COVER SHEET

ction: ROTATING MACH. + PLANT EQUIP. Code: EGE

No.: EGE-00001-00 Calc.Type: EQUIPMENT PERFORMANCE

tle: CLASS 1E MOTOR MINIMUM STARTING VOLTAGE AND ACCELERATION TIME CALCULATIONS

oject: Modification: NONE
cument Page Count: 063

* * * TAG NUMBERS * * *

(none)

* * * COMPONENT(S) AFFECTED * * *

Equip.Type	081	MOTOR
Structure	07	CONTAINMENT BUILDING
Structure	20	INTAKE STRUCTURE
Structure	24	PRIMARY AUXILIARY BUILDING
System	80	480 VOLT ELECTRICAL

ass (Check as appropriate): A ___ FP ___ MET ___ IE X Non-Class ___

epArer/Date 1 nt/Sign)	Reviewer/Date (Print/Sign)	Approval/Date (Print/Sign)	Rev.No.	Super-cedes	Confirm. Required?
OMAS J. MAGEE Thomas J. Mage 9/18/91	BRUCE HEZEKIAH Bruce Hezekiah 9/26/91	RICHARD BOGAN 9/27/91 Richard Bogan			

ncurrence (If Required)

CON EDISON CALCULATION/ANALYSIS SUMMARY SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	1 OF 62

PREPARER/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/20/91	1E

SUBJECT/TITLE

Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV

OBJECTIVE OF CALCULATION

The objective of this calculation was to determine the minimum voltage required to start the Class 1E motors and to calculate the acceleration times at the rated voltage and minimum voltage conditions.

CALCULATION METHOD/ASSUMPTIONS

(1) Calculated minimum motor terminal voltage which provided a motor torque of sufficient magnitude to accelerate load using manufacturer supplied speed vs. torque data. Method of calculating motor torques available at lower than rated voltages is consistent with EPRI endorsed method.

(2) After calculating the minimum motor terminal voltage required, the voltage drop from the bus to the motor terminal was solved for. Refer to Page 5 for a description of equation used.

(3) The acceleration time was calculated using EPRI approved methods and manufacturer supplied values for motor and load wk^2.

DESIGN BASIS AND REFERENCES

(1) Industrial Power System Handbook, Donald Beeman, PP 232-233.

(2) EPRI NP-4917, Commercial-Grade Motors in Safety-Related Applications PP 6-8 thru 6-10

(3) Westinghouse and Reliance Motor Data Sheets and/or speed versus torque curves as detailed in each individual motor calculation.

CONCLUSIONS

(1) The minimum motor terminal voltages and motor bus voltages required for starting are shown on the summary sheet on page 61.

(2) The acceleration times at 100% and 90% rated voltages and at each motors minimum starting voltage are shown on the summary sheet on page 62.

INDIAN POINT UNIT 2 CLASS 1E MOTOR DEGRADED VOLTAGE STARTING STUDY

CONTENTS

1.) INTRODUCTION

The objectives of this study were as follows:

- o To calculate the minimum voltage required to start each Class 1E motor.
- o To calculate each motors acceleration time at its minimum voltage and 100% and 90% rated voltage conditions.

For the purpose of this study, a margin of 15% to 20% motor torque above pump torque was used as criteria in calculating the minimum voltage required for motor starting for all motors.

2.) CALCULATION METHOD

The method used to calculate the minimum terminal voltage required to start each motor is as follows :

I. Where manufacturer motor and pump speed vs. torque curves were available, the data for the 100% rated voltage and a lower voltage (90% rated voltage and/or 80% rated voltage) were used to construct a speed vs. torque curve at a minimum voltage. The method used to calculate the torque available at the minimum voltage is consistent with that recommended in EPRI NP-4917, Commercial Grade Motors in Safety Related Applications, pp. 6-10 & 6-11 (Ref. 2). This referenced torque vs. voltage relationship is:

$$T_{available} = T_{rated} \times \left(V_{available} / V_{rated}\right)^{x}$$

where T = torque in ft.-lbs.
V = voltage
x = a power of 2 to 2.5

As a general rule of thumb, the torque developed by a motor varies approximately with the voltage squared, making the value of x in the above relationship equal to 2. However, due to saturation effects the actual torque available is slightly less. In order to more accurately (and more conservatively) determine the torque available at a lower voltage, the values of torque available for at the 100% voltage and 90% voltage or 80% voltage conditions were used to calculate a value for the power. This value for the power, x, was then subsequently used in calulating the minimum voltage required to produce a sufficient torque to start the motor.

II. After determining the power, x, to be used in calculating the torque available at a lower voltage, the motor vs. load data is analyzed to determine where the minimum torque margin exists. The pump torque at the minimum margin speed (typically 80% rated speed) is then multiplied by 1.15 to 1.20 (which provides a 15 to 20 percent margin of motor torque above pump torque) and the motor terminal voltage to obtain this torque value is solved for.

III. The motor acceleration time was calculated from the following formula :

$$T_{acc} = (WK^2_{pump} + WK^2_{motor})(\Delta rpm)/(308)(motor\ T - load\ T)$$

where:

T_{acc}	=	total acceleration time in seconds
WK^2	=	inertia in lb.- $ft.^2$
motor T	=	motor torque during increment i (ft-lb)
load T	=	load torque during increment i (ft-lb)
Δ rpm	=	shaft speed increment (rpm)

For the purpose of the calculations in this study, the motor accelerating period was divided into 10 speed increments. The method used in these calculations is consistent with that specified in EPRI NP-4917, page 6-8.

3.) DATA USED

A copy of the source of the data used for each motor calculation is provided with the individual study performed for each motor. In many cases, the manufacturer provided a plot of the motor speed vs. torque curves along with data sheets providing motor torque values at off design voltages. In some cases, a plot of the motor speed vs. torque data was not provided by the equipment manufacturer, but instead this data was only listed on data sheets.

4.) CHART SUMMARY

Included with each motor study is a chart that provides the following information:

- Motor torque values at rated and undervoltage conditions
- Accelerating times for rated voltage and undervoltage conditions

5.) MOTOR TERMINAL TO SUPPLY BUS VOLTAGE DROP

After the minimum motor terminal voltages required for starting were calculated, the voltage drop from each motor terminal back to its supply bus was calculated and included on a separate summary chart. This chart lists the resistance and impedance of each cable run, the minimum motor terminal voltage required for starting and the minimum bus voltage required to start each motor. Also included on this chart were values of locked rotor current and starting power factor. The formula used for calculating the voltage drop is as follows:

$$\text{Line-to-neut. voltage drop} = \sqrt{(e_r \cos\theta + IR)^2 + (e_r \sin\theta + IX)^2} - e_r$$

where: e_r = line to neutral voltage at load end
θ = angle whose cosine is the load power factor
I = Line Current
R = Resistance of circuit, ohms
X = Reactance of circuit, ohms

Line - neutral voltage drop x $\sqrt{3}$ = Line - Line voltage drop

The impedance and resistance values for each cable run were taken from the Westinghouse Electric Corporation 480 Volt System Impedance Diagram, Con Ed drawing number A201259, for all motors with the exception of the Component Cooling Water and Auxiliary Feedwater pump motors. The impedance and resistance values for these motors were taken from Con Ed Calculation No. EGP-00015.

SERVICE WATER PUMPS

I. MOTOR DATA

There are six Service Water Pumps at Indian Point Unit 2. Pumps 22, 23, 24 and 26 have identical motors. The following is the motor data for these motors:

- Motor Frame Size — 509 UPH
- Rated Motor Voltage — 440 Volts
- Rated Horsepower — 350 HP
- Pump WK^2 — 25.7 lb.- ft.
- Motor WK^2 — 71 lb.- ft.

II. CALCULATION DATA

Data used for the minimum voltage starting calculations for these motors includes the following:

1.) Westinghouse Motor Data Sheets for 100%, 90% and 80% rated voltages.

2.) Aurora Pump Speed vs. Torque curve, dated 1/03/77.

III. CALCULATION

a.) To determine the power, x, to be used in calculating the torque available at a minimum voltage, the torque and voltage data provided by Westinghouse at 100% and 80% voltage will be used.

At 80% speed, 1440 rpm

100 % Voltage	80 % Voltage
1521.15 ft.-lbs.	904.58 ft.-lbs.

$$T_{avail} = T_{rated}(V_{avail}/V_{rated})^{x}$$

$$905 = 1521\ (352/440)^{x}$$

solving for x, $x = 2.33$

rounded up, $x = 2.35$

b.) The motor torque required at the minimum margin speed, 1440 rpm, is 120 per cent of the pump torque at this speed, or 613 x 1.20 = 735.74. Solving for the voltage required to obtain this torque:

$$735.8 = 1521(V\ avail / 440)^{2.35}$$

V avail = V required = 323 volts = 73.4% rated voltage.

c.) The acceleration time is calculated and is tabulated on the included summary chart. The formula used for calculating the acceleration time is:

$$T\ acc = (WK^2\ pump + WK^2\ motor)(\Delta\ rpm) / 308\ (motor\ T - load\ T)$$

IV.) CALCULATION RESULTS

Salt Water Service pumps 22, 23, 24, and 26 are capable of starting with a motor terminal voltage of 73.4% rated voltage, or 323 volts, with an acceleration time of 2.01 seconds.

CON EDISON CALCULATION/ANALYSIS SHEET

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PREPARER/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV

DESCRIPTION: SERVICE WATER PUMPS
HP: 350 FRAME: 509 UPH
MOTOR WK^2: 71 RATED
PUMP WK^2: 25.7 VOLTAGE: 440
PUMP F.L. TORQUE: 950 FT-LBS

		PUMP									ACCELERATION TIME			
		TORQUE	MOTOR TORQUE				ACCELERATING TORQUE				Time in sec.	Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	80% V	73.4% V	100% V	90% V	80% V	73.4% V	for 100%V	for 90% V	for 80% V	for 73.4% V
0	0	48	1252	976	741	605	1204	928	693	557				
10	180	19	1260	982	745	609	1241	963	726	590	0.05	0.06	0.08	0.10
20	360	38	1205	938	712	582	1167	900	674	544	0.05	0.06	0.08	0.10
30	540	86	1275	992	753	616	1189	906	667	530	0.05	0.06	0.08	0.11
40	720	153	1282	998	758	619	1129	845	605	466	0.05	0.07	0.09	0.12
50	900	240	1303	1014	770	629	1063	774	530	389	0.05	0.07	0.11	0.15
60	1080	345	1300	1012	769	628	955	667	424	283	0.06	0.08	0.13	0.20
70	1260	469	1368	1065	811	661	899	596	342	192	0.06	0.09	0.17	0.29
80	1440	613	1521	1186	905	735	908	573	292	122	0.06	0.10	0.19	0.46
90	1620	775	1885	1479	1133	912	1113	704	358	137	0.05	0.08	0.16	0.41
95	1710	887	2707	2146	1661	1307	1820	1259	774	420	0.02	0.02	0.04	0.07
							TOTAL ACCELERATING TIMES (Sec.):				0.50	0.70	1.13	2.01

MOTOR DATA

PLANT: Indian Point Unit No. 2

COMPONENT: Service Water Pumps

MOTOR MANUFACTURER: Westinghouse Large Motor Division, Buffalo, New York

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 1982666-13 through 65-67

MOTOR H.P. RATING: 350 @ 1782 RPM MOTOR FRAME SIZE: 509

--MOTOR WR^2 = 71 LB-FT^2

LINE VOLTAGE: 440 (100%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	1251.62
95.00	90	1255.44
90.00	180	1260.28
85.00	270	1100.90
80.00	360	1204.87
75.00	450	1266.48
70.00	540	1274.94
65.00	630	1276.93
60.00	720	1281.52
55.00	810	1290.39
50.00	900	1302.90
45.00	990	1320.46
40.00	1080	1300.09
35.00	1170	1335.39
30.00	1260	1367.87
25.00	1350	1432.28
20.00	1440	1521.15
15.00	1530	1652.65
10.00	1620	1889.27
9.50	1629	2000.09
9.00	1638	2121.19
8.50	1647	2212.72
8.00	1656	2308.46
7.50	1665	2408.02
7.00	1674	2546.25
6.50	1683	2576.47
6.00	1692	2630.89
5.50	1701	2675.85
5.00	1710	2706.68
4.50	1719	2716.93
4.00	1728	2698.12
3.50	1737	2639.42
3.00	1746	2527.43
2.50	1755	2346.50
2.00	1764	2080.98
1.50	1773	1713.37
1.00	1782	1236.75

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 1982666-15 through 65-67

LINE VOLTAGE: 396 (90%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	976.41
95.00	90	978.86
90.00	180	982.14
85.00	270	867.54
80.00	360	938.12
75.00	450	985.06
70.00	540	992.30
65.00	630	993.75
60.00	720	997.57
55.00	810	1004.13
50.00	900	1013.93
45.00	990	1027.64
40.00	1080	1011.66
35.00	1170	1039.41
30.00	1260	1065.03
25.00	1350	1115.90
20.00	1440	1186.31
15.00	1530	1296.54
10.00	1620	1479.45
9.50	1629	1568.10
9.00	1638	1664.30
8.50	1647	1737.53
8.00	1656	1814.35
7.50	1665	1894.54
7.00	1674	1982.16
6.50	1683	2032.44
6.00	1692	2078.58
5.50	1701	2117.86
5.00	1710	2146.48
4.50	1719	2159.32
4.00	1728	2149.58
3.50	1737	2108.40
3.00	1746	2024.73
2.50	1755	1885.47
2.00	1764	1677.30
1.50	1773	1385.25

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 1982666-15 through 65-67

LINE VOLTAGE: 352 (88%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	740.59
95.00	90	742.45
90.00	180	744.95
85.00	270	650.45
80.00	360	711.61
75.00	450	747.35
70.00	540	753.85
65.00	630	754.38
60.00	720	751.50
55.00	810	762.73
50.00	900	770.44
45.00	990	781.16
40.00	1080	789.15
35.00	1170	790.66
30.00	1260	810.59
25.00	1350	849.98
20.00	1440	904.58
15.00	1530	982.76
10.00	1620	1132.95
9.50	1629	1201.55
9.00	1638	1276.08
8.50	1647	1333.17
8.00	1656	1393.70
7.50	1665	1456.03
7.00	1674	1529.00
6.50	1683	1565.53
6.00	1692	1603.20
5.50	1701	1635.93
5.00	1710	1660.80
4.50	1719	1673.85
4.00	1728	1669.73
3.50	1737	1641.46
3.00	1746	1580.20
2.50	1755	1475.34
2.00	1764	1315.96 44PM

CON EDISON CALCULATION/ANALYSIS SHEET

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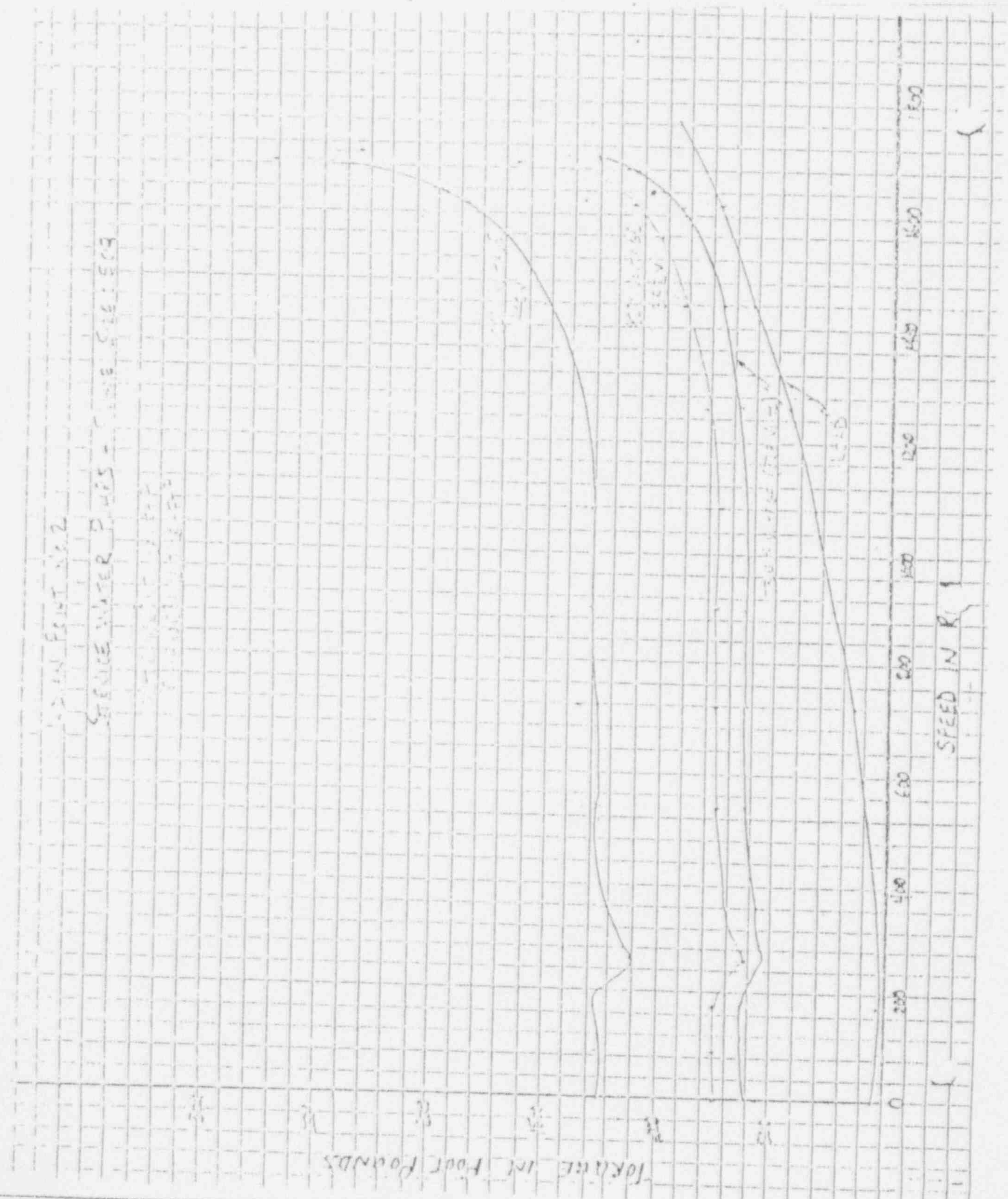
Thomas J. Magee 9/15/91	Bruce Horowitz 9/20/91	1E

