Lockheed Sanders, Inc.

MEMORANDUM

TO : Distribution **DATE :** October 3, 1991

FROM : D. Vaillette **MEMO NO. :** DPV:91/13

SUBJECT : Correlation of Pressure Drop Between Test and COLDPLATE

REFERENCE: 1) French, K., "Air Flow Impedance Survey", Lab Report No. 17169, 7/9/91.

2) Renaud, T.E., "COLDPLATE", Version 2.9.

The pressure drop for a SEM-E flow thru core was tested at the Environmental Lab on 7/9/91 (Reference 1). Figure 1 shows the core that was tested. COLDPLATE (Reference 2), a computer program developed by Tom Renaud that evaluates heat exchangers, was used to predict the theoretical pressure drop. The purpose of this memo is to show the correlation between test and COLDPLATE.

The test consist of a 16"x16"x16" box mounted to the inlet of the flow thru core (sudden contraction). The outlet of the core is exposed to the room (sudden expansion). The static pressure inside the 16"x16"x16" box was measured at various flows. The raw test data results are shown in Table 1 and the COLDPLATE model is shown in Table 2.

Figure 2 shows the correlation between test data and COLDPLATE for an effective width of 4.71 inches. The 4.71 inch width includes 2 plugged passages. It was assumed that during fabrication 1 passage on each side of the center rib would become plugged. The results in Figure 2 shows the worse case error to be 20.4% at 2.2 SCFM. At low flow rates the error may not be as significant due to accuracy (if it is within .1 inches of water) and other effects not accounted for in the analysis. At higher SCFM you would expect better correlation because accuracy and other effects not accounted for would be significantly less than the total loss thru the core. For example, at 15.3 SCFM, the error was .4 %.

By examining the flow thru core tested (Unit C), it was seen that more than 2 passages were plugged. In fact roughly 3.5 passages

were plugged and another passage had debris to make it partially blocked. COLDPLATE was re-ran with an effective width of 4.55 inches, in order to account for the blocked passages. Figure 3 shows the correlation between test data and COLDPLATE. The maximum error was 16%, but again this was at low SCFM. At the highest SCFM measured, the error was only 8%.

In summary, the pressure drop determined by COLDPLATE correlated well with test data. The flow thru cores need to be inspected during fabrication to insure that not many passages are blocked. If too many passages are blocked then the pressure drop will be larger than expected.

David Vaillette

DISTRIBUTION:

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FIGURE 1

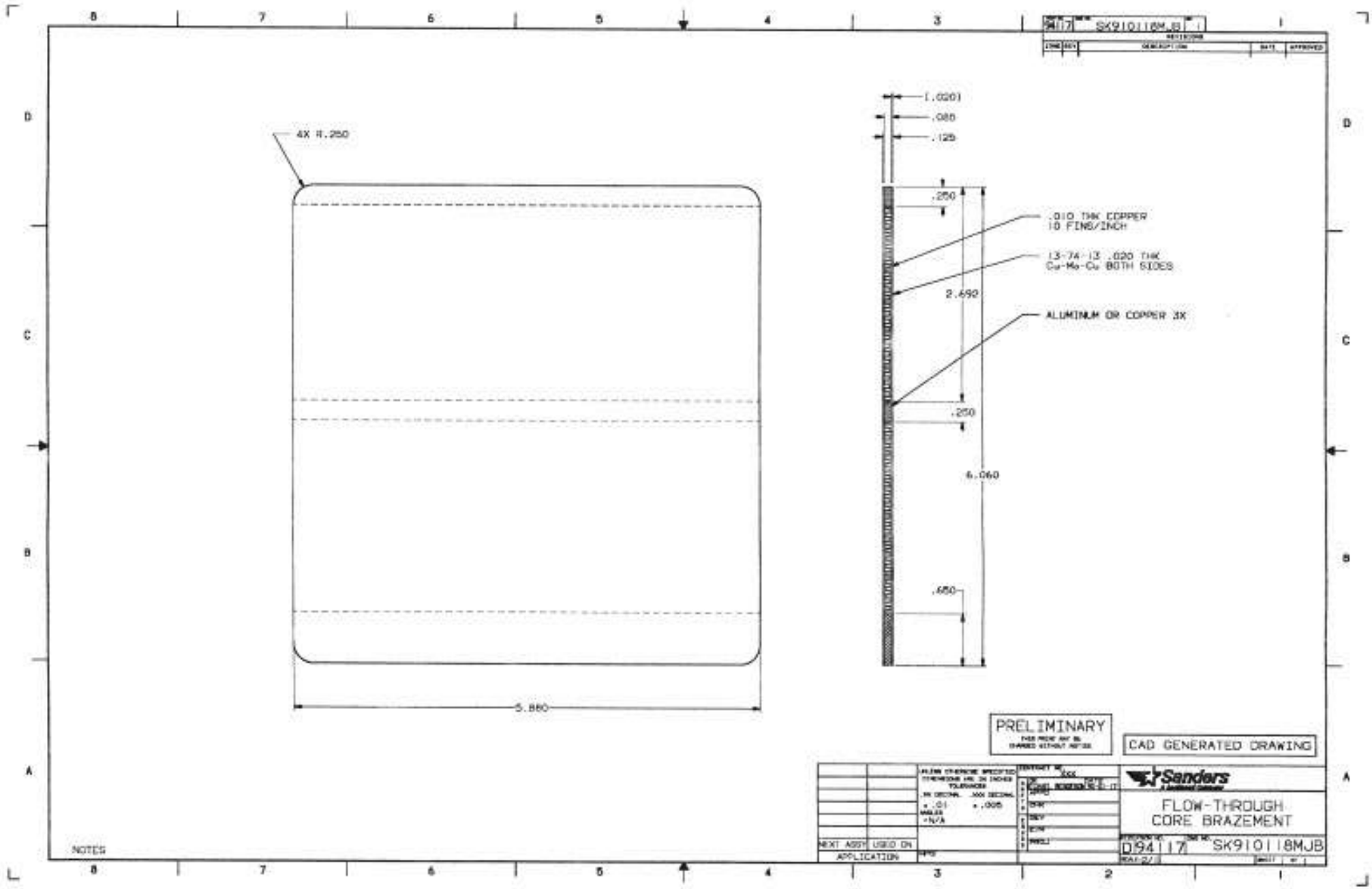
4X R.250
5.880
.020
.080
.125
.250
.010 THK COPPER
10 FINS/INCH
13-74-13 .020 THK
Cu-Mo-Cu BOTH SIDES
2.690
ALUMINUM OR COPPER 3X
.250
6.060
.650
PRELIMINARY
CAD GENERATED DRAWING
Sanders
FLOW-THROUGH
CORE BRAZEMENT
D94117
SK91011 8MJB
NOTES

