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MANNED ORBITING LABORATORY (MOL)

ORBITING VEHICLE
POWER UTILIZATION CONTROL

SAFSL EXHIBIT 30001

~~SECRET~~ SPECIAL HANDLING

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SAFSL J0001 - POWER UTILIZATION AND CONTROL

The undersigned has reviewed the document and understands the contents to the extent necessary to scope subsequent proposals.

5-24-68

(Signed) Wayne T. Stafford
Aerospace

(Signed) Dwight F. Johnson
- Eastman Kodak 5/24/68

(Signed) J3 Jol... GE

(Signed) Charles H. Morris ... 5/29/68

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(Signed)

SECRET

HANDLING

IFSL Exhibit: 3000 1 dated 2 April 1968
MANNED ORBITING LABORATORY (MOL); ORBITING VEHICLE POWER UTILIZATION CONTROL EXHIBIT.

The undersigned understands the technical content of this document and endorses the requirements stated therein.

[illegible] Maj SPO

H.W. Vordyke (A)

C.E. [illegible], DAC (with inclusion of Water Heater [illegible] under ECS section of [illegible] 1).

J.B. [illegible], GE (with exception: (1) [illegible] 3.1 and (2) table 1)

R.F. [illegible], MCASTRO (understanding this is not a contractual document for MCASTRO)

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This exhibit establishes the peak and average power allocations for each segment of the Manned Orbiting Laboratory Orbiting Vehicle. It defines the modes and the assumptions used in determining power utilization against these allocations. It also establishes the minimum data requirements for requests for changes to this exhibit.

This document shall be upgraded as required to reflect approved changes in the contents. Approved changes shall appear as Annexes to this document.

TABLE OF CONTENTS

2.0 APPLICABLE DOCUMENTS

The following document of the exact issue shown form a part of this specification to the extent specified herein.

SAFSL Exhibit 10003	Environmental Design and Test Criteria for the MOL System Laboratory Module, Mission Module, and Associated AGE.

3.0 POWER ALLOCATIONS

3.1 Peak Power Definitions

Peak power available to each OV segment from the LV Central Power System during the various vehicle activities are allocated on the basis of OV Peak Power Modes. These modes are defined below. These definitions constitute mandatory requirements for the mode and do not exclude operation of additional equipments consistent with contractor power allocations.

Mode A - Tracking Mirror Slew - During this mode the main optics tracking mirror slews and/or settles. The ATS are both in operation.

Mode B - Photographic Operations - During this mode the main optics tracking mirror tracks the target and the shutter and camera-back sequence occurs for each frame taken. Both ATS operate during this mode.

Mode C - Mission Payload Checkout - This is a mode over a SGLS Station that permits complete checkout of mission payload systems including the ATS. The idea is to simulate a target pass for purposes of checkout and to determine anomolies in equipment operations in real time.

Mode D_1 - Mission Payload Activation/Preparation - This is a prepass preparation time during which cues are viewed and mission payload equipment is activated and the visual optics magnification is adjusted.

Mode D_2 - Other Mission Payload Operation - This is a mode that occurs during target pass when main optics and ATS are not in operation. This would occur when there are significant periods of time between targets. Certain functions that have been inhibited may be permitted during this period.

Mode E - SGLS Station - This mode covers the period preparing for, acquiring and communicating with a SGLS Station.

Mode F - Wideband Station - This mode covers the period preparing for, acquiring and data transmission to a wideband station.

Mode G - SGLS and Wideband Stations - This mode covers the simultaneous or overlapping operation required in contact with a SGLS and wideband station.

Mode H - All Other Orbital - This mode covers all orbital activities with both crew members in the Laboratory Module excluding communication or MPSS Operation. This mode includes all activities required to support mission operations and includes such activities as film processing, cue study, food preparation, sleep, etc.

Mode I - Early or Late Orbit - This mode covers the early and late orbit periods during which transfer of crew between the Gemini B and Laboratory Vehicle takes place. Early Orbit begins with severance of the Orbiting Vehicle from the booster and ends with the closing of the hatch after transfer of the second crewman. Late Orbit is the reverse operation and begins with the opening of the Laboratory hatch and ends with the transfer from the Laboratory supply back to Gemini B supplied power.

Mode J - Launch and Ascent - This mode covers the launch and ascent periods. It begins when the fuel cells alone supply power to the LV and ends when Gemini B power is required from the LV.

3.2 OV Peak and Average Power Allocations

OV peak and average power allocations based on the preceding mode definitions are given in Table 1. For Mode C, EK is limited to the value corresponding to Mode A if the equipment is being operated in Mode A configuration for checkout, and GE is limited to 1,480 watts with the assumption that both ATS's are not in use simultaneously. If the GE and EK equipment are operated in the Mode B configuration for Mode C checkout, EK is limited to the value for Mode B and GE is limited to 1,076 watts with the assumption that both ATS are not in use simultaneously. For special configurations used in Mode C, checkout procedures shall be designed to prevent exceeding power capability. Each Segment/Contractor shall restrict his peak power to the values shown in the Table. Operations taking less than the maximum value are not restricted.

Gemini B and DAC power utilization for Mode I is further allocated on the basis of three submodes contained in Mode I. Definitions for these submodes and the corresponding allocations are as follows:

		POWER ALLOCATION-WATTS	
SUBMODE	DEFINITION	MAC	DAC
I_1	Beginning of Early Orbit to Start of Crew Transfer to the LV	700	2765
I_2	Start of Crew Transfer to the LV to end of Early Orbit	595	2900
I_3	Late Orbit	630	2900

The allocation for Gemini B and DAC contained in Table 1 for Mode I is the allocation for submode I_3, since I_3 provides the largest total peak power requirement of the three submodes. The total D1 phase will be split into four different operations which cannot be time coincident. Only one of these phases is coincident with EK loads of focus adjust, alignment and Visual Optics (v/o) Magnification Step Change.

The D2 phase (Target Pass Standby) will be defined as the time interval between the last photo operation up to but not including the Drive J door close operation. The load at Drive actuation puts the system into the phase defined as D1-2.

TABLE 1

OV POWER ALLOCATIONS

LV Power Subsystem Modes	Average	A	B	C	D_1	D_2	E	F	G	H	I	J
MCASTRO	100	175	175	175	175	175	250[a]	175	250	175	630**	0
DAC	1109	1710	1710	1869	2327	2250	2135	2100	2030	2500	2900**	1886
GE AVE	317	1751	1291	1480 or 1076*	1414**	1044	640	640	640	854	604	600
EK	285	690	1250	A or B	385**	740	317	236	317	667	305	305
WIDEBAND	11	0	0	0	0	0	0	700	700	0	0	0
TOTAL	1822	4326	4426	4370	4301	4209	3342	3851	3937	4196	4439	2791

* For Operation as in Mode A or B, but only one ATS in use at a time.

** See Paragraph 3.2

(a) For Emergency Communications: 300 watts

NOTE: ALL DATA IN WATTS

The operation for the GE-AVE during phase H (all other Orbital) will be limited to the GE-AVE Loads of Command, Telemetry, VDP and all continuous loads including environmental control and the low G accelerometer.

D1-1 Coarse Warmup

This is a mode of operation during which coarse warmup heaters are energized to ensure proper equipment operation.

D1-2 Door Cycling

This is a mode of operation in which drive electronics are in a standby and the door is actuated.

D1-3 Adjustment Preparation

This is a mode of operation in which the tracking mirror is positioned for EK adjustments.

D1-4 Adjustment

This is a mode of operation in which fpcis adjustment, alignment, and visual optic magnification step change occur.

POWER ALLOCATIONS - (WATTS)

MODE	GE	WATTS	EK	WATTS
D1-1	Coarse Warmup	1300	Telemetry	317
D1-2	Door Cycling	1340	Standby	385
D1-3	Adjustment Preparation	1414	Standby	385
D1-4	Adjustment	944	Visual Optics Mag Chg	785
			Alignment	740
			Focus	430

The upper limit of LV Electrical Power System capacity potentially available for allocation is 1.825 kw average power and 4.5 kw peak power.

3.3 Gemini B Equipment Mode Allocations

Peak power utilized by Gemini B from the LV Central Power System is allocated on the basis of Gemini B equipment modes. The correspondence between LV Peak Power Modes and the Gemini B equipment modes is given in the table below. Peak power allocations for the Gemini B equipment modes are those appearing in Table 1 under the corresponding LV Peak Power mode and in the Gemini B CEI No. CP 58010A.

	LV Peak Power Mode	MAC Equipment Mode
A	Tracking Mirror	Normal
B	Photographic Operations	Normal
C	Mission Payload Checkout	Normal
D_1	Mission Payload Activation/ Preparation	Normal
D_2	Other Mission Operation	Normal
E	SGLS Station	Normal Plus Telemetry*
F	Wideband Station	Normal
G	SGLS & Wideband Stations	Normal Plus Telemetry
H	All Other Orbital	Normal
I	Early or Late Orbit	Early Orbit or Late Orbit; See Paragraph 3.2
J	Launch and Ascent	NONE

3.4 Photographic Payload Equipment Mode Allocations

Peak power utilized by the Photographic Payload is allocated on the basis of Photographic Payload Equipment Modes. The correspondence between LV Peak Power Modes and the Photographic Payload Equipment Modes is given in the table below. Peak Power Allocations for the Photographic Payload Equipment Modes are those appearing in Table 1 under the corresponding LV Peak Power Mode except as noted in the table below.

* Emergency communication allocation 300 watts peak, Gemini B VHF backup to LVSS System.

LV Peak Power Modes		Payload Equipment Mode	Payload Equipment Peak Power Allocation (Watts) *
A.	Tracking Mirror Slew	Tracking Mirror Slew	
B	Photographic Operations	Photographic	
C	Mission Payload Checkout	LV Peak Power Mode A or B	
		Focus	430
		Alignment	740
		Process	667
D_1	Mission Payload Activation/Preparation	See paragraph 3.2	
D_2	Other Mission Payload Operation	Alignment	
		Focus	430
E	SGLS Station	Telemetry	
F	Wideband Station	Environmental	
G	SGLS & Wideband Stations	Telemetry	
H	All Other Orbital	Process	
		Unlock	367
		Environmental	236
I	Early Or Late Orbit	Launch and Boost	
		Environmental	236
J	Launch and Ascent	Launch and Boost	
		Environmental	236

* Where Different from the Corresponding LV Peak Power Mode

NOTE: Environmental Mode Power is 500 watts for the cold case, i.e., after system has been shut off for extended periods or when initially thermally stabilizing.

3.4.1 Simultaneity Assumptions

The subsystem bus activated for each of the photographic payload equipment modes is given in the following table:

Bus \ Equipment Mode	Environmental	Launch	Photo	Slew	Focus	Alignment	Process	SGLS	Unlock	Visual Optic Magnification Change	Standby
Environmental	X	X	X	X	X	X	X	X	X	X	X
LM L & B		X									
LM Instru.		X	X	X	X	X	X	X	X	X	X
Visual Optics			X	X						X	
Proc. Instru.		X	X	X	X	X	X	X	X	X	X
Focus					X						X
MM L & B		X									
MM Instru.		X	X	X	X	X	X	X	X	X	X
Controls & Displays			X	X	X	X				X	X
Unlock									X		
Alignment						X					
Processor	X	X	X	X	X	X	X	X	X	X	X
Photographic			X	X	X						X

A continuous power switching loss is incurred in all modes.

3.5 Power Calculation Assumptions

These assumptions are not to be considered as subsystem constraints or limitations. Their purpose is solely to provide a basis for establishing power utilization and they are not to be interpreted as design requirements.

Peak power is calculated for 25 volts at the LV main bus except for Gemini B which is based on 24.5 volts at the equipment terminals for the normal equipment mode and 27 volts for all other modes. Peak energies less than 10 millijoules are disregarded. Distribution losses shall be accounted for by the contractor responsible for the interface harnessing and are included in the allocations.

Average power for DAC equipment is calculated at 28 volts at the equipment. GE and EK average power is calculated for 24 volts at the respective interfaces.

All DCSG power is charged against DAC.

For MPSS, environmental control power utilization is to be based on a $\beta = 0$ orbit for the entire mission and is to be reported for a nominal time of year of March 21. Nominal fluxes as defined in SAFSL 10003 shall be used for both orbit average and instantaneous fluxes for door open conditions. A representative sun angle for instantaneous albedo calculations shall correspond to 50° N latitude. For LVSS the worst case orbital condition shall be used for environmental power utilization. In addition, the following mission related assumptions are to be used:

1.	Average processor dryer time.	120 min/day
2.	Alignment measurement.	0.5 min/active rev.
3.	Alignment operation (one per day).	10 min/day
4.	Visual Optics.	100 min/day
5.	Magnification Change	
	Visual Optics:	1/active rev.
	ATS:	3/target
6.	Film handling. (Based upon one crewman operation).	100 min/day
7.	Focus monitoring.	60 min/day
8.	Instrumentation. (On during all times when payload equipment is active as well as sampling and station contact).	441 min/day

9. Regulated dc or ac power delivered to payload interface will be charged to the EK budget while power required for activation of command relays will be charged to GE.

10. All EK power mode values include environmental control power at mission average daily cycle (normal case). Environmental power which may be evidenced during ascent, early orbits or during recovery from a sustained abnormal voltage or power-off period is denoted as the cold case and includes all heater controllers on.

11. GE environmental system is inhibited during target pass.

12.	Active target pass.	100 min/day
13.	Active photographic rev.	10/day
14.	Cued targets (tracked by ATS).	1000/day

15.	Tracked targets (primary optics).	185/day
16.	TM pitch slew time.	481 sec/day
17.	TM roll selw time.	703 sec/day
18.	TM tracking time.	2405 sec/day
19.	Photographed targets.	75/day
20.	Primary photographs per photographed target.	6
21.	Secondary camera in-out cycles.	1/photographed target
22.	Secondary camera photographs per photographed target.	1
23.	Door open time per active rev.	390 sec
24.	Door open cycles/day.*	25/day
25.	ZI, Checkout, R&D active revs	2/day
	a) targets tracked	10/day
	b) number of targets cues	20/day
	c) targets photographed	Included in Item 19 above.
	d) door open	6.6 min/day
26.	Computer on-time	244 min/day (39 DAC; 205 C
27.	Station contacts based on contact times:	
	a) clear voice	4/day for 12 min total at 25 percent duty cycle on transmitter
	b) secure voice	16/day for 90 min total
	c) track	16/day for 93 min total
	d) TLM (must include capability to receive secure TRC's)	16/day for 90 min total (16 with computer on 1 minute to accommodate computer summary data readout)
	e) command	8/day for 40 min total

*Includes ZI, Checkout, R&D and Photography only.

28. SGLS time (including warmup). (includes items b, c, d, and e of item 27) — 120 min/day

29. Wideband Contacts:
   - a) number/mission — 60 maximum
   - b) average duration — 3 minutes

30. Door area. — Based on aperture masking to the following look angle constraints:

   a) 14 deg. forward } stereo
   b) 25 deg aft } angle
   c) ± 37 deg obliquity angle

   This aperture includes the following vehicle residual motion:

   a) + 5.8 deg roll
   b) ∓ 3.0 deg yaw
   c) ∓ 2.6 deg pitch

4.0 POWER UTILIZATION CONTROL

4.1 Power Reporting

The allocations in this exhibit shall be utilized in all power reporting documentation to measure power requirements margins. Reported power utilization shall be based on the mode definitions and assumptions contained in this exhibit.

4.2 Exhibit Change Requests

Approval is required for all changes in the peak and average power allocations, mode definitions and assumptions. As a minimum requirement, requests for changes must be accompanied by:

a) a detailed engineering analysis substantiating the need for a change,

b) verification that this change can be made without exceeding system allocation limits for peak and average power capacity and without constraint of mission operational flexibility,

c) a detailed statement of system impact (e.g., weight, schedule, reliabilit documentation, and cost impact), with appropriate breakdown of data to permit SPO evaluation.

Where a change affects more than one associate contractor, the request for change must be coordinated between all affected contractors and submitted as a combined package with the above items identified for each contractor.

ANNEX 1

This Annex to SAFSL Exhibit 30001 contains the ground rules and assumptions applying to LVSS equipment and its operation and the associated LVSS peak and average power allocations.

ECS

1. MOL Sieve Heater and heater controllers are used for contingency only and equipment watts are not included in any peak or average.

2. Waste Management Blower is operational in Mode H only.

3. The water heater is inhibited by crew action for MPSS operation and will remain inhibited in modes A, B, C, D_1 and D_2. It will not be turned on during mode I_2.

ELECTRICAL

1. Contingency items do not contribute to average power (except as noted).

2. Equipment connected to the inhibit bus is inhibited in Modes A, B, C, E, F and G.

3. MPSS Feeder Losses are based on MPSS allocations: MPSS Allocation Watts/24V x 1 volt = MPSS Feeder Loss.

4. G/B Feeder Losses are based on G/B allocations: G/B Allocation Watts/ 24V x 0.4 volt = G/B Feeder Loss.

ACTS/SCE

1. Rotational thrustors are inhibited in Modes A, B, C, G, J and F.

2. Translation thrustor firing will occur in Mode H. Lower activity levels will be planned around orbit adjust. Load management will allow planned orbit adjust.

3. Average power calculations for ACTS/SCE are based on the following duty cycles:

51.2% High Power
44.6% Low Power
4.2% Standby

PROPULSION

The ACTS/Prop Low Thrustor heaters allocation is based on 75% simultaneity for peak allocations.

BIO-INSTRUMENTATION

1. IR Spectrophotometer is considered non-operational in all modes except Modes C, E, and G.

2. Charged Particle Spectrometer is used on a contingency basis only and equipment watts are not included in any peak.

3. Biological Dosimeter is included in Mode H.

DISPLAY

1. Assume 1/3 of total EL Push Button Switches and EL status lights are on for all modes.

2. The EL Caution and Warning Matrices and Incandescent Push Button Switches (Lamp Test Only) are contingency items not included in peak mode allocations.

3. The EL Digital Clock is included in Mode H.

LIGHTING

1. Main Floodlights are reported at 75% of full power for 10.5 hours per day and are off in Modes A, B, C, D_2, I_1 and J.

2. Auxiliary Floor Lights, Sleeping Area Floodlights, and Hygiene Area Floodlights are on in Mode H only.

3. EL Nomenclature Panel Lighting is on only in Modes A, B, C, and D_2.

ACQUISITION

The Digital Recorder is operated in the record condition in Mode C.

DATA COMPUTATION

1. LVSS peak power allocations include full DCSG services for all modes. Computer power requirements are based upon 244 minutes of operation per day.

2. The printer is not operated in Modes A, B, and C.

SAFSL EXHIBIT 30002

MOL PROGRAM EFFECTIVENESS

SECTION 3

SAFSL Exhibit 10032 consistutes the remainder of the Effectiveness Exhibit and together with this section forms the total Exhibit 30002.

6 JUNE 1968

3.1 System Mission Effectiveness

3.1.1 Definition

Mission Effectiveness is defined as the reliability of the MOL System in completing within design performance capability all functions necessary from liftoff to retrieval to support, provide, and return 95% of the planned primary photographic data and the flight crew for a 30-day mission. (R, AVE)

3.1.2 Effectiveness Allocations *

The 30-day mission effectiveness goal shall be .85 for the manned automatic configuration and .63 for the automatic configuration.

a. The allocations given below assume the effectiveness of all other segments = 1.

	Manned Automatic	Automatic Configuration
PSS AVE	.96	.86
MMSS AVE	.965	.92
LVSS AVE	.96	.90
Gemini B	.986	---
Titan III	.97	.95
DRV's (3 required for 30 days) **	---	.94
Ground Net (retrieval function)	---	.995
PSA	.999	---
	.85	.63

* Design changes that are identified solely to meet the allocations specified in 3.1.2 shall not be accomplished without MOL SO approval.

** The reliability of each DRV shall be .98.

3.1.2.1 Segment Effectiveness Criteria

The determinations of segment effectiveness values shall be based on the criteria specified below. (AVE)

3.1.2.1.1 Gemini B System Segment

The Gemini B System Segment shall be deemed to operate with design performance capability provided that operation of AVE is in any manual or automatic, primary or automatic mode such that the crew and transferred DRC's are safely returned to earth for recovery at the end of the MOL 30-day mission consistent with the 95% requirement. (AVE)

3.1.2.1.2 Mission Payload System Segment

The MPSS shall be deemed to operate within design performance capability provided that the MPSS AVE operates in a manner such that (1) the pointing and tracking capabilities of the main tracking mirror are within the 3σ limits of the CEI specification; (2) adequate thermal control is provided; and (3) attainment of 95% of the photographs are possible.

Specific reliability design goals for the MPSS equipment are

(1) Single IVS for M/A mode - IVS S/S mission reliability goal 0.984.

(2) Single ATS reliability goal 0.975. (AVE)

3.1.2.1.3 Laboratory Module System Segment

The LMSS shall be deemed to operate within design performance capability provided that the LMSS AVE operates in such a manner so that:

(1) The crew is free to perform experiments in a shirtsleeve environment.

(2) All displays required by the crew for performing experiments are available.

(3) Real time and recorded telemetry data required for experimentation or mission scheduling are acquired and transmitted to the ground.

(4) The subsystem operating configurations and mode selections provide a level of performance consistent with that prescribed for support of experimentation.

(5) Failures which result in an interruption of any of the above criteria during a time when the degradation does not affect experimentation are included in mission success if the criteria is re-established prior to the time of need or if the interruption lasts for less than one orbit.

The above criteria are constrained by the attainment of 95% of the photographic data. (AVE)

3.1.2.1.4 Photographic System Segment

The PSS shall be deemed to operate within design performance capability provided that the PSS AVE operates in a manner that permits the attainment of 95% of the photographic data. (AVE)

3.1.3 System Level Ground Rules and Assumptions

System level mission effectiveness models and analyses shall be developed by the LVSS contractor using inputs from the segment level mission effectiveness analyses developed by each Associate Contractor. The system level mission effectiveness computations shall be based on the ground rules and assumptions below. (T, AVE)

3.1.3.1 Calculation

Details of the mathematical combinations and associated ground rules are found in the Top Mission Effectivensss Model Report UR 105. (AVE)

3.1.3.2 Timelines and Interval Breakdown

The most recent version of the Flight Vehicle Timeline (U.S. 108) shall be used as the basis for establishing time intervals and operations during those intervals. As a minimum, the following five intervals shall be used for reliability assignment:

Ascent

Early Orbit

Orbit

Late Orbit

Reentry and Retrieval (T, R, AVE)

Further breakdown may be used for ease of the computations, if desired.

3.1.4 Segment Level Ground Rules and Assumptions

The segment effectiveness models and analyses are to be developed by each Associate Contractor for his segment and shall be based on a methodology consistent with system level effectiveness methodology. Each Contractor shall determine the equipment that is required to operate for the completion of each function, and develop the necessary numerics. The segment level effectiveness model shall be capable of providing the inputs required by the system level effectiveness model. (T, AVE)

3.1.5 Data

All input and output data, calculations, assemptions, models, and computer programs shall be available for review by MOL SPO. (T, AVE)

3.2 Probability of Launch On Time (PLOT)

3.2.1 Deleted.

3.2.2 PLOT Allocations

For the manned-automatic configuration, the one-day PLOT requirement is .68 and the any one of three-day PLOT requirement is .89. For the automatic configuration, the one-day PLOT requirement is .68 and the any one of three-day PLOT requirement is .88. These numerics do not include delays resulting from adverse meteorological conditions or local rail traffic control. Contractor allocations against these requirements are as follows: (R, AVE)

	MANNED AUTOMATIC CONFIGURATION		AUTOMATIC CONFIGURATION	
	1 DAY	1 of 3 DAYS	1 DAY	1 of 3 DAYS
PSS	.964	.99	.945	.98
MMSS	.964	.99	.96	.99
LVSS	.95	.985	.94	.975
Gemini B	.95	.985	---	---
T-III	.90	.97	.90	.97
PSA	.999	.9999	---	---
MISSION SUPPORT	.90	.97	.90	.97
DRV's	---	---	.99	.99
TOTAL	.68	.89	.68	.88

All allocations include AGE as well as AVE and are for the last six (6) hours of countdown.

3.2.3 System Level Ground Rules and Assumptions

(U) System Level PLOT model and analyses shall be developed by DAC using inputs from segment level PLOT analyses developed by each Associate Contractor. The system level PLOT model shall be based on the ground rules and assumptions below. (T, AVE)

3.2.3.1 Success Criteria

(U) A launch attempt shall be deemed to be successful if ignition occurs during the one hour window. It shall be assumed that ignition will be withheld if there is any known uncorrected failure of AVE equipment and/or if the ground/air communication operational requirements for ascent and early orbit are not being met. (AVE)

3.2.3.2 Availability

(U) The 2-week-in-advance-specification shall be interpreted to imply that activities prior to countdown can be planned so that the system is ready to start countdown on time. In other words, it is to be assumed that the system is available at the start of countdown. (AVE)

3.2.3.3 Countdown Timeline and Interval Breakdown

(U) The most recent version of the Launch Operation Flow Subgroup Baseline Flow Sequence (LOFS) shall be used as the basis for establishing time intervals for PLOT calculations. The timeline for the PLOT calculation shall be divided into no more than 9 sub-intervals. The sub-intervals shall reflect at least 1) the start and stop times of radio frequency silence, 2) time of insertion of flight crew and 3) the retraction of the mobile service tower. (T, R, AVE)

3.2.4 Segment Level Ground Rules and Assumptions

(U) The segment PLOT models and analyses are to be developed by each Associate Contractor for his segment and shall be based on a methodology consistent with the System Level PLOT methodology. The segment level PLOT model shall be capable of providing the inputs required by the System Level PLOT Model. (T, AVE)

3.2.5 Component Inclusion Guidelines - Segment

(U) For each sub-interval, those components which meet one of more of the following criteria shall be included in the segment PLOT analysis.

a. All AVE components shall be considered.

b. When the expected failures of an operating ground equipment component divided by the expected failures of the total segment operating ground equipment is greater than 0.01.

c. The total corrective action time is expected to be greater than 24 hours.

d. The corrective action requires segment disarming, demating or refueling.

e. Failure requires revalidation of any AVE.

f. The failure of the operating ground equipment component has an effect which crosses a segment interface and induces a secondary dependent failure in that interfacing segment and/or requires changes in the nominal count-down procedures of that interfacing segment. Situations requiring recycling on the second segment or requiring that the second segment wait until corrective action is completed are covered here.

g. A Class III or Class IV hazard to the prime flight crew is involved.

h. The operating ground equipment component is "critical" according to the criteria set forth in the discussion of Reliability Critical Items, RCI (See Paragraph 5.3.1).

i. The component is life limited. (See Paragraph 5.3.2).

(T, R, AVE)

3.2.6 Data

(U) The input and output data, calculations, assumptions, models, and computer programs used for Segment Level PLOT assesment shall be available at the contractor's facility for review by the MOL Systems Office.

(T, AVE)

3.3 SAFETY ANALYSIS

(U) The analysis requirements for the MOL Safety Program are specified in this section. Safety analyses shall be used to evaluate the hazardous conditions that may exist during the MOL mission and the resultant impact on safety. An acceptable level of flight crew fatality risk is specified in 3.1.3.7 of SS-MOL-1B. The hazardous conditions to be considered are specified in MIL-S-38130A. The goals for the maximum probability of occurrence of Class III and IV hazards is specified 3.3.8 herein and allocated to the affected segments. (T, AVE)

(U) Safety analyses are required by MIL-S-38130A for all phases of MOL system segment, and subsystem design and development. There exist a number of analytical techniques that can satisfy this requirement. It is intended that the most effective of these approaches be applied to MOL design to the extent necessary to verify that an acceptable level of safety has been obtained. To achieve this goal within the MOL Associate Contractor structure, each contractor must conduct a safety analysis effort compatible with the programs of all other contractors. Requirements of this section are designed to provide compatibility by assuring uniform and timely application of appropriate techniques at the integration level and apply to those AVE, AGE and facility equipments that support the prelaunch through retrieval phases of the MOL mission. (T, AVE)

3.3.1 Analysis Methods

(U) Four safety analysis methods may be used to satisfy the requirements of this exhibit for system level analysis: Gross Hazards Analysis, Fault Hazard Analysis, Fault Tree Analysis, and Operating Safety Analyses. The extent to which each analytical method is applied, including schedules and milestones, will be specified by the Contractor in his System Safety Plan (SSP), 5.3.11. The program for incorporating various Associate Contractor safety analyses into integrated safety analyses of the overall system will be defined by the phase integrating contractor in his SSP and in coordination with the supporting Associate Contractors. (T, P, AVE)

(U)For safety analysis of hazards confined to an individual segment, alternative techniques may be utilized, providing (1) the data supplied to the integrator is in a form that can be utilized and (2) the Contractor in the SSP provides justification that the techniques being utilized accomplish the end result.

3.3.2 Responsibility for Analysis Integration

(U) The Aerospace Corporation, systems level integration contractor, is responsible for conducting a gross hazards study, fault tree analyses and operational analyses at the system level. The responsibilities for integration of system safety for each mission phase shall be delegated to the associate contractors specified below.

Prelaunch and Launch Phase	Titan IIIM S/S Contractor
Ascent Phase	Gemini B S/S Contractor
On-Orbit Phase	Laboratory Vehicle S/S Contractor
Reentry and Retrieval Phase	Gemini B S/S Contractor

The contractor responsible for the design and development of a segment shall meet the intent of MIL-S-38130A by conducting the analysis defined below, as required, relative to his segment and supply the analyses data in a form that supports the integrated analyses defined above to the criteria provided below.

(T, AVE)

3.3.3 Gross Hazard Analysis

3.3.3.1 Scope of Study

(U) A system level Gross Hazard Analysis (GHA) shall be performed to provide a qualitative safety evaluation of the MOL design. This effort will be performed by the system level integration contractor.

(T, AVE)

3.3.3.2 Environmental Hazards

(U) Hazards associated with the design operational environment will be identified by the Gross Hazard Analysis. The impact of changes in the operational environment will be investigated to establish the degree to which each mission phase should be evaluated for sensitivity to environmental conditions.

(T, AVE)

3.3.3.3 Energy Sources

(U) Particular attention shall be given to sources, control and distribution of energy, such as ordnance devices, fuels and propellants, and electrical systems. (T, AVE)

3.3.3.4 Other Hazards

(U) Other areas to be considered include, but are not limited to, the following:

a. Compatibility of materials
b. Electrical transients and RF energy
c. Pressurized systems
d. Atmospheric Contamination
e. Human interface (T, AVE)

3.3.4 Fault Hazard Analysis

(U) A qualitative Fault Hazard Analysis (FHA) shall be conducted to identify potential hazards associated with each contractor's AVE and the OGE and facility equipments required for the launch phase subsequent to prime flight even insertion into Gemini B and is performed by documenting all identifiable component failure modes and defining their resultant effects. (T, AVE)

3.3.4.1 Classification

(U) The hazard associated with each failure mode shall be classified in conformity with the criteria listed in Paragraph 3.2.3 of MIL-S-38130A. Failures resulting in safe (Class I) or marginal (Class II) conditions or events required no further analysis. Failures resulting in critical (Class III) or catastrophic (Class IV) conditions or events shall be reported to the procuring agency and to the designers with recommendations for remedial action. (T, AVE)

3.3.5 Fault Tree Analysis

Fault tree analyses shall apply to the same time periods and equipment as the FHA

3.3.5.1 Scope

(C) All critical and catastrophic events shall be analyzed to determine the nature of the hazard. Fault tree analyses (FTA) shall be used to identify events or likely groups of events which will produce the defined undesired Class III or IV hazard, with a potential impact on the predicted prime flight crew fatality, or, in the case of the backup mode a qualitative fault tree type of assessment for equipment damage. (T, AVE)

3.3.5.2 Mathematical Evaluation

(U) Each segment contractor shall derive a quantitative risk assessment for all identifiable hazardous conditions, within his segment. Each segment contractor shall derive a quantitative risk assessment of hazards which may propogate across segment interfaces. This interface information shall be of sufficient detail and in such a format as to allow both mission phase and system level integration. Each phase integration contractor shall specify the data requirements such that a quantitative estimate of the probability of flight crew fatality can be established and evaluated against the requirements of SS-MOL-1B. (T, AVE)

3.3.6 Operating Safety Analysis

(U) Each Associate Contractor shall perform operating safety analyses to determine the safety requirements for personnel, procedures and equipment which he provides and which are used in maintenance, support, testing, operation and flight crew training during all phases as specified in the system requirements. Phase integrators (3.3.2) shall perform integrated Operational analyses. The analyses shall be used to verify that the equipment is safe to use or to identify additional procedural requirements necessary to assure safe usage. The analyses to be performed by the Contractor shall be described in the Contractor's SSP (5.3.0). (T, R, AVE)

3.3.6.1 Procedures

(U) The results of the operating safety analyses shall provide the basis for the preparation of procedures, including handbooks for:

a. Rendering the subsystem/system safe under normal and emergency conditions.

b. Emergency escape or egress and rescue operations.

c. Ground handling and transportation operations.

d. Operating and maintenance operations, including warning and caution notes.

(T, AVE)

3.3.7 Analysis Schedule

The analysis schedule provided below shall be used as a guide in establishing formal reviews and data submittal requirements to be shown in the associate contractor's SSP.

3.3.7.1 Analyses Flow

1 — Submittal of gross hazard study and list of identified critical and catastrophic events inherent in system design.

2 — Fault hazard analysis submitted prior to CDR so that integrating contractor can prepare system FTA in time for CDR. Submittal dates established by contract

3 — Fault tree analysis presented at CDR.

4 — Updated safety analyses, including FTA and FHA of equipment if design changes after CDR.

5 — Final safety analysis of CEI submitted for incorporation in system documentation (5.3.11.1.4).

(AVE)

3.3.8 Numerical Allocations

(U) Segment allocations of the probability of occurrence of Class III and Class IV hazards and other "Decision-Conditional" abort conditions which impact prime flight crew safety are given in Tables 3-1 and 3-2. These allocations shall be used as design goals in assessing system safety as a result of equipment failure, human error, or other system conditions. The equipment to be considered shall include all AVE and that OGE and facility equipment required for the launch phase subsequent to prime flight crew insertion into Gemini B. (T, R, AVE)

3.3.8.1 Definitions

(U) The following categories are defined for the purpose of interpreting MIL-S-38130A Class III and Class IV hazards allocated in Tables 3-1 and 3-2.

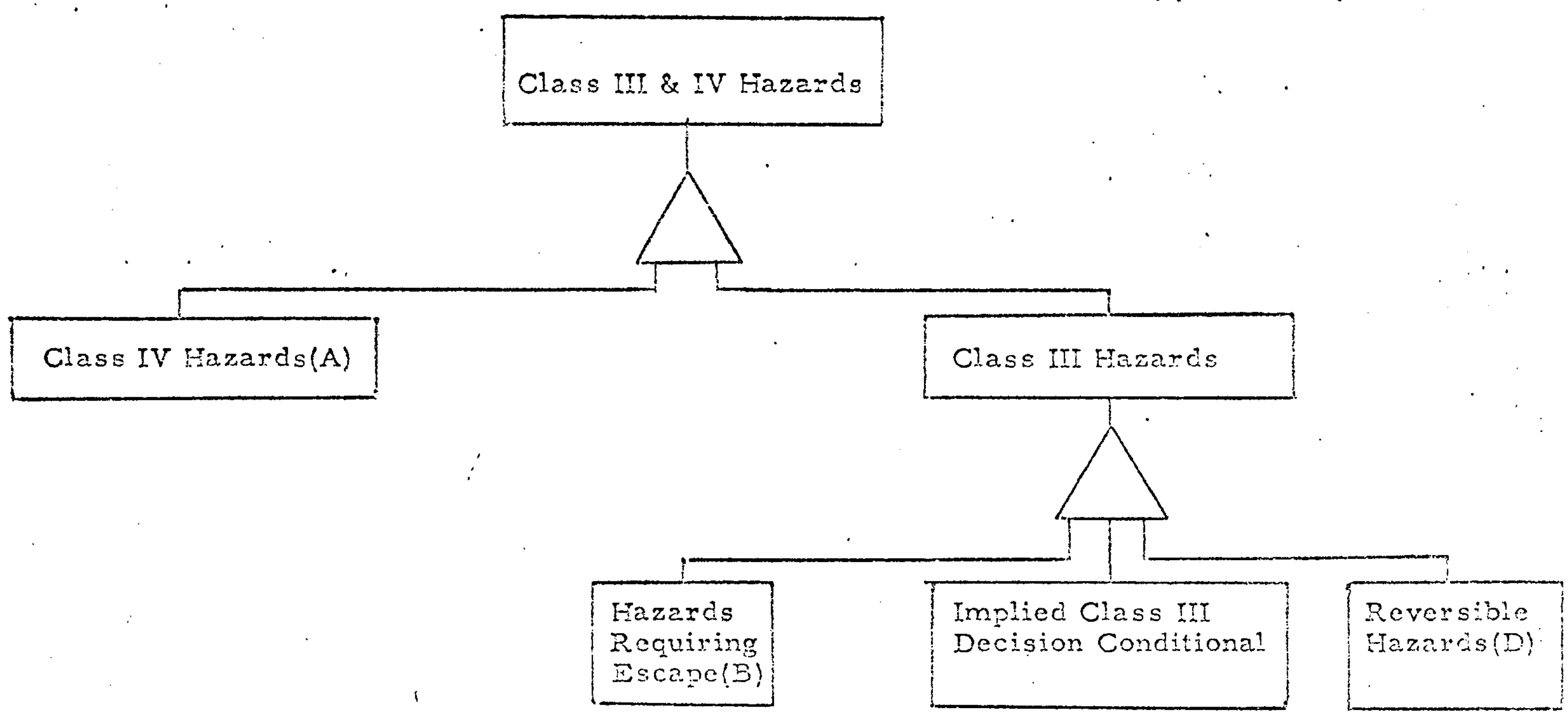
Class IV: Catastrophic Hazards - Conditions which result in crew fatality because corrective action is impossible.

Class III: Critical Hazards - Conditions which require corrective action (including escape/abort) for crew survival.

Decision-Conditional Hazards - Conditions whereby a single subsequent failure of backup equipment or alternate procedures would result in a crew fatality. (AVE)

3.3.8.2 Distribution of Hazards

(U) Tables 3-1 and 3-2 provide the distribution of hazard allocations such that those hazards of primary importance are allocated in Table 3-1. Those hazards which generally are less critical, but do significantly impact on flight crew risk, are allocated in Table 3-2. Of those hazards allocated in Table 3-1 no more than 1% of the individual values shall be Class IV catastrophic, except during the reentry phase where an escape capability does not exist. For the Reentry Phase of the mission, the Class IV hazard allocations shall not exceed 10% of the value in Table 3-1. Of those hazards allocated in Table 3-2, no more than 10% of the individual allocations distributed in each phase shall be "Decision-Conditional." Figure 3-1 provides a descriptive interpretation of the Class III and IV hazards disbribution. (T, R, AVE)



Note: Table 3-1 (A+B)
Table 3-2 (C+D)

FIG. 3-1 Distribution of Hazards

TABLE 3-1

Probability of Occurrence of Hazards For The Manned Automatic Configuration

(Class IV and Class III Hazards Requiring Escape, ppm)

System Segment	Launch (T-120 to Liftoff)	Mission Phase: Ascent	Mission Phase: Orbit	Mission Phase: Re-Entry	Retrieval
Titan IIIM	660	30,000	N/A	N/A	N/A
Gemini B	1,000	2,000	20,000	5,000	2,000
Lab Module	2,000	2,000	40,000	N/A	N/A
Mission Module	40	800	4,000	N/A	N/A
PSA	0.1	1	0.1	100	0.01
Facilities	0.1	N/A	N/A	N/A	N/A
Flight Operations	N/A	1.0	10	1.0	N/A
Recovery	N/A	N/A	N/A	0.1	1.0

Table 3-2

Probability of Occurrence of the Hazards For The Manned Automatic Configuration.

(Class III Reversible and Decision-Conditional Hazards, ppm)

System Segment	Launch (T-120 Min. to L.O.)	Mission Phase: Ascent	Orbit	Re-Entry	Retrieval
Titan IIIM	N/A	N/A	-	-	-
Gemini B	400	2,000	20,000*	5,000	3,000
Lab Module	20	20	50,000	-	-
Mission Module	40	800	16,000	-	-
PSA	1	10	10	100	N/A
Facilities	N/A	N/A	N/A	N/A	N/A
Flight Operations	N/A	1.0	10	-	-
Recovery	-	-	-	1.0	1.0

* The allocation of decision-conditional aborts for Gemini B shall not exceed 80% of this value.

APPENDIX D

EK DEVIATIONS

TO

SAFSL 30002

EK's current contract baseline calls for a reliability goal of at least 91.4% for the probability of successfully exposing 14,000 ft. of primary record at an acceptable quality level in the manned-automatic mode. This requirement is lower than the goal allocation given in paragraphs 3.1.1, 3,1.2, & 3.2.2.

