P-7, [illegible]

MSC-01343

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FINAL REPORT

APOLLO 13 LiOH CANISTER BREAKTHROUGH TEST

CSD-A-1070

CREW SYSTEMS DIVISION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
July 15, 1970

MSC-01343

PROJECT DOCUMENT COVER SHEET

FINAL REPORT

APOLLO 13 LIOH

CANISTER BREAKTHROUGH TEST

REPORT NUMBER	DATE
CSD-A-1070	7-15-70

PREPARED BY:	J. C. LeBlanc (BRANCH AND/OR SUPPORT OFFICE)
APPROVED:	D. F. Trombley A. H. Hinners, Jr.
APPROVED:	(DIVISION) R. E. Smylie
APPROVED:	(PROGRAM OFFICE)

REVISIONS

DATE	PREPARED BY	APPROVALS: BRANCH	APPROVALS: DIVISION	APPROVALS: PROGRAM OFFICE	CHG. LETTER

CSD-A-1070
REPORT NUMBER

MSC FORM 151A (JUL 66)

CONTENTS

FIGURES

ABSTRACT

THE APOLLO 13 LITHIUM HYDROXIDE CANISTER TEST WAS CONDUCTED IN THE CREW SYSTEMS DIVISION 11-FOOT-DIAMETER CHAMBER TO EVALUATE EMERGENCY MEASURES DESIGNED TO ENABLE THE APOLLO 13 CREW TO USE COMMAND MODULE LITHIUM HYDROXIDE CANISTERS IN THE LUNAR MODULE. THE TEST VERIFIED THE EFFECTIVENESS OF THE EMERGENCY SYSTEM AND ESTABLISHED THAT THE CANISTERS IN THE COMMAND MODULE WOULD PROVIDE AMPLE CO2 REMOVAL FOR THE RETURN OF THE APOLLO 13 CREW. THE TIME INTERVAL BETWEEN CANISTER CHANGES ON THE FLIGHT WAS ALSO DETERMINED IN THE TEST. THIS REDUCED POWER DEMAND ON THE LUNAR MODULE BY ELIMINATING THE NEED FOR TELEMETRY IN DETERMINING CANISTER REPLACEMENT TIMES. WHEN IT BECAME APPARENT THAT THE SYSTEM WOULD PERFORM SATISFACTORILY, DETAILS OF THE CANISTER MODIFICATIONS WERE RELAYED TO THE FLIGHTCREW, AND A REPLICA OF THE TEST SYSTEM WAS ASSEMBLED IN THE FLIGHT VEHICLE. USE OF THE SYSTEM REDUCED CO2 CONCENTRATION IN THE FLIGHT VEHICLE FROM 15 MM HG TO 0.2 MM HG.

OBJECTIVE

THE APOLLO 13 LITHIUM HYDROXIDE CANISTER TEST WAS PERFORMED DURING THE FLIGHT OF APOLLO 13 TO VERIFY THAT EMERGENCY PROCEDURES DEVISED BY THE CREW SYSTEMS DIVISION TO CONVERT COMMAND MODULE LITHIUM HYDROXIDE CANISTERS FOR USE IN THE LUNAR MODULE WOULD PROVIDE ADEQUATE CO_2 REMOVAL FOR THE RETURN OF THE APOLLO 13 CREW.

DISCUSSION OF RESULTS

POWER FAILURE ON THE COMMAND MODULE DURING THE APOLLO 13 MISSION MADE IT IMPERATIVE TO DEVELOP AND TEST EMERGENCY MEASURES WHICH WOULD ENABLE THE APOLLO 13 CREW TO UTILIZE THE CO_2 REMOVAL CAPACITY OF THE 24 LITHIUM HYDROXIDE CANISTERS OF THE COMMAND MODULE, BY CONVERTING THEM FOR USE IN THE LUNAR MODULE. USE OF THESE CANISTERS WOULD REQUIRE AN ADAPTATION PERMITTING THEIR ATTACHMENT TO THE LUNAR MODULE ENVIRONMENTAL CONTROL SYSTEM DISCHARGE HOSES WHICH ARE NORMALLY ATTACHED TO THE PRESSURE GARMENT ASSEMBLY. OF NECESSITY, THIS ADAPTATION MUST (1) PROVIDE A WORKABLE SYSTEM, (2) EMPLOY MATERIALS AVAILABLE TO THE FLIGHTCREW, AND (3) BE RELATIVELY SIMPLE SO THAT DETAILS COULD BE TRANSMITTED TO THE CREW WITHOUT DANGER OF MISINTERPRETATION. IT WAS ALSO ESSENTIAL THAT AN EVALUATION OF THE MODIFIED SYSTEM BE COMPLETED IN AMPLE TIME TO PERMIT THE DEVELOPMENT OF ALTERNATE MEASURES IF THESE PROVED TO BE REQUIRED. USING A LIQUID COOLING GARMENT BAG, A FLIGHT PROCEDURE COVER, AND VARIOUS ON-BOARD ADHESIVE TAPES, THE CREW SYSTEMS DIVISION DEVISED A WORKABLE ADAPTATION WHICH MET ALL OF THE ABOVE REQUIREMENTS (FIGURES 1 TO 5).

AFTER CHAMBER TESTS HAD INDICATED THAT THE SYSTEM WOULD PERFORM SATISFACTORILY, DETAILS OF THE MODIFICATIONS WERE TRANSMITTED TO THE FLIGHTCREW, AND A REPLICA OF THE TEST SYSTEM WAS ASSEMBLED AND PUT INTO USE ON THE FLIGHT VEHICLE (FIGURE 6). FOLLOWING THIS INSTALLATION, THE CO_2 CONCENTRATION IN THE FLIGHT VEHICLE, WHICH HAD RISEN TO 15 MM HG, DROPPED TO 0.2 MM HG.

THE MODIFIED CANISTER SYSTEM WAS TESTED IN THE CREW SYSTEMS DIVISION 11-FOOT-DIAMETER CHAMBER (SIMULATED LUNAR MODULE CABIN), WITH ONE OF THE RECONFIGURED CANISTERS CONNECTED TO THE COMMANDER'S DISCHARGE HOSE AND A SECOND CANISTER CONNECTED TO THE LUNAR MODULE PILOT'S HOSE. BOTH CANISTERS WERE SUPPORTED JUST OFF THE CABIN FLOOR EXPOSED TO THE CABIN ATMOSPHERE, AND BOTH HOSES WERE CONNECTED TO INLETS OF THE FLIGHT-CONFIGURED ENVIRONMENTAL CONTROL SYSTEM. WITH THE CHAMBER AT 27000 FEET, THE DIFFERENTIAL PRESSURE WAS 0.3

INCH H2O ACROSS THE COMMANDER'S CANISTER AND 0.4 INCH ACROSS THE LUNAR MODULE PILOT'S CANISTER (SHORTER HOSE CONNECTIONS). THE SUIT FAN DIFFERENTIAL PRESSURE WAS 9.0 INCHES H2O. THE CHAMBER WAS RETURNED TO SITE PRESSURE, AND THE BYPASS OF EACH CANISTER WAS PLUGGED, USING A PORTION OF A LIQUID COOLING GARMENT SOCK AND COVERING IT WITH A PIECE OF A FLIGHT PROCEDURE COVER (FIGURE 1). WITH THE CHAMBER AGAIN AT 27000 FEET, THE DIFFERENTIAL PRESSURE OF EACH CANISTER SHOWED AN INCREASE TO ABOUT 0.8 INCH H2O, AND THE SUIT FAN DIFFERENTIAL PRESSURE INCREASED TO 9.6 INCHES H2O. THESE HIGHER DIFFERENTIAL PRESSURES WERE NECESSARY TO ENSURE ADEQUATE FLOWS THROUGH THE LIOH IN EACH CANISTER. THE TEST WAS UNMANNED, AND CARBON DIOXIDE WAS INJECTED INTO THE CABIN TO SIMULATE THE METABOLIC CO2 OUTPUT OF THE APOLLO CREW.

TO CONSERVE POWER, TELEMETRY FROM THE LUNAR MODULE WAS NOT BEING TRANSMITTED, AND DATA FROM WHICH TO CALCULATE THE EXACT METABOLIC CO2 OUTPUT OF THE CREW UNDER THE CONDITIONS OF THE FLIGHT WERE NOT AVAILABLE. A CO2 INJECTION RATE OF 1100 SCCM WAS USED INITIALLY. THIS INJECTION RATE WAS BEGUN AT ABOUT 2100 HOURS ON APRIL 14, 1970, AND MAINTAINED FOR THE FIRST 144 MINUTES OF THE TEST. TO SIMULATE A WORST CASE METABOLIC CO2 OUTPUT AND TO MINIMIZE THE EVALUATION TIME, THE INJECTION RATE WAS RAISED TO 2000 SCCM FOR THE REMAINDER OF THIS TEST PHASE. READINGS OF CABIN AND ENVIRONMENTAL CONTROL SYSTEM CO2 CONCENTRATIONS WERE TAKEN AT 10-MINUTE INTERVALS AND PLOTTED TO PROVIDE A RUNNING GRAPH OF CANISTER PERFORMANCE. ALL TEST PARAMETERS WERE RECORDED CONTINUOUSLY BY THE DATA ACQUISITION AND RECORDING SYSTEM.

CANISTER SATURATION OCCURRED AFTER SLIGHTLY UNDER 13 HOURS AND CO2 INJECTION WAS TERMINATED ABOUT ONE HOUR LATER, AT WHICH TIME CO2 CONCENTRATION HAD RISEN TO APPROXIMATELY 6 MM HG (FIGURE 7). PREVIOUS LITHIUM HYDROXIDE CANISTER TESTS HAVE ESTABLISHED THAT A SATURATED LITHIUM HYDROXIDE CANISTER WILL PROVIDE ADDITIONAL CO2 REMOVAL FOLLOWING A REST PERIOD. HOWEVER, IT WAS APPARENT FROM THE SATURATION TIME IN THE TEST THAT THE CANISTERS AVAILABLE TO THE CREW WOULD PROVIDE MORE THAN AMPLE CO2 REMOVAL AND THAT REUSE OF THE CANISTERS TO EXTEND THEIR EFFECTIVENESS WOULD NOT BE REQUIRED.

DURING THE FIRST TEST PHASE, TELEMETRY WAS TRANSMITTED INTERMITTENTLY FROM THE LUNAR MODULE, AND FROM THESE DATA THE METABOLIC CO2 OUTPUT OF THE CREW WAS DETERMINED AND FOUND TO BE 1100 SCCM. USING THIS INJECTION RATE, A SECOND TEST PHASE WAS BEGUN AT 1600 HOURS ON APRIL 16, 1970. THE PRINCIPAL PURPOSE OF THIS TEST PHASE WAS TO PERMIT CONSERVATION OF LUNAR MODULE POWER BY DETERMINING THE TIMES AT WHICH THE FLIGHTCREW SHOULD CHANGE CANISTERS, ELIMINATING THE NEED TO USE TELEMETRY DATA FOR THIS PURPOSE. IN ADDITION, THE TEST PROVIDED CONTINUING ASSURANCE THAT THE EMERGENCY CANISTER CONFIGURATION WOULD CONTINUE TO OPERATE

EFFECTIVELY. TO SIMPLIFY NEW CANISTER INSTALLATION BY ELIMINATING CANISTER RECONFIGURATION, EACH OF THE DEPLETED CANISTERS OF TEST PHASE 1 WAS STACKED ON ONE OF THE NEW CANISTERS USED IN TEST PHASE 2. CANISTER SATURATION IN THIS TEST OCCURRED AT ABOUT 35 HOURS 24 MINUTES AFTER THE START OF CO2 INJECTION (FIGURE 8).

CURVES OF THE PARAMETERS RECORDED DURING THE TEST ARE SHOWN IN APPENDIX A. THE TEST WAS CONDUCTED IN ACCORDANCE WITH TEST PROCEDURE CSD-A-1069. THIS TEST PROCEDURE HAS BEEN UPDATED AND IS INCLUDED IN THIS REPORT AS APPENDIX B.

CONCLUSIONS

THE TEST VERIFIED THE EFFECTIVENESS OF THE EMERGENCY MEASURES USED TO CONVERT COMMAND MODULE LITHIUM HYDROXIDE CANISTERS TO LUNAR MODULE USE, AND ESTABLISHED THAT THE SUPPLY OF LITHIUM HYDROXIDE CANISTERS WOULD PROVIDE MORE THAN AMPLE CO2 REMOVAL FOR THE RETURN OF THE APOLLO 13 CREW. THE TEST ALSO ESTABLISHED THE TIME INTERVAL BETWEEN CANISTER REPLACEMENTS, AND REDUCED THE POWER DEMAND ON THE LUNAR MODULE BY ELIMINATING RELIANCE ON TELEMETRY FOR THIS OPERATION. IN A LARGER SENSE, THE TEST DEMONSTRATED THE EFFECTIVENESS OF ADEQUATE GROUND SUPPORT FACILITIES IN SAFEGUARDING A FLIGHT MISSION DURING AN EMERGENCY.

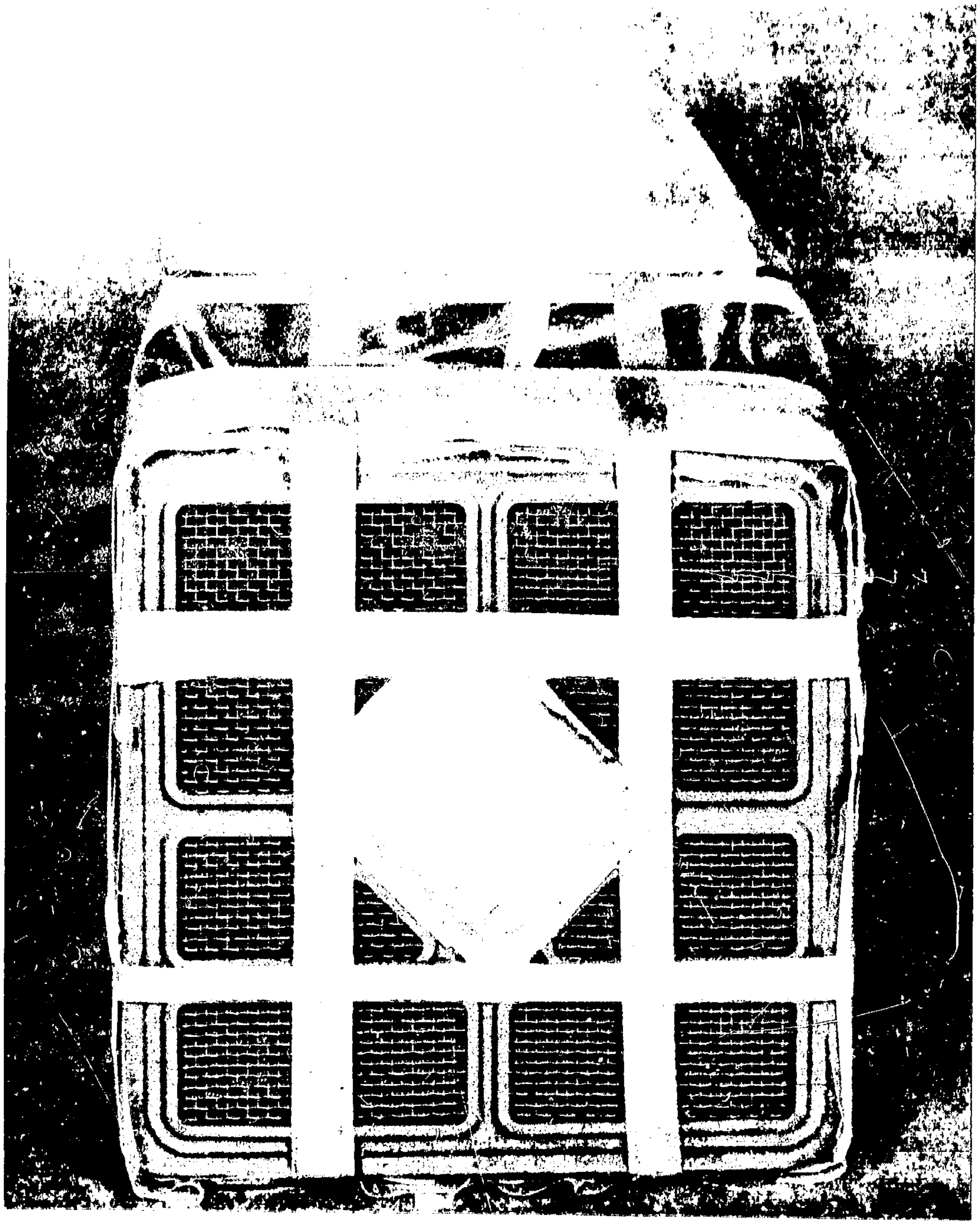


FIGURE 1 MODIFIED LITHIUM HYDROXIDE CANISTER (SINGLE UNIT)

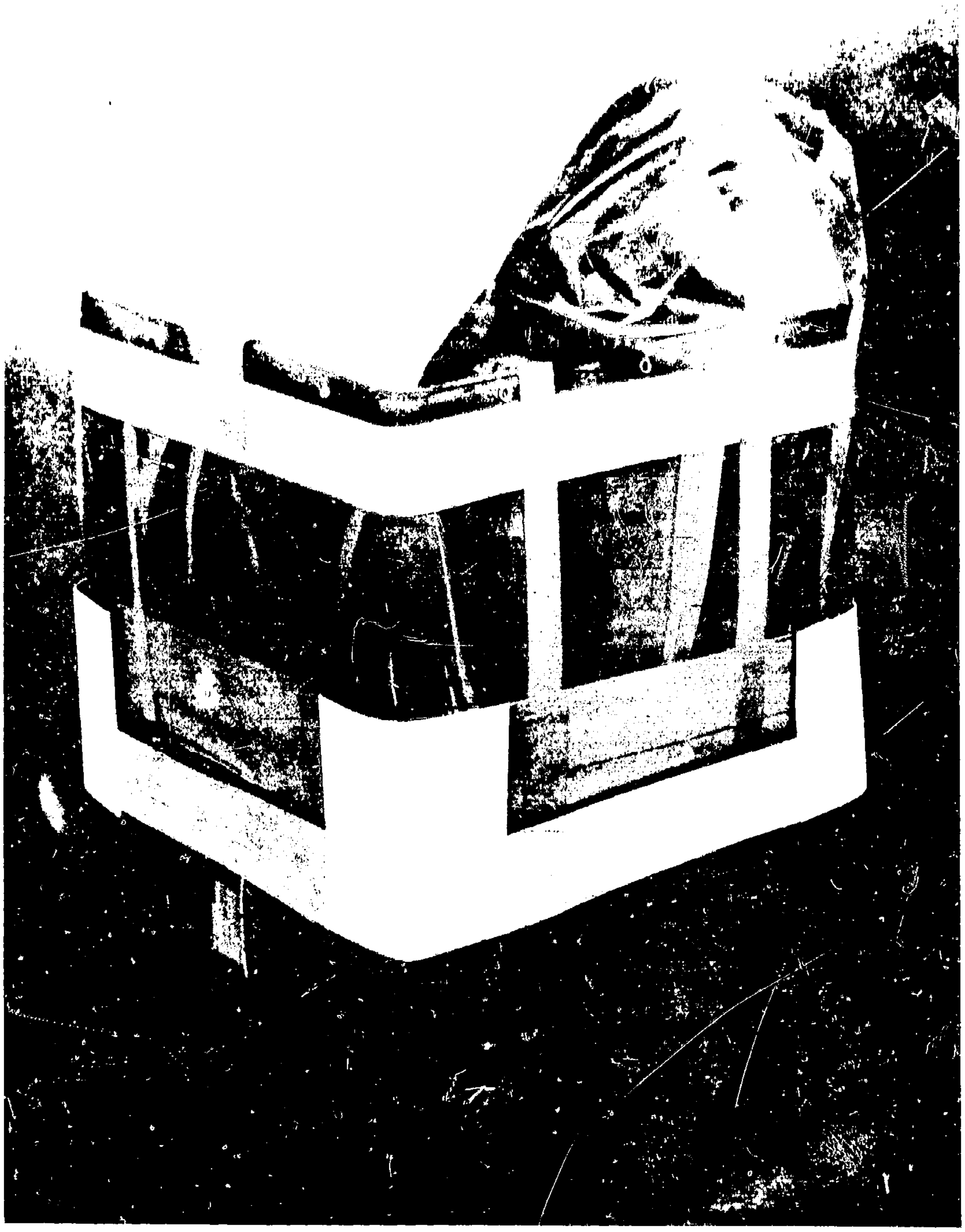


FIGURE 2 DEPLETED LITHIUM HYDROXIDE CANISTER OF TEST PHASE NO. 1 STACKED ON UNUSED TEST PHASE NO. 2 CANISTER

FIGURE 3 DEPLETED AND UNUSED LITHIUM HYDROXIDE CANISTERS, PRIOR TO STACKING

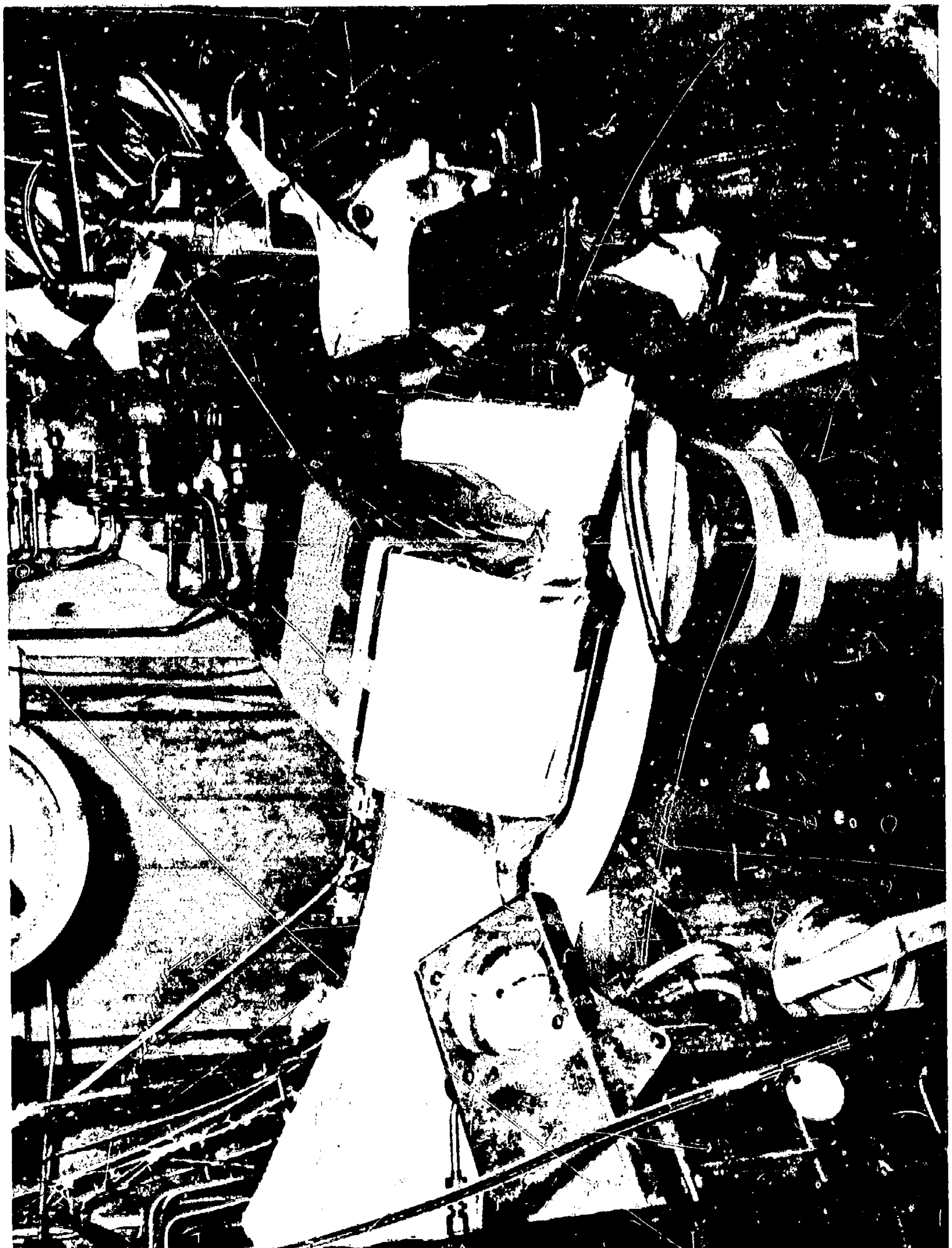


FIGURE 4 COMMANDER'S STACKED LITHIUM HYDROXIDE CANISTERS CONNECTED TO THE ENVIRONMENTAL CONTROL SYSTEM

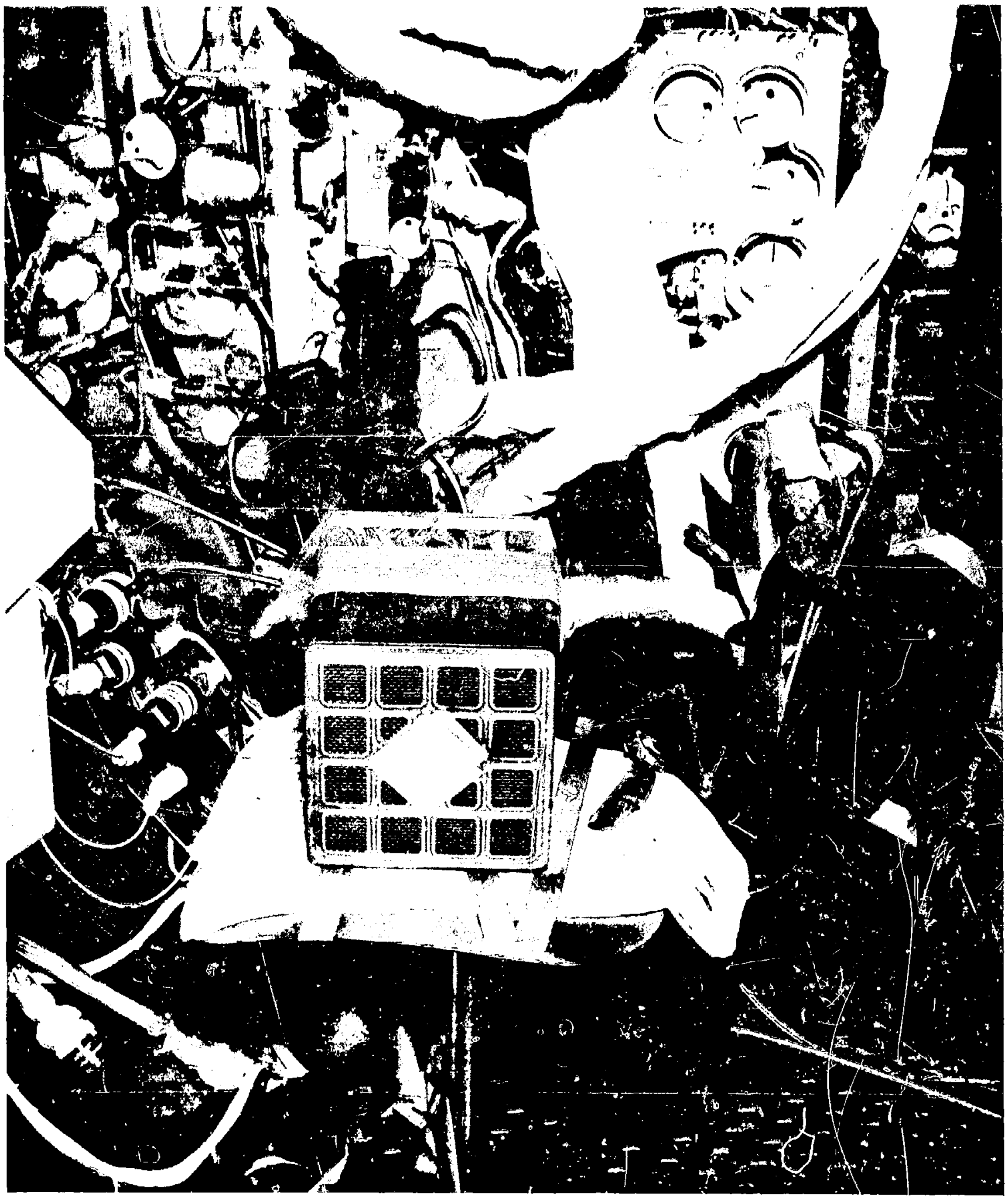


FIGURE 5 LUNAR MODULE PILOT'S STACKED LITHIUM HYDROXIDE CANISTERS CONNECTED TO THE ENVIRONMENTAL CONTROL SYSTEM

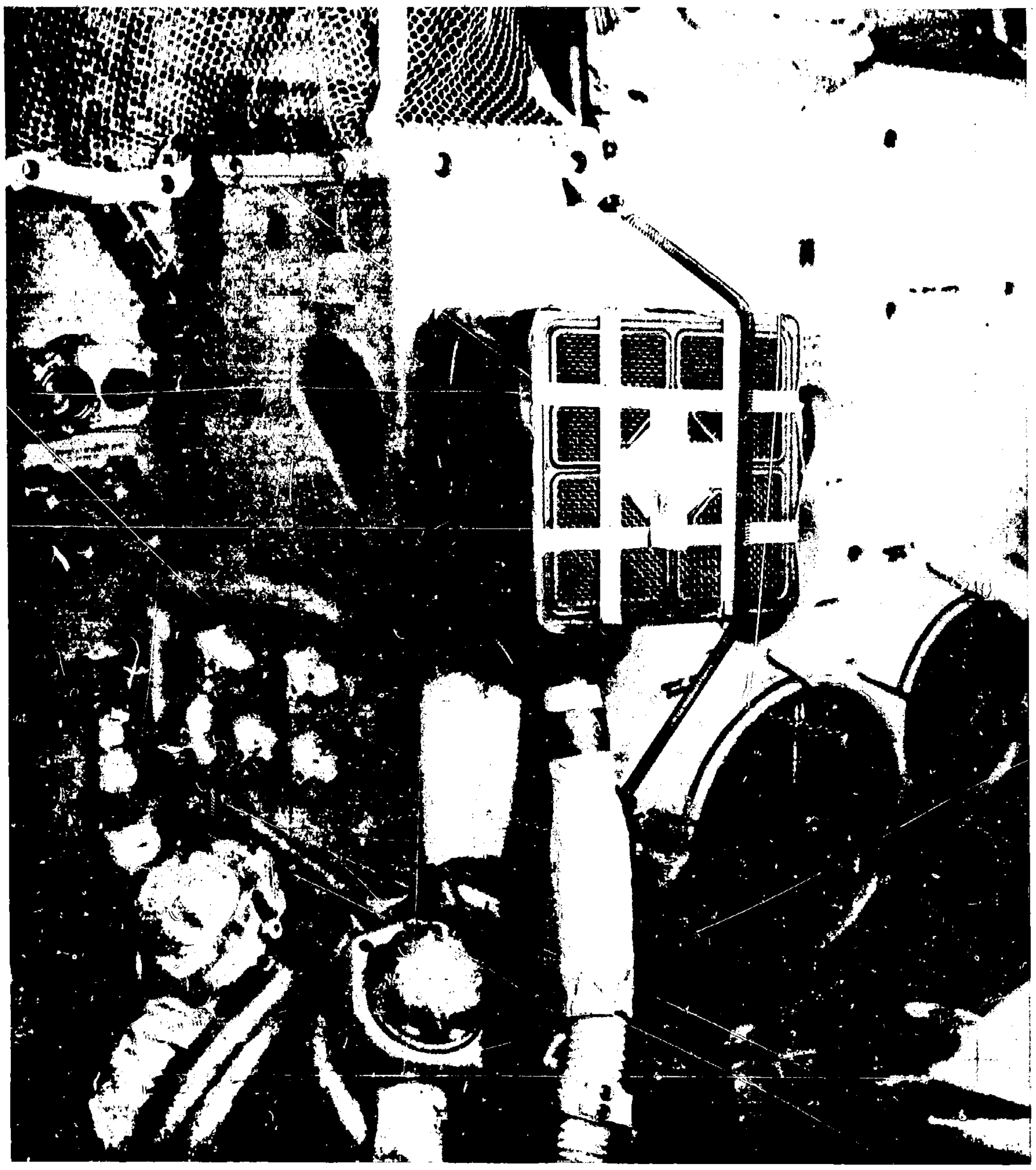


FIGURE 6 MODIFIED LITHIUM HYDROXIDE CANISTER IN OPERATION IN THE APOLLO 13 LUNAR MODULE

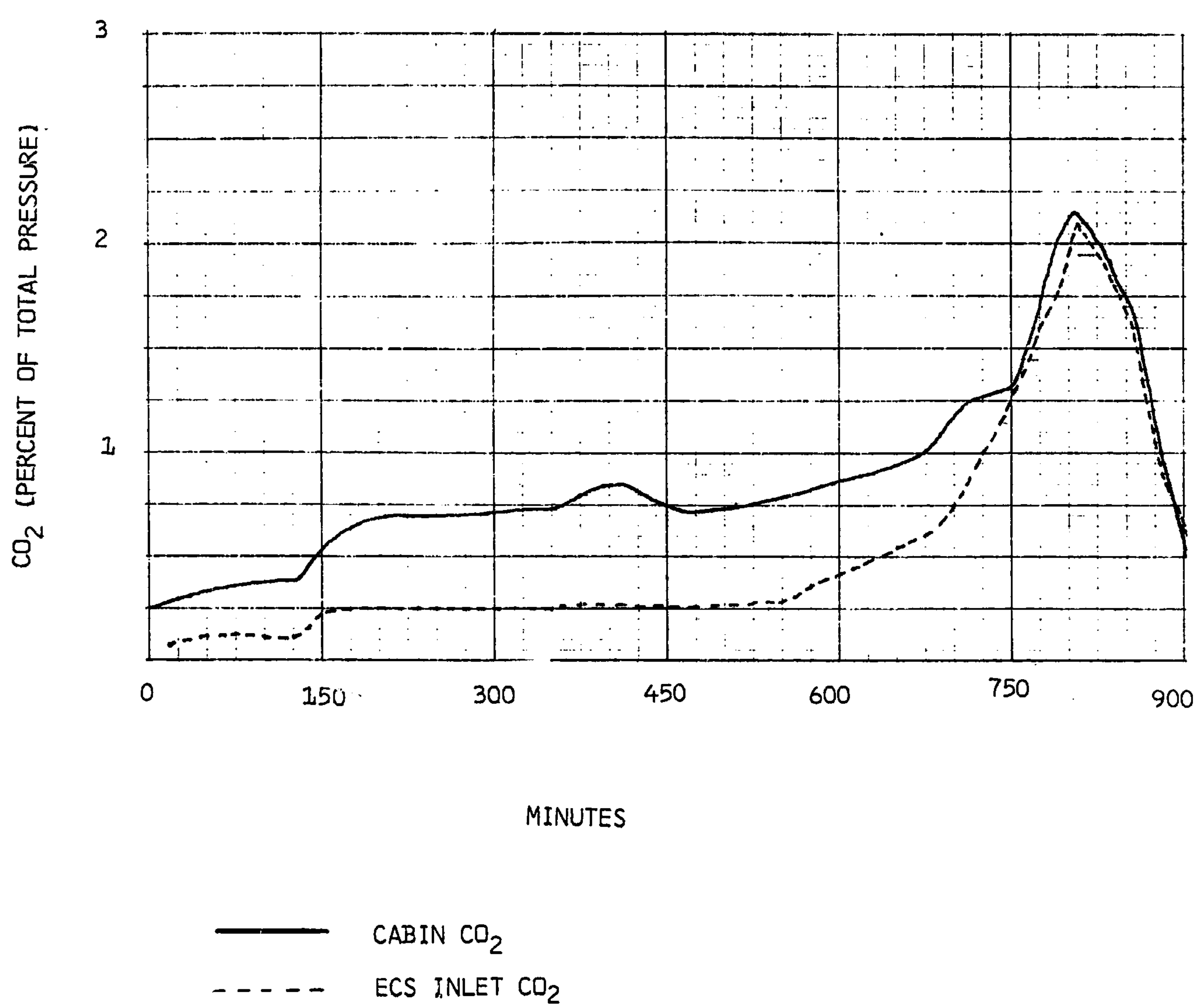


FIGURE 7 CABIN CO2 AND ENVIRONMENTAL CONTROL SYSTEM CO2 (TEST PHASE 1) VERSUS TIME

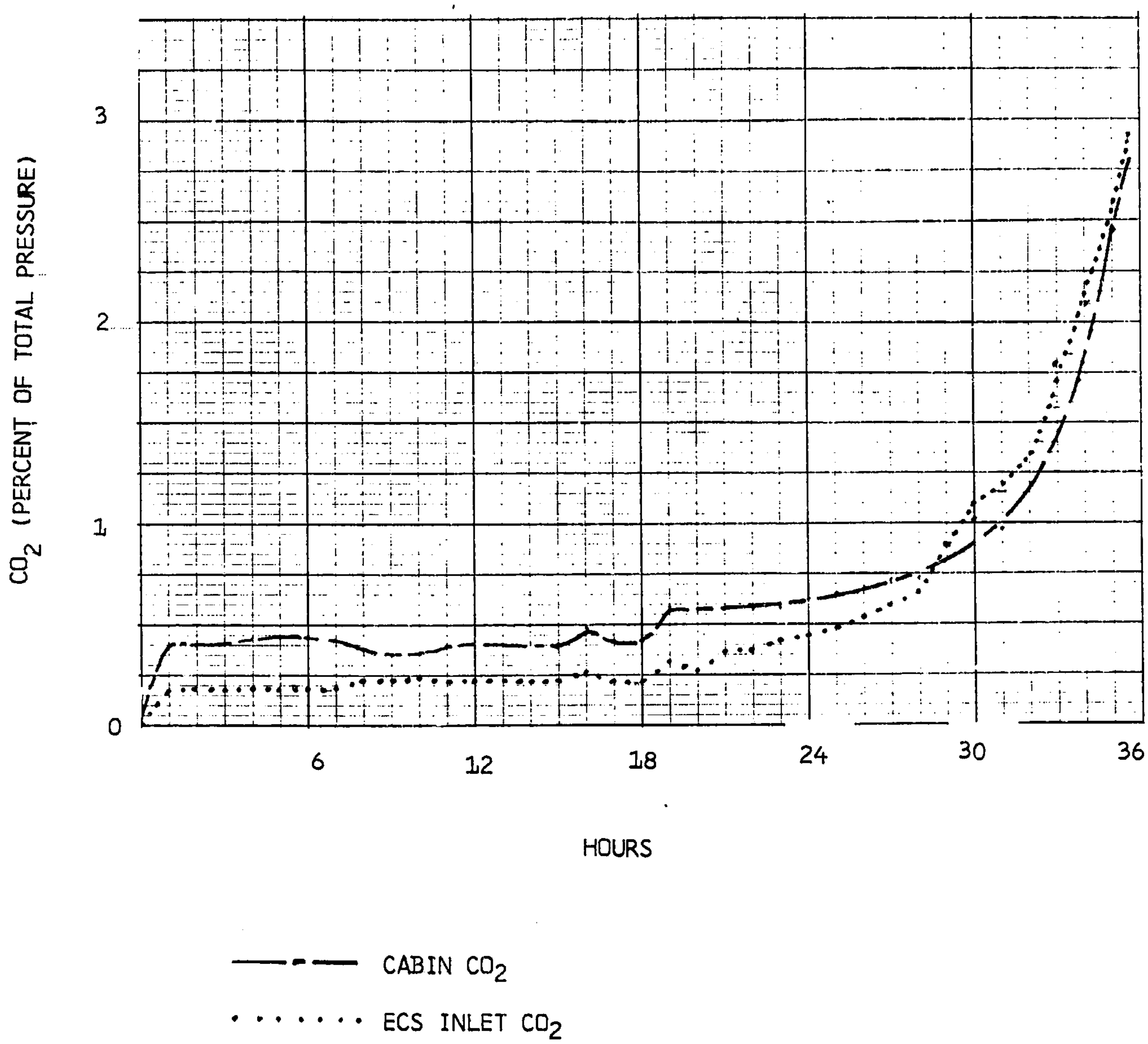


FIGURE 8 CABIN CO2 AND ENVIRONMENTAL CONTROL SYSTEM CO2 (TEST PHASE 2) VERSUS TIME

APPENDIX A

TEST PARAMETERS -

APOLLO 13 LIOH
BREAKTHROUGH TEST

FIGURES

FIGURES

FIGURES FOR TEST NO. 1

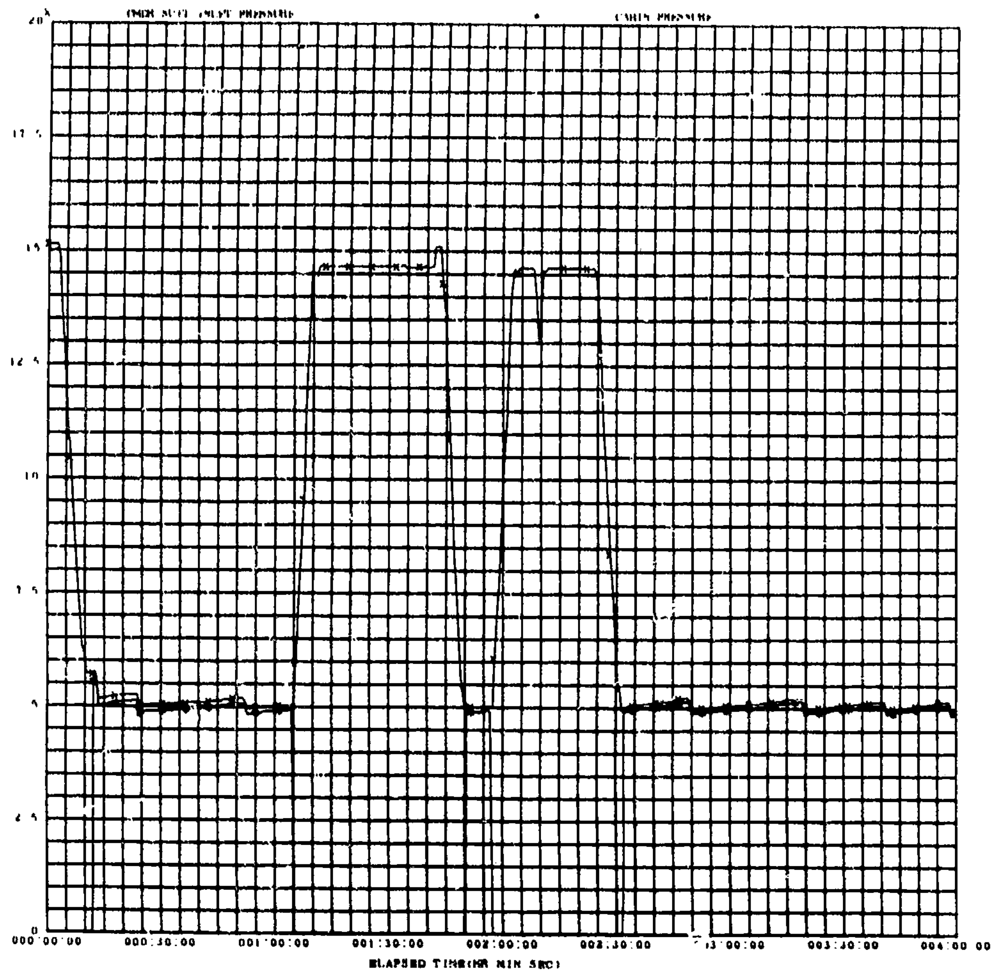


FIGURE 1 CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME

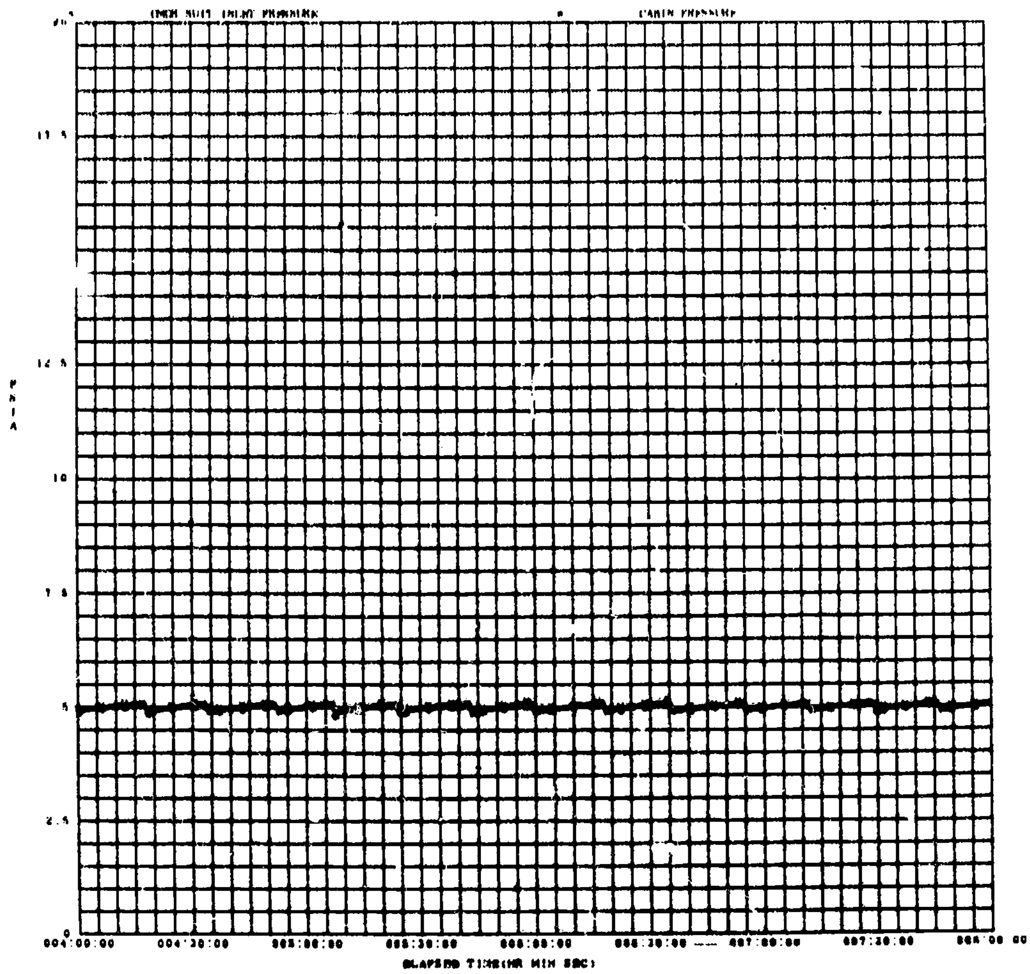


FIGURE 1A CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

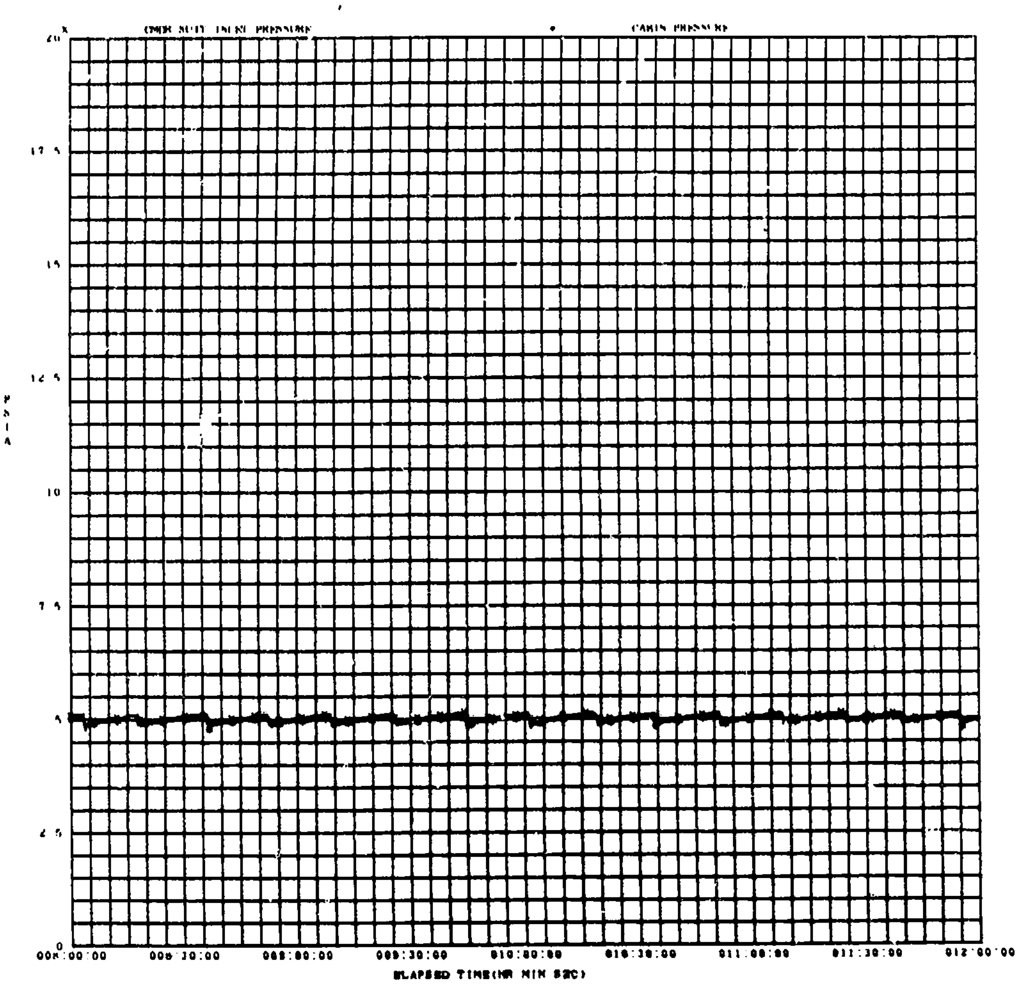


FIGURE 1B CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

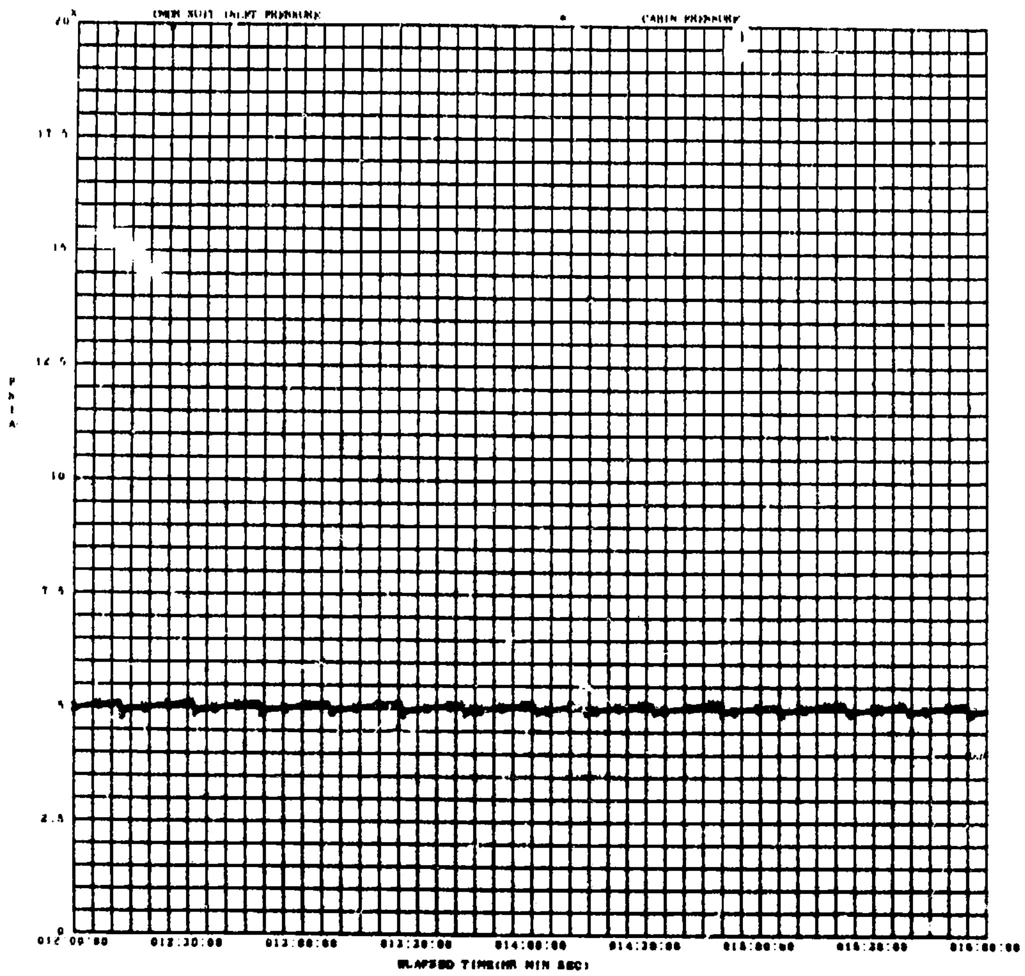


FIGURE 1C CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

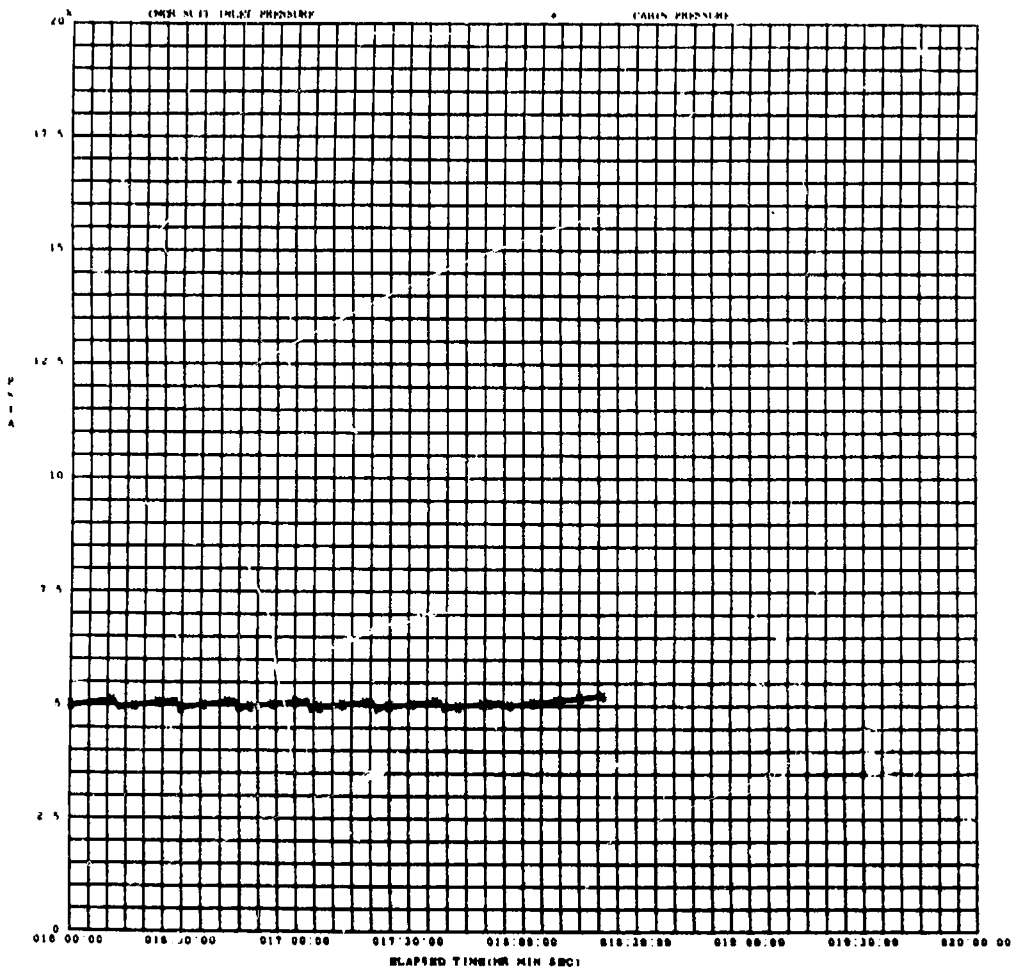


FIGURE 1D CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONCLUDED

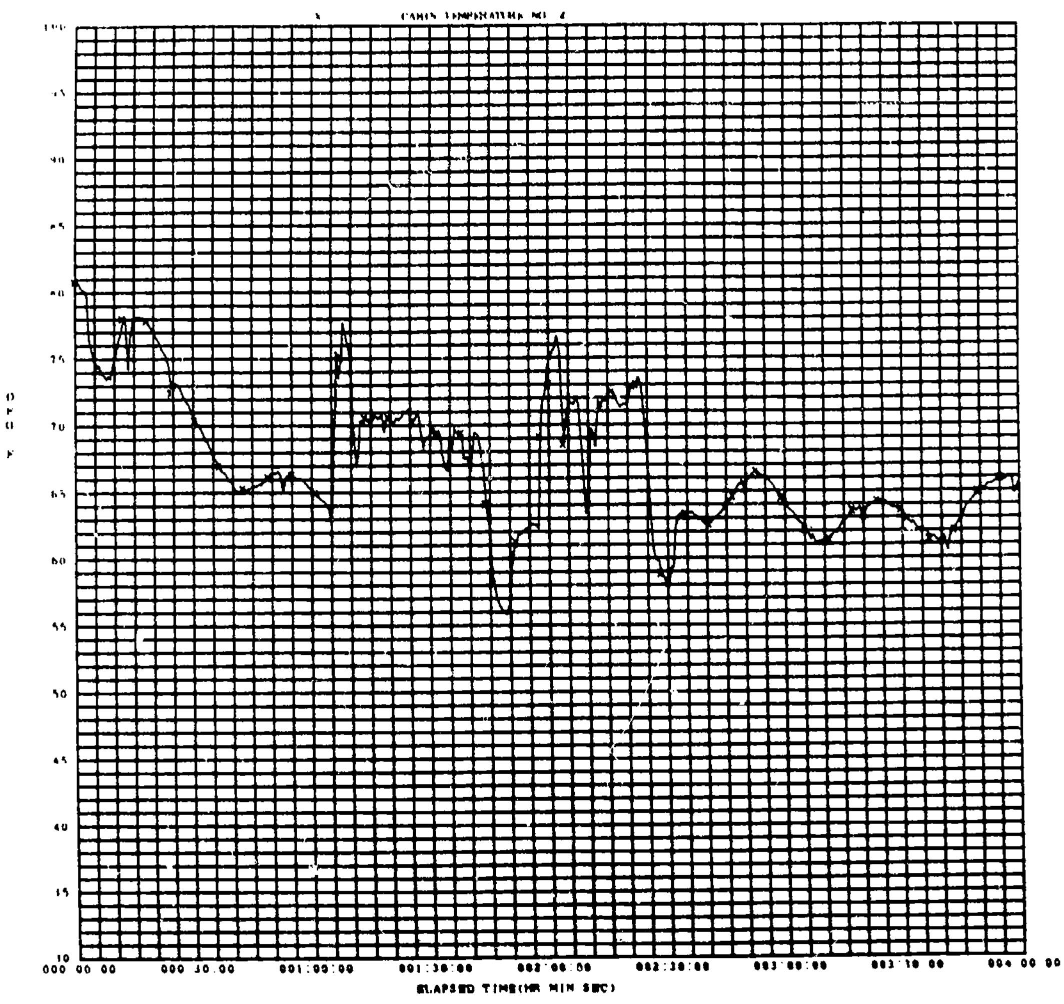


FIGURE 2 CABIN TEMPERATURE NO. 2 VERSUS TIME

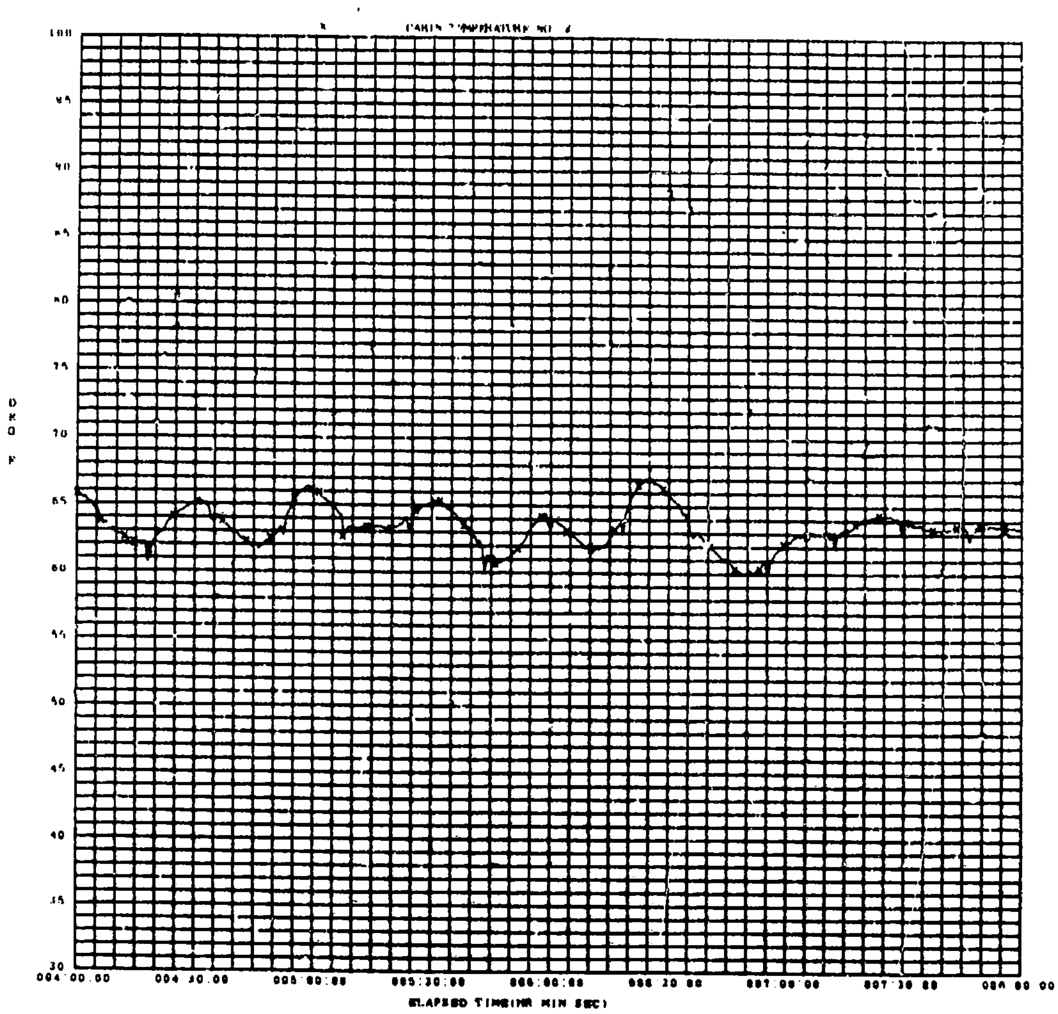


FIGURE 2A CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

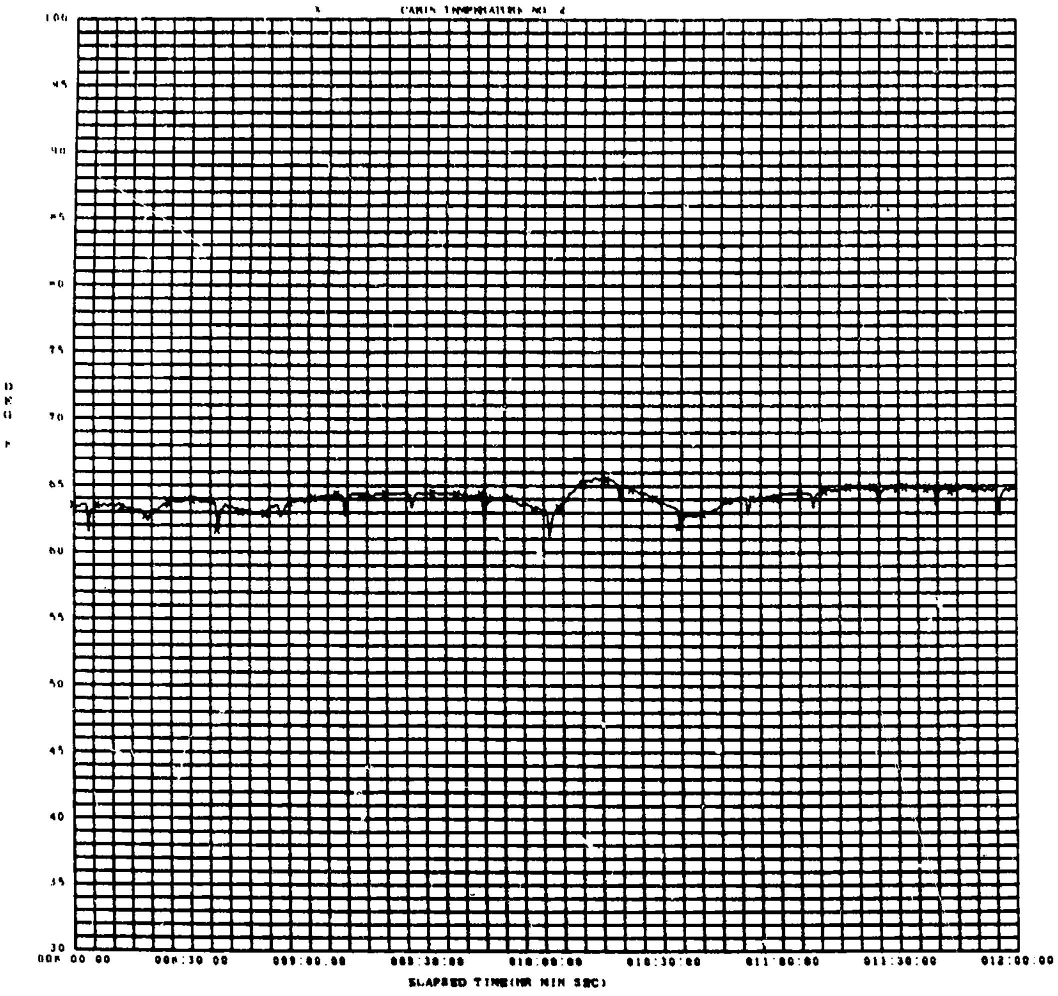


FIGURE 2B CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

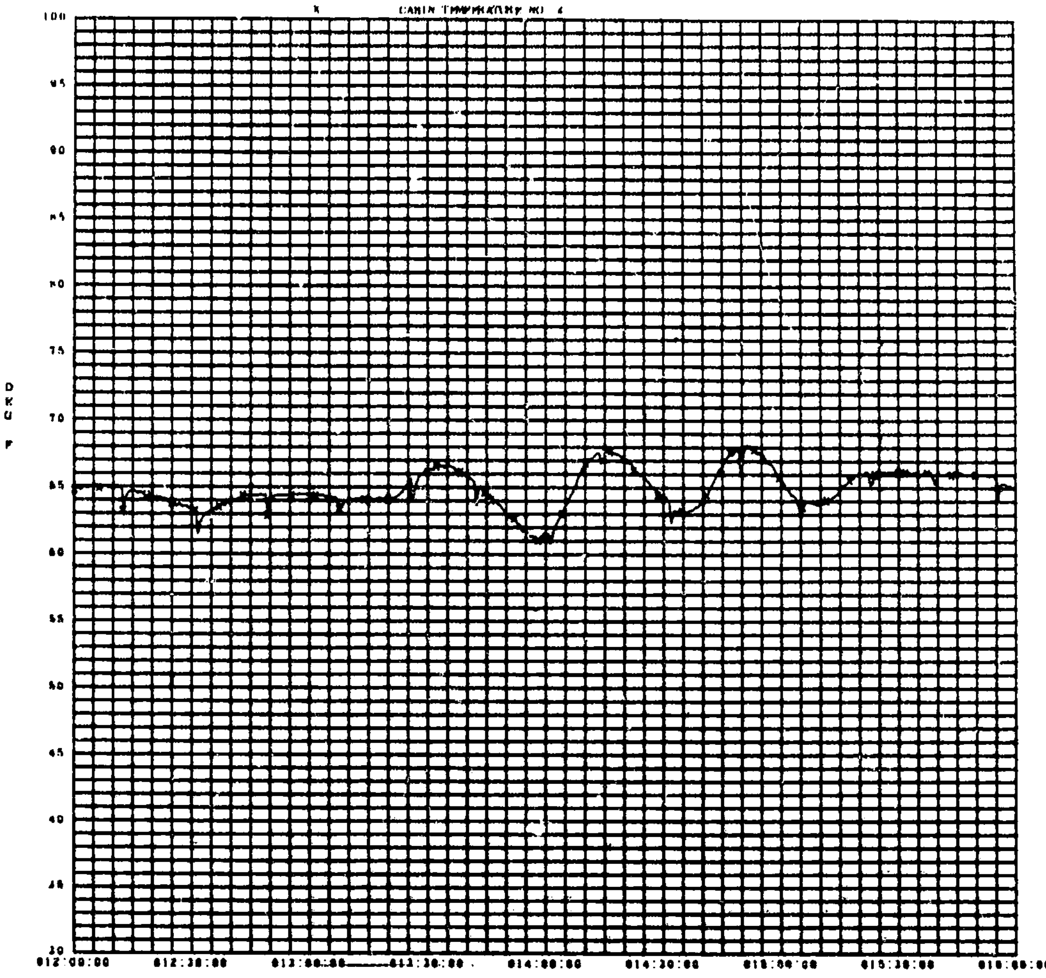


FIGURE 2C CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

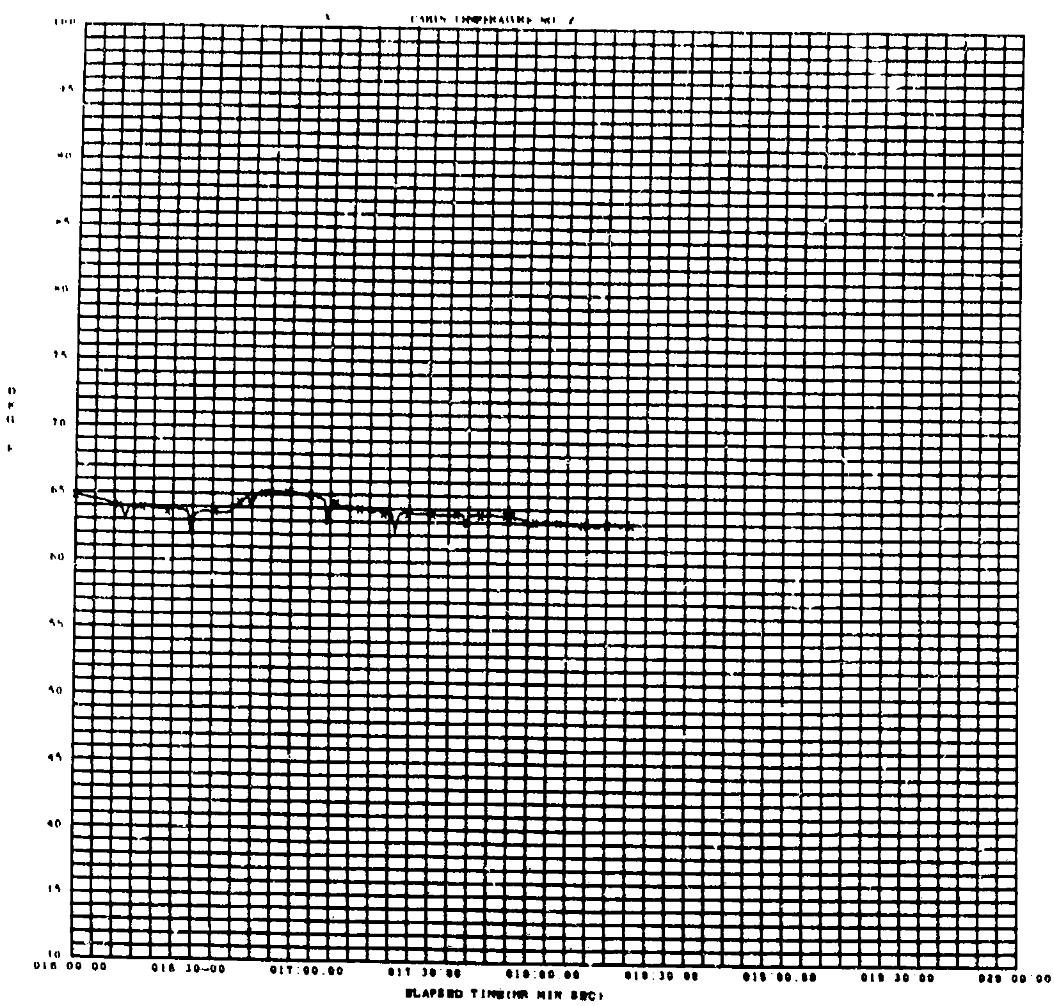


FIGURE 2D CABIN TEMPERATURE NO. 2 VERSUS TIME - CONCLUDED

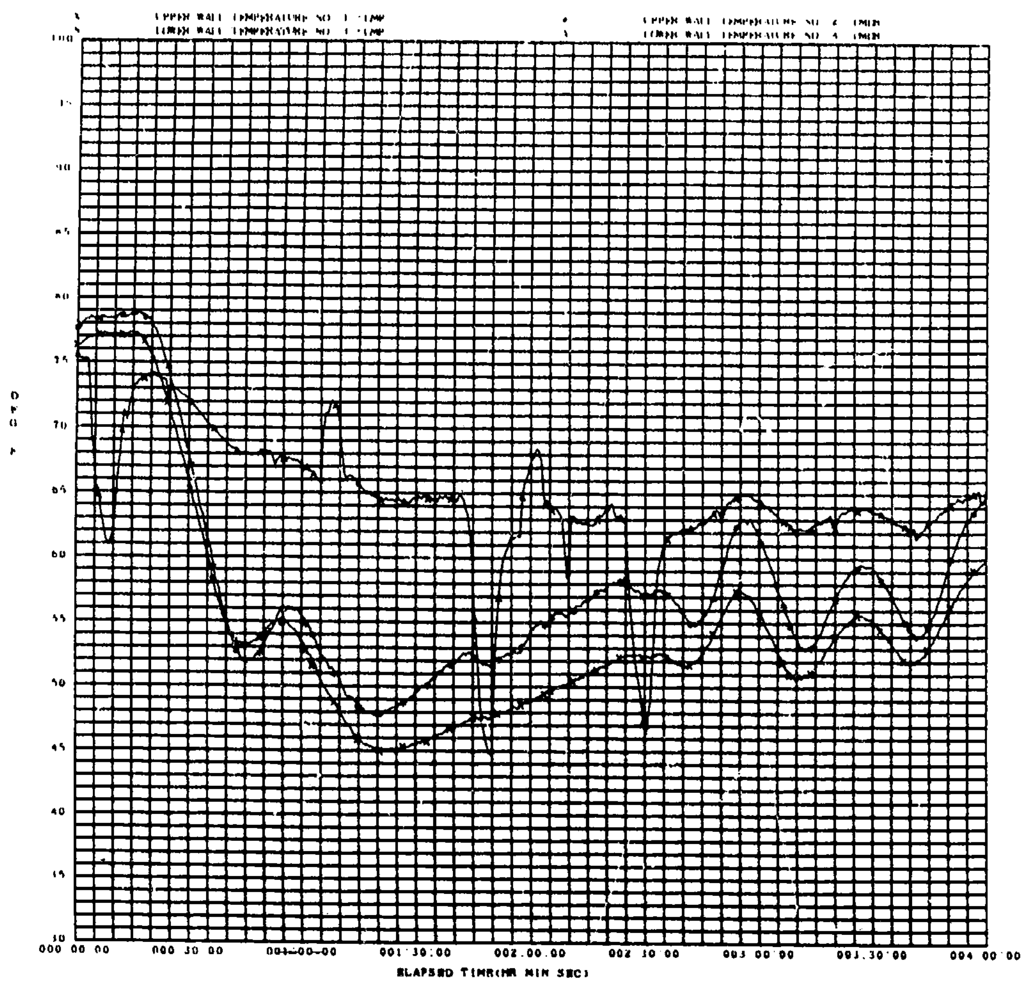


FIGURE 3 WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME

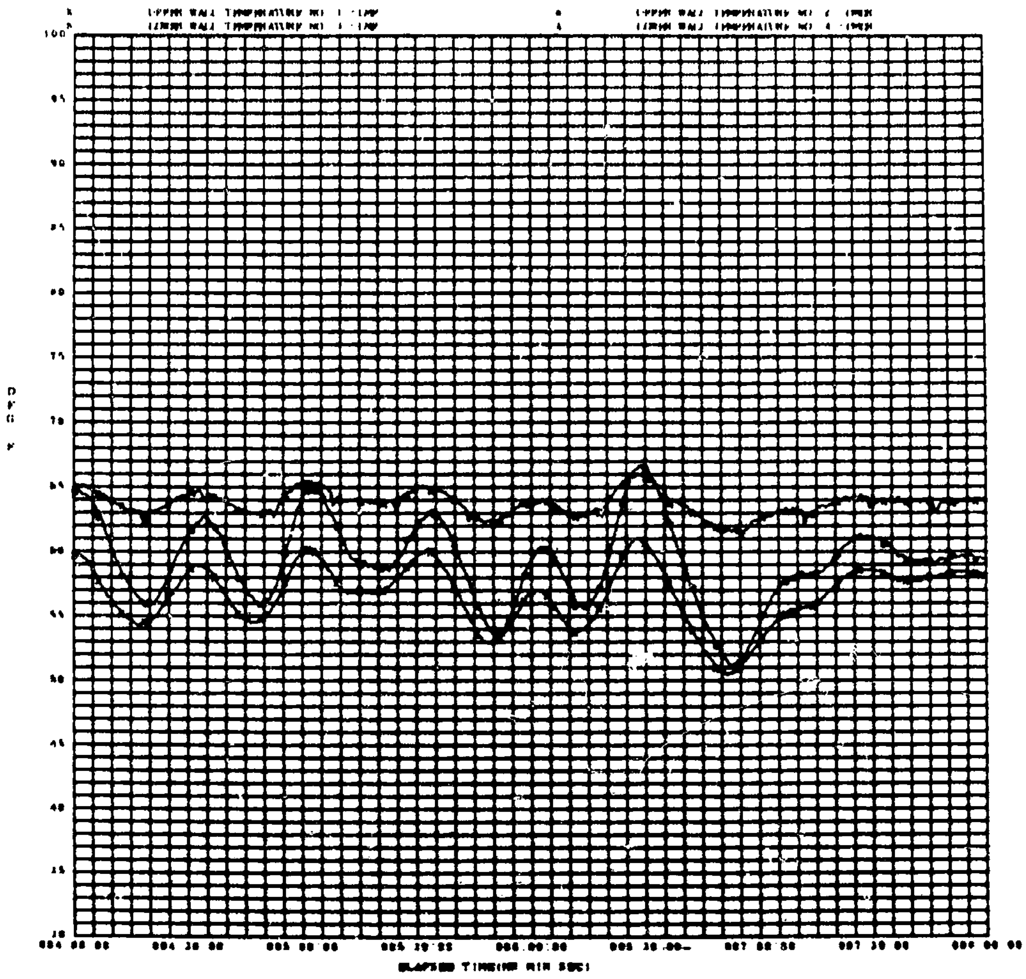


FIGURE 3A WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

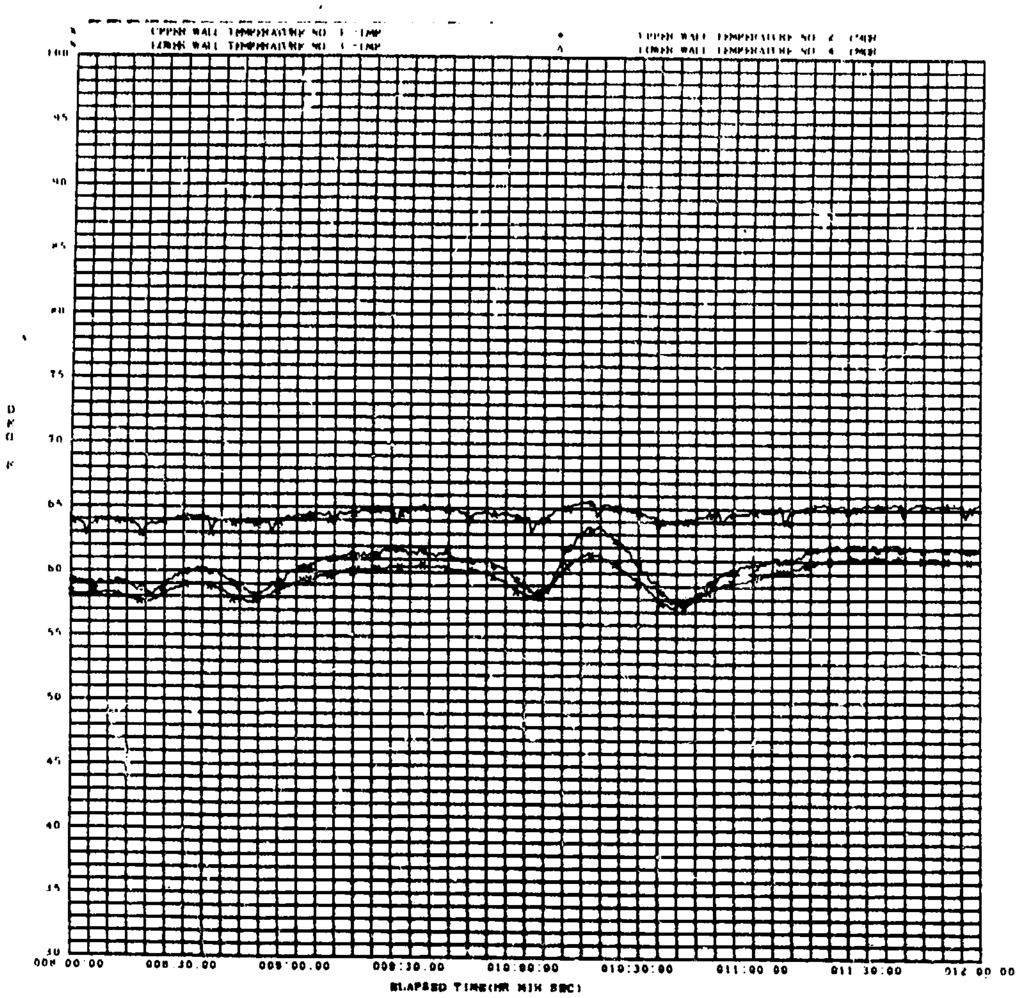


FIGURE 3B WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

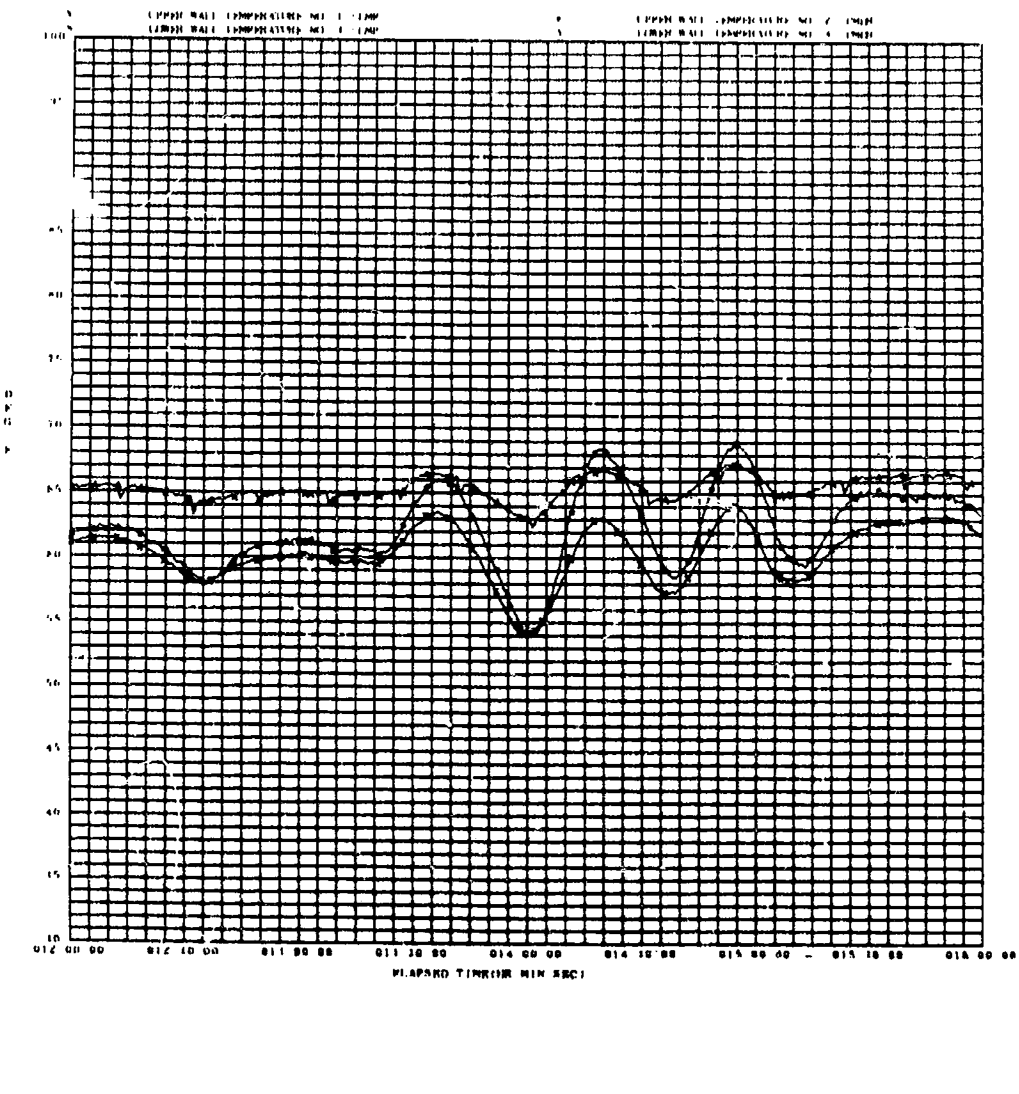


FIGURE 3C WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

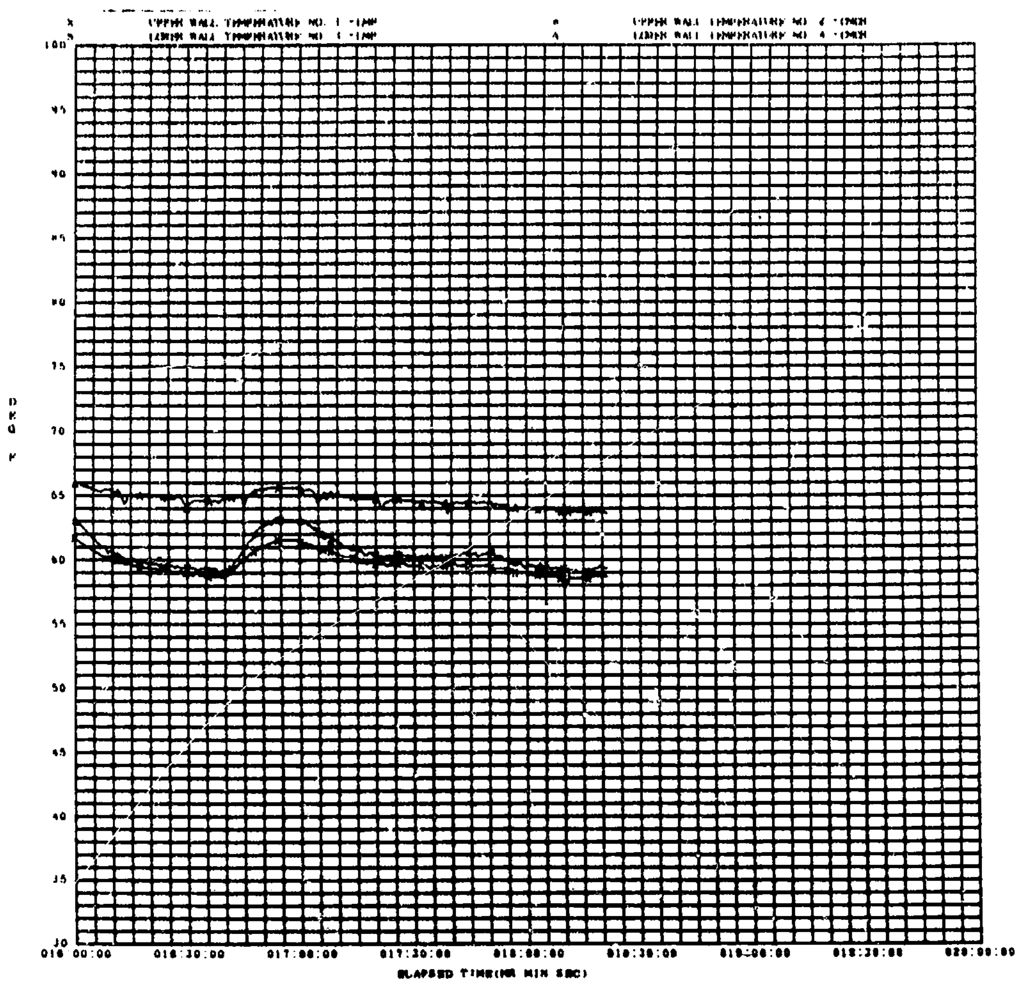


FIGURE 3D WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONCLUDED

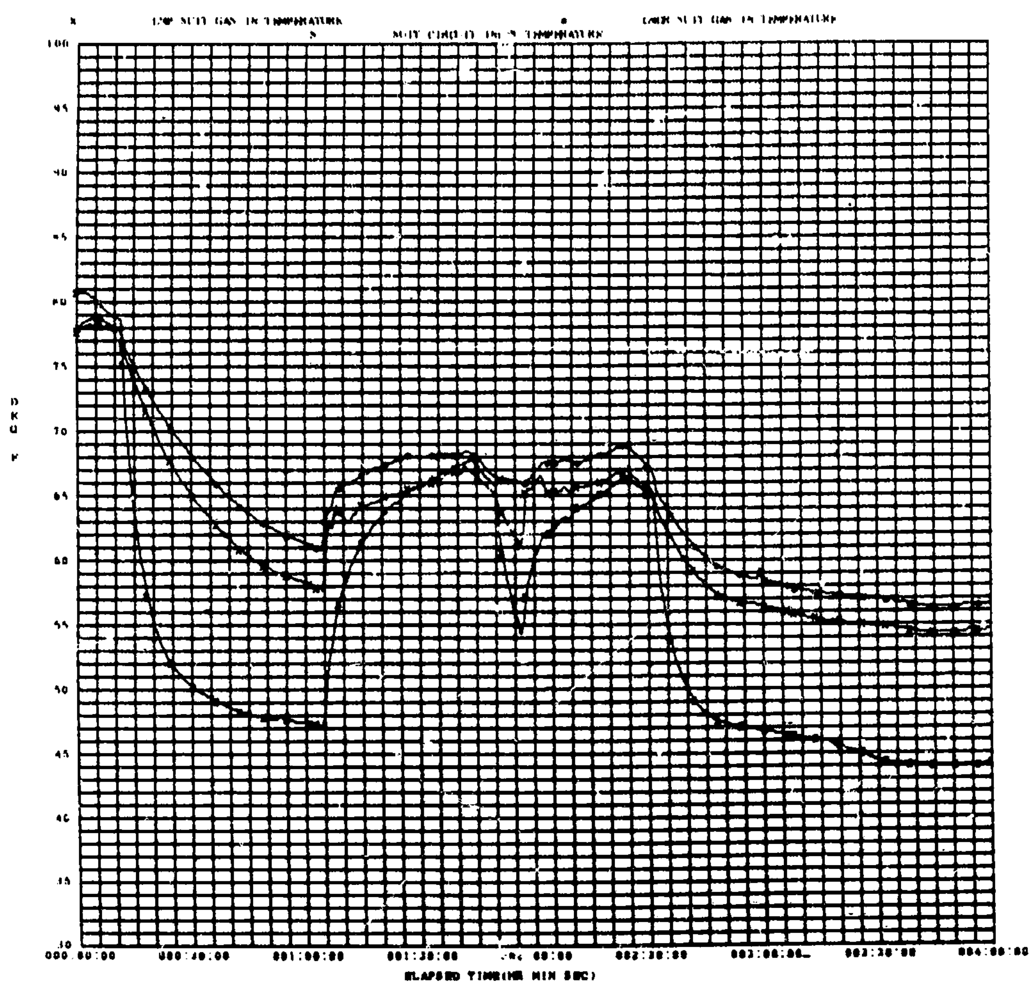


FIGURE 4 SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME

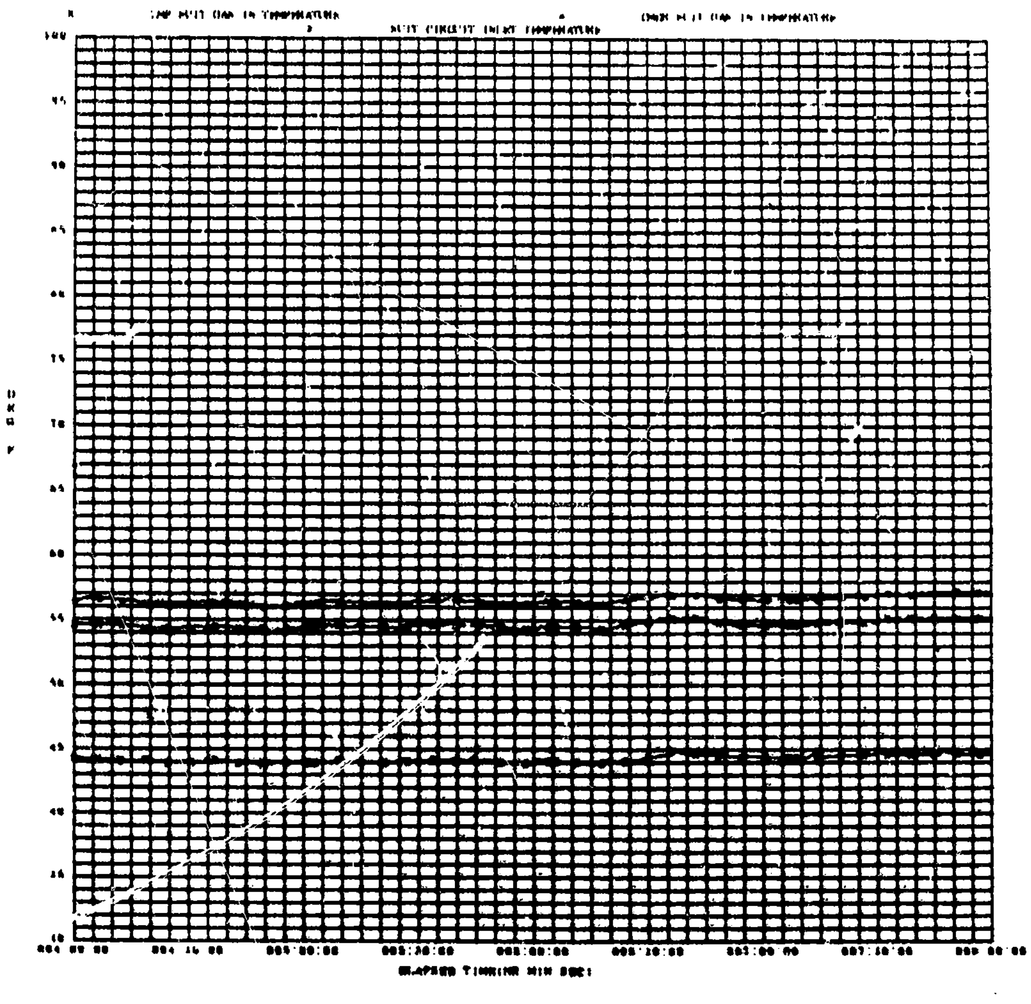


FIGURE 4A SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

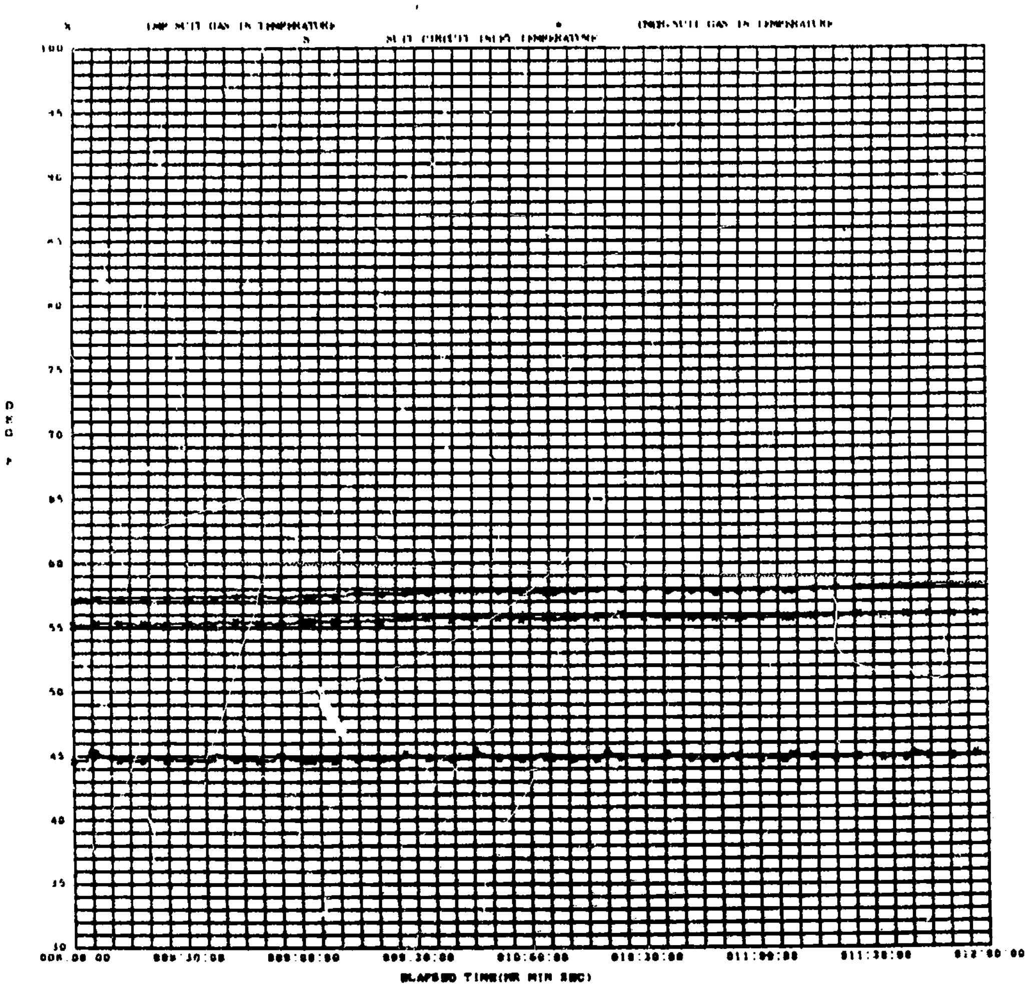


FIGURE 4B SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES
VERSUS TIME - CONTINUED

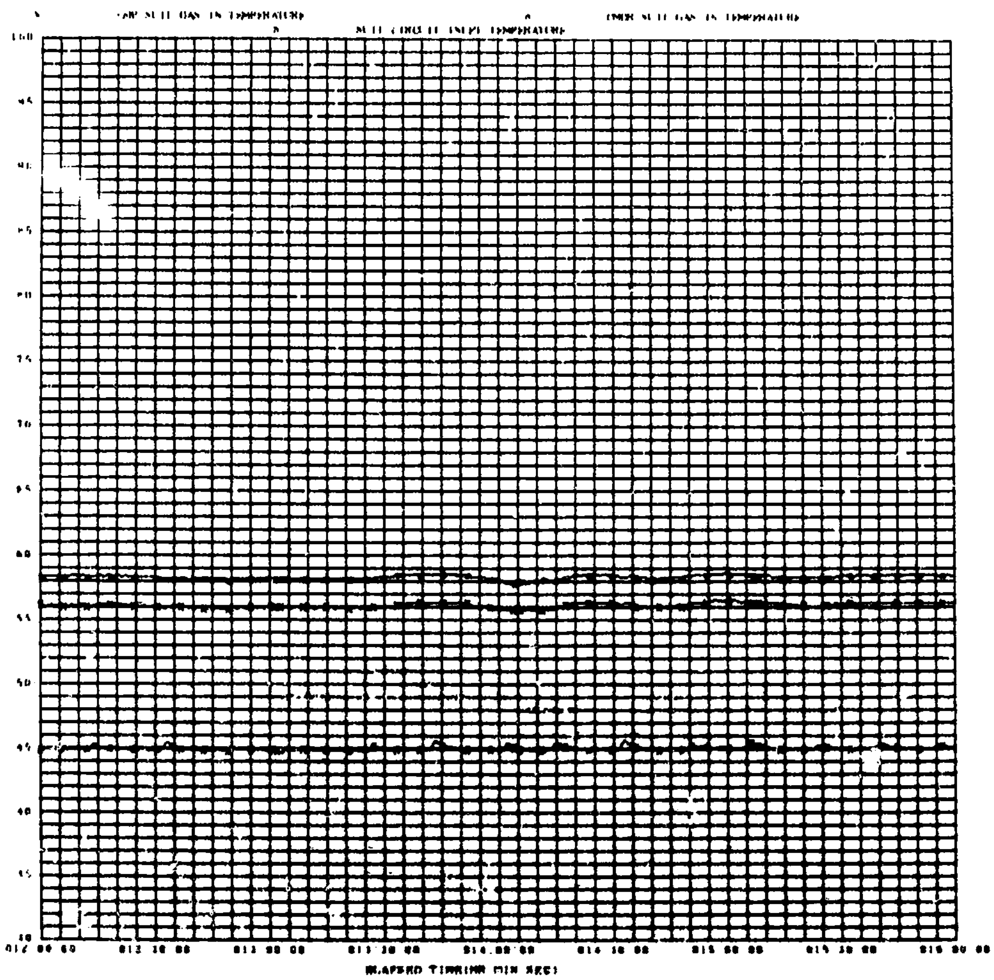


FIGURE 4C SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES
VERSUS TIME - CONTINUED

