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23 Jan 1967
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REVIEW OF MOL/DORIAN

GROUND TEST PLANNING

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OUTLINE OF BRIEFING

- OBJECTIVES
- PARTICIPANTS AND RESPONSIBILITIES
- PROCEDURE FOLLOWED
- BASELINE TEST FLOW
- DEVELOPMENT TESTING
- QUALIFICATION TESTING
- ACCEPTANCE TESTING
- ACOUSTIC TESTING
- SUMMARY RECOMMENDATIONS
- IMPACT

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OBJECTIVES

RE-EXAMINE MOL/DORIAN SYSTEM TEST PLANNING TO:

- ENSURE WELL INTEGRATED CONSISTENT TEST PROGRAM
- REDUCE NEED FOR NEW FACILITIES AND OTHER COSTS CONSISTENT WITH THE OBJECTIVES OF THE PROGRAM
- RESULT IN LEAST IMPACT ON PRESENT ROLES

AREAS OF PARTICULAR CONCERN:

- THERMAL VACUUM TESTING
- ACOUSTIC TESTING
- VIBRATION TESTING FOR MODES
- OPERATIONAL DYNAMICS TESTING
- TEST TIME PRIOR TO FLIGHT
- IMPACT OF FLOW ON AGE/FACILITIES

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PARTICIPANTS AND RESPONSIBILITIES

TEAM CHAIRMAN - J. KENT
CO-CHAIRMAN - N. NIEDERMAN

| <u>CATEGORY CHAIRMEN</u> | <u>PARTICIPANTS</u> |
|--|--|
| DEVELOPMENT TESTING - (F. W. BELINA) | THERMAL - (R. D. LONG) |
| QUALIFICATION TESTING - (F. P. KIEFER/R. J. KREJCI) | ACOUSTIC - (D. L. VANERT/S. D. ZINN) |
| ACCEPTANCE TESTING - (W. C. HAYDEN/F. W. MACNAB) | DYNAMICS - (J. E. ANDERSON/R. W. DEZELAN) |
| | EMC - (W. J. BALDAU) |
| | FACILITIES/AGE - (D. E. WILKINS) (R. E. FINNEY/E. F. SCHMIDT) |

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PROCEDURE FOLLOWED

REVIEW OF FILES

- o MINUTES OF SYSTEM TEST MEETINGS
- o EXCHANGE HARDWARE LIST/TEST FLOW
- o SAFSL DOCUMENTS
- o CONTRACTOR DOCUMENTS
 - SOW'S, CEI'S
 - PROGRAM PLANS
 - PRELIMINARY TEST PLANS
 - FACILITY PROPOSALS

CONTRACTOR VISITS

- o GE - NOVEMBER 21/DECEMBER 13
- o EK - NOVEMBER 22/DECEMBER 14
- o DAC - JANUARY 4

ANALYSIS OF MATERIAL

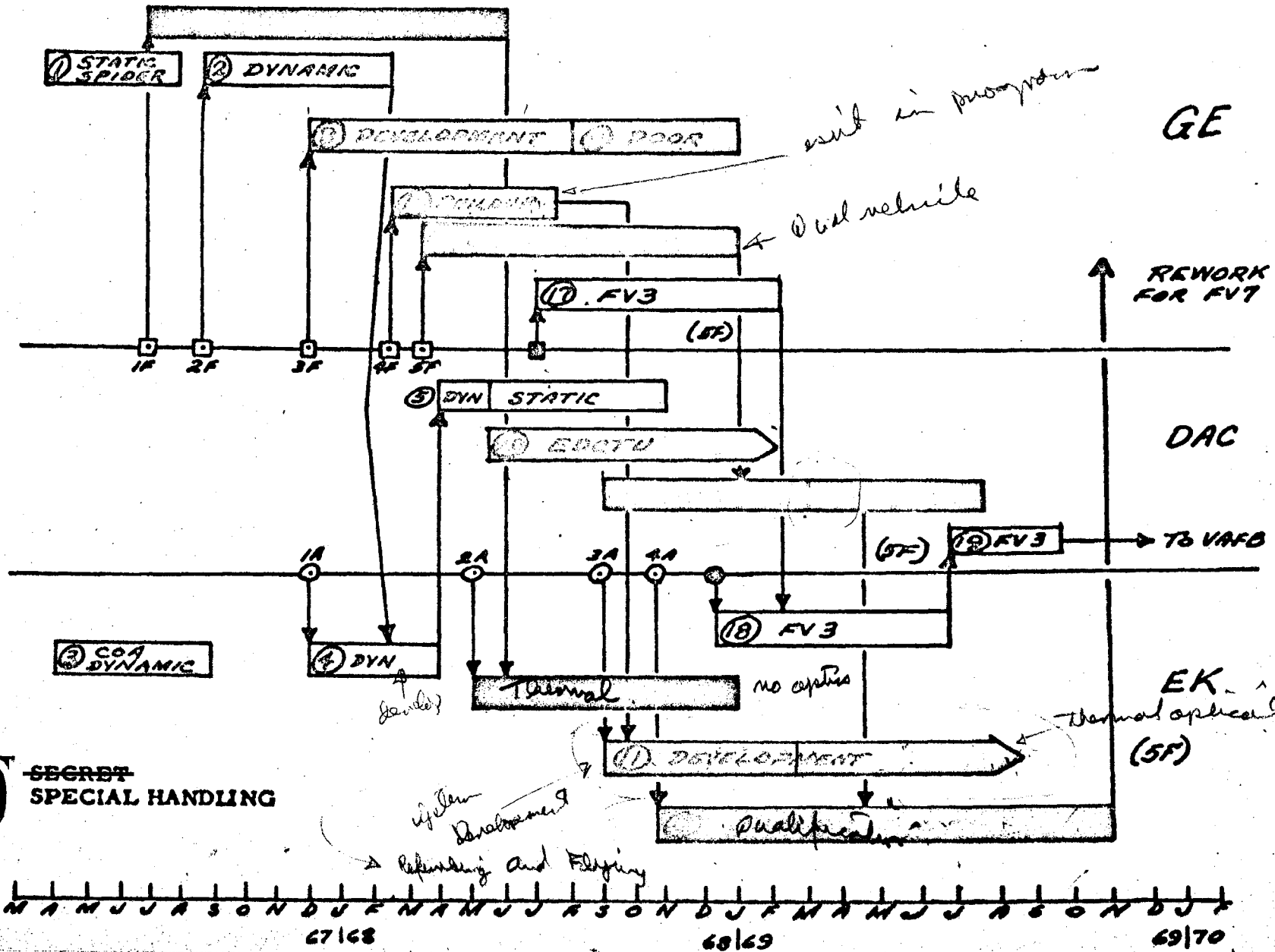
- o STUDY OF PROBLEM AREAS
- o PREPARATION OF RECOMMENDATIONS
- o ESTIMATE IMPACTS

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D INTEGRATED TEST FLOW PLAN

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67/68 68/69 69/70
M A M J J A S O N D J F M A M J J A S O N D J F



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DEVELOPMENT TESTING
KEY AREAS OF INVESTIGATION

1. VALIDITY OF BASIC DEVELOPMENT TEST PHILOSOPHY
2. VALIDITY OF PROPOSED DEVELOPMENT TESTS AND APPROACH
 - o ACOUSTIC
 - o VIBRATION
 - o SHOCK
 - o THERMAL/THERMAL-VACUUM
 - o EMC
 - o STATIC
3. COMBINATION OF SELECTED DEVELOPMENT TESTS
 - o GE AND EK THERMAL TESTING
 - o GE AND DAC DRV TESTING

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DEVELOPMENT TESTING

KEY AREAS OF INVESTIGATION AND SUMMARY RESULTS

1. VALIDITY OF BASIC DEVELOPMENT TEST PHILOSOPHY

| | <u>EVALUATION CRITERIA</u> | <u>OVERALL RESULTS</u> | | |
|----|---|------------------------|-----------|-----------|
| | | <u>DAC</u> | <u>GE</u> | <u>EK</u> |
| a. | SUFFICIENT ENVIRONMENTAL TESTING TO ASSURE A MINIMUM RISK QUALIFICATION PROGRAM | OK | OK | (1) |
| b. | FULL RANGE OF REQUIRED FUNCTIONAL PERFORMANCE DEMONSTRATED | OK | OK | OK |
| c. | PROPER EMPHASIS ON NEW DEVELOPMENT AND MISSION CRITICAL ELEMENTS | OK | OK | OK |
| d. | PROPER BUILD-UP OF TESTS FROM COMPONENT THROUGH SYSTEM LEVELS | OK | OK | OK |
| e. | ORIENTED TOWARD MAXIMUM USE OF EXISTING FACILITIES AND EQUIPMENT | OK | OK | OK |

(1) AS A GENERAL RULE EK DOES NOT PLAN TO EXPOSE FUNCTIONAL DEVELOPMENT COMPONENTS TO EITHER FLIGHT LEVEL OR QUAL LEVEL ENVIRONMENTS.

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DEVELOPMENT TESTING
KEY AREAS OF INVESTIGATION & SUMMARY RESULTS

2. VALIDITY OF PROPOSED DEVELOPMENT TESTS AND APPROACHES

| | <u>DAC</u> | <u>GE</u> | <u>EK</u> |
|--------------------------|------------|-----------|-----------|
| ACOUSTIC | | | |
| COMPONENT ⁽¹⁾ | OK | (2) | OK |
| SYSTEM | OK | OK | OK |
| STATIC | | | |
| COMPONENT ⁽¹⁾ | OK | OK | OK |
| SYSTEM | OK | OK | OK |
| SHOCK | | | |
| COMPONENT ⁽¹⁾ | OK | OK | (7) |
| SYSTEM | (3) | OK | OK |
| VIBRATION | | | |
| COMPONENT ⁽¹⁾ | (4) | OK | (7) |
| SYSTEM | (5) (6) | OK | (8) |
| THERMAL | | | |
| COMPONENT ⁽¹⁾ | OK | OK | (7) |
| SYSTEM | OK | OK | OK |
| EMC | | | |
| COMPONENT ⁽¹⁾ | OK | OK | OK |
| SYSTEM | OK | OK | OK |

(1) COMPONENT TESTS LARGELY UNDEFINED.

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(Note 2) S55-342
ok pg 10

GE COMPONENT ACOUSTIC DEVELOPMENT TESTING

BASELINE

- o INDIVIDUAL COMPONENT ACOUSTIC DEVELOPMENT TESTING PER SAFSL EXHIBIT 10003.
- o ACOUSTIC TESTING IN ADDITION TO COMPONENT VIBRATION TESTING.

CONSIDERATIONS

- o ACOUSTIC TESTING OF COMPONENTS WITHOUT ATTACHING STRUCTURE NOT CONSIDERED VALID.
- o IN GENERAL, VIBRATION TESTING OF SMALL COMPONENTS CONSIDERED ADEQUATE.

RECOMMENDATION

- o DIRECT GE TO DELETE INDIVIDUAL COMPONENT ACOUSTIC TESTING AS A GENERAL PRACTICE.
- o RETAIN COMPONENT ACOUSTIC TESTING ONLY FOR THOSE CONSIDERED SUSCEPTIBLE.

IMPACT

- o MUST NECESSARILY AWAIT EVALUATION OF GE'S IMPLEMENTATION OF THIS PHILOSOPHY.

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MM DOOR JETTISON SHOCK DEVELOPMENT TEST

BASELINE

- o MM TEST ARTICLE WITH SIMULATED COMPONENTS.
- o NO LM TEST ARTICLE DUE TO AVAILABILITY PROBLEM.

RECOMMENDATION

- o LM STRUCTURE AND COMPONENTS SHOULD BE INCLUDED IN TEST CONFIGURATION
- o REASON - TO PROVIDE SHOCK DATA FOR LM INSTALLATIONS AND BETTER ENVIRONMENTAL SIMULATION (CONTINUOUS TEST ARTICLE AVOIDS REFLECTION PROBLEMS DUE TO STRUCTURAL DISCONTINUITY).
- o IMPLEMENTATION - PROGRAM DOOR EJECTION TEST ON STV IMMEDIATELY SUBSEQUENT TO OV MODAL SURVEY (PRIOR TO DEMATE FOR LM ACOUSTIC TEST).

