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MOTOR LOAD STUDY 190-C-PROCESS PUMP DRIVE

AUTHOR

E. J. O'Black

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This document consists of
19 pages, No. 2 of
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January 6, 1955

To: E. E. Weyerts, Superintendent, Maintenance Sub-Section

From: E. J. O'Black, Superintendent, Maintenance Unit 100-B-C

MOTOR LOAD STUDY
190-C PROCESS PUMP DRIVE

CLASSIFICATION CANCELLED AND CHANGED TO

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BY AUTHORITY OF DS LEWIS

8-17-92, CG-M-2

BY TR BURNS 9-15-92

VERIFIED BY J. E. Savely 9-15-92

INTRODUCTION

During the summer months of 1954, the spare 190-C process pump unit was required to be placed in service for extended periods of time due to the motor winding temperatures exceeding the manufacturers recommended maximum operating limits. With nine unit operation each pump was required to supply approximately 9800 gpm to maintain the established power level of the 105-C Reactor.

An operating condition requiring all process pump units to be in service simultaneously is not desirable. Such a condition not only subjects the Reactor Unit to a possible unscheduled outage should trouble develop in any component of a pump assembly but in all probability would delay a startup of the Reactor Unit until arrangements could be completed to operate at reduced pressure in order to eliminate sustained overheating of the pump drive motors.

PURPOSE

The purpose of this report is to summarize the activities undertaken during this investigation in order to arrive at satisfactory conclusions and recommendations for eliminating the overheating of the related motor windings under present and proposed operating conditions.

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GROUP 1

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To: E. E. Weyerts

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I. Present Facilities and to What Extent They are Inadequate

As a result of a progressive increase in the cooling water requirements for the 105-C Reactor Unit during the past two years the original 190-C spare pumping facilities have been absorbed. With the present requirements for cooling water, the motor winding temperatures are exceeding the manufacturers maximum temperature limits during the summer months. Unless corrective measures are taken to eliminate the motor overloads and resultant high winding temperatures during the summer months it is doubtful that the 190-C pumping facilities will be capable of providing an adequate supply of cooling water to the 105-C Reactor to maintain the present Power Level. Since all ten pump units must be in service during extended periods throughout the summer months to eliminate winding temperatures exceeding the manufacturers recommended limits, an undesirable operating condition is encountered. That is, should trouble develop on any one unit during such time there will not be a spare facility available. This in turn would be reflected in terms of additional Reactor "Down-Time." Since such a condition exists under present operating conditions, it is expected that comparable conditions will be experienced following the "Reactor Plant Modifications For Increased Production - Project CG-600".

Under present and proposed pumping requirements it is necessary that each pump motor in operation does not exceed safe winding temperatures during all seasons of the year. This situation must exist with one pump unit being available as a spare to efficiently handle emergency and scheduled equipment repairs.

II. Description of Proposed Facilities

In the future the purpose of the proposed modifications of the 105-C Reactor Plant is to increase the Unit water capacity and to make associated equipment changes. To accomplish this modification requires that increased water flow under reduced pressure be supplied from the existing 190-C pumping facilities. With past operating conditions indicating that the capacity of the present facilities have been exceeded under various operating conditions it becomes apparent that additional pumping capacity must either be reclaimed or installed.

III. History

During a portion of the period that the 190-C process pump motors were operating in a temperature range exceeding the recommended thermal limits of 100° C on the motor windings the Electric Utility Section installed a graphic voltmeter on the 151-B substation 13.8KV bus. These records of the substation voltage survey extended through the period from July 29, 1954 to August 10, 1954. The following is a summary of the voltage survey at the 151-B Substation.

