VEHICLE AND CONTROL SYSTEMS DIVISION
INTERNAL REVIEW
12 MARCH l991

BOND SURFACE EVALUATION BY OSEE INSTRUMENT
TITAN IV PAYLOAD FAIRING

PRESENTED BY

R. P. DATE

MANUFACTURING ENGINEERING DEPARTMENT

DESIGN ENGINEERING SUBDIVISION

AGENDA

- o BACKGROUND
- o PLF MANUFACTURING AT MDSSC
- o SURFACE PREPARATION AND COATING AT LAUNCH SITE
- o TEST PROCEDURE
- o TEST RESULTS
- o OBSERVATIONS AND COMMENTS
- o CONCLUSIONS
- o RECOMMENDATIONS

BACKGROUND

- o TITAN IV PAYLOAD FAIRINGS:
  - MANUFACTURED BY MDSSC
  - ASSEMBLED AT LAUNCH SITE (CCAFS & VAFB)
- o BASE MATERIAL:
  - 7075-T73 ALUMINUM
- o APPROXIMATE DIMENSIONS:
  - DIAMETER- 17 FT
  - LENGTH: 56-86 FT.
- o SECTIONS OF PLF:
  - NOSE CONE SECTION
  - CYLINDRICAL SECTION
  - BOATTAIL SECTION

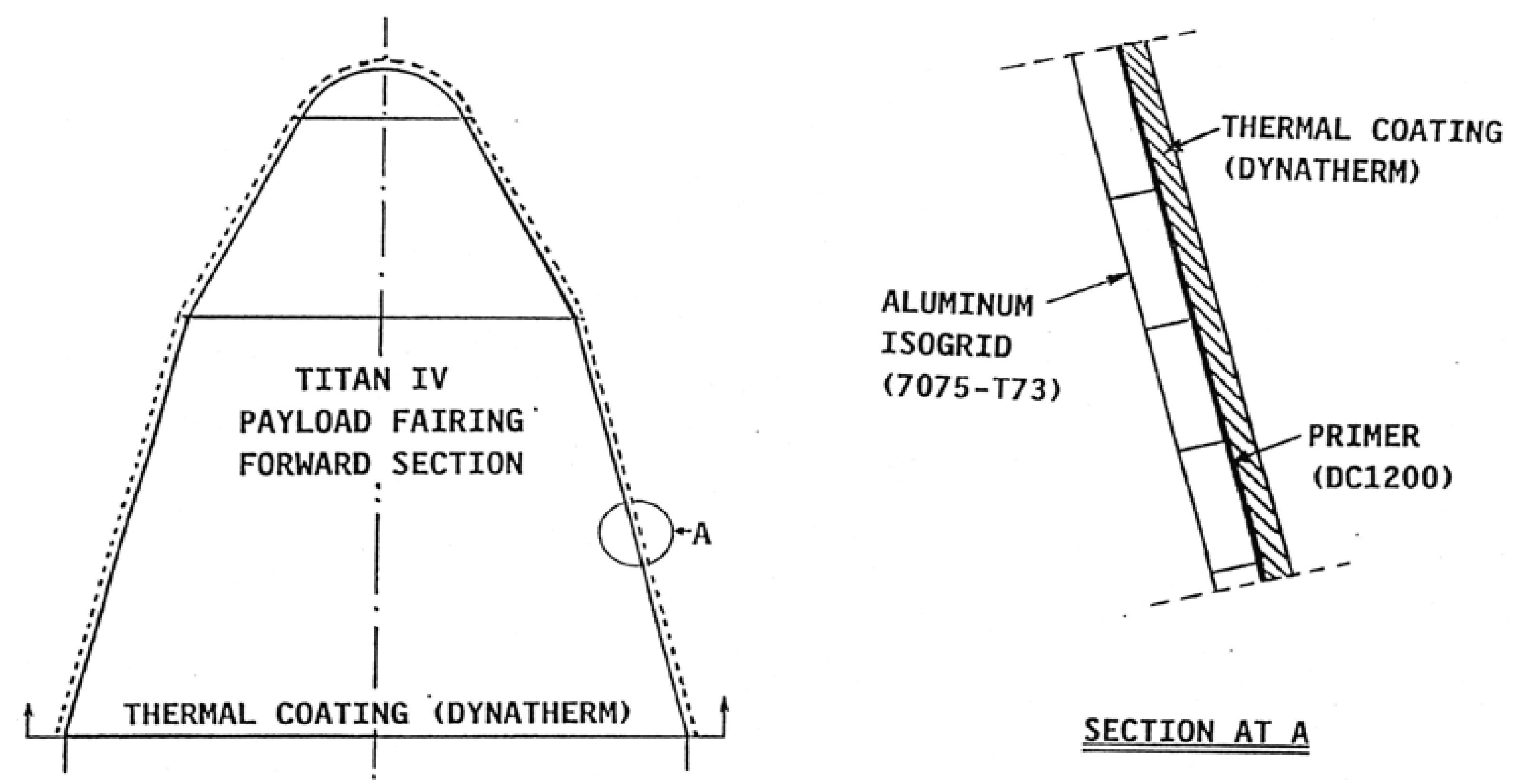
BACKGROUND (CONTINUED)

