B#129

AEROSPACE CORPORATION

AEROSPACE CORPORATION

INTEROFFICE CORRESPONDENCE

64-2130-ELL-12

TO: See Below CC: MOLS Central Files DATE: 11 August 1964

SUBJECT: Crew Safety Briefing Charts FROM: E. L. LaPorte

The attached set of briefing charts is for your information and files. The Crew Safety briefing was given to Col. W. B. Brady on 11 August 1964.

E. L. LaPorte
Director
Gemini B/Titan III Office

ELL:jy

Attachment

To: R. T. Dungan
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W. C. Williams

64-2130 - ELL-1

CREW SAFETY REVIEW

aug. 11, 1969

- CREW SAFETY
  - / INTRODUCTION
  - / ON PAD ABORT
  - / IN-FLIGHT TO 35,000 FEET
  - / IN-FLIGHT 35,000 FEET TO 70,000 FEET
  - / BACK-UP GUIDANCE
  - / EVALUATION CRITERIA
  - / STATUS SUMMARY
  - / CONCLUSION

- EVALUATION OF SEAT EJECTION SYSTEM
  - / USED ONLY DURING STAGE 0 FLIGHT REGIME
  - / REMAINING BOOST PHASE NOT PERTINENT TO SEAT/TOWER SELECTION

- REVIEW/STATUS/CONCLUSION TO DATE FOR STAGE 0 FLIGHT

TITAN IIIC CREW SAFETY CONSIDERATIONS

- TITAN III ABORT ENVIRONMENT MORE SEVERE THAN GLV
  - / HIGHER TNT EQUIVALENCE
  - / THRUST TERMINATION EXHAUST PLUMES IN STAGE 0 FLIGHT
  - / MORE SHORT WARNING TIME MALFUNCTIONS IN INITIAL BURN STAGE
    - NO REDUNDANT F/C - GUIDANCE SYSTEM
  - / STAGING OF TUNNEL FAIRING

- RE-EVALUATION OF GEMINI A EJECTION SEAT ESCAPE MODE REQUIRED
  - / COMPARISON OF NEW ENVIRONMENT VERSUS SEAT/SUIT/MAN CAPABILITY

- MAY REQUIRE ESCAPE TOWER

GLV - TIIIC CREW ESCAPE REQUIREMENTS COMPARISON

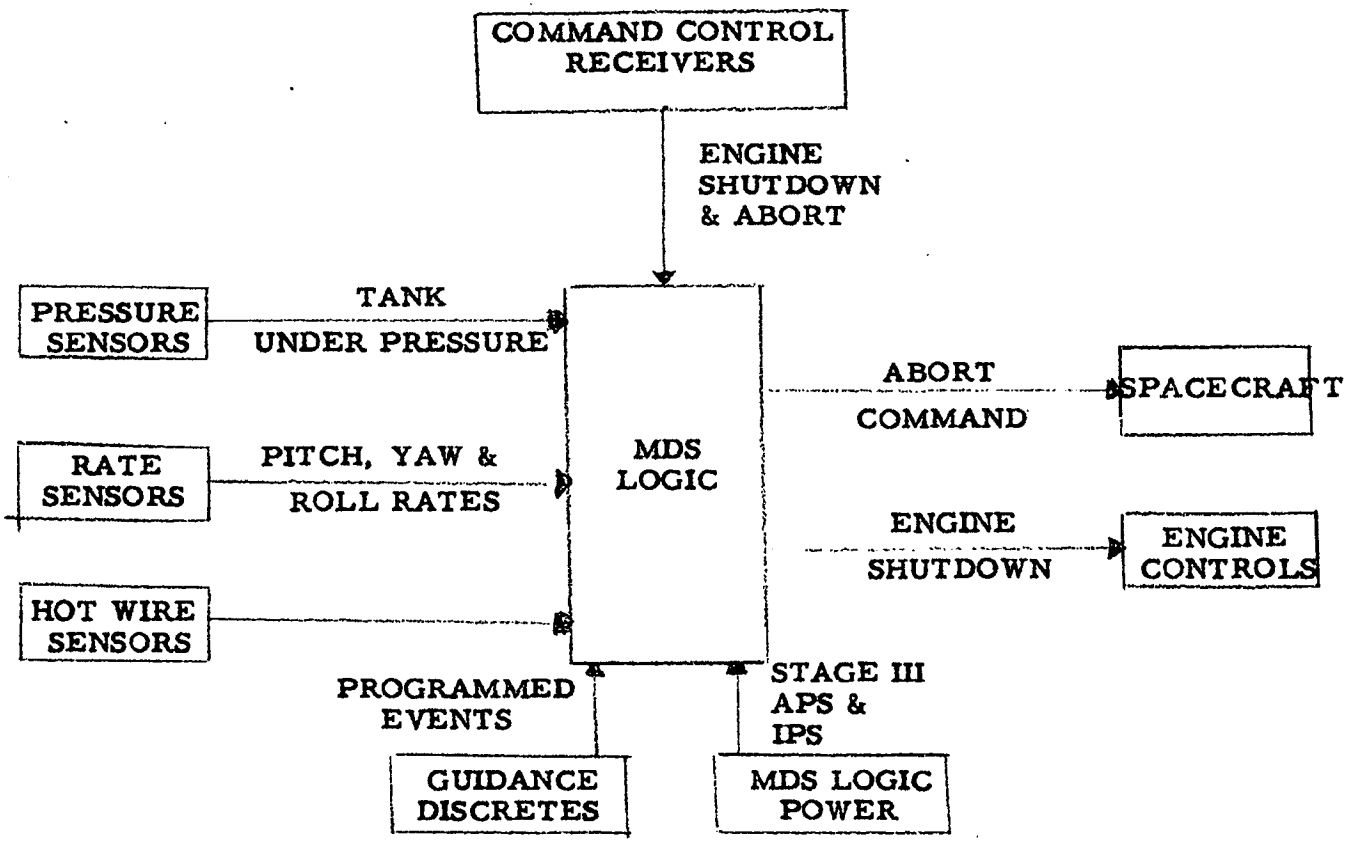
	GLV	TIIIC
PROBABILITY OF MISSION FAILURE DURING INITIAL BURN STAGE	29×10^{-3}	33×10^{-3}
OVERPRESSURE ASSOCIATED WITH VEHICLE BREAK-UP		APPROXIMATELY 50% HIGHER THAN GLV
FIREBALL ASSOCIATED WITH VEHICLE BREAK-UP	610' DIAMETER	735' DIAMETER
THERMAL ENVIRONMENT AFTER THRUST TERMINATION BUT PRIOR TO BREAK-UP	NONE	T. T. EXHAUST PLUMES PRESENT
MALFUNCTION WARNING TIME	COMPLETE SYSTEM DESIGNED TO ELIMINATE MALFUNCTIONS WITH SHORT WARNING TIME	COMPLETE SYSTEM DESIGNED ASSUMING AUTOMATIC ESCAPE SYSTEM FOR SHORT WARNING TIME MALFUNCTIONS
PROBABILITY OF MALFUNCTION WITH LESS THAN 2 SECONDS BETWEEN DETECTION AND BREAK-UP	9×10^{-4}	25×10^{-4}

TITAN IIIC
FAILURE MODE VERSUS FLIGHT PHASE
FAILURES PER MILLION LAUNCHES

	FAILURE MODE	FLIGHT PHASE 0	I	II	III	COAST	TOTAL
1	LOW ENGINE THRUST, NO THRUST OR PREMATURE S/D	4,500	4,700	15,000	27,000	25	52,000
2	VEHICLE UNSTABLE	10,000	17,000	5,000	16,000	2,700	51,000
3	THRUST VECTOR REMAINS ON NULL	850	6,500	1,300	1,300	15,000	25,000
4	HARD-OVER OR FAST ATTITUDE DIVERGENCE	3,400	4,000	1,600	6,000	6,000	21,000
5	SLOW ATTITUDE DIVERGENCE	5,800	180	700	1,800	2,000	11,000
6	COLLAPSE OR PUNCTURE OF PROPELLANT TANK	7,300	860	940	1,100	----	10,000
7	STRUCTURAL BREAK-UP OR EXPLOSION	260	2,000	1,600	95	6	4,000
	FAILURE TO SEPARATE PAYLOAD	----	----	----	----	3,400	3,400
	COLLISION WITH PAYLOAD	----	----	----	----	1,700	1,700
8	TIP-OVER ON PAD	210	----	----	----	----	210
	ENGINE FAILS TO SHUT-DOWN	----	46	64	20	11	140
9	PREMATURE STAGING	23	2	3	42	24	94
10	LOSS OF BEACONS OR RADIO COMMAND LINK	9	2	3	15	11	40
	FALSE ABORT	1	1	22	----	1	25
	PREMATURE STAGE III ENGINE START	----	----	----	----	19	19
	TOTAL	33,000	36,000	27,000	54,000	31,000	180,000

