SPACE STATION CONTROL MOMENT GYRO CONTROL

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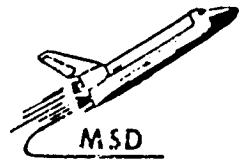
The potential large center-of-pressure to center-of-gravity offset of the Space Station makes the short term, within an orbit, variations in density of primary importance.

The large range of uncertainty in the prediction of solar activity will penalize the Space Station design, development, and operation.



NASA MISSION SUPPORT DIRECTORATE JSC

SPACE STATION CMG CONTROL

NOVEMBER 19, 1985
MPAD/FM4
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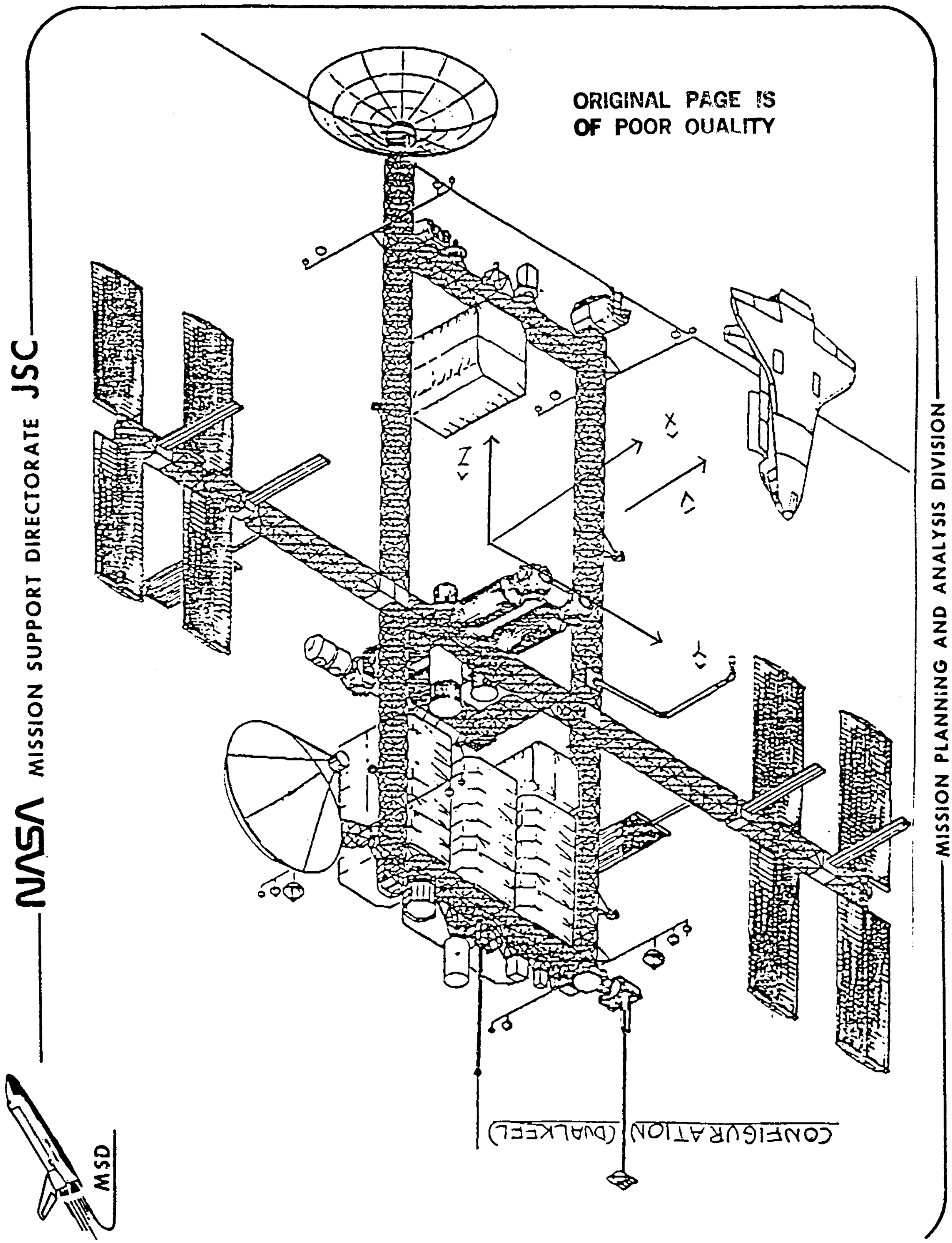
ET AL.

