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GE Nuclear Energy

# BWR OWNERS' GROUP DC MOTOR PERFORMANCE METHODOLOGY-

## *Predicting Capability and Stroke Time in DC Motor-Operated Valves*

**BWR OWNERS' GROUP**

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Subject: BWR Owners' Group DC Motor Program
**BWROG Project Number 691**

Enclosure: NEDC-32958, "BWROG DC Motor Performance Methodology-Predicting Capability and Stroke Time in DC Motor-Operated Valves", Revision 0, dated March 2000

Reference: Scheduled BWROG-NRC Meeting for August 30, 2000

Attention: Chief, Information Management Branch
Policy Management, Policy Development and Analysis Staff

The BWR Owners' Group (BWROG) just completed an effort to develop a generic methodology for predicting the performance of Motor-Operated Valves (MOVs) with Direct Current (DC) Motors considering the effects of valve stem loads, supplied motor voltage and motor winding temperature.

In anticipation of the scheduled reference meeting at which the BWROG will present this methodology to the Staff, twelve (12) copies of the Enclosure are being provided for Staff review prior to the reference meeting.

Draft

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# BWR OWNERS' GROUP DC MOTOR PERFORMANCE METHODOLOGY

*Predicting Capability and Stroke Time*
*in*
*DC Motor-Operated Valves*

Developed for
BWR OWNERS' GROUP
Valve Technical Resolution Group
By
MPR Associates, Inc.

March 2000

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## FOREWORD

To effectively utilize utility resources, the BWR Owners' Group (BWROG) sponsored the development of generic methodology to better predict the performance of MOVs with DC motors under design basis conditions

The BWROG-Valve Technical Resolution Group (VTRG) Committee selected MPR Associates, Inc. as the contractor as they have demonstrated over 30 years of extensive industry experience in the area of motor-operated valves (MOV). This BWROG report is based on the MPR report (MPR-2093, Revision 0) contained herein.

## PARTICIPATING UTILITIES

The utilities listed below contributed to the development of this report. However, while this report has been endorsed by a substantial number of the members of the BWR Owners' Group, it should not be interpreted as a commitment of any individual member to a specific course of action. Each member must formally endorse the BWROG position in order for that position to become the member's position.

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## QUALITY ASSURANCE

Report MPR-2093, Revision 0, was prepared by MPR Associates under their Quality Assurance (QA) program, which meets the requirements of 10 CFR 50, Appendix B. Section 2 of this report discusses the applicability of the DC motor performance method and lists the limitations on its use.

The "spreadsheet" was not developed or validated to the requirements of 10 CFR 50, Appendix B, at the request of the participating utilities. Accordingly, if the spreadsheet is used to perform safety-related calculations, the results need to be verified independently (e.g., by hand calculations or independent software program). Alternatively, users may qualify the spreadsheet under their own QA program for use in performing safety-related calculations.

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Class I
March 2000
MPR-2093, Rev 0

MPR REPORT-2093, Revision 0

# PREDICTING CAPABILITY AND STROKE TIME IN DC MOTOR-OPERATED VALVES

Prepared by
MPR Associates, Inc.

**for**

BWR OWNERS' GROUP

**March 2000**

MPR
ASSOCIATES INC.
ENGINEERS

# Predicting Capability and Stroke Time in DC Motor-Operated Valves

MPR-2093
Revision 0

March 2000

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**QUALITY ASSURANCE DOCUMENT**
This document has been prepared, reviewed and approved in accordance with the Quality Assurance requirements of 10CFR50, Appendix B, as specified in the MPR Quality Assurance Manual.

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# Executive Summary

This report develops, justifies and validates a method for predicting the performance of MOVs with DC motors. The method calculates valve stroke time and actuator capability under design basis conditions. This analytical method is needed because the speed and capability of DC motors are affected by the loads on the valve stem, the voltage supplied to the motor and the temperature of the motor windings. As a result, performance under design basis conditions will not be the same as in a test at nominal conditions (static test with full voltage at ambient temperature).

The method uses an incremental approach to evaluate a valve stroke. At each increment of the stroke, the thrust in the valve stem is calculated from user inputs using a "load profile method." Actuator and motor performance are evaluated based on the stem thrust. Actuator efficiency is determined as a function of torque and speed using an empirically developed correlation. The motor speed is predicted using a first-principles DC motor model, which is documented in the report. In this model, motor performance at nominal conditions (ambient temperature and full voltage) is adjusted for the effects of reduced motor voltage and elevated motor temperature (due to both motor heatup and elevated ambient temperature). The stroke time is determined by cumulatively adding the times for all of the stroke increments. Actuator capability is calculated by using the method in conjunction with a nominal motor torque, which is based on a motor speed of 200 rpm.

The method is justified using motor test data from testing by NRC/INEEL, Crane-MOVATS and a nuclear utility. As part of this justification, the accuracy of the vendor performance curves for motors typically installed on MOVs in nuclear power plants is addressed. In general, the vendor curves are shown to be bounding and are recommended for use in the method. In some cases, where the vendor curves are inadequate, alternate motor performance curves based on test data are recommended.

The method for predicting stroke time is validated using data from in-plant valve tests, covering 22 valve strokes (eleven static and eleven dynamic) of seven valves at four different plants. For 20 of the 22 valve strokes, the stroke time predicted by the method bounds (i.e., is at least as high as) the measured stroke time. For the two strokes for which the predicted stroke time is not bounding, the predictions are within about 2% of the measured values.

The DC motor performance method described in this report is applicable to most MOVs in nuclear power plants with Limitorque DC motor actuators. Specific applicability requirements are listed in the report. The method can be used for other actuators and motor types; however, the user will need to obtain motor performance information (e.g., the vendor curve) and justify the data for input into the model.

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# 1 Introduction

## Background

The actuator performance and stroke time for valves powered by DC motor actuators are strongly affected by the load profile (which is affected by the fluid system conditions and the packing load), motor voltage and motor temperature. The actuator performance and stroke time measured during a test at nominal voltage and ambient temperature and with no flow or differential pressure in the pipe is not indicative of the valve's performance under design basis conditions. Limitorque, who supplies most of the motor actuators installed on valves in nuclear plants, does not provide sufficient guidance for determining stroke time under design basis conditions and for evaluating the impact of motor heatup on actuator capability. Accordingly, a justified and validated method for calculating actuator thrust capability and stroke time of DC motor operated valves (MOVs) is needed.

## Purpose

This report develops, justifies and validates a method for calculating the performance of MOVs with DC motors. The method calculates valve stroke time and actuator thrust capability under design basis conditions. The method is developed based on first principles equations for DC motor performance and uses the motor performance curves provided by the motor or actuator vendor. The method is justified using motor test data from the following:

- Testing of actuators with DC motors by the Idaho National Engineering and Environmental Laboratories (INEEL), sponsored by the Nuclear Regulatory Commission (NRC),
- Dynamometer testing of DC motors and testing of actuators with DC motors by Crane-MOVATS and Vermont Yankee (VY), and
- Dynamometer testing by a nuclear utility.

As part of this justification, the accuracy of the vendor performance curves for motors typically installed on MOVs in nuclear power plants is addressed, and recommendations are made for either using the vendor curves or alternate curves in the method for predicting motor performance.

The method is validated using data from in-plant dynamic valve tests performed by various nuclear utilities.

## DC Motors Used in Safety-Related MOVs

The majority of motor actuators installed on valves in nuclear power plants are supplied by Limitorque Corporation. Based on discussions with Limitorque personnel, DC motors supplied by Limitorque to the nuclear industry have the following characteristics.

- All DC motors are compound-wound motors manufactured by Peerless.*
- The standard DC motors supplied by Limitorque include 13 different nominal starting torques -- 2, 5, 7.5, 10, 15, 25, 40, 60, 80, 100, 150, 200, 250 -- and two different voltage ratings -- 125 and 250 VDC.
- All DC motors with a given nominal start torque and voltage are nominally identical and have the same design motor performance curve. To verify that a specific motor performance curve is applicable to a specific motor, the nominal start torque, voltage and current (full load amperage) on the motor nameplate should be compared to the torque, voltage and current (at 20% torque) on the motor performance curve.
- All DC motors have a nominal speed of 1900 rpm.

## Scope

The DC motor performance method described in this report is applicable to most MOVs in nuclear power plants with Limitorque DC motor actuators. Specific applicability requirements are listed in Section 2. The method can be used for other actuators and motor types; however, the user will need to obtain motor performance information (e.g., the vendor curve) and justify the data for input into the model. For example, users may perform motor dynamometer or actuator testing to justify motor performance data for use in the method.

## Report Organization

Section 2 describes how to implement the DC motor performance method. Section 3 discusses and justifies the key elements of the method. Section 4 describes validation of the method against valve test data. Section 5 lists the references.

---

* Power plant personnel indicate that there are some Limitorque actuators with DC motors not manufactured by Peerless. However, Limitorque's input to this work indicated that only Peerless motors are used and their information covered only Peerless motors. See "Scope" for a discussion of applying this method to other motor types.

# 2 Method Description

## Overview

### *Stroke Time*

Stroke time is calculated by considering the valve stroke in discrete increments. For each increment, the following steps are performed.

- The valve stem thrust at the beginning and end of each increment is determined based on the design basis conditions using the load profile method (alternatively, the user may specify the valve stem thrust as a function of position throughout the stroke).

- The average stem thrust is calculated by averaging the stem thrusts at the beginning and end of the increment.

- The average motor torque is calculated from the average stem thrust using the stem factor under design basis conditions, the actuator overall gear ratio and gearbox efficiency. The gearbox efficiency from the previous stroke position (calculated based on the stem torque and motor speed) is used, and pullout efficiency is used for the first stroke position.

- The motor current is determined from the torque using the motor performance curve. Motor terminal voltage is calculated using the Motor Control Center (MCC) voltage, current and resistance from the MCC to the MOV.

- The motor speed is determined as follows.

  - Adjusted motor torque is determined from the average motor torque by accounting for degraded voltage and motor temperature (the motor temperature at the end of the previous increment is used).
  - Adjusted motor speed is determined from the motor performance curve, using the adjusted motor torque.
  - Motor speed is determined from the adjusted motor speed by accounting for degraded voltage.

- The time for the stroke increment is calculated based on the increment length, motor speed, stem lead and OAR.

- The motor heatup is calculated using heatup rates provided by the motor manufacturer and added to the motor temperature at the beginning of the increment to determine motor temperature at the end of the increment.

These steps are performed for the full stroke of the valve. The predicted stroke time of the valve is the sum of the times calculated for each stroke increment.

### *Actuator Capability and Margin*

Two actuator capabilities and margins are evaluated -- "instantaneous" actuator capability and margin, and "functional" actuator capability and margin. Maximum allowable thrust at torque switch trip (closing strokes) and at unwedging (opening strokes) are also evaluated.

The instantaneous actuator capability (thrust) is calculated at each stroke position by using the nominal motor torque (see Definitions section), adjusted for degraded voltage, elevated motor temperature, and actuator gearbox efficiency (at that stroke position), along with the overall gear ratio and stem factor. The instantaneous margin is calculated at each stroke position by subtracting the required stem thrust from the instantaneous actuator capability. The minimum instantaneous margin for a given valve stroke is an indication of the degree to which the actuator is challenged during the stroke.

The functional actuator capability is determined by iteratively increasing the required stem thrust for the stroke ($F_R$) until the maximum value of adjusted motor torque at any point during the stroke equals the nominal motor torque. At this point, the instantaneous margin is zero. The functional actuator capability is an indication of the thrust capability of the actuator for that particular application, considering the effects of degraded voltage, elevated motor temperature and decreased efficiency as the motor slows down. The functional margin is calculated by subtracting the original required stem thrust from the functional actuator capability.

The minimum instantaneous margin will typically be higher than the functional margin; however, a valve with zero instantaneous margin will also have zero functional margin. Therefore, an MOV can perform its design basis function if the instantaneous capability exceeds the required thrust at all stroke positions or if the functional capability exceeds the maximum required thrust for the stroke. Therefore, either capability can be used to verify proper MOV design.

The maximum allowable thrust at torque switch trip is calculated for closing strokes by using the nominal motor torque, adjusted for degraded voltage (based on the current at nominal motor torque) and for motor temperature at the <u>last</u> stroke position. The maximum allowable thrust at unwedging is calculated for opening strokes by using the nominal motor torque, adjusted for degraded voltage (based on the current at nominal motor torque) and for motor temperature at the <u>first</u> stroke position. Unlike the calculation of instantaneous actuator capability, efficiencies based on the calculated motor speed and stem load are used. As a result, these calculations are iterative. The maximum allowable thrust at torque switch trip is the upper limit for the torque switch based on the nominal motor torque. The maximum allowable thrust at unwedging is the maximum value based on the nominal motor torque.

The maximum allowable thrusts at torque switch trip and unwedging differ from the instantaneous actuator capability at the last and first stroke positions, respectively, as follows.

- In the calculation of maximum allowable thrusts at torque switch trip and unwedging, motor voltage is calculated based on the motor current corresponding to the nominal motor torque, whereas in the calculation of instantaneous actuator capability, the motor voltages at the last stroke position (for torque switch trip) and first stroke position (for unwedging) are used.

- In the calculation of maximum allowable thrusts at torque switch trip and unwedging, gearbox efficiency is determined from Table 2-2, using the stem load and worm speed corresponding to nominal motor torque, whereas in the calculation of instantaneous actuator capability, the gearbox efficiencies at the last stroke position (for torque switch trip) and first stroke position (for unwedging) are used.

## Options

The BWROG DC motor performance method also includes the following optional techniques, which are described at the end of Section 2.

- Using static test data to determine stroke time "adders" associated with items not explicitly covered by the model: disk unwedging, actuator lost motion region, stem thread clearance, T-head clearance, or closing motion from an initial point more than 100% open.

- Evaluating valves with stroke lengths other than the nominal full stroke, including valves with short strokes and valves for which the disk travels beyond the nominal 100% open position,

- Estimating the flow rate through the valve at a specific disk position,

- Using a conservative screening method that is simpler to implement and may be adequate for MOVs with significant margin, and

- Decreasing conservatism in the model (seven suggestions are provided).

## Applicability

The sections below summarize the applicability of the BWROG DC motor performance method.

### *Valve Type and Flow Type*

The method is applicable to solid wedge, flexible wedge, double disk and parallel disk gate valves with pumped or blowdown flow, and unbalanced disk globe valves with pumped flow, based on the applicability of the valve stem load profile method. If the user specifies the stem thrust versus stroke position, there is no restriction related to valve type or flow type for use of the method. In this case, the user is responsible for justifying the accuracy of these inputs.

### *Actuator Type*

The equations in the method are applicable to any rising stem actuator; however, the actuator efficiencies used in the method have been justified for Limitorque SMB-0 and SMB-1 actuators only. Therefore, the applicability of the method is limited to Limitorque actuators. For Limitorque actuators other than SMB-0 and SMB-1, the efficiencies used in the method are considered "best available information."

### *Motor Type*

The method can be used for any compound wound DC motor for which motor performance data are known and justified. As part of development of the DC motor performance method, vendor motor performance curves were obtained for the Peerless (a division of H. K. Porter) motors listed in the table below. These curves are included in Appendix C of this report. As part of justification and validation of the method, the accuracy of these motor curves was evaluated for many of the motors. For some of the motors, the vendor motor performance curves were determined to be bounding and are recommended for use in the method. For other motors, the vendor motor performance curves were inadequate, and alternate motor performance curves, based on the vendor curves and test data, are recommended for use in the method. For motors that were not covered in justification and validation of the method, it is recommended that the vendor motor performance curves be used as "best available information." Table 2-3 lists the motor performance data that is recommended for use in the method.

| Torque, ft-lbs | Voltage, VDC | Full Load Amps[5] | Vendor Curve | Notes |
|---|---|---|---|---|
| 2 | 125<br>250 | 2.0<br>0.8 | K-4557<br>K-11297 | (3)<br>(3) |
| 5 | 125<br>250 | 4.0<br>2.0 | illegible<br>illegible | (1)<br>(3) |
| 7.5 | 125<br>250 | 5.2<br>2.6 | K-4972<br>K-4972 | (3)<br>(3) |
| 10 | 125<br>250 | 6.4<br>3.2 | K-4973<br>K-4973 | (1)<br>(3) |
| 15 | 125<br>250 | 8.9<br>4.5 | K-5010<br>K-5010 | (1)<br>(3) |
| 25 | 125<br>250 | 13.9<br>7.9 | K-5561<br>K-5499 | (1)<br>(3) |
| 40 | 125<br>250 | 24.2<br>11.0 | K-5087<br>K-5050 | (2)<br>(3) |
| 60 | 125<br>250 | 32.6<br>17.4 | K-5013<br>illegible | (1)<br>(3) |
| 80 | 125<br>250 | 43.8<br>21.2 | K-4980<br>K-4053 | (2)<br>(3) |
| 100 | 125<br>250 | 62.0<br>31.0 | illegible<br>K-4054 | (2)<br>(3) |

| Torque, ft-lbs | Voltage, VDC | Full Load Amps[5] | Vendor Curve | Notes |
|---|---|---|---|---|
| 150 | 125<br>250 | ---<br>43.8 | ---<br>illegible | (4)<br>(3) |
| 200 | 125<br>250 | 104.0<br>52.5 | K-5014<br>K-5049 | (1)<br>(3) |

Notes

(1) These vendor motor curves were shown to be bounding and are recommended for use in the method (see Table 2-3).

(2) These vendor motor performance curves were shown to be non-bounding for some motor tests at some motor speeds. The motor performance data in Table 2-3, which is based on the vendor curves and test data, is recommended for use in the method.

(3) The accuracy of these motor curves was not addressed in justification and validation of the method. These curves are recommended for use in the method as "best available information" (see Table 2-3).

(4) A vendor motor performance curve was not obtained for this motor. The motor performance data in Table 2-3 is based on test data for the 150 ft-lb, 125 VDC motor.

(5) Current corresponding to 20% torque on motor performance curve. These values are estimates of the Full Load Amps and may not be identical to values listed on the motor nameplates.

If the user provides the motor speed and current versus torque and the motor winding heatup rate, the method can be used for other compound wound DC motors. In this case, the user is responsible for justifying the accuracy of these inputs.

## User Inputs

The following inputs are needed to implement the BWROG DC motor performance method.

| | |
|---|---|
| $\rho$: | Fluid density (lbm/ft$^3$). Required for gate valves with pumped flow and globe valves to determine load profile. |
| $\tau_{rated}$: | Actuator rated torque (ft-lbs). Required for all valves to determine stroke time and motor performance. |
| $\eta_P$: | Pullout efficiency of actuator. Required for all valves to determine stroke time and motor performance. |
| $\eta_R$: | Run efficiency of actuator. Required for all valves to determine stroke time and motor performance. |
| Ambient temperature: | The initial motor temperature under design basis conditions (°C). Required for all valves to determine stroke time and motor performance. |
| $C_V$: | Flow coefficient (gpm/psi$^{1/2}$) with valve fully open. Required for globe valves to determine load profile. |
| D: | Globe valve stroke length (inches). Required for globe valves to determine stroke time and motor performance. |

$D_{body\text{-}ID}$: Inside diameter of the body seat ring seating surface (inches). If this dimension is not known, the valve port or inlet diameter can be used. The hydraulic stroke of gate valves (e.g., from fully open to flow isolation for a closing stroke) is set equal to this dimension. Required for gate valves to determine stroke time and motor performance.

$D_{disk\text{-}OD}$: Outside diameter of the disk seating surface (inches). Required for gate valves to determine stroke time and motor performance, unless X is input by the user (see Step 1.1 below).

DP: Design basis differential pressure (psi). Required for gate valves with pumped flow and globe valves to determine load profile.

$D_{sr}$: Seat ring inner diameter (inches). If this dimension is not known, the valve port or inlet diameter can be used. Required for gate valves with pumped flow and globe valves to determine load profile.

$D_{stem}$: Stem diameter (inches) at packing. Required for all valves to determine load profile.

Flow type: Pumped flow or blowdown. Required for wedge gate and double disk valves to determine load profile.

Fluid: Flashing water or steam. Required for gate valves with blowdown flow to determine load profile.

$F_{pack}$: Packing load (lbs). Required for all valves to determine load profile.

$F_R$: Maximum required thrust for the stroke, including the effect of water inertia (lbs). For self-actuating globe valve strokes, this parameter should be the load on the valve stem at the fully closed position (expressed as a negative number). Required for all valves to determine load profile.

$F_{WI}$: Required thrust due to water inertia (lbs), calculated as the difference between the required thrust with water inertia ($F_R$) and the required thrust without water inertia. If the EPRI PPM is used to determine required stem thrust, $F_{WI}$ can be calculated by subtracting the predicted thrust at initial wedging (last stroke position evaluated) from the maximum predicted thrust for the stroke. If the "valve factor" equation is used to determine required thrust, $F_{WI}$ can be calculated by subtracting the required thrust calculated using the design basis DP without the DP due to water inertia from the required thrust calculated using the design basis DP including the DP due to water inertia. If there is no contribution of water inertia for a closing stroke, then $F_{WI}$ is equal to zero. Required for all valves to determine load profile. For opening strokes, $F_{WI}$ should be set equal to zero.

lead: Valve stem lead (inches). Required for all valves to determine stroke time and motor performance.

$L_{up}$: Equivalent length of upstream piping (ft). Required for gate valves with blowdown flow to determine load profile.

MGSR: Motor gear set ratio -- the ratio of the number of motor pinion teeth to the number of worm shaft gear teeth. Note that this parameter is the inverse of the "Motor Set Ratio" defined by Limitorque in their Engineering Standard for gearing selection. Required for all valves to determine stroke time and motor performance.

Motor type: Motor type is defined as a given motor rated starting torque and nominal motor voltage ($V_{nom}$), e.g., 10 ft-lbs and 250 volts. Required for all valves to determine stroke time and motor performance.

OAR: Actuator overall ratio. Required for all valves to determine stroke time and motor performance.

$P_B$: Pressure at valve with valve fully open (psig). If $P_B$ is not known, the following values can be used for conservatism – design basis upstream pressure for closing strokes, and 0 for opening strokes. Required for all valves to determine load profile.

$Q_{max}$: Flow rate (gpm) under design basis conditions with valve fully open. Required for gate valves with pumped flow and globe valves to determine load profile.

| | |
|---|---|
| $R_{cable}$: | Resistance (ohms) of motor cables from motor control center (MCC) to valve motor. This parameter is the total circuit resistance at the design basis temperature for the cable. For some MOV configurations, the actual cable length from the MCC to the motor should be multiplied by four in calculating this cable resistance. Required for all valves to determine stroke time and motor performance. |
| $R_{tol}$: | Thermal overload resistance (ohms) under design basis conditions, which may include elevated ambient temperature. Required for all valves to determine stroke time and motor performance. |
| SF: | Stem factor (ft-lb/lb) applicable under design basis conditions for the case where thrust is required from the actuator to move the valve stem and disk. The stem factor should be calculated using a stem-to-stem nut coefficient of friction that is applicable under the valve's design basis condition, i.e., the stem-to-stem nut coefficient of friction should include any effects due to rate-of-loading. Required for all valves to determine stroke time and motor performance. |
| $SF_O$: | Overhauling stem factor (ft-lb/lb). $SF_O$ is the absolute value of the stem factor applicable under design basis conditions for the case where the stroke is self-actuating (i.e., the stem is driven against the stem nut rather than the stem nut driving the stem). The stem factor should be calculated using a stem-to-stem nut coefficient of friction that is applicable under the valve's design basis condition, i.e., the stem-to-stem nut coefficient of friction should include any effects due to rate-of-loading. Required for self-actuating globe valve strokes to determine stroke time and motor performance. |
| Stroke direction: | Open or close. Required for all valves to determine load profile. |
| Valve type: | Wedge gate, double disk or globe. Required for all valves to determine load profile. |
| $V_{mcc}$: | Voltage at MCC (volts) under design basis conditions. Required for all valves to determine stroke time and motor performance. |
| $V_{nom}$: | Nominal motor voltage (volts). Required for all valves to determine stroke time and motor performance. |
| X: | The distance, in %, a gate valve disk travels from flow isolation (defined as 0% open) to initial wedging (defined as -X% open) during a closing stroke. X can be calculated from $D_{disk\text{-}OD}$ and $D_{body\text{-}ID}$, determined from test data., or determined from the valve size based on default values provided in the method. Required for gate valves to determine load profile. |

## Definitions

| | |
|---|---|
| Functional actuator capability, $AC_{func}$ (lbs): | The highest value of maximum required stem thrust that the actuator can overcome (based on the nominal motor torque), determined by iteratively increasing the maximum required thrust ($F_R$) until the maximum adjusted motor torque equals the nominal motor torque ($\tau_{nom}$). A value of functional actuator capability is specific to a given valve stroke (of a given valve design with a given set of design basis conditions). |
| Instantaneous actuator capability, $AC_{inst}$ (lbs): | The capability of the actuator, at any given stroke position, based on the nominal motor torque, adjusted for degraded voltage and for elevated temperature at that stroke position. |

| | |
|---|---|
| Maximum allowable thrust at torque switch trip, $T_{TST\text{-}max}$ (lbs): | The highest value of thrust at torque switch trip that should be allowed during static setup testing based on the nominal motor torque. This value does not include uncertainties related to measured thrust, for example, torque switch repeatability and thrust measurement uncertainty. |
| Maximum allowable thrust at unwedging, $T_{UNW\text{-}max}$ (lbs): | The highest value of thrust at unwedging based on the nominal motor torque. |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs): | The motor torque corresponding to a motor speed of 200 rpm, at full voltage and ambient temperature, as determined from the motor performance data (e.g., the vendor motor performance curve). Values for various motor types are listed in Table 2-5. |

## Implementation

The BWROG DC motor performance method is implemented as follows. (Note that "gate valves" refers to wedge gate valves and double/parallel disk gate valves.)

### *Step 1 – Determine Stroke Range and Increments*

1.1. For gate valves, calculate the distance (% of valve stroke length) the disk travels from flow isolation (0% stroke) to initial wedging, X, using the following equation.

*Equation 2-1:*

$$X = \left( \frac{D_{disk-OD} - D_{body-ID}}{2 * D_{body-ID}} \right) * 100$$

If $D_{disk\text{-}OD}$ and $D_{body\text{-}ID}$ are not known, obtain X from the following table.

| Valve Size | X |
|---|---|
| 3 inches or less | 16% |
| 4 – 10 inches | 10% |
| 12 inches and above | 8% |

X may also be determined from test data by subtracting dimension $D_{body\text{-}ID}$ from the measured stroke length, in inches, dividing by $D_{body\text{-}ID}$ and multiplying by 100 (i.e., the measured stroke length minus $D_{body\text{-}ID}$ should be substituted in Equation 2-1 for $(D_{disk\text{-}OD} - D_{body\text{-}ID})/2$). In addition, if the valve's design basis requirement for closing is to isolate flow only, rather than to achieve full disk wedging, X can be set to 0.

1.2. Determine the stroke range from the table below.

| Valve Type | Opening Stroke | Closing Stroke |
|---|---|---|
| Gate Valves | -X to 100% | 100 to –X% |
| Globe Valves | 0 to 100% | 100 to 0% |

100% open for gate valves is defined as the disk position at which the outside diameter of the disk seat crosses the inside diameter of the body seat, near the beginning of a closing stroke or the end of an opening stroke. Page 2-17 provides guidance for evaluating valve closing strokes in which disk motion starts from a position greater than 100% open.

1.3. Determine the stroke increments from the table below.

| Stroke Range | | Increment | Number of Increments |
|---|---|---|---|
| Open | Close | | |
| -X to 0%(1) | 0 to –X%(1) | 1%(2) | up to 10(2) |
| 0 to 10% | 10 to 0% | 1% | 10 |
| 10 to 30% | 30 to 10% | 2% | 10 |
| 30 to 60% | 60 to 30% | 5% | 6 |
| 60 to 100% | 100 to 60% | 10% | 4 |

(1) This stroke range is applicable for gate valves only
(2) If X is greater than 10, this stroke range should be divided into ten equal increments.

### *Step 2 – Determine Valve Load and Torque Profile*

2.1. For gate valves with pumped flow and globe valves, calculate the equivalent system resistance, $K_{sys}$ (dimensionless), using the following equation.

*Equation 2-2:*

$$K_{sys} = \frac{894.01(D_{sr}^4)(DP)}{Q_{max}^2}\left(\frac{62.4}{\rho}\right)$$

2.2. Next, calculate the load profile coefficient, C (dimensionless), at each value of stroke position from 0 to 100% defined by the increments determined in Step 1.

For gate valves, locate the appropriate C values in Table 2-1 for the valve type, flow type, fluid and stroke direction. Use linear interpolation between columns and rows to find the values appropriate for the specific stroke positions and $K_{sys}$ (for pumped flow) or $L_{up}$ (for blowdown flow). If $K_{sys}$ is greater than 5000, set $K_{sys}$ equal to 5000. If $L_{up}$ is greater than 10,000, then set $L_{up}$ equal to 10,000.

For globe valves, calculate the resistance of the valve, $K_{valve}$ (dimensionless), and C values at each value of stroke position (% stroke) defined by the increments determined in Step 1 using the following equations.

*Equation 2-3:* $$K_{valve} = \left( \frac{29.9D_{sr}^2}{(\%\,\text{stroke})(C_V)} \right)^2$$

*Equation 2-4:* $$C = \frac{K_{valve}}{K_{valve} + K_{sys}}$$

Note that at 0% stroke, $K_{valve}$ is infinite and C is one. This approach assumes that the $C_V$ for the valve is linear with stroke position.

2.3. Calculate the required thrust at fully open, $F_O$ (lbs), using one of the equations below. Note that for some opening strokes, $F_O$ may be negative (i.e., self-actuating).. Note that for globe valves, $F_O$ is the fully open stem thrust not including DP load, which is added in Equation 2-7.

*Equation 2-5:* $$F_O = F_{pack} - \frac{\pi}{4} D_{stem}^2 P_B \quad \textit{for opening strokes}$$

*Equation 2-6:* $$F_O = F_{pack} + \frac{\pi}{4} D_{stem}^2 P_B \quad \textit{for closing strokes}$$

2.4. At each value of stroke position from 0 to 100%, calculate the stem thrust, F (lbs), using the equation below. Note that F may be negative (i.e., self-actuating) at some or all stroke positions.

*Equation 2-7:* $$F = F_O + C(F_R - F_O)$$

2.5. For gate valves, set the stem thrust, F, for all increments from 0 to –X% equal to ($F_R$ -$F_{WI}$).

### *Step 3 – Calculate Time Associated With Each Stroke Increment*

Perform the following steps at each stroke increment.

3.1. Calculate the average stem thrust, $F_{ave}$ (lbs), by averaging the thrust at the beginning and the end of the increment.

3.2. Convert each average stem thrust to an average stem torque, $\tau_{S\text{-}ave}$ (ft-lbs), using one of the following equations.

*Equation 2-8:* $$\tau_{S-ave} = F_{ave} * SF \quad \textit{(for } F_{ave} \geq 0\textit{)}$$

*Equation 2-9:* $$\tau_{S-ave} = \left| F_{ave} * SF_O \right| \quad \textit{(for } F_{ave} < 0\textit{)}$$

3.3. For the first increment, set the gearbox efficiency, $\eta$ (dimensionless), to the pullout efficiency, $\eta_P$. For other stroke positions, determine the gearbox efficiency as follows.

3.3.1. Calculate the worm speed, $\omega_W$ (rpm), for the previous increment (which is applied for the current increment) using the equation below. Note that $\omega_{motor\text{-}previous}$ (rpm) is the true motor speed at the previous increment.

*Equation 2-10:* $\omega_W = \omega_{motor-previous} * MGSR$

3.3.2. Determine the efficiency factor, f (dimensionless), from Table 2-2 using the average stem torque calculated in step 3.2, the actuator rated torque, $\tau_{rated}$, and $\omega_W$. Values of f should be interpolated for $\omega_W$ and $\tau_{S\text{-}ave}/\tau_{rated}$ values not shown in Table 2-2.

3.3.3. Calculate the gearbox efficiency, $\eta$, using the following equation.

*Equation 2-11:* $\eta = \eta_P + f(\eta_R - \eta_P)$

3.4. Convert each average stem torque to an average motor, $\tau_{M\text{-}ave}$ (ft-lbs), torque using the following equation.

*Equation 2-12:* $$\tau_{M-ave} = \left(\frac{\tau_{S-ave}}{(OAR)(\eta)}\right)$$

3.5. Using the motor performance data in Table 2-3 for the appropriate motor (i.e., nominal torque and voltage), determine the motor current, I (amps), corresponding to the <u>average</u> motor torque, $\tau_{M\text{-}ave}$. Use interpolation in Table 2-3, as needed. Calculate the motor terminal voltage, $V_T$ (volts), using the following equation.

*Equation 2-13:* $$V_T = V_{mcc} - (I)(R_{cable} + R_{tol})$$

3.6. Calculate the adjusted motor torque, $\tau'$ (ft-lbs), using the equation below. The temperature at the end of the previous increment should be used as the motor temperature, $T_{motor}$ (°C). For the first stroke increment, use the ambient temperature. Use 25°C for $T_{ref}$. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-14:* $$\tau' = \tau_{M-ave}\left(\frac{V_{nom}}{V_T}\right)\left(\frac{T_{motor} + 234.4}{T_{ref} + 234.4}\right)$$

3.7. Using the motor performance data in Table 2-3, determine the <u>adjusted</u> motor speed, $\omega'$ (rpm), corresponding to the <u>adjusted</u> motor torque. Use interpolation in Table 2-3, as needed. Calculate the true motor speed, $\omega$ (rpm), using the equation below. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-15:* $$\omega = \omega'\left(\frac{V_T}{V_{nom}}\right)$$

3.8. Calculate the stroke time increment, $\Delta t$ (sec), using one of the following equations, based on the stroke increment, $\delta$ (expressed as a decimal number, i.e., 1%=0.01).

*Equation 2-16:* $$\Delta t = \frac{60(\delta)(D_{body-ID})(OAR)}{(\omega)(lead)}$$ *for gate valves*

*Equation 2-17:* $$\Delta t = \frac{60(\delta)(D)(OAR)}{(\omega)(lead)}$$ *for globe valves*

3.9. Identify the reference torque, $\tau_{ref}$ (ft-lbs) (typically 20% of rated torque), in Table 2-4 for the applicable motor type. If more than one reference torque is listed for a motor type, choose the value closest to the average motor torque, $\tau_{M\text{-}ave}$. Identify the reference motor heatup rate, $h_{ref}$ (C°/sec), from Table 2-4 corresponding to the reference torque. Calculate the motor temperature at the end of the increment, $T_{motor}$, using the following equation, based on the motor temperature at the end of the previous stroke increment, $T_{previous}$.

*Equation 2-18:* $$T_{motor} = T_{previous} + (\Delta t)(h_{ref})\left(\frac{\tau_{M-ave}}{\tau_{ref}}\right)^2$$

### *Step 4 – Calculate Valve Stroke Time*

The motor stroke time is the sum of the stroke time increments, $\sum\Delta t$.

### *Step 5 – Calculate Instantaneous Actuator Capability and Margin*

Perform the following steps at each stroke increment to calculate the instantaneous actuator capability, $AC_{inst}$, and margin, $M_{inst}$.

5.1. Calculate the instantaneous actuator capability, $AC_{inst}$, using the equation below. Use the same values of $V_T$, $T_{motor}$ and $\eta$ used in Step 3 for each stroke increment (i.e., use the temperature at the end of the previous increment for $T_{motor}$ and use the motor speed at the end of the previous increment to determine $\eta$). Use 25°C for $T_{ref}$. If the stroke is self-actuating, use $SF_O$ rather than SF.

*Equation 2-19:* $$AC_{inst} = \tau_{nom} * \left(\frac{OAR * \eta}{SF}\right)\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_{motor} + 234.4}\right)$$

5.2. Calculate the instantaneous margin, $M_{inst}$ (lbs), using the stem thrust (F) determined in Step 2 for each increment and the equation below.

*Equation 2-20:* $M_{inst} = AC_{inst} - |F|$

### *Step 6 – Calculate Functional Actuator Capability and Margin*

Calculate the functional actuator capability, $AC_{func}$, and margin, $M_{func}$, as follows.

6.1. Set the required thrust, $F_R$, equal to 90% of the minimum instantaneous actuator capability for the stroke.

6.2. Repeat Steps 2.4, 2.5 and 3 to implement the DC motor performance method for this required thrust. Determine the maximum adjusted motor torque, $\tau'$, for the stroke.

6.3. If $\tau'$ is less than $\tau_{nom}$, then increase $F_R$ and repeat step 6.2. If $\tau'$ is more than $\tau_{nom}$, then decrease $F_R$ and repeat step 6.2.

6.4. Repeat step 6.3 until $\tau'$ equals $\tau_{nom}$. The functional actuator capability ($AC_{func}$) is the value of $F_R$ for which $\tau'$ equals $\tau_{nom}$.

6.5. Calculate the functional margin, $M_{func}$, using the equation below. Note that $F_R$ in this equation is the originally specified maximum required thrust for the stroke, rather than the value that is iteratively increased in steps 6.1, 6.3 and 6.4.

*Equation 2-21:* $M_{func} = AC_{func} - |F_R|$

### *Step 7 – Calculate Maximum Allowable Thrust at Torque Switch Trip (Closing Strokes Only)*

For closing strokes, calculate the maximum allowable thrust at torque switch trip, $T_{TST\text{-}max}$, as follows.

7.1. Determine the terminal voltage ($V_T$) and the available motor torque using the following iterative approach.

7.1.1. Using the motor performance data in Table 2-3 for the appropriate motor, determine the motor current corresponding to the nominal motor torque, $\tau_{nom}$. Use interpolation in Table 2-3, as needed. Initially set the motor current, I (amps), to this value.

7.1.2. Calculate the motor voltage, $V_T$ (volts), using the following equation.

*Equation 2-22:* $V_T = V_{mcc} - (I)(R_{cable} + R_{tol})$

7.1.3. Calculate the available motor torque, $\tau_M$ (ft-lbs), using the equation below. Use the value of $T_{motor}$ from the last stroke increment evaluated (i.e., at -X%). Use 25°C for $T_{ref}$. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-23:* $$\tau_M = \tau_{nom}\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_{motor} + 234.4}\right)$$

7.1.4. Using the motor performance data in Table 2-3 for the appropriate motor, determine the motor current corresponding to $\tau_M$.

7.1.5. Repeat Steps 7.1.2 through 7.1.4 until the motor current change from one iteration to the next is less than 1% of the motor current determined in Step 7.1.1. Use the $\tau_M$ and $V_T$ values calculated for the last iteration in the calculations below.

7.2. Determine the motor speed, $\omega_{nom}$ (rpm), at $\tau_{nom}$ from the motor performance data in Table 2-3, and calculate the worm speed, $\omega_W$, using the equation below. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-24:* $$\omega_W = \omega_{nom}\left(\frac{V_T}{V_{nom}}\right) * MGSR$$

7.3. Determine the gearbox efficiency, $\eta$, using the following iterative approach.

7.3.1. Initially set the gearbox efficiency to the pullout efficiency ($\eta_P$).

7.3.2. Calculate the stem torque, $\tau_S$ (ft-lbs), using the following equation.

*Equation 2-25:* $$\tau_S = \tau_M * OAR * \eta$$

7.3.3. Determine an efficiency factor, f, from Table 2-2 using $\tau_S$, the actuator rated torque, $\tau_{rated}$, and $\omega_W$. Values of f should be interpolated for $\omega_W$ and $\tau_{S\text{-}ave}/\tau_{rated}$ values not shown in Table 2-2.

7.3.4. Calculate the gearbox efficiency, $\eta$, using the following equation.

*Equation 2-26:* $$\eta = \eta_P + f(\eta_R - \eta_P)$$

7.3.5. Re-calculate the stem torque using Equation 2-25.

7.3.6. Repeat steps 7.3.3, 7.3.4 and 7.3.5 until the stem torque change from one iteration to the next is less than 1% of $\tau_{rated}$. The gearbox efficiency is the value of $\eta$ for the final iteration.

7.4. Calculate the maximum allowable thrust at torque switch trip, $T_{TST\text{-}max}$, using the equation below. Use the value of $T_{motor}$ from the last stroke increment evaluated (i.e., at -X%). Use 25°C for $T_{ref}$.

*Equation 2-27:* $$T_{TST-max} = \tau_{nom} * \left(\frac{OAR * \eta}{SF}\right)\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_{motor} + 234.4}\right)$$

### *Step 8 – Calculate Maximum Allowable Thrust at Unwedging (Gate Valve Opening Strokes Only)*

For opening strokes, calculate the maximum allowable thrust at unwedging, $T_{UNW-max}$, as follows.

8.1. Determine the terminal voltage ($V_T$) and the available motor torque using the following iterative approach.

8.1.1. Using the motor performance data in Table 2-3 for the appropriate motor, determine the motor current corresponding to the nominal motor torque, $\tau_{nom}$. Use interpolation in Table 2-3, as needed. Initially set the motor current, I (amps), to this value.

8.1.2. Calculate the motor voltage, $V_T$ (volts), using the following equation.

*Equation 2-28:* $$V_T = V_{mcc} - (I)(R_{cable} + R_{tol})$$

8.1.3. Calculate the available motor torque, $\tau_M$ (ft-lbs), using the equation below. Set $T_{motor}$ equal to the ambient temperature. Use 25°C for $T_{ref}$. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-29:* $$\tau_M = \tau_{nom}\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_{motor} + 234.4}\right)$$

8.1.4. Using the motor performance data in Table 2-3 for the appropriate motor, determine the motor current corresponding to $\tau_M$.

8.1.5. Repeat Steps 8.1.2 through 8.1.4 until the motor current change from one iteration to the next is less than 1% of the motor current determined in Step 8.1.1. Use the $\tau_M$ and $V_T$ values calculated for the last iteration in the calculations below.

8.2. Determine the motor speed, $\omega_{nom}$ (rpm), at $\tau_{nom}$ from the motor performance curve, and calculate the worm speed, $\omega_W$, using the equation below. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-30:* $$\omega_W = \omega_{nom}\left(\frac{V_T}{V_{nom}}\right) * MGSR$$

8.3. Determine the gearbox efficiency, $\eta$, using the following iterative approach.

8.3.1. Initially set the gearbox efficiency to the pullout efficiency ($\eta_P$).

8.3.2. Calculate the stem torque, $\tau_S$ (ft-lbs), using the following equation.

*Equation 2-31:* $$\tau_S = \tau_M * OAR * \eta$$

8.3.3. Determine an efficiency factor, f, from Table 2-2 using $\tau_S$, the actuator rated torque, $\tau_{rated}$, and $\omega_W$. Values of f should be interpolated for $\omega_W$ and $\tau_{S\text{-}ave}/\tau_{rated}$ values not shown in Table 2-2.

8.3.4. Calculate the gearbox efficiency, $\eta$, using the following equation.

*Equation 2-32:* $$\eta = \eta_P + f(\eta_R - \eta_P)$$

8.3.5. Re-calculate the stem torque using Equation 2-31.

8.3.6. Repeat steps 8.3.3, 8.3.4 and 8.3.5 until the stem torque change from one iteration to the next is less than 1% of $\tau_{rated}$. The gearbox efficiency is the value of $\eta$ for the final iteration.

8.4. Calculate the maximum allowable thrust at unwedging, $T_{UNW\text{-}max}$, using the equation below. Set $T_{motor}$ equal to the ambient temperature. Use 25°C for $T_{ref}$.

*Equation 2-33:* $$T_{UNW-max} = \tau_{nom} * \left(\frac{OAR * \eta}{SF}\right)\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_{motor} + 234.4}\right)$$

8.5. Calculate the margin for unwedging by subtracting the required thrust at unwedging (determined by the user) from the maximum allowable thrust at unwedging.

## Other Considerations in Determining Stroke Time

The stroke time predicted using the method above covers closing strokes from 100% open (beginning with initial disk motion) to initial wedging/seating and opening strokes from just after unwedging to 100% open. The predicted stroke time does not include the time required for the actuator to move through the actuator lost motion region, the stem to move through the thread and T-head clearances or for disk unwedging (opening strokes only). If desired by the user, static test data can be used to estimate the additional stroke time due to these effects, as follows.

- For a closing stroke, the time between motor start and initial disk motion can be determined from static test data and added to the stroke time predicted using the DC motor method.

- For an opening stroke, the time between motor start and the point just after unwedging can be determine from static test data and added to the stroke time predicted using the DC motor method.

These methods are approximate; see Section 3 for a discussion of the assumptions and their justification.

## Evaluating Stroke Lengths Other Than the Valve Full Stroke

For gate valves, the DC motor performance method defines fully open (100% stroke) as the point in the stroke where the outside diameter of the disk seat is in line with the inside diameter of the body seat ring, at the top of the seat ring. Theoretical flow isolation is defined as the point in the stroke where the outside diameter of the disk seat is in line with the inside diameter of the body seat ring, at the bottom of the seat ring. Fully closed (-X%) is defined by the user or based on default values in the method. Therefore, full stroke is the inside diameter of the body seat ring seating surface ($D_{body\text{-}ID}$) plus X% times $D_{body\text{-}ID}$. Step 1.1 provides guidance for using a measured valve stroke length in the DC motor performance method. The approach given assumes that hydraulic stroke length is $D_{body\text{-}ID}$, and assumes the difference between the measured valve stroke length and $D_{body\text{-}ID}$ is the travel from theoretical flow isolation to wedging. This approach is conservative for valves that start a closing stroke from above the assumed fully open position. As mentioned in Step 1.1, if a gate valve is required to achieve theoretical flow isolation only (as opposed to achieving full disk wedging), X can be set to zero. For globe valves, the valve full stroke is input by the user and assumed to cover disk travel from fully open to fully closed (disk seating).

For some gate valves, the disk may travel beyond the 100% stroke position. During an opening stroke, the motion beyond 100% open is of no consequence since the valve is already fully open; therefore, no stroke time adjustment is needed. For a closing stroke, the user may adjust the calculated stroke time to account for the additional disk movement required at the beginning of the stroke (i.e., to reach the 100% stroke position). If the user is able to determine (e.g., from test data) the distance the disk travels before reaching the 100% stroke position, d (inches), the stroke time increment associated with this disk travel can be estimated using the equation below, which is based on Equation 2-17. Note that $\omega_{100\%}$ (rpm) is the true motor speed at 100% open, calculated using Equation 2-15.

*Equation 2-34:*

$$\Delta t = \frac{60(d)(OAR)}{(\omega_{100\%})(lead)}$$

Specific valve applications for which the disk is not required to travel the full stroke can be evaluated using the DC motor performance method. The following partial stroke scenarios can be evaluated.

- Closing strokes for which the disk starts from a position other than fully open and/or for which the disk is not required to reach flow isolation, and
- Opening strokes for which the disk starts from a position other than fully closed and/or for which the disk is not required to reach fully open. (Note that gate valve strokes for which the disk starts at flow initiation can be evaluated by setting X equal to 0.)

To evaluate a gate or globe valve stroke for a partial stroke, the DC motor performance method should be implemented as described above except that the calculations described in Step 3, which are performed at each stroke increment, should only be performed for the stroke increments that cover the partial stroke of the valve under design basis conditions. The first stroke increment should be the increment determined in Step 1 that includes the initial position of the disk, and the last stroke increment should be the increment determined in Step 1 that contains the final disk position. The beginning stroke position of the first increment and the final stroke position of the final increment can be adjusted, if desired, to more accurately cover the partial stroke of the valve.

Note that the load profile should be determined in Step 2 using the full valve stroke length, not the partial stroke under design basis conditions. For gate valves, the default stroke length should be used (or X can be determined from test data, as described in Step 1.1), and for globe valves, the full stroke of the valve, not the partial stroke required under design basis conditions, should be used.

Note that the prediction of maximum allowable thrust at torque switch trip is not applicable for gate valve closing strokes for which the disk does not wedge, and the prediction of maximum allowable unwedging thrust is not applicable for gate valve strokes for which the disk is not required to unwedge under design basis conditions.

### *Estimating Valve Flow Rate*

The approach described below can be used to estimate the flow rate through the valve at a given stroke position, e.g., to justify that a valve can achieve a certain flow rate at a certain point in an opening stroke. This approach is only applicable for applications with incompressible, non-choked flow.

1. For gate valves, determine the valve loss coefficient, $K_{valve}$, from Table 2-6 (from Reference 2), based on the stroke position (interpolation should be used, as required). For globe valves, calculate $K_{valve}$ using the equation below.

*Equation 2-35:*

$$K_{valve} = \left( \frac{29.9 * D_{sr}^2}{(\%\ \text{stroke})(C_V)} \right)^2$$

2. Calculate the estimated flow through the valve, Q (gpm), using the equation below.

*Equation 2-36:*

$$Q = \left( \frac{29.9 * D_{sr}^2}{\sqrt{K_{valve} + K_{SYS}}} \right) \sqrt{DP \left( \frac{62.4}{\rho} \right)}$$

Note that the calculation of $K_{SYS}$ (Equation 2-2) neglects the resistance of the valve at the fully open position. Therefore, the maximum flow rate predicted above may be less than the design basis flow rate, particularly for globe valves, for which the fully open resistance may not be negligible.

## Methods to Decrease Conservatism in Method Predictions

Stroke times and capabilities predicted by the DC motor performance method may be conservative for several reasons, some of which are listed below.

- The load profile method may overpredict the required stem thrust as a function of stroke position due to assumptions in the method related to whether the disk is sliding on the guides or on the seat.

- The default X values may overpredict the distance from flow isolation to wedging for some valves.

- The gearbox efficiencies for some actuators may be greater than the values used in the method.

- The speed for a given motor may be higher, as a function of motor torque, than the values used in the method (which are generally based on the vendor motor performance curves).

In addition, conservatism in user inputs (for example, stem factor and voltage at the motor control center) can result in conservatism in the method stroke time predictions.

Since the DC motor performance method provides bounding predictions, users should consider the approaches listed below to decrease conservatism in the predictions before valve or actuator modifications are implemented. These approaches are listed in the order in which they should be considered, i.e., the first approaches listed are expected to have the greatest effect on predicted stroke time, considering the effort required.

- Review the basis for the voltage at the motor control center, $V_{MCC}$, which is a user input. Since degraded voltage affects both the torque and speed of the motor, conservative values of $V_{MCC}$ can significantly affect the predicted stroke time and actuator capability. Remove any conservatism in $V_{MCC}$, and implement the method for the new conditions.

- Review the design basis conditions for the valve, including the maximum required thrust, $F_R$, the ambient temperature and the design basis flow rate (for gate valves with pumped flow). Remove any conservatism in the design basis conditions and implement the method for the new conditions. Justifying a lower value of maximum required thrust can decrease the predicted stroke time and increase the instantaneous actuator capability but will not affect the functional actuator capability. Justifying a lower ambient temperature or design basis flow rate (gate valves with pumped flow only) can decrease the predicted stroke time and increase both the instantaneous and functional actuator capabilities.

- For gate valves, if the method default X value is used, obtain dimensions $D_{disk\text{-}OD}$ and $D_{body\text{-}ID}$ (e.g., from the vendor), and calculate an X value using Equation 2-1. Implement the method using this value of X. This approach can decrease the predicted stoke time and increase both the instantaneous and functional actuator capabilities.

- Remove the motor and perform a dynamometer test to determine the speed and current versus torque characteristic of the motor under nominal conditions. Implement the method using these measured values (adjusted for measurement uncertainty). This data can decrease the predicted stoke time and increase both the instantaneous and functional actuator capabilities.

- Remove the motor actuator from the valve and perform an actuator test to determine the speed versus torque characteristic of the motor under nominal conditions and the gearbox efficiency versus stem load and worm speed. Implement the method using these measured values (adjusted for measurement uncertainty). This data can decrease the predicted stoke time and increase both the instantaneous and functional actuator capabilities.

- For gate valves, perform a static valve test and measure the static stroke length of the valve. Adjust the value of X in the method based on the measured static stroke length, as discussed in Step 1.1 of the method, and implement the method using this value of X. This approach can decrease the predicted stoke time and increase both the instantaneous and functional actuator capabilities.

- Perform a dynamic valve test at the valve's design basis conditions ($V_{mcc}$, ambient temperature, DP and $Q_{max}$) and measure the valve stroke time.

## Screening Method

Some valve applications with stroke time requirements may have significant margin such that a detailed calculation as described above is not required. The following procedure can be used to conservatively screen these valve applications and assure that they can meet their stroke time requirements.

1. Calculate the motor torque corresponding to the maximum required thrust, $F_R$, using the equation below. If the stroke is self-actuating, use $SF_O$ rather than SF.

   *Equation 2-37:* $$\tau = |F_R| * \left( \frac{SF}{OAR * \eta_P} \right)$$

2. Calculate the motor voltage, $V_T$ (volts), using the following equation. The locked rotor current, $I_{LR}$ (amps), is the current at zero speed in Table 2-3 for the applicable motor type.

   *Equation 2-38:* $$V_T = V_{mcc} - (I_{LR})(R_{cable} + R_{tol})$$

3. Calculate the adjusted motor torque, $\tau'$ (ft-lbs), using the following equation. Use 25°C for $T_{ref}$. Use the ambient temperature plus 10°C as $T_{motor}$. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-39:* $$\tau' = \tau\left(\frac{V_{nom}}{V_T}\right)\left(\frac{T_{motor} + 234.4}{T_{ref} + 234.4}\right)$$

4. Using the motor performance data in Table 2-3 for the appropriate motor, determine the adjusted motor speed, $\omega'$ (rpm), corresponding to the adjusted motor torque. Use interpolation in Table 2-3, as needed. If $\omega'$ is less than 1000 rpm, then this screening method cannot be used; a detailed stroke time calculation is required.

5. Calculate the motor speed, $\omega$ (rpm), using the following equation. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$.

*Equation 2-40:* $$\omega = \omega'\left(\frac{V_T}{V_{nom}}\right)$$

6. Calculate the threshold stroke time, $t_T$ (seconds), using the appropriate equation below.

*Equation 2-41:* $$t_T = \frac{60(1+X)(D_{body-ID})(OAR)}{(\omega)(lead)}$$ *for gate valves*

*Equation 2-42:* $$t_T = \frac{60(D)(OAR)}{(\omega)(lead)}$$ *for globe valves*

7. Identify the reference torque, $\tau_{ref}$ (ft-lbs) (typically 20% of rated torque), in Table 2-4 for the applicable motor type. If more than one reference torque is listed for a motor type, choose the value closest to the motor torque, $\tau$. Identify the reference motor heatup rate, $h_{ref}$ (C°/sec), from Table 2-4 corresponding to the reference torque. Calculate the motor temperature at the end of the stroke, $T_f$, using the equation below. Use the ambient temperature as $T_i$.

*Equation 2-43:* $$T_f = T_i + (t_T)(h_{ref})\left(\frac{\tau}{\tau_{ref}}\right)^2$$

8. If $T_f$ is greater than the ambient temperature plus 10°C, restart this procedure from step 3 using $T_f$ + 5°C as $T_{motor}$. Otherwise, continue with step 9.

9. If the threshold stroke time is less than allowable stroke time, the valve is verified to be able to meet its stroke time requirement, and a detailed calculation of stoke time is not required.

10. Use the equation below to calculate the minimum actuator capability, $AC_M$ (pounds), for the stroke. Use 25°C for $T_{ref}$. Note that if $V_T$ is greater than $V_{nom}$, $V_T$ should be set equal to $V_{nom}$. If the stroke is self-actuating, use $SF_O$ rather than SF.

*Equation 2-44:* $$AC_M = \tau_{nom} * \left(\frac{OAR * \eta_P}{SF}\right)\left(\frac{V_T}{V_{nom}}\right)\left(\frac{T_{ref} + 234.4}{T_f + 234.4}\right)$$

11. Use the equation below to calculate the minimum margin, M (pounds), for the stroke.

*Equation 2-45:* $$M = AC_M - |F_R|$$

In the calculation above, the motor current is assumed to be equal to the motor locked rotor current, the gearbox efficiency is assumed to be equal to the pullout efficiency and the motor heatup is estimated. If desired, the calculation approach can be modified to iterate on torque and speed to more accurately calculate the actual motor current and heatup and the gearbox efficiency.

**Table 2-1.** Load Profile Coefficients (4 pages)

Wedge Gate Valves – Closing Strokes – Pumped Flow

| Stroke | System Resistance, $K_{sys}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | ≥5000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 86.96% | 0.007 | 0.007 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 65.22% | 0.050 | 0.050 | 0.027 | 0.011 | 0.006 | 0.003 | 0.001 | 0.001 | 0.000 | 0.000 |
| 54.35% | 0.102 | 0.102 | 0.056 | 0.024 | 0.012 | 0.006 | 0.002 | 0.001 | 0.001 | 0.000 |
| 38.04% | 0.219 | 0.219 | 0.131 | 0.060 | 0.031 | 0.016 | 0.007 | 0.003 | 0.002 | 0.001 |
| 27.17% | 0.352 | 0.352 | 0.240 | 0.123 | 0.068 | 0.036 | 0.015 | 0.007 | 0.004 | 0.002 |
| 16.30% | 0.582 | 0.582 | 0.483 | 0.320 | 0.204 | 0.119 | 0.053 | 0.027 | 0.014 | 0.006 |
| 10.87% | 0.799 | 0.799 | 0.732 | 0.585 | 0.438 | 0.292 | 0.146 | 0.079 | 0.042 | 0.017 |
| 8.70% | 0.863 | 0.863 | 0.818 | 0.707 | 0.577 | 0.422 | 0.233 | 0.134 | 0.072 | 0.030 |
| 6.52% | 0.873 | 0.873 | 0.851 | 0.790 | 0.706 | 0.582 | 0.381 | 0.242 | 0.140 | 0.062 |
| 4.35% | 0.932 | 0.932 | 0.925 | 0.903 | 0.869 | 0.808 | 0.667 | 0.517 | 0.357 | 0.185 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

Wedge Gate Valves – Opening Strokes – Pumped Flow

| Stroke | System Resistance, $K_{sys}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | ≥5000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 86.96% | 0.004 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 65.22% | 0.069 | 0.069 | 0.036 | 0.015 | 0.008 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 |
| 54.35% | 0.137 | 0.137 | 0.075 | 0.032 | 0.016 | 0.008 | 0.003 | 0.002 | 0.001 | 0.000 |
| 38.04% | 0.260 | 0.260 | 0.156 | 0.071 | 0.037 | 0.019 | 0.008 | 0.004 | 0.002 | 0.001 |
| 27.17% | 0.503 | 0.503 | 0.343 | 0.175 | 0.097 | 0.051 | 0.021 | 0.011 | 0.005 | 0.002 |
| 16.30% | 0.838 | 0.838 | 0.695 | 0.460 | 0.294 | 0.171 | 0.076 | 0.039 | 0.020 | 0.008 |
| 10.87% | 0.942 | 0.942 | 0.864 | 0.690 | 0.517 | 0.344 | 0.172 | 0.094 | 0.049 | 0.020 |
| 8.70% | 1.104 | 1.104 | 1.047 | 0.905 | 0.739 | 0.540 | 0.299 | 0.171 | 0.092 | 0.039 |
| 6.52% | 1.180 | 1.180 | 1.150 | 1.068 | 0.954 | 0.786 | 0.515 | 0.327 | 0.189 | 0.083 |
| 4.35% | 1.158 | 1.158 | 1.148 | 1.121 | 1.079 | 1.003 | 0.828 | 0.642 | 0.443 | 0.229 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

**Table 2-1.** Load Profile Coefficients (4 pages)

Double Disk Valves – Closing Strokes – Pumped Flow

| Stroke | System Resistance, $K_{sys}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | ≥5000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 86.96% | 0.007 | 0.007 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 65.22% | 0.050 | 0.050 | 0.026 | 0.011 | 0.006 | 0.003 | 0.001 | 0.001 | 0.000 | 0.000 |
| 54.35% | 0.101 | 0.101 | 0.055 | 0.023 | 0.012 | 0.006 | 0.002 | 0.001 | 0.001 | 0.000 |
| 38.04% | 0.218 | 0.218 | 0.131 | 0.059 | 0.031 | 0.016 | 0.006 | 0.003 | 0.002 | 0.001 |
| 27.17% | 0.348 | 0.348 | 0.237 | 0.121 | 0.067 | 0.035 | 0.015 | 0.007 | 0.004 | 0.001 |
| 16.30% | 0.575 | 0.575 | 0.477 | 0.315 | 0.202 | 0.117 | 0.052 | 0.027 | 0.014 | 0.006 |
| 10.87% | 0.794 | 0.794 | 0.728 | 0.581 | 0.436 | 0.290 | 0.145 | 0.079 | 0.041 | 0.017 |
| 8.70% | 0.855 | 0.855 | 0.811 | 0.701 | 0.572 | 0.418 | 0.231 | 0.133 | 0.072 | 0.030 |
| 6.52% | 0.864 | 0.864 | 0.842 | 0.781 | 0.698 | 0.575 | 0.377 | 0.239 | 0.138 | 0.061 |
| 4.35% | 0.926 | 0.926 | 0.918 | 0.896 | 0.863 | 0.802 | 0.662 | 0.513 | 0.354 | 0.183 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

Double Disk Valves – Opening Strokes – Pumped Flow

| Stroke | System Resistance, $K_{sys}$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 | 1000 | 2000 | ≥5000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 86.96% | 0.004 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 65.22% | 0.068 | 0.068 | 0.036 | 0.015 | 0.008 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 |
| 54.35% | 0.136 | 0.136 | 0.075 | 0.032 | 0.016 | 0.008 | 0.003 | 0.002 | 0.001 | 0.000 |
| 38.04% | 0.259 | 0.259 | 0.155 | 0.071 | 0.037 | 0.019 | 0.008 | 0.004 | 0.002 | 0.001 |
| 27.17% | 0.500 | 0.500 | 0.340 | 0.174 | 0.096 | 0.051 | 0.021 | 0.011 | 0.005 | 0.002 |
| 16.30% | 0.832 | 0.832 | 0.690 | 0.457 | 0.292 | 0.170 | 0.075 | 0.039 | 0.020 | 0.008 |
| 10.87% | 0.939 | 0.939 | 0.861 | 0.688 | 0.515 | 0.343 | 0.171 | 0.093 | 0.049 | 0.020 |
| 8.70% | 1.099 | 1.099 | 1.041 | 0.901 | 0.735 | 0.537 | 0.297 | 0.170 | 0.092 | 0.039 |
| 6.52% | 1.173 | 1.173 | 1.143 | 1.061 | 0.948 | 0.782 | 0.512 | 0.325 | 0.188 | 0.083 |
| 4.35% | 1.153 | 1.153 | 1.143 | 1.116 | 1.074 | 0.999 | 0.825 | 0.639 | 0.441 | 0.228 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

**Table 2-1.** Load Profile Coefficients (4 pages)

Wedge Gate Valves – Blowdown Flow -- Steam

| Stroke | Equivalent Length of Upstream Piping, Lup (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Closing Stroke | | | | | Opening Stroke | | | | |
| | 0 | 10 | 100 | 1000 | ≥10000 | 0 | 10 | 100 | 1000 | ≥10000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 86.96% | 0.040 | 0.040 | 0.031 | 0.015 | 0.006 | 0.0180 | 0.0180 | 0.0138 | 0.0067 | 0.0028 |
| 65.22% | 0.220 | 0.220 | 0.185 | 0.099 | 0.036 | 0.2853 | 0.2853 | 0.2402 | 0.1290 | 0.0473 |
| 54.35% | 0.339 | 0.339 | 0.302 | 0.179 | 0.069 | 0.4300 | 0.4300 | 0.3829 | 0.2277 | 0.0875 |
| 38.04% | 0.433 | 0.433 | 0.407 | 0.283 | 0.119 | 0.4829 | 0.4829 | 0.4541 | 0.3156 | 0.1326 |
| 27.17% | 0.485 | 0.485 | 0.470 | 0.372 | 0.176 | 0.6566 | 0.6566 | 0.6365 | 0.5039 | 0.2387 |
| 16.30% | 0.749 | 0.749 | 0.740 | 0.673 | 0.414 | 0.7650 | 0.7650 | 0.7565 | 0.6877 | 0.4228 |
| 10.87% | 0.877 | 0.877 | 0.873 | 0.840 | 0.642 | 0.7940 | 0.7940 | 0.7907 | 0.7605 | 0.5808 |
| 8.70% | 0.939 | 0.939 | 0.937 | 0.915 | 0.762 | 0.8922 | 0.8922 | 0.8904 | 0.8700 | 0.7243 |
| 6.52% | 0.944 | 0.944 | 0.943 | 0.933 | 0.844 | 0.9267 | 0.9267 | 0.9258 | 0.9154 | 0.8282 |
| 4.35% | 0.958 | 0.958 | 0.958 | 0.955 | 0.924 | 1.0123 | 1.0123 | 1.0123 | 1.0082 | 0.9757 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

Wedge Gate Valves – Blowdown Flow – Flashing Water

| Stroke | Equivalent Length of Upstream Piping, Lup (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Closing Stroke | | | | | Opening Stroke | | | | |
| | 0 | 10 | 100 | 1000 | ≥10000 | 0 | 10 | 100 | 1000 | ≥10000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 86.96% | 0.099 | 0.099 | 0.083 | 0.055 | 0.027 | 0.0442 | 0.0442 | 0.0368 | 0.0244 | 0.0122 |
| 65.22% | 0.405 | 0.405 | 0.361 | 0.247 | 0.131 | 0.5250 | 0.5250 | 0.4680 | 0.3197 | 0.1703 |
| 54.35% | 0.531 | 0.531 | 0.488 | 0.351 | 0.198 | 0.6734 | 0.6734 | 0.6194 | 0.4451 | 0.2516 |
| 38.04% | 0.581 | 0.581 | 0.555 | 0.429 | 0.262 | 0.6482 | 0.6482 | 0.6188 | 0.4789 | 0.2921 |
| 27.17% | 0.591 | 0.591 | 0.577 | 0.486 | 0.315 | 0.7997 | 0.7997 | 0.7812 | 0.6574 | 0.4268 |
| 16.30% | 0.828 | 0.828 | 0.823 | 0.773 | 0.557 | 0.8465 | 0.8465 | 0.8405 | 0.7896 | 0.5689 |
| 10.87% | 0.925 | 0.925 | 0.923 | 0.899 | 0.735 | 0.8377 | 0.8377 | 0.8352 | 0.8142 | 0.6656 |
| 8.70% | 0.974 | 0.974 | 0.972 | 0.957 | 0.864 | 0.9256 | 0.9256 | 0.9237 | 0.9098 | 0.8217 |
| 6.52% | 0.963 | 0.963 | 0.962 | 0.956 | 0.899 | 0.9457 | 0.9457 | 0.9447 | 0.9381 | 0.8822 |
| 4.35% | 0.961 | 0.961 | 0.961 | 0.959 | 0.938 | 1.0154 | 1.0154 | 1.0154 | 1.0133 | 0.9909 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

**Table 2-1.** Load Profile Coefficients (4 pages)

Double Disk Gate Valves – Blowdown Flow -- Steam

| Stroke | Equivalent Length of Upstream Piping, Lup (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Closing Stroke | | | | | Opening Stroke | | | | |
| | 0 | 10 | 100 | 1000 | ≥10000 | 0 | 10 | 100 | 1000 | ≥10000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 86.96% | 0.041 | 0.041 | 0.031 | 0.015 | 0.006 | 0.0195 | 0.0195 | 0.0150 | 0.0072 | 0.0030 |
| 65.22% | 0.207 | 0.207 | 0.174 | 0.093 | 0.034 | 0.2936 | 0.2936 | 0.2471 | 0.1327 | 0.0487 |
| 54.35% | 0.319 | 0.319 | 0.284 | 0.169 | 0.065 | 0.4427 | 0.4427 | 0.3941 | 0.2344 | 0.0901 |
| 38.04% | 0.413 | 0.413 | 0.388 | 0.270 | 0.113 | 0.4990 | 0.4990 | 0.4693 | 0.3261 | 0.1371 |
| 27.17% | 0.453 | 0.453 | 0.439 | 0.348 | 0.165 | 0.6748 | 0.6748 | 0.6541 | 0.5178 | 0.2453 |
| 16.30% | 0.669 | 0.669 | 0.662 | 0.601 | 0.370 | 0.8433 | 0.8433 | 0.8340 | 0.7852 | 0.4661 |
| 10.87% | 0.795 | 0.795 | 0.791 | 0.761 | 0.581 | 0.8830 | 0.8830 | 0.8792 | 0.8456 | 0.6459 |
| 8.70% | 0.846 | 0.846 | 0.844 | 0.825 | 0.687 | 0.9889 | 0.9889 | 0.9868 | 0.9642 | 0.8028 |
| 6.52% | 0.847 | 0.847 | 0.846 | 0.837 | 0.757 | 1.0251 | 1.0251 | 1.0240 | 1.0125 | 0.9161 |
| 4.35% | 0.888 | 0.888 | 0.888 | 0.885 | 0.856 | 1.0781 | 1.0781 | 1.0781 | 1.0737 | 1.0391 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

Double Disk Valves – Blowdown Flow – Flashing Water

| Stroke | Equivalent Length of Upstream Piping, Lup (feet) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Closing Stroke | | | | | Opening Stroke | | | | |
| | 0 | 10 | 100 | 1000 | ≥10000 | 0 | 10 | 100 | 1000 | ≥10000 |
| 100.00% | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 86.96% | 0.100 | 0.100 | 0.083 | 0.055 | 0.028 | 0.0479 | 0.0479 | 0.0398 | 0.0264 | 0.0132 |
| 65.22% | 0.380 | 0.380 | 0.339 | 0.232 | 0.123 | 0.5402 | 0.5402 | 0.4816 | 0.3290 | 0.1753 |
| 54.35% | 0.499 | 0.499 | 0.459 | 0.330 | 0.187 | 0.6933 | 0.6933 | 0.6377 | 0.4582 | 0.2590 |
| 38.04% | 0.554 | 0.554 | 0.529 | 0.409 | 0.250 | 0.6698 | 0.6698 | 0.6395 | 0.4950 | 0.3018 |
| 27.17% | 0.552 | 0.552 | 0.539 | 0.454 | 0.294 | 0.8218 | 0.8218 | 0.8028 | 0.6756 | 0.4386 |
| 16.30% | 0.740 | 0.740 | 0.735 | 0.690 | 0.497 | 0.9332 | 0.9332 | 0.9266 | 0.8705 | 0.6271 |
| 10.87% | 0.839 | 0.839 | 0.836 | 0.815 | 0.666 | 0.9315 | 0.9315 | 0.9287 | 0.9054 | 0.7402 |
| 8.70% | 0.877 | 0.877 | 0.876 | 0.862 | 0.779 | 1.0259 | 1.0259 | 1.0239 | 1.0084 | 0.9108 |
| 6.52% | 0.865 | 0.865 | 0.864 | 0.858 | 0.806 | 1.0460 | 1.0460 | 1.0450 | 1.0376 | 0.9758 |
| 4.35% | 0.891 | 0.891 | 0.891 | 0.889 | 0.870 | 1.0813 | 1.0813 | 1.0813 | 1.0791 | 1.0553 |
| 0.00% | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

**Table 2-2.** Gearbox Efficiency Factors

| $\omega_W$ (rpm) | Efficiency Factor "f" for a ($\tau_{S\text{-}ave}/\tau_{rated}$) of: | |
|---|---|---|
| | **0.00** | **≥0.30** |
| 0 | -0.6 | -0.6 |
| 100 | -0.2 | -0.2 |
| 450 | -0.2 | 0.4 |
| ≥2000 | -0.2 | 0.7 |

**Table 2-3.** Motor Performance Data (7 pages)

| 2 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0.0 | 2300 | 1.00 |
| 0.5 | 2050 | 2.25 |
| 1.0 | 1810 | 3.50 |
| 1.5 | 1570 | 4.90 |
| 2.0 | 1330 | 6.10 |
| 2.5 | 1100 | 7.70 |
| 3.0 | 860 | 9.25 |
| 3.5 | 620 | 11.00 |
| 4.0 | 380 | 12.70 |
| 4.5 | 150 | 14.25 |
| 4.8 | 0 | 15.50 |

| 2 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0.0 | 2200 | 0.30 |
| 0.5 | 1940 | 0.90 |
| 1.0 | 1680 | 1.50 |
| 1.5 | 1440 | 2.03 |
| 2.0 | 1180 | 2.58 |
| 2.5 | 920 | 3.20 |
| 3.0 | 660 | 3.75 |
| 3.5 | 420 | 4.35 |
| 4.0 | 160 | 4.95 |
| 4.3 | 0 | 5.35 |

| 5 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2550 | 1.4 |
| 1 | 1970 | 4.0 |
| 2 | 1570 | 6.4 |
| 3 | 1310 | 8.4 |
| 4 | 1090 | 10.4 |
| 5 | 900 | 12.4 |
| 6 | 725 | 14.2 |
| 7 | 565 | 15.9 |
| 8 | 400 | 17.6 |
| 9 | 260 | 19.3 |
| 10 | 110 | 21.0 |
| 10.8 | 0 | 22.6 |

| 5 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2550 | 0.7 |
| 1 | 1970 | 2.0 |
| 2 | 1570 | 3.2 |
| 3 | 1310 | 4.2 |
| 4 | 1090 | 5.2 |
| 5 | 900 | 6.2 |
| 6 | 725 | 7.1 |
| 7 | 565 | 8.0 |
| 8 | 400 | 8.8 |
| 9 | 260 | 9.7 |
| 10 | 110 | 10.5 |
| 10.8 | 0 | 11.3 |

**Table 2-3.** Motor Performance Data (7 pages)

| 7.5 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2600 | 2.0 |
| 1 | 2240 | 4.0 |
| 2 | 1925 | 6.3 |
| 3 | 1650 | 9.0 |
| 4 | 1445 | 11.0 |
| 5 | 1265 | 13.4 |
| 6 | 1110 | 15.5 |
| 7 | 955 | 17.4 |
| 8 | 820 | 19.2 |
| 9 | 690 | 21.2 |
| 10 | 555 | 22.8 |
| 11 | 440 | 24.8 |
| 12 | 330 | 26.4 |
| 13 | 215 | 28.4 |
| 14 | 115 | 30.0 |
| 15 | 0 | 31.4 |

| 7.5 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2600 | 1.0 |
| 1 | 2240 | 2.0 |
| 2 | 1925 | 3.2 |
| 3 | 1650 | 4.5 |
| 4 | 1445 | 5.5 |
| 5 | 1265 | 6.7 |
| 6 | 1110 | 7.8 |
| 7 | 955 | 8.7 |
| 8 | 820 | 9.6 |
| 9 | 690 | 10.6 |
| 10 | 555 | 11.4 |
| 11 | 440 | 12.4 |
| 12 | 330 | 13.2 |
| 13 | 215 | 14.2 |
| 14 | 115 | 15.0 |
| 15 | 0 | 15.7 |

| 10 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2310 | 2.0 |
| 2 | 1850 | 6.4 |
| 4 | 1530 | 11.0 |
| 6 | 1240 | 15.6 |
| 8 | 980 | 20.4 |
| 10 | 720 | 24.8 |
| 12 | 480 | 29.8 |
| 14 | 240 | 34.4 |
| 16 | 0 | 39.2 |

| 10 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2310 | 1.0 |
| 2 | 1850 | 3.2 |
| 4 | 1530 | 5.5 |
| 6 | 1240 | 7.8 |
| 8 | 980 | 10.2 |
| 10 | 720 | 12.4 |
| 12 | 480 | 14.9 |
| 14 | 240 | 17.2 |
| 16 | 0 | 19.6 |

**Table 2-3.** Motor Performance Data (7 pages)

| 15 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2700 | 1.5 |
| 1 | 2250 | 3.8 |
| 2 | 2000 | 6.5 |
| 4 | 1700 | 11.3 |
| 6 | 1490 | 16.3 |
| 8 | 1330 | 20.6 |
| 10 | 1170 | 25.0 |
| 12 | 1020 | 30.0 |
| 14 | 850 | 34.4 |
| 16 | 700 | 39.0 |
| 18 | 550 | 44.0 |
| 20 | 400 | 48.1 |
| 22 | 240 | 52.5 |
| 24 | 80 | 56.9 |
| 25 | 0 | 59.2 |

| 15 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2700 | 0.8 |
| 1 | 2250 | 1.9 |
| 2 | 2000 | 3.3 |
| 4 | 1700 | 5.7 |
| 6 | 1490 | 8.2 |
| 8 | 1330 | 10.3 |
| 10 | 1170 | 12.5 |
| 12 | 1020 | 15.0 |
| 14 | 850 | 17.2 |
| 16 | 700 | 19.5 |
| 18 | 550 | 22.0 |
| 20 | 400 | 24.1 |
| 22 | 240 | 26.3 |
| 24 | 80 | 28.5 |
| 25 | 0 | 29.6 |

| 25 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0.000 | 3000 | 1.5 |
| 3.125 | 2150 | 10.0 |
| 6.250 | 1710 | 16.5 |
| 9.375 | 1445 | 23.5 |
| 12.500 | 1240 | 30.0 |
| 15.625 | 1070 | 36.0 |
| 18.750 | 915 | 42.5 |
| 21.875 | 760 | 48.0 |
| 25.000 | 625 | 53.5 |
| 28.125 | 480 | 60.0 |
| 31.250 | 360 | 65.5 |
| 34.375 | 225 | 71.5 |
| 37.500 | 100 | 76.0 |
| 40.000 | 0 | 82.0 |

| 25 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0.0 | 2765 | 1.2 |
| 2.5 | 2180 | 4.5 |
| 5.0 | 1850 | 7.8 |
| 7.5 | 1620 | 10.5 |
| 10.0 | 1450 | 13.3 |
| 12.5 | 1300 | 15.6 |
| 15.0 | 1150 | 18.3 |
| 17.5 | 1020 | 20.8 |
| 20.0 | 900 | 23.0 |
| 22.5 | 780 | 25.4 |
| 25.0 | 670 | 27.8 |
| 27.5 | 560 | 30.0 |
| 30.0 | 440 | 32.3 |
| 32.5 | 340 | 34.8 |
| 35.0 | 220 | 37.5 |
| 37.5 | 120 | 38.6 |
| 40.0 | 0 | 41.0 |

**Table 2-3.** Motor Performance Data (7 pages)

| 40 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | *2695* | 2.0 |
| 5 | *1920* | 17.0 |
| 10 | *1575* | 29.0 |
| 15 | *1385* | 40.0 |
| 20 | *1200* | 50.0 |
| 25 | *1030* | 58.0 |
| 30 | *870* | 66.5 |
| 35 | *700* | 75.0 |
| 40 | *540* | 82.0 |
| 45 | *380* | 90.0 |
| 50 | *220* | 97.5 |
| 55 | *60* | 105.0 |
| 57 | *0* | 111.0 |

| 40 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2870 | 0.0 |
| 4 | 2115 | 6.0 |
| 8 | 1725 | 11.0 |
| 12 | 1450 | 15.0 |
| 16 | 1230 | 18.5 |
| 20 | 1070 | 22.5 |
| 24 | 920 | 26.0 |
| 28 | 790 | 30.0 |
| 32 | 660 | 33.0 |
| 36 | 550 | 36.0 |
| 40 | 440 | 39.0 |
| 44 | 330 | 42.0 |
| 48 | 220 | 45.0 |
| 52 | 125 | 47.5 |
| 56 | 30 | 51.0 |
| 57 | 0 | 52.0 |

| 60 ft-lb, 125 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2600 | 3 |
| 10 | 1910 | 28 |
| 20 | 1480 | 51 |
| 30 | 1180 | 73 |
| 40 | 930 | 92 |
| 50 | 700 | 110 |
| 60 | 485 | 128 |
| 70 | 290 | 146 |
| 80 | 100 | 164 |
| 85 | 0 | 172 |

| 60 ft-lb, 250 VDC | | |
|---|---|---|
| Torque, ft-lbs | Speed, rpm | Current, amps |
| 0 | 2600 | 2 |
| 10 | 2000 | 15 |
| 20 | 1550 | 27 |
| 30 | 1125 | 40 |
| 40 | 750 | 52 |
| 50 | 470 | 65 |
| 60 | 300 | 77 |
| 70 | 140 | 90 |
| 80 | 25 | 103 |
| 82 | 0 | 104 |

**Table 2-3.** Motor Performance Data (7 pages)

| 80 ft-lb, 125 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | *2470* | 3 |
| 10 | *1995* | 30 |
| 20 | *1655* | 53 |
| 30 | *1385* | 76 |
| 40 | *1140* | 97 |
| 50 | *920* | 119 |
| 60 | *735* | 140 |
| 70 | *580* | 160 |
| 80 | *455* | 179 |
| 90 | *350* | 197 |
| 100 | *240* | 216 |
| 110 | *140* | 235 |
| 120 | *50* | 254 |
| 125 | *0* | 265 |

| 80 ft-lb, 250 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | 2600 | 2 |
| 10 | 2060 | 14 |
| 20 | 1775 | 26 |
| 30 | 1500 | 38 |
| 40 | 1250 | 50 |
| 50 | 1025 | 62 |
| 60 | 825 | 74 |
| 70 | 625 | 86 |
| 80 | 440 | 98 |
| 90 | 275 | 110 |
| 100 | 125 | 122 |
| 107 | 0 | 130 |

| 100 ft-lb, 125 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | *2400* | *4* |
| 20 | *1950* | *62* |
| 40 | *1544* | *110* |
| 60 | *1207* | *154* |
| 80 | *950* | *194* |
| 100 | *733* | *234* |
| 120 | *532* | *274* |
| 140 | *388* | *314* |
| 160 | *280* | *354* |
| 180 | *200* | *394* |
| 200 | *120* | *434* |
| 220 | *40* | *474* |
| 230 | *0* | *494* |

| 100 ft-lb, 250 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | 3000 | 2 |
| 10 | 2400 | 18 |
| 20 | 1950 | 31 |
| 30 | 1575 | 43 |
| 40 | 1250 | 55 |
| 50 | 1000 | 65 |
| 60 | 800 | 77 |
| 70 | 625 | 88 |
| 80 | 475 | 100 |
| 90 | 325 | 112 |
| 100 | 225 | 124 |
| 110 | 100 | 135 |
| 120 | 0 | 146 |

**Table 2-3.** Motor Performance Data (7 pages)

| 150 ft-lb, 125 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | *2325* | 5 |
| 20 | *2005* | 60 |
| 40 | *1785* | 115 |
| 60 | *1575* | 170 |
| 80 | *1430* | 225 |
| 100 | *1260* | 275 |
| 120 | *1160* | 335 |
| 140 | *1070* | 384 |
| 160 | *990* | 440 |
| 180 | *930* | 500 |
| 200 | *880* | 550 |
| 220 | *800* | 605 |
| 240 | *700* | 665 |
| 260 | *600* | 720 |
| 300 | *400* | 830 |
| 340 | *200* | *940* |
| 380 | *0* | *1050* |

| 150 ft-lb, 250 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | 3000 | 2.5 |
| 20 | 2360 | 30.0 |
| 40 | 2040 | 57.5 |
| 60 | 1800 | 85.0 |
| 80 | 1590 | 112.5 |
| 100 | 1400 | 137.5 |
| 120 | 1240 | 167.5 |
| 140 | 1080 | 192.0 |
| 160 | 940 | 220.0 |
| 180 | 800 | 250.0 |
| 200 | 670 | 275.0 |
| 220 | 550 | 302.5 |
| 240 | 430 | 332.5 |
| 260 | 300 | 360.0 |
| 280 | 180 | 387.5 |
| 300 | 60 | 415.0 |
| 310 | 0 | 425.0 |

**Table 2-3.** Motor Performance Data (7 pages)

| 200 ft-lb, 125 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | 3300 | 10 |
| 25 | 2250 | 65 |
| 50 | 1905 | 130 |
| 100 | 1500 | 240 |
| 150 | 1245 | 345 |
| 200 | 1020 | 450 |
| 250 | 840 | 550 |
| 300 | 655 | 640 |
| 350 | 495 | 740 |
| 400 | 330 | 840 |
| 450 | 180 | 935 |
| 500 | 45 | 1030 |
| 510 | 0 | 1050 |

| 200 ft-lb, 250 VDC | | |
|---|---|---|
| **Torque, ft-lbs** | **Speed, rpm** | **Current, amps** |
| 0 | 3000 | 5.0 |
| 25 | 2235 | 37.5 |
| 50 | 1935 | 62.5 |
| 100 | 1620 | 112.5 |
| 150 | 1380 | 162.5 |
| 200 | 1180 | 207.5 |
| 250 | 975 | 255.0 |
| 300 | 810 | 305.0 |
| 350 | 630 | 350.0 |
| 400 | 450 | 397.5 |
| 450 | 285 | 442.5 |
| 500 | 135 | 490.0 |
| 540 | 0 | 530.0 |

Note: Values is italics are based on test data rather than vendor motor performance curves.

**Table 2-4.** Motor Heatup Rates

| Motor Type | $\tau_{ref}$ (ft-lbs) | $h_{ref}$ (C°/sec) |
|---|---|---|
| 2 ft-lbs, 125V | 0.4 | 0.13 |
| 2 ft-lbs, 250V | 0.4<br>0.8<br>4.3 | 0.04<br>0.11<br>2.67 |
| 5 ft-lbs, 125V | 1 | 0.10 |
| 5 ft-lbs, 250V | 1 | 0.10 |
| 7.5 ft-lbs, 125V | 1.5 | 0.06 |
| 7.5 ft-lbs. 250V | 1.5 | 0.06 |
| 10 ft-lbs, 125V | 2 | 0.08 |
| 10 ft-lbs, 250V | 2 | 0.08 |
| 15 ft-lbs, 125V | 3 | 0.15 |
| 15 ft-lbs, 250V | 3 | 0.15 |
| 25 ft-lbs, 125V | 5 | 0.22 |
| 25 ft-lbs, 250V | 5 | 0.20 |
| 40 ft-lbs, 125V | 8 | 0.17 |
| 40 ft-lbs, 250V | 8 | 0.19 |
| 60 ft-lbs, 125V | 12 | 0.15 |
| 60 ft-lbs, 250V | 12 | 0.19 |
| 80 ft-lbs, 125V | 16 | 0.14 |
| 80 ft-lbs, 250V | 16 | 0.20 |
| 100 ft-lbs, 125V | 20 | 0.29 |
| 100 ft-lbs, 250V | 20 | 0.20 |
| 150 ft-lbs, 125V | 30<br>60 | 0.40<br>0.74 |
| 150 ft-lbs, 250V | 30<br>60 | 0.40<br>0.74 |
| 200 ft-lbs, 125V | 40 | 0.09 |
| 200 ft-lbs, 250V | 40 | 0.11 |

**Table 2-5.** Nominal Motor Torques

| Motor Type | $\tau_{nom}$ (ft-lbs) |
|---|---|
| 2 ft-lbs, 125V | 4.39 |
| 2 ft-lbs, 250V | 3.92 |
| 5 ft-lbs, 125V | 9.40 |
| 5 ft-lbs, 250V | 9.40 |
| 7.5 ft-lbs, 125V | 13.15 |
| 7.5 ft-lbs. 250V | 13.15 |
| 10 ft-lbs, 125V | 14.33 |
| 10 ft-lbs, 250V | 14.33 |
| 15 ft-lbs, 125V | 22.50 |
| 15 ft-lbs, 250V | 22.50 |
| 25 ft-lbs, 125V | 35.00 |
| 25 ft-lbs, 250V | 35.50 |
| 40 ft-lbs, 125V | 50.63 |
| 40 ft-lbs, 250V | 48.84 |
| 60 ft-lbs, 125V | 74.74 |
| 60 ft-lbs, 250V | 66.25 |
| 80 ft-lbs, 125V | 104.00 |
| 80 ft-lbs, 250V | 95.00 |
| 100 ft-lbs, 125V | 180.00 |
| 100 ft-lbs, 250V | 102.00 |
| 150 ft-lbs, 125V | 340.00 |
| 150 ft-lbs, 250V | 276.67 |
| 200 ft-lbs, 125V | 443.33 |
| 200 ft-lbs, 250V | 478.33 |

**Table 2-6.** Gate Valve Loss Coefficients

| Stroke Position | $K_{valve}$ |
|---|---|
| 100% | 0.56 |
| 90% | 0.62 |
| 80% | 0.75 |
| 70% | 0.99 |
| 60% | 1.55 |
| 50% | 2.61 |
| 45% | 3.28 |
| 40% | 4.43 |
| 35% | 6.21 |
| 30% | 8.94 |
| 25% | 13.97 |
| 20% | 23.64 |
| 18% | 30.32 |
| 16% | 40.47 |
| 14% | 55.88 |
| 12% | 79.66 |
| 10% | 119.95 |
| 9% | 157.83 |
| 8% | 212.73 |
| 7% | 309.35 |
| 6% | 456.13 |
| 5% | 810.89 |
| 4% | 1589.35 |
| 3% | 3576.04 |
| 2% | 9933.44 |
| 1% | 52900.00 |
| 0% | $1.00 \times 10^{10}$ |

# 3
# Justification of Method

This section discusses and justifies the key elements of the DC motor performance method.

## Stroke Range and Increments

Valve stroke is defined in terms of percent open. Fully open is defined as 100% stroke position, and the theoretical flow isolation point (for closing) or flow initiation point (for opening) is defined as 0% stroke. For a globe valve, theoretical flow isolation/initiation occurs at disk seating/unseating. Accordingly, globe valves are evaluated from 100% to 0% stroke for closing strokes and 0% to 100% stroke for opening strokes. The stroke length for globe valves is input by the user.

For a gate valve, theoretical flow isolation/initiation occurs when the outside diameter of the disk seat face passes the inside diameter of the seat ring face, toward the end of a closing stroke and the beginning of a opening stroke. The nominal stroke length for gate valves (corresponding to 100% stroke) is set to the inside diameter of the seat ring seating surface. Disk wedging/unwedging occurs at a negative stroke position (defined as -X%) that depends on the detailed disk and seat dimensions. Accordingly, gate valves are evaluated from 100% stroke to -X% stroke. Equation 2-1, which is taken from Reference (2), calculates X, assuming that the centerline of the disk seat face is concentric with the centerline of the seat ring seat face at disk wedging. A table of X values is provided if the disk and seat ring diameters are not available. These values are based on review of typical X values for various gate valves (see Reference 2).

Stroke increments are defined to emphasize portions of the valve stroke where the DP, and therefore the valve stem thrust and motor torque, are changing most rapidly. Increments of 1% stroke are used for stroke positions of 10% and less, where the most rapid DP changes may occur (e.g., for pumped flow strokes). For stroke positions between 10% and 30%, stroke increments of 2% are used. For stroke positions greater than 30%, stroke increments of 5% or 10% are used. Although the valve DP may begin to build up prior to 10% stroke for a closing stroke (e.g., for blowdown strokes), the DP build-up in these cases is gradual and more increments are judged to not be needed. Using these increments, the stem load is expected to be approximately linear over each increment.

## Valve Load Profile Method

The valve load profile method is used in the DC motor performance method to determine the required valve stem thrust at the beginning and end of each increment. Reference (2), which is included in Appendix A, develops and justifies the load profile method. The discussion below is a summary.

The maximum required thrust is input by the user. If water inertia was considered in calculating the required thrust, the required thrust attributable to water inertia effects is also input. The required thrust at 0% open is set to the maximum required thrust (including the required thrust due to water inertia, for closing strokes only). For gate valves, the required thrust at negative stroke positions (after flow isolation for closing strokes and before flow initiation for opening strokes) is set to the maximum required thrust, not including the required thrust due to water inertia.

The required thrust at fully open is calculated as the sum of the packing and stem rejection loads. The variation of required thrust from the value at fully open to 0% open is determined from the "load profile coefficients," which are based on the design basis conditions for the valve.

For gate valves with pumped flow, the load profile coefficients are determined by calculating an overall resistance for the system in which the valve is installed and selecting the appropriate load profile curve. These curves were determined based on first principles modeling (freebody diagrams to determine the forces on the valve disk), computational fluid dynamics work from the EPRI MOV Performance Prediction Methodology (PPM) (to determine the horizontal and vertical loads on the valve disk as a function of DP) and the default PPM flow coefficients for gate valves (to determine the DP across the valve as a function of stroke position). Since the method does not predict when the disk transitions between the guides and the downstream seat, the load profile coefficients conservatively assume the worst case at each stroke position. For gate valves with blowdown flow, the load profile coefficients are determined by evaluating the length of piping upstream of the valve (expressed as an equivalent length) and selecting the appropriate load profile curve. These curves are based on predictions from the PPM. The load profiles predicted by this method for gate valves are expected to bound the load profiles predicted by the PPM.

Note that the load profile method does not include the thrust required to unwedge the disk. The time associated with unwedging can be determined from static testing and added to the predicted stroke time, as discussed later in Section 3. In addition, the effect of the unwedging load on motor heatup is judged to be negligible since the time associated with unwedging is relatively small.

Flow coefficients for globe valves can vary significantly, depending on design. The load profile method for globe valves assumes that the flow coefficient varies linearly with disk position, from 0 at fully closed to the maximum value at fully open. The valve flow coefficient at fully open is input by the user.

## Calculating Stroke Time

An incremental approach is used to determine stroke time. For each increment, the average stem thrust for the increment is calculated by averaging the stem thrusts at the beginning and end of the increment. As discussed above, the increments are selected such that the stem thrust is approximately linear over each increment. The average stem torque is calculated using the average stem thrust and the stem factor input by the user (Equation 2-8 if the required thrust is greater than or equal to 0, or Equation 2-9 if the required thrust is less than 0). Equation 2-8 uses a stem factor applicable for the case where thrust is required from the actuator to move the valve

stem. Equation 2-9 uses a stem factor ("overhauling" stem factor) applicable for the case where the stem thrust is self-actuating. This approach conservatively assumes that the stem/stem nut interface is self-locking. The motor torque is then calculated using the overall ratio input by the user and the gearbox efficiency (Equation 2-12). The gearbox efficiency is determined using Equation 2-10, Equation 2-11 and Table 2-2, along with the motor gear set ratio, actuator rated torque, pullout efficiency and run efficiency, all of which are input by the user. This method for determining gearbox efficiency is justified later in Section 3. Since the gearbox efficiency depends on the motor speed, which is determined in a later step, the motor speed at the end of the previous increment is used in Equation 2-10. For the first increment, the pullout efficiency is used as the gearbox efficiency.

The motor current is determined from the motor performance curve and used along with the user-input values of cable resistance, thermal overload resistance and motor control center voltage, to calculate the motor terminal voltage (Equation 2-13). Use of the vendor performance curves to determine motor current is justified later in Section 3.

The first principles DC motor model documented in Reference (1) indicates that the rotational speed of a DC motor at different voltages and winding temperatures can be related to the output torque using motor performance curves (i.e., torque versus speed) applicable under nominal voltage, ambient temperature conditions. DC motor or DC motor actuator vendors typically provide a motor performance curve that is applicable for nominal voltage and a reference temperature (typically 25°C). The DC motor performance method uses these vendor-supplied motor performance curves (or alternate curves, where appropriate) to determine the motor speed from the motor torque. The first step is to adjust the motor torque using Equation 2-14. Since the adjusted motor torque depends on the motor temperature, which is determined in a later step, the motor temperature at the end of the previous increment is used. For the first increment, the ambient temperature, which is input by the user, is used. The motor performance curve is then used to determine the motor speed corresponding to this adjusted torque. The true motor speed is then calculated using Equation 2-15. The approaches for adjusting the motor torque and speed for degraded voltage and elevated temperature are justified later in Section 3.

Equation 2-16 or Equation 2-17, which can be derived from first principles, are used to calculate the time associated with the increment. The temperature at the end of the increment is then calculated using Equation 2-18. Equation 2-18 uses the vendor reference heatup rates (at specific reference torques) to calculate the motor heatup for the increment. Per Reference (1), the reference heatup rate is multiplied by the square of the ratio of the motor torque to the reference torque. This approach is justified later in Section 3.

The stroke time predicted using the method covers closing strokes from 100% open (beginning with initial disk motion) to initial wedging/seating and opening strokes from just after unwedging to 100% open. Guidance is provided for determining the time required for the actuator to move through the actuator lost motion region, the stem to move through the thread and T-head clearances or for disk unwedging (opening strokes only) using static test data. Although the recommended approach does not adjust this time for degraded voltage and elevated temperature effects, the difference is judged to be negligible.

## Calculating Actuator Capability

The instantaneous actuator capability at each stroke position is calculated in Step 5. Equation 2-19, which combines Equation 2-12 and Equation 2-14, adjusts the nominal motor torque (see next subsection on use of nominal motor torque) for degraded voltage and elevated temperature, and applies the actuator gearbox efficiency, overall gear ratio and stem factor. The instantaneous margin is calculated at each stroke position using Equation 2-20, which subtracts the required stem thrust from the instantaneous actuator capability. The minimum instantaneous margin for a given valve stroke is an indication of the degree to which the actuator is challenged during the stroke.

The functional actuator capability is calculated in Step 6 by iteratively increasing the required stem thrust for the stroke ($F_R$) until the maximum value of adjusted motor torque at any point during the stroke equals the nominal motor torque (see next subsection on use of nominal motor torque). In Step 6.1, $F_R$ is initially estimated to be 90% of the instantaneous actuator capability calculated in Step 5. In Step 6.2, the DC motor performance method is implemented using this required thrust to determine the maximum adjusted motor torque over the stroke, which is compared to the nominal motor torque. In Step 6.3, $F_R$ is then adjusted, either up or down, depending on whether the maximum adjusted motor is less than or greater than the nominal motor torque. This procedure is repeated, in Step 6.4, until the maximum adjusted motor torque equals the nominal motor torque. The functional actuator capability is the value of $F_R$ for which the maximum adjusted motor torque (predicted) equals the nominal motor torque. At this point, the instantaneous margin is zero. The functional actuator capability is an indication of the thrust capability of the actuator for that particular application, considering the effects of degraded voltage, elevated temperature and decreased efficiency as the motor slows down.

The maximum allowable thrust at torque switch trip is calculated in Step 7, for closing strokes only. For this calculation, the required thrust is assumed to increase, and the speed to decrease, from their values at the last stroke position to the values corresponding to the nominal torque and speed. To determine the actual motor torque at this point, the nominal motor torque is adjusted for degraded voltage and temperature at the last stroke position, using Equation 2-23, which is adapted from Equation 2-14. In Step 7.3.1, the gearbox efficiency is determined, using an iterative procedure, based on the motor speed at nominal motor torque (200 rpm), adjusted for degraded voltage (Equation 2-24). In Step 7.3, the efficiency is initially set to pullout efficiency (as a guess). In Step 7.3.2, the stem torque based on the available motor torque (from Equation 2-23), the overall ratio and assumed efficiency is calculated. A new efficiency, based on this calculated stem torque and the motor speed calculated in Equation 2-24, is then determined in Steps 7.3.3 and 7.3.4, and a new stem torque is calculated. This procedure is repeated until the calculated stem torque from one iteration to the next is less than 1% of the actuator rated torque. The final efficiency is then used in Equation 2-27 (which combines Equation 2-12 and Equation 2-14) along with the nominal motor torque, to calculate the maximum allowable thrust at torque switch trip.

The maximum allowable thrust at unwedging is calculated in Step 8, for opening strokes only. This calculation is analogous to the calculation described above for determining maximum allowable thrust at torque switch trip for closing strokes, except that the required thrust is

assumed to increase, and the speed to decrease, from their values at the first stroke position to the values corresponding to the nominal torque and speed.

Note that there is no "Application Factor" included in this method for calculating actuator capability. Limitorque recommends that the nominal actuator starting torque be multiplied by an Application Factor, typically 0.9, when calculating actuator capability under design basis conditions. The Application factor is an empirical factor intended to cover uncertainties in the Limitorque method, for example, uncertainties in the adjustments for degraded voltage and temperature. In the DC motor performance method, approaches for adjusting nominal actuator capability for degraded voltage and temperature effects are developed based on first principles and justified using test data. Accordingly, the Application Factor is not needed in the method.

### *Use of Nominal Motor Torque*

The nominal motor torque, $\tau_{NOM}$, is defined as the motor torque corresponding to a motor speed of 200 rpm on the motor performance curve. In the DC motor performance method, the capability of the motor is limited to the nominal motor torque, adjusted for degraded voltage and elevated temperature. Defining motor capability in terms of a minimum motor speed provides a uniform method of establishing actuator capability for all motors. The value of 200 rpm as the minimum motor speed is based on judgement and typically provides a margin of 9% to 22% from the stall torque.

This approach is used to provide conservatism in the method, even though the method can predict actuator output at low motor speeds, as discussed later in this section. There is additional conservatism in the maximum allowable thrusts at torque switch trip and unwedging since the effects of motor inertia are neglected. Accordingly, users may choose to justify other, less conservative approaches for determining motor capability, e.g., for operability evaluations.

Motor performance data in the DC motor method is discussed later in this section. In general, the vendor motor performance curves are found to be bounding and are recommended for use in the method. In a few cases, the vendor curves are not adequate, and alternate motor performance curves are recommended. Although the vendor curves are generally found to be bounding, there is little motor data at very low speeds (approaching motor stall). The table below lists the motors for which there is test data at or near stall. The table also lists the nominal motor torque, $\tau_{NOM}$, used in the method and the maximum torque measured in the motor test, at the lowest measured motor speed.

| Motor Type | Nominal Motor Torque (ft-lbs) | Maximum Measured Torque (ft-lbs) |
|---|---|---|
| 5 ft-lbs, 125V | 9.40 | 8 @ 500 rpm |
| 10 ft-lbs, 125V | 14.33 | 13 @ 400 rpm<br>17.8 @ 0 rpm(1) |
| 15 ft-lbs, 125V | 22.50 | 25 @ 200 rpm |
| 25 ft-lbs, 125V | 35.00 | 36 @ 350 rpm<br>40 @ 0 rpm(1) |

| Motor Type | Nominal Motor Torque (ft-lbs) | Maximum Measured Torque (ft-lbs) |
|---|---|---|
| 40 ft-lbs, 125V | 50.63 | 55 @ 100 rpm(1)<br>57 @ 0 rpm(1) |
| 80 ft-lbs, 125V | 104.00 | 105 @ 300 rpm |
| 100 ft-lbs, 125V | 180.00 | 160 @ 350 rpm |

Note (1): These results are from the NRC/INEEL testing in Reference (5). For the 40 ft-lb motor, the two results are for the newer motor and older motor, respectively.

As shown, for all motors tested to a motor speed of 200 rpm or less, the maximum measured motor torque is greater than the nominal motor torque used in the method. For the other motors, the maximum measured motor torques bound the nominal motor torque, if the data is extrapolated to a motor speed of 200 rpm.

As discussed later in this report, one of the conclusions from the NRC/INEEL DC motor test program was that there is a "minimum motor speed threshold below which additional motor torque produced little or no additional actuator torque." The motor speed threshold for the four motors tested was up to about 300 rpm, corresponding to a worm shaft speed up to about 370 rpm. The 200 rpm threshold used to determine nominal motor torque in the DC motor model is not intended to address this observed behavior, which is attributable to a combination of effects, including:

- The gearbox efficiency decreases significantly as the motor slows down, and
- The motor heats up as the motor slows down, affecting both the motor torque output and speed.

As discussed in the Justification of Specific Model Features below, the gearbox efficiency values used in the DC motor performance model compare favorably against the values measured in the NRC/INEEL testing, and the method for predicting motor heatup and its effect on motor performance compares favorably against the NRC/INEEL data. Accordingly, it is concluded that the DC motor performance model would predict the behavior observed in the NRC/INEEL testing, and there is therefore no need to limit the motor torque based on the INEEL conlcusion.

## Justification of Specific Model Features

### *First Principles DC Motor Model*

Reference (1) documents the first principles equations related to the performance of a DC motor. Implementation of these equations for a specific motor requires detailed information about the motor, for example, the number and size of the wires in the armature and field windings. This information is not typically available for DC motors used on valve actuators. Therefore, Reference (1) develops an approach for establishing the performance of a DC motor that uses information typically provided by the motor or actuator manufacturer, i.e., a plot of motor speed

and current versus motor torque under nominal conditions (ambient temperature and full voltage). Reference (1) then develops the method for adjusting this information for temperatures above ambient and voltages other than the full voltage. See the subsections below related to the effect of temperature and voltage on motor performance and use of vendor motor performance curves for details.

In developing this approach, some assumptions that are difficult to justify individually must be made. For example, Reference (1) assumes that the motors' magnetic fields are saturated. Although these assumptions are not specifically justified in this report, justification of the effect of temperature and voltage on motor performance and justification of use of the vendor motor performance curves, which are described in the subsections below, provide overall justification of the motor performance method developed in Reference (1). In other words, by verifying that the vendor motor performance curves bound measured motor data, adjusted for temperature and voltage using the motor model, the motor model and its assumptions are verified. Accordingly, although the method used to adjust the motor performance curves for degraded voltage and elevated temperature is based on first principles, the method is somewhat empirical, that is, assumptions in the model are justified by favorable comparisons to test data.

### *Actuator Gearbox Efficiency*

In the DC motor performance method, actuator gearbox efficiency is a function of the rotational speed of the worm shaft and the output torque of the actuator (stem torque as a percentage of actuator rated torque). Table 2-2 provides f-factors that are used in the method to determine gearbox efficiency. These f-factors are based on a review of data from DC motor actuator testing performed by Idaho National Engineering and Environmental Labs (INEEL) and sponsored by the Nuclear Regulatory Commission (NRC) (Reference 5). Based on this data, the gearbox efficiency is low (close to or less than pullout efficiency) for low stem torques (less than about 30% of the rated actuator torque) and low worm speeds (less than about 200 rpm). As long as the stem torque is greater than about 30% of the actuator rated torque, the gearbox efficiency appears to be relatively insensitive to the stem torque, as reflected by the values in Table 2-2. An upper bound gearbox efficiency f-factor of 0.7 at 2000 rpm is conservatively selected based on results for the 25 ft-lb INEEL motor. For the other two motors, the efficiency reached run efficiency (f=1.0) for a portion of the stroke.

To justify these f-factors, comparisons are made to measured f-factors from the NRC/INEEL data. Data from testing of the 10 ft-lb, 25 ft-lb and newer 40 ft-lb motors at 60% and 100% voltage are included. This data covers Limitorque SMB-0 and SMB-1 actuators. The following approach is used for each data set.

- For each test, measured f-factors are determined at each stroke position from the measured stem torque, measured motor torque, actuator overall ratio, pullout efficiency and run efficiency, using Equation 2-11.

- Predicted f-factors are determined at each stroke position from the measured motor speed, motor gearset ratio, measured stem torque and actuator rated torque.

- Plots are made of measured f-factor versus predicted f-factor. On each plot a diagonal line is drawn, representing the case where the measured f-factor is equal to the predicted f-factor. Data points above this line indicate that the predicted f-factor is conservative, i.e., the predicted f-factor is less than the measured f-factor, and the efficiency used in the method is lower than the measured efficiency. Data points below the line indicate that the predicted f-factor is non-conservative.

Figures 3-1 through 3-3 show the results of this comparison. As shown, the predicted f-factors are generally conservative. Note that this data only covers SMB-0 and SMB-1 actuators; additional data is needed to justify the f-factors in the method for other actuators. Until such data is available, it is recommended that the f-factors in the method be used as "best available information" for other actuators.

### *Effect of Voltage and Temperature on Motor Performance*

Reference (1) concludes that applying a voltage less than the nominal voltage to a DC motor has a linear effect on both the torque and speed of the motor, as shown by the following equations.

*Equation 3-1:*

$$\text{Torque at voltage} = \text{Torque at nominal voltgage}\left(\frac{\text{voltage}}{\text{nominal voltage}}\right)$$

*Equation 3-2:*

$$\text{Speed at voltage} = \text{Speed at nominal voltgage}\left(\frac{\text{voltage}}{\text{nominal voltage}}\right)$$

Reference (1) also concludes that elevated motor winding temperature decreases the motor output torque according to the following equation, which is based on the increased resistance of copper wire at elevated temperature.

*Equation 3-3:*

$$\text{Torque at temp} = \text{Torque at reference temp}\left(\frac{\text{reference temp} + 234.4}{\text{temp} + 234.4}\right)$$

In the DC motor performance method, the motor terminal voltage is determined using Equation 2-13, which applies Ohm's law, using the voltage at the motor control center, the resistance of the motor cabling and thermal overloads input by the user, and the motor current, which is determined from the motor performance curve. The motor temperature is determined as discussed later in this section. The true motor torque is calculated based on the load on the valve stem, the actuator overall ratio and the gearbox efficiency. Given the true motor torque, the motor voltage and the motor temperature, Equation 2-14 (which is developed from Equation 3-1 and Equation 3-3) is used to calculate the adjusted motor torque, to normalize to conditions on which the motor performance curves are based. The adjusted speed (i.e., at nominal voltage) is then determined from the motor performance curve, and the true speed is calculated using Equation 2-15 (which is derived from Equation 3-2).

### *Use of Vendor Motor Performance Curves*

The DC motor performance method requires as input the motor speed and motor current as a function of motor torque. The motor or actuator manufacturer typically provides motor performance curves with this information. These vendor curves were obtained for typical motors used on Limitorque DC motor actuators -- 2 through 200 ft-lb motors at 125 and 250 VDC.* Dynamometer and actuator test data obtained from Crane-MOVATS and dynamometer testing by one nuclear utility are used to verify the accuracy of these curves. Table 3-1 summarizes the test data used for this justification.

The following approach is used for each motor test.

- Since time-history temperature was not measured during these tests, a prediction of motor heatup is made using Equation 2-18, along with the measured time and measured motor torque and the vendor motor heatup rates.

- The measured time-history motor torque is adjusted to account for elevated temperature and degraded voltage using Equation 2-14. In this equation, $\tau_{M\text{-}ave}$ is set to the measured motor torque, $V_T$ is set to the measured motor voltage and $T_{motor}$ is set to the predicted motor temperature.

- The measured time-history motor speed is adjusted to nominal voltage conditions using the following equation, which is based on Equation 2-15, where $\omega$ is the measured motor speed.

*Equation 3-4:* $$\omega' = \omega\left(\frac{V_{nom}}{V_{measured}}\right)$$

For each motor type (with a given starting torque and nominal voltage), plots are made comparing the vendor motor performance curves with the measured motor performance data. Specifically, the adjusted motor speed is plotted against the adjusted motor torque, and the measured motor current is plotted against the measured motor torque.

Figures 3-4 through 3-23 show the results of this work. For the speed versus torque plots, the vendor curves are bounding if the test data lies above the vendor curve, indicating that the vendor curve underpredicts the motor speed for a given motor torque. For the current versus torque plots, the vendor data is conservative if the test data lies below the vendor curve, indicating that the vendor curve overpredicts the motor current. Motor current is only used in the method to determine the voltage drop from the motor control center to the motor terminals. An overprediction of the current would result in an overprediction of the voltage drop and therefore an underprediction of the motor torque.

The following conclusions and recommendations are based on Figures 3-4 through 3-23.

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* A survey of BWR plants indicated that 250 ft-lb motors are rarely used, and the motor performance curves for these motors were not obtained or evaluated.

- For the following motors, the vendor speed versus torque curves bound the test data, and there is sufficient test data to justify use of the vendor curves in the DC motor performance method: 5 ft-lb/125 VDC, 10 ft-lb/125 VDC, 15 ft-lb/125 VDC, 25 ft-lb/125 VDC and 200 ft-lb/125 VDC. These vendor speed versus torque curves are recommended for use in the method and will result in conservative predictions.

- For the 60 ft-lb/125 VDC motor, the vendor speed versus torque curve bounds the available test data, but the data for justification is limited. This vendor curve is recommended for use in the method.

- For the following motors, the vendor speed versus torque curves do not adequately model the measured data: 40 ft-lb/125 VDC, 80 ft-lb/125 VDC and 100 ft-lb/125 VDC. For these motors, new curves based on the test data are recommended for use in the method, as shown by dashed lines in the figures and in Table 2-3.

- For the following motors, no data is available to justify use of the vendor speed versus torque curves:

  - 2 ft-lb/125 VDC
  - 2 ft-lb/250 VDC
  - 5 ft-lb/250 VDC
  - 7.5 ft-lb/125 VDC
  - 7.5 ft-lb/250 VDC
  - 10 ft-lb/250 VDC
  - 15 ft-lb/250 VDC
  - 25 ft-lb/250 VDC
  - 40 ft-lb/250 VDC
  - 60 ft-lb/250 VDC
  - 80 ft-lb/250 VDC
  - 100 ft-lb/250 VDC
  - 150 ft-lb/250 VDC
  - 200 ft-lb/250 VDC

  It is recommended that the vendor curves be used for these motors as "best available information."