VEHICLE SYSTEMS

- TITAN IIIC MDS BLOCK DIAGRAM



EJECTION SEAT CHARACTERISTICS

- MANUAL ABORT INITIATION BASED ON PARAMETRIC AND GO-NO-GO DISPLAYS
  - REQUIRED WARNING TIME
    - / MAN DECISION TIME +.45 SECONDS
  - ASTRONAUT/SEAT SEPARATION TIME
    - / MAN DECISION TIME +1.55 SECONDS
  - NON-STABILIZED SEAT WITH POOR NATURAL STABILITY
  - SEATS ARE USED ON PAD AND UP TO 35,000 FEET (MAY BE LOWERED)

ESCAPE TOWER

- CHARACTERISTICS
  - / LAUNCH WEIGHT - 2,000 POUNDS
  - / THRUST - 65,000 POUNDS
  - / TOTAL IMPULSE - 75,000 LB-SEC
  - / LENGTH - 15 FEET
- REQUIRES DEVELOPMENT AND TEST PROGRAM
- REQUIRES MAJOR STRUCTURAL CHANGES TO GEMINI B
  - POSSIBLE TOOLING CHANGES
  - STRUCTURAL TEST

- EFFECT OF MANUAL SEAT ABORT ON PIBOL
  - / PIBOL CANNOT BE UTILIZED DURING STAGE O FLIGHT

- ON-PAD ABORT
  - / FAILURE MODES
  - / ABORT ENVIRONMENT
  - / EFFECT UPON SEAT EJECTION SYSTEM
  - / DATA NEEDED
  - / SUMMARY
  - / CONCLUSIONS

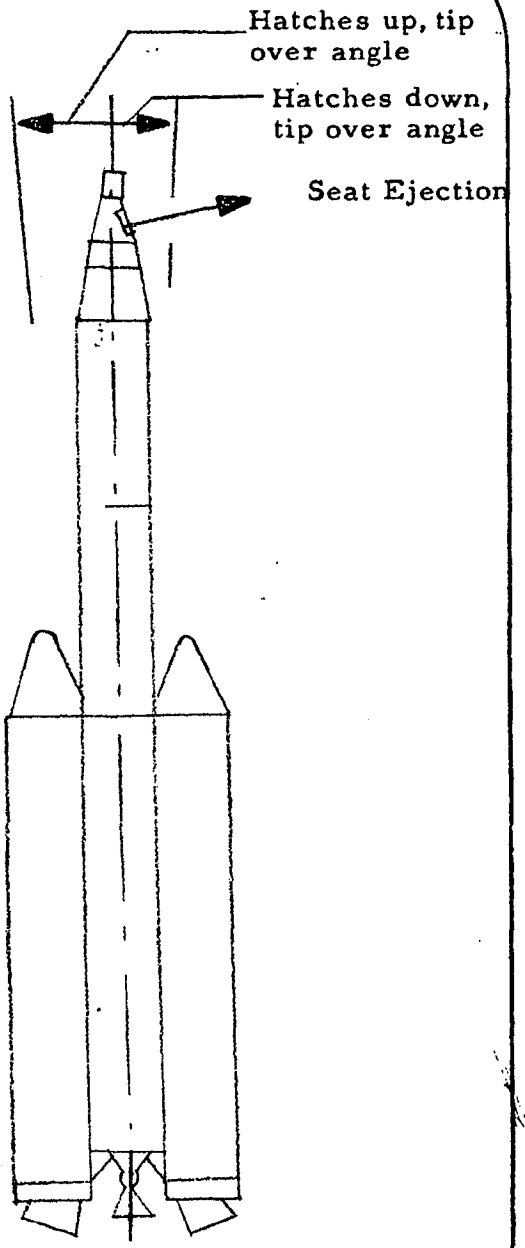
- ON-PAD FAILURE MODES
  - / TIP-OVER
    - PROBABILITY - 200/MILLION LAUNCHES
    - WARNING TIME
      - / MINIMUM - 1.2 SECONDS (IMPACT WITH STAND)
      - / MAXIMUM - 2.6 SECONDS (EXCEED ATTITUDE LIMITS FOR HATCH UP)
  - / SINGLE THRUST VECTOR HARDOVER
    - PROBABILITY - 200/MILLION LAUNCHES
      - / MINIMUM - 1.0 SECONDS (EXCEED ATTITUDE LIMITS FOR HATCH DOWN)
      - / MAXIMUM - 3.2 SECONDS (EXCEED ATTITUDE LIMITS FOR HATCH UP)

- ATTITUDE ANGLE CONSTRAINTS
  - / ANGLE LIMIT, HATCHES DOWN
    - o 5° MAXIMUM SAFE
  - / ANGLE LIMITS, HATCHES UP
    - o 11° FOR 560 FT. RANGE
    - o 25° FOR 400 FT. RANGE
  - / ASSUMES NO WIND
  - / ASSUMES SEAT LEAVES RAIL AT INSTANT BOOSTER ATTAINS LIMITING ANGLE

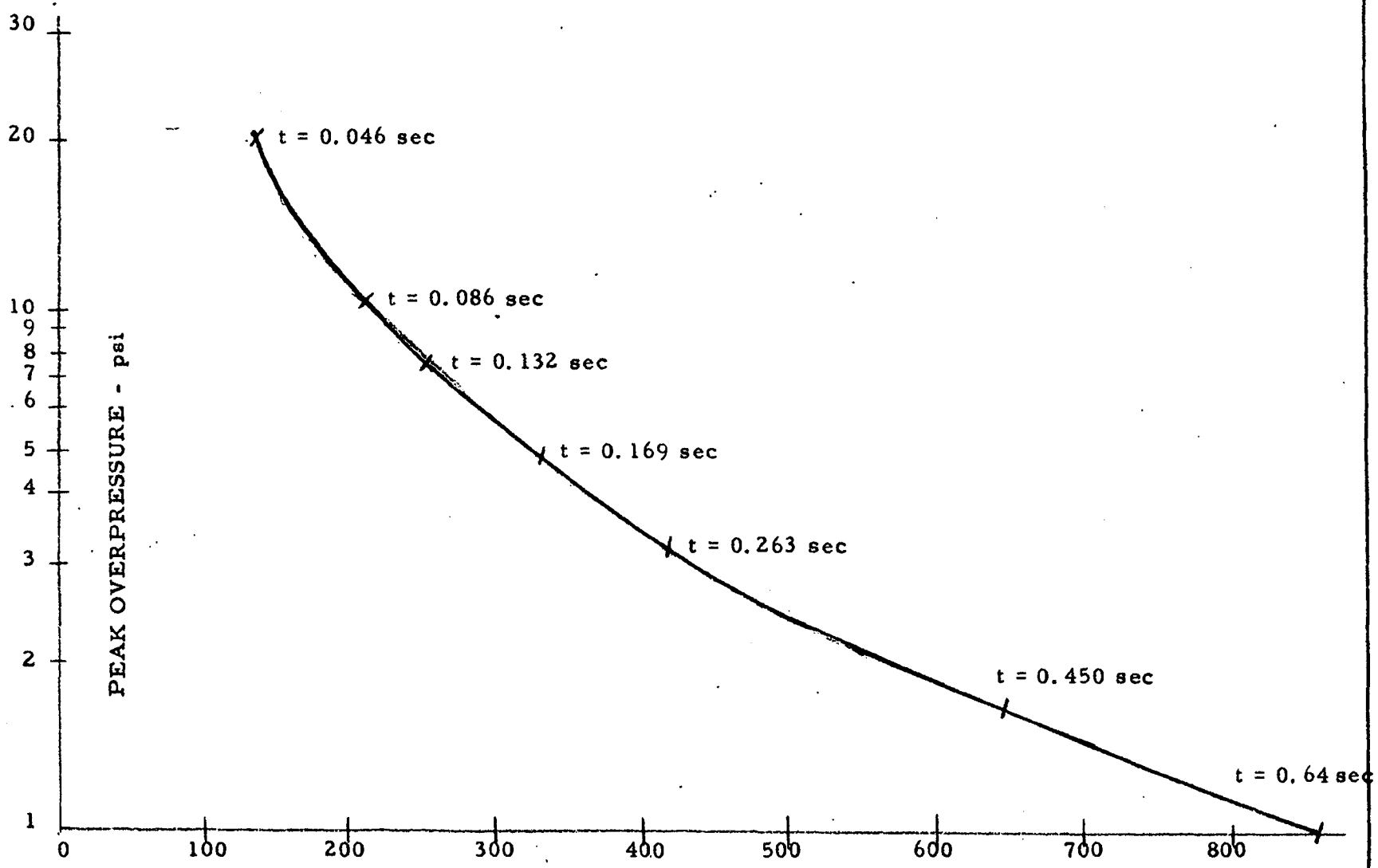
- MDS SIGNAL
  - / P/Y RATE SENSOR AT 3.5°/SEC
  - / ON PAD TIP OVER TRIPS MDS SIGNAL - 0.6 SEC
  - / IN FLIGHT (LIFT OFF) TRIPS MDS SIGNAL - 1.0 SEC

