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GPU Nuclear

Calculation Sheet

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V-14-34 AND 35 REACTOR PRESSURE FOR PRESSURE LOCKING	C-1302-211-5310-087	0	1 of 8

Originator	Date	Reviewed by	Date
Frank J. Stulc, Jr.	1-9-95	J. H. Cooper Jedad Brown 2/3/95	1/9/95

1.0 PROBLEM STATEMENT

THE PURPOSE OF THIS CALCULATION IS TO DETERMINE THE REACTOR PRESSURE AT WHICH PRESSURE LOCKING OF THE ISOLATION CONDENSER CONDENSATE RETURN VALVES, V-14-34 AND 35, MAY OCCUR FROM INITIAL CONDITIONS OF 1020 PSI IN THE REACTOR.

2.0 SUMMARY OF RESULTS

2.1 PRESSURE LOCKING OF V-14-34 MAY OCCUR AT A REACTOR PRESSURE OF 169 PSI FOR AN UNDER-VOLTAGE MOTOR TORQUE OF 45.9 FT-LBS AND AT A REACTOR PRESSURE OF 343 PSI FOR AN UNDER-VOLTAGE MOTOR TORQUE OF 36.6 FT-LBS DERATED FOR TEMPERATURE EFFECTS.

2.2 PRESSURE LOCKING OF V-14-35 MAY OCCUR AT A REACTOR PRESSURE OF 193 PSI FOR AN UNDER-VOLTAGE MOTOR TORQUE OF 34 FT-LBS AND AT A REACTOR PRESSURE OF 330 PSI FOR AN UNDER-VOLTAGE MOTOR TORQUE OF 28.4 FT-LBS DERATED FOR TEMPERATURE EFFECTS.

3.0 REFERENCES

3.1 C-1302-211-5310-065, V-14-34 THRUST AND OPERATOR SIZING.

3.2 C-1302-211-5310-066, V-14-35 THRUST AND OPERATOR SIZING.

3.3 C-1302-730-5350-008, O.C. GL 89-10 MOVs VOLTAGE DROP CALC. FOR DC MOVs.

3.4 EPRI MOV PERFORMANCE PREDICTION PROGRAM UPDATE DATED 12-14-93.

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4.0 ASSUMPTIONS AND BASIC DATA

4.1 ASSUME BONNET PRESSURE (P_{BONNET}) IS EQUAL TO AN INITIAL REACTOR PRESSURE (P_{RX}) OF 1020 PSI + STATIC PRESSURE OF 12 PSI SO P_{BONNET} = 1032 PSI.

4.2 ASSUME THAT BONNET PRESSURE STAYS CONSTANT AT 1032 PSI AS REACTOR PRESSURE DROPS.

4.3 BECAUSE OF THE SYSTEM DESIGN, THE REACTOR + STATIC PRESSURE ACTS ON THE UPSTREAM DISC AND REACTOR PRESSURE ACTS ON THE DOWNSTREAM DISC.

4.4 BECAUSE THE BONNET IS PRESSURIZED AND THERE ARE TWO DISCS, THERE IS A DP OF BONNET PRESSURE - (REACTOR + STATIC PRESSURE) ACROSS THE UPSTREAM DISC AND BONNET - REACTOR PRESSURE ACROSS THE DOWNSTREAM DISC.

4.5 THE AVAILABLE THRUST FROM THE MOTOR OPERATOR MUST OVERCOME PACKING LOAD (F_{PACK}) AND DP EFFECTS ON BOTH DISCS. INCLUDE PISTON EFFECT (F_{PISTON}), WHICH HELPS OPEN THE VALVE, IN THE AVAILABLE THRUST.