- o THERMAL COATING:
  - PRIMER (DC 1200)
  - THERMAL COATING (DYNATHERM)

- o FAILURE HISTORY:
  FEW COATING FAILURES DURING FLIGHT
  SEVERAL IN-PROCESS TEST FAILURES
  - - DUE TO INABILITY TO MEET SPECIFIED BOND STRENGTH

- o DESIGN REQUIREMENT:
  - PLUG PULL ADHESION STRENGTH 40 PSI MINIMUM

CROSS SECTIONAL VIEW OF THERMAL COATING



PLF MANUFACTURING AT MDSSC

7075-T73 ALUMINUM PLATE

MILL ISOGRID POCKETS

BRAKE-FORM ISOGRID PANELS

CHEMICAL CONVERSION COAT

ASSEMLE PLF TRISECTORS

PACKAGE AND SHIP TRISECTORS

STORAGE AT LAUNCH SITE

THERMAL COATING APPLICATION AT LAUNCH SITE

TRISECTORS IN STORAGE

SURFACE PREPERTION

APPLY PRIMER

APPLY THERMAL COATING

PLUG PULL TEST

PAINT

ASSEMBLE PAYLOAD FAIRING

PRELIMINARY ASSESSMENT

- PRIMARY AREAS OF CONCERN:

  CHEMICAL CONVERSION COATING
  SURFACE PREPARATION
  THERMAL COATING APPLICATION

- MOST PROBABLE CAUSE:

  SURFACE CONTAMINATION
  SURFACE PREPARATION METHOD

- SOURCES OF CONTAMINATION:

GREASE	OXIDATION	MOISTURE
OIL	CORROSION	FINGERPRINTS
DIRT		

- OSEE INSTRUMENT USED TO DETECT CONTAMINATION LEVELS

OSEE TECHNIQUE

- o OSEE:

  OPTICALLY STIMULATED ELECTRON EMISSION

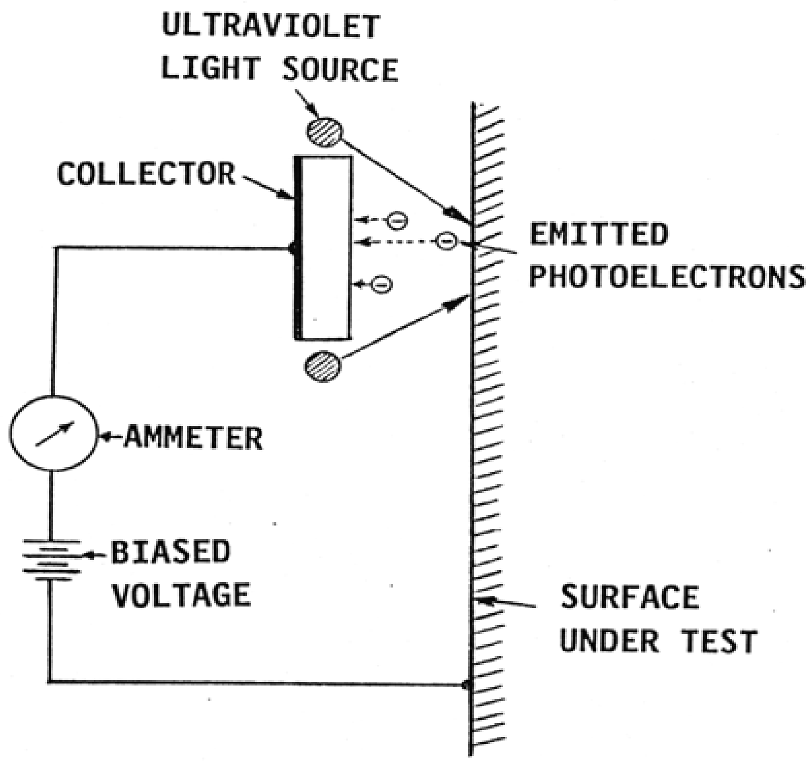
- o OSEE PRINCIPLE:

  SURFACE ILLUMINATED WITH ULTRAVIOLET LIGHT
  UV PROTONS REACT WITH SURFACE TO PRODUCE ELECTRONS
  EMITTED ELECTRONS ARE COLLECTED AND MEASURED
  CHANGE IN EMITTED ELECTRONS IS A MEASURE OF CONTAMINATION

- o ADVANTAGES OF OSEE:

  NONCONTACT, NONDESTRUCTIVE METHOD
  DOES NOT NEED VACUUM OR CONTROLLED ATMOSPHERE
  CAN MEASURE VERY THIN FILMS (FEW A THICKNESS)
  CAN BE USED ON METALS AND NONMETALS AND WITH ORGANIC OR INORGANIC CONTAMINANTS

SCHEMATIC DIAGRAM OF OSEE INSTRUMENT



TEST PROCEDURE

- o 3 IN. X 5 IN. SAMPLES FROM PLF PANEL
- o FOUR TYPES OF SURFACE CONDITION EVALUATED:

(1) SOLVENT CLEANED (MEK)	HEAVY WIPE, 2 LIGHT WIPES, 1 LIGHT WIPE
(2) ABRASIVE APPLIED (SCOTCHBRITE)	HEAVY , LIGHT
(3) CONTAMINANT APPLIED (BOELUBE)	10, 25, 20 & 100 MG/FT^2
(4) CONTAMINANT AAPLIED (RUSTLCIK OIL)	10, 25, 20 & 100 MG/FT^2