SUBJECT/TITLE	PROJECT NO.
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations	
	MOD NO. REV



SPEED TORQUE CURVE

FOR: Con Edison Co.
QUOTATION NO.
PUMP NO. D24831
CAPACITY 5000 HEAD 220'
MAX B.H.P. 323 MAX R.P.M. 1770

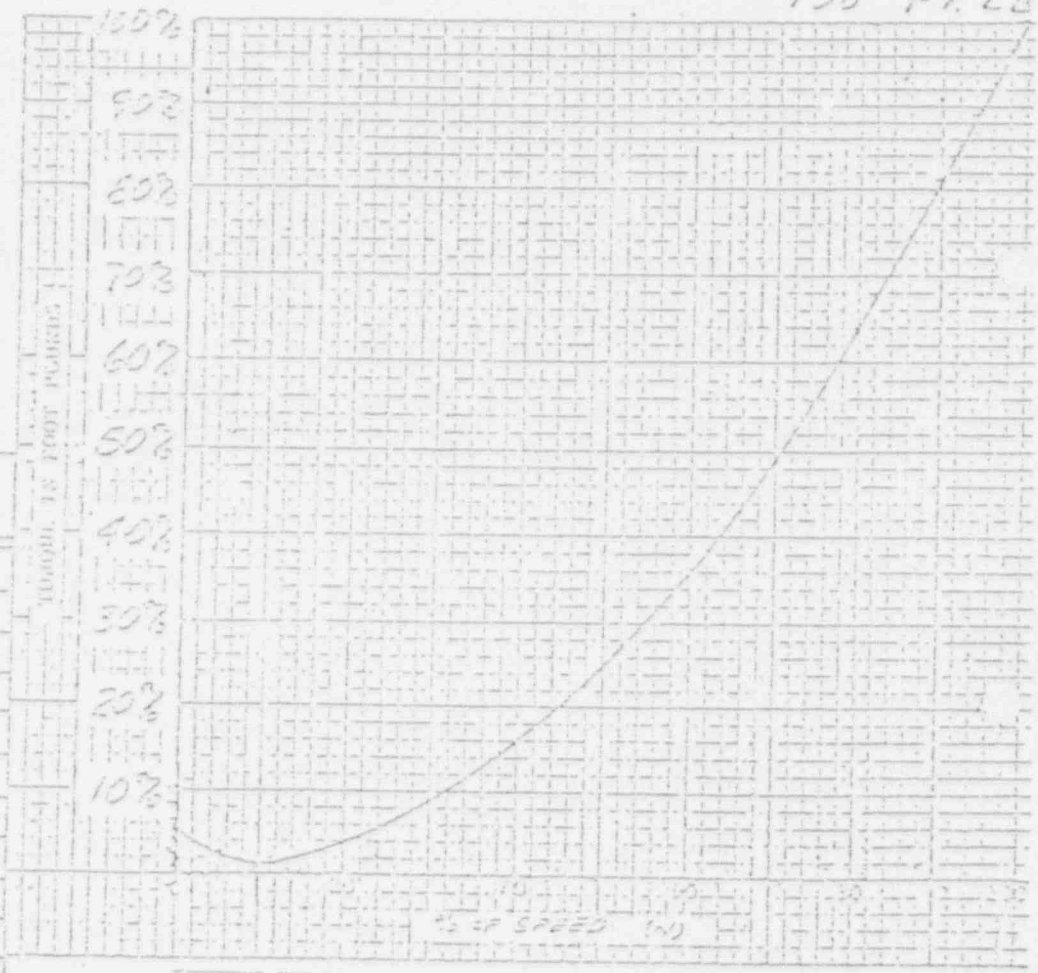
T = TORQUE IN FOOT-POUNDS
N = MAX RPM (PULL RUNNING SPEED)
N' = RPM LESS THAN MAX RPM
K = $\frac{5252 \times \text{MAX B.H.P.}}{N}$ = 958 ft#

$T = \frac{5252 \times BHP}{N'}\left(\frac{N'}{N}\right)^3$ OR $K\left(\frac{N'}{N}\right)^2$

% OF N	K	$\left(\frac{N'}{N}\right)^2$	TORQUE FT – LBS
100		1.0	
90		.81	
80		.64	
70		.49	
60		.36	
50		.25	
40		.16	
30		.09	
20		.04	
10		.01	
0	15% OF TORQUE AT FULL SPEED		

PLOTTED BY R.M.M. DATE 1-3-77
CERTIFIED BY R.R.M. DATE 1-3-77

PUMP WR² = 25.7 #ft.²



AURORA PUMP
A UNIT OF GENERAL SIGNAL

COMPONENT COOLING WATER PUMPS

I. MOTOR DATA

There are three Component Cooling Water pumps at Indian Point Unit 2. Manufacturer data for the motors is as follows:

- Motor Frame Size 504 US
- Rated Voltage 460 Volts
- Rated Horsepower 250 HP
- Motor WK^2 86 lb.- ft.
- Pump WK^2 31.5 lb.- ft.

II. CALCULATION DATA

Data used for the purpose of these calculations was taken from the following:

- Westinghouse supplied Speed vs. Torque Curve #663813
- Computer printout data sheet with motor and pump torque values at 90% rated line voltage (414 volts).

III. CALCULATION

a.) The motor and pump torque values at 100% and 90% voltage at 80% speed are used to determine the proper power value, x, to be used in calculating the minimum voltage that will provide an adequate torque to start the motor. The following are voltage and torque values at 80% speed:

100% voltage	90% voltage
945 ft-lbs.	723.5 ft-lbs.

solving for x in the following equation :

$$T_{avail} = T_{rated} (V_{avail}/V_{rated})^{x}$$

$$723.5 = 945(414/460)^{x}$$

$$.77 = .9^{x}$$

$$x = 2.48$$

b.) The minimum motor and pump torque margin exists at 1440 rpm. The pump torque at this speed is 477 ft-lbs. To have a 15% margin at this speed, the minimum acceptable motor torque is 115 per cent of the pump torque or 1.15 x 477 = 549 ft-lbs. Solving for the minimum voltage that will produce this torque:

$$T_{avail} = T_{rated} (V_{avail}/ V_{rated})^{2.48}$$

2.48

549 = 945 (V avail/ V rated)

V avail/V rated = .803 or V avail = .803(V rated)

V avail = .803(460) = 369 volts

c.) The acceleration time is calculated and is tabulated on the attached summary chart. The acceleration time is calculated with the following formula :

T acc = (WK^2motor + WK^2pump) (Δrpm)/ 308 (motor T - load T)

IV.) CALCULATION RESULTS

With a 15 per cent margin between motor and pump torque values, the Component Cooling Water pumps are capable of starting with a motor terminal voltage of 369 volts. The acceleration time of these motors at the minimum voltage condition is approximately 3.77 seconds.

DESCRIPTION: COMPONENT COOLING PUMP

HP: 250 FRAME: 504 US

MOTOR WK^2: 86 RATED

PUMP WK^2: 31.5 VOLTAGE: 460

PUMP F.L. TORQUE: 719 FT-LBS

		PUMP							ACCELERATION TIME		
		TORQUE	MOTOR TORQUE			ACCELERATING TORQUE			Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	80.3% V	100% V	90% V	80.3% V	for 100%V	for 90% V	for 80.3% V
0	0	112	680	530	394	568	418	282			
10	180	34	685	533	397	652	500	364	0.11	0.14	0.19
20	360	34	690	537	400	657	503	367	0.10	0.14	0.19
30	540	67	700	544	406	633	477	339	0.11	0.14	0.20
40	720	119	705	556	409	586	437	290	0.12	0.16	0.24
50	900	186	715	554	415	529	367	228	0.13	0.19	0.30
60	1080	268	760	586	441	492	318	172	0.14	0.22	0.40
70	1260	365	825	638	478	460	273	113	0.15	0.25	0.61
80	1440	477	965	724	548	468	246	71	0.15	0.28	0.97
90	1620	604	1280	916	742	676	312	138	0.10	0.22	0.50
95	1710	675	1480	1163	858	805	488	183	0.04	0.07	0.19
				TOTAL ACCELERATING TIMES (Sec.):					1.14	1.80	3.77

CON EDISON CALCULATION/ANALYSIS SHEET

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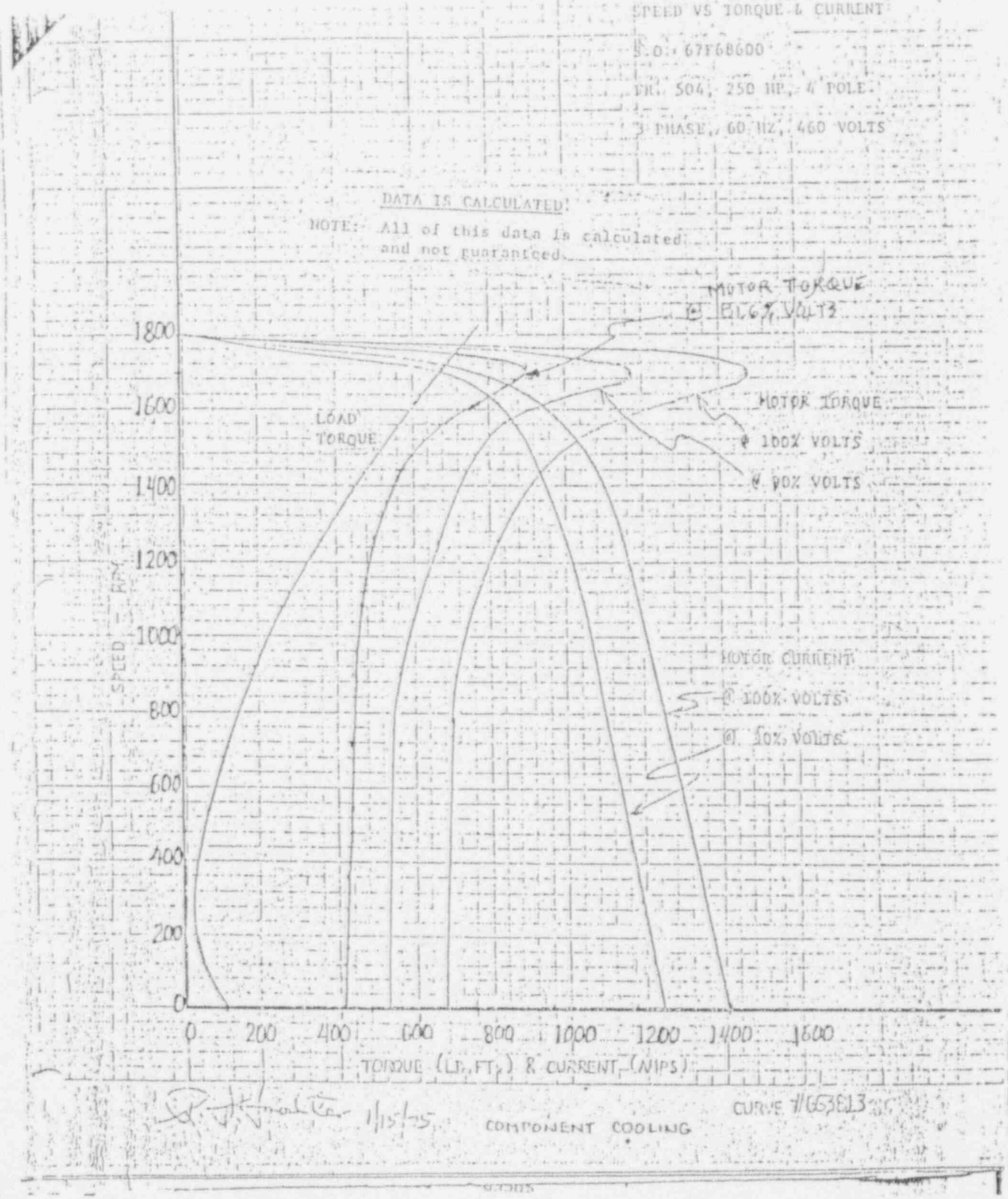
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE	PROJECT NO.
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations	MOD NO. REV



CON EDISON CALCULATION/ANALYSIS SHEET

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Thomas J. Magee 9/18/91	Bruce Horowitz 9/20/91	1E

SUBJECT/TITLE

Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV

CONTAINMENT SPRAY PUMP MOTORS

I. MOTOR DATA

The following is motor data for the Containment Spray Pump motors at Indian Point Unit 2:

- Motor Frame 509 US
- Rated Voltage 460 Volts
- Horsepower 400 HP
- Motor WK^2 119 ft.-lbs.
- Pump WK^2 35 ft.-lbs.

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following:

- Westinghouse supplied Speed vs. Torque curve # 663727. This curve supplies torque values for the pump and motor at 100% voltage and 90% voltage conditions.
- Westinghouse supplied cumputer printout data sheet with motor and pump torque values at 90% rated line voltage (414 volts).

III. CALCULATION

a.) To determine the power, x, to be used in calculating the torque available at a minimum voltage, the torque and voltage data provided at 100% and 90% voltage will be used. At 80% speed, 1440 rpm the data for this motor is:

100 % voltage	90 % voltage
2110 ft.-lbs.	1662 ft.-lbs.

$$T_{avail} = T_{rated}(V_{avail}/V_{rated})^{x}$$

$$1662 = 2110(414/460)^{x}$$

$$.788 = .9^{x}$$

$$x = 2.26$$

rounded up, $x = 2.3$

b.) The motor torque required at the minimum margin speed, approximately 1440 rpm, is 120% of the pump torque at this speed or 730 x 1.20 = 876 ft.-lbs. Solving for the voltage required to obtain this torque:

$$876 = 2110(V_{avail} / V_{rated})^{2.3}$$

$$.415 = (V_{avail} / V_{rated})^{2.3}$$

$$V_{avail} = .68(460) = 313 \text{ volts}$$

c.) The acceleration is calculated and is tabulated on the included summary chart. The formula used for calculating the acceleration time is :

$$T_{acc} = (WK^2_{pump} + WK^2_{motor})(\Delta rpm) / 308 (\text{motor } T - \text{pump } T)$$

IV.) CALCULATION RESULTS

The Containment Spray Pumps are capable of starting with a motor terminal voltage of 68% rated voltage, or 313 volts. The acceleration time at this voltage is 2.75 seconds.

