

**NASA**  
FUTURE APPLICATIONS  
OF  
**BEN FRANKLIN**  
SUBMERSIBLE  
AS A  
SPACE STATION ANALOGUE

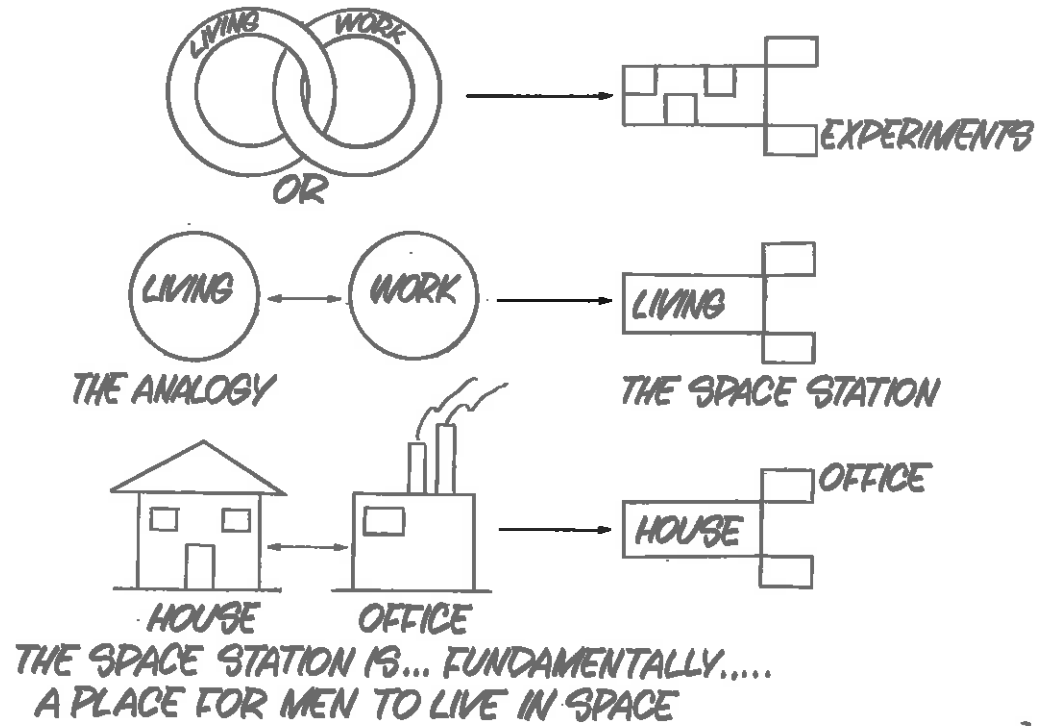
## SIMILARITIES BETWEEN SPACE & SUBMERSIBLE MISSIONS

- MEANINGFUL MISSIONS/TASKS
- SUSTAINED MOTIVATION
- HOSTILE ENVIRONMENT
- OPERATIONAL STRESS
- REMOTE OPERATIONS
- ABORT DIFFICULTY
- REQ MANEUVERABILITY
- CREW INTERDEPENDENCE
- DATA TRANSMISSION
- ON-BOARD SUBSYS MAINT

## **FUTURE MANNED SPACE PROGRAM NEEDS**

- **CONFIDENCE THAT MAN CAN SURVIVE & FUNCTION ON LONG DURATION MISSIONS**
- **CONFIDENCE THAT FUTURE IN-ORBIT OPS CAN BE ACCOMPLISHED EFFECTIVELY & SAFELY**
- **TECHNOLOGY FOR LONG DURATION, ECONOMIC, SAFE, EFFECTIVE & ROUTINE SPACE MISSIONS**