- Figures 3-4 through 3-23 show that the vendor current versus torque curves generally underpredict the measured motor current. This result is consistent with the fact that the vendor speed versus torque curves generally underpredict the motor speed, i.e., for a given torque, an underprediction in speed is consistent with an underprediction in current. For the stroke time prediction in the DC motor performance method, the underprediction of motor current (which results in an overprediction of motor voltage) is offset by the underprediction in motor speed. For the actuator capability evaluations in the method, the underprediction of current is offset by conservatism in the actuator efficiency and conservatism in the limitation of motor output torque to the nominal motor torque (rather

than the stall torque). Accordingly, it is recommended that the vendor current versus speed curves be used in the method.

- For the 150 ft-lb, 125 VDC motor, a vendor motor performance curve was not obtained. An estimated vendor curve was determined using the vendor curve for the 150 ft-lb, 250 VDC motor, i.e., the speed versus torque curves were assumed to be the same for the two motors, and the current for the 125 VDC motor was assumed to be twice the current for the 250 VDC motor at each value of torque. The vendor curves shown in Figures 3-20 and 3-21 are based on these assumptions. However, the speed versus torque curve using this approach does not adequately model the measured data. For the 150 ft-lb, 125 VDC motor, a new speed versus torque curve determined from the test data is recommended for use in the method, as shown by a dashed line in the Figure 3-20 and Table 2-3. It is recommended that the estimated vendor current versus speed curve be used in the method.

### *Prediction of Motor Heatup and Use of Vendor Heatup Rates*

The DC motor performance method requires as input reference heatup rates at one or more values of reference torque, for a given motor type. Per Reference (1), these reference heatup rates are adjusted for use at other motor torques by multiplying them by the square of the ratio of the motor torque to reference motor torque, as shown in Equation 2-18. It is recommended that the motor heatup rates provided by the motor manufacturer be used in the DC motor performance method to predict motor heatup. The vendor typically provides one or more curves of motor temperature rise versus time for specific values of motor torque. For some motors, separate curves are provided for the temperature rise of the series field windings, the shunt field windings and the armature windings. The slope of these curves indicates the motor heatup rate at that torque and time. To determine heatup rate for input into the method, the following procedure is used.

- Using the temperature rise versus time curve provided by the vendor, draw a line from the origin (zero temperature rise at zero time) to the temperature rise at one minute. Data up to one minute is used since MOV stroke times are typically less than one minute. The temperature rise of the armature windings is used when more than one curve is provided, since the armature is the dominant current path influencing motor output.

- Determine the slope of the line (heatup rate), in units of °C per second.

- Use this heatup rate as the reference heatup rate for the applicable motor torque (reference torque).

**Example.** The vendor provides a curve of armature winding temperature rise versus time at 20% running load for a 5 ft-lb, 125 VDC motor. The curve shows a temperature rise of 6°C over the first minute. Therefore, the reference motor heatup rate at 1 ft-lb (20% of 5 ft-lbs) is 0.1°C/second (i.e., 6/60).

The motor heatup rates in Table 2-4, which are recommended for use in the method, were determined from the vendor-provided motor performance data as described above.

There is limited data to justify the vendor motor heatup rates. The NRC/INEEL testing (Reference 5) provides data to justify the heatup rates for 10, 25 and 40 ft-lb motors. To perform this justification, the following approach is used.

- Reference (5) is reviewed to determine the maximum motor torque achieved during the 60% and 100% voltage tests of the 10, 25 and 40 ft-lbs motors tested by INEEL. For the 10 ft-lb and 25 ft-lb motor tests, the motors were tested to stall for both the 60% and 100% voltage tests. In addition, the motors stalled before the loading piston (which provided resistance to the valve stem) bottomed out. For these tests, the maximum measured motor torque is the maximum value achieved during the test. For the 60% voltage test of the 40 ft-lb motor, the motor was not tested to stall. For this test, the maximum measured thrust is the maximum value achieved during the test. For the 100% voltage test of the 40 ft-lb motor, the motor was tested to stall; however, the piston bottomed out before the motor stalled. The maximum measured thrust for this test is the value achieved when the piston bottomed out.

- The DC motor performance method is implemented for these six tests. Measured stem torque values are used as input, i.e., the load profile method is not used.

- For the 10 ft-lb and 25 ft-lb motor tests, the method predicts that the motor stalls prior to the end of the test, indicating that the method predicts an actuator output capability less than that achieved during the test. The predicted temperature rise for these tests is the predicted temperature at the last stroke position before predicted motor stall minus the initial temperature.

- For the 60% voltage test of the 40 ft-lb motor, the INEEL test did not achieve motor stall, and the method does not predict motor stall. For this test, the predicted temperature rise is the predicted temperature at the end of the stroke minus the initial temperature.

- For the 100% voltage test of the 40 ft-lb motor, the predictions cover the portion of the stroke up to the point that the piston bottoms out. The method predicts that the motor stalls just as the piston bottoms out. As with the 10 and 25 ft-lb motors, the predicted temperature rise is the predicted temperature at the final stroke position minus the initial temperature.

- The predicted temperature rise is compared to the maximum measured temperature rise during testing for each test.

The table below summarizes the measured and predicted temperature rises. The motor speeds corresponding to the predicted temperatures rises are also listed.

| Motor/Test | Maximum Measured Motor Torque, ft-lbs | Measured Temperature Rise, °F | Predicted Temperature Rise, °F |
|---|---|---|---|
| 10 ft-lbs, 60% voltage | 8.5 | 23 | 30 @ 74 rpm |
| 10 ft-lbs, 100% voltage | 15 | 40 | 44 @ 75 rpm |
| 25 ft-lbs, 60% voltage | 17 | 45 | 68 @ 103 rpm(1) |
| 25 ft-lbs, 100% voltage | 30 | 80 | 97 @161 rpm(1) |
| 40 ft-lbs, 60% voltage | 21 | negligible | 24 @ 236 rpm |
| 40 ft-lbs, 100% voltage | 40 | 40 | 55 @ 120 rpm(1) |

Note (1): For these tests, the motor speed at the last stroke position before predicted motor stall is much less than 100 rpm. To obtain a more reasonable heatup prediction, the temperature rise at the second-to-last stroke position is used.

As shown above, the predicted temperature rises compare favorably to the measured temperature rises.

Note that as method predictions approach motor stall, the motor speed changes rapidly, and the stroke increments used in the method do not effectively model the behavior (i.e., the assumption that the motor torque and speed are linear over the stroke increment is not true as the motor approaches stall). The motor speed at the end of an increment is much less than the average motor speed for the increment, resulting in high predicted stroke times and motor temperatures. Therefore, if the DC motor method is used for a valve stroke for which the motor approaches stall, small increments should be used at the end of the valve stroke to avoid grossly conservative predictions.

### *Screening Method*

The screening method is provided to allow users to justify that certain valve applications (e.g., those with very high stroke time margin) can meet their stroke time requirements without implementing the full DC motor performance method. The approach is to conservatively assume that the maximum required thrust, $F_R$, is the required thrust for the entire stroke. In Equation 2-37, $F_R$ is converted to a motor torque, assuming pullout efficiency as the gearbox efficiency. In Equation 2-38, the voltage at the motor terminals is calculated, conservatively assuming the motor current is equal to the locked rotor current, which is obtained from Table 2-3. If desired, the user may iterate to determine the actual motor current. The adjusted motor torque is then calculated using Equation 2-39, assuming that the motor temperature is equal to the ambient temperature plus 10°C. At the end of the calculation, a conservative estimate of the final motor temperature is made (Equation 2-43), and the calculation is repeated using a higher temperature if the motor heatup exceeds 10°C. If desired, the user may iterate to determine the actual motor heatup. The adjusted motor speed is then determined from the motor performance data in Table 2-3 for the appropriate motor type and corrected for degraded voltage to determine the true motor speed (Equation 2-40). The threshold stroke time is calculated using Equation 2-41 for gate valves or Equation 2-42 for globe valves. The application is considered to be capable of meeting its stroke time requirement if the threshold stroke time is less than the allowable stroke time.

The minimum actuator capability is calculated using Equation 2-44. This equation provides a conservative estimate of the actuator capability since conservative values of gearbox efficiency (pullout), motor current (locked rotor) and final motor temperature (which is based on the assumption that the thrust is equal to $F_R$ for the entire stroke) are used. Note that if the user implements an iterative approach, accurate values of gearbox efficiency and motor current are used. In this case, the only difference between this minimum actuator capability and the minimum instantaneous actuator capability calculated using the full motor performance method is that the motor heatup is conservative (since the stem thrust is set to $F_R$ for the entire stroke). The margin is calculated as the difference between the minimum actuator capability and the maximum required thrust (Equation 2-45).

### *Estimating Valve Flow Rate*

For some valves, the design basis requirement may be to open sufficiently to allow a certain amount of flow through the valve. The method provided for estimating the valve flow rate at a specific stroke position is based on first principles flow equations. For gate valves, valve flow coefficients ($C_V$s) are taken from Reference (2). These $C_V$ values were developed in the EPRI MOV Program based on evaluation of test data for several gate valves. For globe valves, the $C_V$ is assumed to vary linearly from the 0 at fully closed to the fully open $C_V$, which is input by the user.

## NRC/INEEL DC Motor Actuator Test Program

Reference (5) summarizes the results of DC motor actuator testing by INEEL, sponsored by the NRC. Four DC motor actuators were tested at various voltage and temperature conditions. The sections below discuss the key results and conclusions of the NRC/INEEL testing and describe how the BWROG DC motor performance method addresses these results and conclusions.

### *Gearbox Efficiency and Motor Speed Threshold*

Reference (5) concludes that "the published running efficiency was generally not adequate for predicting actuator performance of the gearboxes, especially at high loads. The published pullout efficiency was adequate for predicting gearbox performance for some gearboxes and at some conditions (moderate loads), but a very low speeds, some of the actual efficiency data fell below the published pullout efficiency." Reference (5) also concludes that "gearbox efficiency is affected by motor speed as well as by the torque load imposed on the actuator" and that there is a "minimum motor speed threshold below which additional motor torque produced little or no additional actuator torque." The motor speed threshold for the four motors tested was up to about 300 rpm, corresponding to a worm shaft speed up to about 370 rpm.

As discussed previously in this report, the gearbox efficiency in the DC motor performance method depends on the worm shaft speed and the actuator output (i.e., stem) torque (as a percentage of the actuator torque rating), consistent with INEEL's conclusions. Table 2-2 shows the gearbox efficiency factors (f) used in the method. An f-factor of 0 indicates an efficiency equal to pullout efficiency, and an f-factor of 1 indicates an efficiency equal to run efficiency. These f-factors are based on evaluation of the NRC/INEEL test data, and a previous section of

this report compares the f-factors in Table 2-2 with f-factors calculated from the NRC/INEEL data. The results, which are shown in Figures 3-1, 3-2 and 3-3, indicate that the f-factors used in the method are generally conservative, relative to the NRC/INEEL data.

As shown in Table 2-2, the highest f-factor used in the method is 0.7; therefore, the highest efficiency used in the method is the pullout efficiency plus 70% of the difference between the run and pullout efficiencies, consistent with INEEL's conclusion that the run efficiency was generally not adequate to predict motor performance. In addition, the f-factors are always less than 0 for worm shaft speeds less than 200 rpm; therefore, the gearbox efficiency used in the method at these speeds will be less than pullout efficiency, also consistent with INEEL's conclusion that some of the data fell below the published pullout efficiency.

### *Degraded Voltage*

Reference (5) concludes that "estimates that anticipated linear reductions in both motor torque and motor speed fell very close to actual DC motor performance at reduced voltage." As discussed previously in this report, the DC motor performance method linearly adjusts both the motor torque and the motor speed based on the ratio of motor terminal voltage to nominal motor voltage, consistent with INEEL's conclusion.

### *Elevated Temperature*

Reference (5) concludes that "elevated temperature had an immediate effect on DC motor output torque" and that "temperature has a linear effect on output torque, similar to the temperature effect on the resistance of copper wire." Reference (5) also indicates that temperature appeared to affect the motor torque but not the motor speed. Temperature increases of 30 to 50°F were typically observed during high-load stall tests. Reference (5) suggests the following equation for adjusting motor torque with elevated temperature, T, in °F, where $\tau$ is the motor torque at ambient temperature (ft-lbs)and $\tau''$ is the motor torque at the elevated temperature (ft-lbs).

*Equation 3-5:*

$$\frac{\tau''}{\tau} = 1 - \frac{T - 70}{70 + 459.67}$$

As discussed previously in this report, the DC motor performance method adjusts the motor torque for elevated temperature, T, in degrees C, using the equation below. This equation is based on the change in the resistance of copper wire at elevated temperatures, consistent with INEEL's conclusions.

*Equation 3-6:*

$$\frac{\tau''}{\tau} = \frac{25 + 234.4}{T + 234.4}$$

The table below compares the elevated temperature corrections that would be calculated using the INEEL method and the DC motor performance method ("Method").

| Temperature | | Temperature Corrections | |
|---|---|---|---|
| °F | °C | Method | INEEL |
| 75 | 23.9 | 1.00 | 0.99 |
| 80 | 26.7 | 0.99 | 0.98 |
| 90 | 32.2 | 0.97 | 0.96 |
| 100 | 37.8 | 0.95 | 0.94 |
| 120 | 48.9 | 0.92 | 0.91 |
| 140 | 60.0 | 0.88 | 0.87 |
| 160 | 71.1 | 0.85 | 0.83 |
| 180 | 82.2 | 0.82 | 0.79 |
| 200 | 93.3 | 0.79 | 0.75 |
| 250 | 121.1 | 0.73 | 0.66 |
| 300 | 148.9 | 0.68 | 0.57 |

As shown, the correction factor for the DC motor performance method is greater (less correction) than the value calculated from the INEEL equation. The difference between the values increases for increasing temperature. This result is consistent with Figures 30 through 35 of Reference (5), which show that the INEEL equation gets more conservative for increasing temperature, for testing at temperatures up to 300°F.

### *Stroke Times*

Reference (5) concludes that "changes in running load can have significant effects on valve stroke time." INEEL ran several tests to demonstrate this effect. For these tests, the stem load was maintained at a relatively constant value throughout the test. For example, for the 10 ft-lb, 125 VDC motor (SMB-0 actuator), INEEL ran the following tests.

- 100% voltage, 3000 pound running load, 8 second measured stroke time
- 100% voltage, 7000 pound running load, 9 second measured stroke time

The DC motor performance method predicts increased stroke times for higher running loads. To illustrate, the DC motor performance method was implemented for the two tests described above. Since the stroke length for these tests is not given in Reference (5), a stroke length was determined by trial and error until the predicted stroke time for the first test above was 8 seconds. The stroke time prediction for the other test was then performed using this stroke length. The results are summarized in the table below.

| Test | Measured Stroke Time, seconds | Predicted Stroke Time, seconds |
|---|---|---|
| 100% voltage, 3000 pound running load | 8 | 8 |
| 100% voltage, 7000 pound running load | 9 | 9.7 |

As shown, the DC motor performance method predicts that the stroke time increases with increased running load and provides a conservative stroke time prediction for the 7000 pounds running load test. The overprediction is attributable to conservatism in the vendor motor performance curve (which underpredicts the motor speed by about 6%).

### *Performance Curves*

Reference (5) concludes that the performance of the 10 ft-lb, 125 VDC motor and the 25 ft-lb, 125 VDC motor matched or exceeded the vendor motor performance curves (speed versus torque), and that the performance of the 40 ft-lb, 125VDC motors was less than the vendor motor performance curve. These conclusions are consistent with the results described in Section 3 of this report, which indicate that the vendor motor performance curves for the 10 ft-lb, 125 VDC motor and the 25 ft-lb, 125 VDC motor can be used in the DC motor performance method, but that an adjusted motor performance curve must be used for 40 ft-lb, 125 VDC motors.

### *Stem Nut Friction*

Reference (5) concludes that "the high loads and slower speeds had little effect on the stem nut coefficient of friction in the actuators " tested. Stem factor is not predicted by the motor performance method but is input by the user.

**Table 3-1.** Matrix of Motor Test Data Used to Justify Vendor Motor Curves (2 pages)

| Motor Type | Data Source | Motor | Test | Test Type |
|---|---|---|---|---|
| 5 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 80% voltage |
| | | | b | 100% voltage |
| | | 2 | a | 85% voltage |
| | | | b | 100% voltage |
| 10 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 75% voltage |
| | | | b | 100% voltage |
| | | 2 | a | 100% voltage |
| | | *3* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |
| 15 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 70% voltage |
| | | | b | 100% voltage |
| | | 2 | a | 85% voltage |
| | | | b | 100% voltage |
| | | 3 | a | 85% voltage |
| | | | b | 100% voltage |
| | | 4 | a | 75% voltage |
| | | | b | 100% voltage |
| | | 5 | a | 75% voltage |
| | | | b | 100% voltage |
| | | *6* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |
| | | *7* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |
| | | *8* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |
| | | *9* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |

**Table 3-1.** Matrix of Motor Test Data Used to Justify Vendor Motor Curves (2 pages)

| Motor Type | Data Source | Motor | Test | Test Type |
|---|---|---|---|---|
| 25 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 75% voltage |
| | | | b | 100% voltage |
| | | 2 | a | 75% voltage |
| | | | b | 100% voltage |
| | | *3* | *a* | ***80% voltage*** |
| | | | *b* | ***100% voltage*** |
| | BWR Plant A | 4 | a | 100% voltage |
| | | 5 | a | 100% voltage |
| 40 ft-lb, 125 VDC | Crane-MOVATS | *1* | *a* | ***75% voltage*** |
| | | | *b* | ***100% voltage*** |
| | | *2* | *a* | ***75% voltage*** |
| | | | *b* | ***100% voltage*** |
| 60 ft-lb, 125 VDC | Crane-MOVATS | *1* | *a* | ***75% voltage*** |
| | | | *b* | ***100% voltage*** |
| 80 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 75% voltage |
| | | | b | 100% voltage |
| | | 2 | a | 75% voltage |
| 100 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 80% voltage |
| | | | b | 100% voltage |
| 150 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 80% voltage |
| | | | b | 100% voltage |
| 200 ft-lb, 125 VDC | Crane-MOVATS | 1 | a | 80% voltage |
| | | | b | 100% voltage |

NOTES

1. All tests were performed at ambient temperature with Peerless compound-wound DC motors.
2. Tests in bold italics are actuator tests; all other tests are dynamometer tests.

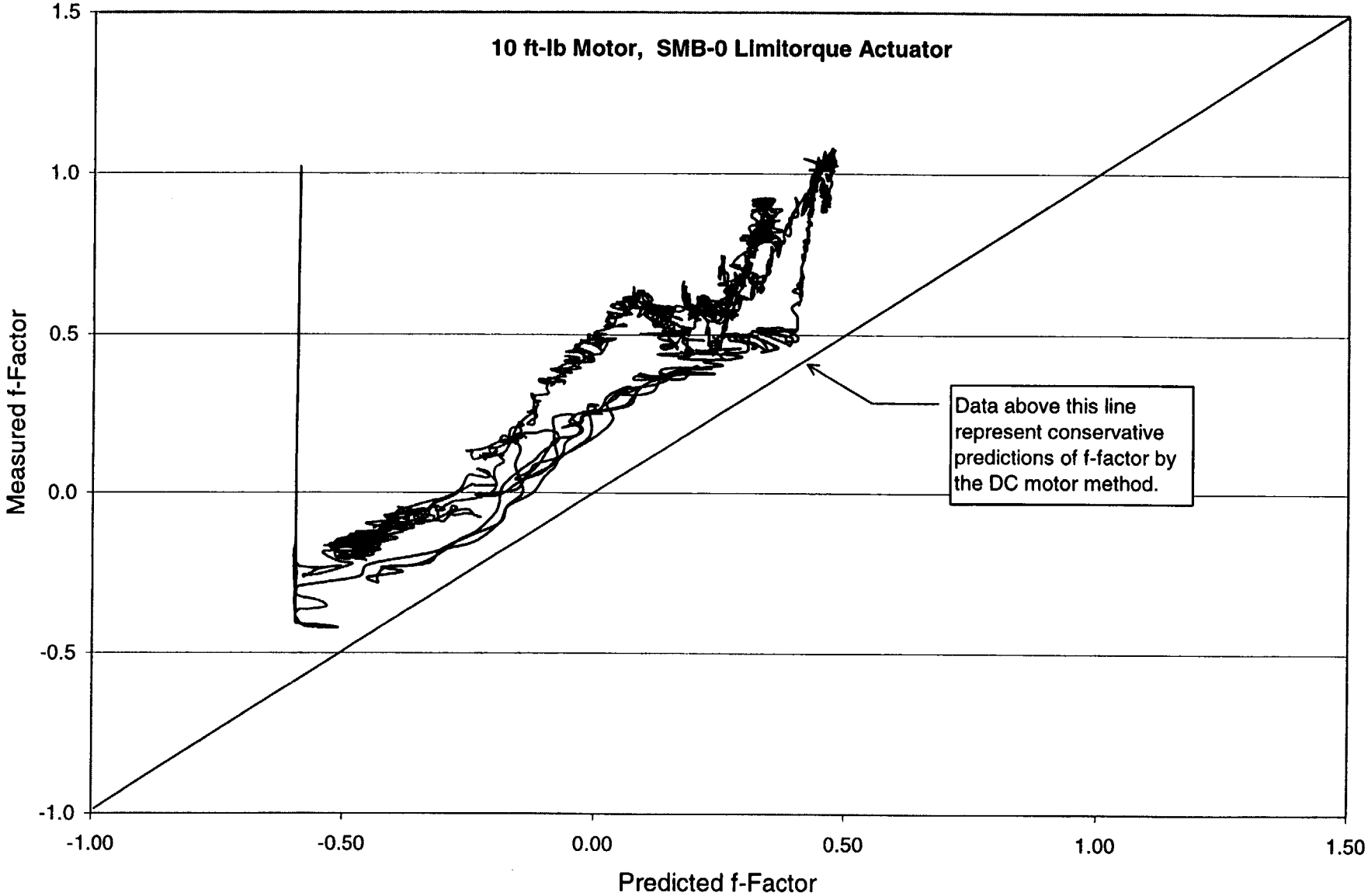


**Figure 3-1.** Predicted versus Measured Gearbox Efficiency f-Factors for NRC/INEEL 10 ft-lb Motor (SMB-0 Limitorque Actuator)

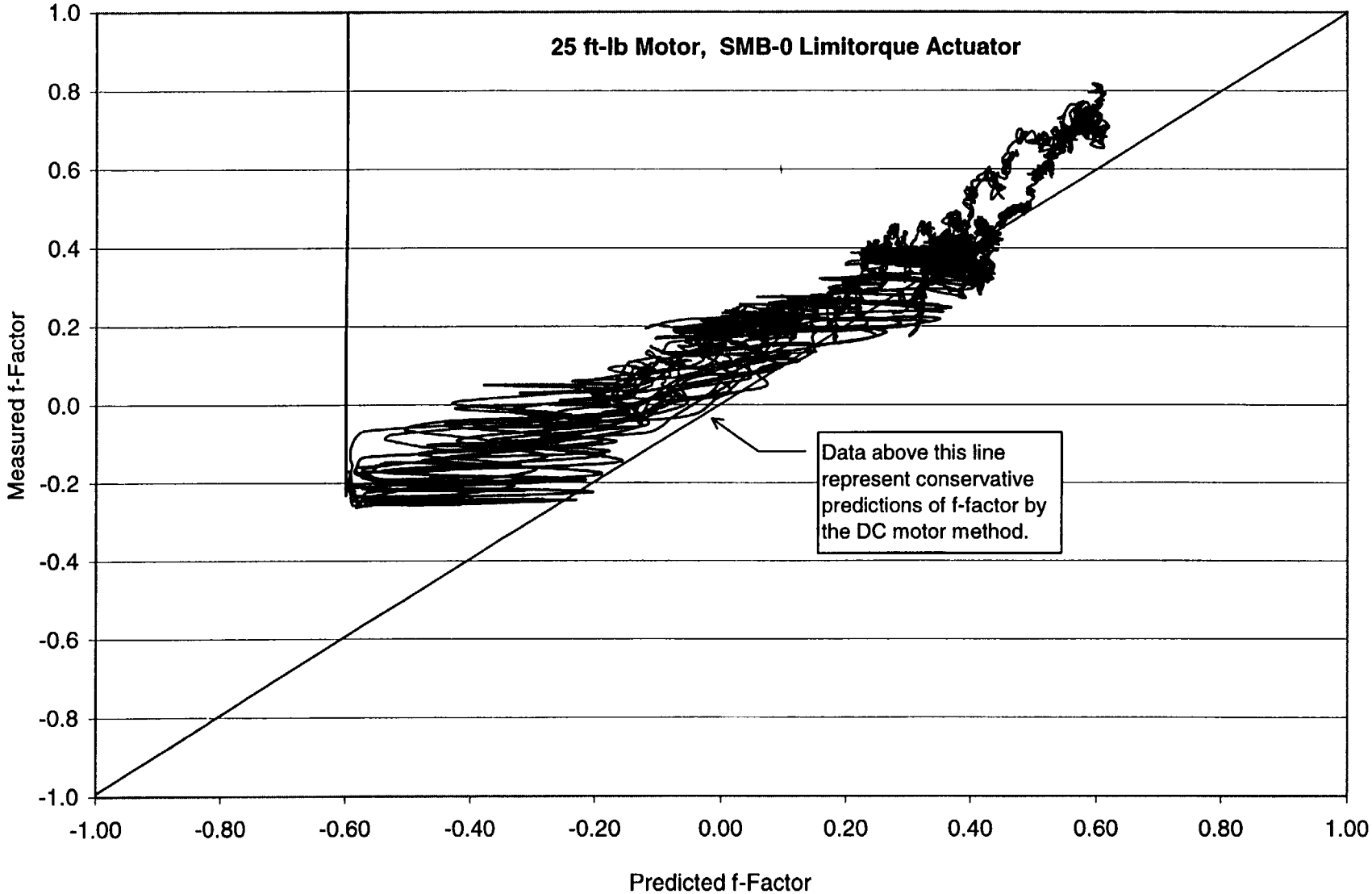


**Figure 3-2.** Predicted versus Measured Gearbox Efficiency f-Factors for NRC/INEEL 25 ft-lb Motor (SMB-0 Limitorque Actuator)

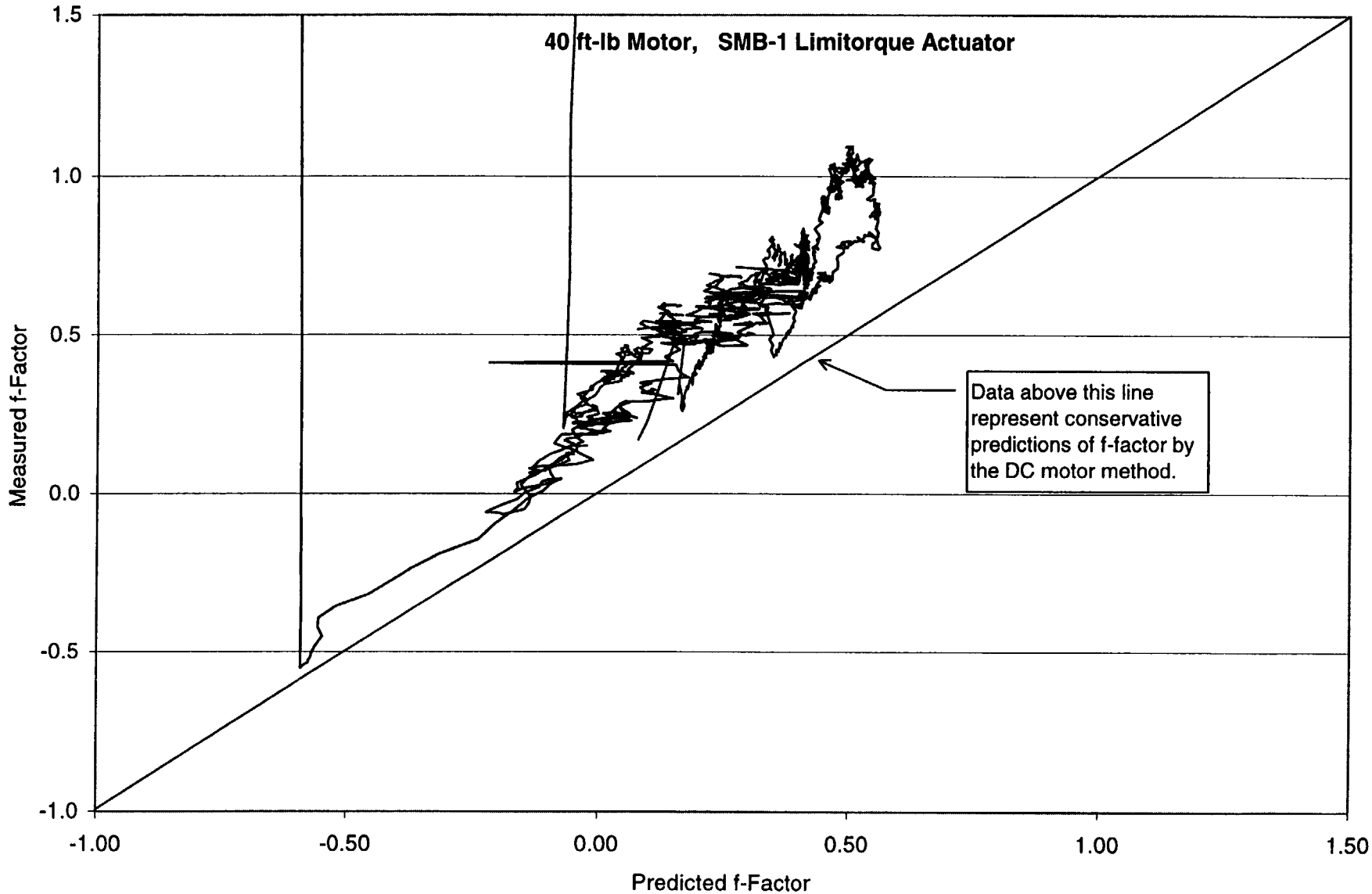


**Figure 3-3.** Predicted versus Measured Gearbox Efficiency f-Factors for NRC/INEEL 40 ft-lb Motor (SMB-1 Limitorque Actuator)

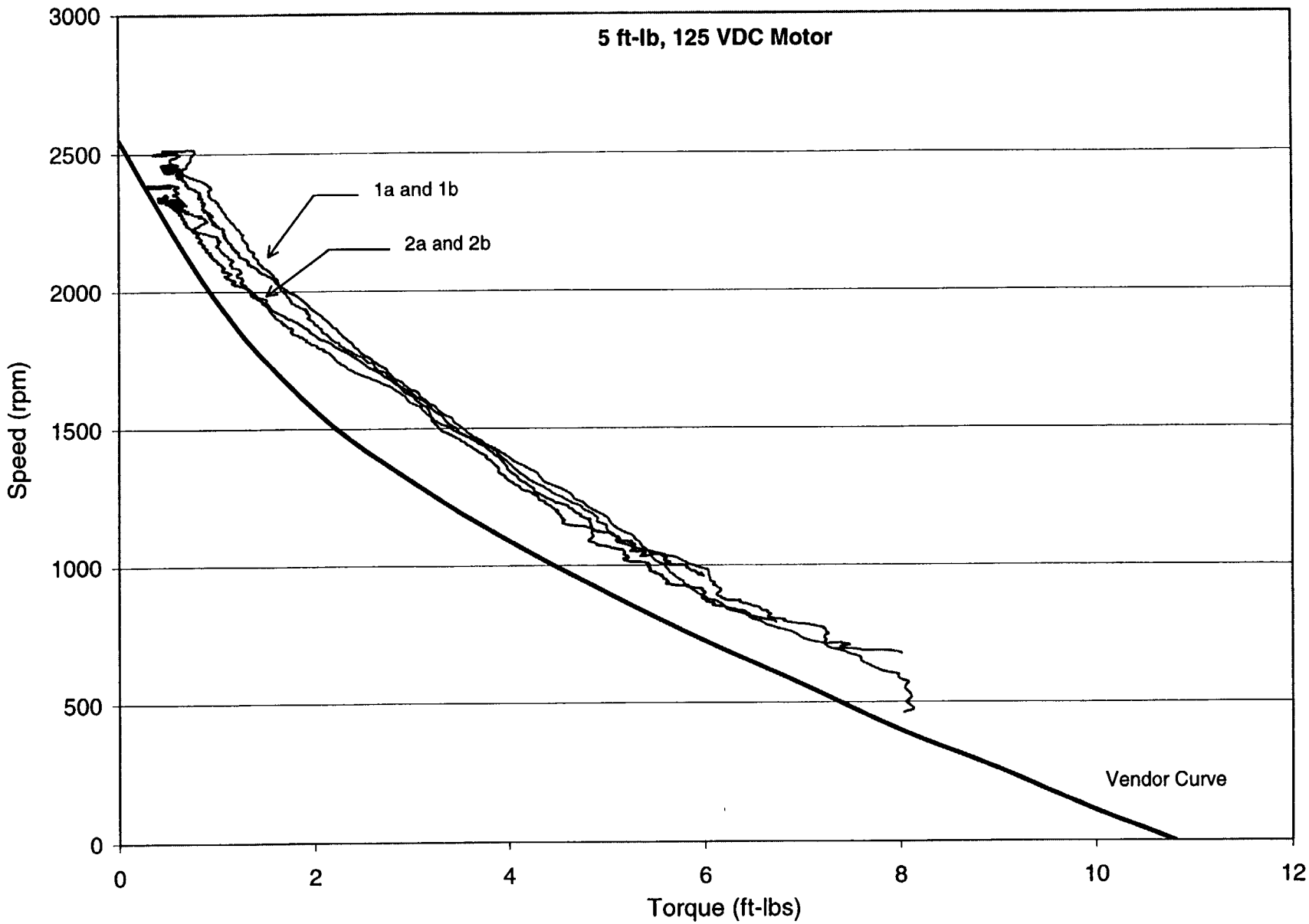


**Figure 3-4.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 5 ft-lb, 125 VDC Motor

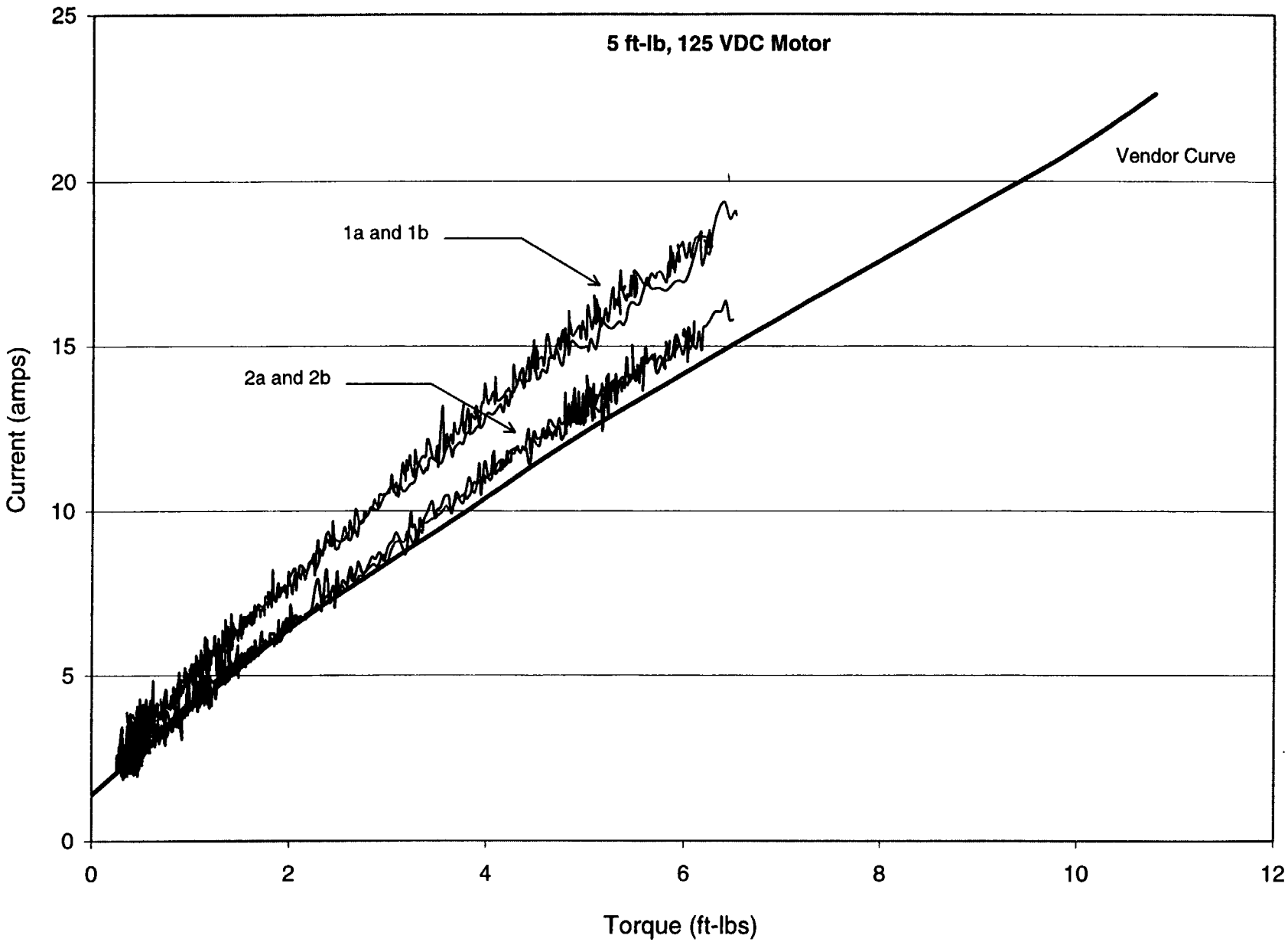


**Figure 3-5.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 5 ft-lb, 125 VDC Motor

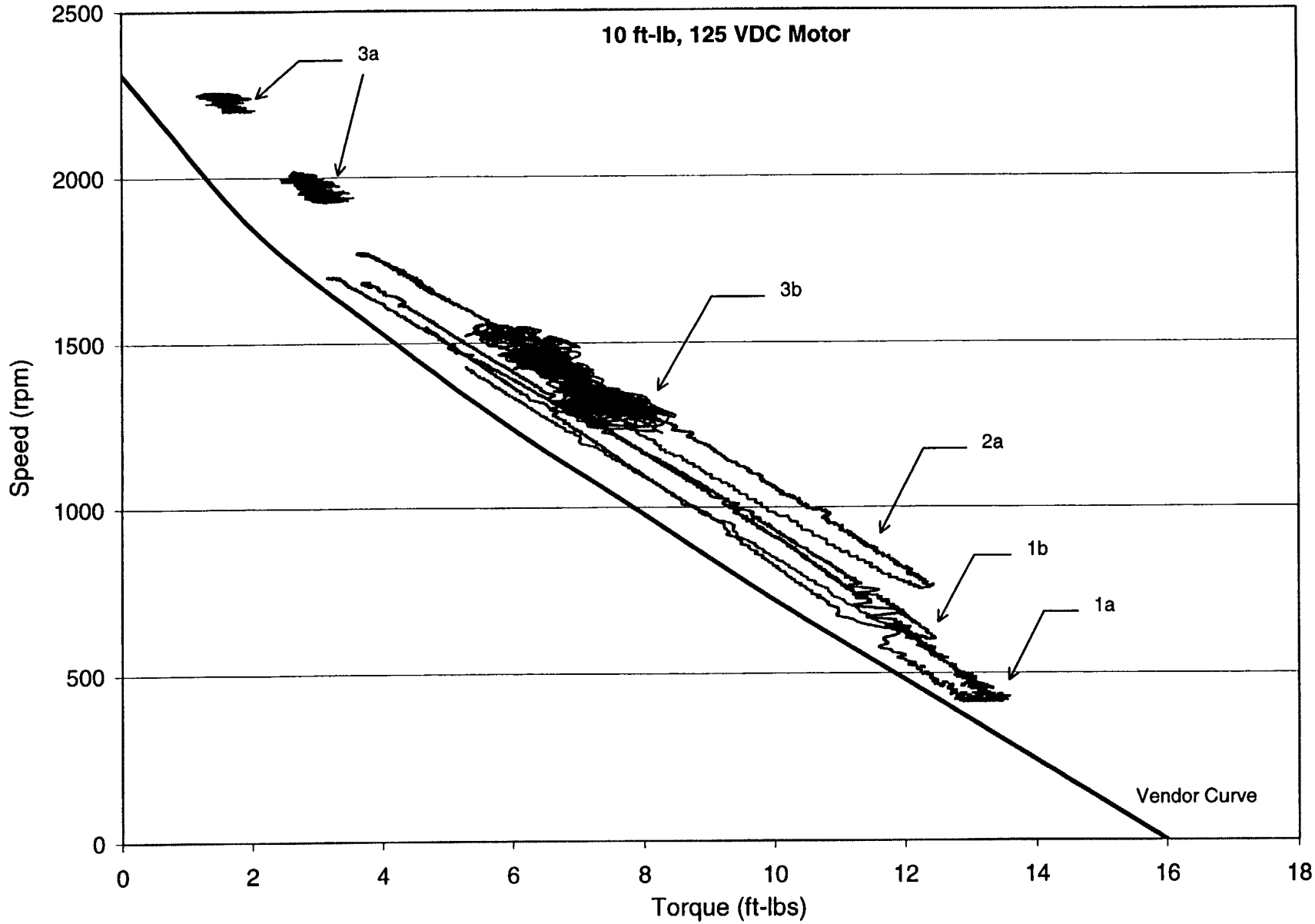


**Figure 3-6.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 10 ft-lb, 125 VDC Motor

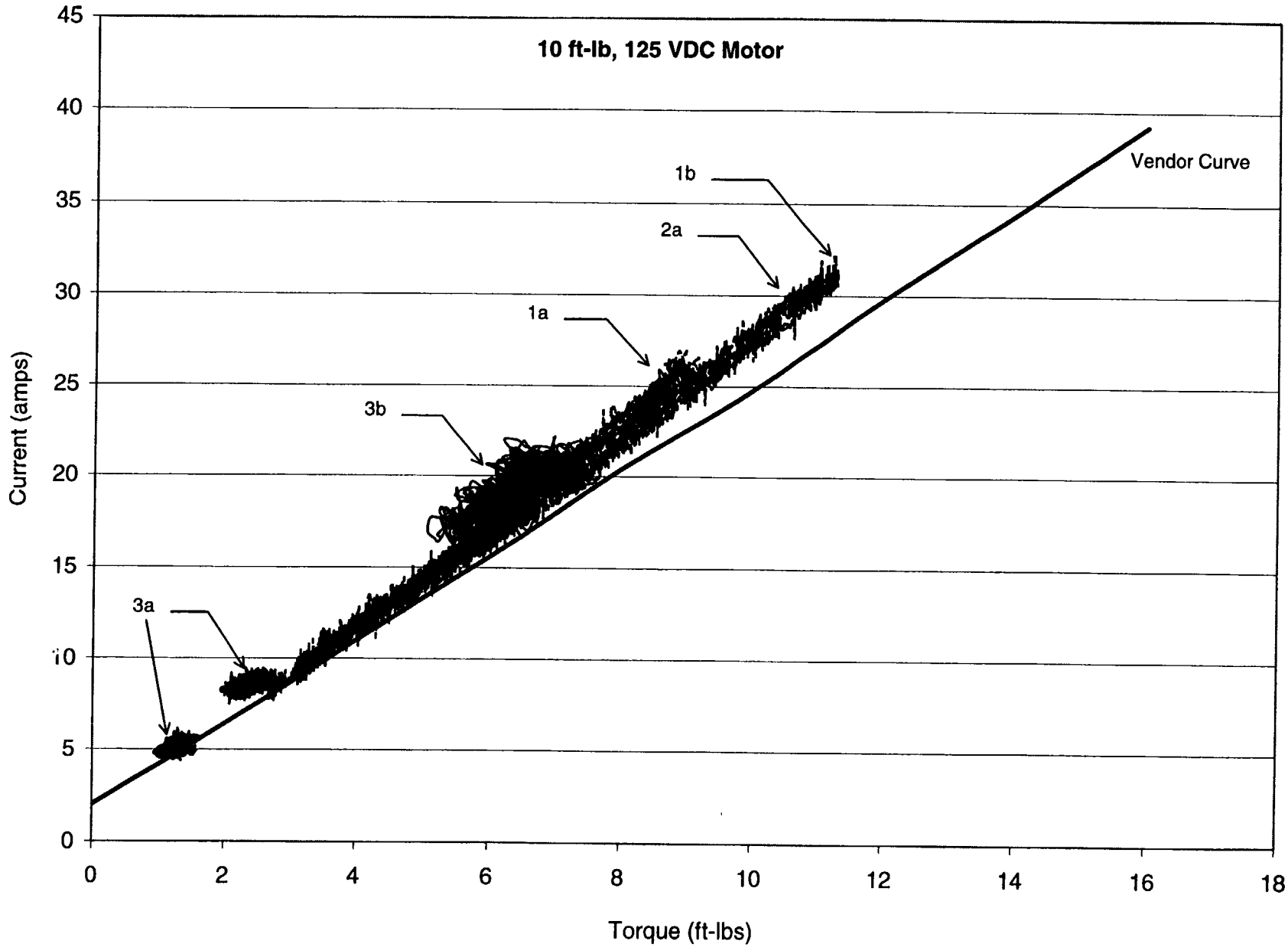


**Figure 3-7.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 10 ft-lb, 125 VDC Motor

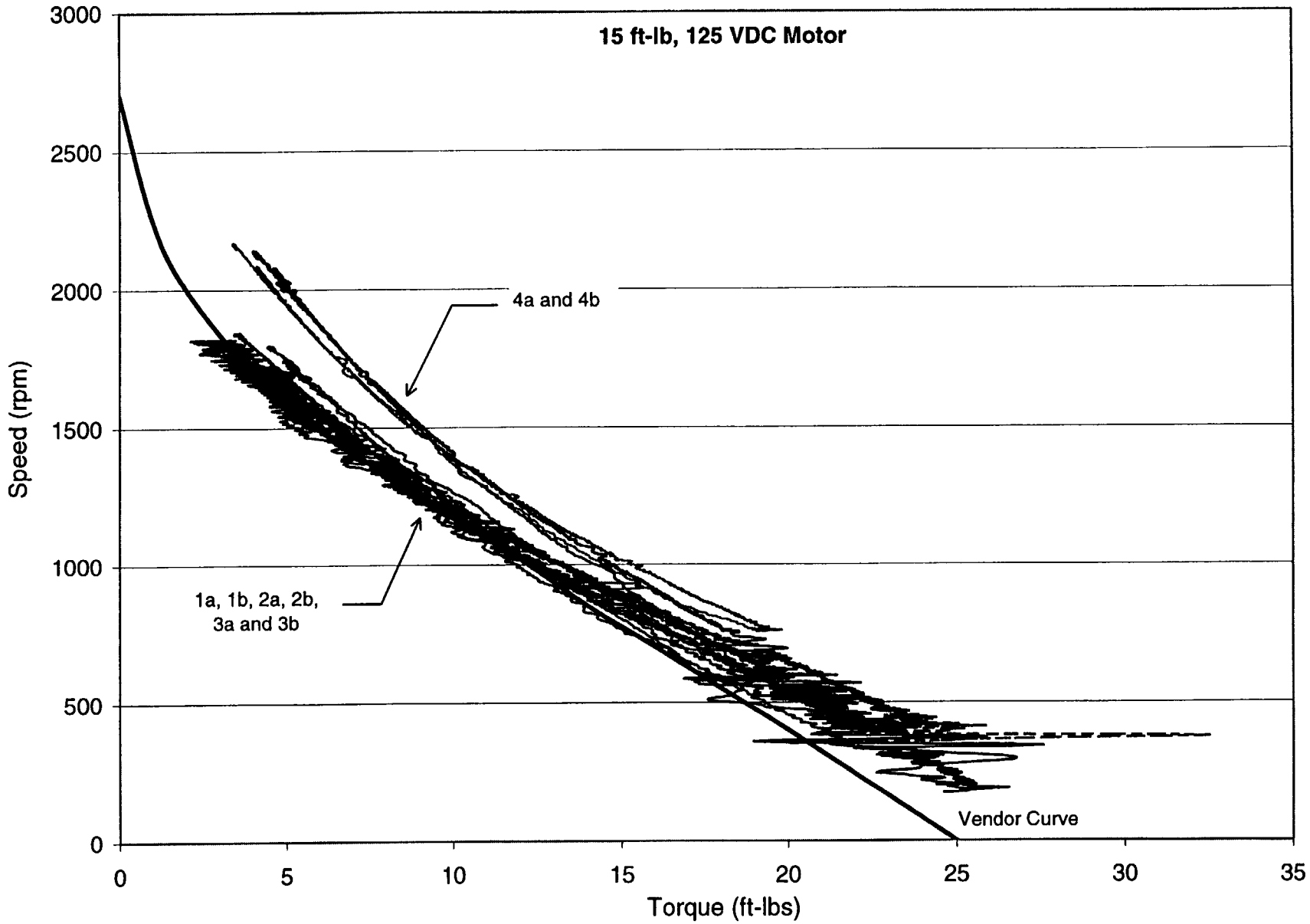


**Figure 3-8a.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

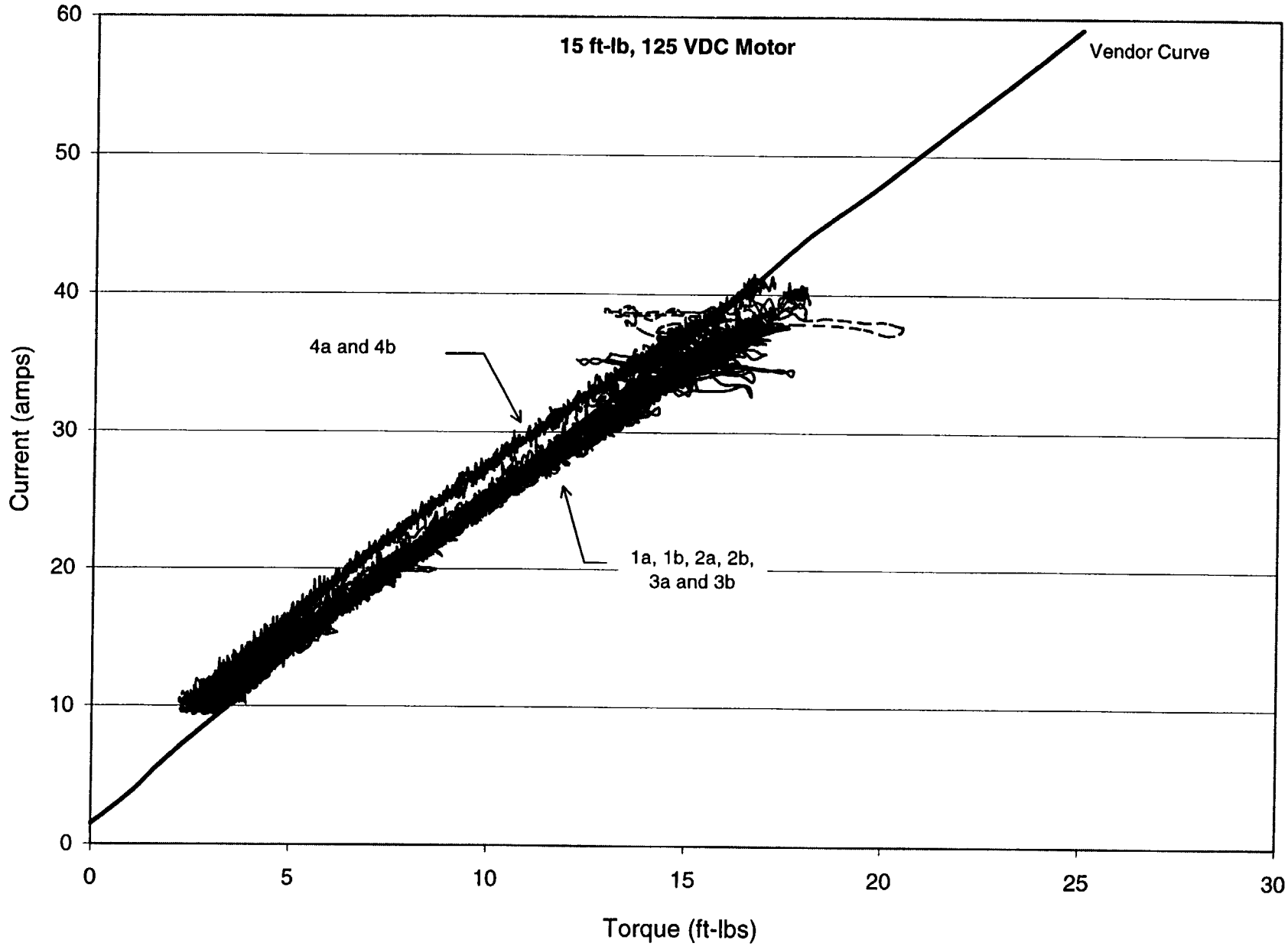


**Figure 3-8b.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

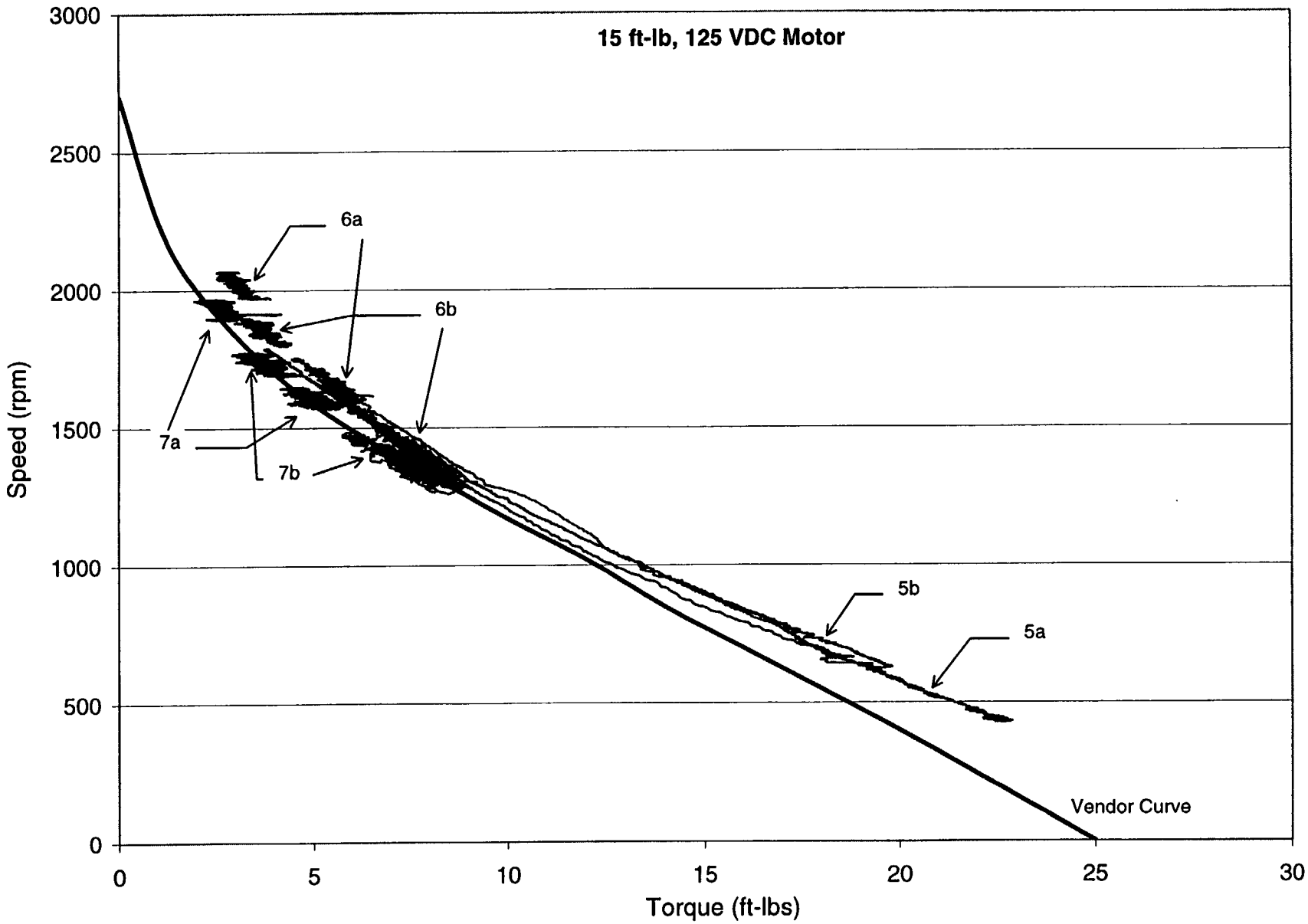


**Figure 3-8c.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

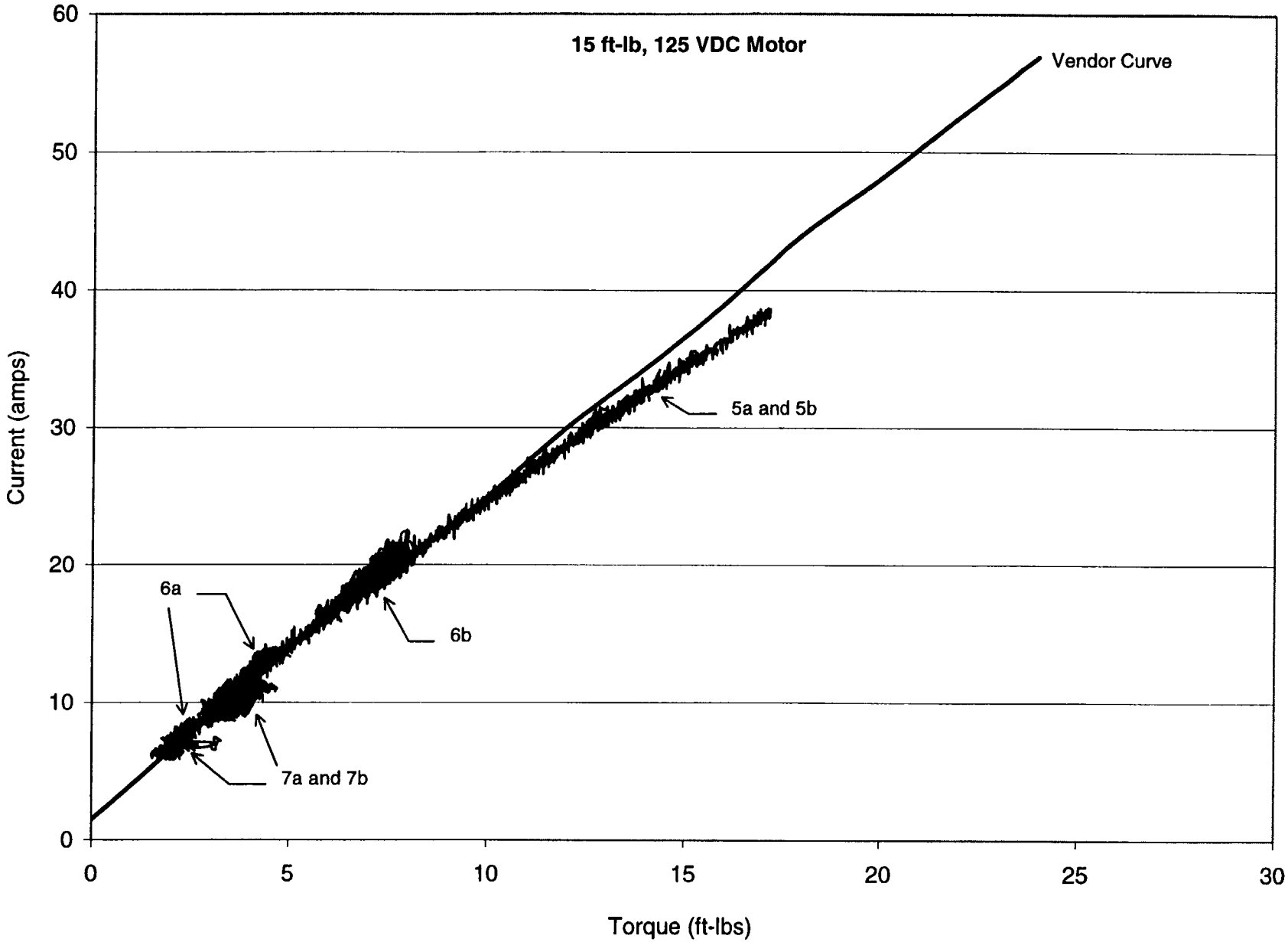


**Figure 3-9a.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

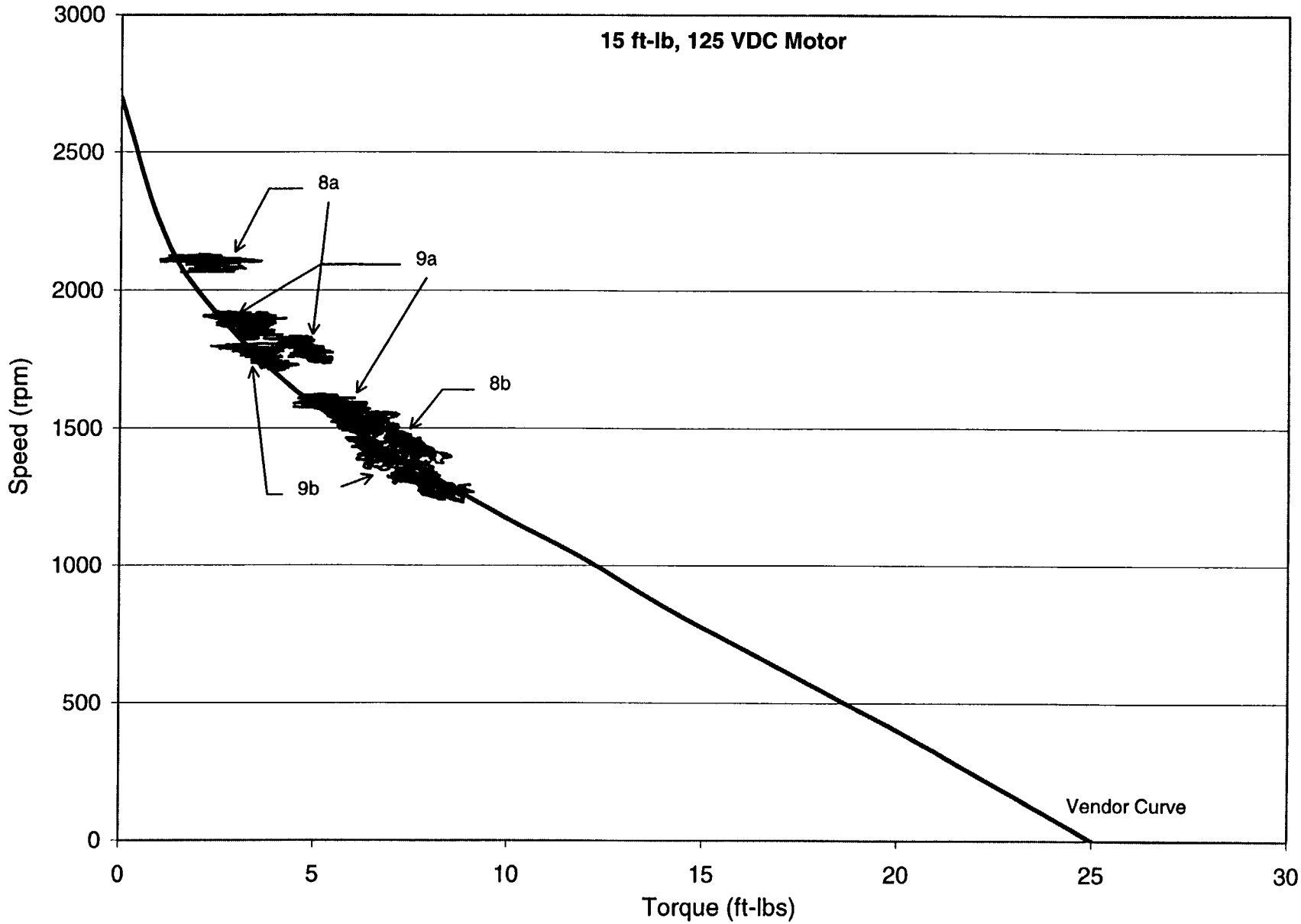


**Figure 3-9b.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

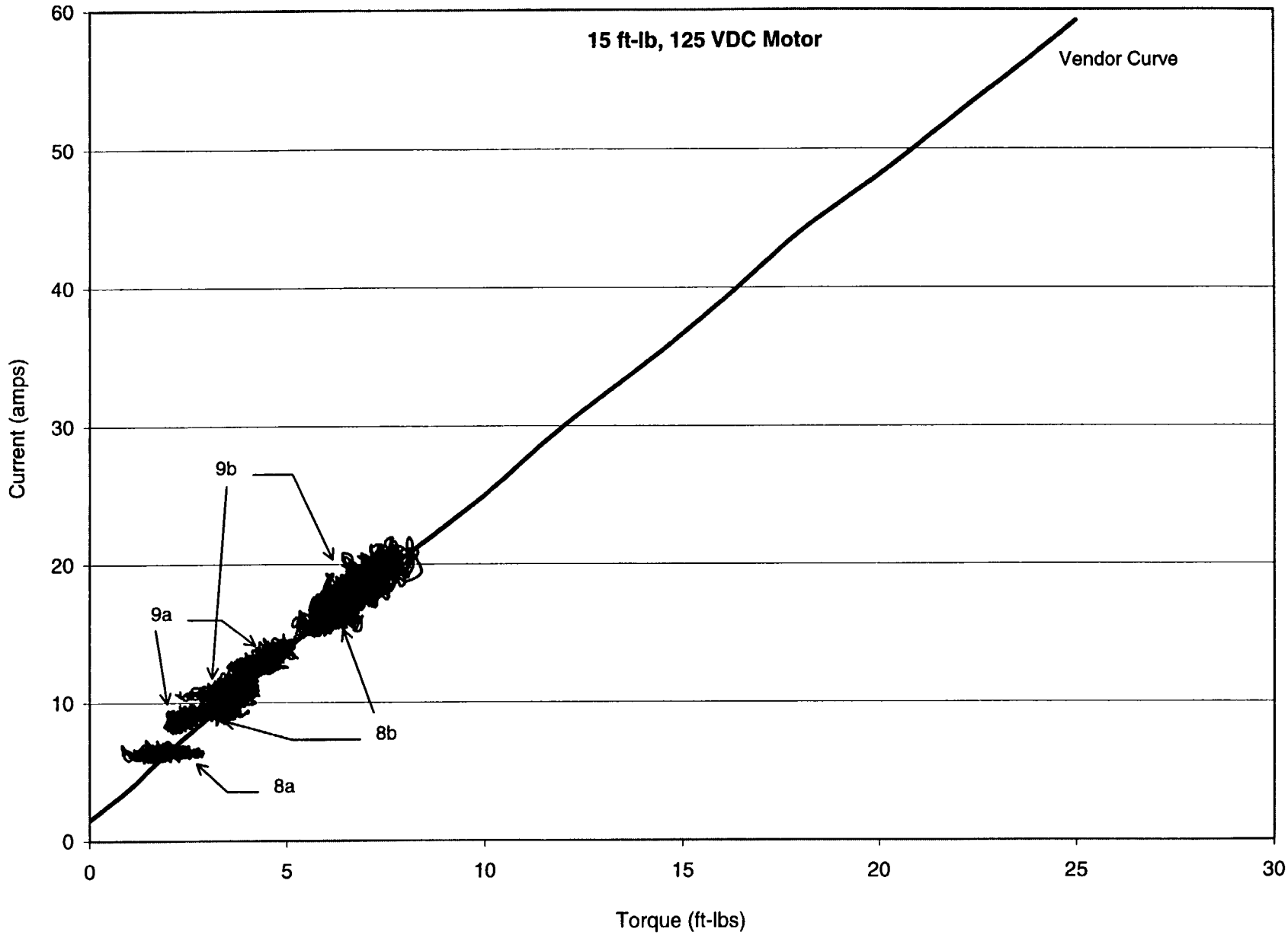


**Figure 3-9c.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 15 ft-lb, 125 VDC Motor

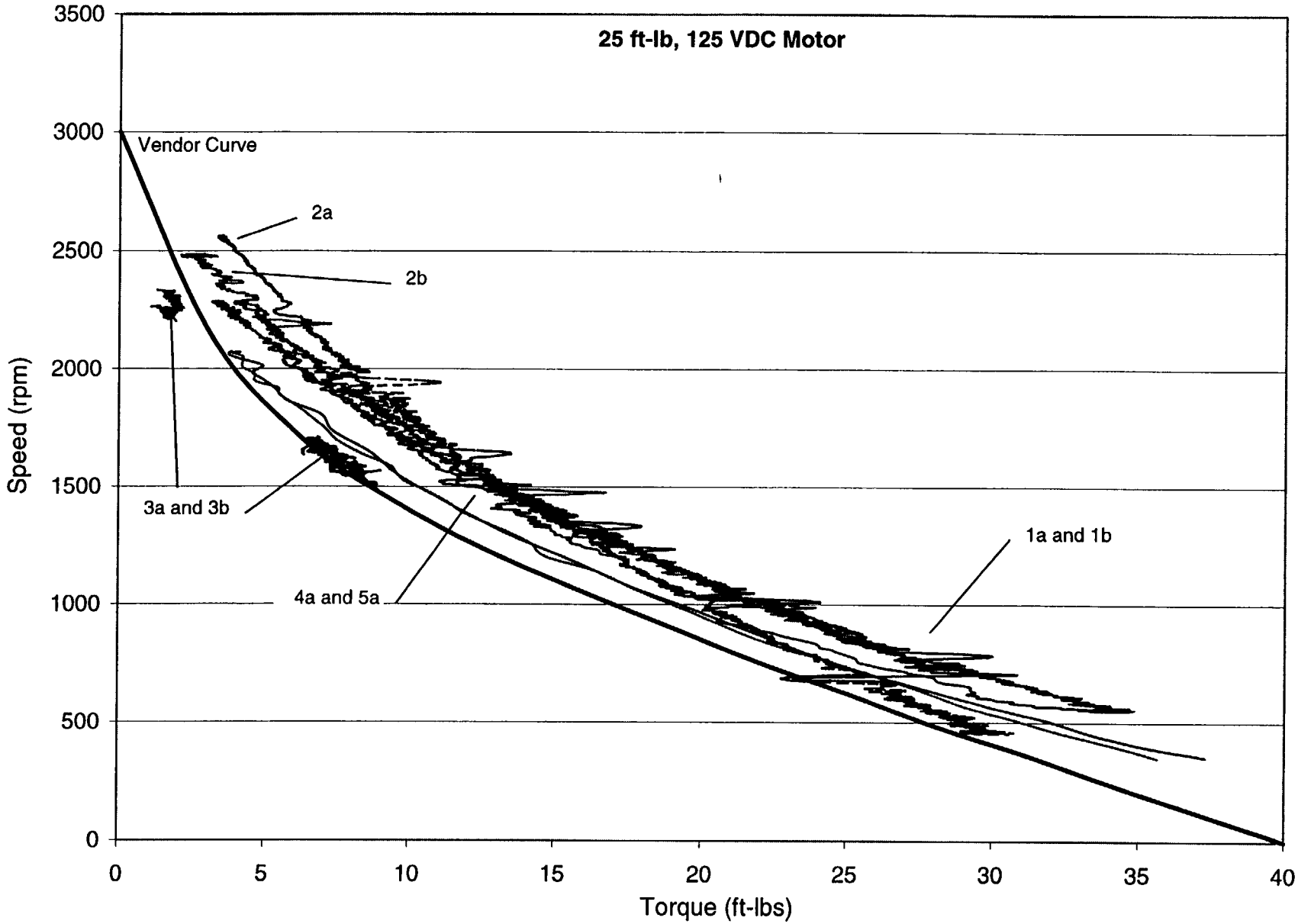


**Figure 3-10.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 25 ft-lb, 125 VDC Motor

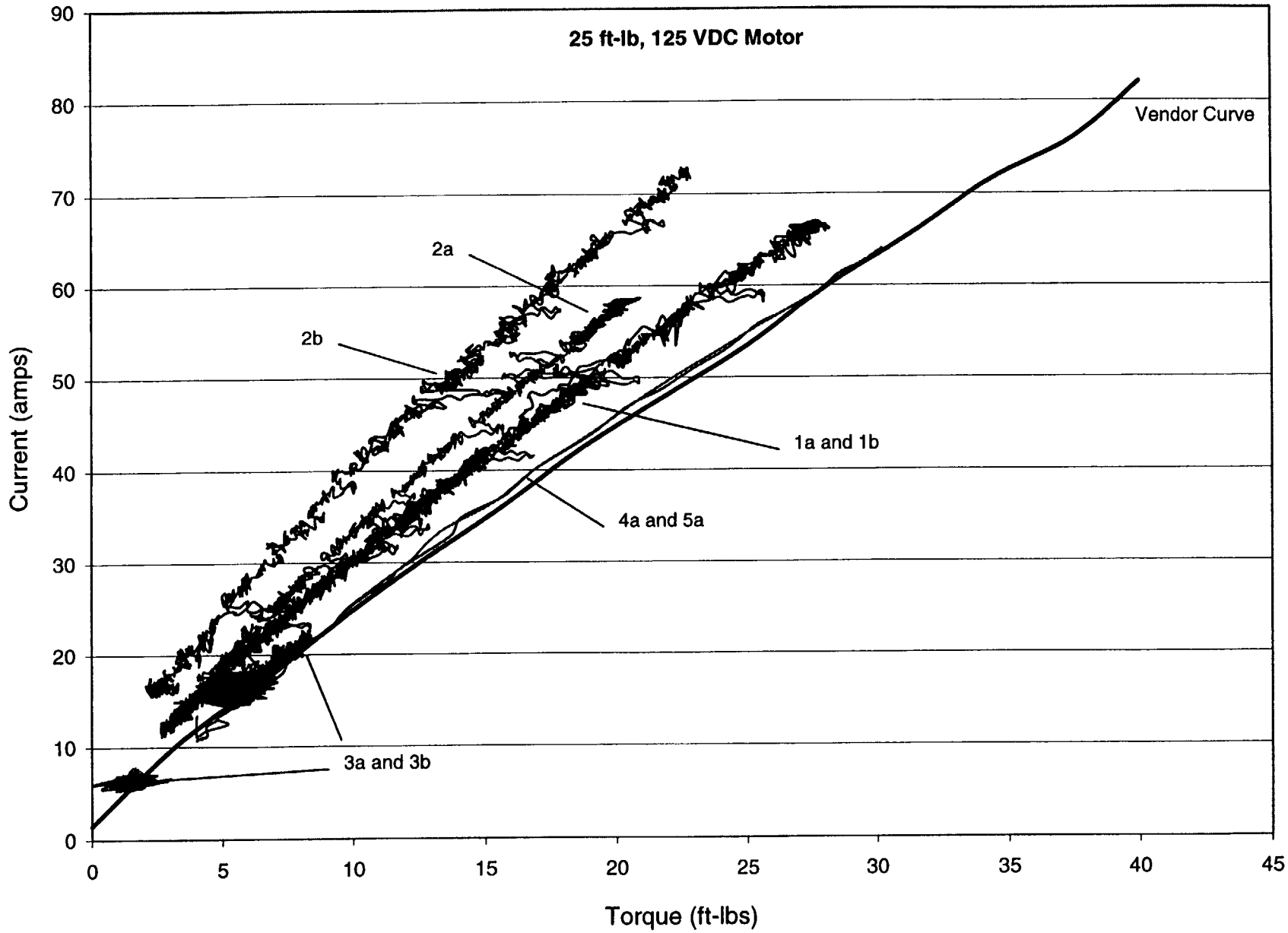


**Figure 3-11.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 25 ft-lb, 125 VDC Motor

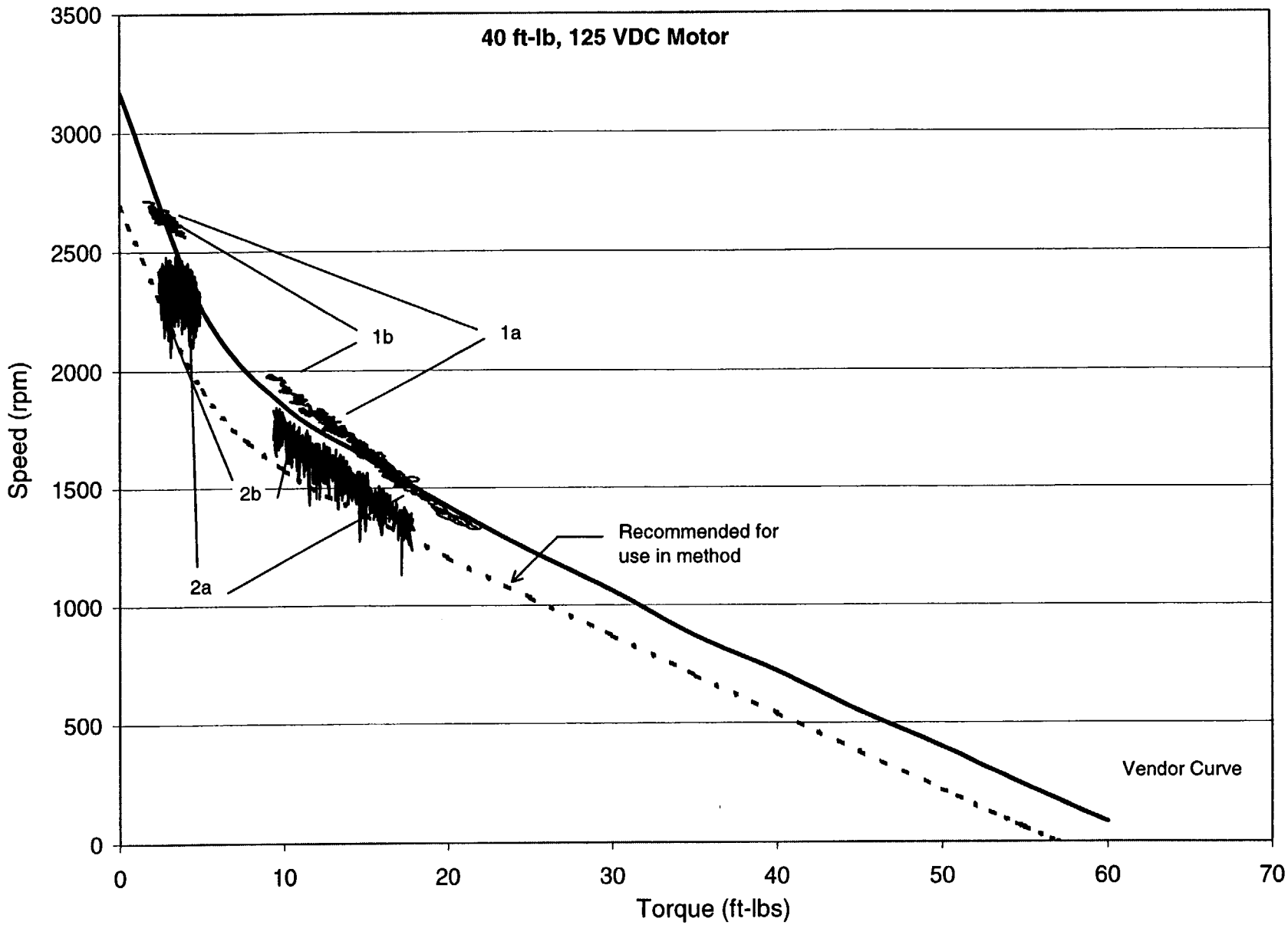


**Figure 3-12.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 40 ft-lb, 125 VDC Motor

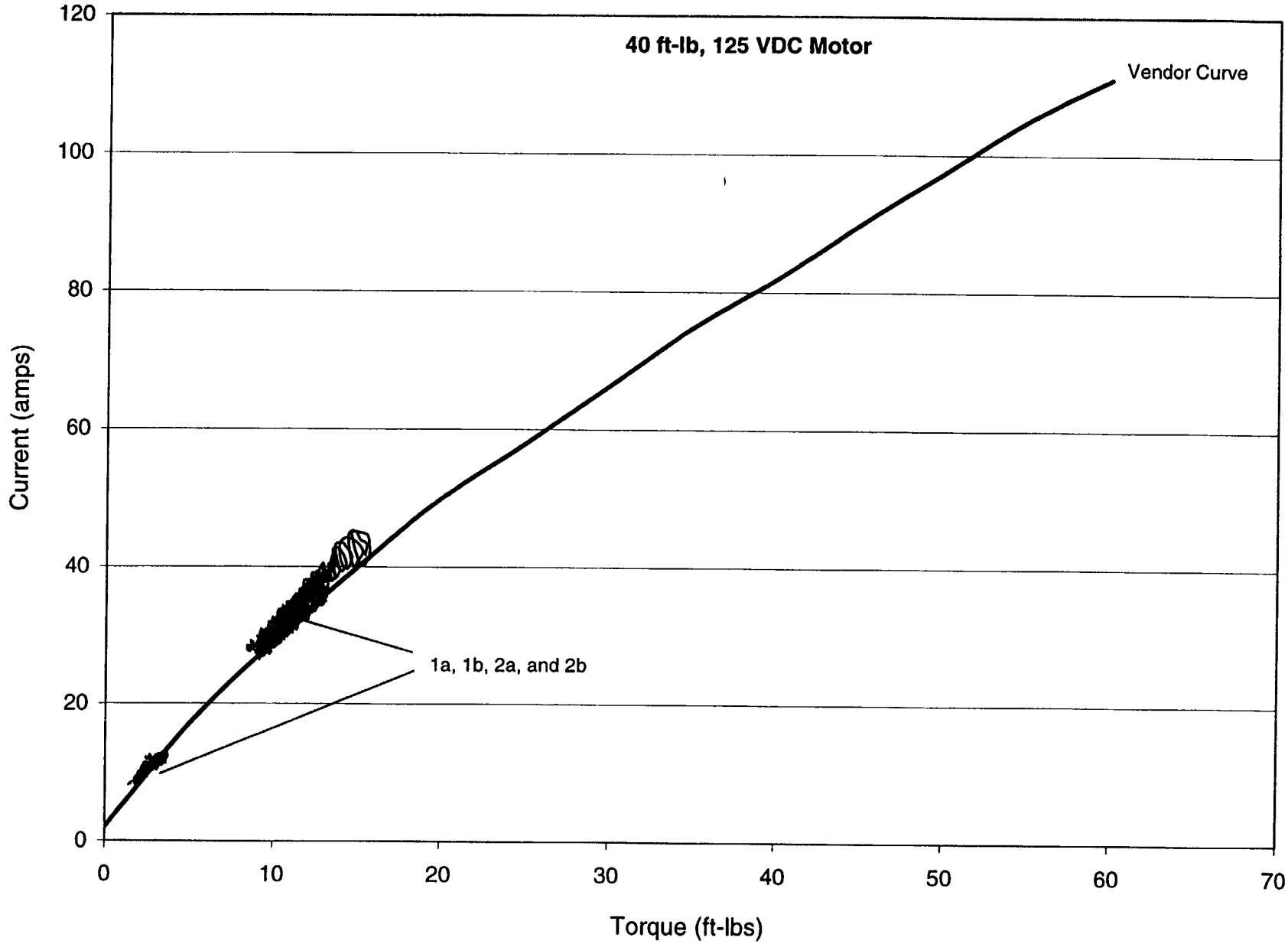


**Figure 3-13.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 40 ft-lb, 125 VDC Motor

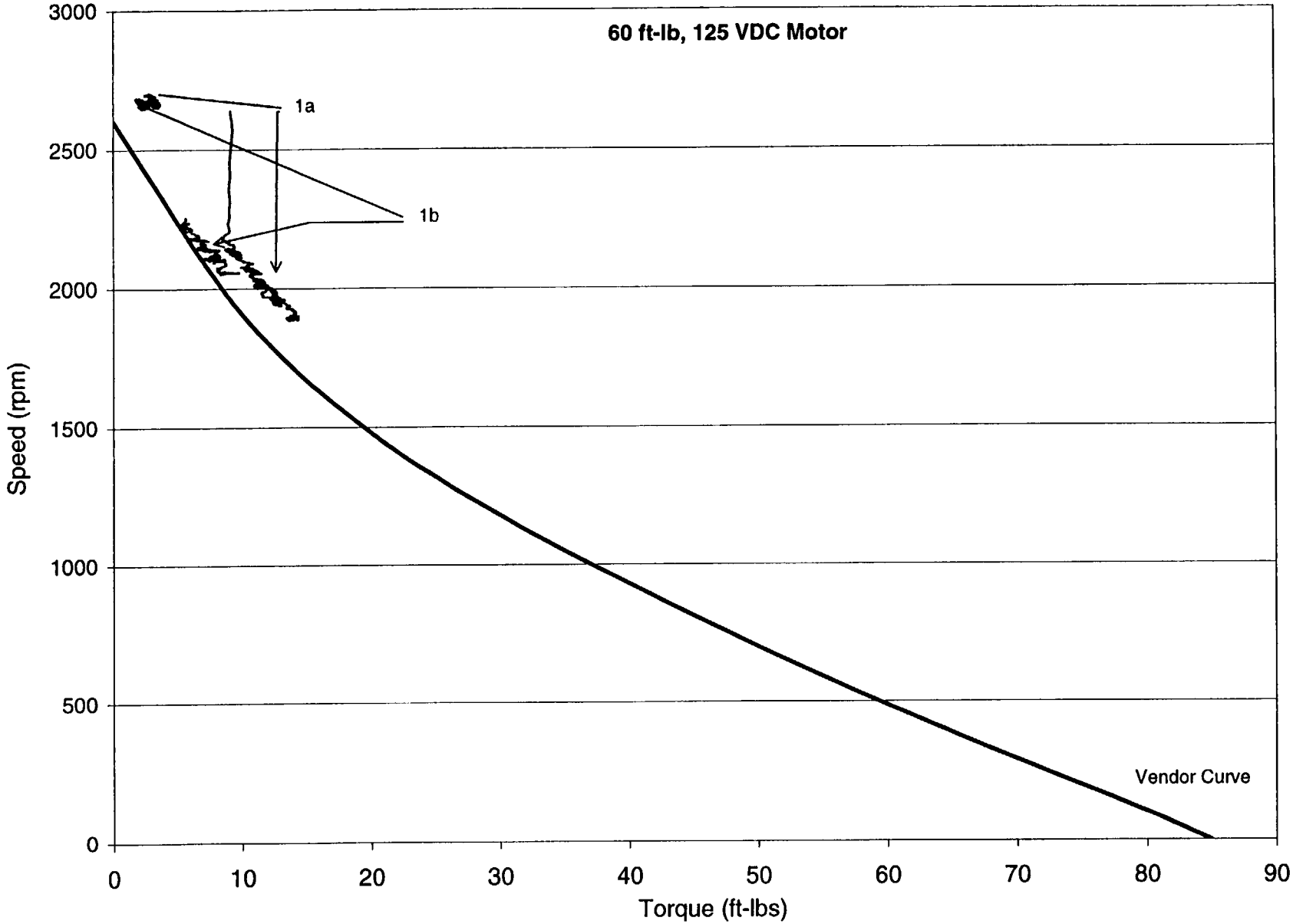


**Figure 3-14.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 60 ft-lb, 125 VDC Motor

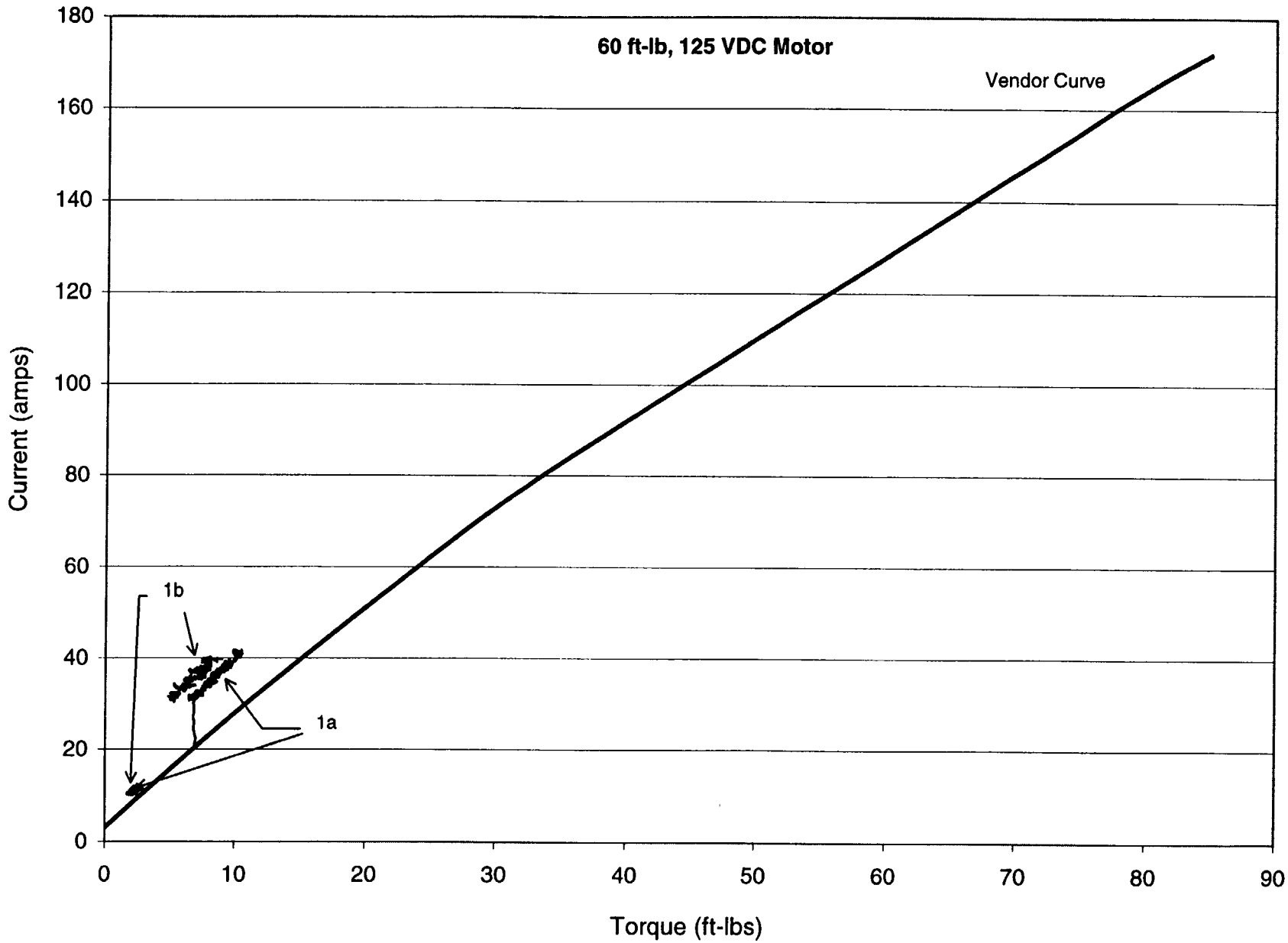


**Figure 3-15.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 60 ft-lb, 125 VDC Motor

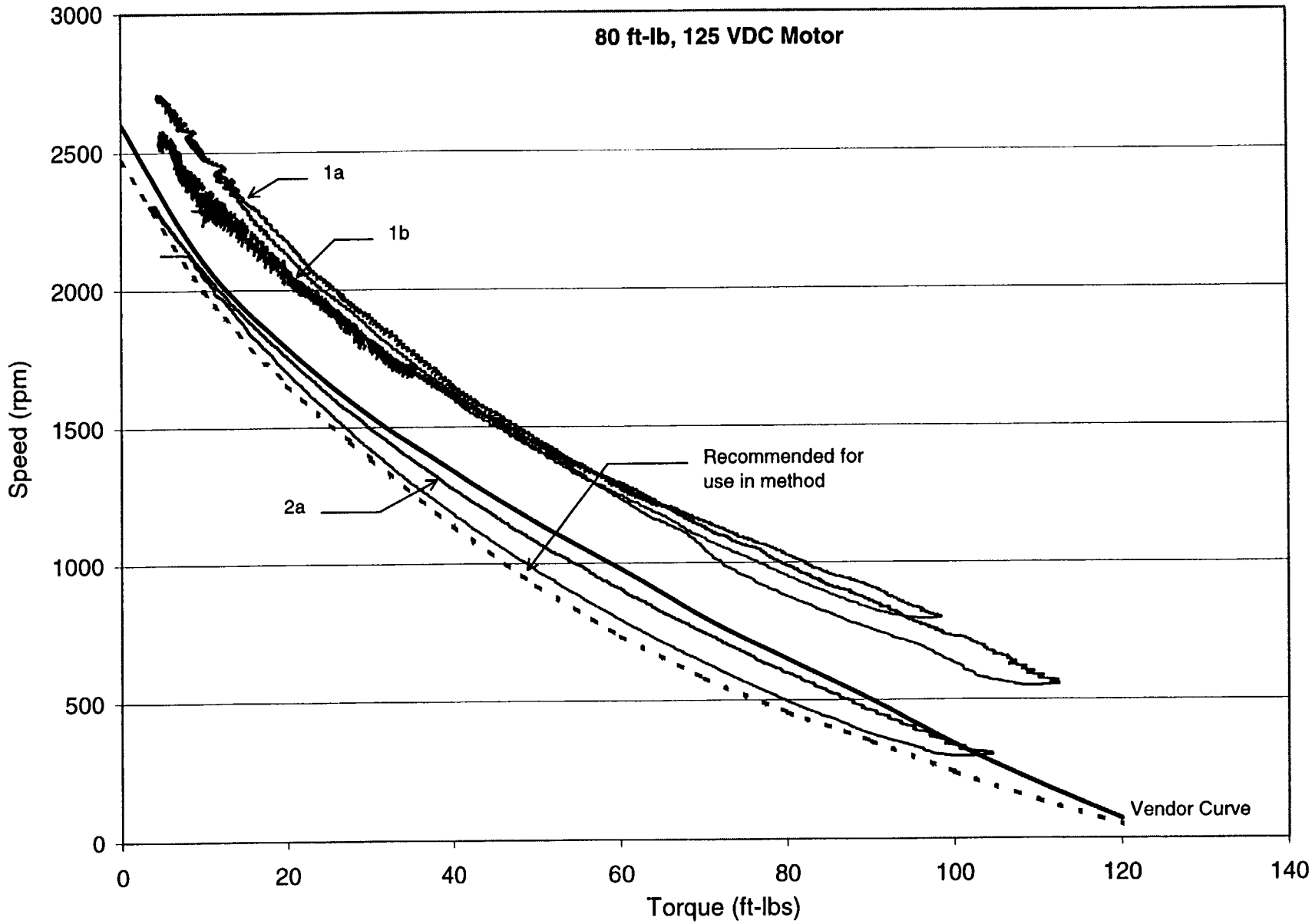


**Figure 3-16.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 80 ft-lb, 125 VDC Motor

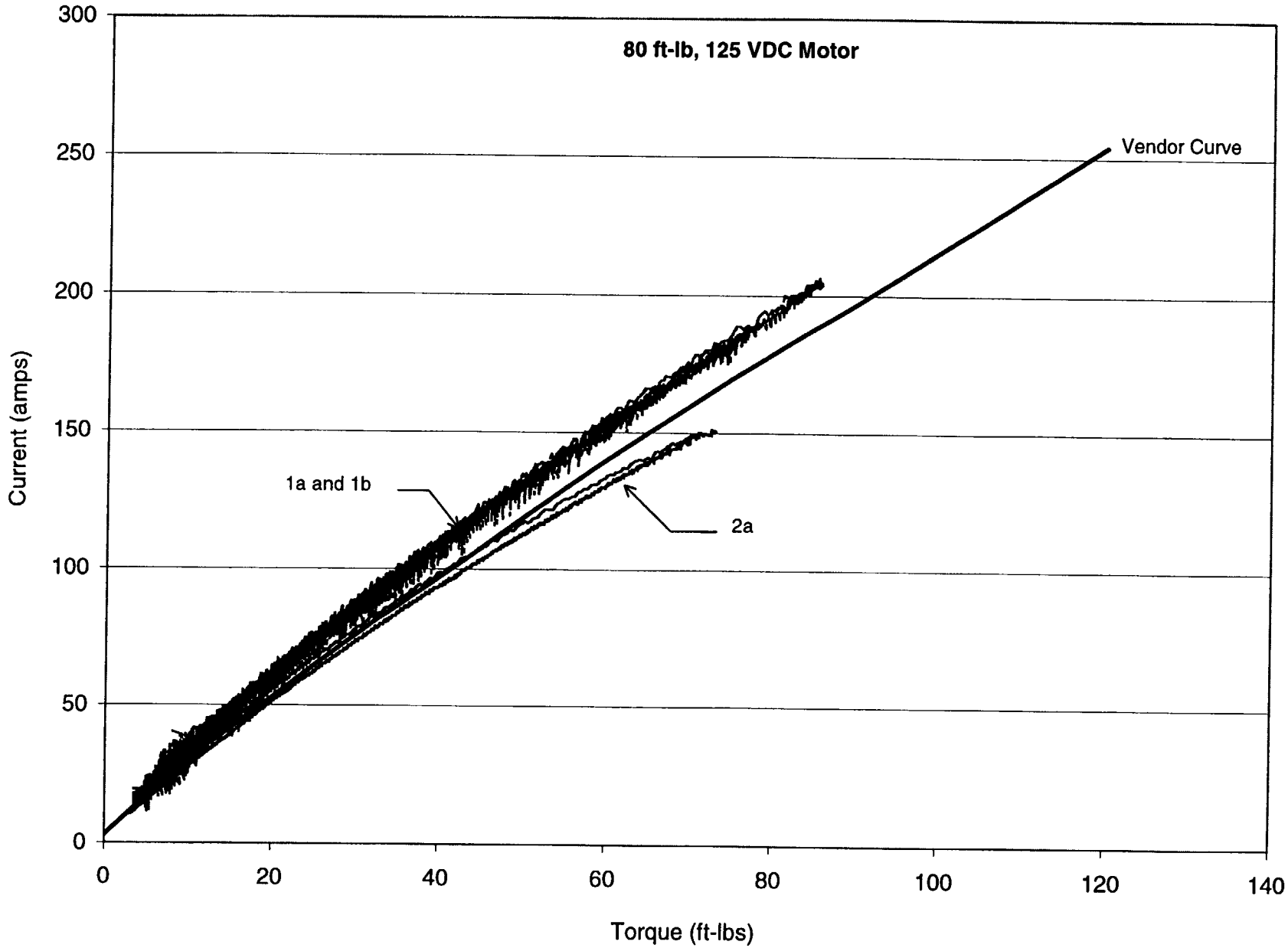


**Figure 3-17.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 80 ft-lb, 125 VDC Motor

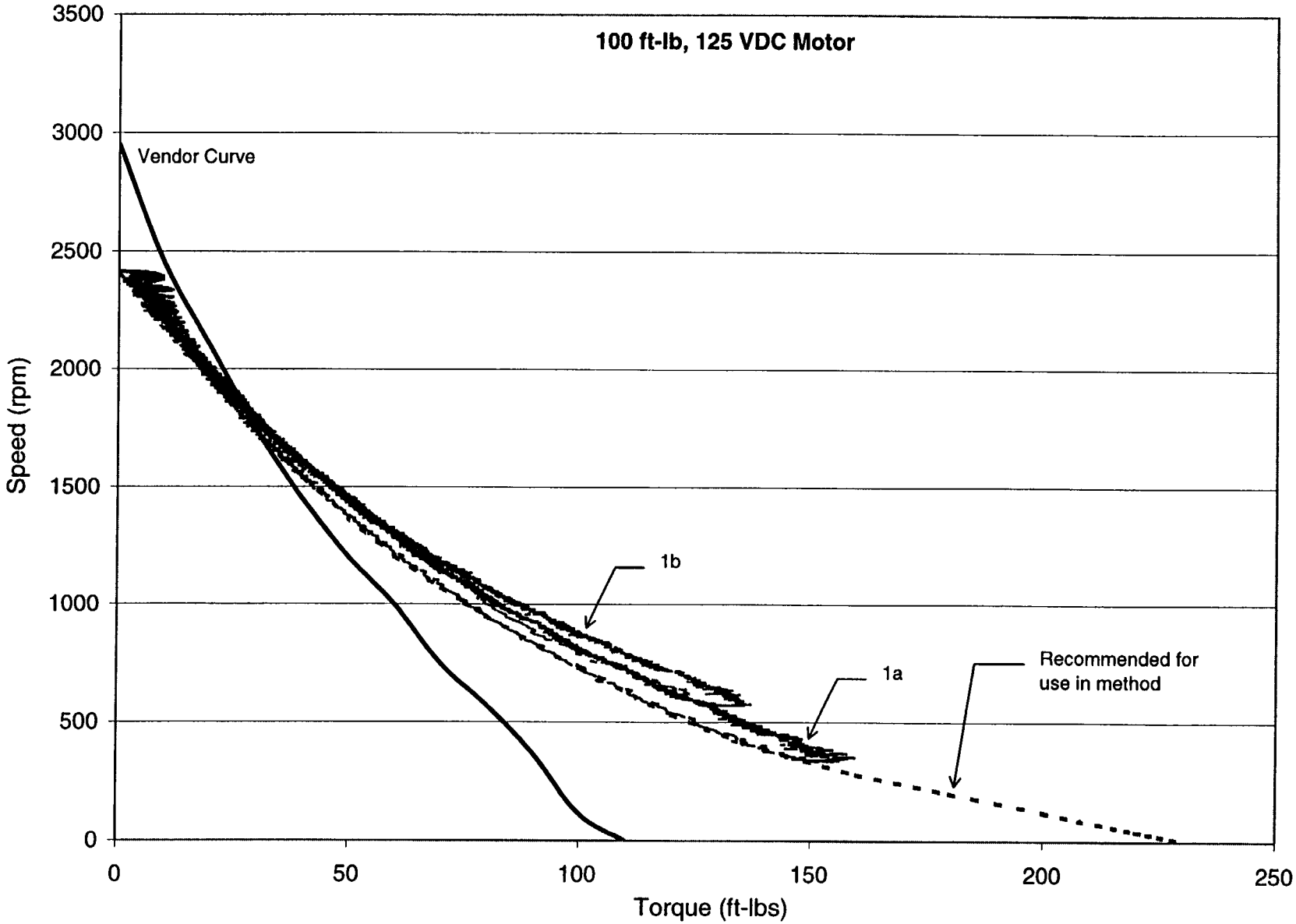


**Figure 3-18.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 100 ft-lb, 125 VDC Motor

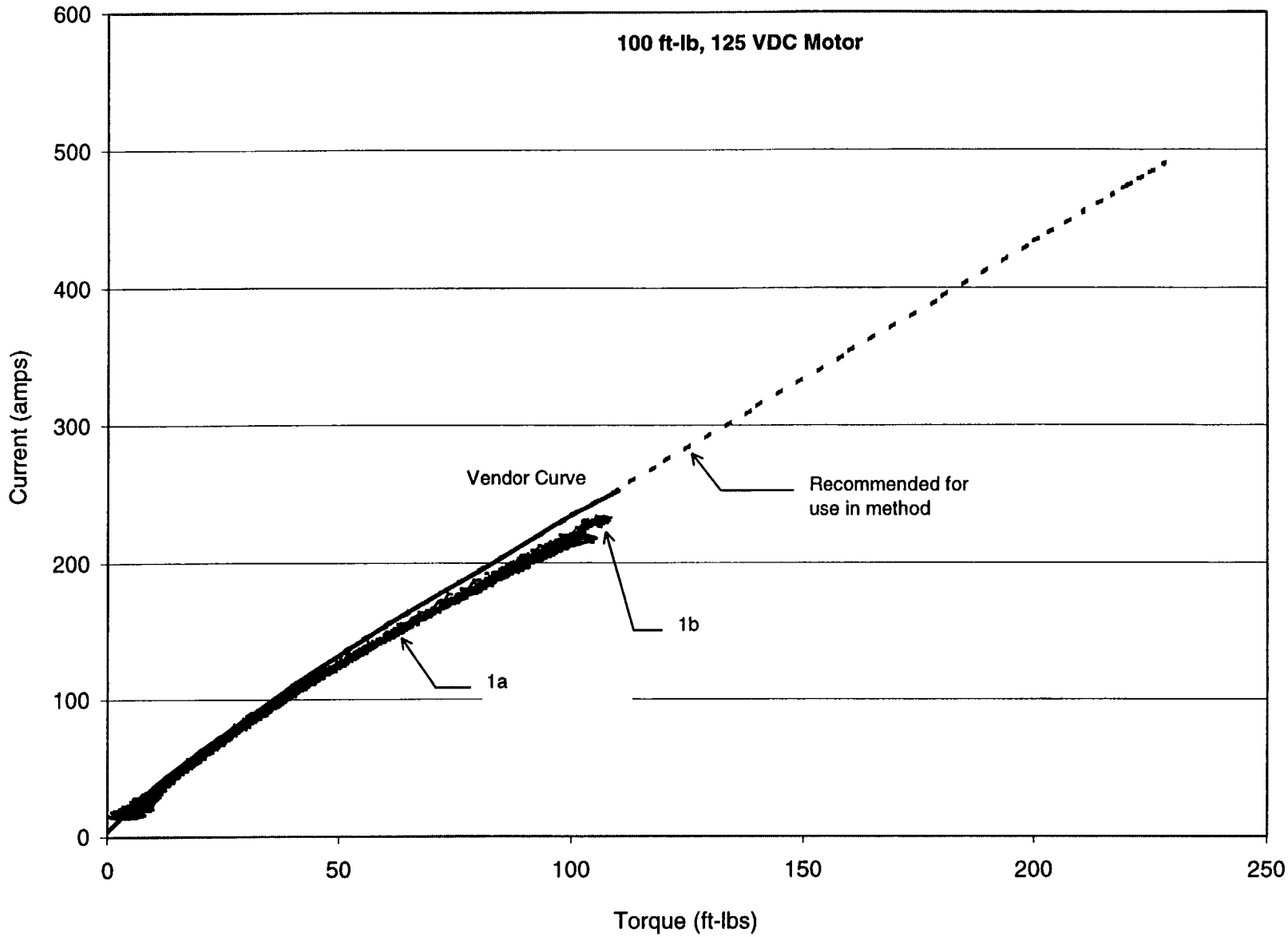


**Figure 3-19.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 100 ft-lb, 125 VDC Motor

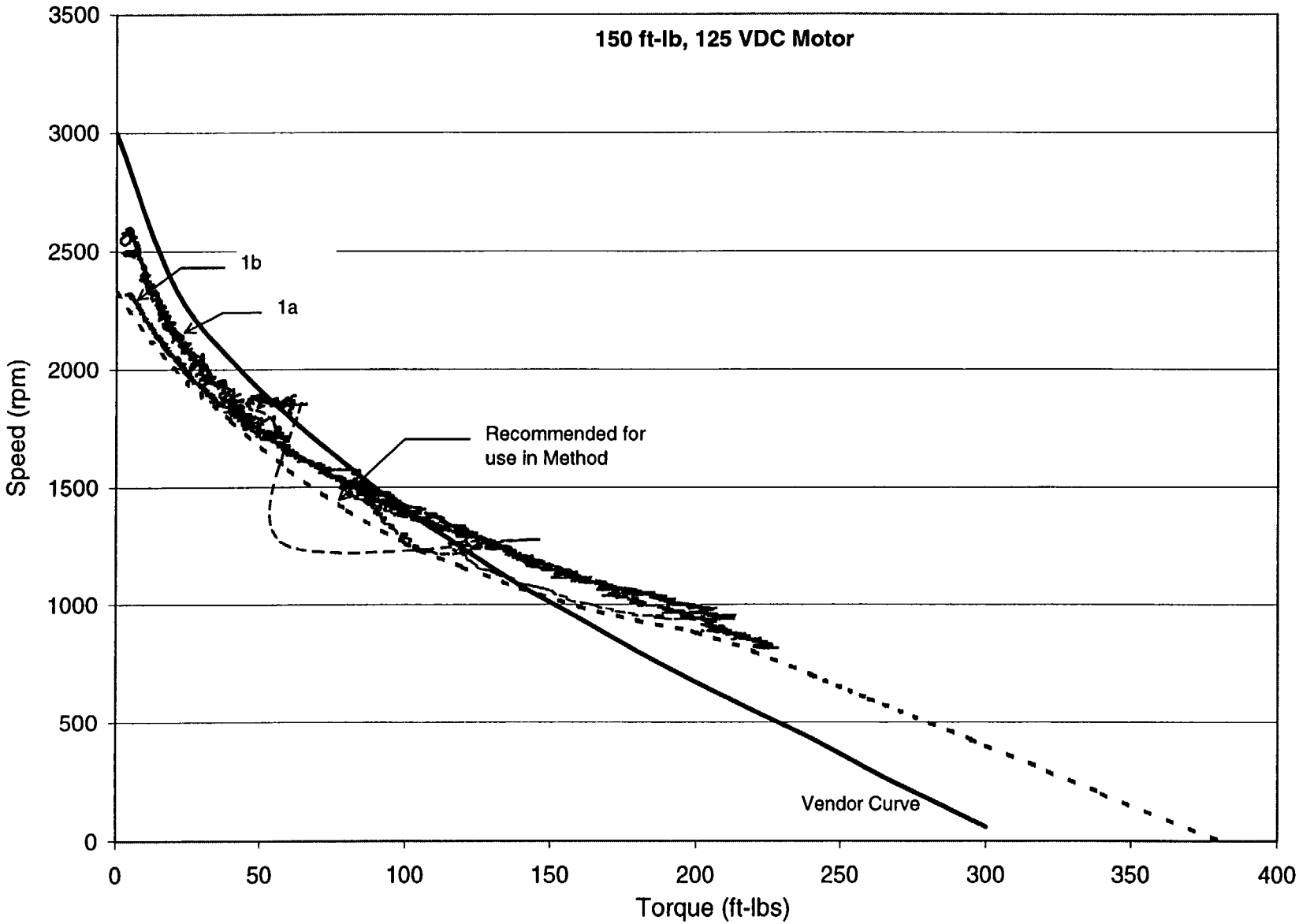


**Figure 3-20.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 150 ft-lb, 125 VDC Motor

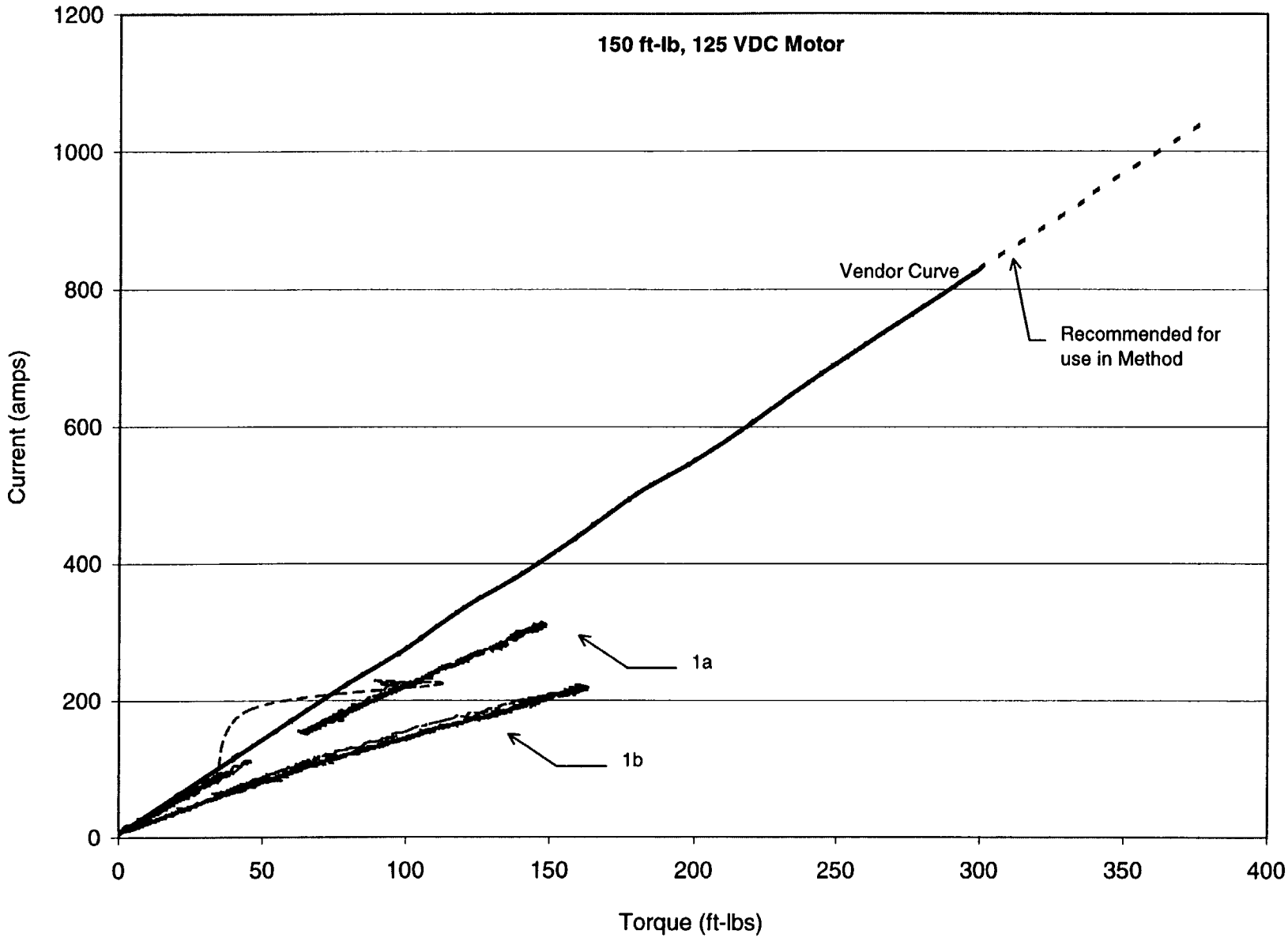


**Figure 3-21.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 150 ft-lb, 125 VDC Motor

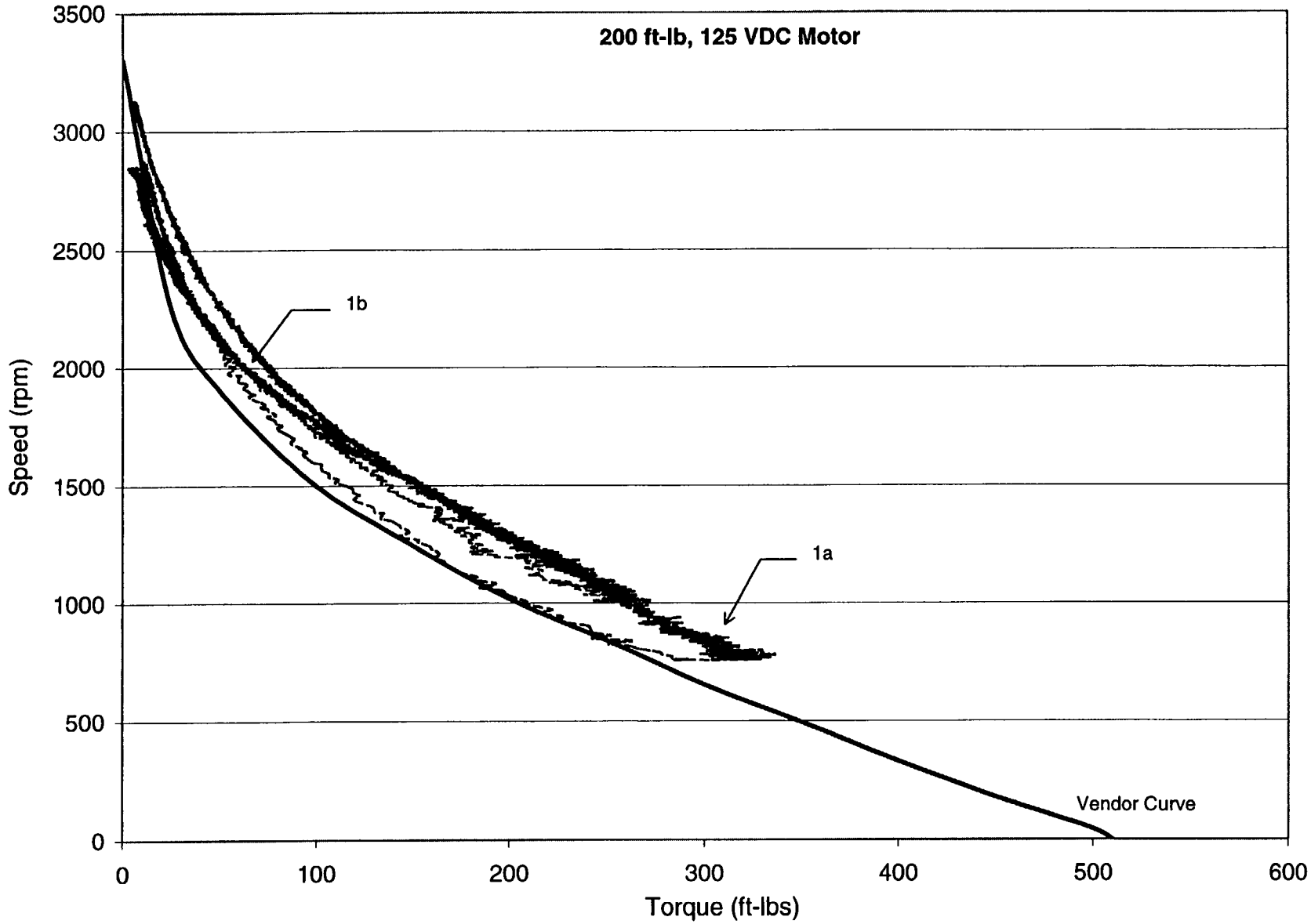


**Figure 3-22.** Comparison of Adjusted Speed versus Torque Curve to Vendor Motor Performance Curve for 200 ft-lb, 125 VDC Motor

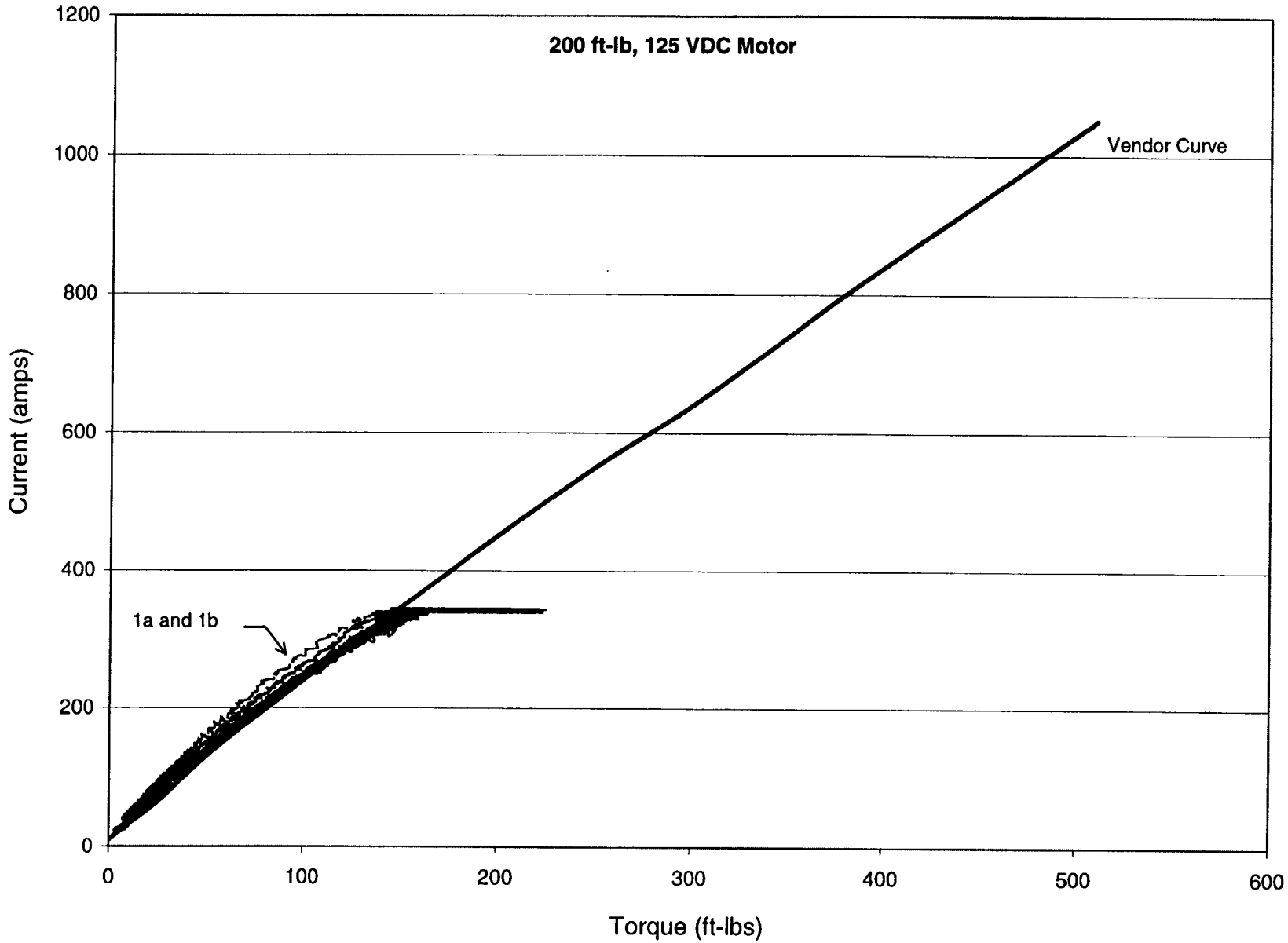


**Figure 3-23.** Comparison of Adjusted Current versus Torque Curve to Vendor Motor Performance Curve for 200 ft-lb, 125 VDC Motor

# 4
# Method Validation

## Approach

To validate the DC motor performance method, test data from in-plant valve flow tests were obtained for seven MOVs from four utilities. The seven MOVs included wedge gate, double disk gate and globe valves, driven by six different actuator types and four different motor types (all Peerless). The test data cover 22 valve strokes (11 static strokes and 11 DP strokes). The DP strokes include pumped flow opening and closing strokes, steam flow opening and closing strokes and a hydrostatic opening stroke. All tests were performed at ambient temperature.

