Purchaser's Identification

No. MPC-MI-E-18 & E19
Issue Date February 3, 1967
Order No. [redacted]

7714520100

EBASCO SPECIFICATION

125 VOLT D-C STORAGE BATTERY AND CHARGER

PURCHASER EBASCO SERVICES INCORPORATED

STATION MILLSTONE POINT NEPS

PROJECT 125 VOLT D-C SUPPLY & BATTERY CHARGERS UNIT

LOCATION NIANTIC BAY, CONNECTICUT

SELLER:

Issue No.	Date	Prepared By:	Reviewed By:	Pages Affected:
Original	2/3/67	J B Rodriguez	M J Palossy	All
Revisions				
R1	~			
R2				

[redacted]

EBASCO SPECIFICATION
125 VOLT D-C STORAGE BATTERY
AND CHARGER

SCOPE

1. The purpose of this Specification is to describe the requirements for a 125 volt d-c battery for ungrounded operation and two static battery charging rectifiers. The battery and battery charger shall be complete in all respects and be furnished with all required accessories, whether or not they are detailed therein. The battery will be used for the auxiliary and control power supply, and starting emergency motor loads encountered in a nuclear generating station.

BATTERY TYPE

2. The battery shall be a 125 volt, 60 cell iron-clad or lead-calcium pasted plate type. The jars shall be of heat-resistant, shock-absorbing transparent plastic of uniform thickness. High and low electrolyte level lines shall be permanently marked on all four sides of the jars. Ample sediment space shall be provided. Cells shall be vented and provided with permanent leakproof, concealed plastic cover with bayonet type vent plug so constructed as to allow escape of gases but preclude the escape of electrolyte spray.

STANDARDS

3. All equipment shall comply with currently applicable standards and rules of the United States of America Standards Institute, The Institute of Electrical and Electronic Engineers, the National Electrical Manufacturer's Association, in the above order of preference.

SERVICE REQUIREMENTS

4. The battery will be located indoors in a ventilated room with an ambient temperature range of 10° C to 40° C. Under emergency conditions, the battery will be subject to an 8 hour duty cycle as follows:

1000 amperes for the first minute.
1200 amperes for the next minute.
622 amperes for the next 58 minutes.
72 amperes for the next 6 hours 59 minutes
and 172 amperes for the last minute.

The battery shall be able to supply all control and emergency circuits at the above 8 hour rate of discharge without the terminal voltage per cell falling below 1.75 volt at 25° C electrolyte temperature.

PLATES AND ELECTROLYTE

5. Plates shall be suspended either from ledges molded in the jar walls or from the cell covers. Positive and negative plates shall be designed and constructed to have equal life. The plates shall be so reinforced and have ample strength to retain their shape and have the necessary conducting material with low internal resistance to carry the current to or from all parts of the plate under all operating conditions. Separators shall be impervious to the chemical action within the cell, provide proper spacing and insulation between the plates and permit free circulation of electrolyte.

The battery shall be furnished complete with electrolyte and fully charged, and its specific gravity should be at least 1.2. The battery shall have a guaranteed life of at least 20 years when maintained as recommended by the manufacturer.

CONNECTORS AND TERMINALS

6. Vendor will supply all intercell connectors and bolts made of lead-plated copper and of adequate construction and current carrying capacity. The connectors and bolts must be designed to withstand a sustained one hour current of 700 amperes and 100 amperes continuously with a temperature rise of no more than 10° C above an ambient temperature of 25° C. Intercell connectors shall provide a minimum of 1/2 inch spacing between cells. The interior connection arrangement shall be subject to Purchaser's approval. The terminal cells shall be provided with connectors for Purchaser's 2, 1/c - 750 Mcm copper cables per terminal.

RACKS

7. The battery shall be mounted on earthquakeproof single tier racks supplied by the Vendor, made of steel rails and properly insulated and painted and properly supported. The racks shall be designed to permit mounting of the battery in a 25 x 37 ft battery room. The racks shall be furnished complete with mounting pads and cell numbers. The rack parts shall be properly identified for easy assembly by Purchaser. The numbers shall be affixed to the cells.

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BATTERY ACCESSORIES

8. The battery shall be shipped with any and all accessories which are essential for proper installation, operation and maintenance of the battery. This shall include, but not be limited to two connector bolt wrenches, vent-mounted hydrometer syringe, portable hydrometer syringe, vent-mounted compensated thermometer, battery cell voltmeter with ±3 volt scale, anti-acid and anti-corroding joint compound, spare electrolyte for two cells and cell lifting device.

BATTERY CHARGER

9. The battery charger shall be of the static type, automatic, self-regulated constant voltage output. The regulating equipment shall not contain vacuum tube devices. All rectifiers, transformers and reactors shall be of the dry type.

The battery charger shall be capable of furnishing floating, equalizing and fast charge in accordance with the battery manufacturers' recommendations. The charger shall be complete with d-c ammeter, voltmeter, d-c voltage adjusting controls, a-c supply indicating lights, 3 pole a-c circuit breaker having 30,000 amperes rms asymmetrical interrupting capacity for the input and 2-pole d-c circuit breaker having interrupting capacity capable to interrupt the short circuit current of the battery at its terminal. All the instruments and controls shall be accessible and visible from the front of the panel. The rectifying diodes shall be protected adequately against switching surges caused by switching of inductive devices. All the instruments shall be of 2% accuracy or better.

Each charger shall be a self-contained device with all the necessary relays, timers, etc to prevent false operation, and for the protection of the charger itself.

The battery charger shall be capable to maintain a regulated float voltage of 2.15 - 2.20 volts per cell while supplying a continuous auxiliary load of 40 amperes, it also shall be able to provide an equalizing voltage adjustable between 2.20 and 2.33 volts

2.33 v.p.c.

9. (Cont'd) BATTERY CHARGER (Cont'd)

per cell. The battery output shall be self-regulating automatically holding output voltage within ±0.5% over the working range from no load to full load for ±10% a-c voltage and ±2% frequency line variation. The unfiltered output ripple shall not be more than the normal 2% RMS level. The input voltage will be 440 volt, 3 phase, 3 wire, 60 cps. Two 2.5% taps above and below this voltage shall be furnished. Battery charger shall be able to restore battery full charge in 12 hours after an emergency discharge. The Battery chargers and their auxiliary devices shall be assembled in a free standing sheet metal cubicle. All external connections will be made at the top or bottom. The charger shall operate without any artificial ventilation in 40° C ambient temperature. Finish shall be ASA-61.

All relays, meters, switches, etc, shall be clearly identified by a black background, white lettered multilayer nameplate. The engraving shall be covered with a non-fading plastic layer to prevent dust, etc to collect in the grooves. The inscription shall describe the function of the device. The efficiency of the charger shall be 90% at 100% rated d-c amperes output.

10. The battery chargers shall be equipped with the following features and alarm initiating devices: BATTERY CHARGER ACCESSORIES

.1 24 hour timer.

.2 D-C ground detection relay with test device to simulate ground fault and reset pushbutton.

.3 Loss of a-c supply relay (all three phases)

.4 Loss of d-c output relay

.5 High d-c voltage.

10. (Cont'd) BATTERY CHARGER ACCESSORIES (Cont'd)

The relays shall be supplied with two contacts closing on abnormal conditions for connection to Purchaser's alarm circuits. The contacts shall be rated 1.0 ampere 120 volts d-c. All the alarms shall be provided with panel mounted local indicating lights. All external control connections shall be terminated in terminal block GE-EB-5.