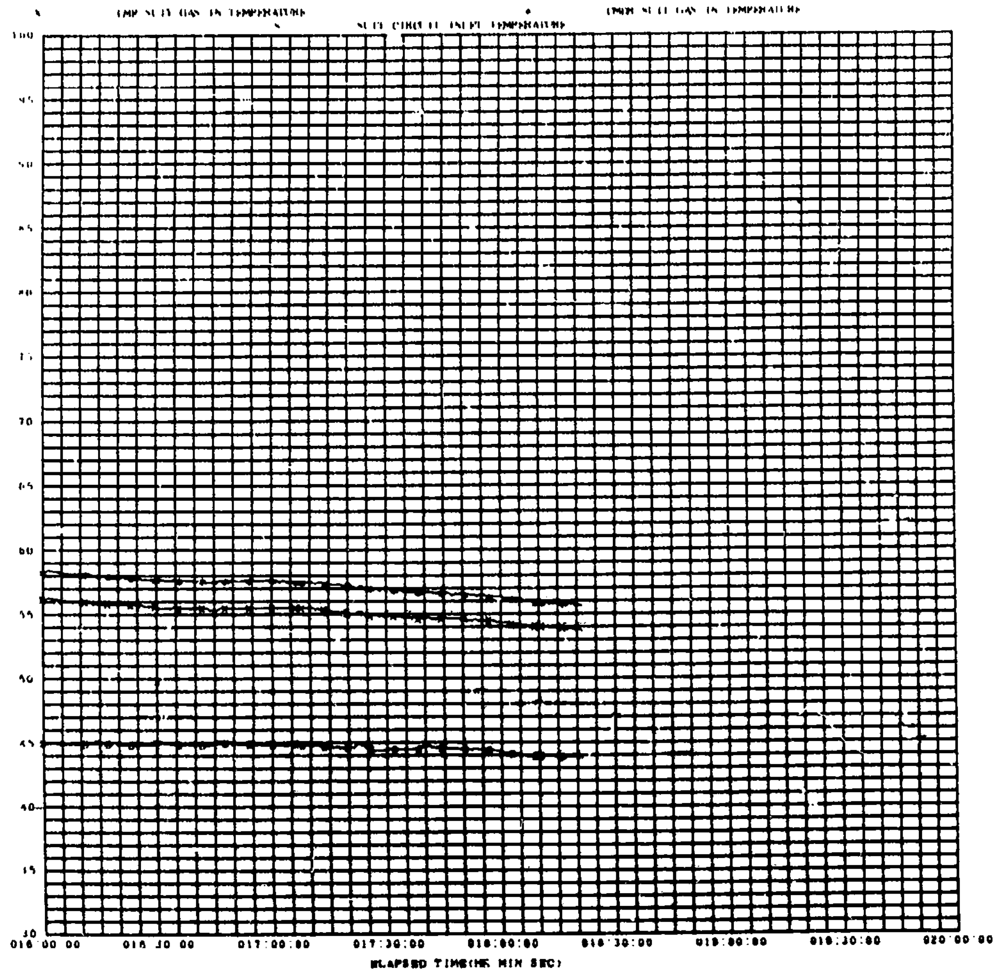


FIGURE 4D SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONCLUDED

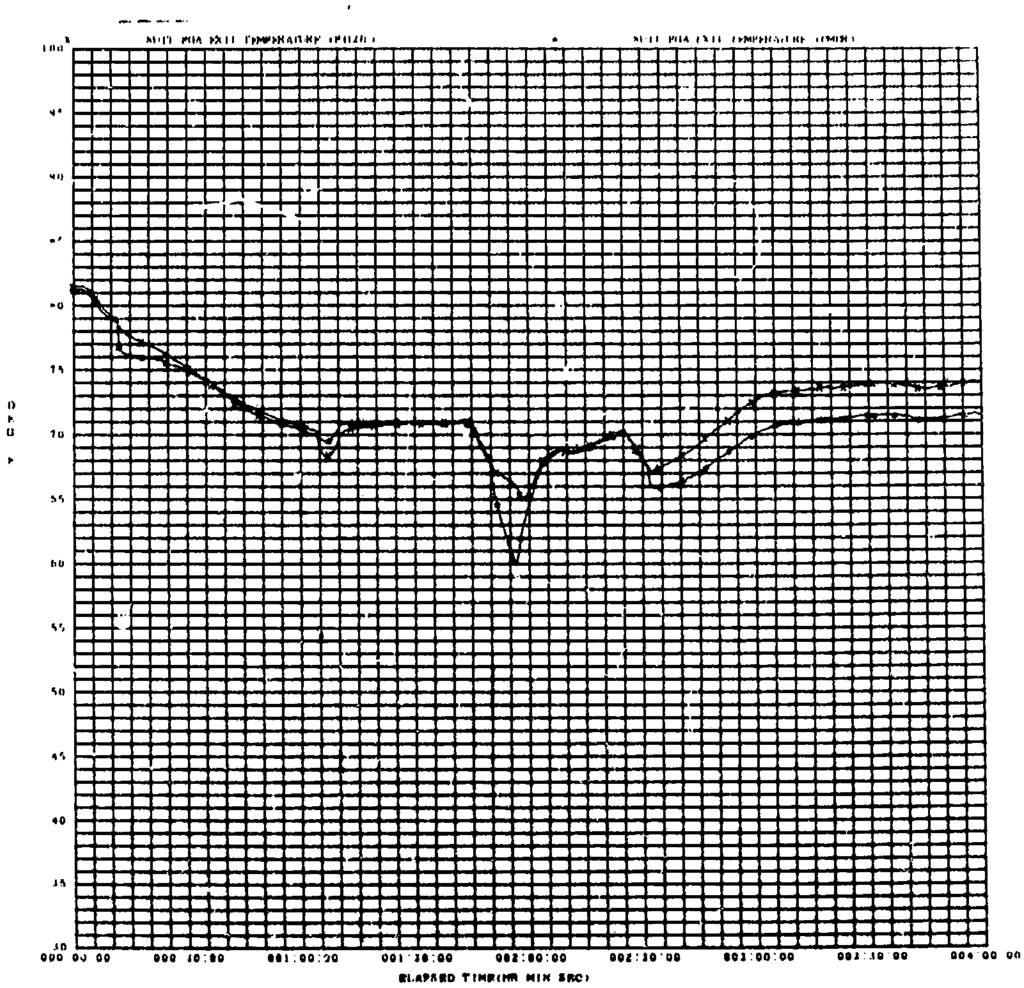


FIGURE 5 CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME

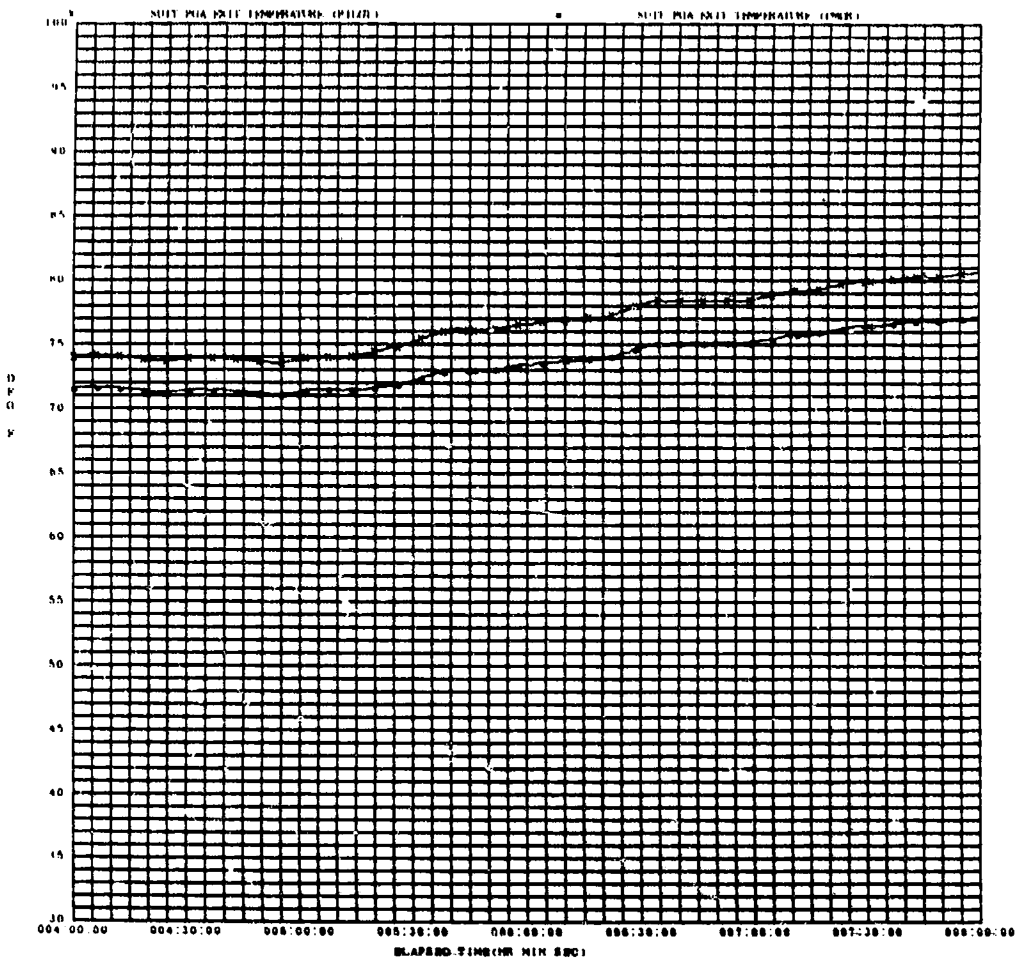


FIGURE 5A CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

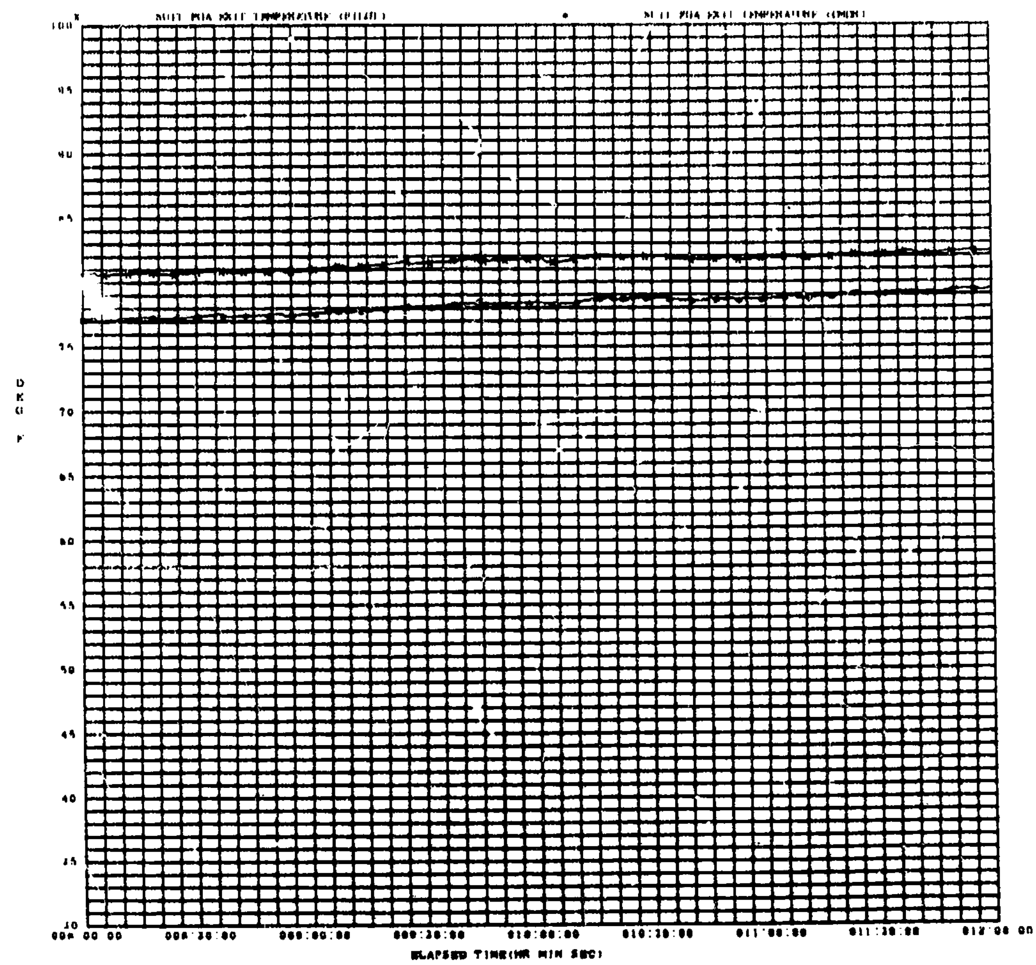


FIGURE 5B CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

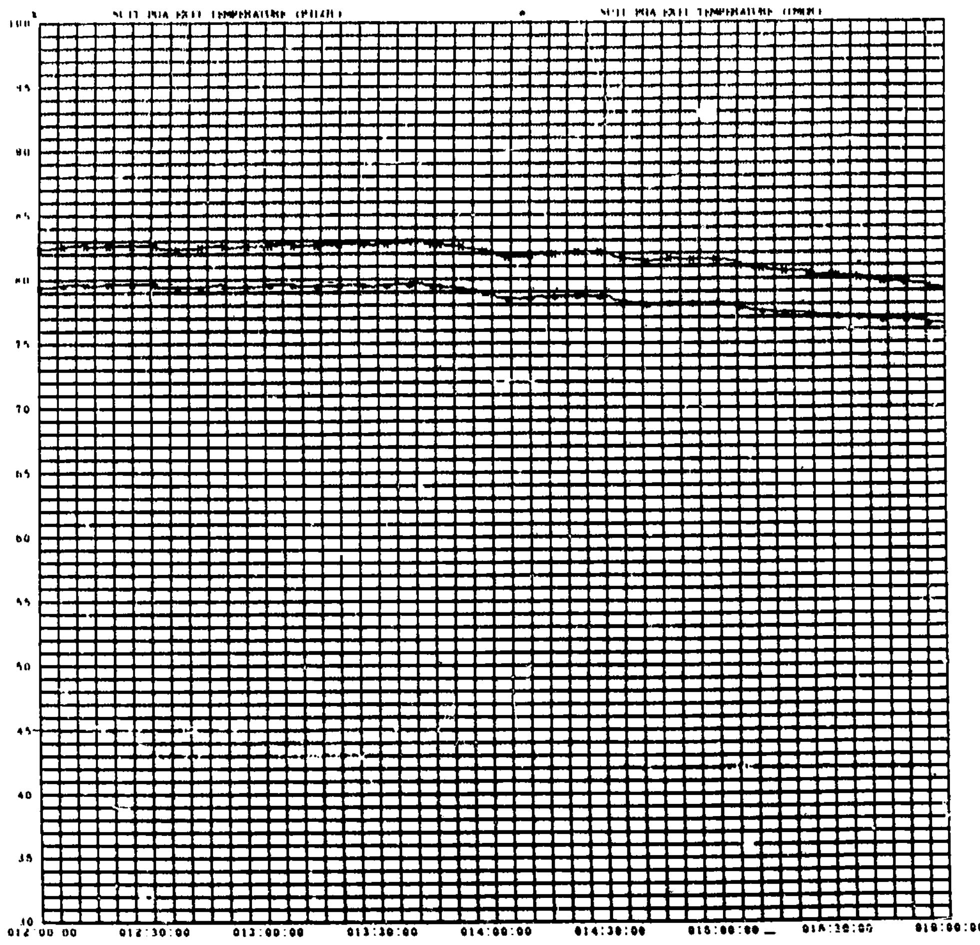


FIGURE 5C CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

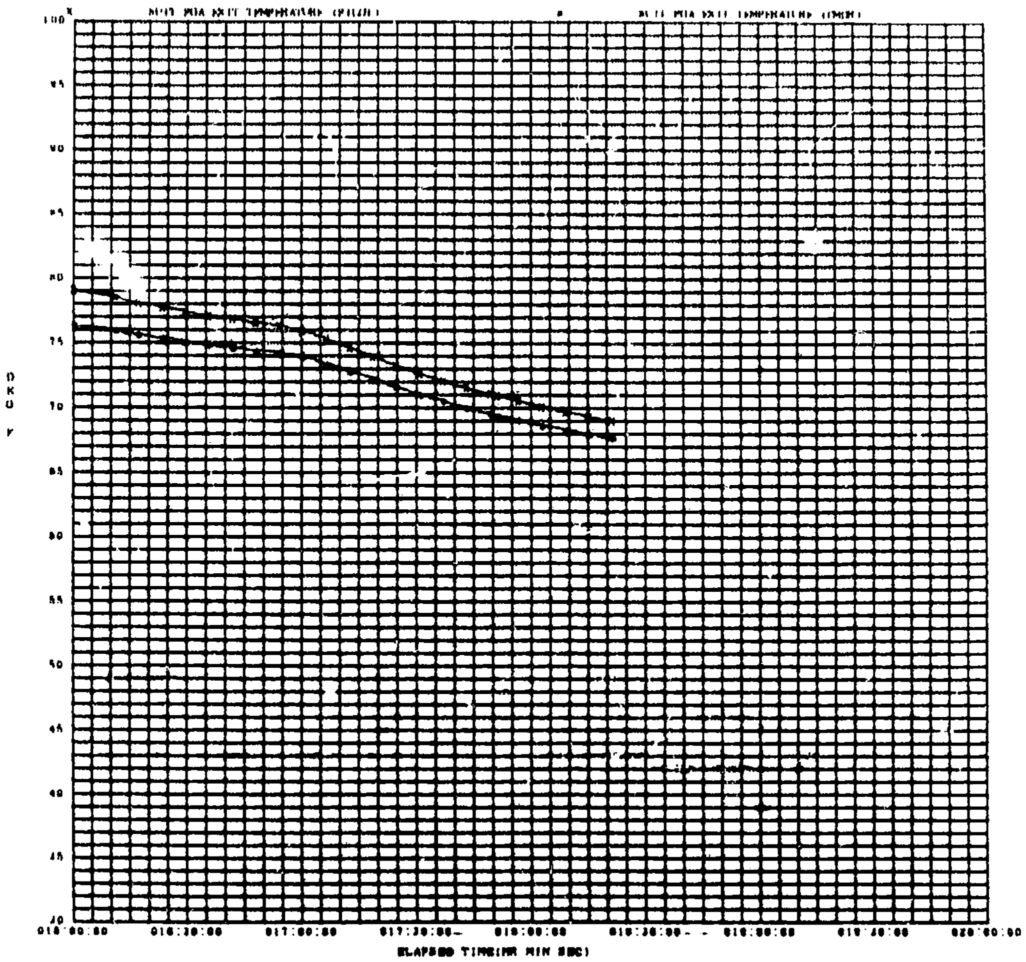


FIGURE 5D CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONCLUDED

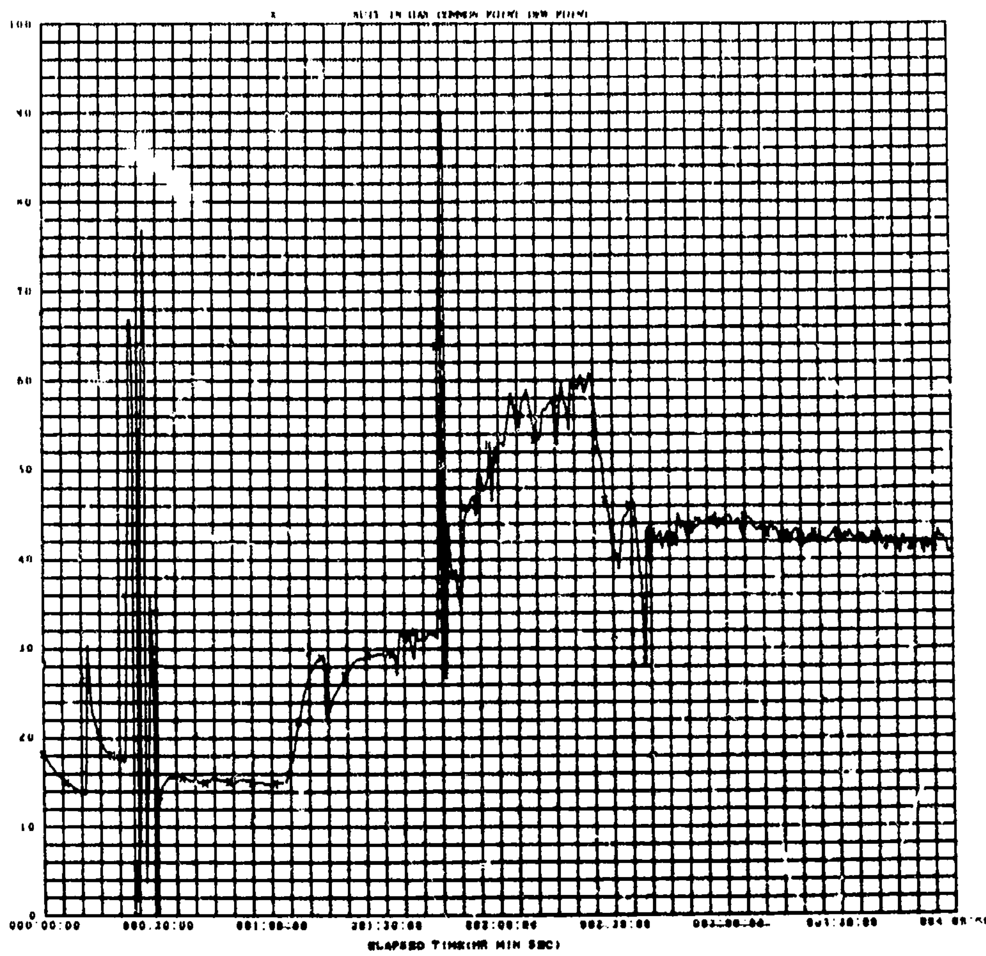


FIGURE 6 SUIT INLET GAS DEWPOINT VERSUS TIME

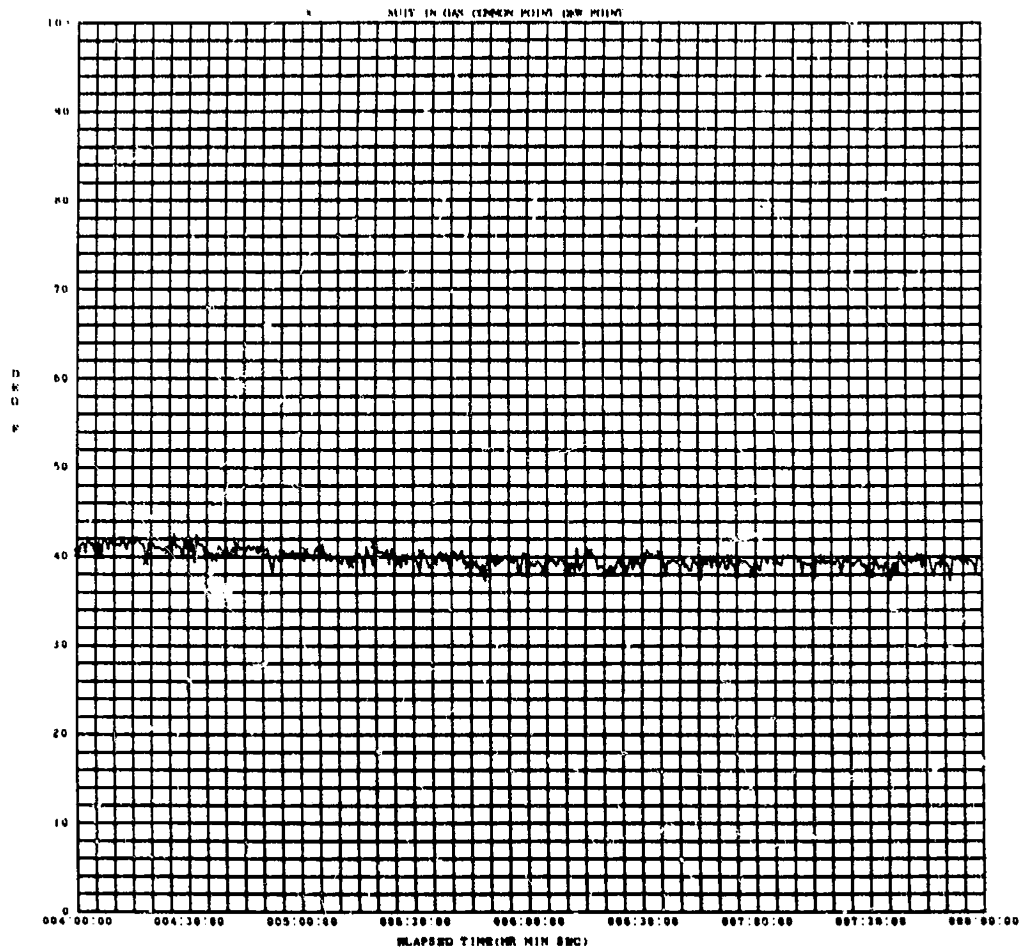


FIGURE 6A SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

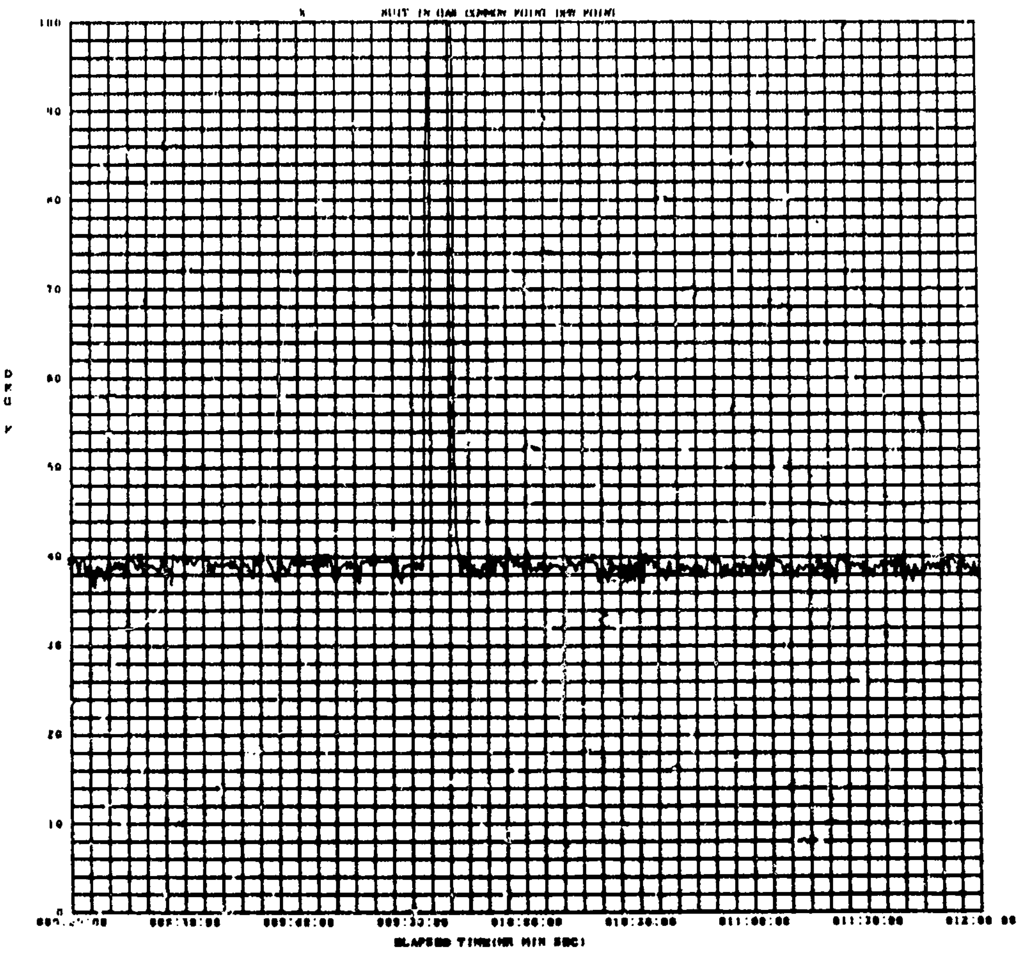


FIGURE 6B SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

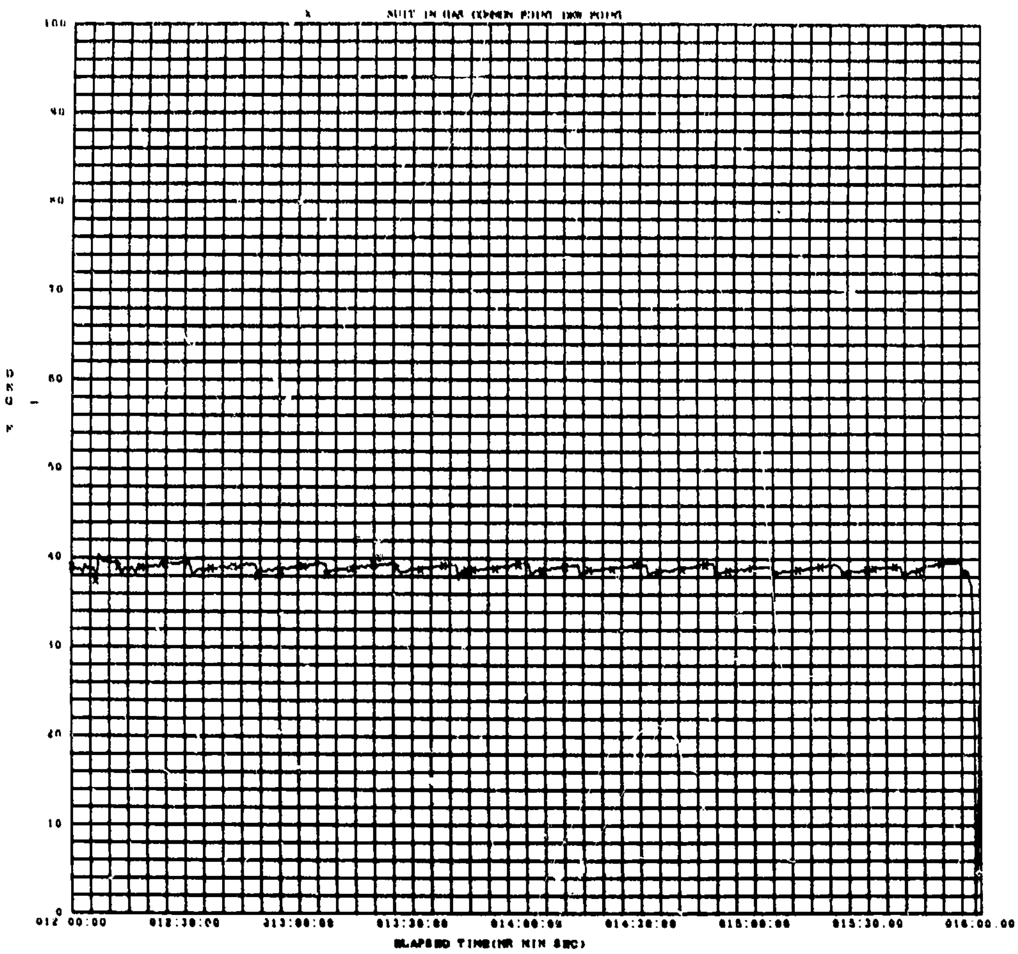


FIGURE 6C SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

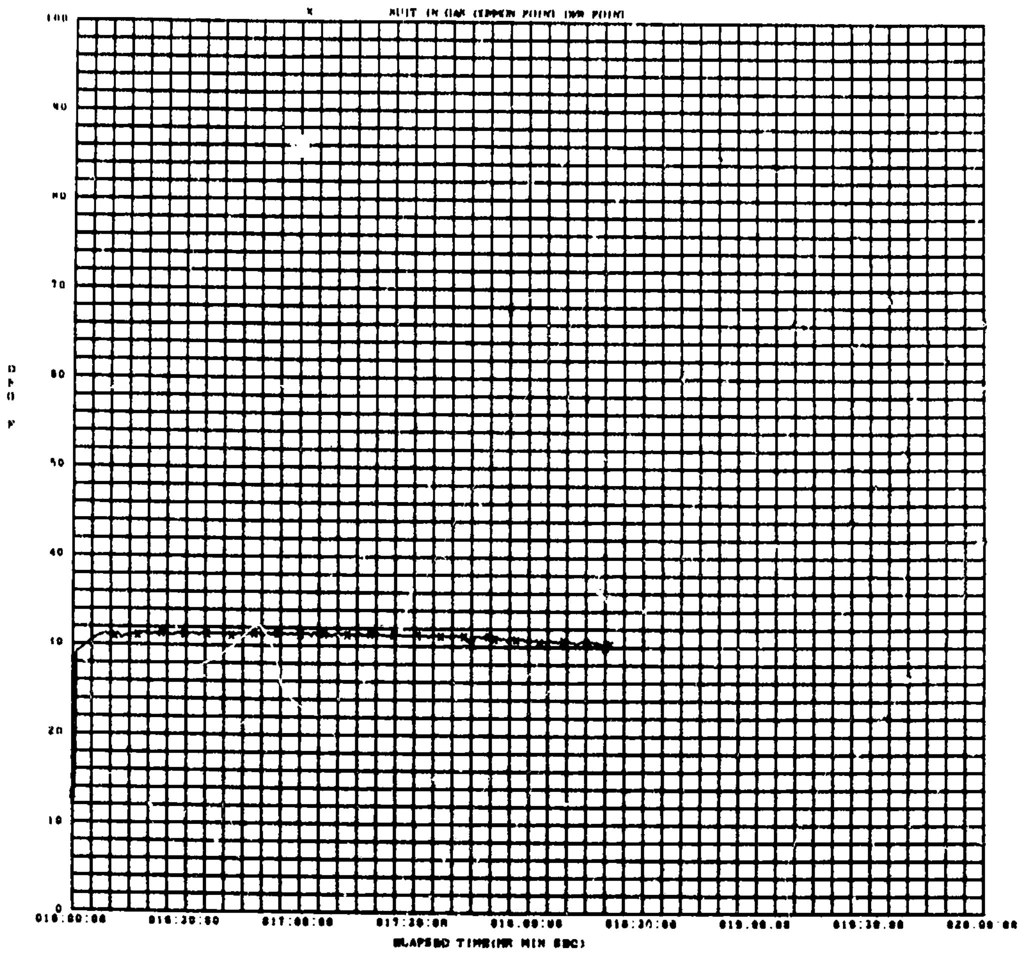


FIGURE 6D SUIT INLET GAS DEWPOINT VERSUS TIME - CONCLUDED

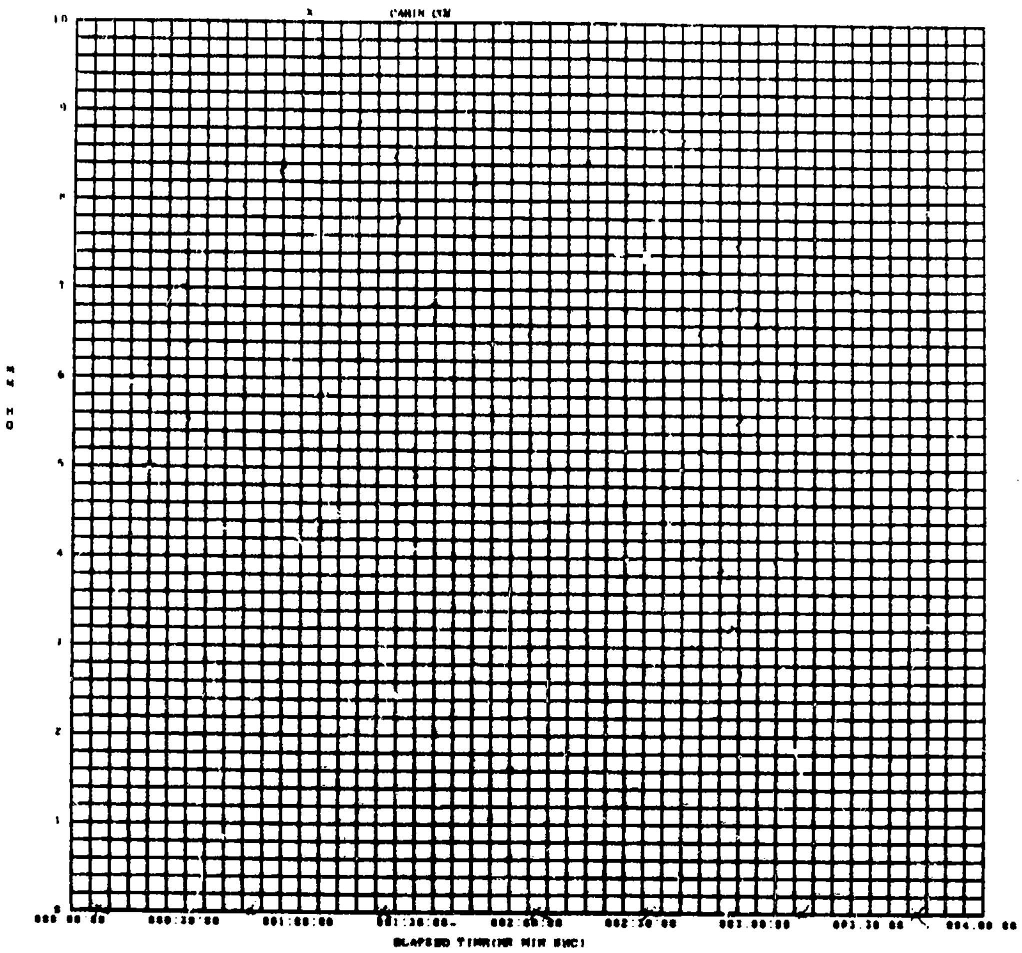


FIGURE 7 CABIN PARTIAL PRESSJRE CU2 VERSUS TIME

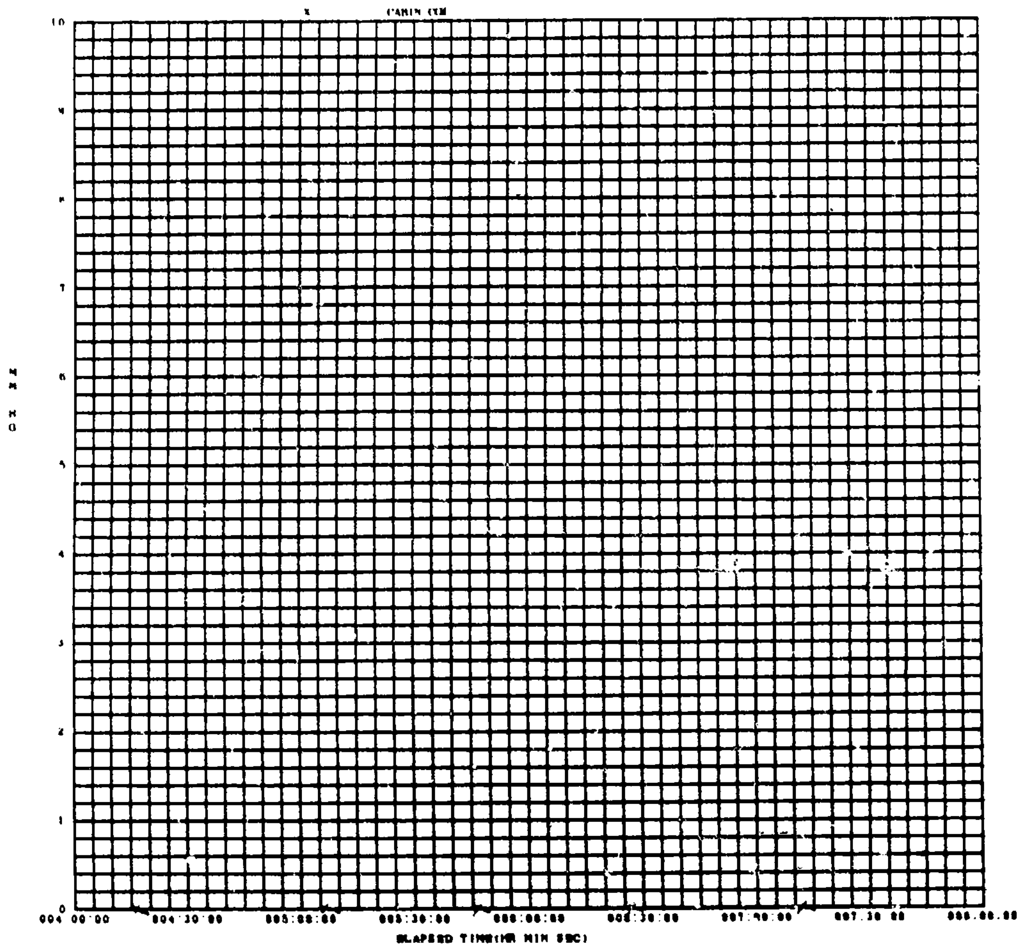


FIGURE 7A CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

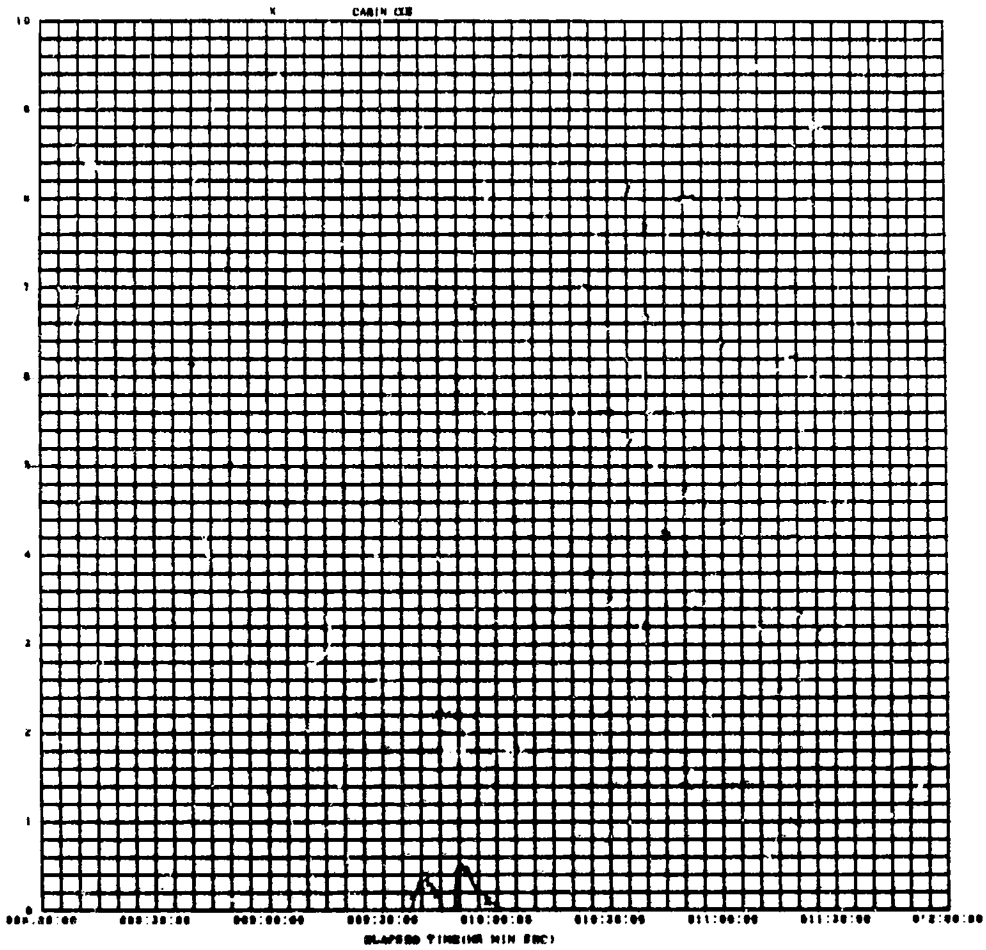


FIGURE 7B CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

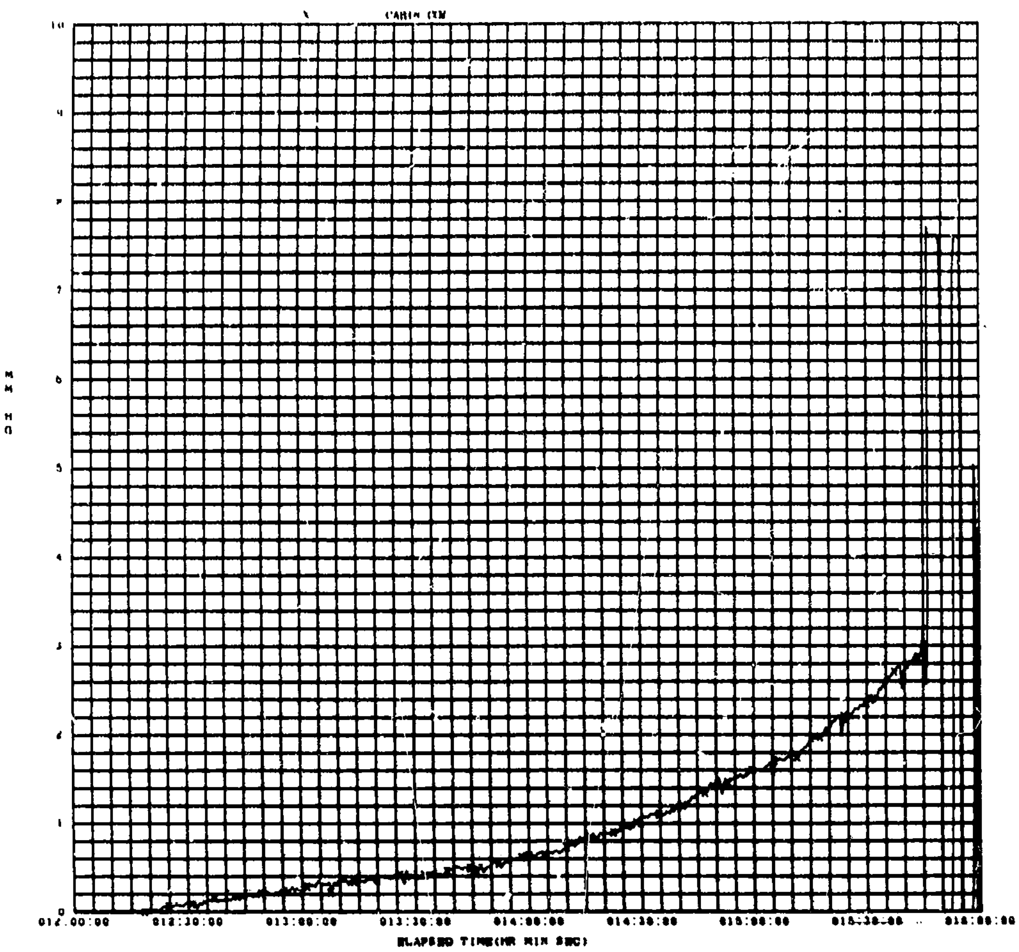


FIGURE 7C CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

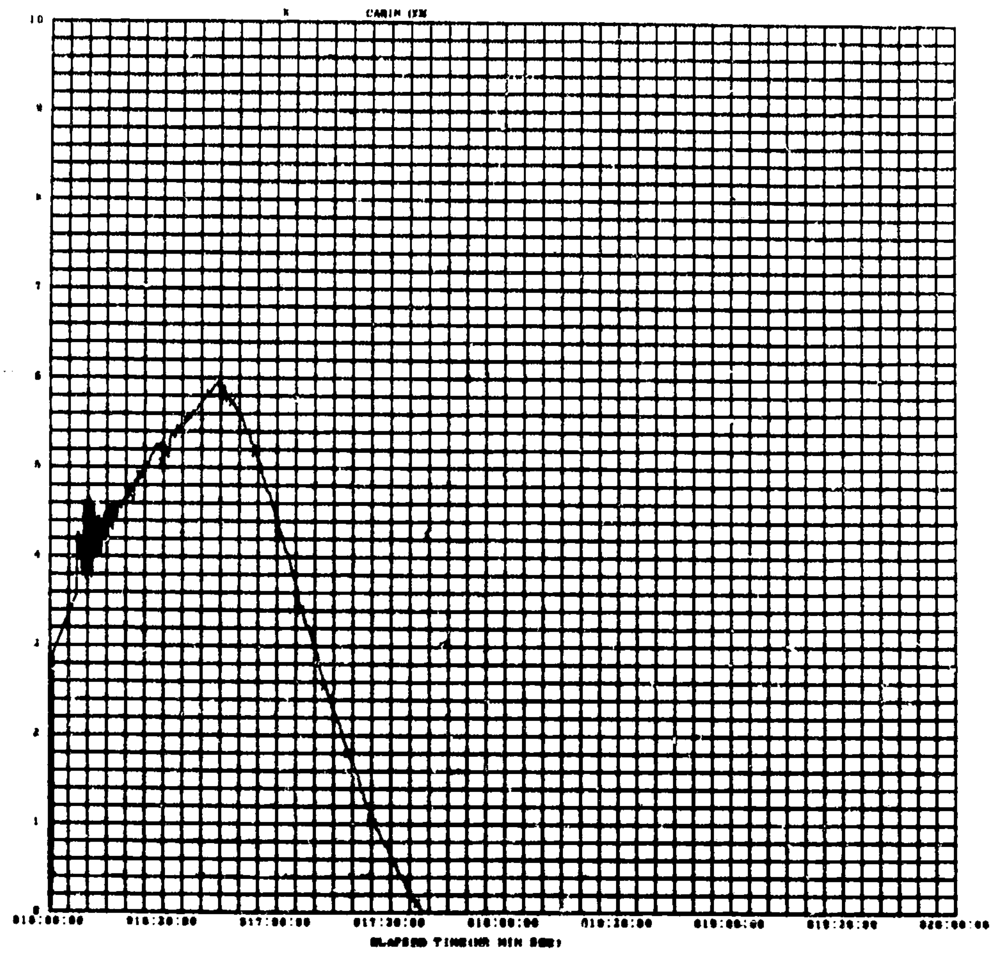


FIGURE 7D CABIN PARTIAL PRESSURE CO2 VERSUS TIME - CONCLUDED

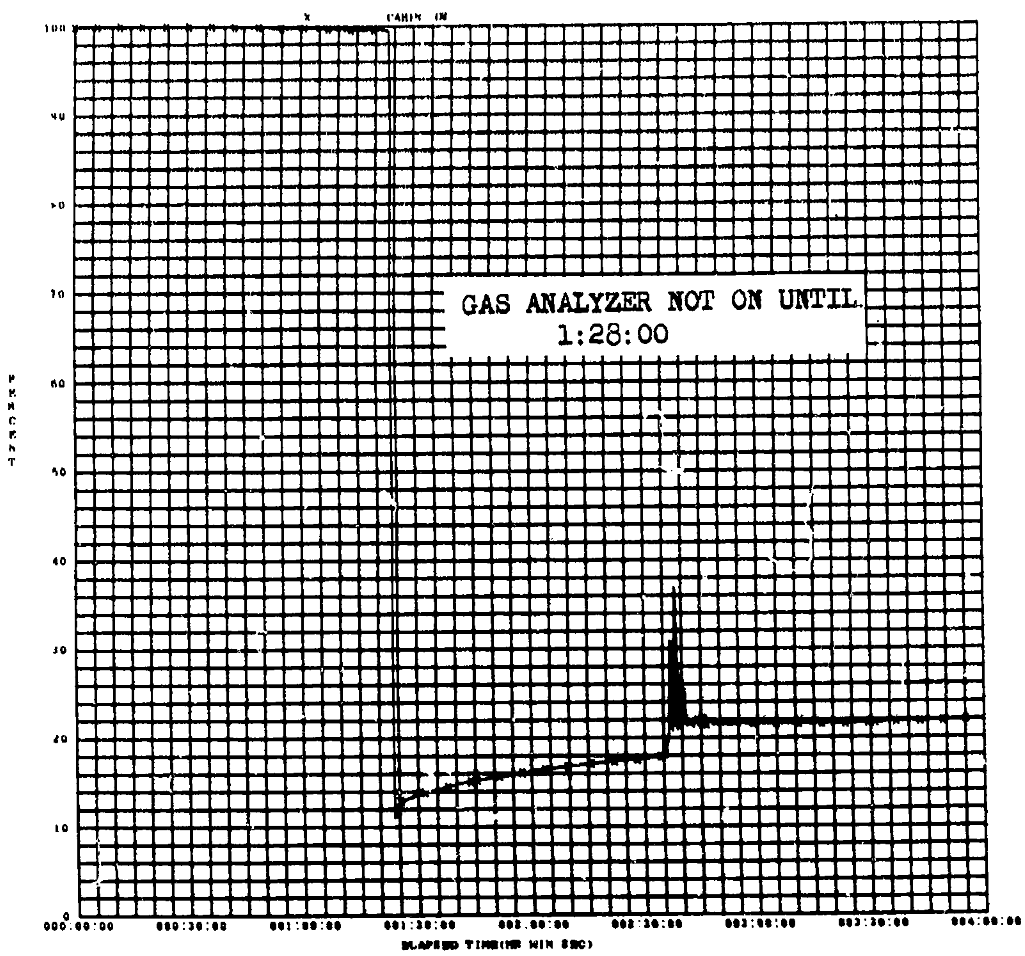


FIGURE 8 CABIN PERCENTAGE O_2 VERSUS TIME

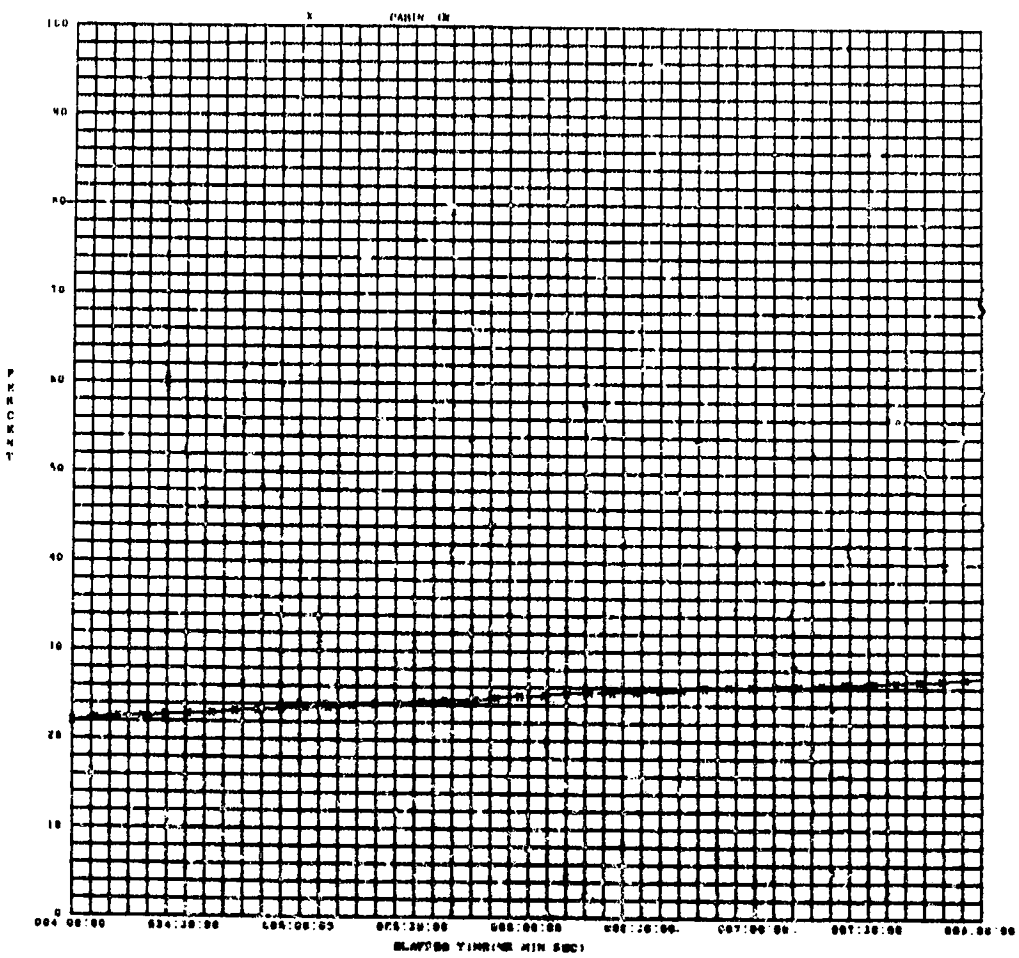


FIGURE 8A CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

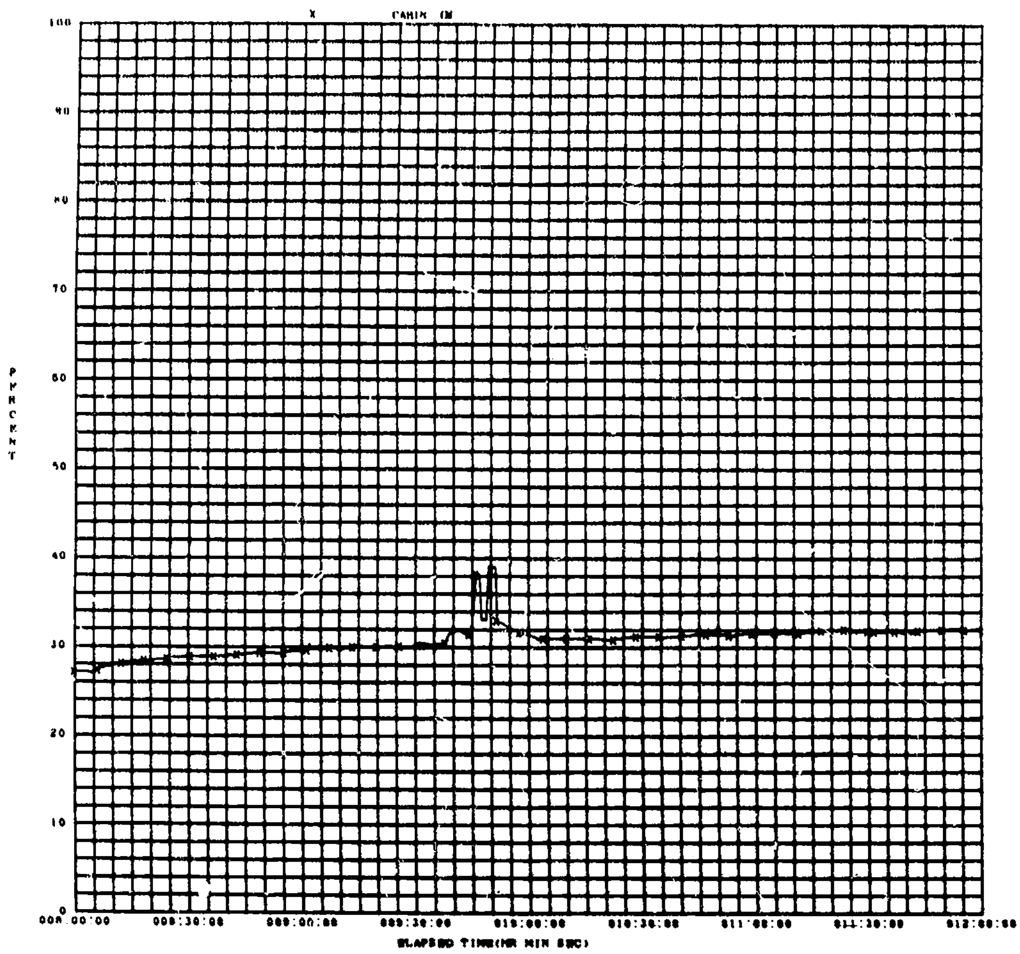


FIGURE 88 CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

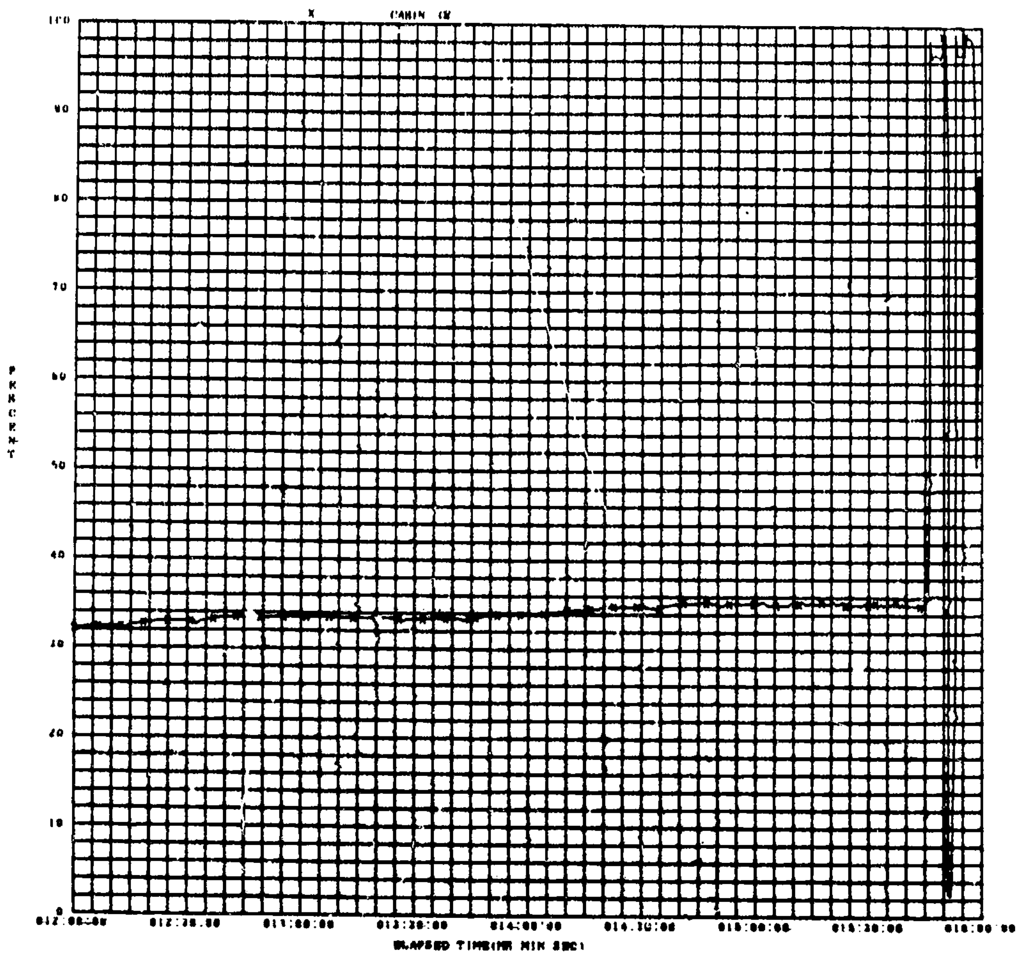


FIGURE 8C CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

C-2

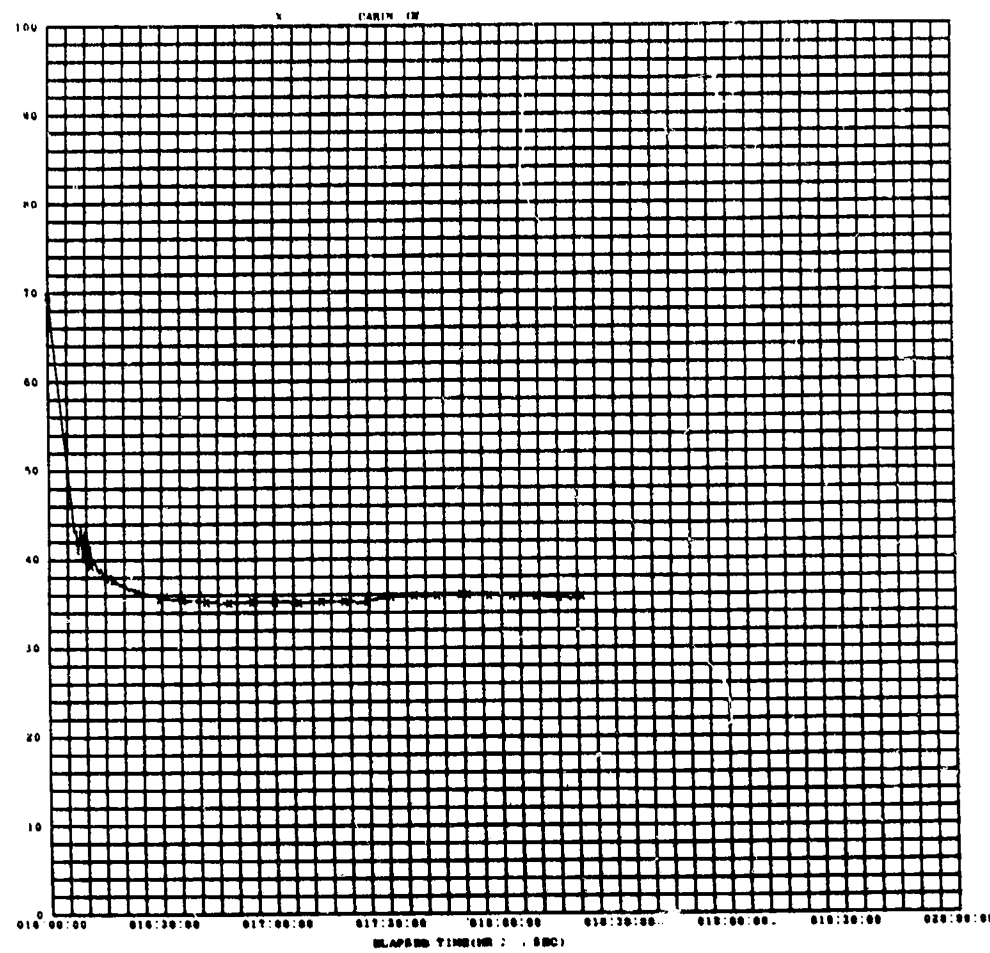


FIGURE 80 CABIN PERCENTAGE O2 VERSUS TIME - CONCLUDED

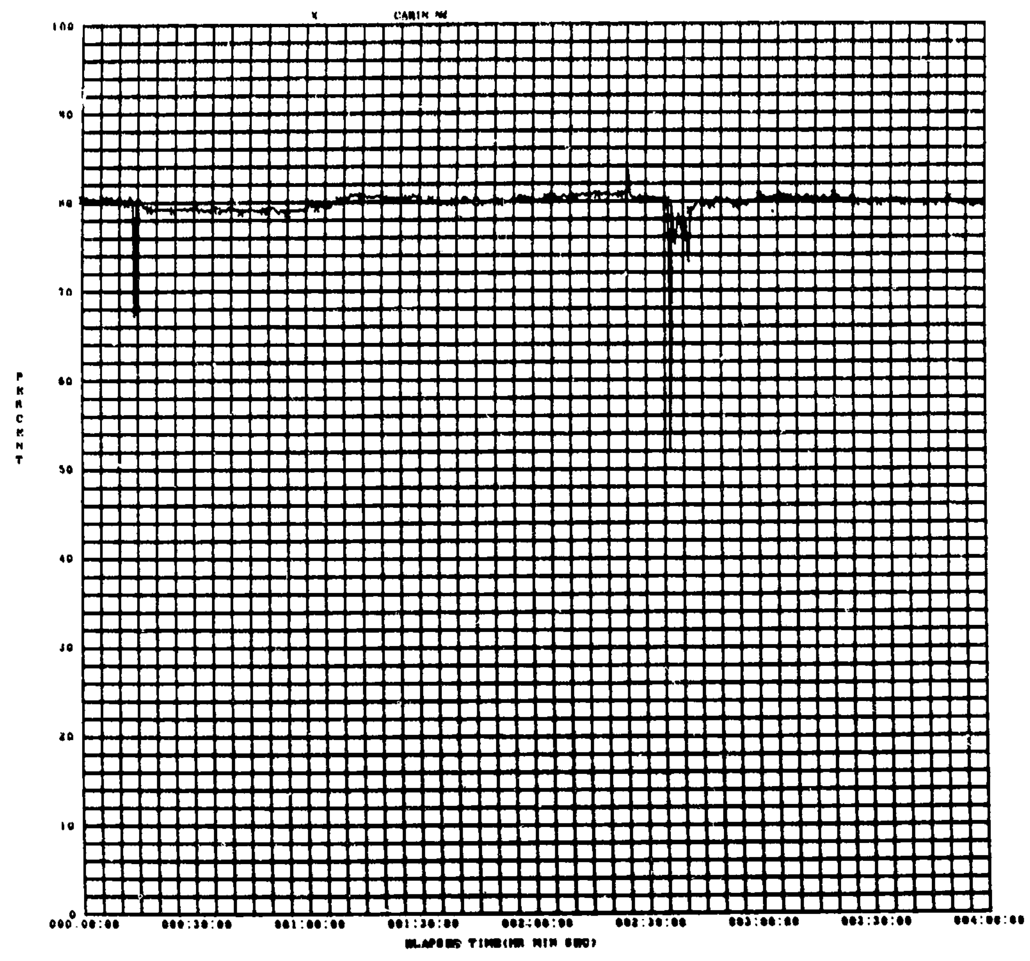


FIGURE 9 CABIN PERCENTAGE N2 VERSUS TIME

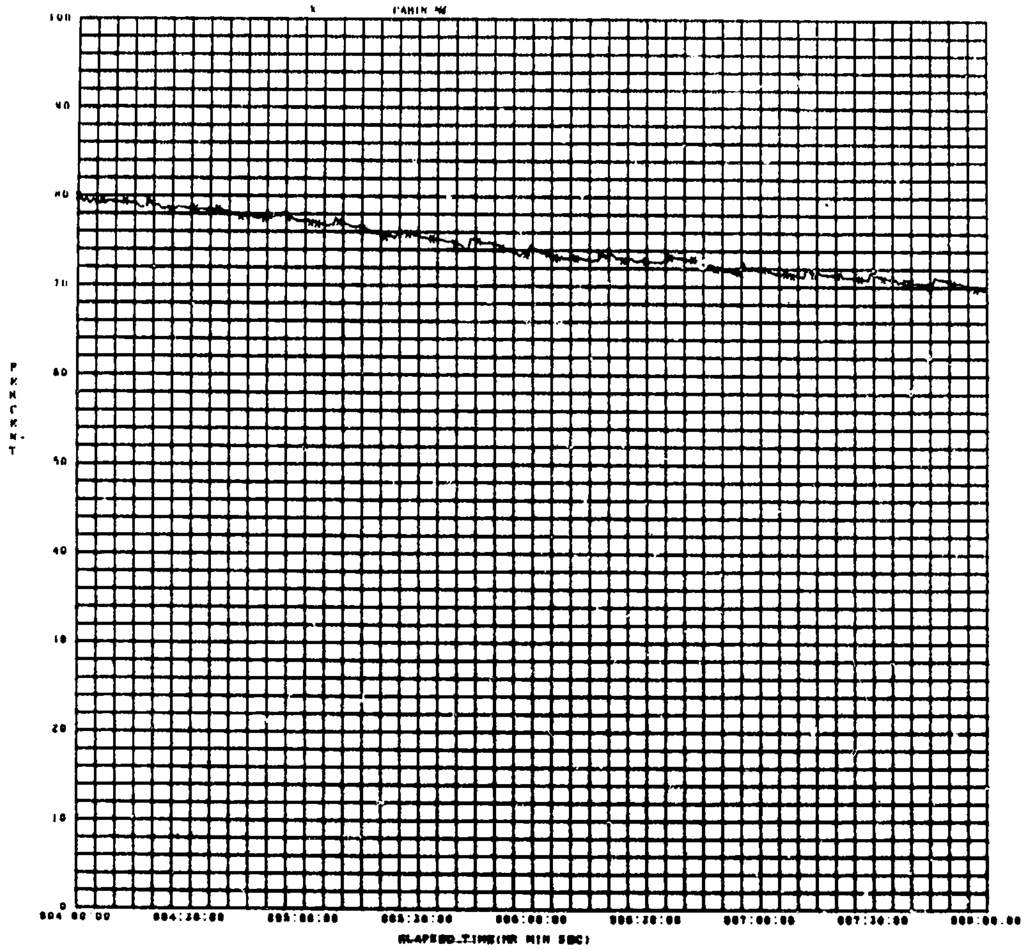


FIGURE 9A CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

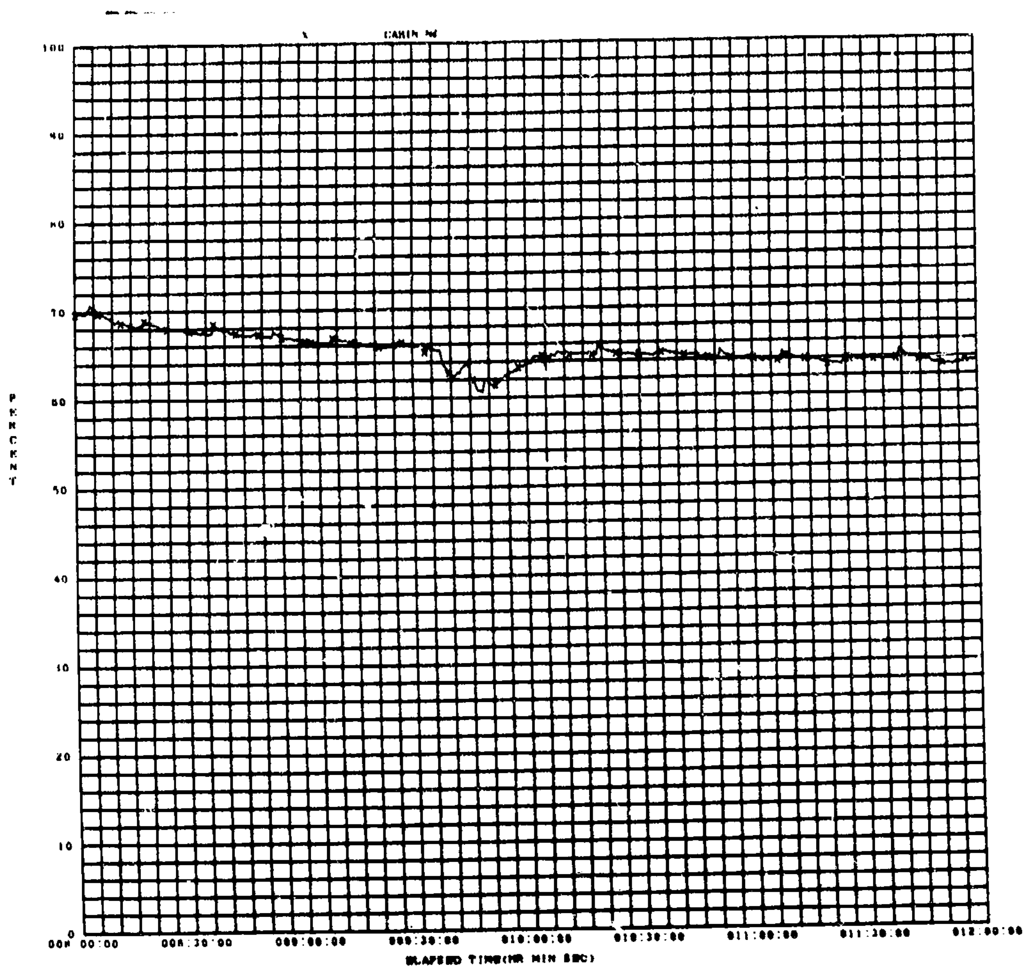


FIGURE 9B. CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

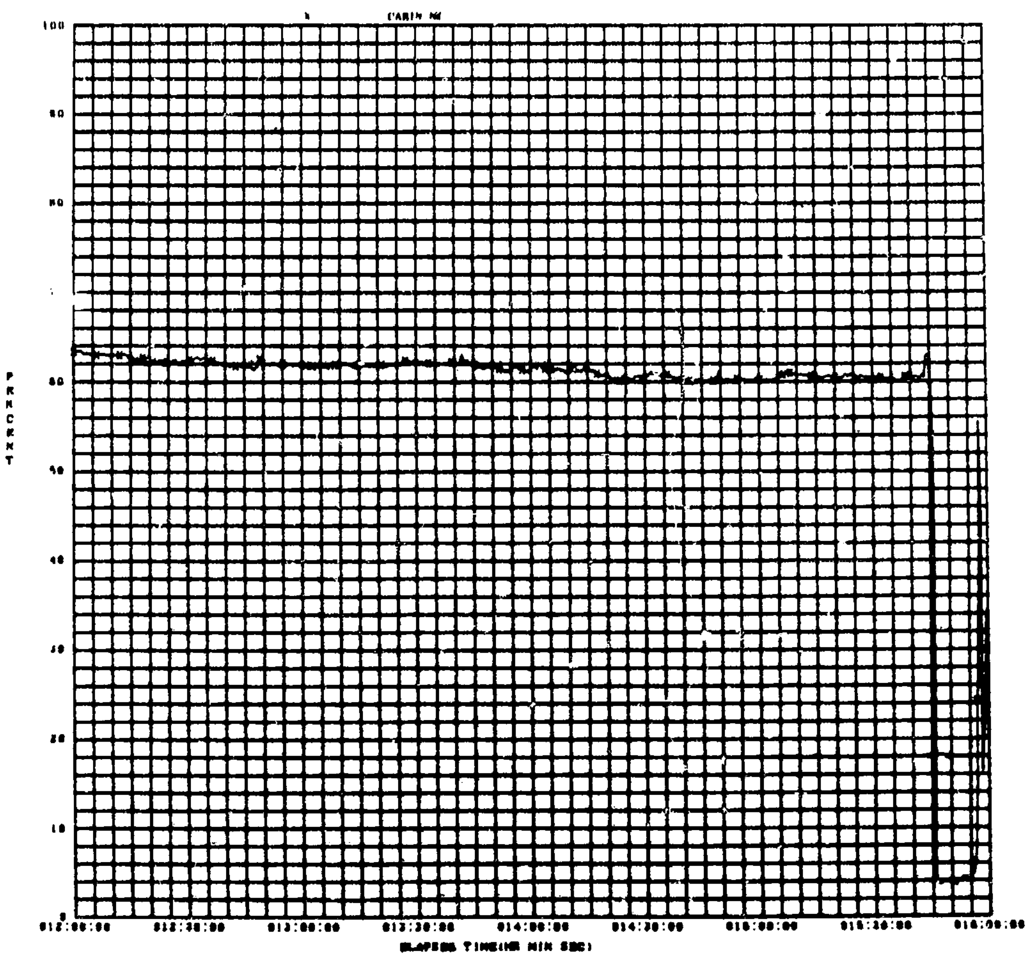


FIGURE 9C CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

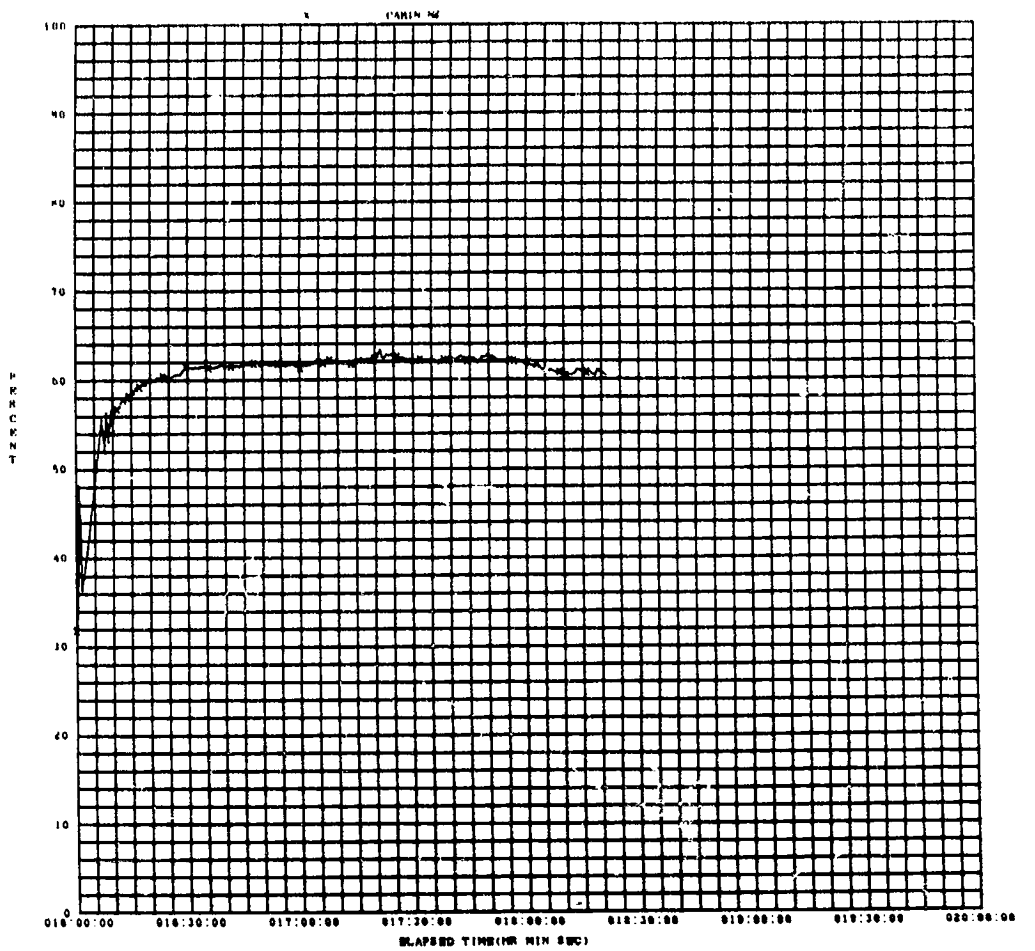


FIGURE 9D CABIN PERCENTAGE N2 VERSUS TIME - CONCLUDED

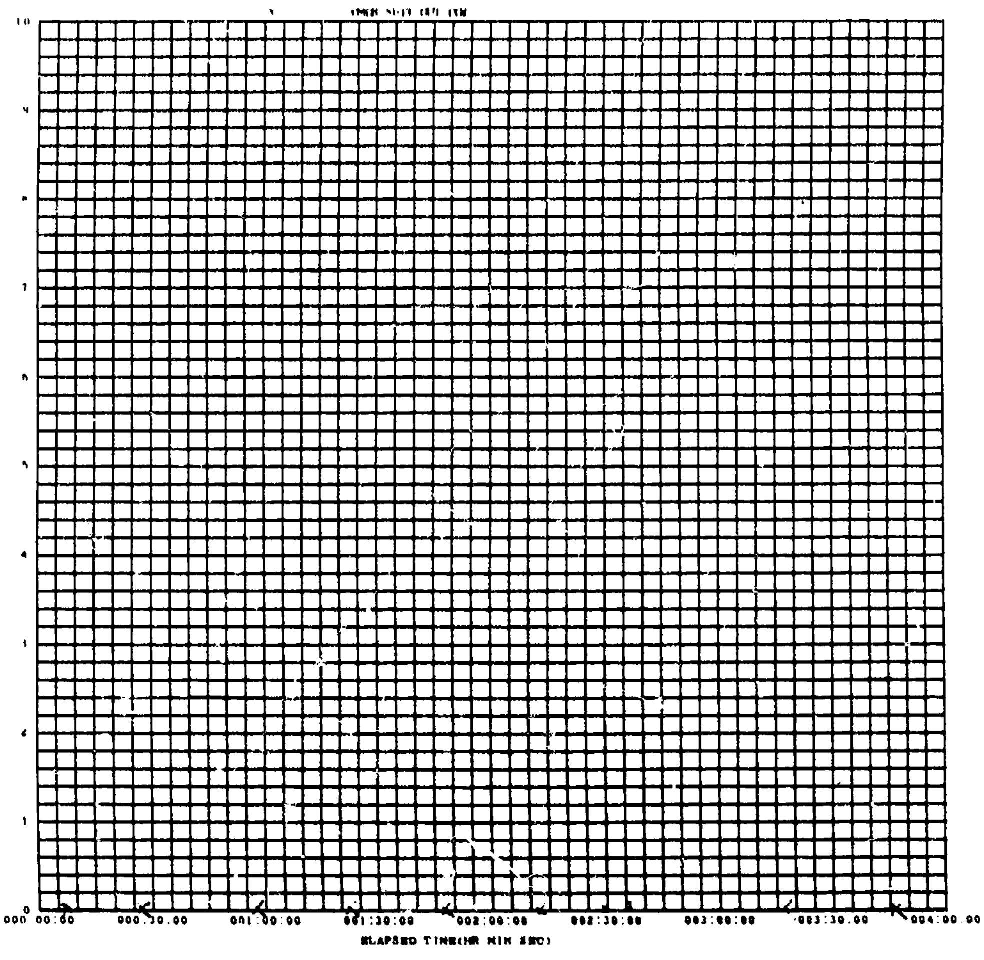


FIGURE 10 CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME

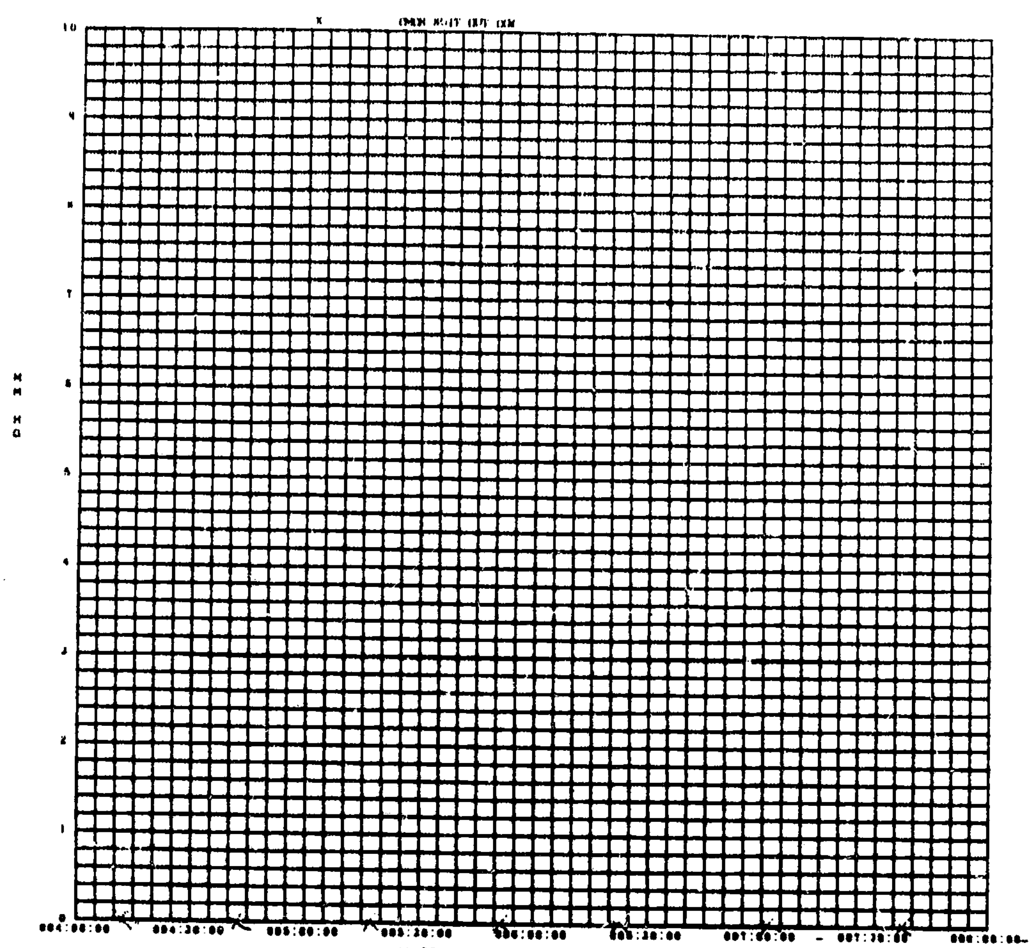


FIGURE 10A CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

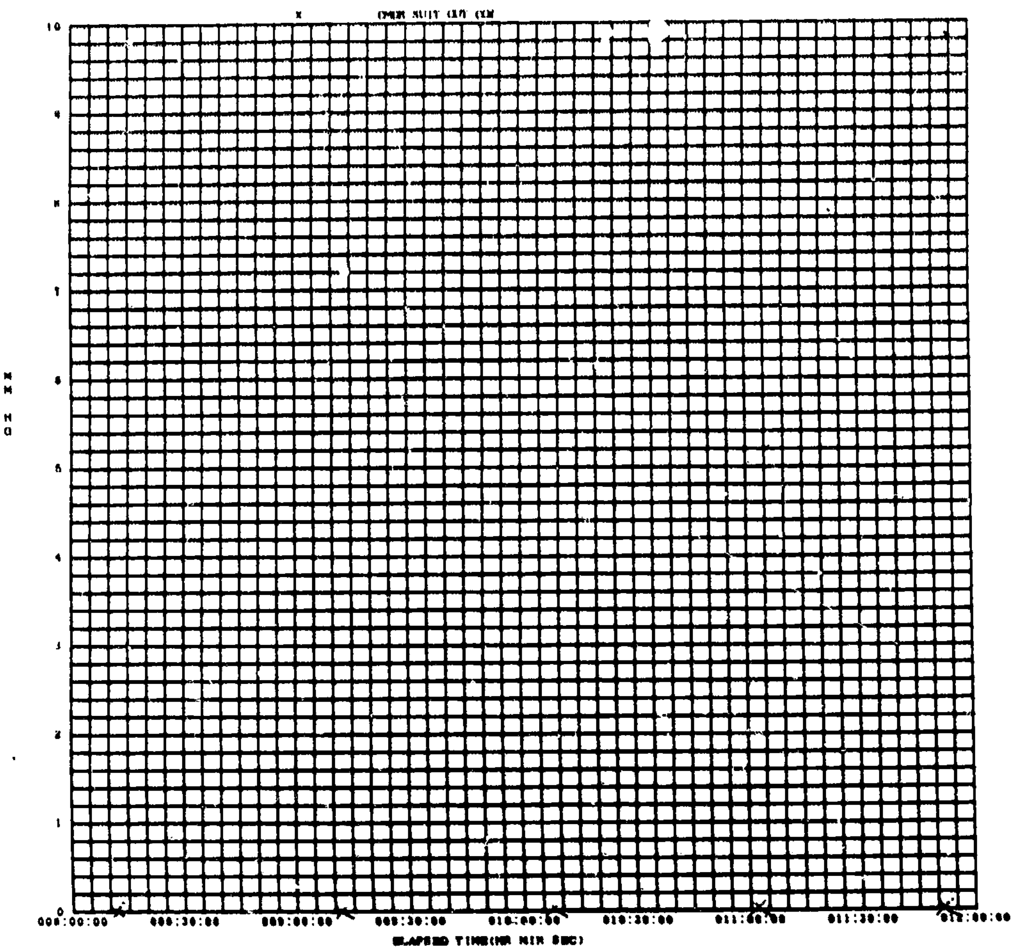


FIGURE 10B CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

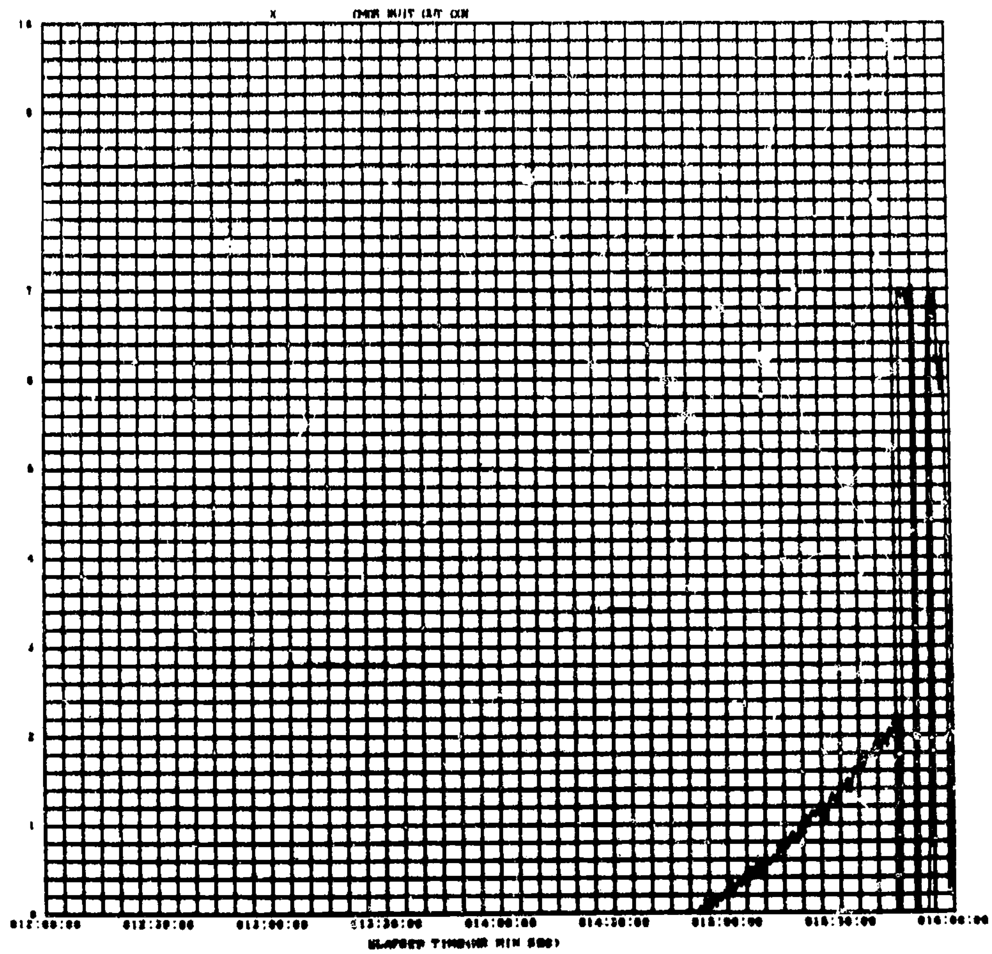


FIGURE 10C CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

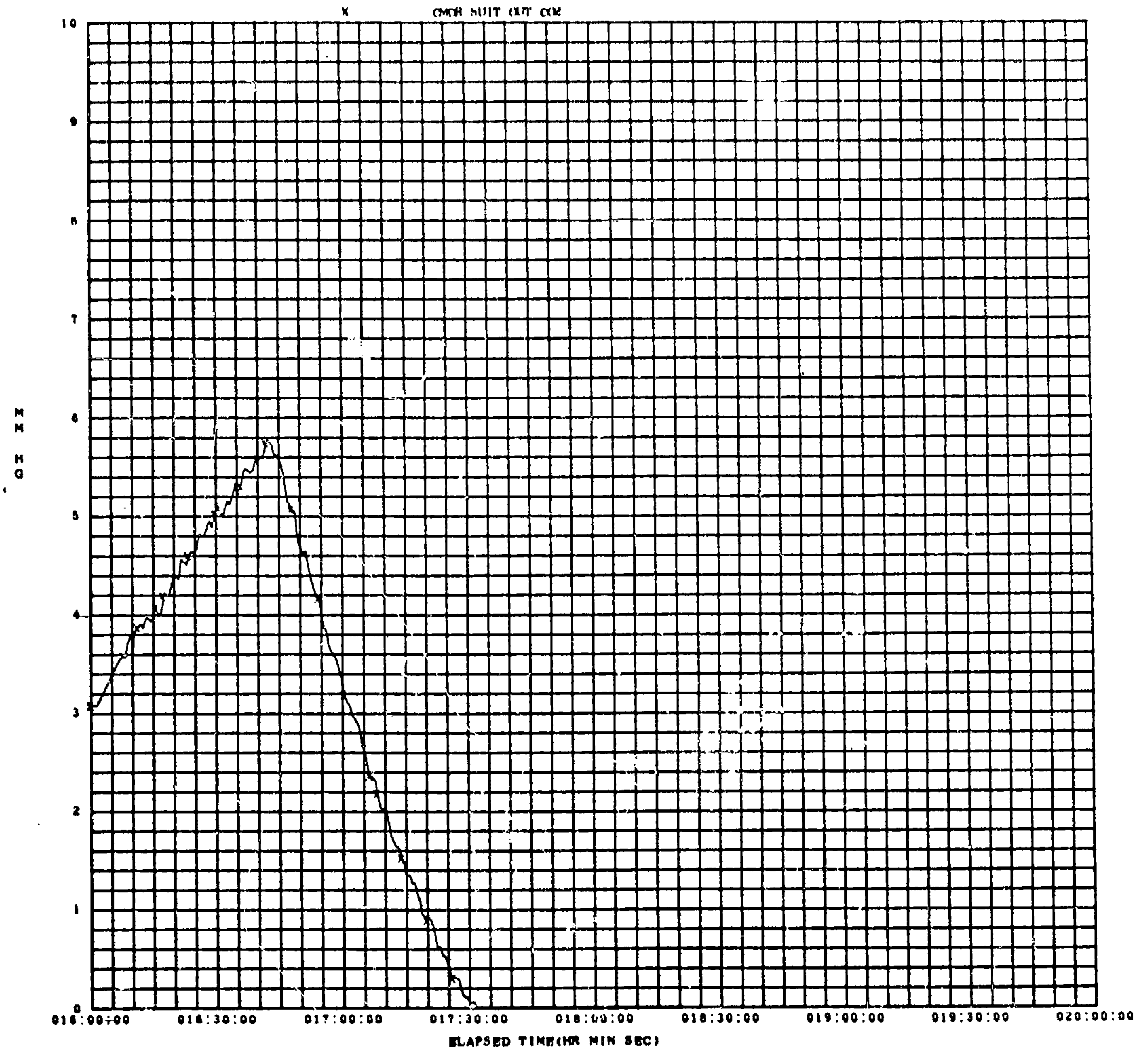


FIGURE 10D CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONCLUDED

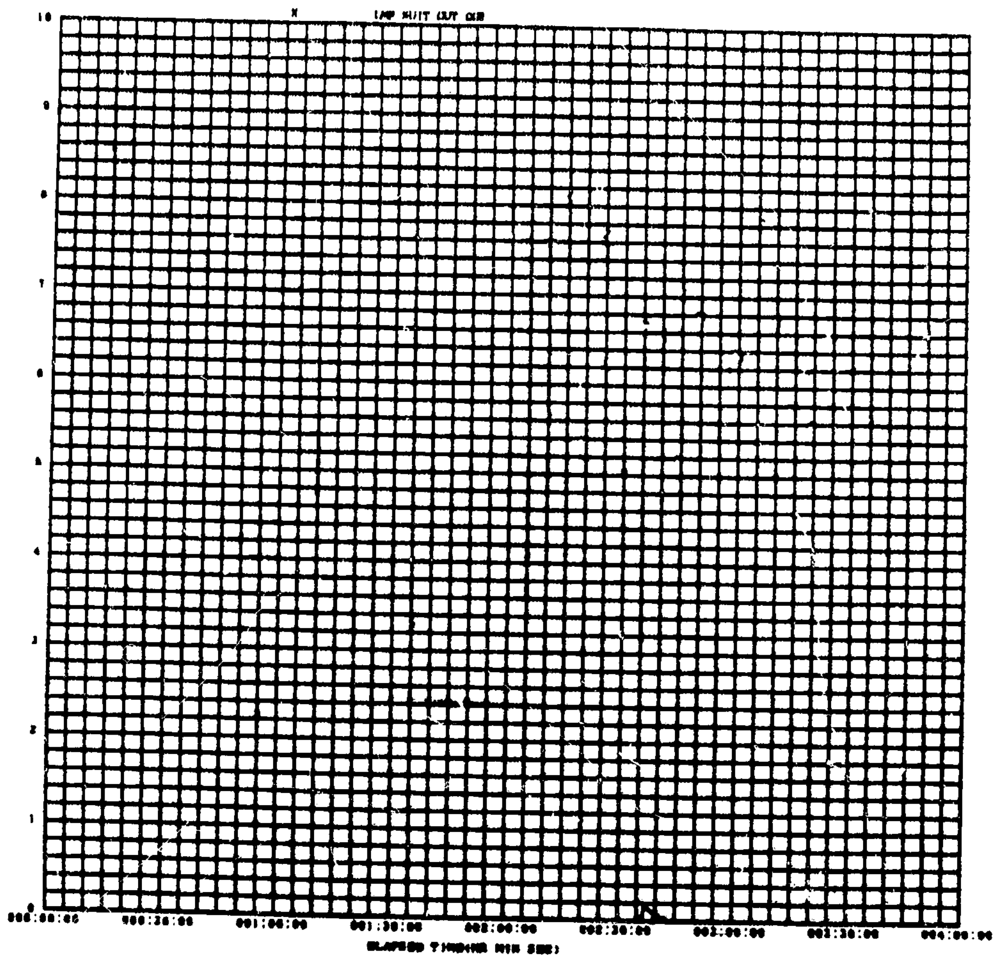


FIGURE 11 LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME

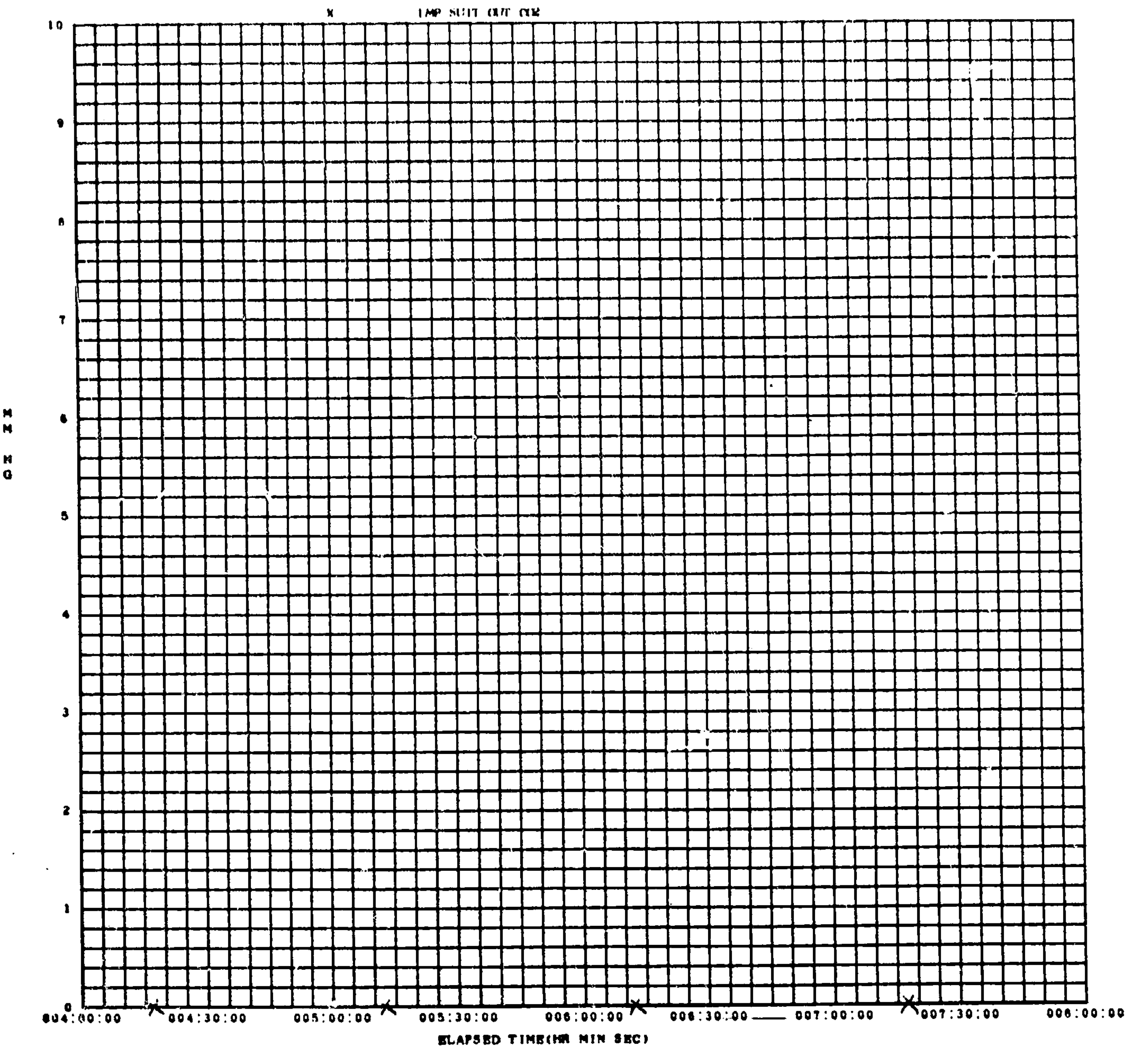


FIGURE 11A LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

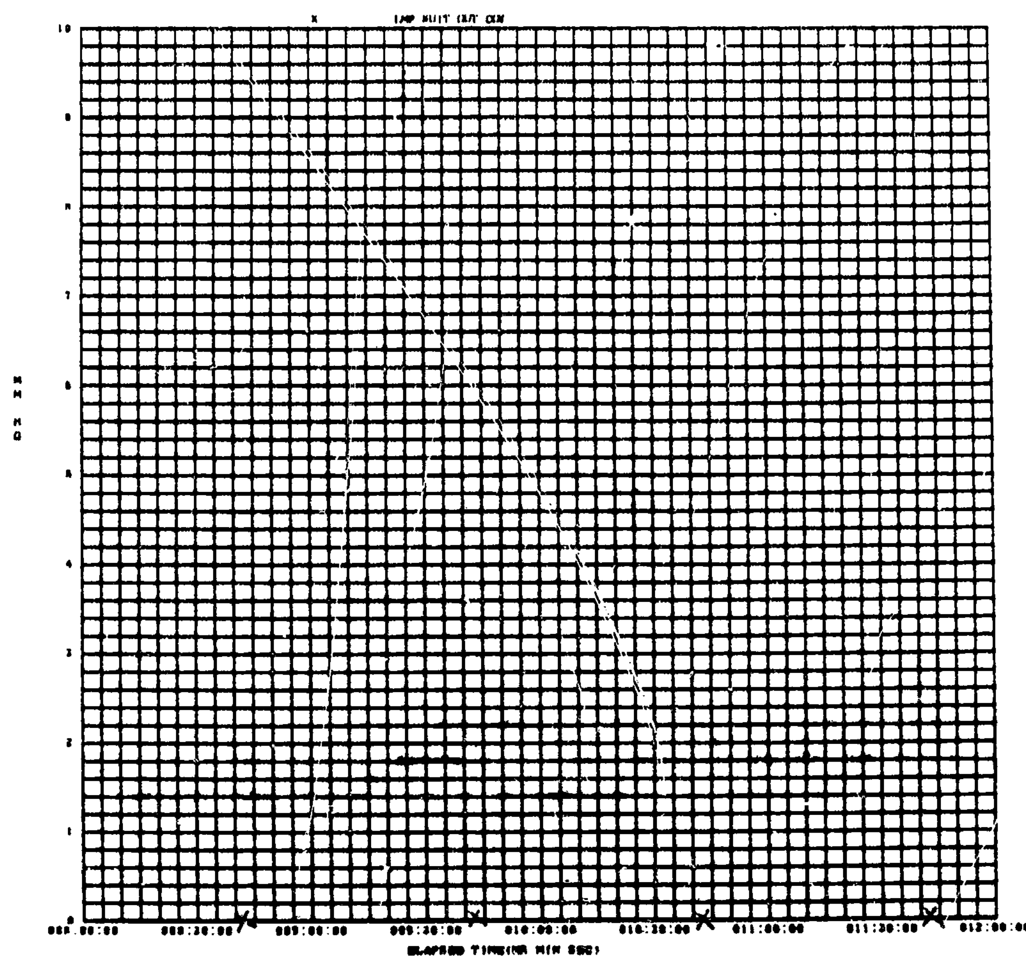


FIGURE 11B LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

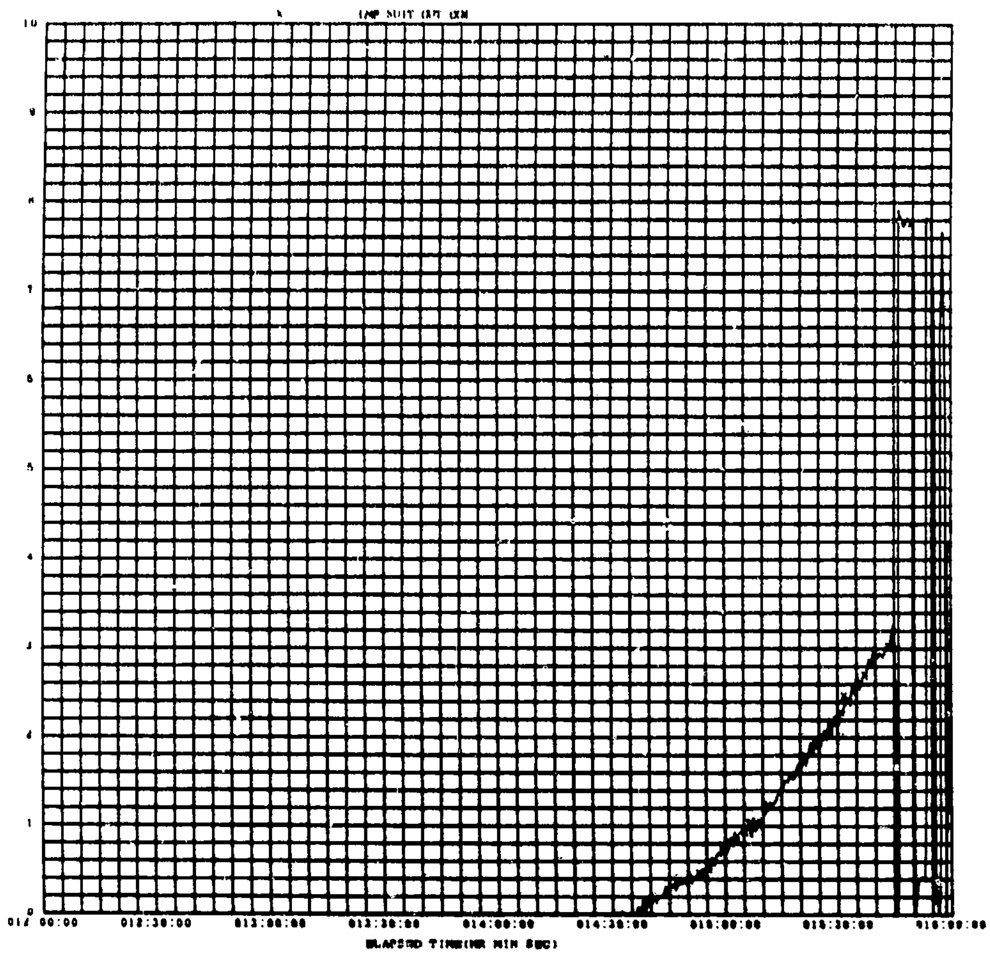


FIGURE 11C LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

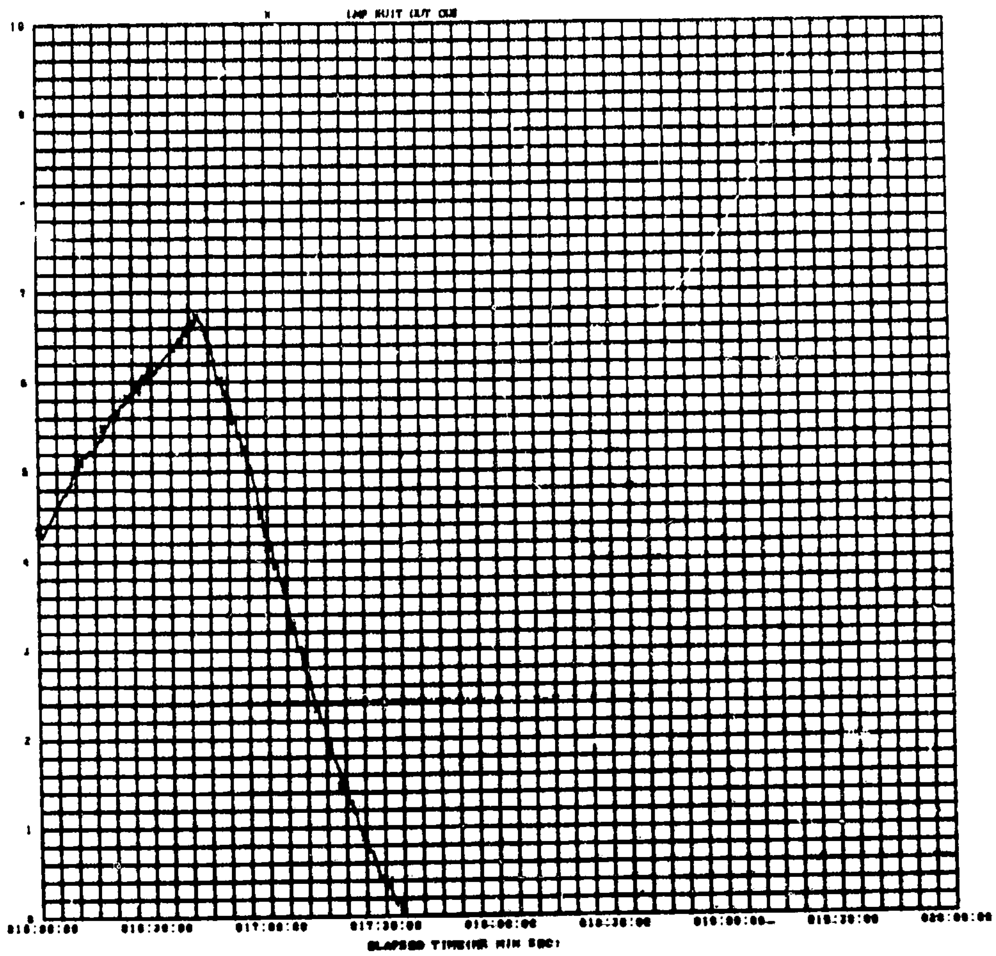


FIGURE 11D LMP SUIT OUTLET PARTIAL PRESSURE CO_2 VERSUS TIME - CONCLUDED

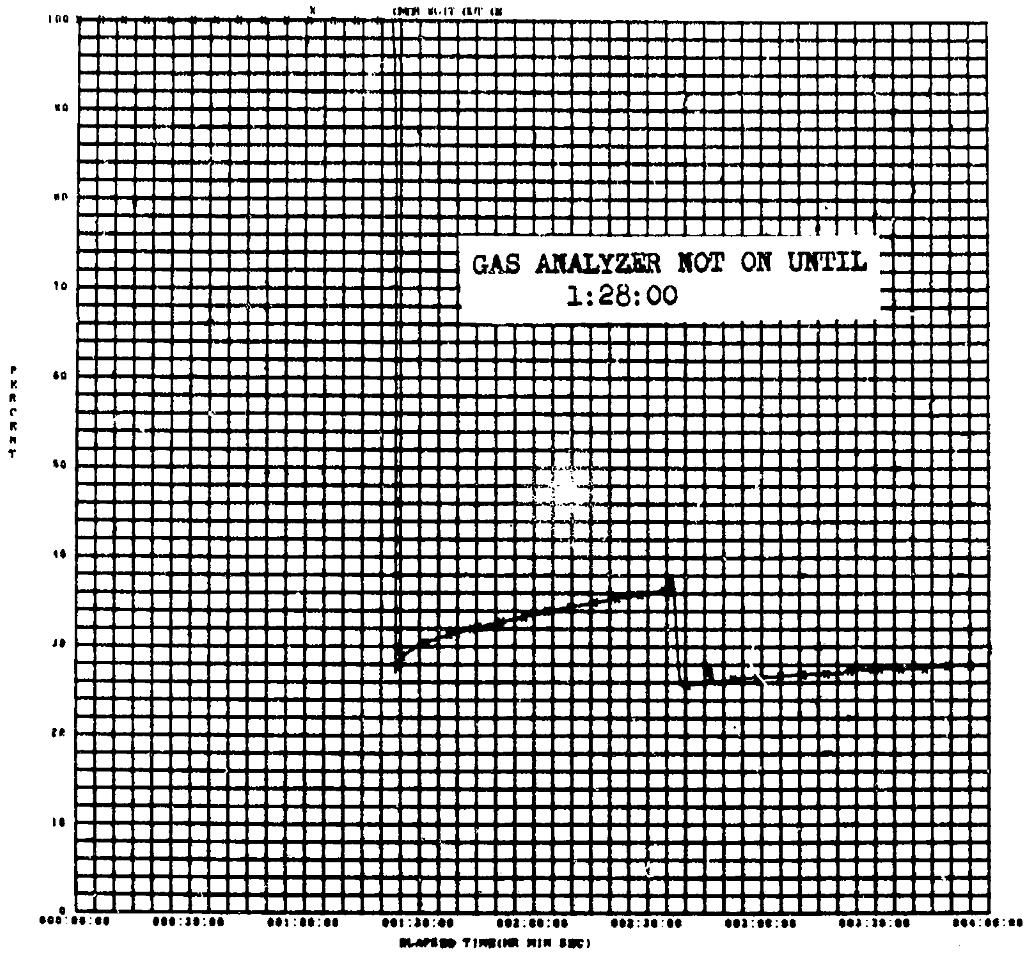


FIGURE 12 CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME

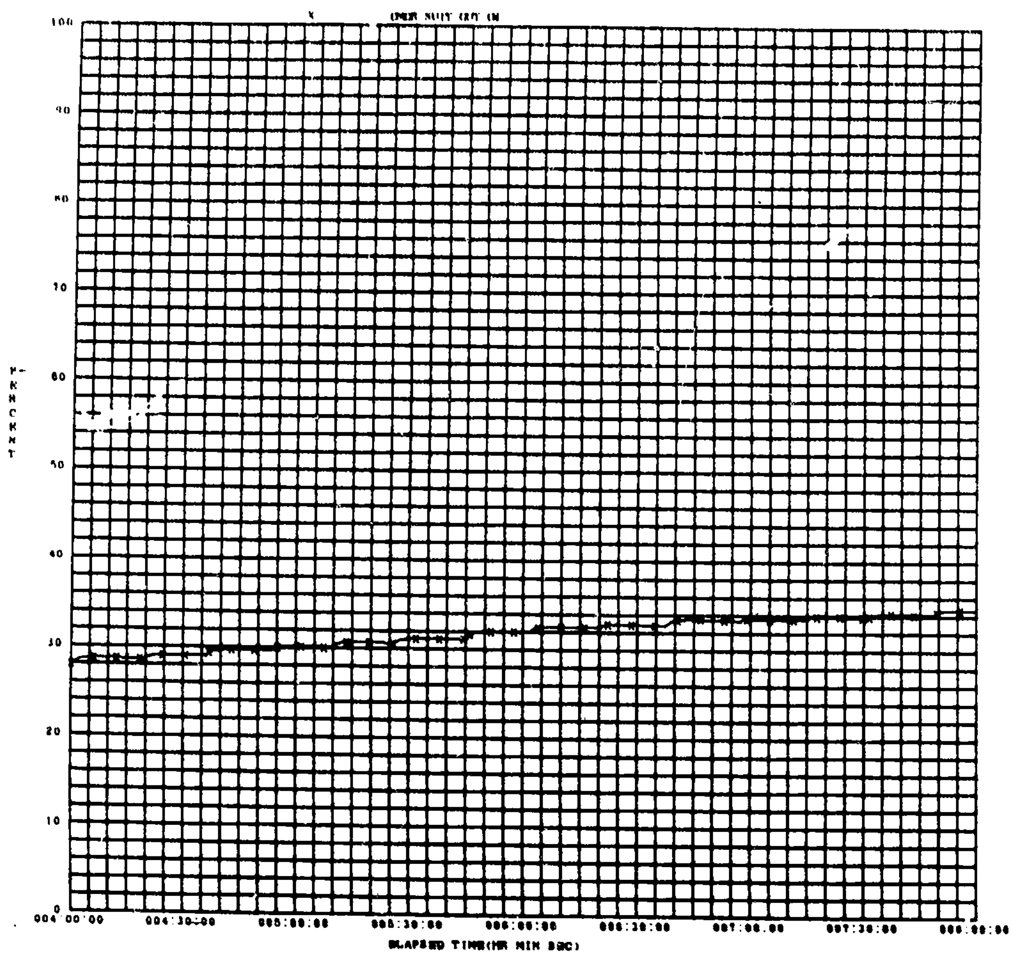


FIGURE 12A CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

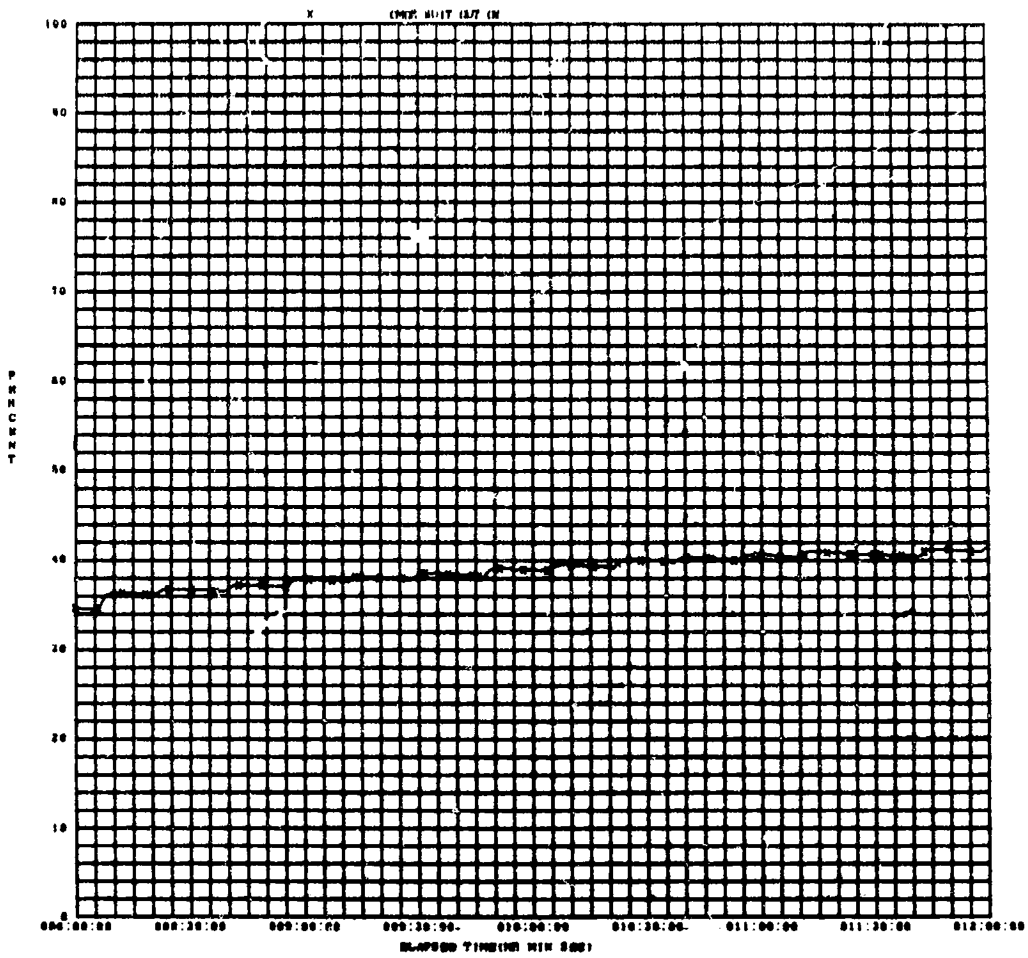


FIGURE 12B CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

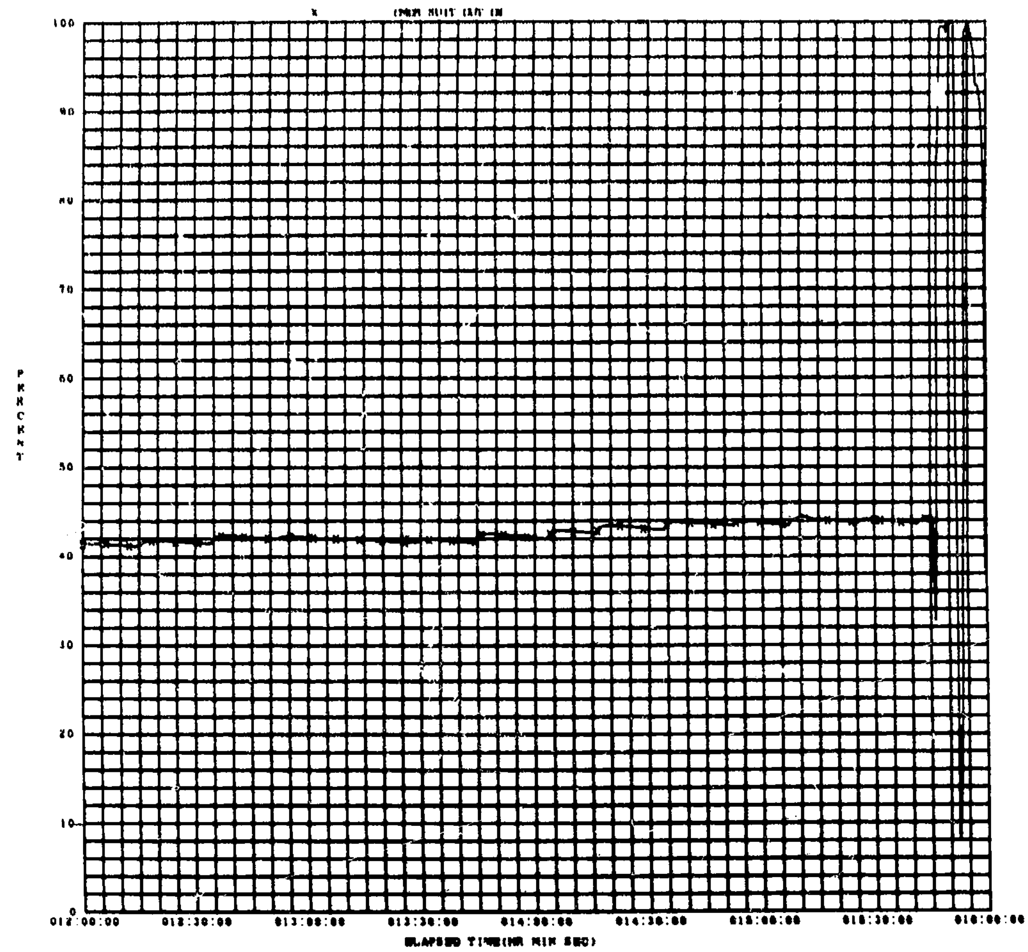


FIGURE 12C CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