Therefore a SAFSL deviation to retain the contractual baseline is granted until a study can be performed to determine the capability of the PSS to meet the SAFSL 30002 requirements.

Included in the study will be identification of changes required to approach the SAFSL effectiveness goal allocation.

PARAGRAPH	TITLE	WAIVER	REASON
1.3	Scope	EK added the following words that define CEI and selected ACE for the purposes of scope and applicability. "Photographic Payload Definition, Figure I-3 of SAFSP Exhibit 11-22, P 23049" "Test Units and Test Sets, Consoles in Table 3-11 of Aerospace Support Equipment, Spec No. 1902-154" Addendum to the Reliability Program Plan; e.g., Where tasks of 10032 are not explicitly in the existing Reliability Program Plan, they will be identified by reference to other existing documents or deliverable documents.	Clarification
4.1.1	Workmanship	MIL-STD-454 to EK 401-119	The requirements in EK 401-119 in general, exceed the requirements of MIL-STD-454.
4.1.3	Parts, Materials	"The use of non-standard materials, parts and processes in lieu of standard items shall be justified"	Presently EKC is using 50 part and material drawings which are not off-the-shelf. Consequently, an extensive part level qualification for 30 new parts would be required.

PARAGRAPH	TITLE	WAIVER	REASON
4.1.3 (cont)		To Read: "The use of parts, materials, and processes not listed in documents 401-113 and 401-119 shall be considered as non-standard and the use of non-standard materials, parts, and processes in lieu of standard items shall be justified. Substantiation of their suitability for the intended application will be provided by submittal of engineering analyses, test reports, etc., to the procuring agency."	
4.1.4		Replace first sentence. "Proper protective measure shall be used which will resist moisture, fungus and corrosion during normal usage"	Design possibility in lieu of extensive part testing.
5.2.1	MIL-STD-785	Substitute Reliability Program Plan	Minimum impact
5.2.2	Quality MIL-Q-9858A (12-16-63) USAF SPEC BULLETIN No. 515 (07-29-63)	The applicable requirements under the column entitled disposition shall be implemented in accordance with EK document 401-130, "Quality Control Manual."	To continue present applicability in effect on this program as well as other high reliability programs.

PARAGRAPH	TITLE	WAIVER	REASON
5.2.3	Maintainability	Delete MIL-STD-470 and MIL-STD-471 except for the following. Develop a joint maintainability demonstration program with appropriate associate contractor as specified in paragraph 5.2 and 5.11	EK has conducted a maintenance analysis that satisfies para. 5.2. On orbit Maintenance as required by MIL-STD-471 is not required.
5.2.5	MIL-S-38130A	Substitute Subsystem Safety Program Plan	Minimum impact
5.3.4.4		Substitute for a, b, and c that an "open critical failure exists"	EK presently uses a system that meets the intent of a problem identification system.
5.3.4.8		Add after the second sentence . . "The customer's local representative will be advised of the open critical failures. The closure of a problem or the subcontractors problem will be a notification to to the customer's local representative.. Notification by EK to in-plant representative and Failure Report and closed Failure Analysis will be made available."	Clarification

Listed below are the document numbers taken from SAFSL Exhibit 10032, Table 4-1. Corresponding to each document number in the table below is an EKC waiver request and a reason.

DOCUMENT NO.	WAIVER REQUEST	REASON
MIL-E-5440H	Substitute 401-119, 1902-154	Minimum impact
MIL-M-8090C	Guide Document Only	
MIL-M-8555A	Guide Document	Minimum impact
MIL-P-116F	Substitute FED-STD-101	Minimum impact
MIL-S-8512B	Substitute 1902-154	Minimum impact
MIL-STD-130B	Substitute 401-100	Minimum impact
MIL-STD-143A	Substitute 401-113	Minimum impact
MIL-STD-195	Substitute 401-119	Minimum impact
MIL-STD-454	Substitute 1902-154, 401-119	Minimum impact.
MIL-STD-1247A	Not applicable	
AFM-88-2A	Not applicable	
FED-STD-209A	Substitute 401-119	
SSD EXH 66-4C	Deleted	
SSD EXH 63-3	Deleted	

DOCUMENT NO.	WAIVER REQUEST	REASON
AFSCM 80-7	Guide document	Minimum impact
MIL-F-7179C	Substitute 401-119	Minimum impact
MIL-STD-810	Guide document	Minimum impact
AFM 127-101 AFWTRM-127-1 1st RADM 127-200 AFM 127-100 MILS-38130A	The segment SSPP and other implementing contractor documentation will replace the following government documents after the Systems Office has formally approved the replacing contractor documentation	Minimum impact

SAFSL EXHIBIT 30005

ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS, ORBITING VEHICLE, GENERAL SPECIFICATION

FOR THE

MANNED ORBITING LABORATORY
PROGRAM

6 JUNE
~~3 MAY~~ 1968

SAFSL 30005

The undersigned has reviewed the document and understands the contents to the extent necessary to scope subsequent proposals.

(Signed) JB Jolute GE ~~([illegible])~~	(Signed) Alan S. Lupfer
(Signed) J R Cummings MAC	(Signed) J. E. Kacht
(Signed) [illegible]	(Signed)
(Signed) [illegible]	(Signed)
(Signed) F. T. Johnson Eastman Kodak 5/15/68	(Signed)
(Signed)	(Signed)
(Signed)	(Signed)

FOREWORD

Electromagnetic Compatibility Design and Test Philosophy

Every precaution should be taken in a Manned Spacecraft program to ensure the safety of the astronauts. It is vitally important that all significant equipment involved in the flight operate properly. One factor in ensuring such operation is the control of Electromagnetic Compatibility (EMC), with the associated control of Electromagnetic Interference (EMI). EMI generation and susceptibility must be kept within limits to ensure that the composite system and its component vehicle system, Aerospace ground equipment system, and their respective subsystems and equipments are compatible within themselves and that they have a high probability of operating within acceptable tolerances in conjunction with other subsystems.

Experience with other space programs has pointed up the need for thorough EMC testing and prompt application of necessary corrective measures, from preliminary design through testing on the pad in order to minimize costly delays due to last minute EMC "fixes."

EMC control can be most expeditiously, effectively, efficiently, and economically applied during the engineering design development phase. For this reason, this specification discusses and stresses the design phases of EMC control and establishes the EMC design and test requirements for the composite system, its component systems, and their respective subsystems and equipments.

The intent of this specification is not to impose arbitrary and unreasonable requirements upon contractors, but rather to assist them in engineering a compatible composite system. For this reason, the various EMC control plans and test plans, discussed herein, are highly important and significant documents.

This specification utilizes the applicable portions of the governmental documents noted in section 2.0. It further supplements this consolidation with additional technical and management requirements to establish a MANNED SPACECRAFT SPECIFICATION. This specification was derived from SSD Exhibit 64-4 and the deviations granted to the MOL Associate Contractors. It applies only to the segments comprising the Orbiting Vehicle and a different specification applies to the T-IIIM. SAFSL Exhibit 10005 is identical to this document except EK deviations have been deleted.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

FIGURES

FIGURES (Continued)

1.0 SCOPE

P This specification provides the requirements of an electromagnetic compatibility (EMC) control program for each manned spacecraft composite system procured by the Manned Orbiting Laboratory Systems Program Office (MOL SPO). The EMC control program for each such system shall be used by MOL SPO to establish and maintain "engineered-in" EMC control from issuance of contractual go-ahead of the program definition phase through the life of the affected system so that the confidence level and degree of probability of system performance in its operational environment will be before the fact. All deliverable data and/or documentation specified in this Exhibit shall be in accordance with the respective contractor CDRL (DD1423 or equiv.) as detailed by Forms 9.

1.1 USE

For MCASTRO, SAFSL Exhibit 10005 shall be applicable to: new equipment, extensively modified equipment, and equipment interfaces between associate contractor segments.

R-AVE

(a) The contractor shall comply with the conducted and radiated interference requirements imposed by the interface specification as measured at the interface.

(b) SAFSL Exhibit 10005 shall apply to relays, solenoids, swtiches, and EED Firing Circuits, but need not apply to other passive equipment.

(c) The test requirements of SAFSL Exhibit 10005 shall not apply to launch complex AGE not associated with vehicle testing or that is not normally used in the vicinity of the launch pad, LCC, or CSA. EMC for this AGE shall be verified by successful functional utilization of this AGE and inspection of the EMC design provisions.

1.1.1 EMC Control Program

T This specification shall be used by the integration contractor assigend such responsibility by MOL SPO to establish and maintain the EMC control program subject to the approval of MOL SPO for the affected composite system and to establish and maintain the application of such a program to the component systems and their respective subsystems and equipments, as formulated in the applicable EMC design control plans, as verified by the applicable EMC test plans, and as documented in the applicable EMC test reports.

1.1.2 Application to Specifications

R-AVE The applicable and intent of this specification shall be implemented in every contractual specification, whatever its kind, class, or sub-class, which defines and describes any item of the composite system, the individual systems, when that item may affect the electrical or electronic functioning of the composite, regardless of whether an aural, electrical, mechanical or video input or output is involved.

1.2 CLASSIFICATION

This specification covers the EMC control of the Orbiting Vehicle Segments. As a composite system, it will consist of all or part of:

(a) the vehicle which will consist of one or more stages and capsules or modules each of which may comprise all or part of theee subsystems:

R-AVE

1. spaceframe, including environment control, separation and joining mechanisms, observation and access areas and provisions therefore

2. propulsion, including primary, secondary, tertiary

3. electrical power, including primary and secondary power sources, such as batteries, solar arrays, fuel cells, and inverters

4. guidance and control, including attitude control and stabilization, orbital adjustment

5. communications, including telemetry, data link

6. life support which will comprise those devices, plumbing, wiring, scaling, seating, etc. which are installed in the life support compartments, bays, or other areas of the appropriate capsule(s) or module(s)

7. experimentation and observation equipments, self-contained power therefore, and the various accessories attendant thereon.

(b) The astronaut subsystem which will include those equipments, materials, and items worn or carried by the individual men, such as radio transmitters and receivers, light sources, body functions, psychophysiological equipments, etc.

(c) The aerospace ground equipment system (AGE) consisting of:

1. the operational ground equipment (OGE) subsystem which includes the instrumentation, control and checkout consoles, cabling, wiring, communications, ground electrical power, fluid loading (whether liquid or gas), handling, including erecting, mating, demating, adjusting, calibrating, command loading, and all other material required to conduct precountdown tests, countdown, and launch

2. the maintenance ground equipment (MGE) subsystem which includes those items and material of the types noted in (1) above, (OGE), which are used to maintain the vehicle system in, or restore it to, a state of readiness for launch, countdown, and precountdown tests. For EK Only: Although support equipment not associated with the vehicle system in its final launch configuration is not considered part of the composite system and thus excluded from the requirements of this specification, factory checkout equipment used for EMC testing shall be designed such that its operation does not degrade the EMC or EMI test results or the operation of the AVE equipment under test. For other Associate Contractors, this EK deviation applies to non-CEI equipment.

3. exchange hardware used for electrical tests with the EDCTU, qualification, acceptance, and readiness tests shall meet the OGE EMC requirements or the allowable EMI limits specified in the appropriate interface specification.

For purposes of this specification, the operational environment shall be understood to be that of the launch environment, including precountdown tests, countdown, and launch, as encompassing the worst environment to be encountered by the composite system, its component systems, and their respective subsystems and equipments. The ambient EMC environment surrounding the launch vehicle is not included in the conditions stated in this specification. The contractors shall inform the SPO when the ambient conditions (data to be furnished by the SPO and analyzed by the EMC integrator) do not allow the contractor to meet the requirements of this specification.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. In case of conflict with this specification, the requirements of this specification shall govern.

(a) MIL-STD-831 - Test Report, Preparation of, dated 28 August 1963

(b) MIL-B-5087B - Bonding, Electrical, and Lightning Protection, for Aerospace Systems, dated 15 October 1964

(c) MIL-STD-202C - Test Methods for Electronic and Electrical Component Parts 12 September 1963

(d) SAFSL 30034-EMC Control Plan Composite System 6 June 1968

It is to be acknowledged that the documents listed below provided source material for this specification, although their particular requirements are not specified herein.

AFMTCP 80-2, Vol I Appendix A	General Range Safety Plan, Air Force Missile Test Center, Patrick Air Force Base, Florida
MIL-STD-826(USAF)	Electromagnetic Interference Test Requirements and Test Methods
MIL-E-6051	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon Systems, Aircraft Subsystems, and Aircraft (Cf. Aerospace Industries Association-proposed "D" revision thereto)
MIL-I-6181	Interference Control Requirements, Aircraft Equipment
MIL-I-26600	Interference Control Requirements, Aeronautical Equipment
AF/BSD Exhibit 62-87	Electro-Interference Control Requirements for Minuteman (WS-133B)

3.0 REQUIREMENTS

3.1 ELECTROMAGNETIC COMPATIBILITY CONTROL PROGRAM

3.1.1 Composite System

It is the intent of this specification to provide the requirements of an Electromagnetic Compatibility (EMC) Control Program for each spacecraft composite system procured by the Manned Orbiting Laboratory System Program Office (MOL SPO). Such a Program shall be used by MOL SPO to establish "engineered-in" electromagnetic compatibility control from approval of go-ahead of the Program Definition Phase through the life of the affected composite system. The implementation of the EMC Control Program requirements shall be accomplished by the EMC Control Board through the composite system EMC Design Control Plan and the subsystem and equipment EMC Design Control Plans and through the EMC Test Plans associated with each. The Test Plan Reports will document the activity and shall function as the formal record of contractual compliance with this specification.

Electromagnetic compatibility shall be engineered-in by before-the-fact design of the composite system components in accordance with the requirements of this specification so as to preclude the existence of any potential undesired interference(s) in or between the components, i.e., the vehicle system and the AGE system, regardless of where their electrical, aural, video and mechanical inputs and outputs fall within the overall frequency spectrum of the composite system.

3.1.1.1 EMC Control Board

The EMC Control Board shall be established by MOL SPO on the initiation of go-ahead of the Program Definition Phase of a manned spacecraft composite system procurement program and shall function through completion of the Development Phase. The Board shall exercise technical control of the composite system EMC Control Program, of the composite system

EMC Design Control Plan which is established and maintained to implement the Program, and of the EMC Test Plan which is established to verify the composite system EMC Design Control Plan within the constraints of the Control Program.

The EMC Control Board shall function as specified in the EMC Board Charter contained in SAFSL 30035.

3.1.1.2 EMC Design Control Plan

3.1.1.2.1 Schedule

The composite system EMC Design Control Plan shall be established by the integration contractor, in coordination with the associate contractors, and shall be submitted to MOL SPO for approval within ninety (90) calendar days after contractual notice of go-ahead for the Program Definition Phase from the procuring activity. At its descretion, MOL SPO shall convene the EMC Control Board to resolve any problem areas arising from lack of complete approval of the submitted Design Control Plan and to establish any schedule(s) necessary for accomplishment of complete approval by MOL SPO.

Maintenance of the composite system EMC Design Control Plan shall be the responsibility of the integration contractor who shall revise or supplement it with the approval of MOL SPO. This maintenance of the composite system EMC Design Control Plan shall be directly related to the EMC Design Control Plans for the individual subsystems and equipments of the vehicle and AGE systems, as noted below.

3.1.1.2.2 Content

P The composite system EMC Design Control Plan shall delineate the methods that shall be used by the EMC Integrator to ensure the electromagnetic compatibility of the combined system segments, in a composite MOL system.

3.1.2 Subsystems and Equipments

3.1.2.1 EMC Control Group

T Each associate contractor (this includes the integration contractor in his function as a direct contractor for one or more of the vehicle and AGE subsystems or equipments) shall establish an EMC Design Control Group which shall function for the affected subsystems/equipments.

The EMC Design Control Group shall meet as required through the life of the composite system program.

3.1.2.2 EMC Design Control Plan

3.1.2.2.1 Schedule

T Each associate contractor shall establish an EMC Design Control Plan for the individual subsystem(s) or equipment(s) for which he has contracted with the procuring activity and shall submit it(s) to the integration contractor within forty-five (45) days of contractual go-ahead of the Program Definition Phase. Such a Plan shall be maintained through the life of the composite system program and shall be submitted in accordance with the schedule(s) established by the integration contractor. Such a design control plan shall include the constraints placed on subcontractors and suppliers to assure EMC.

3.1.2.2.2 Content

Interference shall be controlled to eliminate undesired interaction and malfunctioning of the respective electronic and electrical subsystems and equipments, regardless of whether the affected inputs and outputs of the systems are electrical, aural, video, or mechanical. This requirement applies to the entire frequency range of such subsystems and equipments, and those for which "provisions for" have been incorporated, when performing their intended functions. There shall be no improper response, whether unacceptable or inadvertent, from the output of any vehicle or AGE subsystem or equipment because of electromagnetic interference produced by any or all of the electrical, electronic, and other devices of the subsystems or equipments when tested in accordance with the applicable EMC Test Plan (see section 4.1).

This requires that such subsystems and equipments not be adversely affected by interference voltages and fields reaching them from external sources and also requires that such equipment and subsystems not be sources of interference which might adversely affect the operation of other equipments or subsystems.

The design aspects of the composite system operational environment, utilization of the inherent shielding characteristics of the vehicle or installation, antenna location, shielding and bonding techniques, cable routing, the design and location of interference control components, and alll other pertinent design and control factors shall be included in the affected subsystem/equipment control plans.

Each Design Control Plan shall consider frequency management of all equipments as a prime factor in controlling the operational electromagnetic environment. Frequency management shall consist of: control of all assigned primary radiating bands and requencies, strict conservation of spectrum bandwidths; control of all local oscillator frequencies and rise times; gain bandwidth products, harmonic and sideband control, and time duty cycle operation of equipment.

3.1.3 Short Duration Interference

R-AVE Exemptions shall not be granted for short duration or transient interference in any EMC Design Control Plan, unless such interference occurs at such a time sequence as to not affect the operation of the MOL System and with the approval of MOL SPO (MCASTRO system segment single event switching transients are not required to meet SAFSL 10005 interference requirements provided they do not cause Flight Vehicle system interference. All Gemini B System Segment switches and relays (except hand controller switches) will be considered single event switching devices).

3.1.4 Electromagnetic Interference Safety Margin

R-AVE The Electromagnetic Interference Safety Margin (EMISM) shall be determined for critical leads under operating conditions, including switching equipments or subsystems ON and OFF manually by the astronauts or as programmed. Operating conditions shall be defined as the launch environment for FV system test, factory environment for segment testing and screen room or factory environment for subsystem and equipment testing. The susceptibility threshold shall be determined at the subsystem and equipment level within the constraints of this specification. The reference for system an[illegible] ... shall be actual operating noise.

3.1.5 Electroexplosive Actuated Systems

R-AVE This specification prescribes the minimum acceptable ordnance EMC characteristics to enhance the safety of personnel, the space vehicle system, and the vehicle launch facilities during ordnance operations in existing and planned vehicle electromagnetic radiation environments. The following paragraphs of SAFSL Exhibit 30005, with identified deviations or interpretations, shall apply to the design and verification of design of EED's and firing circuits. Subparagraphs of an applicable paragraph are not applicable unless specifically identified. The remaining paragraphs of SAFSL 30005 apply for design only.*

3.1.6 Government Furnished Equipment

T It shall be the responsibility of each affected associate contractor and subcontractor which uses government-furnished equipment (GFE) as part of its subsystem(s) and equipment(s) to ensure that such equipment meets the requirements of this specification and of the affected EMC design control plan. In the event that such compliance necessitates testor modification of the GFE, which is out of scope of the affected segment contract such tasks shall be subject to separate negotiation.

*The following paragraphs of SAFSL Exhibit 30005, with identified deviations or interpretations, shall apply to the design and verification of design of EED's and firing circuits. Subparagraphs of an applicable paragraph are not applicable unless specifically identified. The remaining paragraphs of SAFSL 30005 apply for design only.

SAFSL Exhibit 10005 Paragraph	Title
3.2.5.2	Interconnecting Wires
3.2.5.4	EED Firing Circuits
3.3.1.3.1	RF Susceptibility
3.3.1.3.2	
3.3.1.3.2.1	
3.3.1.3.2.2	
3.3.1.3.2.3	
3.3.1.3.2.4	EED Validation
3.3.1.3.2.5	
3.3.1.3.2.6	
3.3.1.3.2.7	
3.3.3	Validation of EEED and EED Initiator Circuit
3.3.3.1	System Sensitivity
3.1.4	EMISM
3.3.3.2.1	RF Susceptibility - Data

3.2 DESIGN

3.2.1 Interference-Free Design

R-AVE P Interference control shall be considered in the basic design of all electronic and electrical equipment and subsystems. The design shall be such that, before any interference control components are applied, the amount of interference inherently generated and propagated is the minimum achievable consistent with good design practices. The application of interference control components that must be used, such as filtering, shielding and bonding, shall conform to good aerospace engineering practice and should be an integral part of the system. Any interference control components must be of minimal weight and volume consistent with maximal reliability, vehicle weight constraints and associated tradeoffs.

Separately installed and external components shall not be used unless specifically authorized by the procuring activity.

3.2.2 Susceptibility

All equipment shall be designed to minimize susceptibility to interference from other sources. Any enclosing case construction shall be designed R-AVE P not only to minimize interference propagation but also to minimize interference pick-up from external sources. Where conducted energy on the power or other external leads might cause interference, these leads shall be isolated from others to avoid coupling and where necessary and feasible, shall have line filters at thieir entry into the enclosing case.

Receiving antenna inputs or other low-level signal circuits shall be of low impedance or of balanced design so that coaxial or other shielded transmission lines can be used to ensure an interference-free installation. Routing of such circuits within the equipment shall minimize circuit coupling with power and control leads. There shall be no common impedance paths or sharing of incompatible ground returns between different classifications such as signal, power, control or ordnance circuits or within the same classifications.

3.2.3 Case Shielding

R-AVE Mechanical discontinuities in the case of those enclosures intended to provide EMI Shielding, (such as covers, inspection plates, and joints) shall be kept to a minimum. All necessary discontinuities shall be electrically continuous across the interface of the discontinuity so as to provide a low-impedance current path. Multiple-point spring-loaded contacts are suggested as a desirable method of obtaining this low impedance continuity. Ventilation openings shall be designed not to degrade the required case shielding effectiveness. Electrical bonding shall be provided where access doors or cover plates form a part of the shielding; hinges, in themselves, are not considered satisfactory conductive paths.

3.2.4 Bonding

R-AVE The provisions of MIL-B-5087 with regard to characteristics, application and testing of electrical bonding shall be applicable. The appropriate MIL-B-5087B bonding class shall be used. The use of BE/CU or aluminum bonding straps of L/W ratio $\leq$ 5 and a minimum thickness of .005 inches is permitted. The requirements of paragraph 3.1-3.1.3 of MILB 5087B may be met through the use of contractors preferred parts list.

3.2.5 Design Criteria

3.2.5.1 Interconnecting Wire Design *

AVE Line shielding shall not be used when equivalent interference reduction control or containment can effectively be accomplished inside an equipment. It shall not be used intentionally as a current carrying conductor, except for coaxial conductors in rf circuits. Equipment requiring antennas, but not employing wave guides, shall be designed to utilize coaxial cable as lead-in. When it has been determined that a single braid shield is not adequate, a double or triple braid, or a solid shield, shall be used as required. The following criteria shall be used to determine signal line and shield configuration.

3.2.5.1.1 DC Supplies

To minimize the possibility of DC supply lines coupling interference to other circuits and to protect them from receiving interference from other lines, the best procedure is to use twisted-pair for the supply line and its return. Shielding should not be used on power wires.

3.2.5.1 2 AC Power

Alternating current of comparatively high amperage, characteristic of most AVE AC power lines, makes them potential sources of interference through coupling to adjacent lines. Transposed or twisted lines shall be used for all AC power circuits. The routing of these lines shall be away from susceptible lines. Shielding should not be used on power wires.

3.2.5.1 3 Low Level Signals of Low Impedance ($\leq$100MV and $\leq$1000Ω)

For runs internal to the equipment, the use of a twisted-pair alone may prove adequate. For runs external to the equipment, twisted-pair shielded wire shall be used. When shielded wire passes through a connector, three pins should be made available on the connector to provide insulated passage of the two signal leads and the shield. Shields must be grounded at least at one end. For signal wires external to equipments, balanced circuitry shall be used. Low level RF circuits may use coaxial cable and need not be balanced. Circuit impedance represents either the source or load impedance, whichever is higher.

*The following design criteria are for wiring external to equipment, however the criteria may be used as design guides for wiring internal to equipment.

3.2.5.1.4 Low Level Signals of High Impedance ($\leq$100MV >1000Ω)

-AVE Where signals from high impedance output devices must be transmitted over any appreciable distance, an impedance transforming device such as a transformer, cathode follower or transistor should be used to lower the transmission circuit impedance to 1000 ohms or lower. However, the use of high impedance signals for transmission of information should, in general, be scrupulously avoided, whether high or low level. Where the use of such signals cannot be avoided, the interconnecting lead must be shielded and the shield grounded. In some cases, the use of a double or triple shielded cable grounded at each end may be required if the cable is in an intense electrostatic environment. Circuits not meeting the impedance criteria of $\lesssim$ 1000 Ω of 3.2.5.1.3 are defined as high impedance.

3.2.5.1.5 High Level Signals (>100MV)

Signal circuits of high level will, in general, not be susceptible to EMI. Rather, they may be a source of interference to lower level signal lines. For this reason, and dependent on other characteristics of the signal, either a twisted-pair or a shielded lead should be used. Multiple shielding may be required if the signal is of sufficient level. Shield Grounding should be at both ends of the shield to prevent electrostatic radiation from the cable.

3.2.5.1.6 Reference Voltages

R-AVE The transmission of reference voltages should be avoided. If this is not possible, care should be taken to minimize the possibility of introducing interference as well as AC voltages. Grounding, where required, should be only at one point. Treat the reference voltage as a circuit, always including its return lead either in the form of a twisted-pair or a shielded or coaxial lead.

The use of twisted-pair and/or shielding for the reference voltage lead and its return will minimize the pickup from sources of electromagnetic radiation. In the case of AC reference voltages this treatment will also minimize the interference effect that the reference voltage might have on other circuits. Shielding of the twisted-pair may be helpful, especially when the circuit impedance is not held to a low value; however, filtering of the reference voltage inside the using equipment is to be preferred over the use of shielding. The source impedance of the voltage should be maintained as low as possible in order to minimize electrostatic pickup. In any case, the using element should see only the reference voltages, and not the reference voltage plus small components of other signal and power voltages.

3.2.5.1.7 Control Voltages

The control of various functions is usually accomplished with the use of voltages of either AC or DC which are switched on or off in a step manner. Lines carrying such voltages are potential interference generators; they should be of a nature that will hold coupling to other circuits at a minimum. Separation and shielding are thus applicable.

3.2.5.1.8 RF Signals (>150KHZ or ≤10 u sec rise/fall time signals)

R-AVE RF signals within a unit should be routed in such a way that cross coupling between input and output circuits is held to a minimum. Outside the unit, shielding should be used if necessary to prevent excessive radiation from the wire or excessive pickup on the wire. Grounding of such shields shall be multi-point and continuous for rf signals.

3.2.5.1.9 Shield Continuity

R-AVE The electrical continuity and isolation of signal circuit electrical shields shall be maintained through connectors, equipment, and/or junction boxes intermediate between the signal source and the signal load. Any intermediate terminal strip or block shall be shielded by a metallic enclosure which is bonded to the structure. Where the number of connector pins is limited, shields may be grouped on a selective basis and carried through on a single pin. Individual shield segment may be separately grounded.

3.2.5.1.10 Shield Breakouts

Only the following methods of shield termination are acceptable.

(a) On the electrical connector, provided the connector has a conductive finish and is provided with a conductive path to structure.

(b) Direct to structure, provided the length of shield pigtail is 6 inches or less.

(c) Terminate inside of the equipment by means of a pin in the electrical connector. The combined length of the ground wire and pigtail shall be 6 inches or less.

It is preferred that the shield extend inside the connector shell. In the event that this is not feasible, the shield breakout shall be so positioned that it is as close as possible with not more than 1.5 inch of unshielded, insulated wire showing in back of the connector.

3.2.5.2 Interconnecting Wires Categorization and Seperation

In order to reduce interactions between the different subsystems, interconnecting wiring shall be isolated in accordance with the following criteria. A minimum of 4 inches shall be maintained between wires or wire bundles of the different categories. Separation during constrained passages including ground umbilicals may be less than 4 inches but shall be resumed as soon as practical after passing constrained area. (For EK: If cable separation is required to reduce interactions between wires of different signal types, 4 inch separation, consistent with space allocation factors, should be maintained between wires.) (For the Gemini B Segment: In the re-entry module and at the interface between it and the adapter, in order to reduce interaction between the different subsystems, interconnecting wiring shall be isolated where feasible in accordance with following criteria. A minimum of 4 inches shall be maintained between wires or wire bundles of the different categories, except when different categories use the same connector, or where space and/or weight constraints make such separation impracticable. In such a case, pin assignment and layout shall stress isolation between different categories, and grounded spare pins shall be utilized when available to provide isolation for sensitive circuits.

In the adapter module, interconnecting wiring shall be separted using the same criteria applied in the re-entry module except:

(a) Wires crossing the interface between Gemini B and associate contractor segments shall be classified into categories I, II or III, as applicable. A minimum of four (4) inches shall be maintained between interface wires or wire bundles of these three (3) categories. However, interface wires need not be separated where they pass through guillotines.

(b) Gemini B wires not crossing the interface may be bundled with interface wires providing the interface wire categorization is not violated).

The classifications of the following wire categories are design requirements to assure compatibility. Further subcategorization may be required to achieve compatibility because of complexity of design or in the case of a circuit filling the criteria for two categories and are not precluded by this specification.

Category I

1. Three phase power distribution wiring (twisted)
2. Single phase power distribution (twisted with return wire)
3. Other wiring carrying 115 volts ac
4. DC circuit wiring carrying currents (transients and steady state) above 5 amps
5. Low voltage power circuits (ac)
6. Low voltage lighting circuits (ac)

Category II

Wiring carrying less than 36 V peak and current between 100 ma and 5 amps.

Category III

1. Low level circuits
2. Low voltage signal circuits
3. Receiving antenna coaxial cables

Category IV

All ordnance firing circuits.

Category V

(Not for GE and EK) RF transmitting coaxial transmission lines and wave guides (150 kc and above).

3.2.5.3 Grounding and Isolation

A single-point grounding system shall be the design baseline. A deviation to use multipoint ground will be granted when such is proven to be electromagnetically compatible. Each electrical component shall have the primary power terminals isolated from its own case by a minimum DC resistance of 1 MEGOHM when all of its external harnesses are completely disconnected. (For MCASTRO a separate guidance and control ground may be used. Resulting structure return shall not jeopardize system compatibility.)

3.2.5.3.1 Power System Ground

-AVE The negative lead of individual power sources that are separated from each other by 5 feet or more or are located in separate vehicle compartments shall have its own Structure Ground Point (SGP) connected to the vehicle frame adjacent to the power source. The length of the lead from the power source to the SGP shall not exceed 16 feet and shall not extend through any vehicle interface. All ground return leads for any one load shall be grounded to the SGP for the power source of that load. All DC ground power supplies shall be grounded at the SGP for that particular load. If more than one load or SGP is involved, separate ground power supplies shall be used. There shall be no sharing of ground return leads between separate subsystems. Any deviation from this requirement shall be approved by MOL SPO. (For MCASTRO, the negative lead of individual power sources, within the Gemini B shall terminate at a negative bus which in turn is connected to one (1) structural ground point on the spacecraft vehicle frame. The length of leads from power sources to the negative bus shall be as short as practicable. All ground power supplies shall be grounded at the SGP for that particular load. If more than one load or SGP is involved, separate ground power supplies shall be used. There shall be no sharing of ground return leads. Any deviation to this requirement must be approved by the MOL SPO).

3.2.5.3.2 Sensitive Circuit Grounding

R-AVE Grounding connections for signal circuits shall be made to the SGP of the power source supplying the signal source or load.

3.2.5.3.3 Aerospace Ground Equipment (AGE)

R The low or neutral sides of AGE power supplies and operational, calibration, and test circuitry associated with the vehicle shall, except for rf circuits, be isolated from each ground potential and shall be terminated at the vehicle. When the circuit is disconnected from the vehicle, a switched safety ground may be used to preclude personnel hazard.

3.2.5.3.4 Radio Frequency Sensitive Circuits

R-AVE Equipment intentionally operated in frequency ranges above 150 kc or rise or fall times less than 10 micro seconds may have secondary power supply circuit ties exist, the following ground and isolation requirements are mandatory. Excluding primary input power (which is covered in Paragraph 3.2.5.3).

(a) A minimum dc resistance of 10,000 ohms shall exist between all audio frequency (0-150 KHZ) input or output terminals or leads and the RF circuits with both audio frequency and RF frequency circuits having a common ground reference at the unit case.

(b) Wire shields, including coaxial cable outer conductors, shall be multiple grounded; they must be continuous and tied to the unit case(s) at both ends.

R-AVE 3.2.5.4 EED Firing Circuits

Firing circuit conductors, shall be twisted pairs to maintain electrical balance and reduce induction. EED firing circuits shall be isolated from other electrical circuits and each other by means of individual shields before and after installation of the EED. Shielded EED circuits may be routed together in a common secondary shield. There shall be no electrical discontinuity or gaps in the shields. No EED circuit shall share th L-6006

Firing circuits to EED's shall be balanced to, and isolated from, the EED case and other conducting parts of the vehicle. If a circuit must be grounded for static discharge protection, it be grounded with a static discharge resistor of 100,000 ohms or more.

3.3 INTERFERENCE CONTROL REQUIREMENTS

3.3.1 Subsystems and Equipments

Requirements for interference control for subsystems and equipments are
R-AVE included in the table of Figure 1. The limits defined in the various sections noted in Figure 1 are relaxed for AGE only as follows: Radiated interference for Operational Ground Equipment (OGE) shall be measured at a distance of three feet. An increase of 10 db in the limits for conducted interference for OGE is allowed for wiring that does not directly interface with AVE. Only requirements A and B of Figure 1 are applicable to Maintenance Ground Equipment (MGE). Radiated interference for MGE shall be measured at a distance of three feet, with an increase of 20 db allowed in the limits for radiated interference and 10 db in the limits for conducted interference. No relaxation of these requirements shall be permitted for carry-on equipment.

3.3.1.1 Interference Generation Limits

3.3.1.1.1 Conducted Interference

R-AVE Interference voltages or currents in the frequency range of 30 cps to 100 Mc, generated by an equipment or subsystem in excess of the values indicated in Figures 2 and 3, shall not appear on any conductor which may conduct interference to other equipments or subsystems. A description of the test setup is found in Paragraph 4.7.2 and Figures 9, 10 and 11.
Interference limits of Figures 2 and 3 shall not be applied to those leads carrying the intentional signals within the frequency passbands specified in individual equipment performance specifications).

3.3.1.1.1.1 30 cps to 15 kc

R-AVE Narrowband cw conducted interference shall not exceed the value shown in Figure 2 when the meter is used with a 60-cps or less bandwidth. Broadband and pulsed cw conducted interference shall not exceed the values shown in Figure 2, when measured in a wideband peak mode of the meter as shown in Paragraph 4.7.2.1. The fundamental and harmonics (2-5) of the powerline measured in the powerline shall be exempt from meeting this requirement, however, the measurements shall be made and 6 db EMISMS for all critical circuits shall be maintained.

3.3.1.1.1.2 15 kc to 100 Mc

R-AVE In the frequency range of 15 kc to 100 Mc the interference values shall not exceed those shown in Figure 3 when tested as required by Paragraph 4.7.2.1.

3.3.1.1.2 Radiated Interference

R-AVE Radiated interference fields in excess of the values shown in Figures 4 through 7 shall not radiate from any unit, cable (including control, pulse, IF, video, antenna transmission, and power cables), or interconnecting wiring over the frequency range of 15 kc to 400 Mc for broadband impulsivd interferences and 15 kc to 10 Gc for cw and pulsed cw interference. (EK: "For testing purposes, the upper frequency limit shall be 1 Gc, or the twentieth harmonic of the highest fundamental frequency being purposely generated, whichever is higher, for cw and pulsed cw interference.") This requirement includes transmitter fundamental spurious radiation, oscillator radiation, other spurious radiations, and broadband interference, but does not include radiation emanating from antennas. A description of the test is included in Paragraph 4.7.2.2.

3.3.1.1.3 Antenna-Conducted Spurious Emanations

3.3.1.1.3.1 Transmitter (Keyup) or Receiver

R-AVE The rf output of any transmitter (keyup) or receiver shall not exceed 40 db above 1 microvolt for cw or 60 db above 1 microvolt per Mc for impulse interference at any frequency between 0.15 and 10,000 Mc. Actual measurements above 1,000 Mc will not be required, if the contractor can show that such measurements would not result in significant data.

3.3.1.1.3.2 Transmitter (Keydown)

AVE Spurious emanations shall not exceed a level of -25 dbm, when tested as described in Paragraph 4.7.2.3. Actual measurements above 1,000 Mc will not be required, if the contractor can show that such measurements would not result in significant data.

3.3.1.1.3.3 Transmitter Crossmodulation

R-AVE The transmitter shall meet the requirements of Paragraph 3.3.1.1.3.2 above while being subjected to the test described in Paragraph 4.7.2.4.

3.3.1.2 Susceptibility

R-AVE Equipment deemed by the procuring activity to be incapable of being affected by applied extraneous signals will be exempt from the susceptibility requirements noted below.

3.3.1.2.1 Conducted Susceptibility

3.3.1.2.1.1 Conducted - 30 cps to 150 kc

R-AVE No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when a sine wave voltage of the level shown in Figure 15 is applied in series (for AGE, the conducted susceptibility test requirement shall be per Figure 15 or 3 volts rms, whichever is smaller) with each power [illegible] of the test sample.

The test setup will be as described in Paragraph 4.7.2.5.1.1.

3.3.1.2.1.2 Conducted - 150 kc and Above

R-AVE No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when an rf signal of +13 dbm, developed across a 50 ohm load, is applied across the power input terminals of the test samples. The test description is found in Paragraph 4.7.2.5.1.2.

3.3.1.2.1.3 Conducted - Transient

R-AVE No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when a pulse or transient is induced in or across the power line and between each power line and case in each polarity using the test setup and transient description found in Paragraph 4.7.2.5.1.3. (EK Deviation: No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when a pulse or transient is induced into it in accordance with section 4.7.2.5.1.3. This is not a requirement for equipment internal to the system (i.e., non-interface) where it has been shown by analysis or test that the equipment will not be subjected to a transient of this magnitude. However, for internal equipment, an appropriately reduced test level shall be used).

3.3.1.2.2 Induced into Cable

R-AVE Interconnecting cables shall withstand, without evidence of equipment performance degradation, the application of a magnetic field caused by a wire carrying 20 amperes rms at the fundamental power frequency. The test description is found in Paragraph 4.7.2.5.2.1.

3.3.1.2.3 Induced into Equipment

R-AVE No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when it is subjected to an ambient magnetic field as described in Paragraph 4.7.2.5.2.2.

3.3.1.2.4 Radiated Field

No undesirable response, malfunction, or degradation of performance shall be produced in any equipment when it is subjected to the following radiated fields:

R-AVE

Frequency	Field Strength
0.015 to 35 Mc	10 v/m
35 to 1000 Mc	5 v/m
1 to 10 Gc	5 v/m

The test setup and equipment are described in Paragraph 4.7.2.5.3. The test shall be carried out to the level of equipment malfunction or a 6 db higher field intensity, whichever is lower. However, if analysis or prior test data indicates that equipment damage above the normal susceptibility test limits will result, these malfunction threshold level tests need not be performed and the susceptibility threshold shall be the susceptibility test limits.

3.3.1.2.5 Intermodulation

R-AVE Receivers, preamplifiers, or antenna couplers shall not produce an output indication when two sine wave signals, representing undesired signals, are connected to the input terminals of the test sample. The test frequency selection and levels are given in Paragraph 4.7.2.6.

3.3.1.2.6 Receiver Front End Rejection

R-AVE Front end rejection of receivers shall be equal to or greater than the limit shown in Figure 8, except that image rejection outside the tuning range of the receiver shall be 60 db. This requirement shall apply to each tuning unit on receivers with plug-in or separate tuning units. Dimension (a) in Figure 8 shall not be greater than 20 percent of (fc). A description of the test and the method of calculating the front end rejection ratio are given in Paragraph 4.7.2.7.

3.3.1.2.7 Susceptibility Threshold

R-AVE A susceptibility threshold curve shall be determined experimentally with supporting analysis for each critical test point (See Paragraph 6.2). This data will be used during full system testing to establish the EMISM (See Section 6).