FIGURE 2

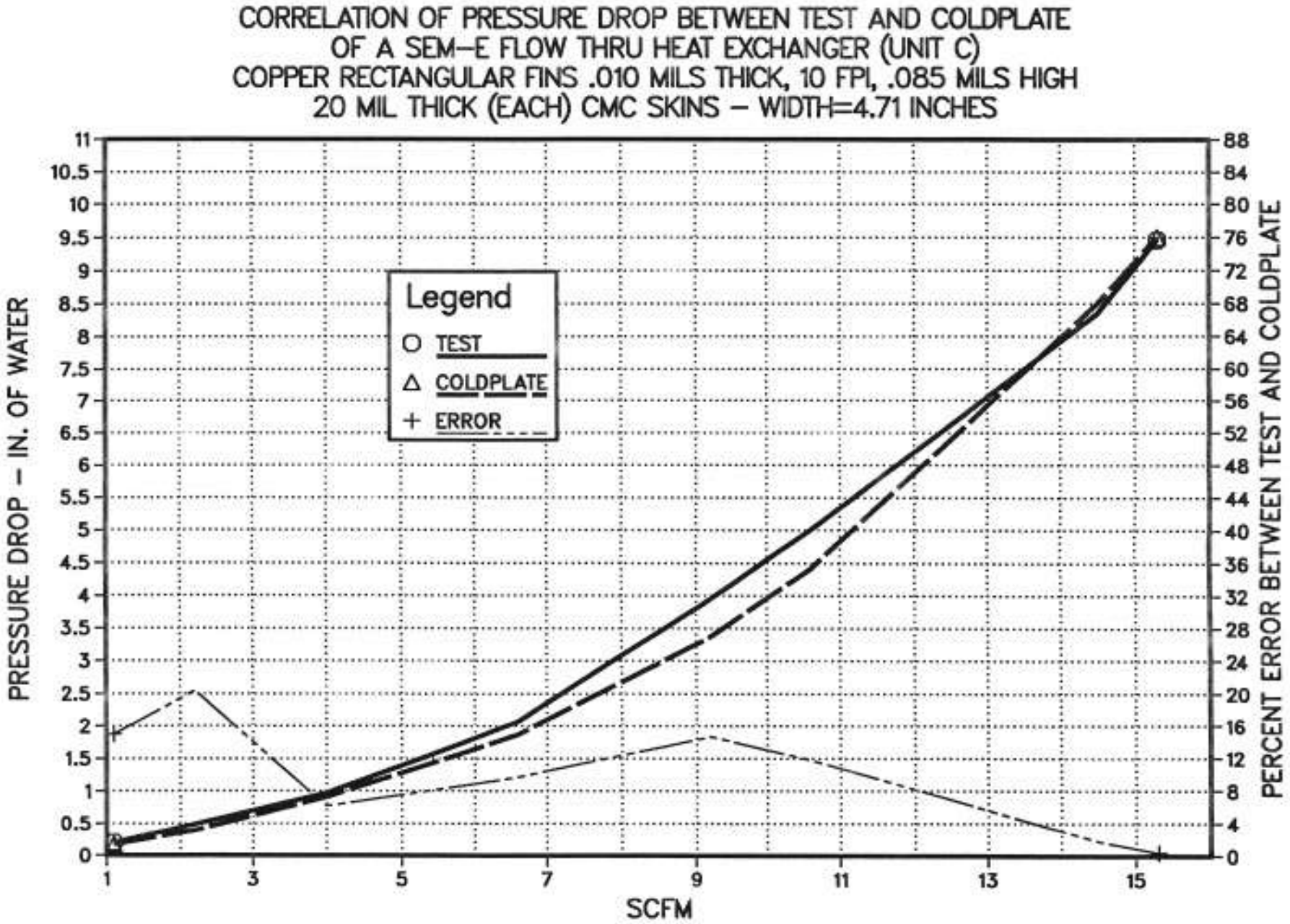
CORRELATION OF PRESSURE DROP BETWEEN TEST AND COLDPLATE
OF A SEM-E FLOW THRU HEAT EXCHANGER (UNIT C)
COPPER RECTANGULAR FINS .010 MILS THICK, 10 FPI, .085 MILS HIGH
20 MIL THICK (EACH) CMC SKINS - WIDTH=4.71 INCHES
Legend
TEST
COLDPLATE
ERROR
PRESSURE DROP - IN. OF WATER
PERCENT ERROR BETWEEN TEST AND COLDPLATE
SCFM
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
1
3
5
7
9
11
13
15

