SPACE PROPULSION TECHNOLOGY AND CRYOGENIC FLUID DEPOT

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SPACE PROPULSION PROGRAM AREAS

BASE R & T

ON-BOARD

LUNAR

ADVANCED CONCEPTS

PATHFINDER

CHEMICAL TRANSFER

CARGO VEHICLE

ORBIT TRANSFER

MAJOR THRUSTS

CHEMICAL PROPULSION
- LOX/LH_2
- EXPANDER CYCLE

ELECTRIC PROPULSION
- MPD
- ION

CHEMICAL TRANSFER PROPULSION

PROGRAM OBJECTIVES

- PROVIDE VALIDATED TECHNOLOGY BASE FOR HIGH PERFORMANCE, SPACE BASED, THROTTLEABLE, LOX/HYDROGREN EXPANDER CYCLE ENGINES
  - VALIDATION AT COMPONENT AND ENGINE SYSTEMS LEVEL
  - RESPONSIVE TO CONCURRENT MISSION STUDIES
- ENABLE SIGNIFICANT REDUCTIONS IN ON-ORBIT PROPELLANT MASS REQUIRED FOR LUNAR/PLANETARY TRANSFER AND DESCENT/ASCENT VEHICLE OPERATIONS

TECHNOLOGY ISSUES

- HIGH PRESSURE ENGINE OPERATION (PERFORMANCE)
- DEEP THROTTLING WITH MINIMUM PERFORMANCE LOSS
- LONG-LIFE, HIGH RELIABILITY DESIGN CAPABILITY
- DESIGN FOR ON-ORBIT MAINTAINABILITY
- AUTOMATED FLIGHT READINESS OPERATIONS
- FAULT-TOLERANT ENGINE OPERATIONS METHODOLOGY

CHEMICAL TRANSFER PROPULSION

PROGRAM DESCRIPTION

- Responsible Centers: LeRC (N. Hannum) & MSFC (S. McIntyre)

MILESTONES

• COMPONENT TECHNOLOGY VERIFICATION	FY 1992
• TESTBED SYSTEM PERFORMANCE VALIDATION	FY 1994
• AUTOMATED INSPECTION/CHECKOUT TECHNIQUES DEMONSTRATED	FY 1996
• HEALTH MONITORING/CONTROL SYSTEM DEFINED	FY 1997
• FAULT TOLERANT ENGINE OPS DEMONSTRATED	FY 1999

CHEMICAL TRANSFER PROPULSION

DELIVERABLES

• **COMPUTER CODES**	FOR SIMULATING INTERNAL ENGINE PROCESSES, DEFINING LOADS, PREDICTING PERFORMANCE, LIFE AND ENGINE TRANSIENT AND STEADY STATE OPERATIONS
• **ADVANCE DESIGN CONCEPTS**	FOR EXTENDING COMPONENT LIFE, ENHANCING PERFORMANCE, OPERATIONS AND CONTROLS
• **DIAGNOSTICS**	FOR COMPONENT CONDITION MONITORING AND INCIPIENT FAILURE DETECTION AND CORRECTIONS
• **EXPERIMENTAL DATA BASE**	FOR VALIDATION OF ADVANCED DESIGN CONCEPTS AND COMPUTER CODES
• **OPERATING ENGINE SYSTEM**	FOR DEVELOPMENT PROGRAM PROBLEM SOLVING AND PRODUCT IMPROVEMENTS

