(213) 939-2183

SIEBELAIR

5563-65 W. WASHINGTON BLVD.
LOS ANGELES 16, CALIF.

Engineering Report

NSI-1 SQUIB ADAPTER DEVELOPMENT AND FINAL TEST REPORT FOR USAGE ON SPACE SHUTTLE GAS SAMPLER VALVE/BOTTLE ASSEMBLY 3270 (PROPOSED REPLACEMENT FOR P/N 2270)

DATE June 15, 1983, Issue

PREPARED

CHECKED

APPROVED

CONTRACT NO NASA/JSC NAS-9-16814

NO. PAGES 21

STATE OF CALIFORNIA }
COUNTY OF LOS ANGELES } ss.

_____, being duly sworn, deposes and says: That the information contained in this report is to the best of his knowledge true and correct in all respects.

SUBSCRIBED and sworn to before me this _____ day of _____, 19___

Notary Public in and for the County of Los Angeles, State of California

My commission expires _____ 19___

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1.0 SCOPE

1.1 Purpose of Program

The purpose of this development program was to determine the possibility of utilizing the NSI-1 squib in place of SieBelAir cartridge assembly 2270 for the function of both events required for the Space Shuttle Gas Sampler Valve/Bottle Assembly 3270, NASA P/N SED33102111-301. Additionally, it was a requirement that the closure disk of the NSI-1 squib and explosive residue therefrom be retained from the valve cavity in so far as possible to prevent any significant particulate from scratching the valve bore and causing sample leakage following the postfire 2 event.

2.0 PROCEDURE

2.1 Squib Adapter Design

Squib adapters P/N 3592-1 thru -6 were designed and manufactured in accordance with the accompanying drawing 3592 Rev. A. The internal configuration of the NSI-1 squib cavity was patterned after the internal configuration of the SOS qualified booster module per LMSC Spec. No. 1421333 Rev. B and shown on SOS drawing No. 116401 Rev. F (SOS proprietary item). Therefore, the maximum containment of closure disk fragments and explosive residue had been exhibited by prior development and subsequent qualification.

2.2 Squib " Full Open " adapter design

Adapter P/N 2196 Rev. A was also manufactured per the accompanying drawing. This adapter was intended to exhibit the P/T characteristics of an NSI-1 squib with no attempt to contain any particulate and therefore anticipated to exhibit the maximum pressure to be attained.

2.3 Pressure vs Time Calibration Cartridge

SieBelAir cartridge assembly P/N 2270, Lot No. ULX, load sizing calibration unit, was employed to verify the equivalent performance of this unit and to compare with those tests run on the NSI-1 squib.

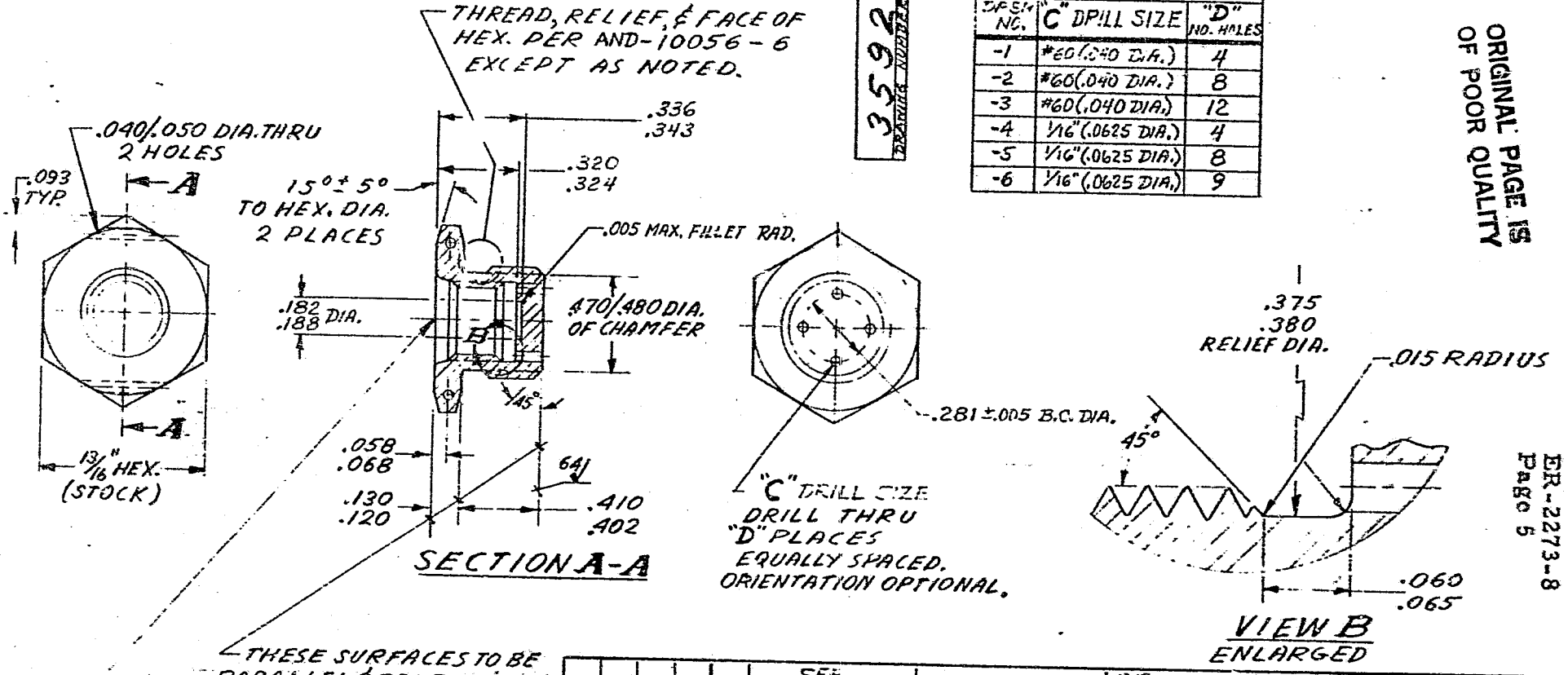
2.4 Test Bomb

SieBelAir test bomb P/N 1474-1 N/C was used for all P/T testing and is the same as historically used for such performance and acceptance verification. All tests were conducted at room temperature using a firing current of 5 amps. for 10 millisecond duration.

3592 A
DRAWING NUMBER

PART NO. TABULATION

DASH NO.	"C" DRILL SIZE	"D" NO. HOLES
-1	#60 (.040 DIA.)	4
-2	#60 (.040 DIA.)	8
-3	#60 (.040 DIA.)	12
-4	1/16" (.0625 DIA.)	4
-5	1/16" (.0625 DIA.)	8
-6	1/16" (.0625 DIA.)	9



NO. REQUIRED	ITEM NO.	PART NO.	NAME	SIZE OR FSN	DESCRIPTION	SPEC OR MFR	CODE IDENT.
		SEE P/N TABULATION		13/16 HEX. X 9/16" LG.	TYPE 303 CRES BAR	QQ-S-763 CL. 303 COND A	

MATERIAL

HEAT TREAT TO
SPEC.
ANODIZE PER SPEC.
PLATE PER SPEC:
ADDITIONAL PROCESSING PASS-TIVE PER 20-8-15

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UNLESS OTHERWISE SPECIFIED
TOLERANCES ARE: FRACT: ± 1/32 DEC ± .010 ANG. ± ½°
ALL MACHINED SURFACES 63 PER MIL-STD-10
ALL DIAMETERS TO BE CONCENTRIC WITHIN .005 FIR
DIAMETERS MARKED ℄ CONCENTRIC WITHIN — FIR
FILLET RADII NOTED BREAK SHARP EDGES .005 MAX

APPVD.		WEIGHT	LBS.
STRESS		CODE IDENT. NO. 15862	
CHECK			
DRAWN	Victor 8-25-72		

— 4/12 3270
DASH NO. | IND. REQ'D | NEXT ASSEM.
CAGE CODE
COST SPEC.

