External Barrel and Handguard Temperature of the 5.56mm M4 Carbine

Final Report

SMALL ARMS BRANCH
SMCAR-ESW-S

Prepared By:
Jeff Windham
Small Arms Branch
Engineering Support Directorate
Rock Island, Illinois

September 1994

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER SMCAR-ES-94-1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) External Barrel and Handguard Temperature of the 5.56mm M4 Carbine		5. TYPE OF REPORT & PERIOD COVERED Final Report Sept. 1994
		6. PERFORMING ORG. REPORT NUMBER SMCAR-ES-94-1
7. AUTHOR(s) Jeff Windham SMCAR-ESW-S Rock Island, IL 61299-7300		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESW-S Rock Island, IL 61299-7300		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE Sept. 1994
		13. NUMBER OF PAGES 86
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Statement A: Distribution is unlimited ~~when the contractors code sheet is removed~~.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

5.56mm	Small Arms
M4 Carbine	Temperature
Handguard	M16A2 Rifle
Barrel	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This test report examines the external barrel temperature of the 5.56mm M4 series Carbines as a function of time and as a function of longitudinal location on the barrel. It also compares the effects of the handguard on barrel temperature and measures the temperature of the M4 Carbine handguard external surface and internal liners.

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Final Report

SEPTEMBER 1994

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This test report examines the external barrel temperature of the 5.56mm M4 series Carbines as a function of time and as a function of longitudinal location on the barrel. It also compares the effects of the handguard on barrel temperature and measures the temperature of the M4 Carbine handguard external surface and internal liners.

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1.0 INTRODUCTION

1.1 This report describes the test methods, analysis and results used to examine the M4 and M4A1 Carbine barrel and handguard temperatures during firing. It evaluates and compares the barrel temperature for a carbine when fired without handguards, with Colt commercial handguards, and with M4 Carbine handguards. The Colt commercial handguard is a small diameter, single aluminum liner handguard which hereafter will be referred to in this report as the "small" handguard. The M4 Carbine handguard is a relatively large diameter, double aluminum liner handguard which will hereafter be referred to in this report as the "large" handguard. In addition, the temperature of the large, double liner M4 Carbine handguard is evaluated in the top and bottom position.

1.2 Other reports which are related to this effort:

a. External Barrel Temperature of the M16A1 Rifle, R-TR-75-045, July 1975, Rodman Laboratory, Rock Island Arsenal, IL.

b. XM4 Carbine Development Program, AD-E401 627, Sept 1987, Colt Firearms, Hartford, CT.

c. M4 Carbine Initial Production Contract Pre-Production Engineering Report, Colt Mfg. Co. Hartford, CT. (Report not formally released as of September 1994).

1.3 All testing described in this report was conducted by the Ware Simulation Laboratory, Rock Island Arsenal, Rock Island, IL.

2.0 BACKGROUND:

2.1 Short barreled carbine versions of the 5.56mm M16 series rifles have been in existence since the 1960's. These short barreled weapons have been used commercially and by various military services since that time. One complaint with earlier versions of these carbines was handguard overheating during severe firing schedules. The handguard used on these weapons is a relatively small diameter, round, single aluminum liner handguard. During development of the M4 Carbine in 1984, Colt Mfg. Co. developed several handguard prototypes in an attempt to remedy this overheating problem. The design that was adopted consisted of a large diameter, round, double aluminum liner handguard with resistance welded aluminum tabs. This double liner configuration proved very successful in improving resistance of the handguard to overheating.

2.2 During the Pre-Production Engineering Phase of the initial production contract for the M4 Carbine (June through Dec. 1993), Colt Mfg. Co. developed several alternatives to the handguard configuration in an attempt to improve producibility. Handguard temperature profiles were developed during this effort showing the handguard temperature for the small Colt commercial handguard, the large M4 Carbine handguard, the M16A2 rifle handguard and several other prototype configurations.

2.3 The temperature profile developed in the Pre-Production Engineering Phase of the M4 Carbine contract indicated the large, double liner handguard performed well in insulating the firer's hand from the heat of the barrel. Because the large M4 handguard remained relatively cool compared to the small, Colt commercial handguard, concerns were raised that the large, double liner M4 handguard might be insulating the barrel of the weapon too well, thereby causing a significant increase in the temperature of the barrel. Part of this testing examines this condition.

3.0 OBJECTIVE:

3.1 The objectives of this testing were as follows:

a. Determine the temperature profile of the M4 and M4A1 barrels.

b. Determine the effects of the handguard on barrel temperature and compare barrel temperature differences between the small, Colt commercial handguard and the large, M4 handguard.

c. Determine the large, M4 handguard temperature profile in both the top and bottom handguard position.

4.0 TEST PROCEDURE:

4.1 This test was conducted in four phases. Each phase consisted of two firing schedules. The first firing schedule consisted of 280 rounds fired in full automatic as fast as possible (approximately 140 to 160 rounds per minute). The second firing schedule consisted of firing 280 rounds in semi-automatic fire as fast as possible (approximately 100 to 120 rounds per minute). The temperature at each thermocouple was recorded during the firing and for approximately 10-12 minutes thereafter (for a total elapsed time of 14 minutes). The test setup is shown in Figure 1. The four phases of firing are outlined below:

4.2 PHASE I. One M4A1 Carbine barrel was modified by the attachment of six thermocouples located in the positions shown in Figures 2 and 3. The weapon was then fired with no handguard on the weapon using the firing schedules described in paragraph 4.1. The temperature at each thermocouple location was recorded.

4.3 PHASE II. The thermocoupled M4A1 barrel was fired with the small handguards on the weapon, using the firing schedules described in paragraph 4.1 above. The temperature at each thermocouple location was recorded. During the semi-automatic portion of this test, a weapon malfunction occurred during firing which took approximately 30 seconds to clear. The test was refired without malfunction. The temperature profile of the firing sequence with the malfunction is shown in appendix A, charts II-S-1-a through II-S-6-a, in order to show the amount of cooling which can occur during such a brief firing interruption.

4.4 PHASE III. The thermocoupled M4A1 barrel was fired with the large, M4 Carbine handguards installed on the weapon, using the firing schedules described in paragraph 4.1 above. The temperature at each thermocouple location was recorded.

4.5 PHASE IV. One large, M4 Carbine handguard was modified with five thermocouples as shown in Figure 4. Thermocouple 7 was located on the inner liner next to one of the two rear tabs. Thermocouple 8 was located on the outer liner next to one of the two rear tabs. Thermocouples 9, 10, and 11 were located on the outside of the handguard at the rear, middle and front of the handguard respectively. These thermocouples measure the temperature the firer's hand will encounter. This test was fired in two parts, once with the thermocoupled handguard in the top position on the weapon and once with the thermocoupled handguard in the bottom position on the weapon.

5.0 TEST RESULTS:

5.1 Graphs of each thermocouple temperature vs. time for each firing sequence and test phase are shown in appendix A. A test matrix of each test and the corresponding temperature profile graph number is shown in Table I. The graph numbers are coded in the following manner:
(Test Phase No.) - (Firing Schedule, F=Full Auto, S=Semi Auto) - (Thermocouple No.) - (Suffix if applicable: a=additional test due to malfunction, T=Top handguard position, B=Bottom handguard position)

5.2 During test firing of the large handguard, severe deformation of the inner aluminum liner occurred. This deformation occurred during firing of 280 rounds in full automatic mode on the top handguard only. Photographs of the deformed handguard liner are shown in Figures 5 and 6. The thermocouples on the handguard liner show the inner liner on the top handguard reached approximately 700 degrees at the rear tab location (the temperature of the inner liner directly above the gas tube is likely significantly higher) during the severe 280 round/full auto firing schedule.

6.0 ANALYSIS:

6.1 Due to the difficulty in deriving useful information from the individual thermocouple graphs, the graphs were rescaled and combined via computer software. The following combined graphs are shown:

6.1.1 The barrel thermocouple temperature for full automatic fire for a bare barrel is shown in Figure 7. It can be seen from this graph that the highest temperature location measured was at thermocouple 4 approximately midway between the chamber and the front sight. The coolest point on the barrel is at thermocouple 6 and is due to the upper receiver and barrel nut acting as a heat sink.

6.1.2 Barrel thermocouple temperature for full automatic fire for a barrel with the small handguards attached is shown in Figure 8. The highest temperature location is also thermocouple 4 with the coolest being at thermocouple 6.

6.1.3 Barrel thermocouple temperature for full automatic fire for a barrel with the large handguards attached is shown in Figure 9. The highest temperature location is also thermocouple 4 with the coolest being at thermocouple 6.

6.1.4 Maximum barrel temperature comparison at thermocouple 3 for the bare barrel, small handguard barrel and large handguard barrel is shown in Figure 10. As expected, the bare barrel maximum temperature is less than that of the barrel with handguards attached and the cooling rate of the bare barrel is greater than that of the barrels with handguards. This is due to the maximum amount of convective cooling on a barrel without handguards. The difference in maximum temperature and cooling rate between the small and large handguards is insignificant. (As can be seen from the graph, there was a slight delay in firing of the large handguard that caused the time to fire the 280 rounds to be increased about 20 seconds. This would have an impact on the maximum temperature achieved, however this effect is considered small).

6.1.5 Maximum barrel temperature comparison at thermocouple 4 for the bare barrel, small handguard barrel and large handguard barrel is shown in Figure 11. This graph shows the same results as described in paragraph 6.1.4 above.

6.1.6 Maximum barrel temperature vs. location on the barrel is shown in Figure 12 for each firing condition (i.e. bare barrel; small handguard; and large handguard.)

M4 Carbine Barrel Temperature Test Matrix

TEST		THERMOCOUPLE LOCATION										
		Barrel						Inner Liner	Outer Liner	Handguard		
		1	2	3	4	5	6	7	8	9	10	11
Phase I Bare Brl.	Full Auto	I-F-1	I-F-2	I-F-3	I-F-4	I-F-5	I-F-6	N/A	N/A	N/A	N/A	N/A
	Semi Auto	I-S-1	I-S-2	I-S-3	I-S-4	I-S-5	I-S-6	N/A	N/A	N/A	N/A	N/A
Phase II Small Handguard	Full Auto	II-F-1	II-F-2	II-F-3	II-F-4	II-F-5	II-F-6	N/A	N/A	N/A	N/A	N/A
	Semi Auto	II-S-1	II-S-2	II-S-3	II-S-4	II-S-5	II-S-6	N/A	N/A	N/A	N/A	N/A
	*Semi Auto Malf. Rnd	II-S-1-a	II-S-2-a	II-S-3-a	II-S-4-a	II-S-5-a	II-S-6-a	N/A	N/A	N/A	N/A	N/A
Phase III Large M4 Handguard	Full Auto	III-F-1	III-F-2	III-F-3	III-F-4	III-F-5	III-F-6	N/A	N/A	N/A	N/A	N/A
	Semi Auto	III-S-1	III-S-2	III-S-3	III-S-4	III-S-5	III-S-6	N/A	N/A	N/A	N/A	N/A
Phase IV Large Hand-Guard and Liner Temp in Top Position	Full Auto	N/A	N/A	N/A	N/A	N/A	N/A	IV-F-7-T	IV-F-8-T	IV-F-9-T	IV-F-10-T	IV-F-11-T
	Semi Auto	N/A	N/A	N/A	N/A	N/A	N/A	IV-S-7-T	IV-S-8-T	IV-S-9-T	IV-S-10-T	IV-S-11-T
Phase IV Large Hand-guard & Liner Temp in Bottom Position	Full Auto	N/A	N/A	N/A	N/A	N/A	N/A	IV-F-7-B	IV-F-8-B	IV-F-9-B	IV-F-10-B	IV-F-11-B
	Semi Auto	N/A	N/A	N/A	N/A	N/A	N/A	IV-S-7-B	IV-S-8-B	IV-S-9-B	IV-S-10-B	IV-S-11-B

* A malfunction occurred in magazine 12. Charts are provided to show the temperature drop in the time it took to clear the stoppages.

TABLE I

6.1.7 Handguard thermocouple temperature for full automatic fire for the large handguard in the top position is shown in Figure 13. As shown in this graph, the temperature of the inner liner is by far the hottest portion of the handguard. The temperature of the outside of the handguard plastic reached a point at which it could not be comfortably held with the bare hand in about two minutes, with the temperature being highest near the front of the handguard. (A handguard temperature of 150 degrees Fahrenheit is considered the temperature at which the handguard could not be comfortably held.) It can also be seen the maximum temperature of the outer portion of the handguard occurs after about 6 minutes or about 4 minutes after the firing has ended and maximum barrel temperature has been achieved.

6.1.8 Handguard thermocouple temperature for full automatic fire for the large handguard in the bottom position is shown in Figure 14. In the bottom position on the weapon, all thermocouples locations are significantly cooler than when the handguard is in the top position. The outside of the handguard never reached the 150 degree Fahrenheit threshold.

6.2 The deformation of the inner handguard liner appears to have been caused by the thermal expansion of the liner inside the handguard plastic. As the aluminum liner heats, it will attempt to expand inside the plastic. Because the coefficient of thermal expansion of the plastic is much less than the aluminum liner, and the plastic is much cooler than the aluminum, the liner will be constrained inside the handguard plastic and kept from expanding. From the liner thermocouple readings, the inner liner will reach temperatures of approximately 700 degrees F. The thermal coefficient of expansion of aluminum is 12.6 inches/(inch)(degree F) x 10^{-6} . The length of the liner is 5.825 inches. If ambient temperature is assumed to be 80 degrees F, the thermal expansion of the handguard liner is (700 °F - 80 °F) ((12.6 inches/(inch)(degree F)) x 10^{-6})(5.825 inches) = .046 inches. Because the liner cannot expand it will buckle and deform. Once the liner has cooled, it contracts and is pulled away from the ends of the handguard causing the condition shown in figures 5 and 6.

7.0 CONCLUSIONS:

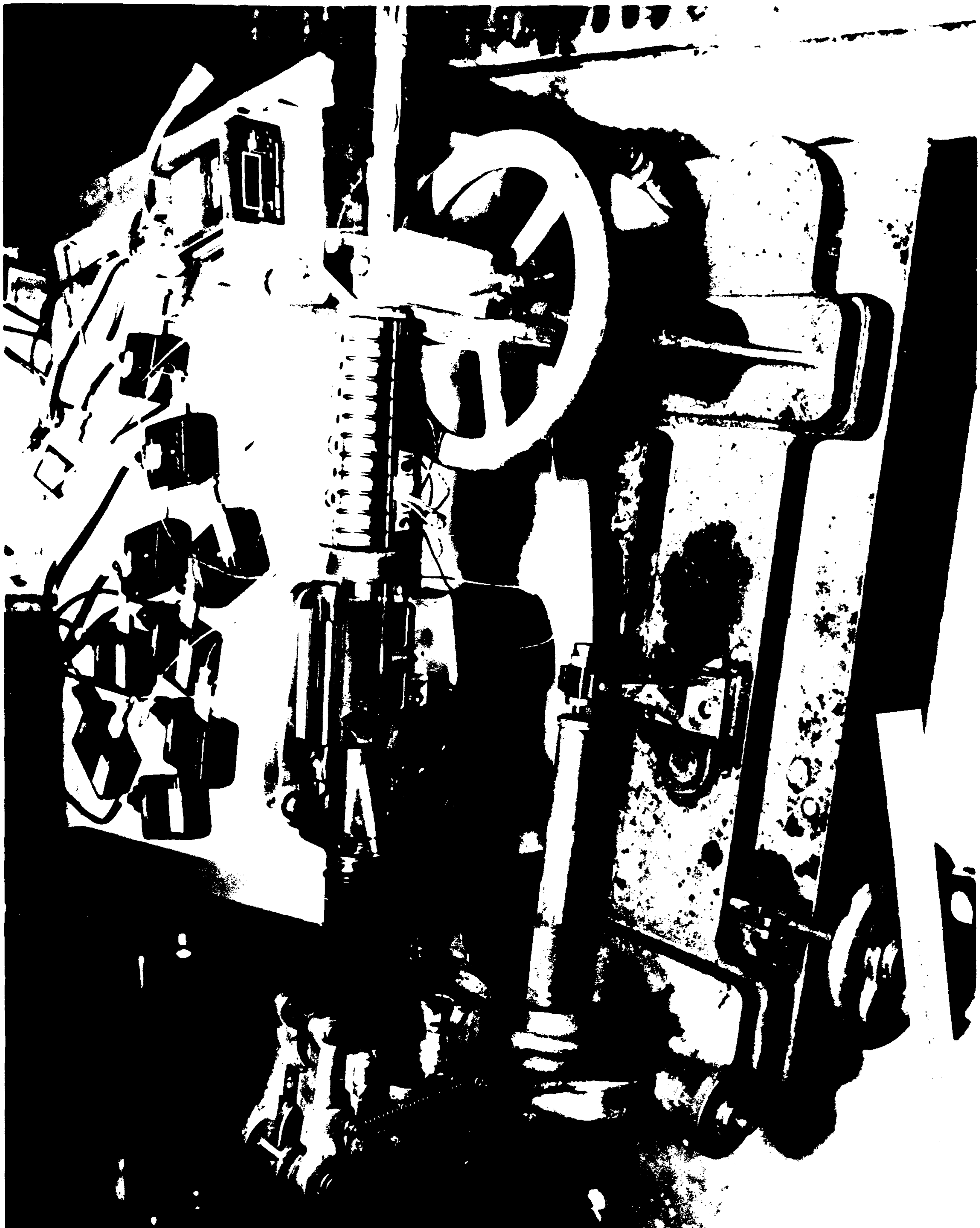
7.1 The maximum temperature on the M4 Carbine barrel occurs at approximately 4 inches forward of the breech face on the barrel. Due to the spacing of the thermocouples during this test, the exact location of the maximum temperature could not be determined. Based on the previous test reports referenced in paragraph 1.2, the location of the maximum barrel temperature changes with rate of fire. It is also likely the exact location of maximum temperature of the barrel would change slightly with different types of handguards.

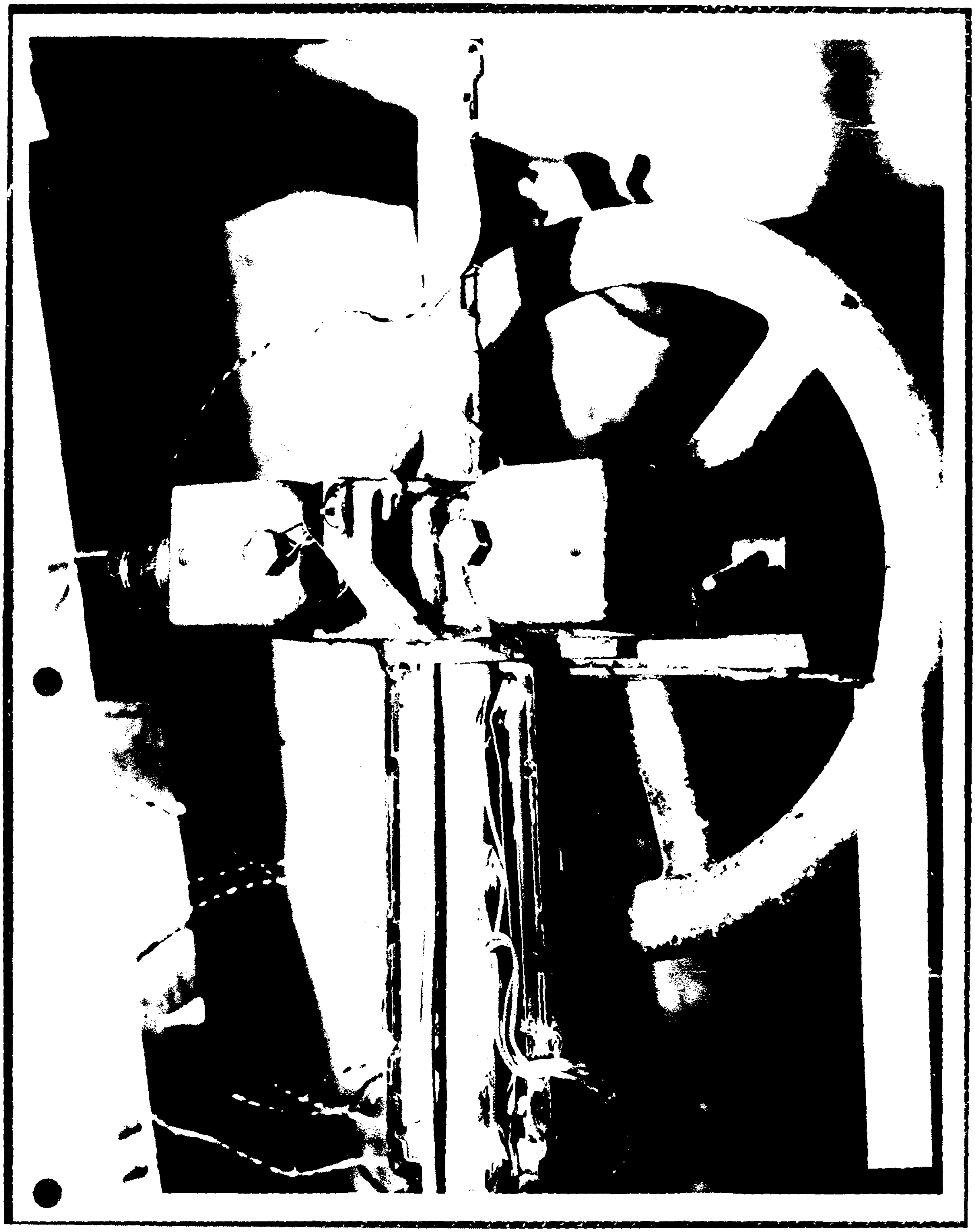
7.2 Although the bare barrel heats less rapidly and cools more rapidly than a barrel covered by a handguard, this difference is considered small.

7.3 There is no significant difference in barrel heating and cooling rates between the small handguard and the large handguard.

7.4 Under severe firing schedules the inner liner of the M4 Carbine large handguard in the top position will likely deform and buckle. Because the liner of the handguards is not a replaceable item, this condition will require replacement of the entire handguard. Because the firing schedule used in this test is much more severe than that expected in field service, this should not pose a significant field problem. However, this is an undesirable condition and efforts to improve the heat resistance of the liners should be considered.

7.5 The large M4 Carbine handguard greatly reduces the problem of handguard overheating as has been reported by field units when using small Colt commercial handguards.