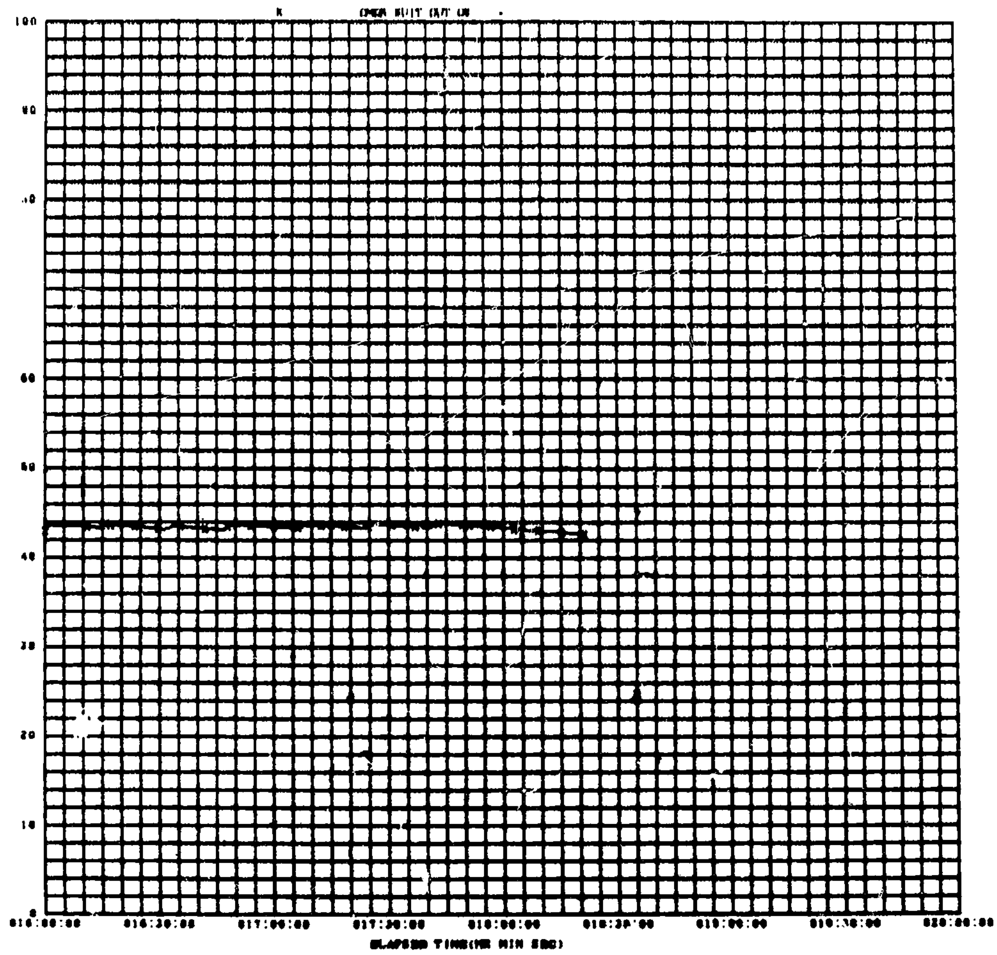


FIGURE 12D. CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONCLUDED

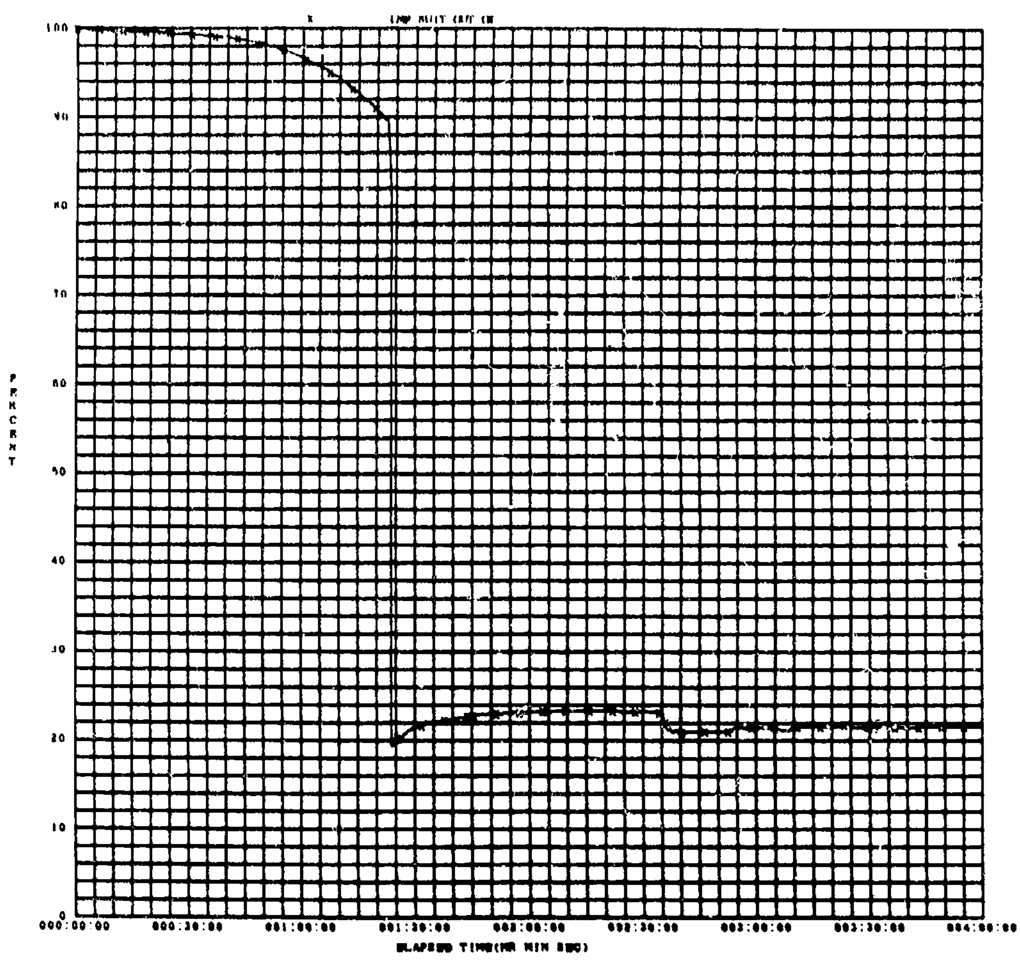


FIGURE 13 LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME

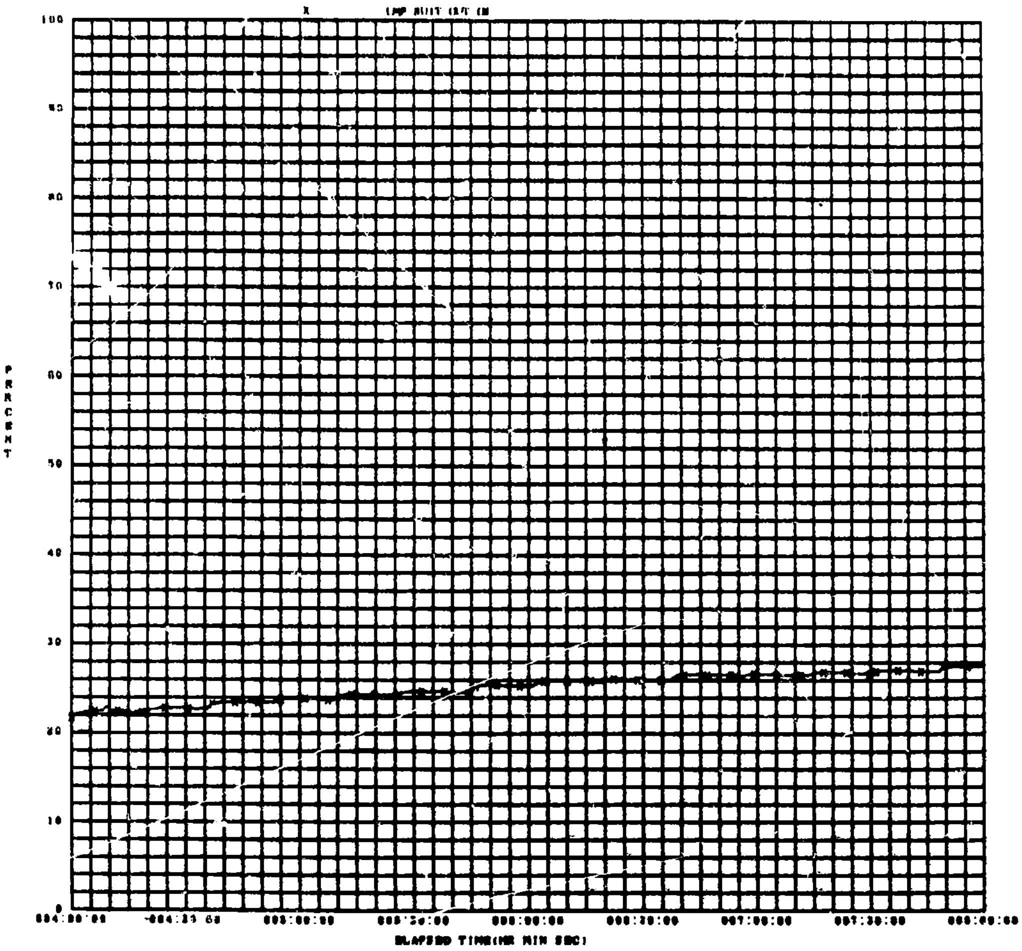


FIGURE 13A LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

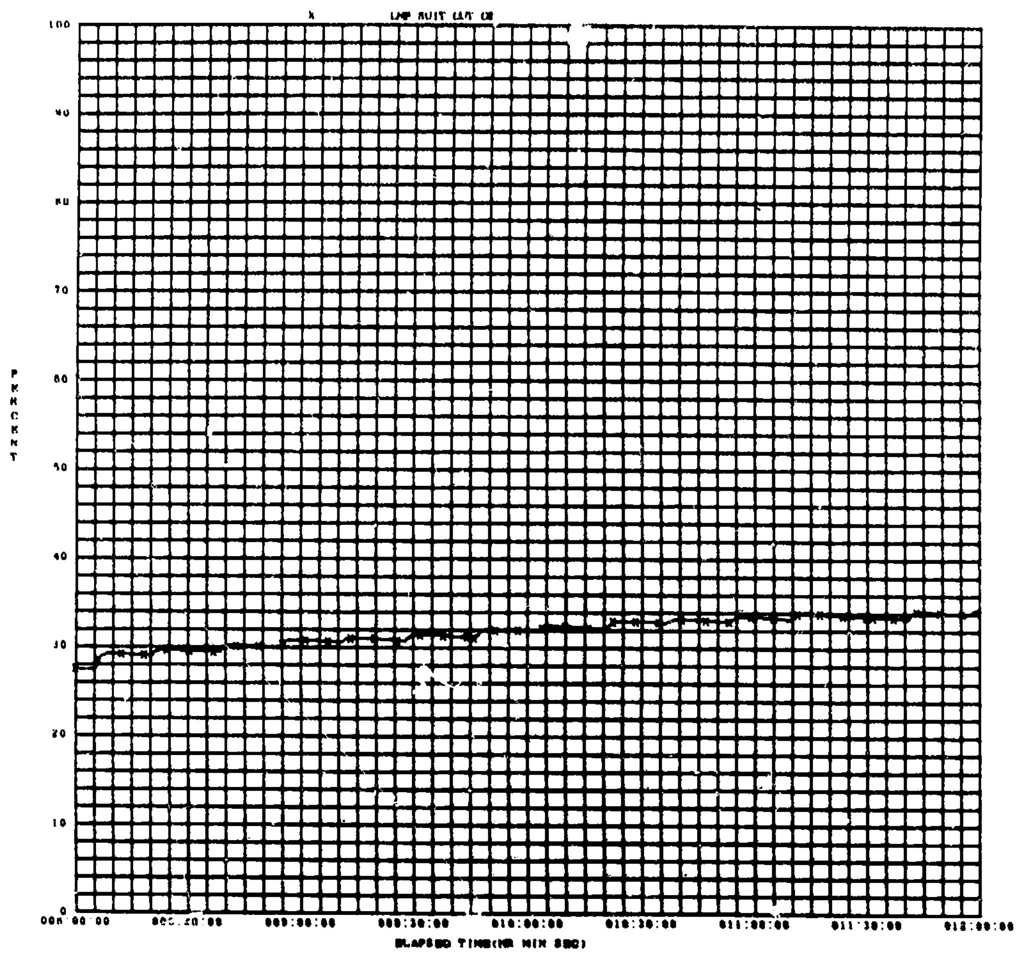


FIGURE 13B LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

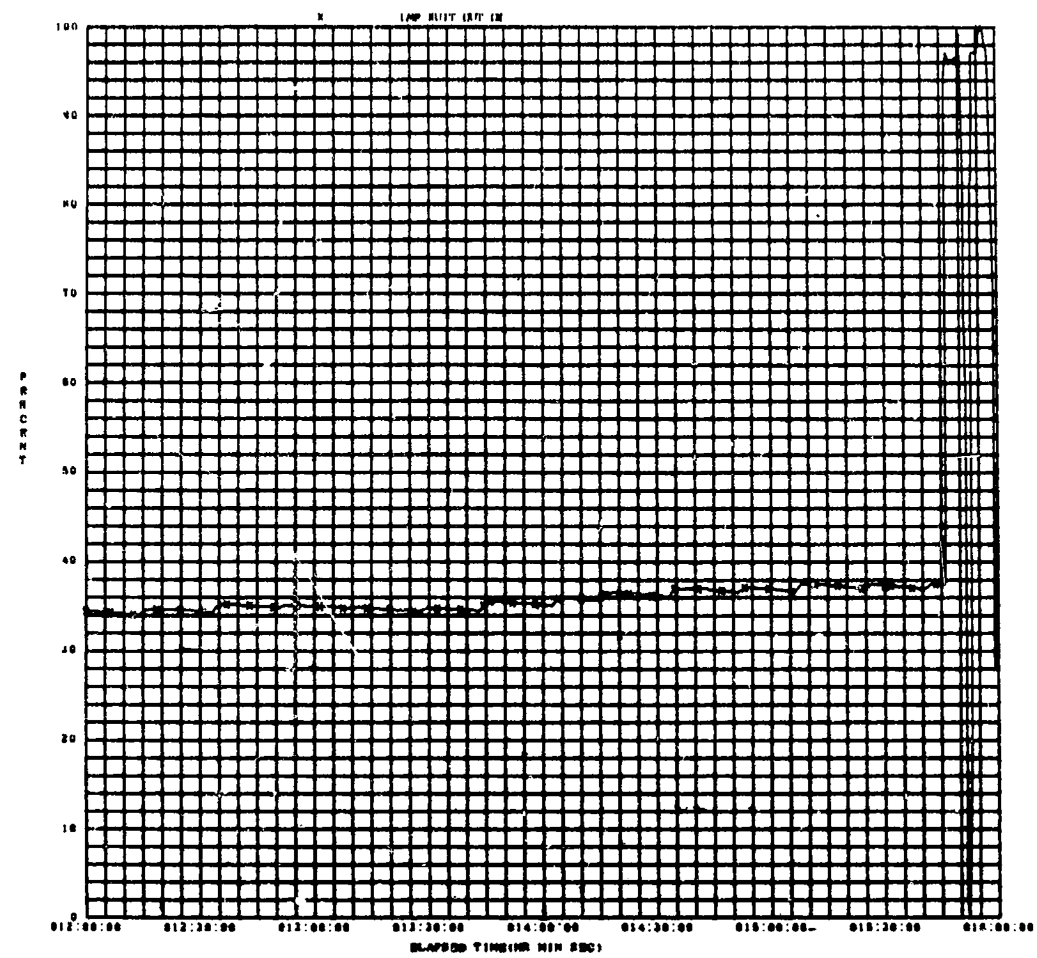


FIGURE 13C LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

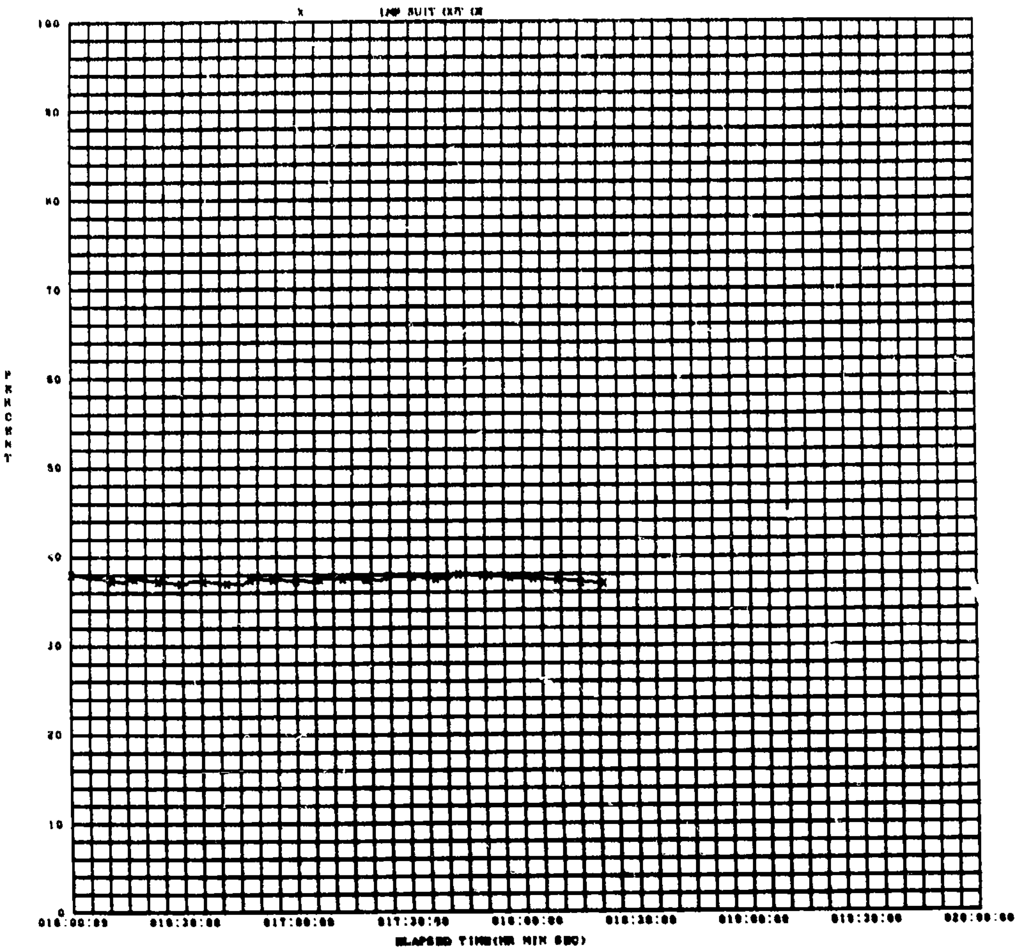


FIGURE 13D LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONCLUDED

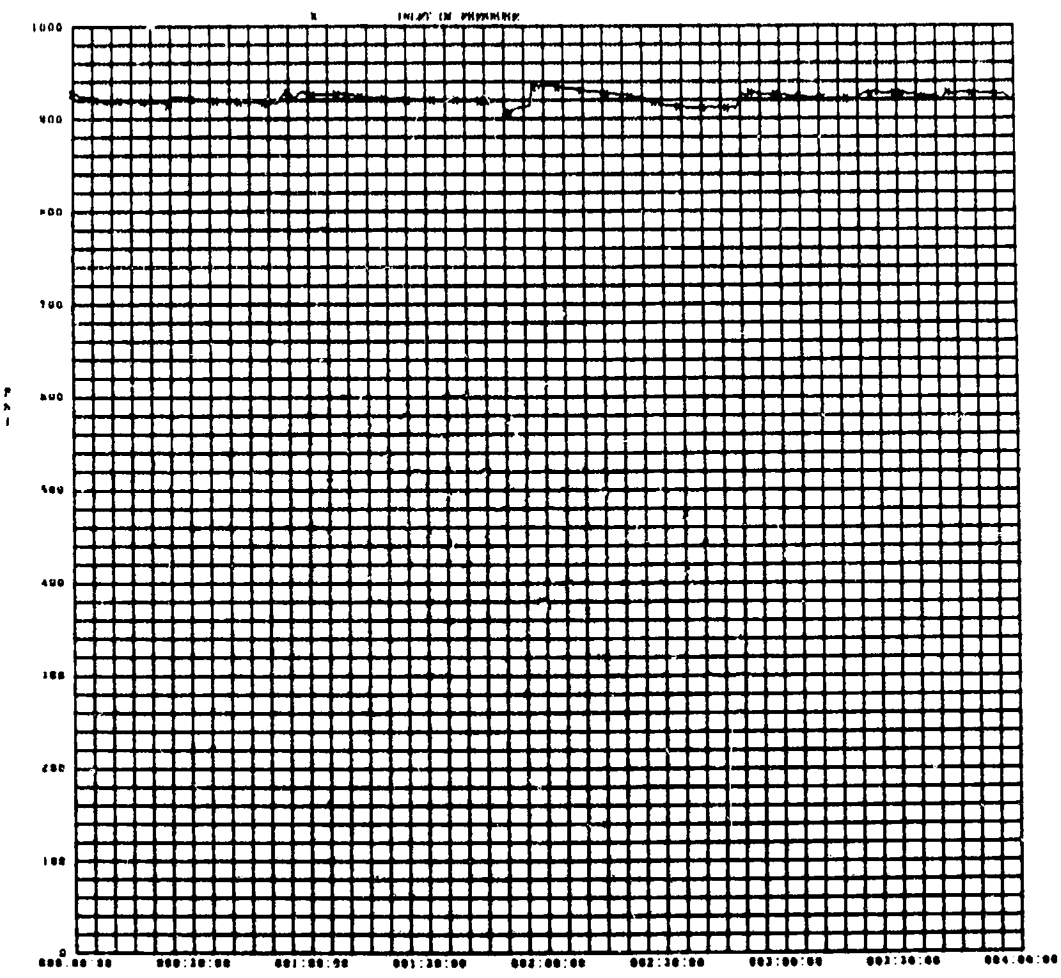


FIGURE 14 LM ECS O2 SUPPLY PRESSURE VERSUS TIME

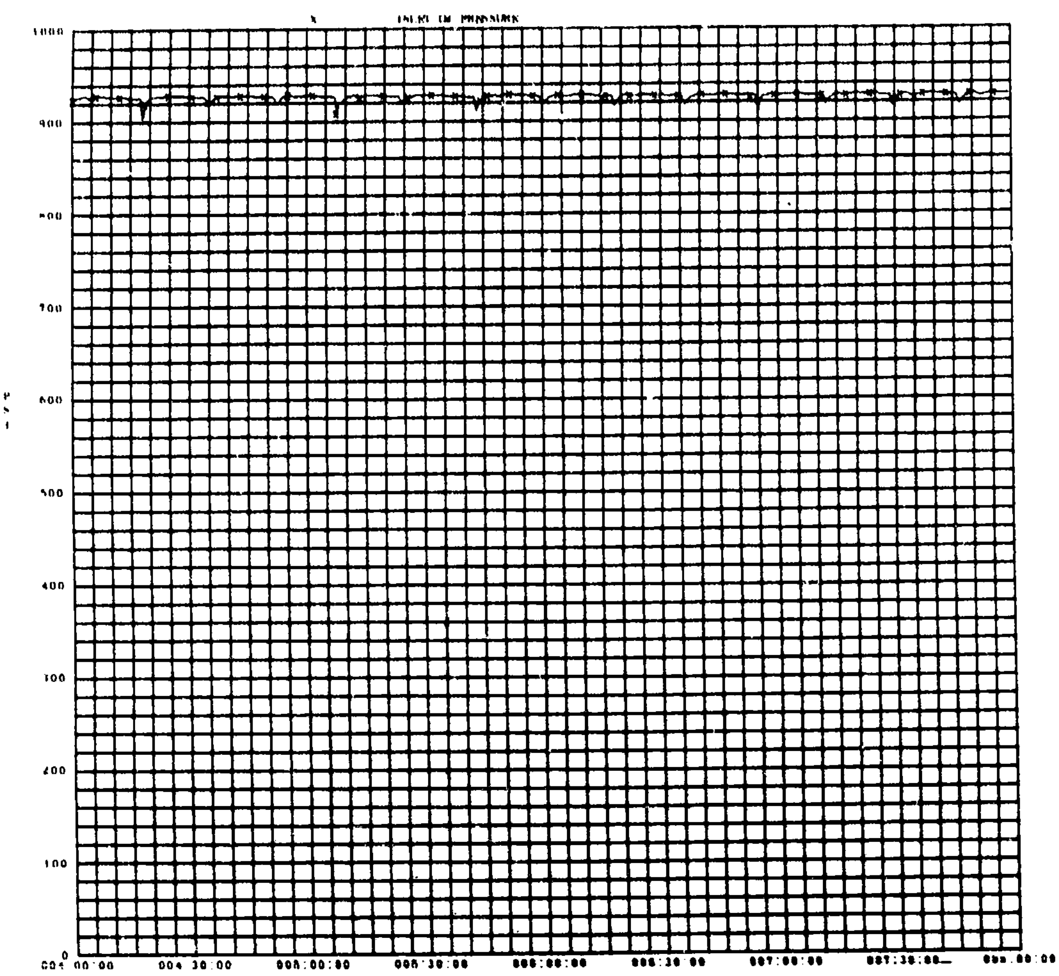


FIGURE 14A LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

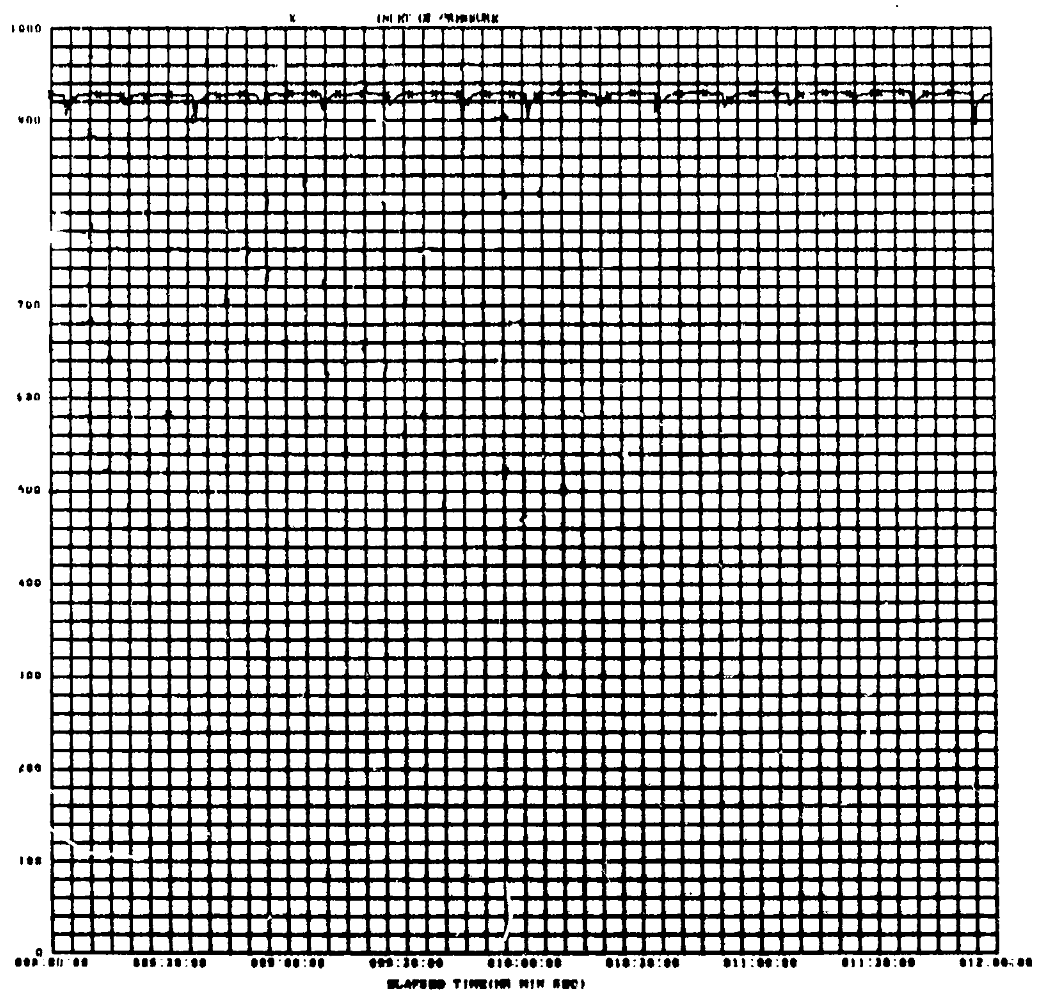


FIGURE 14B LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

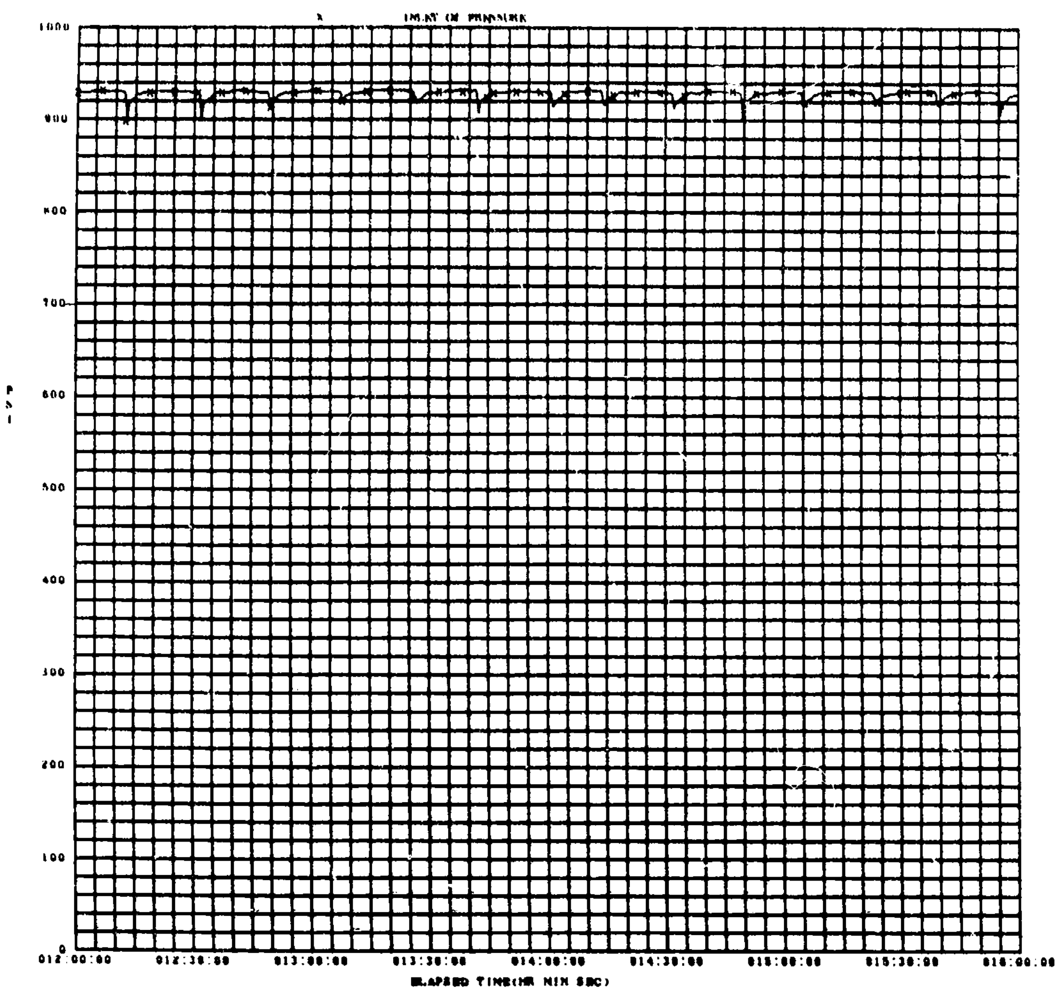


FIGURE 14C LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

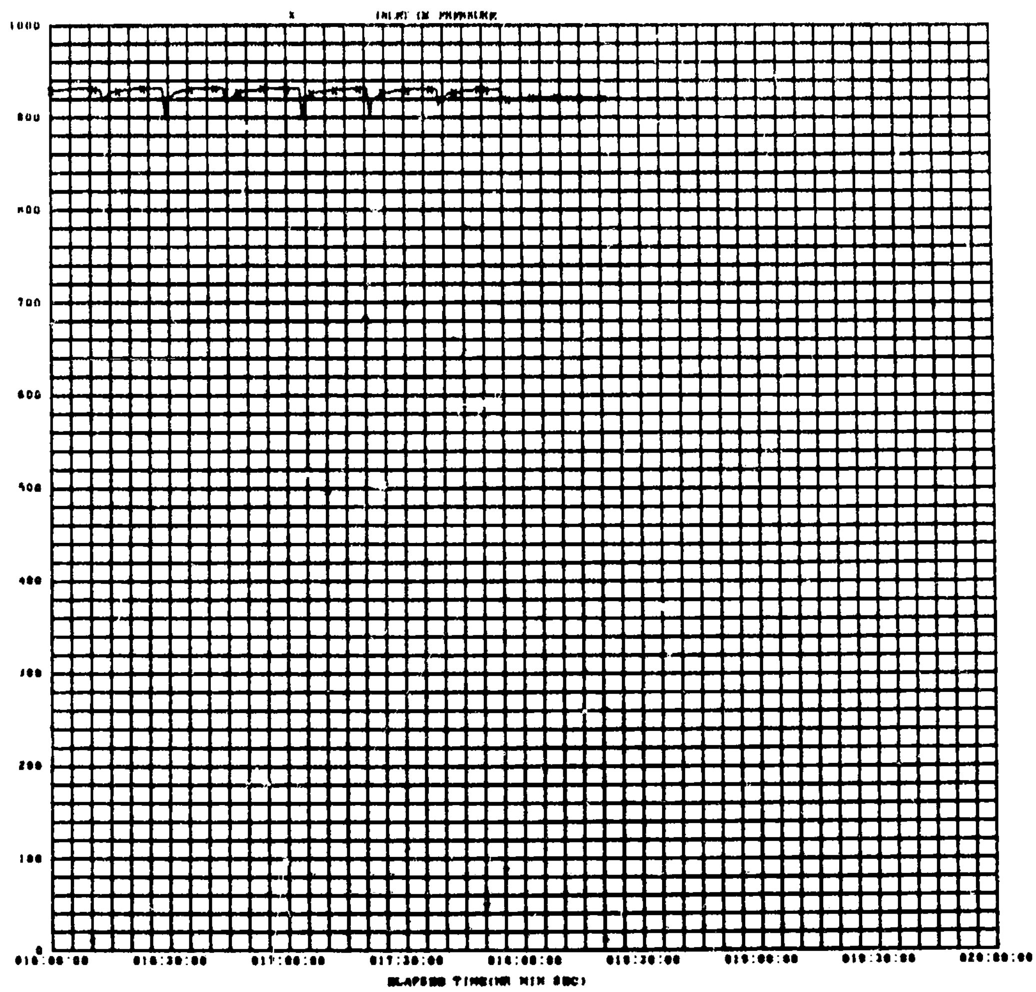


FIGURE 14D LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONCLUDED

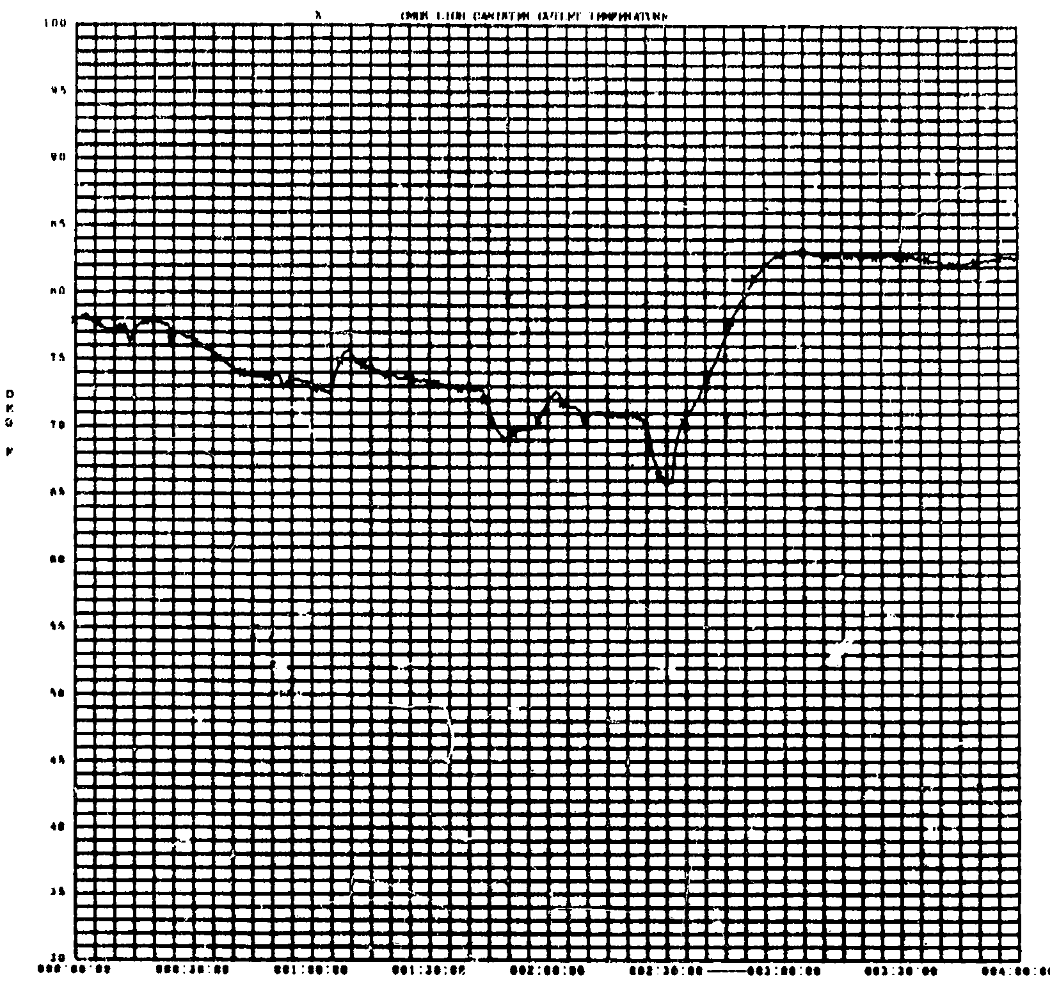


FIGURE 15 CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME

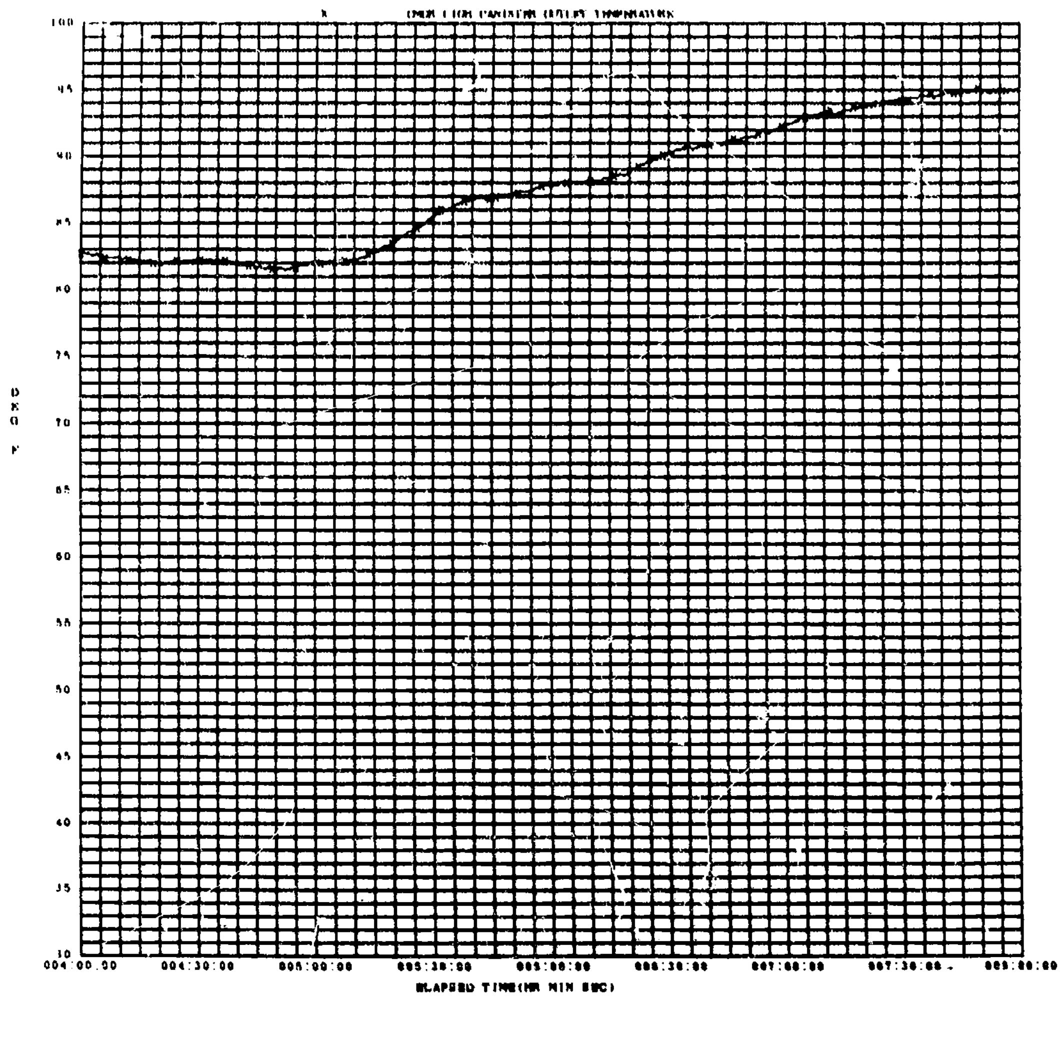


FIGURE 15A CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME - CONTINUED

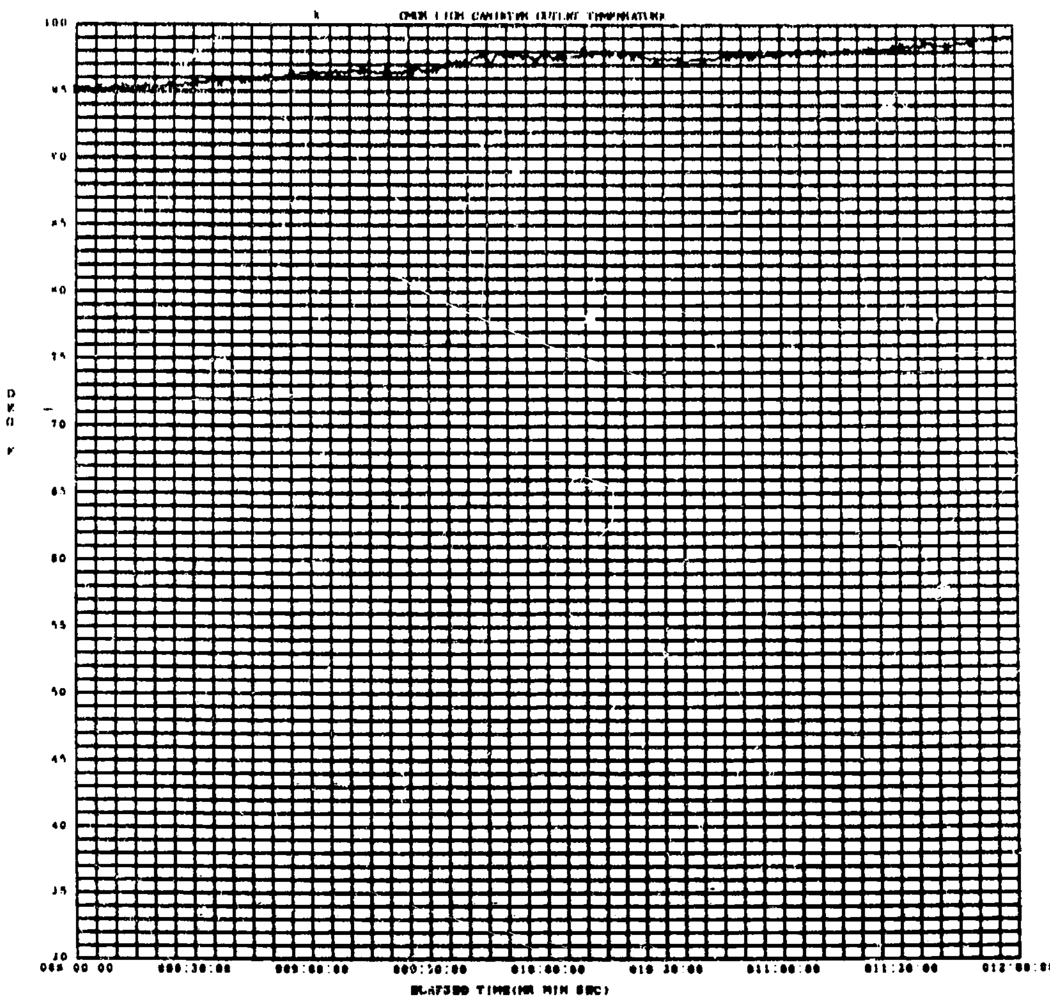


FIGURE 15B CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

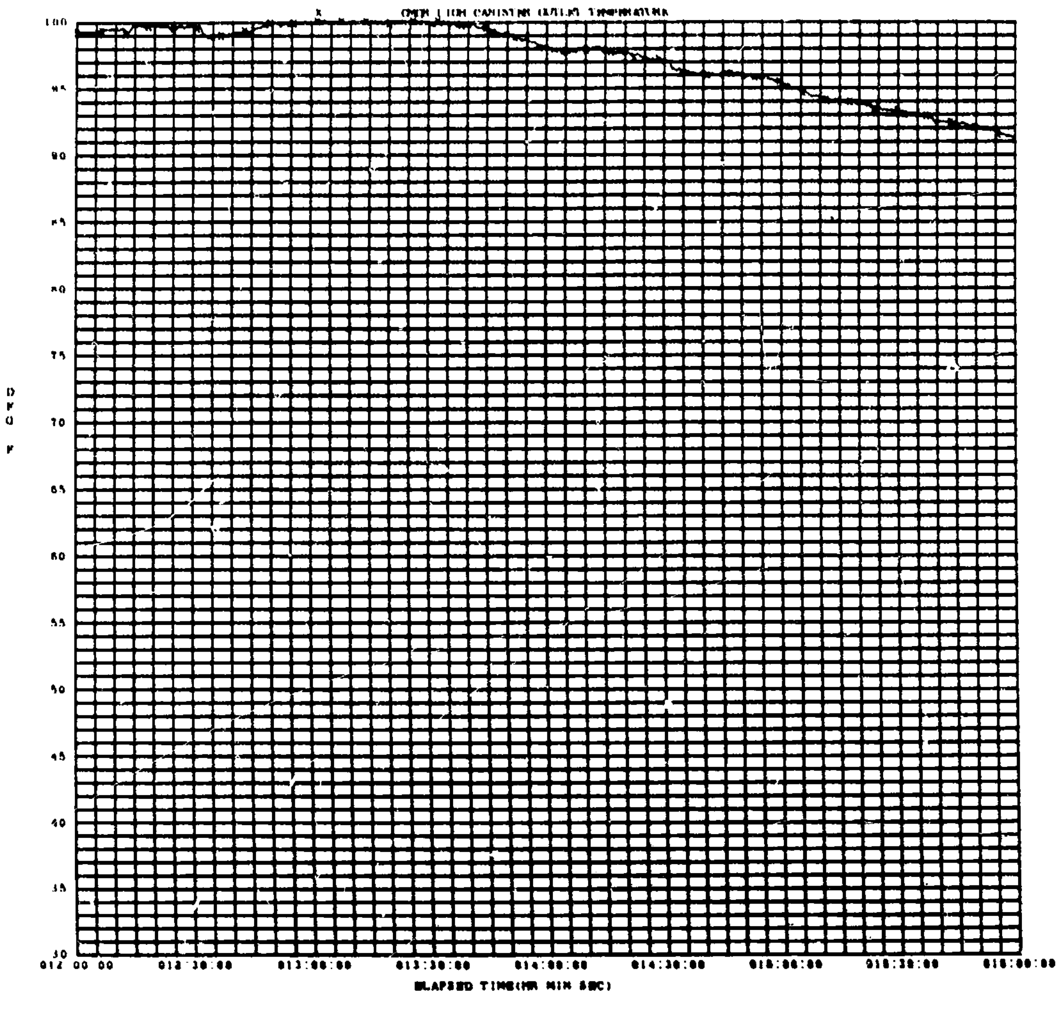


FIGURE 15C CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
--CONTINUED

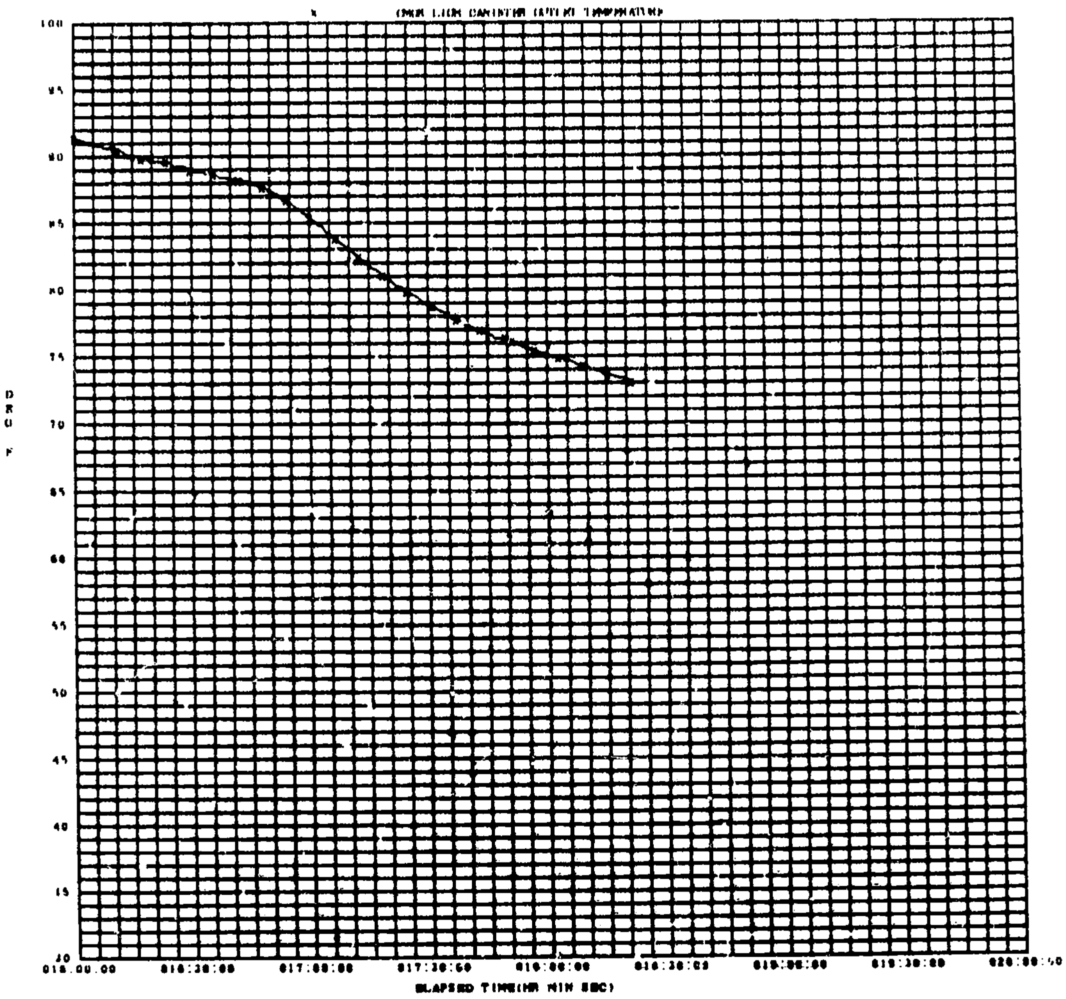


FIGURE 15D CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONCLUDED

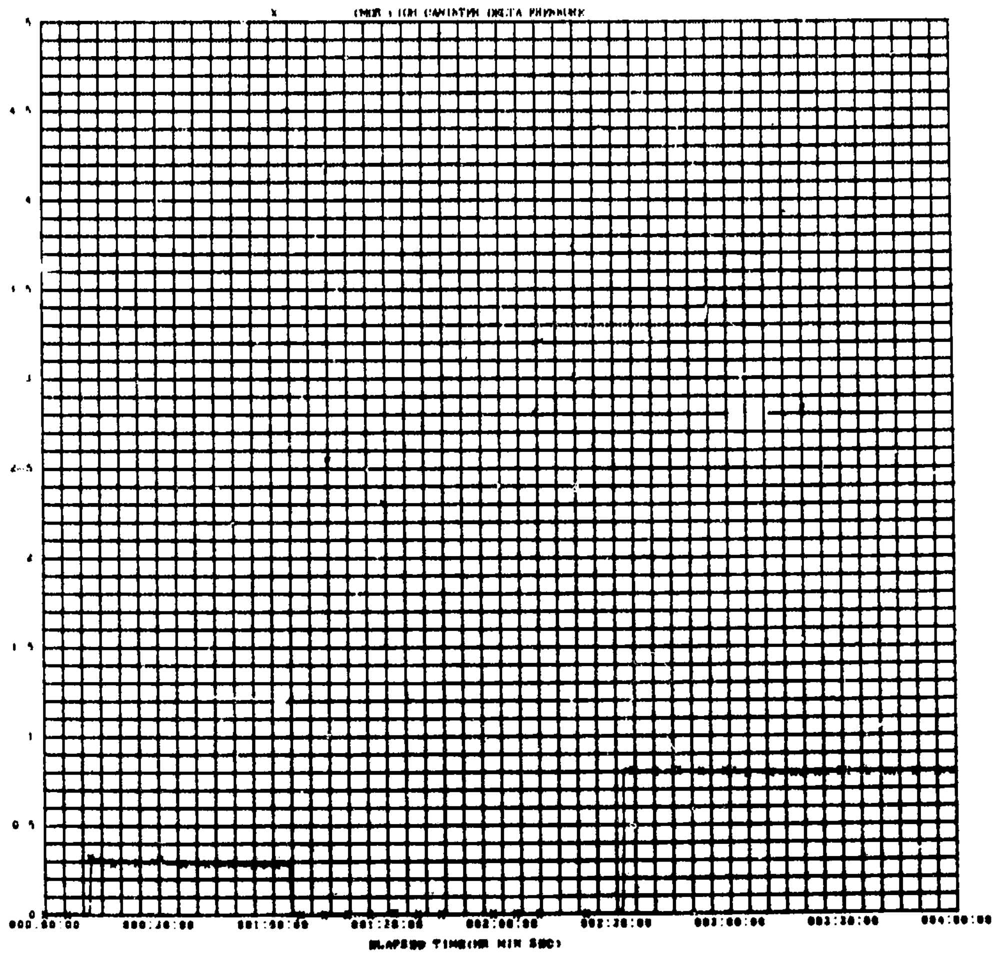


FIGURE 16 CDR LIOH CANISTER DELTA P VERSUS TIME

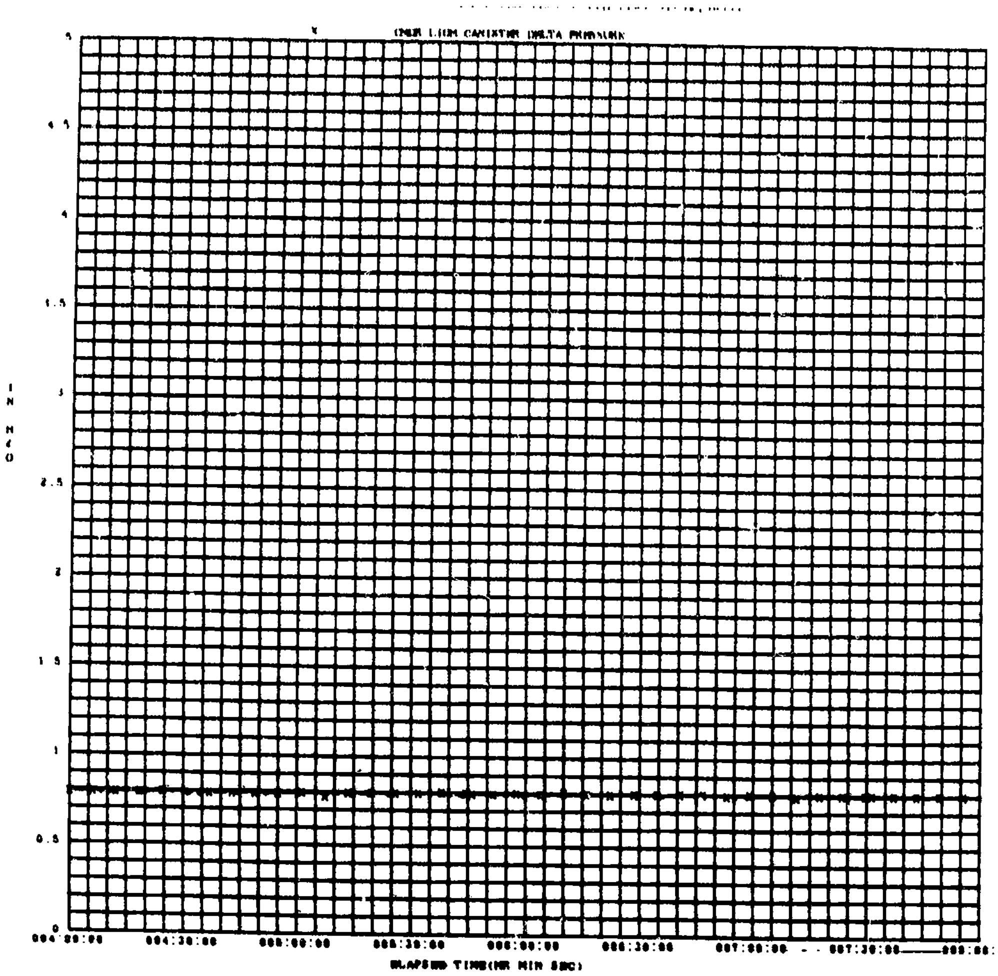


FIGURE 16A CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

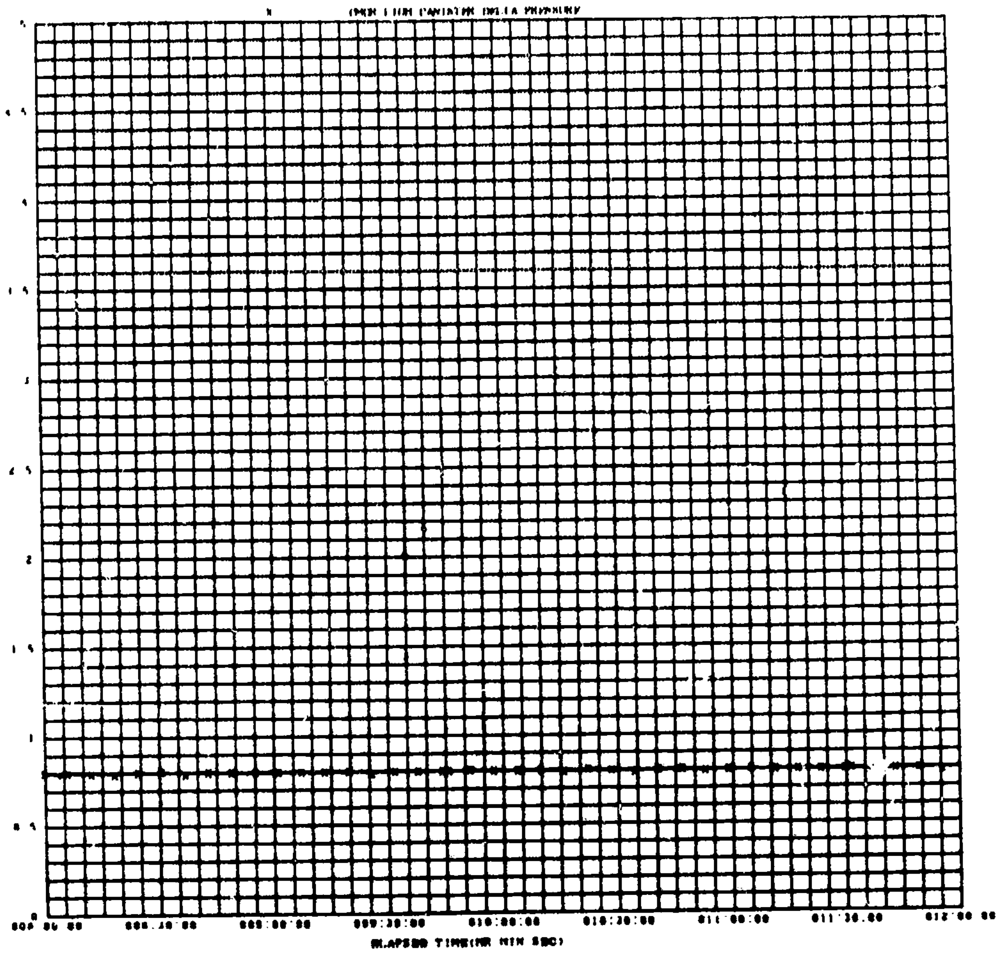


FIGURE 16B CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

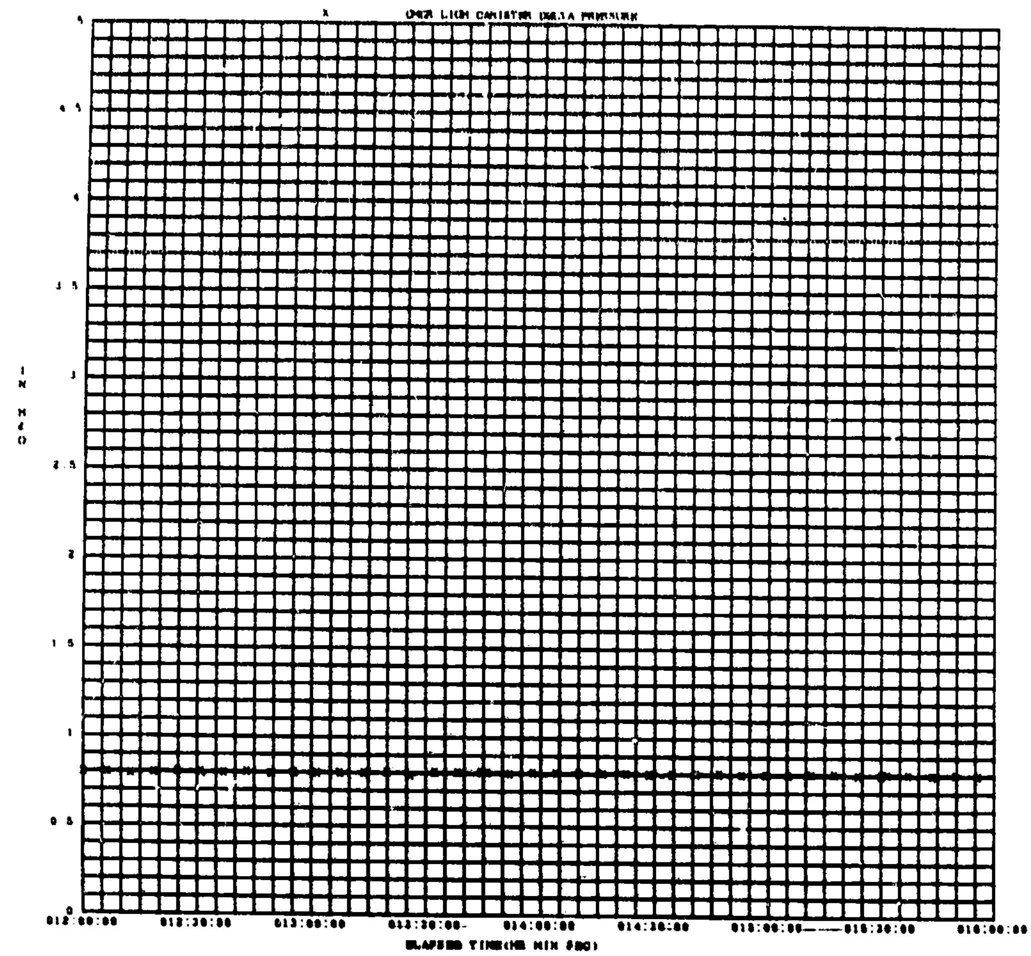


FIGURE 16C CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

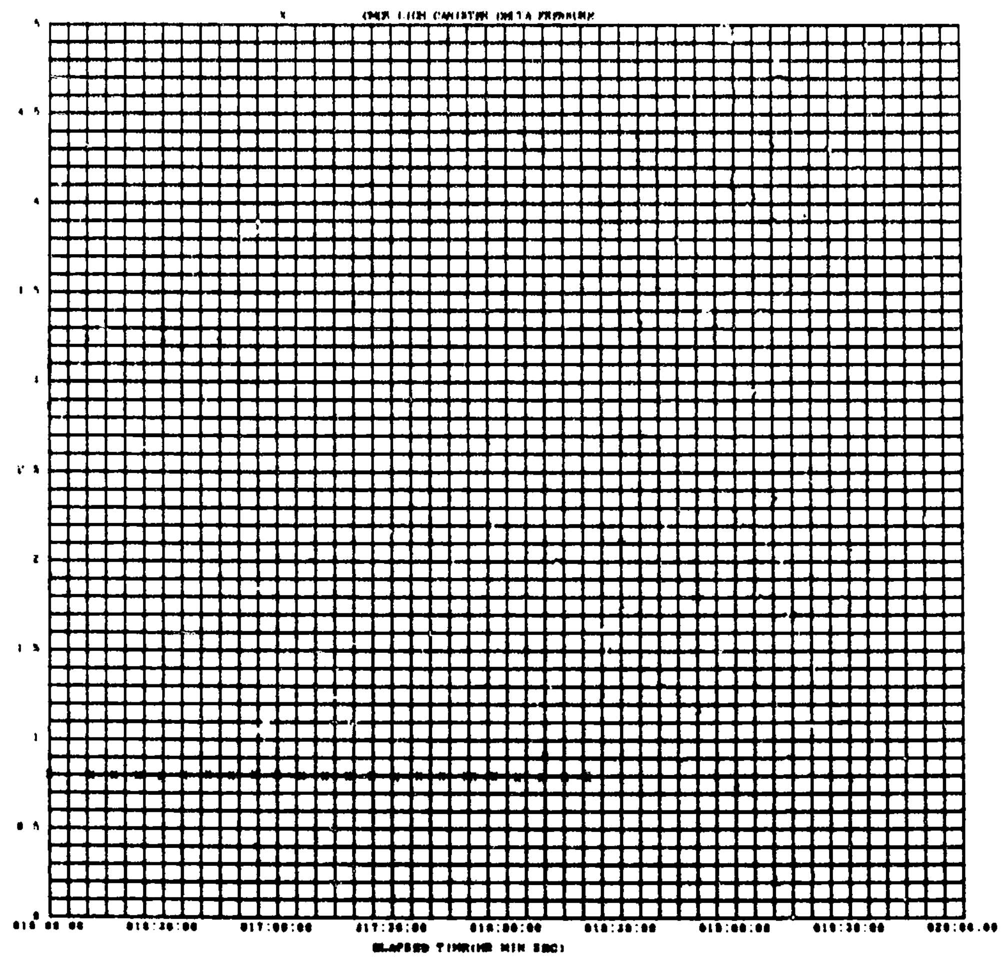


FIGURE 16D CDR LIOH CANISTER DELTA P VERSUS TIME - CONCLUDED

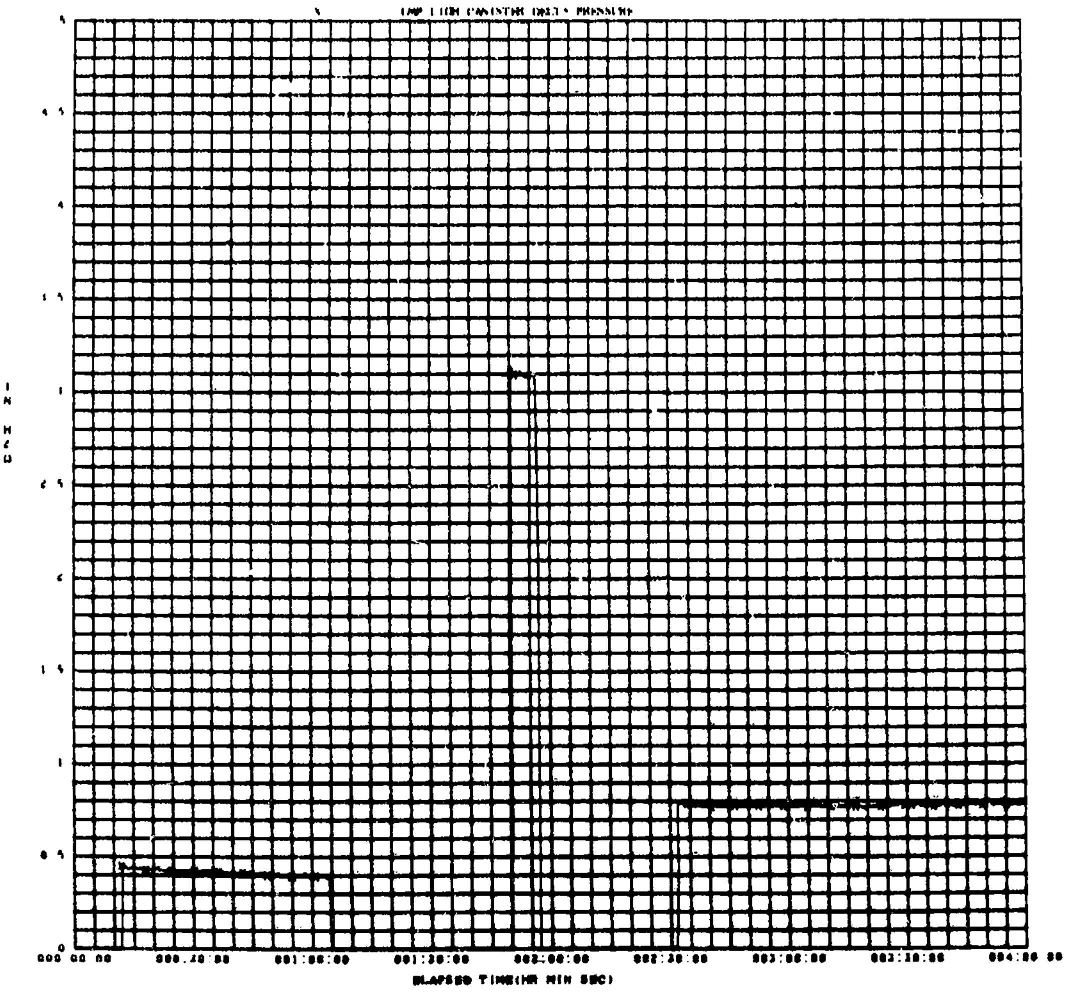


FIGURE 17 LMP LIOH CANISTER DELTA P VERSUS TIME

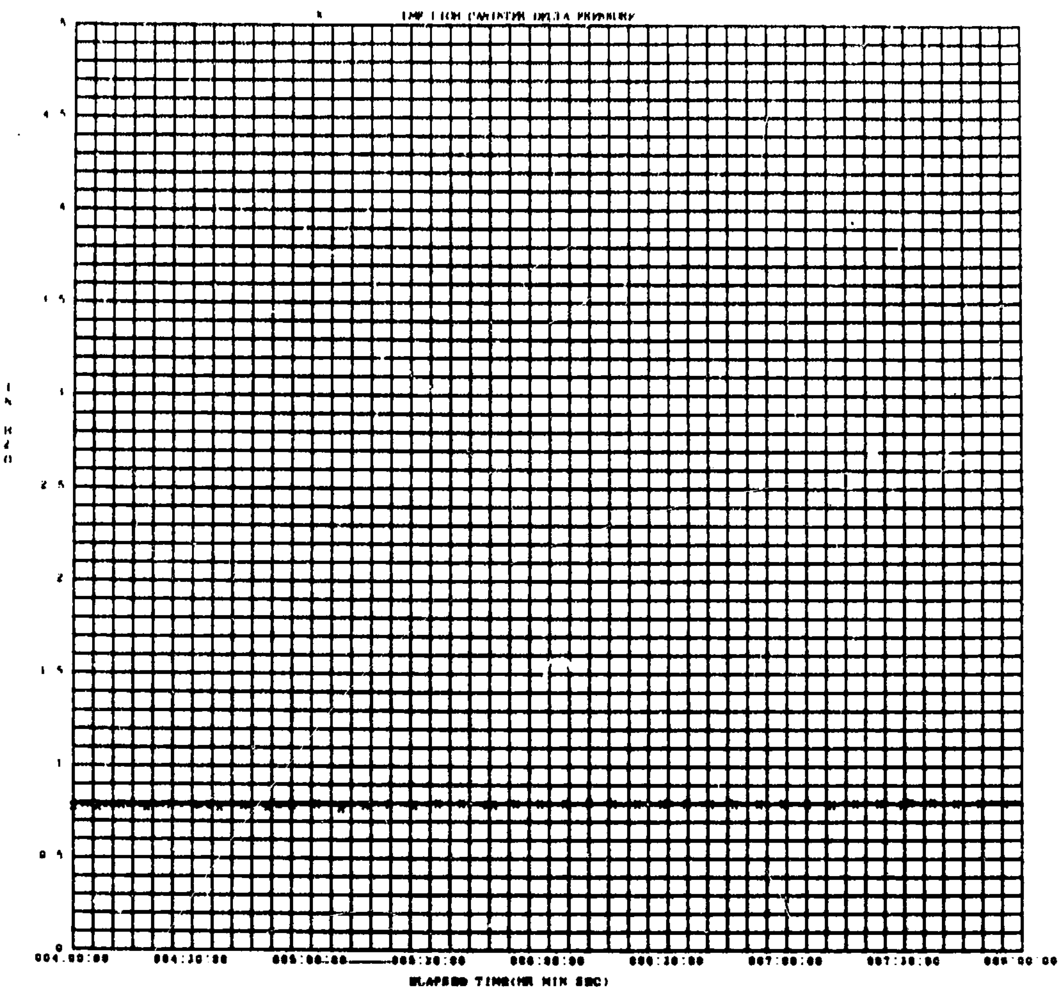


FIGURE 17A LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

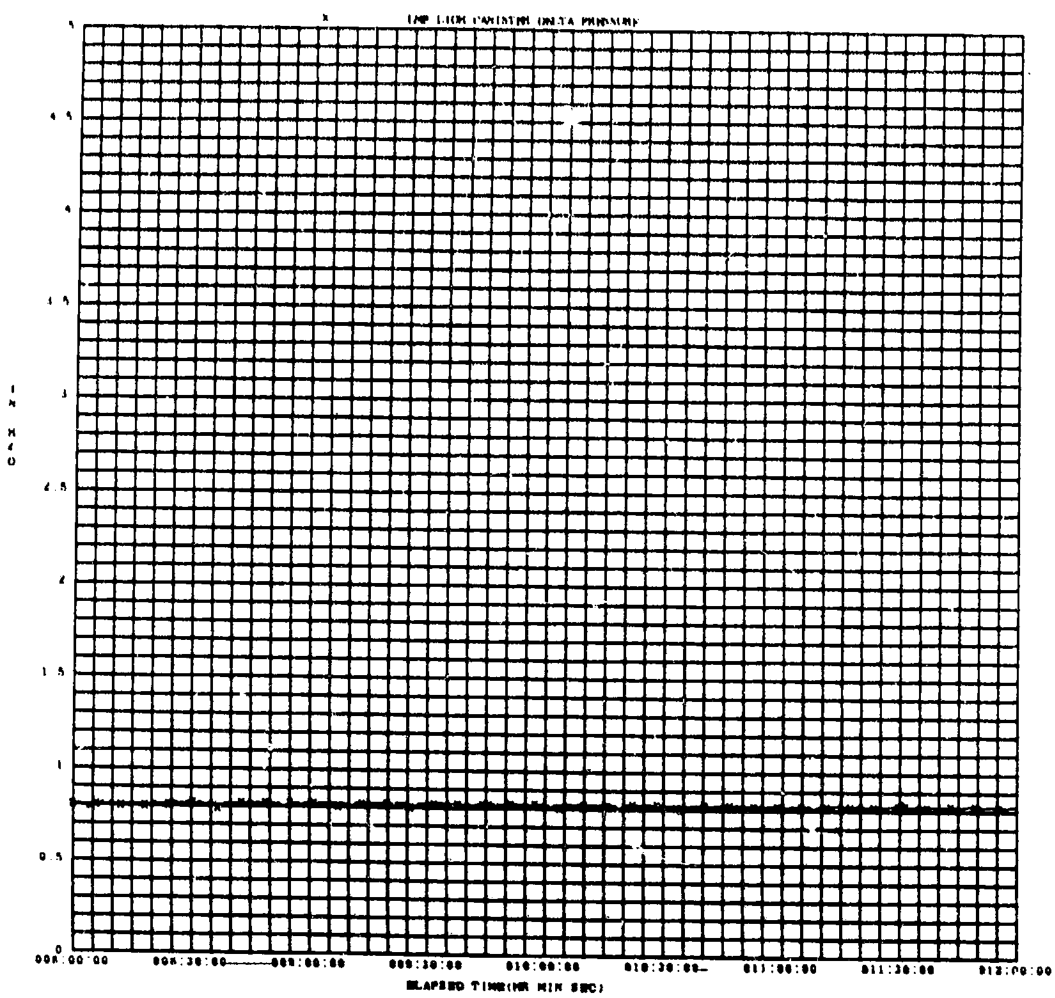


FIGURE 17B LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

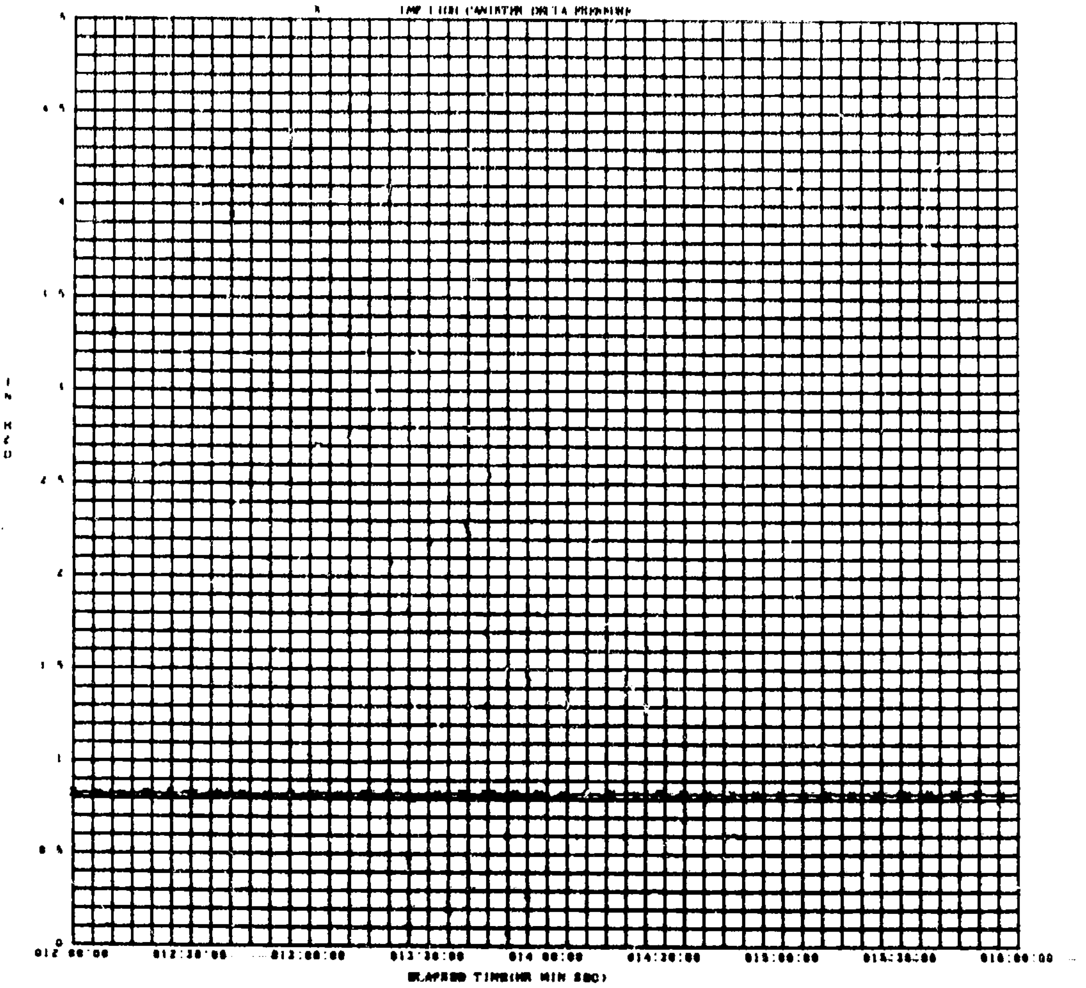


FIGURE 17C LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

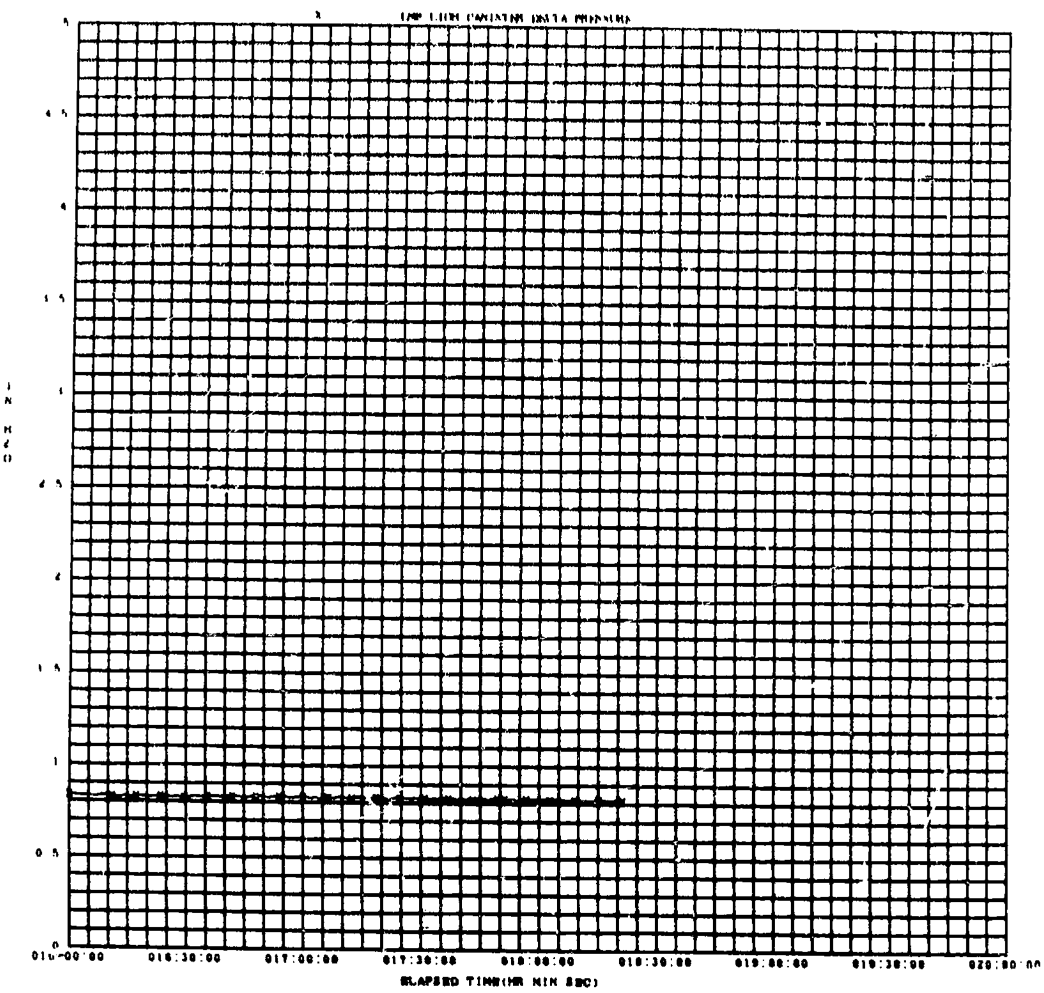


FIGURE 17D LMP LIOH CANISTER DELTA P VERSUS TIME - CONCLUDED

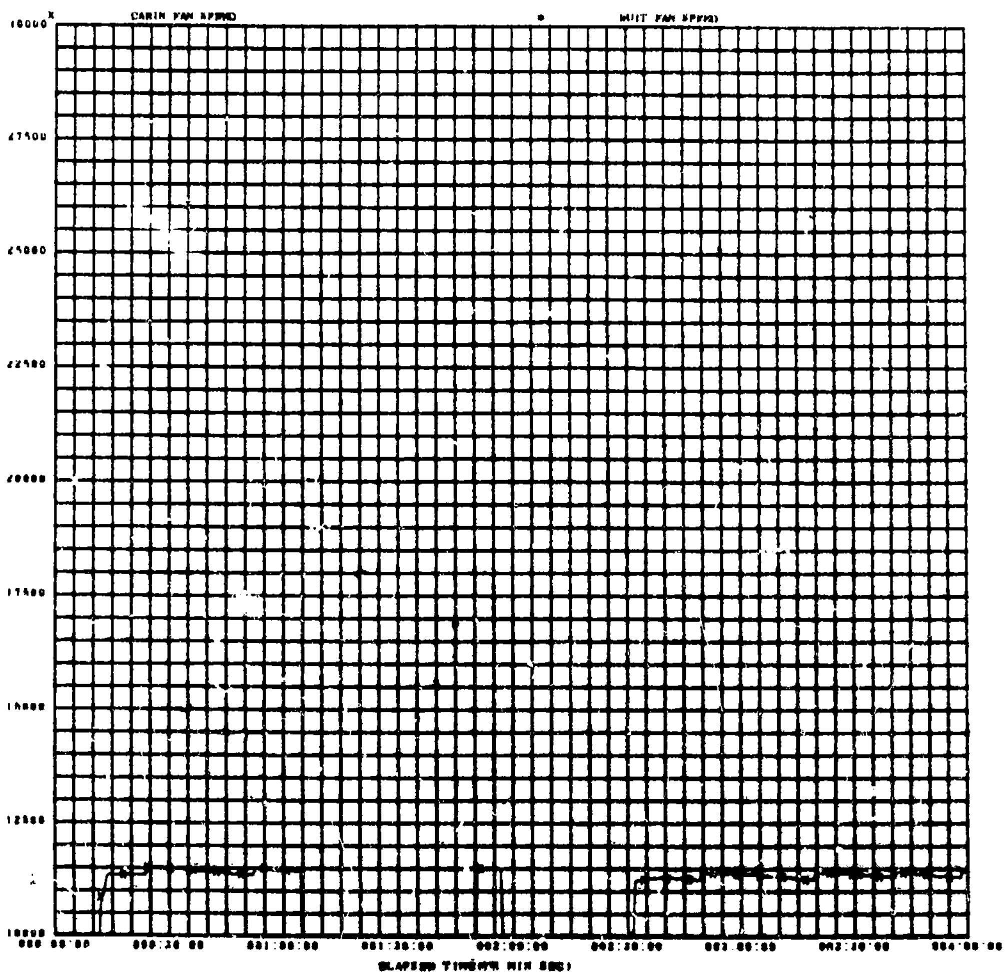


FIGURE 18 CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME

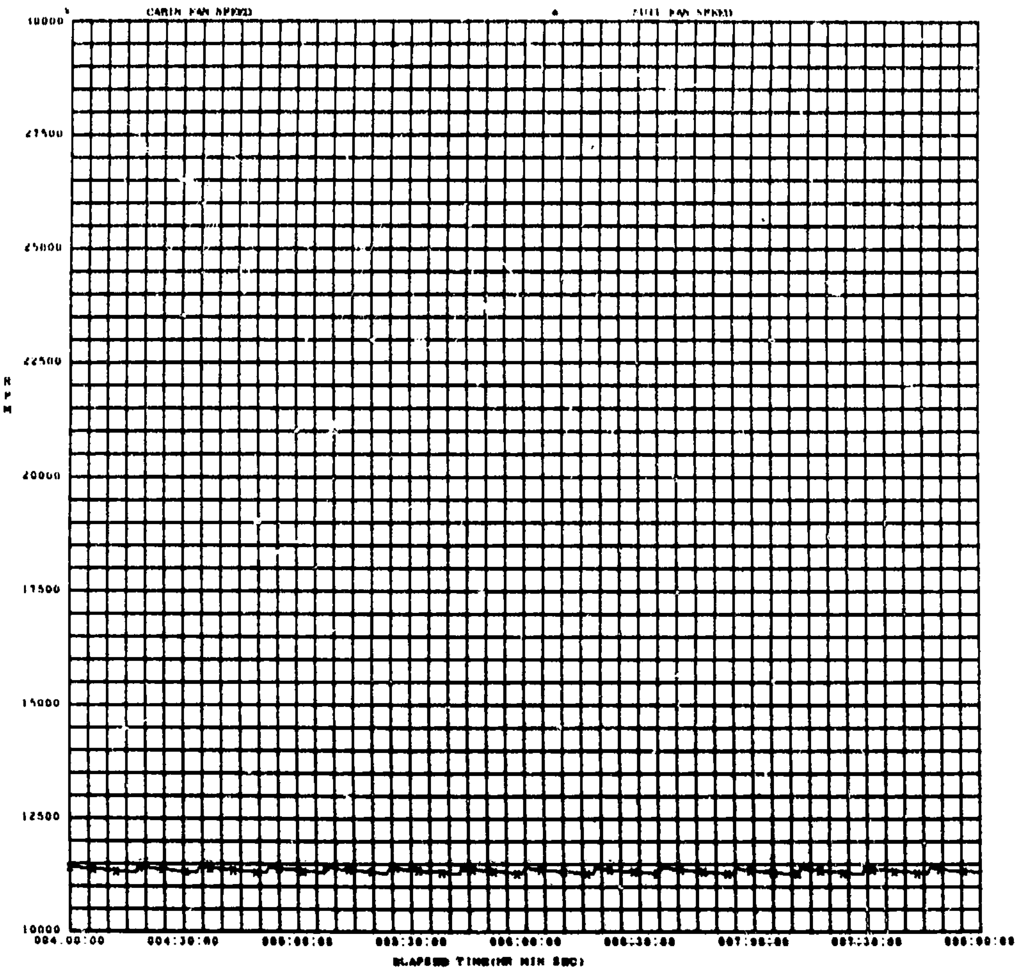


FIGURE 3.8A CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

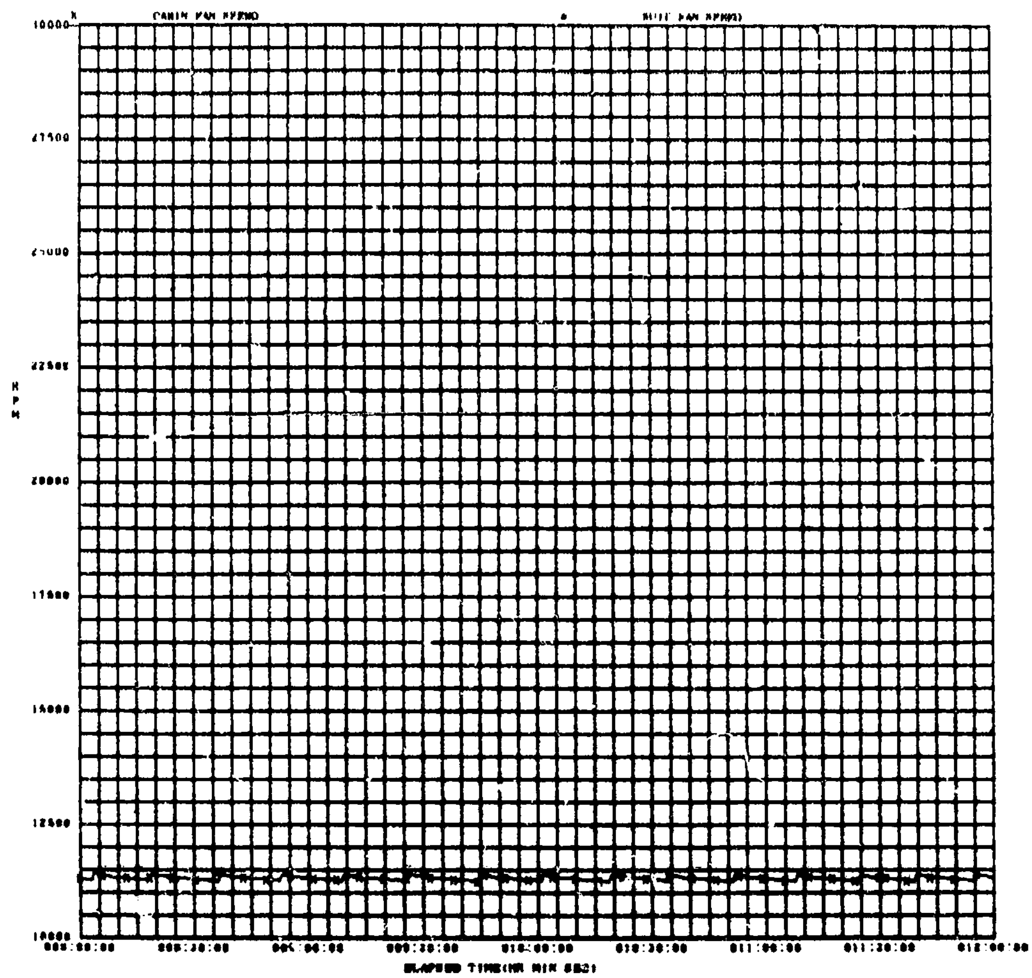


FIGURE 18B CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

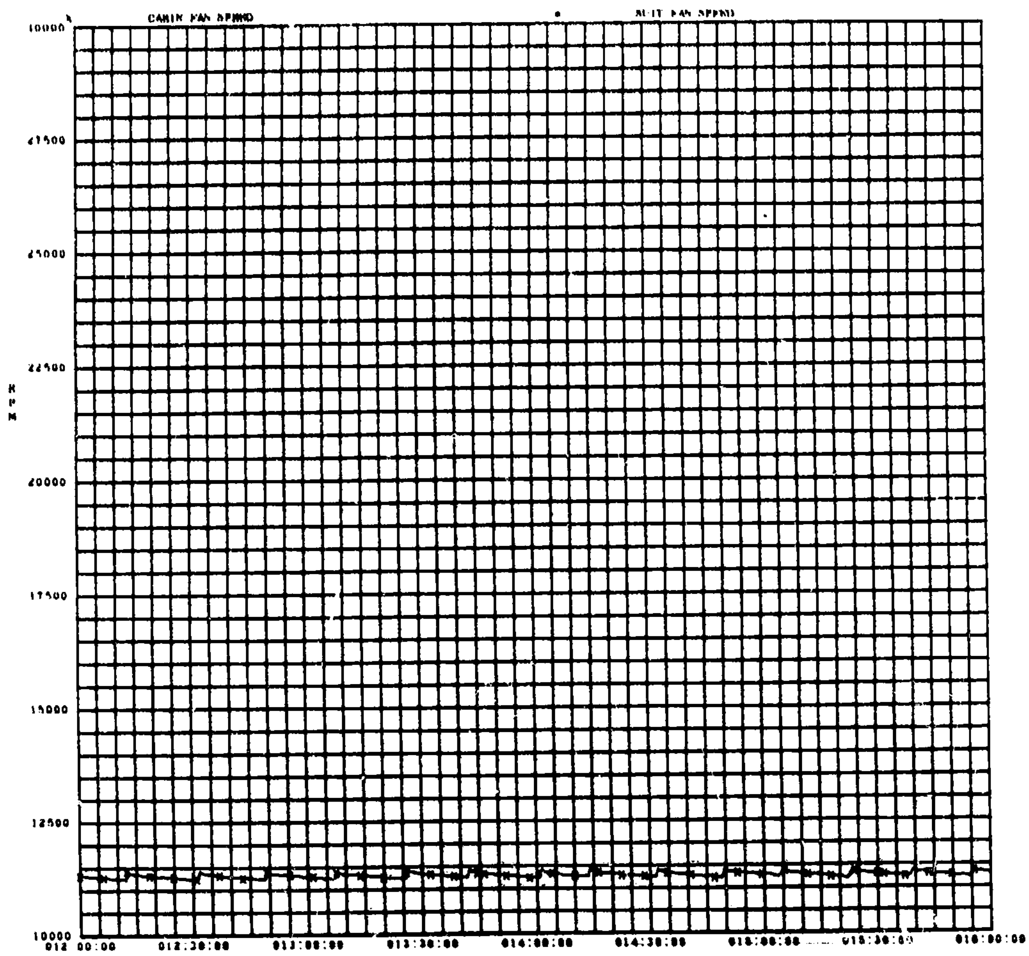


FIGURE 18C CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME - CONTINUED

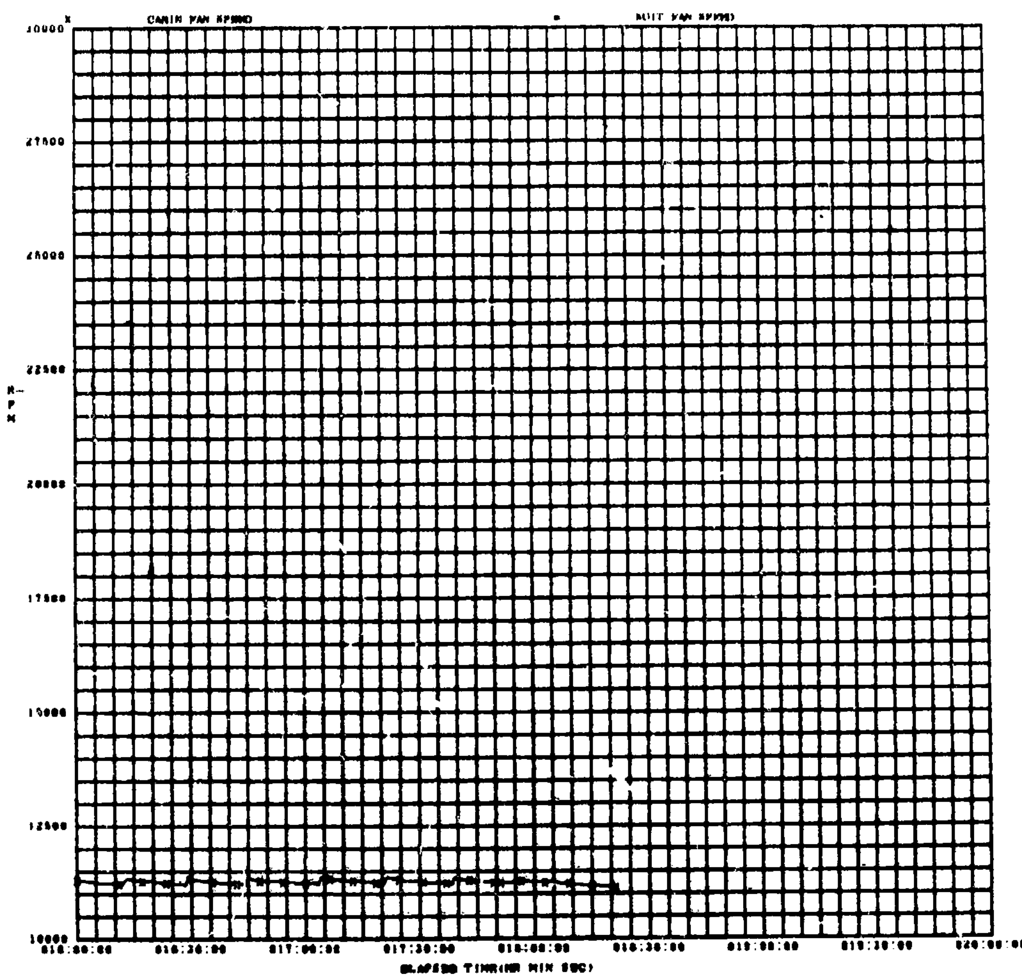


FIGURE 18D CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONCLUDED

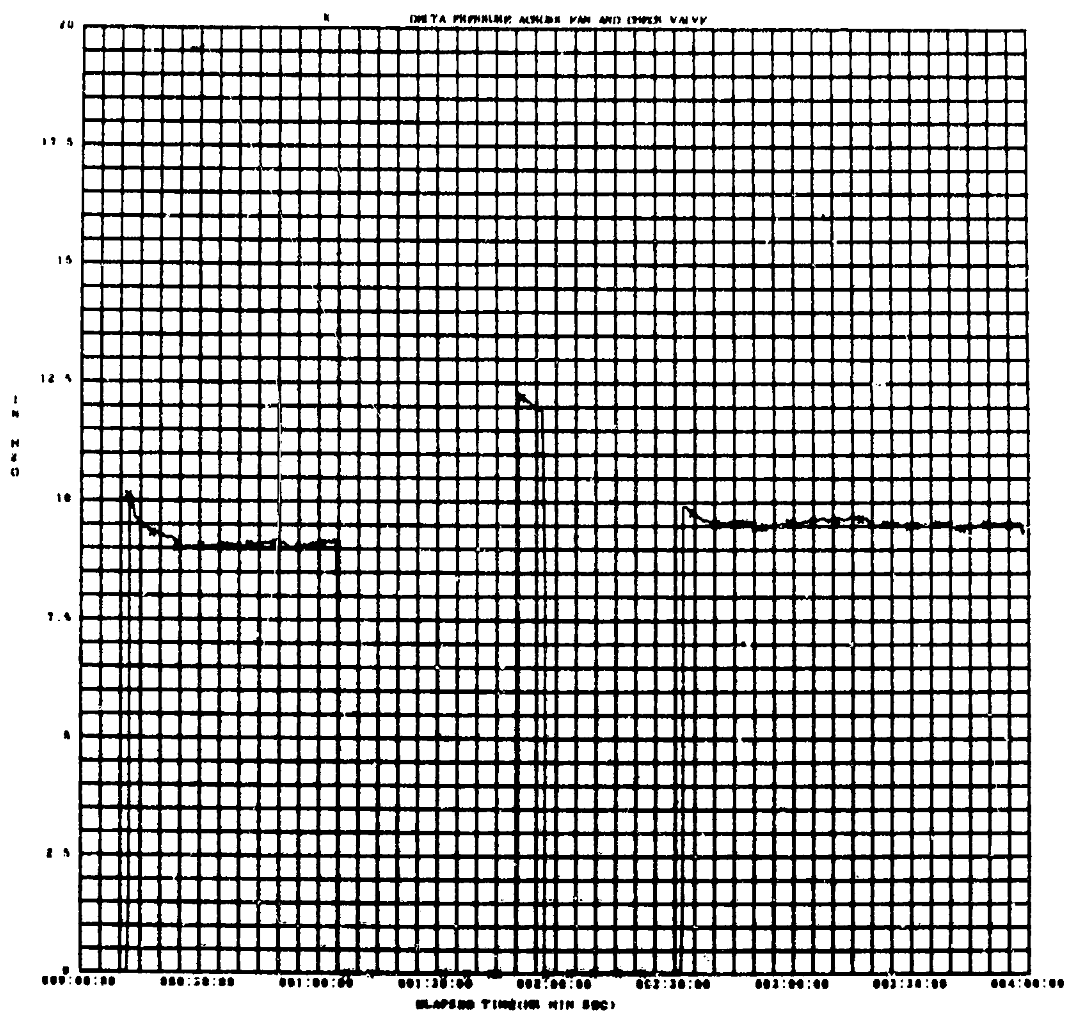


FIGURE 19 FAN AND CHECK VALVE DELTA P VERSUS TIME

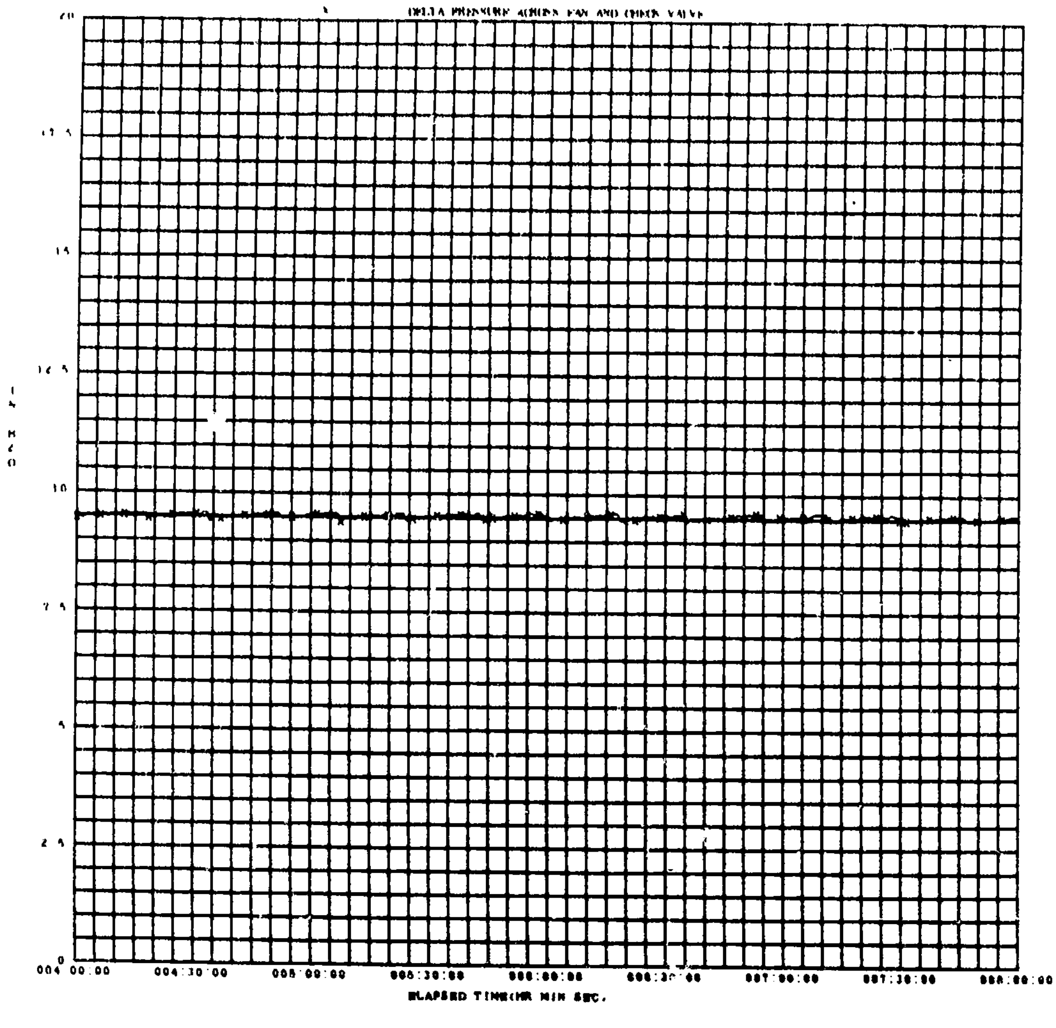


FIGURE 19A FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

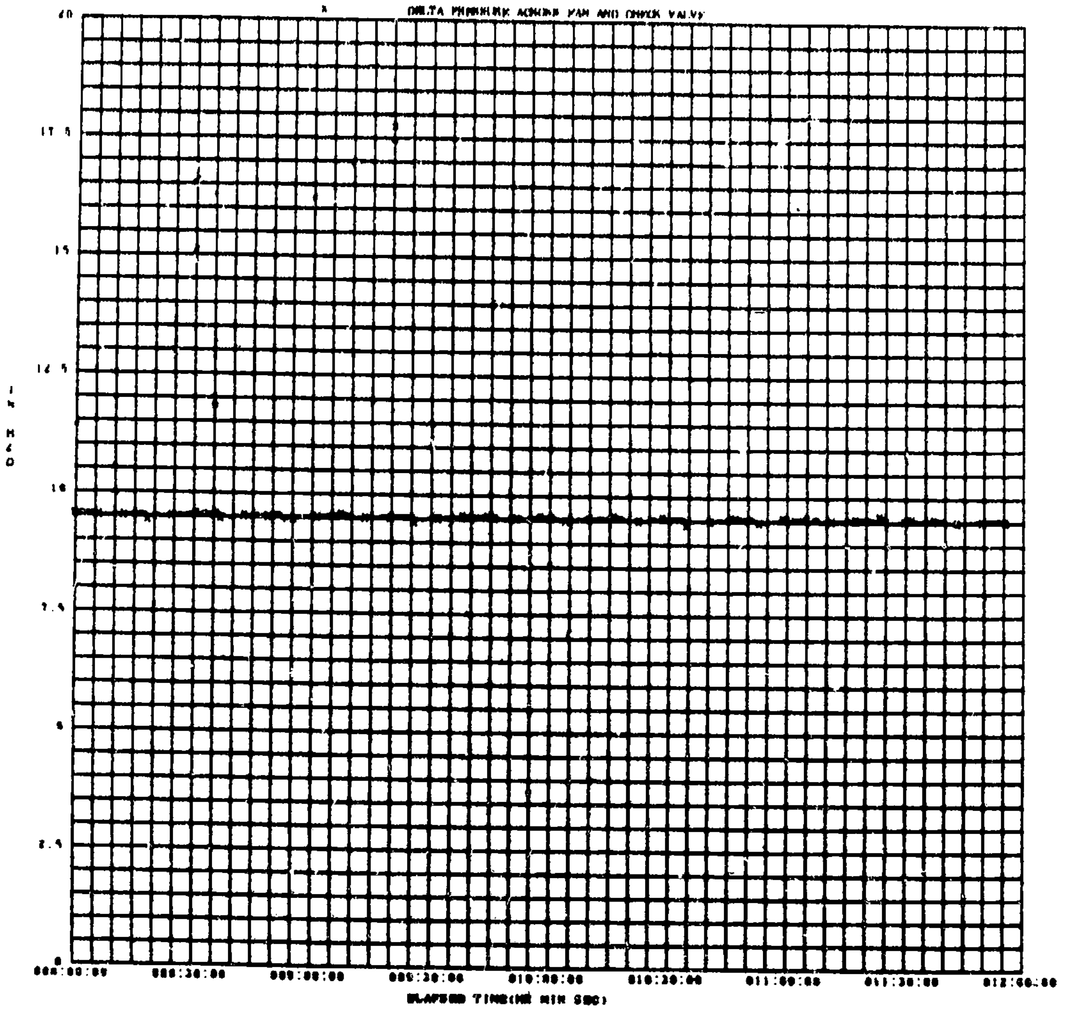


FIGURE 19B FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

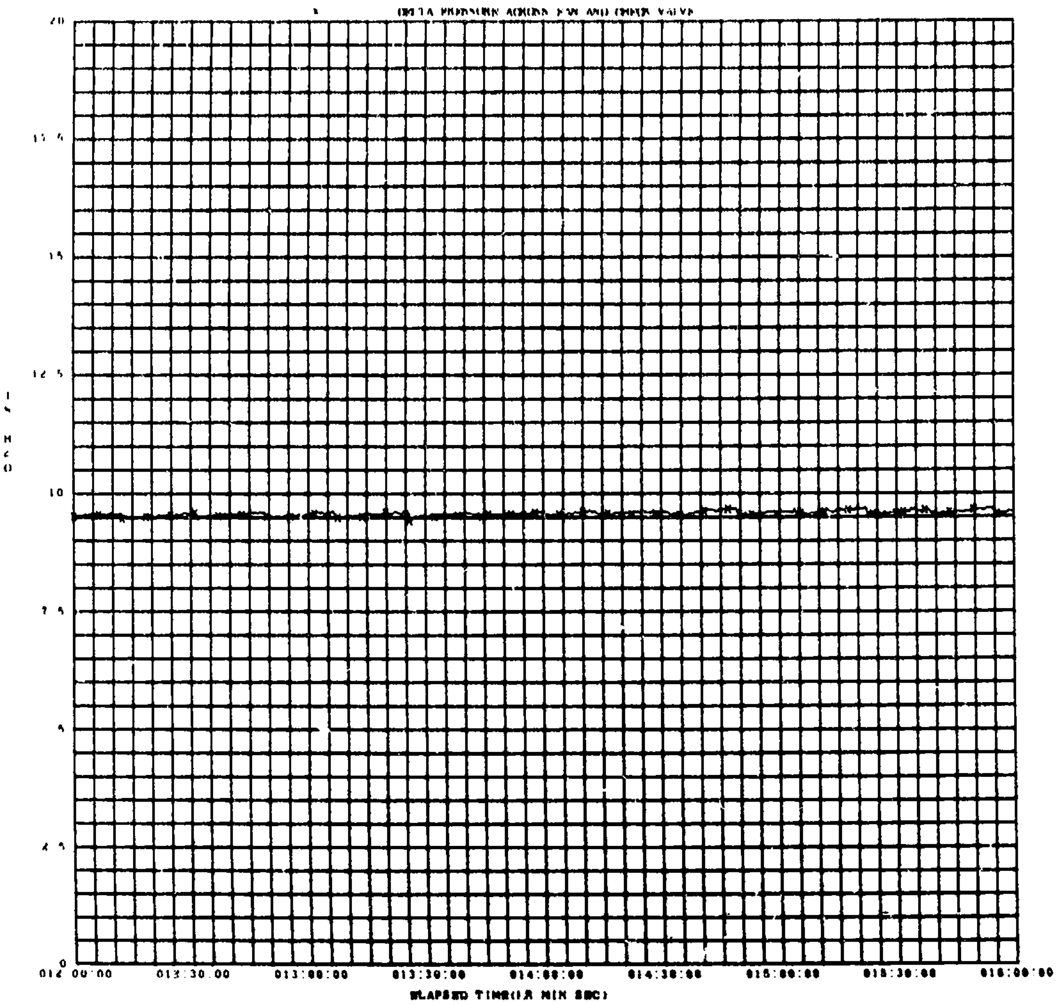


FIGURE 19C FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

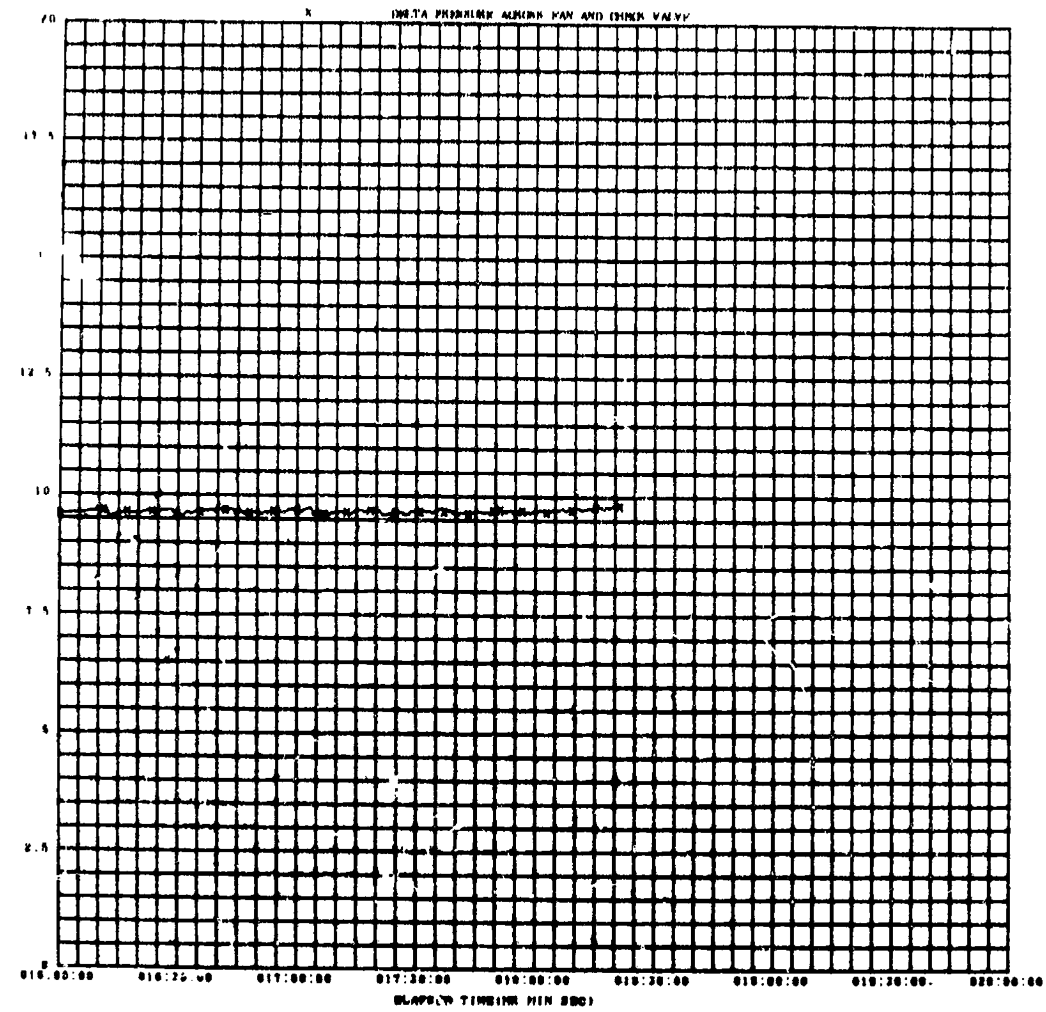


FIGURE 19D FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONCLUDED

FIGURES FOR TEST NO. 2

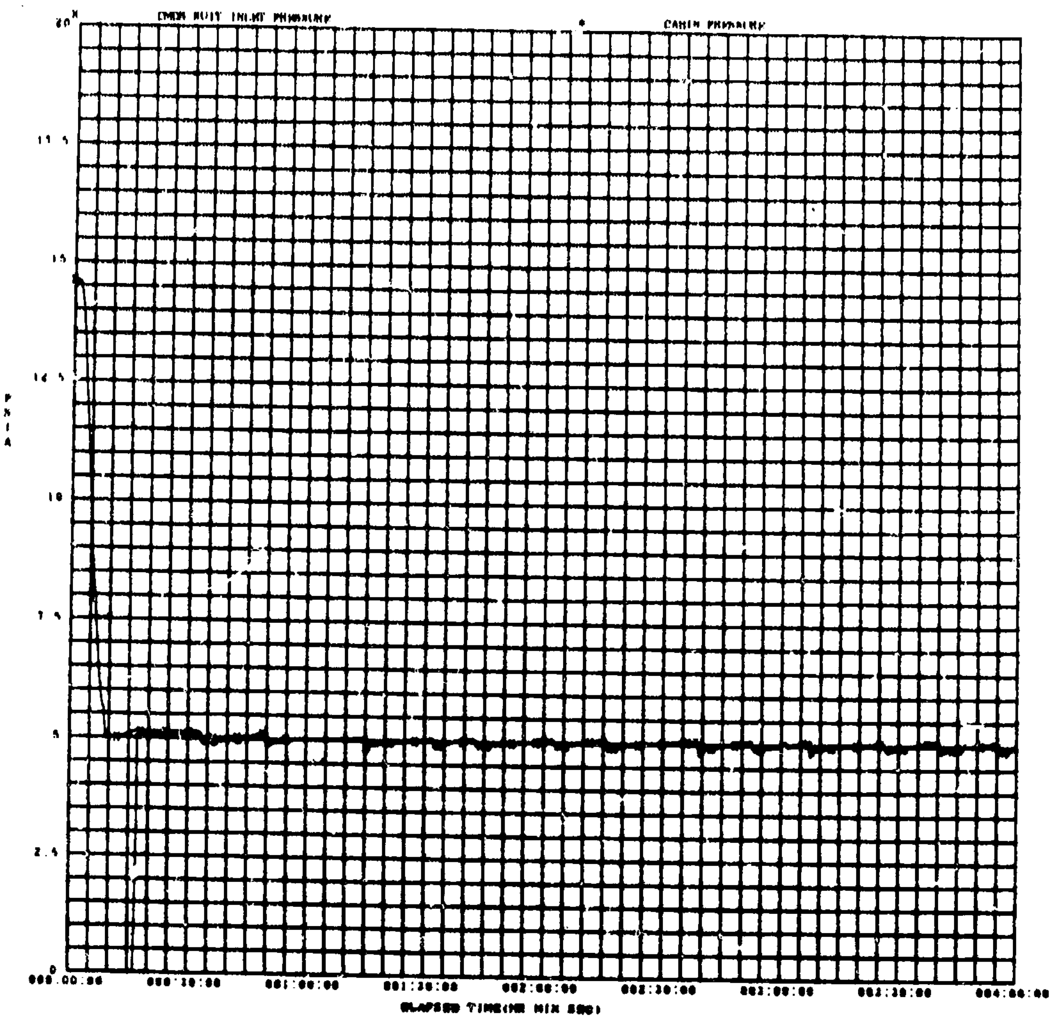


FIGURE 20 CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME

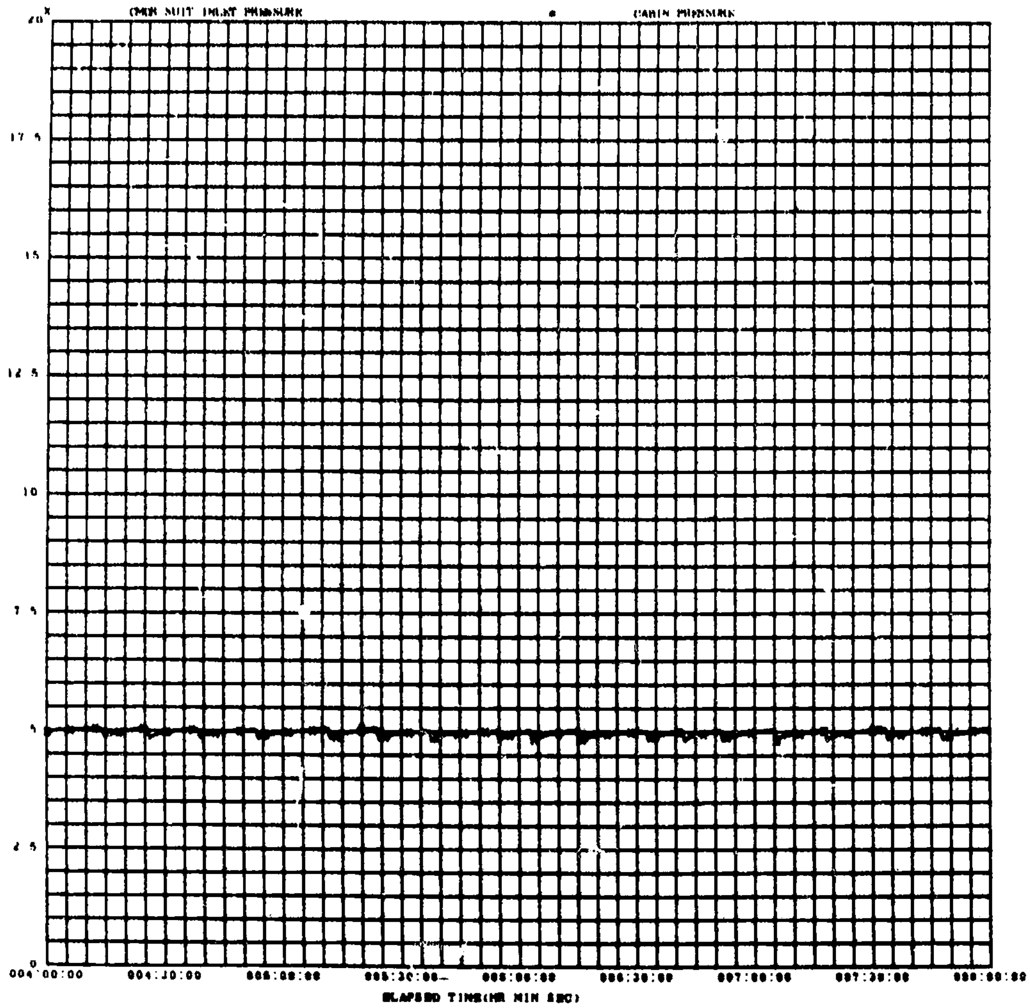


FIGURE 20A CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS
TIME - CONTINUED

