Office of
Aeronautics and
Space
Technology

NASA

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PATHFINDER

HUMANS IN SPACE

Technology for NASA Future Missions
an AIAA/NASA OAST Conference

September 12-13, 1988
The Capital Hilton
Washington, DC

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HUMANS IN SPACE
PROGRAM INTEGRATOR

HUMAN EXPLORATION OF THE SOLAR SYSTEM

MISSION CONDITIONS

- O DURATION INCREASE OF AN ORDER OF MAGNITUDE
- O UNACCUSTOMED ENVIRONMENTAL STRESS FROM:
  - * SMALL GROUP, CONFINED ISOLATION
  - * UNFAMILIAR RISKS
  - * SPACE RADIATION
  - * UNNATURAL GRAVITY FIELDS
- O TOTAL, UNRELIEVED DEPENDENCE ON ADVANCED TECHNOLOGICAL SYSTEMS

HUMAN EXPLORATION OF THE SOLAR SYSTEM

HUMAN SELF-SUFFICIENCY

- ON PAST MISSIONS, FLIGHTS HAVE BEEN SHORT, ACTIVITIES NEW AND CHALLENGING, AND RESOURCES EXPENDABLE
  - * PERFORMANCE REQUIREMENTS HAVE FALLEN WITHIN EASY REACH OF HUMAN VERSATILITY AND SHORT-TERM ADAPTABILITY
  - * SUPPORT REQUIREMENTS HAVE FALLEN WITHIN OUR TRANSPORT CAPABILITY
- BUT FOR MUCH LONGER MISSIONS:
  - * HUMANS MUST FUNCTION OUTSIDE THE BOUNDARIES OF THE CURRENTLY KNOWN PERFORMANCE ENVELOPE
  - * LIFE SUPPORT RESOURCES MUST BE REGENERATED

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RATIONALE

- EXISTING TECHNOLOGIES MAY NOT BE SCALABLE TO MEET HUMAN PERFORMANCE AND SUPPORT REQUIRMENTS OVER LONG, SELF-SUFFICIENT MISSIONS

- TECHNOLOGY IDENTIFICATION AND ADVANCEMENT CANNOT EFFECTIVELY PROCEED INDEPENDENTLY FROM THE DETERMINATION OF THE HUMAN REQUIREMENTS

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JOINT PROGRAM

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

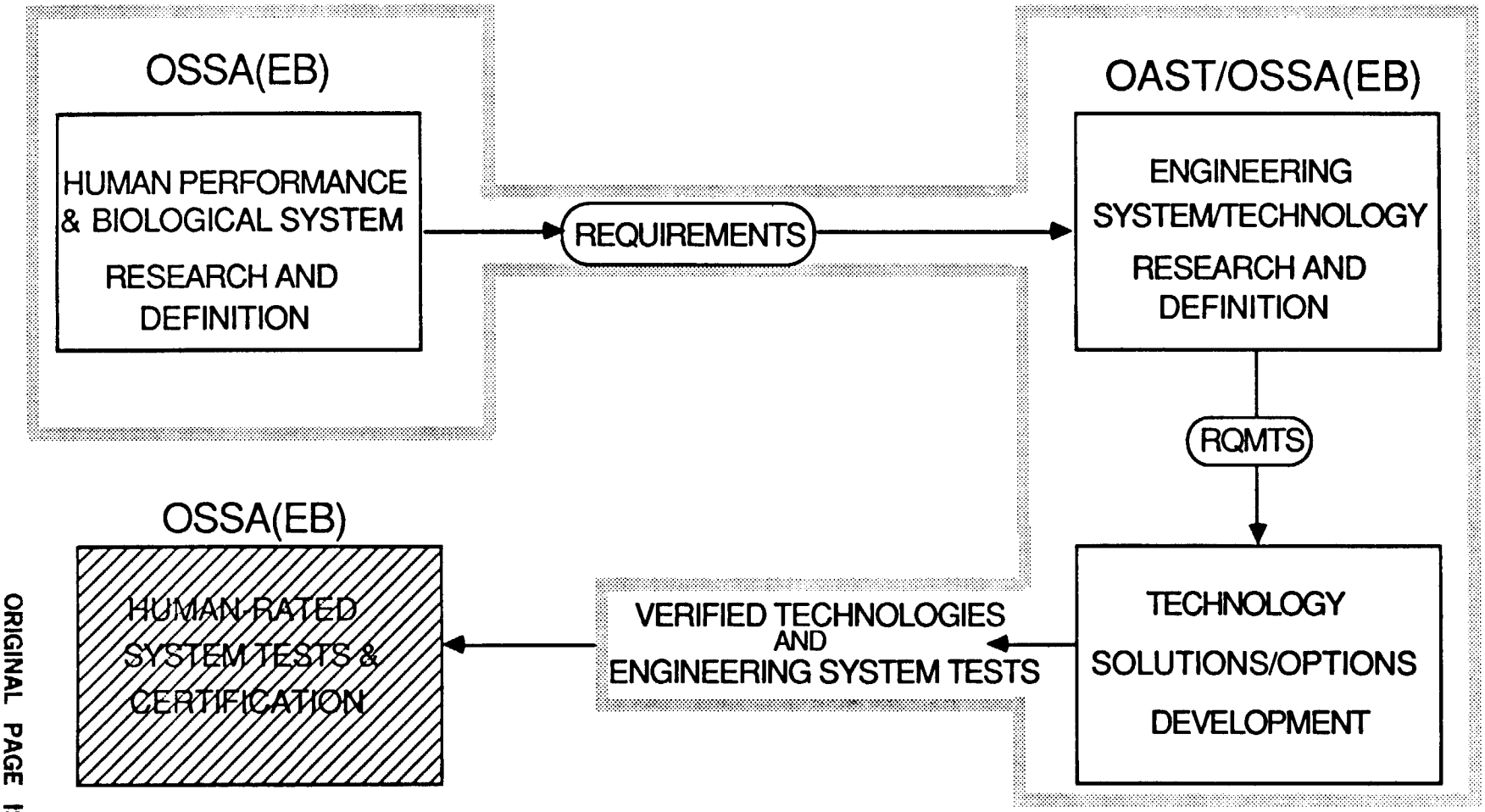
OFFICE OF SPACE SCIENCE AND APPLICATIONS
(LIFE SCIENCES DIVISION)