3.3.1.3 Electroexplosive Devices (EED's) Class A

R-AVE MCASTRO: Applies to new EED's only. (NASA Gemini/EED's, analysis and tests shall be conducted as reported in MAC Report B078 dated 21 February 1966, title, "Analysis of Electromagnetic Radiation Hazard in Gemini and Augmented Target Docking Adapter Pyrotechnic System.")

(For GE: The EED's used on the DRV are exempt from this requirement)

R-AVE 3.3.1.3.1 RF Susceptibility

The susceptibility of each EED to RF energy shall be determined over the frequency range of 0.150 to 10,000 MHZ with the following as a minimum number of frequency points:

Test Frequency Range (MHZ)	Conditions
5 - 10	CW
25 - 450	CW
900 - 1350	CW
1750 - 1850	CW
2200 - 2290	CW
5000 - 6000	CW
8500 - 10,000	CW
1750 - 1850	Pulsed
2200 - 2290	Pulsed
5000 - 6000	Pulsed
8500 - 10,000	Pulsed

Susceptibility shall be determined for the following modes:

a. Pin-to-Pin (P-P),

b. Pin-to-Case (P-C),

c. Bridgewire-to-Bridgewire (B-B) (then requirement only applies to initiators with two or more bridgewires).

R-AVE 3.3.1.3.2 EED Validation

The validation of compliance with 3.3.1.3.1 shall include the following:

R-AVE 3.3.1.3.2.1 DC Constant Current Sensitivity Test (45 initiators)

A Bruceton test (Pin-to-Pin mode) using a group of 45 initiators using each bridgewire shall be conducted in which the pulse time will be held constant and the current will be variable. The pulse time in this test shall be 10 seconds or longer. Five of the initiators may be used to find the proper starting level for the test.

The DC constant current sensitivity Bruceton test data obtained for SAFSL Exhibit 10030 may be used in lieu of this testing.

R-AVE 3.3.1.3.2.2 Impedance Measurement (10 Initiators)

The dc resistance and RF impedance for all frequencies (and all modes) of 3.3.1.3.1 shall be determined for a sampling of 10 initiators.

R-AVE 3.3.1.3.2.3 RF Comparison Tests (Single bridge - 135 initiators, Dual bridge - 225 initiators)

The RF power exposure level for all of the RF comparison tests shall be the mean firing level determined in the 3.3.1.3.2.1 dc constant current test converted to power. For this conversion to power, the RF resistance shall be taken into account. This calculated power will be delivered to the EED's at each test frequency and in each mode, i.e., pin-to-pin, pin-to-core, and bridgewire-to-bridgewire. Non-fires from the pin-to-pin and bridgewire-to-bridgewire modes may be revised for the pin-to-case mode testing.

Ten EED's shall be exposed to the test power at each condition for a duration of 10 seconds or greater (note: it is only necessary to size the pin-to-case test sample to 5 since some no-fires should be obtained from the pin-to-pin tests).

If 8 or more of the 10 initiator samples fire, it shall be considered that the EED at the particular frequency and mode is more sensitive than the dc level. Otherwise it shall be assumed that initiator has a sensitivity equal to or less than the dc level for the particular frequency and mode.

R-AVE 3.3.1.3.2.4 RF Bruceton Tests (80 initiators)

Following the probing tests of 3.3.1.3.2.3, two RF Bruceton tests shall be conducted at the most sensitive conditions.. In the event more than two conditions have sensitivities greater than the dc level, RF Bruceton tests shall be run for all these conditions.

R-AVE 3.3.1.3.2.5 EED Sensitivity

For the conditions having the 3.3.1.3.2.4 test, the RF Bruceton test data shall be used to determine 0.001 probability of initiation with 95% confidence. For those conditions where it is determined by 3.3.1.3.2.3 that the RF sensitivity is less than the dc level (and where 3.3.1.3.2.4 tests were not made) it shall be assumed that RF 0.001 probability of initiation with 95% confidence is the same as the dc value.

3.3.1.3.2.6 Determination and reporting of the smallest field intensity capable of producing in the EED, in its normal respective configuration, the power determined in paragraph 3.3.1.3.2.4 above. The determination shall be based on the most favorable conditions for induced power during routine handling, processing, transport and storage. Data shall be presented as described in paragraph 3.3.3.2 below.

R-AVE 3.3.1.3.2.7 Evaluation of the EED as a receiver of RF energy during installation.

The evaluation shall consist of determining and reporting the minimum RF field intensity or field strength required to produce in the EED the power determined according to paragraph 3.3.1.3.2.6 above. The evaluation shall include the most favorable conditions for induced power, including unshorted, uninstalled conditions. Data will be presented as described in paragraph 3.3.3.2 below.

T 3.3.2 Space Vehicle System

3.3.2.1 Electrical/Electronic Compatibility Test

The first spacecraft's complete electrical/electronic system shall be subjected to a complete functional compatibility test. The vehicle shall be tested in accordance with paragraph 4.7.1 of this specification to demonstrate compliance with its requirements. Any modification or relocation of the electrical or electronic subsystems or equipments, resulting from the elimination of an unacceptable or inadvertent response as defined in paragraphs 3.3.2.2 and 3.3.2.3 below, shall require a re-test unless such specifically waived by the procuring activity.

3.3.2.2 Improper Response

The requirement for improper response shall be considered to have been met when the sum of all energy coupled into the most critical point of each subsystem by extraneous electromagnetic or electrostatic fields or by direct conduction is at least 6 db below that input, which would produce or prevent operation, actuation, or functioning. Detailed test methods, instrumentation, monitored points, interference tolerance limits, and test procedures applicable to the functional usage of the particular subsystem or component shall be outlined in the test plan specified herein.

3.3.2.2.1 Unacceptable Response

Output responses from any subsystem which are the result of operation of any planned combination of subsystems shall be unacceptable when these outputs cause the space system performance to be degraded in excess of the required performance limits. This unacceptable response for other than aural outputs shall be determined in terms of the degree that performance limits are degraded at the subsystem output. This degradation shall be related, if applicable, to the signal plus noise to noise ratio (S + N/N) at the most critical point of the subsystem exhibiting the unacceptable response. Unacceptable response for equipment providing aural outputs shall be determined in terms of the electrical power equivalent, measured in the audio line, of the threshold of hearing in the system operating environment.

3.3.2.2.2 Inadvertent Response

Criteria to prevent inadvertent response shall be defined interms of the margin (EMISM) between interference levels and circuit thresholds of operation at critical points within each subsystem. This margin, or separation, shall be a minimum of 6 db but may be greater than 6 db depending upon the characteristics of the particular subsystem. If the criteria for inadvertent response at critical subsystem points cannot be determined prior to test for inclusion in the test plan, these criteria may be determined as part of the test. In such cases, the integration contractor shall specify the test approach to be used in demonstrating that a 6 db minimum EMISM exists at these critical points.

R 3.3.3 Validation of EED and EED Initiator Circuit

(MCASTRO Only: For NASA Gemini Class A EED's, analyses and tests shall be conducted as reported in MAC Report B-078, dated 21 February 1966, entitled, "Analysis of Electromagnetic Radiation Hazard in Gemini and Augmented Target Docking Adapter Pyrotechnic System.) (For GE: Existing EED's on the DRV's are exempt)

The EED's shall survive before, during and after installation when exposed to the following electromagnetic fields:

Frequency Range	Field Intensity
150 kc to 50 Mc	2 watts per square meter (28 volts per meter)
above 50 Mc	100 watts per square meter (194 volts per meter)

R-AVE 3.3.3.1 System Sensitivity

The evaluation shall consist of determining analytically and/or experimentally and reporting the minimum RF field intensity or field strength required to produce in the EED the power determined in paragraph 3.3.1.3.2.4 above after ordnance installation but with access ports open. Data will be presented as described in paragraph 3.3.3.2 below.

3.3.3.2 Presentation of Data

P 3.3.3.2.1 RF Susceptibility

The RF susceptibility of each device shall be presented in graphical form. The ordinate scale will be in relative db above or below a 0 db reference level. The 0 db reference will be applicable ordnance survival level, as defined in paragraph 3.3.3, and as noted below:

50 Mc and below: $db = 10 \log \frac{P_1}{2}$

or

$db = 20 \log \frac{E_1}{28}$

Above 50 Mc: $db = 10 \log \frac{P}{100}$

or

$db = 20 \log \frac{E}{194}$

P 3.3.3.2.2 Positive DB Values

Positive db values will indicate EED susceptibility to RF fields of larger magnitude than the survival levels contained in paragraph 3.3.3 and, therefore, represent safer conditions than negative db values. Data shall be presented on standard semi-logarithmic paper 8-1/2 by 10-1/2 inches with a linear db scale and a logarithmic frequency scale. Graphical data will be limited to the following frequency ranges per graph maximum:

0.100 to 100 Mc
100 to 10,000 Mc

3.3.3.2.3 Graphical Data

Graphical data depicting the RF susceptibility of each EED within each frequency range for the four conditions described in paragraphs 3.3.1.3.3(a), (b), and (c) and 3.3.3.1 are required. Where no sacrifice in clarity will result, the four conditions may be plotted as four curves on one graph for each frequency range.

A description of the test equipment and test procedures used to obtain the data shall be provided.

P 3.3.3.2.3 Graphical Data

Graphical data depicting the RF susceptibility of each EED within each frequency range for the conditions described in paragraphs 3.3.1.3.2.4 and 3.3.3.1 are required. Where no sacrifice in clarity will result, the conditions may be plotted as curves on one graph for each frequency range.

A description of the test equipment and test procedures and/or analyses used to obtain the data shall be provided.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 ELECTROMAGNETIC COMPATIBILITY TEST PLANS

4.1.1 Composite System

R-AVE 4.1.1.1 Schedule

The composite system EMC test plan shall be prepared by the integration contractor, in coordination with the associate contractors, to outline the techniques, procedures, and instrumentation to be used for verifying that the vehicle system and the AGE system of the composite system are capable of performing in accordance with the requirements of the composite system EMC design control plan. The initial submittal of this test plan to MOL SPO for approval shall be accomplished within six (6) months after issuance of contractual go-ahead of the Development Phase or as specified by the procuring activity. This composite system Test Plan shall be maintained by the integration contractor through the life of the composite system program by revisions at times scheduled by the EMC Control Board.

R-AVE 4.1.1.2 Content

The composite system EMC test plan shall include separate but related sections for the vehicle and AGE systems. Each system section shall incorporate the electromagnetic compatibility design requirements for the component subsystems and the general testing procedures for them and their respective interfaces with the other subsystems of the vehicle and the AGE as applicable. Of primary importance will be:

a. Susceptibility threshold curve
b. The 6 db point for the EMISM
c. Test conditions
d. Frequency response or response time of test equipment

4.1.2 Subsystems and Equipments

R-AVE 4.1.2.1 Schedule

Each associate contractor (this includes the integration contractor in his function as a hardware contractor) shall submit to the integration contractor within ninety (90) days after issuance of contractual go-ahead of the Development Phase or as specified by the procuring activity an EMC test plan for each equipment or subsystem of the vehicle or AGE systems for which he has contracted. Each such test plan shall be used by the integration contractor in preparation of the initial composite system EMC test plan and shall be submitted individually to MOL SPO for approval. Each such subsystem/ equipment test plan shall be revised at time(s) specified by the integration contractor or the EMC Control Board, with the latter the governing factor.

MOL SPO shall convene the EMC Control Board to handle the resolution of problem areas, assign action items to responsible contractor(s), and schedule such action(s).

R-AVE 4.1.2.2 Content

Each subsystem/equipment EMC test plan shall present the methods, techniques, procedures, and instrumentation to be used for testing to verify the requirements of the applicable EMC design control plan(s). Items to form part of the affected Test Plan shall include:

a. Nomenclature and serial numbers of test equipment to be used.
b. Methods of calibration to be used.
c. Detector functions to be used on measuring equipment.
d. Methods of loading and triggering.

margin. For example, an engine nozzle motion which has a tolerance of ±X%; the interference voltage at the input of the servo amplifier (with sufficient error signal to eliminate the "deadband") shall be 6 db below the point at which the +X% or -X% engine motion tolerance is reached.

In the event that the "deadband" cannot be eliminated, the voltage point (level) at the driving amplifier input, one fourth of the way between zero volt and the first indication of system actuation or motion at the amplifier output, shall be the 6 db monitoring point.

R-AVE 4.1.2.2.3 Criteria for the Selection of Critical Test Points

Test points shall be those points which monitor low-level signal circuits or other low-level critical circuits of an equipment, subsystem, or system, which are susceptible to EMI. Tests shall be performed to determine the most critical or susceptible points in an equipment or subsystem. All subsystems on the vehicle shall have a minimum number of critical points which will adequately monitor system, subsystem, and equipment performance. The critical test points, together with a justification for their selection, shall be submitted for approval with the test plan.

R-AVE 4.1.3 Test Report Schedule

The reporting of the results of each EMC test plan shall normally be made by the responsible associate contractor within thirty (30) days of completion of the test, except in those cases where MOL SPO specifically instructs performance at or within a different time, to the integration contractor and to MOL SPO. The results of each EMC test plan shall be reported in accordance with AFSCM/AFLCM 310-1, Vol II and MIL-STD-831.

e. Operation of test sample.

f. Control settings on test sample.

g. Frequencies at which interference might be expected, local oscillator, intermediate frequencies, multipliers, etc.

h. Response time of test equipment for transient testing.

i. Interfaces with other vehicle and AGE subsystems/equipments.

Each set of test instrumentation shall, whenever practicable, be separate and distinct from other support equipment which will be concurrently monitored as an integral part of the operational system complex. Each EMC test plan shall specify the method of connection to each monitored circuit and its associated support equipment and shall describe all isolation techniques, rejection filters, detectors, scaling and equalizing networks, recorders, and other components, parts, or methods used to monitor electro-interference as required by this specification, together with complete test procedures.

Detailed step-by-step test procedures based upon the test plan shall be prepared by the contractor as required for his use. These test procedures shall not be subject to procuring agency approval, but shall be made available for its review.

R-AVE 4.1.2.2.1 Input Circuits

Input circuits shall be monitored on equipments having outputs which operate such devices as solenoid valves and relays, which rapidly change state from zero to full output.

R-AVE 4.1.2.2.2 Deadband Circuits

Circuits which have an inherent lag or "deadband", such as servo systems, shall have an error signal introduced to eliminate the lag or "deadband"; the circuit shall be on the threshold of operation. System tolerance will then be used as a means of determining the electromagnetic interference safety

4.2 INTERFERENCE MEASURING INSTRUMENTS

R-AVE 4.2.1 Vehicle and AGE Subsystem and System Test Equipment

The equipment used to test vehicle and AGE system and subsystem compatibility shall be capable of measuring at least 6 db below the susceptibility threshold over the full frequency range of the circuit under test. Provisions shall be made to permanently record the EMISM. Liberal use shall be made of wideband oscilloscopes, wideband transients detectors, circuit monitors, recorders, signal conditioners, or any other type of test equipment that is capable of monitoring system and subsystem critical test points. The equipment used shall have the approval of MOL SPO.

R-AVE 4.2.2 Subsystem and Equipment

Instruments used to perform the measurements required by this specification shall be the highest quality equipment available for making required measurements under applicable program funding constraints. Suitable commercially available and approved instruments are listed by category in Table 1; the categories indicate the capabilities of the instruments to comply with the requirements of this specification.

R-AVE 4.2.2.1 Category A

Category A instruments are those approved interference measuring instruments which are capable of adequately measuring the parameters of interference signals as required by this specification. Only combinations of Category A-rated instruments may be used for the required measurements.

Instruments that have been modified from Categories B or C to meet Category A requirements shall not be used unless a distinctive non-removable label has been attached by the instrument manufacturer. Any restrictions on the usage of the modified instrument or any of its accessories shall be indicated on the label.

Category	Frequency Range	Commercial Nomenclature	Manufacturer
A	20 cps to 50 kc	EMC-10	Fairchild
	20 cps to 15 kc	NF-315	Empire
	30 cps to 15 kc	NM-40A	Stoddart
	15 kc to 150 kc	NM-10A	Stoddart
	15 kc to 150 kc	T-X NF-105	Empire
	0.15 to 25 Mc	NM-20A, B, NM-22	Stoddart
	0.15 to 30 Mc	T-A/NF-105[2]	Empire
	20 to 400 Mc	NM-30A[3] (Ser. No. 191-1 or higher)	Stoddart
	20 to 200 Mc	T-1/NF-105	Empire
	200 to 400 Mc	T-2/NF-105	Empire
	400 to 1000 Mc	T-3/NF-105[4]	Empire
	375 to 1000 Mc	NM-50A (Ser. No. 222-1 and higher); NM-50B, NM-52	Stoddart
	1 to 21 Gc	FIM	Polarad
	1 to 21 Gc	NF-112	Empire
	1 to 10 Gc	NM-62A	Stoddart
	1 to 15 Gc	CFI	Polarad
B	30 cps to 15 kc	NM-40A[8]	Stoddart
	375 to 1000 Mc	NM-50A[5] (Ser. No. 190-50 and below)	Stoddart
C	0.15 to 30 Mc	T-A/NF-105[6]	Empire
	20 to 400 Mc	NM-30A[5] (lower than Ser. No. 191-1)	Stoddart
	400 to 1000 Mc	T-3/NF-105[7]	Empire

[1] This table is subject to change upon reasonable notice to include new instruments having superior performance characteristics and to change the category of older instruments which have become obsolete.

[2] This category applies only to tuning units purchased after 11 March 1957.

[3] This category applies only when power supply 91226-1 is used.

[4] This category applies to instruments purchased after 9 May 1956.

[5] These instruments can be modified to Category A requirements by the manufacturer.

[6] This category applies to instruments purchased prior to 11 March 1957. The manufacturer can supply information on the changes necessary to modify the tuning units to Category A requirements.

[7] This category applies to instruments purchased prior to 9 May 1956. These instruments can be modified to Category A requirements by the instrument manufacturer.

[8] Such instruments with an unmodified receiver shall be modified by connecting the "wideband" amplifier input on the output or the installed 20 kc cutoff low pass filter.

R-AVE 4.2.2.2 Category B

Category B instruments are those instruments which are in general testing use but which do not adequately measure the parameters of interference signals as required by this specification.

Any such instrument must be modified to the Category A rating to permit its use and must carry a non removable label certifying such uprating by the instrument manufacturer or the contractor-user, as applicable.

R-AVE 4.2.2.3 Category C

Category C instruments are those which have been recently developed but do not meet Category A requirements, and which can be modified by the manufacturer to attain a Category A rating.

Category C instruments shall not be used until all necessary modifications to up-rate them to Category A have been accomplished. Each shall carry a non-removable label certifying such by the instrument manufacturer or the contractor-user, as applicable.

4.2.2.4 Broadband Spectrum Analyzers

Broadband spectrum analyzers may be of assistance in determining areas of interference and reducing overall test time.

4.2.2.5 Automatic/Semiautomatic Test Instrumentation

Contractors should be alert to, and take full advantage of, the use of automatic or semiautomatic test instrumentation which will markedly reduce the test time required. Use of such devices shall be described in the applicable test plan.

R-AVE 4.3 OPERATION OF MEASURING INSTRUMENTS

For both conducted and radiated interference measurements, the instruments used shall be calibrated and operated as indicated in their respective instruction manuals, subject to modification thereof as noted in the affected EMC test plan.

R-AVE 4.3.1 Calibration

Interference measuring instrumentation shall be maintained in a known condition of accuracy. Periodic checks on the calibration accuracy shall be made with laboratory generators. Re-calibration shall be accomplished when the standardized gain setting fails to reflect a meter reading within plus or minus 20 percent of the known input signal. Substitution-type measurements can be used in lieu of the calibrated method. It is therefore not necessary to calibrate (adjust to a known value) the gain of the interference meter prior to making measurements. It shall be permissible to use either a calibrated sine wave or calibrated impulse noise generator (as appropriate) in substitution with the unknown at the time of measurement. Impulse noise generators which are integral with, or which accompany, an interference meter must be periodically checked against laboratory standards to detect degradation due to time, usage, and transportation handling.

R-AVE 4.3.2 Generator Accuracy

Laboratory-type signal generators and impulse generators capable of an output voltage accuracy of at least 20 percent shall be used to calibrate interference measuring instruments and for substitution measurements.

R-AVE 4.3.3 Broadband Interference Measurements

Broadband interference shall be measured by using an impulse generator with the substitution technique (see Section 6.0), or by calibrating the interference measuring instrument so that it reads directly in decibels above one microvolt per unit bandwidth. The peak detector function on the interference measuring instruments shall be used for broadband and pulsed cw measurements. The process of calibrating the meter to read voltage per unit bandwidth consists of dividing the meter reading by the impulse band-width (see Section 6.0) of the meter.

R-AVE 4.3.4 CW Interference Measurements

CW interference shall be measured by calibrating the interference measuring instrument so that it reads directly in decibels above one microvolt or by using a signal generator with a substitution technique.

R-AVE 4.3.5 Pulsed CW Interference Measurements

Pulsed CW shall be measured in accordance with the procedures and limits used for broadband interference.

R-AVE 4.3.6 Monitoring

The interference measuring instrument shall be monitored with a headset, loudspeaker, oscilloscope, or other indicating devices, during all measurements. Precaution shall be taken to ensure that the monitoring does not influence the meter reading on the interference measuring equipment.

When making "Peak Detector Function" readings on interference which is steady, in the sense that there is no functional reason for it to vary with time, the interference meter output shall be observed for a least ten seconds, and there shall be no appreciable variation within that time.

R-AVE 4.3.7 Bonding of Measuring Instruments

Interference measuring instruments used for radiated or conducted measurements shall be grounded utilizing the best available techniques consistent with current MIL specification methods. Such methods shall be delineated in the final EMC Test Plan.

R-AVE 4.3.7.1 Rod Antennas

The counterpoise on rod antennas shall be bonded to the ground plane with a strap of such length that the rod antenna can be positioned correctly. The strap shall be as wide as the counterpoise. This applies to rod antennas utilizing the interference measuring instruments as a counterpoise and to rod antennas mounted on a separate counterpoise.

R-AVE 4.3.7.2 Instrument Grounding

The interferrence measuring instruments shall be physically grounded with only one connection. If a copper strap is used, neither the ground clip, the ground terminals, nor the power supply shall be connected to ground.

R-AVE 4.4 TEST FREQUENCIES

The interference measuring instrument shall be slowly tuned through each frequency octave and the frequencies at which the maximum interference or susceptibility is obtained shall be selected as test frequencies. Test frequencies shall not be selected prior to the interference test, except when making broadband transient interference measurements. A minimum of three measurements shall be made in each frequency octave. If test frequencies are pre-selected during broadband transient tests, a minimum of three measurements shall be made in each frequency octave below 1 Mc and five measurements per octave above 1 Mc. The affected test report shall include a certification that the test frequencies were selected after each octave was scanned.

4.5 TUNING

For equipment containing oscillator circuits, the interference measuring instrument shall be tuned to, and measurements should be made at, the primary oscillator frequency and at all primary harmonics up to the third carrier harmonic (if the output carrier frequency is different from the primary oscillator frequency) above the highest carrier harmonic which measures 6 db below the allowed limit. Additional checks shall be made by scanning for and measuring any signal or spurious response that can be anticipated.

4.6 TEST CONDITIONS

4.6.1 System

All electronic and electrical equipment included in the applicable system test plan shall be included in the system test complex and shall be in normal operating condition as determined by the test procedures and techniques specified in the detailed subsystem test plans. Specific provisions shall include the following:

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(a) All support equipment normally operating during a standard countdown and launch shall be operating.

(b) All flight systems shall be operating.

(c) All pertinent missile test range support equipment such as radar, command transmitters, communication transmitters, etc., shall be operating and directed at the vehicle.

(d) Mobile service or other such towers shall be removed

(e) A complete mission profile shall be performed. This shall include a simulated prelaunch, launch ascent and orbit. All systems will be operating normally.

(f) Provisions shall be made for remote monitoring of the critical test points

(g) During tests, all electronic subsystems shall be operated in the modes or conditions expected to be most susceptible to interference.

4.6.2 Subsystems and Equipments

R-AVE 4.6.2.1 Ambient Interference Level

It is desirable that the ambient interference level during testing, measured with the test sample de-energized, be at least 6 db below the allowable specified interference limit. However, in the event that at the time of measurement, the levels of ambient interference plus test item interference are not above the specified limit, the tested item shall be considered to have met the specified requirement. This requirement shall apply equally to both radiated and conducted ambient interference levels.

A shielded enclosure or screen room may be used if necessary or desired. If a shielded enclosure is used, the minimum length shall be such that a 35 Mc tuned dipole can be placed in the room with at least 12 inches clearance between the antenna extremities and the shielded enclosure.

R-AVE 4.6.2.2 Ground Plane

A copper or brass ground plane, 0.01 inch thick minimum for copper, 0.025 inch thick minimum for brass, 12 square feet or more in area, with a minimum width of 30 inches, shall be used. In a screen room, the ground plane shall be bonded to the shielded room at intervals no greater than 3 feet and at both ends of the ground plane. The ground plane and screen room walls may be considered equivalent to a vehicle spaceframe for purposes of simulating a normal installation. For large equipment systems mounted on a metal test stand, the test stand may be considered, for testing purposes, to be part of the ground plane and shall be bonded accordingly. When a shielded room is not used, the measuring equipment may be placed on a solid support for operation. The support may be solid earth, steel or iron flooring, metal bedplate, metal-covered planking, or the like.

R-AVE 4.6.2.3 Bonding

Only the provisions included in the design of the equipment and specified in the installation instructions in compliance with the EMC test plan, shall be used to bond units, such as equipment case and mount, together or to the ground plane. If bonding straps are required to complete the test setup, they shall conform to the requirements of paragraph 3.2.4. Connections made with such bond straps shall have clean metal-to-metal contact.

R-AVE 4.6.2.3.1 Shock and Vibration Isolators

Shock or vibration isolators shall be used in the test setup, if they are required in the operational installation. If bonding straps are supplied for such isolators, they shall be connected to the ground plane. Bond straps will only be used as specified in the operational installation.

R-AVE 4.6.2.3.2 External Ground Terminal

When an external terminal or connector pin is available for a ground connection on the test sample, this terminal shall be connected to the ground plane, if the terminal is normally grounded in the installation. If the installation conditions are unknown, the terminal shall not be grounded.

R-AVE 4.6.2.3.3 Portable Equipment

Portable equipment that is intended to be grounded through a power cord shall not be bonded to the ground plane unless specific operating conditions require bonding. In such case(s), bonding shall be utilized.

R-AVE 4.6.2.4 Power Supply Voltage

The power supply voltages at the equipment terminals shall be within the tolerances specified in the detail specification for the test sample. The AVE test sample shall be operated at the maximum and minimum operating voltages for audio conducted susceptibility. For all other tests the operating voltage shall be within equipment voltage limits. All AGE tests will be conducted at nominal line voltage.

R-AVE 4.6.2.5 Arrangement and Operating Conditions

The general arrangement of equipment, interconnecting cable assemblies, and supporting structures shall be such as to simulate actual installation and usage insofar as practicable. The front surface of each unit shall be located 4 inches ± 1/2 inch from the edge of the ground plane; interconnecting cables shall be routed between the units and the edge of the ground plane. In those cases where equipment size exceeds the ground plane dimensions, the above instructions shall be adhered to as closely as possible.

R-AVE 4.6.2.5.1 Feed-Through Capacitors

Ten microfarad feed-through capacitors shall be required in the test sample power lines when making interference measurements, unless the operational power supply is being used to supply power to the test sample. These capacitors shall be so selected that their respective temperature rise is not more than $5^{\circ}C$.

When phase is important for specific test samples, matched capacitors shall be used. A bleeder resistor shall be connected across the capacitors to reduce shock hazard. Figures 9 and 10 show typical test setups utilizing the capacitors.

Feed-through capacitors may not be feasible in certain instances, as when initial charging current would damage the test sample, when the total reactive current would degrade the ac power supply, and, in some situations, when testing switching devices. In such situations, the associate contractor will specify other methods or techniques in the affected test plan. Neither feed-through capacitors nor other impedance standardization devices shall be used if the test sample is powered by the operational power supply.

R-AVE4.6.2.5.2 Dummy Antennas

Any dummy antennas used shall have electrical characteristics which closely simulate those of the normal antenna, and shall be shielded where possible. The dummy antenna shall be capable of handling the power required and shall contain any unusual components which are used in the normal antenna (such as filter, crystal diodes, etc.).

A minimum 5-foot length of double shielded coaxial cable or special lines as specified in the test requirements, shall be used between a transmitter and its dummy antenna.

R-AVE4.6.2.5.3 Test Sample Leads

The test sample leads to the required feed-through capacitors, when used, shall be 24 inches ± 1 inch in length, where possible, and shall be so arranged that the distance between the leads and from each lead to ground or grounded enclosure is approximately 2 inches.

Interconnecting leads between units comprising test sample shall be between 2 and 5 feet long. Leads from these units to auxiliary equipment, such as meters and loads, shall be 5 feet long. The above is not a requirement for audio frequency testing. In lieu of these requirements, an actual system harness may be used to interconnect the test specimen with associated sources or loads.

R-AVE 4.6.2.6 Antenna Orientation and Positioning in Shielded Enclosures

The test sample shall be oriented on the ground plane for maximum interference effects within allowable operating requirements. Those interference measuring instruments which use a rod antenna shall be so placed that the rod antenna is in a vertical position and the instrument panel or counterpoise is 6 inches below the level of the ground plane. The rod antenna shall be located at the point of maximum interference indications while the test sample is operating in the steady state mode. This maximum is obtained by moving the antenna along a line parallel with the edge of the ground plane. Those interference measuring instruments which use a resonant dipole antenna shall have the dipole positioned parallel with the front edge of the ground plane. Its height shall be 12 inches ± 1 inch above the level of the ground plane and its center shall be adjacent to the geometrical center of the units under test. The rod or the dipole antenna shall be located at the distance from the test sample specified in the typical test setups. When the dimensions of the dipole or directive antenna become smaller than the test layout, the antenna shall be moved parallel to the edge of the ground plane to keep its sensitive elements adjacent to the point of maximum leakage or susceptibility. In place of the above, more than one antenna may be used with the details delineated in the final EMI test plan. At frequencies from 25 up to and including 35 megacycles the measurements shall be taken with the dipole antenna adjusted to 35 Mc. The dipole antenna shall be adjusted to the proper length at all frequencies above 35 Mc.

R-AVE 4.6.2.7 Antenna Orientation and Positioning (Free Space)

Those interference measuring instruments which use a rod antenna shall be so placed that the rod antenna is in a vertical position. Those interference measuring instruments which use a dipole antenna shall be so placed that the antenna is parallel with the test sample and on the same level as the midpoint of the test sample. The antenna shall be at the distance from the test sample specified in the typical test setups. The antenna shall be located at a point around the perimeter of the test sample where maximum interference signal is received.

R-AVE 4.6.2.8 Loads

The equipment under test shall be loaded with the full mechanical and electrical load, or equivalent, for which it is designed.

This requirement specifically includes electrical loading of the contacts of mechanisms which are designed to control electrical loads even though such loads are physically separate from the equipment under test. Operation of voltage regulators and other circuits which operate intermittently is required. The loads used shall simulate the resistance, inductance, and capacitance of the actual load. All input and output circuits, whether power, signal, or control, which are otherwise unterminated in the test sample, shall have impressed upon them appropriate simulated signals, with equivalent circuit termination impedance.

R-AVE 4.7 TEST METHODS

R-AVE 4.7.1 Composite System

Tests to indicate improper (inadvertent or unacceptable) responses for the composite system shall be based upon the general test approaches of paragraph 4 7. 1. 3. Tests shall be devised to demonstrate compatibility of the composite system over the complete spectrum associated with each component system and that of the individual subsystem and equipments of the systems including its expected external electromagnetic environment. Instrumentation used shall have frequency responses adequate for this task. Vehicle and AGE system and subsystems capable of transmission or reception at a multitude of frequencies shall be tested at the minimum number of frequencies necessary to indicate electromagnetic compatibility. Frequencies shall be indicated in the interference test plan, when applicable for a specific test approach.

R-AVE 4.7.1.1 Implementation

The integration contractor shall establish test criteria for determining compliance with this specification in terms of performance requirements and definitions of vehicle and AGE system component and subsystem improper responses. These criteria shall be included in the test plans specified herein, along with detailed test methods, instrumentation, critical points, monitoring points, and intended functioning of each subsystem.

R-AVE 4.7.1.2 Improper Response

4.7.1.2.1 Inadvertent Response

Criteria to prevent inadvertent response shall be defined in terms of the margin (EMISM) between interference levels and circuit thresholds of operation at critical points within each subsystem. This margin, or separation, shall be a minimum of 6 db exclusive of instrumentation errors but may be greater than 6 db depending upon the characteristics of the particular subsystem. If the criteria for inadvertent response at critical subsystem points cannot be determined prior to test for inclusion in the test plan, these criteria may be determined as part of the test. In such cases, the integration contractor shall specify the test approach to be used in demonstrating that a 6 db minimum EMISM exists at these critical points.

4.7.1.2.2 Unacceptable Response

Criteria for unacceptable response shall be in terms of performance limits at a monitoring point at the output of the subsystem components. The occurrence of unacceptable responses at these monitoring points during testing will constitute failure to meet the requirements of this specification and are mandatory correction items. The EMISM for unacceptable response shall be 6 db, exclusive of instrumentation errors, and shall be determined from a point at which the output of the equipment under test reaches the extremes of its acceptable tolerance. Out of tolerance operation of the equipment resulting from interference is considered unacceptable response.

4.7.1.3 Test Approaches

Tests shall be performed to demonstrate compliance with the improper response requirements of this specification. One or more of the following general test approaches may be used:

a. Injecting interference at critical system points at a 6 db higher level than exists, exclusive of instrumentation errors, while monitoring other system points for improper responses.

b. Measuring the susceptibility of critical system circuits for comparison to existing interference levels, to determine if a 6 db margin exists, exclusive of instrumentation errors.

c. Sensitizing the system so as to render it 6 db more susceptible to interference exclusive of instrumentation errors, while monitoring for improper responses.

4.7.2 Equipment Test Methods

The radio frequency interference generation measurements described below are directly suitable for the measurement of steady state signals. In the case of short duration signals having very low repetition rates, special test methods may be required. The transient duration shall be considered to be the duration of the interference pulse at the output of the second detector of the interference meter.

R-AVE 4.7.2.1 Conducted Interference

Conducted interference measurements shall be made over the frequency range of 30 cps to 100 Mc, using a clamp-on interference current measuring (meter) device and an appropriate receiver from Table 1. In the case of a component with a large number of similar inputs or outputs, the conducted interference measurements may be limited to representative conductors in each cable. A typical test setup is shown in Figure 11. The test conditions shall be as described in Paragraph 4.6.

For steady-state interference measurements, the current probe shall be positioned at the point of maximum interference on the lead to be tested. This maximum interference point shall be located at each test frequency for steady-state operation where the physical length of the test specimen cable is greater than $\lambda/20$, (λ = free space wave length at the test frequency). The location of the current probe shall be fully described in the test report. Switching transients may be measured with wideband (minimum - 10 Mc) oscilloscope directly connected across the test sample/signal/power leads.

R-AVE 4.7.2.2 Radiated Interference

Radiated interference measurements shall be made from 15 kc to 10 Gc for broadband/impulsive interference and 15 KHZ to 10 GHZ for CW and pulsed CW interference. Typical test setups are illustrated in Figures 12, 13 and 14. In the frequency range from 1 to 10 Gc, the measuring distance shall be 3 feet. The antenna polarization and direction shall be adjusted for maximum pickup. The antenna and measuring system correction factors to be used are those specified by the interference measurement instrument manufacturer. The test conditions shall be as described in Paragraph 4.6.

4.7.2.3 Transmitter (Keydown)

The transmitter shall be operated into a matched dummy load. A suitable coupling device shall be used to sample the transmitter output and to protect the measuring equipment, such as a bridge "T" or other filter rejection network. Transfer and other characteristics of such devices shall be fully described in the test report. Attention should be given to oscillator frequency and harmonics, outputs from frequency multipliers and crystal saver circuits, beat frequency oscillator outputs, etc. External filters shall not be used for compliance with the specified limits herein without MOL SPO approval.

R-AVE 4.7.2.4 Transmitter Crossmodulation

The transmitter shall meet the conducted spurious emanation (keydown) limits of paragraph 3.3.1.1.3.2 while the output is subjected to off-frequency energy at level 15 db below the fundamental power. The off-frequency signal shall be within 2.5 percent of a given fundamental frequency yet outside the fundamental band edges; further, at least one of the sum and difference heterodyne products shall be in the range of 0.15 to 10,000 Mc. The transmitter shall be modulated either normally or 30 percent at 400 cps. As an alternate test condition, the off-frequency energy may be at a level 25 db below fundamental power, provided the limit of paragraph 3.3.1.1.3.2 is changed accordingly, to facilitate instrumentation. The off-frequency signal shall be amplitude modulated 30 percent at 1000 cps. The transmitter and the off-frequency source shall have their outputs connected by a resistive network to properly terminate the transmitter and to couple the off-frequency signal. The measurement of transmitter level, off-frequency level, and spurious levels shall be made at the transmitter output with the same meter coupling device used in paragraph 4.7.2.3

R-AVE 4.7.2.5 Susceptibility

When performing susceptibility tests on receivers, all external and internal controls shall be set for maximum signal plus noise-to-noise ratio. All external and internal controls for squelch or limiting shall be set to give minimum limiting action. On other equipment, all external and internal controls shall be set for maximum indication of susceptibility, or, if this causes an equipment to malfunction or to become inoperable as a result of such a control setting, the critical control shall be adjusted as directed in the equipment instruction manual. The equipment under test shall not be supplied with any inputs other than those required to energize the equipment, to render the equipment capable of responding to interference, and to provide indication of operation.

4.7.2.5.1 Conducted Susceptibility

R-AVE 4.7.2.5.1.1 Conducted, 30 cps to 150 kc

The voltage levels indicated in Figure 15 are the ripple voltages applied in series with each power input of the test sample. The voltage will be measured as shown in Figure 16 with the equipment power source connected and the equipment under test operating. Tests will be made over the frequency range of 30 cps to 150 kc. If no malfunctions occur, the test shall be repeated at a 6 db higher voltage level or the malfunction threshold level, whichever is lower. However, if analysis or prior test data indicates that equipment damage above the normal susceptibility test limits will result, these malfunction threshold level tests need not be performed and the susceptibility threshold shall be the susceptibility test limits. Equipment need not be qualified to the 6 db higher voltage level. These 6 db tests may be run on development hardware. In those cases where the power lines are heavily bypassed at the equipment, presenting a very low impedance to the injected interference voltage, the following procedure may be followed.

The interference voltage injected into the power line may be measured across the secondary of the transformer provided the dc power source used to supply the equipment under test has an impedance of 0.1 ohm or less. The audio frequency ripple current from the interference generating source may be limited to that resulting from an audio frequency generator having a 1/2 ohm output impedance. Further, if the impedance of the power line looking into the equipment under test is so low at the higher frequencies that the required test voltage cannot be attained with a 50 watt generator, the following procedure may be used. Measure the ac drive voltage of the amplifier output stage which produces the desired voltage in series with the power line at 1000 cps. Maintain this drive voltage while making the test over the required frequency band between 30 cps and 150 kc. The output transformer characteristics should be flat over this frequency.

R-AVE 4.7.2.5.1.2 Conducted, 150 kc to 400 Mc

The test setup for 150 kc to 400 Mc shall be the same as in Paragraph 4.7.2.1, except that the 10-microfarad capacitors shall be removed. If no malfunctions occur, the test shall be repeated at a 6 db higher voltage level or the malfunction threshold level, whichever is lower. However, if analysis or prior test data indicates that equipment damage above the normal susceptibility test limits will result, these malfunction threshold level tests need not be performed and the susceptibility threshold shall be the susceptibility test limits. Equipment need not be qualified to the 6 db higher voltage level. These 6 db tests may be run on development hardware. An attenuator, or equal termination, shall be used at the end of the coaxial cable to properly terminate the signal source. A coupling capacitor, having an impedance of 5 ohms or less at the test frequency, shall be connected from this termination to the lead under test. The capacitor may be changed during the test to maintain the specified impedance. The signal source output required is the applicable limit plus the nominal termination insertion loss. The test signal shall be applied to each power lead in turn. When necessary, components can be added in series with the power leads to isolate the power source. The output impedance of the signal generator shall be as low as practicable and no greater than 50 ohms. Tests shall be made over the frequency range of 150 kc to 400 Mc. The rf signal shall be modulated 30 percent, 400 or 1,000 cps, on equipments that are not designed for other modulation frequencies or special forms of modulation. When applicable, actual modulation frequencies or special forms of modulation shall be used as appropriate.

