Radiation from Carbon in a Rocket Plume Mixing Region with Coupled Convective and Radiative Energy Fluxes and General Optical Thickness," GASL Report #628. Contract NAS8-20298 was completed on 09 66. This work will be continued under a new contract with GASL. Reporting dates 08 66 - 02 67.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY— 67	-	54
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Vehicle and Base Heating			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002769	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 15 08 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-04-62	No Change

11. TITLE: (U) Research Related to Application of Shock Tube Techniques to the Study of Base Thermal Environment of Rocket-Propelled Vehicles (Base Heating Research)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 014600 Rocket Motors, 016700 Thermodynamics	02 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER NAS8-20027 a. DATE 02 65 c. TYPE M. CPFF d. AMOUNT P$169,725	PRIOR FY 67	1.0	-
		CURRENT FY 68	1.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Wilson, Homer B., Jr., R-AERO-AT TEL: 205 876-1833 (FTS)	NAME: Cornell Aeronautical Laboratory ADDRESS: P. O. Box 235 Buffalo, New York 14221 INVESTIGATOR'S PRINCIPAL: Bird, K. D. ASSOCIATE: Hendershot, K.C. TEL: 716 632 7500 Ext. 233 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS: Electron Beam Measurements, Laser Measurements, Short-Duration Techniques, Recirculating Flow Field, Thermal Base Environment

24. (U) OBJECTIVE - a. Problem: - To develop new techniques for determining base environments of launch vehicles employing rocket engines for power. b. Application: - To use these techniques to generate data for thermal design of launch vehicles. c. Analytical schemes are not available for generating data for thermal design criteria so we must rely on generating data by use of model tests.

25. (U) APPROACH. Presently available techniques are expensive and complex; therefore, we are investigating new techniques for generating design data and to provide basic information leading to better understanding of reversed flow fields and better techniques for generating environments of reversed flows. Attempts will be made to study such parameters as Reynolds number, O/F ratio, mean flow concentration, etc.

26. (U) PROGRESS. a. 15 09 66 to 15 02 67. b. The analysis of radiance measurements of freely expanded plumes taken near the nozzle exit plane of solid propellant S-I, S-IB, and S-IC retrorocketshas been completed. Radiant heat transfer has been measured on the S-IB interstage ramp. An experimental program designed to measure rocket exhaust plume electron density levels is currently underway using the 1/20-scale F-1 rocket model. A zone radiometer is being developed to obtain the radial temperature distribution in the model F-1 rocket exhaust plume.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		931-31, 931-50, 933-32 933-33	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY 67	-	-
	CURRENT FY 68	-	100
	NEXT FY 69	-	200

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

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(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U RPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-05-62	No Change

11. TITLE:
(U) Radiation of Gases

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics 014600 Rocket motors and engines	09 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER: NAS8-11468 a. DATE: 09 64 c. TYPE: M. CPFF d. AMOUNT: P$25,000	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Hopson, G. D. R-P&VE-PTD TEL: 205 876-7815 (FTS)	NAME: University of California ADDRESS: Davis, California INVESTIGATORS PRINCIPAL: Giedt, Dr. W. ASSOCIATE: Brandt, Dr. H. TEL: a/c 916 752-0580 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Heat Transfer, Spectral Absorptivity

24. OBJECTIVE (U) To experimentally determine the spectral absorptivity, over a wave length range of 1 to 6 microns, of water vapor, carbon dioxide, and water/carbon dioxide mixtures. Measurements are to be performed over temperature and pressure ranges of from 1000 to 2200°F and 0.25 to 3 atmospheres.

25. APPROACH (U) An apparatus has been designed and constructed for experiment. The key element is a graphite resistance furnace with an inert ceramic tube liner for the containment of high-temperature gases. A beam of radiation from a high-temperature source is directed through a known length of test gas in the center region of the furnace. A monochrometer on the opposite end of the furnace is used to measure the amount of energy absorbed as a function of wave length.

26. PROGRESS (U) Measurements of the spectral absorptivities of carbon dioxide up to 1500K have been reported. These included data from the 4.67 micron fundamental band at path lengths of 1, 5, 10, and 20 cm and temperatures of 300, 600, 900, 1200, and 1500 K over the pressure range of ¼ to 3 atmospheres. For the first overtone band, absorption was found to be significant only for a path length of 20 cm at pressures of 1, 2, and 3 atmospheres for the same temperatures. During the coming quarter additional measurements of CO spectral absorption at pressures up to 3 atmospheres and at temperatures above 1800 K will be conducted. Results will be presented in the form of spectral absorptivity distribution curves in a phase report.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-31, 933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Vehicle and Base Heating			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004297	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Complete 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-06-62	No Change

11. TITLE:
(U) Calculation of Three-Dimensional Interaction Regions in Multi-Rocket Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 016700 Thermodynamics 014600 Rocket Motors	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8- 20101 DATE 06 65	PRIOR FY— 67	0.1	--
	c. TYPE M. CPFF d. AMOUNT 51,223	CURRENT FY— 68	0.1	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: General Dynamics Corporation
ADDRESS: Huntsville, Alabama 35812	ADDRESS: San Diego, California 92101
	INVESTIGATORS PRINCIPAL: Thommen, Hans
RESP. INDIV. Sims, Joseph L., R-AERO-AM	ASSOCIATE:
TEL: 205 876-2300 (FTS)	TEL: 714 298-8900; Ext 4391 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Base Heating Difference Scheme, Three-Dimensional

24. (U) OBJECTIVE - a. Problem: - To develop the necessary analysis and computer program for the calculation of the inviscid, supersonic, three-dimensional flow fields formed by the interaction of multiple rocket engine exhausts. b. Application: - The computer program will be used to compute gas dynamic results in the interaction region near the vehicle base for use in thermal environment analyses.

25. (U) APPROACH - The analysis and computer program will be based on numerical finite-difference solution of the Euler Equations of Motion. This finite-difference scheme is an adaptation and extension of the Lax-Wendroff solution for unsteady flow fields.

26. (U) PROGRESS - a. 15 08 66 to 15 02 67 b. The program reported received in the previous progress reporting period has been utilized in analyzing the plumes issuing from liquid hydrogen-oxygen engines for several ambient pressures. For high ambient pressures good results were obtained; however, for the lower pressures (on the order of 0.7 PSF) the analysis appears to be inadequate. This problem is now being investigated. Contract NAS8-20101 was completed.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	--	--
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	--	--
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	--	--
35. TASK AREA: Vehicle and Base Heating			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 15 08 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-07-62	No change

11. TITLE:
(U) Recirculation of Gases Along the Base

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Mechanics 016700 Thermodynamics, 014600 Rocket Motors	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Grant	b. NUMBER 04-001-015 c. TYPE Y. G. d. AMOUNT 21,910 e. DATE 06 66	PRIOR FY 67	0.1	-
		CURRENT FY 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Huffaker, Robert M., R-AERO-ATP TEL: 205 876-0431 (FTS)	NAME: University of Arkansas ADDRESS: Graduate Institute Little Rock, Arkansas 72203 INVESTIGATOR'S PRINCIPAL: Story, J. ASSOCIATE: Testerman, M. TEL: 501 375-7247 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Current analysis of base recirculating flow fields

24. (U) OBJECTIVE - a. Problem: - The current analysis of base recirculating flow field is lacking sufficient verification by experimental measurement. b. Application: - Considerable basic work is needed in interpreting the velocity data of the doppler velocity instrument to be used in mapping the velocity field of a S-II recirculating flow field.

25. (U) APPROACH. The parameters that affect the doppler velocity measurement will be studied. The effect of solid angle in the receiving optic and the scattering intensity with angle will also be studied. The effect of scattering volume size and numbers of particles on the heterodyned signal will be studied.

26. (U) PROGRESS. Considerable data have been taken on parameters that affect the heterodyned signal. Interpretation of this signal in terms of velocity has also been studied.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
None	PRIOR FY 67	-	-
	CURRENT FY 68	-	40
	NEXT FY 69	-	40

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 05 67	D Change 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-09-62	No Change

11. TITLE:
(U) Base Flow and Separation Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 009700 Statistics, 016000 Launch Vehicles	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-20392 c. TYPE M. CPFF d. AMOUNT $53,287 e. DATE 06 66	PRIOR FY— 67	0.5	--
		CURRENT FY— 68	0.5	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Dahm, Werner K., R-AERO-A TEL: 205 876-4566 (FTS)	NAME: IIT Research Institute ADDRESS: 10 West 35th Street Chicago, Illinois 60616 INVESTIGATOR'S PRINCIPAL: Fisher, Michael J. ASSOCIATE: TEL: 312 225-9630 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS Turbulence, reattachment, acoustics, base heating, convection, sound radiation, hot wires, scaling laws

24.(U) OBJECTIVE - a. Problem: - To study aerodynamic feedback by turbulent convection and sound radiation in base recirculation areas. b. Application: - The simulation and reduction of base heating and base pressure fluctuations through a systematic investigation of scaling laws and turbulence measurements comparing the results of an optical correlation system with previous hot wire data. c. To verify present hypothesis about the dependence and conditioning of heat flow resistance and noise production through acoustic-resonance and turbulent shock wave interactions.

25.(U) APPROACH - Using a two-dimensional wind tunnel model with a tracer in the flow measurements will be made by an optical correlation method to compare previous data with two point space-time correlations between a hot wire probe in the flow and one on the base so as to disentangle the acoustical and heat transfer effects of turbulent convection and sound radiation for various plume impingement angles, Reynolds numbers and mass additions.

26.(U) PROGRESS - 09 66 to 02 67 A computer program is under development which can be used universally to relate heat transfer coefficient to the hot wire, wire current, and wire temperature with the flow velocity. Of primary interest is the separation of hot wire end losses from the convective heat transfer coefficient and the application of King's law in low density flows. The base flow model is being modified for the test phase which will start in April.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	--	60
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY—68	--	50
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY— 69	--	80
35. TASK AREA	Vehicle and Base Heating			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-10-62	No Change

11. TITLE:
(U) Study of Numerical Solution of Special Flow Problems for Saturn Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-20409	a. DATE 06 66	PRIOR FY– 67	0.2	--
	c. TYPE M.CPFF	d. AMOUNT $22,470	CURRENT FY– 68	--	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Northrop Corporation
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Northrop Space Laboratories Huntsville, Alabama 35805
RESP. INDIV: Sims, Joseph L., R-AERO-AM	INVESTIGATOR'S PRINCIPAL: Tatom, Frank B.
TEL: 205 876-2300 (FTS)	ASSOCIATE:
	TEL: 837-0580 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Launch Vehicles, Supersonic Transport	N/A

23. KEYWORDS
Flow Fields, Finite Difference Methods, Elliptic Equations

24. (U) OBJECTIVE - a. Problem: - To develop techniques for determining the flow field about Saturn type bodies at zero angle of attack in a supersonic free stream. Special emphasis is to be placed on obtaining solutions in mixed supersonic-subsonic flow areas such as blunt noses and expanding frustum sections. b. Application: - The computer programs using these techniques will be used to compute the flow fields around space launch vehicles.

25. (U) APPROACH - This analysis will use a finite difference solution of the time dependent flow equations. No time dependent forcing function is used and the desired steady state solution is found as an asymptotic time solution. All shock waves occurring in the flow field will be treated as discrete discontinuities.

26. (U) PROGRESS - a. 20 06 66 to 15 02 67. b. The contractor has an initial program for the blunt body program in operation. This program is being used to investigate solution stability criteria and various types of boundary point solutions. The results of these investigations will be utilized in the final computer program.

NOTE: This work unit is related to 124-10-01-21-62.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY – 67	--	--
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY– 68	--	--
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY– 69	--	--
35. TASK AREA: Vehicle and Base Heating			

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1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 15 12 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-11-62	No change

11. TITLE:
(U) Short Duration Base Heating Model Research

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 014600 Rocket Motors, 016700 Thermodynamics	04 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-21028 c. TYPE M. CPFF d. AMOUNT P e. DATE 10 66	PRIOR FY-67	0.2	-
		CURRENT FY-68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Wilson, Homer B., R-AERO-AT TEL: 205 876-1833 (FTS)	NAME: Hayes International Corp. ADDRESS: Box 2287 Birmingham, Alabama 35201 INVESTIGATORS PRINCIPAL: Reardon, John E. ASSOCIATE: TEL: 205 592-0011 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Short duration technique, scaling, base heating rates

24. (U) OBJECTIVE - a. Problem: - Establish the effect of model scale on the base heating rates of clustered rockets at high altitude. b. Application: - Proper correction methods will be developed whereby model base heating data will be comparable with flight data resulting in more accurate thermal design criteria. c. The effects of scale will be studied by both geometric and nozzle Reynolds number variations.

25. (U) APPROACH. A short duration model will be tested without external flow in the MSFC Impulse Base Flow Facility. Tests of a single 0.08 scale J-2 nozzle and a similar conical nozzle will be made to determine starting transients and duration of steady flow. A cluster of four J-2 engines or conical nozzles of .02, .04, and .08 scale will be tested with a heated base plate to determine the base gas recovery temperature. The nozzle stagnation pressure will be varied to change the nozzle Reynolds number.

26. (U) PROGRESS. The short duration technique of testing has been well developed along with compatible instrumentation. The I.B.F.F. is a well established and operating facility uniquely suited for this type of in-house research.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933- 31	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY-67	-	50
	CURRENT FY-68	-	50
	NEXT FY-69	-	50

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

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1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 21 11 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-12-62	No change

11. TITLE:
(U)Analysis of Ablator Effects on RF Attenuation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 006400 Fluid Mechanics, 016700 Thermodynamics	11 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-21022 a. DATE 11 66	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT P	CURRENT FY—68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Cooper, Eugene E., R-AERO-ATA TEL: 205 876-3006 (FTS)	NAME: Lockheed Missiles and Space Company ADDRESS: 4800 Bradford Drive Huntsville, Alabama 35805 INVESTIGATOR'S PRINCIPAL: Prozan, Robert ASSOCIATE: TEL: 205 837-1800 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Ablation, RF Attenuation

24. (U) OBJECTIVE - a. Problem: - To determine RF attenuation caused by an ablator in a very high enthalpy gas stream. b. Application: - The selection of ablators which, when placed in a plume, protect components efficiently but aggravate the RF attenuation problem as little as possible. c. The products from many ablators are rich in free electrons which cause RF attenuation.

25. (U) APPROACH. Estimates will be made of the heating rates, ablator mass losses, and the composition of the ablated material including electron density. The collision cross sections for the flow about the body will be estimated. Flow conditions of the gas approaching the body will be parameterized and the conditions will be found where electron density is small, hence RF attenuation is slight.

26. (U) PROGRESS. Computer programs are available which will calculate the flow about the components including chemical reaction effects. The products given off by many ablators are fairly well known. Contract NAS8-21022 was initially funded with Saturn program funds. This contract is being amended to include the above scope of work. This work is related to 124-10-02-04.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		932-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY-67	-	15
	CURRENT FY-68	-	-
	NEXT FY69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

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RESEARCH AND TECHNOLOGY RESUME

2. GOVT ACCESSION	3. AGENCY ACCESSION

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE (09 01 67)	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-13-62	No Change

11. TITLE:
(U) Precursor Radiation Effects on High Enthalpy Gas Streams

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 016700 Thermodynamics	04 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER; a. DATE; c. TYPE Pending; d. AMOUNT	PRIOR FY-67	0.1	-
		CURRENT FY68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Cooper, Eugene E., R-AERO-AT TEL. 205 876-3006 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Radiation, normal shock waves

24. (U) OBJECTIVE - a. Problem: - To establish analytical models for estimating precursor radiation effects in high enthalpy gas streams. b. Application: - To predict precursor radiation effects on the flow characteristics in high enthalpy gas streams. c. Radiation from very hot gases downstream of shock waves can be absorbed by gases upstream of the shock and be convected back across the shock. This affects the flow characteristics. Procedures for estimating this effect need to be formulated and tried.

25. (U) APPROACH. Choose a flow system where precursor radiation effects are most severe, e.g., flow approaching a normal shock. Mathematically describe the flow system as one in which the gas at each cross section can emit radiation and absorb that emitted from other locations in the flow. Choose a gas for which absorption coefficients can be described easily as input to demonstration cases for the technique.

26. (U) PROGRESS. Absorption coefficients are available or can be described simply for some gases. This work is related to work unit 124-10-02-04-62.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50-30	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY-67	-	10
	CURRENT FY68	-	-
	NEXT FY69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Vehicle and Base Heating

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D CHANGE 15 08 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-14-62	124-10-02-06-62

11. TITLE:
(U) Study on Exhaust Plume Radiation Predictions

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016700 Thermodynamics, 006400 Fluid Mechanics, 000500 Aerodynamics	01 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-21082 a. DATE 01 67	PRIOR FY67	0.1	37
	c. TYPE M. CPFF d. AMOUNT 37,425	CURRENT FY68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: General Dynamics/Astronautics
ADDRESS: Huntsville, Alabama 35812	ADDRESS: San Diego, California 92101
	INVESTIGATORS PRINCIPAL: Ludwig, C. B.
RESP. INDIV.: Huffaker, Robert M., R-AERO-ATP	ASSOCIATE:
TEL: 205 876-0431 (FTS)	TEL: 714 277-8900 Ext. 3536 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Radiation, heat transfer, gas properties

24.
(U) OBJECTIVE - a. Problem: - Determination of the curves of growth for H_2O, and the band model parameters for H_2O and H_2O, CO_2, and CO mixtures for temperature from 300°K to 3000°K. b. Application: - This data will go into a radiative heat transfer computer program to estimate heating to the S-II stage and other engines.

25. (U) APPROACH. The contractor will continue the evaluation of the data obtained under NASA Contract and further improve the appropriate curves of growth for H_2O and CO_2. The band model parameters will be obtained from this data.

26. (U) PROGRESS. Considerable data have been taken under this contract. A complete first set of band model parameters has been obtained for H_2O, CO_2 and CO for the temperature range from 300 to 3000°K. Further refinement in this data, however, is necessary. The equation for the inhomogeneous heat transfer equations was evaluated and the overall accuracy determined.

NOTE: This work unit is related to 124-10-02-06-62.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None		PRIOR FY67	-	37
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY68	-	35
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY69	-	35
35. TASK AREA	Vehicle and Base Heating			

William G. Johnny

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-15-62	N/A

11. TITLE:
(U) Reacting Gas Flows

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 016700 Thermodynamics, 014600 Rocket Motors	07 67	07 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE / b. NUMBER / c. TYPE: Pending / d. AMOUNT	PRIOR FY67	-	-
		CURRENT FY-68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Farmer, Richard C., R-AERO-ATB TEL: 205 876-2060 (FTS)	NAME: General Applied Science Laboratory ADDRESS: Merrick and Stewart Avenue Westbury, L. I., New York 11590 INVESTIGATORS PRINCIPAL: Slutsky, Simon ASSOCIATE: TEL: 516 333-6960 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Reacting Flows

24. (U) OBJECTIVE - a. Problem: - Computer programs are available which describe, with due consideration to the finite rate of chemical reactions, a free-shear layer, a boundary layer, and an inviscid, shock-free supersonic flow; now these programs must be coupled to describe flows which cannot be properly described as any one of the particular types. b. Application: - To calculate and provide a mathematical model for low altitude rocket exhaust plumes. c. Pressure and thermal fields can be predicted for launch and early flight conditions.

25. (U) APPROACH. Existing parabolic and hyperbolic programs will be coupled to obtain the desired flow descriptions. Shock logic will be included in the hyperbolic program. A subroutine for converting from a general kinetics package to a linearized one will also be provided.

26. (U) PROGRESS. The basic programs and knowledgeable uses of these programs already exist at General Applied Science Laboratory.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY-67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	50
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY69	-	-
35. TASK AREA: Vehicle and Base Heating			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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INFORMATION REQUIRED
FOR THE SECOND SHEET TO FORM 1122 FOR ALL NEW STARTS

1. SUBJECT: (U) Reacting Gas Flows

2. CODE: 124-10-02-15-62

3. BASIS OF NEED: (U) This work is needed to gain the maximum benefit from past programs of this nature.

4. APPLICATION: (U) The work will yield a better plume model; hence, a better description of base heating and RF attenuation effects.

5. SPIN OFFS AND APPLICATION: (U) These programs are also useful for describing rocket or air-breathing engine performance.

6. TOTAL TIME AND EFFORT: .2 man years and 50 k.

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-02-16-62	N/A

11. TITLE:
(U) Optical Measurement of Multi-Plume Interaction

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics, 009600 Physics	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY-67	-	-
		CURRENT FY-68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Brewer, Edwin B., R-AERO-ATB TEL: 205 877-3232 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Laser doppler flowmeter, cross beam correlation, multi-plume, impingement

24. (U) OBJECTIVE - a. Problem: - To carefully define the flow field resulting from multi-plume impingement to include the mean and fluctuating velocity components. b. Application: - Improved mathematical models of recompression and reverse flow fields. c. The determination of the inviscid three-dimensional flow field will offer checks against three-dimensional characteristic solutions and other solutions now starting to appear in the literature. The determination of the viscous three-dimensional recompression region and the reverse flow region will be the first such data recorded.

25. (U) APPROACH. A series of experiments will be recorded using relatively new instruments that make possible the measurement of turbulence and mean velocities in complex flow fields without disturbing the flow. The laser doppler flowmeter and the cross beam correlation techniques and hot wire anemometry will be used. The tests will be carried out in a low density flow where the two optical techniques mentioned above have not been used. Tracers will be required.

26. (U) PROGRESS. It is noted that the majority of hardware necessary for this test is already fabricated, including instruments, test cell and model.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None		PRIOR FY-67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY-68	-	50
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY69	-	40
35. TASK AREA	Vehicle and Base Heating			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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INFORMATION REQUIRED
FOR THE SECOND SHEET TO FORM 1122 FOR ALL NEW STARTS

1. SUBJECT: (U) Optical Measurement of Multi-Plume Interaction

2. CODE: 124-10-02-16-62

3. BASIS OF NEED: (U) To obtain necessary experimental data and insight to make theoretical analysis of free plume impingements and reverse flow field.

4. APLLICATION: (U) Improved mathematical model of the recompression region and detail of detached shock. The first mathematical model of the reverse flow.

5. SPIN OFFS AND APPLICATION: (U) To provide experimental data to those involved in three-dimensional characteristics study.

6. TOTAL TIME AND EFFORT: 2 years, 90K

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006933

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U PPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-01-62	No Change

11. TITLE:
(U) Aerodynamic Noise Research

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 006400 Fluid Mech., 000200 Acoustics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER NAS8-21100 DATE 03 67	PRIOR FY— 67	1.4	35
	c. TYP M.CPFF d. AMOUNT 34,625	CURRENT FY— 68	1.4	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 Alternate: Wilhold, Gilbert A., R-AERO-AU Tel: 205 876-0962 (FTS) RESP. INDIV. Schutzenhofer, Luke A., R-AERO-AUA TEL 205 876-8063 (FTS)	NAME: Wyle Laboratories ADDRESS: Huntsville, Alabama INVESTIGATORS PRINCIPAL: ASSOCIATE: Dr. Lowson TEL: 205 837-4411 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Design criteria for supersonic transports	N/A

23. KEYWORDS Flow Instability, Unsteady Aerodynamics, Acoustics, Noise, Separated Flow, Turbulence, Oscillating Shocks

24. (U) OBJECTIVE - a. Problem: - Theoretical and experimental investigations are needed to delineate the surface pressure fluctuations and flow instabilities associated with turbulent shock wave interactions in the vicinity of typical vehicle protuberances and interstage regions. b. Application: - The results of this work should allow the assessment of the severity of the unsteady aerodynamic environment experienced by structure in the interstage regions of present and future flight vehicles.

25. (U) APPROACH - Perform analytical studies of the coupling of shock waves with boundary layer turbulence or other sources and determine the mechanisms of shock wave instabilities. These results will be confirmed by designing and performing the appropriate experimental investigations either in-house (MSFC) or at another NASA Center.

26. (U) PROGRESS - Experimental investigations to study the mean flow characteristics have been completed. From these experiments flow separation distances, shock configurations and shock motion were obtained for various geometric parameters as well as supersonic Mach and Reynolds numbers. In the subsonic Mach regime mean velocity profiles and pressure fluctuations were obtained behind rearward facing steps. Concurrent with the aforementioned, sources of instabilities of shock waves and the effects of a sound wave passing through a shock wave were delineated. Experimental studies were outlined to demonstrate shock instabilities and their sources. Contract NAS8-11308 was completed in December 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	38
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	60
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	60
35. TASK AREA: Acoustic Noise Propagation			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006934

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U	U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-02-62	No Change

11. TITLE:
(U) Study of Absorption of Low Audio Frequency Energy in the Atmospheric Media

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Atmospheric Energy Absorption 000200	06 63	05 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER NAS8-20331 DATE 06 63	PRIOR FY— 67	0.1	-
B. Contract	c. TYPE M. CPFF d. AMOUNT $41,941	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Columbia University
ADDRESS: Huntsville, Alabama 35812	ADDRESS: New York, New York
RESP. INDIV.: Farrow, J. H. and Jewell, R.E.	INVESTIGATOR'S PRINCIPAL ASSOCIATE: Harris, Cyril M.
TEL: 205 876-9067 (FTS)	TEL: 215 280-1754, ext. 313 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Absorption Low Aduio Frequency Energy Atmospheric Media

24. (U) OBJECTIVE; To develop techniques for measuring the absorption of sound in air at very low frequencies. Investigate attenuation as a function of frequency with parameters of temperature, humidity, and altitude. Also to investigate the velocity of sound with changes in humidity.

(U) APPROACH: A spherical chamber with a sound source inside is used in the experiments. The source is very small physically to minimize the error introduced by absorption at the source. The pressure, humidity, and temperature can be very accurately controlled in the chamber. By measuring the reverberation time when the different atmospheric parameters are varied the absorption of energy by the atmosphere can be determined.

