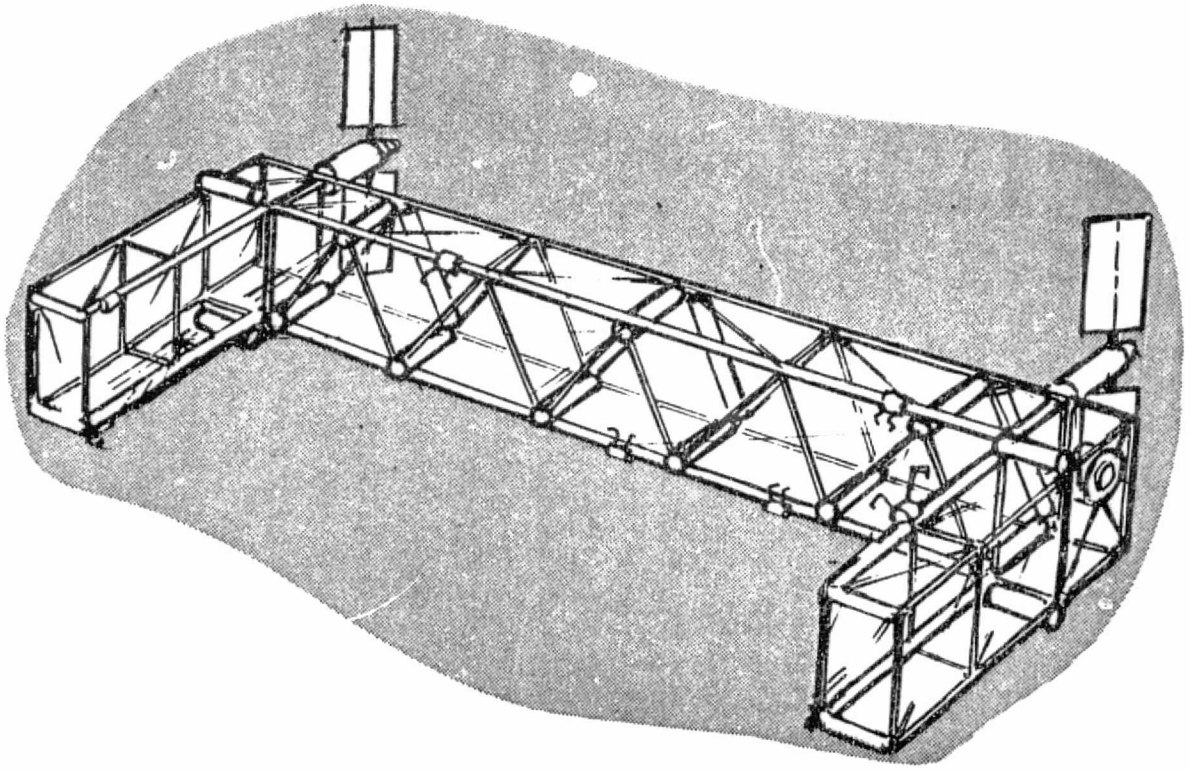
(NASA-CR-150764) SPACE STATION SYSTEMS ANALYSIS STUDY, PROGRAM REVIEW (Grumman Aerospace Corp.) 123 p HC A06/MF A01
CSCL 22A
N78-29116
Unclas
G3/12 15158

space station systems analysis study



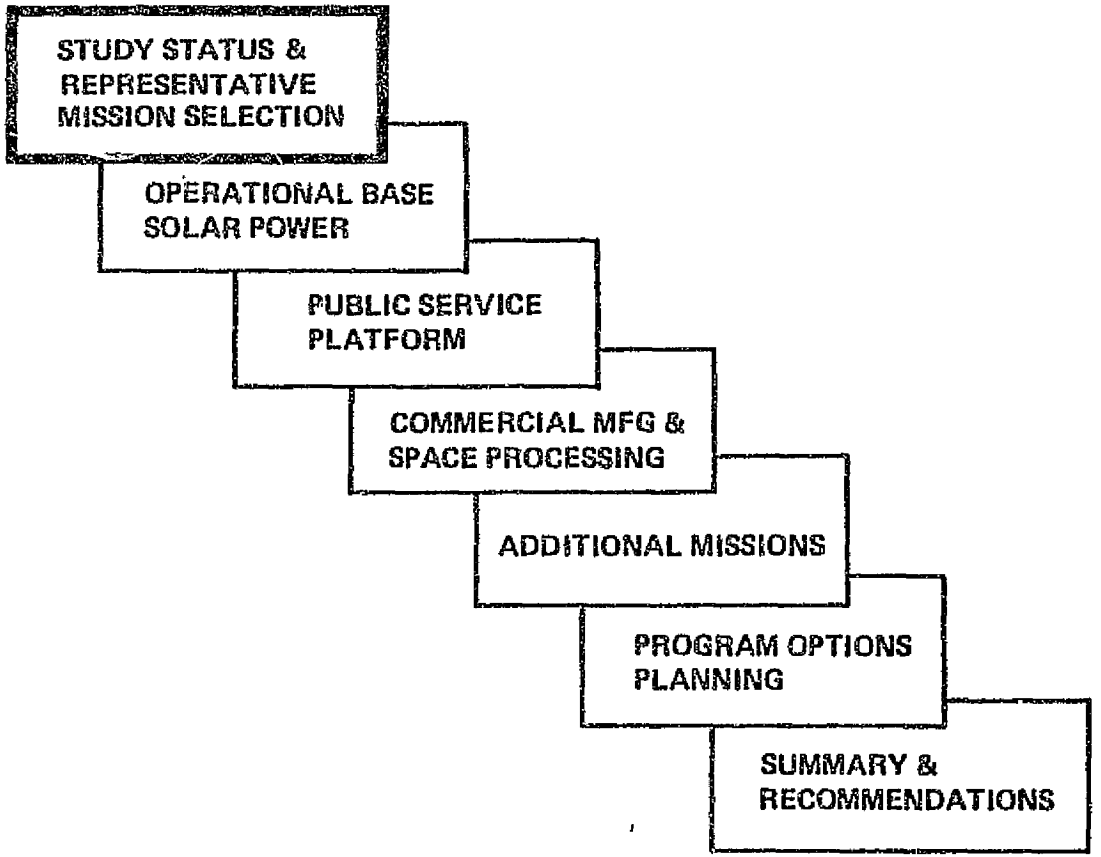
PROGRAM REVIEW

17 June 1976

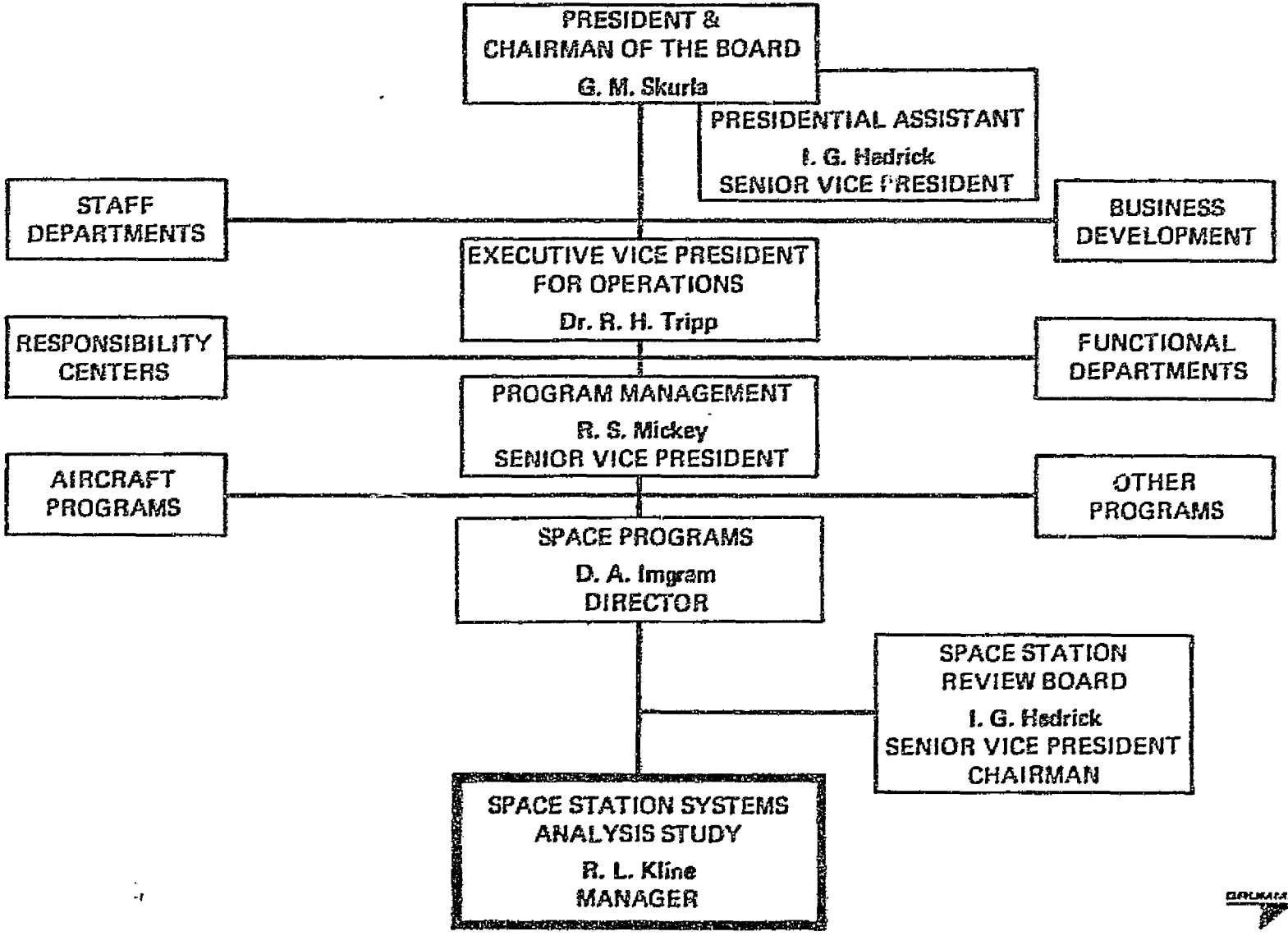
Contract No. NAS8-31993

GRUMMAN

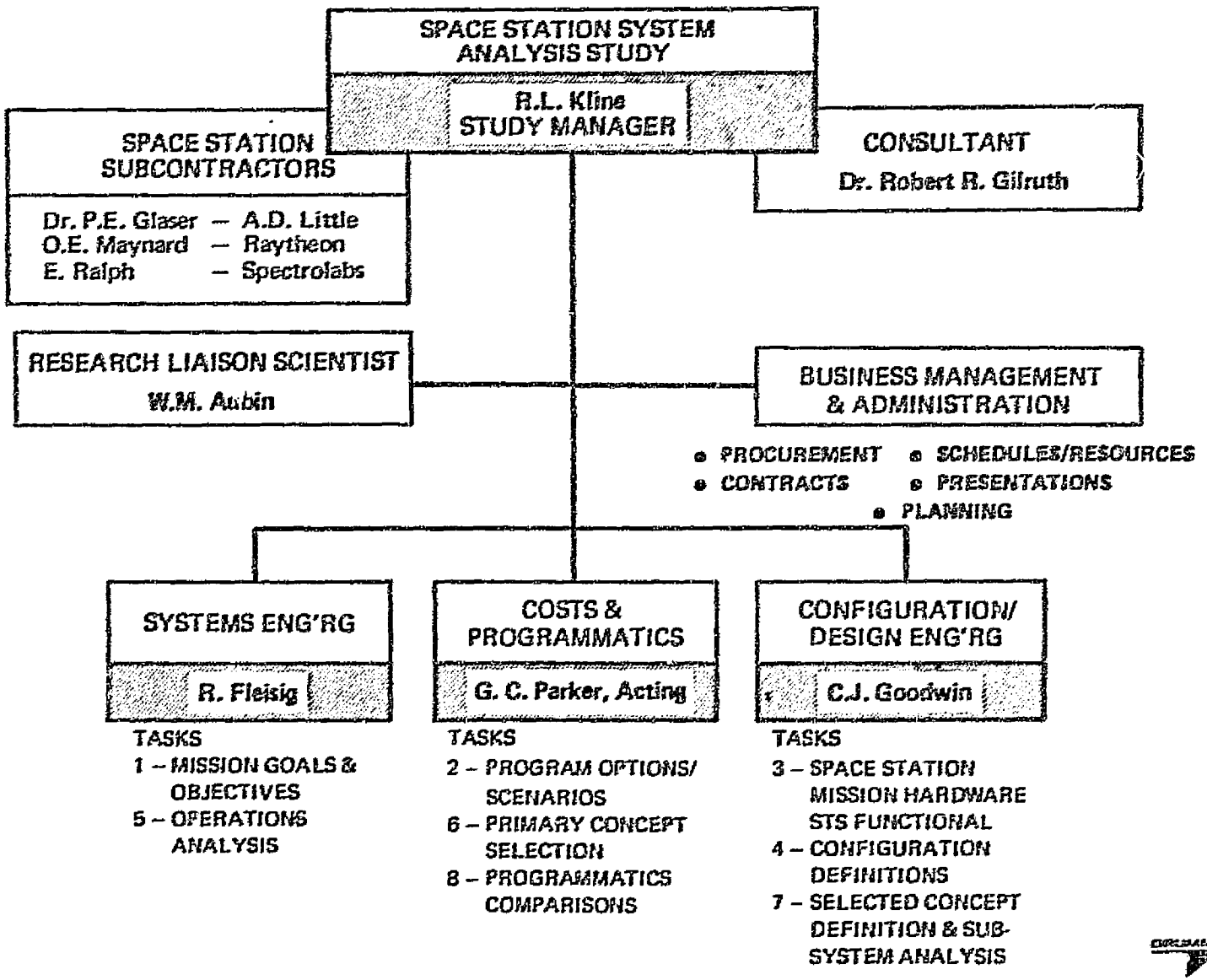
SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



RELATIONSHIP OF SPACE STATION SYSTEMS ANALYSIS STUDY TO GRUMMAN AEROSPACE ORGANIZATION



SSSA STUDY TEAM



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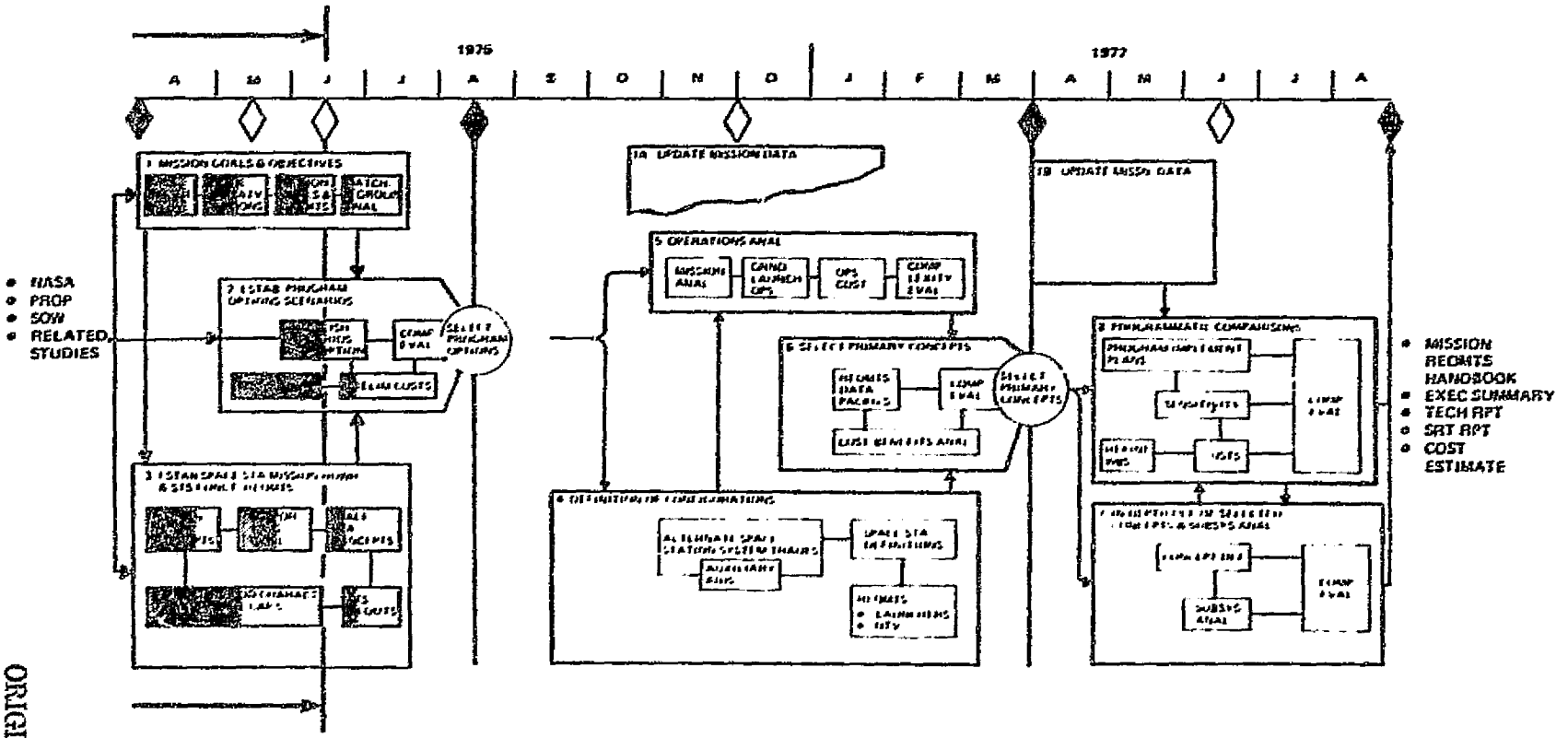

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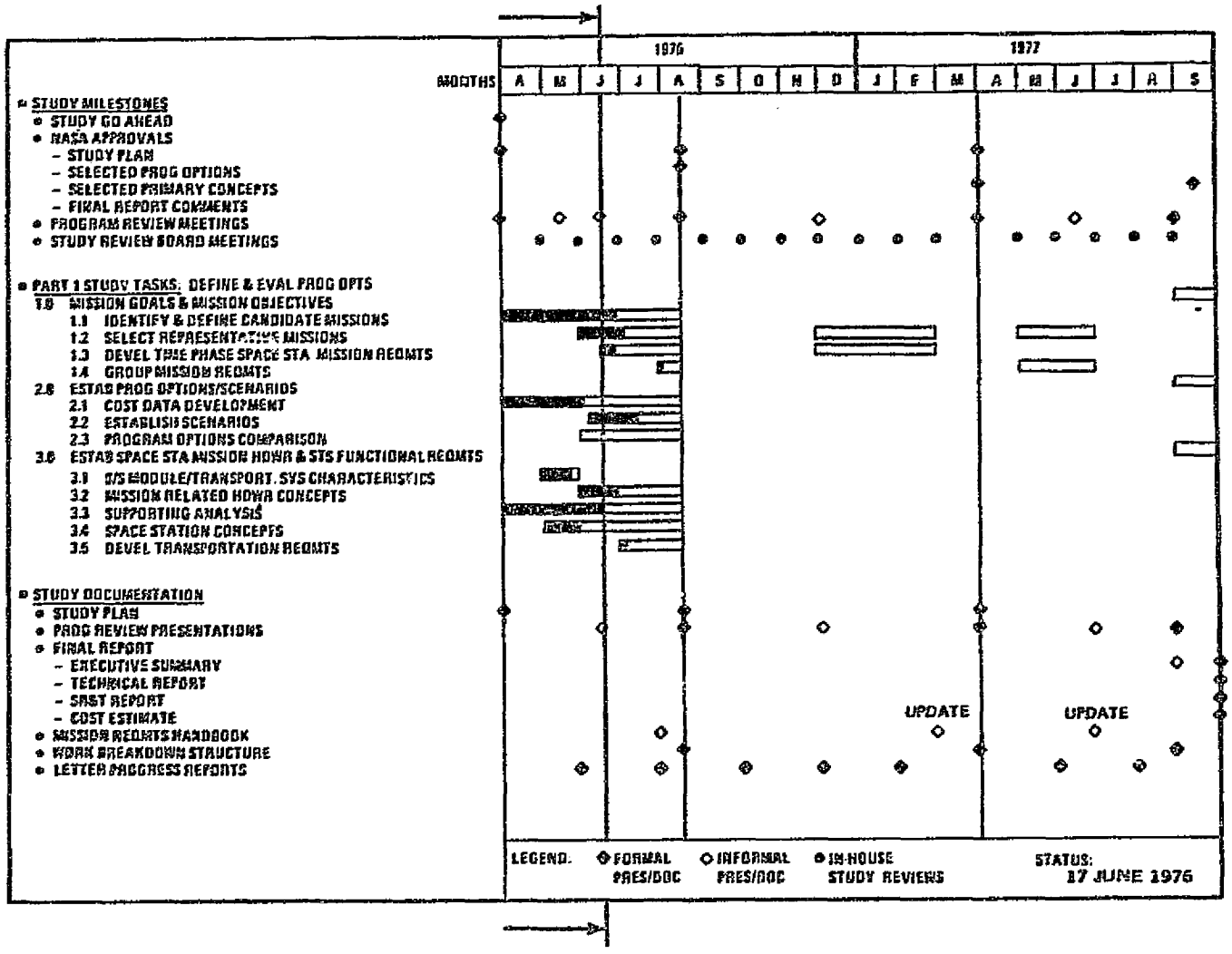
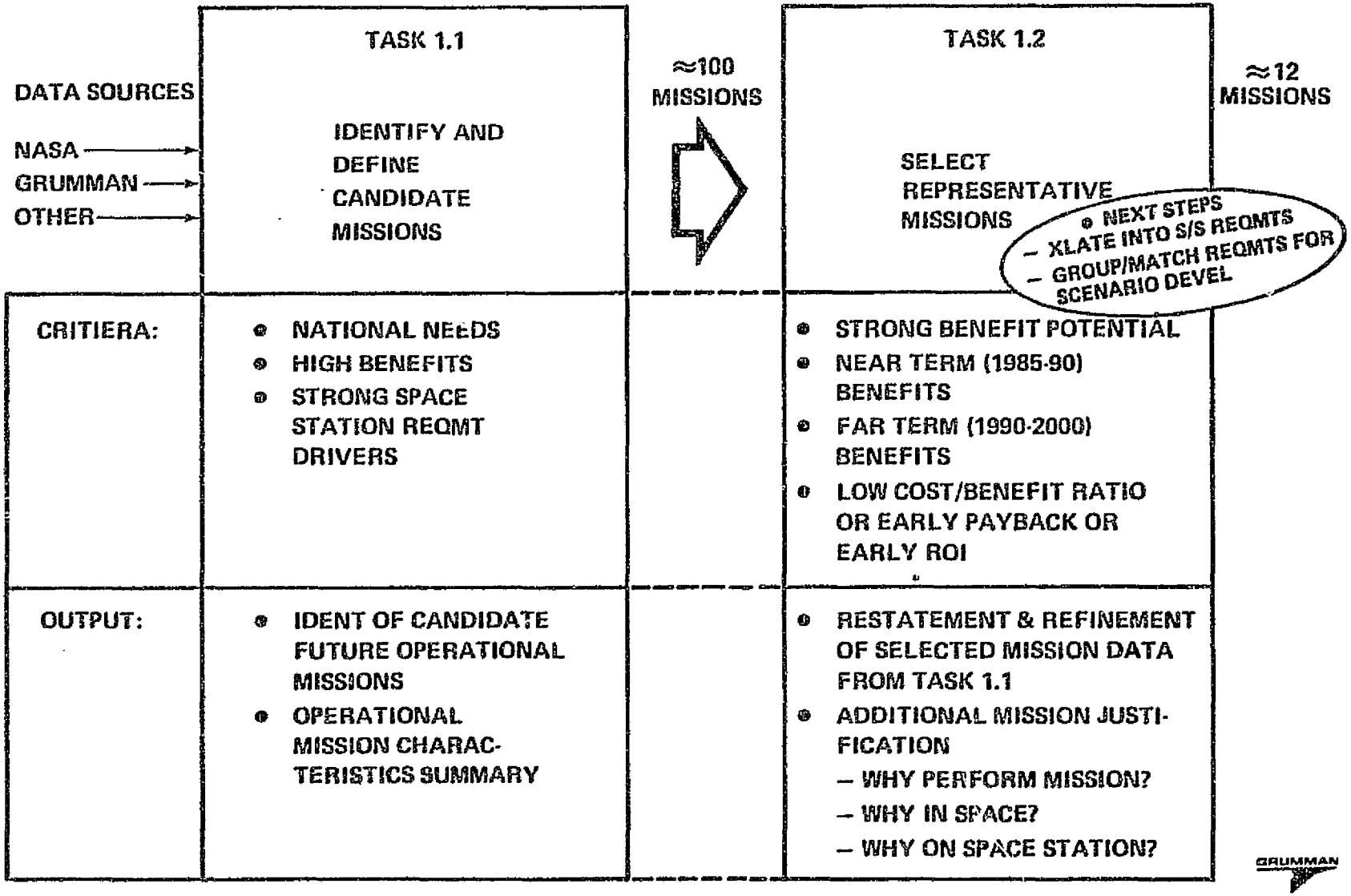
SSSA STUDY SCHEDULE



SELECTION OF REPRESENTATIVE FUTURE OP MISSIONS THAT DRIVE REQMTS FOR SPACE STATION



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STATUS

PERIODIC UPDATING THROUGHOUT STUDY

MISSION THEME/SUBTHEME	MISSIONS IDENTIFIED	OPERATIONAL CHARACTERISTICS SUMMARIZED
OPERATIONAL BASE	5	3
MATERIAL PROCESSING AND COMMERCIAL MANUFACTURING	11	10
LIFE SCIENCES	10	—
EARTH OBSERVATIONS	7	7
SPACE PHYSICS AND ASTRONOMY	17	5
BASIC AND APPLIED PHYSICAL SCIENCES	—	—
ENGINEERING LABORATORY	0	0
INNOVATIVE/ADVANCED	27	26
TOTAL	77	51

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SELECTION OF REPRESENTATIVE MISSIONS - OPERATIONAL BASE

- SATELLITE SOLAR POWER STATION – PHOTOVOLTAIC
- SOLAR CONCENTRATOR – THERMONIC/BRAYTON CYCLE
- NUCLEAR POWER PLANT IN SPACE
- PUBLIC SERVICE PLATFORM
- MULTI-PURPOSE SPACE POWER PLATFORM
- SPACE EXPLORATION

HIGH LONG TERM BENEFIT POTENTIAL
STRONG SPACE STATION DRIVER

NEAR TERM CONSTRUCTION THEME BENEFIT

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SELECTION OF REPRESENTATIVE MISSIONS – COMMERCIAL MANUFACTURING

SELECTION SPANS 4 SPACE-UNIQUE PROCESSES

- METALLURGY
  - HIGH COERCIVE STRENGTH MAGNETS — STRONG SPACE STATION DRIVER; SPACE DEMONSTRATED; PERF IMPROVEMENT
  - NUCLEAR FUEL ELEMENTS
  - HIGH PURITY RARE EARTH CATALYSTS
  - SUPERCONDUCTING CABLE
  - FATIGUE RESISTANT PARTS FOR MACHINERY
- CRYSTAL GROWTH
  - SINGLE CRYSTAL SHEETS, OR TUBES OF SOLAR CELL MATERIALS — STRONG SPACE STATION DRIVER
  - THIN FILM MAGNETIC MEMORIES
  - LARGE SINGLE CRYSTALS FOR NUCLEAR DETECTORS
- AMORPHOUS MATERIALS
  - BORON FILAMENTS FOR COMPOSITES
  - HOLLOW GLASS SPHERES FOR LASER/ION FUSION TARGETS
  - NEW GLASS COMPOSITIONS
  - HOMOGENEOUS LASER GLASSES
  - OPTICAL WAVE GUIDES
- PHARMACEUTICALS (proteins)
  - MICROBIAL PRODUCTS — FERMENTATION PROCESS
  - CURATIVES FOR BURNS, ULCERS
  - DIAGNOSTICS FOR CANCER

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IDENTIFICATION OF REPRESENTATIVE MISSIONS – LIFE SCIENCES

- SPACE STATION OPERATIONS SUPPORT
  - UP TO 1 YR EFFECTIVE MISSIONS
- HEALTH ON EARTH
  - BODY FLUID, BLOOD VOLUME DIST, ELECTROLYTE METABOLISM (5 EXPTS)
  - CARDIOVASCULAR FCN, HEMODYNAMICS, HEMATOLOGY (4 EXPTS)
  - VESTIBULAR FCN (3 EXPTS)
  - 6 TO 8 ADDITIONAL TO BE DEFINED

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SELECTION OF REPRESENTATIVE MISSIONS – EARTH OBSERVATIONS

- EXTRACTABLE RESOURCES
- WEATHER AND CLIMATE
- ENVIRONMENTAL QUALITY
- LAND USE
- OCEAN DYNAMICS

NEAR TERM
SECOND USE FOR
MICROWAVE ANTENNA

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SELECTION OF REPRESENTATIVE MISSIONS
SPACE PHYSICS AND ASTRONOMY

- IR OBSERVATORY
- DEEP SKY SURVEY
- SMALL OPTICAL – UV TELESCOPE
- EXTREME UV TELESCOPE
- SOLAR PHOTOMETER
- SUBMILLIMETER IR TELESCOPE
- SELECTED STAR FIELD SURVEY
- MULTI-WAVE LENGTH ASTRONOMICAL OBSERVATORY
- COMBINED UV MISSION
- TRANSIENT ASTRONOM PHENOM OBSERV
- GAMMA RAY OBSERVATORY
- LOW ENERGY X-RAY TELESCOPE
- COSMIC RAY LAB
- AMPS
- SOLAR OBSERVATORY
- RADIO TELESCOPE
- PINHOLE CAMERA SOLAR OBS

SECOND USE
OF SOLAR ARRAY

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SELECTION OF REPRESENTATIVE MISSIONS –

INNOVATIVE/ADVANCED MISSIONS

- ADVANCED RESOURCES – POLLUTION OBSERVATORY
- ✓ FOREST FIRE DETECTION
- BORDER SURVEILLANCE
- COASTAL PASSIVE RADAR (SHIP NAVIGATION & COLLISION AVOIDANCE)
- ELECTRONIC MAIL TRANSMISSION
- URBAN/POLICE
- ✓ DISASTER CONTROL (Eg., Earthquake)
- VOTING/POLLING
- NATIONAL INFORMATION SERVICES
- ✓ PERSONAL COMMUNICATIONS
- ENERGY GENERATION PLANT (RTG)
- NUCLEAR WASTE DISPOSAL
- AIRCRAFT BEAM POWERING

COMMON VOICE/DATA ANTENNA
SOME SPACE STATION SUBSYS

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SELECTION OF REPRESENTATIVE MISSIONS – INNOVATIVE/ADVANCED MISSIONS (CONTINUED)

COMMON SPACE STATION SUBSYSTEMS

- CITY NIGHT ILLUMINATOR
- SPACE DEBRIS SWEEPER
- ENTERTAINMENT
- INEXPENSIVE NAVIGATION SYSTEM
- SYNCHRONOUS METEOROLOGICAL SATELLITE
- EXTREMELY HIGH RESOLUTION OBSERVATIONS
- INTERNATIONAL PEACE
- HIGH RESOLUTION EARTH MAPPING RADAR
- 3D HOLOGRAPHIC TELECONFERENCING
- ADVANCED TV BROADCAST
- GLOBAL EARTHQUAKE DETECTION/PREDICTION
- WATER AVAILABILITY INDICATOR
- VEHICULAR SPEED CONTROL
- NUCLEAR FUEL LOCATION SYSTEM
- BURGLAR ALARM INTRUSION DETECTION

COMMON VOICE/VIDEO ANTENNA

COMMON DETECTION/ CONTROL ANTENNA

CORRELATION OF REPRESENTATIVE FUTURE OPERATIONAL MISSIONS WITH SPACE STATION THEMES/SUBTHEMES

SPACE STATION THEMES/ SUBTHEMES		REPRESENTATIVE FUTURE OPERATIONAL MISSIONS								
		SOLAR POWER	PUBLIC SERVICE PLATFORM	SPACE PROCESSING	OCEAN OBSERVATIONS	RADIO-TELESCOPE	OTHER			
OPERATIONAL BASE	CONSTRUCTION BASE	✓	✓		✓	✓				
	TEST FACILITY	✓								
	S/C SERVICING FAC	✓								
	ORBIT DEPOT	✓								
	CLUSTER SUPPORT	✓								
MAT PROC & COMM MFG				✓						
LIFE SCIENCES										
BASIC & APP PHY SCIENCES										
EARTH OBS/APPLICATIONS			✓		✓					
SPACE PHYSICS & ASTRONOMY						✓				
ENGINEERING LAB										
INNOV/ADV MISSIONS			✓							

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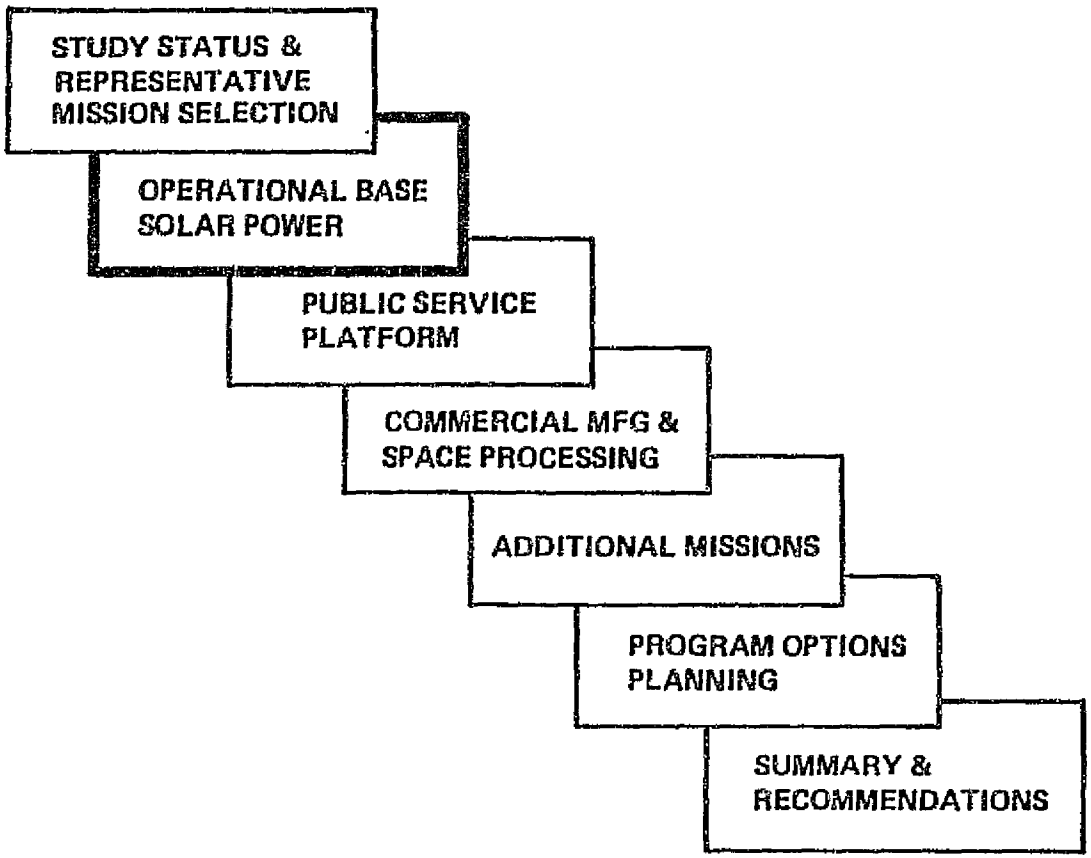
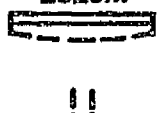
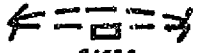
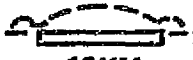
SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



SATELLITE POWER MW TRANSMISSION DEVELOPMENT
SCALE CONSIDERATIONS

	GROUND		SUBSCALE (SPDL)			INTERMEDIATE O'SIZE ANT.	INTERMEDIATE PILOT PLANT	FULL SIZE OPS
			LEO		GEOS			
ANTENNA	 210M		90M 		90M 	2620M 	830M 	830M 
IONOSPH - LAYER	D	F	D	F				
PWR LEVEL (W/M^2)	220	220	220	220	0.07	220	22	220
DURATION	LONG	LONG	SHORT	SHORT	LONG	LONG	LONG	LONG
DIA (KM)	0.2	0.3	0.8	0.5	90	3.2	10	10
NUMBER	1	1	1	1	1	1	1	MANY
RECTENNA					 1KM	 3.2KM	 10KM	 10KM
STEADY PWR TO GROUND					0.5GW	0.5GW		5GW
SAT. TO SAT. PWR TRANSFER			INTERMITTNT.		CONTIN.			