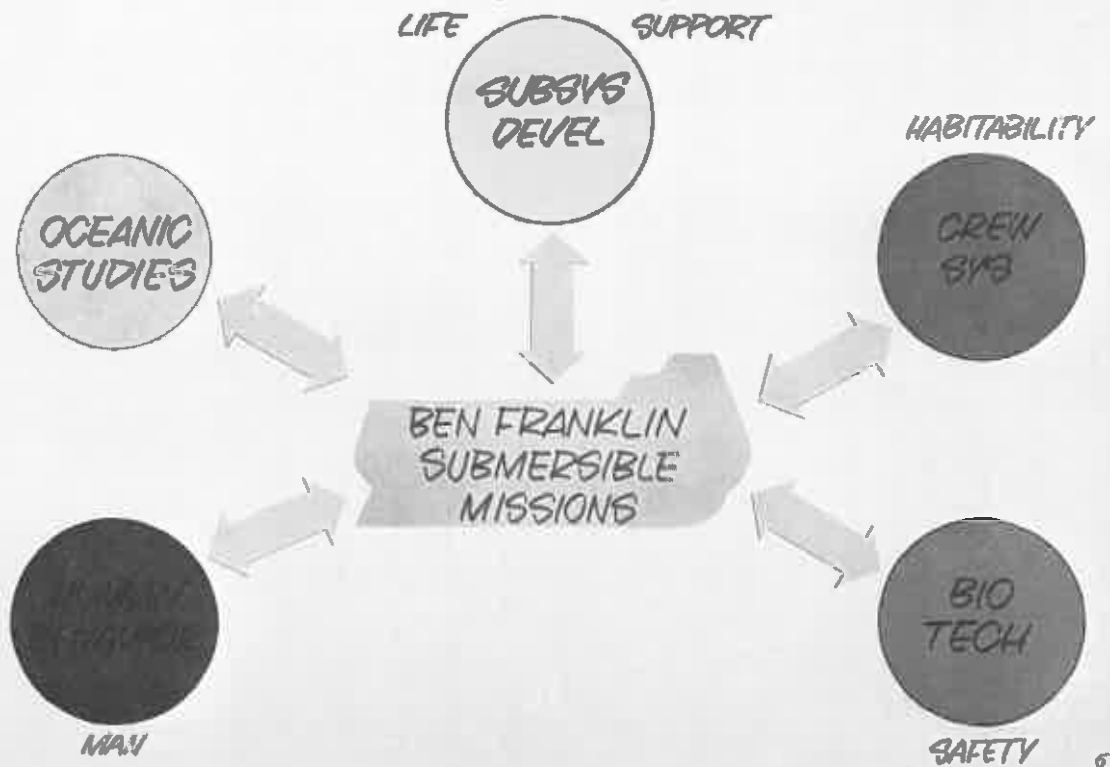
# THE LIVING / WORK PHILOSOPHY



## LIVING IN SPACE - FUNDAMENTAL NEEDS

- LIFE SUPPORT
- POWER
- COMMUNICATIONS
- HABITABILITY
- SAFETY

# SUBMERSIBLE APPLICATIONS



## THE SUBMERSIBLE CAN DEVELOP CONFIDENCE IN MAN & SPACE HARDWARE

- SUBSYS DEVEL
  - EC/LSS
  - MAINTAINABILITY / CHECKOUT
  - CONTAMINATION CONTROL
- BIOTECHNOLOGY STUDIES
  - 30/60/90 DAY MISSION W/CREW ROTATION
  - MICROBIOLOGY
- CREW SYS
  - HABITABILITY
  - FOOD
  - CLOTHING
  - HYGIENIC PROVISIONS