(U) PROGRESS: The results of the experiments on low frequency acoustic absorption in the atmosphere were transmitted to be used as the International Standard. A NASA Contractor report entitled "Absorption of Sound in Air versus Humidity and Temperature," is in publication and should be released soon. The spherical test facility is being prepared to commence experiments on the influence of humidity on the speed of sound.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	50
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA: Acoustic Noise Propagation			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006935	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U~~T~~ W~~HK~~U	N/A	NL	A-Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-06-62	No change

11. TITLE: (U) Investigation of Noise Generation Mechanisms of Deflected and Undeflected Supersonic Rocket Exhaust

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Acoustics 000200 Wave Prop. 017000 Spacecraft Launch Veh. & G. S. E. 016000	09 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER Pending; a. DATE; c. TYPE; d. AMOUNT *P	PRIOR FY— 67	0.6	-
		CURRENT FY— 68	0.6	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Jones, Jess H., R-AERO-AUA TEL: 205 876-8063 (FTS)	NAME: Wyle Laboratories ADDRESS: 7800 Governors Drive West Huntsville, Alabama 35800 INVESTIGATORS PRINCIPAL: Mr. R. Potter ASSOCIATE: Dr. M. Lowson TEL: 205 837-4411 ext 373 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS: Shadowgraph Study, Exhaust Simulation, Near Field Noise, Fluctuating Flow Properties, Correlation Lengths

24 (U) OBJECTIVE - a. Problem: - Delineate the fundamental noise generation mechanism associated with hot supersonic exhaust flows. b. Application: - Sound pressures, expecially in the near field region of an exhaust flow, can impose severe loads on the vehicle structure as well as the adjacent ground support equipment. Accurate prediction of these sound pressures is mandatory if the structural integrity of the vehicle is to be maintained. Confidence in the predicted levels, in this region of interest, can only be assured by obtaining a more basic understanding of the turbulent
25 mixing region of the exhaust flow field. These are the regions in which these intense levels are generated. This will be accomplished by analytical analysis of the mean and fluctuating properties of the flow field. Emphasis will also be placed on the sound radiated in the near field.

(U) APPROACH - This work effort will include the following experiments: (a) Measurement of the mean flow parameters (temperature, velocity, pressure, and gas composition) of a simulated rocket exhaust flow; i.e, using a helium jet. (b) Measurement of the turbulent characteristics of a hot model rocket exhaust flow field. (c) Shadowgraph studies of the radiated near field noise. From the definitive information obtained by the
26 above experiments an analytical model for estimating the near field noise will be formulated. Experiments to evaluate this technique will then be designed and conducted.

(U) PROGRESS - Studies to define the macroscale turbulence of jets and near field radiation phenomena of supersonic exhaust flows have been completed. The near field shadowgraph studies are being reported on. Also a report on the prediction of the near-field noise of supersonic jets has been completed. Contract NAS8-11312 was completed in December 1966.

*Note: This work was funded from other sources in FY 67.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	40
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	80
35. TASK AREA: Acoustic Noise Propagation			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
Items 1 to 28 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006936	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U (RPT) U (WRK)	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-08-62	No Change

11. TITLE: (U) Investigation of Atmospheric Influences on Far-Field Sound Propagation Predictions (Sound Propagation Predictions)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002200 Atmospheric Phy. 010000 Meteorology	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-11348 c. TYPE M.CPFF d. AMOUNT P $77,592 e. DATE 06 64	PRIOR FY— 67	0.2	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 ALTERNATE: Mabry, James E., R-AERO-T RESP. INDIV.: Smith, O. E., R-AERO-YT TEL: 205 876-7580 (FTS)	NAME: Kaman Nuclear ADDRESS: Garden of the Gods Road Colorado Springs, Colorado 80907 INVESTIGATORS PRINCIPAL: Buell, Dr. Eugene ASSOCIATE: TEL: 303 473-5880 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Atmospheric variables, propagation of sound, static test of large space vehicles

24. (U) OBJECTIVE-a. Problem: -Sound propagation predictions. b. Application: -Improved sound propagation prediction techniques. c. To determine effects of atmospheric variables on the propagation of sound generated by the static test of large space vehicles. To develop analytical models to predict sound pressure level over large distances and to determine the accuracy requirements of the velocity of sound profile for the prediction models.

25. (U) APPROACH: -Analyze the error effects inherent in the atmosphere and sound intensity level for several prediction models. Investigate the feasibility of obtaining practical numerical solutions to pertinent partial differential equations in an attempt to eliminate some of the very stringent, but necessary, assumptions imposed on the classical ray tracing technique. Investigate prediction estimates of sound intensity in the neighborhood of a sound focal zone.

26. (U) PROGRESS:

a. 15 Aug. 66 to 15 Feb. 67

b. A measure of the effects of the inherent variability of atmospheric parameters has been investigated and preliminary ranges of variation of intensity estimate determined. Indications are that a combination deterministic and probabilistic method is the most feasible approach to predict far-field sound propagation. The inhouse prediction verification program will continue, and further statistical refinements developed from this program. A final comprehensive technical report has been received from the contractor and has been issued as a contract report. In addition, a supplementary report on progress of the next phase has been received and will be published as a contractor report.

This task has been discussed with Mr. John Greene, OART-RV.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
			103-10

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	50
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	50
34. SUB PROGRAM: Launch Vehicle Aerthermodynamics	NEXT FY— 69	-	50
35. TASK AREA: Acoustic Noise Propagation			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004311

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D Change 15-08-66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-09-62	

11. TITLE:
(U) Sound Propagation and Acoustical Danger Points

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 Acoustics	07 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.8	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 ALTERNATE: Mabry, James E. R-AERO-T RESP. INDIV: Heybey, Willi H. R-AERO-T TEL: 205 876-5480 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Preventing Sound Hazards	N/A

23. KEYWORDS
Acoustical Foc and Focal lines. Sound pressure level on earth's surface

24. (U) OBJECTIVE: a. Problem: Noise of the intensity given off by rockets may have adverse effects on ground structures and population through return of accumulated sound energy from the atmosphere. Methods must be set up for determining whether or not this is likely to occur at the time of firing. b. Application: Firings may have to be delayed if critical zones are foreseen in built-up areas or of especially high intensity elsewhere.

25. (U) APPROACH: The theory and its application has been worked for some time past for level country and static point sources. It is being progressively refined and checked with observations. Sound propagation a) over hilly terrain, and b) from a moving source remain major problem areas.

26. (U) PROGRESS: Further work in these areas has been continued with the idea of verifying, by experimental efforts, the theoretical conclusions. To this end, close coordination between MTF and MSFC has been maintained as well as close contact with the Aero-Astrophysics Division of Aero Lab. Published report "Focal Point Computation in a Three Layered Atmosphere."

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	-
35. TASK AREA	Acoustic Noise Propagation			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006937	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-10-62	No Change

11. TITLE:

(U) Acoustic Model Studies of Rocket Exhaust Flows

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Acoustics 000200, Wave Prop. 01700, Spacecraft Laun. Veh. & GSE 016000	03 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER c. TYPE Pending a. DATE d. AMOUNT	PRIOR FY— 67	2.0	-
		CURRENT FY— 68	2.0	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Jones, Jess H., R-AERO-AU Tel: 205 876-8063 (FTS) RESP. INDIV.: Guest, Stanly H., R-AERO-AU TEL.: 205 876-8063 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
SST Design Criteria Aircraft Noise Control FAA	N/A

23. KEYWORDS: Source Characteristics, Spatial Correlation, Wave Propagation, Scaling Studies, Cluster Effects, Deflecter Effects, Acoustic Prediction Techniques, Noise

24. (U) OBJECTIVE - a. Problem: - Extend current methods of estimating the near (vehicle and ground plane), mid and far field acoustic environments. b. Application: - This work will result in methods which will allow much more accurate predicted environments for current and future space vehicles. c. In current prediction techniques the complex flow field of a rocket exhausting down onto a deflector is replaced by a distributed set of hypothetical acoustic sources whose characteristics are then derived from measured data. These characteristics are collapsed for dynamically similar conditions
25. and then used in extrapolating to new vehicle engines and configurations. The current normalized curves are extremely deficient in many aspects such as effects of clustering engine geometry variations, exhaust plane to deflector spacing, and many other factors. This work unit is to evaluate these factors and generate new curves to account for them. In addition to these effects hypothetical models are to be generated which will allow calculation of the spatial correlation of the acoustic field.

(U) APPROACH - The new "Acoustic Model Research Facility" of MSFC will be used to conduct a series of experiments designed to delineate the effects of the flow field parameters noted above (i.e., engine geometry, exhaust plane deflector spacing, clustering,
26. etc.). The resultant data will be utilized to derive new hypothetical source models for the various configurations which will provide better estimates of the environment and in some cases will provide models which do not exist at the present time (i.e., near field models, correlation models, etc.)

(U) PROGRESS - The test facility has recently become operational. Facility checkout experiments have been completed and the results are presently being analyzed. Even though FY-68 funds were requested in the FY-67 submission, this study could not be submitted within guidelines.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
MSFC Acoustic Model Research Facility & Support Equipment	PRIOR FY— 67	-	-
	CURRENT FY—68	-	-
	NEXT FY— 69	40	60

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Acoustic Noise Propagation

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006938	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	RD U WNK	N/A	FO	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-11-62	No Change

11. TITLE: (U) Evaluation of the Acoustic Sources of Background Noise in Wind Tunnel Facilities

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Mech. 000500 Aerodynamics, 000200 Acoustics	04 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	Pending b. NUMBER	a. DATE	PRIOR FY— 67	0.5	-
B Contract	c. TYPE	d. AMOUNT	CURRENT FY— 68	1.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Young, James C., R-AERO-AUE Tel: 205 876-1611 (FTS) RESP. INDIV.: Howard, Paul W., R-AERO-AUE TEL: 205 876-1522 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Aircraft, Missiles, Craft	N/A

23. KEYWORDS

Background Noise, Acoustics, Fluctuating Pressure, Unsteady Aerodynamics

24. (U) OBJECTIVE - a. Problem: - To determine the sources of high acoustic background noise in wind tunnels and define their acoustic characteristics. b. Application: - The unknown background noise sources in wind tunnels interferes with aerodynamic noise testing of scale model vehicles. This work unit is to identify these sources and define their basic acoustic characteristics such that their influence on the test data can be determined and their overall effect minimized. This effort will result in more accurate data on which inflight noise environments are based.

25. (U) APPROACH - Review and list all possible noise sources for the various types of wind tunnels used in aerodynamic noise testing. Plan a suitable experiment for each type of tunnel such that evaluation of these sources can be made. Obtain acoustic measurements in the various type wind tunnels (continuous, blowdown, etc.). These data are then to be analyzed with respect to their overall magnitude, and their spectral and spatial characteristics. This will allow characterization of noise associated with various types of wind tunnels in general (continuous, blowdown, etc) and also will allow the determination of the sources (basic wind tunnel components) contributing to each individual tunnel's background noise. This program will be conducted for the complete Mach number range (i.e., sub, trans. and super sonic) at various government facilities.

26. (U) PROGRESS - A request for quotation (MSFC # 1-7-75-20117) was issued 01 02 67.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
MSFC 14" wind tunnel facility (No Cost)	PRIOR FY— 67	-	40
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	50
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	30
35. TASK AREA: Acoustic Noise Propagation			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006940

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	Completed 15 08 66	U (PT) U (WAK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-13-62	No Change

11. TITLE:

Acoustic Scale Model Tests of High Speed Flows

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Acoustics 000200, Wave Propagation 017000, Sp Launch Vehicles and C.S.E. 016000	03 65	12 66	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NASA 20223 a. DATE 06 65 c. TYPE M. CPFF d. AMOUNT P 65,450	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Wilhold, G. A., R-AERO-AU 205 876-0962 (FTS) RESP. INDIV.: Jones, Jess H., R-AERO-AU TEL: 205 876-8063 (FTS)	NAME: Martin-Marietta Corp., Denver Division ADDRESS: Denver, Colorado 80201 INVESTIGATOR'S PRINCIPAL: Smith, E. B. ASSOCIATE: TEL: 303,794-5211 Ext 2530 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Supersonic Transport Design, FAA Airport Acoustics, Propulsion/ Nuclear Engine Noise	N/A

23. KEYWORDS

Clustering, Acoustic Efficiency, Source Characteristics, Fluid Mechanics

24.

(U) OBJECTIVE - a. Problem: - Investigation of the acoustic field developed by high speed exhaust flows. (b) Application: To obtain a better definition of the acoustic field developed by current NASA vehicles and to establish more reliable methods for predicting these acoustic fields. (c) Exhaust flows, when arranged in clustered configurations, produce complex acoustic fields. The resultant acoustic field is a function of basic characteristics of the cluster configuration and the individual exhaust properties as well as the propagating characteristics between source and receiver. This study effort will evaluate the effect of clustering high speed flows.

25. (U) APPROACH - Acoustic test of high speed flows arranged in several different cluster configurations were performed under the study effort. The purpose of this study effort was to extend the cluster configurations to more advance forms in order to delineate the effects of clustering on the resultant acoustic field.

26. (U) PROGRESS - This total effort has resulted in the acquisition of acoustic data from various cluster configurations. The results are presented in the following reports:

1. "Acoustic Scale - Model Tests of High-Speed Flows," by E. B. Smith, Martin-Marietta Corp., Denver Division, Martin-CR-66-13, March 1966.
2. "Acoustic Scale - Model Test of High-Speed Flows Phase II Final Report," by E. B. Smith and W. L. Brown, Martin-Marietta Corp., Denver Division, Martin-CR-66-75, December 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY— 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Acoustic Noise Propagation

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006941

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (30 11 66)	U (PRT) U (WRK)	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-14-62	No Change

11. TITLE: (U) Sound and Shear Wave Interaction with Oblique Shock Fronts

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 Acoustics 000500 Aerodynamics, 006400 Fluid Mech.	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	Pending	a. DATE	PRIOR FY— 67	0.1	-
B Contract	b. NUMBER c. TYPE	d. AMOUNT	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Wilhold, Gilbert A., R-AERO-AU Tel: 205 876-0962 (FTS) RESP. INDIV.: Schutzenhofer, Luke A., R-AERO-AUA TEL: 205 876-8063 (FTS)	NAME: Purdue University ADDRESS: School of Mechanical Engineering Lafayette, Indiana 47907 INVESTIGATOR'S PRINCIPAL: Dr. K. Purdy ASSOCIATE: TEL: 219 92-2971 Ext. 232 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Launch Vehicle Technology, Aircraft, Missiles, Spacecraft	N/A

23. KEYWORDS Acoustics, Noise, Fluctuating Pressures, Unsteady Aero, Noise Mechanisms, Oscillating Shocks

24. (U) OBJECTIVE - a. Problem: - To provide a firm foundation for understanding the intense fluctuating pressures resulting from unsteady aerodynamic flow shock front interactions. Such interactions occur for supersonic rocket exhausts and oscillating shock fronts at separated flow regions during supersonic flight. b. Application: - A realistic understanding of such unsteady aerodynamics interactions would result in orders of magnitude in improvement of current acoustic environmental analyses for generating space vehicle design and qualification criteria.

25. (U) APPROACH - a. From a linear unsteady aerodynamic analysis, derive the appropriate analytical expressions for describing the velocity, density, and pressure field and the shock front displacement and velocity resulting from the interaction of plane sinusoidal sound and shear waves with an oblique shock front. These waves are to be of arbitrary incidence and wave length. The above expressions are to be functions of the upstream Mach number shock front angle, the angle of wave front incidence and wavelength. b. Design and conduct a series of experiments to measure the fluctuating pressure field associated with the interaction of plane sound waves and an oblique shock front. c. Compare the sound pressure amplification and frequency change

26. obtained from the experimental data with those predicted by the theoretical model. This is related to work unit 124-10-04-01.

(U) PROGRESS - A preliminary study of a plane sound wave of arbitrary orientation and wavelength convected thru a stationary oblique shock front has been completed. Classical work has been done by noted authors on the special cases of interactions with plane or normal shock fronts.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	13
	CURRENT FY— 68	-	15
	NEXT FY— 69	-	20

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Acoustic Noise Propagation

William G. Johnny

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A.New (Proposed)	U NAT W/NAT U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-15-62	N/A

11. TITLE: (U) Delineation of Ground Attenuation Effects on Measured Acoustic Spectra

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Acoustic 000200 Propagation 017000 Space Launch Veh & G.S.E. 01600	09 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	-	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Jones, Jess H., R-AERO-AUA TEL: 205 876-8063 (FTS)	NAME: Not Selected ADDRESS: INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
FAA Airport Acoustic Problems	N/A

23. KEYWORDS: Source Characteristics, Acoustic Efficiency, Wave Propagation, Ground Attenuation

24. (U) OBJECTIVE - a. Problem: - Investigation of the anomaly which has been observed in the measured acoustic pressure spectrum associated with all acoustic measurements taken near the ground. This anomaly appears in the form of a severe loss in the acoustic pressure level and it always occurs in the frequency range from 100 to 800 cps. Accurate estimates of the pressure in this frequency range are extremely important because the maximum energy associated with most model test normally lie within this range. This abnormal loss of pressure consequently, results in estimates

25. of source power characteristics, i.e., acoustic efficiency, total acoustic power, etc. which are considerably less than what they should be. These estimates, which are subsequently extrapolated to full scale vehicles configurations, therefore result in non-conservative predictions.

(U) APPROACH - A theoretical and experimental program will be conducted to define the anomaly noted above. The experimental study will be performed with a broad frequency band, random, non-directional acoustic source; i.e., speaker. A parametric study consisting of the following variables will be performed (1) source-to-receiver distance, (2) source height, (3) receiver height and (4) ground conditions.

26.

(U) PROGRESS - N/A

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY— 68	-	50
	NEXT FY— 69	-	80

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Aerothermodynamics
35. TASK AREA	Acoustic Noise Propagation

William G. Johnny

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

SUBJECT: Delineation of Ground Attenuation Effects on Measured Acoustic Spectra

CODE: 124-10-04-15-62

BASIS OF NEED: To obtain a more exact definition of the acoustic source characteristics associated with rocket exhaust flows. This will allow more accurate estimates of the acoustic environment to be made.

APPLICATION: The results will be used to correct existing model test data so that more realistic estimates of full scale environments can be made.

SPIN OFF AND APPLICATION: The results of this study could be used to increase the effectiveness of the noise abatement programs currently under study.

TOTAL TIME AND EFFORT: Three years and $160,000.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U / U	N/A	NL	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-10-04-16-62	N/A

11. TITLE: (U) Investigation of the Noise Produced in the High Entropy Regions of a Hot Rocket Exhaust Stream

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 Acoustics 006400 Fluid Mech, 01700 Wave Propagation	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B contract	b. NUMBER Pending; a. DATE; c. TYPE; d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Jones, Jess H., R-AERO-AU Tel: 205 876-8063 (FTS) RESP. INDIV.: Wilhold, Gilbert A., R-AERO-AU TEL: 205 876-0962 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Civilian Jet Craft, Noise Technology	N/A

23. KEYWORDS Nonsteady Aero, Jet Noise, Turbulence, Fluid Mechanics, Entropy, Acoustics Noise Generating Mechanisms

24. (U) OBJECTIVE - a. Problem: - Investigate the high entropy producing regions of hot rocket exhaust flows and determine their importance with respect to the acoustic noise field produced by such jets. b. Application: - This work would contribute toward a method for estimating the near noise field of modern rocket exhausts and provide guidance as to the suppression of these fields. Additionally it will define the primary noise producing mechanisms of a hot supersonic exhaust field.

25. (U) APPROACH - Lighthill's integral solution for the noise radiated from a cold jet has been reformulated for a hot supersonic jet. The integrand contains terms which express the contribution from the regions of extreme entropy variations within the jet. An analytical model describing these regions is to be developed and the contribution of the above terms to the resultant acoustic field radiated from the jet is to be evaluated.

26. (U) PROGRESS - Prior studies have shown the importance of entropy production in regions of discontinuities (shock surfaces) in supersonic exhaust flows. Considerable noise reduction has been achieved experimentally by partially eliminating the shock surfaces by means of nozzle plugs. This indicates their importance as noise generating mechanisms. A crude analytical model has been generated for the noise fields radiated from a hot rocket exhaust (undeflected). This model is based on the shock geometry within the flow. The radiated field calculated with this analytical model has compared extremely well with the directivity characteristics of such exhausts. This is the first time an analytical model has been generated for hot rocket exhaust flows. Although this model provides directivity characteristics it has to be modified to provide amplitude and spectral information.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	35
34. SUB PROGRAM: Launch Vehicle Aerothermodynamics	NEXT FY— 69	-	55
35. TASK AREA: Acoustic Noise Propagation			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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SUBJECT: Investigation of the Noise Produced in the High Entropy Regions of a Hot Rocket Exhaust Stream

CODE: 124-10-04-16-62

BASIS OF NEED: The above work unit is required to provide critical information on a possible noise generating mechanism of hot rocket exhaust flows which has not been investigated before. Such information will be used to generate an environmental prediction technique for the near noise field of launch vehicles. Design and qualification criteria for structures and components are based on such estimates. This indicates the paramount importance of an accurate prediction technique.

APPLICATION: By investigating the internal fluid dynamic precesses of a hot rocket exhaust flow and the relationship of these processes to the radiated acoustic field of such flows, the major noise generation mechanisms will be identified and described. This will result in adequate guidance for:

a. Development of an accurate near field noise prediction technique

b. Information on how to suppress the intense noise fields of hot exhaust flows.

SPIN OFFS AND APPLICATION: This information will also contribute to:

a. Supersonic transport design and qualification criteria.

b. The FAA airport noise problem attendant with major cities throughout the country.

TOTAL TIME AND EFFORT: This work unit should take approximately two years, and $90,000.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (01 04 65)	U	U	N/A	NF FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-01-62	No Change

11. TITLE:
(U) Development of Structural Test Articles from New and Unconventional Materials

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	07 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-20522 DATE 07 65	PRIOR FY— 67	4.0	-
B. Contract	c. TYPE MCPFF d. AMOUNT $43,111	CURRENT FY—68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Fairchild Hiller
ADDRESS: Huntsville, Ala. 35812	ADDRESS: Farmingdale, Long Island, N. Y.
	INVESTIGATORS PRINCIPAL: Bohmann, G.
RESP. INDIV.: Gerry, G. B., R-P&VE-SAA	ASSOCIATE:
TEL: 205-877-3063 (FTS)	TEL: 516-531-0105 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Commercial Aircraft Structure	N/A

23. KEYWORDS
Fabrication, Forming Parameters, Beryllium, Magnesium-Lithium Alloy

24. OBJECTIVE: (U) To develop design criteria for future guidance of structural design utilizing beryllium and magnesium-lithium alloys.

25. APPROACH: (U) To build a box beam utilizing most of the shop fabrication techniques and to develop forming parameters of beryllium stretch and shrink flanges. The beryllium forming study is based on the comparison of empirically derived formability limits with those obtained by actual tests. Specimen tests will be conducted by the A. E. C. to determine elevated temperature mechanical properties and effect of strain rate on material workability.

26. PROGRESS: (U) Specimens have been removed from one lot of material received from Brush Beryllium Corporation and forwareded to the A. E. C., Upon receipt of this data tools will be made for forming the material to verify the predicted.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004307	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (15 08 66)	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-03-62	No Change

11. TITLE: (U) Manufacturing Development of Advanced Tank Configurations (Intersecting Pressure Vessel)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft 016300 Structural Engrg.	01 62	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY - 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Hutsville, Alabama 35812	ADDRESS: Not Selected.
	INVESTIGATOR$ PRINCIPAL:
RESP. INDIV.: Hollingsworth, T.H. R-ME-A	ASSOCIATE: Wuenscher, H.F. R-ME-DIR
TEL: 205-876-5376(FTS)	TEL: 205-876-6365(FTS) TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Spacecraft, Manufacturing Technology	N/A

23. KEYWORDS

24.

(U) OBJECTIVE - a. Problem: To develop manufacturing technology for intersecting pressure vessel and other advanced tank configurations.

b. Application: Proposed tank shapes are applicable to lifting body recoverable boosters and other type vehicle pressurized containers.

c. Development of intersecting pressure vessels and shaped tank configurations will be continued in order to optimize for packaging efficiency, aerodynamic and load carrying requirements, and reuseability and refurbishment aspects for launch vehicle propellant containers. The concept of modular segments has great potential with respect to manufacturing and facility requirements. The relative ease of transporting and manufacturing sub-assemblies of large containers will result in significant savings in future tank development programs.

25.

(U) APPROACH - Determine the optimum configuration and method of construction of a shaped Multicell Tank and to verify the manufacturing feasibility with respect to processes, tooling, and materials. The 200 inch Multicell Tank test program support will be continued.

26.

(U) PROGRESS - A 200 inch Multicell Tank that was developed and built in-house is in structural test. A contract has been initiated to determine the optimum configuration and type of construction of a shaped Multicell Tank.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Materials (10)	PRIOR FY — 67	-	25
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	20	30
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	200	-
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004308	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. CHANGE (15 08 66)	U RPT U WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-04-62	No Change

11. TITLE:

(U) Development of Solid State Bonding Techniques

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
008000 Industrial Processes 009900 Metallurgy & Metallograph	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-20384 a. DATE 06 66	PRIOR FY— 67	0.2	-
B. Contract	c. TYPE M. CPFF d. AMOUNT $52,398	CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY		20. PERFORMING ORGANIZATION	
NAME:	Marshall Space Flight Center	NAME:	Harvey Aluminum, Inc.
ADDRESS:	Huntsville, Alabama 35812	ADDRESS:	19200 S Western Ave. Torrance, California 90509
	Wood, C. M. / Nichols, R. L.	INVESTIGATORS PRINCIPAL:	Long, James R.
RESP. INDIV.	R-ME-MMP / R-ME-MMP	ASSOCIATE:	
TEL:	205-876-5445 / 205-876-8596	TEL:	213-775-2141 Ext. TYPE 683

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24.