- o CONTAMINANT LEVELS MEASURED WITH OSEE INSTRUMENT
- o ALL SAMPLES COATED WITH:

  PRIMER (DC 1200)
  THERMAL COATING (DYNATHERM)

- o ALL SAMPLES PLUG PULL TESTED USING:

  ALUMINUM PLUGS (0.798 IN. DIA)
  SEALENT (RTV)
  3 PLUGS FOR EACH SAMPLE

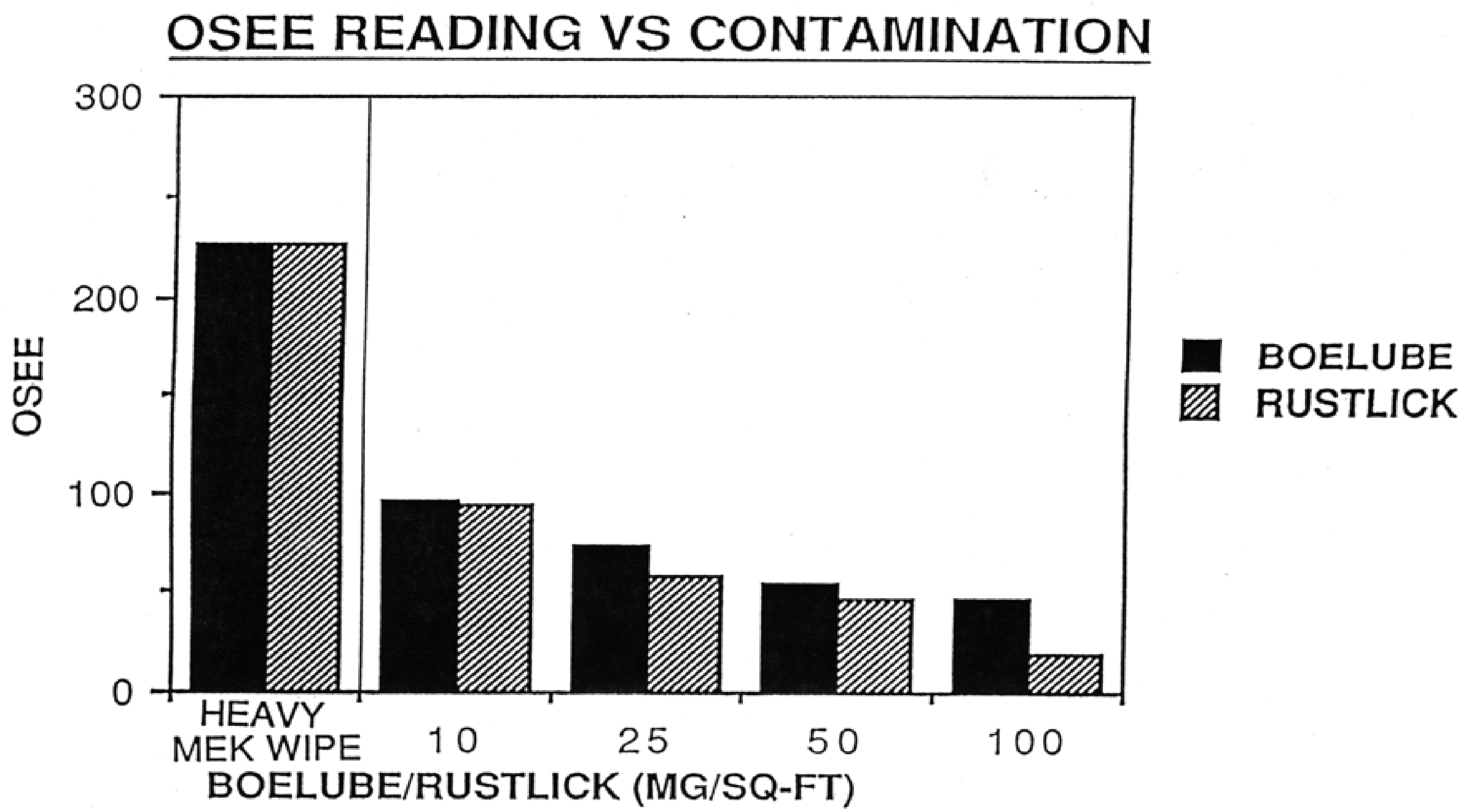
TABLE I
TEST RESULTS

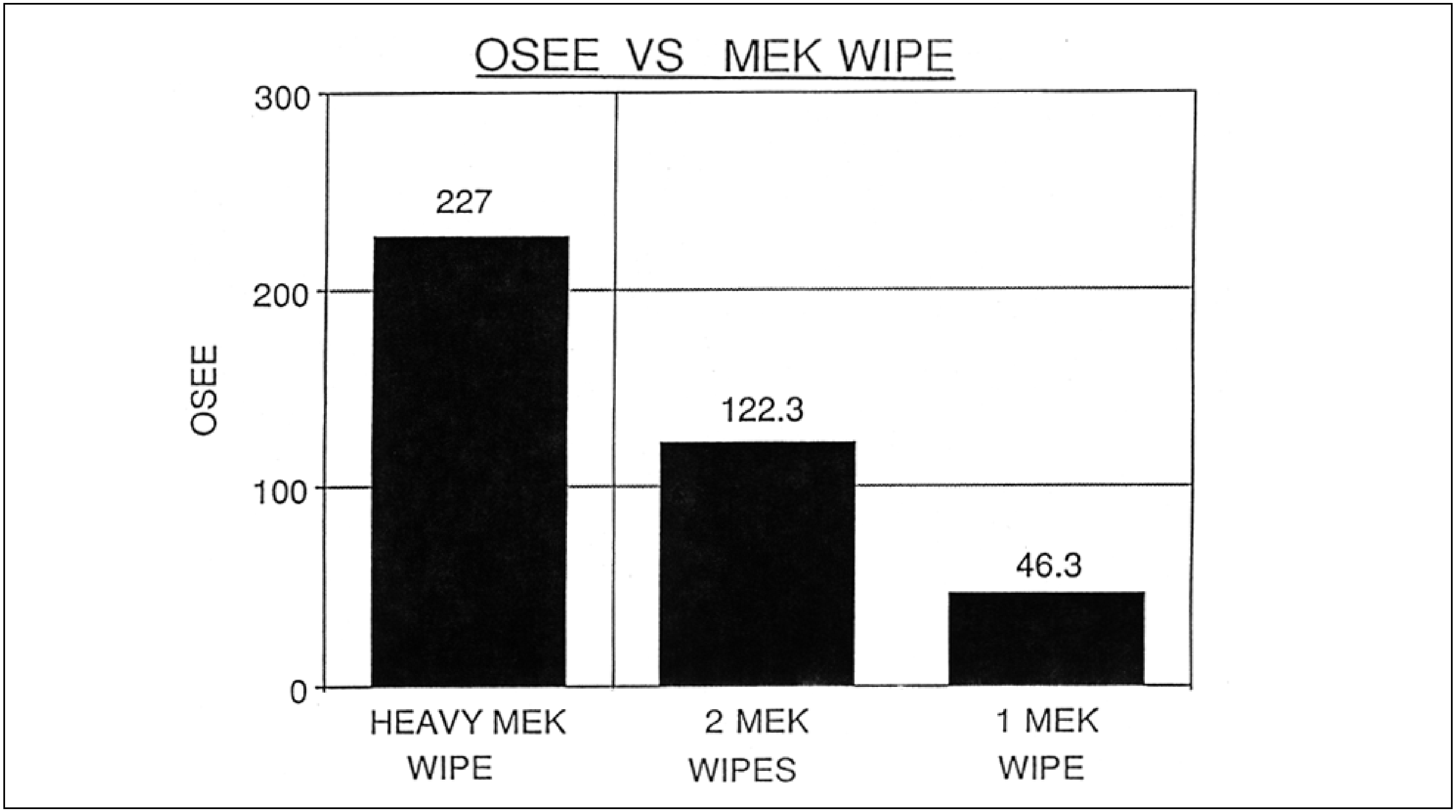
SPECIMEN TYPE	OSEE READING	NUMBER OF PLUG PULL SAMPLES	LOAD (LBS.)	BOND STRENGTH (PSI)	MODE OF FAILURE **
1) HEAVY MEK WIPE	227.0	6	85.2	170.4	2 ADHESION/ 4 TEST SET UP
2) 2 LIGHT MEK WIPES	122.3	3	56.0	112.0	3 ADHESION/ 4 TEST SET UP
3) 1 LIGHT MEK WIPE	46.3	3	48.0	96.0	3 ADHESION/ 4 TEST SET UP