R-AVE 4.7.2.5.1.3. Conducted Transient

The transient or pulse shall be induced in or across the power lines and between each power line and case in both the plus and minus polarities. A typical pulse shape with definitions of amplitude, rise time and pulsewidth is shown in Figure 17.* The pulse repetition rate shall be at least two (2) pps. The transient generator shall be capable of delivering at least 30×10^{-3} joules to the test sample. If the transient cannot be generated across the test sample with 30 millijoules, then the component is assumed to have passed the test. The transient voltage shall be measured across the input terminals of the test sample with the test sample operating. Schematics of a suggested type of test equipment are shown in Figures 18 and 19.

4.7.2.5.2 Audio Frequency Induced

R-AVE 4.7.2.5.2.1 Induced into Cables

Interconnecting cables shall withstand, without evidence of equipment performance degradation, the application of a magnetic field caused by a wire carrying 20 amperes rms at 400 cps spaced 2 inches away. Other test frequencies, up to 15 kc depending on the anticipated environment, shall be used as directed by the detail specification. Power input and output leads are exempt from the requirement of this paragraph. The applied magnetic field shall be generated by the current in a wire routed 2 inches

* For EK non-interfacing equipment, use amplitude of 30 volts, for all 3 tests. All contractors use 30 volts for return lead to case test.

away and parallel to the cable under test for a distance of 5 feet. The wire shall be oriented in two angular positions, 90 degrees apart, about the cable. To implement this, two wires 90 degrees apart may be routed, and the current then switched from one to the other (figure 21). Cabling of the test sample shall be routed at least 2 inches away from the ground plane or equipment rack. The current carrying wires shall break away from the test sample cable at least 6 inches short of the cable connectors. The wire return leads shall be kept at least 2 feet from the cable under test and from all other cables of the test sample. Cables need not be tested individually, but may be tested in whatever bundled configuration is convenient. Regardless of the number of current carrying wire segments installed for test, only one wire segment shall be energized at a time.

R-AVE 4.7.2.5.2.2 Induced into Equipment

Equipment shall withstand, without evidence of performance degradation, an ambient magnetic field at 400 cps. Other test frequencies may be used, as defined by the affected EMC test plan. The applied magnetic field shall be generated by a minimum current of 20 amperes rms in a straight wire segment which is located 2 inches from the sample unit periphery and from sample interconnecting cables. The various units of the sample shall be individually tested. The segment shall be oriented as necessary to thoroughly probe each unit for susceptibility. The length of the segment shall be such that it extends, at each end, 2 feet past the unit under test. The leads supplying current to the segment shall be routed at least 2 feet from any portion of the sample and from the segment itself (that portion of the segment directly opposite the unit under test).

R-AVE 4.7.2.5.3 Radiated Field Susceptibility

The radiation field shall be established with a signal generator driving the antenna listed below. The fields specified are those calculated (assuming plane wave/free space propagations) to exist at the equipment under test. The test setup is shown in figure 22 for the long wire antenna and is similar to figures 13 and 14 for the other antennas, with the signal source replacing the interference meter. For the dipole and directive antennas, the power delivered to the antenna shall be monitored. Figure 23 may be used for ease in establishing the required power level for the dipole antenna.

Frequency	Field Strength	Antenna
0.015 to 35 Mc	10 v/m	Long Wire
35 to 1000 Mc	5 v/m	Tuned Dipole or Directive Antenna
1 to 10 Gc	5 v/m	Directive Antenna

In the long wire antenna test over the frequency range of 15 kc to 35 Mc, the field shall be established by a known current flowing through an unshielded wire terminated at the far end to the ground plane. The wire shall be routed 1 foot from the equipment under test. Figure 24 may be used for convenience in establishing the equivalent field strength based on the measured current in the line.

R-AVE 4.7.2.6 Intermodulation

Receivers, preamplifiers or antenna couplers shall not produce an output indication when two sine wave signals, representing undesired signals, are connected to the input terminals of the test sample. The two frequencies shall be chosen so that their sum or difference is equal to the test frequency and so that neither will give an output when applied alone. The magnitude of each shall be 100 mv at the test sample terminal; one shall be modulated 30 percent with a 1000 cycle signal, and the other 30 percent with a 400 cycle signal. Impedance matching networks shall be used as required.

R-AVE 4.7.2.7 Receiver Front End Rejection

This test shall be performed with signal generators equipped with an accurate attenuator and capable of a signal output at least 80 db greater than the minimum signal perceptible at the tuned frequency of the particular receiver being tested. If necessary, matching networks shall be used to obtain a 50-ohm (± 20 percent) output. All measurements shall be corrected to account for any changes in output voltages due to addition of matching networks and shall be equal to the open circuit voltage at the output terminals.

(a) With the signal generator and receiver connected with a 50-ohm coaxial cable and tuned to the same frequency, the generator setting which gives the minimum perceptible reading above the receiver background noise shall be noted. Modulation may be used in conjunction with an output meter, if the receiver is not equipped to give meter indications of cw signals. The frequency range between 150 kc and 10 Gc shall then be scanned with the generator output preferably set at least 80 db above the output originally noted. Those frequencies at which output signals are obtained shall be investigated to obtain the generator reading which corresponds to the original receiver output signal. Since all signal generators emit a substantial amount of harmonics, care should be taken that the receiver is not erroneously rejected because of such spurious signal content.

(b) Front end rejection is calculated with the following formula:

Front end rejection = 20 log V_2/V_1

V_1 = Signal generator voltage required for minimum perceptible receiver output on channel or frequency under test.

V_2 = Signal generator voltage required for minimum perceptible receiver output at all other frequencies.

When this test cannot be accomplished due to the possibility of crystal burn-out or other reasons, the test signal shall be injected into the test sample by using a suitable antenna fed from a signal generator. The test procedure to be used shall be included in the test plan.

R-AVE 4.7.2.8 Isolation Resistance Measurements

Add new paragraph, title and text:

Prior to the conduct of interference and susceptibility equipment tests, the 1.0 megohm minimum dc resistance requirement of Paragraph 3.2.5.3 shall be verified on each separate component in accordance with Method 302 of MIL-STD-202C. Unless otherwise restricted because of circuit or component damage hazards, the test potential shall be 500 volts ± 10%, per Test Condition B of Method 302. Otherwise, the test potential is the highest acceptable voltag

5.0 PREPARATION FOR DELIVERY

Not applicable.

6.0 NOTES

6.1 INTENDED USE

The test procedures and limits specified herein are intended to ensure that the electrical and electronic equipments of the composite system components space vehicle and AGE systems and their respective subsystems will operate properly in service use when subjected to electromagnetic interference voltages and will not cause malfunctions by generation of, or response to, interference voltages.

6.2 DEFINITIONS

The connotations described below shall obtain for the purposes of this specification.

6.2.1 Aerospace Ground Equipments (AGE)

The equipments required on land or water at a launch complex to make an aerospace composite system operational in its intended environment. This includes all equipments required to install, launch, arrest, guide, control, direct, inspect, test, adjust, calibrate, appraise, gauge, measure, assemble, disassemble, handle, transport, safeguard, store, service, repair, overhaul, maintain, and operate, as applicable, the composite system. This definition applies regardless of the method of development, funding, or procurement. AGE is subclassified as operating ground equipments (OGE) and maintenance ground equipments (MGE). The term aerospace ground equipments has replaced the terms ground support equipments (GSE) and ground operating equipments (GOE).

6.2.2 Ambient Interference

Ambient interference, for the purpose of this specification, is the interference level emanating from sources other than the test sample, including the internal background noise of the interference measuring equipment.

6.2.3 Antenna Induced Microvolts

Antenna induced microvolts is that voltage which exists across the open-circuited antenna terminals.

6.2.4 Associate Contractor

An aerospace industry concern which has directly contracted with the United States Air Force Space Systems Division (SSD) to supply space vehicle subsystem(s) or equipment(s), aerospace ground equipment end item(s), material or services, or any combination thereof for a specific program. It is to be noted that an associate contractor may be assigned by SSD to function as the integration contractor for the program, in which event the contractor carries out a dual role as materiel supplier and as integrator.

6.2.5 Certification

A signed statement by a responsible representative of a manned spacecraft program certifying that the space vehicle ordnance systems:

(a) Have been tested and evaluated in accordance with the requirements of this specification.

(b) Comply with the criteria established by this specification.

6.2.6 Component

A component is a functional part of a composite system, system, subsystem, equipment, or assembly essential to operational completeness of that of which it is a part. Examples are a manned vehicle system of a composite system, a subsystem of the vehicle system, an antenna of the vehicle communications subystem, and the case of an electronic device.

6.2.7 Composite System

A composite system consists of all or part of:

a. the vehicle which will consist of one or more stages and capsules or modules each of which may comprise all or part of these subsystems:

1. spaceframe, including environment control, separation and joining mechanisms, observation and access areas and provisions therefore

2. propulsion, including primary, secondary, tertiary

3. electrical power, including power sources, such as batteries, solar arrays, fuel cells, and inverters

4. guidance and control, including attitude control and stabilization, orbital adjustment

5. communications, including telemetry, data link

6. life support which will comprise those devices, plumbing, wiring, sealing, seating, etc. which are installed in the life support compartments, bays, or other areas of the appropriate capsule(s) or module(s)

7. experimentation and observation equipments, self-contained power therefor, and the various accessories attendant thereon

b. the astronaut subsystem which will include those equipments, materials, and items worn or carried by the individual men, such as radio transmitters and receivers, light sources, body functions, psychophysiological equipments, etc.

c. the aerospace ground equipment system (AGE) consisting of:

1. the operational ground equipment (OGE) subsystem which includes the instrumentation, control and checkout consoles, cabling, wiring, communications, ground electrical power, fluid loading (whether liquid or gas), handling, including erecting, mating, demating, adjusting, calibrating, command loading, and all other material required to conduct pre-countdown tests, countdown, and launch

2. the maintenance ground equipment (MGE) subsystem which includes those items and materials of the types noted in (1) above, (OGE), which are used to maintain the vehicle system in, or restore it to, a state of readiness for launch, countdown, and pre-countdown tests.

Note: Since the following are not subject to this specification, they are listed for information as to the elements of a composite system.

d. the telemetry, tracking, and command system which consists of:

1. the ground station network and the facilities and equipments thereof which are used to acquire data

telemetered from the vehicle from before launch through useful orbital life and recovery, including data and information on vehicle performance, internal and external environment, data link transmissions, and, as applicable, command loading

2. the inter-station communications links, including landline, radio, submarine cable, etc.

3. the control center for this network, its inter-station links, and its data and information processing and reduction facility(s) and equipments

4. the Advanced Range Instrumentation Ships (ARIS) which function as mobile stations and supply similar information to the control center

e. the recovery system which consists of the facilities, ships, aircraft, land vehicles, ground effect machines, forces, and their respective equipments which are used for air, water, or ground recovery of the manned capsule(s) or module(s).

For purposes of this specification, the operational environment shall be understood to be that of the launch environment, including pre-countdown tests, countdown, and launch, as encompassing the worst environment to be encountered by the composite system, its component systems, and their respective subsystems and equipments.

6.2.8 Contractor-Furnished Aerospace Equipment (CFAE)

CFE is that piece(s) of equipment that is furnished by, and included in a system or subsystem by an associate contractor as a component(s) of the subsystems and equipments for which it has contracted with the procuring activity.

6.2.9 Critical Test Point

A critical test point is a point in a component subsystem or system that is considered susceptible to electromagnetic interference, because of sensitivity or inherent susceptibility, and which is important to mission objectives. Critical test points shall be chosen for demonstrating compliance to the 6 db EMISM requirement.

6.2.10 Current Sensitivity

The least amount of current required to initiate a particular EED at a specified probability and confidence when conditions of EED temperature and power application are specified.

6.2.11 Detectors

A detector is any instrumentation device, including dc converters, rejection filters, scaling resistors, flip-flops, zener diodes, or other parts or circuits, used specifically and only at the monitored point of pick-up to provide data and information as to subsystem or equipment performance to environment.

6.2.12 Electroexplosive Device (EED)

A device in which electrical energy is used to cause initiation of explosives contained herein. The term is limited in use to single components such as primers, detonators, squibs, switches, etc. as opposed to fuses, S-A devices, etc., which contain a number of individual explosive components the output of one forming the input to another and all of which being triggered by an electro-explosive device.

6.2.13 Electromagnetic Environment

The electromagnetic environment or area interference level is the signal and noise complex within which a space vehicle or AGE system and their respective subsystems or equipments are likely to be immersed in operational use.

6.2.14 Electromagnetic Interference Safety Margin (EMISM)

The EMISM shall be defined as the ratio between the susceptibility threshold and the interference present on a critical test point or a signal line. The EMISM shall be 6 db exclusive of instrumentation errors.

6.2.15 Electro-Interference

Electro-interference is an undesired electrical phenomenon which is created by, or which adversely affects, any device whose normal functioning is predicated upon the utilization of electrical phenomena. Electrical interference is known colloquially, and is referred to, as radio and electrical noise or interference, hash, jitter, grass, hunting, ambiguity, cross modulation, TV interference (TVI), hum, etc. The word "interference" may be used along or with appropriate modifiers in reference to some manifestation of electro-interference when mutually understood. Electro-interference also includes ground loops, radiated as well as conducted noise, and self-generated as well as mutually-coupled interference as it affects a given component.

6.2.16 Equipment

Equipment is a major functional part of a system or subsystem, usually consisting of several components, which is essential to operational completeness of the system or subsystem. Examples are inertial platform of a guidance subsystem, a radio command set and ground electrical power supply of the operational ground equipment subsystem.

6.2.17 Fire

The ignition of the prime explosive surrounding the bridgewire.

6.2.18 Firing Circuit

The firing circuit of an installed EED includes all of the electrical circuits and components between the initiation power source and the electroexplosive element of the EED. The firing circuit power source shall be considered as the last point of the electrical power entry to the EED during the arming-firing sequence.

6.2.19 Government-Furnished Equipment (GFE)

GFE is that piece(s) of equipment which is furnished by the military directly to the associate contractor for inclusion as such in a system or subsystem of a composite system.

6.2.20 Improper Response

A subsystem or equipment response which may be either inadvertent or unacceptable.

6.2.21 Impulse Bandwidth

The impulse noise bandwidth of the interference measuring instrument should be used in calculations involving broadband noise. Effective (random) bandwidth should not be used.

6.2.22 Impulsive Interference

For the purpose of this specification, all broadband noise, including random noise, is considered to be impulsive interference.

6.2.23 Inadvertent Response

An inadvertent response is a proper subsystem functional response (within normal range of limits) actuated by electro-interference but occurring at other than the normal operational cycle, which in turn causes improper response to the total space system (e.g., an automatic flight control system commanding a maximum pitch rate due to electro-interference at maximum velocity which overstresses the airframe, causing disintegration of the vehicle in flight).

6.2.24 Integration Contractor

In an aerospace program, the associate contractor assigned by the procuring activity the task of coordinating the activities of all of the associate contractors to assure achievement of the planned composite system electromagnetic compatibility. Such coordination is subject to the approval of the procuring activity.

6.2.25 Interference Control

Interference control is that design, placement of components, shielding, employment of rejection filters, and other techniques which effectively regulate the interference environment and/or susceptibility of individual space system components.

6.2.26 Maintenance Ground Equipments (MGE)

Those equipment end items of an aerospace ground equipment system which are essential elements thereof for the maintaining of the operating ground equipments in, or restoring them to, readiness condition for the respective pre-countdown tests, countdown, and launch of the space vehicle; such end items include calibration standards and testing equipments, collimators, timing references, etc.

6.2.27 Microvolts per Mc

The nearest approach to a standard unit of measurement of broadband radio interference is in terms of microvolts per megacycle. Interference intensity in microvolts per megacycle per megacycle is equal to the number of root mean square sine wave microvolts (unmodulated) applied to the input of the measuring circuit at its center frequency that will result in detector peak response in the circuit equal to that resulting from the interference pulse being measured, divided by the impulse bandwidth of the circuit in megacycles. The impulse bandwidth is the area divided by the height of the voltage response versus radio frequency selectivity curve from antenna through the peak detector. Impulse bandwidth is approximately equivalent to the bandwidth between the 0.45 voltage points on the selectivity curve.

6.2.28 Monitor Point

One or more points in a subsystem used to observe or measure unacceptable or inadvertent responses of the subsystem. Monitor points for determining unacceptable response shall be at the output of each subsystem and need not be electrical in nature. Monitor points used in conjunction with critical points in determining that no inadvertent response exists in the subsystem may be located at either internal subsystem points or at the subsystem output. If these monitor points occur at internal subsystem location, they will be electrical in nature and will be required due to the presence of non-analog circuitry between the critical points and the subsystem output.

6.2.29 No-Fire

(a) The failure of an EED to fire upon the application of electrical energy, or

(b) The rendering of an EED to a permanent inoperative state without any ignition process occurring (dudding).

6.2.30 No-Fire Current

The current sensitivity at which no more than one EED per thousand will fire with a confidence of 95%.

6.2.31 No-Fire Power

The power sensitivity at which no more than one EED per thousand will fire with a confidence of 95%.

6.2.32 Octave

An octave is a frequency ratio of 1 to 2; i.e., from 1 to 2 Mc, 2 to 4 Mc, 500 to 1000 Mc, et cetera.

6.2.33 Open Space

The term open space, as used in this specification, is intended to designate an ideal site for radiated interference measurements. This ideal site should be open, flat terrain at a considerable distance (100 feet or more) from buildings, electric power lines, fences, trees, underground cables, and pipe lines. This site should have a sufficiently low ambient level of radiated interference to permit testing to the governing radiated interference limit at any test frequency selected.

6.2.34 Operational Environment

The aggregate of all conditions and influences which may affect the operation of a composite system, vehicle system, and AGE system and their respective subsystems and equipments, including physical location and operating characteristics of surrounding or nearby equipments, temperature, humidity, pressure, acceleration, shock, vibration, radiation, contaminants, climatology, corrosion, and other modifying conditions during pre-countdown tests, countdown, and launch.

6.2.35 Operating Ground Equipments (OGE)

Those equipment end items of an aerospace ground equipment system, which are essential operating elements thereof and which are used to directly support pre-countdown tests, countdown, and launch of the vehicle; these include such diverse end items as the launch complex cables, cameras, and antennas and the system and subsystem test consoles and instrumentation.

6.2.36 Operator and Observer Positions

In those cases where the operator's or observer's location seems to vary a measurement reading, a minimum distance of 3 feet should be maintained between his body and the antenna; the operator should change position slightly until a maximum reading is obtained. In all cases, as few observers as possible should be present in the screen room during the radiated measurements.

6.2.37 Power Sensitivity

The least amount of electrical power required to initiate a particular EED at a specified probability and confidence when conditions of EED temperature and power application are specified.

6.2.38 Radio Receiver Front End Rejection

Front-end rejection is the measured capability of a receiver, expressed in decibels, in rejecting signals at the antenna terminals that are outside the channel, or frequency, to which the receiver is tuned.

6.2.39 Receiver Internal Background Noise

The receiver internal background noise is the receiver output obtained at the test location under the following conditions:

(a) All controls at standard settings.
(b) All other space vehicle equipment off.
(c) A shielded dummy antenna connected to the receiver input.

6.2.40 RF Field Intensity

The power flux density of electro-magnetic waves passing through a surface normal to the direction of propagation.

6.2.41 RF Field Strength

The magnitude of the electric or magnetic field vector (E or H) at a given location resulting from the passage of radio waves.

6.2.42 RF Radiation Hazards

Tri-service limit for exposure to rf radiation for human safety has been established at 0.01 watt/cm^2 at any frequency. It is possible to encounter even higher power densities than this established safe maximum limit during the tests required by this specification; however, these exceedingly high densities are usually localized. Power densities of 0.030 watt/cm^2 have been measured on equipment near tuning adjustments. Adequate safety precautions are recommended. This warning is intended to produce a healthy respect for rf radiation.

6.2.43 RF Susceptibility

The magnitude of the smallest electric field expressed as an rf field intensity or rf field strength capable of producing the no-fire current or no-fire power in an EED.

6.2.44 Shield

A metallic barrier which completely encloses a device for the purpose of preventing or reducing induced energy.

6.2.45 Slide-Back Circuit

To obtain a true peak reading, use is made of the slide back circuit technique. Such a circuit consists of an adjustable bias on the detector diode which blocks signals which produce voltages less than that required to overcome the bias. The procedure is to adjust the bias manually until the output indication just disappears, using the highest possible gain of the output stages. At this point, the bias is just equal to the peak value of the applied signal.

6.2.46 Standard Antennas

Because of the non-uniformity of the electro-magnetic field which usually exists close to a test sample, it is imperative that tests for radiated interference be conducted with antennas identical to those specified. Attempts to correlate results obtained with other antennas by reducing the results to microvolts per meter, based upon plane wave calculations and antenna effective height, may be erroneous and will not be accepted as indicating compliance with this specification.

6.2.47 Substitution Technique

This term describes a method of measuring interference. The method depends on the use of a calibrated signal generator whose output is of similar character to that of the unknown signal; that is, use of an impulse noise generator for broadband noise measurements and a sine wave generator for cw measurements. The method is: connect the interference meter to the unknown signal and record the reading. Disconnect the meter (at the meter terminals) from the unknown and connect it to the signal generator output. Adjust the signal generator output level to obtain the previous reading. The unknown signal is then considered to be equal to the signal generator output in whatever units the generator calibration is stated.

6.2.48 Subsystem

A subsystem is a major functional part of a vehicle or aerospace ground equipment system, usually consisting of several equipments which are essential to the operational completeness of the subsystem. Examples are the communications subsystem of a space vehicle and the communications checkout subsystem of the AGE.

6.2.49 Susceptibility

Susceptibility is that characteristic which causes an equipment to malfunction or exhibit an undesirable response when its case or any external lead or circuit, excepting antennas, is subjected to the specified radio or audio frequency voltage or field. Unless otherwise specified, the term "no inadvertent response" may be taken to mean that the extraneous electromagnetic energy which is introduced into a sample is 6 db below that which would produce operation, actuation, or functioning of the sample.

6.2.50 Susceptibility Threshold

The curve that gives the relation between frequency (30 cps to 10 gc) and the relative intensity of the signal at a critical test point which just causes operation or a response in the equipment, subsystem, or system.

6.2.51 System

A system is a major component of a composite system, including its subsystems and equipments and in all related equipments, materials, services, and personnel required to make the system a complete element of the composite system and operational in its planned environment.

6.2.52 Unacceptable Response

Unacceptable response or unacceptable degradation of performance is an abnormality in the expected operation or output of receiver or subsystem due to electro-interference which may be considered improper. A complete subsystem or system failure would be termed a malfunction.

6.3 REFERENCED FIGURES AND TABLES

to read:

REQUIREMENT		LIMIT	TEST METHOD
A.	Conducted Current Probe	Para. 3.3.1.1.1 Fig. 2,3,9,10,11	Para. 4.7.2.1 Fig. 11
B.	Radiated Measured at 1 ft to 1 Gc and 3 ft above 1 GC	Para. 3.3.1.1.2 Fig. 4,5,6,7	Para. 4.7.2.2 Fig. 12,13,14
C.	Antenna Conducted		
	1. Transmitter Key-up or Receiver	Para. 3.3.1.1.3.1	
	2. Transmitter Key-down	Para. 3.3.1.1.3.2	Para. 4.7.2.3
	3. Transmitter Cross-modulation	Para. 3.3.1.1.3.3	Para. 4.7.2.4
D.	Susceptibility		
	1. AF Conducted	Para. 3.3.1.2.1.1	Para. 4.7.2.5.1.1 Fig. 15,16
	2. RF Conducted	Para. 3.3.1.2.1.2	Para. 4.7.2.5.1.2
	3. Conducted Transient	Para. 3.3.1.2.1.3	Para. 4.7.2.5.1.3 Fig. 17,18,19
	4. Audio Frequency Induced into Cable	Para. 3.3.1.2.2	Para. 4.7.2.5.2.1 Fig. 21
	5. Audio Frequency Induced into Equipment	Para. 3.3.1.2.3	Para. 4.7.2.5.2.2
	6. Radiated Field	Para. 3.3.1.2.4	Para. 4.7.2.5.3 Fig. 13,14,22,23,24
	7. Intermodulation	Para. 3.3.1.2.5	Para. 4.7.2.6
	8. Front End Rejection	Para. 3.3.1.2.6 Fig. 8	Para. 4.7.2.7

Figure 1. Interference Control Requirements

Notes:

1. Only requirements A and B are applicable to Maintenance Ground Equipment (MGE).
2. Radiated interference for MGE shall be measured at a distance of 3 feet, with an increase of 20 db allowed in the limits for radiated interference and 10 db in the limits for conducted interference.
3. An increase of 10 db in the limits for conducted interference for OGE is allowed for wiring that does not directly interface with AVE.
4. Radiated interference for Operational Ground Equipment (OGE) shall be measured at a distance of three feet.
5. No relaxation of requirements shall be permitted for carry-on equipment.

NARROW BAND

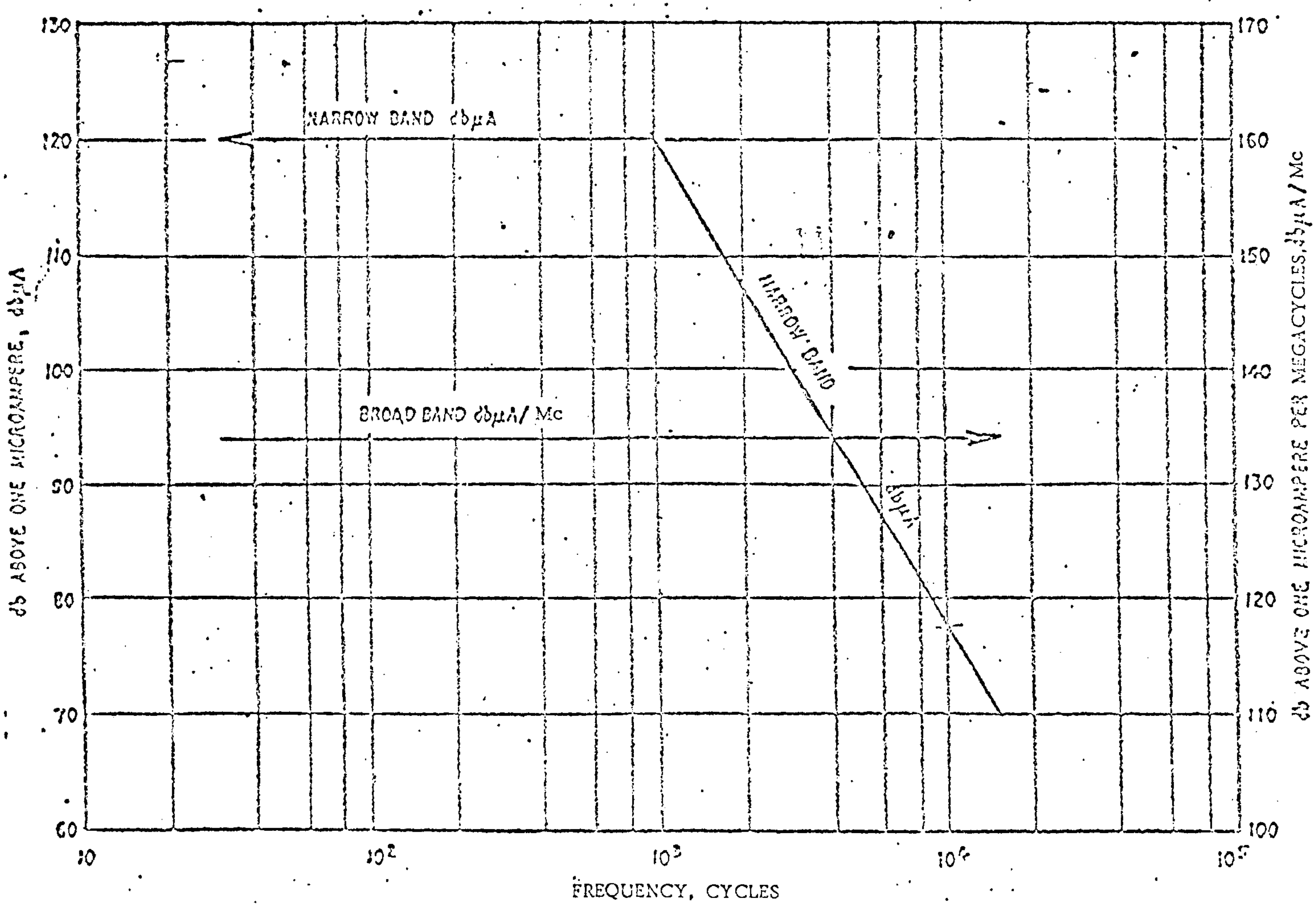


Figure 2. Conducted Interference Limits (30 CPS TO 15 KC)
R-AVE

SECRET SPECIAL HANDLING

BROAD BAND

NARROW BAND

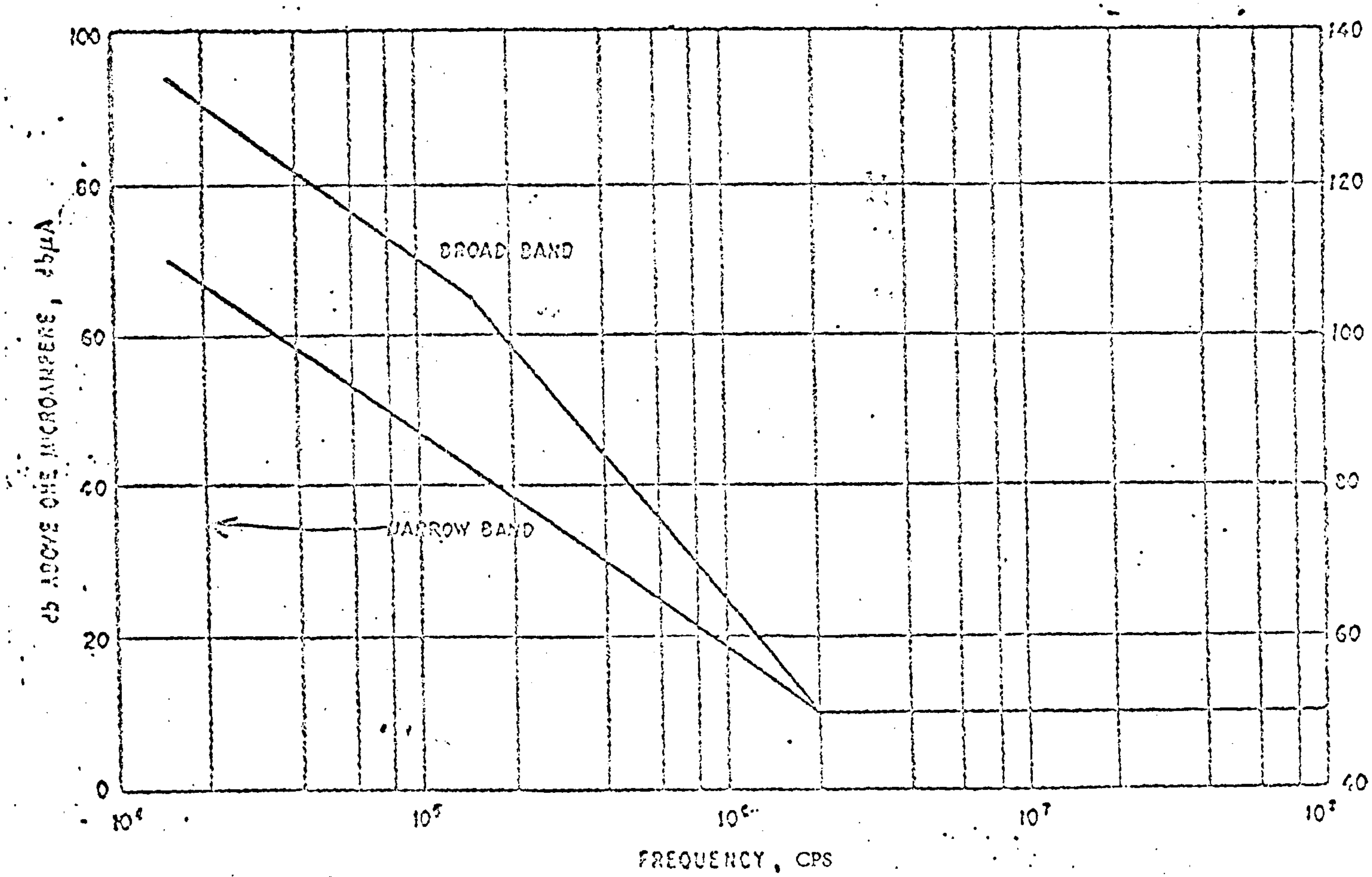


Figure 3. Conducted Interference Limits (15 Kc TO 100 Mc)