(U) OBJECTIVE - a. Problem: To advance the state-of-the-art and process applicability for the solid state bonding methods of explosive welding and diffusion bonding.

b. Application: - Provide increased strength with reduced weight for future space vehicles.

c. Diffusion bonding can achieve joint strength equivalent to parent metal strength, but the technique results from a combination of pressure, temperature, and time. This work will determine optimum parameters of manufacture to achieve reliable bonding.

25.

(U) APPROACH - Sub-scale test components shall be made to establish manufacturing design parameters and to provide test specimens for evaluation of the metallurgical examination and mechanical testing. Major problems relate to establishing pressures, temperatures, and times for various combinations of materials.

(U) PROGRESS - (15 08 66 to 15 03 67) Two (2) sets of sub-scale specimens have been prepared and rolled at different temperatures. The first test specimens were rolled at 1500°F, and no bonding was evident. The second set was rolled at 1600°F, and all samples achieved some bonding. The studies will be continued in order to find the optimum combination of temperature, pressure, and vacuum. Conventional joining methods such as brazing and welding have low joint efficiencies and result in a loss of toughness, strength, and ductility. Diffusion bonding has shown it can provide strengths approaching or equal to the base metal without harmful effects.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure /Material Concepts			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004309

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 09 67	B. CHANGE (15 08 66)	U	U	N/A	CA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-05-62	NO CHANGE

11. TITLE:
(U) Fusion Spot Welding System (Hybrid MIG-TIG)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009200 Machinery & Tools 006000 Industrial Processes	07 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20590 DATE 04 66 c. TYPE M.CPFF d. AMOUNT $33,499	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812	NAME: ADDRESS: Merrick Engineering Inc. 2401-C 12th Avenue, S. Nashville, Tennessee 37212
RESP. INDIV.: McCampbell, W. M., R-ME-MW TEL: 205-876-6106 (FTS)	INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Automotive, Structural, Aircraft	N/A

23. KEYWORDS

25.

(U) OBJECTIVE - a. Problem: - To develop a fusion spot welding system that is simpler, less costly, more dependable, and capable of doing better work than the ones presently in use on the Saturn V program.

b. Application: - This project, if successful, should result in a system more universally adaptable to fusion spot welding in space vehicles.

c. The hybrid concept has been verified to the extent that it is known to be feasible. A partially developed system invented by the Manufacturing Engineering Laboratory personnel would use a hybrid torch and a special system during the several phases of the critical heat cycle. In a given spot weld, the mode would shift from consumable electrode to tungsten arc as required to derive the best advantages of the two processes. This includes: TIG start and warm-up, MIG hole-Blow and fill with heat decay, and further heat decay and polish-off on TIG. (NOTE: With common power supply, arc transfers to electrode, whether tungsten or consumable, which instantaneously has shortest tip-to-work distances.

(U) APPROACH - Design a special torch, with particular attention to prevention of flash-over and prevention of tungsten contamination, utilize pulse start technique, build prototype (breadboard) system, based on principles outlined above. Evaluate and re-package into system suitable for use in Saturn V program.

(U) PROGRESS - (15 09 66 through 15 03 67) Prototype controls and hand gun were completed under Contract NAS8-20590. Experiments have just begun and it is too early to make an accurate estimate of the chances of success. Final report will be completed during the next reporting period. Upon receipt of the final report, this work unit will be considered completed.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure /Material Concepts			

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 002858	
4. DATE OF RESUME: 15 03 67	5. KIND OF RESUME: D. CHANGE (15 08 66)	6. SECURITY: RPT U WRK U	7. REGRADING: N/A	8. RELEASE LIMITATION: GA	9. LEVEL OF RESUME: A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-06-62	NO CHANGE

11. TITLE:

(U) Development of Technology using Composite Sandwich Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
004100 Composites 000300 Adhesives 016000 Spacecraft	07 62	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER c. TYPE N/A a. DATE d. AMOUNT	PRIOR FY— 67	0.5	-
		CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Davis, B. K., R-ME-MMS TEL: 205-876-8394 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Composite Structures, Manufacturing Technology	N/A

23. KEYWORDS

24.

(U) OBJECTIVE - a. Problem: - To develop the state-of-the-art in specific areas of fabrication of composite sandwich structures,

b. Application: - Critical structural areas on space launch vehicles

c. Manufacturing and bonding techniques will be refined to assure reliability of fabricated parts. Emphasis will be given to the following: Development of spirally bonded honeycomb sandwich cylinders; development of edge connections, close-outs and fasteners for panel joining.

25.

(U) APPROACH - Manufacturing techniques employed by contractors and the in-house organization will be evaluated and, where necessary, refined or redirected to conform to the requirements imposed in the manufacture of space vehicle components. New and more efficient methods for fabricating honeycomb structures must be developed, including assembly; fabrication methods will be developed which will allow for utilization of new high-temperature resin systems in heat shield fabrication.

26. (U) PROGRESS - (15 09 66 - 15 03 67) - Work on this program has continued with production of the 10' diameter cylinders, to be used in load deflection tests to generate empirical design criteria; other larger cylindrical segments, developed as manufacturing prototypes for large payload shrouds, are being fabricated.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Materials(5) Tooling(35) Equipment(10)	PRIOR FY— 67	30	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	50	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure /Material Concepts			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 005266	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. CHANGE (15 09 66)	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-07-62	NO CHANGE

11. TITLE:
(U) Methods and Techniques for Fabrication, Assembly and Modification in Space

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009200 Machinery & Tools 008000 Industrial Processes	11 65	12 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT				18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER		c. TYPE	d. DATE / d. AMOUNT			
N/A		N/A			PRIOR FY— 67	2.0	-
					CURRENT FY— 68	2.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY		20. PERFORMING ORGANIZATION	
NAME:	Marshall Space Flight Center	NAME:	
ADDRESS:	Huntsville, Alabama 35812	ADDRESS:	Same as 19.
RESP. INDIV.:	Yost, V. H.	INVESTIGATORS PRINCIPAL:	Wuenscher, H. F.
	R-ME-MTA		R-ME-DIR
TEL:	205-876-4919	TEL:	205-876-6365
		TYPE:	

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

(U) OBJECTIVE - a. Problem: To determine which terrestial manufacturing processes can be used in earth orbit and on the lunar surface and what, if any, modifications are necessary to adapt these processes.

b. Application: Fabrication, assembly, and modification in the environments mentioned in (a).

c. Equipment is being obtained to provide the capability of simulating conditions which exist in earth orbit or on the lunar surface.

(U) APPROACH - A multiphase approach is being used: (1) selection and purchase of currently available equipment, setting up the test facility, evaluation of equipment capabilities and determination of what area(s) need future study and (2) investigate new equipment to accomplish space fabrication, assembly, and modification tasks which the existing equipment are not capable of doing. Some major problems are to determine the scaling factors between simulated and actual earth orbital and lunar gravity environments; forces which cause the operator to rotate and/or translate when operating conventional hand and power tools; chip removal, loose hardware storage, and tethering.

(U) PROGRESS - (15 09 66 through 15 03 67) The Zero and Partial Gravity Simulator, Action-Reaction Free Fall Simulator, Martin-Black & Decker Space Tool Kit and Space Tool Power Sources were evaluated. Minor modifications are being made to the simulators to reduce set-up time. Contract NAS8-20582, "Design and Development for Serpentuator", has been completed. This concept development will be further utilized in the Work Unit 905-31-21-03-62, "Tooling Concept for Manufacturing Operations in Space (Serpentuator)". Actions are being initiated to procure special tools for evaluation and test.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Space Tools (34) Space Simulation Equipment (16)	PRIOR FY— 67	66	20
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	50	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	75	-
35. TASK AREA: Advanced Structure/Material Concepts			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006949

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C. TERMINATED (15 08 66)	U (ATT) U (WRK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-15-62	NO CHANGE

11. TITLE:
(U) Technology for Shaping and Thermal Treating Advanced High Strength Alloys

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
008000 Industrial Processes	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV.: Irvine, C. H., R-ME-IIP
TEL: 205-876-3440(FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS:
Same as 19.
INVESTIGATORS PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24.
(U) OBJECTIVE - a. Problem: - To develop technology in advancing the state-of-the-art for shaping and thermal processing advanced high strength alloys.
b. Application: - To improve dimensional, physical, and performance characteristics of shaped components of complex geometry which will be required in the fabrication of space vehicles.
c. Primary effort will be placed on optimizing component geometry, mechanical properties, metallurgical structure, and minimizing residual stresses.

25.
(U) APPROACH - The development of electroconvection technology is under advisement. Selective heat treating coupled with faster quenching rates are reported advantages of the process. In addition, efforts will be directed toward developing technology for shaping, thermal treating, stress relieving, and contour refining of selected prototype components of complex geometry from advanced aerospace materials.

(U) PROGRESS - (15 09 66 through 15 03 67) A preliminary literature study was made on the electroconvection process and indicated that this process has a potential for

26. future development. Information, data, and materials obtained under this work unit will be further utilized in the proposed development for the 121 Program.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	2	-
	CURRENT FY— 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006952

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (16 04 66)	RPU WAK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-18-62	No Change

11. TITLE:

(U) Test Tank Slosh Program

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	a. DATE	PRIOR FY— 67	0.1	-
N/A	c. TYPE N/A	d. AMOUNT	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Mims, Milton D., R-P&VE-SAE

TEL: 205-876-0790 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS:

INVESTIGATORS PRINCIPAL:

ASSOCIATE: Same as 19

TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Effects of Tank Configurations on Propellant Slosh Characteristics

24. OBJECTIVE: (U) Since propellant slosh effects have been a critical factor in the performance of launch vehicles, it is important to determine the slosh characteristics of propellant tank configuration considered for use. The test tank slosh program is a means of evaluating the various space vehicle propellant tank configurations with respect to slosh.

25. APPROACH: (U) A test tank slosh facility for oscilating propellant tanks at various exciting amplitudes and frequencies has been constructed. Each tank to be considered for use is placed on this facility and the resonant frequency, amplitude, and the forces exerted by the propellant are obtained for various liquid levels in the tank.

PROGRESS: (U) The slosh facility has been completed and several slosh tests for the horizontally positioned cylindrical tank have been conducted. Further testing has been delayed due to low priority and a lack of pressure sensors needed for the proper measurement of the slosh effects. Testing of the various tank configurations will be resumed whenever time and circumstances permit.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006953

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C. Terminated (16 04 66)	U (MT) U (WRK)	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-19-62	No change

11. TITLE:

(U) Structural Design with New Materials

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft 016000 Spacecraft Launch Veh. & Ground Suppt.	10 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER N/A a. DATE	PRIOR FY— 67	0.2	-
	c. TYPE d. AMOUNT	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATORS PRINCIPAL:
RESP. INDIV.: Gerry, G. B., R-P&VE-SAA	ASSOCIATE: Same as 19
TEL: FTS 205-876-9748	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Aircraft	N/A

23. KEYWORDS

Beryllium, Fabrication, New Materials

24.

Objective: (U) The program objective is a compilation of structural design data on new and unconventional engineering materials presented in a tabular form for quick reference during preliminary structural design.

Approach: (U) A format will be developed to present all appropriate material properties, material availability, attractive material attributes, and typical applications in a condensed and consistent manner.

25. A literature search of the various materials selected will then be conducted. After completion of this search, all significant data will be entered on the format.

Progress: (U) Program was combined with "Structural tests on new and unconventional materials" (124-11-01-01-62).

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Advanced Structure/Material Concepts			

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006954	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U RPT U WRK	N/A	NF	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-20-62	No Change

11. TITLE:
(U) Influence of Meteoroid Protection Requirements on Structural Design

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	04 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER c. TYPE N/A a. DATE d. AMOUNT	PRIOR FY— 67	1.5	-
		CURRENT FY— 68	1.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Nevins, C. D., R-P&VE-SA TEL: 205-876-0269 (FTS)	NAME: ADDRESS: INVESTIGATOR$ PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Meteoroid Protection, Structural Design

24. (U) OBJECTIVE: a. Problem: To determine the influence of meteoroid protection requirements on the structural design of space vehicles.

b. Application: Near-earth missions of long duration and interplanetary missions.

c. The end-product will be design recommendations summarized in a meteoroid protection design guide.

25. (U) APPROACH: Literature on meteoroid protection concepts, hypervelocity impact, and flux criteria are continually reviewed. Hypervelocity test data on thin sheet structures are organized and tables and diagrams are established which will enable preliminary design and final design of spacecraft structures for any foreseeable space mission. Problem areas include the evaluation of considerable, yet isolated, test data, interpretation of bumper effectiveness as a function of the variables, and influence of filters (such as indulations).

26. (U) PROGRESS: a. Reporting Interval - August 15, 1966 through February 15, 1967.

b. Using the flux-mass relationship of NASA TMX-53512, curves for single-sheet thickness versus penetrating flux have been established for near-earth missions. A method to account for meteoroid streams was derived. A penetration flux for a Mars and Venus mission has also been established and the flux-mass relationship for interplanetary travel has been investigated. An outline for experimental investigation of bumper parameter influences has been formulated.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006957	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U_PT U_K	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-23-62	No Change

11. TITLE:

(U) Development of a System for Prestressing Brittle Materials

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003100 ceramics, 004100 composite materials, 015900 spacecraft	12 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS7-429	a. DATE 12 65	PRIOR FY— 67	0.3	-
B. Contract	c. TYPE M.CPFF	d. AMOUNT (P)	CURRENT FY -68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Douglas Aircraft Company, Inc.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Santa Monica, California 90406
	INVESTIGATOR PRINCIPAL:
RESP. INDIV. Seitzinger, Vaughn F, R-P&VE-MNC	ASSOCIATE:
TEL. 205-876-0498 (FTS)	TEL: 213-EX9-9311 Ext. 4830

21. TECHNOLOGY UTILIZATION	22. COORDINATION
ceramic processing for industry aircraft design	Mr. N. J. Mayer, RV-2 NASA Headquarters, Washington, D. C. 20546

23. KEYWORDS

Prestressed ceramics, composites, high temperature

24. (U) Technical Objective: The objective of this program is to develop high-strength thermal-shock and impact resistant ceramic-metal composites for high temperature structural applications. The concept is designed to circumvent the low tensile strength of ceramics by taking advantage of their high compressive strengths, thus minimizing failure from induced thermal and mechanical stresses.

25. (U) Approach: The concept consists of precompressing a ceramic with continuous, pretensioned metal filaments while processing the composite at low temperatures, thereby eliminating the degradation of the metal reinforcing which occurs if conventional high temperature ceramic processing is used. Trade-off studies will be conducted on the strength of the proposed composites employing various combinations of ceramics and reinforcements to select candidate materials. Chemical bonding systems for the ceramics will be developed. Studies will be conducted to determine the optimum reinforcement configuration and the placement, quantity, and magnitude of the applied stress in the reinforcement. Flat composite specimens will be prepared and evaluated at room and elevated temperatures. The results will serve as a basis for extending the concept to practical configurations such as rings, reinforced cylinders, and nose shrouds which incorporate biaxial prestressing.

26. (U) Progress: Trade-off studies have been conducted and candidate materials selected. Tungsten was selected as the reinforcement, and zirconium oxide and aluminum oxide were selected as the ceramics. The bonding systems for the ceramics have been developed. The reinforcement configuration has been selected, and the placement, quantity, and magnitude of the applied stress in the reinforcement determined. Flat composite specimens are being prepared and evaluated at room and elevated temperatures to determine the efficiency of the prestressed, reinforced concept.

Funds for FY-68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	75
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure /Material Concepts

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	
		NR 006958	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Change (15 08 65)	U (RPT) U (WRK)	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-24-62	904-21-01-16-62 (FY-66)

11. TITLE:
(U) Torus and Semi-Toroidal Tank Manufacturing Technology

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft 008000 Industrial Processes	02 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.5	9
		CURRENT FY - 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812	NAME: ADDRESS: Not Selected.
Dishman, L. R. Yates, I. C. RESP. INDIV: R-ME-A R-ME-A TEL: 205-876-6627(FTS) 205-876-7508(FTS)	INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24. (U) OBJECTIVE - a. Problem: This program was started as a result of low confidence in common dome bulkheads. Advanced space vehicles require new concepts to reduce stage length and manufacturing technology is needed as a basis for the new design concepts.

b. Application: This tank configuration could be used for space launch vehicles and payload modules.

c. This work unit is a continuation of the OMSF Work Unit, "Investigation of Semi-Toroidal Bulkhead Configuration" and the FY-67 OART Work Unit. This work unit is designed to provide preliminary manufacturing development necessary to evaluate the Torus and Semi-Toroidal Containers for consideration as future space vehicles and payload modules.

25.

(U) APPROACH - This year's funding will be used to overcome unforseen tooling problems in the installation of slosh baffles, baffle rings and sumps. Fabrication and testing will require another year.

26.

(U) PROGRESS - (15 09 66 through 15 03 67) a. Torus Tank - Both bulkheads have been assembled and the Y-ring welded to the upper bulkhead. A study is being initiated to develop concepts for the application of high performance insulation to the tank. This effort on insulation will be continued under 124-08-08 in FY-68. b. Semi-Toroidal - The tank was completed with exception of slosh baffles and is currently undergoing tests to establish basic slosh and vortex characteristics before these baffles are installed.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
Tooling (20), Materials (5)	PRIOR FY 67	10	15
33. UNIQUE PROJECT: Space Vehicle Systems SRT	CURRENT FY 68	25	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	25	-
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnny

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1965 O-795-048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006959	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C. Terminated (15 08 66)	U	U	N/A	6A	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-25-62	N/A

11. TITLE: (U) Use of Moire Patterns for Measuring Strains in Welded Joints, Explosive Formed Parts and Detection of Flaws in Composite Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
004100 Composite Materials 014100 Recording Devices	05 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT				18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	a. DATE					
N/A	c. TYPE	N/A	d. AMOUNT		PRIOR FY— 67	—	—
					CURRENT FY— 68	—	—

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19.
RESP. INDIV.: Vose, V. H., R-ME-MA	INVESTIGATOR'S PRINCIPAL:
TEL: 205-876-4919 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Manufacturing Technology	N/A

23. KEYWORDS

24.

(U) OBJECTIVE - a. Problem: - To reduce distortion caused by welding, to be able to analyze composite structures and to locate areas with weak bonds as well as gross flaws, and to provide a means of studying distortion and strain as related to high energy forming processes.

b. Application: - Welding processes which cause the least distortion can be developed to join large space vehicle parts.

25.

c. If internal strains caused by welding could be observed and measured during and after welding, b. can be accomplished.

(U) APPROACH - Moire pattern will be etched or engraved on the material through which the weld is to be made. An identical pattern will be placed at the focal plane in a television camera. The distortion of the pattern on the material being welded will produce moire fringes which when analyzed will yield the internal strains. This analysis will be automated to record strain graphically once the application of patterns on the material to be welded is perfected. In the case of composite structures and high energy forming, it may be desirable to utilize an X-ray Vidicon system in conjunction with the moire patterns.

(U) PROGRESS - (15 09 66 through 15 03 67) The television camera and X-ray Vidicon systems, which were originally planned for this in-house effort will not be available in the foreseeable future. The principal investigator is working on other assignments and is not available for this work. This effort is therefore considered terminated.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	—	—
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY— 68	—	—
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY— 69	—	—
35. TASK AREA	Advanced Structure/Material Concept			

William G. Johnson

☆ U.S. GOVERNMENT PRINTING OFFICE: 1965 O 795-048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U U	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-28 -62	No Change

11. TITLE:
(U) Development of a High Strength, High Modulus Ceramic Fiber

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003100 Cer., Refr. & Glass 006200 Fibers 004100 composite materials	06 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCE EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE: Pending d. AMOUNT	PRIOR FY 67 CURRENT FY 68	0.1 0.3	- -

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: King, H. M., R-P&VE-MNC TEL: 205-876-0490 (FTS)	NAME: Not selected ADDRESS: INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Fiber reinforced plastics, filament winding technology	N/A

23. KEYWORDS:
High strength, high modulus, ceramic fiber, continuous fiber

24.
(U) Technical Objective: The objective of this contract is the development of high strength, high modulus ceramic fiber. The fiber is intended for use as the reinforcement for plastic or other low modulus matrices by filament winding, chopped fiber, or other techniques to form high efficiency, structural composite materials. The fiber property objectives for this contract are: diameter less than 125 microns; modulus of elasticity greater than 30×10^6 psi; tensile strength greater than 25×10^4 psi; resistance to atmospheric corrosion to be equal to or better than Type E glass. The process for production of the fiber shall be capable of producing continuous fiber lengths greater than 1000 feet and shall be capable of producing large quantities of fiber in an inexpensive manner.

(U) Approach: A selection of a material composition or compositions and a selection of a process or processes to be investigated shall be made. Materials suggested include aluminum oxide, beryllium oxide, and very low silica-content glasses. Processes which appear most suitable are the extrusion process and the fiber drawing (melt) process. The processes of crystalline fiber growth from a melt and crystalline fiber growth from a fluxed melt are also promising, but are less well developed technologically. The tensile strength, diameter, and modulus of elasticity of developed fibers shall be monitored continuously. The resistance to atmospheric corrosion of the fibers shall be determined. The density, thermal expansion, and crystal phases and microstructure (if crystalline rather than glassy fibers are produced) of the fibers shall be determined at least once during the term of the contract. Other property determinations shall be made as deemed appropriate.

Funds for FY-68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT LEVEL CODE	30. ORG. LEVEL CODE

31. SPECIAL EQUIPMENT:

32. FUNDS ($ K)	IN HOUSE	CONTRACT
PRIOR FY 67	-	50
CURRENT FY 68	-	-
NEXT FY 69	-	75

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15-03-67	D. Change (10 01 67)	REP U WRK U	N/a	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-31-62	No Change

11. TITLE:
(U) Development of a Beryllium Honeycomb Sandwich Composite

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009900 Metallurgy and Metallorgraphy	05 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT a. DATE b. NUMBER c. TYPE d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	Pending	PRIOR FY 67	0.1	-
		CURRENT FY 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama
RESP. INDIV. La Iacona, F. P., R-P&VE-MMP
TEL: 205-876-2467 (FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS:
Not Selected
INVESTIGATORS PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Aircraft and Aerospace Material and Design	N/A

23. KEY WORDS
Beryllium honeycomb composite, diffusion bonding, resistance welding, brazing

24. (U) Technical Objective: To develop a beryllium honeycomb sandwich composite adaptable for use as a light weight composite material for aircraft and aerospace applications. This task is intended to examine promising methods for joining beryllium to itself and forming the material into a usable light weight composite.

(U) Approach: Initally, the development of beryllium core material will be undertaken. Methods to be studied for bonding cell members will include brazing, diffusion bonding, resistance welding , and adhesive bonding. Following development of core fabrication techniques, methods will be studied for producing beryllium honeycomb composite structures and an evaluation made of the resulting composite mechanical properties and metallurgical structure. The first year's effort will be directed primarily toward basic and fundamental research to demonstrate the feasibility of development of beryllium composite materials. Extensive effort will be devoted to preparation of beryllium core from various grades or alloys of beryllium, and subsequent bonding of this core to various thickness face sheets. The FY 68 program will continue the basic research program and include the development of manufacturing technology for using the composite developed, with specific emphasis directed towards pertinent mechanical property evaluation, demonstration of the feasibility of manufacture, and determination of the reliability of manufacturing techniques.

(U) Progress: Contract pending.

Funds for FY-68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	10	90
	CURRENT FY 68	-	-
	NEXT FY 69	-	150

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnny

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U HPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-11-01-32-62

10b. PRIOR NUMBER/CODE: 933-31-01-00-62

11. TITLE:
(U) Honeycomb Test Cylinder Program

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles and Ground Support	11 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A; a. DATE; c. TYPE; d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Ala. 35812
R-P&VE-SA
RESP. INDIV: Cobb, W. E., Bianca, C. J.
TEL: (FTS) 205-876-9748 205-876-9513

20. PERFORMING ORGANIZATION
NAME:
ADDRESS: Same as 19
INVESTIGATORS PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION
Aircraft Structure

22. COORDINATION
N/A

23. KEYWORDS
Honeycomb Sandwich, Cylinder Buckling, Structural Stability

24. (U) OBJECTIVE: To obtain experimental data on the buckling strength of honeycomb cylinders as support to the use of small deflection theory in the design and analysis of a large honeycomb cylinders.

25. (U) APPROACH: A series of 120-inch diameter sandwich cylinders with 1/4-inch honeycomb cores will be fabricated and tested in compression. Various core densities, for shell thickness, and cylinder length will be used.

26. (U) PROGRESS: a. Reporting Interval: August 15, 1966 to February 15, 1967.
b. Three cylinders have been fabricated, inspected, and delivered for testing. Three additional cylinders are awaiting final inspection and five cylinders are in various stages of manufacture. Actual testing is awaiting installation of test equipment.

27.	28. REQUESTING AGENCY	29. PROJECT CHECK CODE	30. [illegible] CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA: Advanced Structure/Material Concept			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U / U	N/A	NL	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-33-62	933-50-02-03-62

11. TITLE:

(U) Testing of Aluminum Alloy Welds Subjected to Biaxial Stress

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	07 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES ES'.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER / a. DATE / c. TYPE N/A / d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY - 68	0.1	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
RESP. INDIV. Bianca, C.J. R-P&VE-SSV	INVESTIGATORS PRINCIPAL: Same as 19
TEL: 205-876-9513 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Welds, Testing

24. OBJECTIVE:(U)

a. Problem: To determine the biaxial tensile properties for welds on 2219-T87 and 2014-T651 aluminum alloys.

b. Application: Use of actual strengths for these types of welds in the design of space vehicle structures.

c. The strengths of welds under biaxial stress may be different than the corresponding uniaxial properties. With the biaxial values available, the designer will be in a better position to design the geometry of the structure in the vicinity of the welds.

25. APPROACH:(U) Biaxial stress ratios of 1:1 and 2:1 are to be investigated with cylinders of various diameters and R/t ratios using 2219-T87 and 2014-T651 aluminum alloys. An evaluation will be made of weld efficiency, sensitivity of strength to flaw size, weld allowables and existing failure theories with respect to welds.

