804272

ARMY CONCEPT TEAM IN VIETNAM
APO 96243

ACTIV-AAD/MS

20 DEC 1966

SUBJECT: Final Report of Cartridge, 40mm, WP, XM-574, ACTIV Project Number AAD 9/67

TO: Commanding General
United States Army Vietnam
ATTN: AVHAV-RA
APO 96307

DDC
DEC 30 1966

1. REFERENCES

a. DA letter, Aberdeen Proving Ground STEAR-DS-TI, Safety Release of Cartridge, 40mm, WP, XM-574, USATECOM Project Number 4-4-1500-35, 13 May 66, w/1st Ind Hqs APG AMSTE-BG, 18 May 66.

b. Letter (C), Hq USARV, same subject, 7 Aug 66.

c. ACTIV msg 26985, subject: same as 1a, DTG 050032 Aug 66.

d. USATECOM msg APG 15220, subject: same as 1a, DTG 011400 Sep 66.

e. POMM 1310-208-12 (PA-DB7), subject: Preliminary Operating and Maintenance Manual and Maintenance Package, Cartridge, 40mm White Phosphorus, XM-574, Nov 64.

f. TM 9-1300-206, subject: Care, Handling, Preservation, and Destruction of Ammunition, Nov 64.

g. TM 9-1910, subject: Military Explosives, Apr 65.

2. AUTHORITY

Authority for testing was the USARV letter, reference 1b, requesting an evaluation be conducted to determine the conditions under which the XM-574 WP round was safe for use.

3. PURPOSE

The purpose of the evaluation was to establish a set of rules

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applicable to handling, storage, and firing the XM-574 round during tactical and administrative uses. These rules were to be simple to implement and provide for the safety of all personnel.

4. BACKGROUND

a. In mid-July 1966, approximately 15,000 rounds of XM-574, WP, 40mm ammunition were received in Vietnam. A distribution plan for further issue of the ammunition to units equipped with the M-5 helicopter armament system was published on 25 July 1966 with instructions that issue should be accomplished as soon as possible, but not later than 5 August 1966.

b. Concurrent with delivery of the ammunition a safety release (reference 1a) and preliminary operations manual (reference 1e) were received. These two documents established the following reservations and restrictions associated with use of XM-574, WP, ammunition:

(1) Firings of WP ammunition will be limited to temperatures at which the filler remains in a solid state; otherwise, short flight, a high percentage of projectile duds, and possible premature functions may occur.

(2) Safety precautions normally associated with the storage, handling, and firing of WP loaded cartridges will be observed.

(3) This ammunition will not be fired if the ambient temperature is over plus 109° F; will not be fired if it has not been stored for at least three hours, prior to firing time, at a temperature of less than plus 105° F; and must be protected from sun rays at all times.

(4) If the procedures in paragraph 4b(3), above, are not followed, the white phosphorus will liquify causing the XM-574 cartridges to tumble and strike the ground at a maximum distance of 700 meters, regardless of weapon range setting. Moreover, approximately one-half of these fired rounds will be duds.

(5) Troops moving into an area that has been subjected to XM-574 cartridge fire must be warned that all unexploded projectiles are extremely dangerous and must not be touched or disturbed in any manner. They will be destroyed by EOD personnel or other qualified personnel.

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c. The restrictions enumerated above were distributed to users and handlers of 40mm WP ammunition by the USARV Aviation Safety Officer and Ammunition Officer. A number of rounds of this ammunition were fired by the 197th Aviation Company using their UH-1B mounted M-5 helicopter armament system. They reported by telephone, through command channels, that they did not desire to use this ammunition because it was erratic, did not always detonate, and left a heavy smoke canopy which tended to mask the target area from further engagement by other weapons.

d. Research of the shortcomings reported by using units revealed the probability that ammunition being fired could have been overheated, either in storage or while loaded on a helicopter sitting in the hot sun, due to the "greenhouse effect." This could not be confirmed, however, because the users could not remember the outside air temperature during firing missions. From weather station reports, however, it did not seem the free air temperatures had been high enough to affect the ammunition adversely. This situation precipitated a requirement to obtain factual information concerning actual outside air temperatures or conditions in the Republic of Vietnam which would cause the temperature of a 40mm WP round to reach the critical liquifying level of + 109° Fahrenheit.

e. Attempts were made to obtain accurate temperature recording devices to permit simultaneous recordings from multiple locations in and around a helicopter equipped with the M-5 system over a period of 12 to 14 consecutive hours. Concurrently, a message was dispatched to AMC (reference 1c) requesting all available information concerning test results and temperature evaluation on the 40mm, WP, XM-574 cartridge be forwarded to ACTIV as soon as possible.

f. All previously issued 40mm, WP, XM-574 ammunition was recalled from using units and placed in storage at Tan Son Nhut Ammunition Supply Point pending the outcome of this evaluation.

5. DISCUSSION

a. It was finally possible, on 24 August 1966, to obtain 12 thermometers whose scales where high enough to record temperatures up to plus 150° Fahrenheit. Six of these had centigrade and the other six Fahrenheit scales. All were tested, calibrated and compared against each other in a free air environment during a 10 hour period on 25 August 1966. Results are tabulated in inclosure 1. They were placed in a box relatively protected from wind and direct sun rays, but open to the air. Readings were taken and recorded every hour between 0800 hours and 1700 hours. After the 1400 hour reading, the boxes were

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placed in direct sun rays for the 1500 hour reading to be taken in that position. They were then returned to the protected location where the 1600 hours and 1700 hours readings were taken. This test confirmed that all of the thermometers were accurate and compatible with each other to the extent necessary for later testing.

b. Since it was impossible to obtain automatic temperature measuring devices which would continously measure and record the temperatures at multiple locations, the thermometers were located in positions where XM-574 cartridges would normally be found. These thermeters were read by an observer and measurements were recorded at specific time intervals during a normal day. After a reasonable period of time, which included representative weather and sky coverage conditions prevalent in the Republic of Vietnam, the mechanically recorded temperatures were transposed to graphs for comparison and analysis.

c. The next step in the evaluation was to have been a live firing test during which normal and preheated ammunition were to be fired from a standard M-5 system mounted in a UH-1B. During those firings, actual counts of impact explosions, erratic projectile flights, preliminary explosions and duds were to have been recorded. These flight tests were subsequently cancelled for reasons given below.

d. Staff coordination resulted in the establishment of test sites and units. Helicopter and M-5 gun system temperatures were measured at the 197th Assault Helicopter Company at Bien Hoa. Ammunition storage area temperatures were taken at the 197th Aviation Company and the Tan Son Nhut Ammunition Supply Point. Live firing of the UH-1B/M-5 system was scheduled for the Navy Overwater Ordnance Salvo Range in the China Sea near Vung Tau. The RVN Infantry Training Center Range at Thu Doc was also obtained.

e. On 27 August 1966, thermometers and ACTIV-prepared charts (Inclosures 2 and 3) on which to record temperatures were delivered to the test sites. Designated project officers were instructed on methods and procedures to be used in recording data. The helicopter on which the data was collected at the 197th Aviation Company was an M-5/UH-1B in its normal parking position in the unit parking area. (See Inclosures 4, 5, and 6.) A thermometer was mounted near the OAT guage (Inclosure 7) to be used as a control to identify any differential between OAT readings and ambient temperatures in part of the helicopter. (The OAT guage is calibrated in centigrade; for simplicity, however, all readings have been converted to Fahrenheit.) A second thermometer was mounted on the M-5 chuting (Inclosures 8 and 9) at the point just inside the chute cover where the 40mm ammunition exits the most forward

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point in the helicopter. A third thermometer was mounted within the M-5 turret at the gun feeder (Inclosures 10 and 11), the last point in the system where 40mm rounds are located prior to entering the gun breech and barrel. A fourth thermometer was mounted in the ammunition box where 40mm ammunition is stored when the gun system is loaded and mission ready (Inclosure 12.) The M-5 system was loaded with ammunition throughout the data collection period. In the ammunition storage areas (Inclosure 13) three thermometers were used. They were placed (as shown in Inclosure 14) on top of the stack, in the center of the stack, and approximately six inches above ground level at the bottom of the stack.

f. Temperatures were read and recorded each hour on selected days beginning 28 August 1966 and ending 12 September 1966. Attempts were made to obtain temperature readings on days which had various types of weather and sky coverage normally experienced in the Republic of Vietnam. Data were collected with helicopter doors and windows open and closed. The officially reported hourly temperatures during the data collection period as taken by the Weather Detachment, Bien Hoa Air Force Base were also obtained (Inclosure 15.) A chart listing the mean maximum temperature for each month within the Republic of Vietnam was obtained from the MACV Climatalogist (Inclosure 16.)

g. All data collection was completed on 12 September 1966 and the temperature readings from the test sites were plotted on graphs for comparisons. These graphs are as follow:

(1) With helicopter doors and windows closed - Inclosures 17 through 20.

(2) With helicopter doors and windows open - Inclosures 21 through 23.

(3) Ammunition storage areas - Inclosures 24 through 37.

h. Study and comparison of the collected data revealed that the "greenhouse effect" caused overheating in all areas where 40mm ammunition was stored or used. The greatest amount of overheating occurred in the M-5/UH-1B helicopter with its doors and windows closed. The least amount of overheating occurred in ammunition storage areas where the ammunition was covered and protected from direct sun rays at all times.

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i. On 20 September 1966, a box of 50 rounds of 40mm WP, XM-574 ammunition was taken to Vietnamese Infantry Training Center at Thu Doc. All packing and crating were removed from the linked ammunition and it was arranged in a cardboard box to duplicate, insofar as possible, the conditions which exist when it is loaded in an M-5/UH-1B ammunition container. From a range of one hundred meters, 7.62mm ball ammunition was fired into the ammunition until one of the 40mm rounds was hit. Two evaluators plus an EOD team observed the results of this test and agreed on the affects of what they saw. The induced and sympathetic white phosphorus explosions appeared to be of sufficient magnitude to destroy a helicopter. In the interest of safety, the live firing tests scheduled for the overwater range were cancelled. This concluded the evaluation.

6. FINDINGS

a. In a UH-1B helicopter at rest on the ground, the OAT was from 3° F lower to 18° F higher than the free air temperature received from an authorized weather station. (Compare inclosures 15 and 17 through 23.)

b. In a UH-1B helicopter at rest on the ground with doors and windows open, the temperature inside the helicopter was from 2° F to 21° F higher than the temperature indicated on the OAT guage. (Compare graph inclosures 21 through 23.)

c. In a UH-1B at rest on the ground with doors and windows closed, the temperature inside the helicopter was from 5° F to 38° F higher than the temperature indicated on the OAT guage. (Compare graph inclosures 17 through 20.)

d. With helicopter doors and windows closed, temperatures in the chuting, turret, and ammunition box of the M-5 system ranged from 3° F to 38° F higher than the OAT. Plotted graphs (Inclosures 17 through 20) show that the critical temperature of 109° F was reached in the M-5 system when the OAT guage registered as low as 87° F. The lowest recorded free air temperature at which the OAT reached 87° F and some portion of the M-5 system reached 109° F was 82° F.

e. In a UH-1B helicopter with the doors and windows open, there was no instance of the M-5 system temperature exceeding 109° F until the OAT reached 92° F. (See inclosures 21 thru 23.)

f. Free air temperatures within the Republic of Vietnam can be expected to reach 82° Fahrenheit or higher during any month of the

year. In the northern and central areas of the country, it is not likely that temperatures will reach as high as 82° Fahrenheit in the months of November, December, January, and February.

g. Temperatures in stacks of 40mm ammunition in covered storage areas ranged from 4° F lower to 8° F higher than recorded free air temperatures. Ammunition in open storage (roof only) reached temperatures as much as 33° F higher than the free air temperature in places where direct sun rays entered the storage area. The critical temperature of 109° F was not reached in covered ammunition storage areas during this test period but, by extrapolation, the critical temperature might be reached whenever the free air temperature is 101° F or higher.

h. Ball ammunition fired into a box of linked 40mm, WP, XM-574 ammunition caused an instantaneous high order detonation. Without any additional firing or aggravation, there were seven additional sympathetic detonations within 6 minutes 32 seconds of the first. The initial detonation and five of the seven sympathetic detonations were high order explosions. Each of these seemed to release sufficient energy to destroy a UH-1B helicopter, if they had detonated anywhere in the M-5 system.

7. CONCLUSIONS

a. Rules and procedures for storage, handling, and firing of 40mm, WP, XM-574 ammunition with the assurance that the number of duds and shorts would consistently remain within acceptable limits would be too complex to permit use of the rounds in Vietnam.

b. A hit by a single round of ball ammunition could cause one or more white phosphorus explosions sufficient to destroy a helicopter.

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8. RECOMMENDATION

It is recommended that the 40mm, WP, XM-574 cartridge not be used in combat in the Republic of Vietnam in the M-5 helicopter armament system.

Merrill G. Hatch
MERRILL G. HATCH
Colonel, Artillery
Chief

38 Incl
as (Incl 1 thru 37)
38. Distribution List

TEMPERATURES IN FAHRENHEIT

TIME	1	2	3	4	5	6
0800	84	84	84	84	84	84
0900	84	84	84	84	84	84
1000	84	84	84	84	84	84
1100	86	86	86	86	86	86
1200	87	87	87	87	87	87
1300	91	91	91	91	91	91
1400	92	92	92	92	92	92
1500	138	138	138	138	138	138
1600	94	94	94	94	94	94
1700	94	94	94	94	94	94

TEMPERATURES IN CENTIGRADE

TIME	1	2	3	4	5	6
0800	28.5	28.5	28.5	29	28.5	28.5
0900	29	29	29	29	29	29
1000	29.5	29.5	29.5	29.5	29.5	29.5
1100	30	30	30	30.5	30	30
1200	31	31	31	31	31	31
1300	32	32	32	32	32	32
1400	33	33	33	33	33	33
1500	40	40	39	40	40	40
1600	34	34	34	34	34	34
1700	34	34	34	34	34	34

Thermometer Calibrations 25 August 1966.

Incl 1

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TEMPERATURE RECORDINGS
(M-5/UH-1B AT REST)

DATE_____

LOCATION_____

			M-5 SYSTEM TEMPERATURES		
TIME	OAT A/C	CONTROL	AMMO BOX	CHUTING	FEEDER
0800	_____	_____	_____	_____	_____
0900	_____	_____	_____	_____	_____
1000	_____	_____	_____	_____	_____
1100	_____	_____	_____	_____	_____
1200	_____	_____	_____	_____	_____
1300	_____	_____	_____	_____	_____
1400	_____	_____	_____	_____	_____
1500	_____	_____	_____	_____	_____
1600	_____	_____	_____	_____	_____
1700	_____	_____	_____	_____	_____

_____
Signature

_____
Name, Rank, SN

_____
Unit

ACTIV Form to record M-5 temperatures

Incl 2

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TEMPERATURE RECORDINGS

(40MM AMMUNITION STORAGE)

DATE:_____

LOCATION_____

	AMMUNITION TEMPERATURE		
TIME	*BOTTOM OF STACK	TOP OF STACK	CENTER OF STACK
0800	_____	_____	_____
0900	_____	_____	_____
1000	_____	_____	_____
1100	_____	_____	_____
1200	_____	_____	_____
1300	_____	_____	_____
1400	_____	_____	_____
1500	_____	_____	_____
1600	_____	_____	_____
1700	_____	_____	_____

*Thermometer height 6" above ground

_____
Signature

_____
Name, Rank, SN

_____
Unit

ACTIV Form to record ammunition storage temperatures.