CON EDISON CALCULATION/ANALYSIS SHEET

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AUTHOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE: Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

NOD NO. REV

DESCRIPTION: CONTAINMENT SPRAY PUMP

HP: 400 FRAME: 509 US

MOTOR WK^2: 119 RATED

PUMP WK^2: 35 VOLTAGE: 460

PUMP F.L. TORQUE: 1106 FT-LBS

		PUMP							ACCELERATION TIME		
		TORQUE	MOTOR TORQUE			ACCELERATING TORQUE			Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	68% V	100% V	90% V	68% V	for 100%V	for 90% V	for 68% V
0	0	110	1460	1138	606	1350	1028	496			
10	180	13	1500	1175	623	1487	1162	610	0.06	0.08	0.15
20	360	30	1470	1145	610	1440	1115	580	0.06	0.08	0.16
30	540	95	1590	1246	660	1495	1151	565	0.06	0.08	0.16
40	720	185	1645	1280	683	1460	1095	498	0.06	0.08	0.18
50	900	290	1690	1321	701	1400	1031	411	0.06	0.09	0.22
60	1080	405	1800	1347	747	1395	942	342	0.06	0.10	0.26
70	1260	555	1860	1465	772	1305	910	217	0.07	0.10	0.41
80	1440	730	2110	1662	876	1380	932	146	0.07	0.10	0.62
90	1620	920	2710	2101	1125	1790	1181	205	0.05	0.08	0.44
95	1710	1025	3180	2526	1320	2155	1501	295	0.02	0.03	0.15
				TOTAL ACCELERATING TIMES (Sec.):					0.58	0.80	2.75

CON EDISON CALCULATION/ANALYSIS SHEET

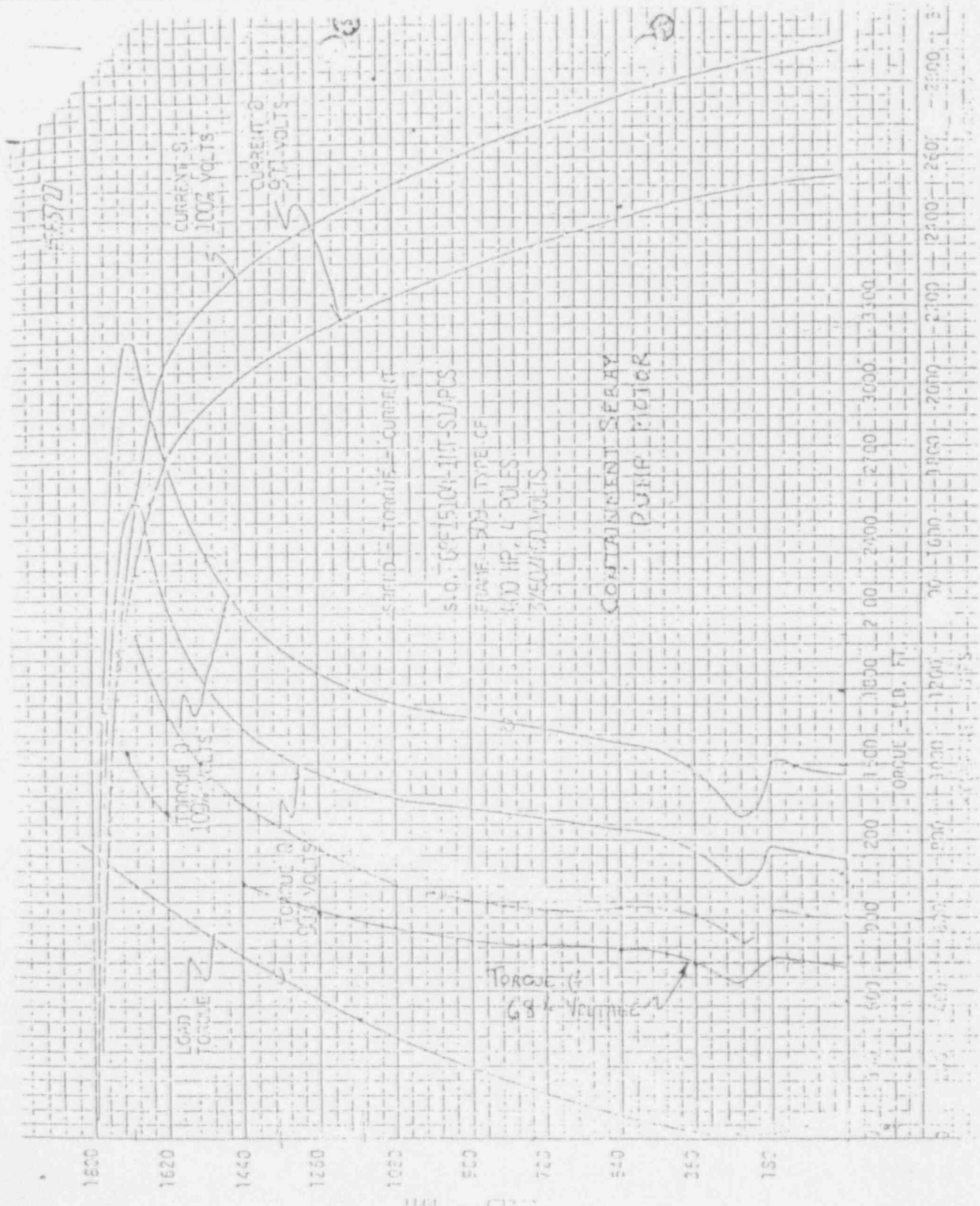
CALCULATION NO.	REVISION	PAGE
EGE-00001	0	22 OF 62

PREPARER/DATE	REVIEWER/DATE	CLASS
Thomas J. Maggee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV



CON EDISON CALCULATION/ANALYSIS SHEET

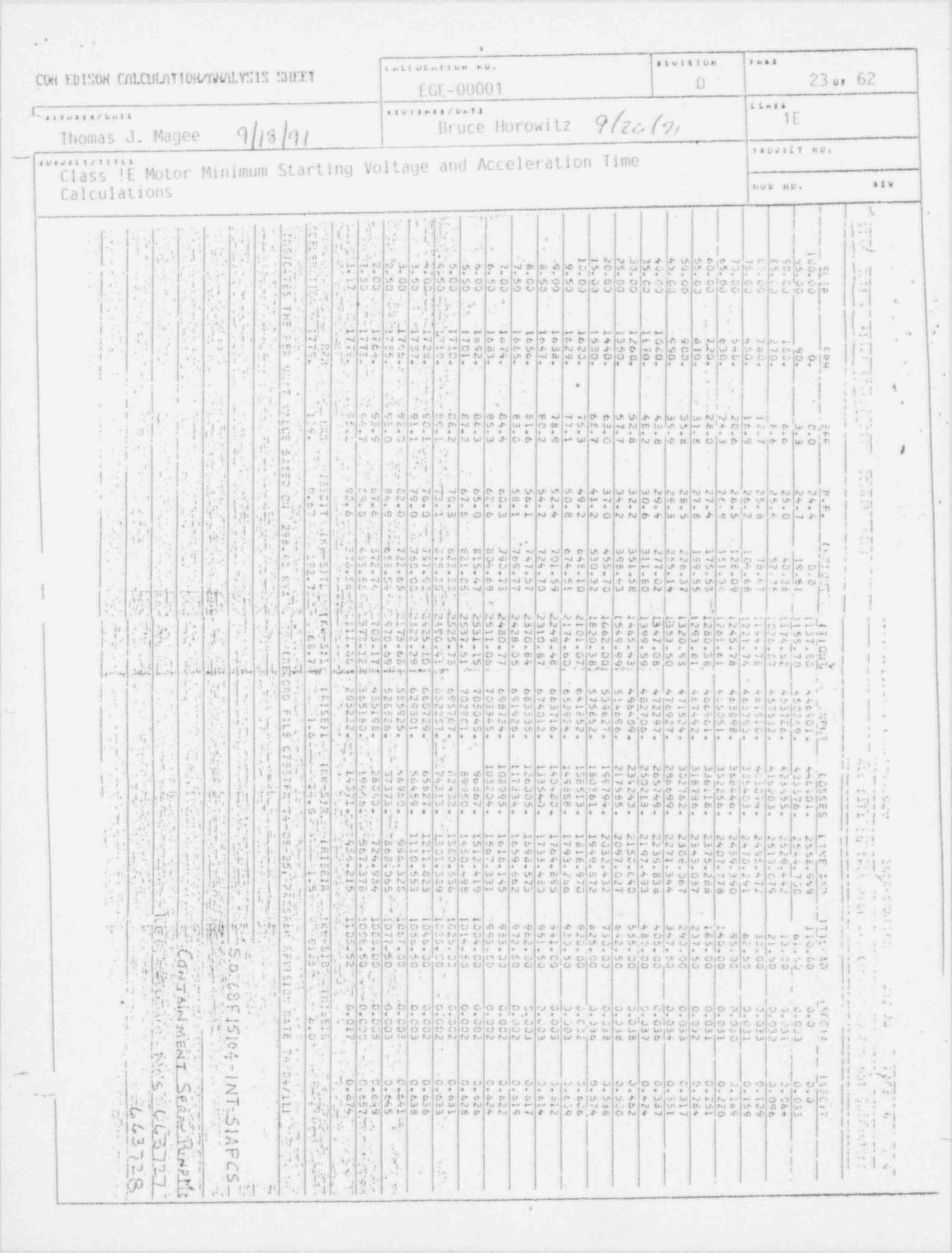
CALCULATION NO.	REVISION	PAGE
EGE-00001	0	23 OF 62

AUTHOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/20/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

NUP NO. XIV



RESIDUAL HEAT REMOVAL PUMPS

I. MOTOR DATA

The motor data for the Residual Heat Removal Pump motors installed at Indian Point Unit 2 is as follows:

- Frame Size 5008 P20
- Horsepower 400 HP
- Rated Voltage 460 volts
- Motor WK^2 122 lb-ft
- Pump WK^2 48 lb-ft

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following :

- Westinghouse supplied speed vs. torque curves #'s 17131LN100.1, 17131LN90.1, and 1713LN80.1, dated 08/08/87. These curves provide motor and pump torque data for 100% voltage, 90% voltage and 80% rated voltage conditions.

III. CALCULATION

a.) The power, x, to be used in calculating the torque available at a minimum voltage varies between approximately 2 at higher speeds (70% to 95% rpm) to 2.25 at speeds of 10 to 60 per cent rated rpm. To be conservative, 2.25 will be used for all speeds for the purpose of this calculation. Analyzing the data provided on the Westinghouse supplied curves shows us that the minimum margin exists at 95 per cent rated speed.

b.) The minimum voltage required for successful starting is calculated with the equation:

$$T_{avail} = T_{rated}(V_{avail}/V_{rated})^{2.25}$$

where:

$T_{avail} = T_{required} = 1107 \times 1.2 = 1326$ [1107 = pump ft-lbs at 95% rpm]

T_{rated} @ 100 % voltage = 2750 ft.-lbs.

$$1326 = 2750\,(V_{avail}/V_{rated})^{2.25}$$

$$.482 = (\text{V avail}/\text{ V rated})^{2.25}$$

V avail/ V rated = .723 or V avail = .723 x 460 = 333 volts

c.) The acceleration time for the Residual Heat Removal Pump motors is tabulated on the included summary chart. The formula used for calculating the acceleration time is:

$$T = (\text{motor } WK^2 + \text{load } WK^2)(180)/(308)\ (\text{motor torque} - \text{load torque})$$

IV. CALCULATION RESULTS

The Residual Heat Removal Pumps will start with a motor terminal voltage of 72.3 per cent rated voltage, or 333 volts. The acceleration time for the motor at this voltage is approximately 1.91 seconds.

DESCRIPTION:		RESIDUAL HEAT REMOVAL PUMP												
HP:		400					FRAME: 5008 P20							
MOTOR WK^2:		122					RATED							
PUMP WK^2:		48					VOLTAGE: 460							
							PUMP F.L. TORQUE: 1192 FT-LBS							
		PUMP									ACCELERATION TIME			
		TORQUE	MOTOR TORQUE				ACCELERATING TORQUE				Time in sec.	Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	80% V	72.3% V	100% V	90% V	80% V	72.3% V	for 100%V	for 90% V	for 80% V	for 72.3% V
0	0	0	1657	1294	996	799	1657	1294	996	799				
10	180	[illegible]	1668	1305	1013	804	1650	1287	995	786	0.06	0.08	0.10	0.13
20	360	85	1635	1277	996	788	1550	1192	911	703	0.06	0.08	0.11	0.14
30	540	103	1788	1413	1106	862	1685	1310	1003	759	0.06	0.08	0.10	0.13
40	720	196	1890	1498	1144	911	1694	1302	948	715	0.06	0.08	0.10	0.14
50	900	316	2009	1584	1226	968	1693	1268	910	652	0.06	0.08	0.11	0.15
60	1080	443	2154	1720	1328	1038	1711	1277	885	595	0.06	0.08	0.11	0.17
70	1260	596	2350	1890	1464	1133	1754	1294	868	537	0.06	0.08	0.11	0.19
80	1440	792	2614	2120	1720	1260	1822	1328	928	468	0.05	0.07	0.11	0.21
90	1620	1013	3116	2520	2027	1502	2103	1507	1014	489	0.05	0.07	0.10	0.20
95	1710	1107	2750	2163	1736	1326	1643	1056	629	219	0.03	0.05	0.08	0.45
							TOTAL ACCELERATING TIMES (Sec.):				0.55	0.73	1.03	1.91

CALCULATED AT 100% LINE VOLTAGE

CUSTOMER: W-HSID

S.O. 17531LN

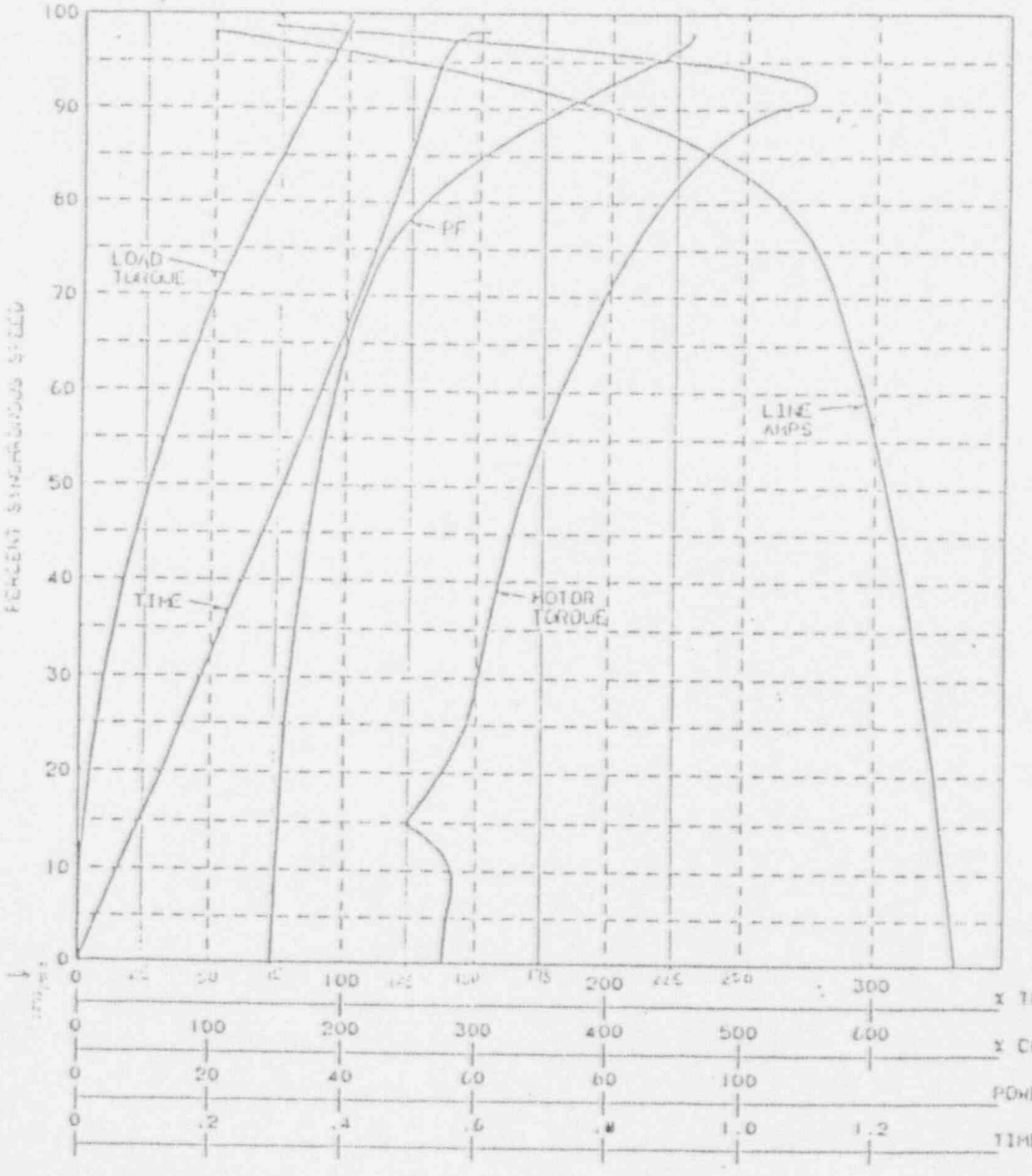
HP 400 VOLTS 460 PH 3 HZ 60 POLES 4 RPM (FL) 1763