C 3

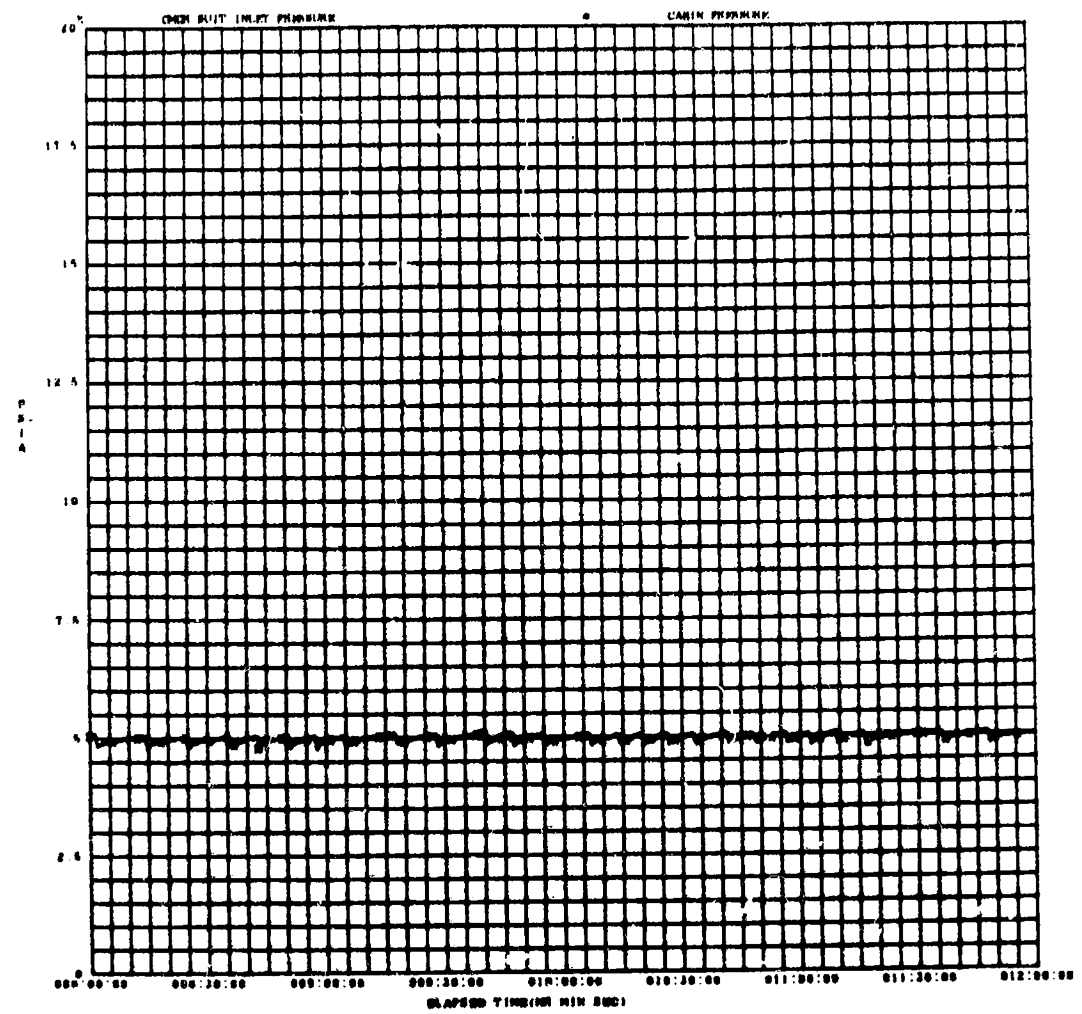


FIGURE 20B CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

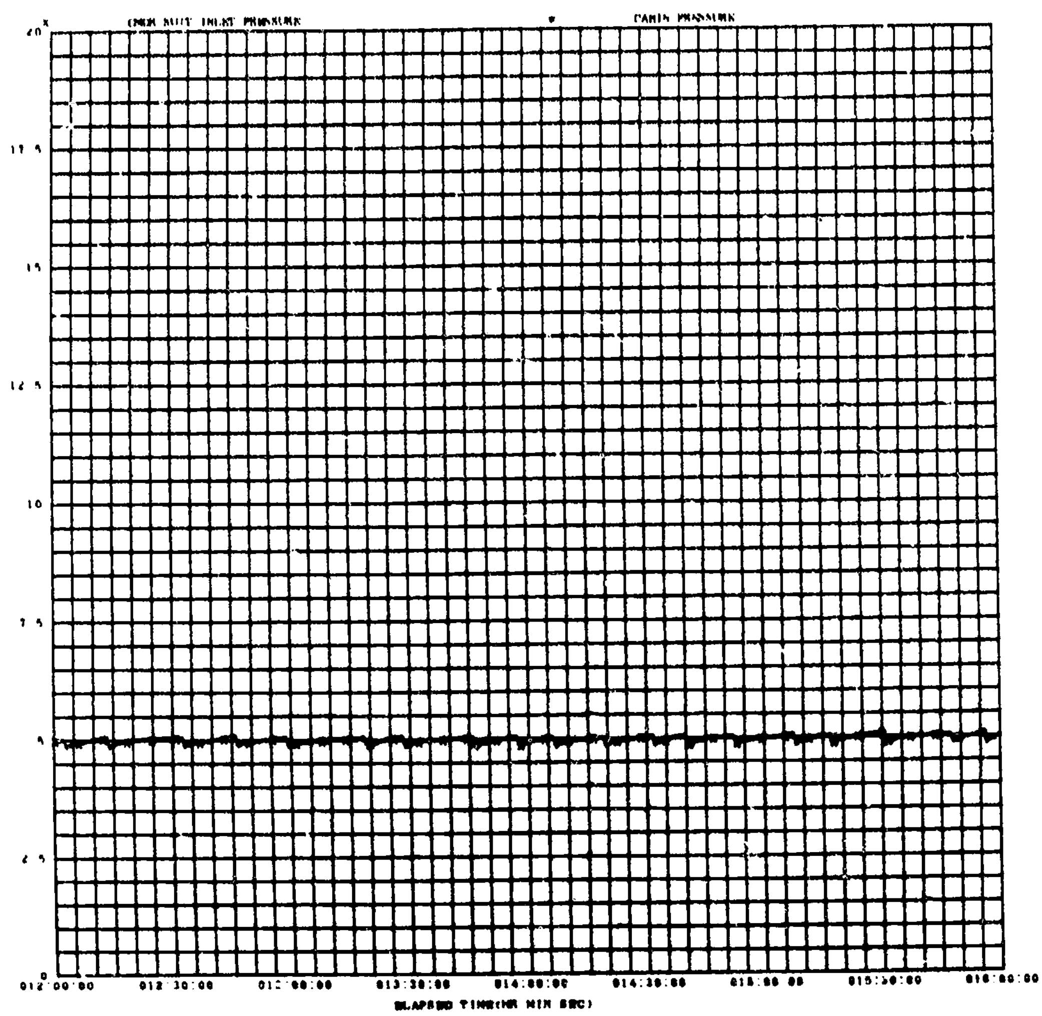


FIGURE 20C CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

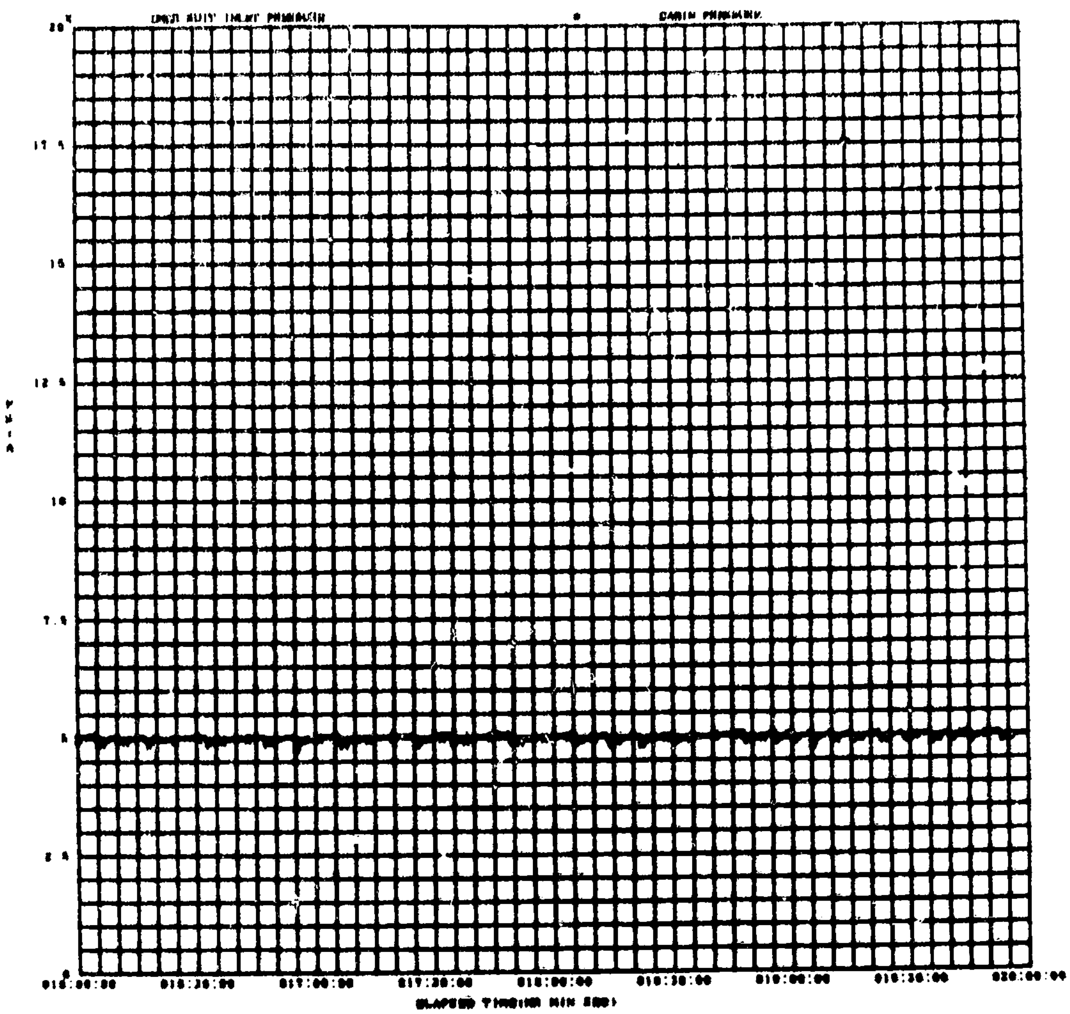


FIGURE 20D CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

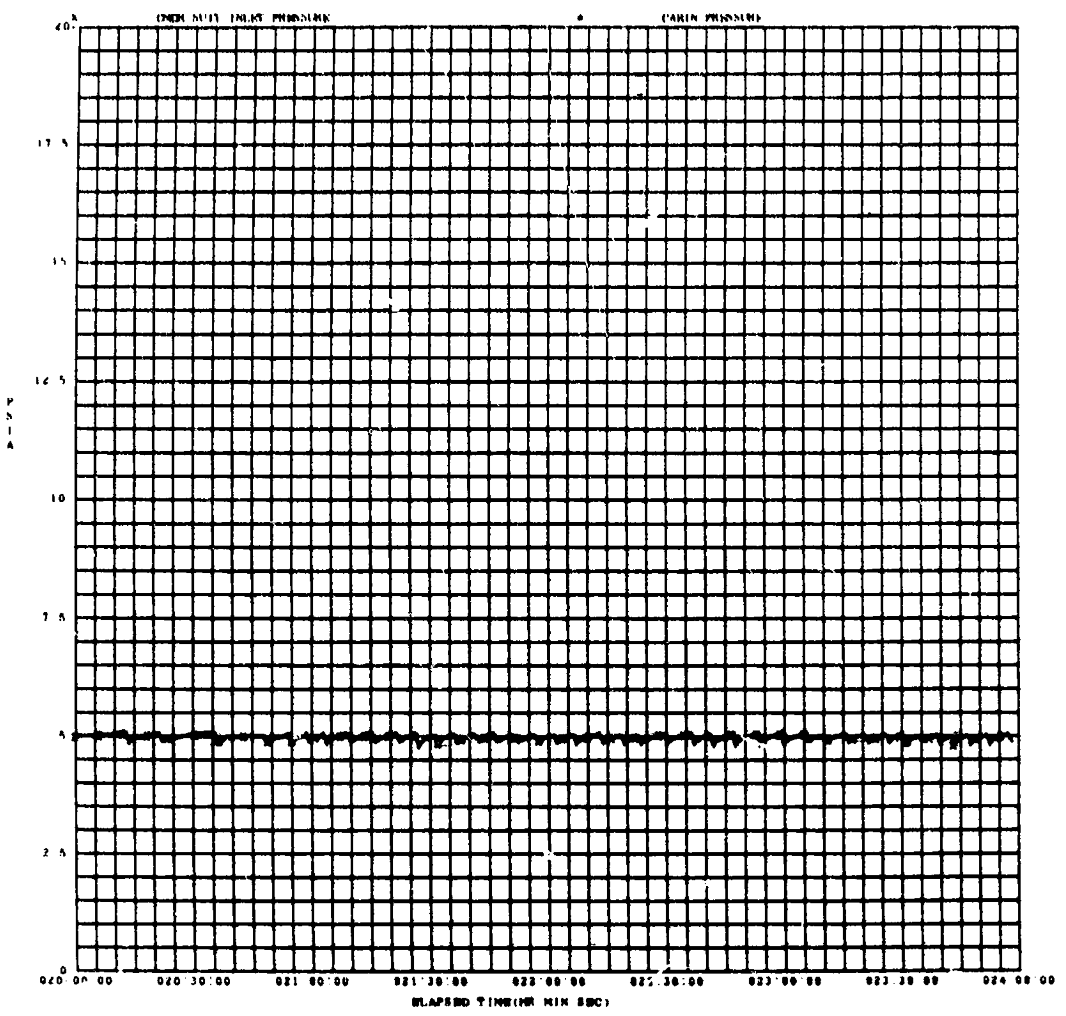


FIGURE 20E CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

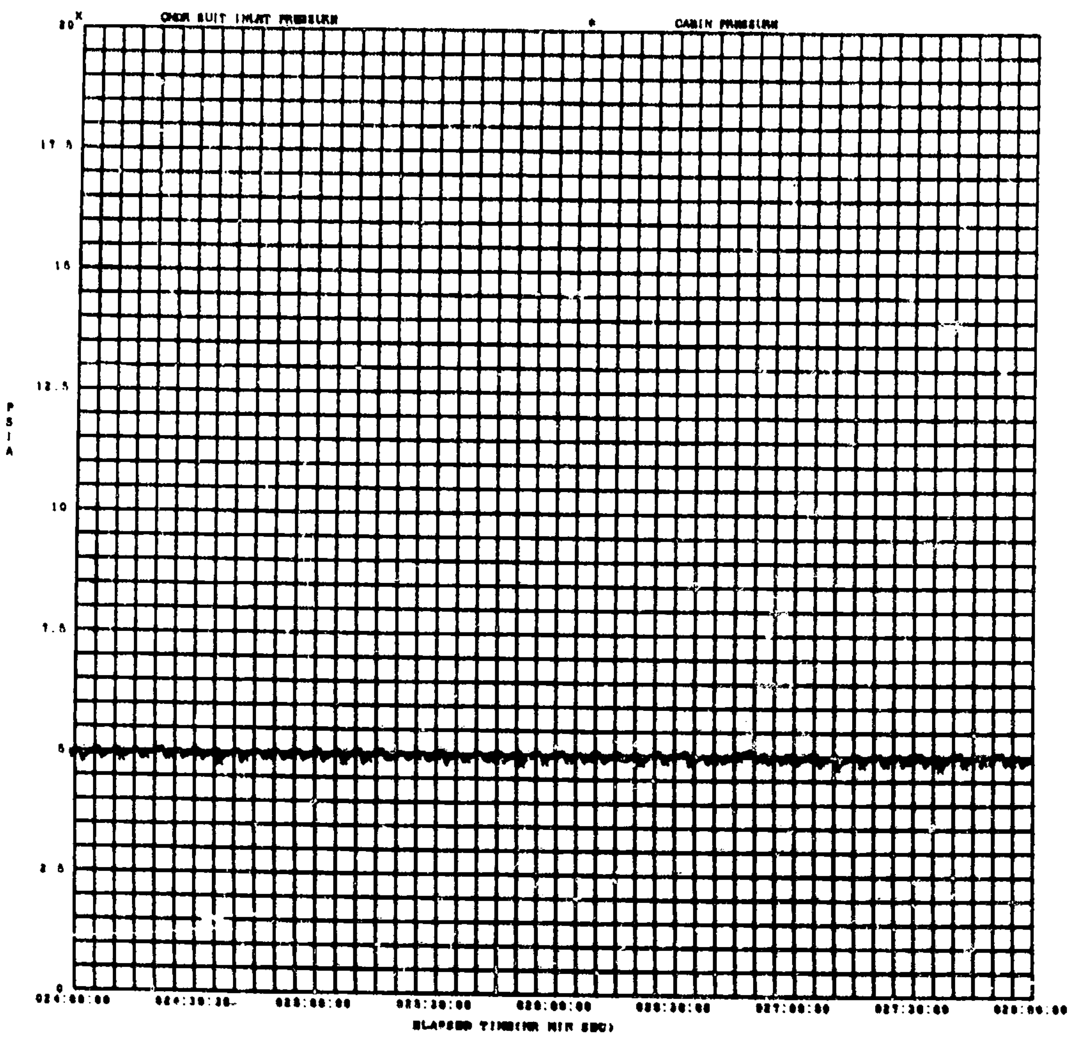


FIGURE 20F CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

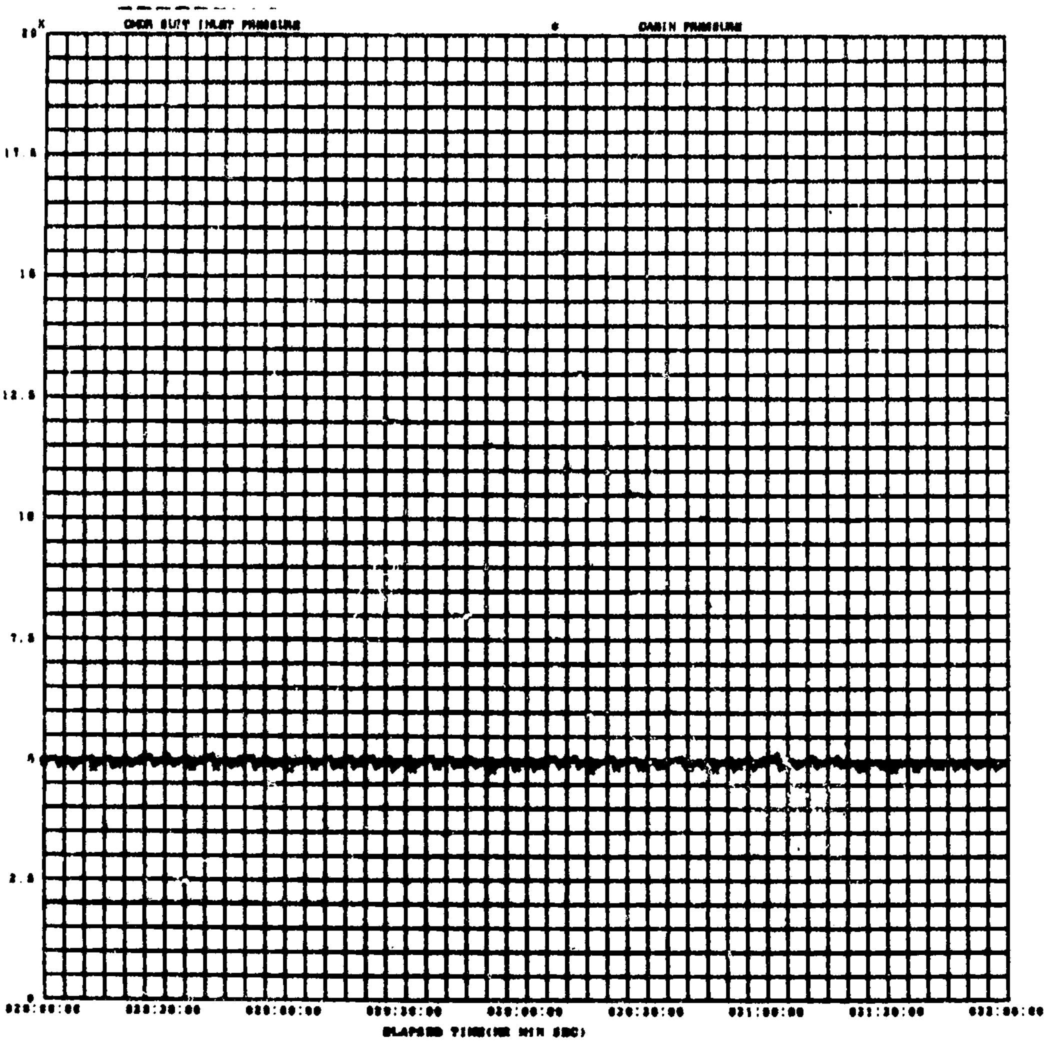


FIGURE 20G CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

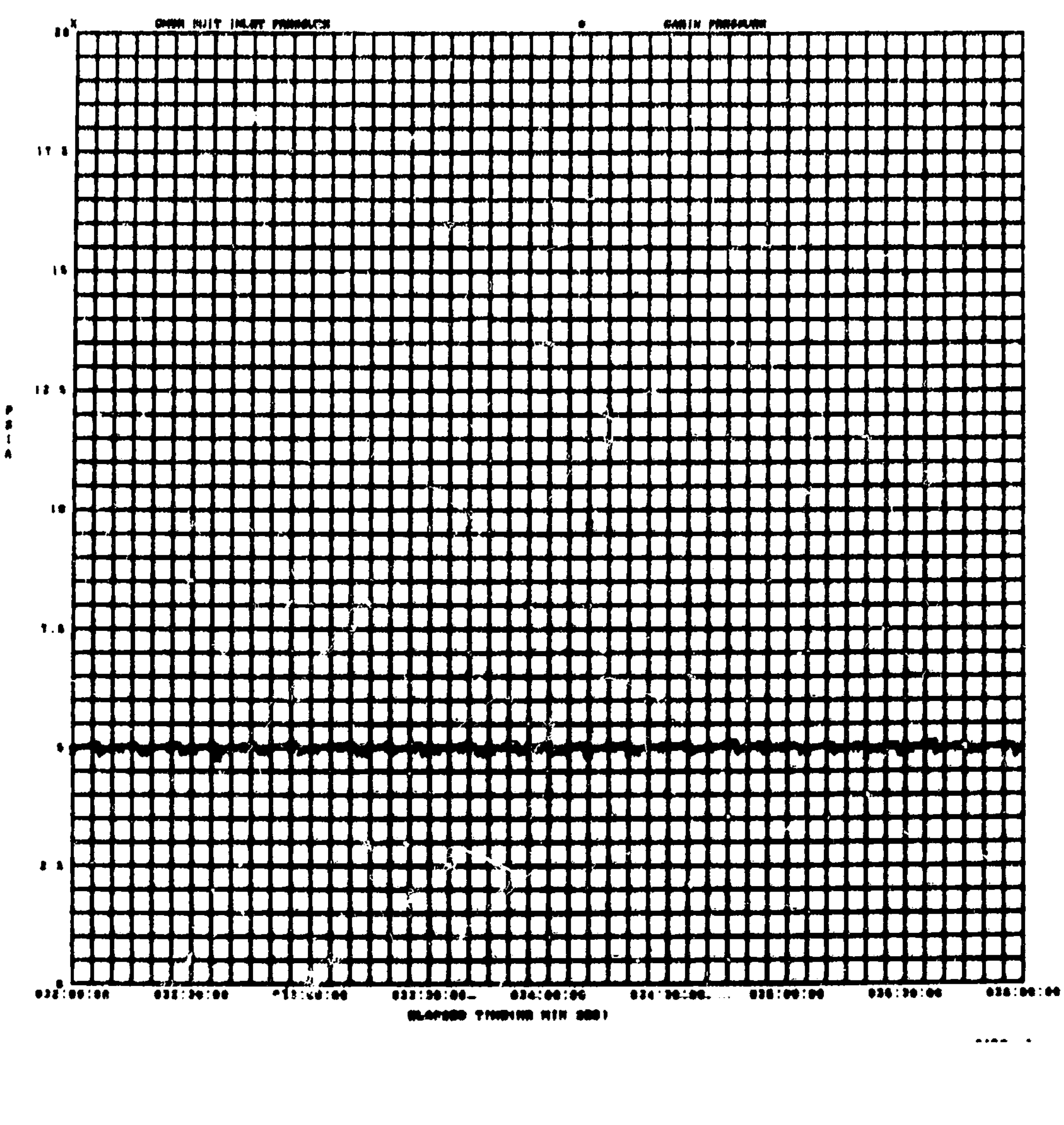


FIGURE 20H CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONTINUED

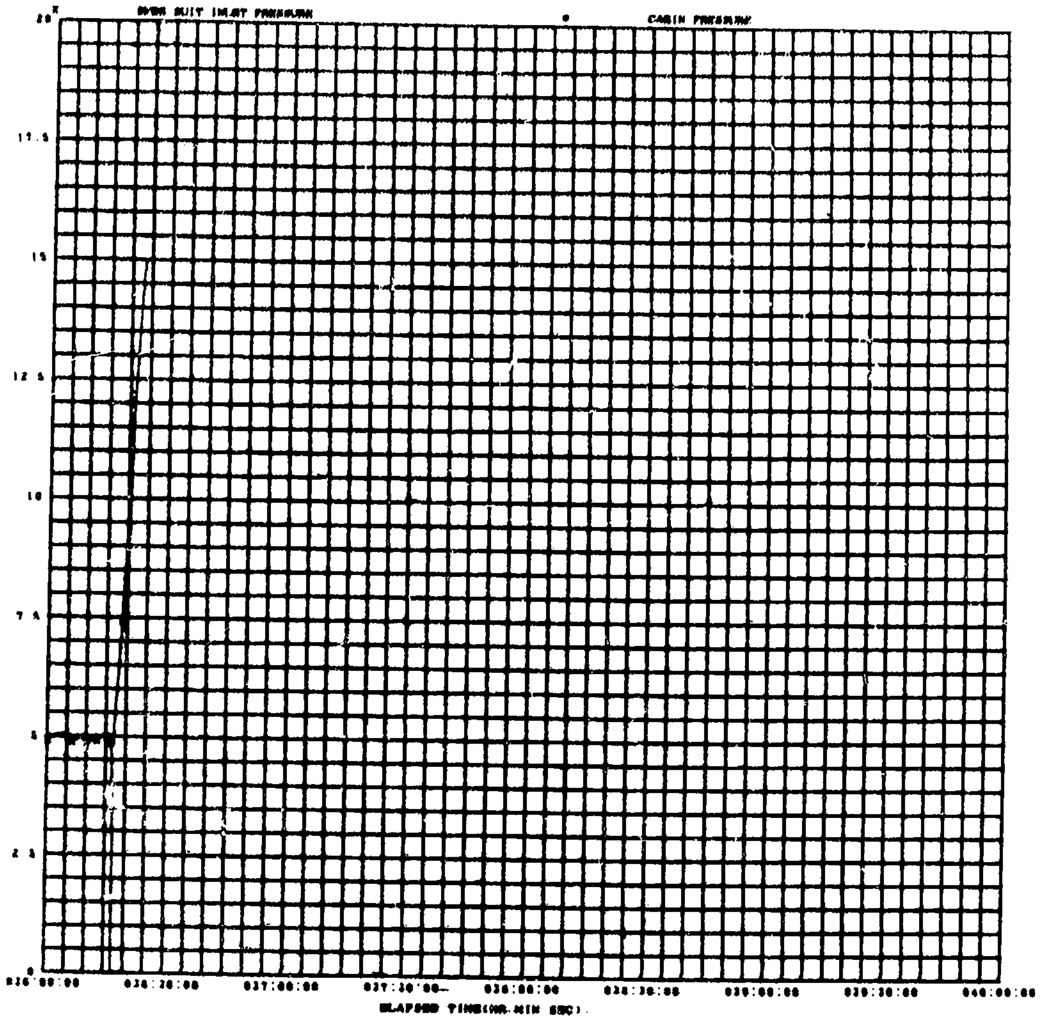


FIGURE 20J CABIN PRESSURE AND CDR SUIT INLET PRESSURE VERSUS TIME - CONCLUDED

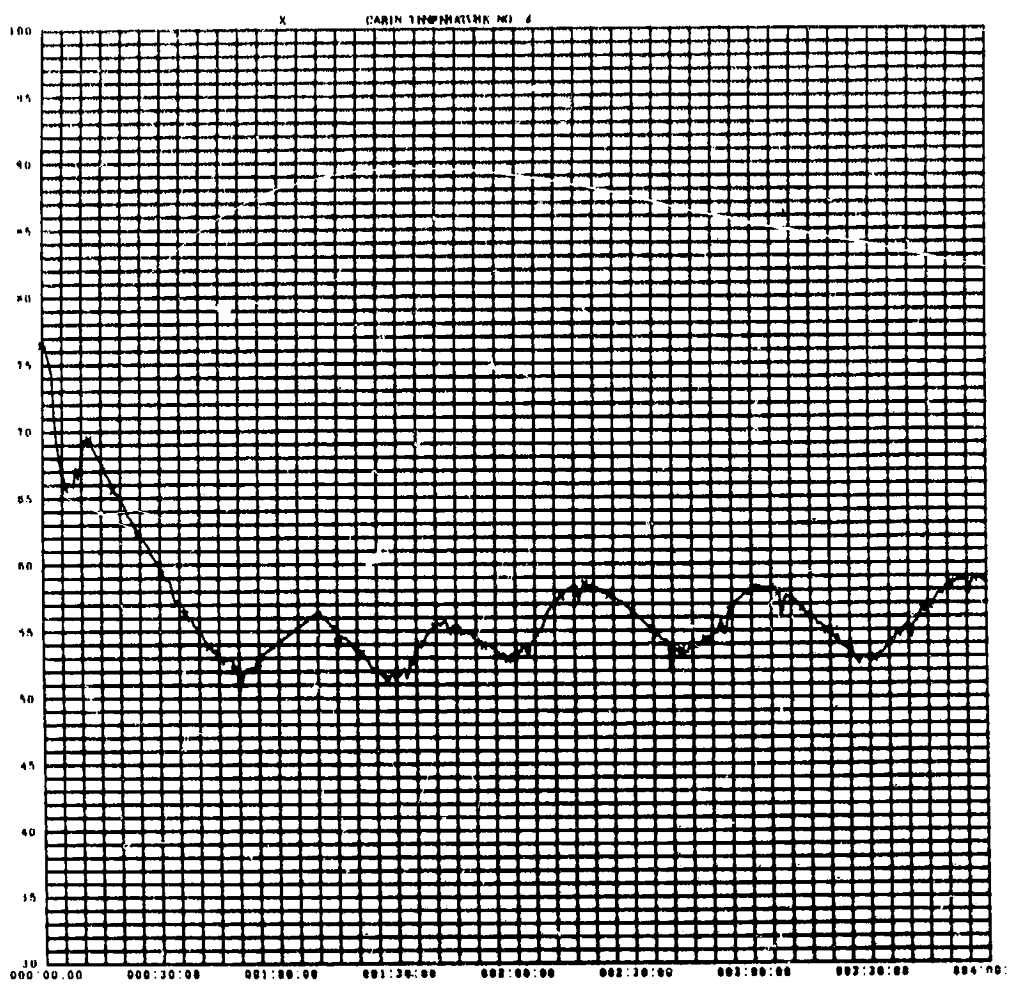


FIGURE 21 CABIN TEMPERATURE NO. 2 VERSUS TIME

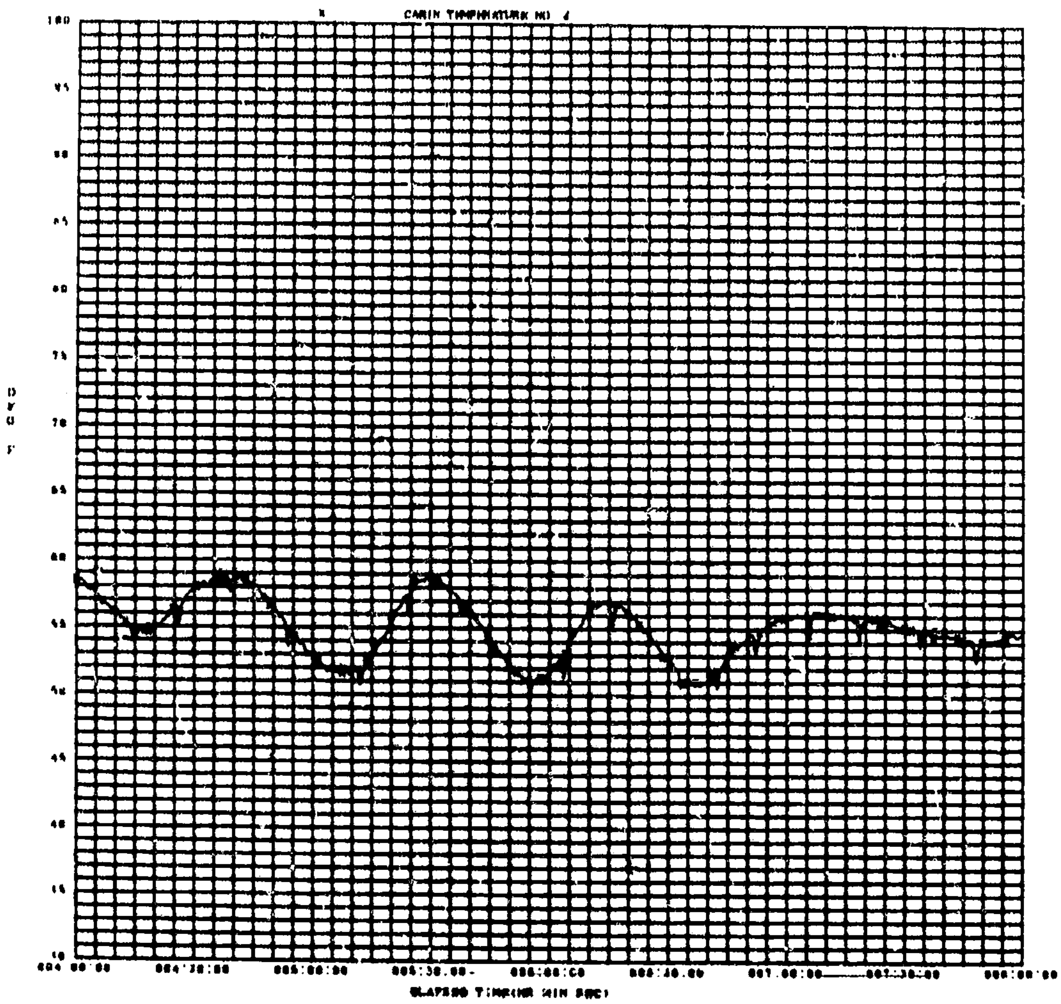


FIGURE 21A CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

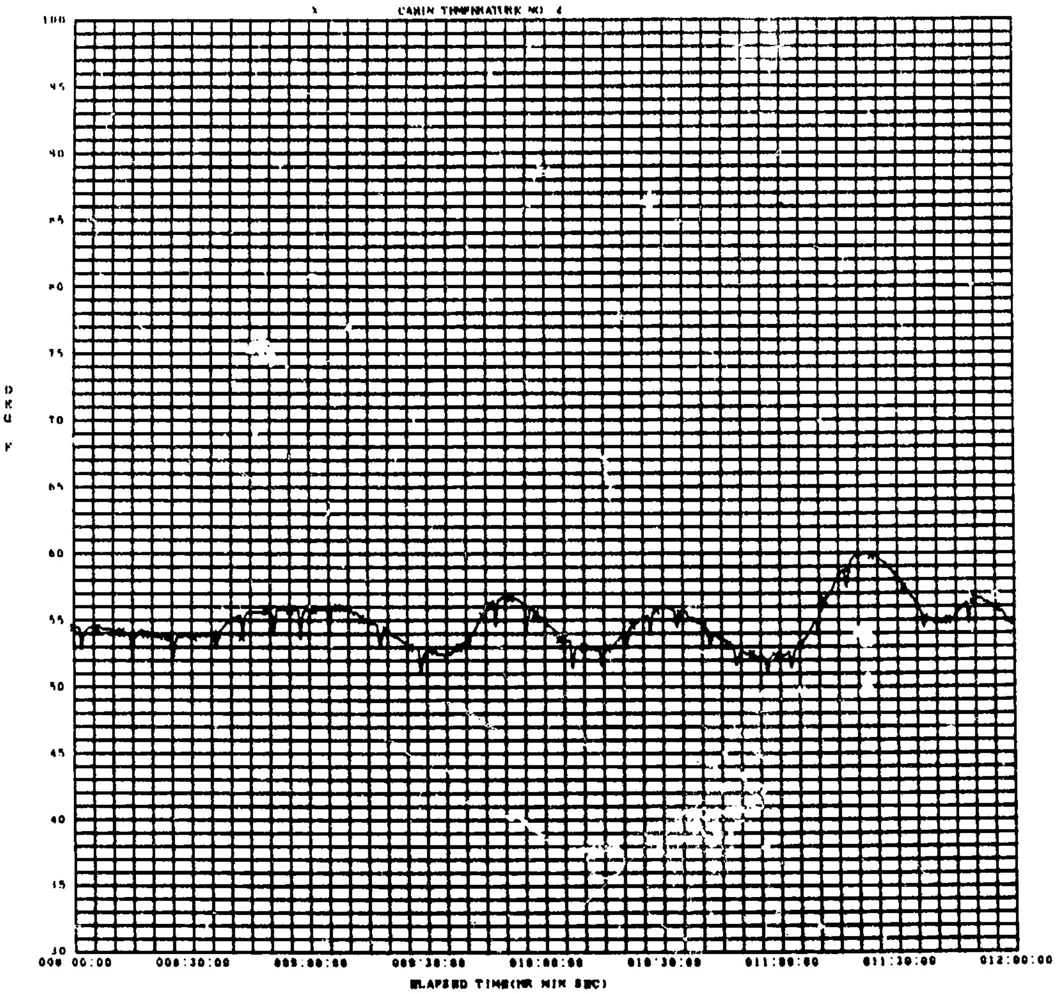


FIGURE 21B CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

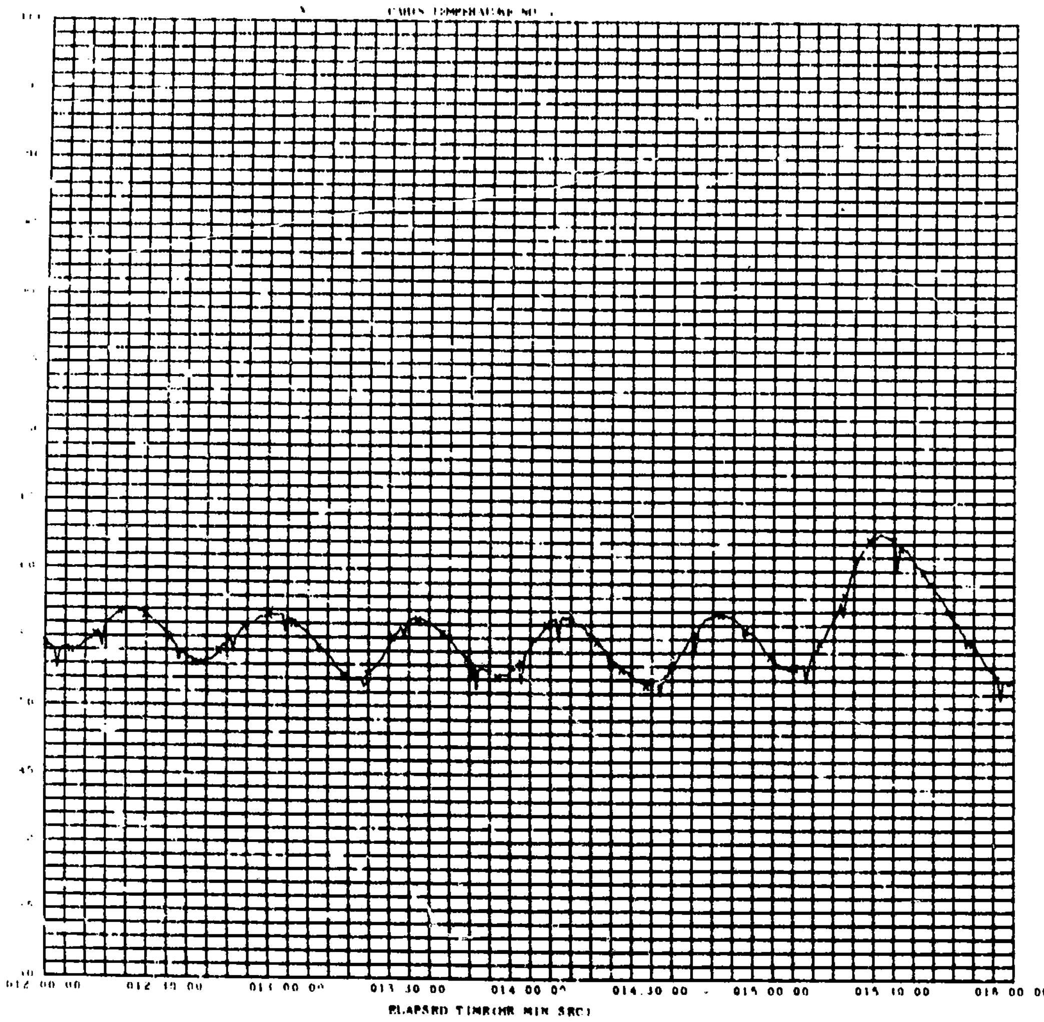


FIGURE 21C CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

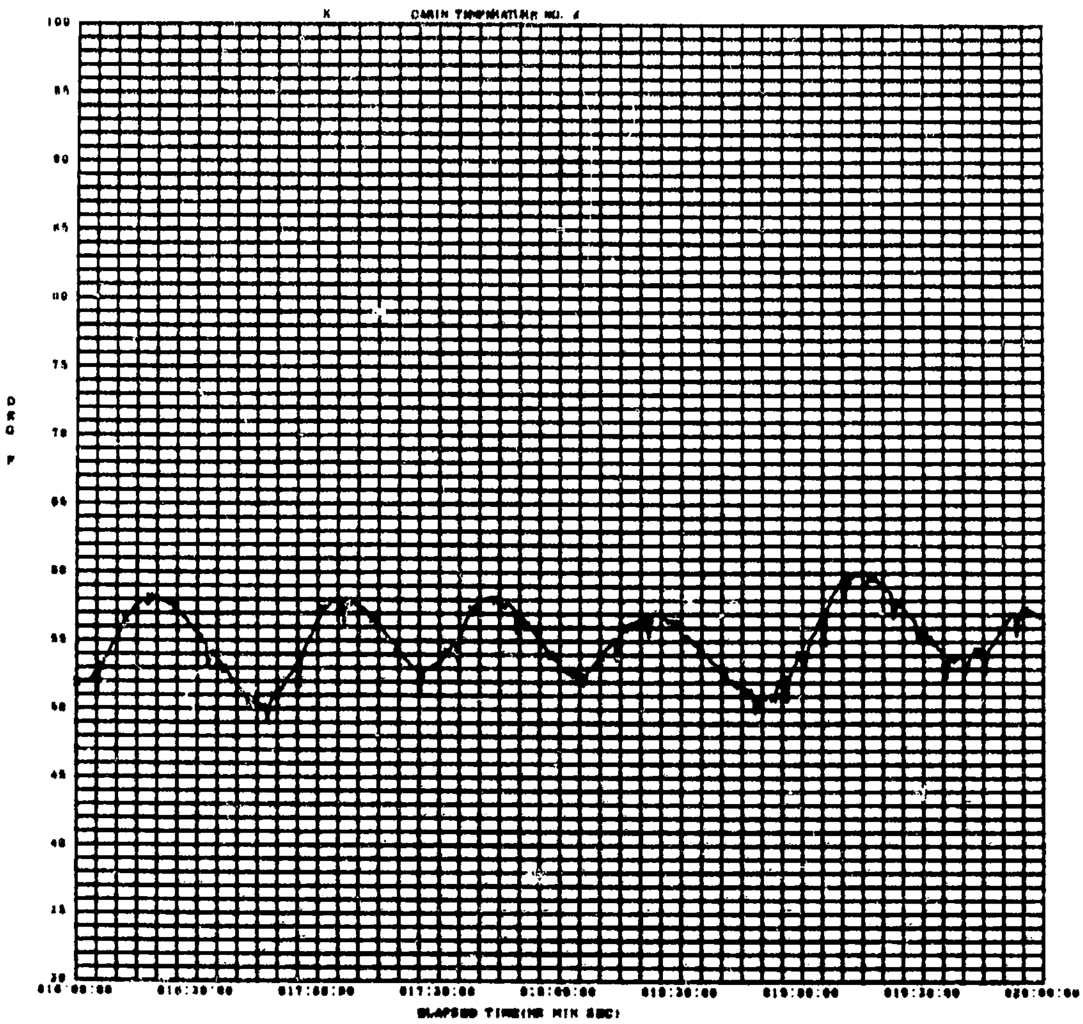


FIGURE 21D CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

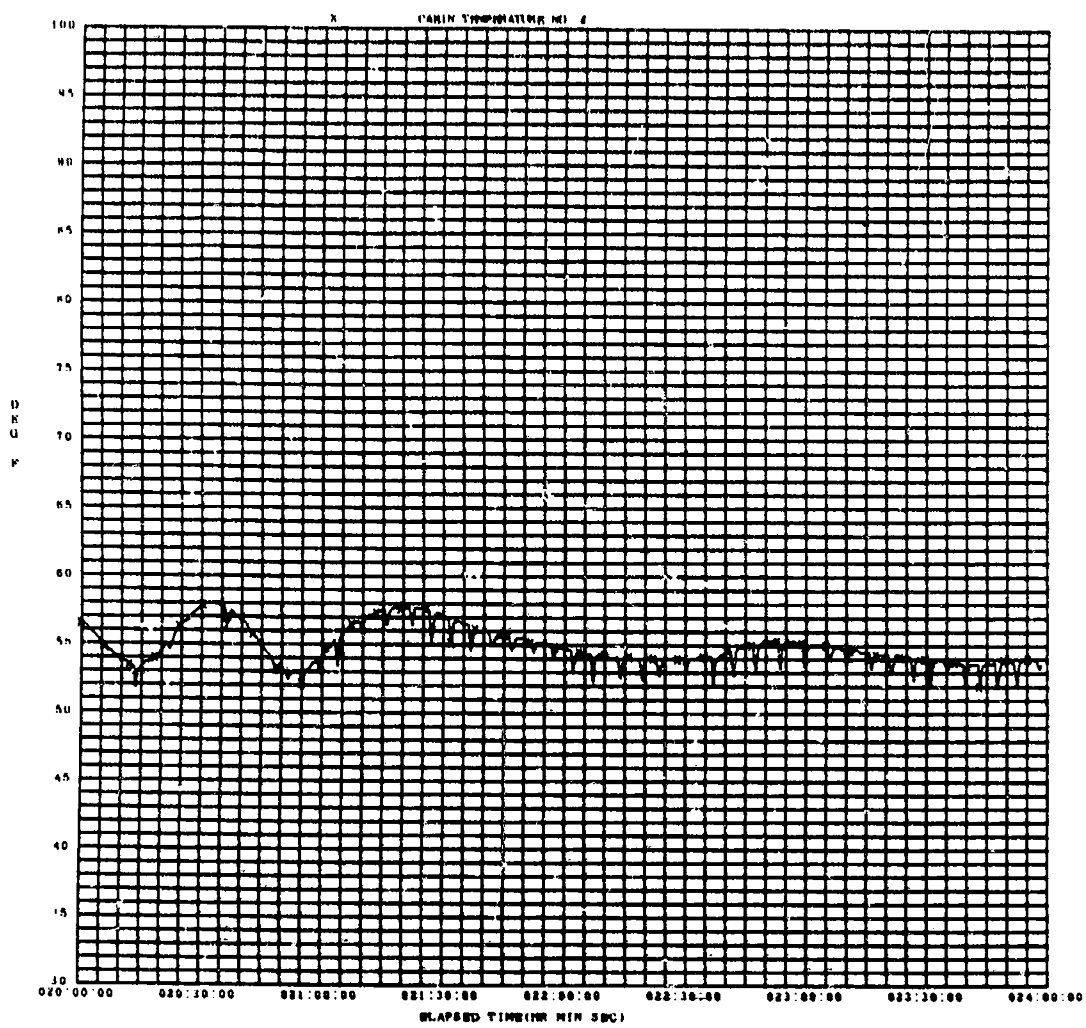


FIGURE 21E CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

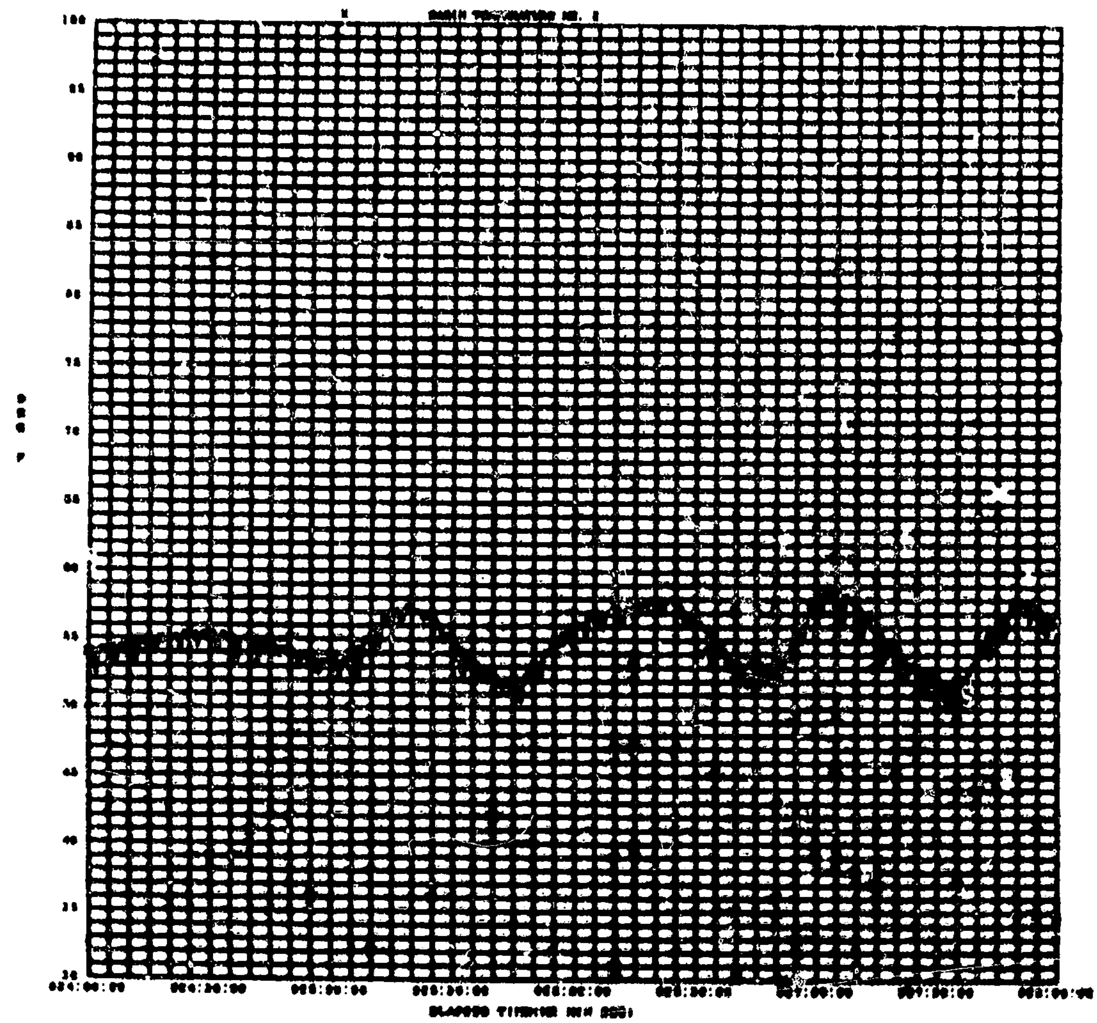


FIGURE 21F CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

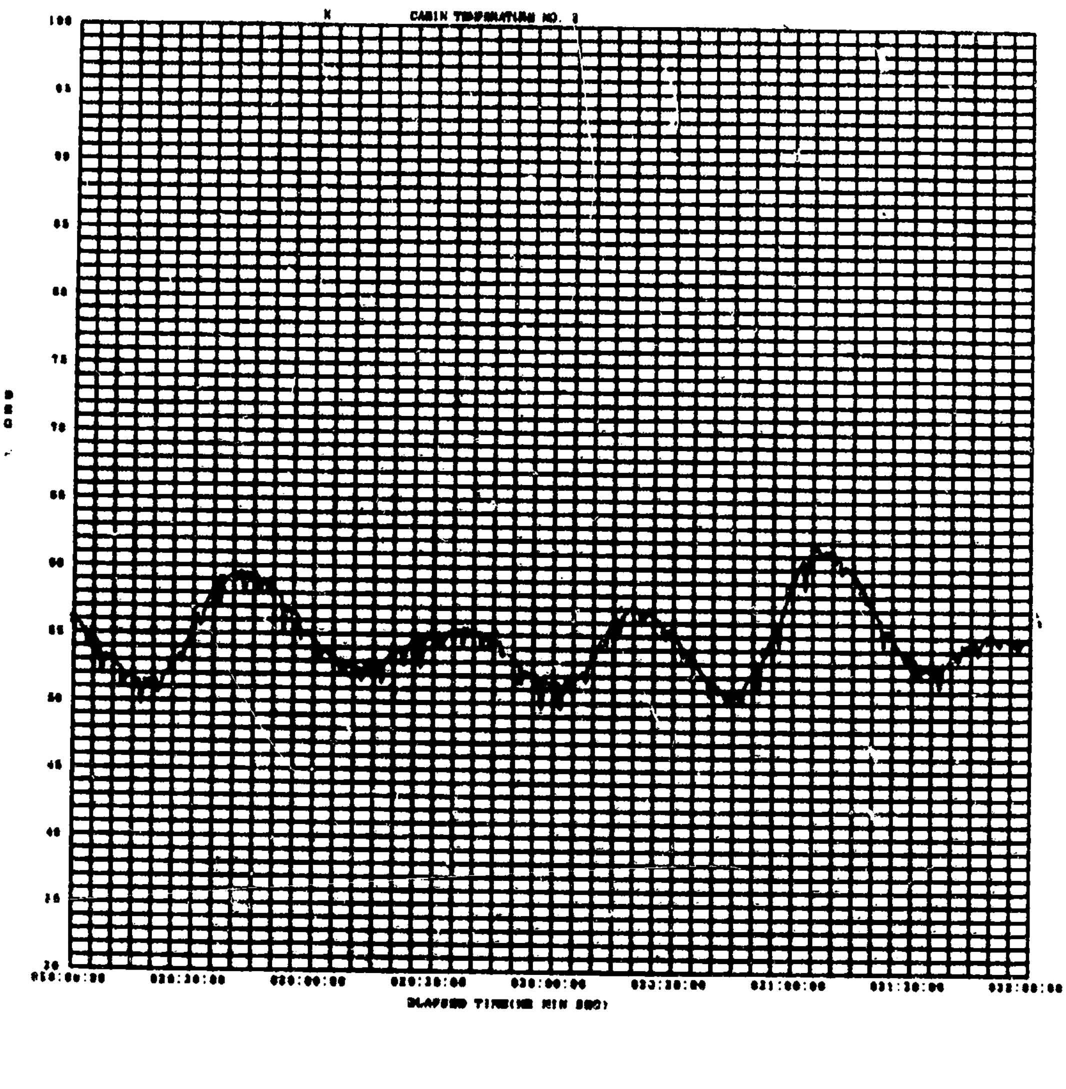


FIGURE 21G CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

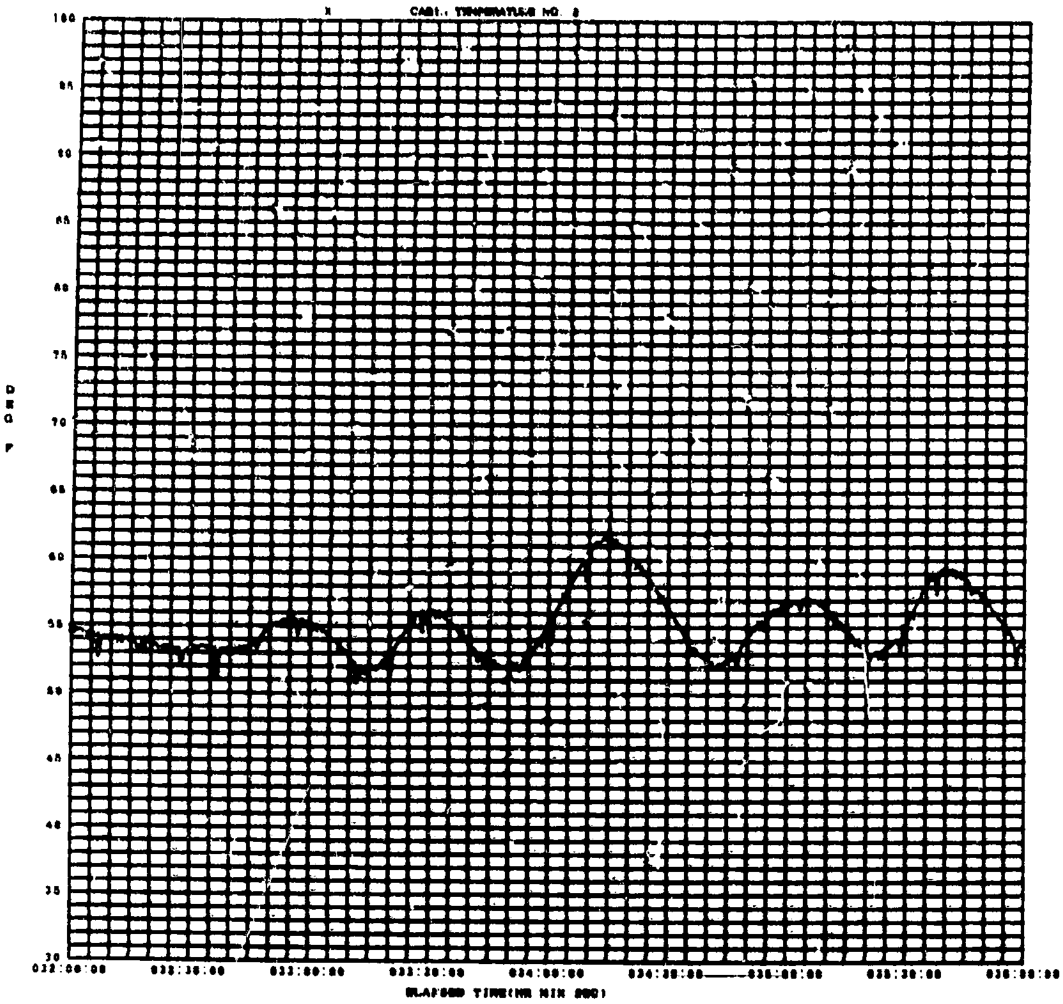


FIGURE 21H CABIN TEMPERATURE NO. 2 VERSUS TIME - CONTINUED

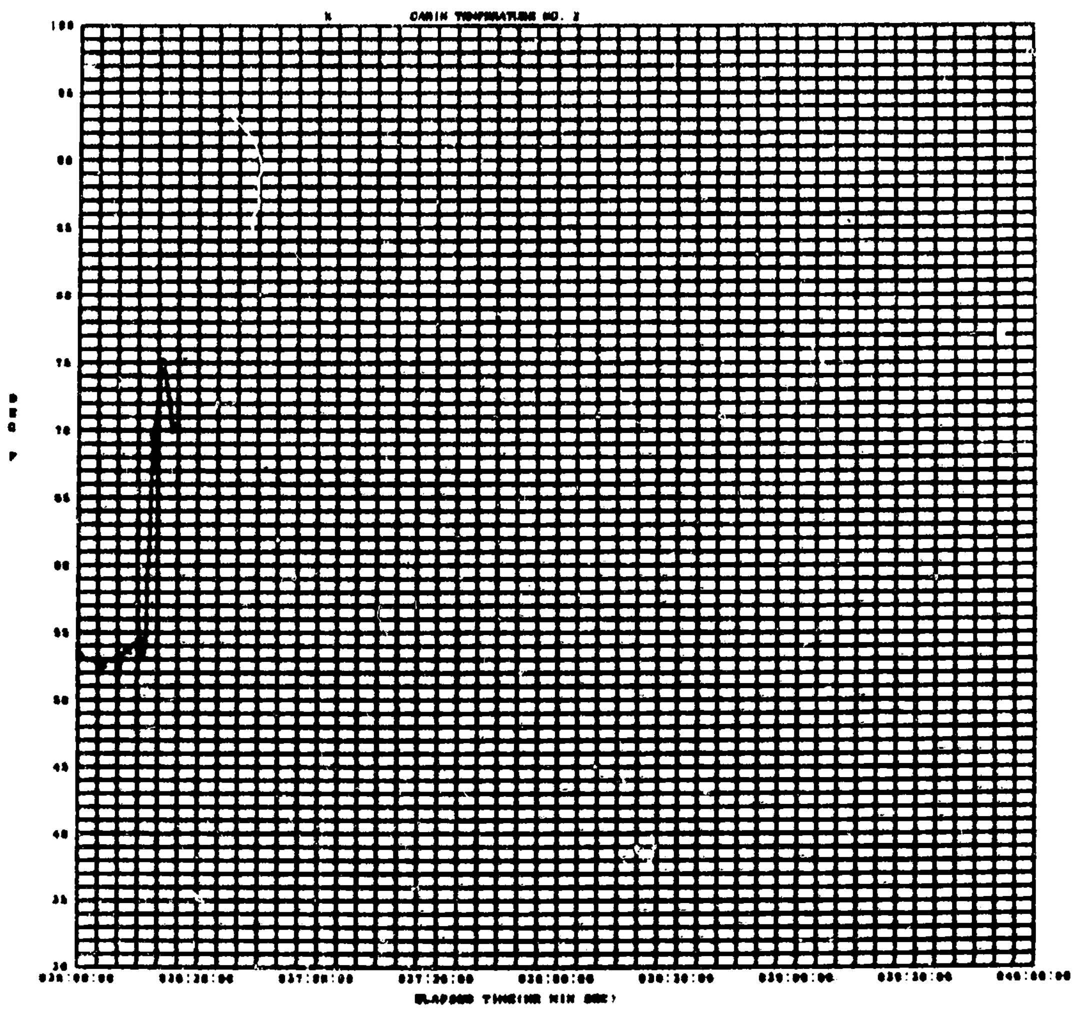


FIGURE 21J CABIN TEMPERATURE NO. 2 VERSUS TIME - CONCLUDED

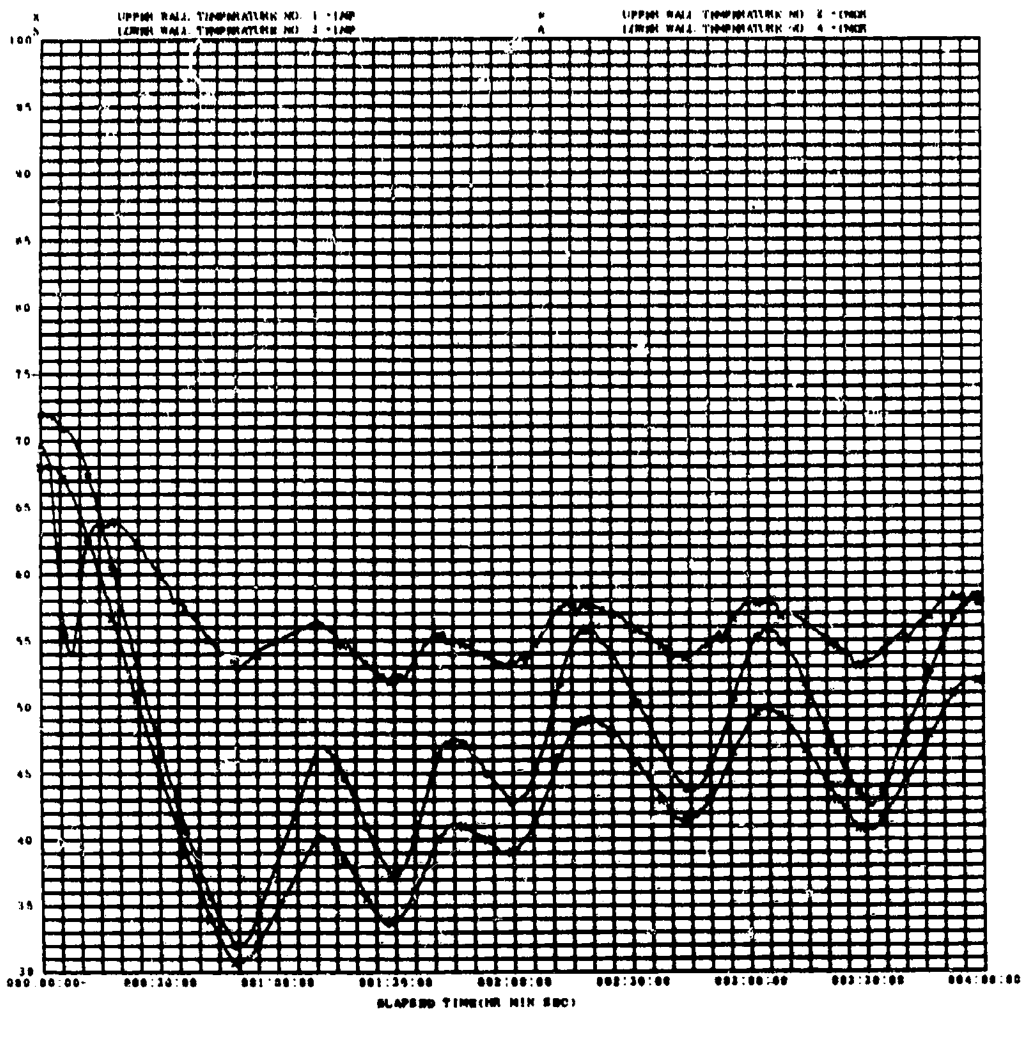


FIGURE 22 WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME

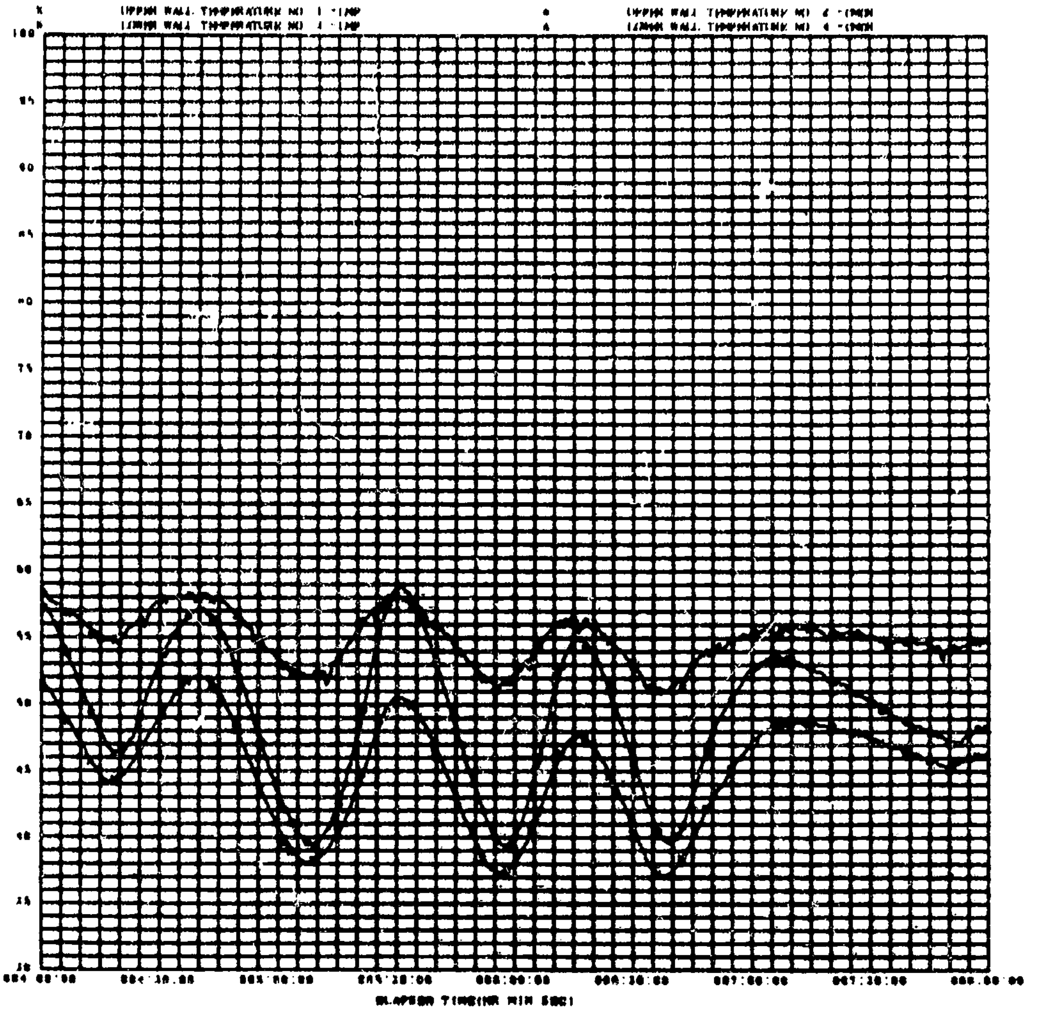


FIGURE 22A WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

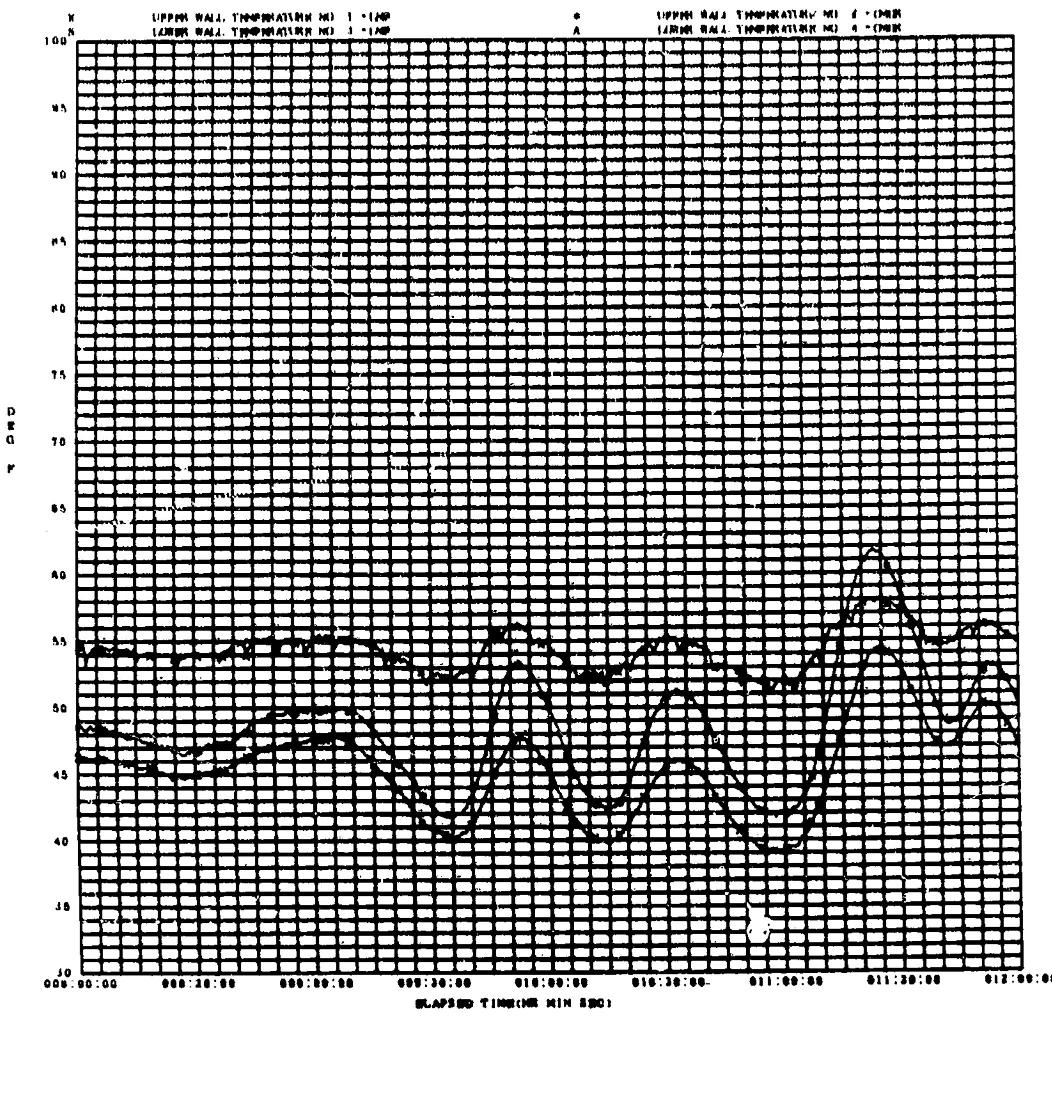


FIGURE 22B WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

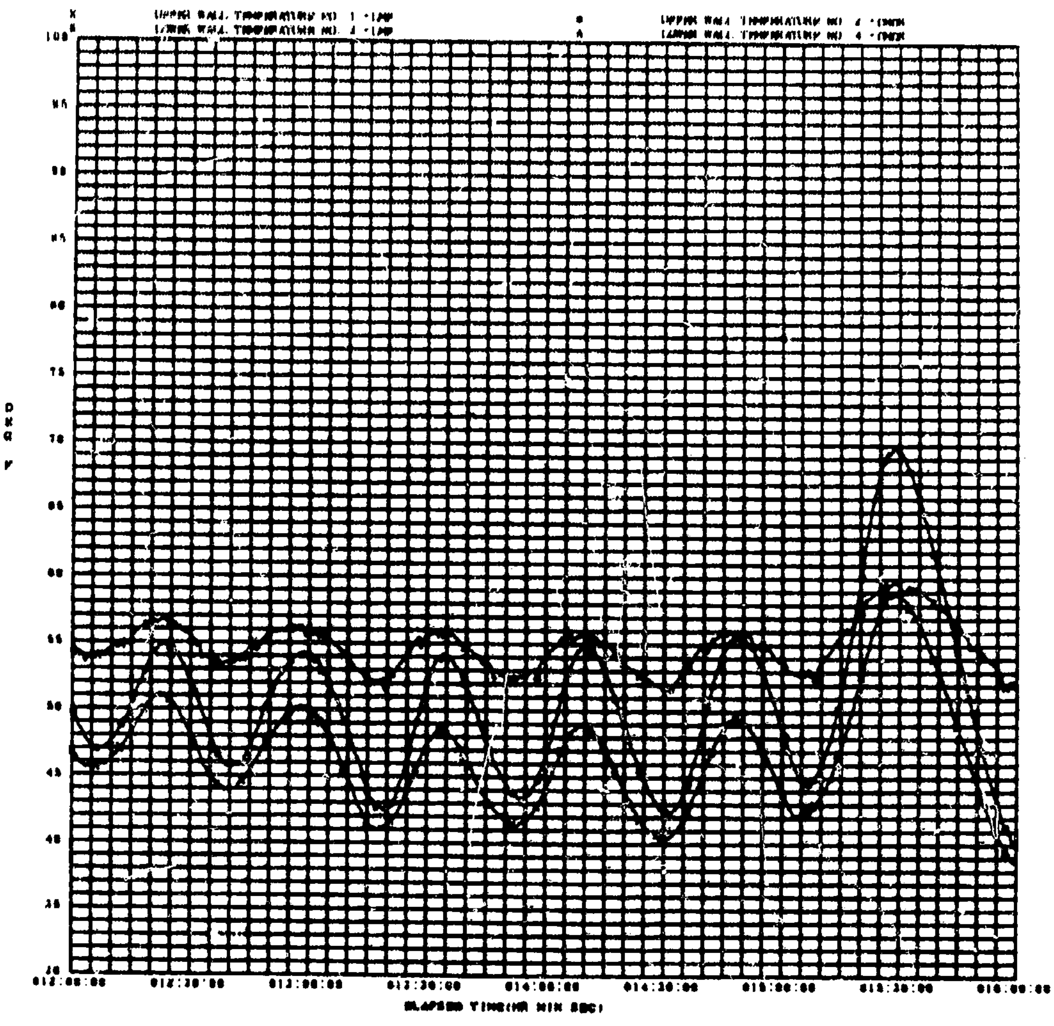


FIGURE 22C WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

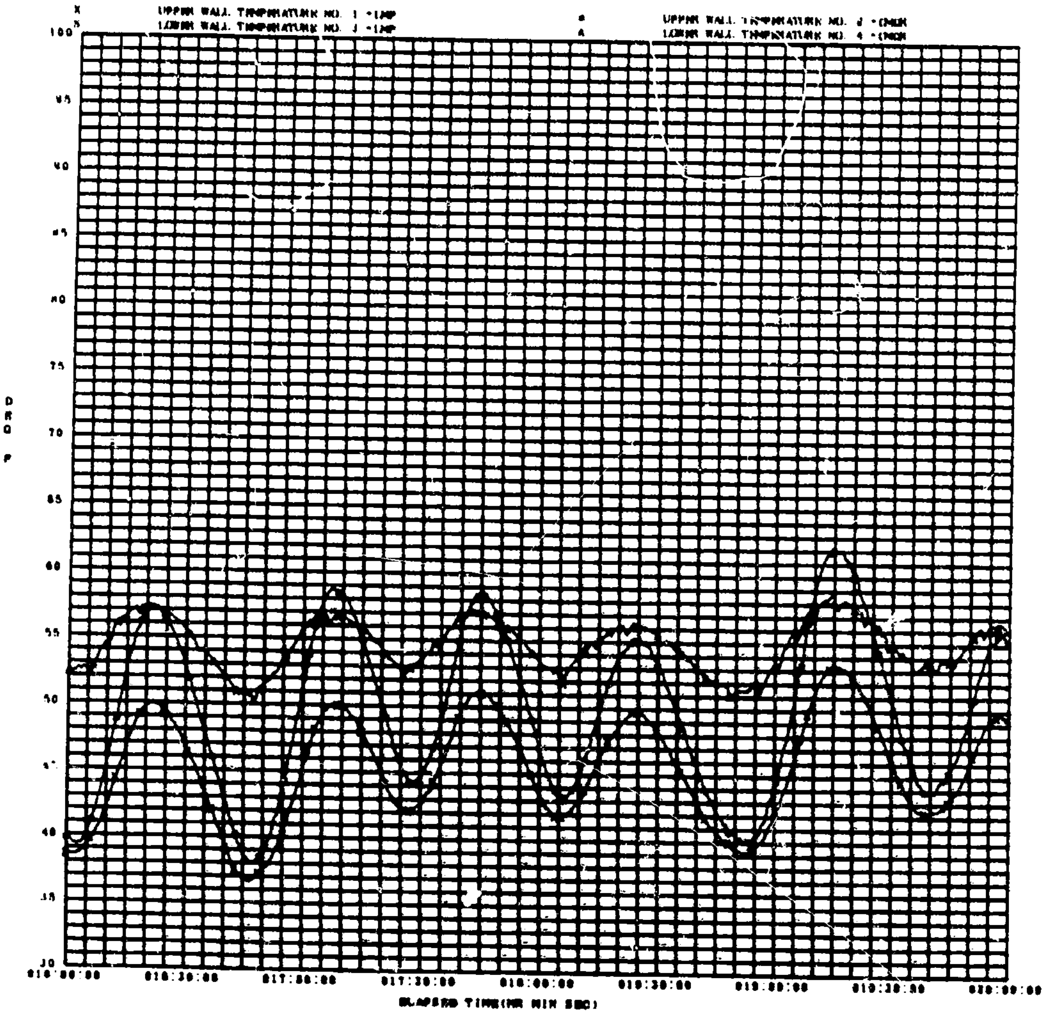


FIGURE 22D WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME - CONTINUED

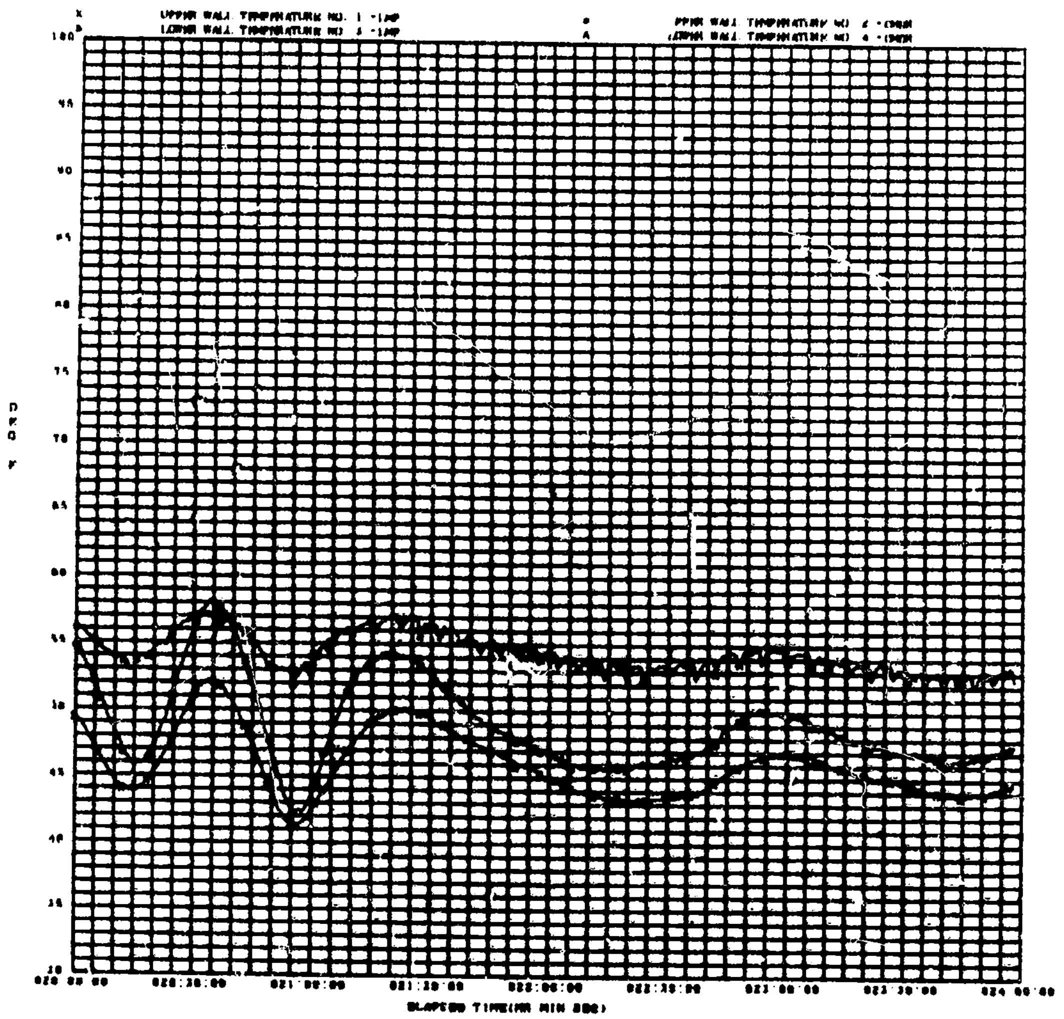


FIGURE 22E WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

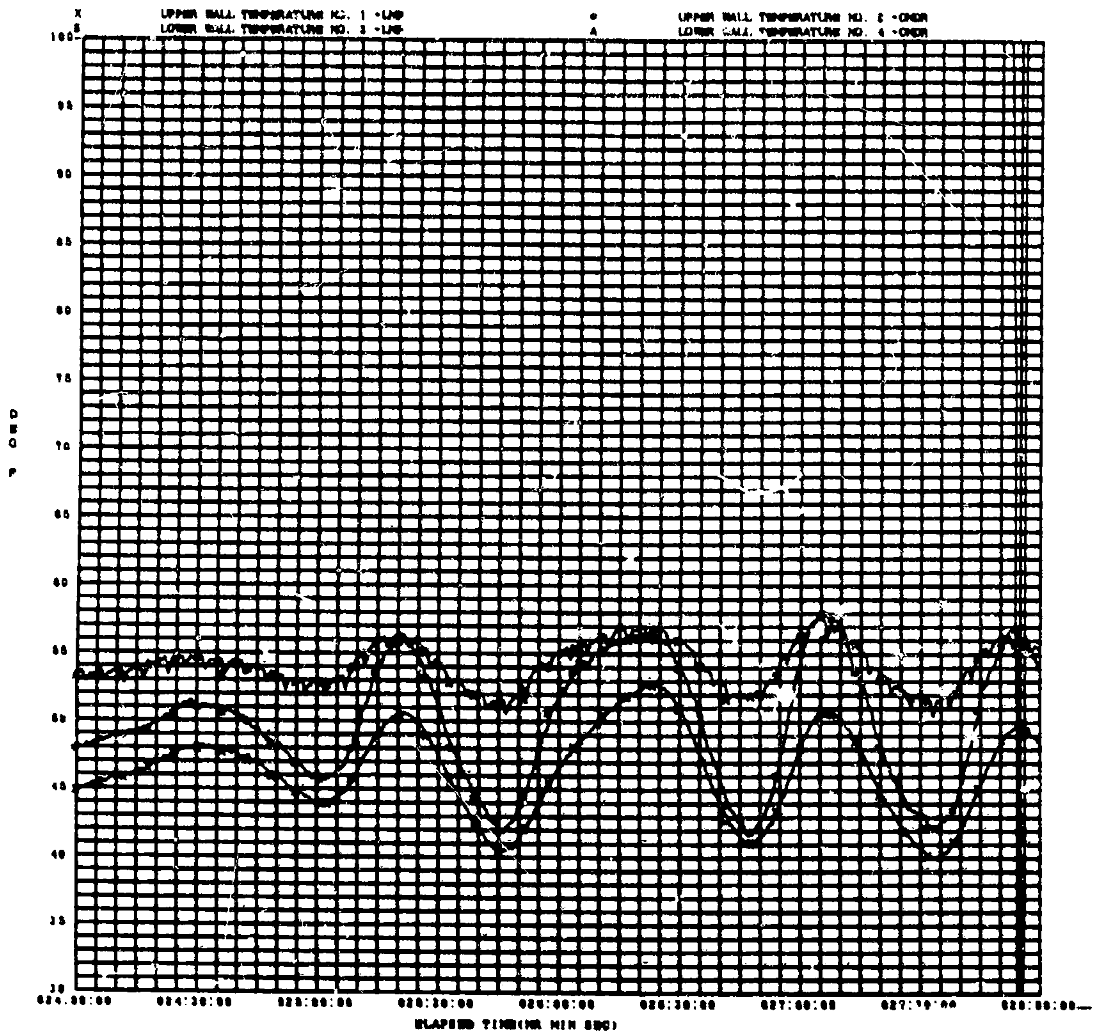


FIGURE 22F WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

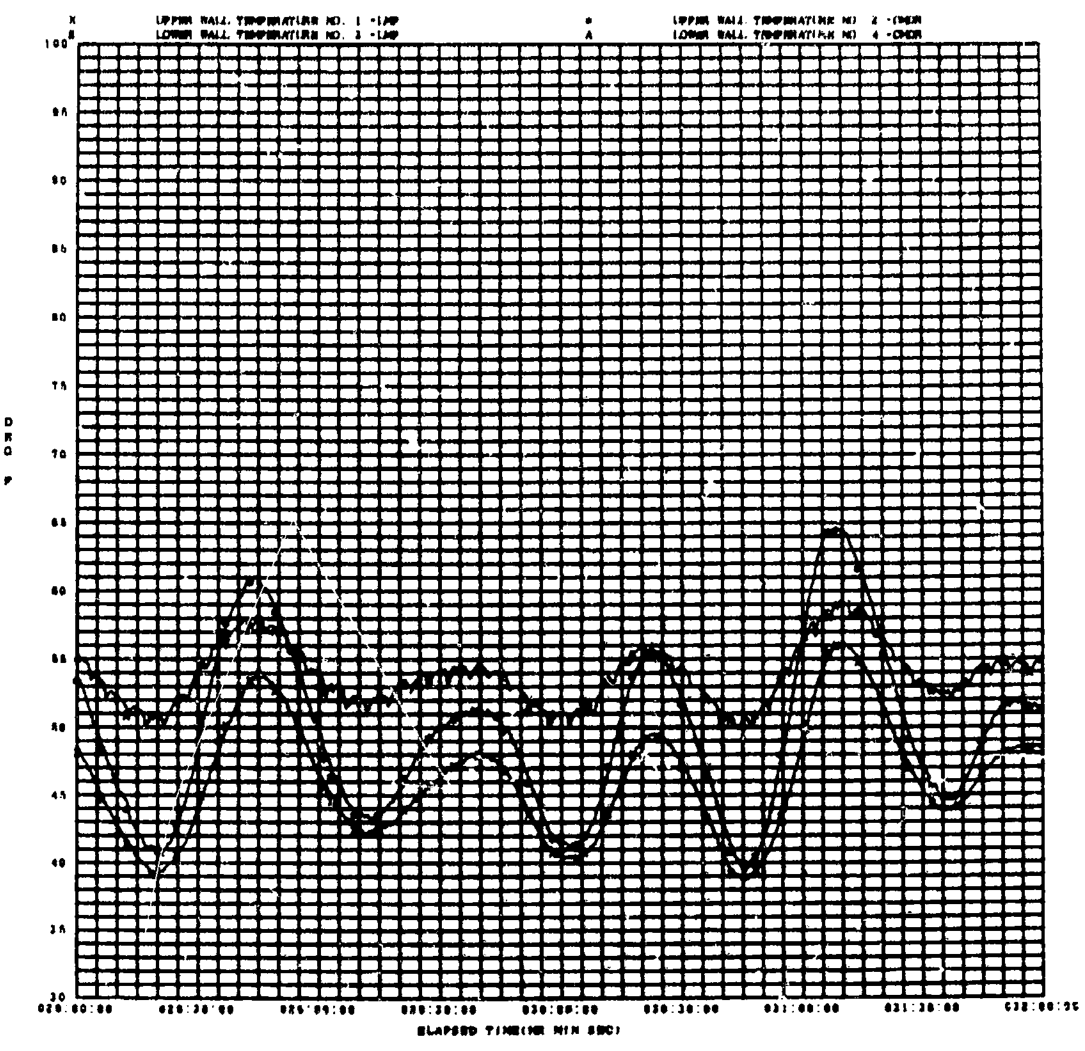


FIGURE 22G WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

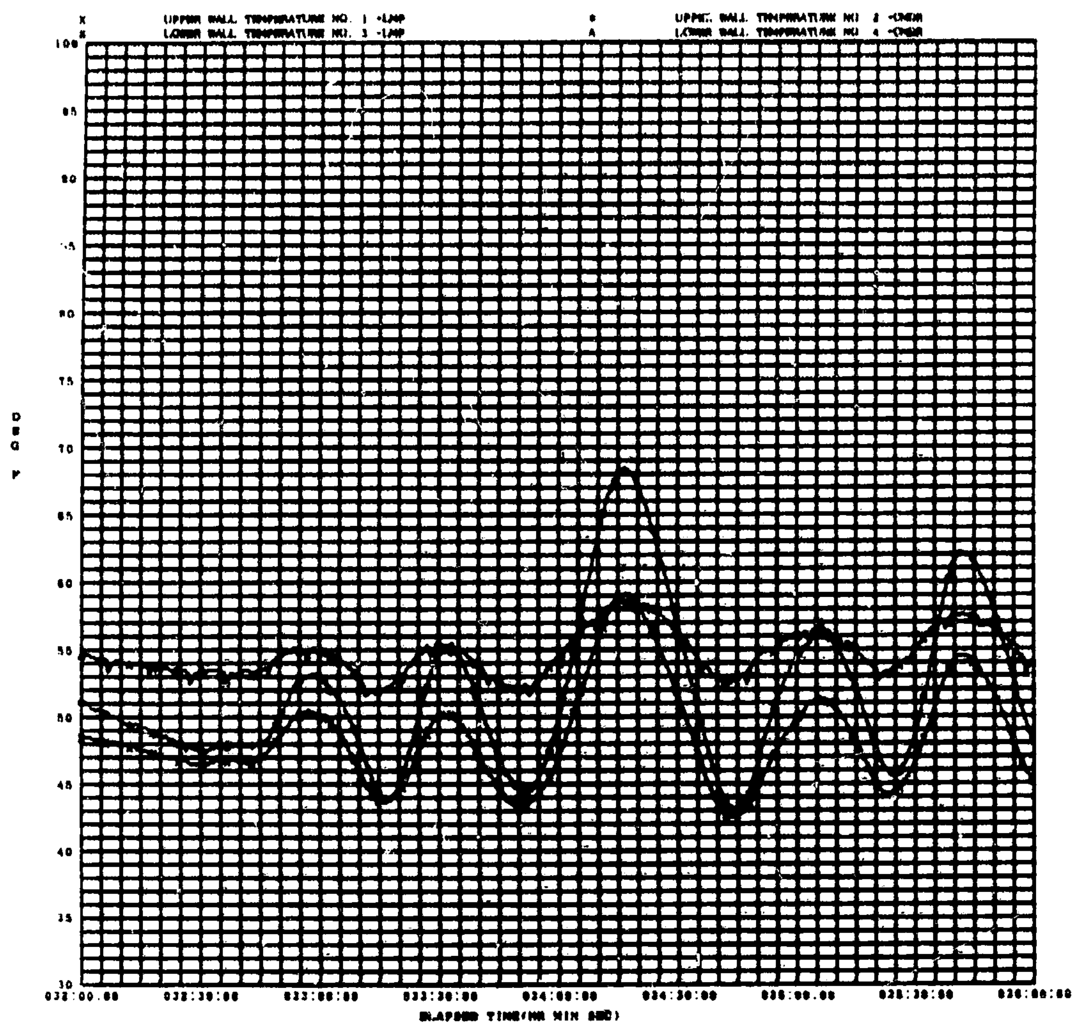


FIGURE 22H WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONTINUED

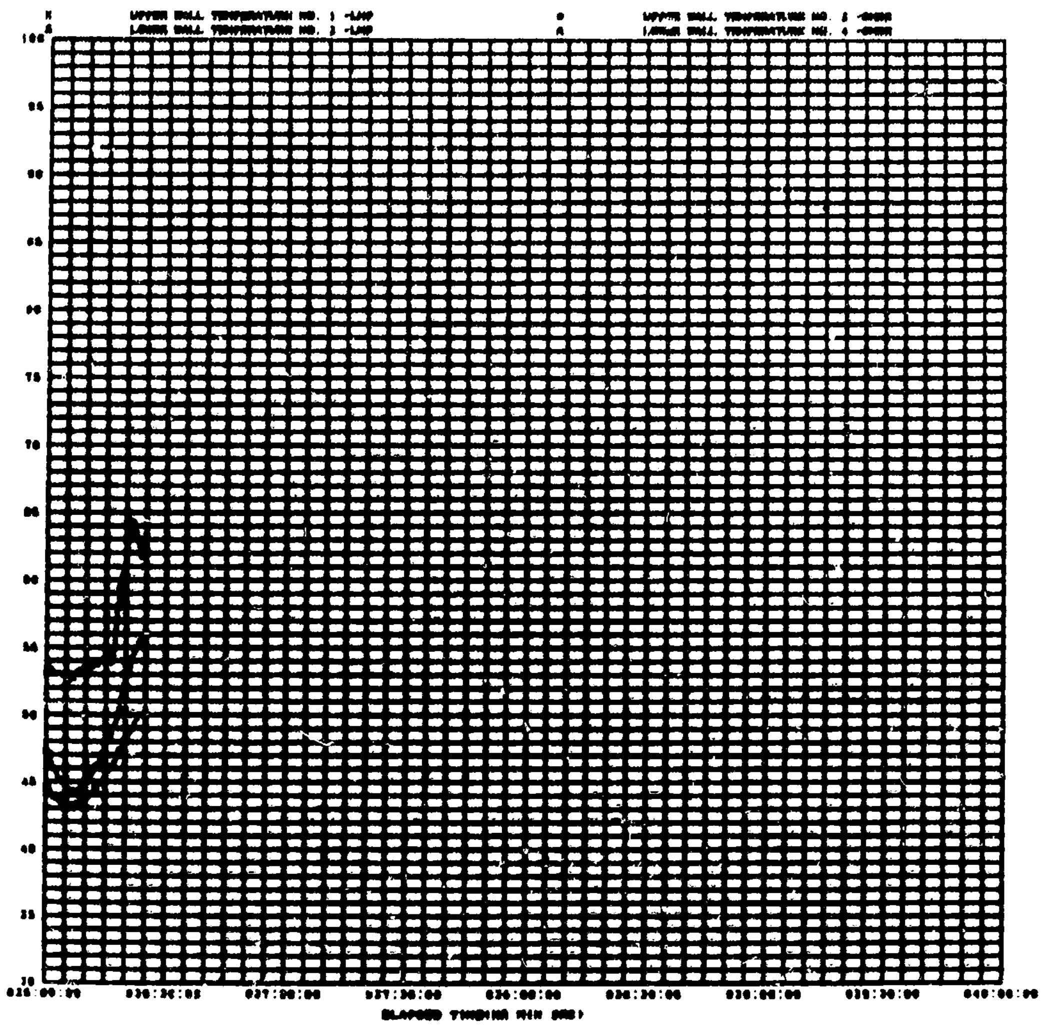


FIGURE 22J WALL TEMPERATURES 1, 2, AND 4 VERSUS TIME
- CONCLUDED

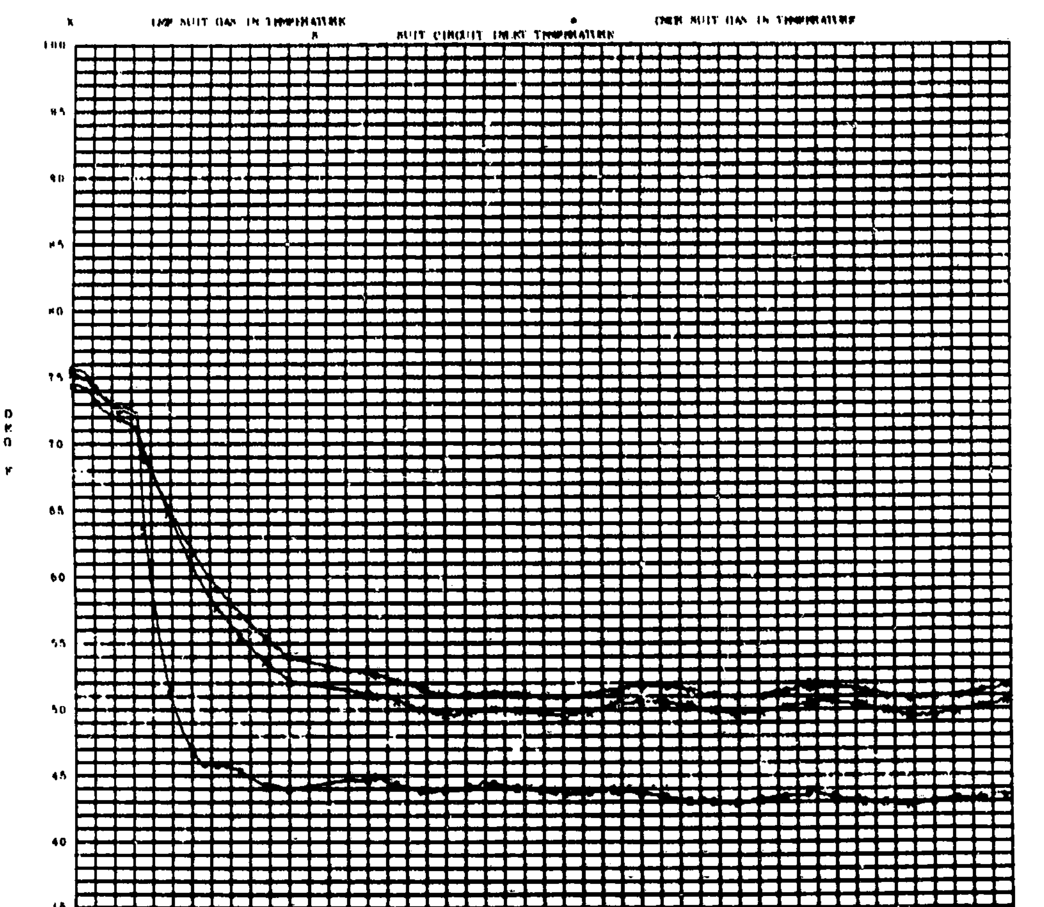


FIGURE 23 SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME

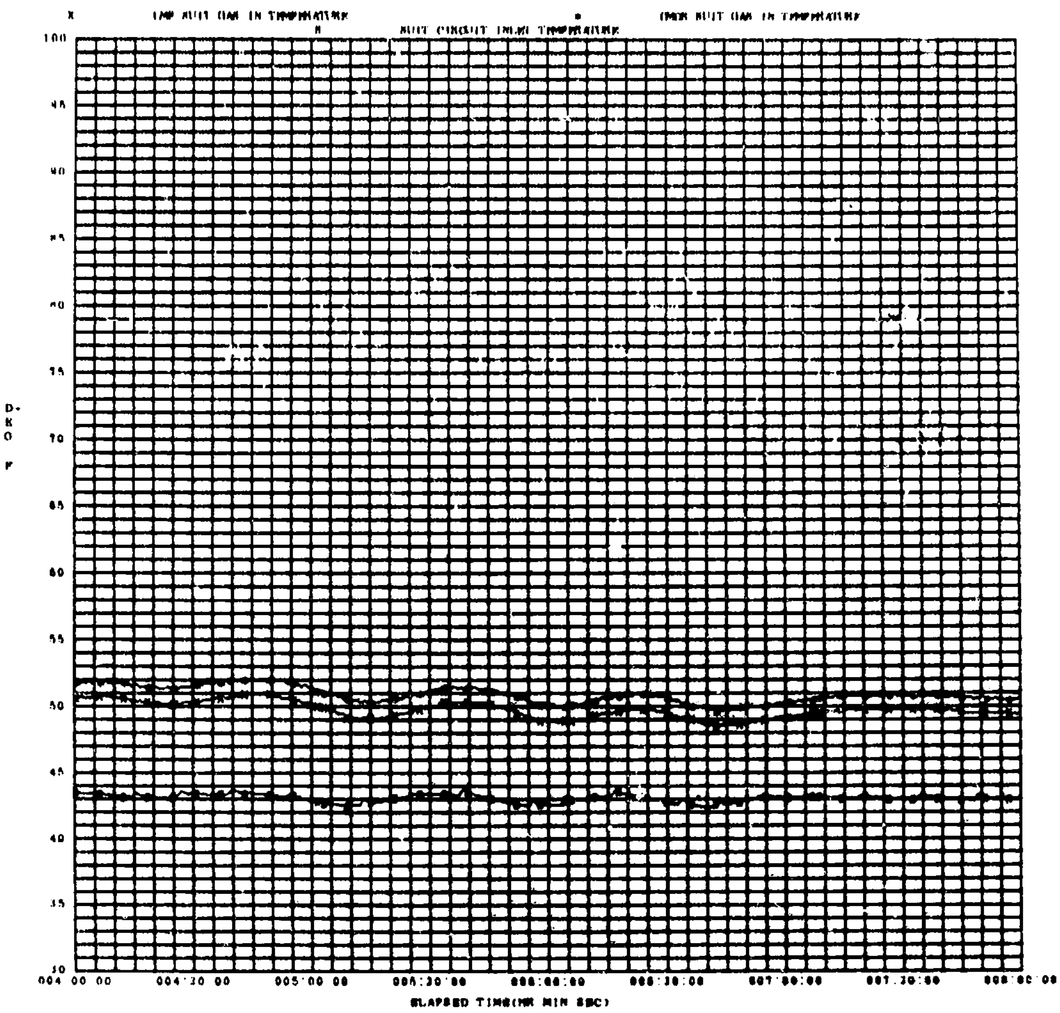


FIGURE 23A SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

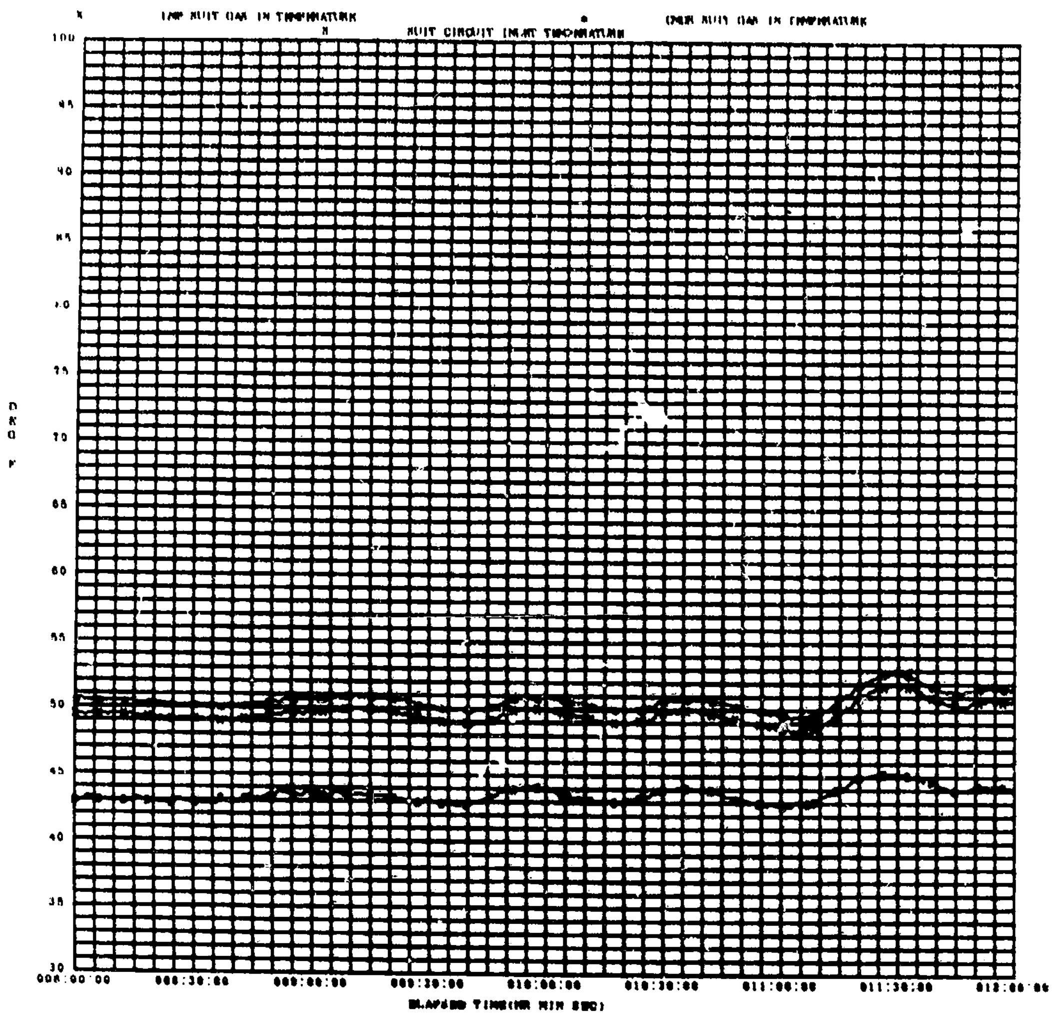


FIGURE 23B SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

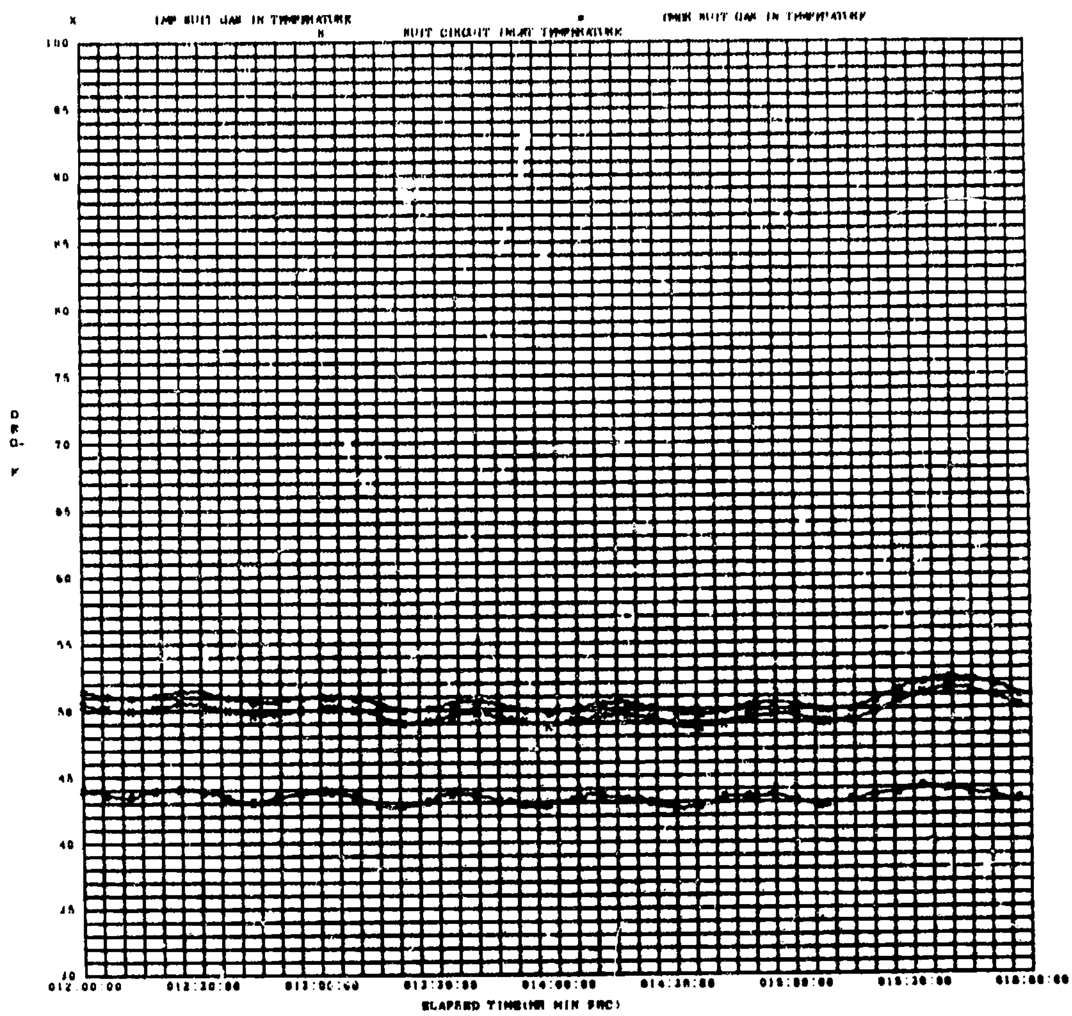


FIGURE 23C SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

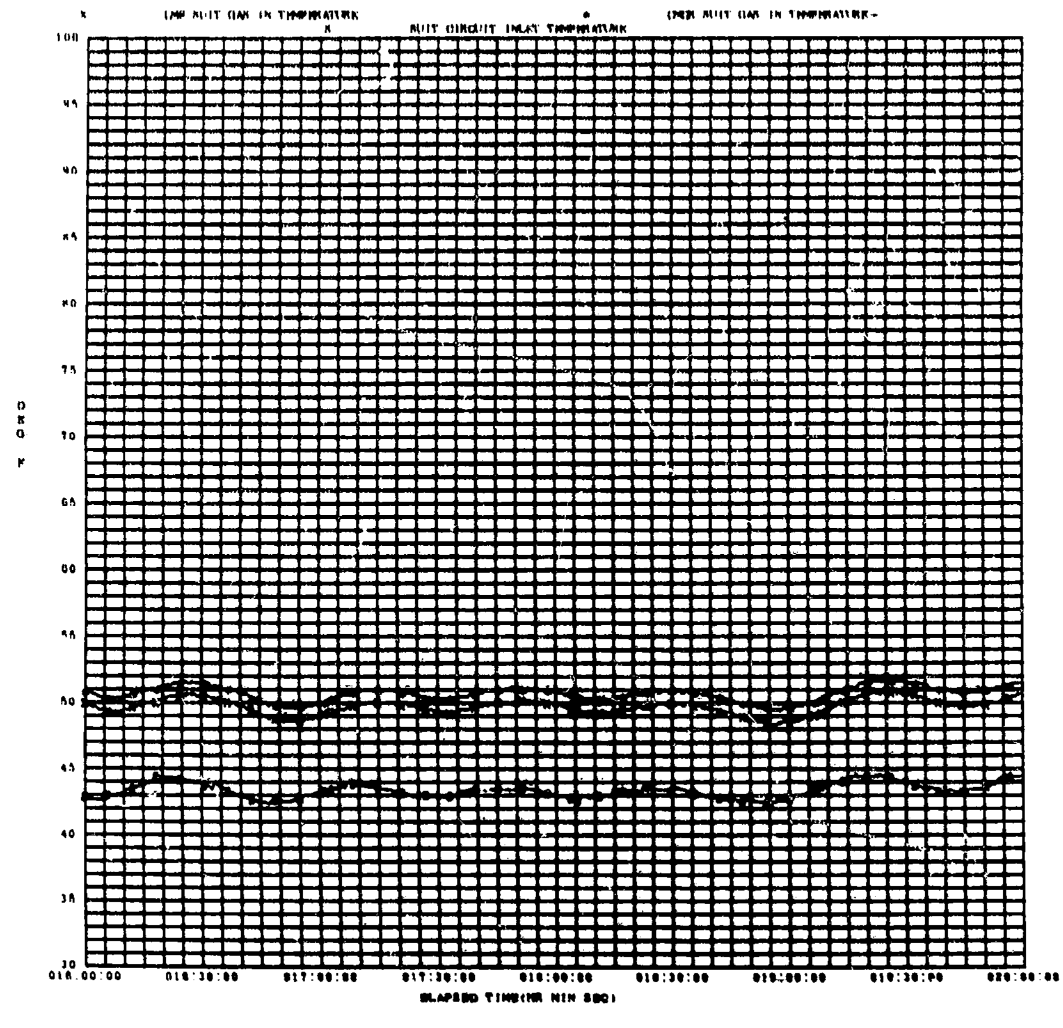


FIGURE 23D SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

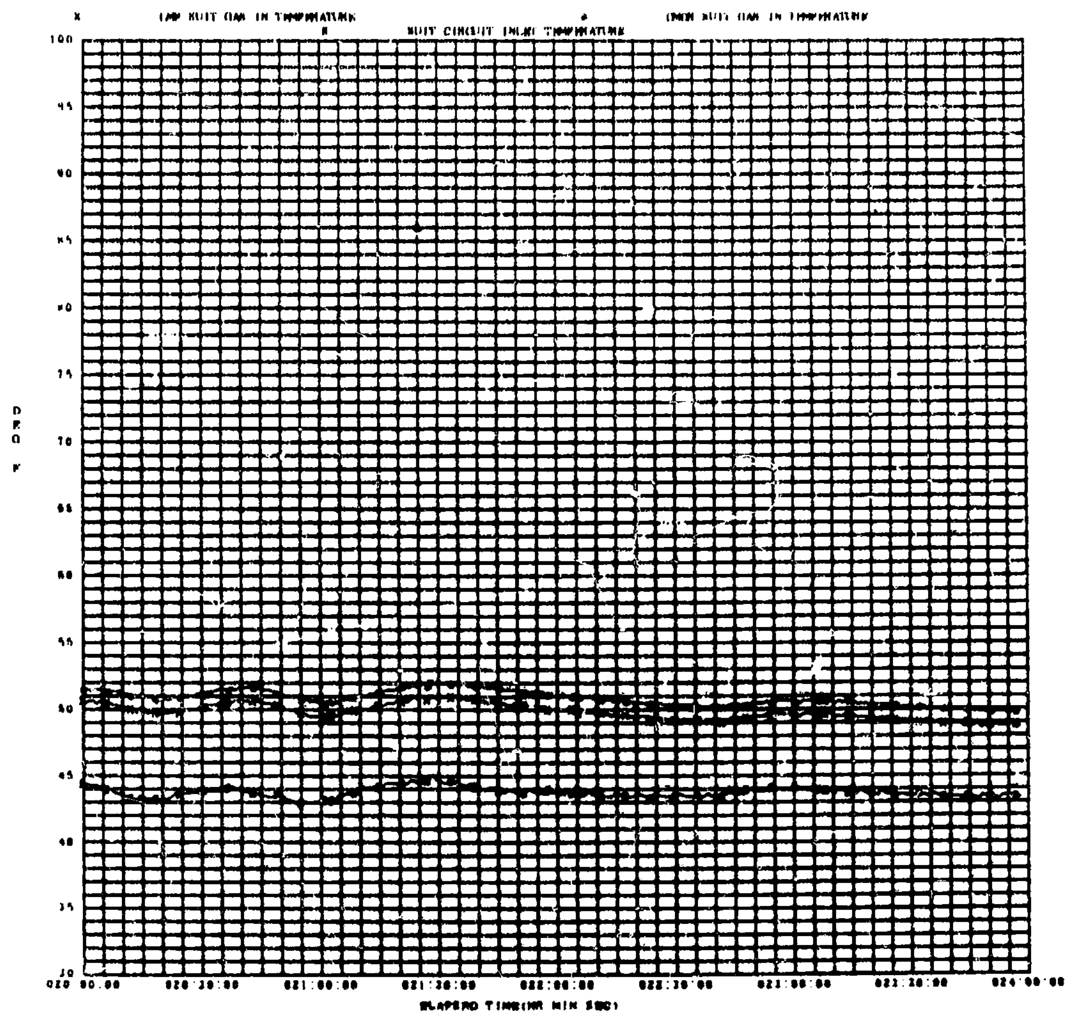


FIGURE 23E SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

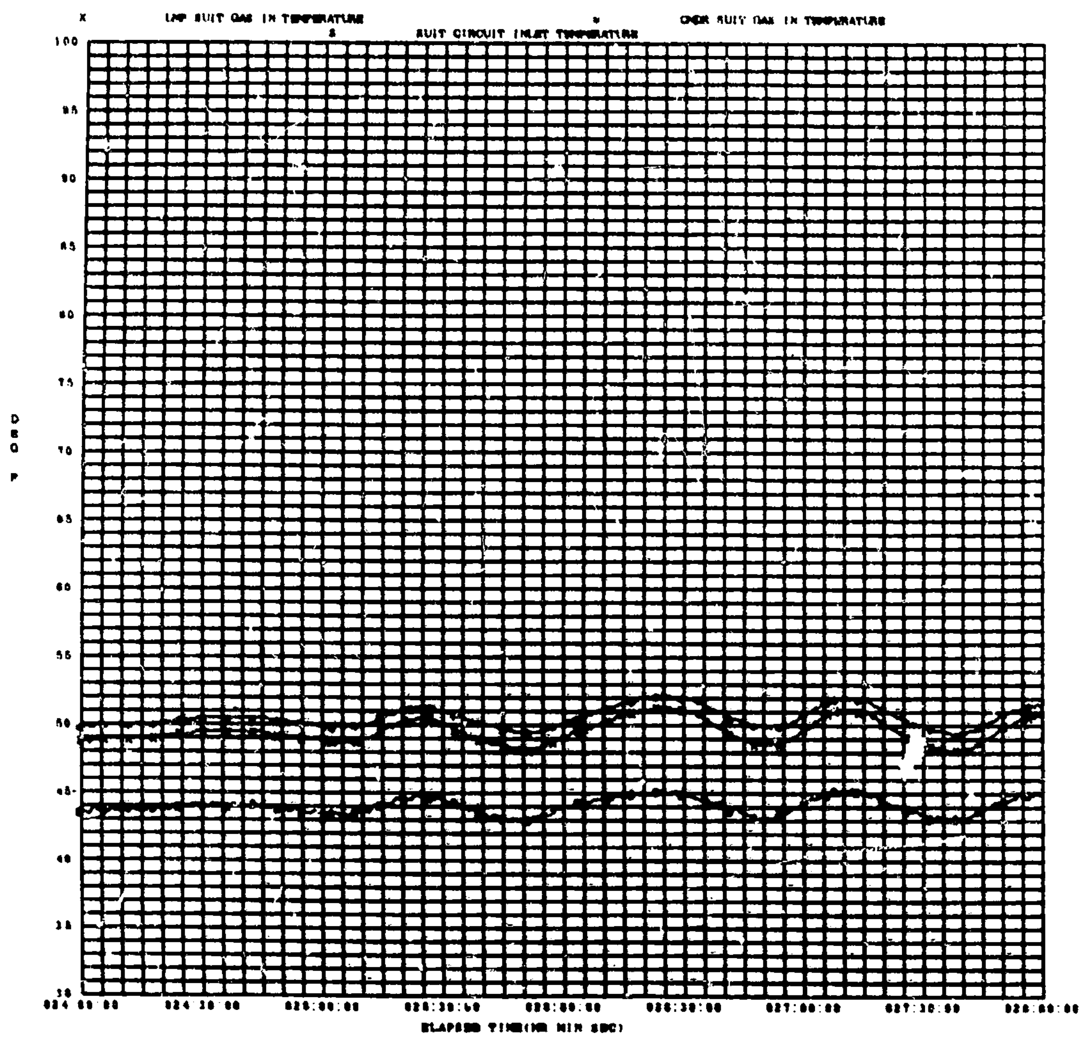


FIGURE 23F SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

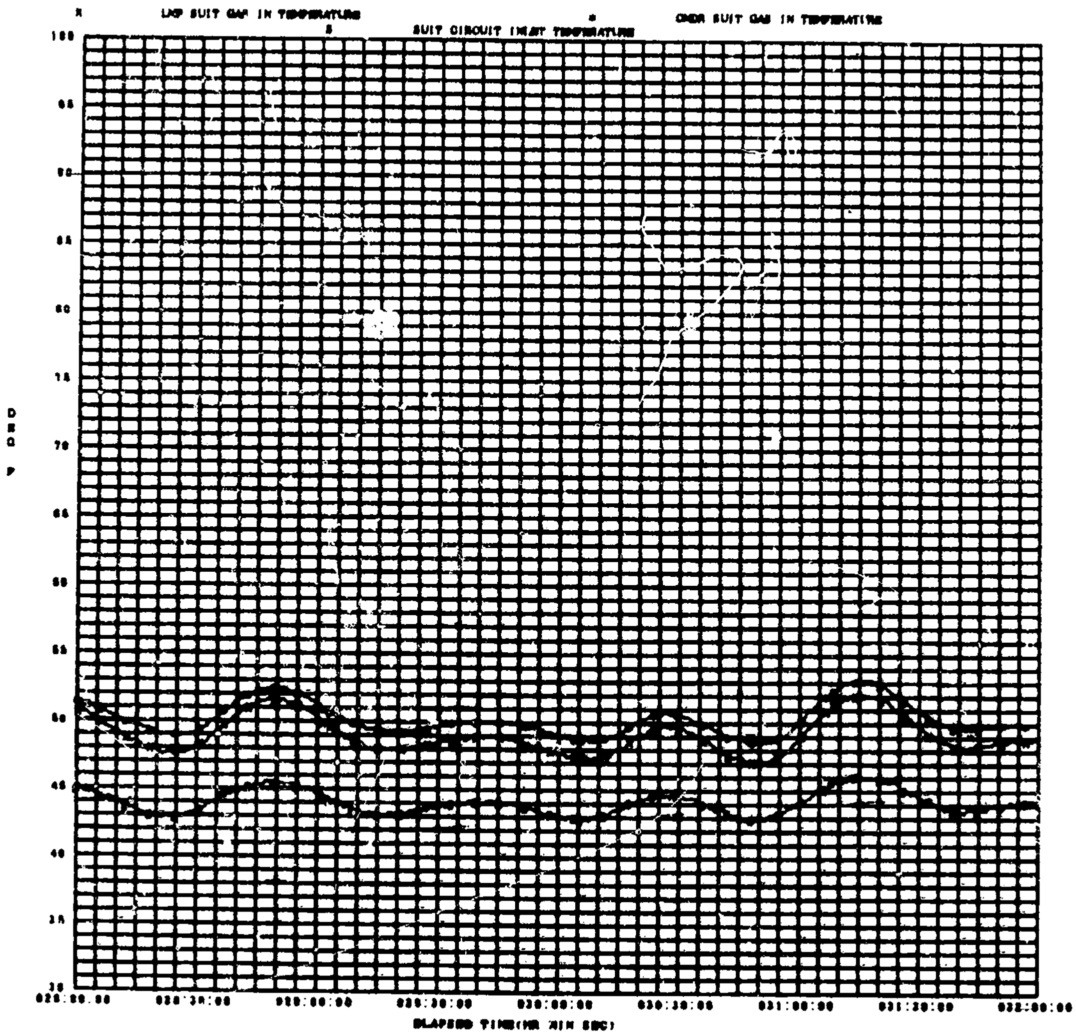


FIGURE 23G SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES
VERSUS TIME - CONTINUED

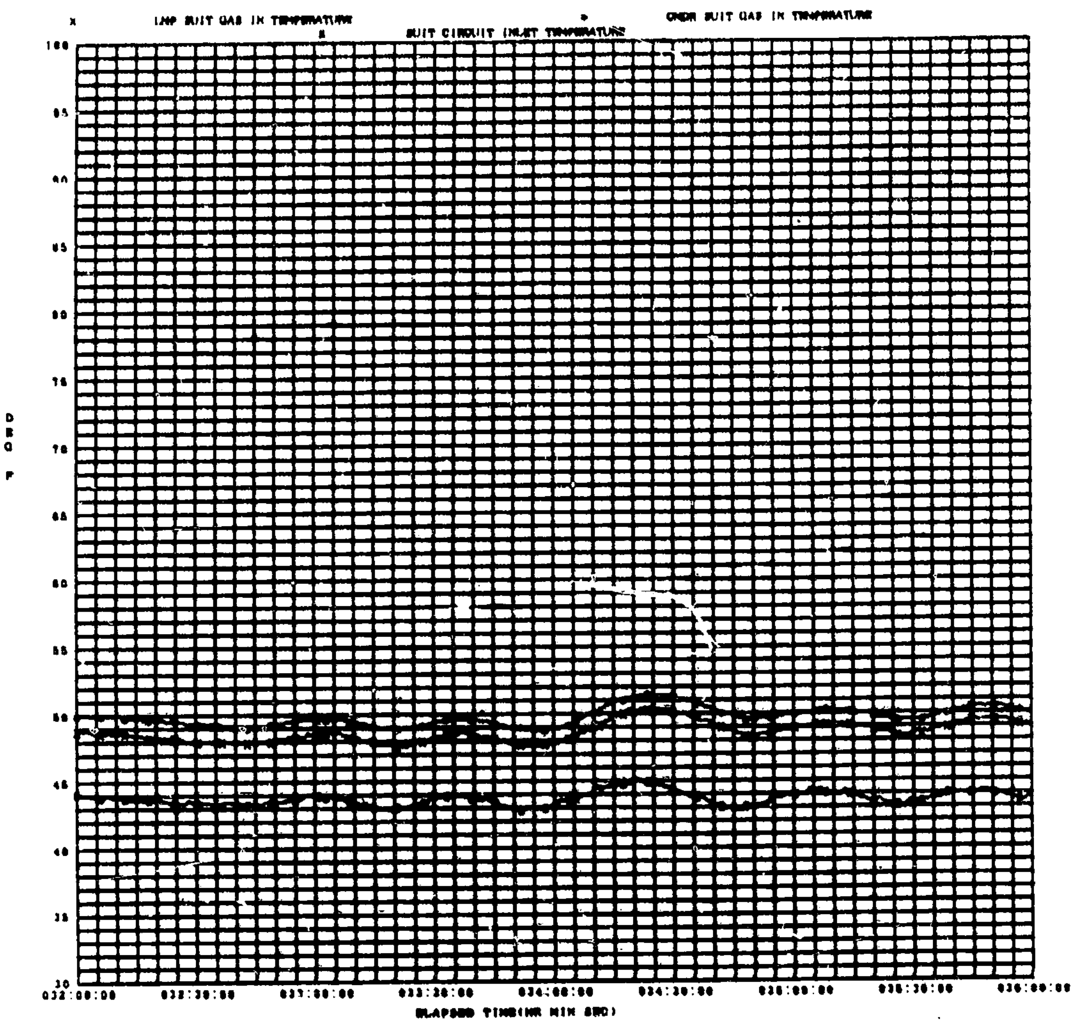


FIGURE 23H SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES VERSUS TIME - CONTINUED