11. Seller shall guarantee that the equipment meets satisfactorily and successfully the listed requirements under the specified conditions. Expected life span, and guaranteed life span shall be supplied by the Vendor. GUARANTEES

12. The assembled battery, its components and accessories shall be subject to factory tests. Materials, apparatus and tests shall be subject to inspection by an authorized representative of the Purchaser. These tests and inspections may be made during any stage of manufacture and equipment found unsatisfactory as to workmanship or material will be rejected. Inspection or waiving of inspection by Purchaser shall not relieve Seller of his obligation to furnish equipment in accordance with the intent of this specification. INSPECTION AND TESTS

13. The battery cells and battery charger shall be shipped completely assembled and charged unless otherwise specified. Equipment shall be properly packed and crated for protection in transit. Seller shall be responsible for and make good at his expense any and all damage due to improper preparation for shipment. Each piece in the shipment shall be marked with Purchaser's order and item number. SHIPMENT

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DRAWINGS, INSTRUCTION MANUALS

14.1 The type of preliminary drawing required by the Purchaser is a single direct reading reproducible of each drawing of no lesser quality than "albanized" sepia or "autopositive" on extra thin paper able to produce clear and legible prints; it should be noted that ordinary "sepia" or similar process reproducibles are not acceptable. The reproducible shall be made 3 inches longer than the original drawings with the 3-inch extension on the right side of the sheet. * All reproducibles must be submitted rolled (not folded) on the outside of regular mailing tubes, except for small sizes capable of being mailed unfolded in an envelope with a cardboard backing. Reproducibles shall be forwarded in the most expeditious manner and they shall be accompanied by a letter of transmittal in six (6) copies addressed to EBASCO SERVICES INCORPORATED, Attention: Mr R B Harvey, c/o Central File, Room 200, Two Rector Street, New York, New York 10006. Letter of transmittal shall include the following items of identifying information:

1 - Engineering Order Identification Number GE-5385

2 - Purchase Contract Number

3 - Seller's Drawing Number

Purchaser will return to Seller one (1) print of the reproducible either: (a) Stamped "approved" or, (b) Marked up with "comments." In case (a) two (2) further reproducibles are required by Purchaser. In case (b) Seller shall correct his original drawings to conform to the comments made by Purchaser and submit three (3) new reproducibles within two (2) weeks after the marked-up comment print was received.

.2 Seller shall furnish two sets of positive reading mylar reproducibles and six (6) complete sets or at Seller's option, forty-one (41) copies of instruction books. If the instruction books contain photographs or multicolor prints and the Seller elects to supply reproducibles, the 41 copies of aforementioned photographs and multicolor prints shall be supplied.

* Preferred drawing sizes to be 28" x 34"

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AND CHARGER

15. Vendor shall furnish the following battery information: MANUFACTURER'S DATA

a) Guaranteed ampere hour capacities for 1 minute, 1 hour, 3 hours and 8 hours discharge rates to 1.75 volt per cell final voltage.

b) Specification for electrolyte.

c) Specific gravity of electrolyte at 25° C, fully charged.

d) Volume of electrolyte per cell.

e) Weight per cell, with and without electrolyte.

f) Total net weight of battery, including rack.

g) Total shipping weight.

h) Cell dimensions, outline drawing.

i) Rack dimensions, outline drawing.

j) Battery to be shipped, whether dry or filled.

k) Battery to be shipped, whether charged or uncharged.

l) Time battery can be stored dry without charging.

m) Time battery can be left without charging if shipped filled.

n) Terminal detail for outgoing cable connections.

o) List of equipment and recommended spare parts.

p) Estimated salvage value.

q) Method used in calculating life.

r) List of material to be provided under the contract.

and for the battery charger the following data:

s) Output capacity.

t) Input capacity.

u) Voltage regulation.

v) Voltage range. (d-c)

w) Normal voltage settings.

x) Current limiting.

y) Efficiency.

z) Metering.

aa) Overload protection.

bb) Surge Protection.

cc) Ripple content.

dd) Recommended Spare Parts.

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AND CHARGER

16. Equipment shall be designed to withstand earthquakes resulting in horizontal seismic coefficient of 0.12 g and vertical seismic coefficient of 0.046 g. Supports shall be designed to prevent displacement of equipment assuming that friction does not exist. SEISMIC LOADING

C&D BATTERIES
DIVISION OF ELTRA CORPORATION
3043 WALTON ROAD, PLYMOUTH MEETING, PENNSYLVANIA 19462 • TELEPHONE: 215-828-9000
TELETYPE: 510-660-8436

October 27, 1972

Millstone Nuclear Power
Waterford, Conn.

Attention: Mr. B. Place

Subject: Millstone #1 Battery

Dear Mr. Place:

The attached sheet shows the calculations used to determine the battery size necessary to meet your specified duty cycle load profile.

The actual ampere hour drain seen by the battery during the 8 hour duty cycle is 1207 AH. An LCU-17 type battery, with an 8 hour capacity rating of 1200 ampere hours, would almost satisfy this energy requirement if discharged at its 8 hour rate of 150 amperes. However, the non-linear nature of the duty cycle with high current drain during the first hour period will be the determining criterion for sizing the battery.

A larger battery such as an LCU-21 with an 8 hour rating of 1500 ampere hours would easily satisfy the first hour energy requirements (excluding the initial 2 second load of 2987 amperes) with capacity to spare for the balance of the 8 hour period. Even this size cell, however, would not supply the initial inrush current surge of 2987 amperes for 2 seconds. To satisfy this load an even larger cell, an LCU-27 with an 8 hour capacity of 1950 ampere hours, is required. Thus the 2 second load requirement is the factor that determines the actual battery size. It will, of course, be capable of maintaining the final seven hour energy requirement for an extended period of time, up to 17 additional hours.

Attached also are two copies of the cell voltage and plate potential readings taken on the subject batteries on 10-19-72. They indicate all cells to be in a normal healthy condition.

If you have further questions relative to the Millstone #1 battery, please do not hesitate to call me.

Very truly yours,

George N. Stover
Chief Engineer

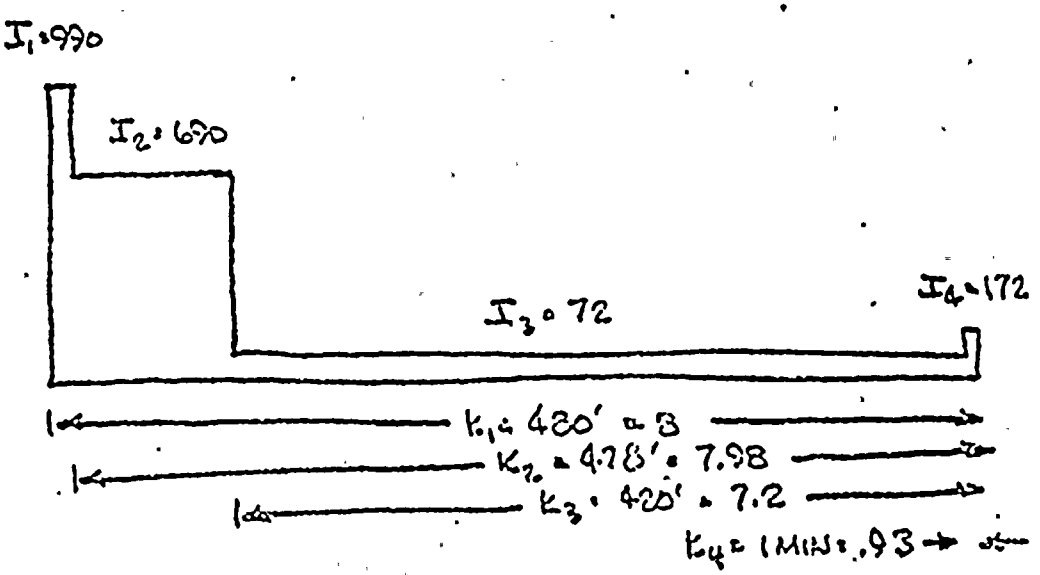
Encl.

