72-031C-09A J.K. Mitchell

SOIL MECHANICS EXPERIMENT (S-200)

APOLLO 16 - LSRP DATA PACKAGE

MAY, 1972

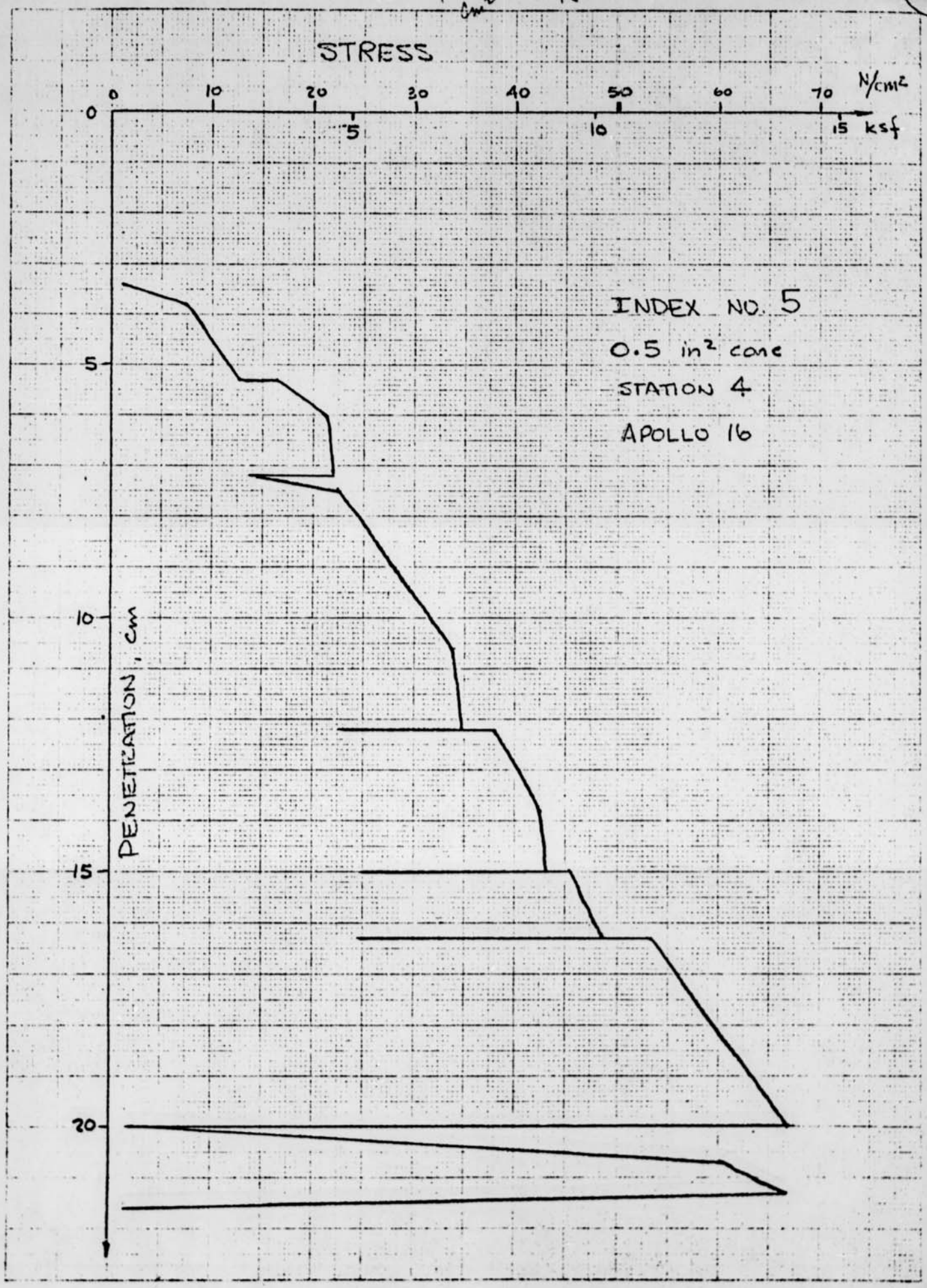
(A)