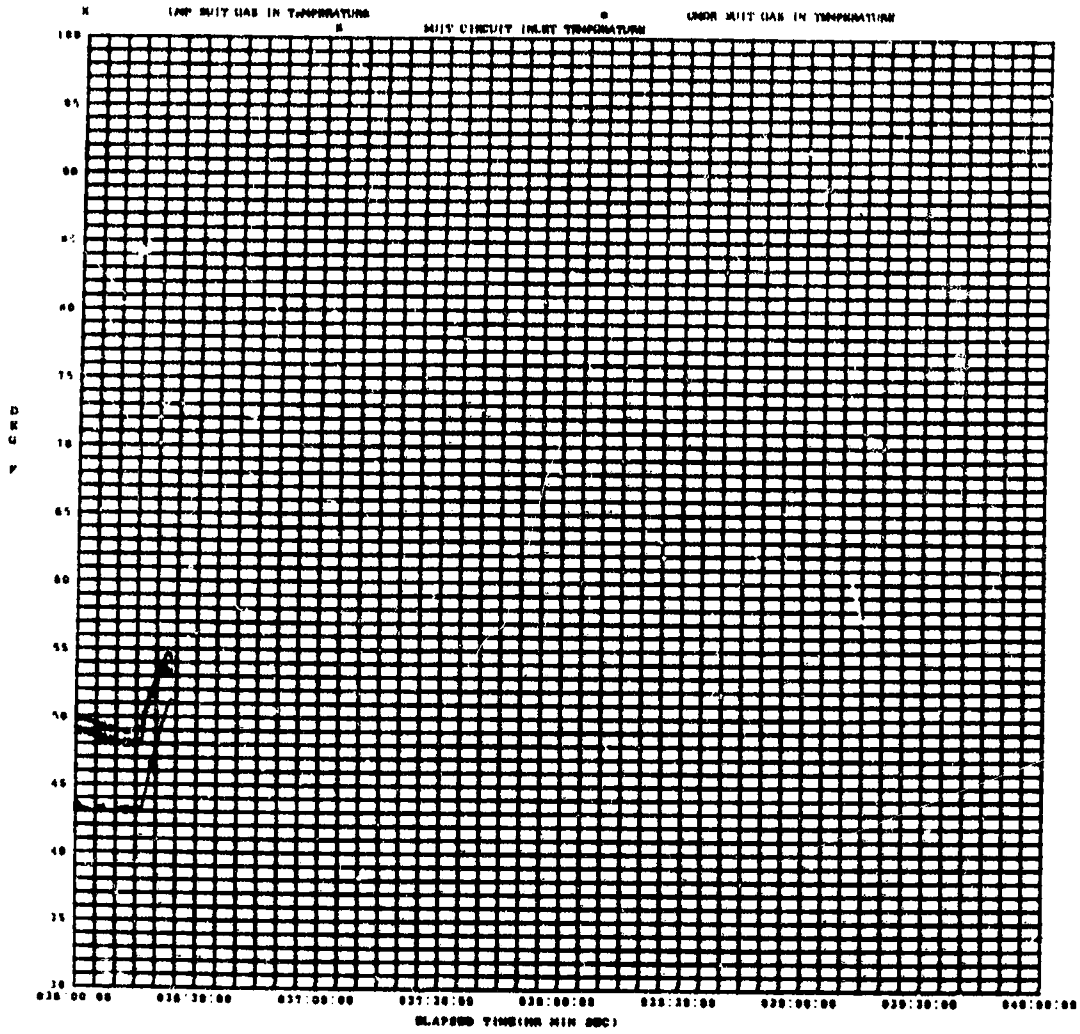


FIGURE 23J SUIT CIRCUIT, CDR, AND LMP GAS INLET TEMPERATURES
VERSUS TIME - CONCLUDED

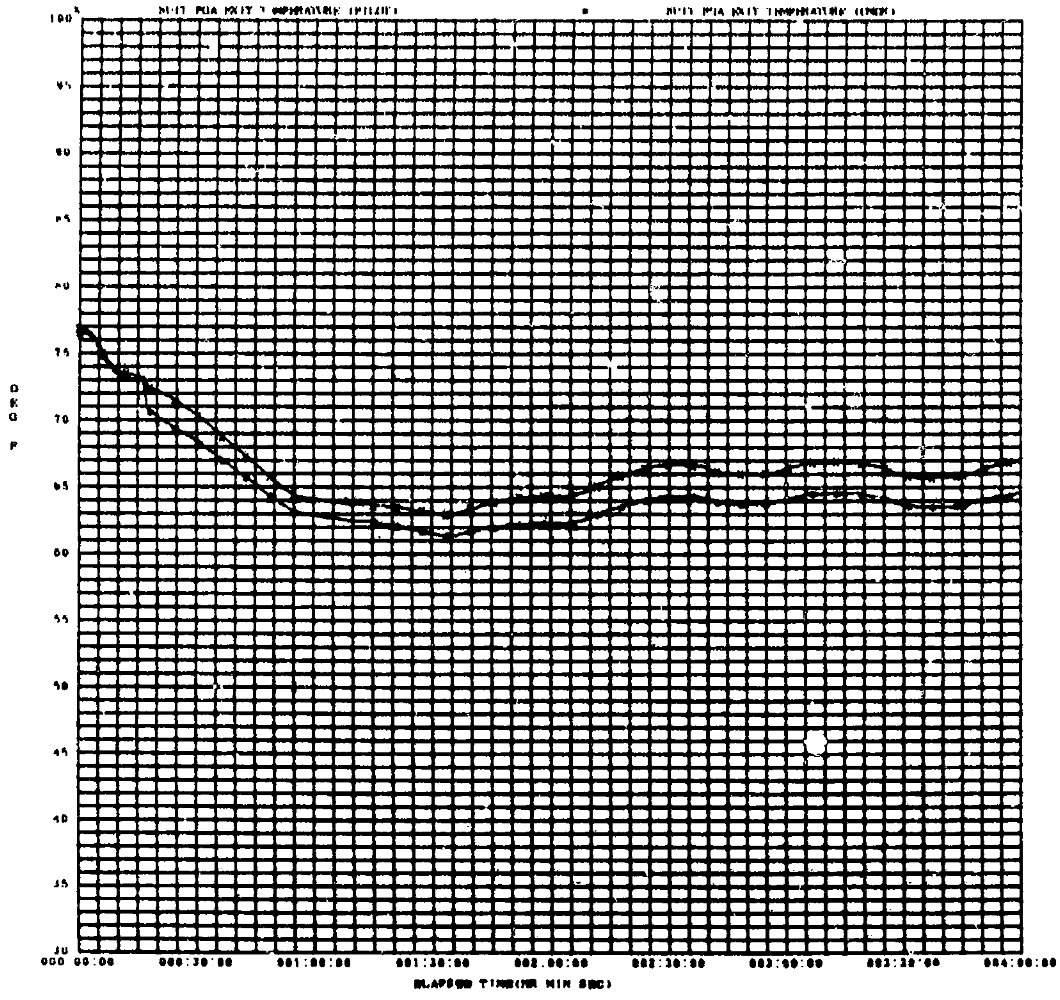


FIGURE 24 CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME

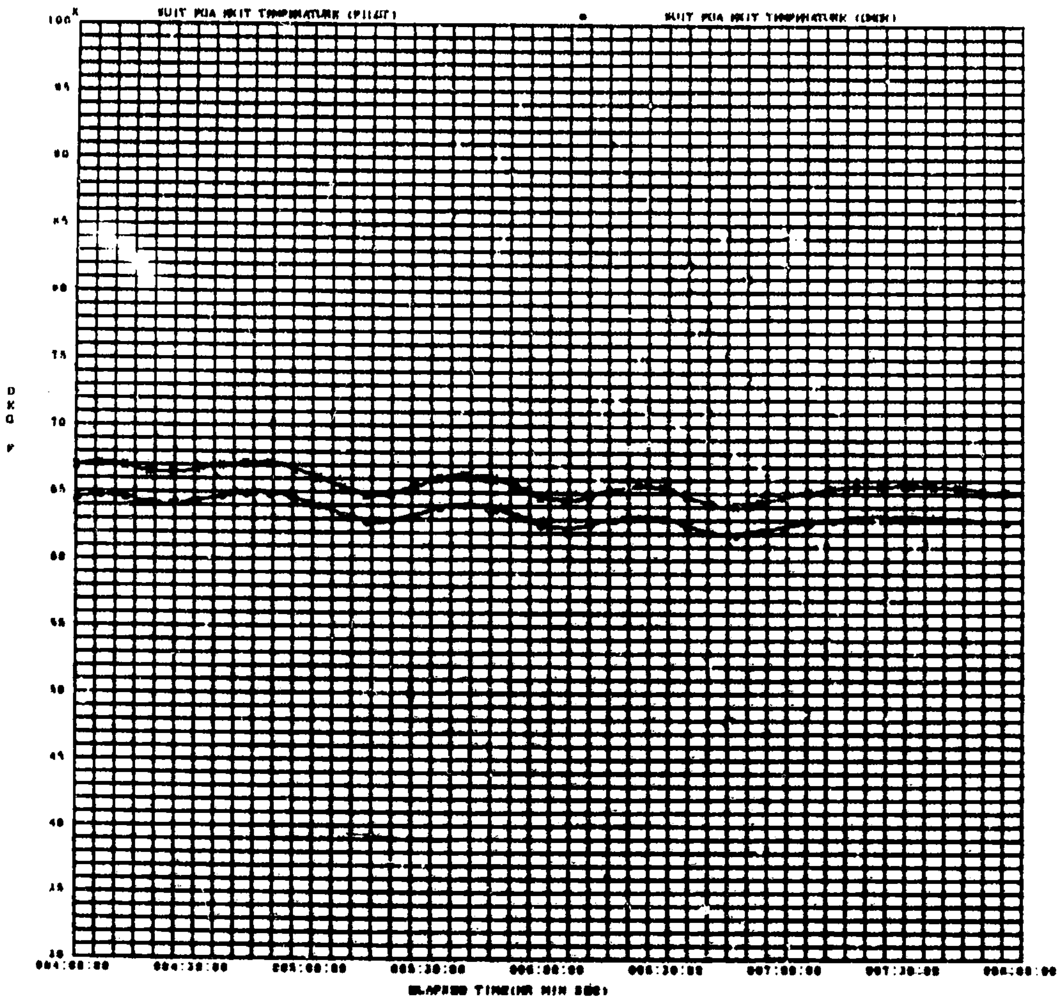


FIGURE 24A CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

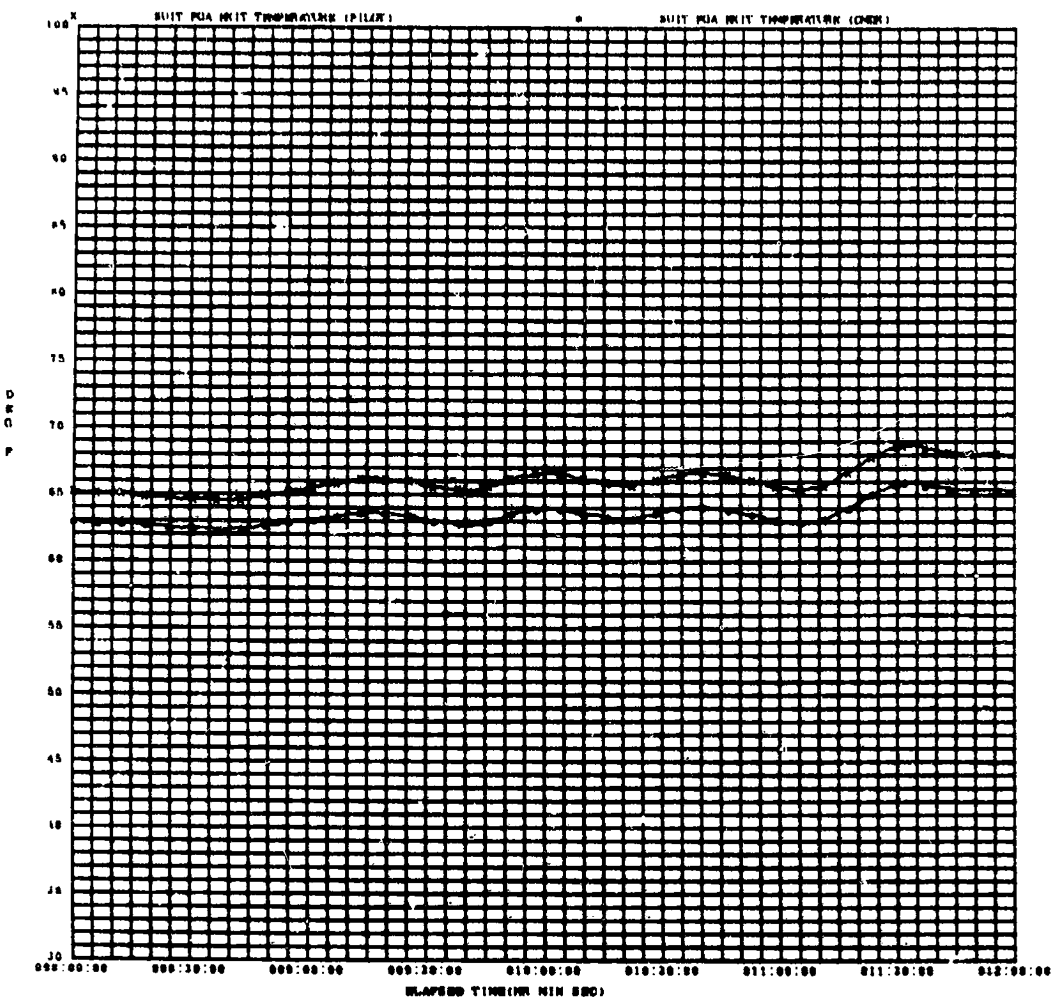


FIGURE 24B CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

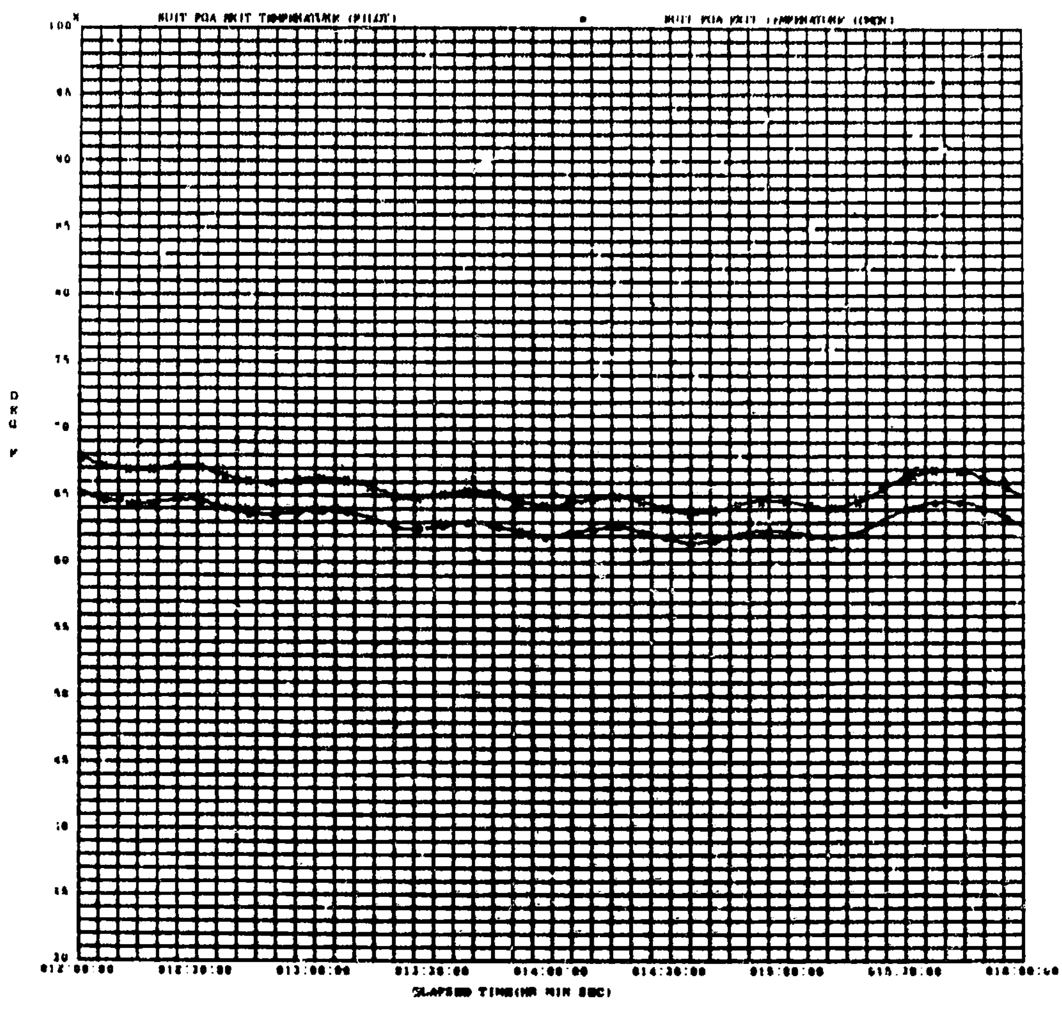


FIGURE 24C CDR AND LMP-SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

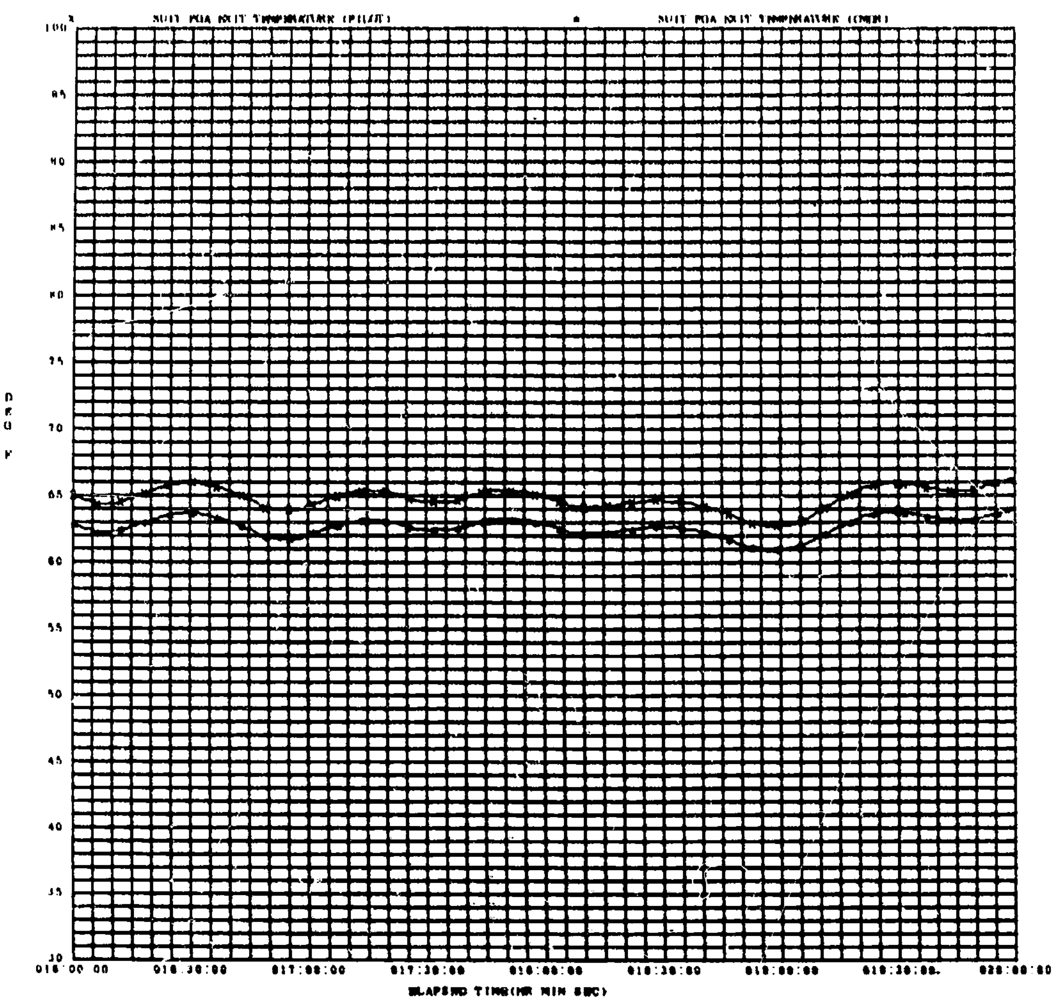


FIGURE 24D CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

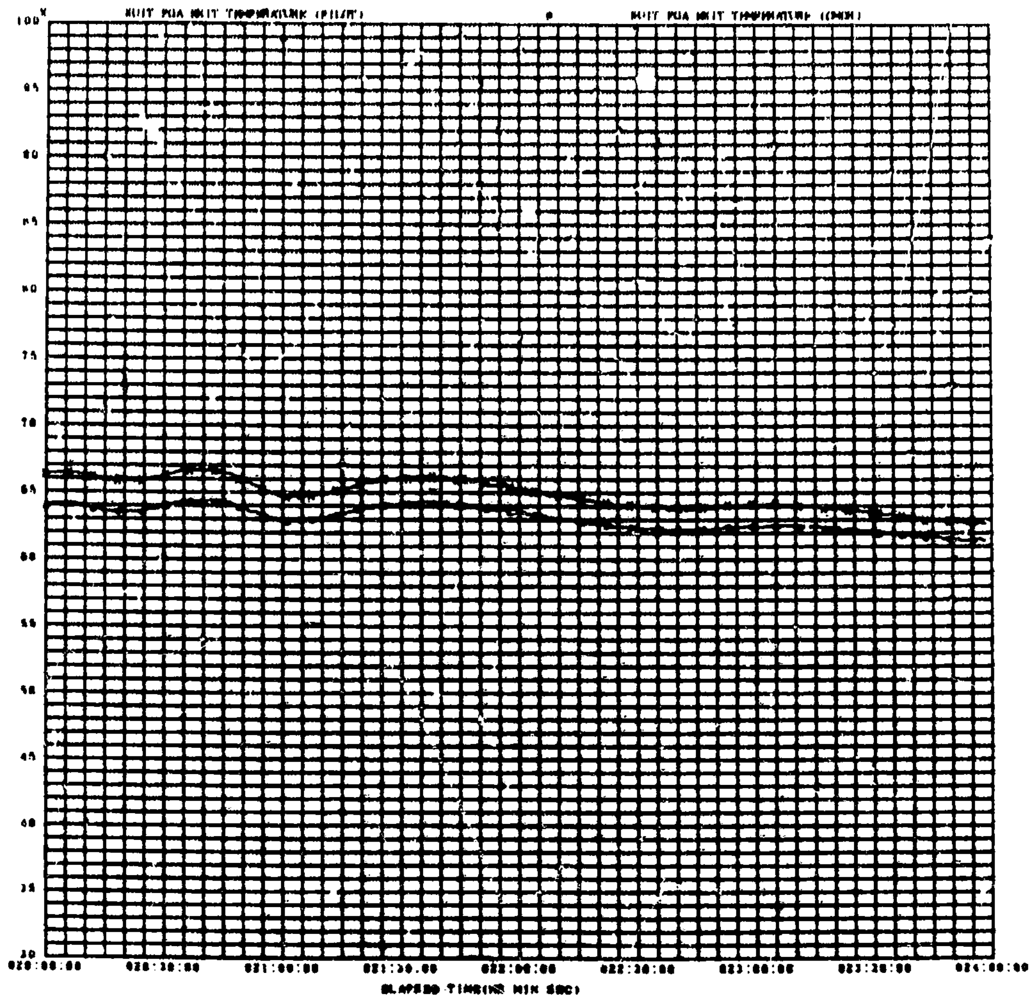


FIGURE 24E CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

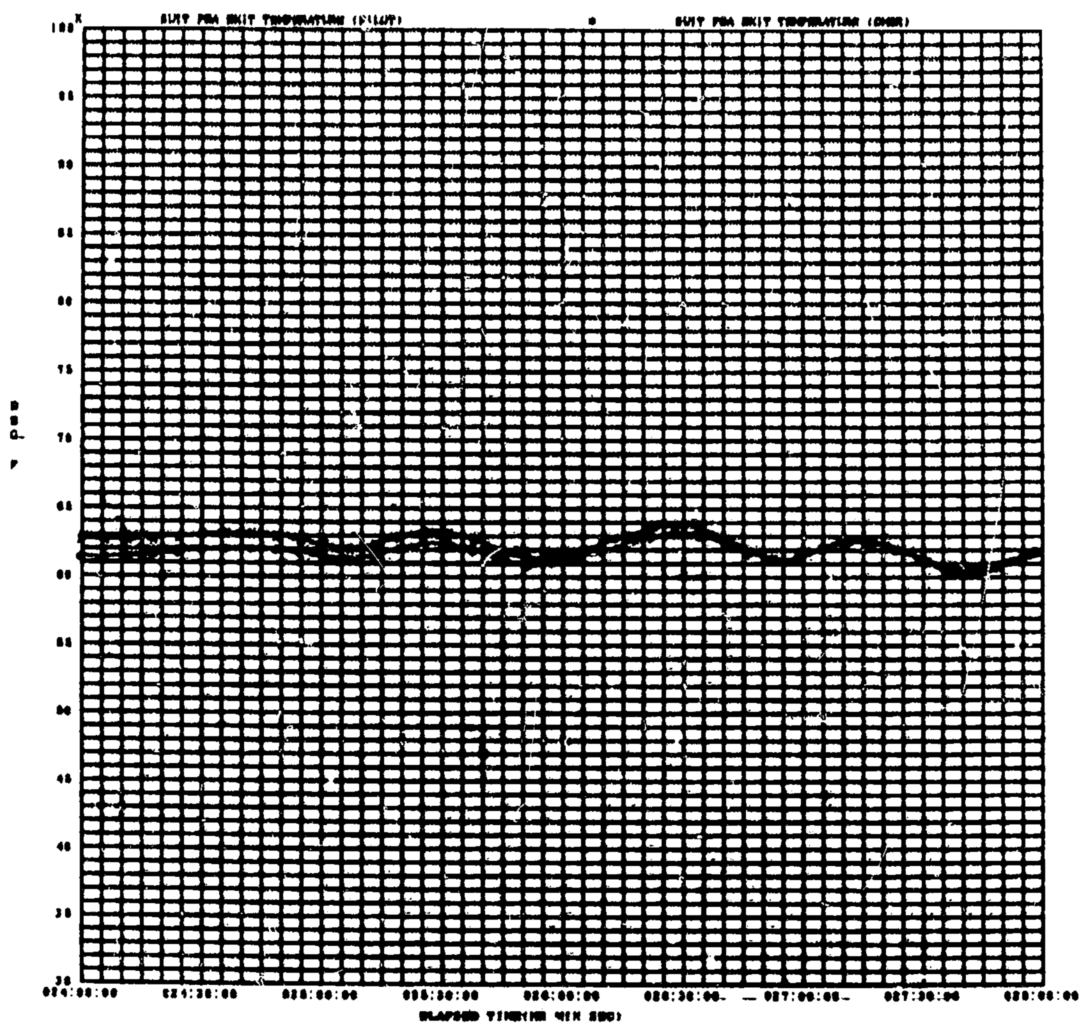


FIGURE 24F CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

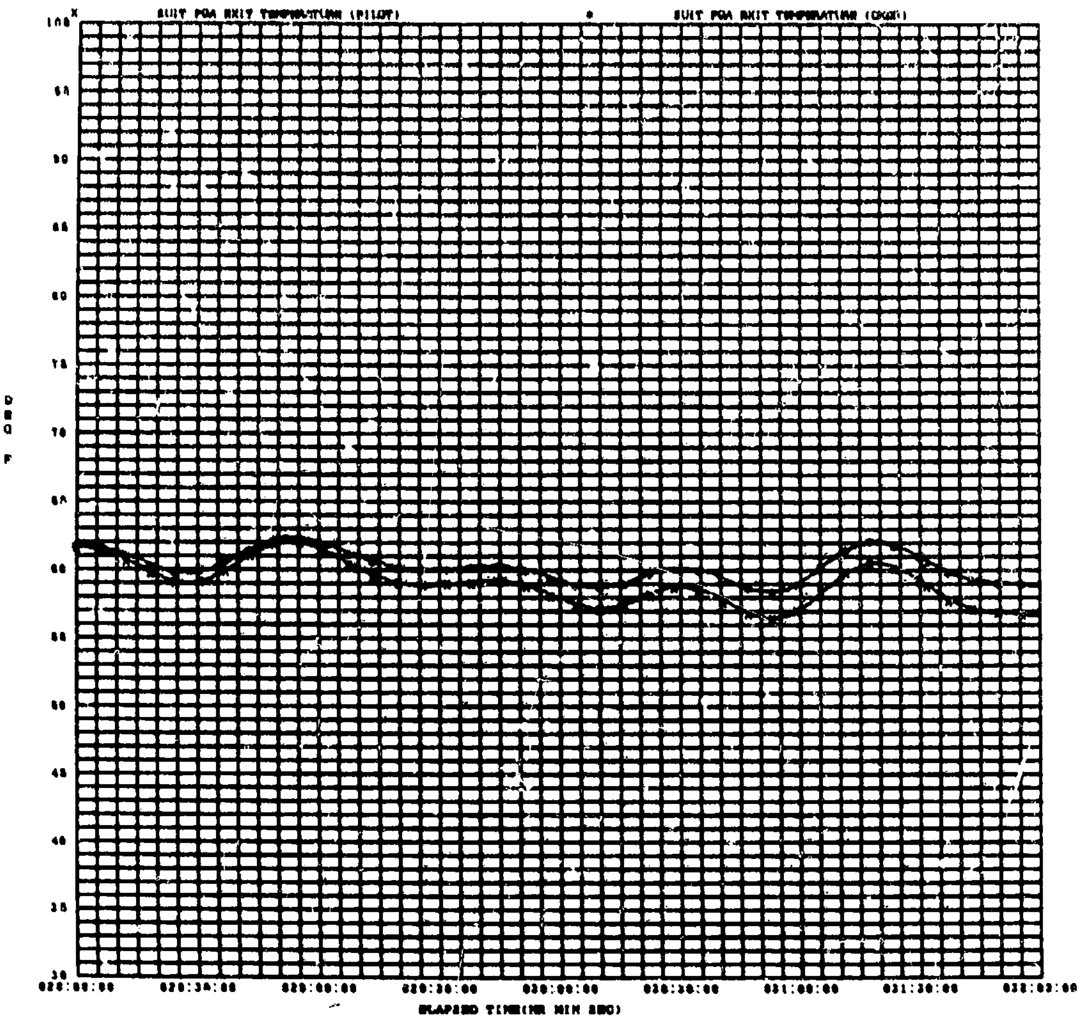


FIGURE 24G CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

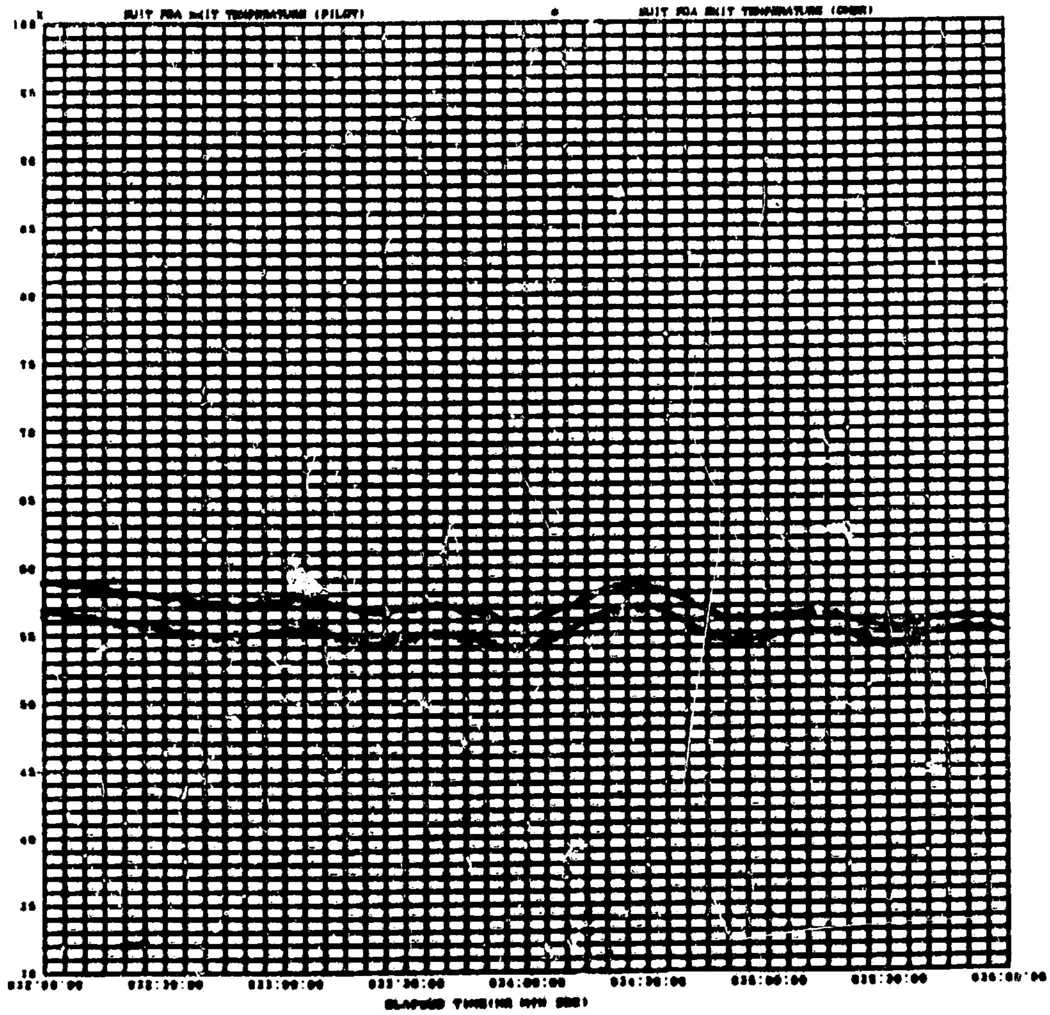


FIGURE 24H CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONTINUED

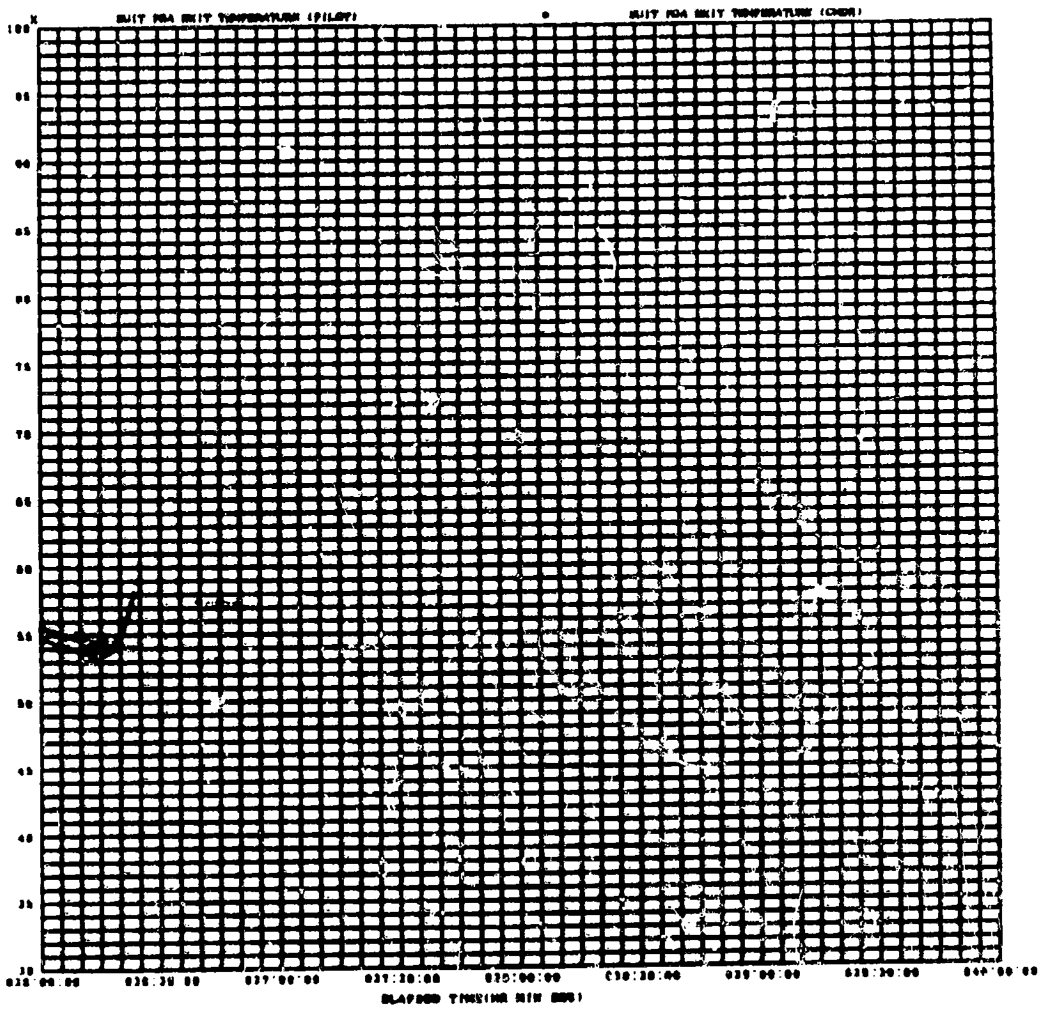


FIGURE 24J CDR AND LMP SUIT OUTLET GAS TEMPERATURES VERSUS TIME - CONCLUDED

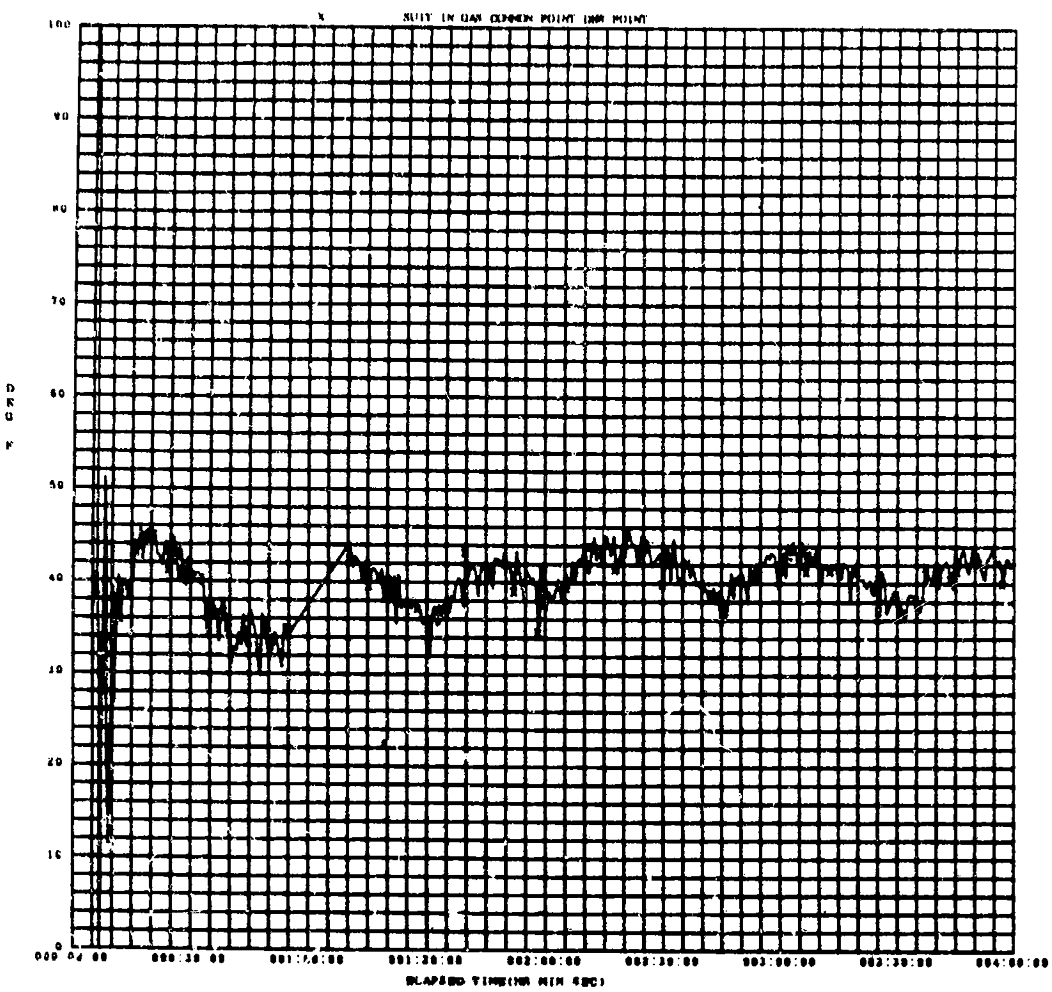


FIGURE 25 SUIT INLET GAS DEWPOINT VERSUS TIME

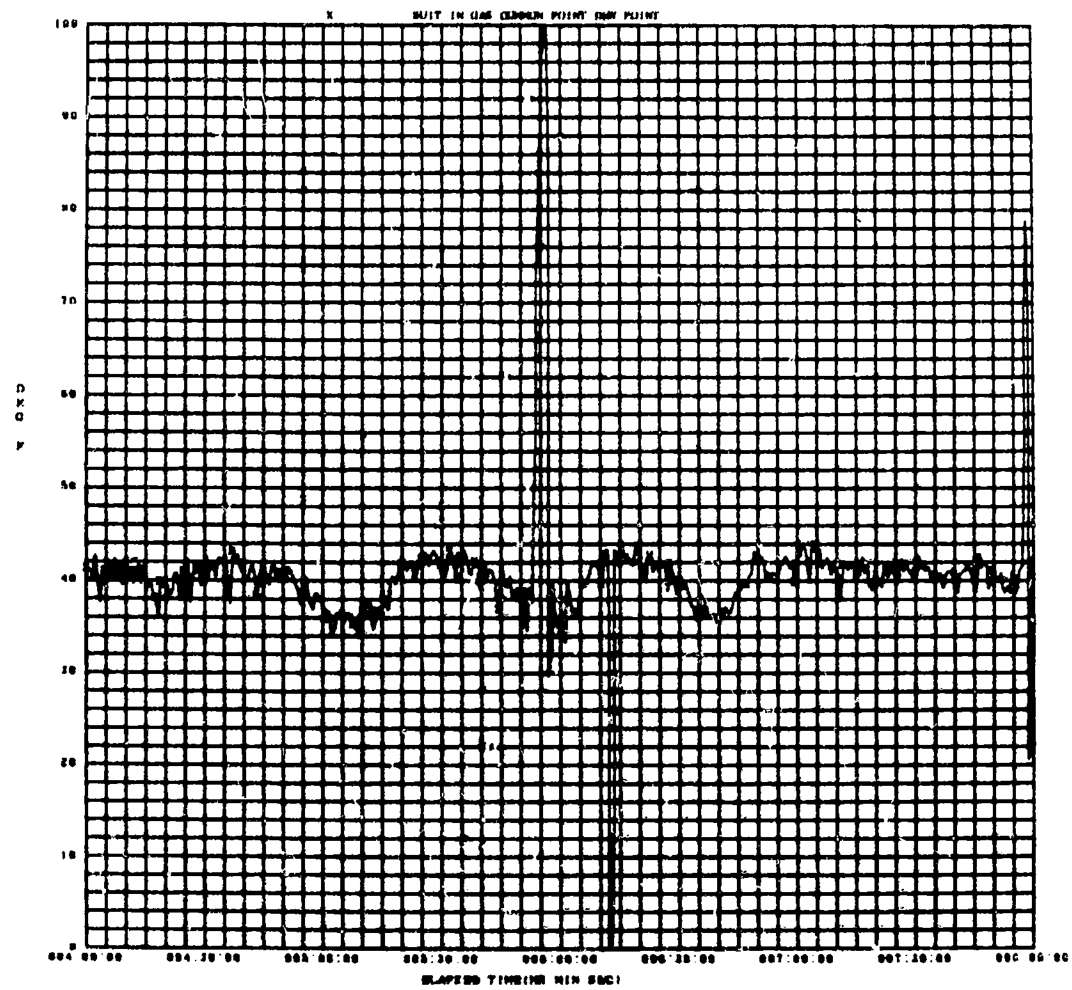


FIGURE 25A SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

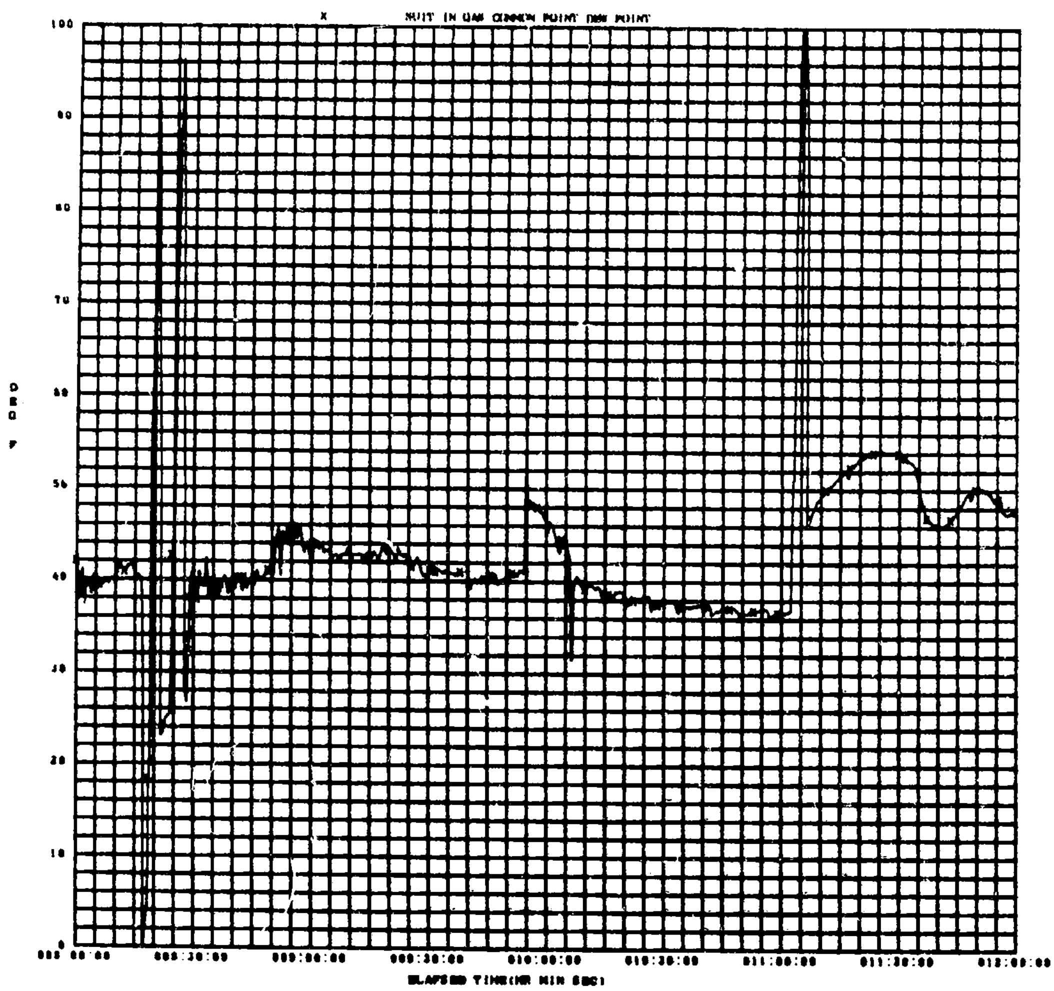


FIGURE 25B SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

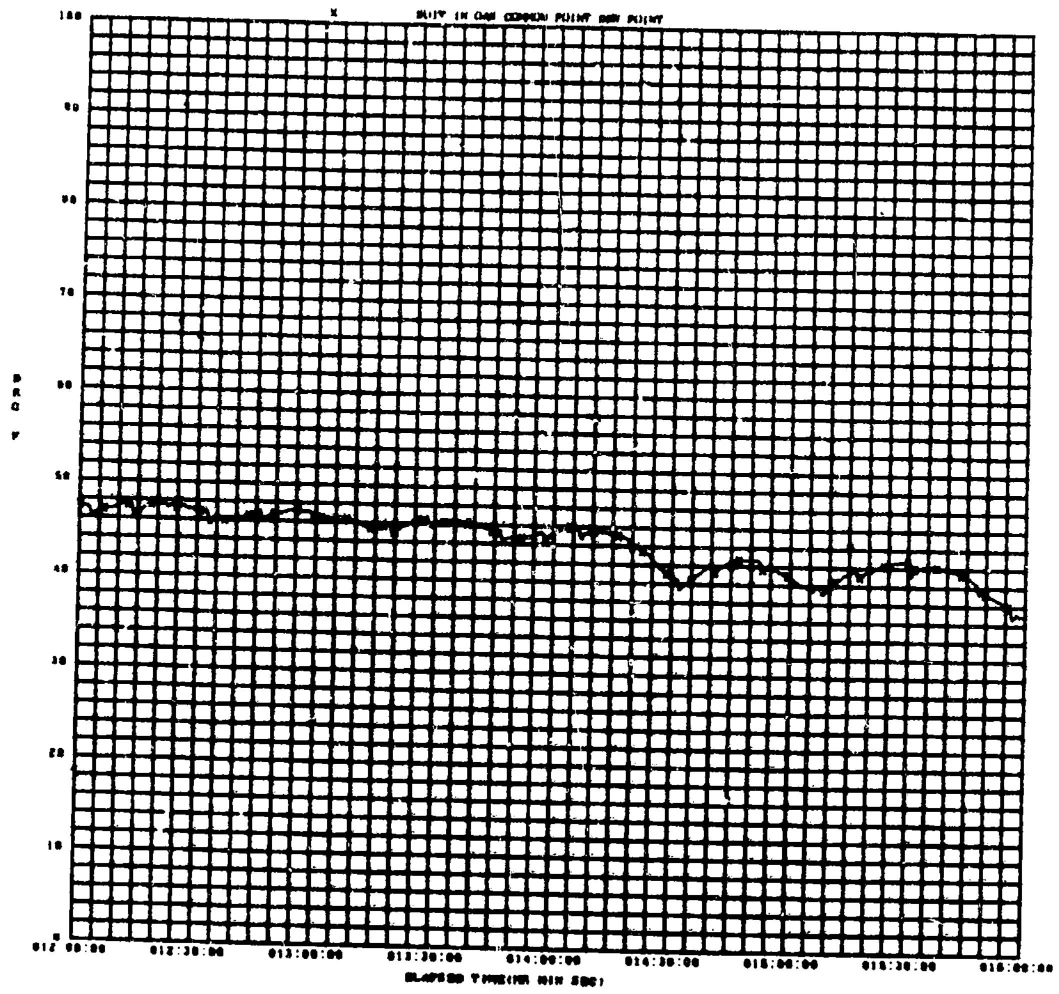


FIGURE 25C SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

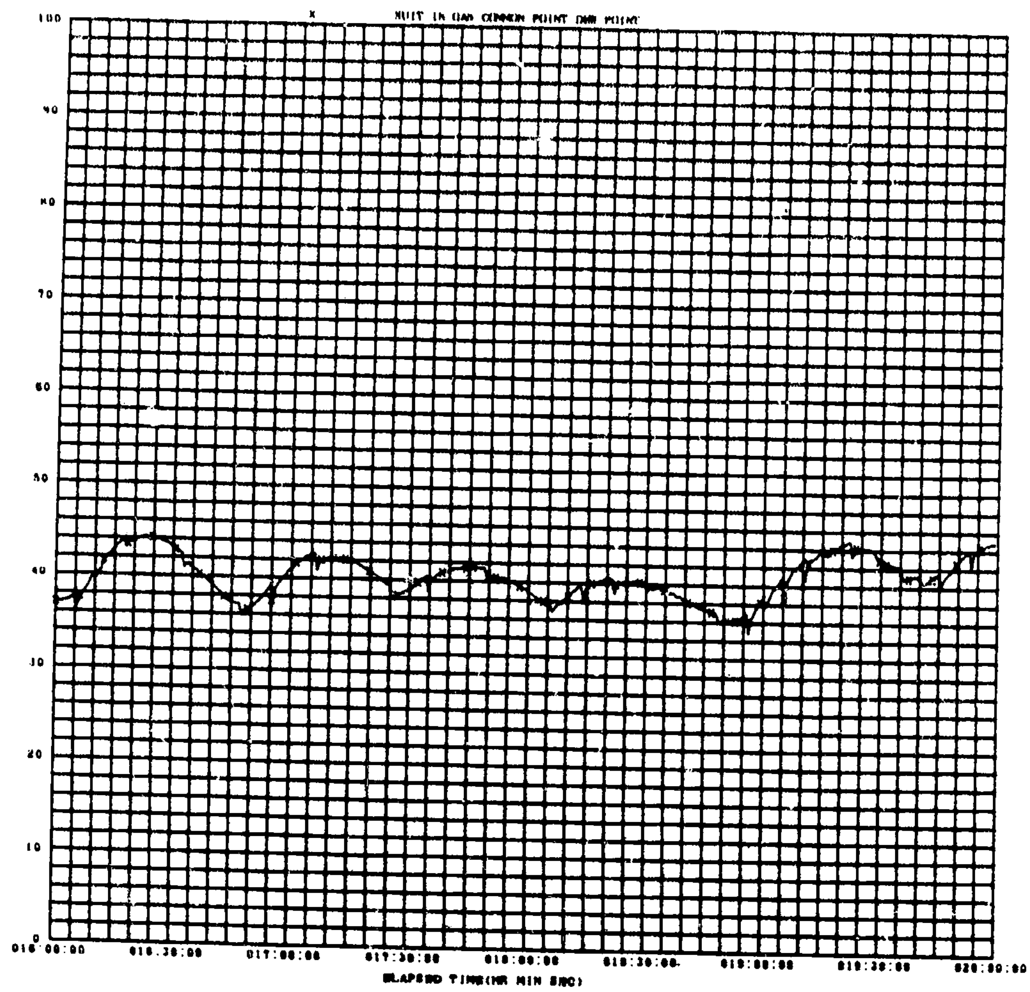


FIGURE 25D SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

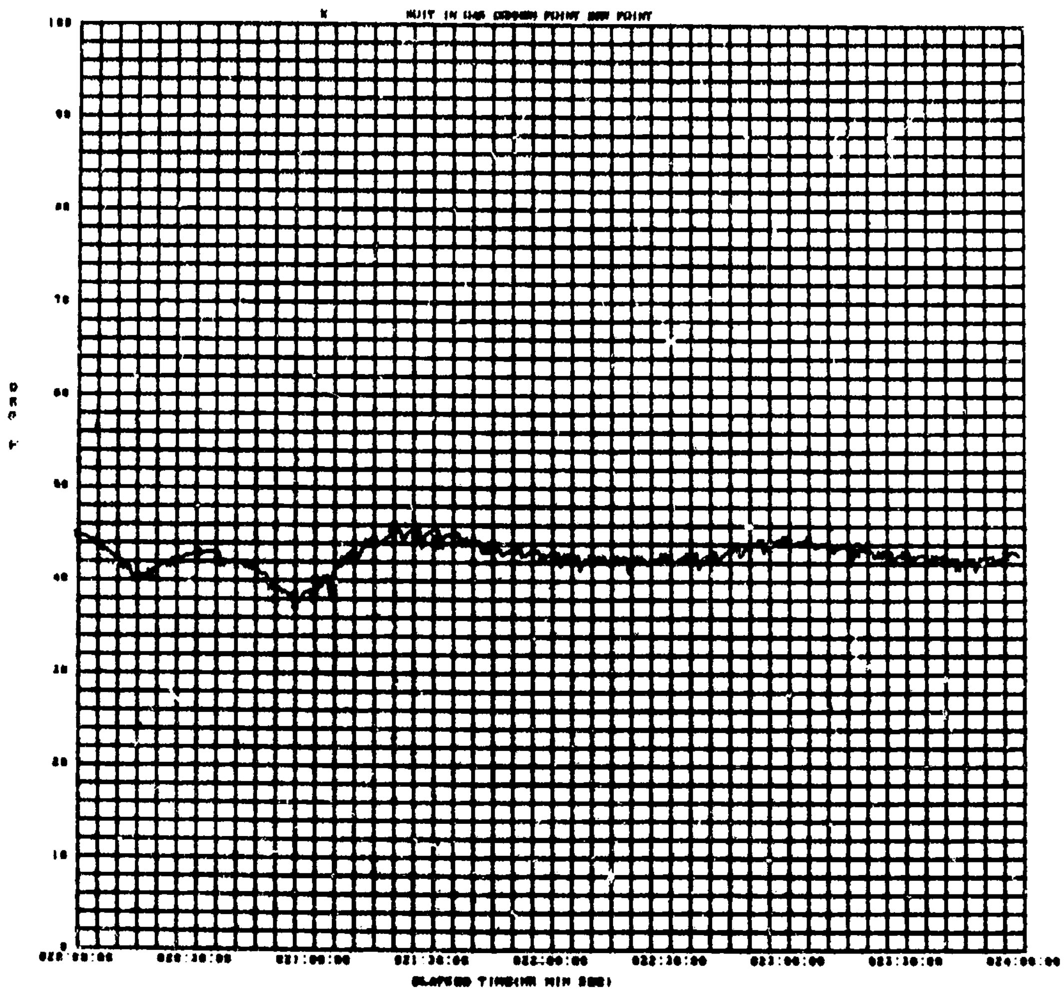


FIGURE 25E SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

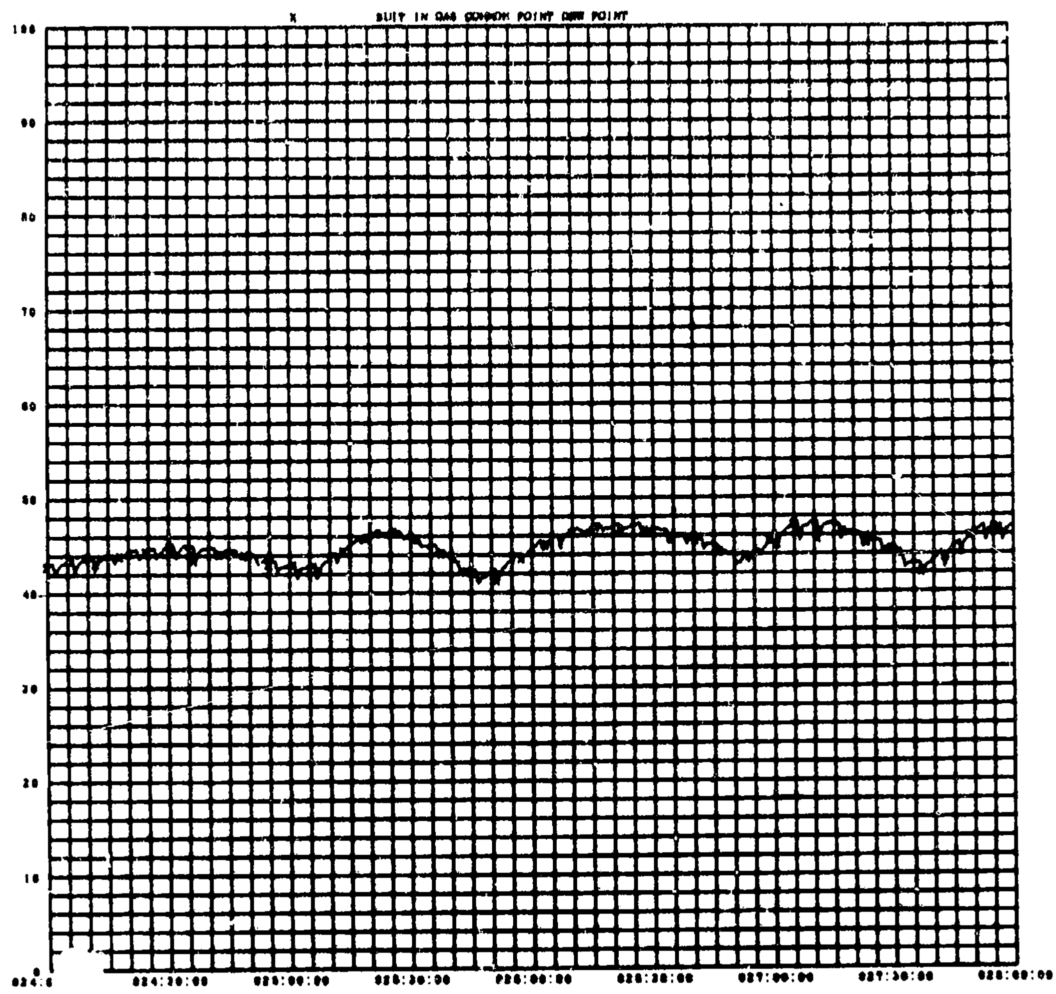


FIGURE 25F SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

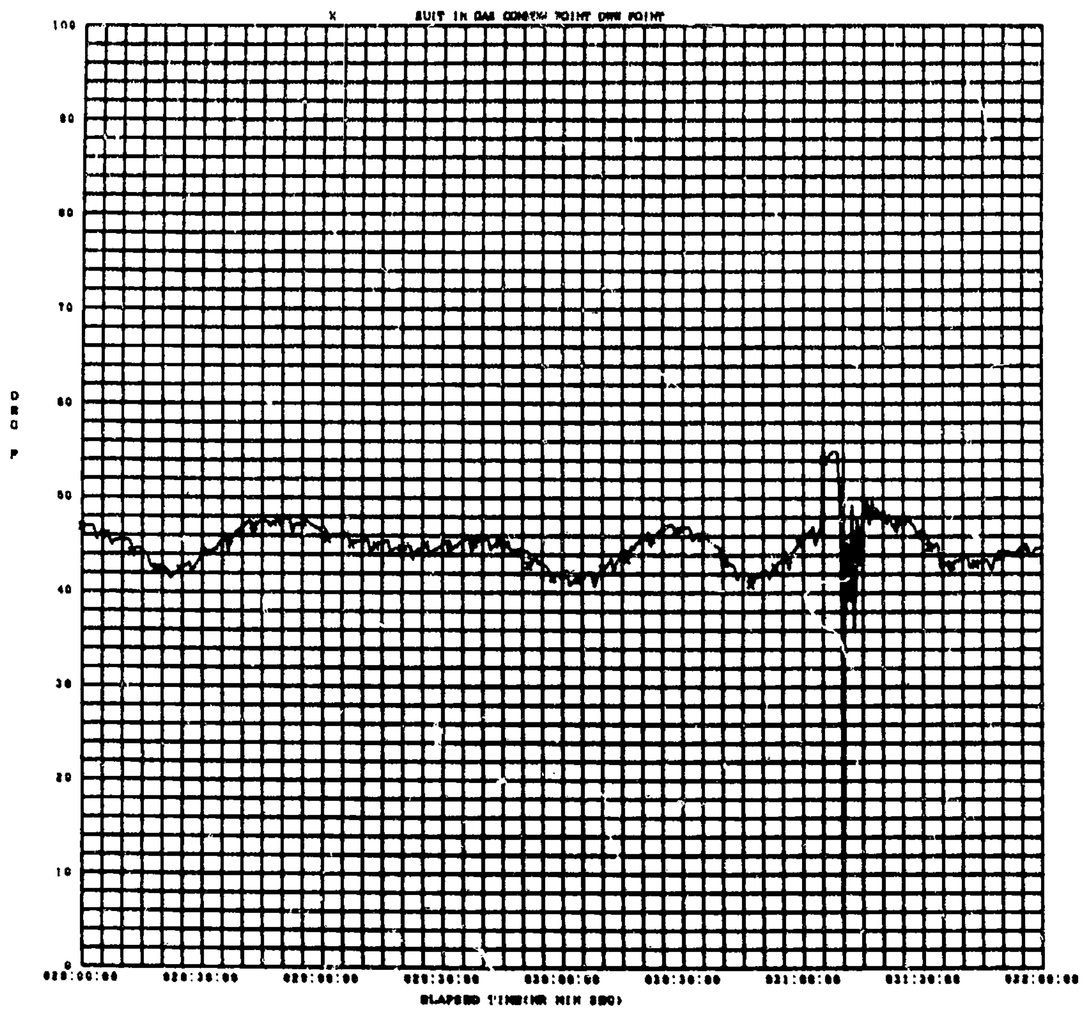


FIGURE 25G SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

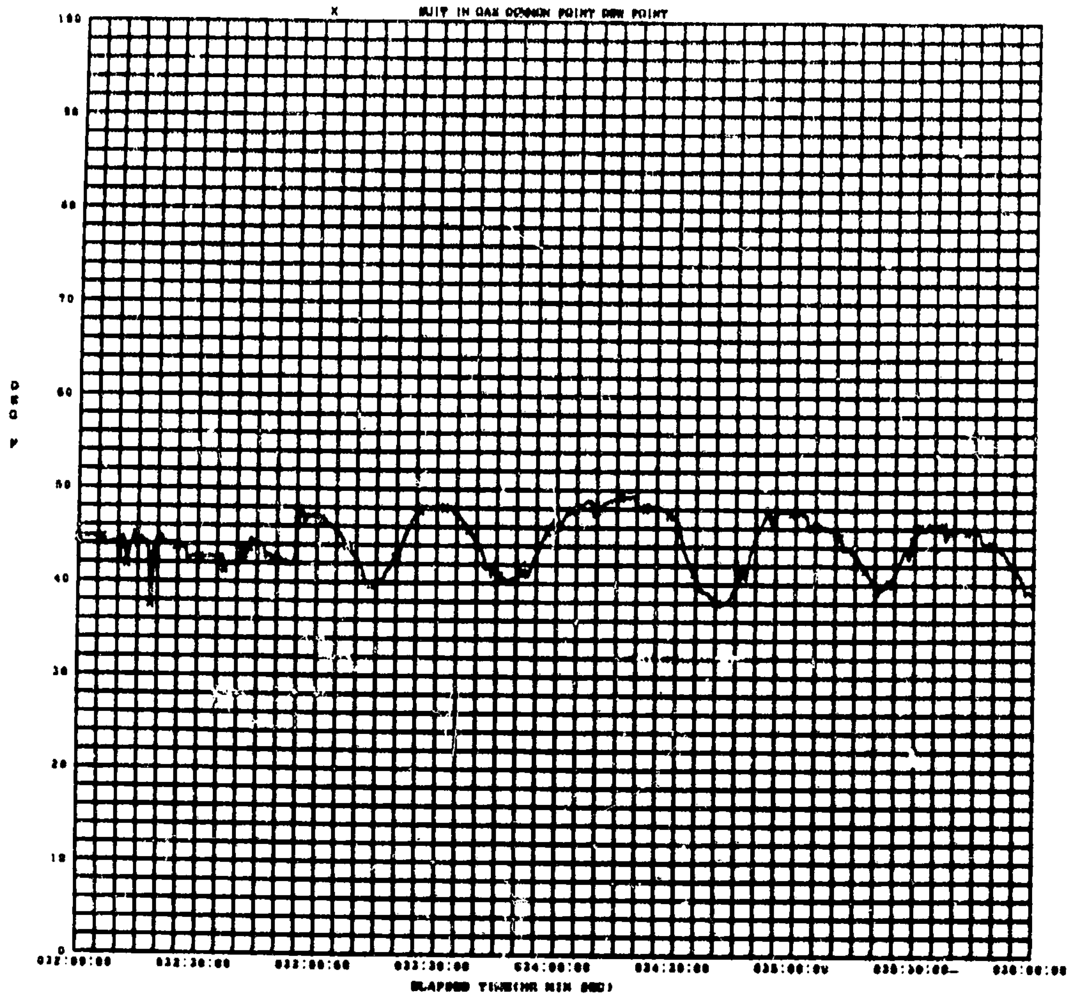


FIGURE 25H SUIT INLET GAS DEWPOINT VERSUS TIME - CONTINUED

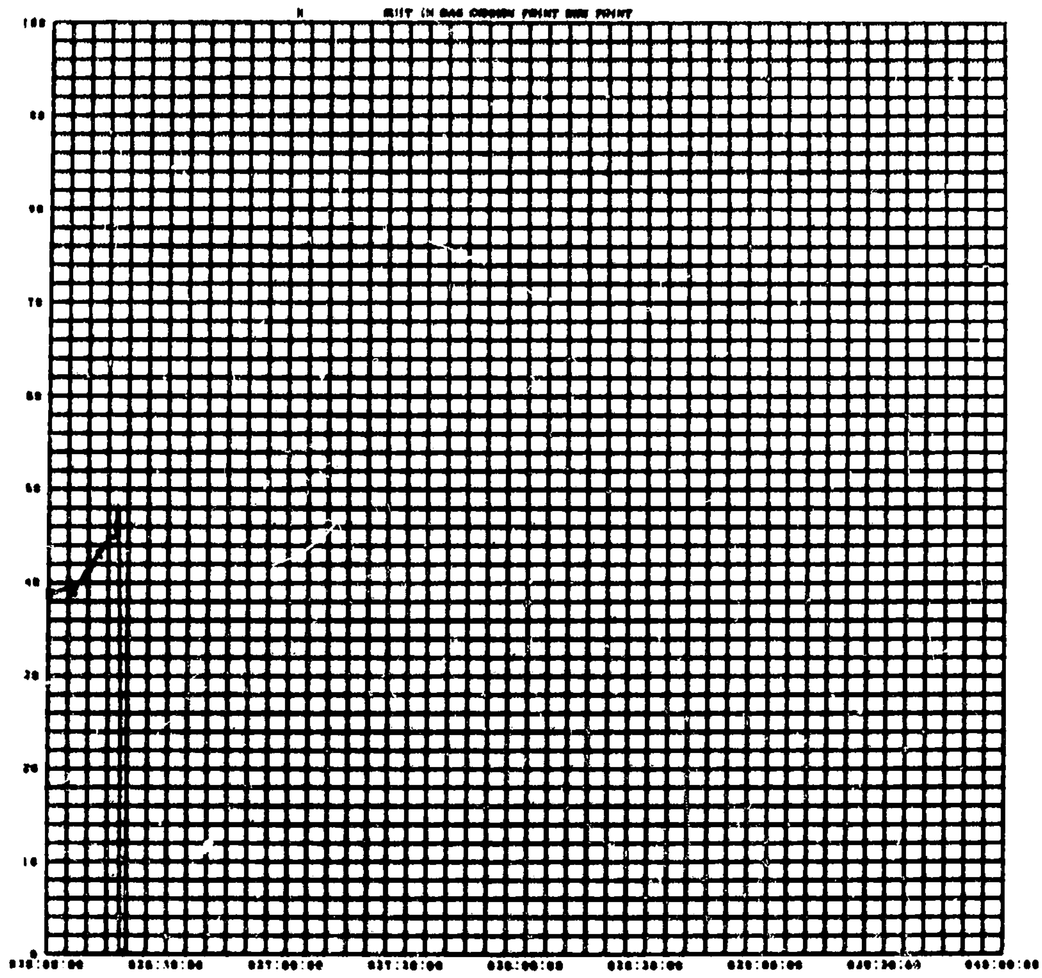


FIGURE 25J SUIT INLET GAS DEWPOINT VERSUS TIME - CONCLUDED

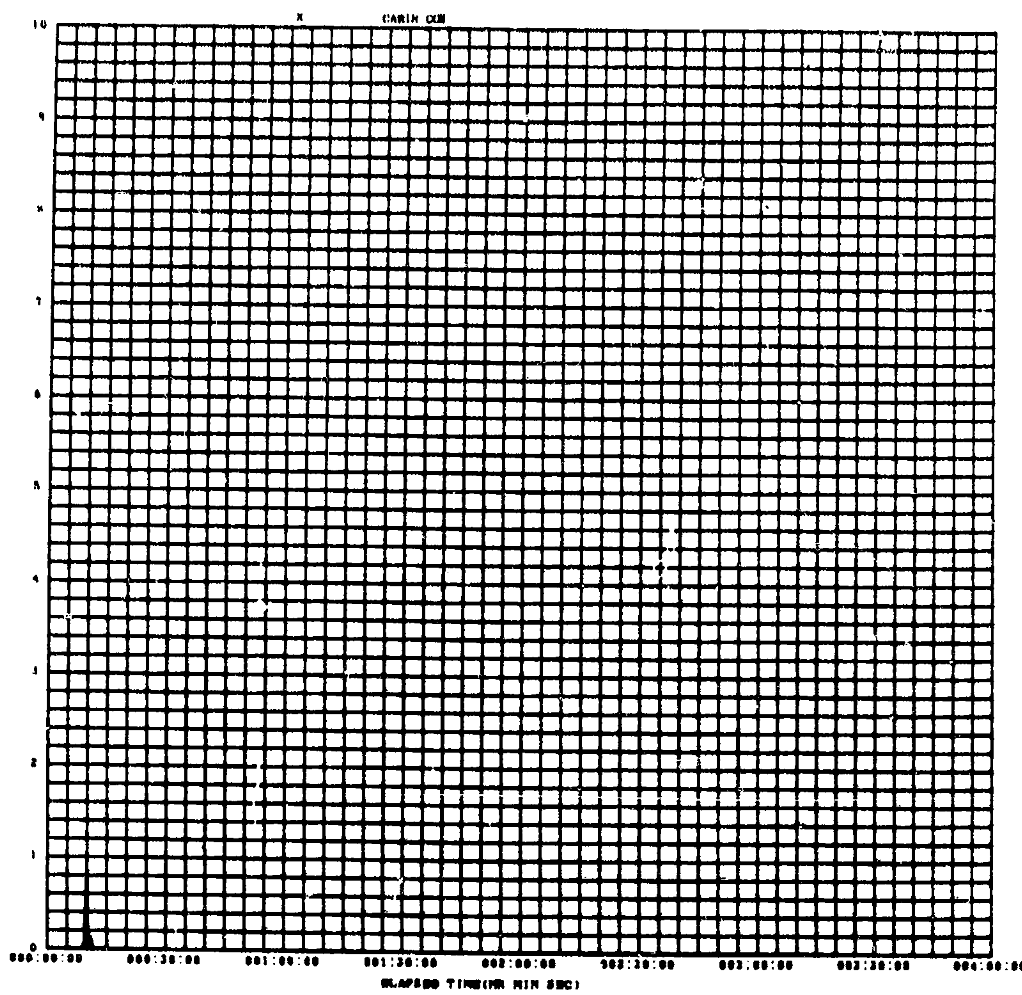


FIGURE 26 CABIN PARTIAL PRESSURE CO2 VERSUS TIME

C-4

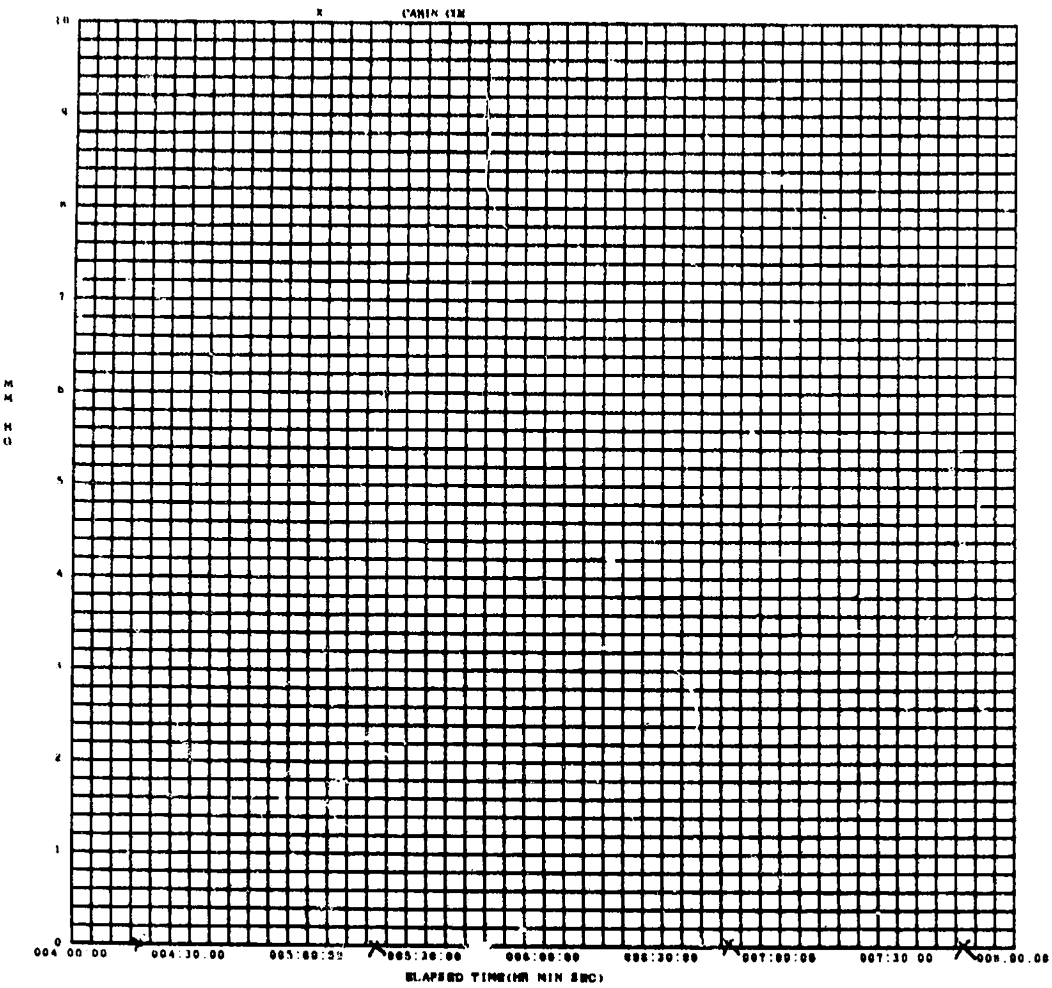


FIGURE 26A CABIN PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

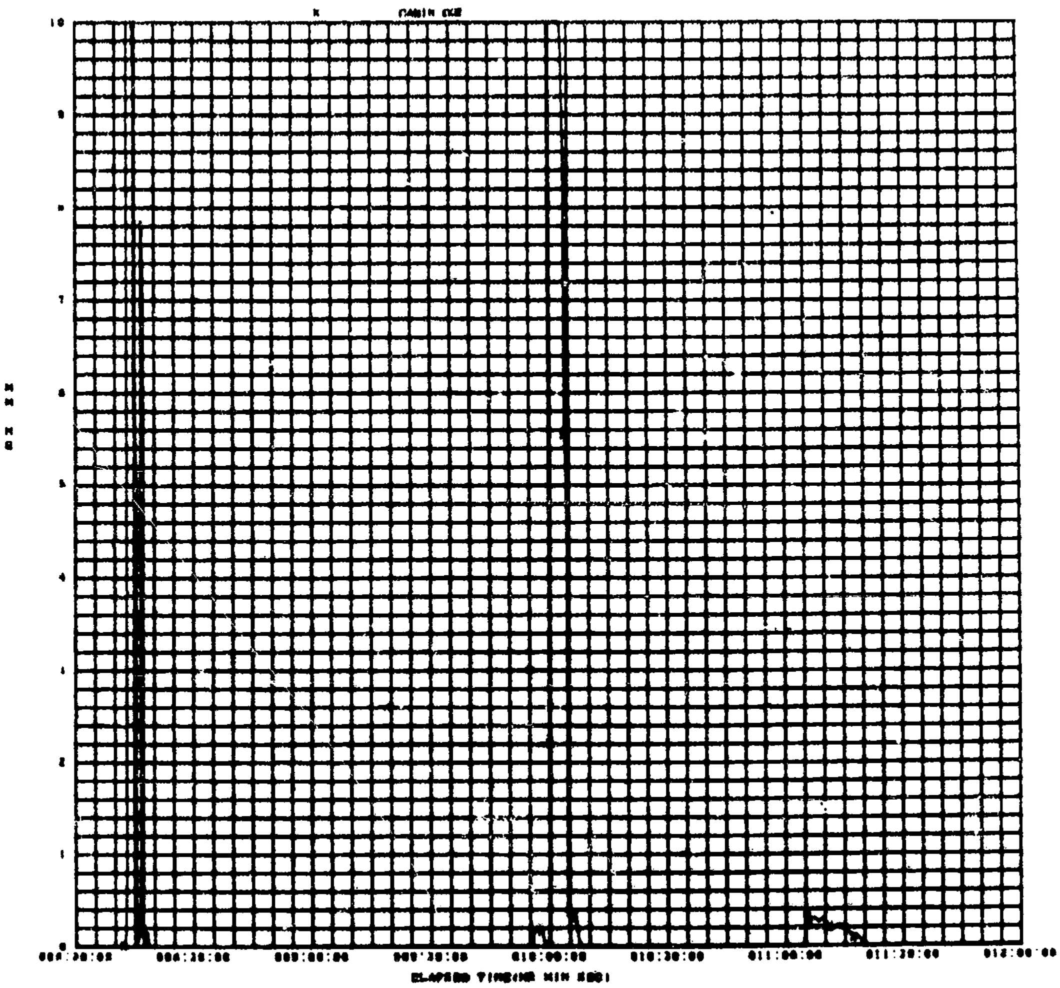


FIGURE 26B CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

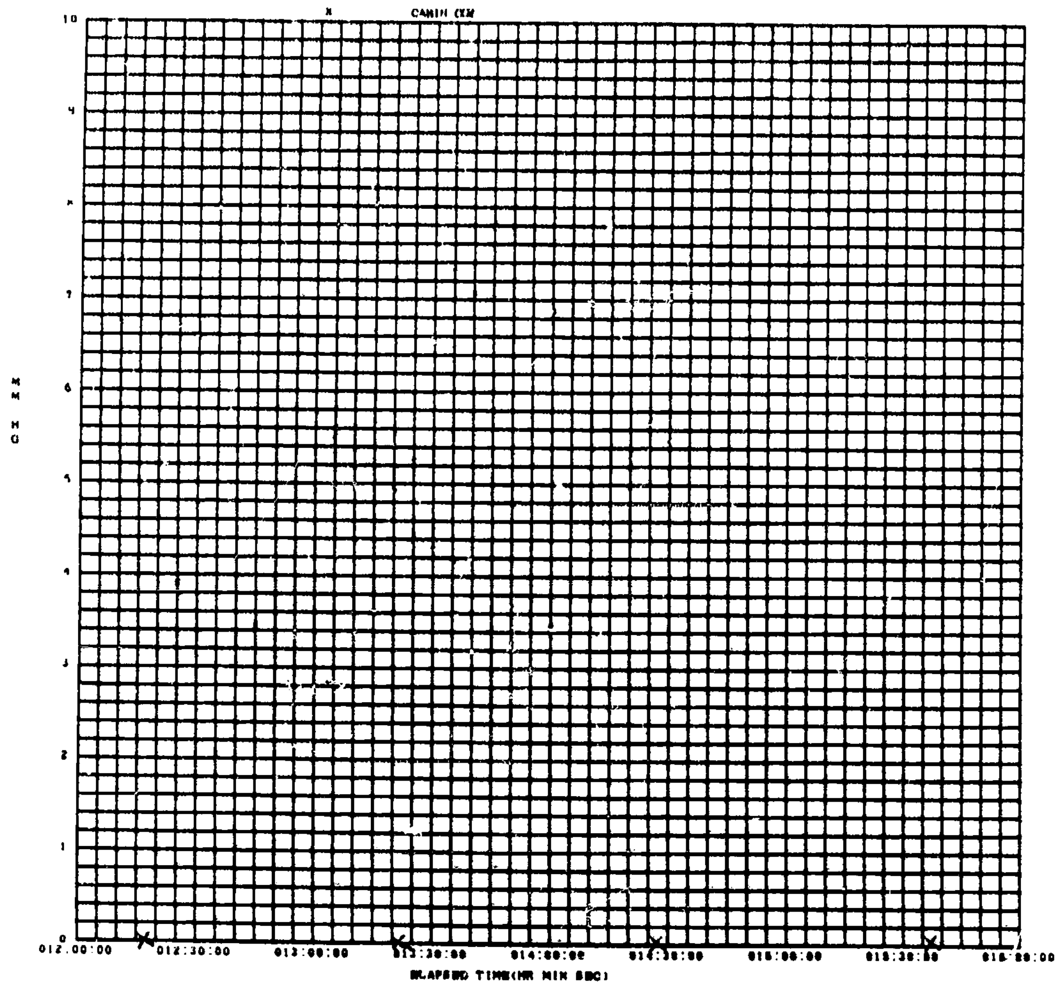


FIGURE 26C CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

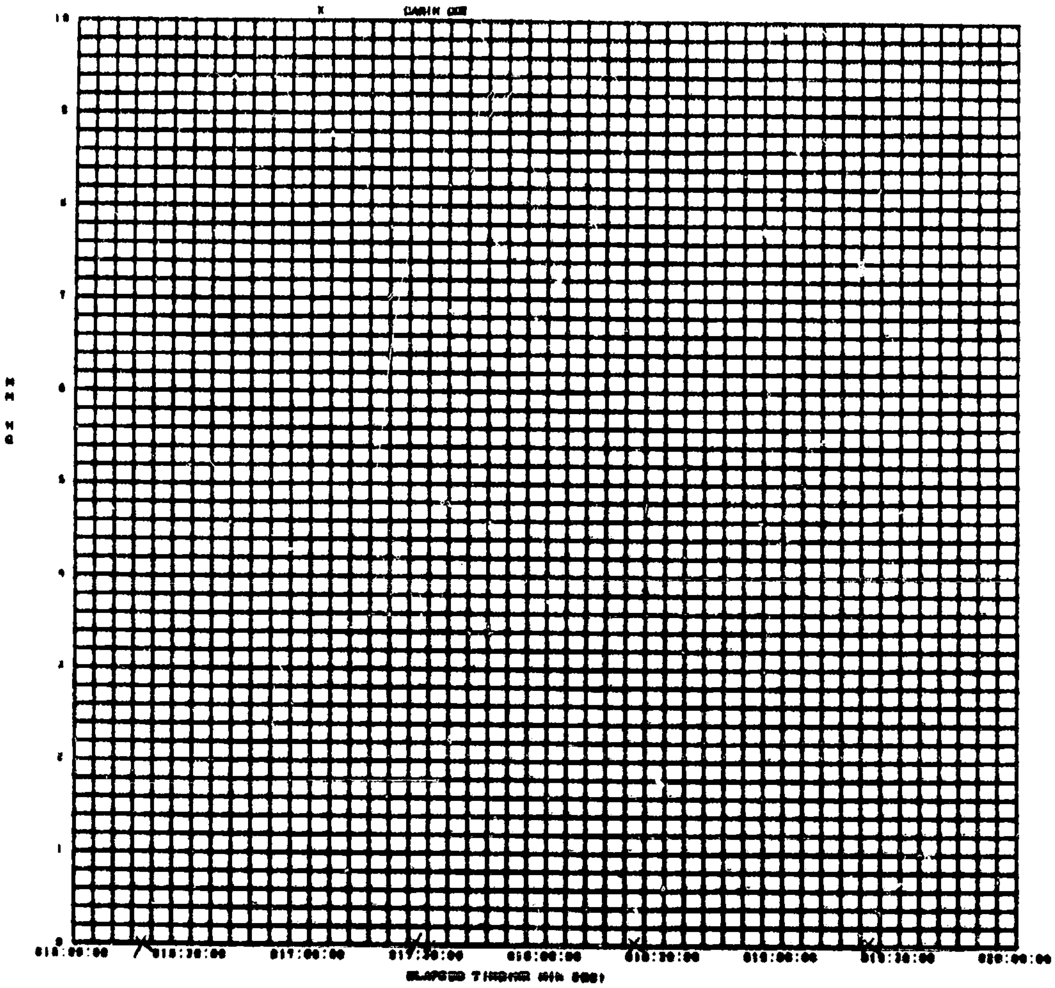


FIGURE 26D CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

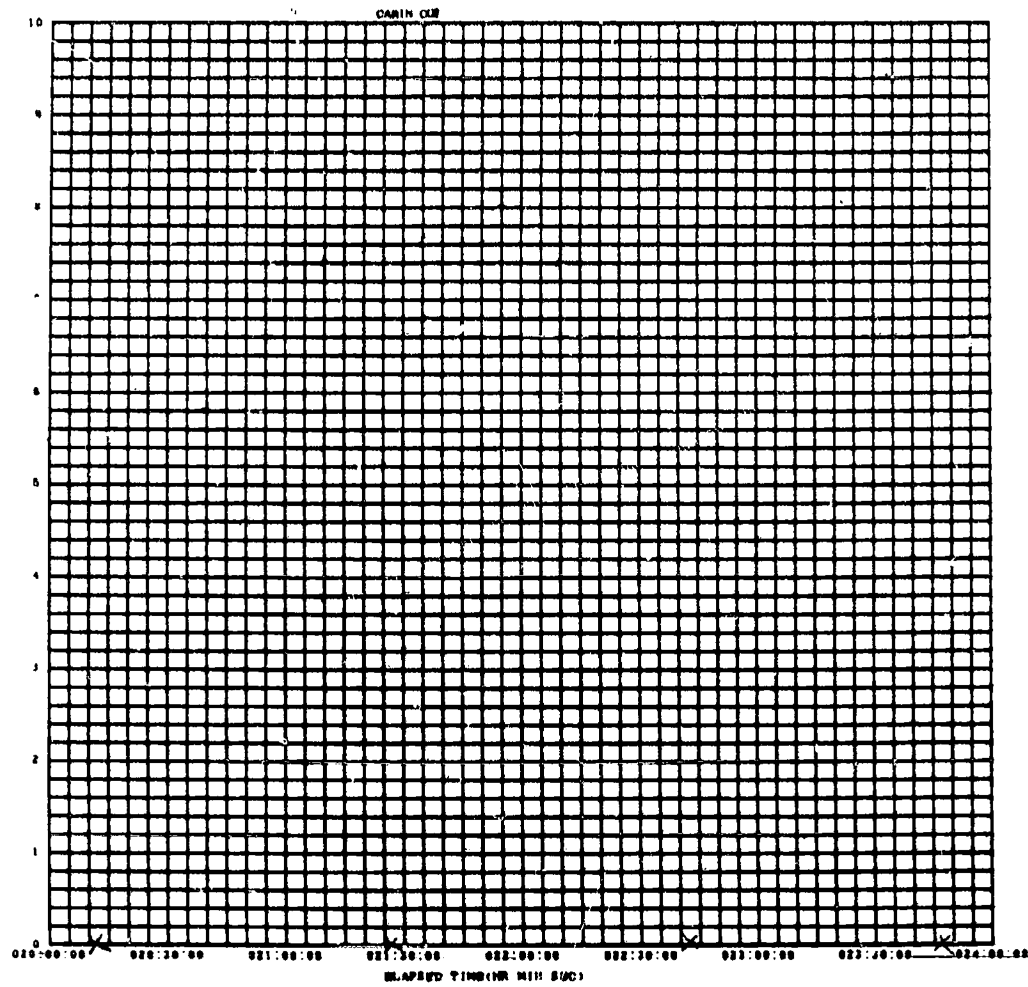


FIGURE 26E CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

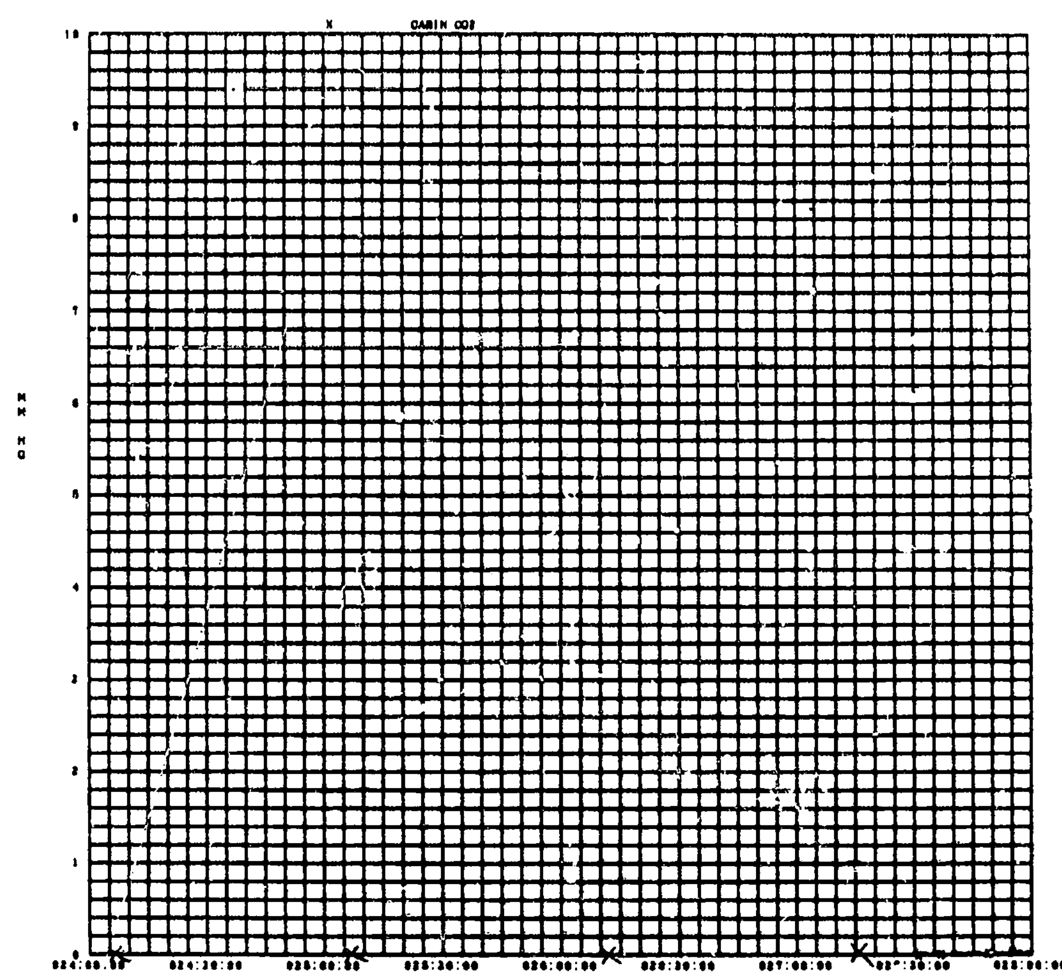


FIGURE 26F CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

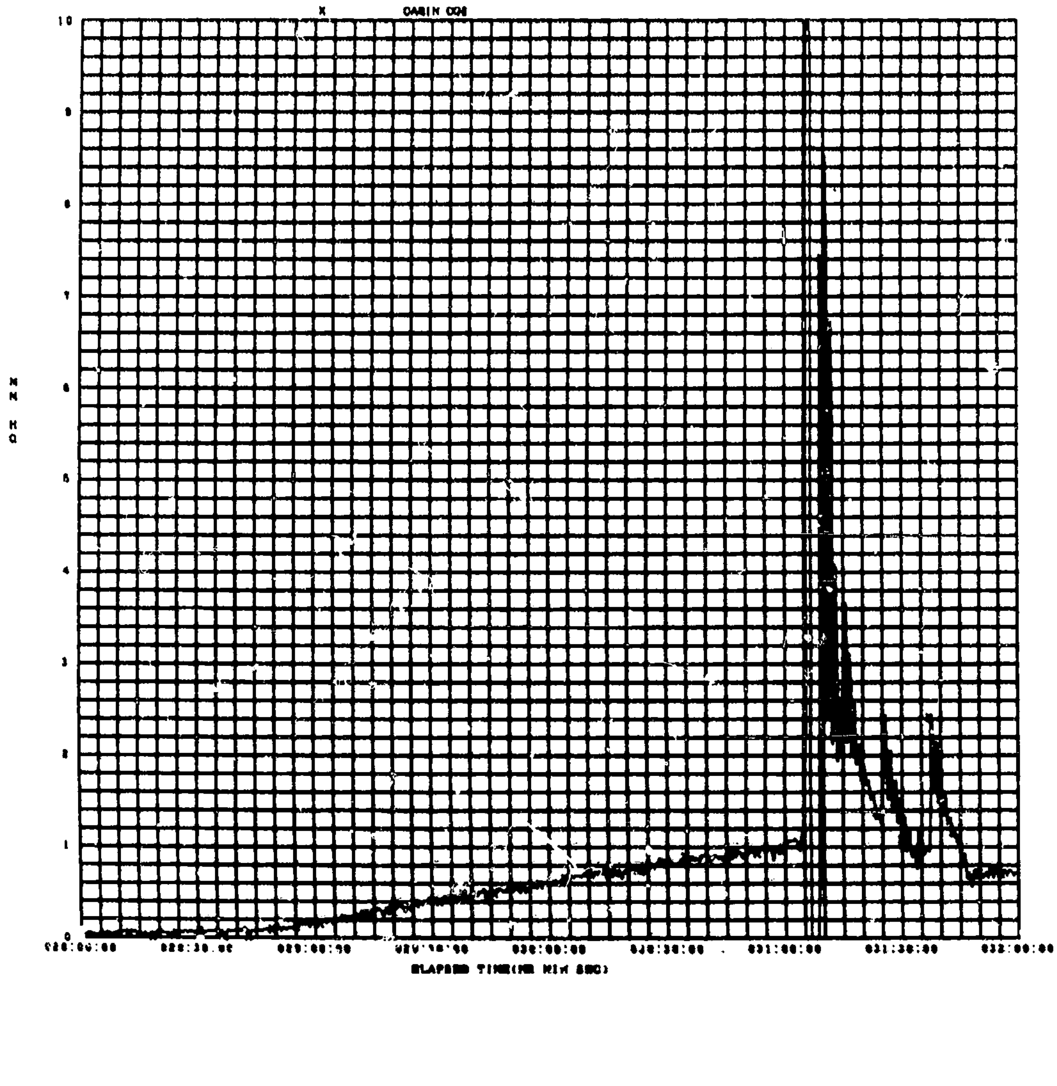


FIGURE 26G CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

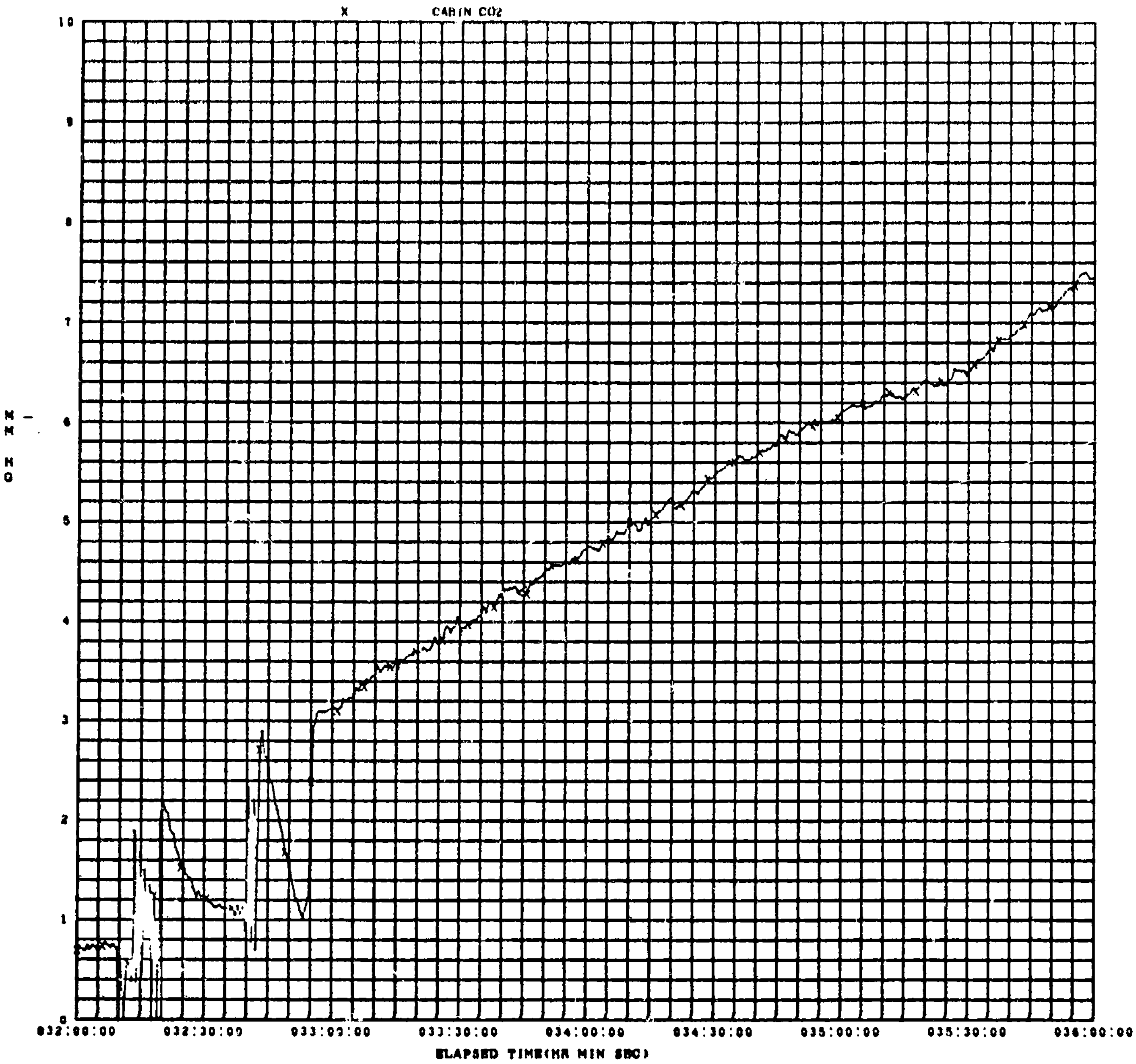


FIGURE 26H CABIN PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

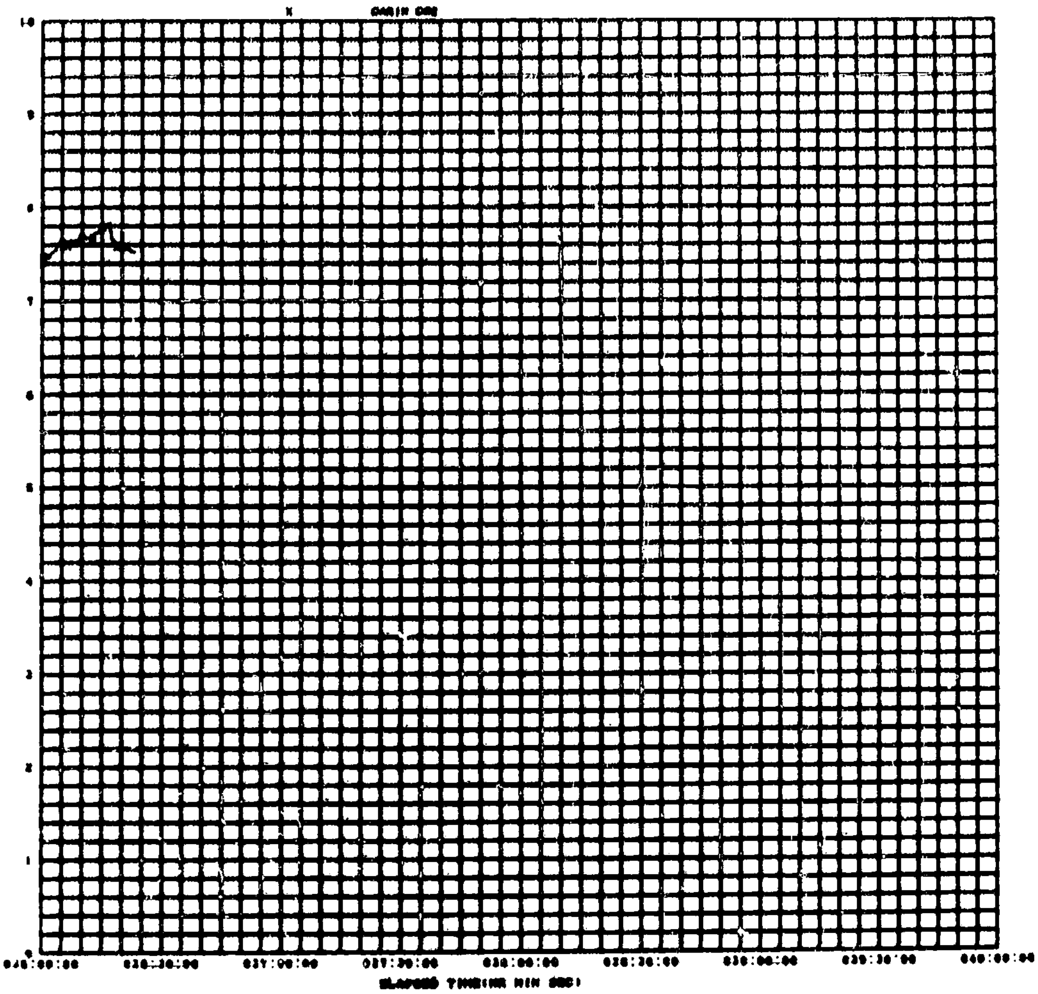


FIGURE 26J CABIN PARTIAL PRESSURE CO2 VERSUS TIME
- CONCLUDED

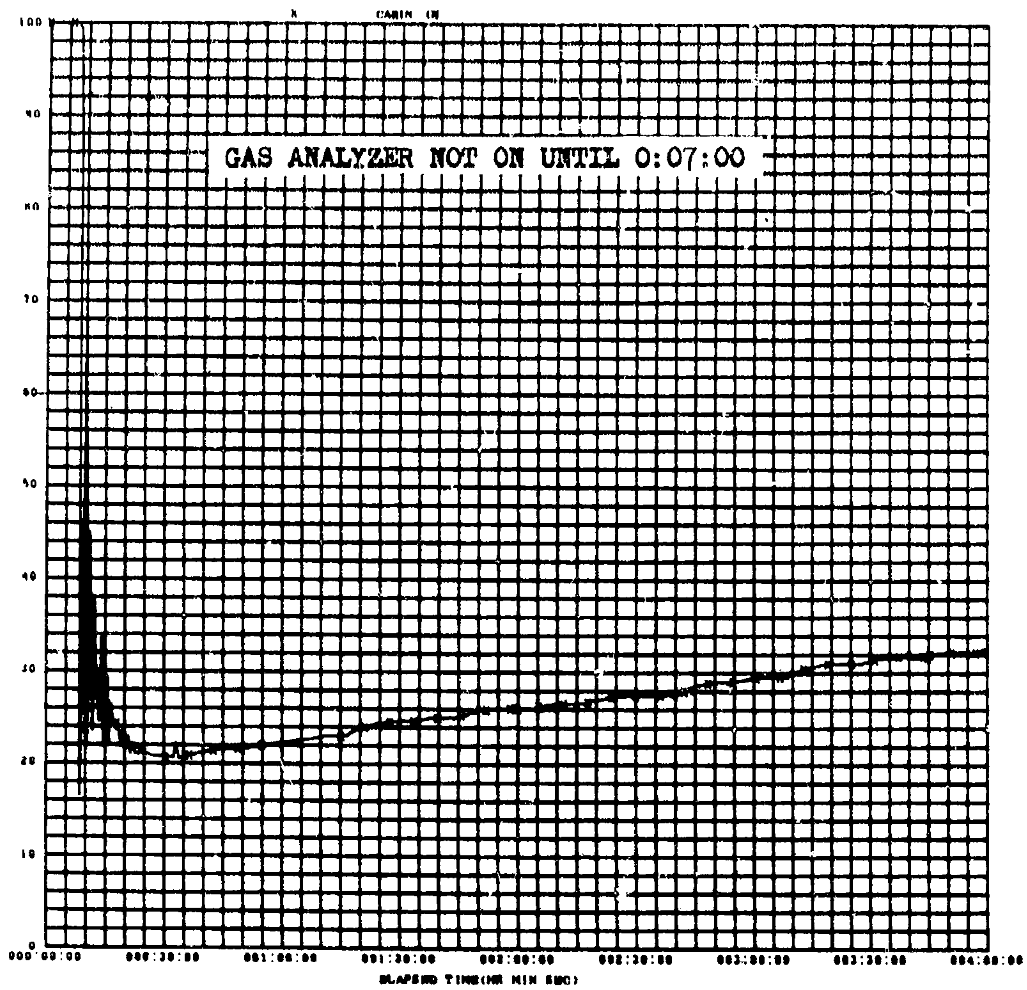


FIGURE 27 CABIN PERCENTAGE O2 VERSUS TIME

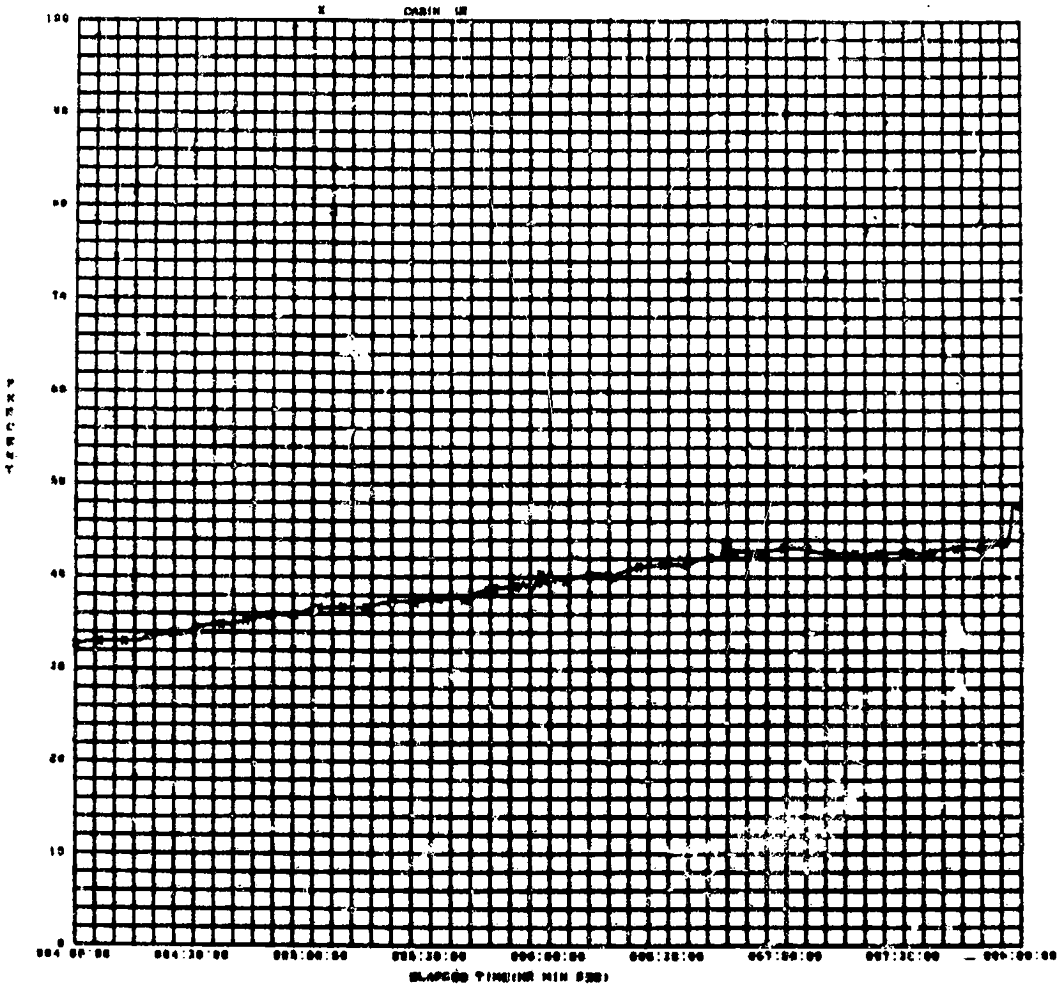


FIGURE 27A CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

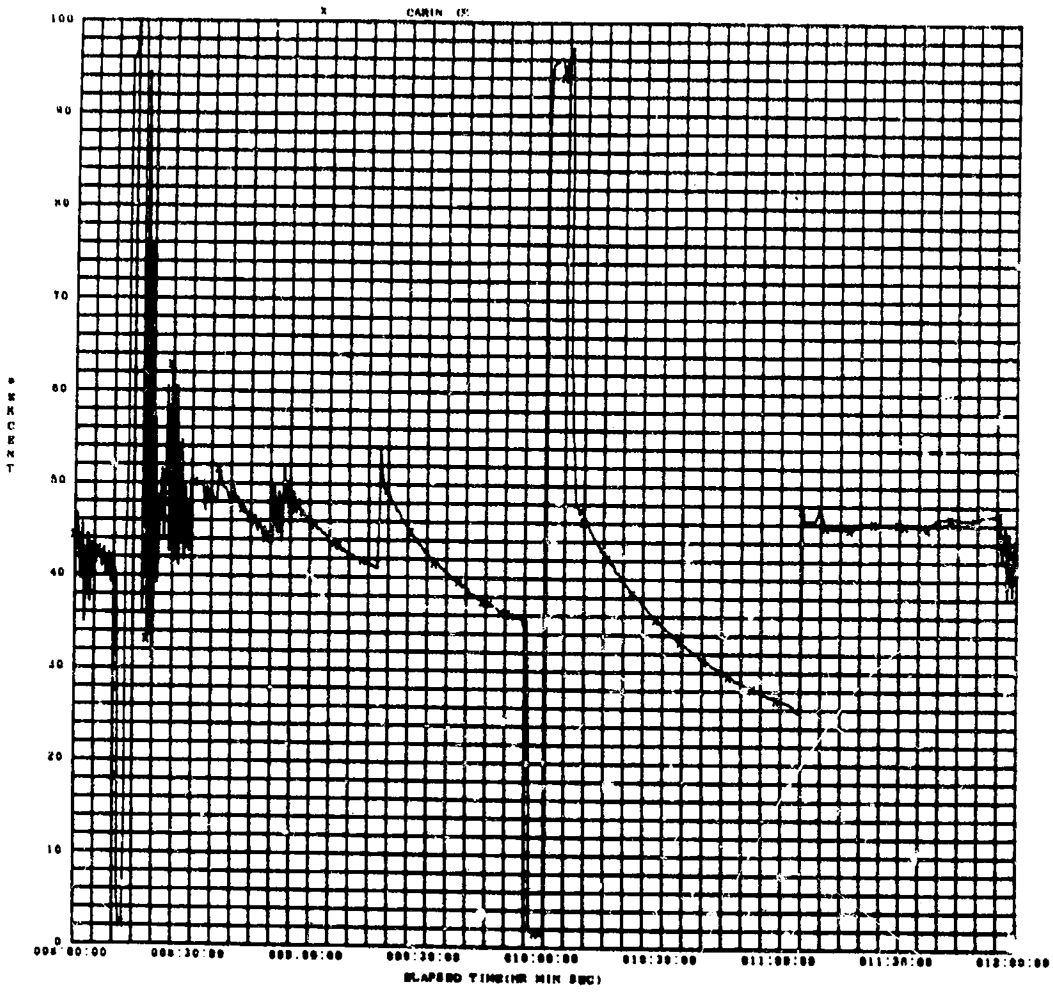


FIGURE 27B CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

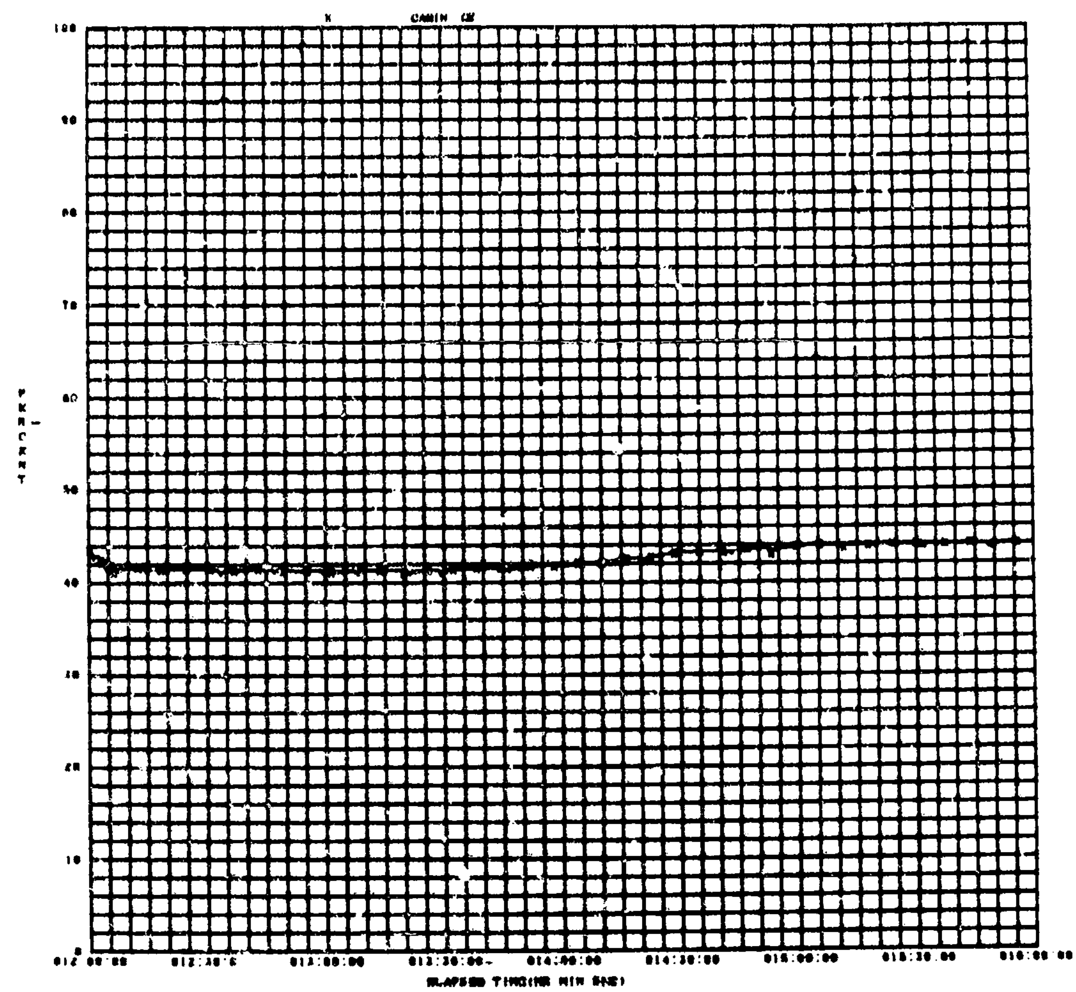


FIGURE 27C CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

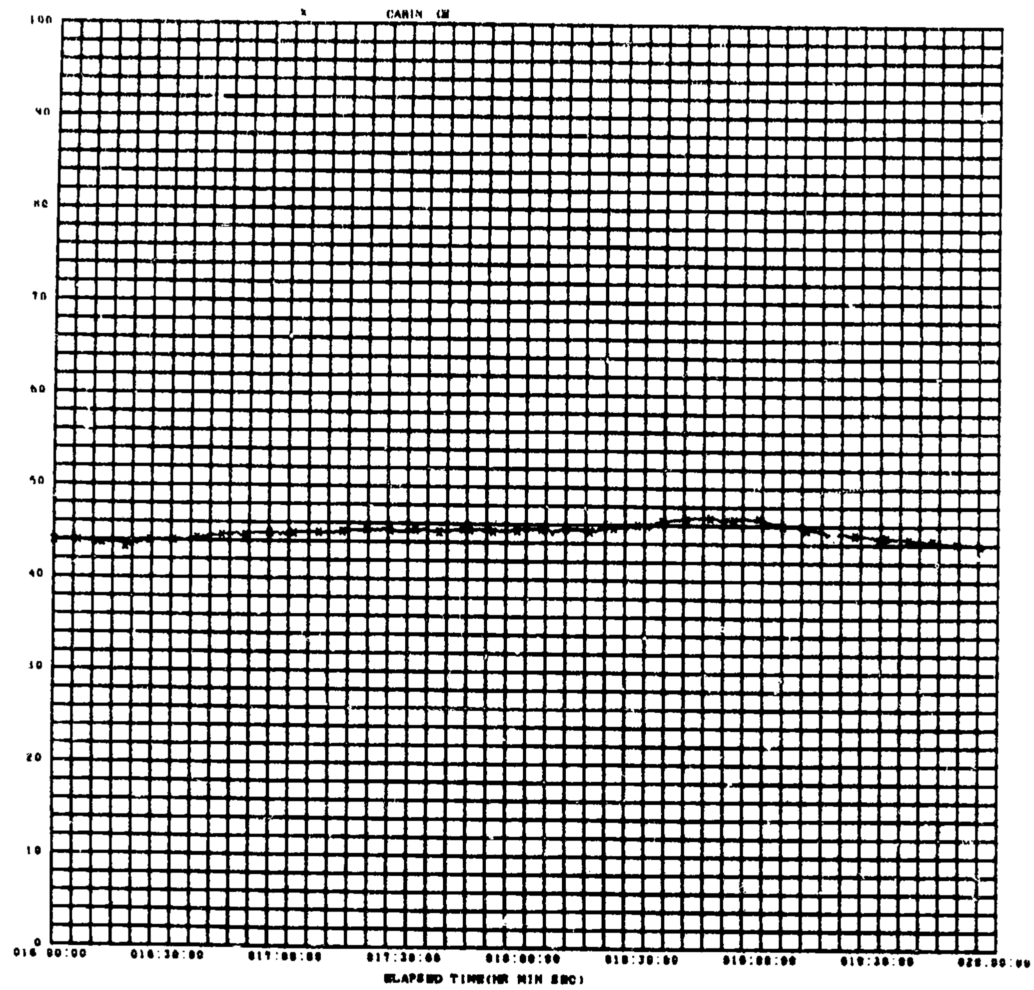


FIGURE 27D CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