OBJECTIVES

Determine the enabling system engineering and technology requirements and develop technology options

Determine critical human and system performance requirements for enabling human health, productivity and self-sufficiency

PATHFINDER/HUMANS-IN-SPACE
TECHNICAL REQUIREMENTS INTERFACES



HUMANS IN SPACE - FUNCTIONAL OBJECTIVES

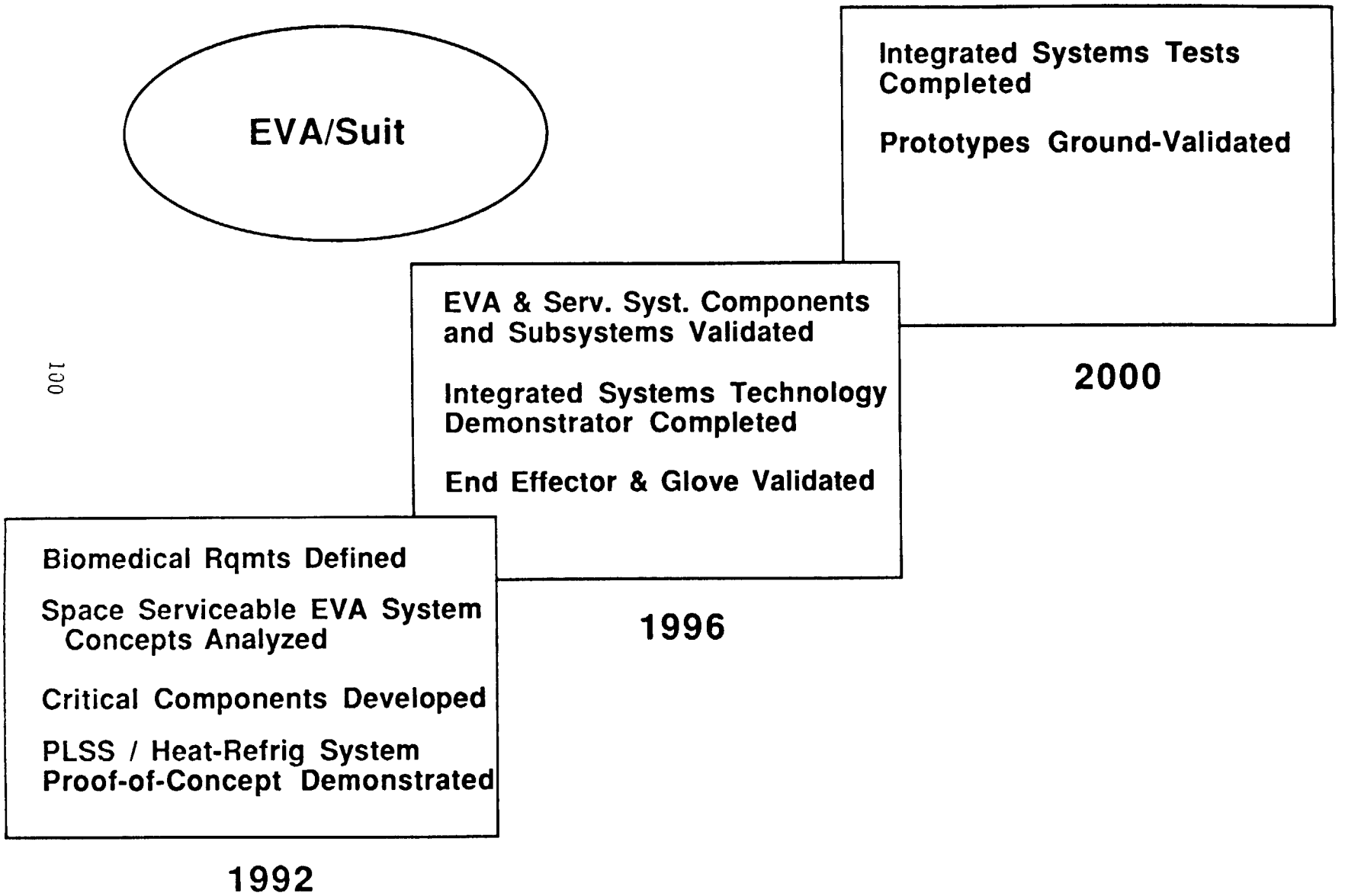
ENABLE:	ON-DEMAND, EXTENDED DURATION SURFACE EVA WITH ON-SURFACE SUIT MAINTENANCE AND ECLSS REGENERATION

