Form 0.077 (R7-92)

FORM 101.1	REVISION 14

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER KEOWEE 1 + 2

TITLE OF CALCULATION Keowee Governor Mechanical Single Failure Analysis

CALCULATION NUMBER KC-UNIT 1-2-0098

ORIGINALLY CONSISTING OF:

PAGES 1 THROUGH 13

TOTAL ATTACHMENTS 3 TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES ______ TYPE I CALCULATION/ANALYSIS YES ☐ NO ☒

TYPE I REVIEW FREQUENCY N/A

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY John B. Bauman DATE 9/29/93

CHECKED BY Wm. R. Darling DATE 9/29/93

APPROVED BY S L Nader DATE 10-14-93

ISSUED TO DOCUMENT CONTROL Kathy B. Lee DATE 10-28-93

RECEIVED BY DOCUMENT CONTROL WJMcC DATE 10/28/93

MICROFICHE ATTACHMENT LIST: ☐ Yes ☒ No SEE FORM 101.4

REV. NO.	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE
1		12, 13	12, 12A 13						J. Bauman 5/23/95	HEA 5/23/95	MWS 5/24/95	HBB 6/29/95 / 7/6/95

9E

Form 394187 (R9-89) • Previously Form 26164 • **Form 101.2 • Revision 1**

File /Calculation No. KC-UNIT 1-2-0098

REVISION DOCUMENTATION SHEET

Revision Number	Review Frequency Changed Yes/No	Revision Description
1	No.	Revised Per NSM ON-52966

I PURPOSE

The purpose of this calculation is to verify that there is no creditable active single failure in the mechanical governor system that could prevent a Keowee Hydro Unit from performing its intended safety function.

II RELATION to NUCLEAR SAFETY

Since this calculation makes conclusions about a safety related system this calculation is designated as QA Condition 1.

III DESIGN METHOD

Each active component in the governor system will be evaluated for creditable failures and the effects of the failures on the governor system.

IV APPLICABLE CODES and STANDARDS

ANSI N45.2.11 has been reviewed and all applicable design inputs are addressed in the appropriate sections of this calculation.

V OTHER DESIGN CRITERIA

None

VI FSAR CRITERIA

FSAR Section 8.3

VII ASSUMPTIONS

7.1 It is assumed that Keowee operation at frequencies of 60±5% Hz is acceptable. This is justified by standard statements in electrical equipment purchase specifications that identify frequency tolerance on equipment of 60±5% Hz (Ex. OSS-0320.00-00-0015 Rev. 2 Section 3.2.4.1) and Regulatory Guide 1.9

VIII REFERENCES

8.1 KFD 105A-1,2.1 Rev. 0
8.2 KM 200-85 Rev. G
8.3 NRC Information Report SECY-77-439
8.4 FSAR Section 8.3.1.2
8.5 KM-200-158 Doc Control Date July 11,1990
8.6 KEE-111 and 211

IX CALCULATION

ITEM	Function	Failure	Effect
Governor Oil Pump KM 200-0085	Maintain Pressure Tank Pressure	Fails to run or runs with reduced discharge pressure	Each GO Pump is backed up by two other GO Pumps. On loss of auxiliary power all three GO Pumps will fail to run. The Pressure Tank maintains enough oil inventory to provide for complete unit operation for some period of time. This period of time is approximately 1 Hr. depending on the amount of load changes. This will allow operators enough time to restore auxiliary power. AP Procedures are in place to direct the operators to restore the auxiliary power in this situation.