- VEHICLE ATTITUDE AT MDS TRIP
  - / ON PAD - 1°
  - / IN FLIGHT - 5°

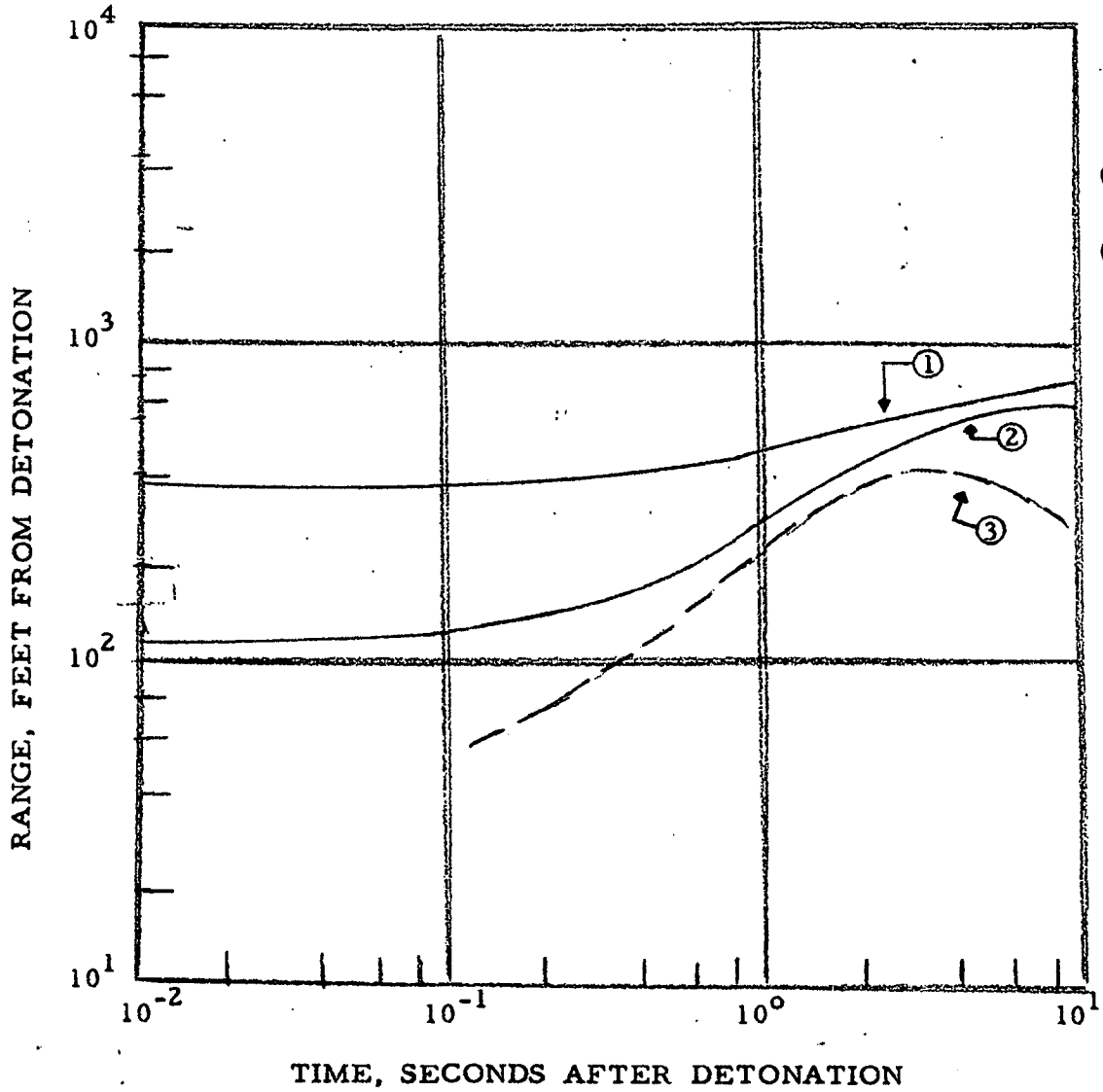
- CONCLUSION
  - / ATTITUDE CONSTRAINT NOT GOVERNING FOR ON PAD TIP OVER
  - / ANGLE CONSTRAINT CRITICAL FOR IN FLIGHT THRUST VECTOR HARD OVER WITH HATCHES DOWN



o OVERPRESSURE VS RANGE AND TIME ON PAD EXPLOSION OF TITAN IIIC



ASTRONAUT AND FIREBALL RANGE VERSUS TIME



① ASTRONAUT ABORT AT 2 SECONDS BEFORE DETONATION

② ASTRONAUT ABORT AT DETONATION

③ 735 FEET DIAMETER FIREBALL

④ AVERAGE FIREBALL SURFACE TEMP - 3000°F

⑤ TOTAL HEAT TO ASTRONAUT --

CASE ① - 119 BTU/FT^2

CASE ② - 250 BTU/FT^2

(ALLOWABLE WITH SUIT - UNKNOWN)

(ALLOWABLE BARE SKIN - 15 BTU/FT^2 2ND DEGREE FLASH BURNS)

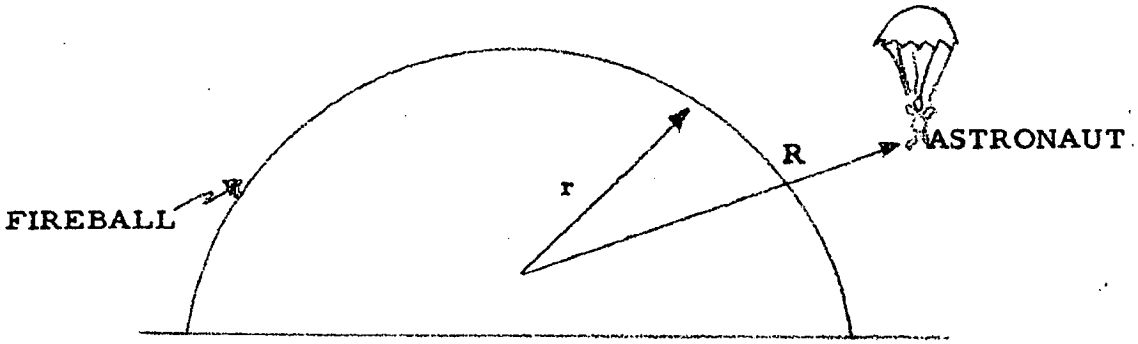
6. TOTAL HEAT TO PARACHUTE --

CASE ① - 82 BTU/FT^2

CASE ② - 130 BTU/FT^2

(ALLOWABLE BTU/FT^2)

o HEAT FLUX



/ HEAT FLUX ON ASTRONAUT = $\sigma T^4 \left(\frac{r}{R}\right)^2 = 5.67 \times 10^{-12} \frac{\text{watt}}{\text{cm}^2\ {}^{o}\text{K}^4} (1870^{o}\text{K})^4 \times \left(\frac{r}{R}\right)^2 = 61 \frac{\text{Btu}}{\text{ft}^2\text{-Sec}} \left(\frac{r}{R}\right)^2$ *

where: $\sigma = \int_{T_a}^{T} B_\nu$

T = Fireball Surface Temp., (^{o}K)