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SATELLITE POWER DEVELOPMENT - IRRADIATION OF IONOSPHERE

- NEAR TERM EXPERIMENTS
  - FROM LEO
    - DURATION TOO SHORT
  - FROM GROUND
    - SPOT SIZE SMALL WITH S-BAND
    - TRY HF
- LATER

  FULL SIMULATION OF EFFECTS REQUIRES APPROX FULL SYSTEM

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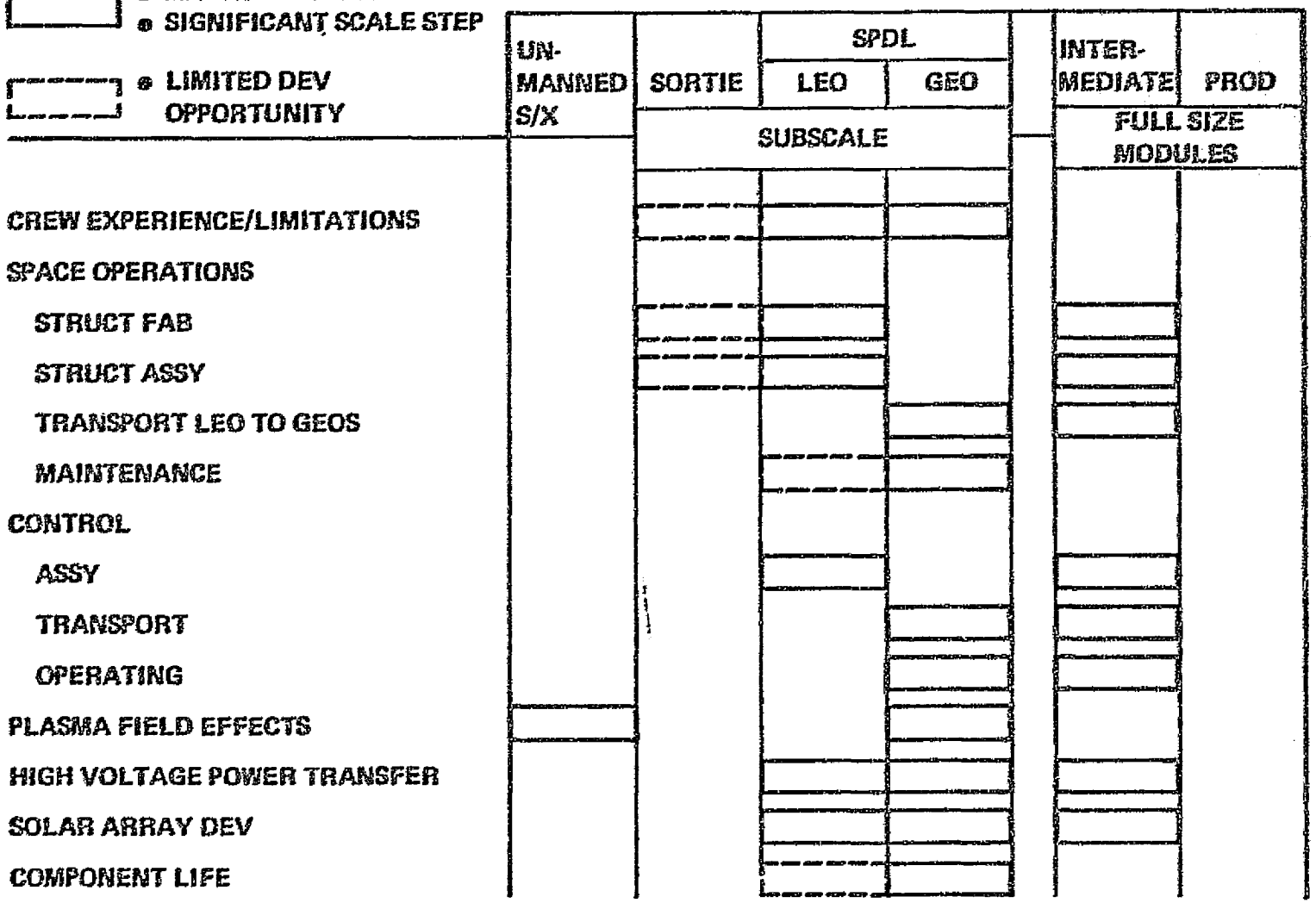
SATELLITE POWER DEVELOPMENT STEPS

LEGEND:

- ⊕ MAJOR DEV. PHASE
- ⊕ SIGNIFICANT SCALE STEP
- ⊕ LIMITED DEV OPPORTUNITY



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SATELLITE POWER DEVELOPMENT

- NEAR-TERM OPTIONS FOR PROOF OF CONCEPT
  - VERY FRIEF/INFREQ PWR TO EARTH FROM LEO
  - VERY LOW PWR DENSITY TO EARTH FROM GOES
  - PWR FROM SPDL TO FREE FLYER
- NEAR-TERM OPTIONS WILL PROBABLY BE SIZED BY
  - ANT./SOLAR ARRAY SIZED FOR DEVEL OF WAVE FRONT CONTROL
  - SUBSCALE STRUCT - SUFFICIENT MODULES TO EXERCISE ASSY & ALIGN. PROBLEMS
  - INDIVIDUAL CHECKS ON FULL SCALE FEATURES (e.g.):
    - FULL-SCALE BEAMS/JOINT
    - HIGH-VOLTAGE SLIP RING
    - ETC

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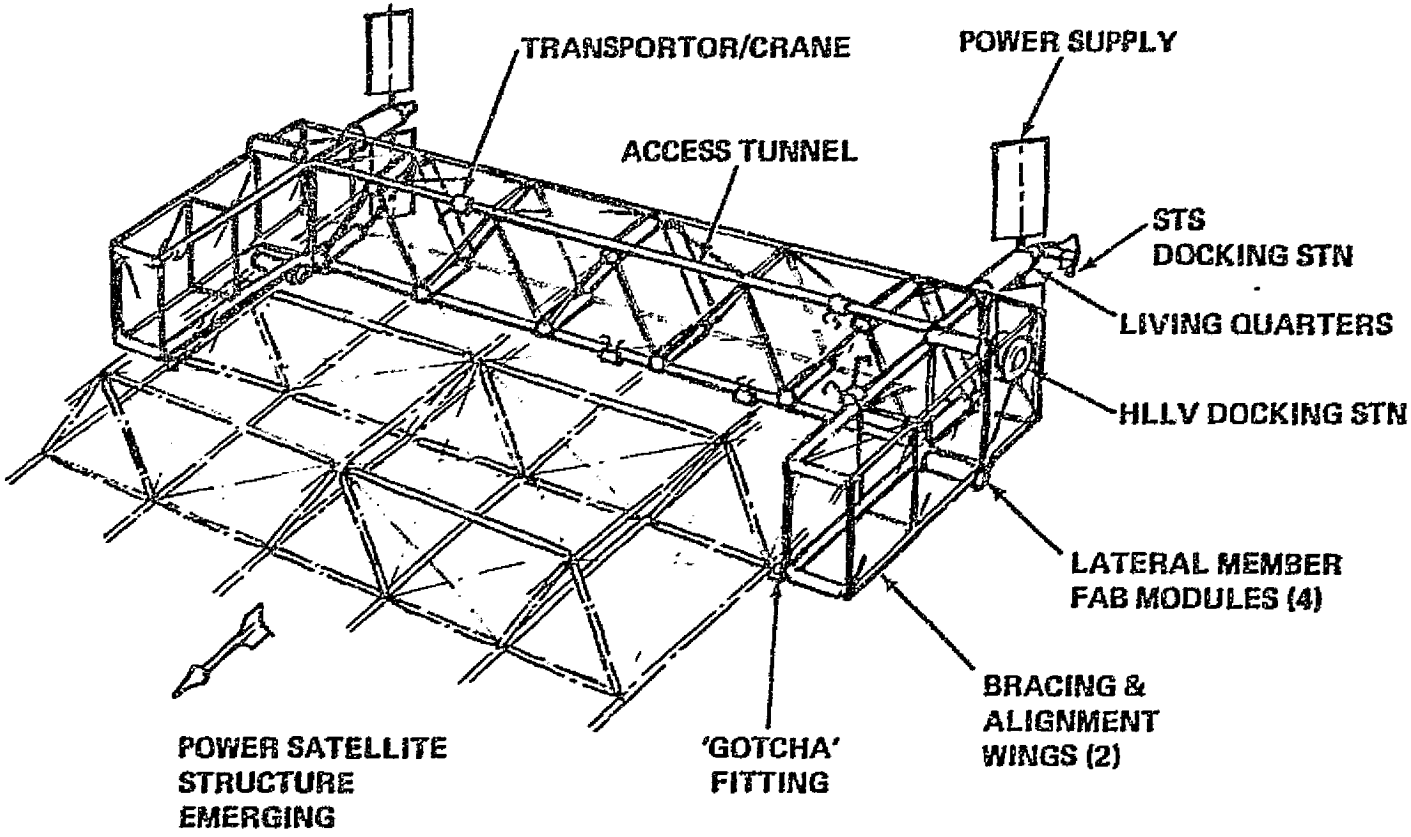
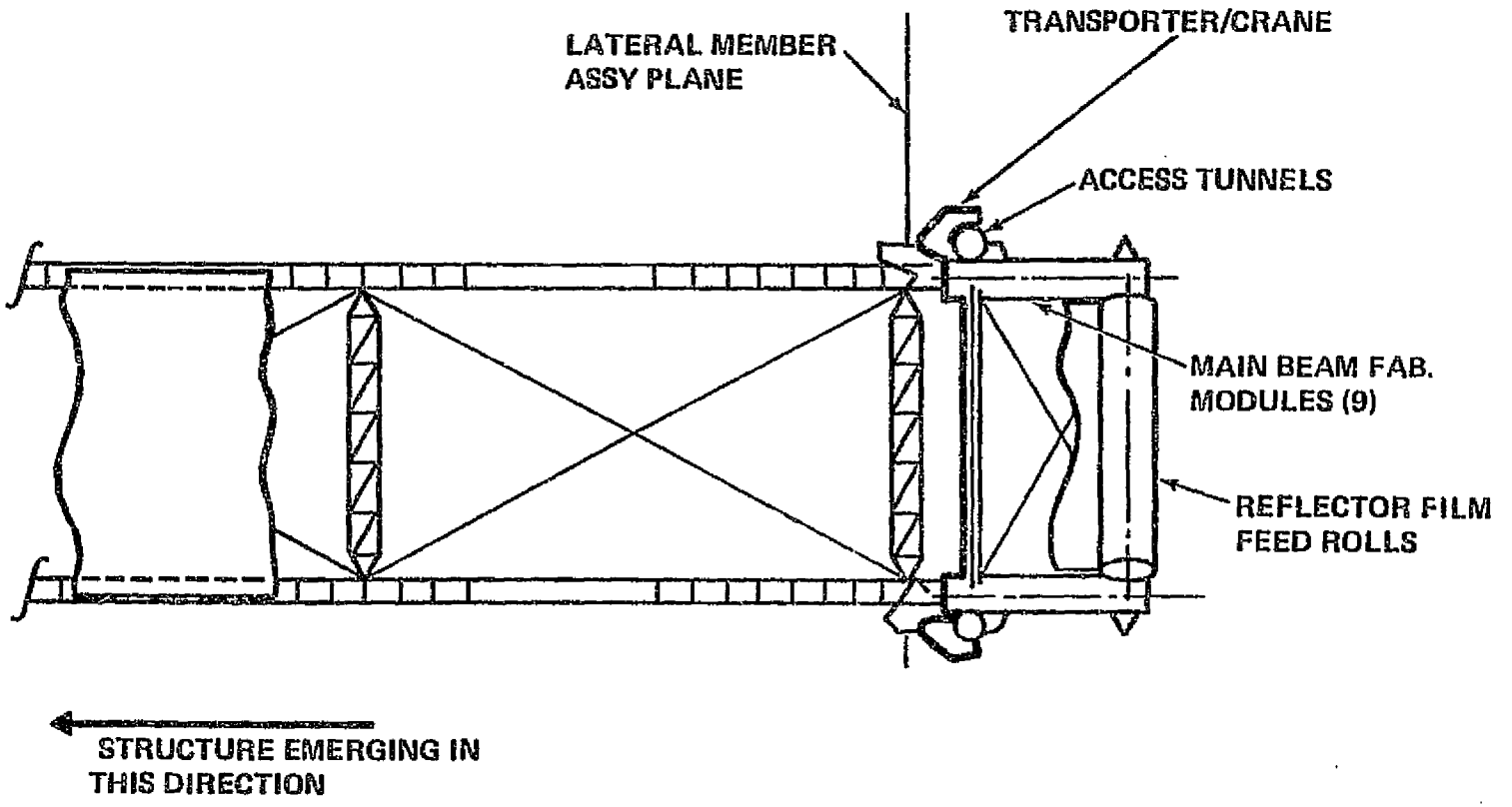
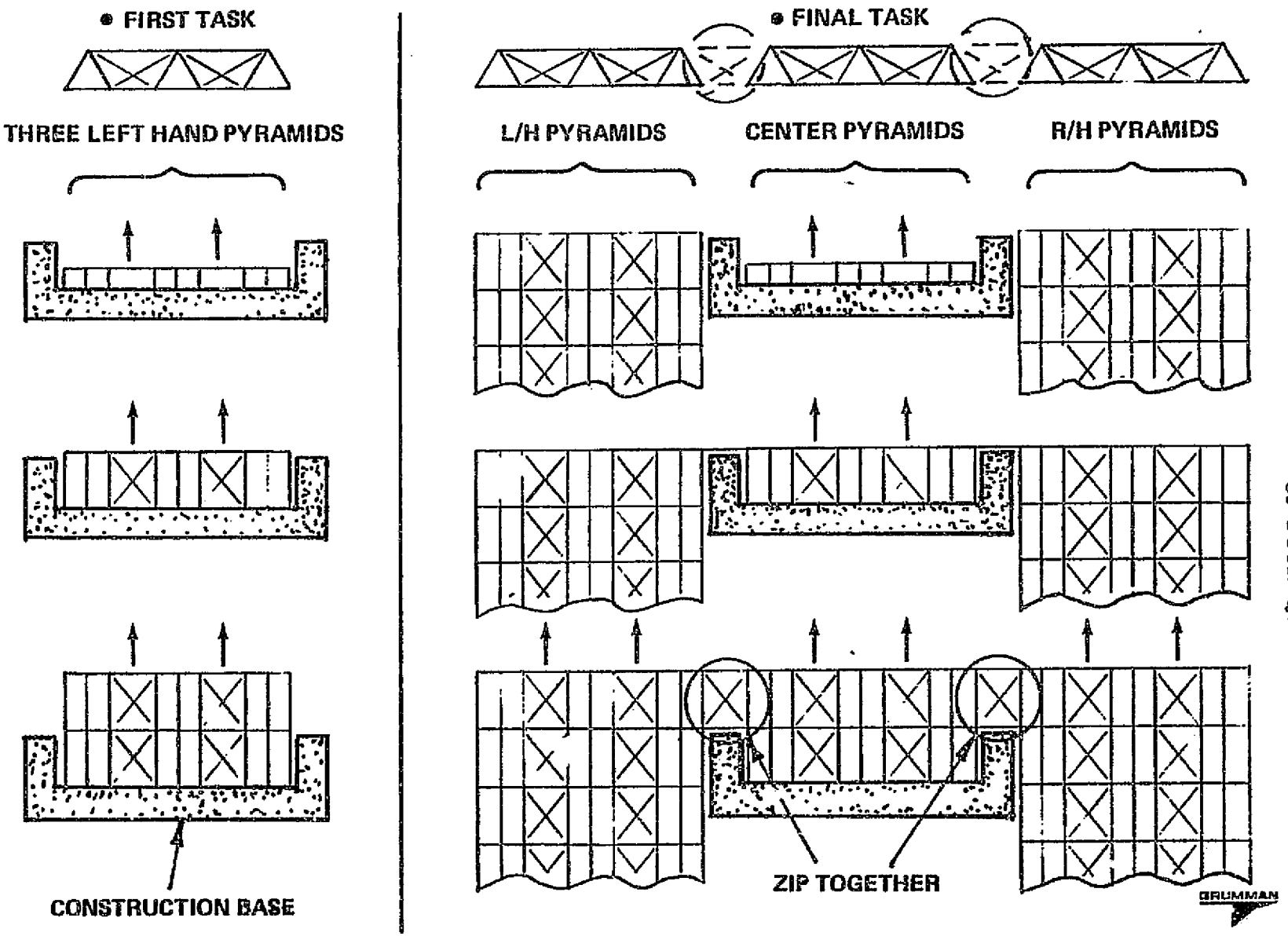
CONSTRUCTION BASE/TEST FACILITY FOR SATELLITE POWER



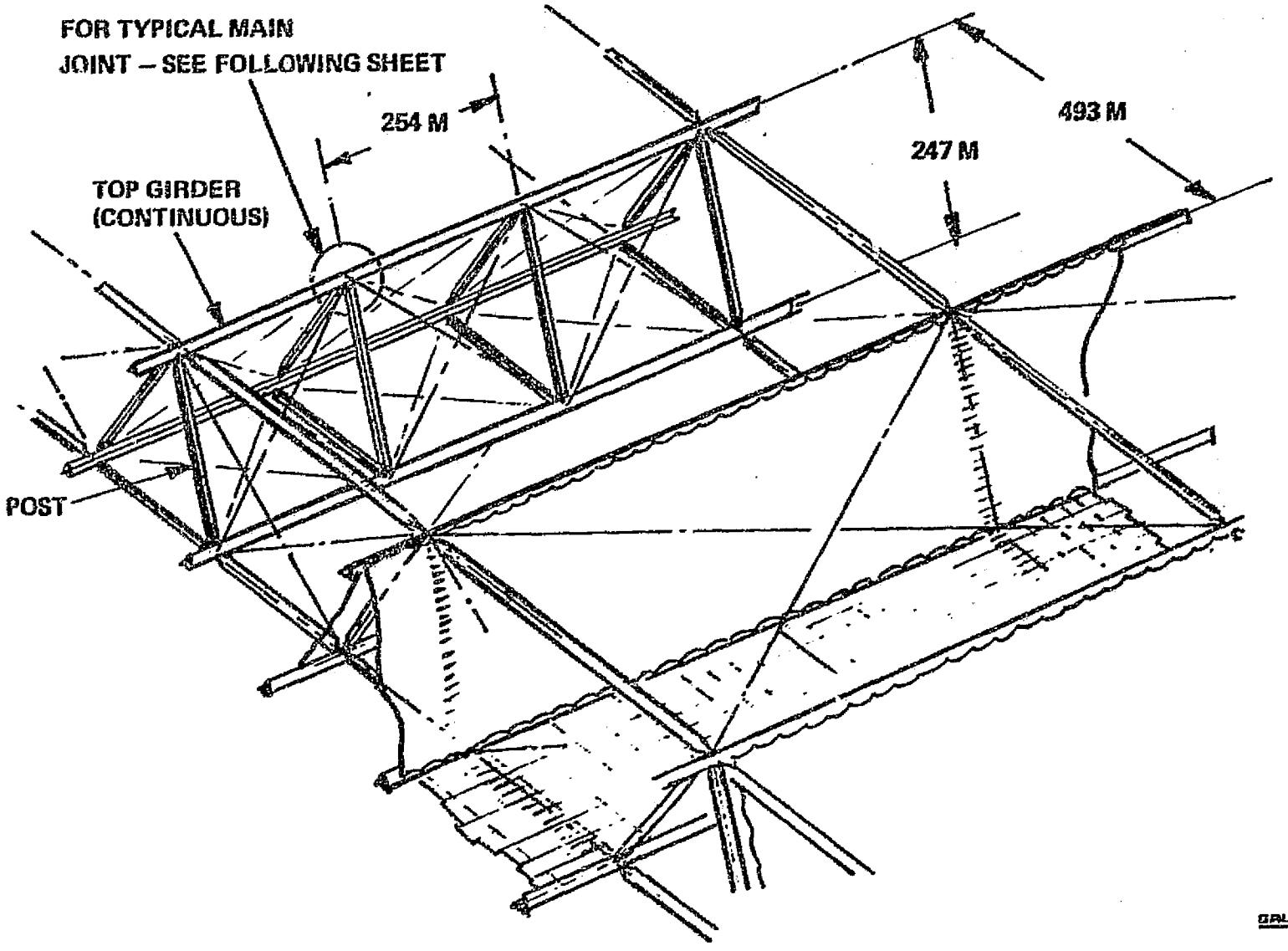
SECTION THRU MAIN BODY OF CONSTRUCT BASE



PHOTOVOLTAIC SOLAR ARRAY – CONSTR SEQUENCE



PHOTOVOLTAIC SSPS PYRAMID STRUCT



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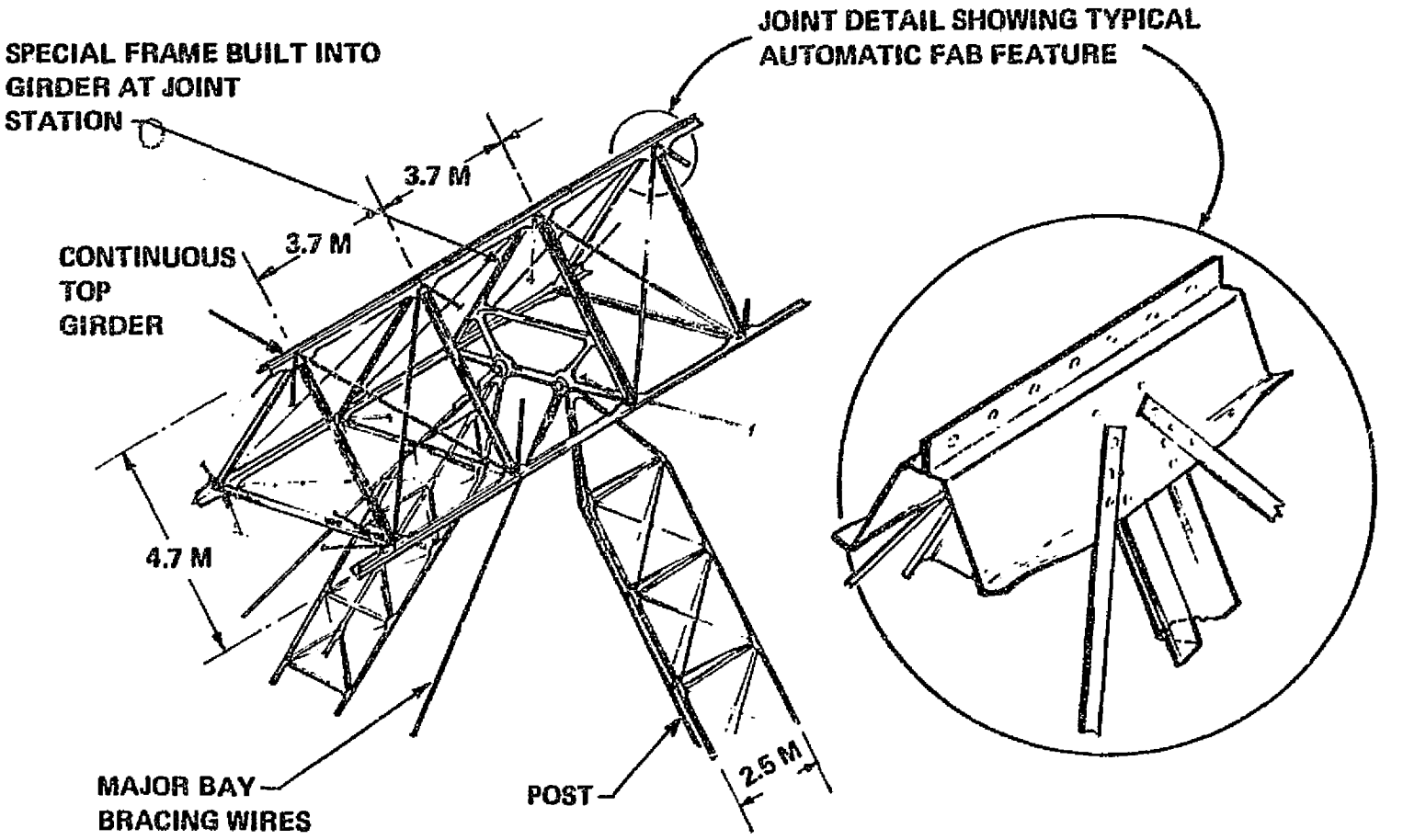
PHOTOVOLTAIC SATELLITES POWER PYRAMID STRUCTURE – JOINT BETWEEN TOP GIRDER & POSTS



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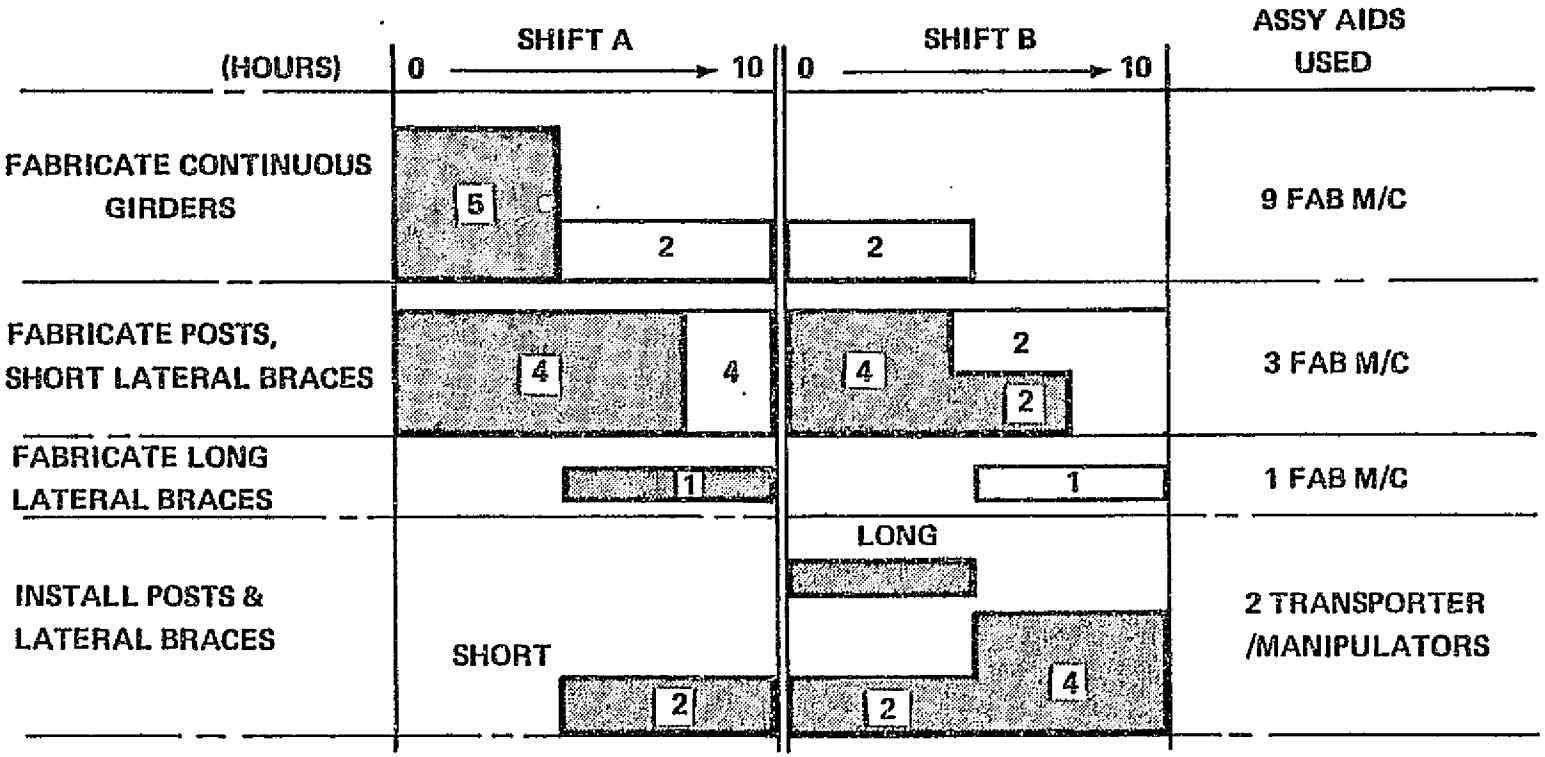
SPACE ASSEMBLY OF SOLAR ARRAY

- PRELIMINARY TIMELINE FOR ASSY OF ONE BAY
  THREE PYRAMIDS WIDE, 254 M LONG



- WORKING CREW – 9 MEN
- LEGEND — ACTIVE FAB & ASSY

  FETCHING MATERIALS & MAINTENANCE
  NUMBER OF MEN SHOWN IN BOX

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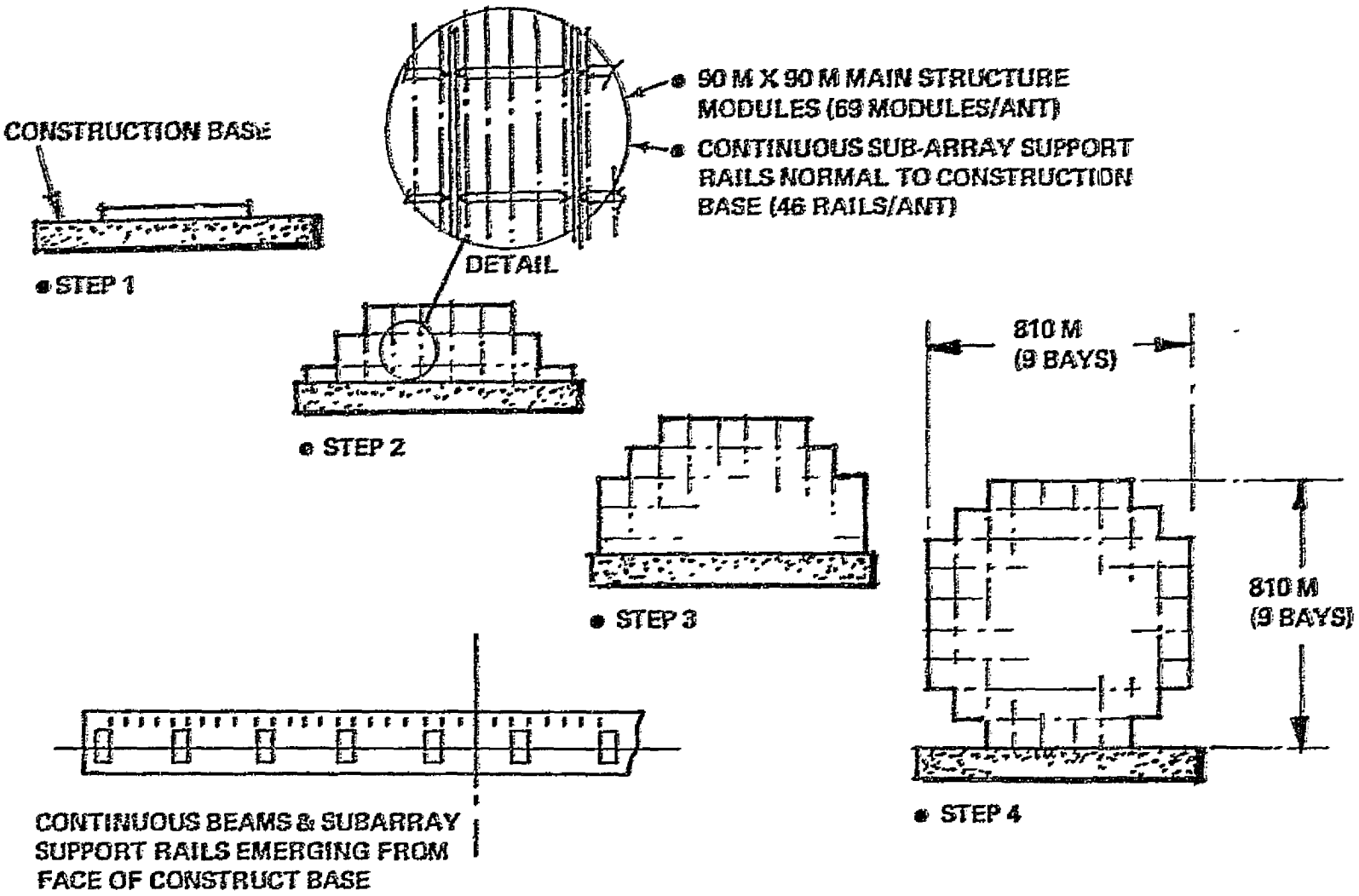
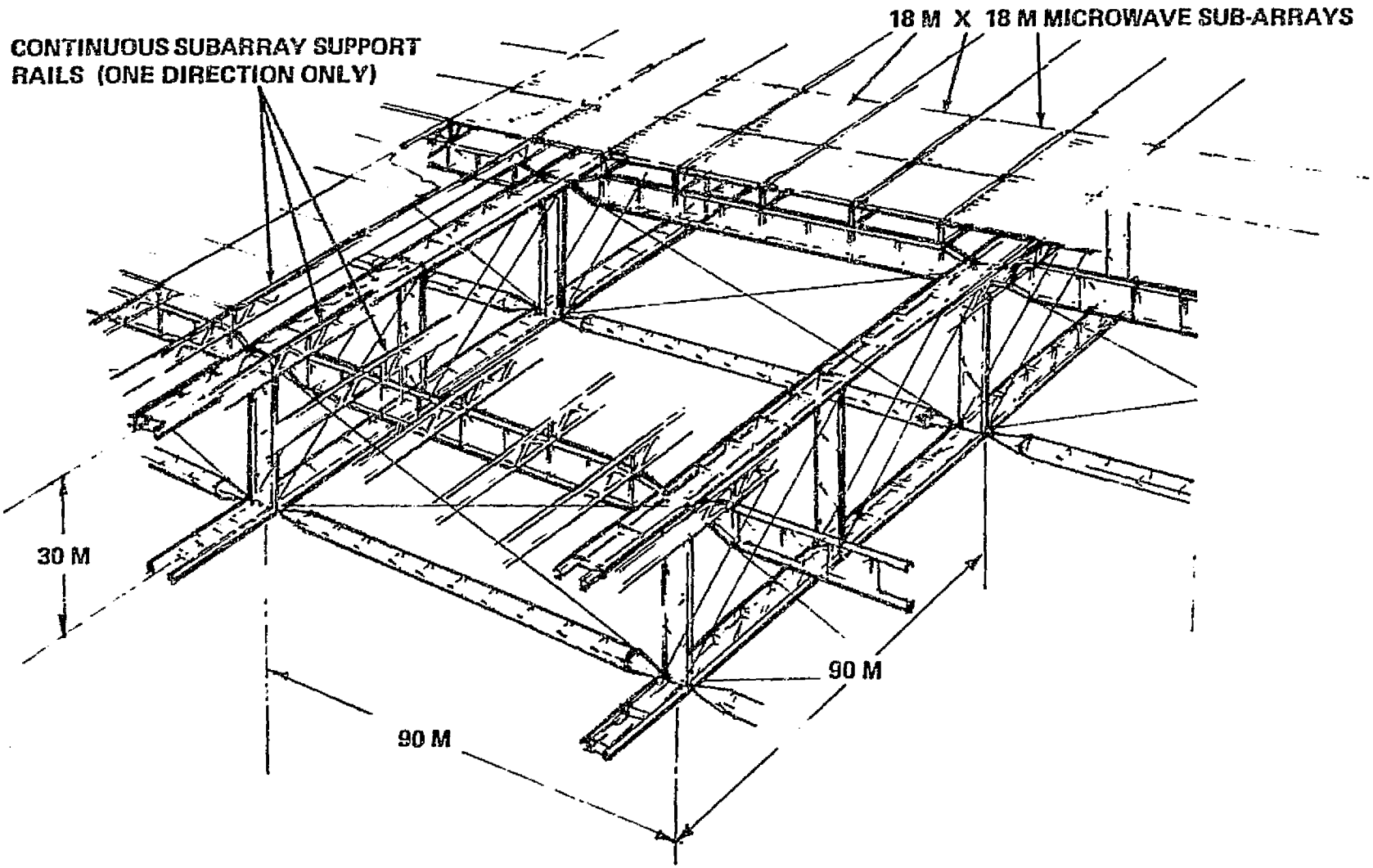
MICROWAVE ANTENNA CONSTR SEQUENCE