PF 91.0 FL AMPS 435 LOCK AMPS (X) 664 RPM (SYN) 1800

FL TORQUE (LB-FT) 1192 LOCK TORQUE (X) 139

LOAD WK^2 (LB-FT^2) 48 MOTOR WK^2 (LB-FT^2) 128 FRAME 5008P20

APPLICATION: RHR PUMP



VESTINGHOUSE ELECTRIC CORPORATION - HIMD ROUND ROCK, TEXAS

SIGNATURE: [signature] DATE 06/08/87 CURVE 17531LN.100.1

INDUCTION MOTOR STARTING CHARACTERISTICS
CALCULATED AT 90% LINE VOLTAGE

CUSTOMER: W-NSID

S.O. 17531LN

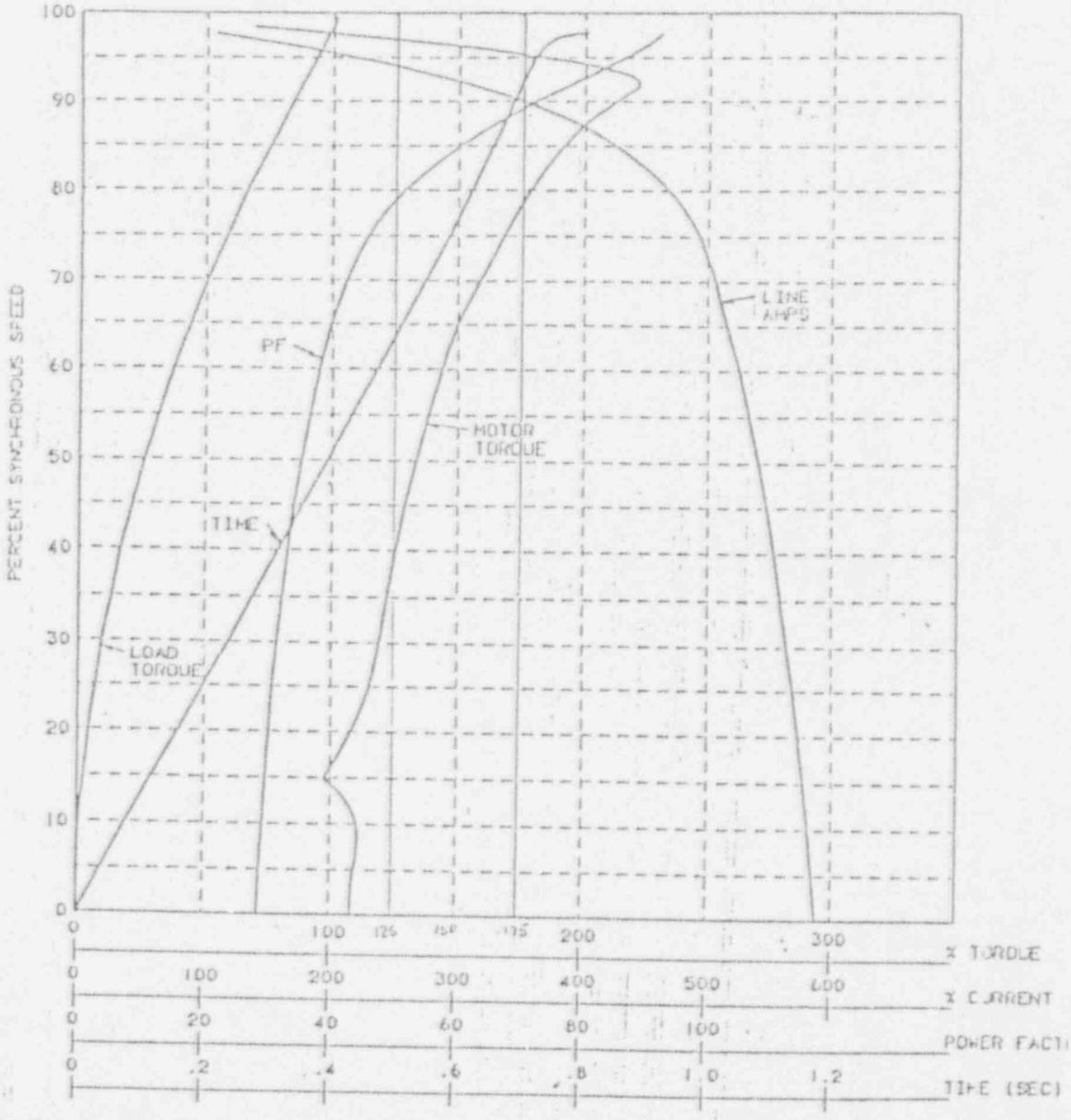
HP 400 VOLTS 460 PH 3 HZ 60 POLES 4 RPM (FL) 1793

PF 91.8 FL AMPS 435 LOCK AMPS (%) 588 RPM (SYN) 1800

FL TORQUE (LB-FT) 1192 LOCK TORQUE (%) 108

LOAD WK^2 (LB-FT^2) 48 MOTOR WK^2 (LB-FT^2) 122 FRAME 5008P20

APPLICATION: RHR PUMP



WESTINGHOUSE ELECTRIC CORPORATION - HIMD ROUND ROCK, TEXAS

SIGNATURE: [signature] DATE 08/08/87 CURVE 17531LN,SD,1

INDUCTION MOTOR STARTING CHARACTERISTICS
CALCULATED AT 80% LINE VOLTAGE

CUSTOMER: W-NSID

S.O. 17531LN

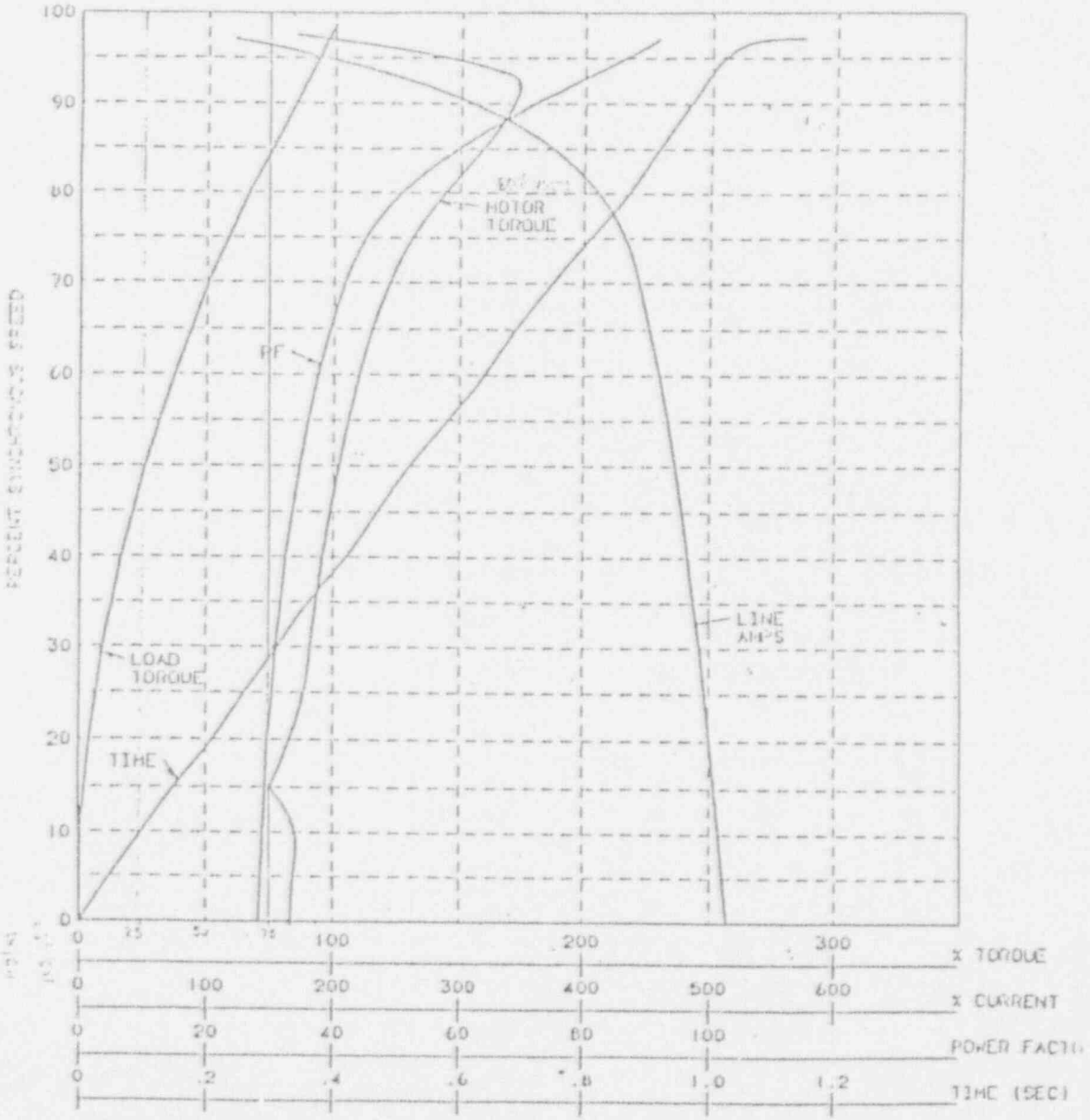
HP 400 VOLTS 460 PH 3 HZ 60 POLES 4 RPM (FL) 1763

PF 91.8 FL AMPS 435 LOCK AMPS (%) 514 RPM (SYN) 1800

FL TORQUE (LB-FT) 1192 LOCK TORQUE (%) 82

LOAD WK^2 (LB-FT^2) 48 MOTOR WK^2 (LB-FT^2) 122 FRAME 5008P20

APPLICATION: RHR PUMP



WESTINGHOUSE ELECTRIC CORPORATION - HIMD ROUND ROCK, TEXAS

SIGNATURE: DATE 06/06/67 CURVE 17531LN,00,1

SAFETY INJECTION PUMP MOTORS

I. MOTOR DATA

There are three Safety Injection Pump motors at Indian Point Unit 2. Motor data for the originally installed Westinghouse motors is:

- Frame Size 509 US
- Horsepower 400 HP
- Rated Voltage 440 volts
- Motor WK^2 38 lb.- ft.
- Pump WK^2 13 lb.- ft.

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following:

- Westinghouse supplied motor data sheets. These sheets give motor torque data for the 100%, 90% and 80% rated voltage conditions.
- Pacific Pump supplied Speed vs. Torque curve, dated April 9, 1970.

III. CALCULATION

a.) To determine the power, x, to be used in calculating the torque available at a minimum voltage, the torque and voltage data provided at the 100% and 80% voltage is used. At 80% speed, 2880 rpm, this data is:

100 % voltage	80 % voltage
813.6 ft-lbs	473.5 ft-lbs

Solving for x in the following equation:

$$T_{avail} = T_{rated} (V_{avail}/V_{rated})^{x}$$

$$473.5 = 813.6\ (352/440)^{x}$$

$$.582 = .8^{x}$$

$$x = 2.43$$

rounded up, $x = 2.45$

b.) The required motor torque at the minimum margin speed, 2880 rpm, is 120 per cent of the pump torque at this speed or 1.20 x 366 = 439 ft-lbs. The voltage required to produce this torque is:

$$T_{avail} = T_{rated} (V_{avail}/V_{rated})^{2.45}$$

$$439 = 813.6 (V_{avail}/V_{rated})^{2.45}$$

Solving for V avail/ V rated = approximately .78 of V available = 78 per cent of rated voltage = 343 volts.

c.) The acceleration time is tabulated on the included summary chart. The formula used for calculating the acceleration time is:

$$T_{acc} = (WK^2_{pump} + WK^2_{motor})(\Delta rpm) / 308 (\text{motor } T - \text{pump } T)$$

IV. CALCULATION RESULTS

The original Safety Injection Pumps are capable of starting at 343 volts. The acceleration time for these motors at this voltage is approximately 4.21 seconds.

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	32 OF 62

PREPARER/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE: Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV

DESCRIPTION: SAFETY INJECTION PUMP
HP: 400 FRAME: 509U8
MOTOR WK^2: 38 RATED
PUMP WK^2: 13 VOLTAGE: 440
PUMP F.L. TORQUE: 590 FT-LBS

		PUMP											
		TORQUE	MOTOR TORQUE				ACCELERATING TORQUE				ACCELERATION TIME			
% SPEED	RPM	(FT-LBS)	100% V	90% V	80% V	78% V	100% V	90% V	80% V	78% V	Time in sec. for 100%V	Time in sec. for 90% V	Time in sec. for 80% V	Time in sec. for 78% V
0	0	59	407	313	234	221	348	254	175	162				
10	360	30	423	326	244	230	393	296	214	200	0.15	0.20	0.28	0.30
20	720	30	415	320	239	226	385	290	209	196	0.15	0.21	0.29	0.30
30	1080	53	465	359	268	253	412	306	215	200	0.14	0.19	0.28	0.30
40	1440	89	478	368	276	260	389	279	187	171	0.15	0.21	0.32	0.35
50	1800	139	516	398	298	281	377	259	159	142	0.16	0.23	0.37	0.42
60	2160	200	568	439	329	309	368	239	129	109	0.16	0.25	0.46	0.55
70	2520	280	649	502	376	353	369	222	96	73	0.16	0.27	0.62	0.82
80	2880	366	814	631	474	443	448	265	108	77	0.13	0.23	0.55	0.77
90	3240	472	1241	970	735	675	769	498	263	203	0.08	0.12	0.23	0.29
95	3420	531	1464	1155	899	796	933	624	368	265	0.03	0.05	0.08	0.11
							TOTAL ACCELERATING TIMES (Sec.):				1.33	1.96	3.48	4.21

MOTOR DATA

PLANT: Indian Point Unit Nos. 2 and 3

COMPONENT: Safety Injection Pumps

MOTOR MANUFACTURER: Westinghouse Large Motor Division, Buffalo, New York

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F62502-15 through 6S-67

MOTOR H.P. RATING: 400 @ 3556 RPM MOTOR FRAME SIZE: 509

MOTOR WRR = 38 LB-FT^2

LINE VOLTAGE: 440 (100%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	406.71
95.00	180	414.50
90.00	360	422.93
85.00	540	368.53
80.00	720	415.00
75.00	900	448.99
70.00	1080	465.28
65.00	1260	461.87
60.00	1440	477.56
55.00	1620	495.41
50.00	1800	515.94
45.00	1980	539.87
40.00	2160	568.22
35.00	2340	602.48
30.00	2520	649.39
25.00	2700	716.75
20.00	2880	813.57
15.00	3060	966.40
10.00	3240	1241.38
9.50	3258	1272.71
9.00	3276	1304.07
8.50	3294	1335.04
8.00	3312	1365.09
7.50	3330	1393.49
7.00	3348	1419.28
6.50	3366	1441.21
6.00	3384	1454.29
5.50	3402	1463.96
5.00	3420	1463.51
4.50	3438	1449.73
4.00	3456	1419.18
3.50	3474	1370.07
3.00	3492	1293.13
2.50	3510	1181.93
2.00	3528	1030.28
1.50	3546	835.35

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F62502-1S through 6S-67

LINE VOLTAGE: 396 (90%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	313.34
95.00	180	319.42
90.00	360	325.98
85.00	540	284.10
80.00	720	319.99
75.00	900	346.28
70.00	1080	358.91
65.00	1260	356.31
60.00	1440	368.49
55.00	1620	382.35
50.00	1800	398.30
45.00	1980	416.91
40.00	2160	438.97
35.00	2340	465.65
30.00	2520	502.22
25.00	2700	554.84
20.00	2880	630.59
15.00	3060	750.83
10.00	3240	970.21
9.50	3258	995.61
9.00	3276	1021.16
8.50	3294	1046.56
8.00	3312	1071.40
7.50	3330	1095.12
7.00	3348	1116.99
6.50	3366	1136.05
6.00	3384	1148.55
5.50	3402	1158.50
5.00	3420	1160.69
4.50	3438	1154.94
4.00	3456	1135.40
3.50	3474	1098.17
3.00	3492	1038.57
2.50	3510	951.22
2.00	3428	830.99
1.50	3546	675.52