T_a = Ambient Temperature, (^{o}K)

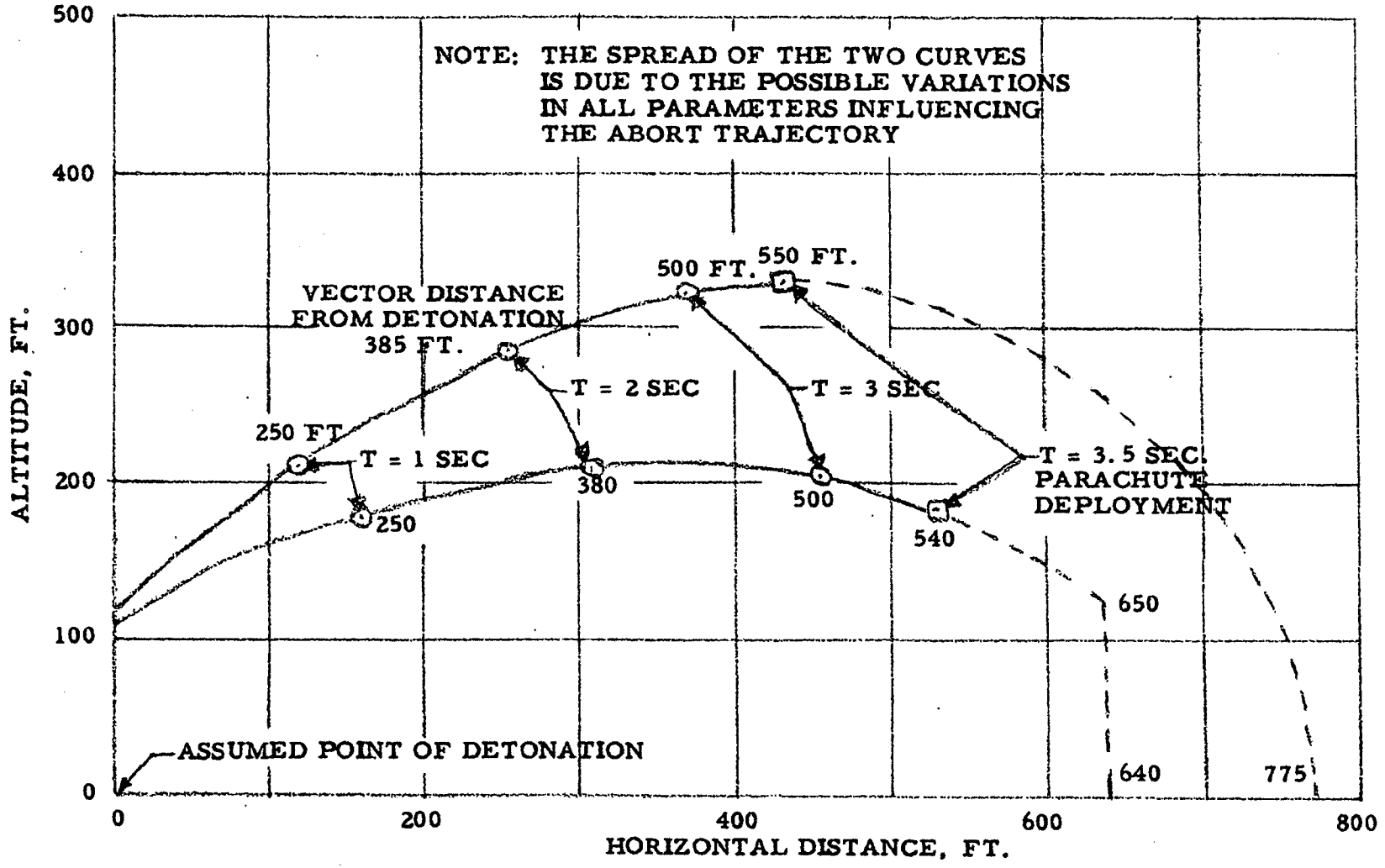
B_ν = Unit Black Body Radiation, $\frac{\text{watt}}{\text{cm}^2\ {}^{o}\text{K}^4}$

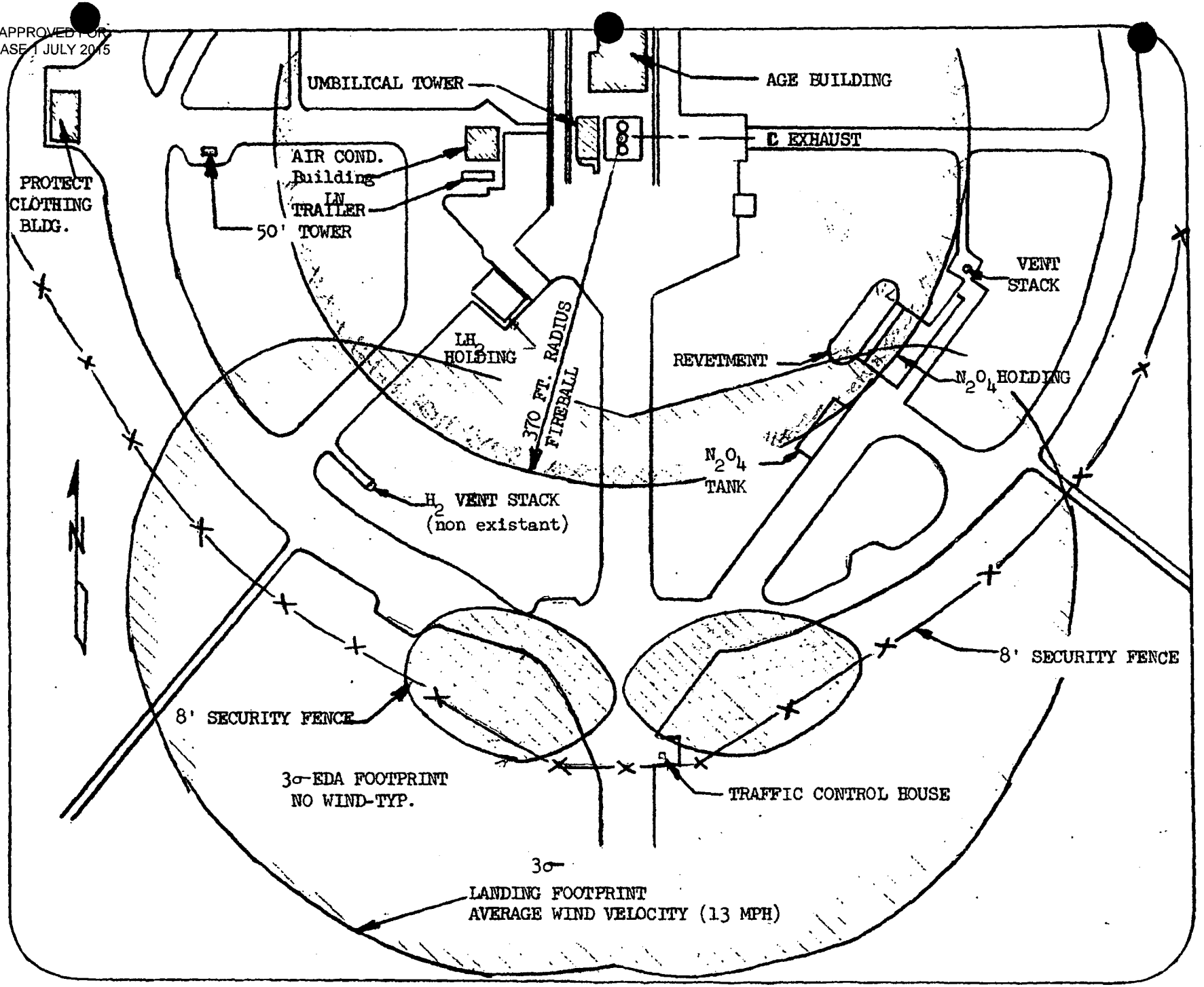
r = Fireball Radius, (ft)

R = Radial Distance, Center of Fireball to Astronaut, (ft)