IMPACT

- o SCHEDULE - POTENTIAL ADDITION OF ONE MONTH TO LM PORTION OF STV SCHEDULE. RESULTS IN ONE MONTH'S LESS WORTH OF POTENTIAL CHANGE INCORPORATION IN LM STRUCTURE FOR FV NO. 1 AND 2.
- o COST - INCREASE DUE TO SCHEDULE STRETCHOUT SHOULD NOT EXCEED \$25,000 (ROM).

ok
instrumentation
feasibility
(still some problem)

yes

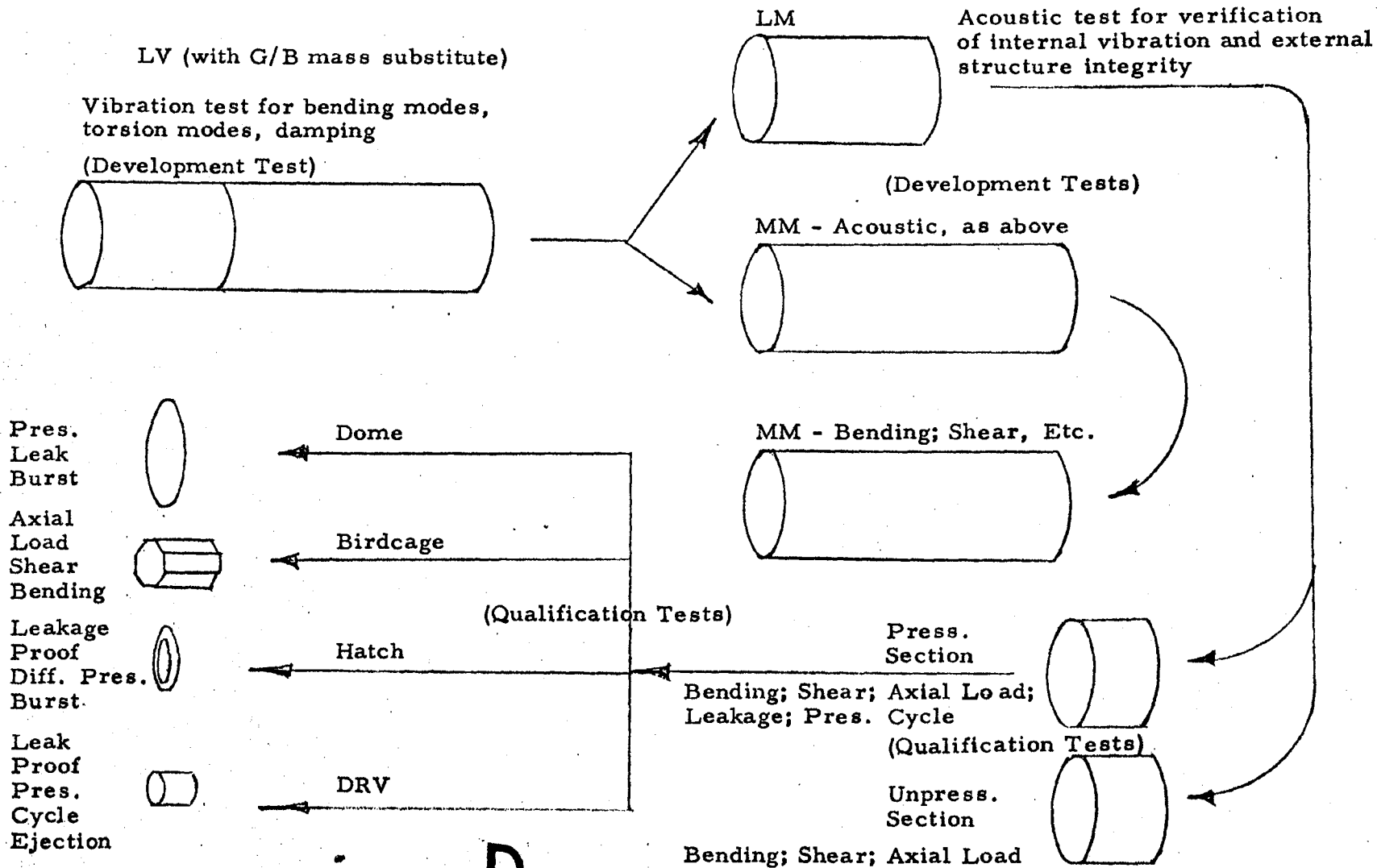
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STRUCTURAL DEVELOPMENT AND QUALIFICATION TEST FLOW

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(Note: All structures are production hardware)



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(Note 4)

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*OK - but I can not
commit that
it is
technically
feasible*

METEOROID SHIELD FLUTTER TEST
DEVELOPMENT - DAC

| ALTERNATIVES | CONSIDERATIONS |
|---|---|
| <p><u>BAS ELINE</u></p> <ul style="list-style-type: none"> o MODEL FLUTTER TEST AT TULLAHOMA o MAGNESIUM MODEL TO OBTAIN DESIRED Q MARGIN o TRANSONIC TESTS ONLY | <ul style="list-style-type: none"> o DYNAMIC PRESSURE LIMITATIONS REQUIRE MAGNESIUM MODEL CONSTRUCTION o TEST WILL DEMONSTRATE Q MARGIN o MACH NUMBER RANGE INSUFFICIENT TO DEMONSTRATE M MARGIN |
| <p><u>ALTERNATIVE 1</u></p> <ul style="list-style-type: none"> o SUPERSONIC RUNS ADDITIONALLY | <ul style="list-style-type: none"> o PLANNED TEST RUNS WILL NOT DEMONSTRATE MACH NO. MARGIN o OTHER TEST EXPERIENCE SUGGESTS CRITICAL Q's MAY OCCUR AT HIGHER MACH NUMBERS |

RECOMMENDATION:

ADDITIONAL RUNS BE SCHEDULED (SAME TIME, MODEL) IN SUPERSONIC TUNNEL TO DEMONSTRATE REQUIRED Q AND M MARGINS.

IMPACT:

COST: TUNNEL NO COST-TEST SUPPORT - \$5,000 (ROM)
SCHEDULE: ADDED TUNNEL AND TEST TIME APPROX. 4 DAYS - NO PROGRAM IMPACT

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(Note 5) P9, 14
yes definitely

BOOST PHASE VEHICLE MODAL SURVEY
DEVELOPMENT (STV) - H. B.

| ALTERNATIVES | CONSIDERATIONS |
|---|--|
| <ul style="list-style-type: none">o BASELINE - CONDUCT TEST ON STV SUSPENDED VERTICALLY BY BUNGEE | <ul style="list-style-type: none">o DETERMINE FREE-FREE VIBRATION MODES OF OV IN BOOST CONFIGURATION FOR VALIDATION/CORRECTION OF VEHICLE LOADS PREDICTIONS |
| <ul style="list-style-type: none">o ALTERNATE 1 - SUPPORT TEST ARTICLE AT BASE BY FIXTURE SIMULATING T-IIIIM ADAPTOR FLEXIBILITY | <ul style="list-style-type: none">o FREE-FREE BOUNDARY CONDITIONS OF BASELINE TEST ARE NOT SUITABLE FOR VEHICLE MODE VERIFICATION SINCE FLEXIBILITY OF MM SHELL IS NOT PROPERLY EMPHASIZED, AND ADAPTOR LOAD DISTRIBUTION EFFECTS ARE OMITTED ENTIRELY |

RECOMMENDATION:

CONDUCT TEST WITH SUPPORT SIMULATING TITAN ADAPTOR STRUCTURAL FLEXIBILITY

IMPACT:

NONE AS STATIC TEST FIXTURE SHOULD BE USABLE

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(Note 6)

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ORBITAL VEHICLE MODAL SURVEY

DEVELOPMENT (STV) - H. B.

yes definitely

| ALTERNATIVES | CONSIDERATIONS |
|---|--|
| <ul style="list-style-type: none">o BASELINE CONDUCT TEST AT DAC ON STV SUSPENDED VERTICALLY IN A FREE-FREE CONDITION SUPPORTED BY BUNGEE ATTACHED TO FWD END OF OV. WITH TRUSS | <ul style="list-style-type: none">o DETERMINE FREE-FREE OV VIBRATION MODES TO VALIDATE OR CORRECT PERFORMANCE PREDICTIONSo DOOR OPEN BUT REPLACED BY STRUCTURAL TRUSS |
| <ul style="list-style-type: none">o ALTERNATIVE 1 REMOVE STRUCTURAL TRUSS | <ul style="list-style-type: none">o FLEXIBILITY OF OPEN MM DOOR IS EXPECTED TO BE IMPORTANT EFFECT ON MODESo DOOR TRUSS WILL ALTER STV DYNAMICS |

RECOMMENDATION:

CONDUCT TEST ON STV WITH DOOR OPEN AND TRUSS REMOVED.

IMPACT:

NONE

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EK COMPONENT DEVELOPMENT TESTS

yes, on dynamic tests, in fact have approach on qualification maybe the way to go. 555-342 Pg 16

| ALTERNATIVES | CONSIDERATIONS |
|--|---|
| <p>BASELINE</p> <ul style="list-style-type: none"> o EK PLANS ONLY LIMITED THERMAL-LOW VACUUM TESTING OF SELECTED OPTICAL PIECES o EK PLANS NO DYNAMIC TESTING OF COMPONENTS DURING DEVELOPMENT TESTING | <ul style="list-style-type: none"> o DOES NOT INCLUDE ANY THERMAL OR THERMAL-HARD VACUUM EXPOSURE OF ANY OTHER FUNCTIONAL ELEMENTS ON A COMPONENT BASIS. SYSTEM LEVEL EXPOSURE ON THM AND EM NOT CONSIDERED ADEQUATE SUBSTITUTE. o DYNAMIC TESTS ON SDM AND EM NOT CONSIDERED ADEQUATE SUBSTITUTE |
| <p>ALTERNATIVE</p> <p>PLAN ON THERMAL, THERMAL-VACUUM, AND DYNAMIC EXPOSURES OF SELECTED COMPONENTS AT COMPONENT LEVEL TO ASSURE MINIMUM RISK QUAL PROGRAM</p> | <p>TOTAL IMPACT MUST NECESSARILY AWAIT EVALUATION OF SELECTED TESTS. ALTERNATIVE PHILOSOPHY SHOULD BE CONVEYED TO EK, HOWEVER, AS A BASIC REQUIREMENT.</p> |

RECOMMENDATION:

REVISE DEVELOPMENT TEST AND PROVIDE APPROPRIATE DIRECTION.

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I don't really understand this test.
ok *555-342*
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EK GROUND CONDITIONING TEST (THERMAL MODEL)

BASELINE:

- o CONDUCT GROUND CONDITIONING TEST TO DETERMINE IMPACT OF GROUND ENVIRONMENT (TRANSPORTATION AND PAD) ON MM.

CONSIDERATIONS:

- o CONFIGURATION:
 - ENVIRONMENT ENCLOSURE ADJACENT TO CHAMBER A, ENVIRONMENT GENERATORS, INSTRUMENTATION, & TEST CONSOLE.
- o DURATION:
 - 42 DAYS INCLUDING SET UP & TEAR DOWN.

RECOMMENDATION:

- o DELETE TEST - RESULTS WOULD BE INCONCLUSIVE.

IMPACT

- o COST SAVINGS:
 - AGE & FACILITIES \cong \$ 150K
 - OPERATION \cong 32K

ROM TOTAL = \$ 182K

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COA MODE SURVEY TEST
(DEVELOPMENT)

*Probably ok, but
if any big problem
can be done as proposed
to complete with competition
Note 8)*
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| ALTERNATIVES | CONSIDERATIONS |
|--|---|
| BASELINE <ul style="list-style-type: none">o MODE SURVEY CONDUCTED ON DMo FREE-FREE SUPPORTS (BUNGEE) | THESE DATA REQUIRED TO VALIDATE/ CORRECT THE COA DYNAMIC MODELING UTILIZED FOR PERFORMANCE AND LOADS PREDICTIONS |
| ALTERNATE 1 <ul style="list-style-type: none">o MODIFY TEST CONFIGURATION BY PROVIDING FIXED SUPPORTS AT THREE MOUNTING POINTS. | <ul style="list-style-type: none">o THE IMPORTANT EFFECTS OF LOCAL FLEXIBILITIES AT LOAD CONCENTRATION POINTS REQUIRES HARD POINT SUPPORTSo FIXED BOUNDARY CONDITIONS MATCH ANALYTICAL MODE PROCEDURES |

RECOMMENDATION:

AN APPROPRIATE TEST FIXTURE SHOULD BE PROVIDED SO THAT THE DESIRED
FIXED BOUNDARY CONDITIONS CAN BE SIMULATED FOR THIS TEST.

IMPACT:

COST APPROX \$20,000 (MAX) FOR FIXTURE. NO PROGRAM SCHEDULE IMPACT.

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DEVELOPMENT TESTING

SPECIFIC AREAS OF INVESTIGATION & SUMMARY RESULTS

3. COMBINATION OF SELECTED DEVELOPMENT TESTS

- o GE & EK THERMAL TESTING
 - SCHEDULING PRECLUDES FURTHER COMBINATION
 - GE REQUIRES MORE EXTENSIVE AND EARLIER DEVELOPMENT THAN EK CAN EFFECTIVELY SUPPORT
 - NO BENEFITS IN REGARD TO INTERFACE SUBSTITUTE SAVING

- o GE & DAC DRV TESTING
 - SCHEDULE PRECLUDES COMBINATION
 - BENEFITS SMALL DUE TO GE CANCELLATION OF REQUEST FOR COMPLEX LAUNCH TUBE SUBSTITUTE

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*I don't understand
this one - need
more explanation,
SSS-342
Talk to P9.20
J. Henry*

LM/GEMINI B ADAPTOR SEPARATION SHOCK DEVELOPMENT TEST

BASELINE

- TEST ARTICLE CONSISTS OF LM FORWARD UNPRESSURIZED COMPARTMENT WITH SEPARATION ZONE OF GEMINI B ADAPTOR
- CONSTITUTES QUALIFICATION OF LM ELECTRICAL COMPONENTS TO SHOCK
- TANKS ARE SIMULATED

*(Text are
beautiful)*

RECOMMENDATION

- INCLUDE GEMINI B ADAPTOR COMPLETE WITH COMPONENTS
- REASON -- TO REDUCE PROGRAM EFFORT THROUGH INTEGRATION OF MAC AND DAC TEST OBJECTIVES

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QUALIFICATION TESTING

DEFINITION

- A TEST TO VERIFY THE MANUFACTURED DESIGN OPERATING UNDER ITS SPECIFIED ENVIRONMENTS WITH A MARGIN

CRITICAL FEATURES

- CONTROL OF TEST SPECIFICATION AND REPORT BY CUSTOMER
- TEST SPECIMEN TRULY REPRESENTATIVE OF PRODUCTION HARDWARE
- SUFFICIENT PRIOR DEVELOPMENT TESTING TO PROMISE SUCCESSFUL QUALIFICATION TESTING

BROAD EVALUATION
QUESTIONS

- EXAMINE CONTROL AND TYPE OF DEVELOPMENT TESTS WHICH ARE SOLE SOURCE OF QUALIFICATION INFORMATION
- ARE SEGMENT OR SYSTEM LEVEL QUALIFICATION TESTS COMPARABLE?
- DO COMPONENT QUALIFICATION TESTS SHOW SUFFICIENT SAFETY MARGIN IN DESIGN?