MISSION PLANNING AND ANALYSIS DIVISION

- CURRENT STUDY INTEREST AND EFFORTS
  - CMG CONTROL SYSTEM SIZING *
  - DUAL KEEL MOMENTUM SENSITIVITIES *
  - MOMENTUM MANAGEMENT STRATEGIES AND SUPPORTING ALGORITHM DEVELOPMENT

*DATA PACKAGES INCLUDED FOR HARRY BUCHANAN



- CONFIGURATION (CONT.)

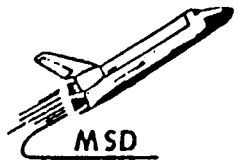
POWER TOWER + PL & SERVICING				DUAL KEEL + PL			
WEIGHT	- 452007 LB			WEIGHT	- 580162 LB		
INERTIAS	IXX	1.8900E8	SLG-FT^2	INERTIAS	IXX	1.4060E8	SLG-FT^2
	IYY	1.8522E8			IYY	1.0897E8	
	IZZ	8.4067E6			IZZ	5.7214E7	
	IXY	6.9866E4			IXY	1.0580E6	
	IXZ	-8.7079E5			IXZ	6.5741E5	
	IYZ	-3.9985E5			IYZ	1.2931E6	
CG	XCG	-.88671	FT	CG	XCG	-24.45463	FT
	YCG	-1.13842			YCG	-5.011408	
	ZCG	143.5007			ZCG	- 1.022853	
CP	XCP	≈ 0.0	FT		XCP	≈ -13.65645	FT
	YCP	≈ 0.0			YCP	≈ -29.48985	
	ZCP	≈ 0.0			ZCP	≈ -31.20042	