4) BOELUBE, 10 MG /FT^2	97.0	3	62.3	124.6	1 ADHESION/ 2 TEST SET UP
5) BOELUBE, 25 MG /FT^2	73.0	3	30.0	60.0	2 ADHESION/ 1 TEST SET UP
6) BOELUBE, 50 MG /FT^2	54.8	3	18.3	36.6	3 ADHESION/ 1 TEST SET UP
7) BOELUBE, 100 MG /FT^2	45.6	3	21.0	42.0	3 ADHESION/ 1 TEST SET UP
8) RUSTLICK, 10 MG /FT^2	95.6	3	77.3	154.6	3 ADHESION/ 1 TEST SET UP
9) RUSTLICK, 25 MG /FT^2	57.4	3	76.7	153.4	3 ADHESION/ 1 TEST SET UP
10) RUSTLICK, 50 MG /FT^2	46.6	3	63.0	126.0	3 ADHESION/ 1 TEST SET UP
11) RUSTLICK, 100 MG /FT^2	20.0	3	28.0	56.0	3 ADHESION/ 1 TEST SET UP
12)LIGHT SCOTCHBRITE	317.0	3	79.0	158.0	3 ADHESION/ 3 TEST SET UP
13) HEAVY SCOTCHBRITE	2620.0*	3	104.3	208.6	3 ADHESION/ 3 TEST SET UP