		Pump fails to stop	When the oil pressure reaches the pressure setting of the unloader pilot valve, the pump is unloaded and is bypassed to the Governor Oil Sump. The unloader would still load and unload the running pump as required.
Oil Pressure Switches (63Q)	Switch 1-provides alarm on low Pressure Tank pressure	This switch is alarm only	This switch is backed up by Switch-4, Emergency Pump Run. This switch provides its own alarm plus starts one GO Pump. (See Emergency Pump Run Switch)
	Switch 2-provides Normal Unit Lockout on Extremely low oil Pressure	Switch does not actuate when required.	This switch is bypassed in Emergency operation, therefore it would require more than two failures to lock the unit out on an emergency start. Pressure switch is also backed up by the Emergency pump run circuit 63Q-4
GO Pump Discharge Check Valves OG-11,14&17	Isolates the GO Pump from the Pressure Tank	Check Valve failures are Passive Failures Ref 8.3	Keowee Mechanical Systems are not required to be passive failure proof Ref 8.4

GO Pump Unloader, Unloader Pilot, Unloader Switch	Allows GO Pump to start in an unloaded condition, Starts and stops pump and determines at what pressure the GO Pump starts and stops.	Fails to start pump	See GO Pump
		Fails to stop pump	See GO Pump
		Fails to unload pump	Each pump is protected by a safety valve OG-13,16,19 Ref. 8.1
		Fails to load pump	Same as pump fails to start.
Safety Valves OG-13,16,19	Overpressure protection of GO Pump discharge	Safety valves are Passive Failures Ref. 8.3	For these valves to be required to operate, failure of the Oil Pump Unloader must occur. Keowee Mechanical Systems are not required to be passive failure proof Ref 8.4
Emergency Pump Run Pressure Switch (63Q-4)	Monitors pressure of Governor Oil Pressure Header And initiates The Emergency Pump Run On low Oil Pressure	Fails to start Pump	A failure of the two other GO Pumps or a passive failure of valve OG-7 is required for this Press Switch to be needed. Therefore this is not a creditable failure.

Emergency Pump Run Solenoid (20QGPA)	Used to initiate Emergency Pump Run start by Emergency Pump Run Pressure Switch.	Fails to operate.	A failure of the two other GO Pumps or a passive failure of valve OG-7 is required for this solenoid to be needed. Therefore this is not a creditable failure.
Auxiliary Valve	Is used for manual control of turbine speed during maintenance.	This valve is bypassed in emergency operation by the manual transfer valve.	This valve has no effect on emergency operation and is used only during maintenance. During this time of use the Unit would be under a Tech Spec LCO and the other Keowee Unit would be available.
Distribution valve	Directs Pressurized oil to the appropriate side of the Gate Servo Motors to open or close the gates.	This valve is inherently rugged and simple in operation. There are no creditable failures of this item. (Att. 1)	

Distribution Valve Servo Motor	This Hydraulic Servo Motor positions the Distribution Valve so that the turbine gates can be moved.	This Servo Motor is inherently rugged and simple in operation. There are no creditable failures of this item. (Att. 1)
Gate Servo Motor	These Servo Motors are attached to the turbine gate mechanism and they provide the opening and closing forces to these gates.	This Servo Motor is inherently rugged and simple in operation. There are no creditable failures of this item. (Att. 1)
Pilot Valve	This valve receives position input from the Governor Head and directs pressurized oil to the appropriate side of the Distribution Valve Servo Motor to move the Distribution Valve in the proper direction to allow for proper gate movement.	This Pilot Valve is inherently rugged and simple in operation. There are no creditable failures of this item. (Att. 1)

Oil Motor Vibrator	Provide constant agitation to the pilot valve and distribution valve to prevent sticking	This is a hydraulic motor and is always in operation the only failure mode is to stop.	If the Vibrator motor fails, only long term operation of the unit may be affected. The purpose of the is motor is to prevent the buildup of varnish on the internal moving parts of the Pilot and Distribution Valves. This failure would have no short term effect on the emergency operation of the Governor.
Governor Linkages, Cables and Gearing	Transfers input motion and feed back to the hydraulic valves.	These linkages are inherently rugged and simple in operation. There are no creditable failures of these items. (Att. 1)	
Compensating Dashpot	Provides stability to the control of the unit.	The dash pot is inherently rugged and simple in operation. There are no creditable failures of this item. (Att. 1)	