BATTERY TO PROVIDE THE FOLLOWING DUTY CYCLE AT 77°F WITHOUT FALLING BELOW 1.75 VPC. DUTY CYCLE DOES NOT INCLUDE THE INITIAL 2 SECOND LOAD OF 2987 AMPS.

990 AMPS FOR 2 MINUTES
690 AMPS FOR 58 MINUTES
72 AMPS FOR 419 MINUTES
172 AMPS FOR 1 MINUTES

TOTAL. 8 HOURS

GRAPHICALLY:



ASSIGNING "K" VALUES

CALCULATING: $C = K_1 I_1 + K_2 (I_2 - I_1) + K_3 (I_3 - I_2) + K_4 (I_4 - I_3)$

$= 8 \times 990 - 7.98 \times 300 - 7.2 \times 618 + .93 \times 100$

$= 7920 - 2394 - 4445 + 93$

$= 8013 - 6839$

$= 1164$ AH BATTERY REQUIRED (LCU-17)

LCU-17, WITH A ONE HOUR RATE OF 600 AMPS WILL NOT CARRY THE FIRST HOUR. THIS LOAD WILL DETERMINE BATTERY SIZE.

$C = 2 \times 990 - 1.95 \times 300$

$= 1980 - 585$

$= 1395$ AH BATTERY REQUIRED (LCU-21)

PRESENT LCU-22 WILL RUN APPROXIMATELY 24 HOURS

BY [illegible] DATE 8-15-66

EBASCO SERVICES
INCORPORATED
NEW YORK

SHEET NO. 1 OF
CHKD. BY DATE
E.O. NO. DIV.
COMPANY
PROJECT MILLSTONE - DC SUPPLY
SUBJECT BATTERY 4.16KV ACB CLOSING & TRIPPING WRF

	SOLENOID CLOSING	STORED	TRI
4KV BKR			
4.16 - 250 MVA	95 A	6 / 6.5A Mot	6.
- 350 MVA	145 A	6 / 6.5A Mot	6
480V BKRS			
AK2-15 225A	44		1.9
2-25 600A	44		1.9
2-50 1600A		30	1.9
2-75 3000A		30	1.9

FILE COPY

SEP 9

FILE DC [illegible]

copy [illegible] to N. [illegible] Sep 9 for comment [illegible] due [illegible] Sep 20

IND LIGHTS	0.035 A
ANNUNCIATOR PT	0.07 A

ALL VALUES AT 125V D.C.

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BY Pdrossy DATE 8-15-66 EBASCO SERVICES INCORPORATED NEW YORK SHEET NO. 2 OF _____

CHKD. BY _____ DATE _____ E.O. NO. _____ DIV. _____

COMPANY _____

PROJECT MILLSTONE - DC SUPPLY

SUBJECT BATTERY 4.16 KV ACB TRIPPING & CLOSING LOADS.

BUS 1	EACH	TRIP	CLOSE		
2 INC FD	6T/6+6.5	12	25		
3 LOADS	6T/145C	18	435		350 MVA
BUS 2					
2 INC FD		12	25		
[illegible]		12	290		350 MVA
BUS 3					
2 INC FD		12	25		
12 LOAD	6T/95C	72	1130		250 MVA
BUS 3					
2 INC FD		12	25		
10 LOAD		60	950		
BUS 5					
GEN			12		
8 LOAD		48	760		
BUS 6					
GEN			12		
9 LOAD		54	865		

TOTAL 52

Closing 30 will trip simultaneously 30 · 6 = 180A

BY [illegible] DATE 8-15-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 3 OF ____

CHKD. BY ____ DATE ____ | E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE — DC - SUPPLY

SUBJECT BATTERY - 480V SWGR & MISC LOADS.

	EACH	TRIP	CLOSE	TRIP	CLOSE
480V SWGR 1					
INC	2T/30C	2	30		
6 TDP's	21/44C	12	264		
480V SWGR 1A		14	294		
2.		14	294		
2A		14	294		

[illegible] 30 BUP A

CONTINUOUS LOAD

(1)

SWGR IL. AT GEAR	50 x 0.035 =	1.75A		
AT MCBD	50 x 0.035 =	1.75A.		
100 VALVES IL	100 x 0.035 =	3.5A		
200 ANNUNCIATOR (AFTER SHUT DOWN)	200 x 0.07 =	14 A		
		21 A		

(3) MOMENTARY 2 MIN

ISOLATION VALVES	20HP	2 MIN	I 140 A	2 SEC INRUSH

CONTINUOUS LOAD.

(2)

TURBINE - GEN CONTR	500W	8HR	5A	60A
FIRE PILOT	500W	8HR	5A	
DC LTG	3KW	8HR	30A	
[illegible]	2 KW	8HR	20A	

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BY Pdlosso DATE 8-15-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 4 OF ____

CHKD. BY ____ DATE ____ | E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE - DC SUPPLY

SUBJECT BATTERY D.C MOTOR LOADS 125V D.C.

		RUN	INRUSH
EMERGENCY BRG OIL PUMP	40 HP	240A	560A 1 HR
EMERGENCY SEAL OIL PUMP	7.5 HP	58A	116A 1 HR
VITAL AC GENERATOR MOTOR	30 HP	212A	440 1 HR
		550	

AT 250V DC CURRENTS ARE 1/2 OF THE VALUES ABOVE

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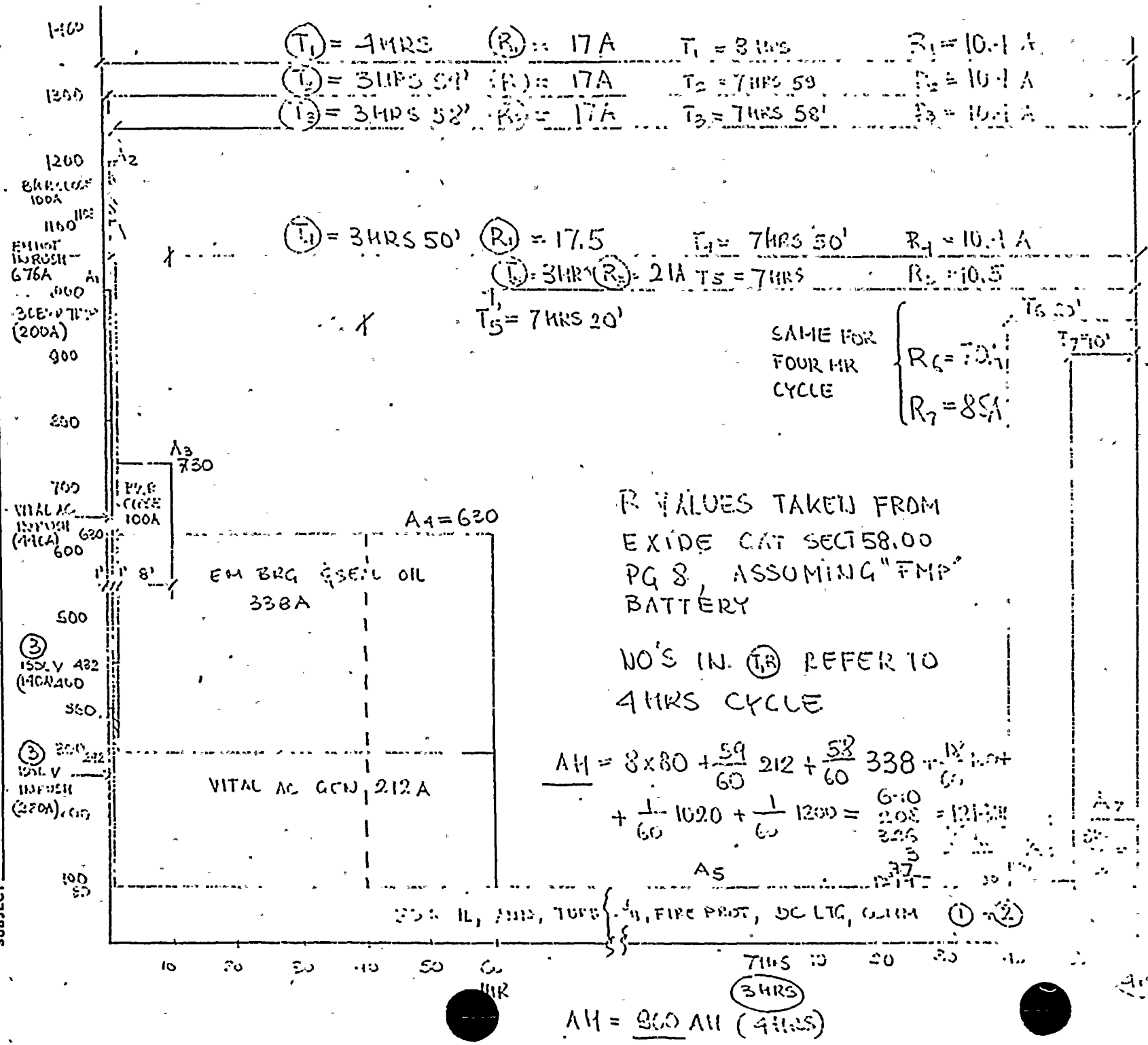
NEW YORK