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<u>Load Condition</u>	<u>Time</u>	13.8KV	(Calculated)
		<u>Bus Volts</u>	<u>230 KV System Volts</u>
Heavy - 46,000 to 48,000 KW	Day (Monday-Saturday)	13.93 = 14.3	233 = 239
	Night (" = ")	13.7 (Avg.)	299.5 (Avg.)
	Day (Sunday)	13.93 (Avg.)	233 (Avg.)
	Night (Sunday)	13.7 (Avg.)	299.5 (Avg.)
	Momentary Low	13.2	221.5
Light - 15,000 to 25,000 KW	Day (Monday-Saturday)	14.17 = 14.52	237 = 243
	Night	14.05 (Avg.)	235.5 (Avg.)
	Momentary Low	13.4	224

The 151-B Substation transformers are rated at 220Kv/Gr=Y 13.8KV and are set on the number 3 tap resulting in a transformer ratio of 16/1 or 16.75/1 when corrected for transformer losses and reactance. There are two additional taps which can be used in event further voltage boost is required after the K plants or facilities for increased water requirements are placed in operation.

The above voltage data indicates that the BPA system voltage is within contractual limits of 10 per cent above and below a base of 220 KV. An additional operating agreement specifies a maximum of 242 KV based on the HIL rating of the transformers and a minimum of 208 KV except during times of system disturbances.

To determine the relationship between the 151-B Substation voltage supply and related effects on the 190-C pump unit assemblies four graphs were compiled. One of these graphs extended through a 24 hour period several days prior to the voltage survey period mentioned previously with the remaining three graphs falling within the survey period. One outstanding feature of the various graphs is that each one represents a different operating condition within the area that in turn reflects in the substation power load. In each instance the No. 1 Pump unit of 190-C building was used as the reference.

Graph No. 1 reflects conditions while "C" Area is shutdown.

Graph No. 2 reflects conditions while "B" Area is shutdown.

Graph No. 3 reflects conditions while "B" and "C" Areas are shutdown.

Graph No. 4 reflects conditions while "B" and "C" Areas are operating.

IV. Effects of Motor Terminal Voltage Variation

A review of graphs No. 1 through 4 reveal that a voltage variation from 13.4 KV to 14.8 KV on the 13.8 KV bus at 151-B Substation was experienced during the survey period.

A similar variation in system voltage was also revealed in the results of the Electric Utility Section data mentioned previously. However, during a longer period of operation the 13.8 KV system voltage drops to a low of 13.1 KV.

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In considering the motor terminal volts while 13.1 KV is applied at the 151-B substation approximately 4.07 KV becomes available at the motor. Since each process pump motor is served by means of an individual transformer, provisions are available for varying the motor terminal volts by means of transformer taps. At the present time the transformer tap for Units 1-5 and 8-11 are set on tap D, while the No. 12 Unit transformer tap is set on tap E. In case of the "D" tap setting a 2½% increase in voltage is obtained while a 5% increase in voltage is obtained with the E tap in service. During periods whenever the "C" area facilities are shutdown, a high voltage at the 151-B substation bus is experienced. With the individual process pump motor transformer tap set in the "E" position during a shutdown period of the 105-C facilities and the 151-B substation voltage of 14.8 KV or higher the motor terminal voltage would exceed the permissible safe range of 10% over rated voltage. However, if the transformer is set on the "D" tap it is not likely that the system voltage would rise enough to cause the motor terminal voltage to exceed the 10 % limitation above rated voltage.

In comparing winding temperatures between No. 11 and No. 12 pump motors, it was noted that for a given load only a 1-2°C drop in winding temperature was experienced with the No. 12 motor which was served by the transformer with the "E" tap setting. The corresponding motor air temperature of No. 12 Unit was found to be approximately 5°C lower than that of the No. 11 motor.

V. Thermal Effects of Cooling Facilities

In an effort to determine the feasibility of improving the thermal characteristics of the 190-C Process Pump motors several tests involving change of air flow, change of water flow rates through the motor cooling coil and operating the motor in an atmosphere of helium gas were conducted. As a matter of record these tests will be listed in a chronological order.