SIEBELAIR
LOS ANGELES, CALIFORNIA

CHG. LET.	DESCRIPTION OF CHANGES	BY	DATE
A	COMPLETELY REVISED - NO PARTS MATCH.	J.L.	9/12

SCALE: 2X & NOTED

ADAPTER-SQUIB CLOSURE DISK RETAINING

DWG. SIZE B — 3592 DRAWING NUMBER

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OF POOR QUALITY

2196

— THREAD, RELIEF & FINISH OF HEX. PER AND-10156-6 EXCEPT AS NOTED.

.040/.050 DIA. THRU 2 HOLES

.093 TYP.

15° ± 5° TO HEX. DIA 2 PLACES

— C'SINK 90° X .375 DIA. MAX

.470/.480 DIA. OF CHAMFER

— THESE SURFACES TO BE PARALLEL & TRUE WITH THREADS WITHIN .002 IN./IN.

13/16" HEX. (STOCK)

.058
.068

.130
.120

64

.410
.402

SECTION A-A

— PORT PER MS-16142-3 (3/8-24 THD.) PERFECT THD. REQUIRED THRU FULL LENGTH OF PART

NO. REQUIRED	ITEM NO.	PART NO.	NAME	SIZE OR FSN	DESCRIPTION / MATERIAL	SPEC. OR MFR.	CAGE IDENT.
				13/16 HEX. X 9/16 LG	TYPE 303 (PES) BAR	QQ-S-763 CL. 303 COND A	

HEAT TREAT TO
SPEC.
ANODIZE PER SPEC.
PLATE PER SPEC.
ADDITIONAL PROCESSING
APPVD. [illegible] 8-10-65

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UNLESS OTHERWISE SPECIFIED
TOLERANCES ARE: FRACT. ± 1/32 DEC ± .010 ANG. ± ½°
ALL MACHINED SURFACES 63 µ/ PER MIL-STD-10
ALL DIAMETERS TO BE CONCENTRIC WITHIN .005 FIR
DIAMETERS MARKED ℄ CONCENTRIC WITHIN — FIR
FILLET RADII NOTED BREAK SHARP EDGES .005 MAX.

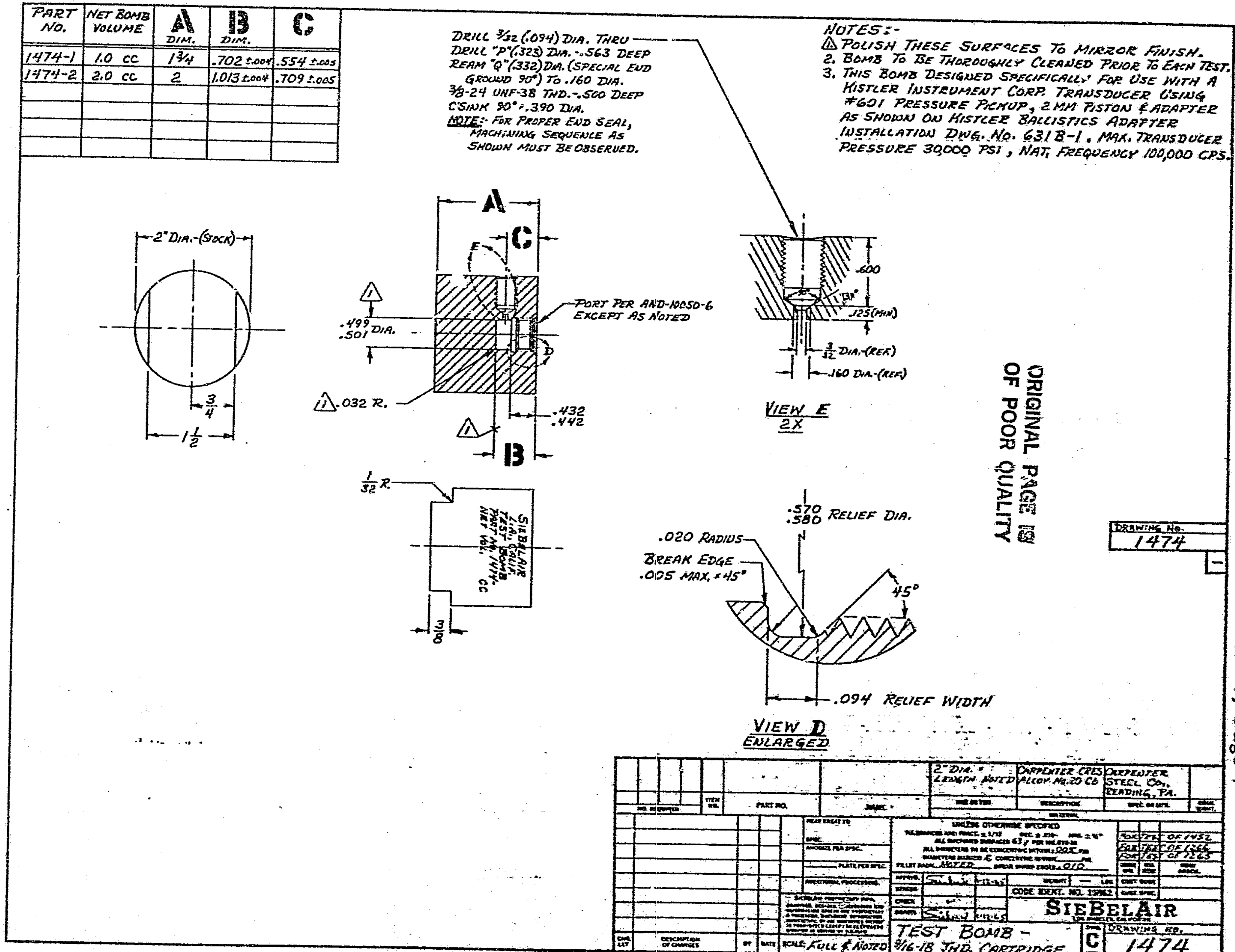
				—	1/2 STD PART
				DASH NO.	NO. REQ.	NEXT ASSEM.
APPVD.	S EEE	8-12-65	WEIGHT	LBS.	CUST CODE	
STRESS			CODE IDENT. NO. 15862		CUST SPEC	
CHECK	ME EEE	8-12-65	SIEBELAIR LOS ANGELES, CALIFORNIA			
DRAWN	VI CTS	8-12-65				