SHEET NO. 5 OF ____
E.O. NO. ____ DIV. ____

BY D. DESSI DATE 8-16-66
CHKD. BY ____ DATE ____

COMPANY DC SUPPLY
PROJECT MILLSTONE - ONE 125V DC BATT
SUBJECT BATTERY LOADS



T_1 = 4 HRS (R) = 17 A T_1 = 3 HRS R_1 = 10.1 A
T_2 = 3 HRS 59' (R) = 17 A T_2 = 7 HRS 59 R_2 = 10.1 A
T_3 = 3 HRS 58' (R) = 17 A T_3 = 7 HRS 58' R_3 = 10.1 A
T_4 = 3 HRS 50' R_4 = 17.5 T_4 = 7 HRS 50' R_4 = 10.1 A
T_5 = 3 HRS (R) = 21 A T_5 = 7 HRS R_5 = 10.5
T_5 = 7 HRS 20'
T_6 20'
T_7 10'

SAME FOR FOUR HR CYCLE
R_6 = 70.1
R_7 = 85 A

R VALUES TAKEN FROM EXIDE CAT SECT 58.00 PG 8, ASSUMING "FMP" BATTERY

NO'S IN (T,R) REFER TO 4 HRS CYCLE

$$AH = 8 \times 80 + \frac{59}{60} 212 + \frac{58}{60} 338 + \frac{1}{60} 1020 + \frac{1}{60} 1200 = \begin{matrix} 640 \\ 208 \\ 336 \\ 17 \\ 17 \end{matrix} = 1218 \text{ AH}$$

AH = 960 AH (4 HRS)

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$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} + \frac{A_7}{R_7}$$

since $R_1 = R_2 = R_3 = R_4$

$$P = \frac{A_4}{R_1} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} + \frac{A_7 - A_6}{R_7} =$$

$$= \frac{630}{10.4} + \frac{80 - 630}{10.5} + \frac{90 - 80}{70} + \frac{180 - 90}{85} =$$

$$= \frac{630}{10.4} - \frac{550}{10.5} + \frac{10}{70} + \frac{90}{85} = \begin{matrix} + \\ 60.5 \\ 0.143 \\ 1.06 \end{matrix} \quad \begin{matrix} - \\ 52.3 \end{matrix}$$

$$61.703 - 52.3 = 9.403 \sim 10 \text{ plates}$$

CHECK FIRST 2 PERIODS (PERIOD ONE STILL CONTROLS)

1200A

R = 110A

$$P_2 = \frac{1200}{110} = 10.9 < 10 \text{ plates}$$

1/2 min.

BY Paluzzi DATE 8-16-66 | **EBASCO SERVICES INCORPORATED NEW YORK** | SHEET NO. 7 OF

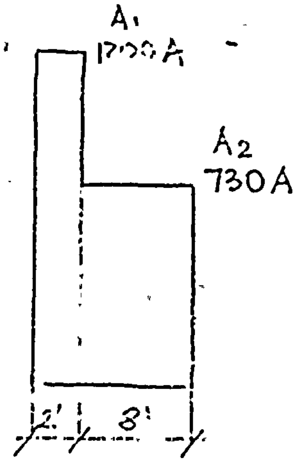
CHKD. BY ______ DATE ______ E.O. NO. ______ DIV. ______

COMPANY ______

PROJECT MILLSTONE . DC SUPPLY

SUBJECT BATTERY SIZING — ONE 125V D.C. BATTERY

CHECK FIRST 3 PERIODS

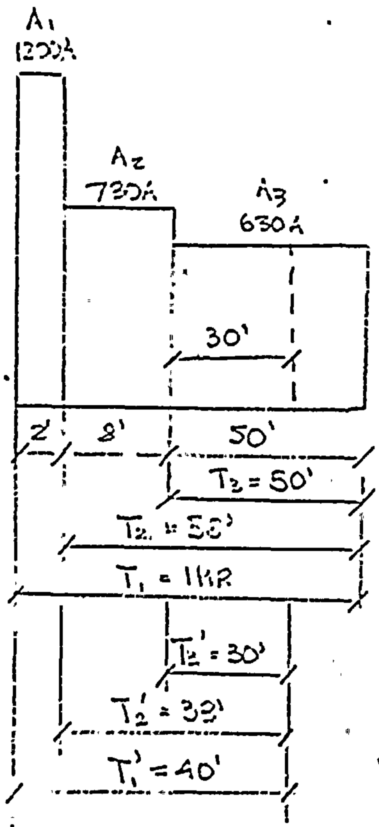


$$P_3 = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} = \frac{A_2}{R_1} = \frac{730}{85} = 8.6 < 10$$

$R_1 = 85A$ for 10 min

$R_2 \approx 8? A$ for 8 min

CHECK FIRST 4 PERIODS



$$P_4 = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3}$$

$R_1 = 42A$

$R_2 = 42A$

$R_3 = 46A$

$R_1 = R_2$

$$P_4 = \frac{A_2}{R_2} + \frac{A_3 - A_2}{R_3} = \frac{730}{42} + \frac{630 - 730}{46}$$

−100

$P_4 = 17.4 - 2.17 = 15.23 > 10$

NOT GOOD, FOR THE FIRST 4 P[illegible] WE [illegible] 16 @ P[illegible]

$AH = 16 \times 10.4 \times 8 = 1340$ AH

P↑ A/+P[illegible] HRS

[illegible] ... THP [illegible] [illegible] ... [illegible]

FORM 881 REV 7-59

BY Blasey DATE 8-16-55

CHKD. BY ____ DATE ____

EBASCO SERVICES
INCORPORATED
NEW YORK

SHEET NO. 8 OF ____

E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE - DC SUPPLY

SUBJECT BATTERY SIZING - ONE 125V D.C. BATTERY

CHECK FIRST 4 PERIODS FOR REDUCED (40') DUTY

$$P_4 = \frac{A_1}{R_1'} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3}$$