26. PROGRESS:(U) Fifteen cylinders were tested during this report period, August 16, 1966 - February 15, 1967. Remaining specimens are expected to be tested at the rate of two per month. Thirty-six cylinders have been tested to date.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U / U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-11-01-34-62

10b. PRIOR NUMBER/CODE: 933-50-02-03-62

11. TITLE: (U) Cryogenic Burst Test Program of 2014-T651 and 2219-T87 Cylinders and Hemispherical Bulge Specimens

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	01 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER / a. DATE / c. TYPE N/A / d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV: Bianca, C.J. R-P&VE-SSV

TEL: 205-876-9513 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS:

INVESTIGATORS PRINCIPAL: Same as 19

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Biaxial Tensile Properties, Cryogenic Temperatures

24. OBJECTIVE: (U)

a. Problem: To determine the biaxial tensile properties at cryogenic temperatures for 2219-T87 and 2014-T651 aluminum alloys.

b. Application: Use of true strength of these materials in space-vehicle structures leading to possible weight reductions.

c. Biaxial strength properties of materials at cryogenic temperatures may be different than the corresponding uniaxial properties. The designer of space vehicles has only the uniaxial properties available. Weight savings may be possible by the use of true material properties.

25. APPROACH: (U) Cylinders and hemispherical bulge specimens of 2219-T87 and 2014-T651 are to be tested at -423°F, -320°F, and room temperature. Five specimens of each configuration and each material will be tested at each temperature making a total of 60 specimens.

26. PROGRESS: (U) All hemispherical bulge specimens, but only 10 cylindrical specimens out of 30 were manufactured and delivered. The cylindrical configuration's manufacturing techniques for the remaining 20 specimens were finalized. Facilities and instrumentation are 95% complete. No testing was accomplished. Plan to continue program and begin testing as priority and availability of test personnel permit.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE
		933-50	

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN HOUSE	CONTRACT
		PRIOR FY 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA	Advanced Structure/Material Concepts			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965—O 795-618

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY (RPT / WRK)	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U / U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER,CODE	10b. PRIOR NUMBER/CODE
124-11-01-35-62	933-50-02-03-62

11. TITLE:

(U) Reverse Pressure Tests

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	01 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Bianca, C.J. R-P&VE-SSV TEL: 205-876-9513 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same As 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

External Pressure, Bulkhead Test

24. OBJECTIVE: (U)

a. Problem: To determine the external pressure necessary to collapse thin-walled aluminum ellipsoidal and torispherical bulkheads.

b. Application: Use these results after correlation with theory, for application to space vehicle stress analysis.

c. There is a need for data on the collapse strength of thin-walled ellipsoidal and torispherical shells. These shapes are often used for space vehicle tank bulkheads.

25. APPROACH: (U) Two specimens each of six ellipsoidal models, and two each of three torispherical configurations have been fabricated. These will be subjected to uniform external pressure until failure occurs. The stresses, displacements and failure mode shapes will be correlated with theory.

26. PROGRESS: (U) One reverse pressure bulkhead test was conducted during the report period August 16, 1966 - February 15, 1967. The test specimen was a 6061-T6 aluminum ellipsoidal bulkhead. Lack of priority and test personnel have delayed program. Plan to continue program and testing as priority and availability of test personnel permit.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY—67	-	-
	CURRENT FY 68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Thurm

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WNK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U / U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-36-62	No Change

11. TITLE:

(U) Monocoque Bulkhead Hoop Compression Buckling

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	01 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY - 68	0.1	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Bianca, C.J. R-P&VE-SSV TEL: 205-876-9513 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Buckling Strength, Bulkheads

24. OBJECTIVE:(U) a. Problem - To determine the buckling strength of bulkheads in circumferential direction.

b. Application - Use these results after correlation with theory for application to space vehicle design and stress analysis.

c. The buckling phenomenon referred to above can occur when a bulkhead which is full or partially full of fluid is accelerated in the longitudinal direction. Then, if the negative hoop stresses become high enough, buckling of the bulkhead in the hoop direction will occur.

25. APPROACH:(U) A group of 12 aluminum bulkheads have been fabricated with various ratios of semi-major to semi-minor axes. The bulkheads will be exposed to inertial forces by the use of a centrifuge which will spin the bulkheads filled with varying levels of fluid. Stress measurements and photographic coverage will be made.

26. PROGRESS:(U) No testing was accomplished during the report period. Plan to continue test program as priority and availability of test personnel permit.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. TASK GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Advanced Structure/Material Concepts

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U RPT U WRK	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-37-62	N/A

11. TITLE:
(U) Correlation of Stress Wave Emission Characteristics with Fracture

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft 000200 Acoustics	11 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER c. TYPE Pending d. AMOUNT e. DATE	PRIOR FY-- 67	-	-
		CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Gause, R. L.,R P&VE-MER TEL 205-876-0011	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Fracture Mechanics	N/A

23. KEYWORDS

Nondestructive Test, Fracture Mechanics

24. (U) OBJECTIVE: The objective of this program is to develop a technique to interrogate nondestructively and continuously the structural integrity of space vehicle tankage and other structures. Presently, these structures are tested prior to use. Cracks can be initiated or can grow during qualification testing resulting in later failures. The monitoring of crack initiation or growth by means of a permanently attached system is required to provide an index of structural condition at any time. The stress wave emission (SWE) technique holds great promise for this application since crack initiation or growth in metals is accompanied by the emission of stress waves.

25. (U) APPROACH: Data will be obtained to characterize the SWE of materials subjected to various stress waves. Appropriate theoretical analyses based on fracture mechanics theory (FMT) will be made and compared to the SWE characteristics and the appropriate material parameters. The correlation between SWE and FMT will provide the key to the utilization of SWE techniques as a tool for the evaluation of space vehicle structures.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY - 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY - 68	-	75
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY - 69	-	60
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U (RPT) U (WRK)	N/A	GA/FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-11-01-38-62

10b. PRIOR NUMBER/CODE: 933-50-02-00-62 (932-50-02-00-62) (933-32-01-04-62)

11. TITLE: (U) Development of Materials and Materials Application Concepts for Joint use as Cryogenic Insulation and Micrometeorite Bumpers

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
004100 composite materials, 016700 thermodynamics	06 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER Nas8-11747 DATE 06 64 c. TYPE MCPFF d. AMDT. (P)	PRIOR FY 67	0.3	-
		CURRENT FY 68	0.3	-

19. GOVT LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
Princip. Nevins, C. D., R-P&VE-SAA
205-876-2069
RESP. INDIV. Alt. Stuckey, J. M., R-P&VE-MNM
TEL: 205-876-5904 (FTS)

20. PERFORMING ORGANIZATION
NAME: Goodyear Aerospace Corp.
ADDRESS: 1210 Massillon Road
Akron, Ohio
INVESTIGATOR PRINCIPAL: Burkley, R. A.
ASSOCIATE: Rollins, S. R.
TEL: 216-794-2359 TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS:
Cryogenic Insulation, Micrometeoroid Protection

24. (U) Objective: The objective is to develop and evaluate effective combined high performance multilayer insulation and micrometeoroid barrier systems for cryogenic tankage up to 33-feet in diameter for space missions exceeding seven days duration. The heat leak through the insulation in space shall be less than 0.25 Btu/ft^2/hr., and the weight of the combined system shall be limited to approximately 0.5 lb/ft^2. The insulation concept shall perform reliably under pre-launch, launch, and space flight conditions.

25. (U) Approach: Materials and material concepts are first evaluated for thermal effectiveness on a small flat-plate calorimeter. Promising concepts are then applied to a sub-scale tank for application studies and to evaluate thermal and structural performance during simulated ground hold, ascent heating, rapid evacuation, and space conditions. Hypervelocity impact tests are performed to determine the ability of the insulation-shield system to prevent damage or penetration of tank walls by micrometeoroids.

26. (U) Progress: An insulation system, approximately two inches thick and meeting weight requirements, consisting of alternate layers of thin-sliced polyurethane foam and double aluminized Mylar film has performed satisfactorily during simulated ground-hold, ascent heating, rapid evacuation, and space tests. For tanks 120-inch in diameter or less, the aluminized Mylar film can be applied in thin strips by a filament winding technique. The insulation has been panelized for application to larger tanks. Under space conditions heat leaks as low as 0.10 Btu/ft^2/hr were obtained with the filament wound insulation, and 0.19 for the panelized version. With an appropriate bumper wall, the insulation provides protection against micrometeoroid penetrations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	300
NXT FY 69	-	-

33. UNIQUE PROJECT: Space Vehicle Systems, SRT
34. SUB PROGRAM: Launch Vehicle Structures
35. TASK AREA: Advanced Structure/Material Concepts

William G. Johnson

NASA FORM 1122 (Rev. Nov 65)
(Items 1 to 35 identical to DD Form 1498)

GOVERNMENT PRINTING OFFICE: 1966 O-205-140

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (proposed)	RPT U WRK U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-39-62	N/A

11. TITLE:
(U) Structure - Thermal Insulation - Meteoroid protection integration

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	10 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER Pending a. DATE c. TYPE d. AMOUNT	PRIOR FY— 67	-	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Ala. 35812 RESP. INDIV: Verble, A. J., R-P&VE-S TEL: (FTS) 205-876-1012	NAME: Not selected ADDRESS: INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS:
Meteoroid protection, Spacecraft Structure, Insulation

24. OBJECTIVE (U): The objective of this new program will be to integrate the load-carrying structure, meteoroid protection, and thermal insulation into an optimum structure for long term space mission. The meteoroid protection requirements are currently controlling the structural design, and thus weight, of vehicles under investigation for medium to long term space missions. Through proper design procedures early in the concept definition stages, meteoroid protection structure can be load-carrying and provide some measure of thermal insulation. In addition, high-performance
25. insulation can be used as effective meteoroid protection. This program will utilize these combined load-carrying structure, meteoroid protection, and thermal insulation into an efficient structure for typical vehicles. Typical missions are: Cryogenic orbital tanker, nuclear flight stage, large orbital and planetary manned payloads.
APPROACH (U): The study will be performed in 2 phases: Phase I: Using given flux and penetration criteria, establish optimum structure for variation of exposure time, size and internal pressure. Phase II: Design, fabricate and test representative panels, verify penetration criteria and insulation degradation.

26. PROGRESS (U): N/A

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	150
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	100
35. TASK AREA: Advanced Structure/Material Concepts			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-03-62	No Change

11. TITLE:
(U) High Resolution Wind Measuring Systems Evaluation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002200 Atmospheric Physics 010400 Missile Launching & Ground Support	06 64	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER		a. DATE	PRIOR FY— 67	0.1	-
N/A	c. TYPE N/A		d. AMOUNT	CURRENT FY—68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19.
RESP. INDIV. Scoggins, J. R., R-AERO-Y	INVESTIGATOR& PRINCIPAL:
TEL: 205 876-5645 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Research, State of the Art, Detailed Wind Profile Measurements

24. (U) OBJECTIVE - a. Problem: - To perform a critical engineering and scientific evaluation of all known methods for measuring detailed wind profiles to an altitude of 20 km. b. Application: - Provide improved instrumentation for use in measuring detailed wind profiles. c. Accurate wind profile data are needed in the design and operation of space vehicles. The results of this study are providing information about systems which can be used for making accurate wind profile measurements and to improve existing systems.

25. (U) APPROACH - An exhaustive literature search is being conducted and a critical examination made of each proposed method. Accuracies and limitations of each system are to be specified and recommendations made for systems which appear to have the best capability for making reliable wind profile measurements.

26. (U) PROGRESS - Dr. James R. Scoggins has prepared a thesis (to be published as a NASA technical report) on the dynamics of the Jimsphere wind sensor. Results from an examination of the lift and drag coefficients versus time and dispersion characteristics of the Jimsphere are discussed. Another inhouse study continues on the comparison of Jimsphere and the AFCRL Rose sphere data.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY—68	-	-
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Loads

William G. Johnson

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965 O 795 048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 30 04 64	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-06-62	No Change

11. TITLE:
(U) Low Altitude Wind and Temperature Profile Study

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 002200 Atmospheric Physics	12 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
Interagency	b. NUMBER H-92101	a. DATE 12 64		PRIOR FY— 67	0.5	-
	c. TYPE Z-IA	d. AMOUNT P$43,000		CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. C. K. Hill, R-AERO-YE TEL: 205-876-0034 (FTS)	NAME: U.S. Dept. of Commerce, ESSA ADDRESS: National Severe Storms Laboratory 1616 Halley Ave., Norman, Okla. 73070 INVESTIGATORS PRINCIPAL: Mr. Leslie D. Sanders ASSOCIATE: TEL: 3-405-236-2311 536-0388(NSSL) TYPE: (FTS)

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS: Lower Atmospheric Wind and Temperature Data
Atmospheric Boundary Layer Theory

24. (U) OBJECTIVE - a. Problem: - To acquire wind velocity and temperature profile data from the 1600 ft. TV-tower located near Norman, Oklahoma. These data are to be used in conjunction with locally measured rawinsonde profile data (at Oklahoma City Weather Station) for empirically and theoretically defining lower atmospheric wind profiles to 1600 ft. and to develop continuous profiles of wind and temperature from near ground to about 30 km altitude. b. Application: - These data will be used to aid in properly defining environmental criteria for the design and launch of large space vehicles as is required for NASA's space vehicle program.

25. (U) APPROACH - All atmospheric profile data acquired at the 1600 ft TV-tower at Norman, Oklahoma by Environmental Science Services Administration (ESSA) personnel are recorded on paper strip chart. These charts are well identified as for level on tower, time, etc., and the data on wind and temperature are reduced by routine methods. These reduced data are placed on punched cards and sent to MSFC/NASA for processing and analysis. Various analytical schemes are being used to study these profile data to obtain concepts on wind and temperature profile conditions to a height of 1600 ft. Routinely acquired rawinsonde data obtained at a station near the tower are being made available to study continuous wind and temperature profile conditions to heights of about 30 km.

26. (U) PROGRESS - Wind profile data, as acquired at the 1600 ft TV-tower near Norman, Oklahoma are now available starting in May 1966. These data along with simultaneously recorded temperature data are being reduced and placed on punched cards by NSSL personnel and are being sent on a month-to-month basis to R-AERO-Y/MSFC. Studies are being initiated to analytically define continuous wind and temperature profile conditions to a height of 1600 ft and higher by use of simultaneously recorded rawinsonde data. Inhouse efforts are underway to analyze some of the initial profile data that have been received from NSSL.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structure
35. TASK AREA	Structural Loads

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-09-62	No Change

11. TITLE:
(U) Analysis of Detailed Vertical Wind Profiles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
01000 Meteorology 002200 Atmospheric Physics	08 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY– 67	0.5	–
		CURRENT FY– 68	0.5	–

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Scoggins, James R., R-AERO-Y TEL. 205 876-5645 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Dynamics of Atmosphere; Detailed Wind Profiles

24. (U) OBJECTIVE: a. Problem: - To investigate the causes of small-scale wind motions and relate the magnitude of associated wind shears and turbulence to the quasi-steady state winds to an altitude of 20 km. b. Application: - Establish wind design and flight criteria for space vehicles. c. Little technical information is available on the causes of turbulence and pronounced wind shears over limited heights within the first 20 km of the atmosphere. The reason is that high resolution vertical wind profile data were not available for study until recently.

25. (U) APPROACH: The physical features of small-scale wind motions will be studied to determine their characteristics and causes. Soon, high resolution temperature profile data associated with such wind data will be available for study. Dynamic meteorology and hydrodynamics will be employed to determine the reasons for wind anomalies of the upper atmosphere. Atmospheric turbulence which effects vertically rising vehicles will be analysed and defined. Wind and associated temperature variability, in time and with altitude, will be studied. Synoptic weather conditions, empirical relationship and mathematical models will be used to derive the causes and to establish prediction techniques of small-scale motions.

26. (U) PROGRESS: Three contract and several inhouse reports have been published. Contractor efforts have been at a minimum this fiscal year (FY-67) to allow time for digesting results to date, decide on new analytical approaches and to acquire more data. Inhouse work has continued and is being pursued with vigor because of the importance of this research in space vehicle design and operations. This task has been discussed with Mr. Douglas Gilstad, OART, Code RV-2, NASA, Headquarters. This work was begun under contract NAS8-5294 which was partially funded by 124-11-04-09.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY– 67	–	50
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY–68	–	50
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY– 69	–	100
35. TASK AREA	Structural Loads			

William G. Johnny

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965- O-795 048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	RPT U WORK U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-12-62	No Change

11. TITLE: (U) Effect of Shock Induced Separation on Vehicle Dynamics

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Aerodynamics 000500 Spacecraft 015900	05 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER NAS8-20354 a. DATE 05 66 c. TYPE M.CPFF d. AMOUNT $66,254	PRIOR FY— 67	0.5	-
		CURRENT FY - 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Howard, Paul W., R-AERO-AUE Tel: 205 876-1522 (FTS) RESP. INDIV: Young, James C., R-AERO-AUE TEL: 205 876-1611 (FTS)	NAME: Lockheed Missiles & Space Co. ADDRESS: Sunnyvale, California INVESTIGATORS PRINCIPAL: Ericsson, L. E. ASSOCIATE: Rieding, J. P. TEL: 405 743-2535 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Dynamics of Shock Induced Separation, Unsteady Aero, Aeroelasticity

24. (U) OBJECTIVE - a. Problem: - The effects that up stream cross-flow and locally accelerated flow have upon the boundary layer build-up and separation.
b. Application: - Prediction of aeroelastic interactions of launch vehicles. c. Shock induced boundary layer separation plays a dominant role in the effects of seperated flow on vehicle dynamics. It is important to know the effects of shock induced separation on overall vehicle dynamics. If we can relate the unsteady aerodynamics and the steady aerodynamic characteristics we will have provided a powerful tool for future vehicle design. Studies indicate that this is possible utilizing quasi-steady techniques. The problem in applying this technique is to determine how the time-lagged forces depend upon the motion of the upstream portion of the vehicle. The boundary layer separation is guided by the effects of upstream cross-flow and locally accelerated flow. This project will investigate the effect of upstream motion on boundary layer separation near compression and expansion corners, and the effect of the shock induced boundary layer separation has on overall vehicle and local structural dynamics.

25.

26. (U) APPROACH - (1) Consider factors producing aerodynamic forces in a region of shock induced separation. (2) Evaluate relative importance and develop analytic models that account for the main effects of the various factors. (3) Using quasi-steady techniques, establish analytical relationships between unsteady and steady forces in the separated flow region. (4) Plan and direct experiments and verify these relationships. (5) Formulate an analytic method for computation of the main effects of shock induced separation on the overall and local dynamics of launch vehicles.
(U) PROGRESS - Contract initiated 05-66. Fifty percent of experiments completed in MSFC tunnel. A literature search has been completed and reported in Lockheed Report L-87-66-1, entitled "Flow Separation Studies", December 1966, Report period 08 66-02 67

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
(1) MSFC 14" Wind Tunnel Facility (no cost) (2) Scaled Model Construction ($10,000)	PRIOR FY— 67	-	30
	CURRENT FY 68	-	40
	NEXT FY— 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Loads

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 28 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-13-62	No Change

11. TITLE:
(U) Theoretical Analysis of Meteorological Tower Data

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 002200 Atmospheric Physics	01 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama RESP. INDIV.: Fichtl, G., R-AERO-YE TEL: 205 876-6392 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATOR$ PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Boundary Layer Theory, Dynamics of Lower Atmosphere, Turbulence

24. (U) OBJECTIVE: a. Problem: - To theoretically define the behavior of lower atmospheric phenomena from the surface to 150 meters at Cape Kennedy, Florida. b. Applications: - Vehicle design criteria and vehicle response to lower atmospheric phenomena, especially winds. c. Mathematical and empirical definitions are to be derived from establishing the characteristic behavior of lower atmospheric phenomena at Cape Kennedy, Florida. Physical principles must be established for the relationships of atmospheric turbulence, wind shear, gusts and steady state winds as a function of stability, season, synoptic conditions, etc. Results of this effort will be
25. used as vehicle design criteria, vehicle response to winds, and to predict wind conditions for vehicle transport (VAB/pad) and launch.

(U) APPROACH: Data from NASA's 150 m Meteorological Tower and as recorded at various launch pads at Cape Kennedy will be used. Auto- and cross-correlations, spectra and cross-spectra, gust shapes will be computed, relationships between turbulence and wind shears and the steady state wind, and the influence of the thermal stability on the observed wind motions will be determined. The results will be used as criteria for input to vehicle response studies and to improve forecast methods.
26.
(U) PROGRESS: A cross service work order has been in effect with the National Weather Records Center, Asheville, North Carolina, to reduce, edit, then store all of NASA's 150 m Meteorological Tower data (i.e., wind, temperature, humidity, and pressure) onto magnetic tape for transmittal to MSFC/NASA. Various computer programs have been generated inhouse to analyse these data but, much work remains to be done. This task has been discussed with Mr. Douglas Gilstad, Code RV-2, NASA, Headquarters. The new effort will replace cross service order 13207A.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	46
	CURRENT FY-68	-	50
	NEXT FY— 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Loads

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-14-62	No change

11. TITLE: (U) Analysis of Relationship Between Micro-, Meso-, and Synoptic-Scale Meteorological Parameters

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 002200 Atmospheric Physics	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.5	-
		CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Scoggins, J. R., R-AERO-Y TEL 205 876-5645 (FTS)	NAME: ADDRESS: Not Selected. INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Turbulence, Aerospace Vehicle Design Criteria, Small-Scale Motions

24. (U) OBJECTIVE - a. Problem: - To establish relationships between small-scale variations of wind, temperature, extreme shears, turbulence and gusts in association with synoptic conditions. b. Application: - To determine space vehicle design criteria and to develop basis for improving forecasting techniques. c. Space vehicles environmental design and operational criteria will be developed inhouse using results from contractor and inhouse efforts.

25. (U) APPROACH - Hydrodynamics, turbulence, and statistical theories will be employed as required. Relationships between the synoptic and meso-scale features of winds, temperatures, etc., of the upper atmosphere will be analyzed initially to determine what relationships exist between these phenomena; then, relationships will be determined between the meso-scale and micro-scale features; and finally, corollaries will be made between the synoptic, meso and micro characteristics of upper atmospheric data. The detailed upper atmospheric winds and temperature data to be used in this study are those profile data acquired by the FPS-16 radar/Jimsphere technique.

26. (U) PROGRESS - A considerable amount of work has already been done and more is planned, both inhouse and by contractors, on the analysis of detailed wind profiles and on relationships between meteorological variables. Contractual work is underway in developing a technique to obtain detailed temperature data using the Jimsphere balloon system. This temperature developmental work is being carried out by the GCA Corporation under Contract No. NAS8-20588. This task has been discussed with Mr. Douglas Gilstad, NASA Headquarters, RV-2.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	50
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicles Structures
35. TASK AREA	Structural Loads

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-18-62	No Change

11. TITLE:
(U) Development of Low Level Turbulence Models

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002200 Atmospheric Physics 010000 Meteorology	01 61	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	b. NUMBER c. TYPE N/A a. DATE d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV: Fichtl, George H., R-AERO-YE TEL: 205 876-0875 (FTS)	NAME: ADDRESS: Same as 19. INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Boundary Layer Theory, Atmospheric Turbulence, Gusts, Steady State Wind Profiles

24. (U) OBJECTIVE - a. Problem: - To study the complete wind field from the surface to 500 ft. altitude at Cape Kennedy. b. Application: - Vehicle response (design and operation) to ground winds. c. Mathematical and empirical models are being derived which establish profile characteristics and relationships between turbulence, gusts, and steady state winds as a function of stability, season, climatic conditions, wind direction, etc. Space and time variability will be studied and forecasting methods developed. Results of this task are being used as input for evaluation of vehicle responses to low altitude winds, and to predict wind conditions for vehicle launch and operations.

25. (U) APPROACH - Atmospheric data from the 500 ft. (150-meter) meteorological tower, service structures, and other locations on Cape Kennedy are being utilized. Auto- and cross-correlations, spectra and cross-spectra, and gust shapes are being computed, relationships established between gusts at various altitudes and steady state winds, and the influence of stability on the observed motions are being determined. This information is being used to derive the mathematical and/or empirical models which present relationships between the various parameters and form the basis for input to vehicle response studies and for developing forecasting methods.

26. (U) PROGRESS - Computer programs have been developed in-house to investigate gust structure, spectra and cross-spectra of turbulence, steady state wind profiles, and statistics of mean wind flow. Results are being documented for use as, (1) environmental criteria, (2) vehicle operations, (3) full-scale vehicle response studies, (4) profile typing for wind tunnel model testing, etc.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY - 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Loads

William G. Johnson

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965 - O 795 048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-01-19-62	124-12-03-06-62

11. TITLE:
(U) Atmospheric Measuring Technique and Research Studies

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
005700 Elect. & Elect Erg. 002200 Atmosphere Physics	07 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER		a. DATE			
N/A	c. TYPE N/A		d. AMOUNT	PRIOR FY— 67	0.4	-
				CURRENT FY – 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
	INVESTIGATORS PRINCIPAL:
RESP. INDIV: Turner, Robert E., R-AERO-Y	ASSOCIATE:
TEL: 205 876-2767 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Weather Studies	N/A

23. KEYWORDS
Atmospheric Measuring Technique and Studies

24. (U) OBJECTIVE - a. Problem: - To establish techniques for increasing the overall performance of atmospheric measuring equipment, instrumentation, and/or other devices for use in support of MSFC/NASA space projects and programs. b. Application: - Atmospheric measuring equipment, instrumentation and/or devices. c. Atmospheric measuring equipment should be updated as new and unique techniques are developed to extract these type of data. These in-house studies are attempting to provide MSFC/NASA with the best equipment for this purpose.

25. (U) APPROACH - To modify or redesign present atmospheric measuring equipment, instrumentation and devices to increase its present engineering capacity and accuracies. This will be on existing equipment, and/or instrumentation.