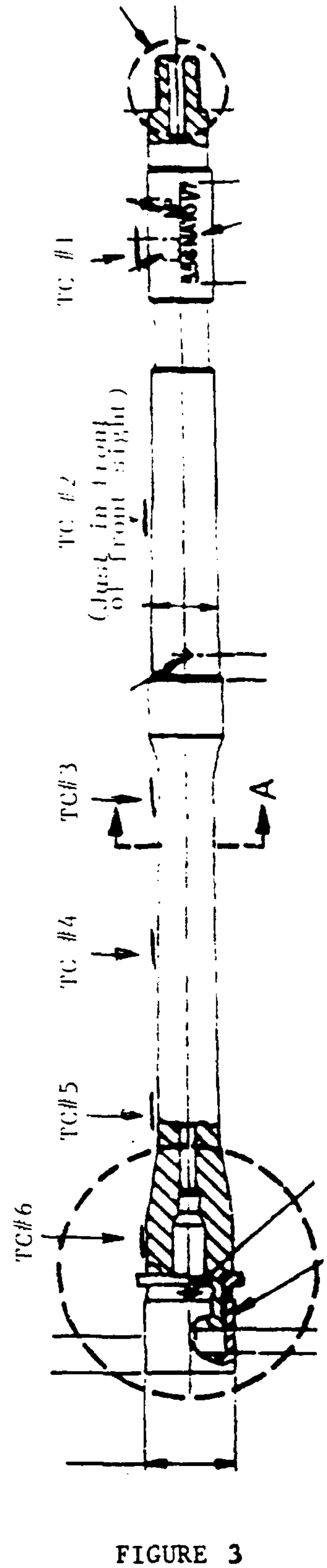


FIGURE 3
Barrel Thermocouple Location

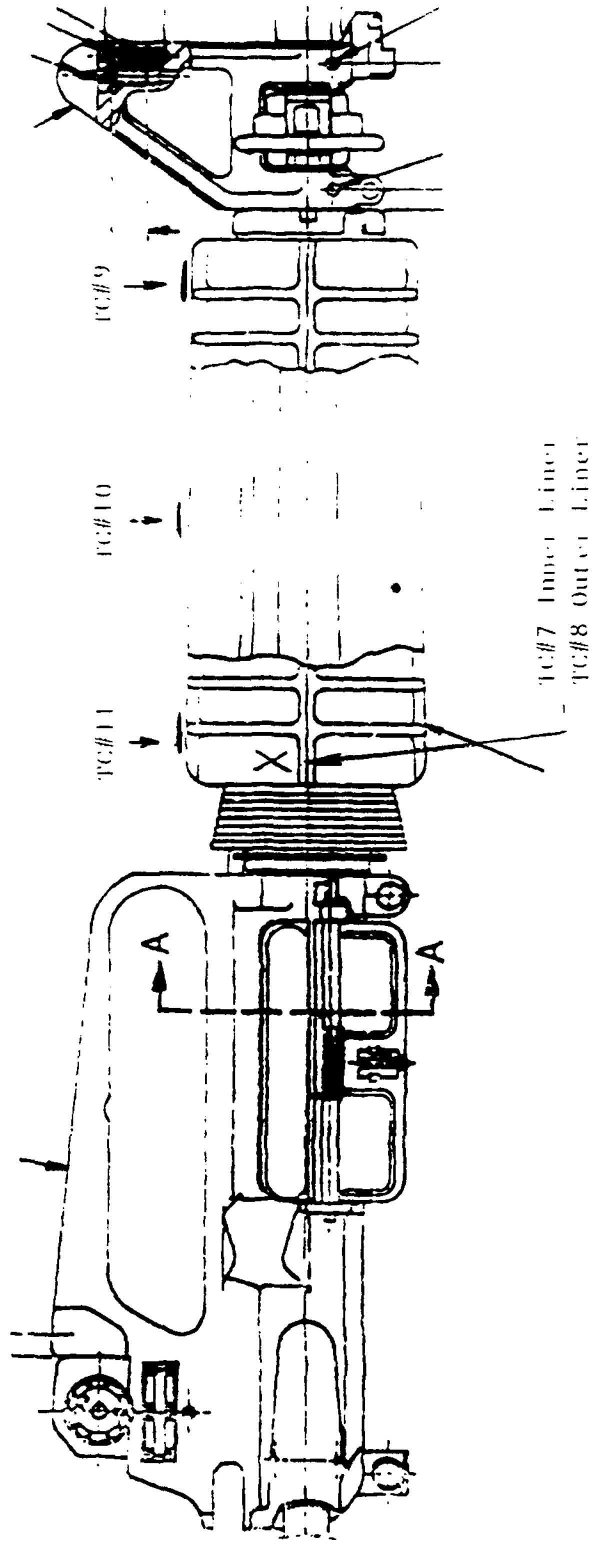


FIGURE 4
Handguard Thermocouple Location

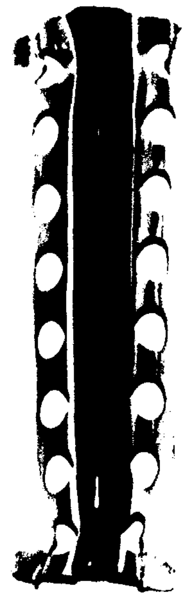


FIGURE 5-DEFORMED HANDUARD LINER

FIGURE 6-DEFORMED HANDUARD LINER

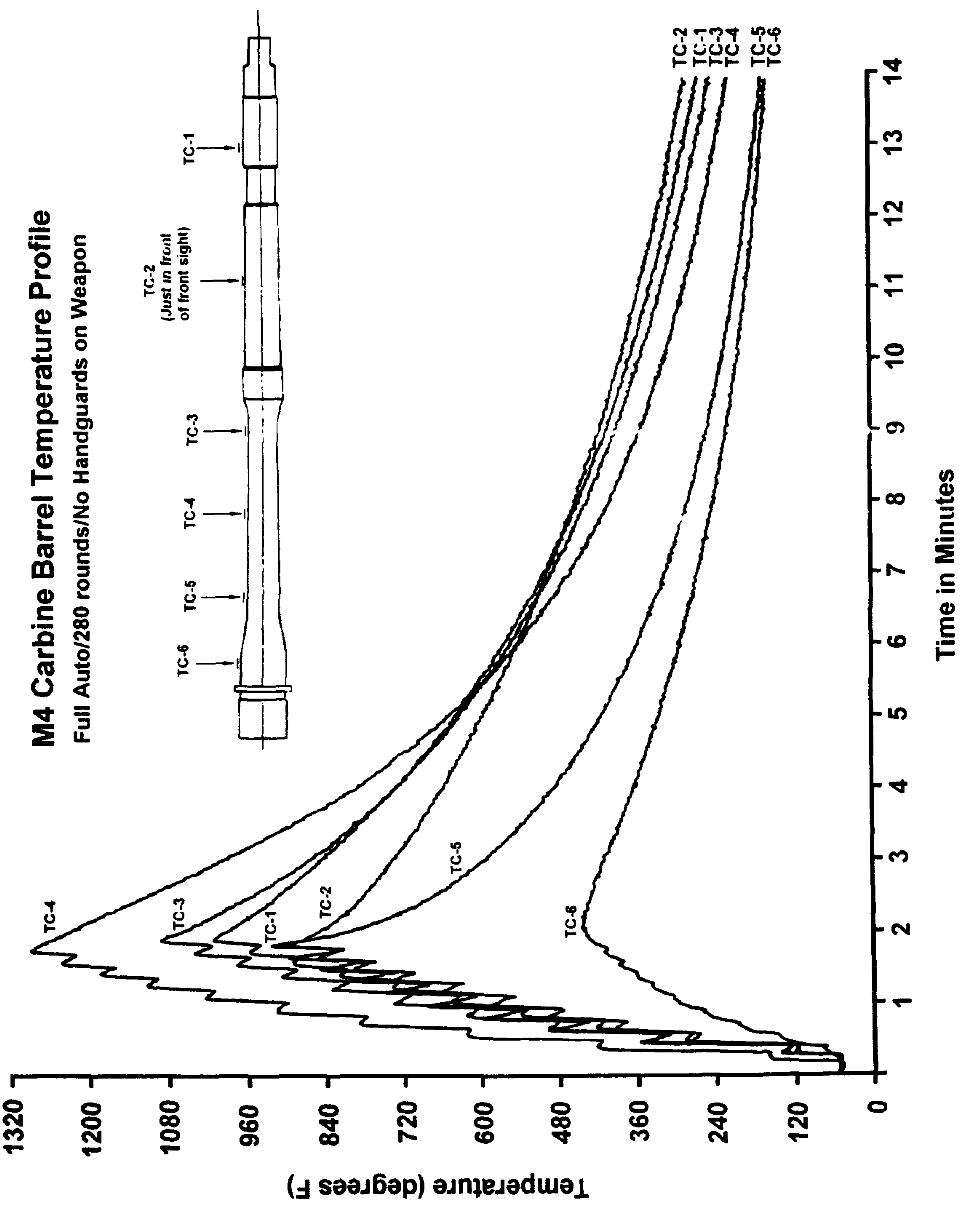


FIGURE 7 - Barrel Temp. for Bare Barrel

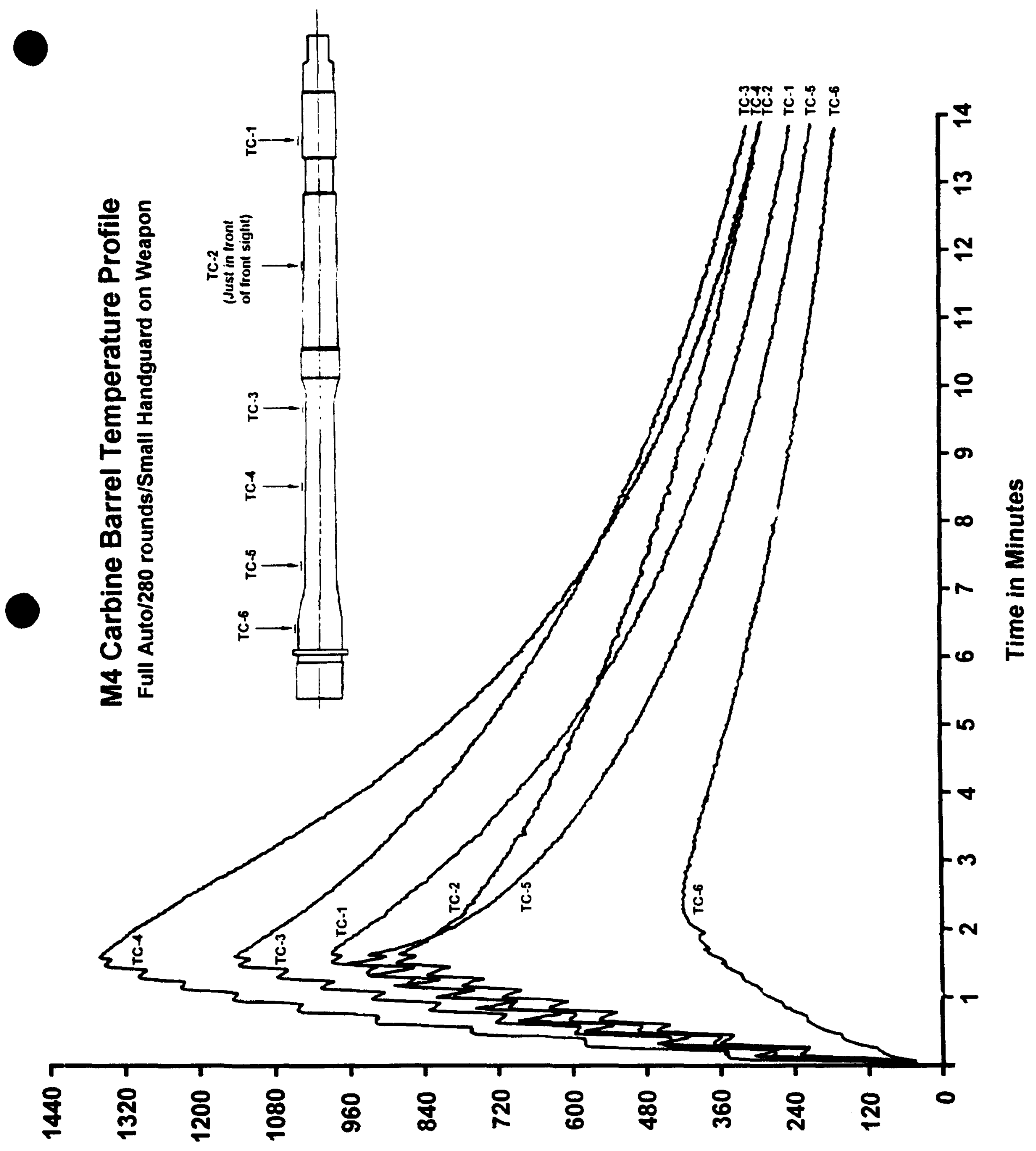


FIGURE 8 - Barrel Temp. for Small Handguard

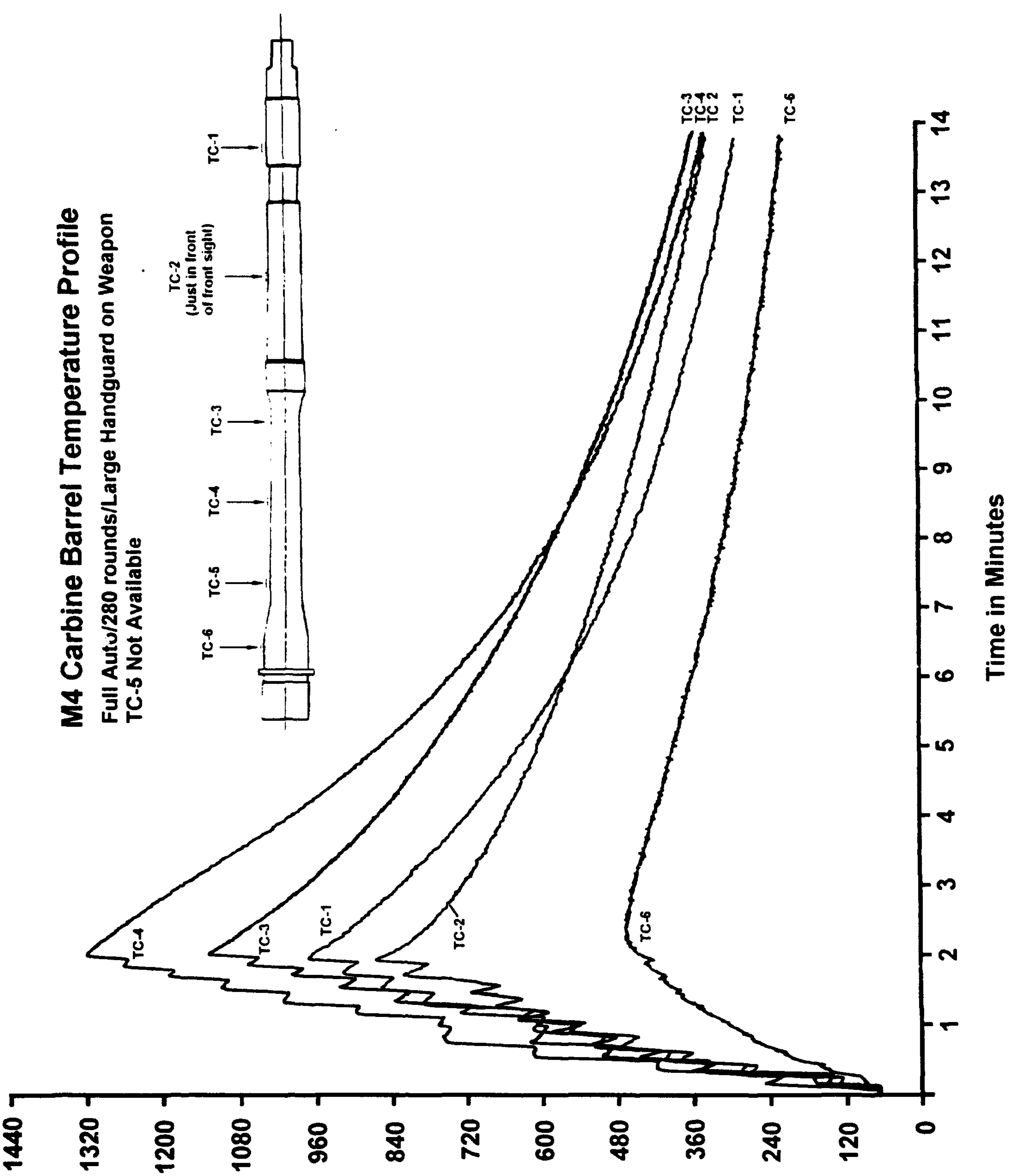


FIGURE 9 - Barrel Temp. for Large
Handguard

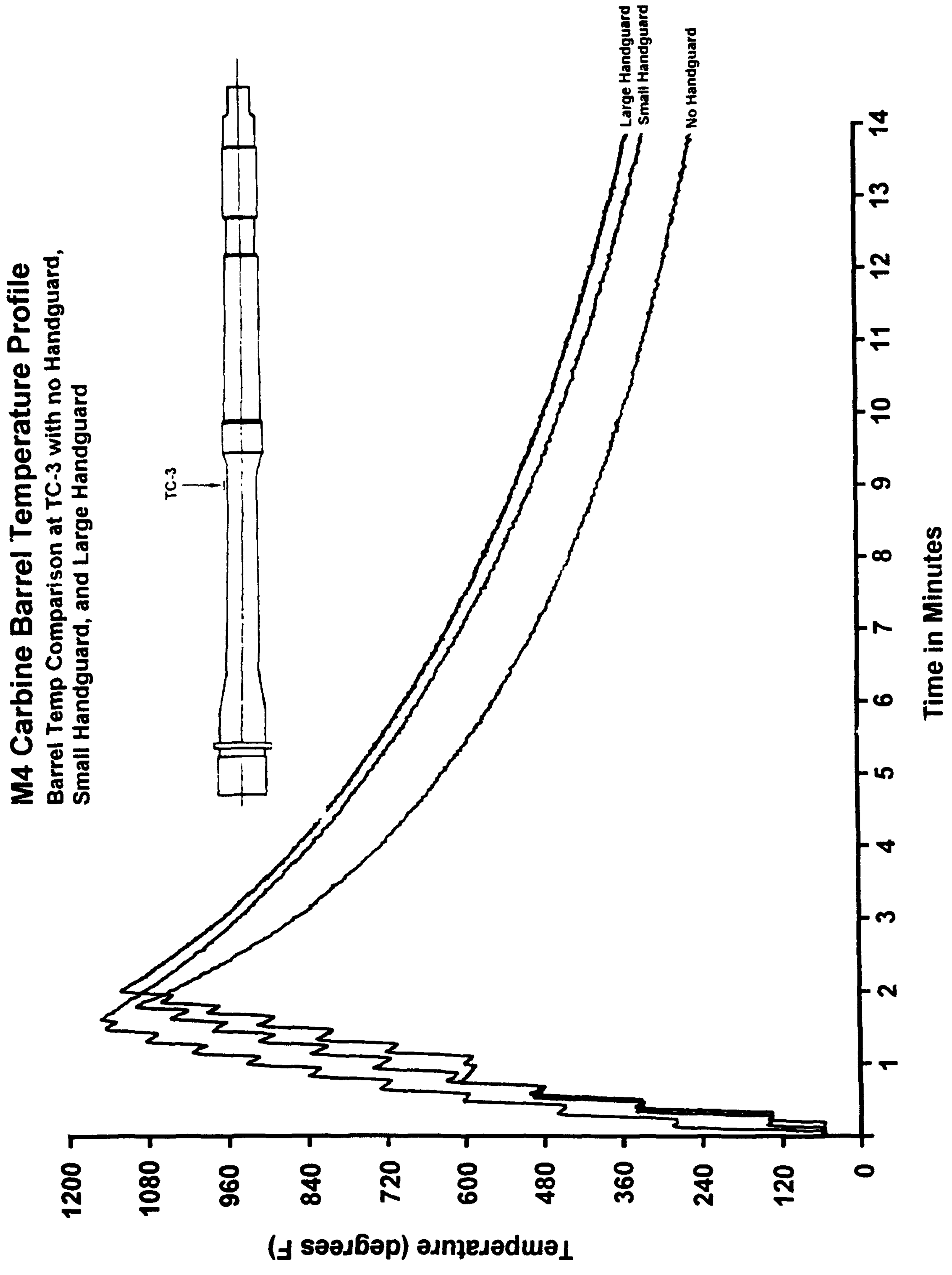


FIGURE 10 - Maximum Barrel Temp. at Thermocouple 3

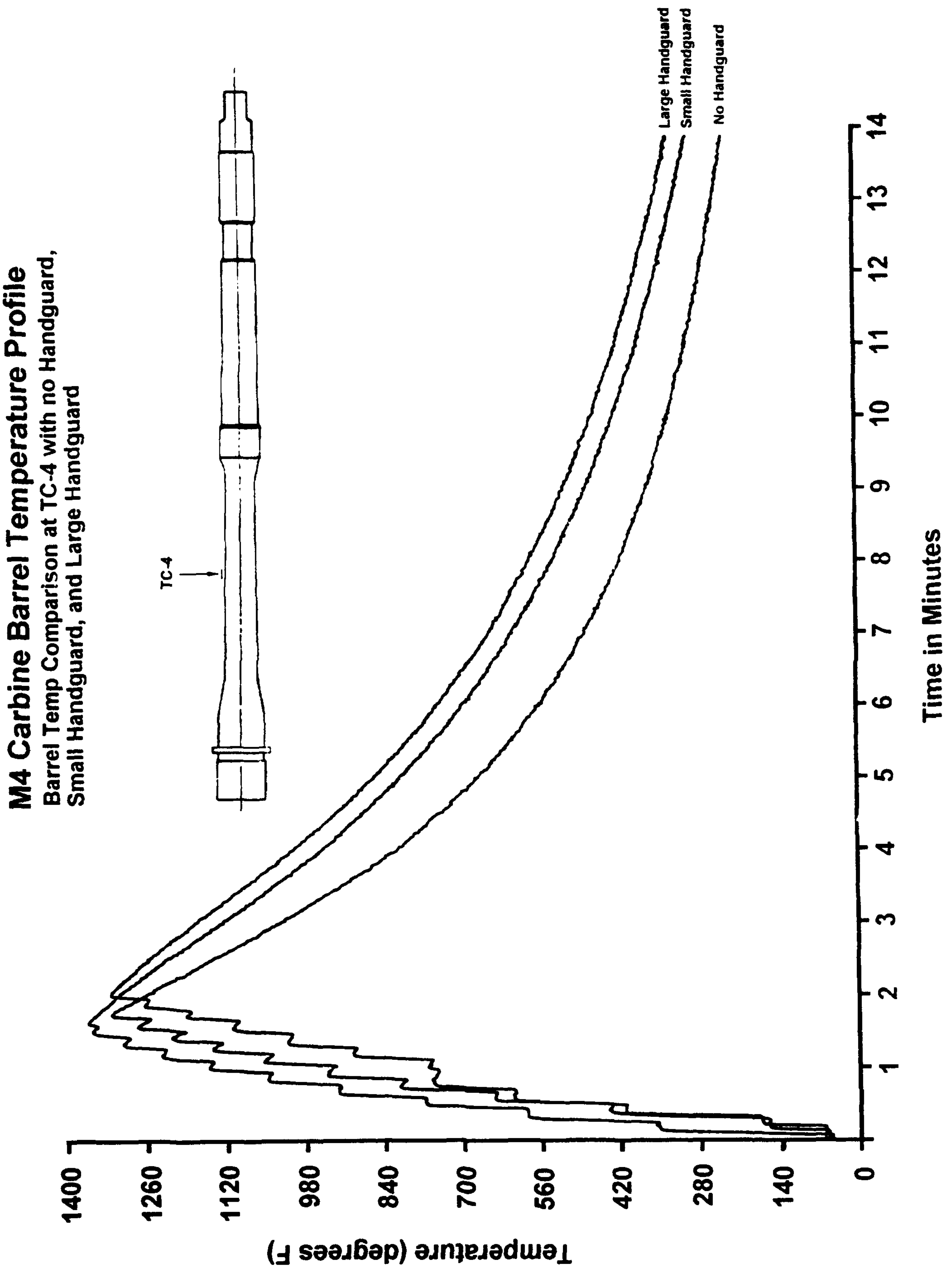


FIGURE 11

Maximum Barrel Temp. at
Thermocouple 4

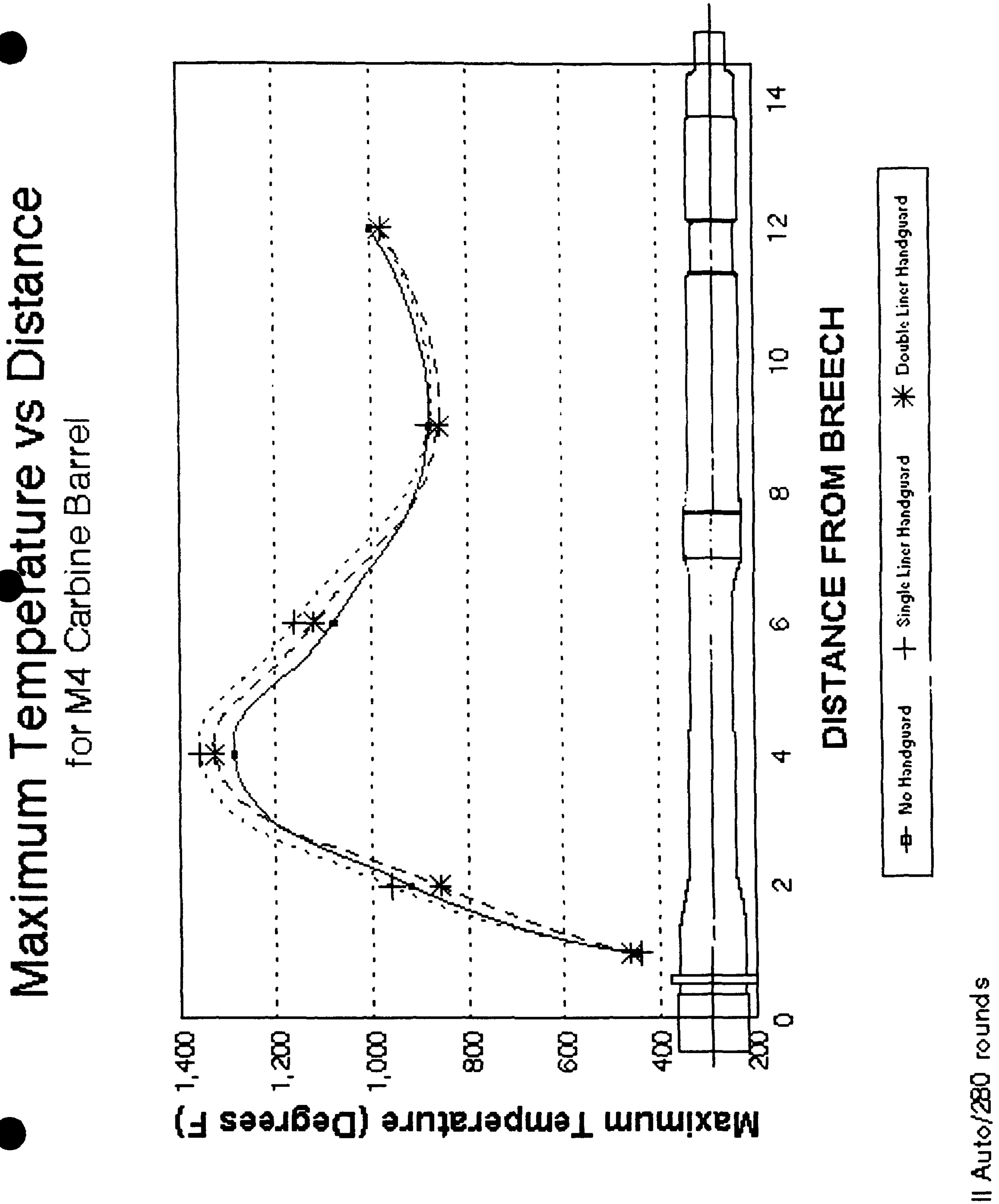


FIGURE 12 - Maximum Barrel Temp. vs
Barrel Location

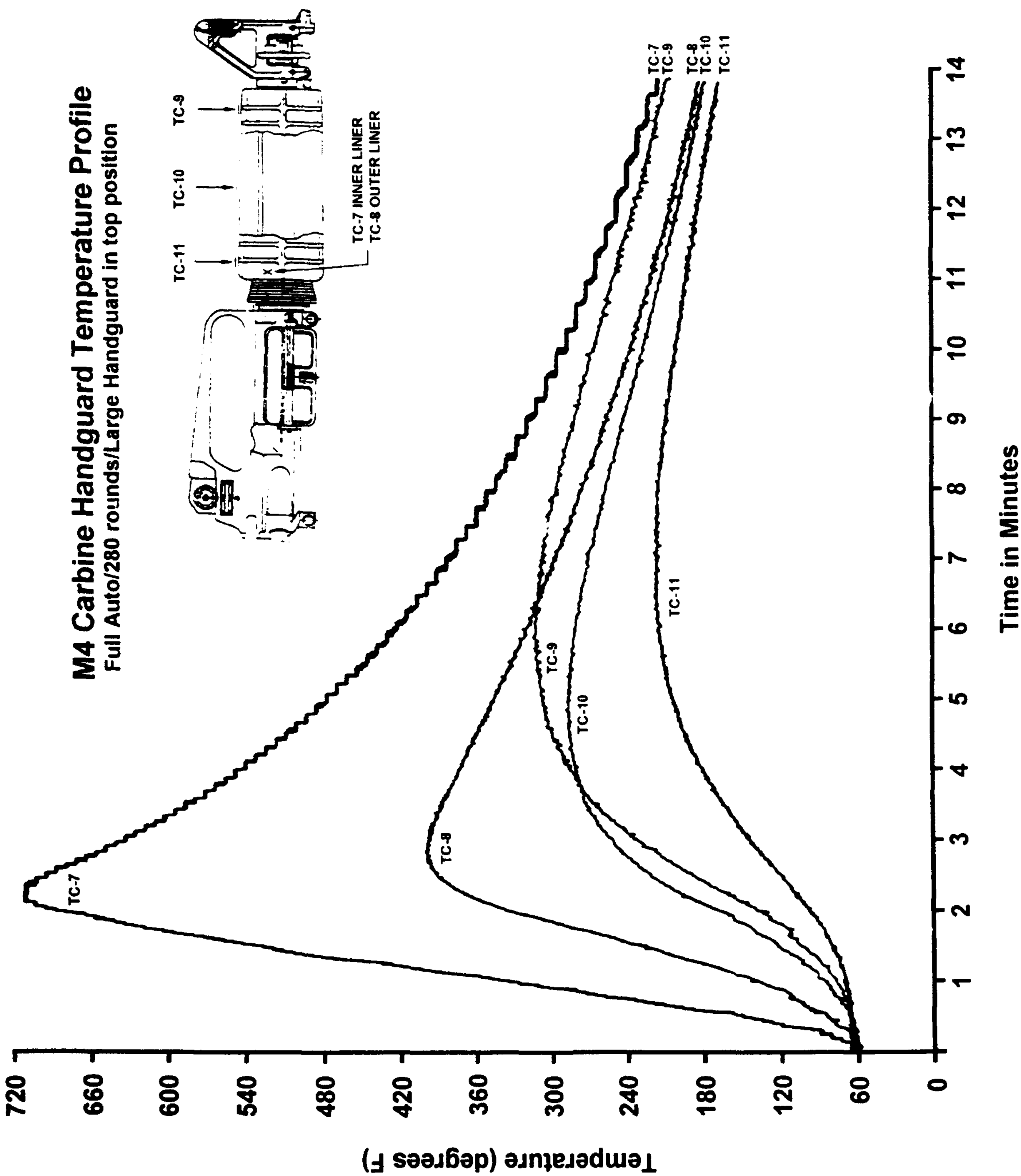


FIGURE 13
Handguard Temp. for Large Handguard

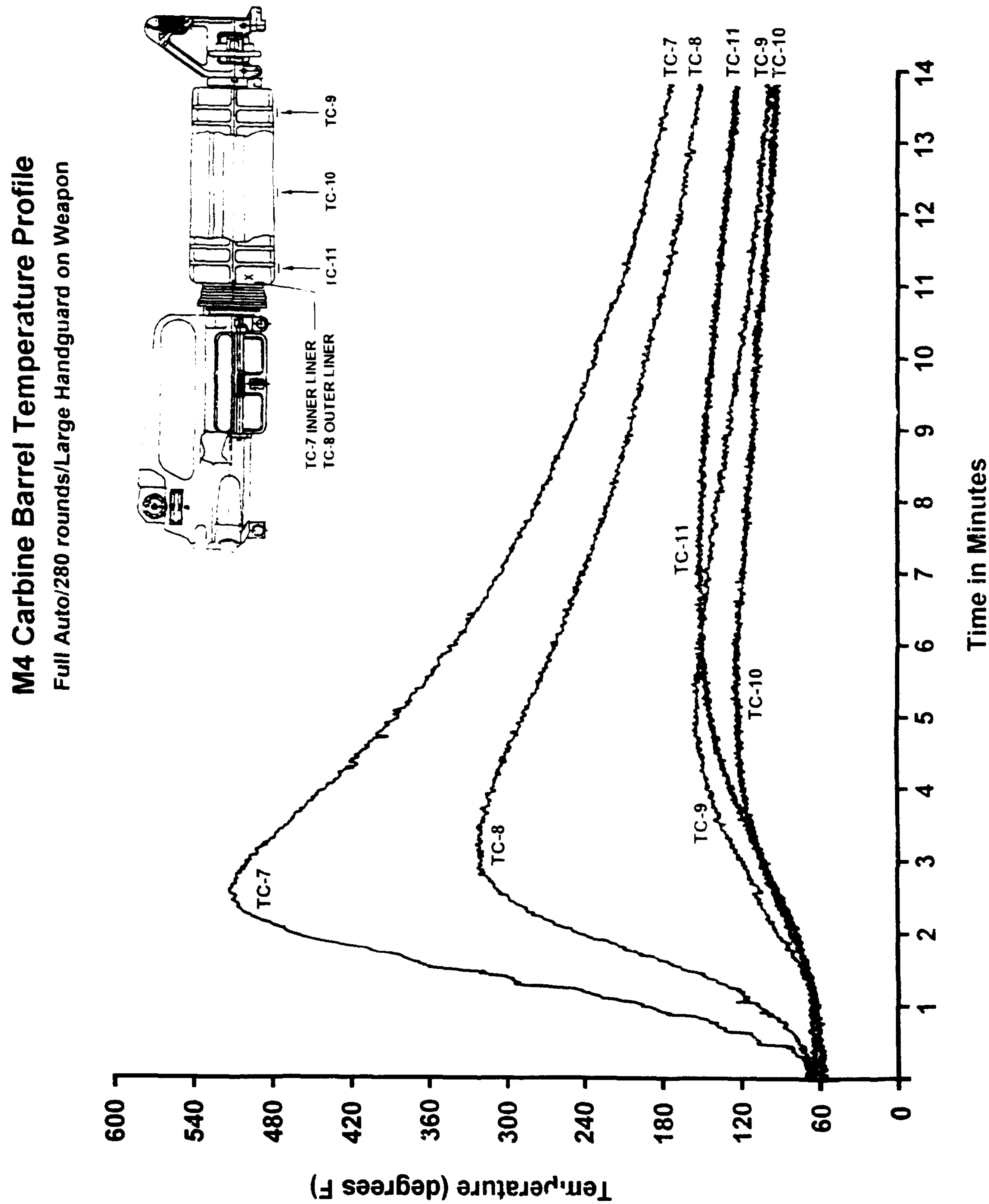
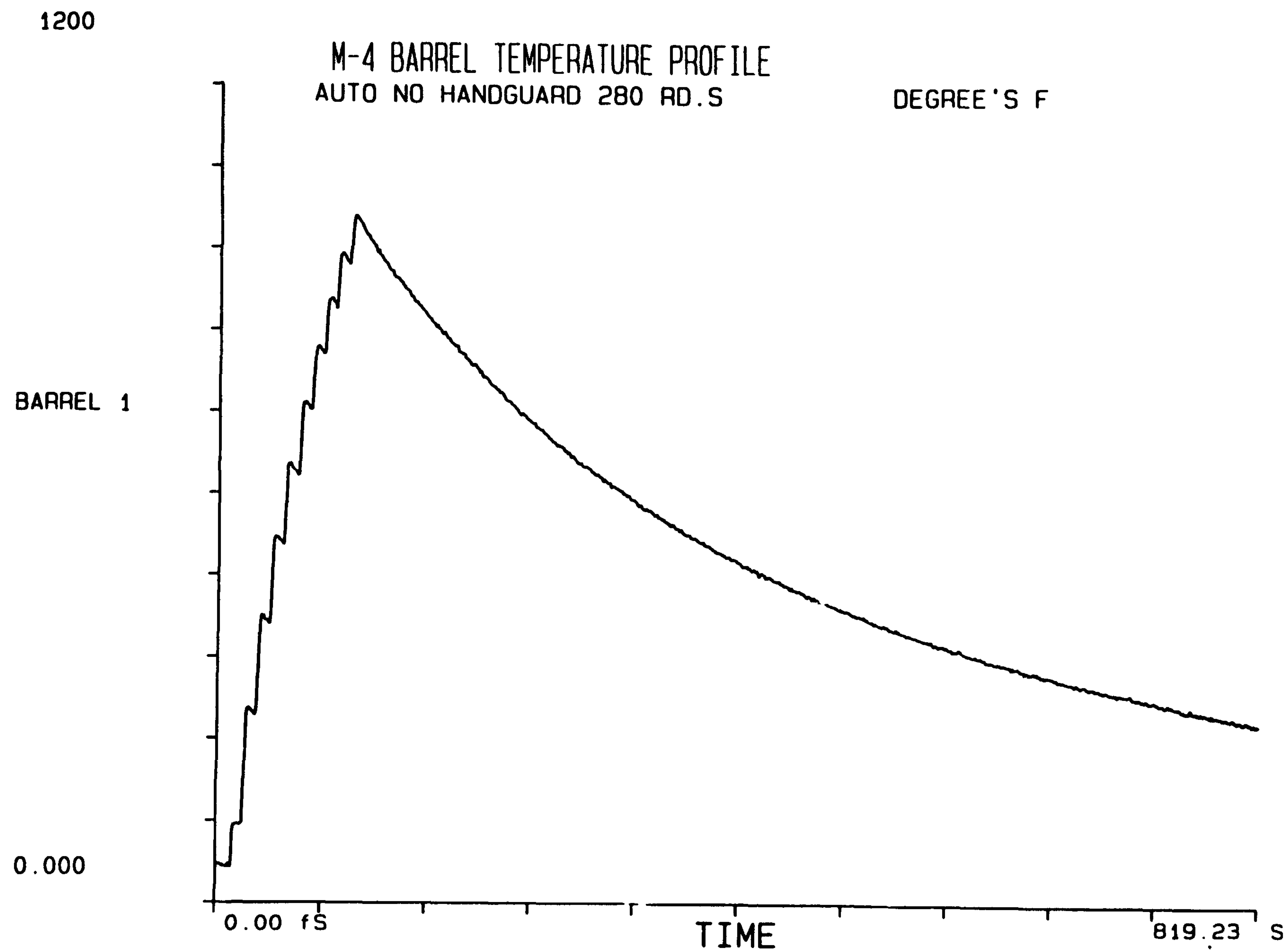