ENABLE:	PRODUCTIVE COGNITIVE, PHYSICAL, BEHAVIORAL, AND TEAM PERFORMANCE THROUGHOUT MISSIONS OF UNACCUSTOMED ENVIRONMENTAL STRESS AND DEPENDENCE ON TECHNOLOGICAL SYSTEMS

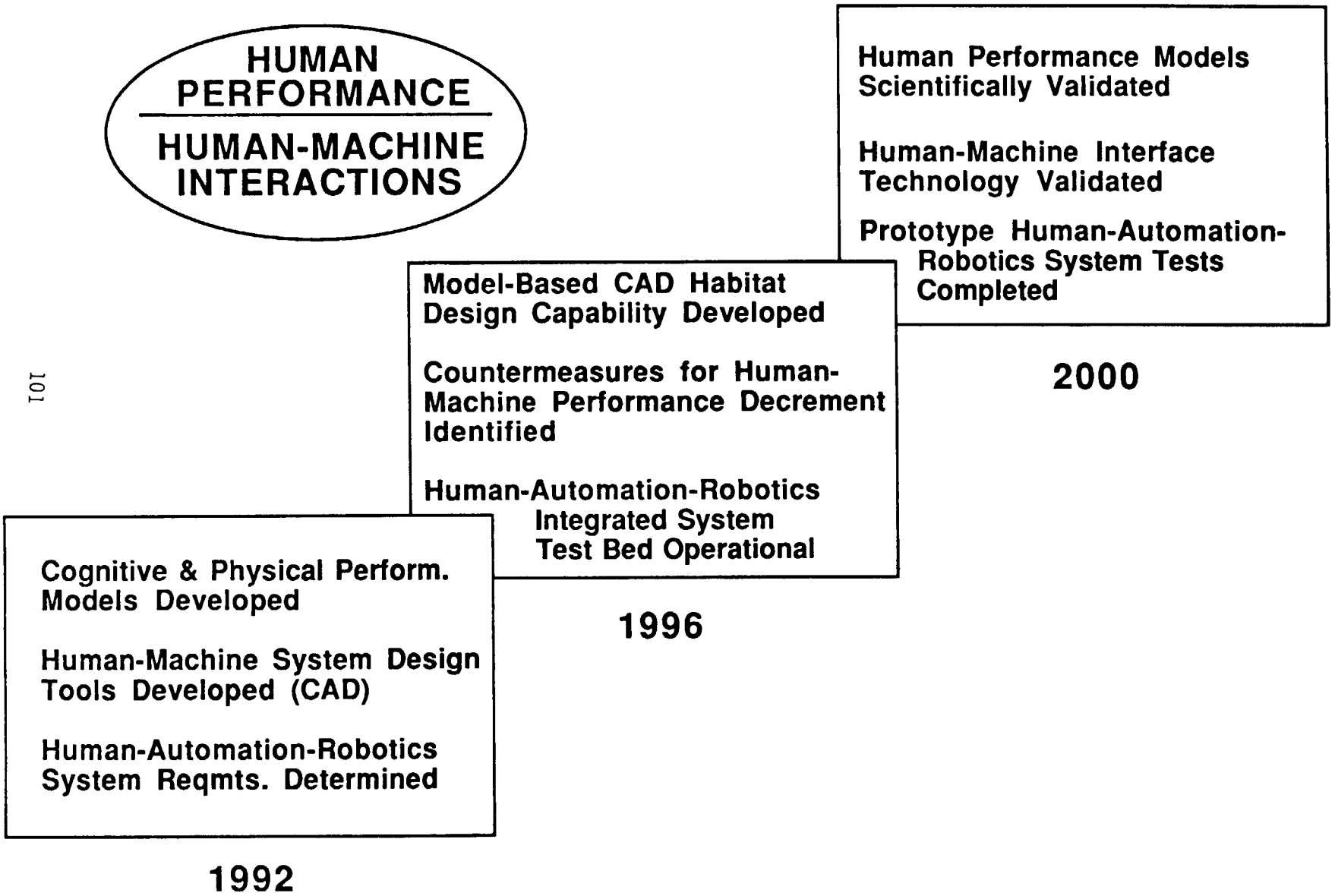
ENABLE:	A MEANS TO MAINTAIN HEALTH AND PHYSICAL CONDITIONING DURING LONG EXPOSURE TO UNNATURAL GRAVITY FIELDS AND SPACE RADIATION