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F62502-1S through 6S-67

LINE VOLTAGE: 352 (80%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	233.96
95.00	160	238.55
90.00	360	243.51
85.00	540	212.26
80.00	720	239.12
75.00	900	258.80
70.00	1080	268.29
65.00	1260	266.35
60.00	1440	275.50
55.00	1620	285.92
50.00	1800	297.91
45.00	1980	311.91
40.00	2160	328.52
35.00	2340	348.63
30.00	2520	376.24
25.00	2700	416.07
20.00	2880	473.49
15.00	3060	565.18
10.00	3240	734.94
9.50	3258	754.92
9.00	3276	775.13
8.50	3294	795.34
8.00	3312	815.27
7.50	3330	832.20
7.00	3348	850.56
6.50	3366	867.92
6.00	3384	882.79
5.50	3402	893.58
5.00	3420	898.62
4.50	3438	895.76
4.00	3456	882.32
3.50	3474	855.18
3.00	3492	810.57
2.50	3510	743.43
2.00	3528	651.69

"DUPLICATE"

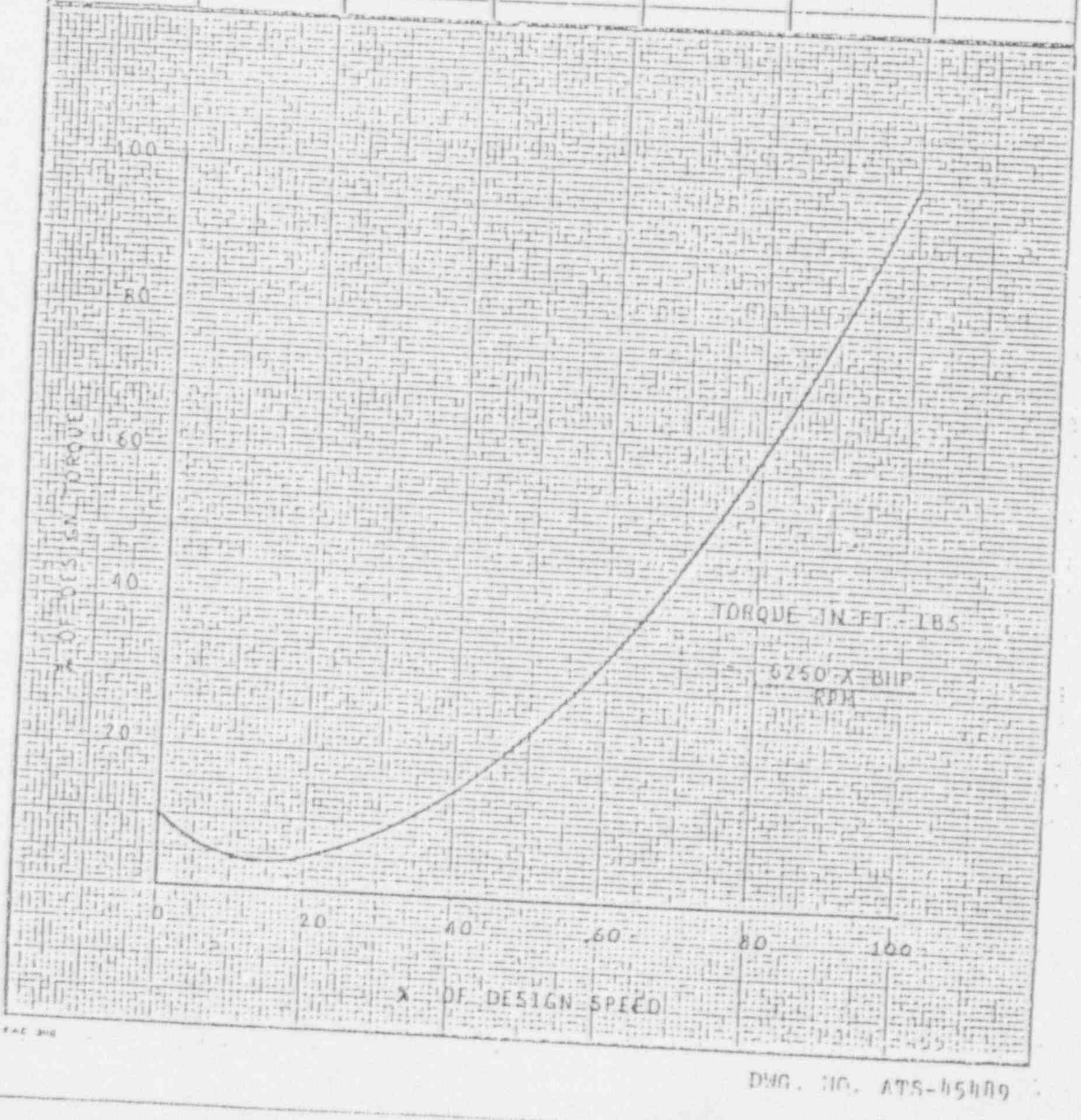
CUSTOMER WESTINGHOUSE - APD

DATE APRIL 9, 1970

CUSTOMER REF. NO.	PACIFIC REF. NO	ITEM NO.	PUMP		TORQUE IN FT-LB	
			SIZE	TYPE	RATED	25 GPM*
54-E-70503B	9546-554 and R29-080		2 1/2"	JTCH	590	286

* MINIMUM FLOW

WR^2 INCLUDING COUPLING = 1? lb.ft.^{2}



DWG. NO. ATS-45409

CON EDISON CALCULATION/ANALYSIS SHEET

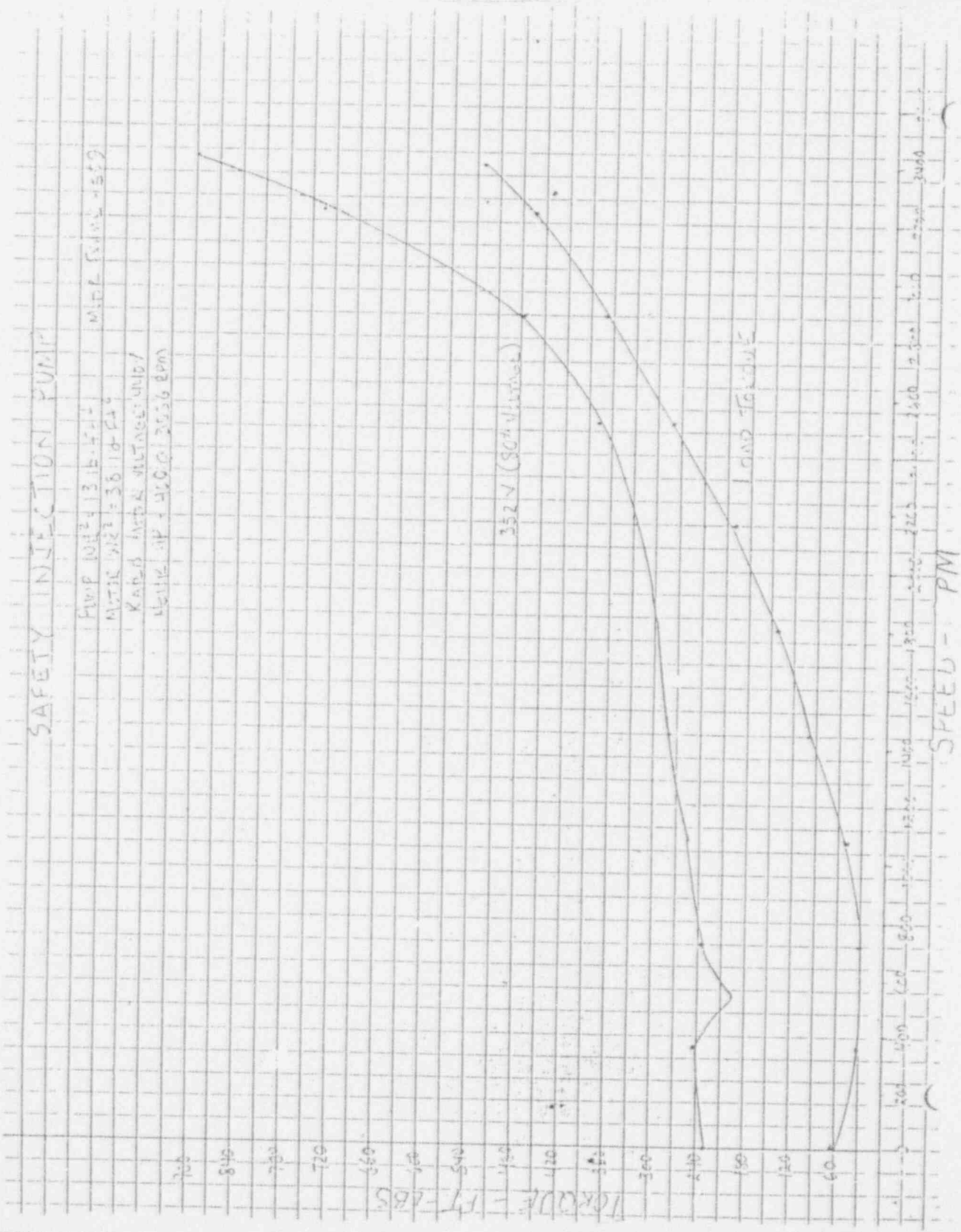
CALCULATION NO.	REVISION	PAGE
EGE-00001	0	37 OF 62

ORIGINATOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV



REACTOR CONTAINMENT RECIRCULATION FAN MOTORS

I. MOTOR DATA

There are five Reactor Containment Recirculation Fans at Indian Point Unit 2. Motor data for the originally installed motors includes the following:

o Motor Frame Size	588.5
o Horsepower	350 HP
o Rated Voltage	440 volts
o Motor WK^2	515 lb.- ft.
o Fan WK^2	2460 lb.- ft.

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following:

- Westinghouse supplied motor data sheets which provide motor torque data for 100%, 90% and 80% rated voltage conditions.
- Westinghouse supplied Speed vs. Torque curves dated 2/18/77. The curve utilized for the purpose of this calculation is the worst case (i.e.- .175 density) curve.

III. CALCULATION

a.) To determine the power, x, to be used in calculating the minimum voltage required to produce a required torque, the torque and voltage data provided at 100% and 80% rated voltage is used. At 80% speed, 960 rpm, the data for this motor is:

100% Voltage	80% Voltage
3081.72 ft-lbs	1920.01 ft-lbs

$$T_{avail} = T_{rated}(V_{avail}/V_{rated})^{x}$$

$$1920 = 3082(352/440)^{x}$$

$$.623 = .8^{x}$$

Solving for x, x= 2.1

* NOTE: At low speeds, x was calculated to be 2.2. This is a more conservative figure and is used for this calculation.

b.) The acceleration time was calculated for a minimum voltage of 71.2 percent rated voltage, or 313 volts. The minimum voltage was determined by calculating the motor voltage required to produce a torque 20 percent larger than the load torque at the minimum margin speed of 95% rated. 120 per cent of the fan torque at this speed is 1.2 x 1490 = 1788 ft.-lbs.

$$T_{avail} = T_{rated} (V_{required}/440)^{2.2}$$

$$1788 = 3773 (V_{required}/440)^{2.2}$$

$$.474 = (V_{required}/440)^{2.2}$$

$V_{required}$ = 313 volts

c.) The acceleration time was calculated with the following formula:

$$T_{acc} = (WK^2_{fan} + WK^2_{motor}) (\Delta rpm) / 308 (T_{motor} - T_{fan})$$

IV. CALCULATION RESULTS

The Containment Recirculation Fans are capable of starting with a terminal voltage of 71.2 percent rated, or 313 volts. The calculated acceleration time for the fans at this voltage is 16.96 seconds.

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	40 OF 62

ORIGINATOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/20/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

MOD NO. REV

DESCRIPTION: CONTAINMENT RECIRCULATION FANS

HP: 350 FRAME: 588.5

MOTOR WK^2: 515 RATED

PUMP WK^2: 2460 VOLTAGE: 440

PUMP F.L. TORQUE: 1409 FT-LBS

		PUMP									ACCELERATION TIME			
		TORQUE	MOTOR TORQUE				ACCELERATING TORQUE				Time in sec.	Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	80% V	71.2% V	100% V	90% V	80% V	71.2% V	for 100%V	for 90% V	for 80% V	for 71.2% V
0	0	160	2222	1765	1347	1053	2062	1605	1187	893				
10	120	130	2277	1808	1380	1079	2147	1678	1250	949	0.54	0.69	0.93	1.22
20	240	110	2341	1859	1418	1110	2231	1749	1308	1000	0.52	0.66	0.89	1.16
30	360	130	2379	1888	1440	1128	2249	1758	1310	998	0.52	0.66	0.88	1.16
40	480	250	2430	1928	1474	1152	2180	1678	1224	902	0.53	0.69	0.95	1.29
50	600	390	2508	1989	1527	1189	2118	1599	1137	799	0.55	0.73	1.02	1.45
60	720	560	2547	2017	1558	1207	1987	1457	998	647	0.58	0.80	1.16	1.79
70	840	750	2752	2179	1695	1304	2002	1429	945	554	0.58	0.81	1.23	2.09
80	960	990	3082	2463	1920	1481	2092	1473	930	471	0.55	0.79	1.25	2.46
90	1080	1270	3701	2981	2333	1754	2431	1711	1063	484	0.48	0.68	1.09	2.39
95	1140	1490	3773	3066	2411	1788	2283	1576	921	298	0.25	0.37	0.63	1.94
							TOTAL ACCELERATING TIMES (Sec.):				5.10	6.87	10.02	16.96

PLANT: Indian Point Unit No. 2

COMPONENT: Containment Recirculation Fans

MOTOR MANUFACTURER: Westinghouse Large Motor Division, Buffalo, New York

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F92631-15 through 55-68

MOTOR H.P. RATING: 350 @ 1183 RPM MOTOR FRAME SIZE: 588.5

MOTOR WRR = 515 LB-FT^2

LINE VOLTAGE: 440 (100%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	2222.39
95.00	60	2248.98
90.00	120	2277.47
85.00	180	2308.08
80.00	240	2341.05
75.00	300	2361.52
70.00	360	2379.30
65.00	420	2401.87
60.00	480	2430.08
55.00	540	2465.03
50.00	600	2508.18
45.00	660	2473.77
40.00	720	2546.87
35.00	780	2637.64
30.00	840	2751.55
25.00	900	2896.24
20.00	960	3081.72
15.00	1020	3328.13
10.00	1080	3700.52
9.50	1086	3727.15
9.00	1092	3762.43
8.50	1098	3779.84
8.00	1104	3824.53
7.50	1110	3859.97
7.00	1116	3883.26
6.50	1122	3890.89
6.00	1128	3878.59
5.50	1134	3841.29
5.00	1140	3773.07
4.50	1146	3667.12
4.00	1152	3515.93
3.50	1158	3311.53
3.00	1164	3054.02
2.50	1170	2729.06
2.00	1176	2325.62
1.50	1182	1841.12
1.23	1185	1551.98

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 82F92631-15 through 55-65

LINE VOLTAGE: 396 (90%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	1764.79
95.00	60	1785.84
90.00	120	1808.39
85.00	180	1832.60
80.00	240	1858.66
75.00	300	1874.65
70.00	360	1888.42
65.00	420	1905.93
60.00	480	1927.84
55.00	540	1955.01
50.00	600	1988.55
45.00	660	1960.46
40.00	720	2017.42
35.00	780	2089.06
30.00	840	2178.66
25.00	900	2301.99
20.00	960	2463.43
15.00	1020	2682.03
10.00	1080	2980.80
9.50	1086	3011.49
9.00	1092	3041.06
8.50	1098	3055.78
8.00	1104	3093.63
7.50	1110	3124.18
7.00	1116	3145.08
6.50	1122	3153.48
6.00	1128	3145.91
5.50	1134	3118.22
5.00	1140	3065.53
4.50	1146	2982.24
4.00	1152	2862.11
3.50	1158	2706.56
3.00	1164	2501.55
2.50	1170	2236.11
2.00	1176	1906.13
1.55	1181	1554.56