Test No. 1 - Air Flow No. 12 Unit October 1, 1954

This test was conducted while the motor was operating under a 400 ampere load, which is slightly below the rated full load motor current. Prior to starting this test the temperature detectors imbedded in the motor stator indicated a low of 80° C and a high of 85° C. During this test the inspection plates located near the top of each end section of the motor housing were removed. When this occurred a one degree C drop in winding temperature was noted at the end of a fifteen minute period. Results were recorded one hour later that since then have not been duplicated. At this time, the data indicated a low of 73° C and high of 78° with a continuing drop 30 minutes later to a low of 71° C and a high of 75° C. When the plates were replaced the temperature detectors indicated that the winding temperatures were restored in a matter of minutes to within 1 to 2 degrees C of the original winding temperatures prior to the test. The only logical explanation at this time is that the calibration knob was inadvertently touched during the process of operating the temperature detector selector switches. For final data under similar conditions, refer to test No. 4.

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Test No. 2 Water Flow, Air Flow, and Atmosphere Change, Unit No. 12, October 12, 1954

- 2a. Starting from a normal operating condition with the motor loaded to 380 amperes a Helium gas was injected into the motor housing. The gas pressure was increased to a maximum of 15 pounds with one tank being expended within a one hour period. In this instance a decrease in the motor winding temperatures of 2 to 3 °C were experienced.
- 2b. Continuing with the No. 12 Unit with a 380 ampere load another test was conducted that involved reducing the cooling water flow from 220 gpm to 65 gpm. An increase in winding temperatures of 4 to 6 °C were noted in this instance in less than a three hour period. These increases in winding temperatures provided a low of 81° C and a high of 85° C by the temperature detector. With the cooling water flow increased to 120 gpm the winding temperatures dropped to a low of 78° C and a high of 82° C.
- 2c. Starting from an operating condition with the motor loaded to 390 amperes and 120 gpm water flow through the motor cooling coil the temperature indicator of the motor winding indicated a low of 78° C and a high of 82° C. With the removal of one inspection plate the temperature detector indicated a low of 77° C and a high of 80° C. With the removal of the remaining end inspection plate no appreciable change was noted. However, when the water flow through the cooling coil was increased to 220 gpm the temperature detectors indicated a low of 75° C and a high of 79° C.

When the motor cooling water flow was increased from 120 gpm to 220 gpm an overall 3° C improvement from the start of this test was obtained.

Test No. 3 Air Flow and Water Flow - No. 11 Unit October 14, 1954

This test was conducted with a normal water flow rate of more than 65 gpm passing through the motor air cooler and the motor loaded to 380 amperes at the start of the test. In this instance the winding temperature detectors indicated a low of 75° C and a high of 78° C. After the inspection plates were removed from each end of the motor housing a drop of only 1 to 2 degrees C. was experienced. The temperature of the air in the motor housing dropped only 2° C.

To compare results between motors a similar test was performed on No. 5 Unit. In this instance similar results were experienced.

Test No. 4 Air Flow No. 12 Unit October 19, 1954

To clarify conditions as reported in Test No. 1 the No. 12 Unit was over-loaded to 420 amperes with a normal flow of 220 gpm through the motor cooling coil. The temperature detectors indicated a low of 86° C and a high of 91° C prior to the start of the test. Following the removal of the end inspection plates the detectors indicated a low of 84° C and a high of 87° C for a 2 to 3° C. drop in winding temperature.

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Test No. 5 Increased Pump Flows Nine Units October 19, 1954

This test summarizes the data obtained with nine pump units in service. In this instance the remaining pump unit was out of operation due to emergency repairs being completed to the turbine assembly.

With an average pump output varying between 9200-9600 gpm the various motor currents were found to vary between 390-450 amperes. The results of each motor indicated that whenever the motor was operating within the range mentioned above the winding temperatures for six out of nine motors were found to average 90° C or above.