ENABLE:	LIFE SUPPORT SYSTEM SELF-SUFFICIENCY AND SIGNIFICANT REDUCTION IN EXPENDABLES WEIGHT & TRANSPORT REQUIREMENTS FOR MISSIONS > 1 YR

HUMANS IN SPACE - PROGRAM MILESTONES



HUMANS IN SPACE - PROGRAM MILESTONES



HUMANS IN SPACE - PROGRAM MILESTONES

HUMAN PERFORMANCE

ARTIFICIAL GRAVITY
HUMAN FACTORS
RADIATION

1992

- Prelim. Rqmts Determ. for Art-G
  - Chronic Rotation Tolerance
  - Feasibility of Acute-G Loading
- Partial-G Load Ground Test Facility Completed
- Prelim. Shielding Rqmts for Space Radiation Defined
- Analog Environ. Operational

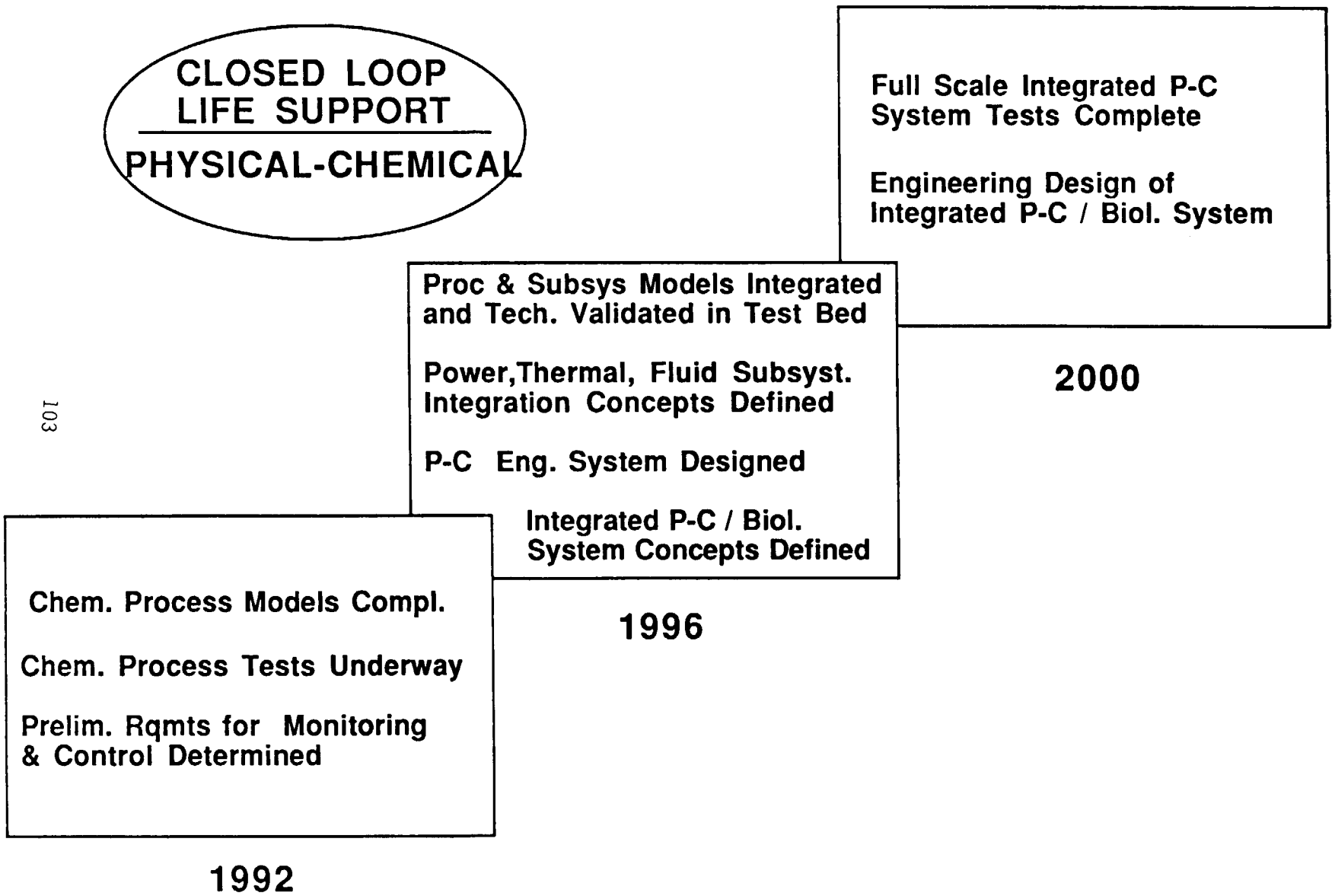
1996

- Ongoing Tests to Determine Operational and Structural Parameters of Art.-G Systems
- Ongoing Tests to Determine Crew Factor and Habitability Parameters

2000

- Radiation Shielding Rqmts.
- Artificial Gravity Rqmts.
- Habitability Rqmts.
- Selection, Training, Crew Factors & Mission Rqmts.

HUMANS IN SPACE - PROGRAM MILESTONES



HUMANS IN SPACE - PROGRAM MILESTONES

CLOSED LOOP
LIFE SUPPORT
BIOREGENERATIVE

Integrated Bioregenerative
System Tests Complete

2000

Initial Tests Conducted in
Human-Rated Test Facility

Complete Model of Integrated
System Behavior & Control

Define Bioregen. System with
Advanced P/C Subsystems