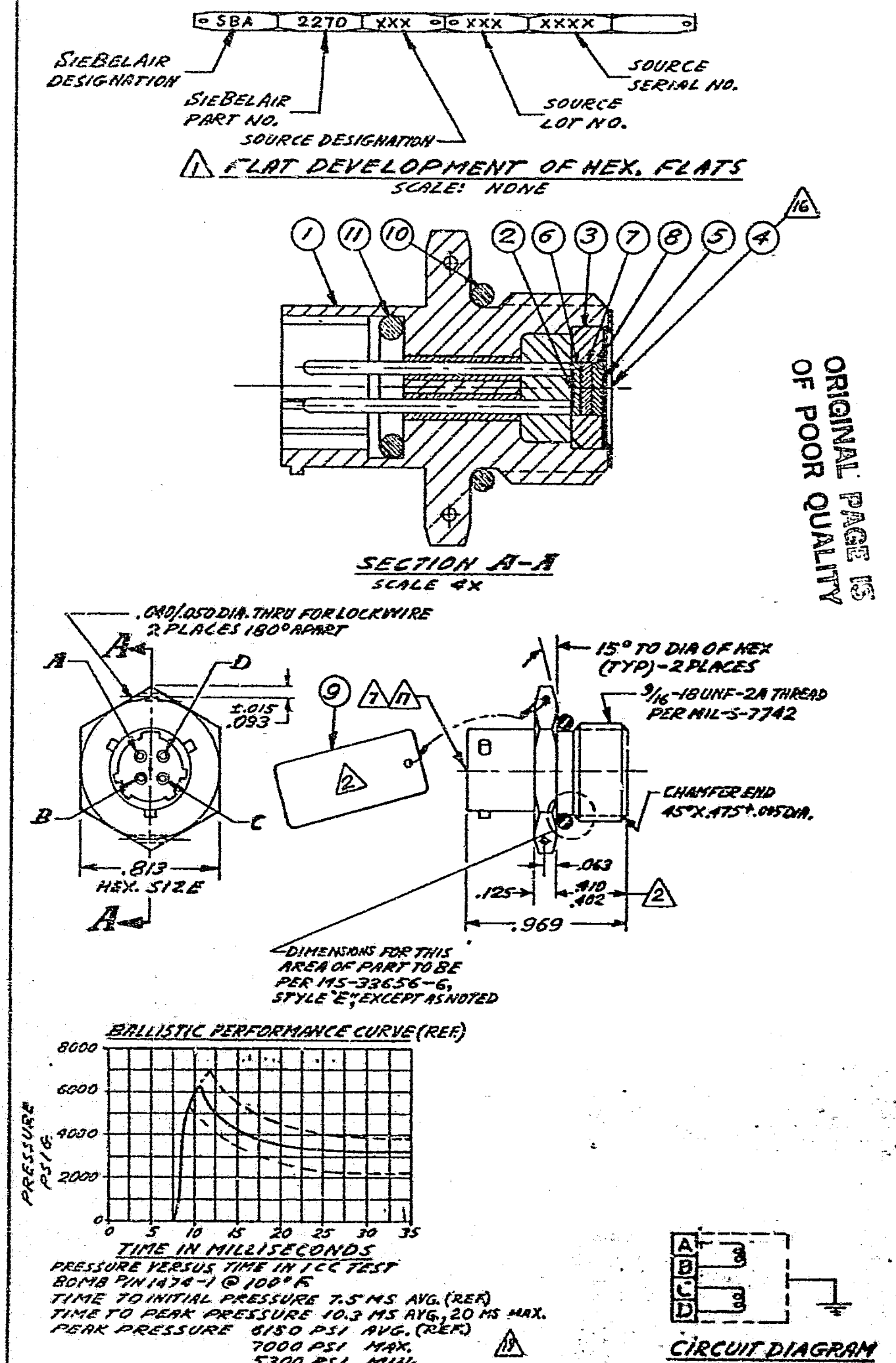
CHG LET	DESCRIPTION OF CHANGES	BY	DATE
A	REVISED PER ECP [illegible]	VIC	7/23
N/C	PER ECP [illegible] A SIZE REVISED BLOCK	VIC	2/[illegible]

SCALE: 2X

ADAPTER-(303 CRES) 9/16-18 THD. TO 3/8-24 THD.

DWG. SIZE B — 2196


PART NO. | NET BOMB VOLUME | A DIM. | B DIM. | C
1474-1 | 1.0 cc | 1 3/4 | .702 ±.004 | .554 ±.005
1474-2 | 2.0 cc | 2 | 1.013 ±.004 | .709 ±.005
DRILL 3/32 (.094) DIA. THRU
DRILL "P" (.323) DIA. - .563 DEEP
REAM "Q" (.332) DIA. (SPECIAL END GROUND 90°) TO .160 DIA.
3/8-24 UNF-3B THD. - .500 DEEP
C'SINK 90° × .390 DIA.
NOTE:- FOR PROPER END SEAL, MACHINING SEQUENCE AS SHOWN MUST BE OBSERVED.
NOTES:-
1. POLISH THESE SURFACES TO MIRROR FINISH.
2. BOMB TO BE THOROUGHLY CLEANED PRIOR TO EACH TEST.
3. THIS BOMB DESIGNED SPECIFICALLY FOR USE WITH A KISTLER INSTRUMENT CORP. TRANSDUCER USING #601 PRESSURE PICKUP, 2 MM PISTON & ADAPTER AS SHOWN ON KISTLER BALLISTICS ADAPTER INSTALLATION DWG. NO. 631B-1. MAX. TRANSDUCER PRESSURE 30,000 PSI, NAT. FREQUENCY 100,000 CPS.
2" DIA. - (STOCK)
3/4
1 1/2
A
C
B
PORT PER AND-10050-6 EXCEPT AS NOTED
.499 .501 DIA.
.032 R.
.432 .442
1/32 R.
SIEBELAIR L.A., CALIF. TEST BOMB PART NO. 1474- NET VOL. CC
3/8
.600
.125 (MIN)
3/32 DIA. - (REF)
.160 DIA. - (REF)
VIEW E 2X
.570 .580 RELIEF DIA.
.020 RADIUS
BREAK EDGE .005 MAX. × 45°
45°
.094 RELIEF WIDTH
VIEW D ENLARGED
ORIGINAL PAGE IS OF POOR QUALITY
DRAWING NO. 1474
2" DIA. LENGTH NOTED
CARPENTER CRES ALLOY NO. 20 Cb
CARPENTER STEEL CO. READING, PA.
UNLESS OTHERWISE SPECIFIED
CODE IDENT. NO. 25962
SIEBELAIR
TEST BOMB - 9/16-18 THD. CARTRIDGE
SCALE FULL & NOTED
C
DRAWING NO. 1474



NOTES:

1. Mark approx. as shown on available hexagon flats per Aerospace Std. AS-478, Class B with SieBelAir designation, SieBelAir part no., source designation, source lot no., & source serial no., (See flat development of Hex flats).
2. Each cartridge furnished shall have an explosives warning & identification tag attached showing SieBelAir P/N, Serial No., actual measurement of thread length, and resistance of each bridgewire @ 70°F.
3. No fire capability is 1.0 amp. or 1.0 watt for 5 min. using circuit A-B and C-D simultaneously.
4. The sure fire characteristic is 3.00 ampere using circuit A-B and C-D.
5. The recommended firing current is 4.50 amperes using circuit A-B or C-D.
6. This unit shall be dual bridgewire, dual circuit cartridge. Resistance of each bridgewire to be 1.0 ± 0.1 ohm.
7. Unit shall be shipped & stored with helical spring shunt (or equiv.) such that all connector pins (4) and case are electrically interconnected. Do not remove until ready to connect into electrical system and then only after the circuit has been tested and no current is flowing.
8. Recommended installation torque: 175 to 200 lb.-in.
9. CONSTRUCTION:
Cartridge shell to be type 303 CRES or equiv. Connector pins to be hermetic glass sealed and closure of firing end to be corrosion resistant steel & must be helium gas leak tight joint.
10. Operating Temperature range: -65°F. to +160°F.
11. Autoignition: Shall be capable of exposure to 350°F. for 10.0 minutes maximum.
12. Cartridge assem. No. 2270 shall comply with Engrg. source control specification no. ER-2273-1, latest revision. Additionally, this unit shall be equal as to form, fit, and function to Cartridge assem. No. 1544 & 1602 latest revision, except "O" rings to be Buna "N" material as noted.
13. Item no. 6 to be 35 ± 3 mg Ignition charge consolidated at 4600 psi.
14. Item no. 7 to be 15 ± 3 mg intermediate charge consolidated at 4600 psi.
15. Item no. 8 to be 45 ± 2 mg output charge consolidated at 2000 psi.
16. Item no. 4 to be stitch-welded to item no. 1 and weld joint leakage shall not exceed 1×10^{-5} scc/sec of helium gas at a differential pressure of 3 atmospheres.
17. The electrical connector end mates with Bendix pygmy straight plug PT-06-8-4S, any service, class, or equiv.
18. This unit is identical replacement for part Nos. 1544 & 1602.
19. Output charge weight may be adjusted by lot load sizing to meet 6150 psi average pressure in specified test bomb.