FIGURE 14
Handguard Temp. for Large Handguard

APPENDIX A

Individual thermocouple temperature charts for each phase of the testing.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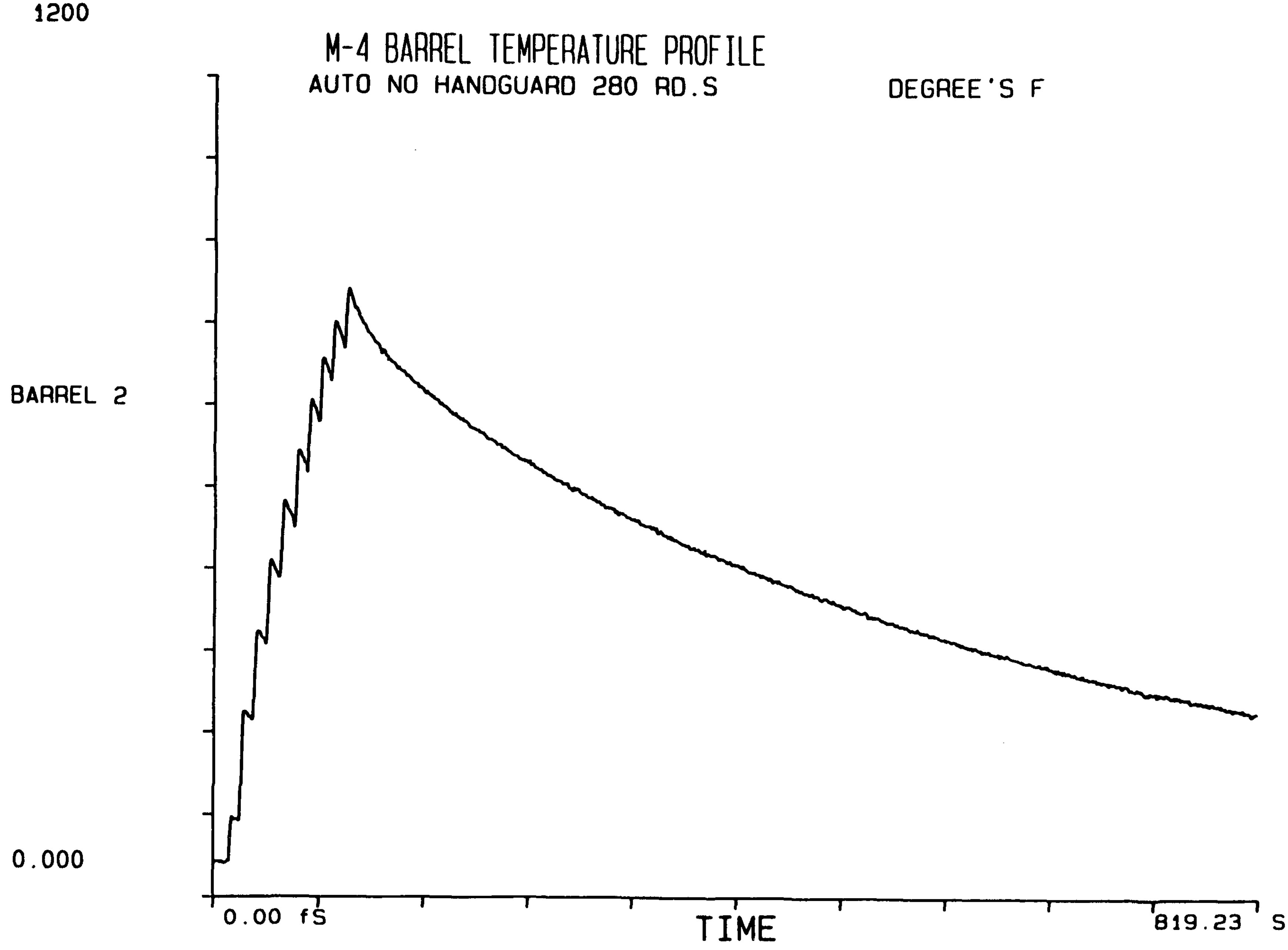
0.00 fS
TIME
819.23 S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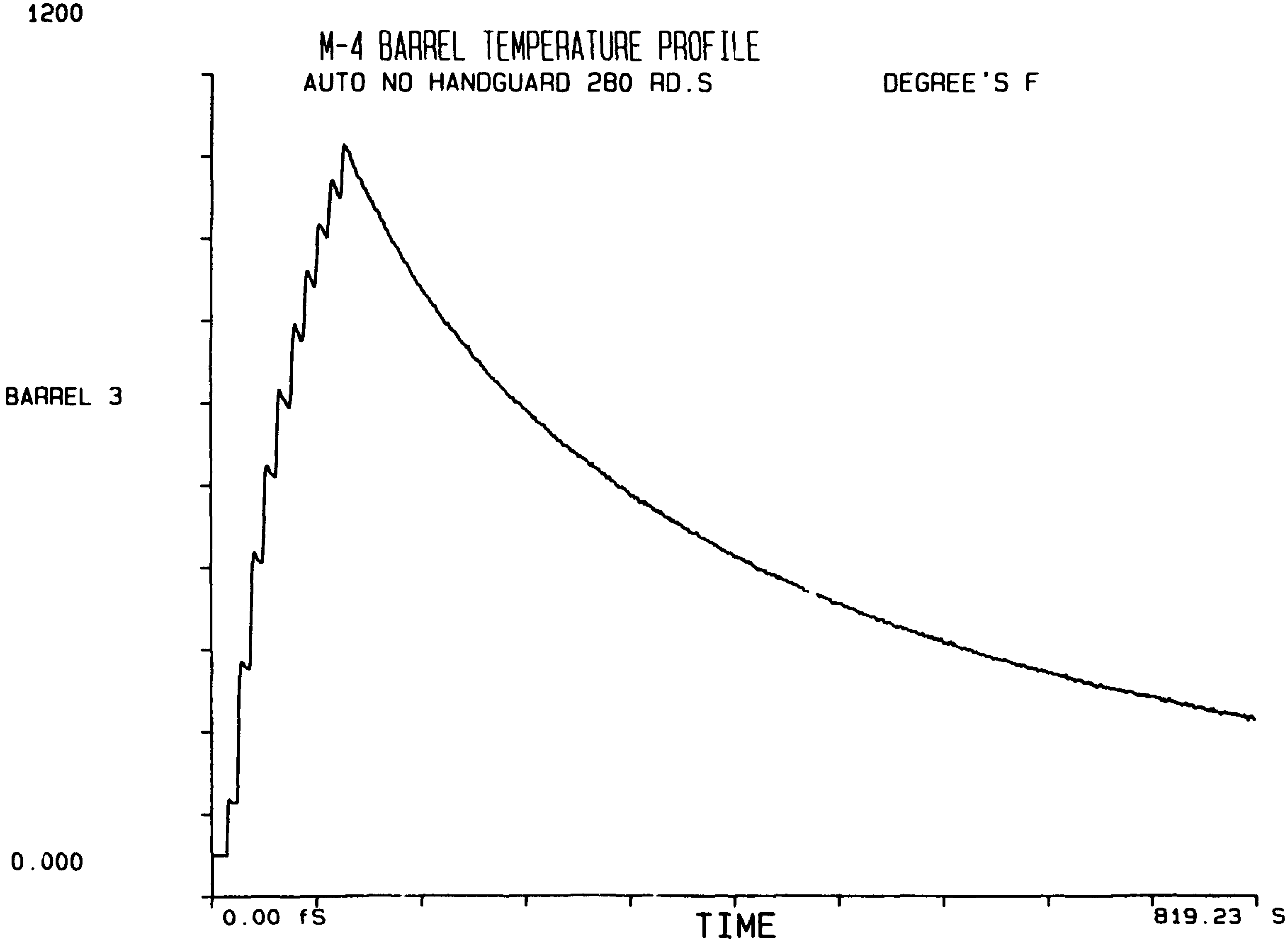
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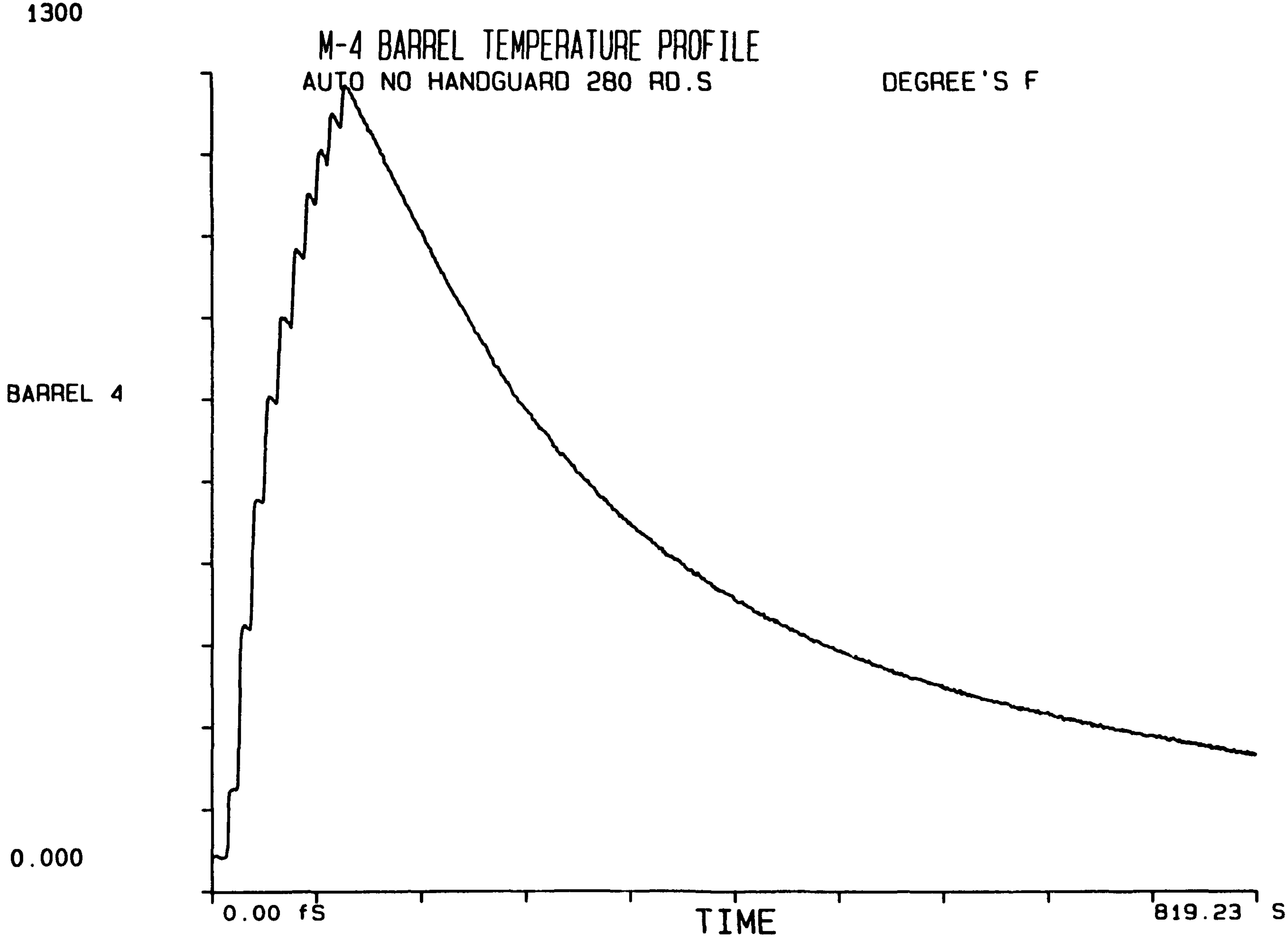
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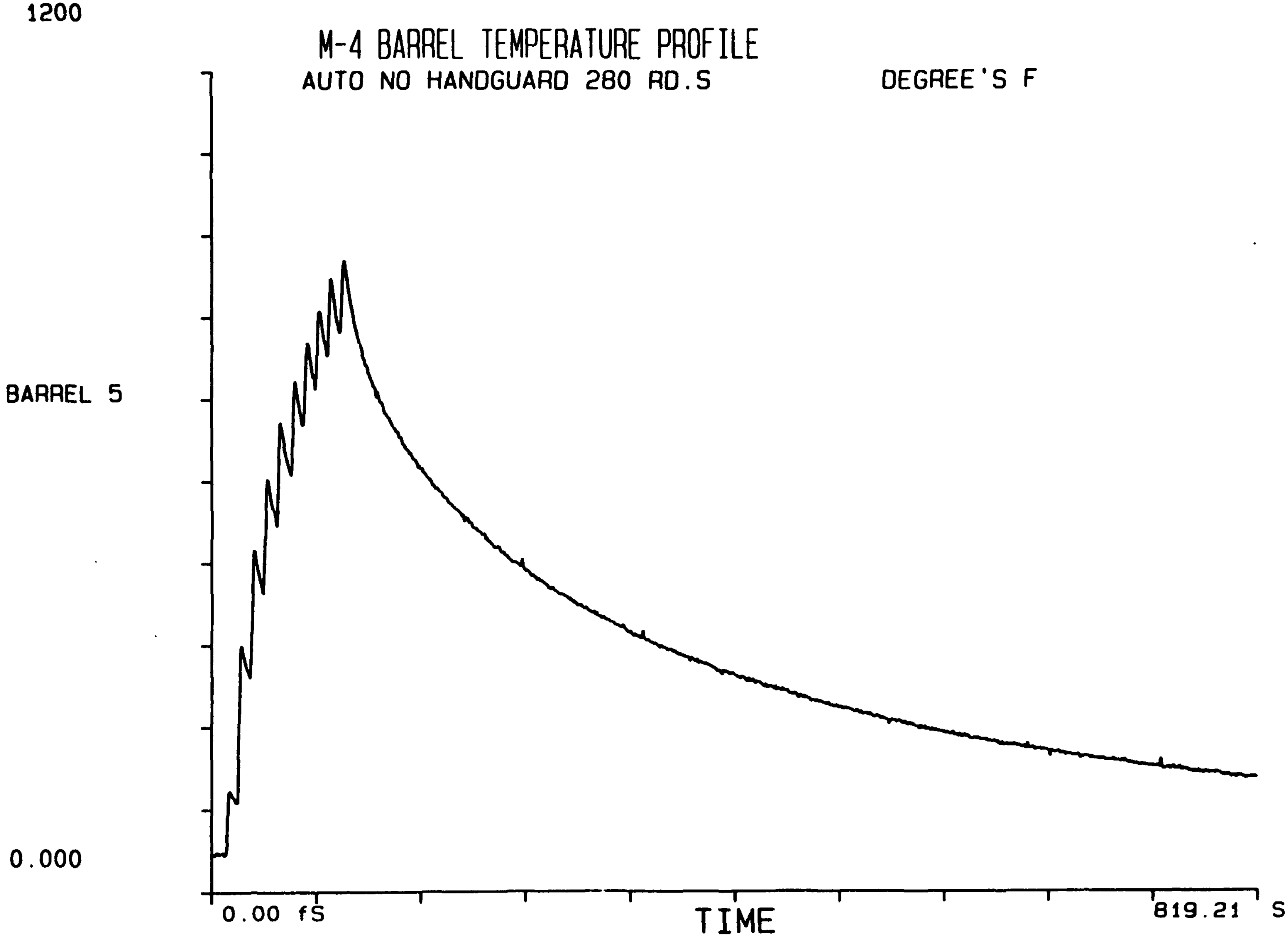
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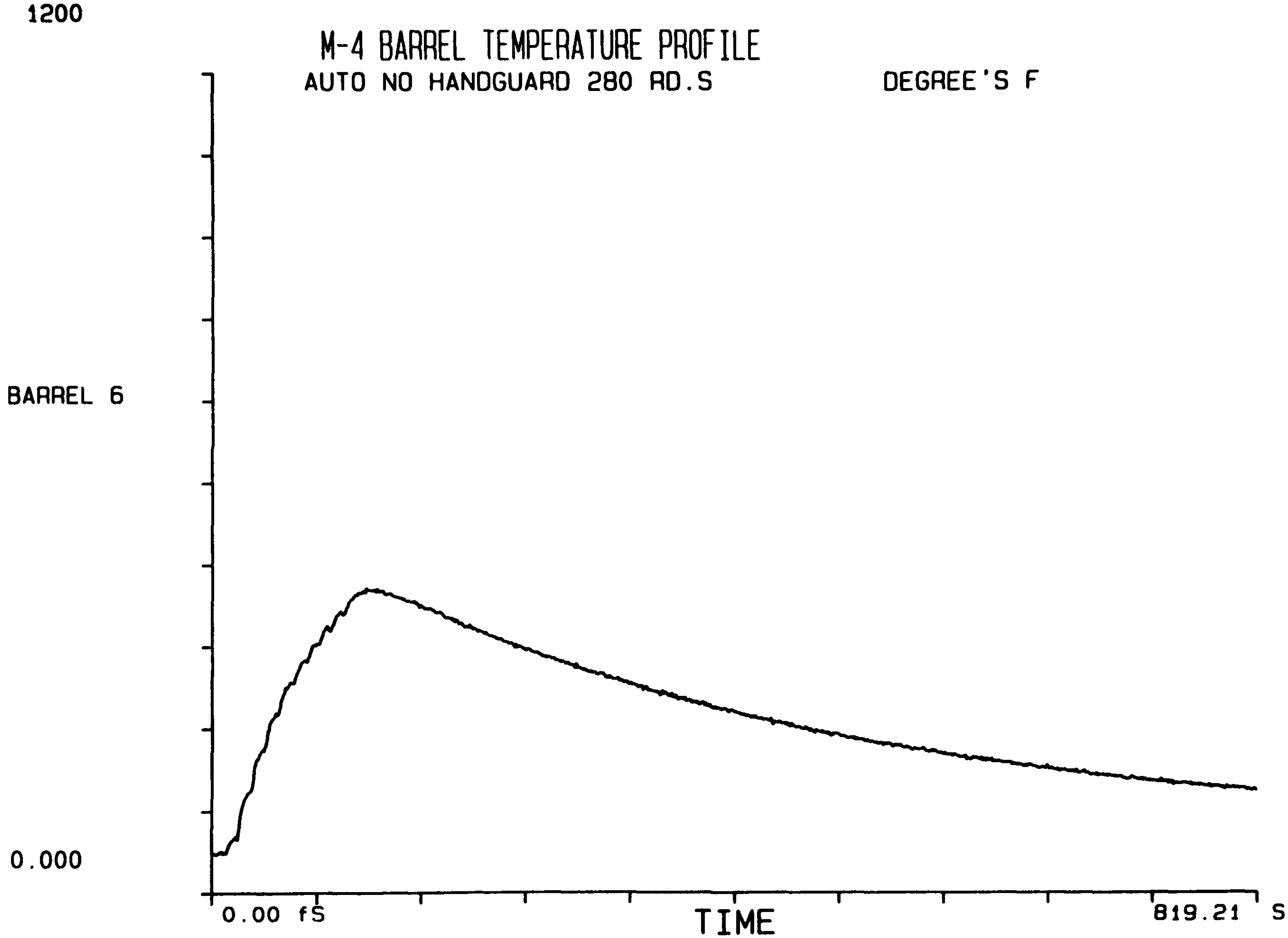
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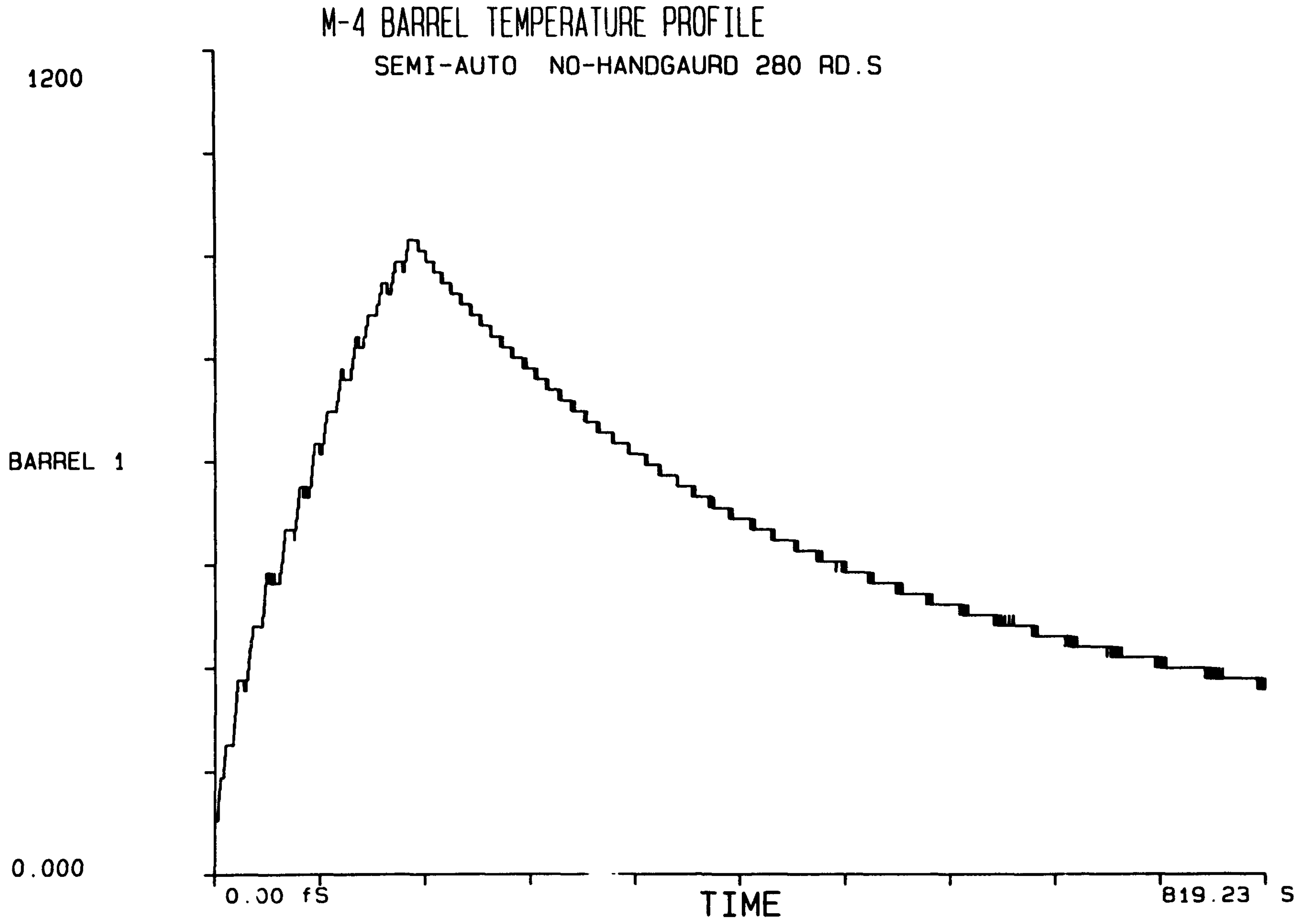
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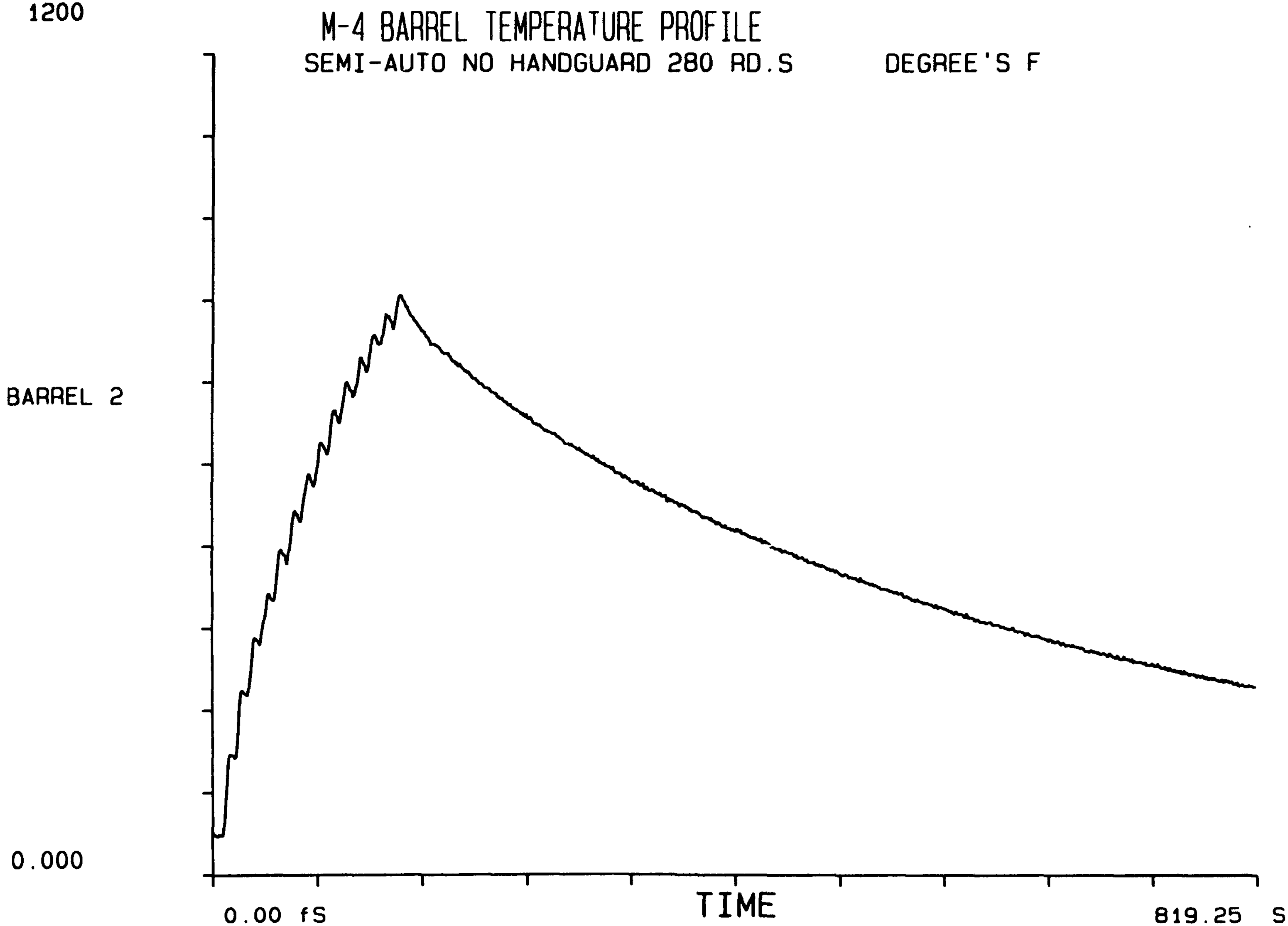
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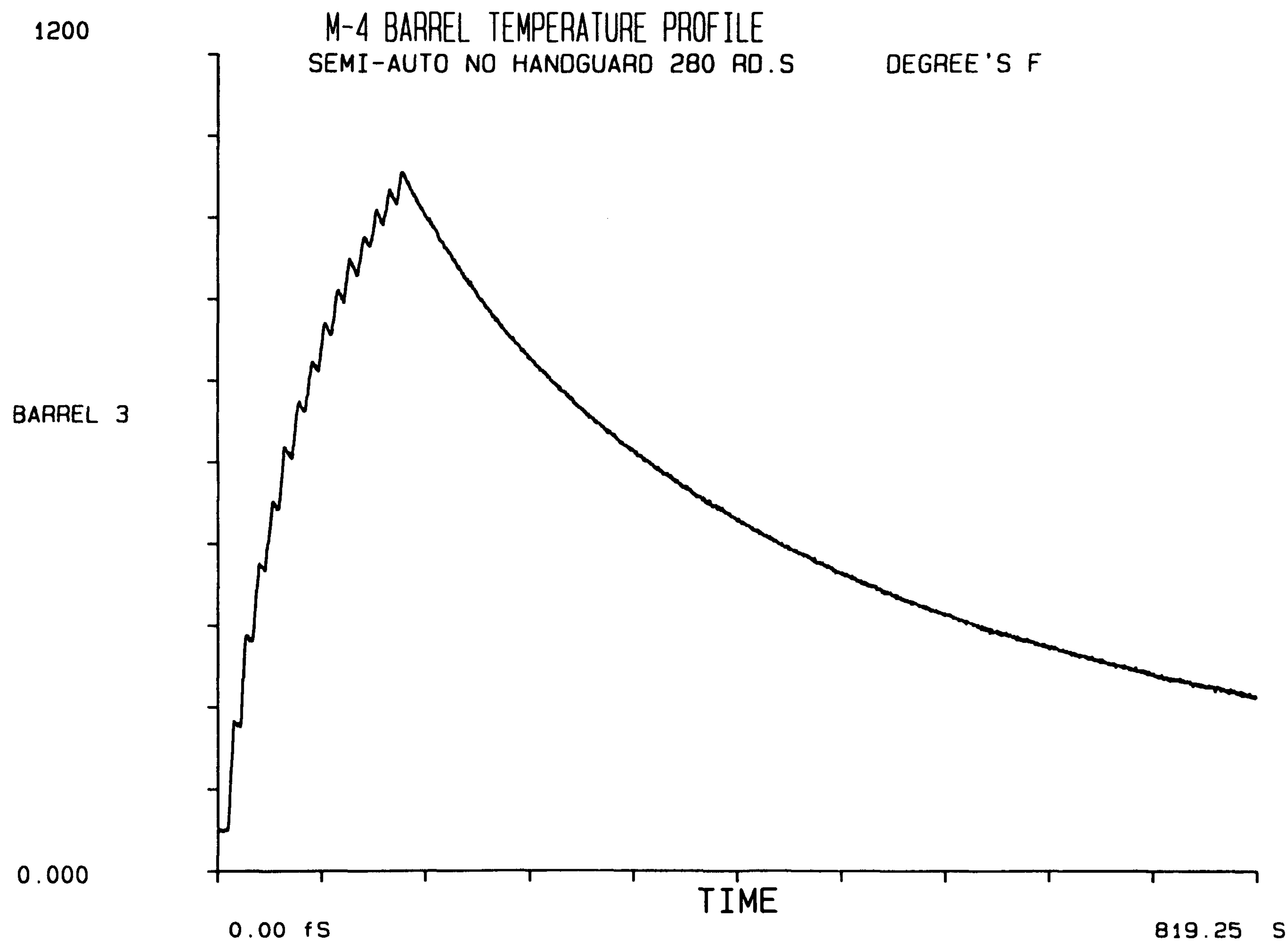
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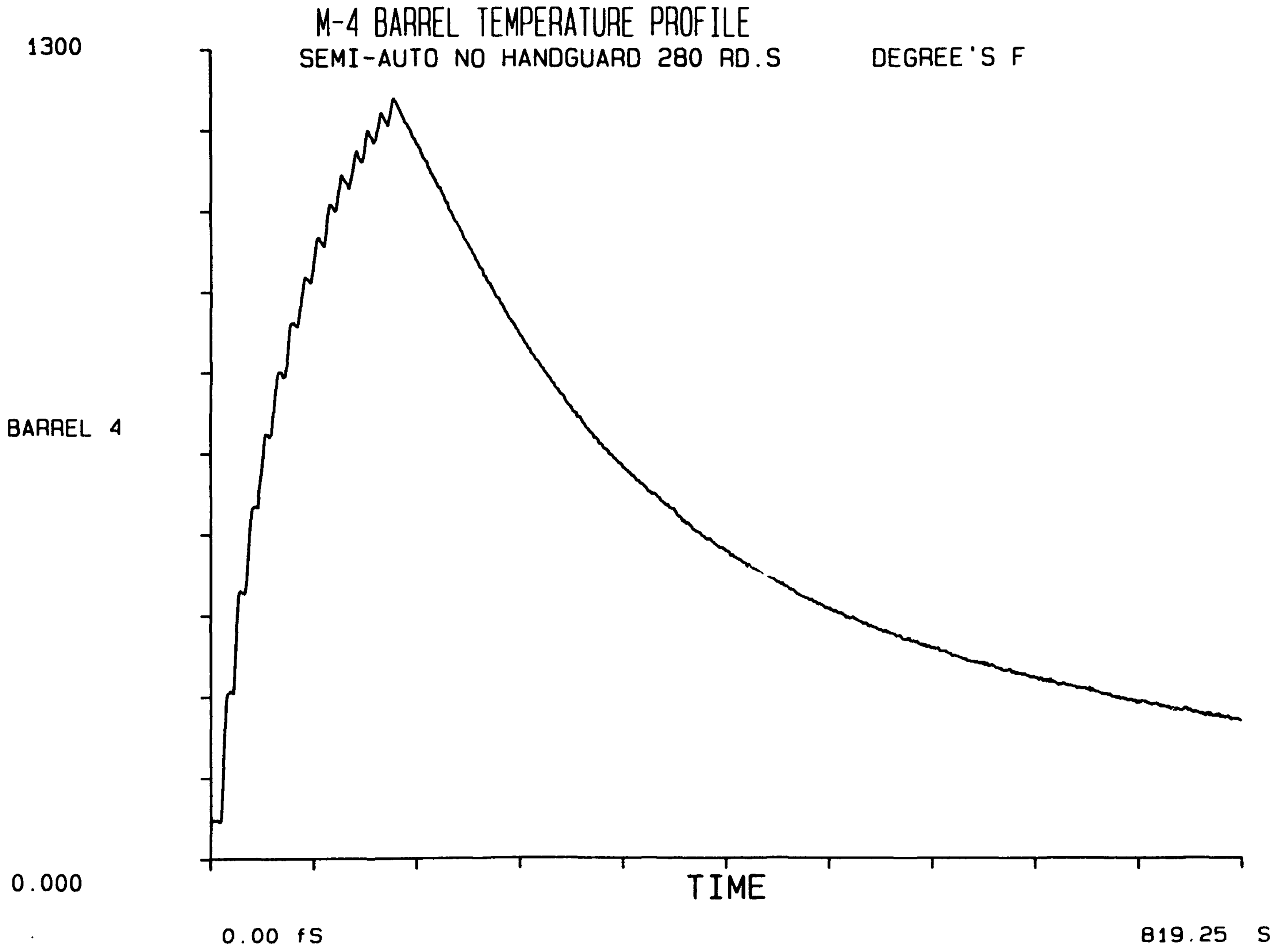
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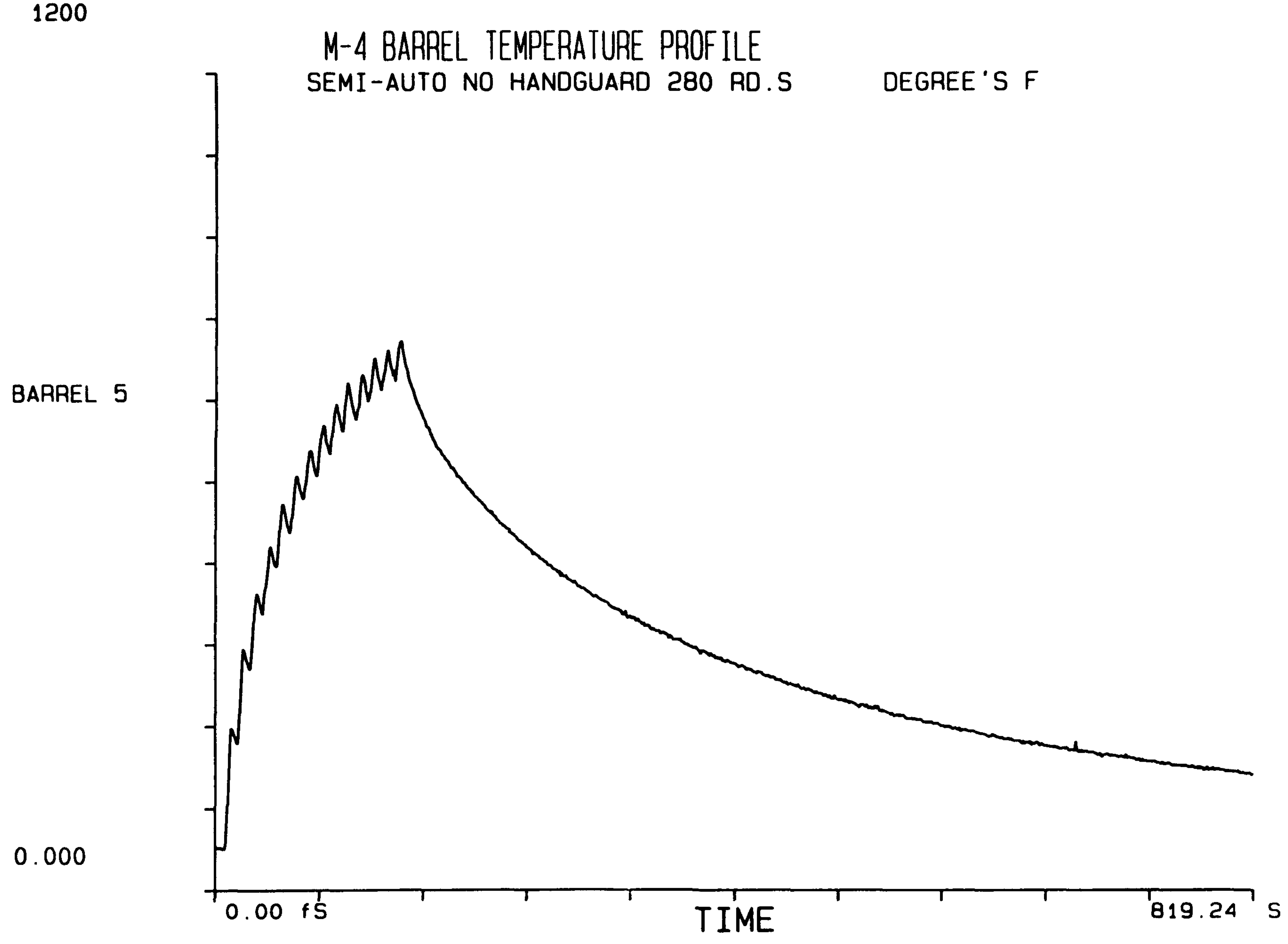
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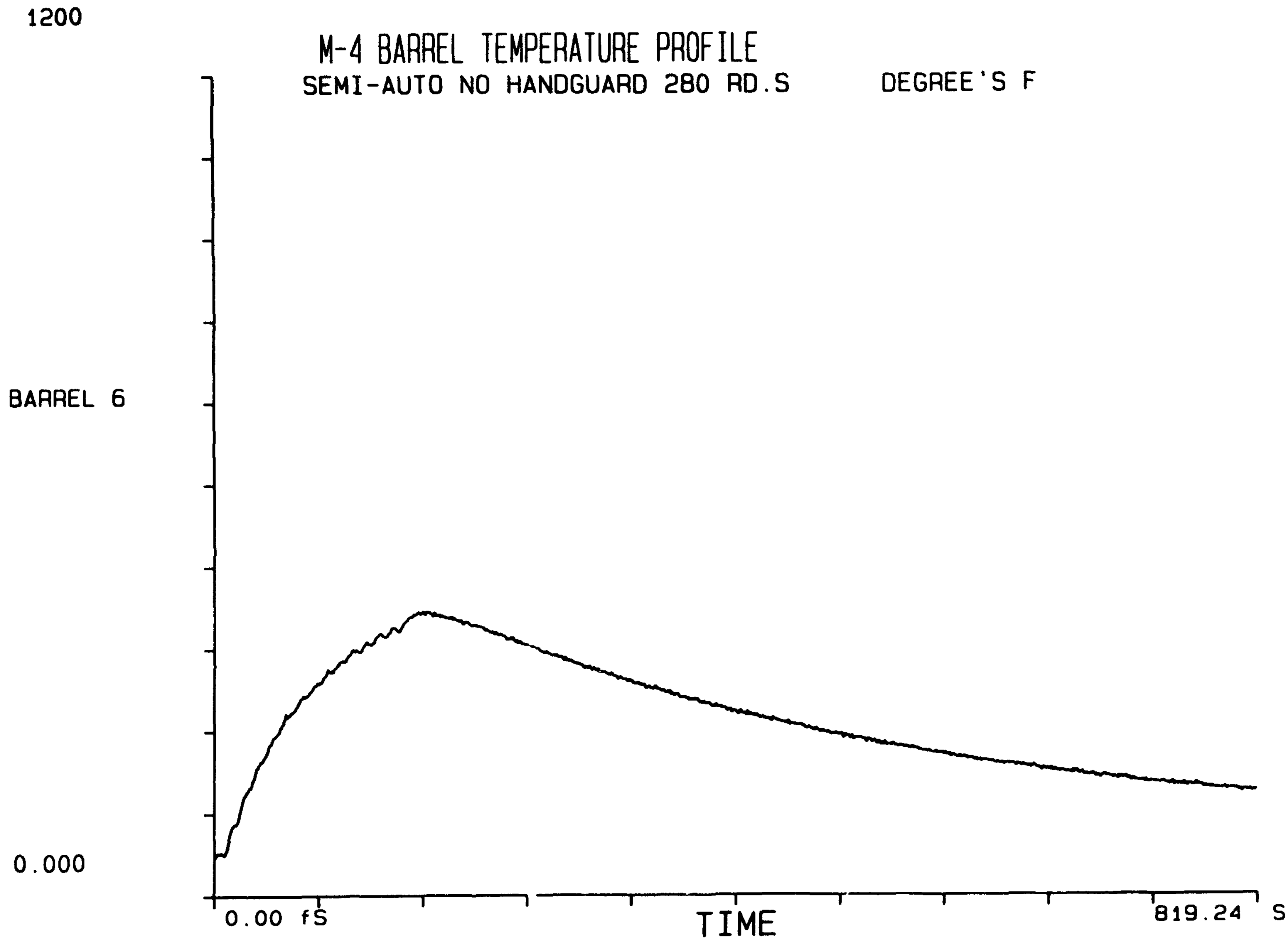
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO NO HANDGUARD 280 RD.S
DEGREE'S F
BARREL 5
0.000
0.00 fS
TIME
819.24
S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DEGREE'S F
BARREL 6
0.000
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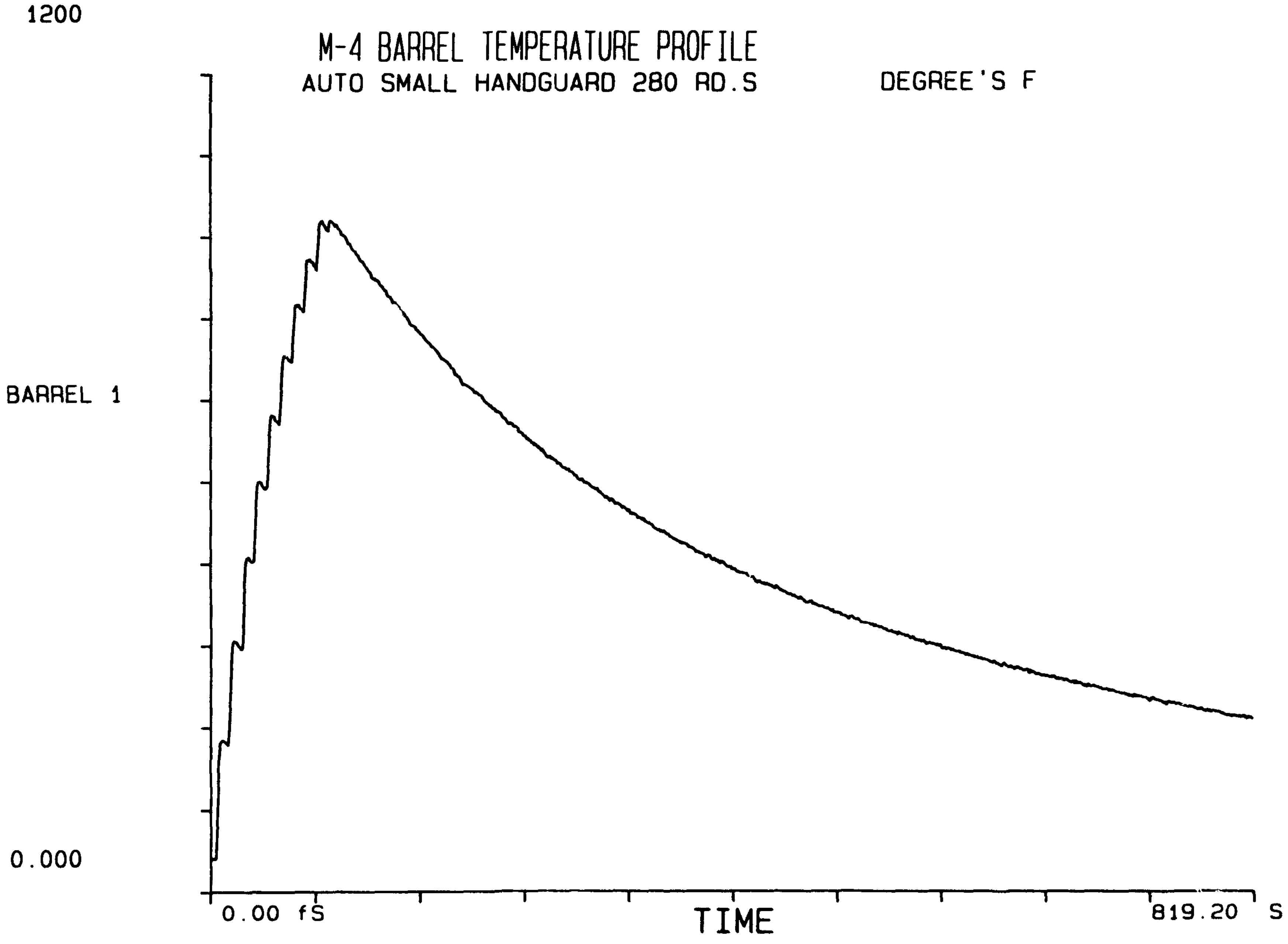
TIME
819.24 S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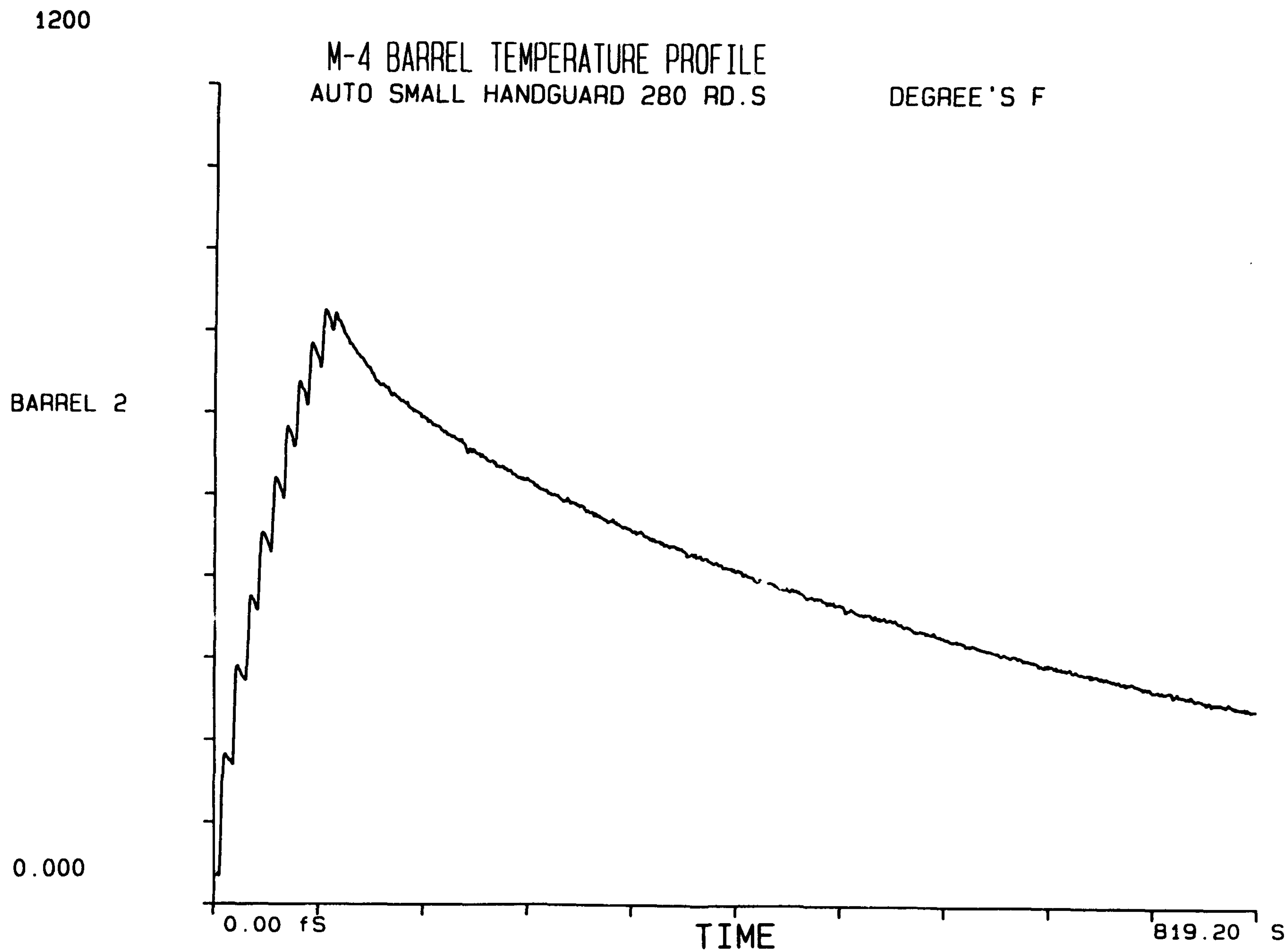
AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
BARREL 1
0.000
0.00 fS
TIME
819.20
S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BARREL 2
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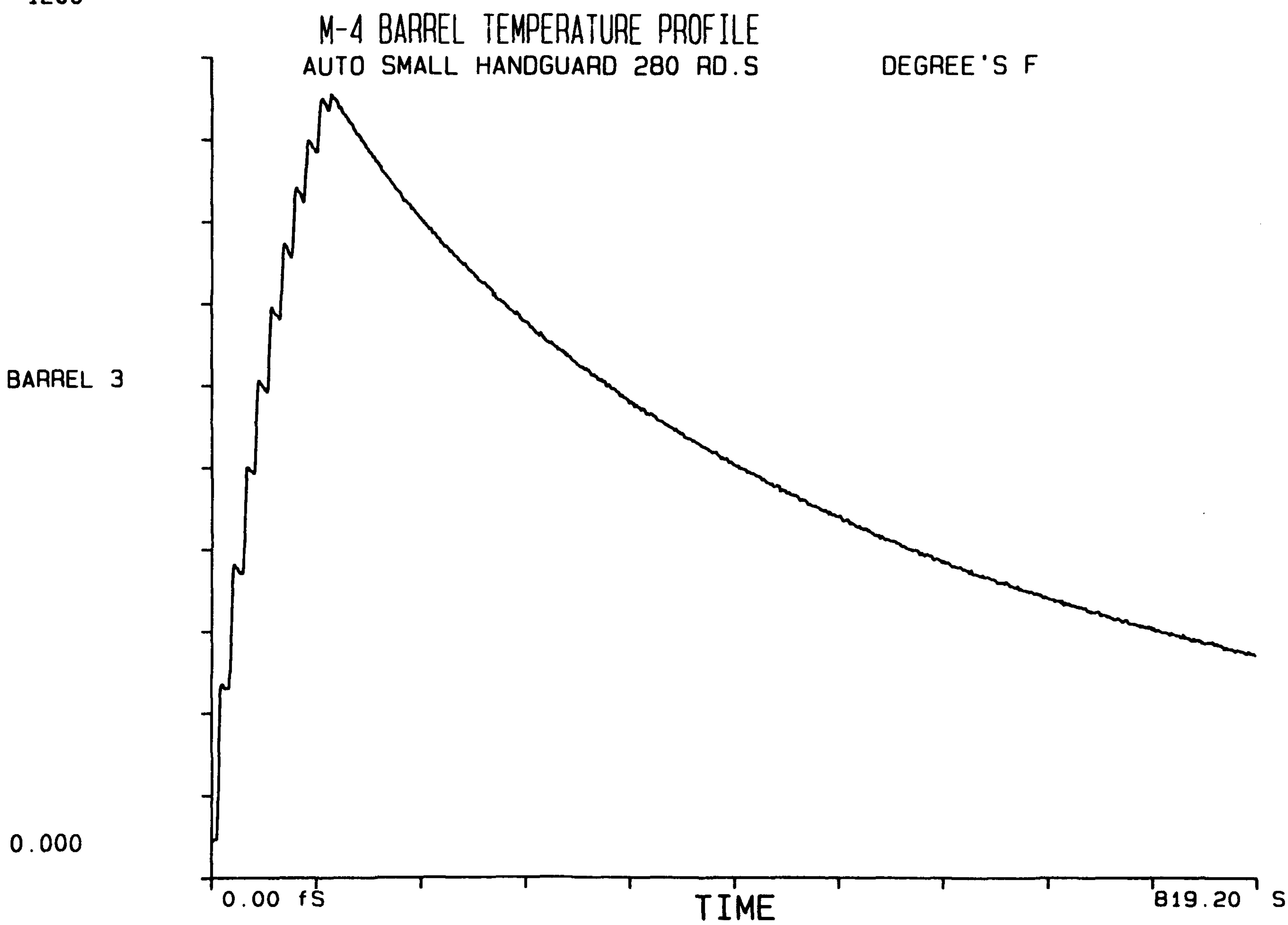
0.00 fS
TIME
819.20 S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DEGREE'S F
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BARREL 3
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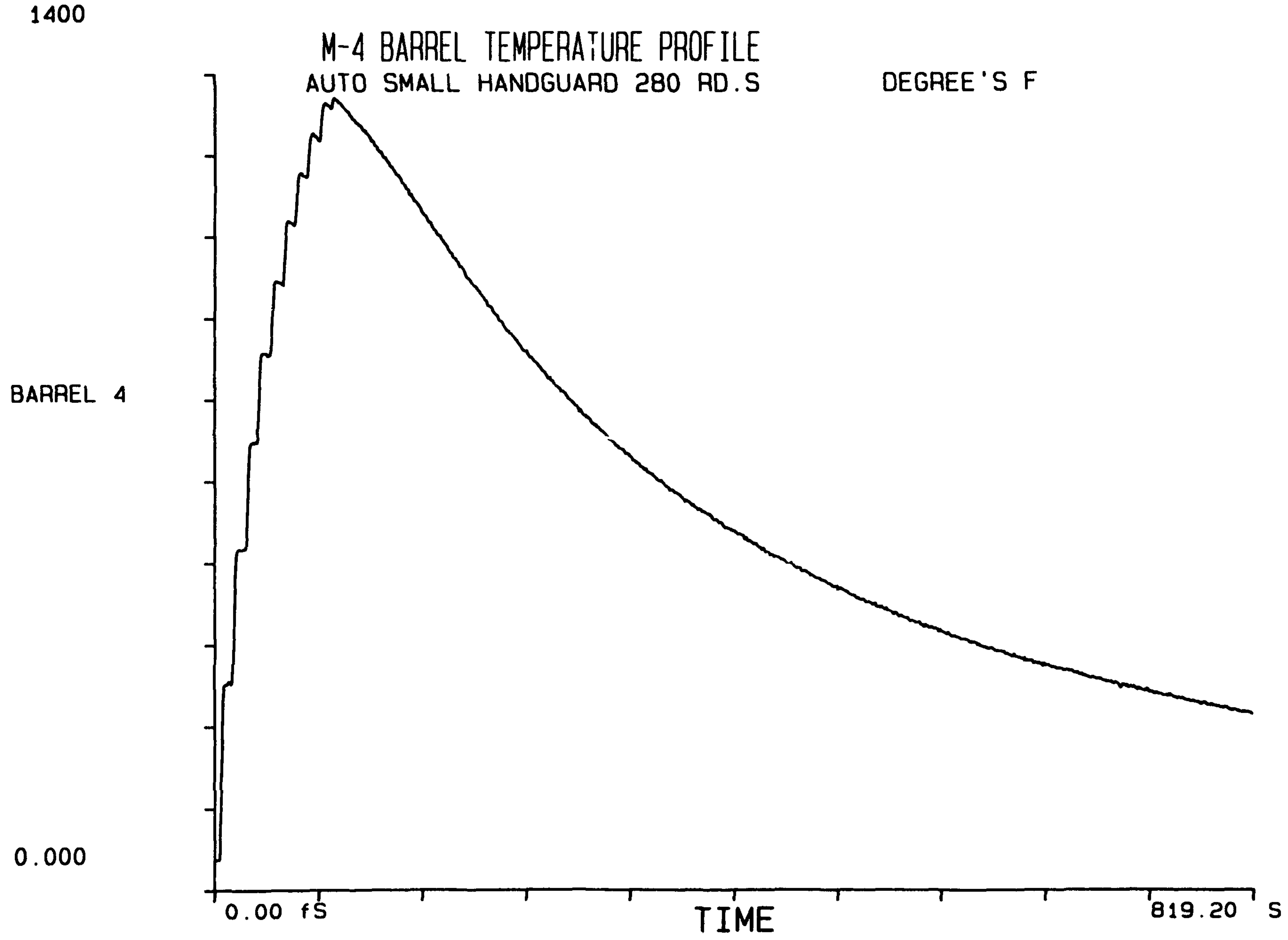