R-AVE

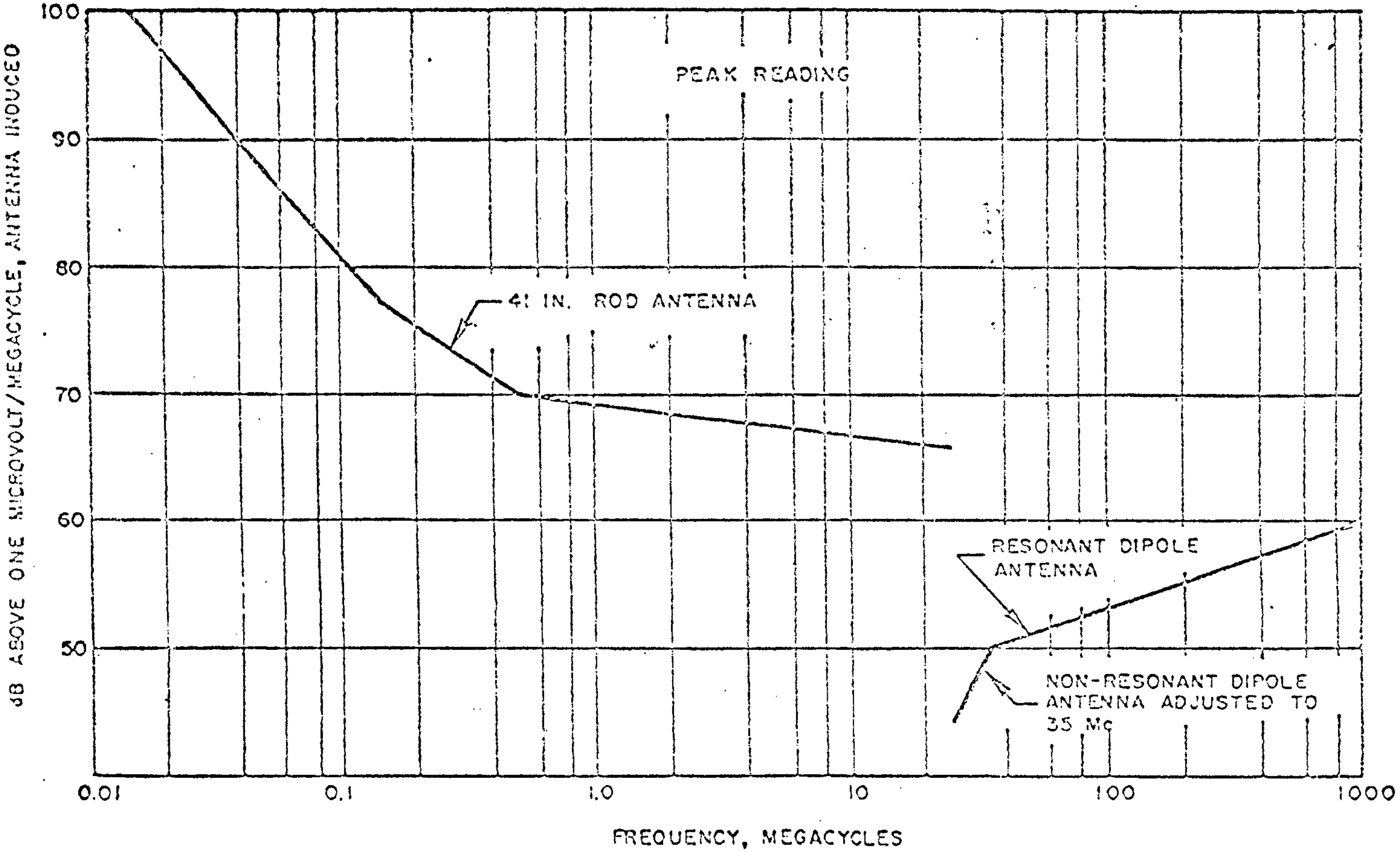


Figure 4 Broadband and Pulsed CW Radiated Interference Limits

R-AVE

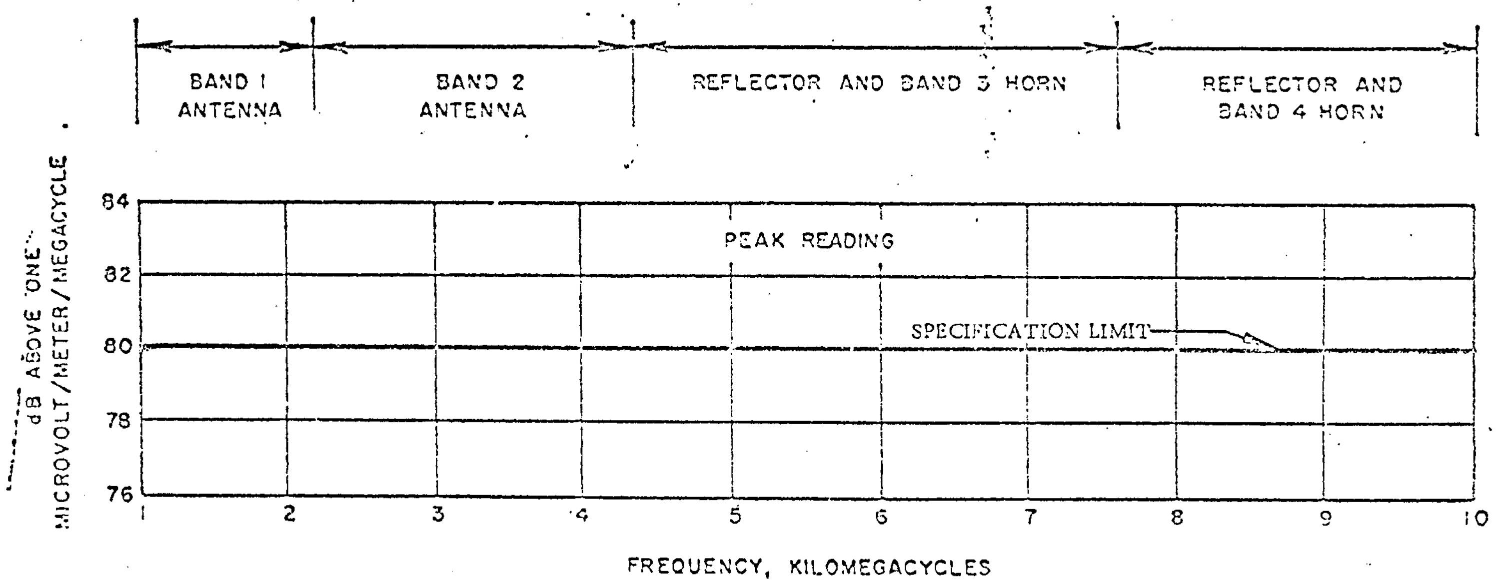


Figure 5. Broadband and Pulsed CW Radiated Interference Limits

R-AVE

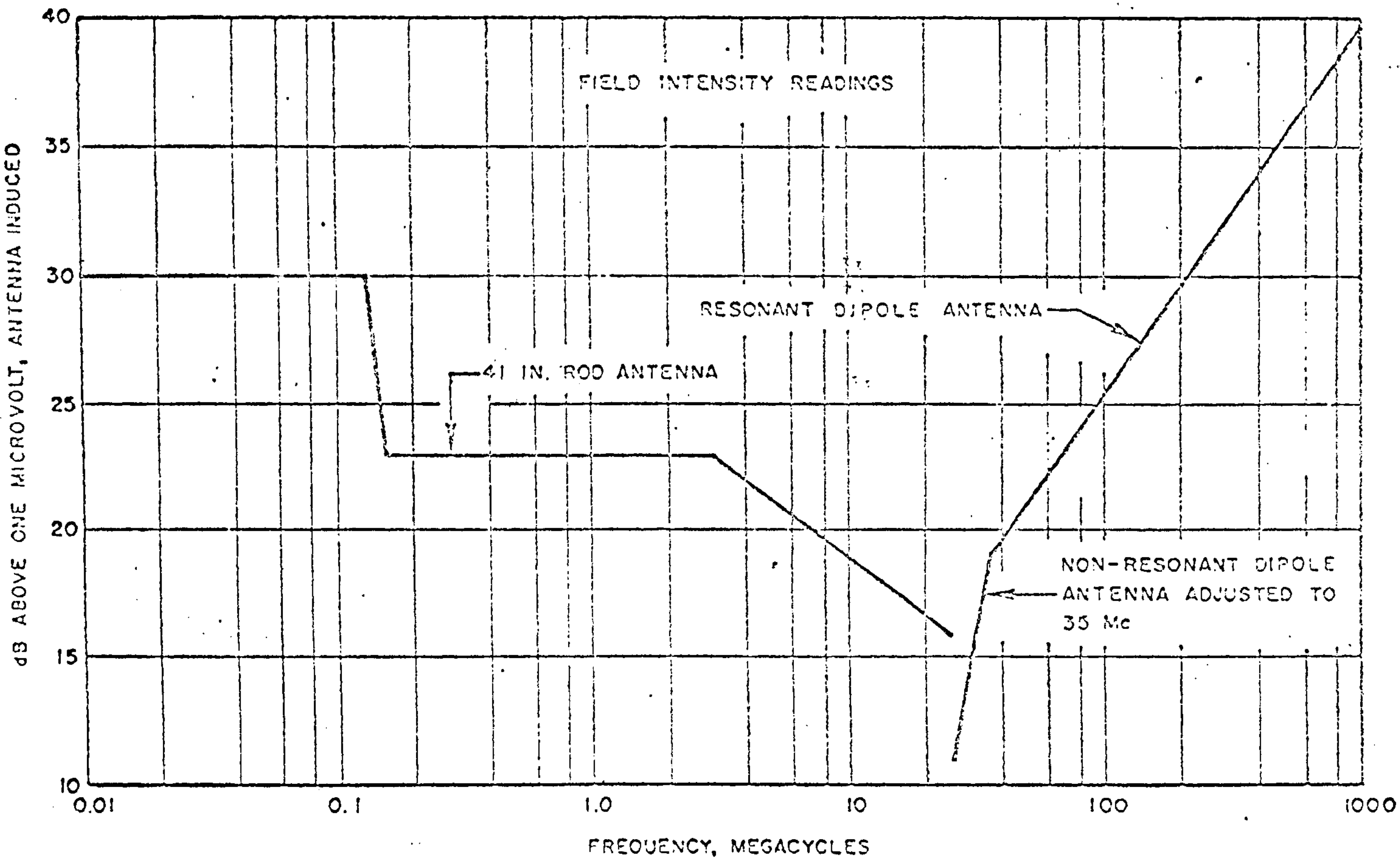


Figure 6. Narrow Band (CW) Radiated Interference Limits

R-AVE

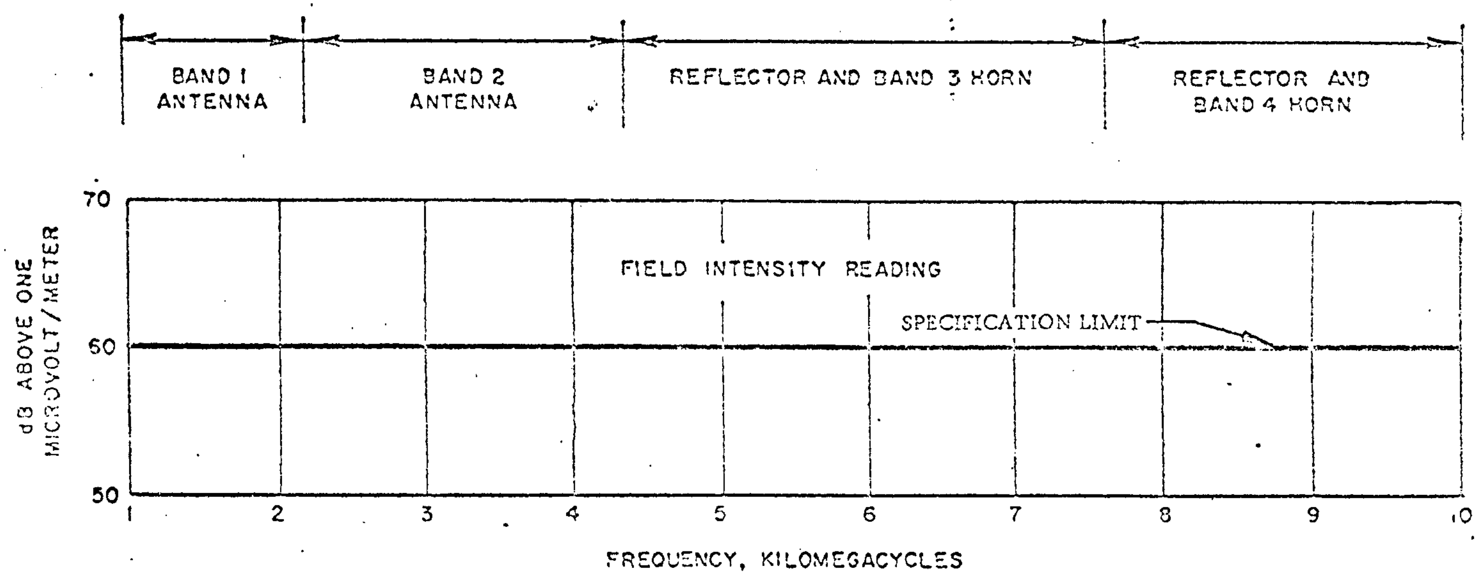


Figure 7. Narrow Band CW Radiated interference Limits

R-AVE

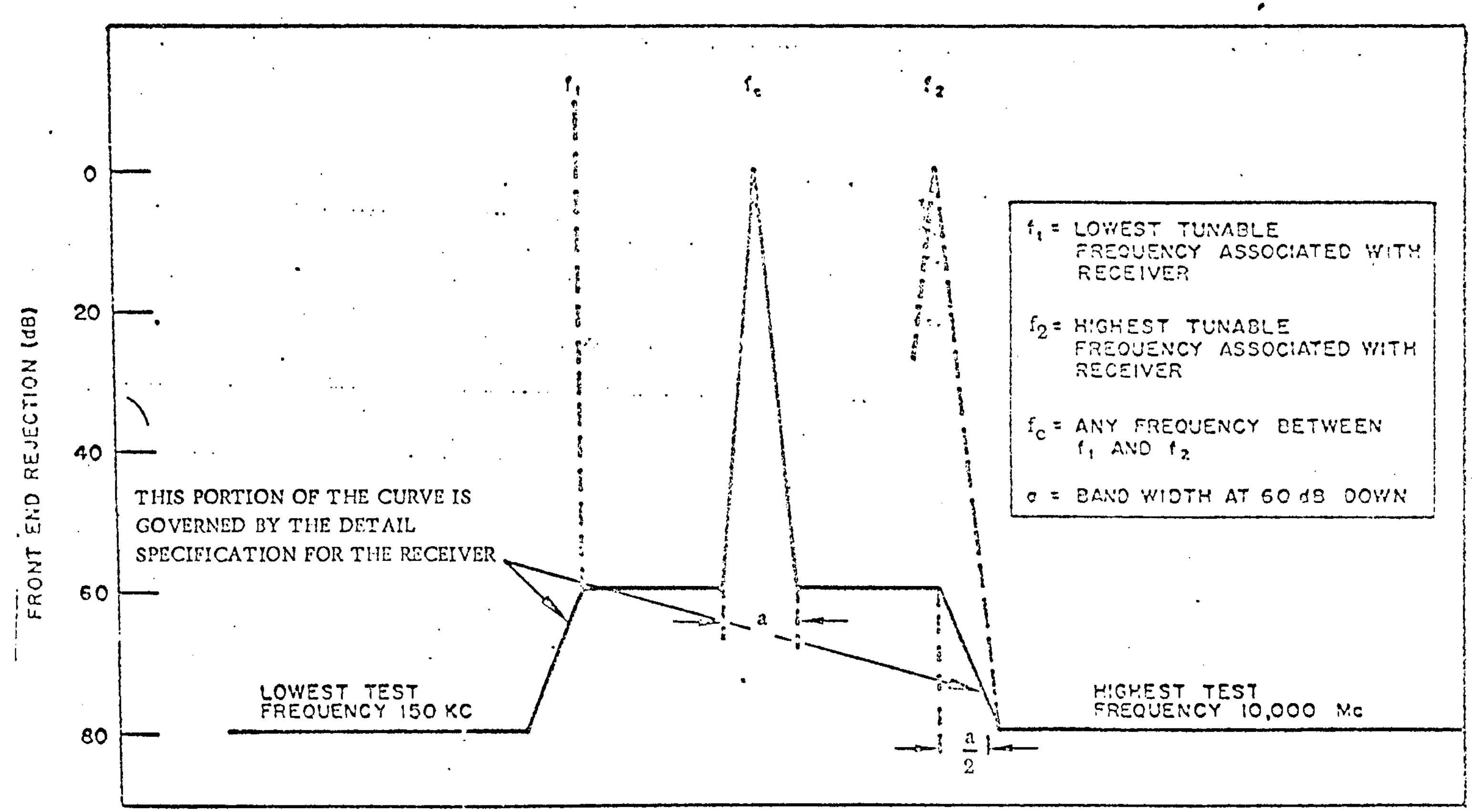


Figure 8. Receiver Front End Rejection

R-AVE

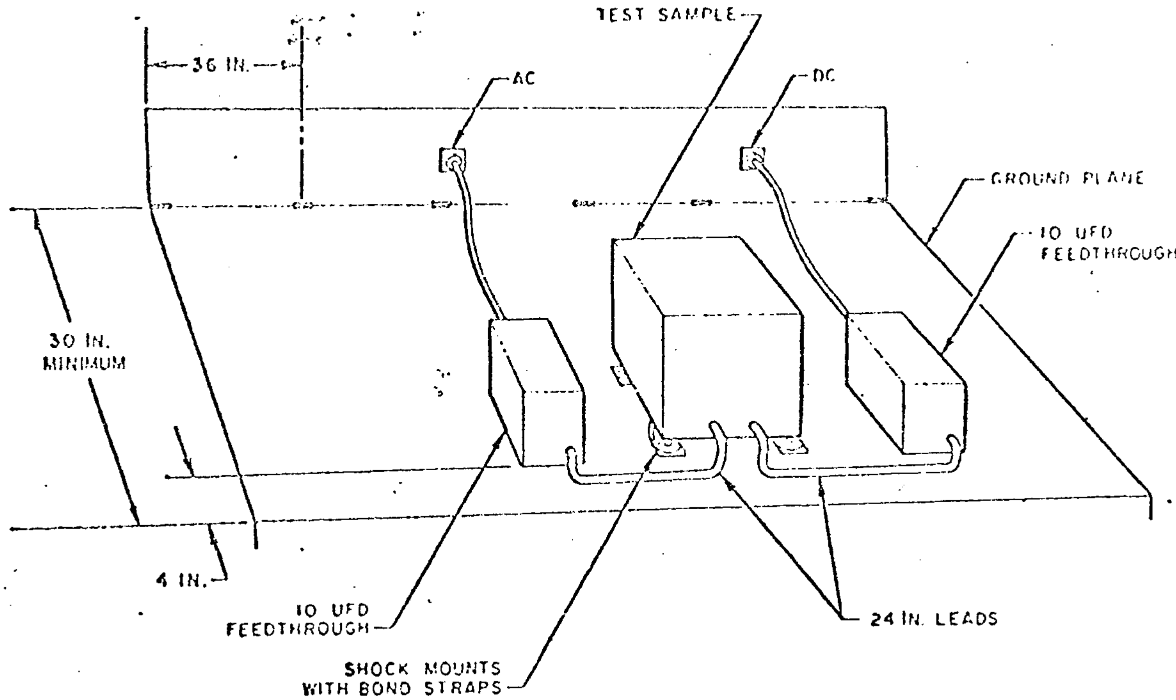


Figure 9. Typical Simple Test Setup

R-AVE

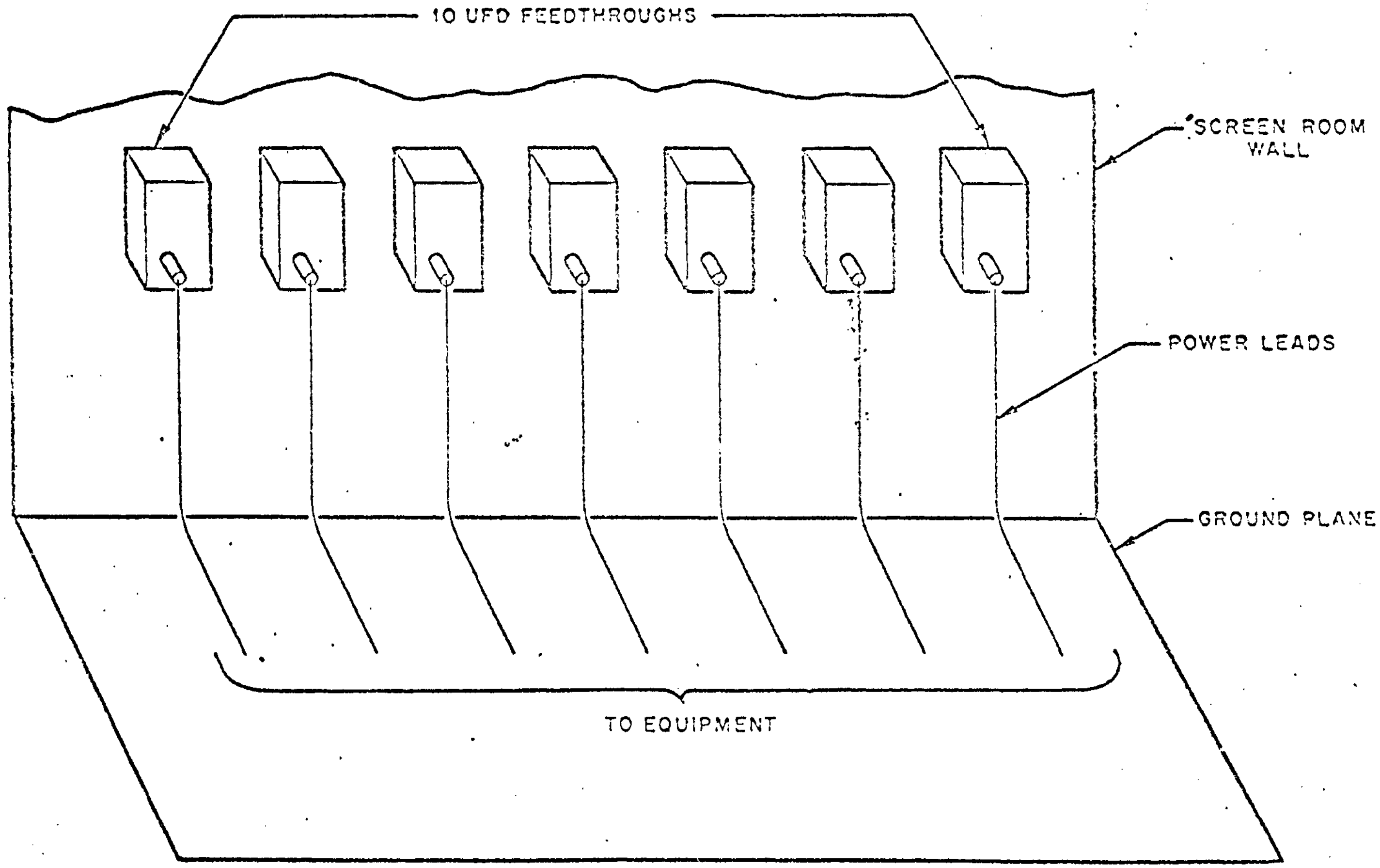


Figure 10. Typical Test Setup Using More Than Two Power Lines

R-AVE

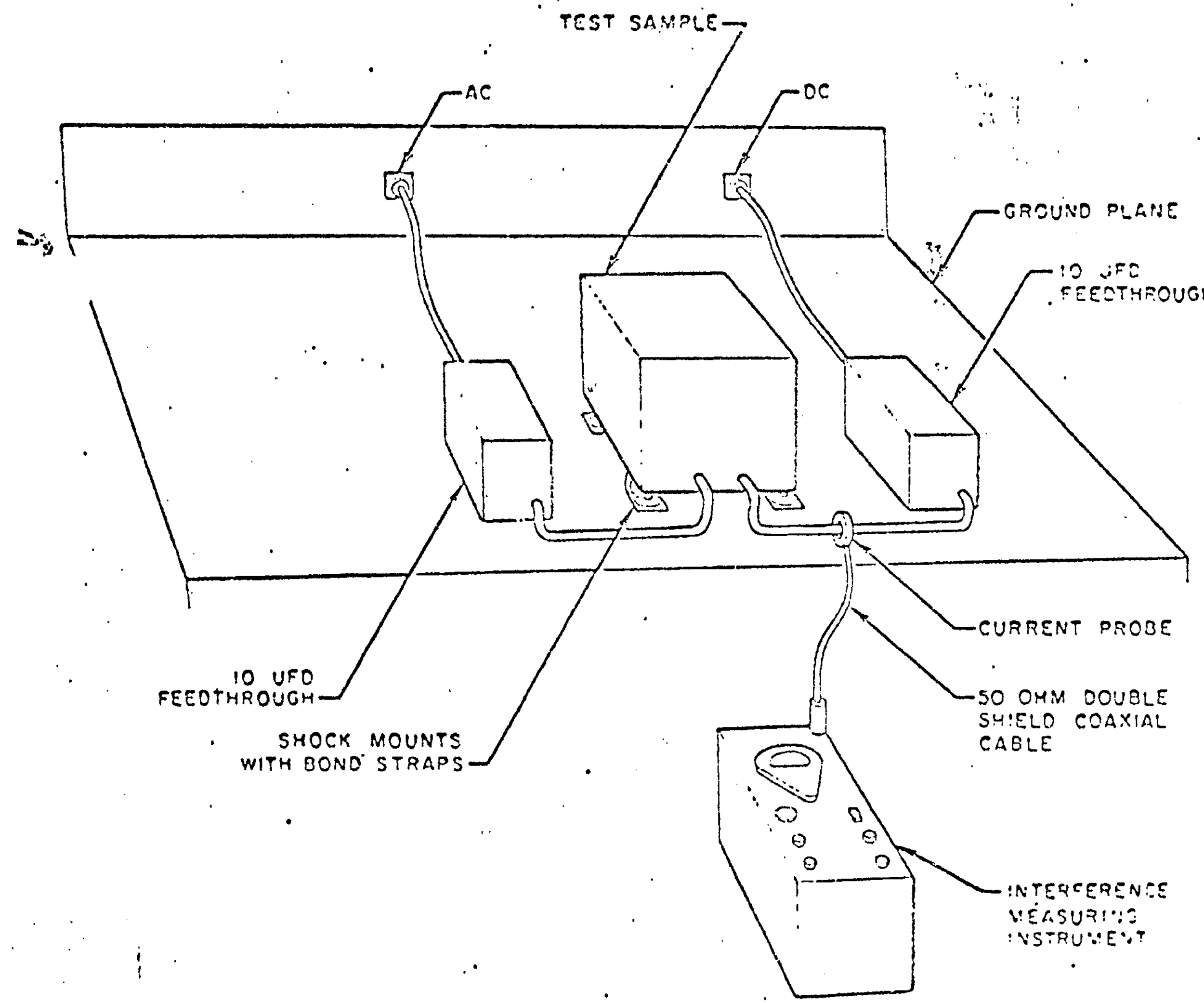


Figure 11. Typical Test Setup for Conducted Interference Measurements

R-AVE

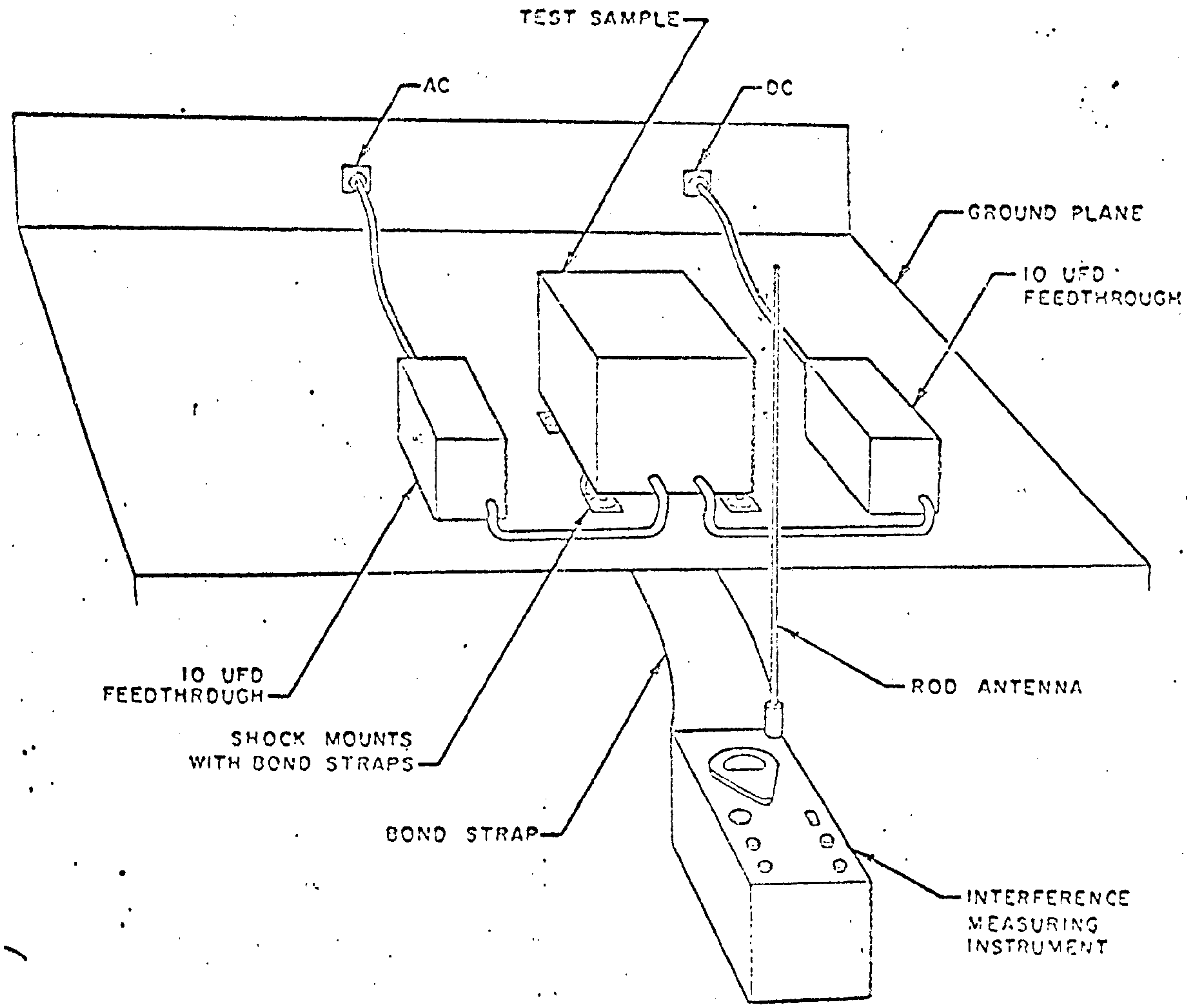


Figure 12. Typical Test Setup for Radiated Measurements, Rod Antenna

R-AVE

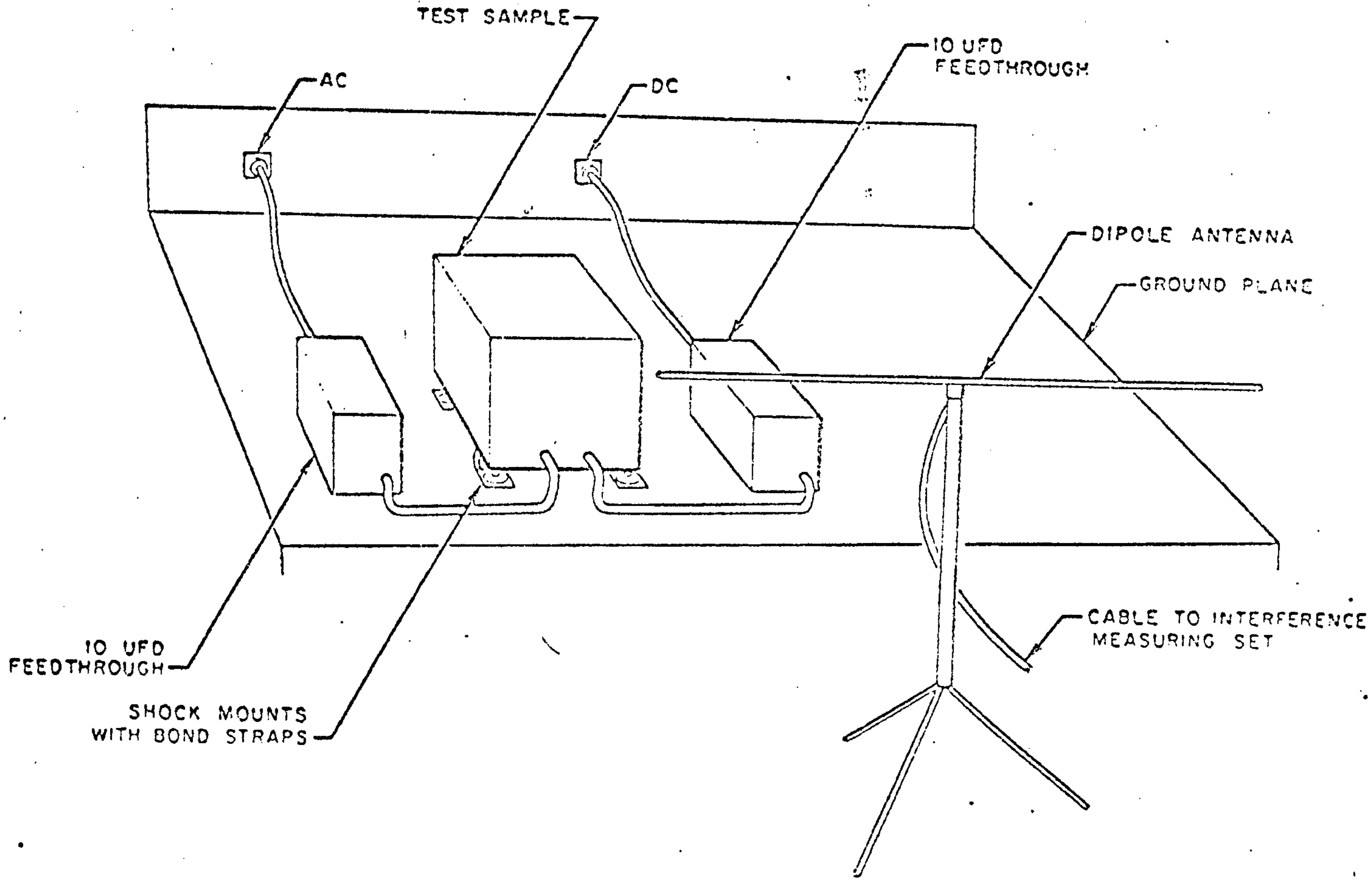


Figure 13. Typical Test Setup for Radiated Measurements, Dipole Antenna
R-AVE

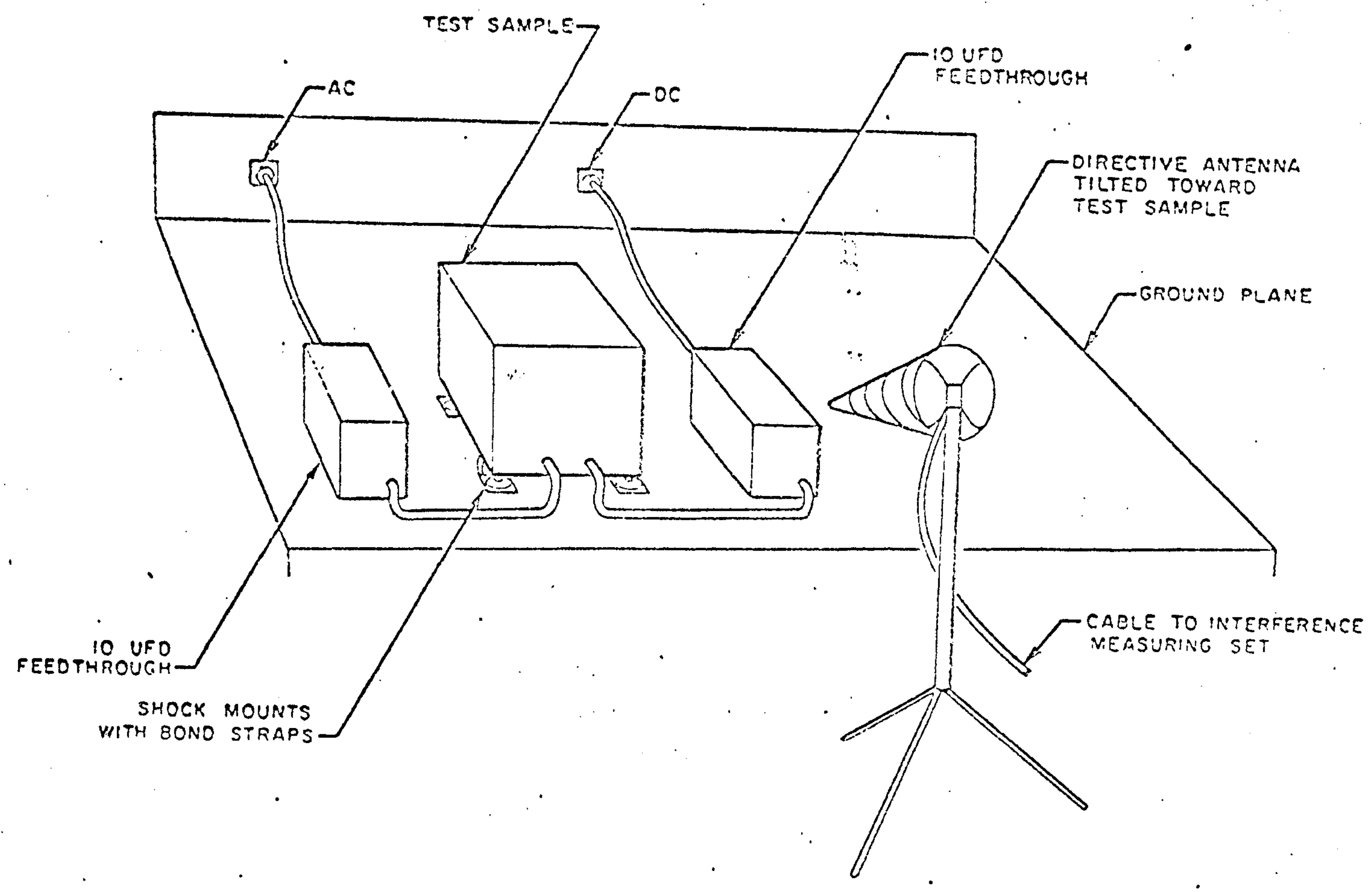
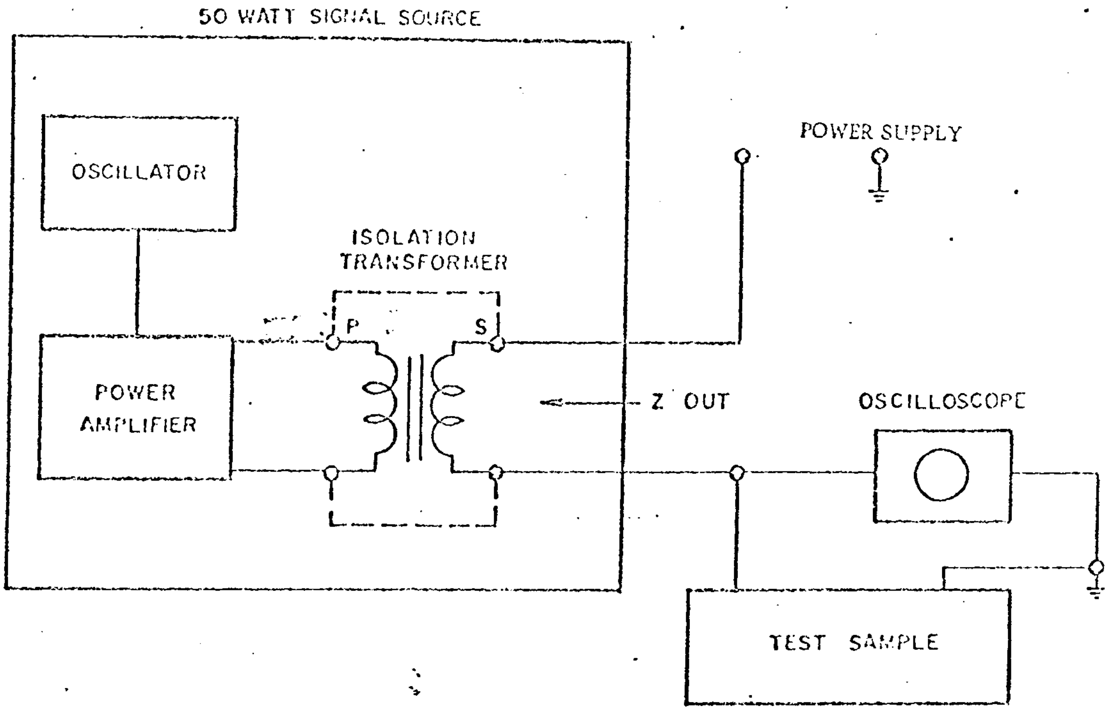


Figure 14. Typical Test Setup for Radiated Measurements, Conical, Log Spiral Antenna

R-AVE



1. Z OUT FROM 30 CPS TO 150KC WILL BE 0.5 OHMS OR LESS.
2. TRANSFORMER SHALL CARRY ALL CURRENTS WITHOUT SATURATION AND SHALL HAVE LOW LEAKAGE REACTANCE, LESS THAN ONE MICROHENRY AND SECONDARY CURRENT CAPABILITY OF 35 AMPERES WITH 10 PERCENT DROP.
3. TEST FUNCTION AMPLITUDES ACROSS THE TEST SAMPLE INPUT SHALL BE MEASURED AND RECORDED OVER THE FREQUENCY SPECTRUM WITH AN OSCILLOSCOPE.
4. A 100 μfd CAPACITOR ACROSS THE DC POWER SUPPLY MIGHT HELP IF DIFFICULTY IS ENCOUNTERED IN OBTAINING THE REQUIRED TEST VOLTAGE.

Figure 16. Susceptibility Test Setup, 30 CPS to 150 KC

R-AVE

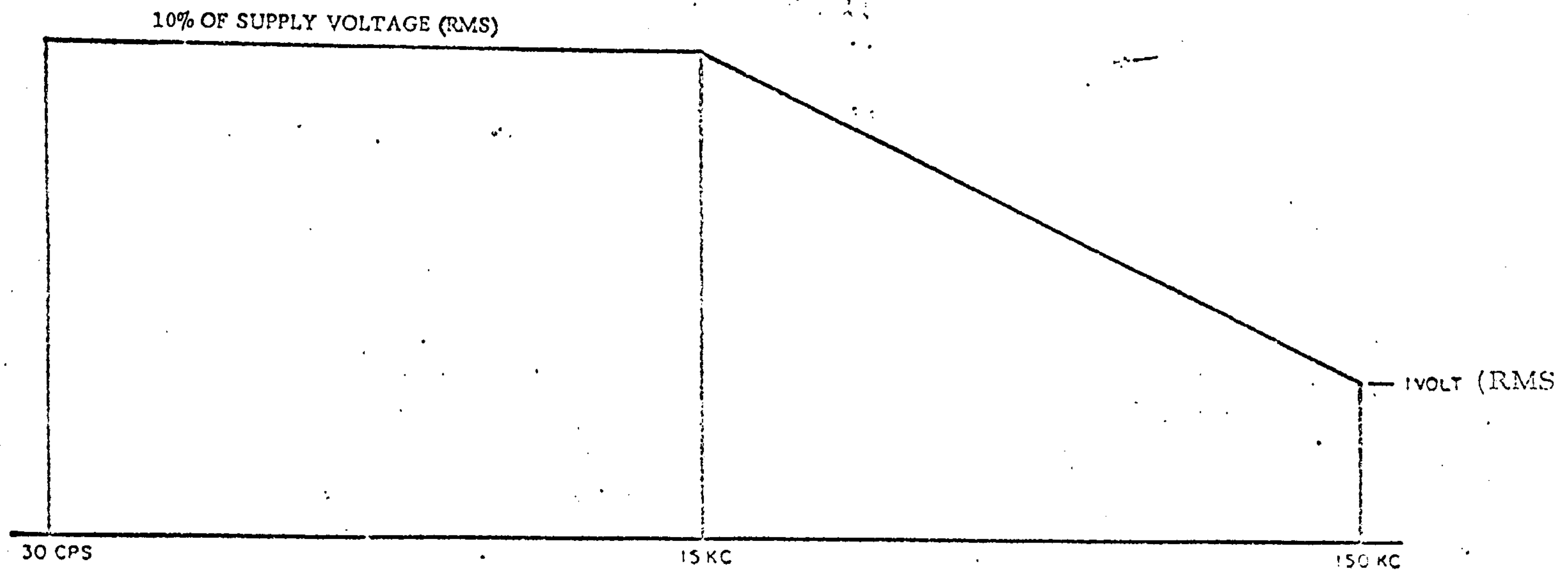
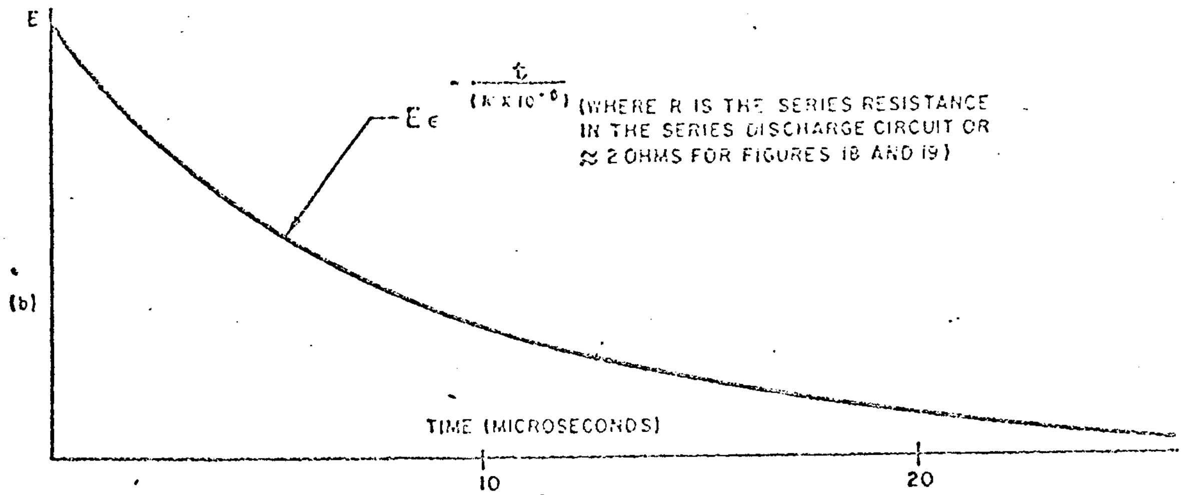
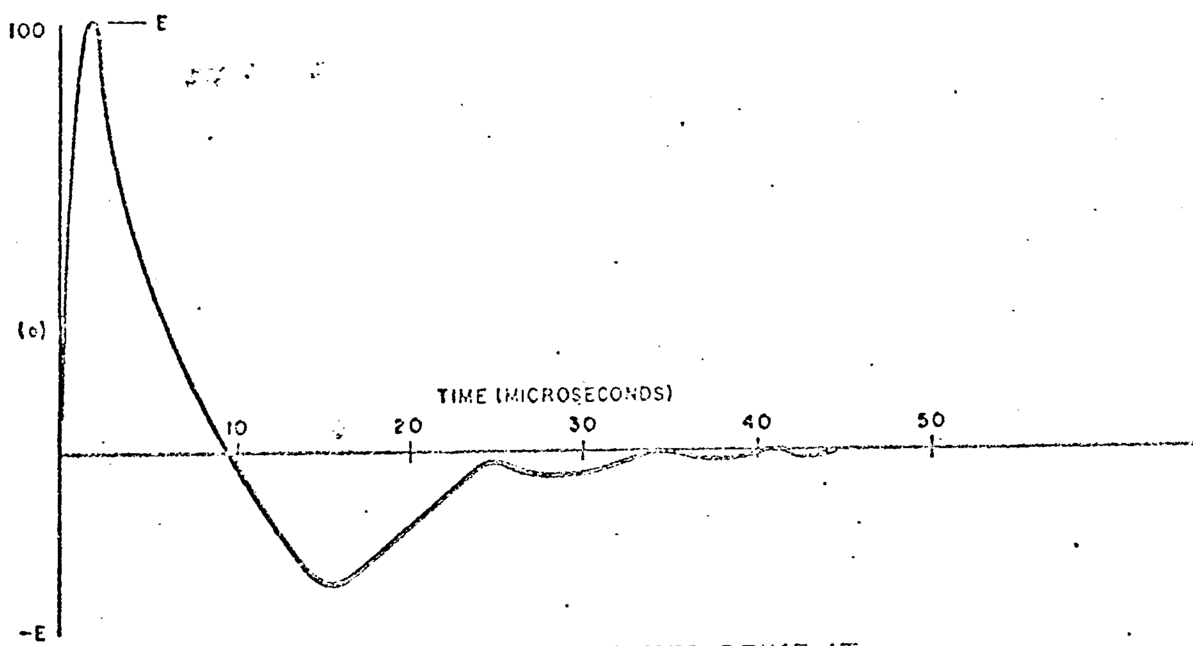