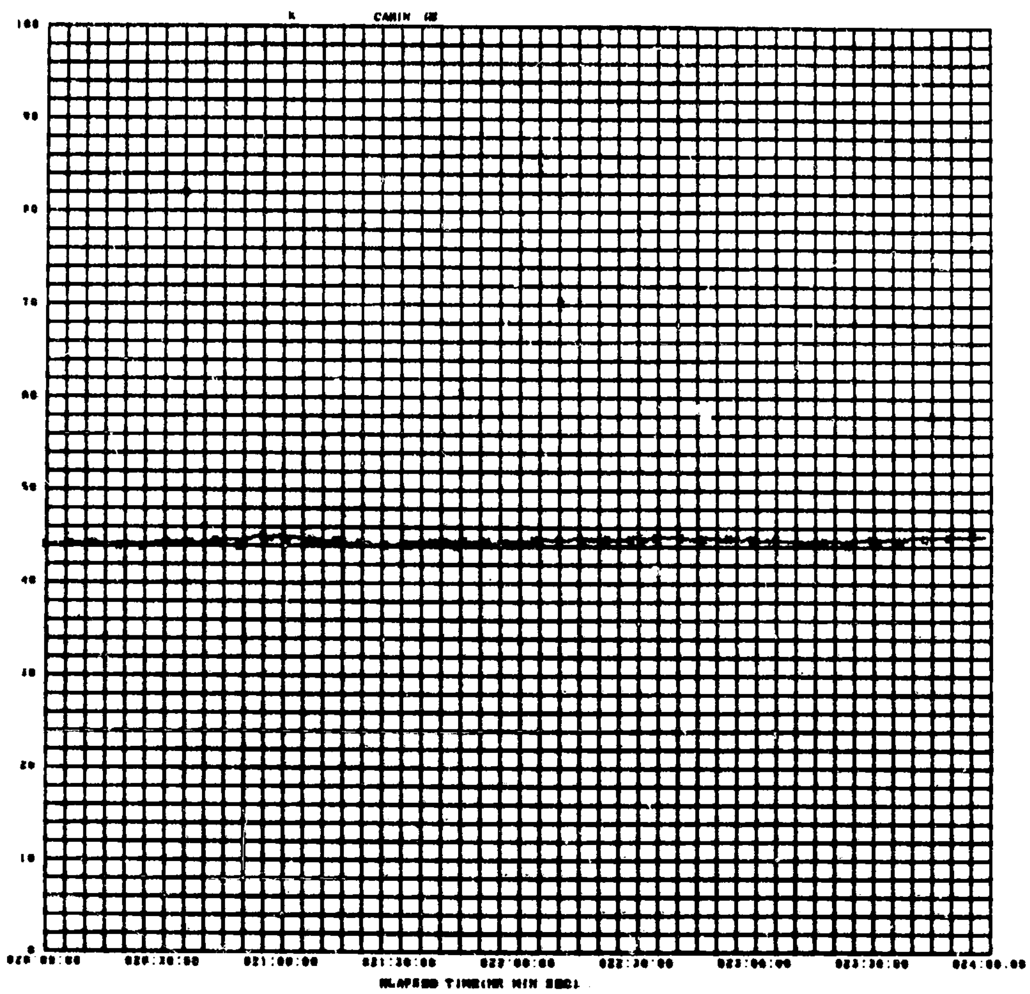


FIGURE 27E CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

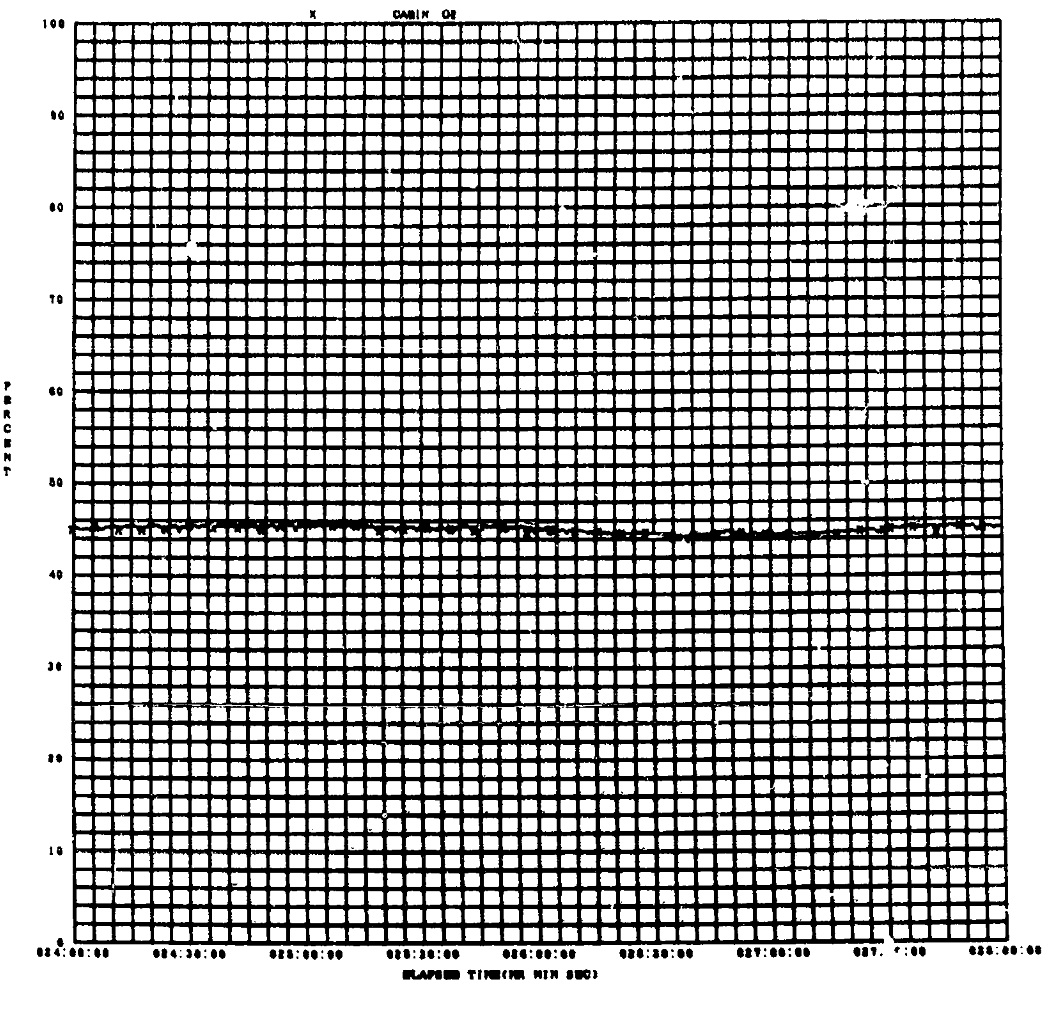


FIGURE 27F CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

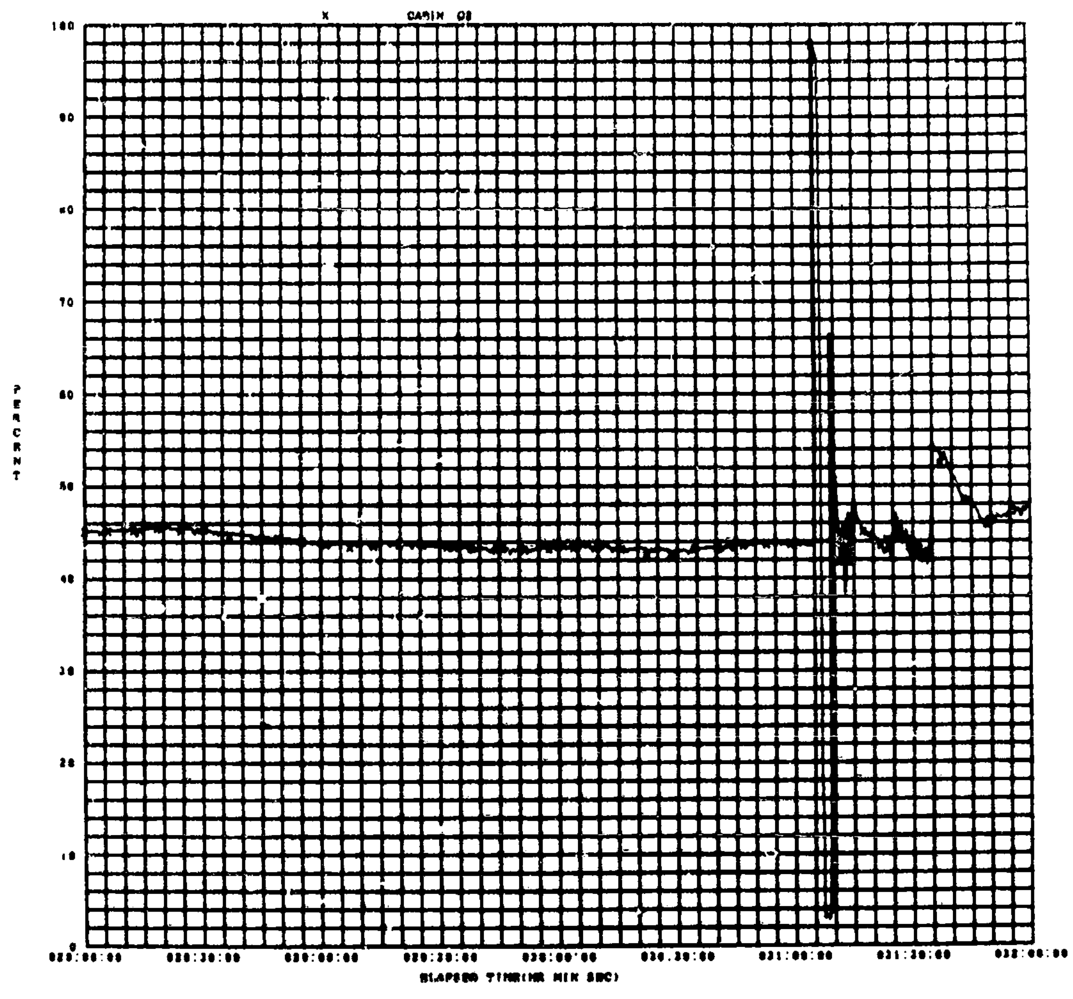


FIGURE 27G CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

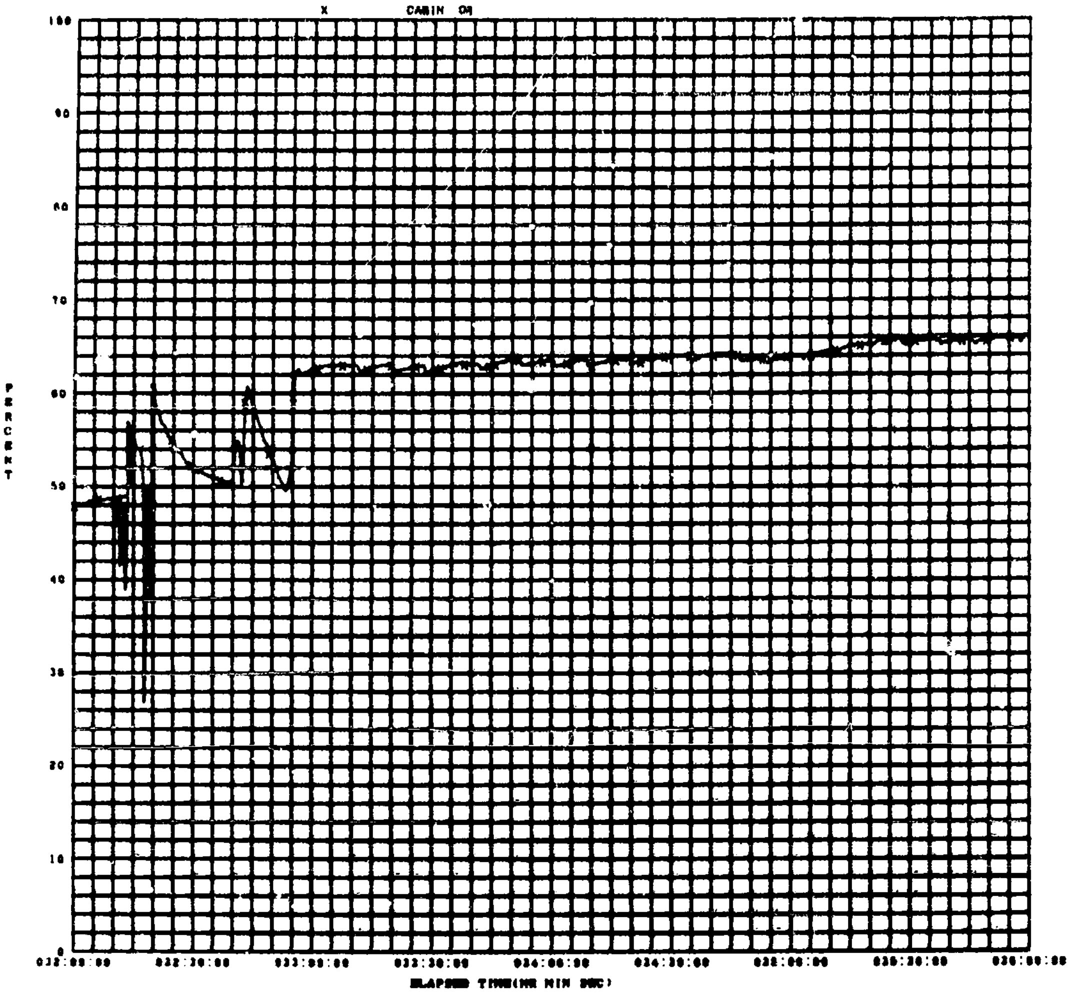


FIGURE 27H CABIN PERCENTAGE O2 VERSUS TIME - CONTINUED

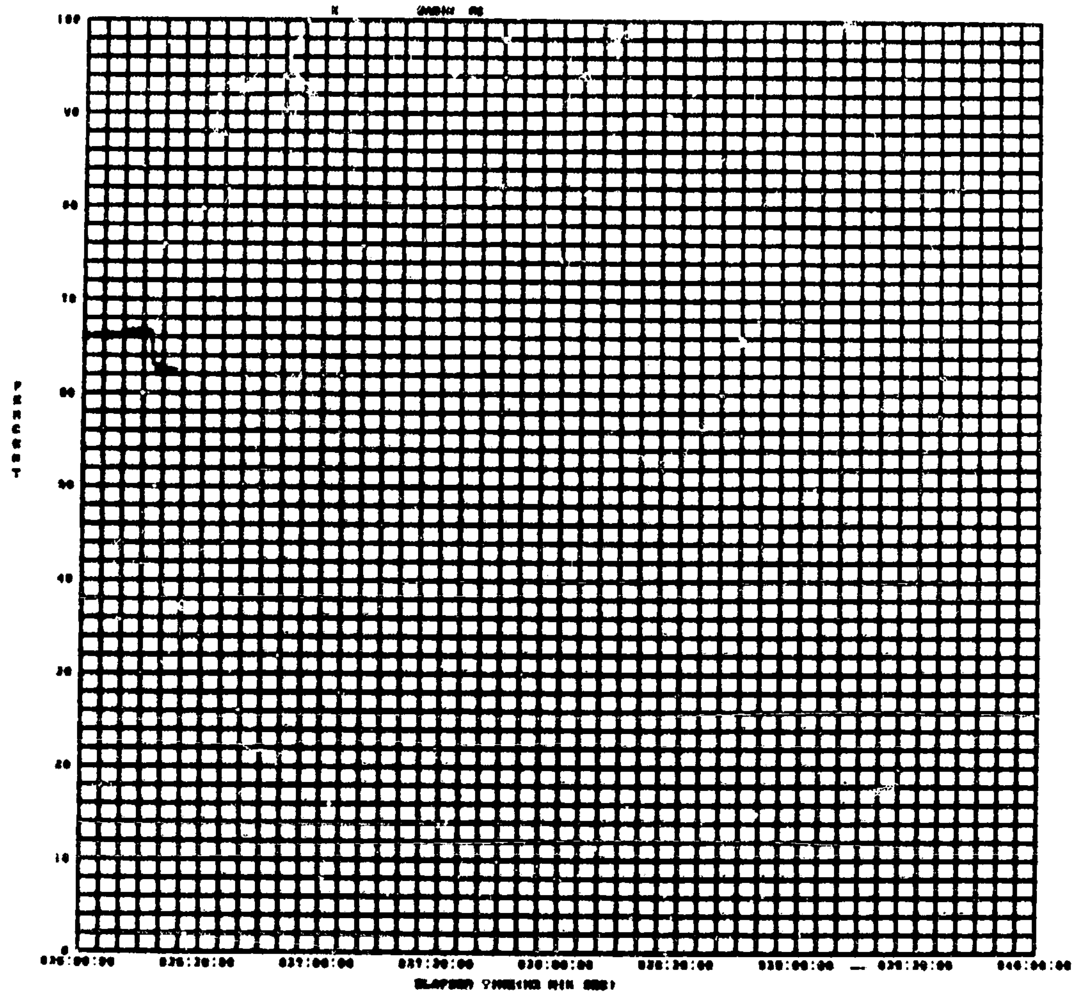


FIGURE 27J CABIN PERCENTAGE O2 VERSUS TIME - CONCLUDED

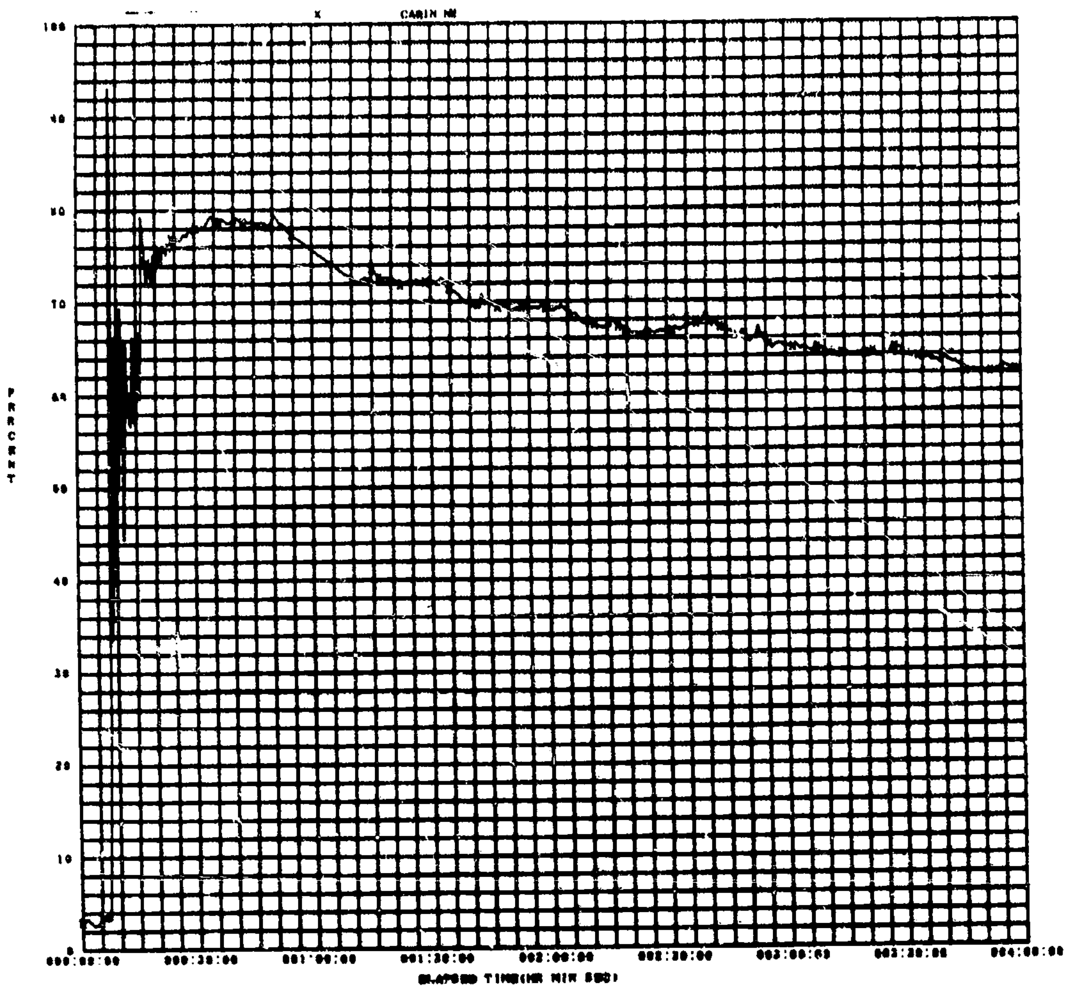


FIGURE 28 CABIN PERCENTAGE N2 VERSUS TIME

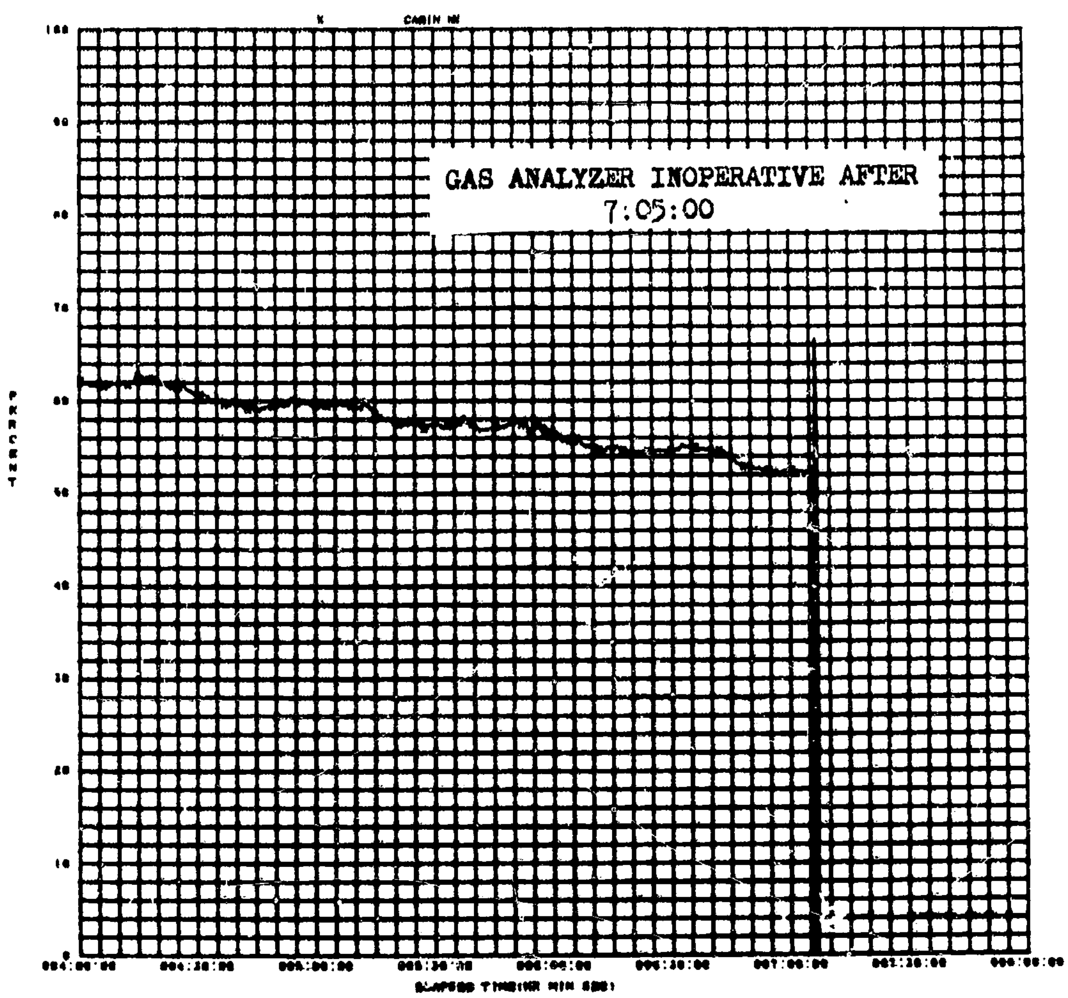


FIGURE 28A CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

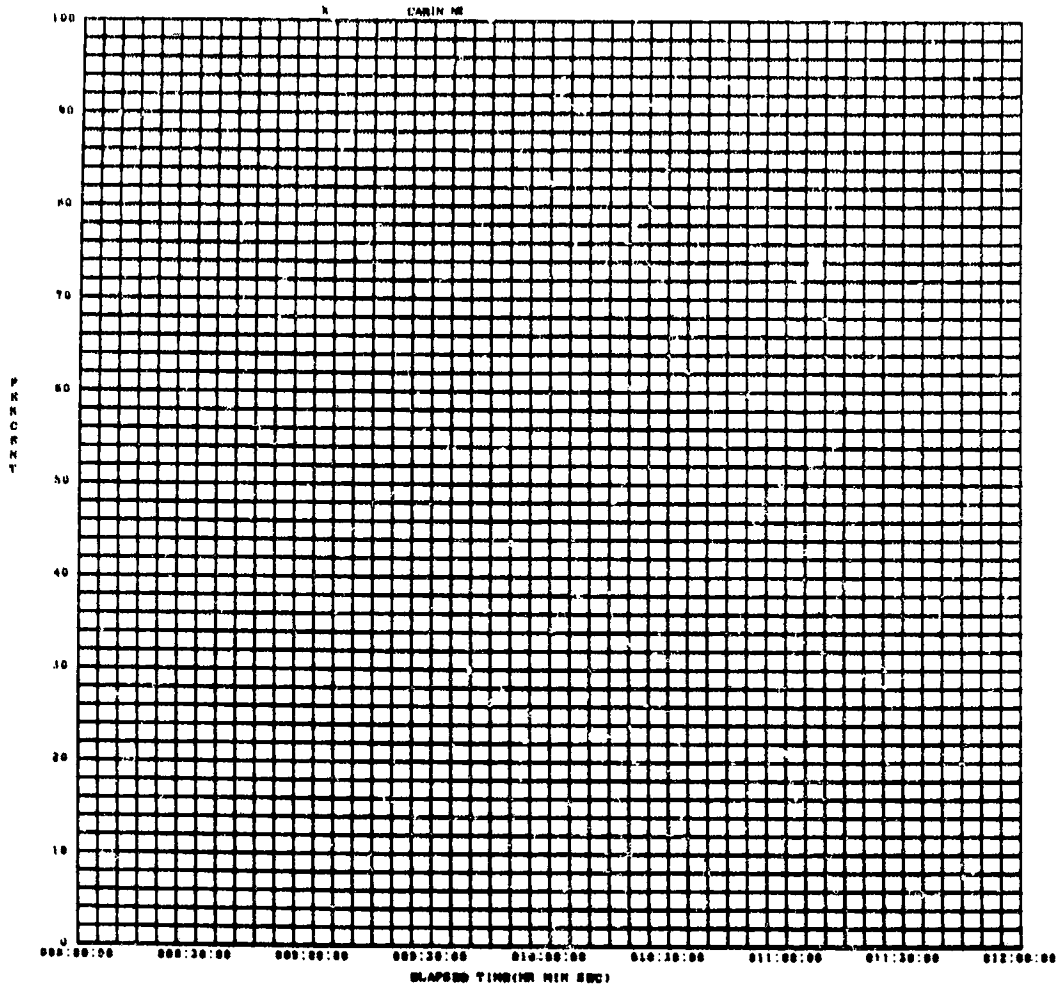


FIGURE 28B CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

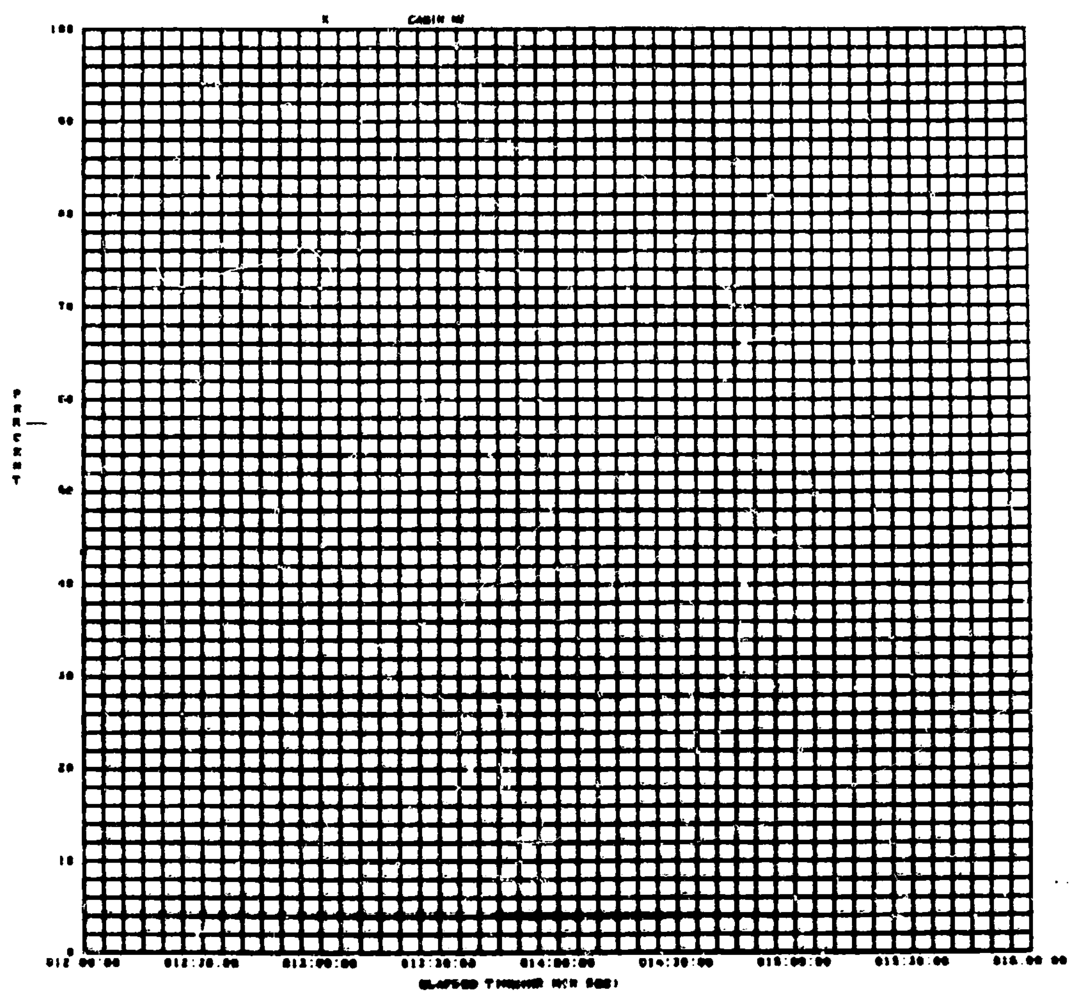


FIGURE 28C CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

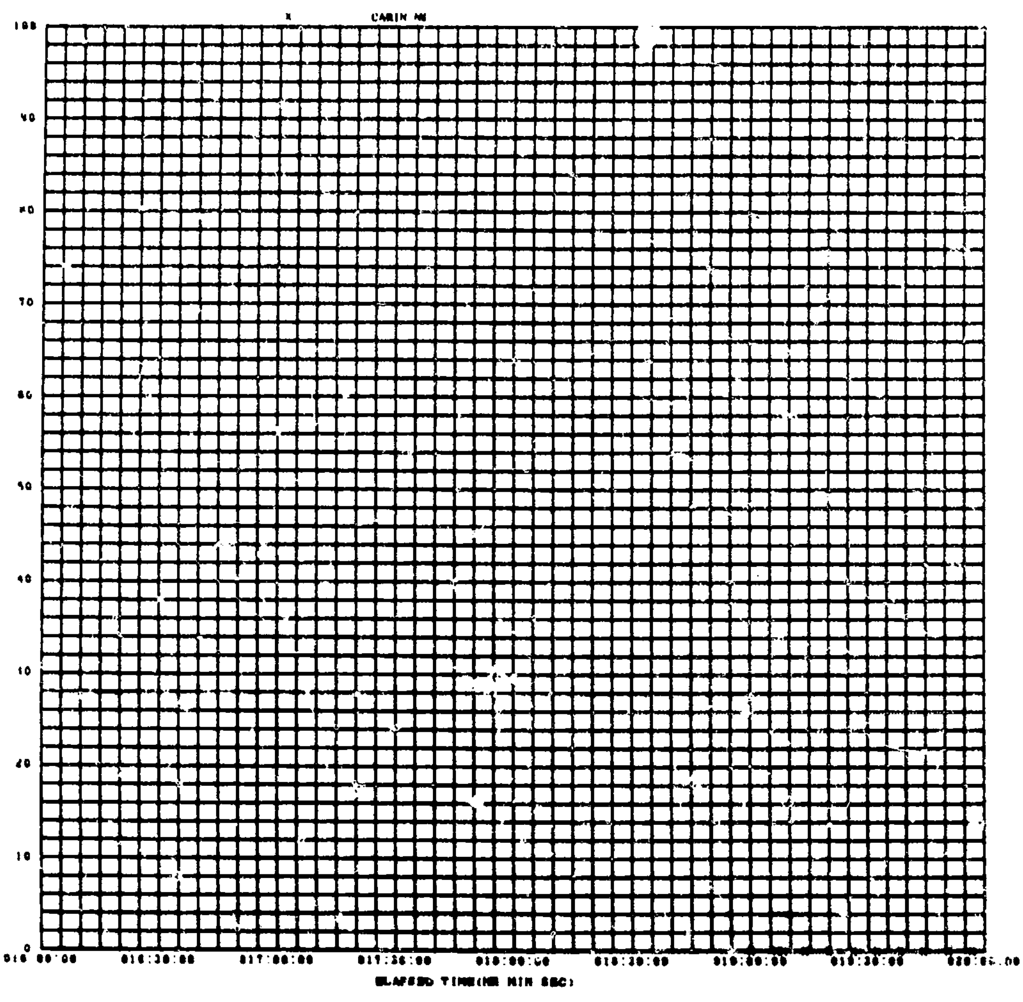


FIGURE 28D CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

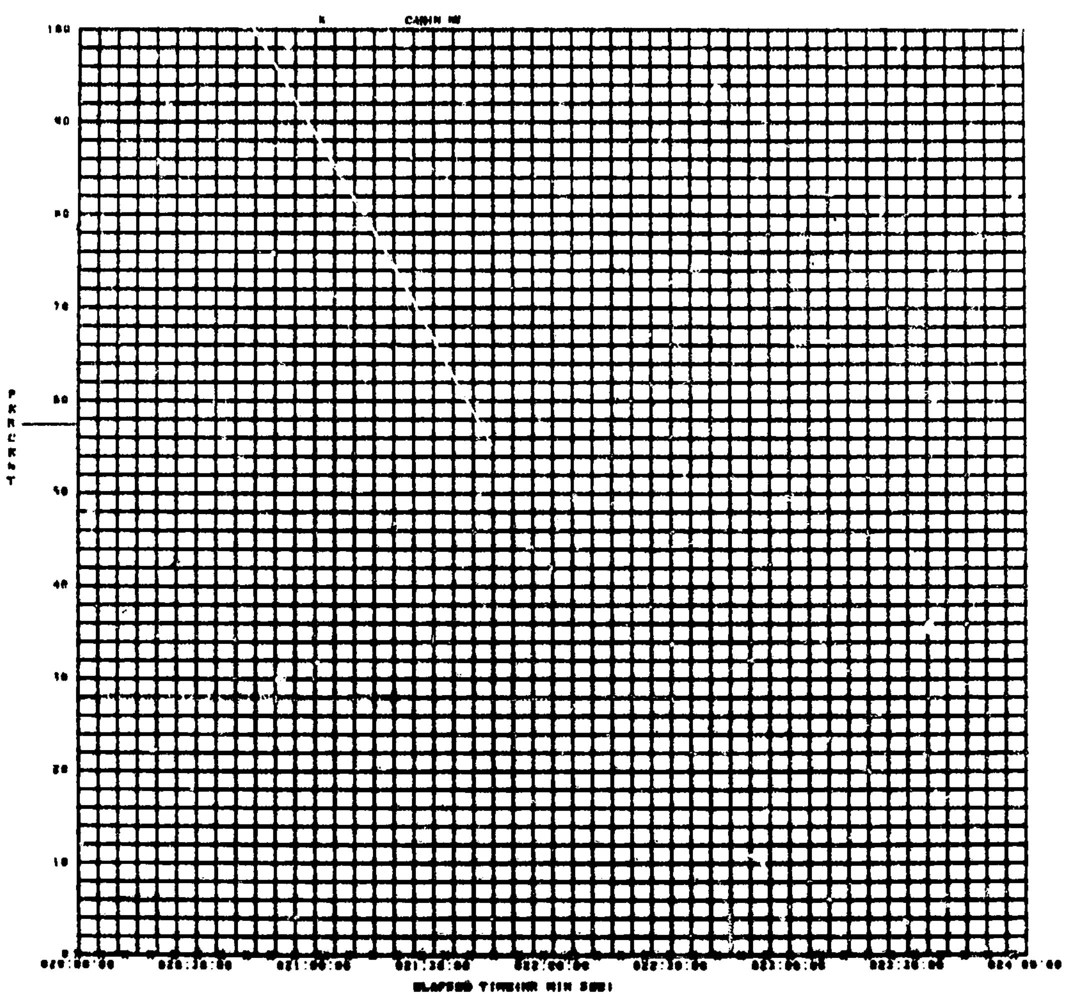


FIGURE 28E CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

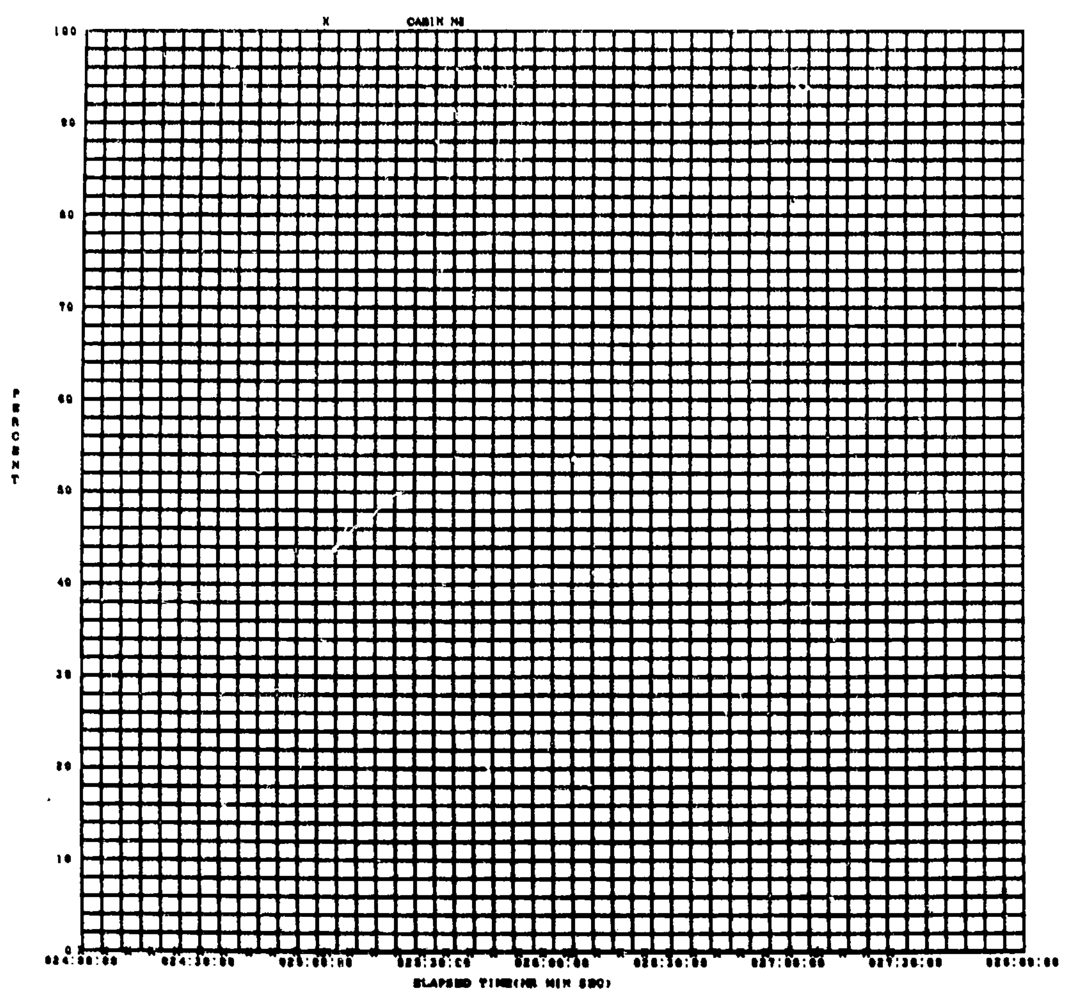


FIGURE 28F CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

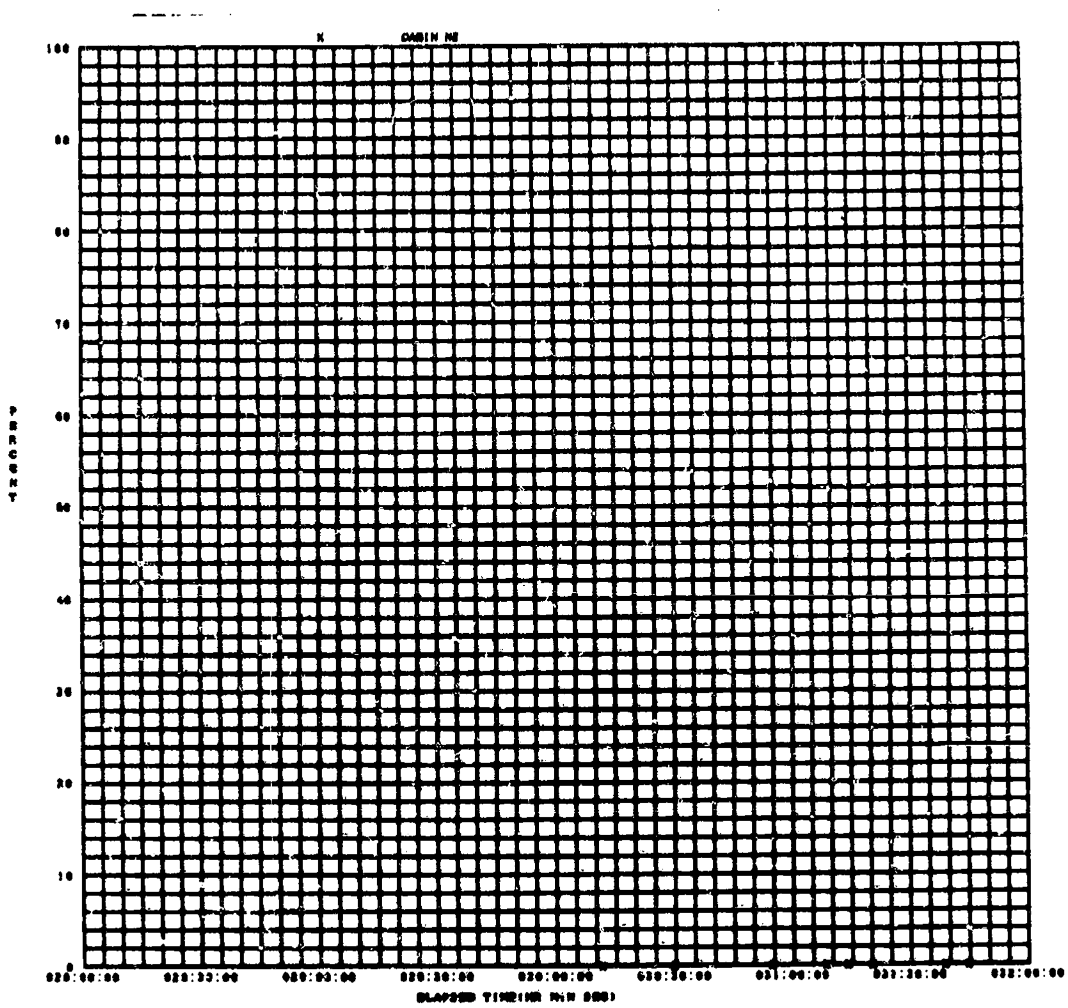


FIGURE 28G CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

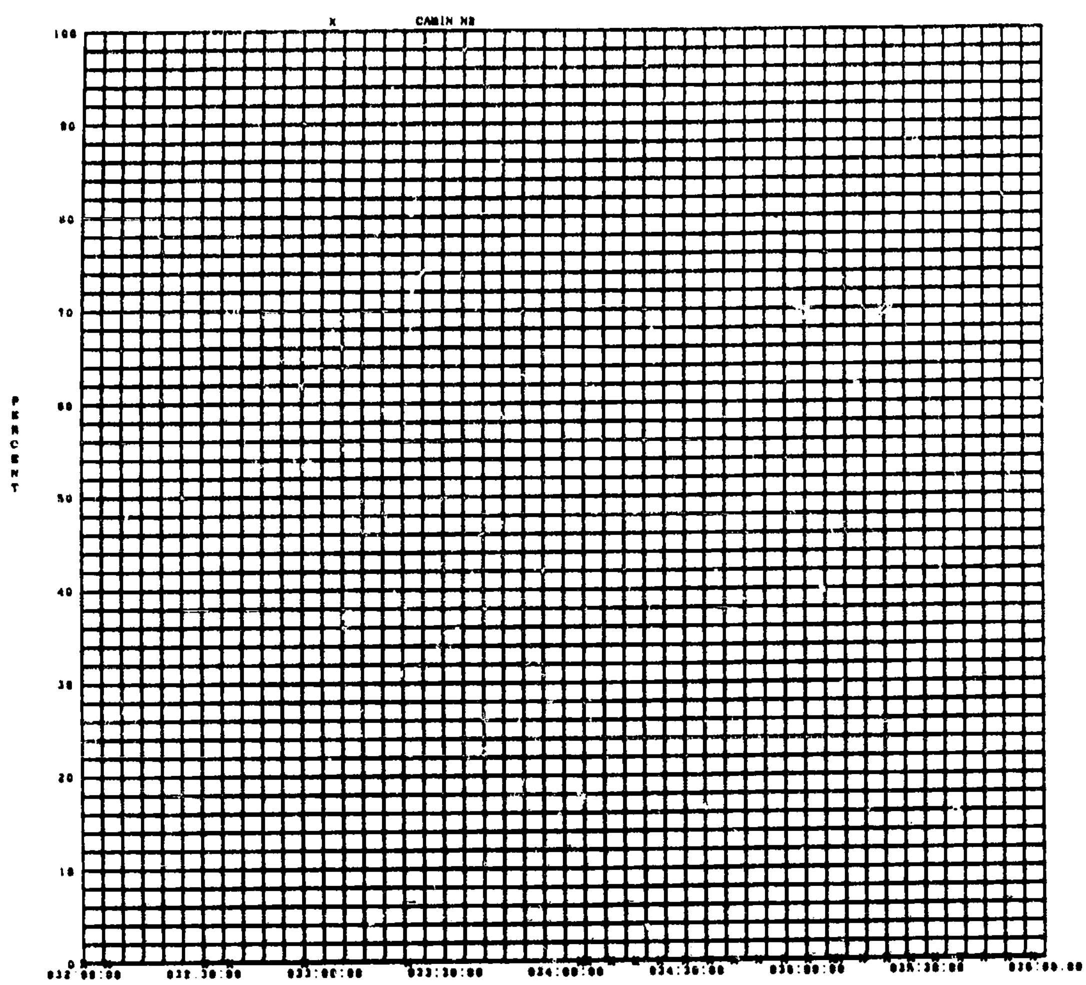


FIGURE 28H CABIN PERCENTAGE N2 VERSUS TIME - CONTINUED

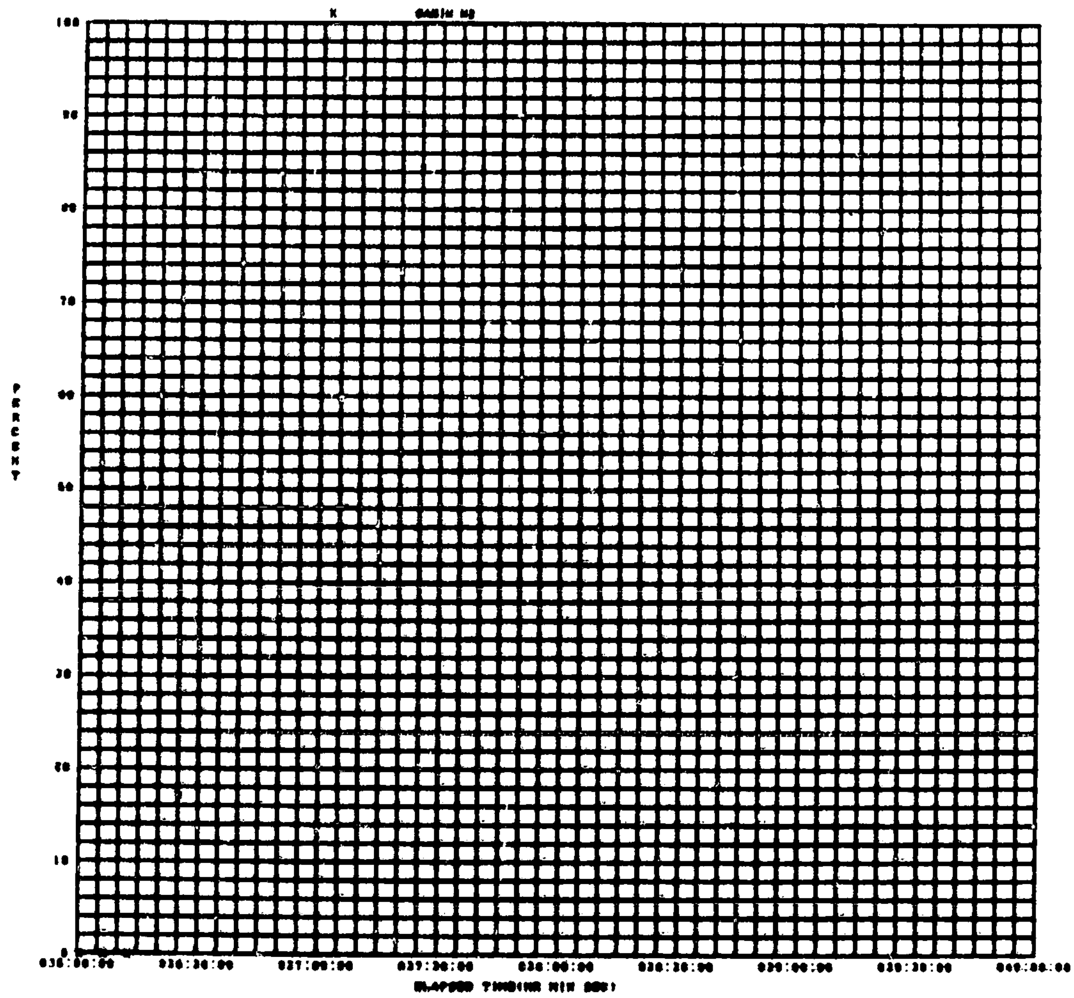


FIGURE 28J CABIN PERCENTAGE N2 VERSUS TIME - CONCLUDED

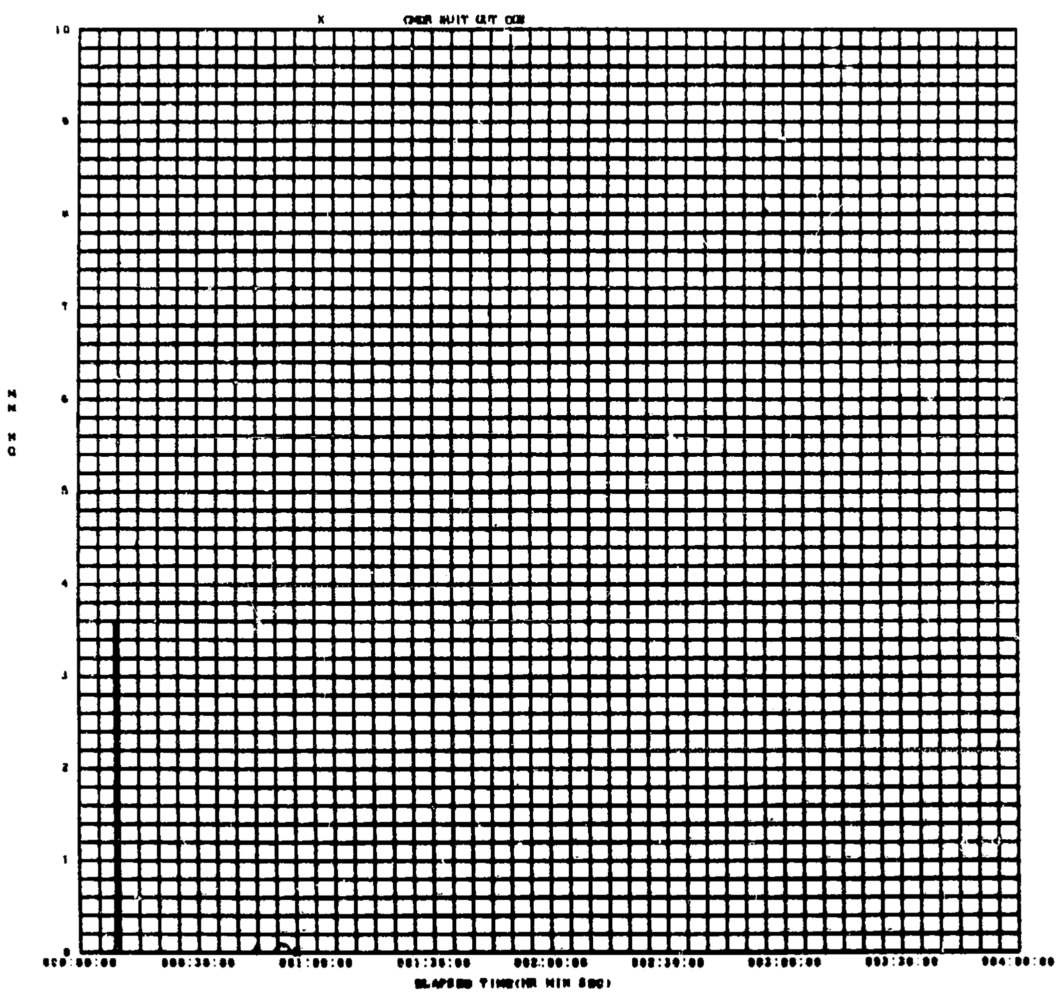


FIGURE 29 CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME

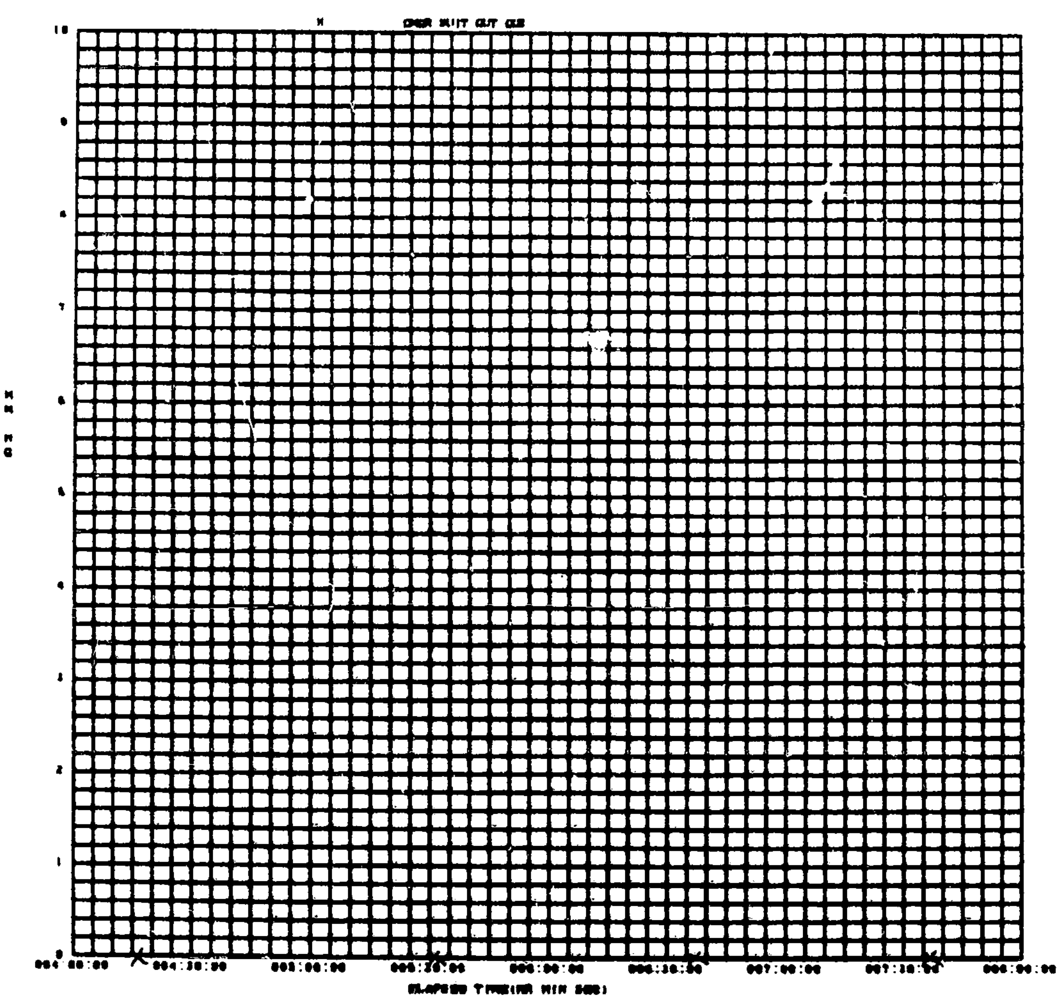


FIGURE 29A CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

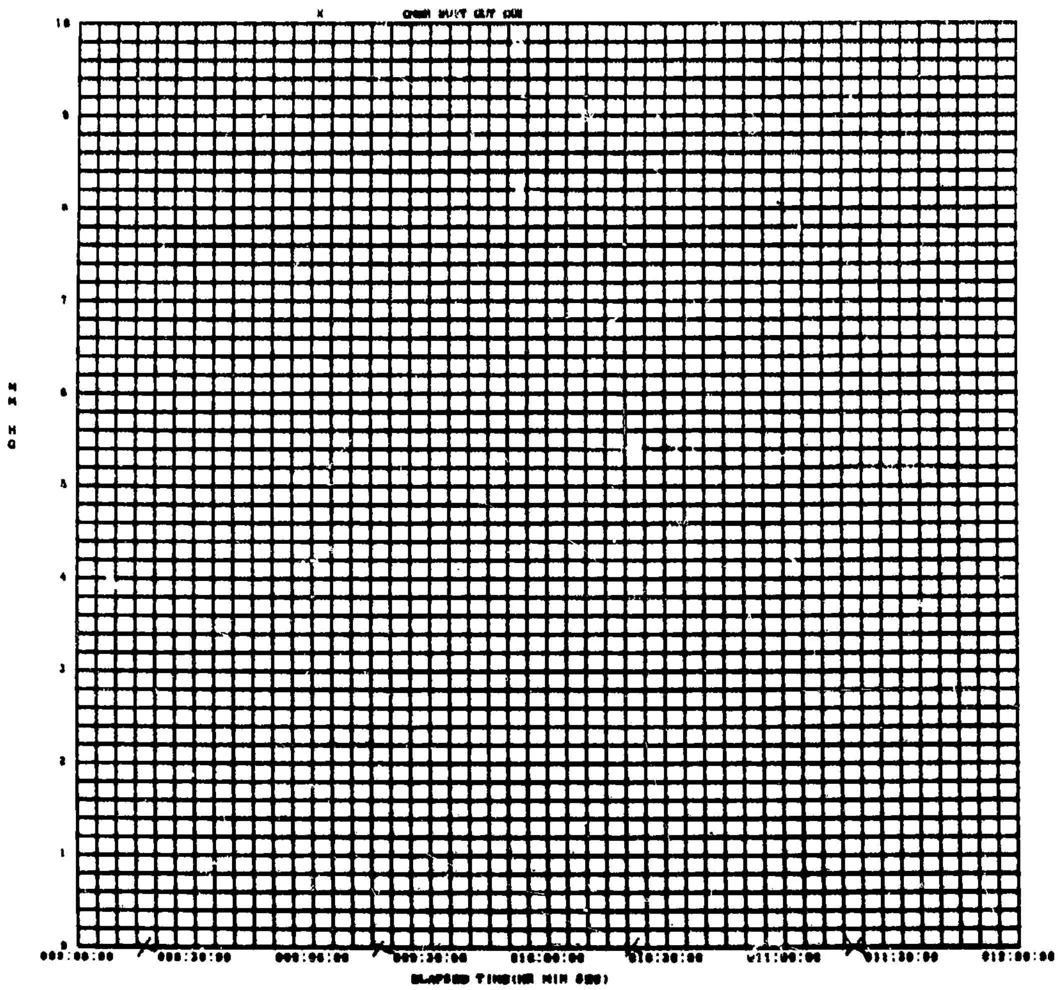


FIGURE 29B CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

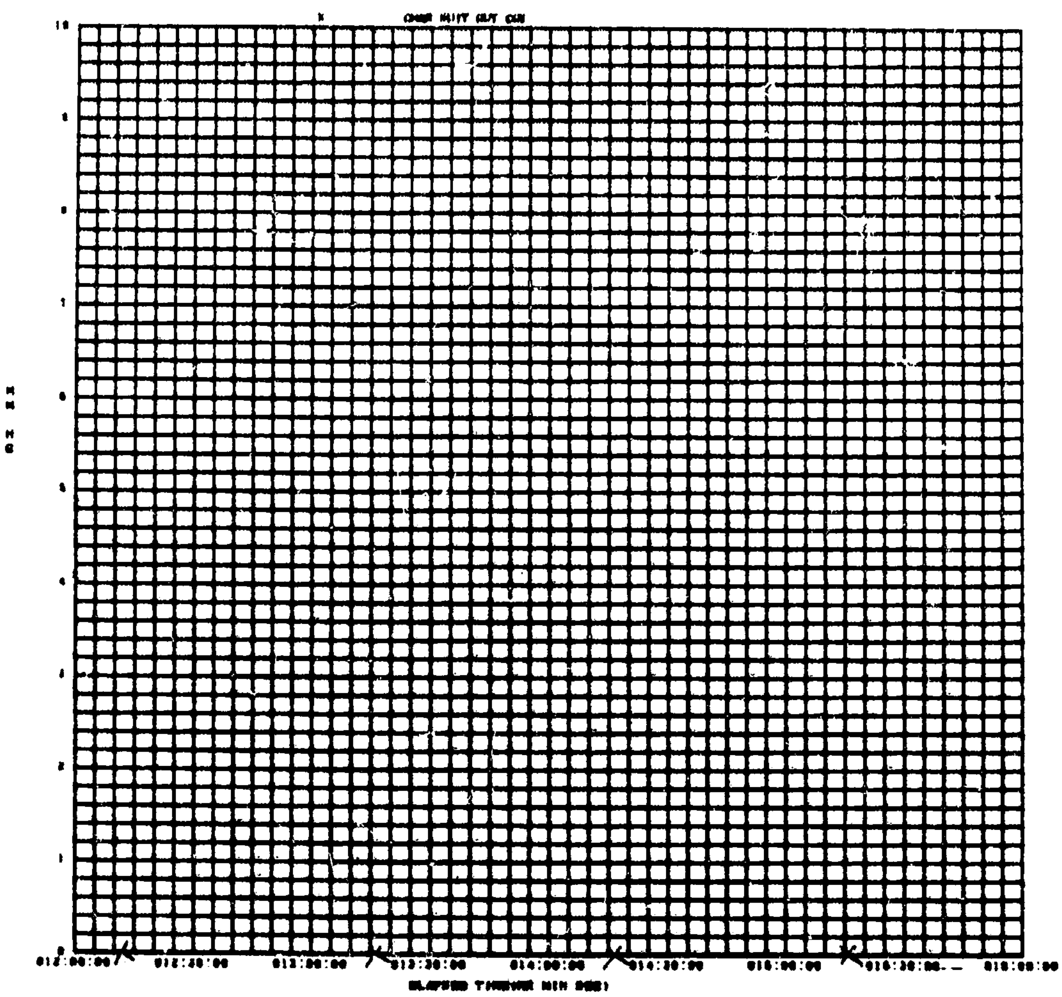


FIGURE 29C CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

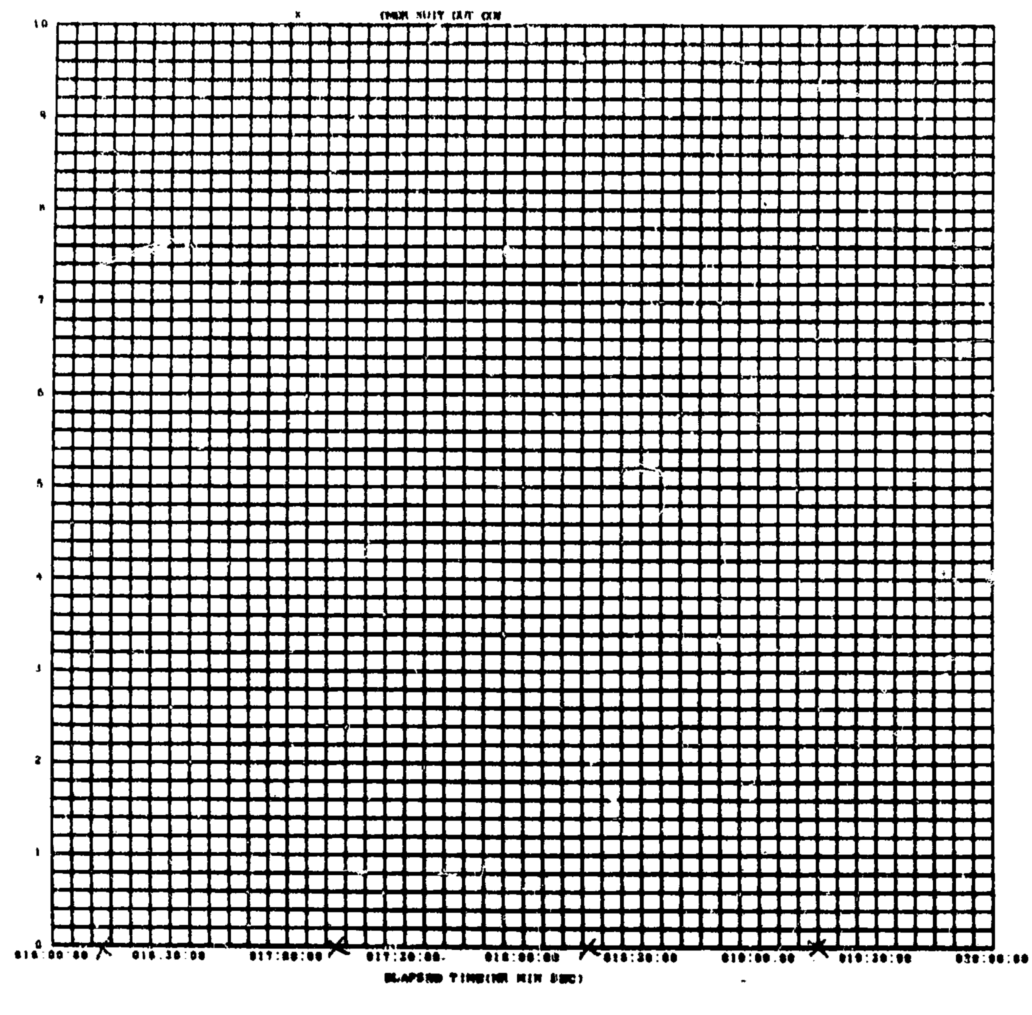


FIGURE 29D CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

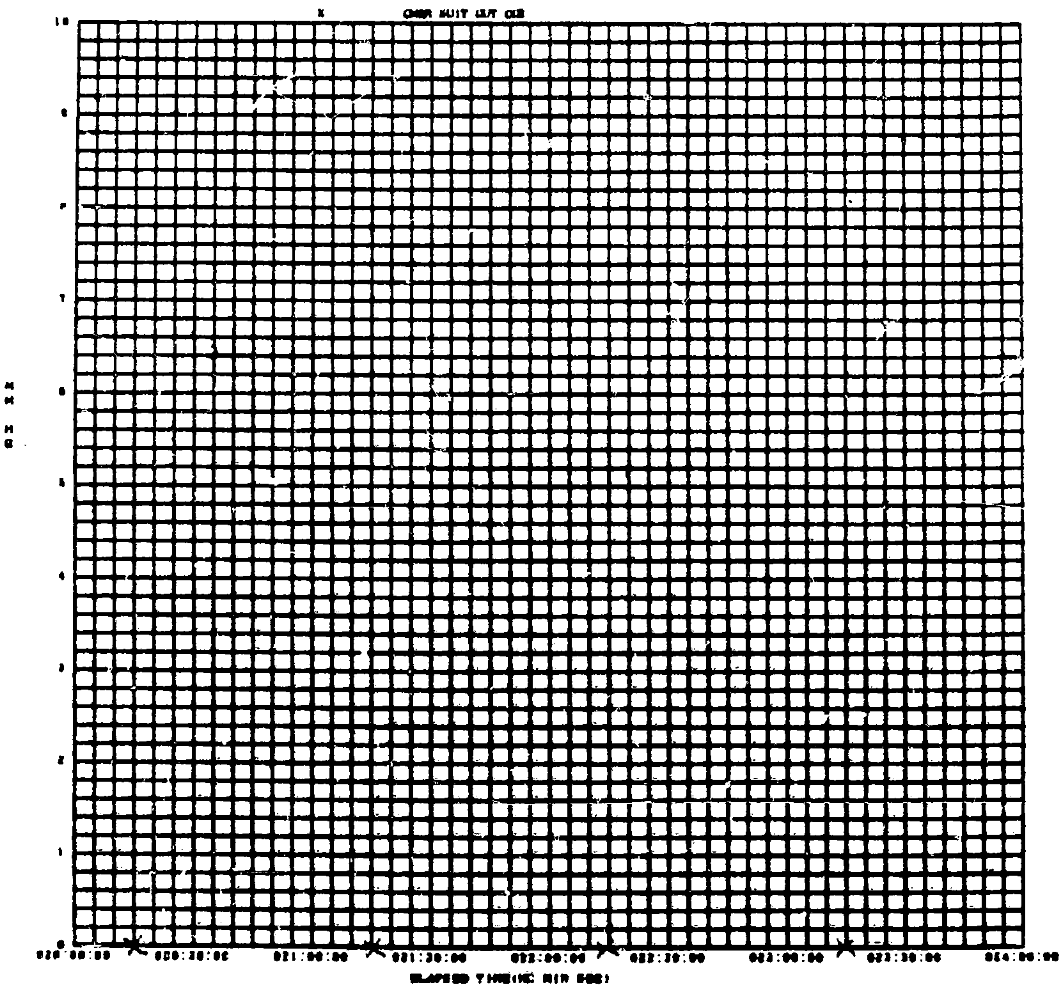


FIGURE 29E CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

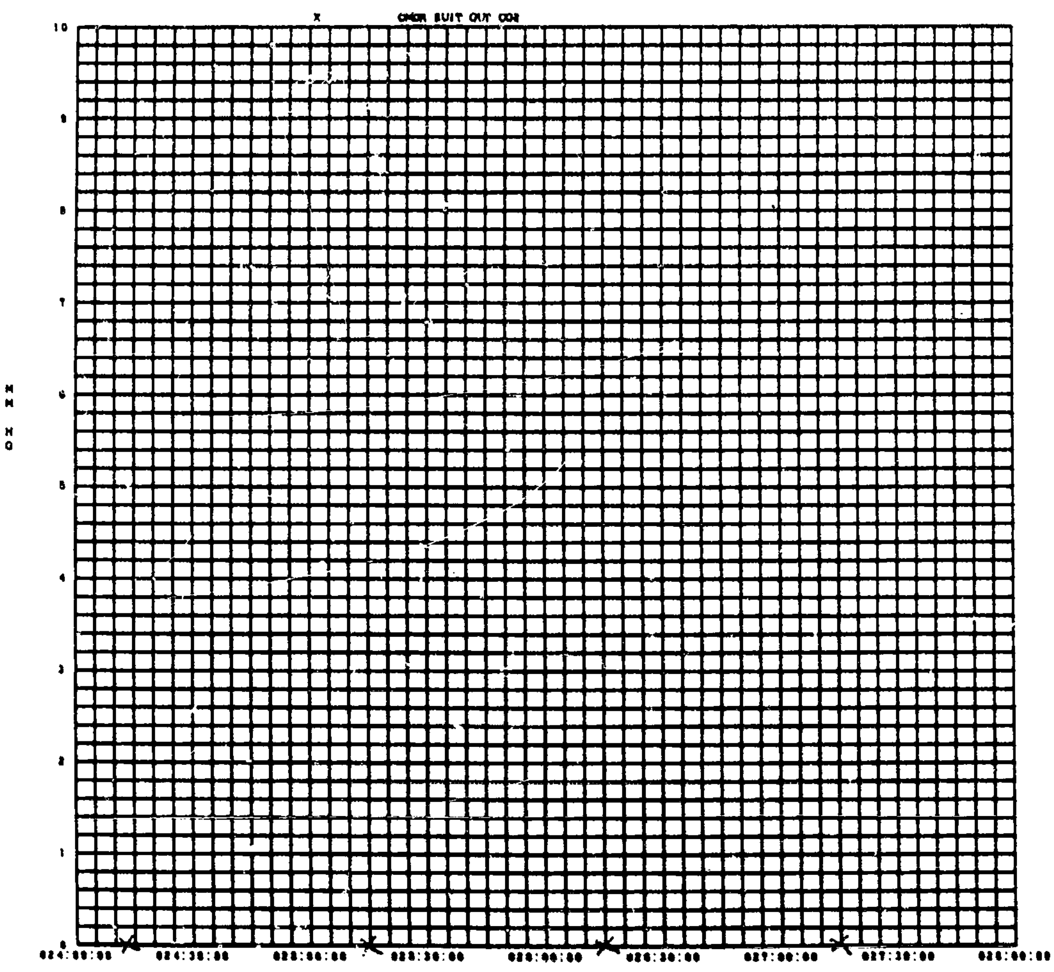


FIGURE 29F CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

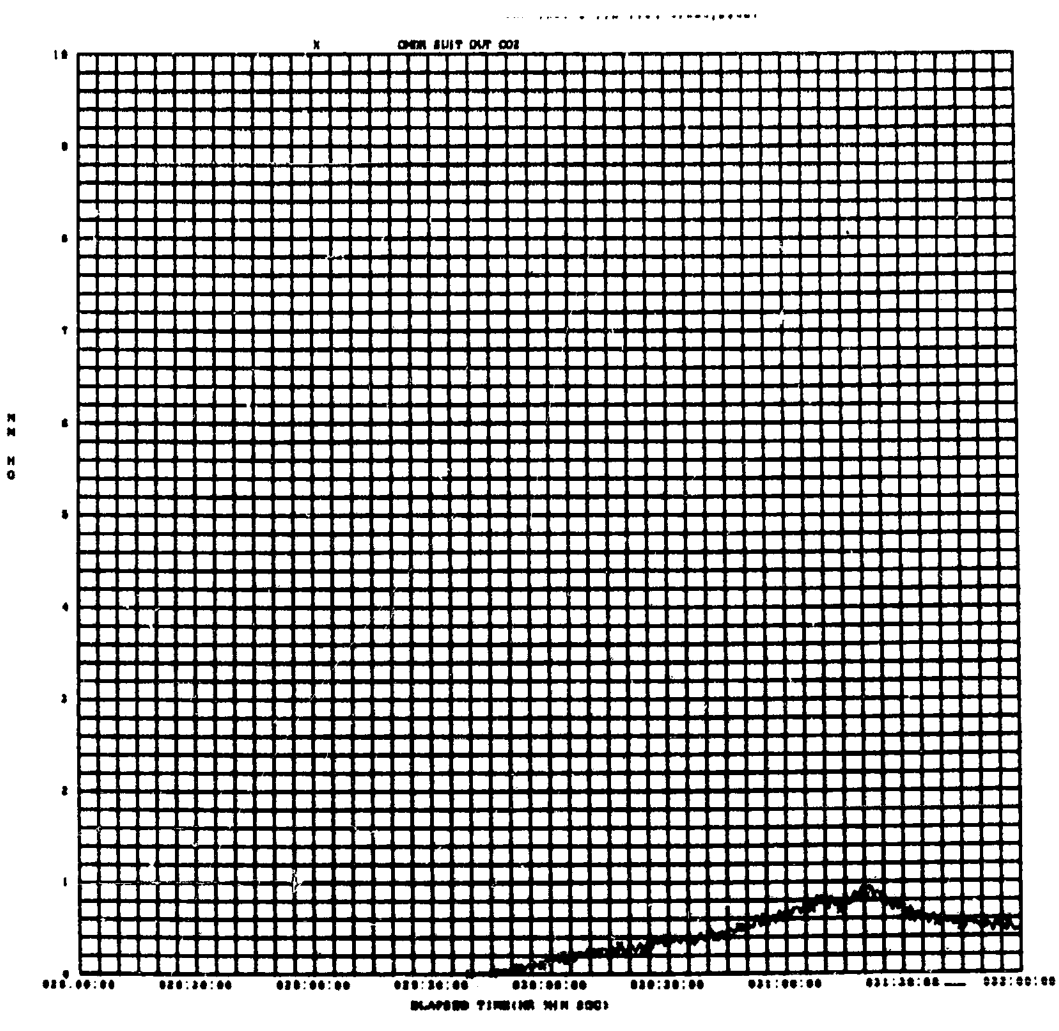


FIGURE 29G CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

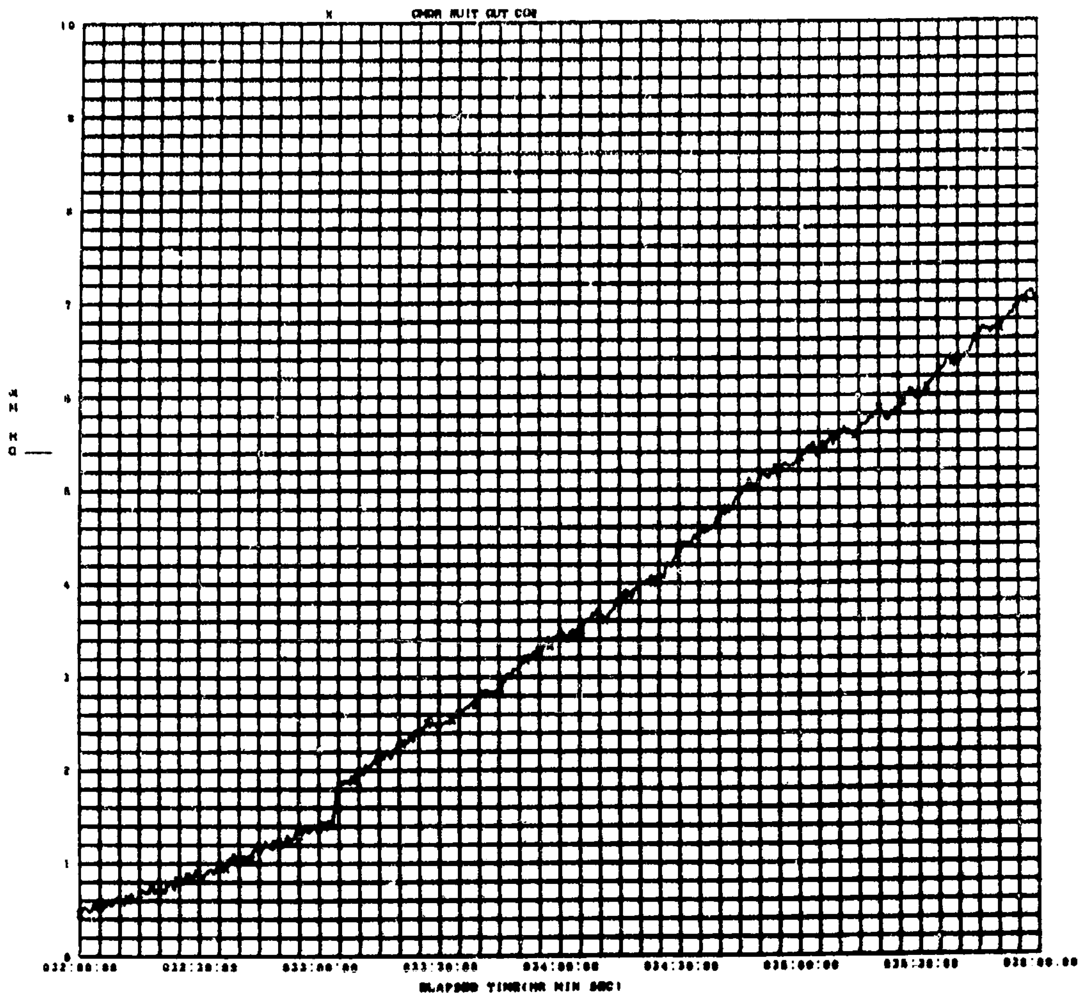


FIGURE 29H CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

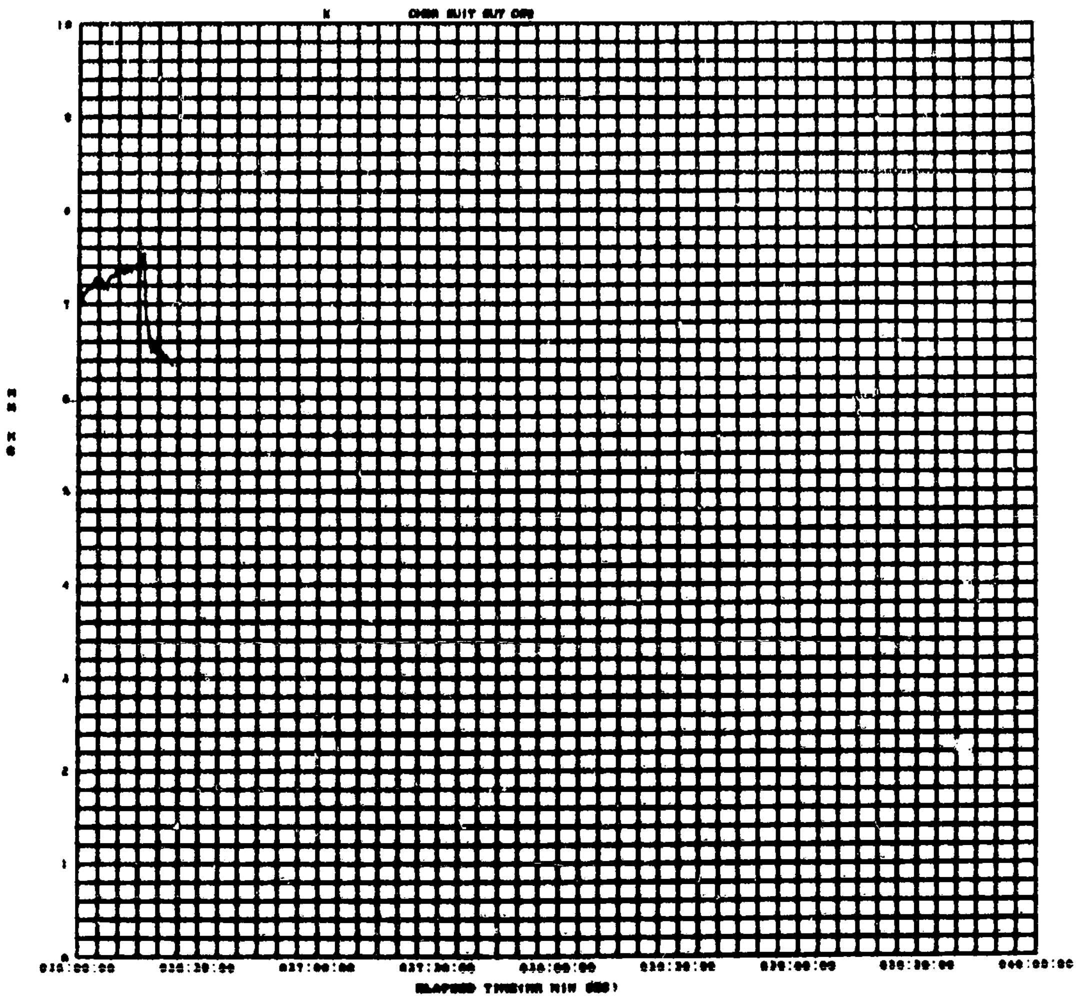


FIGURE 29J CDR SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONCLUDED

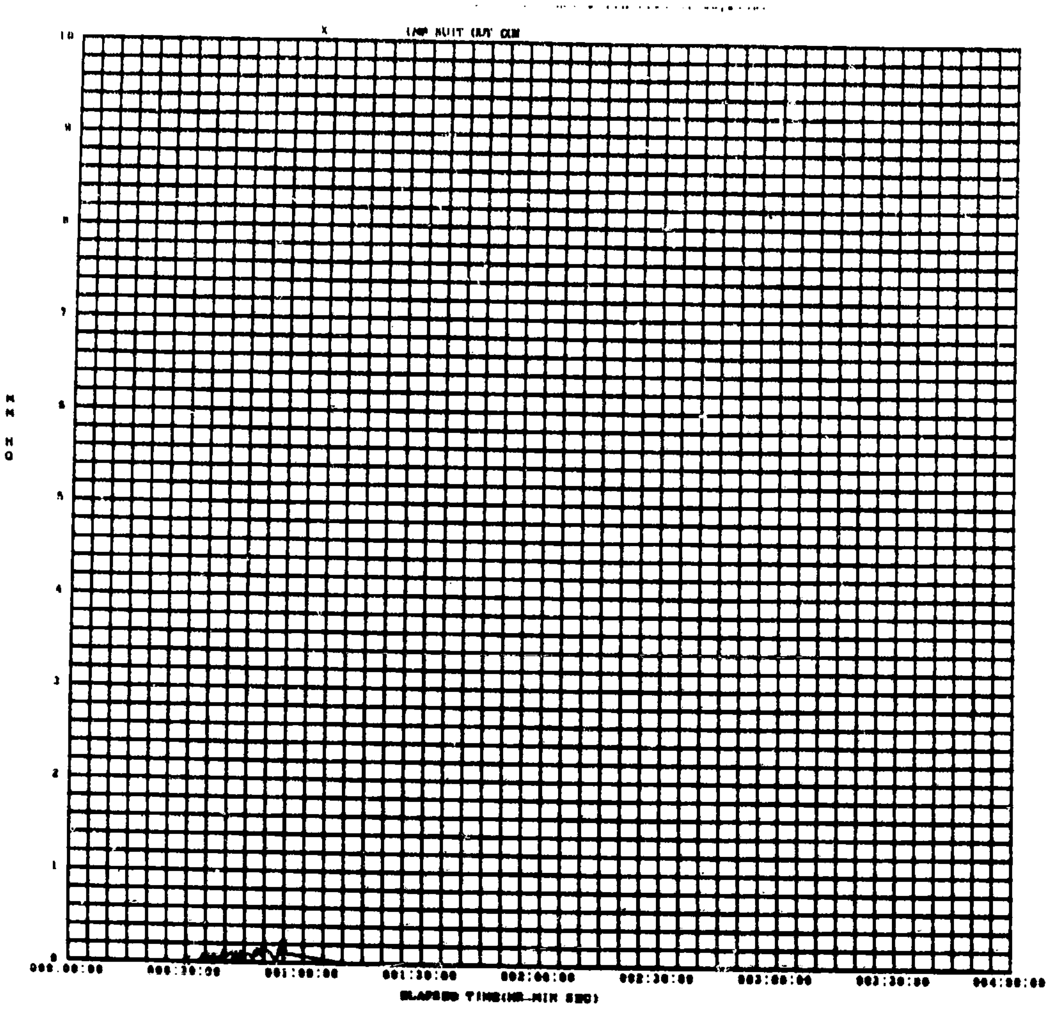


FIGURE 30 LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME

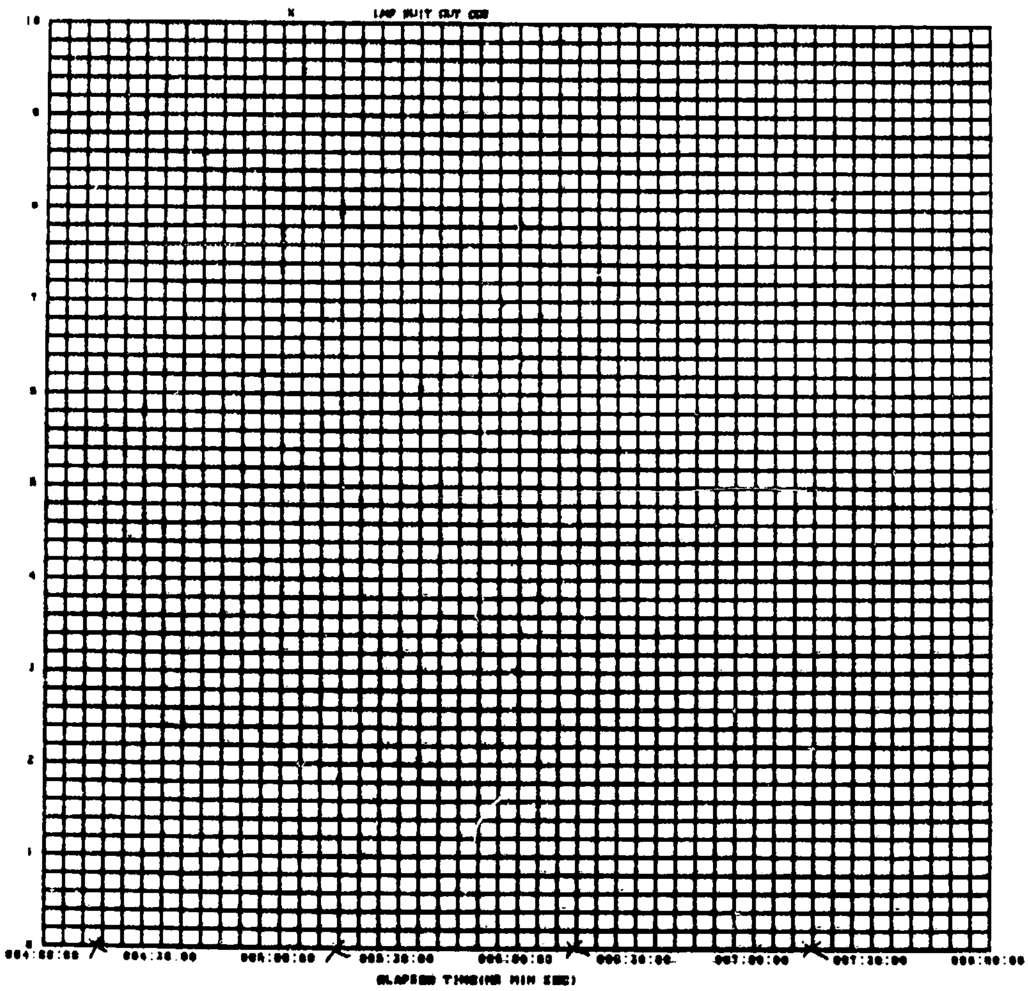


FIGURE 30A LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

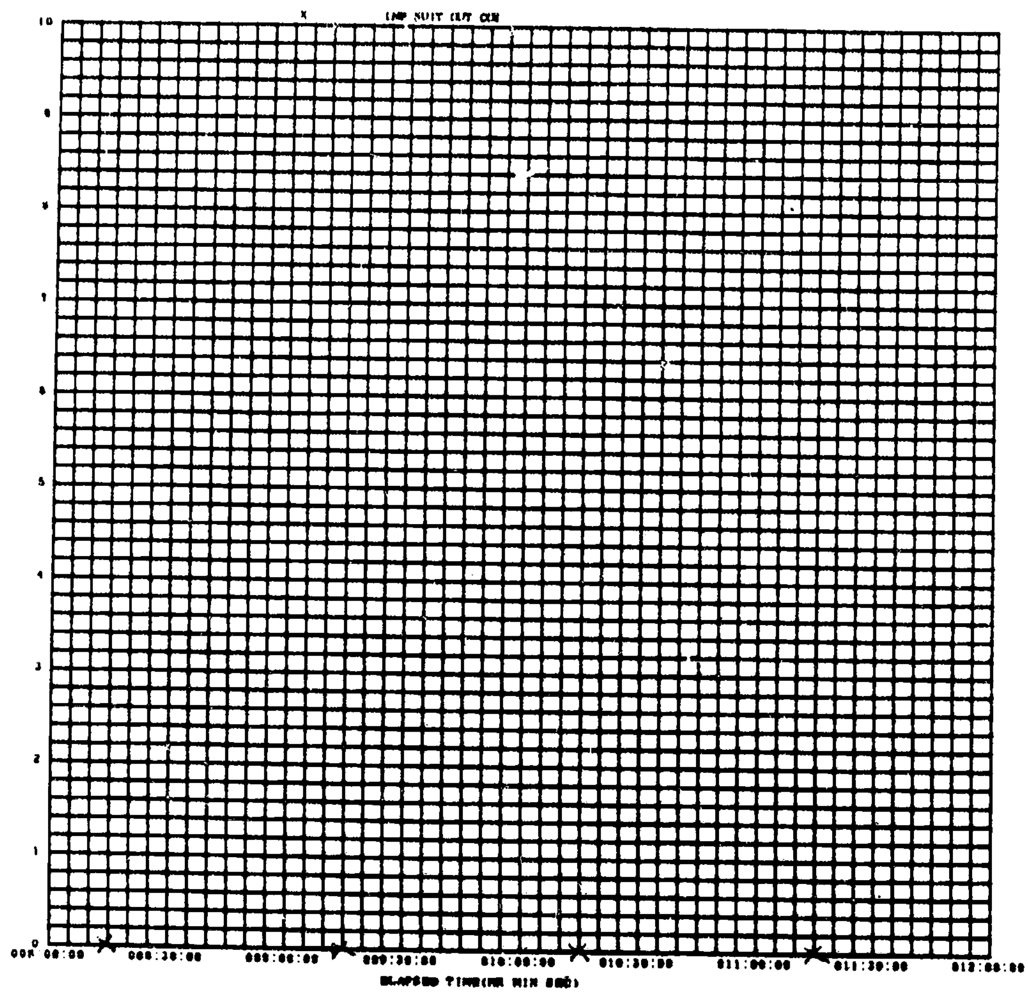


FIGURE 30B LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

PRECEDING PAGE BLANK NOT FILMED

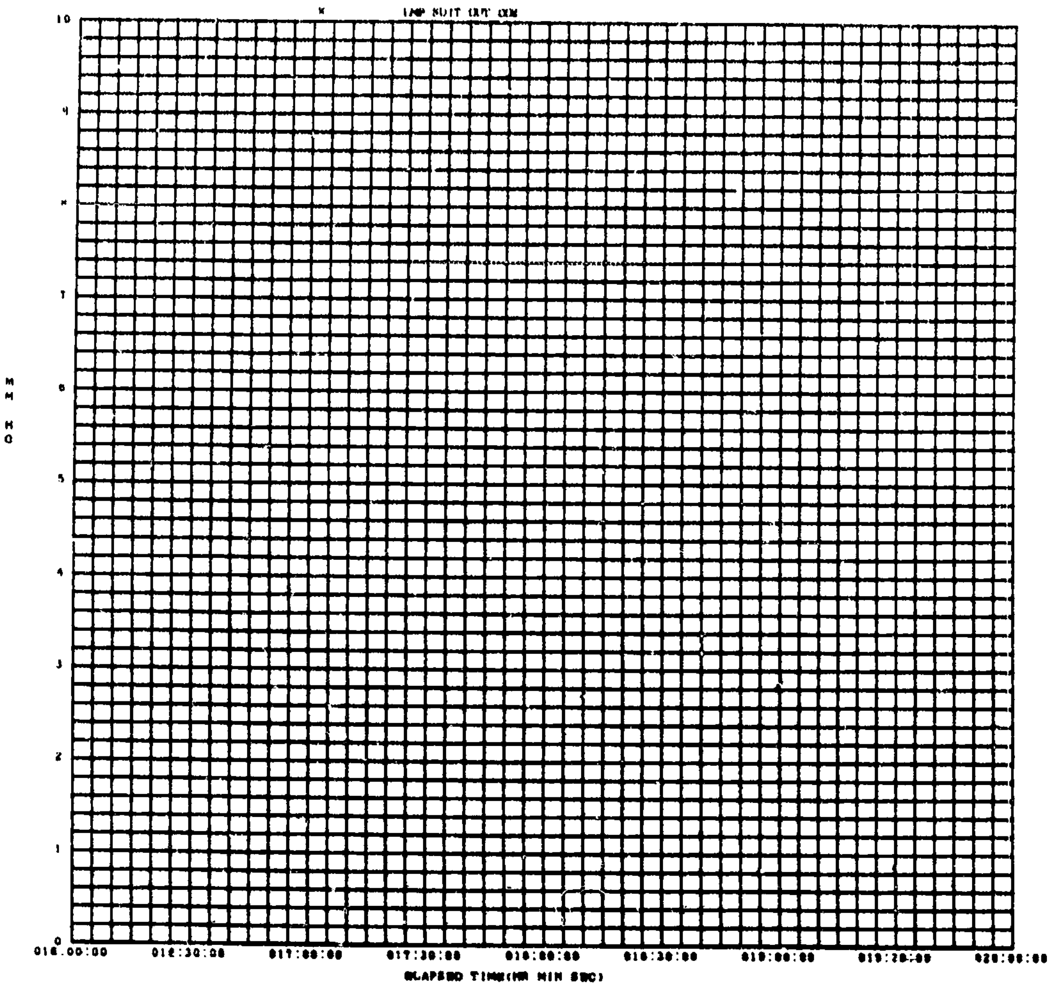


FIGURE 30D LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

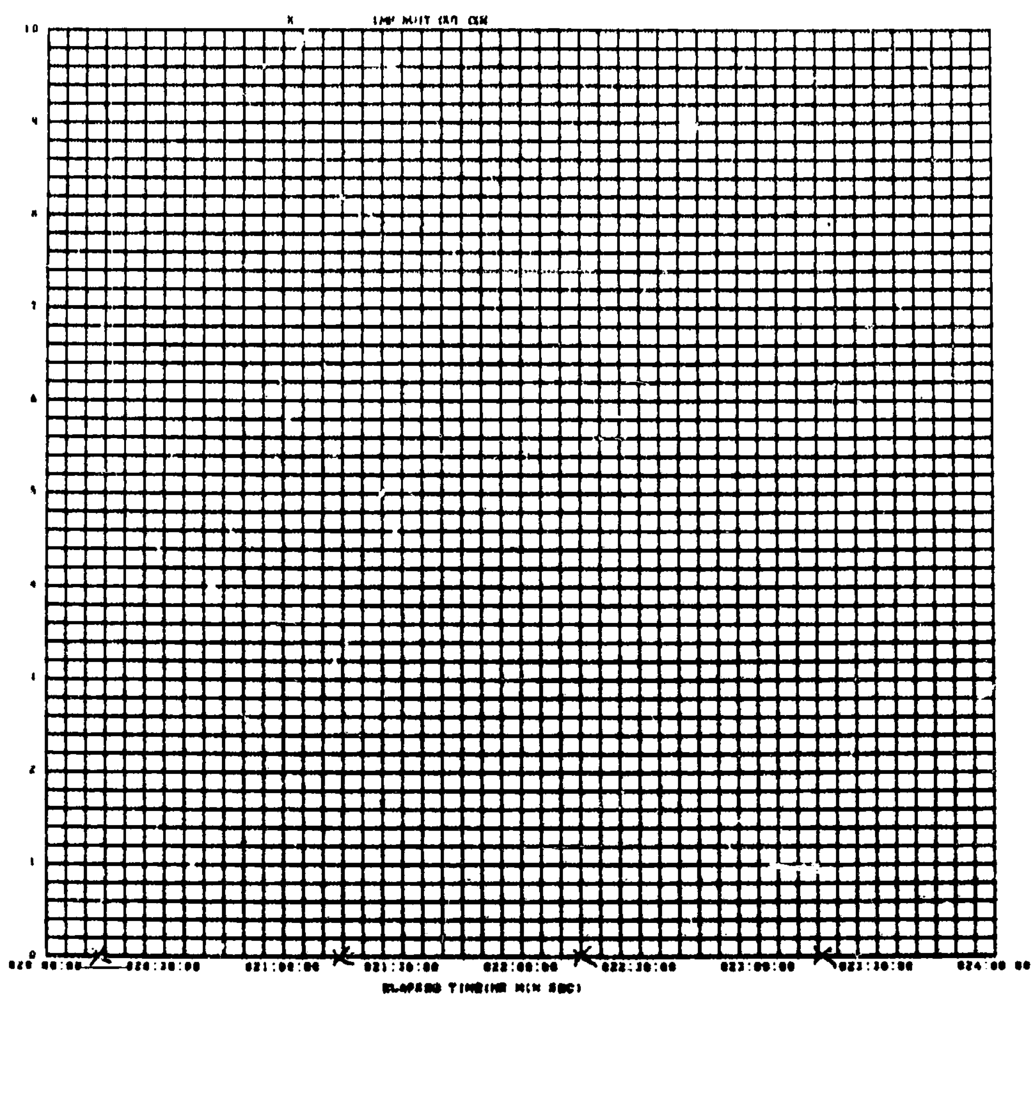


FIGURE 30E LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

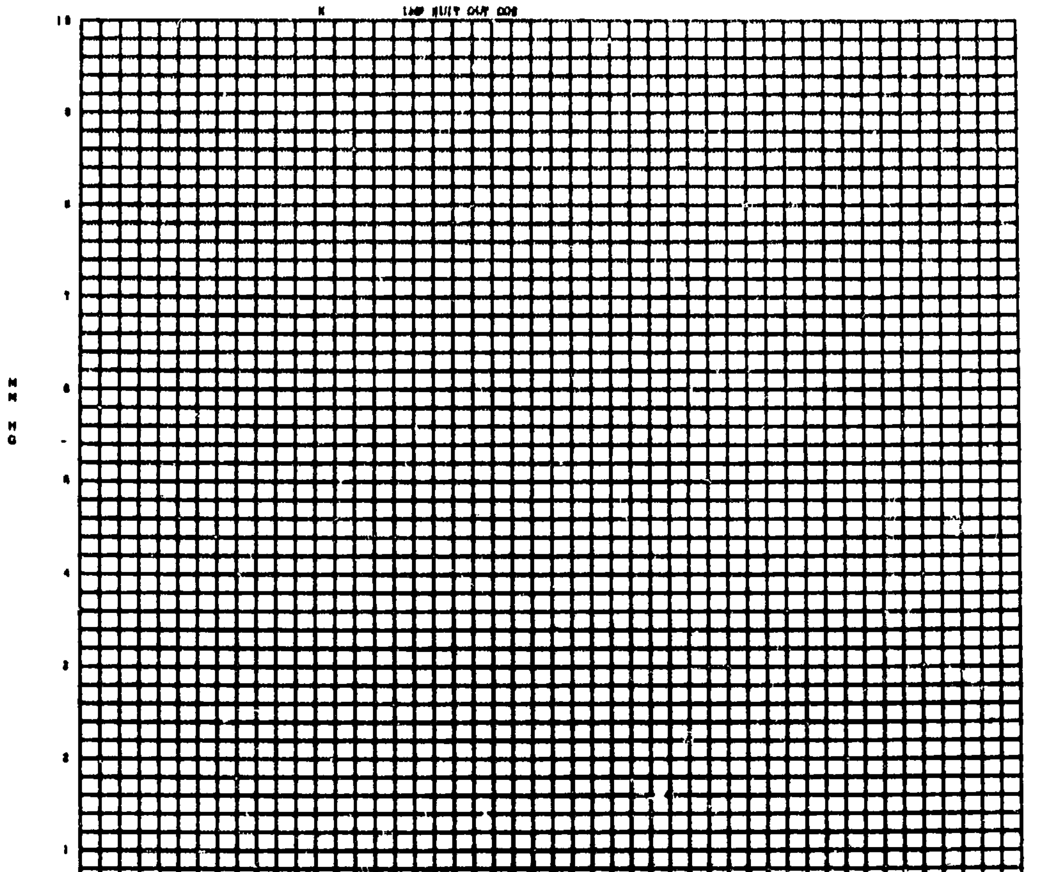


FIGURE 30F LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME
- CONTINUED

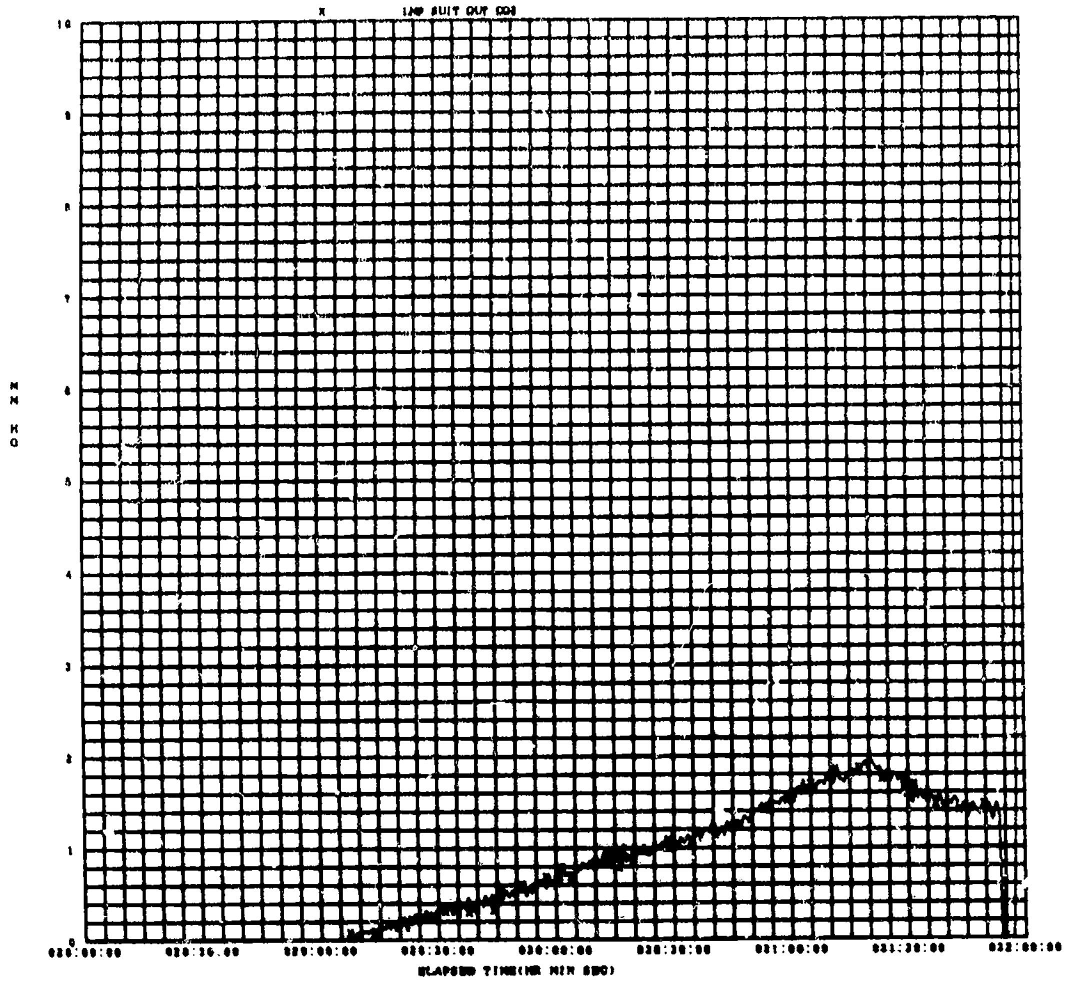


FIGURE 30G LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

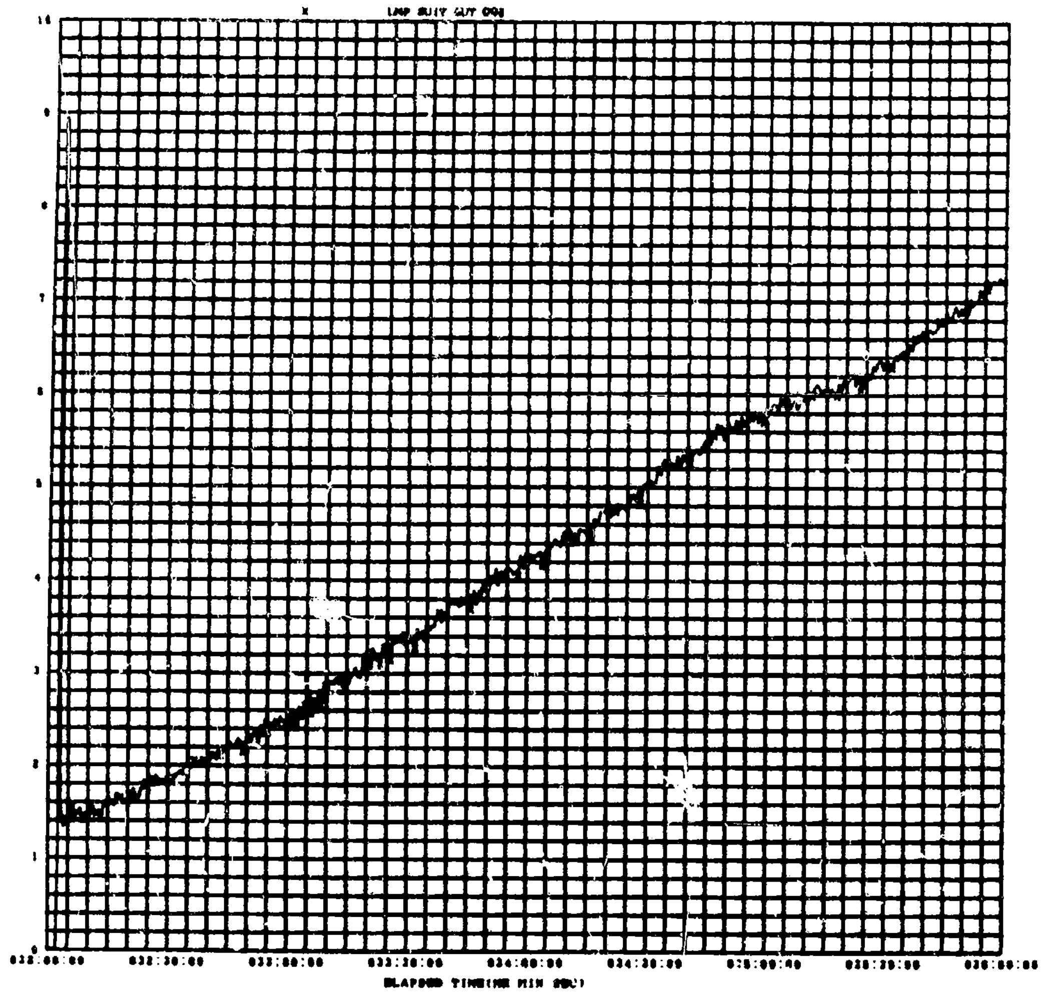


FIGURE 30H LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONTINUED

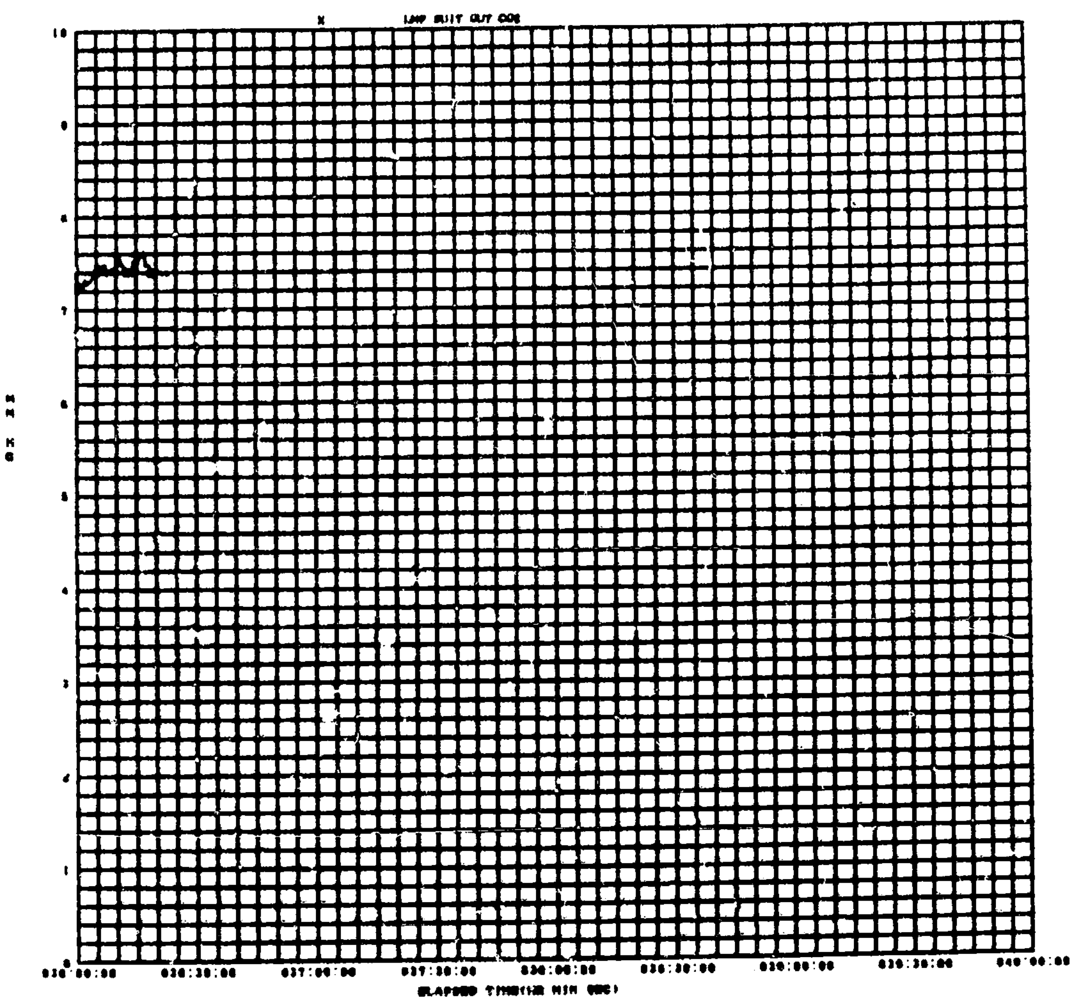


FIGURE 30J LMP SUIT OUTLET PARTIAL PRESSURE CO2 VERSUS TIME - CONCLUDED

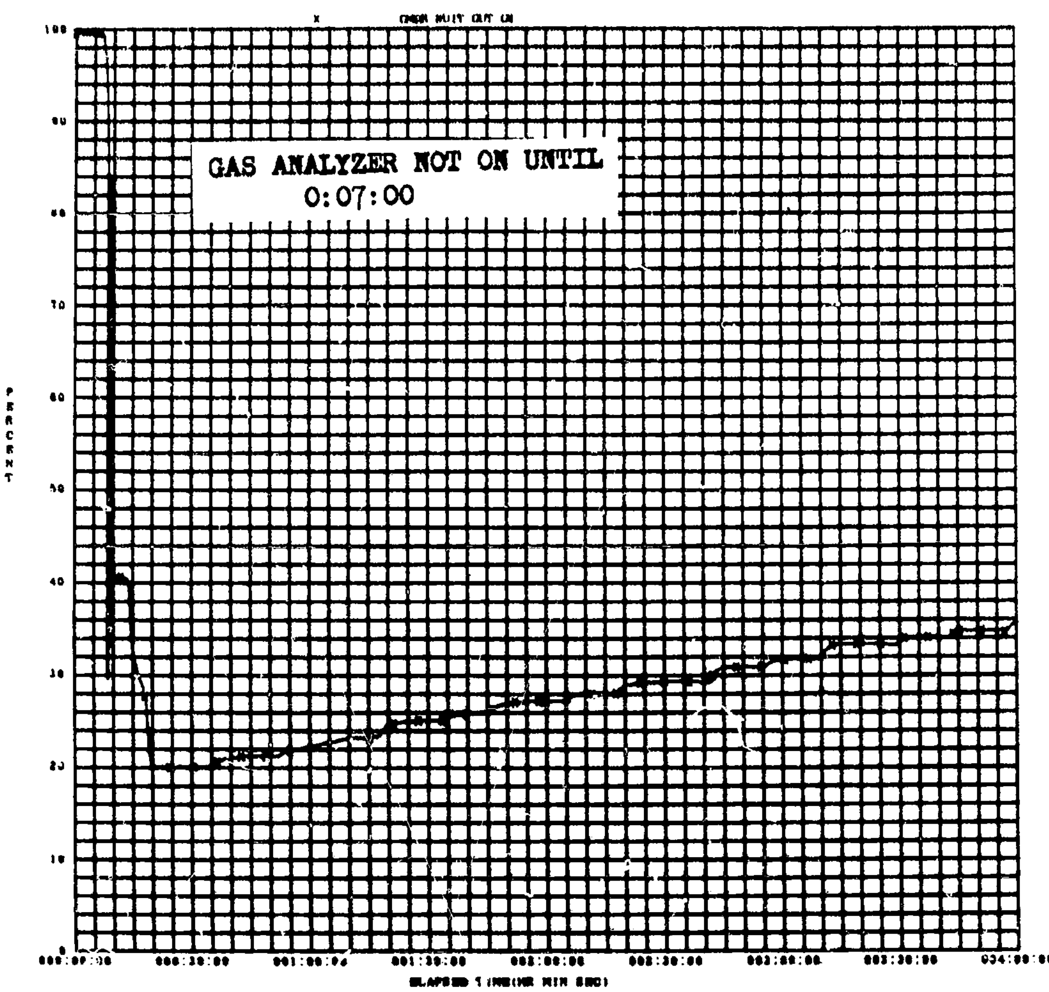


FIGURE 31 CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME

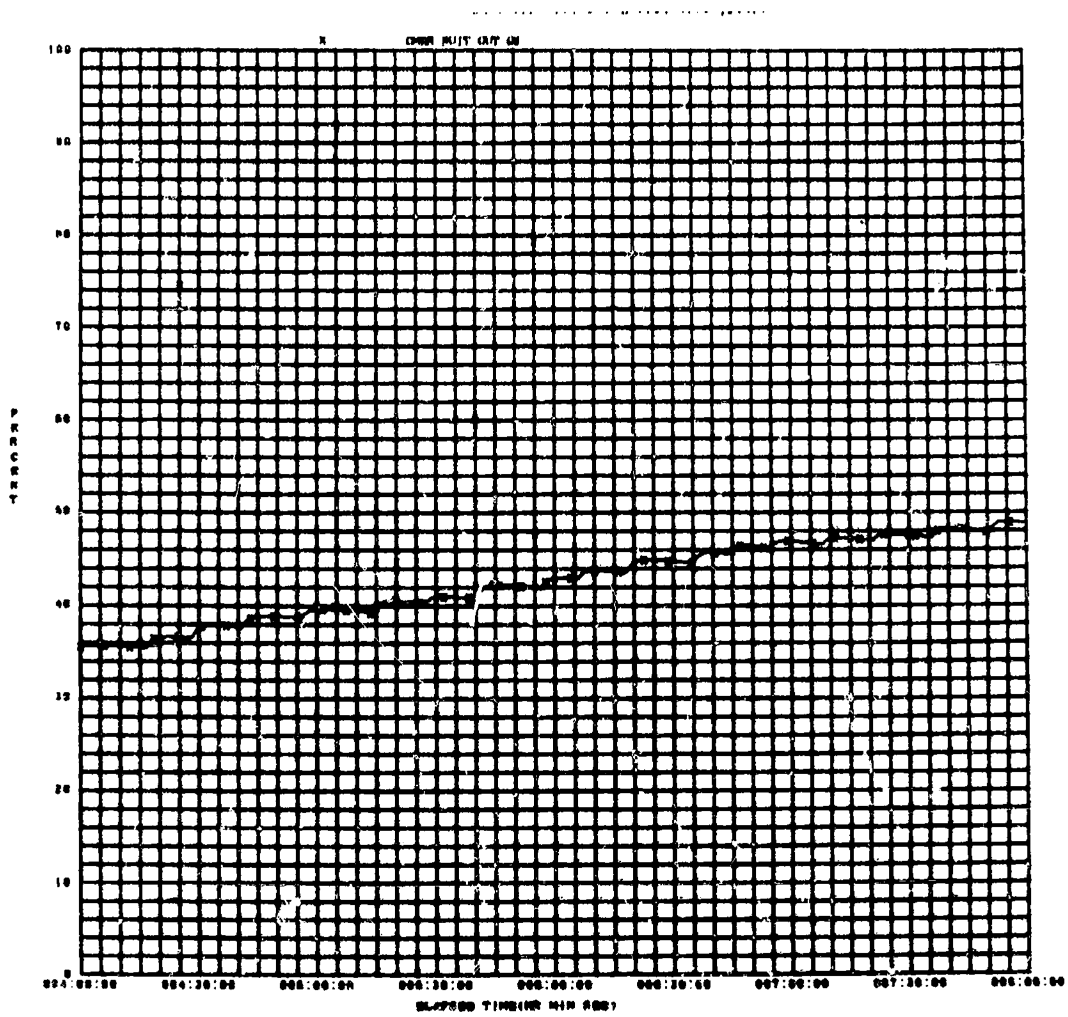
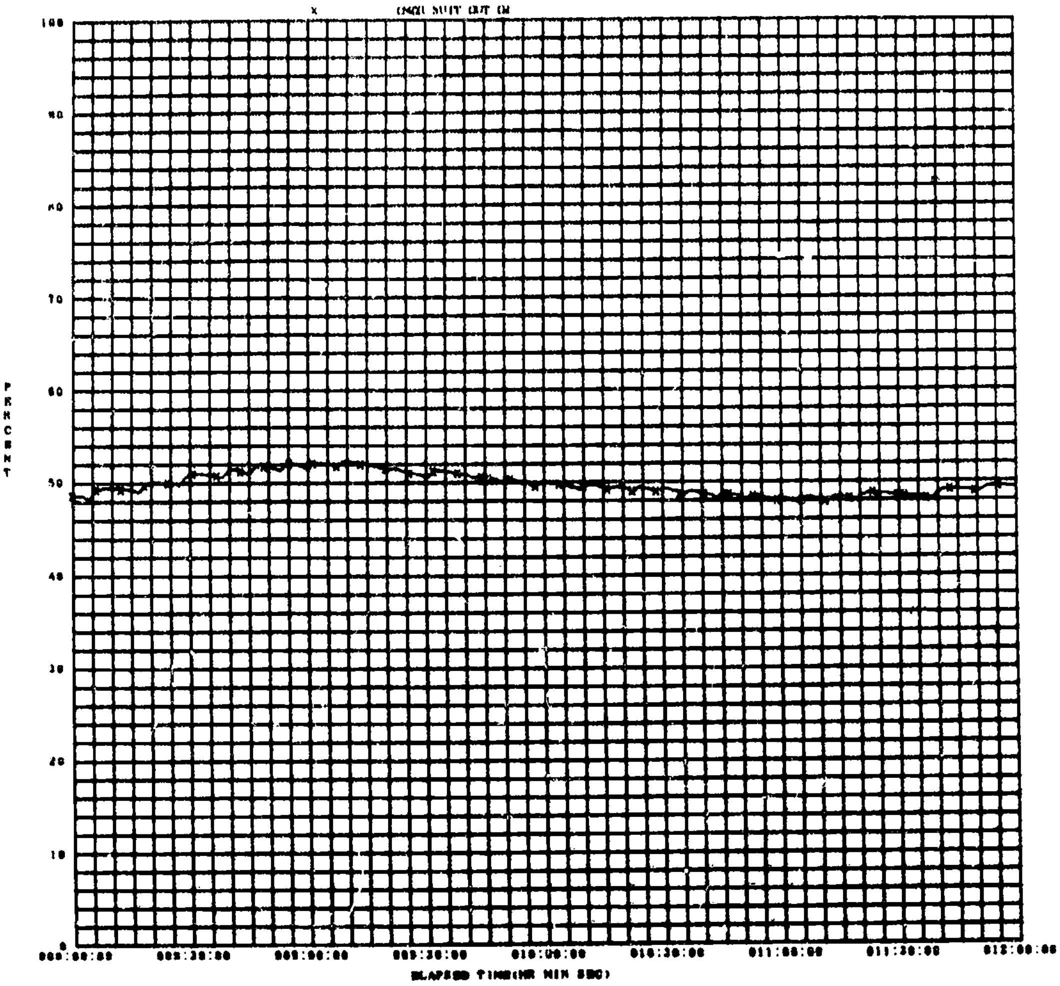