TEST SUMMARY

Test No.	Type	Pump No.	Date	Remarks
1	Air Flow	12	10-1-54	Voided
2a.	Helium Atmosphere	12	10-12-54	1°C improvement at 5#
2b.	Water Flow to Cooler	12	10-12-54	2-3°C improvement at 1#
	Water Flow to Cooler	12	10-12-54	4-6°C temp. rise with cooling water reduced from 220 to 65 gpm.
				3°C temp. rise experienced with cooling water reduced from 220 to 120 gpm.
2c.	Air Flow	12	10-13-54	1 to 2°C drop in temp. with one inspection plate removed and 120 gpm cooler flow.
	Air Flow	12	10-13-54	No change with second inspection removed.
	Water Flow to Cooler	12	10-13-54	Additional 1°C drop with cooler flow increased from 120 to 220 gpm.
3	Air Flow	11	10-14-54	1-2°C drop with inspection plates removed and greater than 65 gpm cooler flow.
4	Air Flow	12	10-19-54	2-3°C drop with inspection plates removed and 220 gpm cooler flow.
5	Nine Unit Operation	-	10-19-54	Six motors averaged winding temperatures of 90°C or above.

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CONCLUSION

1. Removal of one inspection plate reduces the temperature on a motor winding 2-3° C. Removal of the second inspection plate does not result in additional gains. Significant benefits cannot be realized through this method.
2. Tests made with adding helium to the motor atmosphere reduces the winding temperature 1° C at 5 pounds pressure and 2-3° C at 15 pounds pressure. Leakage is too great to be worth while.
3. An increase in cooling water flow from 120 to 220 gpm resulted in a temperature decrease of the motor windings by 1° C. The exchange of rotometers on units 1-4 and 8-11 for increased capacity meters would not result in significant benefits.
4. The motors are sensitive to voltage swings and this condition becomes aggravated during the times the motors are subjected to overloads.
5. During the summer months when nine process pump units are in operation the resultant overload coupled with the high ambient temperature result in the motor air temperature exceeding the 40° C rise up to a maximum of 4° C.
6. Motor manufacturers summarizes this motor application in the following manner:
 - a. Operating at 100° C as measured by temperature detector is not in violation of NEMA minimum requirements, but is inconsistent with practices of all other industries that operate motors continuously.
 - b. To insure reasonable insulation life for such service the temperature should be limited to 90° C or less as measured by temperature detector.
7. Since a motor that operates continuously is subjected to three times the service of the ordinary motor which runs 8 hours per day or less and the insulation life is doubled by each 8-10° C reduction in operating temperature it is recommended that an additional pump assembly be provided at 190-C to eliminate the present marginal condition existing at the 190-C Building during the summer months.

E. J. O'Black
E. J. O'Black
Superintendent 100-B-C
MAINTENANCE UNIT

EJO'B:dlt

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No. 12 UNIT

190-C-PROCESS PUMP MOTOR DATA

Date 10-1-1954

Time	Volts	Amps	Amps. Inlet Temp.	Outlet Temp.	Flow	Air Out Plate Therm.	Temperature Detectors						Remarks
							1	2	3	4	5	6	
9:05	13.6	400	72°	15°	18°	44°	84	80	81	82	85	85	Normal Condition
9:20	13.6	400	72°	15°	18°	44°	84	80	81	82	85	85	Normal Condition
9:35	13.6	400	72°	15°	18°	43°	83	79	80	81	83	84	Plates Removed
9:50	13.6	400	72°	15°	18°	43°	83	79	79	81	83	83	Plates Removed
10:05	13.6	400	72°	15°	18°	43°	83	78	79	81	83	83	Noticable Drop
10:20	13.6	400	72°	15°	16°	43°	83	79	79	81	83	83	45 min. to 1 hr.
10:35	13.6	400	72°	15°	18°	43°	82	78	78	73	74	74	after removal of
10:50	13.6	400	72°	15°	18°	43°	73	72	72	73	74	75	Plates.
11:05	13.6	400	72°	15°	18°	43°	73	71	72	73	75	75	
11:20	13.6	400	72°	15°	18°	44°	82	78	78	80	83	83	Plates replaced
11:35	13.6	400	72°	15°	18°	44°	81	77	78	79	83	83	immediate rise in
11:50	13.6	400	72°	15°	18°	44°	81	78	78	79	83	83	temperature to
12:05	13.6	400	73°	15°	18°	44°	81	77	78	79	83	83	within 1-2° of original condition