0.00 fS
TIME
819.20
S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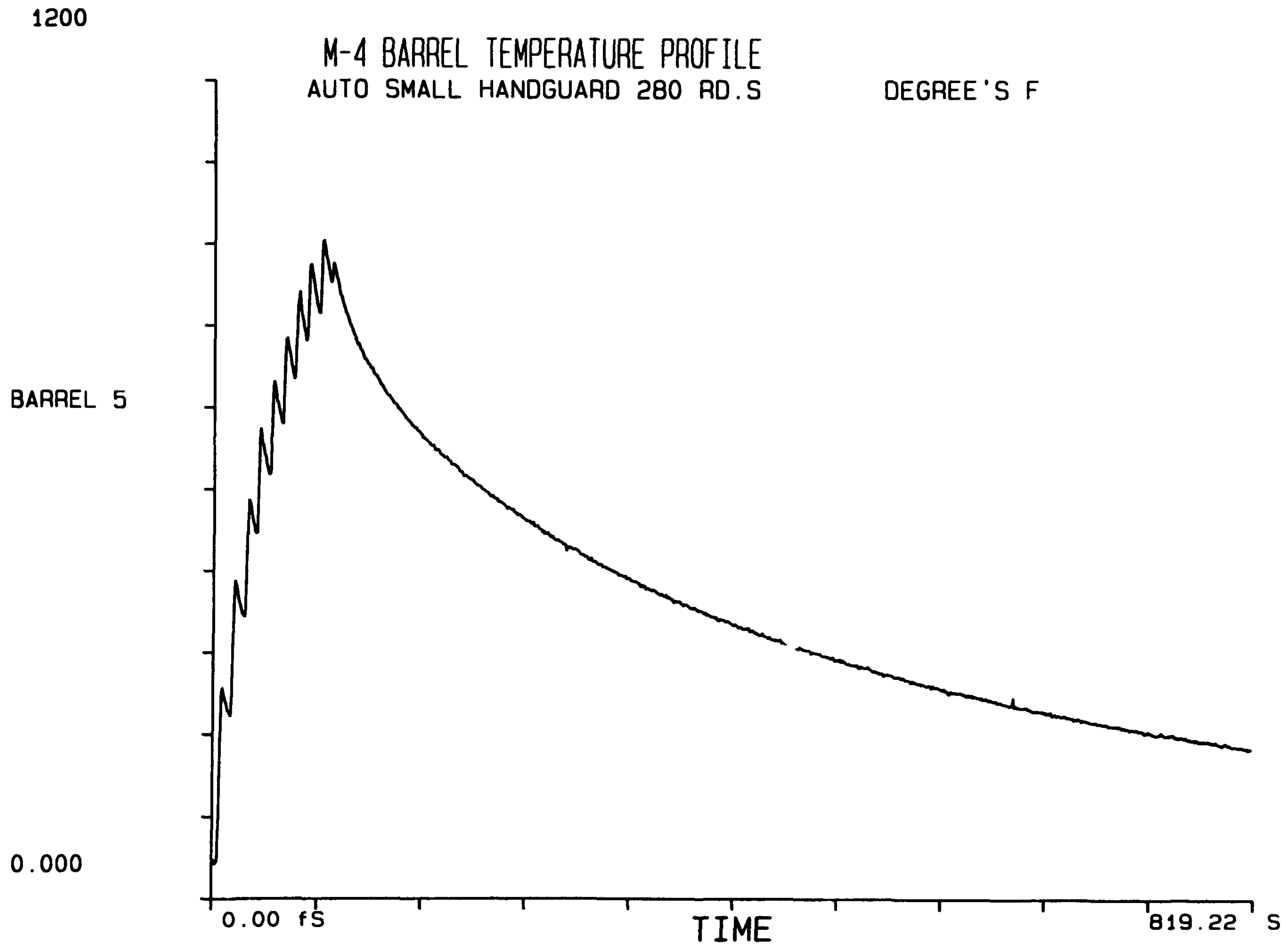
AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
BARREL 4
0.000
0.00 fS
TIME
819.20 S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AUTO SMALL HANDGUARD 280 RD.S
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BARREL 5
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0.00 fS
TIME
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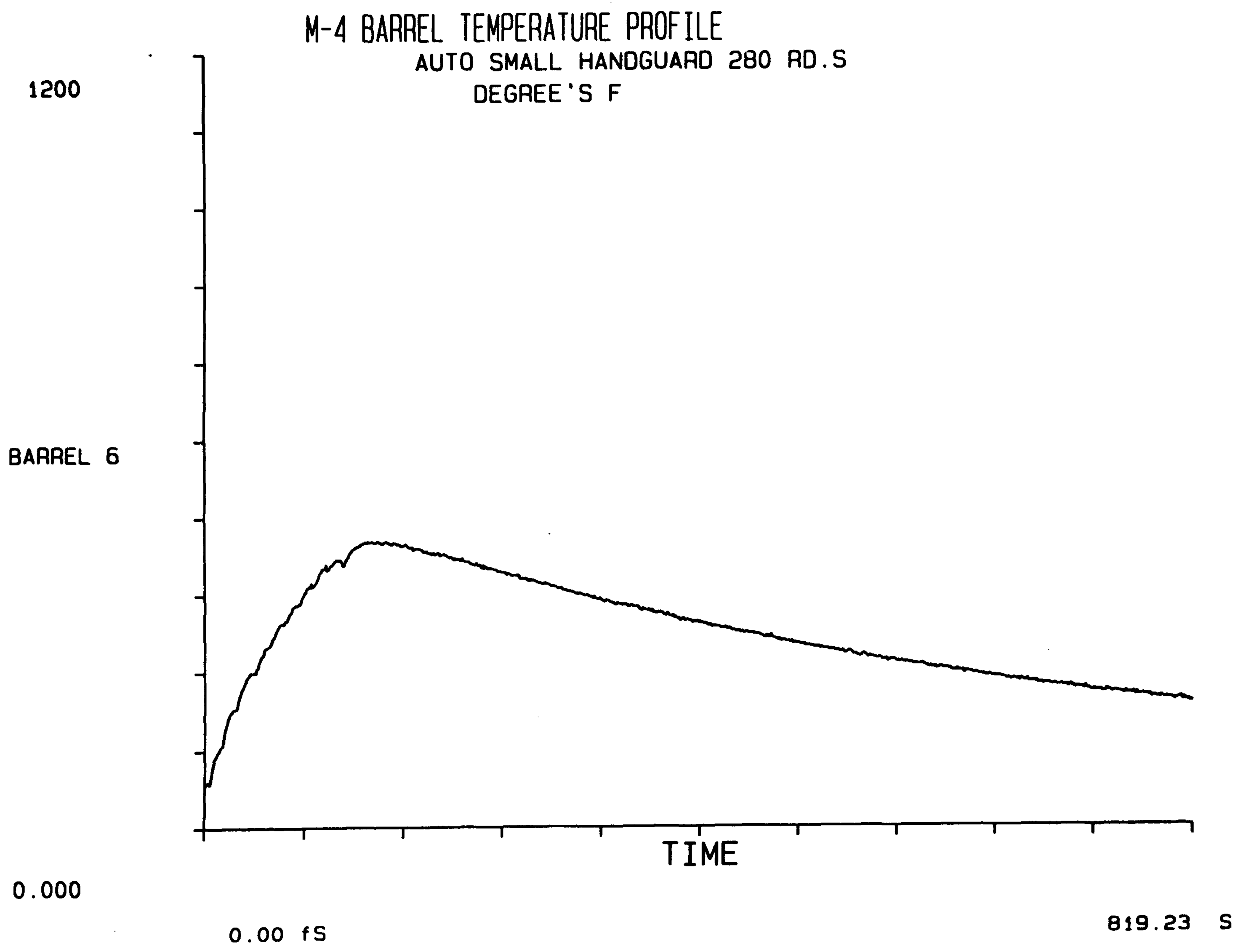
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DEGREE'S F
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BARREL 6
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TIME
0.00 fS
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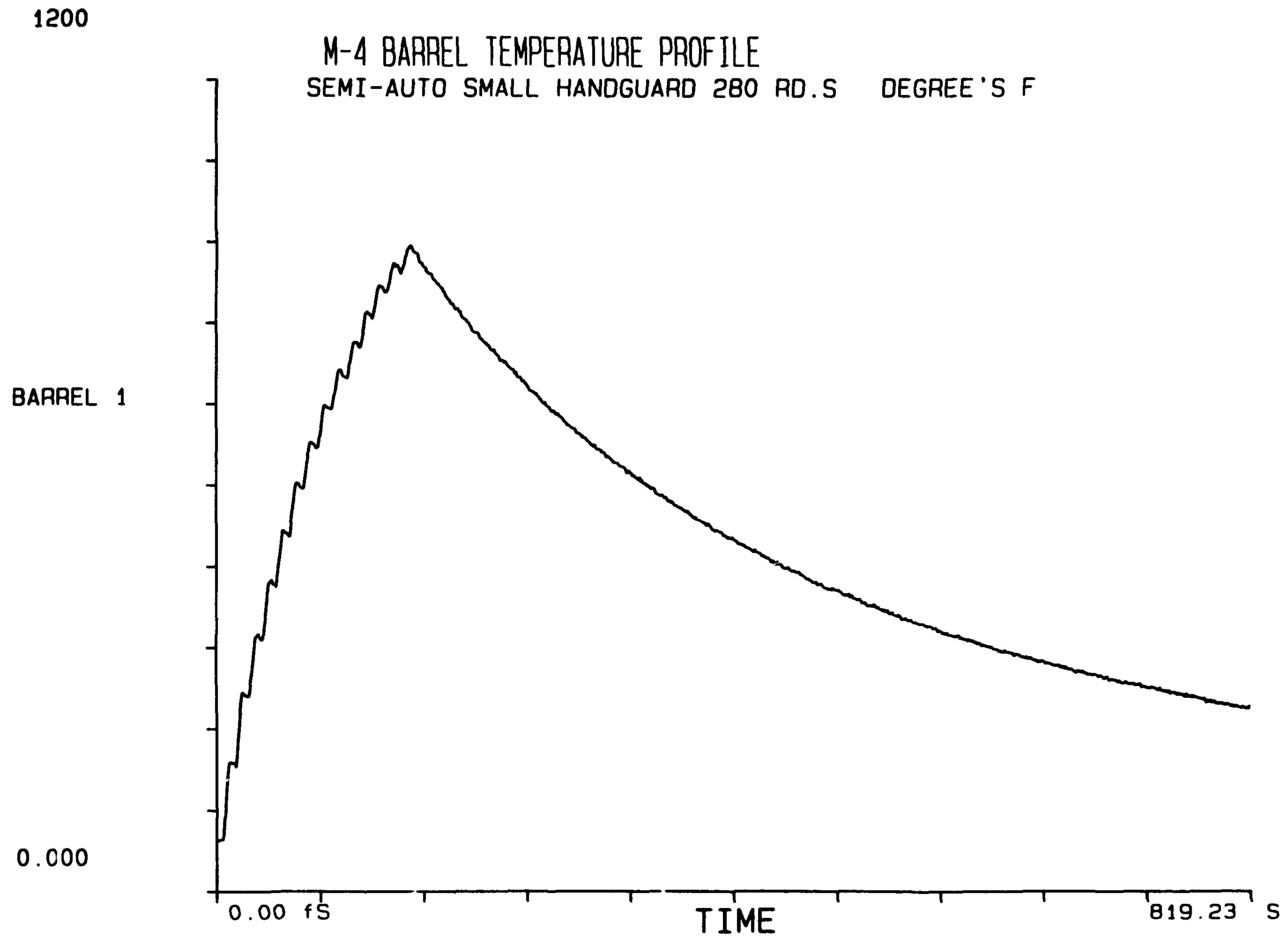
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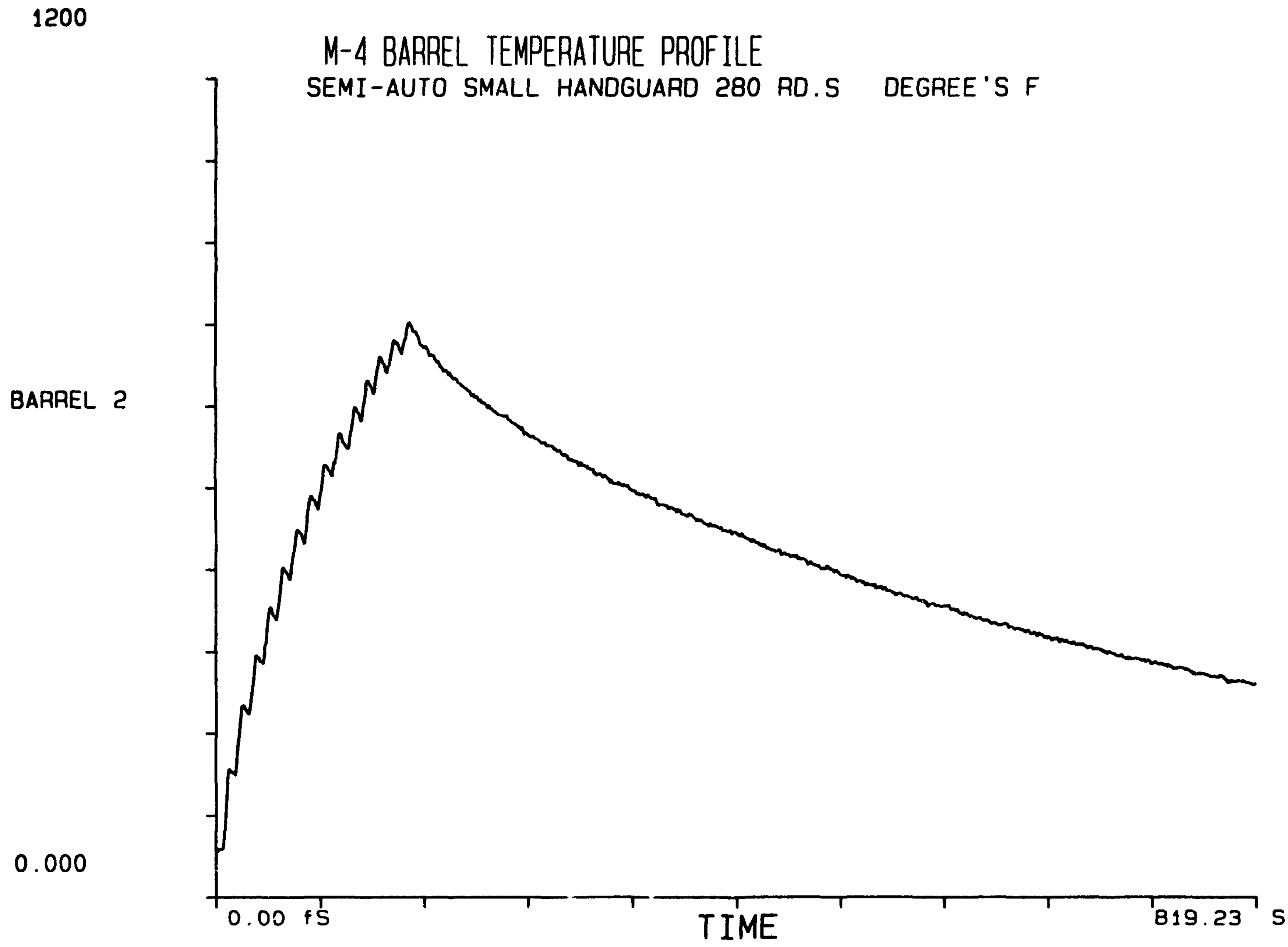
BARREL 1
0.000
0.00 fS
TIME
819.23 S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SEMI-AUTO SMALL HANDGUARD 280 RD.S DEGREE'S F
BARREL 2
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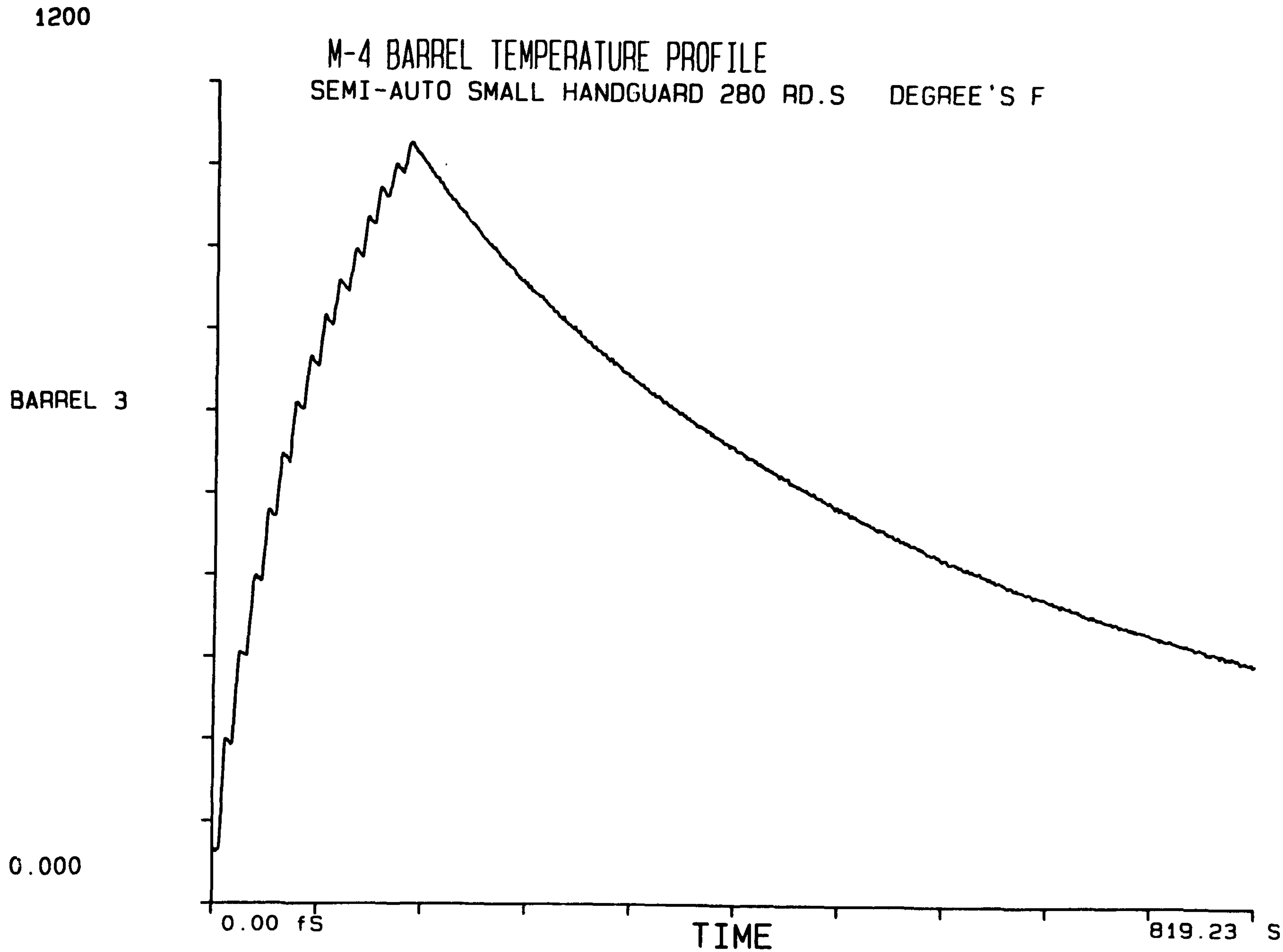
0.00 fS
TIME
819.23 S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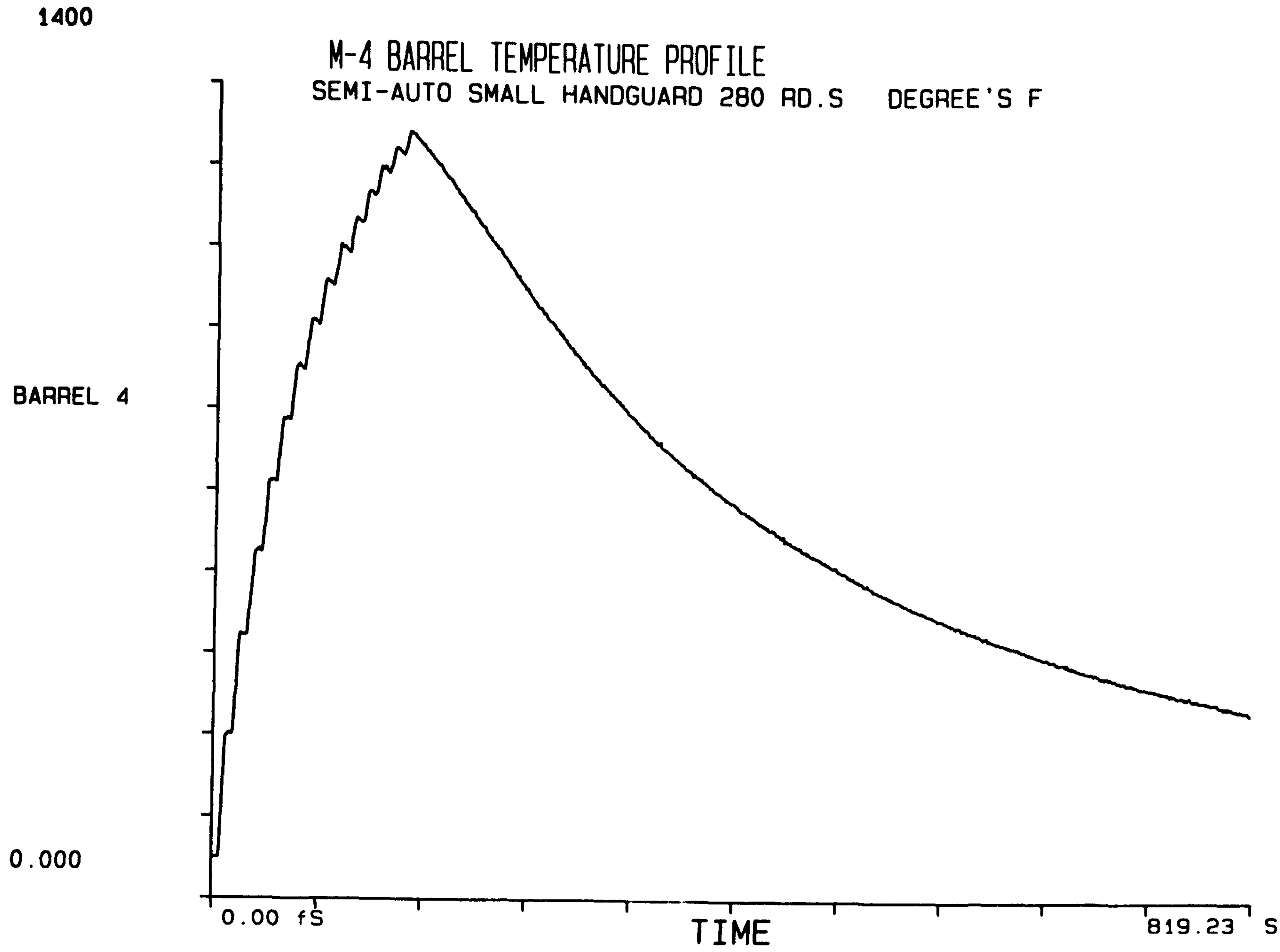
1200
BARREL 3
0.000
0.00 fS
TIME
819.23 S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SEMI-AUTO SMALL HANDGUARD 280 RD.S DEGREE'S F
BARREL 4
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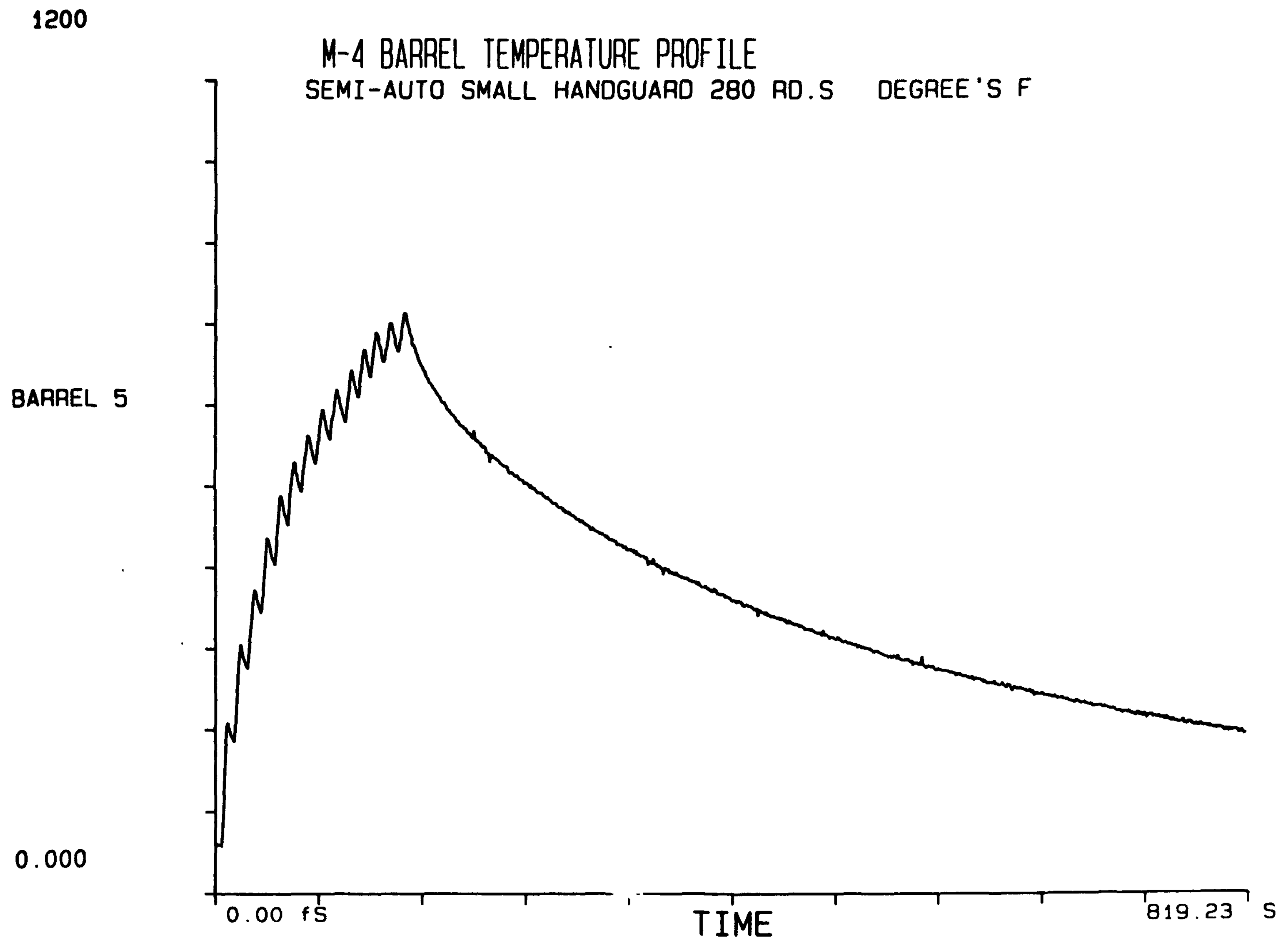
TIME
819.23 S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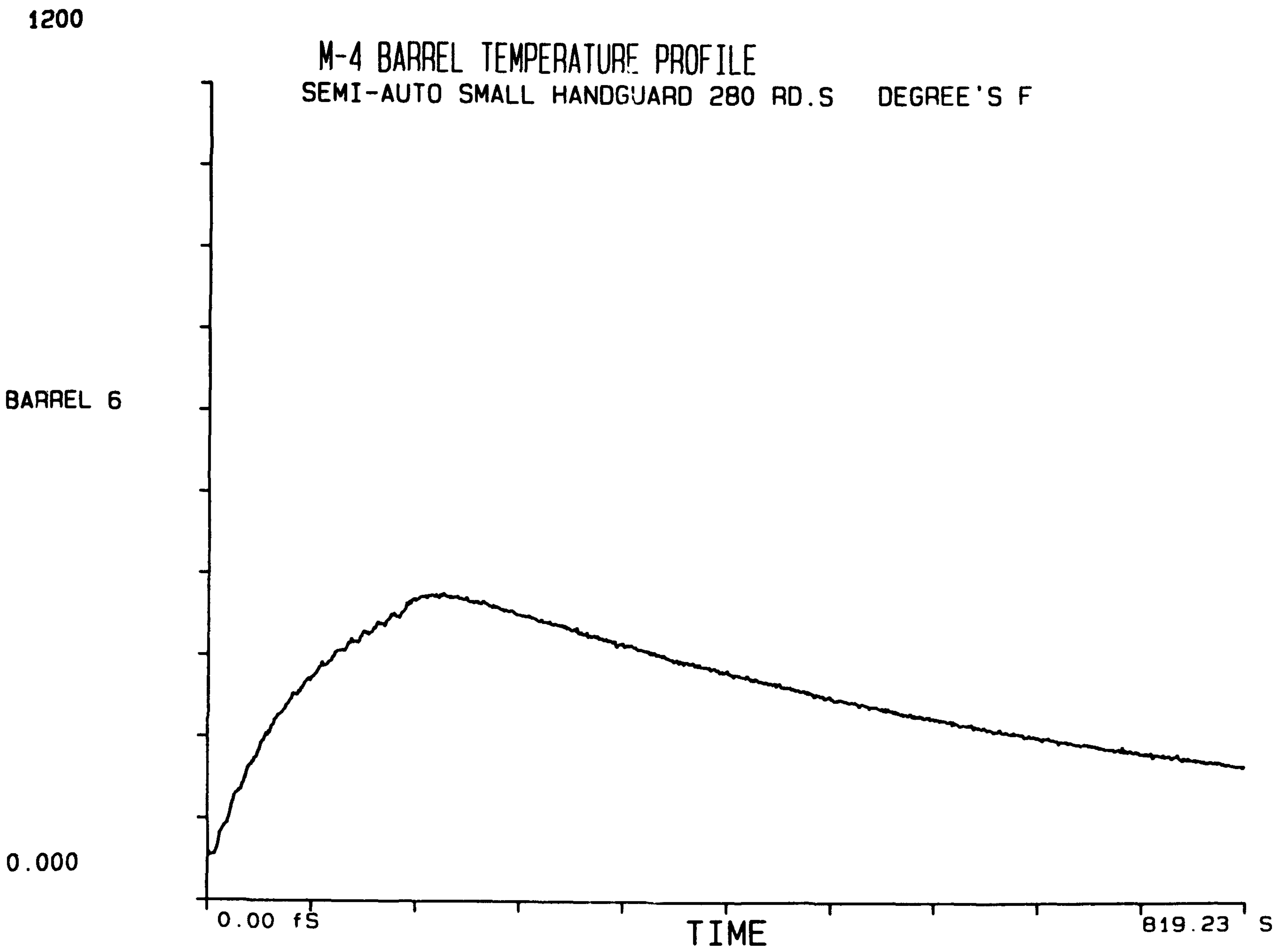
SEMI-AUTO SMALL HANDGUARD 280 RD.S DEGREE'S F
BARREL 5
0.000
0.00 fS
TIME
819.23 S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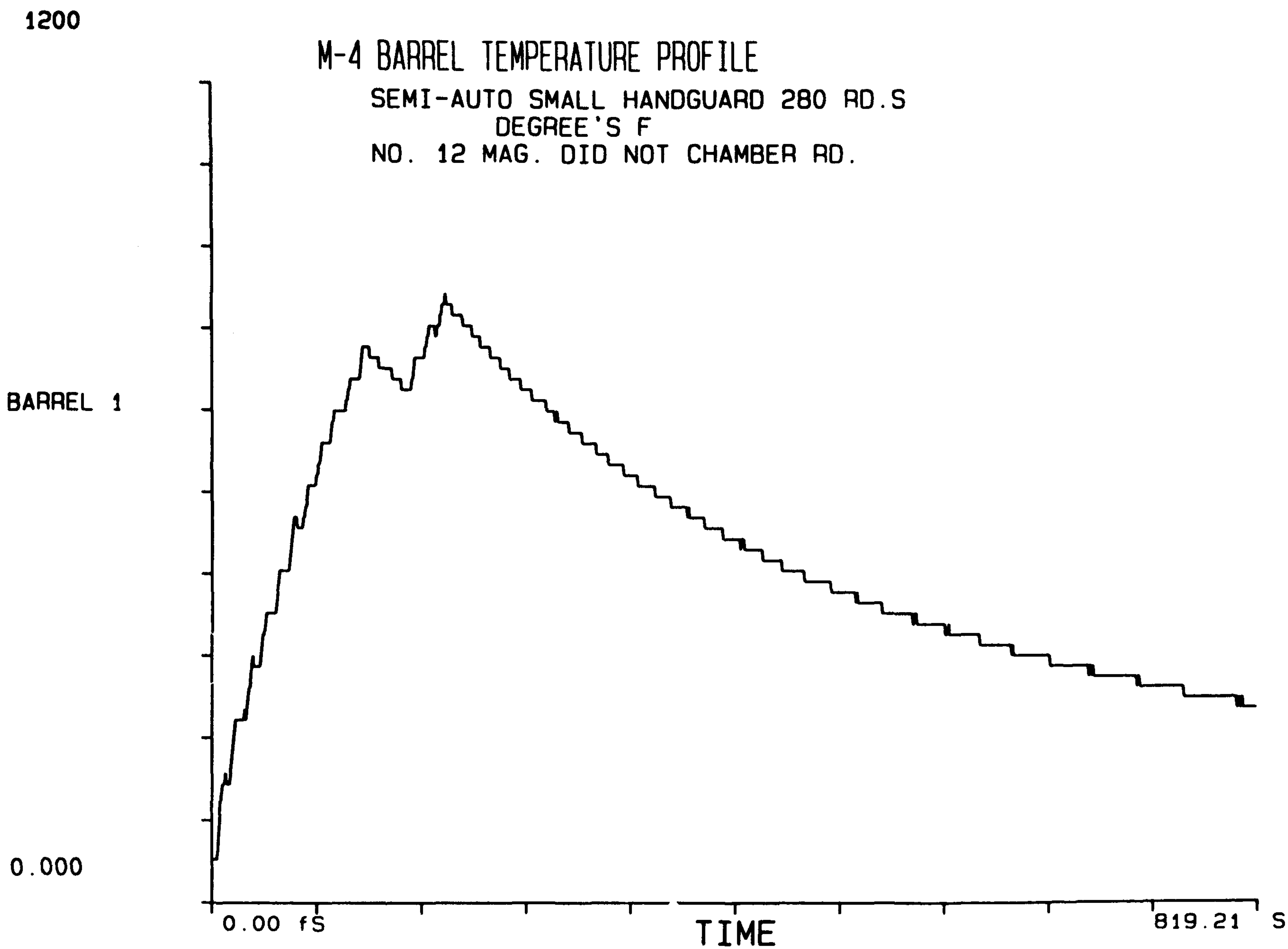
SEMI-AUTO SMALL HANDGUARD 280 RD.S DEGREE'S F
BARREL 6
0.000
0.00 fS
TIME
819.23 S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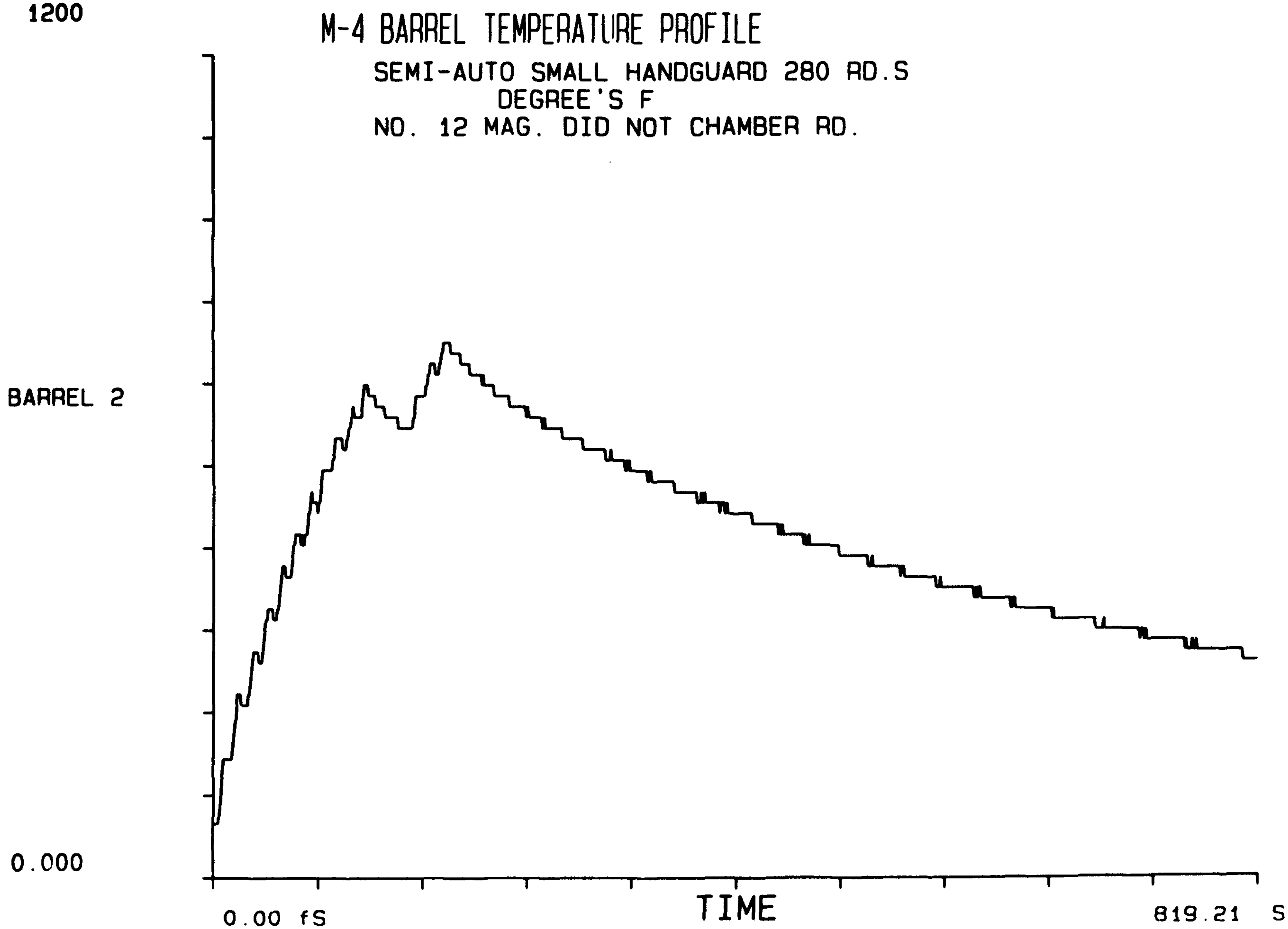
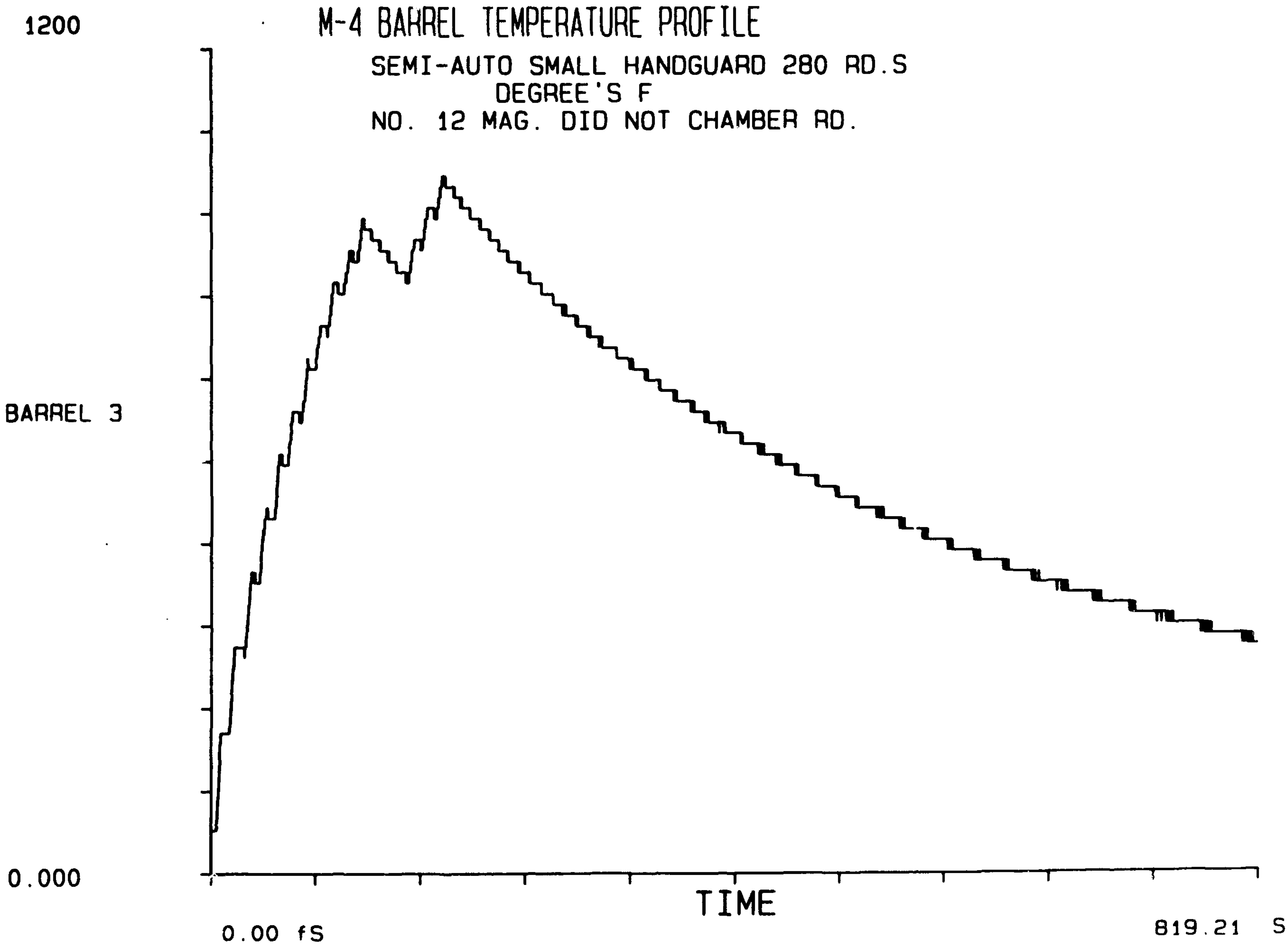
SEMI-AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
BARREL 1
0.000
0.00 fS
TIME
819.21
S