* EXTRAPOLATED READING

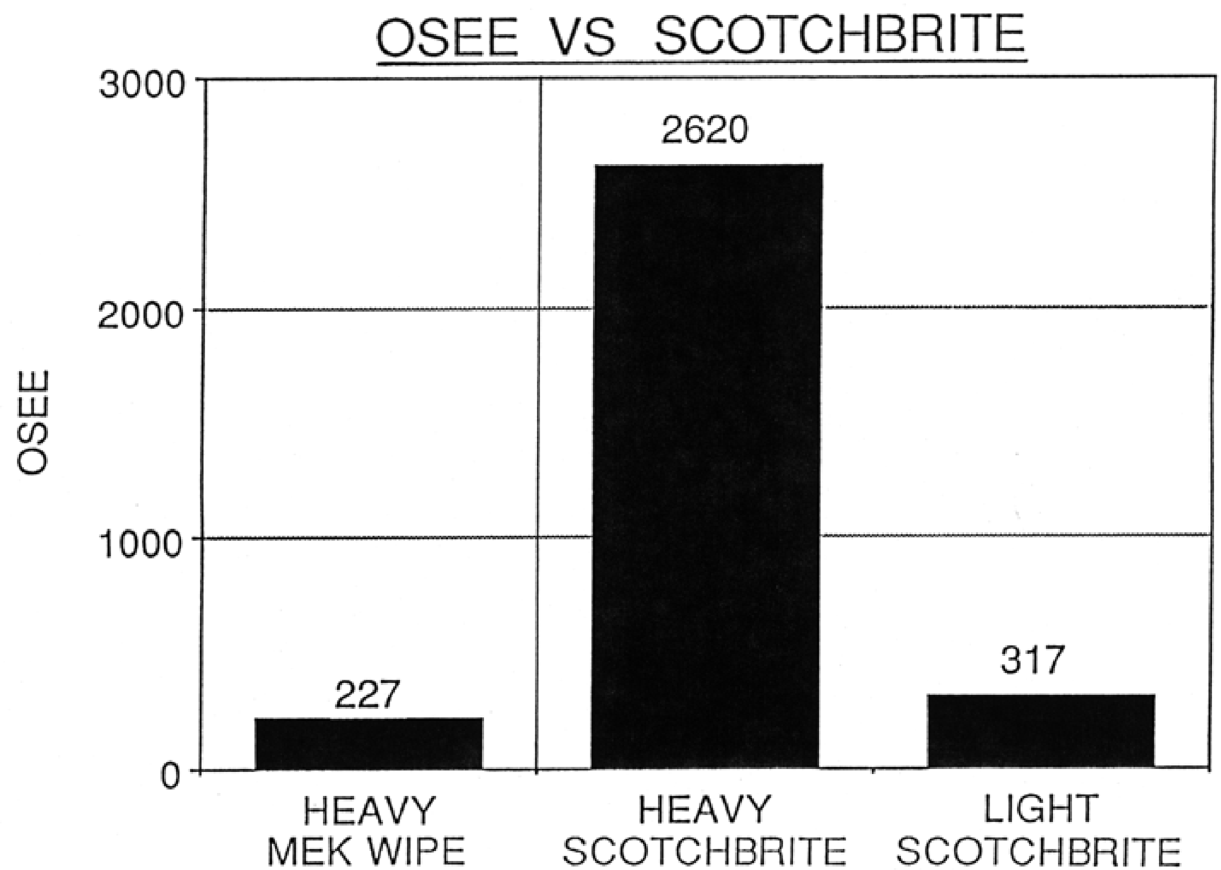
** ADHESION FAILURES: FAILED AT ISOGRID-PRIMER INTERFACE
TEST SET UP FAILURES: FAILED AT PLUG-SEALENT INTERFACE