FIGURE 3

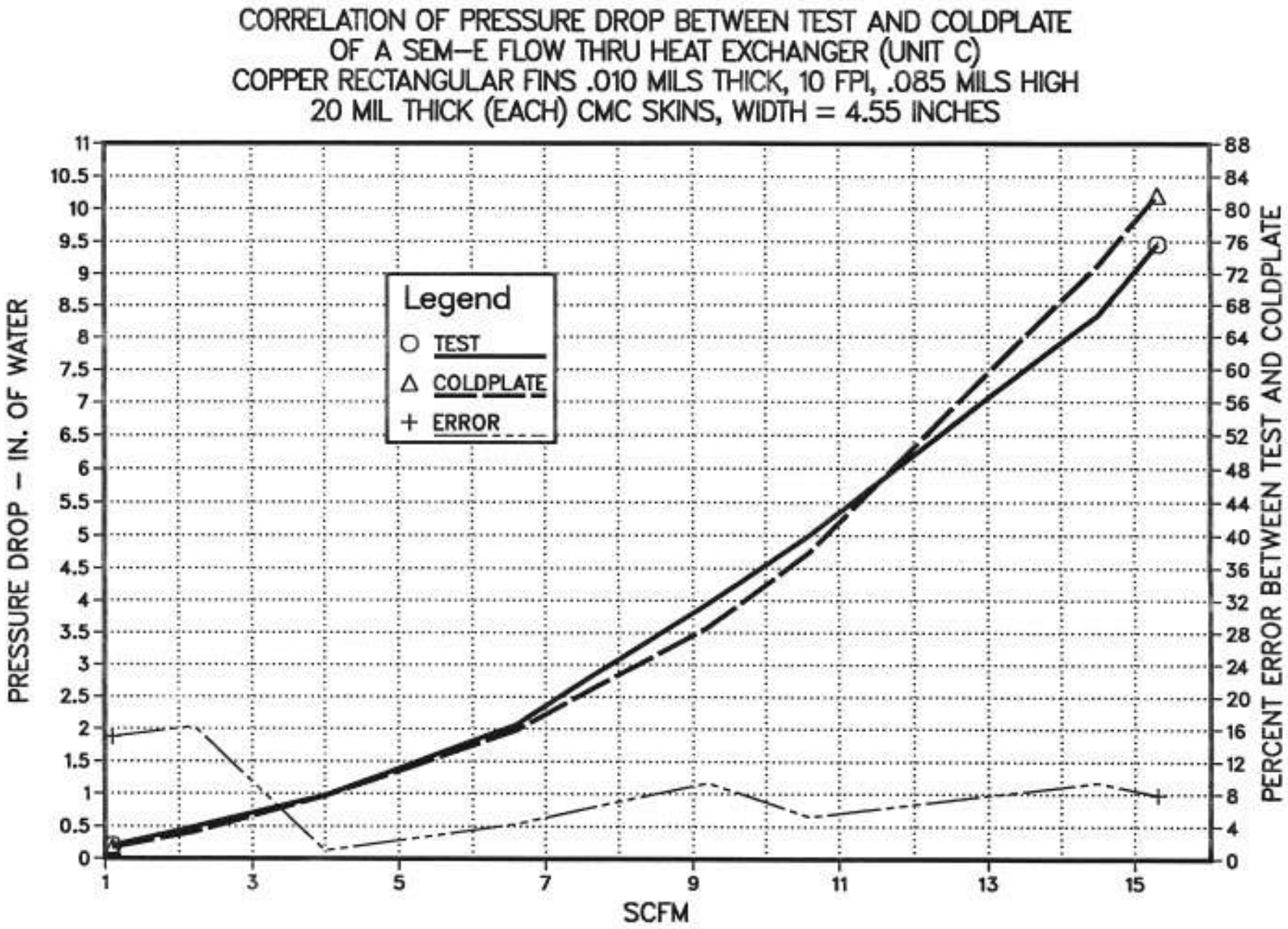
CORRELATION OF PRESSURE DROP BETWEEN TEST AND COLDPLATE
OF A SEM–E FLOW THRU HEAT EXCHANGER (UNIT C)
COPPER RECTANGULAR FINS .010 MILS THICK, 10 FPI, .085 MILS HIGH
20 MIL THICK (EACH) CMC SKINS, WIDTH = 4.55 INCHES
Legend
TEST
COLDPLATE
ERROR
PRESSURE DROP – IN. OF WATER
PERCENT ERROR BETWEEN TEST AND COLDPLATE
SCFM
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
1
3
5
7
9
11
13
15

TABLE 1

SANDERS ASSOCIATES, INC.