Figure 15. Conducted Susceptibility Limits, 30 CPS to 150 KC

R-AVE



A. IDEAL SPIKE

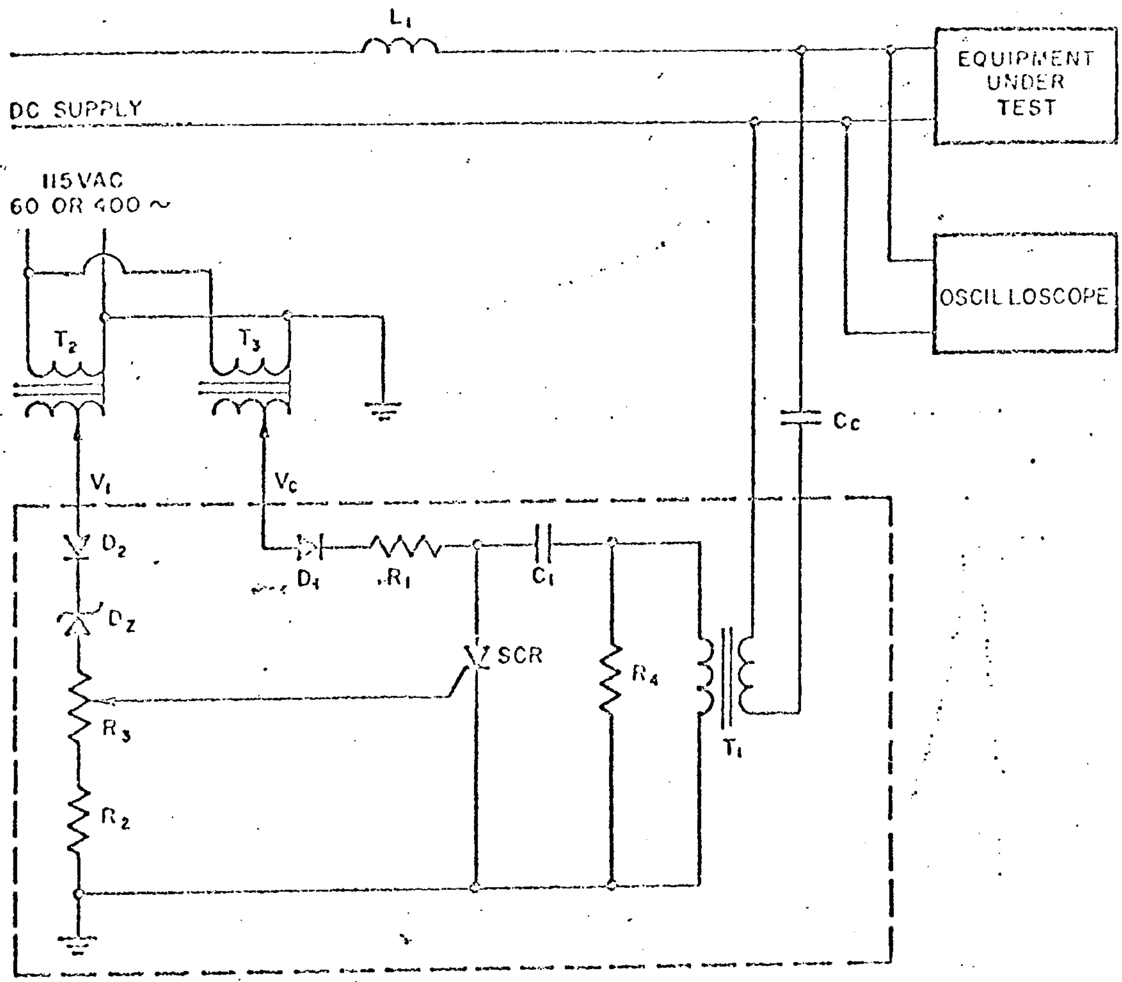


B. TYPICAL INJECTED SPIKE AT INPUT TO PACKAGE UNDER TEST

NOTE: -E WILL BE REGULATED TO SOME DEGREE BY THE IMPEDANCE OF THE LINE INTO WHICH THE PULSE IS INJECTED

Figure 17. Spike Characteristics

R-AVE



C_1 = 1 μfd

C_c = 8K μfd TANTALUM

D_1, D_2 = IN540

D_Z = IN2843B

L_1 = 20 μh

R_1 = 100 Ω NOMINAL

R = 200 Ω NOMINAL

R_3 = 1K Ω POT NOM

R_4 = 1 Ω NOMINAL

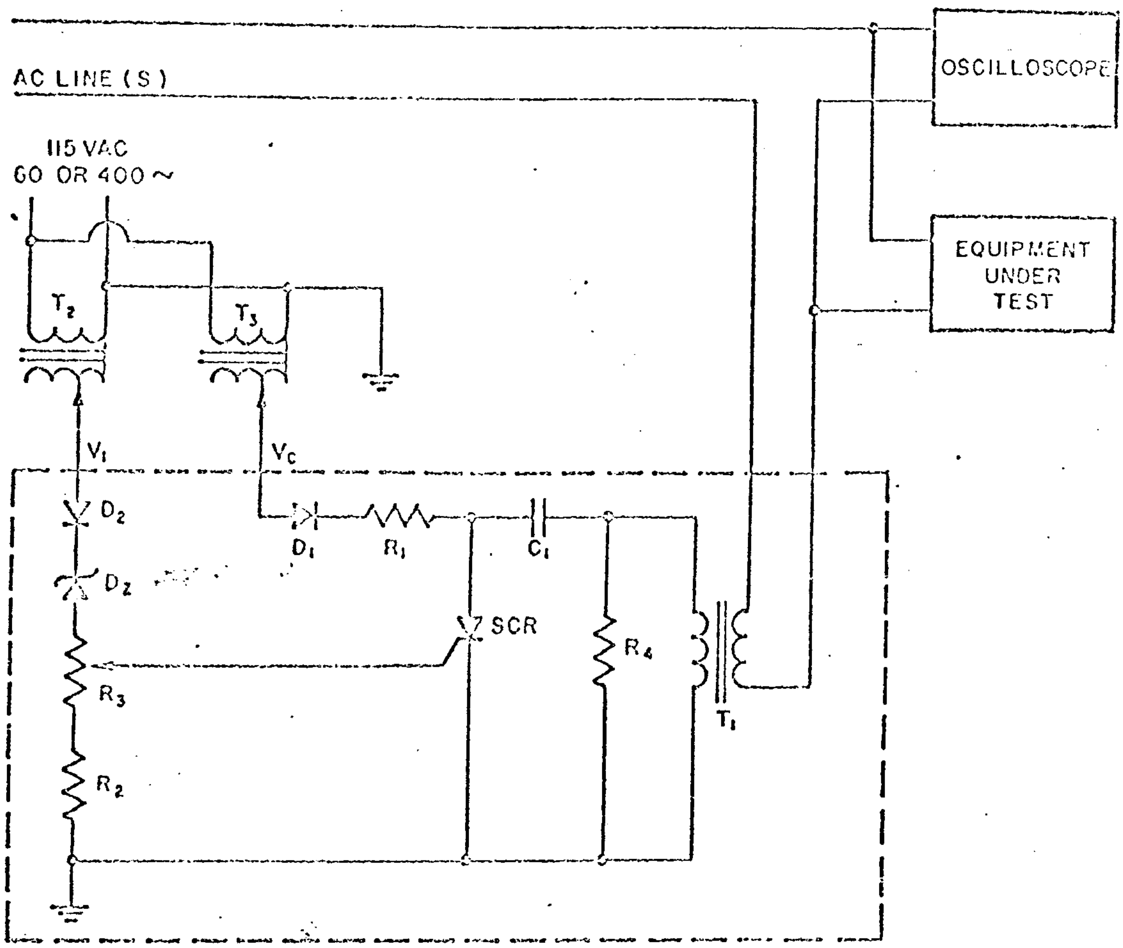
SCR = 2N685

T_1 = PULSE TRANSFORMER

T_2, T_3 = ADJUSTABLE TRANSFORMERS

Figure 18. Spike Generator, DC Lines

R-AVE



C_1 = 1 μfd

D_1, D_2 = 1N540

D_2 = 1N2843B

R_1 = 100 Ω NOMINAL

R_2 = 200 Ω NOMINAL

R_3 = 1K Ω POT. NOM.

R_4 = 1 Ω NOMINAL

SCR = 2N685

T_1 = PULSE TRANSFORMER

T_2, T_3 = ADJUSTABLE TRANSFORMERS

Figure 19. Spike Generator, AC Lines

R-AVE

Core material		Ferrox Cube Company of America (or equal)
		E section 783 E 608
		I section 783 B 608
Turns - Primary (12)		Copper sheet 1 mil thick 0.75 inch wide
Secondary (12)		Copper sheet 5 mil thick 1 inch wide (Bifilar wound)
Layer insulation	=	10 mil teflon tape
Core gap	=	0.1 inch per leg
Primary open-circuit inductance	=	12 microhenry ± 10 percent
Primary resistance	=	0.047 ohm
Secondary resistance	=	0.006 ohm
Secondary load current	=	43.5 amps

Figure 20. Pulse Transformer Specifications

R-AVE

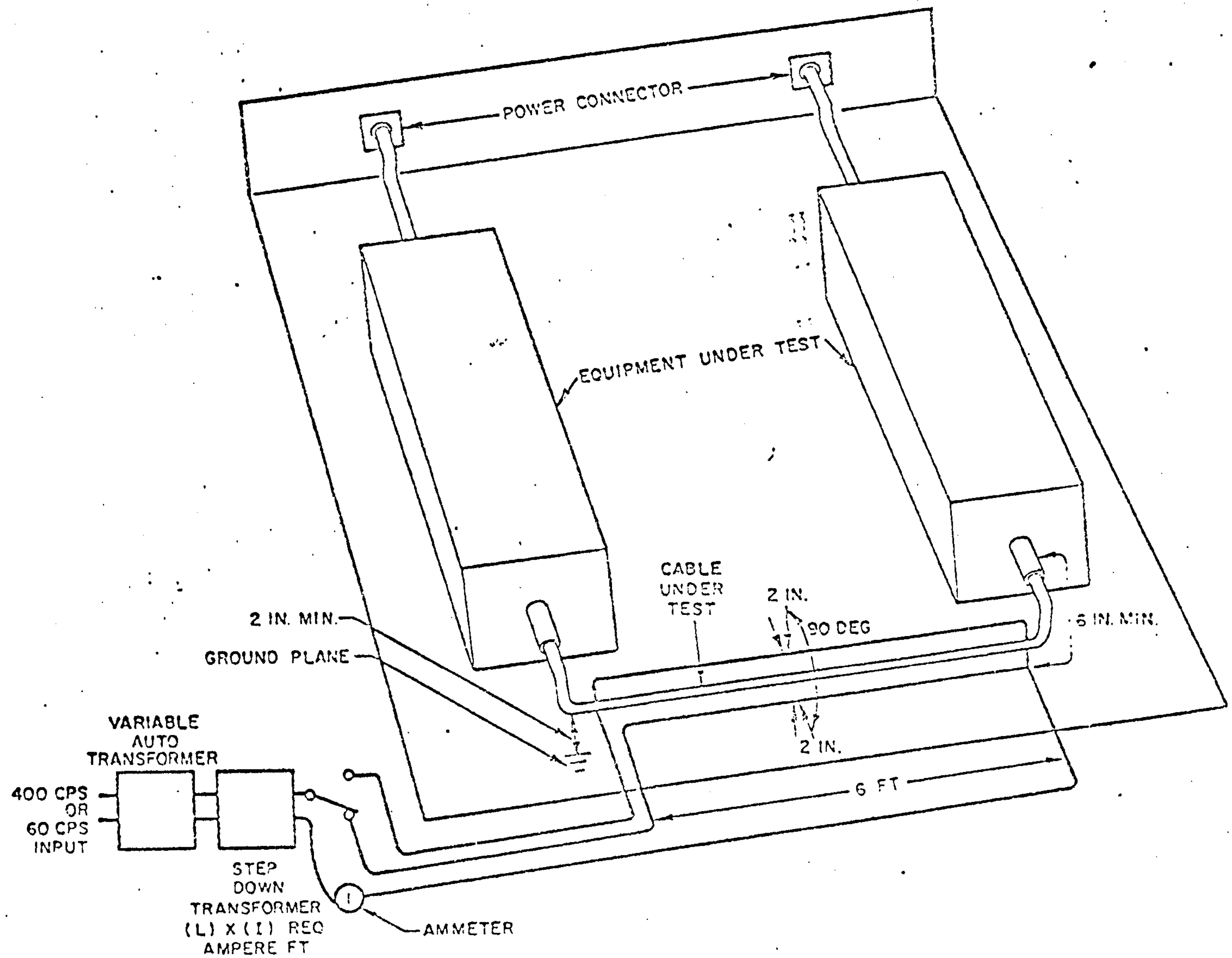


Figure 21. Typical Cable Induction Test Setup
R-AVE

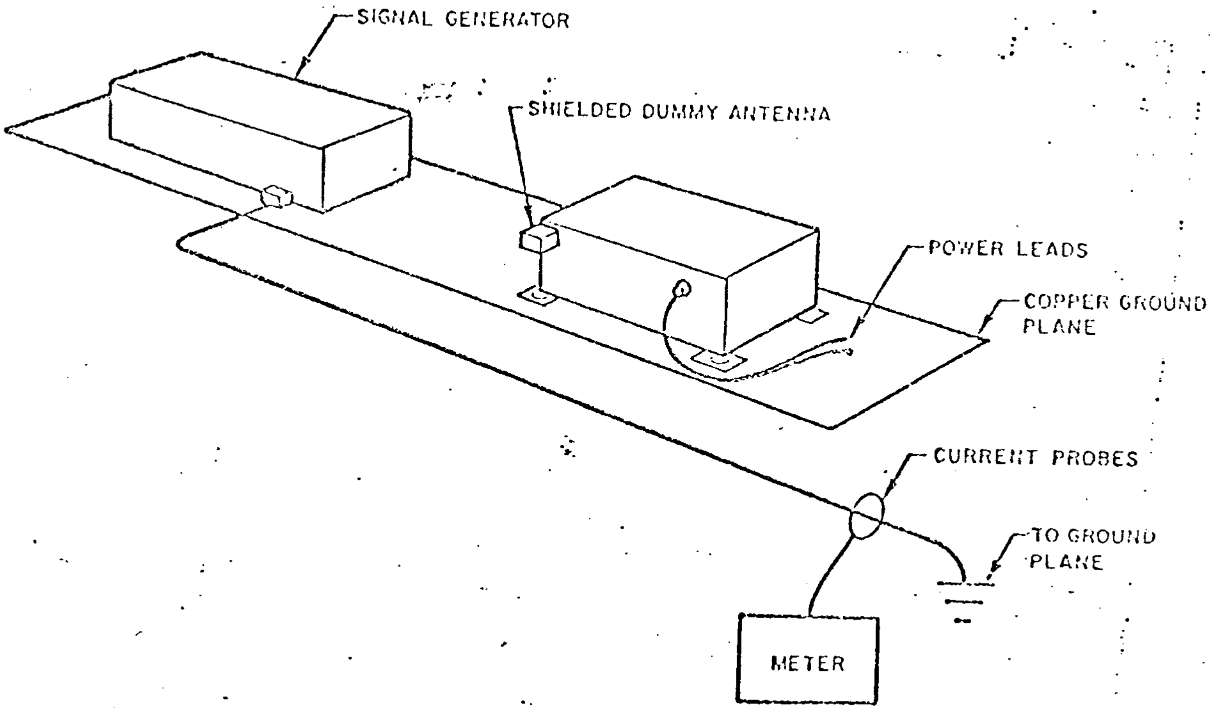
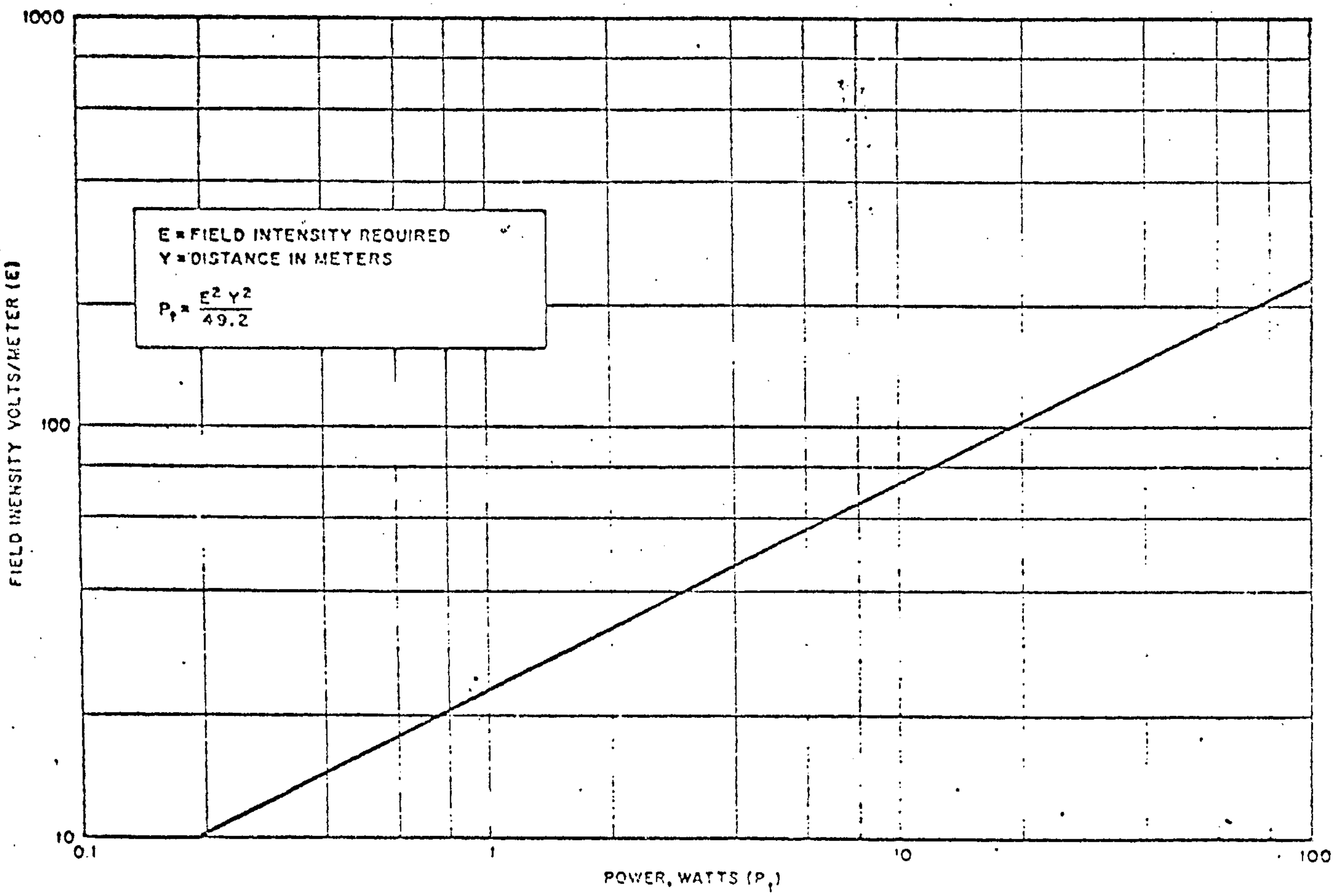


Figure 22. Typical Radiated Field Susceptibility Test Setup Using Long Wire Antenna

R-AVE



R-AVE

Figure 23. Power Delivered to a Tuned Dipole Antenna versus Radiated Field Intensity in Volts/Meter for One Foot Distance

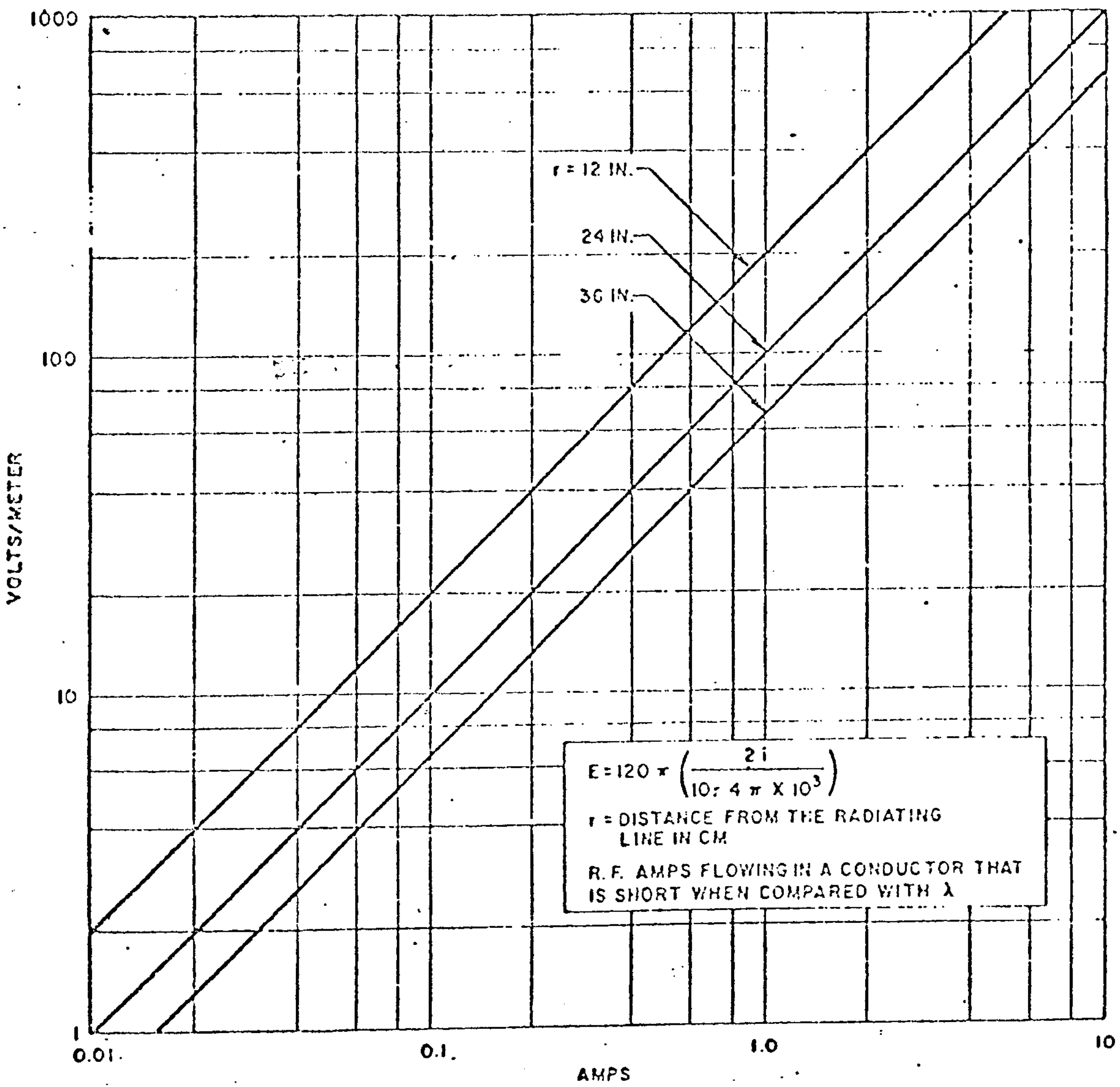


Figure 24. Radiated Volts/Meter vs Line Current in the Radiated Line

R-AVE

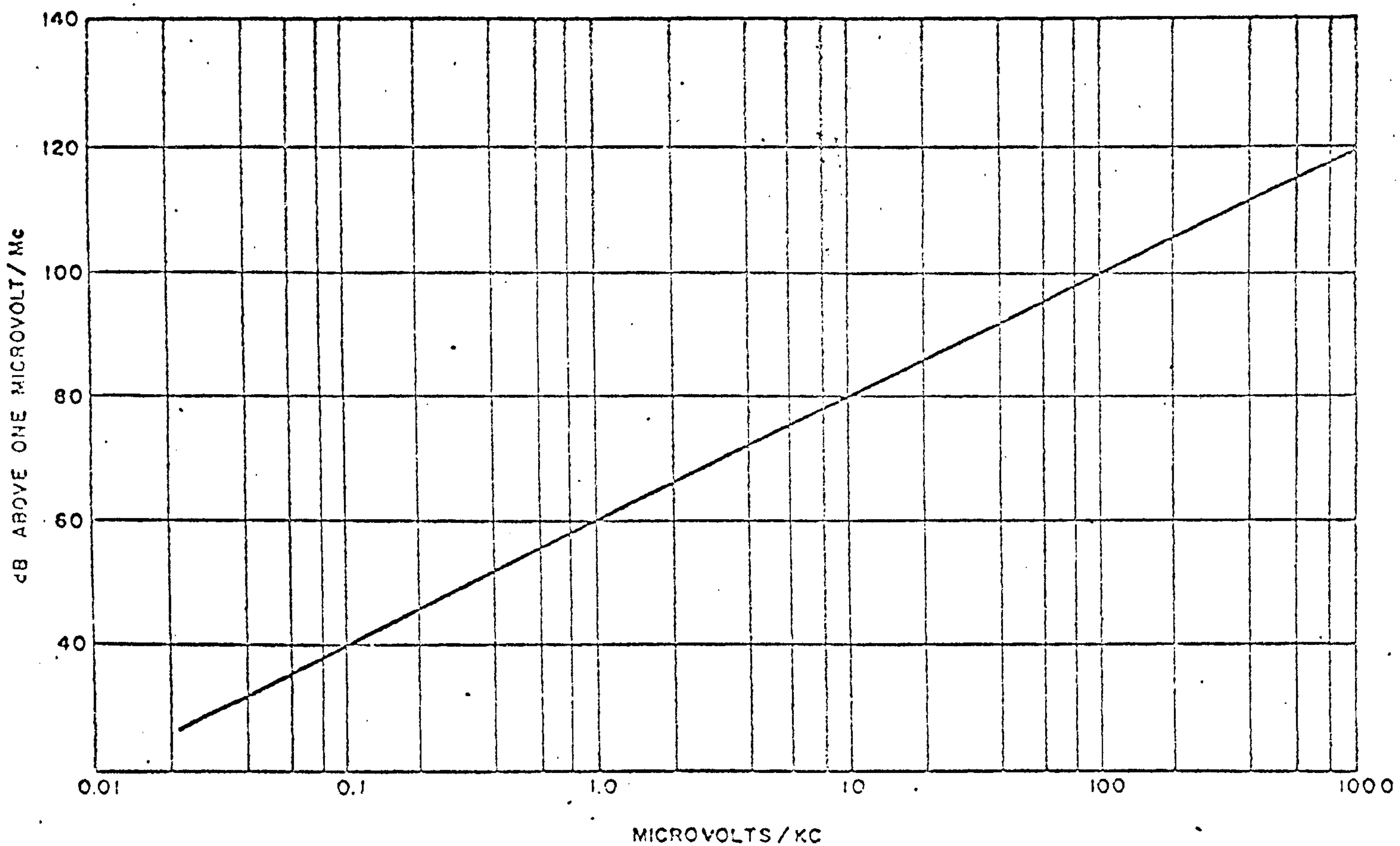


Figure 25. Conversion Chart - Microvolts/kc to dB/Mc

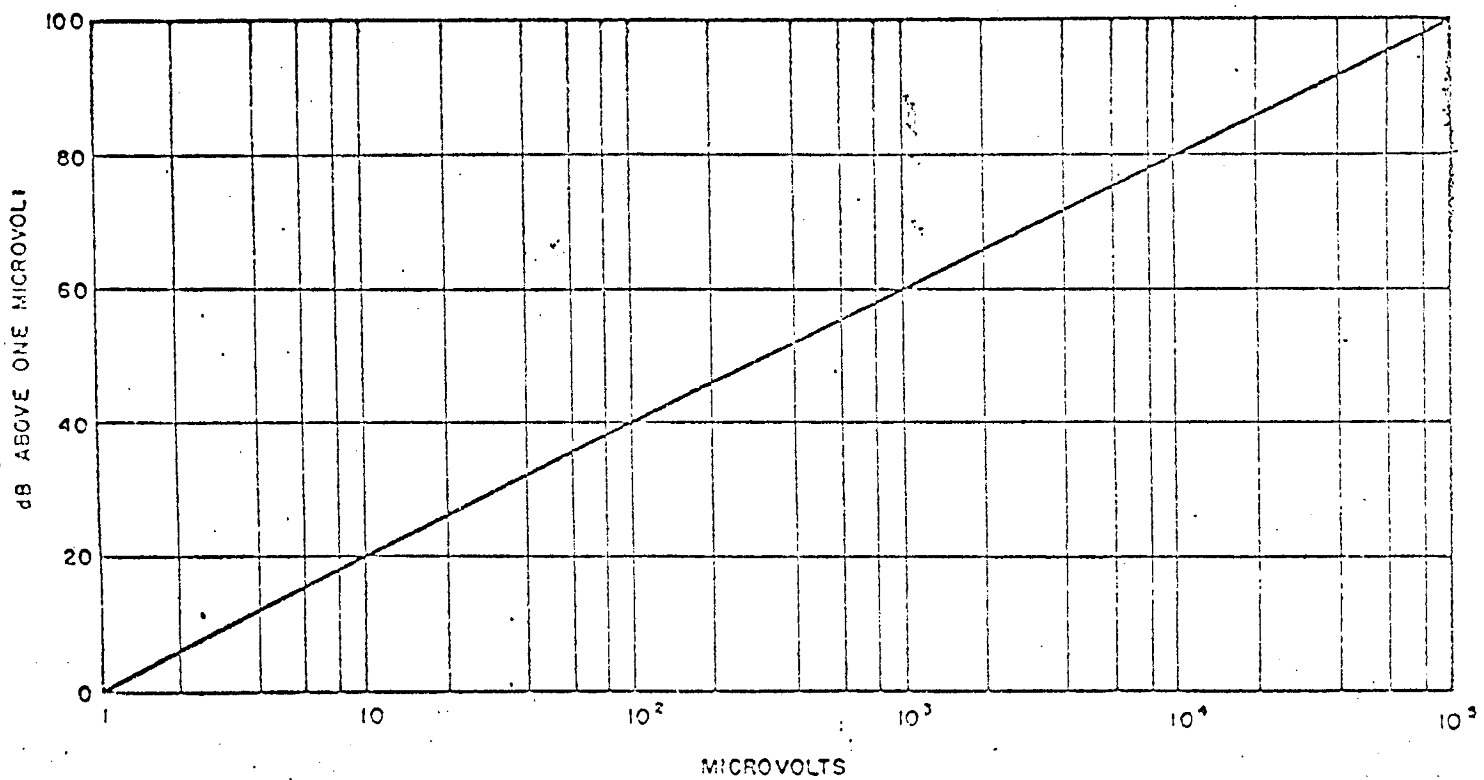


Figure 26. Conversion Chart - Microvolts to db Above One Microvolt

GE APPENDIX

The following paragraphs of SAFSL 30005 are not applicable to GE because the GE segment does not contain equipment pertaining to these paragraphs. In the event changes are made to the GE segment to include equipment which pertains to these paragraphs they shall apply.

3.3.1.1.3
3.3.1.2.5
3.3.1.2.6
4.7.2.3
4.7.2.4
4.7.2.6
4.7.2.7

EK APPENDIX

I. APPLICABLE PARAGRAPHS (INTERFERENCE GENERATED LIMITS)

3.3.1.1.1

3.3.1.1.2

The conducted and radiated generated interference limits of 3.3.1.1.1 and 3.3.1.1.2 shall not apply to interference sources switching (1) less than 5 volts at less than 5 milliamperes, (2) less than 1.75 volts at less than 1.75 amperes and (3) rates of current change of less than 30,000 amperes per second.

II. APPLICABLE PARAGRAPH 3.2.5.3 Grounding & Isolation

Brush-type d.c. motors shall have an isolation resistance between power leads and motor frame of 50,000 ohms or more. Electrical components whose leakage tests involve circuits which contain motors will have specification limits adjusted to reflect the effects of the associated motors.

III. 4.1.3 APPLICABLE PARAGRAPH - Test Report Schedule

The Contractor shall submit to MOL/SPO all data and results for system level EMC tests on the Qualification Model 30 days after completion of the test. In addition, the Contractor shall submit any significant results of system level EMC tests on other developmental models within 30 days of the test completion.

EK APPENDIX (continued)

IV. The following paragraphs are not applicable to Eastman Kodak Company because the Eastman Kodak Company segment does not contain equipment pertaining to the paragraphs. In the event changes are made to the EK segment to include equipment which pertains to these paragraphs, they then shall apply.

3.2.5.4	EED Firing Circuits
3.3.1.2.5	Intermodulation
3.3.1.2.6	Receive Front End Rejection
3.3.1.3 - 3.3.1.3.2.3	Electroexplosion Devices (EEDS)
3.3.3 - 3.3.3.2.3	Validation of EED and EED Initiator Circuit
4.7.2.3	Transmitter (Keydown)
4.7.2.4	Transmitter Crossmodulation
4.7.2.6	Intermodulation
4.7.2.7	Receiver Front End Rejection

As an alternate to maintaining the transient generator at ± 100 v during component operation, transient susceptibility testing may be done with a transient source whose unloaded output voltage has been set at ± 100 v. To obtain the 30 millijoule level, a 6 microfarad capacitor will be used as an energy source of the transient. Peak transient current will be limited by an equivalent generator output impedance of 1 ohm.

WIRING HARNESS SPECIFICATION

FOR THE MOL SYSTEM

SAFSL EXHIBIT 30006

6 JUNE 1968

CERTIFICATION OF DOCUMENT CLASSIFICATION

I HEREBY CERTIFY THAT ALL PAGES OF THE ATTACHED DOCUMENT

[illegible]
(Document Title or Other Identification)

CARRY PROPER SECURITY CLASSIFICATION MARKINGS.

(Signed) [illegible]

(Signed) [illegible] May 25 68

(Signed) ____________________

SAFSC EXHIBIT 30006
(WIRING HARNESS)

The undersigned has reviewed the document and understands the contents to the extent necessary to scope subsequent proposals.

(Signed) W. J. [signature] 25 May 68 (Signed)

(Signed) [signature] GE 25 MAY 1968 (Signed)

(Signed) D. T. Johnson Eastman Kodak 5/25/68 (Signed)

(Signed) [signature] TRC 5/25/68 (Signed)

(Signed) [signature] May 25, 68 (Signed)

(Signed) [signature] SAFSL 25 May 68 (Signed)

(Signed) (Signed)

1.0 SCOPE

This specification covers the general requirements for electrical wiring harnesses external to components which are installed in spacecraft. All deliverable data and/or documentation specified in this Exhibit shall be in accordance with the respective contractor's CDRL (DD 1423) or equivalent as detailed by Form 9.

2.0 APPLICABLE DOCUMENTS

The following documents of the issue date shown form a part of this specification to the extent specified herein:

2.1 Specifications

2.1.1 Military

MIL-C-26482D	Connectors, Electric, Circular, Miniature, Quick Disconnect, Environment Resisting dated 2 January 1968.
MIL-C-38300	Connectors, Electronic, Circular, Multicontract, High Environment, Quantitative Reliability, General Requirements for, dated 15 August 1963 with amendments and supplements.
MIL-C-38999	Connectors, Electric, Miniature, Quick-Disconnect with Removable Crimp Contacts for Special Weapons System Circuitry, Established Reliability, dated 21 August 1967.
MIL-P-26539B	Propellant, Nitrogen Tetroxide, dated 15 Oct 1965.
MIL-P-27402A	Propellant, Hydrazine-Uns-Dimethyhydrazene (50% N_2H_4, 50% UDMH) dated 24 February 1967.
MIL-P-27404	Propellant, MonoMethyl Hydrazine, dated 3 Apr 1962.
MIL-P-27408	Propellant, Nitrogen Tetroxide Nitric Oxide (90% N_2O_4 -10% NO_2), dated 5 May 1967.
MIL-S-23190B	Strap, Cable, Adjustable, Plastic, dated 27 July 1966.
MIL-W-8160D	Wiring, Guided Missiles, Installation of, General Specifications for, dated 24 December 1963.
MIL-W-16878/4A	Wire, Electrical, Type E, 200°C and 260°C, 600 Volts (Insulated High Temp) dated 5 July 1961.
MIL-W-22759	Wire, Electric, Fluorocarbon-Insulated, Copper and Copper Alloy with amendments dated 3 Jan 1968.

MIL-C-22557A	Connectors, Co-axial, Radio Frequency, Miniature, (Screw-on), General Specification for, dated 26 January 1967.
MIL-C-24308	Connector, Electric, Rectangular, Miniature, Polarized Shell, Rack and Panel General Specification for, dated 30 November 1967 with supplement.
MIL-C-39012	Connector, Co-axial, Radio Frequency, General Specification for, dated 23 May 1966 with Amendments and Supplement.
MIL-C-23329A	Connector, Co-axial, Radio Frequency, Series SC, dated 15 February 1965 with Supplements and Ammendments.
MIL-W-81381(AS)	Wire, Electric, Polymide-Insulated, Copper and Copper Alloy, dated 15 October 1966.
NAS 1599 (Rev. 3)	Connectors, General Purpose, Electrical, Miniature Circular, Environmental Resisting, 200°C Maximum Temperature, dated 15 October 1966.
MS 33586	Metals, Definition of Dissimilar, dated 16 Dec 1958.
MSC-PPD-2	Propellant, Inhibited, Nitrogen Tetroxide, dated 6 January 1966.
SAFSL Exhibit 30005	Electromagnetic Compatibility Requirements, Orbiting Vehicle, General Specification for the Manned Orbiting Laboratory, dated 7 June 1968.
SAFSL Exhibit 10010	Nonmetalic Materials Combustion & Atmospheric Contamination Control Standard.

3.0 REQUIREMENTS

3.1 General Requirements

In the case of a conflict between this document and any applicable document, this document shall prevail.

3.2 Electromagnetic Compatibility

The wiring harness shall be designed and installed to aid the system in meeting the electromagnetic compatibility requirements of SAFSL Exhibit 30005. The wiring harness shall comply with the SAFSL Exhibit 30005. requirements for wire routing, signal separation, wire twisting, shielding and grounding.

3.2.1 Shield Terminations

Shield terminations shall be in accordance with SAFSL Exhibit 30005. Shield terminations at the same end of the harness shall not be successively connected in series, one to another with one end of this chain being grounded or carried through on connector contacts.

3.2.2 Redundant Wiring

Where practicable, redundant-circuit wiring shall be routed in separate wire bundles, and separation of wire bundles shall be maintained to the maximum extent possible, including the use of separate connectors.

3.2.3 Spare Wires

All wire harnesses located in inaccessible areas of the Orbiting Vehicle that contain circuits which if inoperative will result in a launch countdown termination shall include spares. Inaccessible areas are defined as "those areas where replacement wires cannot be installed on the launch pad". All spare wires shall be terminated in connectors at each end of the harness.

3.3 Propellant Compatibility

In those areas subject to exposure to hypergolic propellants the wiring harness and all parts used in the wiring installation shall be compatible with the MOL system propellants which are specified in MIL-P-26539A, MIL-P-27404, MIL-P-27408, MSC-PPD-2, and MIL-P-27402, except for direct contact as a result of spillage or immersion. The wiring harness shall be capable of continued operation following short duration exposure to spacecraft propellants as a result of spillage; however, extensive spillage prior to launch shall be sufficient cause for replacement of affected wiring harnesses.

3.4 Flammability

The design of the wiring harness shall minimize effects of potentially catastrophic fires within the AVE by reducing the quantity of flammable materials, limiting ignition sources and limiting flame propagation paths. SAFSL Exhibit 10010 shall be used as a guide.

3.5 Connectors

3.5.1 Non-coaxial Connectors

Connectors shall be of the removable crimp-contact type, except where use of such connectors is not feasible or where approval of another type has been granted by the MOL System Office. Each connector shall meet the performance requirements of one of the following specifications as a minimum:

a) MIL-C-26482
b) MIL-C-38300
c) MIL-C-38999
d) NAS-1599
e) MIL-W-8160, paragraphs 3.7.6, 3.7.6.1, 3.7.6.2, 3.7.6.3, exclusive of subparagraphs.
f) MIL-C-24308

3.5.2 Co-Axial Connectors

Each co-axial connector shall meet the requirements of one of the following specifications:

a) MIL-C-39012
b) MIL-C-23329
c) MIL-W-8160 - paragraph 3.7.6.4
d) MIL-C-22557

3.5.3 Finish

The finish of connector shells and accessory hardware shall provide an electrically-conductive path from mated plugs to receptacles from cable-clamp screws to connector shells. Connector finishes shall not flake, peel, chip, corrode or sublimate when subjected to their normal handling, storage and operational environments.