BASIC EVALUATION
PROBLEM

- ONLY ONE COMPANY AS AN AGREED-UPON DETAIL AF-APPROVED TEST PLAN

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DEVELOPMENT TESTS AS SOURCES OF QUALIFICATION DATA

- GE
- MM STATIC
 - DYNAMIC MM FWD STR (113D)
 - MIRROR AND MOUNTS AND SUPPORT EQUIPMENT -- VIBRATION
 - SUBSYSTEM -- EMC
- DAC
- LV MODE SURVEY
 - LM ACOUSTICS
 - FWD UNPRESSURIZED COMPARTMENT -- VIBRATION
 - LV BENDING MODES
 - GEMINI B -- SEPARATION SHOCK
 - MM/THH -- SEPARATION SHOCK
 - EMC
 - MM DOOR EJECTION
- EK
- COA -- VIBRATION MODE
 - MM AFT SECTION -- ACOUSTIC
 - MM -- ACOUSTIC
 - EQUIPMENT (DYNAMIC) MOTION TEST

NOTE: THESE TESTS PROVIDE DATA UPON WHICH THE COMPONENT QUALIFICATION TEST REQUIREMENTS ARE BASED

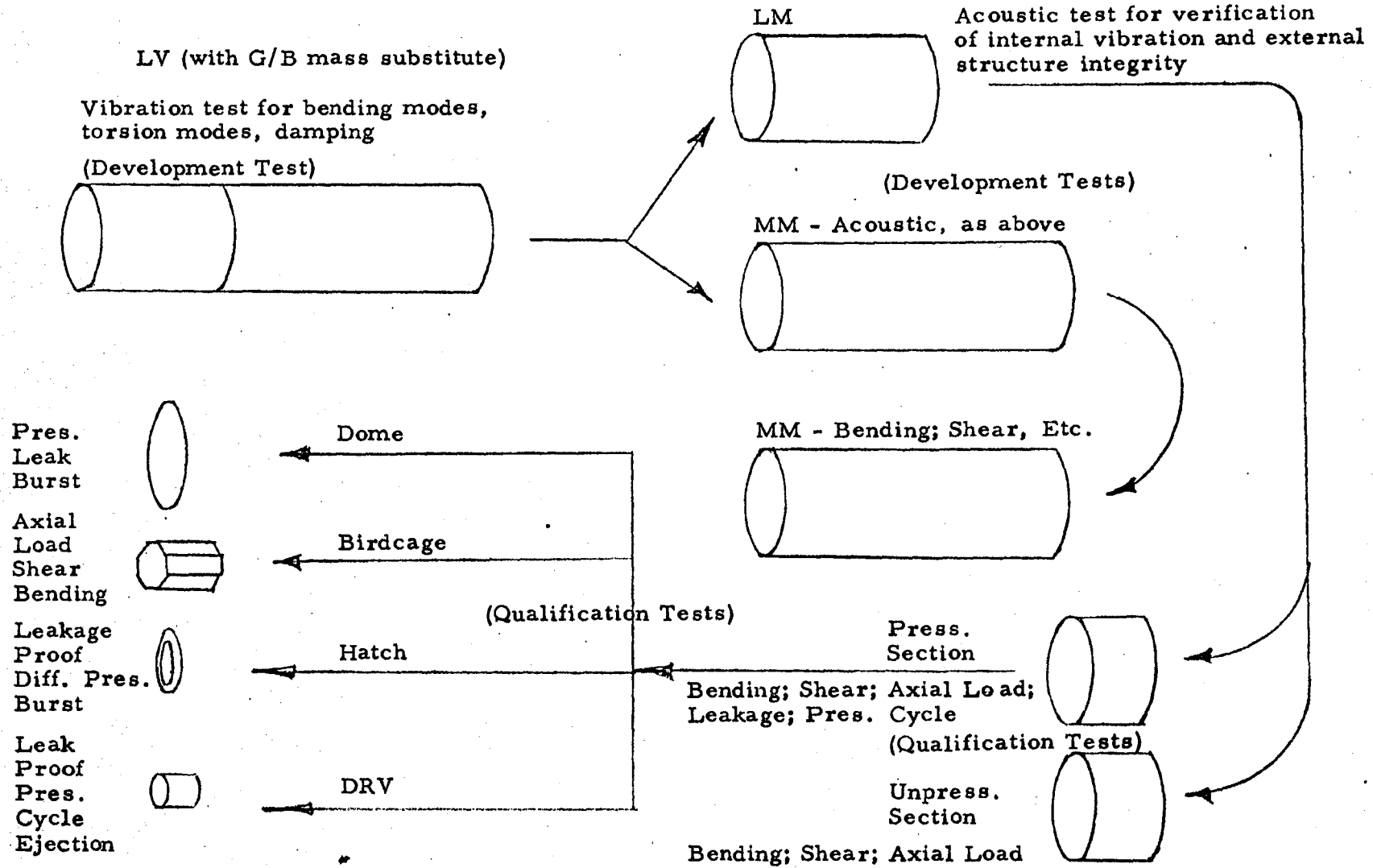
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STRUCTURAL DEVELOPMENT AND QUALIFICATION TEST FLOW

(Note: All structures are production hardware)



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SEGMENT SUB-SYSTEM GROUP LEVEL QUALIFICATION

- DAC
- LMQTV -- 30-DAY TEST IN THERMAL-VACUUM
 - EC/LS -- A COMPLETE SUBSYSTEM UNDER ENVIRONMENT (T/V)
 - ACTS/PROP -- A COMPLETE SECTOR AMBIENT
 - MAJOR STRUCTURAL ELEMENTS OF LM (BIRDCAGE, THERMAL RADIATOR, PRESSURIZED COMPARTMENT, UNPRESSURIZED COMPARTMENT, DRV)
 - EMC ON LV PRESENTLY PLANNED -- FOLLOWED BY EMC ON OV AT VAFB
- GE
- NO SYSTEM LEVEL DUAL CONSOLE AND LM EQUIPMENT TESTS -- THIS VALIDATION IS OBTAINED AS PART OF LM AND MM QUALIFICATION TESTS
 - EMC OF SUB-SYSTEM GROUP
 - TM BAY QUAL (# 115)
- EK
- MM QUAL (60 DAYS) IN THERMAL-VACUUM FOLLOWING 30-DAY T/V OF COA
 - EMC ON LMPE AND EXPERIMENTAL SUPPORT EQUIPMENT

NOTE: ACOUSTIC QUALIFICATION OF LM RECOMMENDED BUT NOT IN PLAN

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KEY AREAS OF INVESTIGATION AND SUMMARY RESULTS

VALIDITY OF PROPOSED QUALIFICATION TESTS AND APPROACHES:

| | <u>DAC</u> | <u>GE</u> | <u>ONF</u> |
|-----------|------------|-----------|------------|
| ACOUSTIC | (1) | (2) | OK |
| STATIC | (3) | OK | OK |
| SHOCK | OK | OK | OK |
| VIBRATION | OK | OK | OK |
| THERMAL | OK | OK | OK |
| EMC | (4) | OK | OK |

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(Note 1)

Continues

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LM FORWARD UNPRESSURIZED COMPARTMENT COMPONENT

VIBRATION QUALIFICATION TEST

NO

BASELINE

- LOW FREQUENCY SINUSOIDAL VIBRATION TEST
- RANDOM VIBRATION APPLIED AT BASE TO PROVIDE SPECIFICATION LEVELS (SAFSL EXHIBIT 10003) AT COMPONENT MOUNTING POINTS

RECOMMENDATION

- REPLACE RANDOM VIBRATION WITH ACOUSTIC EXCITATION
- RETAIN SINUSOIDAL TEST
- REASON -- TO AVOID UNREALISTIC FAILURE MODES; IMPROVES ENVIRONMENTAL SIMULATION BY PROVIDING UNIFORM EXCITATION OVER EXTERNAL SURFACE

- yes
- I still doubt this

In fact as a fall back position from Qual testing the lab vehicle this was meant.

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(Note 2a)

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yes

GE SUBSYSTEM COMPONENT ACOUSTIC QUAL TESTING

BASELINE

- INDIVIDUAL COMPONENT ACOUSTIC QUALIFICATION TESTING PER TEST PLAN
- ACOUSTIC TESTING IS IN ADDITION TO COMPONENT VIBRATION TESTING

RECOMMENDATION

- DELETE INDIVIDUAL COMPONENT ACOUSTIC TESTING AS A GENERAL PRACTICE
- RETAIN COMPONENT ACOUSTIC TESTING ONLY FOR COMPONENTS CONSIDERED SUSCEPTIBLE (DELICATE COMPONENT WITH LIGHT CONSTRUCTION AND LARGE SURFACE AREA)
- REASON -- TO AVOID UNNECESSARY COMPONENT QUALIFICATION TESTING

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(Note 2b)

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yes

TM BAY VIBRATION QUALIFICATION TEST

BASELINE

- SINUSOIDAL VIBRATION TEST ONLY
- RANDOM VIBRATION MAY BE ADDED BASED ON DATA FROM MM ACOUSTIC DEVELOPMENT TEST

RECOMMENDATION

- DELETE TM BAY VIBRATION QUALIFICATION TEST *yes*
- REPLACE WITH TM BAY ACOUSTIC QUALIFICATION TEST AT ROCHESTER *yes*
- REASON -- TO PROVIDE MEANINGFUL CONSISTENT QUALIFICATION TEST PHILOSOPHY

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MISSION MODULE SHELL STRENGTH TEST QUALIFICATION

(Note 3)
555-342
Pg. 29 but still
I go, don't understand how
we get away stopping
at limit load.

Handon

| ALTERNATIVES | CONSIDERATIONS |
|---|---|
| BASELINE: STATIC LOADING TO LIMIT VALUES | <ul style="list-style-type: none">- SHELL SUPPORTED BY SIMULATED THIM/MM INTERFACE STRUCTURE- SUBJECTED TO LIMIT AXIAL, SHEAR, BENDING MOMENT COMBINATIONS- DIFFERENTIAL PRESSURE NEGLECTED |
| ALTERNATE 1: INCLUDE DIFFERENTIAL PRESSURE | <ul style="list-style-type: none">- SHELL EXPECTED TO BE SENSITIVE TO CRUSHING PRESSURE LOADING- OMISSION OF INCREMENTAL PRESSURE EFFECTS IS UNCONSERVATIVE |

RECOMMENDATION: STATIC LOADING OF SHELL STRUCTURE SHOULD BE COMBINED WITH MOST CRITICAL INCREMENTAL PRESSURES ANTICIPATED FROM VENTING STUDIES

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LM/MMFS EMC "PRE-QUAL" TEST AT DAC

(Note 4)
*I am inclined
to agree with this
because of the
rescheduling*
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OPTION

RETAIN BASELINE
TEST

● PRO/O CON

- PROVIDES LM/MMFS EMC TEST SIX MONTHS SOONER
- LM/MMFS MATE AND ACCEPTANCE EXPERIENCE BEFORE FV3
- ONLY THREE WEEKS IN BASELINE FOR MATE/ACCEPTANCE/EMC TEST
- COA NOT PRESENT

ELIMINATE BASELINE
TEST

- PERMITS EARLIER LM QUAL THERMAL/VACUUM TEST
- IMPROVES ACCEPTANCE SCHEDULE
- ENHANCES MMFS FLIGHT OPTION
- LMQTV CURRENTLY PROVIDES LM EMC QUALIFICATION

RECOMMENDATION:

ELIMINATE BASELINE TEST

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QUALIFICATION TESTING -- CONCLUSIONS

not if HM is as a whole,

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DAC

- SAMPLE SIZE OF ONE TOO SMALL
- PRESENT TEST SCHEDULE UNREALISTIC (TOO SHORT) AND DOES NOT MESH WITH DEVELOPMENT TESTS
- NO ACOUSTIC TEST OF LM -- A COSTLY ADDITION ✓
- SPO CONTROLS ARE ADEQUATE
- ENVIRONMENTAL DEVELOPMENT IS ADEQUATE
- AEROSPACE RECOMMENDATIONS ON SPECIFIC TESTS CAN BE INCORPORATED

GE

- SAMPLE SIZE ADEQUATE (*lowly but probably somewhat plus relative to DAC*)
- DEVELOPMENT TESTS FOR PREPARATION ADEQUATE
- SCHEDULE TIGHT
- SPO CONTROLS ADEQUATE
- AEROSPACE RECOMMENDATIONS ON SPECIFIC TESTS CAN BE INCORPORATED

EK

- COMPONENT PLANS ARE NOT DOCUMENTED
- 60-DAY MM QUALIFICATION UNREALISTIC
- INSUFFICIENT PREPARATION IN DEVELOPMENT BEFORE COMMITMENT TO QUALIFICATION
- CONTROLS UNDEFINED

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p9.32

QUALIFICATION TESTS -- RECOMMENDATIONS

1. ACOUSTIC QUALIFICATION -- UNDER STUDY -- AWAITING HARD DOLLAR ESTIMATE FROM DAC. A DESIRABLE TEST.
2. EMC TEST OF LV AT DAC PRIOR TO LMOTV T/V TEST IS TIME CONSUMING AND COULD BE ELIMINATED. IMPORTANT TEST IS ONE AT VAFB.
3. AMEND PRESENT DAC GROUND TEST PLAN WITH SUGGESTIONS FROM DISCIPLINE EXPERTS.
4. AMEND GE PLAN SIMILARLY BEFORE AGREEMENT.
5. EXPLORE EK PLAN -- MAINTAIN QUALIFICATION T/V TEST OF COA AT 30 DAYS AND DESIGNATE REMAINDER AS MM RELIABILITY TEST, OR CONSIDER REDUCTION.
6. DELETE ACROSS-THE-BOARD ACOUSTIC TESTS FOR COMPONENTS AT GE.
7. IN ALL CASES, MAKE CERTAIN THAT QUALIFICATION LEVELS, PARTICULARLY IN VIBRATION AND TEMPERATURE, PROVIDE A SUFFICIENT MARGIN OF SAFETY.
8. INCREASE THE SAMPLE SIZE OF CRITICAL COMPONENTS SUBMITTED TO QUALIFICATION TESTING BY DAC.

*still yes
back up
unprocessed
reducer*

?