4.6 ASSUME A VALVE FACTOR (V.F.) OF 0.4 FROM EPRI TESTING OF A SIMILAR VALVE. (VALVE #41, REFERENCE 3.4)

4.7 THE OVERALL GEAR RATIO (OAR) IS 72.01 FOR V-14-34 AND 108 FOR V-14-35. (REFERENCES 3.1 AND 3.2)

4.8 DISC AREA (A_{DISC}) IS 67.64 IN^2. (REFERENCES 3.1 AND 3.2)

4.9 STEM AREA (A_{STEM}) IS 2.41 IN^2. (REFERENCES 3.1 AND 3.2)

4.10 $F_{PISTON} = P_{BONNET} \times A_{STEM} = 1032\ PSI \times 2.41\ IN^2 = 2487\ LBS.$

4.11 STEM FACTOR, BASED ON A STEM COEFFICIENT OF FRICTION (μ) OF 0.2, IS .0285 FOR BOTH VALVES. (REFERENCES 3.1 AND 3.2) ACTUAL STEM FRICTION IS LOWER, THEREFORE THE AVAILABLE THRUST WILL BE HIGHER AND THE REACTOR PRESSURE FOR PRESSURE LOCKING WILL BE LOWER.

4.12 TWO MOTOR TORQUES AT UNDERVOLTAGE WILL BE USED FOR EACH VALVE; ONE AT THE WORST CASE VOLTAGE AND THE OTHER AT WORST CASE VOLTAGE DERATED FOR TEMPERATURE. FOR V-14-34 THE TORQUE VALUE IS 45.9 FT-LBS AT WORST CASE VOLTAGE AND 36.6 FT-LBS DERATED FOR TEMPERATURE. FOR V-14-35 THE TORQUE VALUE IS 34 FT-LBS AT WORST CASE VOLTAGE AND 28.4 FT-LBS DERATED FOR TEMPERATURE. (REFERENCE 3.3) THE TORQUE AT WORST CASE VOLTAGE REPRESENTS DEGRADED VOLTAGE DURING AN ACCIDENT. THE TORQUE AT WORST CASE VOLTAGE DERATED FOR TEMPERATURE REPRESENTS DEGRADED VOLTAGE DURING AN ACCIDENT WITH A HELB IN THE ISO-CONDENSER PIPING CAUSING HIGH ENVIRONMENTAL TEMPERATURES.

4.13 ASSUME A PACKING LOAD (F_{PACK}) OF 2500 LBS FOR BOTH VALVES. (REFERENCES 3.1 AND 3.2)

4.14 PULLOUT EFFICIENCY IS .4 FOR V-14-34 AND .35 FOR V-14-35. (REFERENCES 3.1 AND 3.2)

5.0 CALCULATIONS

V-14-34

AVAILABLE STEM TORQUE = AVAILABLE MOTOR TORQUE x PULLOUT EFF. x OAR

$T_A = T_{MA} \times EFF. \times OAR = 45.9 \text{ FT-LBS} \times .4 \times 72.01 = 1322.1 \text{ FT-LBS}$

AVAILABLE STEM THRUST = $\frac{\text{AVAILABLE STEM TORQUE}}{\text{STEM FACTOR}}$

$$F_S = \frac{T_A}{S.F.} = \frac{1322.1 \text{ FT-LBS}}{.0285 \text{ FT.}} = 46,389 \text{ LBS.}$$

AVAIL. STEM THRUST FOR DP = AVAIL. STEM THRUST - PACKING LOAD + PISTON EFFECT

$$F_{SDP} = F_S - F_{PACK} + F_{PISTON} = 46,389 - 2500 + 2487 \text{ LBS} = 46,376 \text{ LBS}$$

$$F_{SDP} = V.F. \times A_{DISC} \left\{ [1032 - (P_{RX} + 12)] + [1032 - P_{RX}] \right\}$$

$$F_{SDP} = V.F. \times A_{DISC} \left\{ [1020 - P_{RX}] + [1032 - P_{RX}] \right\}$$

$$F_{SDP} = V.F. \times A_{DISC} \left\{ 2052 - 2P_{RX} \right\}$$

$$\frac{F_{SDP}}{V.F. \times A_{DISC}} = 2052 - 2P_{RX}$$

$$2P_{RX} = 2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}} \right]$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{46,376}{.4(67.64)} \right] = 169 \text{ PSI}$$