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2270 F

Notes	Req'd	Item No.	Part No.	Name	Description	Material	Spec. or Mfr.
	1	11	MS-28775-011	"O" RING		BUNA N 70 SHORE HDNS.	MIL-P-25732
	1	10	MS-28778-6	"O" RING		BUNA N 90 SHORE HDNS.	MIL-P-5510
	1	9	2417	TAG - WARNING & IDENTIFICATION		PAPER OR LIGHT TAG WITH TIE ATTACHED	
19, 15		8	2416	OUTPUT CHARGE		HERCULES HI-TEMP	
14		7	2415	INTERMEDIATE CHARGE		ZIRCLO	
13		6	2414	IGNITION CHARGE		219 MOV. MIX.	
	1	5	2413	PAPER DISK		FILTER PAPER	WHATMAN NO. 1
	1	4	2412	CLOSURE DISK		302 CRES	
	1	3	2411	CHARGE HOLDER		MELAMINE	MIL-P-79 TYPE GMG
	2	2	2410-12	BRIDGEWIRE		80-20 NICKEL CHROME WIRE	
	1	1	2409	G/M SEAL ASSEM.		PER DETAIL DWG.	

Chg. Ltr.	Description of Changes	By	Date
F	ADDED NOTE 19 - REVISED TO FACILITATE PRODUCTION	VIC	7/7/1
E	ITEM 6 WAS 175 CLR. MIX. RECORD CHANGE ONLY.		
D	THIS PART METHOD ... 219 MIX. ... REVISED ...	VIC	
C	... "O" RING ...		
B	ADDED NOTE 18	VIC	
A	REVISED & REDRAWN ...	VIC	

Unless otherwise specified

Apprd: SIEBEL | Chkd: MEYERS | Drawn: VICTOR

Actual weight .04 lbs | CODE IDENT. NO. 15862 | FINAL | STD. PART

SIEBELAIR

SCALE: 2X / NOTED

CARTRIDGE ASSEMBLY | C | 2270

3.0 TEST RESULTS

3.1 Squib Bomb Test Data

3.11 One (1) P/N 2270 calibration unit fired in the test bomb exhibited a peak pressure of 5980 psi which is considered an acceptable output (see drawing No. 2270 Rev. F).

3.12 Eight (8) NSI-1 squibs were fired to exhibit the output pressure developed using adapters 3592-1 thru -6 and finally using " Full Open " adapter 2196. The results shown on the following data sheets show the highest pressure recorded used the adapter configuration 3592-6 and exhibited a pressure peak of 3341 psi which is 63 percent of the minimum pressure required on our drawing number 2270.

4.0 CONCLUSION

4.1 On the basis of tests performed in a closed bomb it was not considered worthwhile to perform tests in any valves where the output pressures were so far below minimum values which have been established by qualification and historic performance. It is however worthwhile to note that adapters P/N 3592-1 thru -6 managed to contain the NSI-1 squib closure disks and postfire explosive residue in the bomb was minimal. Although not part of the investigation, it appears that if the NSI-1 had

an output somewhat larger than 650 psi (nominal) in a 10 cc bomb, that we could well have met the required pressure-time requirements. The alternative of course is to consider the use of a booster for the NSI-1 squib as provided for on SieBelAir drawing 3270 Rev. J. This drawing shows the -3 and -4 configuration both of which we have exhibited will not provide the required output pressure. The -5 configuration however provides for the use of a qualified booster which when used with the NSI-1 will not only provide the required pressure but not generate closure disk fragmentation which could possibly damage the valve bore. The closure of this booster has a captive full petalling closure (8 petals), each petal being peripherally contained by welding to the booster body. Therefore, minimal development verification testing could be anticipated and no qualification would seem necessary.

BOMB: SieBelAir P/N 1474-1 (1.0 cc)
TEST: 5 AMPS & 10 MS @ R. T.

SQUIB BOMB TEST DATA

ENGRG. FORM NO. 51

DEV. TEST NO.	TEST DATE	SQUIB PART NO.	S/N	L/N	RES. (OHMS)	MFR. DATE	MFR.	adapter P/N	PEAK PRESS. (PSI)	PEAK TIME (MS)	BOMB DEBRIS
1	4-18 83	SEB-26100001-216	0281	MNC	1.054	12-74	HS	3592-1	2029	1.56	
2			0283		1.012			3592-2	2909	1.50	
3			0355		1.004			3592-3	3030	1.40	
4			0359		1.030			3592-4	3206	1.44	
5			0361		1.008			3592-5	3093	1.44	
6			0362		1.060			3592-6	3341	1.36	
7			0369		1.013			2196	3320	1.30	
8	4-18 83		0370		1.077			2196	3264	1.28	
9			0373		0.999						
10			0375		0.996						
11			0376		1.015						
12			0380		1.010						
13			0382		1.013						
14			0385		0.986						
15			0386		1.007						
16			0388		0.996						
17			0392		0.980						
18		SEB-26100001-216	0399		1.055						
19		SEB-26100001-256	0436		1.075						
20		SEB-26100001-256	0449	MNC	1.013	12-74	HS				
CAL.	4-18 83	SIEBELAIR 2270 (CONTROL)	CALIBRATION UNIT	ULX	A-B 1.01 C-D 1.05	7-82	SOS	NOT REQUIRED	5980	5.14	
22											
23											
24											
25											
26											
27											

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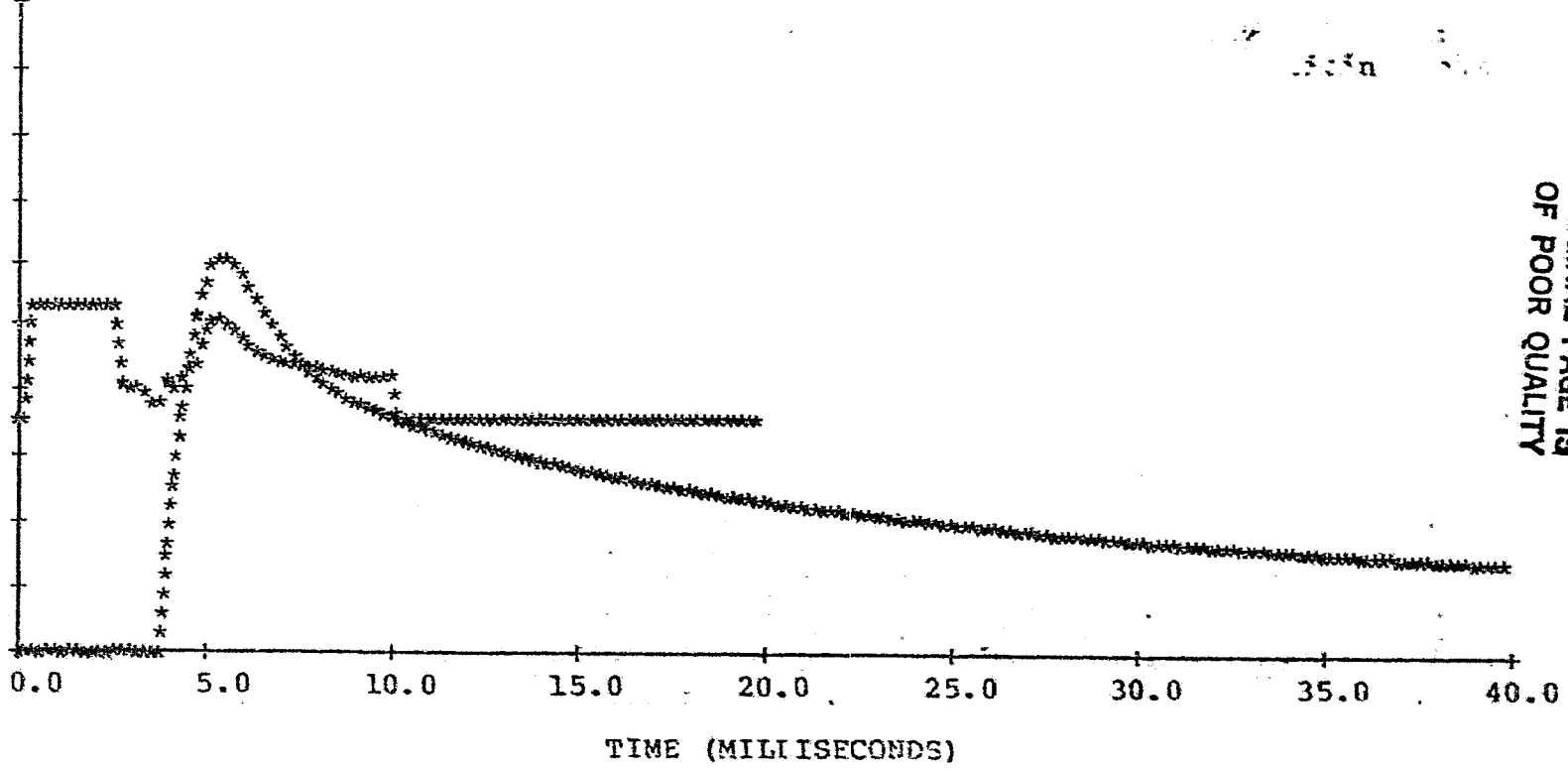
LOT # SieBelAir DATE 4-18-83