} ?

yes

yes

no

*no if 1 is
accepted*

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LM CRITICAL COMPONENTS -- SAMPLE SIZE BREAKDOWN

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p9.33

| <u>EC/LS</u> | <u>WAS</u> | <u>IS</u> |
|--|------------|-----------|
| TEMPERATURE CONTROL VALVE | 2 | 1 |
| WATER PUMP PACKAGE | 1 | 1 |
| VALVE, MOLECULAR SIEVE | 1 | 1 |
| CONTROLLER, 2 GAS | 1 | 1 |
| PPO ₂ - PRESS. TRANSDUCER | 1 | 1 |
| FAN, CABIN | 1 | 1 |
| TIMER, MOLECULAR SIEVE | 1 | 1 |
| VALVE, CABIN DUMP & RELIEF | 2 | 1 |
| O ₂ ACCUMULATOR | 2 | 1 |
| TANK - H ₂ - O ₂ | 2 | 1 |
| TANK - He | 1 | 1 |
| <u>ELEC. POWER</u> | | |
| FUEL CELL PURGE TIMER | 1 | 1 |
| INVERTER, ELEC. LAB | 1 | 1 |
| <u>DATA MGT</u> | | |
| COMPUTER CONTROLLER | 2 | 1 |
| COMPUTER | 1 | 1 |
| CENTRAL PCM ASSY. | 2 | 1 |
| COMMAND LOGIC UNIT | 2 | 1 |

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LM CRITICAL COMPONENTS -- SAMPLE SIZE BREAKDOWN

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p9 34

| <u>INSTR. DISPLAY</u> | <u>WAS</u> | <u>IS</u> |
|----------------------------------|------------|-----------|
| MONITOR & ALARM ASSEMBLY | 2 | 1 |
| <u>ACTS/SCE</u> | | |
| INTERFACE & DISPLAY | 1 | 1 |
| HORIZON SENSOR | 1 | 1 |
| ATTITUDE GYRO ASSEMBLY | 1 | 1 |
| INVERTER | 1 | 1 |
| <u>ACTS/PROPULSION</u> | | |
| TANK ASSEMBLY, He | 2 | 1 |
| RELIEF VALVE, LO-He | 1 | 1 |
| PLENUM ASSEMBLY, LO, He | 2 | 1 |
| <u>FLIGHT CREW EQUIPMENT</u> | | |
| BIOLOGICAL DOSIMETER MON. | 2 | 1 |

NOTE: RECOMMEND STUDY OF ADDITIONAL TEST SPECIMENS ON GROUND RULE OF TWO OR MORE FOR CRITICAL COMPONENTS.

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POSSIBLE DAC COMPONENT QUALIFICATION TEST IMPROVEMENTS

- INCREASE SAMPLE SIZE OF CRITICAL COMPONENTS FROM 1 TO 2
 - a. INVOLVES 32 COMPONENTS AS PRESENTLY DEFINED
 - b. MORE DIFFICULT TO "TAILOR-MAKE" 2 UNITS TO PASS QUAL.
 - c. GREATER CONFIDENCE NEEDED BECAUSE OF MISSION EFFECT OF FAILURE.

- IMPLEMENT THE EFFECTIVENESS (RELIABILITY) TEST PLAN
 - a. PLAN IS TO BE SUBMITTED UNDER SAFSL-21013 BUT NOT IMPLEMENTED.
 - b. AIMED AT NEW, UNFLOWN, CRITICAL COMPONENTS.
 - c. PLAN TO EXPLORE SAFETY MARGIN IN DESIGN--BOTH IN PARAMETRIC LEVEL AND OPERATING TIME.
 - d. CAN BE IMPLEMENTED AS FOLLOW-ON TO PRESENT QUAL PROGRAM.
 - e. BRIDGES THE GAP OF KNOWLEDGE BETWEEN FLOWN, MATURE COMPONENTS AND NEW, UNTRIED COMPONENTS.

NOTE: THESE ADDITIONS MAY BE COSTLY AND ARE CURRENTLY OUT-OF-SCOPE.

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ACCEPTANCE TESTING

VALIDITY OF PROPOSED ACCEPTANCE TESTS

| | <u>DAC</u> | <u>GE</u> | <u>EK</u> |
|---------------------|------------|-----------|-----------|
| THERMAL/VACUUM | (1) | OK | OK |
| STRUCTURAL DYNAMIC | (2) | (3) | (4) |
| OPTICAL PERFORMANCE | -- | -- | (5) |
| AMBIENT PERFORMANCE | (6) | (7) | OK |
| EMC | OK | OK | (7) |

NOTE (5): ELAPSED TIME FOR EK OPTICAL TESTS APPEARS EXCESSIVE

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LV THERMAL VACUUM TESTING AT DAC

(● PRO/O CON)

(Note 1)
This one really bothers
me - Post history has
proved this to be valuable
yet NASA (apollo limit
doing it)

555-342
P 9 37

| ALTERNATIVES | CONSIDERATIONS |
|------------------------------|--|
| LAB VEHICLE THERMAL/VAC TEST | <ul style="list-style-type: none"> ● POSSIBLE HIGHER CONFIDENCE IN THERMAL INTERFACE ○ POSSIBLE CONTAMINATION ○ HANDLING PROBLEMS ○ SCHEDULE DELAY DUE TO FINDING LM PROBLEMS IN LV CONFIGURATION |
| LM THERMAL/VAC TEST | <ul style="list-style-type: none"> ● SAVES 280 HOURS OF MM REDUNDANT TESTING ● AVOIDS POSSIBLE MM CONTAMINATION ● AVOIDS HANDLING PROBLEMS ● FINDS PROBLEMS IN SIMPLER CONFIGURATION ○ 5-WEEK LAUNCH SLIP UNLESS DELETE PRE-QUAL EMC AND IMPROVE ECLS TEST SCHEDULE |

any

RECOMMENDATION: T/V TEST LM INSTEAD OF LV, REVISE TEST FLOW TO ALLEVIATE SCHEDULE PROBLEM

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important on DAC schedule

D ~~SECRET~~ SPECIAL HANDLING

PROBLEMS IN DAC SPACE SIMULATION LAB

(Note 1a)
Two points
1.) DAC is on contract to
do this
2.) This oil diffusion
problem of real
will damage
the scopes
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p 9 38

- o I/R ARRAY AND LN₂ PANELS MUST BE REMOVED FOR LV INSTALLATION AND SECTIONS REASSEMBLED AROUND LV. LV DAMAGE RISK, MULTIPLE CONNECTIONS INVOLVED.
- o INSTALLATION OF SPOOL PIECES AND CHAMBER LID INVOLVES RISK OF DAMAGE TO LV BECAUSE OF EXISTING FACILITY HEIGHT LIMITATION.
- o INSTALLATION OF LV IN CHAMBER INVOLVES USE OF TWO BRIDGE CRANES FOR TILT CAPABILITY. LV DAMAGE RISK INCURRED.
- o EXISTING FACILITY HEIGHT PRECLUDES USE OF THERMAL SUBSTITUTES.
- o EXISTING FACILITY AIRLOCK MUST BE REMOVED TO PROVIDE LV HANDLING SPACE. CHAMBER CONTAMINATION RISK INCURRED.
- o EXISTING FACILITY SPACE LIMITATIONS REQUIRE THAT SPOOL PIECES, CHAMBER LID, I/R ARRAY, LN₂ PANELS BE STORED OUTSIDE DURING LV INSTALLATION. CONTAMINATION PROBLEM INCURRED.
- o OIL DIFFUSION PUMPING RESULTS IN LOW PROBABILITY OF OIL CONTAMINATION OF LV DURING ACCEPTANCE TESTING. TEST PROGRAM NEEDED TO ASSESS CONTAMINATION ON LEVELS IN DAC CHAMBER.
- o TEST VEHICLE AND/OR SUPPORT EQUIPMENT OUTGASSING HAS HIGH PROBABILITY OF CONTAMINATING CRITICAL SURFACES.

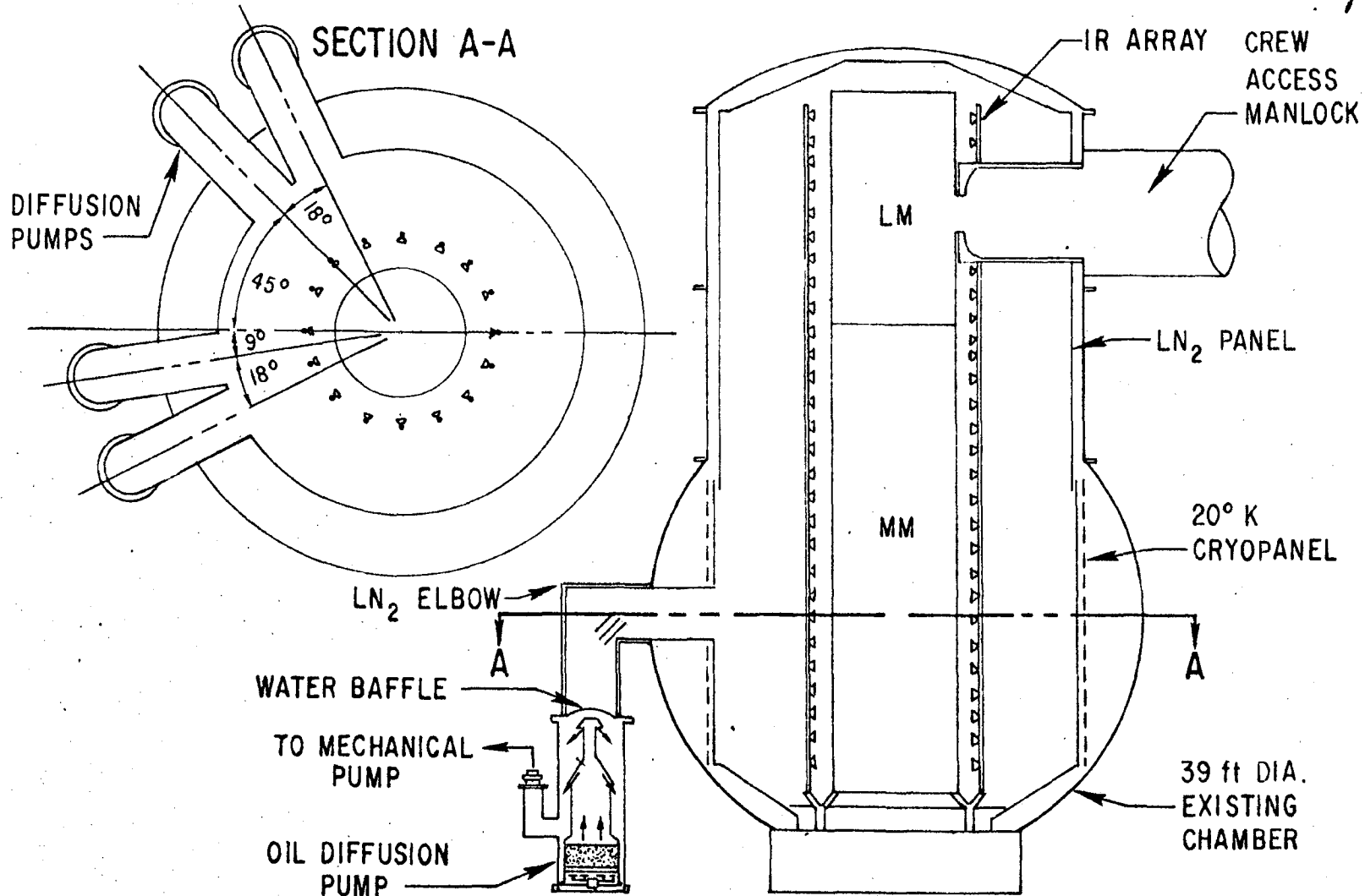
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LABORATORY VEHICLE T/V TEST - DOUGLAS

(Note 1b)
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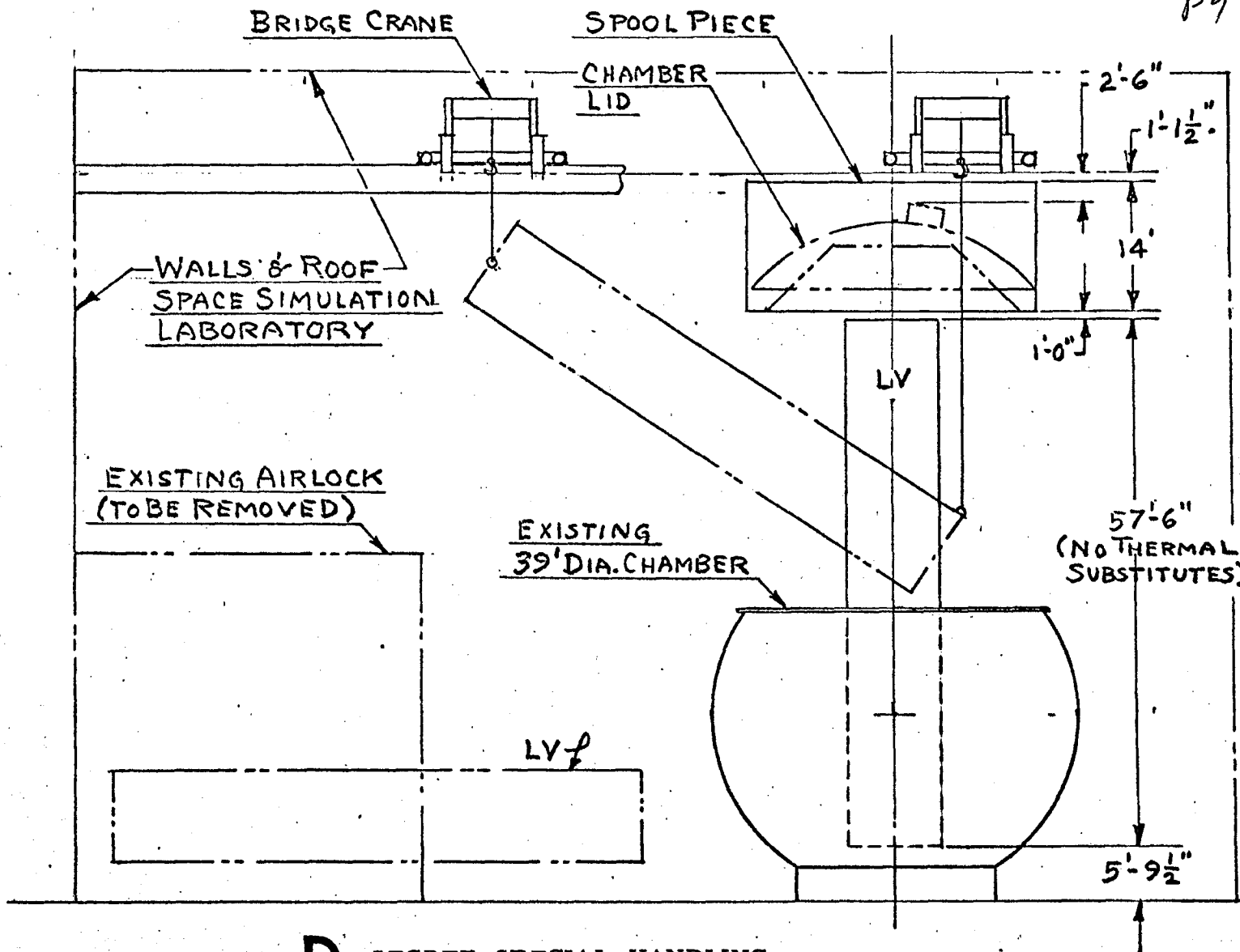
AEROSPACE CORPORATION 

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LV INSTALLATION IN DAC T/V CHAMBER

(Note 1c)

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MMFS MODE VERIFICATION TEST
ACCEPTANCE

(Note 3)
*I am still unconvinced
also worried about damage
to bearings*
555-342
Pg 41

| ALTERNATIVES | CONSIDERATIONS |
|--|--|
| 1. NO ACCEPTANCE MODAL VERIFICATION IS PRESENTLY PLANNED IN BASELINE | <ul style="list-style-type: none">o A STATIC DEFLECTION MEASUREMENT IS TO BE PERFORMED ON THE SPIDER STRUCTURE ONLY |
| 2. PERFORM A MMFS MODE VERIFICATION MEASUREMENT ON EACH ASSEMBLY AS A PART OF ACCEPTANCE PROCEDURE | <ul style="list-style-type: none">o TM DYNAMIC CHARACTERISTICS ARE ONE OF MOST CRITICAL STRUCTURAL CONSIDERATIONSo MODE MEASUREMENTS OF MMFS ASSEMBLY IS BEST METHOD OF VERIFICATIONo FIXTURE REQUIRED FOR HARD SUPPORT AT MMFS/LM INTERFACE STATION |

RECOMMENDATION:

A MODE VERIFICATION TEST OF THE MMFS BE INCORPORATED INTO THE GE ACCEPTANCE TEST PROGRAM.