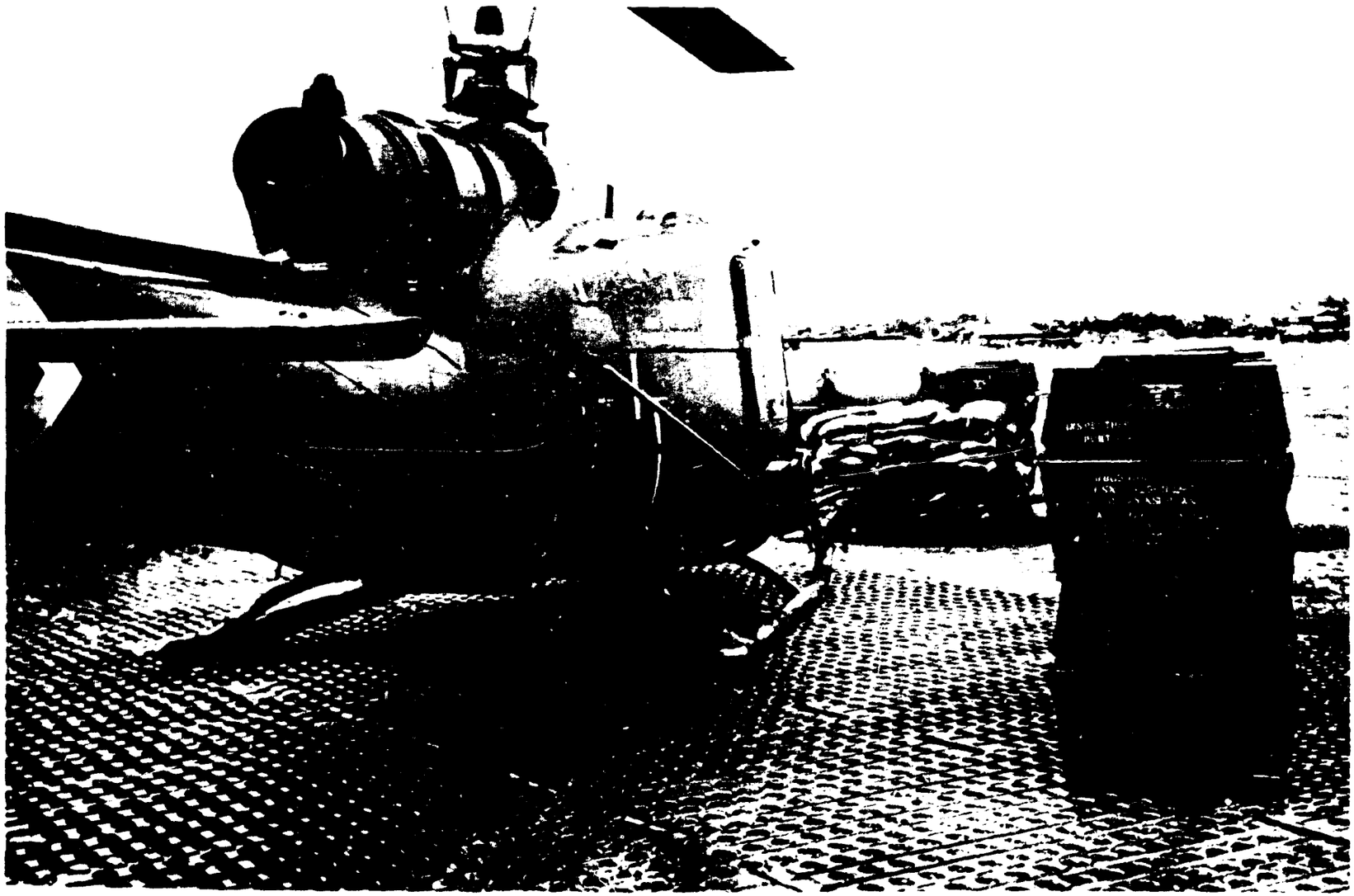
Incl 3

UH-1B/M-5 mounted helicopter on which temperatures were taken. 197th Aviation Company PSP parking area at Bien Hoa. Helicopter parked with front toward southwest; with L shape revetment on southwest and northwest sides; with work space between helicopter and revetment.

Incl 4

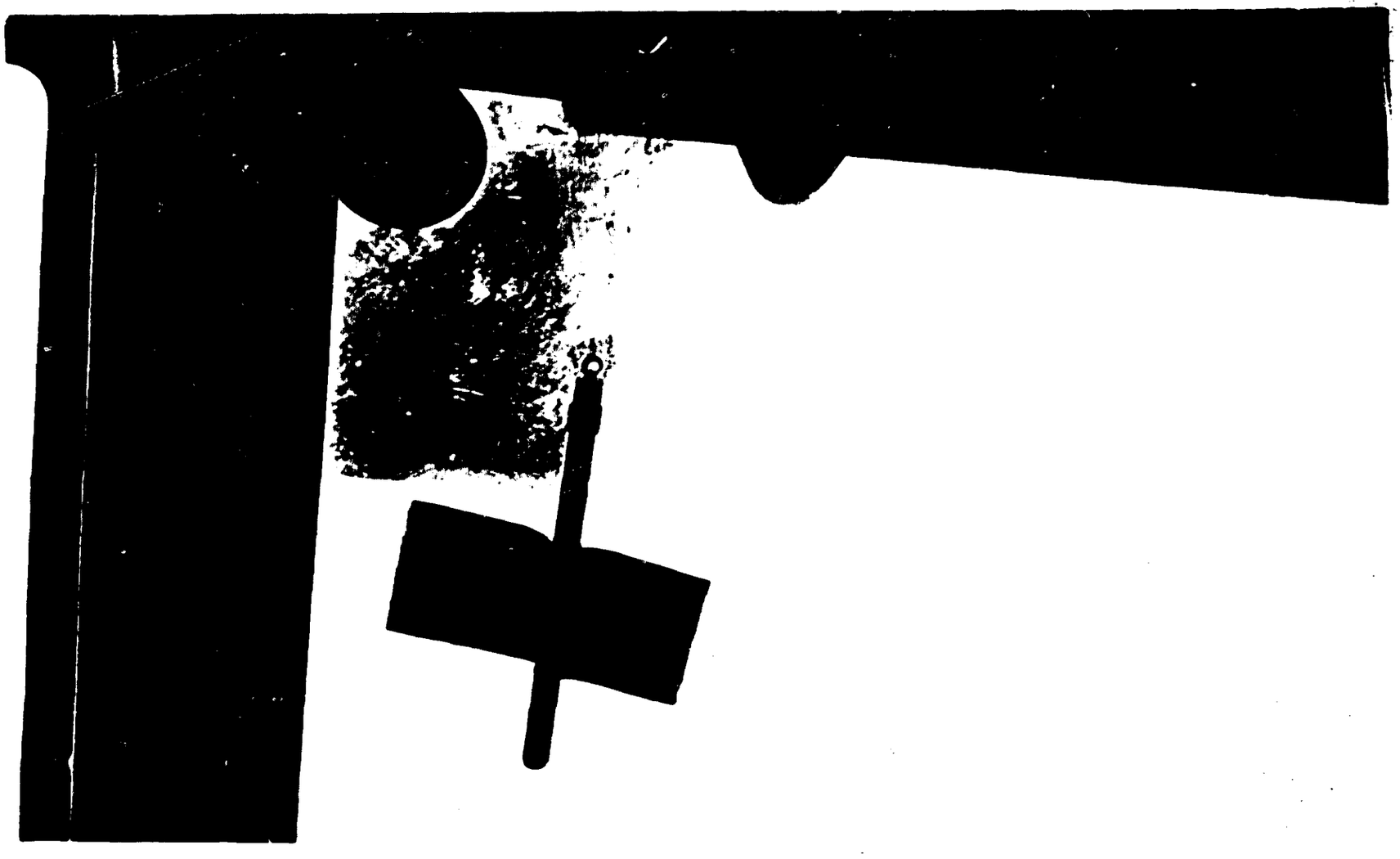
UH-1B/M-5 mounted helicopter on which temperatures were taken. 197th Aviation Company PSP parking area at Bien Hoa. Helicopter parked with front toward southwest; with L shape revetment on southwest and northwest sides; with work space between helicopter and revetment.

Incl 5



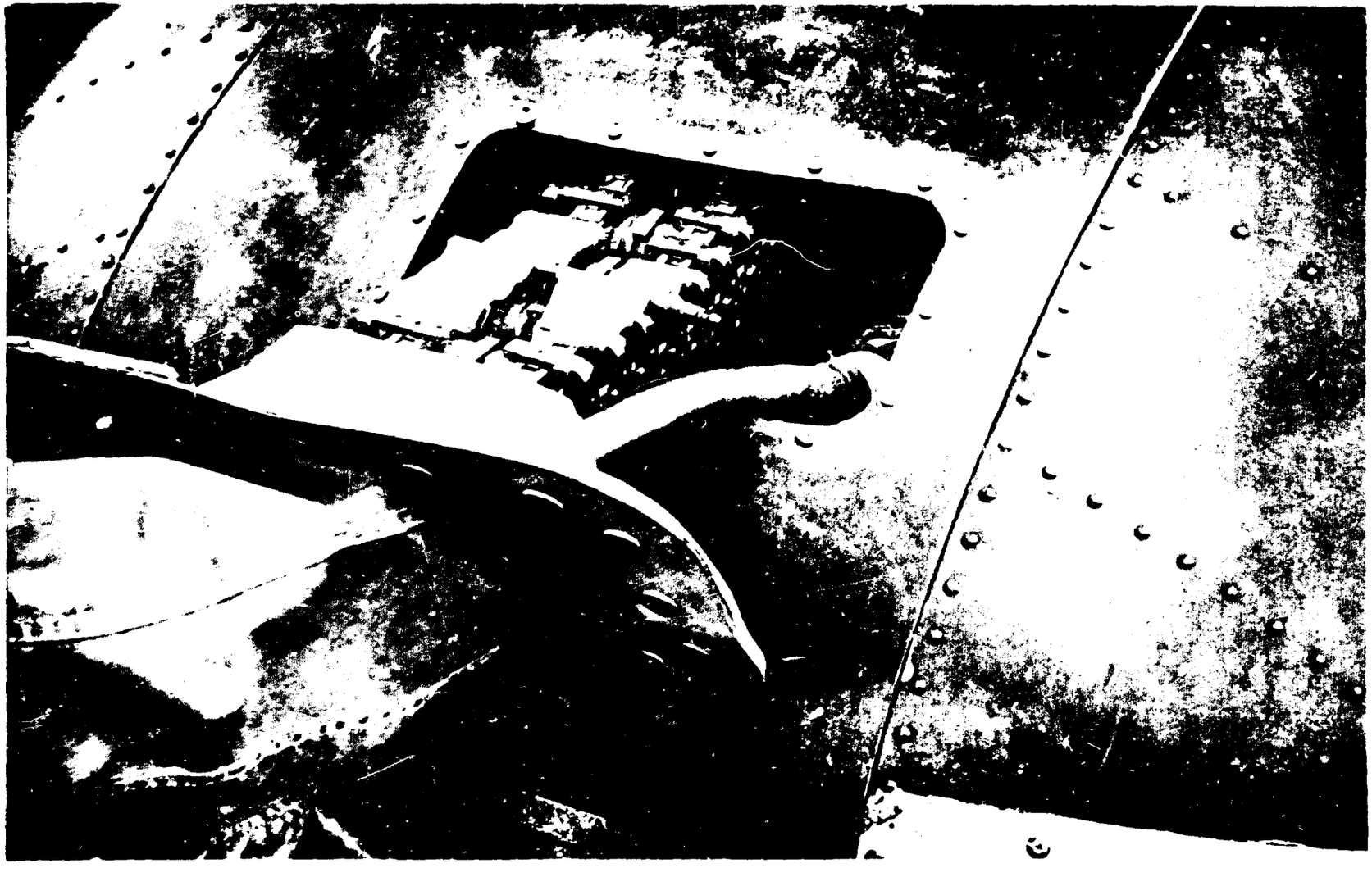
UH-1B/M-5 mounted helicopter on which temperatures were taken. 197th Aviation Company PSP parking area at Bien Hoa. Helicopter parked with front toward southwest; with L shape revetment on southwest and northwest sides; with work space between helicopter and revetment.

Incl 6



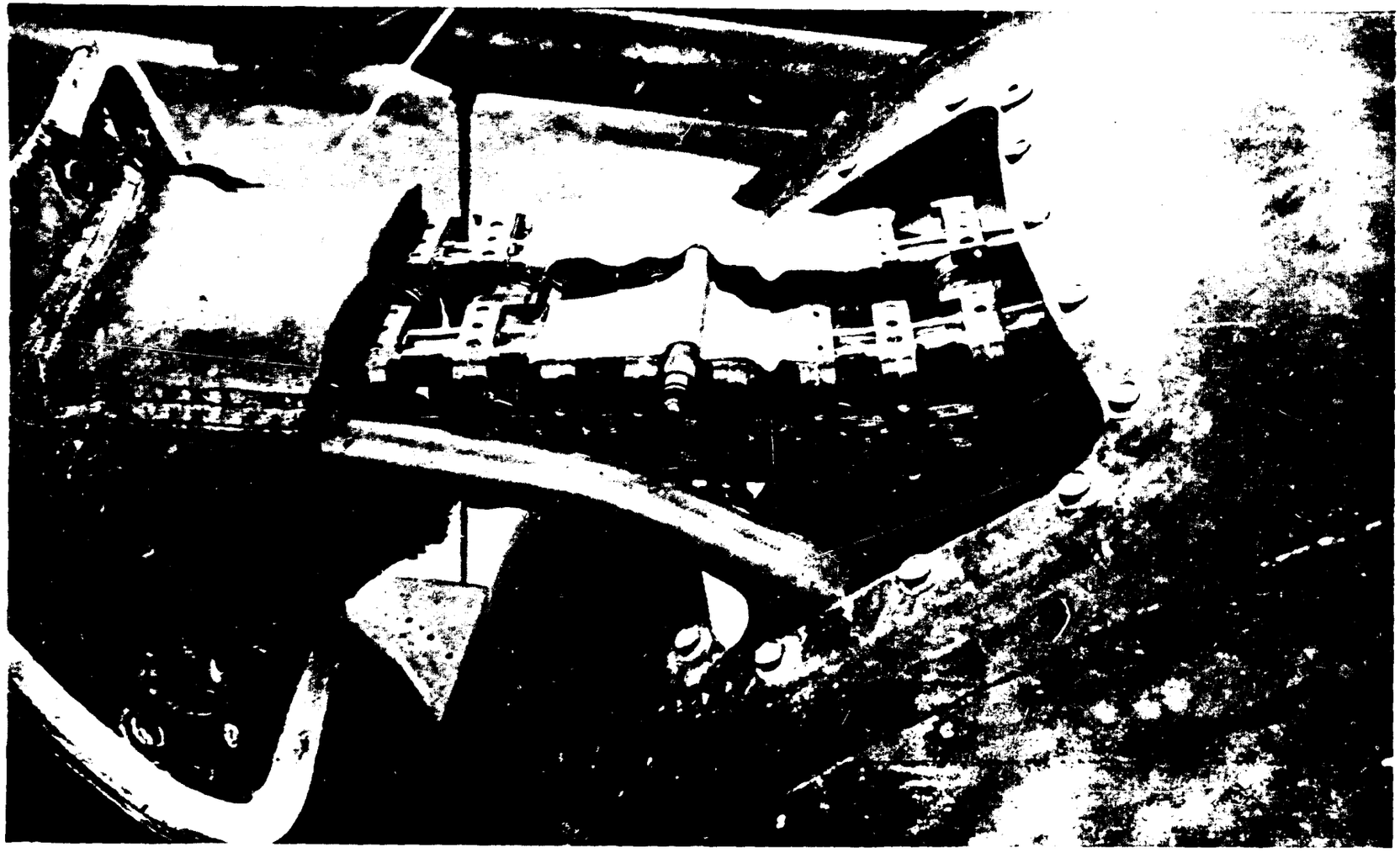
Outside air temperature guage with control thermometer located nearby and taped inside the plexiglass.