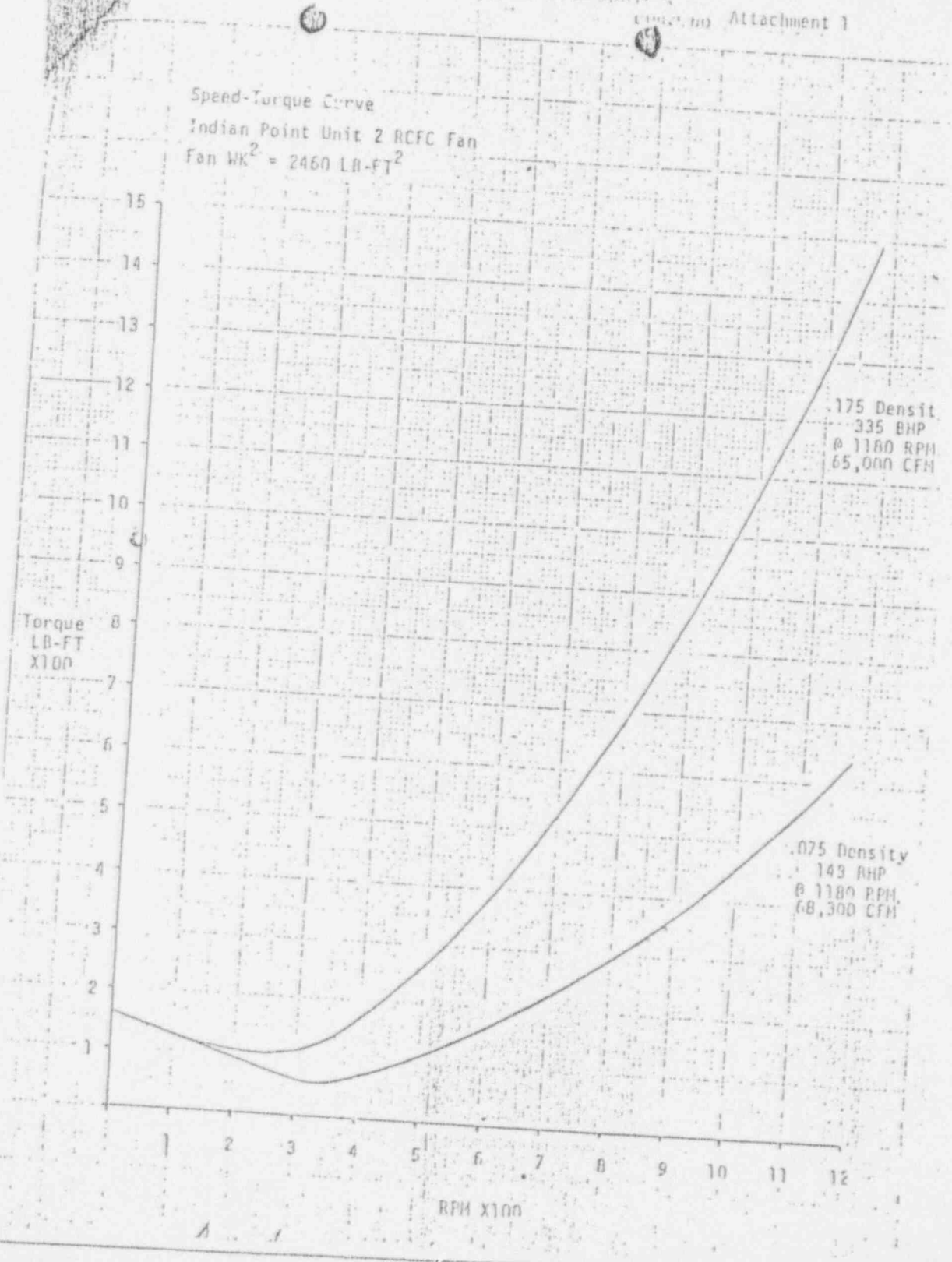
MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F92631-15 through 55-68

LINE VOLTAGE: 352 (80%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	1347.05
95.00	60	1363.20
90.00	120	1380.25
85.00	180	1398.54
80.00	240	1418.20
75.00	300	1429.99
70.00	360	1439.94
65.00	420	1452.65
60.00	480	1474.32
55.00	540	1498.40
50.00	600	1527.84
45.00	660	1509.16
40.00	720	1557.91
35.00	780	1618.49
30.00	840	1694.79
25.00	900	1792.53
20.00	960	1920.01
15.00	1020	2086.92
10.00	1080	2332.49
9.50	1086	2357.16
9.00	1092	2381.02
8.50	1098	2393.00
8.00	1104	2423.82
7.50	1110	2449.03
7.00	1116	2466.82
6.50	1122	2474.92
6.00	1128	2470.62
5.50	1134	2450.62
5.00	1140	2411.06
4.50	1146	2349.81
4.00	1152	2266.27
3.50	1158	2146.39
3.00	1164	1984.00
2.50	1170	1773.61
2.09	1175	1562.79

Attachment 1



CON EDISON CALCULATION/ANALYSIS SHEET

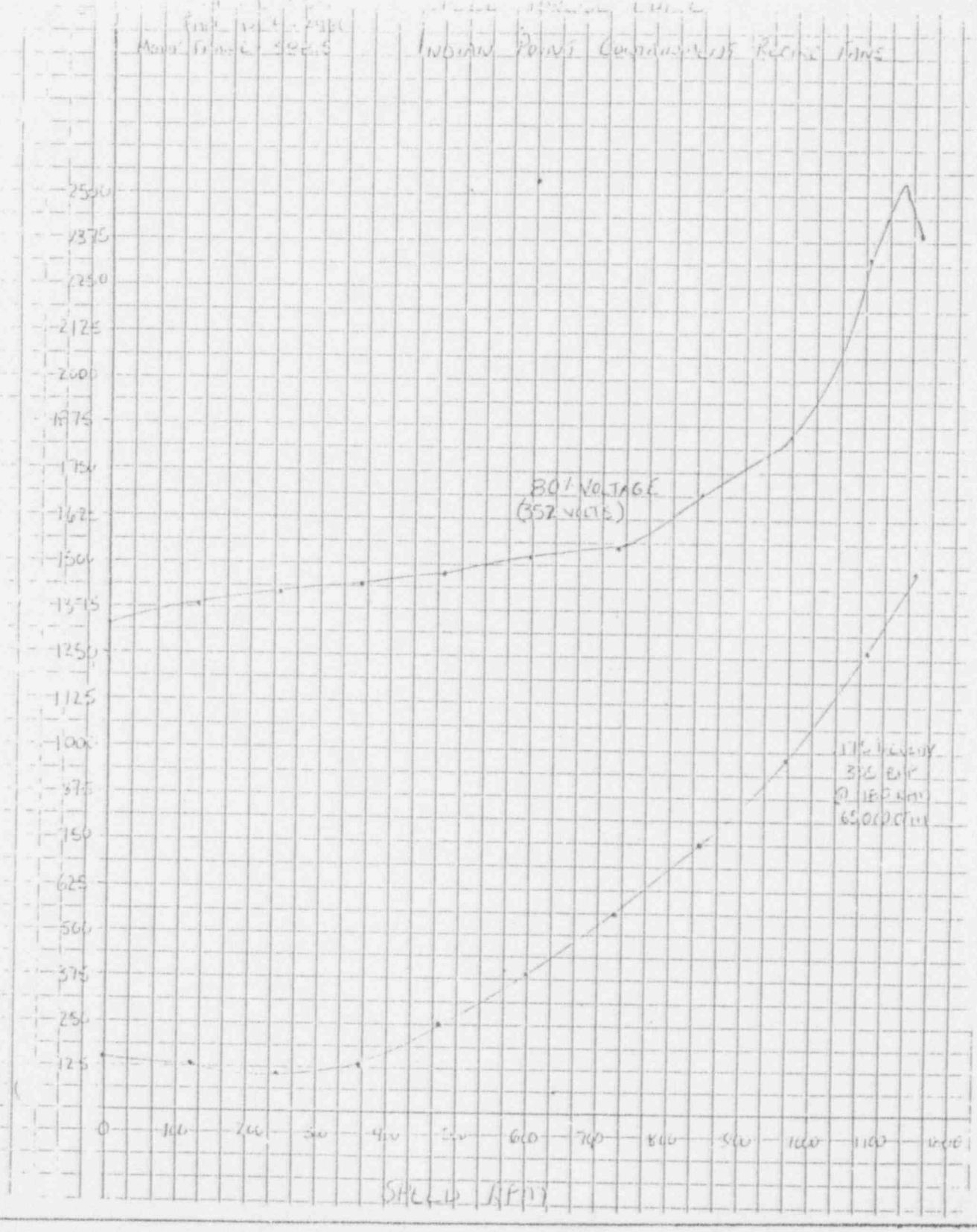
CALCULATION NO.	REVISION	PAGE
EGE-00001	0	45 OF 62

ORIGINATOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/24/91	1E

SUBJECT/TITLE
Class 1E Motor Minimum Starting Voltage and Acceleration Time, Calculations

PROJECT NO.

NOD NO. REV



AUXILIARY FEEDWATER PUMP MOTORS

I. MOTOR DATA

There are two motor driven Auxiliary Feedwater Pumps at Indian Point Unit No. 2. Motor data for the existing motors includes the following:

o Motor Frame Size	E5008S
o Rated Voltage	440 volts
o Horsepower	400 HP
o Motor WK^2	44 lb.- ft.
o Pump WK^2	14.3 lb.- ft.

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following:

- Reliance Electric supplied motor speed vs. torque curves for the 100% and 80% rated voltage conditions (Curve # V4769.TES2, dated 4/16/84).
- Ingersoll Rand supplied pump speed vs. torque curve 34-3308 S-T-1, dated 2/11/83.
- R. Boggia plot of motor speed vs. torques for 100% rated voltage and 87.5% rated voltage conditions, dated 3/31/87. Included with these curves are pump speed vs. torque curves for the valve open and valve closed conditions.

III. CALCULATION

a.) The values of motor torque available at 100% voltage and 80% voltage were analyzed to determine what power, x, should be utilized to calculate the minimum voltage required for successful motor starting. The torque values plotted on this curve, curve V4769.TES2, were actual values produced during field testing of the motor. The torques available at 80% rated voltage were found to be approximately 64% of rated voltage torques for the entire range of motor speeds. Thus, a value of 2.0 for the power, x, is used to calculate the torque available at a lower than rated voltage.

A study performed in 1987 showed that the Auxiliary Feedwater Pump motor was capable of starting at a voltage of 87.5% rated voltage, or 385 volts, with a 25 per cent margin at the minimum margin speed of 2880 rpm.

b.) To determine the minimum voltage necessary for a successful start, with a 20% margin of motor torque above pump torque, the following formula is used :

$$T_{avail} = T_{rated} (V_{avail} / V_{rated})^2$$

where T_{avail} = required Torque to accelerate pump at minimum margin condition.

= 1.20 x pump Torque at 2880 rpm
= 1.20 x 440

T_{avail} = 528 ft-lbs

T_{rated} = 700 ft-lbs
V_{rated} = 440 ft-lbs

$$528 = 700 (V_{avail}/V_{rated})^2$$

$$.754 = (V_{avail}/ V_{rated})^2$$

V_{avail} = .87(V_{rated})
= .87 (440)
= 382.8 volts

c.) The acceleration time was calculated with the following formula:

$$T = (\text{motor } WK^2 + \text{pump } WK^2)(\Delta rpm)/ 308 (\text{pump } T - \text{motor } T)$$

$$T = (44 + 14.3) (409)/ 308 (\text{pump } T - \text{motor } T)$$

*NOTE: As previously mentioned, the Auxiliary Feedwater Pump motor speed vs. torque data consists of actual test data. Because of this, the minimum voltage that the motor could start with an acceleration time less than five seconds, disregarding the requirement for a 20 per cent margin is tabulated on the included summary chart. The minimum voltage that would be capable of starting the Auxiliary Feedwater Pump motors in less than five seconds is 84 per cent rated voltage, or approximately 370 volts. The acceleration time at this voltage is 4.88 seconds. The minimum torque margin at this voltage is approximately 15 per cent.

IV. CALCULATION RESULTS

Factory test data was used in plotting the speed vs. torque curves for the Auxiliary Feedwater Pump motors. Knowing this, a calculation was performed to determine the minimum voltage that could accelerate the motors in less than five seconds without being limited by a minimum 20 per cent margin between motor and pump torques. The motors were found to be capable of starting with a voltage of 84% rated voltage, or 370 volts, in 4.88 seconds. At this voltage there is a 15 per cent margin.

DESCRIPTION: AUXILIARY FEEDWATER PUMPS

HP: 400 FRAME: E50088

MOTOR WK^2: 44 RATED

PUMP WK^2: 14.3 VOLTAGE: 440

PUMP F.L. TORQUE: 670 FT-LBS

	PUMP							ACCELERATION TIME		
	TORQUE	MOTOR TORQUE			ACCELERATING TORQUE			Time in sec.	Time in sec.	Time in sec.
RPM	(FT-LBS)	100% V	90% V	84% V	100% V	90% V	84% V	for 100%V	for 90% V	for 84% V
0	105	405	328	286	300	223	181			
400	28	434	352	306	406	324	278	0.19	0.23	0.27
800	34	457	370	322	423	336	288	0.18	0.23	0.26
1200	75	470	381	332	395	306	257	0.19	0.25	0.29
1600	135	485	393	341	350	258	206	0.22	0.29	0.37
2000	216	495	401	349	279	185	133	0.27	0.41	0.57
2400	297	562	455	397	265	158	100	0.29	0.48	0.76
2800	419	680	551	480	261	132	61	0.29	0.57	1.24
3200	554	927	751	654	373	197	100	0.20	0.38	0.76
3400	620	1175	952	829	555	332	209	0.14	0.23	0.36
					TOTAL ACCELERATING TIMES (Sec.):			1.96	3.08	4.88

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	50 of 62

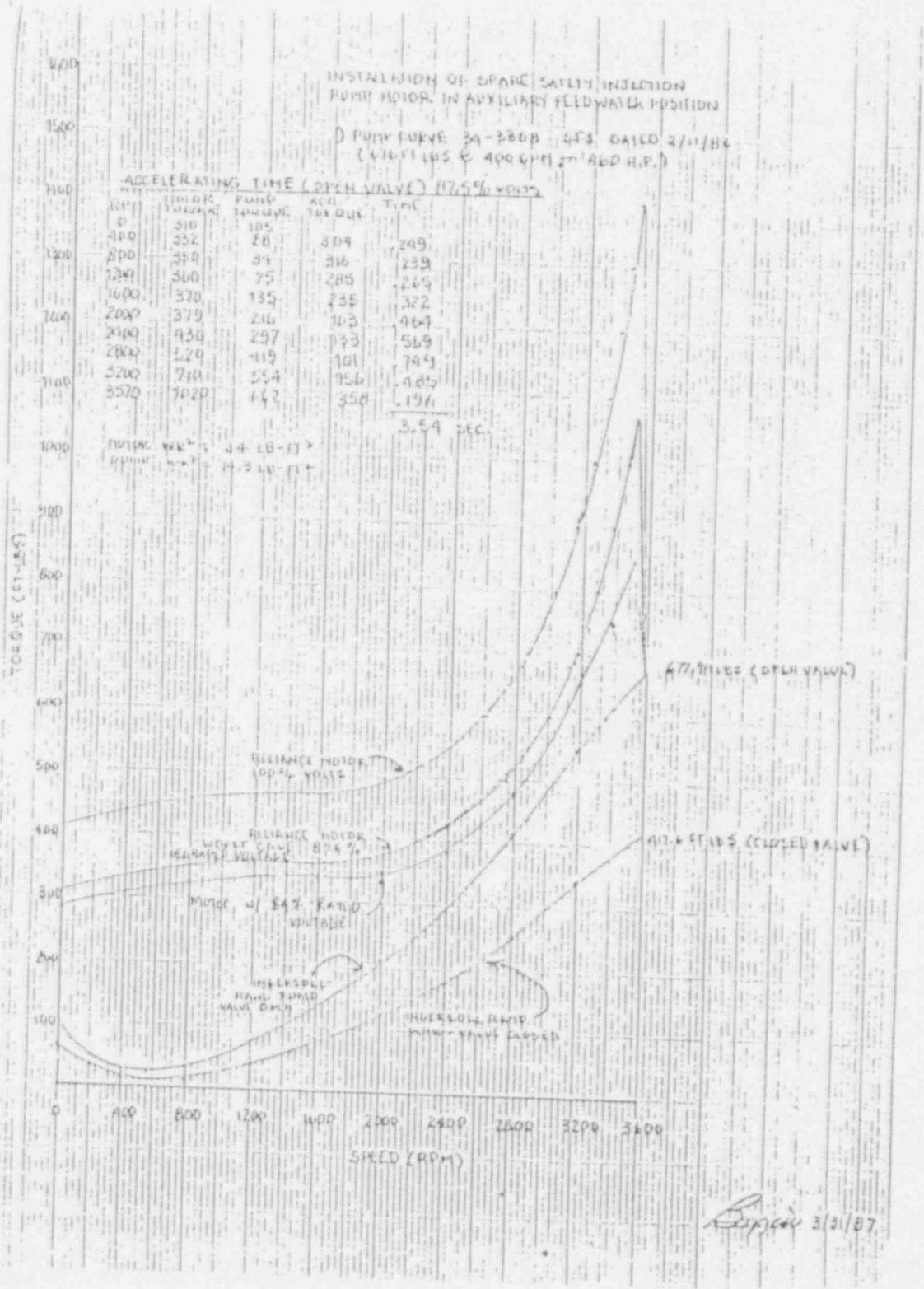
ORIGINATOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/24/91	1E

SUBJECT/TITLE

Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.