$R_1' = 52$ A

$R_2' = 53$ A

$R_3' = 60$ A

$$= \frac{1200}{52} + \frac{730 - 1200}{53} + \frac{630 - 730}{60}$$

$$= 23.1 - \frac{470}{53} - \frac{100}{60} = 23.1 - \underbrace{8.8 - 1.66}_{10.46} = 12.64 > 11 \text{ plates}$$

USE 12 PLATES THIS IS THE MAX SIZE

FMP-25 $8 \times 124.5 = 996$ AH

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BY [illegible] DATE 8-16-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 9 OF ____

CHKD. BY ____ DATE ____ | E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE DC SUPPLY

SUBJECT BATTERY SIZING — ONE 125V D.C. BATTERY

AHR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} + \frac{A_7 - A_5}{R_7}$$

$R_1 = R_2 = R_3 = 17.A$

$$P = \frac{A_3}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} + \frac{A_7 - A_5}{R_7}$$

$$P = \frac{730}{17} + \frac{-100}{17.5} + \frac{630 - 730}{21} + \frac{-550}{70} + \frac{80 - 630}{85} + \frac{10}{90} + \frac{90 - 80}{180 - 90}$$

$$P = 43 - 5.72 = 12.283 + \text{plates}$$

$0.143 \quad 26.2$

1.06

$44.203 - 31.92$

TAKE 12+plates

THIS BATTERY IS NO GOOD EITHER

CHECKING THE FIRST TWO, THREE & FOUR PERIODS REFER TO SH'S 7 & 8

TWO OK $10.9 < 12$

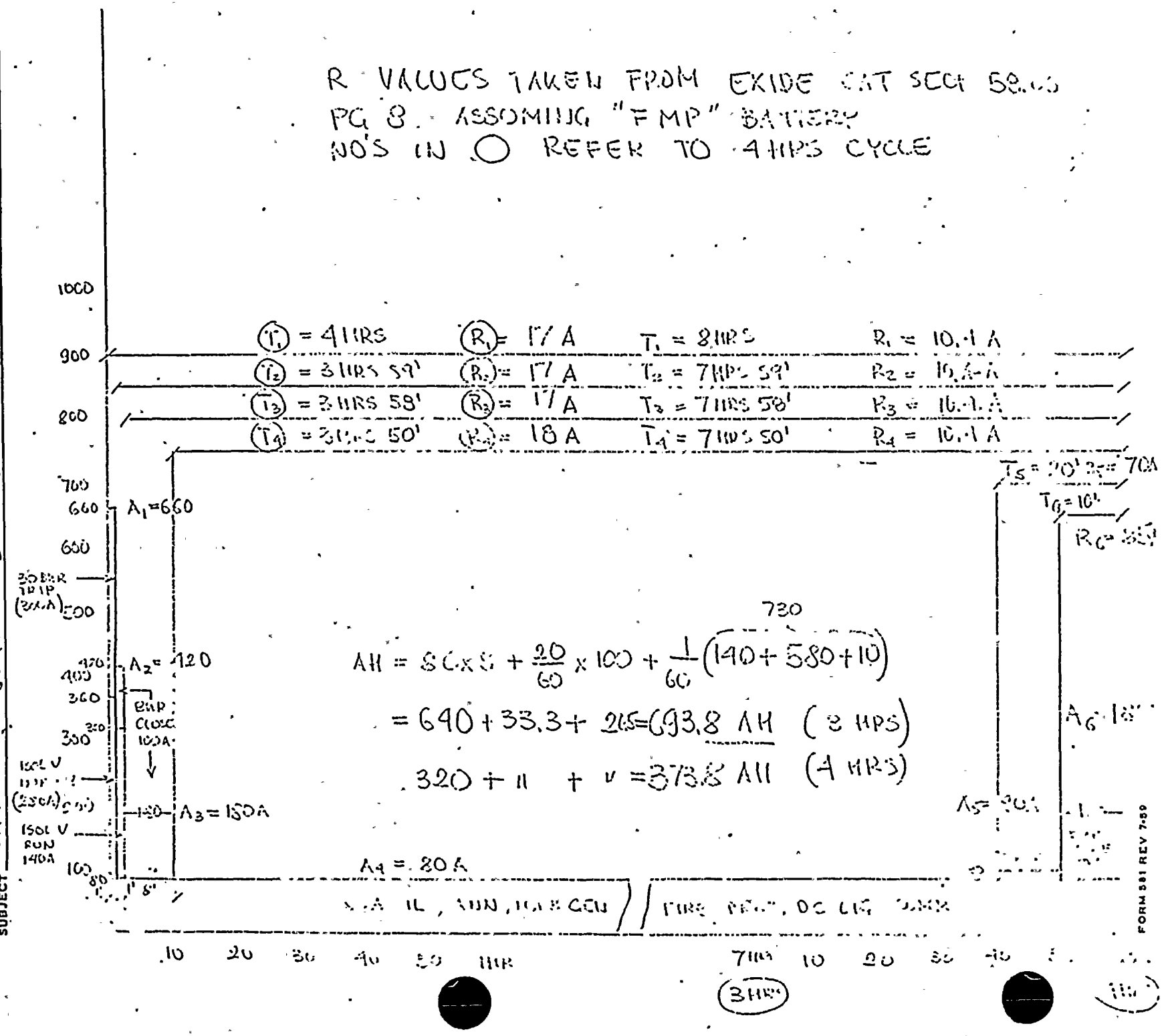
THREE ok $8.6 < 12$

FOUR NOT OK $15.23 > 12$

EBASCO SERVICES
INCORPORATED
NEW YORK

BY [illegible] DATE 8-16-65
CHKD. BY _____ DATE _____
COMPANY MILLSTONE DC SUPPLY
PROJECT BATTERY LOAD - 2 BATTERIES - 125V. OUTR BAT
SUBJECT _____
SHEET NO. 10 OF _____
E.O. NO. _____ DIV. _____

R VALUES TAKEN FROM EXIDE CAT SEC 58.05 PG 8. ASSUMING "FMP" BATTERY
NO'S IN ○ REFER TO 4 HRS CYCLE



8 HR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6}$$

$R_1 = R_2 = R_3 = R_4 = 10.4$ A

$$P = \frac{A_4}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} = \frac{80}{10.4} + \frac{90-80}{70} + \frac{180-}{85}$$

$P = 7.7 + 0.143 + 1.06 \cong 9$ plates

CHOOSE FMP — 19 $8 \times 93.4 = 746$ AH

CHECK OF FIRST AND SECOND PERIOD

$$\frac{A_1}{R_1'} = \frac{660}{110} = 6 \text{ plates} < 9 \text{ plates ok.}$$

1 MIN

4 HR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6}$$

$R_1 = R_2 = R_3 = 17$ A

$$P = \frac{A_3}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6} =$$

$$= \frac{150}{17} + \frac{90-150}{18} + \frac{90-90}{70} + \frac{150-90}{95} = 10.5 - 5.56 = 0.143$$

0.143
~ 71

BY Pinto DATE 8-17-66

CHKD. BY _____ DATE _____

EBASCO SERVICES
INCORPORATED
NEW YORK

SHEET NO. 12 OF _____

E.O. NO. _____ DIV. _____

COMPANY _____

PROJECT MILLSTONE DC SUPPLY

SUBJECT BATTERY SIZING — 2 BATTERIES — 125V CONTROL

CHOOSE FMP-15 AH = 8 × 72.6 = 580 AH

(FMP-13) (AH = 8 × 62.3 = 497 AH)