Incl 7



Front view of thermometer attached to chuting just inside opening above forward radio compartment of UH-1B helicopter.

Incl 8



Side view of thermometer attached to chuting just inside opening above forward radio compartment of UH-1B helicopter.

Incl 9

Top front view of thermometer attached to feeder near rotating cam cylinder M-5 housing.

Incl 10

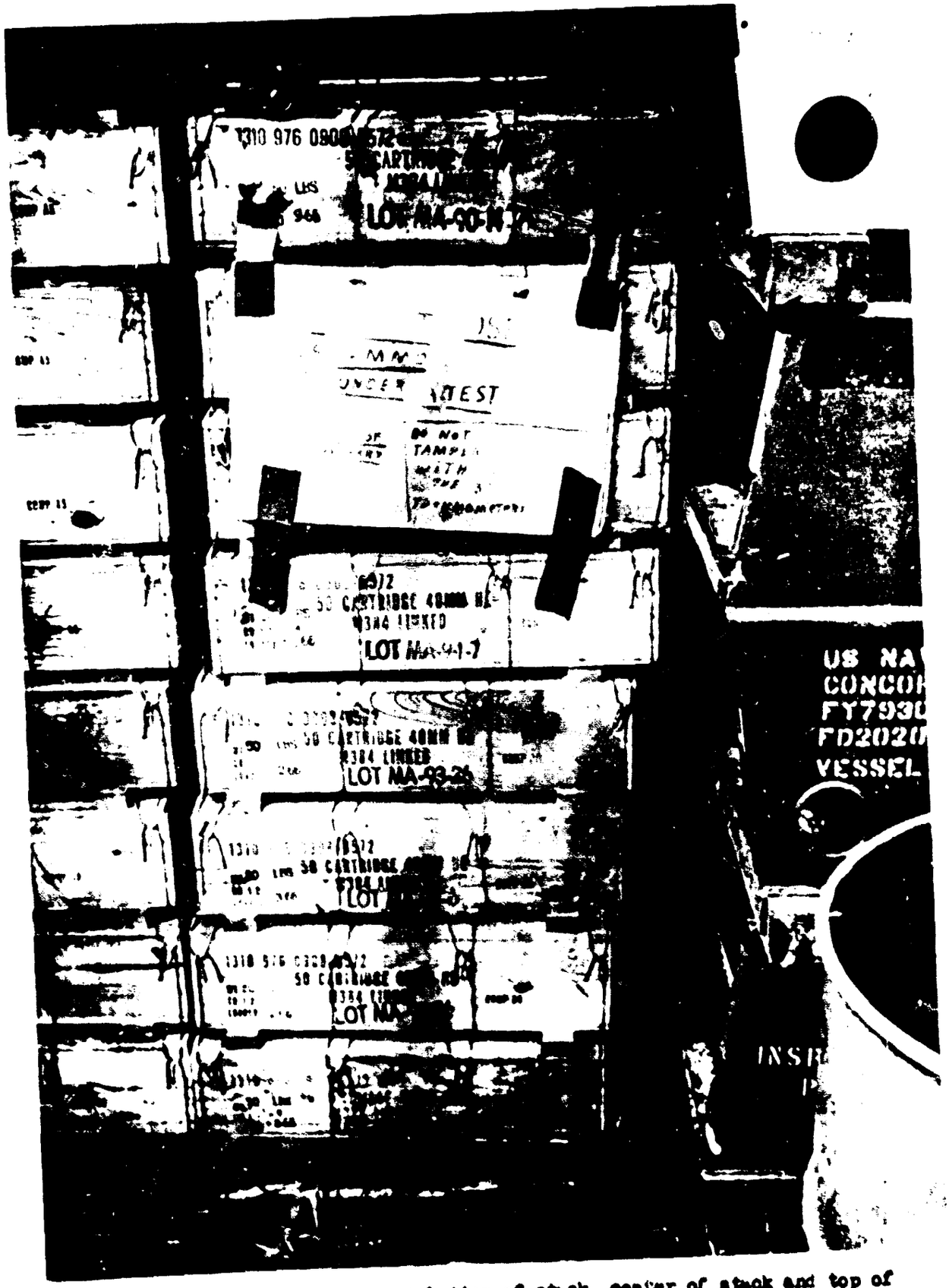
Top left view of thermometer attached to feeder near rotating cam cylinder M-5 housing.

Incl 11

Location of thermometer in 40mm ammunition box in troop seat area, center rear cabin floor of UH-1B helicopter.

Incl 12

40mm ammunition storage area near flight line of 197th Aviation Company in Bien Hoa where temperatures were taken. Opening is toward north-northwest. Incl 13



Thermometers located at bottom of stack, center of stack and top of stack in ammunition storage area. Early morning direct sun rays covered lower three boxes.

Incl 14

HOUR	AUG 28	AUG 29	AUG 30	AUG 31	SEP 1	SEP 2	SEP 3	SEP 4	SEP 5	SEP 6	SEP 7	SEP 8	SEP 9	SEP 10	SEP 11	SEP 12	SEP 13	SEP 14	SEP 15	SEP 16
0800	78	76	77	74	72	73	74	75	76	75	78	77	79	78	77	79	74	73	75	77
0900	78	76	77	74	73	75	76	77	77	80	81	79	82	79	78	79	78	76	79	79
1000	79	77	76	75	75	79	80	77	79	83	82	83	82	82	82	81	82	79	82	82
1100	81	79	77	76	78	80	81	77	80	86	83	82	85	81	84	84	85	76	84	82
1200	84	81	81	76	80	83	82	76	82	87	84	87	87	83	85	86	83	76	85	83
1300	81	85	82	77	80	85	83	77	83	86	86	88	87	85	86	87	75	76	87	82
1400	81	82	82	85	81	87	84	80	85	87	88	85	89	84	88	88	76	76	88	85
1500	81	82	87	83	83	86	79	82	86	85	87	83	88	85	88	89	77	76	83	87
1600	81	82	86	74	82	80	79	80	85	83	85	86	88	85	88	87	77	78	81	88
1700	81	82	84	74	81	78	79	83	86	89	84	86	83	85	87	82	78	80	80	86

Hourly temperatures recorded at the weather station, Bien Hoa Air Force Base, during period 28 Aug 66 to 16 Sep 66.

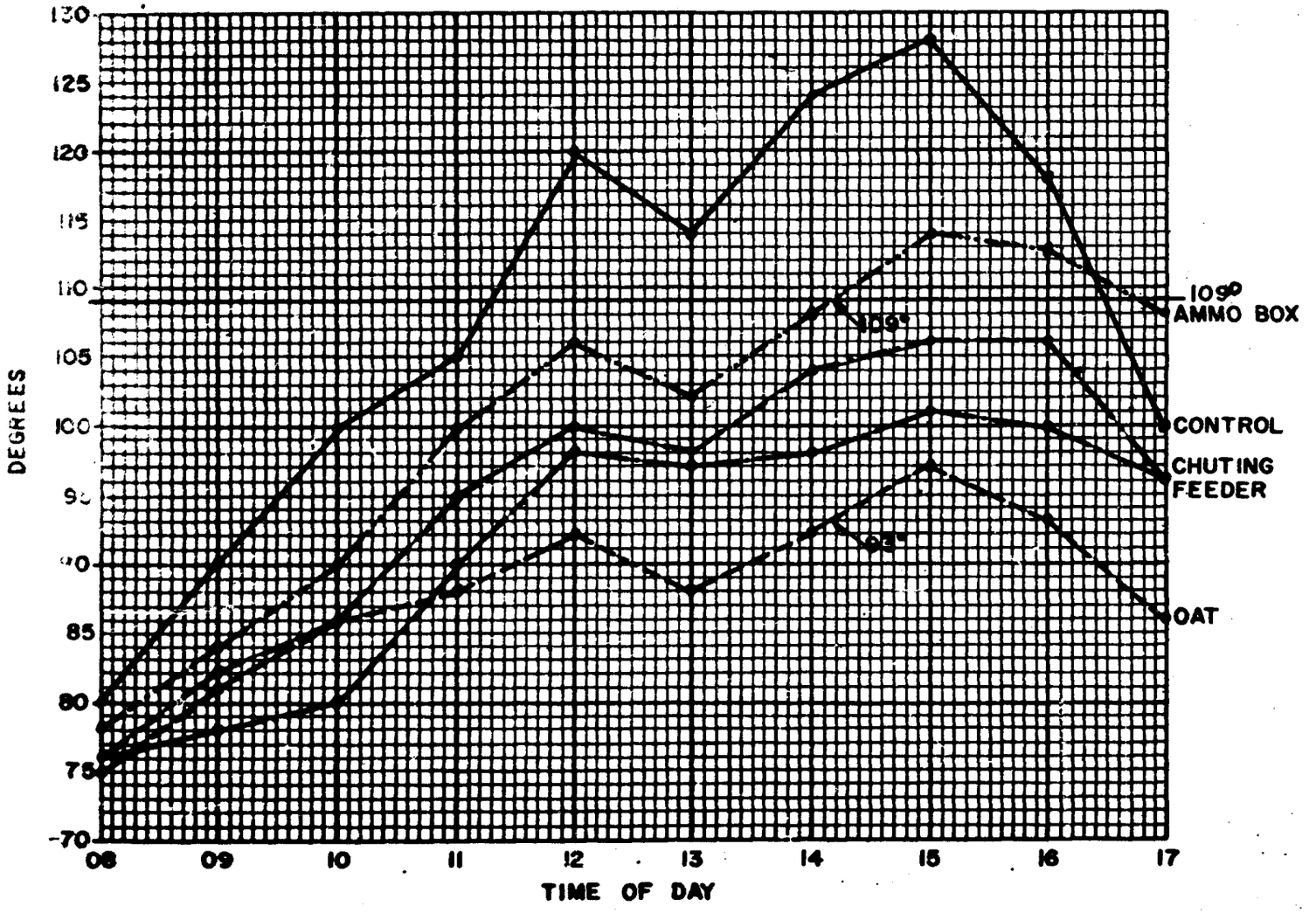
Incl 15

MONTH	SOUTH	CENTRAL	NORTH
January	90 - 84	81 - 77	77 - 73
February	92 - 87	85 - 80	80 - 75
March	97 - 88	85 - 80	85 - 80
April	98 - 91	87 - 82	85 - 80
May	93 - 90	85 - 80	90 - 85
June	91 - 84	85 - 80	90 - 85
July	88 - 84	85 - 80	90 - 85
August	90 - 86	90 - 80	90 - 75
September	85 - 83	80 - 76	85 - 80
October	85 - 83	85 - 75	85 - 75
November	86 - 84	80 - 74	75 - 70
December	87 - 81	80 - 75	75 - 70

Monthly mean maximum temperatures in Vietnam. Critical temperatures underlined.

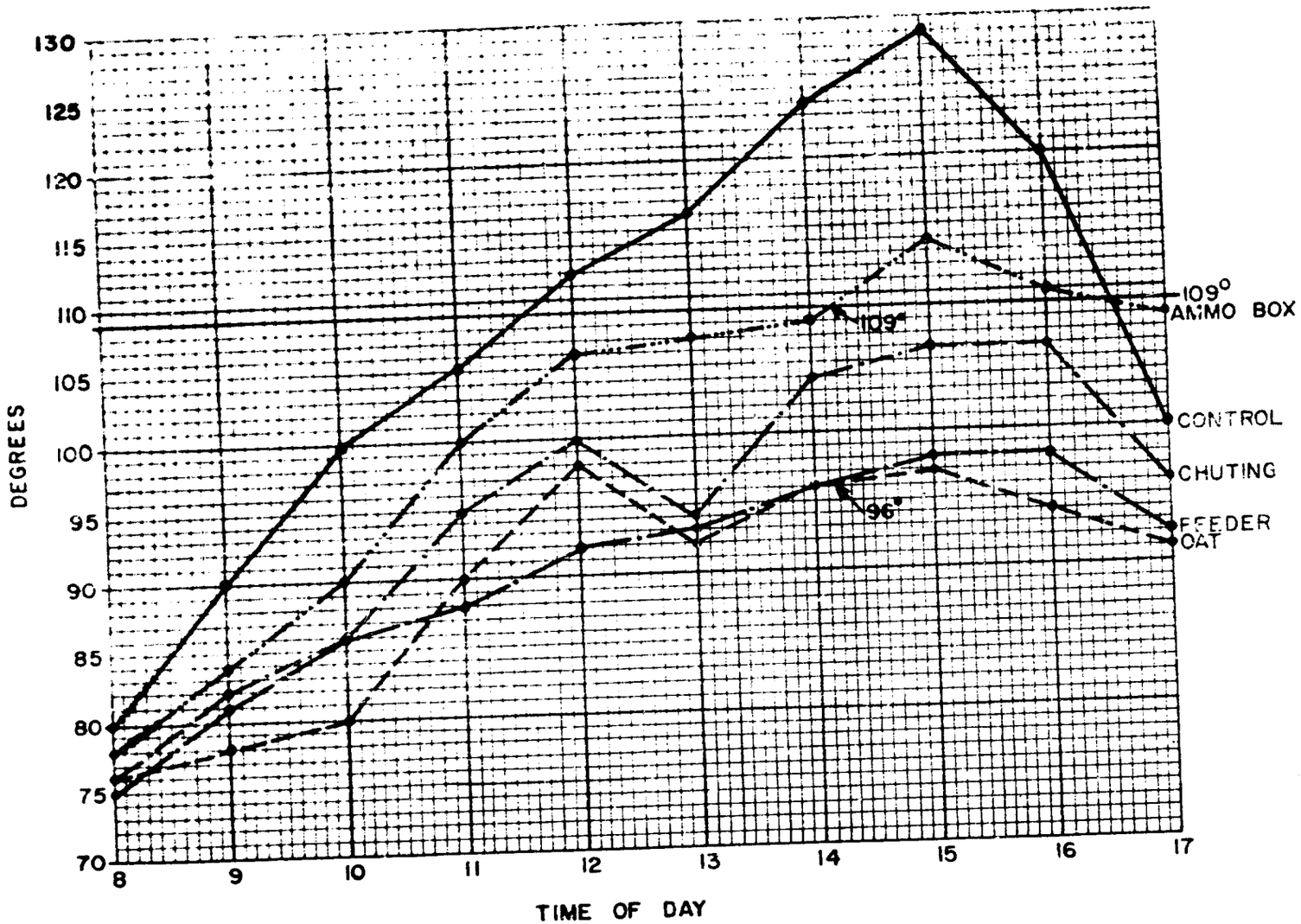
MONTH	SOUTH	CENTRAL	NORTH
January	90 - 84	81 - 77	77 - 73
February	92 - 87	85 - 80	80 - 75
March	97 - 88	85 - 80	85 - 80
April	98 - 91	87 - 82	85 - 80
May	93 - 90	85 - 80	90 - 85
June	91 - 84	85 - 80	90 - 85
July	88 - 84	85 - 80	90 - 85
August	90 - 86	90 - 80	90 - 75
September	85 - 83	80 - 76	85 - 80
October	85 - 83	85 - 75	85 - 75
November	86 - 84	80 - 74	75 - 70
December	87 - 81	80 - 75	75 - 70

Monthly mean maximum temperatures in Vietnam. Critical temperatures underlined.