FIGURE 31A CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED



FIGURF 31B CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

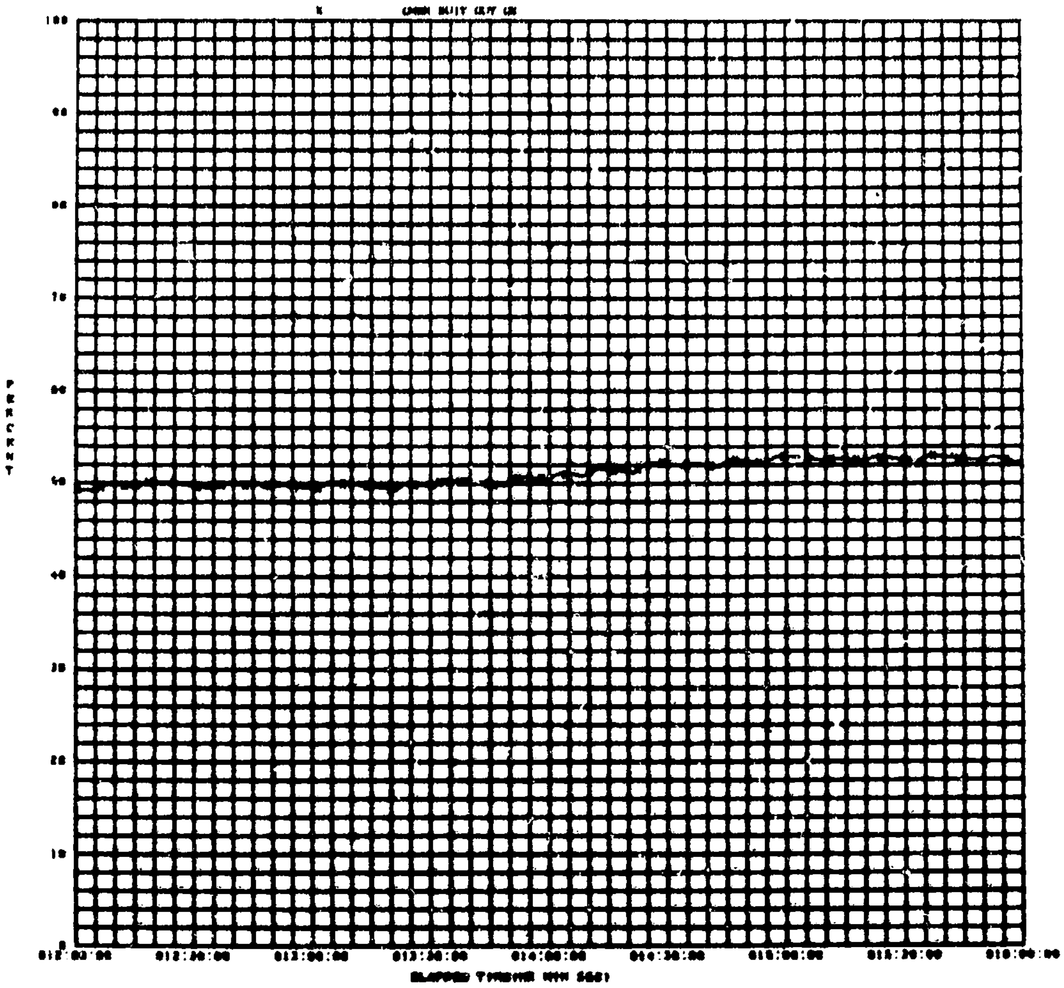


FIGURE 31C CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

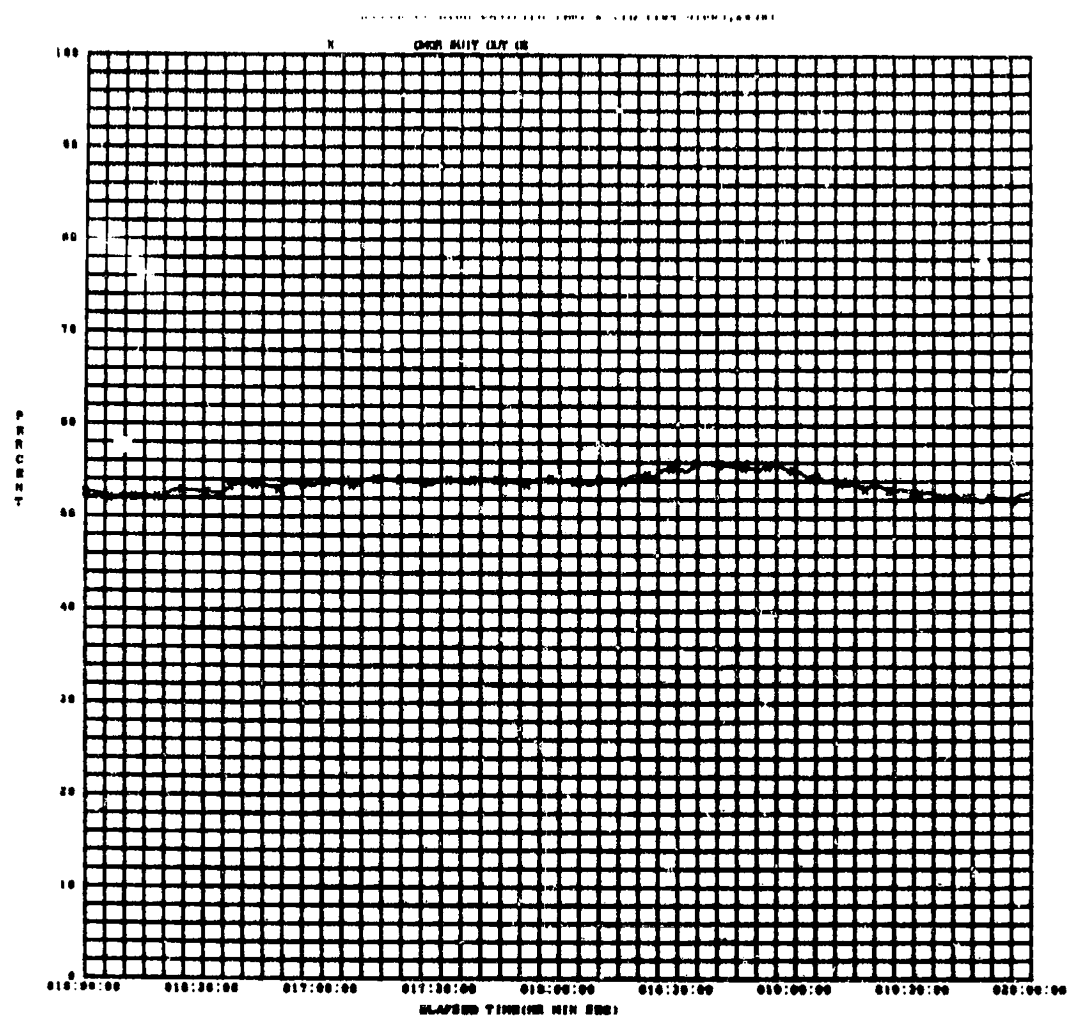


FIGURE 31D CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

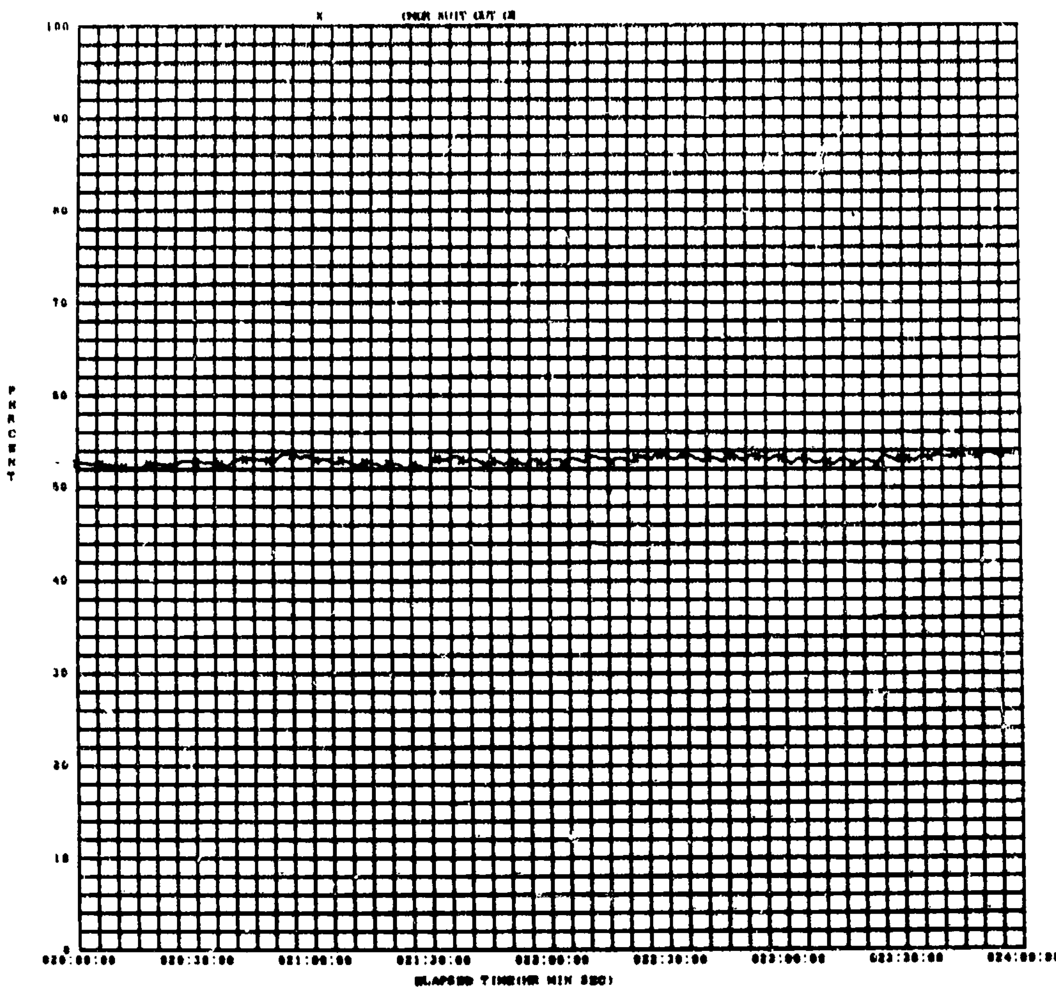


FIGURE 31E CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

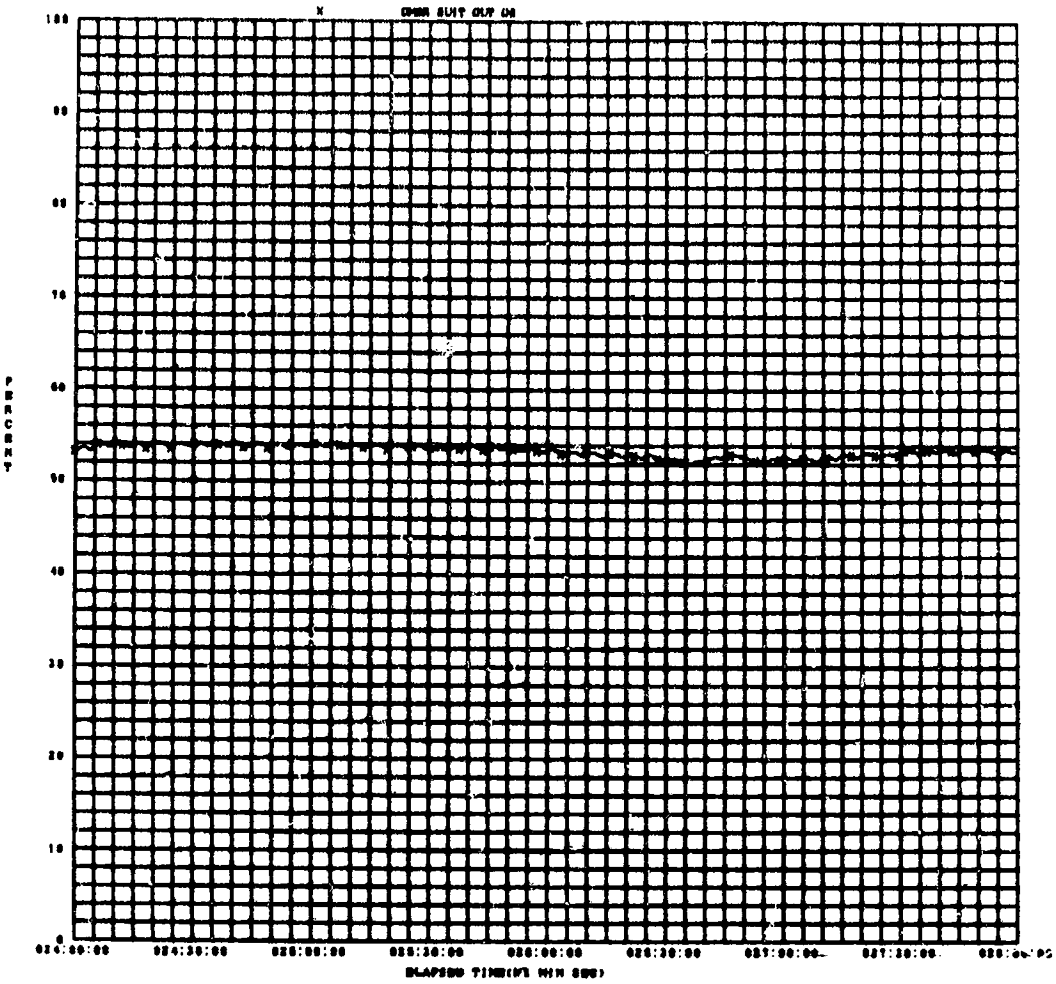


FIGURE 31F CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

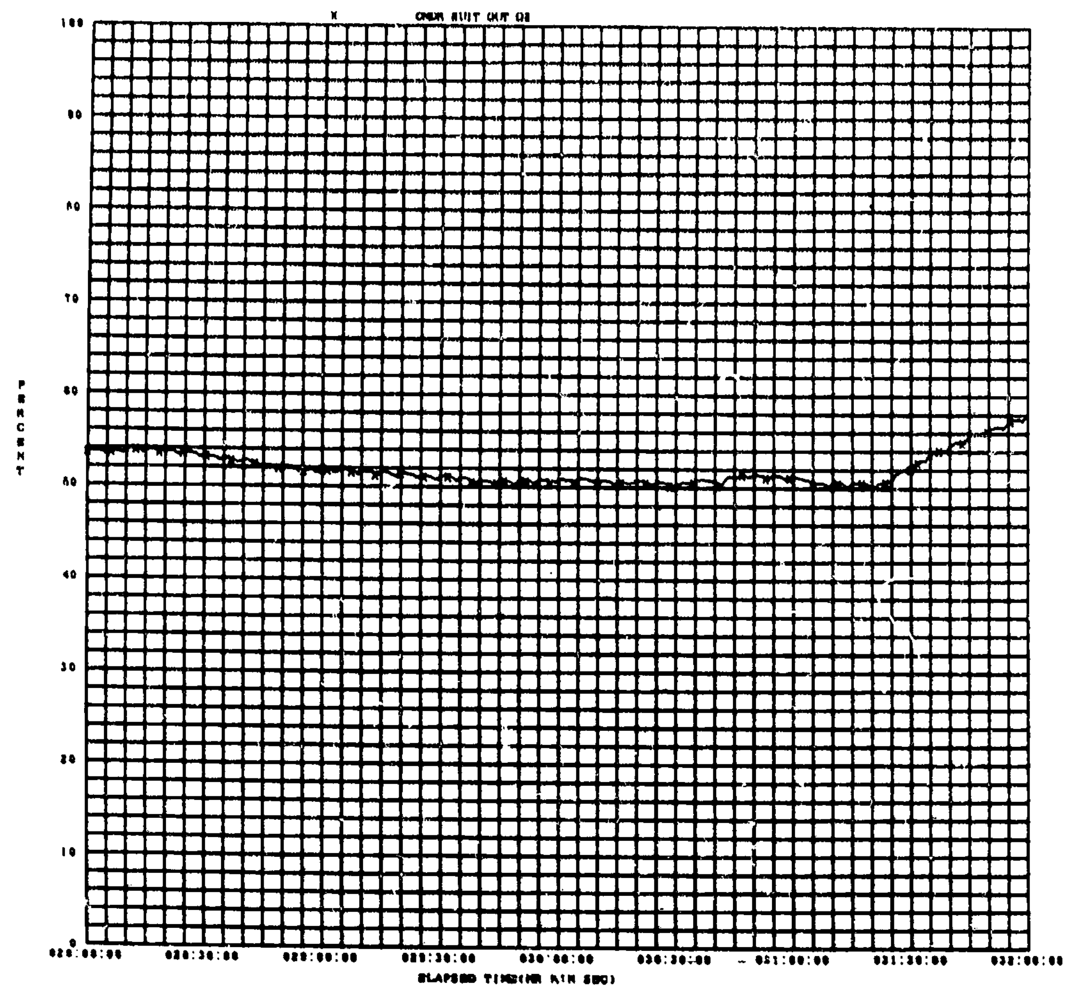


FIGURE 31G CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

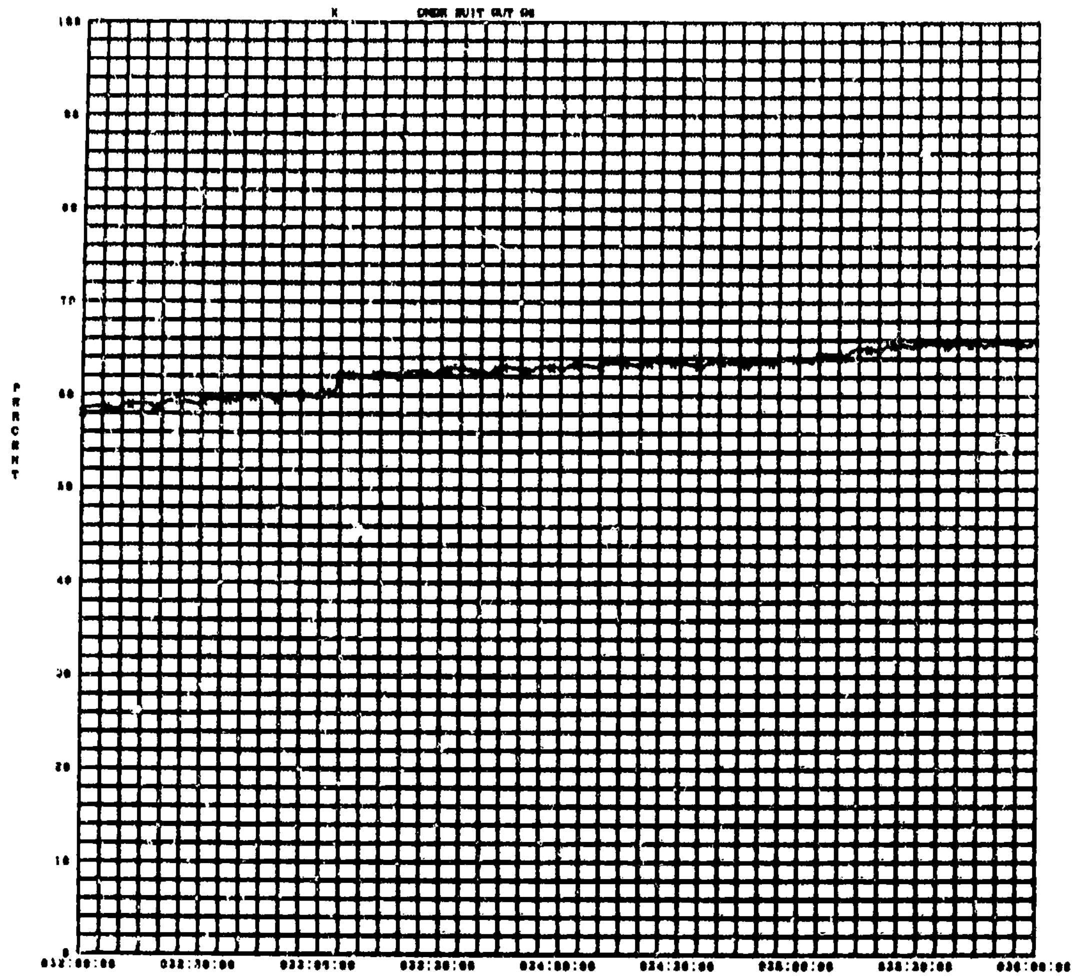


FIGURE 31H CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

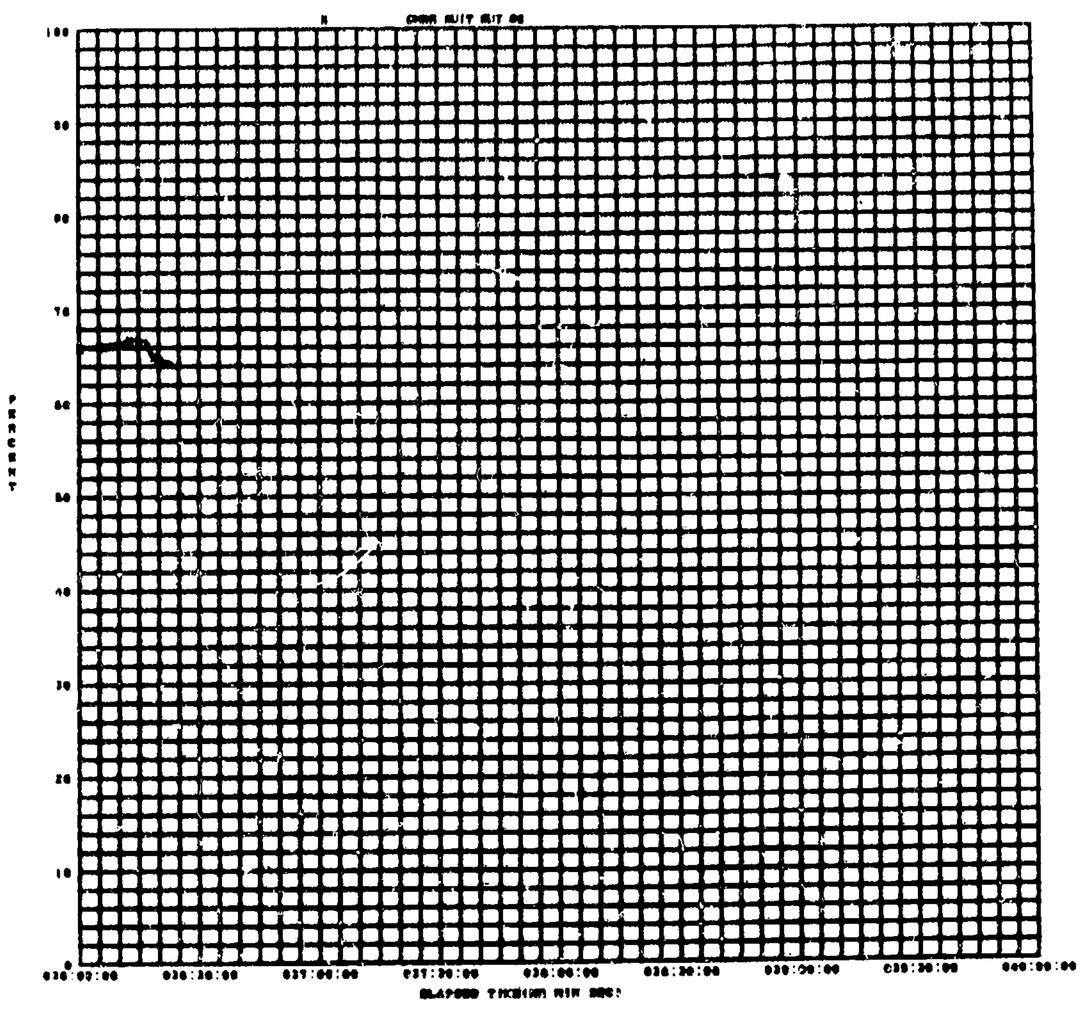


FIGURE 31J CDR SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONCLUDED

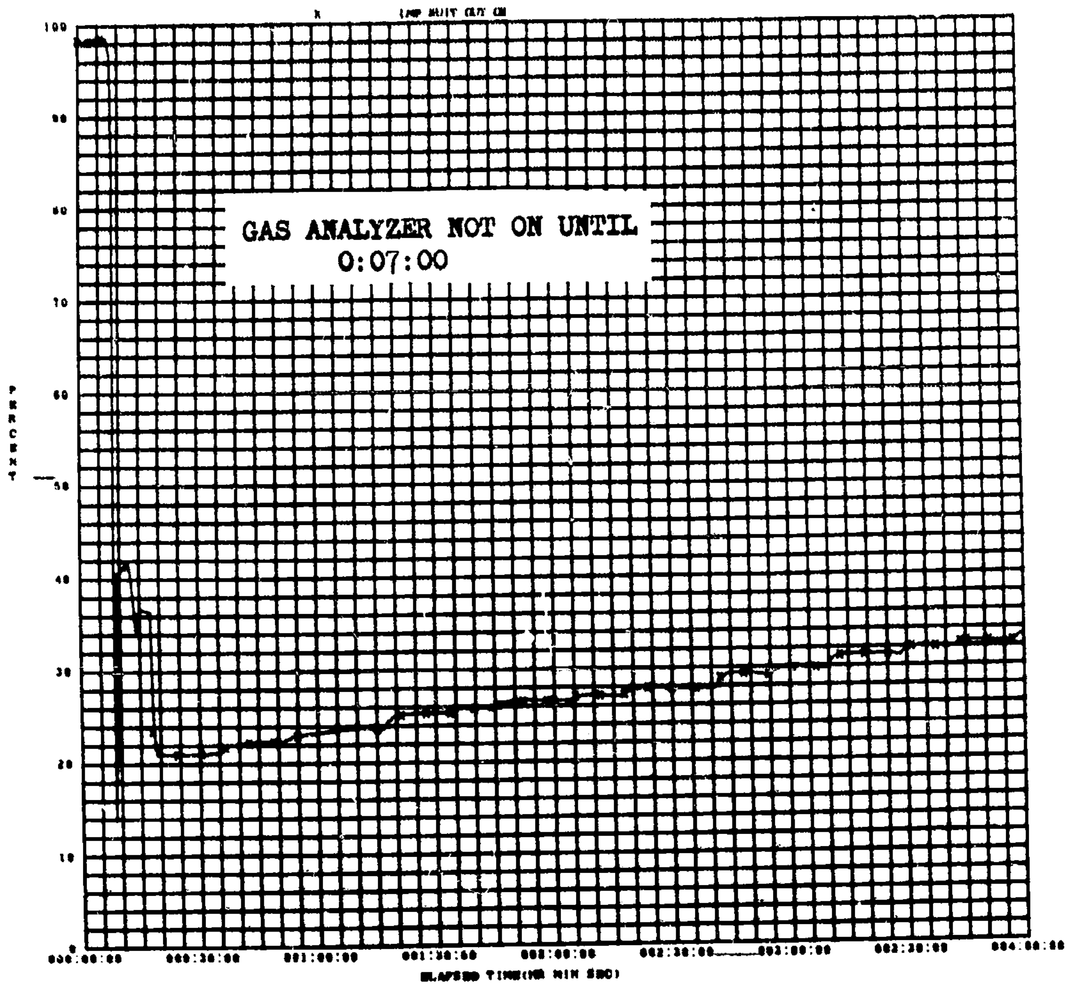


FIGURE 32 LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME

C-5

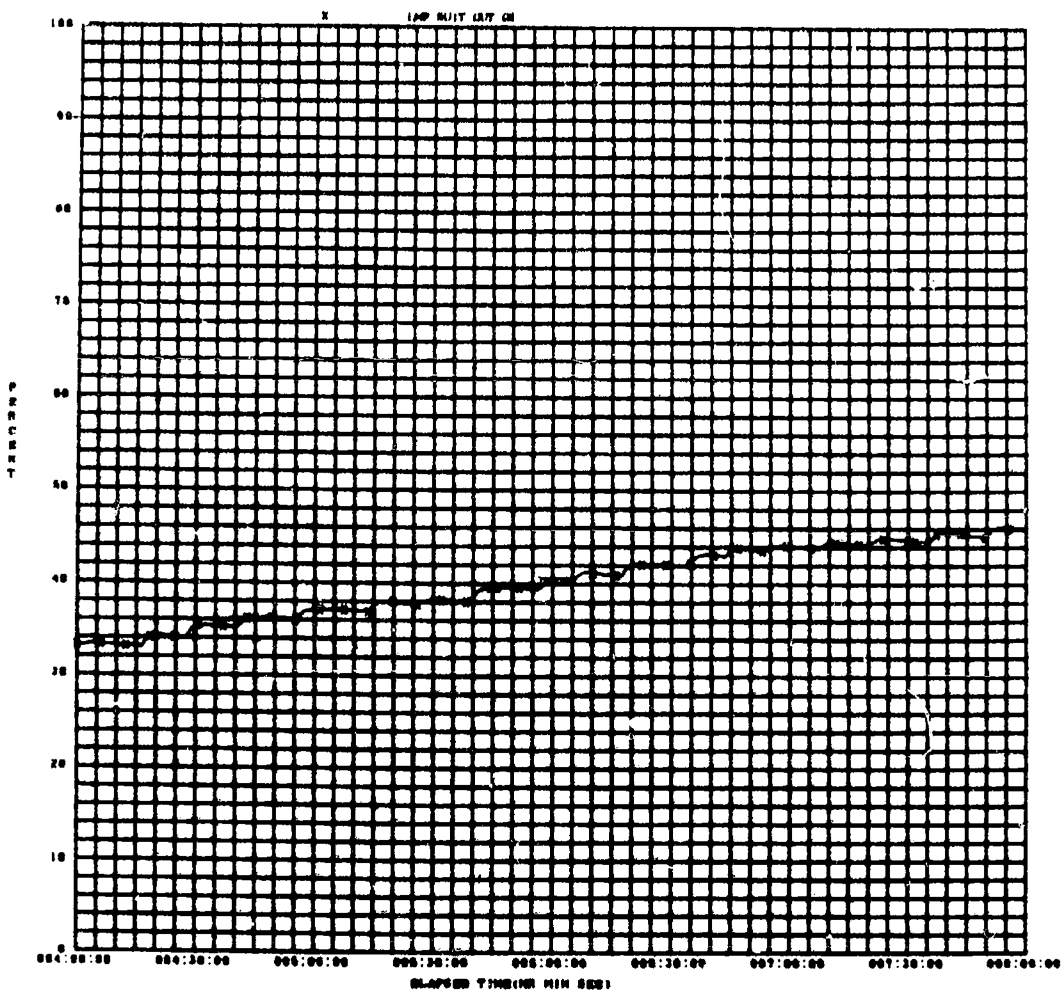


FIGURE 32A LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

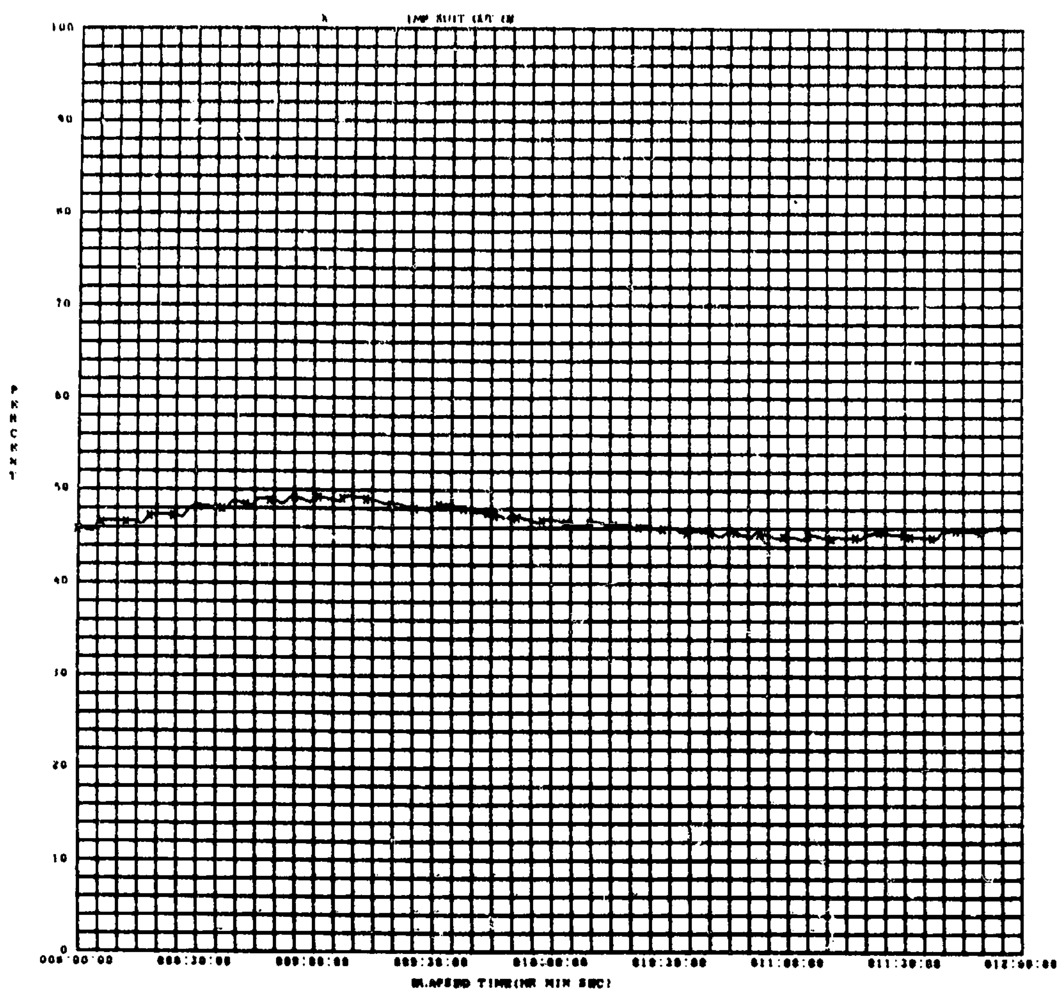


FIGURE 32B LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

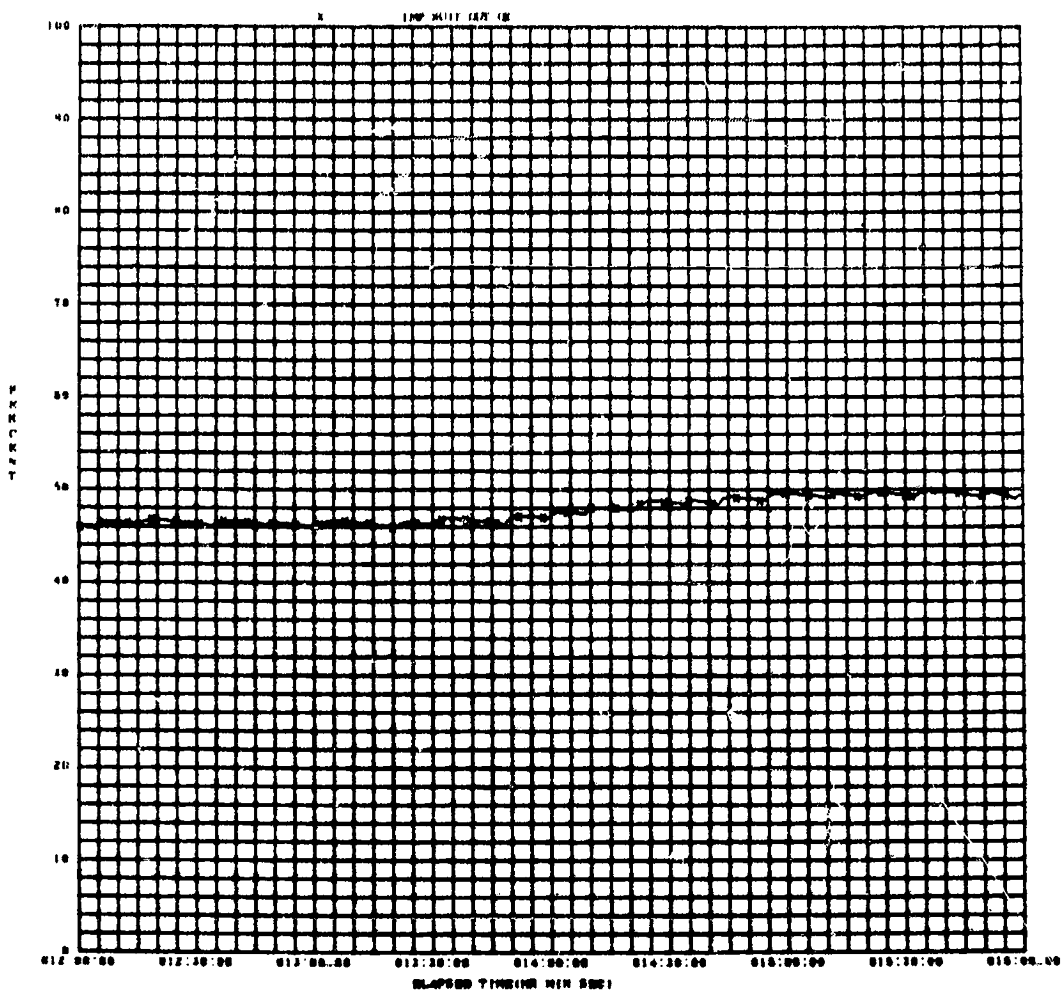


FIGURE 32C LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

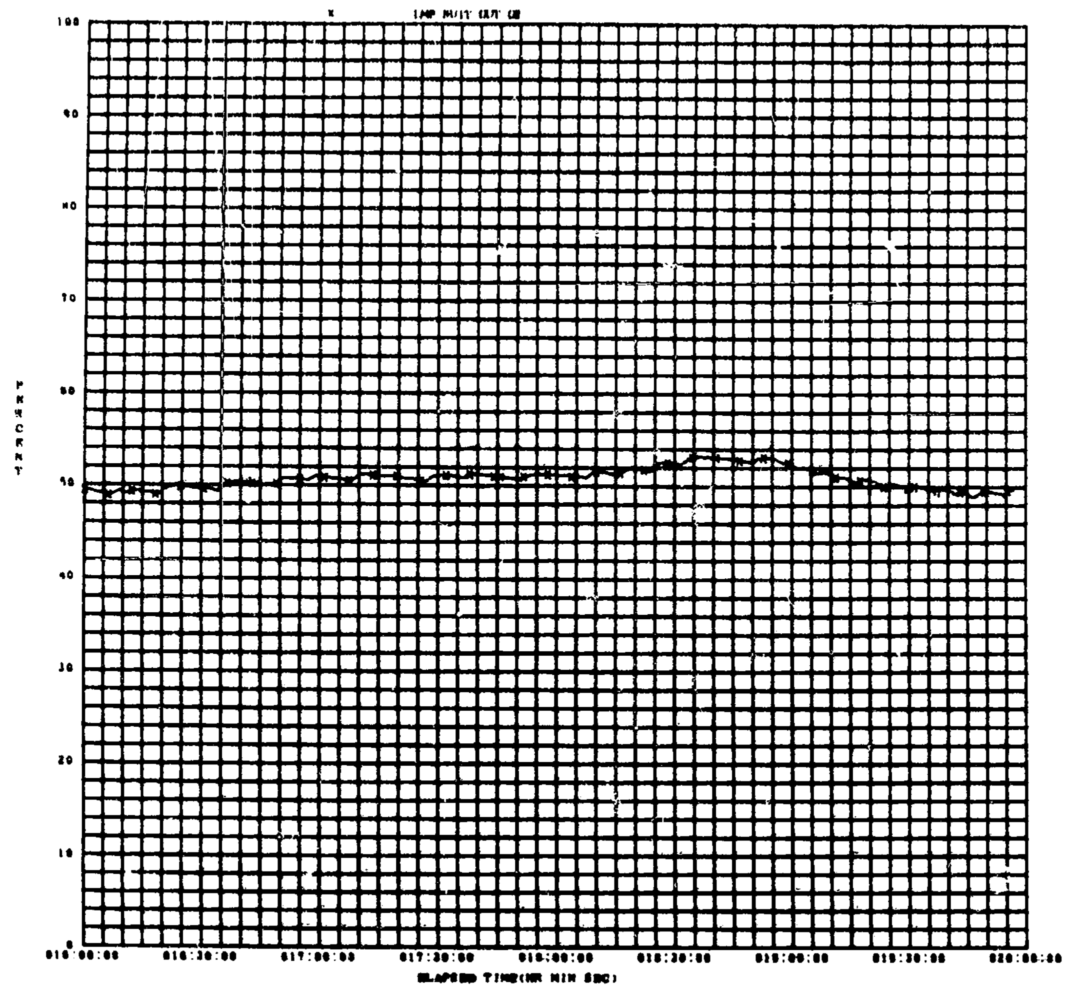


FIGURE 32D LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

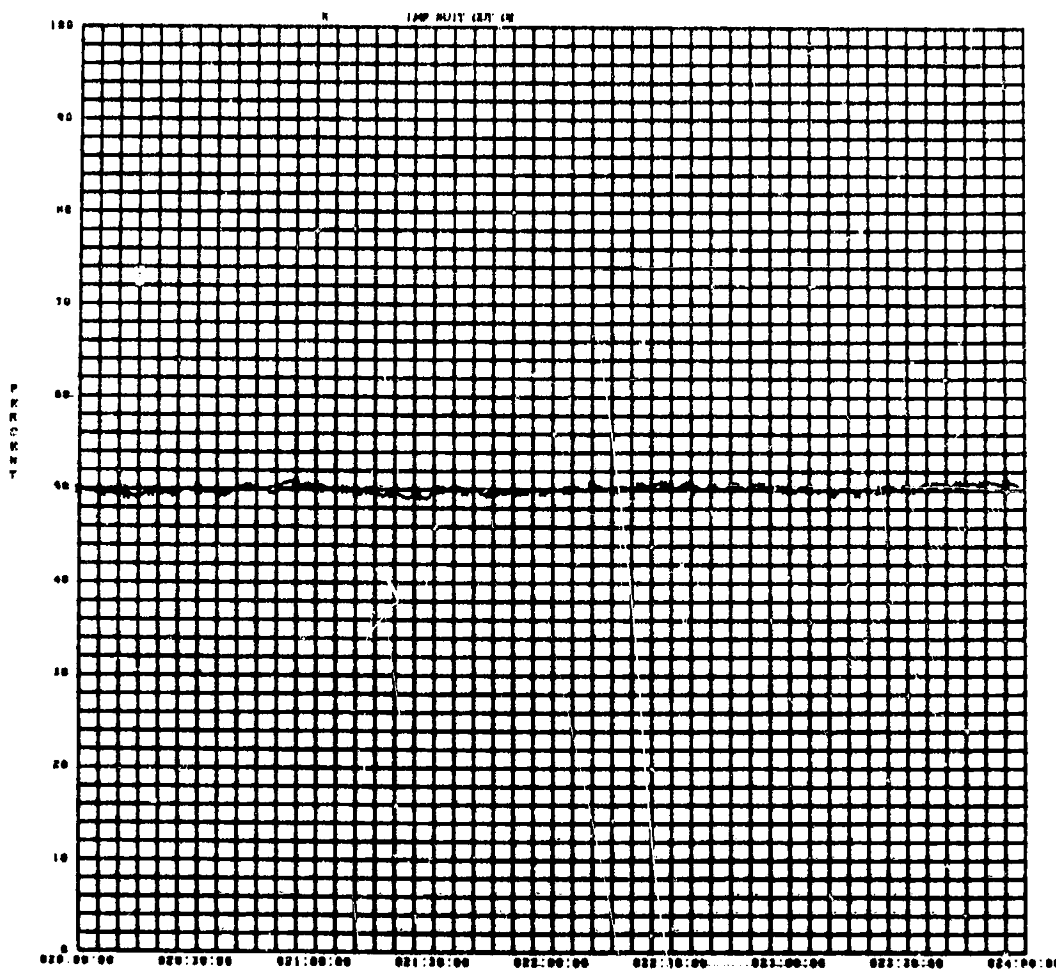


FIGURE 32E LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

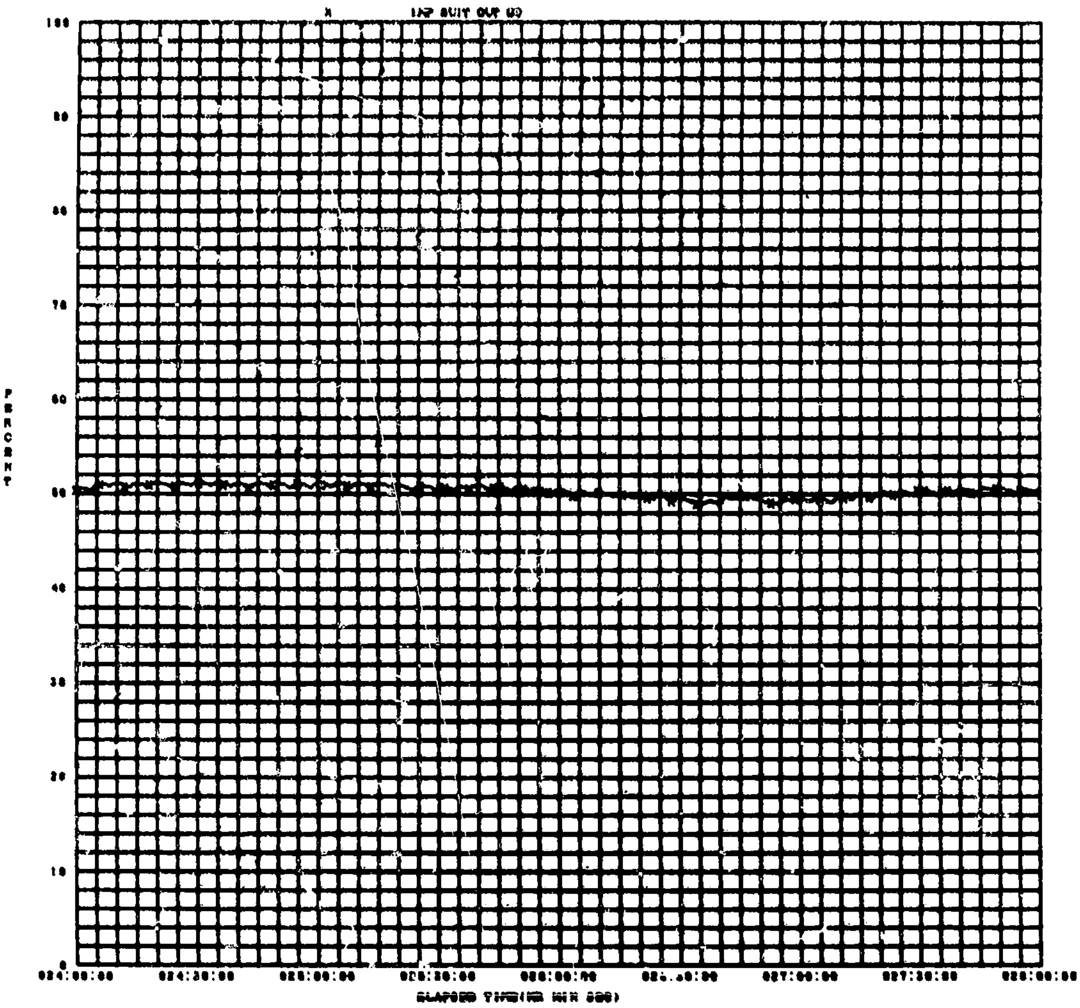


FIGURE 32F LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

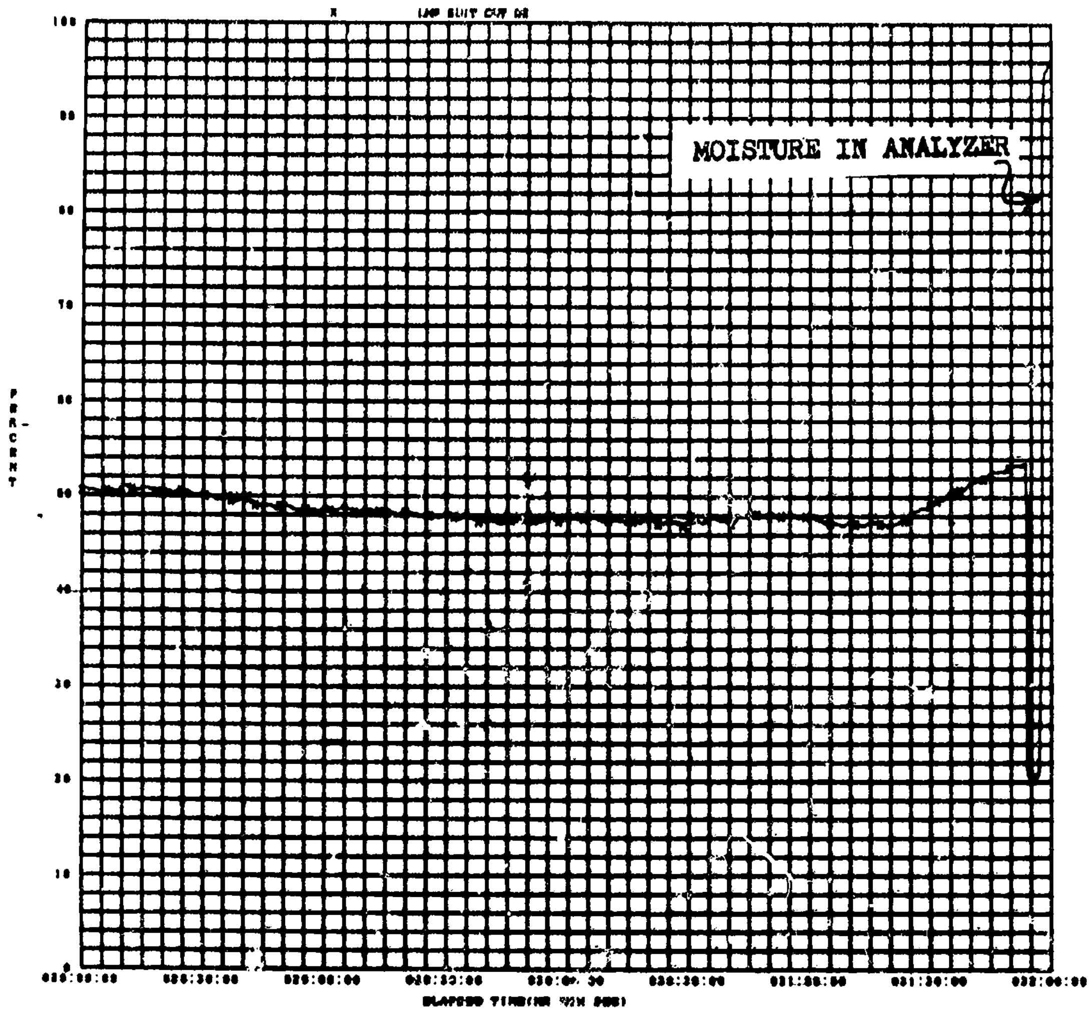


FIGURE 32G LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONTINUED

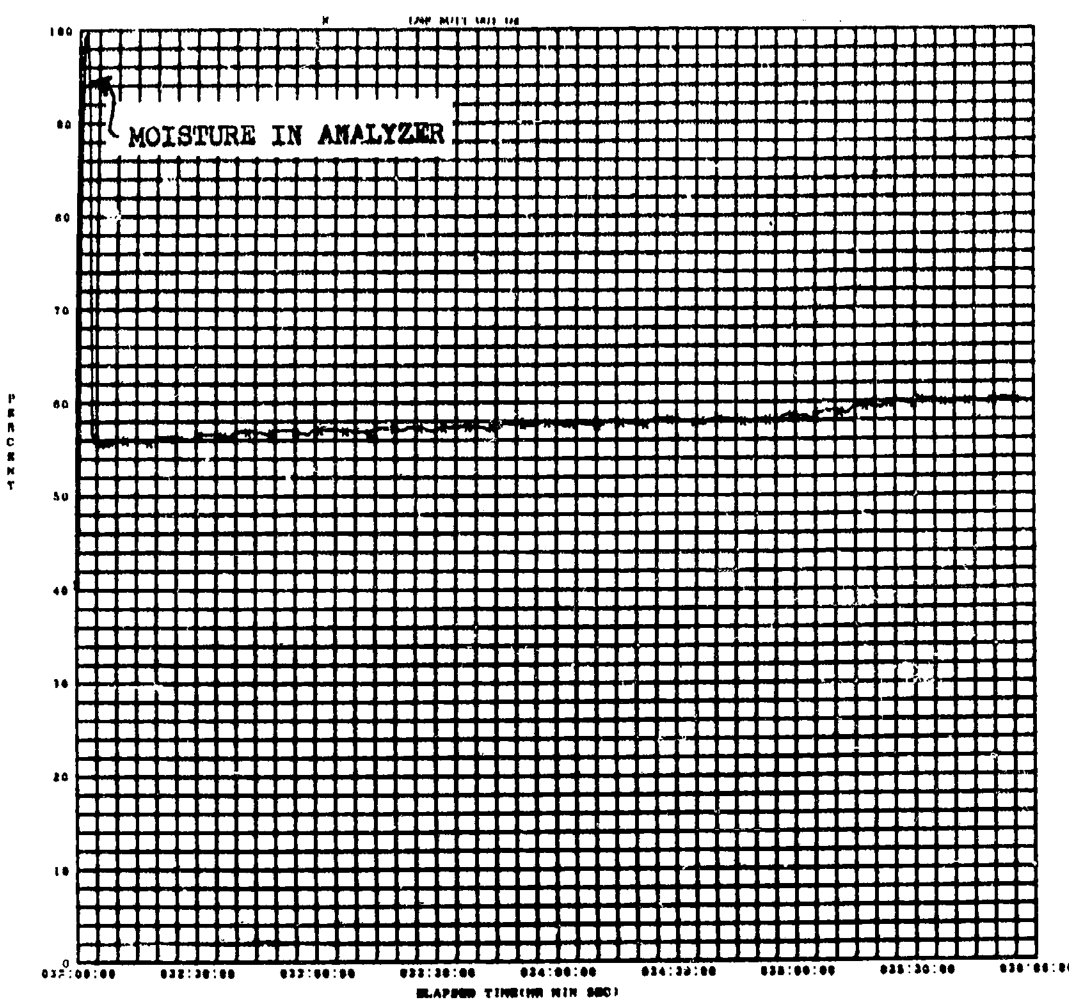


FIGURE 32H LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME - CONTINUED

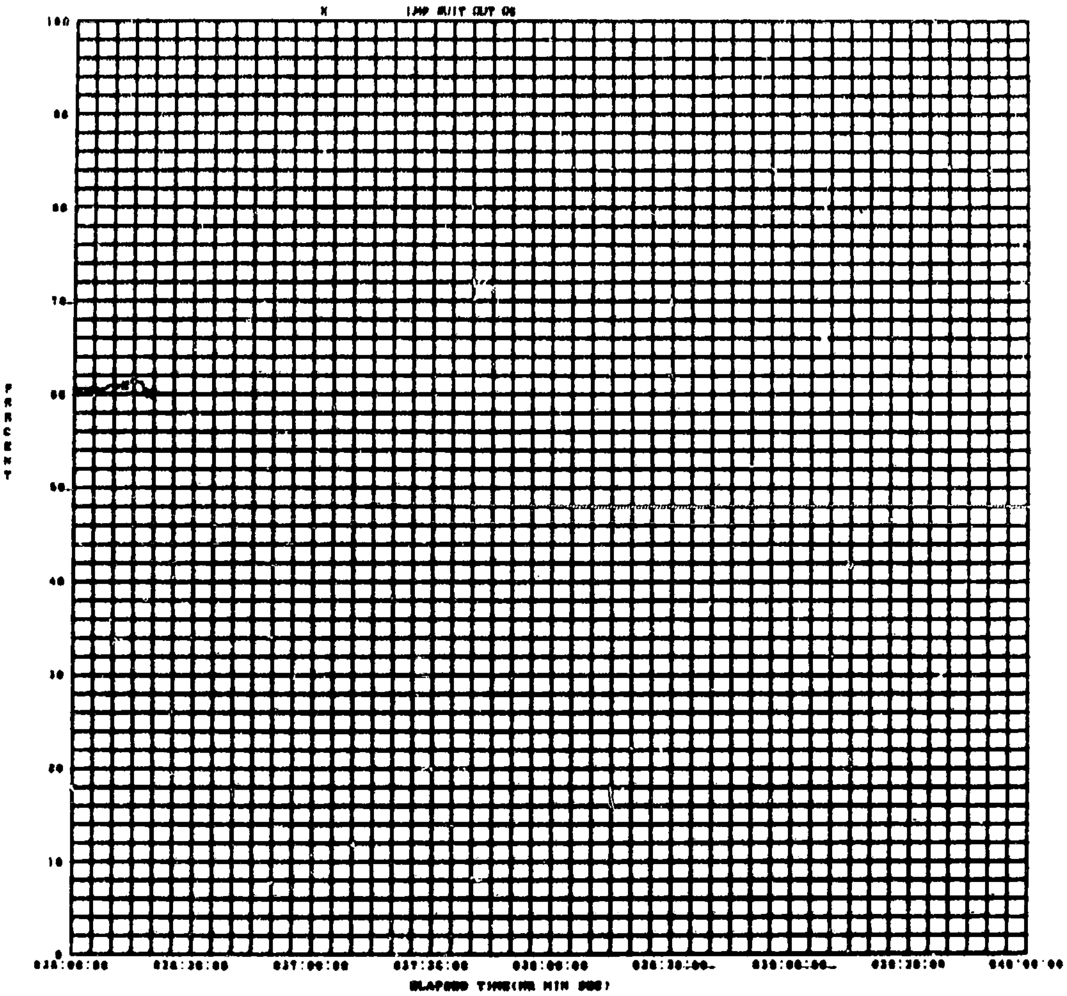


FIGURE 32J LMP SUIT OUTLET PERCENTAGE O2 VERSUS TIME
- CONCLUDED

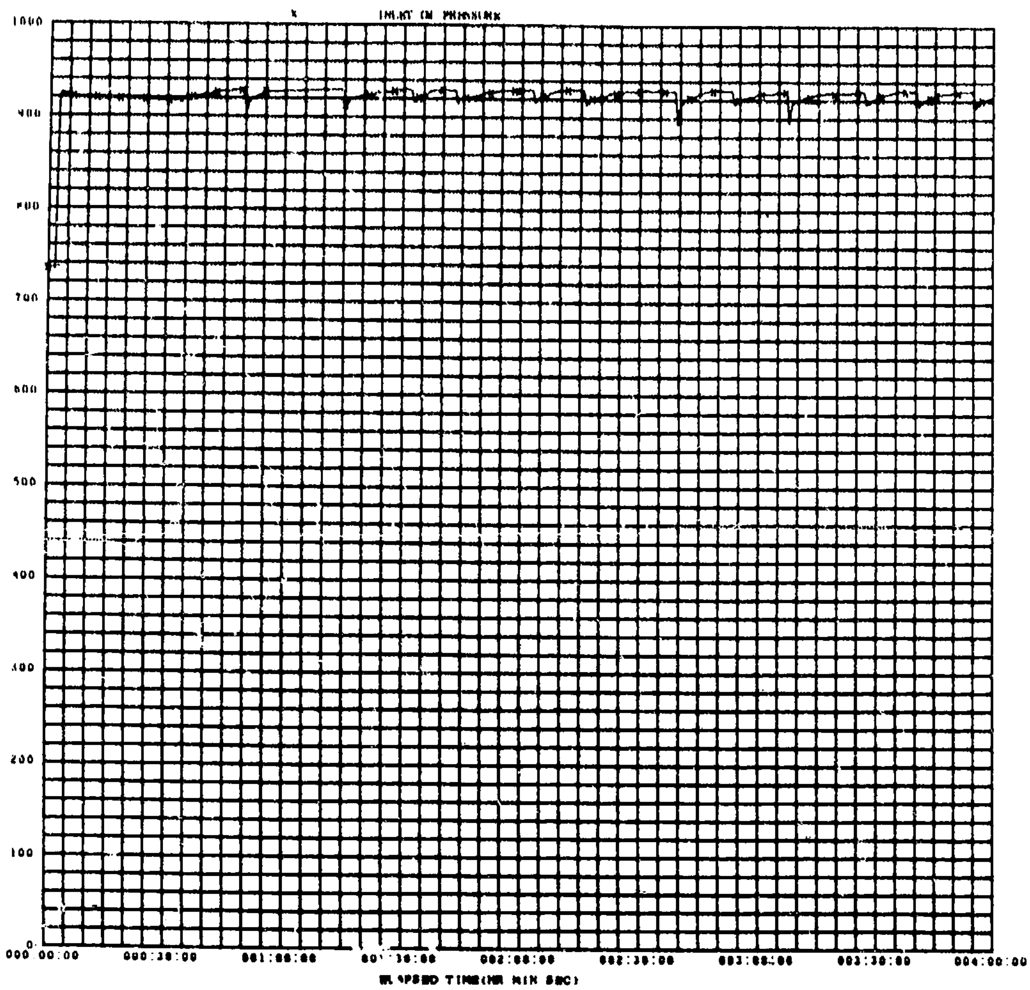


FIGURE 33 LM ECS O2 SUPPLY PRESSURE VERSUS TIME

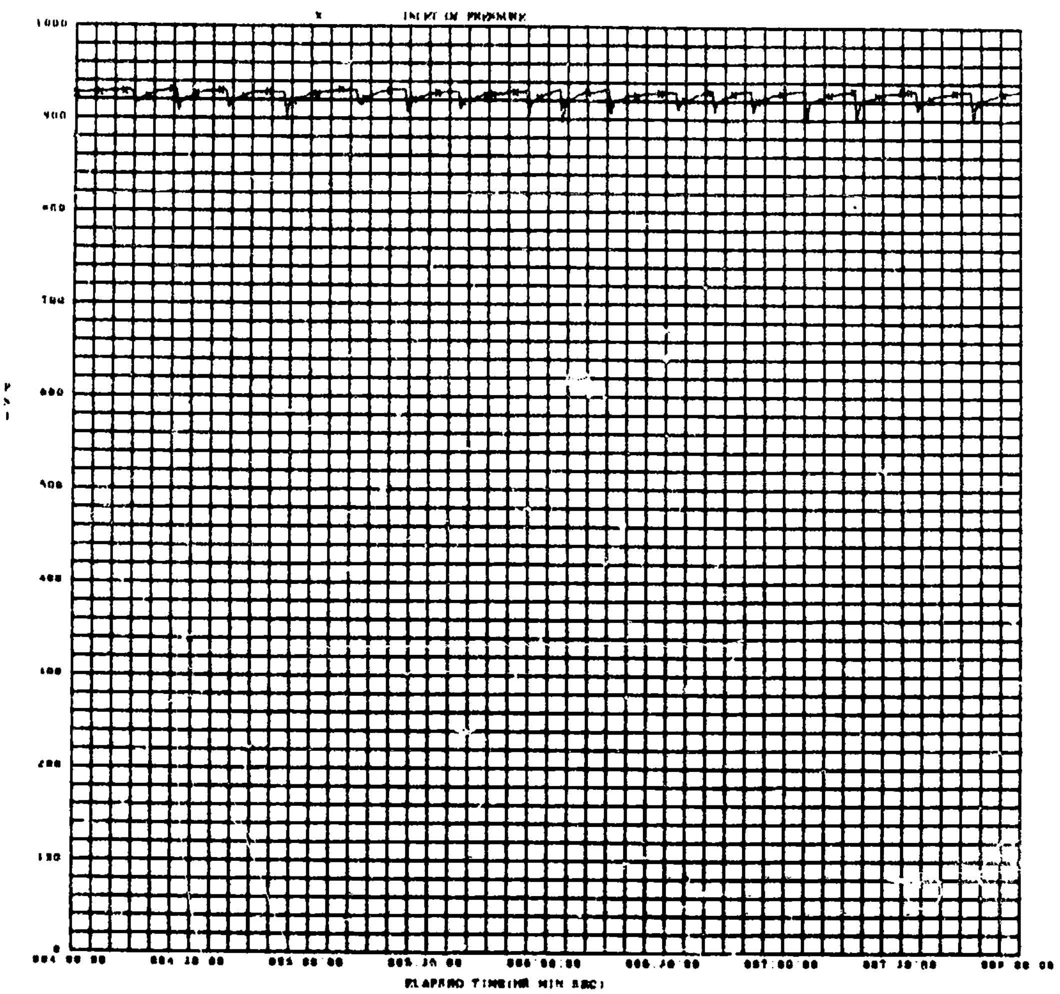


FIGURE 33A LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

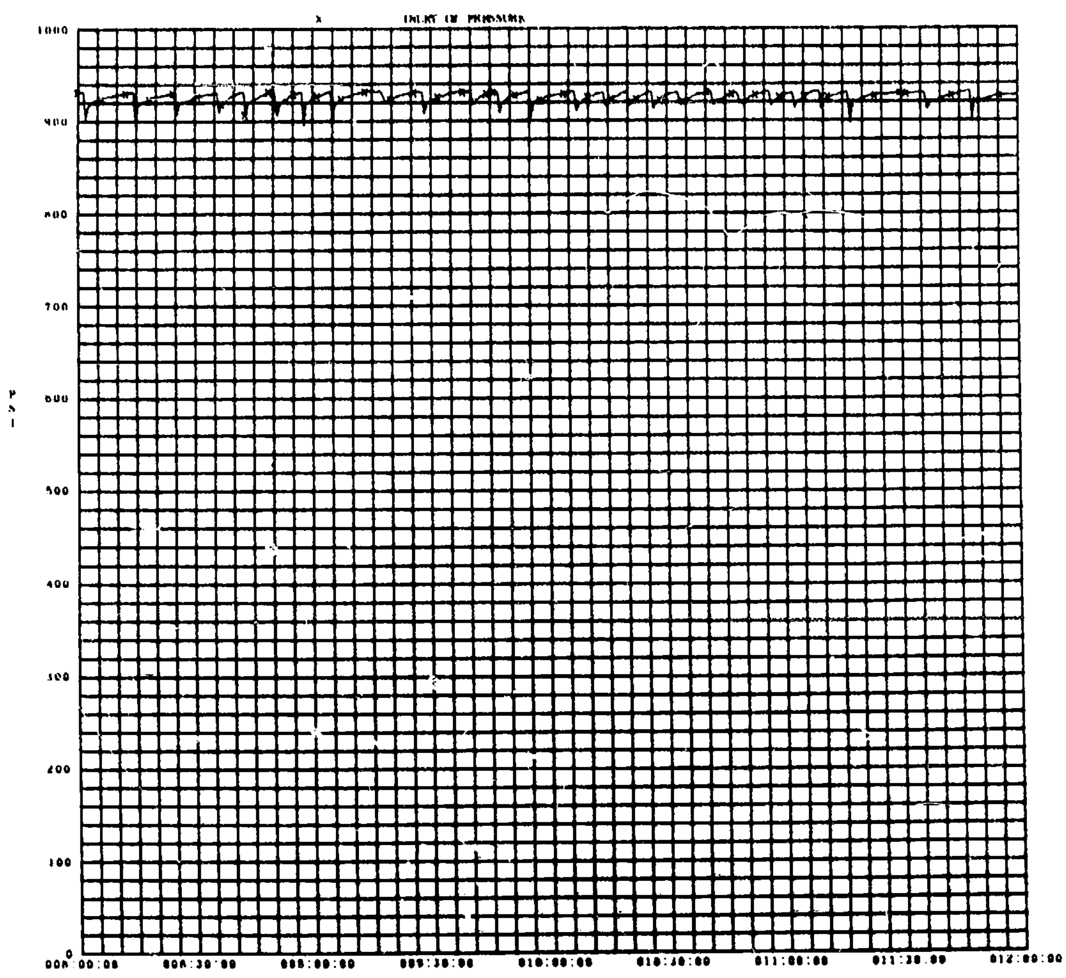


FIGURE 33B LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

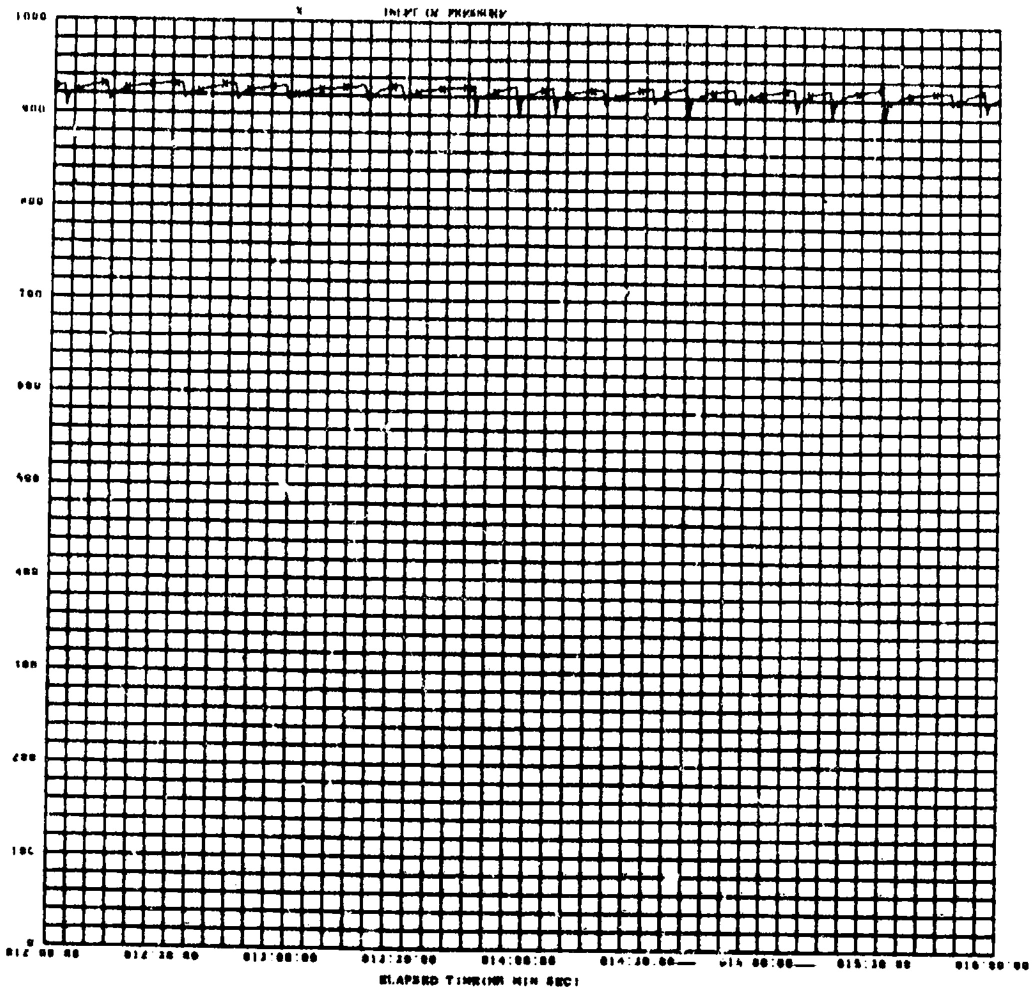


FIGURE 33C LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

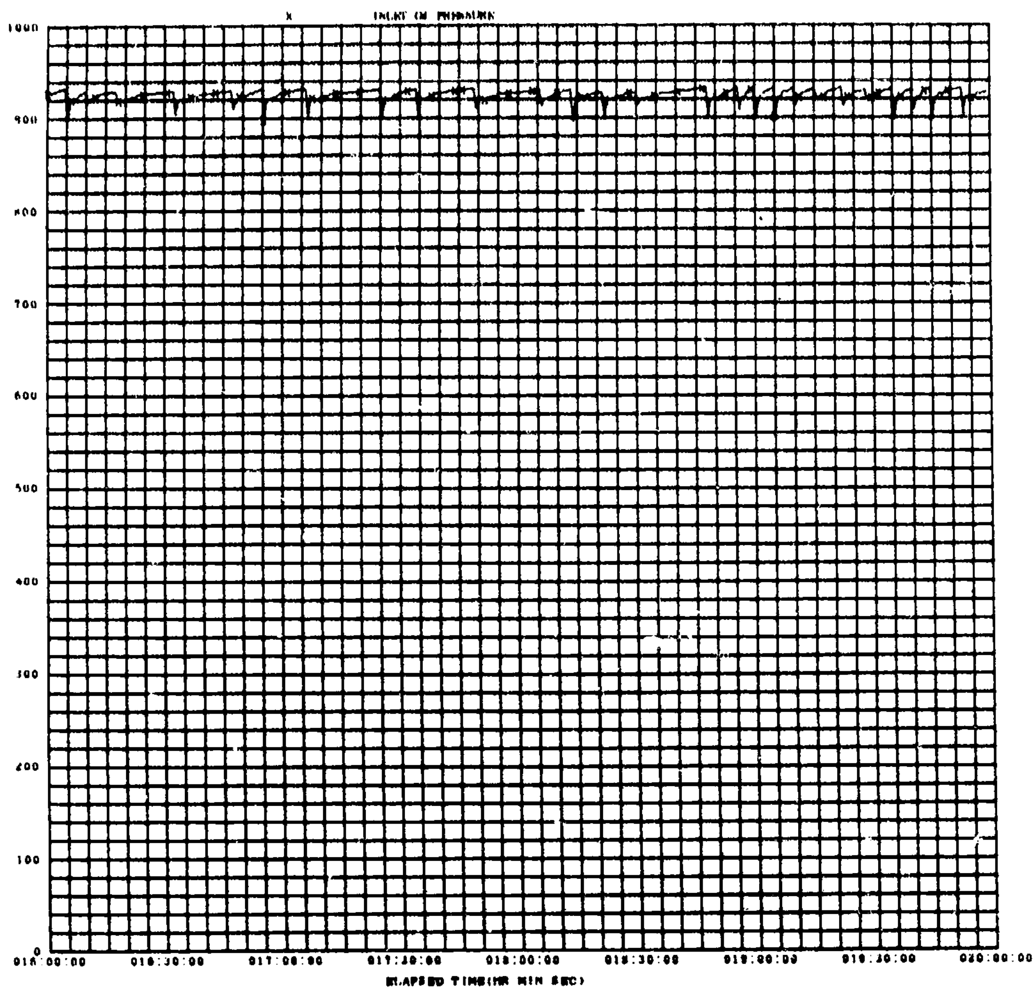


FIGURE 33D LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

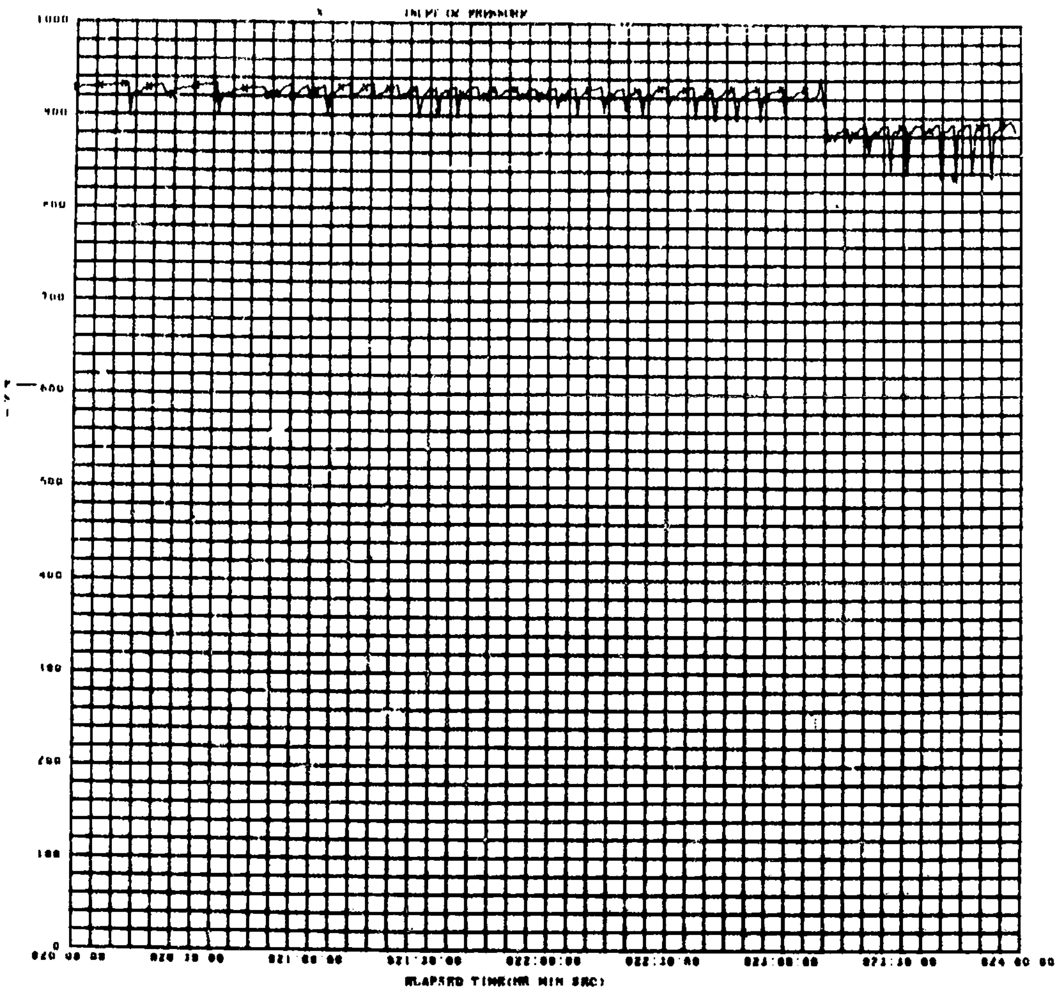


FIGURE 33E LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

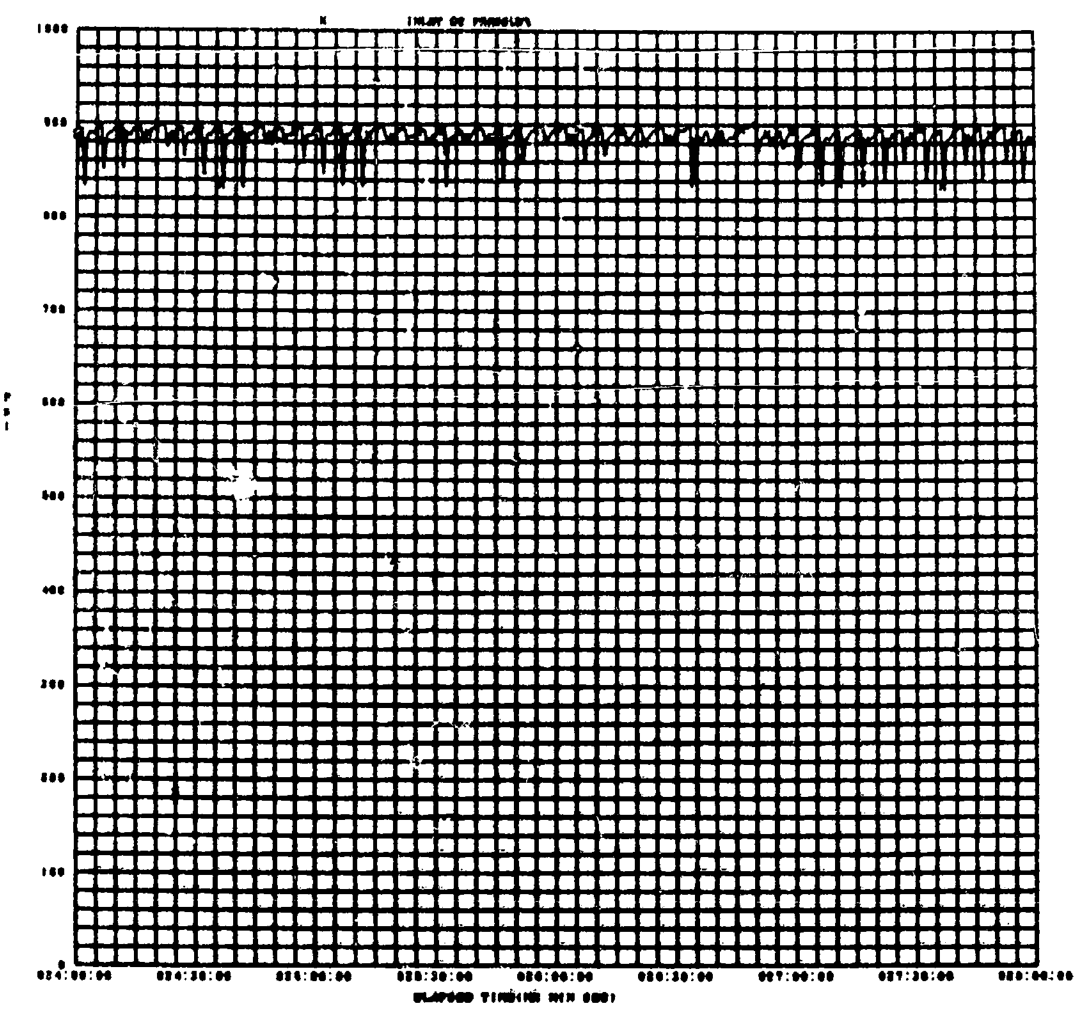


FIGURE 33F LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

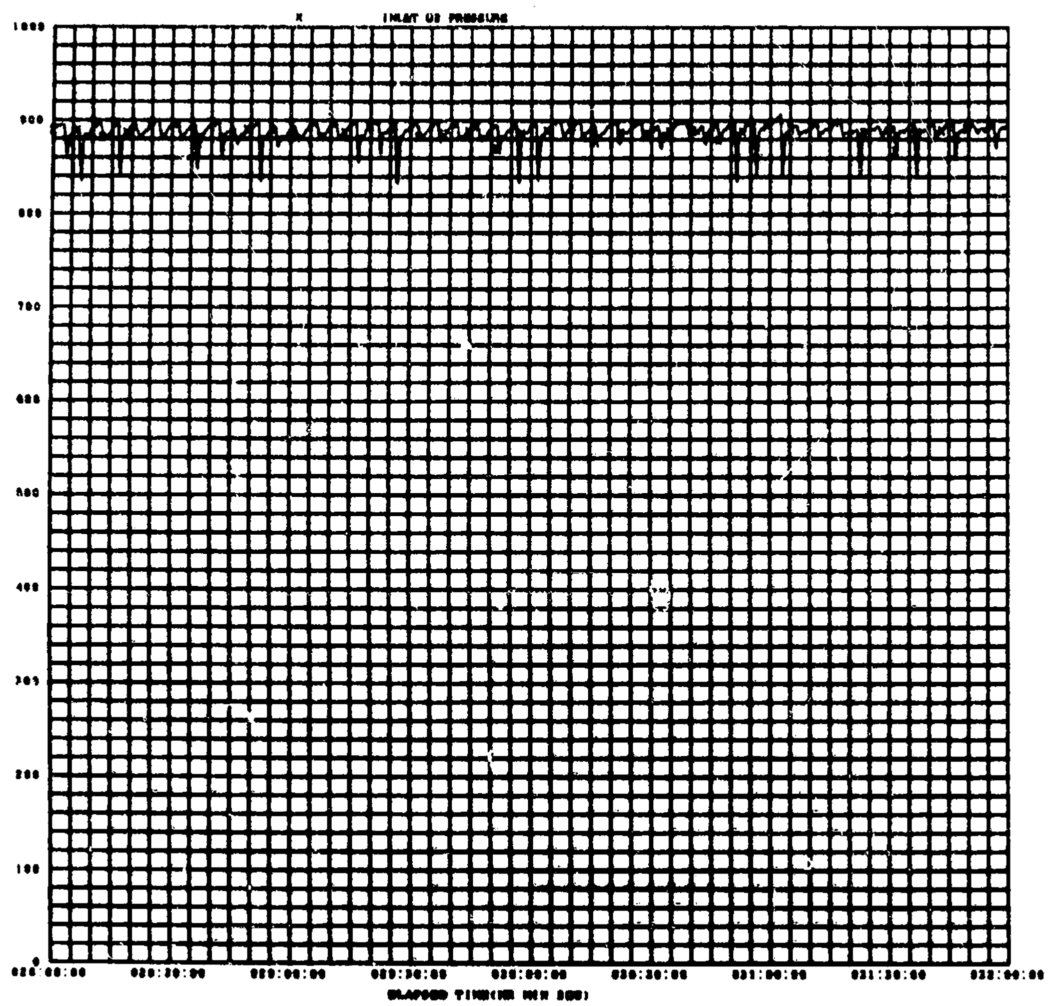


FIGURE 33G LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

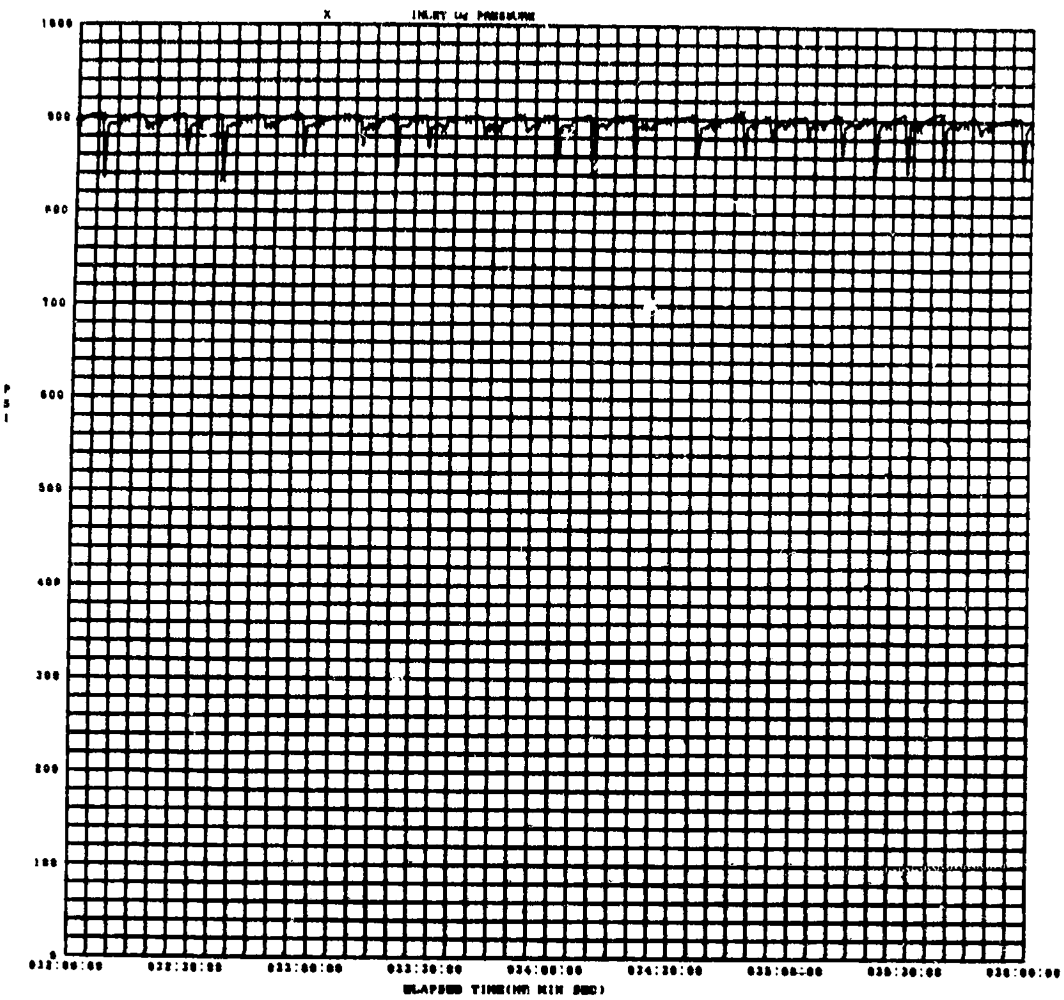


FIGURE 33H LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONTINUED

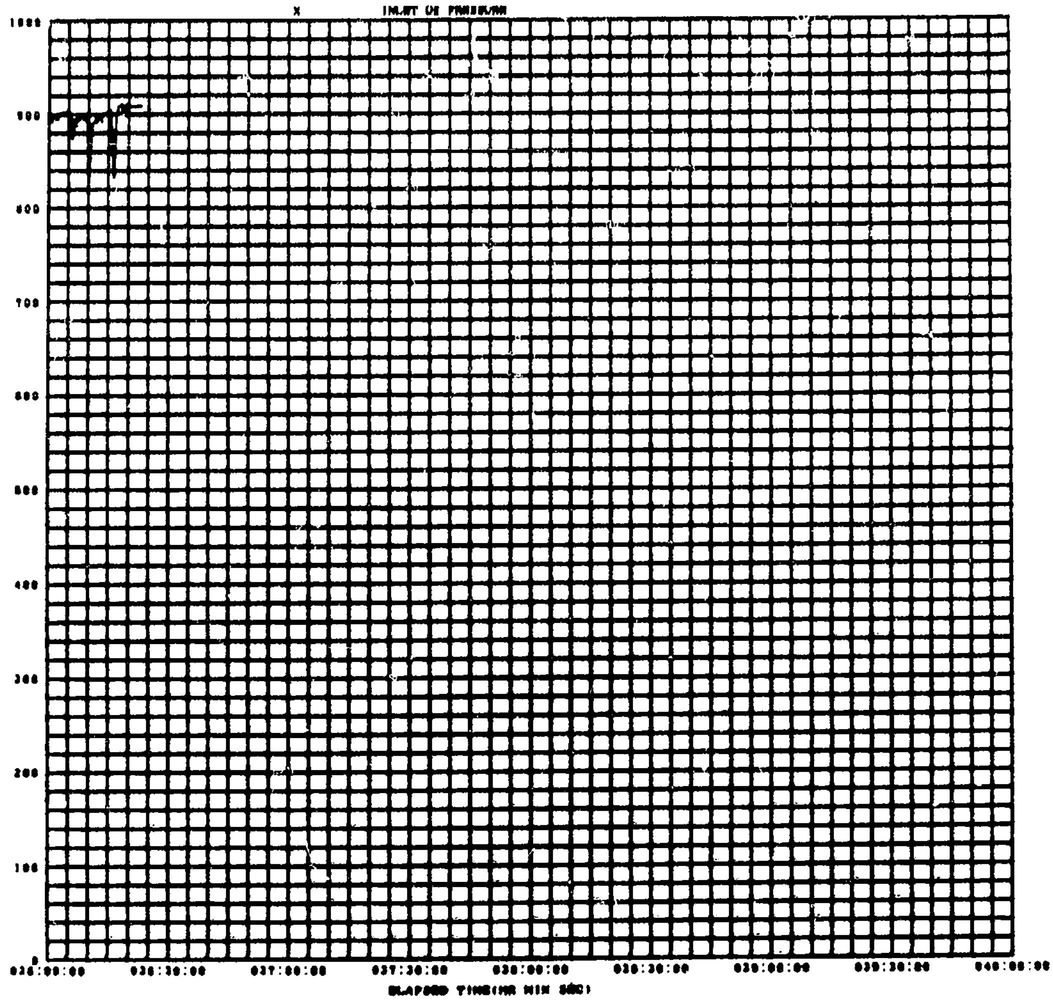


FIGURE 33J LM ECS O2 SUPPLY PRESSURE VERSUS TIME - CONCLUDED

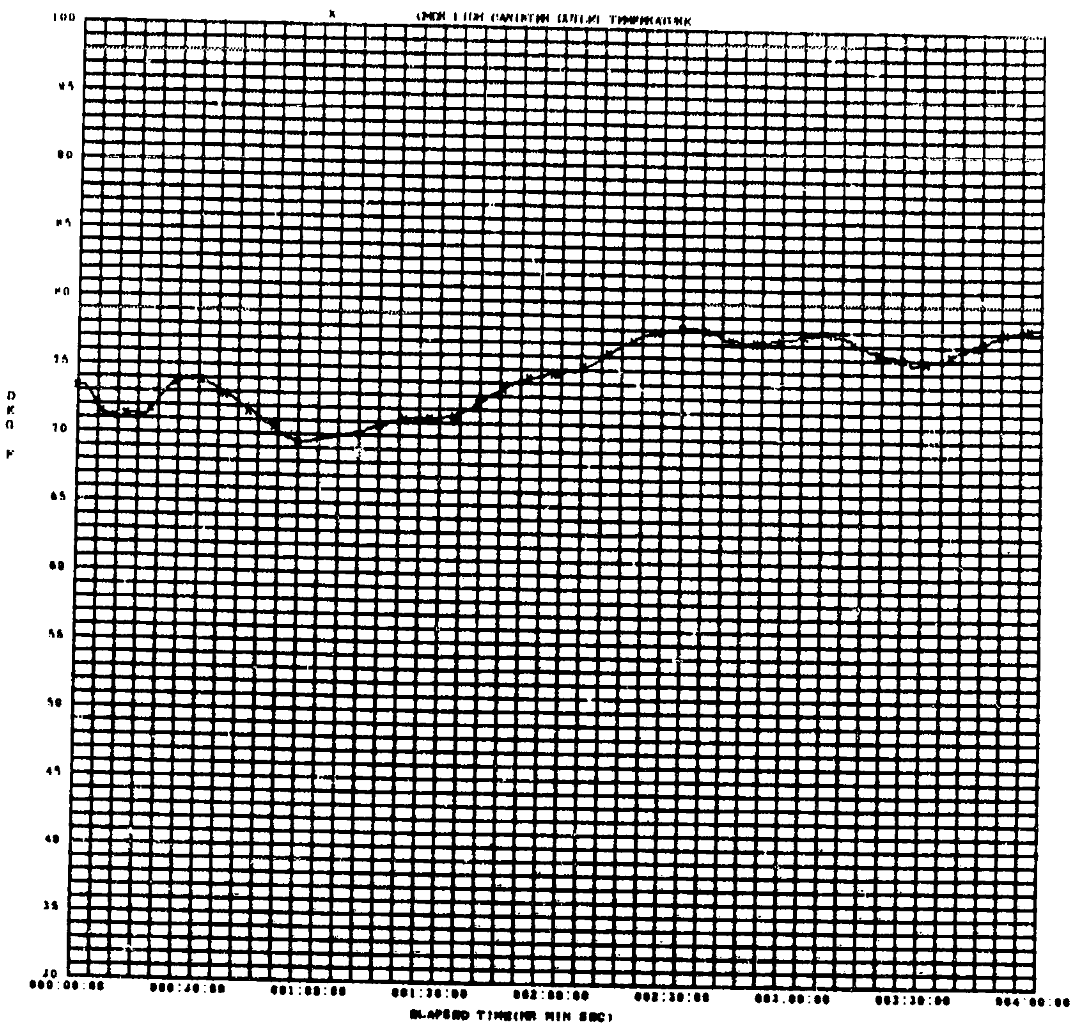


FIGURE 34 CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME

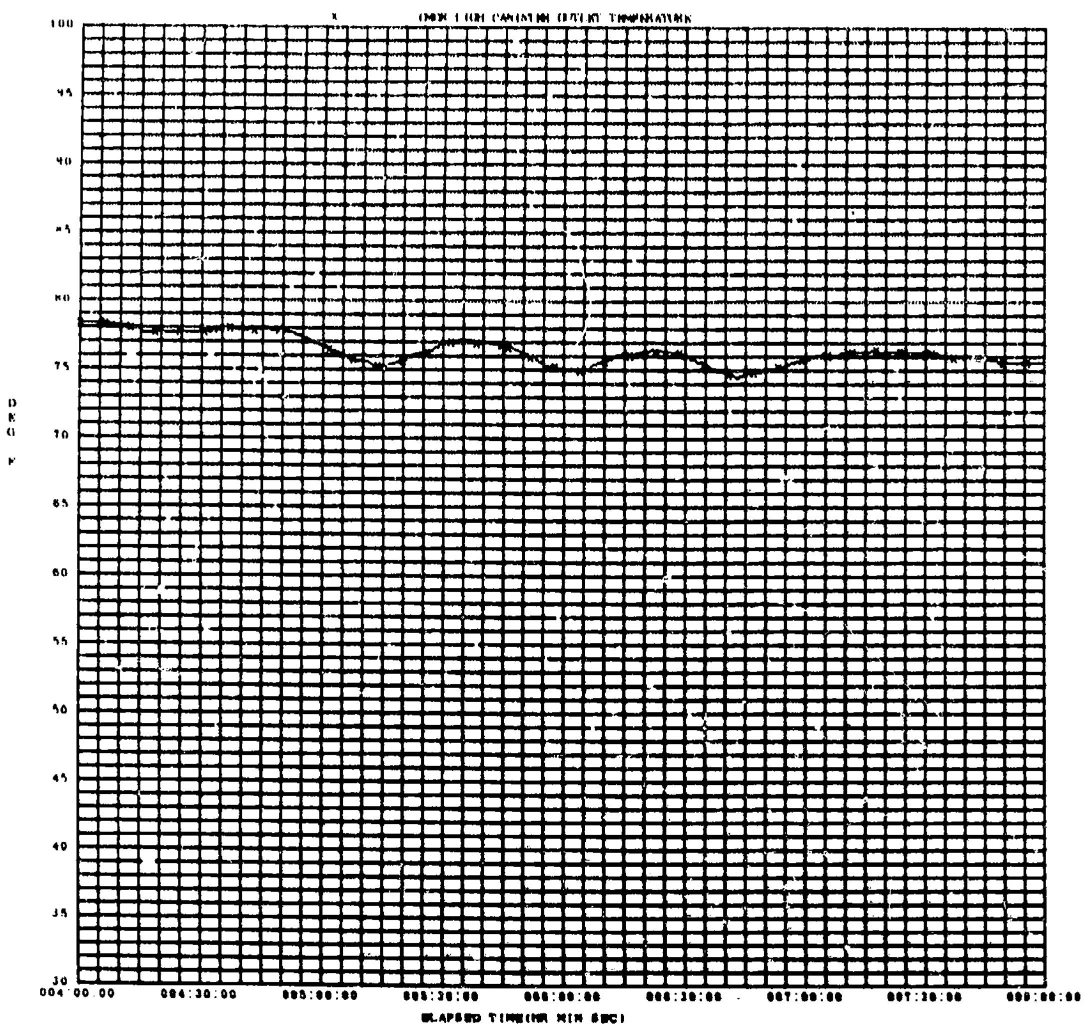


FIGURE 34A CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

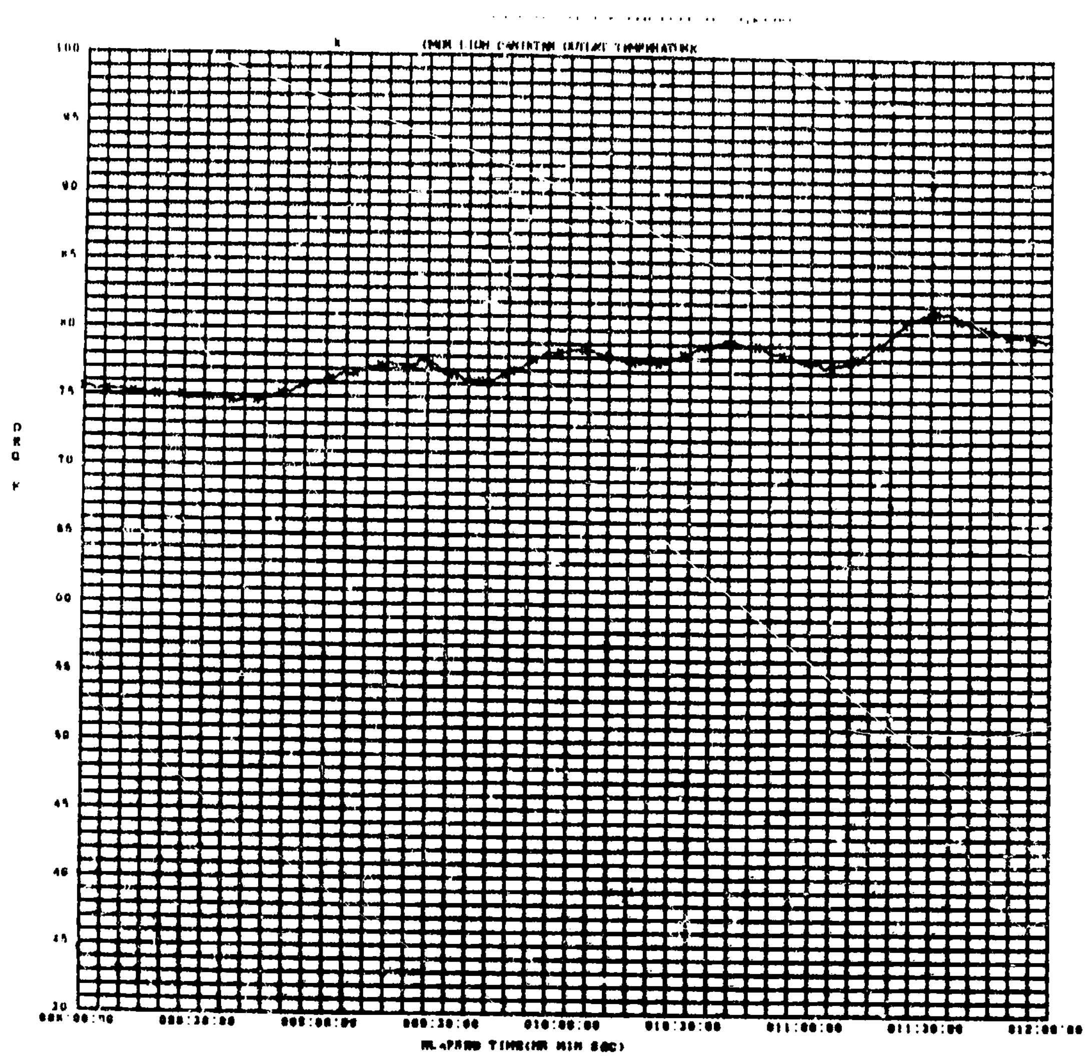


FIGURE 34B CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

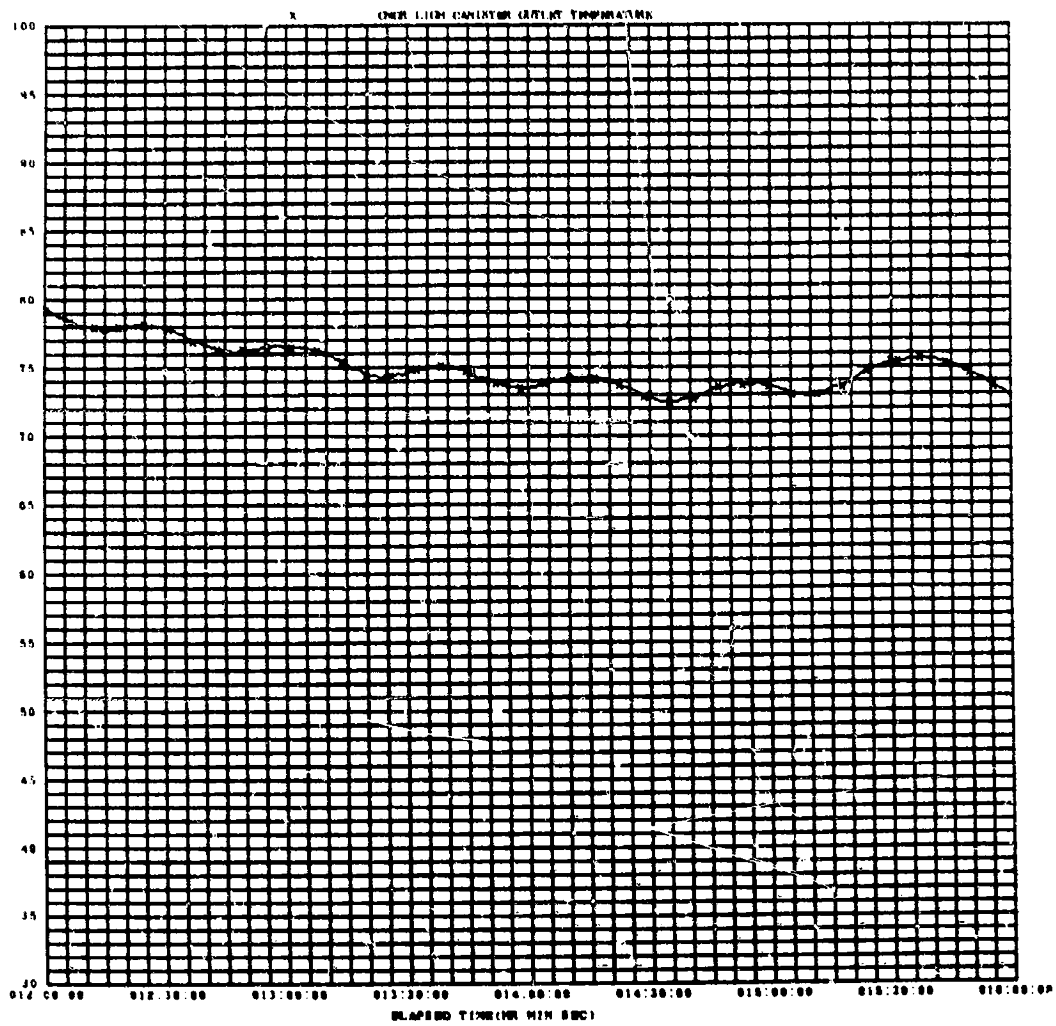


FIGURE 34C CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

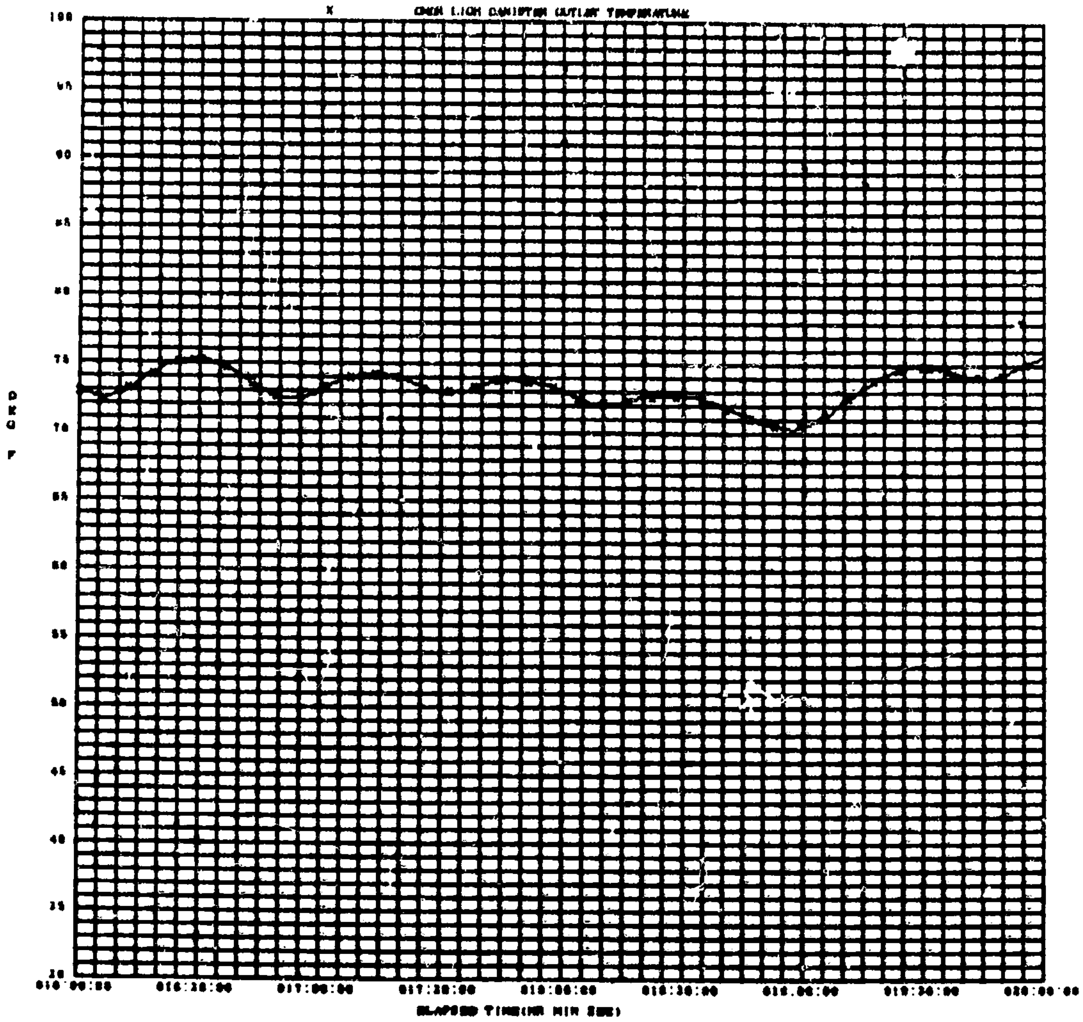


FIGURE 34D CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

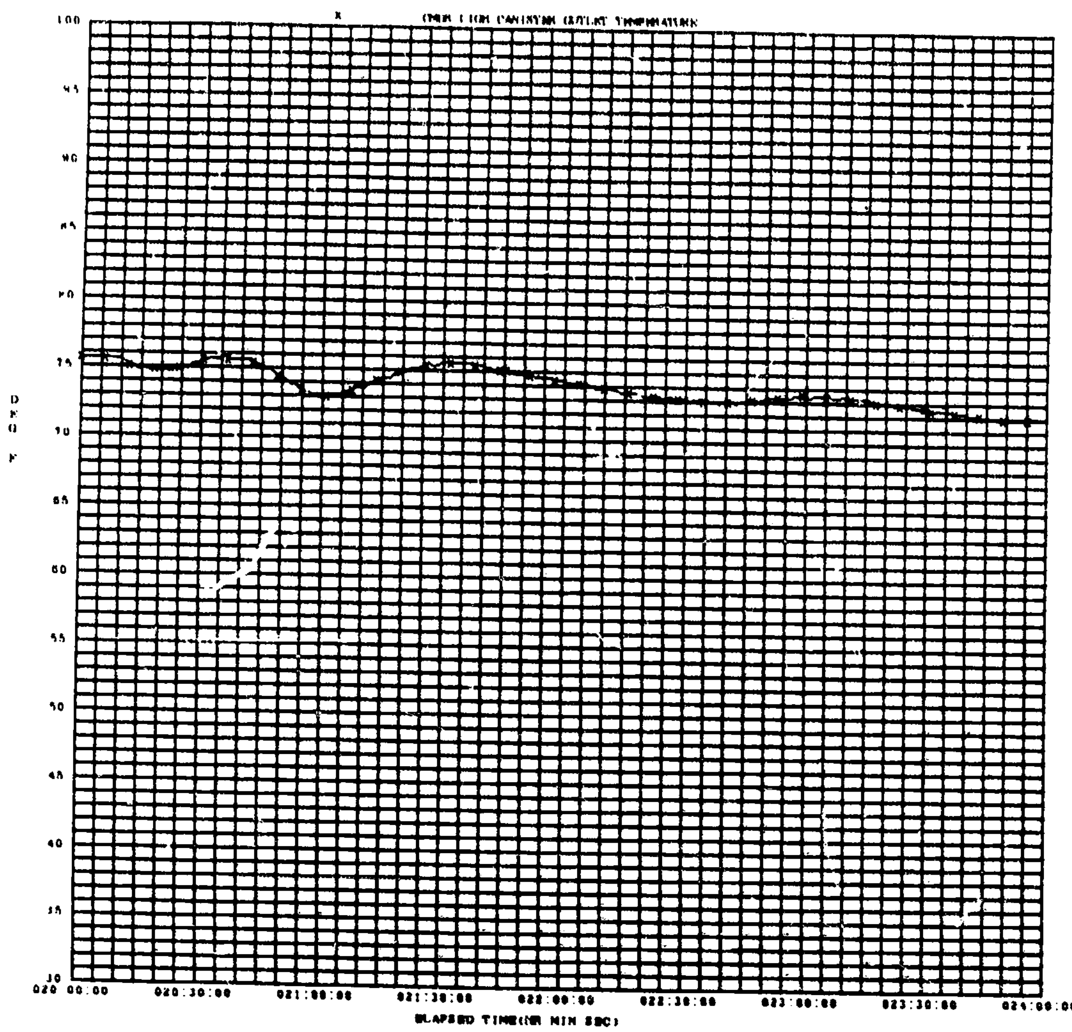


FIGURE 34E CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

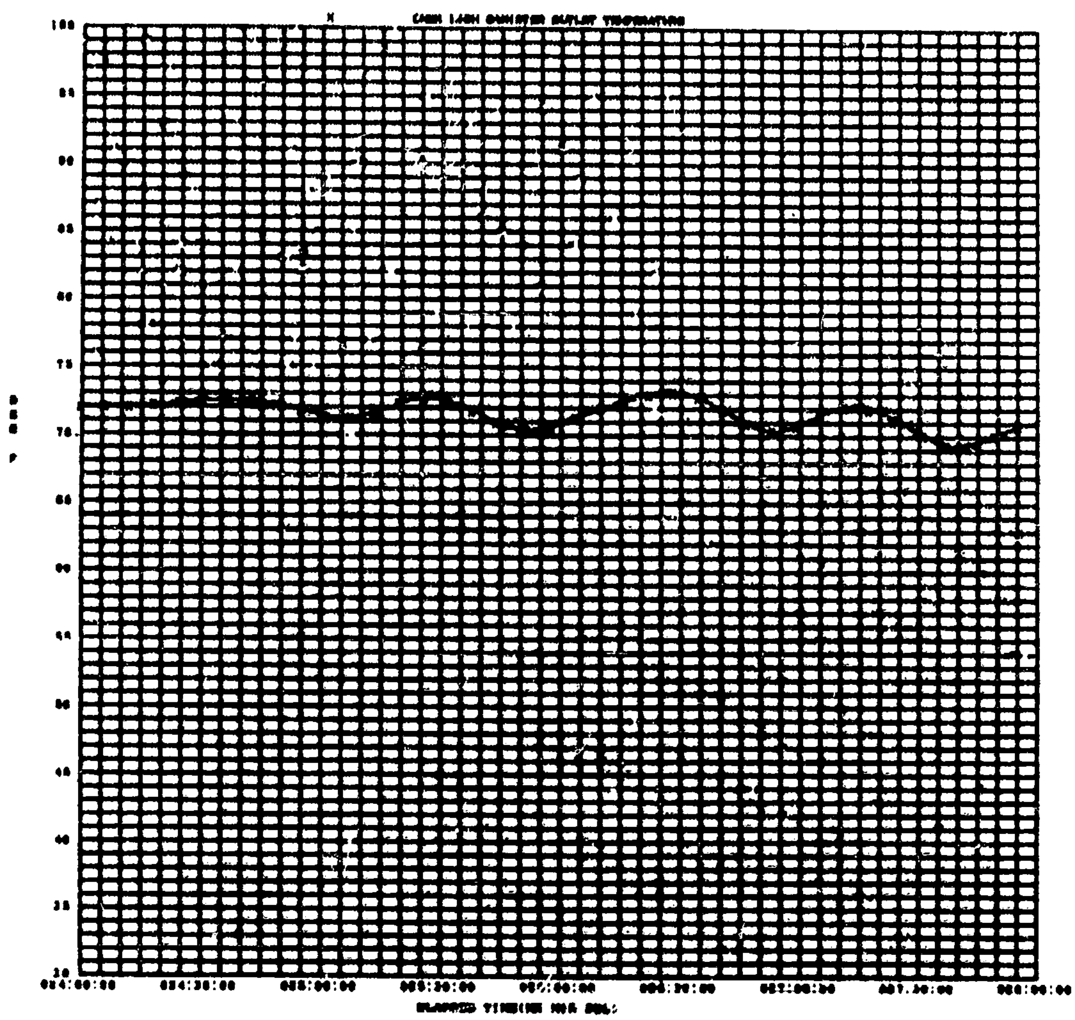


FIGURE 34F CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

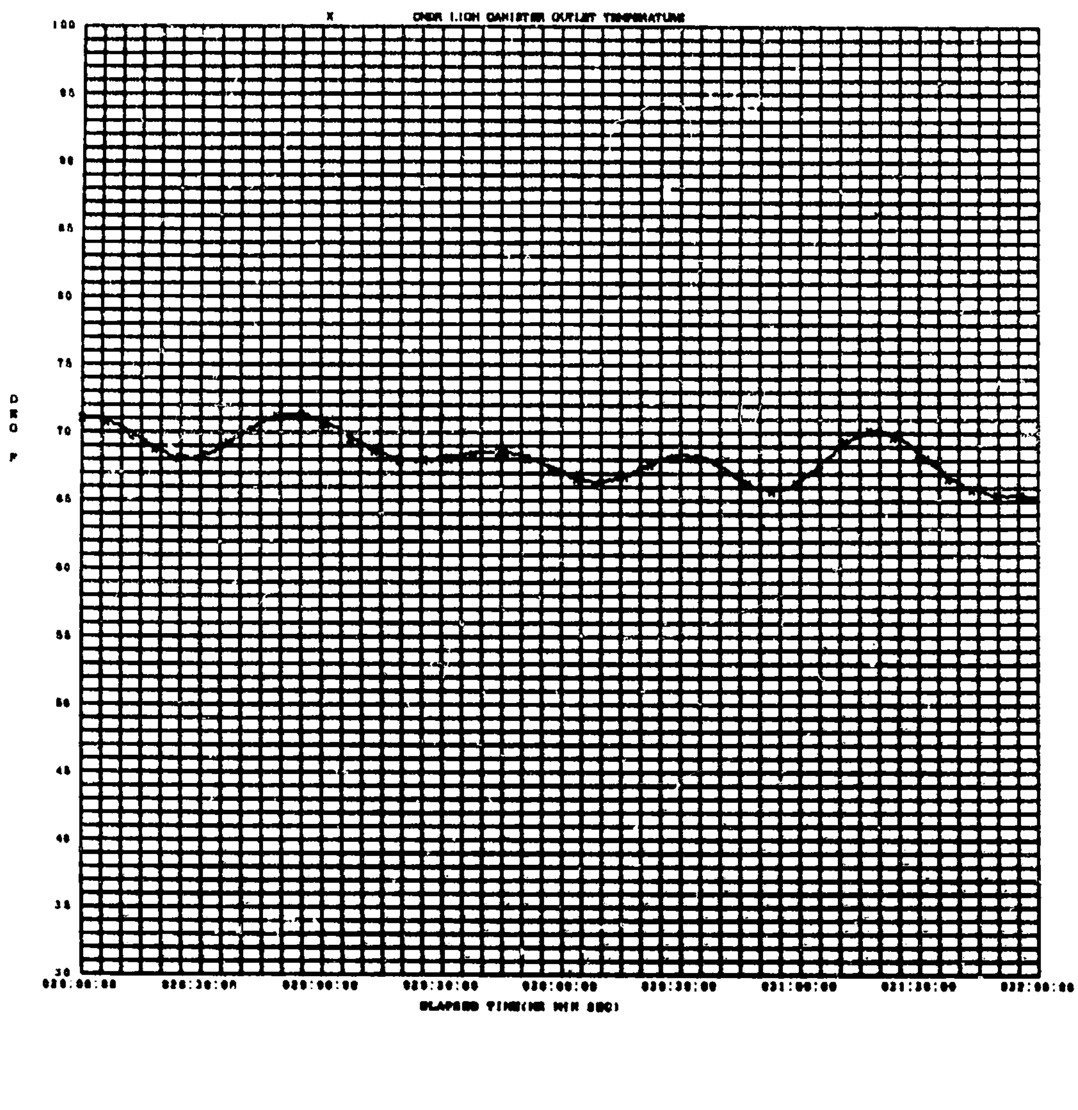


FIGURE 34G CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONTINUED

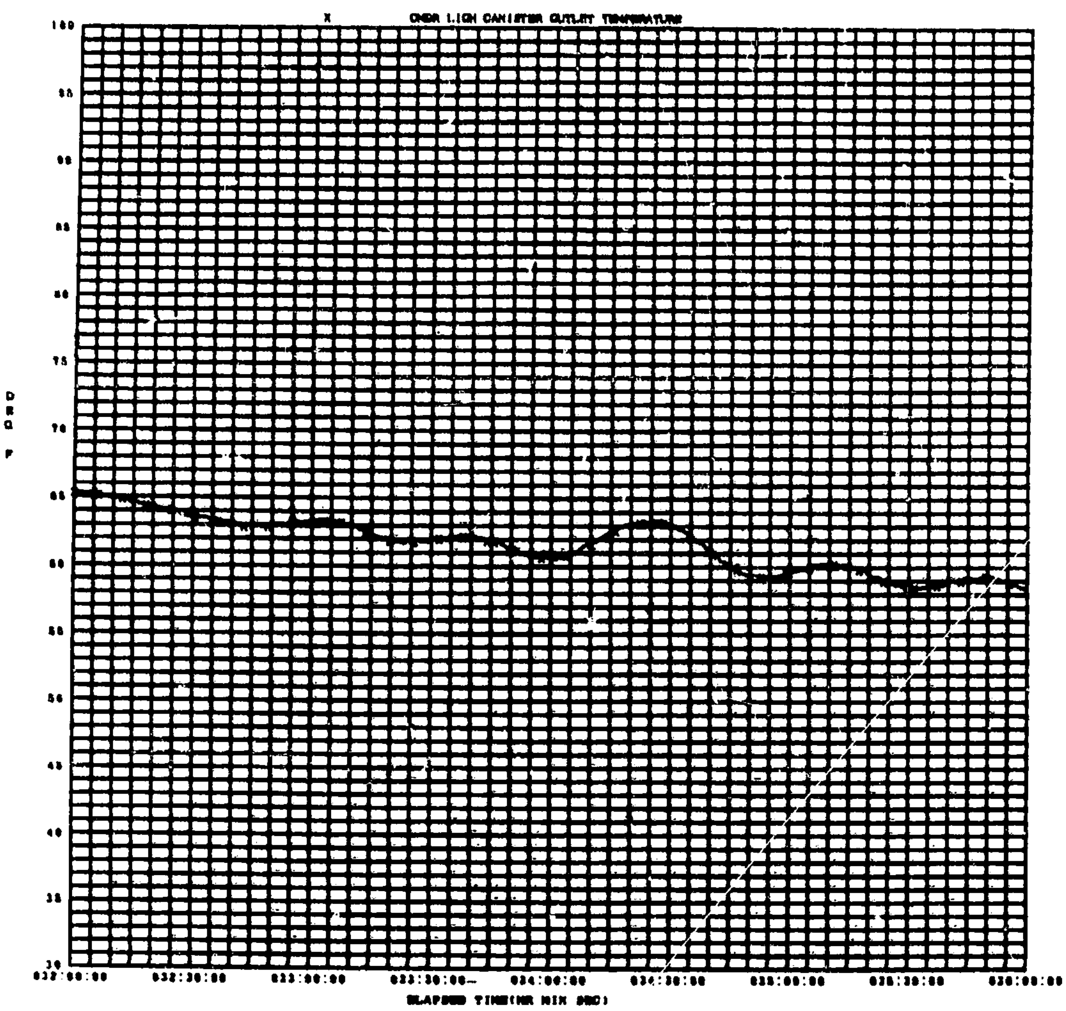


FIGURE 34H CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME - CONTINUED

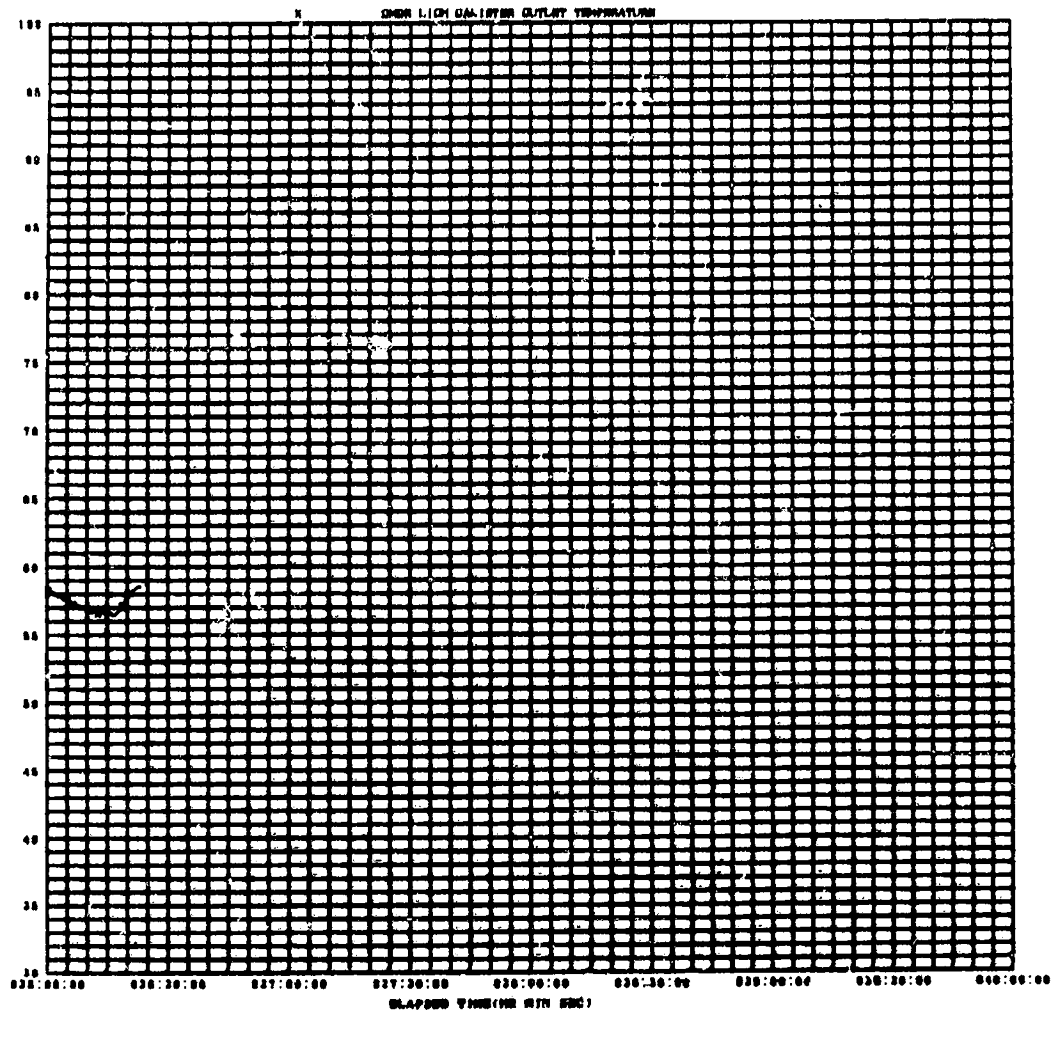


FIGURE 34J CDR LIOH CANISTER OUTLET TEMPERATURE VERSUS TIME
- CONCLUDED

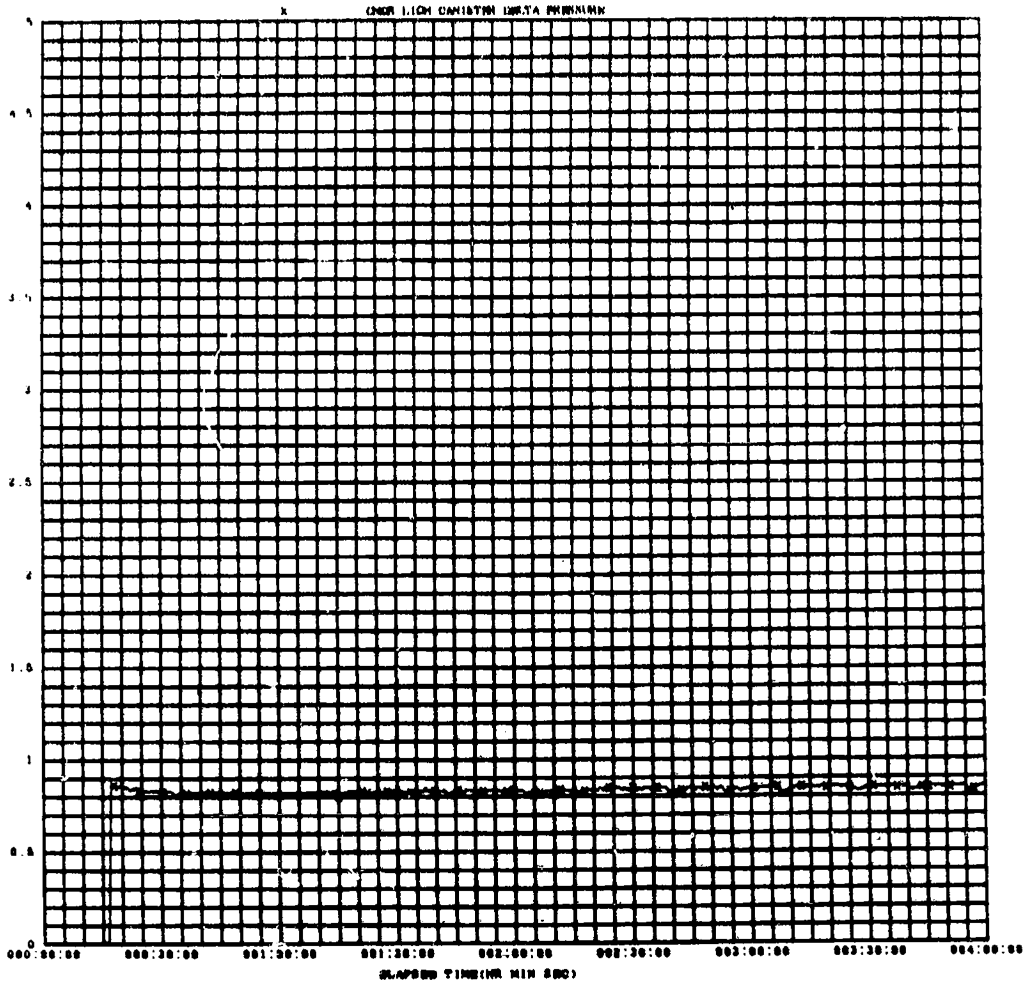


FIGURE 35 CDR LIOH CANISTER DELTA P VERSUS TIME

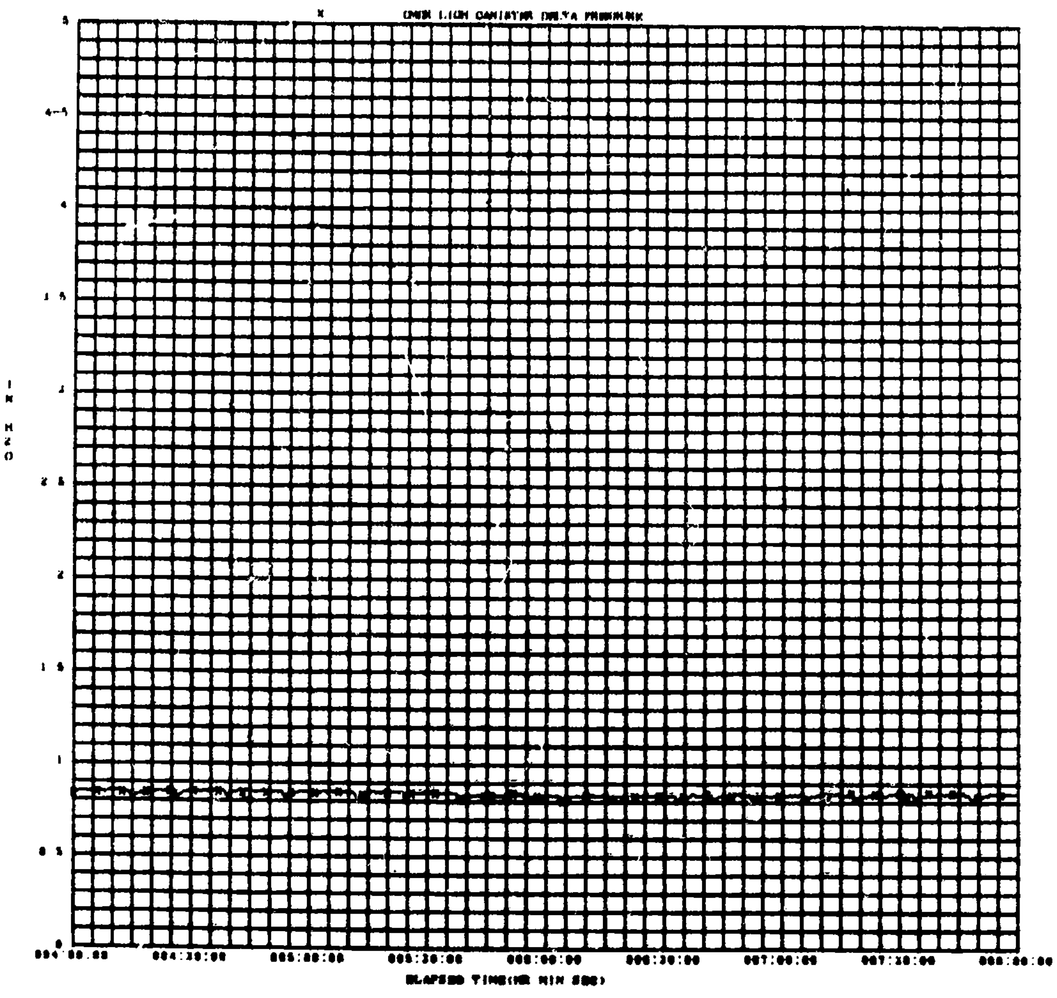


FIGURE 35A CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

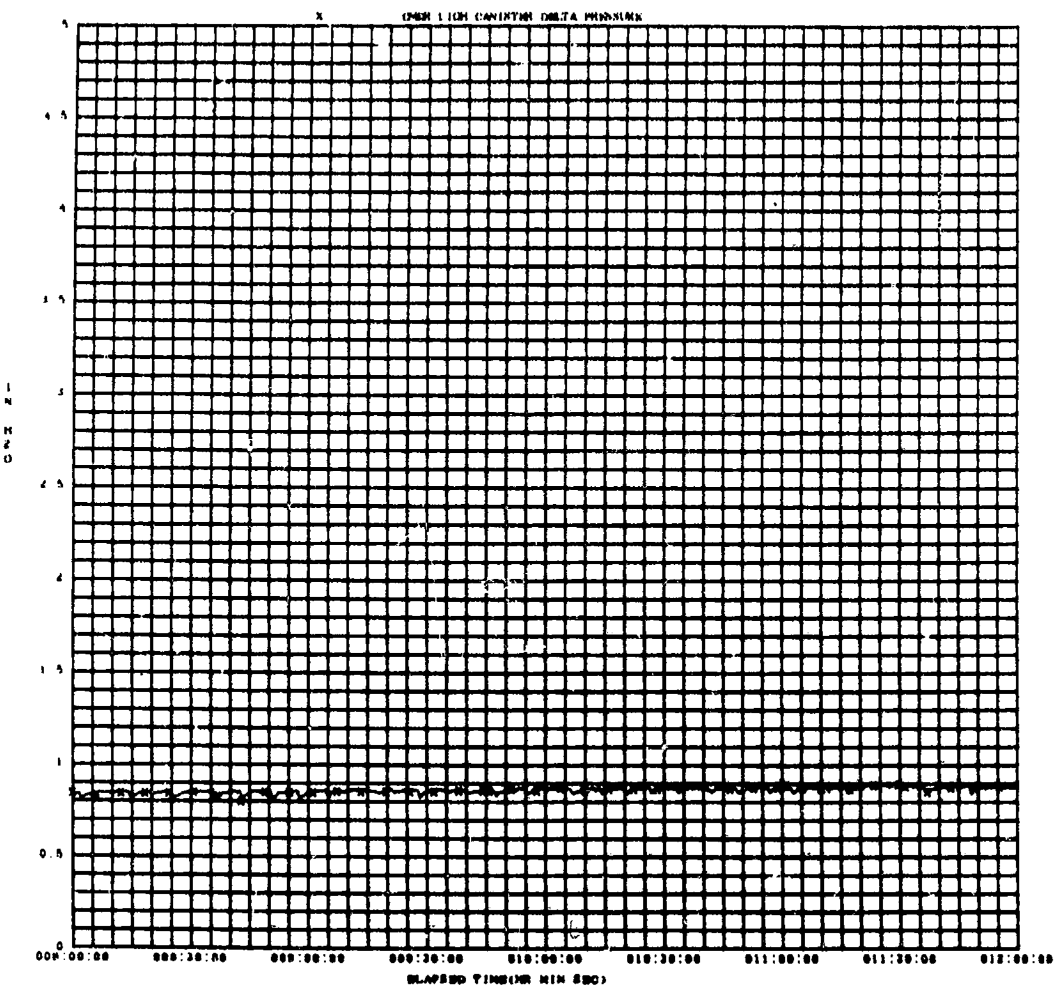


FIGURE 35B CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

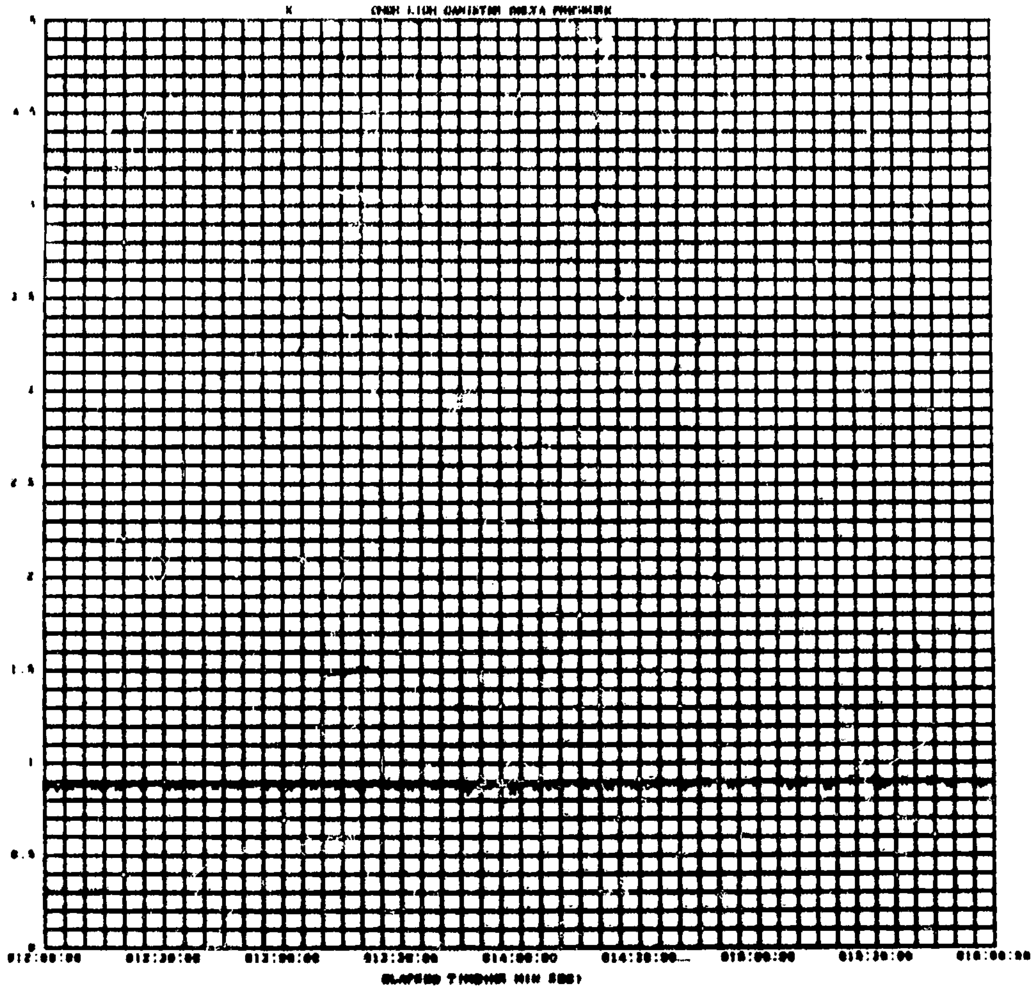


FIGURE 35C CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

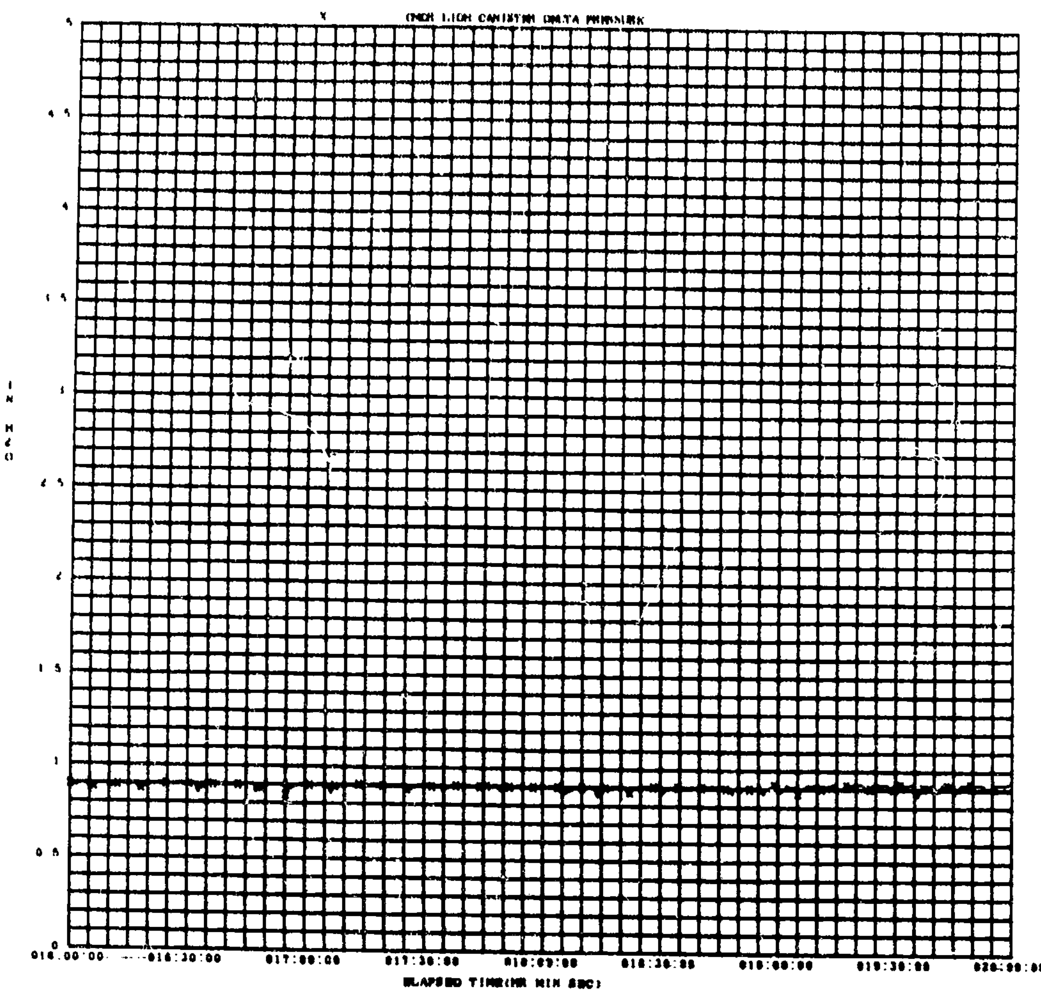


FIGURE 35D CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

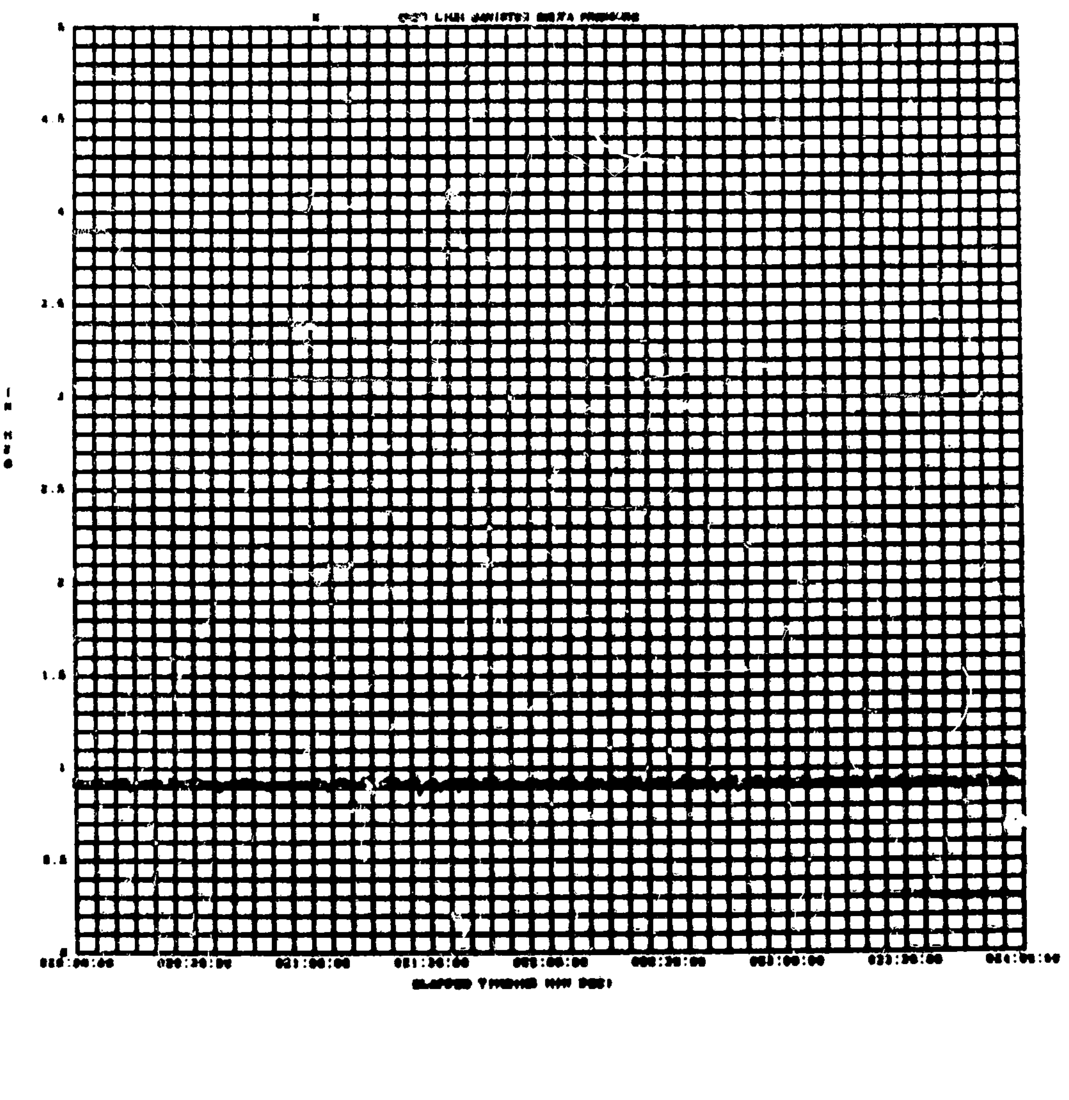


FIGURE 35E CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

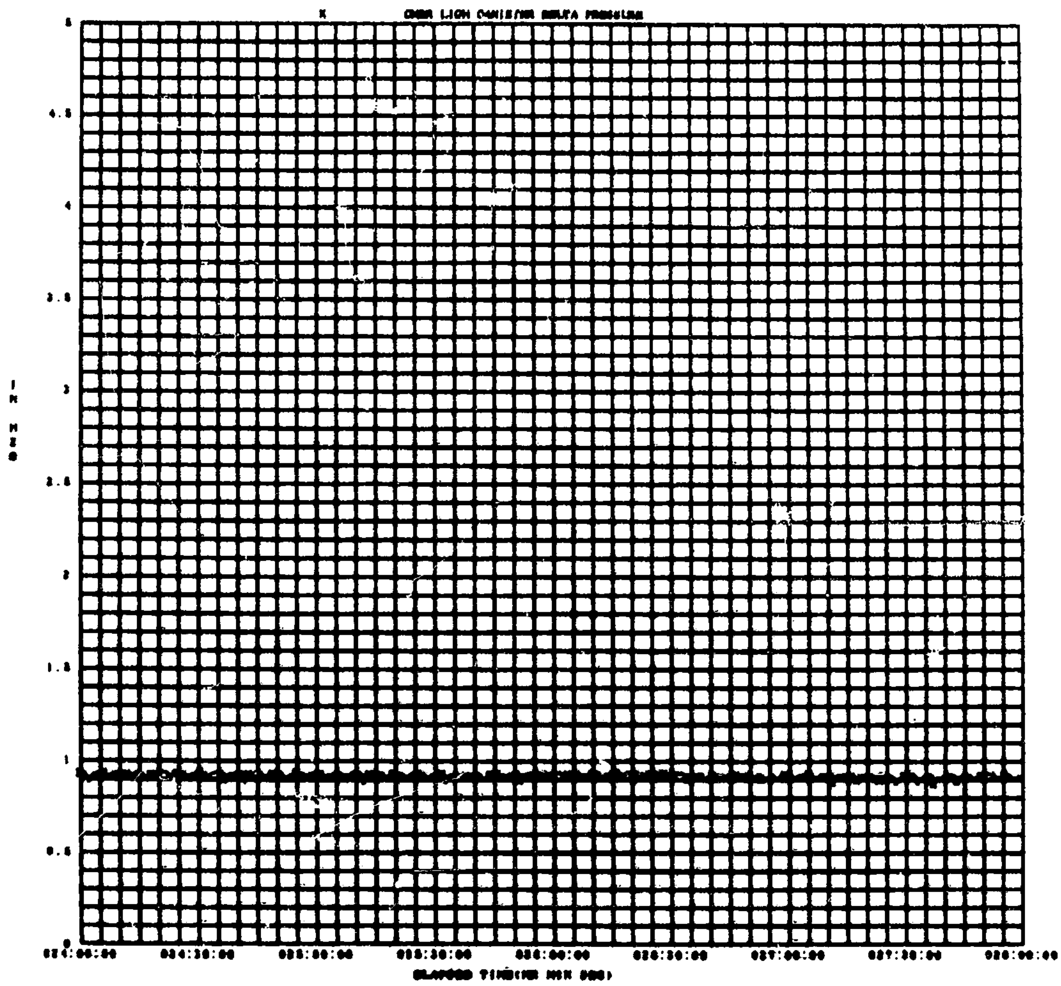


FIGURE 35F CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

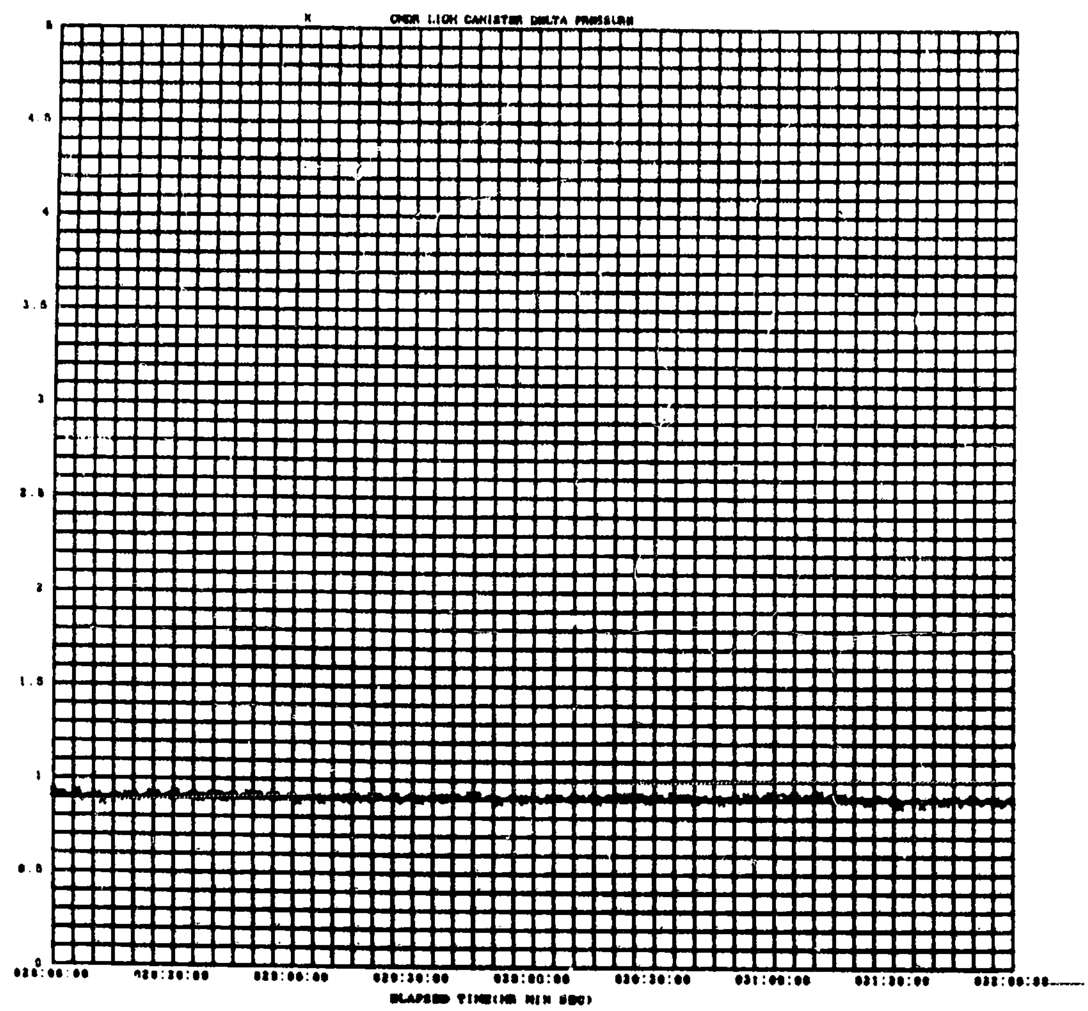


FIGURE 35G CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

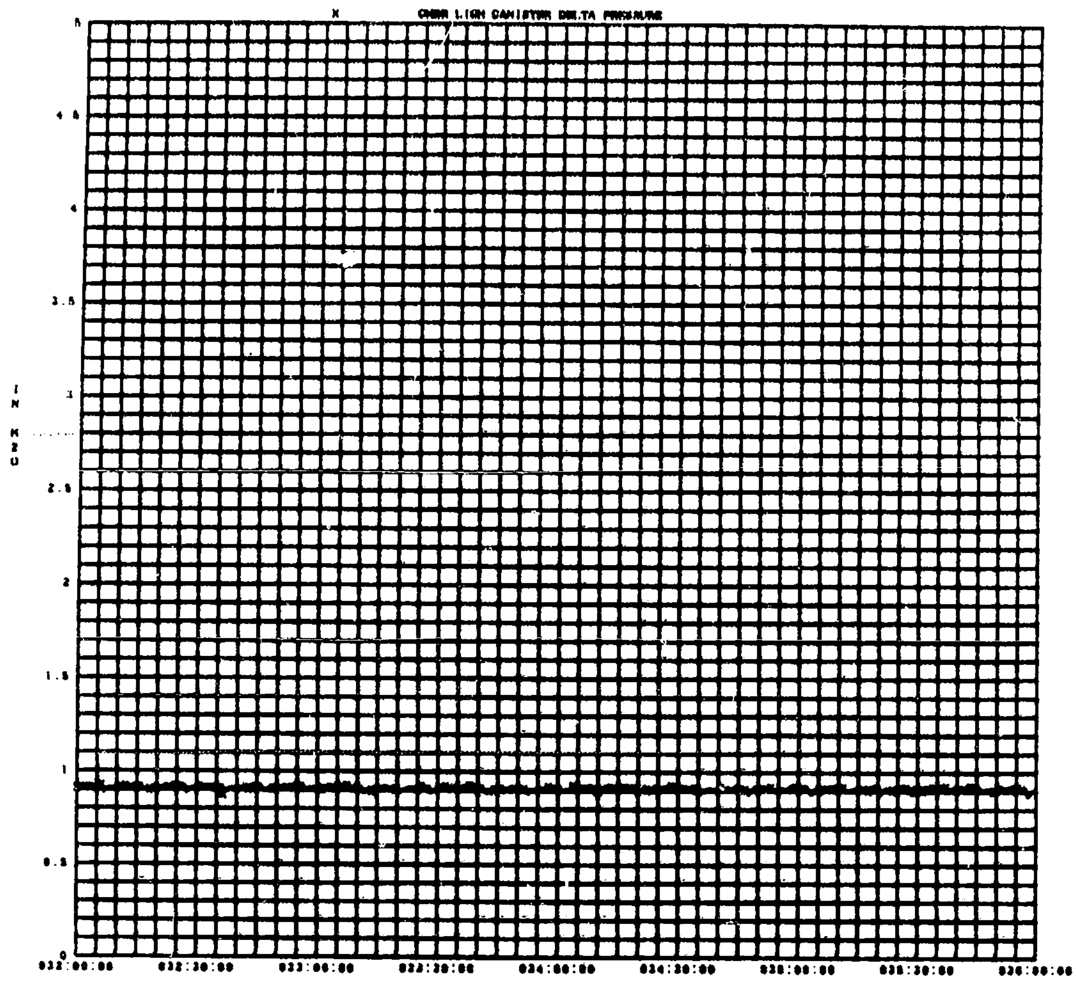


FIGURE 35H CDR LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

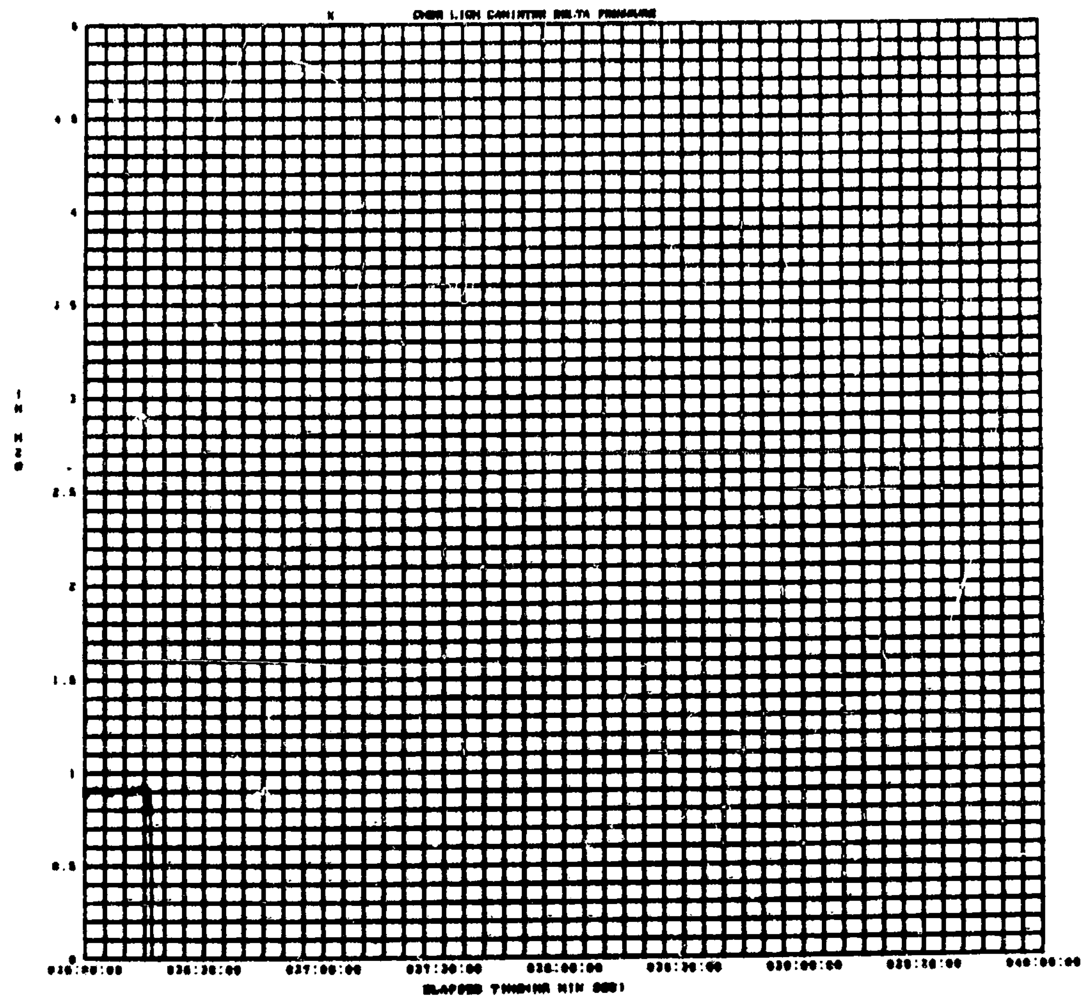


FIGURE 35J CDR LIOH CANISTER DELTA P VERSUS TIME - CONCLUDED

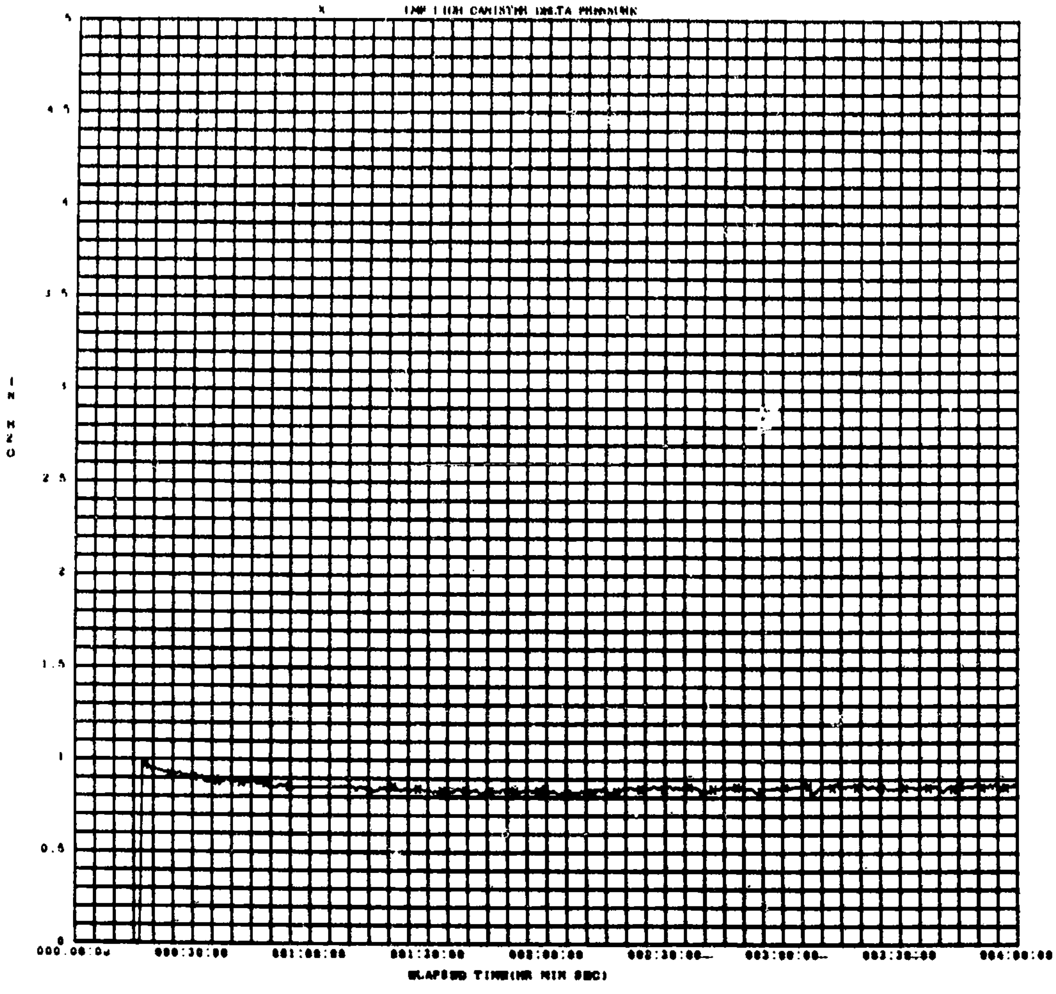


FIGURE 36 LMP LIOH CANISTER DELTA P VERSUS TIME

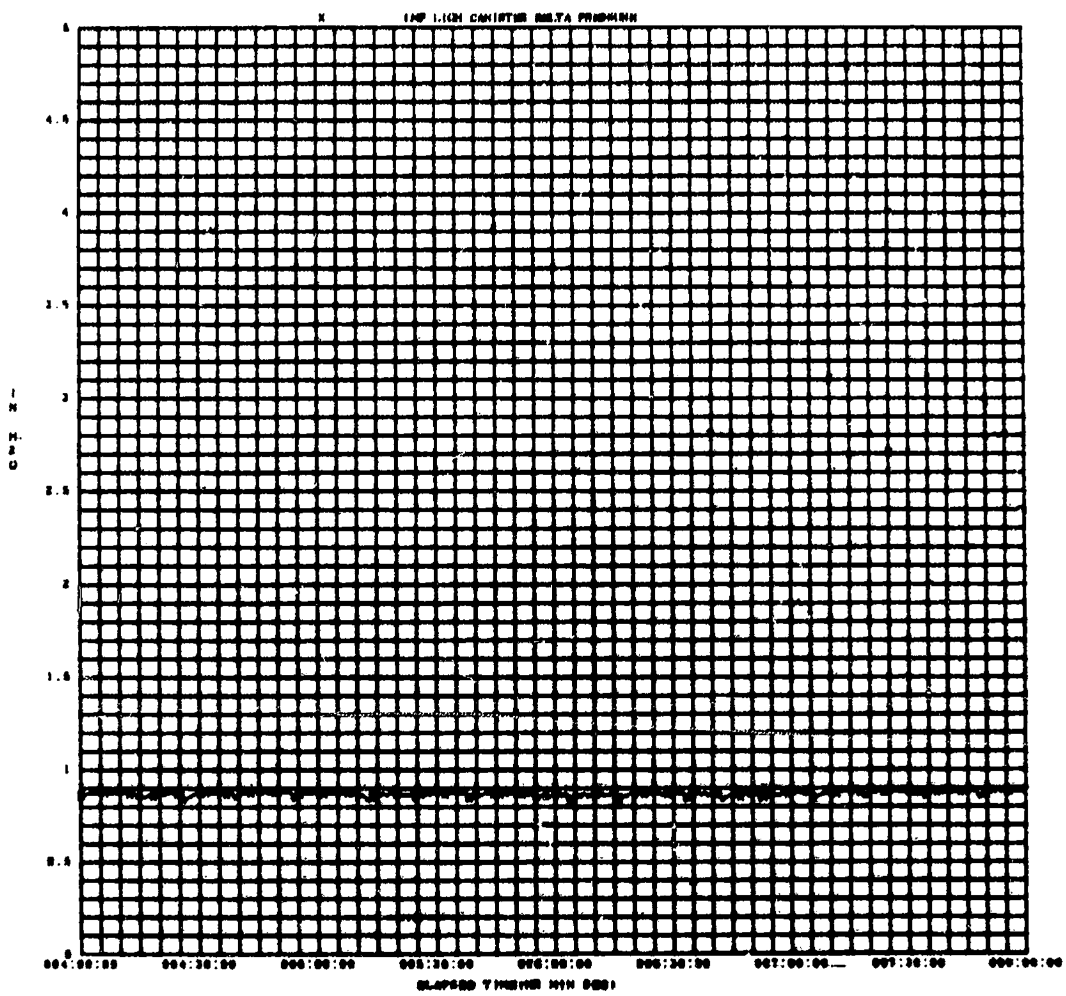


FIGURE 36A LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

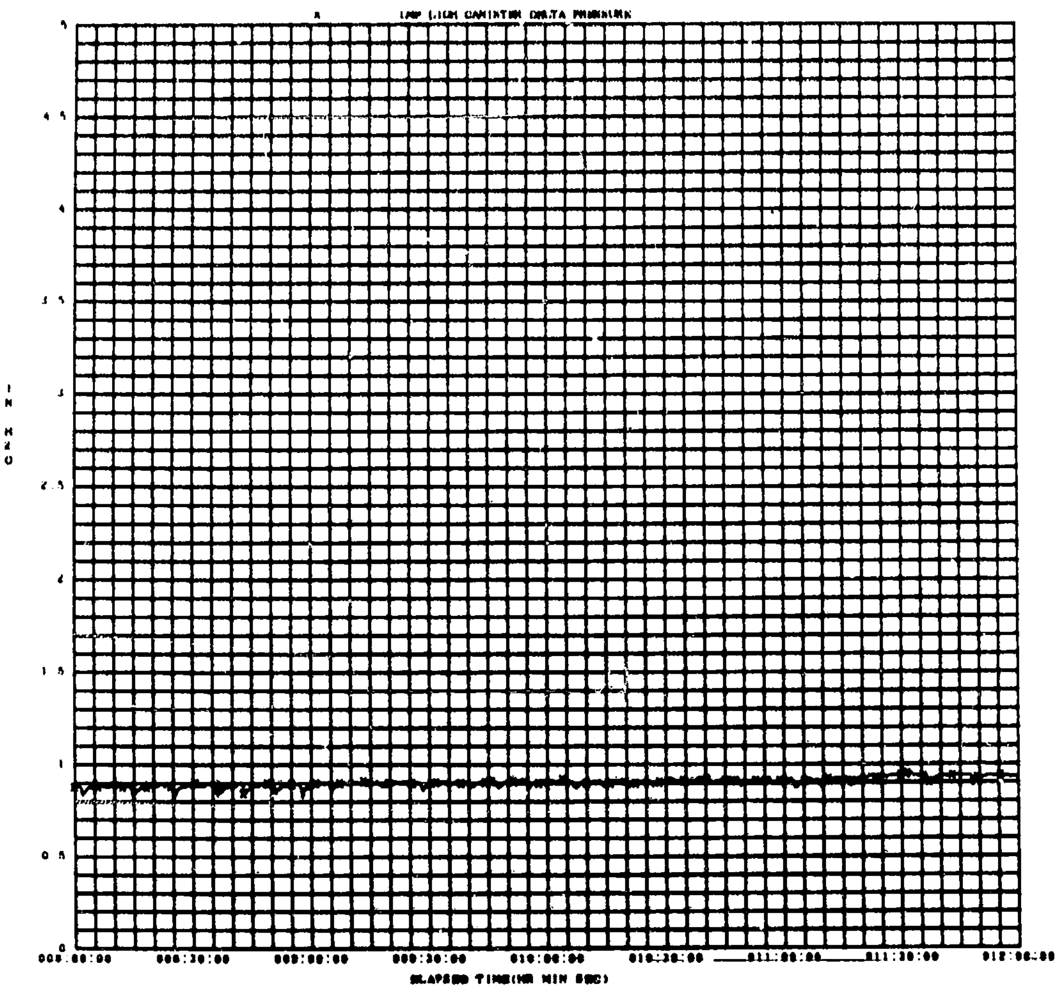


FIGURE 36B LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

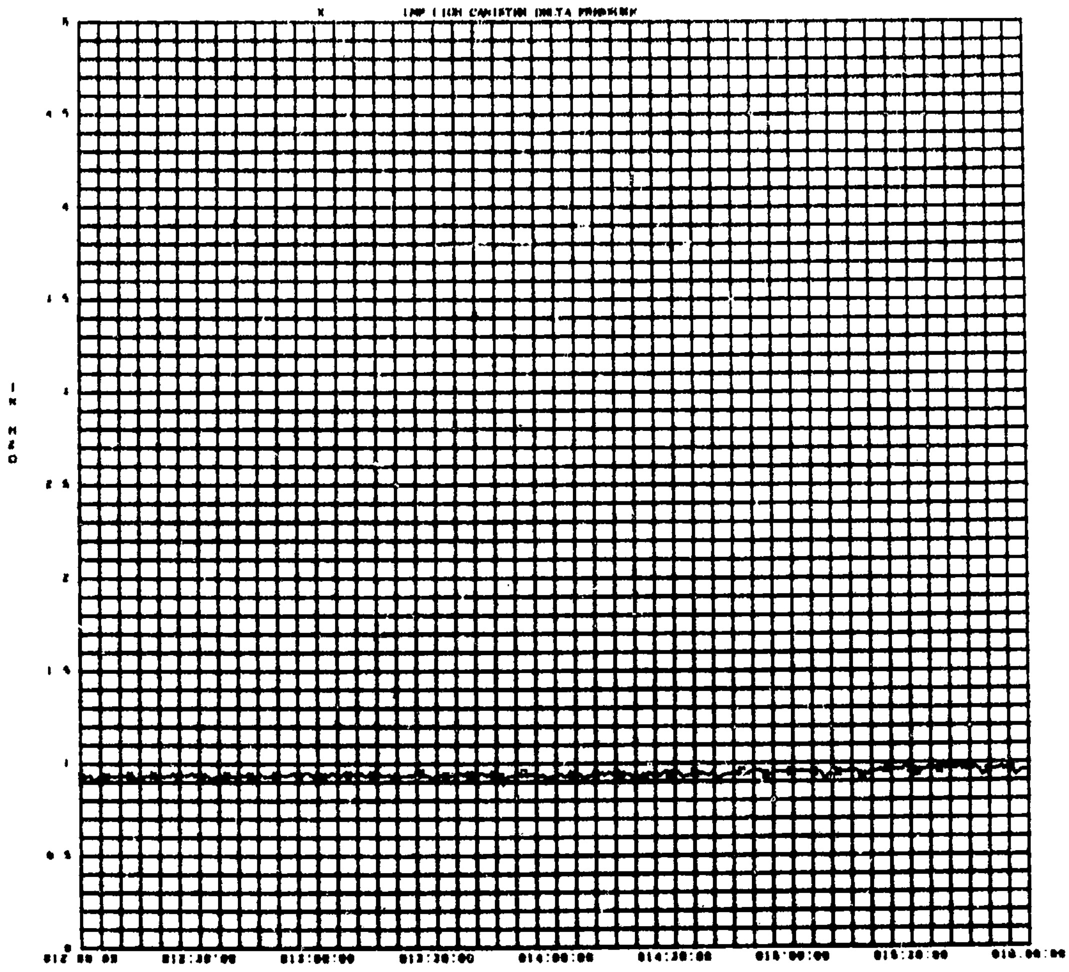


FIGURE 36C LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

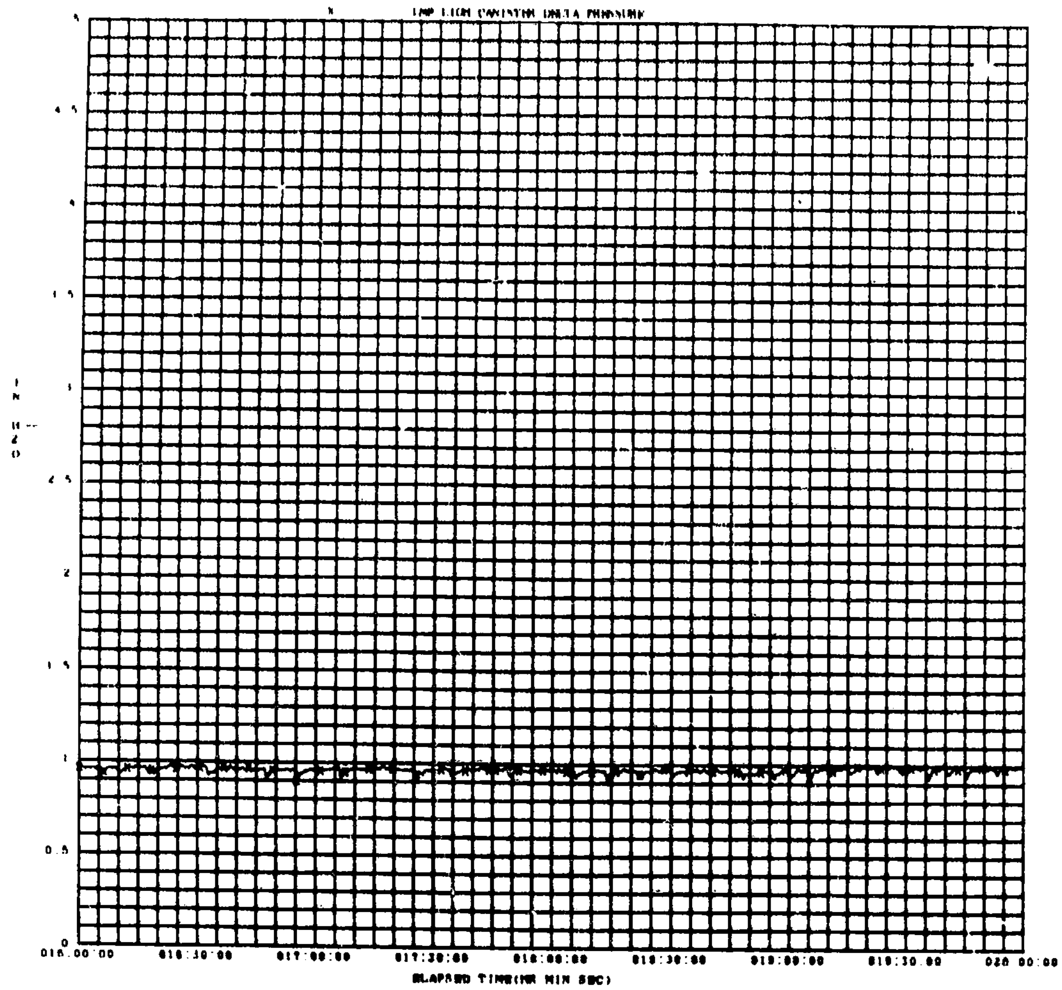


FIGURE 36D LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

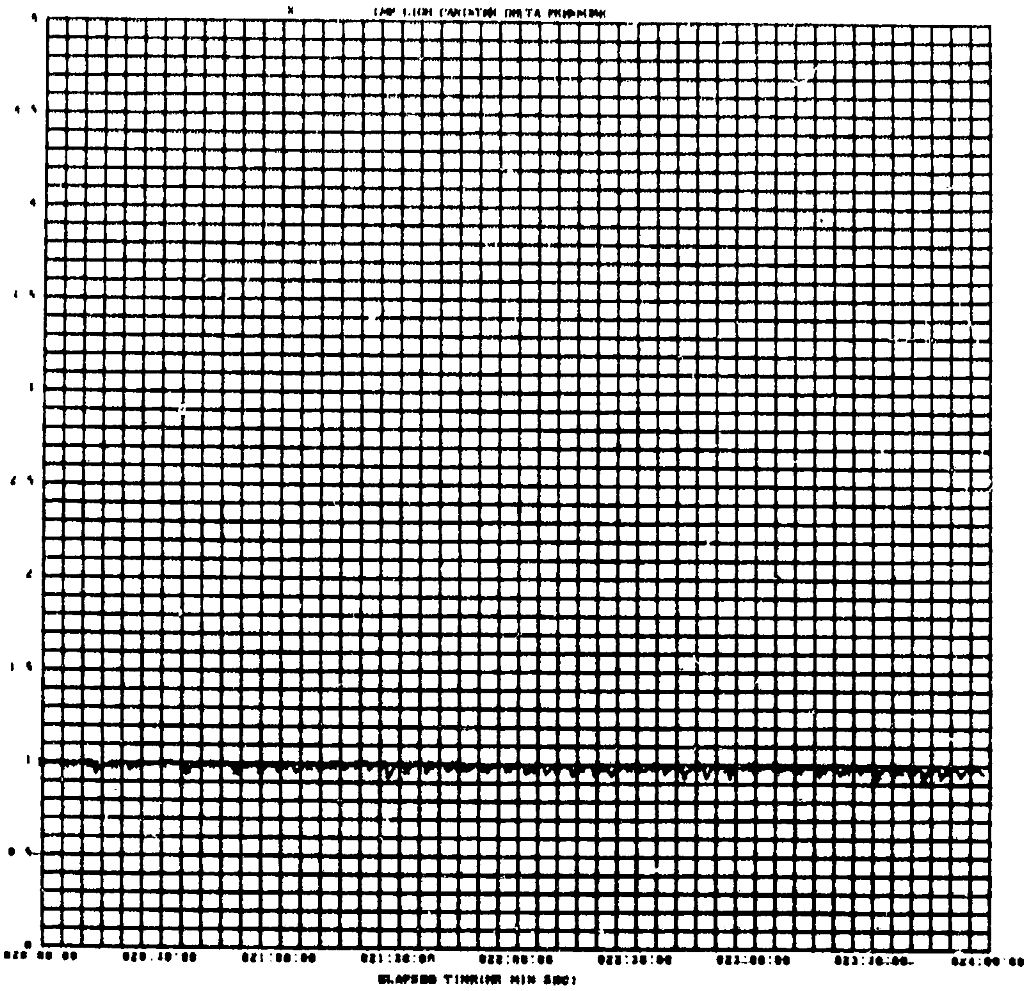


FIGURE 36E LMP LiOH CANISTER DELTA P VERSUS TIME - CONTINUED

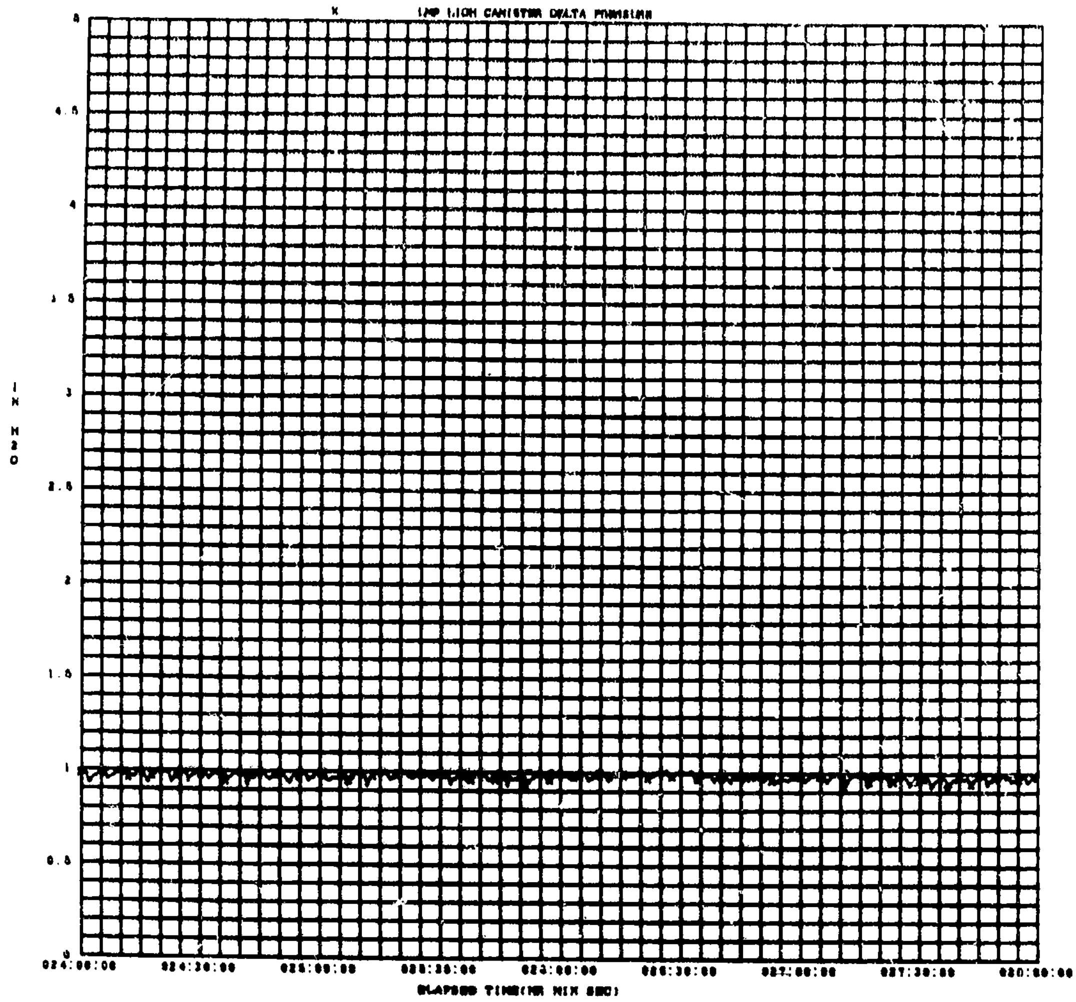


FIGURE 36F LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

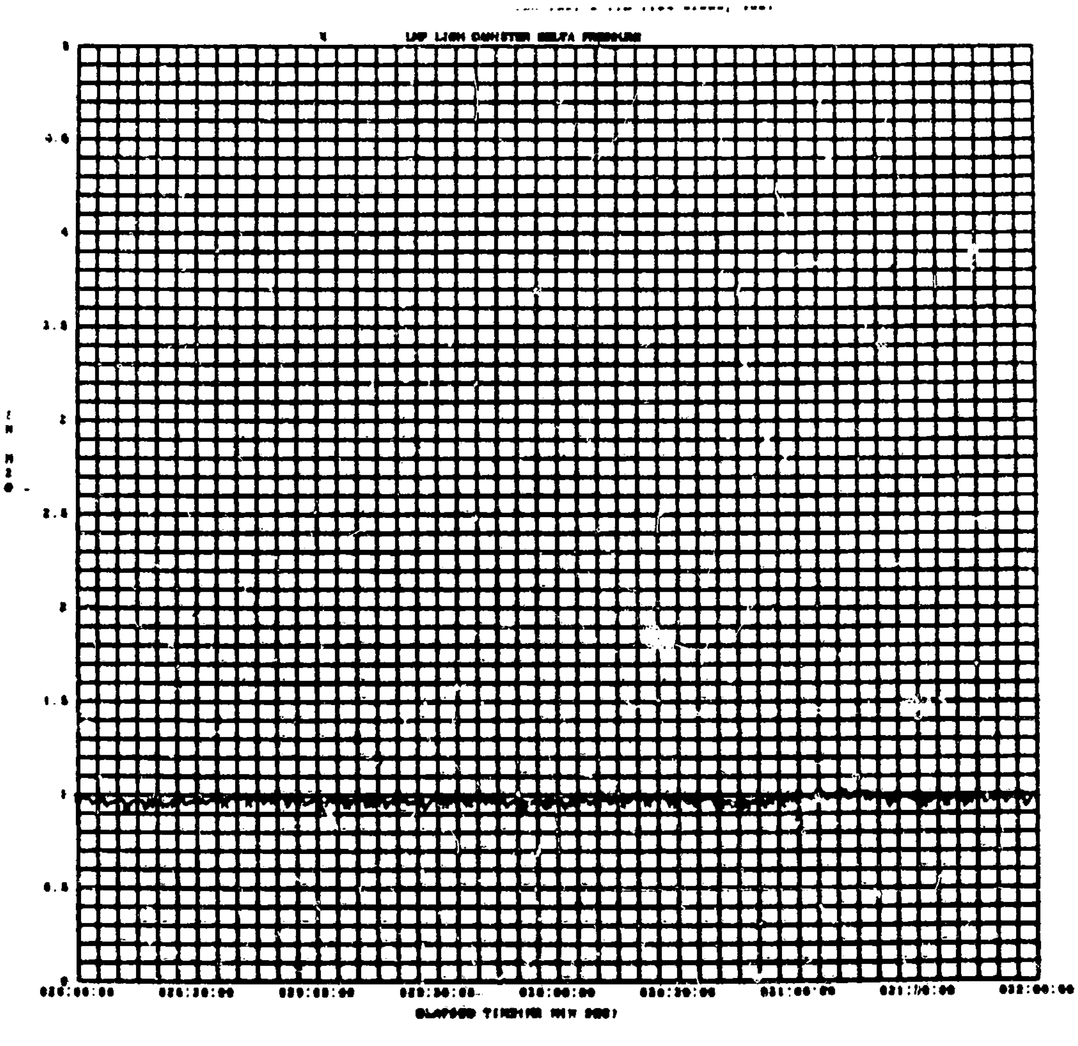


FIGURE 36G LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

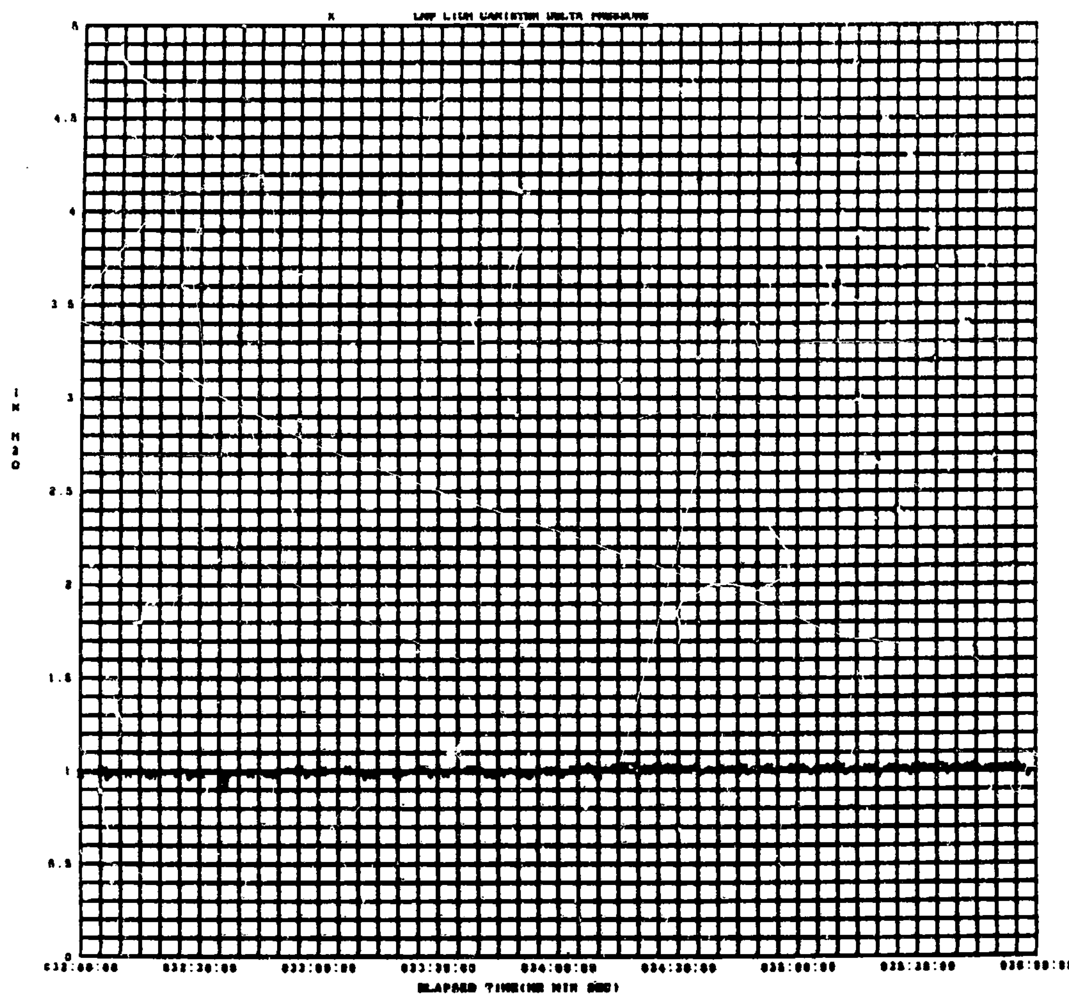


FIGURE 36H LMP LIOH CANISTER DELTA P VERSUS TIME - CONTINUED

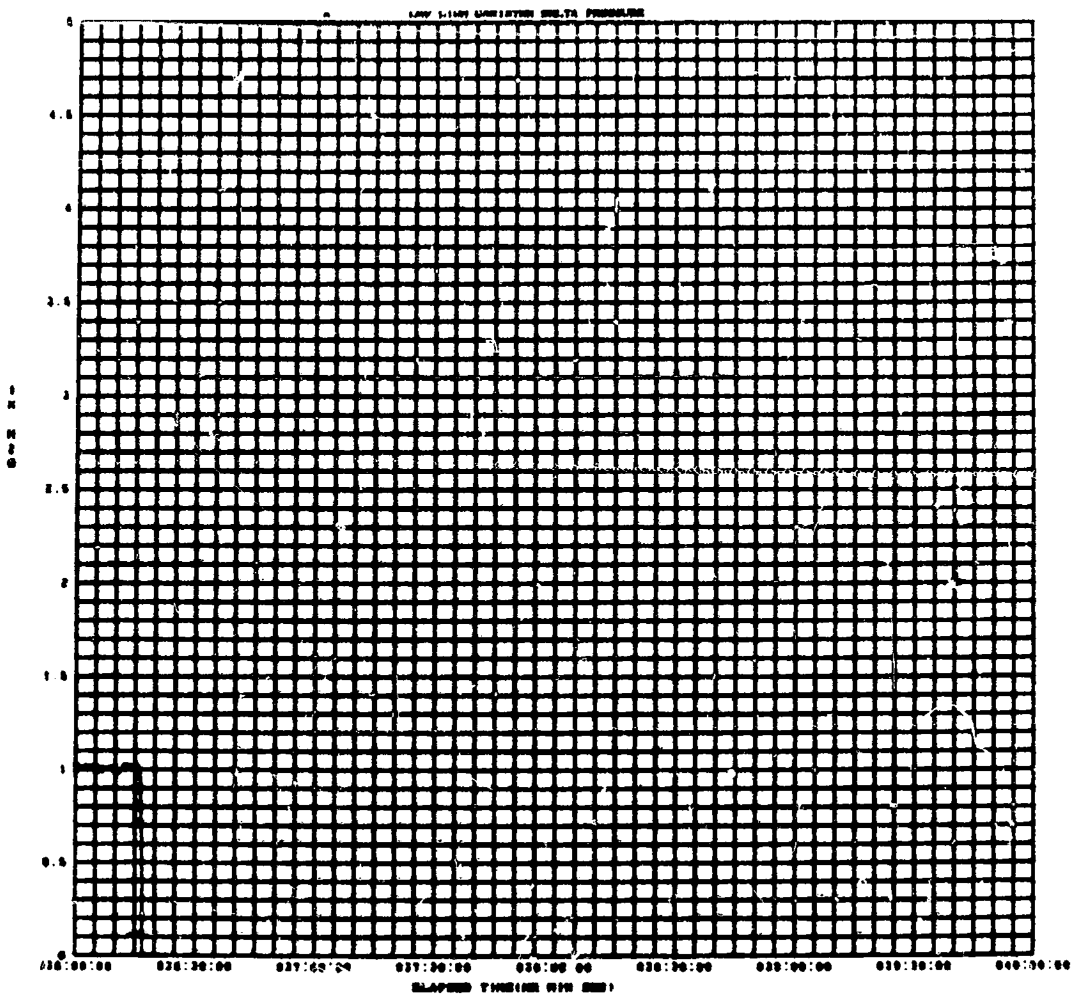


FIGURE 36J LMP LIOH CANISTER DELTA P VERSUS TIME - CONCLUDED

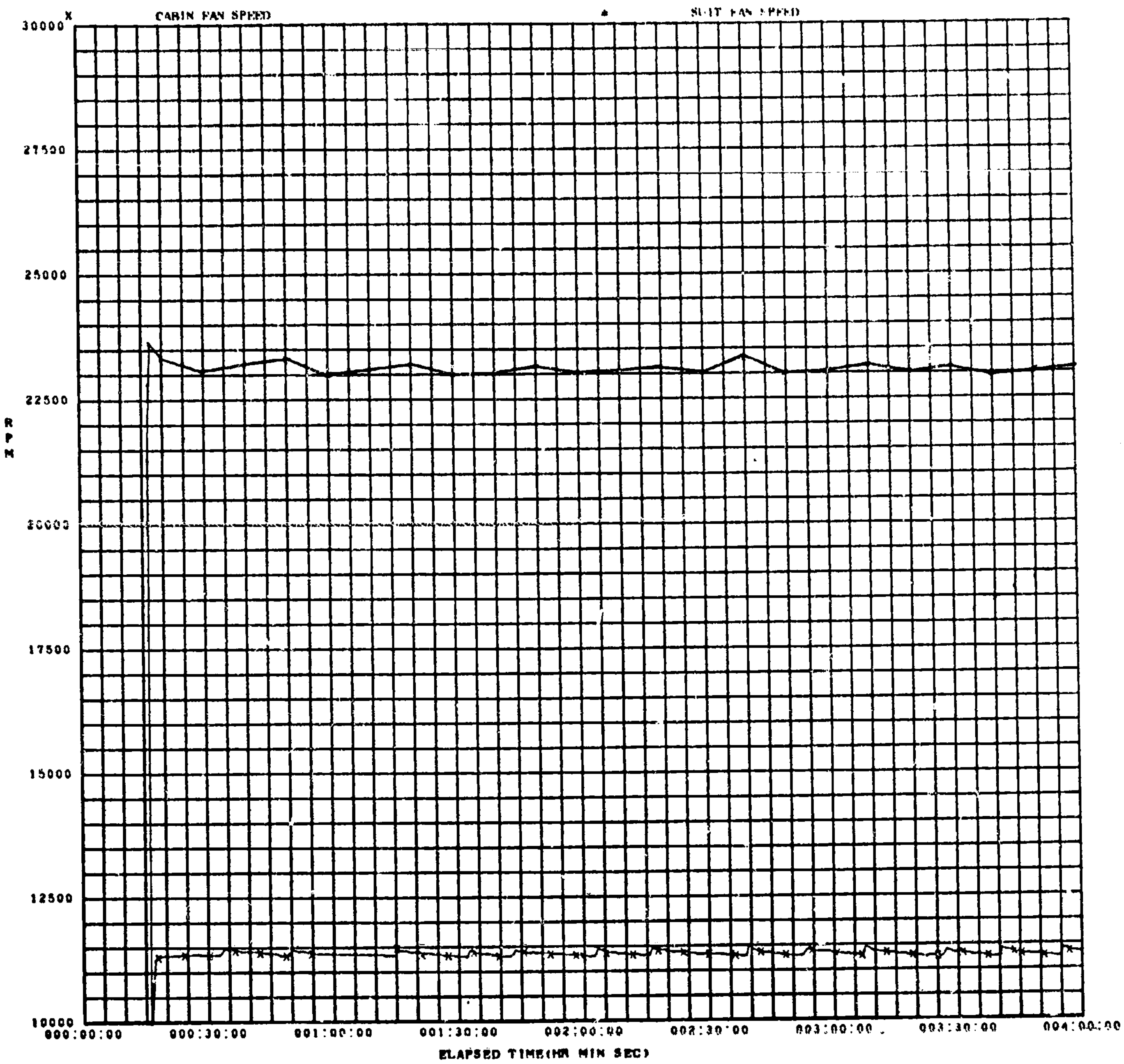


FIGURE 37 CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME

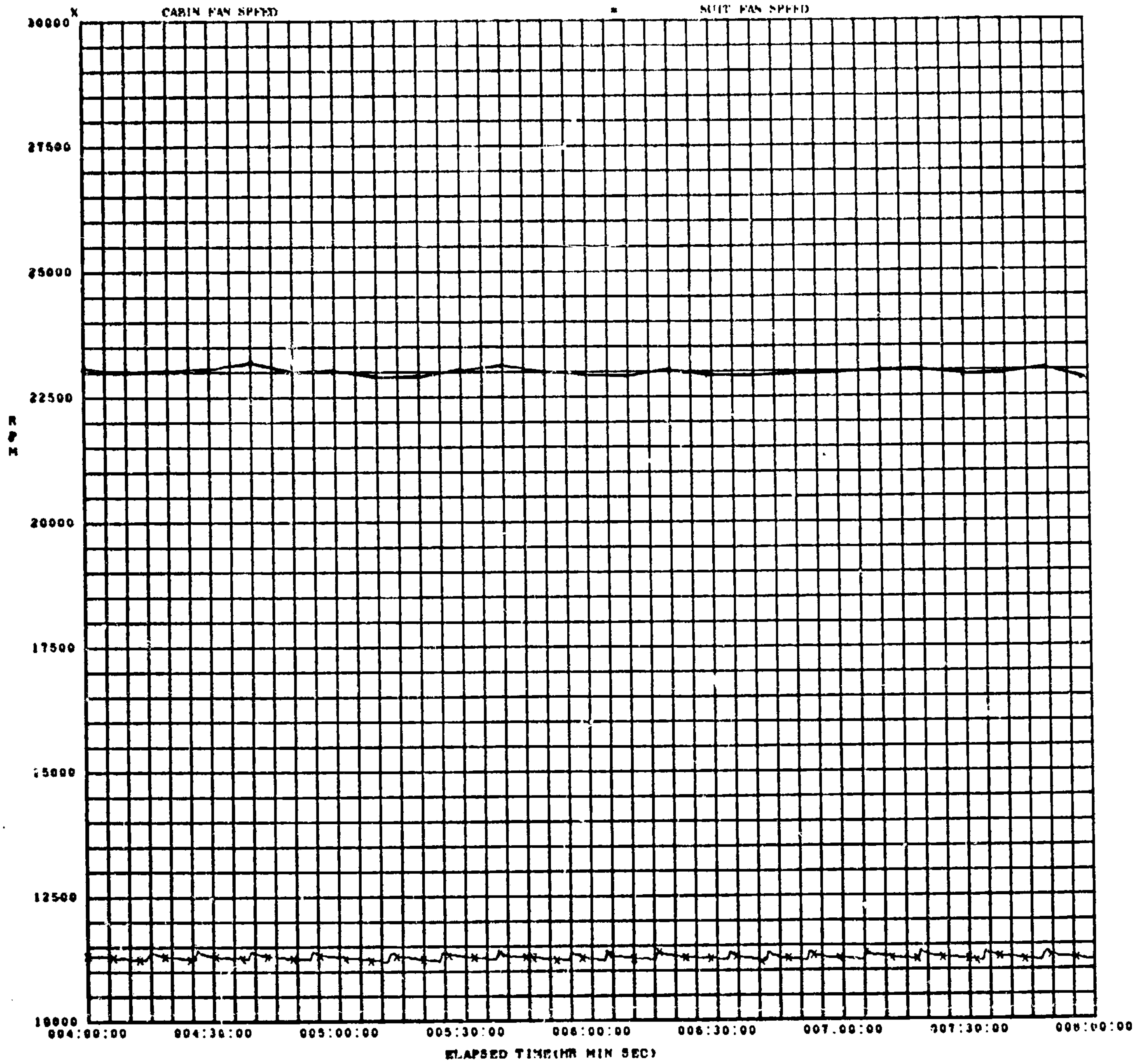


FIGURE 37A CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

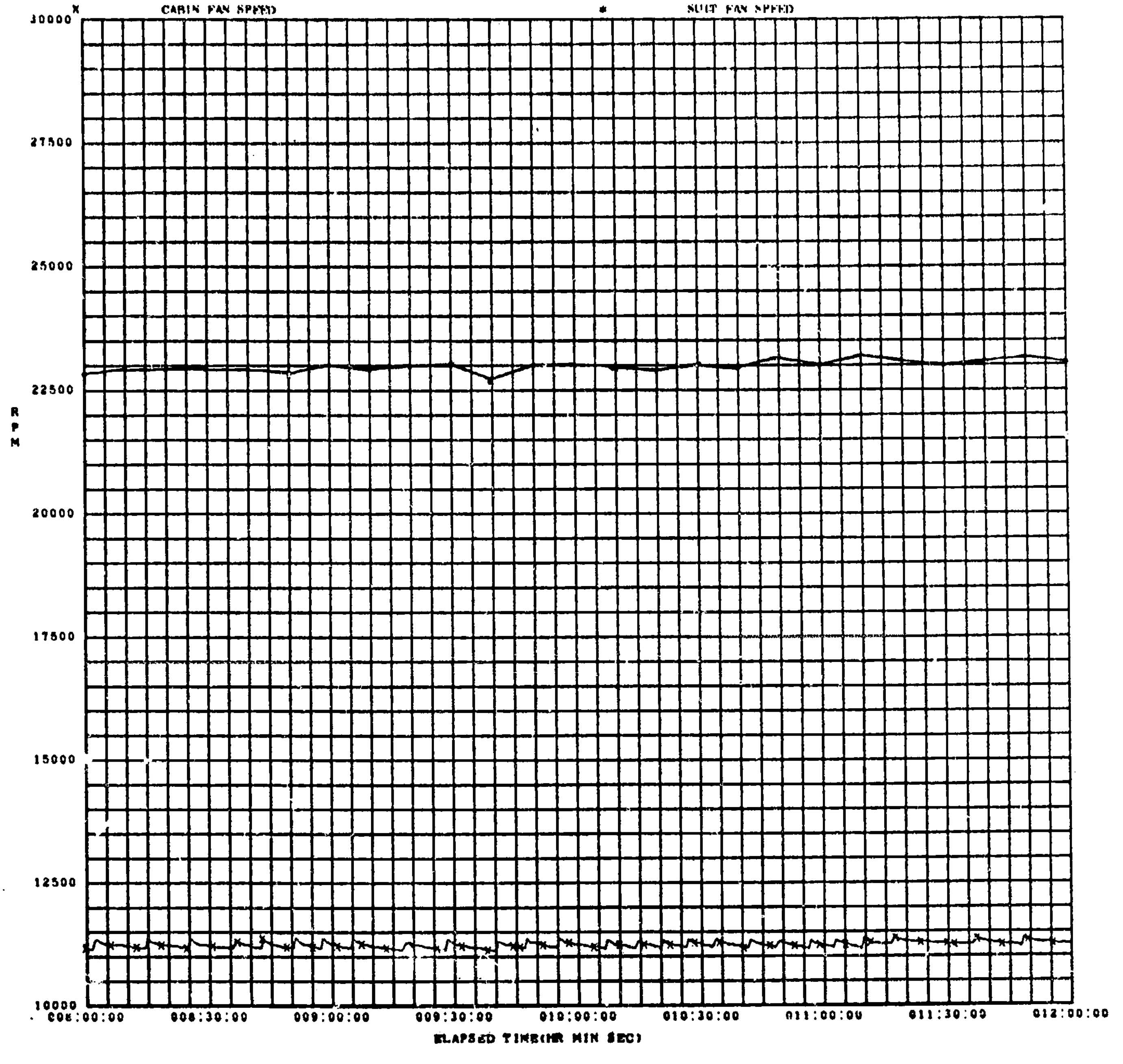


FIGURE 37B CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

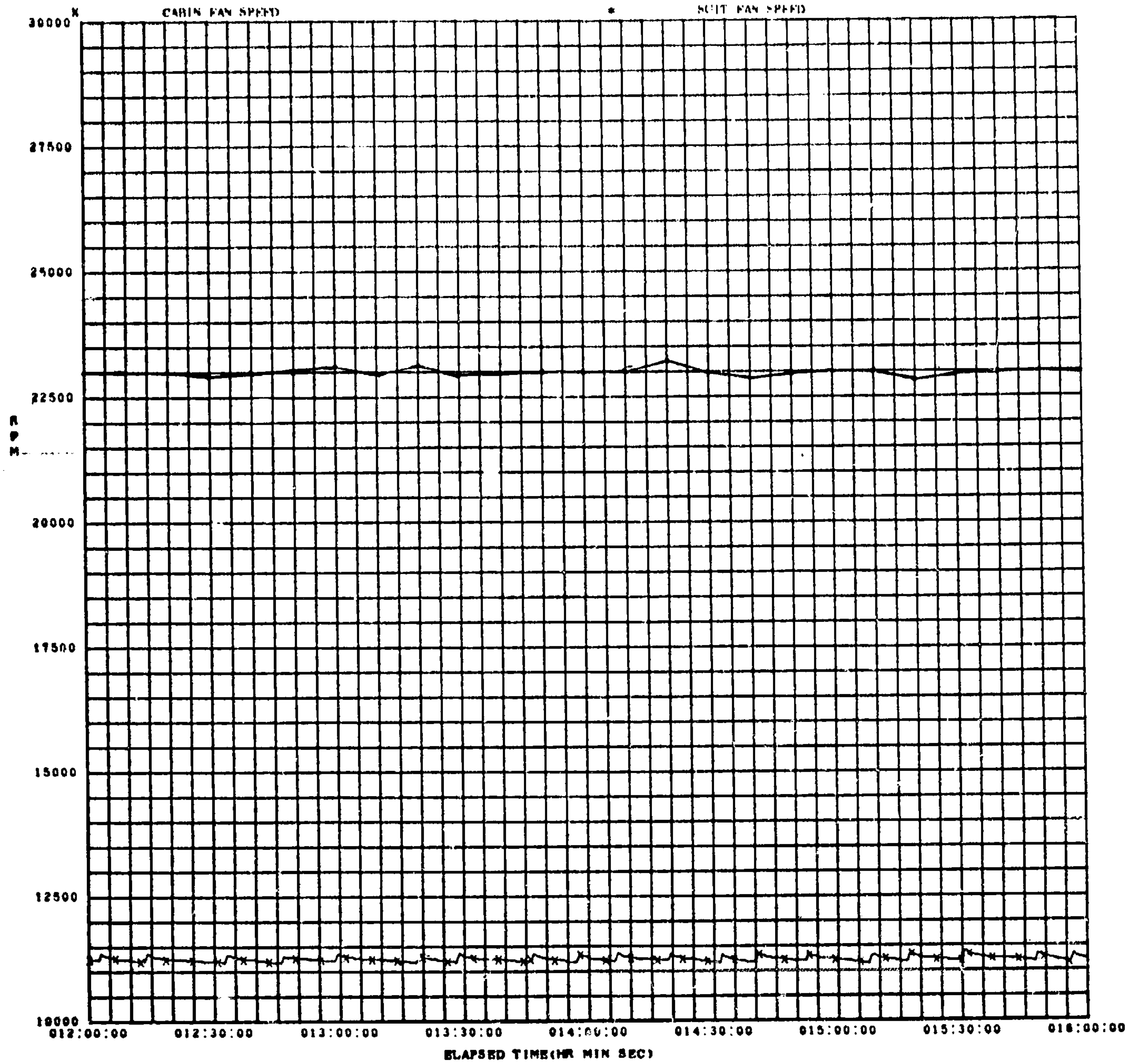


FIGURE 37C CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

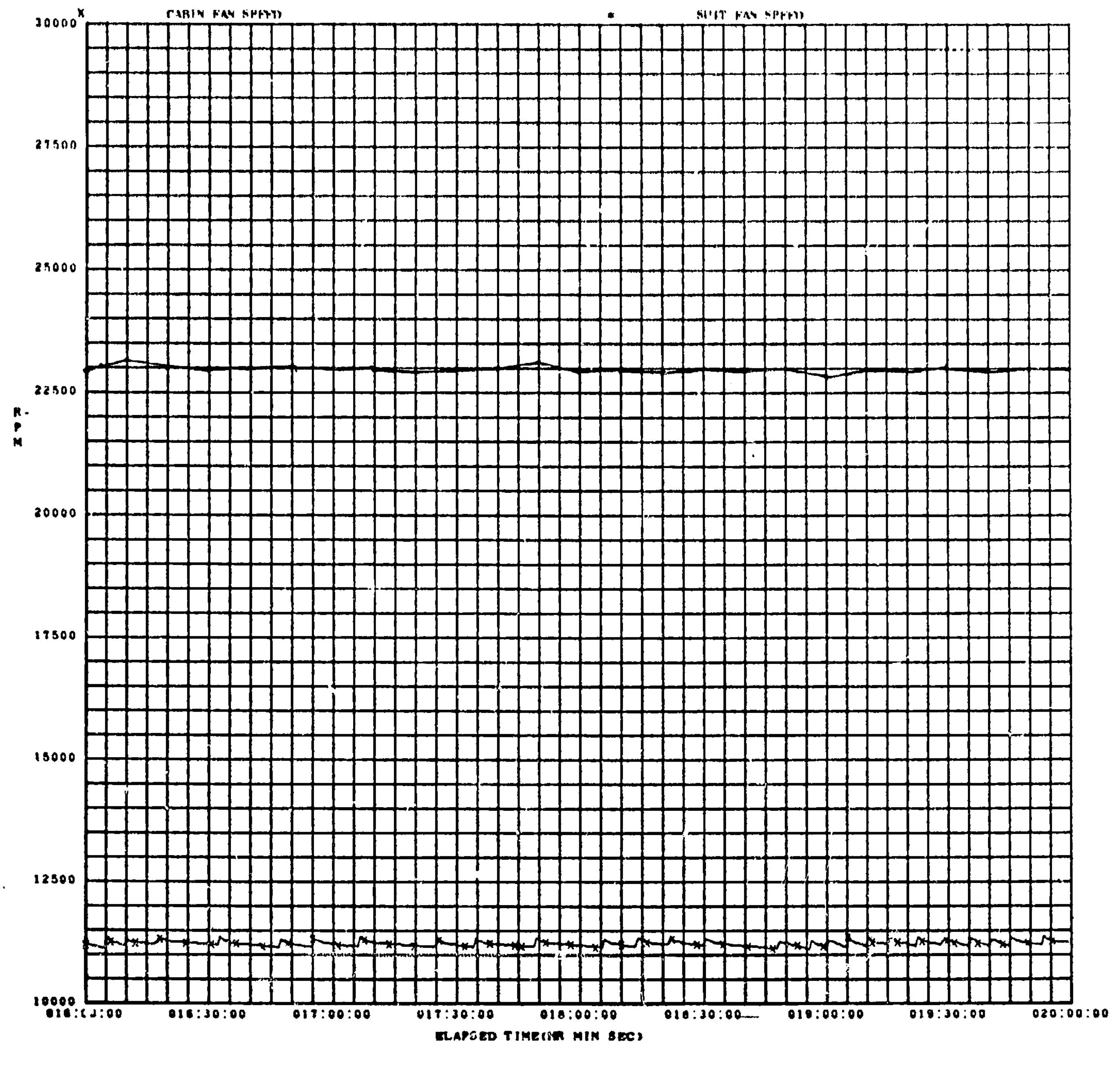


FIGURE 37D CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

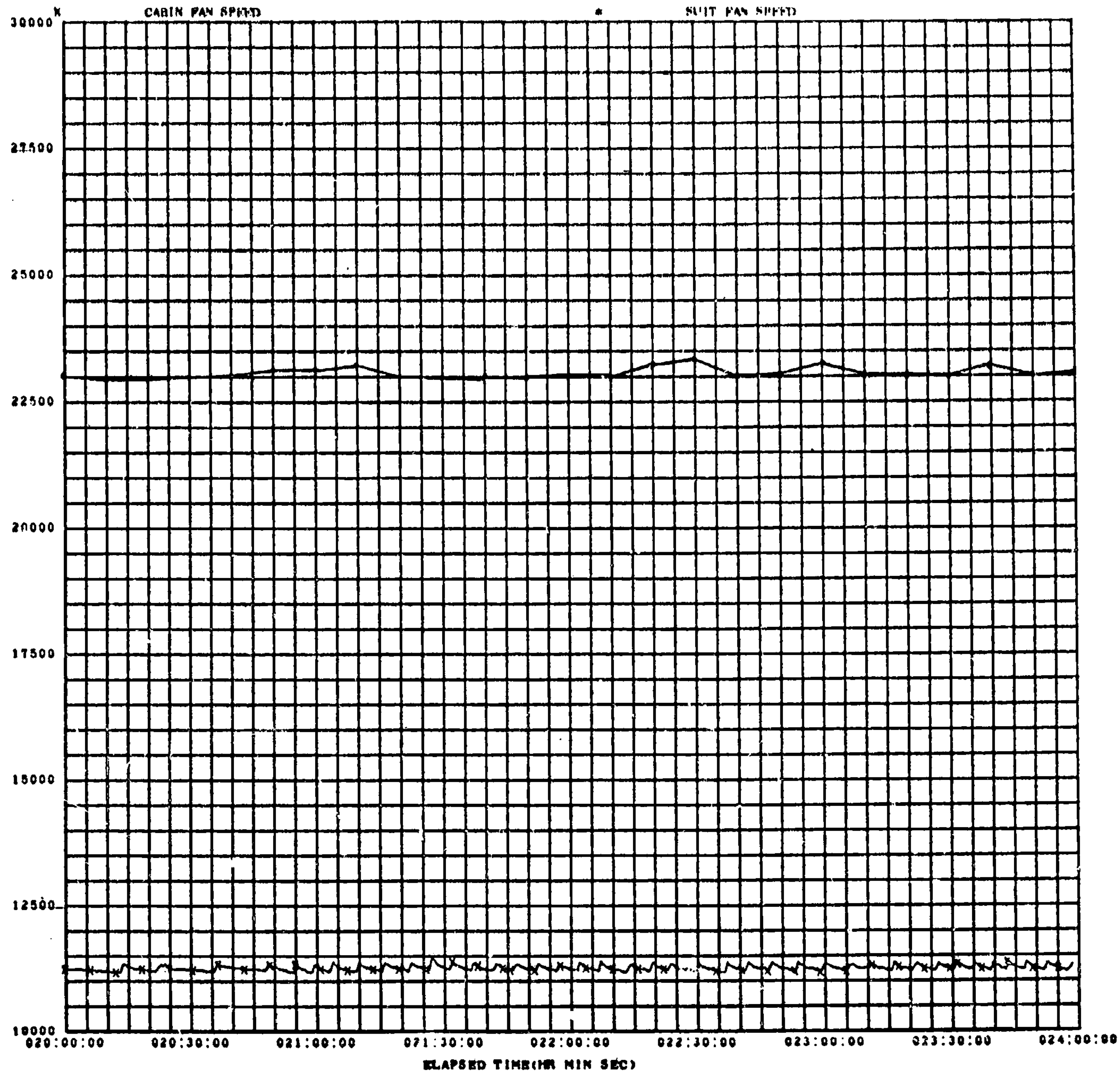


FIGURE 37E CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

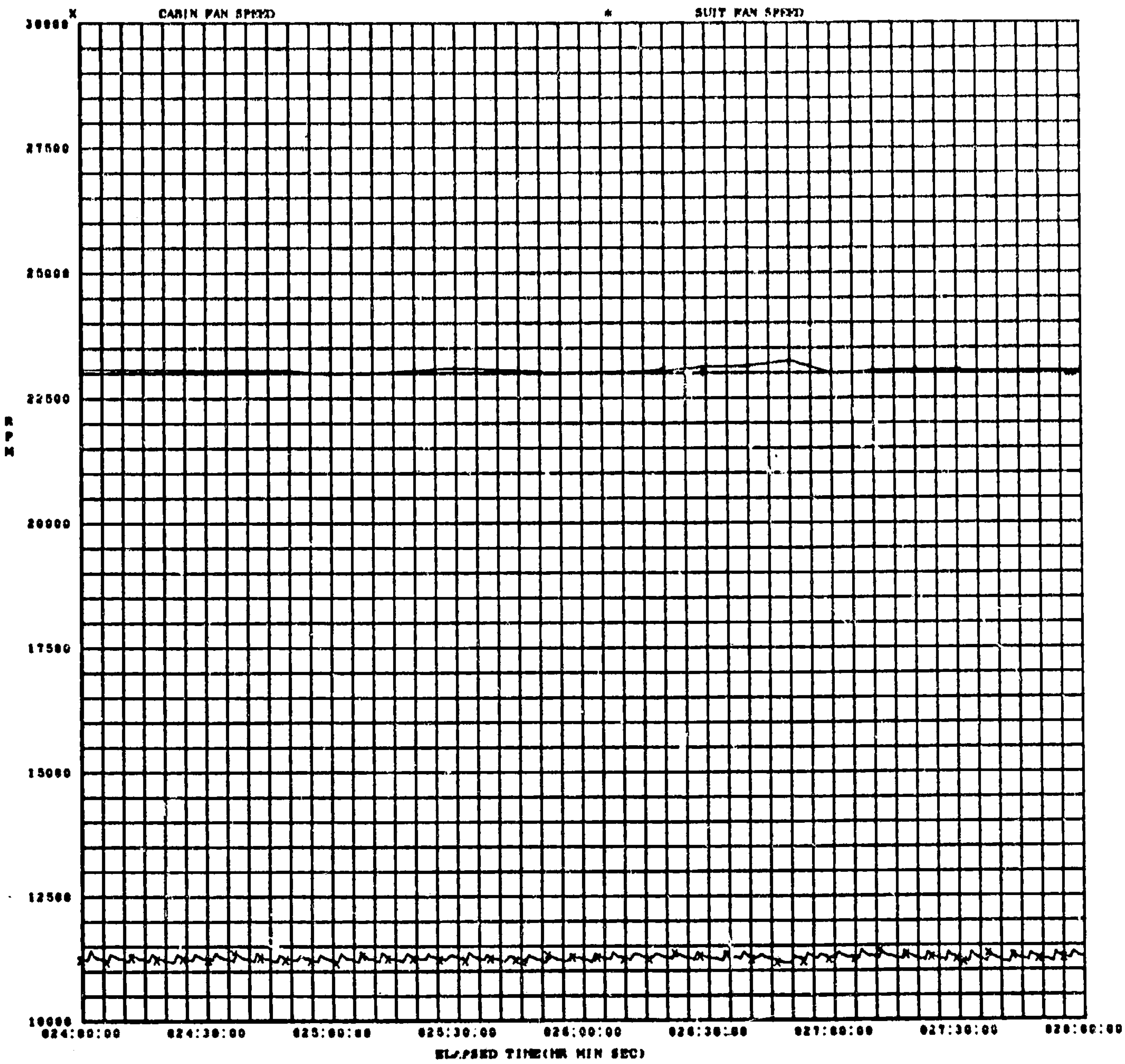


FIGURE 37F CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

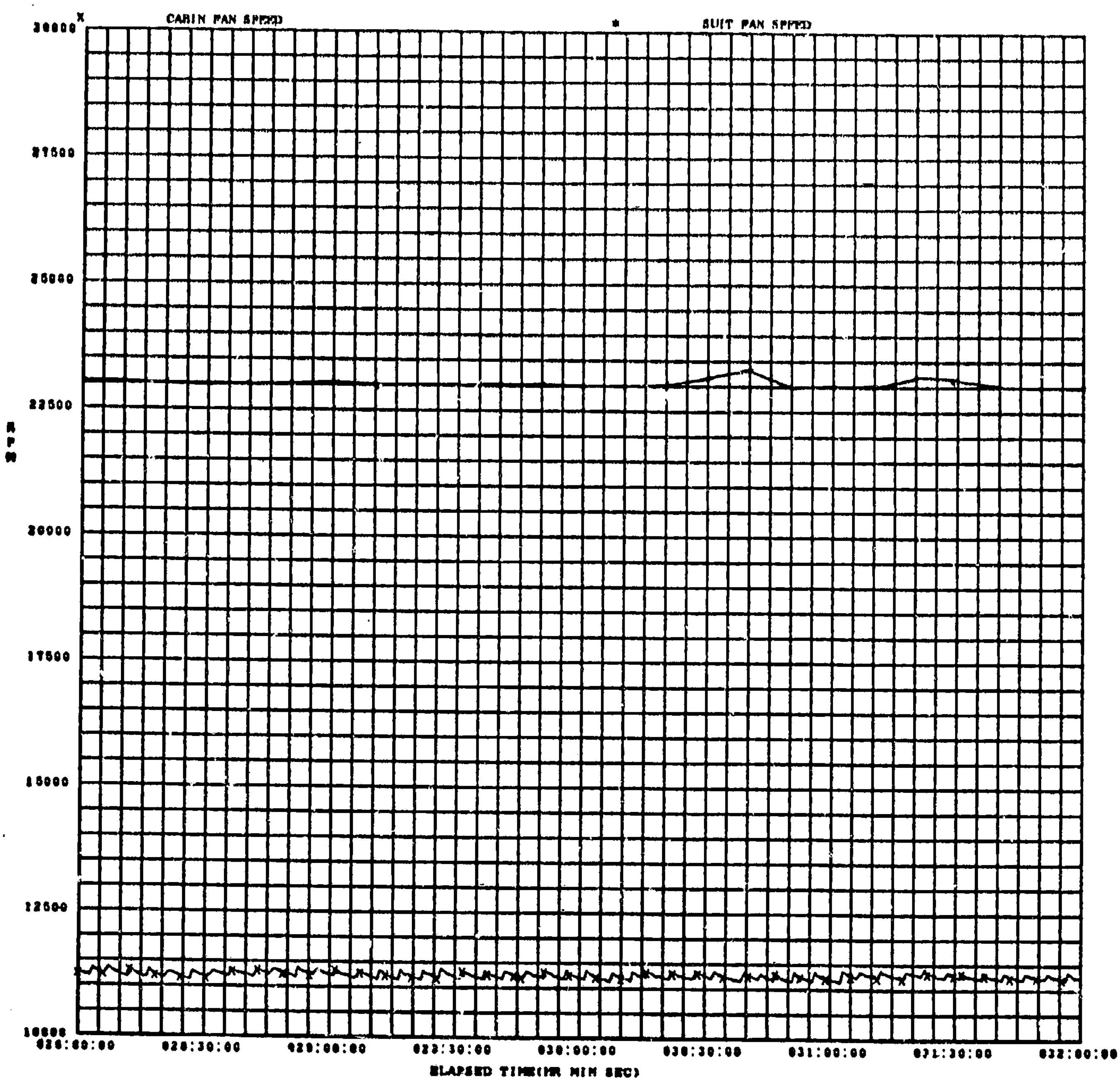


FIGURE 37G CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

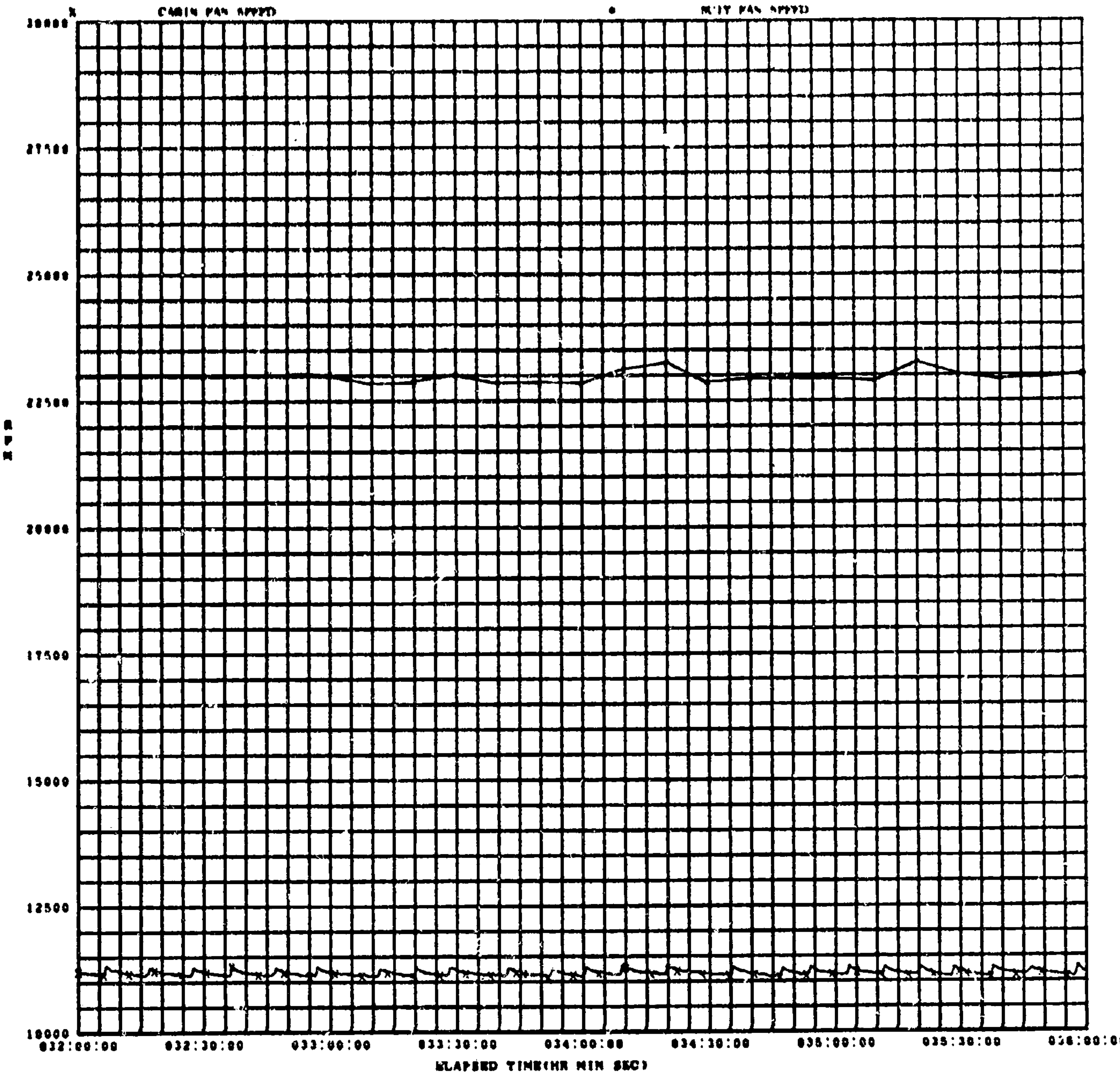


FIGURE 37H CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONTINUED

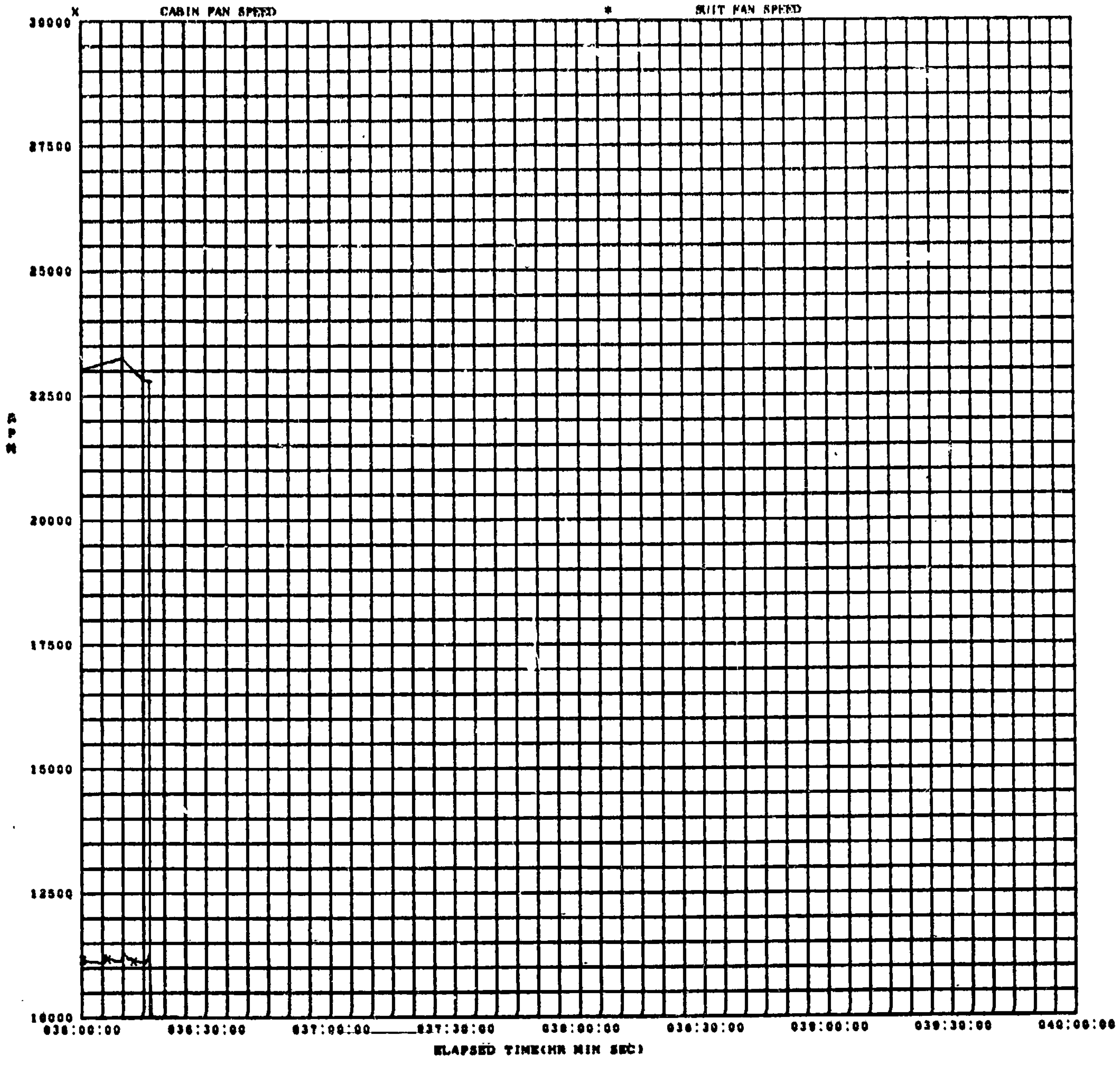


FIGURE 37J CABIN FAN AND SUIT FAN SPEEDS VERSUS TIME
- CONCLUDED

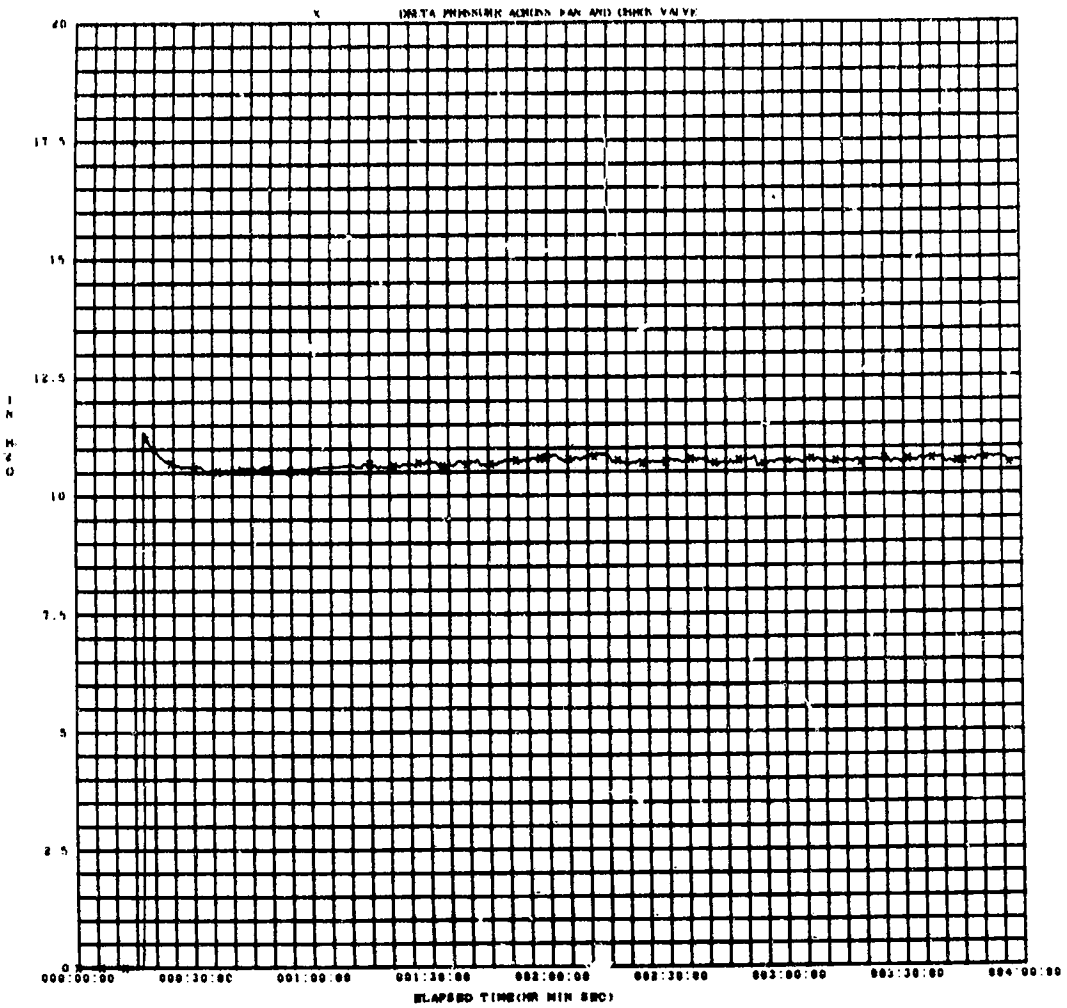


FIGURE 38 FAN AND CHECK VALVE DELTA P VERSUS TIME

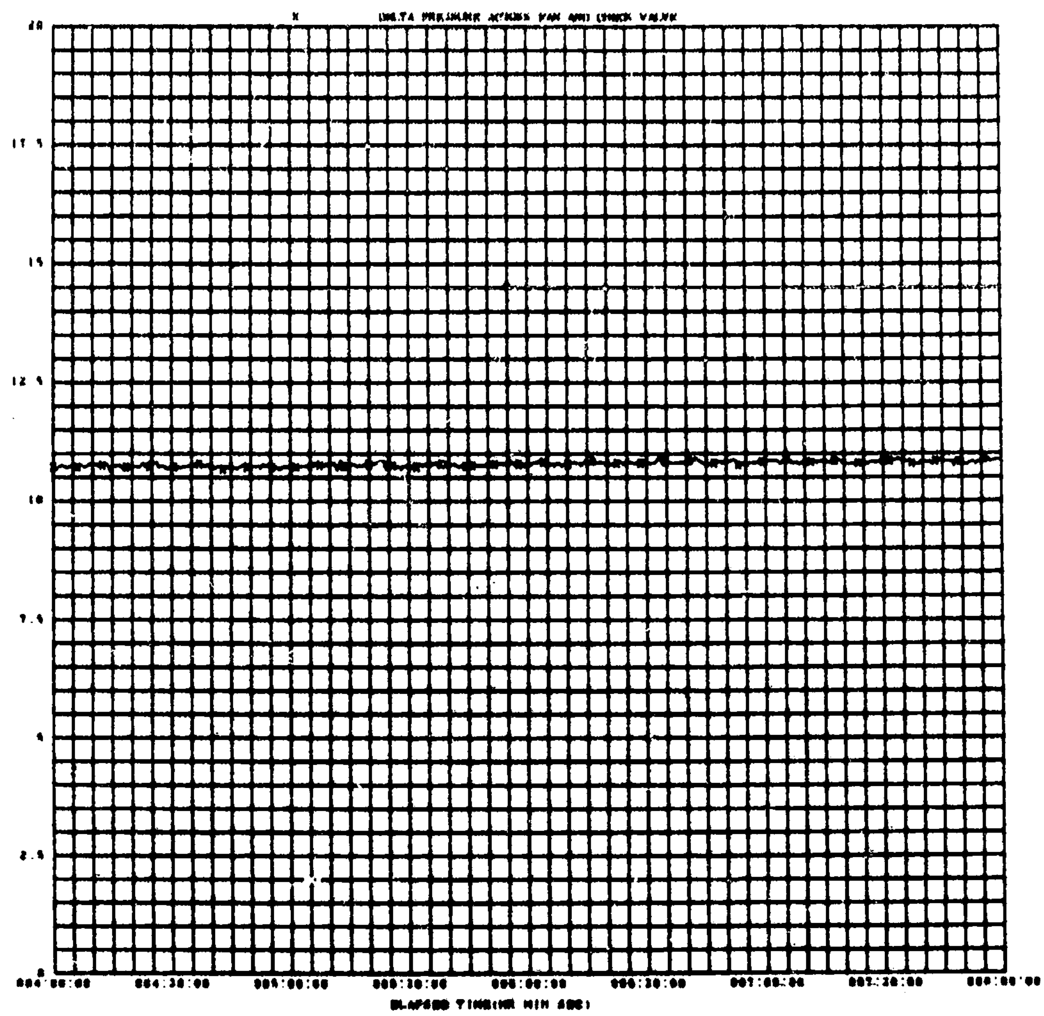


FIGURE 38A FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

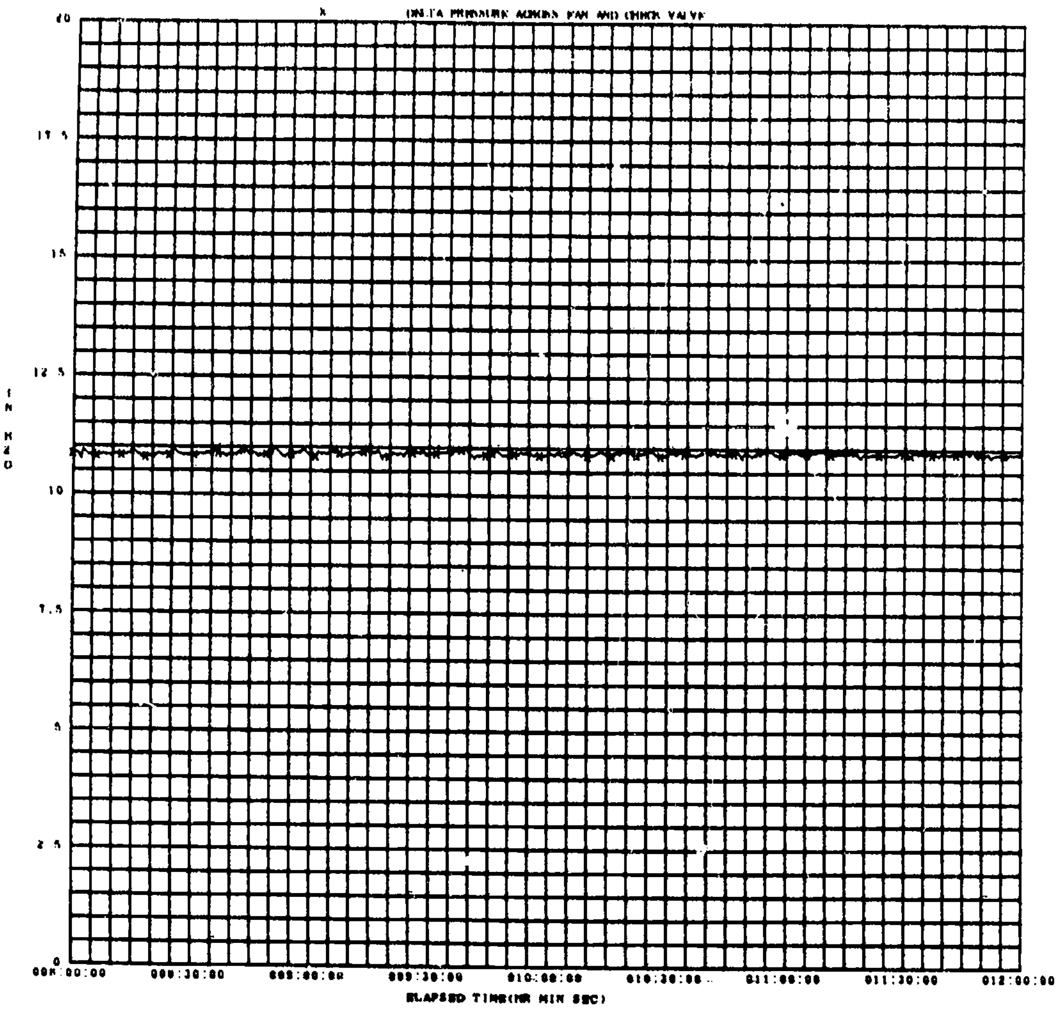


FIGURE 38B FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

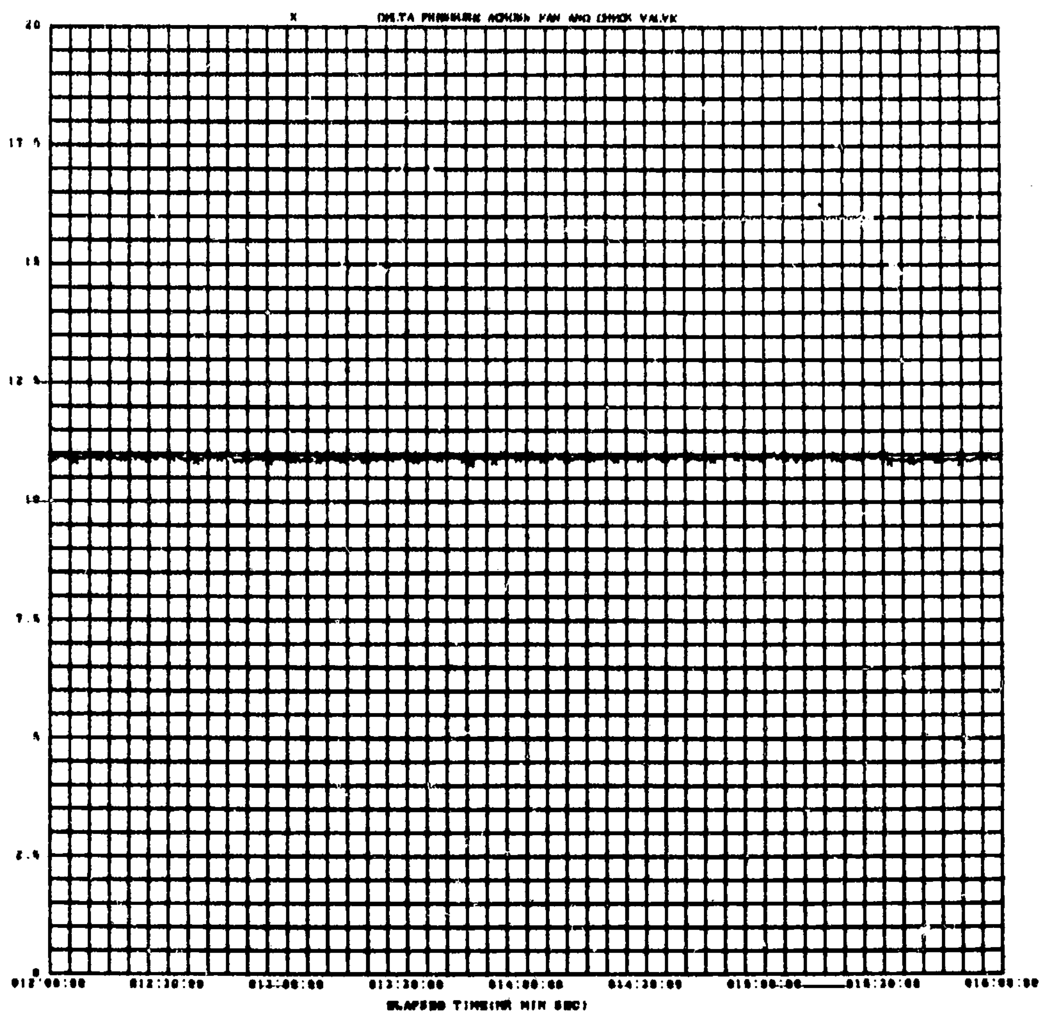


FIGURE 38C FAN AND CHECK VALVE DELTA P VERSUS TIME
—CONTINUED

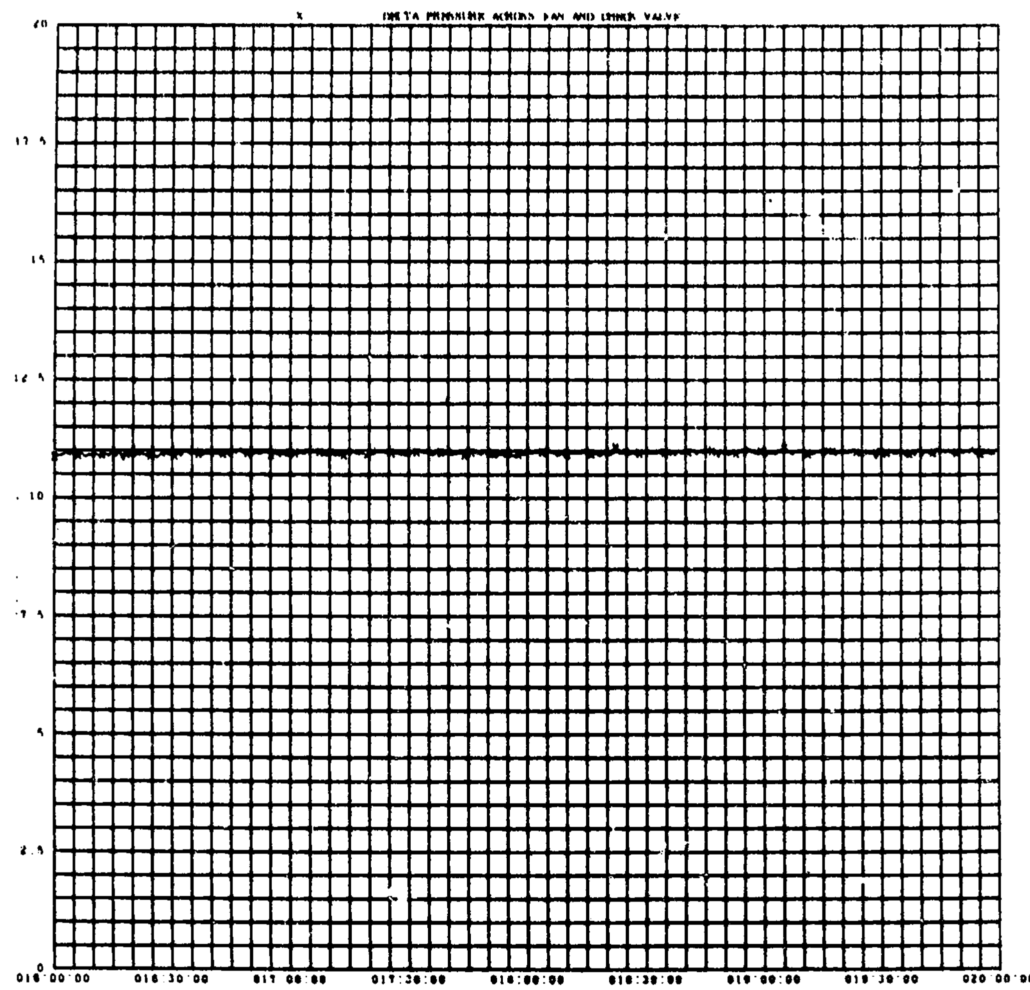


FIGURE 38D FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

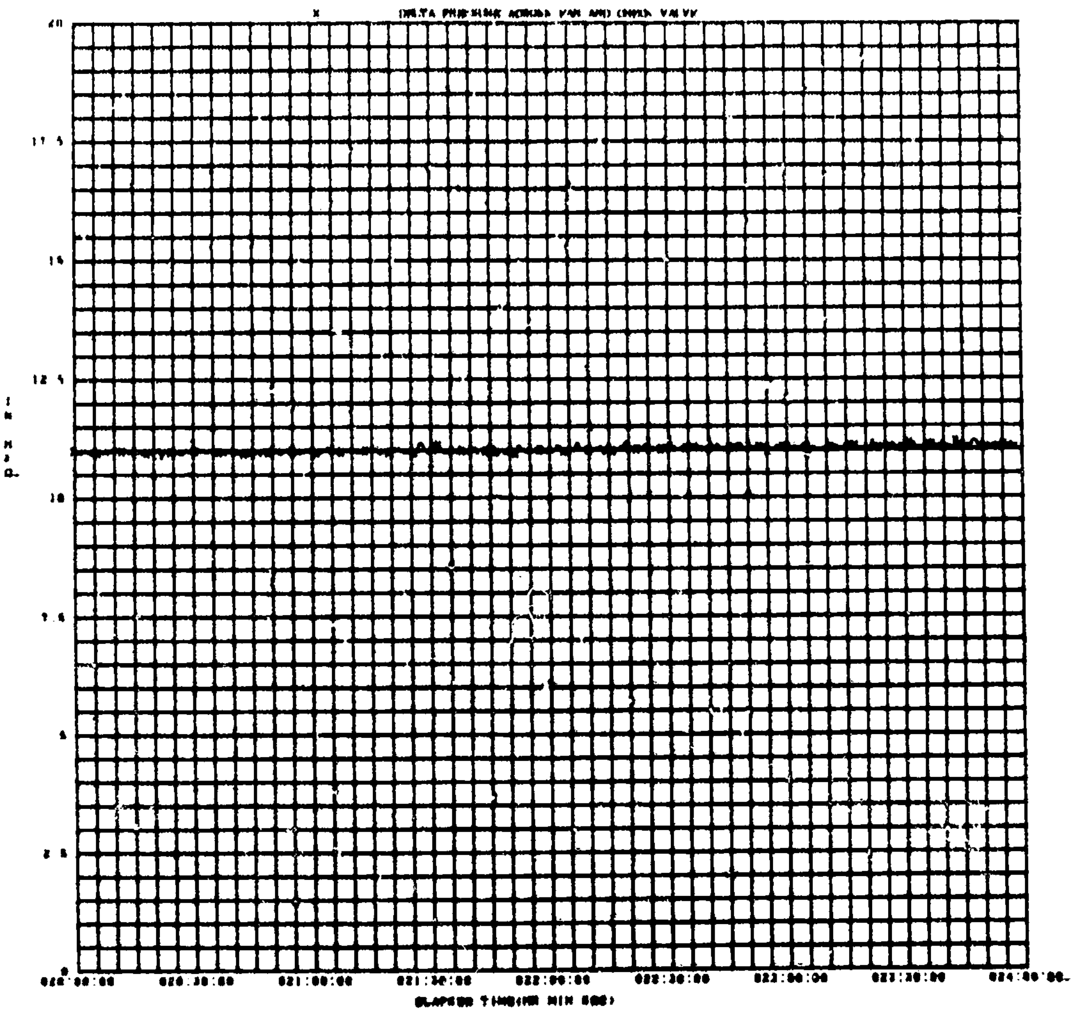


FIGURE 38E FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

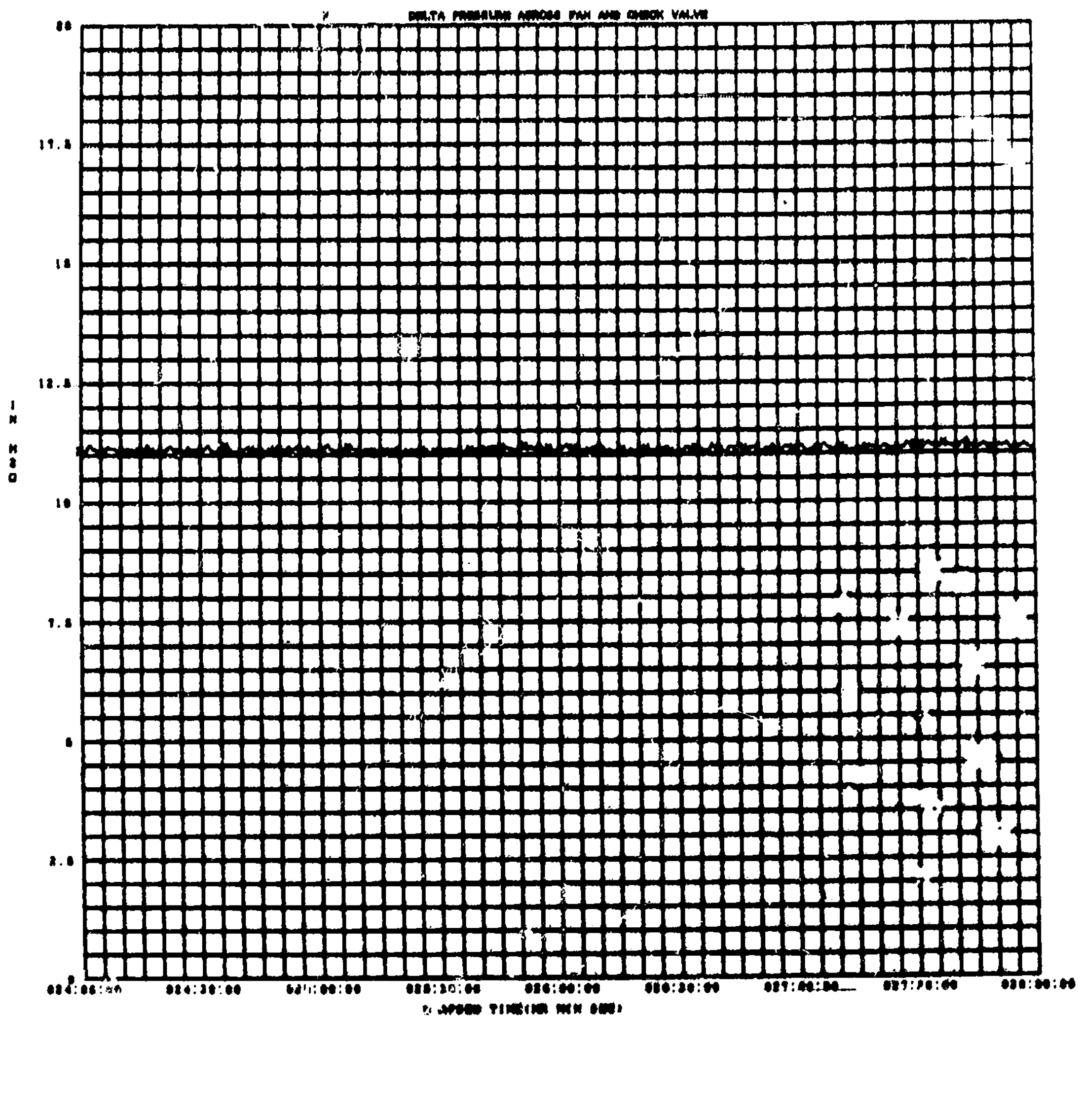


FIGURE 38F FAN AND CHECK VALVE DELTA P VERSUS TIME - CONTINUED

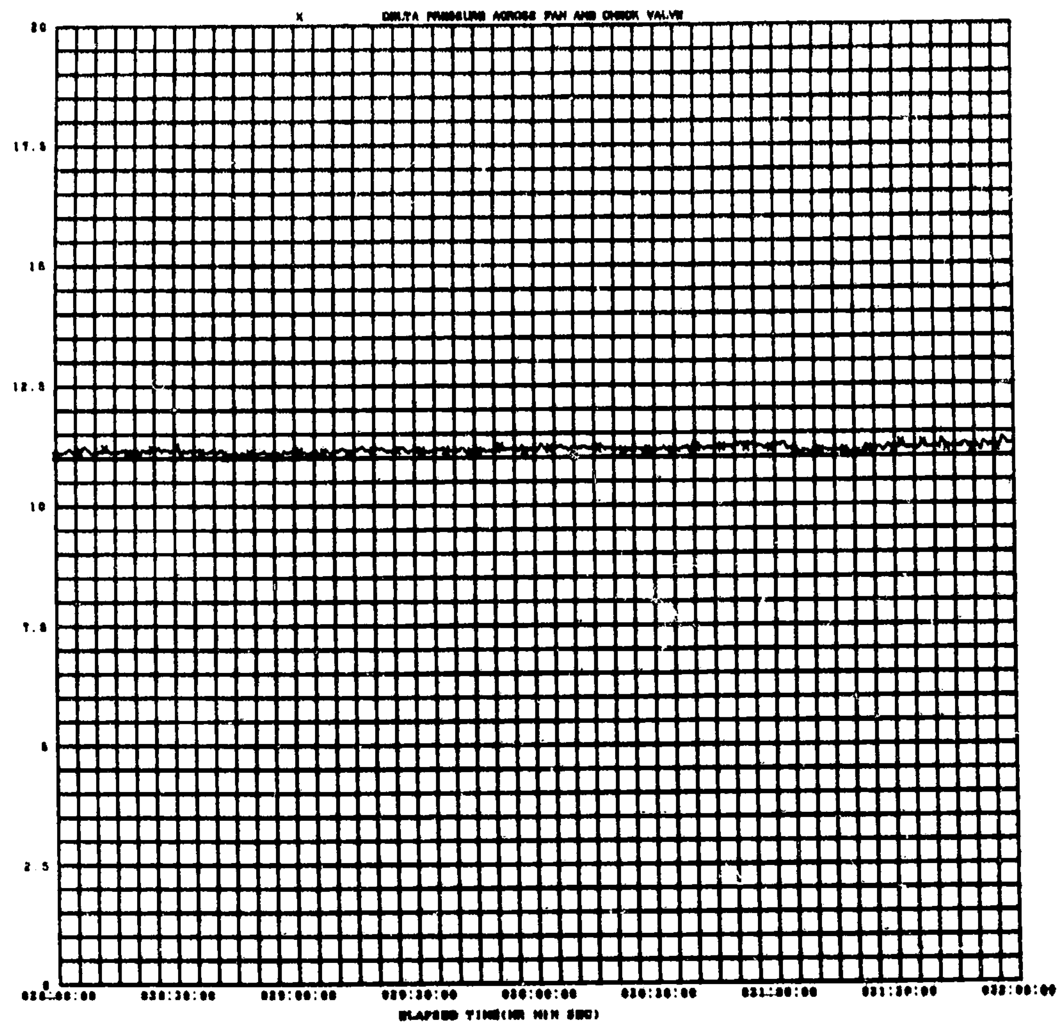


FIGURE 38G FAN AND CHECK VALVE DELTA P VERSUS TIME - CONTINUED

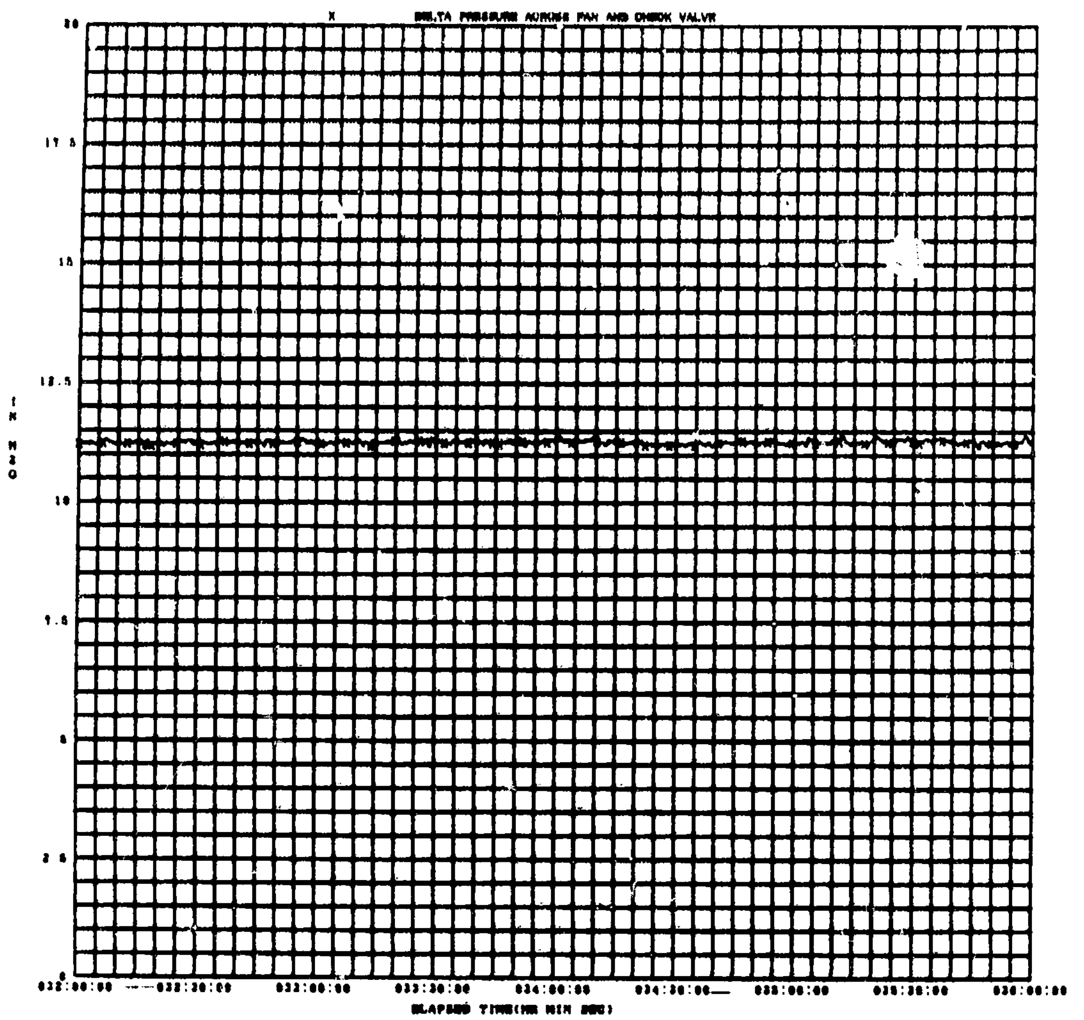


FIGURE 38H FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONTINUED

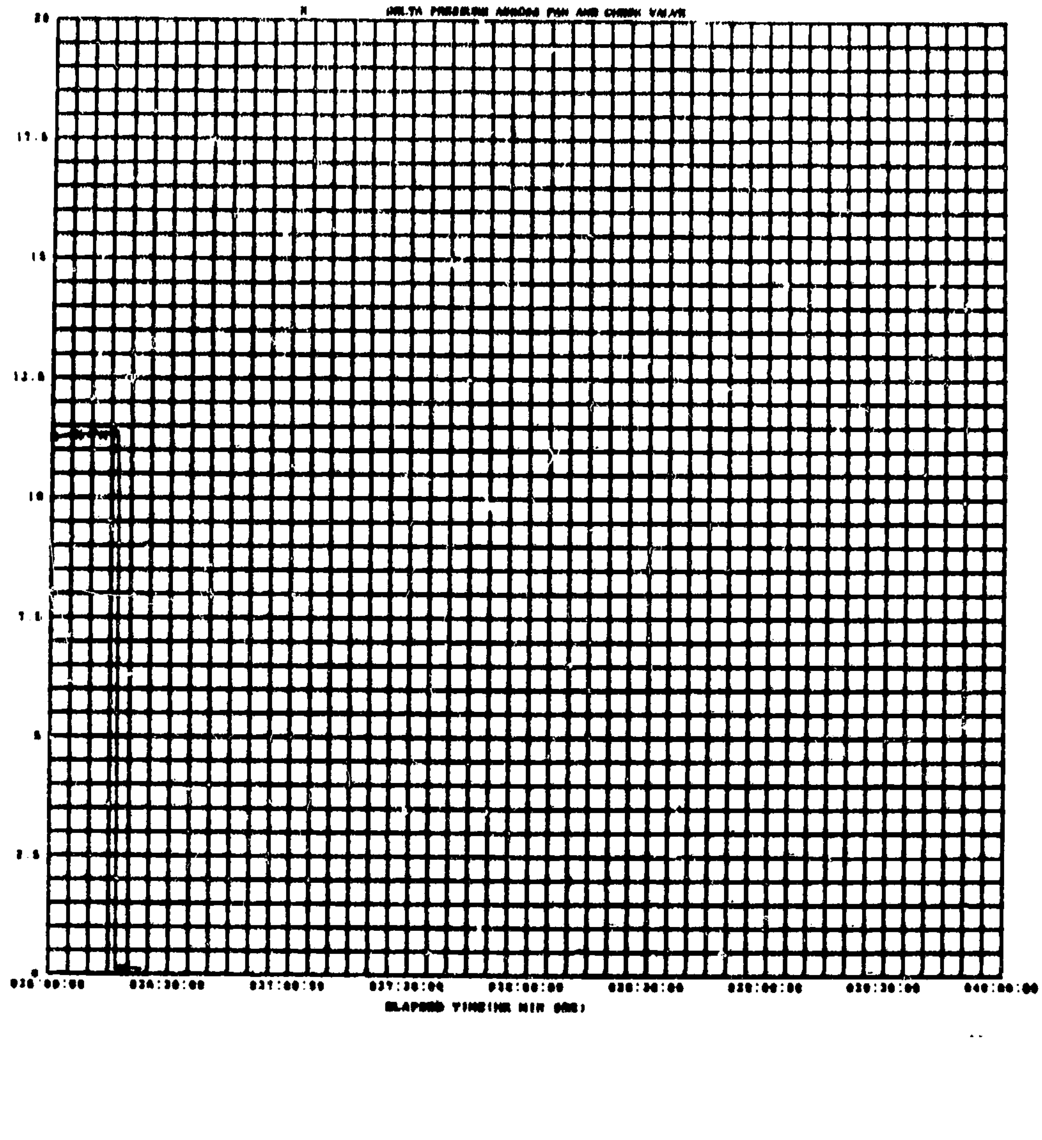


FIGURE 38J FAN AND CHECK VALVE DELTA P VERSUS TIME
- CONCLUDED

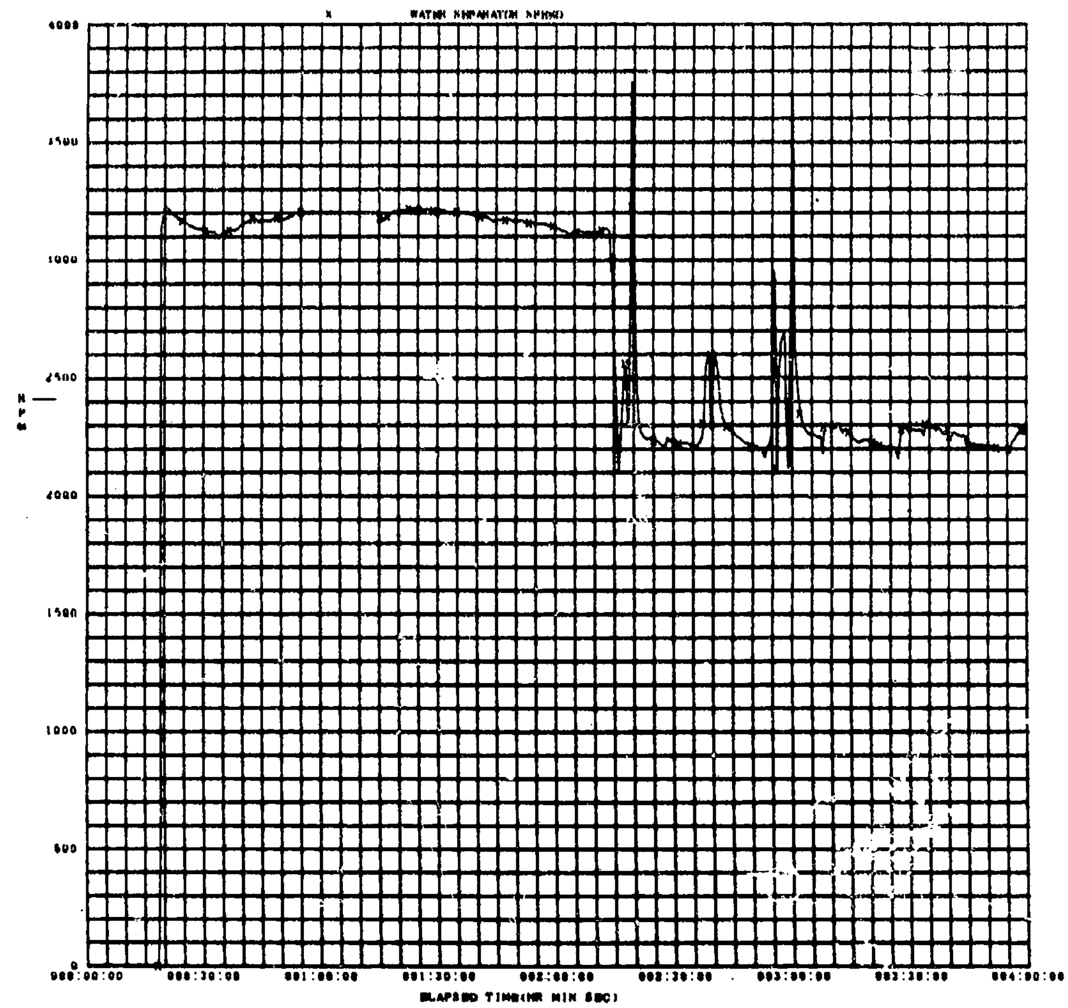


FIGURE 39 WATER SEPARATOR SPEED VERSUS TIME

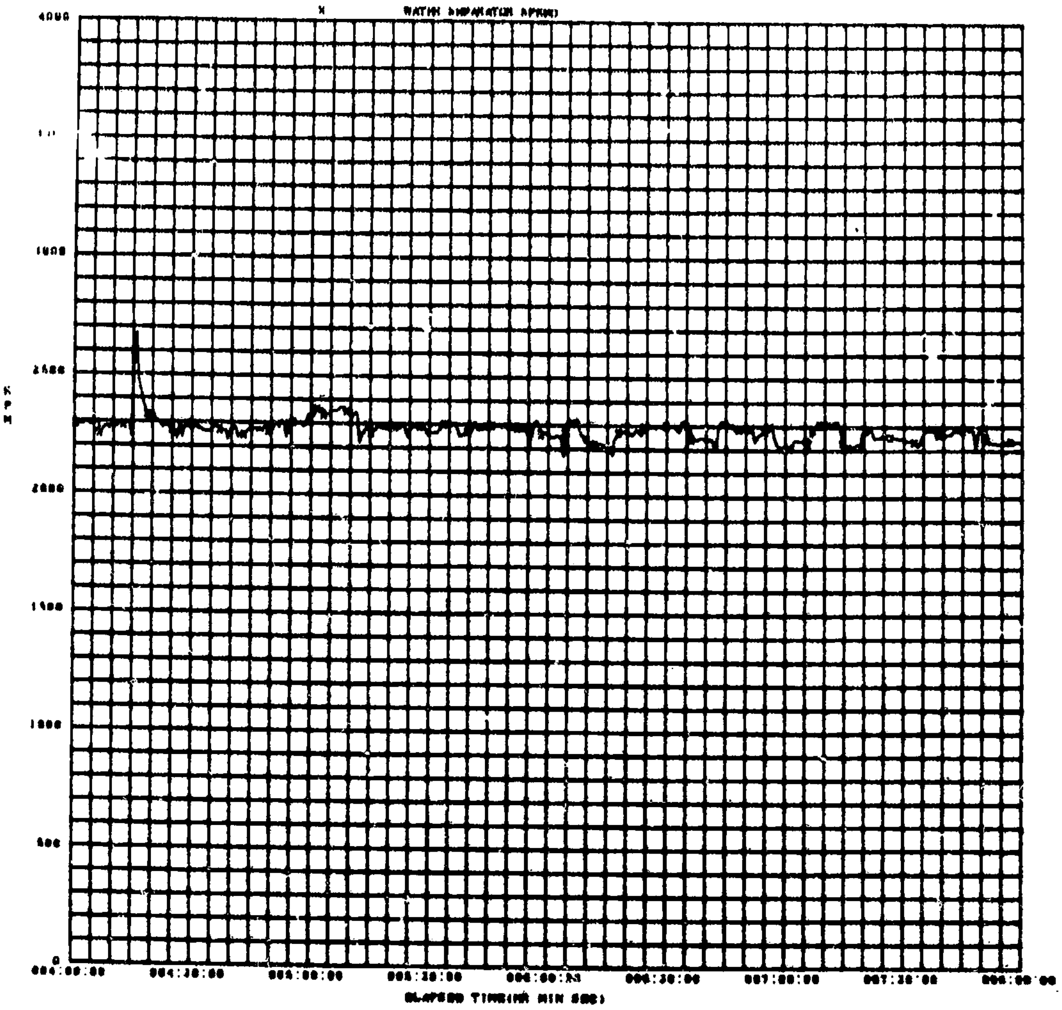


FIGURE 39A WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

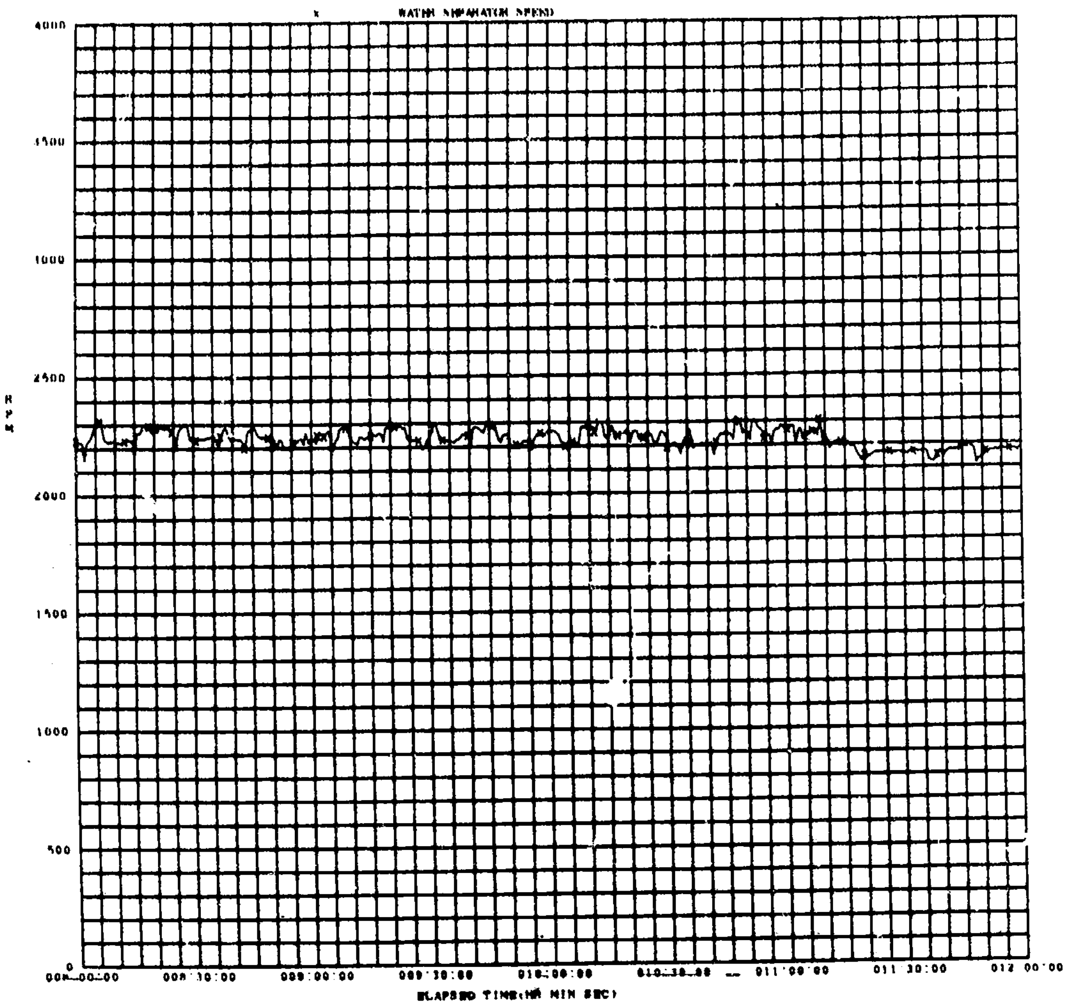


FIGURE 39B WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

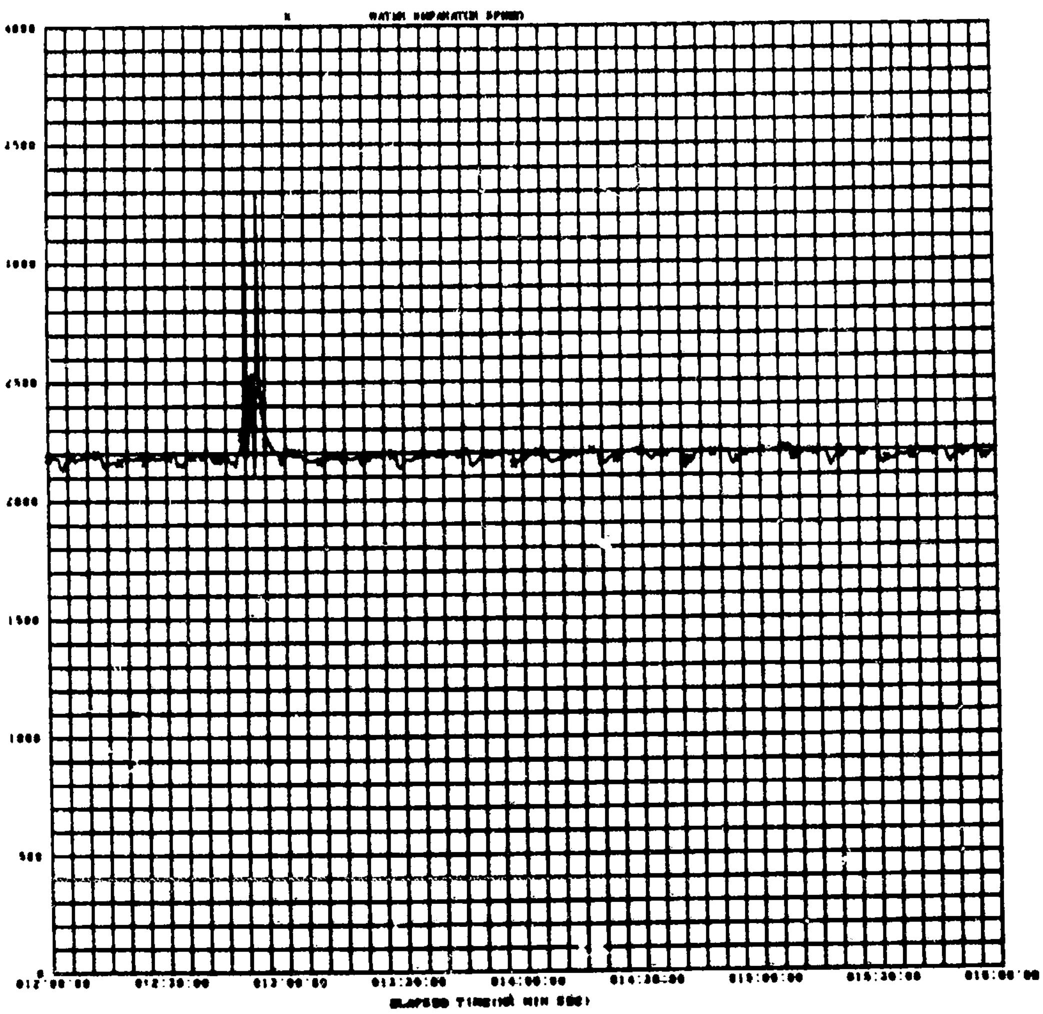


FIGURE 39C WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

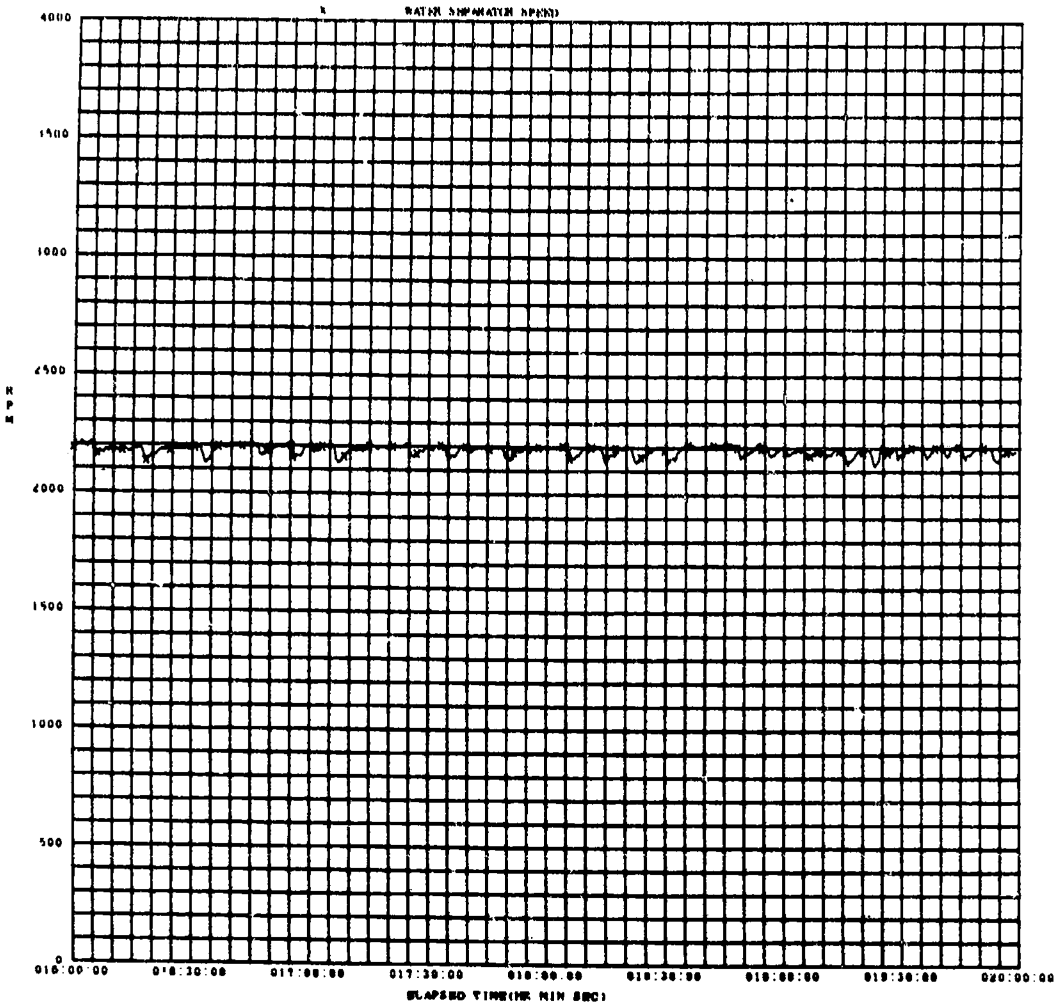


FIGURE 39D WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

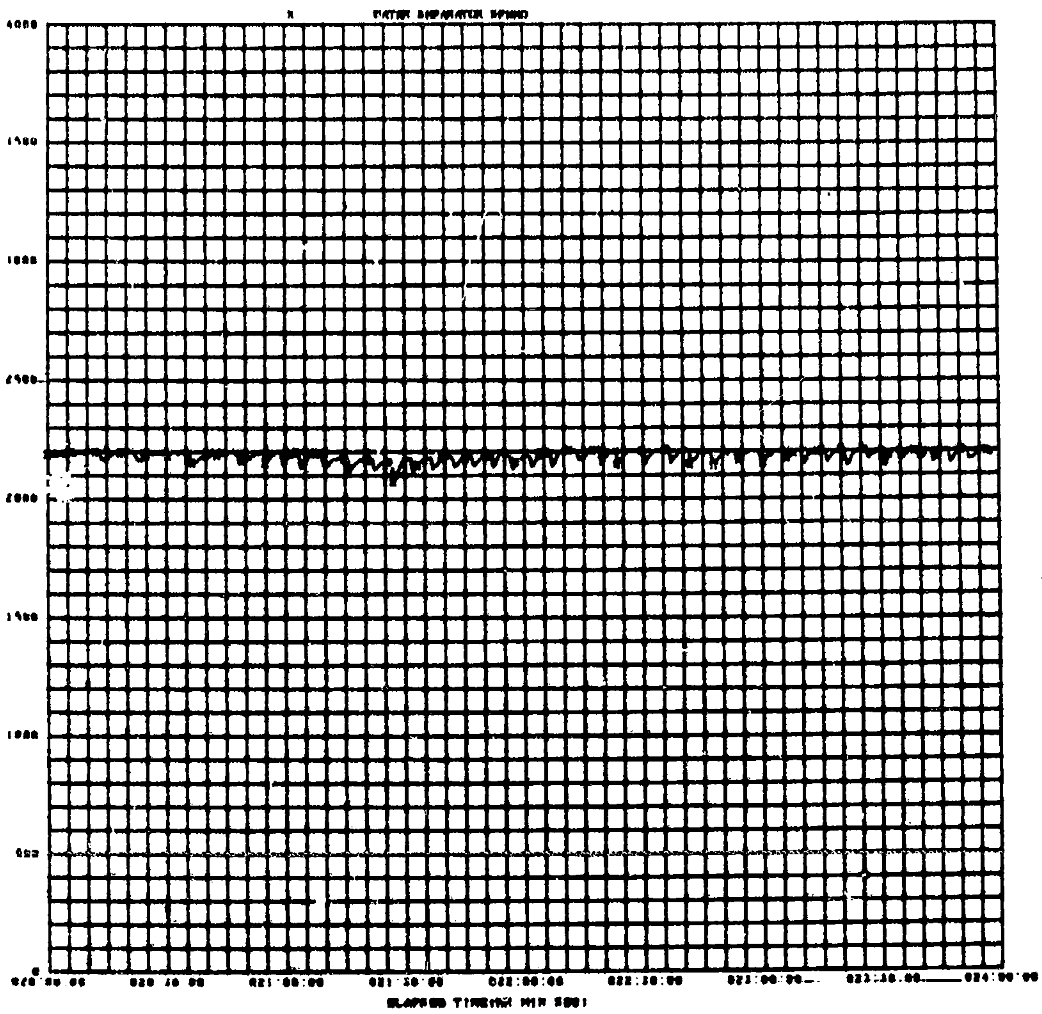


FIGURE 39E WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

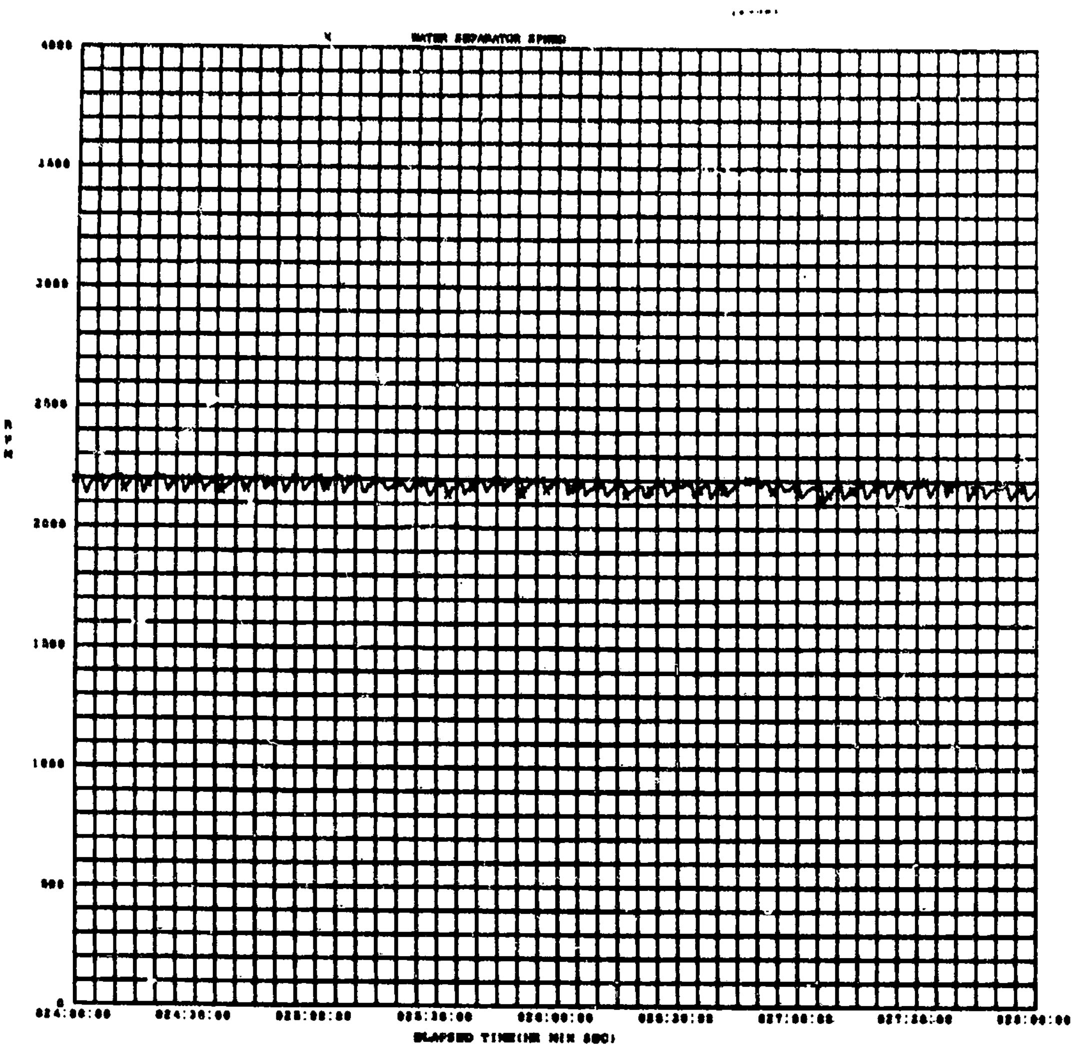


FIGURE 39F WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

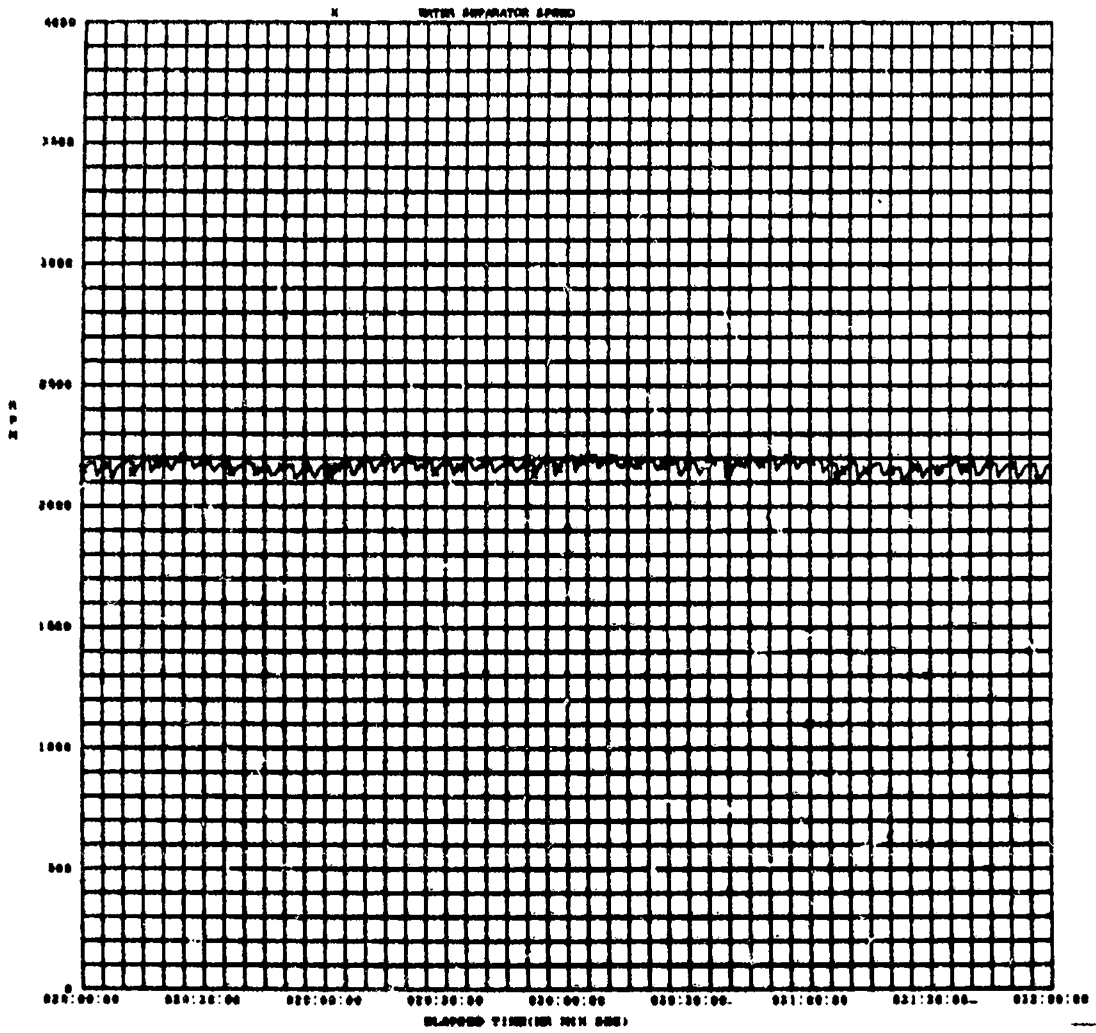


FIGURE 39G WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

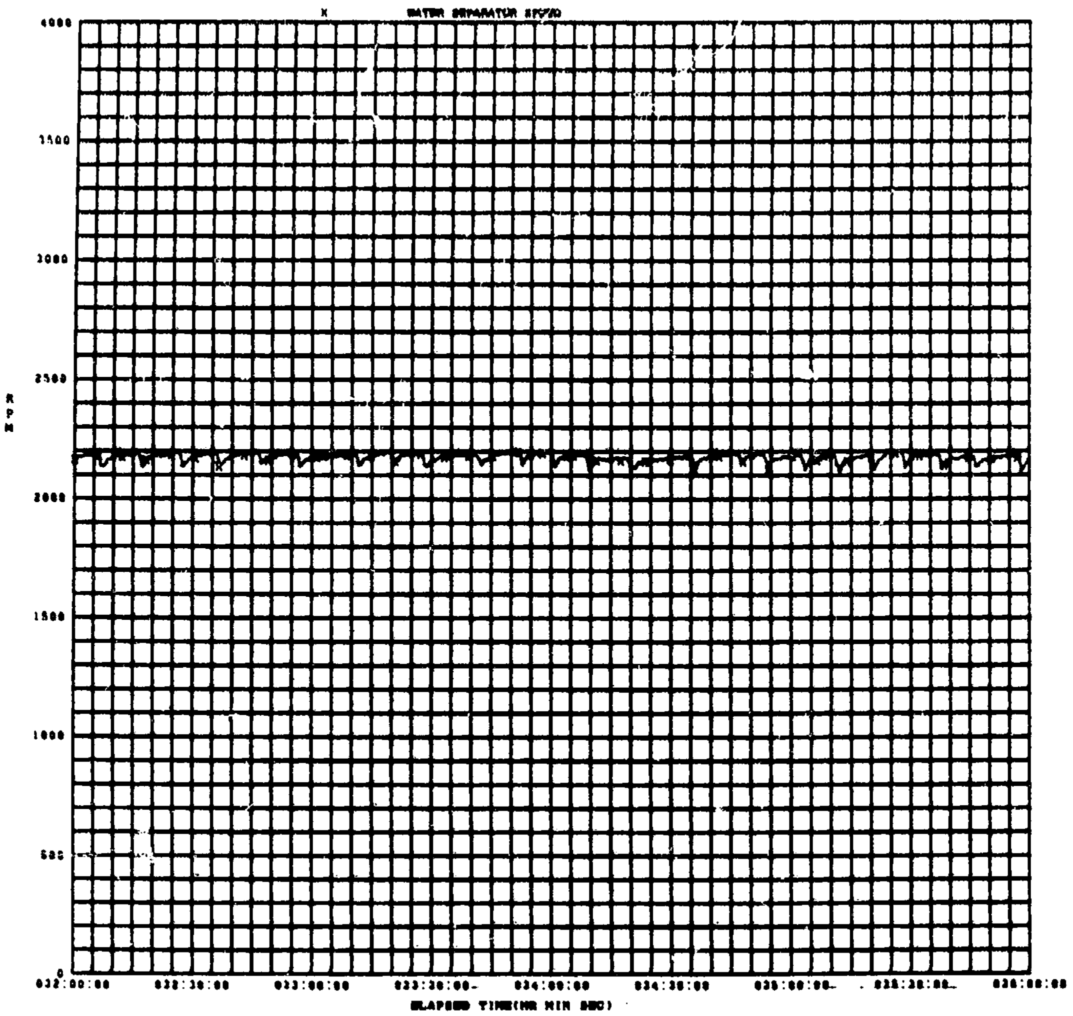


FIGURE 39H WATER SEPARATOR SPEED VERSUS TIME - CONTINUED

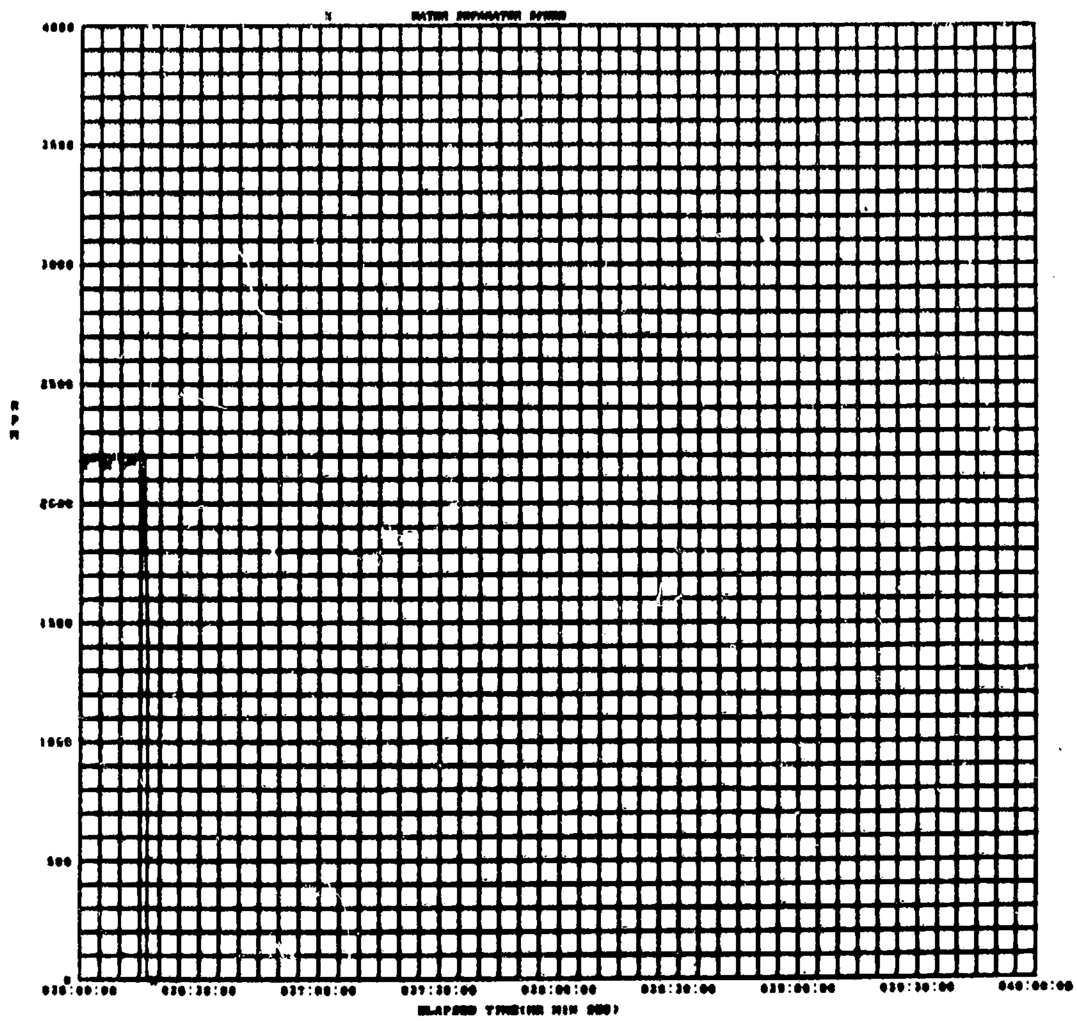


FIGURE 39J WATER SEPARATOR SPEED VERSUS TIME - CONCLUDED

APPENDIX B

FINAL TEST PROCEDURE

APOLLO 13 LIOH CANISTER EVALUATION

CSD-A-1069

APRIL 14, 1970

NOTE

THIS DOCUMENT HAS BEEN APPROVED FOR USE IN CONDUCTING THIS TEST. CONTENTS OF THIS DOCUMENT ARE SUBJECT TO CHANGE BY THE TEST DIRECTOR DURING THE PERFORMANCE OF THE TEST ONLY WHEN CHANGES ARE BASED UPON ABSOLUTE REQUIREMENTS NECESSARY TO FULFILL THE STATED TEST OBJECTIVES. THIS DOCUMENT WILL BECOME FINAL WHEN THE TEST TITLE IS SUPERSEDED BY THE PHRASE 'FINAL TEST PROCEDURE.'

CONTENTS

1.0 APPLICABLE DOCUMENTS

THE FOLLOWING DOCUMENTS ARE AVAILABLE IN SUPPORT OF THIS TEST...

A. GRUMMAN DOCUMENT NO. LMA790-8-5510, 'LUNAR MODULE SUPPORT MANUAL, INTERNAL ENVIRONMENT SIMULATOR.'

B. MIL-O-27210 'OXYGEN AVIATORS BREATHING, LIQUID AND GAS, SPECIFICATION FOR.'

C. OPERATION AND MAINTENANCE MANUAL FOR BECKMAN 210 SYSTEM.

D. SYSTEMS TEST BRANCH STANDARD OPERATING PROCEDURES MANUAL.

E. MSC MANUAL 5312, 'MSC RELIABILITY AND QUALITY ASSURANCE MANUAL.'

F. MSC MANUAL 1700, 'MSC SAFETY MANUAL.'

G. GRUMMAN DOCUMENT NO. LSG770-430-42-LM-3, 'ENVIRONMENTAL CONTROL SUBSYSTEM STUDY GUIDE - LUNAR MODULE LM-3.'

H. STB-F-028, 'FAILURE MODES AND EFFECTS ANALYSIS FOR CSD 11-FT CHAMBER.'

I. MSC-SPEC-C-6B, 'SPECIFICATION, SPACECRAFT CHEMICAL AND FLUID CLEANLINESS REQUIREMENTS.'

2.0 SYMBOLS AND ABBREVIATIONS

AC	ALTERNATING CURRENT
ACFM	ACTUAL CUBIC FEET PER MINUTE
AL	ALUMINUM
AMB	AMBIENT
ARS	ATMOSPHERE REVITALIZATION SECTION
ASSUR	ASSURANCE
ASSY.	ASSEMBLY
ATD	ASSISTANT TEST DIRECTOR
AVT	ALTITUDE VERIFICATION TEST
BIO	BIOINSTRUMENTATION
BIOMED	BIOMEDICAL
BRN	BROWN AND ROOT-NORTHROP
BT	BIOINSTRUMENTATION TECHNICIAN
BTH	BOTH
BTU/HR	BRITISH THERMAL UNITS PER HOUR
CO2	CARBON DIOXIDE
CAL.	CALIBRATION
C/B	CIRCUIT BREAKER
CCA	COMMUNICATIONS CARRIER ASSEMBLY
CDR	COMMANDER
CKD	CHECKED
CM	CREWMAN, CREWMEN

SYMBOLS AND ABBREVIATIONS - CONTINUED

COMM	COMMUNICATIONS
C OP	CABIN OPERATOR
COMPAT	COMPATIBLE
CPS	CYCLES PER SECOND
CSD	CREW SYSTEMS DIVISION
CTPS	CHAMBER TEST PROJECTS SECTION
CU-CON	COPPER-CONSTANTAN
DARS	DATA ACQUISITION AND RECORDING SYSTEM
DC	DIRECT CURRENT
DEG F	DEGREES FAHRENHEIT
DELTA P	DIFFERENTIAL PRESSURE
DELTA T	DIFFERENTIAL TEMPERATURE
DP	DEWPOINT
DR/MRR	DISCREPANCY REPORT/MATERIAL REVIEW RECORD
ECG (EKG)	ELECTROCARDIOGRAM
ECS	ENVIRONMENTAL CONTROL SYSTEM
ER	EMERGENCY REPRESSURIZATION
EV	EXTRAVEHICULAR
EVCS	EXTRAVEHICULAR COMMUNICATIONS SYSTEM
EVVA	EXTRAVEHICULAR VISOR ASSEMBLY
FC	FACILITY COORDINATOR
FCS	FECAL CONTAINMENT SUBSYSTEM
FIG.	FIGURE

SYMBOLS AND ABBREVIATIONS - CONTINUED

FM	FACILITY MANAGER
FSO	FLIGHT SAFETY OFFICE
FT	FOOT, FEET
GA	GAS ANALYZER
GMT	GREENWICH MEAN TIME
GN2	GASEOUS NITROGEN
GOX	GASEOUS OXYGEN
GSE	GROUND SUPPORT EQUIPMENT
H2O	WATER
H/X	HEAT EXCHANGER
IDR	INTERIM DISCREPANCY REPORT
IE	INSTRUMENTATION ENGINEER
ILO	INNER LOCK OPERATOR
IN.	INCH, INCHES
INT	INTERMEDIATE
IT.	INSTRUMENTATION TECHNICIAN
IV	INTRAVEHICULAR
LB/HR	POUNDS PER HOUR
LCG	LIQUID COOLING GARMENT
LIOH	LITHIUM HYDROXIDE
LM	LUNAR MODULE
LMP	LUNAR MODULE PILOT
LN2	LIQUID NITROGEN
LO	LOCK OBSERVER

SYMBOLS AND ABBREVIATIONS - CONTINUED

LOX	LIQUID OXYGEN
MAX.	MAXIMUM
MIN	MINUTE, MINUTES
MIN.	MINIMUM
MM HG	MILLIMETERS OF MERCURY
MO	MEDICAL OFFICER
MON	MONITOR
MSC	MANNED SPACECRAFT CENTER
MT	MECHANICAL TECHNICIAN
N2	NITROGEN
NA	NOT APPLICABLE
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NO.	NUMBER
O2	OXYGEN
OLO	OUTERLOCK OPERATOR
OPER	OPERATOR
OPS	OXYGEN PURGE SYSTEM
PARA	PARAGRAPH
PCT	PERCENT
PE	PERSONNEL EQUIPMENT TECHNICIAN
PG	PAGE
PGA	PRESSURE GARMENT ASSEMBLY
PIA	PREINSTALLATION ACCEPTANCE

SYMBOLS AND ABBREVIATIONS - CONTINUED

PLSS	PORTABLE LIFE SUPPORT SYSTEM
P/N	PART NUMBER
PO2	PARTIAL PRESSURE OF OXYGEN
POS	PRIMARY OXYGEN SUPPLY
PRESS.	PRESSURE
PRV	PRESSURE RELIEF VALVE
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSID	POUNDS PER SQUARE INCH DIFFERENTIAL
PSIG	POUNDS PER SQUARE INCH GAGE
PT	PLSS TECHNICIAN
Q/A	NASA QUALITY ASSURANCE INSPECTOR
RCU	REMOTE CONTROL UNIT
REG	REGULATOR
REQD	REQUIRED
RFG	RADIO-FREQUENCY GROUND STATION
R/H	RIGHT HAND
SCC/MIN (SCCM)	STANDARD CUBIC CENTIMETERS PER MINUTE, MEASURED AT 14.7 PSIA AND 70 DEG F
SCFM	STANDARD CUBIC FEET PER MINUTE, MEASURED AT 14.7 PSIA AND 70 DEG F
SEC	SECOND
SIP.	SAFETY INSTRUMENTATION PACKAGE
S/N	SERIAL NUMBER
SOPM	STANDARD OPERATING PROCEDURES MANUAL

SYMBOLS AND ABBREVIATIONS - CONCLUDED

SPEC	SPECIFICATION
SQ	SEQUENCE
SSC	SPACE SUIT COMMUNICATIONS
S ST	STAINLESS STEEL
ST	SUIT TECHNICIAN
STB	SYSTEMS TEST BRANCH
STD	STANDARD
T/C	THERMOCOUPLE
TCO	TEST CONTROL OFFICE
TCUT	TRIM CONTROL UNIT TECHNICIAN
TD	TEST DIRECTOR
TECH	TECHNICIAN
TEMP.	TEMPERATURE
TM	TELEMETRY
TPS	TEST PREPARATION SHEET
TSO	TEST SAFETY OFFICE
UCTA	URINE COLLECTION AND TRANSFER ASSEMBLY
V	VOLTS
VT	VIDEO TECHNICIAN
W&T	WALLACE AND TIERNAN
X-DUCER (X-DCR)	TRANSDUCER
ZPN	IMPEDANCE PNEUMOGRAPH
+/-	PLUS OR MINUS

3.0 TEST DESCRIPTION AND PARAMETERS

3.1 TEST OBJECTIVE

THE APOLLO 13 LIOH CANISTER EVALUATION WILL BE CONDUCTED TO DETERMINE IF THE COMMAND MODULE ECS LIOH CANISTERS CAN BE USED IN THE LM. THIS TEST WILL ALSO DETERMINE THE TIME TO BREAKTHROUGH WITH SIMULATED LM CONDITIONS AND A CONSTANT RATE OF CO2 INJECTION.

3.2 TEST DESCRIPTION

THE APOLLO 13 LIOH CANISTER EVALUATION WILL BE CONDUCTED IN THE CSD 11-FT-DIAMETER CHAMBER CABIN. THE LM ECS CABIN WILL BE CONFIGURED AS PER THE APOLLO 13 FLIGHT CONFIGURATION AND CONDITIONS.

TWO APOLLO COMMAND MODULE LIOH CANISTERS WITH ADAPTORS FABRICATED FROM MATERIALS (FLIGHT PROCEDURE COVER, LCG STOWAGE BAGS, SMALL TOWELS AND TAPE) AVAILABLE ABOARD APOLLO 13, WILL BE ATTACHED TO THE SUIT OUTLET (RED) HOSES.

AFTER THE FIRST SET OF CANISTERS BECOME INEFFECTIVE IN REMOVING CO2, TWO ADDITIONAL CANISTERS WILL BE STACKED ON THE ORIGINAL CANISTERS. THE SYSTEM WILL BE OPERATED AS BEFORE WITH A CO2 INJECTION RATE OF 1100 SCC/MIN UNTIL CO2 LEVEL IN THE CABIN REACHES 15 MM HG PARTIAL PRESSURE.

3.3 ELECTRICAL SYSTEMS AND INTERFACES

THE INSTRUMENTATION PORTION OF THE 11-FT CHAMBER FACILITY CONSISTS OF TEST INSTRUMENTATION, CHAMBER ECS INSTRUMENTATION, DATA DISPLAY AND TEST DIRECTOR'S CONSOLE, BIOMED CONSOLE, MEDICAL MONITOR'S CONSOLE, COMMUNICATIONS SYSTEM, DATA ACQUISITION AND RECORDING SYSTEM, AND A CLOSED-CIRCUIT TV SYSTEM.

THE TEST ARTICLE/FACILITY INTERFACE OCCURS AT THE PNEUMATIC PRESSURE PORTS OF THE TEST INSTRUMENTATION TRANSDUCERS AND AT THE SUIT ELECTRICAL CONNECTOR. THE TEST TRANSDUCERS PROVIDE ELECTRICAL ANALOGS OF THE TEST PARAMETERS WHICH ARE CONDUCTED THROUGH THE CHAMBER BULKHEAD AND INSTRUMENTATION CONTROL CONSOLE TO THE DATA ACQUISITION AND RECORDING SYSTEM.