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COA MODE SURVEY TEST
(ACCEPTANCE)

(Note 4b) 555-342
P1 42
*not convinced
all ready on
qualification*

| ALTERNATIVES | CONSIDERATIONS |
|---|---|
| BASELINE MODE SURVEY OF COA NOT PLANNED ON EACH ARTICLE | |
| ALTERNATIVE CONDUCT MODE SURVEY SIMILAR TO DM TEST | <ul style="list-style-type: none">o THE RESULTS WILL VERIFY THAT DYNAMIC PROPERTIES OF COA ARE AS PREDICTEDo WILL PROVIDE MINIMUM SHAKE-OUT OF WORKMANSHIP |

RECOMMENDATION:

A MODE SURVEY TEST SHOULD BE CONDUCTED ON EACH FLIGHT ARTICLE. THIS TEST SHOULD UTILIZE HARD-POINT SUPPORT FIXTURE AS DESCRIBED FOR DM TEST

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ORBITAL VEHICLE MODAL SURVEY
ACCEPTANCE (VEHICLES 3 & 6)

I doubt the value of this but if low level acceptance test is needed then the additional time to do this will be small.

| ALTERNATIVES | CONSIDERATIONS |
|--|---|
| BASELINE - CONDUCT TEST ON VEHICLES 3 & 6 | <ul style="list-style-type: none">o VERIFY THAT LOW FREQUENCY OV MODAL CHARACTERISTICS ARE NOT SIGNIFICANTLY DIFFERENT FROM STV TO CAUSE SERIOUS PERFORMANCE DEGRADATIONo OV SUSPENDED VERTICALLY BY BUNGEE WITH DOOR CLOSED |
| ALTERNATE 1 CONDUCT TEST WITH DOOR OPEN | <ul style="list-style-type: none">o DESIRED OV CONFIGURATION REQUIRES DOOR OPEN |
| ALTERNATE 2 DELETE TEST | <ul style="list-style-type: none">o IF ANALYTICAL STUDIES PREDICT ACCEPTABLE MARGIN OF DYNAMIC PERFORMANCEo IF STV TEST VERIFIES PREDICTED MODES |

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RECOMMENDATION:

- o ALTERNATE 1 - PERFORM TEST WITH DOOR OPEN
- o RE-EVALUATE NEED WHEN STV TEST RESULTS AND DYNAMIC PERFORMANCE PREDICTIONS ARE COMPLETED/MINORITY SAY "DELETE NOW"

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LV
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OPERATIONAL DYNAMICS TEST
ACCEPTANCE

(Note #a)
*I have never believed in
this as an acceptance test.*
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Pg 44

| ALTERNATIVES | CONSIDERATIONS |
|---|---|
| <p>1. BASELINE ACCEPTANCE TEST</p> <ul style="list-style-type: none">o MM WITH SIMULATED LM SUSPENDED IN VACUUM CHAMBERo TM IN LAUNCH LOCKSo PM ON AIRBAG | <ul style="list-style-type: none">o FEASIBILITY OF BASELINE TEST AS A PERFORMANCE MEASUREMENT UNCERTAINo RESULTS OF ANALYTICAL STUDIES WILL AID IN DETERMINING VALUE OF TEST |
| <p>2. RETAIN TEST ON A DEVELOPMENT BASIS</p> | <ul style="list-style-type: none">o PROVIDES A MEANS TO EVALUATE TEST FROM A PHYSICAL AND PRACTICAL STANDPOINTo PROVIDES DATA FOR CHECK OF ANALYTICAL MODELING |

RECOMMENDATION:

- o RETAIN TEST ON A DEVELOPMENT BASIS
- o RE-EVALUATE TEST AS AN ACCEPTANCE PROCEDURE WHEN RESULTS OF SUPPORTING ANALYTICAL STUDIES ARE AVAILABLE

minor fix

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(NOTE 6 a)

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AK

LM/MM FUNCTIONAL TESTING AT DAC

APPROACH

(● PRO/O CON)

CHECK OUT DAC LM AVE ALONE
BEFORE MATING WITH GE LM AVE
(CHANGE)

- INCREASED ASSURANCE OF COMPATIBILITY
- REQUIRES ADDITIONAL SUBSTITUTE AND SOFTWARE
- ADDS 6 DAYS, 96 HOURS TO SCHEDULE WITH ADDED AVE COMPLEXITY
- SYSTEMS ARE CHECKED INDIVIDUALLY BEFORE INSTALLATION

NOT RECOMMENDED

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(Note 6b)

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P746

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—

LM/MM FUNCTIONAL TESTING AT DAC

APPROACH

(PRO/O CON)

CHECK OUT LM BEFORE
MATING WITH MM
(BASELINE)

- INSIGNIFICANT HARDWARE ACCESSIBILITY
IMPROVEMENT
- REQUIRES 8 DAYS, 128 OPERATING HOURS
- LM/MM INTERFACE TESTED PREVIOUSLY
- NECESSARY BEFORE LM THERMAL/VACUUM
TEST

RECOMMENDED

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(NOTE 6 c)

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2 copies

LM/MM FUNCTIONAL TESTING AT DAC

APPROACH

(PRO/O CON)

CHECK OUT MM AT DAC
BEFORE MATING WITH LM
(BASELINE)

- O DUPLICATES PREVIOUS TESTS AT GE & EK
- O LM/MM INTERFACE TESTED PREVIOUSLY
- O REQUIRES SUBSTITUTE CAPABILITY NOT IN GE BASELINE (\$200-500K)
- O SIGNIFICANT FACILITY IMPACT (VERTICAL TESTS)

NOT RECOMMENDED: ABSORB IN PART IN LV TEST

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*A am against
- this
SSS-342
P 7 48
ok*

DAC/GE AGE INTERRELATION

(Note 6d)

APPROACH

(● PRO/O CON)

INDEPENDENT FUNCTIONAL TEST
CAPABILITY FOR MPSS, AFTER
MATING MM TO LM

- CAPABILITY FOR INDEPENDENT OPERATION (BYPASSING DAC TELEMETRY AND COMPUTER, OPTIONAL BYPASS OF DAC POWER) IS DESIGNED AND COSTED IN GE HARDWARE/SOFTWARE
- USE OF THIS CAPABILITY FOR ABNORMAL (DAC AVE OR AGE DISABLED) TROUBLE-SHOOTING WOULD PROVIDE VALUABLE OPERATING FLEXIBILITY.
- PLANNED, NORMAL INDEPENDENT OPERATIONS AFTER GE AND DAC AVE HAS BEEN INTER-CONNECTED WOULD PROVIDE NO ADVANTAGE & WOULD REQUIRE MORE TEST TIME.
- SLIGHT MODIFICATION TO NORMAL LV TEST CONFIGURATION REQUIRED.

RECOMMENDATION:

CONSIDER BACKUP UTILIZATION OF CAPABILITY PRIOR TO START OF LV CHECKOUT AND FOR TROUBLESHOOTING.

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(Note 6 e)

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APPROACH

BASELINE - FLIGHT CAMERA ARRIVES
WITH MM.

PERFORM LM CHECKOUT WITH REAL
RATHER THAN DUMMY CAMERA
(CHANGE)

RECOMMENDATION:

SHIP FLIGHT CAMERA WITH OTHER
EK LM/MP EQUIPMENT FOR INSTALLA-
TION DURING LM ASSEMBLY.

(● PRO/O CON)

- PERMITS USE OF FLIGHT CAMERA FOR MM ACCEPTANCE TESTING
- REQUIRES USE OF DUMMY CAMERA FOR LM CHECKOUT
- ESTABLISHED INTERFACE NOT BROKEN
- PERMITS COMPLETE LM-MPE TEST BEFORE INSTALLATION
- REQUIRES USE OF NON-FLIGHT CAMERA FOR MM TESTING
- MINIMIZE MAJOR INSTALLATION TASK AFTER LM IS CHECKED OUT

. D

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(Note 7)

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MISSION MODULE TESTING

APPROACH

(O PRO/O CON)

SEPARATE COMPATIBILITY AND
PERFORMANCE TESTS AT GE,
BEFORE & AFTER INSTALLING
TM SIMULATOR
(BASELINE)

GE AMBIENT BASELINE REPEATED
FOR FINAL DEMONSTRATION
(BASELINE)

EMC TESTS AT EK DO NOT PROVIDE
DATA FOR GE
(BASELINE)

- o PROMOTES INDIVIDUAL TEST REPETITIONS
- o INSIGNIFICANT ACCESSIBILITY PROBLEM *yes*
- RECOMMEND COMBINING THE TESTS

- o REPEATS IMMEDIATELY PRIOR TEST
- o HARDWARE IS MOVED IN INTERIM *Post and acceptance yes*
- RECOMMEND ACCOMPLISH JUST ONCE

- o GE GETS NO DATA ALTHOUGH THEIR
EQUIPMENT OPERATES AS PART OF
EK TEST *yes*

RECOMMEND JOINT EK/GE TEST /

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DETAIL REPETITIVE TESTING

- PROVIDE BACKUP INDEPENDENT GE TEST CAPABILITY AT DAC *no*
- CONDUCT JOINT EK/GE MM EMC TEST *yes*
- PERFORM MM C/O AT DAC AFTER LV MATE, INTEGRATE MPSS AND LV TESTS *yes*
- PROVIDE FLIGHT CAMERA INSTEAD OF DUMMY FOR LM CHECKOUT AND LM-MPE CONSOLES TEST (DAC) *yes*
- REVIEW TIMES ALLOCATED FOR OPTICAL TESTS
- COMBINE GE COMPATIBILITY AND PERFORMANCE TESTS *yes*
- ACCOMPLISH GE FINAL BASELINE JUST ONCE *I still don't understand*

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SCHEDULE PROBLEMS

OVERLAP OF QUALIFICATION AND ACCEPTANCE

EXCHANGE HARDWARE DELIVERIES

LM THERMAL/VACUUM ACCEPTANCE

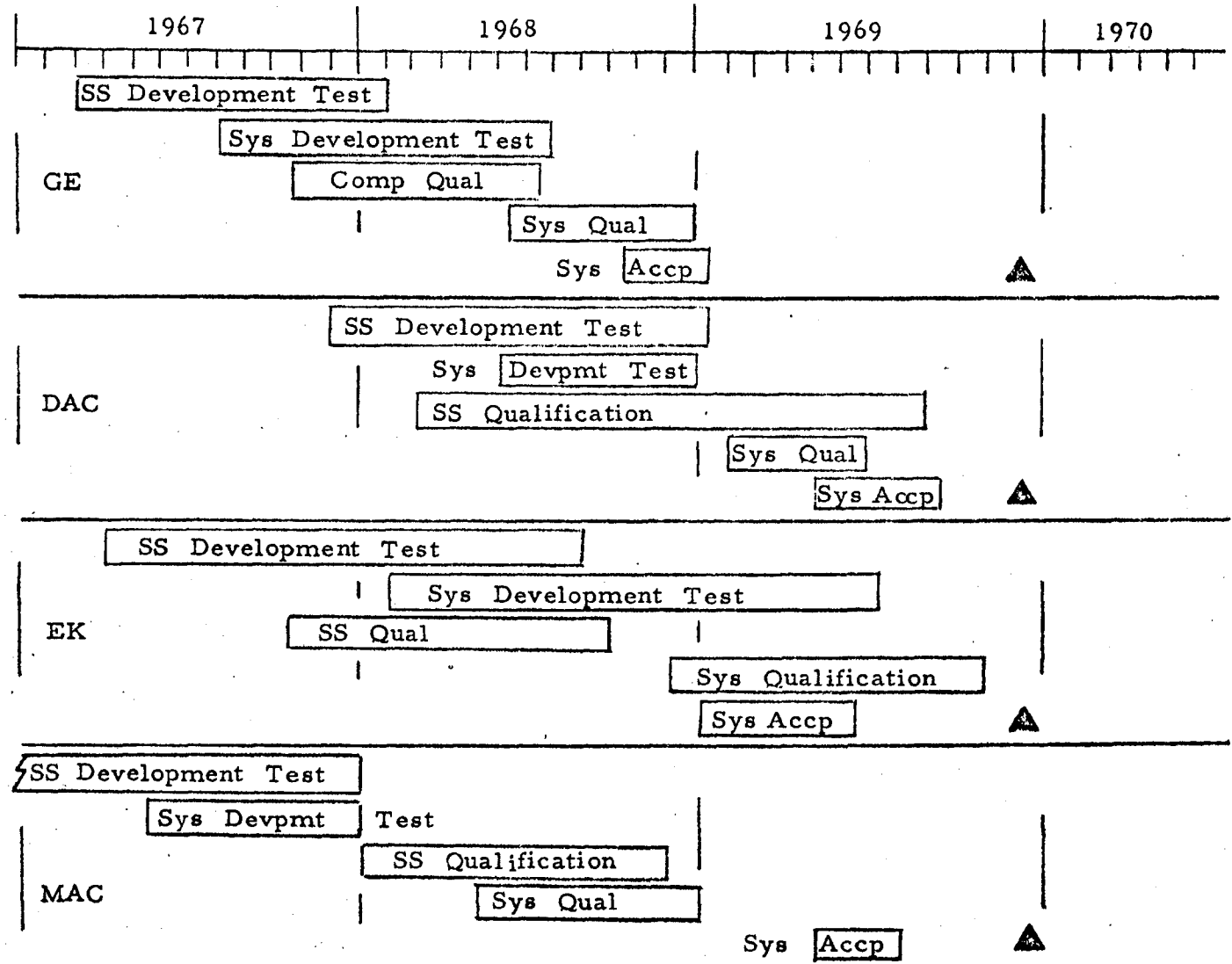
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QUALIFICATION-ACCEPTANCE OVERLAP