CHECK FIRST PERIOD (FMP 15)

$\frac{660}{110}$ = 6 plates < 7 plates

I MIN

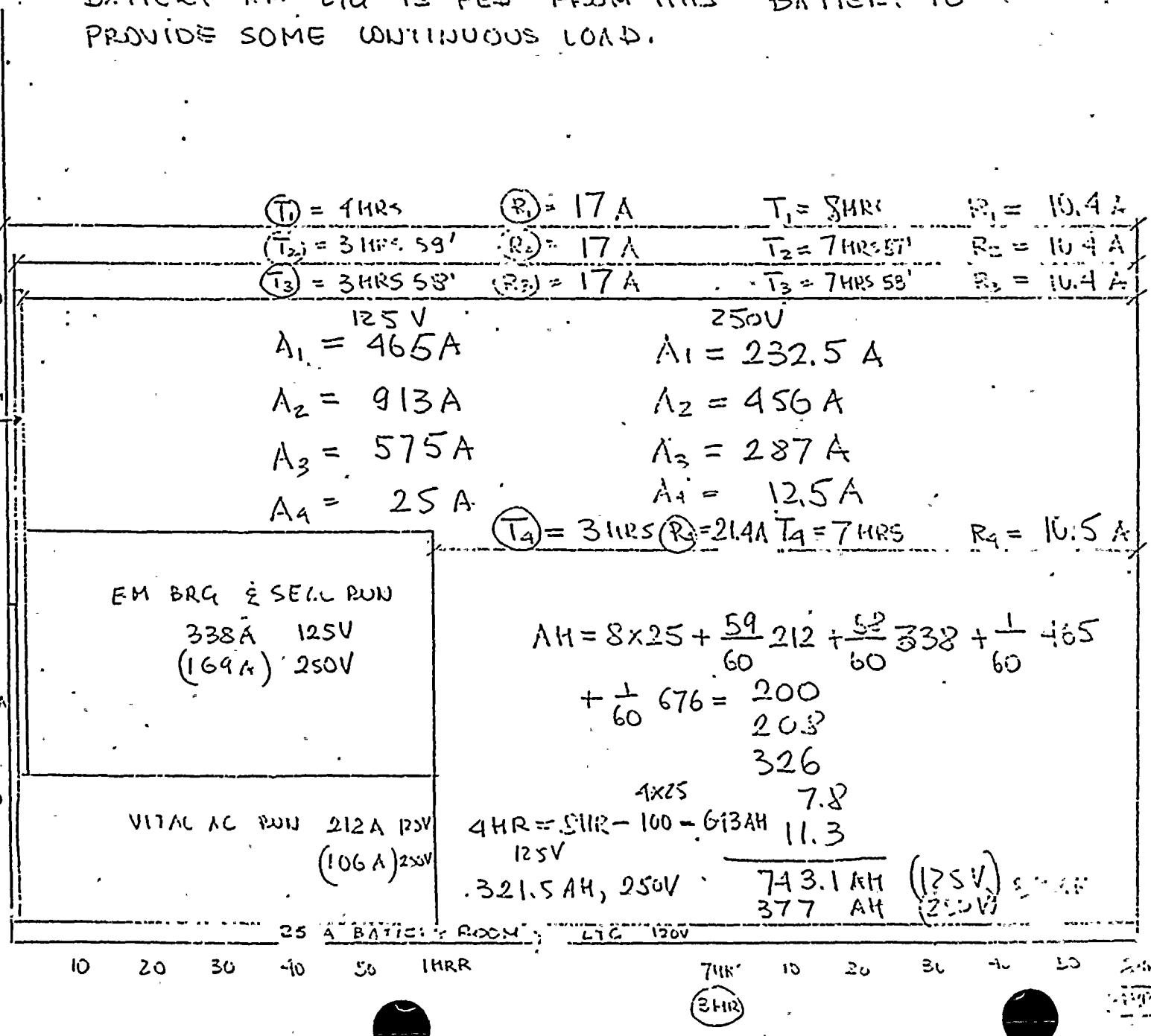
EBASCO SERVICES INCORPORATED NEW YORK

BY Rudasky DATE 8-17-66 CHKD. BY ____ DATE ____

COMPANY ____ PROJECT MILLSTONE SUBJECT BATTERY LOAD — 2 BATTERIES — 125/250V MOTOR EXT. DC SUPPLY

SHEET NO. 13 OF ____ E.O. NO. ____ DIV. ____

BATTERY RM LTG IS FED FROM THIS BATTERY TO PROVIDE SOME CONTINUOUS LOAD.



$$AH = 8\times25 + \frac{59}{60}212 + \frac{52}{60}338 + \frac{1}{60}465 + \frac{1}{60}676 = 200 + 203 + 326 + 7.8 + 11.3 = 743.1\ AH\ (125V)$$

4HR = 5HR − 100 − 613AH (4×25)

125V

321.5 AH, 250V

377 AH (250V)

FORM 881 REV 7-59

BY Polisseni DATE 8-17-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 14 OF ____

CHKD. BY ____ DATE ____ | E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE DC SUPPLY

SUBJECT BATTERY SIZING — 2 BATTERIES — 125V. MOTOR BAT

8HR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4}$$

$R_1 = R_2 = R_3 = 10.4 \qquad R_4 = 10.5$

$$P = \frac{575}{10.4} + \frac{25 - 575}{10.5} = 55 - 52.3 = 2.7 \text{ plate}$$

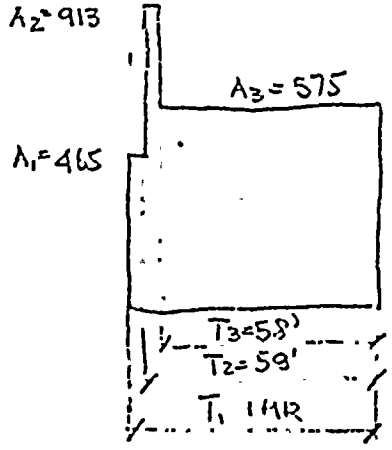
(-550)

CHECK PERIOD 1+2

$$\frac{A_2}{P_1'} = \frac{.913}{110} = 8.3 \text{ plate} > 2.7 \text{ plate}$$

1 min

CHECK PERIOD 1, 2, 3



$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} =$$

$$= \frac{465}{41.8} + \frac{913 - 465}{42} + \frac{575 - 913}{42.2}$$

$$= 11.1 + \underbrace{\frac{10.7 - 8}{2.7}} = 13.8 + \text{plates} > 2.7$$

14 positive

$R_1 = 41.8$ A

$R_2 = 42$ A

$R_3 = 42.2$ A

913 913
−465 −575
448 338

SUCH BATTERIES DOES NOT EXIST.

IT'S NO USE TO FIGURE THE FOUR HR CYCLE BECAUSE THE FIRST HR GOVERNS.