Complete Shutdown Solenoid	Manually bypasses the governor controls and shuts the unit down by forcing the turbine gates closed	The Complete Shutdown Solenoid is energized during unit operation. A failure would de-energize the solenoid.	A de-energized solenoid would result in the unit shutting down completely. If this occurred while the unit is carrying emergency loads, the power control circuits would transfer to the other operating Keowee unit.
Partial Shutdown Solenoid	Is used to limit turbine gate movement during normal startups	The Partial Shutdown Solenoid is energized during unit operation. A failure would de-energize the solenoid.	A de-energized solenoid would result in the unit being limited to the Partial Shutdown gate limit. This limit is set at approximately 25% open. The governor will operate normally below this amount. This limit is sufficient to allow normal unit operations for the emergency loads.
Synchronizing motor	Used to raise and lower speed from remote locations and for synchronizing the unit to the grid.	Motor is normally off, could fail on to raise unit speed	This motor is designed to override the governor controls a small amount to allow for synchronizing the unit's speed with that of the Power grid. The amount is defined by the amount of droop set on the machine. The droop setting defines the band around 60Hz that the unit would operate. Keowee is set at maximum droop (5%). This would allow frequency to change ±2.5% If this

			motor failed on, and began to raise the unit speed, then the governor would begin to compensate. Frequency would remain elevated 2.5% while the motor is running. This would be acceptable for the emergency loads. (Assumption 7.1)
		Motor could fail on to lower unit speed	Same as above except the unit would run at 2.5% lower frequency. (Assumption 7.1)
Gate Limit Motor	Used to change the Gate Limit (Maximum amount of gate opening allowed) from remote locations.	Assume failure causes the Gate Limit Motor to lower the gate limit. The Unit is at rest in standby.	If the Keowee Unit is at rest, then the gate limit is automatically set at 50% open. Taking the failure of the Gate Limit Motor at the event initiation, the gate limit would decrease rapidly while the unit is starting up. As the gate limit continues to decrease, it would begin to limit the units speed and ultimately shut the unit down. Then the other Keowee Unit would be available for the Emergency Loads. This would occur in less than the required 23 sec. because of the quick speed (16 sec. 50% to 0%) of the Gate Limit Motor (Att. 3)
		Keowee unit is running	When the unit is running, the gate

and the Gate Limit Motor fails to lower the limit.	limit is automatically changed to 100%. If the motor tries to lower the limit, then the raise and lower portion of the Gate Limit Motor would begin competing with each other. The raise winding is trying to raise the limit back to 100% and the failed lower circuit is trying to lower the limit. Under this condition, the motor would stop and the protective circuits would see a fault condition and open the circuit. The gate limit would remain at the setting just prior to this occurrence and would be in the vicinity of 100%. This limit is in excess of the unit's emergency operation requirements and will not hinder its operation.
Failure causes the Gate Limit Motor to raise the gate limit	The gate limit would rise to 100% which is how it is supposed to respond.

Pressure Tank Float Valve OG-7	Prevents air in the Pressure Tank from entering the OG system	This valve is normally open. Fails closed	This failure is a passive failure and is not considered for Keowee Mech Systems. (See Pressure Switch 63Q-4 Emergency Pump Run)
		Valve fails to close when required	This valve closes only when the oil level in the Pressure Tank drops to the point where air may enter the hydraulic system. For this to occur, another failure must have occurred. For example, the failure of all three GO Pumps. If all Oil Pumps fail (see Gov. Oil Pump) and the unit is operated for an extended period of time, then the oil level may drop to a point where the float valve may close. If this occurs then the governor becomes inoperable (the unit could no longer control speed but would maintain the same turbine gate position). If the float valve fails to close then air would enter the governor and it again would become inoperable. Therefore this valve serves no safety function. The only function of this valve is to make regaining control of the unit easier.