## THE SUBMERSIBLE CAN DEVELOP CONFIDENCE IN MAN & SPACE HARDWARE (CONT)

- HUMAN BEHAVIOR
  - CREW PERF
  - MAN/MACHINE
  - MAN/MAN
  - BIOMED INSTR
  - PSYCHOLOGICAL TEST TECHNIQUES



## BIOTECHNOLOGY GUIDELINES FROM BEN FRANKLIN MISSION FOR SPACECRAFT DESIGNS

DO	DON'T
<ul style="list-style-type: none"><li>• DEV/ AUTOMATED ON-LINE CONTAMINANT MONITORING</li><li>• PROVIDE MEANS FOR DECONTAMINATION</li><li>• PROVIDE FOR WASTE DISPOSAL</li><li>• PROVIDE LAUNDRY FACILITIES</li><li>• PROVIDE FOR "HOME COOKING"</li><li>• COMPARTMENTIZE THE SPACECRAFT</li><li>• MAINTAIN POTABLE H<sub>2</sub>O ABOVE 165° F BEFORE USE</li></ul>	<ul style="list-style-type: none"><li>• TAKE UP CREW TIME WITH CONTAMINANT SAMPLING &amp; ANAL</li><li>• EXCLUDE SPACE-TYPE "LYSOL"</li><li>• STORE WASTE W/NO DEACT BUGS</li><li>• STORE UNTREATED GARMENTS</li><li>• USE PROCESSED FOOD EXCL</li><li>• PERMIT SPREAD OF CONTAMINANT</li><li>• NEGLECT PRE-HEAT/ STORAGE OF DRINKING WATER</li></ul>

## BIOTECHNOLOGY GUIDELINES FROM BEN FRANKLIN MISSION FOR SPACECRAFT DESIGNS (CONT)

DO	DON'T
<ul style="list-style-type: none"><li>• MAKE PROVISIONS FOR HOT SHOWERS &amp; DAILY CHANGE OF CLOTHING</li></ul>	<ul style="list-style-type: none"><li>⊗ USE CHEMICAL-WIPES FOR LONG MISSIONS</li></ul>
<ul style="list-style-type: none"><li>• CONTROL HUMIDITY TO MINIMIZE BUG GROWTH</li></ul>	<ul style="list-style-type: none"><li>⊗ ALLOW WIDE HUMIDITY EXCURSIONS</li></ul>
<ul style="list-style-type: none"><li>• DESIGN TOILETS TO PERMANENTLY DEACTIVATE WASTE</li></ul>	<ul style="list-style-type: none"><li>⊗ USE CHEMICAL TOILETS</li></ul>
<ul style="list-style-type: none"><li>• INCINERATE MICROBES</li></ul>	<ul style="list-style-type: none"><li>⊗ RELY ON FILTERS</li></ul>
<ul style="list-style-type: none"><li>• MONITOR CREW BUG COUNT</li></ul>	<ul style="list-style-type: none"><li>⊗ PERMIT SPREAD OF INFECTION</li></ul>
<ul style="list-style-type: none"><li>• PROVIDE ISOLATION WARD</li></ul>	<ul style="list-style-type: none"><li>⊗ PERMIT SPREAD OF INFECTION</li></ul>

## BIOTECHNOLOGY GUIDELINES FROM BEN FRANKLIN MISSION FOR SPACECRAFT DESIGNS (CONT)

DO	DON'T
<ul style="list-style-type: none"><li>• SCREEN CREW FOR FLORA</li></ul>	<ul style="list-style-type: none"><li>• STAFF CREW IN/COMPATIBLE BUGS</li></ul>
<ul style="list-style-type: none"><li>• MAINTAIN FLORA IN EQUILIBRIUM IN FLIGHT</li></ul>	<ul style="list-style-type: none"><li>• DISTURB FLORA EQUILIBRIUM</li></ul>
<ul style="list-style-type: none"><li>• DESIGN FOR EFFECTIVE HOUSECLEANING</li></ul>	<ul style="list-style-type: none"><li>• ALLOW BUG "BREEDING GROUNDS"</li></ul>
<ul style="list-style-type: none"><li>• SELECT BIO-COMPATIBLE MATERIALS</li></ul>	<ul style="list-style-type: none"><li>• PROVIDE BUG NUTRIENTS</li></ul>
<ul style="list-style-type: none"><li>• KEEP HYGIENE AREAS UNDER NEGATIVE PRESSURE</li></ul>	<ul style="list-style-type: none"><li>• PERMIT CONTAMINANT INFLUX INTO LIVING AREAS</li></ul>

## PROPOSED 1970 SPACE APPL - UNMOD BEN FRANKLIN

- **EC/LSS**

- H<sub>2</sub>O & ATM CONTAMINANT MEAS & CONTROL

- **MAINTAINABILITY**

- SCHED & UNSCHED TASKS ANALYSIS

- FAILURE PREDICTION TECHNIQUES

- ADDITIONAL BASELINE DATA

- **BIOTECHNOLOGY**

- FABRIC TREATMENT (MICROBIO CONTROL)