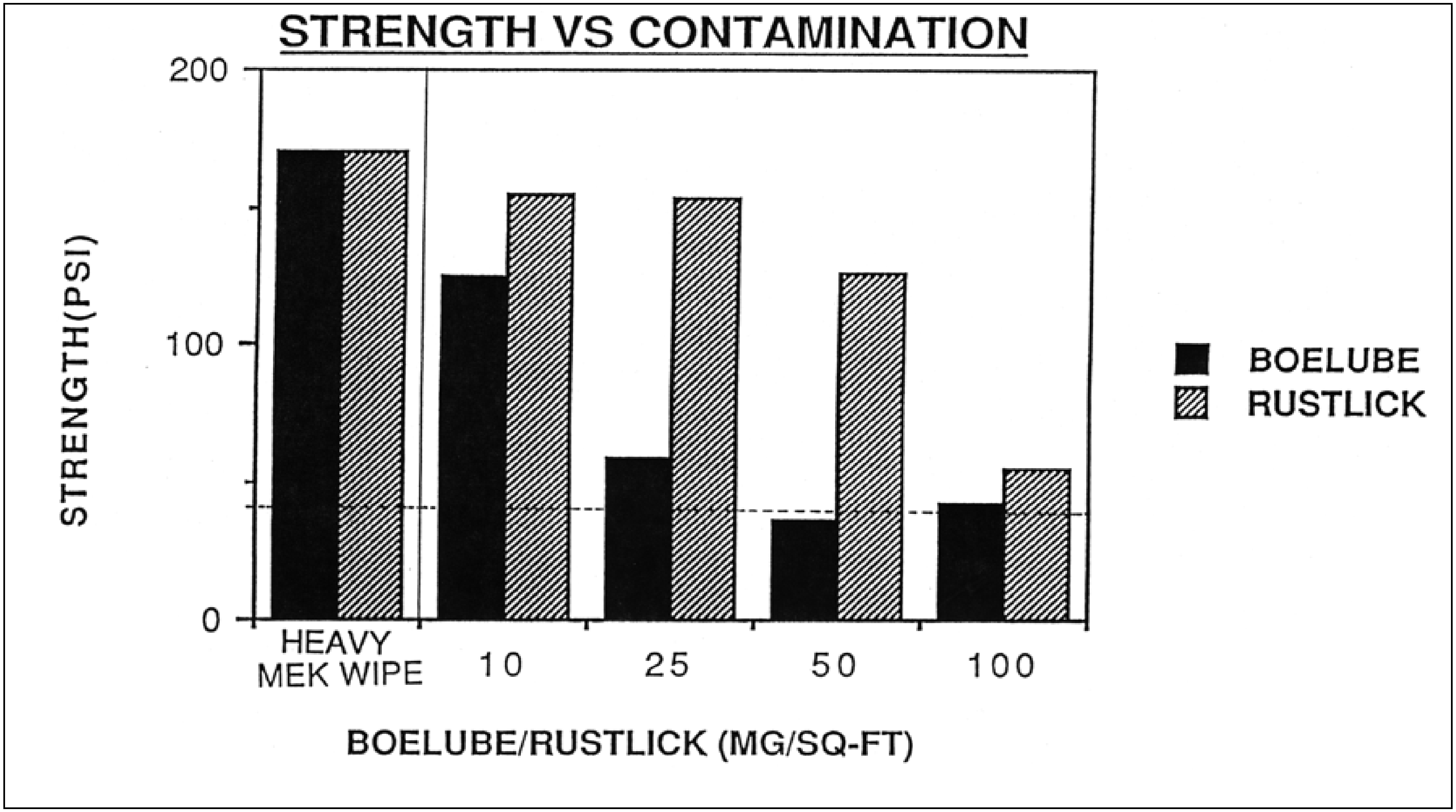
Manufacturing Engineering Department
Vehicle and Control Systems Division
THE AEROSPACE CORPORATION