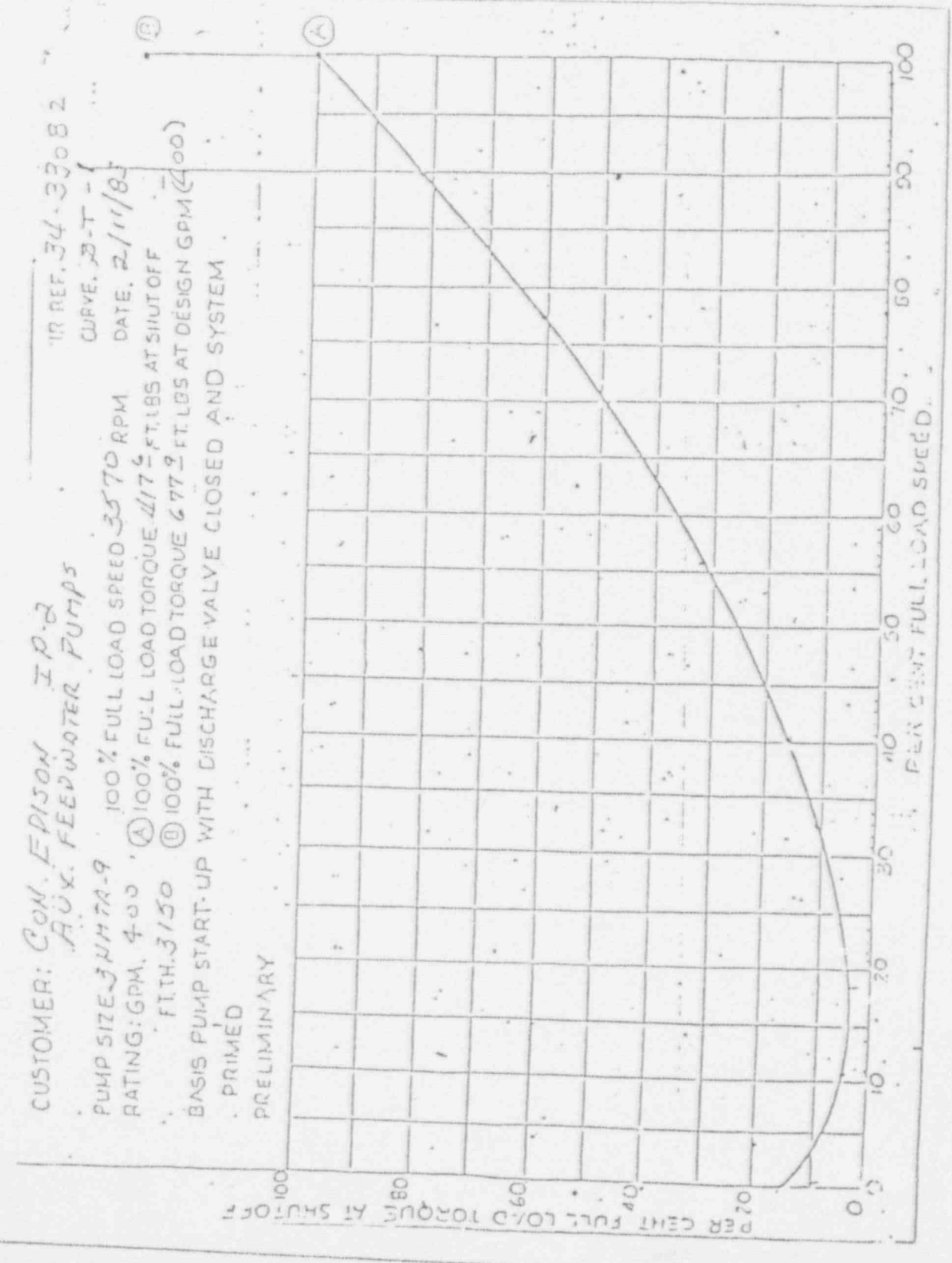
MOD NO. REV



3/31/87

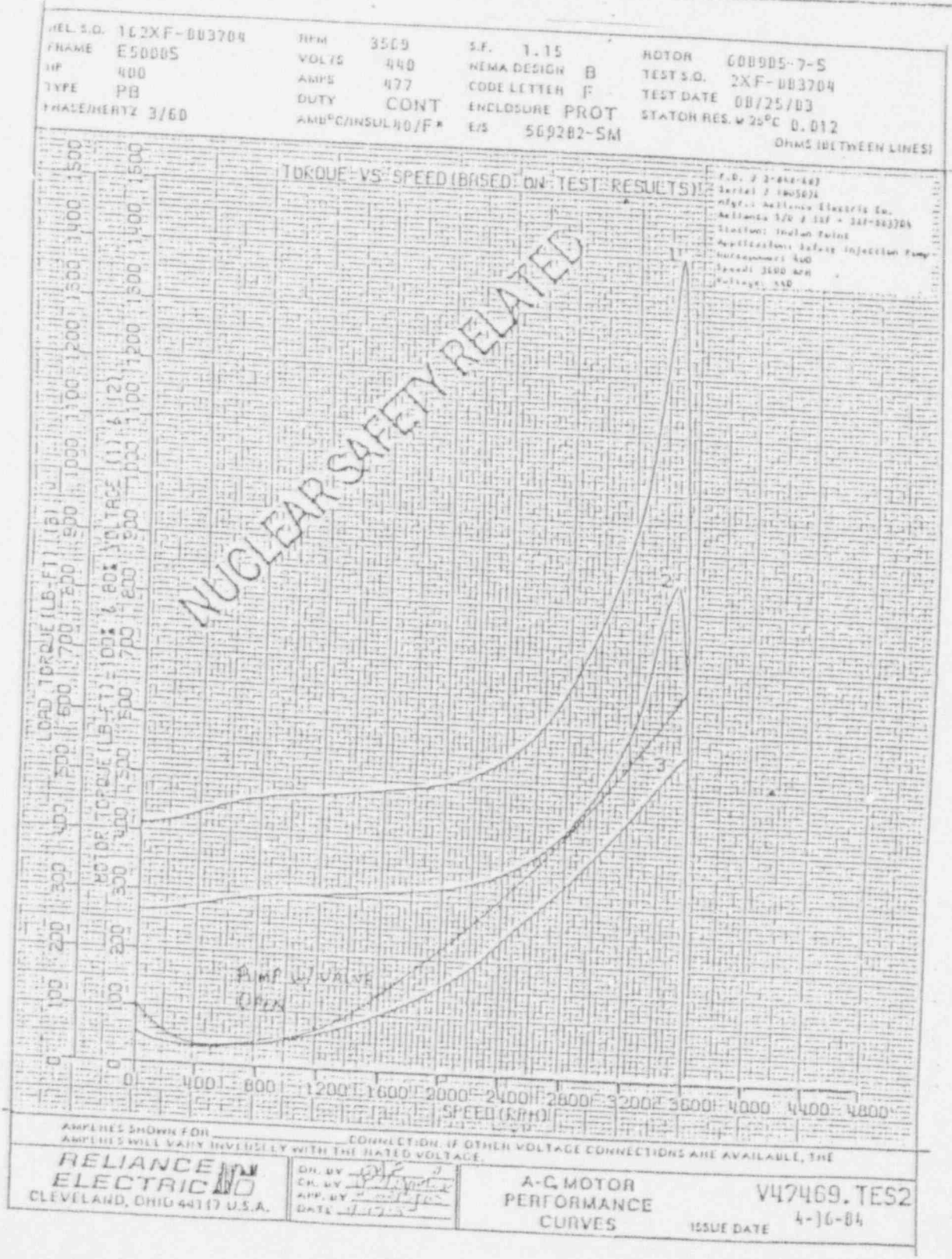
CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO. EGE-00001	REVISION 0	SHEET 51 OF 62	
PREPARER/DATE Thomas J. Magee 9/18/91	REVIEWER/DATE Bruce Horowitz 9/26/91	CLASS 1E	
SUBJECT/TITLE Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations		PROJECT NO.	
		NUP NO.	REV



CON EDISON CALCULATION/ANALYSIS SHEET

PREPARER/DATE: Thomas J. Magee 9/18/91	CALCULATION NO.: EGE-00001	REVISION: 0	PAGE: 52 OF 62
	REVIEWER/DATE: Bruce Horowitz 9/26/91		CLASS: 1E
SUBJECT/TITLE: Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations			PROJECT NO.:
			HOR NO.: REV



SAFETY INJECTION RECIRCULATION PUMP MOTORS

I. MOTOR DATA

Motor data for the Safety Injection Recirculation Pump motors is as follows:

- Motor Frame Size 588.5
- Rated Voltage 440
- Horsepower 350
- Motor WK^2 313
- Pump WK^2 130

II. CALCULATION DATA

Data used for the purpose of these calculations includes the following:

- Westinghouse supplied motor data sheets for shop order motors 67F63897-1S through 4S-67 for the 100%, 90% and 80% voltage conditions.
- Westinghouse supplied computer printout data sheets for the 100% and 90% rated voltage conditions.

III. CALCULATION

a.) To determine the power, x, to be used in calculating the minimum voltage required to produce the required torque, the torque and voltage data provided at the 100% and 90% voltages is used. The value of x was found to be approximately 2.2 for this motor.At 60% speed the data is:

100% Voltage	90% Voltage
2386.40 ft.-lbs.	1889.42 ft.-lbs.

$$T_{avail} = T_{rated}(V_{avail}/V_{rated})^{x}$$

$$1889.42 = 2386.40(396/440)^{x}$$

$$.792 = .9^{x}$$

solving for x, $x = 2.2$

b.) The minimum motor and pump torque margin exists at 94.5% speed, 1134 rpm. The pump torque at this speed is 1421 ft.-lbs. Solving for the voltage required to produce the required minimum torque of 120 per cent of 1421, or 1705 ft-lbs:

$$T_{avail} = T_{rated} (V_{avail}/ V_{rated})^{2.2}$$

$$1705 = 3711 (V_{avail}/ V_{rated})^{2.2}$$

$$.46 = (V_{avail}/ V_{rated})^{2.2}$$

V avail/V rated = .71 or 71 rated voltage = 312 volts

c.) The acceleration time is included on the attached summary chart. The formula used for calculating the acceleration time is:

$T = (\text{motor } WK^2 + \text{pump } WK^2) (\Delta rpm)/ 308 (\text{pump } T - \text{motor } T)$

$T = (313 + 130) (120)/ 308 (\text{pump } T - \text{motor } T)$

IV. CALCULATION RESULTS

The Safety Injection Recirculation Pumps are capable of starting with a terminal voltage of 71 percent of rated voltage or 312 volts. The acceleration time at this voltage is approximately 2.94 seconds.

DESCRIPTION: SAFETY INJECTION RECIRCULATION PUMP MOTORS

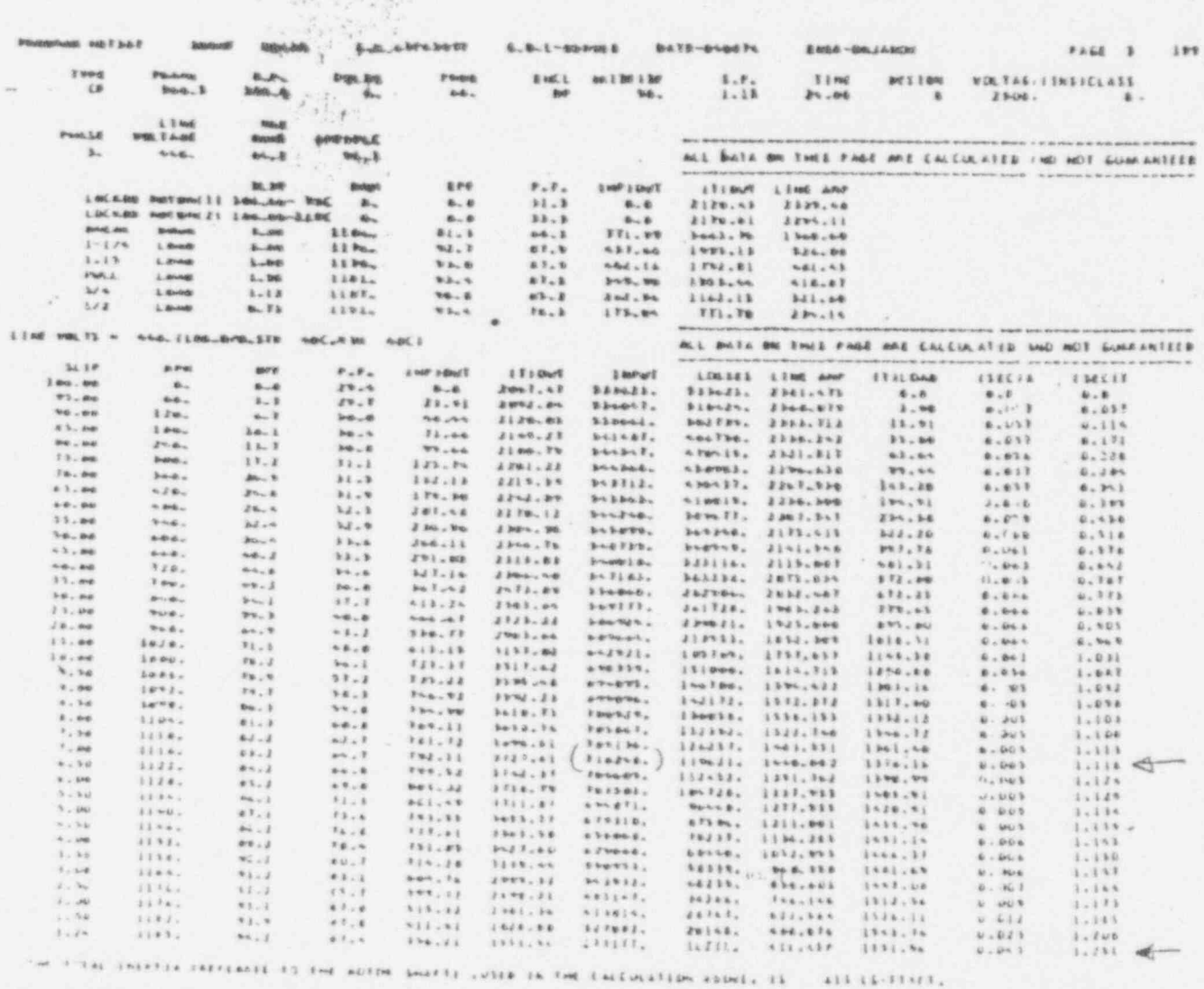
HP: 350 FRAME: 588.5

MOTOR WK^2: 313 RATED

PUMP WK^2: 130 VOLTAGE: 440

PUMP F.L. TORQUE: 1554 FT-LBS

		PUMP							ACCELERATION TIME		
		TORQUE	MOTOR TORQUE			ACCELERATING TORQUE			Time in sec.	Time in sec.	Time in sec.
% SPEED	RPM	(FT-LBS)	100% V	90% V	71% V	100% V	90% V	71% V	for 100%V	for 90% V	for 71% V
0	0	0	2067	1641	972	2067	1641	972			
10	120	16	2120	1683	996	2104	1667	981	0.08	0.10	0.18
20	240	64	2181	1731	1025	2117	1667	961	0.08	0.10	0.18
30	360	143	2219	1760	1043	2076	1617	900	0.08	0.11	0.19
40	480	235	2270	1800	1067	2036	1565	832	0.08	0.11	0.21
50	600	398	2347	1859	1103	1949	1461	705	0.09	0.12	0.24
60	720	572	2386	1889	1122	1814	1317	550	0.10	0.13	0.31
70	840	780	2584	2053	1214	1804	1273	435	0.10	0.14	0.40
80	960	1018	2904	2330	1365	1885	1311	346	0.09	0.13	0.50
90	1080	1303	3518	2842	1653	2214	1539	350	0.08	0.11	0.49
96.5	1134	1421	3712	3013	1745	2291	1592	324	0.03	0.05	0.24
					TOTAL ACCELERATING TIMES (Sec.):				0.81	1.10	2.94



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ALL DATA ON THIS PAGE ARE CALCULATED AND NOT GUARANTEED

ALL DATA ON THIS PAGE ARE CALCULATED AND NOT GUARANTEED

(*) TOTAL INERTIA REFERRED TO THE MOTOR SHAFT, USED IN THE CALCULATION ABOVE, IS ALL LB-FT**2.