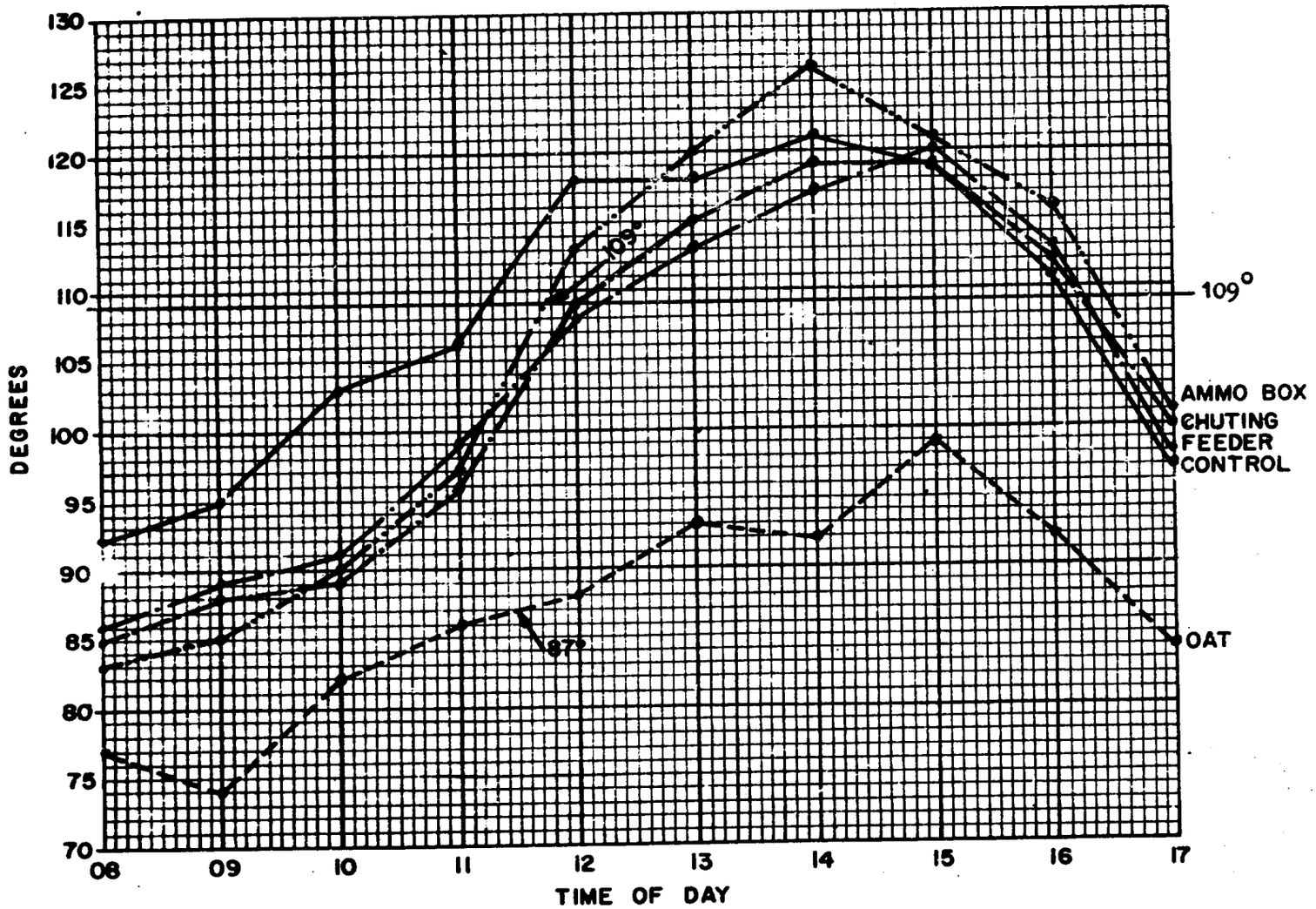
M-5 System Temperatures, 28 Aug 66, Doors and Windows Closed

Incl 17



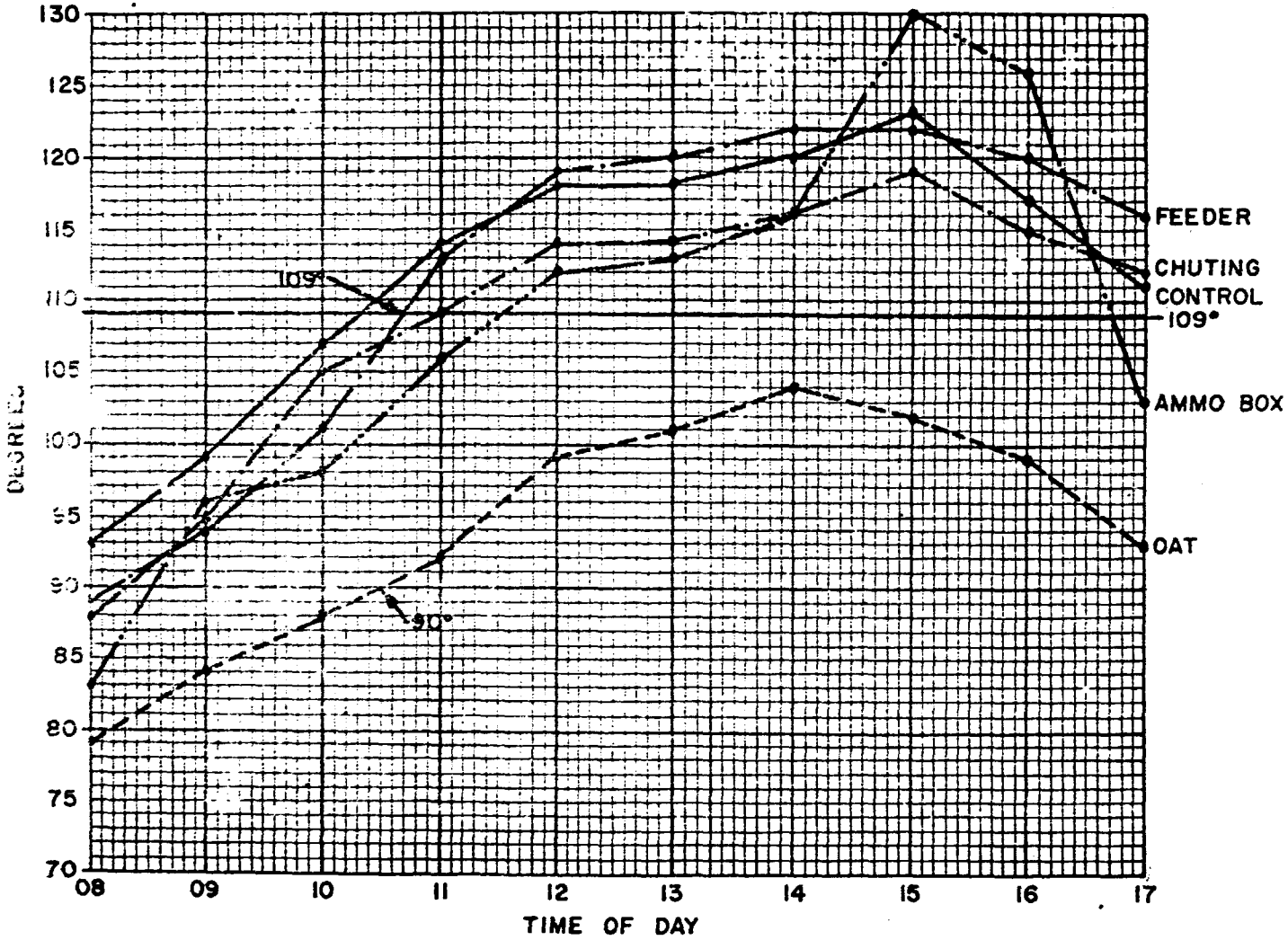
M-5 System Temperatures, 30 Aug 56, Doors and Windows Closed

Incl 18



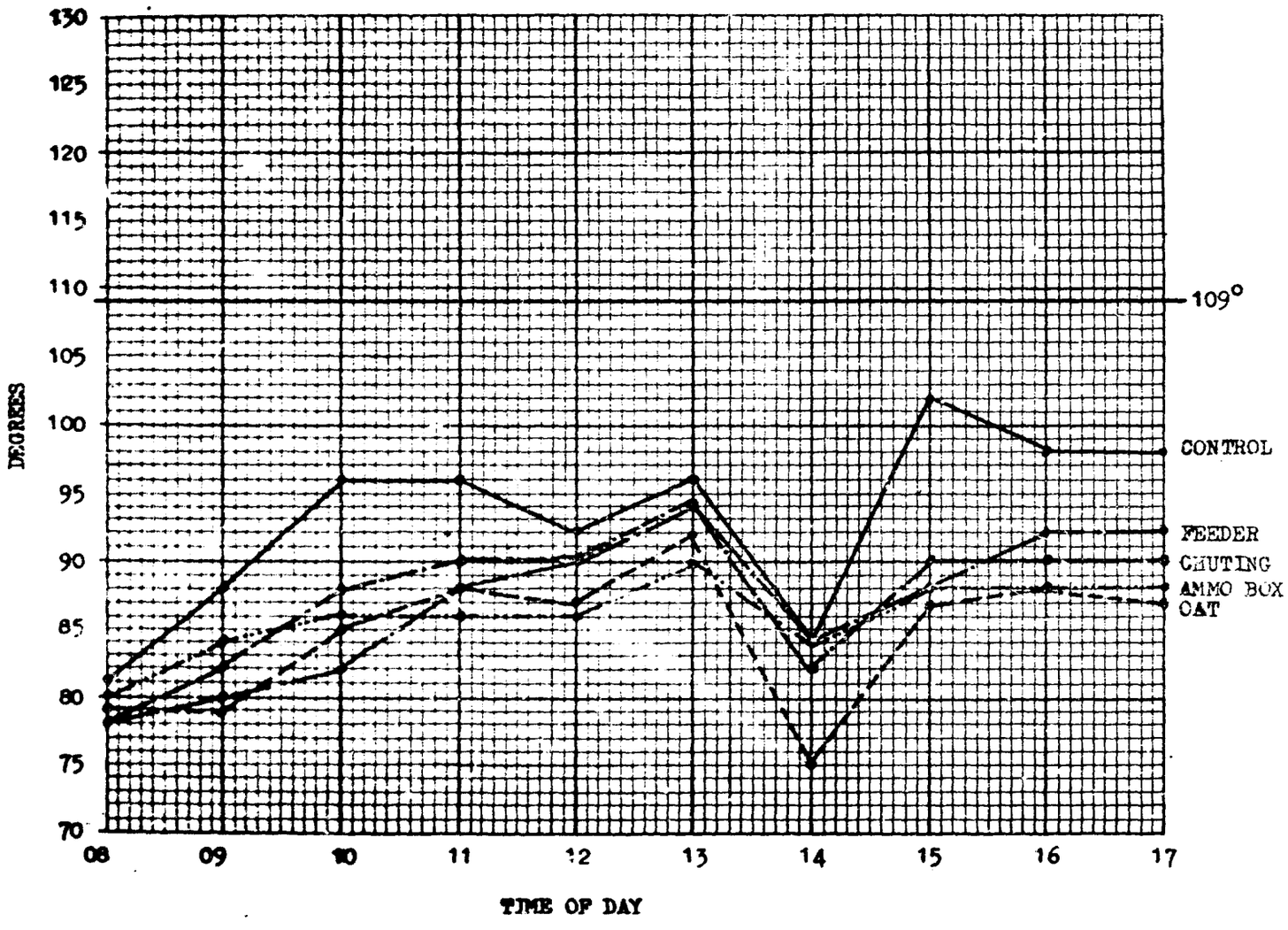
M-5 System Temperatures, 2 Sep 66, Doors and Windows Closed