- CREW ROTATION (30/60/90 DAY)

- ON-BOARD MICROBIO LAB

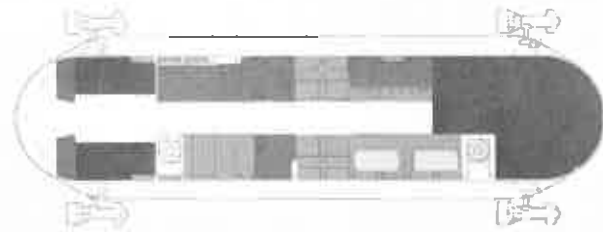
PROPOSED 1970 SPACE APPL - UNMOD BEN FRANKLIN (CONT)

- CREW SYS
  - BIOMED INSTR
  - HYGIENIC PROVISIONS
  - FOOD, CLOTHING
- - PHYSIOLOGICAL MEAS
  - CREW SELECTION TEST VERIFICATION

# BEN FRANKLIN TYPICAL ARRANGEMENT - 1970 MISSION



- EC/LSS
- MAINTAINABILITY
- BIOTECHNOLOGY
- CREW SYSTEMS
- HUMAN BEHAVIOR



## PROPOSED 1971 SPACE APPL-MOD BEN FRANKLIN

- **EC/LSS**
  - INTERIM SPACE TYPE EC/LSS
- **MAINTAINABILITY**
  - INTERIM EC/LSS MAINTAINABILITY
  - ON-BOARD CHECKOUT
  - TASK FAILURE
  - FAILURE PREDICTION TECHNIQUES
  - BASELINE DATA
- **LOW SYS**
  - EQUIP. & INTERIOR ARRANGEMENTS
  - HYGIENIC PROVISIONS
  - FOOD, CLOTHING
  - INCR HABITABILITY VERIFICATION

PROPOSED 1971 SPACE-MOO  
BEN FRANKLIN (CONT)

- BIOTECHNOLOGY

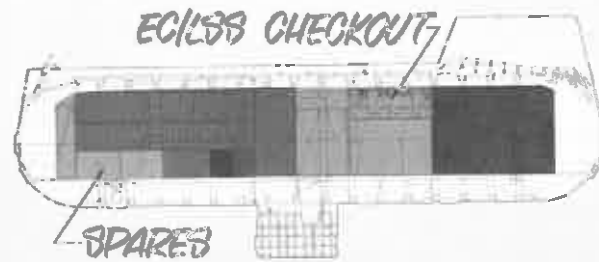
- CREW/EC/LSS INTERACTION
- CONTAMINATION PROFILES
- ON-BOARD DECONTAMINATION TECHNIQUES
- FABRIC TREATMENT (MICROBIO CONTROL)
- CREW ROTATION (30/60/90 DAY)
- ON-BOARD MICROBIO LAB

- [REDACTED]

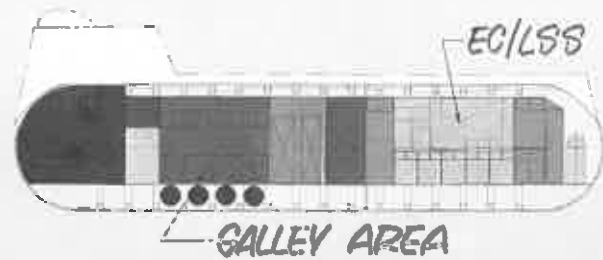
- PHYSIOLOGICAL MEAS
- CREW SELECTION TEST VERIFICATION
- PERF PREDICTION VERIFICATION