SSPS: TYPICAL MICROWAVE ANTENNA STRUCT



30 M X 90 M X 90 M BASIC MODULE

- BEAMS NORMAL TO CONST BASE – CONTINUOUS
- BEAMS PARALLEL TO CONST BASE – INTERCOSTAL

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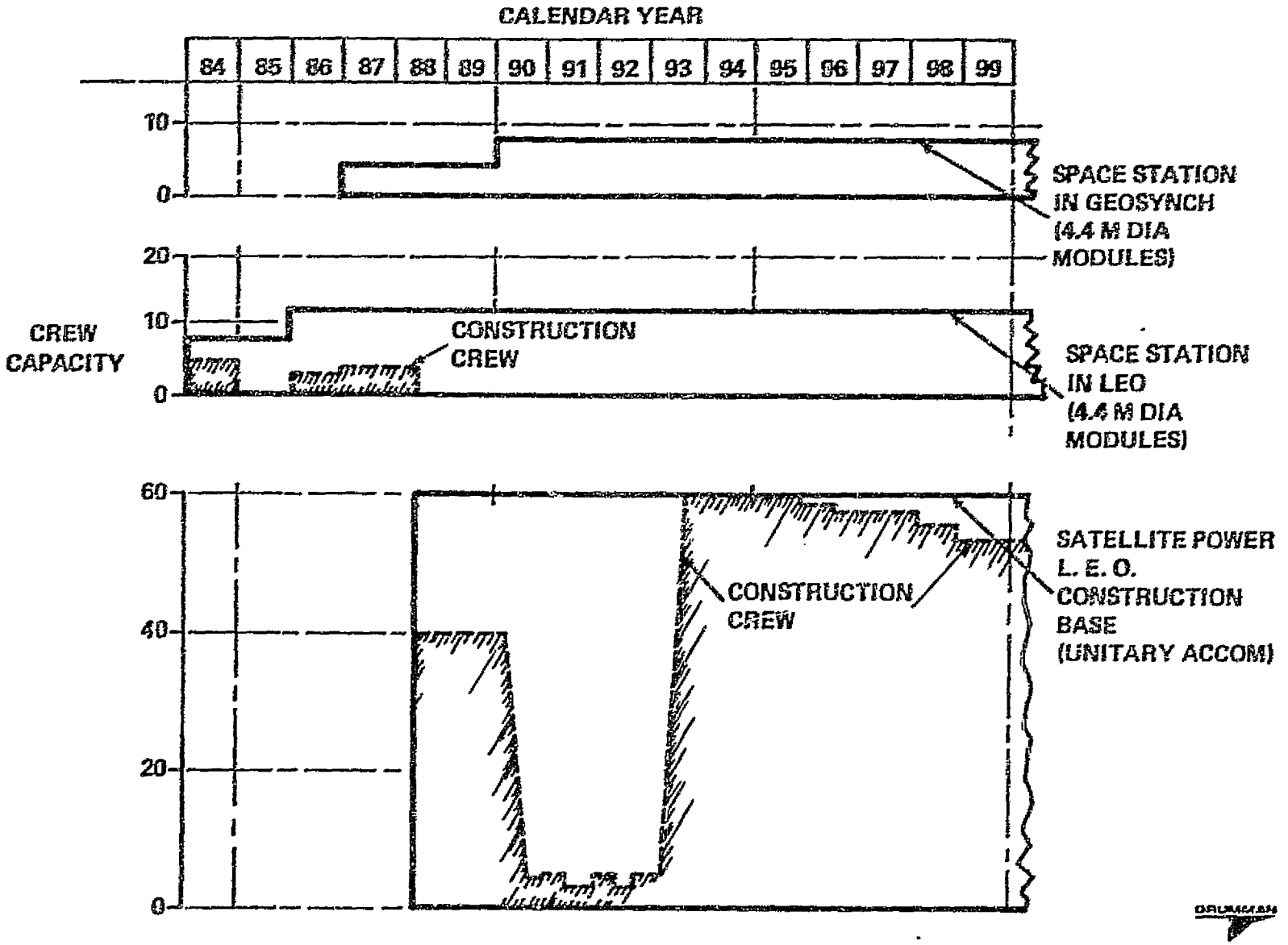
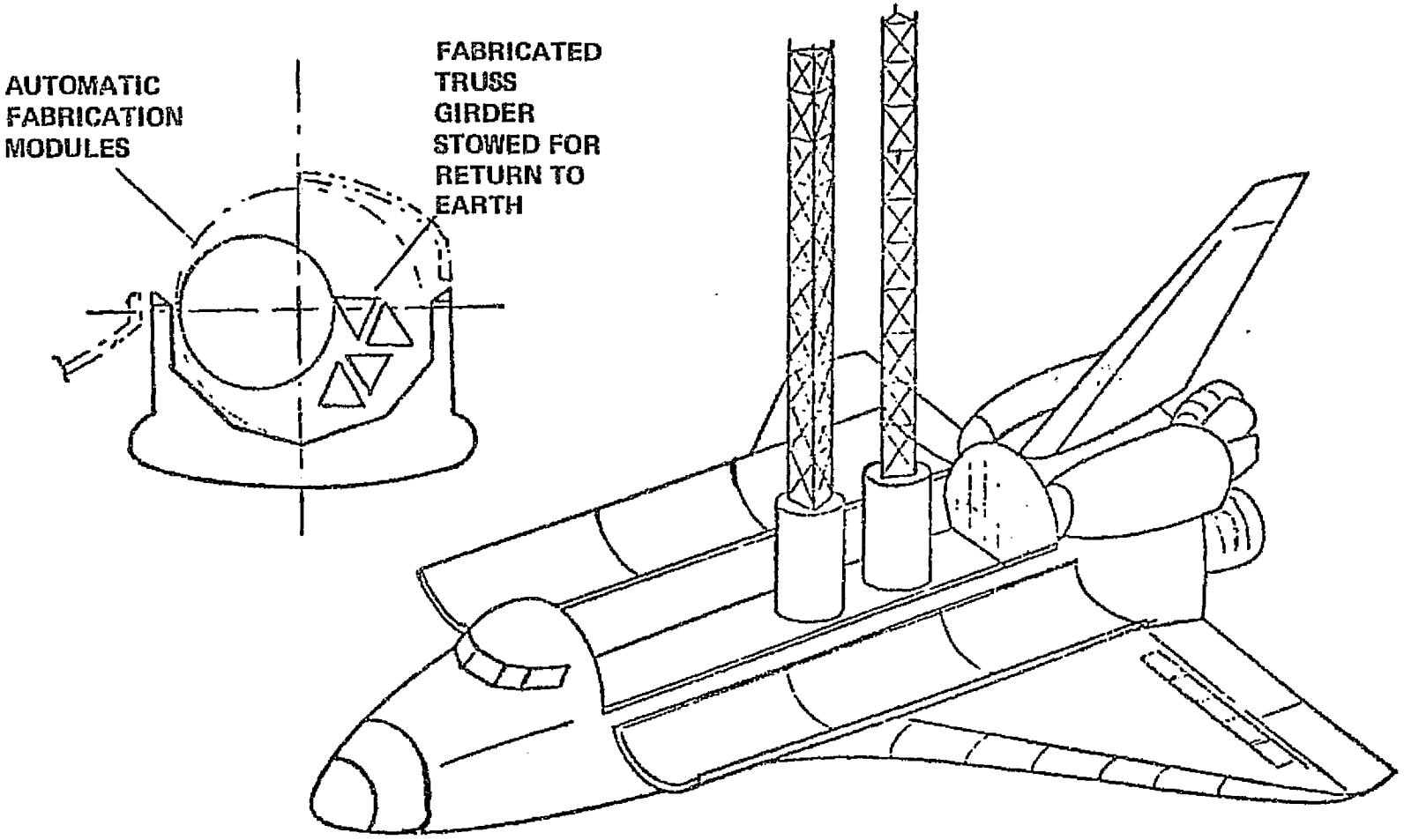
SPACE STATION CREW CAPACITY GROWTH

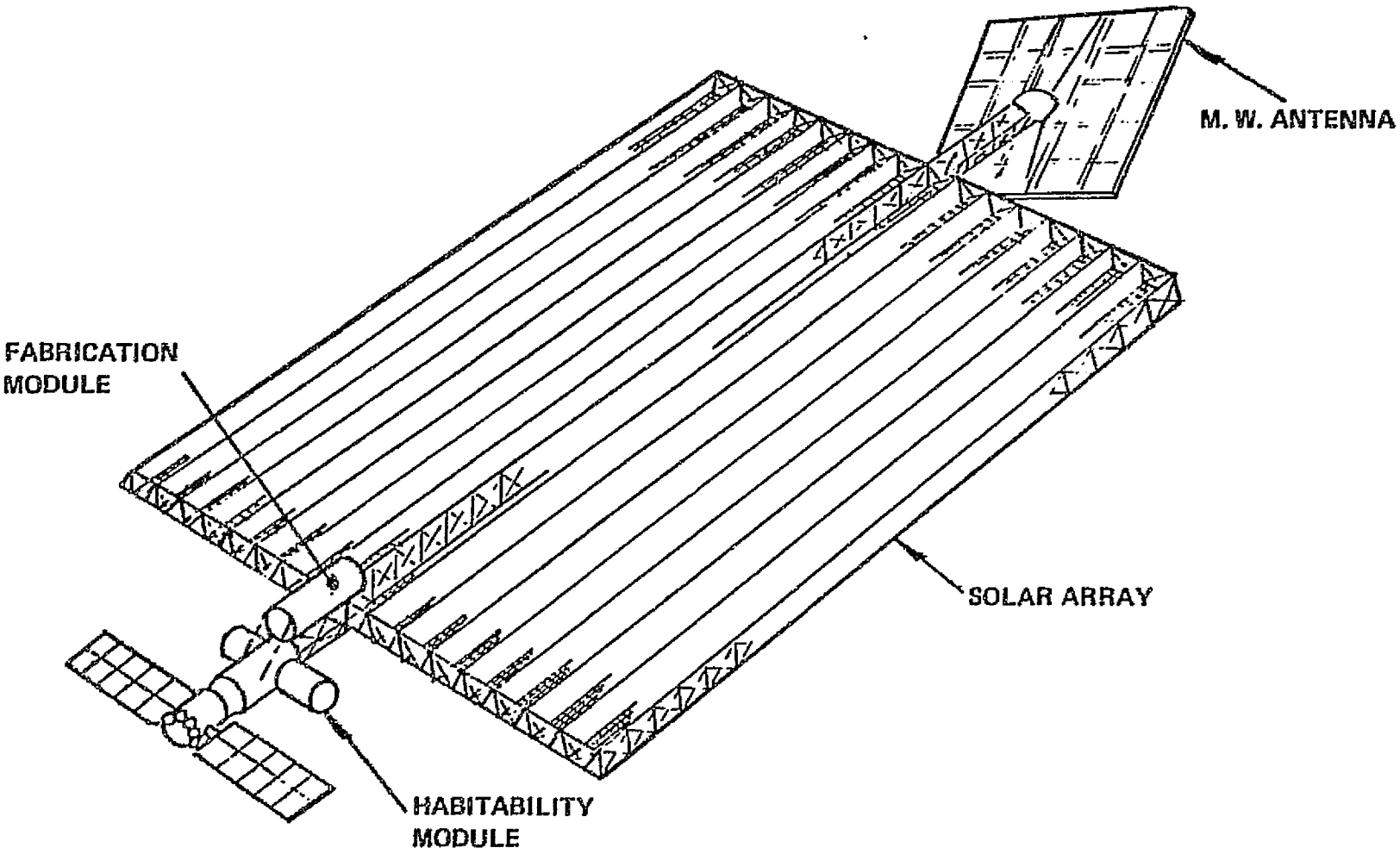


SORTIE FLIGHT DEMONSTRATION OF AUTOMATIC FABRICATION IN ORBITER



- MANUFACTURE 1 M X 18 M TRUSS GIRDERS IN ALUMINUM ALLOY & COMPOSITE
- RETURN TO EARTH FOR EVALUATION & TEST

SATELLITE POWER DEVELOPMENT LABORATORY – LEO – (VERSION USING SPACE FABRICATION TRIANGULAR BEAMS FOR SOLAR ARRAY)



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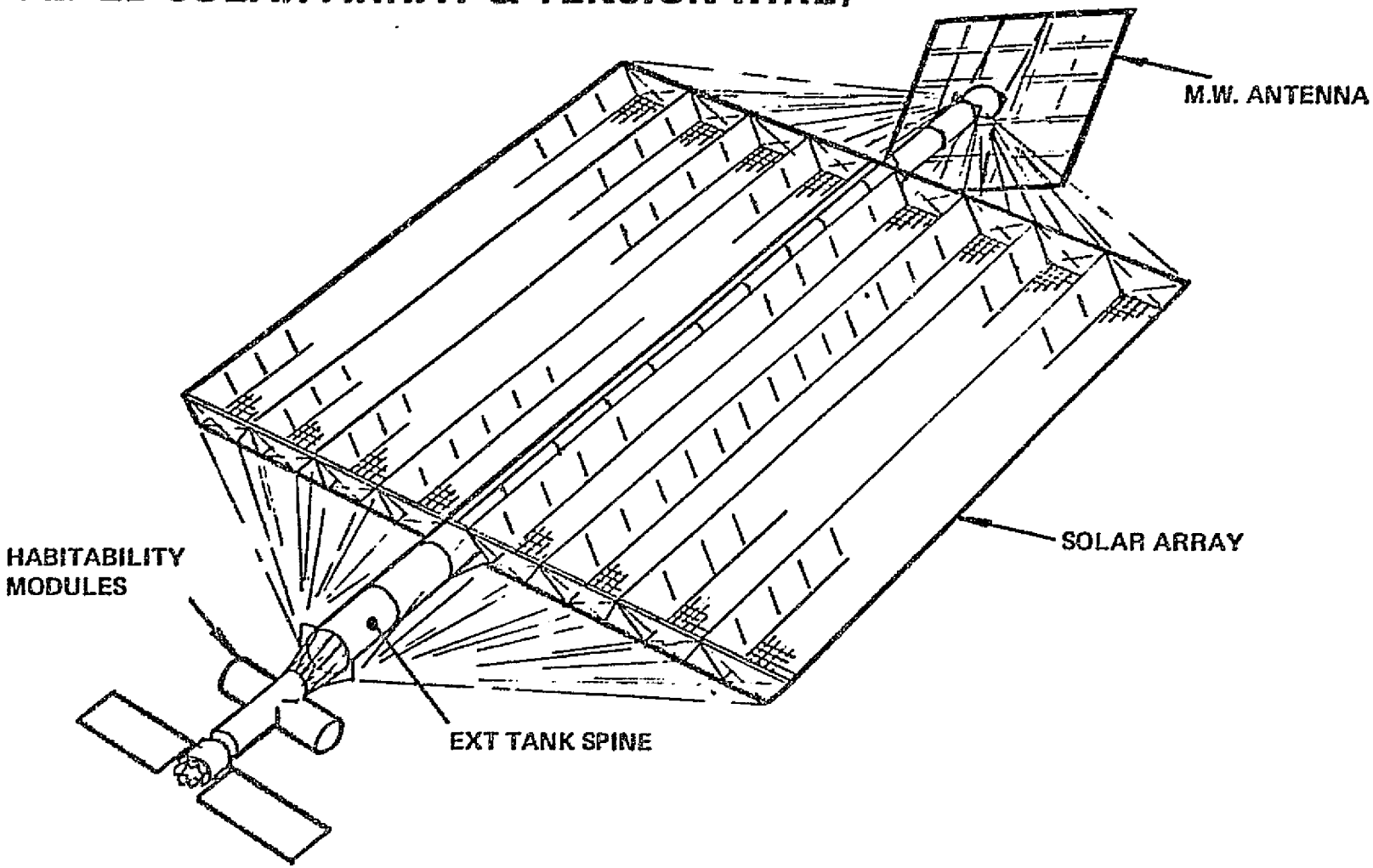
SATELLITE POWER DEVELOPMENT LABORATORY - LEO - (VERSION USING SHUTTLE EXT TANKS AS A SPINE WITH FOLDED SOLAR ARRAY & TENSION WIRE)



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SATELLITE POWER CONSTRUCTION BASE & TEST FACILITY - STUDY STATUS

- FULL SIZE/INTERMEDIATE SIZE BASE - PROBABLE CHARACTERISTICS:
  - SPECIALIZED CONFIG & FAB. EQUIPMENT
  - LOW MANPOWER LEVELS
  - LARGE - 1-2 KM
- NEAR-TERM SUBSCALE BASE REQMTS & ISSUES
  - SIZED TO SUIT SPDL
  - PRIME DEVEL AREAS:
    - FEASIBILITY OF:
      - CO-ORDINATED FAB.
      - JOINING & ALIGN.
      - LOGISTICS MOVEMENTS
    - STRUCT INTEGRITY, VERIFICATION, & REPAIR
    - RELIABLIITY OF MACHINES
  - POTENTIALLY USEFUL FOR OTHER MISSIONS

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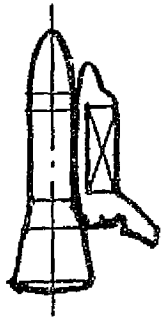
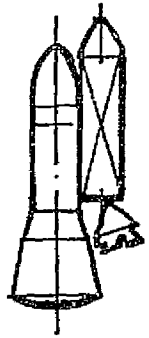
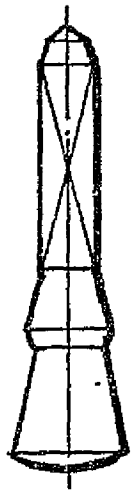
SPACE STATION: LAUNCH SYSTEMS

	• SHUTTLE – DIRECT PHASED DEVEL				• HLLV-4	
	STS		SHUTTLE GROWTH	HLLV ½		
						
P/L DIA (M)	4.6	60	4.6	9	16	
BAY SIZE L (M)	18.3	PASS.	18.3	30	62.2	
				LOWER UPPER	LOWER	UPPER
REUSES				300 500	300	500
TURN AROUND (DAYS)				7.3 5.3	7.3	5.3
DDT&C ($M)		120		3100	6800	
FLTS/YEAR - FACILITIES ($M)				23 ~ 368 45 ~ 705	100 ~ 2000 500 ~ 4500	
FLTS/YEAR - COST/FLT ($M)	14.5	14.5		5 ~ 8.9 23 ~ 8.7 45 ~ 8.4	100 ~ 7.6 500 ~ 6.9	

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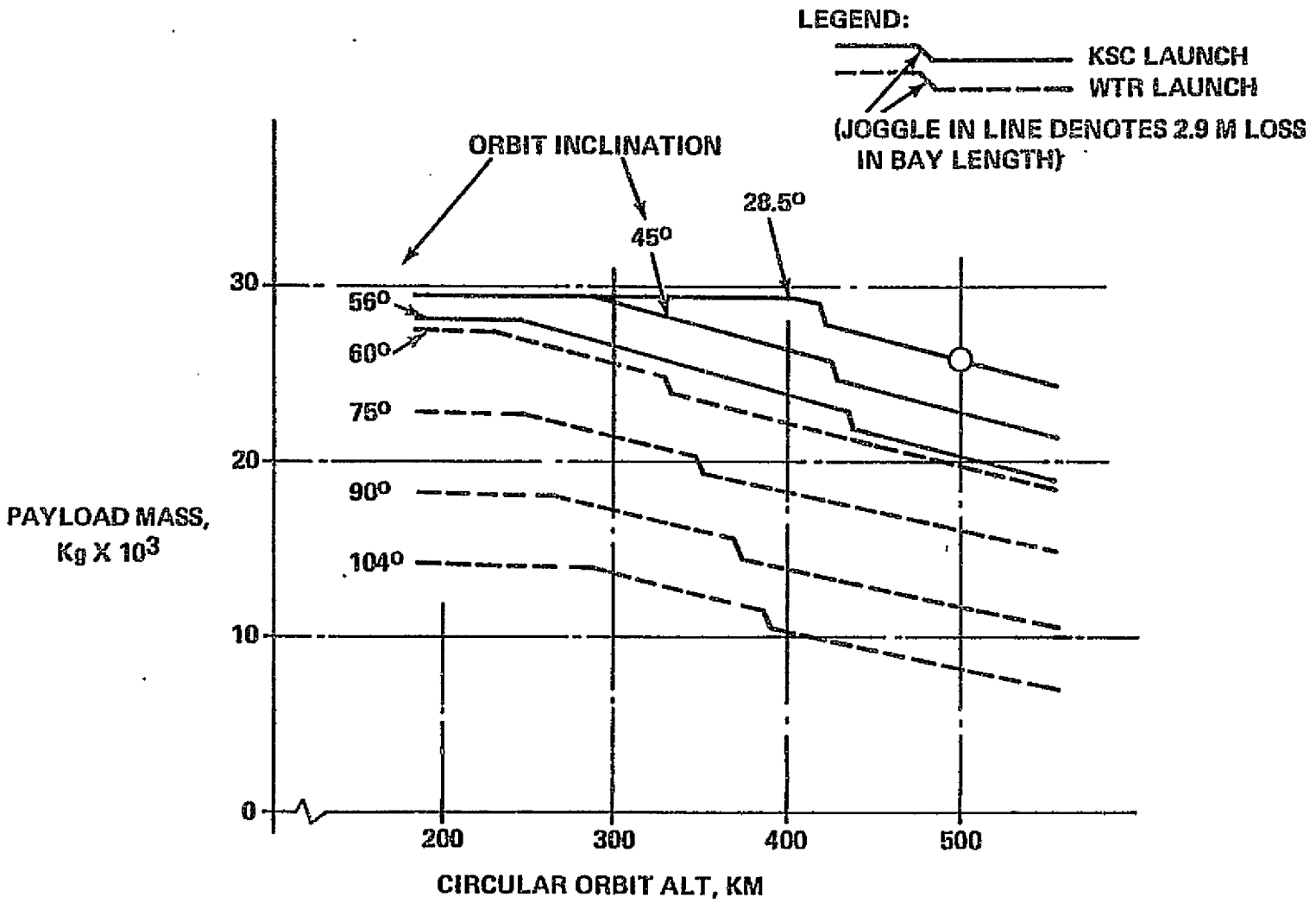
SPACE STATION: STS - P/L VS ORBIT ALT & INCL



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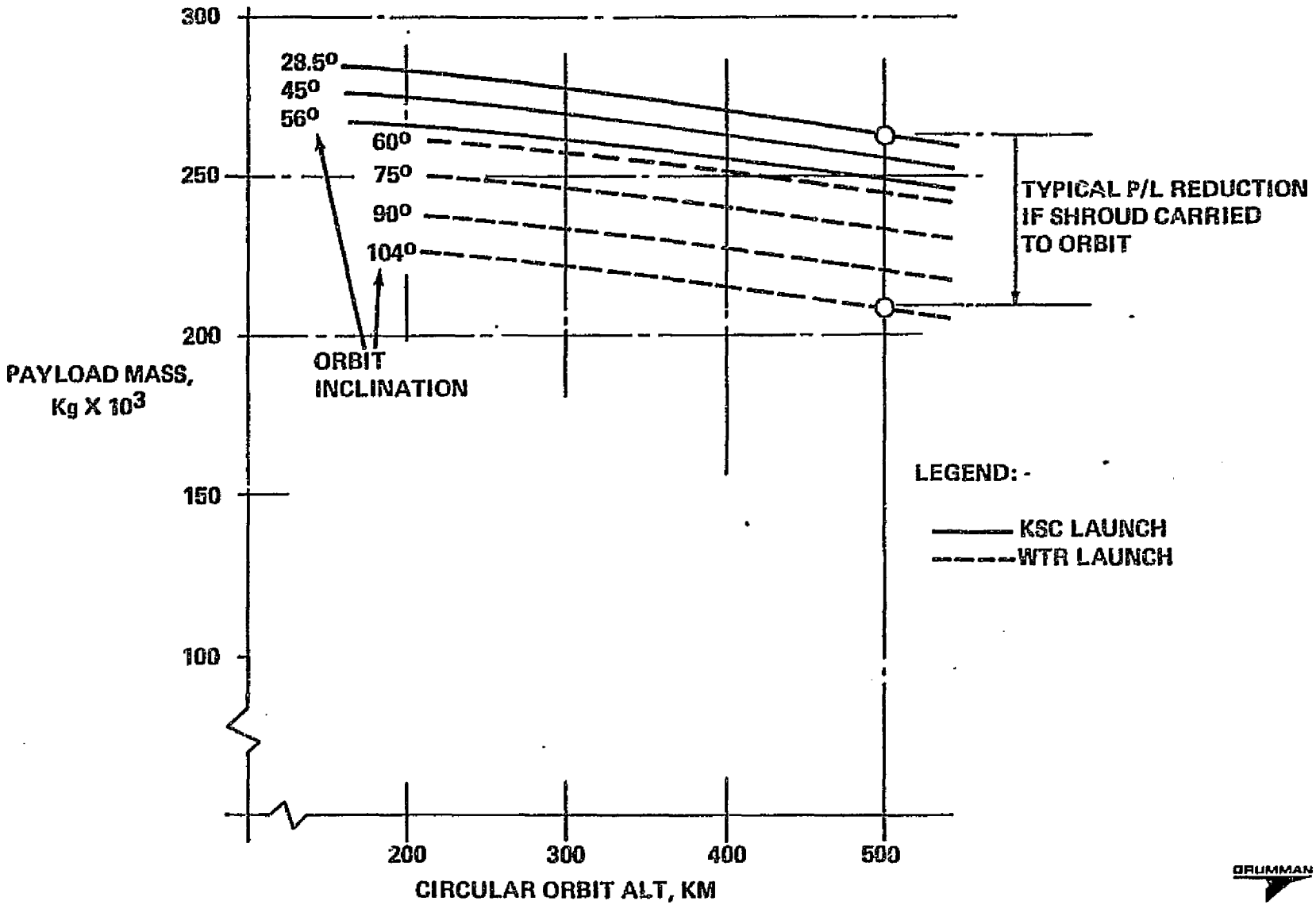
SPACE STATION: HILLV-4 - P/L VS ORBIT ALT & INCL

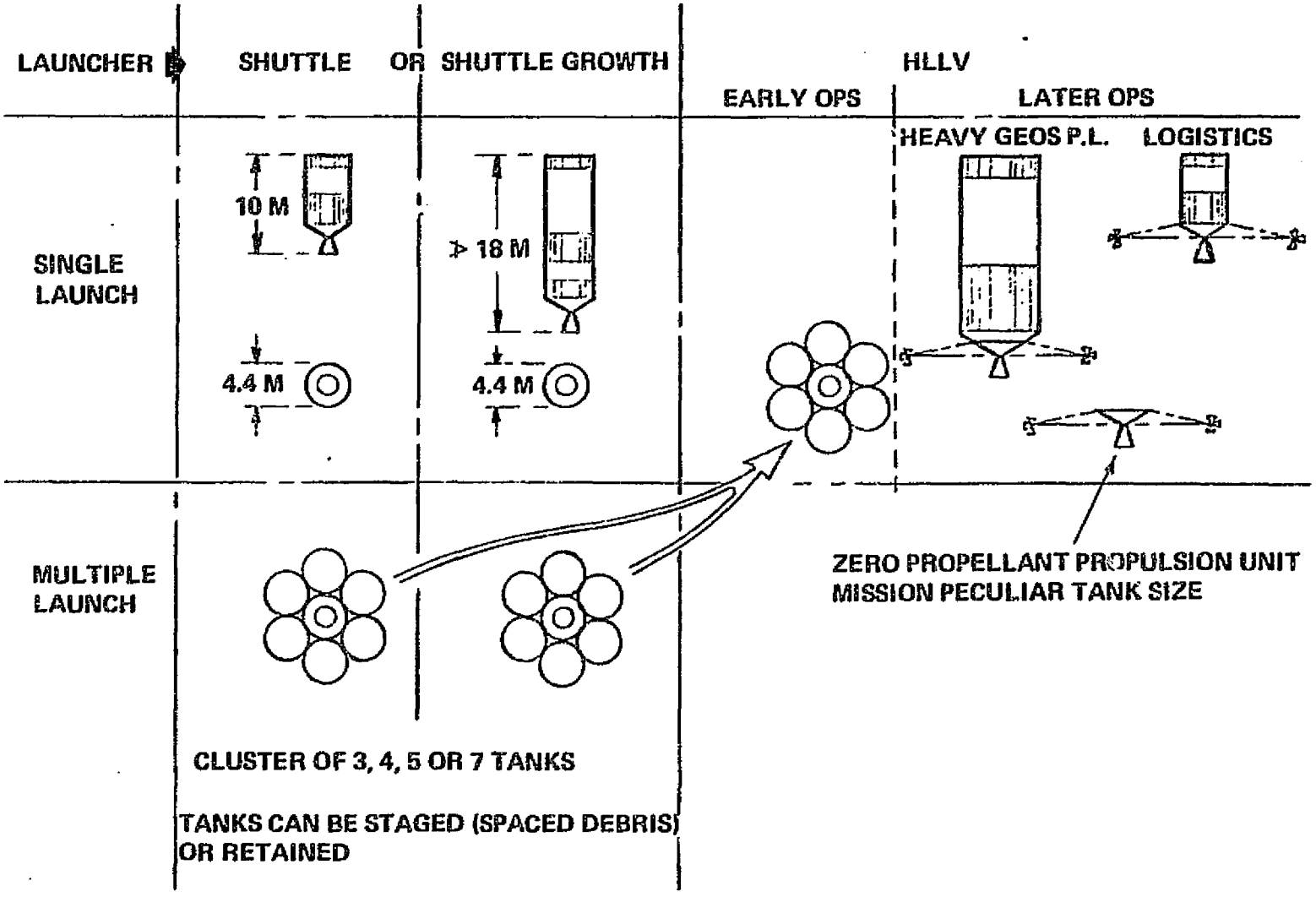
- SHROUD DENSITY 20 Kg/M_3
- SHROUD JETTISONED 60 SECS AFTER STAGING



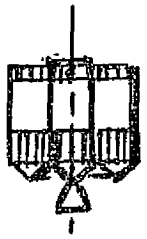
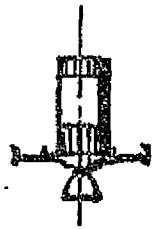
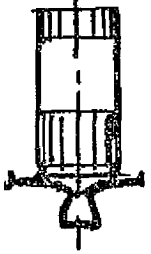
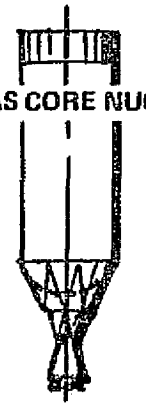
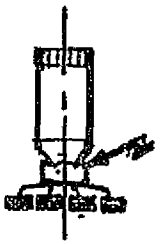
GRUMMAN

OTV: CRYO TUG – PHASED GROWTH TO SUIT VARIOUS LAUNCHERS

- PROPULSION & GUIDANCE RETRAINED
- TANKS RESIZED



SPACE STATION: NEW LONG RANGE OPS

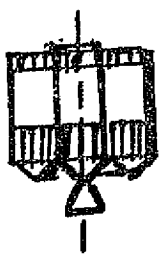
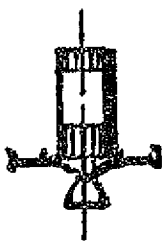
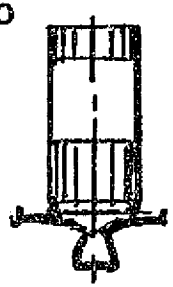
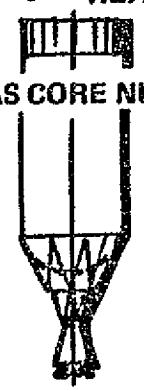
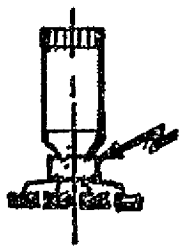
	• RAPID TRANSIT MANNED OTS			• HEAVY CARGO OTS	
	PHASED DEV CRYO			GAS CORE NUC.	MPD*
					
TYPICAL MISSION	GEO ROUND TRIP	LOGISTIC	GEO ROUND TRIP	GEO ROUND TRIP	GEO ROUND TRIP
PROPELLANT/ EXHAUST VEL (M/SEC)	CRYO/ 4600			LH_2/ 21600	ARGON/ 98100
THRUST LEVEL (N)	150000			400000	
TYPICAL MASS ($Kg \times 10^3$) • P/L • PROPULSION, ETC • TANKS • PROPELLANT					

*MPD PROPULSION REQUIRES:

- CHEM ASSIST TO 1500 KM
- POWER FROM P/L

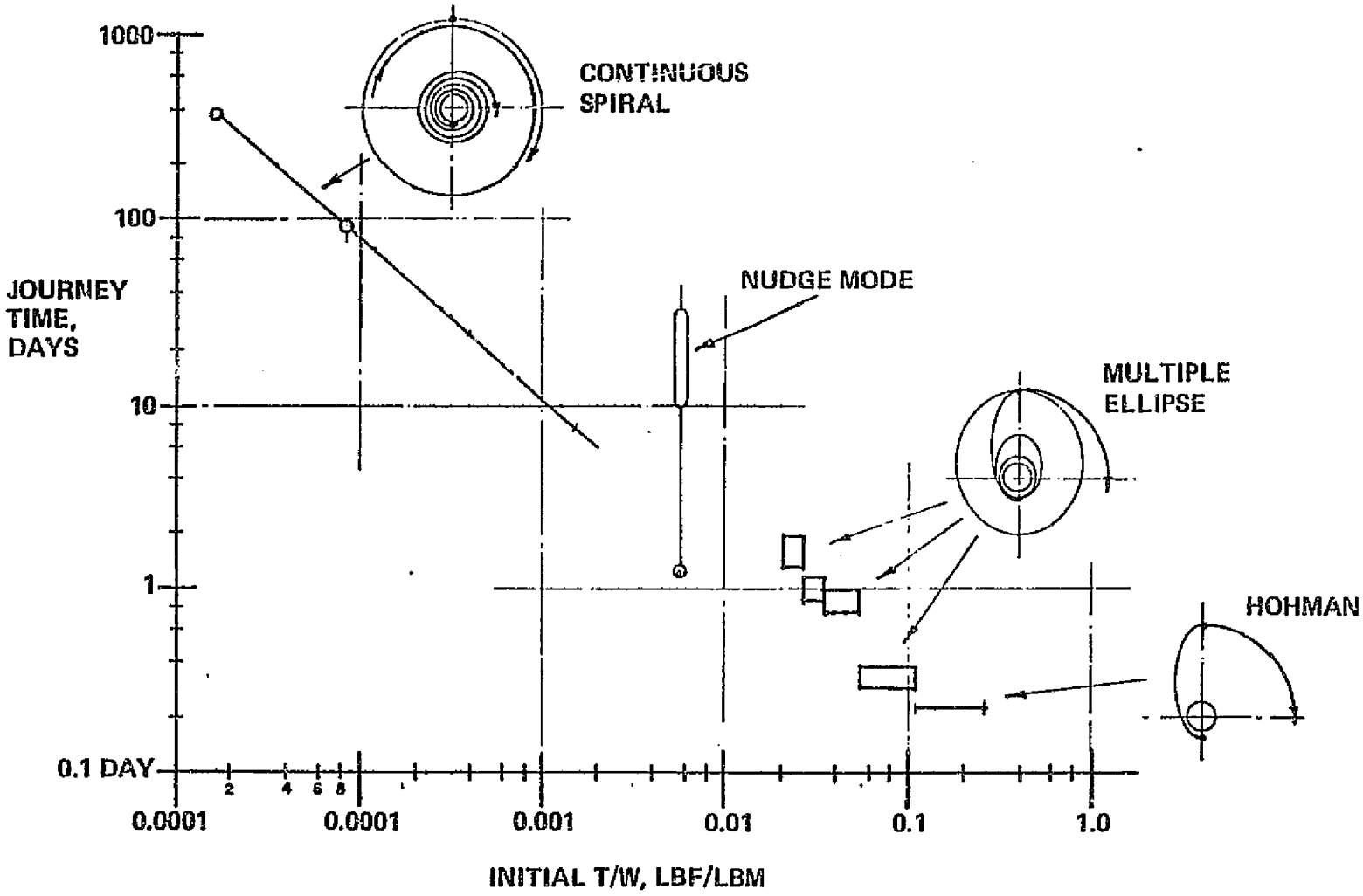
GRUMMAN

SPACE STATION: NEW LONG RANGE OPS

	• RAPID TRANSIT MANNED OTS			• HEAVY CARGO OTS	
		PHASED DEVEL CRYO		GAS CORE NUC.	MPD
					
LAUNCH TO LEO BY:	STS	HLLV			
SERVICED AT:	GROUND	SS			
REUSES	100	40			
TURNAROUND (DAYS)	10	2		10	
DDT & E $M				3100	265
FIRST UNIT COST $ M				110	50x ( )
COST/FLT $M					

GRUMMAN

JOURNEY TIME - LEO TO GEO, VS T/W



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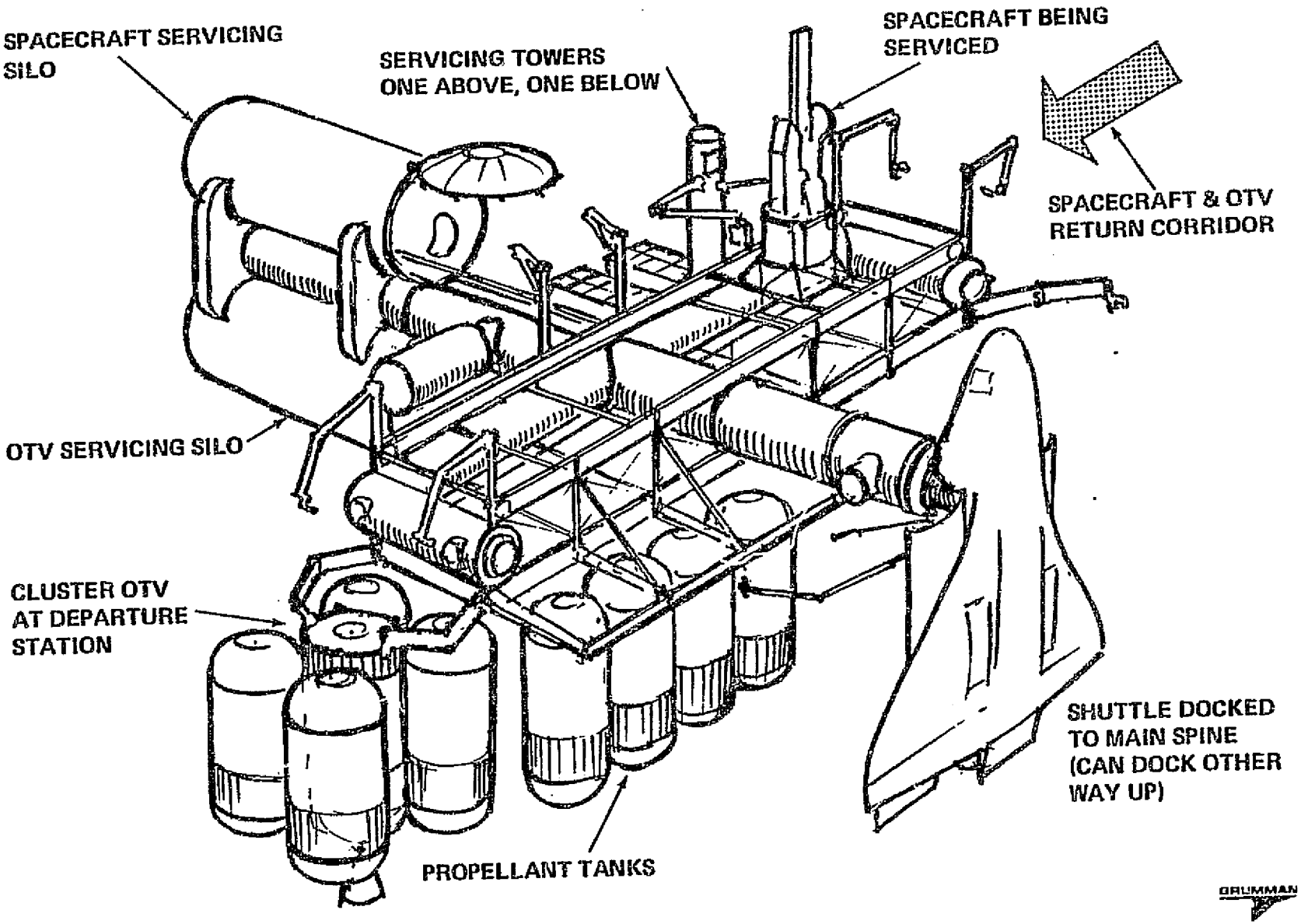
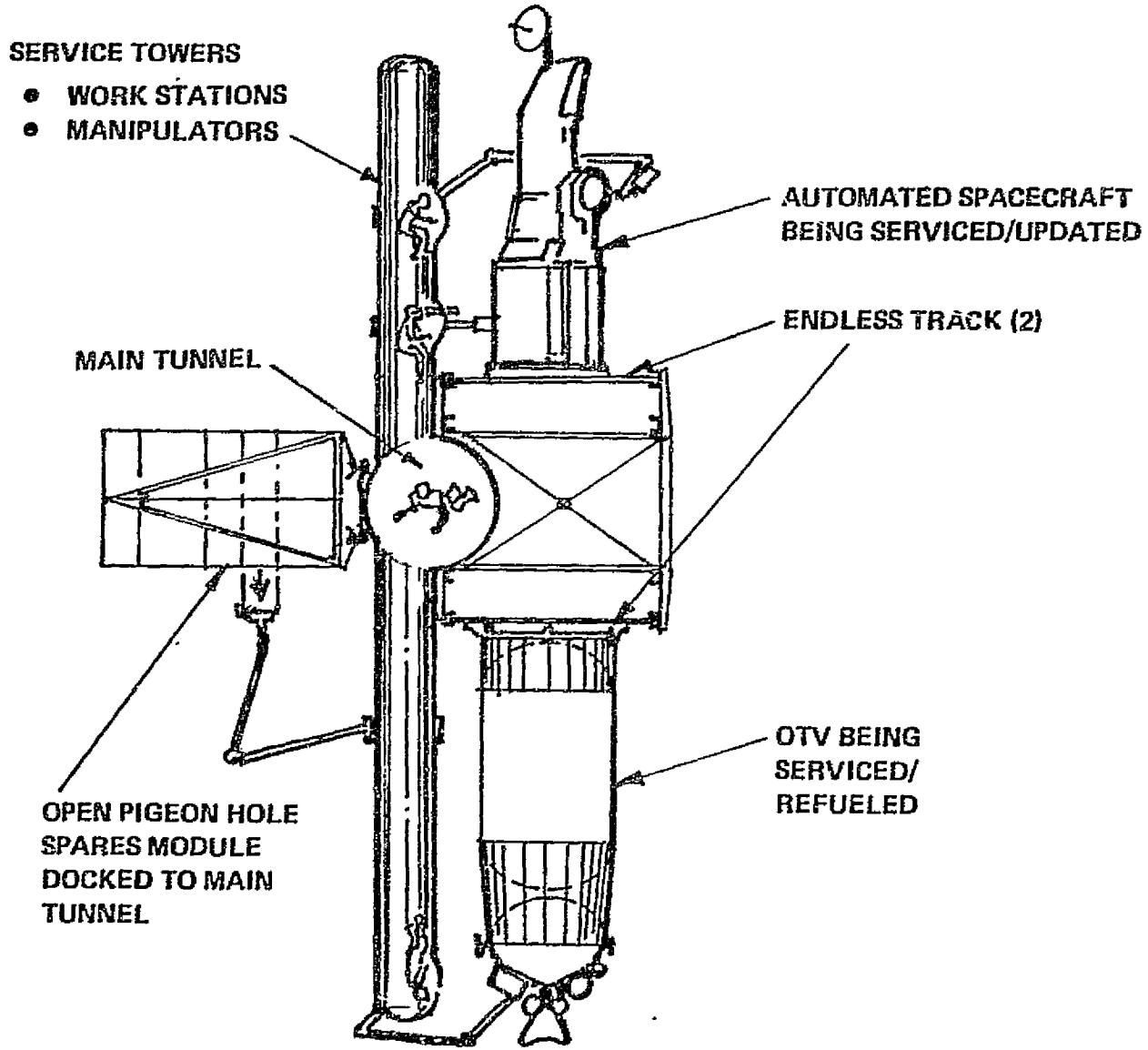
SPACECRAFT SERVICING & ORBITAL DEPOT



GRUMMAN

ORIGINAL PAGE IS
OF POOR QUALITY

ORBITAL DEPOT/SPACECRAFT SERVICE CONCEPT – EXTERNAL SERVICE STATION

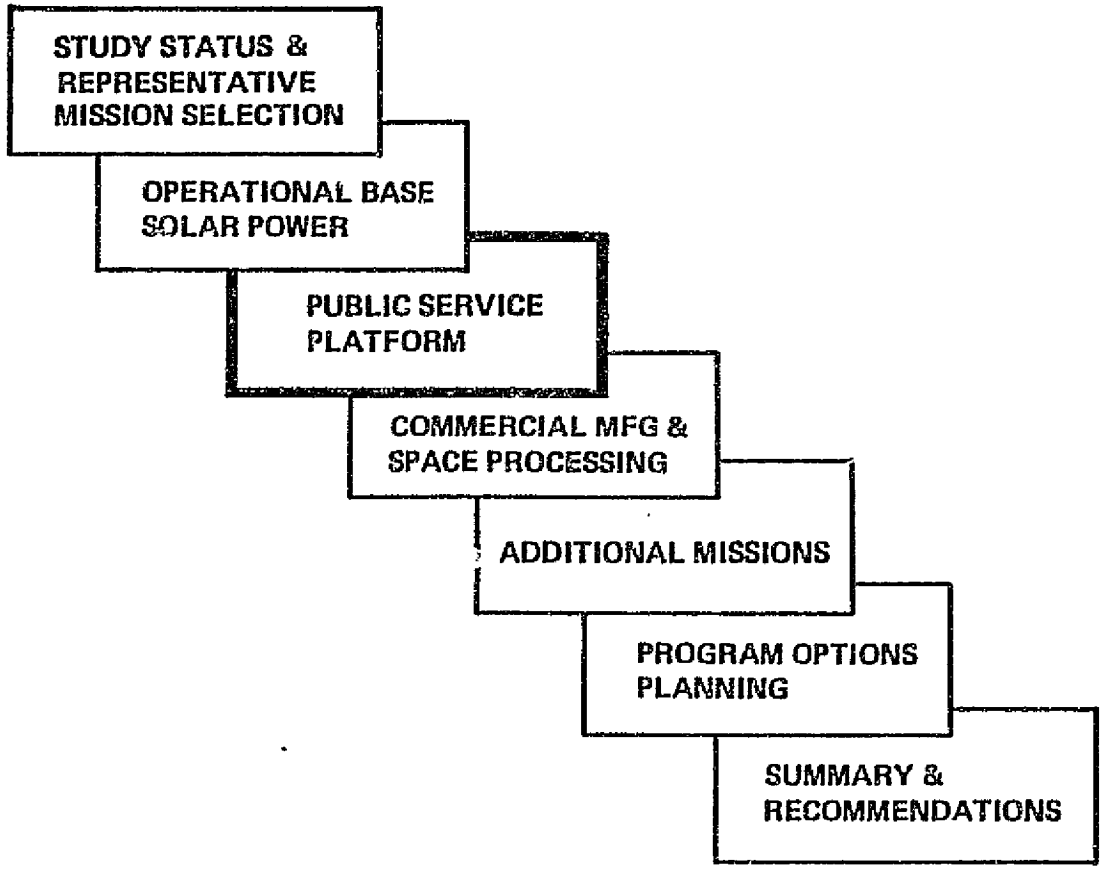


ORBITAL DEPOT/SPACECRAFT SERVICING - STUDY STATUS

- USED FOR MORE THAN SAT PWR MISSIONS
- MULTIPLE FUNCTIONS
  - SERVICING & REFUELING RAPID TRANSIT OTV'S
    - SHUTTLE SUPPORTED
    - HLLV SUPPORTED
  - SERVICING AUTOMATED SPACECRAFT
  - SERVICING CARGO OTV'S - IF REUSABLE
- TRAFFIC FLOW HIGHLY SENSITIVE TO SCENARIO - TBD

GRUMMAN

SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



PUBLIC SERVICE PLATFORM

- OBJECTIVE
  - PERFORM WIDE RANGE OF COMMUNICATION, DETECTION & CONTROL FUNCTIONS FOR PUBLIC SERVICE SECTOR
- FUNCTIONS
  - ELECTRONIC MAIL
  - PERSONAL & POLICE COMM
  - DISASTER CONTROL
  - NATL INFO SERVICE
  - VOTING/POLLING
  - ADVANCED TV
  - 3D HOLOG TELECONF
  - NUC FUEL LOCATOR
  - EARTHQUAKE DETECTION/PREDICTION
  - WATER AVAIL INDICATOR
  - VEHICLE SPEED CONTROL
  - INTRUDER DETECTION
- IMPLEMENTATION STRATEGY
  - OBTAIN HIGH BENEFIT-TO-COST RATIO USING SPACE STATION

- NATIONAL NEEDS
  - ECONOMY
  - QUALITY OF LIFE
  - NATIONAL PRESTIGE

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PUBLIC SERVICE PLATFORM JUSTIFICATION

WHY PERFORM MISSION?	WHY PERFORM IT IN SPACE?	WHY ON SPACE STATION?
• REDUCE SERVICE COSTS	• SPACE PLATFORM PROVIDES CENTRAL LOS RELAY FOR MANY COMPATIBLE FUNCTIONS	• LARGE SPACE STRUCTURE REQUIRED
• INCREASE SERVICE SPEED	• GEO PLATFORM SERVES ENTIRE CONUS; ADDED PLATFORMS EXPAND SYSTEM FOR GLOBAL SERVICE	• MAN'S ROLE IS SIGNIFICANT – REGULAR MAINTENANCE & SERVICE – UPGRADING OF SOFTWARE & ASSOCIATED ELECTRONICS – CHANGING OF HARDWARE-TO-SOFTWARE INTERFACE
• INCREASE SERVICE COVERAGE	• DISADVANTAGES OF CURRENT SERVICES ARE OBVIATED – SIGNAL PATH BLOCKAGE BY SURFACE FEATURES – ATMOSPHERIC/IONOSPHERIC DISTURBANCES	
• INCREASE PERSONAL SECURITY/SAFETY		
• IMPROVE LAND USE		

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PUBLIC SERVICE PLATFORM FUNCTIONAL REQUIREMENTS

FUNCTION		GROUND RESOLUTION DIA/BEAM, NMI	USAGE/ ORBIT, %	FREQ BAND
VOICE/ DATA	ELECTRONIC MAIL	60	40	S
	PERSONAL COMM	60	100	S
	POLICE COMM	60	100	S
	DISASTER CONTROL	60	10	S
	NATL INFO SERVICE	60	100	S
	VOTING/POLLING	60	10	S
VOICE/ VIDEO	ADVANCED TV	100	100	K
	3-D HOLOG TELECONF	100	50	K
DETECTION/ CONTROL	NUCLEAR FUEL LOCATOR	350	10	TBD
	EARTHQUAKE DETECT/ PREDICT.	100	100	TBD
	WATER AVAIL. INDIC.	50	10	TBD
	VEHICLE SPEED CONTROL	75	100	TBD
	BURGLAR ALARM/ INTRUSION DETECT.	100	50	TBD

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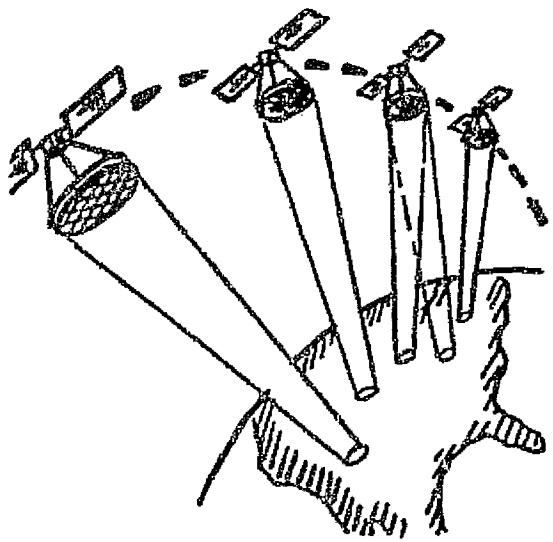
MULTIPLE-FUNCTION PUBLIC SERVICE PLATFORM DESIGN CONCEPTS

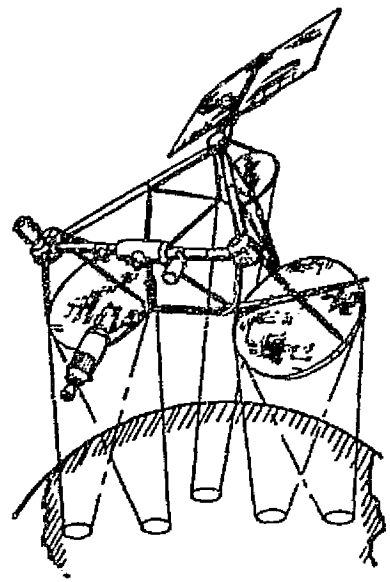
- DEDICATED



NON-INTEGRATED SYSTEM — 13 FREE FLYERS

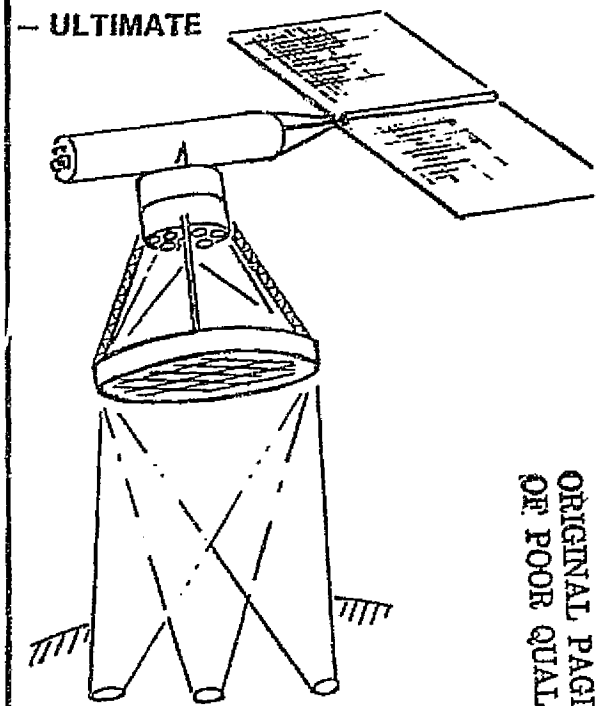
- SPACE STATION

— NEAR TERM



SEMI-INTEGRATED PLATFORM WITH 3 ANTENNAS

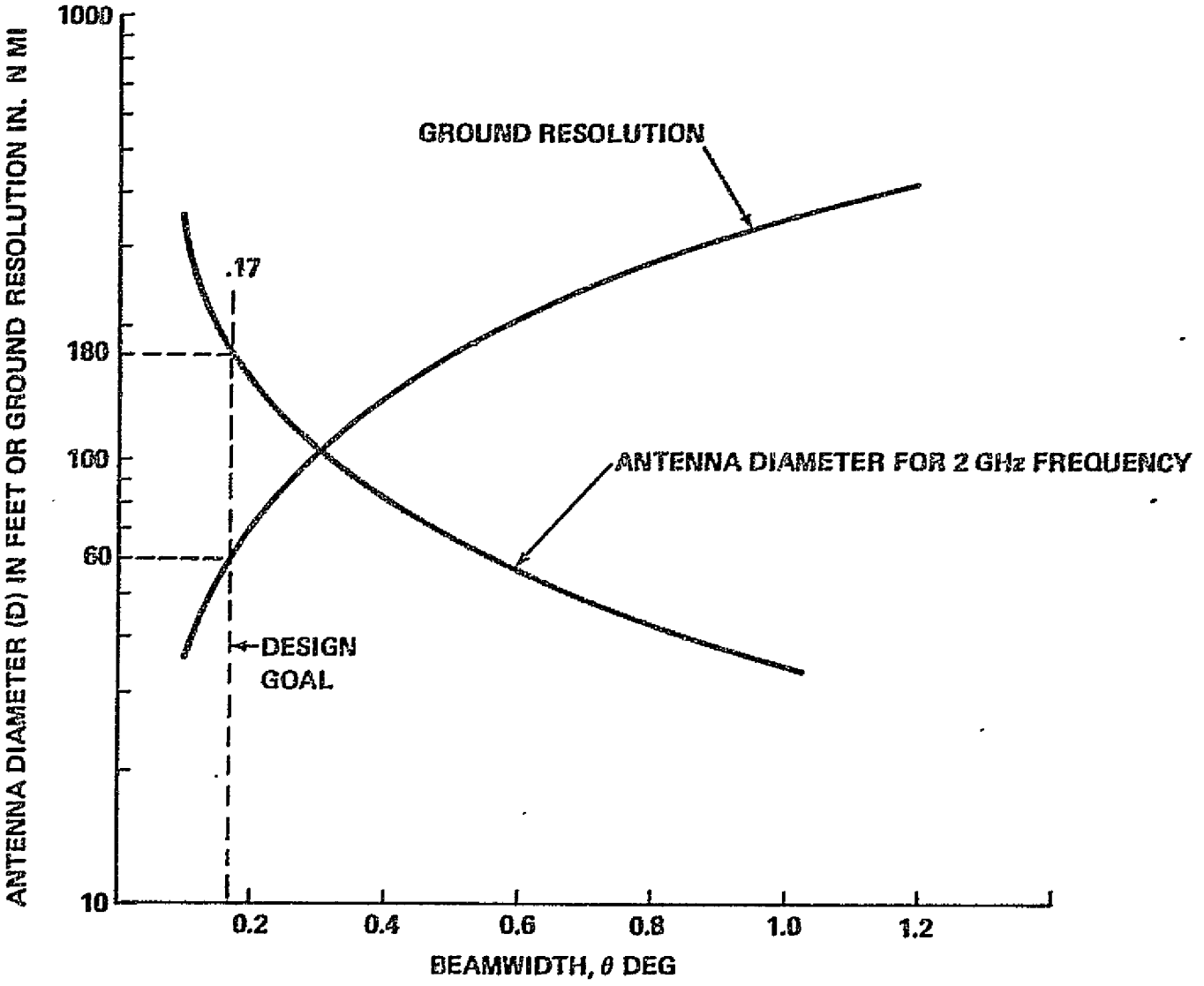
— ULTIMATE



FULLY INTEGRATED MULTI-MISSION LARGE ANTENNA

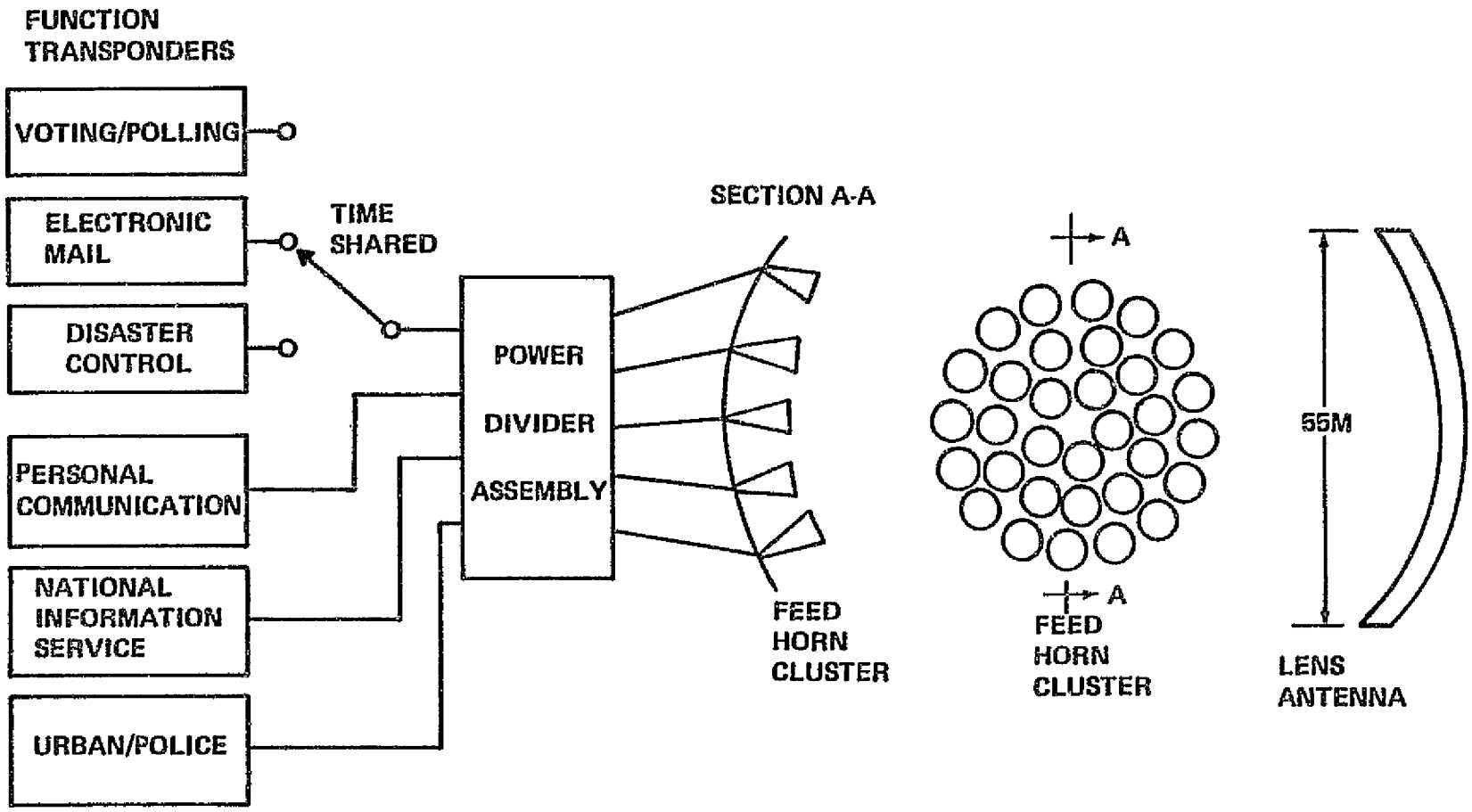
GRUMMAN

PSP ANTENNA SIZING



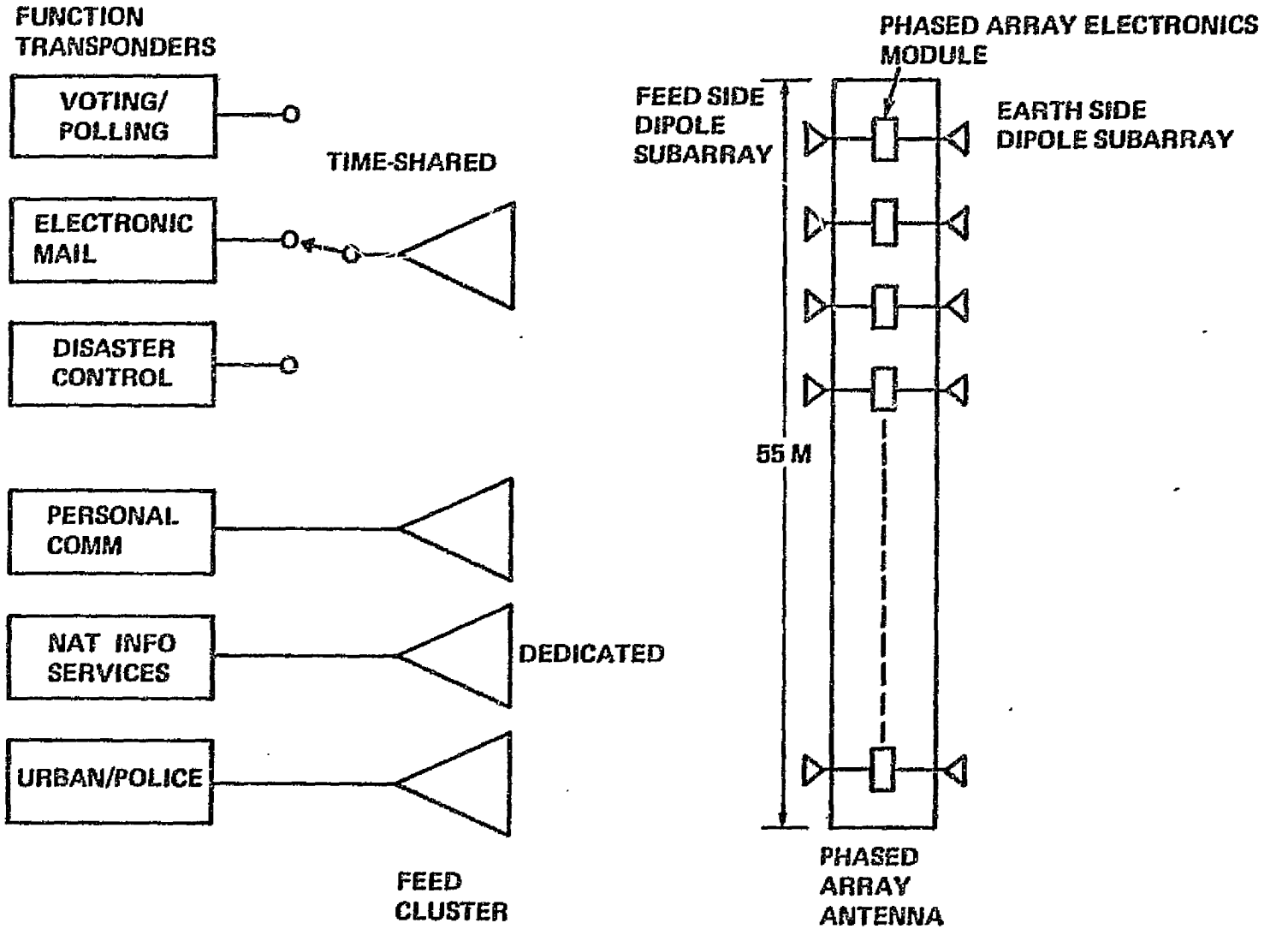
MULTI-FEED LENS ANTENNA CONCEPT

VOICE/DATA COMMUNICATIONS



MULTIBEAM SPACE-FED PHASED-ARRAY LENS ANTENNA CONCEPT

VOICE/DATA COMMUNICATIONS



GRUMMAN

ANTENNA SELECTION CRITERIA

- NUMBER OF BEAMS
- TYPE OF MODULATION
- USER EFFECTIVE RADIATED POWER
- NUMBER OF USERS
- OPERATING FREQUENCY
- USER DATA RATES

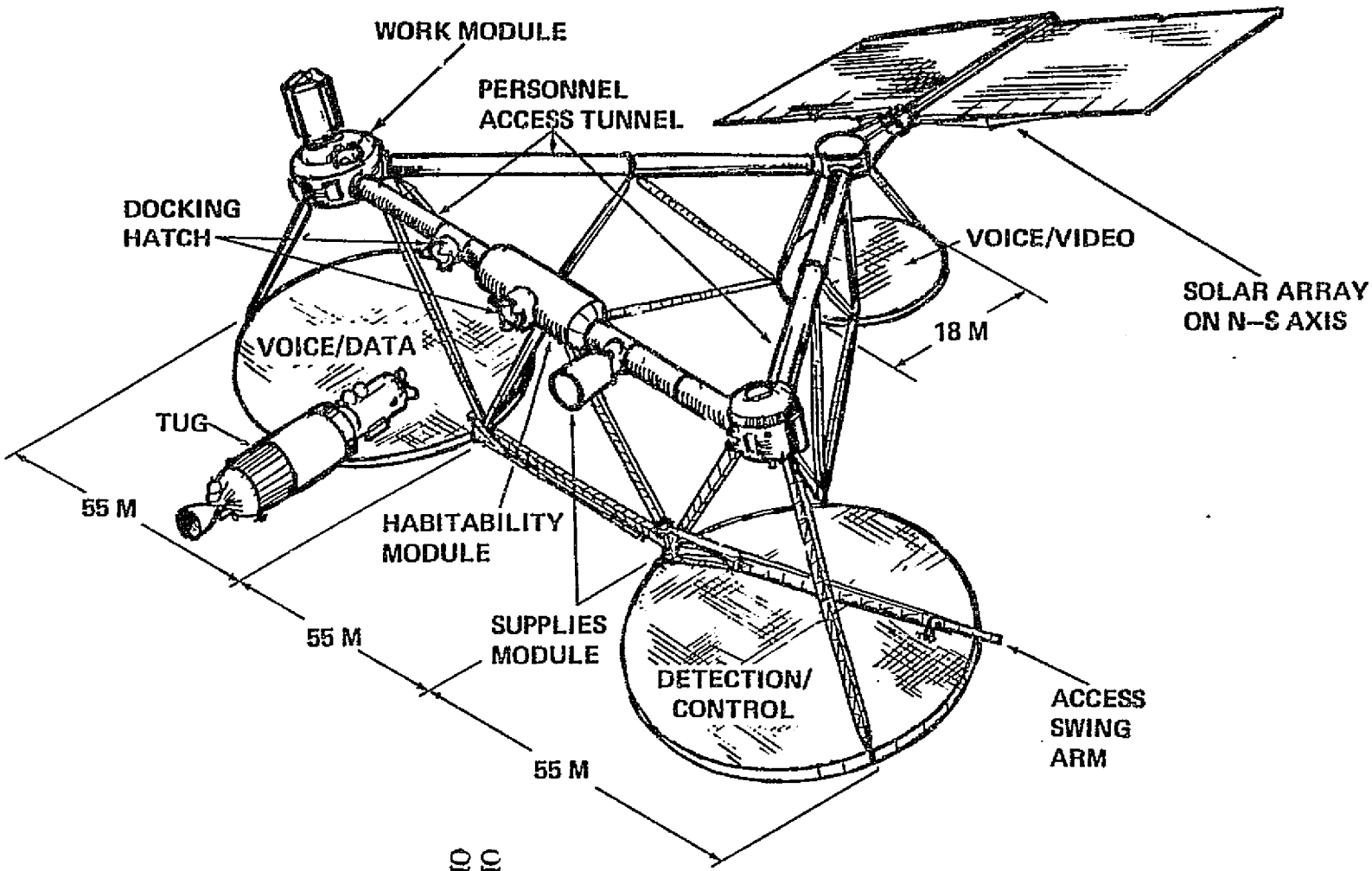
GRUMMAN

SPACE STATION CONFIGURATION DRIVERS

- **ANTENNA**
  - **SIZE** — **18 TO 55 M DIAMETER**
  - **SPACING** — **55 M APART**
  - **FEED TO APERTURE RATIO** — **1 TO 2.5**
- **POWER** — **1 MW TOTAL**
- **ONBOARD REPAIR/MAINTENANCE** — **ANTENNA: EVA ON SWING ARM**
  OTHER HARDWARE:
  SHIRT SLEEVES