Incl 19

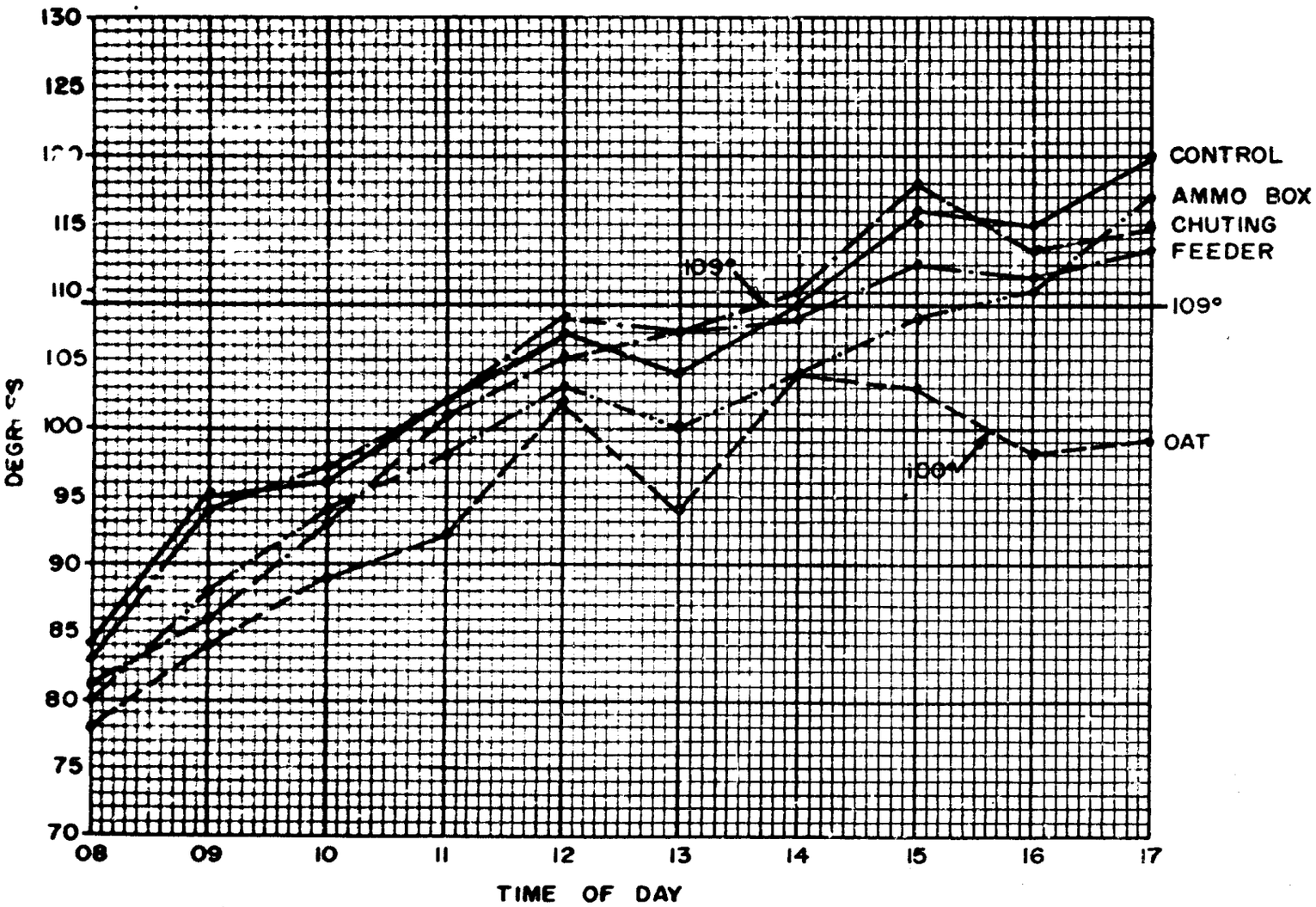


M-5 System Temperatures, 9 Sep 66, Doors and Windows Closed

Incl 20

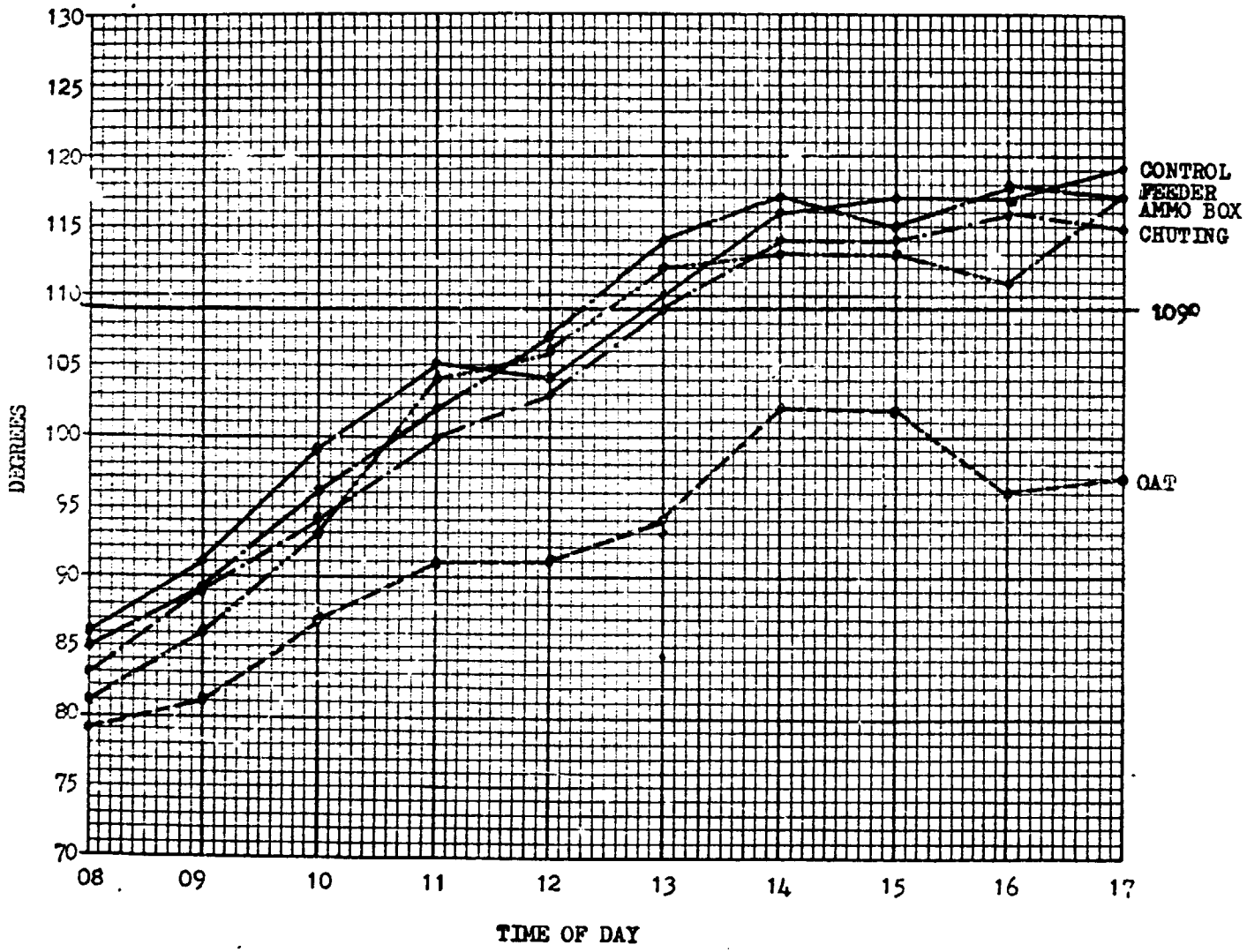


M-5 System Temperatures, 29 Aug 66, Doors and Windows Open (intermittant rain all day) Incl 21



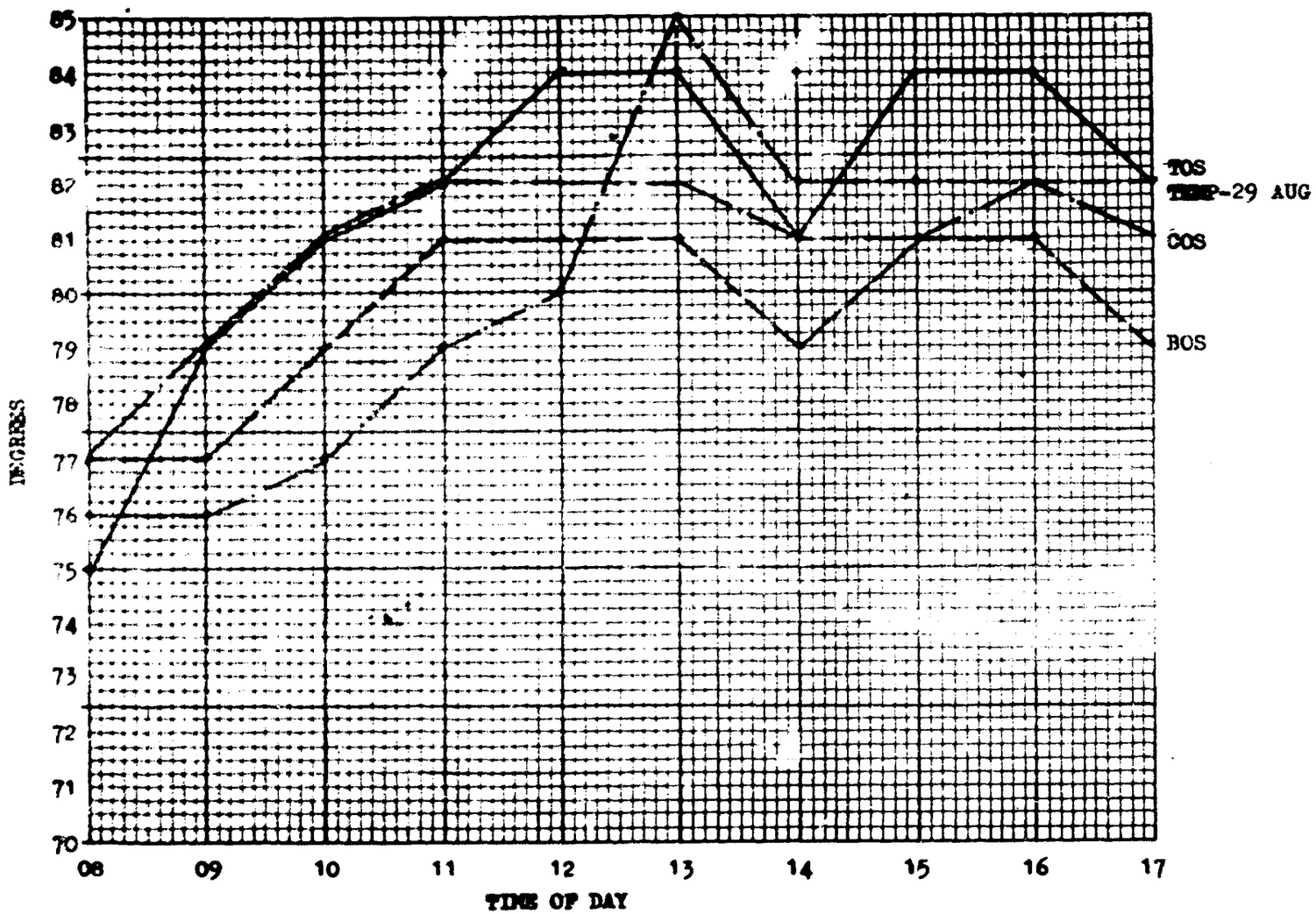
M-5 System Temperatures, 6 Sep 66, Doors and Windows Open

Incl 22



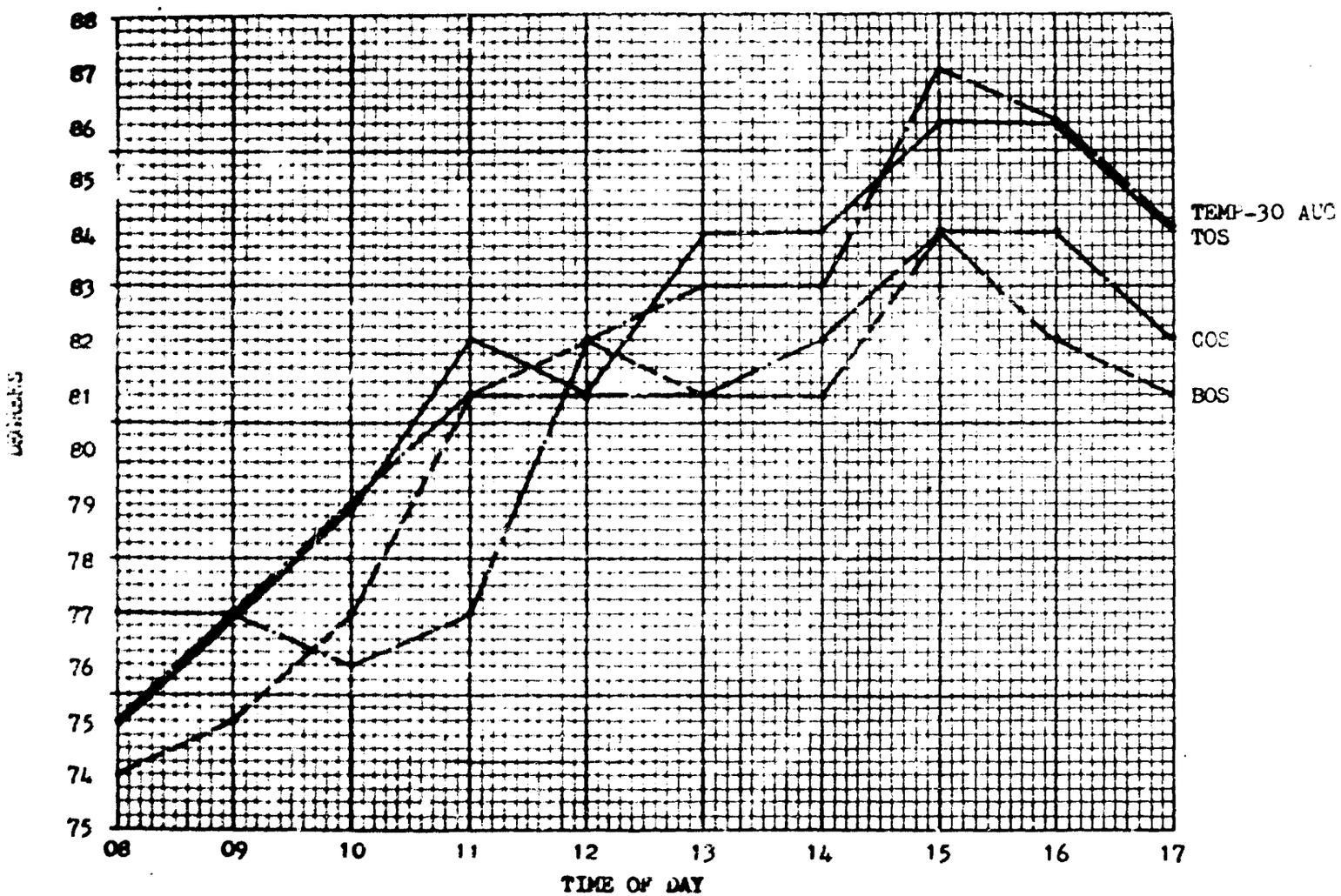
M-5 System Temperatures, 11 Sep 66, Doors and Windows Open