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190-C-PROCESS PUMP MOTOR DATA

Test No. 3
Date 10-14-54

Motor No. 11

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Time	Volts	Amps	Amps. Temp.	Water Inlet Temp.	Water Outlet Temp.	Air Inlet Temp.	Air Outlet Temp.	Air Flow Out	Air Flow Out	Temperature Detectors						Remarks
										1	2	3	4	5	6	
10-14-54																
9:15	13.9	360	72			107.5	240			76	75	76	77	78	78	Normal
9:50	13.9	360	72			106	1580	1740	1940	76	75	76	77	78	78	Both inspection plates removed
10:00	13.8	365	73			105.5	1580	1740	1940	75	74	76	77	78	78	
10:30	13.8	365	73			105.5	1580	1740	1940	75	74	76	77	78	78	
11:00	13.8	365	73			105.5	1580	1740	1940	74	74	75	76	77	77	Plates replaced, unit restored to normal.

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Test No. 3
Date 10-14-54

190-C-PROCESS PUMP MOTOR DATA

Motor No. 5

Time	Volts	Amps.	Amps. Temp.	Water Inlet Temp.	Water Outlet Temp.	Air Inlet Temp.	Air Outlet Temp.	Air Flow In	Air Flow Out (east)	Air Flow Out (west)	Temperature Detectors						Remarks
											1	2	3	4	5	6	
10-14-54																	
1:15	14.1	385	75			109		280			82	80	82	83	80	78	Normal
1:30	14.1	385	75			107.5		1750	1990	2420	81	80	81	82	80	76	Both plates removed
2:00	14.1	385	75			106		1750	1990	2420	80	79	80	81	79	77	
2:45	14.1	385	75			106		1750	1990	2420	80	79	80	81	79	77	
3:15	14.1	385	75			106		1750	1990	2420	80	79	80	81	79	77	Plates replaced, unit restored to normal.

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190-C-PROCESS PUMP MOTOR DATA