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DELIVERY OF EK CONSOLE COMPONENTS

(ARRIVAL DATES)

EK TO GE

GE TO DAC

EK TO DAC

| FOR LMQTV | | FOR FV3 | |
|-----------|-------------|-----------|-------------|
| REQ'D | EK RESPONSE | REQ'D | EK RESPONSE |
| 22 JUL 68 | 22 DEC 68 | 1 DEC 68 | 14 JAN 69 |
| 1 SEP 68 | ---- | 7 JAN 69 | ---- |
| 1 SEP 68 | 22 DEC 68 | 14 JAN 69 | 14 JAN 69 |

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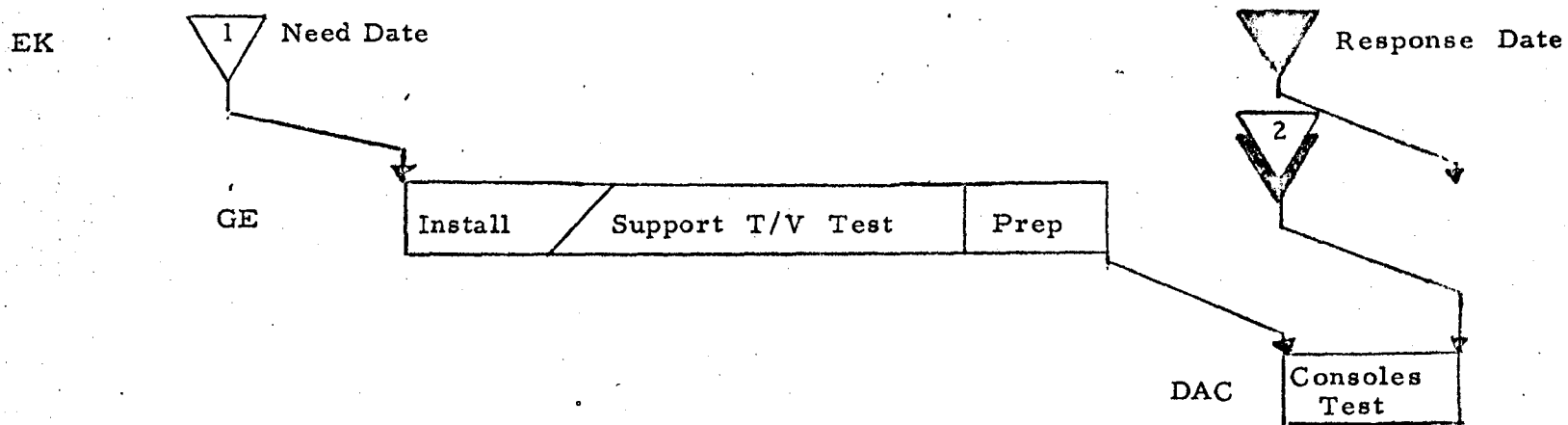
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EK CONSOLE COMPONENTS FLOW

FLIGHT VEHICLE 3



Nov 26 1968 Dec 3 Dec 10 Dec 17 Dec 24 Dec 31 Jan 7 1969 Jan 14

1 EK TO GE: CAMERA ELECTRONICS, BAYS 2-8 CONTROLS

2 EK TO DAC: VISUAL OPTICS, FILM CHUTE, PROCESSOR (CAMERA)

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LMQTV WORK-AROUND APPROACH

BYPASS GE FOR ALL EK CONSOLE COMPONENTS (LMQTV ONLY)

VISUAL OPTICS ASSEMBLY
CABLES, HARNESS
FILM PROCESSOR (DESIRABLE)
FILM CHUTE (DESIRABLE)

DELIVER TO DAC BY 1 SEPTEMBER 1968, INSTALL
BEFORE BIRDCAGE IS INSERTED IN LM

CAMERA ELECTRONICS
BAYS 2 AND 8 CONTROLS
CAMERA

DELIVER TO DAC BY 22 DECEMBER 1968 FOR
INDIVIDUAL INSTALLATION THROUGH CONSOLE
FRONTS

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ACCEPTANCE ALTERNATIVES

COMPLETE BAYS 2-8 AT GE PER
PRESENT BASELINE

- PERMITS COMPLETE BAYS 2-8/MMFS TEST AT GE
- GE RESPONSIBLE ASSEMBLY PERFORMED AT GE
- SIX WEEKS (LAUNCH SLIP OR EK ADVANCEMENT)

COMPLETE BAYS 2-8 AT GE
AFTER T/V TEST

- PERMITS BRIEF BAYS 2-8/MMFS TEST AT GE
- GE RESPONSIBLE ASSEMBLY PERFORMED AT GE
- THREE WEEKS (LAUNCH SLIP OR EK ADVANCEMENT)

COMPLETE BAYS 2-8 AT DAC
BEFORE LM ASSEMBLY

- NO BAYS 2-8/MMFS ACCEPTANCE TEST AT GE
- BRIEF BAYS 2-8 TEST AT DAC
- GE RESPONSIBLE ASSEMBLY PERFORMED AT DAC
- TWO WEEKS (LAUNCH SLIP OR EK ADVANCEMENT)

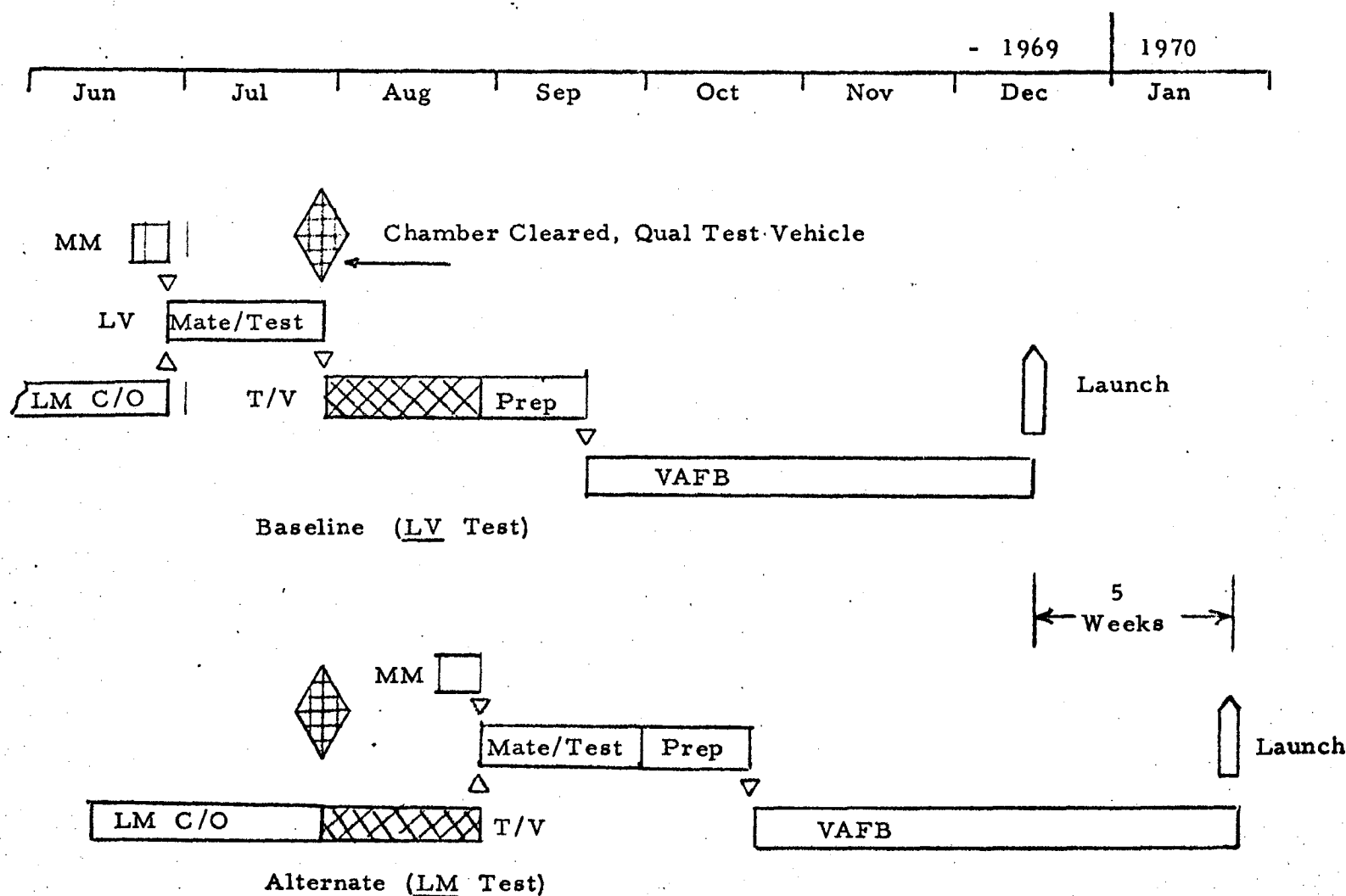
RECOMMENDATION: OPTION 1

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DAC THERMAL TEST SCHEDULE PROBLEM



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DAC SPACE CHAMBER USAGE

| 1968 | | | | | | 1969 | | | | | | | |
|------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |

EC & LS
Development



EC & LS
Qual

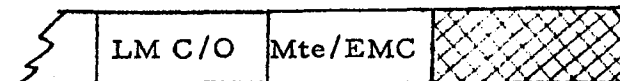


Ship Date

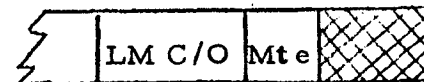


Need Date / LM

LMQTV



Flight Vehicle #3



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ACCEPTANCE TEST RECOMMENDATIONS

OK
penetration

o RETAIN PRESENT MODULAR ACCEPTANCE APPROACH, REDUCING MMFS OPERATING TIME BY CONDUCTING LM THERMAL/VACUUM TEST INSTEAD OF LV TEST

o IMPROVE STRUCTURAL DYNAMIC ACCEPTANCE TESTING BY:

- ADDING MM MODE VERIFICATION TESTS *no*
- REVIEWING MM OPERATIONAL DYNAMICS TEST AFTER THOROUGH ANALYSIS OF TEST CONSTRAINTS *no*
- REVIEWING LV MODAL SURVEY AFTER FURTHER DYNAMIC ANALYSIS

Retain only if easy to perform at 3

o IMPROVE REPETITIVE TESTING OPERATIONS BY:

- PROVIDING BACKUP INDEPENDENT GE TEST CAPABILITY AT DAC *no*
- CONDUCTING JOINT EK/GE MM EMC TEST *yes*
- PERFORMING MM CHECKOUT AT DAC AFTER LV MATE, INTEGRATING MPSS AND LV TESTS *yes*
- PROVIDING FLIGHT CAMERA INSTEAD OF DUMMY FOR LM CHECKOUT AND LM-MPE PRE-INSTALLATION TEST *yes*
- REVIEWING TIMES ALLOCATED FOR EK OPTICAL TESTS
- COMBINING GE COMPATIBILITY AND PERFORMANCE TESTS *(R)*
- ACCOMPLISHING GE FINAL BASELINE JUST ONCE *(R)*

o ALLEVIATE SCHEDULE PROBLEM BY:

- ADVANCING EK LM COMPONENTS DELIVERIES *yes*
- ELIMINATING LMQTV EMC TEST TO ADVANCE THERMAL/VACUUM TEST *I don not need*

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ACOUSTIC AND VIBRATION TESTING

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TEST OBJECTIVES

- o DEVELOPMENT TESTING
 - ENGINEERING TEST TO PROVIDE COMPONENT ENVIRONMENTAL DESIGN AND QUALIFICATION TEST DATA, AND TO VERIFY STRUCTURAL DESIGN MARGIN
- o QUALIFICATION TESTING
 - PROVE DESIGN IS ADEQUATE FOR EXPECTED ENVIRONMENT WITH MARGIN
- o ACCEPTANCE TESTING
 - PROVE PARTICULAR ARTICLE IS FREE OF WORKMANSHIP DEFECTS, PERFORMS TO SPECIFICATIONS AND READY FOR FLIGHT

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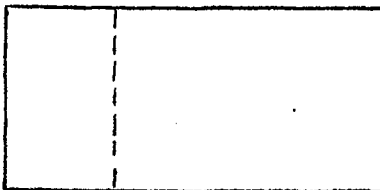
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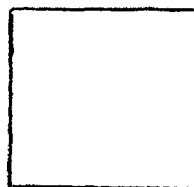
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SEGMENT FLOW

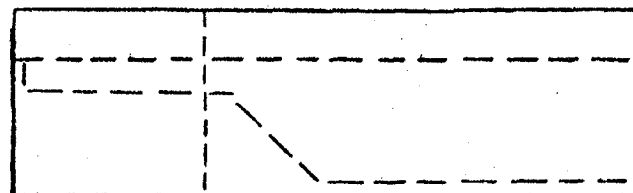
LM
SEGMENT



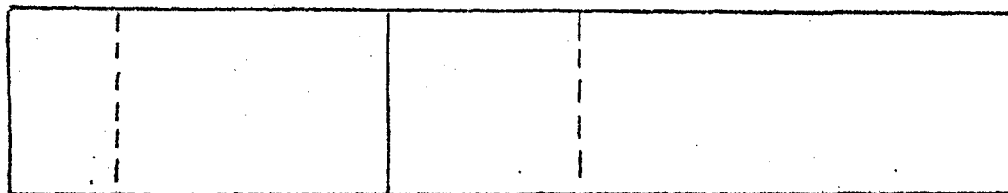
MM - FWD
TM BAY



MM SEGMENT
MM = TM BAY + COA BAY



LV
SYSTEM



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PRESENT MOL DYNAMICS TEST PROGRAM (NOVEMBER 1966)

| TEST PHASE | System LV = LM + MM | System Segments | | | Components** | | |
|---------------|------------------------|-----------------|--------------------------|----------|--------------|-------------------------|-----------|
| | | LM | TM Bay* | COA Bay* | LM | TM Bay | COA Bay |
| DEVELOPMENT | | Acoustic | Acoustic Modal Survey | | | | |
| QUALIFICATION | | | Vibration | Acoustic | Vibration | Vibration & Acoustic | Vibration |
| ACCEPTANCE | | | Vibration | Acoustic | Vibration | Vibration & Acoustic | Vibration |