* Meas. Data Aerojet @ 2:1 - 10 ft = 60 $\left(\frac{r}{R}\right)^2$

GEMINI ON-PAD ABORT TRAJECTORY ENVELOPE

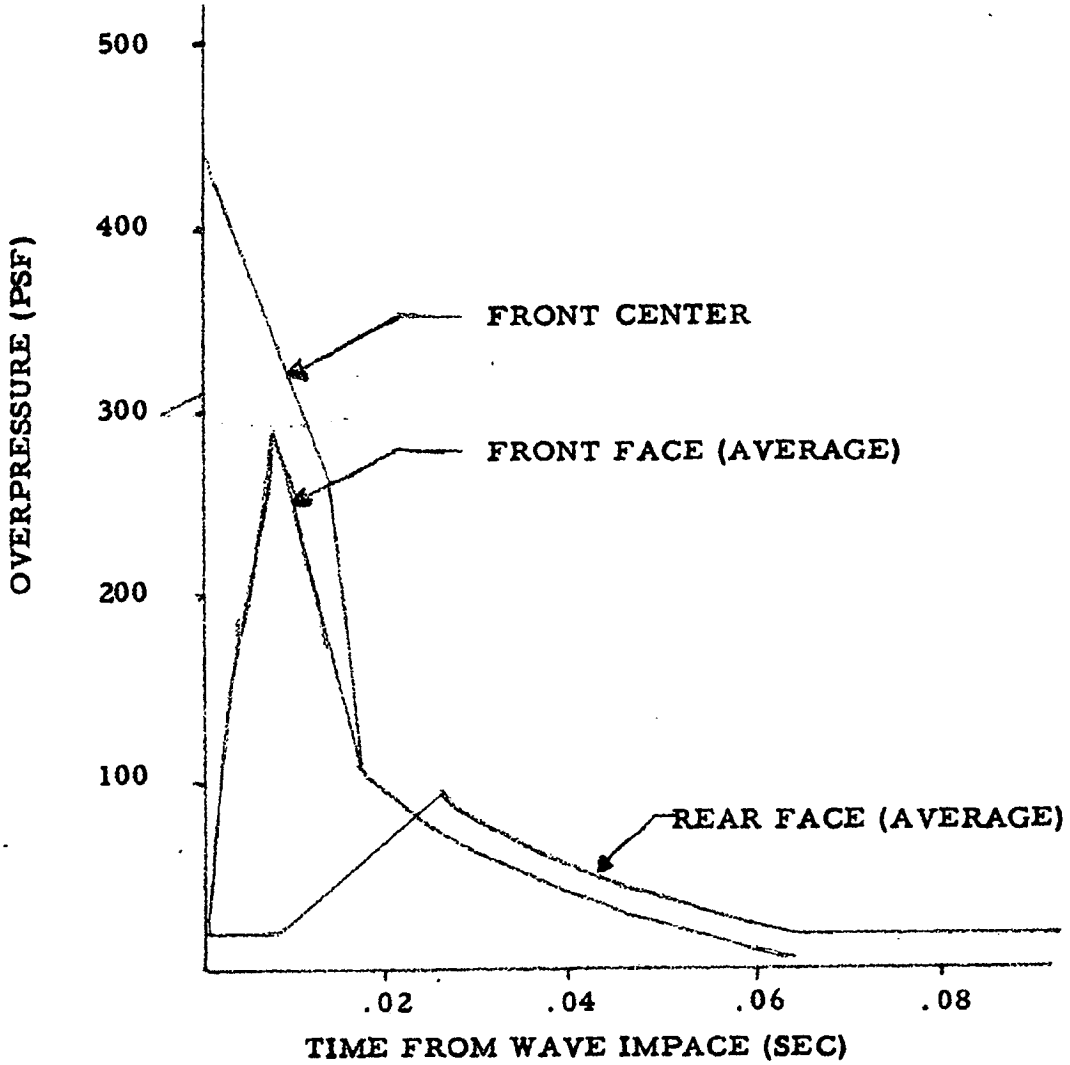




OVERPRESSURE ON FRONT AND REAR FACES OF PARACHUTE DUE TO BLAST WAVE PASSING

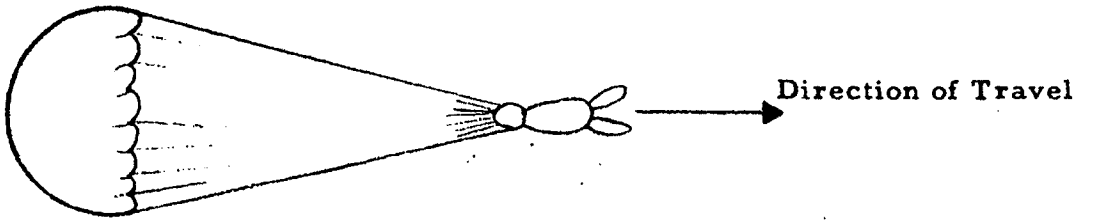
SLANT RANGE = 587 FEET

YIELD = 6800 LB. TNT

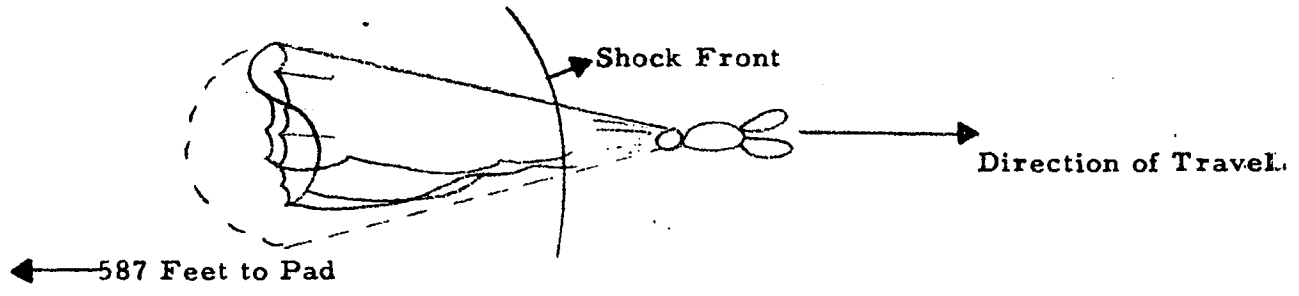


EFFECT OF BLAST OVER PRESSURE ON PARACHUTE

- PARACHUTE PRIOR TO BLAST OVERPRESSURE (C-9 CANOPY)



- PARACHUTE 0.023 SECONDS AFTER SHOCK WAVE STRIKES CANOPY



- RESULTS OF CANOPY DISTORTION
  - / POSSIBLE PARACHUTE COLLAPSE DUE TO RAPID, NON-UNIFORM CANOPY DISTORTION
  - / POSSIBLE PARACHUTE TANGLING DUE TO RAPID SUSPENSION LINE LOAD RELAXATION
  - / POSSIBLE FABRIC TEARING DUE TO IMPACT LOADING

POSSIBLE SOLUTIONS

- PARACHUTE DESIGN
  - / ADD PRESSURIZED MEMBERS TO PRESENT CANOPY
    - STIFFEN CANOPY TO AVOID COLLAPSE
  - / PROVIDE GEOMETRIC POROSITY ON CANOPY TO PERMIT RAPID EQUALIZATION OF BLAST PRESSURE EFFECTS
    - USE RING SLOT CHUTE
  - / REQUIRES DROP TEST PROGRAM

ABORT LEAD TIME

ABORT TIME - SEC (FROM DETONATION)	ASTRONAUT DISTANCE AT DETONATION	RESULTING ENVIRONMENT	POSSIBLE EFFECT
T > -15	600 - 800 FT. (ON GROUND)	O'PRESS 91.1 - 1.5 PSI) FIREBALL (370 FT. RADIUS)	NONE NONE
-15 SEC > T > -3.5	550 - 800 FT. (PARACHUTE OPEN)	O'PRESS (1.1 - 1.9 PSI) FIREBALL (370 FT. RADIUS)	PARACHUTE COLLAPSE PARACHUTE BURN?
-3.5 SEC > T > -2	380 - 550 FT.	O'PRESS (1.9 - 3.4 PSI)	EARDRUM RUPTURE?
-2 SEC > T > 0	60 - 380 FT.	O'PRESS (3.4 - 200 PSI)	50% LETHAL

- SAFE ABORT LEAD TIME FROM DETONATION IS:
  - / 2 - 3.5 SEC.
  - / < 15 SEC.