Table 4-1 lists the 22 strokes and the corresponding valve type, actuator and motor type, voltage at the motor control center (MCC) and general test conditions (e.g., static, pumped flow, hydrostatic or steam flow) for each stroke. For each of these strokes, the DC motor performance method is implemented to calculate a predicted stroke time. Inputs to implement the method were obtained from the plants. The following approaches are used in implementation of the method.

- For static strokes, the stem thrust profile is input into the method, rather than using the load profile method. In general, the average of the measured running load and the measured load at wedging/unwedging is input as the required thrust for the entire stroke.

- For DP strokes, the load profile method is used to predict the stem thrust profile. Packing loads ($F_{pack}$) and maximum required thrusts ($F_R$) are determined from the data. However, for the steam flow strokes, the flow is specified as blowdown, and a value of 10,000 feet (maximum value) is input for $L_{UP}$ (equivalent length of upstream piping). This approach is used because these valves are turbine steam admission valves. The load profile method assumes that, for blowdown strokes, there is a line break downstream of the valves and that any pressure losses in the system occur upstream of the valve. For a turbine steam admission valve, a significant portion of the system DP is taken across the turbine when the valve is partially open, and the DP across the valve is much less than for a true blowdown application. The "equivalent length" of a turbine is likely more than 10,000 feet; however, 10,000 feet is the highest value allowed in the method. As a result, the predicted load profile will be higher than the actual load profile, resulting in higher predicted stroke times.

- For the BWR Plant D globe valve with a 2 ft-lb, 125 VDC motor, the valve stroke length is determined by trial and error to predict the measured static stroke time.

- Stem factors are determined from information provided by the plants. Dynamic stem factors are used because they are judged to be representative of the friction conditions at

the stem-to-stem nut interface for the majority of both a static and a dynamic valve stroke.

- For all gate valve tests, default "X" values are used (see Step 1.1 of the method).

## Results

Table 4-1 lists the measured and predicted stroke times for each stroke evaluated. As shown, the predicted stroke times bound the measured stroke times for all strokes except two, a static closing stroke (40 ft-lb, 250 VDC motor) and a hydrostatic opening stroke (15 ft-lb, 125 VDC motor). In both cases, the predicted stroke times are within 2% of the measured stroke times. For both strokes, the loads on the valve stem are small for the majority of the stroke. Therefore, these non-conservative results indicate that the motor speed may be slightly overpredicted at very low stem loads (at or near running load). The stroke time predictions for the other strokes of these valves match or bound the measured stroke times. In addition, one of the BWR Plant D valves has a 40 ft-lb/250 VDC motor, and the predictions for that valve are bounding. As discussed in Section 3, there is ample data for 15 ft-lb, 125 VDC motors to justify the vendor motor performance curve for these motors. Therefore, these slight stroke time underpredictions are considered acceptable, and no changes to the DC motor performance method are recommended.

Figures 4-1 through 4-4 show measured versus predicted stem thrust for the dynamic strokes of the BWR Plant B and E valves. These are the only validation test valves for which digital test data was obtained from the plants. As shown in these figures, the predicted load profiles bound the measured thrusts with margin. These bounding predictions are a result of the approach used to model these turbine admission valves, which is described above.

**Table 4-1.** Summary of Results of Validation of DC Motor Performance Method

| Plant | Valve Type | Actuator and Motor Type | General Test Conditions | Voltage at MCC (volts) | Stroke Time (sec) | |
|---|---|---|---|---|---|---|
| | | | | | Measured | Predicted |
| BWR Plant B | Double disk gate | SMB-2, 60 ft-lb, 250 VDC | static closure | 265 | 16.8 | 17.9 |
| | | | static opening | 265 | 16.1 | 17.8 |
| | | | steam flow closure | 265 | 18.2 | 20.0 |
| | | | steam flow opening | 265 | 16.3 | 20.0 |
| BWR Plant C | Flex wedge gate | SMB-1, 60 ft-lb, 250 VDC | static closure | 268 | 28.1 | 33.5 |
| | | | static opening | 268 | 27.2 | 33.6 |
| | | | steam flow closure | 268 | 31.5 | 38.3 |
| | | | steam flow opening | 268 | 28.2 | 35.3 |
| BWR Plant D | Flex wedge gate | SMB-0, 40 ft-lb, 250 VDC | static closure | 261 | **10.5** | **10.3** |
| | | | static opening | 261 | 9.7 | 11.1 |
| | | | pumped flow closure | 210 | 13.4 | 14.5 |
| | | | pumped flow opening | 210 | 12.9 | 16.2 |
| BWR Plant D | Globe | SMB-2, 60 ft-lb, 250 VDC | static closure | 262 | 11.3 | 11.6 |
| | | | pumped flow closure | 210 | 14.3 | 14.6 |
| BWR Plant D | Flex wedge gate | SMB-00, 15 ft-lb, 125 VDC | static opening | 130 | 12.0 | 12.0 |
| | | | hydrostatic opening | 106 | **15.6** | **15.5** |
| BWR Plant D | Globe | SMB-000, 2 ft-lb, 125 VDC | static closure | 130 | 24.2 | 24.2 |
| | | | pumped flow closure | 106 | 31.0 | 31.6 |
| BWR Plant E | Double disk gate | SMB-1, 40 ft-lb, 250 VDC | static closure | 250 | 12.4 | 15.0 |
| | | | static opening | 250 | 12.3 | 15.5 |
| | | | steam flow closure | 250 | 14.9 | 22.3 |
| | | | steam flow opening | 250 | 10.4 | 17.6 |

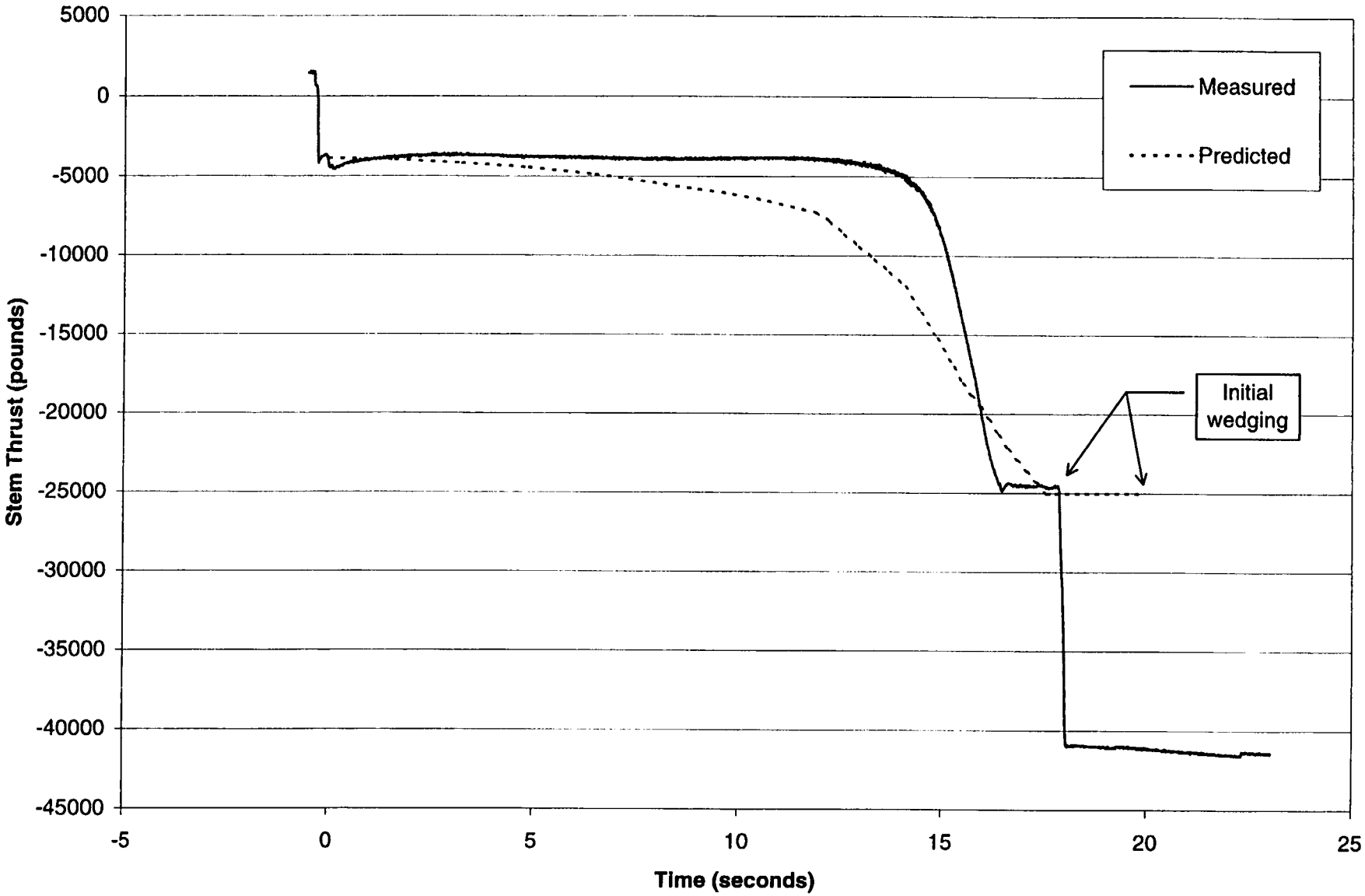


**Figure 4-1.** Comparison of Measured and Predicted Stem Thrust for BWR Plant B Dynamic Closing Stroke (Steam Flow)

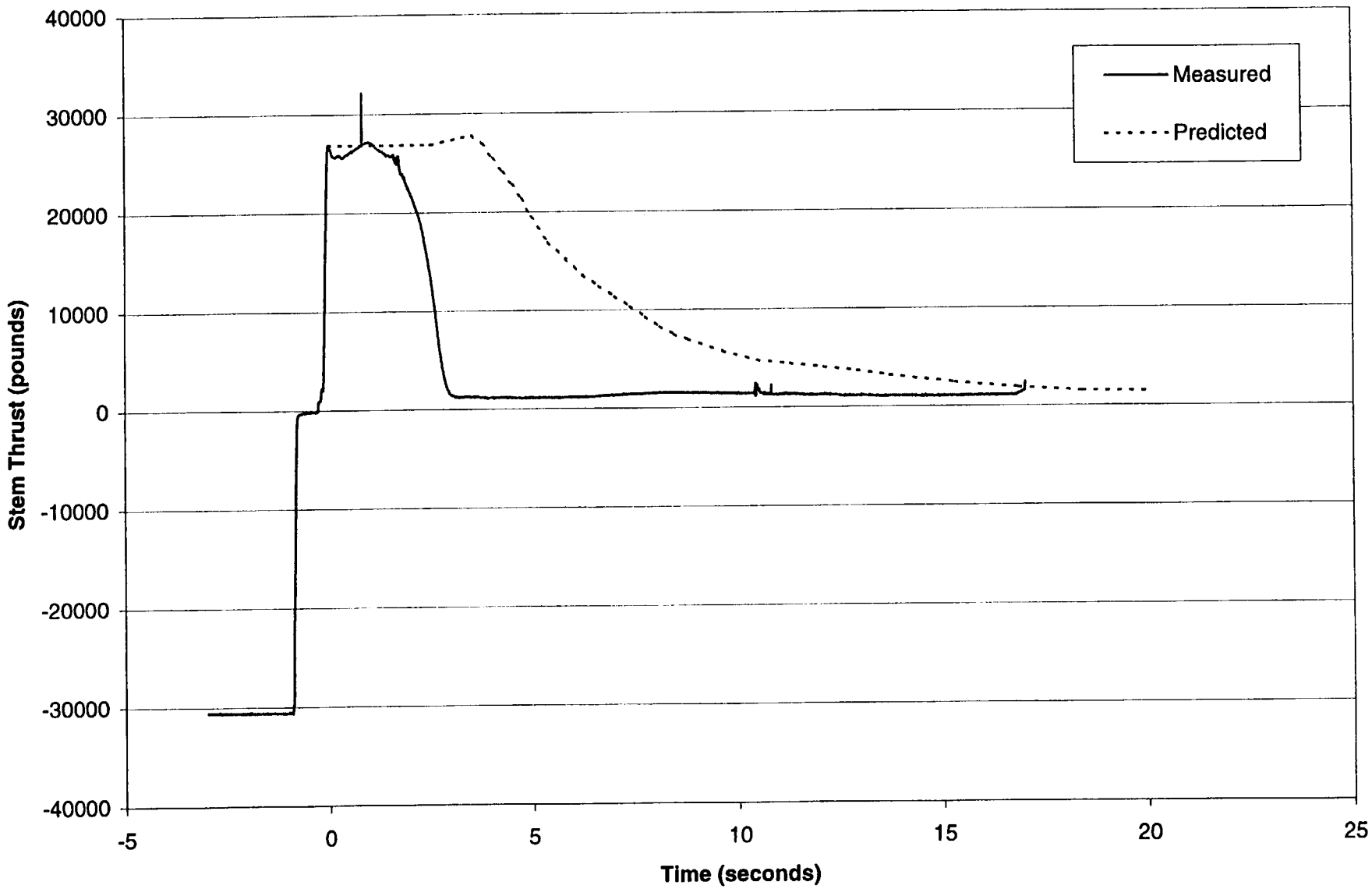


**Figure 4-2.** Comparison of Measured and Predicted Stem Thrust for BWR Plant B Dynamic Opening Stroke (Steam Flow)

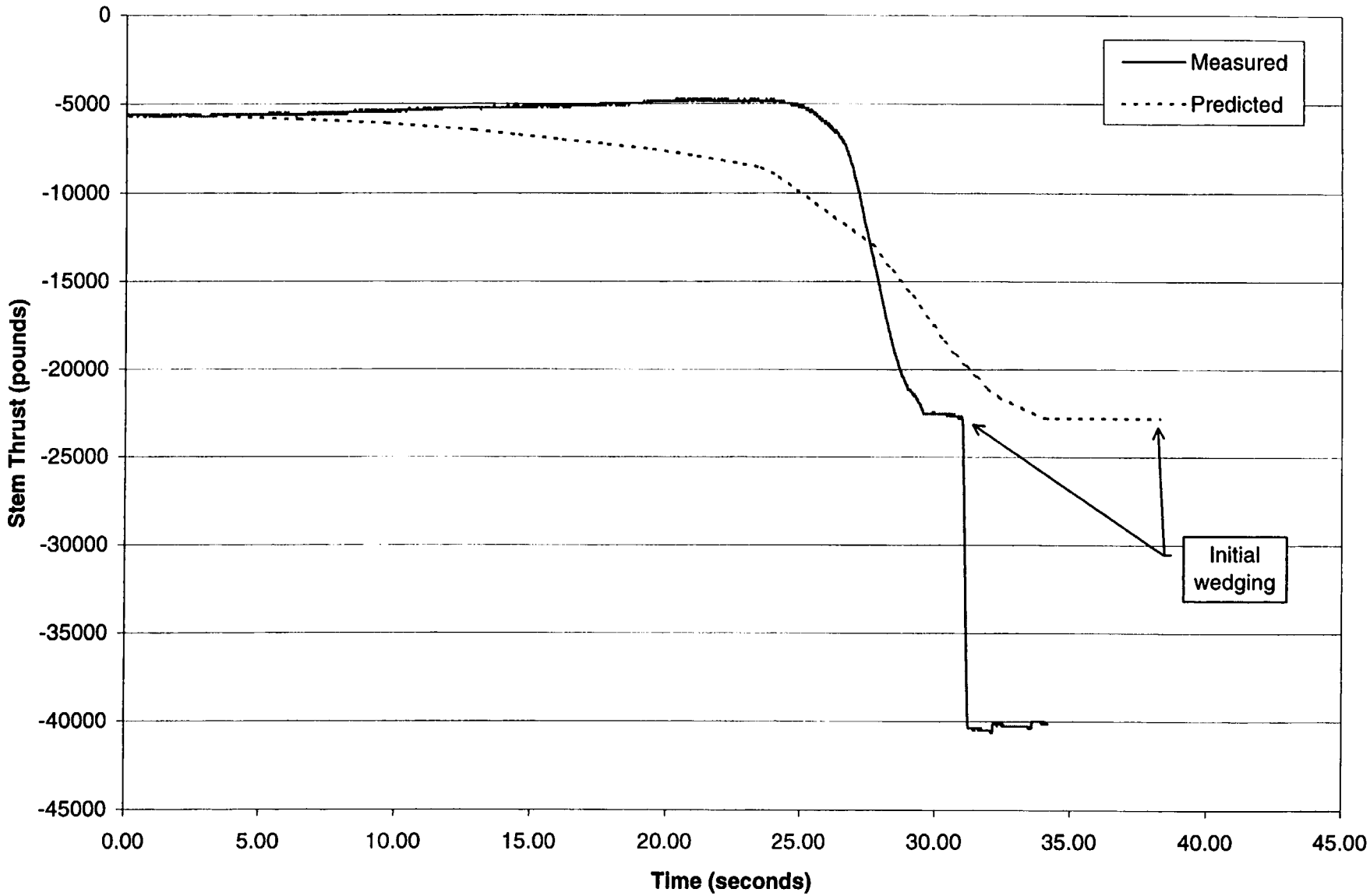


**Figure 4-3.** Comparison of Measured and Predicted Stem Thrust for BWR Plant C Dynamic Closing Stroke (Steam Flow)

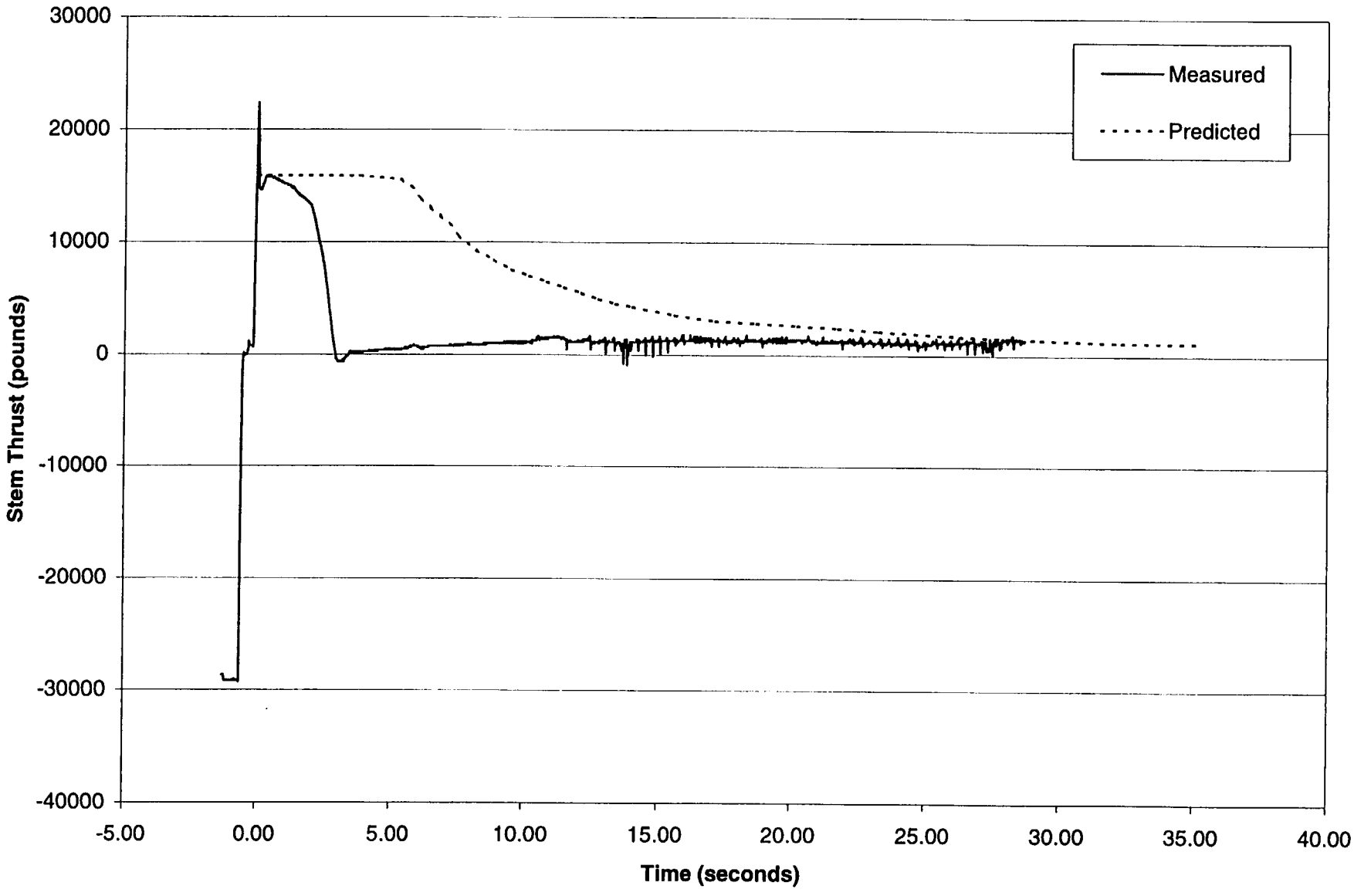


**Figure 4-4.** Comparison of Measured and Predicted Stem Thrust for BWR Plant C Dynamic Opening Stroke (Steam Flow)

# 5 References


1. MPR Calculation 197-003/PLV-01, "Compound DC Motor Analysis Including Degraded Voltage and High Temperature Conditions," Revision 1 (included in Attachment A)

2. MPR Calculation 197-003-PCC-01, "Valve Stem Thrust vs. Stroke Position for DC Powered MOVs," Revision 0 (included in Attachment A)

3. MPR Calculation 197-003-TS-1, " Justification of the DC Motor Performance Method, Including Vendor Motor Performance Curves," Revision 0 (included in Attachment B)

4. MPR Calculation 197-003-TS-2, "Validation of DC Motor Performance Method," Revision 0 (included in Attachment B)

5. NUREG/CR-6620, "Testing of dc-Powered Actuators for Motor-Operated Valves," May 1999

# A

# Method Development Calculations

The following calculations are attached.

- MPR Calculation 197-003/PLV-01, "Compound DC Motor Analysis Including Degraded Voltage and High Temperature Conditions," Revision 1
- MPR Calculation 197-003-PCC-01, "Valve Stem Thrust vs. Stroke Position for DC Powered MOVs," Revision 0

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# CALCULATION TITLE PAGE

| | | |
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| Client | BWR Owner's Group | Page 1 of 18 |
| Project | Methodology for Predicting MOV Stroke Time | Task No. 197-9901-003-0 |
| Title | Compound DC Motor Analysis Including Degraded Voltage and High Temperature Conditions | Calculation No. 197-003/PLV-01 |

| Preparer-Date | Checker-Date | Reviewer/Approver-Date | Rev. No. |
|---|---|---|---|
| Paul Villeneuve | James Moroney | Stephen Daubresse | 0 |
| Thomas Walker 1-11-2000 | Robert M. Carritte 11-Jan-2000 | Robert M. Carritte 11-Jan-2000 | 1 |

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RECORD OF REVISIONS

| Calculation No. | Prepared By | Checked By | Page 2 |
|---|---|---|---|
| 197-003/PLV01 | Thomas Walker | [illegible] | |

| Revision | Description |
|---|---|
| 0 | Initial Issue. |
| 1 | Added last assumption on Page 5; revised Equation 18a on Page 14; added Equation 18b on page 14. |

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## 1.0 PURPOSE

The purpose of this calculation is to develop an approach to predict the steady state speed of DC motors used on MOVs. The speed obtained by this calculation will be based on the torque required from the motor to position the valve. The approach will include the effects of degraded voltage and increased motor temperature for both elevated ambient temperatures (external temperature effects), and motor heating due to operation (internal temperature effects). Knowing the speed of the motor under various operating conditions will help determine the total stroke time for the MOV.

## 2.0 SUMMARY OF RESULTS

The following two steps are performed to calculate motor steady state speed for DC MOVs under all operating conditions:

- Step 1: Starting with the required motor torque, use the motor voltage and motor temperature to determine adjusted torque. Look up the speed for the adjusted torque from the manufacturer's motor output torque versus steady state speed curve. Determine the actual speed from the speed obtained from the curve.
- Step 2: Calculate the motor winding temperature increase due to operating torque over the time increment being analyzed. Add this temperature increase to the motor temperature used during the current time increment, to obtain the motor temperature for use in the next time increment.

Steps 1 and 2 are repeated as necessary to cover the entire stroke of the DC MOV.

## 3.0 ASSUMPTIONS

Several assumptions were made to develop this calculation. A summary of the assumptions is provided below. For specific technical justification for each of the assumptions, refer to Section 4.0, Discussion.

- All motors used on DC MOVs are cumulatively compounded.
- The voltage drop associated with the series field is negligible.
- The motor flux $\phi$ is constant at motor loads greater than 20% of nameplate and for a degraded voltage no lower than 60% of rated voltage. This assumption was confirmed with the vendor. However, further validation of this assumption is required to ensure its accuracy.
- Motor winding temperature does not appreciably affect the motor flux.
- To determine the effect temperature has on motor steady state speed, it is assumed that:
  - The motor output torque versus steady state speed curves are applicable for a constant temperature specified by the manufacturer (i.e., they do not include the effects of increased temperature).
  - The motor windings are constructed of copper with a conductivity of 100% of the International Annealed Copper Standard.
  - The temperature effects on the shunt field resistance will have a negligible impact on the motor equivalent resistance.
  - At a given motor torque, motor winding temperature increases linearly with time.
- The change in winding resistance from the beginning of an increment to the end of an increment can be neglected for the purpose of estimating the change in motor temperature (Equation 18b). This assumption is considered reasonable as long as the time increments are selected such that the change in winding temperature is small (i.e., less than a few degrees C).

## 4.0 DISCUSSION

A compound DC motor is a motor with both a shunt and series field. A compound DC motor can be configured to be cumulative or differential. That is, the strength of the magnetic field generated from the series winding can either aid or oppose the field generated from the shunt winding. In almost all applications, a cumulatively compounded configuration is used. It is assumed that all DC MOVs to be analyzed using this calculation are cumulatively compounded.

DC motor theory has been investigated extensively. The analysis usually begins with the development of an equivalent circuit of a DC motor. For a compound DC motor, the equivalent circuit is provided in Figure 1. Note that this figure represents a long shunt compound motor (the shunt field is connected between the motor terminals and the series field). Not all of the motors used on DC MOVs are configured as long shunt. A short shunt configuration (the shunt field is connected between the armature and the series field) may also be used. However, the equations describing the operation of the motors will be the same, since the voltage drop associated with the series field will be neglected. This is a reasonable assumption as the series field typically consists of only a few turns of a relatively large copper conductor, and therefore, its resistance (and correspondingly its voltage drop) is very small.

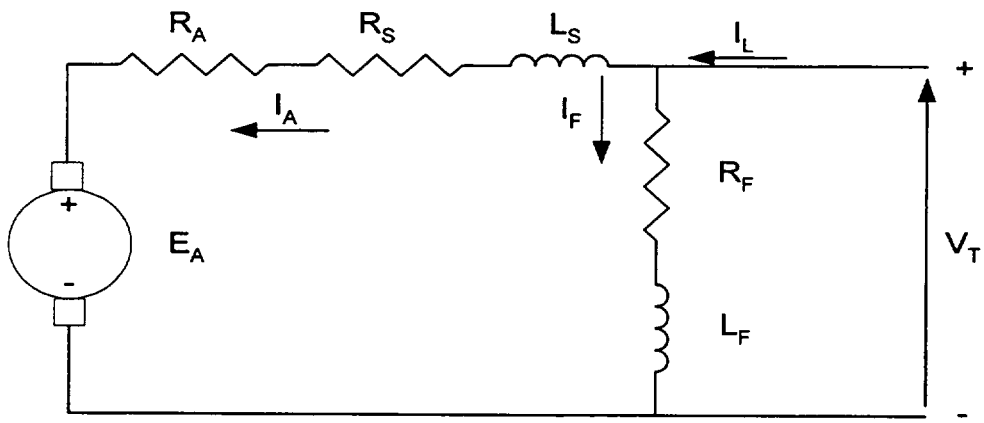


Figure 1

Where,

| | |
|---|---|
| $E_A$ - Armature Voltage | $R_A$ - Armature Winding Resistance |
| $R_S$ - Series Winding Resistance | $L_S$ - Series Winding Inductance |
| $I_L$ - Total Motor Current | $I_A$ - Armature Winding Current |
| $I_F$ - Field Winding Current | $R_F$ - Field Winding Resistance |
| $L_F$ - Field Winding Inductance | $V_T$ - Terminal Voltage at Motor |

The armature voltage is an induced voltage that depends on several parameters. The equation for this voltage is developed in Reference 1 (pages 250 through 251) and is as follows:

$$E_A = K_V \phi \omega \qquad \text{Equation 1}$$

Where,

$K_V$ - A constant depending on the construction of the machine

$\phi$ - Pole flux

$\omega$ - Motor rotational speed (in RPM)

It is also necessary to obtain an equation for the torque that the DC motor can produce. The equation for the torque, $\tau$, of a DC motor is developed in Reference 1 (pages 251 through 252) and is as follows:

$$\tau = K_T \phi I_A \qquad \text{Equation 2}$$

Where,

$K_T$ - A constant depending on the construction of the machine

$\phi$ - Pole flux

$I_A$ - Armature current

Note that the K terms used in Equations 1 and 2 are related as follows:

$$K_V = \left( \frac{2\pi radians}{60 \frac{Sec}{Min}} \right) K_T \qquad \text{Equation 3}$$

If the unit for the speed term in Equation 1 is in radians per second, the K terms would be the same.

With Equations 1 and 2 and Figure 1, the equivalent circuit model of a DC motor, we can predict motor performance using the parameters specified in the equations. However, typical manufacturer's data supplied with the motor does not provide most of these parameters. As a result, an alternative method to determining motor speed based on torque is required.

Testing on motors is completed at the factory to determine motor performance. The test data that is usually supplied to motor purchasers are nameplate data and characteristic curves identifying the following:

- motor output torque versus motor speed,
- motor output torque versus motor input current,
- motor output torque versus motor efficiency, and
- motor running time versus winding temperature rise for a given torque.

The motor output torque versus motor speed curves can accurately indicate motor speed based on required torque only when the motor is operated under conditions which match those during the motor testing.

To determine the conditions which have the largest impact on motor speed we develop an equation to calculate motor speed under steady state conditions. From Figure 1, if we ignore the series field voltage drop we have:

$$E_A = V_T - I_A R_A \qquad \text{Equation 4}$$

Substituting Equation 1 into Equation 4 and solving for ω yields:

$$\omega = \frac{V_T - I_A R_A}{K_V \phi} \qquad \text{Equation 5}$$

From Equation 5, we can determine the parameters which affect speed. Note that $K_V$ is a constant and will not change. The motor flux $\phi$ is assumed to be constant for motor loads greater than 20% of nameplate and for degraded voltage no lower than 60% of rated terminal voltage. This is a result of operating the motor in its saturation region. It follows from Equation 2 that the armature current $I_A$ is also constant for a given torque since all the other parameters in the equation are constant.

The remaining parameters identified in Equation 5 impact the speed determined from the motor characteristic curves. As a result, a terminal voltage that is not similar to the voltage applied during the factory testing can result in measured speeds that are significantly different than the calculated speed. Also, changes in the armature resistance, due to ambient temperature changes and/or internal motor heatup, can affect the speed. The impact each of these items has on motor speed is described below.

We start off by re-writing Equation 4 as follows:

$$V_T = E_A + I_A R_A \qquad \text{Equation 6}$$

Substituting Equations 1 and 2 into Equation 6 and rearranging yields:

$$V_T = K_V \phi \omega + \frac{\tau}{K_T \phi} R_A \qquad \text{Equation 7}$$

We normalize Equation 7 by dividing through by $V_T$. Equation 7 becomes:

$$1 = \frac{K_V \phi \omega}{V_T} + \frac{\tau}{K_T \phi V_T} R_A \qquad \text{Equation 8}$$

As stated earlier, a characteristic curve depicting motor output torque (independent variable) versus motor speed (dependent variable) is available. We rearrange Equation 8 to isolate the normalized dependent and independent variables of the characteristic curve as follows:

$$1 = K_V \phi \left( \frac{\omega}{V_T} \right) + \frac{R_A}{K_T \phi} \left( \frac{\tau}{V_T} \right) \qquad \text{Equation 9}$$

We can further rearrange the equation to account for the degraded voltage effects as follows:

$$1 = \frac{K_V \Phi}{V_{NOM}} \left( \frac{\omega}{\frac{V_T}{V_{NOM}}} \right) + \frac{R_A}{K_T \Phi V_{NOM}} \left( \frac{\tau}{\frac{V_T}{V_{NOM}}} \right) \qquad \text{Equation 10}$$

This equation results in a curve of normalized output torque versus normalized motor speed. As can be seen in Equation 10, we determine the steady state speed of the DC motor under degraded voltage conditions by dividing the torque by the voltage ratio to obtain an "adjusted" torque. If we wish to obtain actual motor speed, we then multiply the speed corresponding to the adjusted torque on the characteristic curve by the voltage ratio.

We also see in Equation 10 that the armature resistance is another parameter that affects the torque. We assume that the motor nameplate data was obtained under an ambient temperature of $T_1$°C (usually 25°C) which resulted in a corresponding resistance value $R_{AT1}$. To correct the armature resistance for a temperature of $T_2$°C ($R_{AT2}$), we rewrite Equation 10 as follows:

$$1 = \frac{K_V \Phi}{V_{NOM}} \left( \frac{\omega}{\frac{V_T}{V_{NOM}}} \right) + \frac{R_{AT1}}{K_T \Phi V_{NOM}} \left( \frac{\tau}{\frac{V_T}{V_{NOM}}} \frac{R_{AT2}}{R_{AT1}} \right) \qquad \text{Equation 11}$$

Equation 11 reveals that the effect of temperature on armature resistance can be accounted for by multiplying the required torque by the ratio of the elevated temperature resistance to the nominal resistance and finding the corresponding speed on the motor output torque versus motor speed characteristic curve. The parameters which are not inside the parenthesis are constant and therefore do not need to be included when determining speed. This procedure works since we utilize the characteristic curves to obtain the speed for a given torque and we do not need to know the values for the constants.

The parameters provided by manufacturers do not include armature resistance. As a result, the resistance ratio identified in Equation 11 must be modified to include only parameters based on vendor data. Manufacturers typically provide locked rotor current which is the current measured when the armature of the motor is stationary. If we divide the nominal terminal voltage by the locked rotor current, we obtain an equivalent motor resistance ($R_M$) at a nominal temperature (usually 25°C). This resistance can be substituted for armature resistance and will vary depending on motor winding temperature. This is a reasonable approximation as the temperature effects on the shunt field resistance will have a small impact on the motor equivalent resistance.

We can rewrite Equation 11 as follows:

$$1 = \frac{K_V \Phi}{V_{NOM}} \left( \frac{\omega}{\frac{V_T}{V_{NOM}}} \right) + \frac{R_{MT1}}{K_T \Phi V_{NOM}} \left( \frac{\tau}{\frac{V_T}{V_{NOM}}} \frac{R_{MT2}}{R_{MT1}} \right) \qquad \text{Equation 12}$$

We now define the parameters adjusted speed, ω', and adjusted torque, τ', as follows:

$$\omega' = \frac{\omega}{\frac{V_T}{V_{NOM}}} \qquad \text{Equation 13}$$

$$\tau' = \tau \frac{\frac{R_{MT2}}{R_{MT1}}}{\frac{V_T}{V_{NOM}}} \qquad \text{Equation 14}$$

The motor output torque versus steady state speed curve provided by the manufacturer has the ratios $V_T/V_{NOM} = 1$ and $R_{MT2}/R_{MT1} = 1$ and therefore may also be used as a performance curve for $\omega'$ and $\tau'$. As a result, the motor output torque versus steady state speed relationship for other voltages and temperatures can be determined by using the manufacturer's curve and the adjusted parameters shown above.

The ratio to determine the effects that elevated temperature has on copper windings can be calculated by a simple equation. If we assume the windings are constructed of copper with a conductivity of 100% of the International Annealed Copper Standard, from Reference 2 (page 2-9), we derive the equation to correct resistances for various temperatures as follows:

$$\frac{R_{MT2}}{R_{MT1}} = \frac{T_2 + 234.4}{T_1 + 234.4} \qquad \text{Equation 15}$$

Note that the values for temperature ($T_2$ and $T_1$) must be in °C.

We are now able to correct the resistance of the motor due to external heating effects, but we have not developed an approach to determine the temperature rise as a result of the $I^2R$ losses in the windings.

We refer to the manufacturer's characteristic curve(s) of motor operating time versus temperature rise. For those values of required torque for which a characteristic curve exists, we may obtain the temperature rise of the winding from the curve by considering the time increment in the calculation at that value of torque.

For torque values other than the values given in the manufacturer's curves, the rate at which winding temperature rises is governed by the following equation:

$$\Delta T = k(I^2R)\Delta t \qquad \text{Equation 16}$$

Where,

k - Constant which characterizes the transfer of internally generated heat absorbed by the motor

$I^2R$ - Internally generated heat from the motor current

$\Delta t$ - time increment in the calculation at that value of torque

For a given time increment, we determine a ratio of motor winding heatup as follows:

$$\frac{\Delta T_2}{\Delta T_1} = \frac{k((I_2)^2R_2)\Delta t}{k((I_1)^2R_1)\Delta t} \qquad \text{Equation 17}$$

Rearranging and dividing out the constants we have:

$$\Delta T_2 = \Delta T_1 \left(\frac{I_2}{I_1}\right)^2 \left(\frac{R_2}{R_1}\right) \qquad \text{Equation 18a}$$

For small time increments, the change in the resistance of the windings will be small. Therefore:

$$\Delta T_2 = \Delta T_1 \left(\frac{I_2}{I_1}\right)^2 \qquad \text{Equation 18b}$$

We can use Equation 2 to substitute torque for current in Equation 18b and obtain:

$$\Delta T_2 = \Delta T_1 \left(\frac{K_T\Phi\tau_2}{K_T\Phi\tau_1}\right)^2 \qquad \text{Equation 19}$$

As stated previously, $K_T$ is constant and $\phi$ is constant for motor loads greater than 20% of nameplate and for degraded voltage no lower than 60% of rated voltage. Dividing out the constants in Equation 19 yields:

$$\Delta T_2 = \Delta T_1 \left(\frac{\tau_2}{\tau_1}\right)^2 \qquad \text{Equation 20}$$

As we can see from Equation 20, the corrected winding temperature rise is determined by:

1) taking the square of the ratio of the required torque value to the nearest torque value with a characteristic curve, then

2) multiplying that ratio times the motor temperature increase for the characteristic curve (nearest torque value) using the time increment of the calculation.

The winding temperature for calculations in the next time increment is determined by adding the temperature rise (calculated above) to the current motor temperature.

**Conclusion**

Given the preceding discussion, we are able to determine steady state speed of the motor for required torques greater than 20% of rated load and for terminal voltages greater than 60% of rated under various steady state operating conditions. Including the approach to calculate speed during motor starting is not within the scope of this calculation. However, the motors used on DC MOVs have no starting resistors to limit the inrush current. This allows the motor to develop a large torque when starting. As a result, it is expected that the motor starting time will be a small percentage of the total MOV stroke times.

## 5.0 SUMMARY OF METHOD

To determine motor steady state speed for DC MOVs, we must first obtain the necessary data. As described in Section 4.0, Discussion, the following manufacturer supplied information is required:

- Characteristic curves containing the following:
  - Motor output torque versus motor speed,
  - Motor operating time versus winding temperature rise for various torque values
- Motor rated voltage and nominal temperature for which the characteristic curves apply

With this information, we may now calculate the motor steady state speed for DC MOVs.

**Step 1, Determine Actual Speed from Speed Obtained from Curve**

a) Starting with the required motor torque, the motor voltage, and the motor temperature, calculate an adjusted motor torque, τ' using the following equation:

$$\tau' = \tau \frac{\dfrac{T_{MOTOR}+234.4}{T_{NOMINAL}+234.4}}{\dfrac{V_T}{V_{NOM}}} \qquad \text{Equation 21}$$

Note: For the initial time increment, $T_{MOTOR}$ equals $T_{NOMINAL}$.

b) From the manufacturer's characteristic curve, obtain the value of speed (ω') corresponding to the value of adjusted torque (τ').

c) Determine the actual motor speed (ω) from the speed (ω') using the following equation:

$$\omega = \omega' \frac{V_T}{V_{NOM}} \qquad \text{Equation 22}$$

**Step 2, Determine Motor Temperature for Next Time Increment**

a) Calculate a motor temperature rise using the following equation:

$$\Delta T = \Delta T_{REF} \left( \frac{\tau}{\tau_{REF}} \right)^2 \Delta t \qquad \text{Equation 23}$$

Where,

$\tau$ - current torque value

$\tau_{REF}$ - nearest torque value (to $\tau$) for which a curve exists

$\Delta T_{REF}$ - heating rate of that curve

$\Delta t$ - length of time increment

b) Calculate a motor temperature for the next time increment using the following equation:

$$T_{NEXT} = T_{CURRENT} + \Delta T \qquad \text{Equation 24}$$

Steps 1 and 2 are repeated for each increment of DC MOV stroke time.

**Motor Steady State Speed for DC MOVs Under All Operating Conditions**

The speed obtained in Step 1 is the steady state motor speed incorporating all steady state operating conditions. It is only necessary to perform those steps for which operation outside nominal operating conditions is expected.

## 6.0 REFERENCES

1. "Electric Machinery Fundamentals"; Stephen J. Chapman; Second Edition; Copyright 1991 by McGraw-Hill, Inc.

2. "Standard Handbook for Electrical Engineers"; Donald G. Fink and H. Wayne Beaty; Thirteenth Edition; Copyright 1993 by McGraw-Hill, Inc.

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# CALCULATION TITLE PAGE

| | | |
|---|---|---|
| Client | GE Nuclear Energy | Page 1 of 30<br>+ Appendices A,B,C,D |
| Project | DC MOV Stroke Time | Task No.<br>197-003 |
| Title | Valve Stem Thrust vs. Stroke Position Methodology for DC Powered MOVs | Calculation No.<br>197-003-PCC-01 |

| Preparer-Date | Checker-Date | Reviewer/Approver-Date | Rev. No. |
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| 4/13/99<br>Pete Carlone | Hemadri Seneviratne<br>4/14/99<br>Hemadri Seneviratne | 4/15/99<br>Bill McCurdy | 0 |

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# RECORD OF REVISIONS

| Calculation No. | Prepared By | Checked By | Page 2 |
|---|---|---|---|
| 197-003-PCC-01 | | | |

| Revision | Description |
|---|---|
| 0 | Initial Issue |

## 1.0 PURPOSE

The purpose of this calculation is to define and justify a method to determine the valve stem thrust versus stroke position profile for use in analyses of motor operated valves (MOVs) with DC motors.

## 2.0 RESULTS

If a gate valve has been analyzed using the EPRI MOV Performance Prediction Methodology (PPM), the PPM results contain the stem thrust vs. stroke position information. Otherwise, use the method as described below.

The method to determine stem thrust vs. stroke position is as follows, see Figure 1 for details.

- Determine a "full open" thrust ($F_o$), which includes the effects of stem rejection load, packing load, weight, torque reaction, etc., but does not include any contribution of differential pressure (DP). Separate values of $F_o$ need to be determined for closing and opening strokes, if both stroke directions are to be analyzed.

- Determine a required thrust ($F_R$), which is the maximum thrust to actuate the valve while it is at or near the fully closed position. Separate values of $F_R$ need to be determined for closing and opening strokes, if both stroke directions are to be analyzed. The effect of DP is included in this required thrust. If there is a water inertia contribution to the maximum DP, use the DP with the water inertia contribution in this calculation.

- Using the appropriate normalized profile as described in this calculation, determine stem thrust vs. stroke position for the range of travel between fully open (100% open stroke position) and closed flow isolation (0% open stroke position). The normalized profile applies to the range of thrust between $F_O$ and $F_R$. Graphs of normalized load profiles are included as Figures 2 - 10, as follows.

  - Figure 2 - Gate Valve, Wedge, Pumped Flow Closing (High and Low Flow)
  - Figure 3 - Gate Valve, Wedge, Pumped Flow Opening (High and Low Flow)
  - Figure 4 - Gate Valve, Wedge, Blowdown Flow Closing
  - Figure 5 - Gate Valve, Wedge, Blowdown Flow Opening
  - Figure 6 - Gate Valve, Double Disk, Pumped Flow Closing (High and Low Flow)
  - Figure 7 - Gate Valve, Double Disk, Pumped Flow Opening (High and Low Flow)
  - Figure 8 - Gate Valve, Double Disk, Blowdown Flow Closing
  - Figure 9 - Gate Valve, Double Disk, Blowdown Flow Opening
  - Figure 10 - Globe Valve Pumped Flow Opening and Closing

Note that the system resistance needs to be calculated to use Figures 2,3,6,7 or 10. The equation for system resistance is given below, taken from Reference (5).

$$K_{sys} = \left[\frac{(894.01)(D_{sr})^4(\Delta P_{max})}{(Q_{max})^2}\right]\left[\frac{62.4}{\rho_f}\right]$$

Where:

$K_{sys}$ = system resistance
$D_{sr}$ = seat ring inner diameter (inches)
$\rho_f$ = density of water in pipe (lb/ft$^3$)
$\Delta P_{max}$ = maximum differential pressure across the valve (psi)
$Q_{max}$ = flow when valve is fully open (gpm)

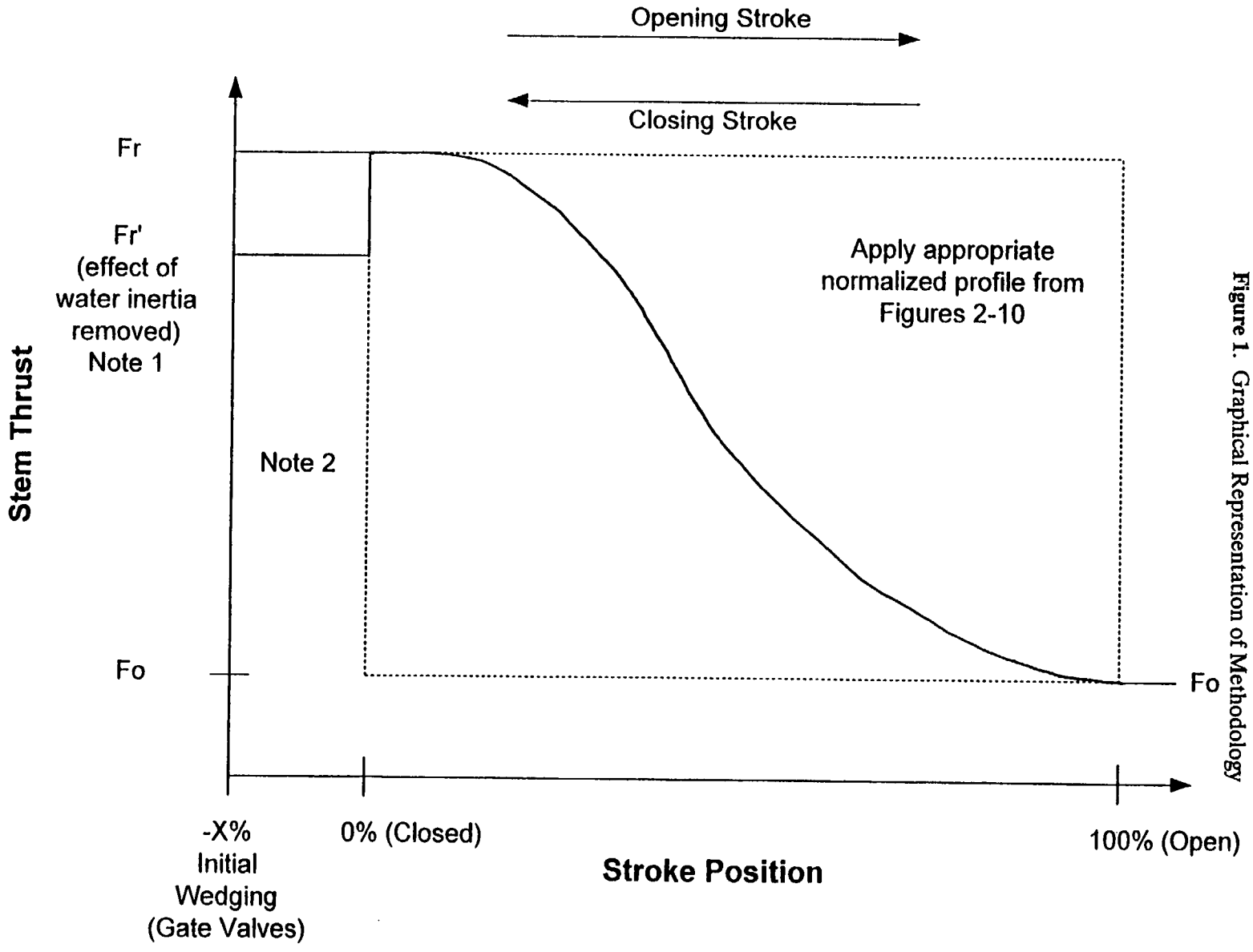



**Figure 1.** Graphical Representation of Methodology

Note 1. Fr' only pertains to gate valve closing strokes.
Note 2. The area from -X% to 0% only applies to gate valves.

For Figures 4,5,8 and 9, the piping upstream of the valve needs to be analyzed to determine its resistance (expressed as an equivalent length).

This step gives the final result to use for globe valves; for gate valves see the additional steps below.

- For gate valve closing strokes, there is an additional part to the profile at the end of the stroke which covers travel from 0% (flow isolation) to -X% (disk hard-seated). The stem thrust for this range of travel is the required closing thrust as described above, except that the DP contribution of water inertia (if there is one) can be removed from the calculation. The value of X is determined by the following equation.

$$X = \frac{\frac{1}{2}(OD_{disk} - ID_{sr})}{ID_{sr}} \times 100$$

Where: $OD_{disk}$ = disk sealing face OD
$ID_{sr}$ = seat ring sealing face ID

If values of dimensions needed to calculate X are not known, select the valve from the table below that best represents the subject valve. Information in the following table is summarized from Appendix B.

| Valve Size | X |
|---|---|
| 3 inches and less | 16% |
| 4 inches through 10 inches | 10% |
| 12 inches and greater | 8% |

- For gate valve opening strokes, there is an additional part to the profile at the beginning of the stroke, which covers travel from -X% (unwedging) to -0% (flow initiation). The stem thrust for this range of travel is the required opening thrust as described above.

## 3.0 SCOPE

Load versus stroke position profiles are determined for the following scenarios:

- Gate Valve, Wedge, Pumped Flow Closing (High and Low Flow)
- Gate Valve, Wedge, Pumped Flow Opening (High and Low Flow)
- Gate Valve, Wedge, Blowdown Flow Closing
- Gate Valve, Wedge, Blowdown Flow Opening
- Gate Valve, Double Disk, Pumped Flow Closing (High and Low Flow)
- Gate Valve, Double Disk, Pumped Flow Opening (High and Low Flow)
- Gate Valve, Double Disk, Blowdown Flow Closing
- Gate Valve, Double Disk, Blowdown Flow Opening
- Globe Valve Pumped Flow Opening and Closing

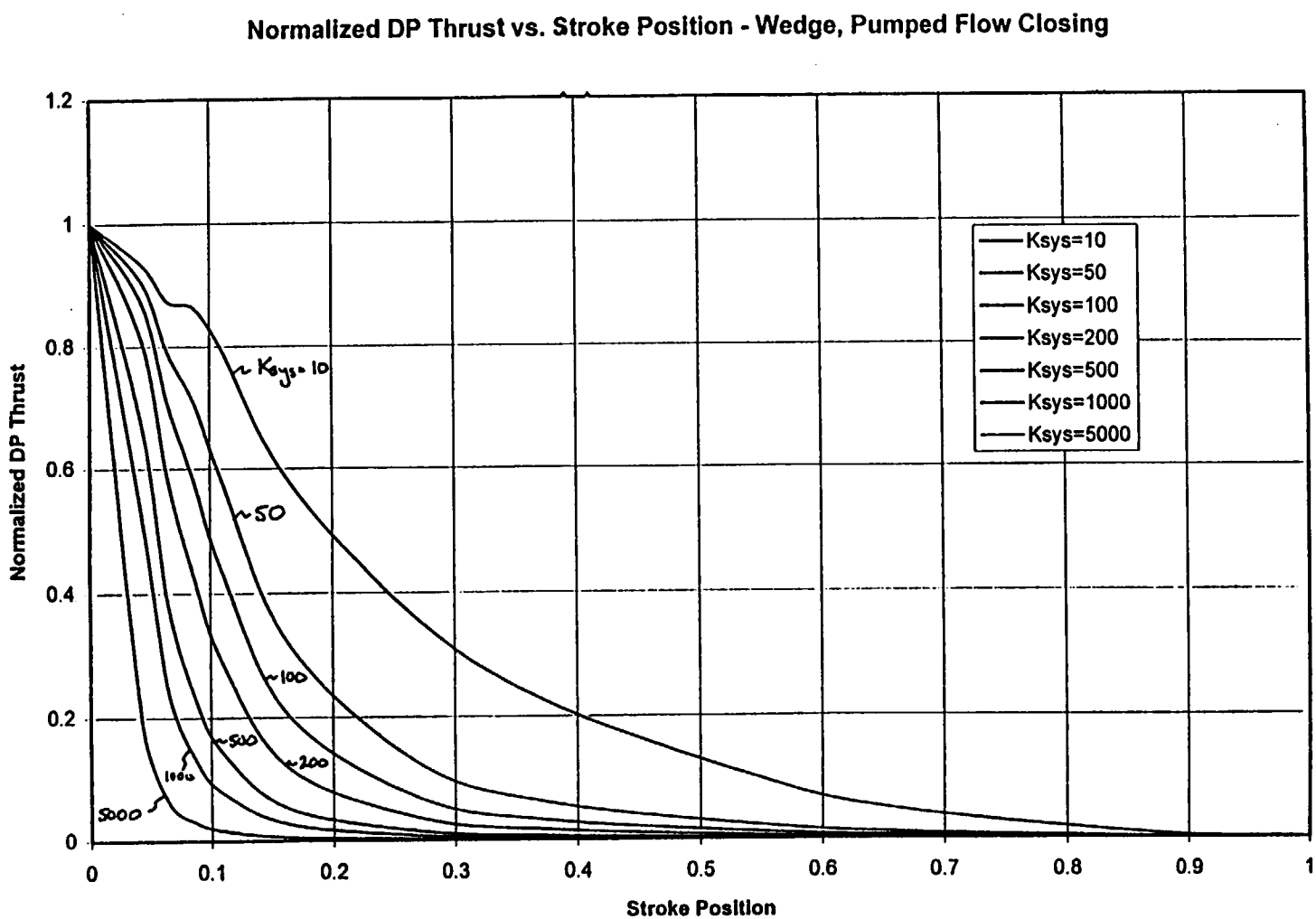
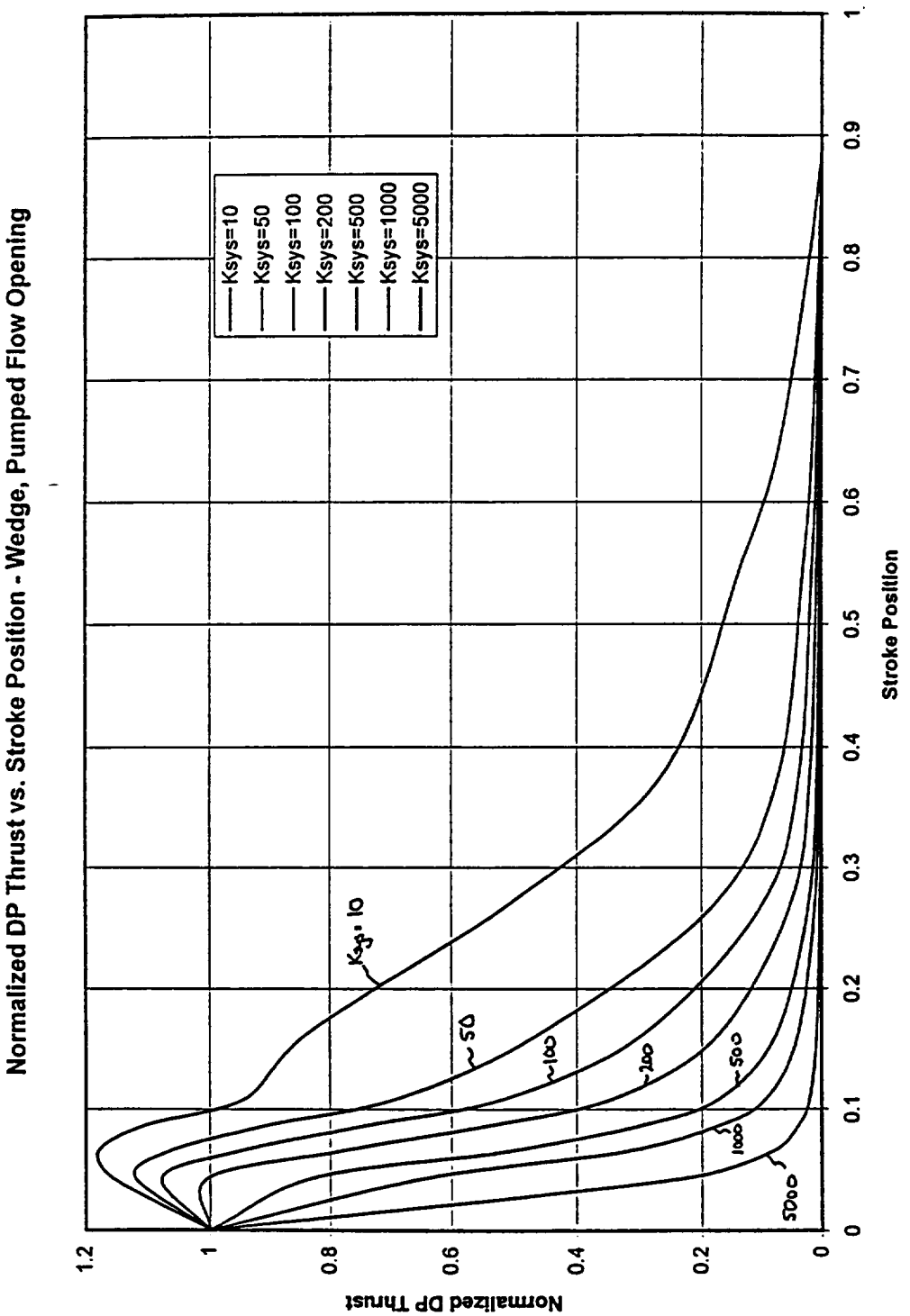



**Figure 2.** Gate Valve, Wedge, Pumped Flow Closing (High and Low Flow)

**Figure 3.** Gate Valve, Wedge, Pumped Flow Opening (High and Low Flow)



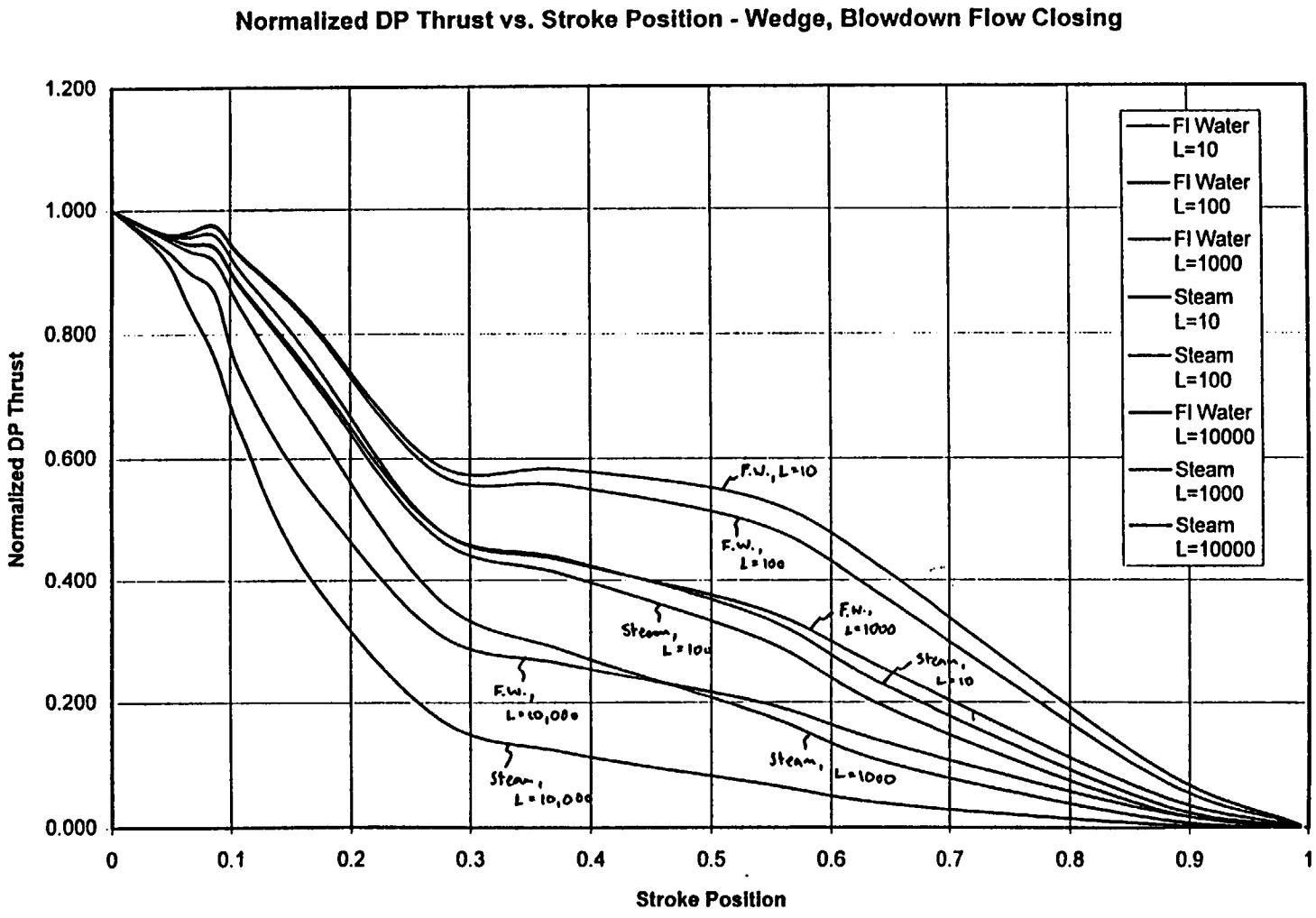



**Figure 4.** Gate Valve, Wedge, Blowdown Flow Closing
(Note: Fl Water denotes Flashing Water)

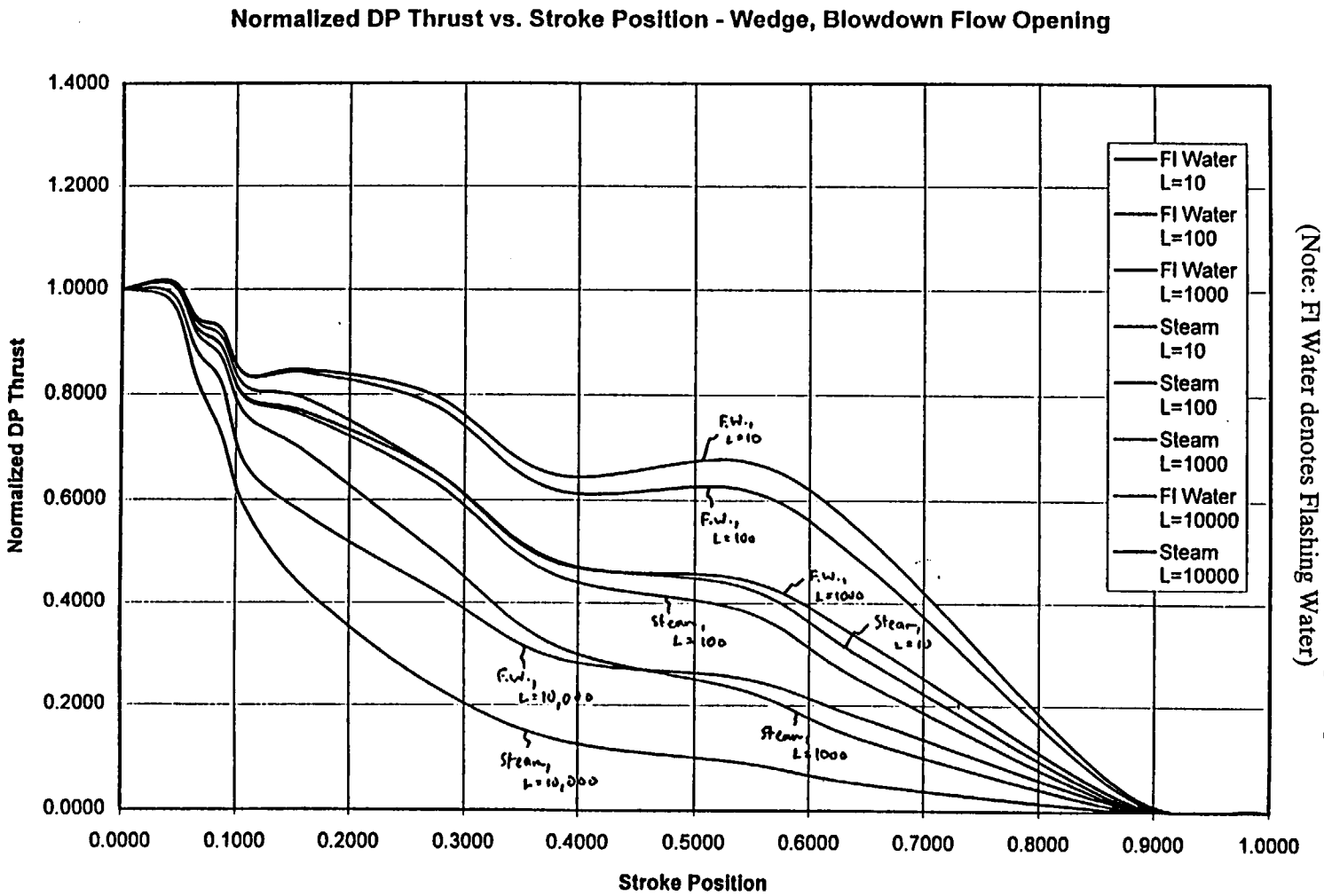



**Figure 5.** Gate Valve, Wedge, Blowdown Flow Opening
(Note: Fl Water denotes Flashing Water)

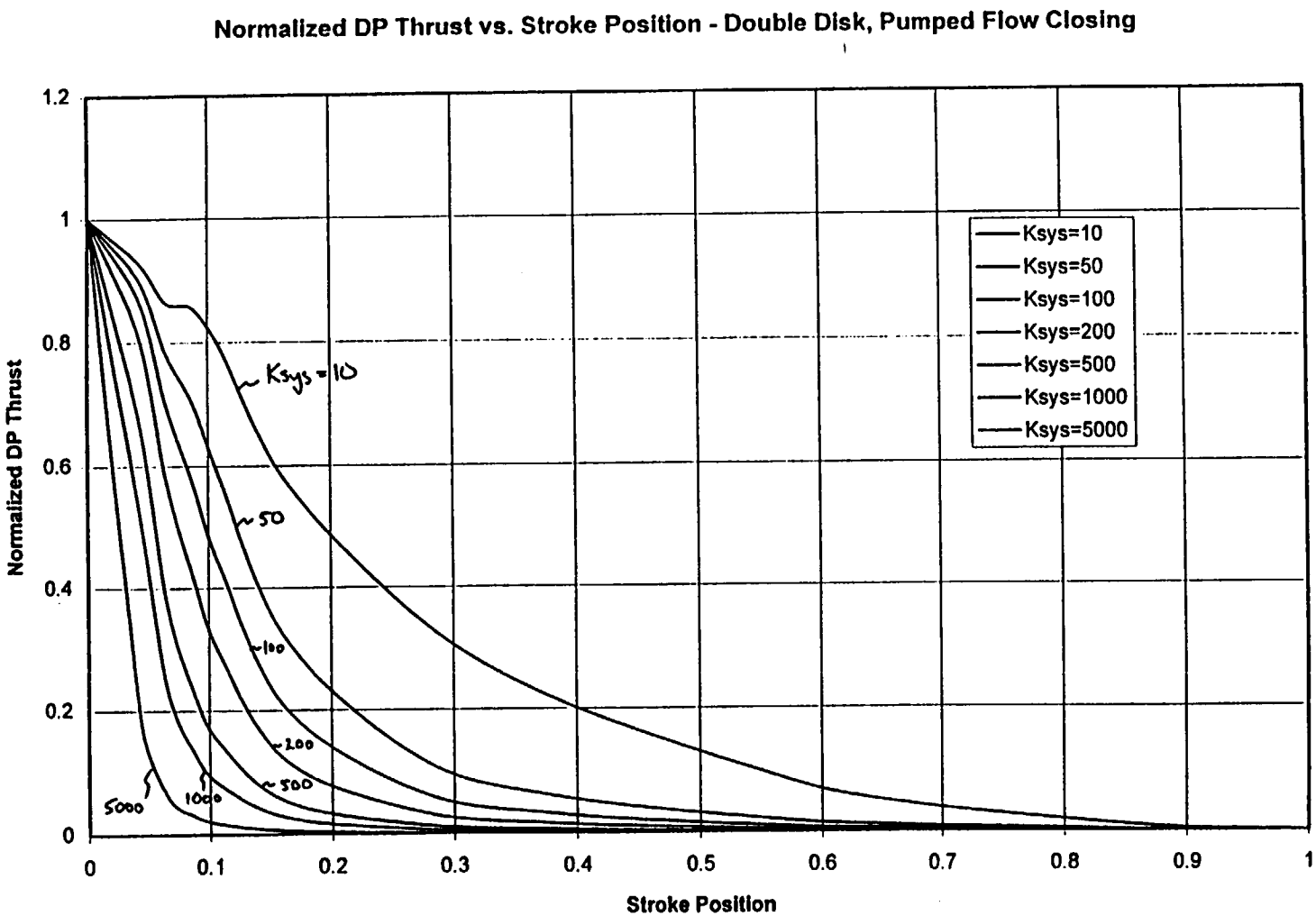
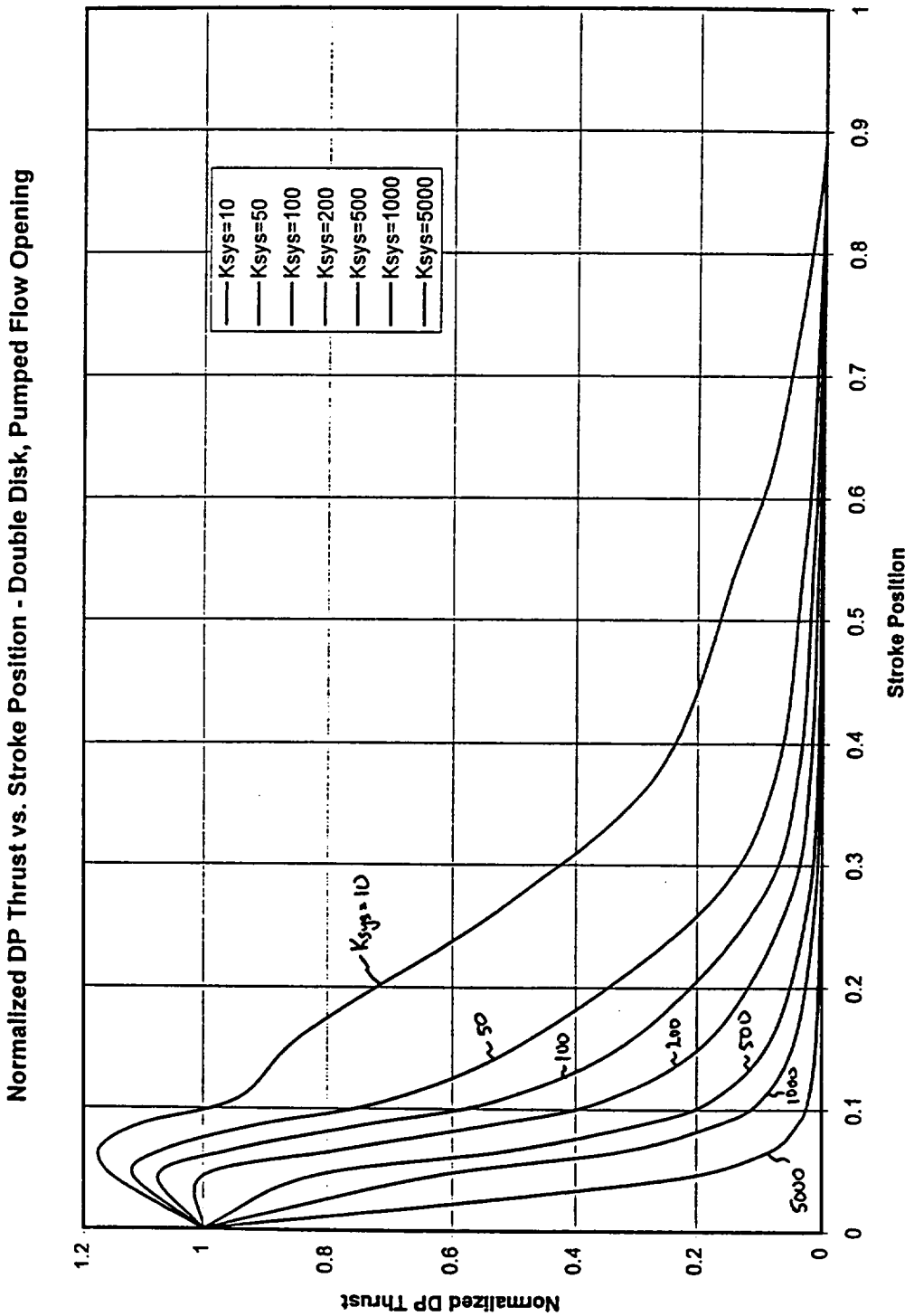



**Figure 6.** Gate Valve, Double Disk, Pumped Flow Closing (High and Low Flow)

**Figure 7.** Gate Valve, Double Disk, Pumped Flow Opening (High and Low Flow)



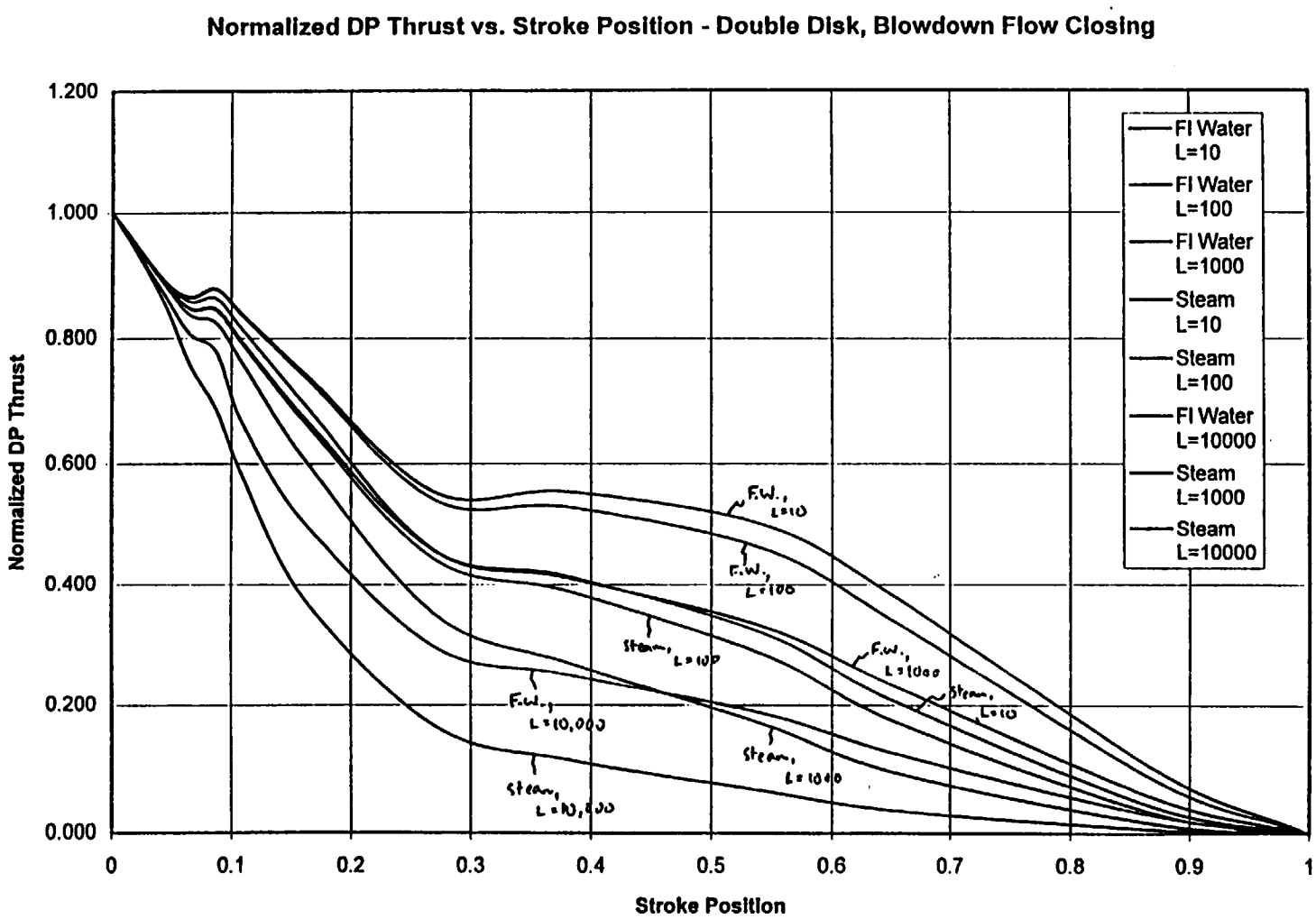



**Figure 8.** Gate Valve, Double Disk, Blowdown Flow Closing
(Note: Fl Water denotes Flashing Water)

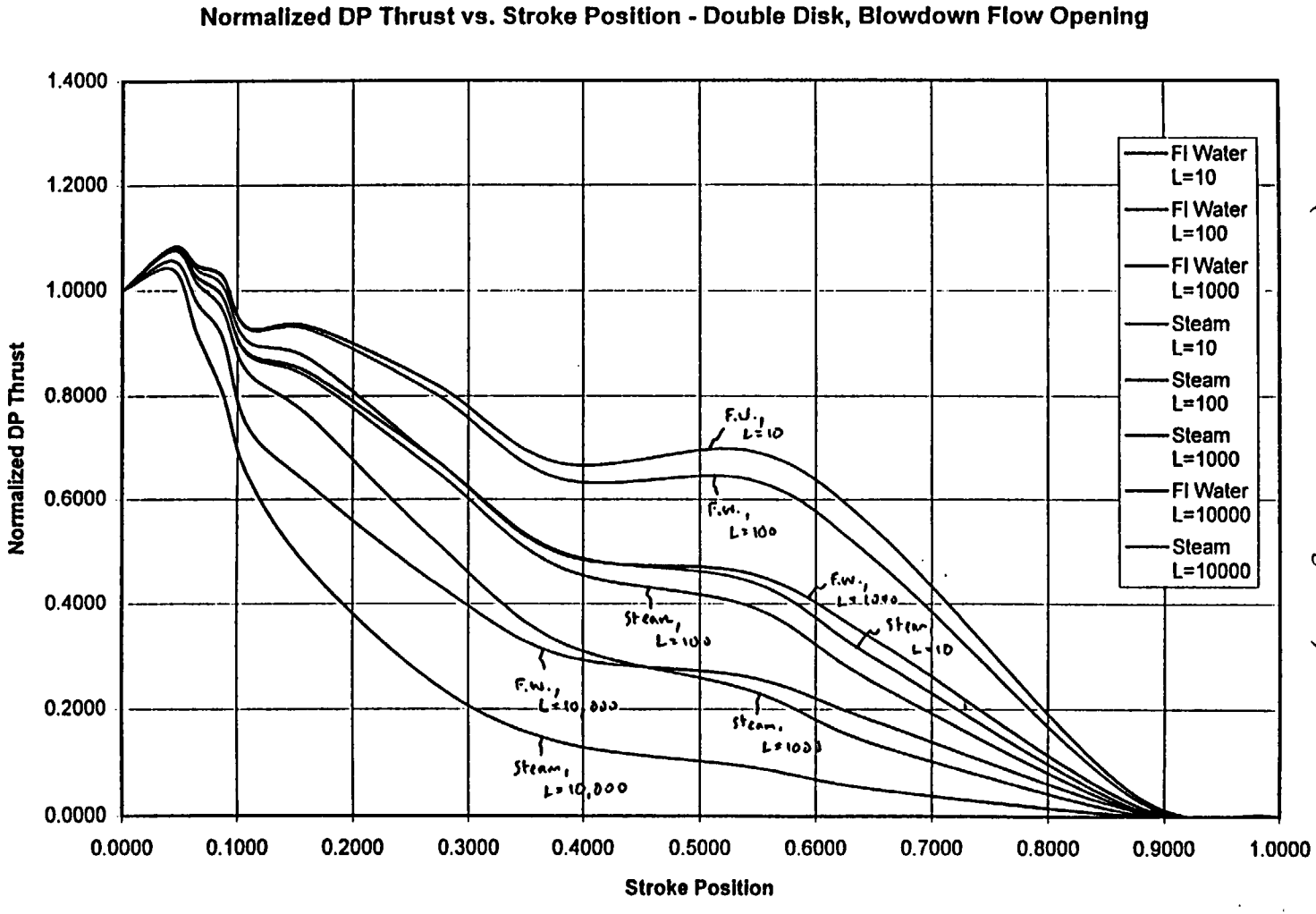
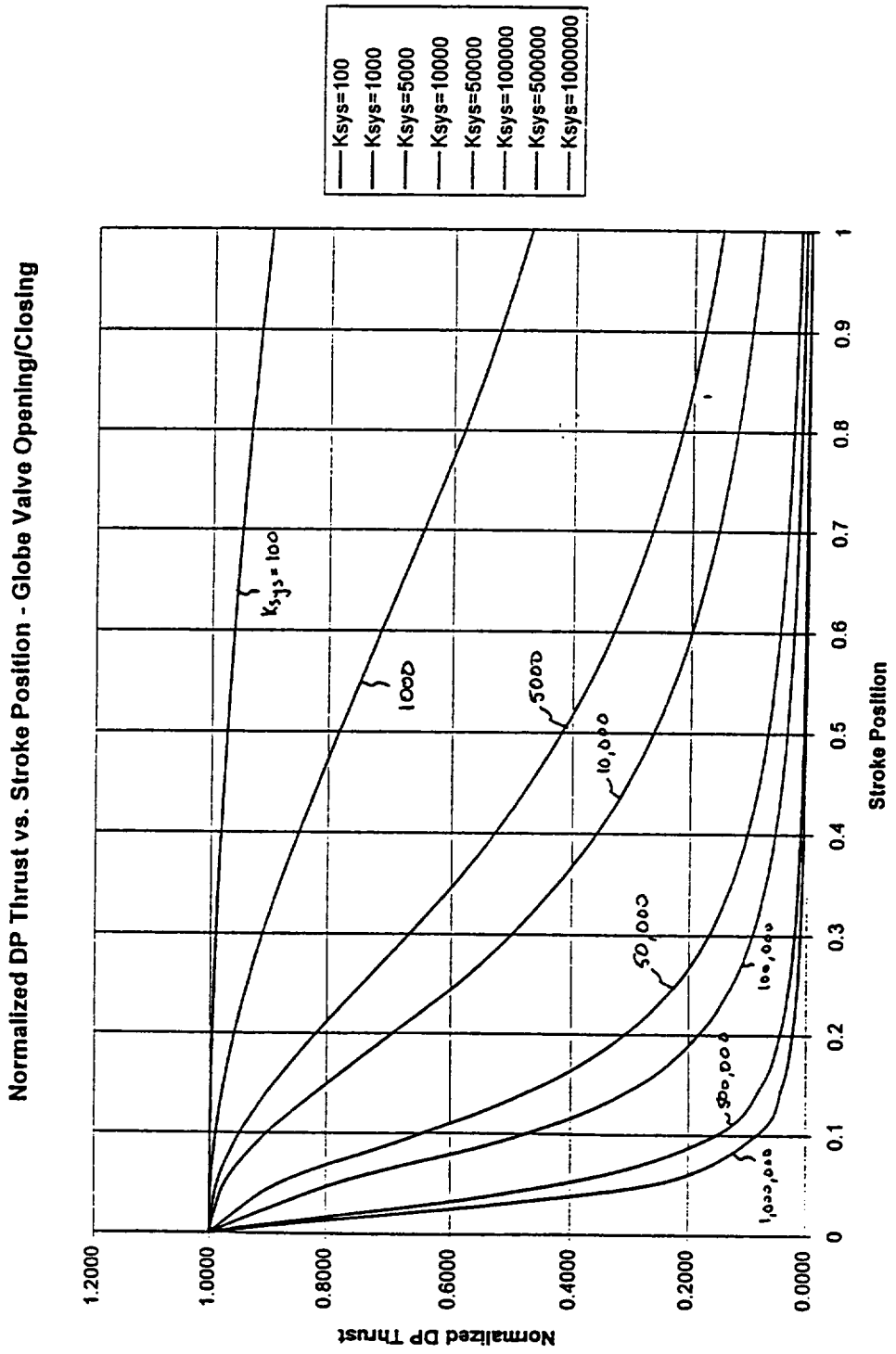



**Figure 9.** Gate Valve, Double Disk, Blowdown Flow Opening
(Note: Fl Water denotes Flashing Water)

**Figure 10.** Globe Valve, Pumped Flow Opening/Closing
Special Case for $C_v$ of 16 and Valve Inlet Diameter of 4" (See pages 28-29 for other globe valves)



## 4.0 METHODOLOGY

### 4.1 Gate Valves

To move a gate valve disk when there is DP across the valve, stem thrust is needed to overcome frictional forces between the disk and the body surface supporting the disk (either guide rails or seat ring). Using results from the EPRI gate valve method, the loads on the disk per unit DP can be determined as a function of stroke position. Using a free body model of the disk, the required stem thrust per unit DP can be determined from the applied loads, the disk configuration (e.g., wedge angle) and the appropriate friction coefficient.

For incompressible flow systems (i.e., pumped flow systems), the normalized DP variation can be determined by considering the resistance of the gate valve in different stroke positions (using information from the EPRI gate valve method) in conjunction with the resistance of the system in which the valve is located. For blowdown applications, the PPM system model is used to determine the normalized DP variation.

Using the results from the approaches above, the thrust per unit DP is multiplied by the normalized DP through out the stroke, to obtain a normalized stem thrust for the stroke. A range of system resistances is considered to provide a range of possible results.

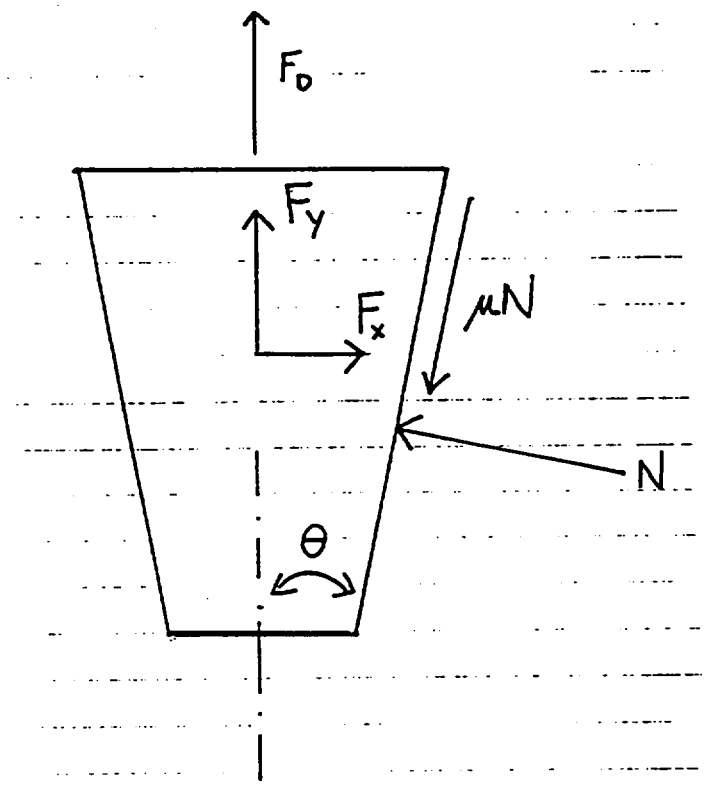
#### 4.1.1 Thrust Per Unit DP

Free body diagrams of the forces acting on the disk of a gate valve are shown separately below for the opening stroke and closing stroke when the disk is in contact with the seat ring and when the disk is in contact with the guides.

$F_D$ is equal to the thrust per unit DP.

5° is an assumed value for $\theta$ (one-half wedge angle) based on typical wedge valve configurations. The value of $\theta$ for double disk gate valves is equal to zero.

Opening - Contact with Seat




$$\Sigma F_x = 0 \qquad F_x - N\cos\theta - \mu N\sin\theta = 0 \qquad (1)$$

$$\Sigma F_y = 0 \qquad F_D + F_y + N\sin\theta - \mu N\cos\theta = 0 \qquad (2)$$

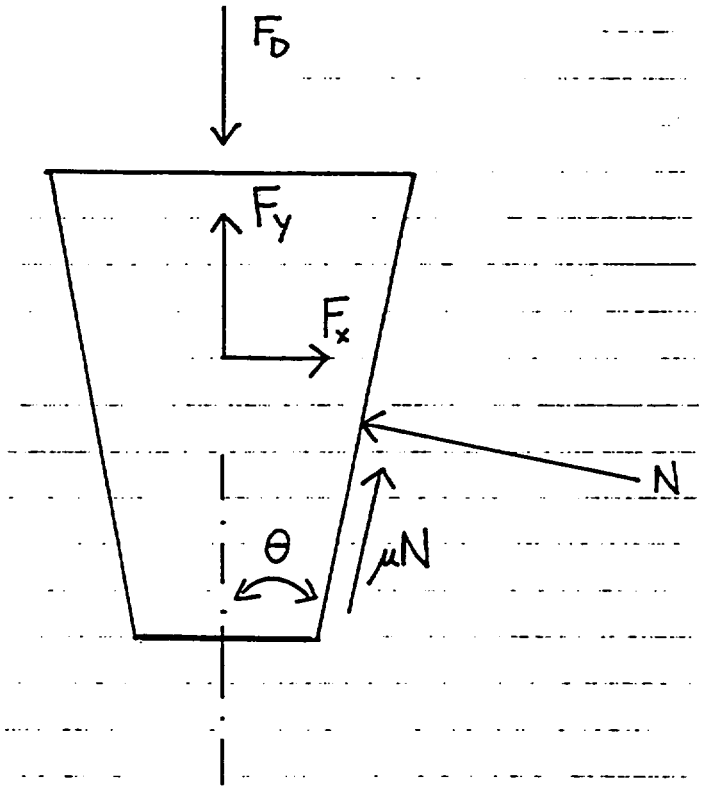
From (1) above,

$$N = \frac{F_x}{\cos\theta + \mu\sin\theta} \qquad (3)$$

Substitute into (2) above,

$$F_D = -F_y + \frac{F_x(\mu\cos\theta - \sin\theta)}{\cos\theta + \mu\sin\theta} \qquad (4)$$

Closing - Contact with Seat




$$\Sigma F_x = 0 \qquad F_x - N\cos\theta + \mu N\sin\theta = 0 \qquad (5)$$

$$\Sigma F_y = 0 \qquad F_y + N\sin\theta + \mu N\cos\theta - F_D = 0 \qquad (6)$$

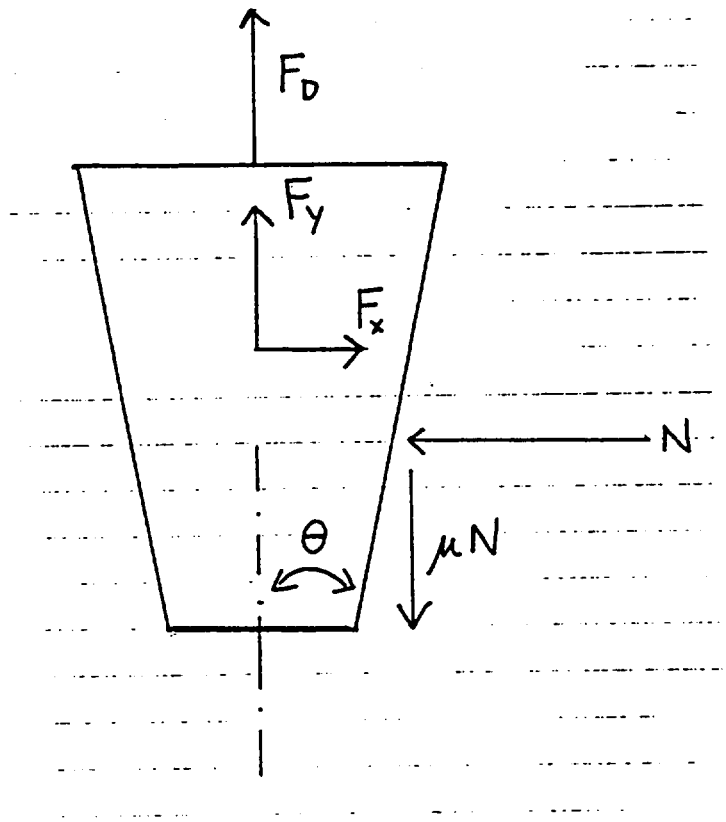
From (5) above,

$$N = \frac{F_x}{\cos\theta - \mu\sin\theta} \qquad (7)$$

Substitute into (6) above,

$$F_D = F_y + \frac{F_x(\sin\theta + \mu\cos\theta)}{\cos\theta - \mu\sin\theta} \qquad (8)$$

Opening - Contact with Guides




$$\Sigma F_x = 0 \qquad F_x - N = 0 \qquad (9)$$

$$\Sigma F_y = 0 \qquad F_D + F_y - \mu N = 0 \qquad (10)$$

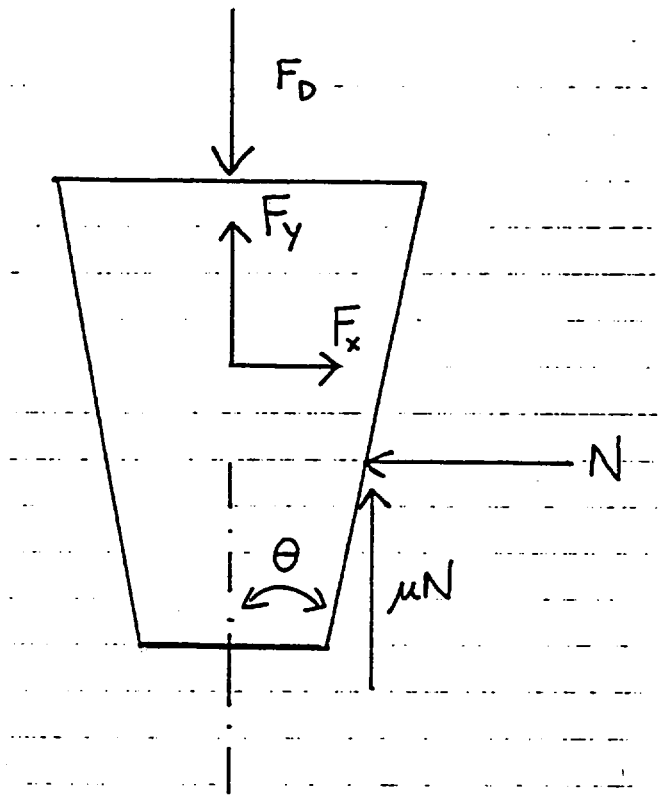
From (9) above,

$$N = F_x \qquad (11)$$

Substitute into (10) above,

$$F_D = -F_y + \mu F_x \qquad (12)$$

Closing - Contact with Guides




$$\Sigma F_x = 0 \qquad F_x - N = 0 \qquad (13)$$

$$\Sigma F_y = 0 \qquad F_D - F_y - \mu N = 0 \qquad (14)$$

From (13) above,

$$N = F_x \qquad (15)$$

Substitute into (14) above,

$$F_D = F_y + \mu F_x \qquad (16)$$

The values for $\mu$ shown in Table 1 below are taken from Table 2-3 of Reference (1) for wedge gate valves and Tables 3-1 and 3-2 from Reference (5) for double disk gate valves.

**Table 1. Friction Coefficients**

| Fluid Medium | Valve Type | Surface | Contact Materials | Maximum Friction Coefficient, $\mu$ |
|---|---|---|---|---|
| Water | Wedge | Disk to Seat Ring | Stellite 6 - Stellite 6 | 0.61 |
| | | Guide Slot to Rail | Carbon Steel - Carbon Steel | 0.60 |
| | Double Disk | Disk to Seat | Stellite 6 - Stellite 6 | 0.61 |
| Steam | Wedge | Disk to Seat Ring | Stellite 6 - Stellite 6 | 0.45* |
| | | Guide Slot to Rail | Carbon Steel - Carbon Steel | 0.60 |
| | Double Disk | Disk to Seat | Stellite 6 - Stellite 6 | 0.45 |

*This value was interpolated from Reference (1) at 500°F.

Values of normalized forces ($F_x$ and $F_y$) at various stroke positions for gate valves are provided in Appendix B of Reference (1). Two separate tables are shown in Reference (1), one corresponding to forces when the disk is in contact with the seat (stellite-stellite) and one corresponding to forces when the disk is in contact with the guides (carbon steel-carbon steel). When the data in the two tables are plotted, it can be seen that at a stroke position of 0.77, the curves closely overlap. Accordingly, these tables are combined using seat contact results when the valve is more closed than position 0.77 and guide contact results when the valve is more open than 0.77.

For wedge gate valves, DP thrust per unit DP ($F_D$) was analyzed to determine whether disk to seat ring contact or guide slot to rail contact would yield more limiting values. As shown in Appendix D, using the friction coefficients given in Table 1, for pumped flow, the limiting case is disk to seat ring contact for both the opening and closing stroke. For blowdown flow, guide slot to rail contact is limiting for the closing stroke and disk to seat ring contact is limiting for the opening stroke.

For the opening stroke of wedge gate valves the 0.45 friction coefficient only applies to steam/flashing water temperatures greater than 500°F. For the closing stroke of wedge gate valves, there is no constraint on temperature because 0.60 is the applicable value of guide $\mu$ for a wide range of temperatures. For double disk valves, the 0.45 friction coefficient only applies to steam/flashing water temperatures greater than 500°F.

**Table 2. DP Thrust Per Unit DP**

| Stroke Position (from Reference (1)) | Equivalent Stroke Position* | Fx | Fy |
|---|---|---|---|
| 0.00 | 1.00 | 0.0 | 0.0 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 |
| 0.67 | 0.2717 | 0.777 | -0.153 |
| 0.77 | 0.1630 | 0.864 | -0.172 |
| 0.82 | 0.1087 | 0.931 | -0.129 |
| 0.84 | 0.0870 | 1.009 | -0.165 |
| 0.86 | 0.0652 | 1.021 | -0.184 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 |
| 0.92 | 0.00 | 0.976 | -0.0854 |
| 1.00 | -0.0870 | 1.001 | -0.0876 |

* According to Reference (1), a 0.00 stroke position in the table above corresponds to the valve being fully open. A 0.92 stroke position corresponds to flow isolation. For the purposes of this calculation, a valve in the fully open position corresponds to a 1.00 stroke position and flow isolation corresponds to a 0.00 stroke position. Consequently, the stroke position (1st) column in the table above is adjusted using the following formula:

$$\text{Equivalent Stroke Position} = 1 - \frac{\text{Stroke Position}}{0.92}$$

The values of $F_x$ and $F_y$ in Table 2 above are calculated in Reference (1) for a 5° half wedge angle. Any valve with a half wedge angle other than 5° will require an adjustment in the $F_y$ term. This adjustment is performed for a zero degree half wedge angle for double disk valves but can be applied to any half wedge angle.

Pumped Flow - Wedge

DP thrust per unit DP for wedge valves in pumped flow is obtained by plugging in the $F_x$ and $F_y$ values from Table 2, above, into equations (4) and (8), with $\theta$ equal to 5° and $\mu$ equal to 0.61. These values are then normalized against the fully closed position (0.00 equivalent stroke position) to obtain normalized DP thrust per unit DP values at each equivalent stroke position. The results are shown in Appendix A.

Blowdown Flow - Wedge

DP thrust per unit DP for wedge valves in blowdown flow is obtained by first adjusting the $F_x$ and $F_y$ values from Table 2, above, and then plugging them into equations (4) and (16), with $\theta$ equal to 5° and $\mu$ equal to 0.6 for closing stokes and 0.45 for opening strokes. The adjustments made to $F_x$ and $F_y$ are based on Tables 6-5 and 6-6 from Reference (1) which list reduction factors that account for the difference between incompressible and compressible fluids. By determining the pressure ratio across the valve, the reduction factors can be calculated. Pressure ratio is equal to the ratio of downstream pressure to upstream pressure. This process is shown in Appendix A.

$F_D$ values are normalized against the fully closed position (0.00 equivalent stroke position) to obtain normalized DP thrust per unit DP values at each equivalent stroke position. The results are shown in Appendix A.