CARGO VEHICLE PROPULSION

PROGRAM OBJECTIVES

- ESTABLISH FEASIBILITY OF ELECTRIC PROPULSION WITH

  Isp > 4000 sec
  EFFICIENCY > 0.60
  SPECIFIC MASS < 10 kg/kw
  SCALABLE TO MULTI-MEGAWATT

- DURABILITY FOR TOTAL IMPULSE OVER 10^8 N-sec PER ENGINE

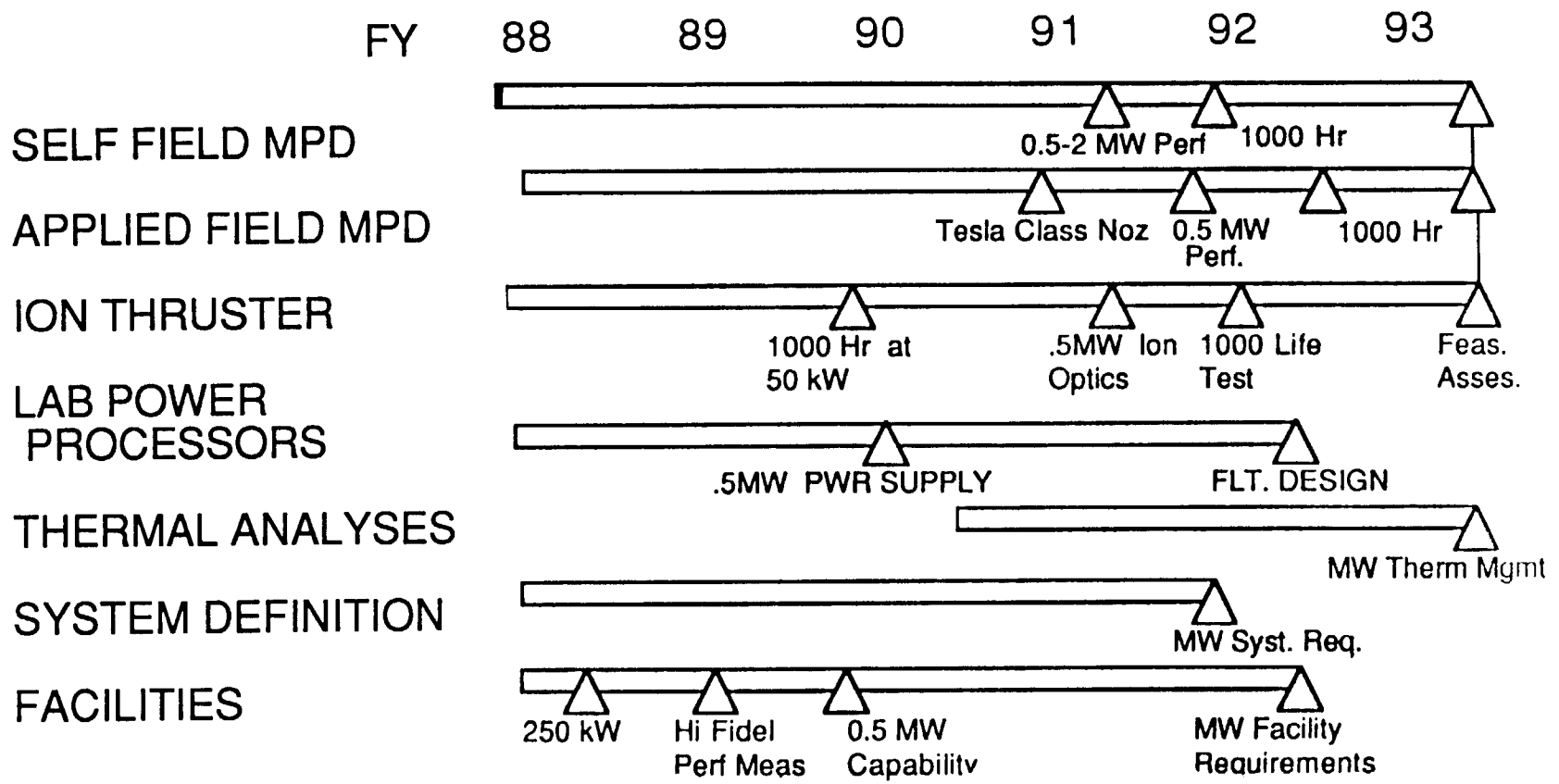
TECHNOLOGY ISSUES

- SCALE-UP OF ION OPTICS TO HIGH POWER
- MPD EFFICIENCY AND LIFE FOR BOTH APPLIED FIELD AND SELF FIELD
- LIFE EVALUATION METHODS