- DATA NEEDED
  - / SUIT CAPABILITY
  - / FRAGMENTATION
  - / TOXICITY

SUMMARY

- ON-PAD FAILURE PROBABILITIES ARE LOW
  - / ≈ 400/MILLION LAUNCHES
- ADDITIONAL DATA NEEDED
  - / ABORT ENVIRONMENT
  - / SUIT CAPABILITY
  - / FUNCTIONAL RELIABILITY OF SEATS
- LANDING FOOTPRINT SENSITIVE TO WIND VELOCITY AND DIRECTION
- ABORT INITIATION TIME WINDOW NARROW
  - / ≈ 2 - 3.5 SECONDS PRIOR TO DETONATION
- RELIABILITY OF SEAT SYSTEM HAS TO BE FACTORED IN TO DETERMINE CREW FATALITY RATE

- CONCLUSIONS
  - / SEAT EJECTION ABORT FOR ON-PAD FAILURE APPEARS EXTREMELY HAZARDOUS
  - / SEAT EJECTION SYSTEM SHOULD NOT BE DISCARDED ON BASIS OF ON-PAD ABORT
    - LOW FAILURE RATE - 400 FAILURES/MILLION LAUNCHES EXCLUDING SEAT RELIABILITY

ABORT FOR IN-FLIGHT TO 35,000 FEET

- CONSIDERATIONS
  - / CRITICAL FAILURE MODES
  - / WARNING TIMES
  - / FAILURE ENVIRONMENT
  - / SEAT EJECTION MODE

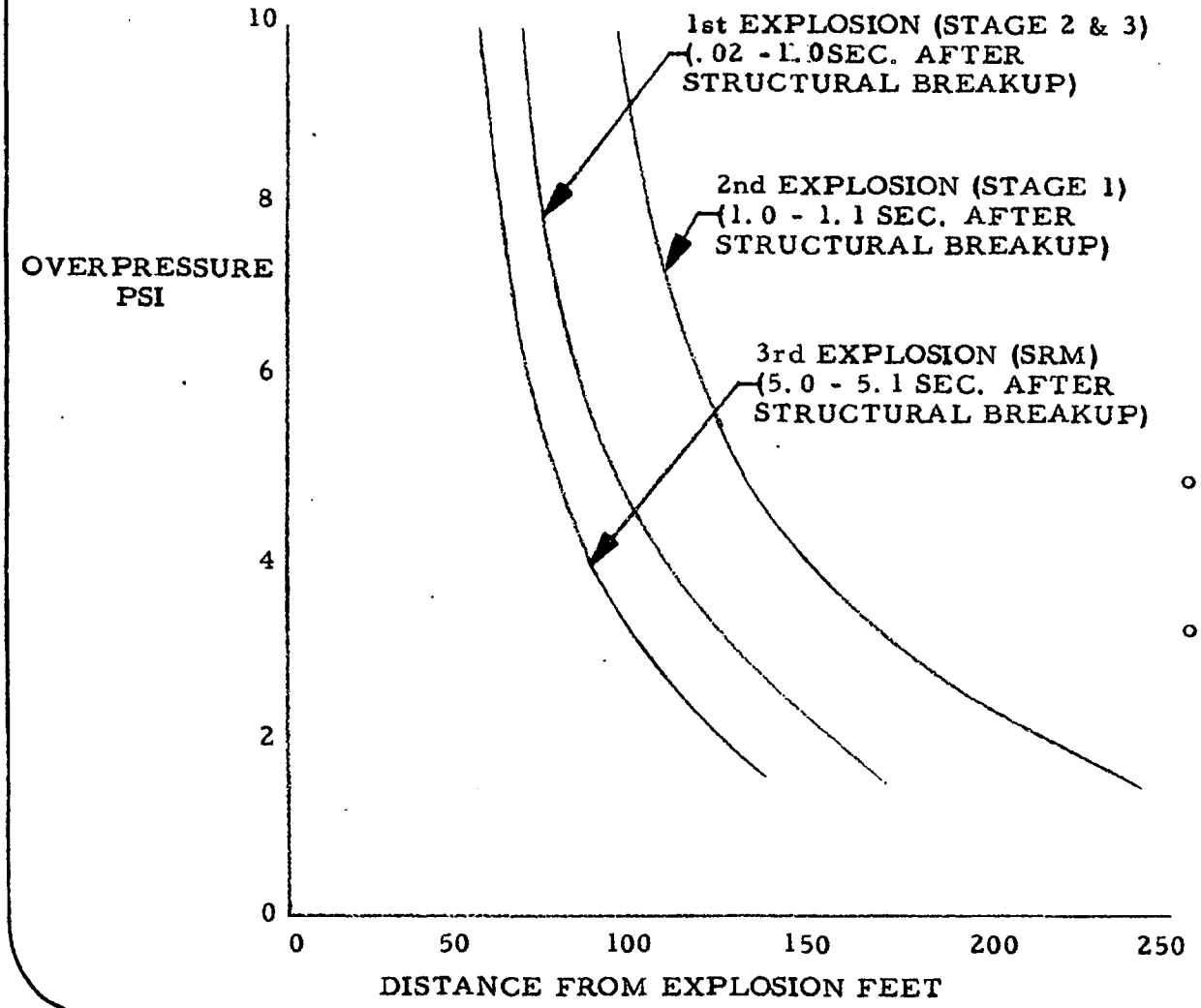
- CRITICAL FAILURE MODES AND PROBABILITIES
  - / VEHICLE UNSTABLE
    - PROBABILITY ~5300 PER MILLION
  - / THRUST VECTOR REMAINS ON NULL
    - PROBABILITY ~450 PER MILLION
  - / HARD OVER OR FAST DIVERGENCE
    - PROBABILITY ~1800 PER MILLION
  - / COLLAPSE OR RUPTURE OF PROPELLANT TANKS
    - PROBABILITY ~3800 PER MILLION
  - / SLOW ATTITUDE DIVERGENCE
    - PROBABILITY ~3100 PER MILLION

- TOTAL FAILURE PROBABILITY IN THIS FLIGHT REGIME
  - / APPROXIMATELY 14,000 PER MILLION

- WARNING TIMES
  - / NO FIRM DATA TO DATE
  - / MMC WILL HAVE BY 14 AUGUST
  - / MDS
    - PITCH/YAW RATE SENSOR TRIPS AT 3.5°/SEC
  - / VEHICLE BREAKS UP AT APPROXIMATELY 20° ANGLE OF ATTACK (MAX q)
  - / ONE THRUST VECTOR HARD OVER
    - ATTITUDE ACCELERATION-APPROXIMATELY $10^{\circ}/SEC^2$
    - WARNING TIME~1.7 SEC FROM MDS SIGNAL TO BREAK UP
  - / TWO THRUST VECTOR HARD OVER
    - ATTITUDE ACCELERATION-APPROXIMATELY $20^{\circ}/SEC^2$
    - WARNING TIME-.7 SEC FROM MDS SIGNAL TO BREAK UP

- VEHICLE MOTIONS DUE TO FAILURES
  - / MMC HAS CALCULATED
- IN FLIGHT OVER PRESSURES
  - / EXPLOSION DUE TO STRUCTURAL BREAK UP
  - / EXPLOSION DUE TO COMMAND DESTRUCT
- IN FLIGHT FIREBALL
  - / MMC WILL HAVE DATA BY 14 AUGUST
- FRAGMENTATION
  - / VERY LITTLE DATA AVAILABLE
  - / MMC WILL HAVE "BEST GUESS" BY 14 AUGUST
- THRUST TERMINATION PLUME
  - / UTC DATA AVAILABLE

OVERPRESSURE FROM IN-FLIGHT EXPLOSION
(TYPICAL CURVE ~ 30,000 FEET ALTITUDE SHOWN)



- THESE CURVES PERMIT EVALUATION OF SEAT-SUIT-MAN FOR IN-FLIGHT ABORTS
- DATA REQUIRED
  - / SEAT TRAJECTORIES
  - / WARNING TIMES
  - / SEAT-SUIT-MAN CAPABILITY

- SEAT EJECTION MODE
  - / SEAT EJECTION SEQUENCE AND WARNING TIMES CRITICAL
  - / MAC WILL HAVE SEAT TRAJECTORIES BY 14 AUGUST
  - / SEAT-SUIT-MAN CAPABILITY IN ENVIRONMENT UNKNOWN
  - / PARACHUTE CAPABILITY
    - CURRENT INDICATIONS - NO PROBLEM