Governor Head, Permanent Magnet Generator (PMG)	Provides the corrective force for turbine speed correction	Governor Head fails to run	If the Governor head fails to run, this would be an indication of no turbine speed and the governor would react by opening the turbine gates. The gates would open until the unit tripped on overspeed. Following the installation of NSM ON-52966, Gov. Head Failures will be detected differently:
		Gov. Head Fails when the unit is initially at rest.	The response of the unit would be such that Gov. would open the gates in an attempt to increase the Gov. Head speed. This failure would be detected by new circuitry using a speed sensing magnetic pickup (14MPU/1). If this MPU does not sense rotation of the Gov. Head then that unit is not allowed to load to ONS.
		Gov. Head Fails when the unit is initially at Power Generation.	Again the Gov would open the gates full open trying to increase the Gov. Head speed. The unit speed would increase due to this as well as the normal Load Rejection overspeed caused by Emergency start signal. New over frequency relays (81/X1, 81/Y1 and

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			81/Z1) would prevent the failed unit from loading to ONS.
		Governor Head runs at wrong speed	Since the Governor Head Motor is tied solely to the PMG which is directly coupled to the generator shaft, There are no failures that could make the Governor Head Motor run at any speed other than the correct proportional synchronous speed of the generator. Therefore this is not a creditable failure.
Compensating Dashpot Bypass Solenoid	Allows for the bypassing of the effects of the Compensating Dashpot	Solenoid is normally off, could fail on.	There are two contacts in series that are opened during emergency operation that will prevent a single failure from energizing this solenoid. Therefore this is not a creditable failure. Ref 8.6

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X CONCLUSION

The above calculation found no failures that would result in the Keowee Unit operating at an unacceptable speed or frequency. Several failures were found that would result in the shutdown of the unit. With these failures the other Keowee Unit would be available for the emergency load.

XI ATTACHMENTS

1 Memo to File, by S.L. Nader, Dated Jan.15, File K-201.

2 Telephone Conversation Report between John Beckman (Duke) and Jerry Runion (Woodward Gov. Co). Dated 9/22/93.

3 Keowee Unit 2 Governor Actuator inspection report following initial installation.

ATTACHMENT 1
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9773

Memo To File

Jan. 15,1993

Re: Oconee Nuclear Station
Keowee Hydro Station
Governor Operation
File: K-201

The purpose of this memo is to document the substance and conclusions of conversations on Jan. 13 and 14, 1993 addressing the potential single failures that could affect the governor at Keowee. Individuals involved in these conversations were Bob Dobson, Julian Davis and Dhiia Jamil, Oconee Electrical Engineering; Steve Nader and John Beckman, Oconee Mechanical Engineering; Don Couch, Keowee Station Manager; Rick Gerbers, Hydro Maintenance; Bob Howell, DESI; Bob Hall, McGuire Mechanical Engineering; and an engineering representative from Woodward Governor Co.

The conclusion reached by all members of the discussion was that there are no credible design basis mechanical failures that could affect the governor without also tripping the unit. The following scenarios were discussed. One or both Keowee units are generating to the grid when Oconee has a LOCA/LOOP requiring emergency loads to be supplied from Keowee. Keowee has a load rejection, isolating it from the grid. The question at this point is are there any credible single failures of the governor that might keep the unit running at a speed other than design (128.6 rpm). Keeping in mind that if the governor closes the wicket gates, the unit will trip; and if the governor opens the wicket gates the overspeed switch will trip the unit, discussions focused on potential failures that might keep the wicket gates in some "stuck" mid-position. (It should be noted that the Woodward representative could recall no instances in his 16 years experience when this had occurred).

Complete sudden loss of hydraulic oil pressure was postulated. This would result in no movement of the wicket gates. This is beyond design basis. No passive failures must be assumed except in ECCS systems in long term operation. Other failures in the hydraulic oil system such as loss of governor oil pumps or failure of the valve in the oil pressure tank will result in a slow loss of pressure over the long term. However the oil tank is designed for three opening strokes of the wicket gates. With the expected small variances in electrical load after an accident, the stored oil pressure will be sufficient for the period of time necessary to recover oil pressurization capability.

A failure in the wiring from the Permanent Magnet Generator (PMG) to the ball head will result in the ball head sensing no or low speed, thereby opening the wicket gates. An overspeed trip will trip the unit.