FORM 881 REV 7-59

BY D.Jissy DATE 8-19-66

CHKD. BY _____ DATE _____

COMPANY _____

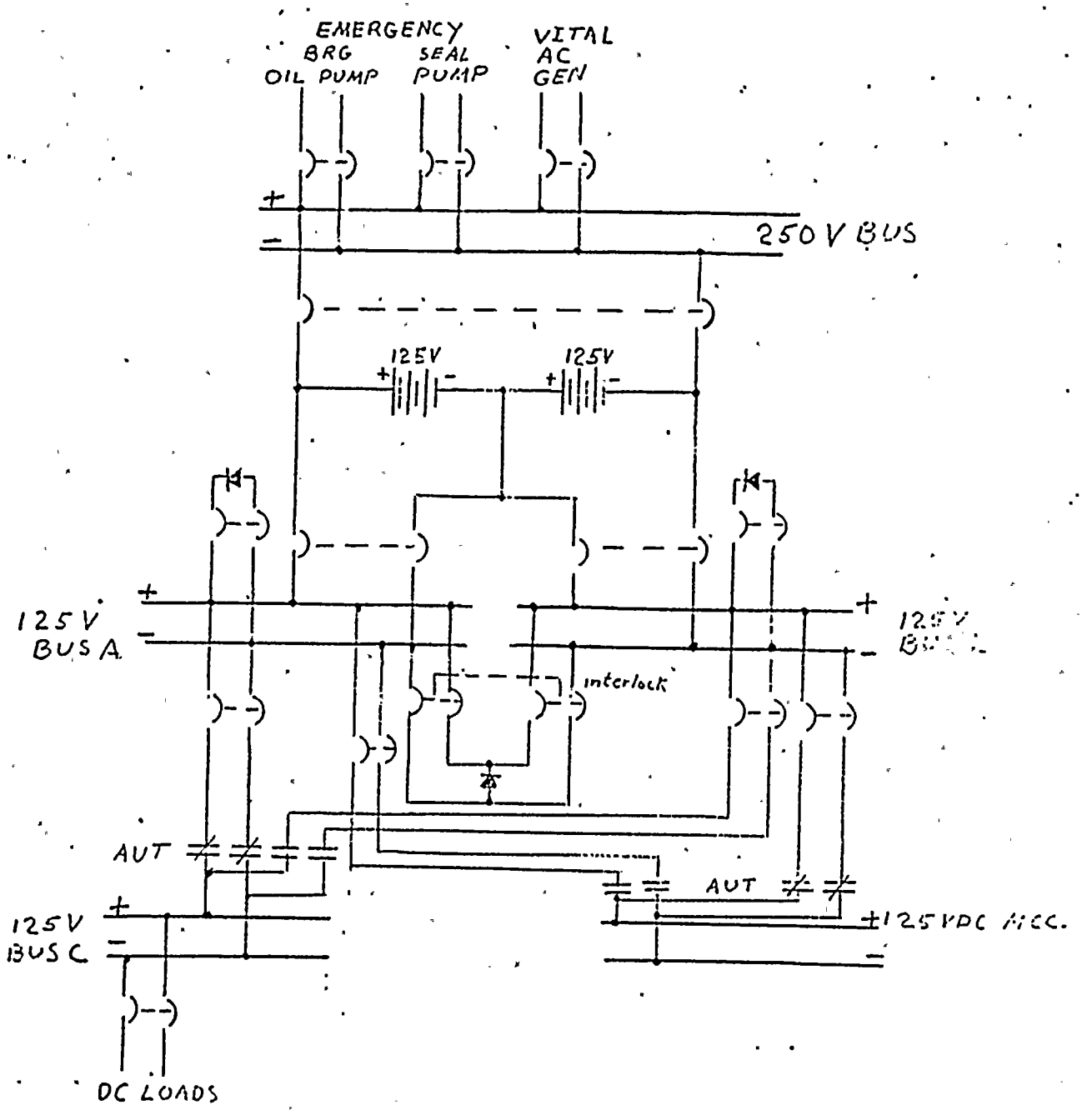
PROJECT MILLSTONE - DC SUPPLY

SUBJECT Ω - 125V BATTERIES IN SERIES

EBASCO SERVICES
INCORPORATED
NEW YORK

SHEET NO. 15 OF _____

E.O. NO. _____ DIV. _____

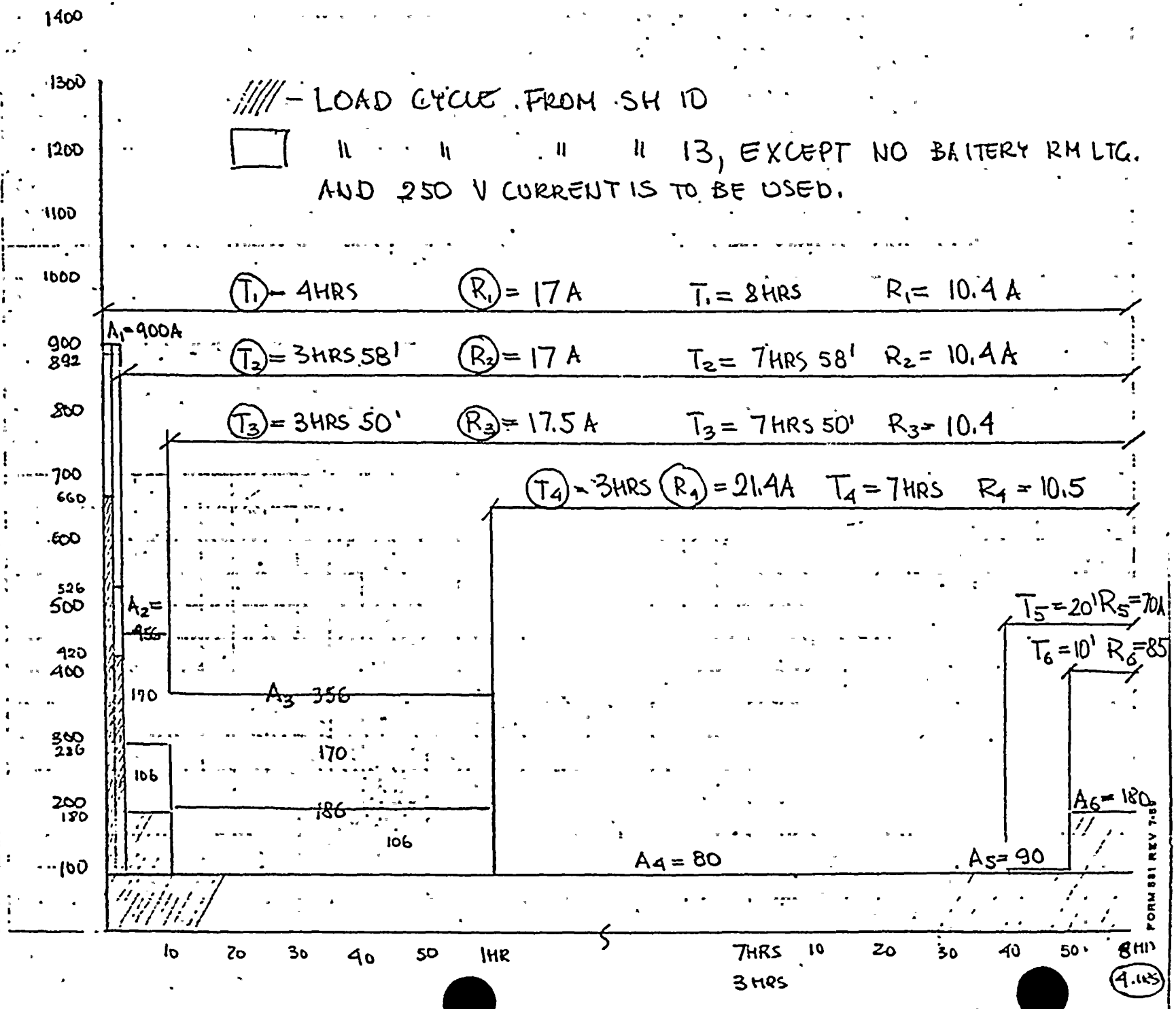


EBASCO SERVICES
INCORPORATED
NEW YORK

BY Palossy DATE 8-18-66
CHKD. BY ____ DATE ____
COMPANY ____
PROJECT MILLSTONE DC SUPPLY
SUBJECT 2-125V BATTERIES IN SERIES
SHEET NO. 16 OF ____
E.O. NO. ____ DIV. ____

////- LOAD CYCLE FROM SH 10

□ " " " " 13, EXCEPT NO BATTERY RM LTG. AND 250 V CURRENT IS TO BE USED.