BIOMEDICAL PARAMETERS REQUIRED FOR SAFETY OF SUBJECTS ARE CONDUCTED THROUGH THE SUIT CONNECTOR TO THE BIOMED CONSOLE WHERE THEY ARE DISPLAYED AND/OR RECORDED FOR THE MEDICAL OFFICER.

REQUIRED TEST PARAMETERS ARE RETURNED FROM THE DATA ACQUISITION AND RECORDING SYSTEM TO THE TEST DIRECTOR'S CONSOLE FOR THE SYSTEMS ENGINEER.

THE FACILITY COMMUNICATIONS SYSTEM INTERFACES AT THE BIOMED CONSOLE AND PROVIDES THE AUDIO LINK BETWEEN ALL TEST PERSONNEL.

THE CLOSED-CIRCUIT TV SYSTEM PROVIDES VIDEO MONITORING OF THE TEST. THE TV SIGNAL IS RECORDED ON VIDEO TAPE AND IS ALSO DISPLAYED AT THE TEST DIRECTOR'S AND MEDICAL OFFICER'S CONSOLES.

3.4 STATEMENT OF ACCURACY

ESTABLISHED STB VERIFICATION PROCEDURES SHALL BE USED TO SHOW TRACEABILITY OF CALIBRATIONS TO THE NBS AND ASSURE AN ACCURACY OF +/- 3 DEGREES F FOR TEMPERATURES AND +/- 3 PERCENT FULL SCALE FOR ALL OTHER PARAMETERS UNLESS OTHERWISE STATED.

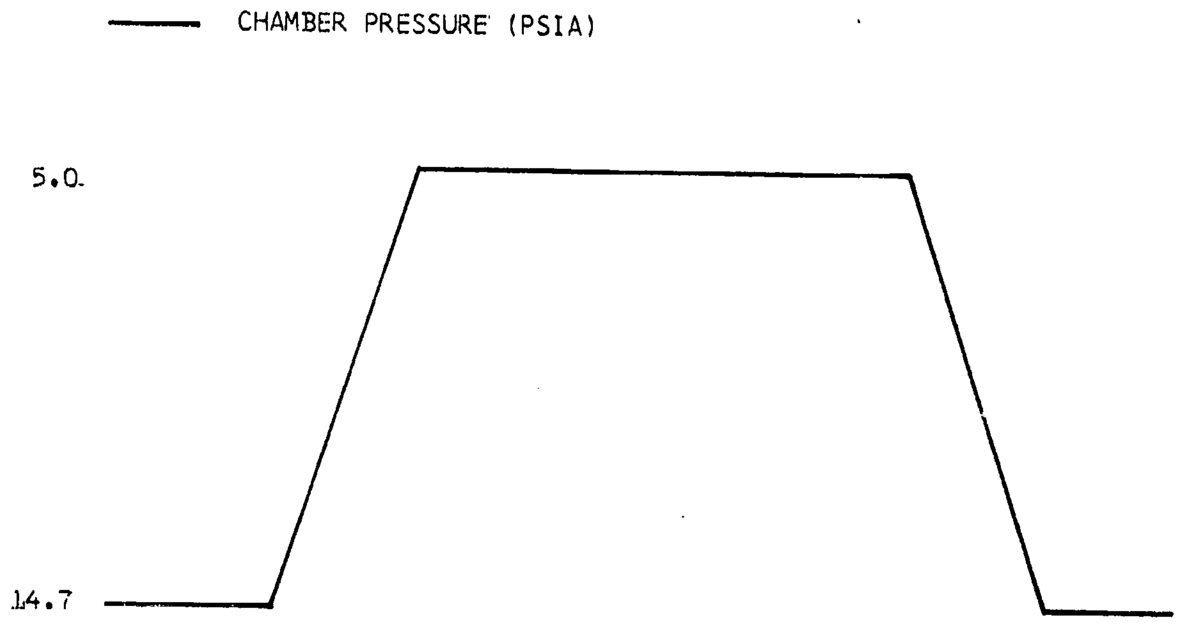
3.5 TEST CONDITIONS

THE TEST OPERATIONS DEFINED WITHIN THIS TEST PROCEDURE SHALL BE CONDUCTED UNDER THE FOLLOWING CONDITIONS...

A. CABIN PRESSURE... 5.0 PLUS OR MINUS 0.2 PSIA

B. CABIN TEMP... 55 PLUS OR MINUS 5 DEG F

3.6 FLIGHT PRESSURE PROFILE



3.7 PARAMETERS TO BE MEASURED

TEST DATA WILL BE RECORDED ON MAGNETIC TAPE BY A DIGITAL DATA ACQUISITION AND RECORDING SYSTEM. ALL ACCURACIES ARE BASED ON THE TYPE ELECTRICAL SYSTEMS AND PROCEDURES INVOLVED. THESE INCLUDE THE CALIBRATION AND VERIFICATION DATA OF THE SENSING ELEMENT (TRANSDUCER, THERMOCOUPLE, ETC.) AND THE DATA ACQUISITION AND RECORDING SYSTEM.

3.8 CURVES TO BE GENERATED

THE FOLLOWING DATA SHALL BE PRESENTED IN GRAPHICAL FORM VERSUS TIME...

A. WALL TEMPERATURE NO. 1
   WALL TEMPERATURE NO. 2
   WALL TEMPERATURE NO. 3
   WALL TEMPERATURE NO. 4

B. CABIN PRESSURE

C. CDR SUIT INLET PRESSURE

D. CABIN TEMPERATURE

E. LMP SUIT GAS IN TEMP
   SUIT CIRCUIT IN TEMP
   CDR SUIT GAS IN TEMP

F. LMP SUIT OUT TEMP
   CDR SUIT OUT TEMP

G. ECS OUT DEWPOINT

H. CABIN CO2 PARTIAL PRESSURE

I. CABIN O2 PARTIAL PRESSURE

J. CABIN N2 PARTIAL PRESSURE

K. CDR SUIT OUT CO2

L. LMP SUIT OUT CO2

M. CDR SUIT OUT O2

N. LMP SUIT OUT O2

O. ECS INLET O2 PRESSURE

P. CDR LIOH CANISTER OUT TEMP

Q. CDR LIOH CANISTER DELTA P

CURVES TO BE GENERATED - CONCLUDED

R. LMP LIOH CANISTER DELTA P

S. CABIN FAN SPEED
SUIT FAN SPEED

T. SUIT FAN DELTA P

U. WATER SEPARATOR SPEED

V. CABIN DEWPOINT TEMPERATURE

4.0 MISSION RULES

ITEM	CONDITION	ACTION
001	HIGH-PRESSURE O2 SWITCH ACTUATION	
	A. PRIMARY O2 BANK SUPPLYING ECS	
	01. 1800-PSIG RANGE ACTUATION	CONTINUE TEST. SWITCH OVER TO BACKUP O2 BANK WHEN PRESSURE REACHES 1100 PSIG
	02. 1000-PSIG RANGE ACTUATION	SWITCH OVER TO BACKUP O2 BANK. NOTE... DO NOT ER UNTIL SWITCHOVER IS COMPLETE
	B. BACKUP O2 BANK	
	01. 1800-PSIG RANGE ACTUATION	FTC INVESTIGATE CAUSE OF LOSS OF PRESSURE
	02. 1000-PSIG RANGE ACTUATION	ABORT AT DISCRETION OF TD
002	LOW-PRESSURE BUILDING O2 SUPPLY	
	A. LOSS OF PRIMARY SUPPLY WITH NORMAL SECONDARY SUPPLY AND NORMAL HIGH-PRESSURE SUPPLY	VERIFY AUTOMATIC SWITCHOVER TO SECONDARY SUPPLY. FTC RESTORE PRESSURE TO PRIMARY SUPPLY SYSTEM
	B. LOSS OF SECONDARY SUPPLY WITH NORMAL PRIMARY AND NORMAL HIGH-PRESSURE SUPPLY	CONTINUE TEST. FTC INVESTIGATE CAUSE OF LOSS OF PRESSURE
	C. LOW PRESSURE ON SECONDARY SUPPLY WITH FAILED PRIMARY SUPPLY	VERIFY 80-PSIG DELIVERY TO CHAMBER. REPLACE BOTTLES ON NO. 1 SECONDARY MANIFOLD (MANIFOLD C)

MISSION RULES - CONTINUED

ITEM	CONDITION	ACTION
	D. ACTUATION OF 'REDUNDANT LOW-PRESSURE' SWITCH WITH FAILED PRIMARY SUPPLY	A. LOCK OBSERVER SWITCH TO PORTABLE OXYGEN SUPPLY B. ABORT TEST
003	LOSS OF CABIN PRESSURE	CABIN OPERATOR CLOSE VACUUM ISOLATION VALVE. HOLD AND EVALUATE
004	FIRE AND/OR SMOKE IN TEST FACILITY	
	A. CABIN	FOLLOW EMERGENCY PROCEDURES
	B. INNER LOCK	FOLLOW EMERGENCY PROCEDURES
	C. OUTER LOCK	FOLLOW EMERGENCY PROCEDURES
	D. CONTROL ROOM	FOLLOW EMERGENCY PROCEDURES

5.0 TEST BUILDUP AND PERSONNEL

5.1 EQUIPMENT VALIDATION

5.1.1 EQUIPMENT VALIDATION BY TEST CONTROL OFFICE

THE TEST CONTROL OFFICE OF SYSTEMS TEST BRANCH SHALL CONDUCT A THOROUGH INSPECTION OF THE TEST COMPLEX IN ACCORDANCE WITH THE ENCLOSED MECHANICAL AND ELECTRICAL INSPECTION AND EQUIPMENT REQUIREMENT LISTS. THIS INSPECTION SHALL VERIFY THAT THE STB STANDARD OPERATING AND CLEANING PROCEDURES HAVE BEEN FOLLOWED DURING EQUIPMENT BUILDUP AND THAT THE TEST COMPLEX IS PREPARED FOR TEST OPERATION.

DURING EQUIPMENT ASSEMBLY, THE TEST CONTROL OFFICE SHALL WITNESS AND RECORD VALUES OF THE GAS CIRCUIT LEAKAGE TEST.

5.1.2 TEST VALIDATION AND VERIFICATION BY QUALITY ASSURANCE

THE QUALITY ASSURANCE BRANCH SHALL PROVIDE AN INSPECTOR WHO SHALL CONDUCT AN INSPECTION OF THE TEST COMPLEX IN ACCORDANCE WITH THE ENCLOSED EQUIPMENT REQUIREMENT LISTS AND SCHEMATICS. THE INSPECTOR SHALL ALSO WITNESS PREPARATION OF THE TEST ARTICLES AND THE TESTING PROCEDURE. HE SHALL MONITOR THE PERFORMANCE OF THE TEST AND DOCUMENT ANY SYSTEM FAILURE AND/OR ANOMALY WHICH OCCURS DURING TESTING ON AN IDR OR DR/MRR AND PROCESS AS PER THE MSC QUALITY ASSURANCE MANUAL. THE INSPECTOR SHALL ALSO MAKE FINAL ACCEPTANCE OF THE TEST DIRECTOR'S OFFICIAL COPY OF THE TEST PROCEDURES.

5.1.3 EQUIPMENT VALIDATION BY TEST DIRECTOR

PRIOR TO BEGINNING THE TEST, THE TEST DIRECTOR SHALL WITNESS A FUNCTIONAL TEST OF ALL SYSTEMS. ALL PERSONNEL INVOLVED IN RUNNING THE TEST SHALL PARTICIPATE IN A DRY RUN OF THE PROCEDURES PRIOR TO RUNNING THE TEST.

5.2 TEST PERSONNEL STATIONS

THE FOLLOWING TEST STATIONS REQUIRE PERSONNEL AS OPERATORS AND/OR MONITORS TO ADEQUATELY SUPPORT THIS TEST. PRIMARY AND ALTERNATE PERSONNEL ARE AS SHOWN.

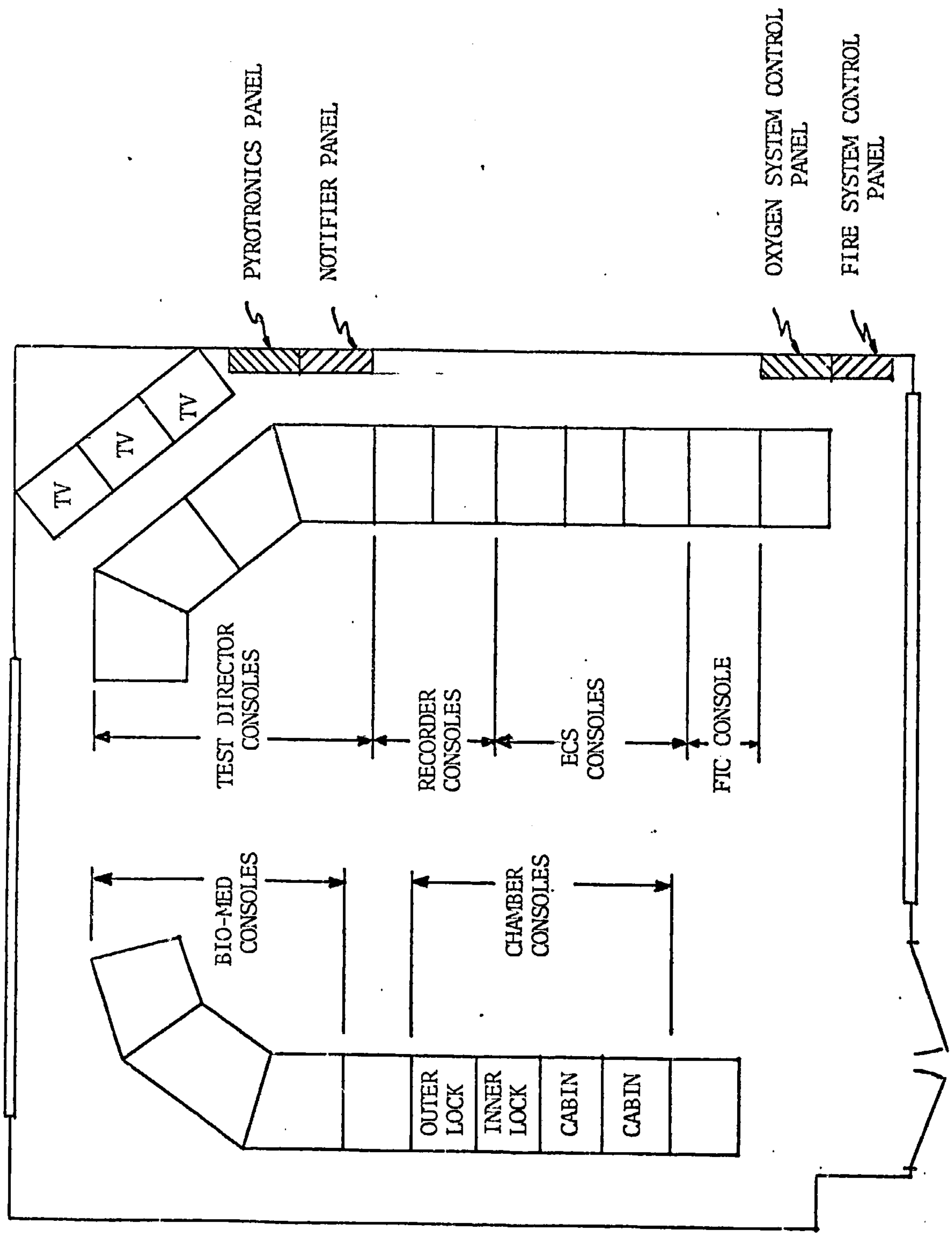
PERSONNEL TITLE	TEST STATION	NO	PRIMARY	ALTERNATE
TEST DIRECTOR	11-FT-CHAMBER CONTROL ROOM	1	J. LEBLANC	
ASSISTANT TEST DIRECTOR	11-FT-CHAMBER CONTROL ROOM	1	J. MAYS	A. BEHREND T. BRISBIN J. SKIPPER
INSTRUMENTATION ENGINEER	11-FT-CHAMBER CONTROL ROOM	1	F. METCALF	L. CASEY
GSE CONSOLE OPERATOR	11-FT-CHAMBER CONTROL ROOM	1	T. WILKS	J. ROGERS
QUALITY ASSUR INSPECTOR	11-FT-CHAMBER CONTROL ROOM	1	A. SULLIVAN	H. MCDONALD
TEST CONTROL OFFICE	11-FT-CHAMBER CONTROL ROOM	1	D. CARTER	W. HAGAN
INSTRUMENTATION TECHNICIAN	11-FT-CHAMBER CONTROL ROOM	1	C. CONLEE	D. AYOUB
CABIN OPERATOR	11-FT-CHAMBER CONTROL ROOM	1	R. THOMPSON	CENATIEMPO
MECH TECH	WEST SIDE OF 11-FT-CHAMBER		R. DUGAN	C. GEORGE
ECS BRANCH REPRESENTATIVE	11-FT-CHAMBER CONTROL ROOM	1	D. PRICE	

TEST PERSONNEL STATIONS - CONCLUDED

PERSONNEL TITLE	TEST STATION	NO	PRIMARY	ALTERNATE
GAS ANALYZER OPERATOR	WEST SIDE OF 11-FT-CHAMBER PLATFORM	1	W. ODEN	M. HEAUSER
TRIM CONTROL UNIT TECH	WEST FLOOR BY 11-FT CHAMBER	1	R. HEAP	J. WAGNER
052 UNIT TECH	EAST SIDE OF BUILDING 7	1	D. BURRIS	J. MORLEDGE
ECS TECHNICIAN	SOUTH AND EAST SIDE OF 11-FT CHAMBER	1	V. MURRAY	
DARS OPERATOR	ROOM 114	1	W. GULLETT	R. WEMHOFF
VIDEO OPERATOR	ROOM 114	1	R. STITT	R. MARTIN
TEST SAFETY OFFICER	ROOM 114	1	S. CARMINES	

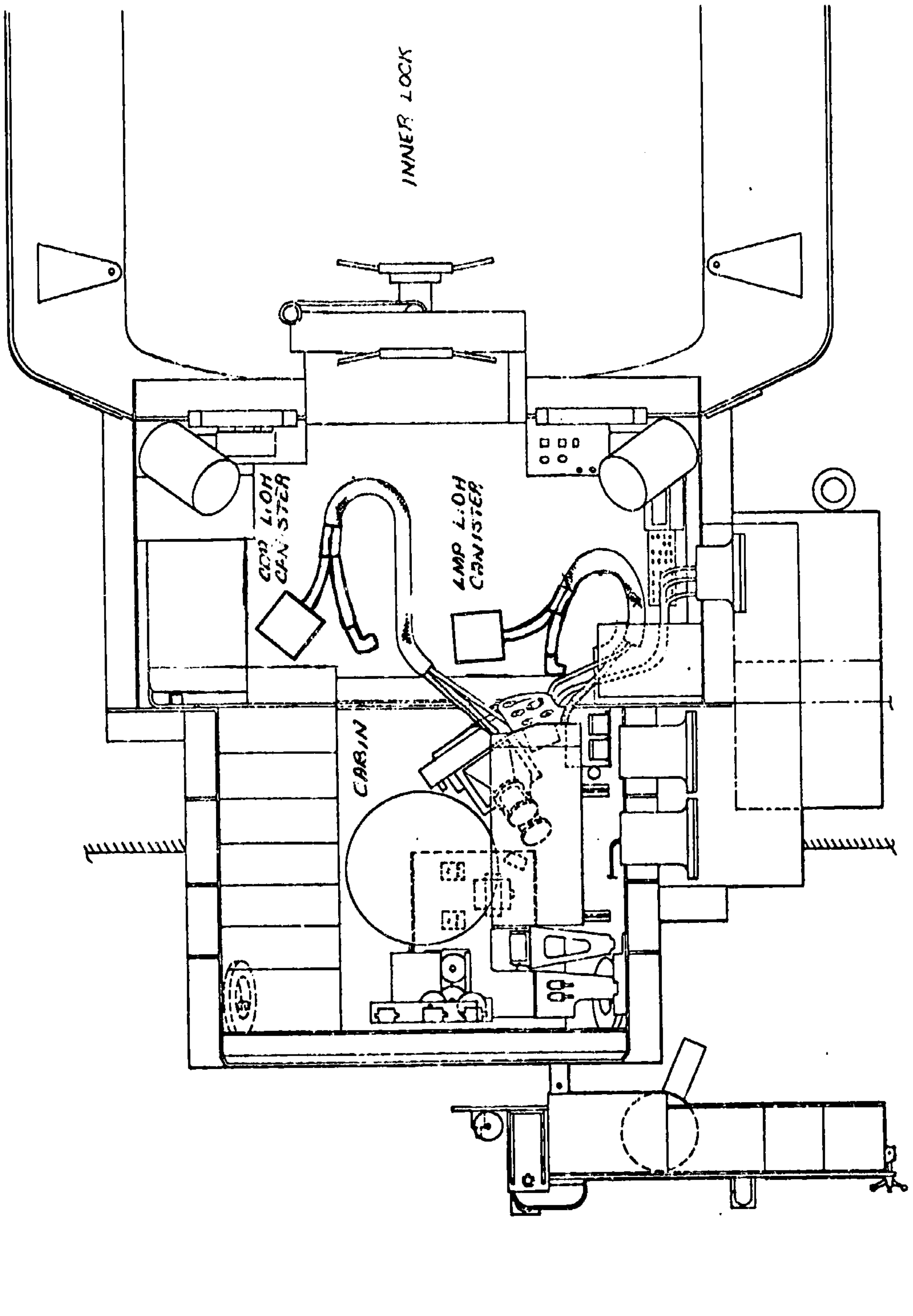
5.3 TEST BUILDUP SCHEMATICS

5.3.1 TEST EQUIPMENT LOCATION SCHEMATIC



CONTROL ROOM LAYOUT

5.3.2 GENERAL CHAMBER LAYOUT



6.0 TEST PREPARATION

6.1 MECHANICAL EQUIPMENT REQUIREMENTS

ITEM	REQ	NOMENCLATURE - MANUFACTURER / PARAMETER - RANGE - ACCURACY	MODEL NUMBER / SERIAL NUMBER	CAL. DUE DATE	DATE CKD.	TCO / Q/A
	2	SUIT NOZZLE (BLUE) - TSD	SDB38100-681-301	NA		
			1002&1003			
	2	SUIT NOZZLE (RED) - TSD	SDB38100-681-302	NA	70	
			1002&1003			
	4	LIOH CANISTER		NA		
	1	DEWPT ANALYZER - CAMBRIDGE	992	PRE-TEST		

6.2 ELECTRICAL EQUIPMENT REQUIREMENTS

THE ELECTRICAL INSTRUMENTATION INSTALLED IN 11-FT CHAMBER, AND THE ROUTING OF SIGNALS TO RECORDING DEVICES AND DISPLAYS ARE SHOWN ON DRAWING Q02-E1201, SHEETS 1 TO 5. ALSO SHOWN ARE THE MODEL NUMBER, SERIAL NUMBER, AND RANGE OF EACH TRANSDUCER.

6.3 MECHANICAL INSPECTION CHECKSHEET

ITEM	EMU/ CHMBR SYSTM	IES ECS					
PROPER TUBE FLAR-ING TECHNIQUE			X				
COLOR CODING OF LINES	X		X				
STRUCTURAL RIGI 'TY			X				
ALL LINES LABELED			X				
OXYGEN CLEAN AS PER STB SOPM							
GENERAL LOOK OF TEST SETUP							
MATERIAL SELECTED AS PER STB SOPM							
VERIFIED WITH SCHEMATIC(S)			X				
FUNCTIONAL CHECK			X				

4.14.70

6.4 ELECTRICAL INSPECTION CHECKSHEET

ITEM	CHMBR X-DCR	IES ECS X-DCR	T/C SYSTEM	DATA ACQ SYSTEM	POWER	BIOMED SYSTEM
FUSES			X	X		
PROPER WIRE SIZE				X		
SIGNAL WIRING AS PER STB SOPM					X	
GROUND WIRING AS PER STB SOPM			X			
PROPER MATERIALS				X	X	
JUNCTIONS POTTED				X	X	
HERMETICALLY SEALED/O2 COMPAT				X	X	
X-DUCERS PROPERLY INSTALLED				X	X	
CABLING AS PER STB SOPM						
POWER DISTRIBUTION			X	X		
OXYGEN CLEAN AS PER STB SOPM				X	X	

4-14-70

4

7.0 SYSTEMS AND SUBSYSTEMS TEST READINESS VERIFICATION

THE FOLLOWING PERSONNEL VERIFY THAT THEIR EQUIPMENT IS READY FOR EXPOSURE TO THE TEST CONDITIONS SPECIFIED IN THIS PROCEDURE. BEFORE SIGNING, THE RESPONSIBLE PERSONNEL HAVE GIVEN THE TEST DIRECTOR A TPS OR AN EQUIVALENT CHECKSHEET

BIOMEDICAL RECORDING SYSTEM, DATA SYSTEM, AND ELECTRICAL SUPPORT EQUIPMENT	Bobbie E. Pond INSTRUMENTATION ENGINEER	4-14-70 DATE
MECHANICAL BUILDUP EQUIPMENT	James C. LeBlanc TEST DIRECTOR	4-14-70 DATE
CHAMBER, EMERGENCY EQUIPMENT, AND FACILITY EQUIPMENT	J. V. Marsden FACILITY TEST CONDUCTOR	4-14-70 DATE
TEST CREWMEN AND INSIDE OBSERVERS	N/A MEDICAL OFFICER	N/A DATE
TEST HARDWARE	Donald Price ECS BRANCH REPRESENTATIVE	4-14-70 DATE
Q/A VERIFICATION AND ALL DR/MRR'S DISPOSITIONED	A. J. Sullivan R&QA-QC INSPECTOR	4-14-70 DATE

8.0 TEST SEQUENCES

SQ	TO	OPERATION	REMARKS
		THE FOLLOWING TEST SEQUENCES ARE TO BE PERFORMED AS THEY APPEAR. THE TEST DIRECTOR WILL DIRECT THE PERSON INDICATED IN SEQUENCE TO PERFORM THE ACTION REQUIRED BY THAT SEQUENCE. ALL SUCH DIRECTIONS SHALL BE GIVEN OVER THE COMMUNICATIONS LOOP WITH THE PERSON RECEIVING THE DIRECTION VERIFYING THE COMMUNICATION WAS RECEIVED AND ALSO THAT THE ACTION WAS PERFORMED. NO SEQUENCE SHALL BE PERFORMED UNTIL THE TEST DIRECTOR HAS DIRECTED THAT IT BE PERFORMED	
001	TD	ENSURE MODE SWITCH ON TD CONSOLE IN UNMANNED MODE	
002	TD	PERFORM COMMUNICATIONS AND STATION STATUS CHECK	
		DURING COMMUNICATIONS AND STATION STATUS CHECK PERSONNEL SHALL ACKNOWLEDGE WITH A 'GO' OR 'NO GO' OVER THE COMM LOOP AND IF APPROPRIATE BY ALSO DEPRESSING THE 'GO' BUTTON ON THEIR STATION STATUS PANEL. WHEN ALL STATIONS HAVE REPORTED A 'GO' CONDITION, THE TD SHALL DEPRESS THE 'TEST' BUTTON. IF DURING CONTINUATION OF THE TEST, A 'NO GO' CONDITION RESULTS AT ANY STATION, THAT STATION SHALL INFORM THE TD OVER THE COMM LOOP OF THE 'NO GO' CONDITION AND THE TD SHALL RESET THE STATION STATUS CONDITION TO 'NO GO.' THE TD SHALL THEN DECLARE A 'HOLD' CONDITION IF IT IS APPROPRIATE AND DEPRESS THE 'HOLD' BUTTON. WHEN ALL STATIONS ARE 'GO' AGAIN, THE TD SHALL DEPRESS	

4-14-70

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
		THE 'TEST' BUTTON AND CONTINUE THE TEST SEQUENCES	
		A. ASSISTANT TEST DIRECTOR	
		B. INSTRUMENTATION ENGINEER	
		C. CABIN OPERATOR	
		D. Q/A INSPECTOR	
		E. INSTRUMENTATION TECHNICIAN	
		F. ECSB REPRESENTATIVE	
		G. GSE CONSOLE OPERATOR	
		H. ECS MONITOR	
		I. ECS TECH	
		J. GAS ANALYZER OPERATOR	
		K. TRIM CONTROL UNIT TECH	
		L. -052 UNIT OPERATOR	
		M. DARS OPERATOR	
		N. VIDEO TECHNICIAN	
		O. TEST SAFETY OFFICER	
		P. TEST CONTROL OFFICER	
003	TD	ALL STATIONS - THROUGHOUT THE ENTIRETY OF THE TEST, THE STRICTEST COMMUNICATIONS DISCIPLINE SHALL BE OBSERVED AS FOLLOWS...	
		A. COMMUNICATIONS SHALL BE KEPT TO A MINIMUM	
		B. WHEN SPEAKING, IDENTIFY THE STATIONS BEING CALLED AND THE STATION CALLING AND	

4-14-70

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
		WAIT FOR A RESPONSE BEFORE PROCEEDING	
		C. IF A PRIVATE CONVERSATION IS DESIRED WITH ANOTHER STATION APPROVAL MUST BE OBTAINED FROM THE TD	
		D. INFORM THE TD WHENEVER LEAVING AND RETURNING TO A STATION	
		E. CLOSE ALL MIKE SWITCHES WHEN NOT IN USE	
		F. ALL TEST PERSONNEL WILL BE REPLACED ONLY BY THEIR ALTERNATE AT A TIME DETERMINED BY THE TD. PRIMARY PERSONNEL WILL BE AWAY FROM THEIR STATIONS FOR A MAXIMUM OF FIVE MINUTES	
004	TD	ALL STATIONS ACKNOWLEDGE TD'S COMMENTS ON COMMUNICATIONS DISCIPLINE WITH A 'GO'	
		A. ASSISTANT TEST DIRECTOR	
		B. INSTRUMENTATION ENGINEER	
		C. CABIN OPERATOR	
		D. Q/A INSPECTOR	
		E. INSTRUMENTATION TECHNICIAN	
		F. ECSB REPRESENTATIVE	
		G. GSE CONSOLE OPERATOR	
		H. ECS MONITOR	
		I. ECS TECH	
		J. GAS ANALYZER OPERATOR	

4-14-70

32M

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
		K. TRIM CONTROL UNIT TECH	
		L. -052 UNIT OPERATOR	
		M. DARS OPERATOR	
		N. VIDEO TECHNICIAN	
		O. TEST SAFETY OFFICER	
		P. TEST CONTROL OFFICER	
005	ECS TECH	VERIFY ECS CONFIGURATION AS FOLLOWS...	
		A. SUIT GAS DIVERTER - PULL EGRESS	
		B. CABIN GAS RETURN - EGRESS	
		C. SUIT CIRCUIT RELIEF - CLOSED	
		D. LMP ISOLATION VALVE - FLOW	
		E. CDR ISOLATION VALVE - FLOW	
		F. CABIN REPRESS VALVE - 'AUTO'	
		G. ARS PRESS REG 'A' - 'CABIN'	
		H. ARS PRESS REG 'B' - 'CABIN'	
		I. DESCENT O2 VALVE - OPEN	
		J. ASCENT O2 NO. 1 - 'CLOSE'	
		K. ASCENT O2 NO. 2 - 'CLOSE'	
		L. SUIT TEMP CONTROL - 'MAX HOT'	
		M. CABIN DUPM VALVES - AUTO	
		N. H2O SEPARATOR - 'PUSH-SEP 1'	
		O. CANISTER SELECT VALVE - 'PRIMARY'	

4-14-70

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
006	ECS TECH	VERIFY CIRCUIT BREAKERS AND SWITCHES AS FOLLOWS...	
		A. SIGNAL SENSOR C/B - CLOSED	
		B. ECS DISPLAYS - CLOSED	
		C. DIVERT VALVE - CLOSED	
		D. CABIN REPRESS VALVE - CLOSED	
		E. SUIT ISOL VALVE - CLOSED	
		F. SUIT FAN CONTROL - CLOSED	
		G. SUIT FAN 1 - CLOSED	
		H. SUIT FAN 2 - CLOSED	
		I. CABIN FAN CONTROL - CLOSED	
		J. CABIN FAN - CLOSED	
		K. SUIT FAN SELECTOR TO SUIT FAN 1	
007	DARS	START DATA SYSTEM AND ALL RECORDERS	GMT 104 23 19 20 DATA TIME 0:00:00
008	TCO	ENTER CABIN, INSPECT TEST SET-UP AND NOTIFY TD WHEN INSPEC-TION IS COMPLETE	
009	ECS TECH	CLOSE THE CABIN ALTITUDE LIMITING VALVE AND EQUALIZATION VALVES, THEN SECURE THE CABIN TO INNER LOCK DOOR	
010	CO	ASCEND CABIN TO 27,000 FT AT 5,000 FT/MIN	
011	GSE OP	TURN SMOKE SENSOR SWITCH 'OFF'	

4-14-70

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
012	ECS TECH	AT 10,000 FT, UNDOG CABIN DOOR	
013	TCUT	ESTABLISH OPERATION OF TRIM CONTROL UNIT TO PROVIDE A FLOW OF 250 LB/HR WITH A SUIT H/X INLET TEMP OF 38 PLUS OR MINUS 2.0 DEG F	
014	GSE OP	START OPERATION OF WALL CHILLER AND CONTROL CABIN TEMP TO 55 PLUS OR MINUS 5.0 DEG F. NOTIFY TD WHEN STABLE	
015	VT	START VIDEO RECORDING	
016	TD	TURN CABIN POWER 'ON'	
017	GA	START SAMPLE PUMPS	
018	GA	PLACE GAS ANALYZERS IN MODES AS FOLLOWS... A. CABIN/ECS CABIN B. CDR SUIT OUT C. LMP SUIT OUT	
019	MT	BEGIN INJECTION OF CO2 AT 1100 SCCM	GMT 105 01 55 00
020	MT	INCREASE CO2 INJECTION RATE TO 2000 SCCM	GMT 105 04 19 00
021	ECSB	INFORM TD WHEN SUFFICIENT DATA HAS BEEN COLLECTED	
022	MT	TERMINATE CO2 INJECTION	GMT 105 15 59 00
023	TD	TURN CABIN POWER OFF	
024	CO	DESCEND CABIN TO SITE AT 5000 FT/MIN	

4-14-70

TEST SEQUENCES - CONTINUED

SQ	TO	OPERATION	REMARKS
025	DARS	STOP DATA SYSTEM AND ALL RECORDERS	GMT 105 17 41 37
026	VT	STOP VIDEO TAPE RECORDING	
027	TCO	ENTER CABIN, INSPECT TEST SET-UP AND NOTIFY TD WHEN INSPECTION IS COMPLETE	
028	ECS TECH	CLOSE THE CABIN ALTITUDE LIMITING VALVE AND EQUALIZATION VALVES, THEN SECURE THE CABIN TO THE INNER LOCK DOOR	
029	DARS	RESTART DATA SYSTEM AND ALL RECORDERS	GMT 105 20 55 14
030	VT	START VIDEO RECORDING	
031	CO	ASCEND CABIN TO 27,000 FT AT 5000 FT/MIN	
032	GSE OP	TURN SMOKE SENSOR SWITCH 'OFF'	
033	ECS TECH	AT 10,000 FT, UNDOG CABIN DOOR	
034	TD	TURN CABIN POWER ON	
035	MT	BEGIN INJECTION OF CO2 AT 1100 SCCM	GMT 105 20 55 20
036	MT	TERMINATE CO2 INJECTION	GMT 107 09 09 00
037	TD	TURN CABIN POWER OFF	
038	CO	DESCEND CABIN TO SITE AT 5000 FT/MIN	

4-14-70

TEST SEQUENCES - CONCLUDED

SQ	TO	OPERATION	REMARKS
039	DARS	STOP DATA SYSTEM AND ALL RECORDERS	GMT 107 09 18 00
040	VT	STOP VIDEO TAPE RECORDING	
041	ALL	SECURE ALL SYSTEMS PER POST-TEST CHECKLISTS	

4-14-70

9.0 TEST DEVIATION SHEET

PG.	PARA/ SEQ	DEVIATION	REASON
		FINAL TEST PROCEDURE HAS BEEN UPDATED TO REFLECT ALL TEST DEVIATIONS. SIGNED TEST DEVIATION SHEETS ARE FILED WITH THE ORIGINAL TEST PROCEDURE IN SYSTEMS TEST BRANCH FILES.	

PREPARED BY------------------------------DATE--------------
TEST DIRECTOR

APPROVED BY------------------------------DATE--------------
INSTRUMENTATION ENGINEER

APPROVED BY------------------------------DATE--------------
SYSTEM ENGINEER

APPROVED BY------------------------------DATE--------------
R&QA-QC INSPECTOR

REVISION ---- SHEET --- OF ---