APOLLO 16 - LSRP

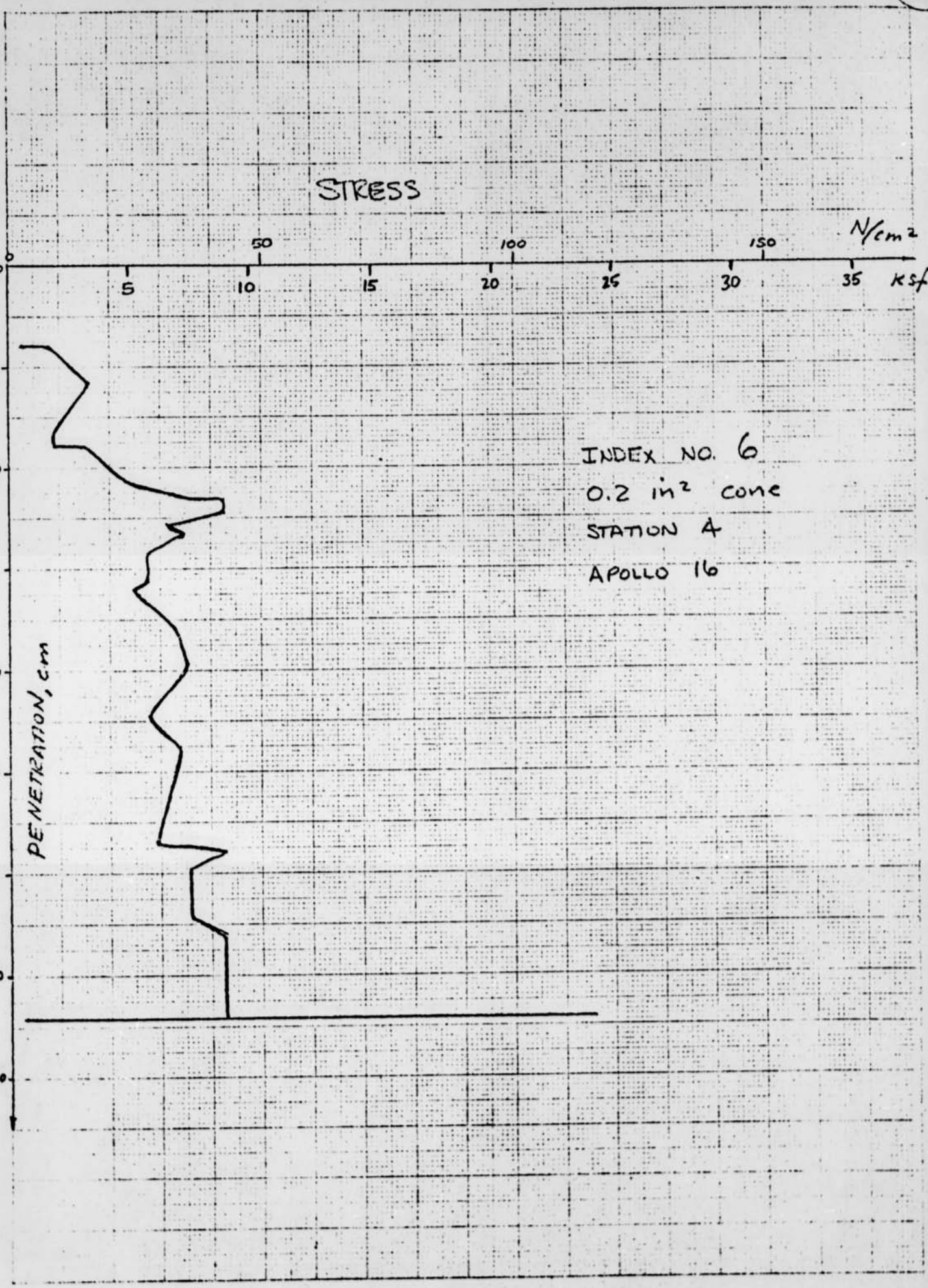
STRESS-PENETRATION CURVES

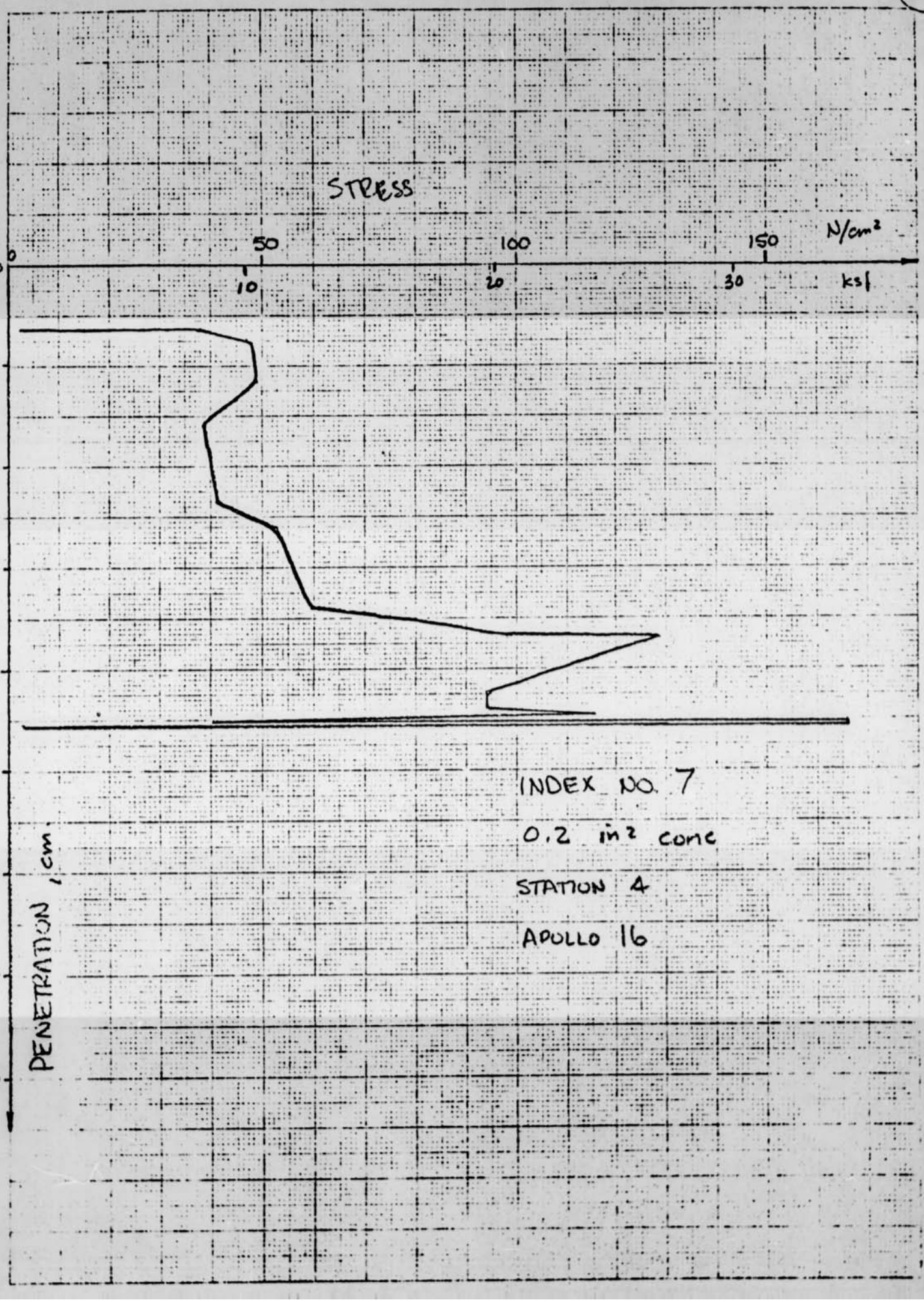
A-1

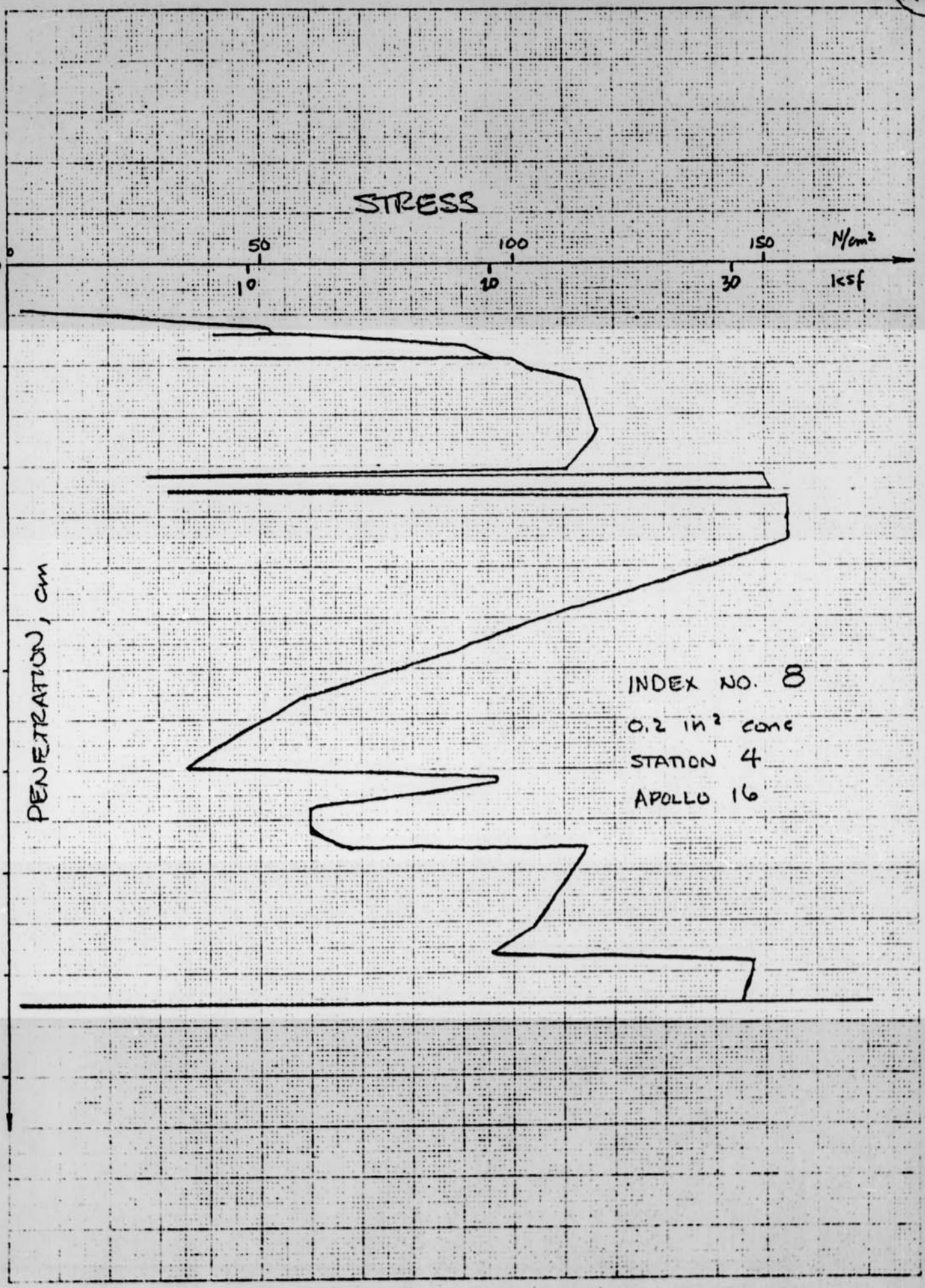
$1 \frac{N}{cm^2} = 1.45$ psi

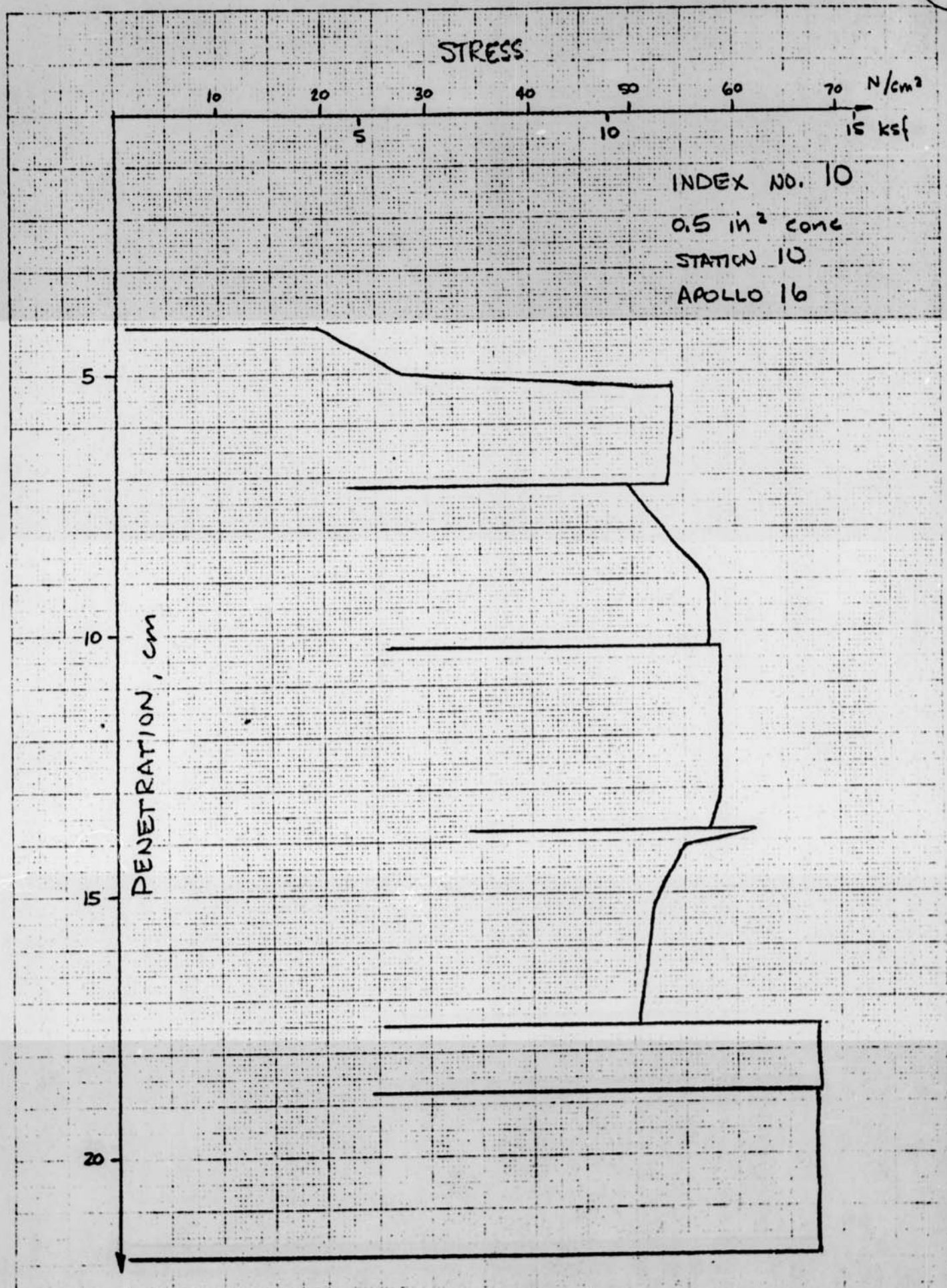


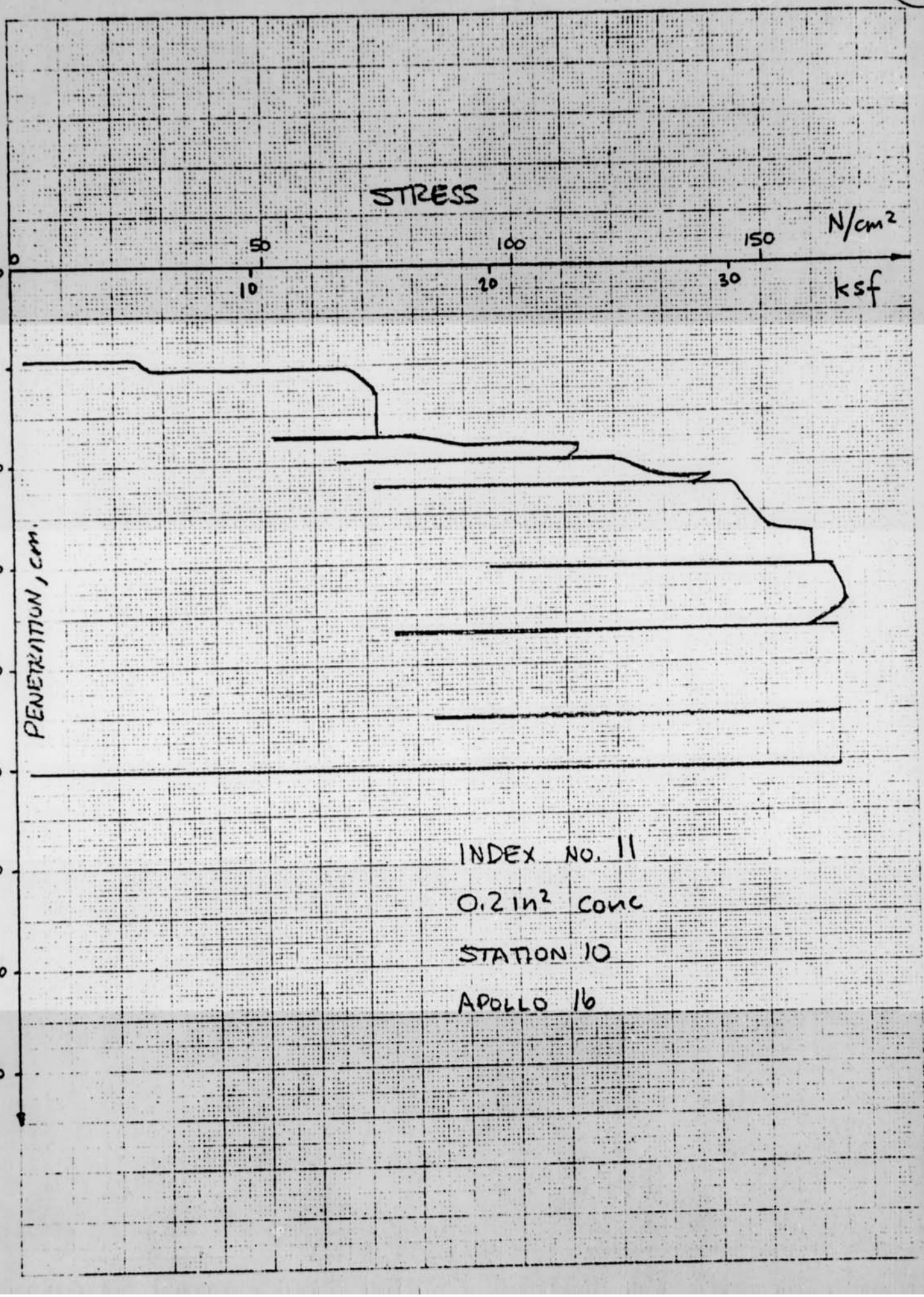
A-2

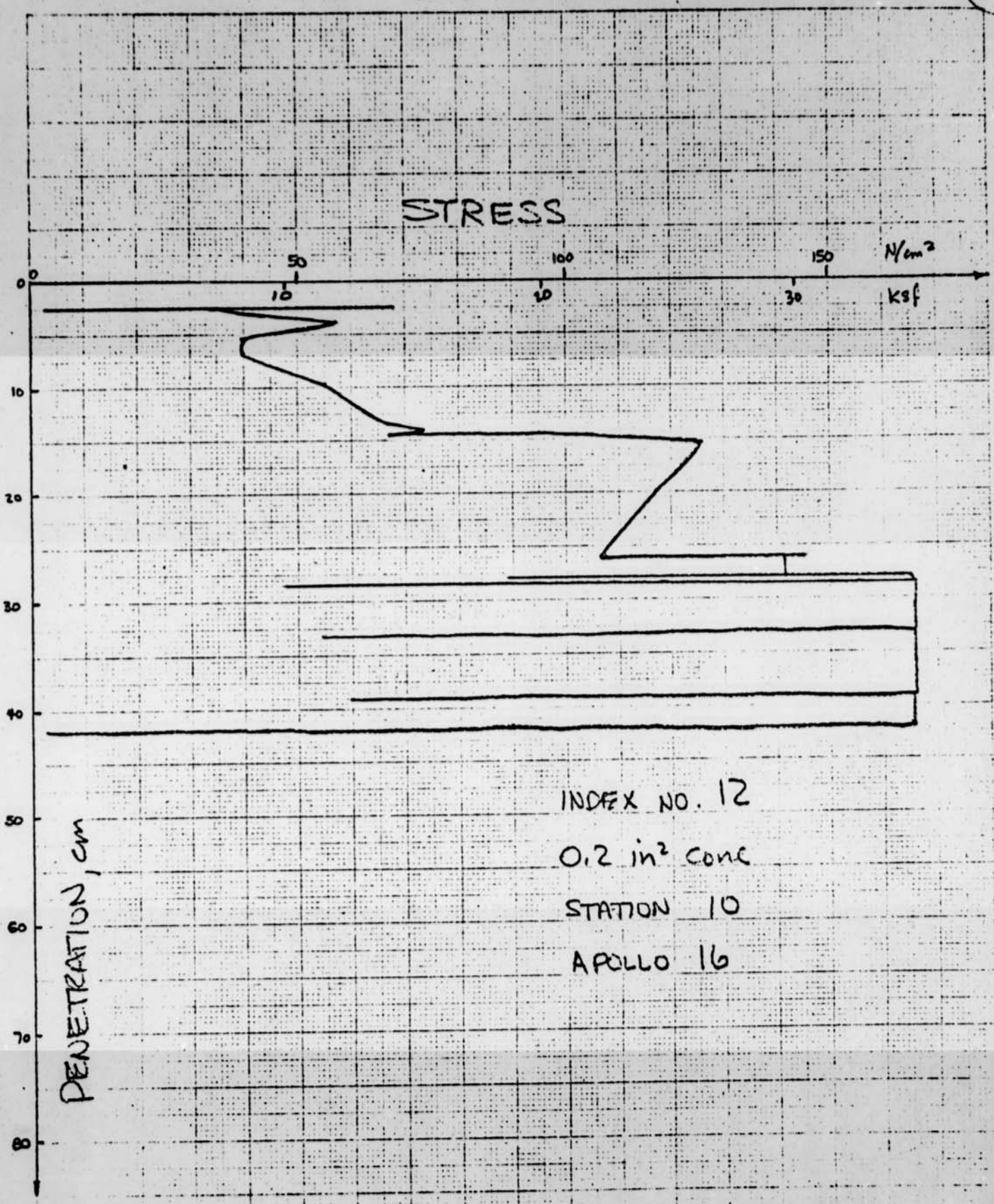

STRESS
0
50
100
150
N/cm²
0
5
10
15
20
25
30
35
ksf
10
20
30
40
50
60
70
80
PENETRATION, cm
INDEX NO. 6
0.2 in² cone
STATION 4
APOLLO 16


STRESS
0
50
100
150
N/cm²
0
10
20
30
ksi
10
20
30
40
50
60
70
80
PENETRATION, cm.
INDEX NO. 7
0.2 in² cone
STATION 4
APOLLO 16


STRESS
0
50
100
150
N/cm²
0
10
20
30
ksf