Date 10-19-1954

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Test No. 5

Page 1

Time	Unit No. 1				Unit No. 2				Unit No. 3				Unit No. 4				Unit No. 5				Voltage	
	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Buss No. 1	Buss No. 2
3 pm	94 ⁰	86 ³	485	410 9400	89 ⁵	86 ³	490	420 9400	93 ¹	96 ⁶	495	410 9400	89 ⁵	79 ⁴	485	400 9200	93 ⁴	89 ⁶	485	420 9600	14.1	14.0
4 pm	91 ⁵	86 ³	485	400 9400	89 ⁵	87 ³	490	420 9400	92 ⁶	88 ¹	495	420 9400	88 ⁶	78 ⁴	485	400 9200	94 ⁴	88 ⁶	485	410 9600	14.1	14.0
5 pm	94 ⁶	87 ³	485	400 9400	90 ⁵	87 ²	490	420 9400	94 ¹	89 ⁵	495	420 9400	89 ⁶	79 ⁶	485	400 9200	94 ⁴	89 ⁶	485	430 9600	14.0	14.0
6 pm	96 ⁶	89 ⁴	485	430 9400	92 ⁶	89 ²	490	440 9400	96 ¹	92 ⁵	495	430 9400	91 ⁶	81 ⁴	485	410 9200	96 ⁴	91 ⁶	485	440 9600	13.9	13.7
7 pm	95 ⁶	88 ³	485	430 9400	90 ⁵	88 ²	490	440 9400	95 ¹	90 ⁵	495	430 9400	90 ⁶	80 ⁶	485	410 9200	95 ⁴	90 ⁶	485	440 9600	14.0	14.0
8 pm	94 ⁶	86 ³	485	430 9400	90 ⁵	87 ²	490	440 9400	94 ¹	90 ⁵	495	420 9400	89 ⁶	79 ⁶	485	400 9200	94 ⁴	89 ⁶	485	420 9600	14.0	14.0
9 pm	95 ⁶	86 ³	485	420 9400	89 ⁵	87 ²	490	420 9400	94 ¹	96 ⁶	495	420 9400	89 ⁶	79 ⁶	485	400 9200	94 ⁴	89 ⁶	485	430 9600	14.0	14.0
10 pm	96 ⁶	89 ³	485	420 9400	91 ⁵	89 ²	490	430 9400	96 ¹	92 ⁴	495	430 9400	91 ⁶	80 ⁶	485	410 9200	96 ⁴	91 ⁶	485	440 9600	13.9	13.7
11 pm	96 ⁶	89 ³	485	410 9400	91 ⁵	89 ²	490	420 9400	96 ¹	91 ⁴	495	430 9400	90 ⁶	80 ⁴	485	410 9200	96 ⁴	91 ⁶	485	440 9600	13.9	13.9
12 mid	100 ⁶	93 ³	490	430 9400	96 ⁵	93 ²	490	450 9400	100 ¹	96 ⁴	495	450 9400	95 ⁶	85 ⁴	485	420 9200	100 ⁴	95 ⁶	485	450 9600	13.4	13.3
Time	Unit No. 8				Unit No. 9				Unit No. 10				Unit No. 11				Unit No. 12				Voltage	
	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Hi Pole Temp.	Low Pole Temp.	Disc. Pres. Amps.	Flow T. Temp.	Buss No. 1	Buss No. 2
3 pm	93 ⁵	85 ⁶	470	400 9400	90 ¹	76 ⁴	470	410 9400	88 ¹	85 ³	470	400 9400	85 ⁵	80 ²	470	400 9500					14.1	
4 pm	93 ⁵	84 ¹	470	400 9400	91 ²	88 ⁴	470	420 9400	88 ¹	85 ²	470	400 9400	85 ⁵	81 ²	470	390 9500					14.1	
5 pm	93 ⁵	85 ¹	470	400 9400	87 ¹	85 ⁴	470	420 9400	89 ¹	86 ²	470	400 9400	86 ⁵	82 ²	470	390 9500					14.0	
6 pm	96 ²	87 ¹	470	400 9400	90 ²	86 ⁶	470	420 9400	91 ¹	88 ³	470	410 9400	87 ⁵	84 ²	470	410 9600					13.9	
7 pm	94 ⁵	84 ⁶	470	400 9400	87 ¹	85 ⁴	470	420 9400	90 ¹	87 ³	470	410 9400	86 ⁵	82 ²	470	410 9600					14.0	
8 pm	93 ³	84 ⁵	470	400 9400	88 ²	85 ⁴	470	410 9400	90 ¹	87 ²	470	410 9400	85 ⁵	81 ²	470	400 9600					14.0	
9 pm	93 ⁵	85 ¹	470	400 9400	88 ²	85 ⁴	470	410 9400	90 ¹	86 ³	470	410 9400	86 ⁵	81 ²	470	400 9600					14.1	
10 pm	96 ⁵	86 ¹	470	410 9400	90 ²	86 ⁴	470	410 9400	92 ¹	89 ³	470	410 9400	87 ⁵	84 ²	470	410 9600					13.8	
11 pm	95 ⁴	86 ¹	470	410 9400	89 ²	86 ⁴	470	400 9400	91 ¹	89 ³	470	400 9600	87 ⁵	83 ²	470	410 9600					13.9	
12 mid	99 ⁵	89 ¹	470	420 9400	93 ²	89 ⁴	470	420 9400	96 ¹	93 ³	465	430 9650	90 ⁶	86 ²	470	420 9600					13.4	