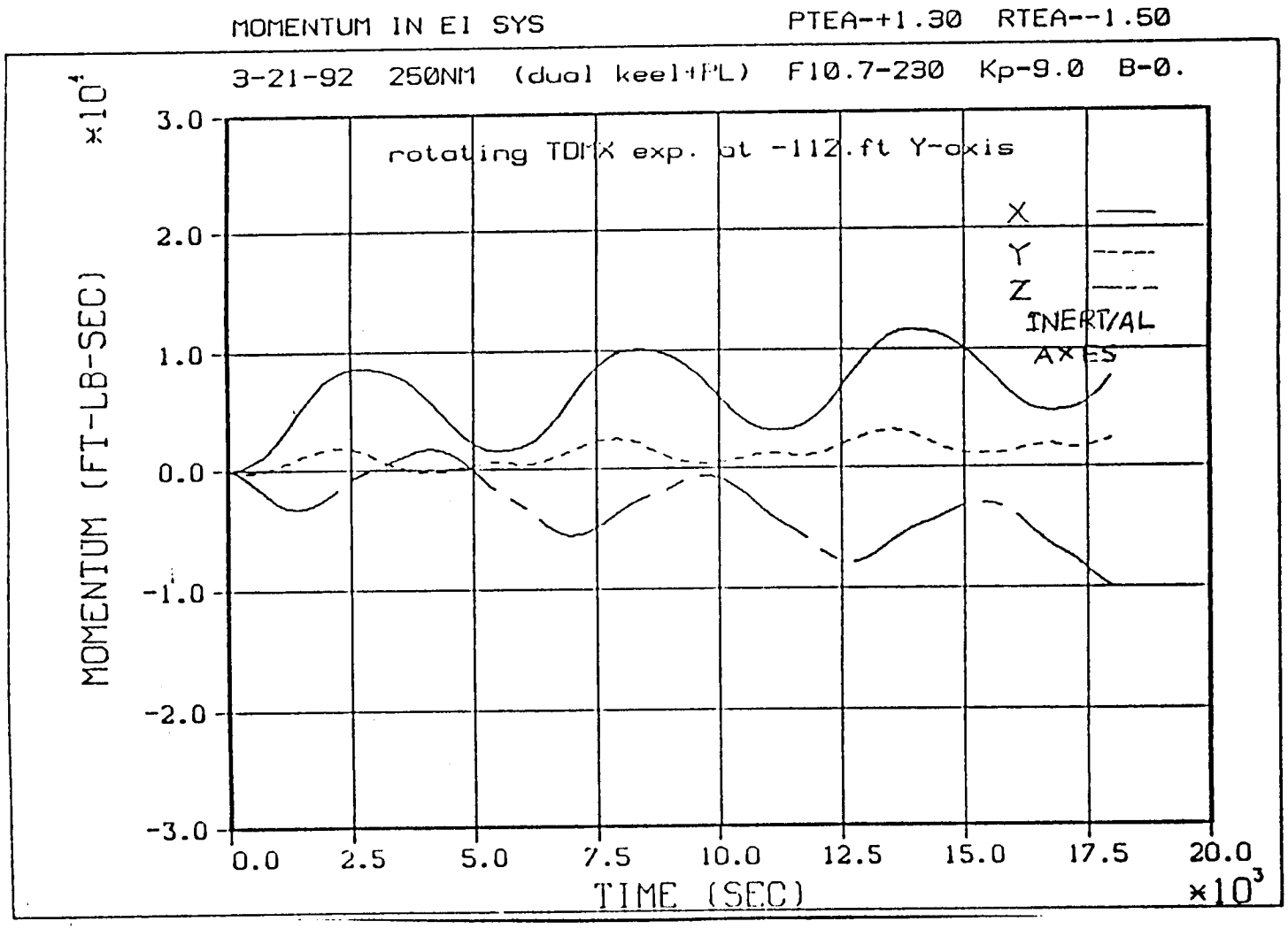
COORDINATE SYSTEM REFERENCE - GEOMETRIC CENTER OF TRANSVERSE BOOM

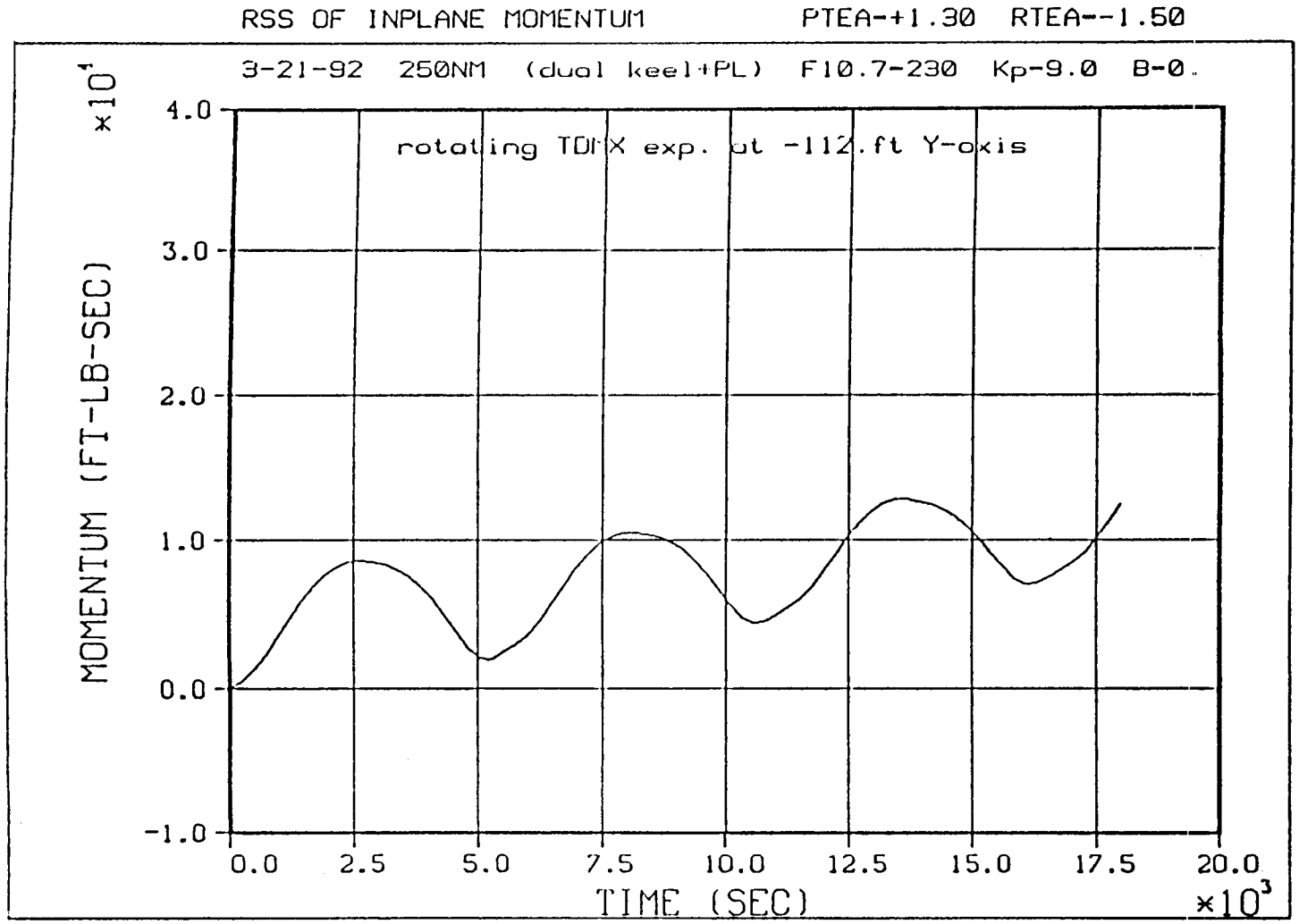
- CMG SIZING KEY POINTS
  - POWER TOWER (IOC)
    - OUT-OF-ORBIT PLANE MOMENTUM WAS THE REQUIREMENT DRIVER DUE TO A LARGE CP. TO CG. OFFSET IN THE STATION X AXIS (> 100 FT.)
    - PITCH TEA WAS EMPLOYED TO REDUCE THE OUT-OF-ORBIT PLANE MOMENTUM