1200
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
BARREL 2
0.000
0.00 fS
TIME
819.21 S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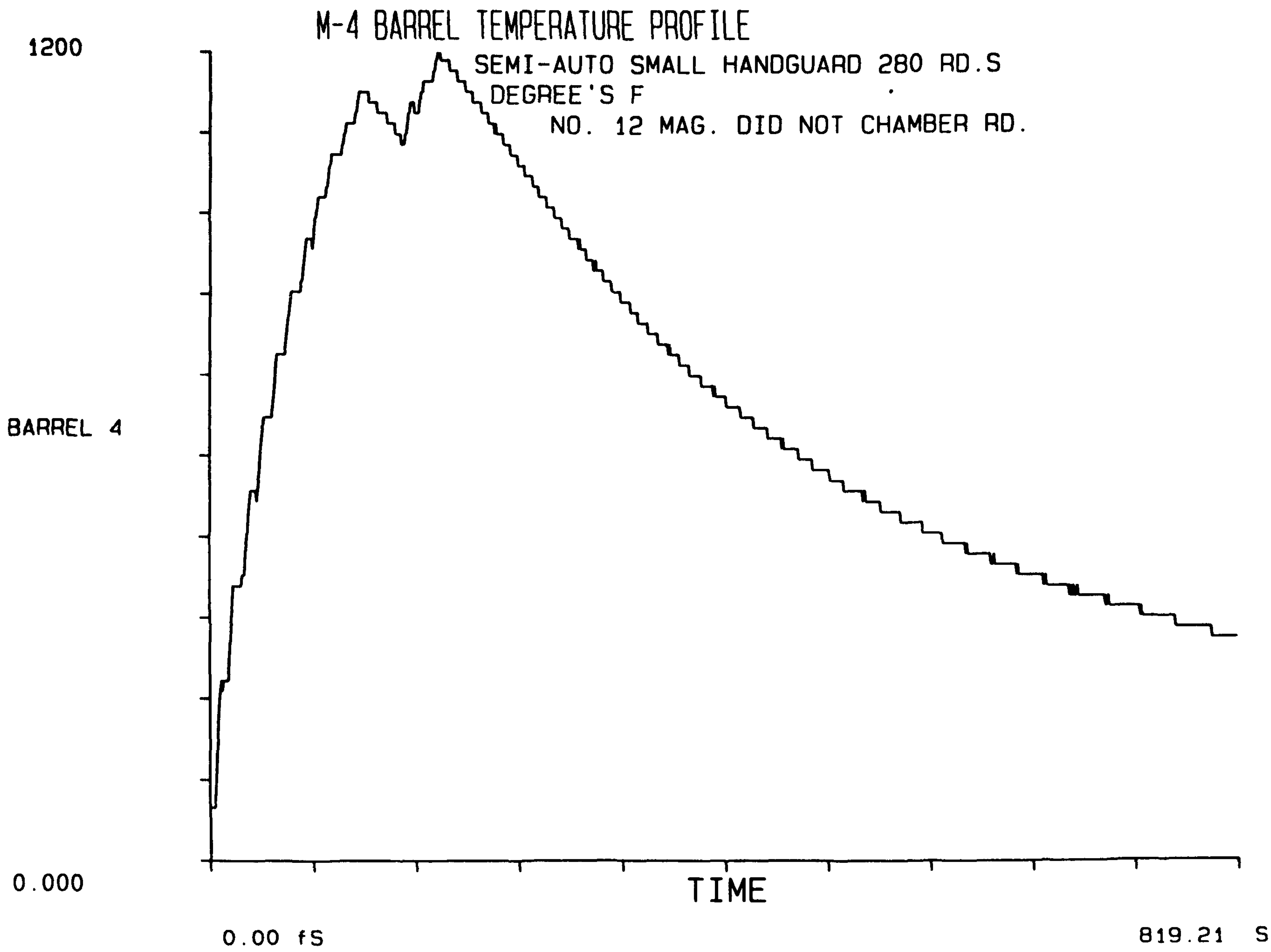
SEMI-AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
1200
BARREL 3
0.000
TIME
0.00 fS
819.21 S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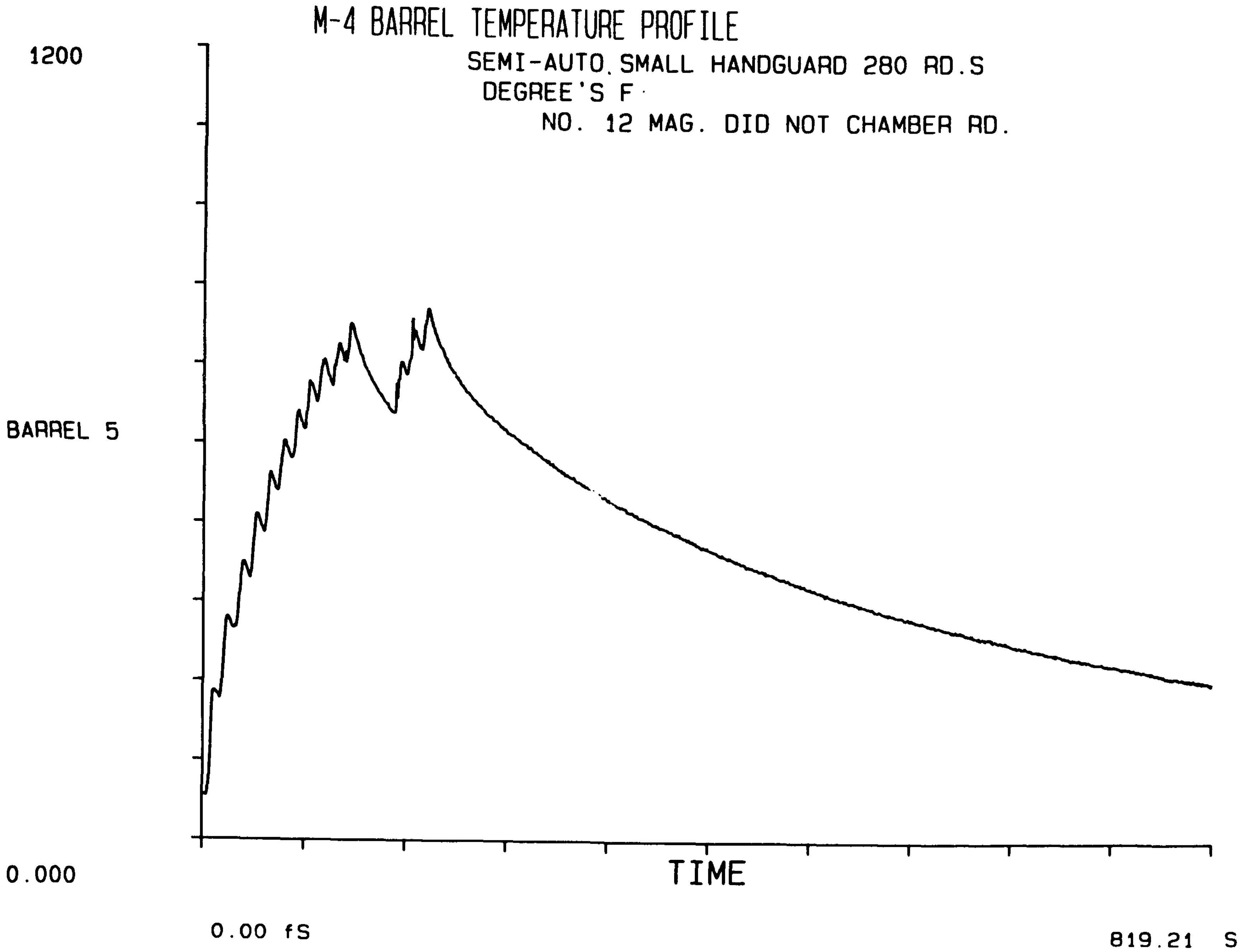
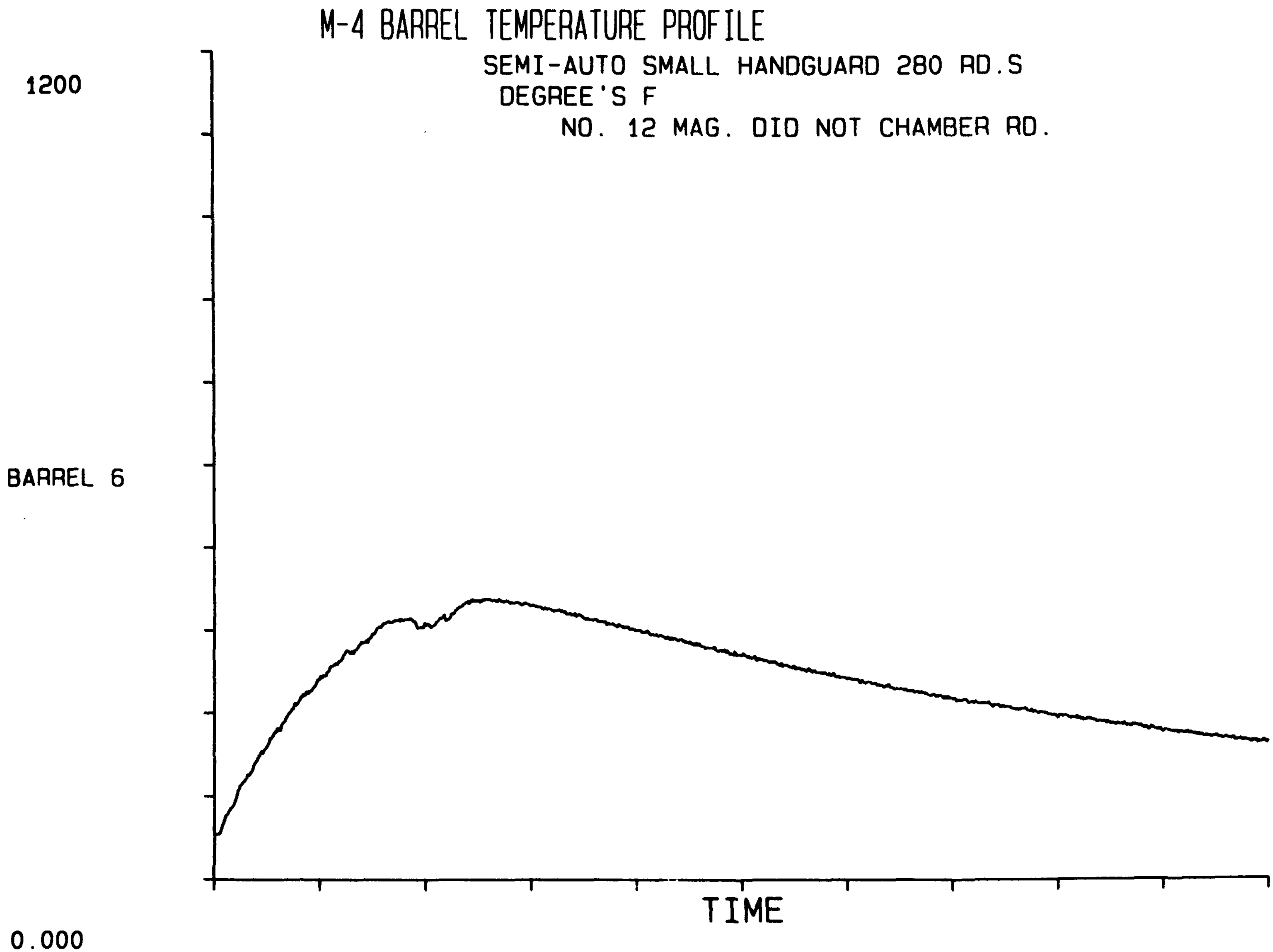
SEMI-AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
1200
BARREL 4
0.000
TIME
0.00 fS
819.21 S


M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO. SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
1200
BARREL 5
0.000
TIME
0.00 fS
819.21 S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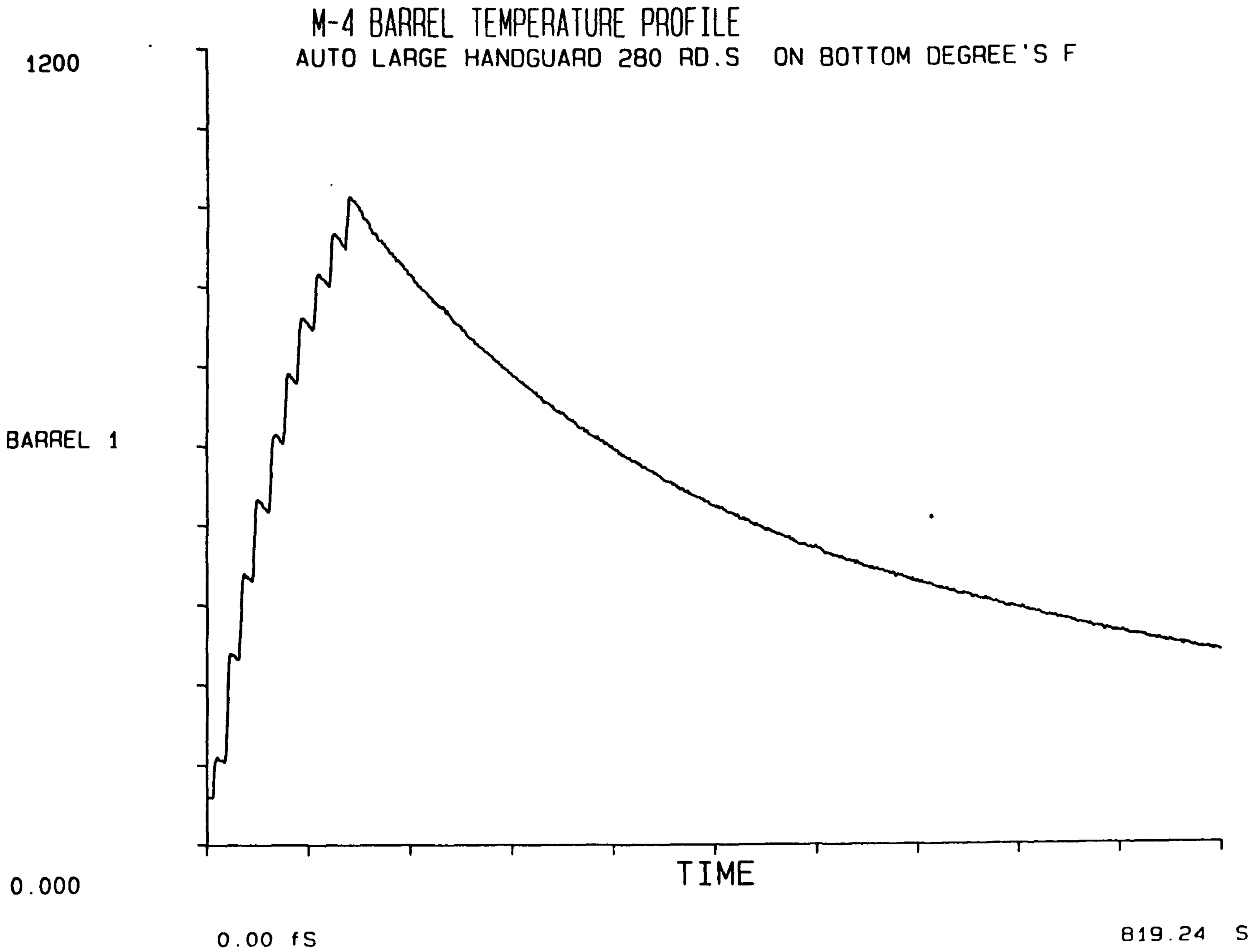
SEMI-AUTO SMALL HANDGUARD 280 RD.S
DEGREE'S F
NO. 12 MAG. DID NOT CHAMBER RD.
1200
BARREL 6
0.000
TIME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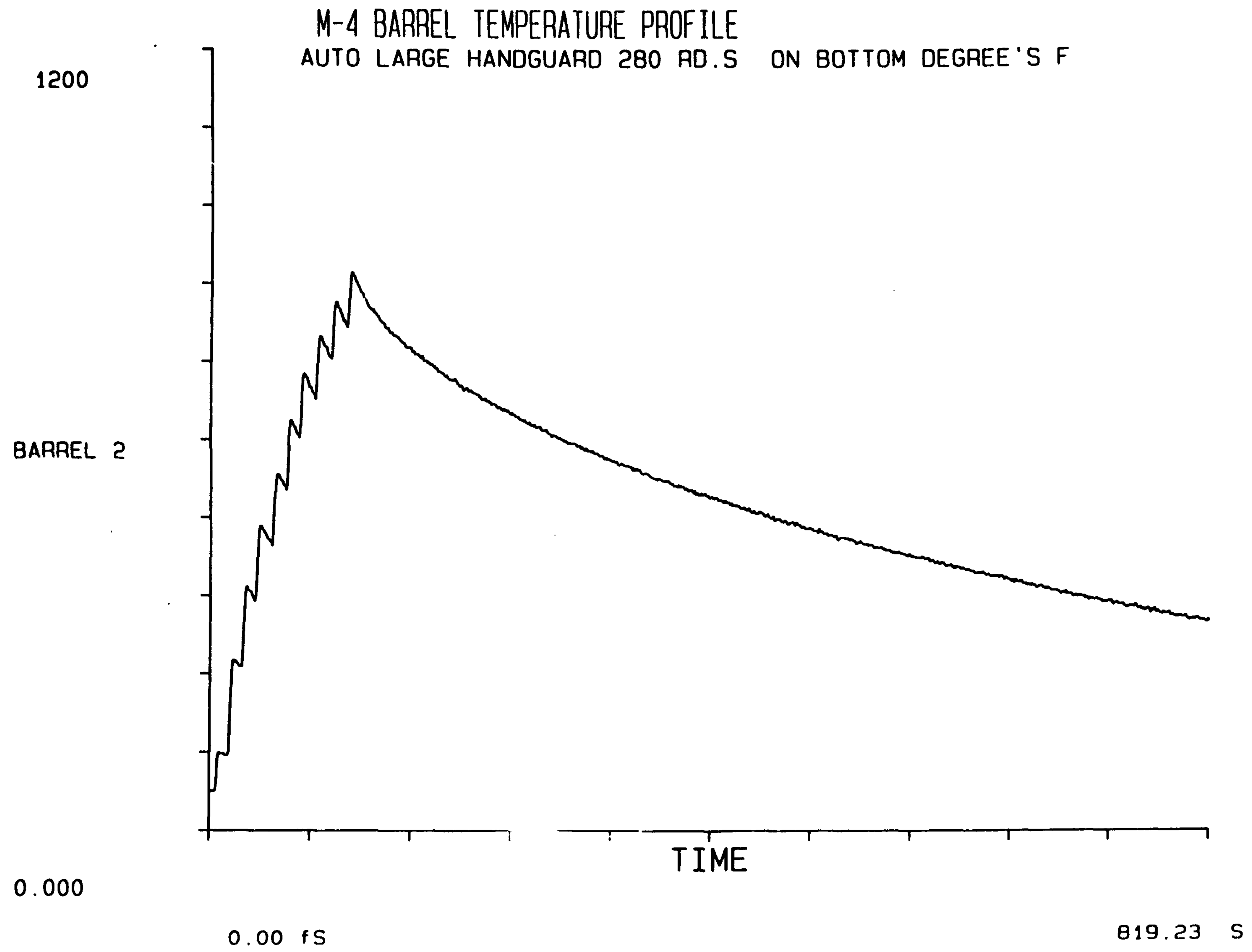
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
1200
BARREL 1
0.000
TIME
0.00 fS
819.24 S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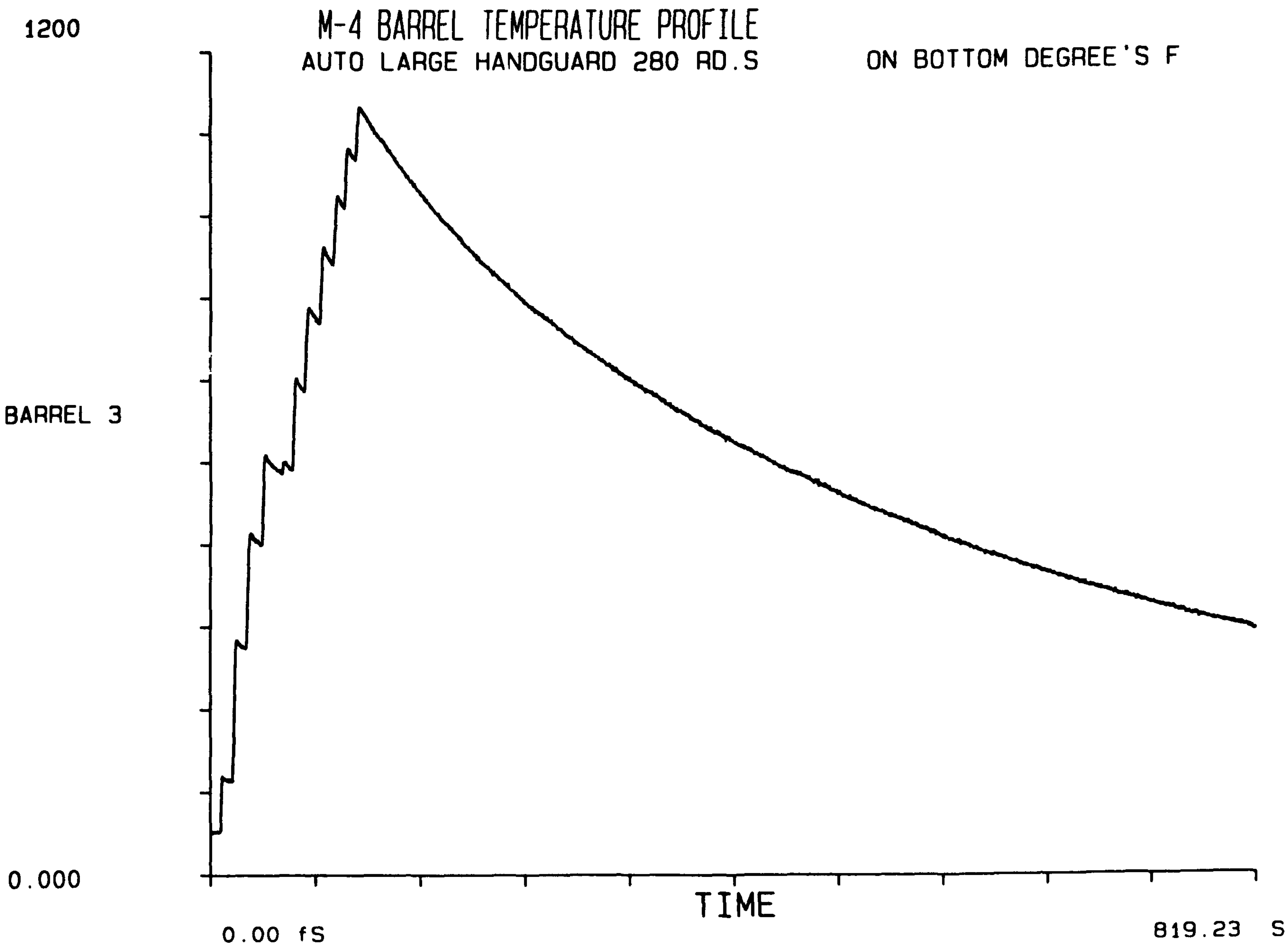
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
1200
BARREL 2
0.000
TIME
0.00 fS
819.23 S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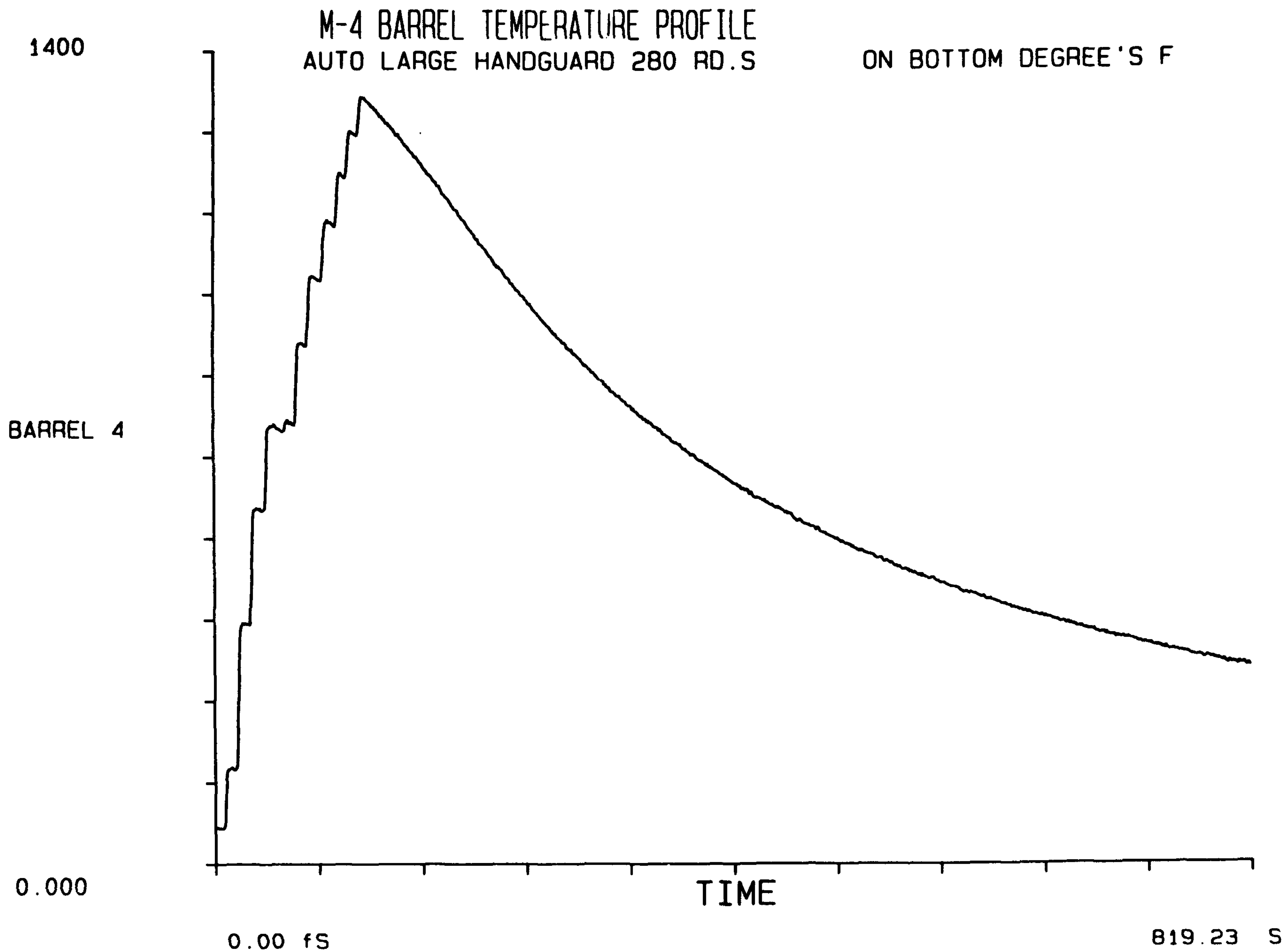
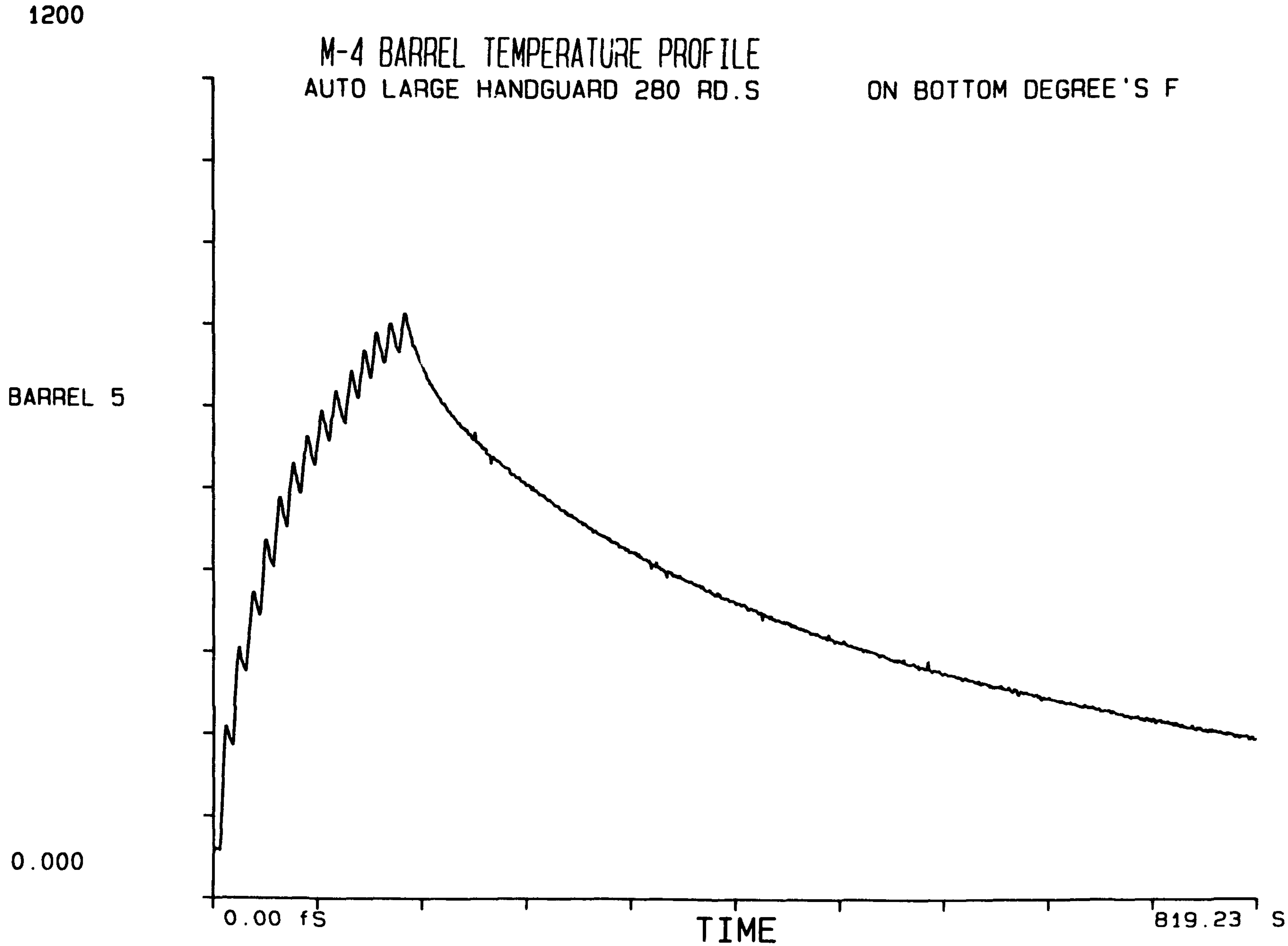
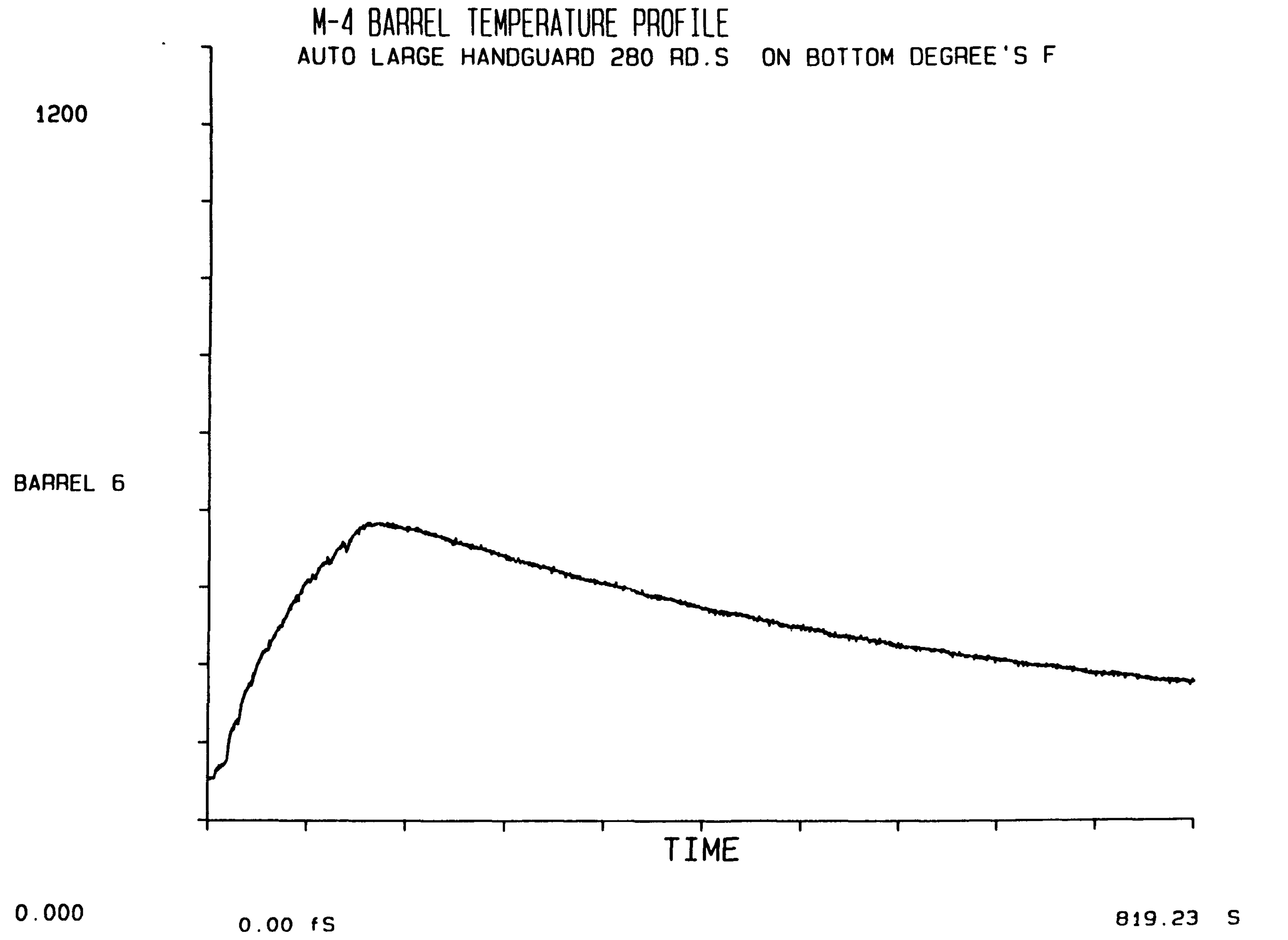
M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S
ON BOTTOM DEGREE'S F
BARREL 3
0.000
TIME
0.00 fS
819.23 S