Pumped Flow - Double Disk

DP thrust per unit DP for double disk valves in pumped flow is obtained by plugging $F_x$ from Table 2 and an adjusted $F_y$ into equations (4) and (8), with $\theta$ equal to 0° and $\mu$ equal to 0.61. $F_y$ is adjusted to account for a half wedge angle other than 5°. This adjustment is made by scaling the $F_y$ values according to Section 5.7 of Reference (1). Note that Reference (1) indicates that the "value" (i.e., magnitude) of the vertical force is reduced by subtracting the $F_x$ term below from the $F_y$ term. Because the $F_y$ values in Table 2 are negative, reducing the magnitude of the vertical force requires adding the $F_x$ term instead of subtracting.

$$F_y' = F_y + F_x \frac{\text{Sin}\ (5°) - \text{Sin}\ (\theta)}{\text{Cos}\ (5°)}$$

$F_D$ values are normalized against the fully closed position (0.00 equivalent stroke position) to obtain normalized DP thrust per unit DP values at each equivalent stroke position. The results are shown in Appendix A.

Blowdown Flow - Double Disk

DP thrust per unit DP for double disk valves in blowdown flow is obtained by a three step process. First, the $F_y$ values from Table 2 are adjusted to account for a half wedge angle other than 5°. This adjustment is made by scaling the $F_y$ values according to Section 5.7 of Reference (1). Note that

Reference (1) indicates that the "value" (i.e., magnitude) of the vertical force is reduced by subtracting the $F_x$ term below from the $F_y$ term. Because the $F_y$ values in Table 2 are negative, reducing the magnitude of the vertical force requires adding the $F_x$ term instead of subtracting.

$$F_y' = F_y + F_x \frac{\text{Sin } (5°) - \text{Sin } (\theta)}{\text{Cos } (5°)}$$

Secondly, adjustments are made to $F_x$ and $F_y$ based on Tables 6-5 and 6-6 from Reference (1) which list reduction factors that account for the difference between incompressible and compressible fluids. By determining the pressure ratio across the valve, the reduction factors can be calculated. Pressure ratio is equal to the ratio of downstream pressure to upstream pressure. This process is shown in Appendix A.

Thirdly, the adjusted $F_x$ and $F_y$' values are plugged into equations (4) and (8), with $\theta$ equal to 0° and $\mu$ equal to 0.45.

Finally, $F_D$ values are normalized against the fully closed position (0.00 equivalent stroke position) to obtain normalized DP thrust per unit DP values at each equivalent stroke position. The results are shown in Appendix A.

4.1.2 Normalized DP

The next step is to determine the normalized DP across the valve. There are two methods for doing this, one for pumped flow and one for blowdown flow.

Pumped Flow

Reference (1), Table 2-1 contains data regarding flow coefficients at various stroke positions of typical gate valves. Flow coefficient is related to equivalent resistance by the following formula, Reference (2):

$$C_v = \frac{29.9d^2}{\sqrt{K_v}}$$

Where, $C_v$ = flow coefficient (gpm/$\sqrt{\text{psi}}$)
$K_v$ = equivalent resistance
d = seat ring inside diameter (in)

The values in Reference (1) are $C_v/d^2$. Therefore, the equation for $K_v$ becomes:

$$K_v = \left( \frac{29.9}{C_v / d^2} \right)^2$$

Using the equivalent stoke positions calculated in section 4.1.1 and performing linear interpolation where necessary, the following values for $K_v$ are calculated:

| **Equivalent Stroke Position** | **$C_v/d^2$ (gpm/√psi-in$^2$)** | **$K_v$** |
|---|---|---|
| 1.00 | 40.00 | 0.56 |
| 0.8696 | 36.94 | 0.66 |
| 0.6522 | 27.13 | 1.22 |
| 0.5435 | 20.89 | 2.05 |
| 0.3804 | 13.34 | 5.03 |
| 0.2717 | 8.868 | 11.37 |
| 0.1630 | 4.810 | 38.65 |
| 0.1087 | 3.000 | 99.35 |
| 0.0870 | 2.281 | 171.83 |
| 0.0652 | 1.556 | 369.25 |
| 0.0435 | 0.855 | 1222.95 |
| 0.00 | 0.00 | 1e10 |

To obtain normalized DP across the valve, the $K_v$ values in the table above are divided by the total system resistance. Total system resistance is equal to the sum of $K_v$ and the resistance due to the rest of the system. System resistances (not including $K_v$ of the valve) of 10, 20, 50, 100, 200, 500, 1000, 2000 and 5000 are used to illustrate how DP across the valve changes depending on the system resistance. The normalized DP across the valve is tabulated in Appendix A.

Blowdown Flow

For blowdown flow it is more appropriate based on experience, to obtain normalized DP values from the MOV Performance Prediction Methodology (PPM). The system model of the PPM uses upstream pipe distances, system pressure and other parameters specified below to calculate DP values for blowdown flow. Both steam and flashing water are modeled. The PPM system model generates the same results for opening and closing strokes for blowdown flow. Therefore, only the closing stroke PPM runs are provided in Appendix C. Upstream pipe distances of 10, 100, 1000 and 10000 pipe diameters are modeled to illustrate how DP varies for blowdown flow. Equivalent stroke position is rounded down to the next whole number to correspond with PPM output. The DP output from the PPM at the rounded equivalent stroke position is divided by the maximum DP (1000 psi) to obtain normalized values. The normalized DP values are tabulated in Appendix A.

Specific PPM parameters are listed below:

Supply Tank Temperature: 575°F (steam), 530°F (flashing water)
Initial Supply Tank Pressure: 1015 psia
Main Valve's Initial Discharge Tank Pressure: 15 psia
Pipe ID: 6 inches
Roughness: 0.00015 (Reference (2) for commercial steel)
Full Stroke: 6 inches
Valve Inlet Diameter: 6 inches
Stroke Time: 30 seconds (input does not affect DP results)
Seat Ring Inside Diameter: 6 inches

### 4.1.3 Normalized DP Thrust

Sections 4.1.1 and 4.1.2 document how to calculate normalized DP thrust per unit DP and normalized DP respectively. By multiplying these two quantities together, the desired value of normalized DP thrust is calculated. This calculation is the basis for the curves in Figures 2 through 9. Appendix A provides the data used to generate these curves.

### 4.2 Globe Valves

For a globe valve, the disk is directly loaded by the DP across the valve, regardless of stroke position. Accordingly, the DP thrust variation is the same as the DP variation as the valve is stroked. For incompressible flow, the DP variation depends only on the system resistance and the resistance of the valve at each stroke position. A flow coefficient ($C_v$) curve plotted against stroke position is required to obtain values of $K_v$. A hypothetical globe valve is used that has a $C_v$ of 16 at the fully open position. Knowing that $C_v$ is equal to 0 at the fully closed position, a linear graph can be created for $C_v$ versus stroke position. Based on experience, this linear assumption is conservative. When available, $C_v$ curves for valves should be obtained from the vendor.

Based on the linear equation $C_v$ = (16)(stroke position), a hypothetical inner diameter of 4 inches and the equation below from Reference (2), $K_v$ versus stroke position is calculated.

$$K_v = \left( \frac{29.9d^2}{C_v} \right)^2$$

| Equivalent Stroke Position | $C_v$ (gpm/√psi) | $K_v$ |
|---|---|---|
| 0.00 | 0.00 | 1e10 |
| 0.05 | 0.8 | 357604 |
| 0.10 | 1.6 | 89401 |
| 0.15 | 2.4 | 39733.78 |
| 0.20 | 3.2 | 22350.25 |
| 0.25 | 4.0 | 14304.16 |
| 0.30 | 4.8 | 9933.44 |
| 0.35 | 5.6 | 7298.04 |
| 0.40 | 6.4 | 5587.56 |
| 0.45 | 7.2 | 4414.86 |
| 0.50 | 8.0 | 3576.04 |
| 0.55 | 8.8 | 2955.40 |
| 0.60 | 9.6 | 2483.36 |
| 0.65 | 10.4 | 2116 |
| 0.70 | 11.2 | 1824.51 |
| 0.75 | 12.0 | 1589.35 |
| 0.80 | 12.8 | 1396.89 |
| 0.85 | 13.6 | 1237.38 |
| 0.90 | 14.4 | 1103.72 |
| 0.95 | 15.2 | 990.59 |
| 1.00 | 16.0 | 894.01 |

$K_v$ is normalized and plotted in Figure 10 to illustrate DP thrust versus stroke position for system resistances (not including $K_v$ of the valve) of 100, 1000, 5000, 10000, 50000, 100000, 500000 and 1000000.

## 5.0 REFERENCES


1. EPRI TR-103229-V1, "EPRI MOV Performance Prediction Program, Gate Valve Model Report, Volume 1: Summary Through Appendix C," November 1994.

2. Crane Technical Paper No. 410, "Flow of Fluids Through Valves, Fittings, and Pipe", 1991.

3. Not used.

4. Not used.

5. EPRI TR-103232, "EPRI MOV Performance Prediction Program, Stem Thrust Prediction Method for Anchor/Darling Double Disk Gate Valves," November 1994.

6. EPRI TR-103231, "EPRI MOV Performance Prediction Program, Performance Prediction Methodology Assessment Report," November 1994.

**APPENDIX A**

Spreadsheet Data

WEDGE

| Pumped Flow | | | | Close-seat | | Open-seat | |
|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | FD= Fy+Acs*Fx | Normalized Seat | FD= -Fy+Aos*Fx | Normalized Seat |
| 0 | 1 | 0 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.0731 | 0.1154 | 0.0335 | 0.0588 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | 0.2930 | 0.4623 | 0.3607 | 0.6333 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | 0.3808 | 0.6009 | 0.4594 | 0.8065 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | 0.4144 | 0.6539 | 0.4418 | 0.7757 |
| 0.67 | 0.2717 | 0.777 | -0.153 | 0.4195 | 0.6620 | 0.5384 | 0.9454 |
| 0.77 | 0.1630 | 0.864 | -0.172 | 0.4646 | 0.7331 | 0.6006 | 1.0545 |
| 0.82 | 0.1087 | 0.931 | -0.129 | 0.5570 | 0.8789 | 0.5908 | 1.0374 |
| 0.84 | 0.0870 | 1.009 | -0.165 | 0.5784 | 0.9128 | 0.6655 | 1.1685 |
| 0.86 | 0.0652 | 1.021 | -0.184 | 0.5683 | 0.8967 | 0.6905 | 1.2123 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | 0.5957 | 0.9400 | 0.6847 | 1.1872 |
| 0.92 | 0 | 0.976 | -0.0854 | 0.6337 | 1.0000 | 0.5695 | 1.0000 |

| Water | mu | A |
|---|---|---|
| CS | 0.61 | 0.736810847 |
| OS | 0.61 | 0.496038701 |

| Steam | mu | A |
|---|---|---|
| CG | 0.6 | 0.6 |
| OS | 0.45 | 0.348779907 |

| theta-water | |
|---|---|
| degs | rads |
| 5 | 0.0872665 |

| theta-steam | |
|---|---|
| degs | rads |
| 5 | 0.0872665 |

| Blowdown Flow | | | | Close-guide Steam, L=10 | | | | Close-guide Steam, L=100 | | | | Close-guide Steam, L=1000 | | | | Close-guide Steam, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides |
| 0 | 1 | 0 | 0 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.764 | 0.0000 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 |
| 0.67 | 0.2717 | 0.777 | -0.153 | 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 |
| 0.77 | 0.1630 | 0.864 | -0.172 | 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 |
| 0.82 | 0.1087 | 0.931 | -0.129 | 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 |
| 0.84 | 0.0870 | 1.009 | -0.165 | 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 |
| 0.86 | 0.0652 | 1.021 | -0.184 | 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 |
| 0.92 | 0 | 0.976 | -0.0854 | 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 |

| Close-guide FW, L=10 | | | | Close-guide FW, L=100 | | | | Close-guide FW, L=1000 | | | | Close-guide FW, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= Fy+Acg*Fx | Normalized Guides |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 | 0.867 | 0.701 | 0.0516 | 0.1031 |
| 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 | 0.867 | 0.701 | 0.2073 | 0.4145 |
| 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 | 0.867 | 0.701 | 0.2695 | 0.5388 |
| 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 | 0.867 | 0.701 | 0.2931 | 0.5859 |
| 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 | 0.867 | 0.701 | 0.2969 | 0.5936 |
| 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 | 0.948 | 0.441 | 0.4156 | 0.8309 |
| 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 | 0.930 | 0.430 | 0.4638 | 0.9272 |
| 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 | 0.922 | 0.426 | 0.4881 | 0.9757 |
| 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 | 0.915 | 0.422 | 0.4829 | 0.9654 |
| 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 | 0.943 | 0.614 | 0.4818 | 0.9633 |
| 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 | 1.000 | 1.000 | 0.5002 | 1.0000 |

| Open-seat Steam, L=10 | | | | Open-seat Steam, L=100 | | | | Open-seat Steam, L=1000 | | | | Open-seat Steam, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.764 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 |
| 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 |
| 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 |
| 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 |
| 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 |
| 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 |
| 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 |
| 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 |
| 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 |
| 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 |
| 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 |

| Open-seat FW, L=10 | | | | Open-seat FW, L=100 | | | | Open-seat FW, L=1000 | | | | Open-seat FW, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides | Fx Factor | Fy Factor | FD= -Fy+Aos*Fx | Normalized Guides |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 | 0.867 | 0.701 | 0.0196 | 0.0460 |
| 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 | 0.867 | 0.701 | 0.2288 | 0.5374 |
| 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 | 0.867 | 0.701 | 0.2911 | 0.6837 |
| 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 | 0.867 | 0.701 | 0.2782 | 0.6534 |
| 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 | 0.867 | 0.701 | 0.3422 | 0.8037 |
| 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 | 0.948 | 0.441 | 0.3615 | 0.8490 |
| 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 | 0.930 | 0.430 | 0.3574 | 0.8394 |
| 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 | 0.922 | 0.426 | 0.3949 | 0.9275 |
| 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 | 0.915 | 0.422 | 0.4035 | 0.9476 |
| 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 | 0.943 | 0.614 | 0.4332 | 1.0174 |
| 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 | 1.000 | 1.000 | 0.4258 | 1.0000 |

WEDGE

| Closing-Pumped Flow | | | 10 | | 20 | | 50 | | 100 | | 200 | | 500 | | 1000 | | 2000 | | 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust |
| Stroke Position | Kv | Normalized DP Thrust per unit DP | Ksys=10 | Ksys=10 | Ksys=20 | Ksys=20 | Ksys=50 | Ksys=50 | Ksys=100 | Ksys=100 | Ksys=200 | Ksys=200 | Ksys=500 | Ksys=500 | Ksys=1000 | Ksys=1000 | Ksys=2000 | Ksys=2000 | Ksys=5000 | Ksys=5000 |
| 1 | 0.56 | 0.000 | 0.0530 | 0 | 0.0272 | 0 | 0.0111 | 0 | 0.0056 | 0 | 0.0028 | 0 | 0.0011 | 0 | 0.0006 | 0 | 0.0003 | 0 | 0.0001 | 0 |
| 0.8696 | 0.66 | 0.115 | 0.0619 | 0.007 | 0.0319 | 0.004 | 0.0130 | 0.002 | 0.0066 | 0.001 | 0.0033 | 0.000 | 0.0013 | 0.000 | 0.0007 | 0.000 | 0.0003 | 3.81E-05 | 0.0001 | 1.52E-05 |
| 0.6522 | 1.22 | 0.462 | 0.1067 | 0.050 | 0.0575 | 0.027 | 0.0238 | 0.011 | 0.0121 | 0.006 | 0.0061 | 0.003 | 0.0024 | 0.001 | 0.0012 | 0.001 | 0.0006 | 0.000 | 0.0002 | 0.000 |
| 0.5435 | 2.05 | 0.601 | 0.1701 | 0.102 | 0.0930 | 0.056 | 0.0394 | 0.024 | 0.0201 | 0.012 | 0.0101 | 0.006 | 0.0041 | 0.002 | 0.0020 | 0.001 | 0.0010 | 0.001 | 0.0004 | 0.000 |
| 0.3804 | 5.03 | 0.654 | 0.3347 | 0.219 | 0.2010 | 0.131 | 0.0914 | 0.060 | 0.0479 | 0.031 | 0.0245 | 0.016 | 0.0100 | 0.007 | 0.0050 | 0.003 | 0.0025 | 0.002 | 0.0010 | 0.001 |
| 0.2717 | 11.37 | 0.662 | 0.5321 | 0.352 | 0.3624 | 0.240 | 0.1853 | 0.123 | 0.1021 | 0.068 | 0.0536 | 0.036 | 0.0222 | 0.015 | 0.0112 | 0.007 | 0.0057 | 0.004 | 0.0023 | 0.002 |
| 0.1630 | 38.65 | 0.733 | 0.7945 | 0.582 | 0.6590 | 0.483 | 0.4360 | 0.320 | 0.2788 | 0.204 | 0.1620 | 0.119 | 0.0718 | 0.053 | 0.0372 | 0.027 | 0.0190 | 0.014 | 0.0077 | 0.006 |
| 0.1087 | 99.35 | 0.879 | 0.9088 | 0.799 | 0.8324 | 0.732 | 0.6652 | 0.585 | 0.4984 | 0.438 | 0.3319 | 0.292 | 0.1658 | 0.146 | 0.0904 | 0.079 | 0.0473 | 0.042 | 0.0195 | 0.017 |
| 0.0870 | 171.83 | 0.913 | 0.9450 | 0.863 | 0.8957 | 0.818 | 0.7748 | 0.707 | 0.6321 | 0.577 | 0.4621 | 0.422 | 0.2558 | 0.233 | 0.1466 | 0.134 | 0.0791 | 0.072 | 0.0332 | 0.030 |
| 0.0652 | 369.25 | 0.897 | 0.9736 | 0.873 | 0.9486 | 0.851 | 0.8807 | 0.790 | 0.7869 | 0.706 | 0.6487 | 0.582 | 0.4248 | 0.381 | 0.2697 | 0.242 | 0.1559 | 0.140 | 0.0688 | 0.062 |
| 0.0435 | 1222.95 | 0.940 | 0.9919 | 0.932 | 0.9839 | 0.925 | 0.9607 | 0.903 | 0.9244 | 0.869 | 0.8594 | 0.806 | 0.7098 | 0.667 | 0.5501 | 0.517 | 0.3785 | 0.357 | 0.1965 | 0.185 |
| 0 | 10000000000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 |

| Opening-Pumped Flow | | | 10 | | 20 | | 50 | | 100 | | 200 | | 500 | | 1000 | | 2000 | | 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust |
| Stroke Position | Kv | Normalized DP Thrust per unit DP | Ksys=10 | Ksys=10 | Ksys=20 | Ksys=20 | Ksys=50 | Ksys=50 | Ksys=100 | Ksys=100 | Ksys=200 | Ksys=200 | Ksys=500 | Ksys=500 | Ksys=1000 | Ksys=1000 | Ksys=2000 | Ksys=2000 | Ksys=5000 | Ksys=5000 |
| 1 | 0.56 | 0.000 | 0.0530 | 0 | 0.0272 | 0 | 0.0111 | 0 | 0.0056 | 0 | 0.0028 | 0 | 0.0011 | 0 | 0.0006 | 0 | 0.0003 | 0 | 0.0001 | 0 |
| 0.8696 | 0.66 | 0.059 | 0.0619 | 0.004 | 0.0319 | 0.002 | 0.0130 | 0.001 | 0.0066 | 0.000 | 0.0033 | 0.000 | 0.0013 | 0.000 | 0.0007 | 0.000 | 0.0003 | 1.94E-05 | 0.0001 | 7.76E-06 |
| 0.6522 | 1.22 | 0.833 | 0.1067 | 0.089 | 0.0575 | 0.036 | 0.0238 | 0.015 | 0.0121 | 0.008 | 0.0061 | 0.004 | 0.0024 | 0.002 | 0.0012 | 0.001 | 0.0006 | 0.000 | 0.0002 | 0.000 |
| 0.5435 | 2.05 | 0.807 | 0.1701 | 0.137 | 0.0930 | 0.075 | 0.0394 | 0.032 | 0.0201 | 0.016 | 0.0101 | 0.008 | 0.0041 | 0.003 | 0.0020 | 0.002 | 0.0010 | 0.001 | 0.0004 | 0.000 |
| 0.3804 | 5.03 | 0.776 | 0.3347 | 0.260 | 0.2010 | 0.156 | 0.0914 | 0.071 | 0.0479 | 0.037 | 0.0245 | 0.019 | 0.0100 | 0.008 | 0.0050 | 0.004 | 0.0025 | 0.002 | 0.0010 | 0.001 |
| 0.2717 | 11.37 | 0.945 | 0.5321 | 0.503 | 0.3624 | 0.343 | 0.1853 | 0.176 | 0.1021 | 0.097 | 0.0536 | 0.051 | 0.0222 | 0.021 | 0.0112 | 0.011 | 0.0057 | 0.005 | 0.0023 | 0.002 |
| 0.1630 | 38.65 | 1.055 | 0.7945 | 0.838 | 0.6590 | 0.895 | 0.4360 | 0.460 | 0.2788 | 0.294 | 0.1620 | 0.171 | 0.0718 | 0.076 | 0.0372 | 0.039 | 0.0190 | 0.020 | 0.0077 | 0.008 |
| 0.1087 | 99.35 | 1.037 | 0.9088 | 0.942 | 0.8324 | 0.864 | 0.6652 | 0.690 | 0.4984 | 0.517 | 0.3319 | 0.344 | 0.1658 | 0.172 | 0.0904 | 0.094 | 0.0473 | 0.049 | 0.0195 | 0.020 |
| 0.0870 | 171.83 | 1.169 | 0.9450 | 1.104 | 0.8957 | 1.047 | 0.7748 | 0.905 | 0.6321 | 0.739 | 0.4621 | 0.540 | 0.2558 | 0.299 | 0.1466 | 0.171 | 0.0791 | 0.092 | 0.0332 | 0.039 |
| 0.0652 | 369.25 | 1.212 | 0.9736 | 1.180 | 0.9486 | 1.150 | 0.8807 | 1.068 | 0.7869 | 0.954 | 0.6487 | 0.786 | 0.4248 | 0.515 | 0.2697 | 0.327 | 0.1559 | 0.189 | 0.0688 | 0.083 |
| 0.0435 | 1222.95 | 1.187 | 0.9919 | 1.178 | 0.9839 | 1.148 | 0.9607 | 1.121 | 0.9244 | 1.079 | 0.8594 | 1.003 | 0.7098 | 0.828 | 0.5501 | 0.642 | 0.3785 | 0.443 | 0.1965 | 0.229 |
| 0 | 10000000000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 |

| Closing-Blowdown Flow | | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | Kv | Steam L=10 | | | | Steam L=100 | | | | Steam L=1000 | | | | Steam L=10000 | | | | Fl Water L=10 | | | |
| 1 | 0.56 | 0.000 | 0.042 | 0.344 | 0.000 | 0.000 | 0.056 | 0.255 | 0.000 | 0.000 | 0.110 | 0.121 | 0.000 | 0.000 | 0.366 | 0.026 | 0.000 | 0.000 | 0.015 | 0.954 | 0.000 |
| 0.8696 | 0.66 | 0.103 | 0.037 | 0.392 | 0.040 | 0.103 | 0.047 | 0.301 | 0.031 | 0.103 | 0.094 | 0.145 | 0.015 | 0.103 | 0.200 | 0.06 | 0.006 | 0.103 | 0.015 | 0.962 | 0.099 |
| 0.6522 | 1.22 | 0.414 | 0.027 | 0.531 | 0.220 | 0.414 | 0.032 | 0.447 | 0.185 | 0.414 | 0.059 | 0.24 | 0.099 | 0.414 | 0.146 | 0.088 | 0.036 | 0.414 | 0.015 | 0.977 | 0.405 |
| 0.5435 | 2.05 | 0.539 | 0.023 | 0.620 | 0.339 | 0.539 | 0.026 | 0.56 | 0.302 | 0.539 | 0.043 | 0.333 | 0.179 | 0.539 | 0.105 | 0.128 | 0.069 | 0.539 | 0.015 | 0.985 | 0.531 |
| 0.3804 | 5.03 | 0.586 | 0.020 | 0.739 | 0.433 | 0.586 | 0.021 | 0.695 | 0.407 | 0.586 | 0.030 | 0.483 | 0.283 | 0.586 | 0.069 | 0.203 | 0.119 | 0.586 | 0.015 | 0.992 | 0.581 |
| 0.2717 | 11.37 | 0.594 | 0.018 | 0.817 | 0.485 | 0.594 | 0.019 | 0.792 | 0.470 | 0.594 | 0.023 | 0.627 | 0.372 | 0.594 | 0.048 | 0.297 | 0.176 | 0.594 | 0.015 | 0.995 | 0.591 |
| 0.1630 | 38.65 | 0.831 | 0.016 | 0.901 | 0.749 | 0.831 | 0.017 | 0.891 | 0.740 | 0.831 | 0.018 | 0.81 | 0.673 | 0.831 | 0.029 | 0.496 | 0.414 | 0.831 | 0.015 | 0.997 | 0.828 |
| 0.1087 | 99.35 | 0.927 | 0.016 | 0.948 | 0.877 | 0.927 | 0.016 | 0.942 | 0.873 | 0.927 | 0.016 | 0.906 | 0.840 | 0.927 | 0.021 | 0.692 | 0.642 | 0.927 | 0.015 | 0.998 | 0.925 |
| 0.0870 | 171.83 | 0.976 | 0.015 | 0.962 | 0.939 | 0.976 | 0.015 | 0.96 | 0.937 | 0.976 | 0.016 | 0.938 | 0.915 | 0.976 | 0.019 | 0.781 | 0.762 | 0.976 | 0.015 | 0.998 | 0.974 |
| 0.0652 | 369.25 | 0.965 | 0.015 | 0.976 | 0.944 | 0.965 | 0.015 | 0.977 | 0.943 | 0.965 | 0.015 | 0.966 | 0.933 | 0.965 | 0.017 | 0.874 | 0.844 | 0.965 | 0.015 | 0.998 | 0.963 |
| 0.0435 | 1222.95 | 0.963 | 0.015 | 0.995 | 0.958 | 0.963 | 0.015 | 0.995 | 0.958 | 0.963 | 0.015 | 0.991 | 0.955 | 0.963 | 0.015 | 0.959 | 0.924 | 0.963 | 0.015 | 0.998 | 0.961 |
| 0 | 10000000000 | 1.000 | 0.015 | 1.000 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1.000 | 1.000 |

| Opening-Blowdown Flow | | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | Kv | Steam L=10 | | | | Steam L=100 | | | | Steam L=1000 | | | | Steam L=10000 | | | | Fl Water L=10 | | | |
| 1.0000 | 0.56 | 0.0000 | 0.042 | 0.344 | 0.0000 | 0.0000 | 0.056 | 0.255 | 0.0000 | 0.0000 | 0.110 | 0.121 | 0.0000 | 0.0000 | 0.366 | 0.026 | 0.0000 | 0.0000 | 0.015 | 0.954 | 0.0000 |
| 0.8696 | 0.66 | 0.0460 | 0.037 | 0.392 | 0.0180 | 0.0460 | 0.047 | 0.301 | 0.0138 | 0.0460 | 0.094 | 0.145 | 0.0067 | 0.0460 | 0.200 | 0.06 | 0.0028 | 0.0460 | 0.015 | 0.962 | 0.0442 |
| 0.6522 | 1.22 | 0.5374 | 0.027 | 0.531 | 0.2853 | 0.5374 | 0.032 | 0.447 | 0.2402 | 0.5374 | 0.059 | 0.24 | 0.1290 | 0.5374 | 0.146 | 0.088 | 0.0473 | 0.5374 | 0.015 | 0.977 | 0.5250 |
| 0.5435 | 2.05 | 0.6837 | 0.023 | 0.620 | 0.4300 | 0.6837 | 0.026 | 0.56 | 0.3829 | 0.6837 | 0.043 | 0.333 | 0.2277 | 0.6837 | 0.105 | 0.128 | 0.0875 | 0.6837 | 0.015 | 0.985 | 0.6734 |
| 0.3804 | 5.03 | 0.6534 | 0.020 | 0.739 | 0.4829 | 0.6534 | 0.021 | 0.695 | 0.4541 | 0.6534 | 0.030 | 0.483 | 0.3156 | 0.6534 | 0.069 | 0.203 | 0.1326 | 0.6534 | 0.015 | 0.992 | 0.6482 |
| 0.2717 | 11.37 | 0.8037 | 0.018 | 0.817 | 0.6566 | 0.8037 | 0.019 | 0.792 | 0.6365 | 0.8037 | 0.023 | 0.627 | 0.5039 | 0.8037 | 0.048 | 0.297 | 0.2387 | 0.8037 | 0.015 | 0.995 | 0.7997 |
| 0.1630 | 38.65 | 0.8490 | 0.016 | 0.901 | 0.7650 | 0.8490 | 0.017 | 0.891 | 0.7565 | 0.8490 | 0.018 | 0.81 | 0.6877 | 0.8490 | 0.029 | 0.496 | 0.4226 | 0.8490 | 0.015 | 0.997 | 0.8465 |
| 0.1087 | 99.35 | 0.8394 | 0.016 | 0.948 | 0.7940 | 0.8394 | 0.016 | 0.942 | 0.7907 | 0.8394 | 0.016 | 0.906 | 0.7605 | 0.8394 | 0.021 | 0.692 | 0.5806 | 0.8394 | 0.015 | 0.998 | 0.8377 |
| 0.0870 | 171.83 | 0.9275 | 0.015 | 0.962 | 0.8922 | 0.9275 | 0.015 | 0.96 | 0.8904 | 0.9275 | 0.016 | 0.938 | 0.8700 | 0.9275 | 0.019 | 0.781 | 0.7243 | 0.9275 | 0.015 | 0.998 | 0.9256 |
| 0.0652 | 369.25 | 0.9476 | 0.015 | 0.976 | 0.9267 | 0.9476 | 0.015 | 0.977 | 0.9258 | 0.9476 | 0.015 | 0.966 | 0.9154 | 0.9476 | 0.017 | 0.874 | 0.8282 | 0.9476 | 0.015 | 0.998 | 0.9457 |
| 0.0435 | 1222.95 | 1.0174 | 0.015 | 0.995 | 1.0123 | 1.0174 | 0.015 | 0.995 | 1.0123 | 1.0174 | 0.015 | 0.991 | 1.0082 | 1.0174 | 0.015 | 0.959 | 0.9757 | 1.0174 | 0.015 | 0.998 | 1.0154 |
| 0.0000 | 10000000000 | 1.0000 | 0.015 | 1.000 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1.000 | 1.0000 |

| Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fl Water L=100 | | | | Fl Water L=1000 | | | | Fl Water L=10000 | | | |
| 0.000 | 0.019 | 0.78 | 0.000 | 0.000 | 0.029 | 0.51 | 0.000 | 0.000 | 0.057 | 0.25 | 0.000 |
| 0.103 | 0.018 | 0.8 | 0.083 | 0.103 | 0.028 | 0.53 | 0.055 | 0.103 | 0.054 | 0.265 | 0.027 |
| 0.414 | 0.017 | 0.871 | 0.361 | 0.414 | 0.025 | 0.595 | 0.247 | 0.414 | 0.045 | 0.317 | 0.131 |
| 0.539 | 0.016 | 0.906 | 0.488 | 0.539 | 0.023 | 0.651 | 0.351 | 0.539 | 0.039 | 0.368 | 0.198 |
| 0.586 | 0.016 | 0.947 | 0.555 | 0.586 | 0.020 | 0.733 | 0.429 | 0.586 | 0.032 | 0.447 | 0.262 |
| 0.594 | 0.015 | 0.972 | 0.577 | 0.594 | 0.018 | 0.818 | 0.486 | 0.594 | 0.027 | 0.531 | 0.315 |
| 0.831 | 0.015 | 0.99 | 0.823 | 0.831 | 0.016 | 0.93 | 0.773 | 0.831 | 0.022 | 0.67 | 0.557 |
| 0.927 | 0.015 | 0.995 | 0.923 | 0.927 | 0.015 | 0.97 | 0.899 | 0.927 | 0.019 | 0.793 | 0.735 |
| 0.976 | 0.015 | 0.996 | 0.972 | 0.976 | 0.015 | 0.981 | 0.957 | 0.976 | 0.017 | 0.886 | 0.864 |
| 0.965 | 0.015 | 0.997 | 0.962 | 0.965 | 0.015 | 0.99 | 0.956 | 0.965 | 0.016 | 0.931 | 0.899 |
| 0.963 | 0.015 | 0.998 | 0.961 | 0.963 | 0.015 | 0.996 | 0.959 | 0.963 | 0.015 | 0.974 | 0.938 |
| 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 |

| Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fl Water L=100 | | | | Fl Water L=1000 | | | | Fl Water L=10000 | | | |
| 0.0000 | 0.019 | 0.78 | 0.0000 | 0.0000 | 0.029 | 0.51 | 0.0000 | 0.0000 | 0.057 | 0.25 | 0.0000 |
| 0.0460 | 0.018 | 0.8 | 0.0368 | 0.0460 | 0.028 | 0.53 | 0.0244 | 0.0460 | 0.054 | 0.265 | 0.0122 |
| 0.5374 | 0.017 | 0.871 | 0.4680 | 0.5374 | 0.025 | 0.595 | 0.3197 | 0.5374 | 0.045 | 0.317 | 0.1703 |
| 0.6837 | 0.016 | 0.906 | 0.6194 | 0.6837 | 0.023 | 0.651 | 0.4451 | 0.6837 | 0.039 | 0.368 | 0.2516 |
| 0.6534 | 0.016 | 0.947 | 0.6188 | 0.6534 | 0.020 | 0.733 | 0.4789 | 0.6534 | 0.032 | 0.447 | 0.2921 |
| 0.8037 | 0.015 | 0.972 | 0.7812 | 0.8037 | 0.018 | 0.818 | 0.8574 | 0.8037 | 0.027 | 0.531 | 0.4268 |
| 0.8490 | 0.015 | 0.99 | 0.8405 | 0.8490 | 0.016 | 0.93 | 0.7896 | 0.8490 | 0.022 | 0.67 | 0.5689 |
| 0.8394 | 0.015 | 0.995 | 0.8352 | 0.8394 | 0.015 | 0.97 | 0.8142 | 0.8394 | 0.019 | 0.793 | 0.6656 |
| 0.9275 | 0.015 | 0.996 | 0.9237 | 0.9275 | 0.015 | 0.981 | 0.9098 | 0.9275 | 0.017 | 0.886 | 0.8217 |
| 0.9476 | 0.015 | 0.997 | 0.9447 | 0.9476 | 0.015 | 0.99 | 0.9381 | 0.9476 | 0.016 | 0.931 | 0.8822 |
| 1.0174 | 0.015 | 0.998 | 1.0154 | 1.0174 | 0.015 | 0.996 | 1.0133 | 1.0174 | 0.015 | 0.974 | 0.9909 |
| 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 |

DOUBLE

| Pumped Flow | | | | | Close-seat | | Open-seat | |
|---|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | Fy' | FD= Fy+Acs*Fx | Normalized Seat | FD= -Fy+Aos*Fx | Normalized Seat |
| 0 | 1 | 0 | 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.0170 | 0.0697 | 0.1171 | 0.0358 | 0.0601 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | -0.0513 | 0.2721 | 0.4571 | 0.3747 | 0.6294 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | -0.0617 | 0.3540 | 0.5947 | 0.4774 | 0.8018 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | -0.0365 | 0.3871 | 0.6502 | 0.4602 | 0.7729 |
| 0.67 | 0.2717 | 0.777 | -0.153 | -0.0850 | 0.3889 | 0.6533 | 0.5590 | 0.9389 |
| 0.77 | 0.1630 | 0.864 | -0.172 | -0.0964 | 0.4306 | 0.7233 | 0.6234 | 1.0472 |
| 0.82 | 0.1087 | 0.931 | -0.129 | -0.0475 | 0.5204 | 0.8740 | 0.6155 | 1.0337 |
| 0.84 | 0.0870 | 1.009 | -0.165 | -0.0767 | 0.5388 | 0.9050 | 0.6922 | 1.1627 |
| 0.86 | 0.0652 | 1.021 | -0.184 | -0.0947 | 0.5281 | 0.8871 | 0.7175 | 1.2051 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | -0.0682 | 0.5555 | 0.9331 | 0.6918 | 1.1620 |
| 0.92 | 0 | 0.976 | -0.0854 | 0.0000 | 0.5953 | 1.0000 | 0.5954 | 1.0000 |

| Water | mu | A |
|---|---|---|
| CS | 0.61 | 0.61 |
| OS | 0.61 | 0.61 |

| Steam | mu | A |
|---|---|---|
| CS | 0.45 | 0.45 |
| OS | 0.45 | 0.45 |

| theta-water | |
|---|---|
| degs | rads |
| 0 | 0 |

| theta-steam | |
|---|---|
| degs | rads |
| 0 | 0 |

| Blowdown Flow | | | | | Close-seat Steam, L=10 | | | | Close-seat Steam, L=100 | | | | Close-seat Steam, L=1000 | | | | Close-seat Steam, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | Fy' | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat |
| 0 | 1 | 0 | 0 | 0 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.887 | 0.764 | 0.0000 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.0170 | 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | -0.0513 | 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | -0.0617 | 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | -0.0365 | 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 |
| 0.67 | 0.2717 | 0.777 | -0.153 | -0.0850 | 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 |
| 0.77 | 0.1630 | 0.864 | -0.172 | -0.0964 | 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 |
| 0.82 | 0.1087 | 0.931 | -0.129 | -0.0475 | 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 |
| 0.84 | 0.0870 | 1.009 | -0.165 | -0.0767 | 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 |
| 0.86 | 0.0652 | 1.021 | -0.184 | -0.0947 | 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | -0.0682 | 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 |
| 0.92 | 0 | 0.976 | -0.0854 | 0.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 |

| Close-seat FW, L=10 | | | | Close-seat FW, L=100 | | | | Close-seat FW, L=1000 | | | | Close-seat FW, L=10000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= Fy+Acs*Fx | Normalized Seat |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 | 0.867 | 0.701 | 0.0456 | 0.1039 |
| 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 | 0.867 | 0.701 | 0.1709 | 0.3891 |
| 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 | 0.867 | 0.701 | 0.2227 | 0.5070 |
| 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 | 0.867 | 0.701 | 0.2453 | 0.5586 |
| 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 | 0.867 | 0.701 | 0.2435 | 0.5545 |
| 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 | 0.948 | 0.441 | 0.3261 | 0.7424 |
| 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 | 0.930 | 0.430 | 0.3690 | 0.8402 |
| 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 | 0.922 | 0.426 | 0.3861 | 0.8791 |
| 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 | 0.915 | 0.422 | 0.3804 | 0.8662 |
| 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 | 0.943 | 0.614 | 0.3921 | 0.8928 |
| 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 |

| Open-seat | | | | Open-seat | | | | Open-seat | | | | Open-seat | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steam, L=10 | | | | Steam, L=100 | | | | Steam, L=1000 | | | | Steam, L=10000 | | | |
| Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.764 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 |
| 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 |
| 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 |
| 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 |
| 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 |
| 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 |
| 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 |
| 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 |
| 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 |
| 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 |
| 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 |

| Open-seat | | | | Open-seat | | | | Open-seat | | | | Open-seat | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FW, L=10 | | | | FW, L=100 | | | | FW, L=1000 | | | | FW, L=10000 | | | |
| Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat | Fx Factor | Fy' Factor | FD= -Fy+Aos*Fx | Normalized Seat |
| 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 | 0.867 | 0.701 | 0.0000 | 0.0000 |
| 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 | 0.867 | 0.701 | 0.0219 | 0.0498 |
| 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 | 0.867 | 0.701 | 0.2428 | 0.5529 |
| 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 | 0.867 | 0.701 | 0.3091 | 0.7038 |
| 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 | 0.867 | 0.701 | 0.2966 | 0.6752 |
| 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 | 0.867 | 0.701 | 0.3627 | 0.8259 |
| 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 | 0.948 | 0.441 | 0.4111 | 0.9360 |
| 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 | 0.930 | 0.430 | 0.4100 | 0.9334 |
| 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 | 0.922 | 0.426 | 0.4515 | 1.0280 |
| 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 | 0.915 | 0.422 | 0.4603 | 1.0481 |
| 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 | 0.943 | 0.614 | 0.4759 | 1.0835 |
| 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 | 1.000 | 1.000 | 0.4392 | 1.0000 |

DOUBLE

| Closing-Pumped Flow | | | 10 | | 20 | | 50 | | 100 | | 200 | | 500 | | 1000 | | 2000 | | 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust |
| Stroke Position | Kv | Normalized DP Thrust per unit DP | Ksys=10 | Ksys=10 | Ksys=20 | Ksys=20 | Ksys=50 | Ksys=50 | Ksys=100 | Ksys=100 | Ksys=200 | Ksys=200 | Ksys=500 | Ksys=500 | Ksys=1000 | Ksys=1000 | Ksys=2000 | Ksys=2000 | Ksys=5000 | Ksys=5000 |
| 1 | 0.56 | 0.000 | 0.0530 | 0 | 0.0272 | 0 | 0.0111 | 0 | 0.0056 | 0 | 0.0028 | 0 | 0.0011 | 0 | 0.0006 | 0 | 0.0003 | 0 | 0.0001 | 0 |
| 0.8696 | 0.66 | 0.117 | 0.0619 | 0.007 | 0.0319 | 0.004 | 0.0130 | 0.002 | 0.0066 | 0.001 | 0.0033 | 0.000 | 0.0013 | 0.000 | 0.0007 | 0.000 | 0.0003 | 3.86E-05 | 0.0001 | 1.55E-05 |
| 0.6522 | 1.22 | 0.457 | 0.1067 | 0.050 | 0.0575 | 0.026 | 0.0238 | 0.011 | 0.0121 | 0.006 | 0.0061 | 0.003 | 0.0024 | 0.001 | 0.0012 | 0.001 | 0.0006 | 0.000 | 0.0002 | 0.000 |
| 0.5435 | 2.05 | 0.595 | 0.1701 | 0.101 | 0.0930 | 0.055 | 0.0394 | 0.023 | 0.0201 | 0.012 | 0.0101 | 0.006 | 0.0041 | 0.002 | 0.0020 | 0.001 | 0.0010 | 0.001 | 0.0004 | 0.000 |
| 0.3804 | 5.03 | 0.650 | 0.3347 | 0.218 | 0.2010 | 0.131 | 0.0914 | 0.059 | 0.0479 | 0.031 | 0.0245 | 0.016 | 0.0100 | 0.006 | 0.0050 | 0.003 | 0.0025 | 0.002 | 0.0010 | 0.001 |
| 0.2717 | 11.37 | 0.653 | 0.5321 | 0.348 | 0.3624 | 0.237 | 0.1853 | 0.121 | 0.1021 | 0.067 | 0.0538 | 0.035 | 0.0222 | 0.015 | 0.0112 | 0.007 | 0.0057 | 0.004 | 0.0023 | 0.001 |
| 0.1630 | 38.65 | 0.723 | 0.7845 | 0.575 | 0.6590 | 0.477 | 0.4360 | 0.315 | 0.2788 | 0.202 | 0.1620 | 0.117 | 0.0718 | 0.052 | 0.0372 | 0.027 | 0.0190 | 0.014 | 0.0077 | 0.006 |
| 0.1087 | 99.35 | 0.874 | 0.9086 | 0.794 | 0.8324 | 0.728 | 0.6652 | 0.581 | 0.4984 | 0.436 | 0.3319 | 0.290 | 0.1656 | 0.145 | 0.0904 | 0.079 | 0.0473 | 0.041 | 0.0195 | 0.017 |
| 0.0870 | 171.83 | 0.905 | 0.9450 | 0.855 | 0.8957 | 0.811 | 0.7746 | 0.701 | 0.6321 | 0.572 | 0.4621 | 0.418 | 0.2558 | 0.231 | 0.1466 | 0.133 | 0.0791 | 0.072 | 0.0332 | 0.030 |
| 0.0652 | 369.25 | 0.887 | 0.9736 | 0.864 | 0.9496 | 0.842 | 0.8807 | 0.781 | 0.7869 | 0.698 | 0.6487 | 0.575 | 0.4248 | 0.377 | 0.2697 | 0.239 | 0.1559 | 0.138 | 0.0688 | 0.061 |
| 0.0435 | 1222.95 | 0.833 | 0.9919 | 0.826 | 0.9839 | 0.818 | 0.9607 | 0.896 | 0.9244 | 0.863 | 0.8594 | 0.802 | 0.7098 | 0.662 | 0.5501 | 0.513 | 0.3795 | 0.354 | 0.1965 | 0.183 |
| 0 | 10000000000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 |

| Opening-Pumped Flow | | | 10 | | 20 | | 50 | | 100 | | 200 | | 500 | | 1000 | | 2000 | | 5000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust | DP/DPmax | Normalized DP Thrust |
| Stroke Position | Kv | Normalized DP Thrust per unit DP | Ksys=10 | Ksys=10 | Ksys=20 | Ksys=20 | Ksys=50 | Ksys=50 | Ksys=100 | Ksys=100 | Ksys=200 | Ksys=200 | Ksys=500 | Ksys=500 | Ksys=1000 | Ksys=1000 | Ksys=2000 | Ksys=2000 | Ksys=5000 | Ksys=5000 |
| 1 | 0.56 | 0.000 | 0.0530 | 0 | 0.0272 | 0 | 0.0111 | 0 | 0.0056 | 0 | 0.0028 | 0 | 0.0011 | 0 | 0.0006 | 0 | 0.0003 | 0 | 0.0001 | 0 |
| 0.8696 | 0.66 | 0.060 | 0.0619 | 0.004 | 0.0319 | 0.002 | 0.0130 | 0.001 | 0.0066 | 0.000 | 0.0033 | 0.000 | 0.0013 | 0.000 | 0.0007 | 0.000 | 0.0003 | 1.98E-05 | 0.0001 | 7.94E-06 |
| 0.6522 | 1.22 | 0.629 | 0.1067 | 0.068 | 0.0575 | 0.036 | 0.0238 | 0.015 | 0.0121 | 0.008 | 0.0061 | 0.004 | 0.0024 | 0.002 | 0.0012 | 0.001 | 0.0006 | 0.000 | 0.0002 | 0.000 |
| 0.5435 | 2.05 | 0.802 | 0.1701 | 0.136 | 0.0930 | 0.075 | 0.0394 | 0.032 | 0.0201 | 0.016 | 0.0101 | 0.008 | 0.0041 | 0.003 | 0.0020 | 0.002 | 0.0010 | 0.001 | 0.0004 | 0.000 |
| 0.3804 | 5.03 | 0.773 | 0.3347 | 0.259 | 0.2010 | 0.155 | 0.0914 | 0.071 | 0.0479 | 0.037 | 0.0245 | 0.019 | 0.0100 | 0.008 | 0.0050 | 0.004 | 0.0025 | 0.002 | 0.0010 | 0.001 |
| 0.2717 | 11.37 | 0.939 | 0.5321 | 0.500 | 0.3624 | 0.340 | 0.1853 | 0.174 | 0.1021 | 0.096 | 0.0538 | 0.051 | 0.0222 | 0.021 | 0.0112 | 0.011 | 0.0057 | 0.005 | 0.0023 | 0.002 |
| 0.1630 | 38.65 | 1.047 | 0.7845 | 0.832 | 0.6590 | 0.690 | 0.4360 | 0.457 | 0.2788 | 0.292 | 0.1620 | 0.170 | 0.0718 | 0.075 | 0.0372 | 0.039 | 0.0190 | 0.020 | 0.0077 | 0.008 |
| 0.1087 | 99.35 | 1.034 | 0.9086 | 0.939 | 0.8324 | 0.861 | 0.6652 | 0.688 | 0.4984 | 0.515 | 0.3319 | 0.343 | 0.1656 | 0.171 | 0.0904 | 0.093 | 0.0473 | 0.049 | 0.0195 | 0.020 |
| 0.0870 | 171.83 | 1.163 | 0.9450 | 1.099 | 0.8957 | 1.041 | 0.7746 | 0.901 | 0.6321 | 0.735 | 0.4621 | 0.537 | 0.2558 | 0.297 | 0.1466 | 0.170 | 0.0791 | 0.092 | 0.0332 | 0.039 |
| 0.0652 | 369.25 | 1.205 | 0.9736 | 1.173 | 0.9496 | 1.143 | 0.8807 | 1.061 | 0.7869 | 0.948 | 0.6487 | 0.782 | 0.4248 | 0.512 | 0.2697 | 0.325 | 0.1559 | 0.188 | 0.0688 | 0.083 |
| 0.0435 | 1222.95 | 1.162 | 0.9919 | 1.153 | 0.9839 | 1.143 | 0.9607 | 1.116 | 0.9244 | 1.074 | 0.8594 | 0.999 | 0.7098 | 0.825 | 0.5501 | 0.639 | 0.3795 | 0.441 | 0.1965 | 0.228 |
| 0 | 10000000000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 | 1.0000 | 1.000 |

| Closing-Blowdown Flow | | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | Kv | | Steam L=10 | | | | Steam L=100 | | | | Steam L=1000 | | | | Steam L=10000 | | | | Fl Water L=10 | | |
| 1 | 0.56 | 0.000 | 0.042 | 0.344 | 0.000 | 0.000 | 0.056 | 0.255 | 0.000 | 0.000 | 0.110 | 0.121 | 0.000 | 0.000 | 0.366 | 0.026 | 0.000 | 0.000 | 0.015 | 0.954 | 0.000 |
| 0.8696 | 0.66 | 0.104 | 0.037 | 0.392 | 0.041 | 0.104 | 0.047 | 0.301 | 0.031 | 0.104 | 0.094 | 0.145 | 0.015 | 0.104 | 0.200 | 0.06 | 0.006 | 0.104 | 0.015 | 0.962 | 0.100 |
| 0.6522 | 1.22 | 0.389 | 0.027 | 0.531 | 0.207 | 0.389 | 0.032 | 0.447 | 0.174 | 0.389 | 0.059 | 0.24 | 0.093 | 0.389 | 0.146 | 0.088 | 0.034 | 0.389 | 0.015 | 0.977 | 0.380 |
| 0.5435 | 2.05 | 0.507 | 0.023 | 0.629 | 0.319 | 0.507 | 0.026 | 0.56 | 0.284 | 0.507 | 0.043 | 0.333 | 0.189 | 0.507 | 0.105 | 0.128 | 0.065 | 0.507 | 0.015 | 0.985 | 0.499 |
| 0.3804 | 5.03 | 0.559 | 0.020 | 0.739 | 0.413 | 0.559 | 0.021 | 0.695 | 0.388 | 0.559 | 0.030 | 0.483 | 0.270 | 0.559 | 0.069 | 0.203 | 0.113 | 0.559 | 0.015 | 0.992 | 0.554 |
| 0.2717 | 11.37 | 0.555 | 0.018 | 0.817 | 0.453 | 0.555 | 0.019 | 0.792 | 0.438 | 0.555 | 0.023 | 0.627 | 0.348 | 0.555 | 0.048 | 0.297 | 0.165 | 0.555 | 0.015 | 0.995 | 0.552 |
| 0.1630 | 38.65 | 0.742 | 0.016 | 0.901 | 0.669 | 0.742 | 0.017 | 0.891 | 0.662 | 0.742 | 0.018 | 0.81 | 0.601 | 0.742 | 0.029 | 0.498 | 0.370 | 0.742 | 0.015 | 0.997 | 0.740 |
| 0.1087 | 99.35 | 0.840 | 0.016 | 0.946 | 0.795 | 0.840 | 0.016 | 0.942 | 0.791 | 0.840 | 0.016 | 0.906 | 0.761 | 0.840 | 0.021 | 0.692 | 0.581 | 0.840 | 0.015 | 0.998 | 0.839 |
| 0.0870 | 171.83 | 0.879 | 0.015 | 0.962 | 0.846 | 0.879 | 0.015 | 0.96 | 0.844 | 0.879 | 0.016 | 0.938 | 0.825 | 0.879 | 0.019 | 0.781 | 0.687 | 0.879 | 0.015 | 0.998 | 0.877 |
| 0.0652 | 369.25 | 0.866 | 0.015 | 0.978 | 0.847 | 0.866 | 0.015 | 0.977 | 0.846 | 0.866 | 0.015 | 0.966 | 0.837 | 0.866 | 0.017 | 0.874 | 0.757 | 0.866 | 0.015 | 0.998 | 0.865 |
| 0.0435 | 1222.95 | 0.893 | 0.015 | 0.995 | 0.888 | 0.893 | 0.015 | 0.995 | 0.888 | 0.893 | 0.015 | 0.991 | 0.885 | 0.893 | 0.015 | 0.959 | 0.856 | 0.893 | 0.015 | 0.998 | 0.891 |
| 0 | 10000000000 | 1.000 | 0.015 | 1.000 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1.000 | 1.000 |

| Opening-Blowdown Flow | | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | Kv | | Steam L=10 | | | | Steam L=100 | | | | Steam L=1000 | | | | Steam L=10000 | | | | Fl Water L=10 | | |
| 1.0000 | 0.56 | 0.0000 | 0.042 | 0.344 | 0.0000 | 0.0000 | 0.056 | 0.255 | 0.0000 | 0.0000 | 0.110 | 0.121 | 0.0000 | 0.0000 | 0.366 | 0.026 | 0.0000 | 0.0000 | 0.015 | 0.954 | 0.0000 |
| 0.8696 | 0.66 | 0.0498 | 0.037 | 0.392 | 0.0195 | 0.0498 | 0.047 | 0.301 | 0.0150 | 0.0498 | 0.094 | 0.145 | 0.0072 | 0.0498 | 0.200 | 0.06 | 0.0030 | 0.0498 | 0.015 | 0.962 | 0.0479 |
| 0.6522 | 1.22 | 0.5529 | 0.027 | 0.531 | 0.2936 | 0.5529 | 0.032 | 0.447 | 0.2471 | 0.5529 | 0.059 | 0.24 | 0.1327 | 0.5529 | 0.146 | 0.088 | 0.0487 | 0.5529 | 0.015 | 0.977 | 0.5402 |
| 0.5435 | 2.05 | 0.7038 | 0.023 | 0.629 | 0.4427 | 0.7038 | 0.026 | 0.56 | 0.3941 | 0.7038 | 0.043 | 0.333 | 0.2344 | 0.7038 | 0.105 | 0.128 | 0.0901 | 0.7038 | 0.015 | 0.985 | 0.6933 |
| 0.3804 | 5.03 | 0.6752 | 0.020 | 0.739 | 0.4990 | 0.6752 | 0.021 | 0.695 | 0.4693 | 0.6752 | 0.030 | 0.483 | 0.3261 | 0.6752 | 0.069 | 0.203 | 0.1371 | 0.6752 | 0.015 | 0.992 | 0.6698 |
| 0.2717 | 11.37 | 0.8259 | 0.018 | 0.817 | 0.6748 | 0.8259 | 0.019 | 0.792 | 0.6541 | 0.8259 | 0.023 | 0.627 | 0.5178 | 0.8259 | 0.048 | 0.297 | 0.2453 | 0.8259 | 0.015 | 0.995 | 0.8218 |
| 0.1630 | 38.65 | 0.9360 | 0.016 | 0.901 | 0.8433 | 0.9360 | 0.017 | 0.891 | 0.8340 | 0.9360 | 0.018 | 0.81 | 0.7582 | 0.9360 | 0.029 | 0.498 | 0.4661 | 0.9360 | 0.015 | 0.997 | 0.9332 |
| 0.1087 | 99.35 | 0.9334 | 0.016 | 0.946 | 0.8830 | 0.9334 | 0.016 | 0.942 | 0.8792 | 0.9334 | 0.016 | 0.906 | 0.8456 | 0.9334 | 0.021 | 0.692 | 0.6459 | 0.9334 | 0.015 | 0.998 | 0.9315 |
| 0.0870 | 171.83 | 1.0280 | 0.015 | 0.962 | 0.9889 | 1.0280 | 0.015 | 0.96 | 0.9868 | 1.0280 | 0.016 | 0.938 | 0.9642 | 1.0280 | 0.019 | 0.781 | 0.8028 | 1.0280 | 0.015 | 0.998 | 1.0259 |
| 0.0652 | 369.25 | 1.0481 | 0.015 | 0.978 | 1.0251 | 1.0481 | 0.015 | 0.977 | 1.0240 | 1.0481 | 0.015 | 0.966 | 1.0125 | 1.0481 | 0.017 | 0.874 | 0.9161 | 1.0481 | 0.015 | 0.998 | 1.0460 |
| 0.0435 | 1222.95 | 1.0835 | 0.015 | 0.995 | 1.0781 | 1.0835 | 0.015 | 0.995 | 1.0781 | 1.0835 | 0.015 | 0.991 | 1.0737 | 1.0835 | 0.015 | 0.959 | 1.0391 | 1.0835 | 0.015 | 0.998 | 1.0813 |
| 0.0000 | 10000000000 | 1.0000 | 0.015 | 1.000 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1.000 | 1.0000 |

| Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fl Water L=100 | | | | Fl Water L=1000 | | | | Fl Water L=10000 | | | |
| 0.000 | 0.019 | 0.78 | 0.000 | 0.000 | 0.029 | 0.51 | 0.000 | 0.000 | 0.057 | 0.25 | 0.000 |
| 0.104 | 0.018 | 0.8 | 0.083 | 0.104 | 0.028 | 0.53 | 0.055 | 0.104 | 0.054 | 0.265 | 0.028 |
| 0.389 | 0.017 | 0.871 | 0.339 | 0.389 | 0.025 | 0.595 | 0.232 | 0.389 | 0.045 | 0.317 | 0.123 |
| 0.507 | 0.016 | 0.906 | 0.459 | 0.507 | 0.023 | 0.651 | 0.330 | 0.507 | 0.039 | 0.368 | 0.187 |
| 0.559 | 0.016 | 0.947 | 0.529 | 0.559 | 0.020 | 0.733 | 0.409 | 0.559 | 0.032 | 0.447 | 0.250 |
| 0.555 | 0.015 | 0.972 | 0.539 | 0.555 | 0.018 | 0.818 | 0.454 | 0.555 | 0.027 | 0.531 | 0.294 |
| 0.742 | 0.015 | 0.99 | 0.735 | 0.742 | 0.016 | 0.93 | 0.690 | 0.742 | 0.022 | 0.67 | 0.497 |
| 0.840 | 0.015 | 0.995 | 0.836 | 0.840 | 0.015 | 0.97 | 0.815 | 0.840 | 0.019 | 0.793 | 0.666 |
| 0.879 | 0.015 | 0.996 | 0.876 | 0.879 | 0.015 | 0.981 | 0.862 | 0.879 | 0.017 | 0.886 | 0.779 |
| 0.866 | 0.015 | 0.997 | 0.864 | 0.866 | 0.015 | 0.99 | 0.858 | 0.866 | 0.016 | 0.931 | 0.806 |
| 0.893 | 0.015 | 0.998 | 0.891 | 0.893 | 0.015 | 0.996 | 0.889 | 0.893 | 0.015 | 0.974 | 0.870 |
| 1.000 | 0.018 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 | 1.000 | 0.015 | 1 | 1.000 |

| Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust | Normalized DP Thrust per unit DP | Rp | DP/DPmax | Normalized DP Thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fl Water L=100 | | | | Fl Water L=1000 | | | | Fl Water L=10000 | | | |
| 0.0000 | 0.019 | 0.78 | 0.0000 | 0.0000 | 0.029 | 0.51 | 0.0000 | 0.0000 | 0.057 | 0.25 | 0.0000 |
| 0.0498 | 0.018 | 0.8 | 0.0398 | 0.0498 | 0.028 | 0.53 | 0.0264 | 0.0498 | 0.054 | 0.265 | 0.0132 |
| 0.5529 | 0.017 | 0.871 | 0.4816 | 0.5529 | 0.025 | 0.595 | 0.3290 | 0.5529 | 0.045 | 0.317 | 0.1753 |
| 0.7038 | 0.016 | 0.906 | 0.6377 | 0.7038 | 0.023 | 0.651 | 0.4582 | 0.7038 | 0.039 | 0.368 | 0.2590 |
| 0.6752 | 0.016 | 0.947 | 0.6395 | 0.6752 | 0.020 | 0.733 | 0.4950 | 0.6752 | 0.032 | 0.447 | 0.3018 |
| 0.8259 | 0.015 | 0.972 | 0.8028 | 0.8259 | 0.018 | 0.818 | 0.6756 | 0.8259 | 0.027 | 0.531 | 0.4388 |
| 0.9360 | 0.015 | 0.99 | 0.9266 | 0.9360 | 0.016 | 0.93 | 0.8705 | 0.9360 | 0.022 | 0.67 | 0.6271 |
| 0.9334 | 0.015 | 0.995 | 0.9287 | 0.9334 | 0.015 | 0.97 | 0.9054 | 0.9334 | 0.019 | 0.793 | 0.7402 |
| 1.0280 | 0.015 | 0.996 | 1.0239 | 1.0280 | 0.015 | 0.981 | 1.0084 | 1.0280 | 0.017 | 0.886 | 0.9108 |
| 1.0481 | 0.015 | 0.997 | 1.0450 | 1.0481 | 0.015 | 0.99 | 1.0376 | 1.0481 | 0.016 | 0.931 | 0.9758 |
| 1.0835 | 0.015 | 0.998 | 1.0813 | 1.0835 | 0.015 | 0.996 | 1.0791 | 1.0835 | 0.015 | 0.974 | 1.0553 |
| 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 | 1.0000 | 0.015 | 1 | 1.0000 |

GLOBE

| diameter (in) | | 4 | 100 | | 1000 | | 5000 | | 10000 | | 50000 | | 100000 | | 500000 | | 1000000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Globe Valve - Opening/Closing | | | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust | DP Thrust | Normalized DP Thrust |
| Stroke Position | Cv | Kv | Ksys=100 | | Ksys=1000 | | Ksys=5000 | | Ksys=10000 | | Ksys=50000 | | Ksys=100000 | | Ksys=500000 | | Ksys=1000000 | |
| 1 | 16 | 894.01 | 0.8994 | 0.8994 | 0.4720 | 0.4720 | 0.1517 | 0.1517 | 0.0821 | 0.0821 | 0.0176 | 0.0176 | 0.0089 | 0.0089 | 0.0018 | 0.0018 | 0.0009 | 0.0009 |
| 0.95 | 15.2 | 990.59 | 0.9083 | 0.9083 | 0.4976 | 0.4976 | 0.1654 | 0.1654 | 0.0901 | 0.0901 | 0.0194 | 0.0194 | 0.0098 | 0.0098 | 0.0020 | 0.0020 | 0.0010 | 0.0010 |
| 0.9 | 14.4 | 1103.72 | 0.9169 | 0.9169 | 0.5247 | 0.5247 | 0.1808 | 0.1808 | 0.0994 | 0.0994 | 0.0216 | 0.0216 | 0.0109 | 0.0109 | 0.0022 | 0.0022 | 0.0011 | 0.0011 |
| 0.85 | 13.6 | 1237.38 | 0.9252 | 0.9252 | 0.5530 | 0.5530 | 0.1984 | 0.1984 | 0.1101 | 0.1101 | 0.0242 | 0.0242 | 0.0122 | 0.0122 | 0.0025 | 0.0025 | 0.0012 | 0.0012 |
| 0.8 | 12.8 | 1396.89 | 0.9332 | 0.9332 | 0.5828 | 0.5828 | 0.2184 | 0.2184 | 0.1226 | 0.1226 | 0.0272 | 0.0272 | 0.0138 | 0.0138 | 0.0028 | 0.0028 | 0.0014 | 0.0014 |
| 0.75 | 12 | 1589.35 | 0.9408 | 0.9408 | 0.6138 | 0.6138 | 0.2412 | 0.2412 | 0.1371 | 0.1371 | 0.0308 | 0.0308 | 0.0156 | 0.0156 | 0.0032 | 0.0032 | 0.0016 | 0.0016 |
| 0.7 | 11.2 | 1824.51 | 0.9480 | 0.9480 | 0.6460 | 0.6460 | 0.2673 | 0.2673 | 0.1543 | 0.1543 | 0.0352 | 0.0352 | 0.0179 | 0.0179 | 0.0036 | 0.0036 | 0.0018 | 0.0018 |
| 0.65 | 10.4 | 2116.00 | 0.9549 | 0.9549 | 0.6791 | 0.6791 | 0.2974 | 0.2974 | 0.1746 | 0.1746 | 0.0406 | 0.0406 | 0.0207 | 0.0207 | 0.0042 | 0.0042 | 0.0021 | 0.0021 |
| 0.6 | 9.6 | 2483.36 | 0.9613 | 0.9613 | 0.7129 | 0.7129 | 0.3319 | 0.3319 | 0.1989 | 0.1989 | 0.0473 | 0.0473 | 0.0242 | 0.0242 | 0.0049 | 0.0049 | 0.0025 | 0.0025 |
| 0.55 | 8.8 | 2955.40 | 0.9673 | 0.9673 | 0.7472 | 0.7472 | 0.3715 | 0.3715 | 0.2281 | 0.2281 | 0.0558 | 0.0558 | 0.0287 | 0.0287 | 0.0059 | 0.0059 | 0.0029 | 0.0029 |
| 0.5 | 8 | 3576.04 | 0.9728 | 0.9728 | 0.7815 | 0.7815 | 0.4170 | 0.4170 | 0.2634 | 0.2634 | 0.0667 | 0.0667 | 0.0345 | 0.0345 | 0.0071 | 0.0071 | 0.0036 | 0.0036 |
| 0.45 | 7.2 | 4414.86 | 0.9779 | 0.9779 | 0.8153 | 0.8153 | 0.4689 | 0.4689 | 0.3063 | 0.3063 | 0.0811 | 0.0811 | 0.0423 | 0.0423 | 0.0088 | 0.0088 | 0.0044 | 0.0044 |
| 0.4 | 6.4 | 5587.56 | 0.9824 | 0.9824 | 0.8482 | 0.8482 | 0.5277 | 0.5277 | 0.3585 | 0.3585 | 0.1005 | 0.1005 | 0.0529 | 0.0529 | 0.0111 | 0.0111 | 0.0056 | 0.0056 |
| 0.35 | 5.6 | 7296.04 | 0.9865 | 0.9865 | 0.8795 | 0.8795 | 0.5934 | 0.5934 | 0.4219 | 0.4219 | 0.1274 | 0.1274 | 0.0680 | 0.0680 | 0.0144 | 0.0144 | 0.0072 | 0.0072 |
| 0.3 | 4.8 | 9933.44 | 0.9900 | 0.9900 | 0.9085 | 0.9085 | 0.6652 | 0.6652 | 0.4983 | 0.4983 | 0.1657 | 0.1657 | 0.0904 | 0.0904 | 0.0195 | 0.0195 | 0.0098 | 0.0098 |
| 0.25 | 4 | 14304.16 | 0.9931 | 0.9931 | 0.9347 | 0.9347 | 0.7410 | 0.7410 | 0.5885 | 0.5885 | 0.2224 | 0.2224 | 0.1251 | 0.1251 | 0.0278 | 0.0278 | 0.0141 | 0.0141 |
| 0.2 | 3.2 | 22350.25 | 0.9955 | 0.9955 | 0.9572 | 0.9572 | 0.8172 | 0.8172 | 0.6909 | 0.6909 | 0.3089 | 0.3089 | 0.1827 | 0.1827 | 0.0428 | 0.0428 | 0.0219 | 0.0219 |
| 0.15 | 2.4 | 39733.78 | 0.9975 | 0.9975 | 0.9755 | 0.9755 | 0.8882 | 0.8882 | 0.7989 | 0.7989 | 0.4428 | 0.4428 | 0.2844 | 0.2844 | 0.0736 | 0.0736 | 0.0382 | 0.0382 |
| 0.1 | 1.6 | 89401.00 | 0.9989 | 0.9989 | 0.9889 | 0.9889 | 0.9470 | 0.9470 | 0.8994 | 0.8994 | 0.6413 | 0.6413 | 0.4720 | 0.4720 | 0.1517 | 0.1517 | 0.0821 | 0.0821 |
| 0.05 | 0.8 | 357604.00 | 0.9997 | 0.9997 | 0.9972 | 0.9972 | 0.9862 | 0.9862 | 0.9728 | 0.9728 | 0.8773 | 0.8773 | 0.7815 | 0.7815 | 0.4170 | 0.4170 | 0.2634 | 0.2634 |
| 0 | 0 | 10000000000.00 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9999 | 1.0000 |

| Factors to Convert Incompressible to Compressible | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Fx | | | | | | |
| | Gatm | Rp | Rp | Rp | Rp | Rp |
| Stroke | Stroke | 0 | 0.266 | 0.666 | 0.866 | 1 |
| 0 | 1 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.12 | 0.8696 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.32 | 0.6522 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.42 | 0.5435 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.57 | 0.3804 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.67 | 0.2717 | 0.867 | 0.867 | 0.949 | 0.947 | 1.000 |
| 0.77 | 0.1630 | 0.948 | 0.948 | 0.978 | 0.992 | 1.000 |
| 0.82 | 0.1087 | 0.930 | 0.930 | 0.949 | 0.969 | 1.000 |
| 0.84 | 0.0870 | 0.922 | 0.922 | 0.937 | 0.960 | 1.000 |
| 0.86 | 0.0652 | 0.915 | 0.915 | 0.925 | 0.951 | 1.000 |
| 0.88 | 0.0435 | 0.943 | 0.943 | 0.950 | 0.967 | 1.000 |
| 0.92 | 0 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| | | | | | | |
| Fy | | | | | | |
| | Gatm | Rp | Rp | Rp | Rp | Rp |
| Stroke | Stroke | 0 | 0.266 | 0.666 | 0.866 | 1 |
| 0 | 1 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.12 | 0.8696 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.32 | 0.6522 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.42 | 0.5435 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.57 | 0.3804 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.67 | 0.2717 | 0.701 | 0.701 | 0.954 | 0.914 | 1.000 |
| 0.77 | 0.1630 | 0.441 | 0.441 | 0.532 | 0.578 | 1.000 |
| 0.82 | 0.1087 | 0.430 | 0.430 | 0.570 | 0.814 | 1.000 |
| 0.84 | 0.0870 | 0.426 | 0.426 | 0.586 | 0.908 | 1.000 |
| 0.86 | 0.0652 | 0.422 | 0.422 | 0.601 | 1.003 | 1.000 |
| 0.88 | 0.0435 | 0.614 | 0.614 | 0.734 | 1.002 | 1.000 |
| 0.92 | 0 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

**APPENDIX B**

Valve Data Table Compiled from Reference (6)

| Valve | % Past Flow Isolation | Valve Size |
|---|---|---|
| 01 | 12% | 3" |
| 02 | 8% | 6" |
| 03 | 9% | 6" |
| 04 | 7% | 10" |
| 05 | 10% | 10" |
| 06 | 4% | 18" |
| 07 | 12% | 3" |
| 08 | 7% | 6" |
| 09 | 7% | 6" |
| 10 | 4% | 12" |
| 13 | 14% | 2.5" |
| 14 | 9% | 6" |
| 16 | 16% | 3" |
| 17 | 5% | 10" |
| 18 | 2% | 4" |
| 23 | 8% | 6" |
| 24 | 8% | 6" |
| 25 | 6% | 10" |
| 29 | 6% | 6" |
| 30 | 7% | 6" |
| 31 | 5% | 12" |
| 61 | 8% | 14" |

**APPENDIX C**

PPM Runs (8)

# INSTALLATION VERIFICATION

Installation of the EPRI MOV Performance Prediction Methodology computer program (PPM), Version 1.0, was verified in MPR Calculation No. 002-0170-TW2, Revision 0.

The PPM was executed for this task on a Dell Dimension P75 computer, Serial No. 4YPCC, using the MS-DOS operating system, Version 6.22.

**SUMMARY INFORMATION**

Date Prediction Performed: 07/23/98 Time: 13:27:07

Files Used:

c:\ppmtasks\cpl\10stcl.mov
c:\ppmtasks\cpl\10stcl.sys

4/13/99

4/14/99

File Descriptions:

SYS: 10-Closing-Steam

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 10 Pipe Diameters Upstream - Steam

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY
(2) MULTIPLE CHOKING OCCURED

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 10-Closing-Steam

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = steam

FLUID CONDITIONS
Supply Tank Temperature = 575.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 5 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 1525219 | 344 |
| 99.0 | 1524873 | 344 |
| 98.0 | 1523301 | 345 |
| 97.0 | 1520503 | 346 |
| 96.0 | 1517011 | 348 |
| 95.0 | 1512207 | 351 |
| 94.0 | 1506407 | 354 |
| 93.0 | 1499926 | 357 |
| 92.0 | 1492272 | 361 |
| 91.0 | 1484146 | 365 |
| 90.0 | 1474850 | 370 |
| 89.0 | 1465038 | 375 |
| 88.0 | 1454709 | 381 |
| 87.0 | 1443635 | 386 |
| 86.0 | 1432508 | 392 |
| 85.0 | 1420644 | 398 |
| 84.0 | 1408650 | 404 |
| 83.0 | 1396943 | 410 |
| 82.0 | 1384759 | 416 |
| 81.0 | 1372854 | 422 |
| 80.0 | 1360941 | 427 |
| 79.0 | 1349021 | 433 |
| 78.0 | 1337547 | 439 |
| 77.0 | 1325774 | 444 |
| 76.0 | 1314162 | 450 |
| 75.0 | 1301954 | 456 |
| 74.0 | 1289616 | 462 |
| 73.0 | 1276403 | 468 |
| 72.0 | 1262316 | 475 |
| 71.0 | 1247981 | 482 |

**FILE:** c:\ppmtasks\cpl\10stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:27:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 1232348 | 489 |
| 69.0 | 1215698 | 497 |
| 68.0 | 1198031 | 505 |
| 67.0 | 1179717 | 514 |
| 66.0 | 1160477 | 522 |
| 65.0 | 1140745 | 531 |
| 64.0 | 1120521 | 541 |
| 63.0 | 1100323 | 550 |
| 62.0 | 1079890 | 559 |
| 61.0 | 1059526 | 568 |
| 60.0 | 1039231 | 577 |
| 59.0 | 1019468 | 586 |
| 58.0 | 999555 | 595 |
| 57.0 | 980074 | 604 |
| 56.0 | 961025 | 612 |
| 55.0 | 942408 | 620 |
| 54.0 | 924012 | 629 |
| 53.0 | 906233 | 636 |
| 52.0 | 889072 | 644 |
| 51.0 | 872343 | 651 |
| 50.0 | 856723 | 658 |
| 49.0 | 841965 | 664 |
| 48.0 | 827722 | 670 |
| 47.0 | 813791 | 677 |
| 46.0 | 799875 | 682 |
| 45.0 | 785673 | 689 |
| 44.0 | 770462 | 695 |
| 43.0 | 754852 | 702 |
| 42.0 | 738164 | 709 |
| 41.0 | 721379 | 716 |
| 40.0 | 703870 | 724 |
| 39.0 | 686616 | 731 |
| 38.0 | 668942 | 739 |

**FILE:** c:\ppmtasks\cpl\10stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:27:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 651482 | 746 |
| 36.0 | 633690 | 754 |
| 35.0 | 616012 | 761 |
| 34.0 | 598449 | 769 |
| 33.0 | 581001 | 776 |
| 32.0 | 563666 | 783 |
| 31.0 | 546947 | 790 |
| 30.0 | 530842 | 797 |
| 29.0 | 515017 | 804 |
| 28.0 | 499118 | 810 |
| 27.0 | 482817 | 817 |
| 26.0 | 465920 | 824 |
| 25.0 | 448426 | 832 |
| 24.0 | 430005 | 839 |
| 23.0 | 411080 | 847 |
| 22.0 | 392182 | 855 |
| 21.0 | 373311 | 863 |
| 20.0 | 355097 | 870 |
| 19.0 | 337257 | 878 |
| 18.0 | 318943 | 885 |
| 17.0 | 299886 | 893 |
| 16.0 | 280489 | 901 |
| 15.0 | 261343 | 909 |
| 14.0 | 242448 | 917 |
| 13.0 | 224447 | 924 |
| 12.0 | 206752 | 931 |
| 11.0 | 189762 | 938 |
| 10.0 | 171371 | 946 |
| 9.0 | 150668 | 954 |
| 8.0 | 130823 | 962 |
| 7.0 | 109521 | 971 |
| 6.0 | 90902 | 978 |

**FILE:** c:\ppmtasks\cpl\10stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Steam

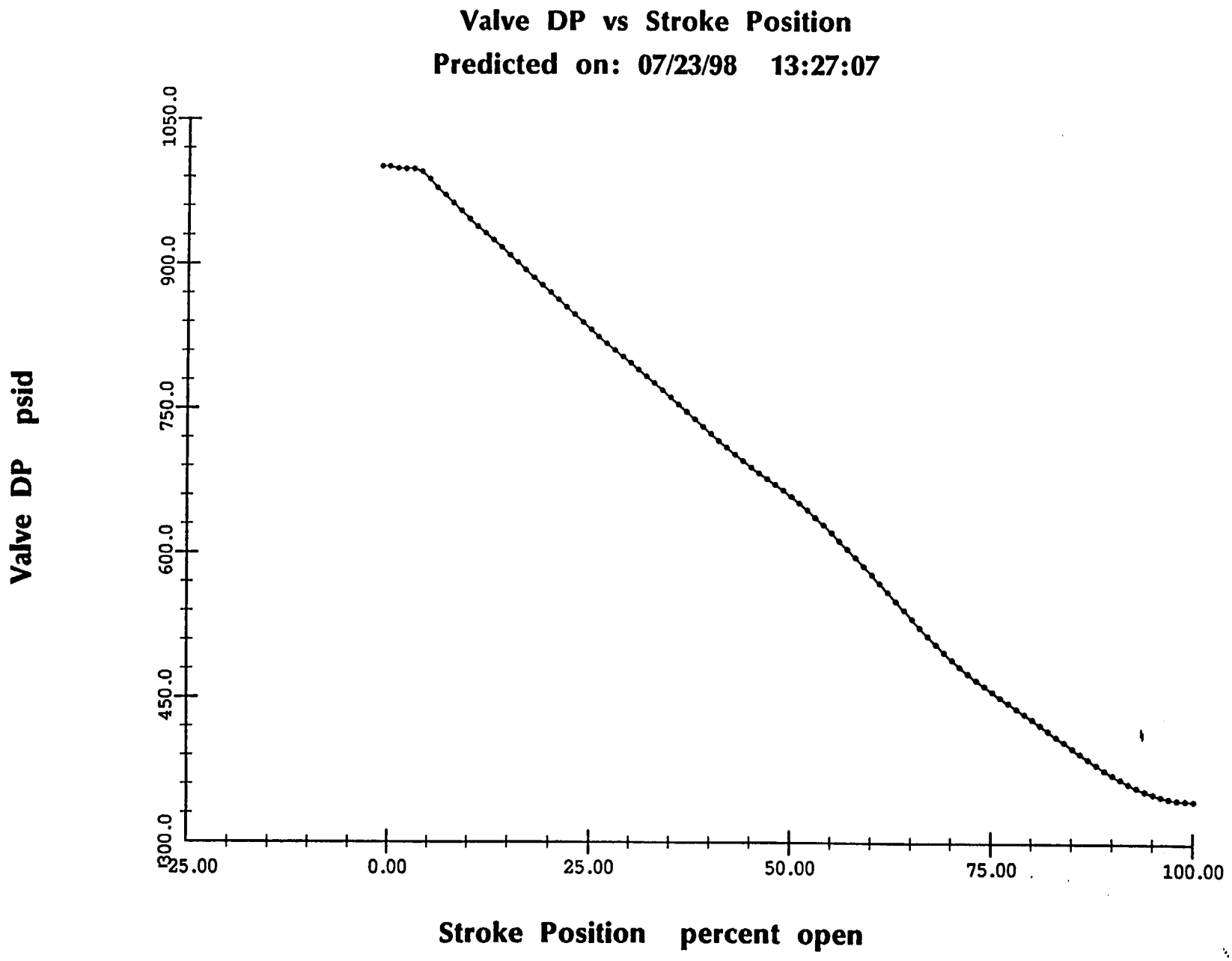
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:27:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 68726 | 987 |
| 4.0 | 49550 | 995 |
| 3.0 | 33372 | 998 |
| 2.0 | 20193 | 998 |
| 1.0 | 9056 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\10stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:27:07 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\10stcl.mov: Closing Stroke - 10 Pipe Diameters

**SUMMARY INFORMATION**

Date Prediction Performed: 07/23/98 Time: 13:39:33

Files Used:

c:\ppmtasks\cpl\100stcl.mov
c:\ppmtasks\cpl\100stcl.sys

4/13/99
4/14/99

File Descriptions:

SYS: 100-Closing-Steam

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 100 Pipe Diameters Upstream - Steam

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY
(2) MULTIPLE CHOKING OCCURED

**FILE:** c:\ppmtasks\cpl\100stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:39:33 **PPM VERSION:** 1.0

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 100-Closing-Steam

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = steam

FLUID CONDITIONS
Supply Tank Temperature = 575.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 50 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 1131431 | 255 |
| 99.0 | 1131179 | 256 |
| 98.0 | 1130820 | 256 |
| 97.0 | 1129602 | 258 |
| 96.0 | 1128104 | 260 |
| 95.0 | 1126651 | 262 |
| 94.0 | 1124615 | 264 |
| 93.0 | 1122234 | 268 |
| 92.0 | 1119507 | 271 |
| 91.0 | 1116523 | 275 |
| 90.0 | 1113082 | 280 |
| 89.0 | 1109721 | 284 |
| 88.0 | 1105660 | 290 |
| 87.0 | 1101376 | 295 |
| 86.0 | 1096867 | 301 |
| 85.0 | 1092136 | 307 |
| 84.0 | 1087612 | 312 |
| 83.0 | 1082603 | 318 |
| 82.0 | 1077502 | 324 |
| 81.0 | 1072510 | 330 |
| 80.0 | 1067380 | 336 |
| 79.0 | 1062349 | 342 |
| 78.0 | 1057145 | 347 |
| 77.0 | 1052006 | 353 |
| 76.0 | 1046651 | 359 |
| 75.0 | 1041080 | 365 |
| 74.0 | 1035295 | 371 |
| 73.0 | 1028868 | 378 |
| 72.0 | 1022191 | 385 |
| 71.0 | 1015005 | 392 |

**FILE:** c:\ppmtasks\cpl\100stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:39:33 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 1007310 | 400 |
| 69.0 | 998777 | 408 |
| 68.0 | 989465 | 418 |
| 67.0 | 979761 | 427 |
| 66.0 | 969429 | 437 |
| 65.0 | 958579 | 447 |
| 64.0 | 947212 | 457 |
| 63.0 | 935380 | 468 |
| 62.0 | 923322 | 478 |
| 61.0 | 911036 | 489 |
| 60.0 | 898524 | 500 |
| 59.0 | 886184 | 510 |
| 58.0 | 873543 | 520 |
| 57.0 | 860878 | 531 |
| 56.0 | 848188 | 541 |
| 55.0 | 835472 | 550 |
| 54.0 | 823031 | 560 |
| 53.0 | 810615 | 570 |
| 52.0 | 798585 | 579 |
| 51.0 | 786750 | 587 |
| 50.0 | 775465 | 596 |
| 49.0 | 764513 | 604 |
| 48.0 | 754080 | 611 |
| 47.0 | 743537 | 619 |
| 46.0 | 733072 | 626 |
| 45.0 | 722332 | 633 |
| 44.0 | 710650 | 641 |
| 43.0 | 698430 | 650 |
| 42.0 | 685359 | 658 |
| 41.0 | 671794 | 668 |
| 40.0 | 658032 | 677 |
| 39.0 | 643782 | 686 |
| 38.0 | 629287 | 695 |

**FILE:** c:\ppmtasks\cpl\100stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:39:33 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 614548 | 704 |
| 36.0 | 599807 | 713 |
| 35.0 | 584869 | 723 |
| 34.0 | 569735 | 732 |
| 33.0 | 554653 | 741 |
| 32.0 | 539623 | 750 |
| 31.0 | 525016 | 759 |
| 30.0 | 510832 | 767 |
| 29.0 | 496495 | 775 |
| 28.0 | 482241 | 783 |
| 27.0 | 467705 | 792 |
| 26.0 | 452234 | 800 |
| 25.0 | 436217 | 809 |
| 24.0 | 419048 | 818 |
| 23.0 | 401782 | 828 |
| 22.0 | 384120 | 837 |
| 21.0 | 366495 | 846 |
| 20.0 | 348904 | 855 |
| 19.0 | 332007 | 864 |
| 18.0 | 314429 | 873 |
| 17.0 | 296168 | 882 |
| 16.0 | 277451 | 891 |
| 15.0 | 258848 | 901 |
| 14.0 | 240728 | 909 |
| 13.0 | 222838 | 918 |
| 12.0 | 205581 | 926 |
| 11.0 | 188957 | 933 |
| 10.0 | 170688 | 942 |
| 9.0 | 150123 | 951 |
| 8.0 | 130511 | 960 |
| 7.0 | 109380 | 969 |
| 6.0 | 90807 | 977 |

**FILE:** c:\ppmtasks\cpl\100stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:39:33 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 68681 | 987 |
| 4.0 | 49535 | 995 |
| 3.0 | 33370 | 998 |
| 2.0 | 20185 | 998 |
| 1.0 | 9048 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

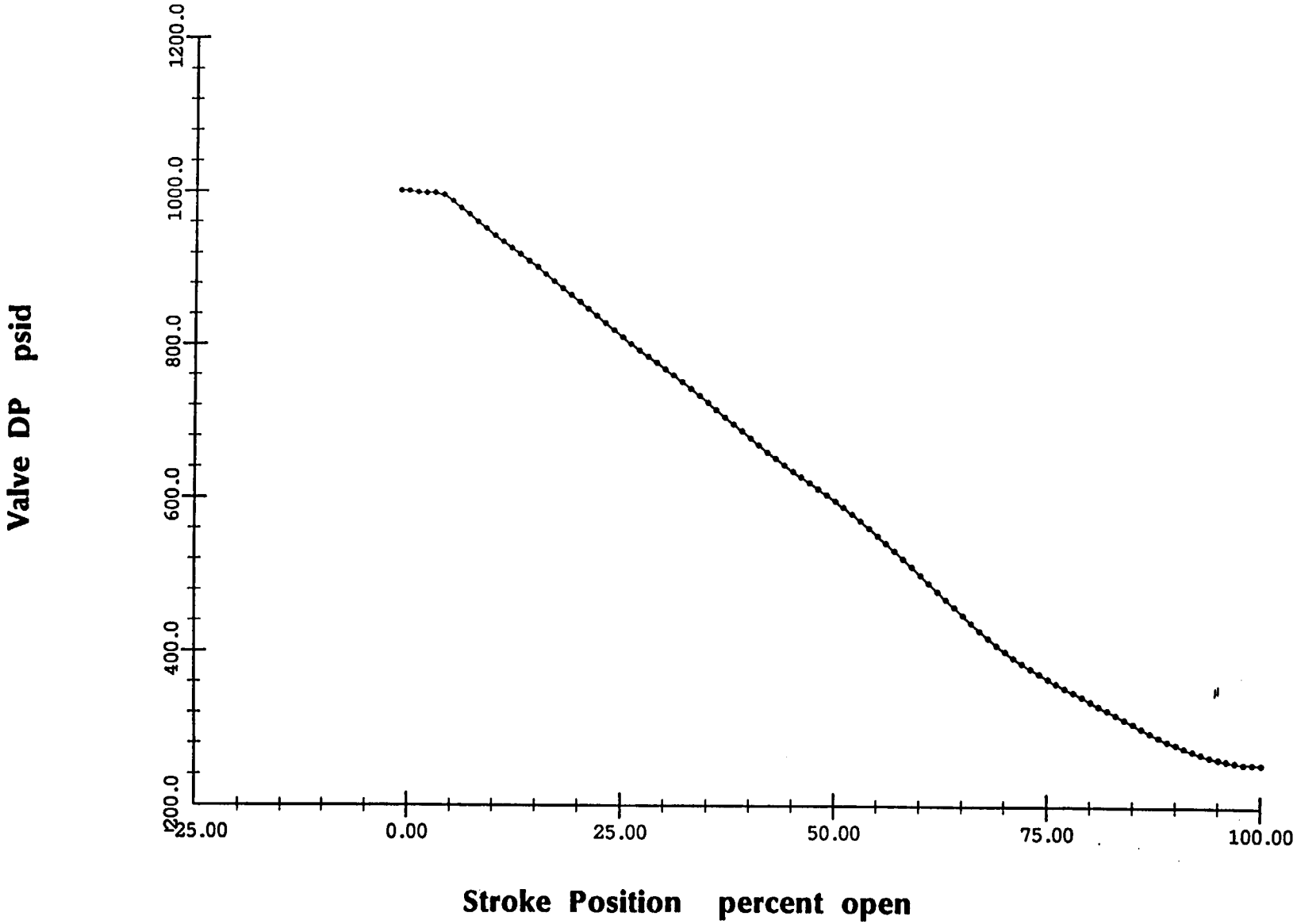
**FILE:** c:\ppmtasks\cpl\100stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 13:39:33 **PPM VERSION:** 1.0

## Valve DP vs Stroke Position

**Predicted on: 07/23/98 13:39:33**




c:\ppmtasks\cpl\100stcl.mov: Closing Stroke - 100 Pipe Diameter:

## SUMMARY INFORMATION

Date Prediction Performed: 07/23/98 Time: 14:12:59

Files Used:

c:\ppmtasks\cpl\1000stcl.mov
c:\ppmtasks\cpl\1000stcl.sys

4/13/99
4/14/99

File Descriptions:

SYS: 1000-Closing-Steam

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 1000 Pipe Diameters Upstream - Steam

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY
(2) MULTIPLE CHOKING OCCURED

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 1000-Closing-Steam

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = steam

FLUID CONDITIONS
Supply Tank Temperature = 575.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 500 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 535957 | 121 |
| 99.0 | 535769 | 122 |
| 98.0 | 535769 | 122 |
| 97.0 | 535750 | 122 |
| 96.0 | 535427 | 124 |
| 95.0 | 535465 | 124 |
| 94.0 | 535024 | 127 |
| 93.0 | 535016 | 127 |
| 92.0 | 534628 | 129 |
| 91.0 | 534102 | 133 |
| 90.0 | 533694 | 135 |
| 89.0 | 533125 | 139 |
| 88.0 | 533033 | 139 |
| 87.0 | 532564 | 142 |
| 86.0 | 532075 | 145 |
| 85.0 | 531282 | 150 |
| 84.0 | 530882 | 152 |
| 83.0 | 530135 | 156 |
| 82.0 | 529529 | 160 |
| 81.0 | 528716 | 164 |
| 80.0 | 528557 | 165 |
| 79.0 | 527646 | 170 |
| 78.0 | 526995 | 174 |
| 77.0 | 526337 | 177 |
| 76.0 | 525464 | 182 |
| 75.0 | 524777 | 185 |
| 74.0 | 524014 | 189 |
| 73.0 | 523138 | 194 |
| 72.0 | 522258 | 198 |
| 71.0 | 521258 | 203 |

**FILE:** c:\ppmtasks\cpl\1000stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:12:59 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 520335 | 207 |
| 69.0 | 519154 | 213 |
| 68.0 | 517825 | 219 |
| 67.0 | 516348 | 226 |
| 66.0 | 514655 | 233 |
| 65.0 | 513169 | 240 |
| 64.0 | 511209 | 248 |
| 63.0 | 509281 | 256 |
| 62.0 | 507387 | 264 |
| 61.0 | 505254 | 272 |
| 60.0 | 503346 | 280 |
| 59.0 | 500993 | 289 |
| 58.0 | 498706 | 297 |
| 57.0 | 496102 | 307 |
| 56.0 | 493629 | 315 |
| 55.0 | 491059 | 325 |
| 54.0 | 488498 | 333 |
| 53.0 | 485685 | 343 |
| 52.0 | 483239 | 351 |
| 51.0 | 480560 | 360 |
| 50.0 | 477894 | 368 |
| 49.0 | 475144 | 377 |
| 48.0 | 472578 | 384 |
| 47.0 | 469991 | 392 |
| 46.0 | 467384 | 400 |
| 45.0 | 464563 | 408 |
| 44.0 | 461237 | 418 |
| 43.0 | 457773 | 427 |
| 42.0 | 454172 | 437 |
| 41.0 | 450203 | 448 |
| 40.0 | 445866 | 459 |
| 39.0 | 441477 | 471 |
| 38.0 | 436740 | 483 |

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 431654 | 495 |
| 36.0 | 426433 | 508 |
| 35.0 | 420753 | 521 |
| 34.0 | 415267 | 534 |
| 33.0 | 409045 | 548 |
| 32.0 | 402970 | 561 |
| 31.0 | 396670 | 574 |
| 30.0 | 390429 | 587 |
| 29.0 | 383903 | 600 |
| 28.0 | 377333 | 613 |
| 27.0 | 370044 | 627 |
| 26.0 | 362257 | 642 |
| 25.0 | 353767 | 657 |
| 24.0 | 344576 | 673 |
| 23.0 | 334682 | 690 |
| 22.0 | 324087 | 707 |
| 21.0 | 313392 | 724 |
| 20.0 | 302311 | 741 |
| 19.0 | 290844 | 758 |
| 18.0 | 278991 | 775 |
| 17.0 | 265836 | 793 |
| 16.0 | 252183 | 810 |
| 15.0 | 238034 | 828 |
| 14.0 | 223388 | 845 |
| 13.0 | 209125 | 861 |
| 12.0 | 194534 | 876 |
| 11.0 | 180263 | 891 |
| 10.0 | 164182 | 906 |
| 9.0 | 145621 | 923 |
| 8.0 | 127657 | 938 |
| 7.0 | 107603 | 953 |
| 6.0 | 89765 | 966 |

**FILE:** c:\ppmtasks\cpl\1000stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Steam

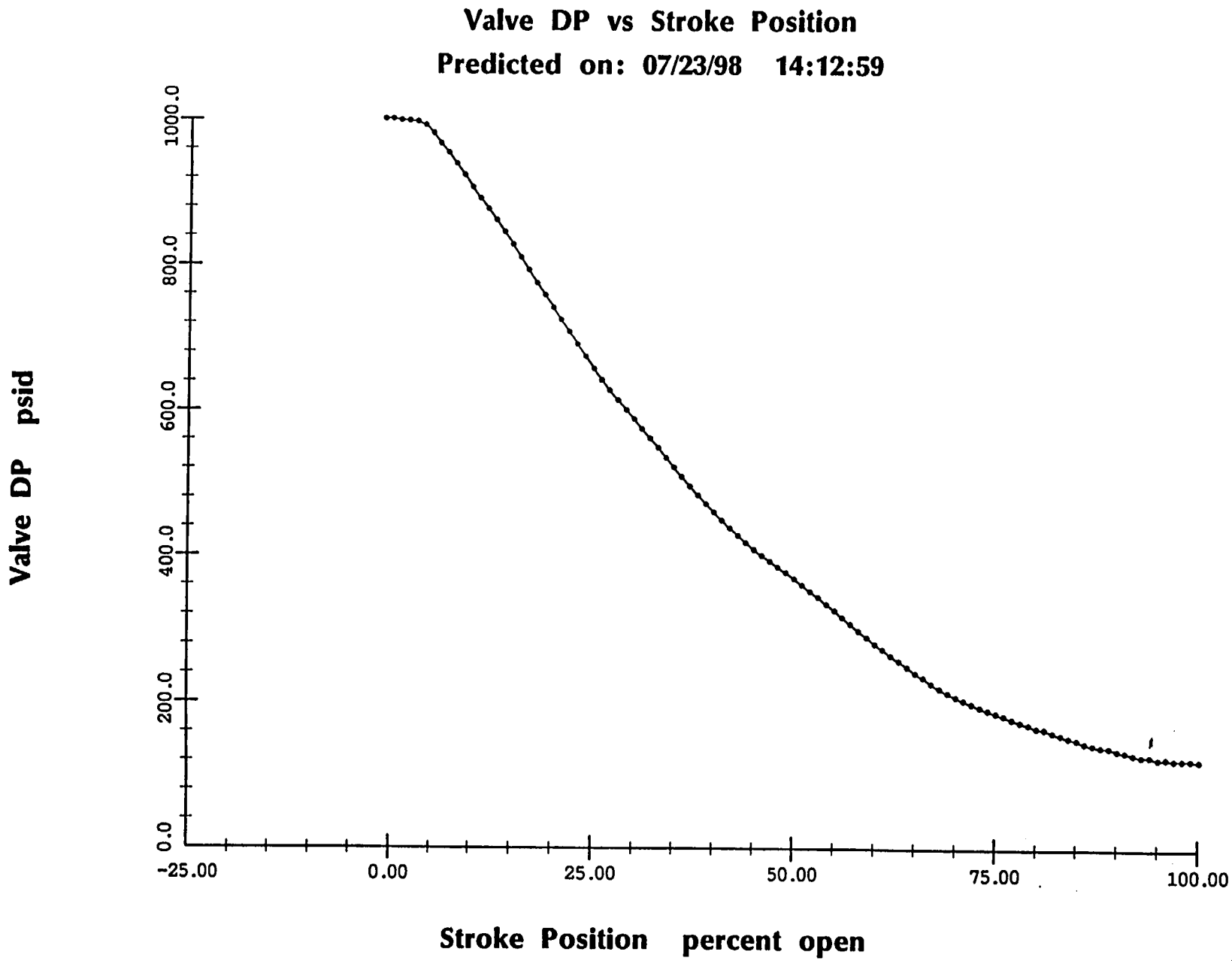
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:12:59 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 68218 | 980 |
| 4.0 | 49369 | 991 |
| 3.0 | 33217 | 996 |
| 2.0 | 20283 | 997 |
| 1.0 | 8964 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\1000stcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:12:59 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\1000stcl.mov: Closing Stroke - 1000 Pipe Diamete

## SUMMARY INFORMATION

Date Prediction Performed: 07/23/98 Time: 14:30:52

Files Used:

c:\ppmtasks\cpl\10000scl.mov
c:\ppmtasks\cpl\10000scl.sys

4/13/99

4/14/99

File Descriptions:

SYS: 10000-Closing-Steam

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 10000 Pipe Diameters Upstream - Steam

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY
(2) MULTIPLE CHOKING OCCURED

**FILE:** c:\ppmtasks\cpl\10000scl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:30:52 **PPM VERSION:** 1.0

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 10000-Closing-Steam

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = steam

FLUID CONDITIONS
Supply Tank Temperature = 575.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 5000 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 188045 | 26 |
| 99.0 | 188031 | 26 |
| 98.0 | 188178 | 32 |
| 97.0 | 188192 | 44 |
| 96.0 | 188039 | 27 |
| 95.0 | 188149 | 33 |
| 94.0 | 187999 | 27 |
| 93.0 | 188170 | 41 |
| 92.0 | 188108 | 34 |
| 91.0 | 188130 | 40 |
| 90.0 | 187990 | 52 |
| 89.0 | 188310 | 39 |
| 88.0 | 188068 | 49 |
| 87.0 | 188291 | 40 |
| 86.0 | 187766 | 60 |
| 85.0 | 187746 | 61 |
| 84.0 | 187968 | 53 |
| 83.0 | 187641 | 65 |
| 82.0 | 187598 | 66 |
| 81.0 | 187567 | 67 |
| 80.0 | 187618 | 65 |
| 79.0 | 187752 | 61 |
| 78.0 | 187776 | 60 |
| 77.0 | 187361 | 74 |
| 76.0 | 187568 | 67 |
| 75.0 | 187526 | 68 |
| 74.0 | 187472 | 70 |
| 73.0 | 187373 | 73 |
| 72.0 | 187369 | 73 |
| 71.0 | 187274 | 76 |

**FILE:** c:\ppmtasks\cpl\10000scl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:30:52 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 187269 | 77 |
| 69.0 | 187099 | 82 |
| 68.0 | 187306 | 75 |
| 67.0 | 187216 | 78 |
| 66.0 | 187149 | 80 |
| 65.0 | 186880 | 88 |
| 64.0 | 187033 | 84 |
| 63.0 | 186668 | 94 |
| 62.0 | 186301 | 103 |
| 61.0 | 186160 | 107 |
| 60.0 | 186082 | 109 |
| 59.0 | 186052 | 110 |
| 58.0 | 185806 | 116 |
| 57.0 | 185705 | 118 |
| 56.0 | 185495 | 123 |
| 55.0 | 185421 | 125 |
| 54.0 | 185273 | 128 |
| 53.0 | 185087 | 132 |
| 52.0 | 184901 | 136 |
| 51.0 | 184728 | 140 |
| 50.0 | 184744 | 140 |
| 49.0 | 184645 | 142 |
| 48.0 | 184223 | 150 |
| 47.0 | 184305 | 149 |
| 46.0 | 184090 | 153 |
| 45.0 | 183962 | 156 |
| 44.0 | 183423 | 166 |
| 43.0 | 182924 | 176 |
| 42.0 | 182782 | 178 |
| 41.0 | 182382 | 185 |
| 40.0 | 182262 | 188 |
| 39.0 | 181609 | 199 |
| 38.0 | 181383 | 203 |

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 180965 | 209 |
| 36.0 | 180658 | 214 |
| 35.0 | 180215 | 221 |
| 34.0 | 179392 | 234 |
| 33.0 | 179230 | 237 |
| 32.0 | 178641 | 245 |
| 31.0 | 177920 | 256 |
| 30.0 | 177292 | 264 |
| 29.0 | 176408 | 276 |
| 28.0 | 175548 | 288 |
| 27.0 | 174851 | 297 |
| 26.0 | 173958 | 308 |
| 25.0 | 172634 | 324 |
| 24.0 | 171653 | 335 |
| 23.0 | 170260 | 351 |
| 22.0 | 168806 | 367 |
| 21.0 | 167055 | 385 |
| 20.0 | 165007 | 406 |
| 19.0 | 162930 | 426 |
| 18.0 | 160593 | 447 |
| 17.0 | 157816 | 471 |
| 16.0 | 154599 | 498 |
| 15.0 | 151032 | 526 |
| 14.0 | 146814 | 557 |
| 13.0 | 142322 | 588 |
| 12.0 | 137363 | 620 |
| 11.0 | 131936 | 653 |
| 10.0 | 125093 | 692 |
| 9.0 | 116212 | 737 |
| 8.0 | 106345 | 781 |
| 7.0 | 93766 | 831 |
| 6.0 | 81202 | 874 |

**FILE:** c:\ppmtasks\cpl\10000scl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Steam

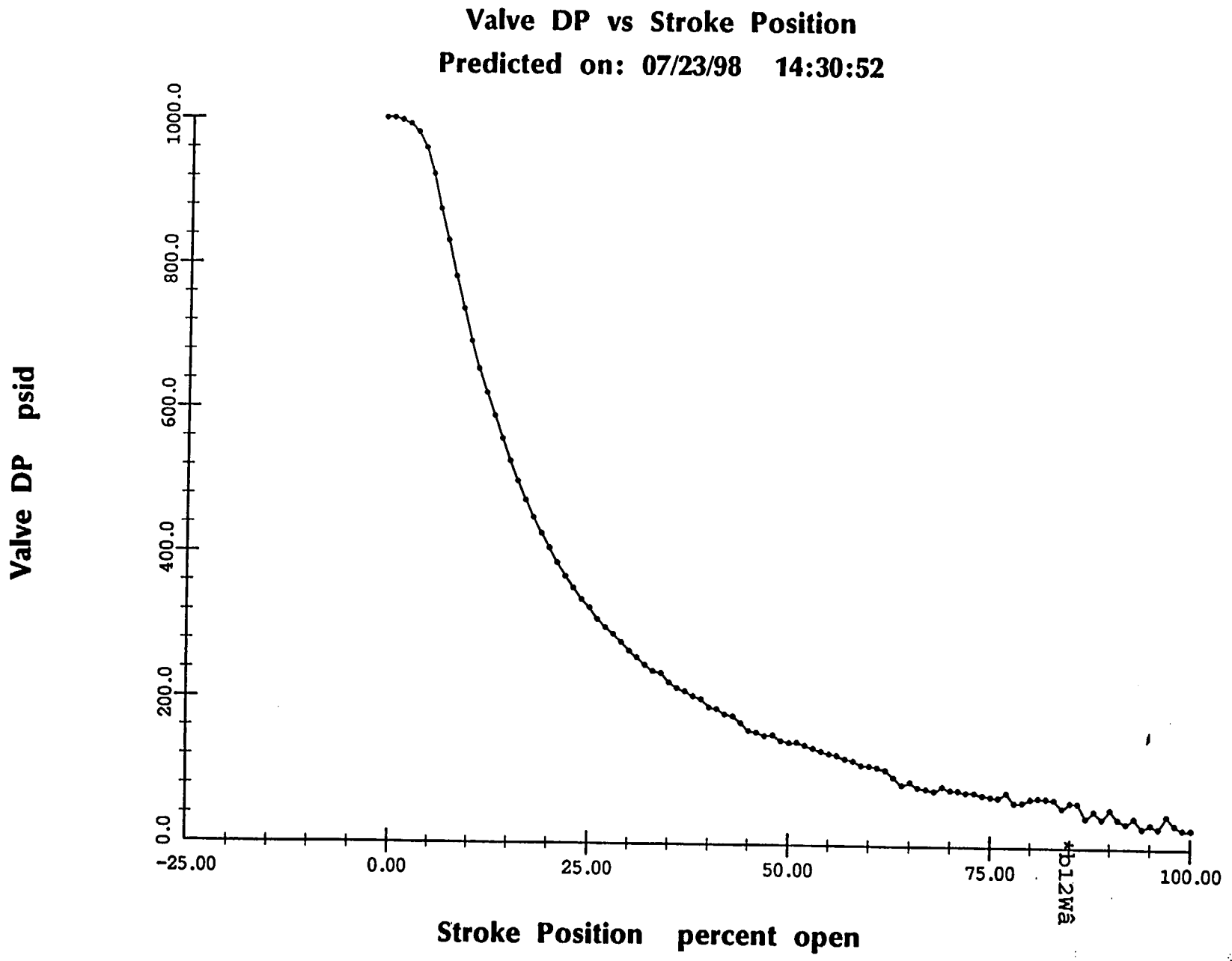
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:30:52 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 64194 | 923 |
| 4.0 | 47773 | 959 |
| 3.0 | 32799 | 980 |
| 2.0 | 20180 | 991 |
| 1.0 | 9023 | 997 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\10000scl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Steam

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:30:52 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\10000scl.mov: Closing Stroke - 10000 Pipe Diamet

## SUMMARY INFORMATION

Date Prediction Performed: 07/23/98 Time: 14:52:07

Files Used:

c:\ppmtasks\cpl\10flcl.mov
c:\ppmtasks\cpl\10flcl.sys

4/13/99

4/14/99

File Descriptions:

SYS: 10-Closing-Flashing Water

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 10 Pipe Diameters Upstream - Flashing Water

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 10-Closing-Flashing Water

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = water/steam mixture

FLUID CONDITIONS
Supply Tank Temperature = 530.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet
Steam/Mixture Mass Ratio = 0.00

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 5 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0

**RESTRICTOR DATA**

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

**VALVE INPUT PARAMETERS**

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 8005173 | 954 |
| 99.0 | 7985542 | 955 |
| 98.0 | 7959387 | 955 |
| 97.0 | 7927428 | 955 |
| 96.0 | 7889663 | 956 |
| 95.0 | 7846662 | 956 |
| 94.0 | 7798427 | 957 |
| 93.0 | 7745787 | 957 |
| 92.0 | 7688523 | 958 |
| 91.0 | 7627366 | 958 |
| 90.0 | 7562316 | 959 |
| 89.0 | 7493985 | 960 |
| 88.0 | 7422679 | 960 |
| 87.0 | 7348974 | 961 |
| 86.0 | 7273375 | 962 |
| 85.0 | 7196203 | 963 |
| 84.0 | 7118314 | 963 |
| 83.0 | 7040018 | 964 |
| 82.0 | 6961796 | 965 |
| 81.0 | 6884118 | 966 |
| 80.0 | 6807445 | 966 |
| 79.0 | 6732061 | 967 |
| 78.0 | 6657655 | 968 |
| 77.0 | 6583460 | 968 |
| 76.0 | 6509178 | 969 |
| 75.0 | 6434032 | 970 |
| 74.0 | 6357689 | 970 |
| 73.0 | 6279320 | 971 |
| 72.0 | 6198608 | 972 |
| 71.0 | 6114763 | 973 |

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 6027450 | 973 |
| 69.0 | 5935950 | 974 |
| 68.0 | 5840745 | 975 |
| 67.0 | 5741834 | 976 |
| 66.0 | 5640167 | 976 |
| 65.0 | 5535517 | 977 |
| 64.0 | 5428627 | 978 |
| 63.0 | 5319494 | 979 |
| 62.0 | 5209362 | 980 |
| 61.0 | 5097922 | 980 |
| 60.0 | 4985891 | 981 |
| 59.0 | 4873782 | 982 |
| 58.0 | 4762219 | 983 |
| 57.0 | 4651856 | 983 |
| 56.0 | 4543356 | 984 |
| 55.0 | 4437389 | 985 |
| 54.0 | 4334632 | 985 |
| 53.0 | 4235766 | 986 |
| 52.0 | 4141479 | 986 |
| 51.0 | 4052467 | 987 |
| 50.0 | 3969428 | 987 |
| 49.0 | 3892363 | 988 |
| 48.0 | 3819677 | 988 |
| 47.0 | 3748634 | 988 |
| 46.0 | 3676209 | 989 |
| 45.0 | 3600316 | 989 |
| 44.0 | 3518618 | 990 |
| 43.0 | 3431967 | 990 |
| 42.0 | 3342009 | 990 |
| 41.0 | 3250351 | 991 |
| 40.0 | 3158654 | 991 |
| 39.0 | 3068285 | 992 |
| 38.0 | 2979244 | 992 |

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 2891531 | 992 |
| 36.0 | 2804895 | 993 |
| 35.0 | 2719094 | 993 |
| 34.0 | 2634129 | 993 |
| 33.0 | 2549328 | 994 |
| 32.0 | 2464693 | 994 |
| 31.0 | 2379387 | 994 |
| 30.0 | 2293117 | 995 |
| 29.0 | 2205556 | 995 |
| 28.0 | 2117218 | 995 |
| 27.0 | 2029269 | 995 |
| 26.0 | 1942466 | 996 |
| 25.0 | 1857640 | 996 |
| 24.0 | 1775514 | 996 |
| 23.0 | 1695212 | 996 |
| 22.0 | 1616390 | 996 |
| 21.0 | 1538174 | 997 |
| 20.0 | 1460012 | 997 |
| 19.0 | 1381571 | 997 |
| 18.0 | 1301442 | 997 |
| 17.0 | 1219625 | 997 |
| 16.0 | 1137145 | 997 |
| 15.0 | 1055797 | 997 |
| 14.0 | 975581 | 998 |
| 13.0 | 897147 | 998 |
| 12.0 | 821160 | 998 |
| 11.0 | 748158 | 998 |
| 10.0 | 672235 | 998 |
| 9.0 | 590619 | 998 |
| 8.0 | 512836 | 998 |
| 7.0 | 428553 | 998 |
| 6.0 | 355542 | 998 |