TEST NUMBER	APP. OF CURRENT TO PEAK	PEAK PRESSURE	PRESSURE @ 14 msec AFTER PEAK	TEST TEMPERATURE	MEASURED FIRING CURRENT
CAL.	5.14	5980	2385	AMB	4.79
1	1.56	2029	79	AMB	4.74
2	1.50	2909	764	AMB	4.68
3	1.40	3030	700	AMB	4.76
4	1.44	3206	729	AMB	4.75
5	1.44	3093	699	AMB	4.82
6	1.36	3341	712	AMB	4.85
7	1.30	3320	700	AMB	4.84
8	1.28	3264	856	AMB	4.81

DATE TESTED: 4/19/83
LOT NO: s.air TEST NO: 2270CAL.
PRESSURE CALIBRATION NO. 1.[illegible]366
CURRENT CALIBRATION (amps/psi) 0.[illegible]
TEST TEMPERATURE.....AMBI[illegible]
MEASURED FIRING CURRENT (amps) 4.[illegible](*)
APP. OF CURRENT TO B/W BURNOUT(ms) 2.70(*)
APP. OF CURRENT TO INIT. PRESS(ms) 3.56(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 5.14
INITIAL PRESSURE TO PEAK PRESS(ms) 1.[illegible](*)
PEAK PRESSURE.....(psig) 5980

(*)→ For information use only, not to be used for accept/reject criteria.



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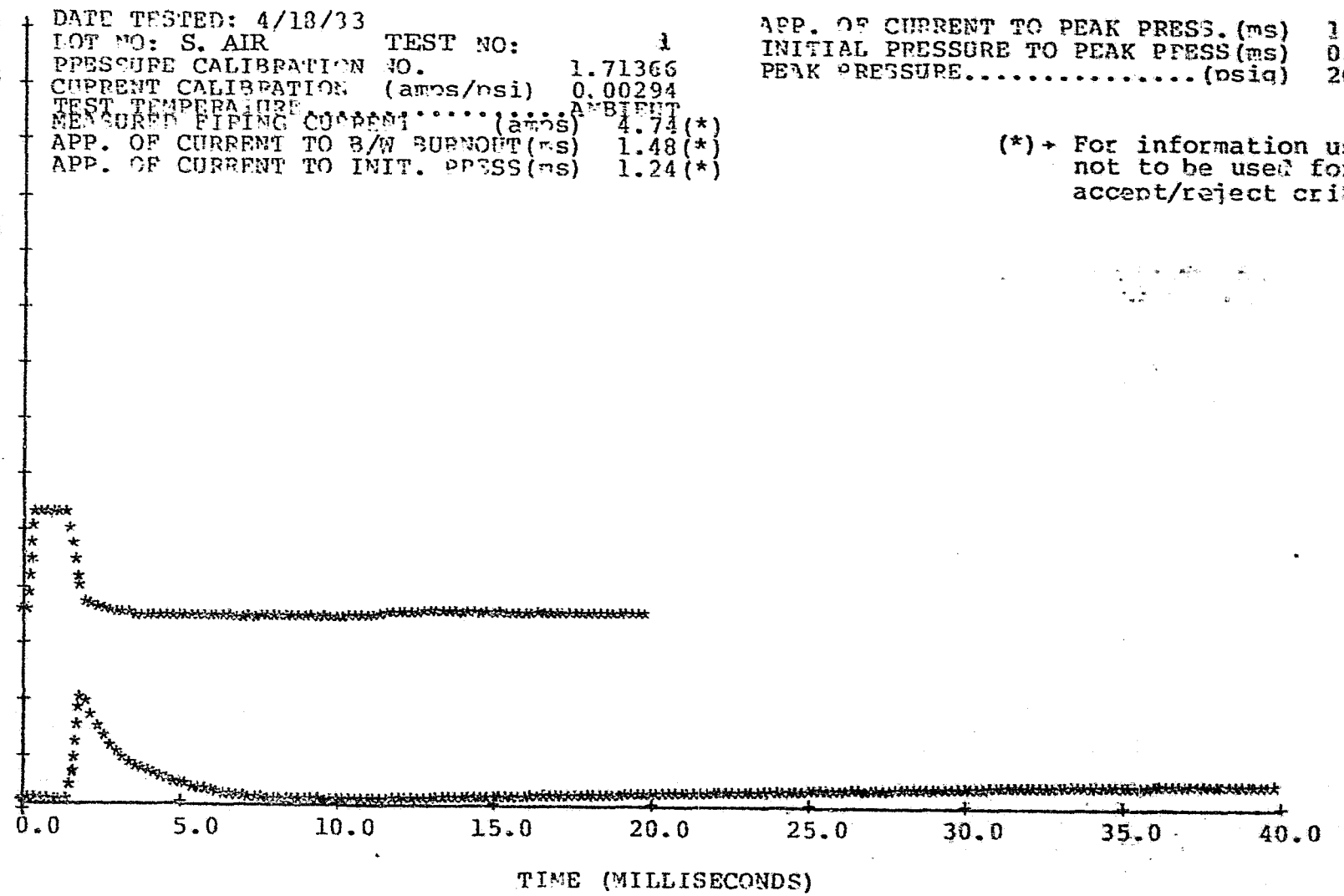
DATE TESTED: 4/18/33
LOT NO: S. AIR TEST NO: 1
PRESSURE CALIBRATION NO. 1.71366
CURRENT CALIBRATION (amps/psi) 0.00294
TEST TEMPERATURE AMBIENT
MEASURED FIRING CURRENT (amps) 4.74(*)
APP. OF CURRENT TO B/W BURNOUT(ms) 1.48(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.24(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.56
INITIAL PRESSURE TO PEAK PRESS(ms) 0.32(*)
PEAK PRESSURE.....(psig) 2029