M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S
ON BOTTOM DEGREE'S F
1400
BARREL 4
0.000
TIME
0.00 fS
819.23 S


1200
M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S
ON BOTTOM DEGREE'S F
BARREL 5
0.000
0.00 fS
TIME
819.23
S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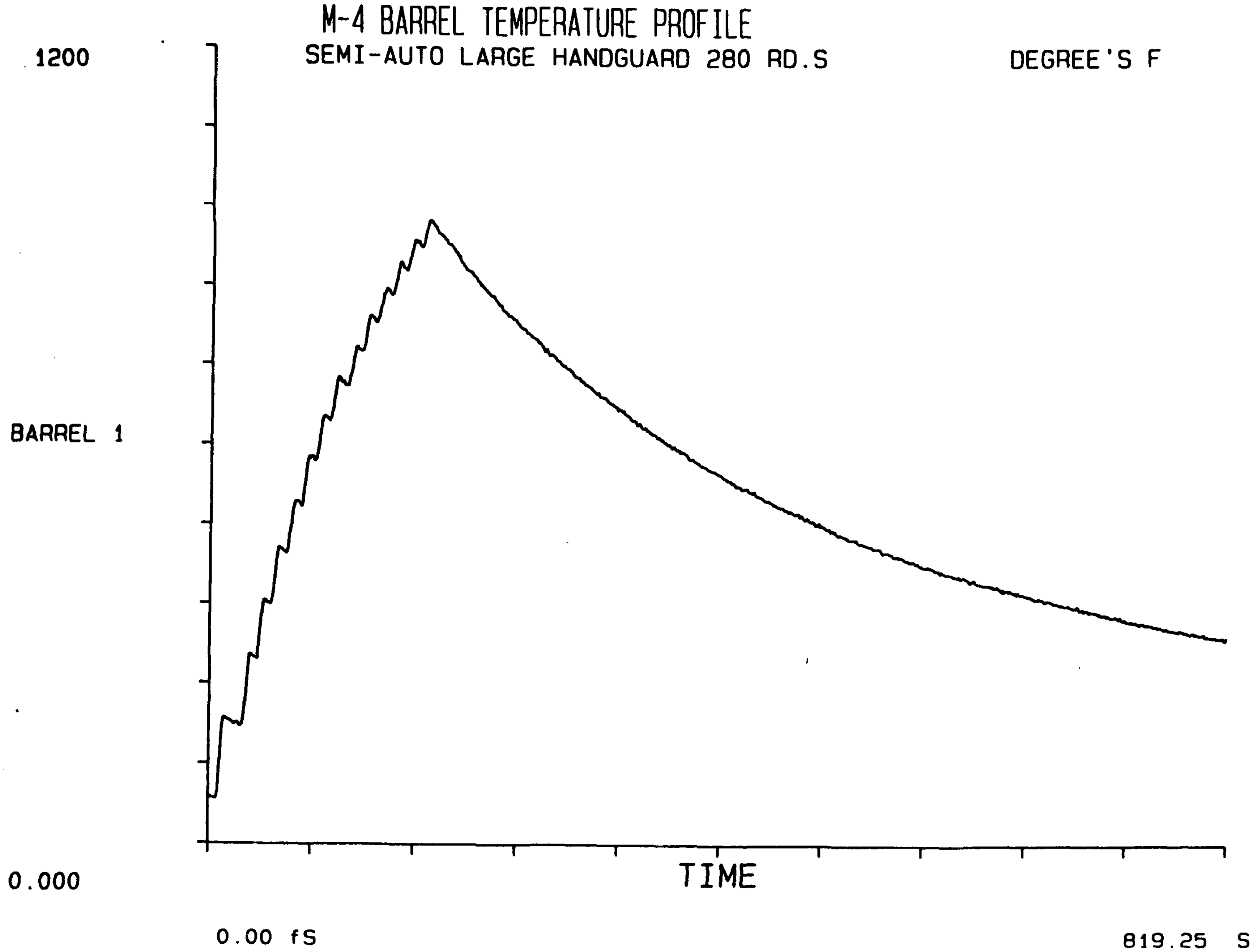
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
1200
BARREL 6
0.000
TIME
0.00 fS
819.23 S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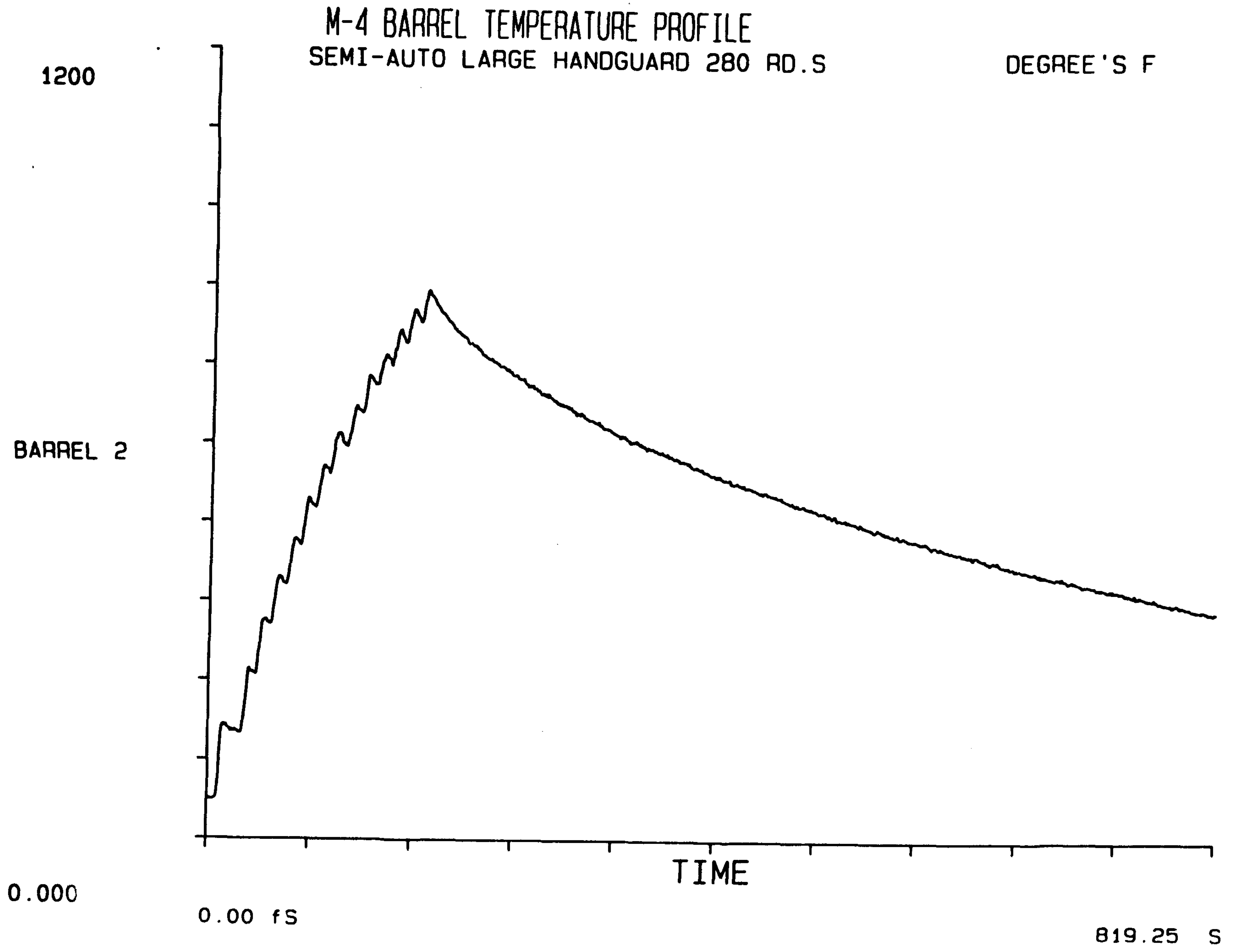
DEGREE'S F
1200
BARREL 1
0.000
TIME
0.00 fS
819.25 S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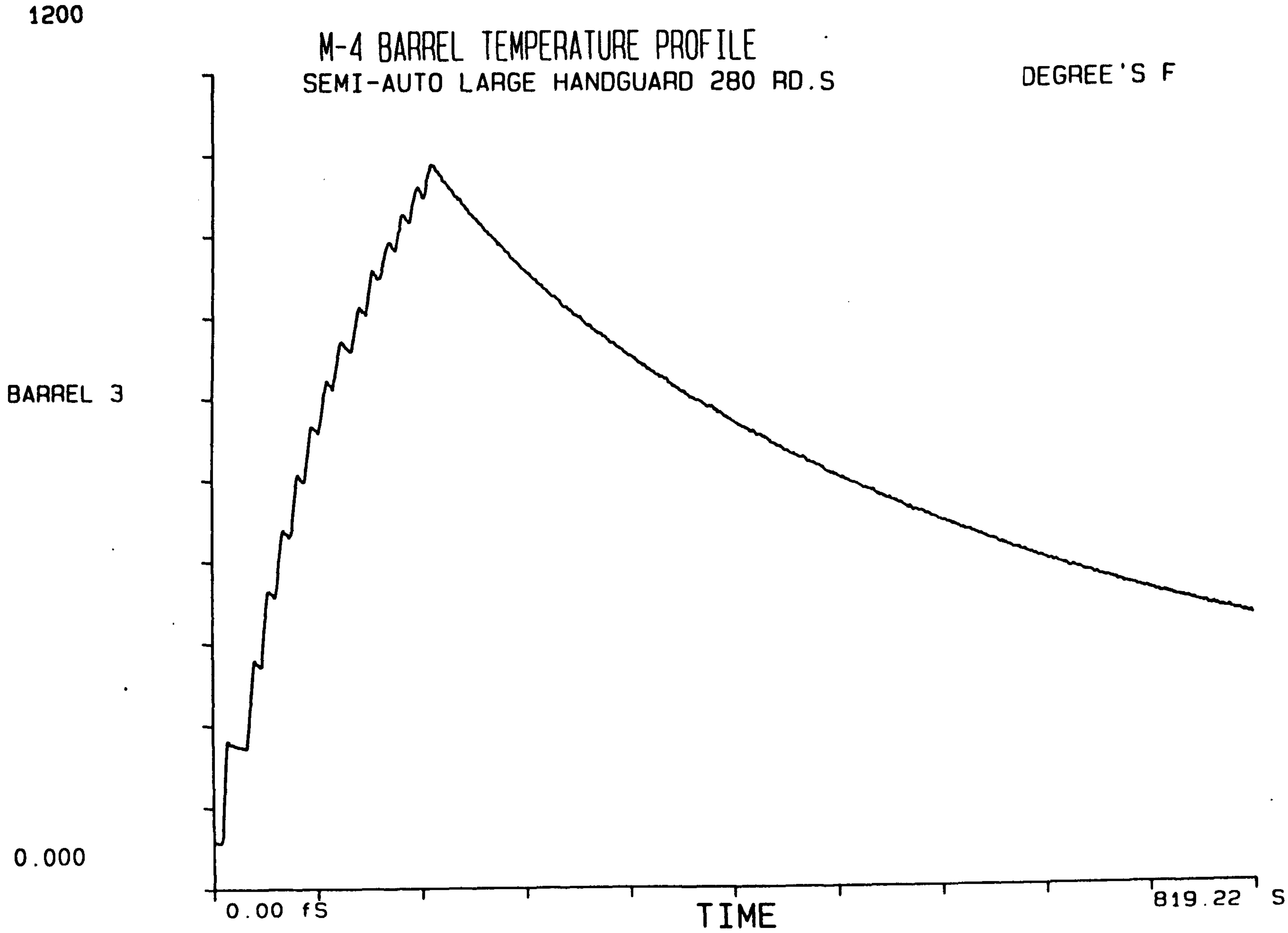
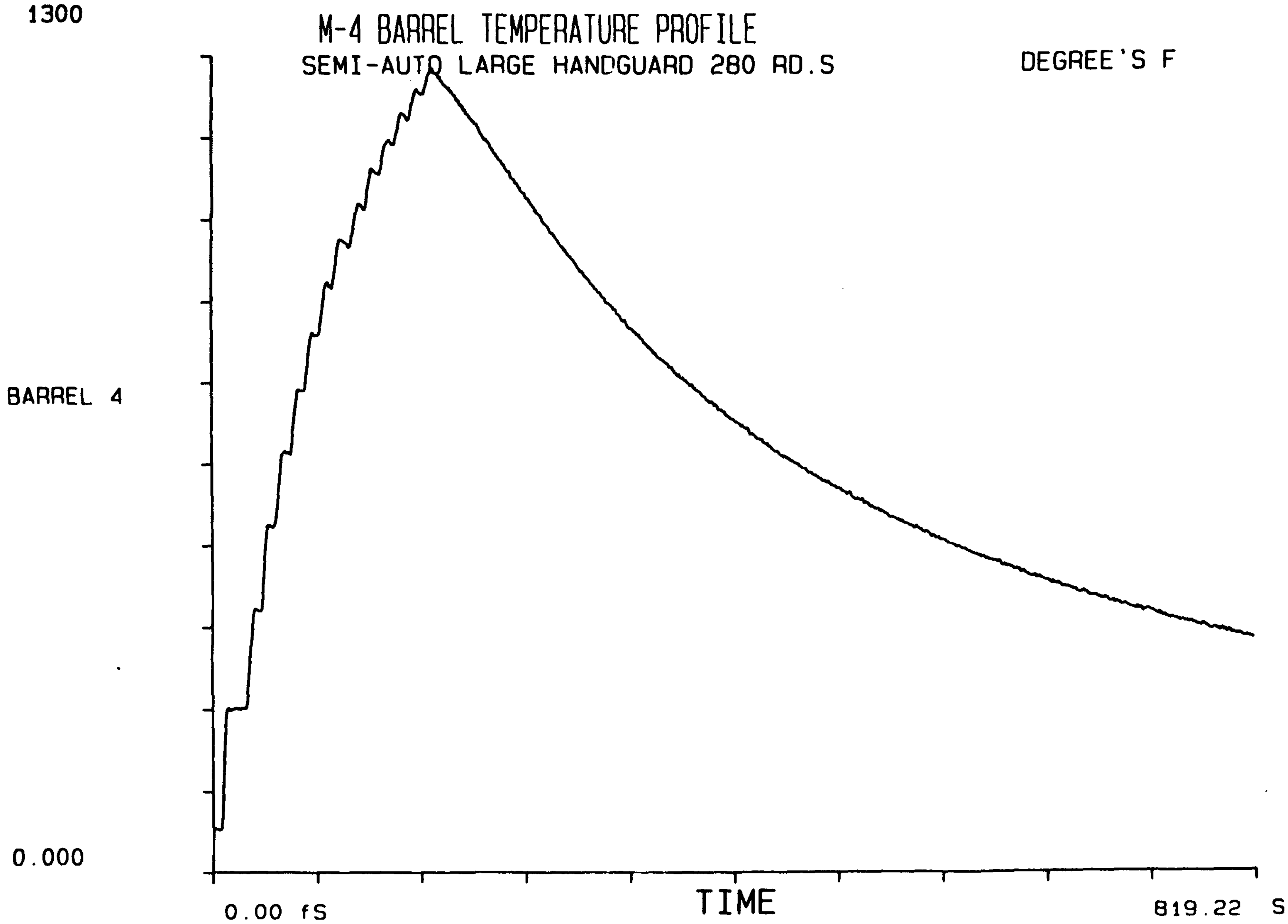
DEGREE'S F
1200
BARREL 2
0.000
0.00 fS
TIME
819.25 S


1200
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S
DEGREE'S F
BARREL 3
0.000
0.00 fS
TIME
819.22 S



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DEGREE'S F
BARREL 4
0.000
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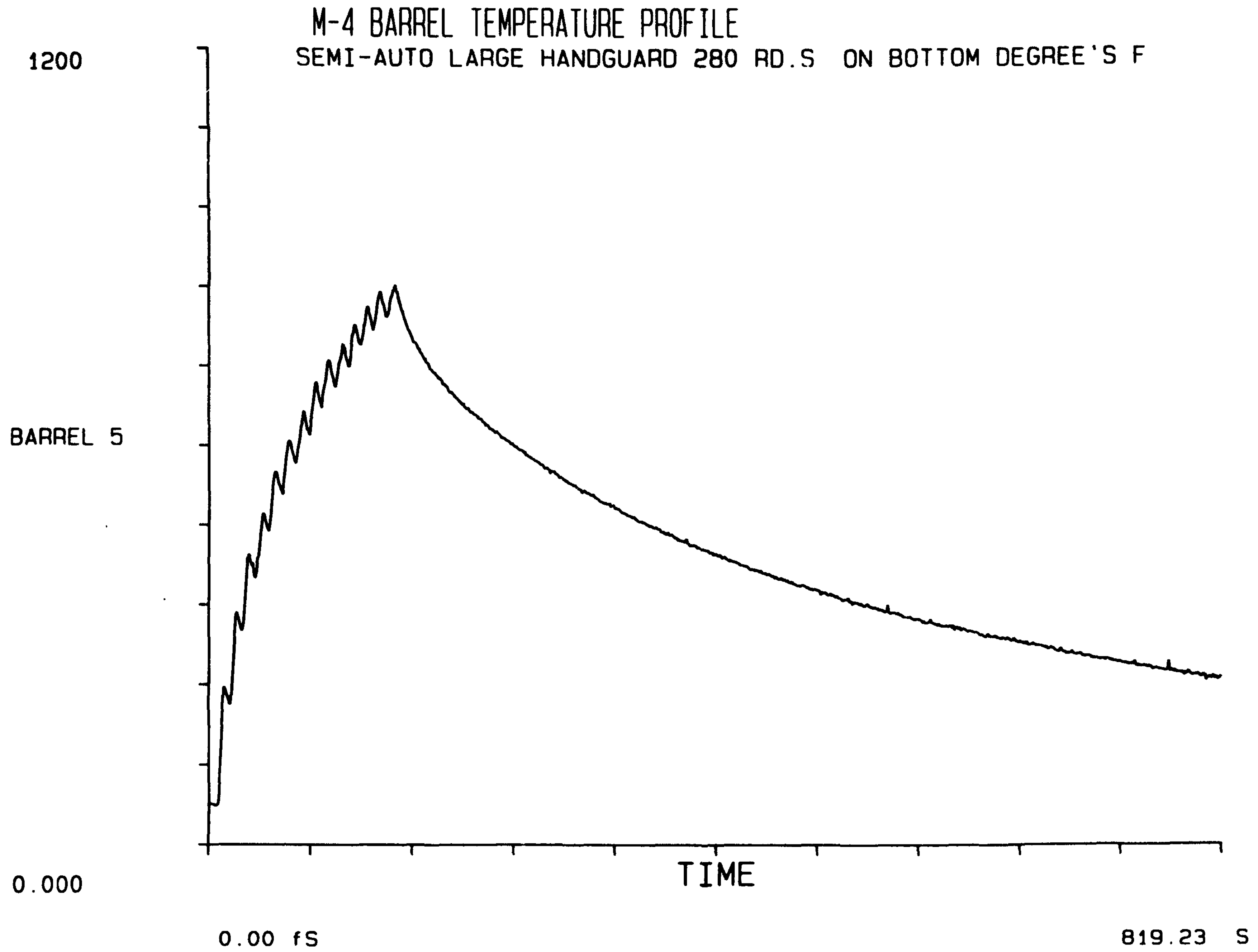
TIME
819.22 S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1200
BARREL 5
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TIME
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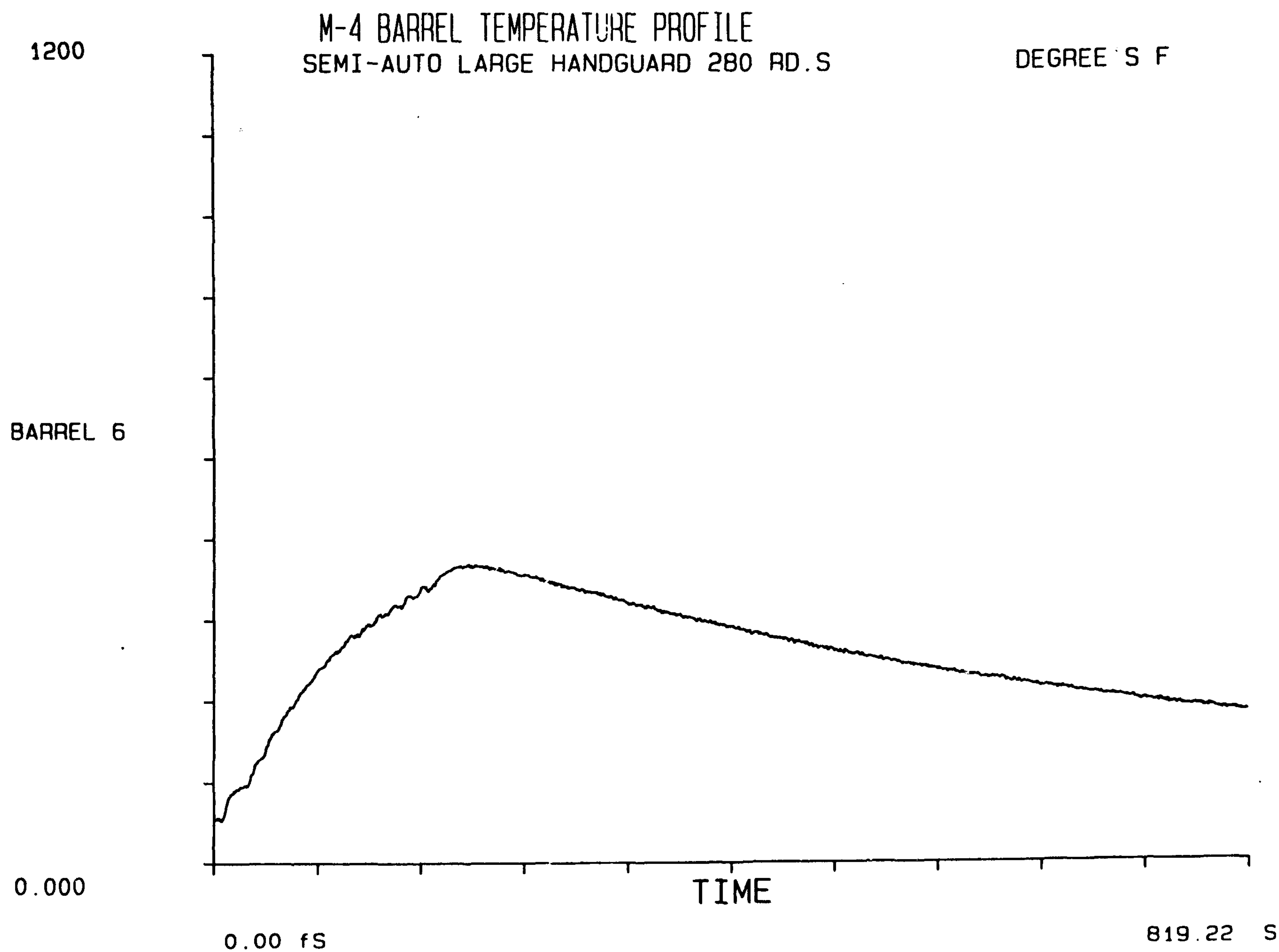
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DEGREE'S F
1200
BARREL 6
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TIME
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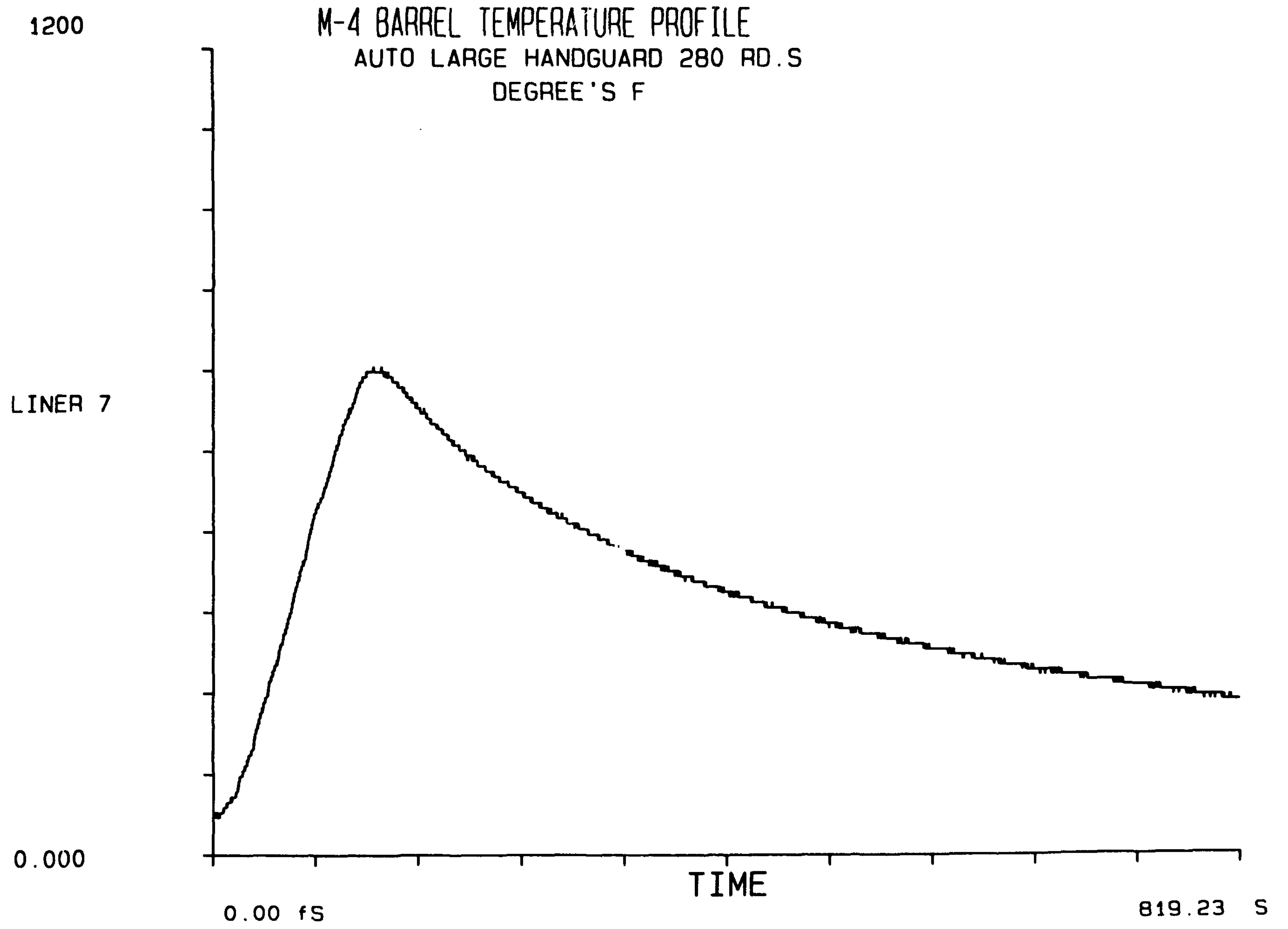
819.22 S