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

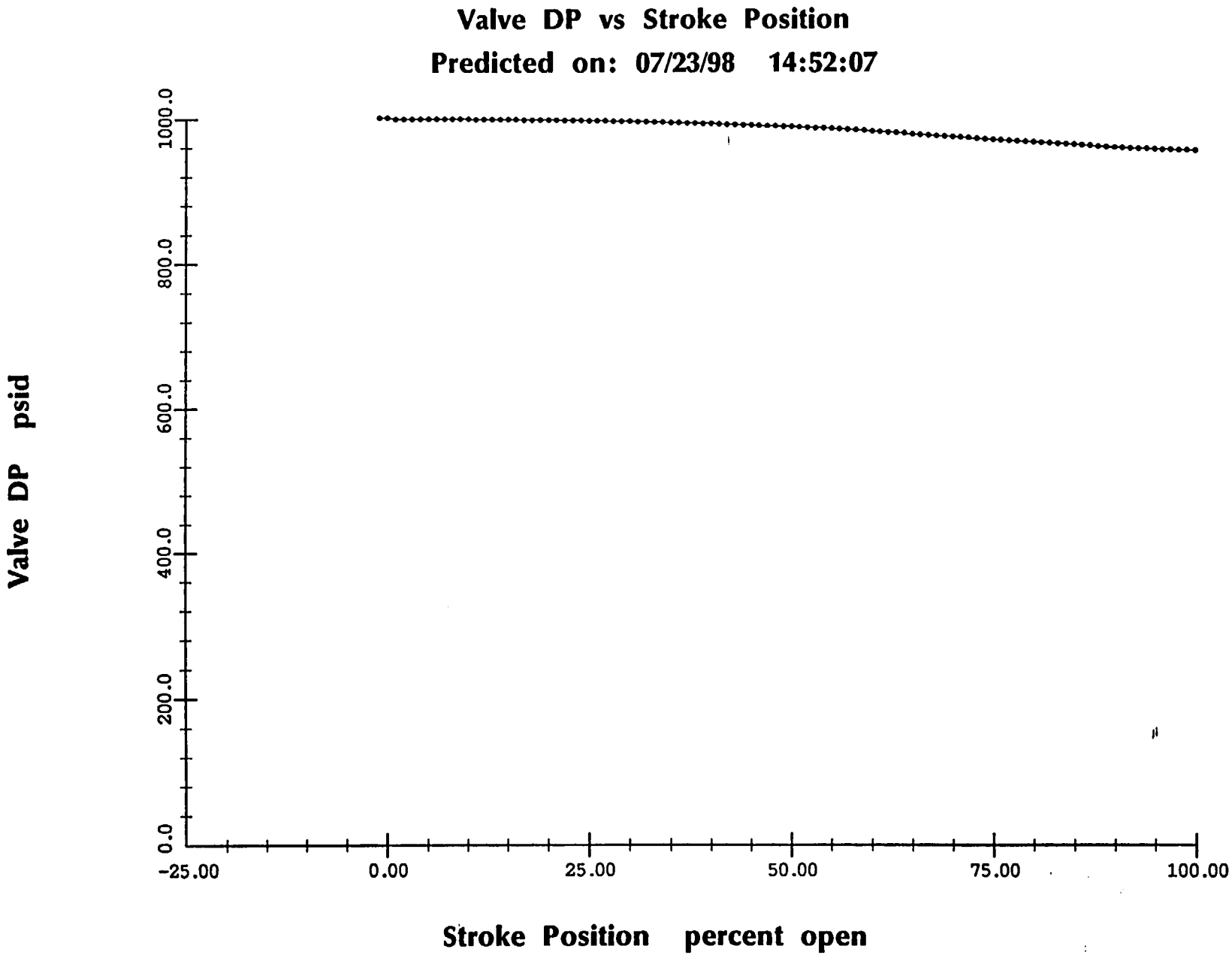
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 268396 | 998 |
| 4.0 | 193813 | 998 |
| 3.0 | 130757 | 998 |
| 2.0 | 79229 | 998 |
| 1.0 | 34897 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\10flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10 Pipe Diameters Upstream - Flashing Wat

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:52:07 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\10flcl.mov: Closing Stroke - 10 Pipe Diameters

**SUMMARY INFORMATION**

Date Prediction Performed: 07/23/98 Time: 14:54:08

Files Used:

c:\ppmtasks\cpl\100flcl.mov
c:\ppmtasks\cpl\100flcl.sys

4/13/99

4/14/99

File Descriptions:

SYS: 100-Closing-Flashing Water

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 100 Pipe Diameters Upstream - Flashing Water

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY

**FILE:** c:\ppmtasks\cpl\100flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Flashing Wa

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:54:08 **PPM VERSION:** 1.0

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 100-Closing-Flashing Water

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = water/steam mixture

FLUID CONDITIONS
Supply Tank Temperature = 530.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet
Steam/Mixture Mass Ratio = 0.00

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 50 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 5646074 | 780 |
| 99.0 | 5642302 | 781 |
| 98.0 | 5635915 | 781 |
| 97.0 | 5626911 | 782 |
| 96.0 | 5615395 | 783 |
| 95.0 | 5601553 | 784 |
| 94.0 | 5585385 | 785 |
| 93.0 | 5567021 | 787 |
| 92.0 | 5546572 | 788 |
| 91.0 | 5524104 | 790 |
| 90.0 | 5499617 | 792 |
| 89.0 | 5473447 | 794 |
| 88.0 | 5445249 | 796 |
| 87.0 | 5415669 | 798 |
| 86.0 | 5384705 | 800 |
| 85.0 | 5352597 | 803 |
| 84.0 | 5319344 | 805 |
| 83.0 | 5285261 | 808 |
| 82.0 | 5250559 | 810 |
| 81.0 | 5215378 | 813 |
| 80.0 | 5179924 | 815 |
| 79.0 | 5144197 | 818 |
| 78.0 | 5107990 | 820 |
| 77.0 | 5071026 | 823 |
| 76.0 | 5032842 | 825 |
| 75.0 | 4992885 | 828 |
| 74.0 | 4950616 | 831 |
| 73.0 | 4905291 | 834 |
| 72.0 | 4856572 | 837 |
| 71.0 | 4803247 | 841 |

**FILE:** c:\ppmtasks\cpl\100flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Flashing Wa

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:54:08 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 4744236 | 845 |
| 69.0 | 4678005 | 849 |
| 68.0 | 4603112 | 854 |
| 67.0 | 4516657 | 859 |
| 66.0 | 4412339 | 865 |
| 65.0 | 4319375 | 871 |
| 64.0 | 4267847 | 874 |
| 63.0 | 4214311 | 877 |
| 62.0 | 4158769 | 880 |
| 61.0 | 4101219 | 883 |
| 60.0 | 4042168 | 887 |
| 59.0 | 3981699 | 890 |
| 58.0 | 3920139 | 893 |
| 57.0 | 3857857 | 896 |
| 56.0 | 3795264 | 900 |
| 55.0 | 3732818 | 903 |
| 54.0 | 3671027 | 906 |
| 53.0 | 3610219 | 909 |
| 52.0 | 3551286 | 912 |
| 51.0 | 3494668 | 915 |
| 50.0 | 3440986 | 917 |
| 49.0 | 3390526 | 920 |
| 48.0 | 3342071 | 922 |
| 47.0 | 3294095 | 924 |
| 46.0 | 3244767 | 926 |
| 45.0 | 3192165 | 929 |
| 44.0 | 3134726 | 931 |
| 43.0 | 3072871 | 934 |
| 42.0 | 3007783 | 936 |
| 41.0 | 2940442 | 939 |
| 40.0 | 2872035 | 942 |
| 39.0 | 2803606 | 944 |
| 38.0 | 2735156 | 947 |

**FILE:** c:\ppmtasks\cpl\100flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Flashing Wa

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:54:08 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 2666685 | 950 |
| 36.0 | 2598193 | 952 |
| 35.0 | 2529680 | 954 |
| 34.0 | 2460810 | 957 |
| 33.0 | 2391295 | 959 |
| 32.0 | 2320898 | 961 |
| 31.0 | 2249319 | 964 |
| 30.0 | 2175915 | 966 |
| 29.0 | 2100685 | 968 |
| 28.0 | 2024072 | 970 |
| 27.0 | 1946840 | 972 |
| 26.0 | 1869826 | 974 |
| 25.0 | 1793830 | 976 |
| 24.0 | 1719418 | 978 |
| 23.0 | 1646229 | 980 |
| 22.0 | 1573583 | 981 |
| 21.0 | 1501218 | 983 |
| 20.0 | 1428369 | 984 |
| 19.0 | 1354473 | 986 |
| 18.0 | 1278849 | 987 |
| 17.0 | 1200870 | 988 |
| 16.0 | 1122070 | 990 |
| 15.0 | 1043719 | 991 |
| 14.0 | 966155 | 992 |
| 13.0 | 889377 | 993 |
| 12.0 | 815338 | 994 |
| 11.0 | 743766 | 994 |
| 10.0 | 669208 | 995 |
| 9.0 | 588475 | 996 |
| 8.0 | 511396 | 996 |
| 7.0 | 427713 | 997 |
| 6.0 | 355060 | 997 |

**FILE:** c:\ppmtasks\cpl\100flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Flashing Wa

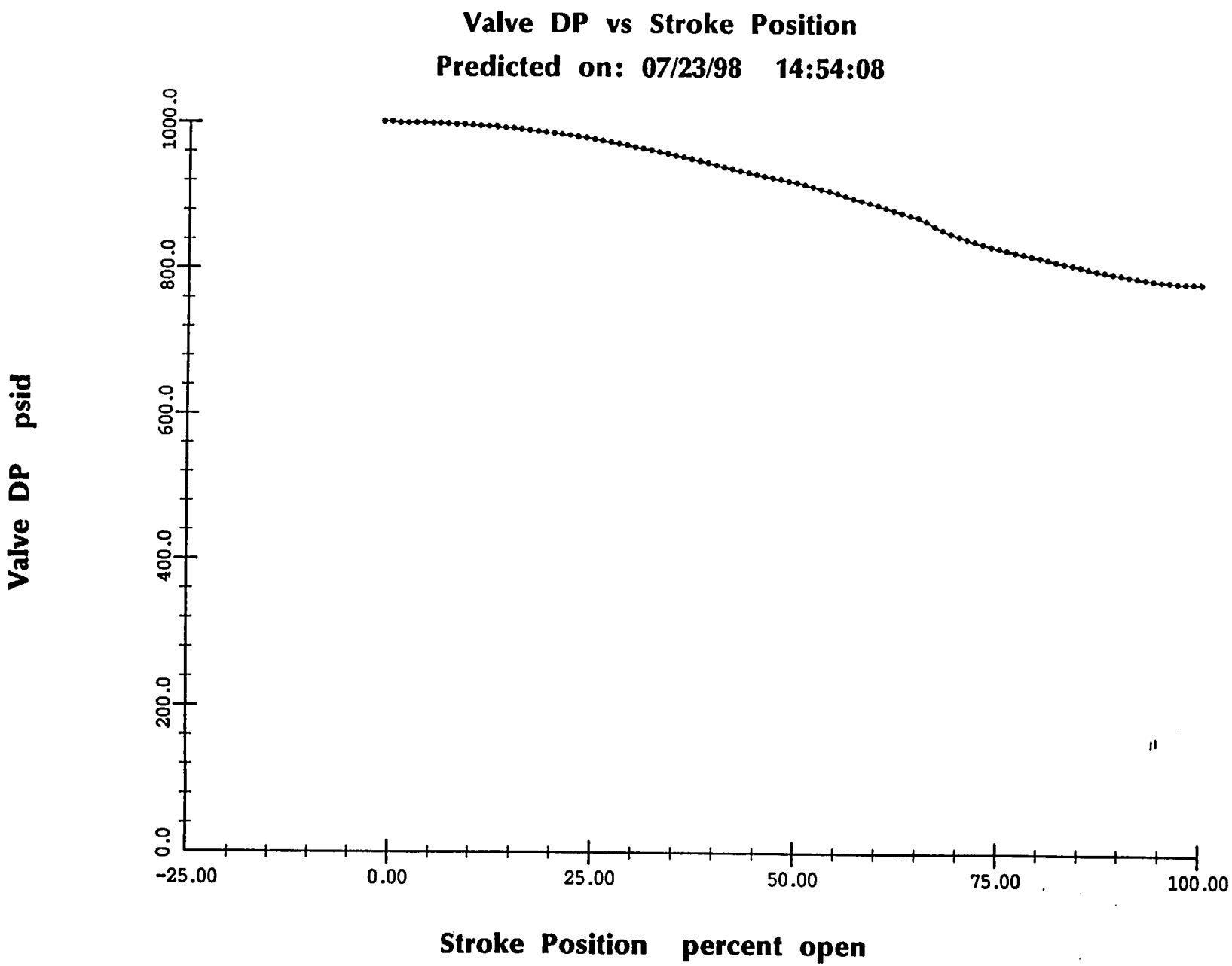
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:54:08 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 268186 | 998 |
| 4.0 | 193733 | 998 |
| 3.0 | 130716 | 998 |
| 2.0 | 79131 | 998 |
| 1.0 | 34881 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\100flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 100 Pipe Diameters Upstream - Flashing Wa

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:54:08 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\100flcl.mov: Closing Stroke - 100 Pipe Diameter:

## SUMMARY INFORMATION

Date Prediction Performed: 07/23/98 Time: 14:56:14

Files Used:

c:\ppmtasks\cpl\1000flcl.mov
c:\ppmtasks\cpl\1000flcl.sys

4/13/99
4/14/99

File Descriptions:

SYS: 1000-Closing-Flashing Water

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 1000 Pipe Diameters Upstream - Flashing Water

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 1000-Closing-Flashing Water

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = water/steam mixture

FLUID CONDITIONS
Supply Tank Temperature = 530.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet
Steam/Mixture Mass Ratio = 0.00

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 500 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 2672359 | 510 |
| 99.0 | 2671999 | 511 |
| 98.0 | 2671023 | 511 |
| 97.0 | 2669247 | 512 |
| 96.0 | 2667132 | 512 |
| 95.0 | 2664294 | 513 |
| 94.0 | 2660960 | 515 |
| 93.0 | 2656929 | 516 |
| 92.0 | 2652711 | 518 |
| 91.0 | 2647824 | 519 |
| 90.0 | 2642585 | 521 |
| 89.0 | 2636792 | 523 |
| 88.0 | 2630581 | 525 |
| 87.0 | 2624147 | 528 |
| 86.0 | 2617438 | 530 |
| 85.0 | 2610497 | 533 |
| 84.0 | 2603584 | 535 |
| 83.0 | 2596377 | 538 |
| 82.0 | 2589079 | 540 |
| 81.0 | 2581769 | 543 |
| 80.0 | 2574491 | 545 |
| 79.0 | 2567246 | 548 |
| 78.0 | 2560034 | 550 |
| 77.0 | 2552622 | 553 |
| 76.0 | 2545351 | 556 |
| 75.0 | 2537668 | 558 |
| 74.0 | 2529575 | 561 |
| 73.0 | 2521015 | 564 |
| 72.0 | 2512024 | 567 |
| 71.0 | 2502601 | 570 |

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 2492255 | 574 |
| 69.0 | 2480851 | 578 |
| 68.0 | 2469068 | 582 |
| 67.0 | 2456434 | 586 |
| 66.0 | 2443020 | 590 |
| 65.0 | 2429050 | 595 |
| 64.0 | 2414526 | 600 |
| 63.0 | 2399446 | 605 |
| 62.0 | 2383938 | 610 |
| 61.0 | 2368174 | 615 |
| 60.0 | 2352159 | 620 |
| 59.0 | 2335962 | 625 |
| 58.0 | 2319811 | 630 |
| 57.0 | 2303382 | 635 |
| 56.0 | 2286790 | 641 |
| 55.0 | 2270177 | 646 |
| 54.0 | 2253543 | 651 |
| 53.0 | 2236845 | 656 |
| 52.0 | 2220526 | 661 |
| 51.0 | 2204537 | 666 |
| 50.0 | 2189214 | 670 |
| 49.0 | 2174309 | 675 |
| 48.0 | 2159550 | 679 |
| 47.0 | 2145229 | 683 |
| 46.0 | 2130338 | 688 |
| 45.0 | 2114611 | 692 |
| 44.0 | 2097369 | 697 |
| 43.0 | 2078955 | 702 |
| 42.0 | 2059369 | 708 |
| 41.0 | 2038321 | 714 |
| 40.0 | 2016604 | 720 |
| 39.0 | 1993862 | 727 |
| 38.0 | 1970096 | 733 |

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 1945546 | 740 |
| 36.0 | 1919994 | 746 |
| 35.0 | 1893165 | 753 |
| 34.0 | 1865621 | 760 |
| 33.0 | 1836567 | 768 |
| 32.0 | 1806615 | 775 |
| 31.0 | 1775316 | 783 |
| 30.0 | 1742398 | 791 |
| 29.0 | 1707267 | 799 |
| 28.0 | 1668392 | 808 |
| 27.0 | 1624150 | 818 |
| 26.0 | 1570824 | 829 |
| 25.0 | 1498747 | 845 |
| 24.0 | 1350173 | 873 |
| 23.0 | 1313913 | 880 |
| 22.0 | 1275989 | 887 |
| 21.0 | 1236400 | 894 |
| 20.0 | 1194769 | 900 |
| 19.0 | 1150569 | 908 |
| 18.0 | 1102950 | 915 |
| 17.0 | 1051716 | 922 |
| 16.0 | 997529 | 930 |
| 15.0 | 941138 | 937 |
| 14.0 | 883082 | 945 |
| 13.0 | 823363 | 952 |
| 12.0 | 763581 | 958 |
| 11.0 | 703735 | 964 |
| 10.0 | 639498 | 970 |
| 9.0 | 568141 | 976 |
| 8.0 | 497672 | 981 |
| 7.0 | 419558 | 986 |
| 6.0 | 350349 | 990 |

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

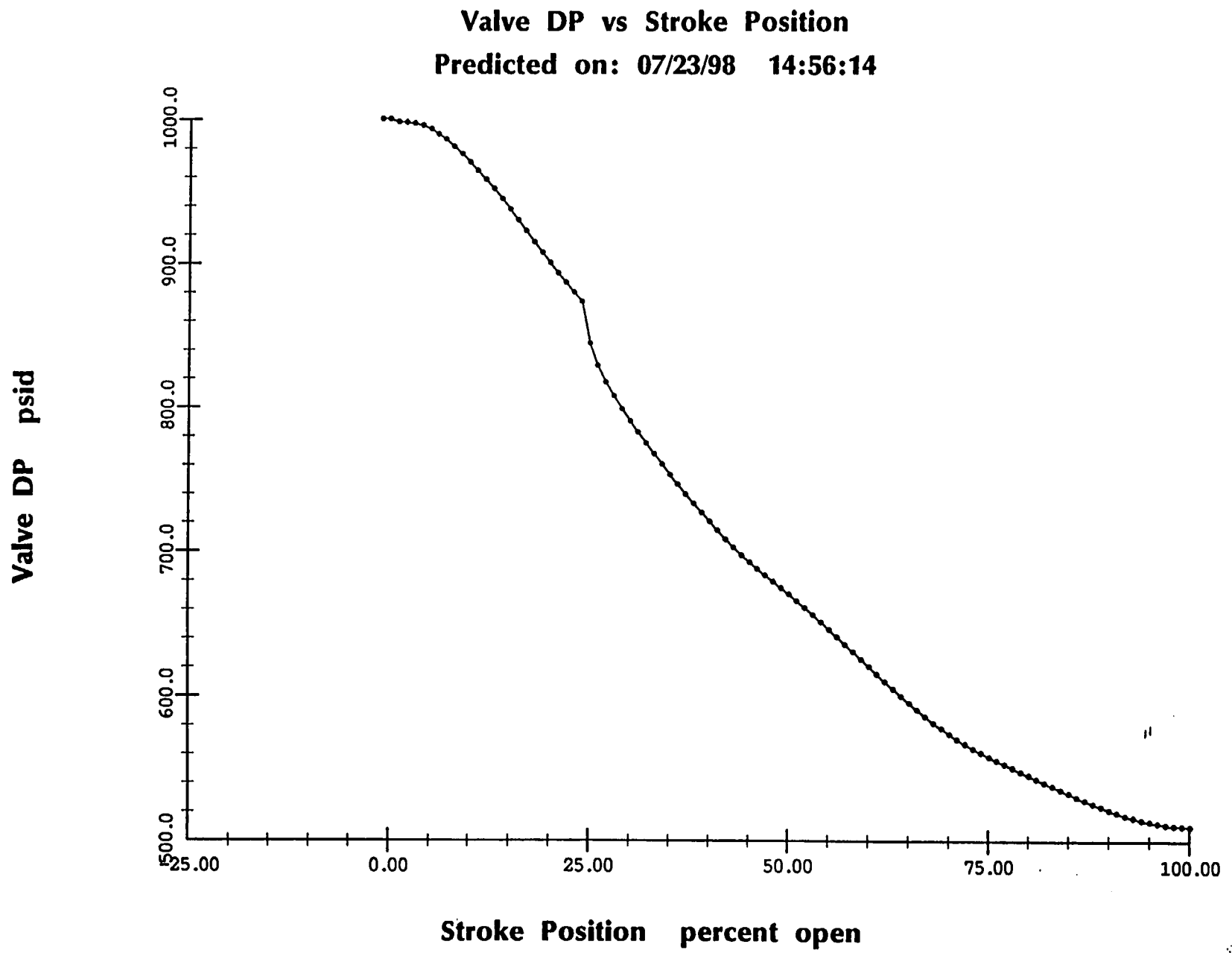
**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 266297 | 993 |
| 4.0 | 192945 | 996 |
| 3.0 | 130292 | 997 |
| 2.0 | 79187 | 998 |
| 1.0 | 34917 | 998 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

**FILE:** c:\ppmtasks\cpl\1000flcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 1000 Pipe Diameters Upstream - Flashing W

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:56:14 **PPM VERSION:** 1.0




c:\ppmtasks\cpl\1000flcl.mov: Closing Stroke - 1000 Pipe Diamete

## SUMMARY INFORMATION

Date Prediction Performed: 07/23/98 Time: 14:58:03

Files Used:

c:\ppmtasks\cpl\10000fcl.mov
c:\ppmtasks\cpl\10000fcl.sys

4/13/99

4/14/99

File Descriptions:

SYS: 10000-Closing-Flashing Water

Calculation Options:

Run System Model

Report Options:

Report includes DP/Flow versus Stroke Position Data

User Comments:

Closing Stroke - 10000 Pipe Diameters Upstream - Flashing Water

System Flow Module Warnings:
(1) CALCULATIONS COMPLETED SUCCESSFULLY

## INPUT PARAMETERS

### SYSTEM INPUT PARAMETERS

File Description = 10000-Closing-Flashing Water

CONFIGURATION
Flow Configuration = blowdown
Fluid Type = water/steam mixture

FLUID CONDITIONS
Supply Tank Temperature = 530.0 degrees F
Initial Supply Tank Pressure = 1015 psia
Main Valve's Initial Discharge Tank Pressure = 15 psia
Supply Tank Elevation = 0 feet
Main Valve's Discharge Tank Elevation = 0 feet
Steam/Mixture Mass Ratio = 0.00

### SUPPLY TANK PRESSURE DATA

| Time (seconds) | Supply Tank Pressure (psia) |
|---|---|
| 0.0 | 1015 |
| 30.0 | 1015 |

### SYSTEM PIPING DATA

| Number () | Pipe Type () | Equiv. Length (feet) | ID (inches) | Roughness (feet) |
|---|---|---|---|---|
| 1 | Supply Tank Outlet | 0 | 6.000 | 0.00000 |
| 2 | Valve Inlet | 5000 | 6.000 | 0.00015 |
| 3 | Valve Outlet | 0 | 6.000 | 0.00000 |
| 4 | Discharge Tank Inlet | 0 | 6.000 | 0.00000 |

**FILE:** c:\ppmtasks\cpl\10000fcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Flashing

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:58:03 **PPM VERSION:** 1.0

## RESTRICTOR DATA

Upstream Restrictor:
Type = none

Downstream Restrictor:
Type = none

## VALVE INPUT PARAMETERS

GENERAL VALVE INFORMATION
Full Stroke = 6.00 inches

VALVE INFORMATION REQUIRED BY SYSTEM FLOW MODULE
Valve Inlet Diameter = 6.00 inches
Stroke Time = 30.0 seconds
Elevation of Valve = 0 feet
Inlet Fitting Loss Coefficient = 0.00
Discharge Fitting Loss Coefficient = 0.00
Use Default Flow Coefficient Data? = yes
Seat Ring Inside Diameter = 6.0 inches

**OUTPUT DATA**
**DP/FLOW versus STROKE POSITION DATA**

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 100.0 | 1044604 | 250 |
| 99.0 | 1044377 | 251 |
| 98.0 | 1044377 | 251 |
| 97.0 | 1044096 | 251 |
| 96.0 | 1043531 | 252 |
| 95.0 | 1042990 | 253 |
| 94.0 | 1042345 | 254 |
| 93.0 | 1041588 | 255 |
| 92.0 | 1040731 | 256 |
| 91.0 | 1039962 | 257 |
| 90.0 | 1039059 | 258 |
| 89.0 | 1037783 | 260 |
| 88.0 | 1036656 | 262 |
| 87.0 | 1035467 | 263 |
| 86.0 | 1034295 | 265 |
| 85.0 | 1032783 | 267 |
| 84.0 | 1031598 | 269 |
| 83.0 | 1030030 | 271 |
| 82.0 | 1028792 | 273 |
| 81.0 | 1027175 | 275 |
| 80.0 | 1025777 | 277 |
| 79.0 | 1024413 | 279 |
| 78.0 | 1023085 | 281 |
| 77.0 | 1021528 | 283 |
| 76.0 | 1019955 | 285 |
| 75.0 | 1018405 | 287 |
| 74.0 | 1016967 | 289 |
| 73.0 | 1015400 | 291 |
| 72.0 | 1013449 | 294 |
| 71.0 | 1011502 | 297 |

**FILE:** c:\ppmtasks\cpl\10000fcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Flashing

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:58:03 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 70.0 | 1009559 | 299 |
| 69.0 | 1007305 | 302 |
| 68.0 | 1004827 | 306 |
| 67.0 | 1002220 | 309 |
| 66.0 | 999208 | 314 |
| 65.0 | 996570 | 317 |
| 64.0 | 993346 | 322 |
| 63.0 | 990068 | 326 |
| 62.0 | 986987 | 331 |
| 61.0 | 983820 | 335 |
| 60.0 | 980214 | 340 |
| 59.0 | 976789 | 344 |
| 58.0 | 973330 | 349 |
| 57.0 | 969943 | 353 |
| 56.0 | 966399 | 358 |
| 55.0 | 962813 | 363 |
| 54.0 | 958961 | 368 |
| 53.0 | 955648 | 372 |
| 52.0 | 952043 | 377 |
| 51.0 | 948601 | 381 |
| 50.0 | 945109 | 386 |
| 49.0 | 941613 | 390 |
| 48.0 | 938360 | 394 |
| 47.0 | 935132 | 399 |
| 46.0 | 931719 | 403 |
| 45.0 | 928454 | 407 |
| 44.0 | 924660 | 412 |
| 43.0 | 920588 | 417 |
| 42.0 | 916002 | 423 |
| 41.0 | 911560 | 428 |
| 40.0 | 906598 | 435 |
| 39.0 | 901578 | 441 |
| 38.0 | 896232 | 447 |

**FILE:** c:\ppmtasks\cpl\10000fcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Flashing

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:58:03 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 37.0 | 890559 | 454 |
| 36.0 | 884912 | 461 |
| 35.0 | 879022 | 468 |
| 34.0 | 872583 | 476 |
| 33.0 | 866474 | 483 |
| 32.0 | 859966 | 491 |
| 31.0 | 853133 | 499 |
| 30.0 | 846469 | 506 |
| 29.0 | 839600 | 514 |
| 28.0 | 832527 | 523 |
| 27.0 | 824889 | 531 |
| 26.0 | 816686 | 540 |
| 25.0 | 807687 | 550 |
| 24.0 | 797892 | 561 |
| 23.0 | 787302 | 573 |
| 22.0 | 776081 | 585 |
| 21.0 | 764229 | 597 |
| 20.0 | 751979 | 610 |
| 19.0 | 739008 | 623 |
| 18.0 | 724721 | 638 |
| 17.0 | 709120 | 653 |
| 16.0 | 691529 | 670 |
| 15.0 | 672898 | 687 |
| 14.0 | 652429 | 705 |
| 13.0 | 630603 | 725 |
| 12.0 | 606765 | 745 |
| 11.0 | 580086 | 767 |
| 10.0 | 545782 | 793 |
| 9.0 | 491851 | 831 |
| 8.0 | 402983 | 886 |
| 7.0 | 357906 | 910 |
| 6.0 | 312061 | 931 |

**FILE:** c:\ppmtasks\cpl\10000fcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Flashing

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:58:03 **PPM VERSION:** 1.0

| Stroke Position (percent open) | Valve Flow (lb/hr) | Valve DP (psid) |
|---|---|---|
| 5.0 | 248092 | 955 |
| 4.0 | 185691 | 974 |
| 3.0 | 128049 | 987 |
| 2.0 | 78789 | 994 |
| 1.0 | 34762 | 997 |
| 0.0 | 0 | 1000 |
| -1.0 | 0 | 1000 |

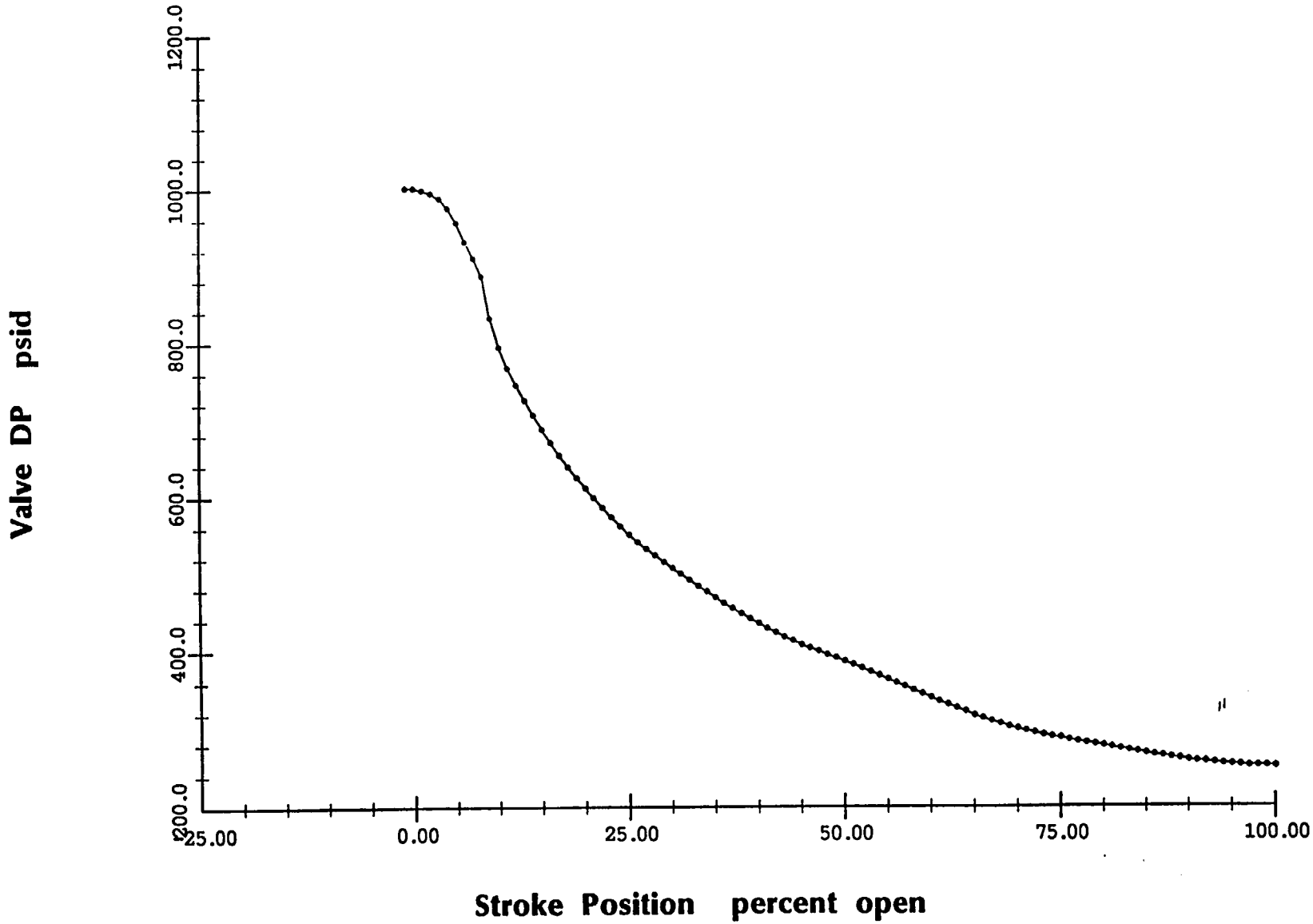
**FILE:** c:\ppmtasks\cpl\10000fcl.mov **STROKE DIRECTION:** close

**MOV COMMENTS:** Closing Stroke - 10000 Pipe Diameters Upstream - Flashing

**VALVE TYPE:** gate **DATE:** 07/23/98 **TIME:** 14:58:03 **PPM VERSION:** 1.0

## Valve DP vs Stroke Position

**Predicted on: 07/23/98 14:58:03**




c:\ppmtasks\cpl\10000fcl.mov: Closing Stroke - 10000 Pipe Diamet

**APPENDIX D**

Wedge Gate Valves, Disk to Seat Ring Contact vs. Guide Slot to Rail Contact

Wedge Gate Valves, Seat vs. Guides

| Pumped Flow | | | | Close-seat | | Close-guides | | Open-seat | | Open-guides | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | FD= Fy+Acs*Fx | Normalized Seat | FD= Fy+Acg*Fx | Normalized Guides | FD= -Fy+Aos*Fx | Normalized Seat | FD= -Fy+Aog*Fx | Normalized Guides |
| 0 | 1 | 0 | 0 | 0.0000 | 0.0000 | 0 | 0.0000 | 0.0000 | 0.0000 | 0 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.0731 | 0.1154 | 0.0613 | 0.1226 | 0.0335 | 0.0588 | 0.0425 | 0.0633 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | 0.2930 | 0.4623 | 0.22042 | 0.4407 | 0.3607 | 0.6333 | 0.41582 | 0.6197 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | 0.3808 | 0.6009 | 0.2876 | 0.5750 | 0.4594 | 0.8065 | 0.5302 | 0.7902 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | 0.4144 | 0.6539 | 0.3194 | 0.6385 | 0.4418 | 0.7757 | 0.514 | 0.7660 |
| 0.67 | 0.2717 | 0.777 | -0.153 | 0.4195 | 0.6620 | 0.3132 | 0.6261 | 0.5384 | 0.9454 | 0.6192 | 0.9228 |
| 0.77 | 0.1630 | 0.864 | -0.172 | 0.4646 | 0.7331 | 0.3464 | 0.6925 | 0.6006 | 1.0545 | 0.6904 | 1.0289 |
| 0.82 | 0.1087 | 0.931 | -0.129 | 0.5570 | 0.8789 | 0.4296 | 0.8589 | 0.5908 | 1.0374 | 0.6876 | 1.0247 |
| 0.84 | 0.0870 | 1.009 | -0.165 | 0.5784 | 0.9128 | 0.4404 | 0.8804 | 0.6655 | 1.1685 | 0.7704 | 1.1481 |
| 0.86 | 0.0652 | 1.021 | -0.184 | 0.5683 | 0.8967 | 0.4286 | 0.8569 | 0.6905 | 1.2123 | 0.7966 | 1.1872 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | 0.5957 | 0.9400 | 0.45584 | 0.9113 | 0.6647 | 1.1672 | 0.77104 | 1.1491 |
| 0.92 | 0 | 0.976 | -0.0854 | 0.6337 | 1.0000 | 0.5002 | 1.0000 | 0.5695 | 1.0000 | 0.671 | 1.0000 |
| 1 | -0.0870 | 1.001 | -0.0876 | 0.6499 | 1.0256 | 0.513 | 1.0256 | 0.5841 | 1.0256 | 0.6882 | 1.0256 |

| Water | mu | A |
|---|---|---|
| CS | 0.61 | 0.736811 |
| CG | 0.6 | 0.6 |
| OS | 0.61 | 0.496039 |
| OG | 0.6 | 0.6 |

| theta | degs | rads |
|---|---|---|
| | 5 | 0.087266 |

| Blowdown Flow | | | | Close-seat | | Close-guides | | Open-seat | | Open-guides | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stroke Position | GATM equiv Stroke Position | Fx | Fy | FD= Fy+Acs*Fx | Normalized Seat | FD= Fy+Acg*Fx | Normalized Guides | FD= -Fy+Aos*Fx | Normalized Seat | FD= -Fy+Aog*Fx | Normalized Guides |
| 0 | 1 | 0 | 0 | 0.0000 | 0.0000 | 0 | 0.0000 | 0.0000 | 0.0000 | 0 | 0.0000 |
| 0.12 | 0.8696 | 0.0865 | 0.0094 | 0.0578 | 0.1255 | 0.0613 | 0.1226 | 0.0208 | 0.0488 | 0.0425 | 0.0633 |
| 0.32 | 0.6522 | 0.5302 | -0.0977 | 0.1990 | 0.4319 | 0.22042 | 0.4407 | 0.2826 | 0.6637 | 0.41582 | 0.6197 |
| 0.42 | 0.5435 | 0.6815 | -0.1213 | 0.2600 | 0.5644 | 0.2876 | 0.5750 | 0.3590 | 0.8431 | 0.5302 | 0.7902 |
| 0.57 | 0.3804 | 0.6945 | -0.0973 | 0.2913 | 0.6323 | 0.3194 | 0.6385 | 0.3395 | 0.7974 | 0.514 | 0.7660 |
| 0.67 | 0.2717 | 0.777 | -0.153 | 0.2817 | 0.6116 | 0.3132 | 0.6261 | 0.4240 | 0.9958 | 0.6192 | 0.9228 |
| 0.77 | 0.1630 | 0.864 | -0.172 | 0.3114 | 0.6760 | 0.3464 | 0.6925 | 0.4733 | 1.1116 | 0.6904 | 1.0289 |
| 0.82 | 0.1087 | 0.931 | -0.129 | 0.3919 | 0.8507 | 0.4296 | 0.8589 | 0.4537 | 1.0655 | 0.6876 | 1.0247 |
| 0.84 | 0.0870 | 1.009 | -0.165 | 0.3996 | 0.8673 | 0.4404 | 0.8804 | 0.5169 | 1.2140 | 0.7704 | 1.1481 |
| 0.86 | 0.0652 | 1.021 | -0.184 | 0.3873 | 0.8406 | 0.4286 | 0.8569 | 0.5401 | 1.2684 | 0.7966 | 1.1872 |
| 0.88 | 0.0435 | 1.0224 | -0.1576 | 0.4144 | 0.8996 | 0.45584 | 0.9113 | 0.5142 | 1.2076 | 0.77104 | 1.1491 |
| 0.92 | 0 | 0.976 | -0.0854 | 0.4607 | 1.0000 | 0.5002 | 1.0000 | 0.4258 | 1.0000 | 0.671 | 1.0000 |
| 1 | -0.0870 | 1.001 | -0.0876 | 0.4725 | 1.0256 | 0.513 | 1.0256 | 0.4367 | 1.0256 | 0.6882 | 1.0256 |

| Steam | mu | A |
|---|---|---|
| CS | 0.45 | 0.559517 |
| CG | 0.6 | 0.6 |
| OS | 0.45 | 0.34878 |
| OG | 0.6 | 0.6 |

# B

# Method Justification/Validation Calculations

The following calculations are attached.

- MPR Calculation 197-003-TS-1, "Justification of the DC Motor Performance Method, Including Vendor Motor Performance Curves," Revision 0
- MPR Calculation 197-003-TS-2, "Validation of DC Motor Performance Method," Revision 0

MPR

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# CALCULATION TITLE PAGE

| | | |
|---|---|---|
| Client | BWR Owners' Group | Page 1 of 38 |
| Project | Predicting Capability and Stroke Time in DC Motor-Operated Valves | Task No. 197-9901-003-0 |
| Title | Justification of the DC Motor Performance Method, Including Vendor Motor Performance Curves | Calculation No. 197-003-TS-1 |

| Preparer-Date | Checker-Date | Reviewer/Approver-Date | Rev. No. |
|---|---|---|---|
| Todd Spears 3-1-2000<br>Todd Spears | Thomas Walker 3-2-2000<br>Tom Walker | Paul Damerell 3-2-00<br>Paul Damerell | 0 |

**QUALITY ASSURANCE DOCUMENT**

This document has been prepared, checked, and reviewed/approved in accordance with the Quality Assurance requirements of 10CFR50 Appendix B, as specified in the MPR Quality Assurance Manual.

MPR

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# RECORD OF REVISIONS

| Calculation No. | Prepared By | Checked By | Page 2 |
|---|---|---|---|
| 197-003-TS-1 | Todd Spears | Thomas Walker | |

| Revision | Description |
|---|---|
| 0 | Initial Issue |

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## 1.0 PURPOSE

The purpose of this calculation is to justify key elements of the methodology for predicting the performance of DC motor-operated valves as presented in MPR-2093 [Reference 1]. Specifically, this calculation justifies the following elements of the method:

- use of vendor motor performance curves for establishing nominal motor performance (motor torque, speed, and current)
- actuator gearbox efficiencies
- use of the vendor motor heatup rates to predict motor temperature

## 2.0 INPUTS

Several sources of DC motor and actuator test data are used in the justification of the DC Motor Performance Method. Specifically, dynamometer and actuator test data obtained from Crane-MOVATS and dynamometer test data obtained from one nuclear utility are used to justify use of the vendor motor performance curves. Table 2-1 provides a matrix of the test data used for this justification, including the file names of the source data files [References 3-6].

Testing performed by INEEL and sponsored by the NRC as published in NUREG/CR-6620 [Reference 2] is used to justify the actuator gearbox efficiencies in the method. This data is also used to justify use of the vendor motor heatup rates. Table 2-2 provides a matrix of the test data used for this justification, including the directory names containing the source data files [Reference 7].

**TABLE 2-1**
Matrix of DC Motor Test Data Used to Justify Vendor Motor Performance Curves [References 3-6]

| Motor Type | Data Source | Motor | Test | Test Type | Source Filename |
|---|---|---|---|---|---|
| 5 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 80% voltage | V13-18l.txt |
| | | | b | 100% voltage | V13-18.txt |
| | | 2 | a | 85% voltage | V13-39l.txt |
| | | | b | 100% voltage | V13-39.txt |
| 10 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 75% voltage | V13-20l.txt |
| | | | b | 100% voltage | V13-20.txt |
| | | 2 | a | 100% voltage | V13-131.txt |
| | | 3 | a | 80% voltage | Jhld.txt |
| | | | b | 100% voltage | Jhnd.txt |
| 15 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 70% voltage | V12-18l.txt |
| | | | b | 100% voltage | V12-18n.txt |
| | | 2 | a | 85% voltage | V13-16nl.txt |
| | | | b | 100% voltage | V13-16n.txt |
| | | 3 | a | 85% voltage | V13-27l.txt |
| | | | b | 100% voltage | V13-27.txt |
| | | 4 | a | 75% voltage | V13-30l.txt |
| | | | b | 100% voltage | V13-30.txt |
| | | 5 | a | 75% voltage | V23-17nl.txt |
| | | | b | 100% voltage | V23-17n.txt |
| | | 6 | a | 80% voltage | Ehld.xt |
| | | | b | 100% voltage | Ehnd.txt |
| | | 7 | a | 80% voltage | Fhld.txt |
| | | | b | 100% voltage | Fhnd.txt |
| | | 8 | a | 80% voltage | Ghld.txt |
| | | | b | 100% voltage | Ghnd.txt |
| | | 9 | a | 80% voltage | Hhld.txt |
| | | | b | 100% voltage | Hhnd.txt |

| Motor Type | Data Source | Motor | Test | Test Type | Source Filename |
|---|---|---|---|---|---|
| 25 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 75% voltage | V23-57l.txt |
| | | | b | 100% voltage | V23-57.txt |
| | | 2 | a | 75% voltage | V23-58l.txt |
| | | | b | 100% voltage | V23-58.txt |
| | | 3 | a | 80% voltage | Dhld.txt |
| | | | b | 100% voltage | Dhnd.txt |
| | BWR Plant A | 4 | a | 100% voltage | ** |
| | BWR Plant A | 5 | a | 100% voltage | ** |
| 40 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 75% voltage | Bhld.txt |
| | | | b | 100% voltage | Bhnd.txt |
| | | 2 | a | 75% voltage | Chld.txt |
| | | | b | 100% voltage | Chnd.txt |
| 60 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 75% voltage | Ahld.txt |
| | | | b | 100% voltage | Ahnd.txt |
| 80 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 75% voltage | V23-14l.txt |
| | | | b | 100% voltage | V23-14.txt |
| | | 2 | a | 75% voltage | V23-16nl.txt |
| 100 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 80% voltage | V23-21l.txt |
| | | | b | 100% voltage | V23-21.txt |
| 150 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 80% voltage | V10-17l.txt |
| | | | b | 100% voltage | V10-17n.txt |
| 200 ft-lb/125 VDC | Crane-MOVATS | 1 | a | 80% voltage | V23-19l.txt |
| | | | b | 100% voltage | V23-19.txt |

** Test data provided in References 5 and 6

**TABLE 2-2**
Matrix of DC Motor and Actuator Test Data Used to Justify Vendor Motor Heatup Rates and Actuator Gearbox Efficiencies [Reference 2 and 7]

| Motor Type | Actuator Type | Run/Pullout Efficiencies | Data Source | Test | Test Type | Source File Directory |
|---|---|---|---|---|---|---|
| 10 ft-lb/125 VDC | SMB-0 | 0.50/0.40 | INEEL/NRC | a | 60% voltage | Dc10d1 |
| | | 0.50/0.40 | | b | 100% voltage | Dc10d5 |
| 25 ft-lb/125 VDC | SMB-0 | 0.55/0.40 | INEEL/NRC | a | 60% voltage | Dc25d1 |
| | | 0.55/0.40 | | b | 100% voltage | Dc25d5 |
| 40 ft-lb/125 VDC | SMB-1 | 0.50/0.40 | INEEL/NRC | a | 60% voltage | Dc40d1 |
| | | 0.50/0.40 | | b | 100% voltage | Dc40d5 |

## 3.0 APPROACH

### 3.1 Justification of Vendor Motor Performance Curves

The DC motor performance method requires as input the motor speed and motor current as a function of motor torque under nominal conditions (ambient temperature and full voltage). The motor or actuator manufacturer typically provides motor performance curves that contain this information. These vendor motor performance curves were obtained for typical motors used on Limitorque DC motor actuators -- 2 ft-lb through 200 ft-lb motors at 125 and 250 VDC (a survey of BWR plants indicated that 250 ft-lb motors are rarely used, and the motor performance curves for these motors were not obtained or evaluated). Dynamometer and actuator test data obtained from Crane-MOVATS and dynamometer testing by one nuclear utility are used to justify the accuracy of these curves.

For each test, several time-history parameters were measured and recorded, including but not limited to the following : motor current, motor terminal voltage, motor shaft speed, and motor torque. In the case of the data obtained from Crane-MOVATS, it was not always clear by examining the source data files which data represented which measured parameter. Crane-MOVATS provided a general key [Reference 10] to interpret the various signals. Reference (9) describes the process that was used to select the signals for motor current, motor voltage, motor speed and motor torque. In some instances, it was also necessary to manipulate the source test data to make the data meaningful. Specifically, the time-history motor torque data, as provided, was zeroed improperly. Therefore, an offset had to be applied to this data to properly zero it. This process, and the specific offsets applied to each test, are documented in Reference (9).

The temperature of the armature windings was not measured during these tests, therefore, a prediction of the motor winding temperature (per MPR-2093) is made at each point in time where data was recorded. The predicted temperature is a function of the average motor torque over each time increment.

The following approach is used to predict motor heatup for each motor test:

(a) For each time increment, Table 2-4 of MPR-2093 [Reference 1] is used to determine the reference motor torque, $\tau_{ref}$ , and reference motor heatup rate, $h_{ref}$. If more than one reference torque is listed for a motor type, the value closest to the average motor torque, $\tau_{M\text{-}ave}$ is used. The average measured motor torque, $\tau_{M\text{-}ave}$, is calculated at each time increment by averaging the torque at the beginning and end of the increment.

(b) The motor temperature at the end of each time increment, $T_{motor}$, is calculated using the following equation, based on the motor temperature at the end of the previous time increment, $T_{previous}$, and the time increment, $\Delta t$. For the first stroke increment, the motor temperature was made equal to ambient conditions. The ambient temperature was assumed for all tests to be 25°C.

$$T_{motor} = T_{previous} + (\Delta t)(h_{ref})\left(\frac{\tau_{M\text{-}ave}}{\tau_{ref}}\right)^2$$

Once the motor temperature is predicted for each point in time, the following approach is used to evaluate the vendor motor performance curves. The approach used in this justification to compare measured motor torque and speed to nominal conditions (full voltage and ambient temperature) is consistent with the approaches in MPR Calculation 197-003/PLV-01 and MPR-2093 [Reference 1]

(a) The measured time-history motor torque is adjusted to ambient temperature and nominal voltage, $V_{nom}$, conditions at each point in time using the equation below. In this equation, $V_{measured}$ is the measured motor terminal voltage and $T_{motor}$ is set to the predicted motor temperature for that time. $T_{ref}$ is set to 25°C

$$\tau' = \tau_{M\text{-}ave}\left(\frac{V_{nom}}{V_{measured}}\right)\left(\frac{T_{motor} + 234.4}{T_{ref} + 234.4}\right)$$

Note that there is no limitation that the voltage ratio be less than or equal to one, therefore $V_{measured}$ may be greater than $V_{nom}$. In cases where the

measured motor torque signal is noisy, the test data is smoothed using a 10-point running average. For these situations, the smoothed motor torque data, $\tau_{smooth}$, is used in place of $\tau_{M\text{-}ave}$ in the equation above.

(b) The measured time-history motor speed, $\omega$, is adjusted to nominal voltage conditions, $V_{nom}$, using the following equation.

$$\omega' = \omega\left(\frac{V_{nom}}{V_{measured}}\right)$$

(c) For each motor type (with a given nominal starting torque and nominal voltage), plots are made comparing the vendor motor performance curves with the measured motor performance data. Specifically, the adjusted motor speed is plotted against the adjusted motor torque, and the measured motor current is plotted against the measured motor torque.

## 3.2 Justification of Actuator Gearbox Efficiencies

In the DC motor performance method, actuator gearbox efficiency is a function of the rotational speed of the worm shaft and the output torque of the actuator (the stem torque as a percentage of the rated output torque of the actuator). Table 2-2 of MPR-2093 provides gearbox efficiency factors, or f-factors, that are used in the method to determine gearbox efficiency. These f-factors are based on a review of data from DC motor actuator testing performed by INEEL and sponsored by the NRC [Reference 2]. To justify these f-factors, comparisons are made of the predicted f-factors using the method to the measured f-factors from the NRC/INEEL data. Data from testing of a 10 ft-lb, 25 ft-lb and

(the newer) 40 ft-lb motors at 60% and 100% rated voltage are used. This data covers Limitorque SMB-0 and SMB-1 actuators, each with a single worm-to-worm-gear ratio.

For each INEEL test, several time-history parameters were measured and recorded, including but not limited to the following: stem torque, motor speed and motor torque. It was not always clear by examining the source data files which data represented which measured parameter. INEEL provided a general key [Reference 7] to interpret the various signals. Reference (9) describes the process that was used to select the signals for stem torque, motor speed and motor torque.

The following approach is used for each test data set:

(a) For each test, the measured gearbox efficiency is determined at each stroke position from the measured stem torque, measured motor torque and the actuator overall ratio using the following relationship.

$$Gearbox\ Efficiency = \frac{Stem\ Torque}{Motor\ Torque * OAR}$$

(b) For each gearbox efficiency, the measured f-factor is then determined using the actuator pullout efficiency and run efficiency.

$$f\text{-}Factor = \frac{Gearbox\ Efficiency\ -\ pullout\ eff}{run\ eff\ -\ pullout\ eff}$$

(c) The predicted f-factor is determined at each stroke position using Table 2-2 of MPR-2093 [Reference 1]. First, the worm speed is determined from the measured motor speed and the motor gearset ratio (MGSR) as follows.

$$worm\ speed = Motor\ speed * MGSR$$

Next, the output torque percentage is determined from the measured stem torque and the rated output torque of the actuator

$$output\ torque\ \% = \frac{stem\ torque}{actuator\ rated\ torque}$$

From these two values, a predicted f-factor is determined from Table 2-2 [Reference 1] at each stroke position. To determine the predicted f-factor at a worm speed and/or output torque in between the values of the table, standard linear interpolation is used.

(d) Once measured and predicted f-factors are determined for each stroke position, a plot is made of measured f-factor versus predicted f-factor for the entire stroke. On each plot a diagonal line is drawn, representing the case where the measured f-factor is equal to the predicted f-factor.

## 3.3 Justification of Vendor Motor Heatup Rates

The DC motor performance method requires a reference heatup rate at one or more values of reference torque, for a given motor type. The motor heatup rates provided by the motor manufacturer are used in the DC motor performance method to predict motor heatup. The vendor typically provides one or more curves of motor temperature rise versus time for specific values of motor torque. For some motors, separate curves are provided for the temperature rise of the series field windings, the shunt field windings and the armature

windings. The curves for the armature windings are used in the DC motor performance method. The slope of these curves indicates the motor heatup rate at that torque and time.

There is limited data to justify the vendor motor heatup rates. The NRC/INEEL testing [Reference 2] provides data to justify the heatup rates for 10, 25 and 40 ft-lb motors. To perform this justification, the following approach is used:

(a) Reference 2 is reviewed to determine the maximum motor torque achieved during the 60% and 100% voltage tests of the 10, 25 and 40 ft-lbs motors tested by INEEL. For the 10 ft-lb and 25 ft-lb motor tests, the motors were tested to stall for both the 60% and 100% voltage tests. In addition, the motors stalled before the loading piston (which provided resistance to the valve stem) bottomed out. For these tests, the maximum measured motor torque is the maximum value achieved during the test. For the 60% voltage test of the 40 ft-lb motor, the motor was not tested to stall. For this test, the maximum measured thrust is the maximum value achieved during the test. For the 100% voltage test of the 40 ft-lb motor, the motor was tested to stall; however, the piston bottomed out before the motor stalled. The maximum measured thrust for this test is the value achieved when the piston bottomed out.

(b) The DC motor performance method was implemented for these six tests. Measured stem torque values were used as inputs (i.e., the load profile method was not used to predict stem load). Appendix A provides a table of the method inputs for this justification along with the reference source.

(c) The predicted temperature rise was compared to the measured temperature rise during testing for each test.

(d) For the 10 ft-lb and 25 ft-lb motor tests, the motors were tested to stall for both the 60% and 100% voltage tests. The method predicts that the motor stalls prior to the end of the test, indicating that the method predicts an actuator output capability less than that achieved during the test. The predicted temperature rise for these tests is the predicted temperature at the last stroke position before predicted motor stall minus the initial temperature.

(e) For the 60% voltage test of the 40 ft-lb motor, the INEEL test did not achieve motor stall, and the method does not predict motor stall. For this test, the predicted temperature rise is the predicted temperature at the end of the stroke minus the initial temperature.

(f) For the 100% voltage test of the 40 ft-lb motor, the predictions cover the portion of the stroke up to the point that the piston bottoms out. The method predicts that the motor stalls just as the piston bottoms out. As with the 10 and 25 ft-lb motors, the predicted temperature rise is the predicted temperature at the final stroke position minus the initial temperature.

## 4.0 RESULTS

### 4.1 Use of Vendor Motor Performance Curves

Figures 3-4 through 3-23 of MPR-2093 [Reference 1] show the comparison of the vendor motor performance curves with the measured motor performance data, adjusted for degraded voltage and motor heatup. For the speed versus torque plots, the vendor curves are bounding if the test data lies above the vendor curve, indicating that the vendor curve under-predicts the motor speed for a given motor torque. For the current versus torque plots, the vendor data is conservative if the test data lies below the vendor curve, indicating that the vendor curve over-predicts the motor current. Motor current is only used by the method to determine the voltage drop from the source (e.g., the motor control center) to the motor terminals, and an under-prediction of the current would result in an under-prediction of the voltage drop, which is conservative for predicting the motor torque.

For the following motors, the vendor speed versus torque curves are conservative (i.e., bounding) as compared to the measured motor performance data, adjusted for degraded voltage and motor heatup: 5 ft-lb/125 VDC, 10 ft-lb/125 VDC, 15 ft-lb/125 VDC, 25 ft-lb/125 VDC, 60 ft-lb/125 VDC and 200 ft-lb/125 VDC.

For the following motors, the vendor speed versus torque curves are non-conservative (i.e., not bounding) over the entire range of torques as compared to the measured motor performance data, adjusted for degraded voltage and motor heatup: 40 ft-lb/125 VDC, 80 ft-lb/125 VDC, 100 ft-lb/125 VDC, and 150 ft-lb/125 VDC. Note that for the 150 ft-lb, 125 VDC motor, a vendor motor performance curve was not obtained. An estimated curve was determined using the curves for the 150 ft-lb, 250 VDC motor (see Section 3 of MPR-2093 for discussion).

For the following motors, no test data was available to justify use of the vendor motor performance curves: 2 ft-lb/125 VDC, 2 ft-lb/250 VDC, 5 ft-lb/250 VDC, 7.5 ft-lb/125 VDC, 7.5 ft-lb/250 VDC, 10 ft-lb/250 VDC, 15 ft-lb/250 VDC, 25 ft-lb/250 VDC, 40 ft-lb/250 VDC, 60 ft-lb/250 VDC, 80 ft-lb/250 VDC, 100 ft-lb/250 VDC, 150 ft-lb/250 VDC, and 200 ft-lb/250 VDC.

Figures 3-4 through 3-23 show that the vendor current versus torque curves generally under-predict the measured motor current. This result is consistent with the fact that the vendor speed versus torque curves generally under-predict the motor speed ( i.e., for a given torque, an under-prediction in speed is consistent with an under-prediction in current).

The complete results of this justification are documented in Reference (9). For each test, a spreadsheet table contains the full time-history measured motor test data (motor current, motor terminal voltage, motor shaft speed and motor torque), the complete adjusted test data, and the predicted motor temperature

## 4.2 Actuator Gearbox Efficiency

Figures 3-1 through 3-3 of MPR-2093 [Reference 1] show the comparison of the measured gearbox efficiency f-factors versus the predicted f-factors using the method. Data points above the 45° line indicate that the predicted f-factor is conservative ( i.e., the predicted f-factor is less than the measured f-factor), and the efficiency used in the method is lower than the measured efficiency. Data points below the line indicate that the predicted f-factor is non-conservative.

As shown, the predicted f-factors are generally conservative. Note that this data only

covers SMB-0 and SMB-1 actuators. The complete results of this justification are documented in Reference (9). For each test, a spreadsheet table contains the full time-history measured motor and actuator test data (stem torque, motor shaft speed and motor torque) and the complete calculated and predicted data.

## 4.3 Use of Vendor Motor Heatup Rates

The table below compares the measured temperature rise to the predicted temperature rise at the maximum measured motor torque for each of the six tests. Data for the measured temperature rise is from Reference (2).

| Motor Type | Test | Maximum Measured Torque (ft-lbs) | Measured Temperature Rise (°F) | Predicted Temperature Rise (°F) |
|---|---|---|---|---|
| 10 ft-lb/125 VDC | 60% voltage | 8.5 | 23 | 30 @ 74 rpm |
| | 100% voltage | 15 | 40 | 44 @ 75 rpm |
| 25 ft-lb/125 VDC | 60% voltage | 17 | 45 | 67 @ 103 rpm (1) |
| | 100% voltage | 30 | 80 | 97 @ 161 rpm (1) |
| 40 ft-lb/125 VDC | 60% voltage | 21 | negligible | 24 @ 236 rpm |
| | 100% voltage | 40 | 40 | 55 @ 120 rpm (1) |

Note (1): For these tests, the motor speed at the last stroke position before predicted motor stall is much less than 100 rpm. To obtain a more reasonable heatup prediction, the temperature rise at the second-to-last stroke position is used.

The complete results of this justification are documented in Appendix B. The stroke time method is implemented using an automated spreadsheet tool. For each of the six INEEL tests for which the DC motor performance method was implemented, Appendix B contains the spreadsheet input form which shows all the inputs used and summarizes the key results of the method. Following each form is the results sheet which provides the full results of the method using the spreadsheet tool.

## 5.0 REFERENCES


(1) MPR-2093, *Predicting Capability and Stroke Time in DC Motor-Operated Valves*, Revision 0.

(2) NUREG/CR-6620, *Testing of dc-Powered Actuators for Motor-Operated Valves*, May 1999.

(3) Crane MOVATS STR-21.0, *Special Test Report to Deliver DC Motor Test Data to MPR Associates, Inc.*, Revision 1, Addendum 1.

(4) Letter and Attachments from S. Hale (Crane-MOVATS) to T. Walker (MPR), September 22, 1999, Subject: DC Motor Test Data.

(5) Schulz Electric Company Work Package for [BWR Plant A], Purchase Order No. 718524, Schulz Job No. N-1222.

(6) Schulz Electric Company Work Package for [BWR Plant A], Purchase Order No. 718524, Schulz Job No. N-1223.

(7) Letter and Attachment from J. Lake (INEEL) to T. Walker (MPR), October 11, 1999, DC Motor Actuator and Gearbox Test Data, including CD.

(8) Limitorque Valve Controls SEL 9.

(9) MPR Memorandum from T. Spears to Project File for Task Number 197-003, *Inputs and Results from the Justification of the DC Motor Performance Method*, March 1, 2000.

(10) Crane MOVATS STR-21.0, *Special Test Report to Deliver DC Motor Test Data to MPR Associates, Inc.*, Revision 1.

# APPENDIX A

## DC MOTOR PERFORMANCE MODEL INPUTS FOR JUSTIFICATION OF THE USE OF VENDOR MOTOR HEATUP RATES

(6 pages)

**Table A-1**
Method Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing

| Valve Description | Valve Type | Flow type | Flow direction | Fluid | Stem diameter $D_{stem}$ (inches) | Seat ring seating surface ID, $D_{body\text{-}ID}$ (inches) | Seat ring inner diameter $D_{sr}$ (inches) | Globe valve stroke length, D (inches) | Isolation-to-wedging travel, X (percent) | Packing load $F_{pack}$ (lbs) | Required thrust (including water inertia), $F_R$ (lbs) | Required thrust due to water inertia, $F_{WI}$ (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INEEL 10 ft-lb motor, SMB-0, 60% voltage | wedge gate (1) | | close (1) | | | 1.2 (2) | | | | | | |
| INEEL 10 ft-lb motor, SMB-0, 100% voltage | wedge gate (1) | | close (1) | | | 1.6 (2) | | | | | | |
| INEEL 25 ft-lb motor, SMB-0, 60% voltage | wedge gate (1) | | close (1) | | | 2.2 (2) | | | | | | |
| INEEL 25 ft-lb motor, SMB-0, 100% voltage | wedge gate (1) | | close (1) | | | 2.7 (2) | | | | | | |
| INEEL 40 ft-lb motor, SMB-1, 60% voltage | wedge gate (1) | | close (1) | | | 2.1 (2) | | | | | | |
| INEEL 40 ft-lb motor, SMB-1, 100% voltage | wedge gate (1) | | close (1) | | | 2.6 (2) | | | | | | |

**Table A-1**
Method Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing

| Valve Description | Flow coefficient $C_V$ (gpm/psi$^{1/2}$) | Actuator overall ratio, OAR | Motor gear set ratio, MGSR | Actuator rated torque, $t_{rated}$ | Stem factor SF (ft-lbs/lb) | Overhauling Stem factor $SF_o$ (ft-lbs/lb) | Voltage at MCC $V_{mcc}$ (volts) | Cable resistance $R_{cable}$ (ohms) | Thermal overload resistance, $R_{tol}$ (ohms) | Nominal voltage $V_{nom}$ (volts) | Motor type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INEEL 10 ft-lb motor, SMB-0, 60% voltage | | 69.56 (1) | 0.532 (1) | 500 (3) | | | 78 (4) | 0.22 (5) | 0 (6) | 125 | 10 ft-lb, 125 VDC (1) |
| INEEL 10 ft-lb motor, SMB-0, 100% voltage | | 69.56 (1) | 0.532 (1) | 500 (3) | | | 126 (4) | 0.21 (5) | 0 (6) | 125 | 10 ft-lb, 125 VDC (1) |
| INEEL 25 ft-lb motor, SMB-0, 60% voltage | | 34.96 (1) | 1.057 (1) | 500 (3) | | | 76 (4) | 0.24 (5) | 0 (6) | 125 | 25 ft-lb, 125 VDC (1) |
| INEEL 25 ft-lb motor, SMB-0, 100% voltage | | 34.96 (1) | 1.057 (1) | 500 (3) | | | 126 (4) | 0.2 (5) | 0 (6) | 125 | 25 ft-lb, 125 VDC (1) |
| INEEL 40 ft-lb motor, SMB-1, 60% voltage | | 42.5 (1) | 0.8 (1) | 850 (3) | | | 78 (4) | 0.23 (5) | 0 (6) | 125 | 40 ft-lb, 125 VDC (1) |
| INEEL 40 ft-lb motor, SMB-1, 100% voltage | | 42.5 (1) | 0.8 (1) | 850 (3) | | | 125 (4) | 0.18 (5) | 0 (6) | 125 | 40 ft-lb, 125 VDC (1) |

**Table A-1**
Method Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing

| Valve Description | Nominal motor torque, $\tau_{nom}$ (ft-lbs) | Valve stem lead (inches) | Pullout efficiency $\eta_p$ | Run efficiency $\eta_r$ | Nominal motor speed (rpm) | Differential pressure, DP (psi) | Bonnet pressure at full open, $P_B$ (psig) | Flow rate $Q_{max}$ (gpm) | Fluid density $\gamma$ (lbs/ft$^3$) | Ambient temperature (C) | Equivalent length of upstream piping, $L_{up}$ (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INEEL 10 ft-lb motor, SMB-0, 60% voltage | 14.3 | 0.5 (1) | 0.4 (1) | 0.5 (1) | | | | | | 32 (1) | |
| INEEL 10 ft-lb motor, SMB-0, 100% voltage | 14.3 | 0.5 (1) | 0.4 (1) | 0.5 (1) | | | | | | 32 (1) | |
| INEEL 25 ft-lb motor, SMB-0, 60% voltage | 35 | 0.25 (1) | 0.4 (1) | 0.55 (1) | | | | | | 31 (1) | |
| INEEL 25 ft-lb motor, SMB-0, 100% voltage | 35 | 0.25 (1) | 0.4 (1) | 0.55 (1) | | | | | | 31 (1) | |
| INEEL 40 ft-lb motor, SMB-1, 60% voltage | 50.6 | 0.5 (1) | 0.4 (1) | 0.5 (1) | | | | | | 30 (1) | |
| INEEL 40 ft-lb motor, SMB-1, 100% voltage | 50.6 | 0.5 (1) | 0.4 (1) | 0.5 (1) | | | | | | 30 (1) | |

**Table A-1**
Method Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing

| Valve Description | Load profile | Load @ 100% | Load @ 90% | Load @ 80% | Load @ 70% | Load @ 60% | Load @ 55% | Load @ 50% | Load @ 45% | Load @ 40% | Load @ 35% | Load @ 30% | Load @ 28% | Load @ 26% | Load @ 24% | Load @ 22% | Load @ 20% | Load @ 18% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INEEL 10 ft-lb motor, SMB-0, 60% voltage | Input stem torque | 89 | 93 | 104 | 123 | 128 | 141 | 147 | 156 | 157 | 165 | 174 | 177 | 185 | 187 | 187 | 192 | 197 |
| INEEL 10 ft-lb motor, SMB-0, 100% voltage | Input stem torque | 87 | 100 | 114 | 141 | 160 | 174 | 182 | 195 | 214 | 233 | 253 | 255 | 266 | 273 | 283 | 293 | 301 |
| INEEL 25 ft-lb motor, SMB-0, 60% voltage | Input stem torque | 83 | 89 | 102 | 112 | 120 | 125 | 138 | 139 | 143 | 154 | 166 | 167 | 176 | 172 | 184 | 181 | 186 |
| INEEL 25 ft-lb motor, SMB-0, 100% voltage | Input stem torque | 84 | 95 | 108 | 121 | 141 | 159 | 165 | 182 | 199 | 212 | 230 | 243 | 244 | 258 | 269 | 275 | 288 |
| INEEL 40 ft-lb motor, SMB-1, 60% voltage | Input stem torque | 140 | 159 | 170 | 182 | 203 | 213 | 223 | 236 | 251 | 262 | 272 | 278 | 285 | 290 | 298 | 303 | 310 |
| INEEL 40 ft-lb motor, SMB-1, 100% voltage | Input stem torque | 175 | 196 | 216 | 255 | 281 | 307 | 326 | 352 | 375 | 405 | 439 | 455 | 466 | 483 | 500 | 517 | 535 |

**Table A-1**
Method Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing

| Valve Description | Load @ 16% | Load @ 14% | Load @ 12% | Load @ 10% | Load @ 9% | Load @ 8% | Load @ 7% | Load @ 6% | Load @ 5% | Load @ 4% | Load @ 3% | Load @ 2% | Load @ 1% | Load @ 0% | Load @ <0% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INEEL 10 ft-lb motor, SMB-0, 60% voltage | 207 | 204 | 210 | 217 | 215 | 220 | 220 | 221 | 227 | 227 | 227 | 230 | 232 | 222 | 222 |
| INEEL 10 ft-lb motor, SMB-0, 100% voltage | 318 | 328 | 333 | 350 | 359 | 360 | 369 | 368 | 381 | 389 | 393 | 397 | 398 | 361 | 361 |
| INEEL 25 ft-lb motor, SMB-0, 60% voltage | 192 | 203 | 206 | 210 | 208 | 215 | 215 | 212 | 217 | 222 | 223 | 221 | 222 | 210 | 210 |
| INEEL 25 ft-lb motor, SMB-0, 100% voltage | 301 | 317 | 335 | 346 | 354 | 358 | 363 | 373 | 375 | 384 | 393 | 394 | 402 | 385 | 385 |
| INEEL 40 ft-lb motor, SMB-1, 60% voltage | 318 | 325 | 332 | 341 | 343 | 349 | 353 | 357 | 362 | 364 | 368 | 372 | 375 | 356 | 356 |
| INEEL 40 ft-lb motor, SMB-1, 100% voltage | 550 | 570 | 589 | 612 | 622 | 629 | 640 | 650 | 658 | 667 | 673 | 680 | 678 | 673 | 673 |

**Notes to Inputs for Justification of Vendor Motor Heatup Rates Using NRC/INEEL DC Motor Testing**

(1) Determined from Reference (2)

(2) Determined from stem position data

(3) Determined from Reference (8)

(4) Calculated by adjusting the measured motor voltage at the beginning of each test stroke for losses from the MCC to the motor.

(5) This value represents the total resistance upstream of the motor. This value is calculated from Reference (2) by dividing the motor voltage increase for the test (from beginning to end) by the motor current.

(6) This value was set as zero. The input for cable resistance represents the total resistance upstream of the motor.

**APPENDIX B**

**INPUT FORMS AND RESULTS FOR JUSTIFICATION OF THE USE OF VENDOR MOTOR HEATUP RATES**

(12 pages)

NOTE: "#REF!" cells in the attached spreadsheets indicate the motors are predicted to stall.

*Select Valve*--> INEEL 10 ft-lb motor, 60% voltage

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input stem torque |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 1.200 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 69.56 |
| Motor gear set ratio, MGSR | yes | 0.53 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 78.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.220 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 10 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 14.3 |
| Maximum motor torque (ft-lbs) | yes | #REF! |
| Maximum adjusted motor torque (ft-lbs) | yes | #REF! |
| Minimum motor speed (rpm) | yes | #REF! |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #REF! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

| *Torque Profile* | |
|---|---|
| 100% | 89 |
| 90% | 93 |
| 80% | 104 |
| 70% | 123 |
| 60% | 128 |
| 55% | 141 |
| 50% | 147 |
| 45% | 156 |
| 40% | 157 |
| 35% | 165 |
| 30% | 174 |
| 28% | 177 |
| 26% | 185 |
| 24% | 187 |
| 22% | 187 |
| 20% | 192 |
| 18% | 197 |
| 16% | 207 |
| 14% | 204 |
| 12% | 210 |
| 10% | 217 |
| 9% | 215 |
| 8% | 220 |
| 7% | 220 |
| 6% | 221 |
| 5% | 227 |
| 4% | 227 |
| 3% | 227 |
| 2% | 230 |
| 1% | 232 |
| 0% | 222 |
| -0.0010% | 222 |
| -100% | 222 |

***Warnings***

***Predicted Stroke Time (Seconds):*** #REF!

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | 0.00 | 32.0 | | | | --- |
| 100% | 1.20 | --- | | | | | | | | | | | | | | | | | |
| 90% | 1.08 | --- | --- | 90.75 | | 0.400 | 3.26 | 9.30 | 78.00 | 76 | 5.51 | 796 | 1.26 | 1.26 | 32.3 | 236 | #DIV/0! | --- | --- |
| 80% | 0.96 | --- | --- | 98.21 | 424 | 0.416 | 3.39 | 9.60 | 78.00 | 76 | 5.74 | 775 | 1.29 | 2.55 | 32.6 | 245 | #DIV/0! | --- | --- |
| 70% | 0.84 | --- | --- | 113.47 | 412 | 0.421 | 3.88 | 10.72 | 78.00 | 76 | 6.60 | 703 | 1.42 | 3.97 | 33.0 | 247 | #DIV/0! | --- | --- |
| 60% | 0.72 | --- | --- | 125.42 | 374 | 0.419 | 4.30 | 11.69 | 78.00 | 75 | 7.35 | 643 | 1.56 | 5.53 | 33.6 | 245 | #DIV/0! | --- | --- |
| 55% | 0.66 | --- | --- | 134.42 | 342 | 0.417 | 4.63 | 12.45 | 78.00 | 75 | 7.95 | 594 | 0.84 | 6.38 | 33.9 | 242 | #DIV/0! | --- | --- |
| 50% | 0.60 | --- | --- | 143.80 | 316 | 0.415 | 4.98 | 13.24 | 78.00 | 75 | 8.57 | 544 | 0.92 | 7.30 | 34.4 | 241 | #DIV/0! | --- | --- |
| 45% | 0.54 | --- | --- | 151.35 | 290 | 0.412 | 5.27 | 13.93 | 78.00 | 75 | 9.12 | 500 | 1.00 | 8.30 | 34.9 | 238 | #DIV/0! | --- | --- |
| 40% | 0.48 | --- | --- | 156.78 | 266 | 0.408 | 5.52 | 14.49 | 78.00 | 75 | 9.57 | 464 | 1.08 | 9.38 | 35.6 | 235 | #DIV/0! | --- | --- |
| 35% | 0.42 | --- | --- | 161.20 | 247 | 0.405 | 5.72 | 14.95 | 78.00 | 75 | 9.96 | 433 | 1.16 | 10.53 | 36.4 | 232 | #DIV/0! | --- | --- |
| 30% | 0.36 | --- | --- | 169.31 | 231 | 0.402 | 6.05 | 15.72 | 78.00 | 75 | 10.59 | 387 | 1.29 | 11.82 | 37.3 | 229 | #DIV/0! | --- | --- |
| 28% | 0.34 | --- | --- | 175.40 | 206 | 0.398 | 6.33 | 16.40 | 78.00 | 74 | 11.15 | 347 | 0.58 | 12.40 | 37.8 | 226 | #DIV/0! | --- | --- |
| 26% | 0.31 | --- | --- | 181.20 | 184 | 0.394 | 6.60 | 17.05 | 78.00 | 74 | 11.66 | 309 | 0.65 | 13.05 | 38.3 | 223 | #DIV/0! | --- | --- |
| 24% | 0.29 | --- | --- | 186.29 | 164 | 0.391 | 6.85 | 17.64 | 78.00 | 74 | 12.14 | 274 | 0.73 | 13.78 | 39.0 | 220 | #DIV/0! | --- | --- |
| 22% | 0.26 | --- | --- | 186.95 | 146 | 0.388 | 6.93 | 17.83 | 78.00 | 74 | 12.32 | 261 | 0.77 | 14.55 | 39.8 | 217 | #DIV/0! | --- | --- |
| 20% | 0.24 | --- | --- | 189.07 | 139 | 0.387 | 7.03 | 18.07 | 78.00 | 74 | 12.54 | 246 | 0.82 | 15.36 | 40.6 | 216 | #DIV/0! | --- | --- |
| 18% | 0.22 | --- | --- | 194.29 | 131 | 0.385 | 7.25 | 18.60 | 78.00 | 74 | 13.00 | 213 | 0.94 | 16.30 | 41.5 | 214 | #DIV/0! | --- | --- |
| 16% | 0.19 | --- | --- | 201.95 | 113 | 0.382 | 7.59 | 19.43 | 78.00 | 74 | 13.70 | 163 | 1.23 | 17.53 | 43.0 | 211 | #DIV/0! | --- | --- |
| 14% | 0.17 | --- | --- | 205.60 | 87 | 0.375 | 7.89 | 20.13 | 78.00 | 74 | 14.33 | 118 | 1.70 | 19.23 | 45.1 | 206 | #DIV/0! | --- | --- |
| 12% | 0.14 | --- | --- | 207.11 | 63 | 0.365 | 8.16 | 20.74 | 78.00 | 73 | 14.96 | 74 | 2.72 | 21.96 | 48.7 | 198 | #DIV/0! | --- | --- |
| 10% | 0.12 | --- | --- | 213.63 | 39 | 0.356 | 8.64 | 21.80 | 78.00 | 73 | 16.09 | #REF! | #REF! | #REF! | #REF! | 190 | #DIV/0! | --- | --- |
| 9% | 0.11 | --- | --- | 216.05 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 8% | 0.10 | --- | --- | 217.56 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 7% | 0.08 | --- | --- | 220.31 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 6% | 0.07 | --- | --- | 220.86 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 5% | 0.06 | --- | --- | 224.30 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 4% | 0.05 | --- | --- | 226.95 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 3% | 0.04 | --- | --- | 226.80 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 2% | 0.02 | --- | --- | 228.37 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 1% | 0.01 | --- | --- | 230.85 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 226.68 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| -0.1% | 0.00 | --- | --- | 221.76 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.76 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 221.52 | #REF! | #REF! | #REF! | #REF! | 78.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| *TST* | --- | --- | --- | *25.48* | *66* | *0.366* | *1.00* | 4.20 | 78.00 | 77 | *14.33* | 123 | --- | --- | --- | *#REF!* | #REF! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | --- | *0.400* | 0.00 | *39.20* | 78.00 | 69 | *0.00* | 1282 | --- | *7.8* | *32.0* | *216* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *762* | *0.380* | 0.00 | 2.00 | 78.00 | 78 | *0.00* | 1433 | --- | *7.0* | *32.0* | *229* | #DIV/0! | --- | --- |

**Valve:** INEEL 10 ft-lb motor, 60% voltage

*Select Valve*--> INEEL 10 ft-lb motor, 100% voltage

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input stem torque |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 1.600 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 69.56 |
| Motor gear set ratio, MGSR | yes | 0.53 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 126.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.210 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 10 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, ρ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 14.3 |
| Maximum motor torque (ft-lbs) | yes | #REF! |
| Maximum adjusted motor torque (ft-lbs) | yes | #REF! |
| Minimum motor speed (rpm) | yes | #REF! |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #REF! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

***Warnings***

***Predicted Stroke Time (Seconds):*** #REF!

| *Torque Profile* | |
|---|---|
| 100% | 67 |
| 90% | 100 |
| 80% | 114 |
| 70% | 141 |
| 60% | 160 |
| 55% | 174 |
| 50% | 182 |
| 45% | 195 |
| 40% | 214 |
| 35% | 233 |
| 30% | 253 |
| 28% | 255 |
| 26% | 266 |
| 24% | 273 |
| 22% | 283 |
| 20% | 293 |
| 18% | 301 |
| 16% | 318 |
| 14% | 328 |
| 12% | 333 |
| 10% | 350 |
| 9% | 359 |
| 8% | 360 |
| 7% | 369 |
| 6% | 368 |
| 5% | 381 |
| 4% | 389 |
| 3% | 393 |
| 2% | 397 |
| 1% | 398 |
| 0% | 361 |
| -0.0010% | 361 |
| -100% | 361 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 1.60 | --- | | | | | | | | | | | | 0.00 | 32.0 | | | | --- |
| 90% | 1.44 | --- | --- | 93.68 | | 0.400 | 3.37 | 9.54 | 126.00 | 124 | 3.49 | 1599 | 0.84 | 0.84 | 32.2 | 385 | #DIV/0! | --- | --- |
| 80% | 1.28 | --- | --- | 107.21 | 851 | 0.428 | 3.60 | 10.07 | 126.00 | 124 | 3.73 | 1559 | 0.86 | 1.69 | 32.4 | 412 | #DIV/0! | --- | --- |
| 70% | 1.12 | --- | --- | 127.44 | 829 | 0.437 | 4.19 | 11.44 | 126.00 | 124 | 4.36 | 1461 | 0.91 | 2.61 | 32.7 | 419 | #DIV/0! | --- | --- |
| 60% | 0.96 | --- | --- | 150.39 | 777 | 0.446 | 4.84 | 12.94 | 126.00 | 123 | 5.06 | 1358 | 0.98 | 3.59 | 33.2 | 426 | #DIV/0! | --- | --- |
| 55% | 0.88 | --- | --- | 166.79 | 722 | 0.445 | 5.38 | 14.19 | 126.00 | 123 | 5.64 | 1271 | 0.53 | 4.11 | 33.5 | 424 | #DIV/0! | --- | --- |
| 50% | 0.80 | --- | --- | 177.66 | 676 | 0.444 | 5.75 | 15.02 | 126.00 | 123 | 6.04 | 1214 | 0.55 | 4.66 | 33.9 | 422 | #DIV/0! | --- | --- |
| 45% | 0.72 | --- | --- | 188.49 | 646 | 0.444 | 6.11 | 15.85 | 126.00 | 123 | 6.43 | 1161 | 0.57 | 5.24 | 34.3 | 420 | #DIV/0! | --- | --- |
| 40% | 0.64 | --- | --- | 204.45 | 618 | 0.443 | 6.63 | 17.11 | 126.00 | 122 | 7.01 | 1085 | 0.62 | 5.86 | 34.8 | 418 | #DIV/0! | --- | --- |
| 35% | 0.56 | --- | --- | 223.35 | 577 | 0.442 | 7.26 | 18.62 | 126.00 | 122 | 7.71 | 994 | 0.67 | 6.53 | 35.5 | 415 | #DIV/0! | --- | --- |
| 30% | 0.48 | --- | --- | 242.86 | 529 | 0.442 | 7.91 | 20.18 | 126.00 | 122 | 8.45 | 898 | 0.74 | 7.27 | 36.5 | 412 | #DIV/0! | --- | --- |
| 28% | 0.45 | --- | --- | 253.85 | 478 | 0.441 | 8.28 | 21.02 | 126.00 | 122 | 8.89 | 840 | 0.32 | 7.59 | 36.9 | 409 | #DIV/0! | --- | --- |
| 26% | 0.42 | --- | --- | 260.77 | 447 | 0.439 | 8.53 | 21.57 | 126.00 | 121 | 9.18 | 803 | 0.33 | 7.92 | 37.4 | 407 | #DIV/0! | --- | --- |
| 24% | 0.38 | --- | --- | 269.90 | 427 | 0.436 | 8.90 | 22.37 | 126.00 | 121 | 9.61 | 748 | 0.36 | 8.28 | 38.0 | 403 | #DIV/0! | --- | --- |
| 22% | 0.35 | --- | --- | 277.97 | 398 | 0.431 | 9.27 | 23.19 | 126.00 | 121 | 10.04 | 693 | 0.39 | 8.66 | 38.6 | 397 | #DIV/0! | --- | --- |
| 20% | 0.32 | --- | --- | 287.70 | 368 | 0.426 | 9.71 | 24.16 | 126.00 | 121 | 10.56 | 631 | 0.42 | 9.09 | 39.4 | 390 | #DIV/0! | --- | --- |
| 18% | 0.29 | --- | --- | 296.84 | 336 | 0.420 | 10.15 | 25.18 | 126.00 | 121 | 11.09 | 568 | 0.47 | 9.56 | 40.4 | 383 | #DIV/0! | --- | --- |
| 16% | 0.26 | --- | --- | 309.60 | 302 | 0.415 | 10.73 | 26.63 | 126.00 | 120 | 11.80 | 485 | 0.55 | 10.11 | 41.7 | 376 | #DIV/0! | --- | --- |
| 14% | 0.22 | --- | --- | 323.18 | 258 | 0.407 | 11.41 | 28.33 | 126.00 | 120 | 12.65 | 387 | 0.69 | 10.80 | 43.5 | 366 | #DIV/0! | --- | --- |
| 12% | 0.19 | --- | --- | 330.40 | 206 | 0.398 | 11.93 | 29.63 | 126.00 | 120 | 13.34 | 306 | 0.87 | 11.67 | 45.9 | 355 | #DIV/0! | --- | --- |
| 10% | 0.16 | --- | --- | 341.19 | 163 | 0.391 | 12.55 | 31.07 | 126.00 | 119 | 14.19 | 207 | 1.29 | 12.96 | 50.0 | 345 | #DIV/0! | --- | --- |
| 9% | 0.14 | --- | --- | 354.09 | 110 | 0.382 | 13.33 | 32.87 | 126.00 | 119 | 15.34 | 75 | 1.78 | 14.74 | 56.3 | 331 | #DIV/0! | --- | --- |
| 8% | 0.13 | --- | --- | 359.14 | 40 | 0.356 | 14.50 | 35.61 | 126.00 | 119 | 17.14 | #REF! | #REF! | #REF! | #REF! | 300 | #DIV/0! | --- | --- |
| 7% | 0.11 | --- | --- | 364.10 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 6% | 0.10 | --- | --- | 368.40 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 5% | 0.08 | --- | --- | 374.58 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 4% | 0.06 | --- | --- | 384.99 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 3% | 0.05 | --- | --- | 391.05 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 2% | 0.03 | --- | --- | 394.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 1% | 0.02 | --- | --- | 397.38 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 379.40 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| -0.1% | 0.00 | --- | --- | 360.97 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.97 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 360.94 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| *TST* | --- | --- | --- | *26.45* | *106* | *0.380* | *1.00* | 4.20 | 126.00 | 125 | *14.33* | 200 | --- | --- | --- | *#REF!* | #REF! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | --- | *0.400* | 0.00 | *39.20* | 126.00 | 118 | *0.00* | 2176 | --- | *6.1* | *32.0* | *366* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *1229* | *0.380* | 0.00 | 2.00 | 126.00 | 126 | *0.00* | 2310 | --- | *5.8* | *32.0* | *369* | #DIV/0! | --- | --- |

**Valve:** INEEL 10 ft-lb motor, 100% voltage

**Select Valve-->** INEEL 25 ft-lb motor, 60% voltage

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input stem torque |

| Valve and Actuator Information | | |
|---|---|---|
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 2.200 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 34.96 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 76.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.240 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 25 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.250 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |

| Design Basis Conditions | | |
|---|---|---|
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 31 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |

| Calculated Values | | |
|---|---|---|
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 35.0 |
| Maximum motor torque (ft-lbs) | yes | #REF! |
| Maximum adjusted motor torque (ft-lbs) | yes | #REF! |
| Minimum motor speed (rpm) | yes | #REF! |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #REF! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

**Warnings**

***Predicted Stroke Time (Seconds):*** #REF!

| Torque Profile | |
|---|---|
| 100% | 83 |
| 90% | 89 |
| 80% | 102 |
| 70% | 112 |
| 60% | 120 |
| 55% | 125 |
| 50% | 138 |
| 45% | 139 |
| 40% | 143 |
| 35% | 154 |
| 30% | 166 |
| 28% | 167 |
| 26% | 176 |
| 24% | 172 |
| 22% | 184 |
| 20% | 181 |
| 18% | 186 |
| 16% | 192 |
| 14% | 203 |
| 12% | 206 |
| 10% | 210 |
| 9% | 208 |
| 8% | 215 |
| 7% | 215 |
| 6% | 212 |
| 5% | 217 |
| 4% | 222 |
| 3% | 223 |
| 2% | 221 |
| 1% | 222 |
| 0% | 210 |
| -0.0010% | 210 |
| -100% | 210 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 2.20 | --- | | | | | | | | | | | | 0.00 | 31.0 | | | | --- |
| 90% | 1.98 | --- | --- | 85.96 | | 0.400 | 6.15 | 16.29 | 76.00 | 72 | 10.90 | 776 | 2.38 | 2.38 | 31.8 | 276 | #DIV/0! | --- | --- |
| 80% | 1.76 | --- | --- | 95.27 | 820 | 0.434 | 6.28 | 16.57 | 76.00 | 72 | 11.18 | 764 | 2.42 | 4.80 | 32.6 | 298 | #DIV/0! | --- | --- |
| 70% | 1.54 | --- | --- | 106.88 | 808 | 0.442 | 6.92 | 18.01 | 76.00 | 72 | 12.43 | 714 | 2.59 | 7.38 | 33.7 | 301 | #DIV/0! | --- | --- |
| 60% | 1.32 | --- | --- | 116.32 | 754 | 0.447 | 7.45 | 19.19 | 76.00 | 71 | 13.48 | 678 | 2.72 | 10.11 | 35.1 | 302 | #DIV/0! | --- | --- |
| 55% | 1.21 | --- | --- | 122.83 | 717 | 0.450 | 7.81 | 19.99 | 76.00 | 71 | 14.24 | 653 | 1.41 | 11.52 | 35.8 | 302 | #DIV/0! | --- | --- |
| 50% | 1.10 | --- | --- | 131.73 | 690 | 0.455 | 8.28 | 21.04 | 76.00 | 71 | 15.19 | 621 | 1.49 | 13.01 | 36.7 | 303 | #DIV/0! | --- | --- |
| 45% | 0.99 | --- | --- | 138.52 | 656 | 0.459 | 8.64 | 21.85 | 76.00 | 71 | 15.95 | 597 | 1.55 | 14.55 | 37.7 | 304 | #DIV/0! | --- | --- |
| 40% | 0.88 | --- | --- | 140.84 | 631 | 0.459 | 8.77 | 22.14 | 76.00 | 71 | 16.27 | 587 | 1.57 | 16.13 | 38.8 | 303 | #DIV/0! | --- | --- |
| 35% | 0.77 | --- | --- | 148.32 | 621 | 0.464 | 9.15 | 22.99 | 76.00 | 70 | 17.08 | 563 | 1.64 | 17.77 | 40.0 | 304 | #DIV/0! | --- | --- |
| 30% | 0.66 | --- | --- | 160.00 | 595 | 0.464 | 9.86 | 24.51 | 76.00 | 70 | 18.59 | 518 | 1.78 | 19.55 | 41.5 | 301 | #DIV/0! | --- | --- |
| 28% | 0.62 | --- | --- | 166.74 | 547 | 0.463 | 10.31 | 25.44 | 76.00 | 70 | 19.60 | 488 | 0.76 | 20.31 | 42.2 | 298 | #DIV/0! | --- | --- |
| 26% | 0.57 | --- | --- | 171.43 | 516 | 0.462 | 10.62 | 26.08 | 76.00 | 70 | 20.29 | 468 | 0.79 | 21.10 | 43.0 | 296 | #DIV/0! | --- | --- |
| 24% | 0.53 | --- | --- | 173.66 | 495 | 0.461 | 10.77 | 26.40 | 76.00 | 70 | 20.66 | 457 | 0.81 | 21.90 | 43.8 | 294 | #DIV/0! | --- | --- |
| 22% | 0.48 | --- | --- | 178.05 | 483 | 0.461 | 11.05 | 26.98 | 76.00 | 70 | 21.31 | 438 | 0.84 | 22.75 | 44.7 | 292 | #DIV/0! | --- | --- |
| 20% | 0.44 | --- | --- | 182.52 | 463 | 0.460 | 11.34 | 27.59 | 76.00 | 69 | 21.99 | 419 | 0.88 | 23.63 | 45.7 | 291 | #DIV/0! | --- | --- |
| 18% | 0.40 | --- | --- | 183.21 | 443 | 0.458 | 11.44 | 27.79 | 76.00 | 69 | 22.27 | 412 | 0.90 | 24.52 | 46.8 | 288 | #DIV/0! | --- | --- |
| 16% | 0.35 | --- | --- | 189.02 | 436 | 0.456 | 11.85 | 28.64 | 76.00 | 69 | 23.22 | 388 | 0.95 | 25.47 | 47.9 | 285 | #DIV/0! | --- | --- |
| 14% | 0.31 | --- | --- | 197.75 | 410 | 0.450 | 12.58 | 30.15 | 76.00 | 69 | 24.88 | 347 | 1.07 | 26.54 | 49.4 | 278 | #DIV/0! | --- | --- |
| 12% | 0.26 | --- | --- | 204.69 | 366 | 0.439 | 13.35 | 31.64 | 76.00 | 68 | 26.70 | 299 | 1.23 | 27.77 | 51.4 | 268 | #DIV/0! | --- | --- |
| 10% | 0.22 | --- | --- | 208.06 | 316 | 0.426 | 13.99 | 32.85 | 76.00 | 68 | 28.27 | 258 | 1.43 | 29.20 | 53.8 | 258 | #DIV/0! | --- | --- |
| 9% | 0.20 | --- | --- | 209.24 | 273 | 0.415 | 14.44 | 33.72 | 76.00 | 68 | 29.53 | 231 | 0.80 | 30.00 | 55.3 | 248 | #DIV/0! | --- | --- |
| 8% | 0.18 | --- | --- | 211.57 | 245 | 0.407 | 14.86 | 34.53 | 76.00 | 68 | 30.64 | 208 | 0.89 | 30.89 | 57.0 | 242 | #DIV/0! | --- | --- |
| 7% | 0.15 | --- | --- | 214.74 | 220 | 0.401 | 15.33 | 35.43 | 76.00 | 67 | 31.89 | 180 | 1.03 | 31.91 | 59.1 | 236 | #DIV/0! | --- | --- |
| 6% | 0.13 | --- | --- | 213.19 | 190 | 0.393 | 15.51 | 35.79 | 76.00 | 67 | 32.55 | 164 | 1.13 | 33.04 | 61.5 | 229 | #DIV/0! | --- | --- |
| 5% | 0.11 | --- | --- | 214.39 | 173 | 0.389 | 15.77 | 36.31 | 76.00 | 67 | 33.42 | 143 | 1.29 | 34.33 | 64.3 | 224 | #DIV/0! | --- | --- |
| 4% | 0.09 | --- | --- | 219.34 | 151 | 0.383 | 16.37 | 37.55 | 76.00 | 67 | 35.18 | 103 | 1.79 | 36.12 | 68.6 | 218 | #DIV/0! | --- | --- |
| 3% | 0.07 | --- | --- | 222.30 | 109 | 0.372 | 17.08 | 39.02 | 76.00 | 67 | 37.41 | 55 | 3.35 | 39.47 | 77.1 | 208 | #DIV/0! | --- | --- |
| 2% | 0.04 | --- | --- | 222.10 | 58 | 0.345 | 18.42 | 41.80 | 76.00 | 66 | 41.91 | #REF! | #REF! | #REF! | #REF! | 185 | #DIV/0! | --- | --- |
| 1% | 0.02 | --- | --- | 221.49 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 215.81 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| -0.1% | 0.00 | --- | --- | 209.88 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.88 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 209.76 | #REF! | #REF! | #REF! | #REF! | 76.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| *TST* | --- | --- | --- | *12.96* | *127* | *0.371* | *1.00* | 4.22 | 76.00 | 75 | *35.00* | 120 | --- | --- | --- | *#REF!* | #REF! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | — | *0.400* | 0.00 | *82.00* | 76.00 | 56 | *0.00* | 1352 | --- | *13.7* | *31.0* | *216* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *1919* | *0.370* | 0.00 | 1.50 | 76.00 | 76 | *0.00* | 1815 | --- | *10.2* | *31.0* | *268* | #DIV/0! | --- | --- |

**Valve:** INEEL 25 ft-lb motor, 60% voltage

*Select Valve*--> INEEL 25 ft-lb motor, 100% voltage

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input stem torque |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 2.700 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 34.96 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 126.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.200 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 25 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.250 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_e$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 31 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 35.0 |
| Maximum motor torque (ft-lbs) | yes | #REF! |
| Maximum adjusted motor torque (ft-lbs) | yes | #REF! |
| Minimum motor speed (rpm) | yes | #REF! |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #REF! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

***Warnings***

***Predicted Stroke Time (Seconds):*** #REF!

| ***Torque Profile*** | |
|---|---|
| 100% | 84 |
| 90% | 95 |
| 80% | 108 |
| 70% | 121 |
| 60% | 141 |
| 55% | 159 |
| 50% | 165 |
| 45% | 182 |
| 40% | 199 |
| 35% | 212 |
| 30% | 230 |
| 28% | 243 |
| 26% | 244 |
| 24% | 258 |
| 22% | 269 |
| 20% | 275 |
| 18% | 288 |
| 16% | 301 |
| 14% | 317 |
| 12% | 335 |
| 10% | 346 |
| 9% | 354 |
| 8% | 358 |
| 7% | 363 |
| 6% | 373 |
| 5% | 375 |
| 4% | 384 |
| 3% | 393 |
| 2% | 394 |
| 1% | 402 |
| 0% | 385 |
| -0.0010% | 385 |
| -100% | 385 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 2.70 | --- | | | | | | | | | | | | 0.00 | 31.0 | | | | --- |
| 90% | 2.43 | --- | --- | 89.41 | | 0.400 | 6.39 | 16.82 | 126.00 | 123 | 6.67 | 1643 | 1.38 | 1.38 | 31.5 | 469 | #DIV/0! | --- | --- |
| 80% | 2.16 | --- | --- | 101.49 | 1737 | 0.456 | 6.36 | 16.76 | 126.00 | 123 | 6.65 | 1645 | 1.38 | 2.76 | 32.0 | 534 | #DIV/0! | --- | --- |
| 70% | 1.89 | --- | --- | 114.65 | 1739 | 0.467 | 7.02 | 18.22 | 126.00 | 122 | 7.36 | 1582 | 1.43 | 4.19 | 32.6 | 545 | #DIV/0! | --- | --- |
| 60% | 1.62 | --- | --- | 131.12 | 1672 | 0.480 | 7.82 | 20.01 | 126.00 | 122 | 8.25 | 1504 | 1.51 | 5.70 | 33.4 | 557 | #DIV/0! | --- | --- |
| 55% | 1.49 | --- | --- | 149.99 | 1590 | 0.493 | 8.70 | 21.99 | 126.00 | 122 | 9.23 | 1417 | 0.80 | 6.49 | 34.0 | 568 | #DIV/0! | --- | --- |
| 50% | 1.35 | --- | --- | 162.05 | 1498 | 0.490 | 9.45 | 23.66 | 126.00 | 121 | 10.08 | 1357 | 0.83 | 7.33 | 34.6 | 563 | #DIV/0! | --- | --- |
| 45% | 1.22 | --- | --- | 173.72 | 1435 | 0.489 | 10.17 | 25.15 | 126.00 | 121 | 10.90 | 1302 | 0.87 | 8.20 | 35.4 | 558 | #DIV/0! | --- | --- |
| 40% | 1.08 | --- | --- | 190.49 | 1376 | 0.487 | 11.19 | 27.28 | 126.00 | 121 | 12.07 | 1223 | 0.93 | 9.13 | 36.4 | 552 | #DIV/0! | --- | --- |
| 35% | 0.95 | --- | --- | 205.57 | 1293 | 0.484 | 12.14 | 29.25 | 126.00 | 120 | 13.18 | 1156 | 0.98 | 10.11 | 37.7 | 546 | #DIV/0! | --- | --- |
| 30% | 0.81 | --- | --- | 221.27 | 1222 | 0.482 | 13.12 | 31.19 | 126.00 | 120 | 14.36 | 1091 | 1.04 | 11.14 | 39.3 | 539 | #DIV/0! | --- | --- |
| 28% | 0.76 | --- | --- | 236.70 | 1153 | 0.480 | 14.09 | 33.06 | 126.00 | 119 | 15.57 | 1025 | 0.44 | 11.59 | 40.0 | 532 | #DIV/0! | --- | --- |
| 26% | 0.70 | --- | --- | 243.41 | 1084 | 0.478 | 14.55 | 33.94 | 126.00 | 119 | 16.15 | 996 | 0.45 | 12.04 | 40.9 | 528 | #DIV/0! | --- | --- |
| 24% | 0.65 | --- | --- | 250.72 | 1053 | 0.477 | 15.02 | 34.84 | 126.00 | 119 | 16.74 | 966 | 0.47 | 12.51 | 41.8 | 524 | #DIV/0! | --- | --- |
| 22% | 0.59 | --- | --- | 263.26 | 1022 | 0.477 | 15.80 | 36.36 | 126.00 | 119 | 17.71 | 918 | 0.49 | 13.00 | 42.9 | 520 | #DIV/0! | --- | --- |
| 20% | 0.54 | --- | --- | 271.95 | 970 | 0.475 | 16.37 | 37.56 | 126.00 | 118 | 18.46 | 881 | 0.51 | 13.52 | 44.1 | 515 | #DIV/0! | --- | --- |
| 18% | 0.49 | --- | --- | 281.79 | 931 | 0.474 | 17.01 | 38.87 | 126.00 | 118 | 19.31 | 839 | 0.54 | 14.06 | 45.5 | 511 | #DIV/0! | --- | --- |
| 16% | 0.43 | --- | --- | 294.62 | 887 | 0.473 | 17.83 | 40.58 | 126.00 | 118 | 20.40 | 786 | 0.58 | 14.63 | 47.1 | 506 | #DIV/0! | --- | --- |
| 14% | 0.38 | --- | --- | 309.02 | 831 | 0.471 | 18.76 | 42.53 | 126.00 | 117 | 21.66 | 724 | 0.63 | 15.26 | 49.0 | 499 | #DIV/0! | --- | --- |
| 12% | 0.32 | --- | --- | 325.94 | 766 | 0.469 | 19.87 | 44.47 | 126.00 | 117 | 23.18 | 659 | 0.69 | 15.95 | 51.4 | 492 | #DIV/0! | --- | --- |
| 10% | 0.27 | --- | --- | 340.18 | 697 | 0.467 | 20.83 | 46.16 | 126.00 | 117 | 24.57 | 601 | 0.75 | 16.70 | 54.3 | 485 | #DIV/0! | --- | --- |
| 9% | 0.24 | --- | --- | 349.81 | 636 | 0.465 | 21.50 | 47.34 | 126.00 | 117 | 25.67 | 554 | 0.41 | 17.11 | 56.0 | 477 | #DIV/0! | --- | --- |
| 8% | 0.22 | --- | --- | 356.18 | 585 | 0.464 | 21.96 | 48.15 | 126.00 | 116 | 26.41 | 521 | 0.43 | 17.54 | 57.8 | 472 | #DIV/0! | --- | --- |
| 7% | 0.19 | --- | --- | 360.58 | 551 | 0.463 | 22.28 | 48.71 | 126.00 | 116 | 26.99 | 496 | 0.46 | 18.00 | 59.8 | 468 | #DIV/0! | --- | --- |
| 6% | 0.16 | --- | --- | 367.89 | 524 | 0.462 | 22.77 | 49.58 | 126.00 | 116 | 27.81 | 459 | 0.49 | 18.49 | 62.1 | 463 | #DIV/0! | --- | --- |
| 5% | 0.14 | --- | --- | 373.93 | 486 | 0.461 | 23.20 | 50.33 | 126.00 | 116 | 28.59 | 429 | 0.53 | 19.02 | 64.6 | 458 | #DIV/0! | --- | --- |
| 4% | 0.11 | --- | --- | 379.44 | 453 | 0.460 | 23.59 | 51.02 | 126.00 | 116 | 29.35 | 401 | 0.56 | 19.59 | 67.3 | 453 | #DIV/0! | --- | --- |
| 3% | 0.08 | --- | --- | 388.45 | 424 | 0.453 | 24.51 | 52.64 | 126.00 | 115 | 30.86 | 346 | 0.65 | 20.24 | 70.8 | 441 | #DIV/0! | --- | --- |
| 2% | 0.05 | --- | --- | 393.24 | 366 | 0.438 | 25.66 | 54.86 | 126.00 | 115 | 32.80 | 270 | 0.84 | 21.08 | 75.7 | 420 | #DIV/0! | --- | --- |
| 1% | 0.03 | --- | --- | 397.80 | 285 | 0.418 | 27.25 | 58.18 | 126.00 | 114 | 35.60 | 161 | 1.41 | 22.49 | 84.8 | 391 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 393.44 | 170 | 0.388 | 29.00 | 61.54 | 126.00 | 114 | 39.24 | 28 | 8.20 | 30.69 | 145.5 | 351 | #DIV/0! | --- | --- |
| -0.1% | 0.00 | --- | --- | 384.93 | 29 | 0.328 | 33.62 | 70.04 | 126.00 | 112 | 54.95 | #REF! | #REF! | #REF! | #REF! | 245 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 384.93 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 384.85 | #REF! | #REF! | #REF! | #REF! | 126.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| *TST* | --- | --- | --- | *13.02* | *211* | *0.372* | *1.00* | 4.22 | 126.00 | 125 | *35.00* | 200 | --- | --- | --- | *#REF!* | #REF! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | --- | *0.400* | 0.00 | *82.00* | 126.00 | 110 | *0.00* | 2630 | --- | *8.6* | *31.0* | *419* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *3171* | *0.370* | 0.00 | 1.50 | 126.00 | 126 | *0.00* | 3000 | --- | *7.6* | *31.0* | *442* | #DIV/0! | --- | --- |

**Valve:** INEEL 25 ft-lb motor, 100% voltage

*Select Valve*--> INEEL 40 ft-lb motor, 60% voltage

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | input stem torque |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 2.100 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 42.50 |
| Motor gear set ratio, MGSR | yes | 0.80 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 78.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.230 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 40 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, ρ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 30 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 50.6 |
| Maximum motor torque (ft-lbs) | yes | 22.5 |
| Maximum adjusted motor torque (ft-lbs) | yes | 45.7 |
| Minimum motor speed (rpm) | yes | 188 |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #DIV/0! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

*Warnings*

***Predicted Stroke Time (Seconds):*** **20.80**

| Torque Profile | |
|---|---|
| 100% | 140 |
| 90% | 159 |
| 80% | 170 |
| 70% | 182 |
| 60% | 203 |
| 55% | 213 |
| 50% | 223 |
| 45% | 236 |
| 40% | 251 |
| 35% | 262 |
| 30% | 272 |
| 28% | 278 |
| 26% | 285 |
| 24% | 290 |
| 22% | 298 |
| 20% | 303 |
| 18% | 310 |
| 16% | 318 |
| 14% | 325 |
| 12% | 332 |
| 10% | 341 |
| 9% | 343 |
| 8% | 349 |
| 7% | 353 |
| 6% | 357 |
| 5% | 362 |
| 4% | 364 |
| 3% | 368 |
| 2% | 372 |
| 1% | 375 |
| 0% | 356 |
| -0.0010% | 356 |
| -100% | 356 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | *0.00* | *30.0* | | | | --- |
| 100% | 2.10 | --- | | | | *0.400* | 8.78 | 26.08 | 78.00 | 72 | 15.54 | 786 | 1.36 | 1.36 | 30.3 | 486 | #DIV/0! | --- | --- |
| 90% | 1.89 | --- | --- | 149.31 | | 0.421 | 9.19 | 27.06 | 78.00 | 72 | 16.33 | 767 | 1.40 | 2.76 | 30.6 | 510 | #DIV/0! | --- | --- |
| 80% | 1.68 | --- | --- | 164.43 | 629 | 0.424 | 9.79 | 28.50 | 78.00 | 71 | 17.50 | 739 | 1.45 | 4.21 | 31.0 | 510 | #DIV/0! | --- | --- |
| 70% | 1.47 | --- | --- | 176.34 | 614 | 0.427 | 10.60 | 30.33 | 78.00 | 71 | 19.09 | 701 | 1.53 | 5.74 | 31.4 | 511 | #DIV/0! | --- | --- |
| 60% | 1.26 | --- | --- | 192.58 | 591 | 0.431 | 11.35 | 31.96 | 78.00 | 71 | 20.57 | 667 | 0.80 | 6.54 | 31.7 | 511 | #DIV/0! | --- | --- |
| 55% | 1.16 | --- | --- | 207.67 | 561 | 0.433 | 11.85 | 33.08 | 78.00 | 70 | 21.59 | 645 | 0.83 | 7.37 | 32.0 | 511 | #DIV/0! | --- | --- |
| 50% | 1.05 | --- | --- | 217.96 | 534 | 0.435 | 12.41 | 34.30 | 78.00 | 70 | 22.72 | 621 | 0.86 | 8.23 | 32.4 | 511 | #DIV/0! | --- | --- |
| 45% | 0.95 | --- | --- | 229.53 | 516 | 0.438 | 13.06 | 35.74 | 78.00 | 70 | 24.06 | 593 | 0.90 | 9.13 | 32.8 | 512 | #DIV/0! | --- | --- |
| 40% | 0.84 | --- | --- | 243.20 | 497 | 0.440 | 13.70 | 37.15 | 78.00 | 69 | 25.40 | 565 | 0.95 | 10.08 | 33.2 | 511 | #DIV/0! | --- | --- |
| 35% | 0.74 | --- | --- | 256.53 | 474 | 0.440 | 14.30 | 38.45 | 78.00 | 69 | 26.66 | 540 | 0.99 | 11.07 | 33.8 | 508 | #DIV/0! | --- | --- |
| 30% | 0.63 | --- | --- | 267.36 | 452 | 0.437 | 14.81 | 39.58 | 78.00 | 69 | 27.77 | 519 | 0.41 | 11.49 | 34.0 | 501 | #DIV/0! | --- | --- |
| 28% | 0.59 | --- | --- | 275.00 | 432 | 0.434 | 15.25 | 40.50 | 78.00 | 69 | 28.72 | 501 | 0.43 | 11.91 | 34.3 | 496 | #DIV/0! | --- | --- |
| 26% | 0.55 | --- | --- | 281.30 | 415 | 0.432 | 15.67 | 41.34 | 78.00 | 68 | 29.62 | 483 | 0.44 | 12.36 | 34.6 | 491 | #DIV/0! | --- | --- |
| 24% | 0.50 | --- | --- | 287.39 | 400 | 0.429 | 16.11 | 42.21 | 78.00 | 68 | 30.57 | 465 | 0.46 | 12.82 | 34.9 | 486 | #DIV/0! | --- | --- |
| 22% | 0.46 | --- | --- | 293.75 | 387 | 0.427 | 16.55 | 43.11 | 78.00 | 68 | 31.55 | 445 | 0.48 | 13.30 | 35.2 | 482 | #DIV/0! | --- | --- |
| 20% | 0.42 | --- | --- | 300.11 | 372 | 0.424 | 17.01 | 44.01 | 78.00 | 68 | 32.56 | 425 | 0.50 | 13.80 | 35.6 | 476 | #DIV/0! | --- | --- |
| 18% | 0.38 | --- | --- | 306.40 | 356 | 0.421 | 17.56 | 45.12 | 78.00 | 68 | 33.79 | 401 | 0.53 | 14.34 | 36.1 | 471 | #DIV/0! | --- | --- |
| 16% | 0.34 | --- | --- | 314.32 | 340 | 0.418 | 18.13 | 46.25 | 78.00 | 67 | 35.07 | 376 | 0.57 | 14.91 | 36.6 | 465 | #DIV/0! | --- | --- |
| 14% | 0.29 | --- | --- | 321.90 | 321 | 0.414 | 18.67 | 47.34 | 78.00 | 67 | 36.32 | 353 | 0.61 | 15.51 | 37.1 | 458 | #DIV/0! | --- | --- |
| 12% | 0.25 | --- | --- | 328.80 | 301 | 0.411 | 19.25 | 48.50 | 78.00 | 67 | 37.68 | 328 | 0.65 | 16.16 | 37.8 | 452 | #DIV/0! | --- | --- |
| 10% | 0.21 | --- | --- | 336.51 | 283 | 0.408 | 19.72 | 49.44 | 78.00 | 67 | 38.82 | 308 | 0.35 | 16.51 | 38.1 | 446 | #DIV/0! | --- | --- |
| 9% | 0.19 | --- | --- | 341.86 | 263 | 0.405 | 20.10 | 50.15 | 78.00 | 66 | 39.71 | 292 | 0.37 | 16.88 | 38.5 | 441 | #DIV/0! | --- | --- |
| 8% | 0.17 | --- | --- | 345.99 | 246 | 0.403 | 20.49 | 50.78 | 78.00 | 66 | 40.62 | 276 | 0.39 | 17.27 | 38.9 | 437 | #DIV/0! | --- | --- |
| 7% | 0.15 | --- | --- | 350.79 | 234 | 0.401 | 20.83 | 51.32 | 78.00 | 66 | 41.44 | 262 | 0.41 | 17.68 | 39.4 | 433 | #DIV/0! | --- | --- |
| 6% | 0.13 | --- | --- | 354.65 | 221 | 0.399 | 21.21 | 51.93 | 78.00 | 66 | 42.36 | 245 | 0.44 | 18.11 | 39.9 | 429 | #DIV/0! | --- | --- |
| 5% | 0.11 | --- | --- | 359.38 | 209 | 0.397 | 21.55 | 52.48 | 78.00 | 66 | 43.20 | 231 | 0.46 | 18.58 | 40.5 | 425 | #DIV/0! | --- | --- |
| 4% | 0.08 | --- | --- | 363.11 | 196 | 0.395 | 21.85 | 52.95 | 78.00 | 66 | 43.97 | 217 | 0.49 | 19.07 | 41.1 | 422 | #DIV/0! | --- | --- |
| 3% | 0.06 | --- | --- | 366.29 | 185 | 0.393 | 22.20 | 53.51 | 78.00 | 66 | 44.86 | 202 | 0.53 | 19.60 | 41.8 | 418 | #DIV/0! | --- | --- |
| 2% | 0.04 | --- | --- | 370.41 | 174 | 0.391 | 22.51 | 54.02 | 78.00 | 66 | 45.69 | 188 | 0.57 | 20.17 | 42.6 | 414 | #DIV/0! | --- | --- |
| 1% | 0.02 | --- | --- | 373.66 | 162 | 0.389 | 22.13 | 53.40 | 78.00 | 66 | 44.94 | 201 | 0.53 | 20.70 | 43.3 | 412 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 365.41 | 150 | 0.390 | 21.45 | 52.33 | 78.00 | 66 | 43.52 | 225 | 0.05 | 20.75 | 43.3 | 414 | #DIV/0! | --- | --- |
| -0.1% | 0.00 | --- | --- | 355.97 | 161 | 0.394 | 21.27 | 52.03 | 78.00 | 66 | 43.11 | 233 | 0.05 | 20.80 | 43.4 | 418 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.97 | 180 | 0.395 | 21.21 | 51.94 | 78.00 | 66 | 43.00 | 235 | 0.00 | 20.80 | 43.4 | 419 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 186 | 0.395 | 21.20 | 51.92 | 78.00 | 66 | 42.96 | 235 | 0.00 | 20.80 | 43.4 | 419 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.20 | 51.91 | 78.00 | 66 | 42.95 | 235 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.19 | 51.91 | 78.00 | 66 | 42.95 | 235 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.19 | 51.91 | 78.00 | 66 | 42.95 | 236 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.19 | 51.91 | 78.00 | 66 | 42.95 | 236 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.19 | 51.91 | 78.00 | 66 | 42.95 | 236 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 355.93 | 188 | 0.395 | 21.19 | 51.91 | 78.00 | 66 | 42.95 | 236 | 0.00 | 20.80 | 43.4 | 420 | #DIV/0! | --- | --- |
| *TST* | --- | --- | --- | *388.90* | *83* | *0.373* | *24.52* | 57.23 | 78.00 | 65 | *50.63* | 104 | --- | --- | --- | *389* | #DIV/0! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | --- | *0.400* | 0.00 | *115.00* | 78.00 | 52 | *0.00* | 1111 | --- | *9.6* | *30.0* | *348* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *1337* | *0.380* | 0.00 | 2.00 | 78.00 | 78 | *0.00* | 1672 | --- | *6.4* | *30.0* | *498* | #DIV/0! | --- | --- |

**Valve:** INEEL 40 ft-lb motor, 60% voltage

***Select Valve--->*** INEEL 40 ft-lb motor, 100% voltage

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input stem torque |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 2.600 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{WI}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 42.50 |
| Motor gear set ratio, MGSR | yes | 0.80 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0000 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 125.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.180 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 40 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 0 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_S$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 30 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 50.6 |
| Maximum motor torque (ft-lbs) | yes | #REF! |
| Maximum adjusted motor torque (ft-lbs) | yes | #REF! |
| Minimum motor speed (rpm) | yes | #REF! |
| Minimum instantaneous actuator capability (lbs) | yes | #DIV/0! |
| Minimum instantaneous margin (lbs) | yes | 0 |
| Maximum torque switch setting | yes | #REF! |
| Efficiency at minimum instantaneous capability | yes | #DIV/0! |

***Warnings***

***Predicted Stroke Time (Seconds):*** #REF!

| ***Torque Profile*** | |
|---|---|
| 100% | 175 |
| 90% | 196 |
| 80% | 216 |
| 70% | 255 |
| 60% | 281 |
| 55% | 307 |
| 50% | 326 |
| 45% | 352 |
| 40% | 375 |
| 35% | 405 |
| 30% | 439 |
| 28% | 455 |
| 26% | 466 |
| 24% | 483 |
| 22% | 500 |
| 20% | 517 |
| 18% | 535 |
| 16% | 550 |
| 14% | 570 |
| 12% | 589 |
| 10% | 612 |
| 9% | 622 |
| 8% | 629 |
| 7% | 640 |
| 6% | 650 |
| 5% | 658 |
| 4% | 667 |
| 3% | 673 |
| 2% | 680 |
| 1% | 678 |
| 0% | 673 |
| -0.0010% | 673 |
| -100% | 673 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 2.60 | --- | | | | | | | | | | | | *0.00* | *30.0* | | | | --- |
| 90% | 2.34 | --- | --- | 185.42 | | *0.400* | 10.91 | 30.99 | 125.00 | 119 | 11.64 | 1445 | 0.92 | 0.92 | 30.3 | 807 | #DIV/0! | --- | --- |
| 80% | 2.08 | --- | --- | 206.12 | 1156 | 0.440 | 11.03 | 31.27 | 125.00 | 119 | 11.79 | 1439 | 0.92 | 1.84 | 30.6 | 885 | #DIV/0! | --- | --- |
| 70% | 1.82 | --- | --- | 235.82 | 1151 | 0.448 | 12.38 | 34.25 | 125.00 | 119 | 13.31 | 1378 | 0.96 | 2.80 | 31.0 | 897 | #DIV/0! | --- | --- |
| 60% | 1.56 | --- | --- | 268.10 | 1102 | 0.453 | 13.94 | 37.66 | 125.00 | 118 | 15.08 | 1307 | 1.01 | 3.82 | 31.5 | 900 | #DIV/0! | --- | --- |
| 55% | 1.43 | --- | --- | 293.88 | 1046 | 0.452 | 15.31 | 40.63 | 125.00 | 118 | 16.67 | 1246 | 0.53 | 4.35 | 31.8 | 892 | #DIV/0! | --- | --- |
| 50% | 1.30 | --- | --- | 316.42 | 997 | 0.451 | 16.52 | 43.05 | 125.00 | 117 | 18.08 | 1192 | 0.56 | 4.90 | 32.2 | 886 | #DIV/0! | --- | --- |
| 45% | 1.17 | --- | --- | 339.15 | 954 | 0.450 | 17.74 | 45.49 | 125.00 | 117 | 19.52 | 1138 | 0.58 | 5.49 | 32.7 | 880 | #DIV/0! | --- | --- |
| 40% | 1.04 | --- | --- | 363.72 | 910 | 0.449 | 19.06 | 48.13 | 125.00 | 116 | 21.09 | 1082 | 0.61 | 6.10 | 33.3 | 873 | #DIV/0! | --- | --- |
| 35% | 0.91 | --- | --- | 390.04 | 866 | 0.448 | 20.48 | 50.77 | 125.00 | 116 | 22.81 | 1024 | 0.65 | 6.75 | 34.0 | 866 | #DIV/0! | --- | --- |
| 30% | 0.78 | --- | --- | 422.11 | 819 | 0.447 | 22.21 | 53.54 | 125.00 | 115 | 24.91 | 954 | 0.70 | 7.44 | 34.9 | 858 | #DIV/0! | --- | --- |
| 28% | 0.73 | --- | --- | 447.29 | 763 | 0.446 | 23.59 | 55.75 | 125.00 | 115 | 26.64 | 899 | 0.29 | 7.74 | 35.4 | 850 | #DIV/0! | --- | --- |
| 26% | 0.68 | --- | --- | 460.41 | 719 | 0.445 | 24.33 | 56.93 | 125.00 | 115 | 27.57 | 870 | 0.30 | 8.04 | 35.9 | 846 | #DIV/0! | --- | --- |
| 24% | 0.62 | --- | --- | 474.22 | 696 | 0.445 | 25.09 | 58.15 | 125.00 | 115 | 28.53 | 840 | 0.32 | 8.36 | 36.4 | 842 | #DIV/0! | --- | --- |
| 22% | 0.57 | --- | --- | 491.27 | 672 | 0.444 | 26.02 | 59.73 | 125.00 | 114 | 29.72 | 804 | 0.33 | 8.69 | 37.0 | 837 | #DIV/0! | --- | --- |
| 20% | 0.52 | --- | --- | 508.19 | 643 | 0.444 | 26.95 | 61.31 | 125.00 | 114 | 30.92 | 765 | 0.35 | 9.03 | 37.7 | 832 | #DIV/0! | --- | --- |
| 18% | 0.47 | --- | --- | 525.92 | 612 | 0.443 | 27.93 | 62.97 | 125.00 | 114 | 32.21 | 723 | 0.37 | 9.40 | 38.4 | 827 | #DIV/0! | --- | --- |
| 16% | 0.42 | --- | --- | 542.76 | 578 | 0.442 | 28.86 | 64.57 | 125.00 | 113 | 33.47 | 682 | 0.39 | 9.79 | 39.3 | 821 | #DIV/0! | --- | --- |
| 14% | 0.36 | --- | --- | 560.09 | 546 | 0.442 | 29.83 | 66.20 | 125.00 | 113 | 34.78 | 640 | 0.41 | 10.20 | 40.3 | 815 | #DIV/0! | --- | --- |
| 12% | 0.31 | --- | --- | 579.51 | 512 | 0.441 | 30.91 | 68.04 | 125.00 | 113 | 36.28 | 595 | 0.45 | 10.65 | 41.4 | 809 | #DIV/0! | --- | --- |
| 10% | 0.26 | --- | --- | 600.76 | 476 | 0.440 | 32.09 | 70.05 | 125.00 | 112 | 37.94 | 545 | 0.49 | 11.14 | 42.7 | 802 | #DIV/0! | --- | --- |
| 9% | 0.23 | --- | --- | 617.13 | 436 | 0.438 | 33.19 | 71.92 | 125.00 | 112 | 39.55 | 497 | 0.27 | 11.40 | 43.5 | 790 | #DIV/0! | --- | --- |
| 8% | 0.21 | --- | --- | 625.66 | 398 | 0.431 | 34.15 | 73.56 | 125.00 | 112 | 40.93 | 456 | 0.29 | 11.69 | 44.4 | 774 | #DIV/0! | --- | --- |
| 7% | 0.18 | --- | --- | 634.79 | 365 | 0.425 | 35.11 | 75.15 | 125.00 | 111 | 42.31 | 416 | 0.32 | 12.01 | 45.4 | 759 | #DIV/0! | --- | --- |
| 6% | 0.16 | --- | --- | 645.21 | 332 | 0.420 | 36.16 | 76.62 | 125.00 | 111 | 43.85 | 371 | 0.36 | 12.37 | 46.7 | 745 | #DIV/0! | --- | --- |
| 5% | 0.13 | --- | --- | 654.21 | 297 | 0.414 | 37.21 | 78.09 | 125.00 | 111 | 45.43 | 325 | 0.41 | 12.78 | 48.2 | 729 | #DIV/0! | --- | --- |
| 4% | 0.10 | --- | --- | 662.47 | 260 | 0.407 | 38.26 | 79.56 | 125.00 | 111 | 47.07 | 278 | 0.48 | 13.26 | 50.0 | 713 | #DIV/0! | --- | --- |
| 3% | 0.08 | --- | --- | 669.91 | 222 | 0.401 | 39.31 | 81.04 | 125.00 | 110 | 48.80 | 228 | 0.58 | 13.84 | 52.4 | 695 | #DIV/0! | --- | --- |
| 2% | 0.05 | --- | --- | 676.82 | 183 | 0.394 | 40.40 | 82.64 | 125.00 | 110 | 50.71 | 174 | 0.76 | 14.60 | 55.7 | 676 | #DIV/0! | --- | --- |
| 1% | 0.03 | --- | --- | 679.39 | 139 | 0.387 | 41.34 | 84.14 | 125.00 | 110 | 52.61 | 120 | 1.11 | 15.71 | 60.8 | 654 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 675.87 | 96 | 0.378 | 42.03 | 85.25 | 125.00 | 110 | 54.51 | 66 | 2.00 | 17.71 | 70.1 | 628 | #DIV/0! | --- | --- |
| -0.1% | 0.00 | --- | --- | 673.22 | 53 | 0.361 | 43.85 | 88.17 | 125.00 | 109 | 58.97 | #REF! | #REF! | #REF! | #REF! | 578 | #DIV/0! | --- | --- |
| 0% | 0.00 | --- | --- | 673.22 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| 0% | 0.00 | --- | --- | 673.43 | #REF! | #REF! | #REF! | #REF! | 125.00 | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | #REF! | --- | --- |
| *TST* | --- | --- | --- | *16.18* | *159* | *0.381* | *1.00* | 5.00 | 125.00 | 124 | *50.63* | 199 | --- | --- | --- | *#REF!* | #REF! | --- | --- |
| *Screen* | --- | --- | *0* | *0.00* | --- | *0.400* | 0.00 | *115.00* | 125.00 | 104 | *0.00* | 2249 | --- | *5.9* | *30.0* | *705* | #DIV/0! | --- | --- |
| *w/iter* | --- | --- | *0* | *0.00* | *2150* | *0.380* | 0.00 | 2.00 | 125.00 | 125 | *0.00* | 2687 | --- | *4.9* | *30.0* | *800* | #DIV/0! | --- | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | INEEL 40 ft-lb motor, 100% voltage | | | | | | | | | | | | | | | | | | |

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

# CALCULATION TITLE PAGE

| | | |
|---|---|---|
| Client | BWR Owners' Group | Page 1 of 62 |
| Project | Predicting Capability and Stroke Time in DC Motor Operated Valves | Task No. 197-9901-003-0 |
| Title | Validation of DC Motor Performance Method | Calculation No. 197-003-TS-2 |

| Preparer-Date | Checker-Date | Reviewer/Approver-Date | Rev. No. |
|---|---|---|---|
| Todd Spears 2-28-2000<br>Todd Spears | Thomas Walker 2-29-2000<br>Tom Walker | Paul Damerell 3-1-00<br>Paul Damerell | 0 |

**QUALITY ASSURANCE DOCUMENT**

This document has been prepared, checked, and reviewed/approved in accordance with the Quality Assurance requirements of 10CFR50 Appendix B, as specified in the MPR Quality Assurance Manual.

