

SPACE SHUTTLE MAIN ENGINE THE FIRST TEN YEARS

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Part 10 – Acknowledgements, Acronyms and Bibliography

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ACKNOWLEDGMENTS

The development of the Space Shuttle Main Engine was an arduous task beset with many technical, logistical and managerial difficulties. The team that solved these problems pushed and advanced the state of the art in many different fields. Thousands of specialists at Rocketdyne and the George C. Marshall Space Flight Center worked doggedly for a decade to produce a device which now ranks high on the list of mankind's greatest engineering achievements. For many, personal sacrifices took the form of long nights, weekends and holidays lost, and punishing cross country air travel with days and weeks at a time away from their families and loved ones. The very fast paced, high stress environment caused others to pay a higher price. There were casualties along the way.

Many individuals deserve special recognition for significant contributions to the success of the program, as can be attested to by the hundreds of awards and certificates that have been presented by the government for this achievement. An attempt by the author to list only the most deserving of these was abandoned after surpassing 200 names and still finding that several very significant contributors were not listed. Wishing to avoid my embarrassment for having ignored someone truly deserving and not wanting to assign the task to a committee, such a list will not appear here.

ACRONYMS AND ABBREVIATIONS

ASI Augmented Spark Igniter
CCV Chamber Coolant Valve
CDR Critical Design Review
CEI Contract End Item
CRES Corrosion Resistant Steel
DCR Design Certification Review
DVS Design Verification Specification
EFL Engineering Field Laboratory
EPL Emergency Power Level
F Fahrenheit (degrees of temperature)
FMOF First Manned Orbital Flight
FPB Fuel Preburner
FPL Full Power Level

FPOV Fuel Preburner Oxidizer Valve
FRF Flight Readiness Firing
g Gravitational Constant
GAO General Accounting Office
gpm Gallons per Minute
G&C Guidance and Control
HPFTP High Pressure Fuel Turbopump
HPOTP High Pressure Oxidizer Turbopump
Hz Hertz (Cycles per Second)
ICD Interface Control Document
INCO Inconel (nickel, chromium and iron)
ISTB Integrated Subsystem Test Bed
KSC Kennedy Space Center
LH2 Liquid Hydrogen
LPFTP Low Pressure Fuel Turbopump
LPOTP Low Pressure Oxidizer Turbopump
MCC Main Combustion Chamber
MEC Main Engine Controller
MFV Main Fuel Valve
MOV Main Oxidizer Valve
MPL Minimum Power Level
MPTA Main Propulsion Test Article
MSFC Marshall Space Flight Center
MTF Mississippi Test Facility
NASA National Aeronautics and Space Administration
NSTL National Space Technology Laboratories
OFT Orbital Flight Test
OPB Oxidizer Preburner
OPOV Oxidizer Preburner Oxidizer Valve
PDR Preliminary Design Review
PFC Preliminary Flight Certification
psi Pounds per Square Inch
psia Pounds per Square Inch (Absolute)
R Rankine (degrees of absolute temperature)
RID Review Item Disposition
rms Root Mean Square
RPL Rated Power Level
rpm Revolutions per Minute
scfm Standard Cubic Feet per Minute
SEM Scanning Electron Microscope

SRB	Solid Rocket Booster
SSC	Stennis Space Center
SSFL	Santa Susana Field Laboratory
SSME	Space Shuttle Main Engine
STS	Space Transportation System
TCA	Thrust Chamber Assembly
T	Time (liftoff)

Authors note: To the reader who thinks that acronyms should be avoided at all costs, consider that these acronyms were an important part of the SSME program language and, therefore, have historical significance worthy of a place in the written history of the program.