FORM 881 REV 7-58

(4 HRS)

BY Polossy DATE 8-18-66
CHKD. BY _____ DATE _____

EBASCO SERVICES
INCORPORATED
NEW YORK

SHEET NO. 17 OF _____
E.O. NO. _____ DIV. _____

COMPANY _____
PROJECT MILLSTONE DC SUPPLY
SUBJECT 2-125V BATTERIES IN SERIES

8HR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2-A_1}{R_2} + \frac{A_3-A_2}{R_3} + \frac{A_4-A_3}{R_4} + \frac{A_5-A_4}{R_5} + \frac{A_6-A_5}{R_6}$$

$R_1 = R_2 = R_3 = 10.4\,A$

$$= \frac{A_3}{R_3} + \frac{A_4-A_3}{R_4} + \frac{A_5-A_4}{R_5} + \frac{A_6-A_5}{R_6}$$

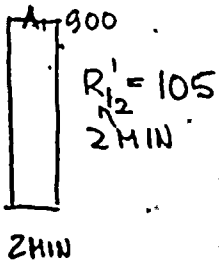
$$= \frac{356}{10.4} + \frac{\overbrace{80-356}^{-276}}{10.5} + \frac{\overset{10}{90-80}}{70} + \frac{\overset{90}{180-90}}{85} =$$

$$P = 34.2 - 26.3 + 0.143 + 1.06 = 9.103$$

say 10+ plates

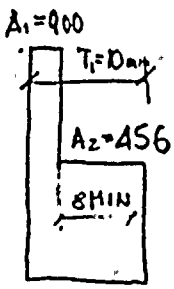
34.2
0.143
1.06
35.403
−26.3
9.103

CHECK OF FIRST PERIOD



$$P_1 = \frac{A_1}{R'_{12}} = \frac{900}{105} = 8.56 < 9.103 \quad \text{ok.}$$

CHECK OF FIRST TWO PERIODS



$R_{1_{10}} = 85\,A$
$R_{2_8} = 85\,A$

$$= P_2 = \frac{A_1}{R_1} + \frac{A_2-A_1}{R_2} = \frac{A_2}{R_2} = \frac{456}{85} = 5.36 < 9.103 \quad \text{ok.}$$

FORM 881 REV 7-59

BY Polossy DATE 8-18-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 18 OF

CHKD. BY DATE | E.O. NO. DIV.

COMPANY

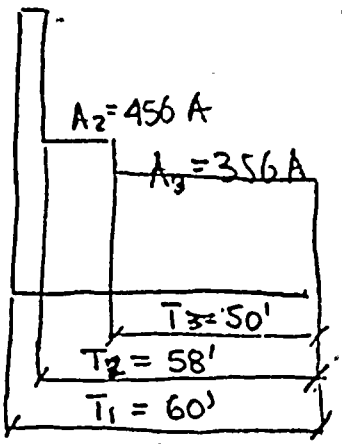
PROJECT MILLSTONE DC SUPPLY

SUBJECT 2 - 125V BATTERIES IN SERIES

8HR CYCLE

CHECK OF FIRST THREE PERIODS

$A_1 = 900A$



$R_1 = 41.8A$

$R_2 = 41.8A$

$R_3 = 45A$

$$P_3 = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} =$$

$R_1 = R_2$

$$= \frac{A_2}{R_2} + \frac{A_3 - A_2}{R_3} =$$

-100

$$= \frac{456}{41.8} + \frac{356 - 456}{45} =$$

$$= 10.9 - 2.2 = 8.7 < 9.10^3$$ ohm

USE FMP-21 10+ plates 8HR AH = 830 AH

4 HR CYCLE

$$P = \frac{A_1}{R_1} + \frac{A_2 - A_1}{R_2} + \frac{A_3 - A_2}{R_3} + \frac{A_4 - A_3}{R_4} + \frac{A_5 - A_4}{R_5} + \frac{A_6 - A_5}{R_6}$$

$R_1 = R_2 = 17A$

-100 -276

$$= \frac{456}{17} + \frac{356 - 456}{17.5} + \frac{80 - 356}{21.4} + \frac{90 - 80}{70} + \frac{180 - 90}{85}$$

$$= 25.8 - 5.72 - 12.9 + 0.143 + 1.06 = 9.383 \text{ + plates}$$

25.8 5.
0.143 12.
1.06 18.(
28.003
18.62
9.383

say 10 plates

FMP-21 8 HRS 830 AH

4 HRS $4 \times 17 \times 10 = 680$ AH.

CHECK OF FIRST THREE PERIODS SEE SH 18,19.

FORM 80 REV. 7-58

BY Palossy DATE 8-17-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 19 OF _____

CHKD. BY _____ DATE _____ | E.O. NO. _____ DIV. _____

COMPANY _____

PROJECT MILLSTONE - DC SUPPLY

SUBJECT BATTERY STUDY SUMMARY.

8HR CYCLE

SH5-7 1. ONE 125V D.C. BATTERY FOR SUPPLYING 77.5HP MOTOR LOADS FOR ONE HOUR AND OTHER CONTROL, INDICATION, ETC PLANT LOADS IS NOT FEASIBLE. BECAUSE EXCESSIVE (NOT AVAILABLE) BATTERY SIZE. WOULD NEED 16 POS PLATES OR FMP-33 CELL, BUT FMP-25 (12+CELLS) IS THE LARGEST.

SH13-13 2. SEPARATE 125V BATTERIES FOR MOTORS & CONTROL LOADS. THE MOTOR BATTERY WOULD NEED 14 POS PLATES. OR FMM-29. NOT FEASIBLE, FMP-25 IS THE LARGEST

SH15-18 3. TWO 125V BATTERIES IN SERIES, 10 POS PLATES. FMP-21 REQUIRED. 830 AH.

4HR CYCLE

SH 9 4. SAME AS 1. BECAUSE LOAD DURING FIRST HR IS GOVERNING.

SH 14. 5. SEPARATE 125V BATTERIES FOR MOTOR & CONTROL, MOTOR BATTERY SAME AS 2.

SH 18 6. TWO 125V BATTERIES IN SERIES. SAME AS 3. BECAUSE FIRST HR GOVERNS. FMP-21 REQUIRED 680 AH.

BY Palossy DATE 8-17-66 | EBASCO SERVICES INCORPORATED NEW YORK | SHEET NO. 20 OF ____

CHKD. BY ____ DATE ____ | E.O. NO. ____ DIV. ____

COMPANY ____

PROJECT MILLSTONE - DC SUPPLY

SUBJECT BATTERY - CHARGER SIZING

TWO 125V BATTERIES IN SERIES

CONTINUOUS NORMAL LOAD

200 IND LIGHT	7A
100 ANNUNCIATOR PT	7A
TURB CONTR	10A
FIRE PROT	10A
	34A SAY 40A

8HR CAPACITY 830AH

8HR DISCHARGE CURRENT : 104A

CHARGE AT 60% OF THAT : 60A

SELECT 100A CHARGER.

CHARGING TIME (FROM TABULATION NO1 "CHARGING LEAD-ACID BATTERIES FROM CONSTANT POT CHARGER BY E A HOAXIE) 100% DISCH AT 77°F, 139V DC