26. (U) PROGRESS - Some modification to ground tracking equipment has been made. Signal to noise ratio improved, ranging technique modified, and recording system, in part, redesigned.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY–68	-	-
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA	Structural Loads			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U ~~RPT~~ U ~~WHK~~	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-20-62	124-12-03-17-62

11. TITLE:

(U) Comparison of Wind Measuring Instruments (Anemometers)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 002200 Atmospheric Physics	01 61	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	a. DATE		PRIOR FY— 67	0.1	-
N/A	c. TYPE N/A	d. AMOUNT		CURRENT FY—68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Camp, D. W., R-AERO-YE TEL: 205 876-0034 (FTS)	NAME: ADDRESS: Same as 19. INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Wind Measuring Instruments, Anemometers, Atmospheric Research Facility

24. (U) OBJECTIVE - a. Problem: - To determine the best off-the-shelf anemometer (if one exists) for the various fixed level wind measurements as needed by MSFC. b. Application: - The results of this determinational study will be utilized whenever purchases of fixed level anemometers are to be made. c. To investigate by comparative methods the relative merit of the various anemometers which are presently being used to obtain wind measurements. The anemometers being compared are mainly off-the-shelf items. The comparison is needed in order to determine the anemometer best suited for the overall requirements for obtaining wind measurements at a fixed level.

25. (U) APPROACH - Wind data as measured by various anemometers at MSFC's Atmospheric Research Facility will be compared. The comparison will be made using statistical, spectral, and relative comparative techniques. The results of the comparison will be utilized in analyzing wind data for input to vehicle response studies.

26. (U) PROGRESS - Several sets of data have been obtained and compared. The results of some of these tests have been published in NASA TM X-53451, "Preliminary Results of Anemometer Comparison Tests," dated April 26, 1967. Further testing, comparison, and publication of results will be forthcoming.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA	Structural Loads			

William G. Johnny

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965— O 795 048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006978	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	RPU WRU	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-04-21-62	N/A

11. TITLE:
(U) Development of Panel Flutter Criteria for Launch Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 010700 Missiles	07 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER: Pending	a. DATE:	PRIOR FY— 67	-	-
B Contract	c. TYPE:	d. AMOUNT:	CURRENT FY— 68	2.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Walker, Robert W., R-AERO-AUE TEL: 205 876-1522 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	LRC & ARC have been contacted and they are not planning to perform work of this type.

23. KEYWORDS Panel Flutter, Aeroelasticity, Launch Vehicle Criteria

24.
(U) OBJECTIVE - a. Problem: - No panel flutter criteria for launch vehicles exist. b. Application: - Flutter analysis of panels on missiles and launch vehicles. c. Basis of Need: - Present panel flutter criteria, which is based on the elimination of flutter, was developed for aircraft where endurance is a prime consideration. For launch vehicles where fatigue is not a problem, controlled flutter may be acceptable from a weight standpoint. Currently there is no existing theoretical or experimental information on which to base adequate flutter design criteria for launch
25 vehicle panels. No work of this type is in progress or planned at Ames or Langley.

(U) APPROACH - a. Review and summarize present flutter criteria. b. Theoretically and/or experimentally establish the most important structural and aerodynamic factors which control the onset and magnitude of panel flutter. c. Design and conduct experiments to parametrically investigate the influence of these factors. d. Summarize the experimental and theoretical efforts in the form of a panel flutter criteria for launch vehicles.

26 (U) PROGRESS - None

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
Government owned wind tunnel (no cost)	PRIOR FY— 67	-	-
	CURRENT FY 68	-	40
	NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Loads

William G. Johnny

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

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SUBJECT: (U) Development of Panel Flutter Criteria for Launch Vehicles

CODE: 124-11-04-21-62

BASIS OF NEED: For launch vehicles where structural fatigue is not a controlling factor it may be desirable from a weight standpoint to allow controlled flutter. At present there is no experimental or theoretical means of predicting the severity of flutter thereby forcing overly conservative design criteria with its associated weight penalty to be used.

APPLICATION: The results of this work will be applied to the development of panel flutter criteria for future launch vehicles and missiles.

SPIN OFFS AND APPLICATION: None

TOTAL TIME AND EFFORT: Approximately 2 years with a total investment of only $140,000.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002852	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U RPT / U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-02-62	No Change (124-11-05-08-62) (931-31-01-00-62)

11. TITLE:
(U) Establishment of Guidelines for Random and Sinusoidal Vibration Correlation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Spacecraft 015900	06 61	03 67	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-2504 a. DATE 06 61	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT (P) 99.881	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Massachusetts Institute of Tech.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Cambridge, Massachusetts
RESP. INDIV.: R-P&VE-SV Farrow, J.H., and Jewell, R.E.	INVESTIGATOR'S PRINCIPAL: Crandall, Stephen H.
TEL: 205 876-9067 (FTS)	ASSOCIATE:
	TEL: 617-UN4-6900 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	Headquarters/Lead Center assignment

23. KEYWORDS
Random and Sinusoidal Vibration; Structural Dynamic Parameters; Multi-Degree of Freedom; Analytical Models

24 OBJECTIVE: (U) (a) Problem: to determine vibro-acoustic response of a complex structure to wide band random excitation and to high frequency shocks. (b) Application: shock and vibration specifications. (c) Recently the problems of pyrotechnic shock involved in separation of rocket booster stages of space vehicles have necessitated a reappraisal of the techniques for handling shock excitations. The response due to wide band random excitation could be treated by the classical approach; however, in cases where the higher modes dominate the response the application of the classical approach becomes
25 expensive and difficult because of the additional computer time required and the need for more detailed structural information than is available during the preliminary design stage.

APPROACH: (U) The existing knowledge concerning dynamic characteristics of rocket vehicles when subjected to random driving functions is limited. The widespread disagreement among dynamicists indicates the necessity for thorough investigation of the random forcing phenomena. Consequently coupled empirical-theoretical studies are needed in order to advance the state of the art.

PROGRESS: (U) Work in the present phase of the contract considers the vibro-acoustic
26 energy distribution in a complex structural model. Analytical and experimental studies will be made to determine the validity and useful range of a dynamic St. Venant's principle. Work during this reporting period has been principally devoted to selecting and assembling instrumentation. Amplifiers, multiplexers, and impedance heads have been tested, orders for necessary equipment have been placed. There have been some delays in transferring the model test cylinders constructed at North American Aviation.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		931-31	

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY— 67	-	35
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY— 68	-	40
34. SUB PROGRAM	Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA	Structural Dynamics			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 002854

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 08 67	D Change 15 08 66	U HPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-09-07-60	No Change

1. TITLE: (U) Theoretical Research on the Pressure Distribution on Nonspinning Multistage Spacecraft performing Bending Oscillations

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000000 Aerodynamics	03 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER NAS8-873 a. DATE 03 61	PRIOR FY— 67	0.1	--
	c. TYPE M.CPFF d. AMOUNT P$143,000	CURRENT FY - 68	--	--

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Massachusetts Institute of Tech.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Cambridge, Massachusetts
RESP. INDIV. Sims, Joseph L., R-AERO-AM	INVESTIGATOR$ PRINCIPAL:
TEL: 205 876-2300 (FTS)	ASSOCIATE: Hsu, P. T.
	TEL: 617 864-6900 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Aircraft and Space Vehicle	N/A

23. KEYWORDS

Pressure Distribution, Aerodynamic Forces, Unsteady Airloads

24. (U) OBJECTIVE - a. Problem: - Theoretical calculation of unsteady airloads on flared, multistage launch vehicles. b. Application: - Results will be applicable to the aerodynamic design of launch vehicles and spacecraft. c. The end product of this investigation will be computer programs for the calculation of unsteady airloads on general axisymmetric bodies.

25. (U) APPROACH - A small perturbation method, starting from a steady flow field computed by the method of characteristics, has been formulated and programmed for predicting the unsteady load distribution due to lateral oscillations of an axisymmetric body in supersonic flow. The major technical problem appears to be the shock wave boundary conditions.

26. (U) PROGRESS - a. This period was 15 08 66 to 15 02 67. b. The checkout of the steady flow field program for the sharp-nosed body with secondary shocks at downstream corners is complete. Programming of the unsteady flow equations is essentially complete and program debugging has been started.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		931-50 (FY-61)	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	--	2
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	--	--
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	--	--
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 08 66)	U PPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-08-62	No Change

11. TITLE:
(U) Axial Transmissibility Characteristics of Typical Rocket Vehicle Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Spacecraft 015900	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-18124 c. DATE 06 66	PRIOR FY— 67	0.2	-
	c. TYPE M. CPFF d. AMOUNT $59,800	CURRENT FY - 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: North American Aviation, Inc.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: 12214 Lakewood Boulevard, Downey, California 90242
	INVESTIGATORS PRINCIPAL: Lee, Stuart
RESP. INDIV.: Schock, R. W., R-P&VE-SVE	ASSOCIATE:
TEL: 205 876-9068 (FTS)	TEL: 923-8111, Ext. 2424 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
(U) OBJECTIVE: The purpose of this contract is to develop techniques to define the effects of equipment mass loading on the shock load response environments in typical rocket vehicle structures.

(U) APPROACH: Analytical and empirical methods will be employed to evaluate and modify previously developed techniques to predict axial shock response of mass loaded cylindrical shell structures subjected to various shock pulses. Program will consist of 3 phases: (1) Analytical investigation, (2) Experimental investigation, and (3) Comparison, evaluation, modification.

25.
(U) PROGRESS: Analytical and empirical results have been compared on five models, including an orthotropic shell and an orthotropic shell with the subsequent addition of ring frames, stringers, bulkheads, mass, and liquid loading. Good agreement on frequency and amplitude has been obtained on the simple shell model with prediction/test correlation decreasing with increase in model complexity. However, correlation has been well within expected tolerances.

PUBLICATIONS: "Axial Transmissibility Characteristics for Typical Rocket Vehicle Structures" SID GS-1435

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY-68	-	75
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (19 10 64)	U (RPT) U (WRK)	N/A	6A	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-10-62	No Change (103-11-07-07-62)

11. TITLE:
(U) Study of Non-Linear Dynamic Behavior of Liquids in Cylindrical Elastic Container

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Mechanics	06 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11045 d. DATE 06 63	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT $164,196	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Southwest Research Inst.
ADDRESS: Huntsville, Alabama 35812	ADDRESS: San Antonio, Texas
	INVESTIGATORS PRINCIPAL: Abramson, Dr. H. Norman
RESP. INDIV: Eulitz, Dr. W. R., R-P&VE-P	ASSOCIATE:
TEL: 205-876-4662 (FTS)	TEL: 512 684-2000 Ex 285 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Liquid behavior, vibrations

24. OBJECTIVE (U) The response of a liquid under longitudinal vibrations is pronouncedly nonlinear. This leads to a complex pressure distribution within the liquid. In an elastic container, shell vibrations will be excited which in turn will interact with the liquid vibrations in a way not yet clarified. The objective of this investigation is to clarify the situation at least semi-quantatively to discern the possible reprecussions of such complicated pressure distributions to the propellant feed system of a large booster vehicle like Saturn V.

25. APPROACH (U) Longitudinally excited liquids in rigid flat bottomed containers have been investigated so far, and work with flexible tanks, but rigid flat bottom is being carried out.

26. PROGRESS (U) Experiments confirm that axisymmetric models are very difficult to obtain for they are most frequently superimposed by nonasixymmetric response. In addition to that, experimental data reveal that the non-axisymmetric response is definitely originated by dynamic instability effects of the tank wall. A linear asixymmetric response has been obtained only with considerably stiff containers such as tube-like steel shells, brass shells, or strongly ring-stiffened shells of elastic materials (mylar). A separate report which presently is in the process for publication will combine all the results obtained from this portion of the contract work.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
			103-11

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY— 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004301	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 08 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-12-62	No change

11. TITLE:
(U) Three-Dimensional Analysis of Launch Vehicles Including Shell Degrees of Freedom

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft lnch vehs and grnd supt	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-21095 DATL 03 67	PRIOR FY— 67	0.2	27
	c. TYPE M. CPFF d. AMOUNT $26,538	CURRENT FY—68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Kiefling, Larry, R-AERO-DDS TEL 205 876-8222 (FTS)	NAME: Lockheed Aircraft Corporation. ADDRESS: Lockheed Missiles and Space Co. P. O. Box 1103 West Station Huntsville, Alabama 35807 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
vibration, stiffened shells, static response, dynamic response

24.
(U) Objective: (a) Problem: Analyze a space vehicle system in three dimensions including shell degrees of freedom. (b) Application: Launch vehicle and space vehicle system vibrations. (c) Vehicle motion out-of-plane excitation has become increasingly important, as have shell modes, as vehicle flexibility has increased. These effects must be described fully to assure control stability of launch vehicles as well as future space vehicles.

25.
(U) Approach: The vibration characteristics of stiffened shell structures, will be determined emphasizing those configurations used in Saturn type launch vehicles. This is done by two methods. First, the differential equations of motion for the curved sheets and the stiffening elements and the difference equations for the structure are formulated. A circumferential lumping of the mass is retaining, however, a continuous distribution in the longitudinal direction. In the second method, the difference-differential equations of motion of the stiffened circular cylinder are solved for the frequencies of vibrations. The solutions are then compared with existing approximate solutions reported in the literature.

26. (U) Progress: Report internal 1 July 66 to 1 Jan 67. A computer program for determining stiffness shell frequencies has been completed. The effect of parameter variations is now being investigated.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	27
	CURRENT FY—68	-	-
	NEXT FY—69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004302

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-13-62	No Change

11. TITLE:

(U) Nonlinear Dynamic Analysis of Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	01 67	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT a. DATE b. NUMBER c. TYPE d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	c. TYPE Pending	PRIOR FY— 67	0.1	-
		CURRENT FY-- 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	Not Selected
RESP. INDIV.: McDonough, George F., R-AERO-D	INVESTIGATOR& PRINCIPAL:
TEL: 205 876-6895 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Launch Vehicles, Space Vehicles	N/A

23. KEYWORDS

nonlinear, large deflections

24. (U) Objective: (a) Problem: Develop methods of analysis of large extremely flexible structures which will include the effects of nonlinearities which have been identified but for which no adequate description has been obtained and no analytical techniques are available. (b) Application: Launch vehicle systems, particularly extremely large and flexible structures considered for advanced configurations of upper propulsive stages and payloads. (c) The solution of the two main nonlinearity problems, nonlinear structural joints and slightly nonlinear overall vehicle dynamic characteristics, leads directly to the problem of highly nonlinear structures which require techniques of analysis which depart radically from linear elastic analysis. This study will explore available techniques.

25. (U) Approach: Several well-known mathematical techniques are available for analysis of highly nonlinear systems but each requires certain assumptions. How closely the assumptions fit the structures of space and launch vehicles will be investigated and trial application will be made.

26. (U) Progress: The basic problems of nonlinear joints have been identified and an analysis technique developed to handle such behavior. Also a computer program has been developed for this problem and for that of a multi-stage vehicle with one or more stages exhibiting nonlinear behavior. Contract NAS8-20387 with Lockheed was completed January 7, 1967. This work will continue in a new contract.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	30
	CURRENT FY-- 68	-	25
	NEXT FY 69	-	35

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 004304	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-15-62	No Change

11. TITLE:

(U) Response of an Elastic Space Vehicle to Random Disturbances

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Veh. & Grd. Sup.	03 67	10 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT b. NUMBER	c. TYPE	d. AMOUNT	e. DATE
B Contract		Pending		

18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
PRIOR FY— 67	0.1	-
CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Not Selected
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATOR'S PRINCIPAL:
RESP. INDIV.: McDonough, George F., R-AERO-D	ASSOCIATE:
TEL.: 205 876-6895 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Launch Vehicle	N/A

23. KEYWORDS

dynamic stability, random inputs

24.

24. (U) Objective: (a) Problem: Analyze stability of vehicle system response to random excitation. (b) Application: Dynamics of launch vehicles, payloads, and space and orbiting vehicles. (c) Sinusoidal inputs, which are now being used in the analyses of vehicle stability for control system design, are inadequate for complete understanding of vehicle response to generalized disturbances. This study will examine the effects of nondeterministic inputs on launch vehicle stability and
25. control and extend these results to payload and space vehicle applications.

25. (U) Approach: System studies will begin with beam-columns, plates, cylindrical shells, and conical shells and increase in difficulty of analysis to realistic ring-and-stringer stiffened shells such as those found in launch vehicle structures. Finally some general forms of complex flexible structures such as those found in space vehicle payloads will be studied. Inputs will be limited to white noise.

26. (U) Progress: The effort under this proposed task is partially an outgrowth
26. of research performed for a paper entitled, "Dynamic Stability of Thin Elastic Plates under the Action of Non-Deterministic Loads" by L. L. Fontenot, G. F. McDonough and D. O. Lomen, presented at the Sixth International Symposium on Space Technology and Sciences, Tokyo, 1965. Previous studies completed under this task have established the fundamental form of the required solution and have shown the inadequacy of using sinusoidal inputs to determine the response characteristic of complex systems when the disturbances to be encountered are random. Contract NAS8 20374 with Lockheed was completed on October 22, 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY — 67	-	25
	CURRENT FY — 68	-	30
	NEXT FY — 69	-	45

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (01 04 65)	~~U~~ ~~WNK~~ U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-17-62	No Change

11. TITLE:

(U)Studies of Liquid Behavior in Randomly Excited Rigid Tanks

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Mechanics	02 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20319 b. DATE 02 66	PRIOR FY— 67	0.1	-
	c. TYPE M. CPFF d. AMOUNT 34,044	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Southwest Research
ADDRESS: Huntsville, Alabama 35812	ADDRESS: San Antonio, Texas
	INVESTIGATORS PRINCIPAL: Kana, Daniel D.
RESP. INDIV: Eulitz, W. R. R-P&VE-P	ASSOCIATE: Abramson, Norman H.
TEL: 205 876-4662 (FTS)	TEL: 512-684-2000 Ex 285 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. OBJECTIVE (U) All previous investigation of liquid response to vibrational excitation were dealing with deterministic processes in which the excitation of the tank is a definite function of time (primarily sinusoidal), and which the response of the liquid is also deterministic. In a launch vehicle, however, random excitations of the systems are more likely. In a random process only the statistical behavior of the system can be predicted and explained. The specific objectives of this project include lateral and longitudinal excitation of rigid cylindrical tanks. In the case of lateral excitation, the objective is to demonstrate the validity of the linear assumption for force response under random excitation. In the longitudinal case the objective is to explore the effects of random excitation on some of the non-linear problems delineated in contract NAS8-11045 carried out by the same contractor.

25. APPROACH (U) This study shall deal with random processes, in which the excitation of the tank and the resulting fluid response can only be described in statistical terms.

26. PROGRESS:(U) The lateral excitation experiments involved random displacement signals having various frequency distributions and energy levels. Comparison between frequency response data under random and sinusoidal excitation are now being conducted. Some exploratory studies have been carried out on the general occurrence of surface breakup and spray under longitudinal random excitation, as well as on the formation and migration of bubbles. Effects in both cases are generally similar to those observed under sinusoidal excitation.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 004306	
4. DATE OF RESUME 15 03 67	5. KIND OF RESUME D Change 15 08 66	6. SECURITY RPT U WRK U	7. REGRADING N/A	8. RELEASE LIMITATION GA	9. LEVEL OF RESUME A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-19-62	No Change

11. TITLE:
(U) Study of the Solution of Nonlinear Algebraic Equations

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009780 Mathematics and Statistics	12 65	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20178 a. DATE 12 65 c. TYPE M. CPFF d. AMOUNT P25,068	PRIOR FY— 67	0.1	-
		CURRENT FY—68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Ryan, Robert S., R-AERO-DD TEL: 205 876-2382 (FTS)	NAME: Lockheed Aircraft Corporation ADDRESS: P. O. Box 1103 West Station Huntsville, Alabama 35811 INVESTIGATORS PRINCIPAL: Cawood, D. W. ASSOCIATE: TEL: 205 837-1800 x255 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
nonlinear algebraic equations

24. (U) Objective: (a) Problem: Solution of a simultaneous set of nonlinear algebraic equations. (b) Application: Solution of nonlinear structure and control problems. (c) The analysis of nonlinear dynamics and control problems of space vehicles leads to the solution of a set of nonlinear algebraic equations. The results of this study will be numerical procedures to be used in nonlinear structural and control problems of space vehicles.

25. (U) Approach: Transform the basic equations into a form suitable for solution. Develop an iteration procedure for obtaining a set of solutions based on initial guesses. Implement a computer routine for obtaining roots.

26. (U) Progress: Three different approaches have been programmed and compared for several different systems of equations. These methods have been improved to speed up convergence rate. A computer program with option to use each method was developed. While this work is considered important, and will continue with minimum effort, no funds were requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	25

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 004298

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Complete 15 08 66	U	U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-21-62	No Change

11. TITLE:
(U) Fuel Sloshing Studies (Optimal Design of Slosh Baffles)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Dyn., 016000 Launch Vehicle	01 66	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-20290 a. DATE 01 66	PRIOR FY— 67	-	-
	c. TYPE MCPFF d. AMOUNT 59,300	CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Southwest Research Institute
ADDRESS: Huntsville, Alabama 35812	ADDRESS: 8500 Culebra Road San Antonio, Texas
RESP. INDIV.: Buchanan, Harry, R-AERO-DDS	INVESTIGATORS PRINCIPAL: Dodge, Franklin ASSOCIATE: Abramson, Norm
TEL: 205 877-2278 (FTS)	TEL: 512, OV4-2000 ex. 269 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Ship design	N/A

23. KEYWORDS
baffles, damping, flexibility

24. (U) Objective: (a) Problem: Determination of procedure for designing an optimal anti-slosh baffle. (b) Application: Design of anti-slosh devices for space vehicles. (c) The control of liquid propellants during flight due to its interaction with vehicle control leads to the design of anti-slosh devices. This study will enhance this design by using baffle flexibility.

25. (U) Approach: The analytical representation of the pressure distribution on a baffle and the damping provided by a series of ring baffles at various angles of orientation is the first step. The formulation should consider baffle flexibility, baffle perforation, and distance from baffle to tank wall. Results of these analytical formulations must be checked with experimental findings and corrections made. The final step is to provide an analytical means or a series of monographs for designing an optimal baffle system for a liquid propellant space booster.

26. (U) Progress: An experimental investigation of slosh damping by flexible ring baffles has been completed. An analytical study of the same problem has been started and some preliminary conclusions have been reached. Publications: Southwest Research Institute Technical Report No. 1, Contract No. NAS8-20290, 17-08-66. This work is related to work unit 124-11-05-35-62.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle System, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (09 30 66)	U RPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-22-62	No Change

11. TITLE:
(U) Mobile Acoustic Research Laboratory (MARL) Utilization

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 acoustics	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-18500	d. DATE 06 66	PRIOR FY— 67	0.1	-
	c. TYPE A. FPF	d. AMOUNT 50,634	CURRENT FY 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Brown Engineering Company
ADDRESS: Huntsville, Alabama 35812	ADDRESS: 300 Sparkman Drive Huntsville, Alabama
RESP. INDIV. Farrow, J.H., Jewell, R.E., R-P&VE-SV	INVESTIGATORS PRINCIPAL:
TEL 205 876-9067 (FTS)	ASSOCIATE: Mentzel, J.
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Mobile Acoustic Research Test Fixture

24.
OBJECTIVE: (U) (a) Problem: To expose large structural segments to intense acoustical fields and investigate vibro-acoustic coupling. (b) Application: Determination of vibro-acoustic transfer functions. (c) The purpose of the MARL is to take advantage of the world's most powerful noise generators such as the F-1 engine S-IC stage, etc., in conducting basic research to determine the effects of high energy acoustics on structures and components of launch vehicles.

APPROACH: (U) The MARL is a transportable test fixture to which various structural assemblies and components will be mounted and exposed to the intense acoustic fields resulting from static firings of stages and engines. The spectrum level and shape can be controlled by moving the MARL about in the acoustic field and also by exchanging the source (i.e., exposing the structure to a single engine environment, rather than a stage environment, etc.).

PROGRESS: (U) Fabrication of the MARL has been completed and at present instrumentation and structures are being obtained and schedules established for utilization of the fixture. Tentative plans are to commence testing on the SA-5 center barrel type instrument unit in June or July of 1967.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	120	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 006979	
4. DATE OF RESUME 15 03 67	5. KIND OF RESUME (16 04 66) B. Complete	6. SECURITY U RPT U WRK	7. REGRADING N/A	8. RELEASE LIMITATION GA FO	9. LEVEL OF RESUME A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-23-62	No Change

11. TITLE:
(U) Vibration Qualification Test - Damage Criteria Study

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016300 Structural Engineering	11 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Schock, R. W., R-P&VE-SVE TEL: 205-876-9068 (FTS)	NAME: ADDRESS: Same As 19 INVESTIGATOR& PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24.
OBJECTIVE: (U) The purpose of this study is to determine the relationship between the G response and stress levels of a typical propellant duct in a vibration environment.

25.
APPROACH: (U) The first phase consisted of subjecting a fuel suction line specimen to sinusoidal and random vibration in the three orthogonal axes. The second phase was evaluating the recorded data and making a study to correlate the response and strain data.

26.
PROGRESS: (U) Tests have been completed and data analyzed. The tests indicated that the only significant primary structure stress levels occurred at the first natural frequency of the line. These measured levels were less than 5000 psi rms, and were well below the endurance limit of the material. It was concluded that stress levels in primary lines (excluding bellows and gimbals) were not sufficient to induce fatigue failures without extensive contribution of stress risers such as welds or stress concentration factors. This report completes this program.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006980	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (16 04 66)	RPT U WRK U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-24 62	No Change

11. TITLE:
(U) Microphone Vibration Sensitivity

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 Acoustics	09 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.5	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Green, C. E., R-P&VE-S TEL 205-877-3791 (FTS)	NAME: ADDRESS: Same As 19 INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Transducers, sensitivity

24.
OBJECTIVE: (U) To determine the capability of certain transducers to function correctly in various severe environments and determine areas where advances in the state-of-the-art are needed.