GRUMMAN

SPACE STATION PUBLIC SERVICE PLATFORM



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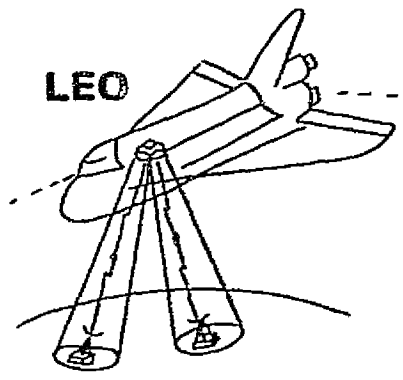
PUBLIC SERVICE PLATFORM

SHUTTLE PRECURSOR TECHNOLOGY

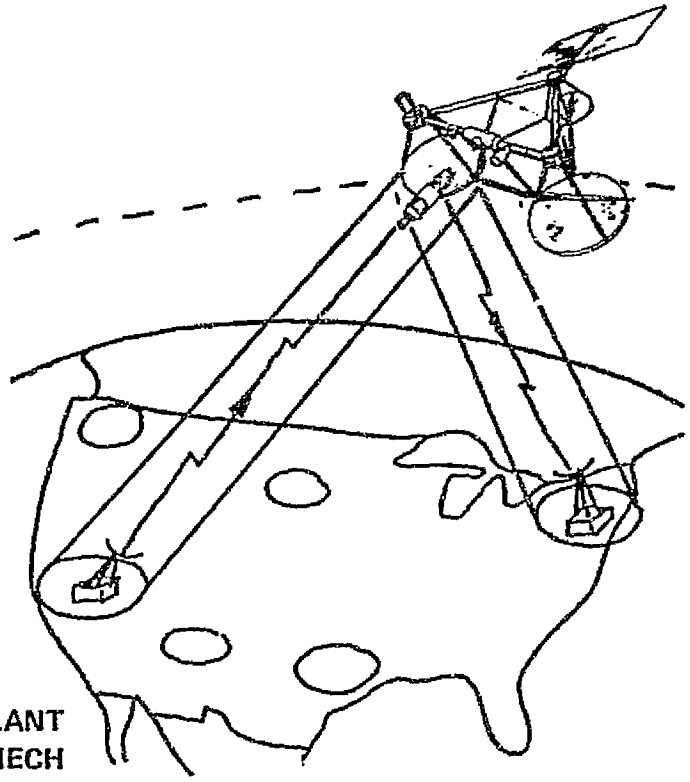


- MISSION
  - SHUTTLE 30-DAY SORTIE MISSION (10C 1980)
  - LEO XMISSION BETWEEN PAIRS OF NEARBY U.S. TEST SITES
  - 100–200 NM CIRC LEO, 28.5–50° INCL
  - 30 – 60 MIN. TEST TIME/DAY
- CONSTRUCTION ISSUES
  - EVAL DUAL BEAM ANT. ALIGN.
    - EVA MOUNTING OF FINAL SIZE ANT. ELEMENTS, 10 – 100 W OF RF PWR
    - C/O OF PRECURSOR SUBSYS
  - EVAL MAN IN EVA ASSY & ALIGN. ROLE
- TEST ISSUES
  - TRANSMIT TEST SIGNALS BETWEEN TEST SITES; C/O ALL LINKS
  - PERFORM PWR DENSITY TEST ON ANIMAL & PLANT LIFE FUNCTIONS ON GROUND
  - CHECK FOR INTERFERENCE WITH ELECTROMECH DEVICES

GRUMMAN

PUBLIC SERVICE PLATFORM DEMONSTRATION

- MISSION
  - 1 YEAR MISSION
  - XMISSIONS BETWEEN 25 WIDELY DISTRIBUTED CONUS CITIES
  - BUILD IN LEO & XSPORT TO GSO (6 MONTHS)
  - TEST IN GSO ORBIT (6 MONTHS)
- CONST ISSUES (IN 100 - 200 N MI/28.5^{O} -50^{O} ORBIT)
  - PERFORM FIXED MULTIBEAM (25 CHANNELS) ANT. ALIGN. (7.5 - 75 KW RF PWR)
  - SCALE MODEL (25 - 150 KW RAW PWR) OF OP SYS
  - EVA CHECK OF MAINT & REPAIR PROCEDURES
- TEST ISSUES (IN GEOSTA ORBIT)
  - TRANSMIT SIGNALS BETWEEN 25 PAIRS OF CONUS CITIES, C/O ALL LINKS
  - VERIFY SAFETY OF PWR DENSITY ON ANIMAL & PLANT LIFE, AS WELL AS INTERFERENCE WITH ELECTROMECH DEVICES
  - EVAL EFFECTS OF ORBITAL PERTURB. & ASSIGNED LOC DRIFT



GRUMMAN

CONCLUSIONS

PRESENT CONCEPT FOR PUBLIC SERVICE PLATFORM

- MAXIMIZES BENEFIT-TO-COST RATIO BY HARDWARE COMMONALITY
  - THREE ANTENNAS FOR MANY FUNCTIONS
  - ALL FUNCTIONS SHARE: ATTITUDE CONTROL; POWER; STATION-KEEPING; TRACKING, TELEMETRY & CONTROL SUBSYSTEMS.
  - RESUPPLY EASED BY SINGLE RENDEVOUS & DOCK: MINIMUM G&N AND ΔV REQUIREMENTS
- UTILIZES ADVANTAGES OF SPACE STATION
  - CONSTRUCTION OF LARGE SPACE STRUCTURE
  - MAN'S ROLE IN HARDWARE MAINTENANCE, REPAIR, & UPGRADING
- REDUCES CROWDING OF GEOSTATIONARY CORRIDOR
- PERMITS ADDITIONAL FUNCTIONS THROUGH MODULAR DESIGN APPROACH

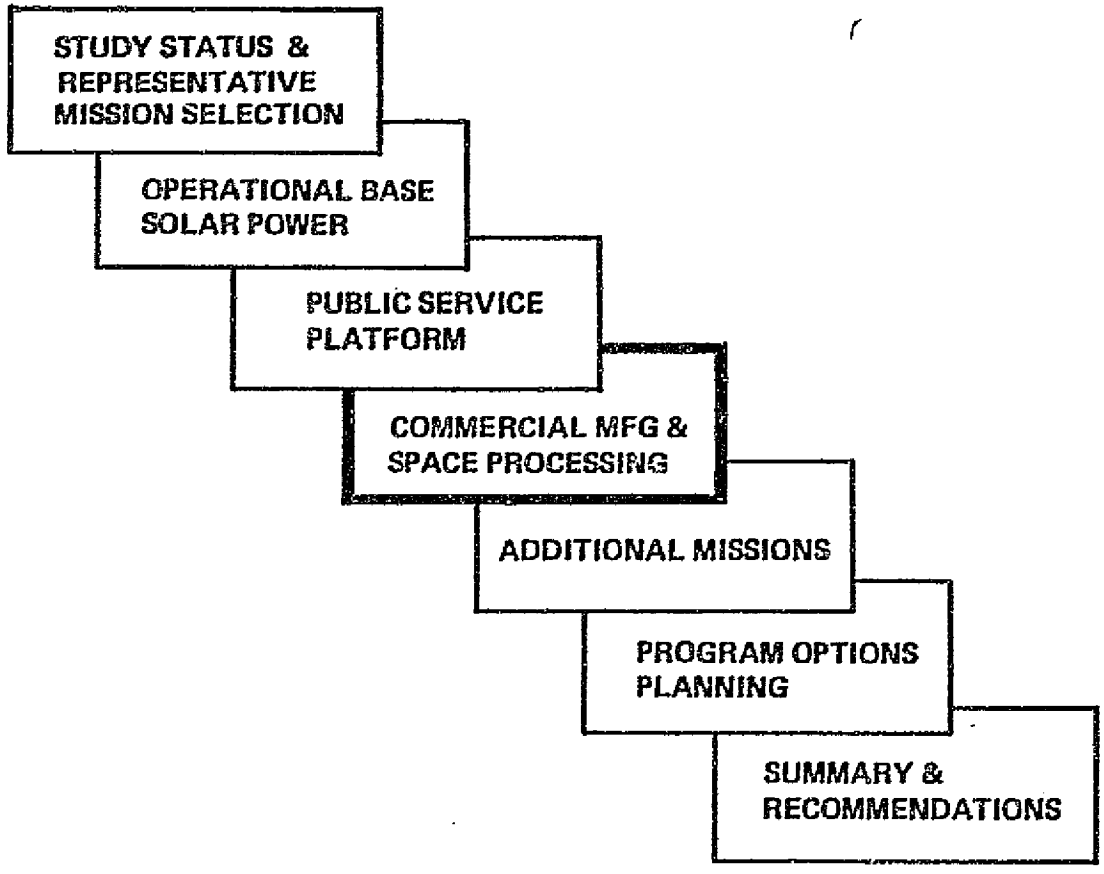
GRUMMAN

WHAT NEXT?

- IDENTIFY IN GREATER DEPTH USER REQUIREMENTS FOR EACH PSP FUNCTION
- PERFORM ANTENNA TRADE & SELECTION STUDY
- FURTHER DEFINE & REFINE SPACE STATION REQUIREMENTS FOR PSP

GRUMMAN

SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



OBJECTIVES

- DEVELOP PROMISING SPACELAB EXPERIMENTS
- ESTABLISH COMMERCIAL MANUFACTURING OPERATIONS ON SPACE STATION

GRUMMAN

REPRESENTATIVE MANUFACTURING OPERATIONS

- PHOTOVOLTAIC SOLAR CELLS
- PHARMACEUTICALS
- HIGH COERCIVE STRENGTH MAGNETS

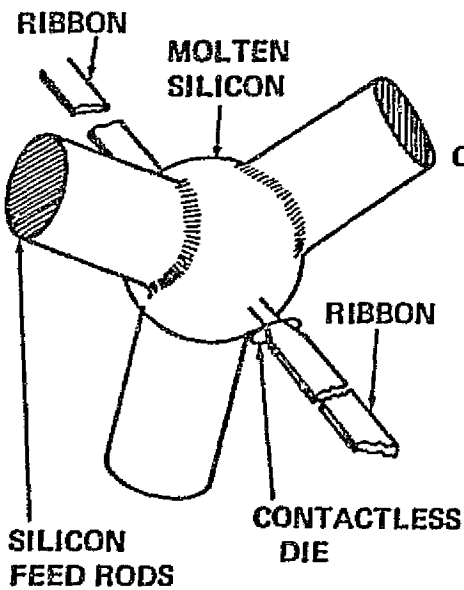
GRUMMAN

COMMERCIAL MANUFACTURING

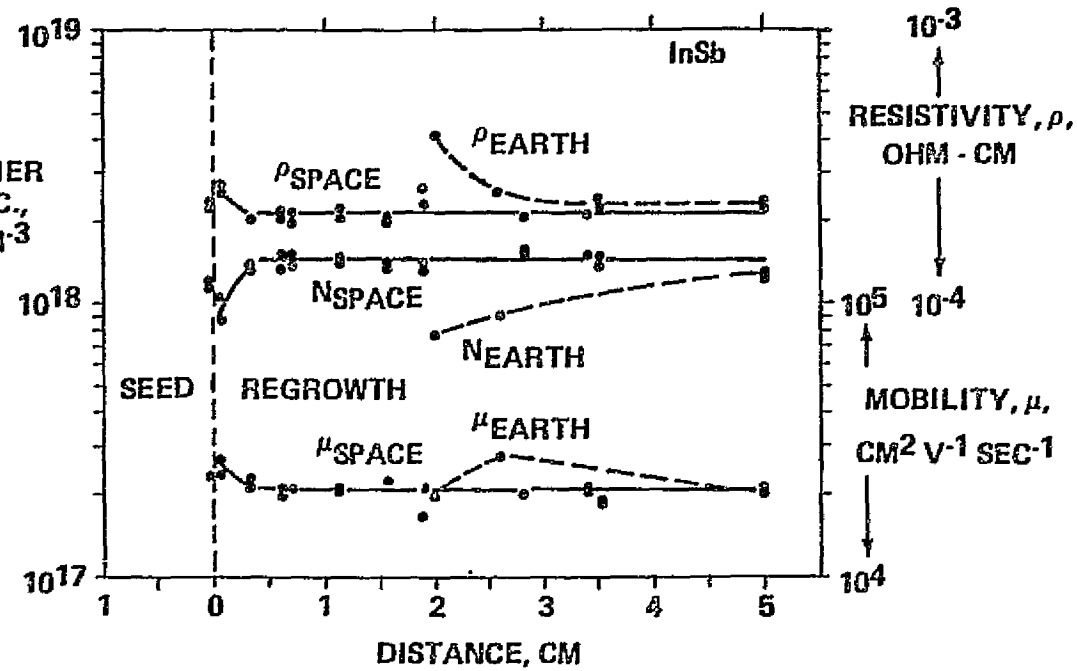
REPRESENTATIVE MISSION	PRODUCT	APPLICATION	WHY IN SPACE?	WHY ON SPACE STATION?
PHOTOVOLTAIC SOLAR CELLS (A.D. LITTLE)	SHEETS OR TUBES OF SINGLE CRYSTAL SILICON (TYCO/ MOBIL) (GE) (A.D. LITTLE)	1. PWR FOR OTHER OPS 2. DEVEL OF SPACE SOLAR PWR	1. SHAPE CONTROL; INCR YIELD 2. ABSENCE OF CONVECTION; HIGHER QUALITY	1. POWER > 5.2 KW 2. WEIGHT > 9000 Kg 3. TIME > 30 DAY
PHARMACEUT-ICALS (A. D. LITTLE)	ANTIBIOTICS, HUMAN HORMONES, GENES ENZYMES	1. CURATIVES FOR ULCERS, BURNS & HEREDITARY DISEASE 2. IMPROVED DIAG-NOSTICS 3. COMMERCIAL PRODUCTS	1. ABSENCE OF SEDIMENTATION; INCREASED YIELD & PURITY	1. TIME > 30 DAYS 2. POWER > 5.2 KW 3. WEIGHT > 9000 Kg
HIGH COERCIVE STRENGTH MAGNETS (GRUMMAN)	MAGNET ALLOYS	1. MICROWAVE TUBES 2. MOTOR BEARINGS 3. LEVITATORS FOR XPORTATION 4. COMMERCIAL PRODUCTS	1. ABSENCE OF CONVECTION; INCR QUALITY 2. ABSENCE OF SEDIMENTATION; INCR PERFOR-MANCE	1. POWER > 5.2 KW 2. WEIGHT > 9000 3. TIME > 30 DAYS

PHOTOVOLTAIC SOLAR CELLS – WHY DO IT IN SPACE?

- ABSENCE OF GRAVITY ELIMINATES, DIE, INCREASES YIELD



- ABSENCE OF CONVECTION ELIMINATES DEFECTS IMPROVES QUALITY

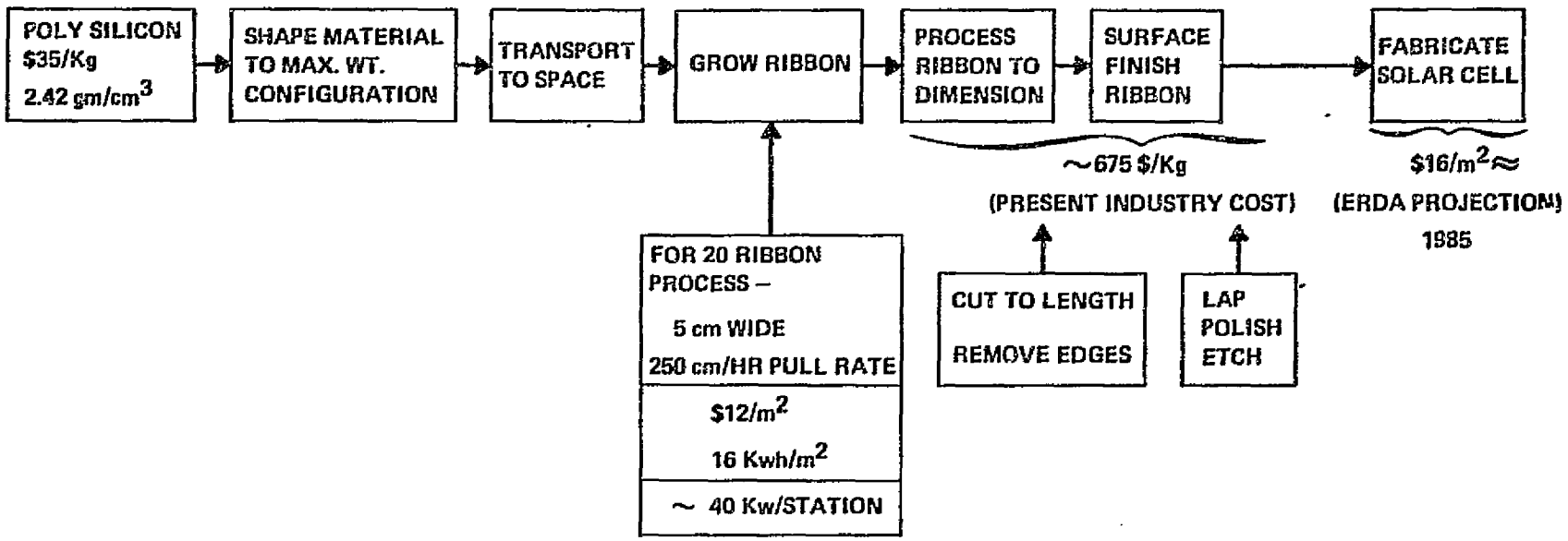


SKYLAB M562 (MIT)

GRUMMAN

PHOTOVOLTAIC SOLAR CELLS (CONT)

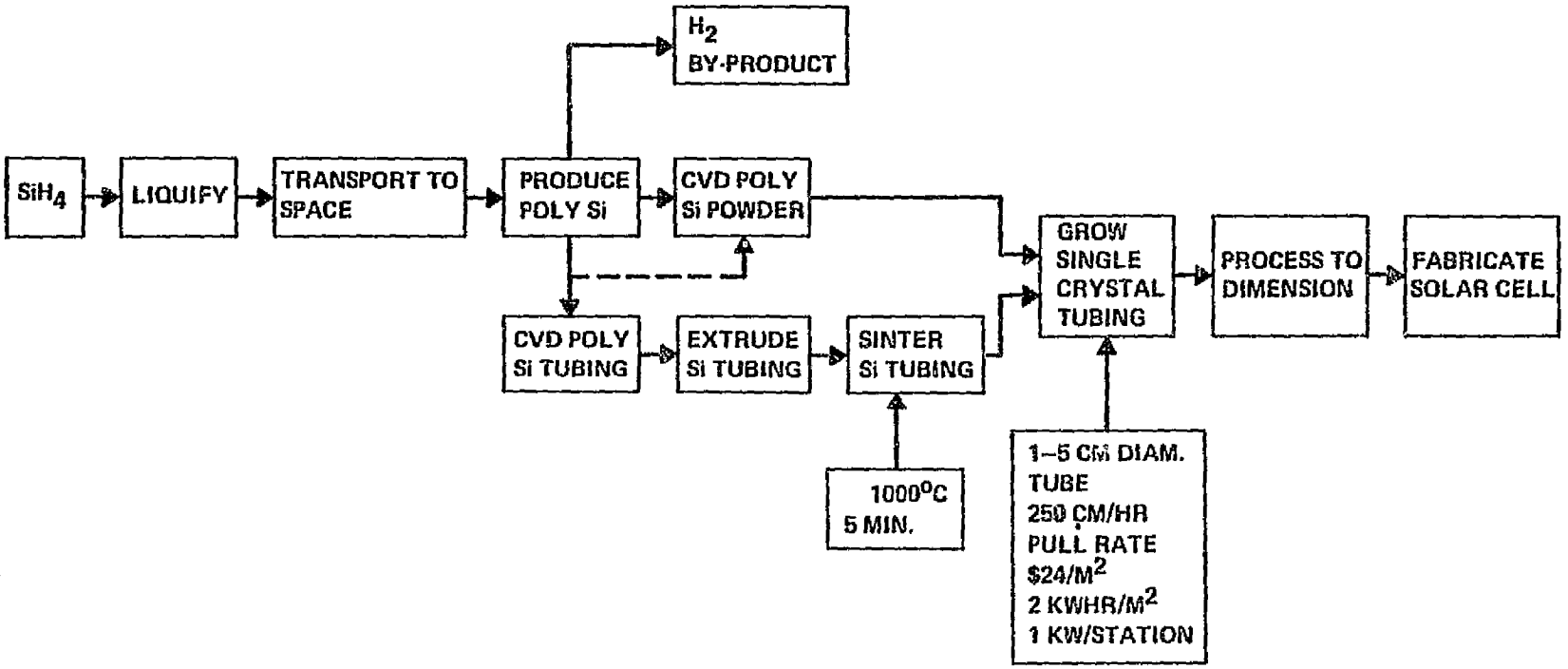
- TYCO/MOBIL – EDGE DEFINED/FILM GROWTH PROCESS



GRUMMAN

PHOTOVOLTAIC SOLAR CELLS

- A. D. LITTLE TUBE PROCESS

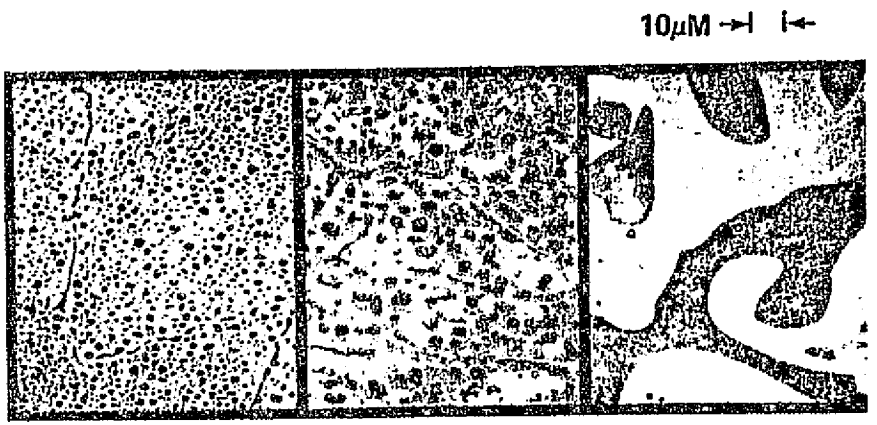


PHARMACEUTICALS – WHY DO IT IN SPACE?

- NEAR ZERO-GRAVITY
  - REFINES DISPERSION
  - ELIMINATES CONTACT INHIBITION
  - ELIMINATES SEDIMENTATION

→

- INCREASED
  - YIELD
  - QUALITY



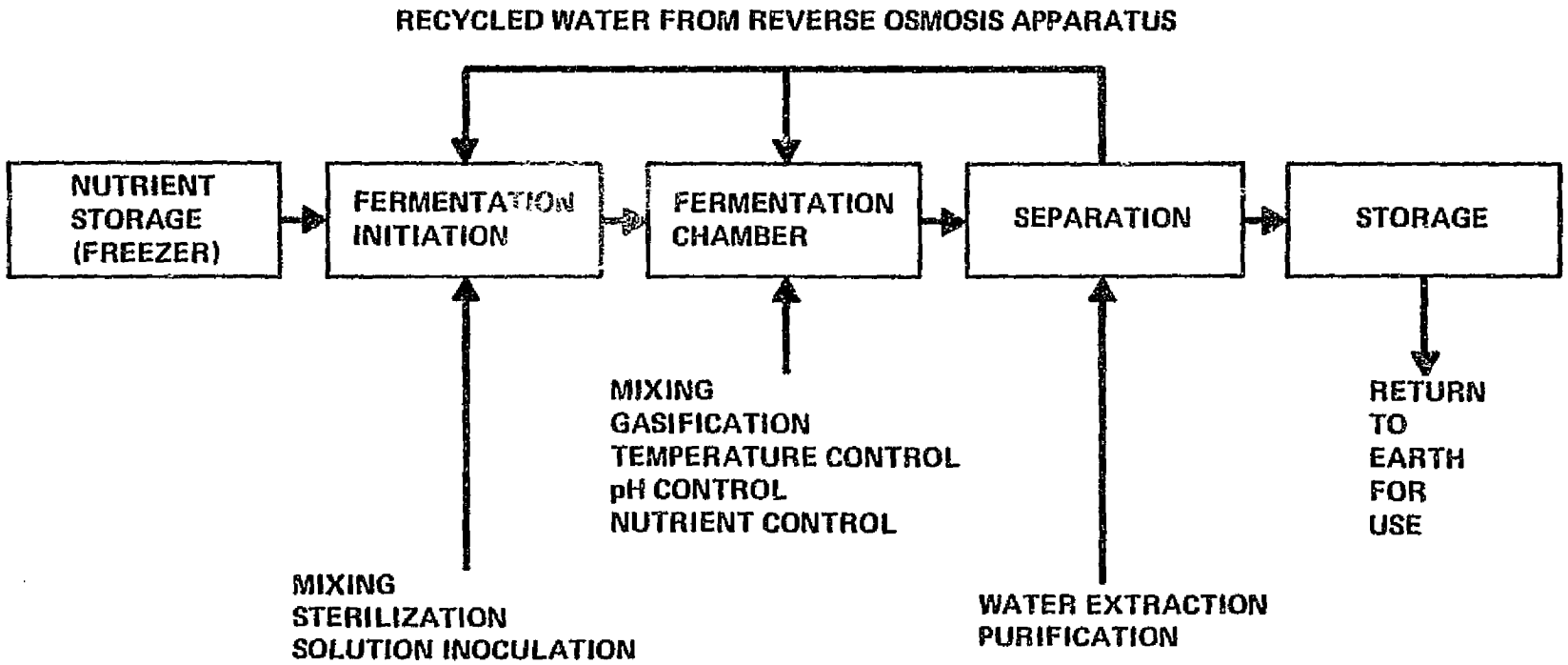
(A) 0-g (B) 0-g (C) 0-g

ANALOG FROM SKYLAB M557 USING
GALLIUM - BISMUTH ALLOYS (TRW)

GRUMMAN

PHARMACEUTICALS

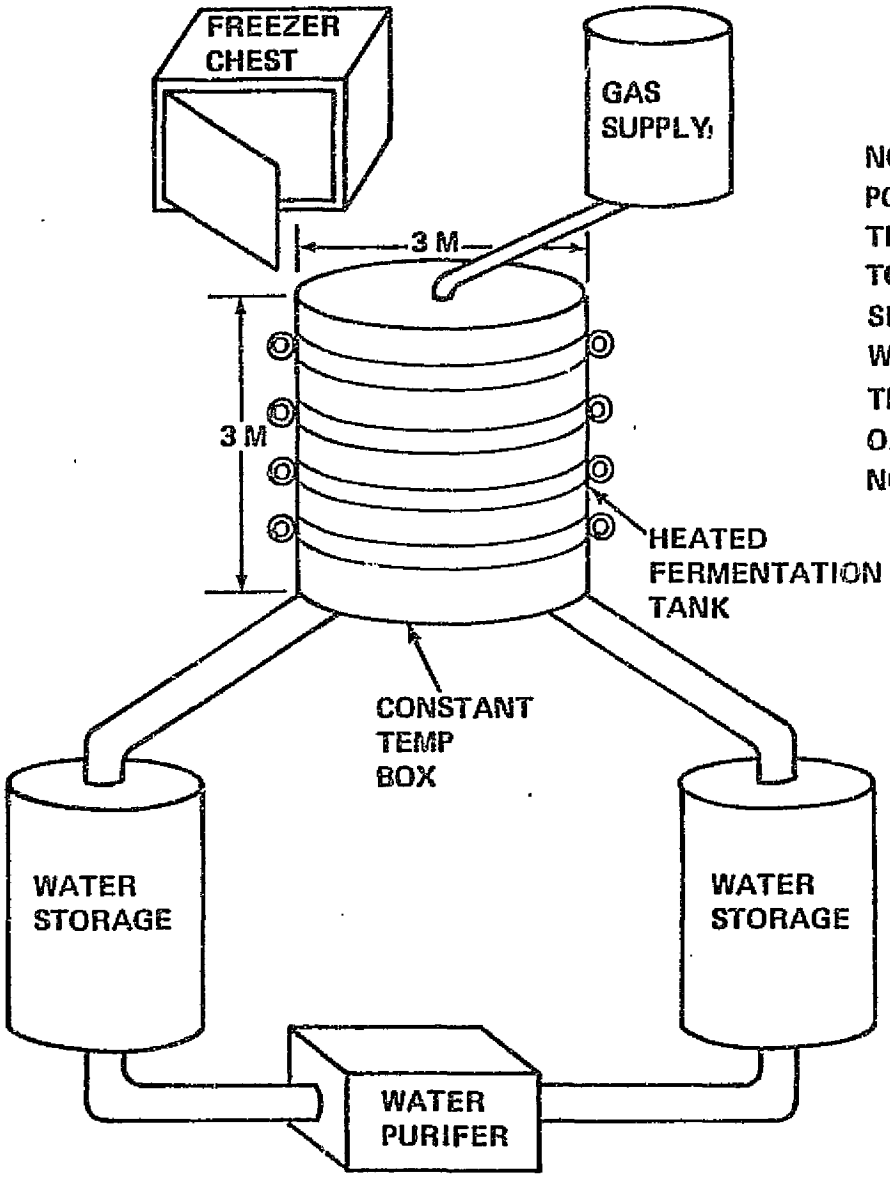
FERMENTATION PROCESSING OF MICROBIAL PRODUCTS



GRUMMAN

PHARMACEUTICALS

CONCEPT



REQUIREMENTS

NO. UNITS	1
POWER	70 KW
TIME	<60 DAYS
TOTAL ENERGY	100×10^3 KWHR
SIZE	10 x 10 x 3 M
WEIGHT	$4X10^4$ Kg
THROUGHPUT	BATCH
ORBIT	LEO
NO. OPERATORS	2

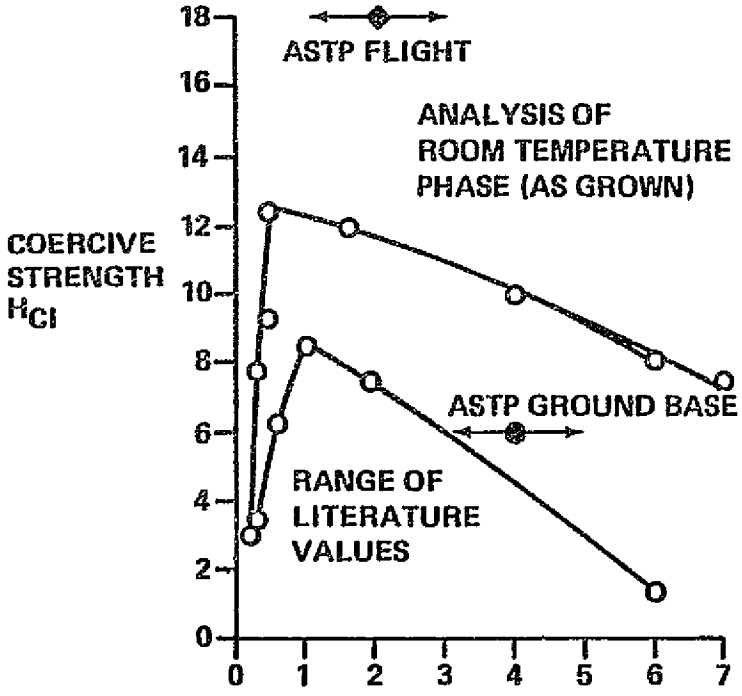
GRUMMAN

HIGH COERCIVE STRENGTH MAGNETS – WHY DO IT IN SPACE?