- CMG SIZING KEY POINTS (CONT)
  - DUAL KEEL (IOC)*
    - IN-ORBIT PLANE MOMENTUM WILL BE THE REQUIREMENT DRIVER DUE TO A POTENTIAL
    - LARGE CP. TO CG. OFFSET IN THE STATION Y AXIS (> 30 FT.)
    - ROLL TEA REDUCES IN-PLANE MOMENTUM SOMEWHAT
    - SOLAR DYNAMIC EXPERIMENT CONTRIBUTES LARGELY TO THE IN-PLANE MOMENTUM
      - LARGE AREA (~ 2400 FT^2)
      - LOCATED NEAR END OF UPPER BOOM (-112 FT.)

*NOT NECESSARILY CONFIGURATION OPTIMAL FOR CMG SIZING OR MOMENTUM MANAGEMENT


MSD


MOMENTUM IN EI SYS
PTEA--+1.30 RTEA--1.50
3-21-92 250NM (dual keel+PL) F10.7-230 Kp-9.0 B-0.
rotating TDRX exp. at -112.ft Y-axis
X
Y
Z
INERTIAL AXES
MOMENTUM (FT-LB-SEC) ×10⁴
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TIME (SEC)
×10³


RSS OF INPLANE MOMENTUM
PTEA-+1.30 RTEA--1.50
3-21-92 250NM (dual keel+PL) F10.7-230 Kp-9.0 B-0.
rotating TDRS exp. at -112.ft Y-axis
MOMENTUM (FT-LB-SEC) ×10⁴
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TIME (SEC)
×10³

- MOMENTUM MANAGEMENT KEY POINTS
  - SECULAR CHANGES CAN BE RELATIVELY LARGE
    (~ 2500 FT-LB-SEC PER ORBIT, FOR STEA)
  - IMPLIES FREQUENT, IF NOT CONTINUOUS, IN-PLANE MOMENTUM DUMPING WITH REASONABLY LARGE ROLL ANGLES (> .5 DEG) ABOUT ROLL TEA
  - MANEUVER MOMENTUM MUST BE SUFFICIENT FOR REQUIRED MOMENTUM DUMPING ($I\Delta\omega$ = 5000 FT-LB-SEC, $\Delta\omega$ = .002°/SEC)

DUAL KEEL CONFIGURATION, CIR, ORBIT ALT. = 250 N.MI., B = 0, 3-21-92.
STEA - SHORT TERM EXTREME ATMOSPHERE F10.7 = 230, KP = 9.

- NATURAL ENVIRONMENT EFFECTS
  - PEAK IN-PLANE MOMENTUM SENSITIVITY TO NATURAL ENVIRONMENT PARAMETERS

	PEAK IN-PLANE MOMENTUM (NO SECULAR CHANGE INCL.)	
F 10.7 = 150, KP = 3	~1200	FT-LB-SEC
150, KP = 7	~2500	
150, KP = 9	~5000	
F 10.7 = 230, KP = 3	~3000	
230, KP = 7	~4200	
230, KP = 9	~7000	← STEA
F 10.7 = 300, KP = 9	~10000	

  - WIDE RANGE OF MOMENTUM REQUIREMENT RANGING FROM AVERAGES TO EXTREMES OF NATURAL ENVIRONMENT PARAMETERS

DUAL KEEL CONFIGURATION, CR, ORBIT ALT. = 250 N.MI. B = O, 3-21-92

- NATURAL ENVIRONMENT QUESTIONS
  - QUALIFICATION AND PREDICTIVE ACCURACY OF THE JACCHIA MODEL TO THE SPACE STATION FLIGHT ENVELOPE (INCL. ≈ 28.5°, ALT ≈ 210 - 270 N. MI.) RELATIVE TO
    - SHORT TERM CONTROL SYSTEM ANALYSIS (ORBIT TO ORBIT)
    - APPLICATION OF SOLAR FLUX AND GEOMAGNETIC INDEX PARAMETERS
  - UNCERTAINTY OF THE PREDICTED SOLAR CYCLE ENVELOPE IN THE DESIGN TIME FRAME