25.
APPROACH: (U) Measure the respective characteristics of 'off-the-shelf' transducers when subjected to the severe environments of today's large rockets. Analysis of this response data will allow determination of the most suitable transducers for a particular environment and point out areas where improvements in transducers are needed.

26.
PROGRESS: (U) Testing has not progressed according to schedule because the 66 transducer specimens have not yet been received. Testing will begin immediately upon receipts of the specimens.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Thomas

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006986	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 04 03 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-30-62	No Change

11. TITLE: (U) Dynamic response of vehicle to detail wind profiles and the construction of a synthetic profile based on these detail profiles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft launch vehicles	01 68	12 69	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT b. NUMBER	c. TYPE	d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A		N/A		PRIOR FY– 67	1.0	-
				CURRENT FY-- 68	1.0	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812
RESP. INDIV.: Ryan, Robert S., R-AERO-DD
TEL: 205 876-2382 (FTS)

20. PERFORMING ORGANIZATION
NAME:
ADDRESS: Same as "19"
INVESTIGATOR$ PRINCIPAL:
ASSOCIATE:
TEL: TYPE:

21. TECHNOLOGY UTILIZATION
missiles, rockets, and space research

22. COORDINATION
N/A

23. KEYWORDS
profiles, detail, turbulence, response, dynamics, synthetic profile meteorology

24.
(U) Objective: (a)Problem: Determine the response of a space vehicle using detail Jimsphere wind profiles. (b) Application: Approach;run vehicle response to many detail profiles. Interpret these results such that the steady-state, shear, and the gust response are separated. Construct one or several synthetic profiles that will produce the same vehicle responses. (c) The response of vehicle to small scale wind disturbance is critical where flexibility is high. The results of this study will be used to improve prediction of vehicle responses to small scale disturbances.

25. (U)Approach: The task is being carried out theoretically using a high speed repetitive analog computer. The vehicle response is obtained for each detail wind profile and a statistical response obtained for the total ensemble of winds. A second run is made for the Rawinsonde form of the detail winds and a run made for the turbulence extracted from the detail profile to construct the Rawinsonde. By comparing various runs and observing the response to individual wind profiles, synthetic wind profiles will be constructed and checked as the statics of the ensemble of detail profiles.

26.(U)Progress: Basic results have been obtained in the form of probability, variance, and mean for wind turbulence, total wind profiles, and quasi-steady wind profiles, and comparisons made with the MSFC synthetic profile. A paper of the results was presented at the AIAA 5th Aerospace Science Meeting, New York, January 22-24, 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006987

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 07 03 66	RPT U WORK U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-32-62	No Change

11. TITLE:
(U) Use of Dynamic Scale Models to Determine Launch Vehicle Characteristics

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft lnch veh & gnd support	09 66	12 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE; b. NUMBER; c. TYPE pending; d. AMOUNT	PRIOR FY– 67	0.1	-
		CURRENT FY– 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATORS PRINCIPAL: Not Selected
RESP. INDIV.: McDonough, George F, R-AERO-DD	ASSOCIATE:
TEL: 205 876-6895	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
scale models, scaling laws, launch vehicle dynamics

24. (U) Objective: (a) Problem: To determine feasibility of using scale models to determine future launch vehicle dynamics. (b) Application: Stability and response studies of launch vehicles. (c) Much full-scale and scale-model testing has been done on several launch vehicles, it now is necessary to examine the data for correlation and verification of model scaling laws.

25. (U) Approach: To examine results from several sources of model dynamic test data and compare with theoretical analyses of these models to determine the limits of the ability to predict model results for several configurations to determine what prototype characteristics must be reproduced in the model. To examine coupling of sloshing propellants, engine dynamics and suspension systems with the structural oscillations of the model and determine whether meaningful extension of these aspects of model testing can be made to full-scale tests.

26. (U) Progress: Bids have been received and evaluated. Negotiations are in progress.

Note: No funds were requested in FY-68 due to funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	25
	CURRENT FY 68	-	-
	NEXT FY 69	-	40

33. UNIQUE PROJECT	Space Vehicle Systems, ART
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006988	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-33-62	No Change

11. TITLE:
(U) Liquid Free Surface Instability Under Random Excitation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
00640 Fluid Mechanics	03 67	10 68	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT a. DATE / b. NUMBER / c. TYPE / d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	c. TYPE Pending	PRIOR FY— 67	0.1	-
		CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. McDonough, George F., R-AERO-D TEL. 205 876-6895 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Vehicle Stability	N/A

23. KEYWORDS
N/A

24. (U) Objective: (a) Problem: To determine the stability of a liquid free surface under the effects of random excitation. (b) Application: Liquid propellant oscillations during launch phase of flight. (c) Sinusoidal inputs are insufficient to establish completely the stability of propellant oscillations in vehicle tanks because of the randomness of disturbances acting on the vehicle, hence random disturbance effects must be considered.

25. (U) Approach: Analytical studies of preliminary nature have shown the possibilities of obtaining meaningful results in the study of liquid free-surface instability under random excitation. This study seeks to define instability (in a mean-square sense) and to develop criteria for the onset of such instability as well as for duration and magnitude of these effects.

26. (U) Progress: The effort under this contract is based on definite efforts as reported in a paper entitled "Liquid Free Surface Instability Resulting from Random Vertical Acceleration" by L. L. Fontenot, G. F. McDonough and D. Lomen, presented to the Sixth International Symposium on Space Technology and Science, Tokyo, 1965.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	25
	CURRENT FY 68	-	25
	NEXT FY 69	-	25

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

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(Items 1 to 26 identical to DD Form 1498.)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006989	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 03 66	R&D U WWK U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-34-62	No Change

11. TITLE:
(U) Local Angle-of-Attack Effects on Vehicle Dynamic Response

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	09 66	12 67	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A a. DATE	PRIOR FY– 67	0.1	-
	c. TYPE d. AMOUNT	CURRENT FY– 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
RESP. INDIV. Papadopoulos, James, R-AERO-DD	INVESTIGATOR$ PRINCIPAL:
TEL: 205 876-9305 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
local angle of attack response loads

24. (U) Objective: (a) Problem: Determine the effect of local angle of attack on launch vehicle dynamics and structural loads during atmospheric flights. (b) Application: Determination of more accurate launch vehicle responses to atmospheric disturbances. (c) The design of vehicle structures is made in relation to the vehicle response to atmospheric disturbances. This study will provide more accurate design methods.

25. (U) Approach: The theoretical equations for vehicle dynamics using local angle of attack will be derived and solved by both harmonic analysis and time response to determine local angle of attack effect and procedures for analyzing. Comparison will be made to flight data available for present vehicles.

26. (U) Progress: The theoretical equations for vehicle dynamics have been expanded to include the effects of local angle of attack. Quasi-state aerodynamics are being utilized. Present indications are that this analysis will appreciably effect the magnitude of local structural load-calculations during atmospheric flight.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY – 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	-
35. TASK AREA: Structural Dynamics			

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	RD U WORK U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-35-62	No Change

11. TITLE:
(U) Analysis of Fuel Sloshing

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid Dyn., 01600 Launch Vehicle	06 65	06 68	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-20290, Mod. 1 a. DATE 01 66 c. TYPE M.CPFF d. AMOUNT P99390	PRIOR FY— 67	0.1	40
		CURRENT FY - 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Ryan, Robert S. R-AERO-DD TEL: 205, 876-2382 (FTS)	NAME: Southwest Research Institute ADDRESS: San Antonio, Texas 78206 INVESTIGATORS PRINCIPAL: U.S. Lindholm ASSOCIATE: D. D. Kana TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
numerical, procedure, arbitrary shaped

24.
(U) Objective: (a) Problem: Description of dynamics characteristics of a liquid in an arbitrary shaped tank. (b) Application: Determination of slosh models for launch vehicles. (c) The design of the system control of launch vehicles requires the description of liquids in the containers. The containers are not adapted to analytical procedures; therefore, the numerical procedure developed will be applied to future launch vehicle design problems.

25. (U) Approach: Write the equation of motion for the liquid in a moving container of arbitrary shape. Linearize the equation and extend the known numerical procedures for a completely arbitrary shaped tank including baffles. Also, improve the present numerical procedures such that less effort is required for solution. Extend the results to nonlinear representation by using perturbation about the dominant frequency, or some other applicable approach.

26. (U) Progress: 15 03 66 to 15 03 67 The analysis of fuel sloshing in arbitrary shaped tanks as described in GD/A-DDE64-062 and GD/A-DDE64-061, has been extended to provide slosh model parameter for the six degrees of freedom case, slosh damping by ring baffles, and force and moment distributions. The work under contract NAS8-20191 has been completed.
This work is related to Work Unit 124-11-05-21-62 and the additional effort will continue under contract NAD8-20290, Modification No. 1 at the Southwest Research Institute.
Funds for FY 68 were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	40
	CURRENT FY 68	-	-
	NEXT FY 69	-	40

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change (15 03 66)	U RPT U WRK	N/A	GA FO	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-36-62	No Change

11. TITLE:

(U) Optimization of Duct Assemblies for Vibration

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
004100 Composite Matls. 010300 Misc. Materials 000200 Acoustics	03 67	N/A	N/A

16. PROCURE METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.1	-
		CURRENT FY-- 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Lifer, C., R-P&VE-SVA RESP. INDIV. Veitch, R. H., R-P&VE-PMF TEL: 205-877-3279 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. (U) OBJECTIVE

(a) Problem: A significant problem area associated with space vehicle ducting systems, having long unsupported spans, is the generation of high vibratory stresses, when exposed to the acoustic and vibration environment, resulting in fatigue failure. In the past the solution to this problem has been the design of additional support bracketry to react the high vibratory response loads on the ducting. Considerable weight could be eliminated if other means of reducing the vibratory response loads could be incorporated in the ducting design, such as the addition of damping mechanisms, or the use of new ducting materials which exhibit high damping properties.

(b) Application: If new concepts prove effective, they should be incorporated on current vehicles as new designs or redesigns.

(c) The objective of this study is to find the optimum materials and design for the devices with MSFC recommended ducting materials. This study should optimize the device design, such as length, thickness and location for maximum vibration absorption. The study should include a correlation of the theory for this concept with the actual test results.

26. (U) APPROACH

This study should include the design, development, and testing of ducting systems utilizing optimum damping techniques and mechanisms for reducing the vibratory response loading on the ducting. A materials study should also be initiated with the purpose of selecting materials for ducting systems which exhibit optimum strength and damping properties. The study should include a correlation of the theoretical analyses for these material and damping mechanism concepts with experimental test results.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	100
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U U	N/A	1A	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-38 -62	N/A

11. TITLE:
(U) Aerodynamic Forces on Fluttering Cylindrical and/or Planar Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics 006400 Fluid Mech	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
Contract	a. DATE b. NUMBER c. TYPE: Pending d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY - 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Beranek, Richard G., R-AERO-AUU TEL: 205 877-3217 (FTS)	NAME: Not Selected ADDRESS: INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Flutter, Aeroelasticity, Aerodynamic Pressure, Shell Flutter

24. (U) OBJECTIVE - a. Problem: - Determine the flutter behavior of cylindrical and/or planar structures in the transonic and low supersonic speed range. b. Application: - Flutter analysis of launch vehicle structures.

25. (U) APPROACH - Linearized, three-dimensional potential flow theory, small deflection plate theory and boundary layer theory will be used in assessing the boundary layer effect on fluttering surfaces in the transonic and low supersonic speed range. Wind tunnel investigations will also be conducted on two and three-dimensional, steady, wavy cylindrical and/or planar surfaces.

26. (U) PROGRESS - A method, employing linearized flow theory and small deflection plate theory, has been developed for predicting the flutter behavior of very low aspect ratio panels in low supersonic flow.

Stability boundaries have also been obtained for short cylindrical shells using linear piston theory, linearized potential flow, and an idealized boundary layer theory.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	35
	NEXT FY 69	-	40

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

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SUBJECT: (U) Aerodynamic Forces on Fluttering Cylindrical and/or Planar Structures

CODE: 124-11-05-38-62

BASIS OF NEED: Current technology has not provided an accurate and rational design criteria for establishing stiffness requirements for both the isotropic and complex anisotropic structures. Data trends indicate that the transonic and low supersonic speed regime imposes the most severe design requirement. The aerodynamic boundary layer, neglected in the past, is suspected of having a pronounced effect on the flutter behavior of outer skin structures in this regime. Present approximations of the effect of the boundary layer on the flutter of panels, flat and curved, and thin cylindrical shells, appear to be inadequate.

APPLICATION: The final result of this program would be a workable method by which the flutter behavior of missile skin structures can be analyzed in the design stage. In this manner, optimum panel and shell designs can be accomplished from stiffness and weight view points.

SPIN OFFS AND APPLICATION: These results may also be applied in aircraft development projects. (SST, etc.)

TOTAL TIME AND EFFORT: 2 years, $75,000

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change(15 08 66)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-39-62	124-11-05-12-62

11. TITLE:
(U) Three-Dimensional Analysis of Launch Vehicles Including Shell Degrees of Freedom

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft launch vehs & gnd suppt	06 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B. Contract	b. NUMBER NAS8-20391 DATE 05 66	PRIOR FY– 67	0.1	13
	c. TYPE M. CPFF d. AMOUNT P26,249	CURRENT FY– 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Kiefling, Larry, R-AERO-DDS TEL: 205 876-8222 (FTS)	NAME: North Carolina State University ADDRESS: Raleigh, North Carolina INVESTIGATOR& PRINCIPAL: McDonald, Donald ASSOCIATE: TEL: 919 755-2332 (commercial) TYPE

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
vibration, stiffened shells, static response, dynamic response

24. (U) Objective: (a) Problem: To include the effects of shell deformations in the analysis of vehicle bending dynamics accurately and economically. (b) Application: Launch vehicles. (c) Shell motion becomes increasingly important as vehicle size increases. These effects must be described fully to assure control stability of launch vehicles both present and future.

25. (U) Approach: The differential equations of motion for the curved sheets and the stiffening elements and the difference equations for the structure are formulated. A circumferential lumping of the mass is used, retaining, however, a continuous distribution in the longitudinal direction. The equations are specialized for the circular cylinder with various boundary conditions included in the formulation. The difference-differential equations of motion of the stiffened circular cylinder are then solved for the frequencies of vibrations. A parametric study will be carried out and the solutions compared with existing approximate solutions.

26. (U) Progress: The formulation and basic computer programming of the shell vibration problem under study was completed. A simplified formulation, valid within a limited frequency band, was obtained and solutions were studied and compared with known solutions for the unstiffened shell. Computer solutions for the more complete formulation were obtained and compared with available solutions, based on various approximations of the shell behavior. Good agreement was found in the frequency bands in which the approximate solutions are valid. This work unit is related to 124-11-05-12 -62.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SET GROUP CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	13
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
Items 1 thru 35 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-40-62	N/A

11. TITLE:
(U) Use of Scale Models to Determine the Structural Dynamic Characteristics of Spacecraft

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015600 solid mech 015900 Spacecraft	01 68	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY– 67	0.1	-
		CURRENT FY– 69	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Kiefling, Larry, R-AERO-DDS TEL: 205 876-8222 (FTS)	NAME: ADDRESS: INVESTIGATOR'S PRINCIPAL: Not Selected ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
spacecraft, scale models, structural dynamics

24. (U) Objective:(a) Problem: To determine the feasibility of using scale models to determine future spacecraft dynamics. (b) Application: Stability and response studies of spacecraft. (c) Much full-scale and scale-model testing has been done on launch vehicles and aircraft. Spacecraft now envisioned have vastly different structural parameters and constructions. The approximations required in modeling these structures must be evaluated.

25. (U) Approach: Several proposed configurations for spacecraft and space stations would be selected for study. Problems involved in directly scaling each dimension would be identified and consequences of alternatives for physically impossible scale members would be evaluated. Effects of earth environment would be predicted. Particular attention would be paid to damping characteristics. Need for a follow on experimental program would be examined. Other alternatives to full scale test will be studied under separate contracts.

26. (U) Progress: No known work has been done in this exact area. Some results of launch vehicle studies such as the 1/10 scale model Saturn V would be useful for analysis of parts of some spacecraft structures.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	30
	NEXT FY 69	-	30

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Heum

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)
U.S. GOVERNMENT PRINTING OFFICE: 1965 O-795-048

Subject: Use of Scale Models to Determine the Structural Dynamic Characteristics of Spacecraft

Code: 124-11-05-40-62

Basis of Need: Many proposed spacecraft cannot be adequately tested for vibration response in the earth environment and cannot be fitted into special test facilities such as vacuum chambers of a reasonable size. Each of the alternatives of scale model testing, pure analysis, or possibly making measurements on a full scale craft in orbit must be investigated.

Application: A large number of manned and unmanned space stations, reflectors, and radio telescopes have been proposed. For the AAP program alone, eleven missions involve "orbital assembly of large structures" and thirteen involve "observatories and space laboratories." Structural dynamic data will be required to predict dynamic stability and response for most of these spacecraft.

Spin Offs and Applications: If an experimental program is carried out, the experience and technology required to manufacture the thin sections should improve manufacturing techniques.

Total Time and Effort: Theoretical study could be accomplished in two years and would cost $60,000. A follow-on experimental effort, if desired, would probably require two more years and an additional $200,000.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05- 41-62	N/A

11. TITLE:

(U) Dynamics of Inflatable Shell Structures

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015900 Spacecraft	02 68	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE b. NUMBER c. TYPE pending d. AMOUNT	PRIOR FY— 67	-	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Milner, James L., R-AERO-DD TEL: 205 876-9305 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Lightweight Structures	N/A

23. KEYWORDS

inflatable, shells

24.

(U) Objective: (a) Problem: Develop methods of dynamic analysis specifically applicable to shell structures which derive their resistance to deformation under applied loads from internal pressurization. These methods will be applicable to a broad range of problems which includes the dynamic analysis of unpressurized thin shell structures and the analysis of the deployment of inflatable shells. (b) Application: Analysis of the controlled deployment of space vehicle antennas, solar panels, gravity-gradient damper booms, and other simular structures; analysis of very-thin pressurized launch vehicle structural elements to determine modal characteristics of the vehicle. (c) Optimization of launch and space vehicle structures is leading to the utilization of more flexible and lighter-weight structures which have dynamic characteristics which cannot be described adequately by available analytical techniques.

25. (U) Approach: Modified shell equations which have been developed for static analysis of inflated structures will be extended in two ways: first, extended to the dynamic case and, second, extended from simple shapes (e.g. right-circular-cylindrical) to those of practical interest for space applications.

26. (U) Progress: N/A

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SET CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	25
34. SUB PROGRAM: Launch Vehicle Structures	NEXT FY 69	-	35
35. TASK AREA: Structural Dynamics			

William G. Johnson

U.S. GOVERNMENT PRINTING OFFICE 1965 O 795-048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-42-62	N/A

11. TITLE:

(U) Sensitivity Analysis of Saturn V Elastic Boosters

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	07 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT b. NUMBER	a. DATE	c. TYPE	d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract			Pending		PRIOR FY—67	0.5	-
					CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. York, Randy J., R-AERO-DM TEL. 205 876-4247 (FTS)	NAME: Phoenix Associates, Inc. ADDRESS: 1211 Stewart Avenue Bethpage, New York 11714 INVESTIGATORS PRINCIPAL: Nicholas C. Szuchy ASSOCIATE: TEL: 516 681-2188 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Process Control	N/A

23. KEYWORDS

Sensitivity analysis, sensitivity coefficients, bending modes, frozen coefficients

24. (U) Objective: (a) Problem: To determine the effect of parameter variations on the dynamics of an elastic booster. (b) Application: Effect of parameter variations on the bending moments of the Saturn V. (c) The sensitivity analysis of the dynamics of an elastic booster such as the Saturn V requires the evolution of mathematical techniques to determine the range of frequency in which a parameter can be varied and the system will stay within desired bounds.

25. (U) Approach: The method of sensitivity coefficients should be employed to determine both its usefulness and feasibility. The system will be one of linear ordinary differential equations with frozen (i.e. time invariant) coefficients. If necessary, time varying coefficient could later be considered. The method should take into account the first three bending modes, at first neglecting the sloshing modes. The sloshing modes will be included later if it is determined that this will make the system more rigorous.

26. (U) Progress: There has been much interest, although little actual progress in the field. One possible avenue of approach was illustrated in the internal note, "A Method for the Sensitivity Analysis of Rigid Body Saturn V Dynamics," by Randy J. York, Aero-Astrodynamics Laboratory.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	25
	NEXT FY 69	-	35

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

Subject: Sensitivity Analysis of Saturn V Elastic Boosters

Code: 124-11-05-42-62

Basis of Need: More powerful tools are needed in the field of sensitivity analysis than those presently existing. As the literature in this field has recently mushroomed, the work unit is needed at first to review these publications and then to continue research in new techniques, especially that of sensitivity coefficients.

Application: Techniques for sensitivity analysis would prove invaluable in many different phases of the Saturn V program. The final result of immediate interest is the determination of the parameter variation effects on bending moments, an outcome of prime importance in an elastic booster. Design engineers could use such a technique to determine which parameters should receive greater attention in a given frequency range.

Spin Offs and Application: The method of sensitivity coefficients in sensitivity analysis promises to be of wide spread importance. The problem: "given a system expressed as a function of several parameters, what is the effect on system behavior caused by parameter variations?", is a universal one. Frequently, engineers are faced with the problem of synthesizing a system which would minimize the control system sensitivity with respect to the parameters. The development of such a technique would prove valuable in feedback system synthesis and filter design. It would also be directly applicable in the study of any phenomena (e.g. space vehicle dynamics) which could be described by a system of linear ordinary differential equations.

Total Time and Effort: Such a study would take two years at an estimated total expenditure of $70,000. NASA intends to work closely with Phoenix Associates and expects to use .5 in-house man-years per year.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New (Proposed)	U_{MPT} U_{WRK}	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-43-62	N/A

11. TITLE: (U) Cross Beam Analyses of, Deflected and Undeflected, Clustered Supersonic Jets

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000200 Acoustics 016000 Spacecraft Launch Veh. & G.S.E.	09 67	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
B Contract	b. NUMBER Pending a. DATE c. TYPE d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 Alternate: Jones, Jess H., R-AERO-AUA Tel: 205 876-8063 (FTS) RESP. INDIV. Guest, Stanley H., R-AERO-AU TEL 205 876-8063 (FTS)	NAME: Not Selected ADDRESS: INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Jet Craft; SST Noise Technology	N/A

23. KEYWORDS

Unsteady Aero., Jet Noise, Acoustics, Fluid Mech., Turbulence, Etc.,

24. (U) OBJECTIVE - a. Problem: -Determine the basic flow field characteristics for deflected and undeflected clustered supersonic jets and determine the effects of cluster and engine geometry variations; and deflection geometries on these characteristics. Use both cold and hot jets. b. Application: - The development of an adequate method for estimating the adverse acoustic forcing function created by rocket exhaust flows logically has to be based on a detailed analyses of the basic flow field. In order to compute realistic structural dynamics effects an adequate description for the

25. intense acoustic input energy has to be achieved.

(U) APPROACH - Utilizing the recently developed cross beam remote flow field measuring system and the R-AERO-A jet facility, define the basic flow field characteristics of both cold and hot (Helium/air) supersonic clustered, deflected and undeflected flows. Perform this experiment for the following conditions: (a) Three different cluster arrangements, undeflected; (b) Three different spacings for each arrangement; (c) For the condition exhibiting the most sensitivity for spacing variation run underexpanded and overexpanded nozzle conditions; (d) Repeat (a) and (b) for three different flat plate deflector spacings; (e) Repeat (d) for three different

26. deflectors inclination angles. Evaluate, analyze, and present the experimental results.

(U) PROGRESS - A unique remote flow measuring tool and a special jet flow facility has just recently become operational at MSFC. These were designed for the specific type of experiments described above. The cross beam flow apparatus coupled with the acoustic jet facility provides an unequaled opportunity to obtain data vital to jet noise(analyses) generation mechanisms.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	40
	NEXT FY 69	-	75

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

SUBJECT: (U) Cross Beam Analyses of Free (Undeflected) Clustered Supersonic Jets

CODE: 124-11-05-43-62

BASIS OF NEED: The above work unit is required to provide a firm basis upon which an adequate acoustic near field prediction model can be generated. This model is necessary before realistic structural design and qualification (both vehicle and ground support equipment) criteria can evolve for current and future acoustic environments created by space vehicles.

APPLICATION: Based upon a detailed description of the basic flow field characteristics of appropriate experimental models a near field physical model will evolve from which the intense adverse acoustic environment can be estimated in full detail. This environment induces severe and dangerous structural dynamic loads. Adequate design and qualification criteria can then be generated for these loads.

SPIN OFF AND APPLICATION: This information will also contribute to:

a. Supersonic transport design and qualification criteria
b. The FAA airport noise abatement problem.

TOTAL TIME AND EFFORT: This work unit should take approximately two years and $115,000.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-05-44-62	N/A

11. TITLE:
(U) Dynamic Stability of a Fuel Tank Subjected to Steady Loading and Oscillational Excitation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
-16000 Spacecraft lnch vehs & gnd supt	07 67	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY– 67	-	-
		CURRENT FY– 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Milner, James L., R-AERO-DD TEL: 205 876-9305 (FTS)	NAME: Southwest Research Institute ADDRESS: San Antonio, Texas 78206 INVESTIGATOR'S PRINCIPAL: U.S. Lindholm ASSOCIATE: D. D. Kana TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
launch vehicle structural dynamics	N/A

23. KEYWORDS
stability, dynamics, vibration, cylindrical shells

24.
(U) Objective: (a) Problem: To determine the dynamic stability boundaries for a pressurized fuel tank. (b) Application: Structural dynamics aspects of launch vehicle control system analysis. (c) Dynamic stability of thin-walled cylindrical shells is of considerable significance in the analysis and design of space vehicles. This study will be used to predict stability boundaries for launch vehicles.