*MM = TM Bay + COA Bay

**Acoustic testing will be performed on limited and fragile components as defined by analysis from the development and qual test program

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PROPOSED SYSTEM-SEGMENT ACOUSTIC TESTS

| TEST PHASE | System LV = LM + MM | System Segments | |
|---------------|---|---------------------|----------|
| | | LM | MM* |
| | | | TM Bay |
| DEVELOPMENT | | Acoustic | Acoustic |
| QUALIFICATION | | Acoustic | Acoustic |
| ACCEPTANCE | Local Excitation at Interface Hard Points | Acoustic | Acoustic |

*Hamilton
SM*

*MM = TM Bay + COA Bay

*I don't think
this is necessary
unless you go to flight levels*

*maybe the way to
go with Hamilton
Facility*

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ACOUSTIC FACILITY COSTS - SEGMENT TESTING

| <u>EK</u> | | <u>DAC</u> | | <u>WYLE</u> | |
|-----------------------------------|------------|-----------------------------|--------------|------------------------------------|------------|
| <u>NEW (MM)</u> | | <u>MODS (LM ONLY)</u> | | <u>MODS (LM & MM-DEV ONLY)</u> | |
| CHAMBER | .40 | NEW BUILDING | .40 | EXCAVATE CHAMBER | .08 |
| 8 HORNS {2-MKVII } {6-EPT-200} | .20 | 3 HORNS (EPT-200) | .06 | 6 HORNS (EPT-200) | .13 |
| MODEL TEST PROGRAM | .04 | SHROUD | .05 | MODEL TEST PROGRAM | .04 |
| AIR SUPPLY SYSTEM | .66 | INSTRUMENTATION | .25 | AIR SUPPLY SYSTEM | .18 |
| CONTROL ROOM & INSTR. | .36 | ENGINEERING | .23 | MECHANICAL AGE | .12 |
| ASSY & PREP AREA | .15 | AIR SUPPLY | .01 | ENGINEERING | <u>.54</u> |
| MECHANICAL AGE | .23 | | \$1.00 M | | |
| ENGINEERING | <u>.42</u> | <u>ADDITIONAL MODS (MM)</u> | | | |
| | | 3 HORNS (EPT-200) | .06 | | |
| | | COMPRESSOR | .22 | | |
| | | LINES | .01 | | |
| | | ENGINEERING | <u>.09</u> | | |
| | | | <u>.38 M</u> | | |
| GRAND TOTAL | \$2.5 M | GRAND TOTAL | \$1.38 M | GRAND TOTAL | \$1.00 M |

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D

PROPOSED MM ACOUSTIC TEST SCHEDULING

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ACOUSTIC FACILITY AT ONF

DESIGN

CONSTRUCTION

EQUIPMENT INSTALLATION

FACILITY CALIBRATION

DEVELOPMENT TESTING

ALIGN & MATE

SHIP TO DAC

LV MODAL SURVEY & DOOR EJECT.

SHIP TO ONF

MM ACOUSTIC TEST

SHIP TO DAC

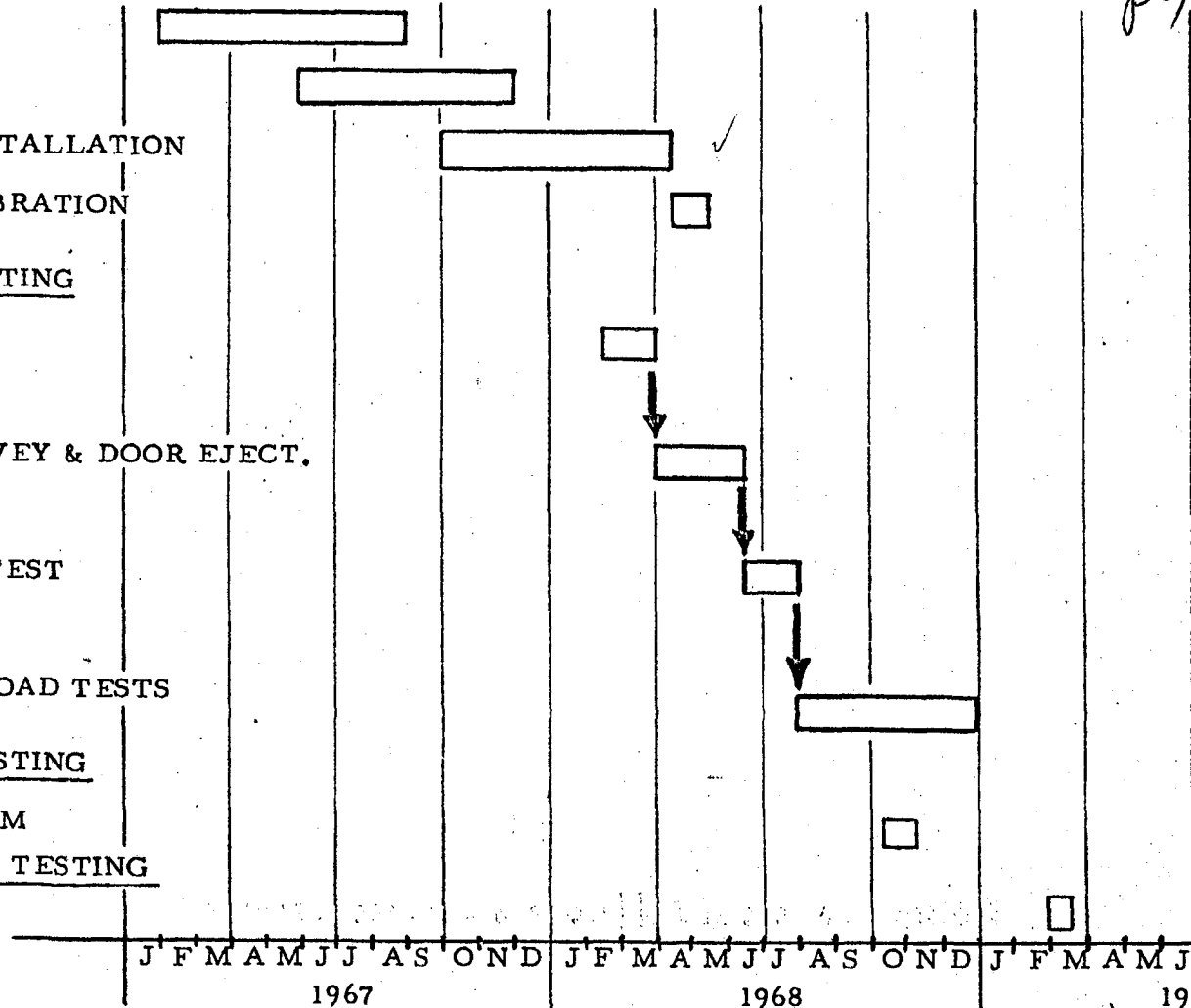
STRUCTURAL LOAD TESTS

ACOUSTIC QUAL TESTING

USE 114E AND EM

ACOUSTIC ACCEPT. TESTING

FV #3



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This chart just convinces me we should give up on development

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RECOMMENDATIONS

- o SEGMENT LEVEL ACOUSTICAL QUALIFICATION TESTING SHOULD BE ADOPTED UNIFORMLY THROUGHOUT THE PROGRAM FOR MINIMUM RISK.
- o ACCEPTANCE TEST FOR WORKMANSHIP AND FUNCTIONAL CONTINUITY SHOULD BE IMPLEMENTED AT THE SEGMENT LEVEL.

yes!!!

*System level, and segment level at;
EK & GE to eliminate
HB troubles*

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IMPLEMENTATION OF ACOUSTIC TEST RECOMMENDATIONS

(MISSION MODULE)

PURCHASE ACOUSTIC FACILITY AT ROCHESTER (MINIMUM CONFIGURATION \$2.5M)

DEVELOPMENT -- ACCEPT PROPOSED MM ACOUSTIC TEST SCHEDULE

QUALIFICATION -- QUALIFY MMFS 114E WITH EK ENGINEERING MODEL

ACCEPTANCE -- INCORPORATE MM ACCEPTANCE INTO EK ACCEPTANCE PLAN

*Alternate: Houston development
component qual EK
unpressurized at SM*

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low level vibration acceptance

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IMPLEMENTATION OF ACOUSTIC TEST RECOMMENDATIONS

(LAB MODULE)

USE SANTA MONICA FACILITY WITH MINIMUM MODIFICATION

DEVELOPMENT -- NO SCHEDULE PROBLEM

go to Houston

QUALIFICATION -- COMPLETE COST STUDY BEFORE FINAL RECOMMENDATION

ACCEPTANCE -- INCORPORATE LM ACCEPTANCE INTO ACCEPTANCE PLAN

*forget
incorporate LV*

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IMPLEMENTATION OF ACOUSTIC TEST RECOMMENDATIONS

(VIBRATION TEST OF LAB VEHICLE)

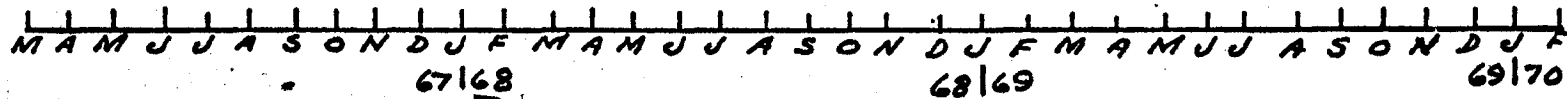
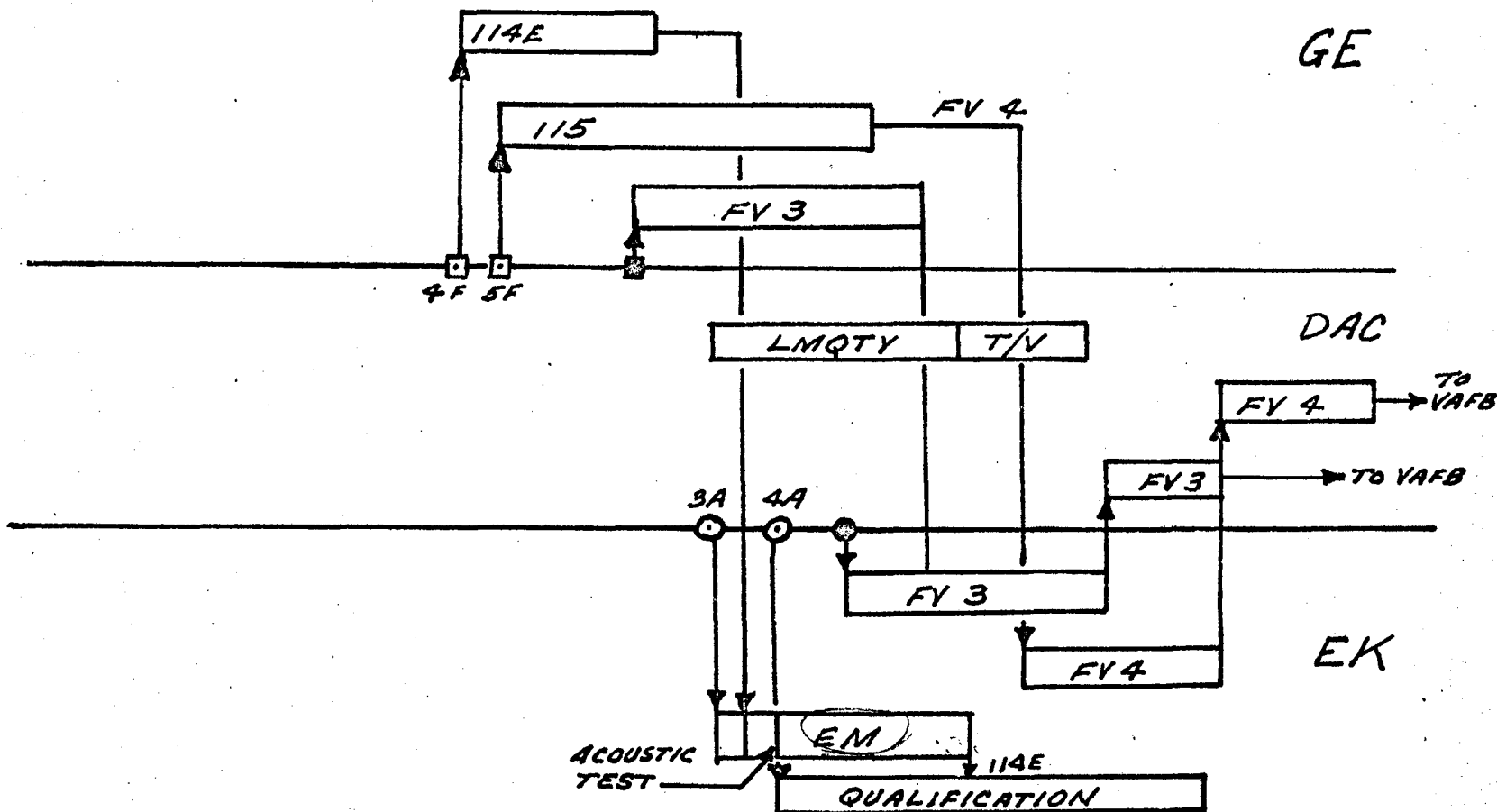
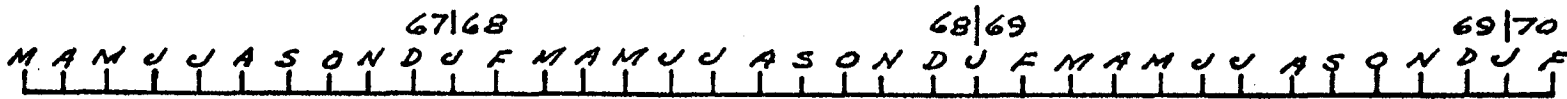
ACCEPTANCE -- SYSTEM IS DYNAMICALLY EXCITED AT INTERFACE HARD
POINTS TO CHECK INTERFACE CONNECTIONS (EXCITER
MAY BE LOCAL ACOUSTIC HORN WITH A DUCT, OR A
SMALL SHAKER OR RIVET GUN)

only way

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RECOMMENDED TEST FLOW REVISIONS