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

# RECORD OF REVISIONS

| Calculation No. | Prepared By | Checked By | Page 2 |
|---|---|---|---|
| 197-003-TS-2 | Todd Spears | Thomas Walker | |

| Revision | Description |
|---|---|
| 0 | Initial Issue |

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## 1.0 PURPOSE

The purpose of this calculation is to validate the methodology for predicting the performance of DC motor-operated valves (MOVs), as presented in MPR-2093 [Reference 1]. Specifically, this calculation compares stroke times predicted by the method to measured stroke times for DC MOVs tested under static and DP conditions.

## 2.0 APPROACH

To validate the DC motor performance method, test data from in-plant valve flow tests were obtained for seven MOVs from four utilities. The seven MOVs include wedge gate, double disk gate and globe valves, which are driven by 6 different actuator types and 4 different motor types (all Peerless). The test data cover 22 valve strokes (11 static strokes and 11 DP strokes). The DP strokes include steam flow opening and closing strokes, pumped flow opening and closing strokes, and a hydrostatic opening stroke. All tests were performed at ambient temperature.

For each test stroke, the DC motor performance method is implemented to calculate a predicted stroke time. The inputs for each test needed to implement the method were obtained from the plants, including design information about the valve, motor and actuator, and information about the test conditions. Three of the valves were tested as part of the Joint Owners' Group (JOG) Periodic Verification (PV) Program; thus, some of the test information was previously supplied to MPR in the form of an assembled test package.

The following approach is used to implement the method for the validation strokes:

(a) For each stroke, the required inputs are determined. The required inputs depend on whether the valve stroke is static or dynamic, whether it is opening or closing, whether the conditions are blowdown or pumped flow,

and whether the valve is a flexible wedge, double disk or globe valve.

(b) For static strokes, the stem thrust profile is input into the method, rather than using the load profile prediction method. An average of the measured running load and initial wedging load (closing strokes) or unseating load (opening strokes) is input as the required thrust for the entire stroke in most cases. In some cases, the initial wedging or unseating load was not reported. In these cases, the reported running load is input as the required thrust for the entire stroke.

(c) - For dynamic strokes, the load profile prediction method is used to predict the DP build-up across the valve and the corresponding build-up of stem thrust as the valve is stroked. The packing loads ($F_{pack}$) and required thrusts ($F_R$) are required inputs for the load profile method and are determined from the test data. The packing load is set to the dynamic running load, adjusted for stem rejection loads. The required thrust, including the effects of water inertia, is set to the maximum measured stem thrust for the stroke, excluding wedging and unwedging of the valve.

(d) Three of the seven valves used in this validation are in steam flow applications. For the dynamic strokes of these three valves, the "blowdown" flow input is used and a value of 10,000 feet is input as the equivalent length of upstream piping, $L_{up}$. This approach is used because these valves are turbine steam admission valves. The load profile method assumes that, for blowdown strokes, there is a line break downstream of the valves and that any pressure losses in the system occur upstream of the valve. For a turbine steam admission valve, a significant portion of the system DP is taken across the turbine when the valve is partially open, and the DP across the valve is

much less than for a true blowdown application. The "equivalent length" of a turbine is likely more than 10,000 feet; however, 10,000 feet is the highest value allowed in the method.

(e) Stem factors are determined from test information provided by the plants. Measured values from dynamic testing are used for both static and dynamic strokes because they are judged to be the most representative of stem friction for the majority of a stroke, static or dynamic. Where the data is provided, closing stroke stem factors are used for all closing strokes, and opening stroke stem factors for all opening strokes; otherwise, a single value is used for both stroke directions.

(f) For all gate valve strokes, default "X" values (percent of stroke length from isolation to wedging) are used (see Step 1.1 of the method -- MPR-2093).

(g) For the BWR Plant D globe valve with a 2 ft-lb, 125 VDC motor, the stroke length reported by the plant resulted in an unrealistically low prediction of stroke time. For this valve, the valve stroke length is determined by trial and error to predict the measured static stroke time.

## 3.0 INPUTS

Appendix A lists the inputs used for each validation stroke. The table below lists each valve type, the motor and actuator type, and a reference to the applicable input source documents.

| Valve Type | Plant | Motor Type/ Actuator Type | Input Source Documents |
|---|---|---|---|
| Double Disk Gate | BWR Plant B | 60 ft-lb/250 VDC SMB-2 | 1. JOG PV Program Baseline Test Package (G60.04-Baseline)<br>2. E-mail and attachment from [Plant B] to T. Spears (MPR) on 1/10/00, Subject: FW: JOG valves with DC Motors |
| Wedge Gate | BWR Plant C | 60 ft-lb/250 VDC SMB-1 | 1. JOG PV Program Baseline Test Package (G41.02-Baseline)<br>2. Fax from [Plant C] to T. Spears (MPR) on 9/2/99 |
| Wedge Gate | BWR Plant D | 40 ft-lb/250 VDC SMB-0 | 1. Transmittal from [Plant D] to T. Spears (MPR) received on 9/10/99, Subject: DC Motor Test Data<br>2. E-mail from [Plant D] to T. Spears on 11/2/99, Subject: DC MOVs Test Data<br>3. E-mail from [Plant D] to T. Spears on 11/10/99, Subject: DC MOV Data/JOG Submittal<br>4. E-mail from [Plant D] to T. Spears on 1/13/00, Subject: RHR-40 and RCIC-22 Stroke Lengths<br>5. Telephone conversation between [Plant D] and T.Spears on 1/13/00. |
| Globe | BWR Plant D | 60 ft-lb/250 VDC SMB-2 | |
| Wedge Gate | BWR Plant D | 15 ft-lb/125 VDC SMB-00 | |
| Globe | BWR Plant D | 2 ft-lb/125 VDC SMB-000 | |
| Double Disk Gate | BWR Plant E | 40 ft-lb/250 VDC SB-1 (ball screw type) | 1. JOG PV Program Baseline Test Package submitted in 9/10/99 transmittal from [Plant E] to P. Damerell (package unapproved at time of issue of Rev. 0 calculation) |

## 4.0 RESULTS

The stroke time method is implemented using an automated spreadsheet tool. Appendix B contains the spreadsheet input form for each validation stroke which shows all the inputs used and summarizes key results of the method, including stroke time. Following each input form is the results sheet which provides the full results of the method using the spreadsheet tool.

The table below summarizes the predicted stroke times for each of the 22 validation strokes. These predicted values are compared to the stroke times measured during the in-plant testing. For closing strokes, the measured stroke times represent the time from initial disk motion to wedging/seating. For opening strokes, the measured stroke times represent the time from peak unwedging/unseating to motor stop.

| Valve Type | Plant | Actuator & Motor Type | General Test Conditions | Voltage at MCC | Stroke Time (sec) | |
|---|---|---|---|---|---|---|
| | | | | | Measured | Predicted |
| Double Disk Gate | BWR Plant B | SMB-2 60 ft-lb/250 VDC | static- closing | 265 | 16.8 | 17.9 |
| | | | static- opening | 265 | 16.1 | 17.8 |
| | | | steam flow- closing | 265 | 18.2 | 20.0 |
| | | | steam flow- opening | 265 | 16.3 | 20.0 |
| Wedge Gate | BWR Plant C | SMB-1 60 ft-lb/250 VDC | static- closing | 268 | 28.1 | 33.5 |
| | | | static- opening | 268 | 27.2 | 33.6 |
| | | | steam flow- closing | 268 | 31.5 | 38.3 |
| | | | steam flow- opening | 268 | 28.2 | 35.3 |
| Wedge Gate | BWR Plant D | SMB-0 40 ft-lb/250 VDC | static- closing | 261 | **10.5** | **10.3** |
| | | | static- opening | 261 | 9.7 | 11.1 |
| | | | pumped flow- closing | 210 | 13.4 | 14.5 |
| | | | pumped flow- opening | 210 | 12.9 | 16.2 |
| Globe | BWR Plant D | SMB-2 60 ft-lb/250 VDC | static- closing | 262 | 11.3 | 11.6 |
| | | | pumped flow- closing | 210 | 14.3 | 14.6 |
| Wedge Gate | BWR Plant D | SMB-00 15 ft-lb/125 VDC | static- opening | 130 | 12.0 | 12.0 |
| | | | hydrostatic- opening | 106 | **15.6** | **15.5** |
| Globe | BWR Plant D | SMB-000 2 ft-lb/125 VDC | static- closing | 130 | 24.2 | 24.2 |
| | | | pumped flow- closing | 106 | 31.0 | 31.6 |
| Double Disk Gate | BWR Plant E | SB-1 40 ft-lb/250 VDC | static- closing | 250 | 12.4* | 15.0 |
| | | | static- opening | 250 | 12.3* | 15.5 |
| | | | steam flow- closing | 250 | 14.9* | 22.3 |
| | | | steam flow- opening | 250 | 10.4* | 17.6 |

*Note: valve may not have fully wedged

## 5.0 REFERENCES

(1) MPR-2093, *Predicting Capability and Stroke Time in DC Motor-Operated Valves*, Revision 0.

**APPENDIX A:**

**DC MOTOR PERFORMANCE MODEL VALIDATION INPUTS**

(6 pages)

**Table A-1**

Method Inputs for Validation Strokes of the DC Motor Performance Method

| | Valve Type | Test Conditions | Stroke direction | Fluid | Stem diameter $D_{stem}$ (inches) | Seat ring seating surface ID, $D_{body\text{-}ID}$, inches | Seat ring inner diameter, $D_{sr}$ (inches) | Globe valve stroke length, D (inches) | Isolation-to-wedging travel, X (percent) | Packing load $F_{pack}$ (lbs) | Required thrust (including water inertia), $F_R$ (lbs) | Required thrust due to water inertia, $F_{WI}$ (lbs) | Flow coefficient $C_V$ (gpm/psi$^{1/2}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BWR Plant B | double disk | static | close | | | 9 | | | 10% | | | | |
| BWR Plant B | double disk | static | open | | | 9 | | | 10% | | | | |
| BWR Plant B | double disk | blowdown | close | steam | 1.75 | 9 | | | 10% | 1540 (1) | 25044 | 0 | |
| BWR Plant B | double disk | blowdown | open | steam | 1.75 | 9 | | | 10% | 3727 (1) | 26849 | 0 | |
| | | | | | | | | | | | | | |
| BWR Plant C | Wedge Gate | static | close | | | 8.75 | | | 10% | | | | |
| BWR Plant C | Wedge Gate | static | open | | | 8.75 | | | 10% | | | | |
| BWR Plant C | Wedge Gate | blowdown | close | steam | 2.125 | 8.75 | | | 10% | 2130 (1) | 22794 | 0 | |
| BWR Plant C | Wedge Gate | blowdown | open | steam | 2.125 | 8.75 | | | 10% | 4434 (1) | 15916 | 0 | |
| | | | | | | | | | | | | | |
| BWR Plant D | Wedge Gate | static | close | | | 5.24 (8) | | | 10% | | | | |
| BWR Plant D | Wedge Gate | static | open | | | 5.24 (8) | | | 10% | | | | |
| BWR Plant D | Wedge Gate | pumped flow | close | | 1.75 | 5.24 (8) | 5.24 (10) | | 10% | 1295 (1) | 22000 | 0 | |
| BWR Plant D | Wedge Gate | pumped flow | open | | 1.75 | 5.24 (8) | 5.24 (10) | | 10% | 1255 (1) | 14500 | 0 | |
| | | | | | | | | | | | | | |
| BWR Plant D | globe | static | close | | | | | 3.187 | | | | | 435 |
| BWR Plant D | globe | pumped flow | close | | 2.125 | | 5.734 | 3.187 | | 1922 | 37508 | 0 | 435 |
| | | | | | | | | | | | | | |
| BWR Plant D | Wedge Gate | static | open | | | 7.72 (8) | | | 10% | | | | |
| BWR Plant D | Wedge Gate | hydrostatic | open | | 1.625 | 7.72 (8) | 7.72 (10) | | 10% | 645 (1) | 1096 | 0 | |
| | | | | | | | | | | | | | |
| BWR Plant D | globe | static | close | | | | | 1.86 (13) | | | | | 200 |
| BWR Plant D | globe | pumped flow | close | | 1.25 | | 3.68 | 1.86 (13) | | 268 | 2751 | 0 | 200 |
| | | | | | | | | | | | | | |
| BWR Plant E | double disk | static | close | | | 9.581 (8) | | | 10% | | | | |
| BWR Plant E | double disk | static | open | | | 9.581 (8) | | | 10% | | | | |
| BWR Plant E | double disk | blowdown | close | steam | 2.25 | 9.581 (8) | | | 10% | 1422 (1) | 38056 | 0 | |
| BWR Plant E | double disk | blowdown | open | steam | 2.25 | 9.581 (8) | | | 10% | 1307 (1) | 19874 | 0 | |

**Table A-1**
Method Inputs for Validation Strokes of the DC Motor Performance Method

| | Actuator overall ratio, OAR | Motor gear set ratio, MGSR | Actuator rated torque, $\tau_{rated}$ | Stem factor SF (ft-lbs/lb) | Overhauling Stem factor $SF_o$ (ft-lbs/lb) | Voltage at MCC $V_{mcc}$ (volts) | Cable resistance $R_{cable}$ (ohms) | Thermal overload resistance, $R_{tol}$ (ohms) | Nominal voltage $V_{nom}$ (volts) | Motor type | Nominal motor torque, $\tau_{nom}$ (ft-lbs) | Valve stem lead (inches) | Pullout efficiency, $\eta_p$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BWR Plant B | 72.01 | 0.46 | 1800 | 0.02343 (2) | | 265 (3) | 0 | 0 | 250 | 60 ft-lb, 250 VDC | 66.3 | 1 | 0.4 |
| BWR Plant B | 72.01 | 0.46 | 1800 | 0.02343 (2) | | 265 (3) | 0 | 0 | 250 | 60 ft-lb, 250 VDC | 66.3 | 1 | 0.4 |
| BWR Plant B | 72.01 | 0.46 | 1800 | 0.02343 (2) | | 265 (3) | 0 | 0 | 250 | 60 ft-lb, 250 VDC | 66.3 | 1 | 0.4 |
| BWR Plant B | 72.01 | 0.46 | 1800 | 0.02343 (2) | | 265 (3) | 0 | 0 | 250 | 60 ft-lb, 250 VDC | 66.3 | 1 | 0.4 |
| | | | | | | | | | | | | | |
| BWR Plant C | 72.42 | 0.47 | 850 | 0.02 (2) | | 268 | 0.093 | 0.019 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| BWR Plant C | 72.42 | 0.47 | 850 | 0.02 (2) | | 268 | 0.093 | 0.019 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| BWR Plant C | 72.42 | 0.47 | 850 | 0.02 (2) | | 268 | 0.093 | 0.019 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| BWR Plant C | 72.42 | 0.47 | 850 | 0.02 (2) | | 268 | 0.093 | 0.019 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| | | | | | | | | | | | | | |
| BWR Plant D | 39.11 | 0.946 | 500 | 0.0127 (4) | | 261 | 0.049 | 0.015 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant D | 39.11 | 0.946 | 500 | 0.0238 (4) | | 261 | 0.049 | 0.015 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant D | 39.11 | 0.946 | 500 | 0.0127 (4) | | 210 | 0.049 | 0.015 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant D | 39.11 | 0.946 | 500 | 0.0238 (4) | | 210 | 0.049 | 0.015 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| | | | | | | | | | | | | | |
| BWR Plant D | 76.99 | 0.429 | 1800 | 0.014 (2) | | 262 | 0.031 | 0.139 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| BWR Plant D | 76.99 | 0.429 | 1800 | 0.014 (2) | | 210 | 0.031 | 0.139 | 250 | 60 ft-lb, 250 VDC | 66.3 | 0.5 | 0.4 |
| | | | | | | | | | | | | | |
| BWR Plant D | 28.2 | 1.596 | 250 | 0.0162 (2) | | 131 | 0.24 | 0.023 | 125 | 15 ft-lb, 125 VDC | 22.5 | 0.5 | 0.4 |
| BWR Plant D | 28.2 | 1.596 | 250 | 0.0162 (2) | | 106 | 0.24 | 0.023 | 125 | 15 ft-lb, 125 VDC | 22.5 | 0.5 | 0.4 |
| | | | | | | | | | | | | | |
| BWR Plant D | 123 | 0.553 | 90 | 0.0089 (2) | | 131 | 0.326 | 0.421 | 125 | 2 ft-lb, 125 VDC | 4.4 | 0.25 | 0.35 |
| BWR Plant D | 123 | 0.553 | 90 | 0.0089 (2) | | 106 | 0.326 | 0.421 | 125 | 2 ft-lb, 125 VDC | 4.4 | 0.25 | 0.35 |
| | | | | | | | | | | | | | |
| BWR Plant E | 32.13 | 1.06 | 850 | 0.00609 (4) | | 250 (5) | 0.465 | 0.0184 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant E | 32.13 | 1.06 | 850 | 0.00644 (4) | | 250 (5) | 0.465 | 0.0184 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant E | 32.13 | 1.06 | 850 | 0.00609 (4) | | 250 (5) | 0.465 | 0.0184 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |
| BWR Plant E | 32.13 | 1.06 | 850 | 0.00644 (4) | 0.00644 (14) | 250 (5) | 0.465 | 0.0184 | 250 | 40 ft-lb, 250 VDC | 48.8 | 0.5 | 0.4 |

**Table A-1**

Method Inputs for Validation Strokes of the DC Motor Performance Method

| | Run efficiency, $\eta_r$ | Nominal motor speed (rpm) | Differential pressure, DP (psi) | Bonnet pressure at full open, $P_B$ (psig) | Flow rate $Q_{max}$ (gpm) | Fluid density $\gamma$ (lbs/ft$^3$) | Ambient temperature (C) | Equivalent length of upstream piping, $L_{up}$ (ft) | Load profile | Load @ 100% | Load @ 90% | Load @ 80% | Load @ 70% | Load @ 60% | Load @ 55% | Load @ 50% | Load @ 45% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BWR Plant B | 0.5 | 1900 | | | | | 29 | | Input Stem Thrust (11) | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 |
| BWR Plant B | 0.5 | 1900 | | | | | 29 | | Input Stem Thrust (11) | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 |
| BWR Plant B | 0.5 | 1900 | | 956 | | | 29 | 10000 | Use default | | | | | | | | |
| BWR Plant B | 0.5 | 1900 | | 951.7 | | | 29 | 10000 | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant C | 0.5 | 1900 | | | | | 32 | | Input Stem Thrust (11) | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 |
| BWR Plant C | 0.5 | 1900 | | | | | 32 | | Input Stem Thrust (11) | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 |
| BWR Plant C | 0.5 | 1900 | | 979 | | | 32 | 10000 | Use default | | | | | | | | |
| BWR Plant C | 0.5 | 1900 | | 927 | | | 32 | 10000 | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant D | 0.55 | 1900 | | | | 62 (6) | 21 (7) | | Input Stem Thrust | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 |
| BWR Plant D | 0.55 | 1900 | | | | 62 (6) | 21 (7) | | Input Stem Thrust | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 |
| BWR Plant D | 0.55 | 1900 | 1074 | 13 (12) | 860 | 62 (6) | 21 (7) | | Use default | | | | | | | | |
| BWR Plant D | 0.55 | 1900 | 1074 | 13 (12) | 860 | 62 (6) | 21 (7) | | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant D | 0.5 | 1900 | | | | 62 (6) | 21 (7) | | Input Stem Thrust | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 |
| BWR Plant D | 0.5 | 1900 | 1011 | 40 | 860 | 62 (6) | 21 (7) | | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant D | 0.5 | 1900 | | | | 62 (6) | 21 (7) | | Input Stem Thrust (11) | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 |
| BWR Plant D | 0.5 | 1900 | 46 | 18 | 1 (9) | 62 (6) | 21 (7) | | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant D | 0.45 | 1900 | | | | 62 (6) | 21 (7) | | Input Stem Thrust | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 |
| BWR Plant D | 0.45 | 1900 | 244 | 235 | 2000 | 62 (6) | 21 (7) | | Use default | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| BWR Plant E | 0.5 | 1900 | | | | | 32 | | Input Stem Thrust | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 |
| BWR Plant E | 0.5 | 1900 | | | | | 32 | | Input Stem Thrust (11) | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 |
| BWR Plant E | 0.5 | 1900 | | 1025 | | | 32 | 10000 | Use default | | | | | | | | |
| BWR Plant E | 0.5 | 1900 | | 1023 | | | 32 | 10000 | Use default | | | | | | | | |

**Table A-1**
Method Inputs for Validation Strokes of the DC Motor Performance Method

| | Load @ 40% | Load @ 35% | Load @ 30% | Load @ 28% | Load @ 26% | Load @ 24% | Load @ 22% | Load @ 20% | Load @ 18% | Load @ 16% | Load @ 14% | Load @ 12% | Load @ 10% | Load @ 9% | Load @ 8% | Load @ 7% | Load @ 6% | Load @ 5% | Load @ 4% | Load @ 3% | Load @ 2% | Load @ 1% | Load @ 0% | Load @ <0% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BWR Plant B | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 | 4129 |
| BWR Plant B | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 | 3765 |
| BWR Plant B | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant B | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant C | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 | 2292 |
| BWR Plant C | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 | 2547 |
| BWR Plant C | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant C | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant D | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 |
| BWR Plant D | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 | 1504 |
| BWR Plant D | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant D | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant D | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 | 1922 |
| BWR Plant D | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant D | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 | 462 |
| BWR Plant D | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant D | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 | 268 |
| BWR Plant D | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant E | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 | 1617 |
| BWR Plant E | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 | 2276 |
| BWR Plant E | | | | | | | | | | | | | | | | | | | | | | | | |
| BWR Plant E | | | | | | | | | | | | | | | | | | | | | | | | |

**Notes to Inputs for Validation Strokes of the DC Motor Performance Method**

(1) Dynamic test running loads used, adjusted for stem rejection loads.

(2) Dynamic as-tested values used.

(3) Voltage at MCC entered as constant value, accounting for constant cable and thermal overload losses (provided as voltage drops) during testing. Cable and thermal overload resistances entered as 0.

(4) Dynamic open stroke values used for open strokes. Dynamic closing stroke values used for closing strokes.

(5) Voltage at MCC was not recorded during testing. Nominal motor voltage value assumed.

(6) Test performed with cold water at a fluid temperature less than 100°F. Density of 62 $lb/ft^3$ used based on Crane Technical Paper No. 410.

(7) Ambient temperature assumed.

(8) This dimension was not provided by the plant and had to be calculated. The mean seat diameter was provided by the plant. The seat ring seating surface ID was calculated using values for seat width based on experience with the valve manufacturer, considering valve type, size, and pressure class. Where exact dimensions were not available, assumptions were made based on best available data.

- 6"-900 lb. Velan, Flex Wedge valve: seat width = 0.35 inches
- 8"-150 lb. Velan, Flex Wedge valve: seat width = 0.45 inches
- 10"-600 lb. Anchor Darling, Double Disk valve: seat width = 0.2 inches

(9) Valve was hydrostatically tested open. No flow was present during test, however method requires a non-zero flow rate as an input to model pumped flow conditions. A negligible flow rate of 1 gpm was used.

(10) This dimension was not provided by the plant. A value equivalent to the seat ring seating surface ID was used for purposes of the validation.

(11) The thrust input for the static load profile is constant for the entire stroke. For closing strokes, an average of the static closing running load and initial wedging load is input as the constant load. For opening strokes, an average of the static opening running load and the after-cracking load is input as the constant load.

(12) Downstream pressure used to represent bonnet pressure at fully open position. Upstream pressure tap separated from valve by a globe valve and check valve.

(13) The stroke length reported by the plant results in an unrealistically low prediction of stroke time. This value for stroke length was determined by trial and error to match the measured stroke static stroke time.

(14) There was insufficient information to calculate an overhauling stem factor for this flow-assisted opening stroke. Therefore, the regular stem factor was conservatively used as the overhauling stem factor value..

**APPENDIX B:**

**INPUT FORMS AND RESULTS FOR THE VALIDATION STROKES OF THE DC MOTOR PERFORMANCE METHOD**

(44 pages)

*Select Valve-->* BWR Plant B, stabc close

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.01 |
| Motor gear set ratio, MGSR | yes | 0.46 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0234 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 265.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.000 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 1.000 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 29 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 3.4 |
| Maximum adjusted motor torque (ft-lbs) | yes | 3.5 |
| Minimum motor speed (rpm) | yes | 2392 |
| Minimum instantaneous actuator capability (lbs) | yes | 78,724 |
| Minimum instantaneous margin (lbs) | yes | 74,595 |
| Maximum torque switch setting | yes | 75,478 |
| Efficiency at minimum instantaneous capability | yes | 0.393 |

***Thrust Profile***

| | |
|---|---|
| 100% | 4,129 |
| 90% | 4,129 |
| 80% | 4,129 |
| 70% | 4,129 |
| 60% | 4,129 |
| 55% | 4,129 |
| 50% | 4,129 |
| 45% | 4,129 |
| 40% | 4,129 |
| 35% | 4,129 |
| 30% | 4,129 |
| 28% | 4,129 |
| 26% | 4,129 |
| 24% | 4,129 |
| 22% | 4,129 |
| 20% | 4,129 |
| 18% | 4,129 |
| 16% | 4,129 |
| 14% | 4,129 |
| 12% | 4,129 |
| 10% | 4,129 |
| 9% | 4,129 |
| 8% | 4,129 |
| 7% | 4,129 |
| 6% | 4,129 |
| 5% | 4,129 |
| 4% | 4,129 |
| 3% | 4,129 |
| 2% | 4,129 |
| 1% | 4,129 |
| 0% | 4,129 |
| -0.0010% | 4,129 |
| -100% | 4,129 |

***Warnings***

***Predicted Stroke Time (Seconds):*** **17.88**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 9.00 | 4129 | | | | | | | | | | | | *0.00* | *29.0* | | | | --- |
| 90% | 8.10 | 4129 | 4129 | 96.74 | | *0.400* | 3.36 | 6.37 | 265.00 | 265 | 3.41 | 2395 | 1.62 | 1.62 | 29.0 | 1,879 | 80,209 | 76,080 | --- |
| 80% | 7.20 | 4129 | 4129 | 96.74 | 1102 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 1.63 | 3.25 | 29.0 | 1,846 | 78,800 | 74,671 | --- |
| 70% | 6.30 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 1.63 | 4.88 | 29.1 | 1,846 | 78,791 | 74,662 | --- |
| 60% | 5.40 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 1.63 | 6.50 | 29.1 | 1,846 | 78,783 | 74,654 | --- |
| 55% | 4.95 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 7.31 | 29.1 | 1,846 | 78,776 | 74,647 | --- |
| 50% | 4.50 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 8.13 | 29.1 | 1,846 | 78,772 | 74,643 | --- |
| 45% | 4.05 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 8.94 | 29.1 | 1,846 | 78,768 | 74,639 | --- |
| 40% | 3.60 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 9.75 | 29.1 | 1,845 | 78,765 | 74,636 | --- |
| 35% | 3.15 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 10.57 | 29.2 | 1,845 | 78,761 | 74,632 | --- |
| 30% | 2.70 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.81 | 11.38 | 29.2 | 1,845 | 78,757 | 74,628 | --- |
| 28% | 2.52 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 11.70 | 29.2 | 1,845 | 78,753 | 74,624 | --- |
| 26% | 2.34 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 12.03 | 29.2 | 1,845 | 78,752 | 74,623 | --- |
| 24% | 2.16 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 12.35 | 29.2 | 1,845 | 78,750 | 74,621 | --- |
| 22% | 1.98 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 12.68 | 29.2 | 1,845 | 78,749 | 74,620 | --- |
| 20% | 1.80 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 13.00 | 29.2 | 1,845 | 78,747 | 74,618 | --- |
| 18% | 1.62 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 13.33 | 29.2 | 1,845 | 78,746 | 74,617 | --- |
| 16% | 1.44 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 13.65 | 29.2 | 1,845 | 78,744 | 74,615 | --- |
| 14% | 1.26 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 13.98 | 29.2 | 1,845 | 78,743 | 74,614 | --- |
| 12% | 1.08 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 14.31 | 29.2 | 1,845 | 78,741 | 74,612 | --- |
| 10% | 0.90 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.33 | 14.63 | 29.2 | 1,845 | 78,740 | 74,611 | --- |
| 9% | 0.81 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 14.79 | 29.2 | 1,845 | 78,738 | 74,609 | --- |
| 8% | 0.72 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 14.96 | 29.2 | 1,845 | 78,738 | 74,609 | --- |
| 7% | 0.63 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.12 | 29.2 | 1,845 | 78,737 | 74,608 | --- |
| 6% | 0.54 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.28 | 29.2 | 1,845 | 78,736 | 74,607 | --- |
| 5% | 0.45 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.44 | 29.2 | 1,845 | 78,735 | 74,606 | --- |
| 4% | 0.36 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.61 | 29.2 | 1,845 | 78,735 | 74,606 | --- |
| 3% | 0.27 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.77 | 29.2 | 1,845 | 78,734 | 74,605 | --- |
| 2% | 0.18 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 15.93 | 29.2 | 1,845 | 78,733 | 74,604 | --- |
| 1% | 0.09 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 16.09 | 29.2 | 1,845 | 78,732 | 74,603 | --- |
| 0% | 0.00 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 16.26 | 29.2 | 1,845 | 78,732 | 74,603 | --- |
| -0.1% | -0.01 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.02 | 16.27 | 29.3 | 1,845 | 78,731 | 74,602 | --- |
| -1% | -0.09 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.15 | 16.42 | 29.3 | 1,845 | 78,731 | 74,602 | --- |
| -2% | -0.18 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 16.58 | 29.3 | 1,845 | 78,730 | 74,601 | --- |
| -3% | -0.27 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 16.74 | 29.3 | 1,845 | 78,729 | 74,600 | --- |
| -4% | -0.36 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 16.91 | 29.3 | 1,845 | 78,729 | 74,600 | --- |
| -5% | -0.45 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.07 | 29.3 | 1,845 | 78,728 | 74,599 | --- |
| -6% | -0.54 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.23 | 29.3 | 1,845 | 78,727 | 74,598 | --- |
| -7% | -0.63 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.39 | 29.3 | 1,845 | 78,726 | 74,597 | --- |
| -8% | -0.72 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.56 | 29.3 | 1,845 | 78,726 | 74,597 | --- |
| -9% | -0.81 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.72 | 29.3 | 1,845 | 78,725 | 74,596 | --- |
| -10% | -0.90 | 4129 | 4129 | 96.74 | 1100 | 0.393 | 3.42 | 6.44 | 265.00 | 265 | 3.47 | 2392 | 0.16 | 17.88 | 29.3 | 1,845 | 78,724 | 74,595 | --- |
| *TST* | --- | --- | *75478* | *1768.44* | *92* | *0.377* | *65.18* | 83.73 | 265.00 | 265 | *66.25* | 200 | --- | --- | --- | *1,768* | 75,478 | 0 | --- |
| *Screen* | --- | --- | *4129* | *96.74* | --- | *0.400* | 3.36 | *104.00* | 265.00 | 265 | *3.54* | 2388 | --- | *17.9* | *29.3* | *1,877* | 80,127 | 75,998 | --- |
| *w/iter* | --- | --- | *4129* | *96.74* | *1100* | *0.393* | 3.42 | 6.44 | 265.00 | 265 | *3.47* | 2392 | --- | *17.9* | *29.3* | *1,844* | 78,723 | 74,594 | --- |

**Valve:** BWR Plant B, static close

*Select Valve*--> BWR Plant B, static open

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | no | 0 |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.01 |
| Motor gear set ratio, MGSR | yes | 0.46 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0234 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 265.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.000 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 1.000 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 29 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 3.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 3.2 |
| Minimum motor speed (rpm) | yes | 2409 |
| Minimum instantaneous actuator capability (lbs) | yes | 78,519 |
| Minimum instantaneous margin (lbs) | yes | 74,754 |
| Maximum allowable thrust at unwedging | yes | 75,556 |
| Efficiency at minimum instantaneous capability | yes | 0.392 |

*Warnings*

***Predicted Stroke Time (Seconds):*** 17.75

| Thrust Profile | |
|---|---|
| 100% | 3,765 |
| 90% | 3,765 |
| 80% | 3,765 |
| 70% | 3,765 |
| 60% | 3,765 |
| 55% | 3,765 |
| 50% | 3,765 |
| 45% | 3,765 |
| 40% | 3,765 |
| 35% | 3,765 |
| 30% | 3,765 |
| 28% | 3,765 |
| 26% | 3,765 |
| 24% | 3,765 |
| 22% | 3,765 |
| 20% | 3,765 |
| 18% | 3,765 |
| 16% | 3,765 |
| 14% | 3,765 |
| 12% | 3,765 |
| 10% | 3,765 |
| 9% | 3,765 |
| 8% | 3,765 |
| 7% | 3,765 |
| 6% | 3,765 |
| 5% | 3,765 |
| 4% | 3,765 |
| 3% | 3,765 |
| 2% | 3,765 |
| 1% | 3,765 |
| 0% | 3,765 |
| -0.0010% | 3,765 |
| -100% | 3,765 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.90 | 3765 | | | | | | | | | | | | *0.00* | *29.0* | | | | --- |
| -9% | -0.81 | 3765 | 3765 | 88.21 | | *0.400* | 3.06 | 5.98 | 265.00 | 265 | 3.11 | 2413 | 0.16 | 0.16 | 29.0 | 1,879 | 80,209 | 76,444 | --- |
| -8% | -0.72 | 3765 | 3765 | 88.21 | 1110 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 0.32 | 29.0 | 1,841 | 78,581 | 74,816 | --- |
| -7% | -0.63 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 0.48 | 29.0 | 1,841 | 78,580 | 74,815 | --- |
| -6% | -0.54 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 0.65 | 29.0 | 1,841 | 78,579 | 74,814 | --- |
| -5% | -0.45 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 0.81 | 29.0 | 1,841 | 78,578 | 74,813 | --- |
| -4% | -0.36 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 0.97 | 29.0 | 1,841 | 78,578 | 74,813 | --- |
| -3% | -0.27 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 1.13 | 29.0 | 1,841 | 78,577 | 74,812 | --- |
| -2% | -0.18 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 1.29 | 29.0 | 1,841 | 78,577 | 74,812 | --- |
| -1% | -0.09 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 1.45 | 29.0 | 1,841 | 78,576 | 74,811 | --- |
| 0% | -0.01 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.15 | 1.60 | 29.0 | 1,841 | 78,575 | 74,810 | --- |
| 0% | 0.00 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.02 | 1.61 | 29.0 | 1,841 | 78,575 | 74,810 | --- |
| 1% | 0.09 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 1.77 | 29.0 | 1,841 | 78,575 | 74,810 | --- |
| 2% | 0.18 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 1.94 | 29.0 | 1,841 | 78,574 | 74,809 | --- |
| 3% | 0.27 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.10 | 29.0 | 1,841 | 78,574 | 74,809 | --- |
| 4% | 0.36 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.26 | 29.0 | 1,841 | 78,573 | 74,808 | --- |
| 5% | 0.45 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.42 | 29.0 | 1,841 | 78,572 | 74,807 | --- |
| 6% | 0.54 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.58 | 29.0 | 1,841 | 78,572 | 74,807 | --- |
| 7% | 0.63 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.74 | 29.0 | 1,841 | 78,571 | 74,806 | --- |
| 8% | 0.72 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 2.90 | 29.0 | 1,841 | 78,570 | 74,805 | --- |
| 9% | 0.81 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 3.07 | 29.0 | 1,841 | 78,570 | 74,805 | --- |
| 10% | 0.90 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.16 | 3.23 | 29.0 | 1,841 | 78,569 | 74,804 | --- |
| 12% | 1.08 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 3.55 | 29.0 | 1,841 | 78,569 | 74,804 | --- |
| 14% | 1.26 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 3.87 | 29.0 | 1,841 | 78,567 | 74,802 | --- |
| 16% | 1.44 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 4.20 | 29.1 | 1,841 | 78,566 | 74,801 | --- |
| 18% | 1.62 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 4.52 | 29.1 | 1,841 | 78,565 | 74,800 | --- |
| 20% | 1.80 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 4.84 | 29.1 | 1,841 | 78,564 | 74,799 | --- |
| 22% | 1.98 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 5.16 | 29.1 | 1,841 | 78,562 | 74,797 | --- |
| 24% | 2.16 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.17 | 2410 | 0.32 | 5.49 | 29.1 | 1,841 | 78,561 | 74,796 | --- |
| 26% | 2.34 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.32 | 5.81 | 29.1 | 1,841 | 78,560 | 74,795 | --- |
| 28% | 2.52 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.32 | 6.13 | 29.1 | 1,841 | 78,559 | 74,794 | --- |
| 30.0% | 2.70 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.32 | 6.46 | 29.1 | 1,841 | 78,557 | 74,792 | --- |
| 35% | 3.15 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 7.26 | 29.1 | 1,841 | 78,556 | 74,791 | --- |
| 40% | 3.60 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 8.07 | 29.1 | 1,840 | 78,553 | 74,788 | --- |
| 45% | 4.05 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 8.88 | 29.1 | 1,840 | 78,550 | 74,785 | --- |
| 50% | 4.50 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 9.68 | 29.1 | 1,840 | 78,547 | 74,782 | --- |
| 55% | 4.95 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 10.49 | 29.1 | 1,840 | 78,544 | 74,779 | --- |
| 60% | 5.40 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 0.81 | 11.30 | 29.1 | 1,840 | 78,541 | 74,776 | --- |
| 70% | 6.30 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 1.61 | 12.91 | 29.2 | 1,840 | 78,538 | 74,773 | --- |
| 80% | 7.20 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 1.61 | 14.52 | 29.2 | 1,840 | 78,531 | 74,766 | --- |
| 90% | 8.10 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 1.61 | 16.14 | 29.2 | 1,840 | 78,525 | 74,760 | --- |
| 100% | 9.00 | 3765 | 3765 | 88.21 | 1108 | 0.392 | 3.13 | 6.06 | 265.00 | 265 | 3.18 | 2409 | 1.61 | 17.75 | 29.2 | 1,840 | 78,519 | 74,754 | --- |
| *UNW* | --- | --- | *75556* | *1770.27* | *92* | *0.377* | *65.24* | 83.82 | 265.00 | 265 | *66.25* | 200 | --- | --- | --- | *1,770* | 75,556 | (0) | --- |
| *Screen* | --- | --- | *3765* | *88.21* | --- | *0.400* | 3.06 | *104.00* | 265.00 | 265 | *3.23* | 2406 | --- | *17.8* | *29.2* | *1,878* | 80,142 | 76,377 | --- |
| *w/ifter* | --- | --- | *3765* | *88.21* | *1108* | *0.392* | 3.13 | 6.06 | 265.00 | 265 | *3.18* | 2409 | --- | *17.8* | *29.2* | *1,840* | 78,513 | 74,748 | --- |
| **Valve:** | BWR Plant B, static open | | | | | | | | | | | | | | | | | | |

*Select Valve*--> BWR Plant B, dynamic close

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | yes | blowdown |
| Stroke direction | yes | close |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.750 |
| Seat ring face ID, $D_{body\text{-}ID}$ (inches) | yes | 9.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,540 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 25,044 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.01 |
| Motor gear set ratio, MGSR | yes | 0.46 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0234 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 265.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.000 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 1.000 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 956 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 29 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | yes | 3,839 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 18.3 |
| Maximum adjusted motor torque (ft-lbs) | yes | 18.7 |
| Minimum motor speed (rpm) | yes | 1607 |
| Minimum instantaneous actuator capability (lbs) | yes | 78,752 |
| Minimum instantaneous margin (lbs) | yes | 63,522 |
| Maximum torque switch setting | yes | 74,862 |
| Efficiency at minimum instantaneous capability | yes | 0.393 |

| *Not required* | |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** 19.96

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 9.00 | 3839 | | | | | | | | | | | | *0.00* | *29.0* | | | | --- |
| 90% | 8.10 | 3937 | 3888 | 91.10 | | *0.400* | 3.16 | 6.11 | 265.00 | 265 | 3.21 | 2407 | 1.62 | 1.62 | 29.0 | 1,879 | 80,209 | 76,320 | --- |
| 80% | 7.20 | 4157 | 4047 | 94.82 | 1107 | 0.393 | 3.35 | 6.36 | 265.00 | 265 | 3.40 | 2396 | 1.62 | 3.24 | 29.0 | 1,845 | 78,752 | 74,705 | --- |
| 70% | 6.30 | 4430 | 4293 | 100.59 | 1102 | 0.394 | 3.55 | 6.61 | 265.00 | 265 | 3.61 | 2384 | 1.63 | 4.87 | 29.1 | 1,849 | 78,897 | 74,604 | --- |
| 60% | 5.40 | 4876 | 4653 | 109.02 | 1096 | 0.395 | 3.84 | 6.99 | 265.00 | 265 | 3.90 | 2366 | 1.64 | 6.51 | 29.1 | 1,854 | 79,112 | 74,459 | --- |
| 55% | 4.95 | 5178 | 5027 | 117.79 | 1088 | 0.396 | 4.13 | 7.37 | 265.00 | 265 | 4.20 | 2348 | 0.83 | 7.34 | 29.1 | 1,859 | 79,332 | 74,304 | --- |
| 50% | 4.50 | 5489 | 5334 | 124.97 | 1080 | 0.397 | 4.37 | 7.69 | 265.00 | 265 | 4.44 | 2333 | 0.83 | 8.17 | 29.1 | 1,863 | 79,511 | 74,177 | --- |
| 45% | 4.05 | 5801 | 5645 | 132.27 | 1073 | 0.398 | 4.62 | 8.00 | 265.00 | 265 | 4.69 | 2318 | 0.84 | 9.01 | 29.2 | 1,867 | 79,694 | 74,049 | --- |
| 40% | 3.60 | 6113 | 5957 | 139.58 | 1066 | 0.399 | 4.86 | 8.32 | 265.00 | 265 | 4.94 | 2304 | 0.84 | 9.86 | 29.2 | 1,871 | 79,875 | 73,918 | --- |
| 35% | 3.15 | 6544 | 6329 | 148.28 | 1060 | 0.400 | 5.15 | 8.70 | 265.00 | 265 | 5.23 | 2286 | 0.85 | 10.71 | 29.2 | 1,877 | 80,092 | 73,764 | --- |
| 30% | 2.70 | 7051 | 6798 | 159.27 | 1052 | 0.401 | 5.51 | 9.17 | 265.00 | 265 | 5.60 | 2264 | 0.86 | 11.57 | 29.3 | 1,883 | 80,367 | 73,569 | --- |
| 28% | 2.52 | 7254 | 7153 | 167.58 | 1041 | 0.402 | 5.79 | 9.52 | 265.00 | 265 | 5.88 | 2247 | 0.35 | 11.91 | 29.3 | 1,888 | 80,565 | 73,413 | --- |
| 26% | 2.34 | 7806 | 7530 | 176.43 | 1034 | 0.403 | 6.08 | 9.90 | 265.00 | 265 | 6.18 | 2229 | 0.35 | 12.26 | 29.3 | 1,893 | 80,785 | 73,255 | --- |
| 24% | 2.16 | 8606 | 8206 | 192.27 | 1026 | 0.405 | 6.59 | 10.56 | 265.00 | 265 | 6.70 | 2198 | 0.35 | 12.62 | 29.3 | 1,902 | 81,188 | 72,982 | --- |
| 22% | 1.98 | 9406 | 9006 | 211.01 | 1011 | 0.408 | 7.19 | 11.34 | 265.00 | 265 | 7.31 | 2162 | 0.36 | 12.97 | 29.3 | 1,913 | 81,654 | 72,648 | --- |
| 20% | 1.80 | 10205 | 9806 | 229.75 | 994 | 0.410 | 7.78 | 12.12 | 265.00 | 265 | 7.91 | 2125 | 0.37 | 13.34 | 29.4 | 1,924 | 82,111 | 72,306 | --- |
| 18% | 1.62 | 11005 | 10605 | 248.48 | 978 | 0.412 | 8.37 | 12.88 | 265.00 | 265 | 8.51 | 2089 | 0.37 | 13.71 | 29.4 | 1,934 | 82,562 | 71,957 | --- |
| 16% | 1.44 | 11932 | 11469 | 268.71 | 961 | 0.415 | 9.00 | 13.70 | 265.00 | 265 | 9.15 | 2051 | 0.38 | 14.09 | 29.4 | 1,946 | 83,046 | 71,578 | --- |
| 14% | 1.26 | 13580 | 12756 | 298.88 | 943 | 0.418 | 9.92 | 14.89 | 265.00 | 265 | 10.09 | 1996 | 0.39 | 14.48 | 29.5 | 1,963 | 83,777 | 71,021 | --- |
| 12% | 1.08 | 15228 | 14404 | 337.49 | 918 | 0.423 | 11.08 | 16.29 | 265.00 | 265 | 11.27 | 1943 | 0.40 | 14.88 | 29.6 | 1,984 | 84,696 | 70,291 | --- |
| 10% | 0.90 | 17060 | 16144 | 378.26 | 894 | 0.428 | 12.27 | 17.73 | 265.00 | 265 | 12.49 | 1888 | 0.41 | 15.29 | 29.6 | 2,007 | 85,652 | 69,508 | --- |
| 9% | 0.81 | 18096 | 17578 | 411.86 | 869 | 0.432 | 13.24 | 18.89 | 265.00 | 265 | 13.48 | 1843 | 0.21 | 15.50 | 29.7 | 2,024 | 86,404 | 68,826 | --- |
| 8% | 0.72 | 18884 | 18490 | 433.22 | 848 | 0.434 | 13.85 | 19.62 | 265.00 | 265 | 14.10 | 1815 | 0.21 | 15.72 | 29.7 | 2,035 | 86,863 | 68,374 | --- |
| 7% | 0.63 | 19564 | 19224 | 450.42 | 835 | 0.436 | 14.34 | 20.21 | 265.00 | 265 | 14.60 | 1793 | 0.22 | 15.94 | 29.8 | 2,044 | 87,235 | 68,011 | --- |
| 6% | 0.54 | 20394 | 19979 | 468.12 | 825 | 0.438 | 14.83 | 20.80 | 265.00 | 265 | 15.11 | 1770 | 0.22 | 16.16 | 29.9 | 2,053 | 87,623 | 67,644 | --- |
| 5% | 0.45 | 21362 | 20878 | 489.17 | 814 | 0.441 | 15.41 | 21.50 | 265.00 | 265 | 15.70 | 1743 | 0.22 | 16.38 | 29.9 | 2,064 | 88,089 | 67,211 | --- |
| 4% | 0.36 | 22236 | 21799 | 510.75 | 802 | 0.443 | 16.00 | 22.20 | 265.00 | 265 | 16.31 | 1716 | 0.23 | 16.61 | 30.0 | 2,075 | 88,556 | 66,757 | --- |
| 3% | 0.27 | 22938 | 22587 | 529.22 | 789 | 0.445 | 16.51 | 22.81 | 265.00 | 265 | 16.82 | 1693 | 0.23 | 16.84 | 30.1 | 2,084 | 88,940 | 66,352 | --- |
| 2% | 0.18 | 23640 | 23289 | 545.66 | 779 | 0.446 | 16.98 | 23.37 | 265.00 | 265 | 17.31 | 1671 | 0.23 | 17.07 | 30.2 | 2,088 | 89,136 | 65,847 | --- |
| 1% | 0.09 | 24342 | 23991 | 562.11 | 769 | 0.446 | 17.50 | 23.99 | 265.00 | 265 | 17.85 | 1647 | 0.24 | 17.30 | 30.3 | 2,087 | 89,067 | 65,076 | --- |
| 0% | 0.00 | 25044 | 24693 | 578.56 | 758 | 0.446 | 18.02 | 24.62 | 265.00 | 265 | 18.38 | 1623 | 0.24 | 17.54 | 30.4 | 2,085 | 88,992 | 64,299 | --- |
| -0.1% | -0.01 | 25044 | 25044 | 586.78 | 746 | 0.446 | 18.28 | 24.94 | 265.00 | 265 | 18.66 | 1610 | 0.02 | 17.57 | 30.4 | 2,083 | 88,915 | 63,871 | --- |
| -1% | -0.09 | 25044 | 25044 | 586.78 | 741 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.67 | 1610 | 0.22 | 17.78 | 30.5 | 2,083 | 88,889 | 63,845 | --- |
| -2% | -0.18 | 25044 | 25044 | 586.78 | 741 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.67 | 1610 | 0.24 | 18.03 | 30.6 | 2,082 | 88,857 | 63,813 | --- |
| -3% | -0.27 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.68 | 1609 | 0.24 | 18.27 | 30.7 | 2,081 | 88,820 | 63,776 | --- |
| -4% | -0.36 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.69 | 1609 | 0.24 | 18.51 | 30.8 | 2,080 | 88,784 | 63,740 | --- |
| -5% | -0.45 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.70 | 1609 | 0.24 | 18.75 | 30.9 | 2,079 | 88,748 | 63,704 | --- |
| -6% | -0.54 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.70 | 1608 | 0.24 | 18.99 | 31.0 | 2,079 | 88,711 | 63,667 | --- |
| -7% | -0.63 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.71 | 1608 | 0.24 | 19.24 | 31.1 | 2,078 | 88,675 | 63,631 | --- |
| -8% | -0.72 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.72 | 1608 | 0.24 | 19.48 | 31.2 | 2,077 | 88,639 | 63,595 | --- |
| -9% | -0.81 | 25044 | 25044 | 586.78 | 740 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.73 | 1607 | 0.24 | 19.72 | 31.3 | 2,076 | 88,603 | 63,559 | --- |
| -10% | -0.90 | 25044 | 25044 | 586.78 | 739 | 0.446 | 18.29 | 24.94 | 265.00 | 265 | 18.73 | 1607 | 0.24 | 19.96 | 31.4 | 2,075 | 88,566 | 63,522 | --- |
| *TST* | --- | --- | *74862* | *1754.01* | *92* | *0.377* | *64.64* | 83.04 | 265.00 | 265 | *66.25* | 200 | --- | --- | --- | *1,754* | 74,862 | (0) | --- |
| *Screen* | --- | --- | *25044* | *586.78* | --- | *0.400* | 20.37 | *104.00* | 265.00 | 265 | *21.47* | 1487 | --- | *28.8* | *44.7* | *1,773* | 75,684 | 50,640 | --- |
| *w/iter* | --- | --- | *25044* | *586.78* | *725* | *0.445* | 18.30 | 24.96 | 265.00 | 265 | *19.43* | 1576 | --- | *27.1* | *41.0* | *2,001* | 85,408 | 60,364 | --- |

**Valve:** BWR Plant B, dynamic close

*Select Valve-->* BWR Plant B, dynamic open

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | yes | blowdown |
| Stroke direction | yes | open |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.750 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 3,727 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 26,849 |
| Required thrust due to water inertia, $F_{WI}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.01 |
| Motor gear set ratio, MGSR | yes | 0.46 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0234 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 265.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.000 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.000 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 1.000 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 951.7 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 29 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | yes | 1,438 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 21.8 |
| Maximum adjusted motor torque (ft-lbs) | yes | 22.2 |
| Minimum motor speed (rpm) | yes | 1457 |
| Minimum instantaneous actuator capability (lbs) | yes | 76,260 |
| Minimum instantaneous margin (lbs) | yes | 53,360 |
| Maximum allowable thrust at unwedging | yes | 75,508 |
| Efficiency at minimum instantaneous capability | yes | 0.385 |

| | *Not required* |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
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| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** **19.95**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.90 | 26849 | | | | | | | | | | | | *0.00* | *29.0* | | | | --- |
| -9% | -0.81 | 26849 | 26849 | 629.07 | | *0.400* | 21.84 | 29.39 | 265.00 | 265 | 22.18 | 1457 | 0.27 | 0.27 | 29.2 | 1,879 | 80,209 | 53,360 | --- |
| -8% | -0.72 | 26849 | 26849 | 629.07 | 670 | 0.444 | 19.66 | 26.60 | 265.00 | 265 | 19.98 | 1551 | 0.25 | 0.52 | 29.3 | 2,086 | 89,028 | 62,179 | --- |
| -7% | -0.63 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 19.95 | 1552 | 0.25 | 0.77 | 29.4 | 2,089 | 89,152 | 62,303 | --- |
| -6% | -0.54 | 26849 | 26849 | 629.07 | 714 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 19.96 | 1552 | 0.25 | 1.02 | 29.6 | 2,088 | 89,111 | 62,262 | --- |
| -5% | -0.45 | 26849 | 26849 | 629.07 | 714 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 19.97 | 1551 | 0.25 | 1.27 | 29.7 | 2,087 | 89,067 | 62,218 | --- |
| -4% | -0.36 | 26849 | 26849 | 629.07 | 714 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 19.98 | 1551 | 0.25 | 1.52 | 29.8 | 2,086 | 89,023 | 62,174 | --- |
| -3% | -0.27 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 19.99 | 1550 | 0.25 | 1.77 | 29.9 | 2,085 | 88,980 | 62,131 | --- |
| -2% | -0.18 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 20.00 | 1550 | 0.25 | 2.02 | 30.1 | 2,084 | 88,936 | 62,087 | --- |
| -1% | -0.09 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 20.01 | 1550 | 0.25 | 2.27 | 30.2 | 2,083 | 88,892 | 62,043 | --- |
| 0% | -0.01 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 20.02 | 1549 | 0.23 | 2.50 | 30.3 | 2,082 | 88,849 | 62,000 | --- |
| 0% | 0.00 | 26849 | 26849 | 629.07 | 713 | 0.445 | 19.63 | 26.55 | 265.00 | 265 | 20.03 | 1549 | 0.03 | 2.52 | 30.3 | 2,081 | 88,809 | 61,960 | --- |
| 1% | 0.09 | 27077 | 26963 | 631.75 | 712 | 0.445 | 19.71 | 26.65 | 265.00 | 265 | 20.12 | 1545 | 0.25 | 2.78 | 30.4 | 2,081 | 88,804 | 61,841 | --- |
| 2% | 0.18 | 27306 | 27192 | 637.10 | 711 | 0.445 | 19.88 | 26.86 | 265.00 | 265 | 20.30 | 1537 | 0.25 | 3.03 | 30.6 | 2,080 | 88,755 | 61,563 | --- |
| 3% | 0.27 | 27534 | 27420 | 642.45 | 707 | 0.445 | 20.05 | 27.06 | 265.00 | 265 | 20.48 | 1530 | 0.25 | 3.28 | 30.7 | 2,078 | 88,697 | 61,277 | --- |
| 4% | 0.36 | 27763 | 27648 | 647.80 | 704 | 0.445 | 20.22 | 27.29 | 265.00 | 265 | 20.67 | 1522 | 0.26 | 3.54 | 30.8 | 2,077 | 88,638 | 60,989 | --- |
| 5% | 0.45 | 26906 | 27334 | 640.45 | 700 | 0.445 | 19.99 | 26.99 | 265.00 | 265 | 20.44 | 1531 | 0.25 | 3.79 | 31.0 | 2,075 | 88,578 | 61,243 | --- |
| 6% | 0.54 | 25466 | 26186 | 613.54 | 704 | 0.445 | 19.15 | 25.98 | 265.00 | 265 | 19.59 | 1568 | 0.25 | 4.04 | 31.1 | 2,075 | 88,550 | 62,364 | --- |
| 7% | 0.63 | 24083 | 24775 | 580.47 | 721 | 0.445 | 18.10 | 24.72 | 265.00 | 265 | 18.53 | 1616 | 0.24 | 4.28 | 31.2 | 2,075 | 88,576 | 63,801 | --- |
| 8% | 0.72 | 22762 | 23423 | 548.79 | 743 | 0.446 | 17.10 | 23.52 | 265.00 | 265 | 17.51 | 1662 | 0.23 | 4.51 | 31.3 | 2,076 | 88,626 | 65,203 | --- |
| 9% | 0.81 | 21287 | 22025 | 516.04 | 765 | 0.443 | 16.17 | 22.40 | 265.00 | 265 | 16.56 | 1705 | 0.23 | 4.74 | 31.4 | 2,064 | 88,094 | 66,069 | --- |
| 10% | 0.90 | 19449 | 20368 | 477.22 | 784 | 0.439 | 15.11 | 21.13 | 265.00 | 265 | 15.48 | 1754 | 0.22 | 4.96 | 31.4 | 2,043 | 87,190 | 66,822 | --- |
| 12% | 1.08 | 16900 | 18175 | 425.83 | 807 | 0.433 | 13.66 | 19.40 | 265.00 | 265 | 14.00 | 1820 | 0.43 | 5.39 | 31.5 | 2,015 | 85,980 | 67,805 | --- |
| 14% | 1.26 | 15217 | 16059 | 376.26 | 837 | 0.427 | 12.24 | 17.68 | 265.00 | 265 | 12.54 | 1885 | 0.41 | 5.80 | 31.6 | 1,987 | 84,808 | 68,749 | --- |
| 16% | 1.44 | 13534 | 14376 | 336.83 | 867 | 0.422 | 11.07 | 16.29 | 265.00 | 265 | 11.35 | 1939 | 0.40 | 6.21 | 31.7 | 1,965 | 83,876 | 69,500 | --- |
| 18% | 1.62 | 12405 | 12969 | 303.87 | 892 | 0.419 | 10.08 | 15.10 | 265.00 | 265 | 10.34 | 1985 | 0.39 | 6.60 | 31.7 | 1,947 | 83,084 | 70,114 | --- |
| 20% | 1.80 | 11372 | 11888 | 278.54 | 913 | 0.416 | 9.31 | 14.10 | 265.00 | 265 | 9.55 | 2027 | 0.38 | 6.98 | 31.8 | 1,932 | 82,471 | 70,582 | --- |
| 22% | 1.98 | 10340 | 10856 | 254.36 | 932 | 0.413 | 8.56 | 13.13 | 265.00 | 265 | 8.78 | 2073 | 0.38 | 7.36 | 31.8 | 1,918 | 81,880 | 71,024 | --- |
| 24% | 2.16 | 9307 | 9824 | 230.17 | 954 | 0.410 | 7.80 | 12.14 | 265.00 | 265 | 8.01 | 2120 | 0.37 | 7.72 | 31.9 | 1,905 | 81,287 | 71,463 | --- |
| 26% | 2.34 | 8275 | 8791 | 205.98 | 975 | 0.407 | 7.03 | 11.14 | 265.00 | 265 | 7.22 | 2167 | 0.36 | 8.08 | 31.9 | 1,891 | 80,690 | 71,898 | --- |
| 28% | 2.52 | 7461 | 7868 | 184.35 | 997 | 0.404 | 6.34 | 10.24 | 265.00 | 265 | 6.50 | 2210 | 0.35 | 8.43 | 31.9 | 1,878 | 80,154 | 72,285 | --- |
| 30.0% | 2.70 | 6955 | 7208 | 168.89 | 1017 | 0.402 | 5.83 | 9.58 | 265.00 | 265 | 5.99 | 2241 | 0.35 | 8.78 | 31.9 | 1,869 | 79,771 | 72,562 | --- |
| 35% | 3.15 | 5691 | 6323 | 148.15 | 1031 | 0.400 | 5.15 | 8.69 | 265.00 | 265 | 5.29 | 2283 | 0.85 | 9.63 | 31.9 | 1,857 | 79,241 | 72,918 | --- |
| 40% | 3.60 | 4778 | 5234 | 122.64 | 1050 | 0.396 | 4.30 | 7.59 | 265.00 | 265 | 4.41 | 2335 | 0.83 | 10.47 | 32.0 | 1,841 | 78,581 | 73,347 | --- |
| 45% | 4.05 | 4412 | 4595 | 107.66 | 1074 | 0.394 | 3.79 | 6.93 | 265.00 | 265 | 3.89 | 2366 | 0.82 | 11.29 | 32.0 | 1,832 | 78,200 | 73,605 | --- |
| 50% | 4.50 | 4046 | 4229 | 99.09 | 1089 | 0.393 | 3.50 | 6.55 | 265.00 | 265 | 3.59 | 2384 | 0.82 | 12.10 | 32.0 | 1,827 | 77,978 | 73,749 | --- |
| 55% | 4.95 | 3665 | 3855 | 90.33 | 1097 | 0.392 | 3.20 | 6.16 | 265.00 | 265 | 3.29 | 2403 | 0.81 | 12.91 | 32.0 | 1,822 | 77,747 | 73,892 | --- |
| 60% | 5.40 | 3181 | 3423 | 80.19 | 1105 | 0.391 | 2.85 | 5.70 | 265.00 | 265 | 2.93 | 2424 | 0.80 | 13.71 | 32.0 | 1,815 | 77,479 | 74,056 | --- |
| 70% | 6.30 | 2420 | 2800 | 65.61 | 1115 | 0.389 | 2.34 | 5.05 | 265.00 | 265 | 2.41 | 2456 | 1.58 | 15.30 | 32.0 | 1,806 | 77,092 | 74,292 | --- |
| 80% | 7.20 | 1886 | 2153 | 50.44 | 1130 | 0.387 | 1.81 | 4.35 | 265.00 | 265 | 1.86 | 2488 | 1.56 | 16.86 | 32.0 | 1,797 | 76,688 | 74,535 | --- |
| 90% | 8.10 | 1496 | 1691 | 39.62 | 1145 | 0.385 | 1.43 | 3.86 | 265.00 | 265 | 1.47 | 2512 | 1.55 | 18.41 | 32.0 | 1,790 | 76,400 | 74,709 | --- |
| 100% | 9.00 | 1438 | 1467 | 34.37 | 1156 | 0.385 | 1.24 | 3.61 | 265.00 | 265 | 1.27 | 2524 | 1.54 | 19.95 | 32.0 | 1,787 | 76,260 | 74,792 | --- |
| *UNW* | --- | --- | *75508* | *1769.16* | *92* | *0.377* | *65.20* | 83.76 | 265.00 | 265 | *66.25* | 200 | --- | --- | --- | *1,769* | 75,508 | 0 | --- |
| *Screen* | --- | --- | *26849* | *629.07* | --- | *0.400* | 21.84 | *104.00* | 265.00 | 265 | *23.02* | 1422 | --- | *30.1* | *47.9* | *1,753* | 74,829 | 47,980 | --- |
| *w/iter* | --- | --- | *26849* | *629.07* | *693* | *0.445* | 19.64 | 26.57 | 265.00 | 265 | *21.04* | 1506 | --- | *28.4* | *43.5* | *1,981* | 84,529 | 57,680 | --- |
| **Valve:** | BWR Plant B, dynamic open | | | | | | | | | | | | | | | | | | |

**Select Valve-->** BWR Plant C, static close

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 8.750 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.42 |
| Motor gear set ratio, MGSR | yes | 0.47 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0200 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 268.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.093 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.019 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 1.6 |
| Maximum adjusted motor torque (ft-lbs) | yes | 1.7 |
| Minimum motor speed (rpm) | yes | 2501 |
| Minimum instantaneous actuator capability (lbs) | yes | 91,833 |
| Minimum instantaneous margin (lbs) | yes | 89,541 |
| Maximum torque switch setting | yes | 88,165 |
| Efficiency at minimum instantaneous capability | yes | 0.393 |

| Thrust Profile | |
|---|---|
| 100% | 2,292 |
| 90% | 2,292 |
| 80% | 2,292 |
| 70% | 2,292 |
| 60% | 2,292 |
| 55% | 2,292 |
| 50% | 2,292 |
| 45% | 2,292 |
| 40% | 2,292 |
| 35% | 2,292 |
| 30% | 2,292 |
| 28% | 2,292 |
| 26% | 2,292 |
| 24% | 2,292 |
| 22% | 2,292 |
| 20% | 2,292 |
| 18% | 2,292 |
| 16% | 2,292 |
| 14% | 2,292 |
| 12% | 2,292 |
| 10% | 2,292 |
| 9% | 2,292 |
| 8% | 2,292 |
| 7% | 2,292 |
| 6% | 2,292 |
| 5% | 2,292 |
| 4% | 2,292 |
| 3% | 2,292 |
| 2% | 2,292 |
| 1% | 2,292 |
| 0% | 2,292 |
| -0.0010% | 2,292 |
| -100% | 2,292 |

**Warnings**

***Predicted Stroke Time (Seconds):*** 33.45

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 8.75 | 2292 | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| 90% | 7.88 | 2292 | 2292 | 45.84 | | *0.400* | 1.58 | 4.06 | 268.00 | 268 | 1.63 | 2502 | 3.04 | 3.04 | 32.0 | 1,869 | 93,435 | 91,143 | --- |
| 80% | 7.00 | 2292 | 2292 | 45.84 | 1176 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 3.04 | 6.08 | 32.0 | 1,837 | 91,870 | 89,578 | --- |
| 70% | 6.13 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 3.04 | 9.12 | 32.0 | 1,837 | 91,865 | 89,573 | --- |
| 60% | 5.25 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 3.04 | 12.16 | 32.0 | 1,837 | 91,862 | 89,570 | --- |
| 55% | 4.81 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 13.68 | 32.0 | 1,837 | 91,858 | 89,566 | --- |
| 50% | 4.38 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 15.20 | 32.1 | 1,837 | 91,856 | 89,564 | --- |
| 45% | 3.94 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 16.72 | 32.1 | 1,837 | 91,855 | 89,563 | --- |
| 40% | 3.50 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 18.24 | 32.1 | 1,837 | 91,853 | 89,561 | --- |
| 35% | 3.06 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 19.76 | 32.1 | 1,837 | 91,851 | 89,559 | --- |
| 30% | 2.63 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 1.52 | 21.28 | 32.1 | 1,837 | 91,849 | 89,557 | --- |
| 28% | 2.45 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 21.89 | 32.1 | 1,837 | 91,847 | 89,555 | --- |
| 26% | 2.28 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 22.50 | 32.1 | 1,837 | 91,847 | 89,555 | --- |
| 24% | 2.10 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 23.11 | 32.1 | 1,837 | 91,846 | 89,554 | --- |
| 22% | 1.93 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 23.72 | 32.1 | 1,837 | 91,845 | 89,553 | --- |
| 20% | 1.75 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 24.32 | 32.1 | 1,837 | 91,845 | 89,553 | --- |
| 18% | 1.58 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 24.93 | 32.1 | 1,837 | 91,844 | 89,552 | --- |
| 16% | 1.40 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 25.54 | 32.1 | 1,837 | 91,843 | 89,551 | --- |
| 14% | 1.23 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 26.15 | 32.1 | 1,837 | 91,842 | 89,550 | --- |
| 12% | 1.05 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 26.76 | 32.1 | 1,837 | 91,842 | 89,550 | --- |
| 10% | 0.88 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.61 | 27.36 | 32.1 | 1,837 | 91,841 | 89,549 | --- |
| 9% | 0.79 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 27.67 | 32.1 | 1,837 | 91,840 | 89,548 | --- |
| 8% | 0.70 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 27.97 | 32.1 | 1,837 | 91,840 | 89,548 | --- |
| 7% | 0.61 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 28.28 | 32.1 | 1,837 | 91,840 | 89,548 | --- |
| 6% | 0.53 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 28.58 | 32.1 | 1,837 | 91,839 | 89,547 | --- |
| 5% | 0.44 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 28.88 | 32.1 | 1,837 | 91,839 | 89,547 | --- |
| 4% | 0.35 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 29.19 | 32.1 | 1,837 | 91,838 | 89,546 | --- |
| 3% | 0.26 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 29.49 | 32.1 | 1,837 | 91,838 | 89,546 | --- |
| 2% | 0.18 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 29.80 | 32.1 | 1,837 | 91,838 | 89,546 | --- |
| 1% | 0.09 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 30.10 | 32.1 | 1,837 | 91,837 | 89,545 | --- |
| 0% | 0.00 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 30.40 | 32.1 | 1,837 | 91,837 | 89,545 | --- |
| -0.1% | -0.01 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.03 | 30.43 | 32.1 | 1,837 | 91,837 | 89,545 | --- |
| -1% | -0.09 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.27 | 30.71 | 32.1 | 1,837 | 91,837 | 89,545 | --- |
| -2% | -0.18 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 31.01 | 32.1 | 1,837 | 91,836 | 89,544 | --- |
| -3% | -0.26 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 31.32 | 32.1 | 1,837 | 91,836 | 89,544 | --- |
| -4% | -0.35 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 31.62 | 32.1 | 1,837 | 91,836 | 89,544 | --- |
| -5% | -0.44 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 31.92 | 32.1 | 1,837 | 91,835 | 89,543 | --- |
| -6% | -0.53 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 32.23 | 32.1 | 1,837 | 91,835 | 89,543 | --- |
| -7% | -0.61 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 32.53 | 32.1 | 1,837 | 91,834 | 89,542 | --- |
| -8% | -0.70 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 32.84 | 32.1 | 1,837 | 91,834 | 89,542 | --- |
| -9% | -0.79 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 33.14 | 32.1 | 1,837 | 91,834 | 89,542 | --- |
| -10% | -0.88 | 2292 | 2292 | 45.84 | 1175 | 0.393 | 1.61 | 4.09 | 268.00 | 268 | 1.65 | 2501 | 0.30 | 33.45 | 32.1 | 1,837 | 91,833 | 89,541 | --- |
| *TST* | --- | --- | *88165* | *1763.30* | *94* | *0.378* | *64.48* | 82.83 | 268.00 | 259 | *66.25* | 200 | --- | --- | --- | *1,763* | 88,165 | (0) | --- |
| *Screen* | --- | --- | *2292* | *45.84* | --- | *0.400* | 1.58 | *104.00* | 268.00 | 256 | *1.69* | 2499 | --- | *33.5* | *32.1* | *1,868* | 93,396 | 91,104 | --- |
| *w/ter* | --- | --- | *2292* | *45.84* | *1175* | *0.393* | 1.61 | 4.09 | 268.00 | 268 | *1.65* | 2501 | --- | *33.4* | *32.1* | *1,837* | 91,833 | 89,541 | --- |
| **Valve:** | BWR Plant C, static close | | | | | | | | | | | | | | | | | | |

**Select Valve-->** BWR Plant C, static open

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 8.750 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.42 |
| Motor gear set ratio, MGSR | yes | 0.47 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0200 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 268.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.093 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.019 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 1.8 |
| Maximum adjusted motor torque (ft-lbs) | yes | 1.8 |
| Minimum motor speed (rpm) | yes | 2490 |
| Minimum instantaneous actuator capability (lbs) | yes | 92,169 |
| Minimum instantaneous margin (lbs) | yes | 89,622 |
| Maximum allowable thrust at unwedging | yes | 88,202 |
| Efficiency at minimum instantaneous capability | yes | 0.395 |

**Warnings**

***Predicted Stroke Time (Seconds):*** **33.59**

| Thrust Profile | |
|---|---|
| 100% | 2,547 |
| 90% | 2,547 |
| 80% | 2,547 |
| 70% | 2,547 |
| 60% | 2,547 |
| 55% | 2,547 |
| 50% | 2,547 |
| 45% | 2,547 |
| 40% | 2,547 |
| 35% | 2,547 |
| 30% | 2,547 |
| 28% | 2,547 |
| 26% | 2,547 |
| 24% | 2,547 |
| 22% | 2,547 |
| 20% | 2,547 |
| 18% | 2,547 |
| 16% | 2,547 |
| 14% | 2,547 |
| 12% | 2,547 |
| 10% | 2,547 |
| 9% | 2,547 |
| 8% | 2,547 |
| 7% | 2,547 |
| 6% | 2,547 |
| 5% | 2,547 |
| 4% | 2,547 |
| 3% | 2,547 |
| 2% | 2,547 |
| 1% | 2,547 |
| 0% | 2,547 |
| -0.0010% | 2,547 |
| -100% | 2,547 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.88 | 2547 | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| -9% | -0.79 | 2547 | 2547 | 50.94 | | *0.400* | 1.76 | 4.29 | 268.00 | 268 | 1.81 | 2492 | 0.31 | 0.31 | 32.0 | 1,869 | 93,435 | 90,888 | --- |
| -8% | -0.70 | 2547 | 2547 | 50.94 | 1171 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 0.61 | 32.0 | 1,844 | 92,214 | 89,667 | --- |
| -7% | -0.61 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 0.92 | 32.0 | 1,844 | 92,213 | 89,666 | --- |
| -6% | -0.53 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 1.22 | 32.0 | 1,844 | 92,212 | 89,665 | --- |
| -5% | -0.44 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 1.53 | 32.0 | 1,844 | 92,212 | 89,665 | --- |
| -4% | -0.35 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 1.83 | 32.0 | 1,844 | 92,212 | 89,665 | --- |
| -3% | -0.26 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 2.14 | 32.0 | 1,844 | 92,211 | 89,664 | --- |
| -2% | -0.18 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 2.44 | 32.0 | 1,844 | 92,211 | 89,664 | --- |
| -1% | -0.09 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 2.75 | 32.0 | 1,844 | 92,210 | 89,663 | --- |
| 0% | -0.01 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.27 | 3.02 | 32.0 | 1,844 | 92,210 | 89,663 | --- |
| 0% | 0.00 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.03 | 3.05 | 32.0 | 1,844 | 92,209 | 89,662 | --- |
| 1% | 0.09 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 3.36 | 32.0 | 1,844 | 92,209 | 89,662 | --- |
| 2% | 0.18 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 3.66 | 32.0 | 1,844 | 92,209 | 89,662 | --- |
| 3% | 0.26 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 3.97 | 32.0 | 1,844 | 92,208 | 89,661 | --- |
| 4% | 0.35 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 4.27 | 32.0 | 1,844 | 92,208 | 89,661 | --- |
| 5% | 0.44 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 4.58 | 32.0 | 1,844 | 92,208 | 89,661 | --- |
| 6% | 0.53 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 4.89 | 32.0 | 1,844 | 92,207 | 89,660 | --- |
| 7% | 0.61 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 5.19 | 32.0 | 1,844 | 92,207 | 89,660 | --- |
| 8% | 0.70 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 5.50 | 32.0 | 1,844 | 92,206 | 89,659 | --- |
| 9% | 0.79 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 5.80 | 32.0 | 1,844 | 92,206 | 89,659 | --- |
| 10% | 0.88 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.31 | 6.11 | 32.0 | 1,844 | 92,205 | 89,658 | --- |
| 12% | 1.05 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 6.72 | 32.0 | 1,844 | 92,205 | 89,658 | --- |
| 14% | 1.23 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 7.33 | 32.0 | 1,844 | 92,204 | 89,657 | --- |
| 16% | 1.40 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 7.94 | 32.0 | 1,844 | 92,203 | 89,656 | --- |
| 18% | 1.58 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 8.55 | 32.0 | 1,844 | 92,202 | 89,655 | --- |
| 20% | 1.75 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 9.16 | 32.0 | 1,844 | 92,201 | 89,654 | --- |
| 22% | 1.93 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 9.77 | 32.0 | 1,844 | 92,200 | 89,653 | --- |
| 24% | 2.10 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 10.38 | 32.0 | 1,844 | 92,200 | 89,653 | --- |
| 26% | 2.28 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 10.99 | 32.0 | 1,844 | 92,199 | 89,652 | --- |
| 28% | 2.45 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 11.60 | 32.0 | 1,844 | 92,198 | 89,651 | --- |
| 30.0% | 2.63 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 0.61 | 12.21 | 32.1 | 1,844 | 92,197 | 89,650 | --- |
| 35% | 3.06 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 13.74 | 32.1 | 1,844 | 92,196 | 89,649 | --- |
| 40% | 3.50 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 15.27 | 32.1 | 1,844 | 92,194 | 89,647 | --- |
| 45% | 3.94 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 16.79 | 32.1 | 1,844 | 92,192 | 89,645 | --- |
| 50% | 4.38 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 18.32 | 32.1 | 1,844 | 92,189 | 89,642 | --- |
| 55% | 4.81 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 19.85 | 32.1 | 1,844 | 92,187 | 89,640 | --- |
| 60% | 5.25 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 1.53 | 21.38 | 32.1 | 1,844 | 92,185 | 89,638 | --- |
| 70% | 6.13 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 3.05 | 24.43 | 32.1 | 1,844 | 92,183 | 89,636 | --- |
| 80% | 7.00 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 3.05 | 27.48 | 32.1 | 1,844 | 92,178 | 89,631 | --- |
| 90% | 7.88 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 3.05 | 30.54 | 32.1 | 1,843 | 92,174 | 89,627 | --- |
| 100% | 8.75 | 2547 | 2547 | 50.94 | 1170 | 0.395 | 1.78 | 4.32 | 268.00 | 268 | 1.83 | 2490 | 3.05 | 33.59 | 32.1 | 1,843 | 92,169 | 89,622 | --- |
| *UNW* | --- | --- | *88202* | *1764.05* | *94* | *0.378* | *64.51* | 82.86 | 268.00 | 259 | *66.25* | 200 | --- | --- | --- | *1,764* | 88,202 | (0) | --- |
| *Screen* | --- | --- | *2547* | *50.94* | --- | *0.400* | 1.76 | *104.00* | 268.00 | 256 | *1.87* | 2488 | --- | *33.6* | *32.1* | *1,868* | 93,387 | 90,840 | --- |
| *w/iter* | --- | --- | *2547* | *50.94* | *1170* | *0.395* | 1.78 | 4.32 | 268.00 | 268 | *1.83* | 2490 | --- | *33.6* | *32.1* | *1,843* | 92,165 | 89,618 | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant C, static open | | | | | | | | | | | | | | | | | | |

*Select Valve*--> BWR Plant C, dynamic close

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | yes | blowdown |
| Stroke direction | yes | close |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 2.125 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 8.750 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 2,130 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 22,794 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.42 |
| Motor gear set ratio, MGSR | yes | 0.47 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0200 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 268.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.093 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.019 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 979 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, ρ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | yes | 5,602 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 14.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 14.6 |
| Minimum motor speed (rpm) | yes | 1793 |
| Minimum instantaneous actuator capability (lbs) | yes | 93,435 |
| Minimum instantaneous margin (lbs) | yes | 80,600 |
| Maximum torque switch setting | yes | 87,188 |
| Efficiency at minimum instantaneous capability | yes | 0.400 |

| | *Not required* |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** 38.25

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 8.75 | 5602 | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| 90% | 7.88 | 5681 | 5642 | 112.83 | | *0.400* | 3.90 | 7.06 | 268.00 | 267 | 4.00 | 2360 | 3.22 | 3.22 | 32.1 | 1,869 | 93,435 | 87,793 | --- |
| 80% | 7.00 | 5870 | 5776 | 115.52 | 1109 | 0.413 | 3.86 | 7.02 | 268.00 | 267 | 3.97 | 2362 | 3.22 | 6.44 | 32.1 | 1,929 | 96,439 | 90,663 | --- |
| 70% | 6.13 | 6108 | 5989 | 119.78 | 1110 | 0.414 | 3.99 | 7.19 | 268.00 | 267 | 4.10 | 2354 | 3.23 | 9.67 | 32.2 | 1,934 | 96,702 | 90,713 | --- |
| 60% | 5.25 | 6493 | 6301 | 126.01 | 1106 | 0.416 | 4.18 | 7.44 | 268.00 | 267 | 4.30 | 2342 | 3.25 | 12.92 | 32.3 | 1,942 | 97,084 | 90,783 | --- |
| 55% | 4.81 | 6754 | 6624 | 132.48 | 1101 | 0.418 | 4.38 | 7.69 | 268.00 | 267 | 4.50 | 2330 | 1.63 | 14.55 | 32.3 | 1,949 | 97,474 | 90,850 | --- |
| 50% | 4.38 | 7018 | 6886 | 137.72 | 1095 | 0.419 | 4.54 | 7.90 | 268.00 | 267 | 4.66 | 2320 | 1.64 | 16.19 | 32.4 | 1,956 | 97,793 | 90,907 | --- |
| 45% | 3.94 | 7281 | 7149 | 142.99 | 1090 | 0.421 | 4.69 | 8.10 | 268.00 | 267 | 4.83 | 2310 | 1.65 | 17.84 | 32.4 | 1,962 | 98,114 | 90,965 | --- |
| 40% | 3.50 | 7545 | 7413 | 148.26 | 1086 | 0.422 | 4.85 | 8.31 | 268.00 | 267 | 4.99 | 2301 | 1.65 | 19.49 | 32.5 | 1,969 | 98,434 | 91,021 | --- |
| 35% | 3.06 | 7922 | 7733 | 154.67 | 1081 | 0.424 | 5.04 | 8.55 | 268.00 | 267 | 5.18 | 2289 | 1.66 | 21.15 | 32.5 | 1,977 | 98,826 | 91,093 | --- |
| 30% | 2.63 | 8373 | 8147 | 162.95 | 1076 | 0.426 | 5.28 | 8.86 | 268.00 | 267 | 5.43 | 2274 | 1.67 | 22.82 | 32.6 | 1,987 | 99,336 | 91,189 | --- |
| 28% | 2.45 | 8553 | 8463 | 169.26 | 1069 | 0.428 | 5.46 | 9.10 | 268.00 | 267 | 5.62 | 2263 | 0.67 | 23.49 | 32.6 | 1,994 | 99,708 | 91,246 | --- |
| 26% | 2.28 | 9068 | 8811 | 176.21 | 1063 | 0.430 | 5.66 | 9.36 | 268.00 | 267 | 5.83 | 2250 | 0.68 | 24.17 | 32.6 | 2,003 | 100,140 | 91,329 | --- |
| 24% | 2.10 | 9821 | 9445 | 188.89 | 1058 | 0.433 | 6.02 | 9.83 | 268.00 | 267 | 6.20 | 2228 | 0.68 | 24.85 | 32.7 | 2,019 | 100,942 | 91,498 | --- |
| 22% | 1.93 | 10574 | 10198 | 203.95 | 1047 | 0.437 | 6.44 | 10.37 | 268.00 | 267 | 6.63 | 2202 | 0.69 | 25.54 | 32.7 | 2,038 | 101,880 | 91,682 | --- |
| 20% | 1.75 | 11327 | 10950 | 219.01 | 1035 | 0.441 | 6.85 | 10.91 | 268.00 | 267 | 7.06 | 2177 | 0.70 | 26.24 | 32.7 | 2,056 | 102,802 | 91,852 | --- |
| 18% | 1.58 | 12080 | 11703 | 234.06 | 1023 | 0.445 | 7.26 | 11.44 | 268.00 | 267 | 7.48 | 2151 | 0.71 | 26.95 | 32.8 | 2,074 | 103,717 | 92,014 | --- |
| 16% | 1.40 | 12936 | 12508 | 250.16 | 1011 | 0.450 | 7.68 | 11.99 | 268.00 | 267 | 7.92 | 2125 | 0.72 | 27.66 | 32.8 | 2,094 | 104,691 | 92,183 | --- |
| 14% | 1.23 | 14380 | 13658 | 273.16 | 999 | 0.451 | 8.37 | 12.88 | 268.00 | 267 | 8.62 | 2083 | 0.73 | 28.39 | 32.9 | 2,099 | 104,926 | 91,268 | --- |
| 12% | 1.05 | 15824 | 15102 | 302.03 | 979 | 0.450 | 9.26 | 14.04 | 268.00 | 266 | 9.55 | 2027 | 0.75 | 29.14 | 33.0 | 2,096 | 104,810 | 89,708 | --- |
| 10% | 0.88 | 17466 | 16645 | 332.90 | 953 | 0.450 | 10.22 | 15.27 | 268.00 | 266 | 10.54 | 1976 | 0.77 | 29.91 | 33.1 | 2,093 | 104,659 | 88,014 | --- |
| 9% | 0.79 | 18417 | 17942 | 358.84 | 929 | 0.449 | 11.03 | 16.23 | 268.00 | 266 | 11.37 | 1938 | 0.39 | 30.31 | 33.2 | 2,090 | 104,509 | 86,567 | --- |
| 8% | 0.70 | 19155 | 18786 | 375.72 | 911 | 0.449 | 11.56 | 16.87 | 268.00 | 266 | 11.92 | 1914 | 0.40 | 30.70 | 33.2 | 2,088 | 104,405 | 85,619 | --- |
| 7% | 0.61 | 19802 | 19478 | 389.57 | 899 | 0.449 | 11.99 | 17.39 | 268.00 | 266 | 12.37 | 1893 | 0.40 | 31.10 | 33.3 | 2,087 | 104,325 | 84,847 | --- |
| 6% | 0.53 | 20442 | 20122 | 402.43 | 890 | 0.449 | 12.39 | 17.87 | 268.00 | 266 | 12.79 | 1875 | 0.41 | 31.51 | 33.4 | 2,085 | 104,253 | 84,131 | --- |
| 5% | 0.44 | 21075 | 20759 | 415.17 | 881 | 0.448 | 12.79 | 18.34 | 268.00 | 266 | 13.20 | 1856 | 0.41 | 31.92 | 33.5 | 2,084 | 104,181 | 83,423 | --- |
| 4% | 0.35 | 21593 | 21334 | 426.68 | 872 | 0.448 | 13.15 | 18.78 | 268.00 | 266 | 13.58 | 1839 | 0.41 | 32.33 | 33.6 | 2,082 | 104,108 | 82,774 | --- |
| 3% | 0.26 | 21893 | 21743 | 434.85 | 864 | 0.448 | 13.40 | 19.08 | 268.00 | 266 | 13.85 | 1827 | 0.42 | 32.75 | 33.7 | 2,081 | 104,035 | 82,293 | --- |
| 2% | 0.18 | 22193 | 22043 | 440.86 | 859 | 0.448 | 13.59 | 19.31 | 268.00 | 266 | 14.05 | 1818 | 0.42 | 33.17 | 33.8 | 2,079 | 103,971 | 81,928 | --- |
| 1% | 0.09 | 22494 | 22343 | 446.87 | 854 | 0.448 | 13.78 | 19.53 | 268.00 | 266 | 14.25 | 1809 | 0.42 | 33.59 | 33.9 | 2,078 | 103,913 | 81,569 | --- |
| 0% | 0.00 | 22794 | 22644 | 452.88 | 850 | 0.448 | 13.97 | 19.76 | 268.00 | 266 | 14.44 | 1800 | 0.42 | 34.01 | 34.0 | 2,077 | 103,853 | 81,209 | --- |
| -0.1% | -0.01 | 22794 | 22794 | 455.88 | 846 | 0.448 | 14.06 | 19.87 | 268.00 | 266 | 14.55 | 1795 | 0.04 | 34.05 | 34.0 | 2,076 | 103,792 | 80,998 | --- |
| -1% | -0.09 | 22794 | 22794 | 455.88 | 844 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.55 | 1795 | 0.38 | 34.43 | 34.1 | 2,076 | 103,778 | 80,984 | --- |
| -2% | -0.18 | 22794 | 22794 | 455.88 | 844 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.56 | 1795 | 0.42 | 34.86 | 34.2 | 2,075 | 103,739 | 80,945 | --- |
| -3% | -0.26 | 22794 | 22794 | 455.88 | 844 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.56 | 1795 | 0.42 | 35.28 | 34.3 | 2,074 | 103,696 | 80,902 | --- |
| -4% | -0.35 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.57 | 1794 | 0.42 | 35.71 | 34.4 | 2,073 | 103,653 | 80,859 | --- |
| -5% | -0.44 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.57 | 1794 | 0.42 | 36.13 | 34.5 | 2,072 | 103,610 | 80,816 | --- |
| -6% | -0.53 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.58 | 1794 | 0.42 | 36.55 | 34.7 | 2,071 | 103,566 | 80,772 | --- |
| -7% | -0.61 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.59 | 1794 | 0.42 | 36.98 | 34.8 | 2,070 | 103,523 | 80,729 | --- |
| -8% | -0.70 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.59 | 1793 | 0.42 | 37.40 | 34.9 | 2,070 | 103,480 | 80,686 | --- |
| -9% | -0.79 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.60 | 1793 | 0.42 | 37.83 | 35.0 | 2,069 | 103,437 | 80,643 | --- |
| -10% | -0.88 | 22794 | 22794 | 455.88 | 843 | 0.448 | 14.06 | 19.88 | 268.00 | 266 | 14.61 | 1793 | 0.42 | 38.25 | 35.1 | 2,068 | 103,394 | 80,600 | --- |
| *TST* | --- | --- | *87188* | *1743.76* | *94* | *0.378* | *63.77* | 81.90 | 268.00 | 259 | *66.25* | 200 | --- | --- | --- | *1,744* | 87,188 | (0) | --- |
| *Screen* | --- | --- | *22794* | *455.88* | --- | *0.400* | 15.74 | *104.00* | 268.00 | 256 | *16.77* | 1695 | --- | *49.3* | *48.1* | *1,762* | 88,103 | 65,309 | --- |
| *w/iter* | --- | --- | *22794* | *455.88* | *832* | *0.447* | 14.07 | 19.88 | 268.00 | 266 | *15.12* | 1770 | --- | *47.3* | *44.3* | *1,998* | 99,875 | 77,081 | --- |
| **Valve:** | BWR Plant C, dynamic close | | | | | | | | | | | | | | | | | | |

**Select Valve-->** BWR Plant C, dynamic open

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | yes | blowdown |
| Stroke direction | yes | open |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 2.125 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 8.750 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 4,434 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 15,916 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 72.42 |
| Motor gear set ratio, MGSR | yes | 0.47 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0200 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 268.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.093 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.019 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 927 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | yes | 1,146 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 11.0 |
| Maximum adjusted motor torque (ft-lbs) | yes | 11.3 |
| Minimum motor speed (rpm) | yes | 1942 |
| Minimum instantaneous actuator capability (lbs) | yes | 89,970 |
| Minimum instantaneous margin (lbs) | yes | 77,519 |
| Maximum allowable thrust at unwedging | yes | 88,182 |
| Efficiency at minimum instantaneous capability | yes | 0.387 |

| | Not required |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** 35.27

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.88 | 15916 | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| -9% | -0.79 | 15916 | 15916 | 318.32 | | *0.400* | 10.99 | 16.19 | 268.00 | 266 | 11.29 | 1942 | 0.39 | 0.39 | 32.1 | 1,869 | 93,435 | 77,519 | --- |
| -8% | -0.70 | 15916 | 15916 | 318.32 | 913 | 0.449 | 9.79 | 14.73 | 268.00 | 266 | 10.06 | 1997 | 0.38 | 0.77 | 32.1 | 2,097 | 104,847 | 88,931 | --- |
| -7% | -0.61 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.05 | 1998 | 0.38 | 1.15 | 32.2 | 2,099 | 104,945 | 89,029 | --- |
| -6% | -0.53 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.05 | 1998 | 0.38 | 1.53 | 32.2 | 2,099 | 104,927 | 89,011 | --- |
| -5% | -0.44 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.05 | 1998 | 0.38 | 1.91 | 32.3 | 2,098 | 104,908 | 88,992 | --- |
| -4% | -0.35 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.05 | 1998 | 0.38 | 2.29 | 32.3 | 2,098 | 104,889 | 88,973 | --- |
| -3% | -0.26 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.05 | 1998 | 0.38 | 2.68 | 32.4 | 2,097 | 104,870 | 88,954 | --- |
| -2% | -0.18 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.06 | 1997 | 0.38 | 3.06 | 32.4 | 2,097 | 104,851 | 88,935 | --- |
| -1% | -0.09 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.06 | 1997 | 0.38 | 3.44 | 32.4 | 2,097 | 104,832 | 88,916 | --- |
| 0% | -0.01 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.06 | 1997 | 0.34 | 3.78 | 32.5 | 2,096 | 104,813 | 88,897 | --- |
| 0% | 0.00 | 15916 | 15916 | 318.32 | 939 | 0.449 | 9.78 | 14.71 | 268.00 | 266 | 10.06 | 1997 | 0.04 | 3.82 | 32.5 | 2,096 | 104,795 | 88,879 | --- |
| 1% | 0.09 | 15833 | 15875 | 317.49 | 939 | 0.449 | 9.75 | 14.68 | 268.00 | 266 | 10.04 | 1998 | 0.38 | 4.20 | 32.5 | 2,096 | 104,793 | 88,919 | --- |
| 2% | 0.18 | 15751 | 15792 | 315.84 | 939 | 0.449 | 9.70 | 14.61 | 268.00 | 266 | 9.99 | 2001 | 0.38 | 4.58 | 32.6 | 2,096 | 104,777 | 88,985 | --- |
| 3% | 0.26 | 15668 | 15710 | 314.19 | 940 | 0.449 | 9.65 | 14.55 | 268.00 | 266 | 9.93 | 2004 | 0.38 | 4.96 | 32.6 | 2,095 | 104,764 | 89,054 | --- |
| 4% | 0.35 | 15586 | 15627 | 312.54 | 942 | 0.450 | 9.60 | 14.48 | 268.00 | 266 | 9.88 | 2007 | 0.38 | 5.34 | 32.7 | 2,095 | 104,752 | 89,125 | --- |
| 5% | 0.44 | 14905 | 15245 | 304.91 | 943 | 0.450 | 9.37 | 14.18 | 268.00 | 266 | 9.64 | 2021 | 0.38 | 5.71 | 32.7 | 2,095 | 104,740 | 89,495 | --- |
| 6% | 0.53 | 13901 | 14403 | 288.05 | 950 | 0.450 | 8.85 | 13.50 | 268.00 | 266 | 9.11 | 2053 | 0.37 | 6.08 | 32.8 | 2,095 | 104,754 | 90,351 | --- |
| 7% | 0.61 | 13041 | 13471 | 269.41 | 965 | 0.450 | 8.27 | 12.75 | 268.00 | 267 | 8.51 | 2089 | 0.36 | 6.45 | 32.8 | 2,096 | 104,807 | 91,336 | --- |
| 8% | 0.70 | 12337 | 12689 | 253.77 | 982 | 0.450 | 7.79 | 12.12 | 268.00 | 267 | 8.02 | 2119 | 0.36 | 6.81 | 32.8 | 2,096 | 104,791 | 92,102 | --- |
| 9% | 0.79 | 11551 | 11944 | 238.88 | 996 | 0.446 | 7.39 | 11.61 | 268.00 | 267 | 7.62 | 2143 | 0.35 | 7.16 | 32.9 | 2,078 | 103,882 | 91,938 | --- |
| 10% | 0.88 | 10574 | 11063 | 221.25 | 1007 | 0.441 | 6.92 | 11.00 | 268.00 | 267 | 7.13 | 2172 | 0.35 | 7.51 | 32.9 | 2,056 | 102,781 | 91,718 | --- |
| 12% | 1.05 | 9239 | 9907 | 198.13 | 1021 | 0.435 | 6.29 | 10.17 | 268.00 | 267 | 6.48 | 2211 | 0.69 | 8.20 | 32.9 | 2,027 | 101,326 | 91,420 | --- |
| 14% | 1.23 | 8379 | 8809 | 176.18 | 1039 | 0.429 | 5.67 | 9.37 | 268.00 | 267 | 5.84 | 2250 | 0.68 | 8.87 | 32.9 | 1,999 | 99,946 | 91,137 | --- |
| 16% | 1.40 | 7520 | 7950 | 158.99 | 1057 | 0.425 | 5.17 | 8.72 | 268.00 | 267 | 5.33 | 2280 | 0.67 | 9.54 | 33.0 | 1,977 | 98,866 | 90,916 | --- |
| 18% | 1.58 | 6966 | 7243 | 144.86 | 1072 | 0.421 | 4.75 | 8.18 | 268.00 | 267 | 4.90 | 2306 | 0.66 | 10.20 | 33.0 | 1,959 | 97,968 | 90,725 | --- |
| 20% | 1.75 | 6465 | 6716 | 134.31 | 1084 | 0.418 | 4.44 | 7.77 | 268.00 | 267 | 4.57 | 2326 | 0.65 | 10.85 | 33.0 | 1,946 | 97,296 | 90,581 | --- |
| 22% | 1.93 | 5965 | 6215 | 124.31 | 1093 | 0.415 | 4.13 | 7.37 | 268.00 | 267 | 4.26 | 2344 | 0.65 | 11.50 | 33.0 | 1,933 | 96,650 | 90,435 | --- |
| 24% | 2.10 | 5465 | 5715 | 114.30 | 1102 | 0.413 | 3.83 | 6.97 | 268.00 | 267 | 3.94 | 2363 | 0.64 | 12.15 | 33.0 | 1,920 | 96,001 | 90,287 | --- |
| 26% | 2.28 | 4965 | 5215 | 104.29 | 1111 | 0.410 | 3.51 | 6.57 | 268.00 | 267 | 3.62 | 2383 | 0.64 | 12.79 | 33.0 | 1,907 | 95,350 | 90,136 | --- |
| 28% | 2.45 | 4552 | 4758 | 95.17 | 1120 | 0.407 | 3.23 | 6.19 | 268.00 | 267 | 3.33 | 2400 | 0.63 | 13.42 | 33.0 | 1,895 | 94,756 | 89,997 | --- |
| 30.0% | 2.63 | 4264 | 4408 | 88.16 | 1128 | 0.405 | 3.00 | 5.90 | 268.00 | 267 | 3.10 | 2414 | 0.63 | 14.05 | 33.1 | 1,886 | 94,299 | 89,891 | --- |
| 35% | 3.06 | 3543 | 3903 | 78.07 | 1135 | 0.402 | 2.68 | 5.48 | 268.00 | 267 | 2.76 | 2434 | 1.56 | 15.61 | 33.1 | 1,873 | 93,632 | 89,729 | --- |
| 40% | 3.50 | 3025 | 3284 | 65.68 | 1144 | 0.399 | 2.27 | 4.96 | 268.00 | 267 | 2.34 | 2459 | 1.55 | 17.16 | 33.1 | 1,856 | 92,810 | 89,526 | --- |
| 45% | 3.94 | 2821 | 2923 | 58.45 | 1156 | 0.397 | 2.03 | 4.64 | 268.00 | 267 | 2.10 | 2474 | 1.54 | 18.69 | 33.1 | 1,847 | 92,334 | 89,412 | --- |
| 50% | 4.38 | 2616 | 2718 | 54.37 | 1163 | 0.396 | 1.90 | 4.47 | 268.00 | 267 | 1.96 | 2483 | 1.53 | 20.22 | 33.1 | 1,841 | 92,064 | 89,345 | --- |
| 55% | 4.81 | 2403 | 2510 | 50.20 | 1167 | 0.395 | 1.76 | 4.28 | 268.00 | 268 | 1.81 | 2491 | 1.53 | 21.75 | 33.1 | 1,836 | 91,784 | 89,274 | --- |
| 60% | 5.25 | 2130 | 2267 | 45.33 | 1171 | 0.393 | 1.59 | 4.07 | 268.00 | 268 | 1.64 | 2501 | 1.52 | 23.27 | 33.1 | 1,829 | 91,457 | 89,190 | --- |
| 70% | 6.13 | 1700 | 1915 | 38.30 | 1176 | 0.391 | 1.35 | 3.76 | 268.00 | 268 | 1.39 | 2516 | 3.02 | 26.29 | 33.1 | 1,820 | 90,984 | 89,069 | --- |
| 80% | 7.00 | 1398 | 1549 | 30.99 | 1183 | 0.389 | 1.10 | 3.43 | 268.00 | 268 | 1.13 | 2532 | 3.00 | 29.30 | 33.1 | 1,810 | 90,491 | 88,942 | --- |
| 90% | 7.88 | 1178 | 1288 | 25.76 | 1190 | 0.388 | 0.92 | 3.19 | 268.00 | 268 | 0.95 | 2543 | 2.99 | 32.29 | 33.1 | 1,803 | 90,140 | 88,852 | --- |
| 100% | 8.75 | 1146 | 1162 | 23.24 | 1195 | 0.387 | 0.83 | 3.08 | 268.00 | 268 | 0.86 | 2549 | 2.98 | 35.27 | 33.1 | 1,799 | 89,970 | 88,808 | --- |
| *UNW* | --- | --- | *88182* | *1763.64* | *94* | *0.378* | *64.49* | 82.84 | 268.00 | 259 | *66.25* | 200 | --- | --- | --- | *1,764* | 88,182 | (0) | --- |
| *Screen* | --- | --- | *15916* | *318.32* | --- | *0.400* | 10.99 | *104.00* | 268.00 | 256 | *11.71* | 1923 | --- | *43.5* | *38.9* | *1,821* | 91,066 | 75,150 | --- |
| *w/iter* | --- | --- | *15916* | *318.32* | *935* | *0.449* | 9.78 | 14.72 | 268.00 | 266 | *10.25* | 1989 | --- | *42.1* | *37.3* | *2,058* | 102,920 | 87,004 | --- |