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DEGREE'S F
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LINER 7
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TIME
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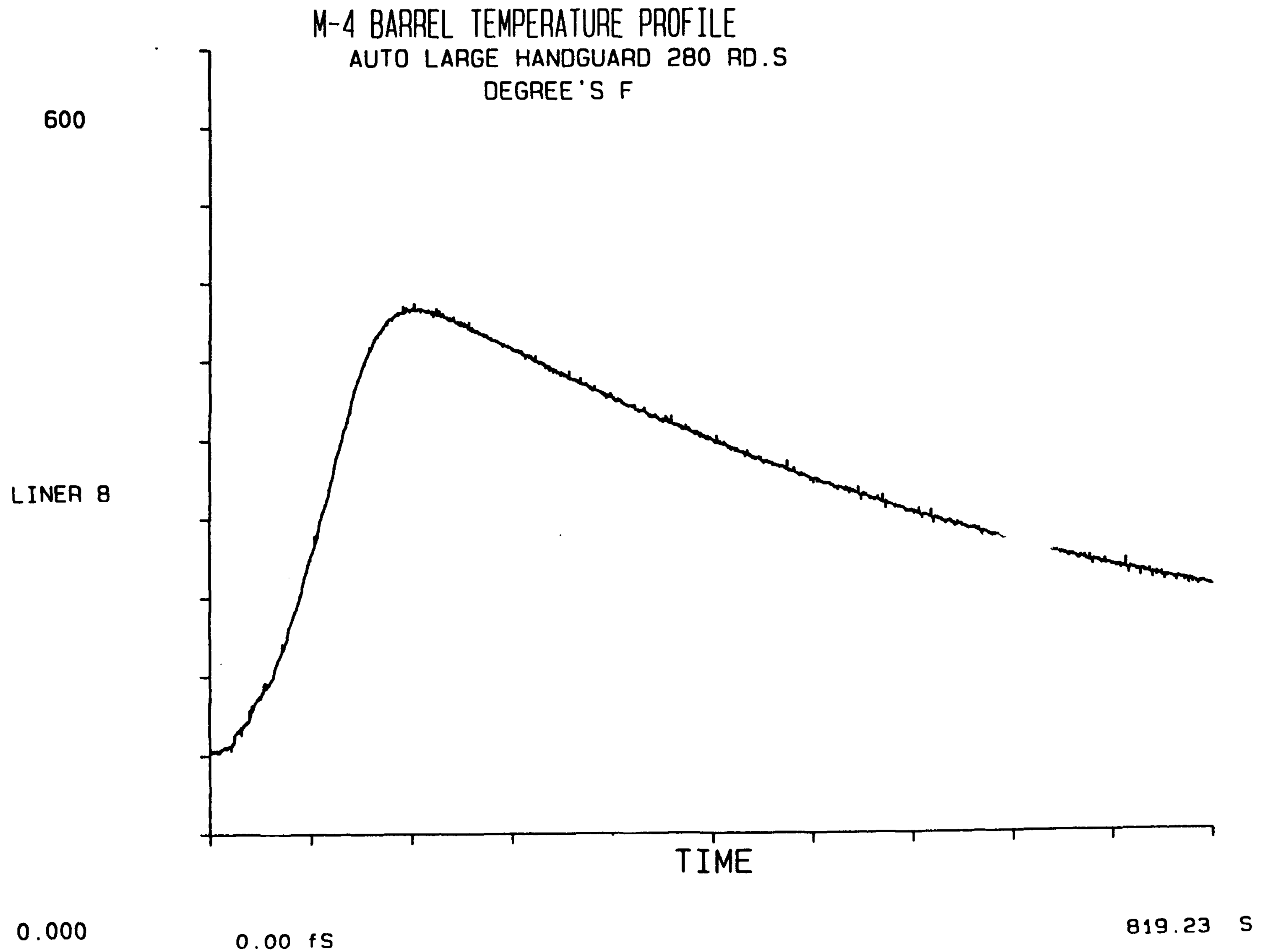
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DEGREE'S F
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LINER 8
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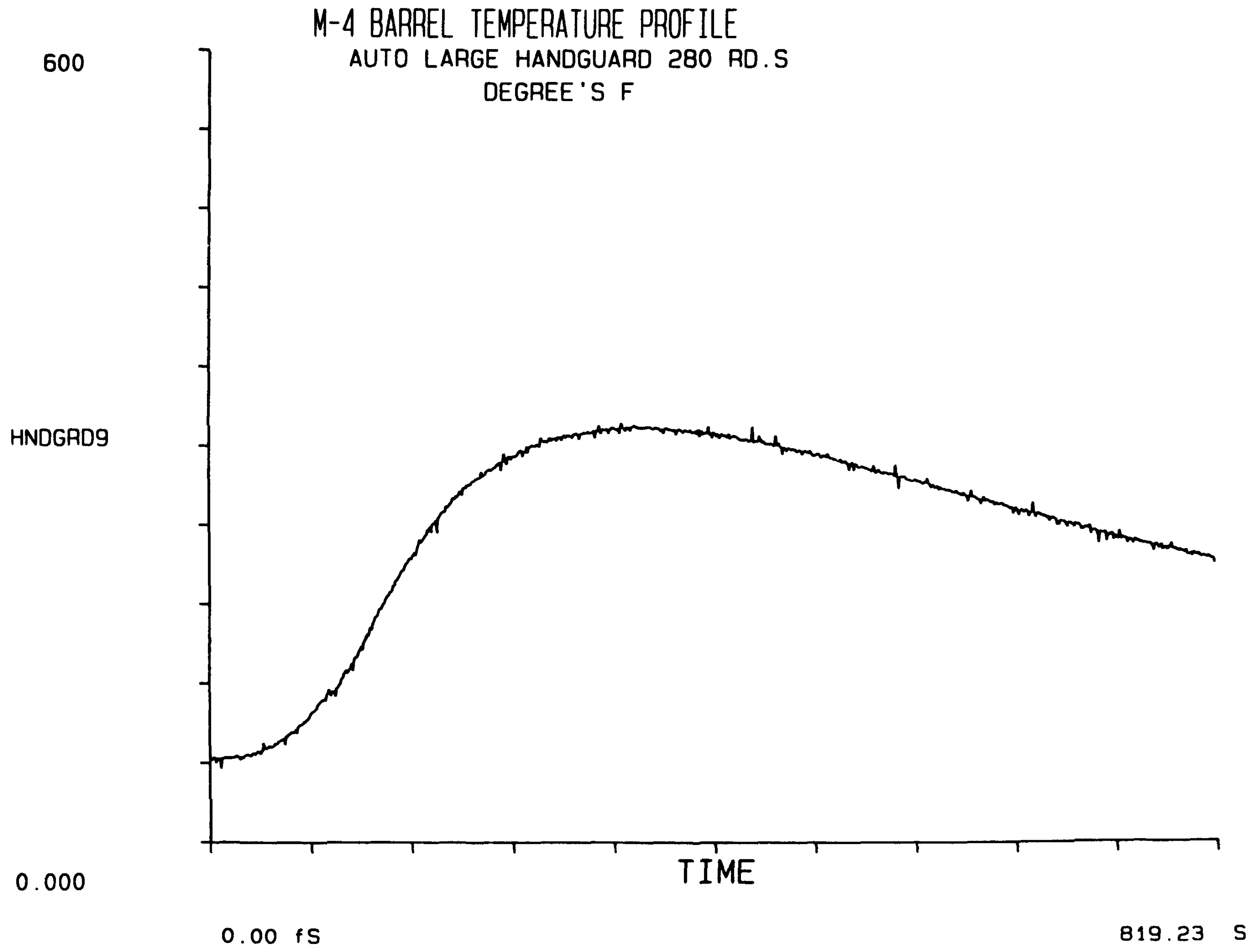
TIME
819.23 S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TIME
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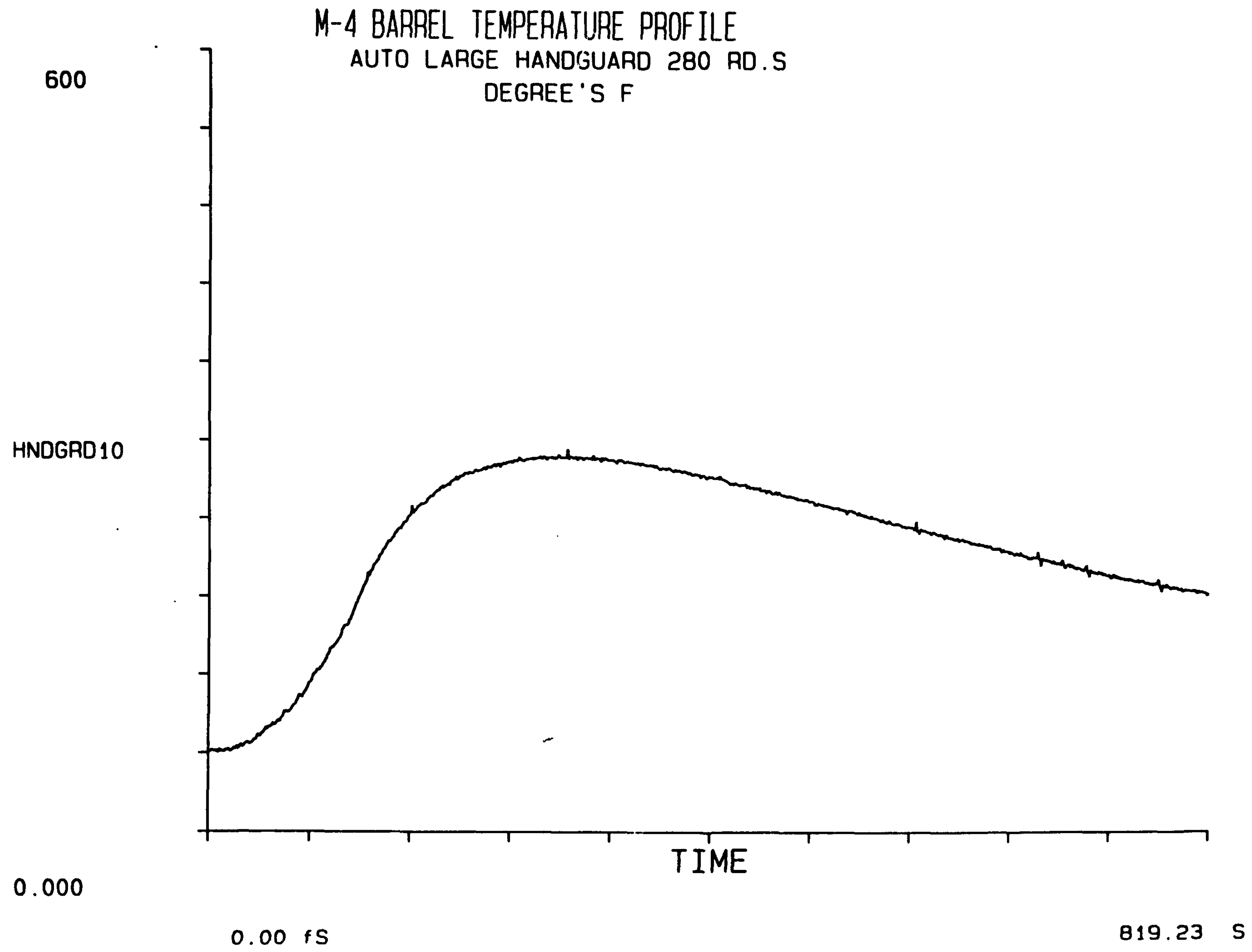
819.23 S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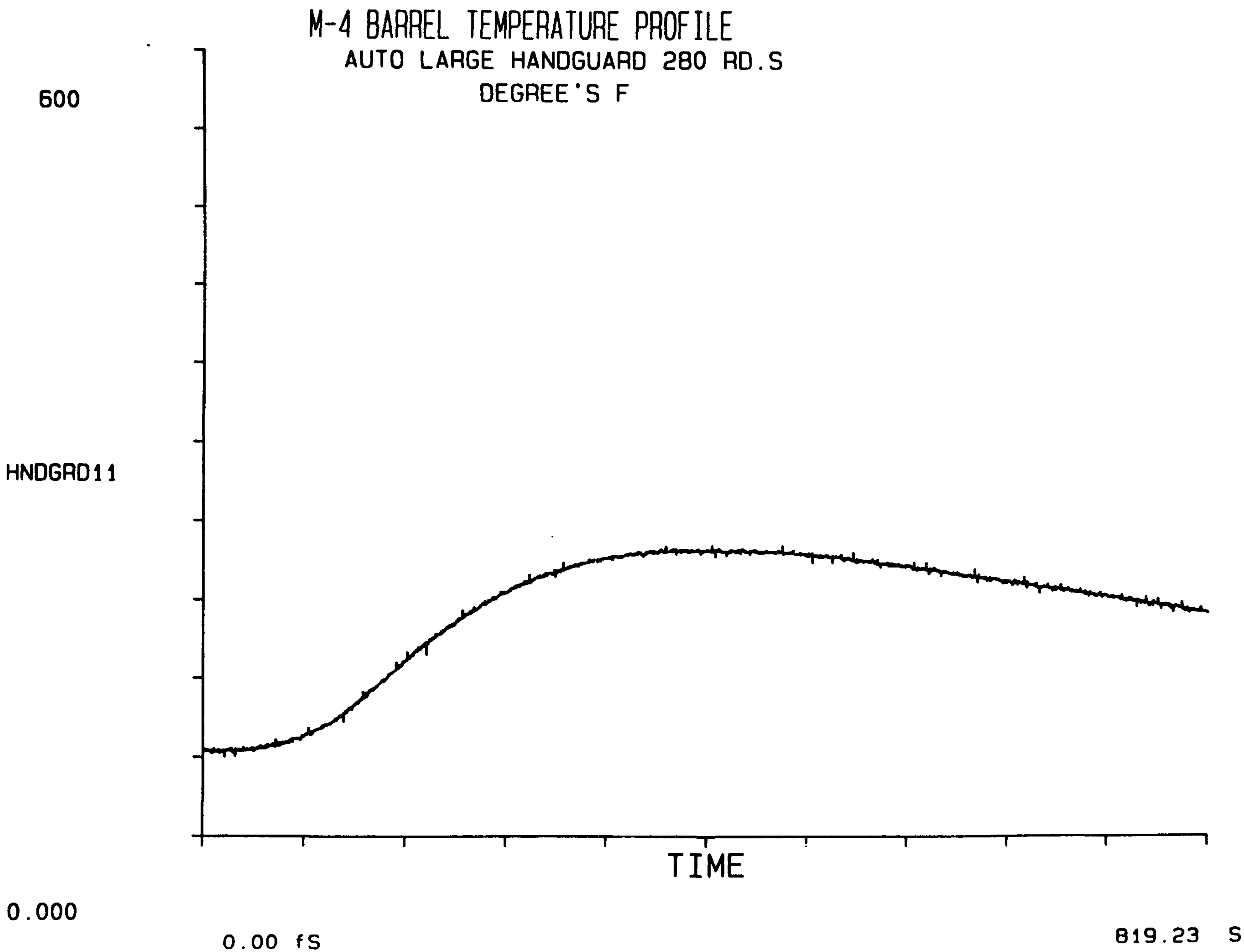
819.23 S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TIME
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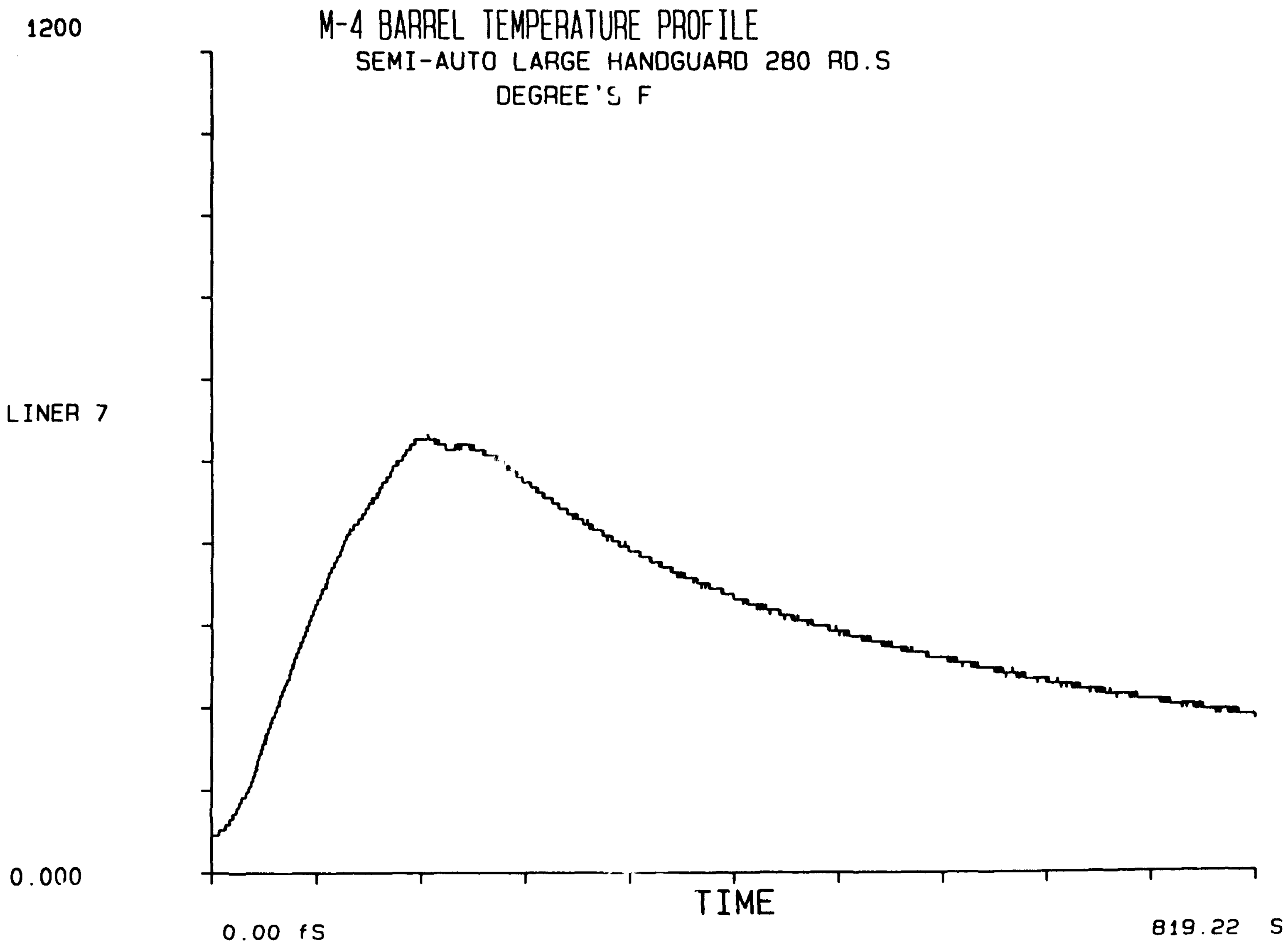
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1200
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TIME
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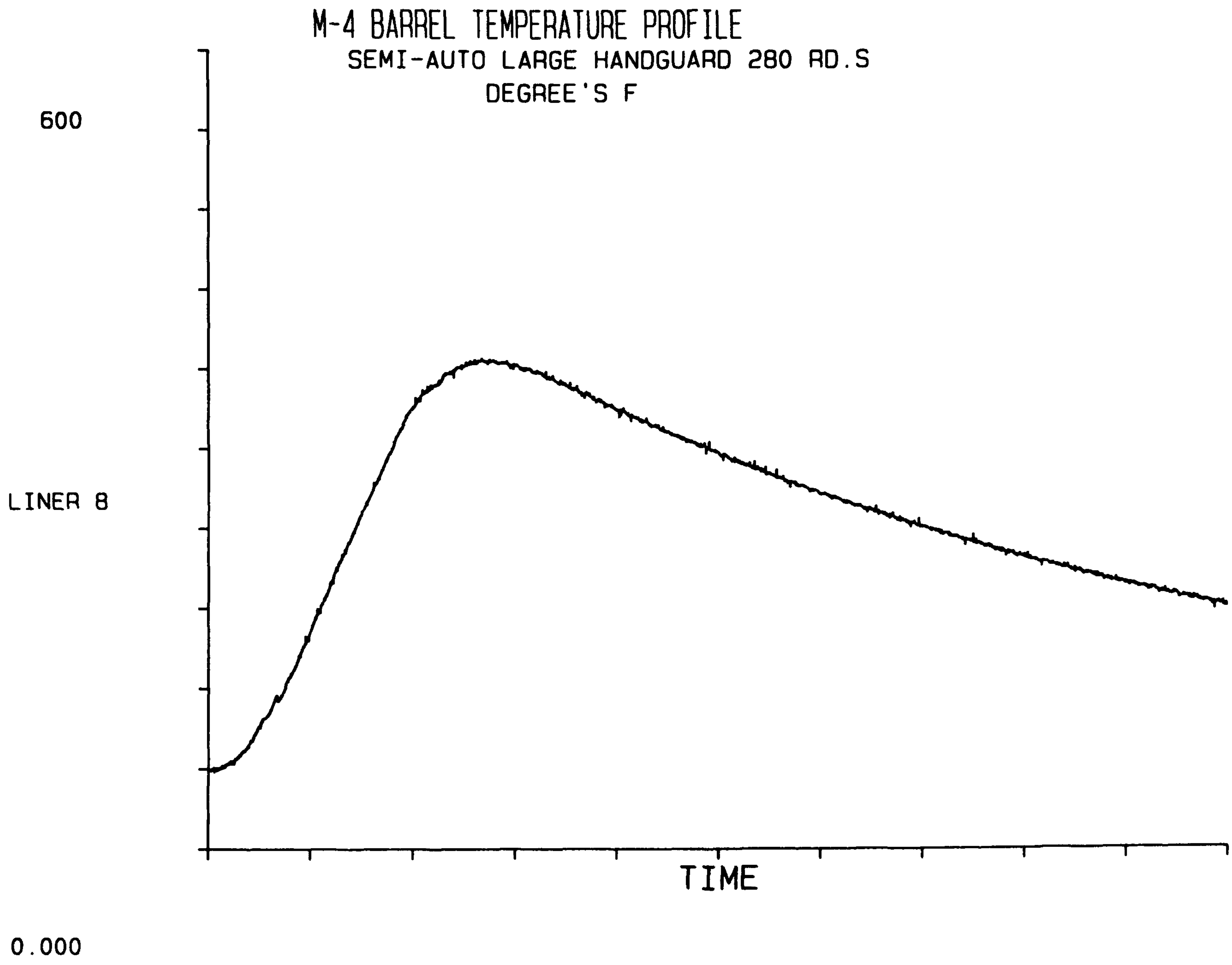
819.22 S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DEGREE'S F
600
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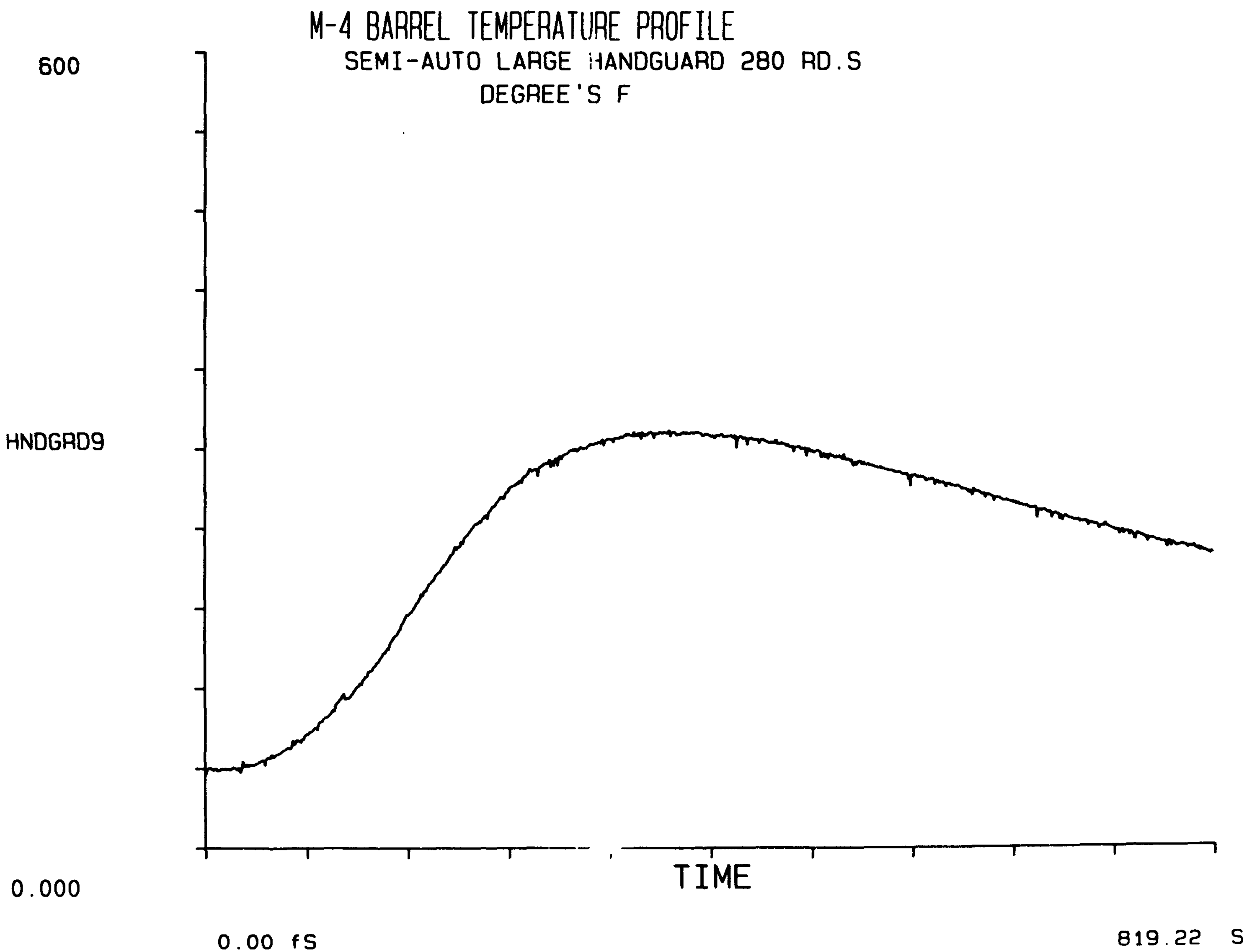
TIME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DEGREE'S F
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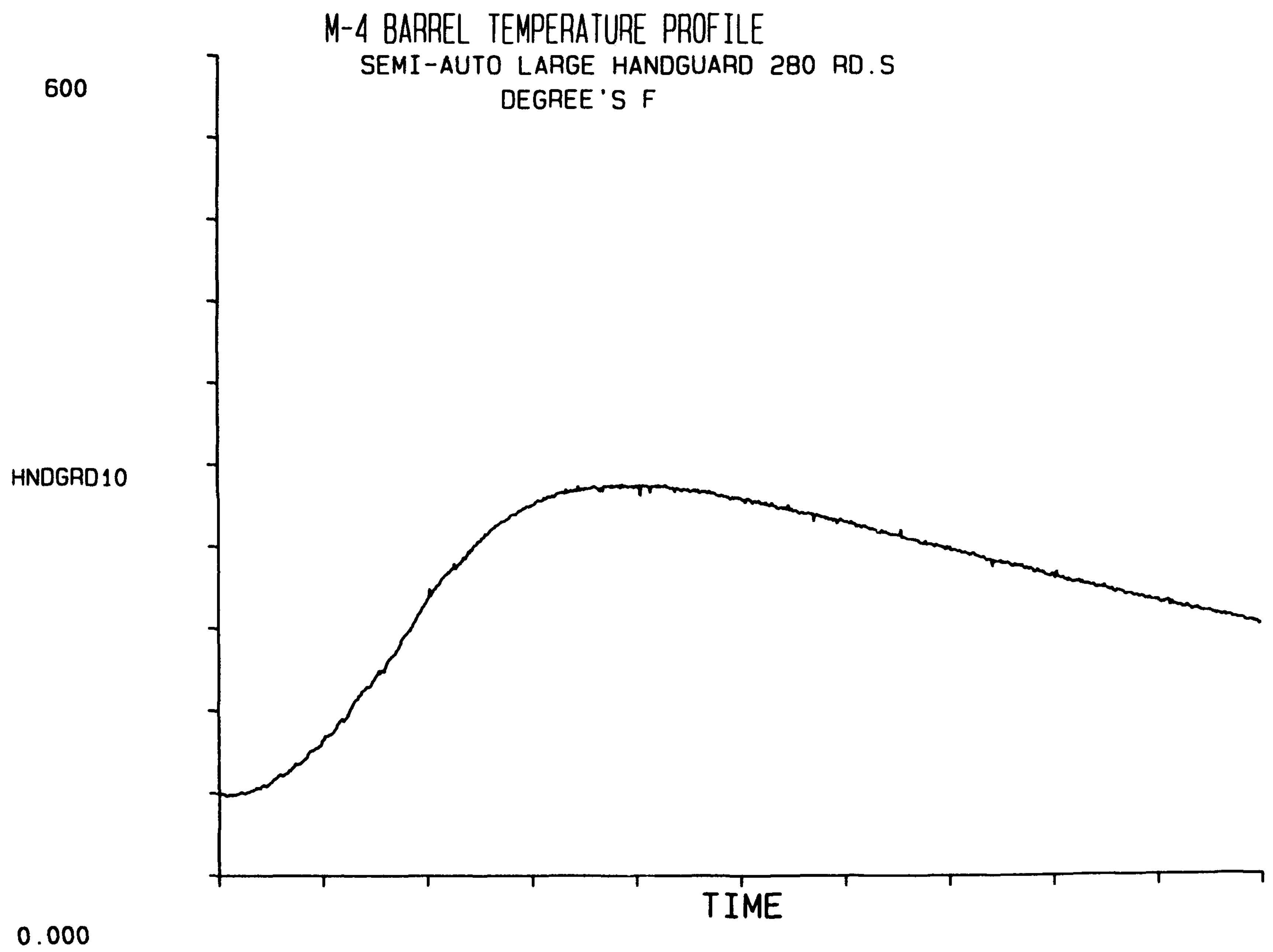
819.22 S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SEMI-AUTO LARGE HANDGUARD 280 RD.S
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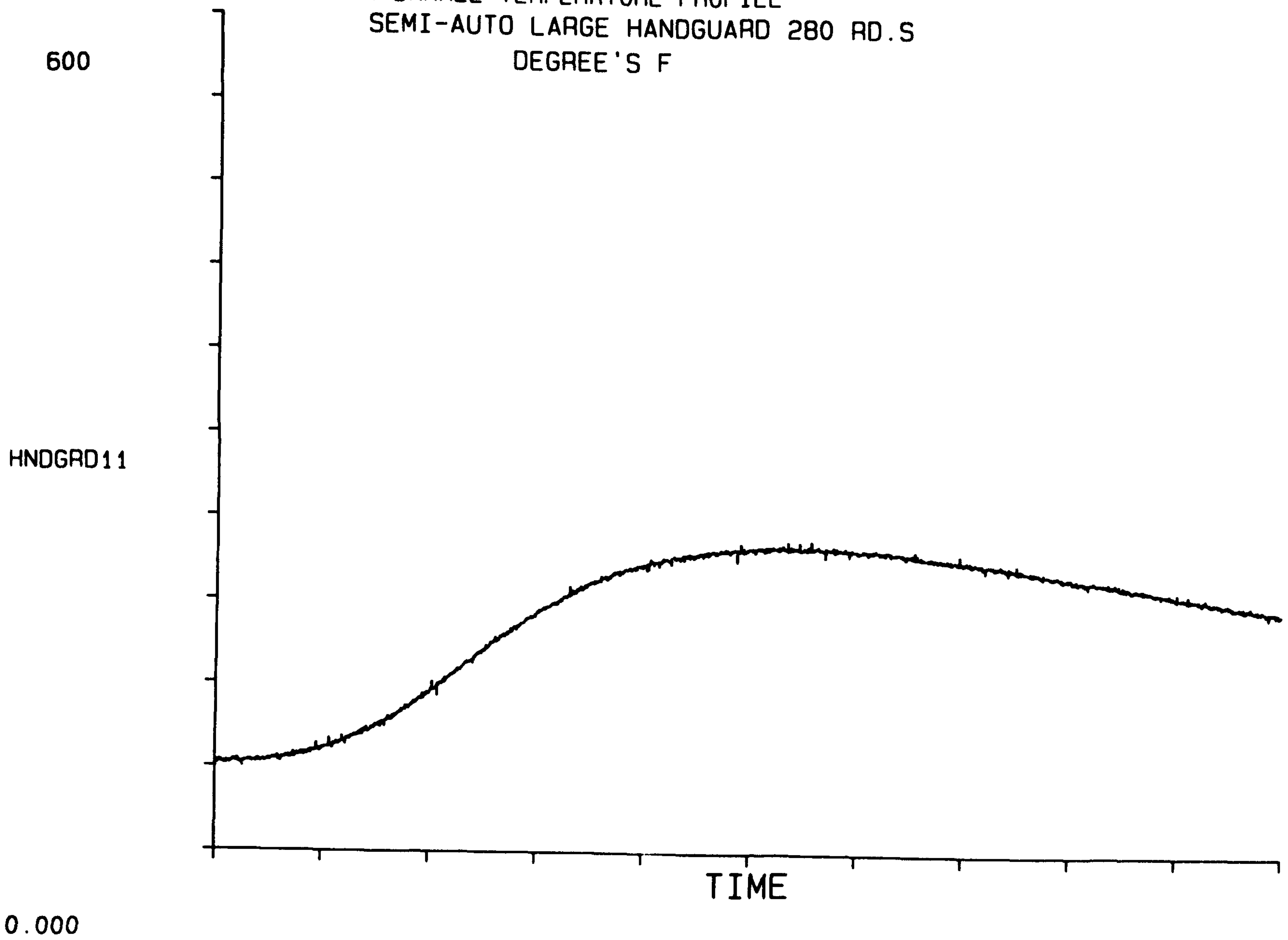
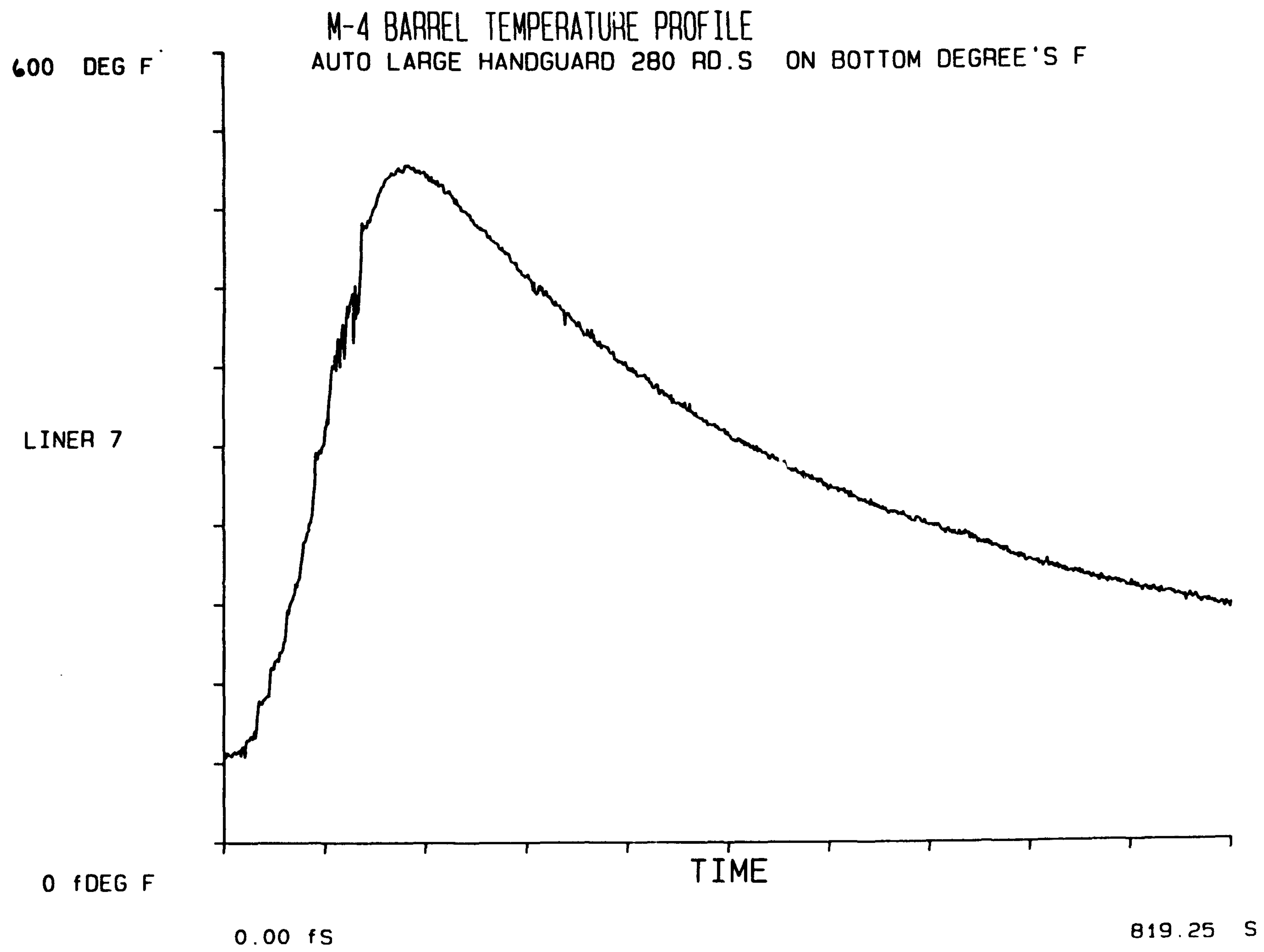
600
HNDGRD10
0.000
TIME