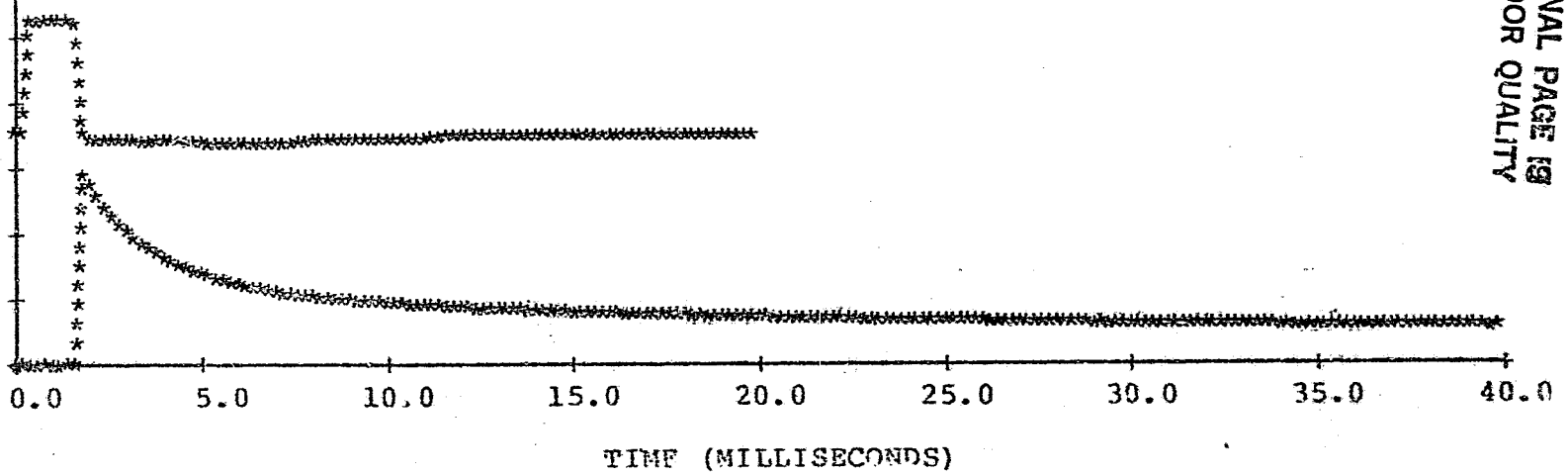
(*)→ For information use only, not to be used for accept/reject criteria.



DATE TESTED: 4/18/83
LOT NO: S.AIR TEST NO: -2
PRESSURE CALIBRATION NO. 1.71366
CURRENT CALIBRATION (amps/psi) 0.00294
TEST TEMPERATURE.....AMBIENT
MEASURED FIRING CURRENT (amps) 4.68(*)
APP. OF CURRENT TO B/W BURNOUT(ms) 1.40(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.30(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.50
INITIAL PPESSURE TO PEAK PPESS(ms) 0.20(*)
PEAK PRESSURE.....(psig) 2909

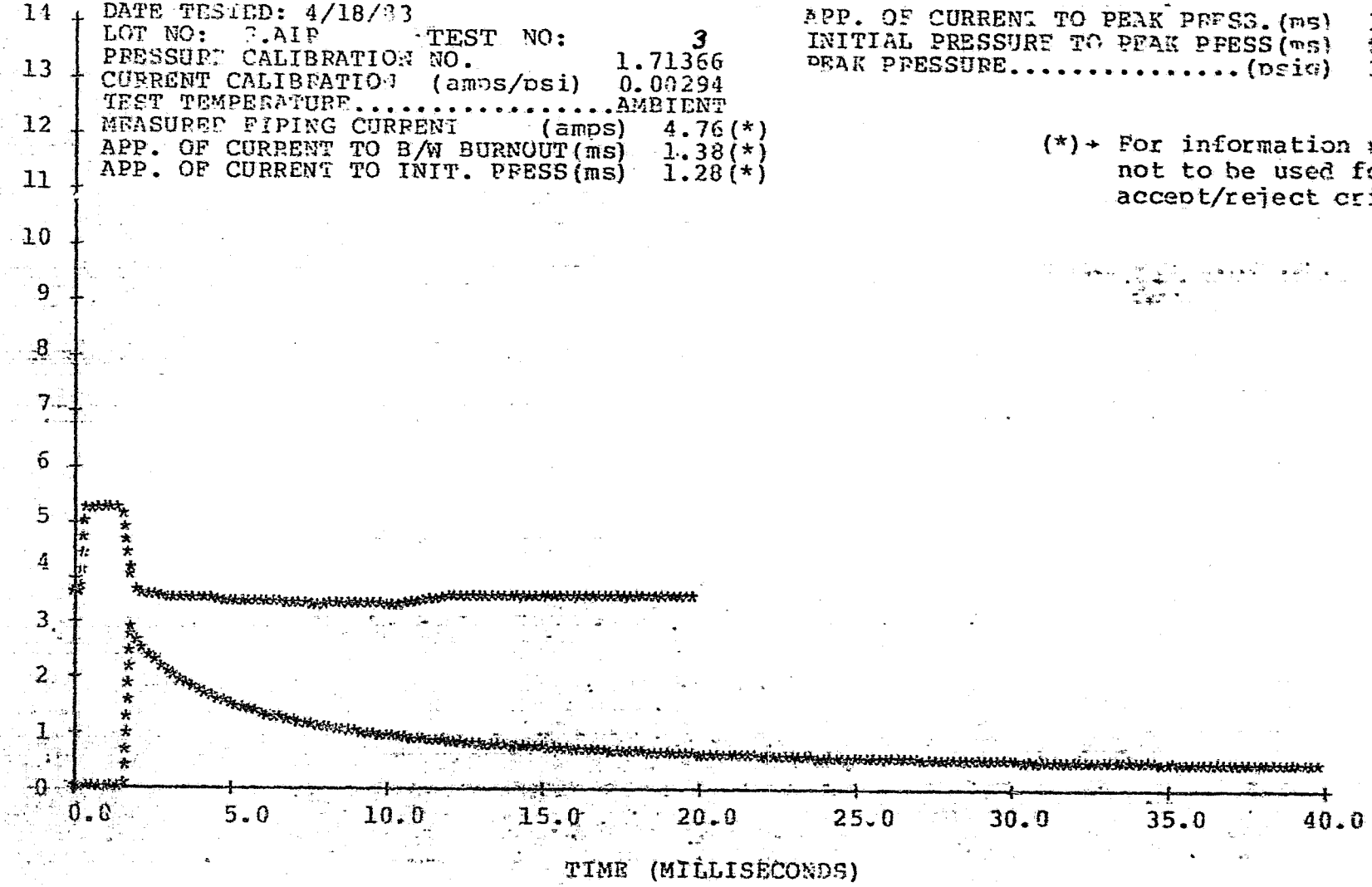
(*)→ For information use only, not to be used for accept/reject criteria.



DATE TESTED: 4/18/83
LOT NO: 3.AIP TEST NO: 3
PRESSURE CALIBRATION NO. 1.71366
CURRENT CALIBRATION (amps/psi) 0.00294
TEST TEMPERATURE.....AMBIENT
MEASURED FIRING CURRENT (amps) 4.76(*)
APP. OF CURRENT TO B/W BURNOUT(ms) 1.38(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.28(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.40
INITIAL PRESSURE TO PEAK PRESS(ms) 0.12(*)
PEAK PRESSURE.....(psig) 3030