10
20
30
40
50
60
70
80
PENETRATION, cm
INDEX NO. 8
0.2 in² cone
STATION 4
APOLLO 16


STRESS
10
20
30
40
50
60
70
N/cm²
5
10
15 ksf
INDEX NO. 10
0.5 in² cone
STATION 10
APOLLO 16
5
10
15
20
PENETRATION, cm


STRESS
N/cm²
0
50
100
150
ksf
0
10
20
30
PENETRATION, cm.
10
20
30
40
50
60
70
80
INDEX NO. 11
0.2 in² Conc
STATION 10
APOLLO 16

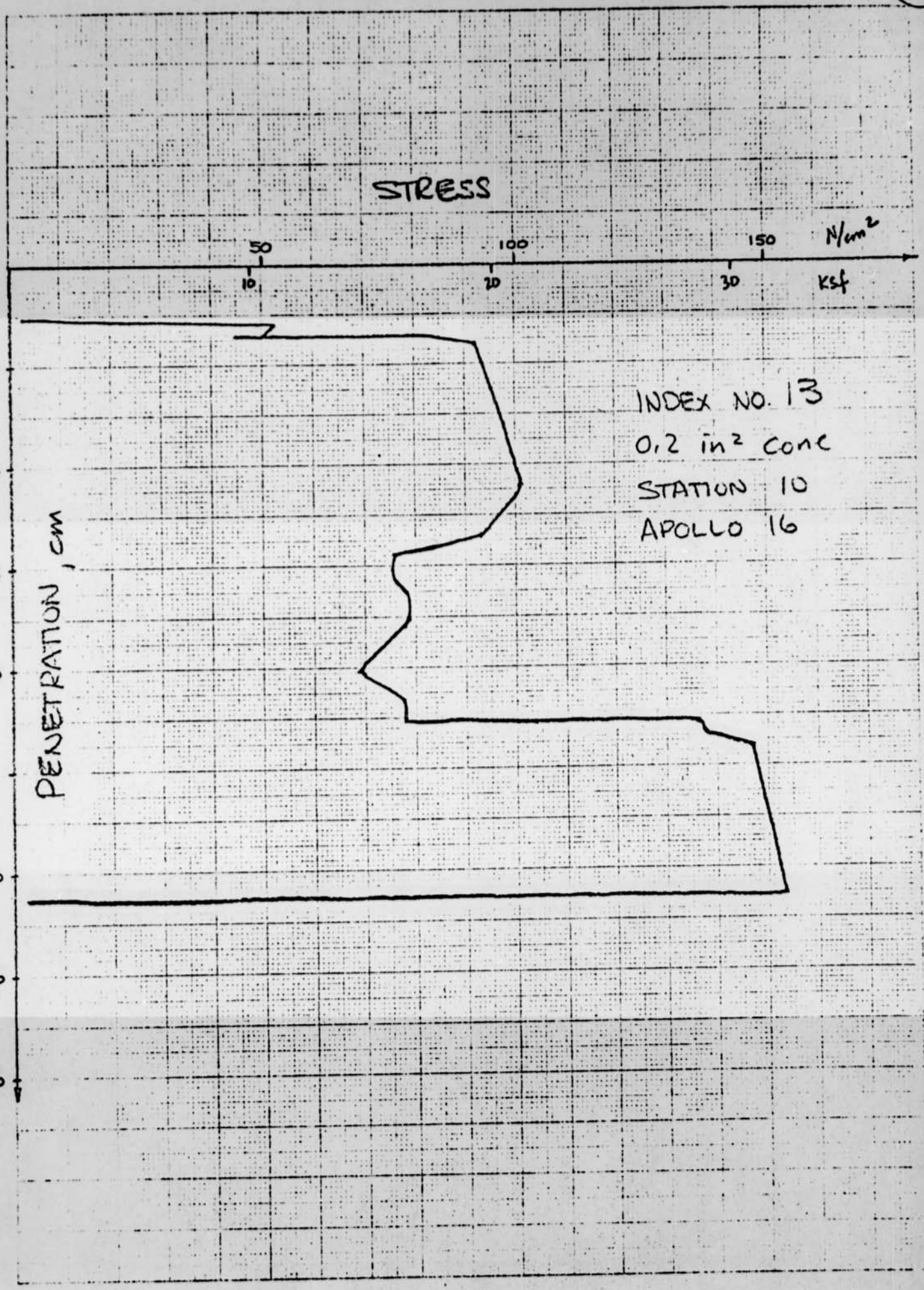


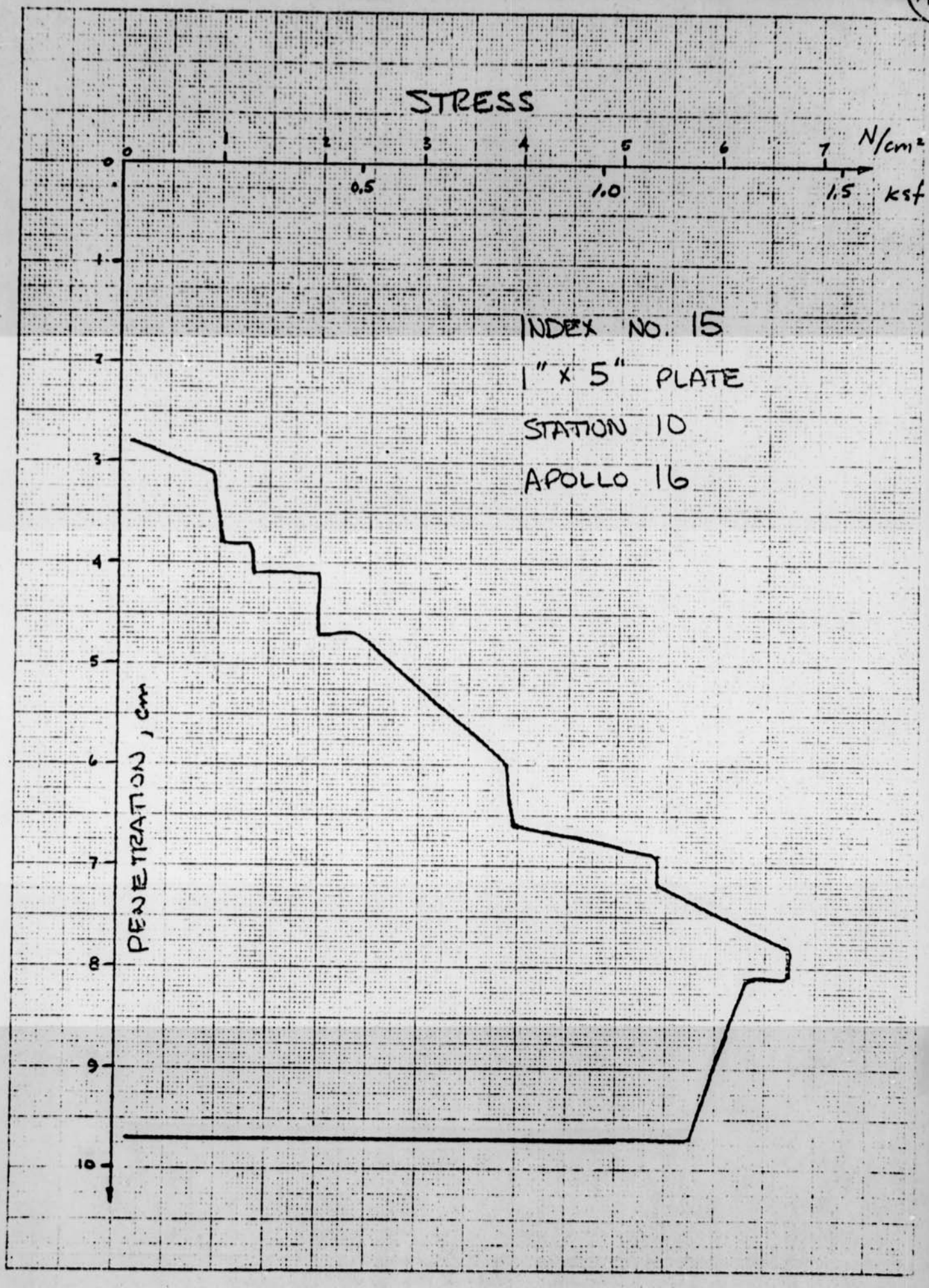
INDEX NO. 12

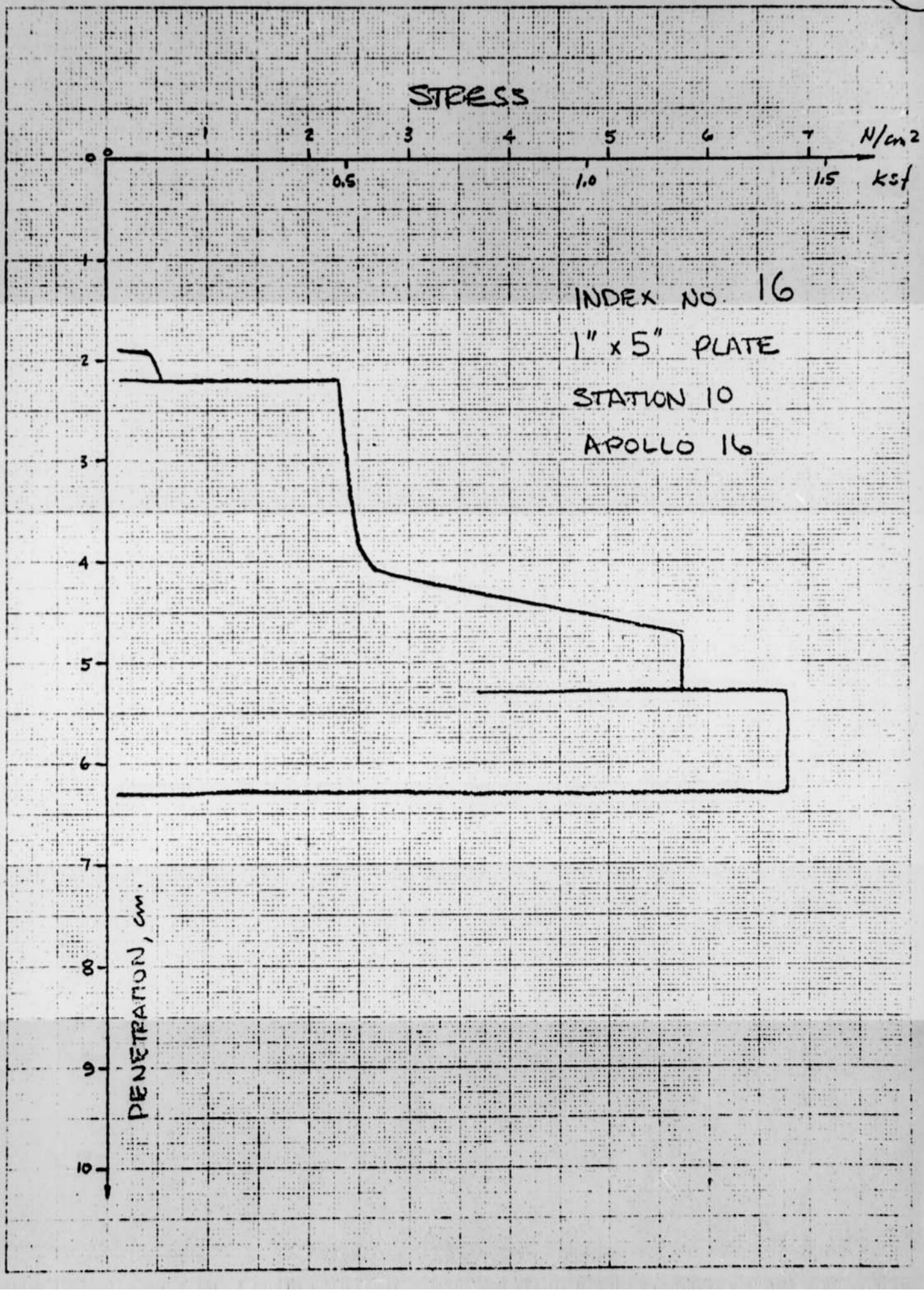
0.2 in² cone

STATION 10

APOLLO 16


STRESS
50
100
150
N/cm²
10
20
30
ksf
10
20
30
40
50
60
70
80
PENETRATION, cm
INDEX NO. 13
0.2 in² cone
STATION 10
APOLLO 16