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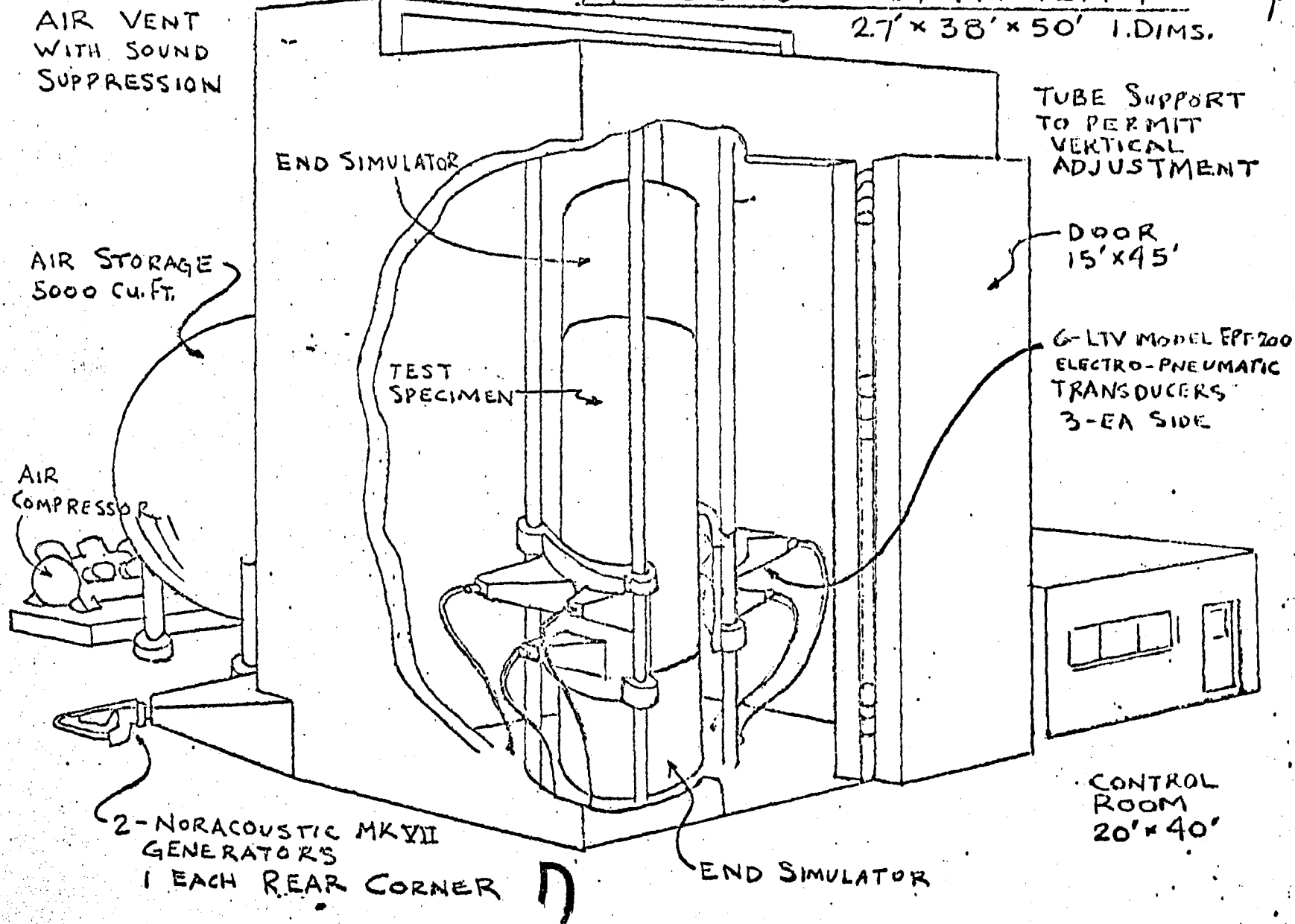
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ACOUSTIC TEST FACILITY

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27' x 38' x 50' I.DIMS.



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SUMMARY RECOMMENDATIONS

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DEVELOPMENT TESTING

ECP
ECP
no other
no other
on an individual ECP submitted
no other
no other
no other

1.4

DIRECT GE TO DELETE INDIVIDUAL COMPONENT ACOUSTIC DEVELOPMENT TESTING AS A GENERAL PRACTICE.

yes

2

DIRECT DAC TO CONDUCT THE MM DOOR JETTISON SHOCK TEST IN LV CONFIGURATION.

yes

3

DIRECT DAC TO CONDUCT SUPERSONIC, AS WELL AS TRANSONIC, METEOROID SHIELD FLUTTER TEST.

maybe

4

DIRECT DAC TO CONDUCT BOOST PHASE MODAL SURVEY WITH STV BASE SUPPORTED BY A STRUCTURE SIMULATING TITAN ADAPTOR.

yes

5

DIRECT DAC TO CONDUCT ORBITAL PHASE MODAL SURVEY ON STC, SUSPENDED VERTICALLY IN FREE-FREE CONDITION, WITH MM DOOR REMOVED AND WITHOUT DOOR TRUSS.

yes

REVIEW THE EK COMPONENT DEVELOPMENT TEST PROGRAM TO ENSURE THAT CRITICAL DEVELOPMENTAL COMPONENTS ARE SUBJECTED TO THERMAL, THERMAL-VACUUM AND DYNAMIC EXPOSURES TO PROVIDE A MINIMUM RISK COMPONENT QUALIFICATION PROGRAM.

R

7.

DIRECT EK TO ~~DELETE~~ ^{omit} PLANNED GROUND CONDITIONING TESTS (TEMPERATURE, HUMIDITY, ETC.) OF MM THERMAL MODEL.

yes

8.

DIRECT EK TO PERFORM THE COA MODAL SURVEY WITH THE BARREL ATTACHED TO FIXED SUPPORTS AT THE THREE MOUNTING POINTS INSTEAD OF SUSPENDED IN A FREE-FREE CONDITION.

yes

9.

Recommend not to rely upon the EK facility for development test.

if not too much trouble

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SUMMARY RECOMMENDATIONS

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QUALIFICATION TESTING

~~1. DIRECT DAC TO UTILIZE ACOUSTIC EXCITATION RATHER THAN RANDOM VIBRATION FOR QUALIFYING THE COMPONENTS OF THE LM UNPRESSURIZED COMPARTMENT. (COMBINE WITH LM ACOUSTIC QUAL TEST IF LATTER IS CONDUCTED.)~~ *delete*

ECP 2. DIRECT GE TO DELETE INDIVIDUAL COMPONENT ACOUSTIC QUAL TESTING AS A GENERAL PRACTICE. (RETAIN COMPONENT VIBRATION QUAL TESTING.) *yes*

ECP 3. DIRECT GE TO DELETE THE PLANNED TM BAY VIBRATION QUAL TEST. *yes*

ECP 4. DIRECT EK AND GE TO PERFORM THE TM BAY QUAL TEST USING 114E ~~AND THE EK ENGINEERING MODEL.~~ *yes*

ECP 5. DIRECT DAC TO PERFORM THE MM SHELL STRENGTH QUAL TEST COMBINING DIFFERENTIAL PRESSURES WITH BENDING MOMENTS. *yes*

~~6. DIRECT DAC TO DELETE THE PLANNED PRE-QUAL LV EMC TEST.~~ *?*

Change 7. REVIEW THE POSSIBILITY OF CONDUCTING AN LM ACOUSTIC QUALIFICATION. *yes*

D

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SUMMARY RECOMMENDATIONS

ACCEPTANCE TESTING

accept (1)
include (2, 3)
delete (4)
delete (5)
leave in action item (6)
action (7)

1. DIRECT DAC TO PERFORM A T/V ACCEPTANCE TEST ON EACH LM; DELETE T/V ACCEPTANCE TEST OF LV

2. DIRECT GE TO PERFORM AN MMFS MODE VERIFICATION ACCEPTANCE TEST ON EACH FLIGHT VEHICLE.

3. DIRECT EK TO PERFORM A COA MODE VERIFICATION ACCEPTANCE TEST ON EACH FLIGHT ARTICLE.

4. DIRECT DAC TO PERFORM ORBITAL PHASE MODAL SURVEY ON TV'S 3 & 6 WITH THE MM DOOR REMOVED AND WITHOUT TRUSS. (CONSIDER DELETION OF TEST AFTER ANALYSIS OF DYNAMIC PERFORMANCE PREDICTIONS AND/OR FOLLOWING REVIEW OF STV MODE SURVEY TEST RESULTS.)

5. CONSIDER DELETION OF THE OPERATIONAL DYNAMICS ACCEPTANCE TEST AT ROCHESTER FOLLOWING ANALYSIS OF THE OV DYNAMIC PERFORMANCE PREDICTIONS AND THE PROPOSED TEST PROCEDURES.

6. REJECT GE RECOMMENDATION THAT THE DAC AVE BE CHECKED OUT INDEPENDENTLY BEFORE MATING WITH GE LM AVE.

7. REJECT DAC RECOMMENDATION THAT THE LM NOT BE CHECKED OUT PRIOR TO MATING WITH THE MM.

8. REJECT THE GE RECOMMENDATION THAT THE MM BE CHECKED OUT AT DAC PRIOR TO MATING WITH THE LM.

9. DIRECT DAC TO PROVIDE FOR RETENTION OF THE CAPABILITY FOR GE TO PERFORM BACKUP INDEPENDENT MPSS TESTING AFTER LV MATE.

10. DIRECT EK TO SHIP FLIGHT CAMERA TO DAC, WITH OTHER EK LM/MP EQUIPMENT, FOR GE CONSOLES TEST AND INSTALLATION DURING LM ASSEMBLY.

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ACCEPTANCE TESTING (CONTD)

11. DIRECT EK AND GE TO CONDUCT JOINT MM EMC ACCEPTANCE TEST AT ROCHESTER.
12. REVIEW EK TEST PROPOSAL TO SEEK REDUCTION OF THE TIME PLANNED BY EK FOR THERMAL-OPTICAL ACCEPTANCE TESTS.
13. DIRECT GE TO COMBINE COMPATIBILITY AND PERFORMANCE ACCEPTANCE TESTS AND TO PLAN FOR THE CONDUCT OF THE FINAL BASELINE ACCEPTANCE TEST ONLY ONCE.
14. IMPROVE THE EK SCHEDULE FOR DELIVERY OF CABLES AND HARNESS FOR THE LMQTV TO DAC BY 1 SEPTEMBER 1968, AND THE OTHER EK LM/MP COMPONENTS FOR THE LMQTV BY 22 DECEMBER 1968.
15. IMPROVE THE EK SCHEDULE FOR DELIVERY TO GE OF THE EK LM/MP COMPONENTS FOR THE FLIGHT VEHICLES BY SIX WEEKS.

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MAJOR RECOMMENDATIONS AND IMPACT

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MAJOR RECOMMENDATIONS AFFECTING EK

| <u>RECOMMENDATION</u> | <u>IMPACT</u> | <u>ROM COST</u> |
|---|---------------------------|-----------------|
| O APPROVE MM ACOUSTIC FACILITY AT ROCHESTER | NEW FACILITY | +\$2.5 M |
| O DELETE GROUND CONDITIONING TEST | ELIMINATE TEST & FACILITY | -\$182 K |
| O USE TM BAY 114E FOR DEV. & QUAL. | REDUCE AGE | -\$1.0M |
| | TEST SUPPORT REDUCT. | -\$500 K |
| | REDUCE SPARES | -\$200 K |

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MAJOR RECOMMENDATIONS AFFECTING GE

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| <u>RECOMMENDATION</u> | <u>IMPACT</u> | <u>ROM COST</u> |
|---|--|----------------------|
| ○ MODIFY TEST FLOW | | |
| DYNAMIC QUAL VEH # 114E (NO VIB QUAL OF 115) | ELIMINATE TEST | -\$100 K |
| USE QUAL VEH #115 AS FV #4 | ELIMINATE ONE SET GE-AVE | -\$5 M to \$6.5 M |
| | ELIMINATE TEST | -\$70 K |
| | ELIMINATE TEST FIXTURE | -\$50 K |
| ○ DIRECT GE TO DELETE MOST COMPONENT DEVEL. & QUAL. ACOUSTIC TESTS | ELIMINATE TESTS | -\$100 K |
| ○ ELIMINATE PRE-QUAL EMC TEST AT DAC | ELIMINATE VEH #115 SUPPORT AT DAC | -\$100 K |
| ○ REJECT GE PROPOSAL TO TEST MM BEFORE LM/MM MATE | ELIMINATE SPECIAL AGE | -\$200 K |

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MAJOR RECOMMENDATIONS AFFECTING DAC

| <u>RECOMMENDATION</u> | <u>IMPACT</u> | <u>R. O. M. COST</u> |
|--|---------------------------|----------------------|
| O APPROVE LM ACOUSTIC FACILITY | FACILITY MODIFICATION | +\$1.0 M |
| O CONDUCT LM ACOUSTIC TEST IN DAC FACILITY | | |
| DEVELOPMENT | TEST REDUCT. TRANSPORT | -\$10 K -\$20 K |
| QUALIFICATION | AVE -NEW OR REFURB. LM | +\$3 M to +\$20 M |
| ACCEPTANCE | TEST INCR. TEST INCR. | +\$50 K +\$250 K |
| O COMBINE ACOUSTIC QUAL OF LM UNPRESSURIZED SECTION WITH LM | FIXTURE ELIMINATION | -\$25 K |
| | ELIMINATE TEST | -\$25 K |
| O DELETE PRE-QUAL LV EMC TEST | ELIM. TEST | -\$500 K |
| O T/V ACCEPTANCE OF LM INSTEAD OF LV | ELIM. CONTAM. TEST | -\$60 K |
| | ELIM. BUILD. MOD. | -\$150. K |

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