3.5.4 Strain Relief

All wiring harnesses terminating in connectors shall be provided with some form of strain relief to relieve the strain on the wire connections at the connector contacts which is exerted when the connector is handled. Acceptable forms of strain relief are strain-relief clamps, potting, and shrink-fit plastic boots.

3.5.5 Orientation

The wiring harness shall be so designed that the nominal orientation of connectors at wiring harness terminations will not require connector rotation to mate the connector.

3.5.6 Angle Connectors

Where space limitations do not permit the wiring harness clearance in mating and demating of the harness connectors, angle connectors or backshells should be used.

3.6 Protection

Protection of wiring harnesses shall be inaccordance with paragraphs 3.9.3, 3.9.3.1, 3.9.3.2 and 3.9.3.5 of MIL-W-8160. Harness design and manufacturing techniques shall be specified and controlled so that potential ignition due to damaged wire insulation shall be minimized.

3.6.1 Abrasion Protection

The wiring harness shall be provided with protection from abrasion from adjacent hardware and ground and flight crew action and prevent damage in areas of potential chafing, nicking, scuffing or cutting.

3.6.2 Connector Protection

Wiring harness connectors shall be provided with protective plastic caps or other suitable means to protect them from damage and contamination during handling, shipping, storage, and installation.

3.7 Splices

Splices shall not be used in wiring harness assemblies.

3.7.1 Rework

The use of splices in the wiring harness rework shall be used only with the approval of the local government representative.

3.8 Wires and Cables

Selection of wires and cables for wiring harnesses shall be in accordance with paragraphs 3.6.1, 3.6.1.5, 3.6.1.6, 3.6.1.6.1, and 3.6.1.6.2 of MIL-W-8160. The voltage drop from the main power bus to the using subsystem shall not exceed two (2) volts under continuous operating conditions at the minimum specified main bus voltage unless otherwise approved by the procuring activity. Wires and cables shall meet the requirements of MIL-W-22759, MIL-W-81381 or MIL-W-16878, or MIL-C-17 as a minimum.

3.9 Wiring Harness Forming

Where a wiring harness must conform to a three-dimensional configuration in the installation, the wiring harness shall be fabricated on a three-dimentional form or layout, except where fabrication on a two-dimensional form or layout provides sufficient flexibility to proclude excessive strain, on the harness in the installation. Where a two-dimensional form is used, the requirements of paragraph 3.9.5 of MIL-W-8160 shall apply.

3.10 Wire Lay

3.10.1 Parallel, Straight or Random Lay

A wiring harness may be fabricated with a parallel, straight or random wire lay over that portion of the harness which is permanently installed in the Orbiting Vehicle and which is not subject to movement after installation.

3.10.2 Twisted, Helical, or Contrahelical Wire Lay

Wiring harnesses, consisting of more than four conductors which are terminated in connectors and which are subject to mating and demating, shall be fabricated with a twisted, helical, or contrahelical wire lay over that portion of the harness which is subject to movement during the mating and demating operations.

3.11 Wiring Harness Breakouts

Wiring harness breakouts shall be brought out in the direction in which the breakout is routed. Breakouts shall be fabricated to provide minimum stress on the conductors and shall be provided with adequate support to maintain the breakout configuration during handling and installation.

3.12 Wiring harness Ties

Wiring harness ties shall not be made close to the back of connectors so as to subject the conductor connection to undue strain. The distance from the first tie to the back of the connector shall not be less than one and one-half (1 1/2) times the outside diameter of the connector.

3.13 Jacketed or Molded Wiring Harnesses

A wiring harness which is completely jacketed in heat-shrinkable tubing or which has a molded jacketing shall have a twisted, helical, or contrahelical wire lay over the entire jacketed or molded length.

3.14 Handling

Means shall be provided to protect the wiring harness from damage and contamination during handling, shipping, storage, and installation, and adequate support shall be provided to maintain the configuration or prevent damage to preformed bends during these operations.

3.15 Installation

Installation of wiring harness shall be in accordance with paragraph 3.10 and subordinate paragraphs of MIL-W-8160. Approval by the procuring activity is not required for use of alternate support devices.

3.16 Rework and Repair

The contractor documentation shall include in-process inspection of the wiring harness, as well as the acceptance, inspection acceptance or other test criteria which shall be applied to assure that the harness will meet the mechanical and electrical requirements.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General

The contractor documentation shall include in-process inspection of the wiring harness, as well as the acceptance, inspection acceptance or other test criteria which shall be applied to assure that the harness will meet the mechanical and electrical requirements.

4.2 Acceptance Tests

Each wiring harness delivered for acceptance shall receive, as a minimum, the following tests:

4.2.1 Examination of Product

4.2.2 Electrical Continuity

4.2.3 Insulation Resistance

This test shall be performed at a dc potential of at least 500 volts. The insulation resistance between each conductor and every other shield, and between each conductor and connector shell shall be greater than 100 megohms. Component pigtails may be excluded from this test.

4.2.4 Dielectric Strength

This test shall be performed at a 60-hertz ac potential which is no less than 75 percent of the rms value of that specified for acceptance testing of the associated harness connectors or at 1000 volts rms plus twice the maximum working voltage of the harness, whichever is the lesser. The test potential shall be applied for one minute at a rate of no less than 500 volts rms per second until the desired test potential is reached. The test potential shall be applied between each conductor and every other conductor, between each conductor and every conductor shield, and between each conductor and connector shell. (Coaxial cables are, and component pigtails may be, excluded from this test). The test time may be reduced if a correlated higher test potential is used or if the test is repeated.

4.2.5 Order of Electrical Tests

The electrical tests shall be performed in the following order:

a) Electrical Continuity
b) Dielectric Strength
c) Insulation Resistance

5.0 PREPARATION FOR DELIVERY

Not applicable.

6.0 NOTES

6.1 Definitions

6.1.1 Wiring Harness

A wire bundle external to the components made up of wires and/or cables and connectors or other terminations.

APPENDIX "A"

DAC DEVIATIONS

1. Paragraph 3.2.3 -

Revise the last sentence to read as follows: "All spare wires shall be terminated in connectors at each end of the wire harness (except for Douglas Flyaway Umbilical)".

2. Paragraph 3.5.4 -

Revise the last sentence to read as follows: "Acceptable forms of strain relief are strain-relief clamps, potting, shrink-fit plastic boots, and wire sealing grommets."

3. Paragraph 3.7 -

Revise the sentence to read as follows: "Splices shall not be used in wiring harness assemblies except for connecting spare wires in the Douglas Flyaway Umbilical wire harness."

APPENDIX "B"

EK DEVIATIONS

1. 3.7 Splices

Add to the end of the existing paragraph as follows: "The use of splices are permitted in circuits used for test purposes."

2. 3.6 Protection

Delete reference to Paragraphs 3.9.3.1 and 3.9.3.5 of MIL-W-8160 D in the first sentence.

The above exception is taken because the requirements deleted are not applicable to Eastman Kodak because the EK segment does not contain equipment pertaining to these paragraph requirements. In the event changes are made to the EK segment, to include equipment which pertains to these requirements, they shall then apply.

3. 2.0 Applicable Documents

In all references to MIL-W-8160 D throughout SAFSL Exhibit 30006, substitute the following:

Eastman Kodak harnessing shall meet the applicable requirements of Eastman Kodak Document 401-119.

APPENDIX "C"

GENERAL ELECTRIC CO. DEVIATIONS

1. The following paragraphs are not applicable to General Electric because the General Electric Company's segment does not contain equipment pertaining to these paragraphs.

In the event changes are made to the GE segment to include equipment which pertains to these paragraphs, they then shall apply.

Paragraphs:

3.7.2 All.

3.8 Reference to Paragraph 3.9.3.1 & 3.9.3.5 of MIL-W-8160.

2. Paragraph 3.9

For the GE DRV: splices may be used in design and in rework of harness assemblies in all but unprotected power circuit wiring, EED wiring or coaxial wiring. However, these splices shall be kept to a minimum consistent with high integrity, low weight and minimum volume design.

3. Paragraph 3.2.1 Except for the GE DRV

4. Paragraph 3.4 Except for the GE DRV

5. Paragraph 3.12.2 Except for the GE DRV

6. Paragraph 4.2.4 Except for the GE DRV

APPENDIX "D"

MAC DEVIATIONS

The following are exceptions or deviations to specific paragraphs of SAFSL Exhibit 30006.

3.5.1 Non-coaxial Connectors (Exception)

(a) Connector finishes need not be cadimum plated provided they meet the requirements of Paragraph 3.5.3 herein.

(b) Bendix PT connector pin retention shall meet or exceed the required pin retention of MIL-C-26482 after connector potting.

3.5.1 Co-axial Connectors (Exception)

(a) Connector finishes need not be cadimum plated provided they meet the requirements of Paragraph 3.5.3 herein.

(b) Bendix PT connector pin retention shall meet or exceed the required pin retention of MIL-C-26482 after connector potting.

3.7 Splices

3.7.1 Rework

Splices may be used in original design and in rework of harness assemblies in all but unprotected power circuit wiring, EED wiring or coaxial wiring. However, these splices shall be kept to a minimum consistent with high integrity, low weight and minimum volume design.

4.2.4 Dielectric Strength

The test potential for thermocouple wiring shall be no less than 250 volts rms.

SAFSL EXHIBIT 30012

DESIGN LOADS
FOR THE
MOL ORBITING VEHICLE

6 JUNE 1968

KNIGHT

REVIEW OF

SAFSL EXHIBIT 30012

DESIGN LOADS CRITERIA FOR THE

MOL ORBITING VEHICLE

May 21, 1968

The undersigned has reviewed the document and understands the contents to the extent necessary to scope subsequent proposals.

Bernard A Knight
Systems Program Office
B. A. Knight

Charles T. Abbate
General Electric Company
C. Abbate

R. H. Herndon
Aerospace Corporation
R. H. Herndon

R. E. Rolfe, Jr.
McDonnell Astronautics Company
R. E. Rolfe, Jr.

B. P. Crass
Douglas Aircraft Company
B. P. Crass

A. S. Bennett 4-25-68 See Note
Eastman Kodak
A. S. Bennett

NOTE: Signature acknowledges agreement with this document, but such agreement does not extend to the documents referenced herein which are not yet agreed upon.

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SAFSL Exhibit 30012 Action Items

1. EK to provide description of subsystem "B" for paragraph 1.1. Due 23 May 68. Complete

2. GE to provide description of subsystems except subsystem B for paragraph 1.1. Due 23 May 68. Complete.

3. Aerospace to provide table from SAFSL Exhibit 10011 for paragraph 3.11. Due 1 August 1968

4. MACASTRO to supply Gemini B loads table data per paragraph 3.1 based on contractor's alternate analysis loads. Due 1 July 68.

5. MACASTRO to supply Gemini B component load factors per paragraph 3.10.2 based on equipment design load factors identified in the Gemini B Structural Design Criteria, MAC Report E-168. Due 1 September 68.

6. Douglas to update Table 3.10.1-2 to include all subsystem equipments. Due 1 November 1968.

7. Douglas to provide tables to define load factors resulting from buffet/acoustic analysis as per paragraph 3.10.2. Due 1 November 1968.

DESIGN LOADS FOR THE MOL ORBITING VEHICLE

1.0 SCOPE

(M) 1.1 Item Description - This document sets forth the design loads for the MOL Orbiting Vehicle during all mission phases. This document as applicable to AVE only.

Subsystem description is given in annex TBD. Mass properties, stiffness properties, orbiting vehicle external configuration and associated dynamic modeling for each of the noted subsystems are provided in IFS-MOL-101002, IFS-MOL-101004, IFS-MOL-707017 and IFS-101.12. Loads resulting from externally applied sources are specified herein.

(M) 1.2 Definitions - For the purpose of this specification, the following definitions are valid.

(M) 1.2.1 Limit Load - The maximum anticipated load, or combination of loads, which a structure may be expected to experience during the performance of specified missions in specified environments.

(M) 1.2.2 Ultimate Load - Obtained by multiplying the limit load by the ultimate factor of safety.

(M) 1.2.3 Factor of Safety - A factor to account for uncertainties and variations from item to item in material properties, fabrication quality and details, internal and external load distributions, random behavior characteristics of the applied environments, i.e., steady-state aerodynamics, engine thrusts and thrust transients, gusts, etc. MOL factors of safety are defined in SAFSL Exhibits 30044 and 12004 and have been appropriately combined with the limit loads to establish ultimate loads contained herein.

(M) 1.2.4 Components - A component is defined as the lowest level of assembly of parts, arranged within one package (black box), that will permit performance of a prescribed function. Examples of components are valves, actuators, amplifiers, batteries, junction boxes, etc. Vehicle structures are not considered as components.

(R) 1.3 Design Conditions - The design loads as specified in Section 3.0 shall be combined with the appropriate environments as specified in SAFSL Exhibits 10003 and 12003 in the manner as specified in SAFSL Exhibits 10004 and 12004, respectively, and shall be combined with the launch and ascent trajectory data specified in IFS-MOL-101002 and IFS-MOL-101004.

(M) 1.4 Coordinate System - The coordinate system utilized herein is given in SS-MOL-1B.

(M) 1.5 Documentation Requirements - All deliverable data and/or documentation specified in this exhibit shall be in accordance with the respective contractor's CDRL (DD 1423 or equivalent) as detailed by Forms 9.

(R) 2.0 APPLICABLE DOCUMENTS - The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and content of Section 3, the detailed content of Section 3 shall be considered a superseding requirement.

SPECIFICATIONS

Military

SS-MOL-1B	System Performance and Design Requirements-General Specifications
SAFSL Exhibit 30033	Environmental Design Criteria and Test Requirements for the MOL System Orbiting Vehicle, less Gemini B, and AGE
SAFSL Exhibit 30044	Structural Criteria for Laboratory Vehicle for MOL Program
SAFSL Exhibit 10011	Crew Systems Design Compatibility Criteria
SAFSL Exhibit 12003	Environmental and Test Requirements-Gemini B Spacecraft
SAFSL Exhibit 12004	Structural Specification--Gemini B Spacecraft

Other

IFS-MOL-101002 20 July 1967	Orbiting Vehicle CEI No. 207001A to T-IIIM
IFS-MOL-101004	Orbiting Vehicle CEI No. 207001B to T-IIIM
IFS-MOL-707017 22 December 1967	Laboratory Vehicle, CEI No. 207013A to Mission Payload System Segment AVE, CEI and GE AVE, CEI MOL010A1
IF 101.12 28 February 1968	Dynamic Mission Payload System Segment to Photographic System Interface Specification for the MOL System CDRL Item No. 64, Data Item No. E-106

(R) 3.0 Loads - The loads and factors defined in this paragraph, based on conditions noted in Table 1, except for Gemini B, shall be used for design of the MOL Orbiting Vehicle. For Gemini B spacecraft see paragraph 3.1.

(R) 3.1 The load conditions specified in Tables TBD* to TBD* and the loads specified in Tables TBD* through TBD* shall be used for design of the Gemini B spacecraft for launch and ascent. Specific design requirements for the various Gemini B loading conditions are as follows:

A. Gemini B shall be designed to withstand the engine shutdown loads induced at T-IIIM, Stage 1, booster cutoff of 430,000 inch pounds of bending moment and 24,000 pounds of tension at Gemini B station Z 103.44 (OV station 802).

B. Components located in the Gemini B pressurized cabin shall be designed to withstand landing loads as specified in Figures 1 and 2.

C. Gemini B shall be designed to withstand the loads during the reentry phase as specified in Appendix TBD*.

(R) 3.2 The load conditions specified in Table I and the loads specified in Reference Tables II through IV shall be used for design of the Laboratory Module and Mission Module. Transportation and handling loads for the Laboratory Module and Mission Module are as specified in Table TBD.**

*To be supplied by MCASTRO
**Transportation and handling loads for the LM and MM are contained in IF 101.4.

(R) 3.3 The load factors specified in Table VI shall be used for design of the Laboratory Module equipment and support structure (birdcage).

(R) 3.4 The load factors specified in Table VII shall be used for design of Laboratory Vehicle Subsystem 'B'.

(R) 3.5 The load factors specified in Table VIII shall be used for the design of Laboratory Vehicle Subsystem 'C'.

(R) 3.6 The load factors specified in Table IX shall be used for the design of Laboratory Vehicle Subsystem 'D'.

(R) 3.7 The load factors specified in Table X shall be used for the design of Laboratory Vehicle Subsystem α.

(R) 3.8 The load factors specified in Table XI shall be used for the design of Laboratory Vehicle Subsystem 'E'.

(R) 3.9 The load factors specified in Table XII shall be used for the design of Laboratory Vehicle Subsystem 'F'.

(T) 3.10 Components Not Included in Paragraphs 3.3 - 3.9

Two conditions shall be considered in design/evaluation of components and subsystems not included under paragraphs 3.3 - 3.9: (1) The ascent transient conditions listed in Table I and (2) Random vibration induced by buffet and acoustic noise. It shall be a design goal that components and subsystems not included under 3.3 - 3.9 shall have fundamental resonant frequencies including their immediate support structures and/or vibration isolators above 30 cps. When this condition is not met, documentation and/or test results which evaluate design adequacy for vibration and transient loads must be submitted to SPO for approval.

(R,T) 3.10.1 Ascent Transient Conditions

Laboratory Vehicle components meeting the natural frequency requirements of paragraph 3.10 shall be designed to the load factors of Table 3.10.1-1. Components not meeting the 30 cps frequency requirement shall be designed to the load factors of Table 3.10.1-2. For OV components not meeting the natural frequency requirements of 3.10 and not listed in Table 3.10.1-2, analyses shall be performed based on load factor time histories obtained from the SPO or from the response spectra of Figures TBD through TBD.

(R) 3.10.2 Random Vibration Load Factors for Buffet and Acoustics

The load factors specified in Tables TBD** to TBD** which are buffeting effects measured during rigid body fluctuating pressure test and/or random vibration values, shall be used for the design of Laboratory Vehicle structural rings, frames and minor weight items (50 pounds or less) attached to the external shell. (Note: **data to be inserted following SPO approval of contractor buffet analyses.)

(R) 3.11 The load factors specified in Table TBD* based on SAFSL Exhibit 10011 shall be used for the design of Laboratory Vehicle equipment subjected to crew system induced loads.

* Ⓐ will provide table

Gemini B components and support structure shall be designed to withstand such factors specified in Table 3.10.1-3*.

Note: Requires change to paragraph 4.d page 8 of SAFSL 10004.

TABLE VI

LABORATORY MODULE EQUIPMENT AND SUPPORT STRUCTURE (BIRDCAGE)

LOAD FACTORS

CONDITION	LIMIT			ULTIMATE		
	N_x	N_y	N_z	N_x	N_y	N_z
Stage I Shutdown	± 7.0	± 0.5	± 0.5	± 9.8	± 0.7	± 0.7
Launch	+ 2.10 - 0.67	± 1.25	± 0.5	+ 2.94 - 0.94	± 1.75	± 0.7
Launch	+ 2.10 - 0.67	± 0.5	± 1.25	+ 2.94 - 0.94	± 0.7	± 1.75
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD
On- Orbit (Max. Sustained):						
A. Translation	+ 0.013	± 0.0065	± 0.0065	+ 0.016	±0.0081	± 0.0081
B. Rotation:						

$\ddot{\theta}$ (along any axis about OV CG): 1.746×10^{-4} rad/sec^2 (limit); 2.181×10^{-4} rad/sec^2 (ult.)

ω (along any axis abouv OV CG): 3.492×10^{-4} rad/sec (limit); 4.362×10^{-4} rad/sec (ult.)

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TABLE VII

SUBSYSTEM 'B' LOAD FACTORS AND ROTATIONAL ACCELERATIONS

CONDITION	LIMIT					ULTIMATE				
	N_x	N_y	N_z	$\ddot{\theta}_y$ Rad/Sec^2 *	$\ddot{\theta}_z$ Rad/Sec^2 *	N_x	N_y	N_z	$\ddot{\theta}_y$ Rad/Sec^2 *	$\ddot{\theta}_z$ Rad/Sec^2 *
Stage 1 Shutdown	-4.5 +4.0	±1.3	±1.3	±0.472	±0.085	-6.3 +5.6	±1.82	±1.82	±0.66	±0.119
Thrust Termination (40 sec)	-6.8 +6.1	±0.5	±0.5	±0.472	±0.085	-7.5 +6.7	±0.55	±0.55	±0.52	±0.094
Lift Off	-0.3 -3.0	±1.5	±1.5	±0.472	±0.085	-0.4 -4.2	±2.1	±2.1	±0.66	±0.119
Maximum Buffet	TBD	TBD	TBD	-	-	TBD	TBD	TBD	-	-
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
On-Orbit (Max. Sustained)										
A. Translation	+0.013	±0.0065	±0.0065	-	-	+0.016	±0.0081	±0.0081	-	-

B. Rotation:

$\ddot{\theta}$ (along any axis above OV CG): 1.746×10^{-4} rad/sec^2 (limit); 2.181×10^{-4} rad/sec^2 (ult.)

ω (along any axis abouv OV CG): 3.492×10^{-4} rad/sec (limit); 4.362×10^{-4} rad/sec (ult.)

* The rotational accelerations are to be applied at the CG of Subsystem 'B'

TABLE VIII

SUBSYSTEM 'C' LOAD FACTORS

CONDITION	LIMIT			ULTIMATE		
	N_x	N_y	N_z	N_x	N_y	N_z
Stage I Shutdown	+ 1.5 - 4.3	± 1.0	± 0.1	+ 2.1 - 6.0	± 1.4	± 0.14
Thrust Termination (40 seconds)	+ 1.65 - 1.89	0	0	+ 1.82 - 2.08	0	0
Launch	- 2.0 - 1.0	± 0.8	± 0.5	- 2.8 - 1.4	± 1.12	± 0.7
Maximum Buffet	TBD	TBD	TBD	TBD	TBD	TBD
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD
On-Orbit (Max. Sustained):						
A. Translation	± 0.013	± 0.0065	± 0.0065	± 0.016	± 0.0081	± 0.0081
B. Rotation:						

$\ddot{\theta}$ (along any axis about OV CG): 1.746×10^{-4} rad/sec^2 (limit); 2.181×10^{-4} rad/sec^2 (ult.)

ω (along any axis about OV CG): 3.492×10^{-4} rad/sec (limit); 4.362×10^{-4} rad/sec (ult.)

TABLE IX

SUBSYSTEM 'D' LOAD FACTORS

CONDITION	LIMIT			ULTIMATE		
	N_x	N_y	N_z	N_x	N_y	N_z
I	0	± 2.5	± 2.5	0	± 3.5	± 3.5
II	± 7.8	0	0	± 10.9	0	0
Maximum Buffet	TBD	TBD	TBD	TBD	TBD	TBD
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD
On-Orbit (Max. Sustained):						
A. Translation	+ 0.013	± 0.0065	± 0.0065	+ 0.016	± 0.0081	± 0.0081
B. Rotation:						

$\ddot{\theta}$ (along any axis about OV CG): 1.746×10^{-4} rad/sec^2 (limit); 2.181×10^{-4} rad/sec^2 (ult.)

ω (along any axis about OV CG): 3.492×10^{-4} rad/sec (limit); 4.362×10^{-4} rad/sec (ult.)

TABLE X

SUBSYSTEM [illegible] LOAD FACTORS

CONDITION	LIMIT N_x	LIMIT N_y	LIMIT N_z	ULTIMATE N_x	ULTIMATE N_y	ULTIMATE N_z
I	± 10.0	± 0.72	± 0.72	± 14.0	± 1.01	± 1.01
II	+ 3.0 - 1.0	± 1.8	± 0.72	+ 4.2 - 1.4	± 2.52	± 1.01
III	+ 3.0 - 1.0	± 0.72	± 1.8	+ 4.2 - 1.0	± 1.01	± 2.52
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD
On-Orbit (Max. Sustained)						
A. Translation	+ 0.013	± 0.0065	± 0.0065	+ 0.016	± 0.0081	± 0.0081

B. Rotation:

$\ddot{\theta}$ (along any axis about OV CG): 1.746×10^{-4} rad/sec^2 (limit); 2.181×10^{-4} rad/sec^2 (ult.)

ω (along any axis abouv OV CG): 3.492×10^{-4} rad/sec (limit); 4.362×10^{-4} rad/sec (ult.)

TABLE XI

SUBSYSTEM 'E'

CONDITION	LIMIT			ULTIMATE		
	N_x	N_y	N_z	N_x	N_y	N_z
Stage 0 Maximum Acceleration	+3.6G	±0.5G	±0.5G	±4.5G	±.625G	±.625G
Stage 1 Maximum Acceleration	+5.0G	±0.5G	±0.5G	±6.25G	±.625G	±.625G
Stage 1 Shutdown (Installations)	±7.0G	±2.0G	±2.0G	±8.75G	±2.5G	±2.5G
Random Vibration (Buffet)	TBD	TBD	TBD	TBD	TBD	TBD
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD

TABLE XII

SUBSYSTEM 'F'

CONDITION	LIMIT			ULTIMATE		
	N_x	N_y	N_z	N_x	N_y	N_z
Stage 1 Shutdown (Installations)	±11.G	±3.5G	±3.5G	±13.75G	±4.38G	±4.38G
Stage 0 Maximum Acceleration	+3.6G	±0.5G	±0.5G	+4.5G	±0.625G	±0.625G
Stage 1 Maximum Acceleration	+5.0	±0.5G	±0.5G	+6.25	±0.625	±0.625
Buffet	TBD	TBD	TBD	TBD	TBD	TBD
Transportation & Handling	TBD	TBD	TBD	TBD	TBD	TBD

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RELEASE 1 JULY 2015

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TABLE 3.10.1 - 1

LIMIT SHELL LOAD FACTORS MAX/MIN

ITEM OF LOCATION	LAUNCH (2)			UNSYMMETRICAL TAIL-OFF & STAGE 1 IGNITION (19)			STAGE 1 SHUTDOWN (20)			STAGE 2 IGNITION (23)			THRUST TERMINATION (12)			MAXIMUM L.F. ALL CONDITIONS		
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
Station 746	-0.57 -2.12	±0.5	±1.03	-5.12 +0.05			-4.25 +1.6	±0.5	±0.5	-5.7 +2.1			-1.9 +1.7	±0.5	±0.5	05.7 +2.1	±0.5	±0.5
732	-0.57 -2.12	±0.5	±1.00	-4.6 -0.4			-4.25 +1.5	±0.5	±0.5	-6.5 +2.9			-1.9 +1.7	±0.5	±0.5	-6.5 +2.9	±0.5	±1.00
702	-0.57 -2.11		±0.92	-4.1 -0.8			-4.25 +1.5			-7.0 +3.4			-1.9 +1.7			-7.0 +3.4	±0.5	±0.92
660	-0.58 -2.11		±0.82	-2.96 -1.4			-4.25 +1.4			-5.3 +2.9			-1.9 +1.7			-5.3 +2.9	±0.5	±0.82
650	-0.58 -2.10		±0.81	-3.2 -1.4			-4.25 +1.4			-4.7 +2.5			-1.9 +1.7			-4.7 +2.5	±0.5	±0.81
607	-0.58 -2.09		±0.80	-4.1 -0.7			-4.25 +1.4			-3.5 +1.3			-1.9 +1.7			-4.25 -2.09	±0.5	±0.80
550	-0.59 -2.08		±0.79	-6.3 +1.7			-4.25 +1.2			-5.1 +2.4			-1.9 +1.7			-6.3 +2.4	±0.5	±0.79
520	-0.59 -2.07		±0.78	-6.3 +1.7			-4.25 +1.1			-5.6 +2.7			-1.9 +1.6			-6.3 +2.7	±0.5	±0.78
502	-0.59 -2.05		±0.75	-6.8 +2.2			-4.25 +0.6			-5.9 +3.0			-1.9 +1.6			-6.8 +3.0	±0.5	±0.75
454	-0.59 -2.05		±0.6	-8.1 +4.0			-4.25 +1.0			-6.5 +3.6			-1.9 +1.6			-8.1 +4.0	±0.5	±0.6
358	-0.59 -2.04		±0.54	-10.8 +6.6			-4.25 +0.75			-7.9 +4.4			-1.9 +1.6			-10.8 +6.6	±0.5	±0.54
208	-0.59 -2.00	↓	±0.56	±11.0			-4.25 +0.5	↓	↓				-1.9 +1.6	↓	↓	±11.0	±0.5	±0.56
75	-0.60 -1.99	±0.5	±0.92	±11.0			-4.25 +0.60	±0.5	±0.5	-8.6 +6.3			-1.9 +1.6	±0.5	±0.5	±11.0	±0.5	±0.5

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TABLE 3.10.1 - 2

LIMIT LOAD FACTORS MAX/MIN FOR LABORATORY VEHICLE

ITEM OR LOCATION	LAUNCH (2)			UNSYMMETRICAL TAIL-OFF & STAGE 1 IGNITION (19)			STAGE 1 SHUTDOWN (20)			STAGE 2 IGNITION (23)			THRUST TERMINATION (12)			MAXIMUM L.F. ALL CONDITIONS		
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
Diluent Tank	-1.1 -0.9	±0.3	±0.2		Use Shell Load Factor From Table 3.9.1-1		+2.3 -4.25	±3.8	±3.0		Use Shell Load Factor		+1.1 -1.9	±1.7	±1.3	+2.3 -4.25	±3.8	±3.0
O_2 Accumulator Tank	-1.0 -1.0	±0.2	±0.2		Use Shell Load Factor		+0.4 -4.25	±2.8	±1.4		Use Shell Load Factor		+0.2 -1.9	±1.25	±0.6	+0.4 -4.25	±2.8	±1.4
Pressurant Tanks		Use Shell Load Factor of Table 3.9.1-1			Use Shell Load Factor		+0.6 -4.25	±3.1	±3.2		Use Shell Load Factor		+0.3 -1.9	±1.4	±1.3	+0.6 -4.25	±3.1	±3.1
Fuel Tanks		Use Shell Load Factor			Use Shell Load Factor		±4.5	±3.1	±3.0		Use Shell Load Factor		±1.9	±1.4	±1.3	±4.5	±3.1	±3.0
Oxidizer Tanks		Use Shell Load Factor			Use Shell Load Factor		±4.9	±2.5	±3.1		Use Shell Load Factor		±2.0	±1.1	±1.3	±4.9	±2.5	±3.1
Elec. Control Panel		Use Shell Load Factor			Use Shell Load Factor		+0.4 -4.25	±0.9	±1.1		Use Shell Load Factor		+0.2 -1.9	±0.4	±0.5	+0.4 -4.25	±0.9	±1.1
EC/LS Control Panel		Use Shell Load Factor			Use Shell Load Factor		+0.7 -4.25	±1.5	±2.3		Use Shell Load Factor		+0.3 -1.9	±0.7	±1.0	+0.7 -4.25	±1.5	±2.3
Tunnel		Use Shell Load Factor			Use Shell Load Factor		+2.6 -4.25	±2.6	±3.8		Use Shell Load Factor		+1.2 -1.9	±1.2	±1.7	+2.6 -4.25	±2.6	±3.8

L-6002
PAGE 19 OF 19
COPY 21 OF 40

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BYE-SL-0081-68
Copy #25
81 Pages

3 July 1968

TO: R. Johnson, R. Pepping, M. Malkin and J. Sewell

SUBJECT: Paragraph Modification and Table Addition to SAFSL Exhibit 30012

Please make the indicated change to Paragraph 3.11 and insert the attached Table 3.11-1 in SAFSL Exhibit 30012, "Design Loads for the MOL Orbiting Vehicle."

L. D. Paige

L. D. PAIGE

2 Atch
1. Change to Para 3.11
2. Table 3.11-1

Cy to: SL-5
SL-6
SL-12
SL-13
SL-14
SL-16
L. Inge

JUL 9 - 1968

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BYE-SL-0081-68
ATTACHMENT 1
COPY 25
1 PAGE

SAFSL 30012 Para. 3.11

PRESENT STATEMENT	PROPOSED STATEMENT
The load factors specified in Table TBD* based on SAFSL 10011 shall be used for the design of Laboratory Vehicle equipment subjected to crew system induced loads.	The loads specified in Table 3.11-1 shall be used for the design of Laboratory Vehicle equipment subjected to crew system induced loads.
(*Aerospace will provide table)	

Reason for Change:

Answer to Aerospace Action Item to update document per SAFSL Exhibit 10011.

ATTACHMENT 1

TABLE 3.11 - 1

LABORATORY VEHICLE LOADS INDUCED BY CREW SYSTEM

DESCRIPTION	LOAD
1. Compressive load applied normal to surface by: (a) personnel, (b) equipment worn or handled by personnel.	150 lbs. (ult.), 100 lbs. (lim.) over an approximately square or circular area of 3 ± 1/4 in.-sq.
2. Handling load applied by one hand grasping equipment and directed in line with any possible arm direction.	Same as above
3. Dynamic load equivalent to that applied normal to a surface by a rigid metal corner composed of three perpendicular planes, with the corner spherical radius TBD.	TBD

Note: The above loads pertain, with the exception of display and control components, to panels, components, and equipment in their normally stowed or installed location in crew spaces with all access covers and doors closed.

REPLACEMENT PAGES

for

SAFSL Exhibit 30020

"SYSTEMS TEST AND OPERATIONS PLAN"

dated

June 1968

SAFSL EXHIBIT 30020

SYSTEMS TEST AND OPERATIONS PLAN

The undersigned has reviewed the document and understands the contents to the extent necessary to scope subsequent proposals, provided the required CDRL (DD Form 1423 and Forms 9, or equivalent thereof) is received with the RFP.

(Signed) [signature] 24 May 68	(Signed) [signature] SL 12 24/5/68
(Signed) [signature] EK 5/24/68	(Signed) [signature] SL-16
(Signed) [signature]	(Signed) [signature] SL-12
(Signed) [signature] 5/24/68 GE	(Signed) Peter P. [signature] SL-14
(Signed)	(Signed)
(Signed)	(Signed)
(Signed)	(Signed)

D ~~SECRET~~

BYE-SL-0015-68
Copy # 23
1 Page
Total Pages 12
9 July 1968

SUBJECT: Change Pages for SAFSL Exhibit 30020

TO: R.L. Johnson, R. Popping, M. Malkin and J. Sewell

The attached replacement pages are to be inserted in the June 1968 issue of SAFSL Exhibit 30020, "Systems Test and Operations Plan".

L. D. Paige

L. D. PAIGE

1 Atch
SAFSL Exhibit 30020
Replacement Pages

Cy to: SL-5
SL-6
SL-7
SL-12
SL-13
SL-14
SL-16
J. Chalmers ✓

JUL 12 1968

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SAFSL EXHIBIT
20020

SYSTEM TEST & OPERATIONS PLAN

JUNE 1968

B. A. HOHMANN

W. F. SAMPSON

S. M. TENNANT

B. P. LEONARD

TABLE OF CONTENTS

1.0
PURPOSE

This document is directive and shall be used by all agencies for planning the ground test and flight operations programs. The System Test and Operations Plan (STOP) identifies and defines the policies and requirements common to both "Test" and "Operations" and the interrelationships required for standardizing lower level planning documentation.

2.0
SCOPE

This document covers the test and operational aspects of the MOL Program. The concepts and principles contained herein shall be applied against all aspects of the MOL Program. For purposes of standardizing definitions, policies, responsibilities, and requirements the most complex version of the MOL Flight Vehicle (#3) is used herein as a baseline. For other vehicles similar (appropriate) terminology will be used as necessary.

Documents called out are applicable as specified herein. All deliverable data and/or documentation specified in this exhibit shall be in accordance with the respective contractor's CDRL (DD 1423) as detailed by Forms 9 (or equivalent).

3.0
TERMINOLOGY

The following terminology shall be adhered to by all associate contractors and supporting government agencies in preparing their required plans and other supporting documents.

Associate Contractor (MOL)

A. C. Electronics Division (ACED)
Aerojet-General Corporation (AGC)
Douglas Aircraft Company (DAC)
Eastman Kodak Company (EK)
General Electric Company (GE)
Hamilton Standard (HS)
Martin Marietta Corporation (MMC)
McDonnell Astronautics Company (MAC)
TRW Systems Group (TRW)
United Technology Center (UTC)
Whirlpool Corporation

Flight Operations (i.e., Operations) - All activities associated with MOL operations from prelaunch preparation (simulation/rehearsals, AFSCF checkout, etc.) through laboratory vehicle disposal, data retrieval and post flight evaluation.

Flight Vehicle - The flight vehicle (FV) consists of the T-IIIM launch vehicle and the MOL orbiting vehicle (OV).

Flight Vehicle Timeline (Operational) - A nominal, chronological sequence, relationship, and status of all FV and ground resources necessary to perform the MOL real-time operational mission. It includes the time, approximate orbital elements/location, subsystem status, consumable profiles, crew activity, and ground support associated with the operational sequences required to accomplish the MOL flight objectives from crew ingress on the pad to Gemini B splashdown and laboratory vehicle disposal. In the case of the automatic configuration, the timeline includes all operational sequences from FV liftoff through OV disposal.

Flight Vehicle Timeline (Test) - A chronological sequence and relationship of all activities associated with FV hardware from first AVE arrival at VAFB through FV liftoff and turnaround.

Government Agencies

6595th Aerospace Test Wing (ATW)
Aerospace Medical Division (AMD) (AFSC)
Air Force Satellite Control Facility (AFSCF)
Air Force Western Test Range (AFWTR)
Air Weather Service (AWS)
DOD Manager for Manned Space Flight Support (DDMS)
SAMSO Plans and Operations Office (SMLC)

Ground Test (i. e., Test) - General term encompassing all test activity from start of initial in-plant development through FV liftoff. This activity also includes turnaround.

Laboratory Vehicle - The integrated AVE of and in the mated laboratory module (LM) and mission module (MM).

Launch Operations - That portion of ground test associated with VAFB. Includes all functions and activities required to handle, assemble, maintain, checkout, and launch the MOL FV, turnaround, and all related plans and procedures.

Liftoff - Event determined by FV motion in the vertical direction as detected by electrical signal to the ground equipment.

Mission - This is part of the orbital phase and is to be used only with reference to the objectives and operations associated with the MM experiments.

Orbiting Vehicle - For the manned/automatic mode the OV consists of the LM, MM, crew equipment, and the Gemini B. For the automatic mode, the Gemini B and crew equipment are replaced by a support module.

Software - Computer programs and their associated documentation.

Support Module - The support module consists of a tank section, a recovery section including six Data Reentry Vehicles, and a fairing section.

System - The MOL system.

System Segment - A discrete package of system performance requirements, functional interfaces, and/or contract end items (CEI's) contracted to one contractor or assigned to one government agency directly responsible to the procuring agency for that part of the system's total performance.

System Test and Operations - MOL system test and operations starts with in-factory development tests, proceeds with that testing activity associated with a particular FV, and terminates with recovery of the data and/or crew retrieval, laboratory vehicle disposal, and post flight analysis.

Turnaround - Those activities following FV liftoff necessary to refurbish the launch site for receipt of the next flight hardware.

Post Flight Evaluation - Post Flight Evaluation is that evaluation conducted to accomplish the following:

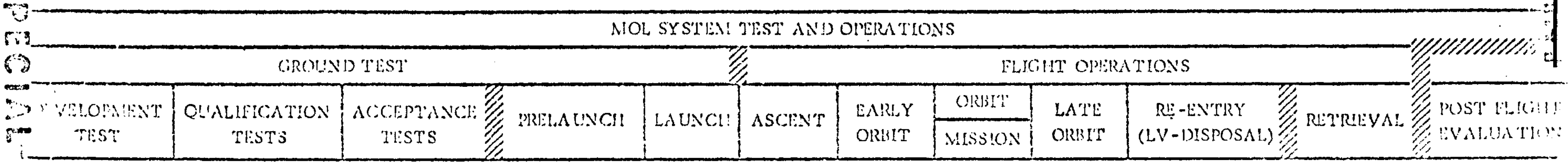
a. To analyze and resolve to corrective levels MOL system anomalies.

b. To verify accomplishment of specific MOL flight test objectives.

Data from design, ground test and flight operations is used to support post flight evaluation.

FIGURE 1

NOMINAL FLOW OF MOL SYSTEMS TEST AND OPERATIONS



NOTES

1. ////// DENOTES A RELATIVELY CONTINUOUS TIME INTERFACE
2. | DENOTES A RELATIVELY SHARP TIME INTERFACE

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HANDLING

4.0

TEST AND OPERATIONS REQUIREMENTS AND POLICY

The proper relationship of personnel safety, security, and program objectives must be recognized during the design, planning, and conduct of MOL Ground Testing and Flight Operations. No data will be collected nor tests conducted for the sole purpose of incentive determination.