STRESS
0
1
2
3
4
5
6
7
N/cm²
0.5
1.0
1.5
ksf
INDEX NO. 15
1" x 5" PLATE
STATION 10
APOLLO 16
PENETRATION, cm
0
1
2
3
4
5
6
7
8
9
10


STRESS
1
2
3
4
5
6
7
N/cm2
0
0.5
1.0
1.5
ksf
INDEX NO. 16
1" x 5" PLATE
STATION 10
APOLLO 16
1
2
3
4
5
6
7
8
9
10
PENETRATION, cm.

B

APOLLO 16 - LSRP

REDUCED DATA

CALIBRATIONS FOR APOLLO 16 DATA REDUCTION

PENETRATION

based on pre- and post-flight calibration

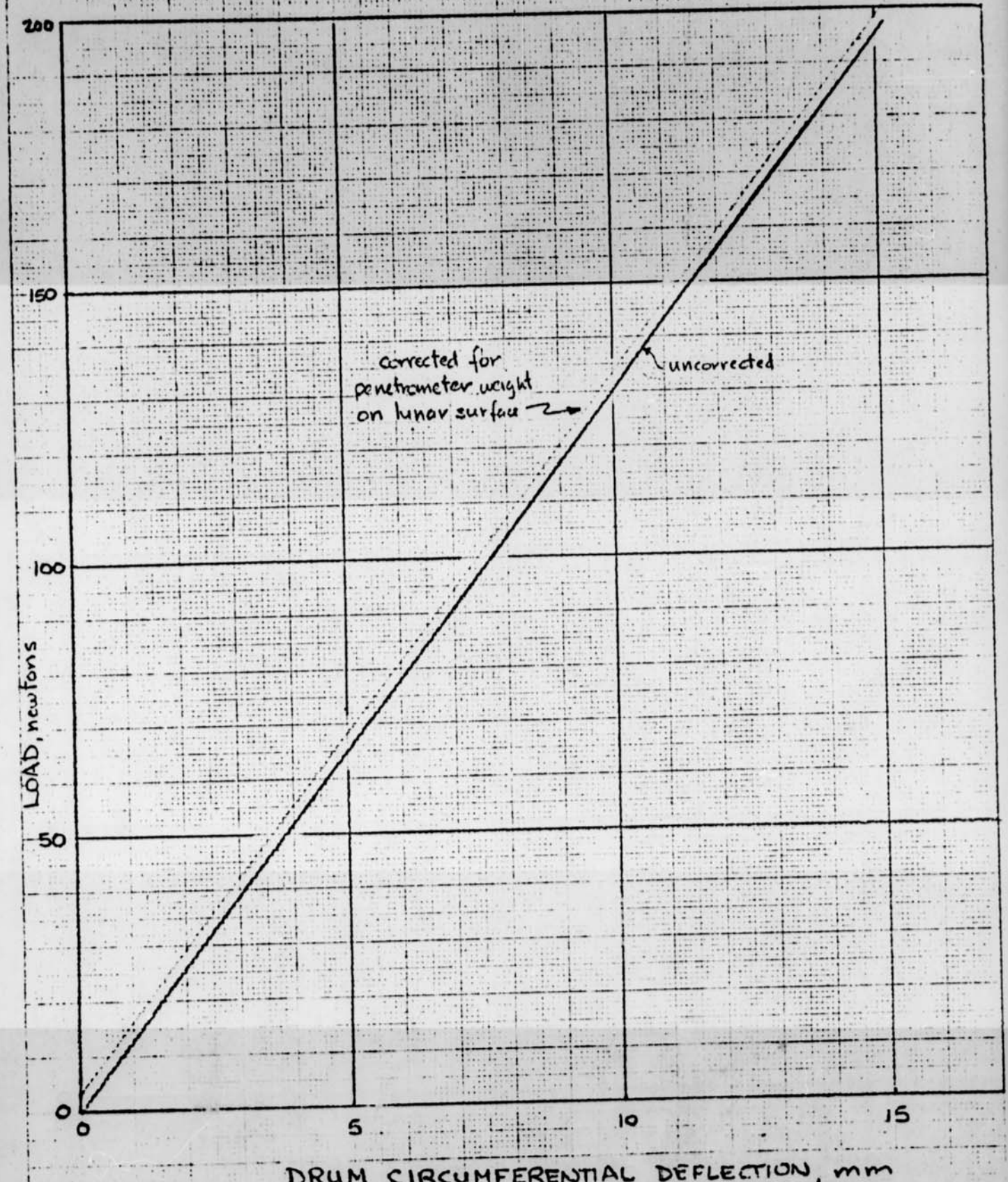
use ratio $\frac{\text{actual}}{\text{recorded}} = 31.3$

LOAD

penetrometer used w/o handle on moon

weight =	on earth	on moon
	4.70 lbs	
	2.132 kg	
	20.914 N	3.4857 N

∴ —— use 3.49 N addition to calibration curve on next page ——



APOLLO 16 LOAD CALIBRATION CURVE

DDT

APOLLO 16

(B-3)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 5 Page No. 1

0.5 in² conc. = 3.2258 cm²

DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD	STRESS		INITIAL DRUM DEPTH / FINAL	Δ DRUM DEPTH READING	ACTUAL PENETR. DEPTH	
	×.5542 →						× 31.3 →		
deg-min	degrees	DEFLECTION mm.	(from calib. curve) newtons	newton/cm²		cm	cm.	cm.	
0°00'	0.00	0.00	0.0	0.0		89.77	0.00	0.00	
0°00'	0.00	0.00*	3.5	1.1		89.88	0.11	3.4	
2°50'	2.83	1.57	23.8	7.4		89.89	0.12	3.8	
5°14'	5.23	2.90	41.0	12.7		89.94	0.17	5.3	
6°55'	6.92	3.84	53.0	16.4		89.94	0.17	5.3	
9°05'	9.08	5.03	68.7	21.3		89.96	0.19	6.0	
9°20'	9.33	5.17	70.3	21.8		90.00	0.23	7.2	
5°40'	5.67	3.14	44.0	13.6		90.00	0.23	7.2	
9°41'	9.68	5.36	72.8	22.6		90.01	0.24	7.5	
14°38'	14.63	8.11	109.0	33.8		90.11	0.34	10.6	
15°02'	15.03	8.33	111.7	34.6		90.16	0.39	12.2	
9°38'	9.63	5.34	72.6	22.5		90.16	0.39	12.2	
16°35'	16.52	9.19	122.7	38.0		90.16	0.39	12.2	
18°33'	18.55	10.28	137.0	42.5		90.21	0.44	13.8	
18°49'	18.82	10.43	139.8	43.0		90.25	0.48	15.0	
8°49'	8.82	4.88	67.0	19.8		90.25	0.48	15.0	
20°00'	20.00	11.08	147.3	45.7		90.25	0.48	15.0	
21°19'	21.32	11.82	157.0	48.7		90.29	0.52	16.3	
8°15'	8.25	4.57	62.5	19.4		90.29	0.52	16.3	
23°24'	23.40	12.97	172.0	53.3		90.29	0.52	16.3	

TREADWELL & MORIWAKI

APOLLO 16

(B-4)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP
FLIGHT UNIT (S/N 2004)
LUNAR DRUM (S/N 2008)
0.5 in² cone

Date 11 & 12 MAY 1972
Lunar Penetration Data Reduction
Index No. 5 Page No. 2

	→ x 1.5542 ←						→ x 31.3 ←		
DRUM LMD ∠	DRUM LOAD ∠	DRUM CIRCUMF. DEFLECTION mm.	LOAD newtons (from calib. curve)	STRESS newton/cm²		INITIAL DRUM DEPTH / FINAL DRUM DEPTH cm	Δ DRUM DEPTH READING cm.	ACTUAL PENETR. DEPTH cm.	
deg-min	degrees								
29°31'	29.52	16.36	216.0	67.0		90.41	0.64	20.0	
0°24'	0.40	0.22	5.8	1.8		90.41	0.64	20.0	
26°35'	26.58	14.73	194.4	60.3		90.43	0.66	20.7	
29°24'	29.40	16.29	215.0	66.7		90.45	0.68	21.3	
0°20'	0.33	0.18	5.1	1.6		90.46	0.69	21.6	

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APOLLO 16

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UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP · Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) Index No. 6 Page No. 1

0.2 in² cone = 1.2903 cm²

	×.5512 →	↓					× 31.3 →	↓	
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL DRUM DEPTH / FINAL	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newton/cm²		cm	READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.76	0.00	0.00	
0°00'	0.00	0.00*	3.5	2.7		90.03	0.25	7.8	
2°08'	2.13	1.18	17.3	14.2		90.03	0.25	7.8	
2°25'	2.42	1.34	20.6	16.0		90.15	0.37	11.6	
1°08'	1.13	0.63	11.5	8.9		90.31	0.53	16.6	
1°08'	1.13	0.63	11.5	8.9		90.35	0.57	17.8	
2°13'	2.22	1.23	19.5	15.1		90.35	0.57	17.8	
3°39'	3.65	2.02	29.5	22.9		90.46	0.68	21.3	
6°15'	6.25	3.46	48.3	37.4		90.52	0.74	23.2	
7°12'	7.20	3.99	55.1	42.7		90.52	0.74	23.2	
7°12'	7.20	3.99	55.1	42.7		90.57	0.79	24.7	
5°09'	5.15	2.85	40.4	31.3		90.60	0.82	25.6	
5°46'	5.77	3.20	45.0	34.9		90.63	0.85	26.6	
4°26'	4.43	2.46	35.5	27.5		90.69	0.91	28.5	
4°26'	4.43	2.46	35.5	27.5		90.78	1.00	31.3	
3°56'	3.93	2.18	31.8	24.6		90.80	1.02	32.0	
5°25'	5.42	3.00	42.5	32.9		90.92	1.14	35.7	
5°52'	5.87	3.25	45.8	35.5		91.04	1.26	39.4	
4°29'	4.48	2.48	35.8	27.7		91.20	1.42	44.5	
5°37'	5.62	3.11	43.9	34.0		91.30	1.52	47.6	

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APOLLO 16

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UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 5 Page No. 2

0.2 in² cone

	→ x.5542	↓					→ x31.3	↓	
DRUM LOAD ↓	DRUM LOAD ↓	DRUM CIRCUMF.	LOAD newtons	STRESS		INITIAL DRUM DEPTH / FINAL DRUM DEPTH cm	Δ DRUM DEPTH READING cm.	ACTUAL PENETR. DEPTH cm.	
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newton/cm²					
4°45'	4.75	2.63	37.7	29.2		91.61	1.83	57.3	
7°12'	7.20	3.99	55.4	42.9		91.63	1.85	57.9	
5°58'	5.97	3.31	46.5	36.0		91.68	1.90	59.5	
5°58'	5.97	3.31	46.5	36.0		91.83	2.05	64.2	
7°12'	7.20	3.99	55.4	42.9		91.89	2.11	66.0	
7°12'	7.20	3.99	55.4	42.9		92.13	2.37	74.2	
20°16'	20.27	11.23	149.5	115.9		92.15	2.37	74.2	
0°00'	0.00	0.00*	3.5	2.7		92.15	2.37	74.2	