25. (U) Approach: In a pressurized fuel tank, flexural motion of the cylindrical tank is coupled with in-plane motion of the shell wall. In addition, there are major parametric loadings due to axial variations in thrust and to resulting liquid-shell interactions. This contract is to develop a three-dimensional analysis of the complete shell-liquid system in order to study both the structural response of the shell and the pressure response in the liquid.

26. (U) Progress: This general problem area has been examined in previous work by Southwest Research Institute. In SWI Final Report 02-1786(IR), comparisons of theoretical and experimental results show good agreement in describing the overall vibrational behavior of a liquid filled circular cylindrical shell experiencing forced longitudinal excitation. In the summary report for contract NAS8-11045, noteworthy progress was reported in the study of the interaction of the liquid and the elastic structure. In addition, many papers in the scientific literature have contributed to the development of the analytical and experimental techniques to be used in this work unit.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	35
	NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Dynamics

William G. Johnson

Subject: Dynamic Stability of a Fuel Tank Subjected to Steady Loading and Oscillational Excitation

Code: 124-11-05-44 -62

Basis of Need: Parametric responses arising from the coupled shell structure and fuel interact to cause amplified displacements and stresses in the shell. In addition, the pressure response in the liquid is amplified. These effects are significant and must be known in order to correctly predict stability boundaries for launch vehicles.

Application: A three-dimensional analysis of the complete shell-liquid system will be obtained.

Spin Offs and Application : None

Total Time and Effort: Two years, $135,000

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change	U RPT U WRK	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-06-06-62	No Change

11. TITLE: (U) Theoretical and Experimental Investigation of Shear Lag in Stiffened Shells and the Stress Analysis of Cone Frustrums and Segments

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	06 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS8-20164 a. DATE 06 66	PRIOR FY— 67	0.2	-
B. Contract	c. TYPE C. FPR d. AMOUNT 77,022	CURRENT FY - 68	0.1	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 RESP. INDIV. Kidd, J. W., R-P&VE-SSS TEL 205-876-3877 (FTS)	NAME: University of Alabama ADDRESS: University, Alabama INVESTIGATORS PRINCIPAL: Rey, W. ASSOCIATE: Chang, C. TEL: 205-348-6311 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Cone Frustrums and Segments Buckling Test, stiffener eccentricity.

24.

OBJECTIVE: (U) a. Problem: To determine the stress distribution in skin stringer panels with load introduced in the stringer and reacted on an elastic foundation and to determine the theoretical stress distribution in stiffened conical frustrums.
b. Application: The results will be applied to determine the stress distributions in the uprated Saturn I Lox and fuel tank skirts and the S-IC stage conical fairings.
c. This analysis and test results will be applicable to shear lag and cone buckling problems.

25.

APPROACH: (U) Shear lag panels with varying stringer to skin area ratios will be tested. Analytical matrix shear lag computer program will be developed to correlate test results. Equations for predicting the stress distribution under various loading conditions for stiffened conical frustrums will be developed. The program was delayed because of unexpected difficulties with the instrumentation on the shear lag panels.

26.

PROGRESS: (U) Three panel configurations (panels I, J, and K) were machined during the report period August 16, 1966 - February 15, 1967. Testing and data reduction were completed on panels G, H, and I. The derivation of the buckling equations for conical shells was completed. Work was begun on a computer program for a conical frustrum subjected to axial load and internal pressure.
The completion date was extended to April 30, 1967, with no additional cost to the Government.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB GROUP CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
current FY 68	-	-
NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Mechanics

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Form 1122 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION
		NR 006990

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY (GPT / WHN)	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change	U / U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-06-07-62	No Change

11. TITLE: (U) Study of Stability of Unpressurized Shell Structures Under Static Loading

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	05 65	N/A	N/A

16. PROCUR. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11181 a. DATE 05 65	PRIOR FY 67	0.2	-
	c. TYPE M. CPFF d. AMOUNT (P) 53,165	CURRENT FY 68	0.3	-

19. GOVT LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

RESP. INDIV: Billmayer, H.L. R-P&VE-SS
TEL: 205-876-4058 (FTS)

20. PERFORMING ORGANIZATION

NAME: General Dynamics, Convair Division
ADDRESS: San Diego, California 92112

INVESTIGATORS PRINCIPAL: Mr. Smith, G.W.
ASSOCIATE: Mr. Spier, E.E.
TEL: 714-277-8900 Ext 2435 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Stability, Longitudinally and Circumferentially Stiffened Shells, Eccentricity Influences

24. OBJECTIVE: (U) Problem a. To develop practical design curves and workable analytical techniques for the prediction of instability in stiffened circular, cylindrical shells subjected to axial compression including eccentricity influences, and to combined loading. b. Application: To be used in preliminary sizing, reliable checking, and for study of trends for shell structures with various eccentric stiffener configurations. c. Can be directly applied to Saturn V intertank, interstage, and skirt structures.

25. APPROACH: (U) Derivation of a suitable buckling expression for cylinders which incorporate both circumferentially and longitudinally stiffeners, each of which may be eccentric with respect to the skin. Development of appropriate means for the presentation of design curves. Simplification of the application procedures for these curves. Extension of the Langley solution to include the influence of applied external shear loading.
Due to the loss of GD/C personnel associated with this contract, the rate of progress has been slower than originally anticipated.

26. PROGRESS: (U) a. Task 1.1 "Equation Verification and Certification" has been completed. Task 1.2 "Extended Interaction Study" has been completed. Task 1.3 "Supplementary Refinements" 90% completed. Task 1.4. Title has been changed to "Parametric Studies and Improved General Instability Curves," 90% completed. Task 1.5 "Plotting of Supplementary Design Curves" has been completed. The completion date was extended to June 20, 1967 with no additional cost to the Government.
b. The progress made during the report period meets the above objectives. c. N/A
d. None. The result of this study will be published in a final report of approximately seven volumes. e. N/A.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS-CODE	30.
		933-50	

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Structural Mechanics

William G. Johnson

NASA FORM 1172 (Rev. Nov. 65)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
			N	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A. New	U (RPT) U (WHS)	N/A	NL	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-06-08-62	N/A

11. TITLE

(U) Buckling Tests of Eccentrically Stiffened Cylinders

12. SUBJECT/TECH AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	01 65	N/A	N/A

16. PROGRAM METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY 67	0.1	-
		CURRENT FY 68	0.1	-

19. GOVT. LABS./INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Bianca, C.J. R-P&VE-SSV TEL: 205-876-9513 (FTS)	NAME: ADDRESS: INVESTIGATORS PRINCIPAL: Same as 19 ASSOCIATE TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

24. OBJECTIVE:(U) a. Problem: To determine the effect of stiffener eccentricity on large-scale cylinders representative of flight vehicle construction.
b. Application: Use these results, after correlation with theory for design and analysis of space vehicle structures.
c. The eccentricity of stiffeners can affect the strength capability of cylindrical tanks. There is a need for some tests of large-scale cylindrical configurations to provide design-type data.

25. APPROACH:(U) A group of eight cylinders, 10 feet in diameter, of 2219-T87 aluminum alloy are being constructed. Three of the cylinders have stringers and ring frames; five have stringers only. The cylinders are constructed so that the effect of varying amounts of eccentricity on cylinder strength will be determined.

26. PROGRESS:(U) Seven cylinders are in various stages of manufacture. One has already been completed. Test facilities and instrumentation are approximately 85% complete. Unexpected difficulty in the springback of the drape-formed panels has delayed the fabrication process. Test program will be initiated as soon as testing priority and availability of test personnel permit.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS-CODE	30. TASK CROSS-CODE
		933-50	

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	-

33. UNIQUE PROJECT
34. SUB PROGRAM
35. TASK AREA

Space Vehicle Systems, SRT
Launch Vehicle Structures

Structural Mechanics

William G. Johnson

NASA FORM 1152 (Rev. Nov. 65)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006992

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	Uppt U Work	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-11-08-02-62	N/A

11. TITLE:
(U) Slosh Damping in Low g

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
006400 Fluid mechanics 016000 launch sp	09 67	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY– 67	–	–
		CURRENT FY– 68	0.2	–

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Buchanan, Harry J., R-AERO-DDS TEL. 205 877-2278 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
low g, damping, baffles

24.
(U) Objective: (a) Problem: Determination of damping provided by baffles in low g and for small fluid velocities. (b) Application: Design of space vehicle anti-slosh devices and control systems for low g environments. (c) The design of a space vehicle control system requires a detailed knowledge of the fluid behavior. Slosh damping is of major concern since it can reduce drastically the forces and moments acting on the vehicle.

25. (U) Approach: Develop the drag equations for oscillating flow around a flat plate at low Reynolds numbers, (very low velocities). For the limiting case, the problem can be reduced to one involving creep flow. Analytical results will be checked against drop tower tests, 1 g tests, and orbital flight data.

26. (U) Progress: An in-house exploratory investigation is in progress. Experimental data from this program will provide a base for analytical studies. Publications: NASA TMX-53559, "Effect of Reynolds Number on Slosh Damping by Flat Ring Baffles," December 1966.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SRT GROUP CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	–	–
CURRENT FY 68	–	20
NEXT FY 69	–	20

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Launch Vehicle Structures
35. TASK AREA	Cryogenic Storage

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

Subject: Slosh Damping in Low g

Code: 124-11-08-02-62

Basis for Need: Studies under high g conditions have indicated that slosh damping by flat ring baffles may be strongly dependent upon Reynolds number. Since extremely low Reynolds number are expected to accompany small longitudinal acceleration levels, it seems logical to presume that damping will be strongly influenced by vehicle acceleration. Further analysis and verification of this trend is necessary for evaluation of slosh damping under low g.

Application: Design of space vehicle control systems and venting procedures under low g environments.

Spin Offs and Application: None

Total Time and Effort: Two years effort at approximately $20,000 per year.

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002626	

4. DATE OF RESUME	5. KIND OF RESUME (15 08 66)	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	B. Completed	RPT U WNK U	N/A	GA FO	A. Work Unit

10a. CURRENT NUMBER/CODE: 124-12-01-02-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE: (U) Collection of Material Property Data and Presentation of Said Data in the Form of Material Data Handbooks

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009900 Metallurgy and Metallography, 016300 Structural Engineering	06 64	N/A	N/A

16. PROCURE METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER NAS 8-11345 DATE 06 64	PRIOR FY— 67	0.2	-
B. Contract	c. TYPE J. C. d. AMOUNT $54,976	CURRENT FY - 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Olsen, M. G., R-P&VE-MMJ
TEL: 205-876-8405 (FTS)

20. PERFORMING ORGANIZATION

NAME: Syracuse University
ADDRESS: Syracuse, New York

INVESTIGATORS PRINCIPAL: Sessler, John G.
ASSOCIATE: Weiss, Volker
TEL: 315-476-5571 TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: Mr. Thomas Cooney, RVA, NASA Headquarters

23. KEYWORDS: Material Data Handbook environmental exposure effects, Aluminum Alloy Design Data

24. (U) OBJECTIVE: The purpose of this project is to collect, analyze, and present technical data in the single source for 14 metal alloys in the form of data handbooks. In addition to mechanical and physical property values, information on the following will be collected and analyzed: stress-strain curves, heat treatment procedures, effect of radiation, vacuum and combined vacuum-solar environments on properties, resistance to corrosion in various media, surface treatments for various environments, alloy stability, forming and machining techniques, joining techniques, metallography and applicable specifications.

25. (U) PROGRESS: This contract expired on September 30, 1966. Handbooks on the following alloys have been completed and reproduced in the required number of copies.

a. Material Data Handbook - Aluminum Alloy 6061
b. Materials Data Handbook - Aluminum Alloy 2219
c. Materials Data Handbook - Aluminum Alloy 2014
d. Materials Data Handbook - Aluminum Alloy 5456
e. Materials Data Handbook - Aluminum Alloy 7075
f. Materials data handbook - Type 321 stainless steel
26. g. Materials Data Handbook - Inconel 718

Insufficient funds were available to complete seven additional handbooks which are in various stages of completion.

27.	28. REQUESTING AGENCY	29. PROJECT GROUP CODE	30. SUB PROJECT CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Structures Design Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 002632	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 08 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-02-62	No Change

11. TITLE:
(U) Environmental Design Criteria Studies (Terrestrial)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 016000 Spacecraft Launch Vehicles	12 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
Inter-Agency	a. DATE 12 64 b. NUMBER H 76789 c. TYPE Z. IA d. AMOUNT P$ 88,500	PRIOR FY— 67	0.4	-
		CURRENT FY - 68	0.5	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 ALTERNATE: Brown, S. C., R-AERO-YT RESP. INDIV. Smith, O. E., R-AERO-YT TEL 205 876-7580 (FTS)	NAME: Environmental Science Service Administration ADDRESS: National Weather Records Center Asheville, North Carolina 28800 INVESTIGATORS PRINCIPAL: Crutcher, Dr. Harold L. ASSOCIATE: TEL: 704 254-0205 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Environmental Criteria, atmosphere, large launch vehicles, terrestrial environment

24. (U) OBJECTIVE - a. Problem: -To study, analyze, and present terrestrial natural environmental data in suitable form for use in space vehicle design, launch opportunity, and vehicle reentry studies. b. Application: -Space vehicle design criteria, mission analysis and planning, and structual response. c. Natural environment parameters create varied response characteristics in launch vehicles. Realistic values of these parameters are obtained through statistical analyses.

25. (U) APPROACH - Stationary and dynamic statistical methods are used to define atmospheric statistics in a form meaningful as inputs to the design and operation of large launch vehicles. Multivariate analysis of several meteorological parameters is made for space vehicle mission analysis, and related operational analysis.

26. (U) PROGRESS - Aug. 15, 1966 - Feb. 15, 1967. A study of thunderstorm occurrence and persistence at Cape Kennedy, Florida was completed. In addition to giving the conditional probability of thunderstorm occurrence, the study compares the empirical data to theoretical distributions. Another study documented during this period uses the Cape Kennedy maximum wind in the 10 - 15 km altitude layer as a vehicle launch criterion. Consecutive and non-consecutive launch opportunities (i=1, 2, 3, . . . 20 12 hour periods) in j periods (j=1, 2, 3, . . . 40 12 hour periods).

A memorandum, R-AERO-Y-130-66, "Climatology for SAA Early Synchronous Orbit Mission," dated Nov. 9, 1966, was produced from statistical data furnished under this contract. The document gives a comparison of winter cloudiness at seven southwestern U. S. sites and the world-wide distribution of thunderstorm days for December, January, and February.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	40
CURRENT FY 68	-	50
NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
Items 1 to 26 identical to DD Form 1498

☆ U.S. GOVERNMENT PRINTING OFFICE : 1965 O-795-048

R SEARCH AND TECHNOLOGY RESUME	1.	2. GOVT ACCESSION	3. AGENCY ACCESSION NR 006995	
4. DATE OF RESUME: 15 03 67	5. KIND OF RESUME: D Change 15 03 66	6. SECURITY: U RPT U WRK	7. REGRADING: N/A	8. RELEASE LIMITATION: GA	9. LEVEL OF RESUME: A Work Unit

10a. CURRENT NUMBER/CODE: 124-12-03-04-62

10b. PRIOR NUMBER/CODE: No change

11. TITLE:

(U) Lunar Surface and Environment for Design Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
001900 Astronautics	06 63	N/A	N/A

16. PROCURL. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY - 68	0.3	-

19. GOVT LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Vaughan, O. H., R-AERO-Y TEL: 205 876-7763 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATOR$ PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Lunar Surface, Environment Design Criteria

24. OBJECTIVE: (U) a. Problem: To establish typical Lunar Surface models.
b. Application: For mobility studies and to determine the Lunar environment parameters for design.

25. APPROACH: (U) A Thorough literature survey is being performed to better understand the Lunar Surface. Surface roughness must be determined based on the latest Ranger data.

26. PROGRESS: (U) The following reports have been completed:

1. Lunar Environment Analysis: A Survey of Lunar Surface Models, contractor report TR-293-6-002E, dated 11 November 1966.
2. Prediction of Lunar Thermal Environment, Summary Report, contractor report TR-292-6-097, dated September 1966.
3. The Lunar Atmosphere, TM X-53399, dated 23 February 1966.
4. Lunar Terrain Model for Use in Lunar Surface Vehicle Mobility Studies, TM X-53412, dated 1 April 1966.
5. The Lunar Surface: Interpretations of Data from Ranger VII, VIII, IX, and Surveyor I Mission, R-AERO-Y-123-66, dated 30 September 1966.
6. Lunar Surface: An Interpretation Based on Photographic Data from the Russian Luna IX and the United States Surveyor I, TM X-53568, 10/15/66

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SUB CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 25 identical to DD Form 1498)

☆ U.S. GOVERNMENT PRINTING OFFICE 1965 O 795-048

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT ACCESSION	3. AGENCY ACCESSION
		NR 006996

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	C Terminated 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-05-62	No Change

11. TITLE:

(U) Planetary Atmospheres

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002200 Atmospheric Physics	11 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	a. DATE			
N/A	c. TYPE N/A	d. AMOUNT	PRIOR FY— 67	0.1	-
			CURRENT FY - 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
RESP. INDIV. Owen, Robert B., R-AERO-YS	INVESTIGATOR'S PRINCIPAL:
TEL: 205 876-2047 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Planetary Atmospheres, Future Project Studies

24. (U) OBJECTIVE - a. Problem: - To establish standard atmospheres for Mars and Venus based on latest space environment data.

b. Applications: - Standard atmospheric models for use as design criteria in MSFC studies (present missions and advanced missions).

c. Atmospheric models of Venus and Mars are required to allow designers and mission planners in establishing the feasibility of placing payloads on the surface of these planets. These in-house studies provide valuable guidelines for use as design criteria.

25. (U) APPROACH: Through a continuing literature survey collect most current models of the atmospheres of both Mars and Venus. Discuss merits of proposed models and recommend a model or models for use in studies referenced above.

26. (U) PROGRESS: a. Atmospheric models of Mars, Venus, Jupiter, and Mercury have been derived and published in TM X-53521, "Space Environment Criteria Guidelines for Use in Space Vehicle Development (1967 Revision), February 1, 1967.

b. Studies relating to the Mars surface, thermal, and atmospheric density related to solar activity have been performed by Northrop Space Laboratories under contract NAS8-20082.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 006998	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-07-62	No Change

11. TITLE:
(U) Wind and Thermodynamic Quantities (Surface to 90 km)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology	10 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER c. TYPE N/A d. AMOUNT e. DATE	PRIOR FY— 67	0.5	-
		CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Daniels, G. E., R-AERO-YT TEL. 205 876-0917 FTS	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Civilian Air Transport	All NASA Centers

23. KEYWORDS atmospheric parameters special studies, interparameter relationships, rocket soundings

24. (U) OBJECTIVE - a. Problem: -To provide information on atmospheric parameters for special studies, design of GSE equipment, or large space vehicles and launch restrictions. b. Application: -Aerospace vehicle aerodynamic heating and performance analysis.

(U) APPROACH -Various problems which develop in design of GSE equipment, design of large space vehicles, because of launch restrictions, etc., require special investigations of available data or collection of special data to provide required information. Among the most common are problems related to the interparameter relationship of the

25. atmospheric parameters. Two approaches are being carried on: One, to prepare studies on those problems of general use, and two, the investigation required to solve a special problem. This task now includes work of task No. 124-12-03-12-62.

(U) Progress - A. Reporting Period -January 4, 1966 to January 4, 1967. Various studies have been completed and reports or memoranda prepared or in process of being prepared on the results. One report, "Scalar and Component Wind Correlations Between Altitude Levels for Cape Kennedy, Florida, and Santa Monica, California," will be published as a NASA TN D in the near future.

26.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 006999

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 03 66	U APT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-08-62	No Change

11. TITLE:
(U) Reference Atmospheres

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
0010000 Meteorology	10 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER c. TYPE N/A a. DATE d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: ADDRESS: Marshall Space Flight Center Huntsville, Alabama 35812 RESP. INDIV.: Smith, O. E., R-AERO-YT TEL: 205 876-7580	NAME: ADDRESS: Same As 19 INVESTIGATOR'S PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Civilian Air Transport	All NASA Centers, Defense Agencies

23. KEYWORDS Reference atmospheres, relationship between meteorological parameters mean atmospheric cross section, patrick reference atmosphere

24. (U) OBJECTIVE - a. Problem: -To formulate Reference Atmospheres, their variability, and study the relationship between meteorological parameters. b. Application: -To serve as a standard reference for atmospheric parameters for theoritical trajectories.

(U) APPROACH - A standard (mean) atmospheric cross section is needed as a reference to design and evaluate large space vehicles. The original Patrick Reference Atmosphere has been revised, but information as to the variability and relationship of the various parameters is required. This information will permit flight simulation and design studies to be conducted using the parameters in their proper perspective; i.e., do we use the maximum densities with the maximum winds?

25.

(U) PROGRESS - A. Reporting Period -January 4, 1966 to January 4, 1967. A revised atmosphere has been prepared.

B. Reports - TM X-53139, "A Reference Atmosphere for Patrick Air Force Base, Florida, Annual, (1963 Revision)," September 23, 1964.

Work on atmospheric density includes:

1. Monthly and annual relative deviations of density with respect to the Patrick
26. Reference Atmosphere, 1963, for certain selected percentiles from 0 to 30 km over Cape Kennedy, Florida.
2. Maximum and minimum density profiles are being generated over the Cape from 0 to 90 km.
3. The "Air Force Interim Supplemental Atmospheres to 90 km" are being computerized as a subroutine to 120 km.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 007000	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 03 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-09-62	No Change

11. TITLE:
(U) Terrestrial Environment Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology 016100 Spacecraft Trajectories and Reentry	10 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT				18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER		a. DATE		PRIOR FY— 67	0.4	-
N/A	c. TYPE	N/A	d. AMOUNT		CURRENT FY—68	0.4	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Daniels, G. E., R-AERO-YT TEL: 205 876-0917	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Equipment Design, Facility Design	All NASA Centers, AFCRL

23. KEYWORDS Variability atmospheric parameters, design criteria, operational studies. Atmospheric environmental parameters.

24. (U) OBJECTIVE - a. Problem: -To obtain, analyze, and compile into documents, variability of atmospheric parameters, to 100 km altitude. b. Application: -For use in design criteria and operational studies of large space vehicles and associated GSE.

25. (U) APPROACH - A knowledge of earth atmosphere environmental parameters is necessary for the establishment of design requirements for space vehicles and associated equipment. Such data are required to define the design condition for fabrication, storage, transportation, test, preflight, and in-flight design conditions and should be considered for both the whole system, the components, and the parts which make up the system. Some of the environments of concern are thermal (temperature and solar radiation), precipitation, winds, pressure, and density. Each environment has special effects on the vehicle. The thermal environment is important for the stresses which unequal heating by solar radiation can cause and in the boil-off (loss) of fuels used. Density is considered for heating along the trajectories and in re-entry. Sources of information are technical publications, weather records, and contact with other specialists in the areas of concern. The data is compiled, analyzed (frequently by computers) and compiled into documents for use.

26. (U) PROGRESS: A. Reporting Period -January 4, 1966 to January 4, 1967. Progress made in the period has resulted in the revision to TM X-53023; i.e., TM X-53328 being published and work towards a future revision of TM X-53328. B. Reports -TM X-53009, "Directional Wind Component Frequency Envelopes, Cape Kennedy, Florida, Atlantic Missile Range," February 21, 1964. TM X-53328, "Terrestrial Environment (Climatic) Criteria Guidelines for Use in Space Vehicle Development, 1966 Revision," May 1, 1966. TM X-53021, "Directional Wind Component Frequency Envelopes, Santa Monica, California (PMR)," March 9, 1964.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Space Vehicle Design Criteria	NEXT FY 69	-	-
35. TASK AREA: Environment Criteria			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 007001	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-10-62	No change

11. TITLE:

(U) Astrodynamic Constants

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
003000 Celestial Mechanics	10 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT		18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	b. NUMBER N/A	a. DATE	PRIOR FY— 67	0.1	-
	c. TYPE	d. AMOUNT	CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabam 35812	ADDRESS: Same as 19
RESP. INDIV.: Euler, H. C., R-AERO-YS	INVESTIGATORS PRINCIPAL:
TEL: 205 876-0870 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Internally consistent set, Astrodynamic constants

24. (U) OBJECTIVE - a. Problem: To establish a standard set of astrodynamic constants which are internally consistent. b. Application: Vehicle trajectory optimization studies. c. A standard set of astrodynamic constants are required to provide a common set of ground rules in performing trajectory optimization studies. This in-house study is an attempt to provide a standard set of astrodynamic constants which can be used for these studies.

25. (U) APPROACH: A statistical approach using a variation of parameters to minimize the residual between measured and calculated values of each parameter.

26. (U) PROGRESS: Four computer programs were developed. Program one used a least square adjustment of thirty-five parameters in fifty astrodynamic equations resulting in internally consistent sets of astrodynamic constants with minimum log of residues of derived minus measured values. Program two computed double precision derived values using various recommended input constants. Program three listed over nine hundred numerical values of forty-five different constants computing their deviation from the mean and their standard deviation. Program four compared measured vs computed earth gravity using NASA earth models. The constants were adjusted so that the computed values approached closer to mean measured values. Program five - A random number program was developed which will adjust 35 or more variables applicable to adjusting the astrodynamic constants. Work has been started on a random number program to adjust the astrodynamic constants.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM: Space Vehicle Design Criteria	NEXT FY 69	-	-
35. TASK AREA: Environment Criteria			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	
		NR 007002	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-11-62	No change

11. TITLE:

(U) Solar Flare Environment

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Radiation	09 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER	c. TYPE	d. AMOUNT / e. DATE			
N/A	N/A			PRIOR FY-- 67	0.2	-
				CURRENT FY-- 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
RESP. INDIV. Roberts, W. T., R-AERO-YS	INVESTIGATORS PRINCIPAL:
TEL. 205 876-2047 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	MSC, GSFC

23. KEYWORDS

Solar flares, flux-energy spectra, environmental models

24. OBJECTIVE: (U) a. Problem: To establish environmental models of solar flare flux-energy spectra. b. Application: For use in determining radiation shielding requirements.