**Valve:** BWR Plant C. dynamic open

**Select Valve-->** BWR Plant D, static close 1

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 5.240 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{WI}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 39.11 |
| Motor gear set ratio, MGSR | yes | 0.95 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0127 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 261.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.049 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.015 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure; DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 1.3 |
| Maximum adjusted motor torque (ft-lbs) | yes | 1.3 |
| Minimum motor speed (rpm) | yes | 2632 |
| Minimum Instantaneous actuator capability (lbs) | yes | 59,184 |
| Minimum Instantaneous margin (lbs) | yes | 57,654 |
| Maximum torque switch setting | yes | 60,016 |
| Efficiency at minimum instantaneous capability | yes | 0.387 |

| Thrust Profile | |
|---|---|
| 100% | 1,530 |
| 90% | 1,530 |
| 80% | 1,530 |
| 70% | 1,530 |
| 60% | 1,530 |
| 55% | 1,530 |
| 50% | 1,530 |
| 45% | 1,530 |
| 40% | 1,530 |
| 35% | 1,530 |
| 30% | 1,530 |
| 28% | 1,530 |
| 26% | 1,530 |
| 24% | 1,530 |
| 22% | 1,530 |
| 20% | 1,530 |
| 18% | 1,530 |
| 16% | 1,530 |
| 14% | 1,530 |
| 12% | 1,530 |
| 10% | 1,530 |
| 9% | 1,530 |
| 8% | 1,530 |
| 7% | 1,530 |
| 6% | 1,530 |
| 5% | 1,530 |
| 4% | 1,530 |
| 3% | 1,530 |
| 2% | 1,530 |
| 1% | 1,530 |
| 0% | 1,530 |
| -0.0010% | 1,530 |
| -100% | 1,530 |

**Warnings**

***Predicted Stroke Time (Seconds):*** 10.28

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 5.24 | 1530 | | | | | | | | | | | | *0.00* | *21.0* | | | | --- |
| 90% | 4.72 | 1530 | 1530 | 19.43 | | *0.400* | 1.24 | 1.86 | 261.00 | 261 | 1.22 | 2639 | 0.93 | 0.93 | 21.0 | 776 | 61,107 | 59,577 | --- |
| 80% | 4.19 | 1530 | 1530 | 19.43 | 2497 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.93 | 1.87 | 21.0 | 752 | 59,194 | 57,664 | --- |
| 70% | 3.67 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.93 | 2.80 | 21.0 | 752 | 59,193 | 57,663 | --- |
| 60% | 3.14 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.93 | 3.74 | 21.0 | 752 | 59,192 | 57,662 | --- |
| 55% | 2.88 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 4.20 | 21.0 | 752 | 59,191 | 57,661 | --- |
| 50% | 2.62 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 4.67 | 21.0 | 752 | 59,190 | 57,660 | --- |
| 45% | 2.36 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 5.14 | 21.0 | 752 | 59,190 | 57,660 | --- |
| 40% | 2.10 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 5.60 | 21.0 | 752 | 59,189 | 57,659 | --- |
| 35% | 1.83 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 6.07 | 21.0 | 752 | 59,189 | 57,659 | --- |
| 30% | 1.57 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.47 | 6.54 | 21.0 | 752 | 59,188 | 57,658 | --- |
| 28% | 1.47 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 6.73 | 21.0 | 752 | 59,188 | 57,658 | --- |
| 26% | 1.36 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 6.91 | 21.0 | 752 | 59,188 | 57,658 | --- |
| 24% | 1.26 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 7.10 | 21.0 | 752 | 59,187 | 57,657 | --- |
| 22% | 1.15 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 7.29 | 21.0 | 752 | 59,187 | 57,657 | --- |
| 20% | 1.05 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 7.47 | 21.0 | 752 | 59,187 | 57,657 | --- |
| 18% | 0.94 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 7.66 | 21.0 | 752 | 59,187 | 57,657 | --- |
| 16% | 0.84 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 7.85 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 14% | 0.73 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 8.03 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 12% | 0.63 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 8.22 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 10% | 0.52 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.19 | 8.41 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 9% | 0.47 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.50 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 8% | 0.42 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.59 | 21.0 | 752 | 59,186 | 57,656 | --- |
| 7% | 0.37 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.69 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 6% | 0.31 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.78 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 5% | 0.26 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.87 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 4% | 0.21 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 8.97 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 3% | 0.16 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.06 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 2% | 0.10 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.16 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 1% | 0.05 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.25 | 21.0 | 752 | 59,185 | 57,655 | --- |
| 0% | 0.00 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.34 | 21.0 | 752 | 59,185 | 57,655 | --- |
| -0.1% | -0.01 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.01 | 9.35 | 21.0 | 752 | 59,185 | 57,655 | --- |
| -1% | -0.05 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.08 | 9.44 | 21.0 | 752 | 59,185 | 57,655 | --- |
| -2% | -0.10 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.53 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -3% | -0.16 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.62 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -4% | -0.21 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.72 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -5% | -0.26 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.81 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -6% | -0.31 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 9.90 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -7% | -0.37 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 10.00 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -8% | -0.42 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 10.09 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -9% | -0.47 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 10.18 | 21.0 | 752 | 59,184 | 57,654 | --- |
| -10% | -0.52 | 1530 | 1530 | 19.43 | 2490 | 0.387 | 1.28 | 1.92 | 261.00 | 261 | 1.26 | 2632 | 0.09 | 10.28 | 21.0 | 752 | 59,184 | 57,654 | --- |
| *TST* | --- | --- | *60016* | *762.20* | *189* | *0.393* | *49.60* | 46.00 | 261.00 | 258 | *48.84* | 200 | --- | --- | --- | *762* | 60,016 | 0 | --- |
| *Screen* | --- | --- | *1530* | *19.43* | --- | *0.400* | 1.24 | *52.00* | 261.00 | 258 | *1.27* | 2630 | --- | *10.3* | *21.0* | *776* | 61,095 | 59,565 | --- |
| *w/iter* | --- | --- | *1530* | *19.43* | *2490* | *0.387* | 1.28 | 1.92 | 261.00 | 261 | *1.26* | 2632 | --- | *10.3* | *21.1* | *752* | 59,183 | 57,653 | --- |
| **Valve:** | BWR Plant D, static close 1 | | | | | | | | | | | | | | | | | | |

*Select Valve-->* BWR Plant D, stabc open 1

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 5.240 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{WI}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 39.11 |
| Motor gear set ratio, MGSR | yes | 0.95 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0238 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 261.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.049 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.015 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 2.3 |
| Maximum adjusted motor torque (ft-lbs) | yes | 2.3 |
| Minimum motor speed (rpm) | yes | 2445 |
| Minimum instantaneous actuator capability (lbs) | yes | 32,607 |
| Minimum instantaneous margin (lbs) | yes | 31,103 |
| Maximum allowable thrust at unwedging | yes | 32,031 |
| Efficiency at minimum instantaneous capability | yes | 0.400 |

| *Thrust Profile* | |
|---|---|
| 100% | 1,504 |
| 90% | 1,504 |
| 80% | 1,504 |
| 70% | 1,504 |
| 60% | 1,504 |
| 55% | 1,504 |
| 50% | 1,504 |
| 45% | 1,504 |
| 40% | 1,504 |
| 35% | 1,504 |
| 30% | 1,504 |
| 28% | 1,504 |
| 26% | 1,504 |
| 24% | 1,504 |
| 22% | 1,504 |
| 20% | 1,504 |
| 18% | 1,504 |
| 16% | 1,504 |
| 14% | 1,504 |
| 12% | 1,504 |
| 10% | 1,504 |
| 9% | 1,504 |
| 8% | 1,504 |
| 7% | 1,504 |
| 6% | 1,504 |
| 5% | 1,504 |
| 4% | 1,504 |
| 3% | 1,504 |
| 2% | 1,504 |
| 1% | 1,504 |
| 0% | 1,504 |
| -0.0010% | 1,504 |
| -100% | 1,504 |

***Warnings***

***Predicted Stroke Time (Seconds):*** **11.06**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.52 | 1504 | | | | | | | | | | | | 0.00 | 21.0 | | | | --- |
| -9% | -0.47 | 1504 | 1504 | 35.80 | | 0.400 | 2.29 | 3.43 | 261.00 | 261 | 2.25 | 2445 | 0.10 | 0.10 | 21.0 | 776 | 32,607 | 31,103 | --- |
| -8% | -0.42 | 1504 | 1504 | 35.80 | 2313 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.20 | 21.0 | 780 | 32,788 | 31,284 | --- |
| -7% | -0.37 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.30 | 21.0 | 780 | 32,787 | 31,283 | --- |
| -6% | -0.31 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.40 | 21.0 | 780 | 32,787 | 31,283 | --- |
| -5% | -0.26 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.50 | 21.0 | 780 | 32,787 | 31,283 | --- |
| -4% | -0.21 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.60 | 21.0 | 780 | 32,787 | 31,283 | --- |
| -3% | -0.16 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.70 | 21.0 | 780 | 32,787 | 31,283 | --- |
| -2% | -0.10 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.80 | 21.0 | 780 | 32,786 | 31,282 | --- |
| -1% | -0.05 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 0.90 | 21.0 | 780 | 32,786 | 31,282 | --- |
| 0% | -0.01 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.09 | 1.00 | 21.0 | 780 | 32,786 | 31,282 | --- |
| 0% | 0.00 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.01 | 1.01 | 21.0 | 780 | 32,786 | 31,282 | --- |
| 1% | 0.05 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.11 | 21.0 | 780 | 32,786 | 31,282 | --- |
| 2% | 0.10 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.21 | 21.0 | 780 | 32,786 | 31,282 | --- |
| 3% | 0.16 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.31 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 4% | 0.21 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.41 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 5% | 0.26 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.51 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 6% | 0.31 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.61 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 7% | 0.37 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.71 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 8% | 0.42 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.81 | 21.0 | 780 | 32,785 | 31,281 | --- |
| 9% | 0.47 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 1.91 | 21.0 | 780 | 32,784 | 31,280 | --- |
| 10% | 0.52 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.10 | 2.01 | 21.0 | 780 | 32,784 | 31,280 | --- |
| 12% | 0.63 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 2.21 | 21.0 | 780 | 32,784 | 31,280 | --- |
| 14% | 0.73 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 2.41 | 21.0 | 780 | 32,784 | 31,280 | --- |
| 16% | 0.84 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 2.61 | 21.0 | 780 | 32,783 | 31,279 | --- |
| 18% | 0.94 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 2.81 | 21.0 | 780 | 32,783 | 31,279 | --- |
| 20% | 1.05 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 3.01 | 21.0 | 780 | 32,782 | 31,278 | --- |
| 22% | 1.15 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 3.22 | 21.0 | 780 | 32,782 | 31,278 | --- |
| 24% | 1.26 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 3.42 | 21.1 | 780 | 32,782 | 31,278 | --- |
| 26% | 1.36 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 3.62 | 21.1 | 780 | 32,781 | 31,277 | --- |
| 28% | 1.47 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 3.82 | 21.1 | 780 | 32,781 | 31,277 | --- |
| 30.0% | 1.57 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.20 | 4.02 | 21.1 | 780 | 32,780 | 31,276 | --- |
| 35% | 1.83 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 4.52 | 21.1 | 780 | 32,780 | 31,276 | --- |
| 40% | 2.10 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 5.02 | 21.1 | 780 | 32,779 | 31,275 | --- |
| 45% | 2.36 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 5.53 | 21.1 | 780 | 32,778 | 31,274 | --- |
| 50% | 2.62 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 6.03 | 21.1 | 780 | 32,777 | 31,273 | --- |
| 55% | 2.88 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 6.53 | 21.1 | 780 | 32,776 | 31,272 | --- |
| 60% | 3.14 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 0.50 | 7.03 | 21.1 | 780 | 32,775 | 31,271 | --- |
| 70% | 3.67 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 1.01 | 8.04 | 21.1 | 780 | 32,774 | 31,270 | --- |
| 80% | 4.19 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 1.01 | 9.05 | 21.1 | 780 | 32,772 | 31,268 | --- |
| 90% | 4.72 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 1.01 | 10.05 | 21.2 | 780 | 32,770 | 31,266 | --- |
| 100% | 5.24 | 1504 | 1504 | 35.80 | 2315 | 0.402 | 2.28 | 3.41 | 261.00 | 261 | 2.24 | 2447 | 1.01 | 11.06 | 21.2 | 780 | 32,768 | 31,264 | --- |
| *UNW* | --- | --- | *32031* | *762.35* | *189* | *0.393* | *49.61* | 46.00 | 261.00 | 258 | *48.84* | 200 | --- | --- | --- | *762* | 32,031 | 0 | --- |
| *Screen* | --- | --- | *1504* | *35.80* | --- | *0.400* | 2.29 | *52.00* | 261.00 | 258 | *2.34* | 2428 | --- | *11.1* | *21.2* | *776* | 32,585 | 31,081 | --- |
| *w/ter* | --- | --- | *1504* | *35.80* | *2315* | *0.402* | 2.28 | 3.41 | 261.00 | 261 | *2.24* | 2447 | --- | *11.1* | *21.2* | *780* | 32,766 | 31,262 | --- |

**Valve:** BWR Plant D, static open 1

*Select Valve-->* BWR Plant D, dynamic close 1

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | yes | pumped flow |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.750 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 5.240 |
| Seat ring inner diameter, $D_{sr}$ (inches) | yes | 5.240 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,295 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 22,000 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 39.11 |
| Motor gear set ratio, MGSR | yes | 0.95 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0127 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 210.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.049 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.015 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | yes | 1074 |
| Valve pressure at full open, $P_B$ (psig) | yes | 13 |
| Flow rate, $Q_{max}$ (gpm) | no | 860 |
| Fluid density, ρ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | yes | 985.1 |
| Fully open stem thrust, $F_O$ (lbs) | yes | 1,326 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 15.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 17.9 |
| Minimum motor speed (rpm) | yes | 963 |
| Minimum instantaneous actuator capability (lbs) | yes | 49,404 |
| Minimum instantaneous margin (lbs) | yes | 37,938 |
| Maximum torque switch setting | yes | 48,343 |
| Efficiency at minimum instantaneous capability | yes | 0.385 |

*Warnings*

***Predicted Stroke Time (Seconds):*** **14.50**

| *Not required* |
|---|
| 100% |
| 90% |
| 80% |
| 70% |
| 60% |
| 55% |
| 50% |
| 45% |
| 40% |
| 35% |
| 30% |
| 28% |
| 26% |
| 24% |
| 22% |
| 20% |
| 18% |
| 16% |
| 14% |
| 12% |
| 10% |
| 9% |
| 8% |
| 7% |
| 6% |
| 5% |
| 4% |
| 3% |
| 2% |
| 1% |
| 0% |
| -0.0010% |
| -100% |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 5.24 | 1326 | | | | | | | | | | | | *0.00* | *21.0* | | | | 857 |
| 90% | 4.72 | 1326 | 1326 | 16.84 | | *0.400* | 1.08 | 1.62 | 210.00 | 210 | 1.26 | 2210 | 1.11 | 1.11 | 21.0 | 652 | 51,304 | 49,978 | 857 |
| 80% | 4.19 | 1333 | 1330 | 16.89 | 2090 | 0.385 | 1.12 | 1.68 | 210.00 | 210 | 1.31 | 2201 | 1.12 | 2.23 | 21.0 | 627 | 49,404 | 48,074 | 857 |
| 70% | 3.67 | 1342 | 1338 | 16.99 | 2082 | 0.385 | 1.13 | 1.69 | 210.00 | 210 | 1.32 | 2200 | 1.12 | 3.35 | 21.0 | 628 | 49,415 | 48,077 | 857 |
| 60% | 3.14 | 1347 | 1345 | 17.08 | 2081 | 0.385 | 1.13 | 1.70 | 210.00 | 210 | 1.33 | 2199 | 1.12 | 4.47 | 21.0 | 628 | 49,424 | 48,079 | 857 |
| 55% | 2.88 | 1348 | 1347 | 17.11 | 2080 | 0.385 | 1.14 | 1.70 | 210.00 | 210 | 1.33 | 2199 | 0.56 | 5.03 | 21.0 | 628 | 49,427 | 48,080 | 856 |
| 50% | 2.62 | 1359 | 1353 | 17.19 | 2080 | 0.385 | 1.14 | 1.71 | 210.00 | 210 | 1.34 | 2198 | 0.56 | 5.59 | 21.0 | 628 | 49,435 | 48,082 | 856 |
| 45% | 2.36 | 1372 | 1366 | 17.34 | 2079 | 0.386 | 1.15 | 1.73 | 210.00 | 210 | 1.35 | 2196 | 0.56 | 6.15 | 21.0 | 628 | 49,453 | 48,087 | 856 |
| 40% | 2.10 | 1386 | 1379 | 17.51 | 2077 | 0.386 | 1.16 | 1.74 | 210.00 | 210 | 1.36 | 2194 | 0.56 | 6.71 | 21.0 | 628 | 49,472 | 48,093 | 855 |
| 35% | 1.83 | 1415 | 1400 | 17.78 | 2075 | 0.386 | 1.18 | 1.77 | 210.00 | 210 | 1.38 | 2191 | 0.56 | 7.27 | 21.0 | 629 | 49,502 | 48,102 | 855 |
| 30% | 1.57 | 1454 | 1434 | 18.21 | 2072 | 0.386 | 1.21 | 1.81 | 210.00 | 210 | 1.41 | 2185 | 0.56 | 7.83 | 21.0 | 629 | 49,551 | 48,116 | 853 |
| 28% | 1.47 | 1469 | 1462 | 18.56 | 2067 | 0.387 | 1.23 | 1.84 | 210.00 | 210 | 1.44 | 2181 | 0.23 | 8.06 | 21.0 | 630 | 49,590 | 48,128 | 853 |
| 26% | 1.36 | 1522 | 1496 | 18.99 | 2064 | 0.387 | 1.25 | 1.88 | 210.00 | 210 | 1.47 | 2176 | 0.23 | 8.28 | 21.0 | 630 | 49,639 | 48,143 | 852 |
| 24% | 1.26 | 1600 | 1561 | 19.82 | 2059 | 0.388 | 1.31 | 1.96 | 210.00 | 210 | 1.53 | 2166 | 0.23 | 8.51 | 21.0 | 632 | 49,733 | 48,172 | 850 |
| 22% | 1.15 | 1678 | 1639 | 20.81 | 2050 | 0.389 | 1.37 | 2.05 | 210.00 | 210 | 1.61 | 2155 | 0.23 | 8.74 | 21.0 | 633 | 49,846 | 48,207 | 849 |
| 20% | 1.05 | 1756 | 1717 | 21.80 | 2038 | 0.390 | 1.43 | 2.15 | 210.00 | 210 | 1.68 | 2143 | 0.23 | 8.97 | 21.0 | 634 | 49,959 | 48,242 | 847 |
| 18% | 0.94 | 1834 | 1795 | 22.80 | 2028 | 0.391 | 1.49 | 2.24 | 210.00 | 210 | 1.75 | 2132 | 0.23 | 9.20 | 21.0 | 636 | 50,071 | 48,276 | 844 |
| 16% | 0.84 | 1961 | 1898 | 24.10 | 2017 | 0.392 | 1.57 | 2.36 | 210.00 | 210 | 1.85 | 2117 | 0.23 | 9.43 | 21.0 | 638 | 50,220 | 48,322 | 840 |
| 14% | 0.73 | 2367 | 2164 | 27.48 | 2002 | 0.395 | 1.78 | 2.67 | 210.00 | 210 | 2.09 | 2078 | 0.24 | 9.67 | 21.0 | 643 | 50,605 | 48,441 | 834 |
| 12% | 0.63 | 2772 | 2569 | 32.63 | 1966 | 0.399 | 2.09 | 3.14 | 210.00 | 210 | 2.45 | 2020 | 0.24 | 9.91 | 21.0 | 650 | 51,163 | 48,594 | 825 |
| 10% | 0.52 | 3465 | 3118 | 39.60 | 1911 | 0.405 | 2.50 | 3.75 | 210.00 | 210 | 2.93 | 1943 | 0.25 | 10.16 | 21.0 | 659 | 51,897 | 48,779 | 809 |
| 9% | 0.47 | 3998 | 3731 | 47.39 | 1838 | 0.411 | 2.95 | 4.42 | 210.00 | 210 | 3.46 | 1860 | 0.13 | 10.29 | 21.1 | 669 | 52,681 | 48,950 | 796 |
| 8% | 0.42 | 4883 | 4440 | 56.39 | 1759 | 0.418 | 3.45 | 5.17 | 210.00 | 210 | 4.05 | 1770 | 0.14 | 10.43 | 21.1 | 680 | 53,560 | 49,120 | 777 |
| 7% | 0.37 | 5918 | 5400 | 68.58 | 1674 | 0.427 | 4.10 | 6.13 | 210.00 | 210 | 4.82 | 1706 | 0.14 | 10.58 | 21.1 | 695 | 54,731 | 49,331 | 748 |
| 6% | 0.31 | 7779 | 6849 | 86.98 | 1614 | 0.442 | 5.03 | 7.29 | 210.00 | 210 | 5.91 | 1616 | 0.15 | 10.73 | 21.1 | 718 | 56,551 | 49,702 | 709 |
| 5% | 0.26 | 10402 | 9091 | 115.45 | 1529 | 0.463 | 6.37 | 8.96 | 210.00 | 209 | 7.49 | 1487 | 0.17 | 10.90 | 21.1 | 753 | 59,282 | 50,192 | 635 |
| 4% | 0.21 | 12903 | 11653 | 147.99 | 1406 | 0.486 | 7.78 | 10.73 | 210.00 | 209 | 9.16 | 1378 | 0.18 | 11.07 | 21.1 | 789 | 62,162 | 50,509 | 530 |
| 3% | 0.16 | 15177 | 14040 | 178.31 | 1303 | 0.485 | 9.40 | 12.40 | 210.00 | 209 | 11.07 | 1267 | 0.19 | 11.27 | 21.2 | 787 | 61,942 | 47,902 | 398 |
| 2% | 0.10 | 17452 | 16314 | 207.19 | 1198 | 0.482 | 11.00 | 14.00 | 210.00 | 209 | 12.95 | 1169 | 0.21 | 11.48 | 21.3 | 781 | 61,510 | 45,196 | 257 |
| 1% | 0.05 | 19726 | 18589 | 236.08 | 1106 | 0.479 | 12.60 | 15.53 | 210.00 | 209 | 14.85 | 1081 | 0.23 | 11.71 | 21.4 | 776 | 61,120 | 42,532 | 116 |
| 0% | 0.00 | 22000 | 20863 | 264.96 | 1023 | 0.477 | 14.21 | 16.94 | 210.00 | 209 | 16.77 | 1002 | 0.25 | 11.95 | 21.5 | 772 | 60,760 | 39,897 | 0 |
| -0.1% | -0.01 | 22000 | 22000 | 279.40 | 948 | 0.474 | 15.06 | 17.67 | 210.00 | 209 | 17.78 | 968 | 0.03 | 11.98 | 21.5 | 768 | 60,436 | 38,436 | --- |
| -1% | -0.05 | 22000 | 22000 | 279.40 | 916 | 0.474 | 15.09 | 17.70 | 210.00 | 209 | 17.82 | 967 | 0.23 | 12.21 | 21.7 | 766 | 60,312 | 38,312 | --- |
| -2% | -0.10 | 22000 | 22000 | 279.40 | 915 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.83 | 967 | 0.25 | 12.46 | 21.9 | 765 | 60,272 | 38,272 | --- |
| -3% | -0.16 | 22000 | 22000 | 279.40 | 914 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.84 | 966 | 0.25 | 12.71 | 22.0 | 765 | 60,230 | 38,230 | --- |
| -4% | -0.21 | 22000 | 22000 | 279.40 | 914 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.85 | 966 | 0.25 | 12.97 | 22.2 | 764 | 60,188 | 38,188 | --- |
| -5% | -0.26 | 22000 | 22000 | 279.40 | 914 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.87 | 965 | 0.25 | 13.22 | 22.4 | 764 | 60,146 | 38,146 | --- |
| -6% | -0.31 | 22000 | 22000 | 279.40 | 913 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.88 | 965 | 0.25 | 13.48 | 22.5 | 763 | 60,104 | 38,104 | --- |
| -7% | -0.37 | 22000 | 22000 | 279.40 | 913 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.89 | 964 | 0.25 | 13.73 | 22.7 | 763 | 60,063 | 38,063 | --- |
| -8% | -0.42 | 22000 | 22000 | 279.40 | 912 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.90 | 964 | 0.26 | 13.99 | 22.9 | 762 | 60,021 | 38,021 | --- |
| -9% | -0.47 | 22000 | 22000 | 279.40 | 912 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.91 | 964 | 0.26 | 14.24 | 23.1 | 762 | 59,979 | 37,979 | --- |
| -10% | -0.52 | 22000 | 22000 | 279.40 | 912 | 0.473 | 15.09 | 17.70 | 210.00 | 209 | 17.93 | 963 | 0.26 | 14.50 | 23.2 | 761 | 59,938 | 37,938 | --- |
| *TST* | --- | --- | *48343* | *613.95* | *157* | *0.385* | *40.81* | 39.61 | 210.00 | 207 | *48.84* | 166 | --- | --- | --- | *614* | 48,343 | 0 | --- |
| *Screen* | --- | --- | *22000* | *279.40* | --- | *0.400* | 17.86 | *52.00* | 210.00 | 207 | *22.10* | 819 | --- | *33.0* | *52.3* | *572* | 45,006 | 23,006 | --- |
| *w/iter* | --- | --- | *22000* | *279.40* | *870* | *0.472* | 15.13 | 17.74 | 210.00 | 209 | *19.22* | 920 | --- | *29.4* | *41.0* | *710* | 55,893 | 33,893 | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant D, dynamic close 1 | | | | | | | | | | | | | | | | | | |

**Select Valve-->** BWR Plant D, dynamic open 1

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | yes | pumped flow |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Use default |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.750 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 5.240 |
| Seat ring inner diameter, $D_{sr}$ (inches) | yes | 5.240 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,255 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 14,500 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 39.11 |
| Motor gear set ratio, MGSR | yes | 0.95 |
| Actuator rated torque, $\tau_{rated}$ | yes | 500 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0238 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 210.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.049 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.015 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.55 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | yes | 1074 |
| Valve pressure at full open, $P_B$ (psig) | yes | 13 |
| Flow rate, $Q_{max}$ (gpm) | no | 860 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | yes | 985.1 |
| Fully open stem thrust, $F_O$ (lbs) | yes | 1,224 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 22.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 26.0 |
| Minimum motor speed (rpm) | yes | 712 |
| Minimum instantaneous actuator capability (lbs) | yes | 26,614 |
| Minimum instantaneous margin (lbs) | yes | 12,687 |
| Maximum allowable thrust at unwedging | yes | 25,969 |
| Efficiency at minimum instantaneous capability | yes | 0.396 |

| Not required | |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** **16.17**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.52 | 14500 | | | | | | | | | | | | *0.00* | *21.0* | | | | 857 |
| -9% | -0.47 | 14500 | 14500 | 345.10 | | *0.400* | 22.06 | 24.30 | 210.00 | 208 | 26.05 | 712 | 0.35 | 0.35 | 21.5 | 647 | 27,187 | 12,687 | 857 |
| -8% | -0.42 | 14500 | 14500 | 345.10 | 673 | 0.466 | 18.92 | 21.42 | 210.00 | 209 | 22.36 | 819 | 0.30 | 0.65 | 21.8 | 754 | 31,672 | 17,172 | 857 |
| -7% | -0.37 | 14500 | 14500 | 345.10 | 775 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.25 | 823 | 0.30 | 0.94 | 22.1 | 758 | 31,834 | 17,334 | 857 |
| -6% | -0.31 | 14500 | 14500 | 345.10 | 778 | 0.470 | 18.79 | 21.29 | 210.00 | 209 | 22.27 | 822 | 0.30 | 1.24 | 22.4 | 757 | 31,802 | 17,302 | 857 |
| -5% | -0.26 | 14500 | 14500 | 345.10 | 778 | 0.470 | 18.79 | 21.29 | 210.00 | 209 | 22.30 | 821 | 0.30 | 1.54 | 22.8 | 756 | 31,761 | 17,261 | 856 |
| -4% | -0.21 | 14500 | 14500 | 345.10 | 777 | 0.469 | 18.79 | 21.29 | 210.00 | 209 | 22.33 | 820 | 0.30 | 1.84 | 23.1 | 755 | 31,721 | 17,221 | 856 |
| -3% | -0.16 | 14500 | 14500 | 345.10 | 776 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.35 | 819 | 0.30 | 2.14 | 23.4 | 754 | 31,681 | 17,181 | 856 |
| -2% | -0.10 | 14500 | 14500 | 345.10 | 775 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.38 | 818 | 0.30 | 2.44 | 23.7 | 753 | 31,640 | 17,140 | 855 |
| -1% | -0.05 | 14500 | 14500 | 345.10 | 774 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.41 | 817 | 0.30 | 2.74 | 24.0 | 752 | 31,600 | 17,100 | 855 |
| 0% | -0.01 | 14500 | 14500 | 345.10 | 773 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.44 | 817 | 0.27 | 3.02 | 24.3 | 751 | 31,560 | 17,060 | 853 |
| 0% | 0.00 | 14500 | 14500 | 345.10 | 772 | 0.469 | 18.80 | 21.30 | 210.00 | 209 | 22.47 | 816 | 0.03 | 3.05 | 24.3 | 750 | 31,523 | 17,023 | 853 |
| 1% | 0.05 | 13424 | 13962 | 332.30 | 772 | 0.469 | 18.10 | 20.60 | 210.00 | 209 | 21.63 | 842 | 0.29 | 3.34 | 24.6 | 750 | 31,525 | 17,563 | 852 |
| 2% | 0.10 | 12349 | 12886 | 306.70 | 797 | 0.470 | 16.68 | 19.18 | 210.00 | 209 | 19.95 | 895 | 0.27 | 3.61 | 24.8 | 751 | 31,552 | 18,666 | 850 |
| 3% | 0.16 | 11273 | 11811 | 281.10 | 847 | 0.472 | 15.24 | 17.84 | 210.00 | 209 | 18.23 | 953 | 0.26 | 3.87 | 25.0 | 753 | 31,636 | 19,825 | 849 |
| 4% | 0.21 | 10197 | 10735 | 255.50 | 901 | 0.473 | 13.81 | 16.58 | 210.00 | 209 | 16.52 | 1010 | 0.24 | 4.11 | 25.2 | 755 | 31,732 | 20,997 | 847 |
| 5% | 0.26 | 8568 | 9383 | 223.31 | 956 | 0.475 | 12.03 | 15.03 | 210.00 | 209 | 14.39 | 1102 | 0.22 | 4.34 | 25.3 | 758 | 31,837 | 22,454 | 844 |
| 6% | 0.31 | 6642 | 7605 | 181.00 | 1043 | 0.477 | 9.70 | 12.70 | 210.00 | 209 | 11.60 | 1236 | 0.20 | 4.54 | 25.3 | 762 | 32,017 | 24,412 | 840 |
| 7% | 0.37 | 5178 | 5910 | 140.66 | 1169 | 0.474 | 7.59 | 10.48 | 210.00 | 209 | 9.07 | 1383 | 0.18 | 4.71 | 25.3 | 757 | 31,815 | 25,905 | 834 |
| 8% | 0.42 | 4217 | 4698 | 111.81 | 1308 | 0.456 | 6.27 | 8.84 | 210.00 | 209 | 7.50 | 1486 | 0.17 | 4.88 | 25.4 | 728 | 30,596 | 25,898 | 825 |
| 9% | 0.47 | 3401 | 3809 | 90.65 | 1406 | 0.441 | 5.25 | 7.57 | 210.00 | 210 | 6.28 | 1586 | 0.16 | 5.03 | 25.4 | 705 | 29,633 | 25,824 | 809 |
| 10% | 0.52 | 2920 | 3161 | 75.22 | 1501 | 0.430 | 4.47 | 6.59 | 210.00 | 210 | 5.34 | 1664 | 0.15 | 5.18 | 25.4 | 688 | 28,919 | 25,759 | 796 |
| 12% | 0.63 | 2347 | 2634 | 62.69 | 1574 | 0.421 | 3.80 | 5.71 | 210.00 | 210 | 4.54 | 1729 | 0.28 | 5.47 | 25.4 | 674 | 28,309 | 25,675 | 777 |
| 14% | 0.73 | 2072 | 2210 | 52.59 | 1636 | 0.414 | 3.25 | 4.88 | 210.00 | 210 | 3.88 | 1793 | 0.27 | 5.74 | 25.4 | 662 | 27,802 | 25,593 | 748 |
| 16% | 0.84 | 1797 | 1935 | 46.05 | 1696 | 0.409 | 2.88 | 4.32 | 210.00 | 210 | 3.44 | 1863 | 0.26 | 6.01 | 25.4 | 654 | 27,477 | 25,542 | 709 |
| 18% | 0.94 | 1696 | 1747 | 41.58 | 1762 | 0.406 | 2.62 | 3.93 | 210.00 | 210 | 3.13 | 1912 | 0.26 | 6.26 | 25.4 | 649 | 27,263 | 25,516 | 635 |
| 20% | 1.05 | 1626 | 1661 | 39.54 | 1809 | 0.404 | 2.50 | 3.75 | 210.00 | 210 | 2.99 | 1935 | 0.25 | 6.52 | 25.4 | 647 | 27,171 | 25,510 | 530 |
| 22% | 1.15 | 1556 | 1591 | 37.86 | 1831 | 0.403 | 2.40 | 3.60 | 210.00 | 210 | 2.87 | 1954 | 0.25 | 6.77 | 25.4 | 645 | 27,085 | 25,494 | 398 |
| 24% | 1.26 | 1485 | 1520 | 36.19 | 1848 | 0.402 | 2.30 | 3.46 | 210.00 | 210 | 2.75 | 1973 | 0.25 | 7.02 | 25.4 | 643 | 26,996 | 25,476 | 257 |
| 26% | 1.36 | 1415 | 1450 | 34.51 | 1866 | 0.400 | 2.21 | 3.31 | 210.00 | 210 | 2.63 | 1991 | 0.25 | 7.26 | 25.4 | 640 | 26,907 | 25,457 | 116 |
| 28% | 1.47 | 1366 | 1391 | 33.10 | 1884 | 0.399 | 2.12 | 3.18 | 210.00 | 210 | 2.53 | 2007 | 0.25 | 7.51 | 25.4 | 639 | 26,832 | 25,442 | 0 |
| 30.0% | 1.57 | 1349 | 1358 | 32.31 | 1899 | 0.398 | 2.07 | 3.11 | 210.00 | 210 | 2.48 | 2016 | 0.24 | 7.75 | 25.4 | 638 | 26,793 | 25,435 | --- |
| 35% | 1.83 | 1305 | 1327 | 31.58 | 1908 | 0.398 | 2.03 | 3.04 | 210.00 | 210 | 2.42 | 2025 | 0.61 | 8.36 | 25.4 | 637 | 26,753 | 25,426 | --- |
| 40% | 2.10 | 1275 | 1290 | 30.70 | 1915 | 0.397 | 1.98 | 2.97 | 210.00 | 210 | 2.36 | 2035 | 0.60 | 8.97 | 25.5 | 636 | 26,704 | 25,414 | --- |
| 45% | 2.36 | 1267 | 1271 | 30.25 | 1925 | 0.397 | 1.95 | 2.92 | 210.00 | 210 | 2.33 | 2040 | 0.60 | 9.57 | 25.5 | 635 | 26,680 | 25,409 | --- |
| 50% | 2.62 | 1258 | 1262 | 30.04 | 1930 | 0.397 | 1.94 | 2.91 | 210.00 | 210 | 2.31 | 2042 | 0.60 | 10.17 | 25.5 | 635 | 26,670 | 25,407 | --- |
| 55% | 2.88 | 1250 | 1254 | 29.84 | 1932 | 0.396 | 1.92 | 2.89 | 210.00 | 210 | 2.30 | 2045 | 0.60 | 10.77 | 25.5 | 634 | 26,658 | 25,404 | --- |
| 60% | 3.14 | 1244 | 1247 | 29.67 | 1934 | 0.396 | 1.91 | 2.87 | 210.00 | 210 | 2.29 | 2047 | 0.60 | 11.37 | 25.5 | 634 | 26,648 | 25,401 | --- |
| 70% | 3.67 | 1234 | 1239 | 29.49 | 1936 | 0.396 | 1.90 | 2.85 | 210.00 | 210 | 2.27 | 2049 | 1.20 | 12.57 | 25.5 | 634 | 26,637 | 25,398 | --- |
| 80% | 4.19 | 1228 | 1231 | 29.30 | 1938 | 0.396 | 1.89 | 2.84 | 210.00 | 210 | 2.26 | 2051 | 1.20 | 13.77 | 25.5 | 634 | 26,626 | 25,394 | --- |
| 90% | 4.72 | 1224 | 1226 | 29.18 | 1940 | 0.396 | 1.88 | 2.83 | 210.00 | 210 | 2.25 | 2052 | 1.20 | 14.97 | 25.5 | 634 | 26,618 | 25,392 | --- |
| 100% | 5.24 | 1224 | 1224 | 29.12 | 1942 | 0.396 | 1.88 | 2.82 | 210.00 | 210 | 2.25 | 2053 | 1.20 | 16.17 | 25.5 | 633 | 26,614 | 25,390 | --- |
| *UNW* | --- | --- | *25969* | *618.07* | *157* | *0.385* | *41.08* | 39.81 | 210.00 | 207 | *48.84* | 166 | --- | --- | --- | *618* | 25,969 | 0 | --- |
| *Screen* | --- | --- | *14500* | *345.10* | --- | *0.400* | 22.06 | *52.00* | 210.00 | 207 | *27.30* | 672 | --- | *40.3* | *79.2* | *523* | 21,956 | 7,456 | --- |
| *w/iter* | --- | --- | *14500* | *345.10* | *680* | *0.467* | 18.91 | 21.41 | 210.00 | 209 | *25.79* | 719 | --- | *37.6* | *60.9* | *653* | 27,456 | 12,956 | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant D, dynamic open 1 | | | | | | | | | | | | | | | | | | |

**Select Valve-->** BWR Plant D, static close 2

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | globe |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | no | 0.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | yes | 3.187 |
| Isolation-to-wedging travel, X (percent) | no | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 435 |
| Actuator overall ratio, OAR | yes | 76.99 |
| Motor gear set ratio, MGSR | yes | 0.43 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0140 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 262.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.031 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.139 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 0.9 |
| Maximum adjusted motor torque (ft-lbs) | yes | 0.9 |
| Minimum motor speed (rpm) | yes | 2546 |
| Minimum Instantaneous actuator capability (lbs) | yes | 141,941 |
| Minimum Instantaneous margin (lbs) | yes | 140,019 |
| Maximum torque switch setting | yes | 136,964 |
| Efficiency at minimum instantaneous capability | yes | 0.384 |

**Thrust Profile**

| | |
|---|---|
| 100% | 1,922 |
| 90% | 1,922 |
| 80% | 1,922 |
| 70% | 1,922 |
| 60% | 1,922 |
| 55% | 1,922 |
| 50% | 1,922 |
| 45% | 1,922 |
| 40% | 1,922 |
| 35% | 1,922 |
| 30% | 1,922 |
| 28% | 1,922 |
| 26% | 1,922 |
| 24% | 1,922 |
| 22% | 1,922 |
| 20% | 1,922 |
| 18% | 1,922 |
| 16% | 1,922 |
| 14% | 1,922 |
| 12% | 1,922 |
| 10% | 1,922 |
| 9% | 1,922 |
| 8% | 1,922 |
| 7% | 1,922 |
| 6% | 1,922 |
| 5% | 1,922 |
| 4% | 1,922 |
| 3% | 1,922 |
| 2% | 1,922 |
| 1% | 1,922 |
| 0% | 1,922 |
| -0.0010% | 1,922 |
| -100% | 1,922 |

***Warnings***

***Predicted Stroke Time (Seconds):*** **11.56**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 3.19 | 1922 | | | | | | | | | | | | *0.00* | *21.0* | | | | --- |
| 90% | 2.87 | 1922 | 1922 | 26.91 | | *0.400* | 0.87 | 3.14 | 262.00 | 261 | 0.86 | 2548 | 1.16 | 1.16 | 21.0 | 2,072 | 148,013 | 146,091 | --- |
| 80% | 2.55 | 1922 | 1922 | 26.91 | 1093 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 1.16 | 2.31 | 21.0 | 1,987 | 141,948 | 140,026 | --- |
| 70% | 2.23 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 1.16 | 3.47 | 21.0 | 1,987 | 141,947 | 140,025 | --- |
| 60% | 1.91 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 1.16 | 4.62 | 21.0 | 1,987 | 141,946 | 140,024 | --- |
| 55% | 1.75 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 5.20 | 21.0 | 1,987 | 141,946 | 140,024 | --- |
| 50% | 1.59 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 5.78 | 21.0 | 1,987 | 141,945 | 140,023 | --- |
| 45% | 1.43 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 6.36 | 21.0 | 1,987 | 141,945 | 140,023 | --- |
| 40% | 1.27 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 6.94 | 21.0 | 1,987 | 141,945 | 140,023 | --- |
| 35% | 1.12 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 7.52 | 21.0 | 1,987 | 141,944 | 140,022 | --- |
| 30% | 0.96 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.58 | 8.09 | 21.0 | 1,987 | 141,944 | 140,022 | --- |
| 28% | 0.89 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 8.33 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 26% | 0.83 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 8.56 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 24% | 0.76 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 8.79 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 22% | 0.70 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 9.02 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 20% | 0.64 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 9.25 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 18% | 0.57 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 9.48 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 16% | 0.51 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 9.71 | 21.0 | 1,987 | 141,943 | 140,021 | --- |
| 14% | 0.45 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 9.94 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 12% | 0.38 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 10.18 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 10% | 0.32 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.23 | 10.41 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 9% | 0.29 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 10.52 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 8% | 0.25 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 10.64 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 7% | 0.22 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 10.75 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 6% | 0.19 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 10.87 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 5% | 0.16 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 10.98 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 4% | 0.13 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 11.10 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 3% | 0.10 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 11.22 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 2% | 0.06 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 11.33 | 21.0 | 1,987 | 141,942 | 140,020 | --- |
| 1% | 0.03 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 11.45 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.12 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0.0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| 0% | 0.00 | 1922 | 1922 | 26.91 | 1092 | 0.384 | 0.91 | 3.18 | 262.00 | 261 | 0.90 | 2546 | 0.00 | 11.56 | 21.0 | 1,987 | 141,941 | 140,019 | --- |
| *TST* | --- | --- | *136964* | *1917.50* | *85* | *0.374* | *66.60* | 85.58 | 262.00 | 247 | *66.25* | 198 | --- | --- | --- | *1,918* | 136,964 | 0 | --- |
| *Screen* | --- | --- | *1922* | *26.91* | --- | *0.400* | 0.87 | *104.00* | 262.00 | 244 | *0.91* | 2487 | --- | *11.8* | *21.0* | *2,025* | 144,644 | 142,722 | --- |
| *w/iter* | --- | --- | *1922* | *26.91* | *1092* | *0.384* | 0.91 | 3.18 | 262.00 | 261 | *0.90* | 2546 | --- | *11.6* | *21.0* | *1,987* | 141,941 | 140,019 | --- |

**Valve:** BWR Plant D, static close 2

*Select Valve-->* BWR Plant D, dynamic close 2

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | globe |
| Flow type | no | pumped flow |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 2.125 |
| Seat ring face ID, $D_{body-ID}$ (inches) | no | 0.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | yes | 5.734 |
| Globe valve stroke length, D (inches) | yes | 3.187 |
| Isolation-to-wedging travel, X (percent) | no | 0% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,922 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 37,508 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | yes (LP) | 435 |
| Actuator overall ratio, OAR | yes | 76.99 |
| Motor gear set ratio, MGSR | yes | 0.43 |
| Actuator rated torque, $\tau_{rated}$ | yes | 1,800 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0140 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 210.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.031 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.139 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 60 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | yes | 1011 |
| Valve pressure at full open, $P_B$ (psig) | yes | 40 |
| Flow rate, $Q_{max}$ (gpm) | no | 860 |
| Fluid density, ρ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | yes | 1329.6 |
| Fully open stem thrust, $F_O$ (lbs) | yes | 2,064 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 66.3 |
| Maximum motor torque (ft-lbs) | yes | 15.5 |
| Maximum adjusted motor torque (ft-lbs) | yes | 18.5 |
| Minimum motor speed (rpm) | yes | 1335 |
| Minimum instantaneous actuator capability (lbs) | yes | 119,037 |
| Minimum instantaneous margin (lbs) | yes | 96,875 |
| Maximum torque switch setting | yes | 107,616 |
| Efficiency at minimum instantaneous capability | yes | 0.384 |

| | *Not required* |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** **14.59**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | *0.00* | *21.0* | | | | 856 |
| 100% | 3.19 | 2199 | | | | *0.400* | 1.01 | 3.31 | 210.00 | 209 | 1.18 | 2119 | 1.39 | 1.39 | 21.0 | 1,736 | 123,998 | 121,783 | 855 |
| 90% | 2.87 | 2231 | 2215 | 31.01 | 909 | 0.384 | 1.07 | 3.39 | 210.00 | 209 | 1.25 | 2115 | 1.39 | 2.78 | 21.0 | 1,667 | 119,037 | 116,784 | 855 |
| 80% | 2.55 | 2275 | 2253 | 31.55 | 907 | 0.384 | 1.09 | 3.42 | 210.00 | 209 | 1.28 | 2113 | 1.39 | 4.18 | 21.0 | 1,667 | 119,063 | 116,755 | 854 |
| 70% | 2.23 | 2340 | 2307 | 32.30 | 907 | 0.384 | 1.13 | 3.47 | 210.00 | 209 | 1.33 | 2111 | 1.39 | 5.57 | 21.0 | 1,667 | 119,102 | 116,713 | 853 |
| 60% | 1.91 | 2438 | 2389 | 33.44 | 907 | 0.384 | 1.17 | 3.52 | 210.00 | 209 | 1.38 | 2109 | 0.70 | 6.27 | 21.0 | 1,668 | 119,142 | 116,669 | 852 |
| 55% | 1.75 | 2508 | 2473 | 34.62 | 906 | 0.385 | 1.21 | 3.57 | 210.00 | 209 | 1.42 | 2106 | 0.70 | 6.97 | 21.0 | 1,669 | 119,181 | 116,627 | 851 |
| 50% | 1.59 | 2600 | 2554 | 35.76 | 905 | 0.385 | 1.26 | 3.64 | 210.00 | 209 | 1.48 | 2103 | 0.70 | 7.67 | 21.0 | 1,669 | 119,233 | 116,571 | 849 |
| 45% | 1.43 | 2724 | 2662 | 37.27 | 904 | 0.385 | 1.33 | 3.72 | 210.00 | 209 | 1.56 | 2099 | 0.70 | 8.37 | 21.0 | 1,670 | 119,305 | 116,495 | 847 |
| 40% | 1.27 | 2895 | 2809 | 39.33 | 902 | 0.385 | 1.42 | 3.85 | 210.00 | 209 | 1.67 | 2093 | 0.70 | 9.07 | 21.0 | 1,672 | 119,406 | 116,388 | 844 |
| 35% | 1.12 | 3142 | 3018 | 42.25 | 900 | 0.386 | 1.57 | 4.04 | 210.00 | 209 | 1.84 | 2084 | 0.71 | 9.78 | 21.0 | 1,674 | 119,557 | 116,229 | 840 |
| 30% | 0.96 | 3515 | 3328 | 46.59 | 898 | 0.386 | 1.70 | 4.21 | 210.00 | 209 | 2.00 | 2076 | 0.28 | 10.06 | 21.0 | 1,676 | 119,696 | 116,079 | 837 |
| 28% | 0.89 | 3719 | 3617 | 50.64 | 894 | 0.387 | 1.81 | 4.35 | 210.00 | 209 | 2.13 | 2070 | 0.28 | 10.35 | 21.0 | 1,677 | 119,805 | 115,961 | 834 |
| 26% | 0.83 | 3970 | 3844 | 53.82 | 891 | 0.387 | 1.94 | 4.52 | 210.00 | 209 | 2.28 | 2062 | 0.29 | 10.63 | 21.0 | 1,679 | 119,941 | 115,816 | 830 |
| 24% | 0.76 | 4280 | 4125 | 57.75 | 888 | 0.388 | 2.10 | 4.73 | 210.00 | 209 | 2.47 | 2052 | 0.29 | 10.92 | 21.0 | 1,682 | 120,110 | 115,635 | 825 |
| 22% | 0.70 | 4670 | 4475 | 62.65 | 884 | 0.389 | 2.30 | 4.99 | 210.00 | 209 | 2.71 | 2039 | 0.29 | 11.21 | 21.0 | 1,685 | 120,324 | 115,404 | 819 |
| 20% | 0.64 | 5169 | 4920 | 68.88 | 880 | 0.390 | 2.56 | 5.33 | 210.00 | 209 | 3.02 | 2023 | 0.29 | 11.50 | 21.0 | 1,688 | 120,601 | 115,106 | 811 |
| 18% | 0.57 | 5821 | 5495 | 76.93 | 875 | 0.391 | 2.91 | 5.78 | 210.00 | 209 | 3.43 | 2002 | 0.29 | 11.79 | 21.0 | 1,694 | 120,964 | 114,710 | 800 |
| 16% | 0.51 | 6688 | 6254 | 87.56 | 868 | 0.393 | 3.37 | 6.38 | 210.00 | 209 | 3.97 | 1974 | 0.30 | 12.09 | 21.0 | 1,700 | 121,453 | 114,173 | 784 |
| 14% | 0.45 | 7872 | 7280 | 101.92 | 859 | 0.395 | 4.00 | 7.20 | 210.00 | 209 | 4.72 | 1935 | 0.30 | 12.40 | 21.0 | 1,710 | 122,126 | 113,426 | 762 |
| 12% | 0.38 | 9528 | 8700 | 121.80 | 847 | 0.399 | 4.89 | 8.35 | 210.00 | 209 | 5.77 | 1881 | 0.31 | 12.71 | 21.1 | 1,723 | 123,072 | 112,358 | 729 |
| 10% | 0.32 | 11900 | 10714 | 150.00 | 830 | 0.402 | 5.74 | 9.46 | 210.00 | 208 | 6.78 | 1828 | 0.16 | 12.87 | 21.1 | 1,736 | 123,971 | 111,288 | 706 |
| 9% | 0.29 | 13466 | 12683 | 177.56 | 807 | 0.405 | 6.47 | 10.42 | 210.00 | 208 | 7.65 | 1783 | 0.17 | 13.03 | 21.1 | 1,746 | 124,745 | 110,333 | 678 |
| 8% | 0.25 | 15358 | 14412 | 201.77 | 784 | 0.408 | 7.35 | 11.55 | 210.00 | 208 | 8.70 | 1729 | 0.17 | 13.21 | 21.1 | 1,760 | 125,682 | 109,183 | 642 |
| 7% | 0.22 | 17639 | 16499 | 230.98 | 765 | 0.412 | 8.38 | 12.89 | 210.00 | 208 | 9.93 | 1666 | 0.18 | 13.38 | 21.1 | 1,775 | 126,789 | 107,789 | 597 |
| 6% | 0.19 | 20361 | 19000 | 266.00 | 742 | 0.417 | 9.57 | 14.44 | 210.00 | 208 | 11.35 | 1610 | 0.18 | 13.56 | 21.1 | 1,793 | 128,069 | 106,121 | 539 |
| 5% | 0.16 | 23534 | 21947 | 307.26 | 715 | 0.422 | 10.90 | 16.07 | 210.00 | 207 | 12.94 | 1548 | 0.19 | 13.76 | 21.1 | 1,813 | 129,533 | 104,223 | 465 |
| 4% | 0.13 | 27086 | 25310 | 354.34 | 691 | 0.428 | 12.29 | 17.75 | 210.00 | 207 | 14.62 | 1484 | 0.20 | 13.95 | 21.2 | 1,835 | 131,083 | 102,150 | 374 |
| 3% | 0.10 | 30780 | 28933 | 405.06 | 664 | 0.434 | 13.62 | 19.34 | 210.00 | 207 | 16.23 | 1422 | 0.21 | 14.16 | 21.2 | 1,856 | 132,552 | 100,079 | 264 |
| 2% | 0.06 | 34165 | 32473 | 454.62 | 636 | 0.438 | 14.70 | 20.63 | 210.00 | 206 | 17.53 | 1372 | 0.21 | 14.38 | 21.3 | 1,872 | 133,709 | 98,322 | 137 |
| 1% | 0.03 | 36609 | 35387 | 495.42 | 610 | 0.440 | 15.31 | 21.37 | 210.00 | 206 | 18.28 | 1343 | 0.22 | 14.59 | 21.4 | 1,880 | 134,309 | 97,250 | 0 |
| 0% | 0.00 | 37508 | 37058 | 518.82 | 589 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,882 | 134,403 | 96,895 | --- |
| 0.0% | 0.00 | 37508 | 37508 | 525.11 | 576 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| 0% | 0.00 | 37508 | 37508 | 525.11 | 573 | 0.441 | 15.48 | 21.57 | 210.00 | 206 | 18.49 | 1335 | 0.00 | 14.59 | 21.4 | 1,881 | 134,383 | 96,875 | --- |
| *TST* | --- | --- | *107616* | *1506.63* | *68* | *0.367* | *53.29* | 68.95 | 210.00 | 198 | *66.25* | 159 | --- | --- | --- | *1,507* | 107,616 | 0 | --- |
| *Screen* | --- | --- | *37508* | *525.11* | --- | *0.400* | 17.05 | *104.00* | 210.00 | 192 | *22.68* | 1105 | --- | *26.7* | *31.2* | *1,533* | 109,481 | 71,973 | --- |
| *w/iter* | --- | --- | *37508* | *525.11* | *565* | *0.441* | 15.48 | 21.58 | 210.00 | 206 | *18.98* | 1317 | --- | *22.4* | *28.1* | *1,833* | 130,907 | 93,399 | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant D, dynamic close 2 | | | | | | | | | | | | | | | | | | |

*Select Valve*--> BWR Plant D, stabc open 3

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | no | 0 |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 7.720 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 28.20 |
| Motor gear set ratio, MGSR | yes | 1.60 |
| Actuator rated torque, $\tau_{rated}$ | yes | 250 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0162 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 131.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.240 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.023 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 15 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 22.5 |
| Maximum motor torque (ft-lbs) | yes | 0.7 |
| Maximum adjusted motor torque (ft-lbs) | yes | 0.7 |
| Minimum motor speed (rpm) | yes | 2398 |
| Minimum instantaneous actuator capability (lbs) | yes | 15,469 |
| Minimum instantaneous margin (lbs) | yes | 15,007 |
| Maximum allowable thrust at unwedging | yes | 15,491 |
| Efficiency at minimum instantaneous capability | yes | 0.389 |

***Warnings***

***Predicted Stroke Time (Seconds):*** 11.99

| ***Thrust Profile*** | |
|---|---|
| 100% | 462 |
| 90% | 462 |
| 80% | 462 |
| 70% | 462 |
| 60% | 462 |
| 55% | 462 |
| 50% | 462 |
| 45% | 462 |
| 40% | 462 |
| 35% | 462 |
| 30% | 462 |
| 28% | 462 |
| 26% | 462 |
| 24% | 462 |
| 22% | 462 |
| 20% | 462 |
| 18% | 462 |
| 16% | 462 |
| 14% | 462 |
| 12% | 462 |
| 10% | 462 |
| 9% | 462 |
| 8% | 462 |
| 7% | 462 |
| 6% | 462 |
| 5% | 462 |
| 4% | 462 |
| 3% | 462 |
| 2% | 462 |
| 1% | 462 |
| 0% | 462 |
| -0.0010% | 462 |
| -100% | 462 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.77 | 462 | | | | | | | | | | | | *0.00* | *21.0* | | | | --- |
| -9% | -0.69 | 462 | 462 | 7.48 | | *0.400* | 0.66 | 3.03 | 131.00 | 130 | 0.65 | 2406 | 0.11 | 0.11 | 21.0 | 258 | 15,912 | 15,450 | --- |
| -8% | -0.62 | 462 | 462 | 7.48 | 3840 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.22 | 21.0 | 251 | 15,474 | 15,012 | --- |
| -7% | -0.54 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.33 | 21.0 | 251 | 15,474 | 15,012 | --- |
| -6% | -0.46 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.44 | 21.0 | 251 | 15,474 | 15,012 | --- |
| -5% | -0.39 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.54 | 21.0 | 251 | 15,474 | 15,012 | --- |
| -4% | -0.31 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.65 | 21.0 | 251 | 15,473 | 15,011 | --- |
| -3% | -0.23 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.76 | 21.0 | 251 | 15,473 | 15,011 | --- |
| -2% | -0.15 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.87 | 21.0 | 251 | 15,473 | 15,011 | --- |
| -1% | -0.08 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 0.98 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 0% | -0.01 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.10 | 1.08 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 0% | 0.00 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.01 | 1.09 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 1% | 0.08 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.20 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 2% | 0.15 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.31 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 3% | 0.23 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.42 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 4% | 0.31 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.53 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 5% | 0.39 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.63 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 6% | 0.46 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.74 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 7% | 0.54 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.85 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 8% | 0.62 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 1.96 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 9% | 0.69 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 2.07 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 10% | 0.77 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.11 | 2.18 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 12% | 0.93 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 2.40 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 14% | 1.08 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 2.61 | 21.0 | 251 | 15,473 | 15,011 | --- |
| 16% | 1.24 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 2.83 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 18% | 1.39 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 3.05 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 20% | 1.54 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 3.27 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 22% | 1.70 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 3.49 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 24% | 1.85 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 3.70 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 26% | 2.01 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 3.92 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 28% | 2.16 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 4.14 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 30.0% | 2.32 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.22 | 4.36 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 35% | 2.70 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 4.90 | 21.0 | 251 | 15,472 | 15,010 | --- |
| 40% | 3.09 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 5.45 | 21.0 | 251 | 15,471 | 15,009 | --- |
| 45% | 3.47 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 5.99 | 21.0 | 251 | 15,471 | 15,009 | --- |
| 50% | 3.86 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 6.54 | 21.1 | 251 | 15,471 | 15,009 | --- |
| 55% | 4.25 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 7.08 | 21.1 | 251 | 15,471 | 15,009 | --- |
| 60% | 4.63 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 0.54 | 7.63 | 21.1 | 251 | 15,470 | 15,008 | --- |
| 70% | 5.40 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 1.09 | 8.72 | 21.1 | 251 | 15,470 | 15,008 | --- |
| 80% | 6.18 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 1.09 | 9.81 | 21.1 | 251 | 15,470 | 15,008 | --- |
| 90% | 6.95 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 1.09 | 10.90 | 21.1 | 251 | 15,469 | 15,007 | --- |
| 100% | 7.72 | 462 | 462 | 7.48 | 3827 | 0.389 | 0.68 | 3.07 | 131.00 | 130 | 0.67 | 2398 | 1.09 | 11.99 | 21.1 | 251 | 15,469 | 15,007 | --- |
| *UNW* | --- | --- | *15491* | *250.95* | *300* | *0.414* | *21.48* | 51.36 | 131.00 | 117 | *22.50* | 188 | --- | --- | --- | *251* | 15,491 | (0) | --- |
| *Screen* | --- | --- | *462* | *7.48* | --- | *0.400* | 0.66 | *59.20* | 131.00 | 115 | *0.74* | 2188 | --- | *13.1* | *21.1* | *238* | 14,688 | 14,226 | --- |
| *w/iter* | --- | --- | *462* | *7.48* | *3827* | *0.389* | 0.68 | 3.07 | 131.00 | 130 | *0.67* | 2398 | --- | *12.0* | *21.1* | *251* | 15,468 | 15,006 | --- |

**Valve:** BWR Plant D, static open 3

*Select Valve-->* BWR Plant D, dynamic open 3

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | wedge gate |
| Flow type | yes | pumped flow |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.625 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 7.720 |
| Seat ring inner diameter, $D_{sr}$ (inches) | yes | 7.720 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 645 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 1,096 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 28.20 |
| Motor gear set ratio, MGSR | yes | 1.60 |
| Actuator rated torque, $\tau_{rated}$ | yes | 250 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0162 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 106.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.240 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.023 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 15 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | yes | 46 |
| Valve pressure at full open, $P_B$ (psig) | yes | 18 |
| Flow rate, $Q_{max}$ (gpm) | no | 1 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | yes | 147015224.0 |
| Fully open stem thrust, $F_O$ (lbs) | yes | 608 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 22.5 |
| Maximum motor torque (ft-lbs) | yes | 1.6 |
| Maximum adjusted motor torque (ft-lbs) | yes | 1.9 |
| Minimum motor speed (rpm) | yes | 1704 |
| Minimum instantaneous actuator capability (lbs) | yes | 13,088 |
| Minimum instantaneous margin (lbs) | yes | 12,218 |
| Maximum allowable thrust at unwedging | yes | 12,207 |
| Efficiency at minimum instantaneous capability | yes | 0.392 |

| ***Not required*** | |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

Ksys is greater than 5000. The load profile for Ksys=5000 is used.

***Predicted Stroke Time (Seconds):*** **15.46**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | *0.00* | *21.0* | | | | 1 |
| -10% | -0.77 | 1096 | | | | *0.400* | 1.57 | 5.35 | 106.00 | 105 | 1.85 | 1704 | 0.15 | 0.15 | 21.0 | 216 | 13,314 | 12,218 | 1 |
| -9% | -0.69 | 1096 | 1096 | 17.76 | | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 0.31 | 21.0 | 216 | 13,358 | 12,262 | 1 |
| -8% | -0.62 | 1096 | 1096 | 17.76 | 2720 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 0.46 | 21.0 | 216 | 13,358 | 12,262 | 1 |
| -7% | -0.54 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 0.61 | 21.0 | 216 | 13,357 | 12,261 | 1 |
| -6% | -0.46 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 0.77 | 21.0 | 216 | 13,357 | 12,261 | 1 |
| -5% | -0.39 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 0.92 | 21.0 | 216 | 13,357 | 12,261 | 1 |
| -4% | -0.31 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 1.07 | 21.0 | 216 | 13,356 | 12,260 | 1 |
| -3% | -0.23 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 1.23 | 21.1 | 216 | 13,356 | 12,260 | 1 |
| -2% | -0.15 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 1.38 | 21.1 | 216 | 13,356 | 12,260 | 1 |
| -1% | -0.08 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.14 | 1.52 | 21.1 | 216 | 13,355 | 12,259 | 1 |
| 0% | -0.01 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.02 | 1.53 | 21.1 | 216 | 13,355 | 12,259 | 1 |
| 0% | 0.00 | 1096 | 1096 | 17.76 | 2722 | 0.401 | 1.57 | 5.34 | 106.00 | 105 | 1.85 | 1706 | 0.15 | 1.68 | 21.1 | 216 | 13,332 | 12,280 | 1 |
| 1% | 0.08 | 1009 | 1053 | 17.05 | 2722 | 0.400 | 1.51 | 5.18 | 106.00 | 105 | 1.78 | 1721 | 0.15 | 1.83 | 21.1 | 215 | 13,287 | 12,320 | 1 |
| 2% | 0.15 | 923 | 966 | 15.65 | 2747 | 0.399 | 1.39 | 4.86 | 106.00 | 105 | 1.64 | 1752 | 0.15 | 1.98 | 21.1 | 215 | 13,241 | 12,361 | 1 |
| 3% | 0.23 | 836 | 880 | 14.25 | 2796 | 0.397 | 1.27 | 4.54 | 106.00 | 105 | 1.49 | 1783 | 0.15 | 2.12 | 21.1 | 214 | 13,195 | 12,402 | 1 |
| 4% | 0.31 | 750 | 793 | 12.85 | 2845 | 0.395 | 1.15 | 4.21 | 106.00 | 105 | 1.35 | 1814 | 0.14 | 2.27 | 21.1 | 213 | 13,159 | 12,435 | 1 |
| 5% | 0.39 | 698 | 724 | 11.73 | 2895 | 0.394 | 1.06 | 3.95 | 106.00 | 105 | 1.24 | 1839 | 0.14 | 2.41 | 21.1 | 213 | 13,137 | 12,455 | 1 |
| 6% | 0.46 | 665 | 682 | 11.04 | 2936 | 0.393 | 1.00 | 3.79 | 106.00 | 105 | 1.17 | 1855 | 0.14 | 2.55 | 21.1 | 213 | 13,122 | 12,467 | 1 |
| 7% | 0.54 | 643 | 654 | 10.60 | 2960 | 0.393 | 0.96 | 3.70 | 106.00 | 105 | 1.12 | 1865 | 0.14 | 2.69 | 21.1 | 212 | 13,113 | 12,475 | 1 |
| 8% | 0.62 | 634 | 639 | 10.34 | 2976 | 0.392 | 0.93 | 3.65 | 106.00 | 105 | 1.10 | 1871 | 0.14 | 2.83 | 21.1 | 212 | 13,108 | 12,479 | 1 |
| 9% | 0.69 | 625 | 630 | 10.20 | 2986 | 0.392 | 0.92 | 3.62 | 106.00 | 105 | 1.08 | 1874 | 0.14 | 2.96 | 21.1 | 212 | 13,105 | 12,481 | 1 |
| 10% | 0.77 | 621 | 623 | 10.10 | 2991 | 0.392 | 0.91 | 3.60 | 106.00 | 105 | 1.07 | 1876 | 0.14 | 3.24 | 21.1 | 212 | 13,102 | 12,483 | 1 |
| 12% | 0.93 | 616 | 619 | 10.02 | 2994 | 0.392 | 0.91 | 3.59 | 106.00 | 105 | 1.06 | 1878 | 0.28 | 3.52 | 21.1 | 212 | 13,100 | 12,485 | 1 |
| 14% | 1.08 | 614 | 615 | 9.97 | 2997 | 0.392 | 0.90 | 3.57 | 106.00 | 105 | 1.06 | 1879 | 0.28 | 3.80 | 21.1 | 212 | 13,099 | 12,486 | 1 |
| 16% | 1.24 | 612 | 613 | 9.93 | 2999 | 0.392 | 0.90 | 3.57 | 106.00 | 105 | 1.05 | 1880 | 0.28 | 4.08 | 21.1 | 212 | 13,098 | 12,486 | 1 |
| 18% | 1.39 | 611 | 612 | 9.91 | 3000 | 0.392 | 0.90 | 3.56 | 106.00 | 105 | 1.05 | 1881 | 0.28 | 4.35 | 21.1 | 212 | 13,097 | 12,486 | 1 |
| 20% | 1.54 | 611 | 611 | 9.90 | 3001 | 0.392 | 0.90 | 3.56 | 106.00 | 105 | 1.05 | 1881 | 0.28 | 4.63 | 21.1 | 212 | 13,097 | 12,486 | 1 |
| 22% | 1.70 | 610 | 610 | 9.89 | 3002 | 0.392 | 0.89 | 3.56 | 106.00 | 105 | 1.05 | 1881 | 0.28 | 4.91 | 21.1 | 212 | 13,096 | 12,486 | 1 |
| 24% | 1.85 | 610 | 610 | 9.88 | 3002 | 0.392 | 0.89 | 3.56 | 106.00 | 105 | 1.05 | 1881 | 0.28 | 5.19 | 21.1 | 212 | 13,096 | 12,486 | 1 |
| 26% | 2.01 | 609 | 609 | 9.87 | 3002 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.05 | 1881 | 0.28 | 5.47 | 21.1 | 212 | 13,095 | 12,486 | 0 |
| 28% | 2.16 | 609 | 609 | 9.86 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.05 | 1882 | 0.28 | 5.74 | 21.1 | 212 | 13,095 | 12,486 | --- |
| 30.0% | 2.32 | 609 | 609 | 9.86 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.05 | 1882 | 0.28 | 6.44 | 21.1 | 212 | 13,095 | 12,486 | --- |
| 35% | 2.70 | 608 | 608 | 9.86 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.05 | 1882 | 0.69 | 7.13 | 21.1 | 212 | 13,094 | 12,486 | --- |
| 40% | 3.09 | 608 | 608 | 9.85 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.05 | 1882 | 0.69 | 7.83 | 21.2 | 212 | 13,093 | 12,485 | --- |
| 45% | 3.47 | 608 | 608 | 9.85 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 0.69 | 8.52 | 21.2 | 212 | 13,093 | 12,485 | --- |
| 50% | 3.86 | 608 | 608 | 9.85 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 0.69 | 9.21 | 21.2 | 212 | 13,092 | 12,485 | --- |
| 55% | 4.25 | 608 | 608 | 9.85 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 0.69 | 9.91 | 21.2 | 212 | 13,092 | 12,484 | --- |
| 60% | 4.63 | 608 | 608 | 9.84 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 1.39 | 11.30 | 21.2 | 212 | 13,091 | 12,484 | --- |
| 70% | 5.40 | 608 | 608 | 9.84 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 1.39 | 12.68 | 21.2 | 212 | 13,090 | 12,483 | --- |
| 80% | 6.18 | 608 | 608 | 9.84 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 1.39 | 14.07 | 21.2 | 212 | 13,089 | 12,482 | --- |
| 90% | 6.95 | 608 | 608 | 9.84 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 1.39 | 15.46 | 21.3 | 212 | 13,088 | 12,481 | --- |
| 100% | 7.72 | 608 | 608 | 9.84 | 3003 | 0.392 | 0.89 | 3.55 | 106.00 | 105 | 1.04 | 1882 | 1.39 | --- | --- | *198* | 12,207 | 0 | --- |
| *UNW* | --- | --- | *12207* | *197.76* | *242* | *0.404* | *17.34* | 42.35 | 106.00 | 95 | *22.50* | 152 | --- | *20.2* | *21.8* | *186* | 11,474 | 10,378 | --- |
| *Screen* | --- | --- | *1096* | *17.76* | --- | *0.400* | 1.57 | *59.20* | 106.00 | 90 | *2.23* | 1422 | --- | *16.9* | *21.7* | *216* | 13,322 | 12,226 | --- |
| *w/iter* | --- | --- | *1096* | *17.76* | *2721* | *0.401* | 1.57 | 5.34 | 106.00 | 105 | *1.85* | 1705 | --- | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant D, dynamic open 3 | | | | | | | | | | | | | | | | | | |

***Select Valve—>*** BWR Plant D, static close 4

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | globe |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | no | 0.000 |
| Seat ring inner diameter, $D_w$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | yes | 1.860 |
| Isolation-to-wedging travel, X (percent) | no | 0% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 200 |
| Actuator overall ratio, OAR | yes | 123.00 |
| Motor gear set ratio, MGSR | yes | 0.55 |
| Actuator rated torque, $\tau_{rated}$ | yes | 90 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0089 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 131.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.326 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.421 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 2 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.250 |
| Pullout efficiency, $\eta_p$ | yes | 0.35 |
| Run efficiency, $\eta_r$ | yes | 0.45 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 4.4 |
| Maximum motor torque (ft-lbs) | yes | 0.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 0.1 |
| Minimum motor speed (rpm) | yes | 2272 |
| Minimum instantaneous actuator capability (lbs) | yes | 20,747 |
| Minimum instantaneous margin (lbs) | yes | 20,479 |
| Maximum torque switch setting | yes | 19,722 |
| Efficiency at minimum instantaneous capability | yes | 0.337 |

***Warnings***

***Predicted Stroke Time (Seconds):*** 24.17

| ***Thrust Profile*** | |
|---|---|
| 100% | 268 |
| 90% | 268 |
| 80% | 268 |
| 70% | 268 |
| 60% | 268 |
| 55% | 268 |
| 50% | 268 |
| 45% | 268 |
| 40% | 268 |
| 35% | 268 |
| 30% | 268 |
| 28% | 268 |
| 26% | 268 |
| 24% | 268 |
| 22% | 268 |
| 20% | 268 |
| 18% | 268 |
| 16% | 268 |
| 14% | 268 |
| 12% | 268 |
| 10% | 268 |
| 9% | 268 |
| 8% | 268 |
| 7% | 268 |
| 6% | 268 |
| 5% | 268 |
| 4% | 268 |
| 3% | 268 |
| 2% | 268 |
| 1% | 268 |
| 0% | 268 |
| -0.0010% | 268 |
| -100% | 268 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 1.86 | 268 | | | | | | | | | | | | *0.00* | *21.0* | | | | --- |
| 90% | 1.67 | 268 | 268 | 2.39 | | *0.350* | 0.06 | 1.14 | 131.00 | 130 | 0.05 | 2273 | 2.42 | 2.42 | 21.0 | 192 | 21,574 | 21,306 | --- |
| 80% | 1.49 | 268 | 268 | 2.39 | 1257 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 2.42 | 4.83 | 21.0 | 185 | 20,752 | 20,484 | --- |
| 70% | 1.30 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 2.42 | 7.25 | 21.0 | 185 | 20,752 | 20,484 | --- |
| 60% | 1.12 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 2.42 | 9.67 | 21.0 | 185 | 20,751 | 20,483 | --- |
| 55% | 1.02 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 10.88 | 21.0 | 185 | 20,751 | 20,483 | --- |
| 50% | 0.93 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 12.08 | 21.0 | 185 | 20,750 | 20,482 | --- |
| 45% | 0.84 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 13.29 | 21.0 | 185 | 20,750 | 20,482 | --- |
| 40% | 0.74 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 14.50 | 21.0 | 185 | 20,750 | 20,482 | --- |
| 35% | 0.65 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 15.71 | 21.0 | 185 | 20,750 | 20,482 | --- |
| 30% | 0.56 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 1.21 | 16.92 | 21.0 | 185 | 20,749 | 20,481 | --- |
| 28% | 0.52 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 17.40 | 21.0 | 185 | 20,749 | 20,481 | --- |
| 26% | 0.48 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 17.89 | 21.0 | 185 | 20,749 | 20,481 | --- |
| 24% | 0.45 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 18.37 | 21.0 | 185 | 20,749 | 20,481 | --- |
| 22% | 0.41 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 18.85 | 21.1 | 185 | 20,749 | 20,481 | --- |
| 20% | 0.37 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 19.34 | 21.1 | 185 | 20,749 | 20,481 | --- |
| 18% | 0.33 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 19.82 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 16% | 0.30 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 20.30 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 14% | 0.26 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 20.79 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 12% | 0.22 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 21.27 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 10% | 0.19 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.48 | 21.75 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 9% | 0.17 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 21.99 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 8% | 0.15 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 22.24 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 7% | 0.13 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 22.48 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 6% | 0.11 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 22.72 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 5% | 0.09 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 22.96 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 4% | 0.07 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 23.20 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 3% | 0.06 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 23.44 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 2% | 0.04 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 23.69 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 1% | 0.02 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 23.93 | 21.1 | 185 | 20,748 | 20,480 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.24 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0.0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| 0% | 0.00 | 268 | 268 | 2.39 | 1256 | 0.337 | 0.06 | 1.14 | 131.00 | 130 | 0.06 | 2272 | 0.00 | 24.17 | 21.1 | 185 | 20,747 | 20,479 | --- |
| *TST* | --- | --- | *19722* | *175.53* | *107* | *0.331* | *4.31* | 13.66 | 131.00 | 121 | *4.39* | 193 | --- | --- | --- | *176* | 19,722 | 0 | --- |
| *Screen* | --- | --- | *268* | *2.39* | --- | *0.350* | 0.06 | *15.50* | 131.00 | 119 | *0.06* | 2169 | --- | *25.3* | *21.1* | *183* | 20,606 | 20,338 | --- |
| *w/iter* | --- | --- | *268* | *2.39* | *1256* | *0.337* | 0.06 | 1.14 | 131.00 | 130 | *0.06* | 2272 | --- | *24.2* | *21.1* | *185* | 20,747 | 20,479 | --- |

**Valve:** BWR Plant D, static close 4

*Select Valve*--> BWR Plant D, dynamic close 4

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | globe |
| Flow type | no | pumped flow |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 1.250 |
| Seat ring face ID, $D_{body-ID}$ (inches) | no | 0.000 |
| Seat ring inner diameter, $D_{sr}$ (inches) | yes | 3.680 |
| Globe valve stroke length, D (inches) | yes | 1.860 |
| Isolation-to-wedging travel, X (percent) | no | 0% |
| Packing load, $F_{pack}$ (lbs) | yes | 268 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 2,751 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | yes (LP) | 200 |
| Actuator overall ratio, OAR | yes | 123.00 |
| Motor gear set ratio, MGSR | yes | 0.55 |
| Actuator rated torque, $\tau_{rated}$ | yes | 90 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0089 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 106.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.326 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.421 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 125 |
| Motor type | yes | 2 ft-lb, 125 VDC |
| Valve stem lead, lead (inches) | yes | 0.250 |
| Pullout efficiency, $\eta_p$ | yes | 0.35 |
| Run efficiency, $\eta_r$ | yes | 0.45 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | yes | 244 |
| Valve pressure at full open, $P_B$ (psig) | yes | 235 |
| Flow rate, $Q_{max}$ (gpm) | no | 2000 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 62.000 |
| Ambient temperature (C) | yes | 21 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | yes | 10.1 |
| Fully open stem thrust, $F_O$ (lbs) | yes | 556 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 4.4 |
| Maximum motor torque (ft-lbs) | yes | 0.5 |
| Maximum adjusted motor torque (ft-lbs) | yes | 0.6 |
| Minimum motor speed (rpm) | yes | 1668 |
| Minimum instantaneous actuator capability (lbs) | yes | 18,083 |
| Minimum instantaneous margin (lbs) | yes | 16,842 |
| Maximum torque switch setting | yes | 15,444 |
| Efficiency at minimum instantaneous capability | yes | 0.350 |

| | *Not required* |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** **31.62**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 1.86 | 1191 | | | | | | | | | | | | *0.00* | *21.0* | | | | 1681 |
| 90% | 1.67 | 1291 | 1241 | 11.05 | | *0.350* | 0.26 | 1.64 | 106.00 | 105 | 0.30 | 1802 | 3.05 | 3.05 | 21.2 | 161 | 18,083 | 16,842 | 1627 |
| 80% | 1.49 | 1410 | 1350 | 12.02 | 996 | 0.361 | 0.27 | 1.68 | 106.00 | 105 | 0.32 | 1794 | 3.06 | 6.11 | 21.3 | 166 | 18,656 | 17,306 | 1560 |
| 70% | 1.30 | 1552 | 1481 | 13.18 | 992 | 0.364 | 0.29 | 1.74 | 106.00 | 105 | 0.35 | 1782 | 3.08 | 9.19 | 21.6 | 167 | 18,790 | 17,309 | 1474 |
| 60% | 1.12 | 1721 | 1637 | 14.57 | 985 | 0.368 | 0.32 | 1.80 | 106.00 | 105 | 0.38 | 1767 | 3.11 | 12.30 | 21.8 | 169 | 18,947 | 17,310 | 1367 |
| 55% | 1.02 | 1816 | 1768 | 15.74 | 977 | 0.371 | 0.34 | 1.86 | 106.00 | 105 | 0.41 | 1754 | 1.56 | 13.86 | 22.0 | 170 | 19,072 | 17,304 | 1303 |
| 50% | 0.93 | 1916 | 1866 | 16.61 | 970 | 0.373 | 0.36 | 1.90 | 106.00 | 105 | 0.43 | 1745 | 1.57 | 15.44 | 22.1 | 171 | 19,167 | 17,301 | 1231 |
| 45% | 0.84 | 2022 | 1969 | 17.53 | 965 | 0.375 | 0.38 | 1.95 | 106.00 | 105 | 0.45 | 1736 | 1.58 | 17.02 | 22.3 | 171 | 19,268 | 17,298 | 1150 |
| 40% | 0.74 | 2132 | 2077 | 18.49 | 960 | 0.378 | 0.40 | 1.99 | 106.00 | 105 | 0.47 | 1726 | 1.59 | 18.61 | 22.5 | 172 | 19,371 | 17,294 | 1060 |
| 35% | 0.65 | 2243 | 2188 | 19.47 | 955 | 0.380 | 0.42 | 2.04 | 106.00 | 104 | 0.49 | 1716 | 1.60 | 20.21 | 22.8 | 173 | 19,476 | 17,289 | 960 |
| 30% | 0.56 | 2354 | 2299 | 20.46 | 949 | 0.383 | 0.43 | 2.09 | 106.00 | 104 | 0.52 | 1707 | 1.61 | 21.82 | 23.0 | 174 | 19,579 | 17,281 | 849 |
| 28% | 0.52 | 2397 | 2375 | 21.14 | 944 | 0.384 | 0.45 | 2.12 | 106.00 | 104 | 0.53 | 1700 | 0.65 | 22.46 | 23.1 | 175 | 19,642 | 17,267 | 802 |
| 26% | 0.48 | 2439 | 2418 | 21.52 | 940 | 0.385 | 0.45 | 2.13 | 106.00 | 104 | 0.54 | 1696 | 0.65 | 23.11 | 23.2 | 175 | 19,678 | 17,261 | 753 |
| 24% | 0.45 | 2479 | 2459 | 21.88 | 938 | 0.386 | 0.46 | 2.15 | 106.00 | 104 | 0.55 | 1693 | 0.65 | 23.76 | 23.3 | 175 | 19,714 | 17,255 | 703 |
| 22% | 0.41 | 2518 | 2498 | 22.24 | 936 | 0.387 | 0.47 | 2.17 | 106.00 | 104 | 0.56 | 1690 | 0.65 | 24.41 | 23.4 | 176 | 19,748 | 17,250 | 651 |
| 20% | 0.37 | 2555 | 2536 | 22.57 | 934 | 0.388 | 0.47 | 2.18 | 106.00 | 104 | 0.56 | 1686 | 0.65 | 25.06 | 23.6 | 176 | 19,780 | 17,243 | 597 |
| 18% | 0.33 | 2589 | 2572 | 22.89 | 933 | 0.389 | 0.48 | 2.20 | 106.00 | 104 | 0.57 | 1683 | 0.65 | 25.71 | 23.7 | 176 | 19,809 | 17,237 | 542 |
| 16% | 0.30 | 2621 | 2605 | 23.19 | 931 | 0.390 | 0.48 | 2.21 | 106.00 | 104 | 0.58 | 1681 | 0.65 | 26.36 | 23.8 | 177 | 19,835 | 17,230 | 486 |
| 14% | 0.26 | 2650 | 2636 | 23.46 | 929 | 0.390 | 0.49 | 2.22 | 106.00 | 104 | 0.58 | 1678 | 0.65 | 27.02 | 23.9 | 177 | 19,858 | 17,222 | 428 |
| 12% | 0.22 | 2676 | 2663 | 23.70 | 928 | 0.391 | 0.49 | 2.23 | 106.00 | 104 | 0.59 | 1676 | 0.66 | 27.67 | 24.1 | 177 | 19,877 | 17,214 | 369 |
| 10% | 0.19 | 2698 | 2687 | 23.92 | 927 | 0.391 | 0.50 | 2.24 | 106.00 | 104 | 0.59 | 1674 | 0.66 | 28.33 | 24.2 | 177 | 19,892 | 17,205 | 309 |
| 9% | 0.17 | 2708 | 2703 | 24.06 | 925 | 0.392 | 0.50 | 2.25 | 106.00 | 104 | 0.60 | 1672 | 0.33 | 28.66 | 24.3 | 177 | 19,899 | 17,196 | 279 |
| 8% | 0.15 | 2717 | 2713 | 24.14 | 925 | 0.392 | 0.50 | 2.25 | 106.00 | 104 | 0.60 | 1671 | 0.33 | 28.99 | 24.3 | 177 | 19,904 | 17,191 | 248 |
| 7% | 0.13 | 2725 | 2721 | 24.22 | 924 | 0.392 | 0.50 | 2.26 | 106.00 | 104 | 0.60 | 1671 | 0.33 | 29.32 | 24.4 | 177 | 19,907 | 17,186 | 218 |
| 6% | 0.11 | 2732 | 2728 | 24.28 | 924 | 0.392 | 0.50 | 2.26 | 106.00 | 104 | 0.60 | 1670 | 0.33 | 29.64 | 24.5 | 177 | 19,910 | 17,181 | 187 |
| 5% | 0.09 | 2738 | 2735 | 24.34 | 923 | 0.392 | 0.50 | 2.26 | 106.00 | 104 | 0.60 | 1669 | 0.33 | 29.97 | 24.5 | 177 | 19,911 | 17,177 | 156 |
| 4% | 0.07 | 2742 | 2740 | 24.39 | 923 | 0.392 | 0.51 | 2.26 | 106.00 | 104 | 0.60 | 1669 | 0.33 | 30.30 | 24.6 | 177 | 19,912 | 17,172 | 125 |
| 3% | 0.06 | 2746 | 2744 | 24.42 | 923 | 0.393 | 0.51 | 2.26 | 106.00 | 104 | 0.61 | 1669 | 0.33 | 30.63 | 24.7 | 177 | 19,911 | 17,167 | 94 |
| 2% | 0.04 | 2749 | 2748 | 24.45 | 923 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.33 | 30.96 | 24.7 | 177 | 19,909 | 17,161 | 63 |
| 1% | 0.02 | 2750 | 2750 | 24.47 | 923 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.33 | 31.29 | 24.8 | 177 | 19,906 | 17,156 | 31 |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.33 | 31.62 | 24.9 | 177 | 19,902 | 17,151 | 0 |
| 0.0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| 0% | 0.00 | 2751 | 2751 | 24.48 | 922 | 0.393 | 0.51 | 2.27 | 106.00 | 104 | 0.61 | 1668 | 0.00 | 31.62 | 24.9 | 177 | 19,897 | 17,146 | --- |
| *TST* | --- | --- | *15444* | *137.46* | *87* | *0.325* | *3.44* | 10.80 | 106.00 | 98 | *4.39* | 157 | --- | --- | --- | *137* | 15,444 | (0) | --- |
| *Screen* | --- | --- | *2751* | *24.48* | --- | *0.350* | 0.57 | *15.50* | 106.00 | 94 | *0.77* | 1450 | --- | *37.9* | *30.9* | *140* | 15,685 | 12,934 | --- |
| *w/iter* | --- | --- | *2751* | *24.48* | *921* | *0.393* | 0.51 | 2.27 | 106.00 | 104 | *0.61* | 1665 | --- | *33.0* | *27.9* | *175* | 19,667 | 16,916 | --- |
| | | | | | | | | | | | | | | | | | | | |
| **Valve:** | BWR Plant D, dynamic close 4 | | | | | | | | | | | | | | | | | | |

**Select Valve—>** BWR Plant E, static close

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | no | 0 |
| Stroke direction | yes | close |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.581 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 32.13 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0061 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 250.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.465 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.018 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | — |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 0.8 |
| Maximum adjusted motor torque (ft-lbs) | yes | 0.8 |
| Minimum motor speed (rpm) | yes | 2708 |
| Minimum instantaneous actuator capability (lbs) | yes | 95,986 |
| Minimum instantaneous margin (lbs) | yes | 94,369 |
| Maximum torque switch setting | yes | 91,385 |
| Efficiency at minimum instantaneous capability | yes | 0.383 |

**Warnings**

***Predicted Stroke Time (Seconds):*** 15.00

| Thrust Profile | |
|---|---|
| 100% | 1,617 |
| 90% | 1,617 |
| 80% | 1,617 |
| 70% | 1,617 |
| 60% | 1,617 |
| 55% | 1,617 |
| 50% | 1,617 |
| 45% | 1,617 |
| 40% | 1,617 |
| 35% | 1,617 |
| 30% | 1,617 |
| 28% | 1,617 |
| 26% | 1,617 |
| 24% | 1,617 |
| 22% | 1,617 |
| 20% | 1,617 |
| 18% | 1,617 |
| 16% | 1,617 |
| 14% | 1,617 |
| 12% | 1,617 |
| 10% | 1,617 |
| 9% | 1,617 |
| 8% | 1,617 |
| 7% | 1,617 |
| 6% | 1,617 |
| 5% | 1,617 |
| 4% | 1,617 |
| 3% | 1,617 |
| 2% | 1,617 |
| 1% | 1,617 |
| 0% | 1,617 |
| -0.0010% | 1,617 |
| -100% | 1,617 |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | 0.00 | 32.0 | | | | --- |
| 100% | 9.58 | 1617 | | | | 0.400 | 0.77 | 1.15 | 250.00 | 249 | 0.79 | 2715 | 1.36 | 1.36 | 32.0 | 610 | 100,142 | 98,525 | --- |
| 90% | 8.62 | 1617 | 1617 | 9.85 | 2878 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 1.36 | 2.72 | 32.0 | 585 | 95,995 | 94,378 | --- |
| 80% | 7.66 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 1.36 | 4.09 | 32.0 | 585 | 95,994 | 94,377 | --- |
| 70% | 6.71 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 1.36 | 5.45 | 32.0 | 585 | 95,993 | 94,376 | --- |
| 60% | 5.75 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 6.13 | 32.0 | 585 | 95,992 | 94,375 | --- |
| 55% | 5.27 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 6.82 | 32.0 | 585 | 95,992 | 94,375 | --- |
| 50% | 4.79 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 7.50 | 32.0 | 585 | 95,991 | 94,374 | --- |
| 45% | 4.31 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 8.18 | 32.0 | 585 | 95,991 | 94,374 | --- |
| 40% | 3.83 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 8.86 | 32.0 | 585 | 95,991 | 94,374 | --- |
| 35% | 3.35 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.68 | 9.54 | 32.0 | 585 | 95,990 | 94,373 | --- |
| 30% | 2.87 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 9.82 | 32.0 | 585 | 95,990 | 94,373 | --- |
| 28% | 2.68 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 10.09 | 32.0 | 585 | 95,989 | 94,372 | --- |
| 26% | 2.49 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 10.36 | 32.0 | 585 | 95,989 | 94,372 | --- |
| 24% | 2.30 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 10.64 | 32.0 | 585 | 95,989 | 94,372 | --- |
| 22% | 2.11 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 10.91 | 32.0 | 585 | 95,989 | 94,372 | --- |
| 20% | 1.92 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 11.18 | 32.0 | 585 | 95,989 | 94,372 | --- |
| 18% | 1.72 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 11.45 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 16% | 1.53 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 11.73 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 14% | 1.34 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 12.00 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 12% | 1.15 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.27 | 12.27 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 10% | 0.96 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 12.41 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 9% | 0.86 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 12.54 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 8% | 0.77 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 12.68 | 32.0 | 585 | 95,988 | 94,371 | --- |
| 7% | 0.67 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 12.82 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 6% | 0.57 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 12.95 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 5% | 0.48 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.09 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 4% | 0.38 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.23 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 3% | 0.29 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.36 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 2% | 0.19 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.50 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 1% | 0.10 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.64 | 32.0 | 585 | 95,987 | 94,370 | --- |
| 0% | 0.00 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.01 | 13.65 | 32.0 | 585 | 95,987 | 94,370 | --- |
| -0.1% | -0.01 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.12 | 13.77 | 32.0 | 585 | 95,987 | 94,370 | --- |
| -1% | -0.10 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 13.91 | 32.0 | 585 | 95,987 | 94,370 | --- |
| -2% | -0.19 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.04 | 32.0 | 585 | 95,987 | 94,370 | --- |
| -3% | -0.29 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.18 | 32.0 | 585 | 95,987 | 94,370 | --- |
| -4% | -0.38 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.32 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -5% | -0.48 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.45 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -6% | -0.57 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.59 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -7% | -0.67 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.73 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -8% | -0.77 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 14.86 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -9% | -0.86 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | 15.00 | 32.0 | 585 | 95,986 | 94,369 | --- |
| -10% | -0.96 | 1617 | 1617 | 9.85 | 2871 | 0.383 | 0.80 | 1.20 | 250.00 | 249 | 0.82 | 2708 | 0.14 | --- | --- | 557 | 91,385 | 0 | --- |
| *TST* | --- | --- | *91385* | *556.53* | *195* | *0.396* | *43.71* | 41.78 | 250.00 | 230 | *48.84* | 184 | --- | *16.7* | *32.0* | *550* | 90,264 | 88,647 | --- |
| *Screen* | --- | --- | *1617* | *9.85* | --- | *0.400* | 0.77 | *52.00* | 250.00 | 225 | *0.91* | 2427 | --- | *15.0* | *32.0* | *585* | 95,986 | 94,369 | --- |
| *w/iter* | --- | --- | *1617* | *9.85* | *2871* | *0.383* | 0.80 | 1.20 | 250.00 | 249 | *0.82* | 2708 | --- | | | | | | |

**Valve:** BWR Plant E, static close

*Select Valve-->* BWR Plant E, static open

| *General Information* | *Required?* | *Value* |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | no | 0 |
| Stroke direction | yes | open |
| Fluid (blowdown only) | no | 0 |
| Load profile method | yes | Input Stem Thrust |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | no | 0.000 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.581 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | no | 0 |
| Required thrust (including water inertia), $F_R$ (lbs) | no | 0 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | no | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 32.13 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0064 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 250.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.465 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.018 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | no | 0 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | no | 0 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | no | 0 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 1.2 |
| Maximum adjusted motor torque (ft-lbs) | yes | 1.2 |
| Minimum motor speed (rpm) | yes | 2631 |
| Minimum instantaneous actuator capability (lbs) | yes | 91,059 |
| Minimum instantaneous margin (lbs) | yes | 88,783 |
| Maximum allowable thrust at unwedging | yes | 86,427 |
| Efficiency at minimum instantaneous capability | yes | 0.385 |

| *Thrust Profile* | |
|---|---|
| 100% | 2,276 |
| 90% | 2,276 |
| 80% | 2,276 |
| 70% | 2,276 |
| 60% | 2,276 |
| 55% | 2,276 |
| 50% | 2,276 |
| 45% | 2,276 |
| 40% | 2,276 |
| 35% | 2,276 |
| 30% | 2,276 |
| 28% | 2,276 |
| 26% | 2,276 |
| 24% | 2,276 |
| 22% | 2,276 |
| 20% | 2,276 |
| 18% | 2,276 |
| 16% | 2,276 |
| 14% | 2,276 |
| 12% | 2,276 |
| 10% | 2,276 |
| 9% | 2,276 |
| 8% | 2,276 |
| 7% | 2,276 |
| 6% | 2,276 |
| 5% | 2,276 |
| 4% | 2,276 |
| 3% | 2,276 |
| 2% | 2,276 |
| 1% | 2,276 |
| 0% | 2,276 |
| -0.0010% | 2,276 |
| -100% | 2,276 |

***Warnings***

***Predicted Stroke Time (Seconds):*** **15.45**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -10% | -0.96 | 2276 | | | | | | | | | | | | 0.00 | 32.0 | | | | --- |
| -9% | -0.86 | 2276 | 2276 | 14.66 | | 0.400 | 1.14 | 1.71 | 250.00 | 249 | 1.18 | 2639 | 0.14 | 0.14 | 32.0 | 609 | 94,597 | 92,321 | --- |
| -8% | -0.77 | 2276 | 2276 | 14.66 | 2798 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.28 | 32.0 | 587 | 91,078 | 88,802 | --- |
| -7% | -0.67 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.42 | 32.0 | 587 | 91,078 | 88,802 | --- |
| -6% | -0.57 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.56 | 32.0 | 587 | 91,078 | 88,802 | --- |
| -5% | -0.48 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.70 | 32.0 | 587 | 91,078 | 88,802 | --- |
| -4% | -0.38 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.84 | 32.0 | 587 | 91,078 | 88,802 | --- |
| -3% | -0.29 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 0.98 | 32.0 | 587 | 91,077 | 88,801 | --- |
| -2% | -0.19 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.12 | 32.0 | 587 | 91,077 | 88,801 | --- |
| -1% | -0.10 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.26 | 32.0 | 587 | 91,077 | 88,801 | --- |
| 0% | -0.01 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.13 | 1.39 | 32.0 | 587 | 91,077 | 88,801 | --- |
| 0% | 0.00 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.01 | 1.40 | 32.0 | 587 | 91,077 | 88,801 | --- |
| 1% | 0.10 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.54 | 32.0 | 587 | 91,077 | 88,801 | --- |
| 2% | 0.19 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.68 | 32.0 | 587 | 91,076 | 88,800 | --- |
| 3% | 0.29 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.83 | 32.0 | 587 | 91,076 | 88,800 | --- |
| 4% | 0.38 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 1.97 | 32.0 | 587 | 91,076 | 88,800 | --- |
| 5% | 0.48 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.11 | 32.0 | 587 | 91,076 | 88,800 | --- |
| 6% | 0.57 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.25 | 32.0 | 587 | 91,076 | 88,800 | --- |
| 7% | 0.67 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.39 | 32.0 | 587 | 91,075 | 88,799 | --- |
| 8% | 0.77 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.53 | 32.0 | 587 | 91,075 | 88,799 | --- |
| 9% | 0.86 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.67 | 32.0 | 587 | 91,075 | 88,799 | --- |
| 10% | 0.96 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.14 | 2.81 | 32.0 | 587 | 91,075 | 88,799 | --- |
| 12% | 1.15 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 3.09 | 32.0 | 587 | 91,075 | 88,799 | --- |
| 14% | 1.34 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 3.37 | 32.0 | 587 | 91,074 | 88,798 | --- |
| 16% | 1.53 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 3.65 | 32.0 | 587 | 91,074 | 88,798 | --- |
| 18% | 1.72 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 3.93 | 32.0 | 587 | 91,073 | 88,797 | --- |
| 20% | 1.92 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 4.21 | 32.0 | 587 | 91,073 | 88,797 | --- |
| 22% | 2.11 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 4.49 | 32.0 | 587 | 91,073 | 88,797 | --- |
| 24% | 2.30 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 4.77 | 32.0 | 587 | 91,072 | 88,796 | --- |
| 26% | 2.49 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 5.05 | 32.0 | 587 | 91,072 | 88,796 | --- |
| 28% | 2.68 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 5.34 | 32.0 | 587 | 91,071 | 88,795 | --- |
| 30.0% | 2.87 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.28 | 5.62 | 32.0 | 586 | 91,071 | 88,795 | --- |
| 35% | 3.35 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 6.32 | 32.0 | 586 | 91,071 | 88,795 | --- |
| 40% | 3.83 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 7.02 | 32.0 | 586 | 91,070 | 88,794 | --- |
| 45% | 4.31 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 7.72 | 32.0 | 586 | 91,069 | 88,793 | --- |
| 50% | 4.79 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 8.43 | 32.0 | 586 | 91,068 | 88,792 | --- |
| 55% | 5.27 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 9.13 | 32.0 | 586 | 91,067 | 88,791 | --- |
| 60% | 5.75 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 0.70 | 9.83 | 32.0 | 586 | 91,066 | 88,790 | --- |
| 70% | 6.71 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 1.40 | 11.23 | 32.0 | 586 | 91,065 | 88,789 | --- |
| 80% | 7.66 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 1.40 | 12.64 | 32.1 | 586 | 91,063 | 88,787 | --- |
| 90% | 8.62 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 1.40 | 14.04 | 32.1 | 586 | 91,061 | 88,785 | --- |
| 100% | 9.58 | 2276 | 2276 | 14.66 | 2788 | 0.385 | 1.18 | 1.78 | 250.00 | 249 | 1.22 | 2631 | 1.40 | 15.45 | 32.1 | 586 | 91,059 | 88,783 | --- |
| *UNW* | --- | --- | *86427* | *556.59* | *195* | *0.396* | *43.72* | 41.79 | 250.00 | 230 | *48.84* | 184 | --- | --- | --- | *557* | 86,427 | (0) | --- |
| *Screen* | --- | --- | *2276* | *14.66* | --- | *0.400* | 1.14 | *52.00* | 250.00 | 225 | *1.35* | 2352 | --- | *17.3* | *32.1* | *550* | 85,346 | 83,070 | --- |
| *w/ter* | --- | --- | *2276* | *14.66* | *2788* | *0.385* | 1.18 | 1.78 | 250.00 | 249 | *1.22* | 2631 | --- | *15.4* | *32.1* | *586* | 91,057 | 88,781 | --- |

**Valve:** BWR Plant E, static open

*Select Valve*--> BWR Plant E, dynamic close

| ***General Information*** | ***Required?*** | ***Value*** |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | yes | blowdown |
| Stroke direction | yes | close |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| ***Valve and Actuator Information*** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 2.250 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.581 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,422 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 38,056 |
| Required thrust due to water inertia, $F_{wi}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 32.13 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0061 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0000 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 250.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.465 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.018 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| ***Design Basis Conditions*** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 1025 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| ***Calculated Values*** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | yes | 5,497 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 16.1 |
| Maximum adjusted motor torque (ft-lbs) | yes | 17.5 |
| Minimum motor speed (rpm) | yes | 1128 |
| Minimum instantaneous actuator capability (lbs) | yes | 97,669 |
| Minimum instantaneous margin (lbs) | yes | 68,157 |
| Maximum torque switch setting | yes | 89,691 |
| Efficiency at minimum instantaneous capability | yes | 0.393 |

***Warnings***

***Predicted Stroke Time (Seconds):*** **22.34**

| ***Not required*** |
|---|
| 100% |
| 90% |
| 80% |
| 70% |
| 60% |
| 55% |
| 50% |
| 45% |
| 40% |
| 35% |
| 30% |
| 28% |
| 26% |
| 24% |
| 22% |
| 20% |
| 18% |
| 16% |
| 14% |
| 12% |
| 10% |
| 9% |
| 8% |
| 7% |
| 6% |
| 5% |
| 4% |
| 3% |
| 2% |
| 1% |
| 0% |
| -0.0010% |
| -100% |

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 9.58 | 5497 | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| 90% | 8.62 | 5647 | 5572 | 33.94 | | *0.400* | 2.64 | 3.96 | 250.00 | 248 | 2.73 | 2336 | 1.58 | 1.58 | 32.0 | 607 | 99,597 | 94,024 | --- |
| 80% | 7.66 | 5985 | 5816 | 35.42 | 2476 | 0.393 | 2.81 | 4.21 | 250.00 | 248 | 2.91 | 2302 | 1.60 | 3.19 | 32.1 | 595 | 97,669 | 91,853 | --- |
| 70% | 6.71 | 6404 | 6194 | 37.72 | 2440 | 0.393 | 2.99 | 4.48 | 250.00 | 248 | 3.09 | 2266 | 1.63 | 4.82 | 32.1 | 596 | 97,807 | 91,613 | --- |
| 60% | 5.75 | 7089 | 6747 | 41.09 | 2402 | 0.395 | 3.24 | 4.86 | 250.00 | 248 | 3.36 | 2214 | 1.67 | 6.48 | 32.2 | 597 | 98,013 | 91,267 | --- |
| 55% | 5.27 | 7553 | 7321 | 44.59 | 2347 | 0.396 | 3.51 | 5.26 | 250.00 | 247 | 3.64 | 2161 | 0.85 | 7.34 | 32.2 | 598 | 98,225 | 90,903 | --- |
| 50% | 4.79 | 8031 | 7792 | 47.45 | 2290 | 0.397 | 3.72 | 5.58 | 250.00 | 247 | 3.87 | 2117 | 0.87 | 8.21 | 32.2 | 599 | 98,402 | 90,610 | --- |
| 45% | 4.31 | 8510 | 8270 | 50.37 | 2244 | 0.398 | 3.94 | 5.91 | 250.00 | 247 | 4.10 | 2081 | 0.89 | 9.10 | 32.3 | 600 | 98,580 | 90,310 | --- |
| 40% | 3.83 | 8989 | 8749 | 53.28 | 2206 | 0.399 | 4.16 | 6.20 | 250.00 | 247 | 4.33 | 2058 | 0.90 | 10.00 | 32.3 | 601 | 98,765 | 90,016 | --- |
| 35% | 3.35 | 9650 | 9319 | 56.76 | 2182 | 0.400 | 4.42 | 6.52 | 250.00 | 247 | 4.60 | 2031 | 0.91 | 10.91 | 32.4 | 603 | 98,989 | 89,670 | --- |
| 30% | 2.87 | 10429 | 10039 | 61.14 | 2153 | 0.402 | 4.74 | 6.92 | 250.00 | 247 | 4.94 | 1996 | 0.93 | 11.83 | 32.4 | 605 | 99,274 | 89,234 | --- |
| 28% | 2.68 | 10740 | 10585 | 64.46 | 2116 | 0.403 | 4.98 | 7.23 | 250.00 | 247 | 5.20 | 1970 | 0.37 | 12.21 | 32.5 | 606 | 99,481 | 88,897 | --- |
| 26% | 2.49 | 11588 | 11164 | 67.99 | 2089 | 0.404 | 5.24 | 7.55 | 250.00 | 246 | 5.47 | 1943 | 0.38 | 12.59 | 32.5 | 607 | 99,716 | 88,552 | --- |
| 24% | 2.30 | 12816 | 12202 | 74.31 | 2060 | 0.406 | 5.69 | 8.12 | 250.00 | 246 | 5.95 | 1895 | 0.39 | 12.98 | 32.5 | 610 | 100,143 | 87,941 | --- |
| 22% | 2.11 | 14044 | 13430 | 81.79 | 2008 | 0.409 | 6.23 | 8.78 | 250.00 | 246 | 6.52 | 1838 | 0.40 | 13.38 | 32.6 | 613 | 100,648 | 87,218 | --- |
| 20% | 1.92 | 15272 | 14658 | 89.27 | 1948 | 0.411 | 6.76 | 9.45 | 250.00 | 245 | 7.08 | 1781 | 0.41 | 13.79 | 32.6 | 615 | 101,061 | 86,403 | --- |
| 18% | 1.72 | 16500 | 15886 | 96.75 | 1888 | 0.413 | 7.29 | 10.11 | 250.00 | 245 | 7.65 | 1725 | 0.43 | 14.22 | 32.7 | 618 | 101,441 | 85,555 | --- |
| 16% | 1.53 | 17924 | 17212 | 104.82 | 1828 | 0.416 | 7.85 | 10.81 | 250.00 | 245 | 8.25 | 1672 | 0.44 | 14.66 | 32.8 | 620 | 101,839 | 84,627 | --- |
| 14% | 1.34 | 20454 | 19189 | 116.86 | 1772 | 0.419 | 8.68 | 11.68 | 250.00 | 244 | 9.14 | 1609 | 0.46 | 15.12 | 32.9 | 624 | 102,513 | 83,325 | --- |
| 12% | 1.15 | 22984 | 21719 | 132.27 | 1706 | 0.424 | 9.72 | 12.72 | 250.00 | 244 | 10.26 | 1531 | 0.48 | 15.60 | 33.0 | 629 | 103,363 | 81,644 | --- |
| 10% | 0.96 | 25798 | 24391 | 148.54 | 1623 | 0.428 | 10.80 | 13.80 | 250.00 | 243 | 11.44 | 1449 | 0.51 | 16.11 | 33.2 | 634 | 104,170 | 79,779 | --- |
| 9% | 0.86 | 27388 | 26593 | 161.95 | 1536 | 0.431 | 11.68 | 14.68 | 250.00 | 243 | 12.40 | 1387 | 0.27 | 16.38 | 33.3 | 638 | 104,715 | 78,122 | --- |
| 8% | 0.77 | 28597 | 27993 | 170.47 | 1470 | 0.433 | 12.24 | 15.21 | 250.00 | 243 | 13.02 | 1353 | 0.27 | 16.65 | 33.4 | 640 | 105,013 | 77,020 | --- |
| 7% | 0.67 | 29642 | 29120 | 177.34 | 1434 | 0.435 | 12.69 | 15.60 | 250.00 | 242 | 13.51 | 1326 | 0.28 | 16.93 | 33.6 | 641 | 105,285 | 76,165 | --- |
| 6% | 0.57 | 30917 | 30280 | 184.40 | 1405 | 0.437 | 13.14 | 16.00 | 250.00 | 242 | 14.01 | 1298 | 0.28 | 17.22 | 33.7 | 643 | 105,581 | 75,302 | --- |
| 5% | 0.48 | 32402 | 31659 | 192.81 | 1376 | 0.439 | 13.67 | 16.46 | 250.00 | 242 | 14.60 | 1266 | 0.29 | 17.51 | 33.9 | 645 | 105,947 | 74,288 | --- |
| 4% | 0.38 | 33745 | 33073 | 201.42 | 1342 | 0.441 | 14.21 | 16.94 | 250.00 | 242 | 15.20 | 1232 | 0.30 | 17.81 | 34.0 | 647 | 106,290 | 73,217 | --- |
| 3% | 0.29 | 34823 | 34284 | 208.79 | 1306 | 0.443 | 14.68 | 17.34 | 250.00 | 242 | 15.72 | 1204 | 0.31 | 18.12 | 34.2 | 649 | 106,535 | 72,252 | --- |
| 2% | 0.19 | 35900 | 35362 | 215.35 | 1276 | 0.444 | 15.09 | 17.70 | 250.00 | 241 | 16.18 | 1181 | 0.31 | 18.43 | 34.5 | 650 | 106,735 | 71,374 | --- |
| 1% | 0.10 | 36978 | 36439 | 221.92 | 1252 | 0.446 | 15.50 | 18.06 | 250.00 | 241 | 16.64 | 1162 | 0.32 | 18.75 | 34.7 | 651 | 106,947 | 70,508 | --- |
| 0% | 0.00 | 38056 | 37517 | 228.48 | 1232 | 0.447 | 15.90 | 18.41 | 250.00 | 241 | 17.10 | 1144 | 0.32 | 19.07 | 34.9 | 653 | 107,166 | 69,648 | --- |
| -0.1% | -0.01 | 38056 | 38056 | 231.76 | 1212 | 0.448 | 16.10 | 18.60 | 250.00 | 241 | 17.34 | 1134 | 0.03 | 19.10 | 34.9 | 653 | 107,177 | 69,121 | --- |
| -1% | -0.10 | 38056 | 38056 | 231.76 | 1202 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.35 | 1134 | 0.29 | 19.40 | 35.2 | 652 | 107,121 | 69,065 | --- |
| -2% | -0.19 | 38056 | 38056 | 231.76 | 1202 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.37 | 1133 | 0.33 | 19.72 | 35.4 | 652 | 107,030 | 68,974 | --- |
| -3% | -0.29 | 38056 | 38056 | 231.76 | 1201 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.38 | 1132 | 0.33 | 20.05 | 35.7 | 651 | 106,928 | 68,872 | --- |
| -4% | -0.38 | 38056 | 38056 | 231.76 | 1200 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.40 | 1132 | 0.33 | 20.37 | 35.9 | 651 | 106,825 | 68,769 | --- |
| -5% | -0.48 | 38056 | 38056 | 231.76 | 1200 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.42 | 1131 | 0.33 | 20.70 | 36.2 | 650 | 106,723 | 68,667 | --- |
| -6% | -0.57 | 38056 | 38056 | 231.76 | 1199 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.43 | 1130 | 0.33 | 21.03 | 36.4 | 649 | 106,621 | 68,565 | --- |
| -7% | -0.67 | 38056 | 38056 | 231.76 | 1198 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.45 | 1130 | 0.33 | 21.35 | 36.7 | 649 | 106,519 | 68,463 | --- |
| -8% | -0.77 | 38056 | 38056 | 231.76 | 1198 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.47 | 1129 | 0.33 | 21.68 | 36.9 | 648 | 106,417 | 68,361 | --- |
| -9% | -0.86 | 38056 | 38056 | 231.76 | 1197 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.48 | 1129 | 0.33 | 22.01 | 37.2 | 647 | 106,315 | 68,259 | --- |
| -10% | -0.96 | 38056 | 38056 | 231.76 | 1196 | 0.448 | 16.11 | 18.61 | 250.00 | 241 | 17.50 | 1128 | 0.33 | 22.34 | 37.4 | 647 | 106,213 | 68,157 | --- |
| *TST* | --- | --- | *89691* | *546.22* | *195* | *0.396* | *42.90* | 41.17 | 250.00 | 230 | *48.84* | 184 | --- | --- | --- | *546* | 89,691 | (0) | --- |
| *Screen* | --- | --- | *38056* | *231.76* | --- | *0.400* | 18.03 | *52.00* | 250.00 | 225 | *21.36* | 916 | --- | *44.3* | *74.8* | *474* | 77,777 | 39,721 | --- |
| *w/iter* | --- | --- | *38056* | *231.76* | *1129* | *0.446* | 16.16 | 18.66 | 250.00 | 241 | *19.12* | 1065 | --- | *38.1* | *61.6* | *592* | 97,201 | 59,145 | --- |