Incl 23

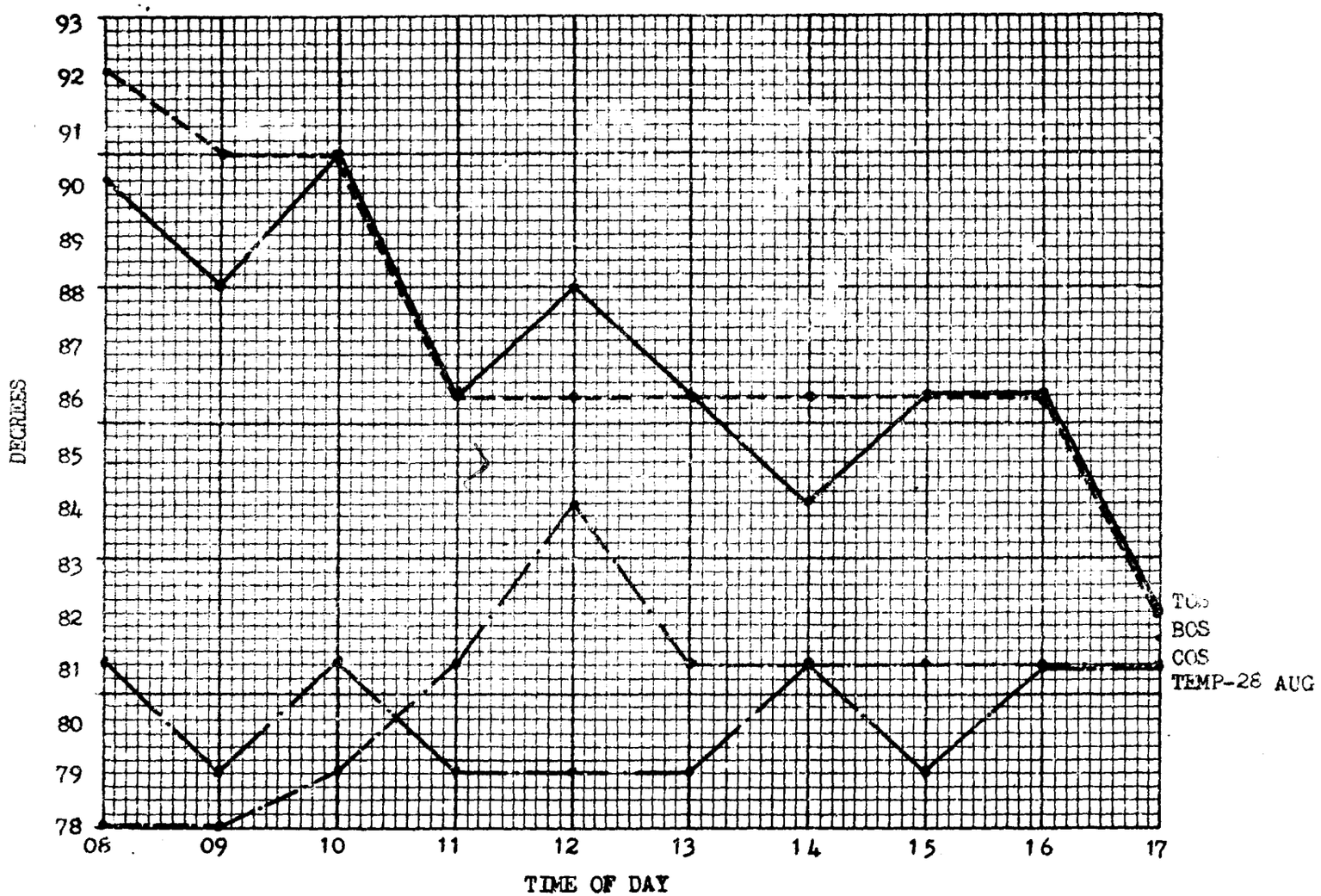


Ammunition Storage Area Temperatures, 29 Aug 66, Bien Hoa

Incl 24

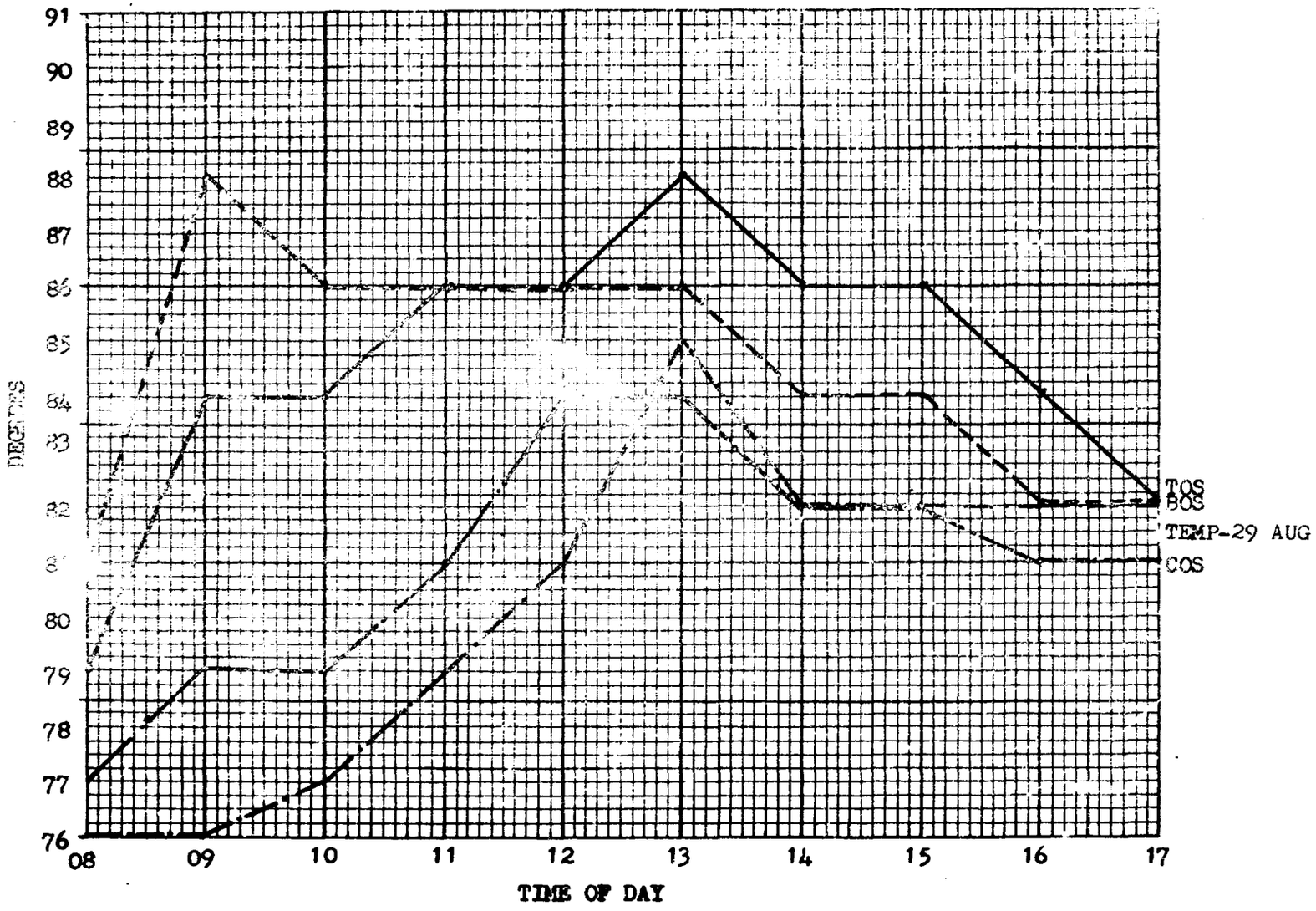


Ammunition Storage Area Temperatures, 30 Aug 66, Bien Hoa Incl 25



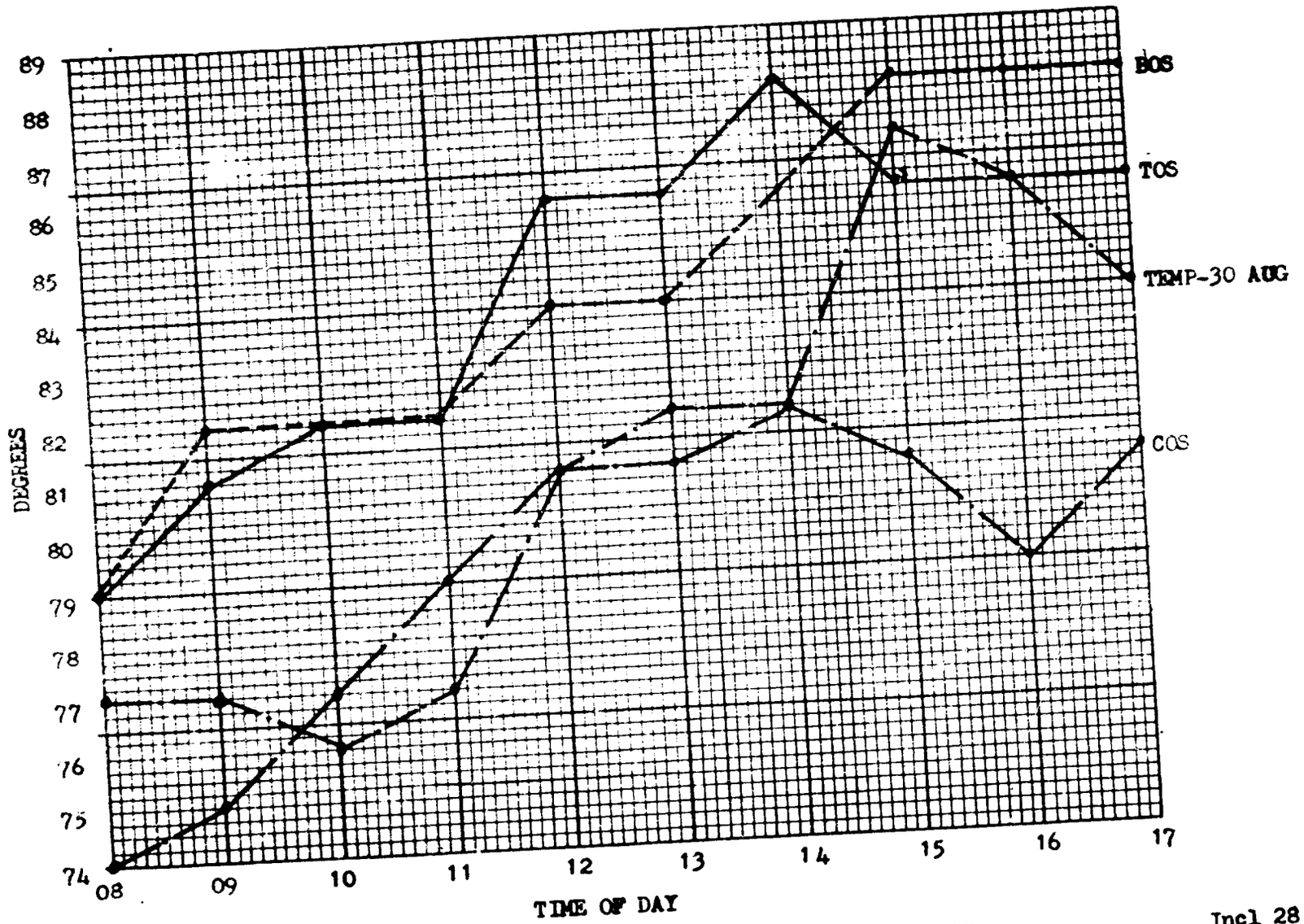
Ammunition Storage Area Temperatures, 28 Aug 66, TSN ASP

Incl 26



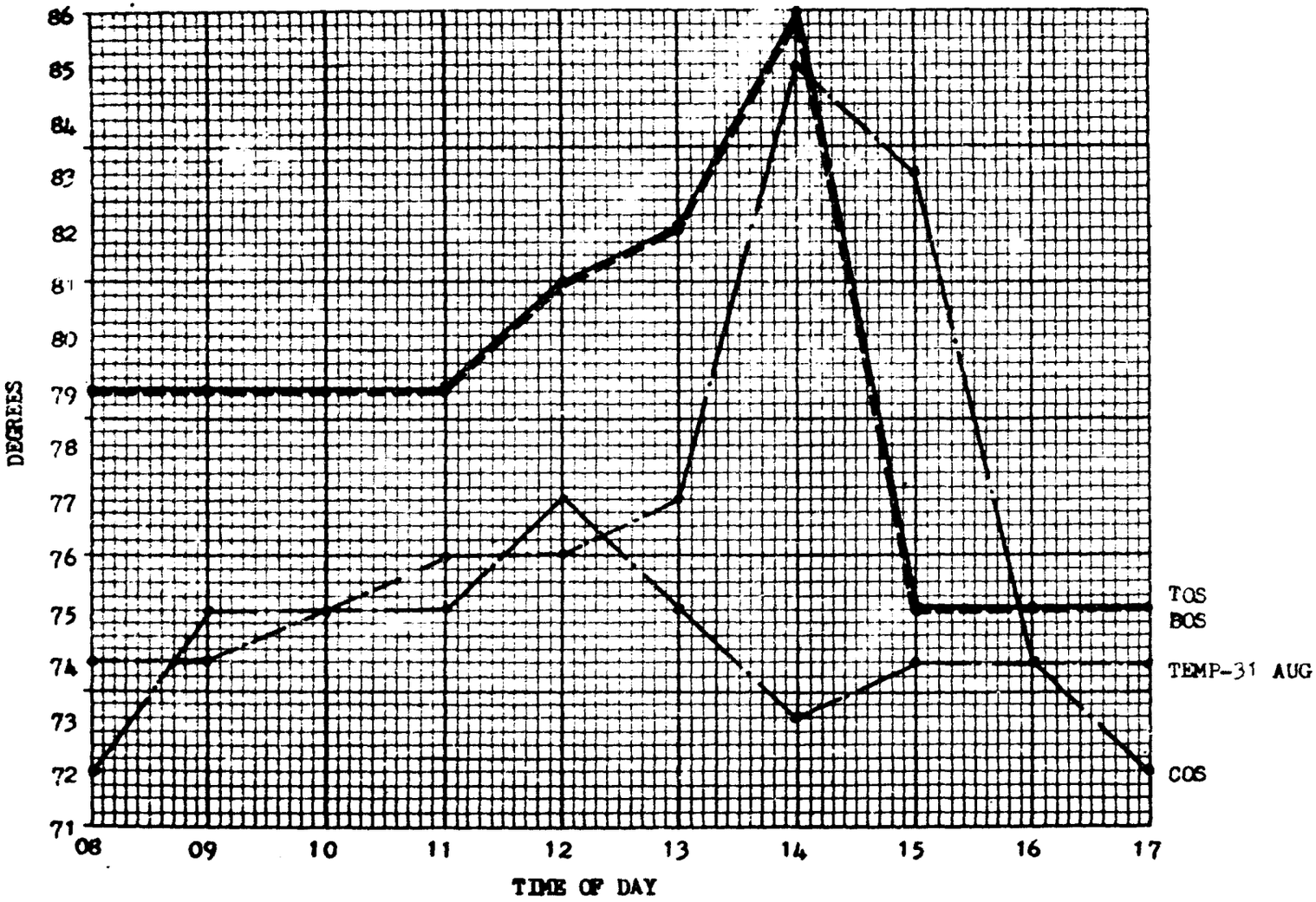
Ammunition Storage Area Temperatures, 29 Aug 66, TSN ASP