CARGO VEHICLE PROPULSION

PROGRAM DESCRIPTION

- Responsible Centers: LeRC (D.Byers) & JPL (J.Stocky)



CARGO VEHICLE PROPULSION

DELIVERABLES

- BY 1993 PROVIDE:

  0.5 MW PERFORMANCE AND LIFE EVALUATION

  - SELF FIELD MPD
  - INDUCED FIELD MPD
  - ION THRUSTER

  MEGAWATT SYSTEM REQUIREMENT AND CONCEPT DEFINITION

  0.5 MW (STEADY STATE) FACILITY AND EVALUATION OF FACILITY IMPACTS

  CONCEPT SELECTION FOR PHASE II FOCUSED PROGRAM

- FOCUSED TECHNOLOGY PROGRAM (1994-98)
- FLIGHT VALIDATION PROGRAM (1998 →)

ON-BOARD PROPULSION

PROGRAM DESCRIPTION

- Responsible Center: Lewis Research Center (D. Byers)

TASK	FY'88	FY'89	FY'90	FY'91	FY'92
Low Thrust Chemical	2600K 5LB Rocket	Integral H/O	Hot Rocket Scaling Tech.	Integrated H/O Rocket Demo	
Electric	1000 Hour, 500 Cycle Arcjet	10K Hour 5KW Ion Feas.	KW Arcjet Interface Evaluation	10 KW Ion Eng. Model System	*1KW Arcjet Flight Test
Fundamentals	Arcjet Plume Definition	2D Chamber Code Demo	Rocket Heat Transfer Model	DSMC Plume Code Verif.	Unified Rocket Code Verif.

* Separate Program. Not Approved.