5.0 CALCULATIONS (cont.)

V-14-34

$T_A = T_{MA} \times EFF. \times OAR = 36.6 \text{ FT-LBS} \times .4 \times 72.01 = 1054.2 \text{ FT-LBS}$

$$F_S = \frac{T_A}{S.F.} = \frac{1054.2 \text{ FT-LBS}}{.0285 \text{ FT}} = 36,990 \text{ LBS}$$

$F_{SDP} = F_S - F_{PACK} + F_{PISTON} = 36,990 - 2500 + 2487 = 36,977 \text{ LBS.}$

$F_{SDP} = V.F. \times A_{DISC} \{[1032 - (P_{RX} + 12)] + [1032 - P_{RX}]\}$

$F_{SDP} = V.F. \times A_{DISC} \{[1020 - P_{RX}] + [1032 - P_{RX}]\}$

$F_{SDP} = V.F. \times A_{DISC} \{2052 - 2P_{RX}\}$

$$\frac{F_{SDP}}{V.F. \times A_{DISC}} = 2052 - 2P_{RX}$$

$$2P_{RX} = 2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}\right]$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{36,977}{.4(67.64}\right]$$

$P_{RX} = 343 \text{ PSI}$

5.0 CALCULATIONS (cont.)

V-14-35

$T_A = T_{MA} \times EFF. \times OAR = 34\ FT\text{-}LBS \times .35 \times 108 = 1285.2\ FT\text{-}LBS$

$F_S = \frac{T_A}{S.F.} = \frac{1285.2\ FT\text{-}LBS}{.0285\ FT} = 45,094\ LBS$

$F_{SDP} = F_S - F_{PACK} + F_{PISTON} = 45,094 - 2500 + 2487 = 45,081\ LBS$

$F_{SDP} = V.F. \times A_{DISC} \{[1032 - (P_{RX} + 12)] + [1032 - P_{RX}]\}$

$F_{SDP} = V.F. \times A_{DISC} \{[1020 - P_{RX}] + [1032 - P_{RX}]\}$

$F_{SDP} = V.F. \times A_{DISC} \{2052 - 2P_{RX}\}$

$\frac{F_{SDP}}{V.F. \times A_{DISC}} = 2052 - 2P_{RX}$

$2P_{RX} = 2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}$

$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}\right]$

$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{45081}{.4(67.64)}\right]$

$P_{RX} = 193\ PSI$

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5.0 CALCULATIONS (cont.)

V-14-35

$T_A = T_{MA} \times EFF. \times OAR = 28.4 \text{ FT-LBS} \times .35 \times 108 = 1073.5 \text{ FT-LBS}$

$$F_S = \frac{T_A}{S.F.} = \frac{1073.5 \text{ FT-LBS}}{.0285 \text{ FT}} = 37,667 \text{ LBS}$$

$F_{SDP} = F_S - F_{PACK} + F_{PISTON} = 37,667 - 2500 + 2487 = 37,654 \text{ LBS.}$

$F_{SDP} = V.F. \times A_{DISC} \{ [1032 - (P_{RX} + 12)] + [1032 - P_{RX}] \}$

$F_{SDP} = V.F. \times A_{DISC} \{ [1020 - P_{RX}] + [1032 - P_{RX}] \}$

$F_{SDP} = V.F. \times A_{DISC} \{ 2052 - 2P_{RX} \}$

$$\frac{F_{SDP}}{V.F. \times A_{DISC}} = 2052 - 2P_{RX}$$

$$2P_{RX} = 2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}}$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{F_{SDP}}{V.F. \times A_{DISC}} \right]$$

$$P_{RX} = \frac{1}{2} \times \left[2052 - \frac{37,654}{.4(67.64)} \right]$$

$P_{RX} = 330 \text{ PSI}$