A failure of the Partial Shutdown Solenoid Valve will result in a gate position of 23% - 25% open. This gate position yields sufficient MW to satisfy ONS emergency power loads. The governor would continue to operate as designed, adjusting wicket gate

ATTACHMENT 1
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ØDB

position to match load.

Servomotor failure was also considered. The servomotor is essentially a large hydraulically operated piston valve. Based on experience it is not expected that a stuck piston is credible. The high hydraulic oil pressure will result in very large piston forces. Credible foreign objects would not be able to interfere with piston operation. In addition, standard single failure licensing rules do not assume partial stroking of valves. They either work as designed or fail to their as-designed failure position. Therefore any credible failure will be expected to trip the unit.

The failure of linkages within the governor and wicket gate shear pins was also evaluated. These components are considered to be passive, inherently rugged items whose failure need not be postulated. Normal operation of the unit would reveal actual problems with these components should they occur.

In general it has been the Oconee position to not consider "smart failure" within control systems. The system is assumed to control as designed or to fail to its as-designed state.

Based on the above, it was concluded that the Keowee governor will continue to operate or result in a tripped unit for all credible design basis single failures.

S.L. Nader

S.L.Nader
Engineering Supervisor
Oconee Mechanical Engineering

cc: R.L.Dobson, D.M.Jamil, J.B.Beckman, B.J.Dolan

Form 1021

KC-UNIT 1-2-0098
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JBB

DUKE POWER COMPANY

TELEPHONE CONVERSATION REPORT

PROJECT Keowee FILE NO. K-201

SUBJECT Keowee Governor Dash pot

PERSON CALLED Jerry Runion Woodward Gov. Co.

DATE 8/27/93 TIME 13:00

PERSON CALLING John Beckman

SPECIFICATION NUMBER KC-UNIT 1-2-0098

SUBJECT DISCUSSED Unit operation with Compensating Dash pot Bypass Solenoid energized

RECOMMENDATION OR RESOLUTION When the Bypass solenoid is energized, the Governor operates with ~~out~~ the Compensating dash pot Bypassed. This means that the unit will become slightly unstable w.r.t. speed. Jerry said that speed swings would be less than ± 3%

SIGNED: John B. Beckman

ATTACHMENT 3 Actuator Inspection
Pg 1 of 5

Inspector [illegible]
Supervisor [illegible]

Duke Power Company--- Keowee Development---- Unit # 2

MECHANICAL FEATURES

rawings Checked for Latest Change

Serial Number [illegible]

Normal Speed [illegible] PMG 385 Ballhead

Speed Droop 0%	386	RPM at 5% Gate
	386	RPM at 50% Gate
	386	RPM at 95% Gate
Speed Droop 5%	396	RPM at 5% Gate
	386.8	RPM at 50% Gate
	377.2	RPM at 95% Gate
Speed Adjustment		RPM + 10% Dial
	406	RPM + 5% Dial
	366	RPM - 5% Dial
	345.2	RPM - 10% Dial
	322.5	RPM - 15% Dial

Max. Gate/Max. Droop/Max. Speed 396 RPM

Min. Gate/ 0 Droop/Min. Speed ______ RPM

w Through	Inner Hole	
	Outer Hole	
Transfer Valve & Gauge		OK
Auxiliary Valve		OK
Gate Limit & Gate Position Ind.		OK
Oil Pressure Gauge		OK
Air Brake Gauge		OK
Manual Shutdown & Reset	None	
Compensating Cable Travel	22.875 in.	OK
Kaplan Valve & Restoring	None	
Oil Motor (Vibrator)		OK
Cotter Pins etc.		OK
Check for Oil Leaks etc.		OK
Ballhead Motor Disconnect Sw.		OK
SNL Setting Relays (2)		OK
Sump Tank Oil Level Sw. (Pumping Unit)		OK
Voltage Comp. Assy. For SNL Net Hd.		OK
Power Supply Assy. For Volt Comp.		OK
SNL Settings Vs. Net Hd. Cam Assem.		OK
tion Signal Transmitter		OK
tion Signal Transmitter Relay		OK
ot Test - Witnessed By- [illegible] 10-22-67		
Gate Lock		
Press. Tank Float Valve		
Tank Inspected by	Date	