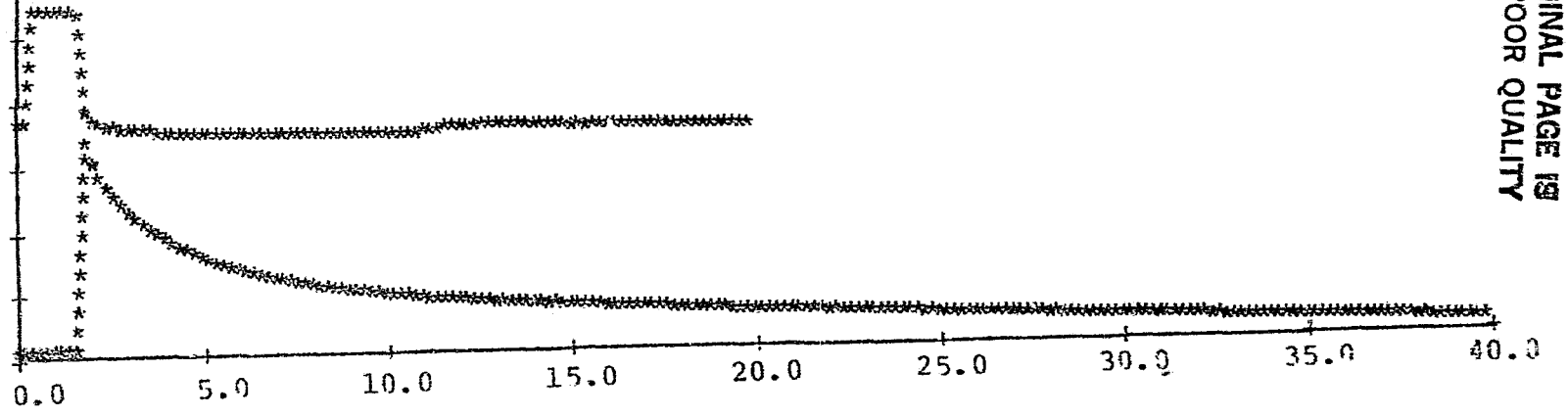
(*)→ For information use only, not to be used for accept/reject criteria.



DATE TESTED: 4/18/83
LOT NO: S.AIR TEST NO: 4
PRESSURE CALIBRATION NO. 1.71366
CURRENT CALIBRATION (amps/psi) 0.00294
TEST TEMPERATURE.....AMBIENT
MEASURED FIRING CURRENT (amps) 4.75(*)
APP. OF CURRENT TO B/M BURNOUT(ms) 1.38(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.30(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.44
INITIAL PRESSURE TO PEAK PRESS(ms) 0.14(*)
PEAK PRESSURE.....(psig) 3206

(*)→ For information use only, not to be used for accept/reject criteria.



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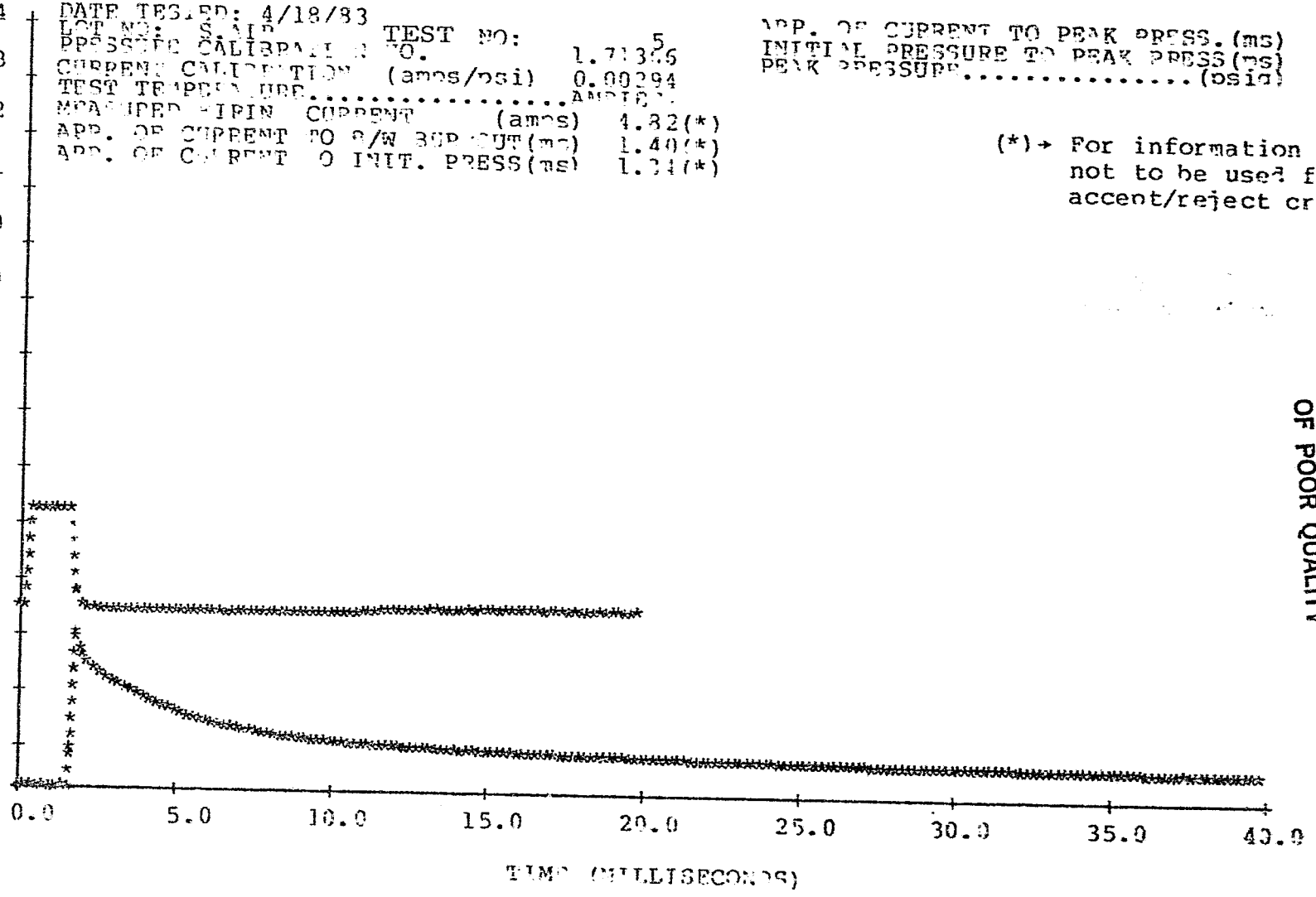
DATE TESTED: 4/18/83
LOT NO: S.AIR TEST NO: 5
PRESSURE CALIBRATION NO. 1.71305
CURRENT CALIBRATION (amps/psi) 0.00294
TEST TEMPERATURE.....AMBIENT
MEASURED FIRING CURRENT (amps) 4.82(*)
APP. OF CURRENT TO B/W BURST(ms) 1.40(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.24(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.14
INITIAL PRESSURE TO PEAK PRESS(ms) 2.10(*)
PEAK PRESSURE.....(psig) 3043

(*)→ For information use only, not to be used for accept/reject criteria.