The general policies contained herein shall be expanded and amplified in both the General Ground Test Plan (GGTP) and the Flight Test and Operations Plan (FTOP). The GGTP shall be adhered to by all associate contractors and supporting agencies in preparing their implementing plans and documents.

Additional guidance for preparation of the implementing plans and documents will be provided in the FTOP.

The GGTP defines in-plant development, qualification, and acceptance testing and launch operations at VAFB through FV liftoff, turnaround, and publication of final test reports.

The FTOP defines the operations activities from flight crew ingress or FV liftoff, as appropriate, through lab vehicle disposal. It shall include those activities required to prepare the flight operations support systems (AFSCF) and Operational Training and Evaluation Facility (OTEF) prior to launch. In addition, the FTOP shall include the requirements for Launch Operations support of the AFSCF and publication of final test reports. The VAFB Launch Operations Requirement document includes the requirements for AFSCF support of Launch Operations.

4.1 Personnel Safety

Personnel safety shall be the prime consideration in all phases of planning, design, test and operations.

(TP) 4.2 Compliance with Program Requirements

The system test and operations program shall be planned and conducted to verify System Performance/Design Requirements (SP/DR). To insure this, all test and operations plans (excluding certain Development Plans) submitted in accordance with Contract Data Requirements List (CDRL) DD Forms 1423 will be approved prior to use.

(TP) 4.3 Establishment of a Data Baseline

The planning, conduct and reporting of system level qualification, acceptance and launch site tests shall produce test data that can be utilized for analysis during systems level acceptance tests, launch site tests or flight. These data will constitute a test data base which will be retrievable for use on a timely basis, as required. The data base is intended for use by the contractors in support of systems test and operations.

(TP) 4.4 Fidelity of Test

Where practical and significant, ground tests shall be conducted in a simulated operational environment/configuration. Determination of practicality and significance shall be made by the associate contractors or supporting government agencies with MOL SO approval. While special test programs may be used in the airborne computer for certain ground tests, verified airborne computer programs shall nominally be used. To provide the necessary fidelity, test command messages must be compatible with operational command messages where hardware configuration permits.

4.5 Flight Crew Participation

The flight crew shall participate in the system test and operations program as specified in the hardware/software test and operations plans.

(TP) 4.6 Failure Analysis and Corrective Action

To assure positive control over test and operations problems, failures, potential failures, and their analyses and corrective action, a reporting system shall be established in accordance with SAFSL 30002.

(TP) 4.7 Test and Operations Plans

Test and operations plans shall have as their basic goal the verification that program requirements are met. In building a test and operations program, the building block concept of sequential testing in operational modes will prevail. Each associate contractor shall define the tests and operations required to satisfy program/contractual requirements. Post operations evaluation must include recommendations that specifically address subsequent FV undergoing test.

(TP) 4.8 Test and Operations Criteria

The criteria used to evaluate test and operational performance shall be based on the requirements in the CEI and/or other applicable specifications. Parametric limits necessary for evaluating Qualification, Acceptance, Launch Operations Testing and Flight Operations shall be established prior to use. Development Tests are excluded from this policy except as specifically identified to the associate contractors by the MOL SO.

(TP) 4.9 Software Policy

During test and training activities prior to launch, both AVE flight support and system support software will be used in conjunction with various test vehicles and simulators. Verified computer programs under test must be essentially identical with that anticipated for use during the operation.

In subsystems used for testing purposes (e.g., AGE or simulators), special software may be used to simulate interface reactions which are not actually present during a test. The simulation must be essentially indistinguishable from the actual interfacing system as viewed from the software subsystem under test.

4.10 MOL System Readiness

MOL SO test and operations documentation shall define a system to provide assurance of MOL System Readiness for flight.

5.0
MANAGEMENT STRUCTURE

This section identifies the participating test and operations government agencies and associate contractors and the respective roles and responsibilities within the MOL system test and operations program.

5.1 MOL Director

The MOL Director is responsible for establishment, management, and conduct of all aspects of test and operations for the MOL Program.

5.2 MOL Deputy Director

The MOL Deputy Director, the implementing agent of the MOL Director, is responsible for the integrity of the overall system during all phases of test and operations.

5.3 MOL Systems Office

The MOL Systems Office (MOL SO), under the direct control and supervision of the Deputy Director, MOL, directs the test and operations of the overall MOL system. This includes responsibility for contracting, acquisition of test facilities, ground test, flight operations, personnel safety, and test and operations analysis and reporting. MOL SO shall be interpreted to include the Aerospace Corporation, where applicable, in fulfilling its role as General Systems Engineering and Technical Direction (GSE/TD) contractor.

5.4 Aerospace Corporation

The Aerospace Corporation is the contractor responsible for providing GSE/TD for the MOL SO for test and operations functions.

(TP) 5.5 Associate Contractors

Each associate contractor is responsible throughout the cycle of test and operations for meeting performance allocations, safety, effectiveness, and specifications applicable to the associate contractor's hardware. When the hardware/software delivered by one associate contractor is absorbed in an assembly to be delivered by another associate, the assembly, host, and/or integrating contractor herein referred to as the integrating contractor has the responsibility to ensure that overall test and operations allocations and integrated test requirements have been fulfilled, and that agreement has been reached with the delivering associate contractor(s) on all test and operations requirements, plans, and procedures which will be established against or performed at the assembled level.

The associate contractor delivering hardware/software to be absorbed in a higher level assembly is responsible for negotiating with the integrating contractor appropriate test and operations requirements, plans, and procedures. Each associate contractor is also responsible for negotiating test and operational interfaces relating to his hardware/software with all affected associate contractors.

System level test and operations analyses are required to ensure that operational and performance requirements are met. Each associate contractor is responsible for detailed analyses appropriate to the software and equipments being delivered by that associate contractor. Additionally, participation in related higher level system studies will be required.

Areas of associate test and operations responsibilities are:

a. Hamilton Standard, Division of United Aircraft Corporation - Hamilton Standard (HS) is the associate contractor for the pressure suite assembly (PSA) system segment.

b. Whirlpool Corporation - Whirlpool is responsible for providing the MOL feeding system segment for all MOL manned flights.

c. TRW Systems (TRW) - TRW will provide STC computer programs for mission planning and evaluations, and for monitoring and controlling ascent and reentry operations.

d. McDonnell Astronautics Coproration (MAC) - MAC is the associate contractor for the Gemini B system segment.

e. Eastman Kodak Company (EK) - EK is the associate contractor for the photographic system segment.

f. General Electric Company (GE) - GE is the associate contractor for the MM system segment.

g. AC Electronics Division (ACED) - ACED is the associate contractor for the booster inertial guidance system (BIGS) segment.

h. Aerojet-General Corporation (AGC) - AGC is the associate contractor for the booster liquid rocket engine system segment.

i. United Technology Corporation (UTC) - UTC is the associate contractor for the booster solid rocket motor system segment.

j. Douglas Aircraft Company (DAC) - DAC is the associate contractor for the laboratory vehicle system segment.

k. Martin Marietta Corporation (MMC) - MMC is the associate contractor for the Titan IIIM system segment.

(TP) At a given site, integrating associate contractor responsibility for the collation, analysis, optimization and/or publication, as necessary, of the plans and procedures for integrated development, qualification, and acceptance testing, and for the integrated conduct of test (i.e., "Test Direction"), for the integrated hardware level is indicated below under integration contractor. In addition to launch operations functions performed by associate contractors and integrating associate contractors at VAFB, separate support services to the MOL SO/6595th ATW are required and are specified below under Support Contractor (Reference SAFSL Exhibit 20023).

Site	Integrating Contractor	Support Contractor
VF	GE	
Roch	EK	
HB	MDC (LM/LV), GE (MM)	
St. L.	MDC	
Denver	MMC	
VAFB	MMC (T-IIIM), MDC (OV), GE (MM)	MMC (FV), MDC (OV & MS)

5.6 SAMSO Plans and Operations Office, Communications, and Electronics Division

This agency is responsible for acquisition and installation of the MOL ground communications system at VAFB in accordance with the requirements of the MOL SO. This agency will direct the communication planning contractor in preparation of the Communication Plan and control the contract for the communications installation contractor during installation of the communications equipment.

5.7 6595th Aerospace Test Wing (ATW)

The 6595th ATW Manned Systems Division (VWM) is responsible for Launch Operations at VAFB. The ATW, as a direct arm of the MOL SO, is responsible for the direction, management, conduct and control of MOL Program activities at VAFB. The ATW interfaces with and ensures AFWTR support.

5.8 SAMSO Deputy Commander, for Satellite Control Operations, AFSCF

This agency is responsible for developing and providing those resources at the Satellite Test Center (STC) and the AFSCF Global Tracking and Communication Networks as necessary to support MOL operations during flight preparation and through all flight phases as defined in the Orbital Requirements Document (ORD). This includes the processing and control of data necessary for support of the flight; the engineering design of telemetry and tracking station equipment, control consoles, AFSCF system support software, integration of all telemetered data formatting requirements and procedures, and interfacing with AFWTR and VAFB activities.

5.9 Air Force Western Test Range (AFWTR)

AFWTR, the lead range for MOL, is responsible for ensuring support of all launch operations requirements as defined in the Program Requirements Document (PRD). This includes support from other ranges and government agencies external to the AFWTR. (Data acquisition during ascent for range safety decisions will be an AFWTR responsibility). AFWTR will provide support as appropriate to AFSCF for mission control at the STC.

5.10 DOD Manager for Manned Space Flight Support (DDMS)

DDMS will provide and control the recovery forces necessary to effect retrieval of the flight crew, spacecraft and data in the areas specified in the Manned Recovery Requirements Document and the spacecraft as specified in the Gemini B Recovery Requirements Document.

5.11 Air Weather Service (AWS) (Military Airlift Command)

AWS is responsible for natural aerospace environment support and services to the MOL Program.

5.12 Aerospace Medical Division (AMD) (AFSC)

AMD is responsible for providing bioastronautics research, development, test, and operations support to the MOL Program.

(P) 6.0

TEST AND OPERATIONS DOCUMENTATION

6.1 General

This section summarizes, for planning purposes, the MOL test and operations documentation. It does not supersede the requirements of the CDRL. Document format, content, scheduled submittals, revision requirements, and governmental approval requirements are governed by the CDRL DD Form 1423 and AFSC Form 9 (or equivalent) where applicable for each associate contractor. This section establishes a common basis of reference for:

a. Document Titles and Terminology
b. Documentation Relationships
c. General Scope
d. Input and Integrate Responsibilities

6.2 Top Documentation

6.2.1 System Test and Operations Plan (STOP)

The STOP establishes planning and standardization requirements applicable to both Ground Test and Flight Test and Operations. It identifies roles and responsibilities of agencies and contractors involved in MOL test and operations activities.

6.2.1.1 General Ground Test Plan (GGTP)

The GGTP provides a summary of all elements of testing to be conducted during the development, qualification, acceptance, and launch operations test programs for which each associate contractor and operating agency is responsible. General requirements, boundaries, and guidelines for the tests to be performed from start of initial factory development testing through integrated MOL system level testing and launch are established.

6.2.1.2 Flight Test and Operations Plan (FTOP)

The FTOP provides guidance to all contractors and government agencies participating in MOL flight operations. It represents the MOL baseline for flight test and operations and is the basis for developing the details of subordinate documentation. The FTOP also provides program management with an overview of the operational concepts and philosophies to be employed in the operations associated with the flight tests.

The FTOP covers the flight from insertion of the flight crew in the FV or FV liftoff, as appropriate, and on through publication of final test reports. It also covers planning and training necessary to accomplish the above.

6.3 Documentation Tree and Table

A schematic presentation of the top and working level test and operations oriented documents is provided in Figure 2.

The functional grouping of test and operations documents in Table 1 is as follows:

- I Top Level Planning Documents
- II Ground Test Documents
- III Flight Test and Operations Documents
- IV Test and Operations Requirements Documents and Support Plans
- V Evaluation Documents

The documents, the agency, and contractor responsibilities for inputs to/or providing the documents, and the responsibilities for integration and publication of the documents are described.

The release dates for publication of the documents are referenced to the initial launch (IL), the initial manned launch (IML), the initial automatic launch (IAL), each launch (L), flight termination (FT), post operations assessment directive (POAD) issuance, and test (T) schedule.

The definitions below are applicable to Table 1.

Data Requirements	A required submittal or input to be integrated which shall consist of and be limited to that contractor's or agency's area of responsibility.
Integrate/Publish	The compilation and publication of inputs, data, and coordinated material.
Release Date	Approximate date of publication/delivery (as appropriate) of completed document, for use in planning and generating individual associate contractor CDRL's (DD Form 1423), in recognition of peculiar requirements of a particular systems segment.

DOCUMENT CONTROL LOG

Control Number WHS-809

Copy Number 1 thru 6

Name of Courier

J. F. Chalmers

Source

J. F. Chalmers

Addressee

Distribution

Description, Date, Subject, cy number, number of pages, any other identifying control number

MOL Orbiting Vehicle Power Utilizaton Control SAFSL EXHIBIT 30001 dated 2 April 1968, 19 pages

Attachments

Remarks

This document same as L-5374

Cy #	Receipt Signature	Date	Inventory Date	Disposition
1	J Chalmers	5/7/68		J. F. Chalmers
2				D. R. Howard ✓
3				W. F. Sampson ✓
4				S. M. Tennant/ S. S. Strong ✓
5				B. A. Hohmann ✓
6				B. Moss ✓

DOCUMENT CONTROL LOG

Control Number L 5374

Copy Number 14 thru 20.

Name of Courier

B. Haskins, 7 May 1968

Source

A/F

Addressee

MOL

Description, Date, Subject, cy number, number of pages, any other identifying control number

MANNED ORBITING LAB., ORBITING VEHICLE, POWER UTILIZATION CONTROL, SAFSL EXHIBIT 30001, cys. 14 thru 20; 19 pages each.
undated.

Attachments

none.

Remarks

Cy #	Receipt Signature	Date	Inventory Date	Disposition
14, 15, 16, 17, 18, 19, 20.				MOL BCF
14				W. Stafford
15				W. Sheng
16				W. D. Pittman
17				R. S. Gaylord
18				GD McGhee
19				H. W. Nordyke
20				J. Meltzer

ITEM	DATA REQUIREMENTS: MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK	INTEGRATE/PUBLISH	RELEASE DATE	SYNOPSIS
1. TOP DOCUMENTATION													
System Test and Operations Plan											MOL SO	June 68	Single source top-level directive document for planning ground test and flight operations. Provides means by which lower level documents are standardized with respect to objectives and philosophy.
General Ground Test Plan (GGTP)											MOL SO	June 68	Summary of all elements of testing to be conducted during the development, qualification, acceptance, and launch operations test program. Establishes general test philosophy, management controls, test criteria, and guidelines for initial component testing through integrated MOL system level testing and launch.
MOL Flight Vehicle Technical Readiness Program for Crew Safety											MOL SO	June 68	Establishes requirements for acceptance and readiness reviews by MOL SO.
Acceptance Plans											MOL SO	June 68	Acceptance Plans implement the FVTRP for each Contractor. They establish and define the role of the MOL SO and Aerospace hardware acceptance teams. They detail the requirements on the Contractors, the procedures to be followed by the Contractors, and the teams to accomplish acceptance of the MOL flight hardware.
VAFB FV Tech Readiness Program for Crew Safety											MOL SO	June 68	Implements the FVTRP at VAFB.
Launch Operations Reqts											MOL SO	June 68	Establishes VAFB Launch Operations management roles; applies test guidelines outlined in GGTP and defines the overall test and operations flow in the mating, testing, preparation and launch of the FV. Shall contain MOL System level plan for test and checkout.
Flight Test and Operations Plan											MOL SO	Released	Provides guidance to MOL contractors and agencies participating in flight test and operations. Provides a baseline for development of detailed planning. Covers the flight from liftoff through postflight test reports. Develops requirements for attendant activity such as training rehearsals, software validation, and ground test support.
11. GROUND TEST DOCUMENTS													
Segment and/or Host Contractor Development Test Plans (TP's)												As Req'd	*Defines test objectives, and approaches; compromises in environment and configuration simulations; describes test conditions. Provides phasing versus production engineering release. Identifies hardware undergoing development test.
**Segment TP's	X	X	X	X	X	X	X			X			
Integrated TP's		X				.	X			X			

LEGEND: *Includes segment-peculiar testing and/or integrated testing at a contractor's fac[illegible]y.
**May be used as i[illegible]s to Integrated TP's.

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ITEM	DATA REQUIREMENTS MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK	INTEGRATE/PUBLISH	RELEASE DATE	SYNOPSIS
Segment and/or Host Contractor Qualification TP's												As Req'd	*Plan for demonstration of specification compliance of all hardware requiring qualification. Establishes allowable repair and retest criteria. Defines in general how environments are simulated. Identifies hardware, number of units and time phasing against engineering release.
**Segment	X	X	X	X	X	X	X	X	X	X			
Integrated		X					X			X			
Segment and/or Host Contractor Acceptance TP's												As Req'd	*Provides assembly and test flow, and objectives of each block; identifies interface simulations/substitutes utilized. Defines AGE/AVE/facility configuration. Provides schedule and data analysis plans. Defines testing for acceptance. Identifies differences between VAFB and factory, test configuration.
**Segment	X	X	X	X	X	X	X	X	X	X			
Integrated		X					X			X			
Flight Vehicle Checkout*** Plan													Defines and describes the technical activities for conducting integrated launch operations at VAFB. It shall cover all activities from receipt of the AVE through liftoff, and, in addition, shall cover those turnaround activities following launch which are required to prepare for the next prelaunch/launch cycle. The major inputs for this documentation shall be the Segment Checkout Requirements Plans prepared by the associate contractors, and the content shall parallel that of the input documents, placing emphasis upon the integrated effort and prepared to a lesser level of detail. Information contained in this documentation shall represent a coordinated effort among all participating contractors and agencies (through appropriate channels), and it shall reflect the joint test flow activities conducted under the authority of the Launch Operations Planning Group and the Launch Operations Working Group. Separate documents shall be prepared for the typical mission baseline and for each flight vehicle.
Part A Typical Flight Vehicle Baseline (Manned/Auto)	X	X	X								DAC	IL-23 mo	
Part B Specific Flight Vehicle Configuration											MMC		
1			X									L-12 mo	
2, 3	X	X										L-12 mo	
6		X										L-24 mo	

LEGEND: *Includes segment-peculiar testing and/or integrated testing at a contractor's facility.
**May be used as inputs to integrated plans
***These input requirements are the Checkout Requirements Plan.

SAFSL EXHIBIT 30020
Revised July 1968

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ITEM	MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK			INTEGRATE / PUBLISH	RELEASE DATE	SYNOPSIS
Checkout Requirements Plan															Defines and describes the launch operations requirements for the contractor's flight vehicle segment and his imtermediate integration responsibilities during the prelaunch and launch phases and during those turnaround activities necessary to prepare for the next prelaunch/launch cycle. It shall be the individual contractor's governing plan for his segment activities and responsibilities, and it shall be a major input for subsequent AVE, AGE, facility, test flow, and procedures development and planning. The document, which shall reflect coordination (through appropriate channels) with other participating contractors and agencies, shall be prepared in sufficient detail to cover the objectives, test requirements, AGE utilization, facility requirements, sequence of operations, etc., associated with the contractor's segment or his intermediate integration responsibility; however, it will not intentionally duplicate the information supplied in another associate contractor's plan. The document shall also include illustrated activity/test-flow sequences, segment-applicable AGE block diagrams, handling-equipment flow illustrations, and test-data requirements to a sufficient level of detail to provide the basis for development of launch-operations procedures. In addition, the contractor shall provide, in the introductory portion of the document, a brief summary of the segment factory-acceptance testing and launch site checkout. A separate document shall be prepared for the typical mission baseline and each flight vehicle.
Part A. Typical Flight Vehicle Baseline (Manned/Auto)														IL-28M	
Part B. Specific Flight Vehicle (1, 2, 3, & 6) Config.															
1, 2, 3														L-15M	
6														L-27M	
T-IIIM (A and B)			X	X	X	X							MMC		
LV (A and B)		X					X	X		O			DAC		
G-B (A and B)	X								X				MAC		
Contractor Vehicle Integ Test Procedures														T-30D	Defines and contains detailed launch-site procedures associated with flight hardware, supplements/complements the Checkout Requirements Plans and the integrated FVCOP Vehicle Operations Plan, and pertains to operations affecting an interface or a system-level test. All other procedures are prepared and conducted by the equipment contractor concerned and do not receive integration.
T-IIIM			X	X	X	X							MMC		
LV		X					X	X		O			DAC		
G-B	X								X				MAC		
OV		⊗											MAC/DAC		
FV	⊗	⊗	⊗										ATW		
Countdown Manual	X	X	X	X	X	X	X		X	O			ATW	L-6M	Details, in a time sequence, the launch countdown procedures.
Ground Safety Plan	X	X	X	X	X		X		X	O			ATW	IL-12M	Presents detailed planning and information outlining all potential ground safety hazards from arrival of the flight hardware at VAFB through liftoff.

NOTE: Inputs to integrator/publisher are required as follows:
1. L ≥ 15 month inputs due 2 months prior to release date
2. L < 15 month inputs due 1 month prior to release date

LEGEND: ⊗ Integrated T-IIIM, LV, G-B Test Procedures
O To be integrated by GE

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SAFSL EXHIBIT 30020
Revised July 1968

ITEM	DATA REQUIREMENTS MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK			INTEGRATE / PUBLISH	RELEASE DATE	SYNOPSIS
Launch Operations Crew Certification Plan	X	X	X	X	X		X		X	X				IL-12M	Defines and describes the associate contractor's plan for the certification of the Launch Operations Crew personnel.
111. FLIGHT TEST AND OPERATIONS DOCUMENTS															
Operations Crew Training Plan															
I Powered Flight													ATC	IML-30M	Describes and defines a plan for training and certifying powered flight controllers in the use of segments of the flight vehicle procedures and operations.
II Orbital Vehicle	X	X					X		X	X			MOL SO	IML-15M	Describes and defines a plan for training and certifying flight operations crew personnel in the use of segments of the Orbiting Vehicle procedures and operations.
III SCF/STC	X	X					X			X			AFSCF	IL-15M	Describes and defines a plan for training and rehearsals involving flight operations crew personnel in the AFSCF/STC procedures, operations and equipment associated with the MOL Program.
Flight Crew Training Reqts															
FV	●	X	⊗				X		X	O			DAC	IML-36M ML-12M	Describes the flight crew training requirements for performance of assigned tasks, during the phases of the flight which involve the operation, monitoring or maintenance of the contractors equipment.
Press Suit									X				HS	IML-36M ML-12M	
Flight Crew Training Plan*													MOL SO	IML-32M ML-11M	Describes and defines the plan for training the flight crew. Includes the outline and approach to be followed for the academic material, simulators, facilities, equipment and procedures, related documents, and normal and contingency plans and procedures.
Flight Directors Handbook	X	X	⊗	X	X	X	X		X	O			MOL SO	IML-18M IAL- 8M	
Vol I System Operations															Vol I contains critical parameters, and associated criteria and procedures for contingency decisions during ascent, orbit, and recovery operations.
Vol II System Test Rules															Vol II contains system test rules.

NOTE: Inputs to integrator/publisher are required as follows:
1. L ≥ 15 month inputs due 2 months prior to release date
2. L < 15 month inputs due 1 month prior to release date

LEGEND:
* Inputs are the flight crew training requirements
⊗ Integrated by MMC for UTC, AGC, and ACED inputs
O To be integrated by GE
● Integrated by MAC for MMC input

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ITEM	DATA REQUIREMENTS: MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK			INTEGRATE / PUBLISH	RELEASE DATE	SYNOPSIS
Mission Simulator Operating* Handbook		X												Acceptance of MS	This document lists operating procedures necessary to operate the LVPS, GBPS and AFSCF as an integrated Mission Simulator.
LVPS Operating Handbook		X					X		X	O			DAC	With Shipment	Contains operating procedures for those consoles used to support the system and which are used by the instructor and operator personnel. It is a comprehensive description of simulator hardware/software as it pertains to the instructor and operator personnel.
GBPS Operating Handbook	X													With Shipment	Contains operating procedures for those consoles used to support the system and which are used by the instructor and operator personnel. It is a comprehensive description of simulator hardware/software as it pertains to the instructor and operator personnel.
Flight Crew Handbook															This is basically a reference document for the crew and will contain:
Laboratory Vehicle	X	X					X		X	O			DAC	IML-18M ML-10M	(1) A brief description of the subsystems and the critical components including safety considerations
Gemini B	X	X	⊗						X				MAC	IML-18M	(2) Details of the critical parameters of the subsystem operational modes, alternate contingency modes, crew equipments, equipment operating and operational procedures, flight phases, and interfaces between equipment, procedures, and operations. The scope of the document may be modified by the flight crew. The format of this document will be suitable for use with the visual display projector.
Recovery Handbook															
Flights No. 2 and 3	X						X		X	O			MAC	L-12M	Contains a description of the vehicle structure and subsystems, describes in detail all necessary safety and handling procedures for the recovery personnel and the procedures to follow for the preservation and temporary storage of the Gemini B/payload until delivery to the receiving agency. Contains procedures for the collection and/or preservation of data/status of the vehicle after recovery.

NOTE: Inputs to integrator/publisher are required as follows:
1. L ≥ 15 month inputs due 2 months prior to release date
2. L < 15 month inputs due 1 month prior to release date

LEGEND:
⊗ Integrated by MMC for UTC, AGC, and ACED inputs
O GE will integrate EK input
* Inputs may be obtained from the LV and G-B Simulator Operations Handbook

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ITEM	DATA REQUIREMENTS: MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK			INTEGRATE / PUBLISH	RELEASE DATE	SYNOPSIS
IV TEST AND OPERATIONS REQUIREMENTS AND SUPPORT PLANS															
Radio Frequency Allocation Request	X	X	X										MOL SO	1 L-24M	Lists and requests approval of all radio frequencies required for the program.
MOL Instrumentation List	X	X	⊗				X			O			MOL SO	Released L-5M	This document provides a description and an instrumentation list for use in the planning and execution of the MOL system test.
Flight Termination System (FTS) Report	X		X	X	X	X							MOL SO	1 L-5M	Detailed description of the FTS: schematic, description of its components, interfaces, checkout, and operation; certification of components, specifications and schematics of all FTS devices or destructors, and test results; cutoff-system and command-system details.
Range Safety Report	X	X	X	X	X		X			O			MMC	1 L-6M L-2M	Provides range safety with complete information on trajectories, impact points, hazards, etc. Basis for establishment of destruct limits.
Calibration Data Book	X	X	⊗				X			O				1ML-18M L-4M	Initial issue lists data points, defines nominal values, operating ranges, accuracies. Calibration curves in L-4M issue only.
Program Requirements Document (PRD)	X	X	X	X	X	X	X		X	O			MOL SO	1 L-22M	Program support requirements to be levied on the lead range. Launch and ascent support requirements to NRD. Includes NRD facilities requirements (may include ships, and insertion and early orbit monitoring and tracking). PRE is program requirements estimate.
Program Support Plan (PSP)													AFWTR	1 L-16M	Details the support provided in response to PRD.
Orbital Requirements Document (ORD)	X	X					X			O			MOL SO	Released L-6M	Program support requirements to AFSCF.
Orbital Support Plan (OSP)													AFSCF	Released L-4M	Details the support provided in response to ORD and is a management and coordinating document for the operations of the AFSCF.
GBQ Recovery Requirements Document (GRRD)	X												MOL SO	GBQ-24M	Specifies requirements for recovery of GBQ Spacecraft.
GBQ Recovery Support Plan (GRSP)													DDMS	GBQ-6M	Details the support provided in response to GRRD.

NOTE: Inputs to integrator/publisher are required as follows:
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LEGEND:
⊗ Integrated by MMC for UTC, AGC, and ACED inputs
O GE will integrate EK input

ITEM	DATA REQUIREMENTS											INTEGRATE/PUBLISH	RELEASE DATE	SYNOPSIS
	MAC	DAC	MMIC	AGC	UTC	ACED	GE	WHIRLP	HAM S	EK				
Manned Recovery Requirements Document (MRRD)	X											MOL SO	1ML-24M	Recommends recovery-force types, locations, and operations. Spacecraft post-retrieval requirements will be described. Refers to Gemini B only.
Manned Recovery Support Plan (MRSP)												DDMS	1ML-6M	Details the support provided in response to MRRD.
Recovery Requirements Document							X			O		MOL SO	1AL-12M	Specifies requirements for air retrieval DRV.
Recovery Support Plan												AFSCF	1AL-6M	Details support plan.
Contractors Orbital Support Plan	X	X					X			X			IML-12M	Details the support and procedures planned for the conduct of operations by the contractor operations support teams.
Flight Vehicle Time Line	X	X					X			O		DAC	Released ML-9M	Provides a detailed examination of the operational capability of the total system based on typical operational loadings of the component systems.
Data Definition Specifications												MOL SO	IL-20M L-9M	Provides a detailed definition of the data processing system for real time, post pass and off line data display, processing and analysis within the SCF during flight operations. Contractor inputs to the ORD provide inputs to this document.
Command Definition Specification		X					X			O		GE	Released L-6M	Provides a detailed definition of all OV commands and their interfaces.
Hardware/Software Limitatio Specification		X					X			O		GE	Released L-6M	Defines the OV functional limitations of the hardware/software interactions and their resulting constraints on command capabilities.
OTEF Operations Plan												MOL SO	1ML-20M	Addresses areas of AF/AF, AF/Contractor and Contractor/Contractor interfaces at OTEF.
Development Flights No. 1 and 2 Planning Document												MOL SO*	1L-29M	This document is prepared for the purpose of providing an authoritive preliminary planning guide to contractors and other agencies affected to assist them in preparing their separate planning requirements relative to the MOL Development Flights 1 & 2. It defines the general test plans, objectives, constraints and requirements for these engineering development flights. Broadly covers MOL vehicle operations from prelaunch listing at VAFB to conclusion of the flight operations. The document is preliminary to and will be superseded by the STO documentation for the flight.

NOTE: Inputs to integrator/publisher are required as follows;
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LEGEND:
* Issued by MOL SO
O GE will integrate EK input

ITEM	MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRL	HAM S	EK	INTEGRATE/PUBLISH	RELEASE DATE	SYNOPSIS
System Test Objectives (STO)	X	X	X	X	X	X	X		X	O	MOL SO	*L-12M L-4M	This document informs all pertinent agencies and contractors of specific, detailed objectives of the flight, and provides the basis for evaluating the flight results. Contains detailed planning for individual flights (launch criteria, test parameters, timeline, mission flight data handling, format, general data disposition, recovery, etc.) including operational aspects.
Test Operations Orders (TOO)											AFSCF	L-6M	Directs AFSCF activities in support of the Flight Operations. Includes necessary contractor information to be obtained from existing documentation.
Launch Test Directive (LTD)	X	X	X	X	X	X	X		X	O	ATW	L-3M	Detail directive to all organizations internal to the ATW, provides direction to the agencies/contractors participating in the launch effort and is based upon the STO.
Operations Directive (OD)											AFWTR	T-1M	Official Range response to each OR.
Operations Requirements (OR)											ATW	T-2M	
Part I													Specifies in detail the range requirements for a specific preflight (or flight) test operation. Based on, and supplements the PRD (Part I) and the ORD (Part II).
Part II											SCF		
V. EVALUATION DOCUMENTS													
Quick-look Ascent and Orbit Report	X	X					X		X	X	MOL SO	L+7D	Preliminary report covering the performance of the individual segments and problem areas during first five days
Quick-look Post-Operations Report	X	X					X		X	X	MOL SO	FT+5	Preliminary report covering the performance of the individual segments and problem areas during the total period of flight.
Post-Operations Assessment Directive (POAD)											MOL SO	L+10D FT+10D	The initial directive will cover the first five days of the operation and the final directive will cover the operation through recovery. These directives will define the major problems of concern and will assign work priority to these problems. These directives will utilize the Quick-look Reports.
Launch Operations Report	X	X	X	X	X	X	X		X	X	ATW	L+20D	Final Launch Operations Performance Analysis Report.
Powered Flight Orbit and Recovery Evaluation Report											AFSCF	FT+30D	AFSCF ground network operations report to the SO.

NOTE: Inputs to integrator/publisher are required as follows:
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LEGEND:
⊗ Integrated by MMC for UTC, AGC, and ACE inputs
O GE will integrate EK input
* Inputs are flight oriented

ITEM	DATA REQUIREMENTS												INTEGRATE / PUBLISH	RELEASE DATE	SYNOPSIS
	MAC	DAC	MMC	AGC	UTC	ACED	GE	WHIRLI	HAM S	EK					
Flight Crew Debriefing Report													MOL SO	As Directed	On-orbit time-line performance report; biomedical report: performance, procedures and equipment report and mission summary.
Manned Recovery Report													DDMS	FT+30D	An operations report which will contain an evaluation, conclusions, and recommendations.
GBQ Recovery Report													DDMS	FT+30D	An operations report which will contain an evaluation, conclusions, and recommendations.
Contractor Post-Flight Segment															Evaluation of Subsystem/Segment/System non-nominal performance vs test objectives. Detailed engineering analysis of failure or deficiencies in performance. Summary of problems encountered and their solutions.
(a) Interim	X	X					X		X	X				POAD+20D	
(b) Final	X	X					X		X	X				POAD+50D	
Final Ascent Evaluation Report	X	X	X	X	X	X	X		X	X				L+45D	Engineering analysis of system performance during ascent (liftoff through insertion).
Final Flight Test * Engineering Report													MOL SO	POAD+80D	This is a systems-level report. Evaluation of system test objectives vs performance results attained. Detailed engineering analysis of the systems performance.
Post Flight Evaluation Plan	X	X					X		X	X				L-20M L-6M	Provides a detailed plan for the post flight analysis to be conducted by the contractors.

NOTE: Inputs to integrator/publisher are required as follows:
1. L ≥ 15 month inputs due 2 months prior to release date
2. L < 15 month inputs due 1 month prior to release date

LEGEND: * Inputs are all evaluation documents
⊗ MMC to integrate UTC, AGC, ACED

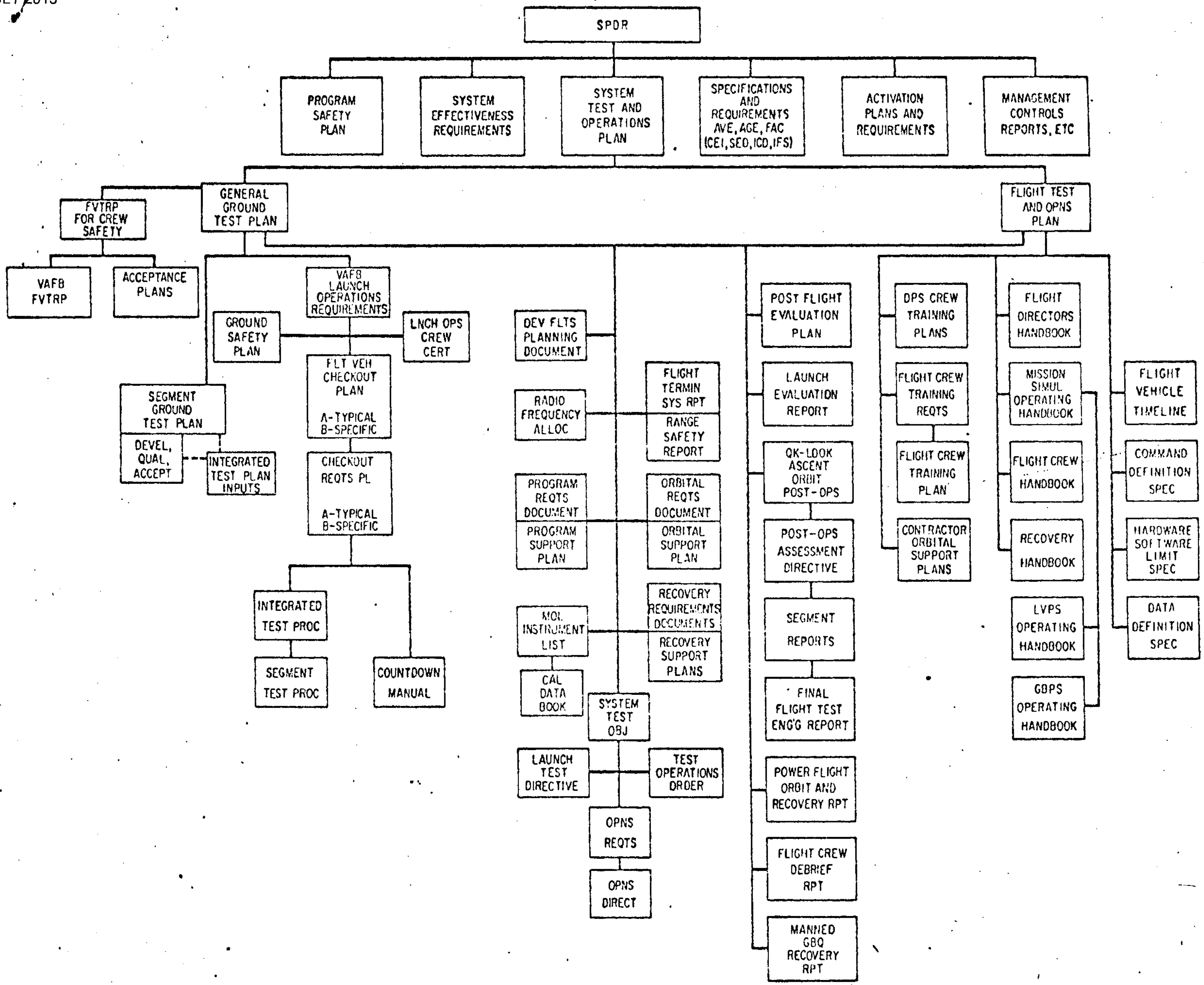

Figure 2

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APPENDIX A

ABBREVIATIONS

ACED	A. C. Electronics Division (of General Motors)
AFSC	Air Force Systems Command
AFSCF	Air Force Satellite Control Facility
AFWTR	Air Force Western Test Range
AGC	Aerojet-General Corporation
AMD	Aerospace Medical Division
ATW	6595th Aerospace Test Wing
AVE	Aerospace Vehicle Equipment
AWS	Air Weather Service
BIGS	Booster Inertial Guidance System
CDRL	Contract Data Requirements List
CEI	Contract End Item
DAC	Douglas Aircraft Company
DDMS	DOD Manager for Manned Space Flight Support
EK	Eastman Kodak Company
EMC	Electromagnetic Compatibility

FT	Flight Termination
FTOP	Flight Test and Operations Plan
FV	Flight Vehicle
FVCOP	Flight Vehicle Checkout Plan
FVTL	Flight Vehicle Timeline
GB	Gemini-B Spacecraft
GE	General Electric Company
GGTP	General Ground Test Plan
GRRD	Gemini Recovery Requirements Document
GSE/TD	General Systems Engineering and Technical Direction
HB	Huntington Beach
H/B	Handbook
HS	Hamilton Standard, Division of United Aircraft Corporation
IAL	Initial Automatic Launch
IL	Initial Launch
IML	Initial Manned Launch
L	Launch
LM	Laboratory Module
LOWG	Launch Operations Working Group
LTC	Launch Test Directive
LV	Laboratory Vehicle

MAC	McDonnell Astronautics Company
MCC	Mission Control Center
MDC	McDonnell Douglas Corporation
MM	Mission Module
MMC	Martin-Marietta Corporation
MOL	Manned Orbiting Laboratory
MOL SO	Manned Orbiting Laboratory Systems Office
MRRD	Manned Recovery Requirements Document
MS	Mission Simulator
ORD	Orbital Requirements Document
ORU	Operational Readiness Unit
OTEF	Operational Training and Evaluation Facility
OV	Orbiting Vehicle
POAD	Post Operations Assessment Directive
PP	Program Plan
PSA	Pressure Suit Assembly
PRD	Program Requirements Document
PRE	Program Requirements Estimate
ROCH	Rochester, New York (EK)
SAF	Secretary of the Air Force
SAMSO	Space and Missile Systems Organization
SCF	Satellite Control Facility
SMLC	SAMSO Plans and Operations Office
SP/DR	System Performance/Design Requirements
STC	Satellite Test Center
ST. L.	St. Louis, Missouri (MDC)
STO	System Test Objectives
STOP	System Test and Operations Plan

T	Test
T-IIIM	Titan-IIIM Launch Vehicle
TD	Technical Direction
TOR	Technical Operating Report
TRW	TRW Systems Group
TP	Test Plans
USAF	United States Air Force
UTC	United Technology Corporation
VAFB	Vandenberg Air Force Base
VF	Valley Forge, Pennsylvania (GE)
VTS	Vandenberg Tracking Station