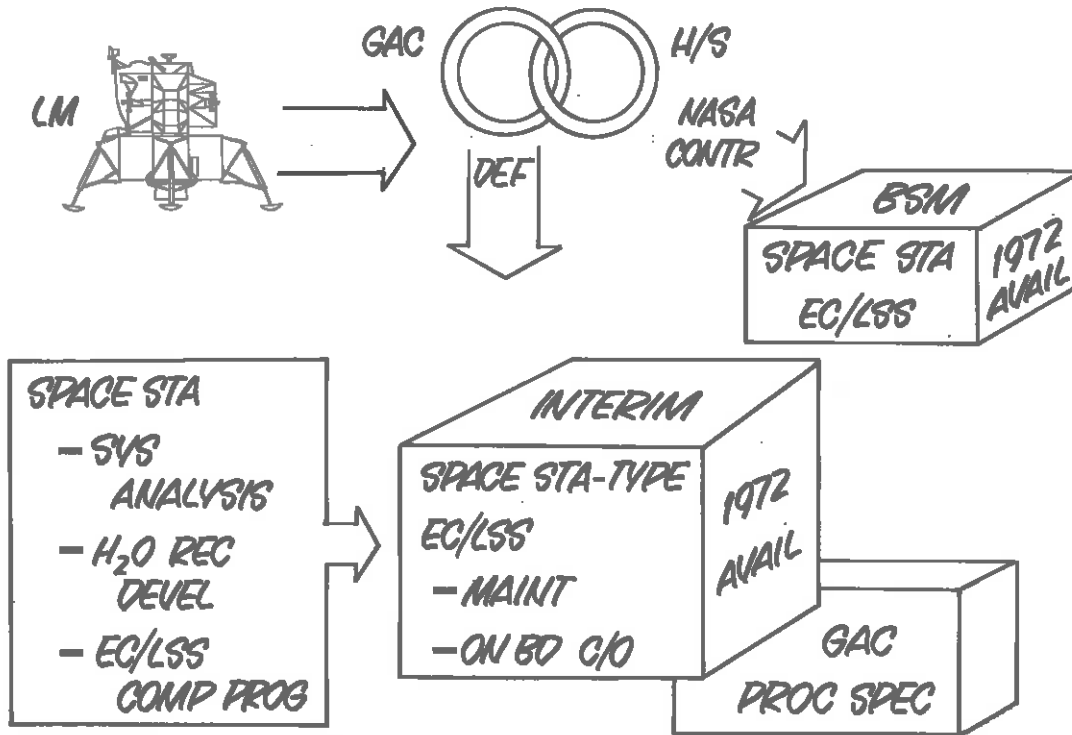
# BEN FRANKLIN TYPICAL ARRANGEMENT - 1971 MISSION