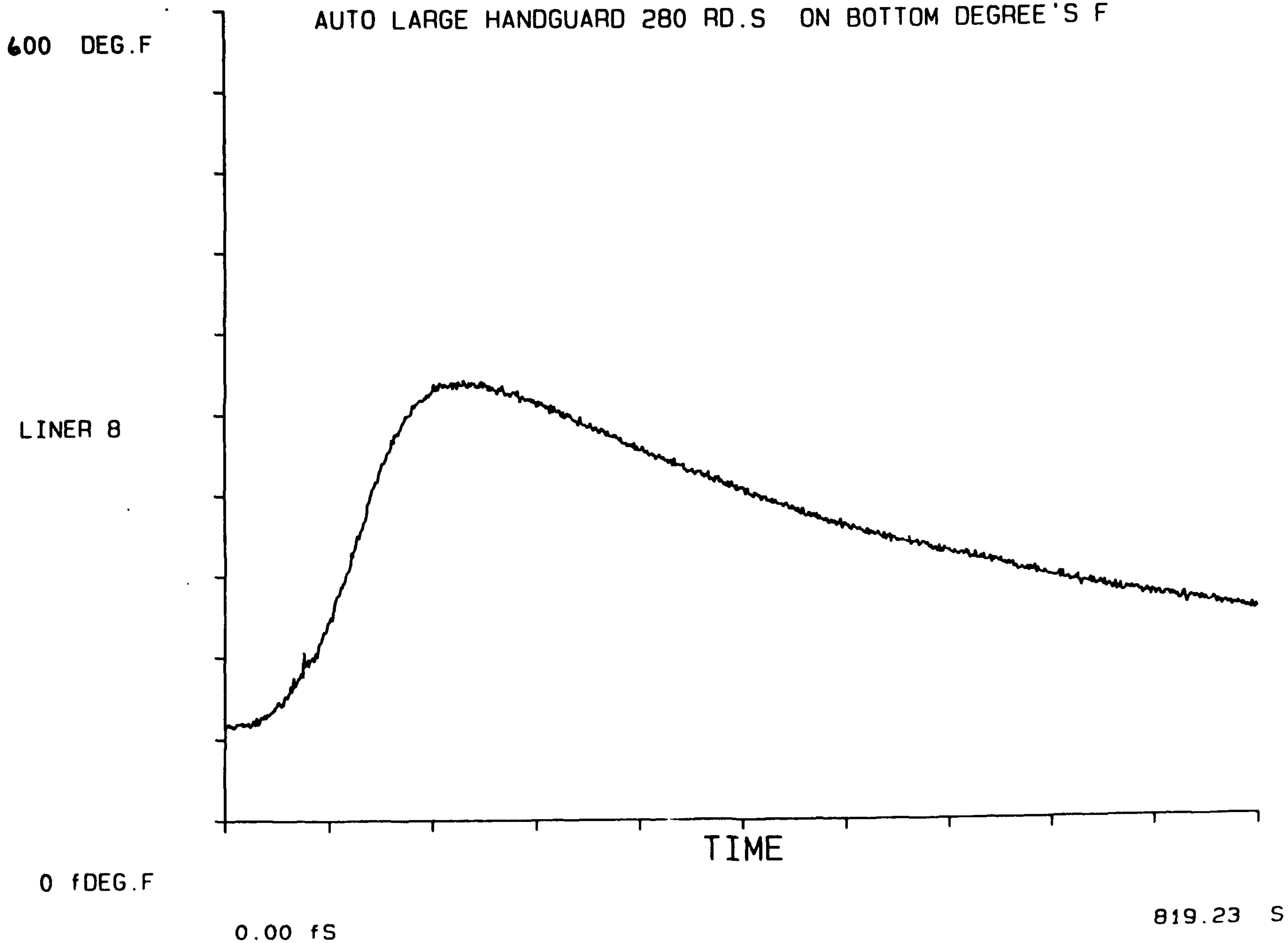
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S
DEGREE'S F

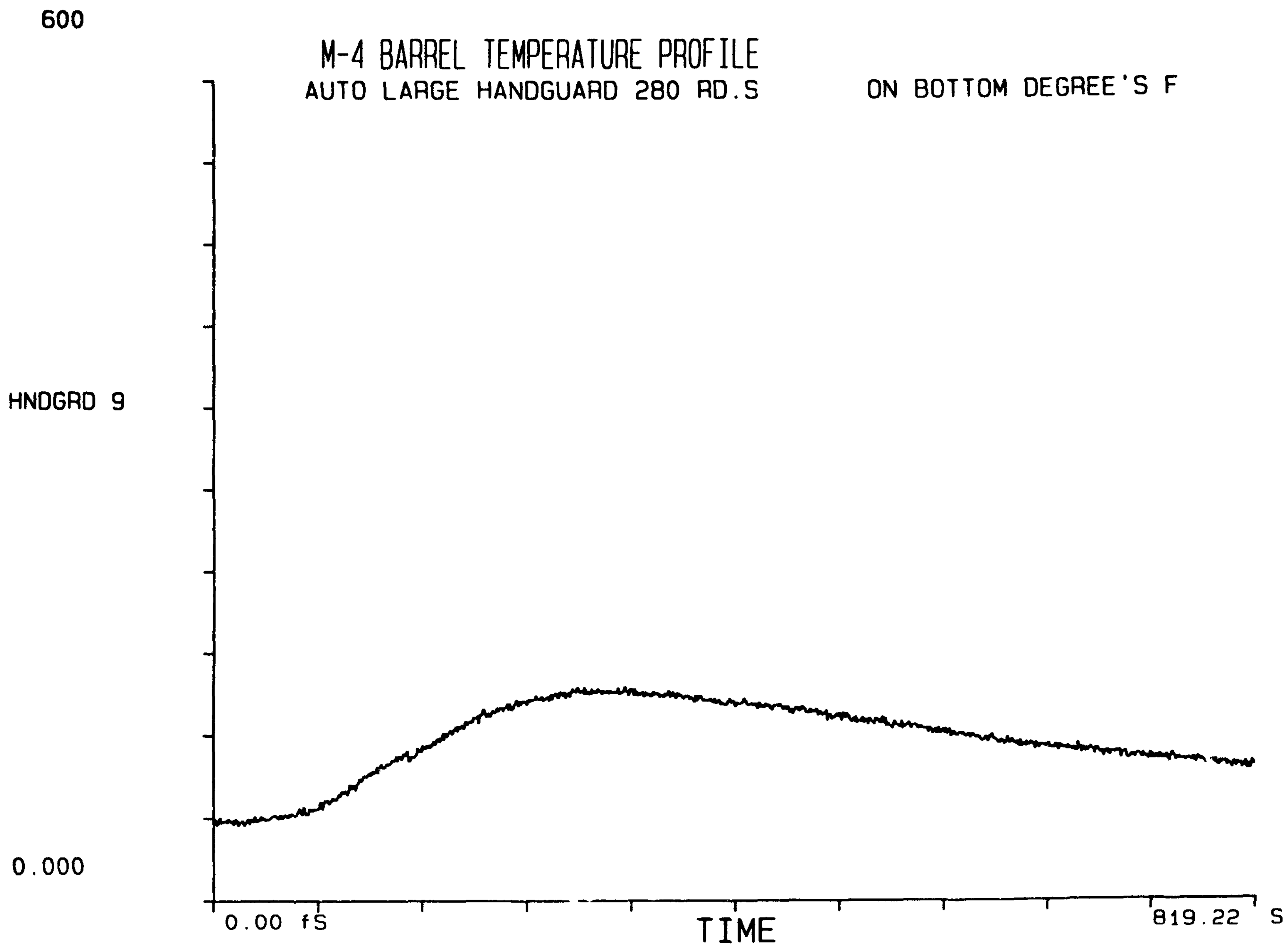



M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
600 DEG F
LINER 7
0 fDEG F
TIME
0.00 fS
819.25 S

M-4 BARREL TEMPERATURE PROFILE

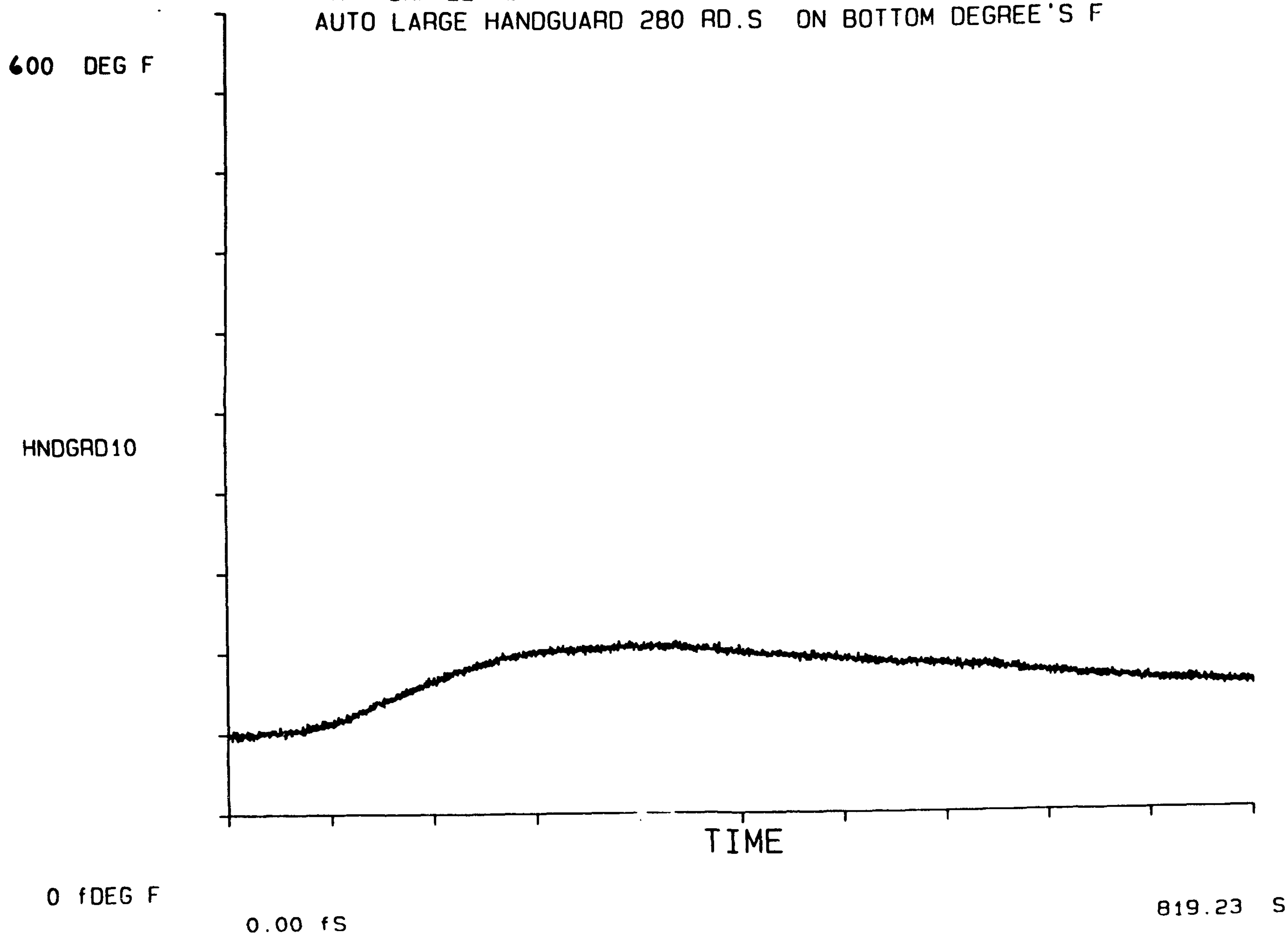
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F

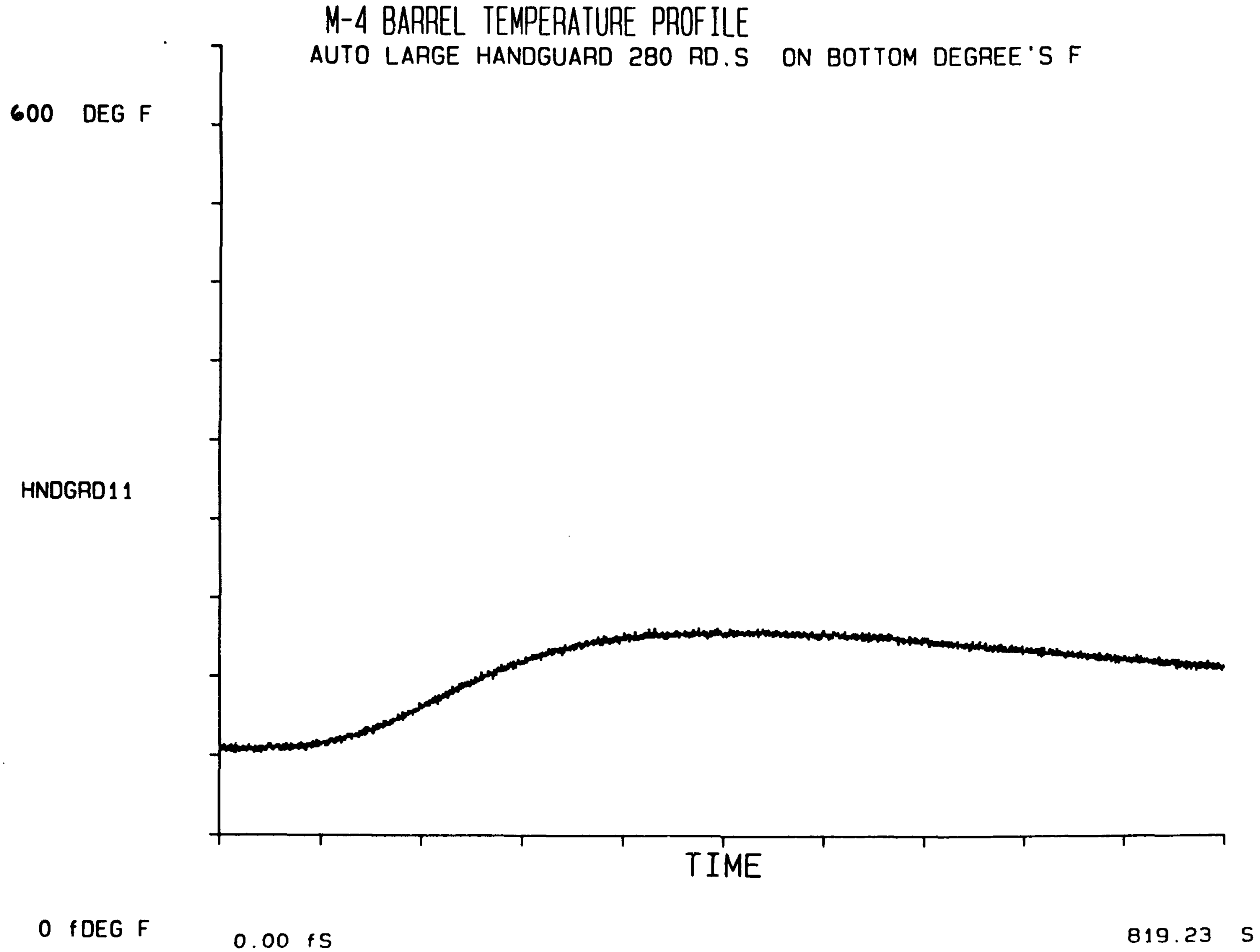


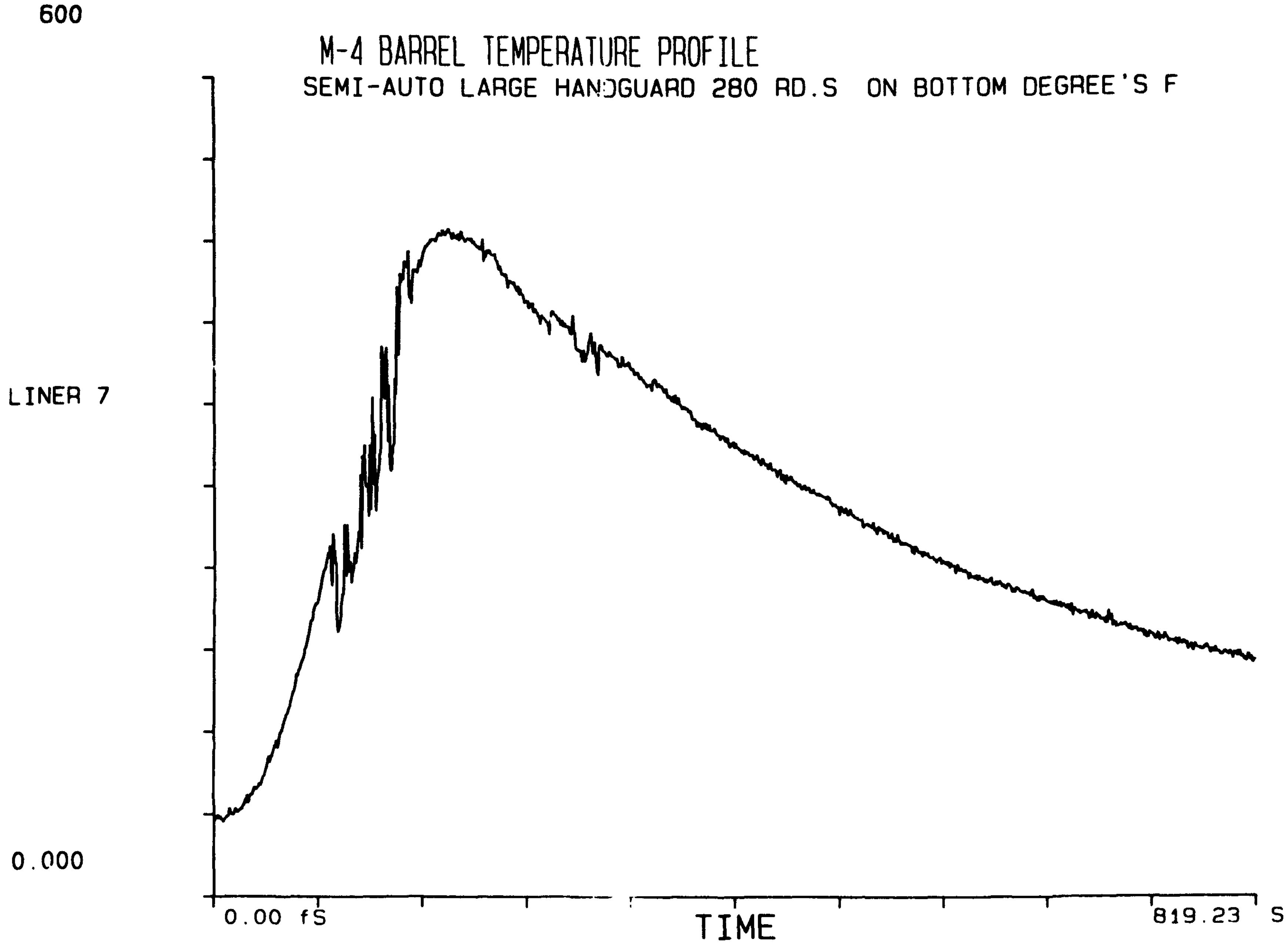

600
M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S
ON BOTTOM DEGREE'S F
HNDGRD 9
0.000
0.00 fS
TIME
819.22
S

M-4 BARREL TEMPERATURE PROFILE

AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F




M-4 BARREL TEMPERATURE PROFILE
AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
600 DEG F
HNDGRD11
0 fDEG F
TIME
0.00 fS
819.23 S


600
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
LINER 7
0.000
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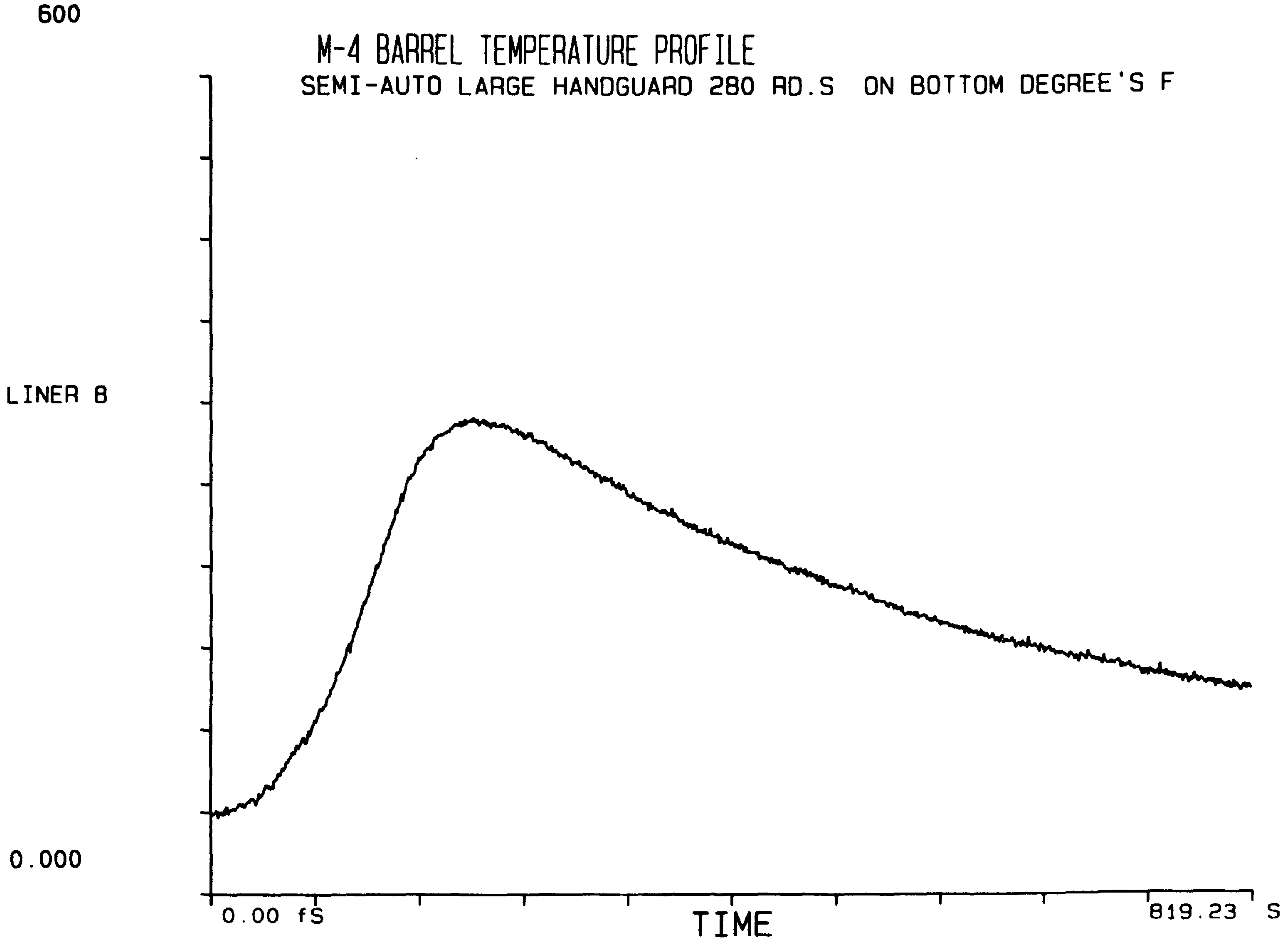
TIME
819.23 S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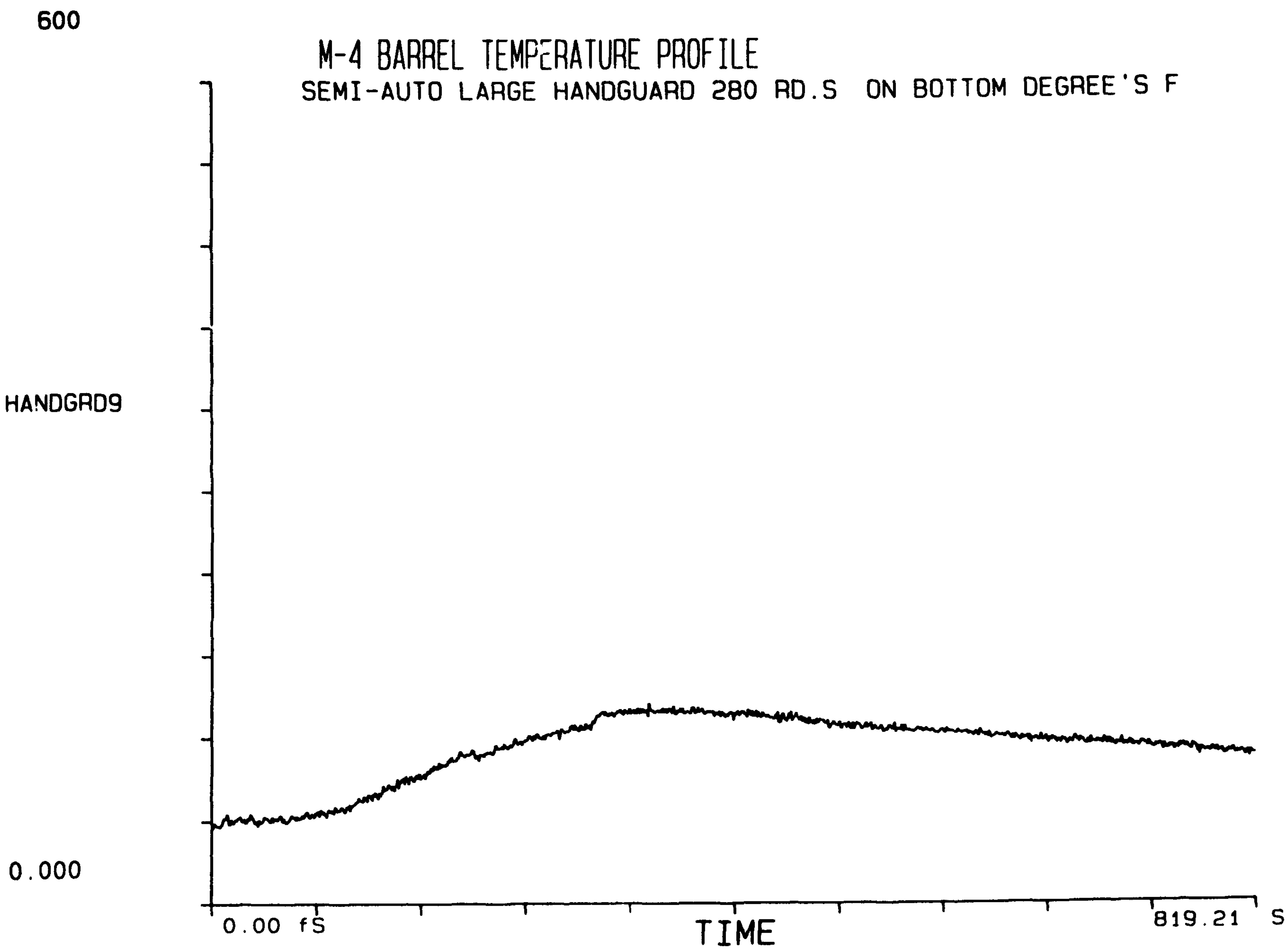
M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
LINER 8
0.000
0.00 fS
TIME
819.23 S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M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
HANDGRD9
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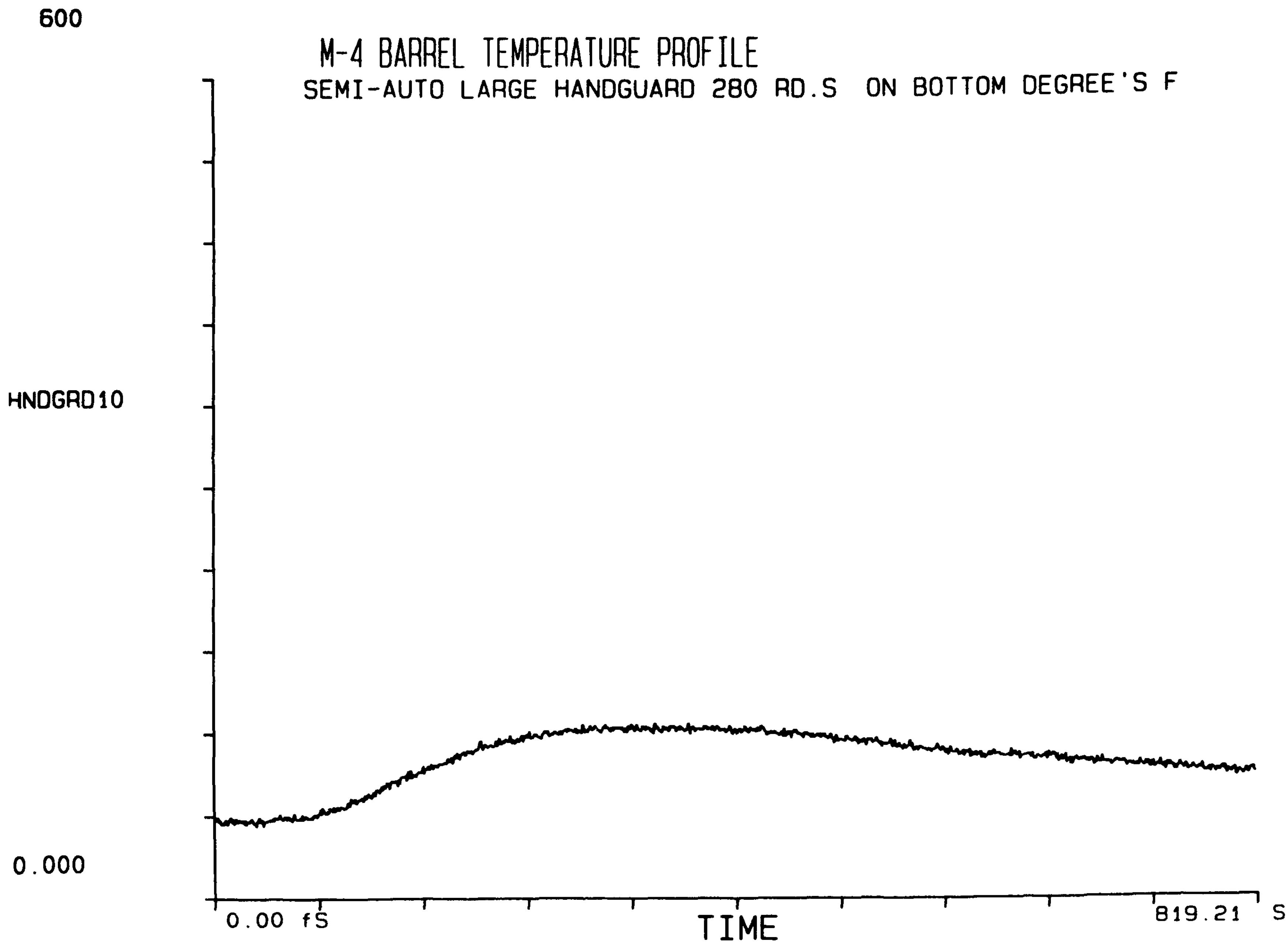
0.00 fS
TIME
819.21
S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M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
HNDGRD10
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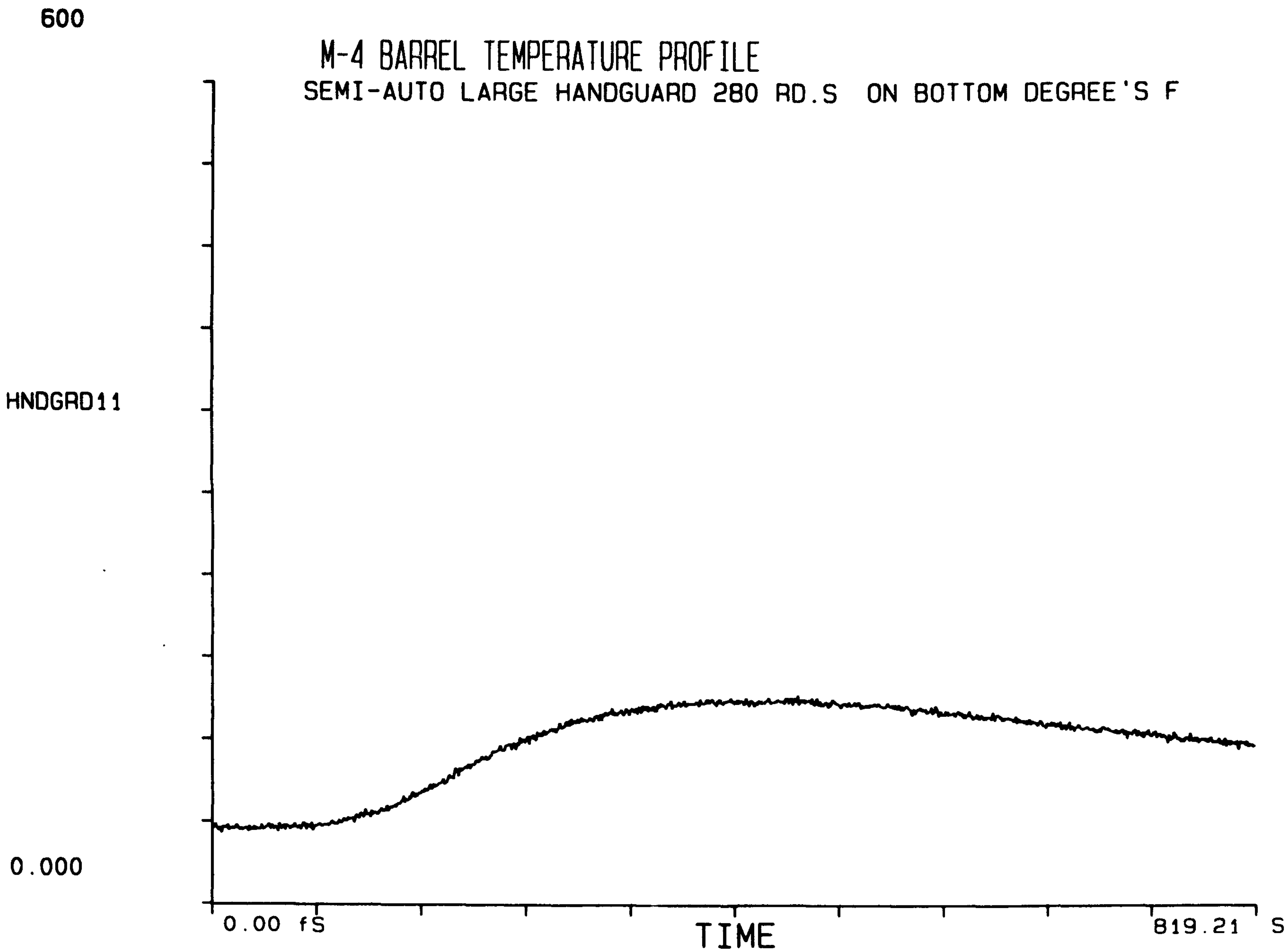
TIME
819.21
S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M-4 BARREL TEMPERATURE PROFILE
SEMI-AUTO LARGE HANDGUARD 280 RD.S ON BOTTOM DEGREE'S F
HNDGRD11
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0.00 fS
TIME
819.21 S