- SEAT EJECTION SEQUENCE

  / TIME 0 - PULL "D" RING

  / .24 SECS - HATCH OPEN

  / .39 SECS - SEAT AT END OF RAIL

  / .72 SECS - SUSTAINER ROCKET BURNOUT

  / 1.46 SECS - INITIATION OF SEAT-MAN SEPARATOR

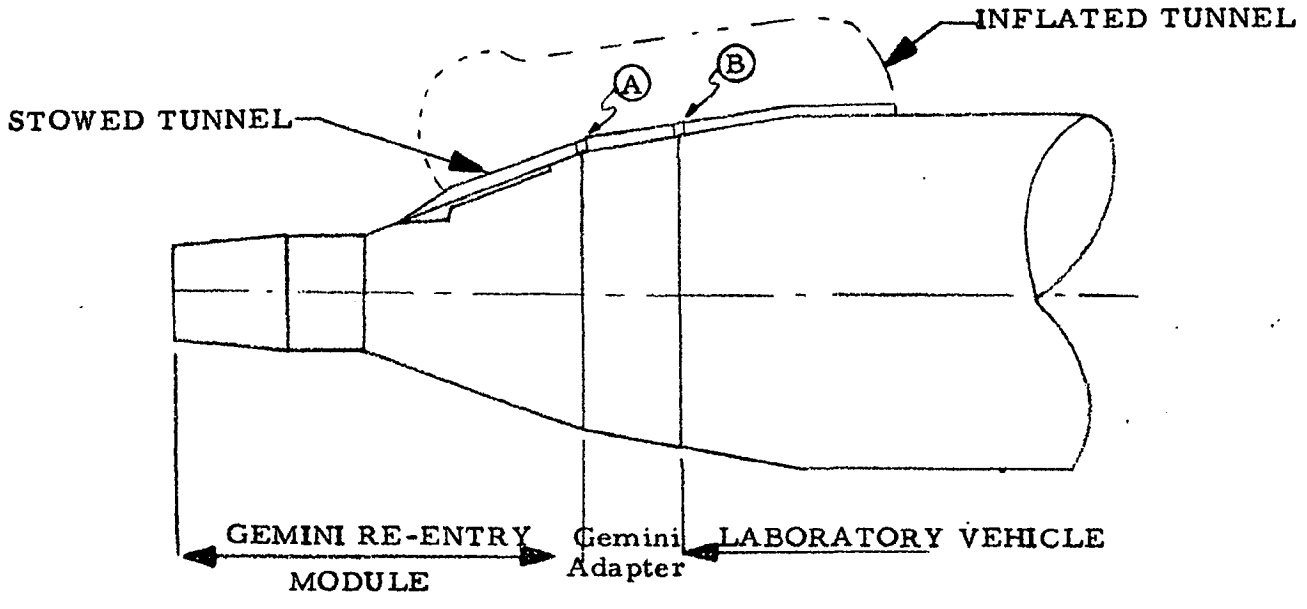
  / 1.50 SECS - MAN FREE OF SEAT

  / VARIABLE - MAN FREE FALLS TO 5700 FEET

  / AT 5700 FT. - INITIATION OF PARACHUTE SYSTEM

- ADDITION OF INFLATABLE CREW TRANSFER TUNNEL ADDS. .05 SECS TO TIME

INFLATABLE TUNNEL ABORT PROVISIONS



- SEAT EJECTION MODE
  - / SHAPED CHARGE CUTS TUNNEL AT Ⓐ
  - / SHAPED CHARGE CUTS FAIRING TIE STRAPS
  - / WITH TIME DELAY AND TOLERANCES, Δt FOR TUNNEL RELEASE $\approx$ .05 SECONDS
  - / HATCH IS FREE TO OPEN AFTER TUNNEL AND TIE STRAP ARE CUT

- CAPSULE ABORT MODE USING RETRO MOTORS
  - / SHAPED CHARGE CUTS TUNNEL AT Ⓑ
  - / SHAPED CHARGE CUTS FAIRING TIE STRAPS
  - / GEMINI ADAPTER/LAB VEHICLE SEPARATION BY SHAPED CHARGE
  - / TIME DELAY INSIGNIFICANT
  - / IF SEAT EJECTION IS SUBSEQUENTLY USED, ABOVE SEQUENCE FOLLOWS

- SUMMARY

  / FAILURE ENVIRONMENT DATA AVAILABLE ON 14 AUGUST

  / SEAT TRAJECTORIES AVAILABLE ON 14 AUGUST

  / WILL PERMIT COMPARING TRAJECTORY TIME HISTORIES WITH ENVIRONMENT TIME HISTORIES AT THAT TIME

  / LACK OF SEAT-SUIT-MAN CAPABILITY DATA WILL NOT PERMIT CLEAR DECISION

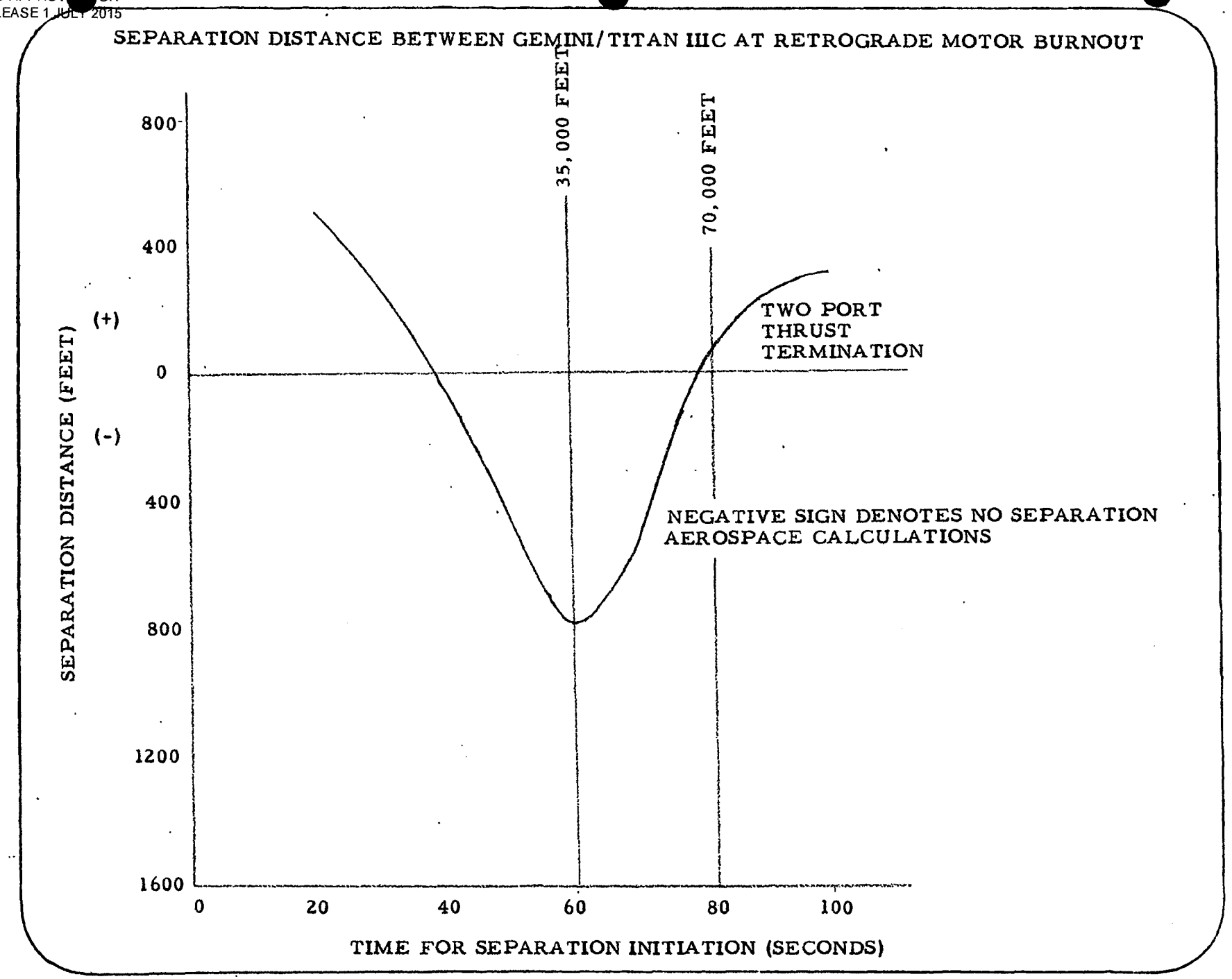
- TENTATIVE CONCLUSION
  - / WARNING TIMES VERY CRITICAL
  - / CAN NOT HANDLE TWO THRUST VECTOR HARD OVER FAILURES
    - LOW PROBABILITY