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75°C
ambient
assumed

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190-C-PROCESS PUMP MOTOR DATA

Test No. 4
Date 10-19-54

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Time	Volts	Amps.	Amps. Temp.	Water Inlet Temp.	Water Outlet Temp.	Air Outlet Temp.	Air Inlet Temp.	Air Flow In	Air Flow Out	Water Flow G.P.M.	Temperature Detectors						Remarks
											1	2	3	4	5	6	
10-19-54																	
10:30	14.	420	74	14	17	46	109½			WideOp.	88	86	87	88	91	91	Plates on.
10:45		420	74	14	17	46	106			Wide Op.	90	86	88	88	90	91	Plates removed 10:40
11:00		420	74	14	17	45	107½			WideOp.	89	66	86	88	91	91	
11:15		420	74	14	17	45	107			WideOp.	88	65	85	88	90	90	
11:30	14.	420	74	14	17	45	107			WideOp.	88	65	86	88	90	90	
11:45		420	74	14	17	45	107			WideOp.	88	85	86	88	89	89	
12:00	14.	415	75	14	17	45	107			WideOp.	88	84	85	86	89	89	
1:00		420	75	14	17	45	107			WideOp.	88	84	85	87	89	89	
1:15		420	75	14	17	45	107			WideOp.	88	84	85	87	89	89	
1:30		420	76	14	17	45	107			WideOp.	88	84	85	87	89	89	
1:45	14.1	420	76	14	17	45	107			WideOp.	88	84	85	87	89	89	
2:00		415	76	14	17	45	107			WideOp.	88	84	85	87	89	89	

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190-C-PROCESS P.U.P. MOTOR DATA

HM-34351

1-10 units during
dates indicated.

No. App.	MOTOR WINDING TEMPERATURE BY DETECTORS										Cooling Coil Temp.		151-B Substation		Setting	Divider	Volt	Date	Time	151-B Line App.
	1	2	3	4	5	6	7	8	9	10	In Let	Out Let	Voltage	Reading	P.F.					
1	400	90 90	86	89	91	93							13.7	2.7	8.8mv	D		6-9	10:00	120
	420	92 90	88	90	93	95							13.6	2.7	8.8mv	D		6-10	10:00	125
2	405	90 86	85	87	89.5	89							13.7	2.7	8.8mv	D		8-9	10:00	120
	420	90 90	90	90	92	91							13.6	2.7	8.8mv	D		6-10	10:00	125
3	405	92 89	89	89	88	90							13.7	2.7	8.8mv	D		6-9	10:00	125
	415	94 90	90	90	90	93							13.6	2.7	8.8mv	D		6-10	10:00	125
4	405	92 90	90	83	84	93							13.7	2.6	85	D		6-9	10:00	120
	400	93 91	91	85	86	95							13.6	2.7	86	D		6-10	10:00	125
5	395	85 85	86	87.5	85	83							13.7	2.7	85	D		8-9	10:00	115
	390	87 86	86	89	87	85							13.6	2.7	86	D		6-10	10:00	115
6	390	87 90	91	87	95.5	88							13.6	2.6	91	D		6-9	10:00	115
	385	87 90	91	87	95.5	87							13.7	8.6	91	D		6-10	10:00	120
7	390	83 85	83	81	81	82.5							13.6	2.6	91	D		6-9	10:00	120
	385	85 85	85	83	83	84							13.7	2.6	91	D		8-10	10:00	120
8	390	87 84.5	84	84.5	85.5	85							13.7	2.6	8.8mv	D		6-9	10:00	115
	385	89 86	86	86	87	87							13.6	2.6	8.8mv	D		8-10	10:00	115
9	395	85 84	85	86	88	87							13.7	2.6	8.8mv	D		6-9	10:00	120
	390	85 84	85	87	89	88							13.6	2.6	8.8mv	D		6-10	10:00	125
10	405	88 85	85	87	90	90					18	20	13.7	2.7	8.8mv	D		8-9	10:00	120
	410	89 86	87	88	90	90					18.5	20.5	13.6	2.7	8.8mv	D		8-10	10:00	125
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Notes: Data obtained during
12-8 shifts during
dates indicated.