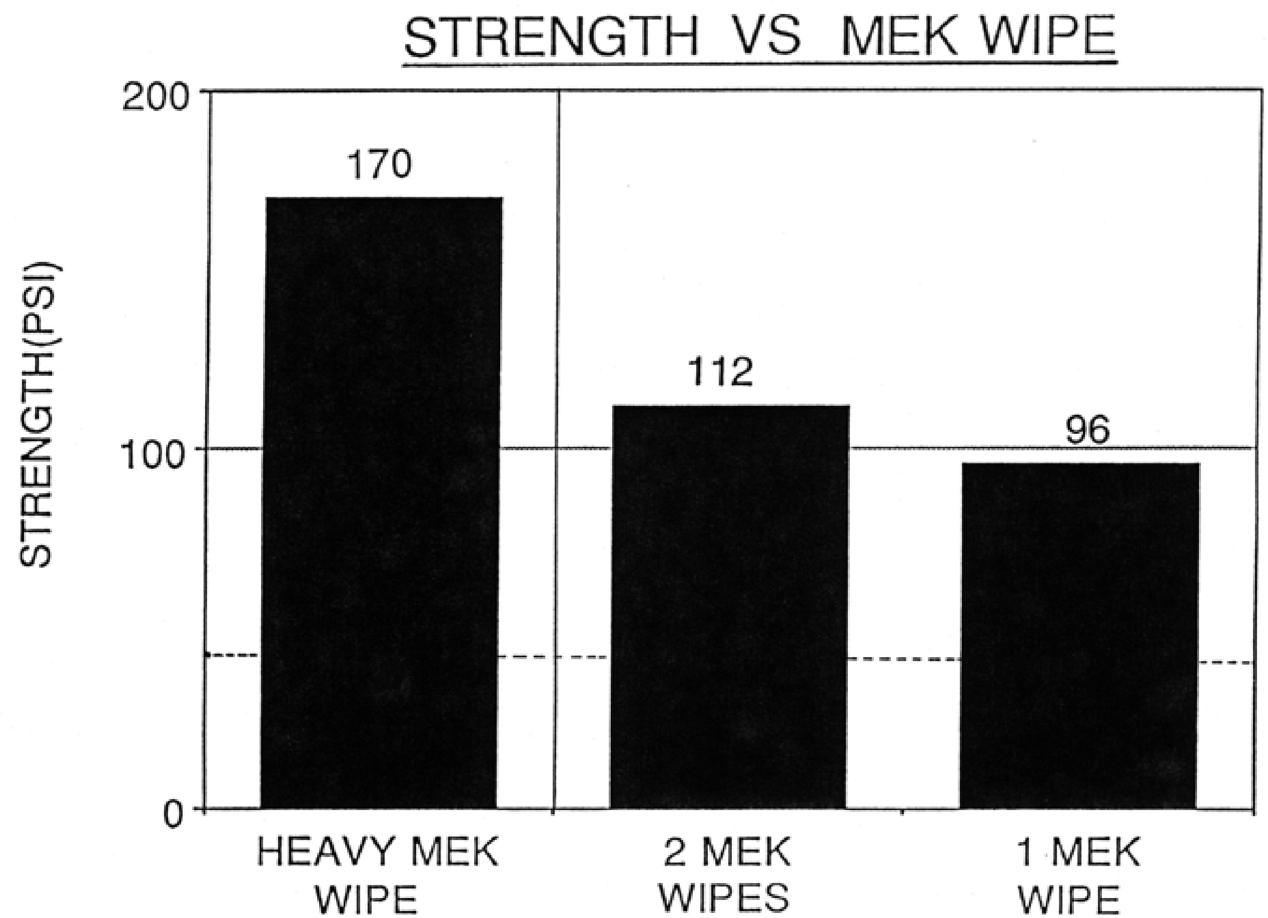

OSEE READING VS CONTAMINATION
300
200
100
0
OSEE
HEAVY
MEK WIPE
10
25
50
100
BOELUBE/RUSTLICK (MG/SQ-FT)
BOELUBE
RUSTLICK



OSEE VS MEK WIPE
OSEE
300
200
100
0
227
122.3
46.3
HEAVY MEK WIPE
2 MEK WIPES
1 MEK WIPE


OSEE VS SCOTCHBRITE
3000
2000
1000
0
OSEE
2620
227
317
HEAVY
MEK WIPE
HEAVY
SCOTCHBRITE
LIGHT
SCOTCHBRITE


STRENGTH VS CONTAMINATION
200
100
0
STRENGTH(PSI)
HEAVY MEK WIPE
10
25
50
100
BOELUBE/RUSTLICK (MG/SQ-FT)
BOELUBE
RUSTLICK