Incl 27



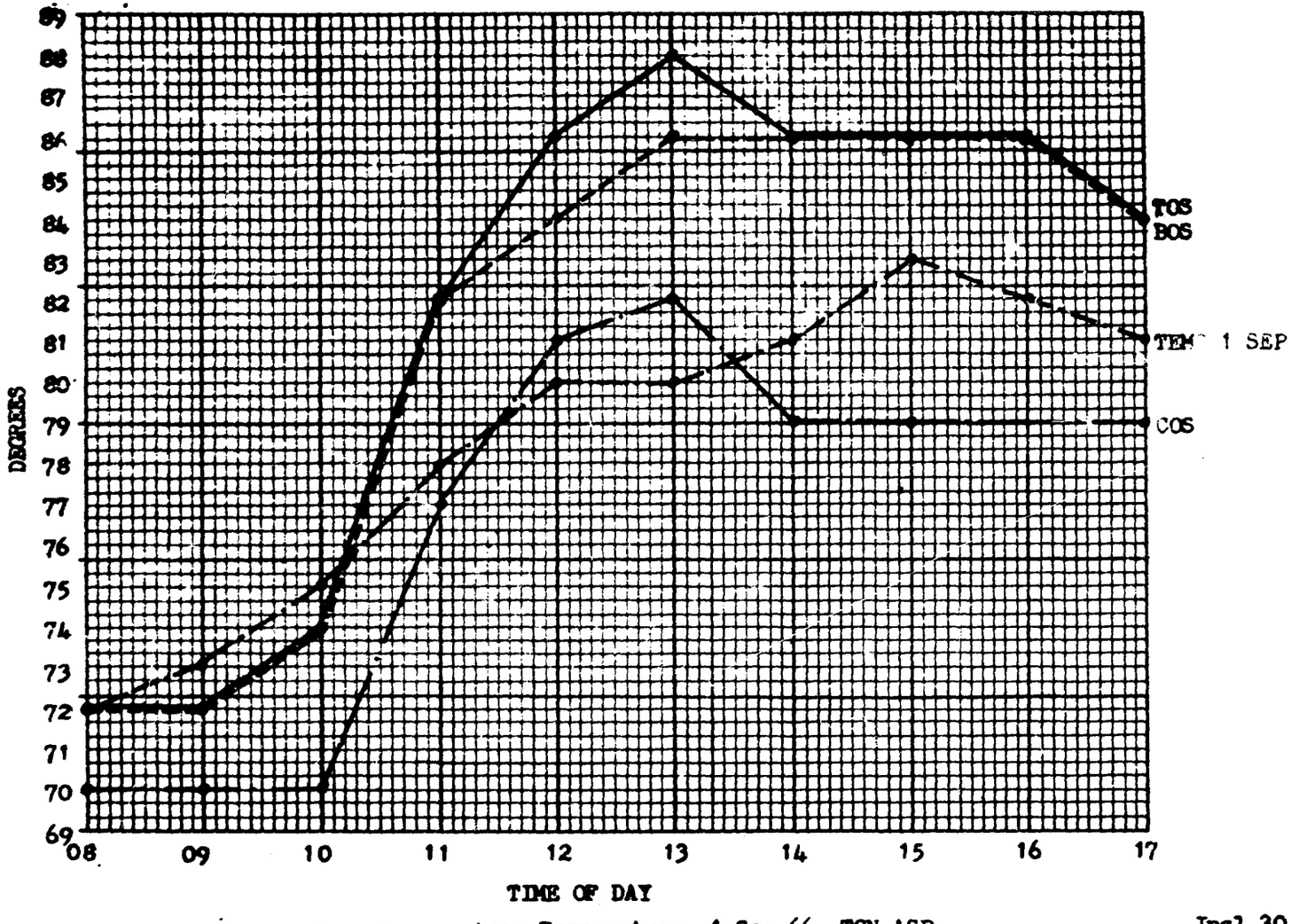
Incl 28

Ammunition Storage Area Temperatures, 30 Aug 66, TSN ASF



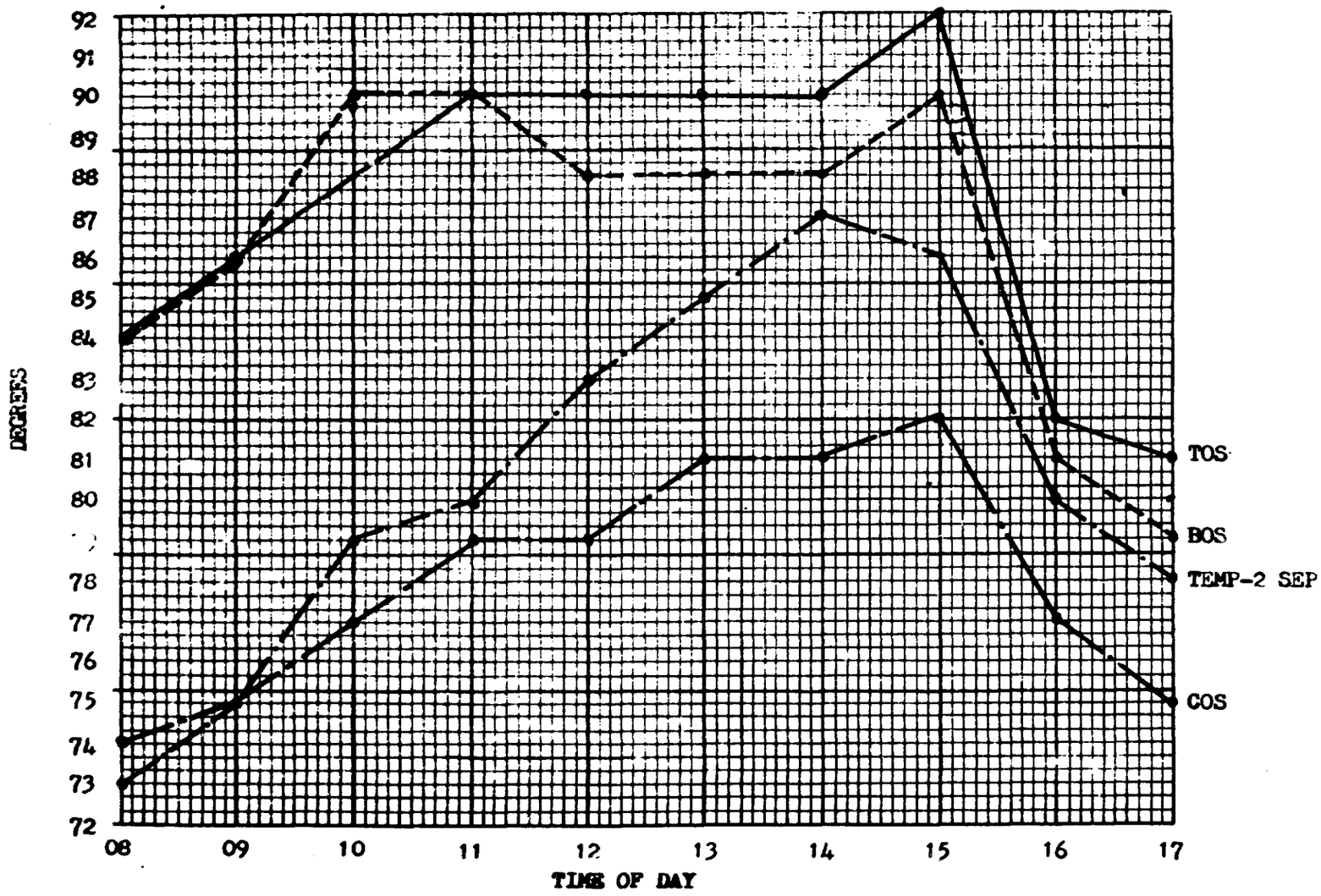
Ammunition Storage Area Temperatures, 31 Aug 66, TSN ASP

Incl 29



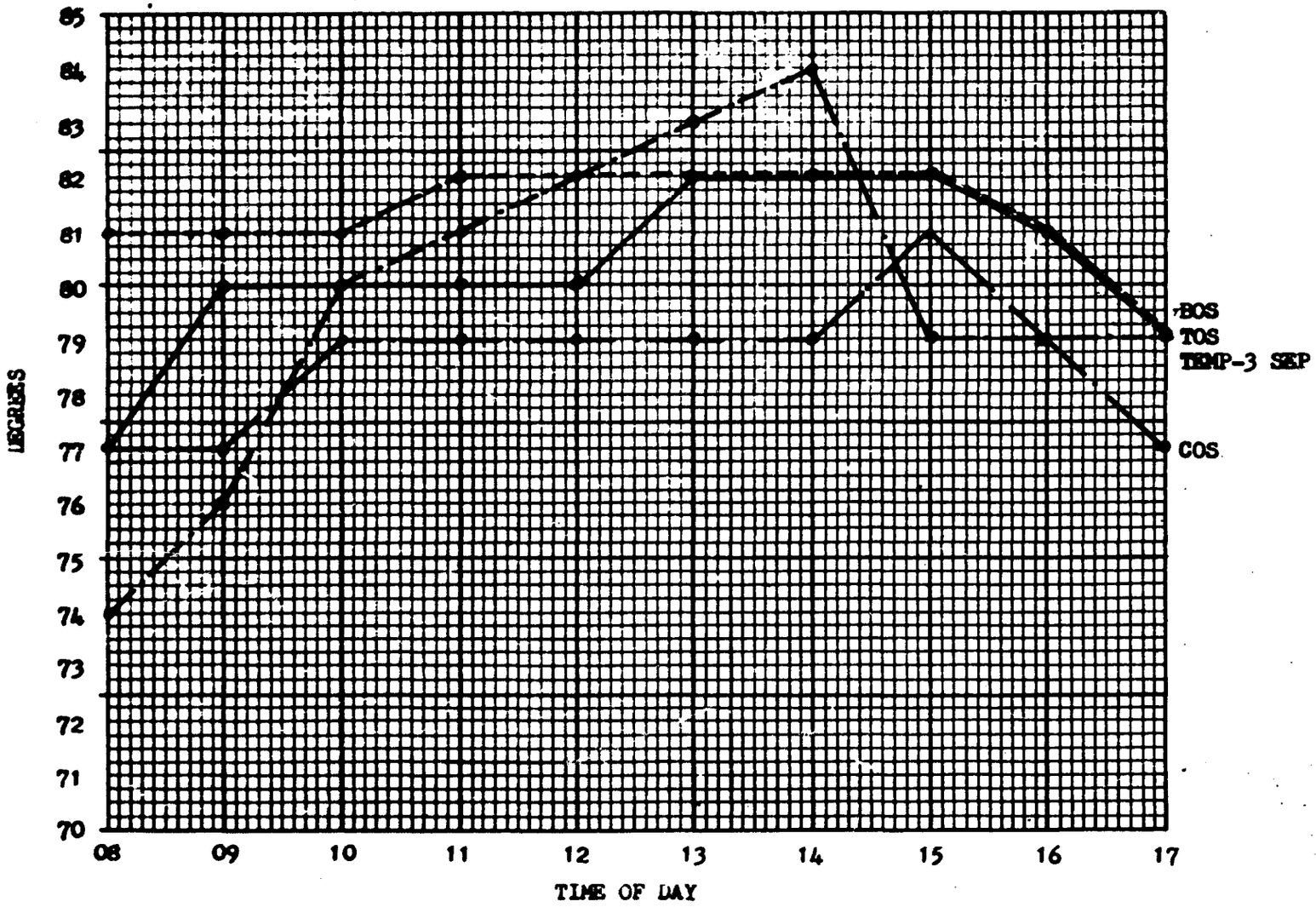
Ammunition Storage Area Temperature, 1 Sep 66, TSN ASP

Incl 30



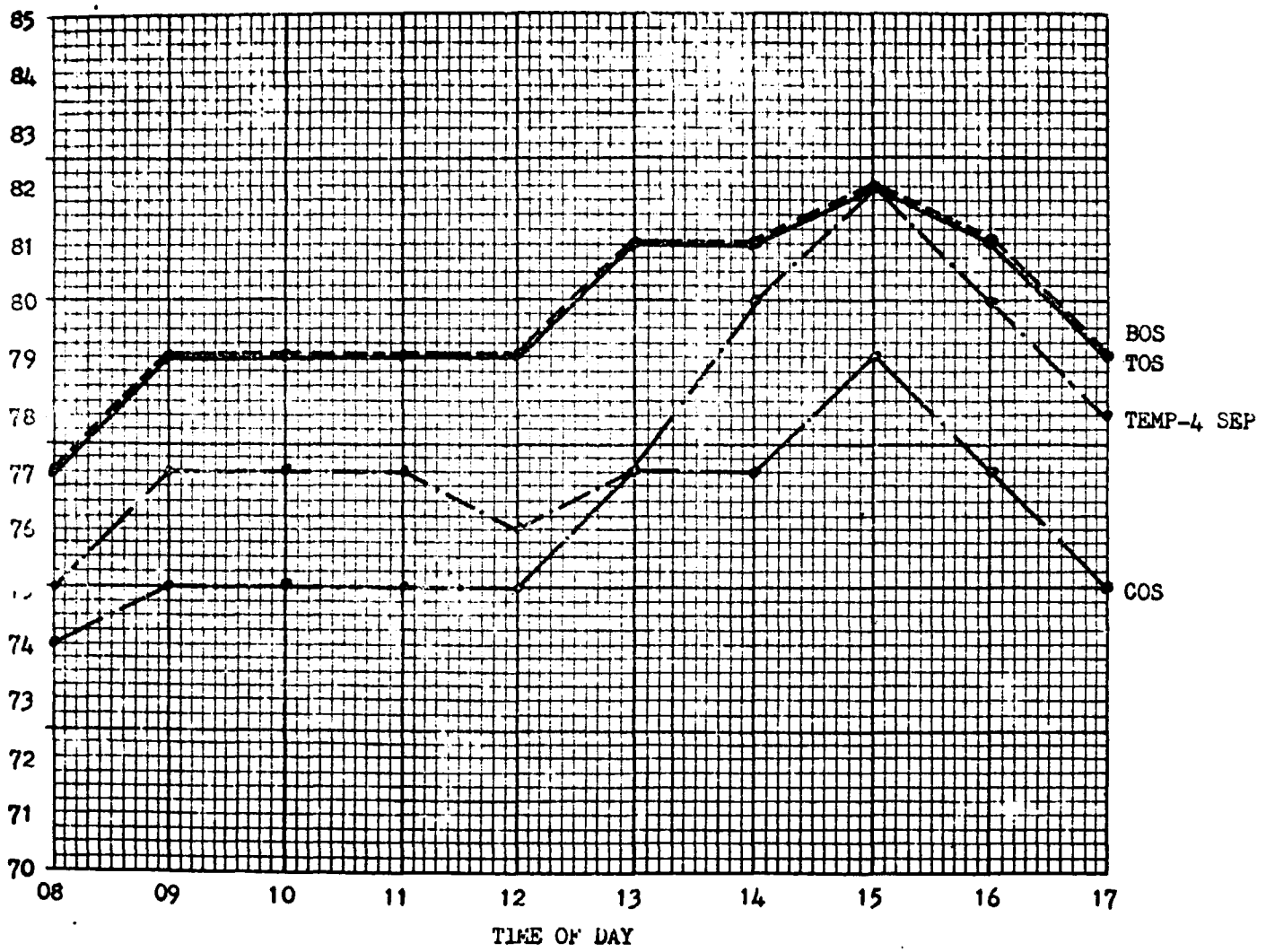
Ammunition Storage Area Temperatures, 2 Sep 66, TSN ASP

