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SELECTED OAST/OSSA SPACE EXPERIMENT ACTIVITIES IN SUPPORT OF SPACE STATION FREEDOM

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ABSTRACT

The Space Experiments Division at NASA Lewis Research Center is developing technology and science space experiments for the Office of Aeronautics and Space Technology (OAST) and the Office of Space Sciences and Applications (OSSA). Selected precursor experiments and technology development activities supporting the Space Station Freedom (SSF) are presented.

The Tank Pressure Control Experiment (TPCE) is an OAST-funded cryogenic fluid dynamics experiment, the objective of which is to determine the effectiveness of jet mixing as a means of equilibrating fluid temperatures and controlling tank pressures, thereby permitting the design of lighter cryogenic tanks. The information from experiments such as this will be utilized in the design and operation of on board cryogenic storage for programs such as SSF.

The Thermal Energy Storage Flight Project (TES) is an OAST-funded thermal management experiment involving phase change materials for thermal energy storage. The objective of this project is to develop and fly in-space experiments to characterize void shape and location in phase change materials used in a thermal energy storage configuration representative of an advanced solar dynamic system design. The information from experiments such as this will be utilized in the design of future solar dynamic power systems.

The Solar Array Module Plasma Interaction Experiment (SAMPIE) is an OAST-funded experiment to determine the environmental effects of the low earth orbit (LEO) space plasma environment on state-of-the-art solar cell modules biased to high potentials relative to the plasma. Future spacecraft designs and structures will push the operating limits of solar cell arrays and other high voltage systems. SAMPIE will provide key information necessary for optimum module design and construction.

The Vibration Isolation Technology (VIT) Advanced Technology Development effort is funded by OSSA to provide technology necessary to maintain a stable microgravity environment for sensitive payloads on board spacecraft. The proof of concept will be demonstrated by laboratory tests and in low-gravity aircraft flights. VIT is expected to be utilized by many SSF microgravity science payloads.

The Space Acceleration Measurement System (SAMS) is an OSSA-funded instrument to measure the microgravity acceleration environment for OSSA payloads on the shuttle and SSF.

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Space Experiments Division

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Space Flight Systems Directorate

AGENDA

- INTRODUCTION
- TANK PRESSURE CONTROL EXPERIMENT
- THERMAL ENERGY STORAGE
- SOLAR ARRAY MODULE PLASMA INTERACTION EXPERIMENT
- VIBRATION ISOLATION TECHNOLOGY
- SPACE ACCELERATION MEASUREMENT SYSTEM
- CONCLUDING REMARKS

INTRODUCTION

- THE LeRC SPACE EXPERIMENTS DIVISION SUPPORTS SSF THROUGH:

  OAST/SPACE EXPERIMENTS OFFICE-FUNDED
  IN-SPACE TECHNOLOGY EXPERIMENTS PROGRAM

  OSSA/MSAD-FUNDED
  MICROGRAVITY SCIENCE EXPERIMENTS
  ADVANCED TECHNOLOGY DEVELOPMENT ACTIVITIES

- THIS PRESENTATION WILL COVER THESE SELECTED TOPICS:
  OAST:
  - TANK PRESSURE CONTROL EXPERIMENT
  - THERMAL ENERGY STORAGE FLIGHT PROJECT
  - SOLAR ARRAY MODULE PLASMA INTERACTION EXPERIMENT

  OSSA:
  - VIBRATION ISOLATION TECHNOLOGY
  - SPACE ACCELERATION MEASUREMENT SYSTEM FOR SSF

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TANK PRESSURE CONTROL EXPERIMENT

TECHNOLOGY NEED:

- CONTROL OF TANK PRESSURE FOR CRYOGENIC FLUID MANAGEMENT

OBJECTIVES:

- CHARACTERIZE FLUID DYNAMICS OF JET-INDUCED MIXING
- ESTABLISH LOW-GRAVITY MIXING TIMES TO EQUILIBRATE PRESSURE & TEMPERATURE

TANK PRESSURE CONTROL EXPERIMENT

APPROACH:

- USE JET-INDUCED FLUID MIXING AS A MEANS OF CONTROLLING PRESSURE OF FREON 113 IN LOW-GRAVITY
- IMPLEMENT AS GAS-CAN EXPERIMENT WITH CONTRACT TO BOEING (OAST-FUNDED)

STATUS:

- EXPERIMENT FLEW ON STS-43 IN AUGUST 1991
- POSITIVE RESULTS OBTAINED
- RE-FLIGHT PLANNED FOR STS-52 IN OCTOBER 1992
  - FOCUS ON SELF-PRESSURIZATION AND POOL BOILING AT LOW HEAT FLUXES
  - EXTEND MIXING DATA BASE TO LOWER FLOWS

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THERMAL ENERGY STORAGE

TECHNOLOGY NEED:

- MELT/FREEZE BEHAVIOR DATA BASE FOR PHASE CHANGE MATERIALS IN LONG DURATION LOW-GRAVITY ENVIRONMENT

OBJECTIVES:

- CHARACTERIZE MELT/FREEZE BEHAVIOR OF PHASE CHANGE MATERIALS IN LOW-GRAVITY
- PROVIDE EXPERIMENTAL DATA TO VERIFY ANALYTICAL MODELS NOW UNDER DEVELOPMENT

THERMAL ENERGY STORAGE

APPROACH:

- THERMALLY CYCLE TWO DIFFERENT PHASE CHANGE MATERIALS
  - LITHIUM FLUORIDE
  - FLUORIDE EUTECTIC
- IMPLEMENT IN-HOUSE AT NASA LEWIS AS GET-AWAY-SPECIAL PAYLOADS (OAST-FUNDED)
- FLY TWO EXPERIMENTS EACH IN 1994 AND 1996

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SOLAR ARRAY MODULE PLASMA INTERACTION EXPERIMENT

TECHNOLOGY NEED:

- DETERMINE THE EFFECTS OF LEO SPACE PLASMA ON SOLAR CELL MODULES

APPROACH:

- EXPOSE SEVERAL TYPES OF MODULES TO SPACE PLASMA OVER A RANGE OF POTENTIALS
- IMPLEMENT IN-HOUSE AT NASA LEWIS (OAST-FUNDED)
- FLY AS CARGO BAY EXPERIMENT IN 1994

OBJECTIVES:

- DETERMINE ARCING THRESHOLDS, RATES AND STRENGTHS
- DETERMINE PLASMA CURRENT COLLECTION CHARACTERISTICS
- MEASURE PARAMETERS FOR DATA ANALYSIS
- VALIDATION OF MODELS

SOLAR ARRAY MODULE PLASMA INTERACTION EXPERIMENT

STATUS:

- EXPERIMENT UNDER DEVELOPMENT FOR OAST-2 MISSION
- SOLAR MODULES WILL INCLUDE:
  - SPACE STATION FREEDOM CELLS
  - ADVANCED PHOTOVOLTAIC SOLAR ARRAY CELLS
  - STANDARD SILICON CELLS (REFERENCE)

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VIBRATION ISOLATION TECHNOLOGY

TECHNOLOGY NEED/OBJECTIVE

PROVIDE THE REQUIRED TECHNOLOGY TO MAINTAIN A STABLE MICROGRAVITY ENVIRONMENT FOR SENSITIVE PAYLOADS OVER THE FREQUENCY RANGE APPLICABLE TO DISTURBANCES PRESENT IN SPACECRAFT.

APPROACH

- DEFINE TECHNOLOGY REQUIREMENTS AND ASCERTAIN LIMITS OF CURRENT STATE OF THE ART METHODS.
- DEVELOP TECHNOLOGY VIA A GROUND BASED PROGRAM THAT MEETS THE REQUIREMENTS; EXPAND THE STATE OF THE ART.
- DEMONSTRATE THE PROOF OF CONCEPT IN A LABORATORY ENVIRONMENT AND IN LOW GRAVITY AIRCRAFT FLIGHTS.

VIBRATION ISOLATION TECHNOLOGY

STATUS

- ACTIVELY CONTROLLED, MAGNETIC ISOLATION SYSTEM DEVELOPED IN LABORATORY,
  - -SIX DEGREES OF FREEDOM
  - -INERTIAL AND POSITION FEEDBACK
  - -ISOLATION DOWN TO MICROGRAVITY LEVELS AT 0.1 HZ
- PROOF OF CONCEPT VERIFIED IN LOW GRAVITY PARABOLIC FLIGHTS DOWN TO 1 HZ
  - -FREQUENCY LIMITED BY LOW GRAVITY TIME AVAILABLE.
  - -TWELVE FLIGHTS WITH 72 TRAJECTORIES FLOWN.
  - -PREFORMANCE OF ISOLATION SYSTEM PREDICTABLE.
  - -ISOLATION ACHIEVED DOWN TO NOISE FLOOR OF SYSTEM.
- LOW FREQUENCY VERIFICATION (< 0.1 HZ) MUST BE DONE THROUGH FLIGHT EXPERIMENT.

SPACE ACCELERATION MEASUREMENT SYSTEM FOR SPACE STATION FREEDOM

PROGRAMMATIC NEED:

- MEASURE THE MICROGRAVITY ENVIRONMENT FOR OSSA SCIENCE PAYLOADS ON SPACE STATION FREEDOM

APPROACH:

- REMOTE SENSORS LOCATED WITHIN EXPERIMENTS
- DATA RECORDED ON-BOARD AND/OR DOWN-LINKED TO GROUND CONTROL CENTER
- IMPLEMENTED IN-HOUSE AT NASA LEWIS (OSSA-FUNDED)

OBJECTIVE:

- SUPPORT OSSA PRINCIPAL INVESTIGATORS WITH MICROGRAVITY ACCELERATION DATA

SPACE ACCELERATION MEASUREMENT SYSTEM FOR SPACE STATION FREEDOM

STATUS:

- SAMS UNITS CURRENTLY BEING FLOWN WITH OSSA SCIENCE EXPERIMENTS ON SHUTTLE MISSIONS
- NEW & IMPROVED INSTRUMENT BEING DEVELOPED FOR U.S. LABORATORY MODULE
- TYPICAL SPACE STATION FREEDOM EXPERIMENTS SUPPORTED:
  - SPACE STATION FURNACE FACILITY
  - COMBUSTION EXPERIMENTS MODULE
  - FLUID EXPERIMENTS MODULE

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CONCLUDING REMARKS

- EXISTING OAST EXPERIMENTS ARE VIEWED AS PRECURSOR EXPERIMENTS FOR SPACE STATION FREEDOM
- VIBRATION ISOLATION TECHNOLOGY REQUIRES VALIDATION TO SUPPORT FUTURE FLUID PHYSICS & OTHER MICROGRAVITY SPACE EXPERIMENTS
- SPACE ACCELERATION MEASUREMENT SYSTEM WILL CONTINUE TO SUPPORT OSSA / MSAD EXPERIMENTS