STRENGTH VS MEK WIPE
STRENGTH(PSI)
200
100
0
170
112
96
HEAVY MEK WIPE
2 MEK WIPES
1 MEK WIPE

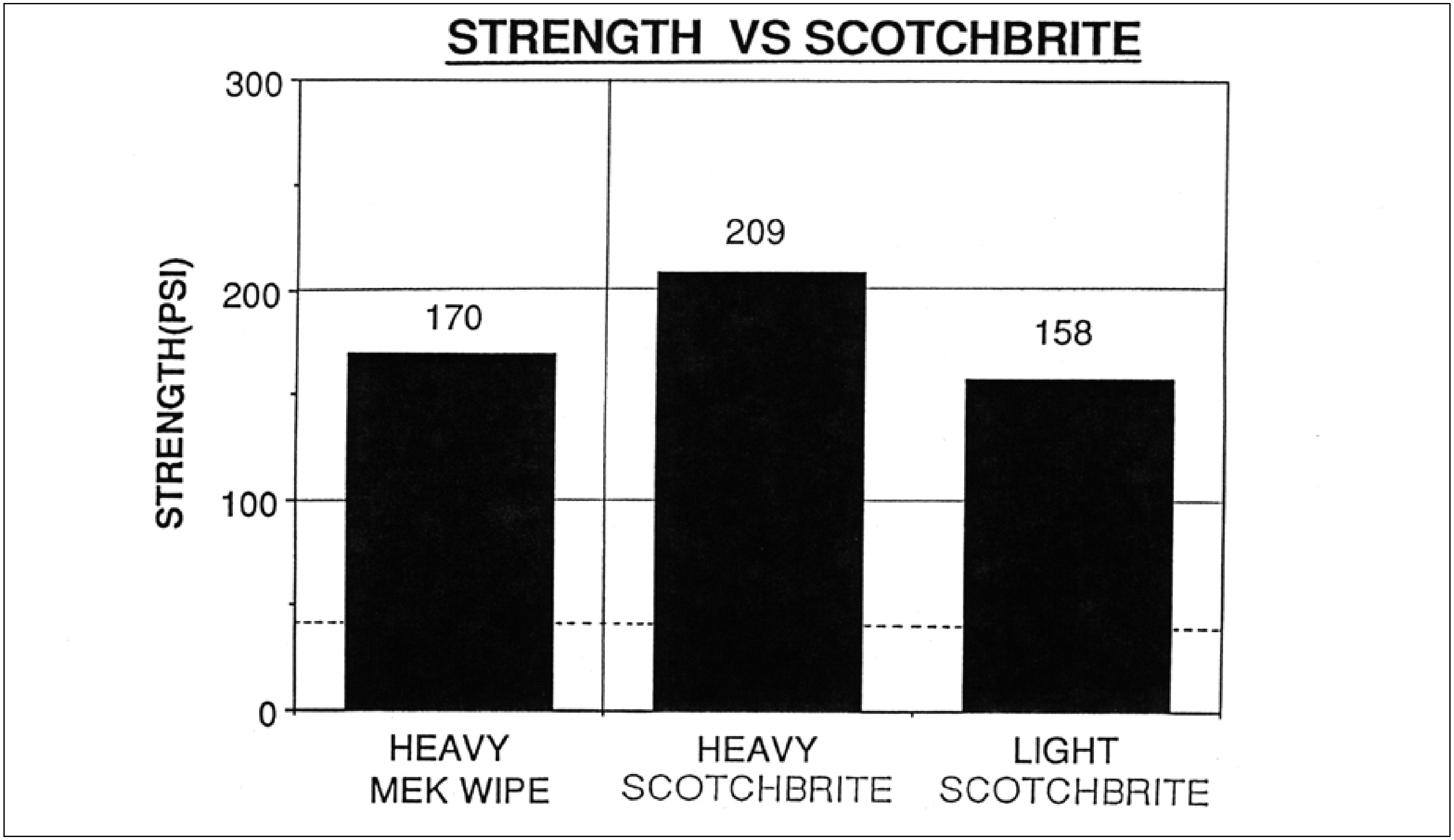

STRENGTH VS SCOTCHBRITE
300
200
100
0
STRENGTH(PSI)
170
209
158
HEAVY
MEK WIPE
HEAVY
SCOTCHBRITE
LIGHT
SCOTCHBRITE

TABLE 2
STRENGTH / OSEE VS. CONFIDENCE
"B" LEVEL (90%)

SPECIMEN NUMBER	DESCRIPTION	OSEE READING (AVERAGE)	STRENGTH (PSI)	"B" LEVEL (90%) * OSEE	"B" LEVEL (90%) * STRENGTH (PSI)
1	HEAVY MEK	227	170	179	65
2	2 X LIGHT MEK	122	112	14	-85
3	LIGHT MEK	46	96	21	23
4	BOELUBE - 10	97	125	80	-9
5	BOELUBE - 25	73	60	31	-81
6	BOELUBE - 50	55	37	27	-67
7	BOELUBE - 100	46	42	29	-119
8	RUSTLICK - 10	96	155	70	-66
9	RUSTLICK - 25	57	153	9	-73
10	RUSTLICK - 50	47	126	-18	-243
11	RUSTLICK - 100	20	56	-5	-55
12	LIGHT SCOTCHBRITE	317	158	-78	-129
13	HEAVY SCOTCHBRITE	2620	209	2487	122

*** REFERENCE MIL-HDBK-5**

STRENGTH / OSEE VS. CONFIDENCE
"A" LEVEL (99%)

SPECIMEN NUMBER	DESCRIPTION	OSEE READING (AVERAGE)	STRENGTH (PSI)	"A" LEVEL (99%) * OSEE	STRENGTH (PSI)
1	HEAVY MEK	227	170	145	-5
2	2 X LIGHT MEK	122	112	-62	-227
3	LIGHT MEK	46	96	3	-28
4	BOELUBE - 10	97	125	68	-104
5	BOELUBE - 25	73	60	2	-183
6	BOELUBE - 50	55	37	8	-142
7	BOELUBE - 100	46	42	17	-235
8	RUSTLICK - 10	96	155	53	-223
9	RUSTLICK - 25	57	153	-25	-235
10	RUSTLICK - 50	47	126	-63	-507
11	RUSTLICK - 100	20	56	-23	-135
12	LIGHT SCOTCHBRITE	317	158	-360	-335
13	HEAVY SCOTCHBRITE	2620	209	2392	60

* REFERENCE MIL-HDBK-5

OBSERVATIONS AND COMMENTS

- BOND STRENGTHS MEASURED IN LABORATORY WERE CONSIDERABLY HIGHER THAN STRENGTHS OBSERVED AT LAUNCH SITE
- THE COATING PROCESS USED AT LAUNCH SITE IS NOT ROBUST
- NUMEROUS CONTAMINANTS MAY BE PRESENT AT THE POINT OF SURFACE PREPARATION
- TEST SET UP FAILURES GIVE SKEWED RESULTS
- TEST METHOD USED AT LAUNCH SITE SHOULD BE ENHANCED TO ELIMINATE TEST SET UP FAILURES

CONCLUSIONS

- EXCELLENT CORRELATION OF OSEE READINGS AND CONTAMINATION LEVEL
- VERY GOOD CORRELATION OF CONTAMINATION LEVEL (OSEEREADINGS) AND BOND STRENGTHS
- OSEE INSTRUMENT IS CAPABLE OF DETECTING VERY SMALL AMOUNTS OF CONTAMINATION
- LABORATORY TESTS APPEAR TO GIVE HIGHER BOND STRENGTHS
- MANUFACTURING MATERIALS AND PROCESSES USED FOR BONDING DYNATHERM ARE NOT ROBUST
- STATISTICAL ANALYSIS SHOWS THAT ONLY HEAVY SCOTCHBRITE IS A ROBUST METHOD OF SURFACE PREPARATION

RECOMMENDATIONS

- CONTROL TIME, TEMPERATURE, RELATIVE HUMIDITY, PRIMER THICKNESS ETC. TO MANUFACTURER'S RECOMMENDATIONS
- CONSIDER APPLICATION OF THERMAL INSULATION IN FACTORY
- CONSIDER PULL TEST ACCEPTABLE IF STRENGTH IS ABOVE 40 PSI. IF FAILURE OCCURS IN 40-79 PSI RANGE DO 4 MORE TESTS IN THE SAME AREA. ALL 4 TESTS MUST PASS 40 PSI MINIMUM.
- USE HEAVY SCOTCBRITE TO PREPARE SURFACE FOR BONDIN
- USE OSEE INSTRUMENT AS A TRAINING AID TO MANUFACTURING PERSONNEL