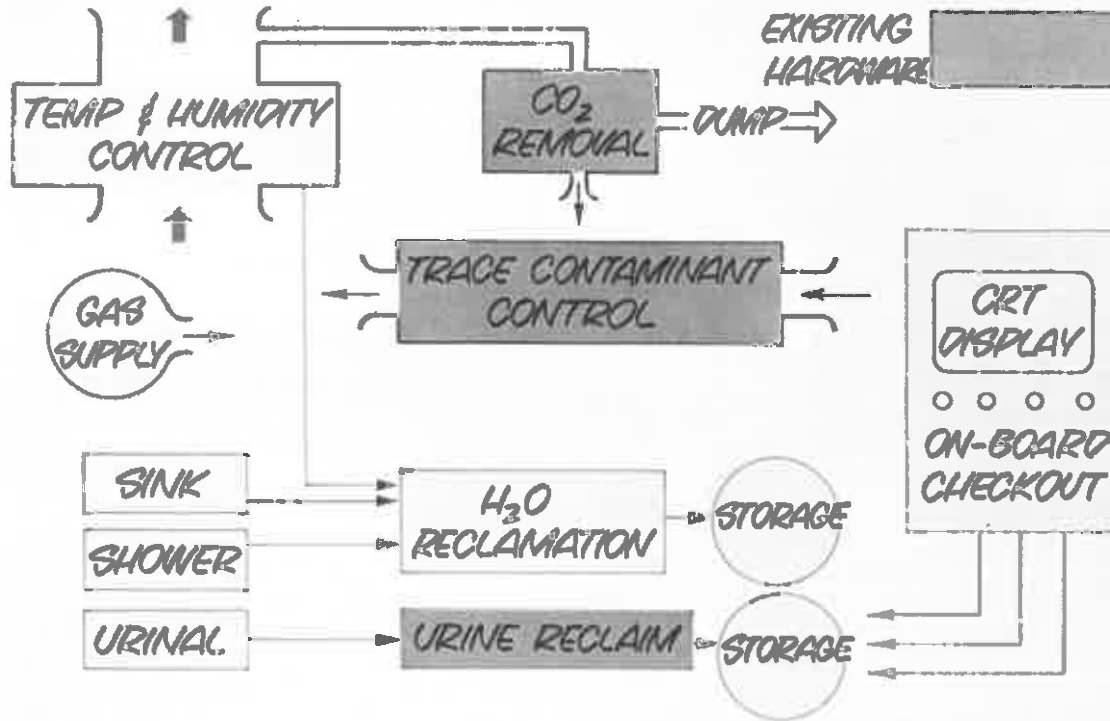
- EC/LSS
- MAINTAINABILITY
- BIOTECHNOLOGY
- CREW SYSTEMS
- HUMAN BEHAVIOR



# LIFE SUPPORT SYS BACKGROUND



GRUMMAN / HAM STD INTERIM EC/LSS  
(NO O<sub>2</sub> RECOVERY)



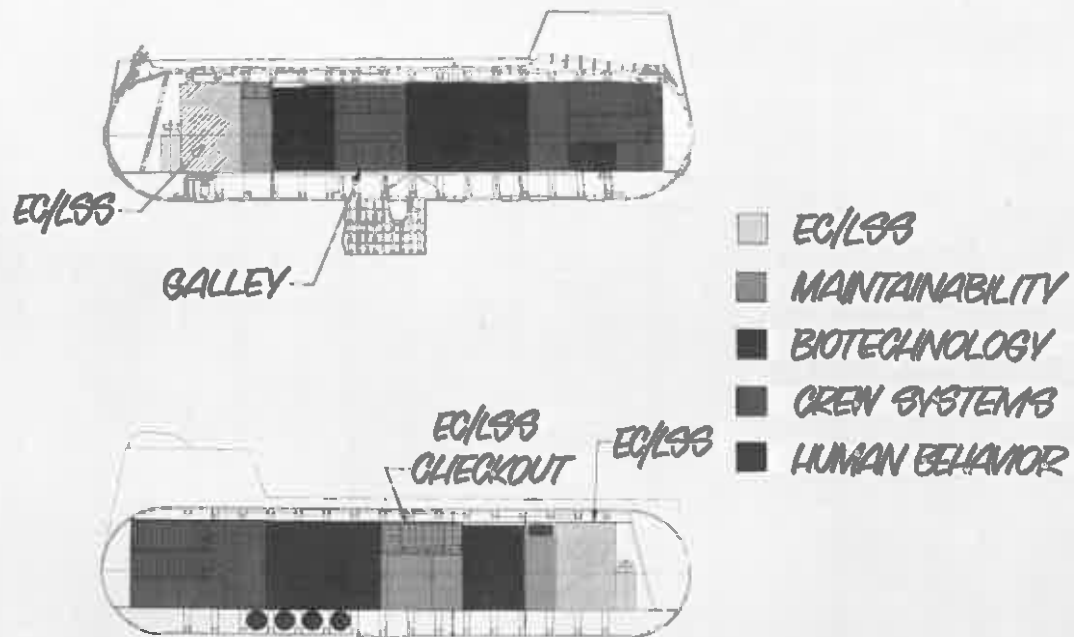
## GRUMMAN/HAMILTON STANDARD (H.S.)