- SIGNIFICANT IMPROVEMENTS IN MAGNETIC PROPERTIES RESULT FROM LOW-G SOLIDIFICATION

COERCIVE STRENGTH OF ROOM TEMPERATURE PHASE VS PARTICLE SIZE

- Mn Bi/Bi EUTECTIC



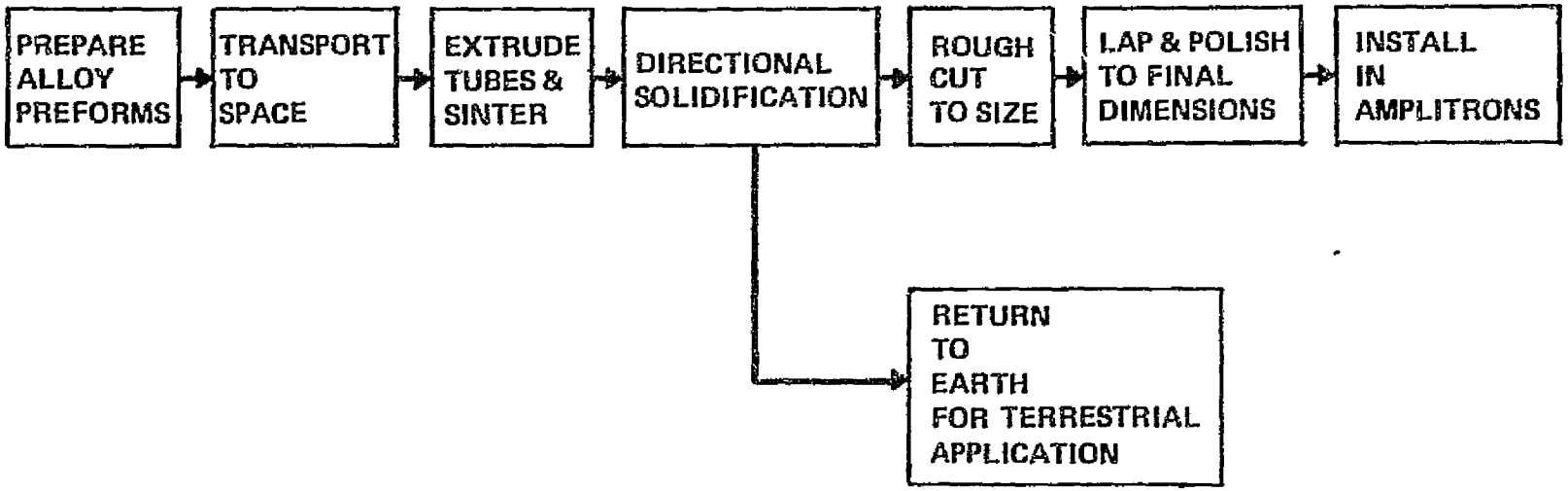
- LOW TEMPERATURE PHASE

MATERIAL	COERCIVE STRENGTH (K Oe)
AS-GROWN ASTP FLIGHT SAMPLES	135 148.75 >150
BEST VALUES REPORTED FOR HEAT-TREATED ALLOY SYSTEM SAMPLES	113
HEAT-TREATED ASTP FLIGHT SAMPLES	>185

ASTP MA-070, DIRECTIONAL SOLIDIFICATION OF Mn Bi/Bi EUTECTICS (GRUMMAN)

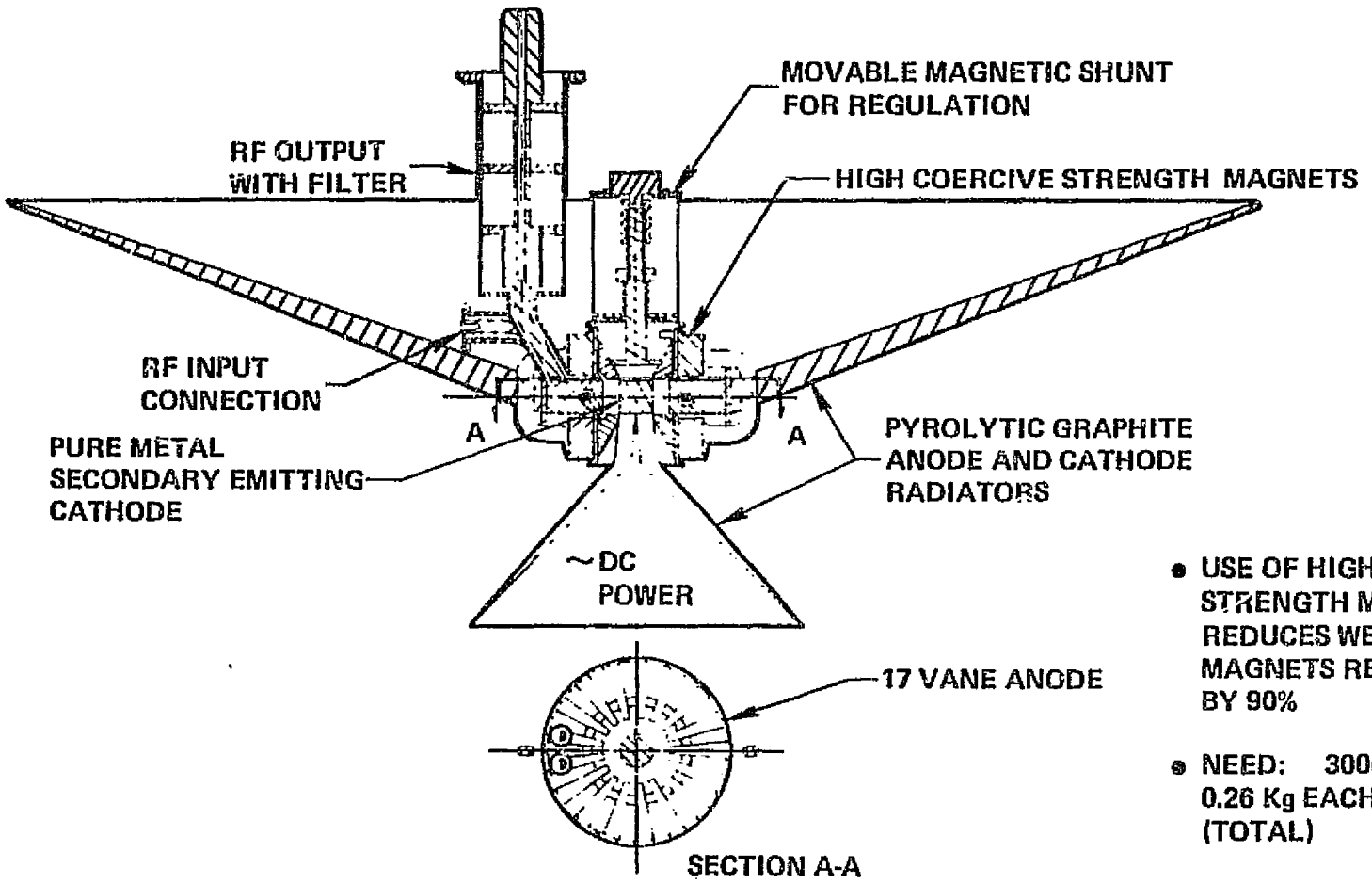
GRUMMAN

HIGH COERCIVE STRENGTH MAGNETS – DIRECTIONAL SOLIDIFICATION



GRUMMAN

USE OF MAGNETS IN AMPLITRON MICROWAVE TUBES FOR 90 X 90 M MICROWAVE ANTENNA



AMPLITRON ASSEMBLY

- USE OF HIGH COERCIVE STRENGTH MAGNETS REDUCES WEIGHT OF MAGNETS REQUIRED BY 90%
- NEED: 3000 MAGNETS 0.26 Kg EACH; 800 Kg (TOTAL)

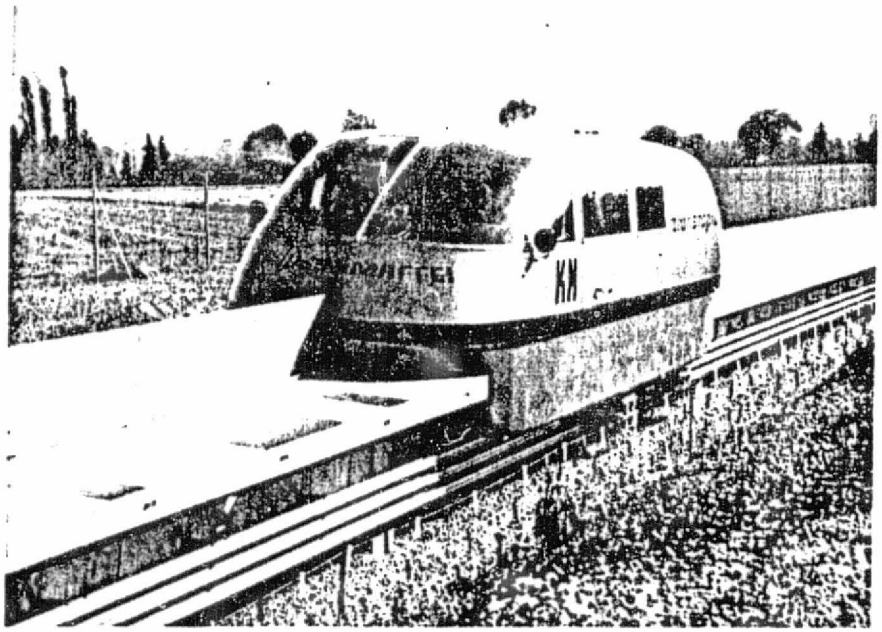
REF: RAYTHEON

GRUMMAN

ORIGINAL PAGE IS OF POOR QUALITY

COMMERCIAL APPLICATIONS OF HIGH COERCIVE STRENGTH MAGNETS

- LEVITATED TRANSPORTATION SYSTEM



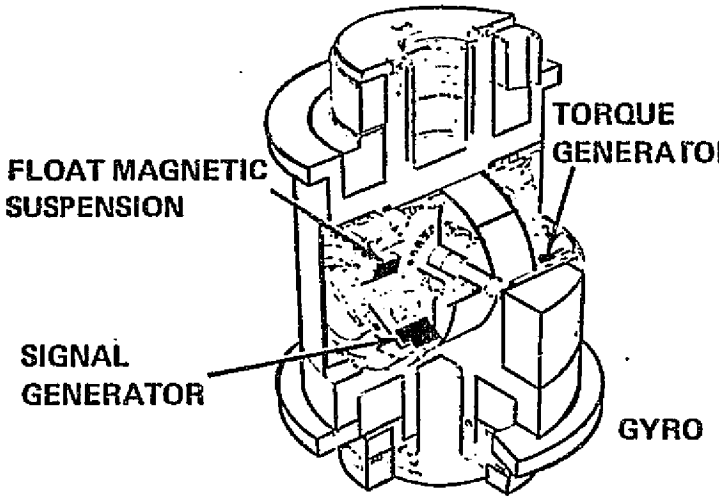
- UNDER DEVELOPMENT IN FRG
- USES ONLY 10% OF THE POWER OF AIR CUSION VEHICLES
- NO CRYOGENS REQUIRED
- REQUIRES 1 - 10 gm MAGNET/ 1 Kg VEHICLE WEIGHT*

*REF: K. J. KRONENBERG, INTERMAG 1973

GRUMMAN

COMMERCIAL APPLICATIONS OF HIGH COERCIVE STRENGTH MAGNETS

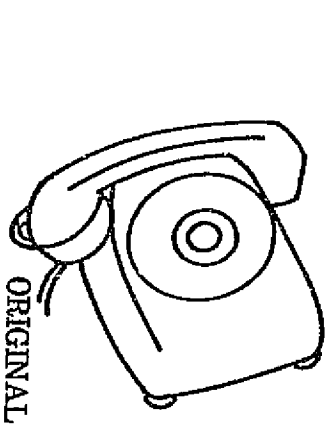
- CONSUMER PRODUCTS



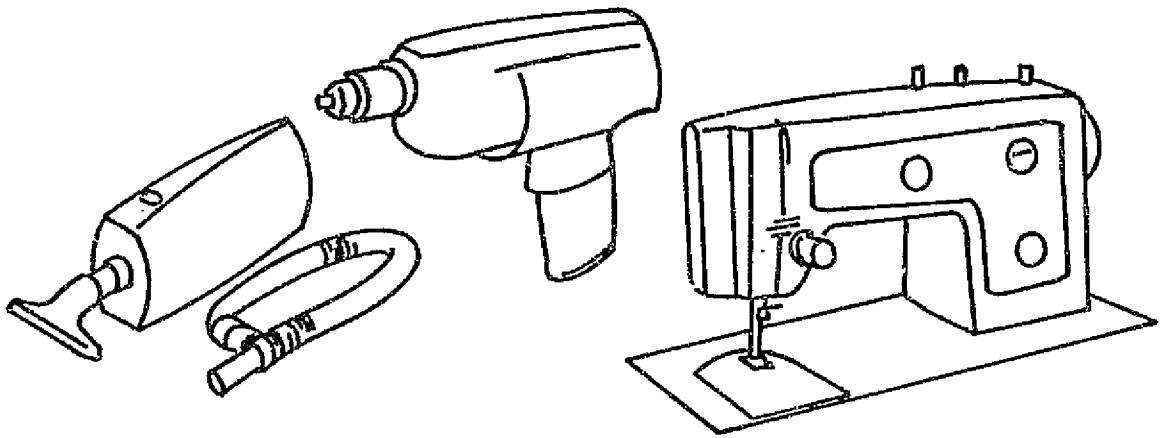
AEROSPACE INSTRUMENTS

- INCREASED RELIABILITY
- MORE EFFICIENT (USES LESS POWER)
- REDUCED COSTS
- 1 gm REPLACES 4 gm CONVENTIONAL MAGNETS*

* REF: J. E. GOULD, COBALT, NO. 55, (6/72)



BUSINESS SERVICES

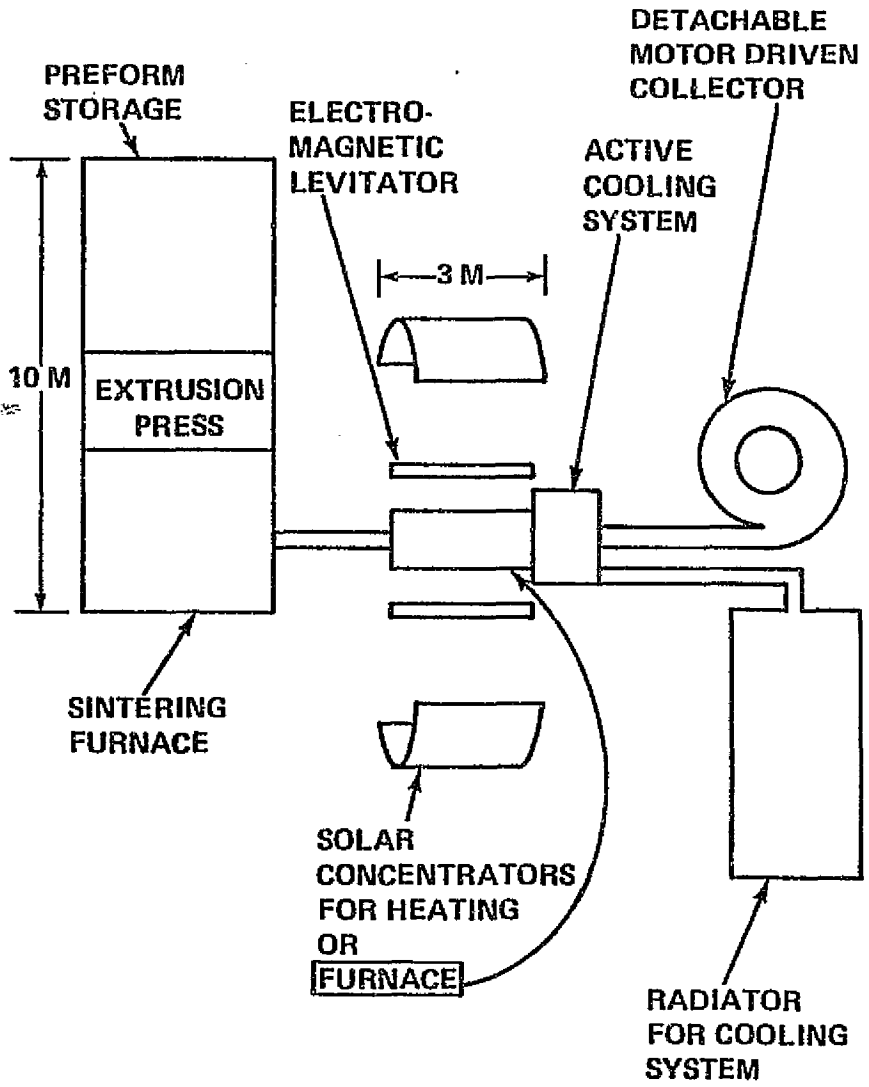


HOME PRODUCTS

GRUMMAN

HIGH COERCIVE STRENGTH MAGNETS

CONCEPT



REQUIREMENTS
(FOR 90 x 90 M MICROWAVE ANTENNA)

NO. UNITS	1
POWER	~20 KW
TIME	6 MONTHS
TOTAL ENERGY	90×10^3 KWhR
SIZE	10 x 10 x 3 M
WEIGHT	4×10^4 Kg
THROUGHPUT	~ .25 Kg/HR
ORBIT	LEO/SUN SYNCHRONOUS
NO. OPERATORS	3

GRUMMAN

MANUFACTURING OPERATIONS – DEVELOPMENT PROGRAM REQUIREMENTS

MISSION	GROUND BASED	SPAR	SPACELAB	EARLY SPACE STATION
PHOTOVOLTAIC SOLAR CELLS	1. PROCESS OPTIM 2. HARDWARE DEVEL 3. COST/BENEFITS	1. ID OF LOW-G EFFECTS 2. CONCEPT VERIF 3. HARDWARE C/O	1. PARAMETER OPTIM 2. PROCESS SELECTION 3. PILOT PLANT	1. OPTIM OF CONTINUOUS PROCESSING TECHNIQUES 2. PACKAGING OPS 3. DEPLOYMENT & EVAL
PHARMACEUTICALS	1. SELECTION OF MATS. 2. HARDWARE DEVEL 3. COST/BENEFITS	1. RESEARCH ON – SEDIMENT. – BUBBLE STAB. – CHEMICAL STAB.	1. FEASIBILITY 2. PROCESS OPTIM 3. EFFECT OF RAD. 4. PILOT PLANT	1. SCALE UP 2. EVAL OF MATERIALS
HIGH COERCIVE STRENGTH MAGNETS	1. ANAL. OF MATS. & PROCESSES 2. SCREENING OF MATS. 3. HARDWARE DEVEL 4. COST/BENEFITS	1. ID REASON FOR PROPERTY IMPROVEMENT 1. EVAL MATS. & PROCESS PARAM 3. SELECT CANDIDATES FOR FURTHER STUDY	1. PARAMETER OPTIM 2. PROCESS SELECTION 3. PRELIM DEVEL OF CONTINUOUS PROCESS 4. PILOT PLANT	1. OPTIM OF CONT PROCESSING TECHNIQUES 2. PACKAGING OPS 3. ASSY INTO AMPLITRONS & EVAL

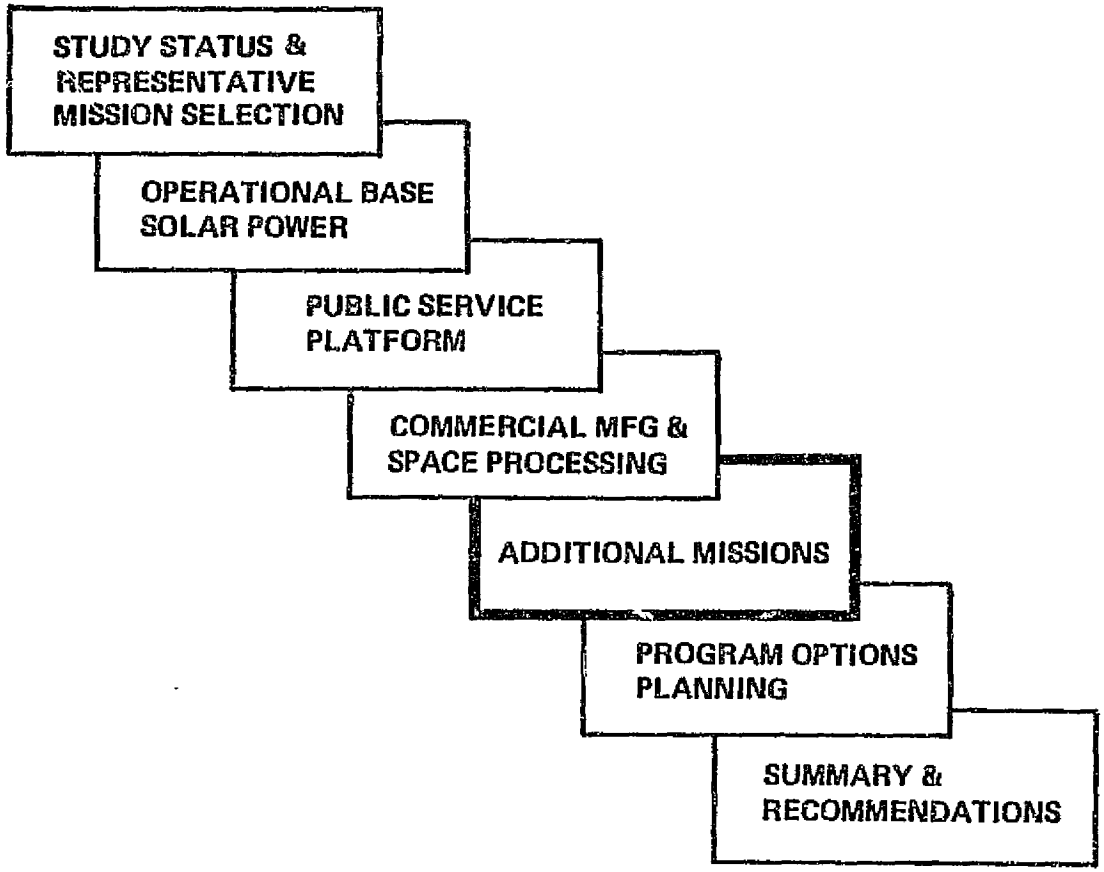
GRUMMAN

WHAT'S NEXT?

- QUANTITATIVE COST/BENEFITS ANALYSIS FOR REPRESENTATIVE MISSIONS
  - PHOTOVOLTAIC SOLAR CELLS (ADL)
  - PHARMACEUTICALS (ADL)
  - HIGH COERCIVE STRENGTH MAGNETS (GRUMMAN)
- IDENTIFY MAN'S ROLE
- DEFINE TECHNOLOGICAL BARRIERS TO IMPLEMENTATION
- IDENTIFY OTHER MISSIONS WITH POTENTIAL EARLY & LARGE PAYBACKS

GRUMMAN

SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



LIFE SCIENCE MISSION SELECTION

- BODY FLUID, BLOOD VOLUME DISTRIBUTION/ELECTROLYTE METABOLISM
  - MISSION WILL ENCOMPASS FIVE EXPERIMENTS (52 TOTAL)
- CARDIOVASCULAR FUNCTION, HEMODYNAMICS, HEMATOLOGY
  - MISSION WILL ENCOMPASS FOUR EXPERIMENTS
- VESTIBULAR FUNCTION
  - MISSION WILL ENCOMPASS THREE EXPERIMENTS
- ADDITIONAL 6 TO 8 MISSIONS TO BE DEFINED
- FINAL MISSION SELECTION STILL TO BE ACCOMPLISHED

GRUMMAN

BASIS FOR MISSION DEFINITION

- STUDY OF PHYSIOLOGICAL MECHANISMS, BIOLOGICAL PROCESSES & ADVANCED SYSTEMS THAT CAN IMPROVE THE QUALITY OF LIFE ON EARTH
  - EMPHASIS ON THE ROLE OF GRAVITY IN LIFE PROCESSES, NORMAL & ABNORMAL
  - EMPHASIS ON MECHANISMS OF BIORHYTHMS
- STUDY PROBLEMS IDENTIFIED AND/OR VERIFIED ON PREVIOUS MISSIONS THAT ARE OF POTENTIAL CONCERN TO MAN & ARE MAIN BIOMEDICAL & BIOLOGICAL DRIVERS FOR SPACE STATION
  - CREW WELL-BEING & EFFECTIVENESS IN ZERO G AND POST FLIGHT G
  - PHYSIOLOGICAL MECHANISMS ASSOCIATED WITH PROBLEMS
  - DETERMINATION OF PHYSIOLOGICAL LIMITS & TOLERANCE
  - EVALUATION OF COUNTERMEASURES

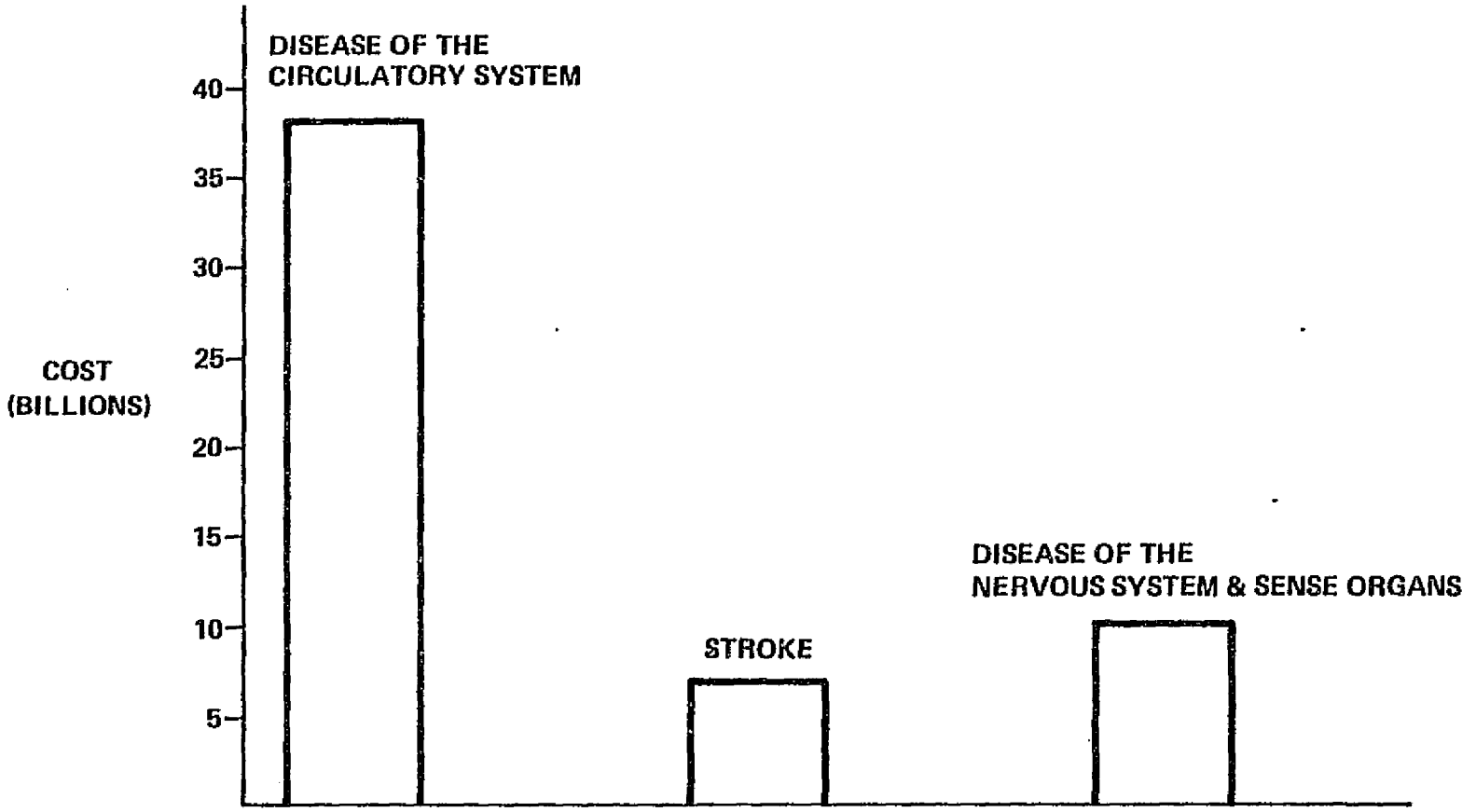
GRUMMAN

NEED FOR IMPROVED QUALITY OF LIFE

- ONE-HALF OF ALL DEATHS & ONE-THIRD OF LOST YEARS & EARNINGS ARE CAUSED BY SOME TYPE OF CIRCULATORY SYSTEM DISEASE.
- CIRCULATORY SYSTEM DISEASE EXPENDITURES COMPRISE 21% OF TOTAL COST FOR ALL ILLNESS.
- 15.5% OF ALL CIRCULATORY SYSTEM DISEASES IS ATTRIBUTABLE TO STROKE
- STROKE EFFECTS 586,000 PEOPLE. THE COST TO SOCIETY FOR EACH STROKE VICTIM IS $10,580

GRUMMAN

COST OF ILLNESS TO SOCIETY



GRUMMAN

DEFINED MISSION GROUPS

- BODY FLUID, BLOOD VOLUME DISTRIBUTIONS & ELECTROLYTE METABOLISM
- CARDIOVASCULAR FUNCTION, HEMODYNAMICS, HEMATOLOGY
- VESTIBULAR FUNCTION

GRUMMAN

BODY FLUID, BLOOD VOLUME DISTRIBUTION

- HUMAN STUDIES
  - BODY FLUID LOSS VS EXPOSURE TO ZERO G
  - CHANGE IN VOLUME OF BODY FLUID COMPONENTS
  - HORMONAL CHANGES & THEIR EFFECTS ON FLUID & ELECTROLYTE SHIFTS IN ZERO G
  - EVALUATION OF COUNTERMEASURES FOR MINIMAL LOSS
- ANIMAL STUDIES
  - SMALL MAMMALIAN EXPERIMENTS TO MEASURE ABSOLUTE RELATIONSHIP BETWEEN LENGTH OF EXPOSURE TO ZERO G & FLUID SHIFTS
  - EVALUATION OF GAUER-HENRY REFLEX IN PRIMATES
- CELL/TISSUE STUDIES
  - STUDY OF ZERO G OR MINIMAL METABOLISM IN HUMAN CELLS & TISSUES

GRUMMAN

CARDIOVASCULAR FUNCTION, HEMODYNAMICS & HEMATOLOGY

- HUMAN STUDIES
  - CARDIOGRAPHIC CHANGES WITH HEMODYNAMIC EVENTS & FLUID SHIFTS
  - PROCEDURE TO EVALUATE THE CARDIOVASCULAR SHIFTS
  - VENOUS COMPLIANCE
  - COUNTERMEASURE
- ANIMAL STUDIES
  - USE OF MONKEY PODS FOR CARDIOVASCULAR STUDIES – CORRELATION WITH CARDIAC OUTPUT WITH CENTRAL NERVOUS PRESSURE

GRUMMAN

VESTIBULAR FUNCTION

- HUMAN STUDIES
  - RELATIONSHIP BETWEEN VESTIBULAR REFLEX EFFECTS IN ZERO G & ONSET OF MOTION SICKNESS
  - TEST OF INFLIGHT SPACE NAUSEA COUNTERMEASURES
  - RELATIONSHIP BETWEEN VESTIBULAR EFFECTS & HEADWARD FLUID SHIFTS IN ZERO G
- ANIMAL STUDIES
  - VESTIBULAR FUNCTION & ADAPTIVE MECHANISM IN PRIMATES IN ZERO G

GRUMMAN

OBJECTIVES FOR LIFE SCIENCES MISSION SELECTION

- USE UNIQUE PROPERTIES OF SPACE ENVIRONMENT TO IMPROVE OUR UNDERSTANDING OF LIFE PROCESSES ON EARTH (ZERO G, BIORHYTHMS, RADIATION)
- PROVIDE LIFE SCIENCE INFORMATION & TECHNOLOGY TO SAFELY EXTEND DURATION OF MANNED SPACE FLIGHT
- ENHANCE MAN'S WELL BEING & PRODUCTIVITY IN SPACE

GRUMMAN

CORE CONCEPT (COMMON OPERATION RESEARCH EQUIPMENT)

- CORE (ITEMS) FOUND THEIR DEVELOPMENT & FUNCTIONALITY IN SPACELAB STUDIES
- REGULAR CORE (PERMANENT)
  - EQUIPMENT ITEMS: BROAD USAGE, MANY RESEARCH AREAS
- INTERMITTENT CORE (SEMIPERMANENT)
  - EQUIPMENT ITEMS: RESTRICTED TO ONE RESEARCH AREA
- PI
  - EQUIPMENT ITEMS: SPECIFIC FOR ONE RESEARCH ACTIVITY FURNISHED BY PRINCIPLE INVESTIGATOR (PI)

GRUMMAN

CHARACTERISTICS OF CORE

REGULAR CORE	INTERMITTANT CORE	TOTAL CORE
POWER – 4217 WATTS	2449 WATTS	6666 WATTS
WEIGHT – 698.2 Kg	1424 Kg	2122 Kg
SIZE – 1937 M^3	14,854 M^3	16,791 M^3

TOTAL COST IN '75 DOLLARS: $18,000 K

GRUMMAN

REPRESENTATIVE MISSION EQUIPMENT CHARACTERISTICS

ITEM	MISSION		
	BODY FLUID	CARDIO VASCULAR	VESTIBULE
REGULAR CORE	YES	YES	YES
INTERMITTENT CORE	YES	YES	YES
PRINCIPAL INVESTIGOR	TBD	TBD	TBD
POWER WATTS	6269	5758	2261
WEIGHT, Kg	2788	3673	915.
SIZE M^3	27021	31537	8605
ORBIT	LEO	LEO	LEO
COST ('75$)	3547 K	4830 K	2207 K
CORE COST (%)	'83-'88	'83-'88	'83-'88

ADDITIONAL DATA TO BE DEFINED: COOLING, CONTROL, THROUGHPUT, LIFE DDT&E COSTS

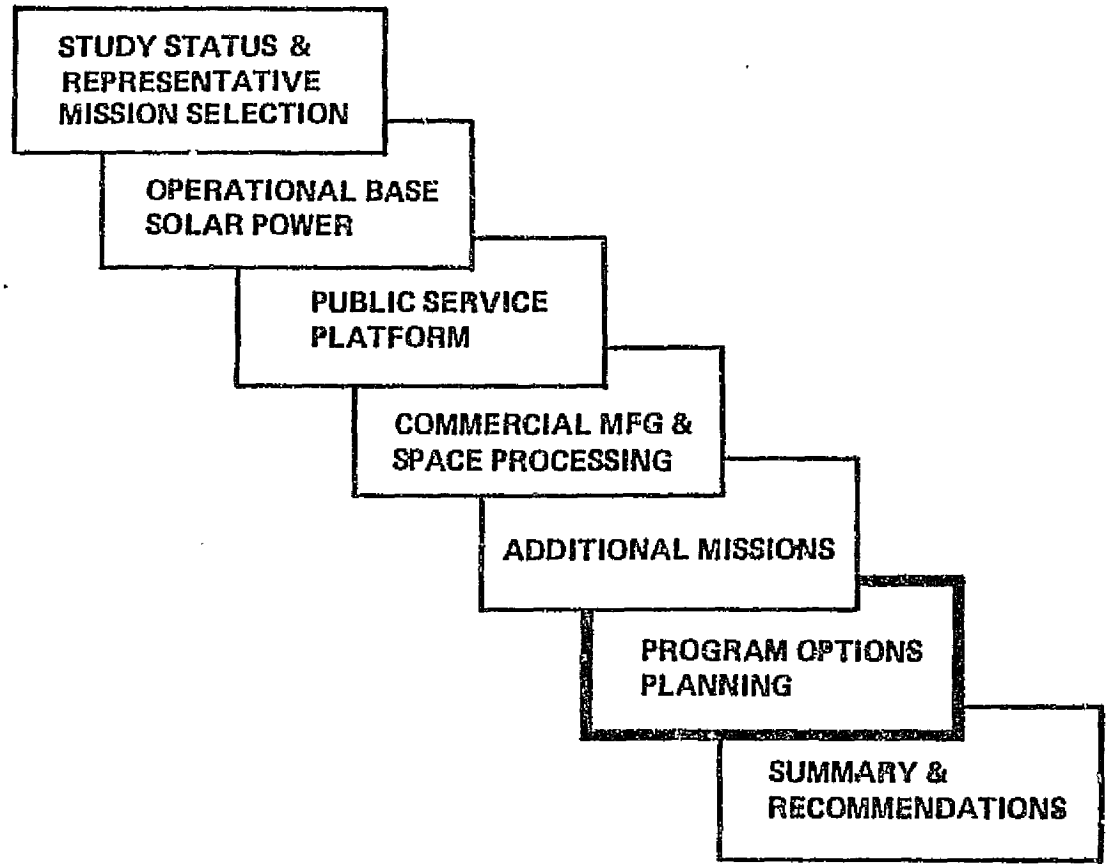
GRUMMAN

WHAT NEXT?