ELECTRICAL FEATURES

Diagrams Checked for Latest Change			
Cabinet Light and Switch			OK
Tachometer & Rotation Signal Coupler			OK
Gate Limit & Gate Position Trans.			110 [illegible]
Speed Adjustment Trans.	110 VAC		OK
Speed Droop Trans.			None
Shutdown Solenoid	~~Energize~~ (De-energize)	S. D.	OK
Speed No Load Sol.	~~Energize~~ (De-energize)	S. D.	OK
Reset Solenoids			None
Dashpot Sol. Operated Bypass			OK
Sol. Operated Brake Valve			OK
Speed Adjustment Limit Switch	4 Pole		OK
Gate Position Limit Switch	6 Pole		OK
Gate Limit (R.H.) Limit Switch	5 Pole		OK
Gen. Brake Control Switch			OK
Dashpot Solenoid Switch			None
Pump Control Switch	(3)		OK
Brake Timer			OK
Magnetic Starter			None
Indicating Lights	(4)		OK
Gate Limit Potentiometer Trans.	(2)		OK
Gate Pos. Potentiometer Trans.	(2)		OK
Shutdown Sol. Aux. Contact	5 Pole		OK
Shutdown & Reset Control Sw.			OK
Spd. No Load Sol. Aux. Contact	5 Pole		
Coincident Switch			OK
S.N.L. Selector Switch (Power Supply)			
~~Dual Gate Lock Sol. Valve Energ. To~~			
~~Main-Aux. Transfer Valve Switch~~			
Ohmeter Check of Ballhead Motor			

Switchboard Instruments OK
1--- Tachometer
1--- Dual Indicator
1--- Spd. Adj. Indic.

Press. Tank Oil Level Trans.

Actuator Inspected by [illegible] Date 10-15-

Wiring Inspected by [illegible] Date 10-22-

PMG & Auxiliaries [illegible] Date 10-15-

...ley Valve Bushing # [illegible] [illegible] Hand ______ P...

Kaplan Valve Bushing# NONE ______ Hand ______ Po...

Limit Motor 125 Volts ~~A.C.~~ /D.C.

31.5 Sec. From 0 Gate to 100% Gate

31.5 Sec. From 100% Gate to 0Gate

Syn. Motor 125 Volts ~~A.C.~~ /D.C.

86 Sec. From 0 Adj. to - 15% Adj.

84 Sec. From -15% Adj. to 0 Adj.

PUMP "A" (Standing at Front of Unit Pump "A" Furthest to Right)

Motor Mfg. Allis Chalmers Serial # 1-5103-25342-2-4 HP 50

Capacity 198 G.P.M. Safety Opens at 383 P.S.I.

On Lead Position Loads at 318 P.S.I. Unloads at 350 P.S.I.

On Lag Position Loads at 298 P.S.I. Unloads at 331 P.S.I.

...P "B" (Standing at Front of Unit Pump "B" Furthest Left)

Motor Mfg. Allis Chalmers Serial # 1-5103-25342-2-5 HP 50

Capacity 198 G.P.M. Safety Opens at 386 P.S.I.

On Lead Position Loads at 316 P.S.I. Unloads at 350 P.S.I.

On Lag Position Loads at 298 P.S.I. Unloads at 332 P.S.I.