General Information

190-C-PROCESS PUMP MOTOR DATA

HA-34351

No.	Line amps.	Motor Winding Temperature By Detectors										Bearings				Cooling Coil Temp.		151-B Substation			Trans. Tap Sett- ing.	Trans. Voltage Divider	Motor Voltage	Date	Time	151-B Line amps.
		1	2	3	4	5	6	In 7	Mtr. Hsng. 8	Out 9	10	In Let	Out Let	Voltage	Reading	P.F.	Setting	Divider	Volt							
1	400	90	88	87	90	92	94	106	118	112	-	-	-	13.8KV	2.7	8.8	D		-	-	8-10	6:00	115			
	410	92	90	88	91	93	96	107	120	113	-	-	-	13.8KV	2.7	8.8	D		-	-	8-11	6:00	120			
2	400	89	88	88	88	91	90	117	116	113	-	-	-	13.8KV	2.7	8.8	D		-	-	8-10	6:00	125			
	420	90	90	90	90	92	91	118	117	113	-	-	-	13.8KV	2.7	8.8	D		-	-	8-11	6:00	125			
3	400	93	89	90	89	88	91	113	114	119	-	-	-	13.8KV	2.7	8.8	D		-	-	8-10	6:00	130			
	410	94	90	91	90	90	92	114	115	120	-	-	-	13.8KV	2.7	8.8	D		-	-	8-11	6:00	130			
4	400	92	90	90	84	84	94	112	117	118	-	-	-	13.9KV	2.7	8.5	D		-	-	8-10	6:00	125			
	410	94	92	92	85	86	95	113	119	119	-	-	-	13.8KV	2.7	8.6	D		-	-	8-11	6:00	125			
5	390	87	86	87	88	86	84	113	115	113	-	-	-	13.9KV	2.7	8.5	D		-	-	8-10	6:00	115			
	400	88	86	87	88	86	84	113	116	113	-	-	-	13.8KV	2.7	8.6	D		-	-	8-11	6:00	115			
6	390	86	89	90	85	94	86	123	113	116	-	-	-	13.7KV	2.6	91	D		-	-	8-10	6:00	118			
	390	87	90	90	87	95	87	124	114	117	-	-	-	13.9KV	2.6	91	D		-	-	8-11	6:00	120			
9	380	83	85	83	81	82	83	115	114	120	-	-	-	13.7KV	2.6	91	D		-	-	8-10	6:00	118			
	390	84	85	84	82	83	84	115	115	121	-	-	-	13.9KV	2.6	91	D		-	-	8-11	6:00	120			
10	390	87	85	84	85	87	85	131	115	120	-	-	-	13.8KV	2.6	8.8	D		-	-	8-10	6:00	115			
	390	87	85	84	85	87	85	131	116	121	-	-	-	13.8KV	2.6	8.8	D		-	-	8-11	6:00	115			
11	390	85	84	85	86	88	87	120	115	112	-	-	-	13.8KV	2.7	8.8	D		-	-	8-10	6:00	120			
	400	84	84	85	87	88	87	122	116	114	-	-	-	13.8KV	2.6	8.8	D		-	-	8-11	6:00	125			
12	410	87	84	85	87	88	88	113	112	108	-	16°C	19°C	13.8KV	2.75	8.8	D		-	-	8-10	6:00	120			
	410	88	85	86	87	89	89	114	113	109	-	-	-	13.8KV	2.7	8.8	D		-	-	8-11	6:00	120			
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