LUNAR/PLANETARY PROPULSION TECHNOLOGY

MAJOR THRUSTS

PROPULSION/TRAJECTORY STUDIES

- INJECTION PROPULSION
- ASCENT/DESCENT PROPULSION
- MIXED MODE

COMBUSTION STUDIES OF PROPELLANT OPTIONS

- GELLED METALLIC MONOPROPELLANTS
- LIQUIFIED ATMOSPHERES
- LIQUID BI-PROPELLANTS

LUNAR/PLANETARY PROPULSION TECHNOLOGY

- THRUST CHAMBER & SYSTEM TECH.
- PROPELLANT GELLING
- THRUST CHAMBER COOLING
- PROPELLANT FEED SYSTEMS

PROPELLANT PRODUCTION STUDIES

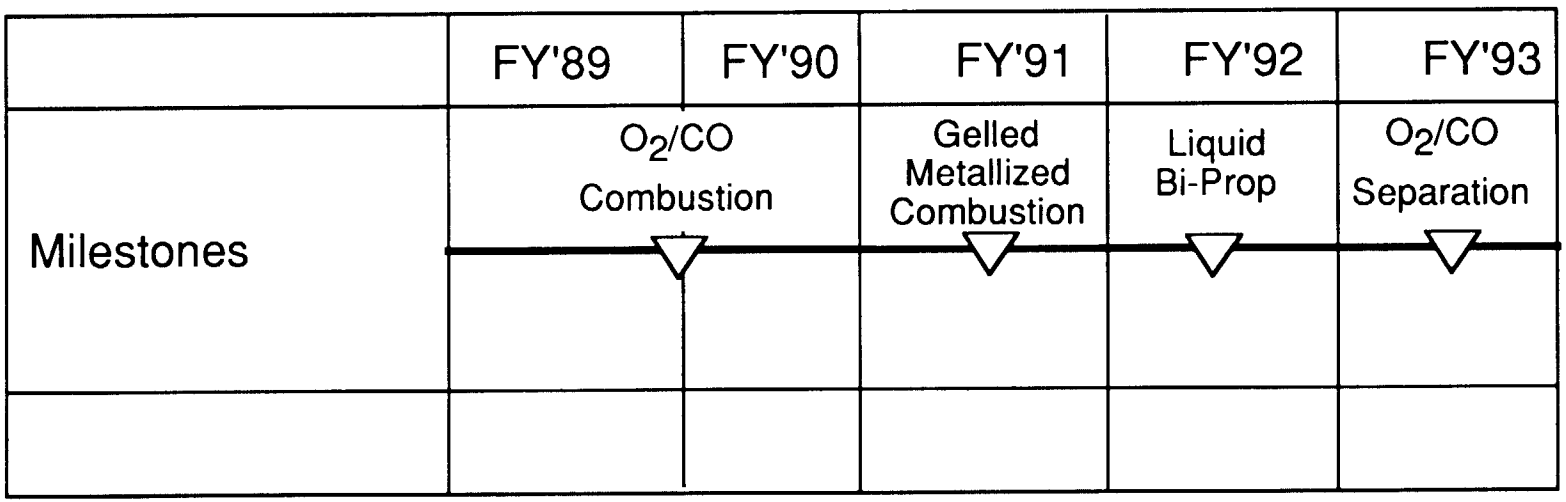
- O_2/CO SEPARATION/PRODUCTION
- LUNAR O_2 PRODUCTION
- LUNAR ALUMINUM PRODUCTION

LUNAR/PLANETARY PROPULSION TECHNOLOGY

PROGRAM DESCRIPTION

- Responsible Centers:

Propulsion	LeRC	Carl A. Aukerman
Propellant Production	JPL	Jack Stocky



ADVANCED CONCEPTS

OBJECTIVE

- Theoretical & Experimental Research on Breakthru Propulsion

MAJOR THRUSTS

- Nuclear Fission/Fusion
- Advanced Electric
- Antimatter & Energetic Propellants
- Concept/Mission Analyses

PROGRAM DESCRIPTION

- Responsible Centers: LeRC (D.Byers) & JPL (J.Stocky)

TASK	FY'88	FY'89	FY'90	FY'91	FY'92
Nuclear Fission/Fusion		Nuc. Prop. Assessments		Mag. Nozzle Definition	
Advanced Electric	KW μWave Rocket	RF Thruster Demo	5T Magnetic Nozzle		Electrodeless Rocket Feas.
Antimatter/Energetic Props.		Anti. Mat ICF Def.	Prop. Study Complete		Anti. Mat. Sys. Eval.
Concept/Mission Analyses		Fusion Mission Eval.			

FLUID MANAGEMENT TECHNOLOGY

OBJECTIVE

TO DEVELOP AND VALIDATE THE TECHNOLOGY REQUIRED TO PERFORM STORAGE, SUPPLY, AND TRANSFER OF SUBCRITICAL CRYOGENIC LIQUIDS IN A MICROGRAVITY SPACE ENVIRONMENT

TECHNOLOGY AREAS

- LIQUID STORAGE
- LIQUID SUPPLY
- LIQUID TRANSFER
- FLUID HANDLING
- ADVANCED INSTRUMENTATION
- TANK MATERIALS AND STRUCTURES

PROJECT PATHFINDER
CRYOGENIC FLUID DEPOT

NASA
Lewis Research Center

OAST

PROGRAM OBJECTIVES

DEVELOPMENT OF DEPOT CONCEPTUAL DESIGNS

PERFORMANCE OF CRITICAL RESEARCH AND ADVANCEMENT OF TECHNOLOGY READINESS LEVELS IN THE AREAS OF:

- FLUID MANAGEMENT
- DEPOT OPERATIONS
- MATERIALS AND STRUCTURES
- ORBITAL OPERATIONS AND LOGISTICS
- SAFETY

DEFINITION OF IN-SPACE EXPERIMENT REQUIREMENTS

CENTER FOCUS

LEWIS RESEARCH CENTER (P. SYMONS)