ABORT FOR IN-FLIGHT

35,000 FEET - 70,000 FEET

- CRITICAL ABORT ALTITUDE (35,000 - 70,000 FEET)
  - / EJECTION SEAT MODE CANNOT BE USED ABOVE 35,000 FEET
  - / PRESENT SPACECRAFT ESCAPE MODE CANNOT BE USED BELOW 70,000 FEET
  - / TITAN IIIC FAILURE RATE
    - 8 FAILURES/1,000 LAUNCHES

- CONCLUSION
  - / NO SAFE ESCAPE METHOD IN THIS CRITICAL ALTITUDE RANGE
  - / INVESTIGATE ALTERNATE ESCAPE MODES
    - LOWER SPACECRAFT ALTITUDE ABORT CAPABILITY TO REDUCE RISK



PRESENT AEROSPACE ABORT STUDIES

- ADDITIONAL THRUST REQUIRED TO ABORT SPACECRAFT SAFELY (WITHOUT ESCAPE TOWER)
- CASES CONSIDERED
  - / ABORT FROM ON-PAD UP TO 70,000 FEET USING SPACECRAFT ONLY (CASE I)
  - / ABORT WITH SPACECRAFT FROM 35,000 FEET AND HIGHER (CASE II)
  - / SAME AS ABOVE AND COMPLEMENTING WITH SEAT EJECTION (CASE III)
  - / WHEN MC DATA IS AVAILABLE, THE STUDY WILL INCLUDE CONSIDERATION OF BOOSTER FAILURE ENVIRONMENT
  - / DETERMINE RETROGRADE AND RE-ENTRY ABORT REQUIREMENTS FOR ORBITAL ALTITUDE = 250 N. M.
- COMPLETION
  - / 15 SEPTEMBER 1964

SPACECRAFT (S/C) ESCAPE MODE

- CASE I (ON-PAD THROUGH 70,000 FEET)
  - / STUDY OUTPUT
    - SEPARATION DISTANCE BETWEEN GEMINI B AND TITAN IIIC
    - ABORT PROPULSION REQUIRED
    - SPACECRAFT DYNAMIC CHARACTERISTICS AFTER ABORT
    - DETERMINE WHETHER S/C MAIN PARACHUTE WILL COLLAPSE
    - MODIFICATIONS REQUIRED TO S/C
- CASE II (35,000 FEET AND HIGHER)
  - / STUDY OUTPUT
    - SIMILAR TO CASE I ABOVE
- CASE III (S/C + SEAT EJECTION)
  - / STUDY OUTPUT
    - SIMILAR TO CASE I AND CASE II ABOVE WITH ADDITIONAL INVESTIGATION OF USING EJECTION SEATS AFTER S/C FREE FALLS

- BACK UP GUIDANCE
  - / IMPROVES G/FC RELIABILITY FROM .938 TO .952
  - / AEROSPACE STUDY TO EVALUATE ROLE OF BACK UP GUIDANCE
    - COMPLETION - 15 OCTOBER 1964

- STAGE 0 FLIGHT CONTROL/GUIDANCE REDUNDANCY DATA
  - / FLIGHT CONTROL/GUIDANCE FAILURE MODE PROBABILITY
    - TOTAL - 20/1000 LAUNCHES
      - / ON-PAD - .2/1000 LAUNCHES
      - / IN-FLIGHT TO 35,000 FT. - 11/1000 LAUNCHES
      - / IN-FLIGHT - 35,000 TO 70,000 FT. - 5/1000 LAUNCHES
  - / REDUNDANT FLIGHT CONTROL/GUIDANCE FAILURE MODE PROBABILITY
    - TOTAL - $\approx$ 4/1000 LAUNCHES
    - / ON-PAD - NEGLIGIBLE
    - / IN-FLIGHT TO 35,000 FT. - $\approx$.1/1000 LAUNCHES
    - / IN-FLIGHT - 35,000 TO 70,000 FT. - $\approx$.025/1000 LAUNCHES
  - / CONCLUSIONS
    - REDUNDANT FLIGHT CONTROL/GUIDANCE SYSTEM FOR TITAN IIIC (STAGE 0 ONLY) CAN REDUCE CREW RISK SIGNIFICANTLY
    - AEROSPACE TO EVALUATE

- ABORT MODES TO BE EVALUATED (STAGE O FLIGHT)
  - / PRESENT SEAT/S. C. SYSTEM
  - / PRESENT SEAT/MODIFIED S/C SYSTEM
    - IMPROVED ABORT CAPABILITY OF S/C SYSTEM
  - / TOWER

- EVALUATION CRITERIA
  - / STAGE O ABORT RISK
    - o ON-PAD
    - o IN-FLIGHT TO 35,000 FEET
    - o IN-FLIGHT 35,000 FEET TO 70,000 FEET
  - / PERFORMANCE
    - o RELIABILITY
    - o GREATER NUMBER OF FLIGHTS
  - / TECHNICAL RISK
  - / DEVELOPMENT AND TEST TIME
  - / ADDITIONAL COST

- STATUS SUMMARY
  - / COMPLETED AEROSPACE STUDIES
    - o "GEMINI/TITAN IIIC ON-PAD ABORT SAFETY ANALYSIS" TOR-269(4107-15)-1
    - o "EFFECT OF HARDOVER MALFUNCTIONS IN TITAN III ON MOL" TOR-469(5107-15)-1
    - o PARACHUTE COLLAPSE ANALYSIS
  - / AEROSPACE STUDIES UNDERWAY
    - o UTILIZE S/C ABORT AT 35,000 FEET AND ABOVE
      - / COMPLETE - 15 SEPTEMBER 1964
    - o BACK-UP GUIDANCE
      - / COMPLETE - 15 OCTOBER 1964
  - / AEROSPACE/MC/MAC MEETING ON 14 AUGUST 1964 IN DENVER
  - / MARTIN TO PROVIDE INTERIM REPORT ON ABORT ENVIRONMENT 14 AUGUST 1964
    - o SHOULD PROVIDE REQUIRED ENVIRONMENT DATA TO EVALUATE SEAT SYSTEM
      - / VEHICLE RATES/OVERPRESSURE CURVES ARE AVAILABLE
  - / MAC TO PROVIDE IN-FLIGHT SEAT TRAJECTORIES AT 14 AUGUST 1964 MEETING
    - o COMBINED WITH MARTIN DATA TO EVALUATE SEATS FOR IN-FLIGHT USE
  - / SSD OBTAINING SEAT/SUIT/MAN CAPABILITY DATA FROM NASA
  - / SSD/AEROSPACE EVALUATION CRITERIA AND WEIGHTING FACTORS
    - o UNDER REVIEW

- CONCLUSIONS
  - / ON-PAD ABORT EXTREMELY HAZARDOUS, BUT HAS LOW PROBABILITY OF OCCURRENCE
  - / FATALITY RATE IS AT LEAST 8 CREWS/1,000 LAUNCHES EXCLUDING S. C. /SEAT RELIABILITY
    - DETERMINED BY TIME GAP BETWEEN SEAT ABORT CEILING AND S/C ABORT CAPABILITY - ≈ 25 SECONDS
  - / BOTH SRM THRUST VECTOR HARDOVERS DO NOT PROVIDE ADEQUATE LEAD TIME FOR SEATS FOR IN-FLIGHT ABORT
    - LOW PROBABILITY OF OCCURRENCE
  - / CONCENTRATE ON FOLLOWING FAILURE MODES
    - SINGLE THRUST VECTOR HARDOVER
    - THRUST VECTOR NULL
  - / NEED MORE IN-FLIGHT ABORT DATA TO EVALUATE FULLY THE SEAT SYSTEM
  - / SELECTION OF SEAT VERSUS TOWER DECISION CAN BE MADE

15 SEPTEMBER 1964