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APOLLO 16

(B-1)

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APOLLO 16 - LSRP
FLIGHT UNIT (S/N 2004)
LUNAR DRUM (S/N 2008)
0.2 in² conc

Date 11 & 12 MAY 1972
Lunar Penetration Data Reduction
Index No. 7 Page No. 1

	→ x.5542	↓					→ x 31.3	↓	
DRUM LOAD %	DRUM LOAD %	DRUM CIRCUMF. DEFLECTION mm.	LOAD Newtons (from calib. curve)	STRESS Newton/cm²		INITIAL DRUM DEPTH / FINAL DRUM DEPTH	Δ DRUM DEPTH READING cm.	ACTUAL PENETR. DEPTH cm.	
deg-min	degrees								
0°00'	0.00	0.00	0.0	0.0		89.73	0.00	0.0	
0°00'	0.00	0.00*	3.5	2.7		89.93	0.20	6.3	
6°14'	6.23	3.45	48.4	37.5		89.93	0.20	6.3	
8°05'	8.08	4.48	61.7	47.8		90.03	0.25	7.8	
8°17'	8.23	4.59	63.2	49.0		90.15	0.37	11.6	
6°28'	6.47	3.59	50.2	38.9		90.23	0.50	15.7	
6°52'	6.87	3.81	53.0	41.1		90.53	0.75	23.5	
8°57'	8.95	4.96	68.0	52.7		90.61	0.83	26.0	
9°15'	9.25	5.13	70.2	54.4		90.87	1.09	34.1	
13°26'	13.43	7.44	100.2	77.7		90.90	1.12	35.1	
16°59	16.98	9.41	125.8	97.5		90.95	1.17	36.6	
22°32'	22.53	12.49	165.8	128.5		90.96	1.18	36.9	
16°21'	16.35	9.06	121.3	94.0		91.13	1.35	42.3	
16°21	16.35	9.06	121.3	94.0		91.17	1.40	43.8	
20°07	20.12	11.15	148.5	115.1		91.20	1.42	44.5	
6°45'	6.75	3.74	52.1	40.4		91.23	1.44	45.1	
29°25'	29.42	16.30	215.4	166.9		91.23	1.44	45.1	
29°25	29.42	16.30	215.4	166.9		91.23	1.45	45.4	
0°00'	0.00	0.00*	3.5	2.7		91.23	1.45	45.4	

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APOLLO 16

(B-8)

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APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 3 Page No. 1

0.2 in² cone

	×.5542 →						× 31.3 →		
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD newtons	STRESS		INITIAL DEPTH / FINAL DEPTH	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm,	(from calib. curve)	newton/cm²			READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.78	0.00	0.00	
0°00'	0.00	0.00*	3.5	2.7		89.35	0.15	4.7	
4°05'	4.08	2.21	32.2	25.0		89.95	0.17	5.3	
8°50'	8.83	4.78	65.6	50.8		89.[illegible]	0.20	6.3	
9°10'	9.17	4.97	68.1	52.8		90.01	0.22	6.9	
6°57'	6.95	3.77	52.5	40.7		90.01	0.22	6.9	
10°31'	10.52	5.71	77.7	60.2		90.01	0.22	6.9	
16°03'	16.05	8.70	116.6	90.4		90.04	0.26	8.1	
17°02'	17.03	9.24	123.6	95.8		90.05	0.30	9.4	
5°39'	5.65	3.06	43.3	33.6		90.05	0.30	9.4	
17°45'	17.75	9.63	128.7	99.7		90.05	0.30	9.4	
18°33'	18.55	10.05	134.2	104.0		90.12	0.34	10.6	
20°17'	20.28	10.99	146.4	113.5		90.15	0.37	11.6	
20°50'	20.83	11.31	150.5	116.6		90.31	0.53	16.6	
19°45'	19.75	10.70	142.6	110.5		90.[illegible]	0.65	20.4	
4°34'	4.57	2.48	35.7	27.7		90.[illegible]	0.67	21.0	
26°59'	26.98	14.61	193.4	149.9		90.45	0.67	21.0	
27°12'	27.20	14.74	195.1	151.2		90.51	0.72	22.5	
5°22'	5.37	2.91	41.3	32.0		90.51	0.72	22.5	
27°52'	27.87	15.11	199.9	154.9		90.5[illegible]	0.74	23.2	

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APOLLO 16

(B-9)

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Soil Mechanics Laboratory

APOLLO 16 - LSRP · Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) Index No. B Page No. 2

0.2 in² cone

	→ x.5542 ↓						↱ x31.3	↳	
DRUM LOAD #	DRUM LOAD #	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL / DRUM DEPTH / FINAL cm	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newton/cm²			READING cm.	DEPTH cm.	
27°52'	27.87	15.11	199.9	154.9		90.65	0.87	27.2	
17°38'	17.63	9.57	127.9	99.1		90.93	1.15	36.0	
16°13'	16.22	8.80	117.9	91.4		90.99	1.21	37.9	
10°15'	10.25	5.56	75.8	58.7		91.15	1.37	42.9	
5°49	5.82	3.22	45.4	35.2		91.37	1.59	49.8	
16°50'	16.83	9.32	124.7	96.6		91.40	1.62	50.7	
16°50'	16.83	9.32	124.7	96.6		91.42	1.64	51.3	
10°16'	10.27	5.68	77.3	59.9		91.50	1.72	53.8	
10°16'	10.27	5.68	77.3	59.9		91.58	1.80	56.3	
11°21'	11.35	6.29	85.3	66.1		91.62	1.84	57.6	
20°04'	20.07	11.10	147.8	114.5		91.62	1.84	57.6	
18°12'	18.20	10.07	134.4	104.2		91.87	2.09	65.4	
16°40'	16.67	9.22	123.4	95.6		91.96	2.18	68.2	
26°00'	26.00	14.40	190.7	147.8		91.90	2.20	68.9	
25°36'	25.60	14.16	187.6	145.4		92.11	2.33	72.9	
30°21'	30.35	16.78	221.6	171.7		92.11	2.33	72.9	
0°00'	0.00	0.00*	3.5	2.7		92.11	2.33	72.9	

TREADWELL & MORIWAKI

APOLLO 16

(B-10)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 10 Page No. 1

0.5 in² cone = 3.2258 cm²

	×1.5542						×31.3	
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL / FINAL DEPTH	Δ DRUM DEPTH	ACTUAL PENETR. DEPTH
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newton/cm²		cm	READING cm.	cm.
0°00'	0.00	0.00	0.0	0.0		89.78	0.00	0.0
0°00'	0.00	0.00 *	3.5	1.1		89.91	0.13	4.1
8°12'	8.20	4.54	62.5	19.4		89.91	0.13	4.1
11°55'	11.92	6.60	89.3	27.7		89.94	0.16	5.0
22°08'	22.13	12.23	162.5	50.4		90.00	0.17	5.3
23°31'	23.52	13.01	172.6	53.5		90.01	0.23	7.2
9°31'	9.52	5.27	72.0	22.3		90.01	0.23	7.2
21°37'	21.62	11.97	159.1	49.3		90.01	0.23	7.2
25°14'	25.23	13.98	185.2	57.4		90.07	0.29	9.1
23°14'	25.23	13.98	185.2	57.4		90.11	0.33	10.3
11°05'	11.08	6.12	83.1	25.8		90.11	0.33	10.3
25°46'	25.77	14.25	188.8	58.5		90.11	0.33	10.3
25°46'	25.77	14.25	188.8	58.5		90.20	0.42	13.2
25°15'	25.25	14.00	185.5	57.5		90.22	0.44	13.8
14°40'	14.67	8.11	108.8	33.7		90.22	0.44	13.8
27°12'	27.20	15.05	199.2	61.8		90.22	0.44	13.8
24°10'	24.17	13.38	177.4	55.0		90.23	0.45	14.1
22°28'	22.63	12.53	167.4	51.9		90.27	0.49	15.3
22°06'	22.10	12.26	162.9	50.5		90.34	0.56	17.5
11°05'	11.08	6.14	83.3	25.8		90.34	0.56	17.5

TREADWELL & MORIWAKI

APOLLO 16

(B-11)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 10 Page No. 2

0.5 in² area =

	×.5542 →						× 31.3 →		
DRUM LMD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL DRUM DEPTH / FINAL cm	Δ DRUM DEPTH	ACTUAL PENETR.	
deg - min	degrees	DEFLECTION mm.	(from calib. curve)	newtons/cm²			READING cm.	DEPTH cm.	
30°00'	30.00	16.60	219.3	68.0		90.3	0.56	17.5	
30°00'	30.00	16.60	219.3	68.0		90.3	0.60	18.8	
10°25'	10.42	5.77	78.5	24.3		90.3	0.60	18.8	
29°55'	29.92	16.55	218.7	67.8		90.3	0.60	18.8	
29°55	29.92	16.55	218.7	67.8		90.4	0.70	21.9	
0°00'	0.00	0.00*	3.5	1.1		30.4	0.70	21.9	

TREADWELL & MORIWAKI

APOLLO 16

(B-12)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 11 Page No. 1

0.2 in² conc. =

	↱ x.5542 ↴						↱ x31.3 ↴		
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD newtons	STRESS		INITIAL DRUM DEPTH / FINAL cm	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newtons/cm²			READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.77	0.00	0.0	
0°00'	0.00	a00*	3.5	2.7		90.07	0.30	9.4	
3°52'	3.87	2.14	31.3	24.3		90.07	0.30	9.4	
4°22'	4.37	2.42	35.0	27.1		90.10	0.33	10.3	
11°31'	11.52	6.39	86.6	67.1		90.10	0.33	10.3	
12°31'	12.52	6.93	93.6	72.5		90.21	0.44	13.8	
12°31'	12.52	6.93	93.6	72.5		90.32	0.55	17.2	
8°44'	8.73	4.83	66.3	51.4		90.32	0.55	17.2	
13°51'	13.85	7.68	103.3	80.1		90.32	0.55	17.2	
15°41'	15.68	8.69	118.5	90.3		90.35	0.58	18.2	
19°43'	19.72	10.92	145.5	112.8		90.35	0.58	18.2	
19°13'	19.22	10.65	142.0	110.1		90.40	0.63	19.7	
11°01'	11.02	6.11	82.9	64.2		90.40	0.63	19.7	
21°05'	21.08	11.68	155.3	120.4		90.40	0.63	19.7	
22°55'	22.92	12.69	168.5	130.6		90.45	0.68	21.3	
24°28'	24.47	13.55	179.7	139.3		90.45	0.68	21.3	
23°53'	23.83	13.20	175.1	135.7		90.48	0.71	22.2	
12°22'	12.37	6.84	92.4	71.6		90.48	0.71	22 2	
25°21'	25.35	14.02	185.8	144.0		90.48	0.71	22.2	
26°33'	26.55	14.69	194.5	150.7		90.63	0.85	26.6	

TREADWELL & MORIWAKI

APOLLO 16

(B-13)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 11 Page No. 2

0.2 in² cone

DRUM LOAD %	DRUM LOAD % (×.5542)	DRUM CIRCUMF. DEFLECTION mm.	LOAD Newtons (from calib. curve)	STRESS Newton/cm²		INITIAL DRUM DEPTH / FINAL DRUM DEPTH cm	Δ DRUM DEPTH READING (×31.3) cm.	ACTUAL PENETR. DEPTH cm.	
deg-min	degrees								
28°06	28.10	15.55	205.7	159.4		[illegible]	0.87	27.2	
28°06	28.10	15.55	205.7	159.4		90.74	0.97	30.4	
16°30'	16.50	9.14	122.3	94.8		90.74	0.97	30.4	
28°51'	28.85	16.00	211.5	163.9		90.74	0.97	30.4	
29°22'	29.37	16.24	214.6	166.3		90.86	1.09	34.1	
27°51'	27.85	15.42	204.0	158.1		90.94	1.17	36.6	
13°04'	13.07	7.24	97.6	75.6		90.94	1.17	36.6	
29°04'	29.07	16.10	212.8	164.9		90.94	1.17	36.6	
29°04'	29.07	16.10	212.8	164.9		91.21	1.44	45.1	
14°24'	14.40	7.98	107.2	83.1		91.21	1.44	45.1	
29°04	29.07	16.10	212.8	164.9		91.21	1.44	45.1	
29°04	29.07	16.10	212.8	164.9		91.38	1.61	50.4	
0°00'	0.00	0.00*	3.5	2.7		91.38	1.61	50.4	