Incl 31



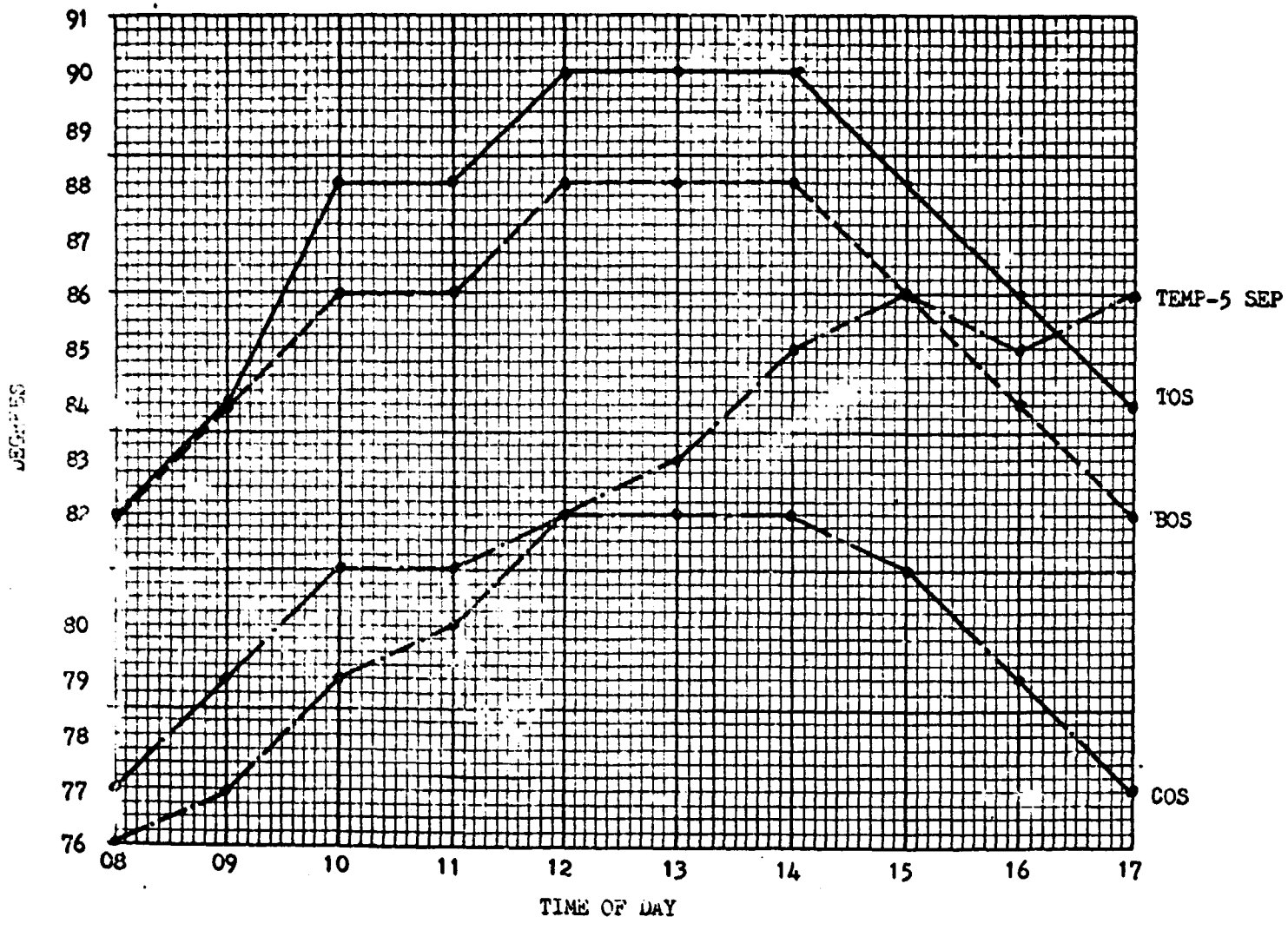
Ammunition Storage Area Temperatures, 3 Sep 66, TSN ASP

Incl 32



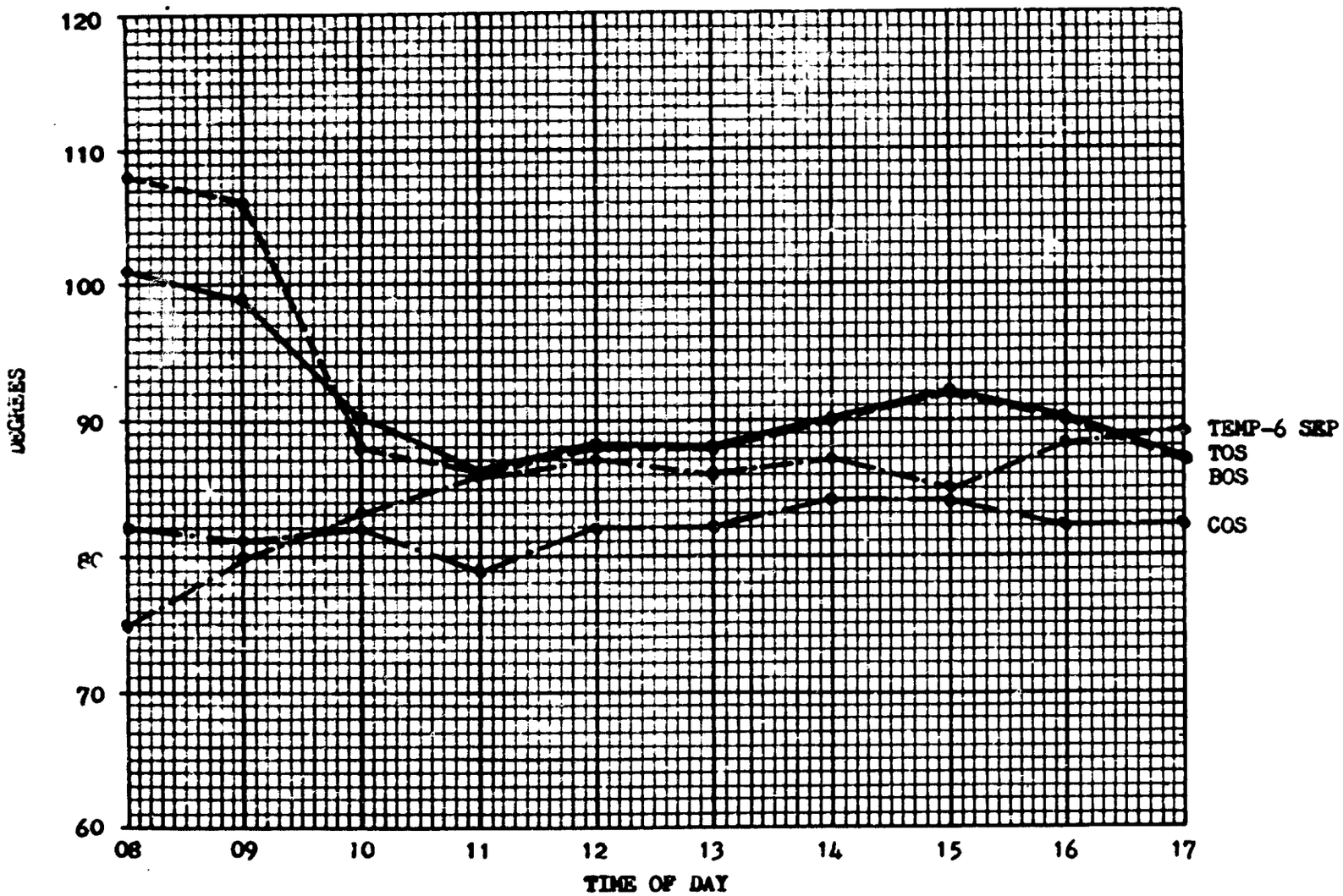
Ammunition Storage Area Temperatures, 4 Sep 66, TSN ASP

Incl 33



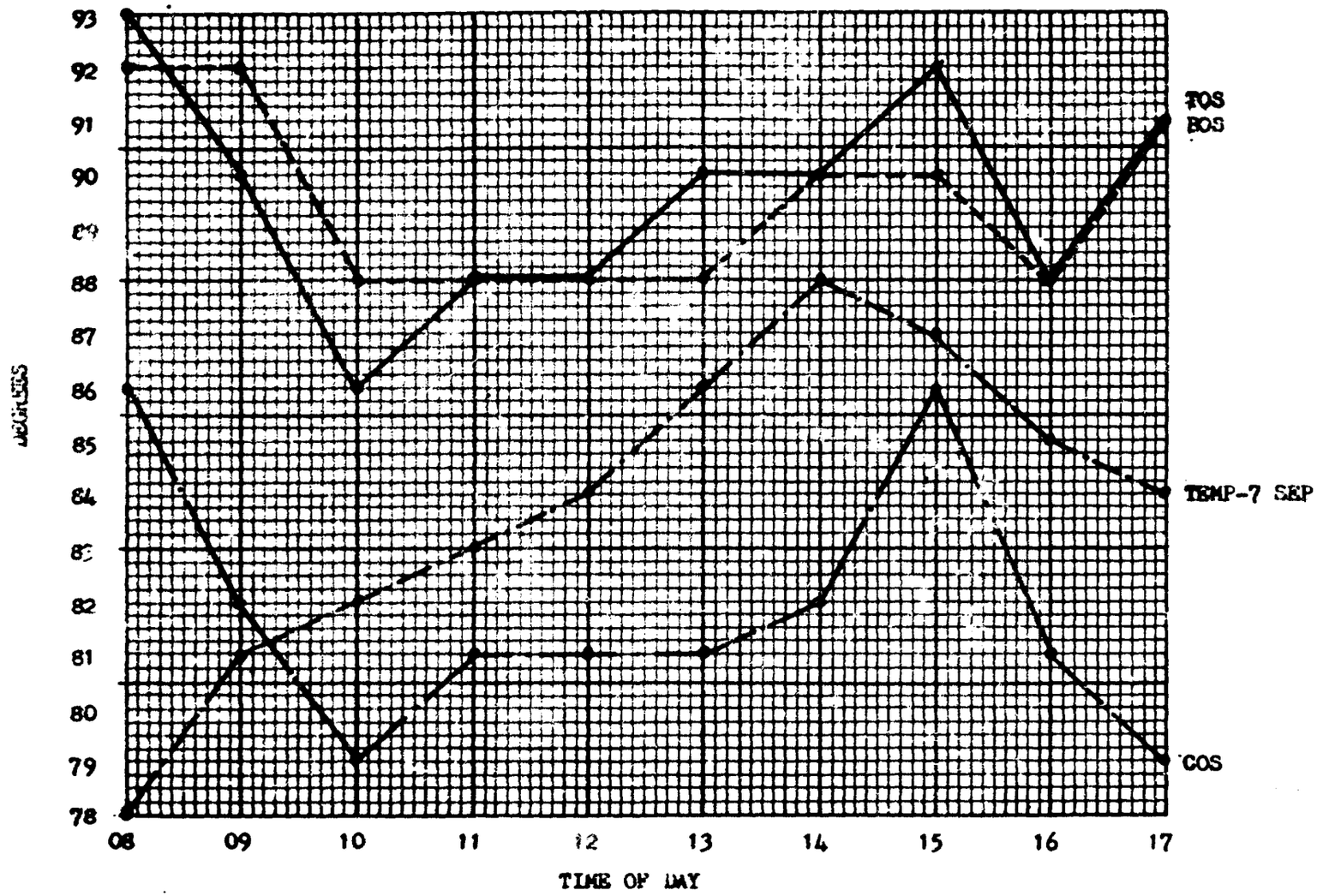
Ammunition Storage Area Temperatures, 5 Sep 66, TSN ASP

Incl 34



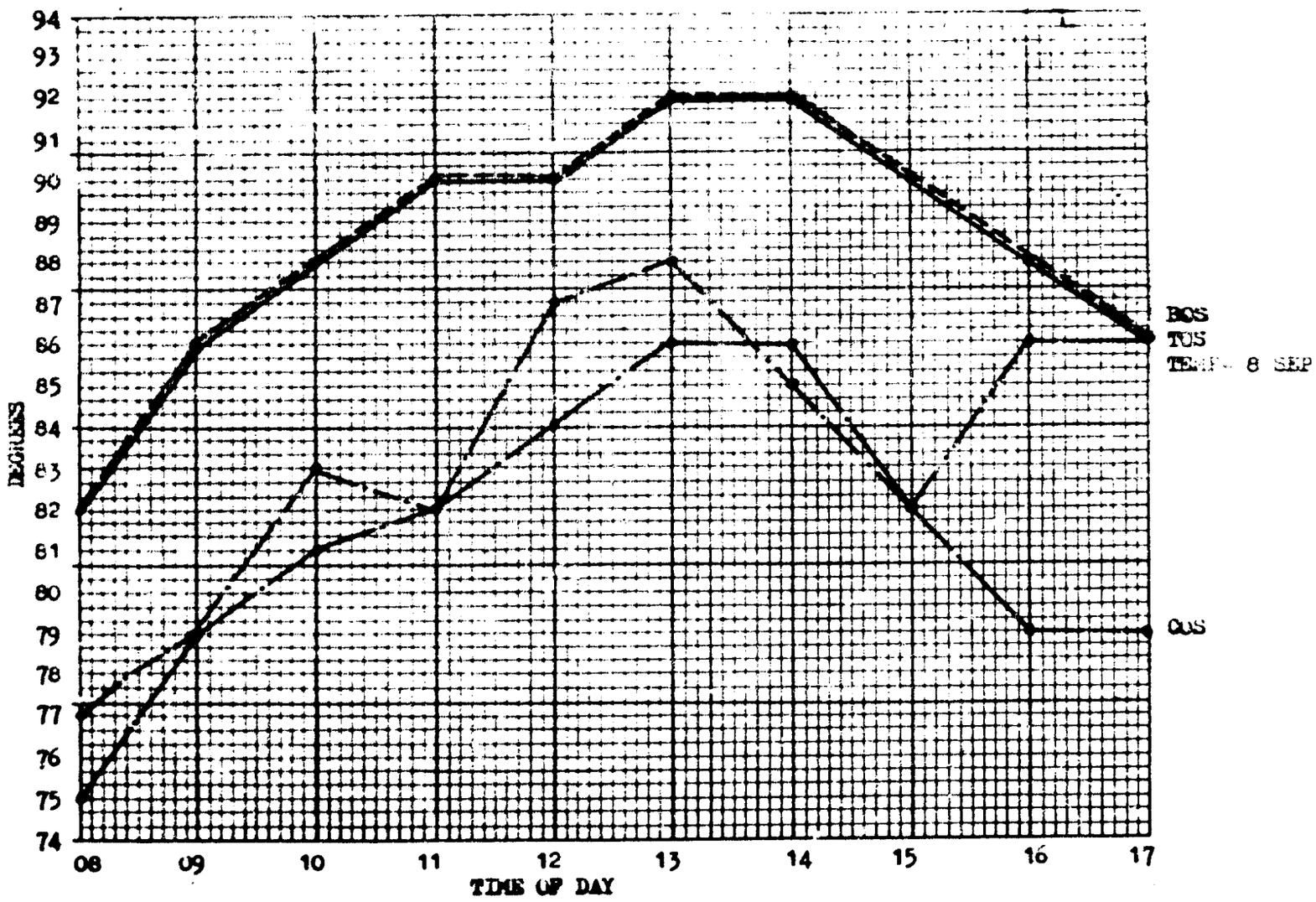
Ammunition Storage Area Temperatures, 6 Sep 66, TSN ASP

Incl 35



Ammunition Storage Area Temperatures, 7 Sep 66, TSN ASP

Incl 36



Ammunition Storage Area Temperatures, 8 Sep 66, TSN ASP

Incl 37