ENVIRONMENTAL LABORATORY TEST DATA SHEET

TEST	E.L. REPORT NO.	DATA SHEET NO.
AIR FLOW IMPEDANCE SURVEY	17169	1

TEST ITEM: FOUR EACH, FLOW THRU MODULE CORE

EMP F	LFE PRESS	LFE H20	PLUM ΔP	CFM CHART	T=21.1°C SCFM	pound/min PPM	
72	14.55	.17	.17	.9	.9	.067	
72	14.57	.33	.38 V	1.9	1.9	.14	UNIT - A
72	14.60	.68	.95	3.6	3.6	.27	
72	14.66	1.17	2.14	6.5	6.5	.48	
72	14.74	1.62	3.88	8.9	8.9	.67	
72	14.82	2.09	5.76	11.5	11.6	.87	
72	14.92	2.56	8.15	14.2	14.4	1.08	
71	14.99	2.78	9.59	15.3	15.6	1.17	
73	14.54	.20	.18	1.1	1.1	.08	
73	14.56	.40	.43	2.2	2.2	.16	UNIT - B
73	14.59	.73	.93	4.0	4.0	.30	
73	14.65	1.32	2.07	7.3	7.2	.54	
73	14.73	1.75	3.80	9.7	9.7	.72	
73	14.81	2.24	5.14	12.3	12.3	.92	width 2.35"+2.20"= 4.55"
72	14.90	2.65	7.49	14.6	14.8	1.11	
72	14.94	2.80	8.46	15.4	15.6	1.17	2.45"±.25"
							ΔP IN-H2 ERROR CORRECTION
74	14.54	.20	.20 R	1.1	1.1	.08	15% .17
73	14.56	.41	.49	2.2	2.2	.16	UNIT C 16% .41
73	14.59	.72	.97	4.0	4.0	.30	1% .96
73	14.64	1.21	2.07	6.7	6.6	.50	4% 1.98
73	14.73	1.65	3.95	9.2	9.2	.69	9% 3.58
73	14.78	1.92	5.00	10.6	10.6	.79	5% 4.74
73	14.92	2.61	8.34	14.4	14.5	1.09	9% 9.13
73	14.97	2.74	9.46	15.1	15.3	1.15	8% 10.21
74	14.54	.20	.19	1.1	1.1	.08	UNIT - D
74	14.54	.43	.47	2.3	2.3	.17	
73	14.58	.76	.99	4.2	4.1	.31	
73	14.64	1.27	2.07	7.0	6.9	.52	
73	14.73	1.91	4.10	10.5	10.4	.78	
73	14.80	2.25	5.49	12.4	12.4	.93	
73	14.89	2.68	7.50 V	14.8	14.9	1.12	
73	14.96	2.87	9.35	15.8	16.0	1.20	

TABLE 2

```
  SEM-E FLOW THRU PRESSURE DROP
 $GEOMETRY
    LENGTH=5.88,
    WIDTH=4.71,
    FHEIGHT=.085,
    FTHICK=.010,
    FDENSITY=10,
    FTYPE='RECTANGULAR',
    CTHICK=.02,
    BTHICK=.02,
 $
 $TEMPERATURE
    TEMPIN=21.1,
 $
 $PRESSURE
    ALTIN=0,
 $
 $COLDPLATE_POWER
  POWER1=.0001
 $
 $FLUID_PROPERTIES
  FLUID='AIR'
 $
 $FLOWS
  CFM=14.5,15.3,2
 $
 $FAN_POWER
 $
 $PRESSURE_DROP
      KINLET=.5,
      KEXIT=1.5,
 $
 $COLDPLATE_PROPERTIES
 $
 $EXTERNAL_TRANSFER
 $
 $PLOTS
 $
 $NONISOTHERMAL
 $
 $EXTRA_NODES_DATA
 $
 $SOURCE_DATA
 $
 $EXTRA_CONDUCTORS_DATA
 $
```