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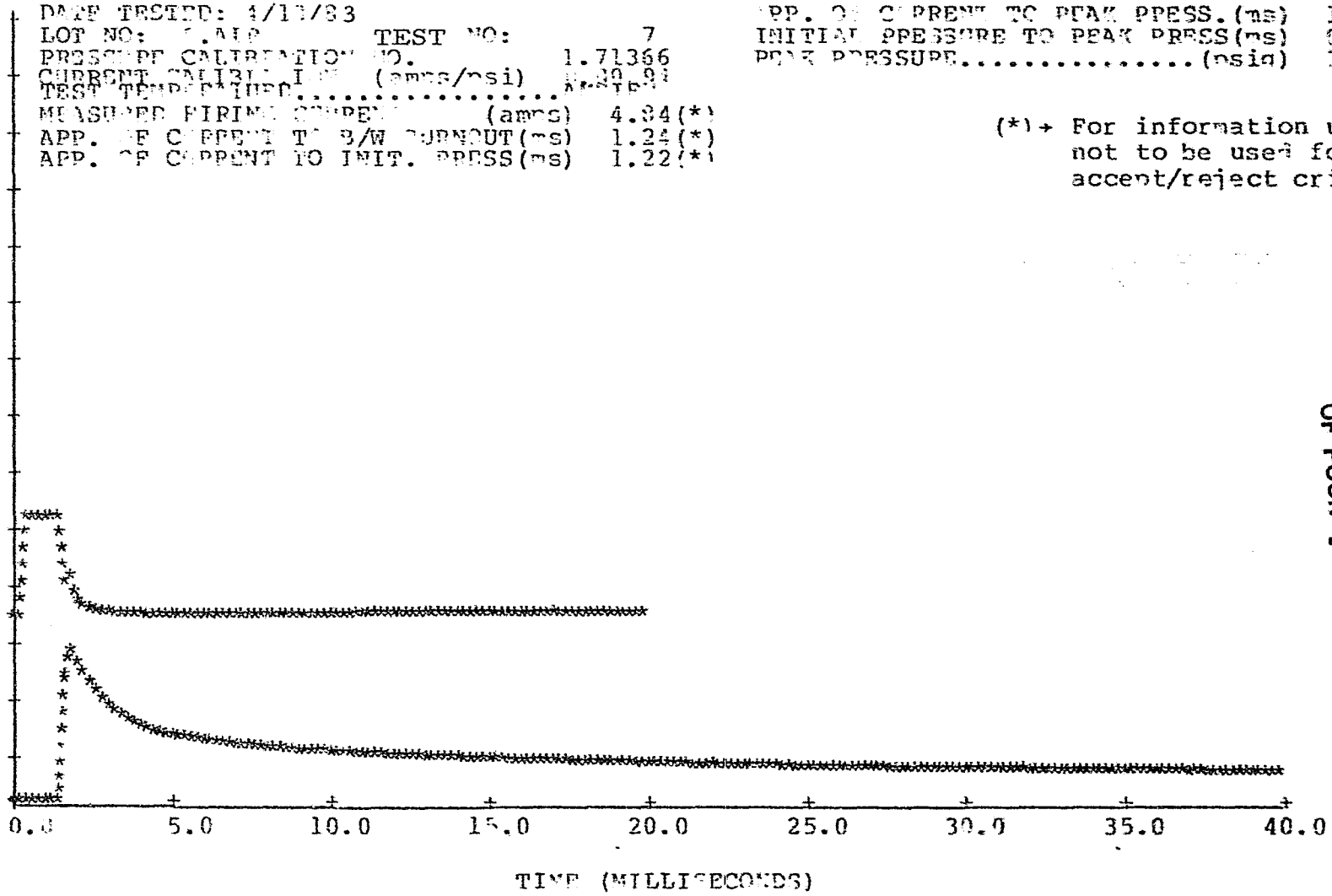
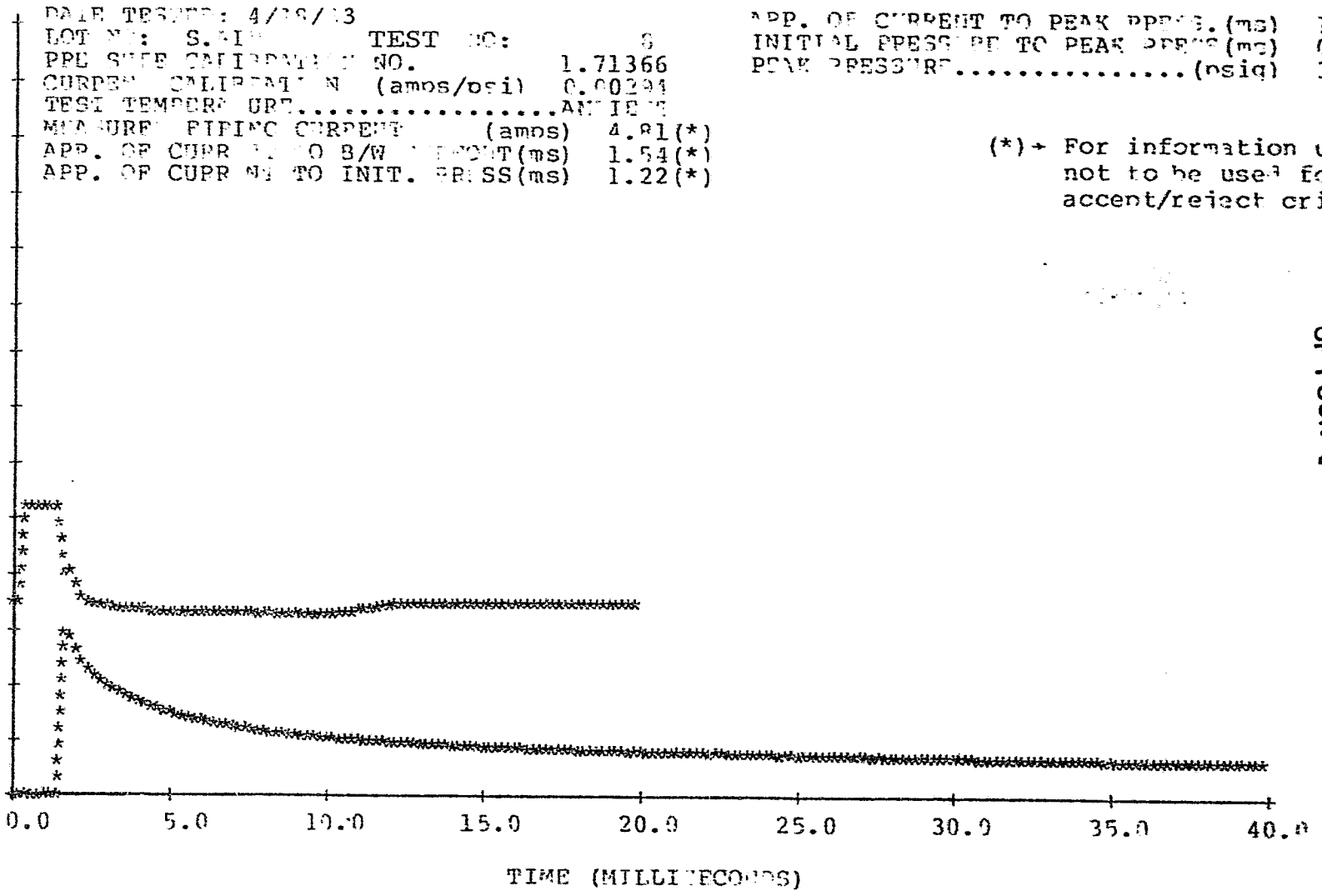
DATE TESTED: 4/13/83
TEST NO:
PPG SURF CALIBRATION
COPPER CALIBRATION (amps/psi)
TEST TIME
MEASURED FIRING CURRENT (amps)
APP. GP SURFACE TO S/W BRKDWN(ms)
APP. GP SURFACE TO UNIT PRESS(ms)
1.71365
1.35(*)
1.32(*)
1.26(*)
APP. GP SURFACE TO PEAK PRESS.(ms)
INITIAL GAGE TO PEAK PRESS(ms)
PEAK PRESSURE (psi)
1.26
0.12(*)
(*) + For information use only, not to be used for accept/reject criteria.
ORIGINAL PAGE IS OF POOR QUALITY
PRESSURE (psi)
TIME (MILLISECONDS)
14
13
12
11
1
2
3
7
5
4
3
2
1
0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0

DATE TESTED: 4/11/83
LOT NO: [illegible] TEST NO: 7
PRESSURE CALIBRATION NO. 1.71366
CURRENT CALIBRATION (amps/psi) [illegible]
TEST TEMPERATURE..... AMBIENT
MEASURED PEAK CURRENT (amps) 4.84(*)
APP. OF CURRENT TO B/W BURNOUT(ms) 1.24(*)
APP. OF CURRENT TO INIT. PRESS(ms) 1.22(*)

APP. OF CURRENT TO PEAK PRESS.(ms) 1.30
INITIAL PRESSURE TO PEAK PRESS(ms) 0.18(*)
PEAK PRESSURE.....(psia) 3370

(*)→ For information use only, not to be used for accept/reject criteria.





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OF POOR QUALITY