25. APPROACH: (U) Through a continuing literature survey collect all available data concerning the flux-energy spectra of the major flares. Establish models through subjective analysis of these spectra.

26. PROGRESS: (U) November 1, 1965 - March 1, 1967
(a) Data is being collected to update models.
(b) Models now being used in calculating probability envelopes.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY-- 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	50

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 007003	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	Terminated 15 03 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-12-62	No Change

11. TITLE:
(U) Wind and Thermodynamic Quantities (30 to 90 km)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
010000 Meteorology	11 63	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
	b. NUMBER		a. DATE			
N/A	c. TYPE N/A		d. AMOUNT	PRIOR FY— 67	0.5	-
				CURRENT FY 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS:
	INVESTIGATORS PRINCIPAL:
RESP. INDIV.: Smith, O. E., R-AERO-YT	ASSOCIATE: Same as 19
TEL: 205 876-7580 FTS	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS: Atmospheric data between 30 to 90 km, large space vehicle design, rocket soundings.

24. (U) OBJECTIVE- a. Problem: -To establish wind and thermodynamic quantities from 30 km to 90 km. b. Application: -Design Criteria. c. To analyze atmospheric data, (thermodynamic and wind), in the region between 30 to 90 km to provide better information for use in large space vehicle design and operational studies.

25. (U) APPROACH: Our present information on the atmosphere between 30 and 90 km has been poor. In the last few years, a considerable number of rocket soundings using a variety of payloads have been made. This data is being analyzed to determine its accuracy and variability with time and space. The circulation at high altitude is also being studied to determine causes of variability.

26. (U) PROGRESS: No progress because of loss of personnel. This is being combined under 124-12-03-07.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 007004	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U / U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-13-62	No change

11. TITLE:
(U) Space Vehicle Environmental Design Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Space Vehicle Design Criteria	04 63	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.5	-
		CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Smith, Robert E., R-AERO-YS TEL: 205 876-4503 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Space Vehicle Environmental Design Criteria

24. (U) OBJECTIVE - a. Problem: - To provide the latest and more realistic space environment data for use as design criteria.

b. Application: - Spacecraft and launch vehicle design criteria.

c. Much of the space and planetary environmental data available for use as design criteria today is, at best, spectulative and will remain as such until addition satellites, planetary probes, and manned space flights provide more information. Considerable care, therefore, must be employed in the interpretation and employment of available space environment for a specific design decision. The purpose of these in-house studies is to establish a standard set of design criteria guidelines for use in MSFC space vehicle research and development programs (present and advanced studies) and to revise these standards if and when more realistic design criteria becomes available.

(U)
25. APPROACH: Compile data on all phases of the natural space environment through a continuing comprehensive literature survey and individual research efforts. Publish environmental design criteria guidelines on which specific design criteria can be based.

26. (U) PROGRESS: TM X-53521, "Space Environment Criteria Guidelines for Use in Space Vehicle Development (1967 Revision)," February 1, 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 007005

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-14-62	N/A

11. TITLE:

(U) Advance Statistical Techniques to Establish Aerospace Vehicle Design Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
009700 Mathematics and Statistics 016000 Spacecraft Launch Vehicle	10 61	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11175 DATE 03 64	PRIOR FY— 67	0.1	-
	c. TYPE J.C. d. AMOUNT $20,950	CURRENT FY 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: University of Georgia
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Department of Statistics Athens, Georgia 30601
RESP. INDIV.: Smith, O. E., R-AERO-YT	INVESTIGATORS PRINCIPAL: Cohen, Dr. A. C., Jr.
TEL: 205 876-7580 (FTS)	ASSOCIATE:
	TEL: 404 542-2911 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Statistical Analysis, Correlated Variables, Random Observations

24. (U) OBJECTIVE- a. Problem: -To develop atmospheric statistical models for use as design criteria inputs. b. Application: -Environment design criteria studies. c. To modify existing methods and develop new methods of statistical analysis for dealing with atmospheric variables correlated both in time and space. Classical statistical methods are based on the assumptions that data samples consist of random observations which are independent (uncorrelated). Since atmospheric data seldom meet these criteria, statistical methods must be modified or developed to allow meaningful analysis of such data for use in space vehicle design criteria.

25. (U) APPROACH- Most atmospheric statistical analysis is approached using empirical statistics rather than theoritical functions because of the inherent difficulties in obtaining the prerequisite random sample. One alternative is to take advantage of the lack of stochastic independence of the sample through the use of advanced statistical techniques found in dynamic statistical analysis of time series, and correlation techniques to derive statistics for vehicle design and mission analysis. Results from this task will be published for the scientific interest in the techniques and will serve as inputs for the task "Environmental Design Criteria Studies."

26. (U) PROGRESS- Several technical reports have been prepared relative to this task: (1) Estimation of Parameters in Compound Weibull Distributions, (2) The Probability of Extending an Observation, (3) On The Distribution of the Sum of Independent Doubly Truncated Gamma Variables. Work in progress includes (1) conditional probability estimates, (2) estimation of exposure time probabilities, and (3) estimation in truncated Weibull distributions.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT		32. FUNDS ($ K)	IN-HOUSE	CONTRACT
		PRIOR FY 67	-	-
33. UNIQUE PROJECT	Space Vehicle Systems, SRT	CURRENT FY 68	-	-
34. SUB PROGRAM	Space Vehicle Design Criteria	NEXT FY 69	-	65
35. TASK AREA	Environment Criteria			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION NR 007006	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-15-62	No change

11. TITLE:
(U) Environmental Design Criteria Studies (Space)

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Space Vehicle Design Criteria	07 64	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	a. DATE b. NUMBER c. TYPE Pending d. AMOUNT	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Marshall Space Flight Center ADDRESS Huntsville, Alabama 35812 Alternate: Vaughan, O. H., R-AERO-Y 205 876-7763 (FTS) RESP. INDIV. Smith, R. E., R-AERO-YS TEL 205 876-4503 (FTS)	NAME: ADDRESS: Not Selected INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Space Vehicle, Design Criteria, Space Environment

24. (U) OBJECTIVE - a. Problem: To establish space environment criteria for spacecraft design. b. Application: Spacecraft design criteria based on latest space environment. c. To compile, analyze, and interpret natural environmental data for application to general space vehicle control, structural, and mission design problems. To provide environmental parameters for specific design problems.

25. (U) APPROACH: Through a comprehensive and continuing literature survey plus individual research on various phases compile available data on natural space environment parameters, analyze, and thereby produce physical descriptions of the environment specifically for vehicle design criteria. Design models are updated with respect to the engineering requirements and design employment of the environmental data in vehicle development as contrasted to the scientific analysis of the data. Statistical data analysis is an integral part in the establishment of design criteria. Close working relationship is maintained with users.

26. (U) PROGRESS: A continuing literature survey combined with individual research in models of the earth's upper atmosphere, planetary environment, radiation environments and ionospheric models has produced TM X-53521, "Space Environment Criteria Guidelines for Use in Space Vehicle Development (1967 Revision)," dated 1 February 1967.

This has been discussed with Mr. M. Charak, OART, RV-1

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE
		933-50	

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	25
	CURRENT FY 68	-	50
	NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME		2. GOVT ACCESSION	3. AGENCY ACCESSION NR 007009	
4. DATE OF RESUME: 15 03 67	5. KIND OF RESUME: D Change 15 03 66	6. SECURITY: U RPT U WRK	7. REGRADING: N/A	8. RELEASE LIMITATION: GA	9. LEVEL OF RESUME: A Work Unit

10a. CURRENT NUMBER/CODE: 124-12-03-18-62

10b. PRIOR NUMBER/CODE: No Change

11. TITLE: (U) Planetary Surface Models for Mobility Design Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
015500 Soil Mechanics	08 65	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER c. TYPE N/A d. AMOUNT	PRIOR FY— 67	0.2	-
		CURRENT FY— 68	0.2	-

19. GOVT. LAB/INSTALLATION/ACTIVITY

NAME: Marshall Space Flight Center

ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Vaughan, O. H., R-AERO-Y

TEL: 205 876-7763 (FTS)

20. PERFORMING ORGANIZATION

NAME:

ADDRESS: Same as 19

INVESTIGATORS PRINCIPAL:

ASSOCIATE:

TEL: TYPE:

21. TECHNOLOGY UTILIZATION: N/A

22. COORDINATION: N/A

23. KEYWORDS: Model Surfaces, Terrain Classifications, Mobility Design Criteria

24. (U) OBJECTIVE - a. Problem: To determine the soil characteristics and roughness of a terrain for use as mobility design criteria. b. Application: The criteria as developed will provide input to a computer program which will determine the energy requirements to operate a roving vehicle over the terrain model.

25. (U) APPROACH: Literature searches are being performed. Possible soil mechanic models are being developed. A computer program is being developed which will use the surface model data and can provide energy requirements for mobility.

26. (U) PROGRESS: The following publications have been completed:

1. A literature survey,"Mars Surface Formation, Surface Materials, and Terrains," RSIC 592, was completed.
2. A contractor report "Analytical Model of the Martian Surface," TR-793-7-142 dated March 15, 1967.
3. A literature survey for The Environment of Mercury was also completed and is ready for publication.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Space Vehicle Design Criteria	NEXT FY — 69	-	-
35. TASK AREA: Environment Criteria			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 007011

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 03 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-20-62	124-09-02-22-62

11. TITLE:
(U) Meteoroid Technology for Design Criteria

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002100 Astrophysics	02 62	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT			18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (*In thousands*)
	b. NUMBER		a. DATE	PRIOR FY— 67	0.5	-
N/A	c. TYPE	N/A	d. AMOUNT	CURRENT FY— 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19
RESP. INDIV.: Dalton, Charles C., R-AERO-Y	INVESTIGATOR$ PRINCIPAL:
TEL.: 205 876-0865 (FTS)	ASSOCIATE:
	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Meteoroid Design Criteria

24. (U) OBJECTIVE: -a. Problem -To provide the most realistic meteoroid flux and puncture models for design criteria usage. b. Application -Space environment design criteria. c. Many meteoroid models today may or may not represent exactly the actual meteoroid environment in space; however, one model should be used for design criteria; therefore, these in-house studies are an attempt to establish statistical models which represent the more likely meteoroid environment.

(U) APPROACH: Analysis of literature and other data will be used to develop statisti-
25. cal models which represent the meteor flux and puncture possibility for use in design criteria.

(U) PROGRESS: In-house efforts in this problem area were continued by Mr. C. C. Dalton who completed the following reports during FY-66:

1. "Inferences from Photographic Meteors," presented 9-13 Aug. 1965, Symp. on Meteor Orbits and Dust, Smithsonian Ast. Obs.
2. "Statistical Analysis of Photographic Meteor Data--Part I--Öpik's Luminous Efficiency and Supplemented Whipple Weighting," NASA TM X-53325, Sept. 1965.
3. "St. An. of Ph. Met. Data, Part II: Verniani's Luminous Efficiency and Sup. Whipple
26. Weighting," NASA TM X-53360, Nov. 1965.
4. "Theo. Relationships for Meteoroid Puncture Experiments," NASA TN D-3244, Feb. 1966.
5. "Revised Meteoroid Flux and Puncture Models," In: Aero-Ast. Res. Rev. No. 4, NASA TM X-53462, April 1966.
6. "Velocity Dependence of Meteor Luminous Efficiency and Consequent Statistical Results," AIAA Paper No. 66-515, 4th Aerospace Sciences Meet., Los Angeles, 27-29 June 1966.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498.)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1966 O-205-548

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (15 08 66)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-21-62	No Change

11. TITLE:
(U) Extension of Knowledge of Solar Cycle Characteristics

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
002100 Astrophysics	02 62	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
A Grant	a. DATE 06 66 b. NUMBER NGR 03-002-101 c. TYPE Y. G. d. AMOUNT 36,172	PRIOR FY— 67	0.3	-
		CURRENT FY— 68	0.3	-

19. GOVT. LAB/INSTALLATION/ACTIVITY
NAME: Marshall Space Flight Center
ADDRESS: Huntsville, Alabama 35812

RESP. INDIV.: Dalton, C. C., R-AERO-Y
TEL: 205 876-0865 (FTS)

20. PERFORMING ORGANIZATION
NAME: University of Arizona
ADDRESS: (Laboratory of Tree-ring Research)
Tucson, Arizona 85721

INVESTIGATORS PRINCIPAL: Fritts, Harold C., Assoc. Prof. of
ASSOCIATE: Dendrochronology
TEL: 602 792-6011 ext.884-2223 (FTS)

21. TECHNOLOGY UTILIZATION
N/A

22. COORDINATION
N/A

23. KEYWORDS
Solar Activity

24. (U) OBJECTIVE - a. Problem: - To find a biological or physical growth or deposition process which retains in a quantitatively ascertainable form a record of the imprints of annual variations in the process rate, color, or other variations giving a time series which may be correlated with the Wolf (sunspot) number index of solar activity variations closely enough for estimating the index for many years prior to the established record for the purpose of checking the accuracy of alternative mathematical models. b. Applications: Predicting mean annual solar activity in future years and decades for its effect both on interplanetary environment and satellite lifetimes.

25. (U) APPROACH: Make appropriate mathematical analysis of the existing or supplemented University of Arizona data for the annual growth rings in trees, make appropriate statistical comparisons with solar activity data, and try to establish a superior mathematical basis for predicting mean annual solar activity.

26. (U) PROGRESS: In December 1965, the University of Arizona proposed a 2.5-year effort at $192,553 for this research with tree-ring and solar activity data. Although there was no funding support for that level of effort, they accepted Grant NGR 03-002-101 for $36,172 in June 1966 to support a lower level of effort. In September 1966 MSFC requested $100K of FY-67 funds toward the support of this effort, but got none. The semi-annual report of January 1967 is quite encouraging; but it is not anticipated that a substantial solution could be found before the present funds in the grant are expanded in FY-67. FY-68 funds were not requested because of funding guidelines.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. TASK CROSS CODE

31. SPECIAL EQUIPMENT

32. FUNDS ($ K)	IN-HOUSE	CONTRACT
PRIOR FY 67	-	-
CURRENT FY 68	-	-
NEXT FY 69	-	100

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY RPT	6. SECURITY WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 12 01 67	U	U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-22-62	N/A

11. TITLE:

(U) Environment Design Criteria Studies (Space) - Sunspot Predictions

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Space Vehicle Design Criteria	11 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT a. DATE	b. NUMBER	c. TYPE	d. AMOUNT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A			N/A		PRIOR FY— 67	0.6	-
					CURRENT FY— 68	1.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME:
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Same as 19.
Alternate: Scissum, J. A., R-AERO-YS 205 876-0975 (FTS)	INVESTIGATOR& PRINCIPAL:
RESP. INDIV.: Dickey, L. R., R-AERO-Y	ASSOCIATE:
TEL: 205 876-0975 (FTS)	TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
orbital lifetime, communications	N/A

23. KEYWORDS

Twentieth Solar Cycle

24. (U) OBJECTIVE - a. Problem: To produce a technical report containing a more accurate prediction of the annual sunspot values during the twentieth solar cycle. b. Application: To be employed in orbital lifetime prediction programs essential to the design of satellites and space vehicles. c. Provide environmental parameters for design problems involving density variations of upper atmosphere as affected by solar activity.

25. (U) APPROACH: Analyze available data on sunspot variations throughout the period of record using standard multiple regression methods. Study available literature to determine any physical considerations which can also be employed in this analysis. Use the results of the analysis to predict annual sunspot values for the twentieth solar cycle.

26. (U) PROGRESS: NASA TM X-53593, "Survey of Solar Cycle Prediction Models," March 30, 1967, is being prepared for publication.

FY-68 funds were not requested because of funding guideline limitations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	15
	CURRENT FY 68	-	-
	NEXT FY 69	-	75

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	A New (Proposed)	RPT U WRK U	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-03-23-62	N/A

11. TITLE:
(U) A Construction of Probability Envelopes for Flux-Energy Spectra

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
013800 Radiation	03 66	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
N/A	a. DATE b. NUMBER N/A c. TYPE d. AMOUNT	PRIOR FY— 67	0.5	-
		CURRENT FY - 68	0.5	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV. Dollman, T. S., R-AERO-YS TEL. 205 876-2047 (FTS)	NAME: ADDRESS: Same as 19 INVESTIGATORS PRINCIPAL: ASSOCIATE: TEL: TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	GSFC, MSC

23. KEYWORDS
Solar flare, typical models, probability envelopes

24. OBJECTIVE: (U) a. Problem: To establish probability of occurrence envelopes
b. Application: For typical models of the solar flare flux-energy spectra.

25. APPROACH: (U) Examine flux-energy spectra of established models of solar flares and calculate probability envelopes through statistical analysis of these data.

26. PROGRESS: (U) March 1, 1966 - March 1, 1967
(a) Preliminary reports issued on probability values.
(b) Study of extreme value envelopes is now in progress.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Environment Criteria

William G. Johnson

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION
		NR 007012

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change (15-08-66)	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-04-01-62	No Change

11. TITLE:
(U) Design Criteria for Control of Space Vehicles During Launch Phase of Flight

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicles	06 65	06 67	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-11494 a. DATE 06 65	PRIOR FY— 67	0.1	-
	c. TYPE M, CPFF d. AMOUNT $125,000	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama - 35812 Alt: Swift, Fred W., R-AERO-DCA Tel: 205 876-6917 RESP. INDIV.: Lewis, Robert C., R-AERO-DCA TEL: 205 876-6917 (FTS)	NAME: General Dynamics/Convair ADDRESS: Dept. 585-3, P.O. Box 1128 San Diego, California - 92112 INVESTIGATOR'S PRINCIPAL: Greensite, Arthur ASSOCIATE: TEL: 714 277-8900, Ext. 2185 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Process Control	N/A

23. KEYWORDS
Design criteria, Control, Space Vehicles

24. (U) OBJECTIVE - a. Problem: To document a "Standard Procedure" outline and guide for the development of the control of space vehicles for the launch phase of flight.

b. Application: To be used by control engineers for all phases of control work in the design of booster and space vehicles.

c. Description: The documentation must encompass all phases of the control problem and specify the most practical and efficient approach for analysis and design studies.

25. (U) APPROACH - A series of eighteen monographs will be prepared, which taken together will constitute a comprehensive design manual for the control of booster and space vehicles. Each monograph must be an independent entity and should function as a complete study article when separated from the other monographs.

26. (U) PROGRESS - Draft copies of each monograph will be submitted to MSFC for approval. After a monograph is revised it is published in final form and submitted to MSFC. Currently, there have been ten published in final form. The others are in the process of being prepared.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY — 67	-	-
	CURRENT FY — 68	-	-
	NEXT FY — 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Stability, Guidance and Control Design Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498)

RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. [illegible]	5. [illegible]	6. SECURITY RPT / WRK	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
[illegible]	D Change 15 08 66	U / U	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-04-02-62	N/A

11. TITLE:

(U) Design Criteria For Flight Evaluation

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
Spacecraft Launch Vehicle 016000	06 66	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B, Contract	a. NUMBER NAS8-20314 b. DATE 06 66 c. TYPE M.CPFF d. AMOUNT $139,750	PRIOR FY— 67	1.0	-
		CURRENT FY— 68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Fulmer, Clarence R., R-AERO-F TEL: 205 876-4428 (FTS)	NAME: TRW Incorporated ADDRESS: One Space Park Redondo Beach, California 90278 INVESTIGATORS PRINCIPAL: Boretz, J. E. ASSOCIATE: TEL: 213 679-8711 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
COMSAT	N/A

23. KEYWORDS

Design Criteria Flight Evaluation

24. (U) Objective: To provide Aero-Astrodynamics Laboratory's Design Criteria for flight Evaluation as input into the "NASA Design Criteria Handbook." The objective of this contract is to establish the "Design Criteria for Flight Evaluation" which will detail the reliability assessment, product improvement, and design verification and refinement that result from the post flight engineering evaluation of the information received from each flight.

25. (U) Approach: Assemble monographs containing all of the latest "state-of-the-art" information available in the areas of Design Criteria for Flight Evaluation.

26. (U) Progress: a. This reporting period covers from the date of the last resume, September 15, 1966, to the date of this resume February 15, 1967. b. Rough drafts of the Orbit Analysis and Trajectory Analysis monographs have been received and reviewed. The final version of the Orbit Analysis monograph has been recieved and is being distributed. Rough drafts of the Guidance Evaluation Monograph is in printing. The schedule of completion dates is generally being adhered to. c. Publications:

* TRW Systems Report 06671-6001-R000, Design Criteria For Flight Evaluation Monograph 1 - Orbit Analysis, January 31, 1967.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY - 67	-	-
	CURRENT FY 68	-	-
	NEXT FY 69	-	-

33. UNIQUE PROJECT	Space Vehicle Systems, SRT
34. SUB PROGRAM	Space Vehicle Design Criteria
35. TASK AREA	Stability, Guidance & Control Design Criteria

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
Items 1 to 9 identical to DD Form 1498

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D Change 15 08 66	U RPT U WRK	N/A	GA	A Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-04-03-62	No change

11. TITLE: (U)
Design Criteria for Guidance, Flight Mechanics and Trajectory Optimization

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
016000 Spacecraft Launch Vehicle	05 65	N/A	N/A

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B Contract	b. NUMBER NAS8-11495 c. TYPE M. CPFF d. AMOUNT 168,704 a. DATE 05 65	PRIOR FY— 67	-	-
		CURRENT FY—68	-	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center ADDRESS: Huntsville, Alabama 35812 RESP. INDIV.: Doris C. Chandler R-AERO-DG TEL: 205 876-1669(FTS)	NAME: North American Aviation ADDRESS: 12214 Lakewood Boulevard Downey, California 90241 INVESTIGATORS PRINCIPAL: H. C. McCarty ASSOCIATE: G. Townsend TEL: 923-8111 x3232 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS
Guidance, Flight trajectory, Flight mechanics

24. (U) OBJECTIVE - Performance of a review of available NASA and industry literature, assessment of validity of techniques in the areas of flight mechanics trajectory optimization and guidance and the preparation of a series of monographs that discuss results of these studies, unify the material, and present computational logic for the resultant standardized techniques.

25. (U) APPROACH - A unified treatment of formulations and techniques is prepared. A comparison of these techniques on the basis of their relative accuracy, efficiency and flexibility is made and preferred approaches selected.

26. (U) PROGRESS - August 15, 1966 to March 15, 1967. The following monographs have been distributed which give the best techniques outlined in the report: General Perturbations, Relative Motion, Dynamic Programming, Guidance Equations for Orbital Operations.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
	PRIOR FY— 67	-	
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY—68	-	-
34. SUB PROGRAM: Space Vehicle Design Criteria	NEXT FY— 69	-	-
35. TASK AREA: Stability, Guidance, and Control Design Criteria			

William G. Johnson

NASA FORM 1122 (Rev. Nov. 65)
(Items 1 to 26 identical to DD Form 1498

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RESEARCH AND TECHNOLOGY RESUME

1.	2. GOVT. ACCESSION	3. AGENCY ACCESSION	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
15 03 67	D. Change 15 08 66	~~U~~ RPT ~~U~~ WRK	N/A	GA	A. Work Unit

10a. CURRENT NUMBER/CODE	10b. PRIOR NUMBER/CODE
124-12-04-04-62	No Change

11. TITLE:

(U) Design Criteria for Aerodynamic Analysis of Launch Vehicles

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
000500 Aerodynamics	12 64	N/A	N/A

16. PROCURE. METHOD.	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	b. NUMBER NAS8-11457 a. DATE 30 Dec 64	PRIOR FY— 67	0.7	-
	c. TYPE M. CPFF d. AMOUNT $129,400	CURRENT FY— 68	0.1	-

19. GOVT. LAB/INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME: Marshall Space Flight Center	NAME: Lockheed Missile & Space Company
ADDRESS: Huntsville, Alabama 35812	ADDRESS: Huntsville, Alabama
	INVESTIGATOR'S PRINCIPAL: John Benefield
RESP. INDIV.: Linsley, E. L., R-AERO-AD	ASSOCIATE:
TEL: 205, 876-3020 (FTS)	TEL: 205, 837-1800 Ext. 446 TYPE:

21. TECHNOLOGY UTILIZATION	22. COORDINATION
N/A	N/A

23. KEYWORDS

Aerodynamics, design criteria

24. (U) OBJECTIVE: a. Problem: Define the aerodynamic criteria necessary to be considered to insure the flight worthiness of launch vehicles. b. Application: To be used by personnel involved in launch vehicle design as a guide to the factors that must be considered and to indicate the methods by which appropriate knowledge and information can be attained to design launch vehicles.

25. (U) APPROACH: Specification in monograph form of the state-of-the-art, criteria to be considered, recommended practices to be used and appropriate references.

26. (U) PROGRESS: Although the contract was originally to be completed by December 31, 1966, a no-cost extension to March 31, 1967 was approved. This was due to the time-consuming iterations between Lockheed and MSFC personnel that are necessary to insure comprehensive monographs. Of twelve monographs, final approval has been given on the following four: (1) Survivability of Re-entry Debris (2) Space Flight Aerodynamics (3) Ascent Flight Heating (4) Space Flight Heating. Two additional monographs have also been submitted in final draft form for final approval.

27.	28. REQUESTING AGENCY	29. PROJECT CROSS CODE	30. SRT CROSS CODE

31. SPECIAL EQUIPMENT	32. FUNDS ($ K)	IN-HOUSE	CONTRACT
None	PRIOR FY—67	-	-
33. UNIQUE PROJECT: Space Vehicle Systems, SRT	CURRENT FY— 68	-	-
34. SUB PROGRAM: Space Vehicle Design Criteria	NEXT FY— 69	-	-
35. TASK AREA: Stability, Guidance and Control Design Criteria			

William G. Johnson

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