BIBLIOGRAPHY

1. Wilhelm, W. F., Space Shuttle Orbiter Main Engine Design, Society of Automotive Engineers Transactions, Vol 81 (1972), Paper 72 0807.
2. Release No. 71 119, Public Affairs Office, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Alabama. July 13, 1971.
3. National Aeronautics and Space Administration Request for Proposal SSME 70 1, March 1, 1971.
4. RSS 8500, SSME Program Technical Proposal, Rocketdyne Division of North American Rockwell Corporation, April 21, 1971.
5. Contract No. NAS8 27759, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, August 31, 1971.
6. Decision No. B 1 73677, Comptroller General of the United States, General Accounting Office, Washington D. C., March 31, 1972.
7. RSS 8558, 470K Space Shuttle Main Engine Design Definition, Rocketdyne Division of North American Rockwell, May 12, 1972.
8. Contract No. NAS8 27980, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, August 14, 1972.
9. 13M1 5000F, Space Shuttle Orbiter Vehicle/Main Engine Interface Control Document, National Aeronautics and Space Administration, February 9, 1973.
10. CP320R0003B SSME Contract End Item Specification, Rocketdyne Division, Rockwell International, May 10, 1973.
11. Thompson, J. R., SA51 74 345, Power Level Terminology, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, October 25, 1974.
12. RSS 8503 2, SSME Program Development Plan Approved 2 August 1982, Rocketdyne Division of Rockwell International, November 3, 1982.
13. BC 81 55 SSME STS 1 Flight Readiness Review MSFC Center Board, Rocketdyne Division of Rockwell International, March 26, 1981.
14. RSS 8570 4, SSME Award Fee Performance Evaluation September 1973 February 1974 Rocketdyne Division of Rockwell International, April 9, 1974.
15. RSS 8570 5, Space Shuttle Main Engine Program Performance Summary March 1974 August 1974, Rocketdyne Division of Rockwell International, September 30, 1974.
16. Larson, E.W., RSS 8595 6, SSME Accident/Incident Report Coca 1A Test 740 007 Incident of 4 February 1976, Rocketdyne Division of Rockwell International, March 31, 1976.
17. Spencer, E. G., RSS 8595 12, SSME Accident/Incident Report Test 745 018 Coca 1B SB 1 Valve Fire 29 June, 1976, Rocketdyne Division of Rockwell International, September, 1977.
18. Statement for the Record by Dr. Robert A. Frosch, Administrator, National Aeronautics and Space Administration, to the Subcommittee on Science, Technology, and Space, of the Senate Committee on Commerce, Science and Transportation, United States Senate, March 31, 1978.
19. Seitz, P. F. and Searle, R. F., Space Shuttle Main Engine Control System, Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, October 16 18, 1973, Paper 73 0927.
20. Nelson, R. L., Unpublished SSME transient model analysis results, Rocketdyne Division of Rockwell International.
21. Childs, D. W., Transient Rotordynamic Analysis for the Space Shuttle Main Engine High Pressure Turbopumps, 1973 ASEE NASA Summary Faculty Fellowship Program Final Report, University of Alabama, 1973.
22. Ek, M. C., Solution of the Subsynchronous Whirl Problem in the High Pressure Hydrogen Turbomachinery of the Space Shuttle Main Engine, AIAA/SAE 14th Joint Propulsion Conference, Las Vegas, Nev. July 25 27, 1978, Paper 78 1002.
23. Johnson, J. R., Development of the Space Shuttle Main Engine (as of 5 May 1977), Unpublished draft paper for the AIAA, July, 1977.
24. Larson, E. W., RSS 8595 11, SSME Accident/incident Report Test 901 110 High Pressure Oxidizer Fire, Rocketdyne Division of Rockwell International, June 30, 1977.
25. Johnson, J. and Colbo, H., Update on Development of the Space Shuttle Main Engine, AIAA/SAE 14th Joint Propulsion Conference, Las Vegas, Nev. July 25 27, 1978, Paper 78 1001
26. Ek, M. C., RSS 8595 13, SSME Accident/Incident Report Test 901 136 High Pressure Oxidizer Fire, Rocketdyne Division of Rockwell International, March 20, 1978.
27. Ek, M. C., RSS 8595 15, SSME Accident/Incident Report Test 901 120 High Pressure Oxidizer Fire, Rocketdyne Division of Rockwell International.
28. Wood, B. K., RSS 8595 22, SSME Accident/incident Report Engine 0010 Test 901 284 High Pressure Oxidizer Fire, Rocketdyne Division of Rockwell International, January 15, 1981.
29. RSS 8732, SSME Turbine Blade Analysis Team Report, Rocketdyne Division of Rockwell International, December 10, 1986.
30. Ek M. C., RSS 8595 18, SSME Accident/Incident Report Test 901 225 Main Oxidizer Fire, Rocketdyne Division of Rockwell International, August 1, 1979.
31. Colbo, H. I., Development of the Space Shuttle Main Engine, AIAA/SAE 15th Joint Propulsion Conference, Las Vegas, Nev. July 18 20, 1979, Paper 79 1141.
32. Gosdin, D. R., SSME Major Incident Overview, Chart Number 2 366 8 4W, Marshall Space Flight Center, March 9, 1988.
33. Wilhelm, W. F., RSS 8595 20, SSME Accident/incident Report MPTA Static Firing Test SF6 01 Main Fuel Valve Failure, Rocketdyne Division of Rockwell International, January 7, 1981.
34. Larson, E. W., Investigation of the Fuel Feed Line Failures on the Space Shuttle Main Engine AIAA/SAE 16th Joint Propulsion Conference, Hartford, Connecticut, June 30 July 2, 1980, Paper 80 1309.
35. Lary, F. B. and Larson, E. W., RSS 8595 19, SSME Accident/Incident Report SSFL Test 750 041, 14 May 1979 Engine 0201 Nozzle Fuel Feed Duct Failure (steerhorn), Rocketdyne Division of Rockwell International, February 25, 1980.
36. Larson, E. W., Ratekin, G. H., and O'Connor, G. M., Structural Response of the SSME Fuel Feed Line to Unsteady Shock Oscillations, 52nd Shock and Vibration Symposium, New Orleans, Louisiana, 27 29 October 1981.
37. Larson, E. W., RSS 8595 21, SSME Accident/Incident Report Main Propulsion Test Article Test MPT SF6 003 Steerhorn Failure, Rocketdyne Division of Rockwell International, February 25, 1980.
38. RSS 8570 16, Space Shuttle Main Engine Program Performance Summary October 1979 through March 1980, Rocketdyne Division of Rockwell International, April 28, 1980.
39. McAlister, D. S., RSS 8719, Failure Analysis Report Engine 0006 Fuel Preburner Burnthrough Incident SF10 01, Rocketdyne Division of Rockwell International, March 25, 1981.
40. Thompson, J. R., SA51 80 243, SSME Project Development and Production Guidelines, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Huntsville, Alabama. May 21, 1980.
41. Johnson, J. R. and Colbo, H. I., Space Shuttle Main Engine Progress Through the First Flight, AIAA/SAE 17th Joint Propulsion Conference, Colorado Springs, Colorado, July 27 29, 1981, Paper 78 1373.