TREADWELL & MORIWAKI

APOLLO 16

(B-14)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 13 Page No. 1

0.2 in² cone =

	→ x.5542 →						→ x 31.3 →		
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD newtons	STRESS		INITIAL DRUM DEPTH / FINAL DRUM DEPTH	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(from calib. curve)	newton/cm²			READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.73	0.00	0.0	
0°00'	0.00	0.00*	3.5	2.7		89.87	0.08	2.5	
11°36'	11.60	6.43	87.1	67.5		89.87	0.08	2.5	
5°30'	5.50	3.04	43.0	33.3		89.87	0.08	2.5	
9°45'	9.75	5.40	73.7	57.1		89.91	0.12	3.8	
6°37'	6.62	3.66	51.1	39.6		89.96	0.17	5.3	
6°37	6.62	3.66	51.1	39.6		90.01	0.22	6.9	
9°23'	9.38	5.20	71.1	55.1		90.10	0.31	9.7	
11°26'	11.43	6.34	85.9	66.6		90.22	0.43	13.5	
12°40'	12.67	7.01	94.6	73.3		90.23	0.44	13.8	
12°40'	12.67	7.01	94.6	73.3		90.24	0.45	14.1	
11°31'	11.52	6.39	86.6	67.1		90.25	0.46	14.4	
16°47'	16.78	9.30	124.4	96.4		90.25	0.46	14.4	
17°41'	17.68	9.78	130.6	125.9		90.26	0.49	15.3	
18°39'	18.65	10.31	137.5	106.6		90.62	0.83	26.0	
25°31'	25.52	14.18	187.8	145.5		90.62	0.83	26.0	
24°52'	24.87	13.78	182.6	141.5		90.62	0.83	26.0	
24°52'	24.87	13.78	182.6	141.5		90.68	0.89	27.9	
15°26'	15.43	8.55	114.7	88.9		90.68	0.89	27.9	
29°05'	29.00	16.05	212.1	164.4		90.68	0.89	27.9	

TREADWELL & MORIWAKI

Page B15 Missing

APOLLO 16

(B-16)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 13 Page No. 1

0.2 in² conc

	→ x.5542	↓					→ x 31.3	→	
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL DRUM DEPTH / FINAL cm	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm,	(from calib. curve)	newton/cm²			READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0.0	0.0		89.74	0.00	0.0	
0°00'	0.00	0.00*	3.5	2.7		89.96	0.17	5.3	
8°52'	8.87	4.92	67.5	52.3		91.78	0.19	6.0	
8°28'	8.47	4.69	64.5	50.0		90.02	0.23	7.2	
7°30'	7.50	4.16	57.6	44.6		90.02	0.23	7.2	
14°22'	14.37	7.96	107.0	82.9		90.03	0.23	7.2	
16°00'	16.00	8.87	118.8	92.1		90.04	0.25	7.8	
17°40'	17.67	9.79	130.8	101.4		90.50	0.71	22.2	
16°10'	16.17	8.96	120.0	93.0		90.66	0.87	27.2	
13°05'	13.08	7.25	97.8	75.8		90.71	0.92	28.8	
13°05'	13.08	7.25	97.8	75.8		90.78	0.99	31.0	
13°35'	13.58	7.53	101.4	78.6		90.83	1.04	32.6	
13°35'	13.58	7.53	101.4	78.6		90.[illegible]	1.13	35.4	
11°45'	11.75	6.51	88.1	68.3		91.08	1.29	40.4	
13°24'	13.40	7.43	100.1	77.6		91.17	1.38	43.2	
13°24'	13.40	7.43	100.1	77.6		91.24	1.45	45.4	
23°57	23.98	13.29	176.3	136.6		91.24	1.45	45.4	
24°15'	24.25	13.44	178.2	138.1		91.29	1.50	47.0	
25°52'	25.87	14.34	189.9	147.2		91.33	1.53	47.9	
27°00'	27.00	14.96	198.0	153.5		91.79	2.00	62.6	
0°00	0.00	0.00*	3.5	2.7		91.79	TREADWELL & MORIWAKI		
						2.00	62.6		

APOLLO 16

(B-17)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Index No. 15 Page No. 1

1" x 5" plate = 32.258 cm²

	→ x.5542	↓					→ x 31.3	↓	
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF. DEFLECTION	LOAD Newtons (from calib. curve)	STRESS		INITIAL DEPTH / FINAL DEPTH	Δ DRUM DEPTH READING	ACTUAL PENETR. DEPTH	
deg-min	degrees	mm.		Newtons/cm²		cm	cm.	cm.	
0°00'	0.00	0.00	0.0	0.00		89.79	0.00	0.0	
0°00'	0.00	0.00*	3.5	0.11		89.82	0.09	2.8	
3°38'	3.63	2.01	29.6	0.92		89.85	0.10	3.1	
4°02'	4.03	2.23	32.5	1.01		89.91	0.12	3.8	
5°20'	5.33	2.95	41.9	1.30		89.91	0.12	3.8	
5°30'	5.50	3.05	43.2	1.34		89.92	0.13	4.1	
8°24'	8.40	4.66	64.1	1.99		89.92	0.13	4.1	
8°24'	8.40	4.66	64.1	1.99		89.94	0.15	4.7	
10°02'	10.03	5.56	75.8	2.35		89.94	0.15	4.7	
16°55'	16.92	9.38	125.4	3.89		89.98	0.19	6.0	
17°13'	17.22	9.54	127.5	3.95		90.00	0.21	6.6	
23°43'	23.72	13.15	174.5	5.41		90.01	0.22	6.9	
23°43'	23.72	13.15	174.5	5.41		90.02	0.23	7.2	
29°35'	29.58	16.39	216.6	6.71		90.04	0.25	7.8	
29°35'	29.58	16.39	216.6	6.71		90.06	0.26	8.1	
27°40'	27.67	15.33	202.8	6.29		90.06	0.26	8.1	
25°15'	25.25	13.99	185.4	5.75		90.10	0.31	9.7	
0°00'	0.00	0.00*	3.5	0.11		90.10	0.31	9.7	

TREADWELL & MORIWAKI

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP

Date 11 & 12 MAY 1972

FLIGHT UNIT (S/N 2004)

Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008)

Index No. 16 Page No. 1

1" x 5" plate = 32.258 cm²

	×1.5542 →						← ×31.3 →		
DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF. DEFLECTION	LOAD Newtons (from calib. curve)	STRESS		INITIAL DRUM DEPTH / FINAL DRUM DEPTH	Δ DRUM DEPTH READING	ACTUAL PENETR. DEPTH	
deg-min	degrees	min.		Newtons/cm²		cm	cm.	cm.	
0°00'	0.00	0.00	0.0	0.00		89.80	0.00	0.0	
0°00'	0.00	0.00*	3.5	0.11		89.86	0.06	1.9	
1°15'	1.25	0.69	12.5	0.39		89.86	0.06	1.9	
1°52'	1.87	1.04	17.0	0.53		89.87	0.07	2.2	
0°06'	0.10	0.06	4.3	0.13		89.87	0.07	2.2	
9°53'	9.83	5.45	74.3	2.30		89.87	0.07	2.2	
10°37'	10.62	5.89	80.1	2.48		89.92	0.12	3.8	
11°24'	11.40	6.32	85.7	2.66		89.93	0.13	4.1	
25°10'	25.17	13.95	184.9	5.73		89.95	0.15	4.7	
25°10'	25.17	13.95	184.9	5.73		89.97	0.17	5.3	
16°00'	16.00	8.87	118.8	3.68		89.97	0.17	5.3	
29°51'	29.85	16.54	218.5	6.77		89.97	0.17	5.3	
29°51'	29.85	16.54	218.5	6.77		90.00	0.20	6.3	
0°00'	0.00	0.00*	3.5	0.11		90.00	0.20	6.3	

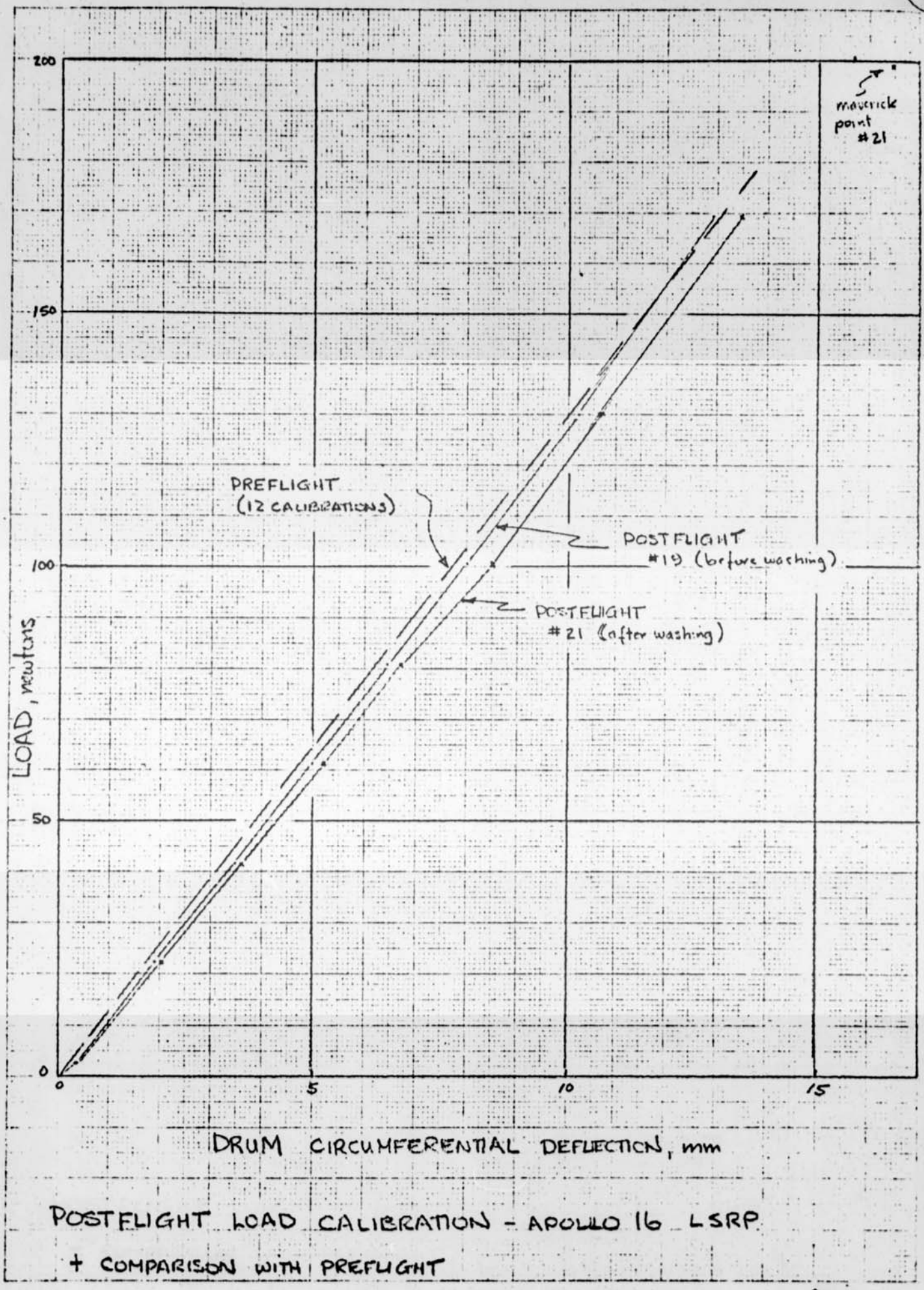
TREADWELL & MORIWAKI

(C)