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	57 OF 62

ORIGINATOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE	PROJECT NO.
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations	
	DWG NO. / REV

[illegible] [illegible] [illegible] [illegible] [illegible] DATE-[illegible] [illegible] PAGE 5 [illegible]

LINE VOLTS = [illegible]

ALL DATA ON THIS PAGE ARE CALCULATED AND NOT GUARANTEED

SLIP	RPM	[illegible]	P.F.	[illegible]	[illegible]	INPUT	LOSSES	LINE AMP	[illegible]	ISEC(I)	ISEC(T)
100.00	0.	0.0	20.1	0.0	1641.06	422275.	422275.	2114.313	0.0	0.0	0.0
95.00	60.	3.3	29.6	16.90	1661.16	424276.	416264.	2102.473	4.01	0.07	0.072
90.00	120.	6.3	29.7	30.43	1680.37	424323.	397794.	2089.331	16.05	0.07	0.144
85.00	180.	10.2	30.3	50.44	1703.64	420133.	363677.	2075.625	36.11	0.07	0.216
80.00	240.	13.7	30.5	75.06	1730.30	416427.	332004.	2066.593	64.19	0.072	0.287
75.00	300.	17.3	30.8	99.74	1756.39	[illegible]	[illegible]	2054.152	100.29	0.072	0.360
70.00	360.	20.9	31.2	120.67	1780.39	[illegible]	346223.	2012.232	144.42	0.07	0.433
65.00	420.	25.7	31.6	142.16	1777.90	427062.	322947.	1985.565	196.58	0.07	0.507
60.00	480.	30.5	32.0	165.47	1795.56	436232.	307727.	1957.668	256.75	0.07	0.584
55.00	540.	34.3	32.6	187.73	1826.18	431489.	291316.	1924.605	324.95	0.07	0.662
50.00	600.	38.5	33.8	212.36	1836.01	433314.	273296.	1897.952	401.18	0.081	0.741
45.00	660.	40.5	33.2	238.48	1833.90	420632.	256756.	1874.111	483.42	0.08	0.828
40.00	720.	44.7	34.3	259.03	[illegible]	433128.	239056.	1836.848	577.69	0.09	0.918
35.00	780.	47.3	33.6	286.61	1956.07	[illegible]	222607.	1795.931	673.96	0.092	1.010
30.00	840.	51.2	37.4	326.32	2052.33	451606.	200041.	1754.120	786.31	0.094	1.104
25.00	900.	55.3	39.6	372.36	2172.73	467196.	189591.	1710.781	902.63	0.09	1.198
20.00	960.	60.1	43.1	423.36	2329.63	[illegible]	178942.	1665.912	1027.01	0.093	1.291
15.00	1020.	71.3	48.1	494.01	2351.68	516936.	148989.	1566.361	1139.48	0.097	1.388
10.00	1080.	76.3	56.3	584.19	2651.09	536781.	121061.	1442.182	1249.81	0.073	1.461
9.50	1086.	75.1	57.4	599.13	2675.21	[illegible]	117570.	1424.211	1314.90	0.008	1.469
9.00	1092.	79.8	58.6	663.81	2901.92	[illegible]	113971.	1409.678	1328.86	0.008	1.477
8.50	1098.	80.3	59.3	618.36	2913.51	[illegible]	110600.	1392.068	1342.50	0.008	1.485
8.00	1104.	81.6	61.1	622.21	2995.92	[illegible]	106100.	1366.671	1356.22	0.008	1.492
7.50	1110.	82.4	63.6	632.19	2993.92	[illegible]	100961.	1335.966	1373.03	0.007	1.499
7.00	1116.	83.3	65.1	641.60	3019.31	[illegible]	96021.	1281.115	1387.91	0.007	1.507
6.50	1122.	85.3	67.2	646.05	3003.17	[illegible]	90300.	1244.375	1402.78	0.007	1.514
6.00	1128.	85.3	69.4	631.38	3032.75	[illegible]	85161.	1196.514	1417.92	0.007	1.521
5.50	1134.	86.3	71.6	630.64	3063.34	[illegible]	77522.	1153.009	1433.85	0.007	1.529
5.00	1140.	87.3	74.2	644.77	2970.35	[illegible]	70044.	1082.165	1448.23	0.007	1.536
4.50	1146.	88.3	76.1	632.41	2896.31	[illegible]	62766.	1016.677	1463.33	0.008	1.543
4.00	1152.	89.3	79.1	611.34	2787.30	[illegible]	55612.	951.833	1478.90	0.009	1.553
3.50	1158.	90.3	81.8	565.88	2646.90	[illegible]	47877.	846.341	1494.34	0.010	1.563
3.00	1164.	91.3	84.4	555.56	2457.80	[illegible]	39762.	785.156	1509.87	0.011	1.574
2.50	1170.	92.3	86.7	491.16	2209.6	[illegible]	30610.	667.628	1525.43	0.015	1.589
2.00	1176.	93.2	88.7	422.46	1900.8	338120.	23890.	551.855	1541.16	0.028	1.617
1.57	1181.	93.9	89.0	359.61	1559.6	277962.	16934.	450.831	1556.41	0.055	1.672

THE TOTAL INERTIA (REFERRED TO THE MOTOR SHAFT) USED IN THE CALCULATION ABOVE, IS 613 LB-FT**2.

Motor Data

PLANT: Indian Point Unit Nos. 2 and 3

COMPONENT: Recirculation Pumps

MOTOR MANUFACTURER: Westinghouse Large Motor Division, Buffalo, New York

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F63897-1S through 4S-67

MOTOR H.P. RATING: 350 @ 1181 RPM MOTOR FRAME SIZE: 588.5

MOTOR WRR = 313 LB-FT^2

LINE VOLTAGE: 440 (100%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	2067.47
95.00	60	2092.84
90.00	120	2120.03
85.00	180	2149.27
80.00	240	2180.79
75.00	300	2201.22
70.00	360	2219.39
65.00	420	2242.09
60.00	480	2270.12
55.00	540	2304.55
50.00	600	2346.76
45.00	660	2315.83
40.00	720	2386.40
35.00	780	2473.89
30.00	840	2583.64
25.00	900	2723.22
20.00	960	2903.66
15.00	1020	3157.02
10.00	1080	3517.62
9.50	1086	3555.48
9.00	1092	3592.23
8.50	1098	3610.73
8.00	1104	3658.74
7.50	1110	3698.61
7.00	1116	3727.61
6.50	1122	3742.37
6.00	1128	3738.79
5.50	1134	3711.89
5.00	1140	3655.77
4.50	1146	3563.58
4.00	1152	3427.60
3.50	1158	3239.44
3.00	1164	2999.32
2.50	1170	2690.21
2.00	1176	2301.36
1.50	1182	1828.88
1.24	1185	1551.96

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F63B97-1S through 4S-67

LINE VOLTAGE: 396 (90%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	1641.06
95.00	60	1661.10
90.00	120	1682.57
85.00	180	1705.64
80.00	240	1730.50
75.00	300	1746.39
70.00	360	1760.39
65.00	420	1777.90
60.00	480	1799.56
55.00	540	1826.18
50.00	600	1858.81
45.00	660	1833.98
40.00	720	1889.42
35.00	780	1958.07
30.00	840	2052.72
25.00	900	2172.75
20.00	960	2329.63
15.00	1020	2543.60
10.00	1080	2841.80
9.50	1086	2873.27
9.00	1092	2903.95
8.50	1098	2919.51
8.00	1104	2959.92
7.50	1110	2993.92
7.00	1116	3019.31
6.50	1122	3033.37
6.00	1128	3032.74
5.50	1134	3013.36
5.00	1140	2970.39
4.50	1146	2898.20
4.00	1152	2787.94
3.50	1158	2648.96
3.00	1164	2457.08
2.50	1170	2204.67
2.00	1176	1886.65
1.57	1181	1554.41

MOTOR DATA
(CONTINUED)

MOTOR SHOP ORDER NUMBER AND/OR SERIAL NUMBER: 67F63897-1S through 4S-67

LINE VOLTAGE: 352 (80%)

SLIP (PERCENT)	MOTOR SPEED (RPM)	MOTOR TORQUE (LB-FT)
100.00	0	1251.88
95.00	60	1267.00
90.00	120	1283.17
85.00	180	1300.53
80.00	240	1319.20
75.00	300	1334.37
70.00	360	1347.47
65.00	420	1363.50
60.00	480	1382.99
55.00	540	1406.67
50.00	600	1435.47
45.00	660	1418.71
40.00	720	1465.87
35.00	780	1524.39
30.00	840	1598.10
25.00	900	1692.65
20.00	960	1816.42
15.00	1020	1980.35
10.00	1080	2224.10
9.50	1086	2249.33
9.00	1092	2274.00
8.50	1098	2286.60
8.00	1104	2319.32
7.50	1110	2347.15
7.00	1116	2368.35
6.50	1122	2380.79
6.00	1128	2381.83
5.50	1134	2368.27
5.00	1140	2336.26
4.50	1146	2285.30
4.00	1152	2210.77
3.50	1158	2100.80
3.00	1164	1948.84
2.50	1170	1748.80
2.12	1175	1563.01

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
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PREPARER/DATE: Thoms J. Magee 9/18/91

REVIEWER/DATE: Bruce Horowitz 9/20/91

CLASS: 1E

SUBJECT/TITLE: Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations

PROJECT NO.:

DWG NO.: N/A

CABLE VOLTAGE DROP AND MINIMUM BUS VOLTAGE SUMMARY

MOTOR DESCRIPTION	LOCKED ROTOR CURRENT(A)	LOCKED ROTOR CURRENT AT MIN. VOLTAGE (A)	STARTING POWER FACTOR	MOTOR RATED VOLTAGE(V)	MIN. % STARTING VOLTAGE	CABLE RESISTANCE (Ohms)	CABLE REACTANCE (Ohms)	L-L VOLTAGE DROP(V)	MIN. MOTOR TERMINAL STARTING V.	MINIMUM VOLTAGE AT BUS (V)
CONTAINMENT SPRAY PUMP (21)	2487	1691	29.7%	460	68.0%	0.0053	0.0069	24.0	313	337
CONTAINMENT SPRAY PUMP (22)	2487	1691	29.7%	460	68.0%	0.0056	0.0073	25.4	313	338
SAFETY INJECTION PUMP (21)	2530	1973	23.0%	440	78.0%	0.0043	0.0056	22.1	343	365
SAFETY INJECTION PUMP (22)	2530	1973	23.0%	440	78.0%	0.0046	0.0061	24.1	343	367
SAFETY INJECTION PUMP (23)	2530	1973	23.0%	440	78.0%	0.0042	0.0055	21.7	343	365
CONTAINMENT RECIRCULATION FAN (21)	2425	1727	32.8%	440	71.2%	0.0115	0.0191	40.5	313	354
CONTAINMENT RECIRCULATION FAN (22)	2425	1727	32.8%	440	71.2%	0.0122	0.0106	42.7	313	356
CONTAINMENT RECIRCULATION FAN (23)	2425	1727	32.8%	440	71.2%	0.0135	0.0113	46.2	313	359
CONTAINMENT RECIRCULATION FAN (24)	2425	1727	32.8%	440	71.2%	0.0146	0.0117	48.6	313	362
CONTAINMENT RECIRCULATION FAN (25)	2425	1727	32.8%	440	71.2%	0.0176	0.0132	56.4	313	370
LO HEAD SI RECIRCULATION PUMP (21)	2425	1722	32.8%	440	71.0%	0.0134	0.0112	45.7	312	358
LO HEAD SI RECIRCULATION PUMP (22)	2425	172	32.8%	440	71.0%	0.0152	0.0110	44.9	312	357
SERVICE WATER PUMP (22)	2560	1879	26.0%	440	73.4%	0.008	0.0084	33.6	323	357
SERVICE WATER PUMP (23)	2560	1879	26.0%	440	73.4%	0.0083	0.0087	34.9	323	358
SERVICE WATER PUMP (24)	2560	1879	26.0%	440	73.4%	0.0089	0.0094	37.6	323	361
SERVICE WATER PUMP (26)	2560	1879	26.0%	440	73.4%	0.0089	0.0094	37.6	323	361
AUXILIARY FEEDWATER PUMP (21)	2534	2129	27.9%	440	84.0%	0.00428	0.00643	27.3	370	397
AUXILIARY FEEDWATER PUMP (23)	2534	2129	27.9%	440	84.0%	0.00484	0.00586	25.0	370	395
COMPONENT COOLING PUMP (21)	1407	1130	28.2%	460	80.3%	0.00765	0.01551	33.4	369	403
COMPONENT COOLING PUMP (22)	1407	1130	28.2%	460	80.3%	0.01275	0.0205	45.7	369	415
COMPONENT COOLING PUMP (23)	1407	1130	28.2%	460	80.3%	0.00935	0.01965	42.1	369	411
RESIDUAL HEAT REMOVAL PUMP (21)	2889	2089	29.7%	460	72.3%	0.0056	0.0076	32.4	333	365
RESIDUAL HEAT REMOVAL PUMP (22)	2889	2089	29.7%	460	72.3%	0.005	0.0069	29.3	333	362

CON EDISON CALCULATION/ANALYSIS SHEET

CALCULATION NO.	REVISION	PAGE
EGE-00001	0	62 OF 62

AUTHOR/DATE	REVIEWER/DATE	CLASS
Thomas J. Magee 9/18/91	Bruce Horowitz 9/26/91	1E

SUBJECT/TITLE	PROJECT NO.
Class 1E Motor Minimum Starting Voltage and Acceleration Time Calculations	
	MOD NO. REV

MINIMUM MOTOR TERMINAL & BUS VOLTAGE AND ACCELERATION TIME AT 100%, 90%, & MIN.% VOLTAGE

MOTOR	MINIMUM VOLTAGE REQUIRED FOR STARTING		ACCELERATION	ACCELERATION	ACCELERATION
DESCRIPTION	AT MOTOR (Volts)	AT BUS (Volts)	TIME (Sec.) MIN.% V	TIME (Sec.) 100%V	TIME (Sec.) 90%V
CONTAINMENT SPRAY PUMP (21)	313	337	2.75	0.58	0.80
CONTAINMENT SPRAY PUMP (22)	313	338	2.75	0.58	0.80
SAFETY INJECTION PUMP (21)	343	365	4.21	1.33	1.96
SAFETY INJECTION PUMP (22)	343	367	4.21	1.33	1.96
SAFETY INJECTION PUMP (23)	343	365	4.21	1.33	1.96
CONTAINMENT RECIRCULATION FAN (21)	313	354	16.96	5.10	6.87
CONTAINMENT RECIRCULATION FAN (22)	313	356	16.96	5.10	6.87
CONTAINMENT RECIRCULATION FAN (23)	313	359	16.96	5.10	6.87
CONTAINMENT RECIRCULATION FAN (24)	313	362	16.96	5.10	6.87
CONTAINMENT RECIRCULATION FAN (25)	313	370	16.96	5.10	6.87
LO HEAD SI RECIRCULATION PUMP (21)	312	358	2.94	0.81	1.10
LO HEAD SI RECIRCULATION PUMP (22)	312	357	2.94	0.81	1.10
SERVICE WATER PUMP (22)	323	357	2.01	0.50	0.70
SERVICE WATER PUMP (23)	323	358	2.01	0.50	0.70
SERVICE WATER PUMP (24)	323	361	2.01	0.50	0.70
SERVICE WATER PUMP (26)	323	361	2.01	0.50	0.70
AUXILIARY FEEDWATER PUMP (21)	370	397	4.88	1.96	3.08
AUXILIARY FEEDWATER PUMP (23)	370	395	4.88	1.96	3.08
COMPONENT COOLING PUMP (21)	369	403	3.77	1.14	1.80
COMPONENT COOLING PUMP (22)	369	415	3.77	1.14	1.80
COMPONENT COOLING PUMP (23)	369	411	3.77	1.14	1.80
RESIDUAL HEAT REMOVAL PUMP (21)	333	365	1.91	0.55	0.73
RESIDUAL HEAT REMOVAL PUMP (22)	333	362	1.91	0.55	0.73

Attachment 2