- GRUMMAN/H.S. INTERIM EC/LSS
  - H<sub>2</sub>O RECOVERY
  - CO<sub>2</sub> REMOVAL
  - CONTAMINATION CONTROL
  - GAS SUPPLY
- EXISTING H.S. HARDWARE
  - AIR EVAP H<sub>2</sub>O RECOVERY
  - MOLECULAR SIEVE CO<sub>2</sub> REMOVAL
  - CATALYTIC BURNER

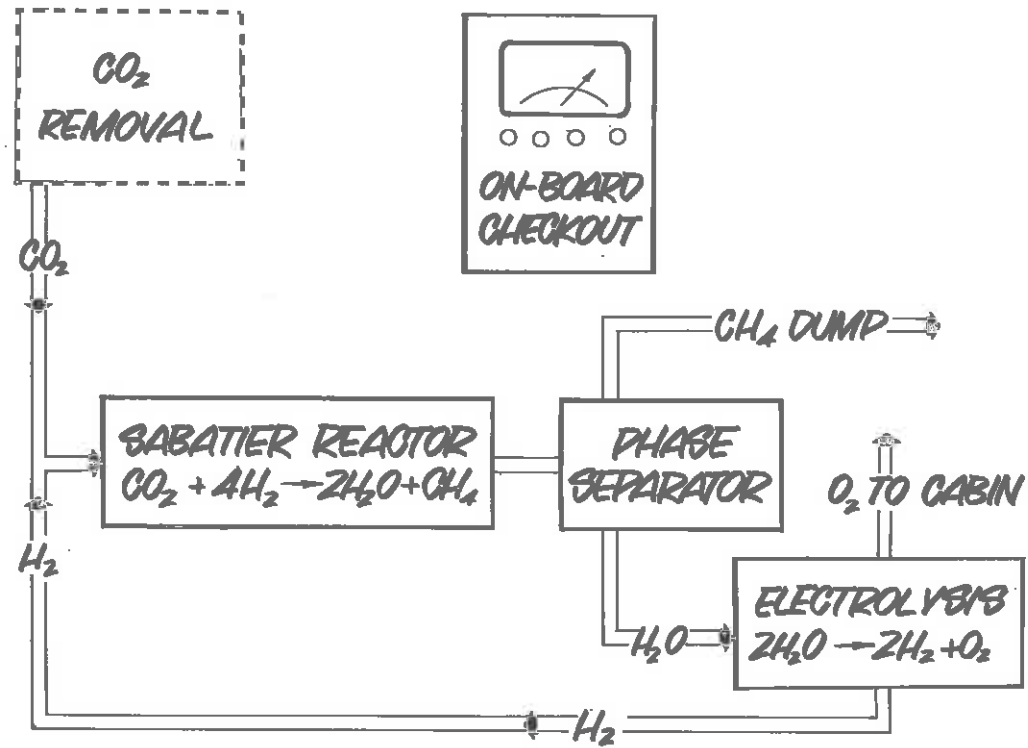
## PROPOSED 1972 SPACE APPL - REDESIGNED BEN FRANKLIN

- AVAILABLE LEAD TIME ALLOWS INSTL OF REPRESENTATIVE SPACE STA EQUIP. & INTERIORS
  - FLT TYPE EC/LSS
  - MAINTAINABILITY, ON-BOARD CHECKOUT
  - IMPROVED HABITABILITY
- EXTENSION OF
  - BIOTECHNOLOGY TESTING
  - CREW SYS EVAL
  - HUMAN BEHAVIOR EVAL

# BEN FRANKLIN TYPICAL ARRANGEMENT-1972 MISSION



# FLIGHT TYPE EC/LSS ADDS OXYGEN RECOVERY



## SUBMERSIBLES & GRD-BASED CHAMBERS ARE COMPLIMENTARY FACILITIES

- ENVIRONMENTAL TESTS

- THERMAL
  - VIBRATION
  - RADIATION
  - LIFE
- } CHAMBER

- OPERATIONAL & CONFIDENCE TESTS

- MISSION ENVIRONMENT
  - MAN
  - MACHINE
- } SUBMERSIBLE



## SUBMERSIBLE INPUTS TO SPACE SYS DEV

- DESIGN CRITERIA/SPECS
  - ON-BOARD MAINTAINABILITY
  - ON-BOARD CHECKOUT
  - MICROBIOLOGY & CONTAMINATION CONTROL
- PERFORMANCE & OPERATIONS EXPERIENCE
  - SPACE STA SUBSYS HARDWARE & CREW SYS EQUIP.

IN OUR  
ABILITY TO  
PROVIDE  
FOR  
FUTURE PROGRAM  
NEEDS