APOLLO 16 - LSRP

POST-FLIGHT CALIBRATION

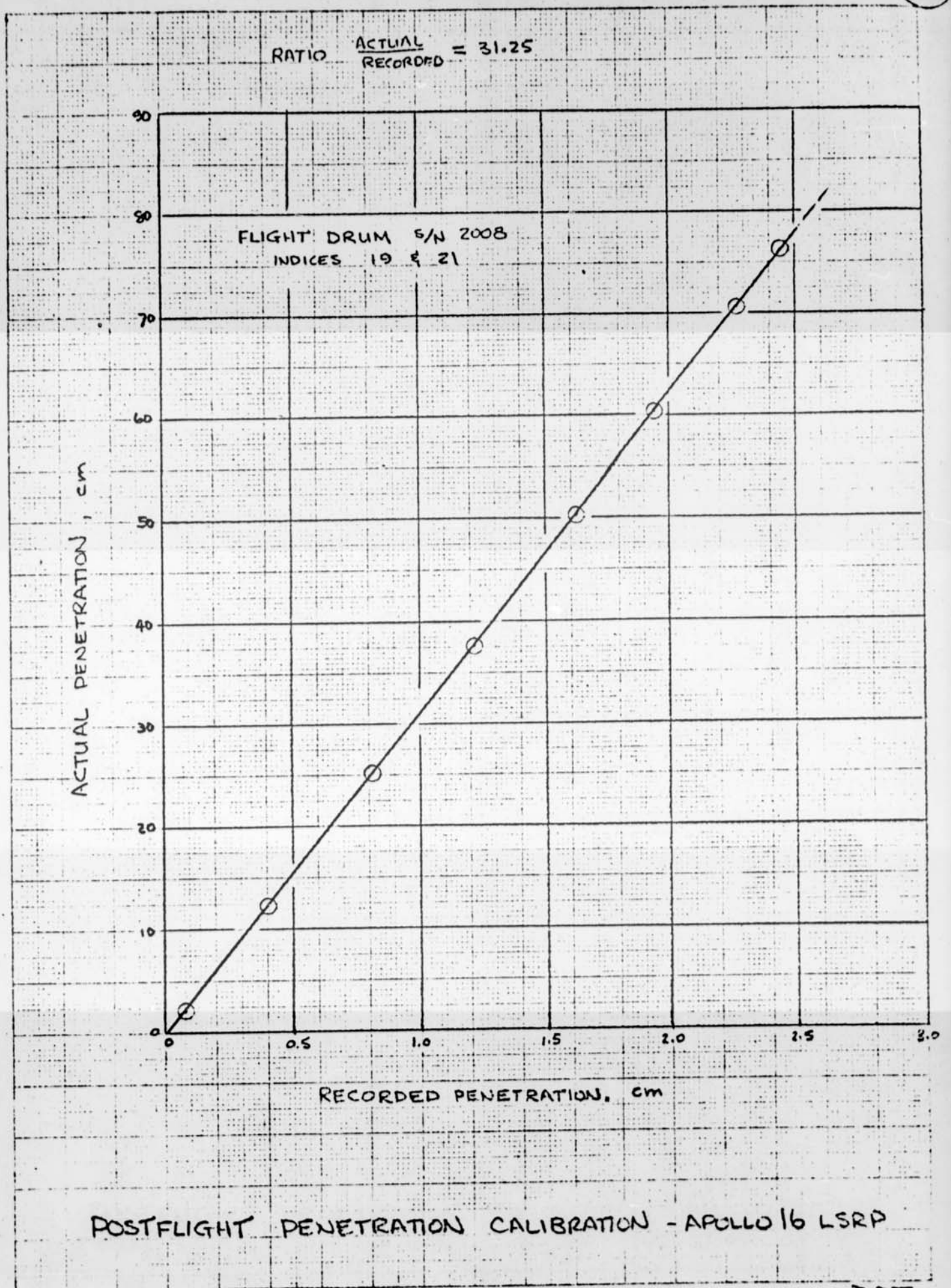
C-1



POSTFLIGHT LOAD CALIBRATION - APOLLO 16 LSRP

+ COMPARISON WITH PREFLIGHT

DDT



POSTFLIGHT PENETRATION CALIBRATION - APOLLO 16 LSRP

PDT

APOLLO 16 (C-3)

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT ( ) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Page No. —

Index #21

DRUM LOAD ∠	DRUM LOAD ∠	DRUM CIRCUMF.	LOAD Newtons	STRESS		INITIAL / FINAL DRUM DEPTH	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(Load Reading)			cm.	READING cm.	DEPTH cm.	
0°00'	0.00	0.0				89.80	0.08	0.0	
0°41'	0.67	0.37	2.41			89.80			
0°41'						89.88	0.08	2.17	
3°37'	3.62	2.04	22.05			89.88			
3°37						90.20	0.40	12.23	
6°30'	6.50	3.60	41.6			90.20			
6°30'						90.61	0.81	25.03	
9°26'	9.43	5.22	61.2			90.61			
9°26'						91.02	1.22	37.60	
12°06'	12.10	6.70	80.9			91.02			
12°06'						91.42	1.62	50.28	
15°22'	15.37	8.51	100.6			91.42			
15°22'						91.75	1.95	60.43	
19°15'	19.25	10.66	130.0			91.75			
19°15'						92.07	2.27	70.59	
24°22'	24.37	1348	169.3			92.07			
24°22'						92.24	2.44	76.2	
0°00'	0.00					92.24			
SPECIAL PT = 29°45' = 29.75° = 44.71*									

89.81

TREADWELL & MORIWAKI

AFTER WASHING W/ALCOHOL

APOLLO 16

C-4

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

APOLLO 16 - LSRP — Date 11 & 12 MAY 1972

FLIGHT UNIT ( ) — Lunar Penetration Data Reduction

LUNAR DRUM (S/N 2008) — Page No. ____

[redacted] Index #19

DRUM LOAD ±	DRUM LOAD ±	DRUM CIRCUMF.	LOAD NEWTONS	[redacted]		INITIAL DRUM DEPTH / FINAL DRUM DEPTH	Δ DRUM DEPTH	ACTUAL PENETR.	
deg-min	degrees	DEFLECTION mm.	(LBS)			cm	READING cm.	DEPTH cm.	
0°00'	0.00	0.00	0			89.80	0.00	0.0	
0°35'	0.58	0.32	2.41			89.80			
0°35'						89.88	0.08	2.17	
3°26'	3.43	1.90	22.05			89.88			
3°26'						90.20	0.40	12.23	
6°18'	6.30	3.49	41.6			90.20			
6°18'						90.61	0.81	25.03	
9°00'	9.00	4.98	61.2			90.61			
9°00'						91.01	1.21	37.60	
11°37'	11.62	6.44	80.9			91.01			
11°37'						91.42	1.62	50.28	
14°26'	14.43	8.00	100.6			91.42			
14°26'						91.74	1.94	60.43	
18°26'	18.43	10.20	130.0			91.74			
18°26'			"			92.07	2.27	70.59	
23°18'	23.30	12.90	169.3			92.07			
23°18'						92.24	2.44	76.2	
0°00'						92.24			

BEFORE WASHING W/ ALCOHOL

TREADWELL & MORIWAKI

POST-FLIGHT CALIBRATION - APOLLO 16 LSRP
performed at Lockheed Building, Houston 5-2-72

LOADING SEQUENCE

	TOTAL PEN.		TOTAL LOAD	
	in.	cm.	kg	N
no penetration				
add cap (0.245 kg)	0	0	0.245	2.41
1st set of rods		2.17		
add 2 kg			2.245	22.05
2nd set of rods		12.23		
add 2 kg			4.245	41.6
3rd set of rods		25.03		
add 2 kg			6.245	61.2
4th set of rods		37.60		
add 2 kg			8.245	80.9
5th set of rods		50.28		
add 2 kg			10.245	100.6
6th set of rods		60.43		
add 3 kg			13.245	130.0
7th set of rods		70.59		
add 4 kg			17.245	169.3
go to latches		76.2		
remove all load (including cap)			0	0

special point on index #21 44.71 # ≒ 199 N
@ 29.75° = 16.45 mm

~~5-3-72~~

Lockheed Bldg; Houston

		total load
bottom out		
no penetration		
	add cap (0.245 kg)	+ 0.245
1st set rods		
	add 2kg ✓ ✓	2.245
2nd set "		
	add 2kg ✓ ✓	4.245
3rd set "		
	add 2kg ✓	6.245
4th set "		
	add 2 kg ✓	8.245
5th set "		
	add 2 kg ✓	10.245
6th set "		
	add 3	13.245
7th set "	add 4 kg	17.245

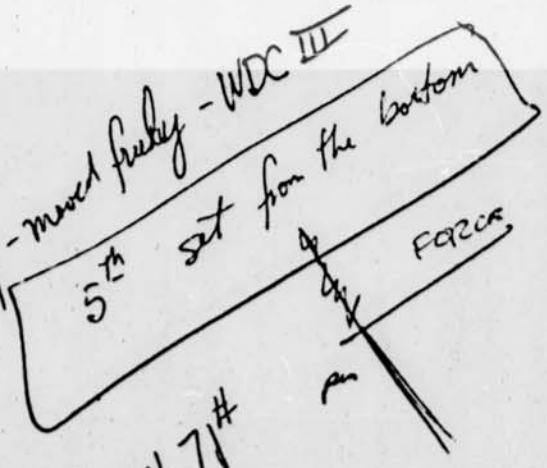
~~take off all load including cap~~

go to latches

take off load including cap.

With dist on Index 19

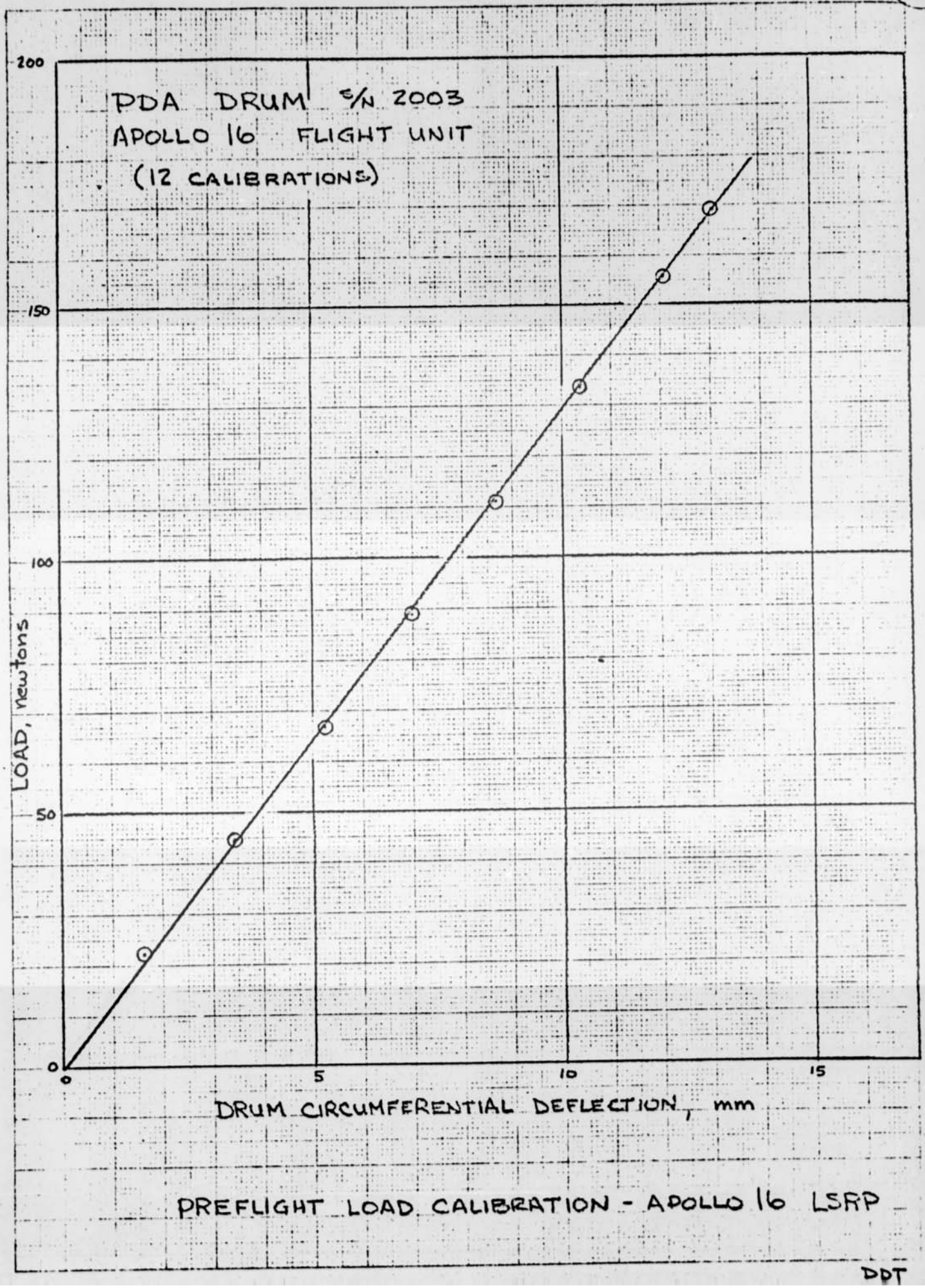
cleaned on Index 21 - qualitatively - moved freely - WDC III



(D)