Define Mission-Specific
Bioregen. System Concepts

1996

Feasibility of Bioregenerative
Concept Demonstrated
in Breadboard Facility

Analytical Process & System
Models Developed

Complete Initial Studies of
Human-Rated Test Facility

1992

PATHFINDER
HUMANS IN SPACE

PROGRAM MANAGEMENT

- O OAST DIVISIONS:
  - * DIRECTORATE FOR SPACE
  - * PROPULSION, POWER & ENERGY
  - * INFORMATION SCIENCES AND HUMAN FACTORS
  - * MATERIALS AND STRUCTURES

OSSA LEAD DIVISION: * LIFE SCIENCES DIVISION

- O NASA FIELD CENTERS:
  - * AMES RESEARCH CENTER
  - * JOHNSON SPACE CENTER
  - * KENNEDY SPACE CENTER

- O FY 1989 BUDGET: $6.0 M
- O FY 90-94 TOTAL BUDGET: $227.5 M

SUMMARY

O EXPANSION OF HUMAN PRESENCE INTO THE SOLAR SYSTEM WILL REQUIRE:

* **DETERMINATION OF HUMAN RESPONSE TO MISSION CONDITIONS**

* **DETERMINATION OF HUMAN REQUIREMENTS FOR WELL-BEING AND PRODUCTIVITY**

* **DEVELOPMENT AND VALIDATION OF TECHNOLOGICAL SOLUTIONS (BIOMEDICAL AND ENGINEERING) TO MEET THE HUMAN AND MISSION REQUIREMENTS**

O PROPOSED PATHFINDER PROGRAM WILL:

* **IDENTIFY THE MOST CRITICAL UNCERTAINTIES IN HUMAN AND TECHNOLOGICAL REQUIREMENTS**

* **RESOLVE THEM TO THE DEGREE POSSIBLE**

* **WHERE APPROPRIATE, DEVELOP TECHNOLOGY SOLUTIONS**