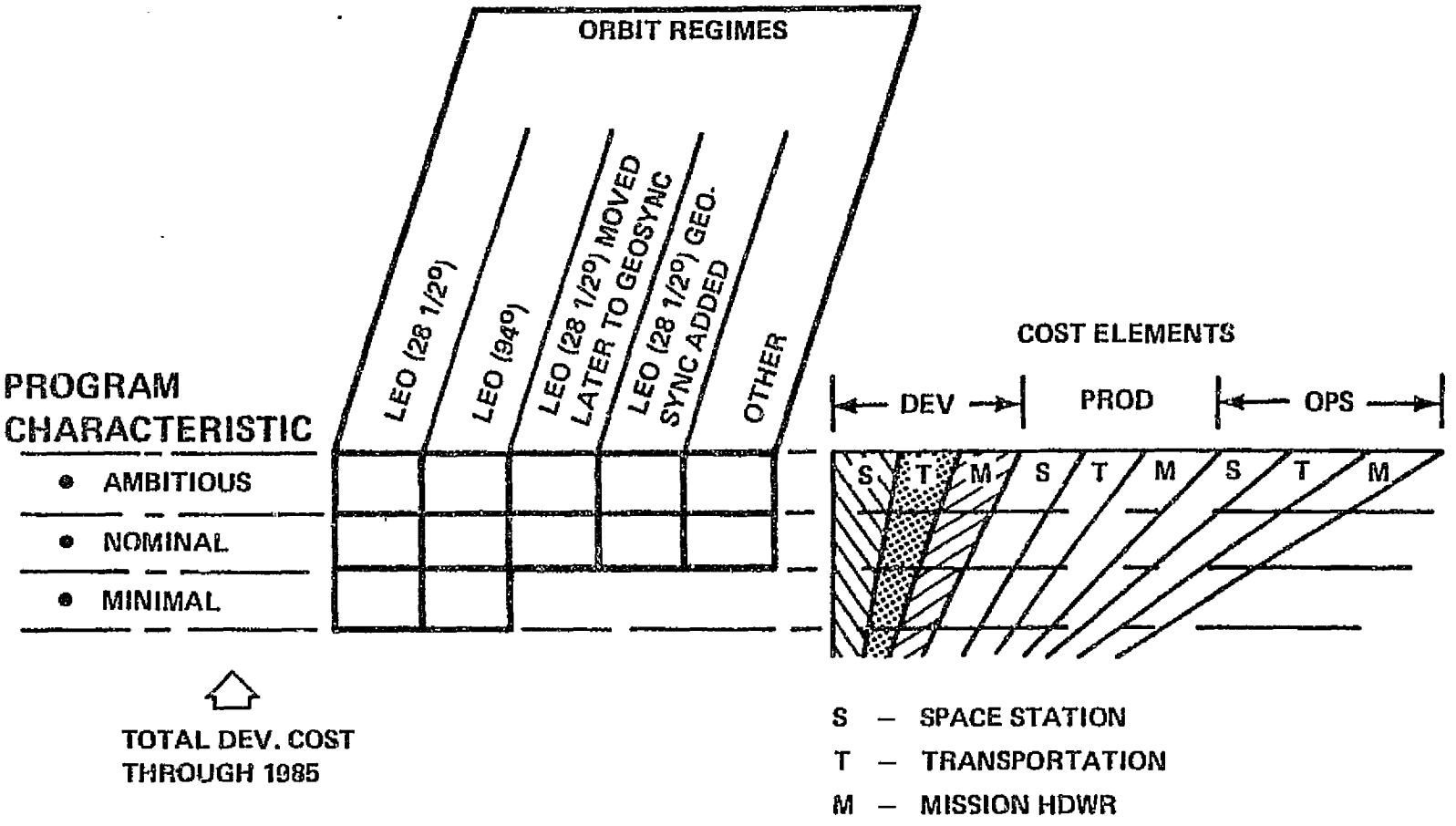
- CONTINUE MISSION GROUP DEFINITION
- SELECT REPRESENTATIVE MISSION GROUPS
- ESTIMATE TOTAL CORE COST FOR EACH MISSION GROUP SELECTED
- COST/BENEFIT FOR SELECTED MISSIONS - QUALITY OF LIFE IS MAIN DRIVER

GRUMMAN

SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW



PROGRAM OPTION MATRIX



GRUMMAN

SSSA PROGRAM: MAJOR DISCRIMINATOR – "LEVEL OF GOVERNMENT INVOLVEMENT"

- CATEGORY 1:
  TECHNOLOGY R & D WITHOUT GOVT FEASIBILITY DEMO/ PRODUCTION COMMERCIALIZATION

- CATEGORY 2:
  TECHNOLOGY R & D PLUS GOVT DEMON OF COMMERCIAL FEASIBILITY, BUT WITHOUT GOVT PRODUCTION COMMERCIALIZATION

- CATEGORY 3:
  TECHNOLOGY R & D, FEASIBILITY DEMON & INITIAL PRODUCTION COMMERCIALIZATION BY GOVT

GRUMMAN

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR

MISSION	R & D TECHNOLOGY	
	PRECURSOR TECHNOLOGY	DEVELOPMENT LAB
1. SSPS	• EVAL SPACE MFG • C/O FAB. MACHINES • CHECKOUT WG FAB. TECH • TEST JOINT/STRUCT ALIGN. • EVAL MAN VS TELE-OP • TEST SOLAR ARRAY • C/O HI-VOLT. ELECT. • INVESTIGATE MATS. • TEST POINTING CONTROL • EVAL MICROWAVE EFFECTS ON IONOSPHERE	• C/O STRUCT JOINT INTEGRITY • EVAL STRUCT ALIGN ETC • EVAL LARGE STRUCT ASY/ MATING • TEST ARRAY/ANT. POINTING CONT. • TEST PWR CONVER EFFICIENCY • INVESTIGATE PWR XMISSION – BEAM PHASING/SIZE & INOSPHERE IMPACT

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR (CONT)

MISSION	FEASIBILITY DEMONSTRATION
	SPACE PILOT PLANT
1. SSPS (CONT)	• EVAL FULL-SCALE STRUCT JOINT INTEGRITY • EVAL LARGE ARRAY STRUCT ALIGN • EVAL TRANSPORT LEO/GEO • EVAL SUBASSY/FINAL ASSY MATING • TEST GEOSTAT POINTING CAP. • TEST PWR HANDLING • TEST STRUCT MATS INTEGRITY • EVAL FULL-SIZE ANT. • CHECK GROUND RAD. SAFETY • INVESTIGATE HI-PWR IONOSPHERE IMPACT

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR (CONT)

MISSION	PROTOTYPE/PRODUCTION
	SPACE PROTOTYPE PLANT
1. SSPS (CONT)	• VERIFY FULL-SCALE STRUCT ALIGN. • VERIFY FULL-SCALE LEO/GEO TRANSPORT • VERIFY SYS OPERATION • CONFIRM RAD. IONOSPHERE IMPACT PROJECTIONS • VERIFY PRODUCTION CONFIG

C-2

GRUMMAN

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR (CONT)

MISSION	R&D TECHNOLOGY	
	PRECURSOR TECHNOLOGY	DEVELOPMENT SATELLITE
2. PUBLIC SERVICE PLATFORM	• EVAL DUAL BEAM ANT. ALIGN. • EVAL MAN IN EVA ASSM & ALIGN. • TEST COMMUNICATION BETWEEN PAIRS OF TEST SITES • PERFORM POWER DENSITY TEST • CHECK ELECTRO-MECH DEV INTERFERENCE	• EVAL FIXED MULTIBEAM (25 CHANNELS) ANT. ALIGN. • EVAL FAB OF 1/20TH SCALE MODEL • EVAL EVA MAINT/REPAIR • TEST COMMUNICATION BETWEEN 25 PAIRS OF CONUS CITIES • VERIFY INTERFERENCE FREEDOM • EVAL ORBITAL PERTURBATIONS/DRIFT

GRUMMAN

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR (CONT)

MISSION	FEASIBILITY DEMONSTRATION
	DEMONSTRATION SATELLITE
2. PUBLIC SERVICE PLAT-FORM (CONT)	• EVAL LARGE STRUCT FAB. • VERIFY FIXED MULTIBEAM (100 CHANNELS) ANTENNA ALIGN. • C/O ANT./SOLAR PWR SYSTEMS • C/O XMISSION BETWEEN SINGLE STA IN EACH OF 100 CITIES • EST OP/MAINT REQMTS

GRUMMAN

PROGRAM SCENARIO – MAJOR PROGRAM DISCRIMINATOR (CONT)

MISSION	PROTOTYPE/PRODUCTION
	PROTOTYPE SATELLITE
2. PUBLIC SERVICE PLATFORM (CONT)	• EVAL FULL-SIZE STRUCT FAB. • VERIFY FIXED MULTIBEAM (1000 CHANNELS) ANT. ALIGN. • C/O OPERATIONAL SYS • C/O XMISSION BETWEEN 1000 AREAS • VERIFY PRODUCTION CONFIG

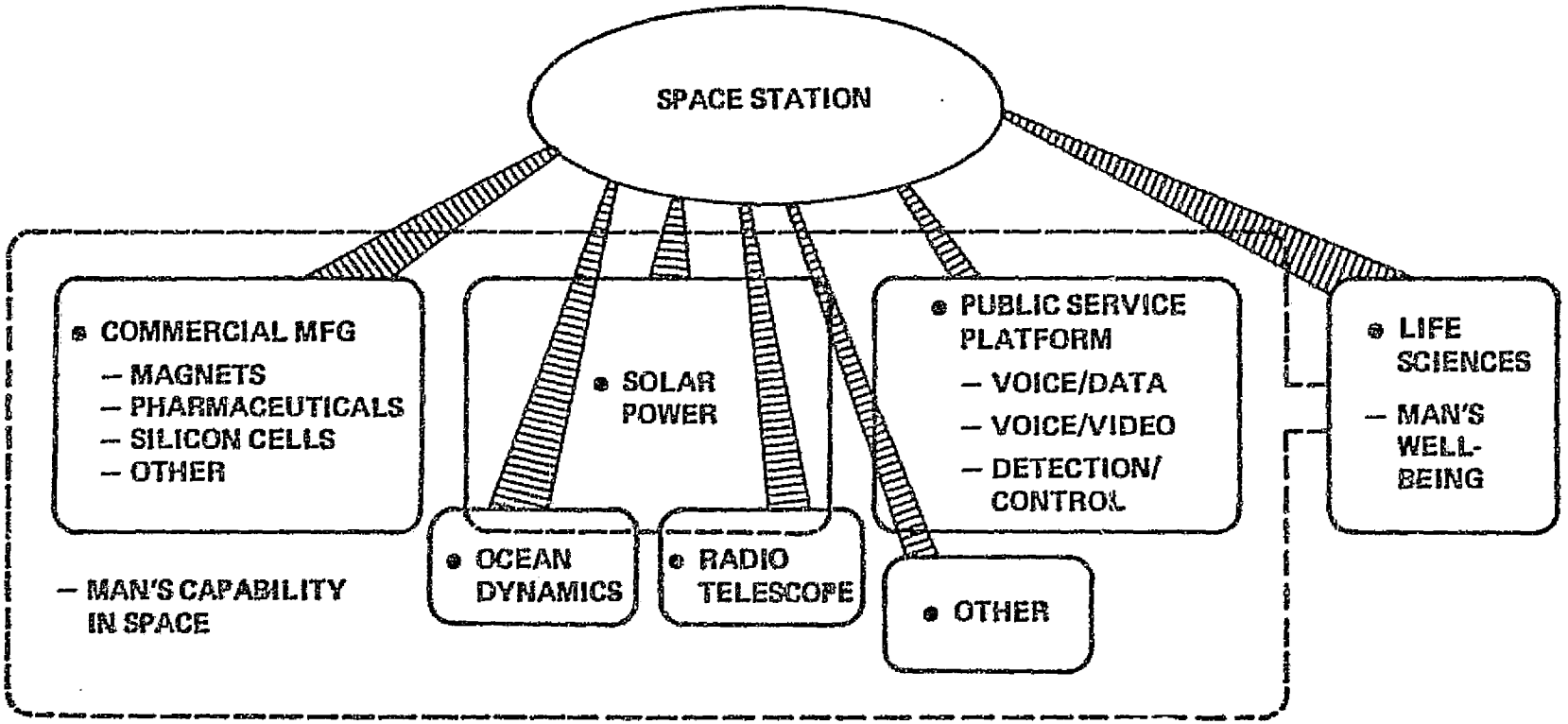
GRUMMAN

SECONDARY PROGRAM DISCRIMINATORS

- SCHEDULE/IOC
- RISK
- MISSION EMPHASIS
- NEW PROGRAM GO AHEAD
- ORBIT

GRUMMAN

PROGRAM OPTION/MISSION INTEGRATION



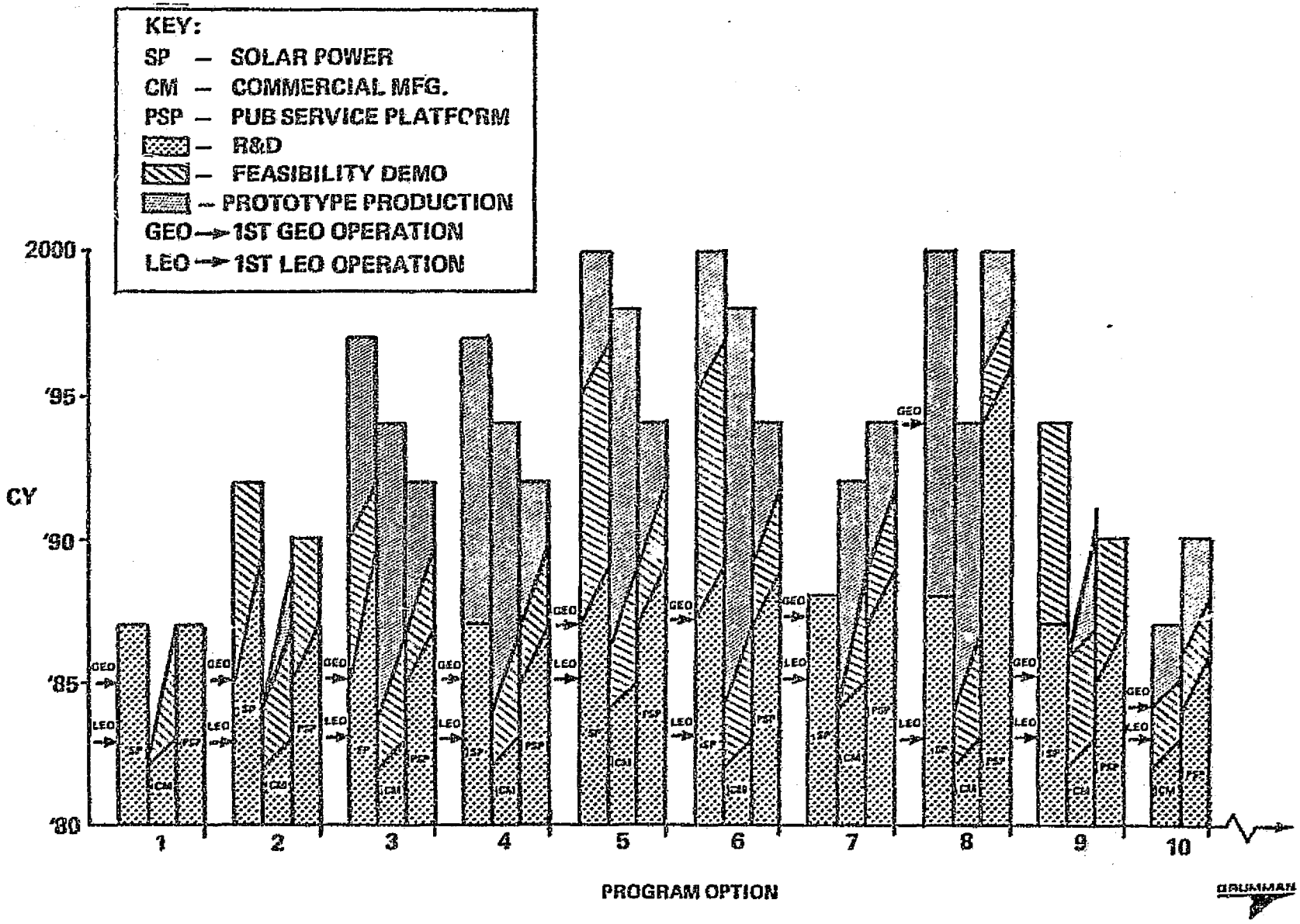
SAMPLE PROGRAM OPTION MATRIX

MISSION			PROGRAM OPTION 1	2	3	4	5	6	7	8	9	10
A. SOLAR POWER	—	R&D				√(84)*						
		FEAS DEMO				–						
		PROTO/PROD.				√(95)						
B. COMMERCIAL MFG	—	R&D				√(82)						
		FEAS DEMO				√(83)						
		PROTO/PROD.				√(85)						
C. PUB SERVICE PLAT	—	R&D				√(85)						
		FEAS DEMO				√(87)						
		PROTO/PROD.				√(90)						
D. RADIO TELESCOPE	—	R&D				√(85)						
		FEAS DEMO				–						
		PROTO/PROD.				–						
E. OCEAN DYNAMICS	—	R&D				√(84)						
		FEAS DEMO				–						
		PROTO/PROD.				–						
F. LIFE SCIENCES	—	R&D				√(83)						
		FEAS DEMO				–						
		PROTO/PROD.				–						

*READINESS DATE FOR START OF R&D TEST, PILOT PLANT PRODUCTION, OR PROTO/PROD OPERATIONS

GRUMMAN

PROGRAM OPTION MATRIX



PROGRAM OPTION

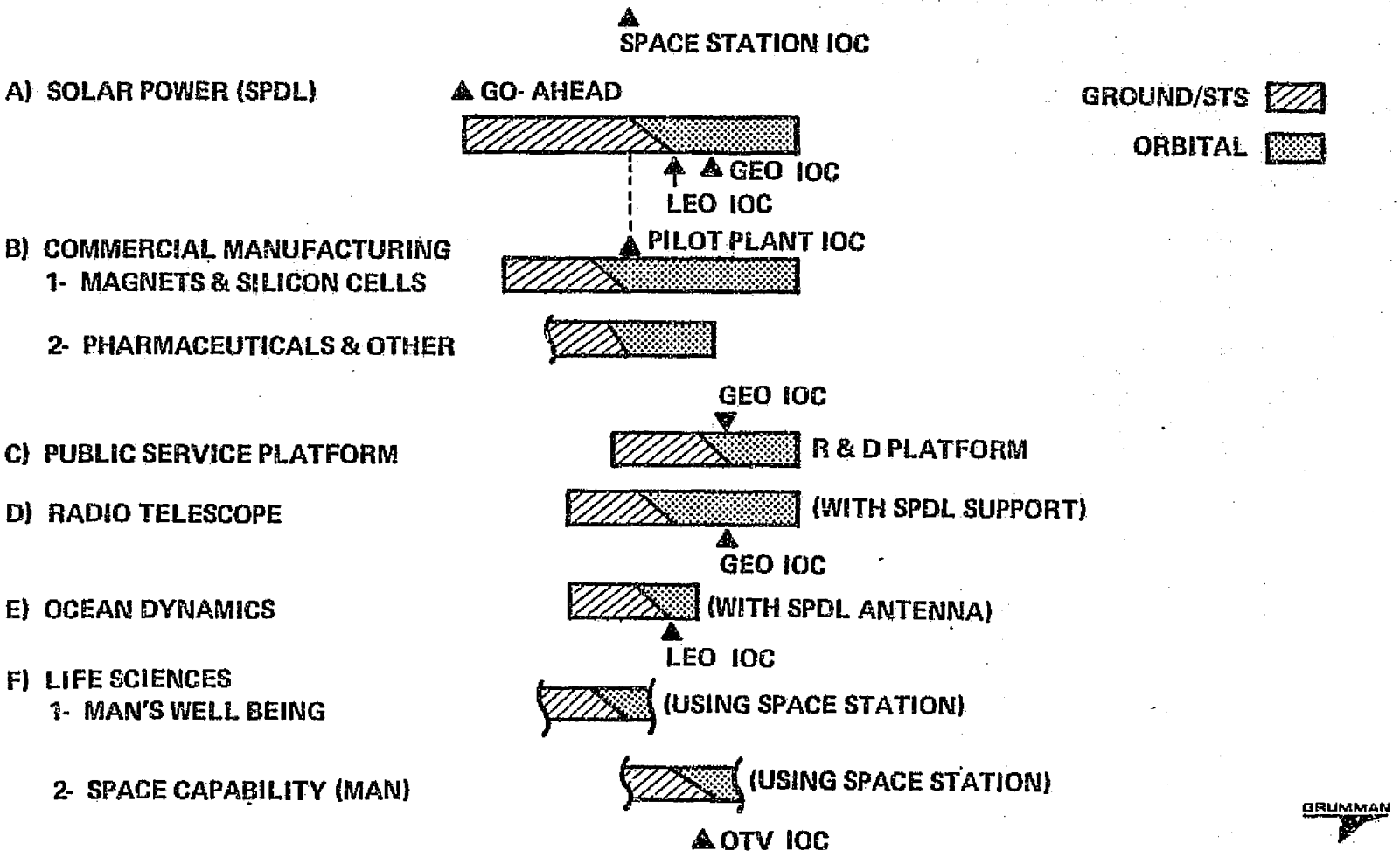
MISSION	1	2	3	4	5	6	7	8	9	10	11	12
A. SOLAR POWER												
(1) R & D	V ('84)	V ('84)	V ('84)	V ('84)	V ('86)	V ('86)	V ('86)	V ('84)	V ('84)			
(2) FEASIBILITY DEMO		V ('90)	V ('90)		V ('94)	V ('94)			V ('92)			
(3) PROTO/PROD			V ('95)	V ('95)	V ('00)	V ('00)		V ('95)				
B. COMMERCIAL MFG												
(1) MAGNETS												
(a) R & D	V ('82)	V ('82)	V ('82)	V ('82)	V ('84)	V ('82)	V ('84)	V ('82)	V ('82)	V ('82)		
(b) FEASIBILITY DEMO	V ('83)	V ('83)	V ('83)	V ('83)	V ('85)	V ('83)	V ('85)	V ('83)	V ('83)	V ('83)		
(c) PROTO/PROD		V ('85)	V ('86)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)		
(2) SILICON CELLS												
(a) R & D	V ('82)	V ('82)	V ('82)	V ('82)	V ('84)	V ('82)	V ('84)	V ('82)	V ('82)	V ('82)		
(b) FEASIBILITY DEMO	V ('83)	V ('83)	V ('83)	V ('83)	V ('85)	V ('83)	V ('85)	V ('83)	V ('83)	V ('83)		
(c) PROTO/PROD		V ('85)	V ('85)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)		
(3) PHARMACEUTICALS												
(a) R & D	V ('83)	V ('83)	V ('83)	V ('83)	V ('85)	V ('83)	V ('85)	V ('83)	V ('83)	V ('82)		
(b) FEASIBILITY DEMO		V ('85)	V ('85)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)	V ('85)	V ('83)		
(c) PROTO/PROD			V ('87)	V ('87)	V ('89)	V ('87)	V ('89)	V ('87)		V ('85)		
(4) OTHER												
(a) R & D	V ('83)	V ('83)	V ('83)	V ('83)	V ('85)	V ('83)	V ('85)	V ('83)	V ('83)	V ('82)		
(b) FEASIBILITY DEMO		V ('85)	V ('85)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)	V ('85)	V ('83)		
(c) PROTO/PROD			V ('87)	V ('87)	V ('89)	V ('87)	V ('89)	V ('87)		V ('85)		
C. PUB SERVICE PLATFORM												
(a) R & D	V ('85)	V ('85)	V ('85)	V ('85)	V ('87)	V ('87)	V ('87)	V ('94)	V ('85)	V ('84)		
(b) FEASIBILITY DEMO		V ('87)	V ('87)	V ('87)	V ('89)	V ('89)	V ('89)	V ('96)	V ('87)	V ('86)		
(c) PROTO/PROD			V ('90)	V ('90)	V ('92)	V ('92)	V ('92)	V ('98)		V ('88)		
D. RADIO-TELESCOPE												
(a) R & D	V ('85)	V ('85)	V ('85)	V ('85)	V ('87)	V ('87)	V ('87)	V ('95)	V ('85)	V ('84)		
(b) FEASIBILITY DEMO												
(c) PROTO/PROD												
E. OCEAN DYNAMICS												
(a) R & D	V ('84)	V ('84)	V ('84)	V ('84)	V ('86)	V ('86)	V ('86)	V ('84)	V ('84)			
(b) FEASIBILITY DEMO												
(c) PROTO/PROD												
F. LIFE SCIENCES												
(1) QUALITY OF LIFE												
(a) R & D	V ('83)	V ('83)	V ('83)	V ('83)	V ('85)	V ('83)	V ('85)	V ('83)	V ('83)	V ('83)		
(b) FEASIBILITY DEMO												
(c) PROTO/PROD												
(2) SPACE CAPABILITY (MAN)												
(a) R & D	V ('85)	V ('86)	V ('85)	V ('85)	V ('87)	V ('85)	V ('87)	V ('85)	V ('85)	V ('85)		
(b) FEASIBILITY DEMO												
(c) PROTO/PROD												

*READINESS DATE FOR START OF RES/DEV TEST, PILOT PLANT PRODUCTION OR PROTO/PROD OPERATIONS

PROGRAM OPTION I

CHARACTERISTICS:
- ALL MISSIONS
- R & D ONLY EXCEPT MAGNET/SILICON CELL PILOT PLT. PRODUCTION
- EARLY ICO DATES

SCHEDULE: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95



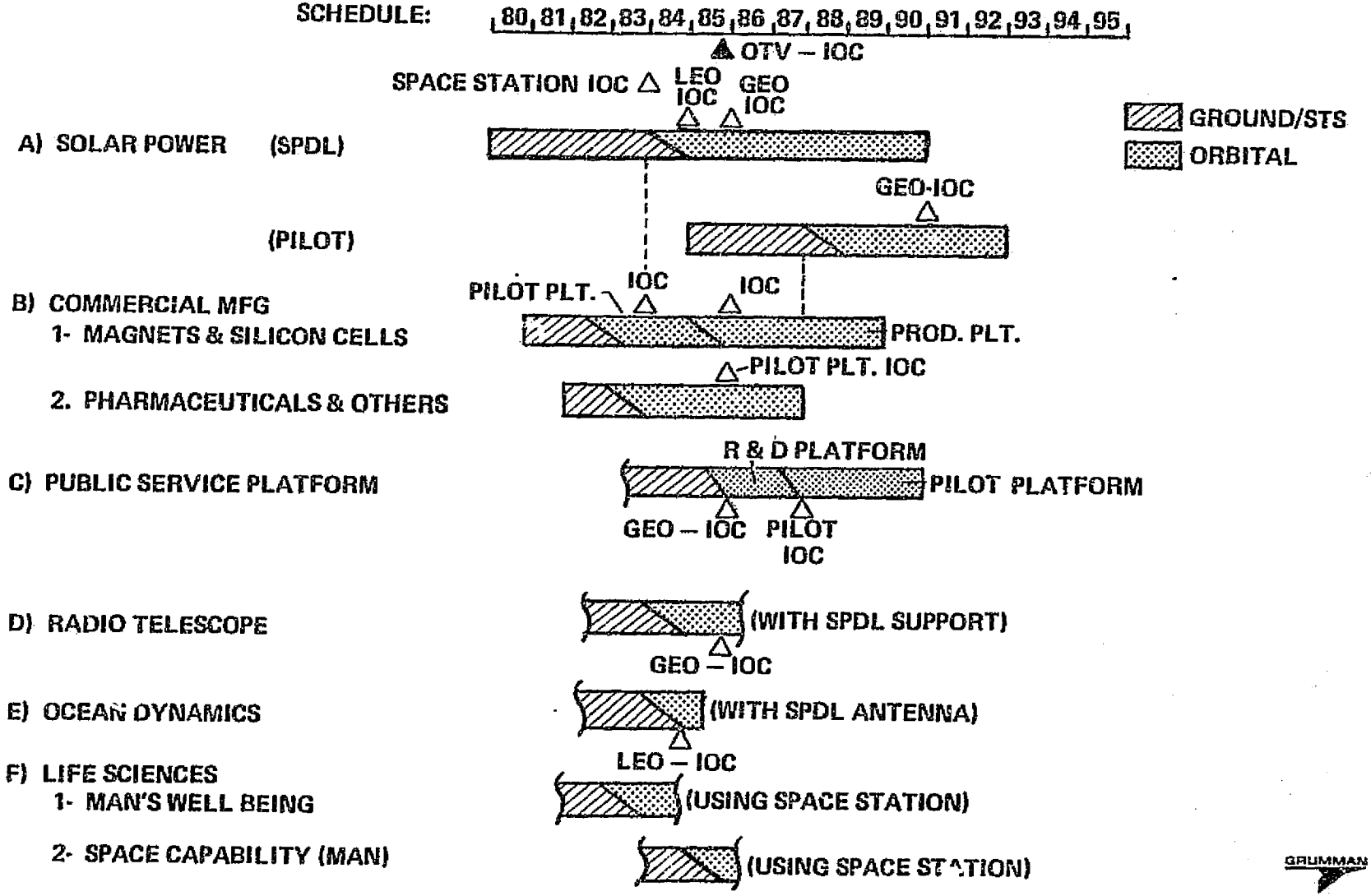
GRUMMAN

PROGRAM OPTION 2

CHARACTERISTICS:

- ALL MISSIONS
- R & D PLUS FEAS. DEMO. FOR SOLAR POWER/COMM. MFG/ PUBLIC SERV. PLAT., AND PROTO./PROD. FOR MAGNETS/SILICON CELLS
- EARLY IOC DATES

SCHEDULE:

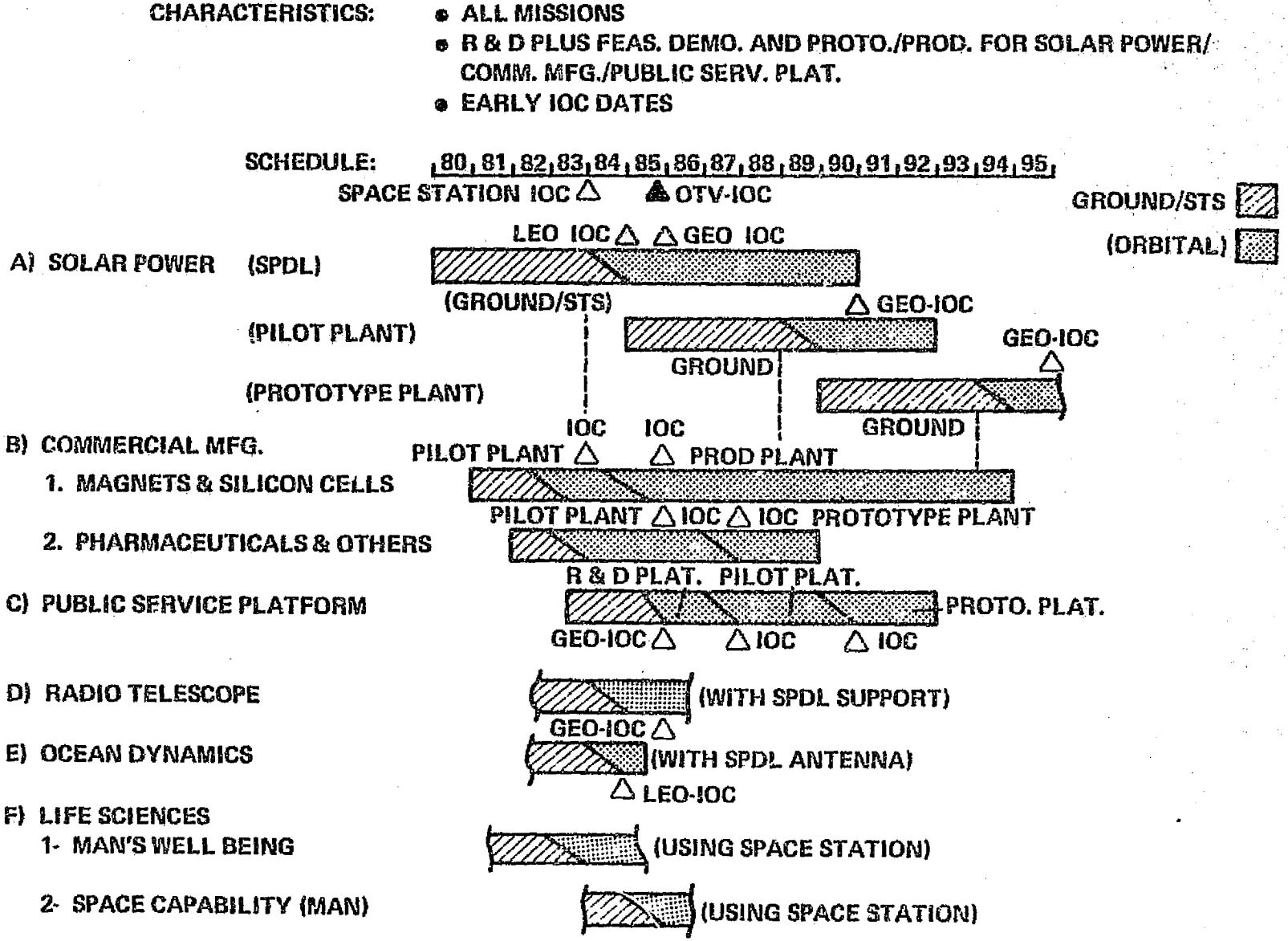


GRUMMAN

PROGRAM OPTION 3

CHARACTERISTICS:

- ALL MISSIONS
- R & D PLUS FEAS. DEMO. AND PROTO./PROD. FOR SOLAR POWER/ COMM. MFG./PUBLIC SERV. PLAT.
- EARLY IOC DATES

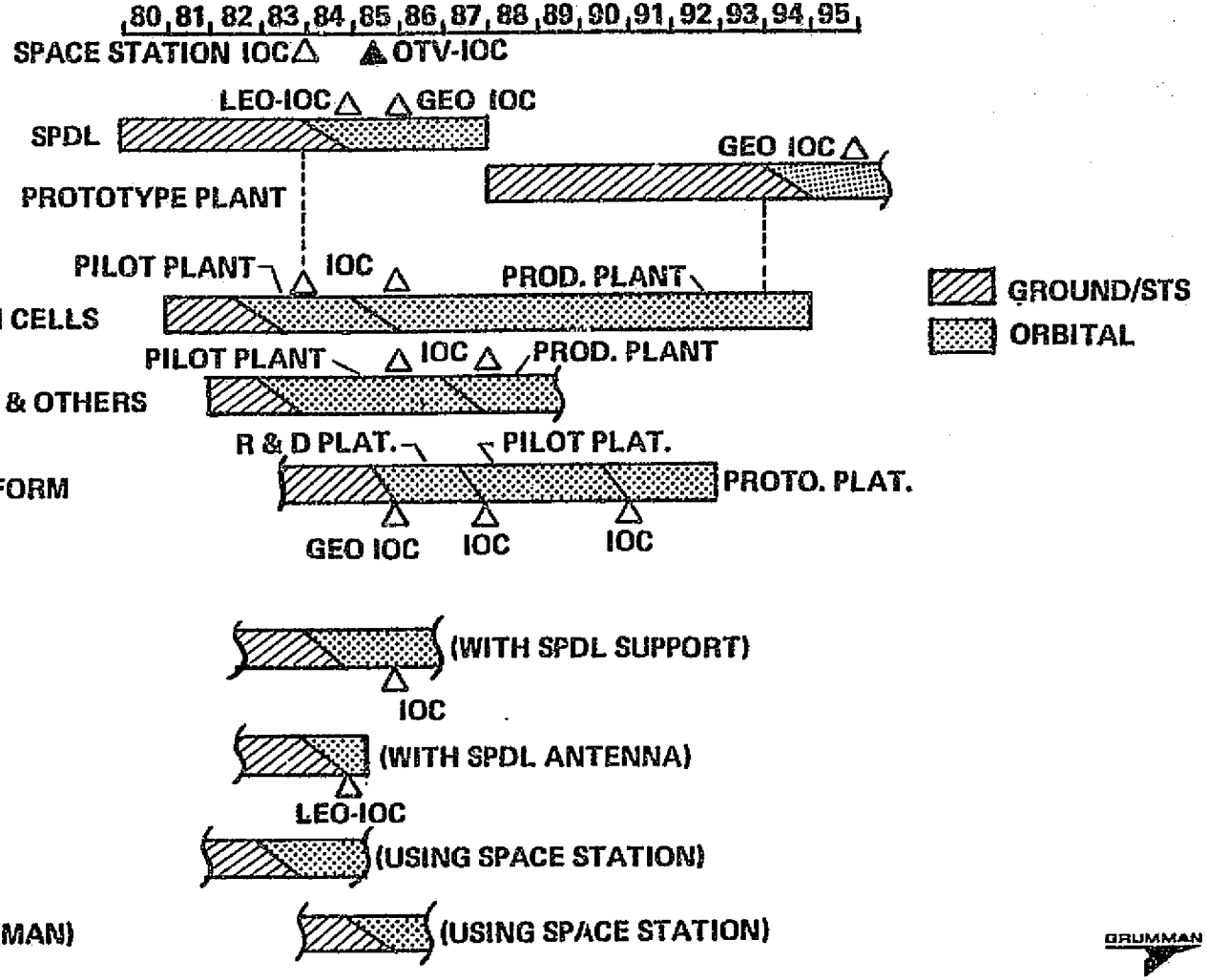


PROGRAM OPTION 4

CHARACTERISTICS:

- ALL MISSIONS
- R & D PLUS FEAS. DEMO. AND PROTO/PROD. FOR COMM. MFG/ PUBLIC SERV. PLAT.; PROTO./PROD. FOR SOLAR POWER (NO PILOT PLANT)

SCHEDULE:

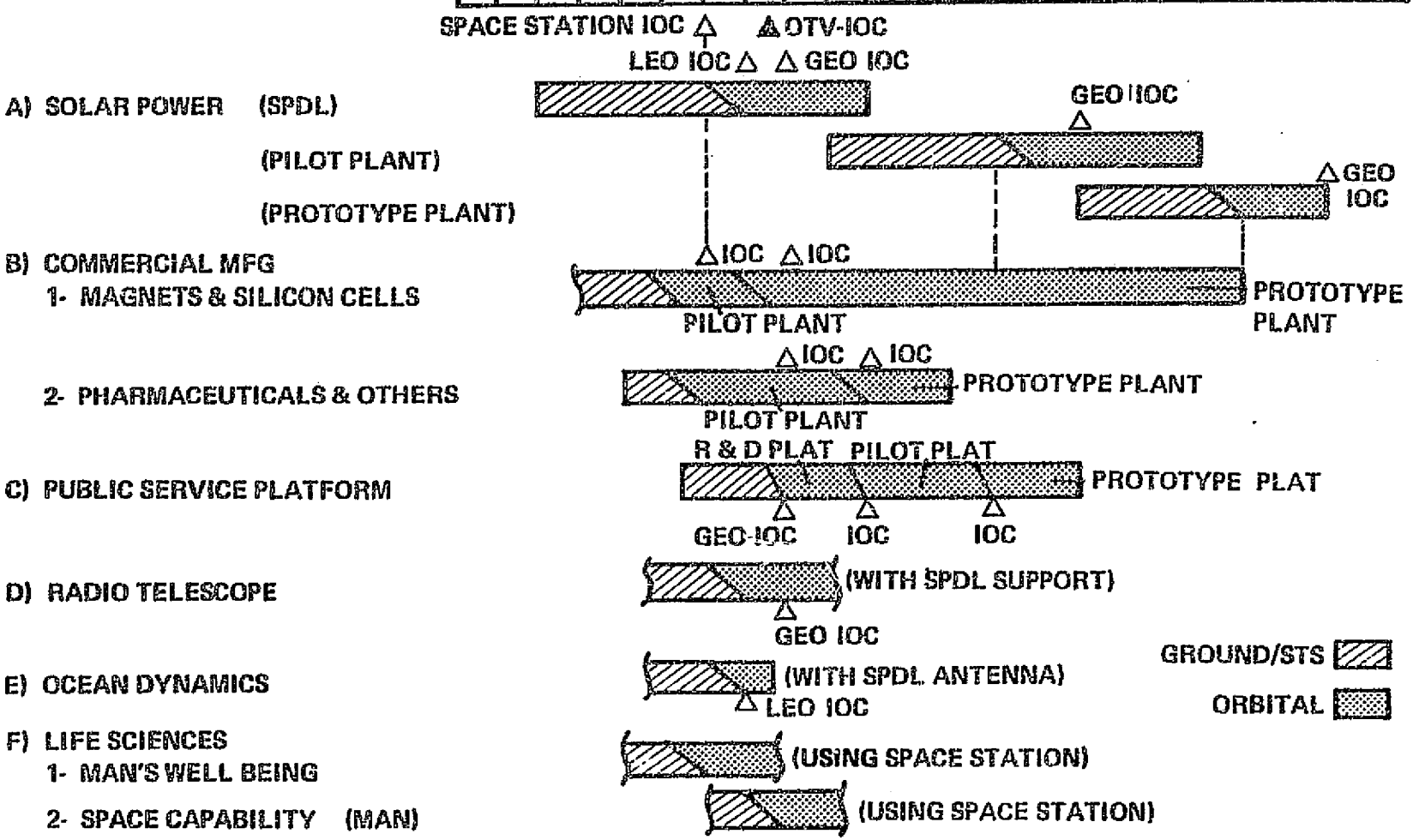


GRUMMAN

PROGRAM OPTION 5

CHARACTERISTICS:
- ALL MISSIONS
- R & D PLUS FEAS. DEMO. AND PROTO./PROD. FOR SOLAR POWER/ COMM. MFG/PUBLIC SERV. PLAT.
- TOTAL PROGRAM DELAYED

SCHEDULE: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02,

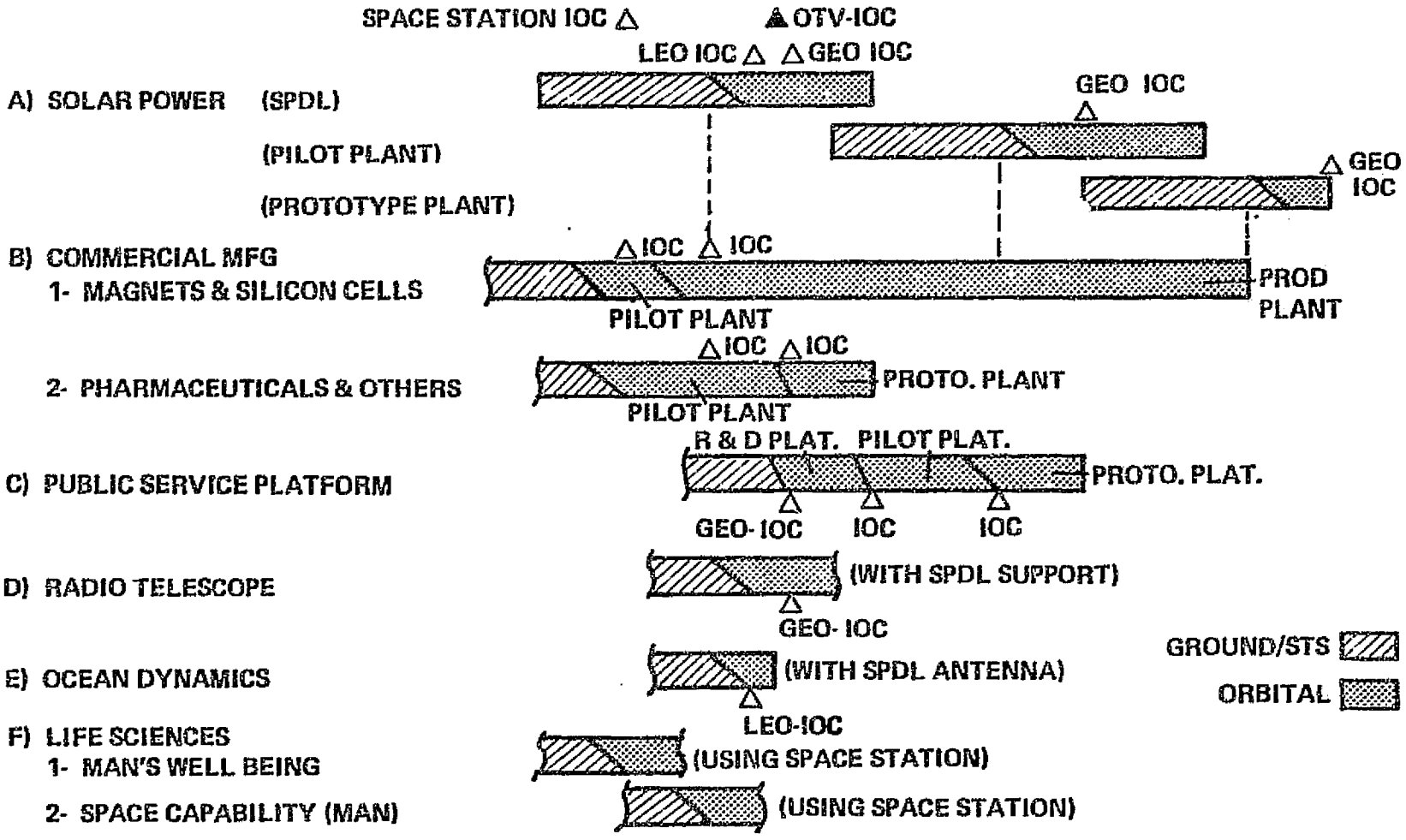


PROGRAM OPTION 6

CHARACTERISTICS:

- ALL MISSIONS
- R & D PLUS FEAS. DEMO AND PROTO./PROD. FOR SOLAR POWER/ COMM. MFG./PUBLIC SERV. PLAT.
- SOLAR POWER/PUBLIC SERV. PLAT. DELAYED; EARLY COMM. MFG IOC

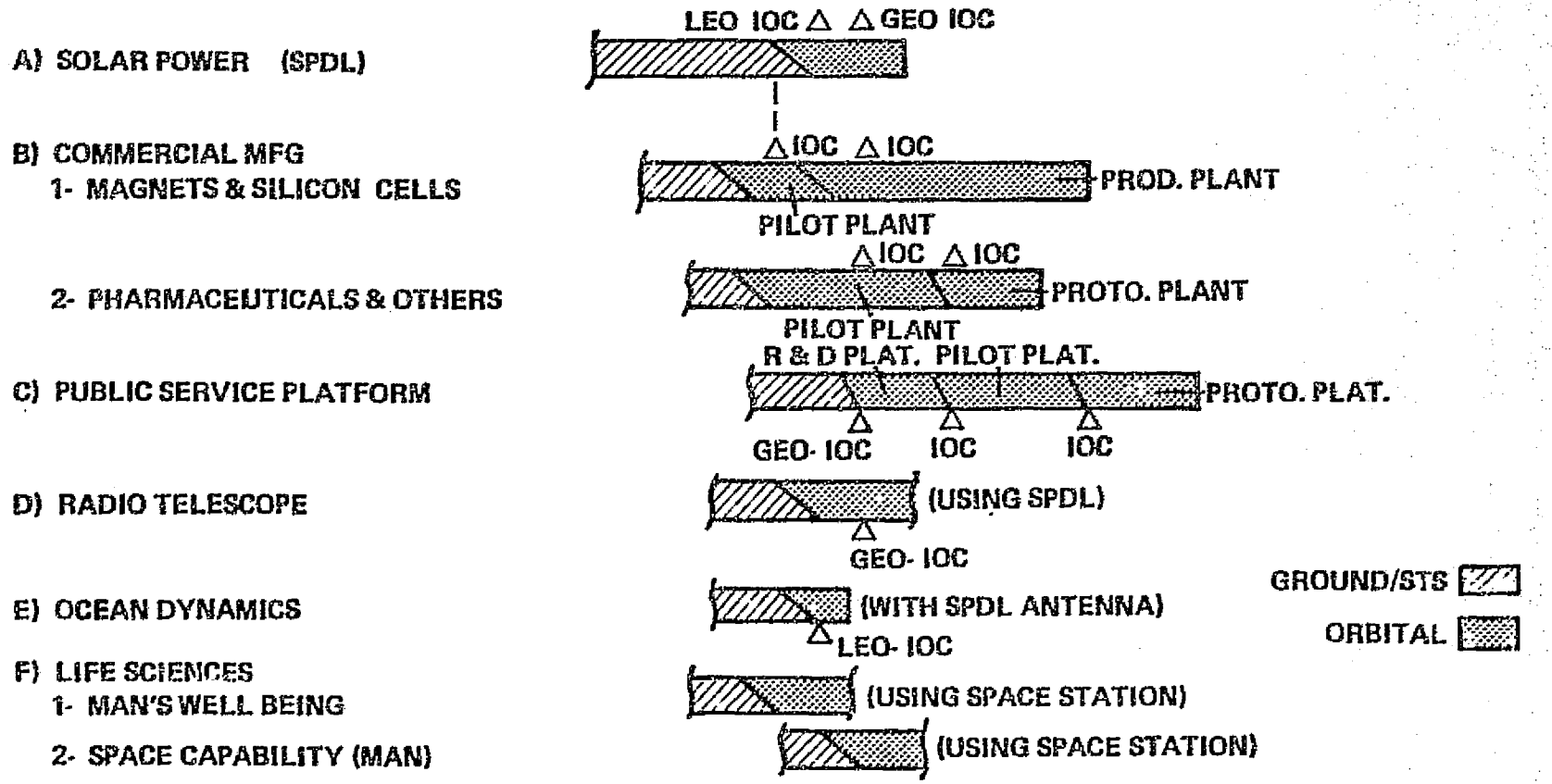
SCHEDULE: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 00, 01



PROGRAM OPTION 7

CHARACTERISTICS:
- ALL MISSIONS
- R & D PLUS FEAS. DEMO. AND PROTO./PROD. FOR COMM. MFG/PUBLIC SERV. PLAT. (SOLAR POWER DEEMPHASIZED)
- TOTAL PROGRAM DELAYED

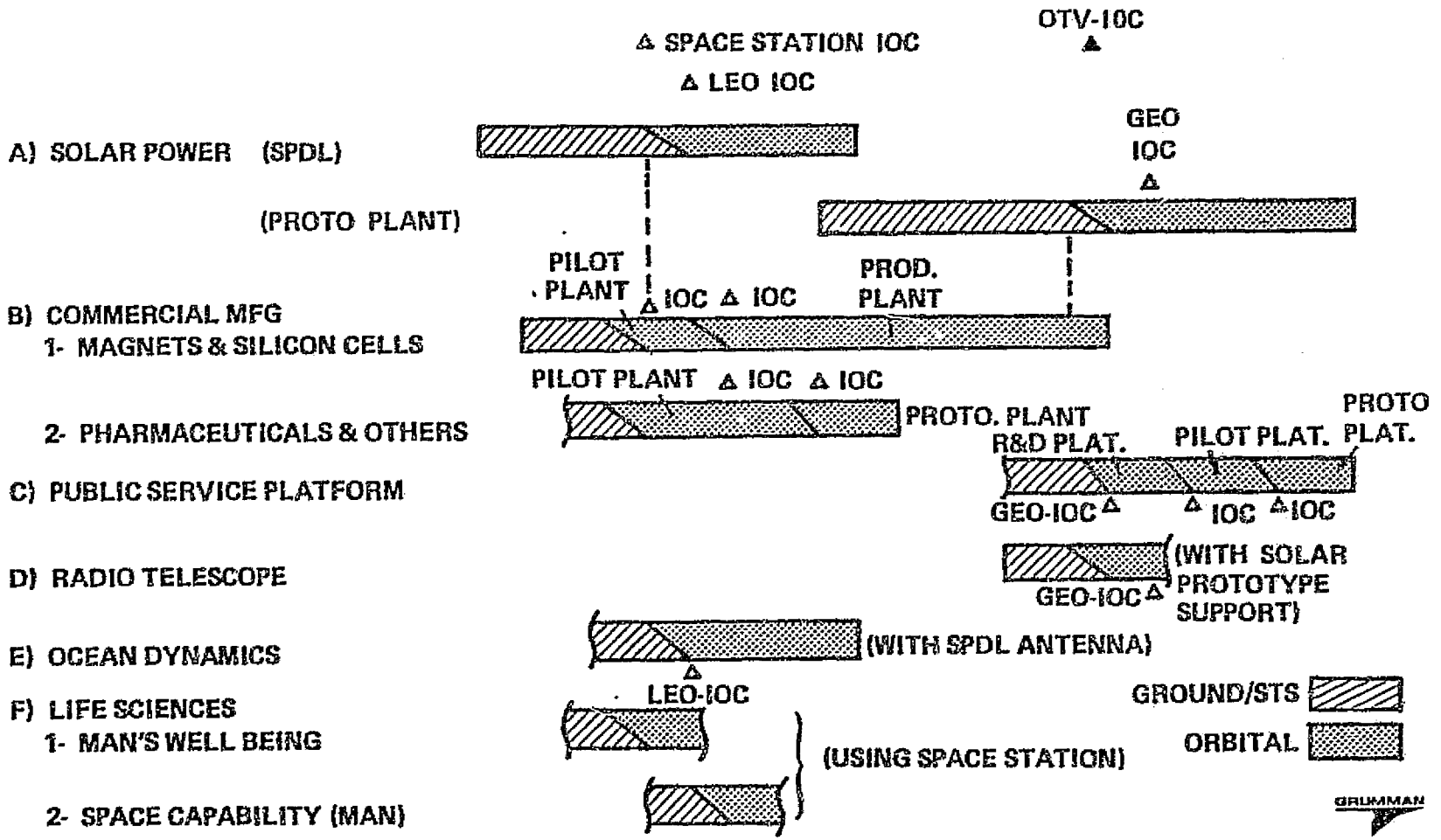
SCHEDULE: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95



PROGRAM OPTION 8

CHARACTERISTICS
- ALL MISSIONS
- R & D PLUS FEAS. DEMO. AND PROTO/PROD. FOR COMM. MFG./ PUBLIC SERV. PLAT., PROTO/PROD. FOR SOLAR POWER . (NO PILOT PLT.)

SCHEDULE: 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01

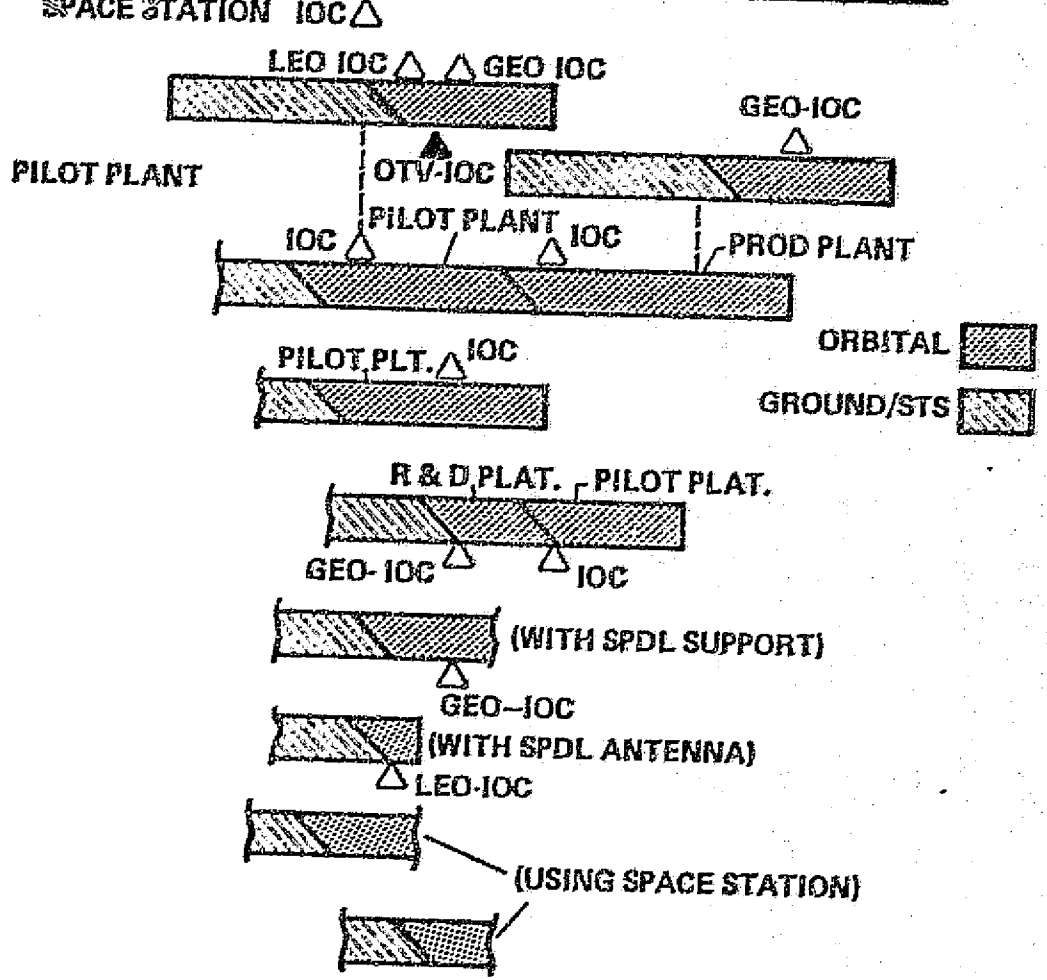


PROGRAM OPTION 9

CHARACTERISTICS:

- ALL MISSIONS
- R & D PLUS FEAS. DEMO. FOR SOLAR POWER/COMM. MFG./ PUBLIC SERV. PLAT.; PROTO./PROD. FOR MAGNETS/SILICON CELLS
- EARLY IOC DATES EXCEPT DELAYED SOLAR POWER FEAS. DEMO.

SCHEDULE:



PROGRAM OPTION I0

CHARACTERISTICS:
- ALL MISSIONS EXCEPT SOLAR POWER AND OCEAN DYNAMICS
- R & D PLUS FEAS. DEMO. AND PROTO/PROD. FOR COMM. MFG/ PUBLIC SERV. PLAT.
- ADVANCED IOC DATES FOR COMM. MFG'/PUBLIC SERV. PLAT.

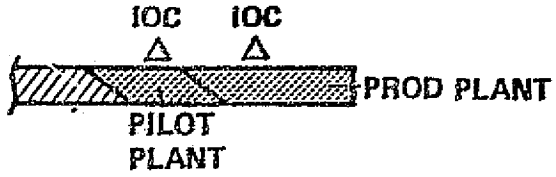
SCHEDULE: 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95

SPACE STATION IOC △ ▲ OTV-IOC

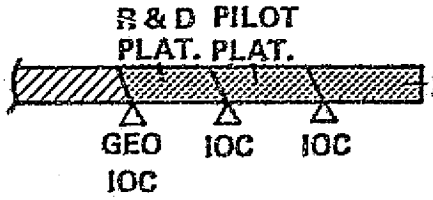
GROUND/STS

ORBITAL

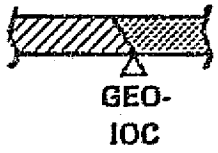
A) COMMERCIAL MFG. MAGNETS, SILICON CELLS PHARMACEUTICALS & OTHERS



B) PUBLIC SERVICE PLATFORM



C) RADIO TELESCOPE



D) LIFE SCIENCES

1- MAN'S WELL BEING

2- SPACE CAPABILITY (MAN)

GRUMMAN

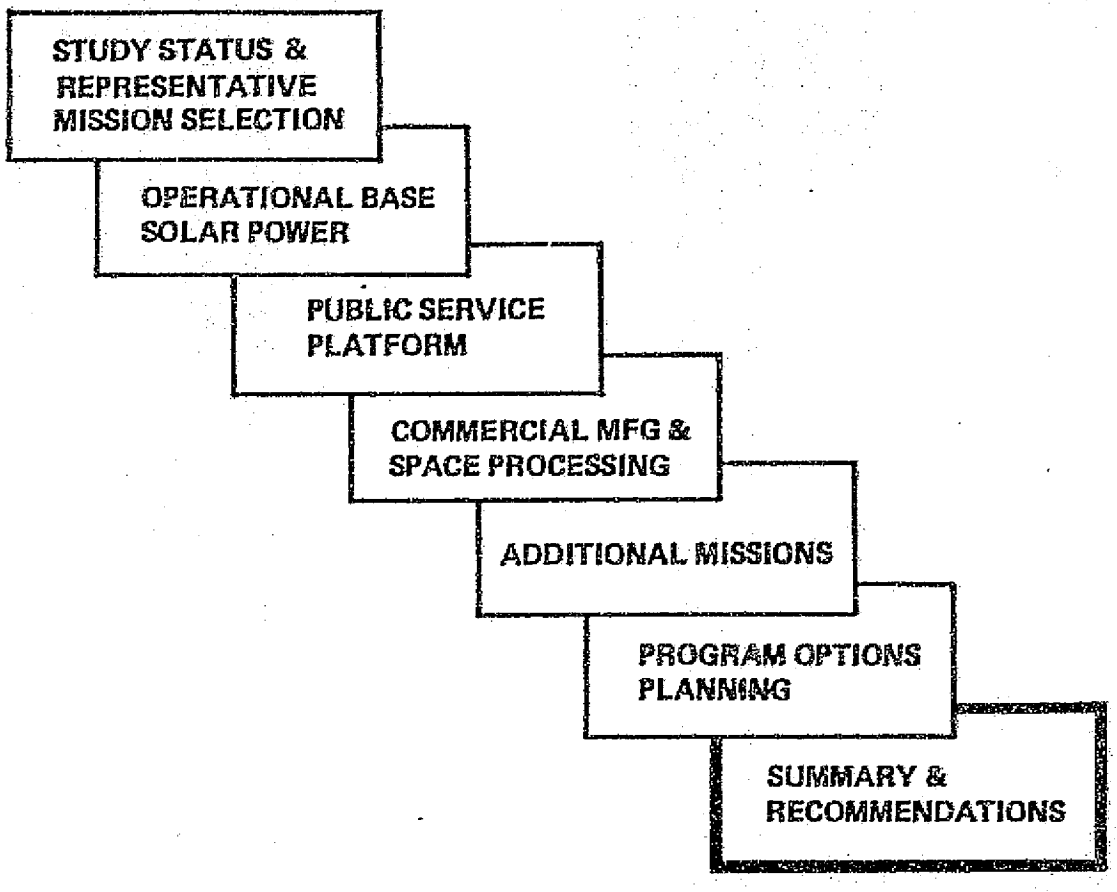
PROGRAM OPTION PLANNING

REQUIRED ACTIONS:

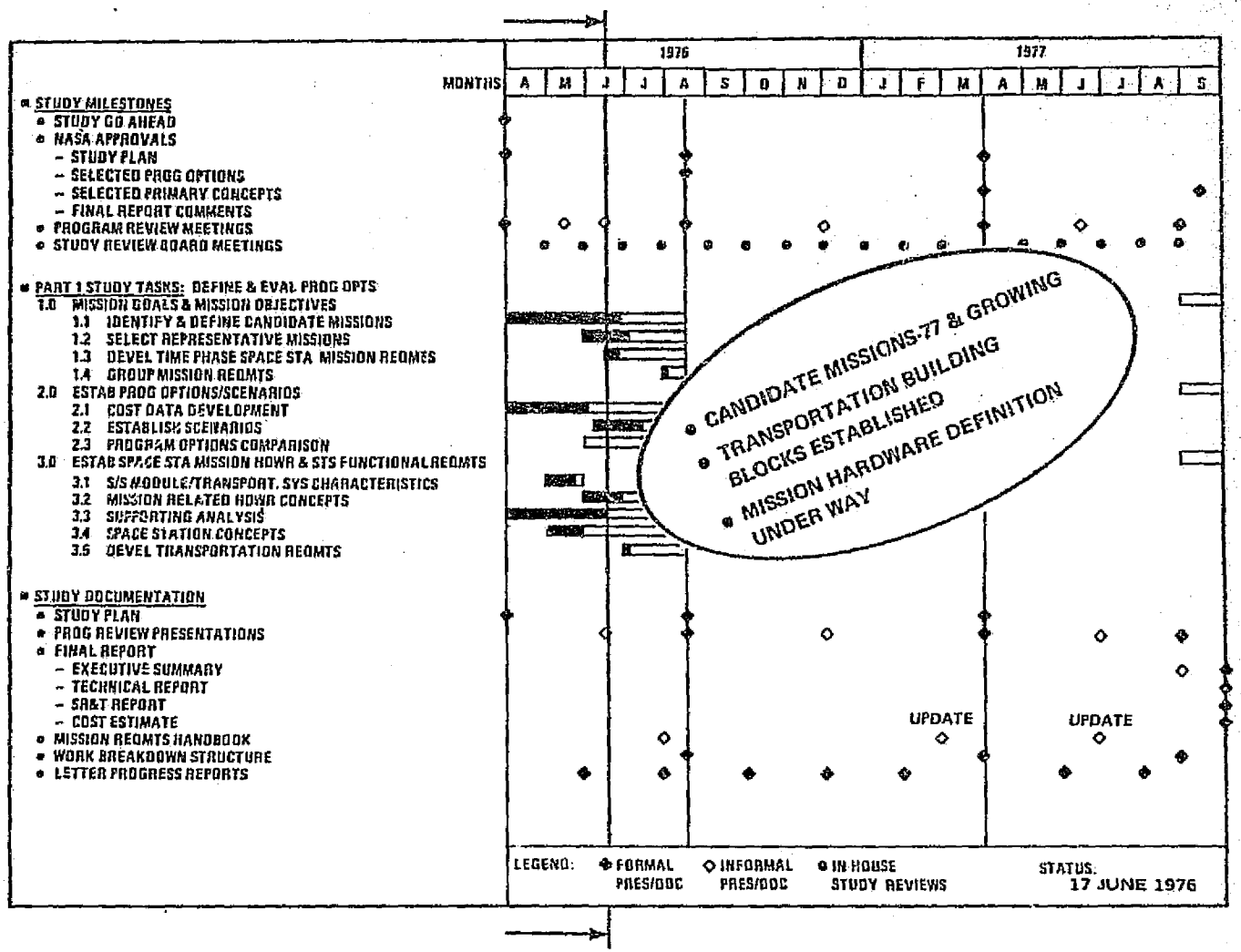
- ADDITIONS/DELETIONS/MODIFICATIONS TO PROPOSED OPTIONS
- IDENTIFICATION OF 2 OR 3 OPTIONS FOR PART I DETAILED DEFINITION
- START-UP/PHASE-OUT DATES FOR PROGRAM COSTING

GRUMMAN

SPACE STATION SYSTEMS ANALYSIS STUDY PROGRAM REVIEW

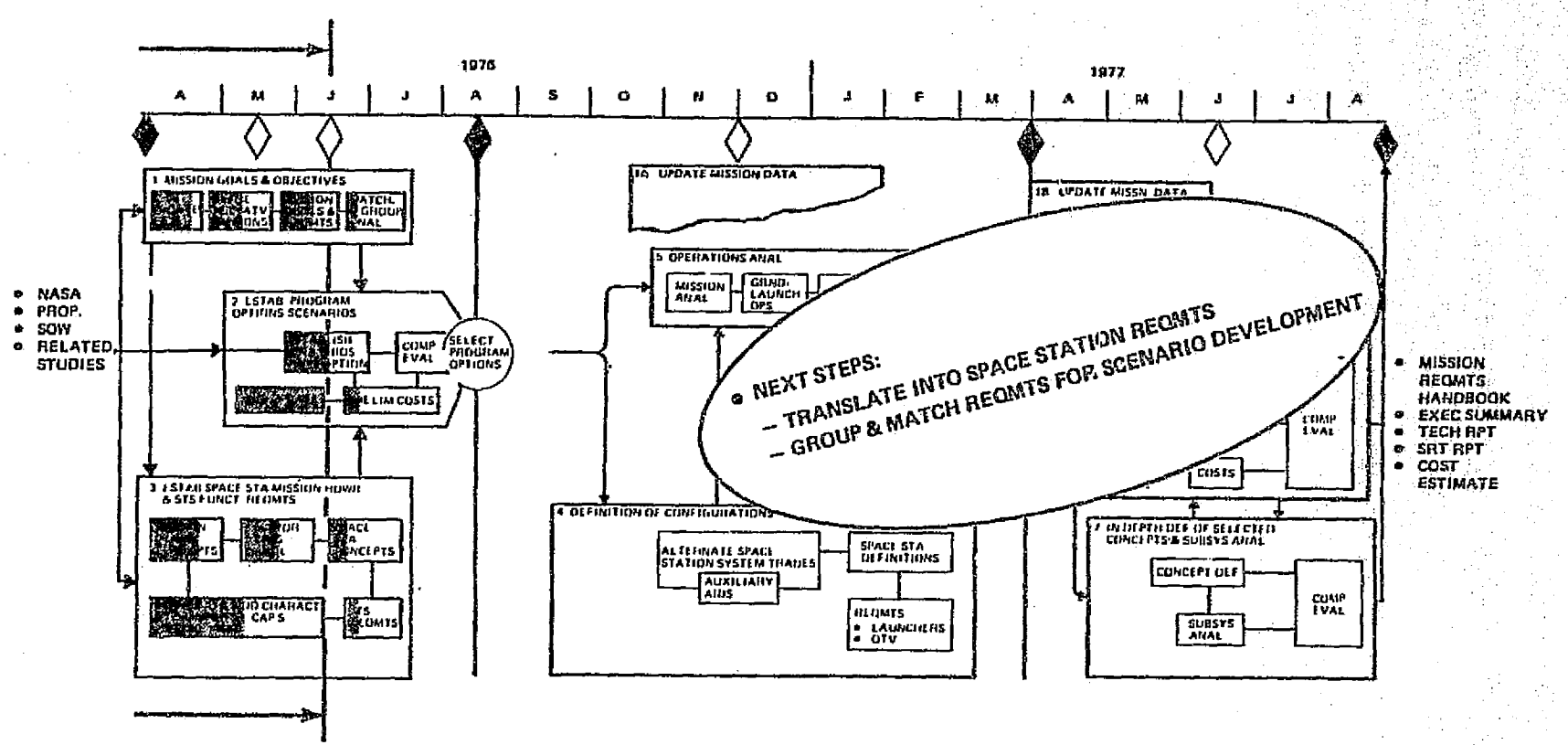


SSSA STUDY SCHEDULE



BRUMMAN

SSSA STUDY LOGIC



SOLAR POWER

KEY ISSUE:
CONSTRUCTION BASE/MANNED
PARTICIPATION

- DEVELOPMENT ACTIVITY & TIME SCHEDULE IS DOMINANT SPACE STATION DRIVER
- 1995 PROTOTYPE IOC MAY REQUIRE SPACE STATION EARLIER THAN 1985
- PRIME NEAR-TERM SPACE STATION ACTIVITY:
  - FEASIBILITY OF:
    - CO-ORDINATED FABRICATION OF LARGE STRUCT
    - JOINING & ALIGNMENT
    - LOGISTICS MOVEMENTS
  - MANNED EFFECTIVENESS - SKILL LEVEL, PRODUCTION RATE, LEARNING CURVE
  - STRUCT INTEGRITY, VERIFICATION, REPAIR
  - RELIABILITY OF MACHINES
- EARLY IONOSPHERIC TESTS FROM GRND SUGGESTED
  - LEO SPACE STATION - 5-SEC DWELL TIME LIMITS TO 1/3 KM TEST VOL
  - GEO SPACE STATION - SEVERAL ANTENNA/RECTENNA PROPORTIONS POSSIBLE TO SAVE $
- CONSIDER SAT-TO-SAT PWR TRANSMISSION IN LEO AS SPACE STATION DEVELOPMENT STEP

GRUMMAN

DECISION OPTIONS

- MISSION SCENARIO DEVELOPMENT VS INITIAL DDT & E CATEGORIES
  - BLEND REPRESENTATIVE MISSIONS
  - SPAN LEO/GEO
  - DEVELOP TIME PHASING FOR AMBITIOUS, NOMINAL & MINIMAL OPTIONS
- BREADTH VS DEPTH
  - SUGGEST STRONG NEAR-TERM EMPHASIS
  - LOOK TO FAR-TERM TO GIVE SHORT-TERM DIRECTION
- MISSION BENEFIT STUDY
  - AUGUST & PART 2 TASKS
  - BUT POSSIBLE AREA FOR ADDED CONCENTRATION

GRUMMAN