OIL PRESSURE FAILURE SWITCHES

1 -- C.L.P. / ~~O.L.P.~~ At 275 P.S.I. --- Resets At 288 P.S.I. Oil

2 -- C.L.P. / ~~O.L.P.~~ At 250 P.S.I. --- Resets At 257 P.S.I. "

3 -- C.L.P. / ~~O.L.P.~~ At 250 P.S.I. --- Resets At 256 P.S.I. "

~~# 4 -- C.L.P. O.L.P. At ______ P.S.I. Reset At ______ P.S.I.~~

~~# 5 -- C.L.P. O.L.P. At ______ P.S.I. Reset At ______ P.S.I.~~

~~# 6 -- C.L.P. O.L.P. At ______ P.S.I. Reset At ______ P.S.I.~~

~~# 7 -- C.L.P. O.L.P. At ______ P.S.I. Reset At ______ P.S.I.~~

(#4–#7: Removed at Custom[er] Request)

C.L.P. O.L.P. At 50 P.S.I. Reset At 57 P.S.I. Air

~~C.L.P. O.L.P. At ______ P.S.I. Reset At ______ P.S.I. Air~~

SHEET 3

...ctor Mfg. Allis Chalmers Serial #1-5153-25372-2-3 HP 50

...city 198 G.P.M. Safety Opens at 388 P.S.I. CENTER PUMP

On Lead Position
Loads at 316 P.S.I. Unloads at 350 P.S.I.

On Lag Position
Loads at 294 P.S.I. Unloads at 326 P.S.I.

UNIT [illegible] ATT 3 Pg 4 of 5
October 24, 1969

[illegible]DWATER ELEVATION	HEADWATER ELEVATION POTENTIOMETER SETTING	NET HEAD	TAILWATER ELEVATION	TAILWATER ELEVATION POTENTIOMETER SETTING	SNL GATE POSITION
775	000	100 Ft.	675	513	30.250%
		90 Ft.	685	769	32.750%
		81 Ft.	694	1000	34.250%
785	400	100 Ft.	685	769	29.750%
		91 Ft.	694	1000	32.500%
	760	100 Ft.	694	1000	30.500%
800	1000	136 Ft.	664	230	20.750%
796	840	128 Ft.	668	333	22.500%
792	680	120 Ft.	672	436	24.750%
788	520	112 Ft.	676	538	27.000%
[illegible]	360	104 Ft.	680	641	29.000%
780	200	96 Ft.	684	744	31.000%
784	360	104 Ft.	680	641	29.750%
788	520	112 Ft.	676	538	27.500%
792	680	120 Ft.	672	436	25.250%
796	840	128 Ft.	668	333	23.000%
800	1000	136 Ft.	664	230	20.500%

B. P. Crittenden Elect. Engr.
[illegible] Haines, Draftsman
W. Schleicher Eng. Tech.

TESTED BY

Stan Haines
Ben Schleicher

DATE 10/21/69

NAME H. Juhlin

P. M. G. ACCEPTANCE DATA

UNIT NAME Keowee Development UNIT 2 ACTUATOR NO. 851616

SHOP ORDER NO. HC-582

P. M. G. SPECIFICATION

NO. OF RINGS 3 NO. OF POLES ___ STATOR ORDER NO. 200147

FRAME ___ WIRING SPEC. NOS. 9972-162

NAME PLATE DATA

SPEED 128.6 R. P. M. FREQUENCY 6.4 CYCLES 3 PHASE

FULL LOAD VOLTS 64 NO LOAD VOLTS 94

FULL LOAD CURRENT 2.2 AMPS. SERIAL NO. 851616

BALLHEAD MOTOR SPECIFICATION

FRAME ___ FREQUENCY ___ VOLTAGE ___

STACK THICKNESS ___ INCHES NO. OF POLES ___

WIRING SPEC. NOS. ___

MAGNETIZATION DATA BY H. Juhlin

MAG. VOLTS 1470 MAG. CURRENT 60 Amps

OPERATION DATA BY H. Juhlin

INITIAL NO LOAD VOLTAGE 115 FINAL NO LOAD VOLTAGE 94

INITIAL FULL LOAD VOLTAGE 87 FINAL FULL LOAD VOLTAGE 76

FULL LOAD CURRENT 2.2 AMPS.

REMARKS:

TESTER [signature]

INSPECTOR [signature]

SUPERVISOR [signature]