APOLLO 16 ~ LSRP

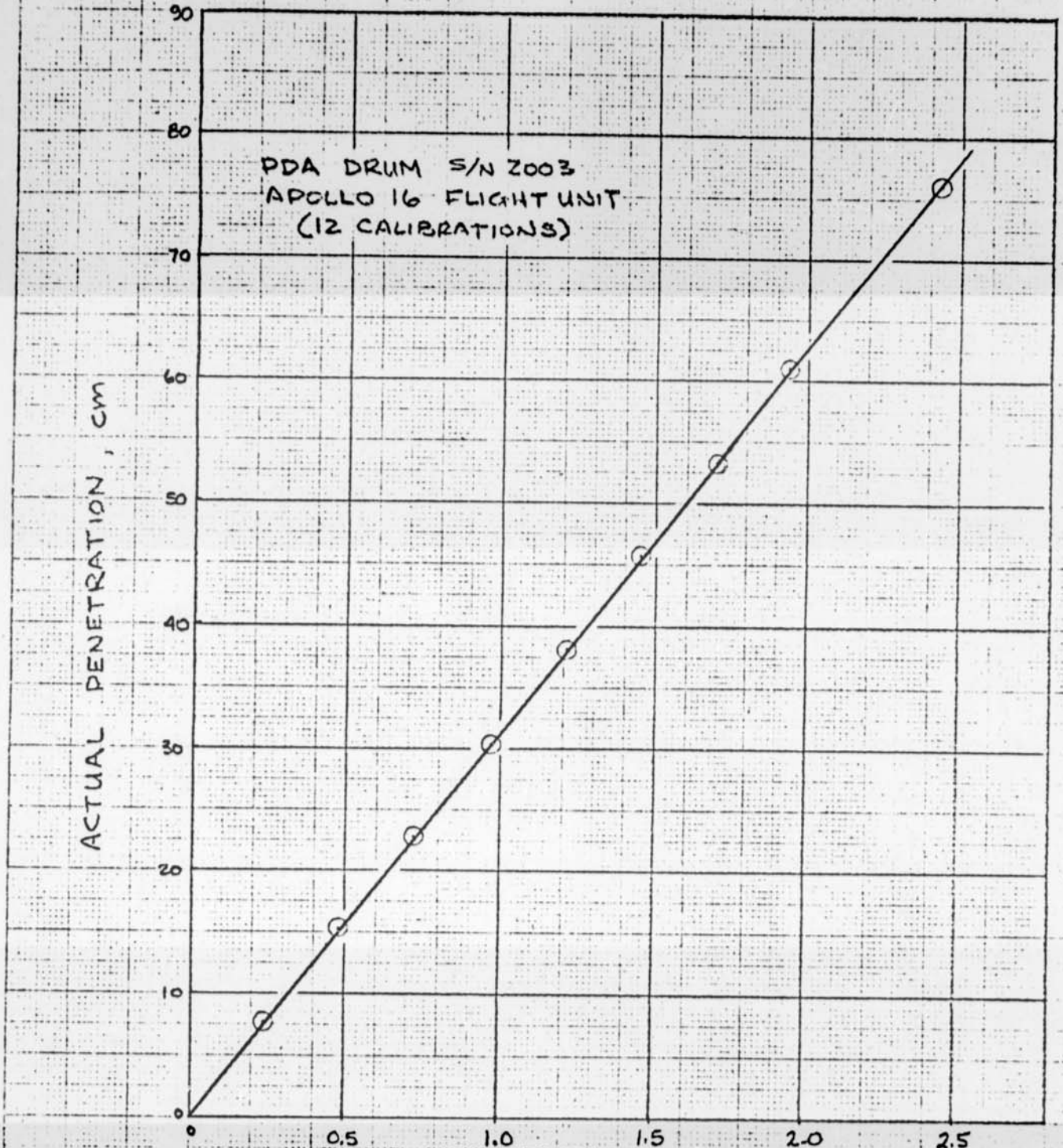
PRE-FLIGHT CALIBRATION



PREFLIGHT LOAD CALIBRATION - APOLLO 16 LSRP

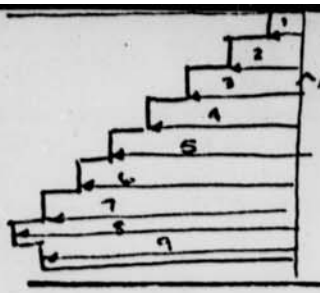
DDT

RATIO $\frac{\text{ACTUAL}}{\text{RECORDED}} = 31.3$



PREFLIGHT PENETRATION CALIBRATION - APOLLO 16 LSRP

DDT



PDA Drum
Flight Unit - Apollo 16

D-3

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

Date 19 April 1972

DEADWEIGHT LOADING

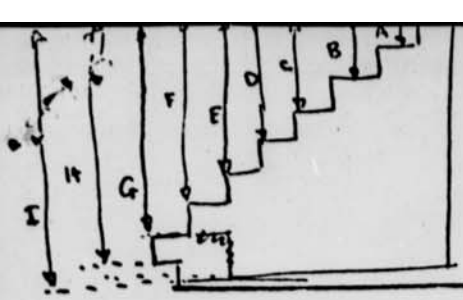
NASA Drum No. S/N 2003

"~~PENETRATION~~ CALIBRATION"
" LOAD

AZIMUTH / DELTA FROM REF

INDEX #									
REF.	1	2	3	4	5	6	7	8	9
1	0°00' /	2°53' / -0°00'	6°15' / -0°15'	10°08' / 0°32'	13°25' / -2°25'	17°46' / -2°46'	19°15' / -2°15'	21°46' / -2°46'	23°25' / -2°25'	21°46' / -2°46'
3	30°01' /	32°57' / -2°56'	36°15' / -6°15'	39°33' / 9°32'	42°52' / 12°37'	45°25' / 15°34'	48°34' / 18°33'	51°51' / 21°50'	53°25' / -23°32'	51°51' / -21°50'
5	60°10' /	63°03' / -2°53'	66°22' / -6°12'	69°39' / 9°29'	72°50' / 12°40'	75°25' / 15°43'	78°52' / 18°42'	81°50' / -21°50'	83°42' / -23°42'	81°50' / -21°50'
7	90°15' /	93°08' / -2°53'	96°25' / -6°11'	99°43' / 9°28'	103°00' / 12°45'	105°31' / 15°46'	109°07' / 18°52'	112°12' / -21°57'	113°52' / -23°37'	112°12' / -21°57'
9	120°03' /	123°05' / -2°57'	126°22' / -6°14'	129°39' / 9°24'	132°50' / 12°42'	135°33' / 15°50'	139°53' / 18°51'	142°12' / -21°52'	143°53' / -23°45'	142°12' / -21°52'
11	150°07' /	153°01' / -2°54'	156°13' / -6°06'	159°30' / 9°23'	162°47' / 12°40'	165°53' / 15°46'	168°52' / 18°50'	172°06' / -21°53'	173°51' / -23°44'	172°06' / -21°53'
13	180°05' /	183°01' / -2°56'	186°10' / -6°05'	189°34' / 9°29'	192°40' / 12°35'	195°45' / 15°40'	198°45' / 18°40'	201°56' / -21°51'	203°43' / -23°38'	201°56' / -21°51'
15	210°02' /	213°02' / -2°54'	216°19' / -6°17'	219°21' / 9°23'	222°35' / 12°27'	225°26' / 15°23'	228°28' / 18°28'	231°41' / -21°24'	233°07' / -23°07'	231°41' / -21°24'
17	240°00' /	242°52' / -2°52'	246°16' / -6°16'	249°31' / 9°31'	252°37' / 12°37'	255°42' / 15°40'	258°48' / 18°48'	261°51' / -21°51'	263°34' / -23°34'	261°51' / -21°51'
19	270°05' /	272°57' / -2°57'	276°16' / -6°11'	279°25' / 9°20'	282°40' / 12°35'	285°45' / 15°40'	288°40' / 18°40'	291°47' / -21°47'	293°38' / -23°33'	291°47' / -21°47'
21	300°00' /	302°58' / -2°58'	306°12' / -6°12'	309°31' / 9°31'	312°20' / 12°20'	315°31' / 15°31'	318°47' / 18°47'	321°39' / -21°39'	323°30' / -23°30'	321°39' / -21°39'
23	329°40' /	332°33' / -2°53'	336°12' / -6°32'	339°24' / 9°24'	342°34' / 12°34'	345°34' / 15°34'	348°41' / 18°41'	351°42' / -21°42'	353°29' / -23°29'	351°42' / -21°42'
1	VV / VV									
LOAD lbs	5	10	15	20	25	30	35	38	35
LOAD, N	22.25	44.5	66.8	89.0	111.1	133.5	155.8	169.1	155.8
AVG deg	2°54'	6°12'	9°27'	12°36'	15°38'	18°43"	21°48'	23°34'	21°48'
AVG deg.	2.90°	6.20°	9.45°	12.60°	15.63°	18.72°	21.80°	23.57'	21.80°
AVG mm	1.605	3.43	5.23	6.98	8.66	10.37	12.06	13.02	12.06

	REF.	1	2	3	4	5	6	7	8	9
1	0°00'	2°50' / 2°50'	~~7°15'~~ / 7°15'	~~10°02'~~ / 10°02'	13°25' / 13°25'	17°46' / 17°46'	19°15' / 19°15'	21°46' / 21°46'	23°35' / 23°35'	21°46' / 21°46'
3	30°01	32°57 / 2°56'	37°07' / ~~7°06'~~	39°33' / 9°32'	42°38 / 12°37'	45°35' / 15°34'	48°34' / 18°33'	51°51' / 21°50'	53°33 / 23°32'	51°51' / 21°50'
5	60°10'	63°03 / 2°53'	66°22' / 6°12'	69°39' / 9°29'	72°50 / 12°40'	75°53 / 15°43'	78°52' / 18°42'	82°00' / 21°50'	8352' / 23°42'	82°00' / 21°50'
7	90°15'	93°08' / 2°53'	96°26 / 6°11'	99°43' / 9°28'	103°00' / 12°45'	106°01' / 15°46'	109°07' / 18°52'	112°12 / 21°57	113°52' / 23°37'	112°12' / 21°57'
9	120°08'	123°05' / 2°57'	126°22' / 6°14'	129°32' / 9°24'	132°50' / 12°42'	135°58' / 15°50'	138°59 / 18°51'	142°00' / 21°52'	143°53' / 23°45'	142°00 / 21°52'
11	150°07'	153°01' / 2°54'	156°13' / 6°06'	159°30' / 9°23'	162°47' / 12°40'	165°55 / 15°48'	168°57' / 18°50'	172°00' / 21°53'	173°51' / 23°44'	172°00' / 21°53'
13	180°05'	183°01 / 2°56'	186°10' / 6°05'	189°34' / 9°29'	192°40' / 12°35'	195°45' / 15°40'	198°45' / 18°40'	201°56 / 21°51'	203°43' / 23°38'	201°56' / 21°51'
15	210°08'	213°02 / 2°54'	216°25' / 6°17'	219°31' / 9°23'	222°35' / 12°27'	225°36' / 15°28'	228°36' / 18°28'	231°42 / 21°34'	233°15' / 23°07'	231°42 / 21°34'
17	240°00'	242°52' / 2°52'	246°16' / 6°16'	249°31' / 9°31'	252°37' / 12°37'	255°40' / 15°40'	258°48' / 18°48'	261°51' / 21°51'	263°36 / 23°36'	261°51' / 21°51'
19	269°55'	272°52' / 2°57'	276°06' / 6°11'	279°15' / 9°20'	282°30' / 12°35'	285°15' / 15°20'	288°35 / 18°40'	291°42' / 21°47'	293°28' / 23°33'	281°42' / 21°47'
21	300°00'	302°58' / 2°58'	306°12' / 6°12'	309°31' / 9°31'	312°30' / 12°30'	315°31' / 15°31'	318°47' / 18°47'	321°39' / 21°39'	323°30' / 23°30'	321°39' / 21°39'
23	330°00'	332°50' / 2°50'	336°12' / 6°12'	339°24' / 9°24'	342°34' / 12°34'	345°34' / 15°34'	348°41' / 18°41'	351°42' / 21°42'	353°29' / 23°29'	351°42' / 21°42'



PSA Drum
Flight Unit - Apollo 16

D-4

UNIVERSITY OF CALIFORNIA
Soil Mechanics Laboratory

Date 19 April 1972

DEADWEIGHT LOADING — NASA Drum No. S/N 2003

"PENETRATION CALIBRATION"

INDEX No. ↓	REF.	A	B	C	D	E	F	G	H (CATH RDG, cm.)	I (DELTA FROM RDG cm)
1	89.87	90.11	90.35	90.59	90.84	91.08	91.32	91.57	91.81	92.30
3										
5										
7										
9										
11										
13										
15										
17										
19										
21										
23										
AVERAGE Δ	0.00	0.24	0.48	0.72	0.97	1.21	1.45	1.70	1.94	2.43
EQUIV Inches	0	3	6	9	12	15	18	21	24	~30
EQUIV cm.	0	7.62	15.24	22.85	30.5	38.1	45.7	53.3	61.0	76.2