**Valve:** BWR Plant E, dynamic close

**Select Valve-->** BWR Plant E, dynamic open

| General Information | Required? | Value |
|---|---|---|
| Valve Type | yes | double disk |
| Flow type | yes | blowdown |
| Stroke direction | yes | open |
| Fluid (blowdown only) | yes | steam |
| Load profile method | yes | Use default |
| **Valve and Actuator Information** | | |
| Stem diameter, $D_{stem}$ (inches) | yes | 2.250 |
| Seat ring face ID, $D_{body-ID}$ (inches) | yes | 9.581 |
| Seat ring inner diameter, $D_{sr}$ (inches) | no | 0.000 |
| Globe valve stroke length, D (inches) | no | 0.000 |
| Isolation-to-wedging travel, X (percent) | yes | 10% |
| Packing load, $F_{pack}$ (lbs) | yes | 1,307 |
| Required thrust (including water inertia), $F_R$ (lbs) | yes | 19,874 |
| Required thrust due to water inertia, $F_{WI}$ (lbs) | yes | 0 |
| Flow coefficient, $C_V$ (gpm/psi$^{1/2}$) | no | 0 |
| Actuator overall ratio, OAR | yes | 32.13 |
| Motor gear set ratio, MGSR | yes | 1.06 |
| Actuator rated torque, $\tau_{rated}$ | yes | 850 |
| Stem factor, SF (ft-lbs/lb) | yes | 0.0064 |
| Overhauling stem factor, $SF_O$ (ft-lbs/lb) | no | 0.0064 |
| Voltage at MCC, $V_{mcc}$ (volts) | yes | 250.0 |
| Cable resistance, $R_{cable}$ (ohms) | yes | 0.465 |
| Thermal overload resistance, $R_{tol}$ (ohms) | yes | 0.018 |
| Nominal voltage, $V_{nom}$ (volts) | yes | 250 |
| Motor type | yes | 40 ft-lb, 250 VDC |
| Valve stem lead, lead (inches) | yes | 0.500 |
| Pullout efficiency, $\eta_p$ | yes | 0.40 |
| Run efficiency, $\eta_r$ | yes | 0.50 |
| Nominal motor speed (rpm), $\omega_{nom}$ | optional | 1,900 |
| **Design Basis Conditions** | | |
| Differential pressure, DP (psi) | no | 0 |
| Valve pressure at full open, $P_B$ (psig) | yes | 1023 |
| Flow rate, $Q_{max}$ (gpm) | no | 0 |
| Fluid density, $\rho$ (lbs/ft$^3$) | no | 0.000 |
| Ambient temperature (C) | yes | 32 |
| Length of upstream piping, $L_{up}$ (pipe diameters) | yes | 10000 |
| **Calculated Values** | | |
| System resistance, $K_{sys}$ | no | --- |
| Fully open stem thrust, $F_O$ (lbs) | yes | -2,761 |
| Nominal motor torque, $\tau_{nom}$ (ft-lbs) | yes | 48.8 |
| Maximum motor torque (ft-lbs) | yes | 10.0 |
| Maximum adjusted motor torque (ft-lbs) | yes | 10.5 |
| Minimum motor speed (rpm) | yes | 1515 |
| Minimum instantaneous actuator capability (lbs) | yes | 89,738 |
| Minimum instantaneous margin (lbs) | yes | 72,658 |
| Maximum allowable thrust at unwedging | yes | 86,405 |
| Efficiency at minimum instantaneous capability | yes | 0.380 |

| Not required | |
|---|---|
| 100% | — |
| 90% | — |
| 80% | — |
| 70% | — |
| 60% | — |
| 55% | — |
| 50% | — |
| 45% | — |
| 40% | — |
| 35% | — |
| 30% | — |
| 28% | — |
| 26% | — |
| 24% | — |
| 22% | — |
| 20% | — |
| 18% | — |
| 16% | — |
| 14% | — |
| 12% | — |
| 10% | — |
| 9% | — |
| 8% | — |
| 7% | — |
| 6% | — |
| 5% | — |
| 4% | — |
| 3% | — |
| 2% | — |
| 1% | — |
| 0% | — |
| -0.0010% | — |
| -100% | — |

***Warnings***

***Predicted Stroke Time (Seconds):*** **17.61**

| Stroke | Position | Stem Thrust | Average Stem Thrust | Average Stem Torque | Worm Speed | Gearbox Efficiency | Average Motor Torque | Motor Current | Vmcc | Motor Voltage | Adjusted Motor Torque | Motor Speed | Stroke Time Increment | Time | Motor Temp | Instant Torque Cap | Instant Act Cap | Instant Margin | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | *0.00* | *32.0* | | | | --- |
| -10% | -0.96 | 19874 | | | | | | | | | | | | | | | | | |
| -9% | -0.86 | 19874 | 19874 | 127.99 | | *0.400* | 9.96 | 12.96 | 250.00 | 244 | 10.49 | 1515 | 0.24 | 0.24 | 32.1 | 596 | 92,532 | 72,658 | --- |
| -8% | -0.77 | 19874 | 19874 | 127.99 | 1606 | 0.421 | 9.45 | 12.45 | 250.00 | 244 | 9.95 | 1553 | 0.24 | 0.48 | 32.1 | 628 | 97,541 | 77,667 | --- |
| -7% | -0.67 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.94 | 1553 | 0.24 | 0.72 | 32.2 | 629 | 97,609 | 77,735 | --- |
| -6% | -0.57 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.95 | 1553 | 0.24 | 0.96 | 32.3 | 628 | 97,587 | 77,713 | --- |
| -5% | -0.48 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.95 | 1553 | 0.24 | 1.20 | 32.3 | 628 | 97,564 | 77,690 | --- |
| -4% | -0.38 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.95 | 1553 | 0.24 | 1.43 | 32.4 | 628 | 97,541 | 77,667 | --- |
| -3% | -0.29 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.95 | 1552 | 0.24 | 1.67 | 32.5 | 628 | 97,517 | 77,643 | --- |
| -2% | -0.19 | 19874 | 19874 | 127.99 | 1646 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.96 | 1552 | 0.24 | 1.91 | 32.5 | 628 | 97,494 | 77,620 | --- |
| -1% | -0.10 | 19874 | 19874 | 127.99 | 1645 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.96 | 1552 | 0.24 | 2.15 | 32.6 | 628 | 97,470 | 77,596 | --- |
| 0% | -0.01 | 19874 | 19874 | 127.99 | 1645 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.96 | 1552 | 0.21 | 2.36 | 32.6 | 628 | 97,447 | 77,573 | --- |
| 0% | 0.00 | 19874 | 19874 | 127.99 | 1645 | 0.422 | 9.45 | 12.45 | 250.00 | 244 | 9.96 | 1552 | 0.02 | 2.39 | 32.6 | 627 | 97,426 | 77,552 | --- |
| 1% | 0.10 | 20077 | 19976 | 128.64 | 1645 | 0.422 | 9.49 | 12.49 | 250.00 | 244 | 10.01 | 1548 | 0.24 | 2.62 | 32.7 | 628 | 97,464 | 77,488 | --- |
| 2% | 0.19 | 20281 | 20179 | 129.95 | 1641 | 0.422 | 9.58 | 12.58 | 250.00 | 244 | 10.11 | 1542 | 0.24 | 2.86 | 32.8 | 628 | 97,514 | 77,335 | --- |
| 3% | 0.29 | 20484 | 20383 | 131.26 | 1634 | 0.423 | 9.67 | 12.67 | 250.00 | 244 | 10.20 | 1535 | 0.24 | 3.10 | 32.8 | 628 | 97,556 | 77,173 | --- |
| 4% | 0.38 | 20688 | 20586 | 132.57 | 1627 | 0.423 | 9.75 | 12.75 | 250.00 | 244 | 10.30 | 1528 | 0.24 | 3.35 | 32.9 | 629 | 97,596 | 77,010 | --- |
| 5% | 0.48 | 19925 | 20306 | 130.77 | 1620 | 0.422 | 9.64 | 12.64 | 250.00 | 244 | 10.18 | 1537 | 0.24 | 3.59 | 33.0 | 628 | 97,442 | 77,136 | --- |
| 6% | 0.57 | 18642 | 19284 | 124.19 | 1629 | 0.420 | 9.20 | 12.20 | 250.00 | 244 | 9.71 | 1570 | 0.24 | 3.82 | 33.0 | 625 | 97,030 | 77,747 | --- |
| 7% | 0.67 | 17410 | 18026 | 116.09 | 1664 | 0.418 | 8.64 | 11.64 | 250.00 | 244 | 9.12 | 1611 | 0.23 | 4.05 | 33.1 | 622 | 96,578 | 78,552 | --- |
| 8% | 0.77 | 16234 | 16822 | 108.33 | 1708 | 0.416 | 8.11 | 11.11 | 250.00 | 245 | 8.54 | 1651 | 0.22 | 4.27 | 33.1 | 619 | 96,159 | 79,336 | --- |
| 9% | 0.86 | 14920 | 15577 | 100.31 | 1750 | 0.414 | 7.55 | 10.44 | 250.00 | 245 | 7.95 | 1695 | 0.22 | 4.49 | 33.2 | 617 | 95,731 | 80,154 | --- |
| 10% | 0.96 | 13283 | 14101 | 90.81 | 1797 | 0.411 | 6.88 | 9.60 | 250.00 | 245 | 7.23 | 1766 | 0.21 | 4.70 | 33.2 | 613 | 95,214 | 81,113 | --- |
| 12% | 1.15 | 11012 | 12148 | 78.23 | 1872 | 0.407 | 5.98 | 8.48 | 250.00 | 246 | 6.28 | 1862 | 0.40 | 5.10 | 33.2 | 609 | 94,532 | 82,384 | --- |
| 14% | 1.34 | 9513 | 10263 | 66.09 | 1974 | 0.403 | 5.10 | 7.38 | 250.00 | 246 | 5.34 | 1956 | 0.38 | 5.48 | 33.3 | 605 | 93,870 | 83,607 | --- |
| 16% | 1.53 | 8014 | 8764 | 56.44 | 2073 | 0.400 | 4.39 | 6.49 | 250.00 | 247 | 4.59 | 2032 | 0.36 | 5.84 | 33.3 | 601 | 93,259 | 84,496 | --- |
| 18% | 1.72 | 7008 | 7511 | 48.37 | 2154 | 0.397 | 3.79 | 5.69 | 250.00 | 247 | 3.96 | 2100 | 0.35 | 6.19 | 33.3 | 597 | 92,734 | 85,223 | --- |
| 20% | 1.92 | 6088 | 6548 | 42.17 | 2226 | 0.395 | 3.32 | 4.99 | 250.00 | 248 | 3.46 | 2195 | 0.34 | 6.53 | 33.3 | 595 | 92,344 | 85,796 | --- |
| 22% | 2.11 | 5169 | 5629 | 36.25 | 2327 | 0.393 | 2.87 | 4.31 | 250.00 | 248 | 2.99 | 2287 | 0.32 | 6.85 | 33.3 | 592 | 91,973 | 86,344 | --- |
| 24% | 2.30 | 4249 | 4709 | 30.33 | 2424 | 0.391 | 2.42 | 3.62 | 250.00 | 248 | 2.51 | 2379 | 0.31 | 7.16 | 33.3 | 590 | 91,603 | 86,894 | --- |
| 26% | 2.49 | 3330 | 3789 | 24.40 | 2522 | 0.389 | 1.95 | 2.93 | 250.00 | 249 | 2.03 | 2473 | 0.30 | 7.46 | 33.3 | 588 | 91,234 | 87,444 | --- |
| 28% | 2.68 | 2605 | 2967 | 19.11 | 2621 | 0.387 | 1.54 | 2.31 | 250.00 | 249 | 1.59 | 2558 | 0.29 | 7.75 | 33.3 | 585 | 90,904 | 87,937 | --- |
| 30.0% | 2.87 | 2154 | 2379 | 15.32 | 2711 | 0.385 | 1.24 | 1.86 | 250.00 | 249 | 1.28 | 2619 | 0.28 | 8.03 | 33.3 | 584 | 90,669 | 88,289 | --- |
| 35% | 3.35 | 1028 | 1591 | 10.25 | 2776 | 0.384 | 0.83 | 1.25 | 250.00 | 249 | 0.86 | 2701 | 0.68 | 8.72 | 33.3 | 582 | 90,353 | 88,763 | --- |
| 40% | 3.83 | 215 | 621 | 4.00 | 2863 | 0.381 | 0.33 | 0.49 | 250.00 | 250 | 0.34 | 2804 | 0.66 | 9.37 | 33.3 | 579 | 89,966 | 89,344 | --- |
| 45% | 4.31 | -111 | 52 | 0.33 | 2972 | 0.380 | 0.03 | 0.04 | 250.00 | 250 | 0.03 | 2864 | 0.64 | 10.02 | 33.3 | 578 | 89,738 | 89,686 | --- |
| 50% | 4.79 | -437 | -274 | 1.77 | 3036 | 0.381 | 0.14 | 0.22 | 250.00 | 250 | 0.15 | 2841 | 0.65 | 10.67 | 33.3 | 578 | 89,827 | 89,553 | --- |
| 55% | 5.27 | -777 | -607 | 3.91 | 3011 | 0.381 | 0.32 | 0.48 | 250.00 | 250 | 0.33 | 2805 | 0.66 | 11.33 | 33.3 | 579 | 89,960 | 89,353 | --- |
| 60% | 5.75 | -1208 | -993 | 6.39 | 2973 | 0.382 | 0.52 | 0.78 | 250.00 | 250 | 0.54 | 2764 | 0.67 | 12.00 | 33.3 | 580 | 90,114 | 89,121 | --- |
| 70% | 6.71 | -1886 | -1547 | 9.96 | 2930 | 0.384 | 0.81 | 1.21 | 250.00 | 249 | 0.84 | 2706 | 1.37 | 13.36 | 33.3 | 582 | 90,335 | 88,788 | --- |
| 80% | 7.66 | -2361 | -2124 | 13.68 | 2868 | 0.385 | 1.11 | 1.66 | 250.00 | 249 | 1.15 | 2645 | 1.40 | 14.76 | 33.3 | 583 | 90,564 | 88,441 | --- |
| 90% | 8.62 | -2708 | -2535 | 16.33 | 2804 | 0.386 | 1.32 | 1.98 | 250.00 | 249 | 1.36 | 2602 | 1.42 | 16.18 | 33.3 | 584 | 90,727 | 88,192 | --- |
| 100% | 9.58 | -2761 | -2734 | 17.61 | 2759 | 0.386 | 1.42 | 2.13 | 250.00 | 249 | 1.47 | 2582 | 1.43 | 17.61 | 33.4 | 585 | 90,804 | 88,070 | --- |
| *UNW* | --- | --- | *86405* | *556.45* | *195* | *0.396* | *43.70* | 41.78 | 250.00 | 230 | *48.84* | 184 | --- | --- | --- | *556* | 86,405 | (0) | --- |
| *Screen* | --- | --- | *19874* | *127.99* | --- | *0.400* | 9.96 | *52.00* | 250.00 | 225 | *11.80* | 1317 | --- | *30.9* | *41.1* | 532 | 82,552 | 62,678 | --- |
| *w/iter* | --- | --- | *19874* | *127.99* | *1628* | *0.422* | 9.45 | 12.45 | 250.00 | 244 | *10.21* | 1535 | --- | *26.5* | *39.0* | *613* | 95,113 | 75,239 | --- |

**Valve:** BWR Plant E. dynamic open

# C

# Vendor Motor Performance Curves

The following vendor motor performance curves are attached.

| Torque, ft-lbs | Voltage, VDC | Full Load Amps[1] | Vendor Curve |
|---|---|---|---|
| 2 | 125<br>250 | 2.0<br>0.8 | K-4557<br>K-11297 |
| 5 | 125<br>250 | 4.0<br>2.0 | illegible<br>illegible |
| 7.5 | 125<br>250 | 5.2<br>2.6 | K-4972<br>K-4972 |
| 10 | 125<br>250 | 6.4<br>3.2 | K-4973<br>K-4973 |
| 15 | 125<br>250 | 8.9<br>4.5 | K-5010<br>K-5010 |
| 25 | 125<br>250 | 13.9<br>7.9 | K-5561<br>K-5499 |
| 40 | 125<br>250 | 24.2<br>11.0 | K-5087<br>K-5050 |
| 60 | 125<br>250 | 32.6<br>17.4 | K-5013<br>illegible |
| 80 | 125<br>250 | 43.8<br>21.2 | K-4980<br>K-4053 |
| 100 | 125<br>250 | 62.0<br>31.0 | illegible<br>K-4054 |
| 150 | 250 | 43.8 | illegible |
| 200 | 125<br>250 | 104.0<br>52.5 | K-5014<br>K-5049 |

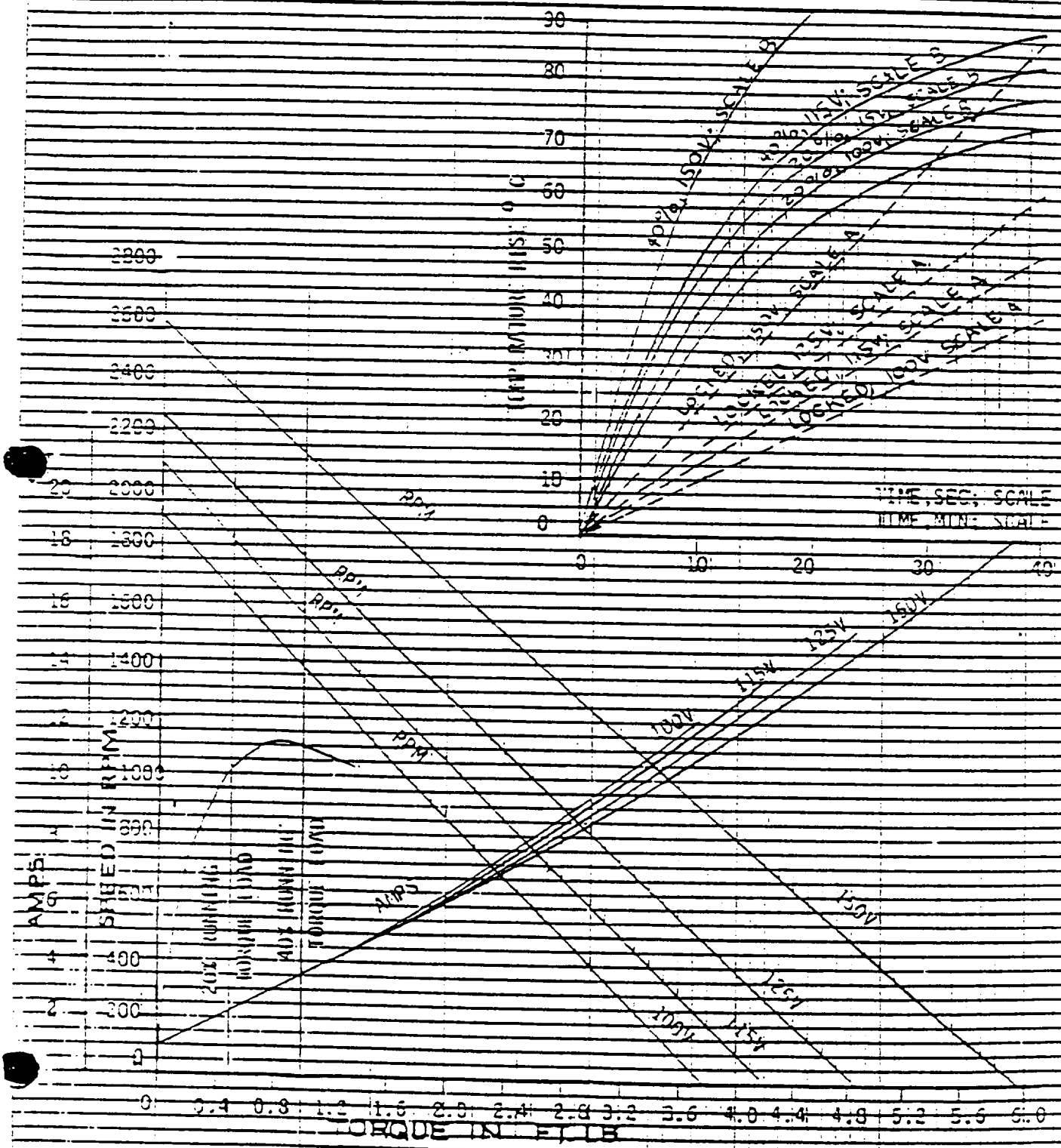
**Note**

1. Current corresponding to 20% torque on motor performance curve. These values are estimates of the Full Load Amps and may not be identical to values listed on the motor nameplates.

# LIMITORQUE CORPORATION

| | | | |
|---|---|---|---|
| NOMINAL LOCKED ROTOR TORQUE | 2 FT.LBS. | | |
| MANUFACTURE | H.K. PORTER | CURVE No. | K-4557 |
| HORSE POWER | .144 | CURVE DATE | 2/10/82 |
| R.P.M. | 1300 | DUTY | 5 MIN. |
| VOLTS | 125 VDC | TEMP. RISE | 85°C |
| AMPS | .7 @ ARM | AMBIENT | 40°C |

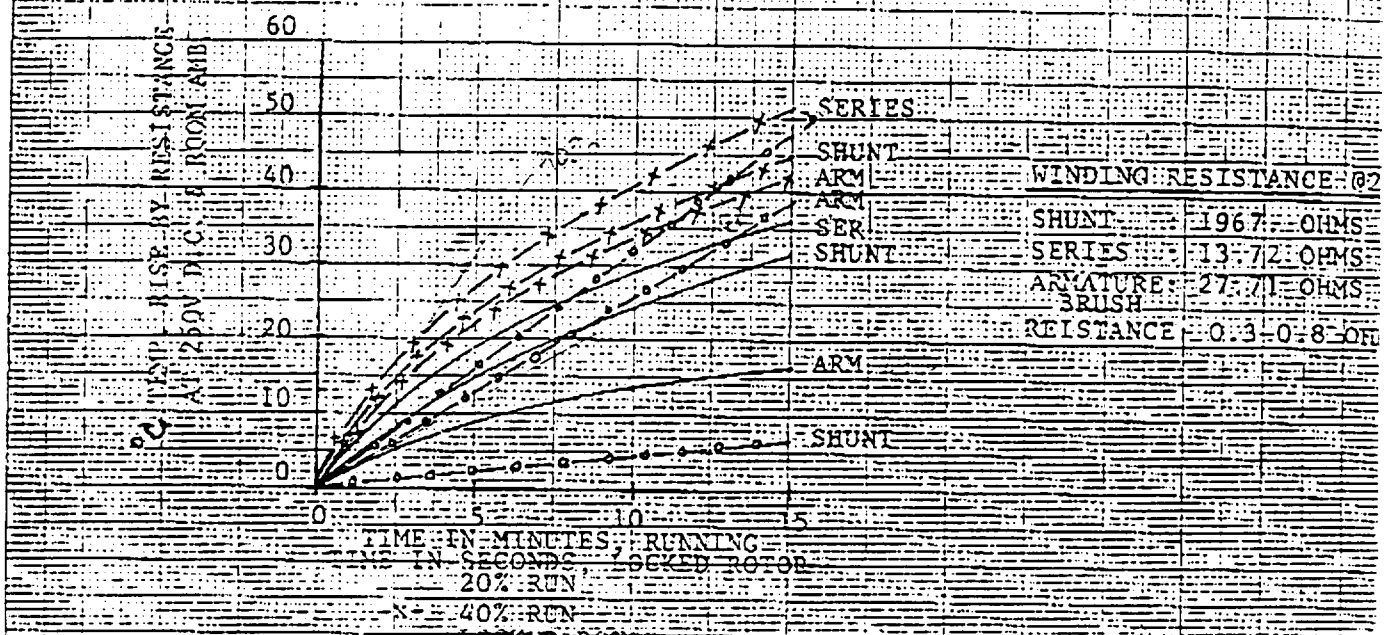
CODE
INSUL. B
ENCL. TENV
FRAME 05GAA




SIGNED MIKE SHIEFFO

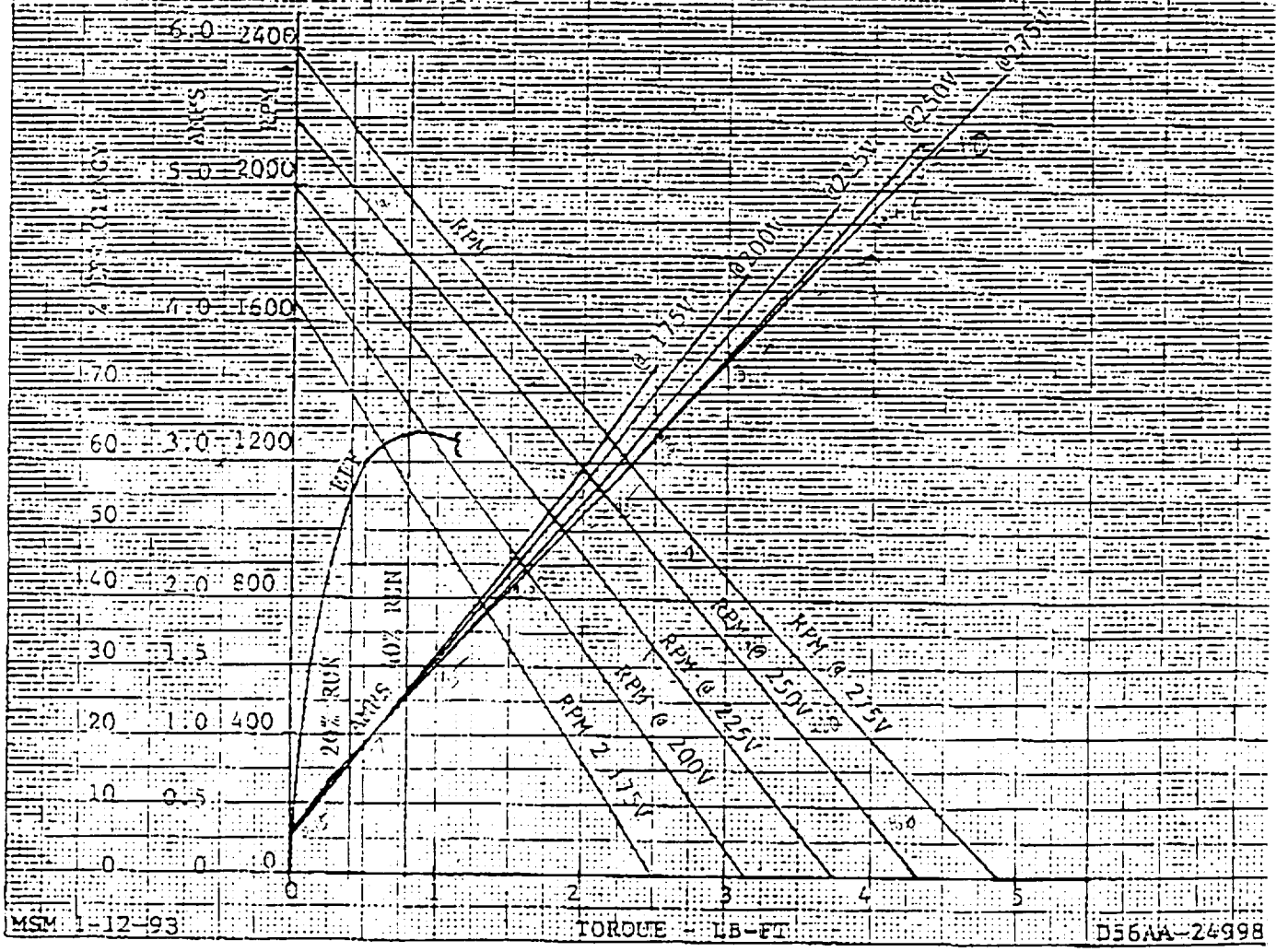
PEERLESS - WINSMITH, INC.
WARREN, OHIO 44485
COMPOUND WOUND D.C. MOTOR
250V D.C. PERFORMANCE DATA

FRAME D56AA, 2 LB.FT. LOCKED, 250V D
20% RUN, 5 MINUTE DUTY, TENV, 1900
RADIATION PROOF MOTOR




WINDING RESISTANCE @2

| | |
|---|---|
| SHUNT | 196.7 OHMS |
| SERIES | 13.72 OHMS |
| ARMATURE | 27.71 OHMS |
| BRUSH RESISTANCE | 0.3-0.8 OH |




MSM 1-12-93

D56AA-24998

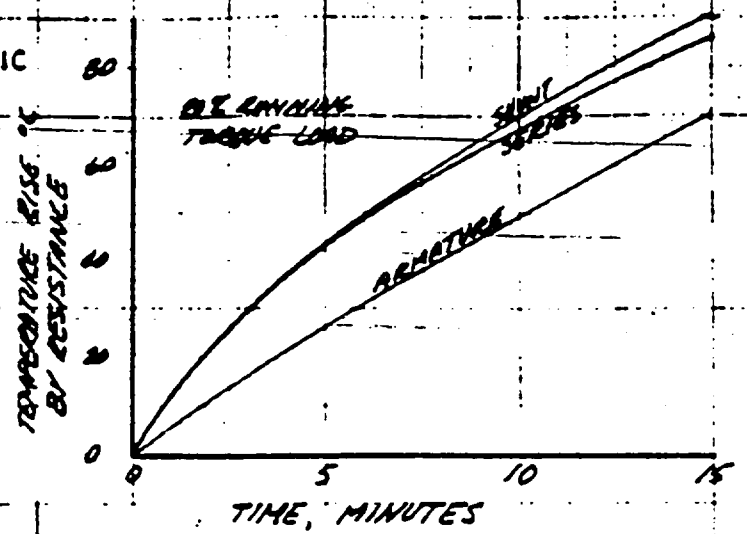
K-11297

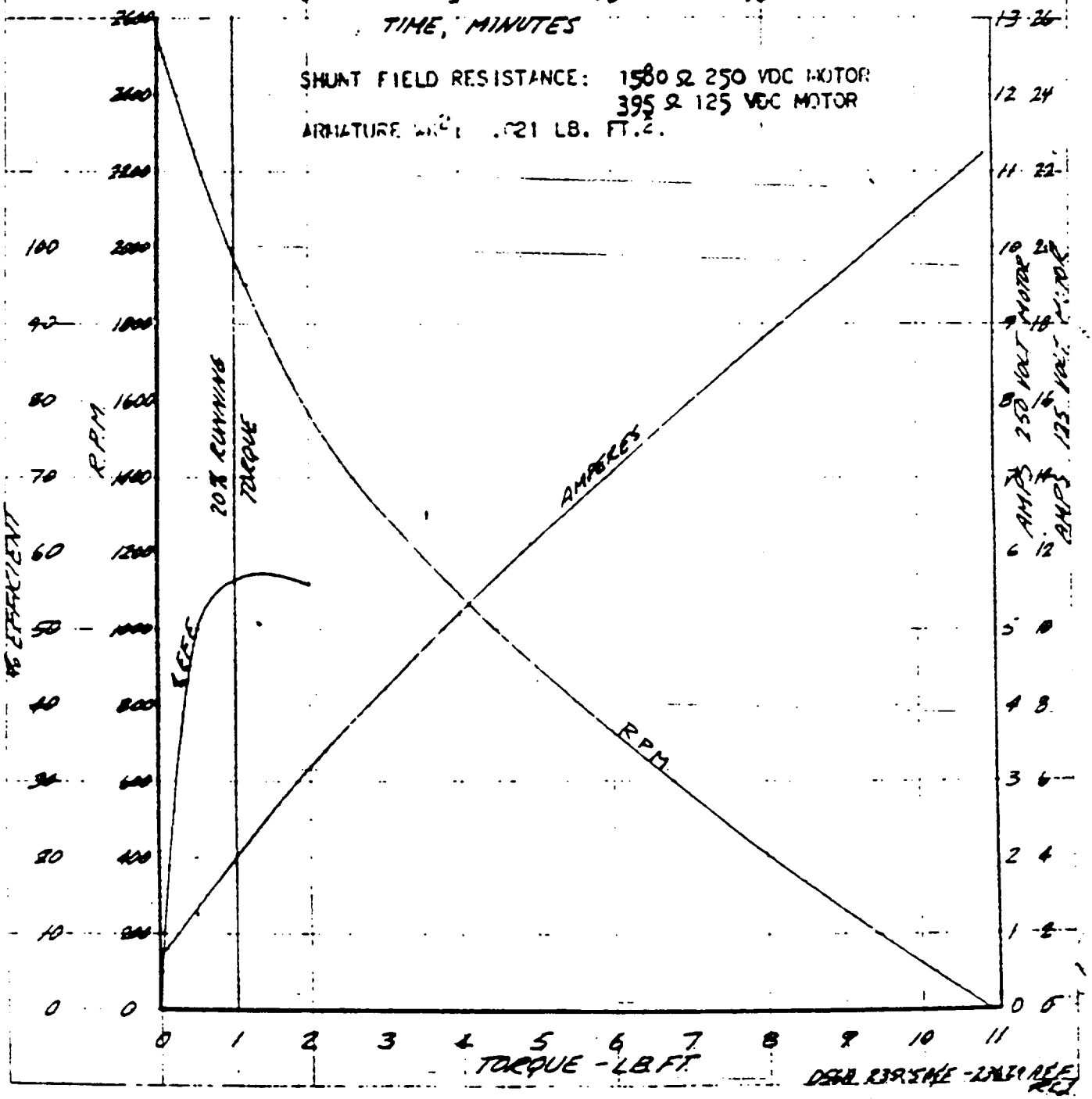
EUGENE DIETZGEN CO. MADE IN U.S.A.
NO. 341-11 DIETZGEN GRAPH PAPER MILLIMETER

D.C. PERFORMANCE CURVES COMPOUND WOUND MOTOR.

PEERLESS ELECTRIC DIVISION. H.K. PORTER COMPANY, INC., WARREN, OHIO

0960 FRAME, 5 LB. FT. LOCKED ROTOR TORQUE, 1900 R.P.M., 20% RUNNING TORQUE, 18.3.



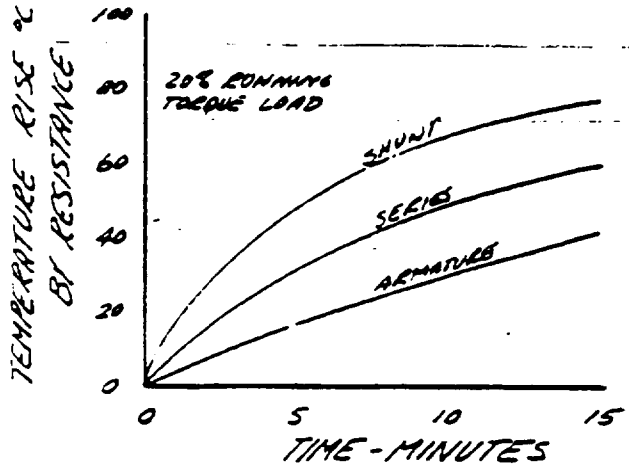



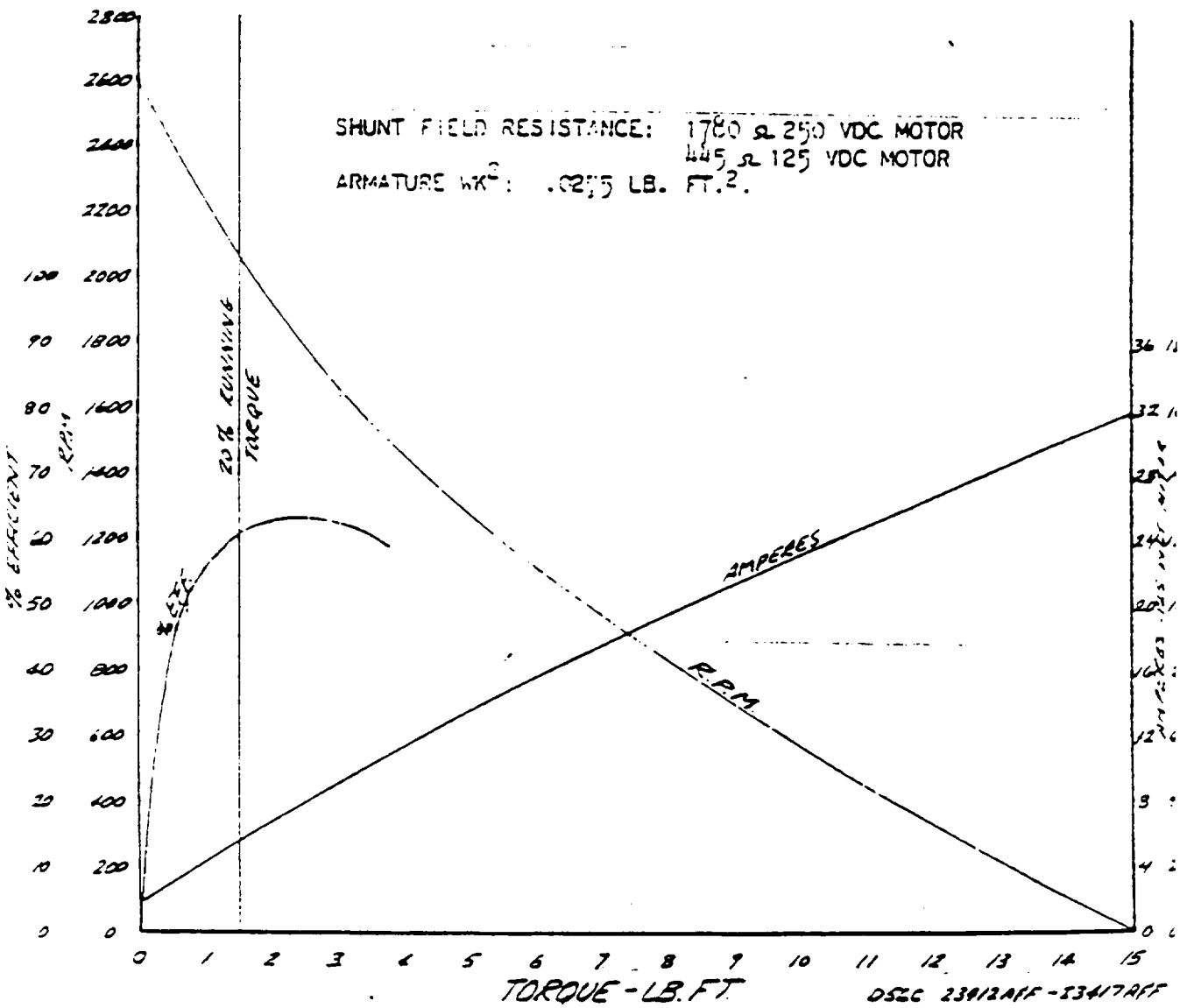
7½-DC-WP

D.C. PERFORMANCE CURVES
COMPOUND WOUND MOTOR

PEERLESS ELECTRIC DIVISION
H.K. PORTER COMPANY, INC.
WARREN, OHIO

D56C FRAME, 7 1/2 LB. FT. LOCKED ROTOR TORQUE, 2700 R.P.M., 20% RUNNING TORQUE, B.B.



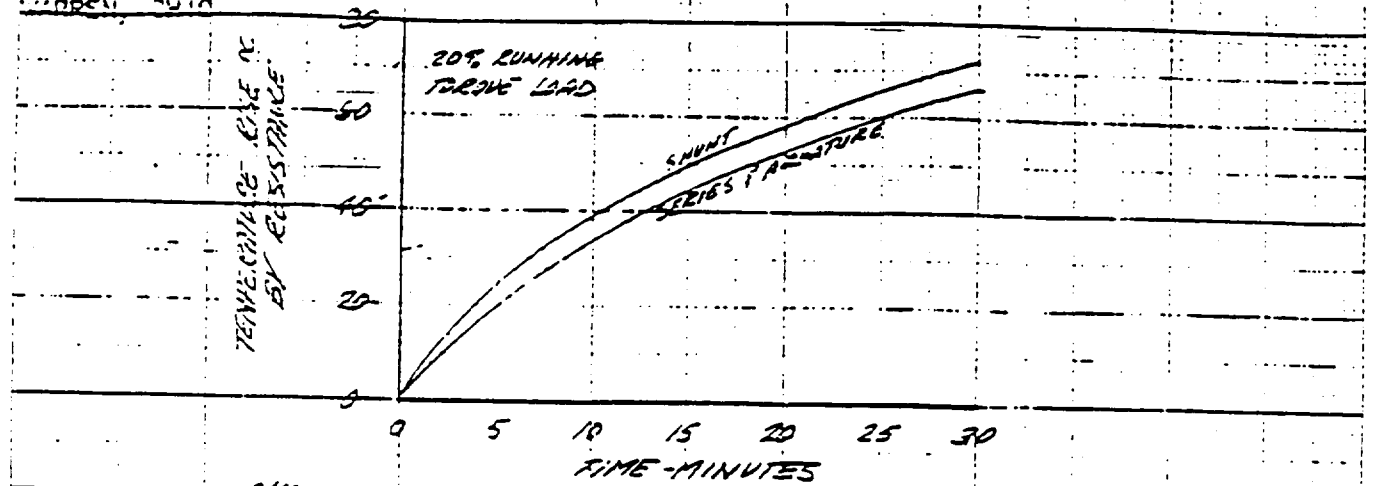



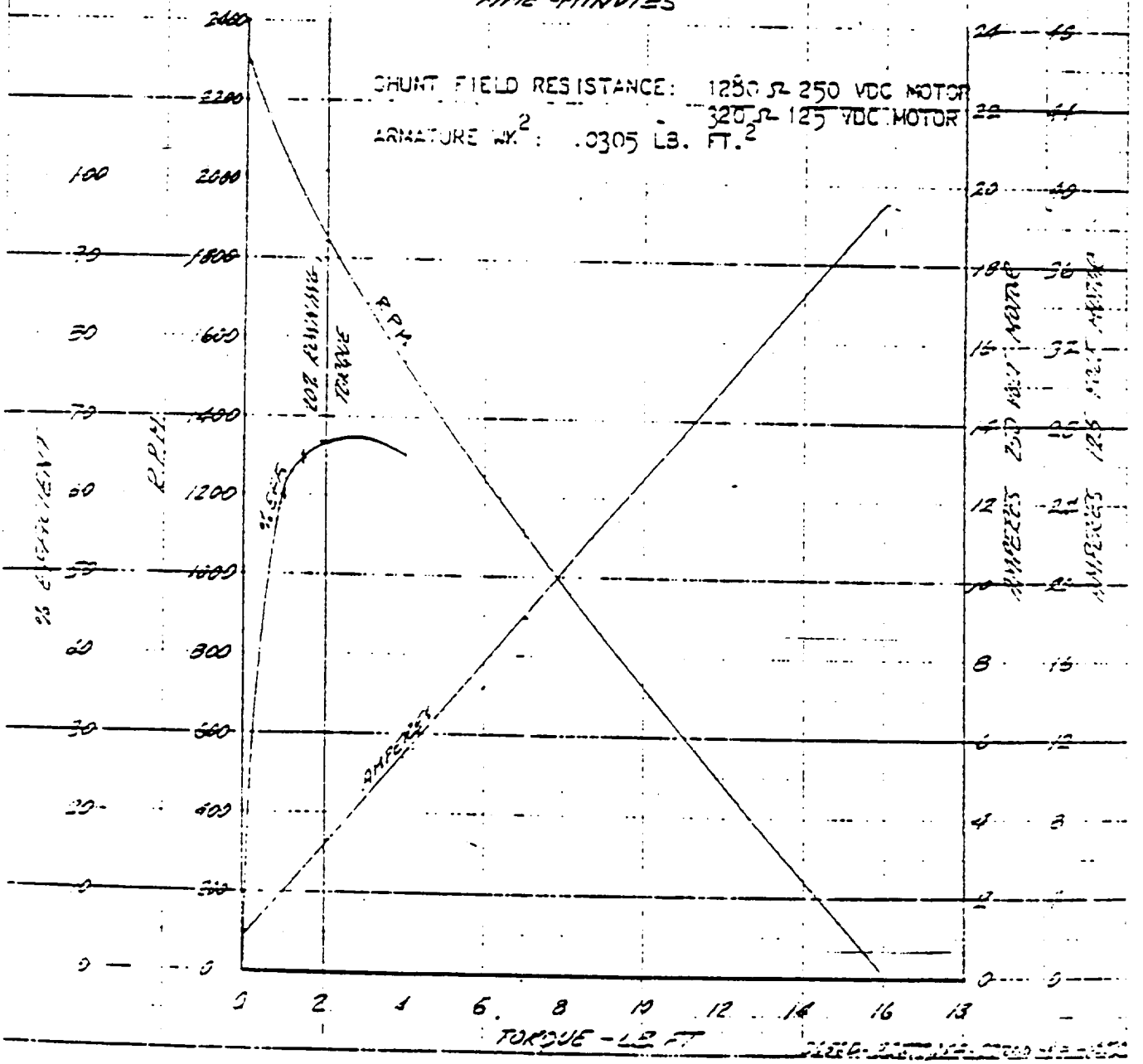

D56C 23412AFF-23417AFF

D.C. PERFORMANCE CURVES
COMPOUND WOUND MOTOR

PEERLESS ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.

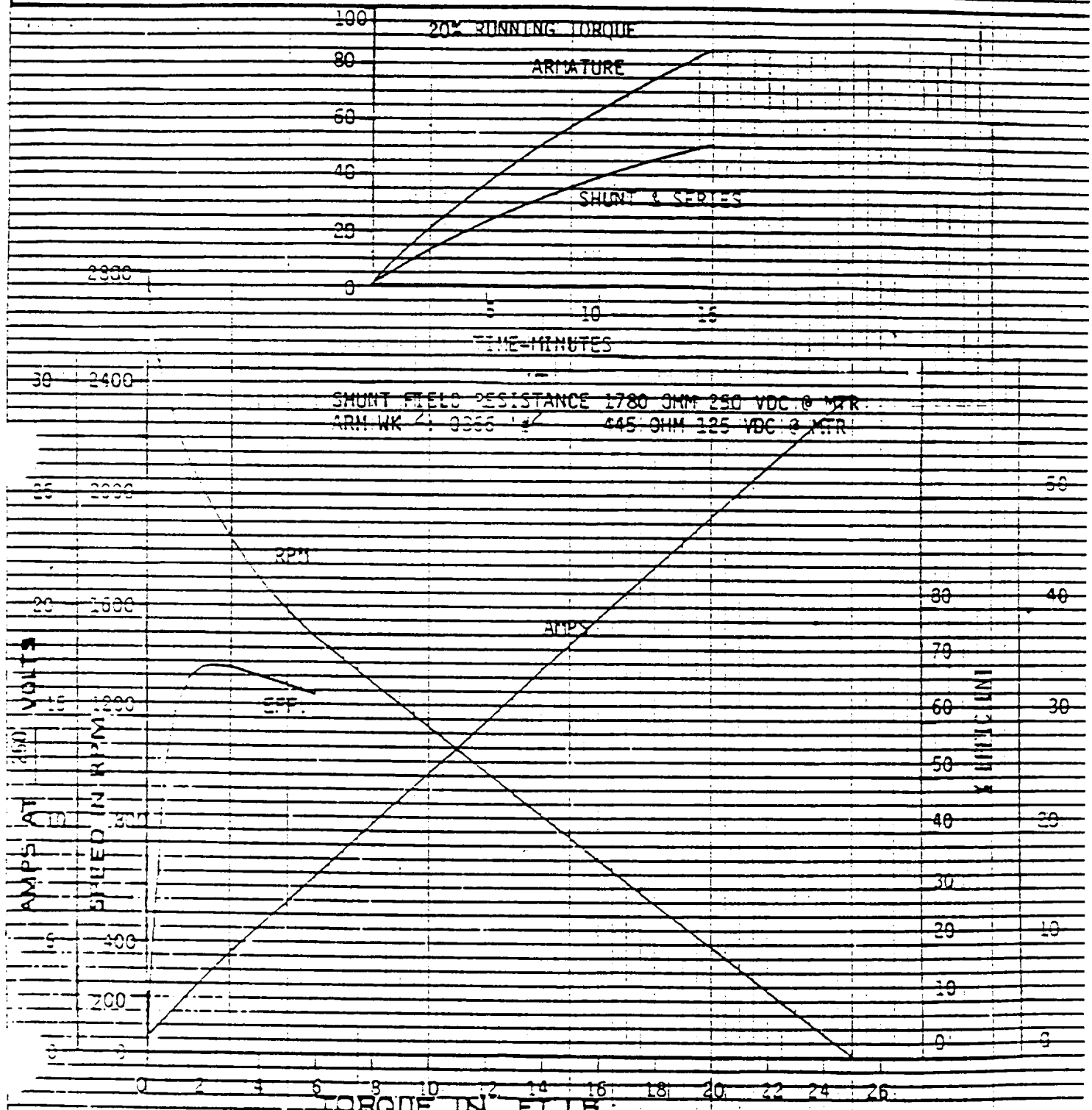
DG560 FRAME, 110 LB. FT.
LOCKED ROTOR TORQUE,
1900 R.P.M., 20% RUNNING
TORQUE, B.B.



# LIMITORQUE CORPORATION

| | | | | | |
|---|---|---|---|---|---|
| OMINAL LOCKED ROTOR TORQUE | 15 | FT.LBS. | | PHASE | |
| ANUFACTURE | H.K. PORTER | CURVE No. | K-5010 | HERTZ | |
| ORSE POWER | 1.0 | CURVE DATE | 2/26/68 | CODE | |
| R.P.M. | 1900 | DUTY | 5 MIN. | INSUL | B |
| VOLTS | 250 VDC | TEMP. RISE | 75°C | ENCL | TENV |
| AMPS | 1.7 @ ARM. | AMBIENT | 40°C | FRAME | D56F |




SIGNED MIKE CHIEFFO

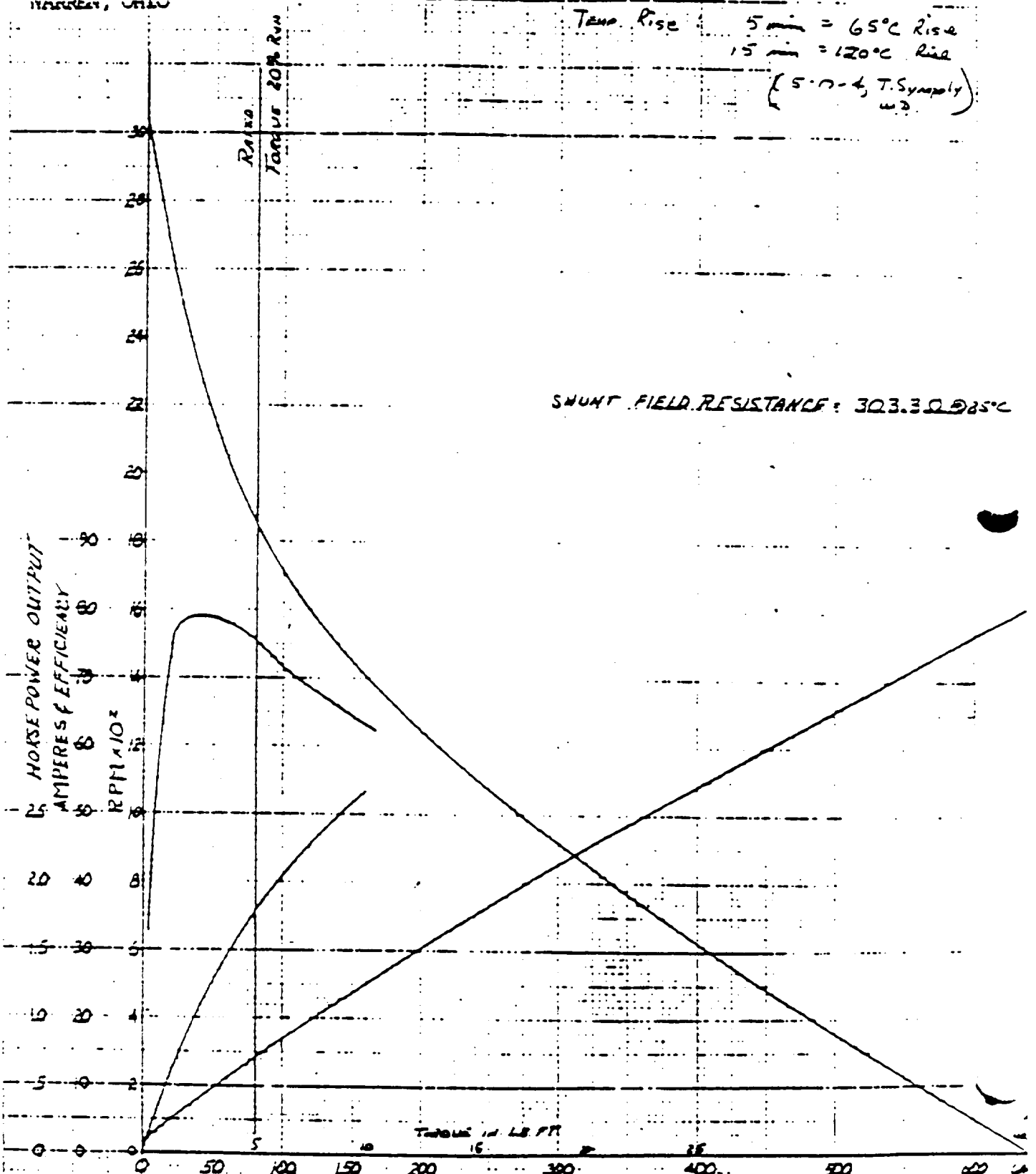
25-DCWO

125 VDC Performance Curves
Compound Wound Motor

H. K. PORTER CO., INC.
PEERLESS ELECTRIC DIV.
WARREN, OHIO

Frame 256AK, 25LB-FT,
1900 RPM, 20% Run, TEXP
5 MIN Duty, U.S. Motor
56 FRAME

Temp. Rise: 5 min = 65°C Rise
15 min = 120°C Rise
(5-17-4, T. Synopoly w.o.)




24202ASE 1-26-67 RLK

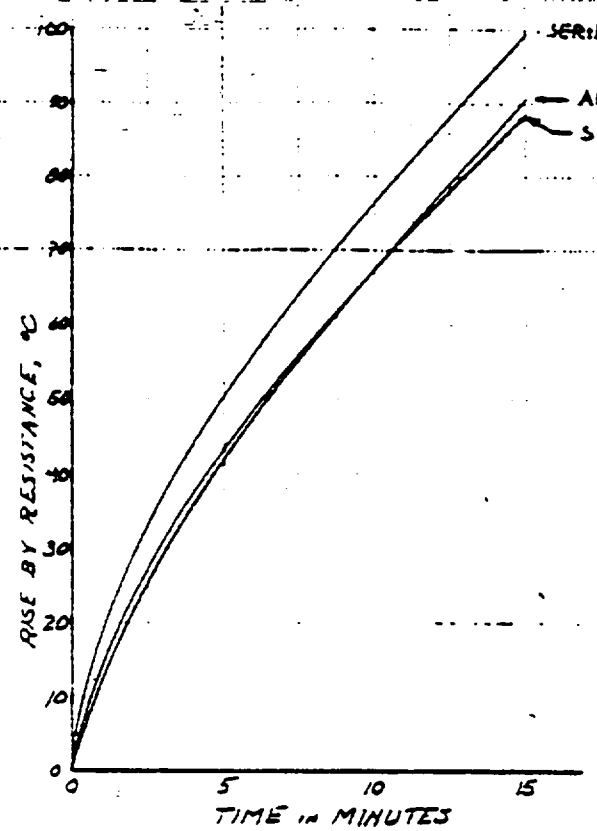
25-DC-WP

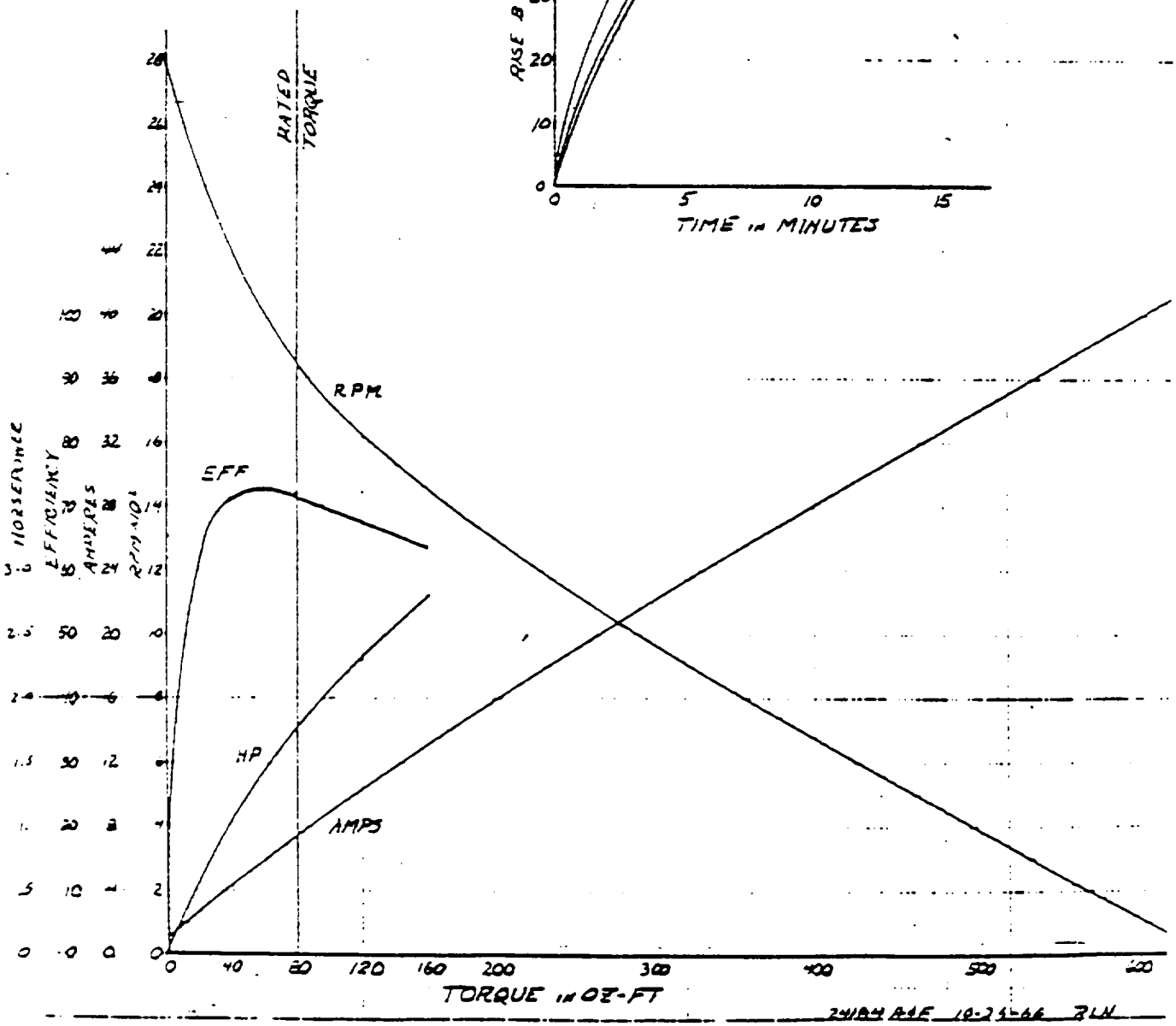
250 . . D.C. PERFORMANCE CURVES
COMPOUND WOUND MOTOR

PRIME DESIGN, 25 LB. FT., 20% RON.,
1900 RPM, T.E.W.P., 5 MIN. DUTY, D.B.
MOTOR

56 Frame

H. K. PORTER COMPANY, INC.
PERFLESS ELECTRIC DIVISION
WARREN, OHIO




24/84 A1E 10-25-66 RLN

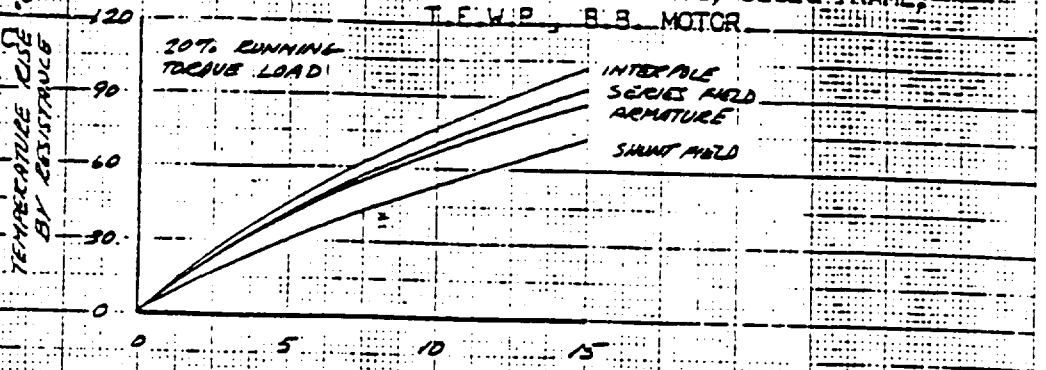
125 VDC CERTIFIED PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

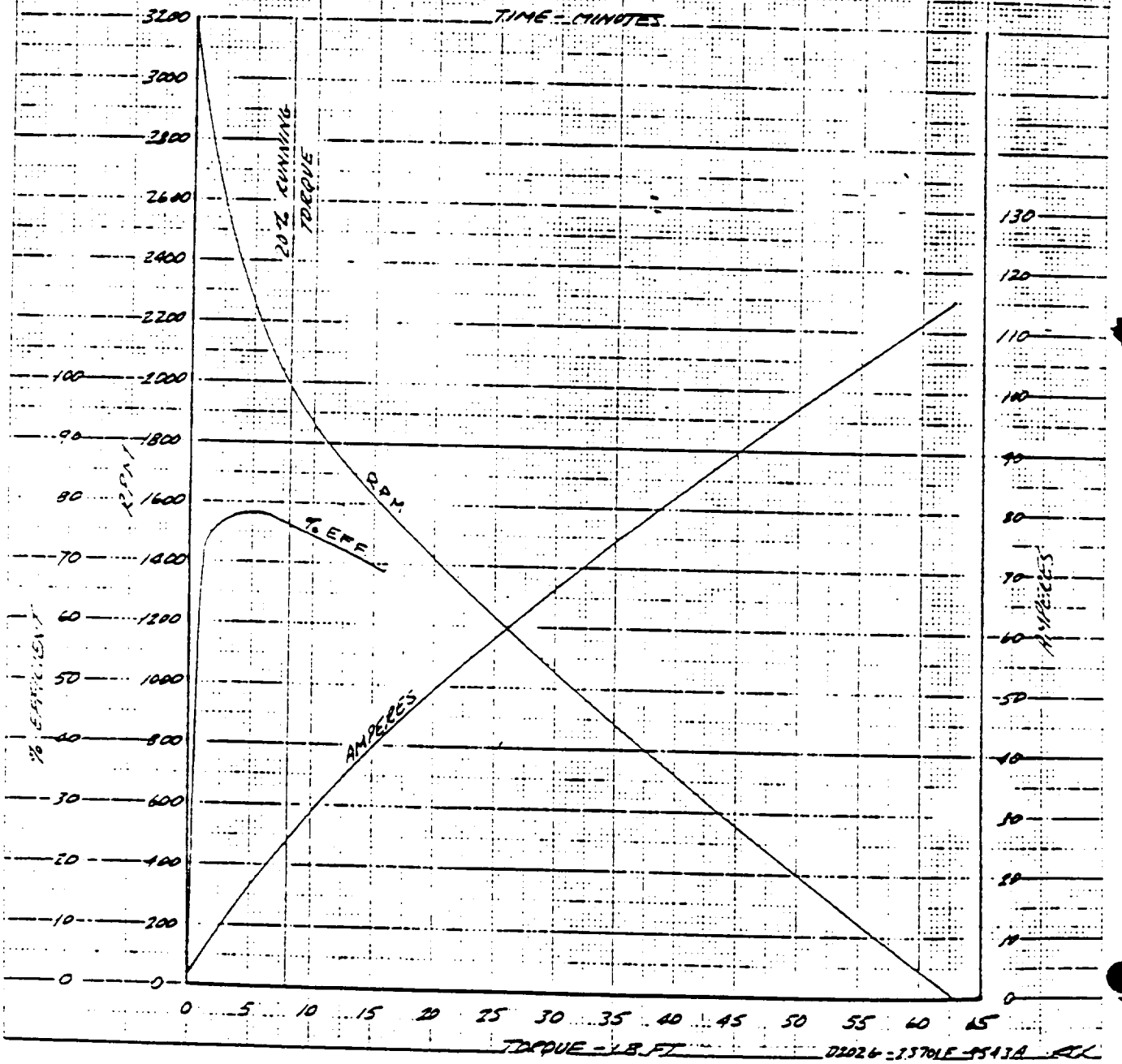
PEERLESS ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.
WARREN, OHIO

PHILA. GEAR ORDER NO. 311769
H. K. PORTER ORDER NO. B-10069
MOTOR SERIAL NO. ES39059

40 LB. FT. LOCKED ARMATURE TORQUE,
20% RUNNING TORQUE, D2C2G FRAME,
T.E.W.P., B.B. MOTOR

RESISTANCES@22.5°C
SHUNT FIELD: 445.3 Ω
SERIES FLD: .227 Ω
INTERPOLE: .1252 Ω
ARMATURE: .3625 Ω
(ON COMMUTATOR)



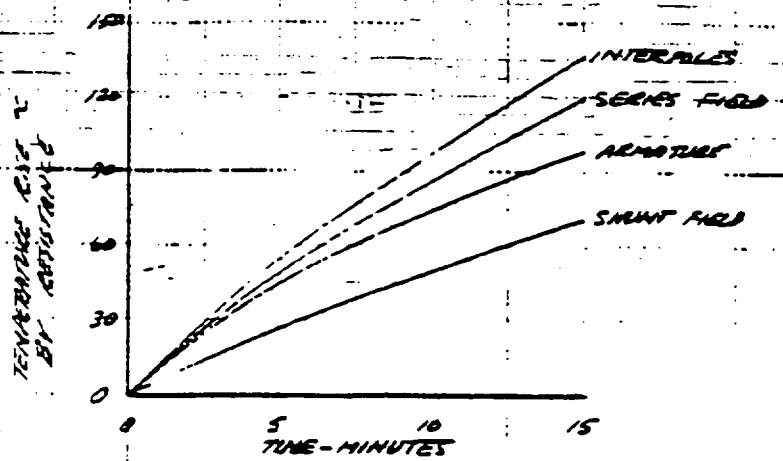

D2026-2370LE-4543A

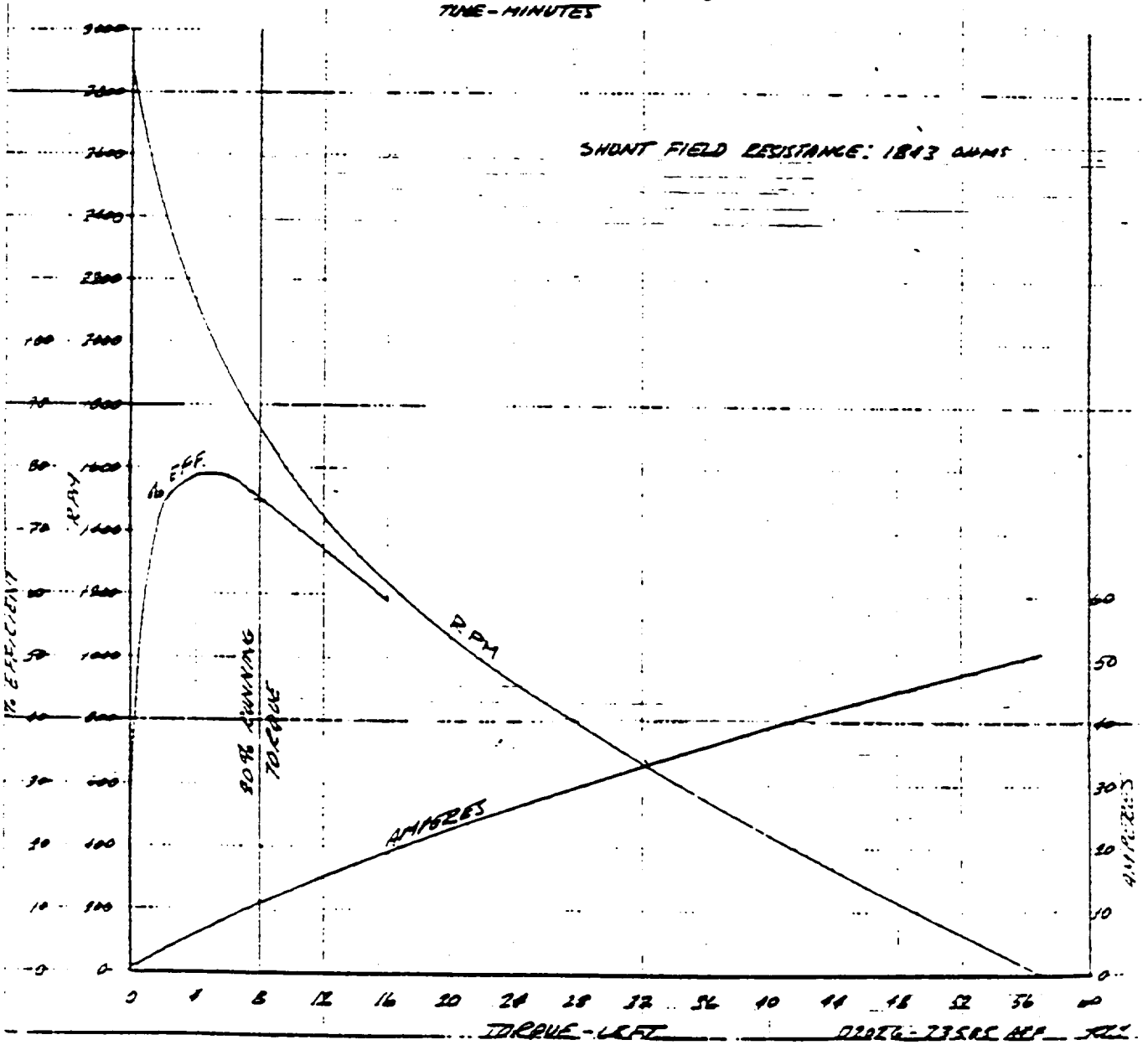
K-5087

250 VOLT PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

PEERLESS ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.
WARREN, OHIO

FRAME D202G, 40 LB. FT. LOCKED ROTOR TORQUE, 1900 R.P.M., 20% RUNNING TORQUE, B.B. MOTOR.




K 5010

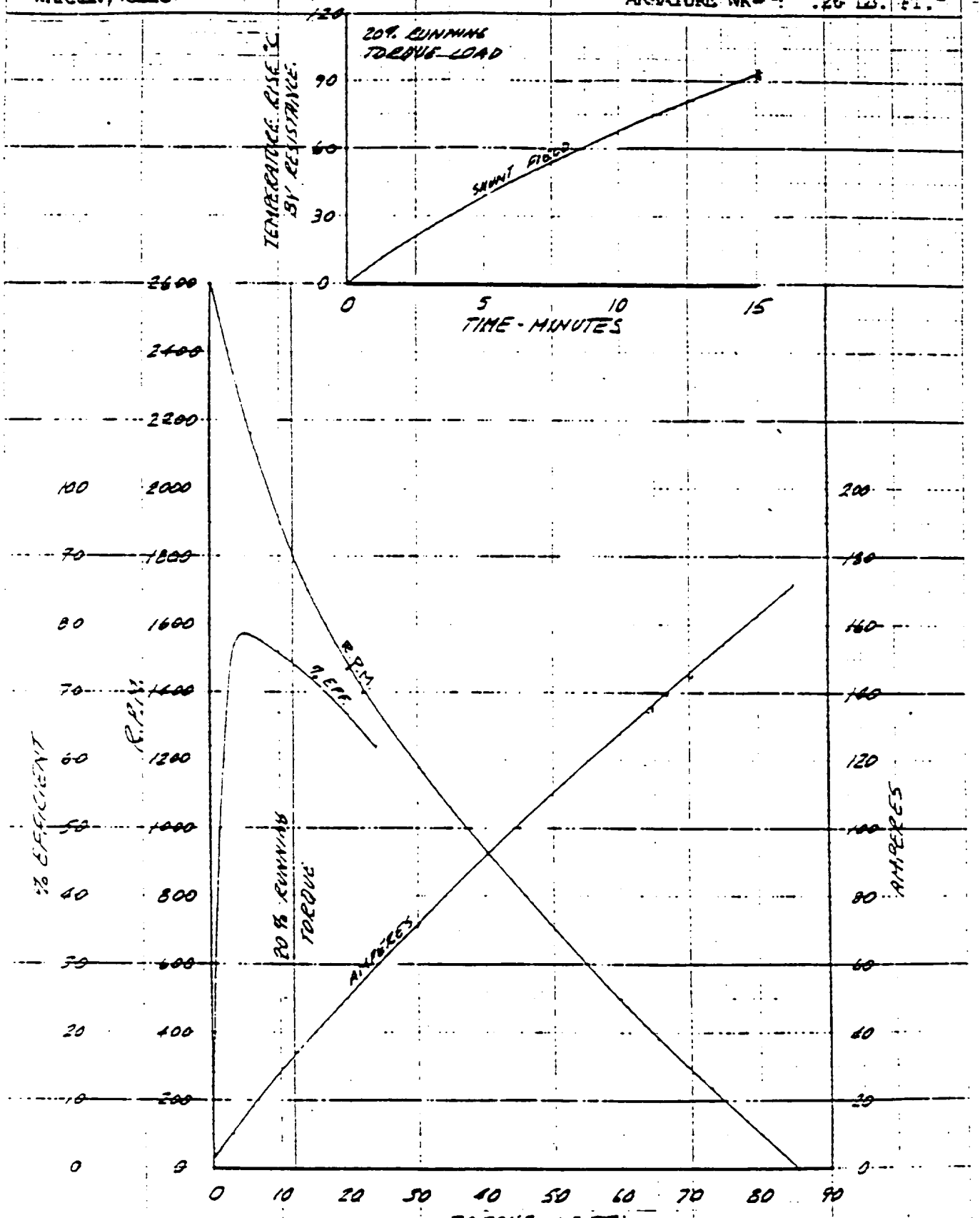
125 V. D.C. PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

PEERLESS ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.
WARREN, OHIO

DS204 FRAME, 60 LB. FT. LOCKED ROTOR TORQUE, 1900 RPM, 20% RUNNING TORQUE, B.B.

SHUNT FIELD RESISTANCE: 105 OHMS
ARMATURE $WK^2$ : .26 LB. FT.$^2$

K-5013




DS204 - 9534 ASE

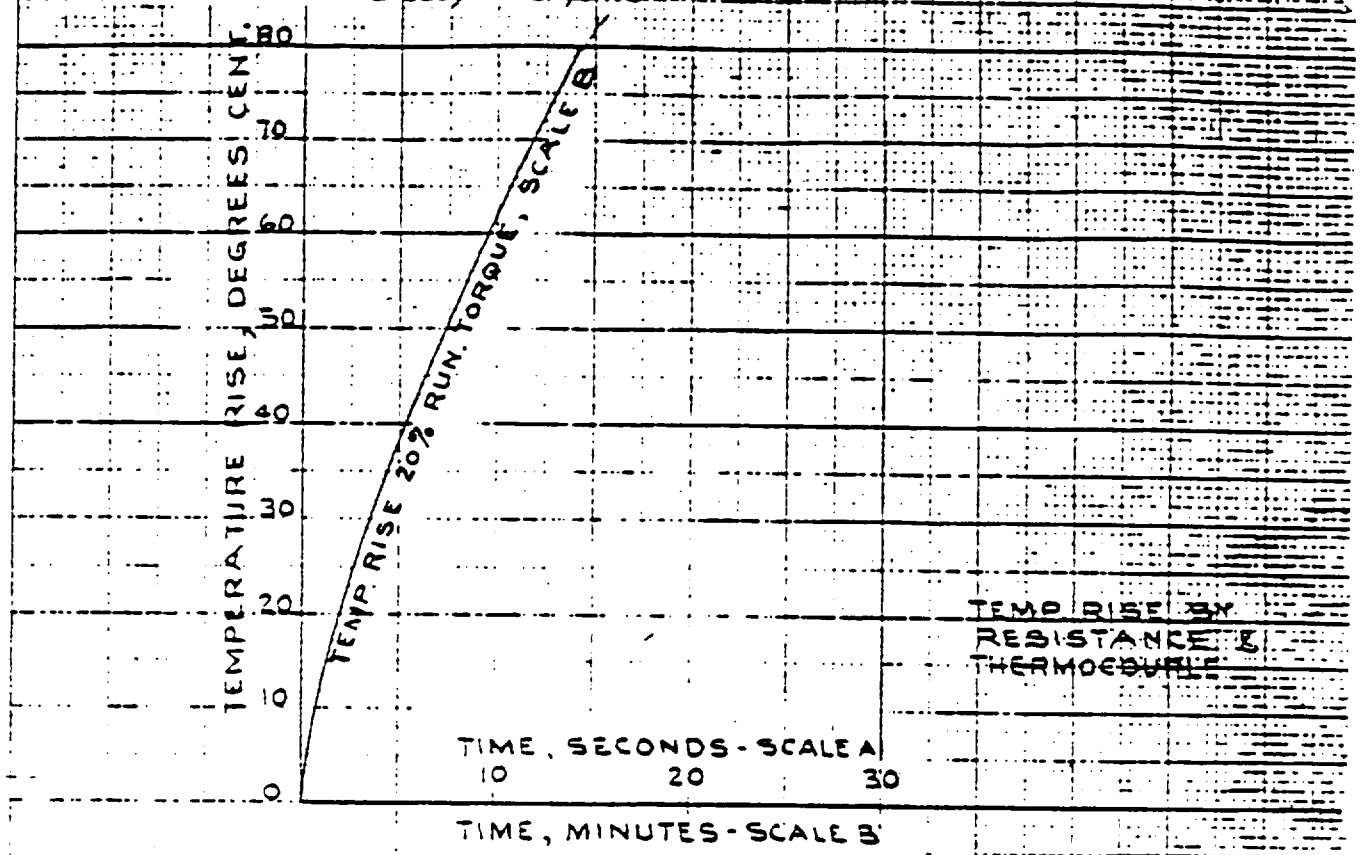
K-5013

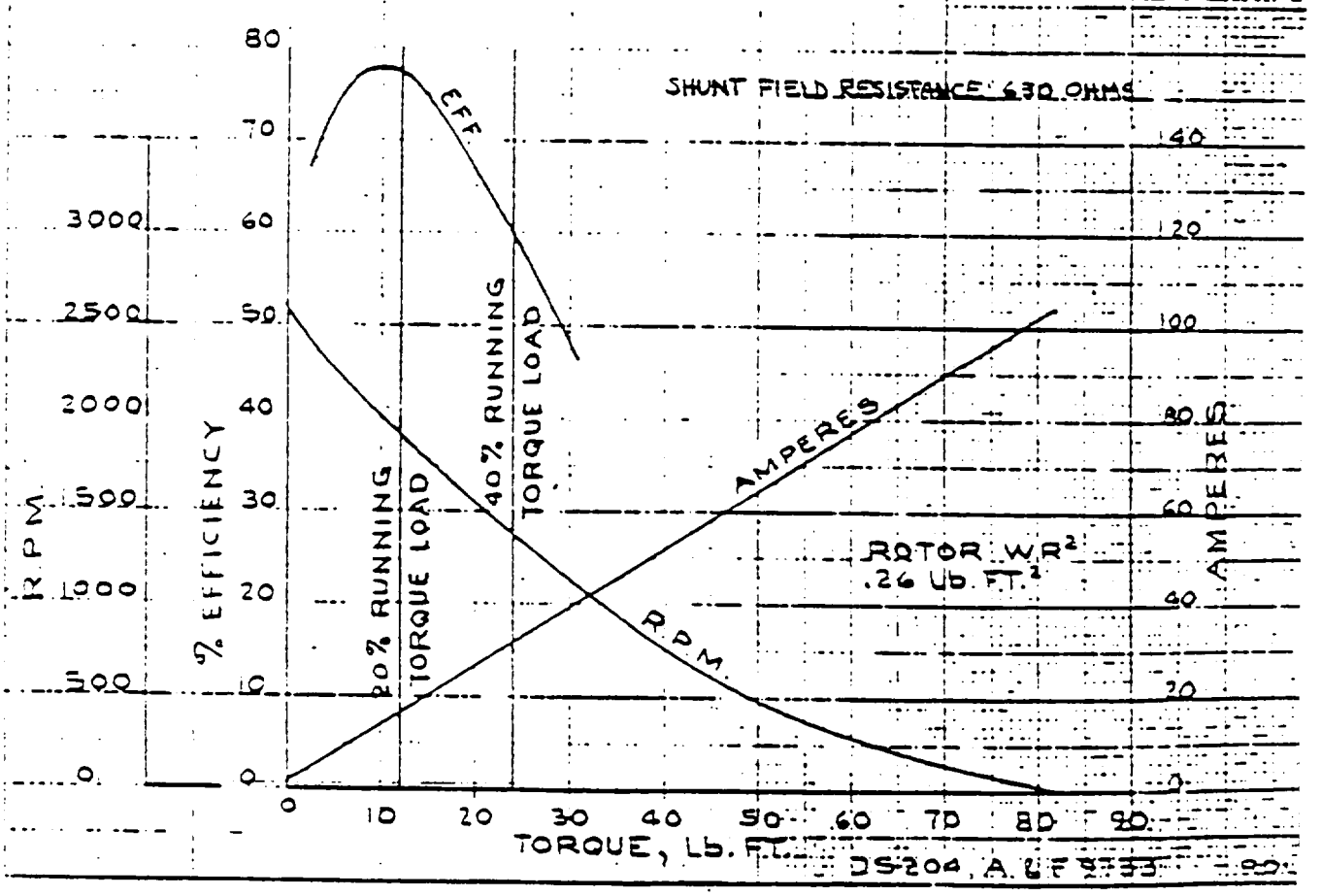
60-DC-WP

250 VOLT PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTORS

60# L.R. TORQUE, DS204 FRAME
250 VOLTS D.C., TENV MOTOR

THE PEERLESS ELECTRIC CO., WARREN, OHIO



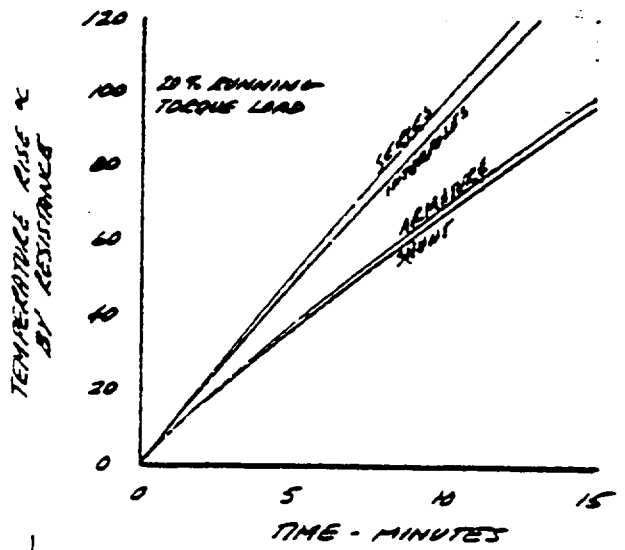

DS-204, A.&F. 9-33

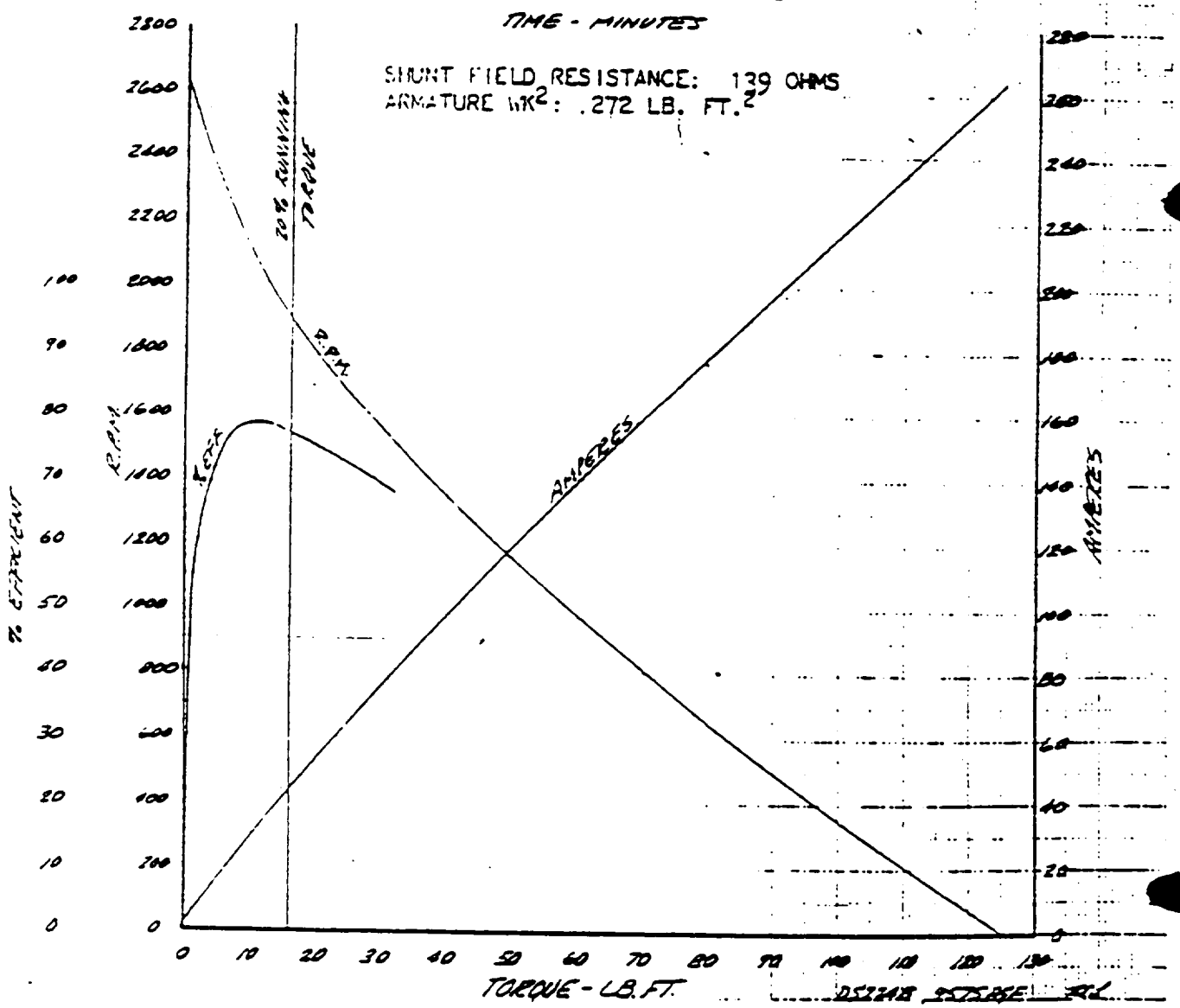
80-DC-WP

125 V DC PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

PEERLESS ELECTRIC DIVISION
H.K. PORTER COMPANY, INC.
WARREN, OHIO

DS2248 FRAME, 80 LB. FT.
ROTOR TORQUE, 1900 R.P.M.,
20% RUNNING TORQUE, B.B.

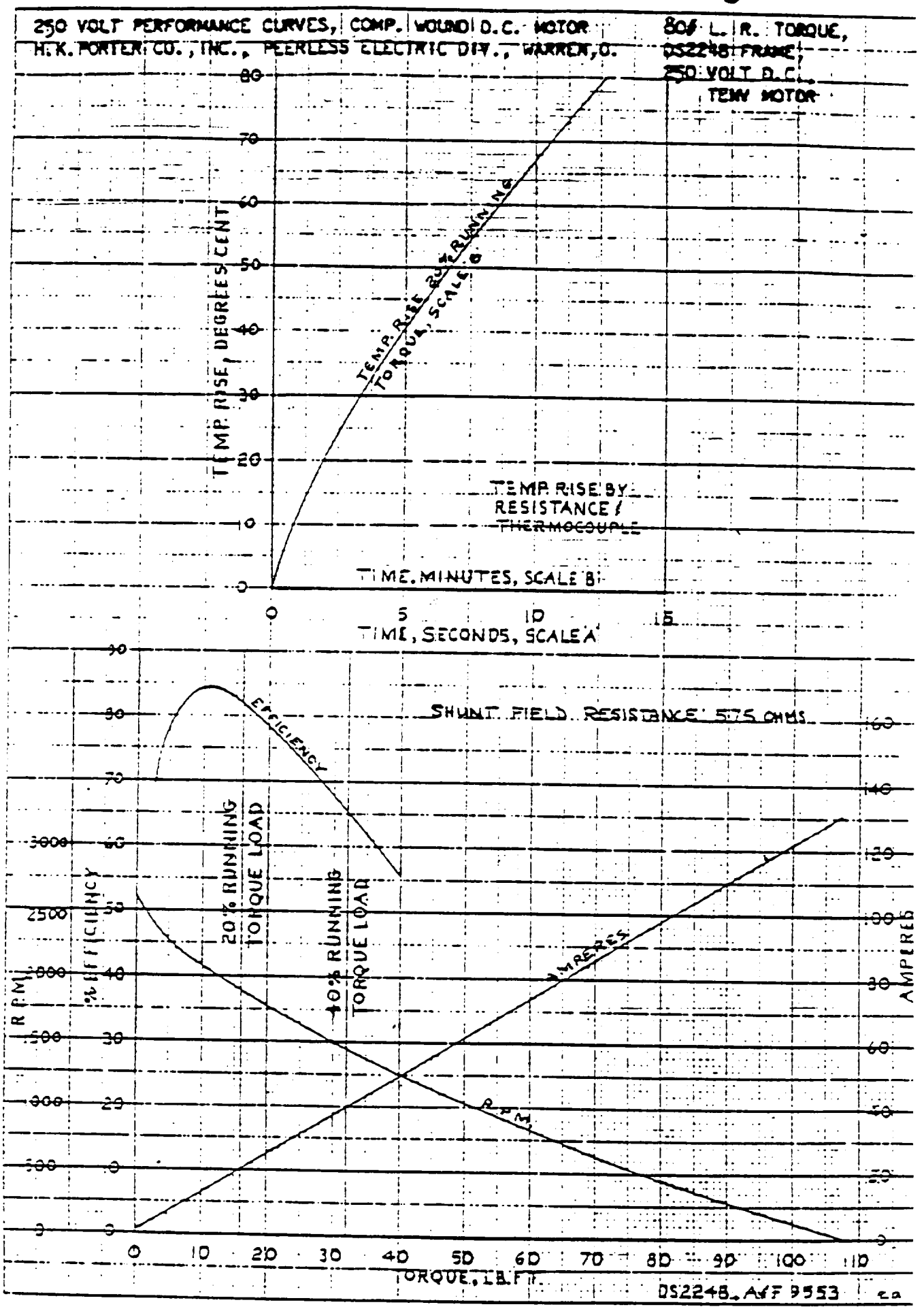



DS2248 SCALE

K- 4980

8B DC-WP

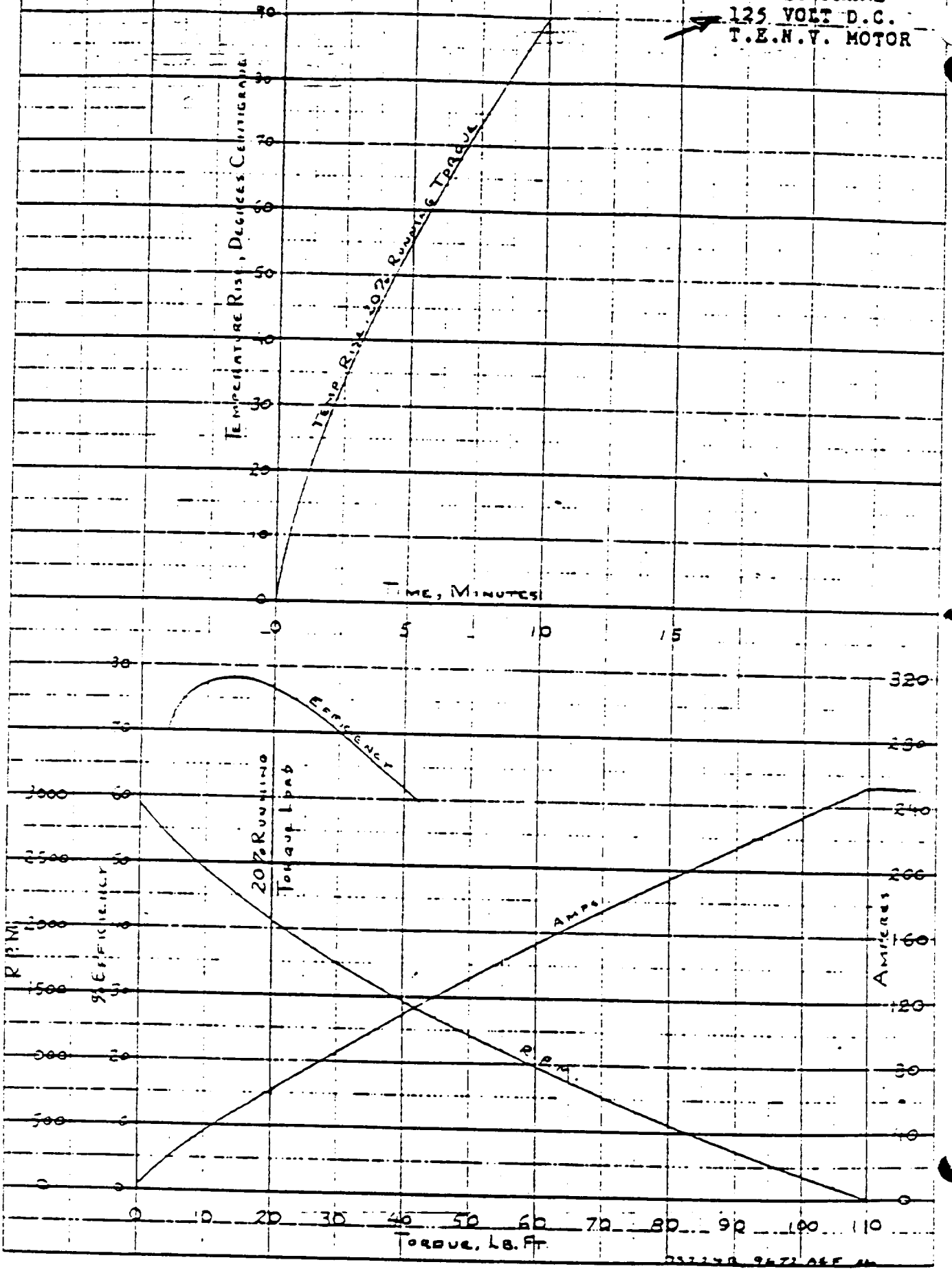



K-4053

100-DC-WP

125 VOLT PERFORMANCE CURVES, COMP.WOUND D.C. MTR.
PEERLESS ELECTRIC DIVISION, H.K.PORTER CO., INC.

100#' LA TORQUE
DS224B FRAME
125 VOLT D.C.
T.E.N.V. MOTOR

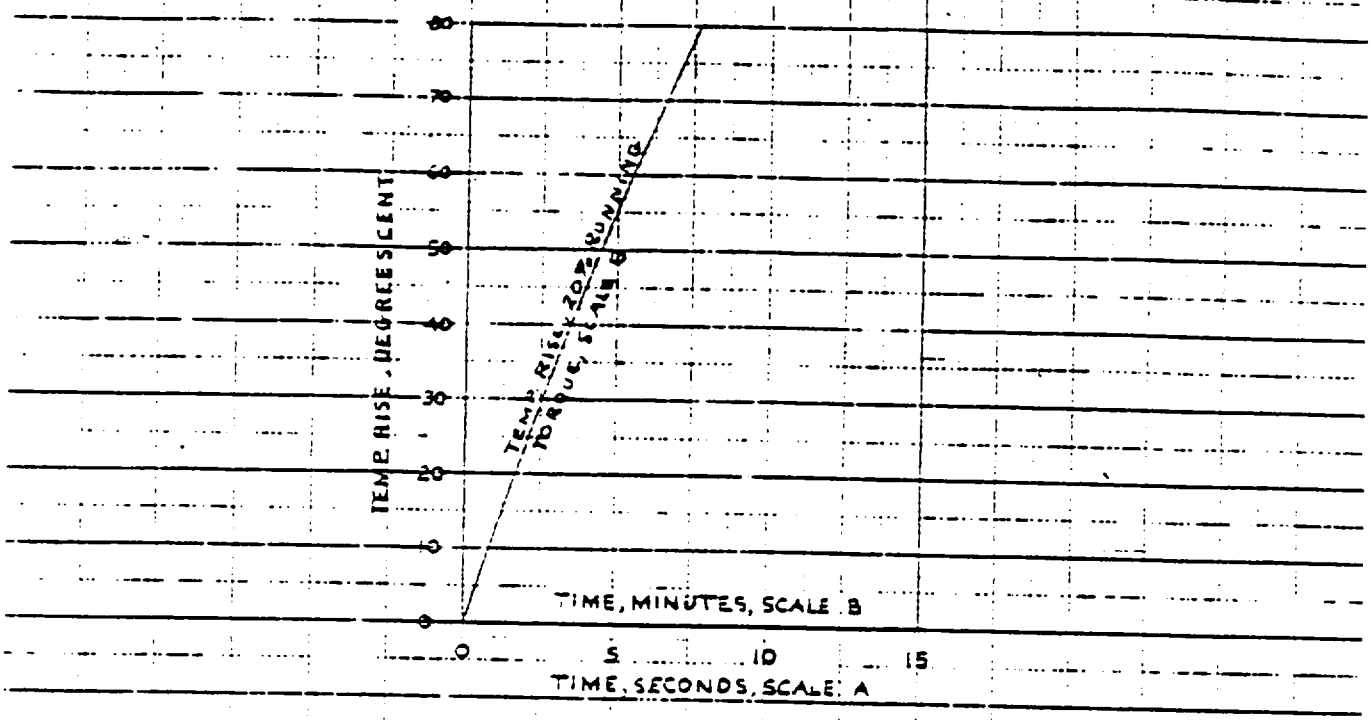


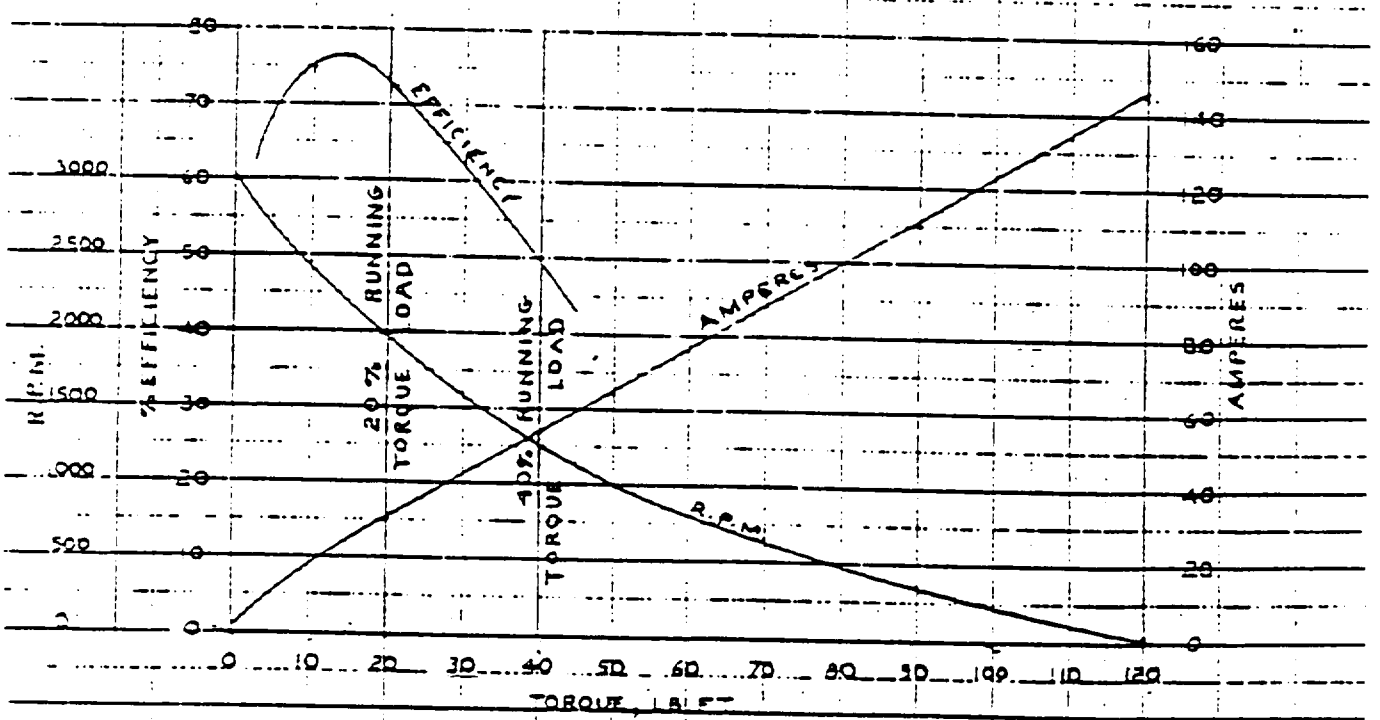
100 - DC - WP

250 VOLT PERFORMANCE CURVES, COMP. WOUND D.C. MOTOR
H.K. PORTER CO., INC., PEERLESS ELECTRIC DIV., WARREN, O.

100% L.R. TORQUE,
DS2248 FRAME,
250 VOLTS D.C.,
TENV MOTOR

FL = 30 AMP
LR = 146 AMP



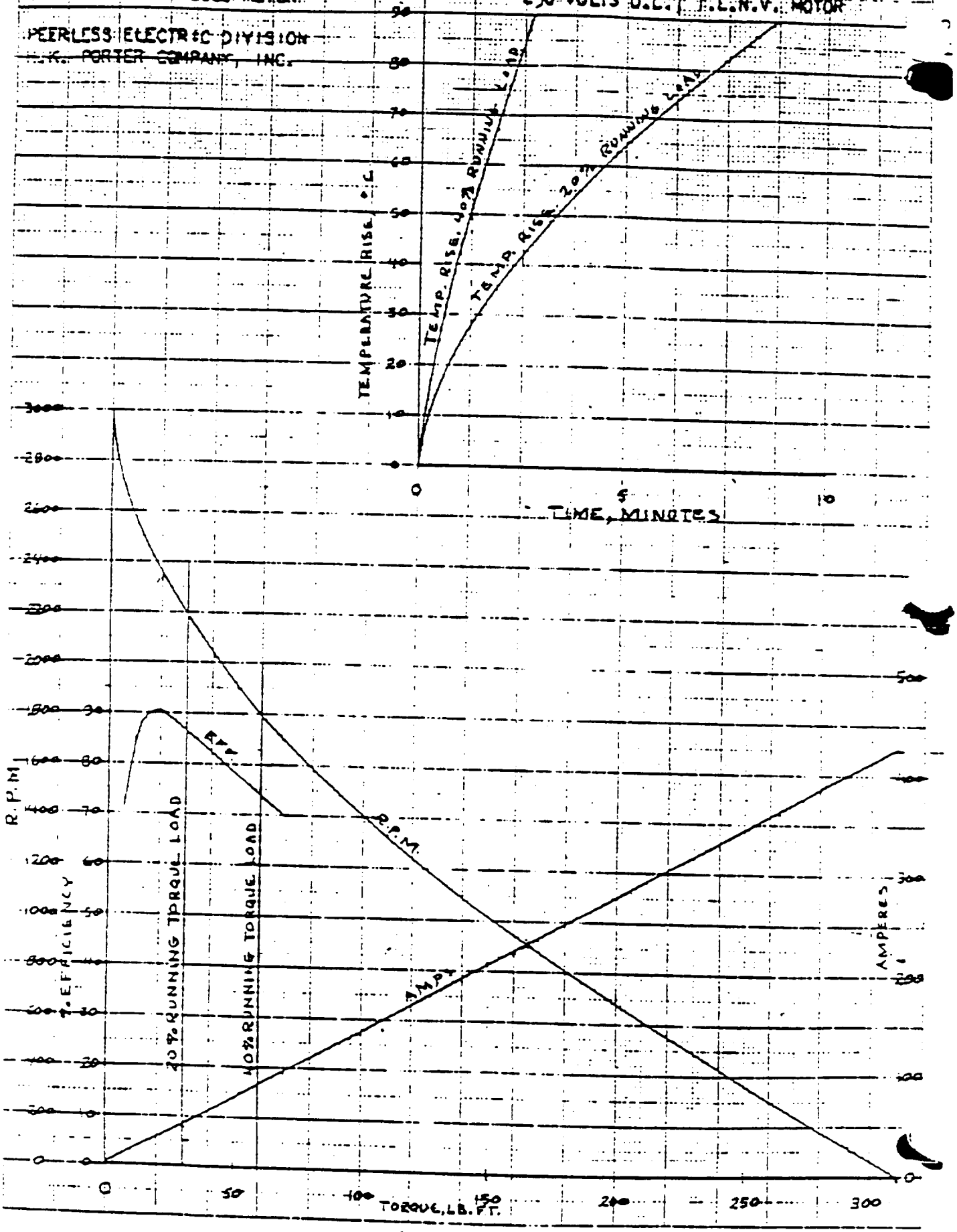




DS2248 AIF2823L

250 VOLT PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

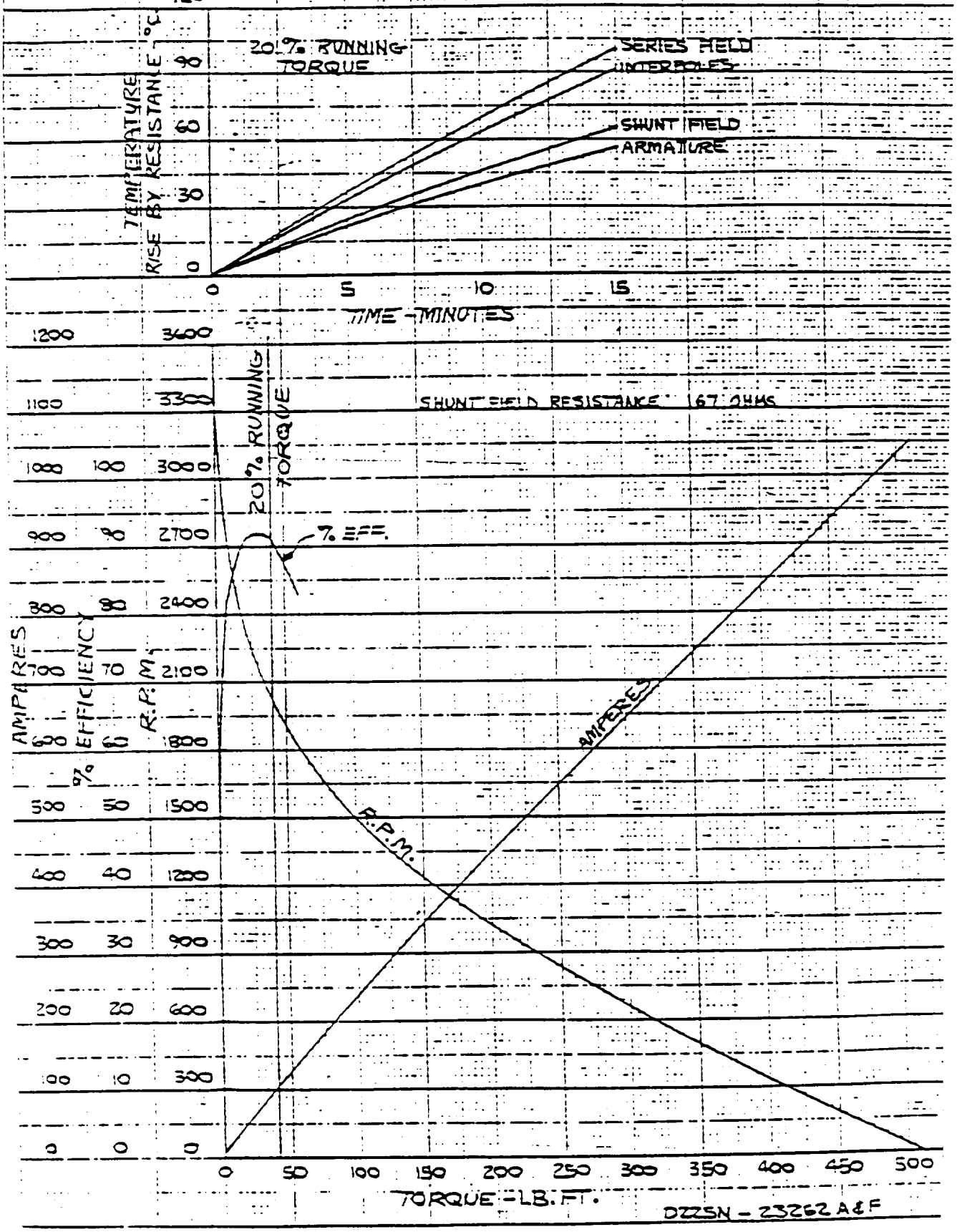
PEERLESS ELECTRIC DIVISION
H.K. PORTER COMPANY, INC.

150# L.A. TORQUE, D225D FRAME,
250 VOLTS D.C. T.E.N.V. MOTOR



125 VOLT PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR
H.K. PORTER CO., INC. PEERLESS ELECTRIC DIV.
WARREN, OHIO

FRAME D225N, 200 LB. FT. LOCKE
ROTOR TORQUE, 1900 R.P.M.,
20% RUNNING TORQUE, S.B.

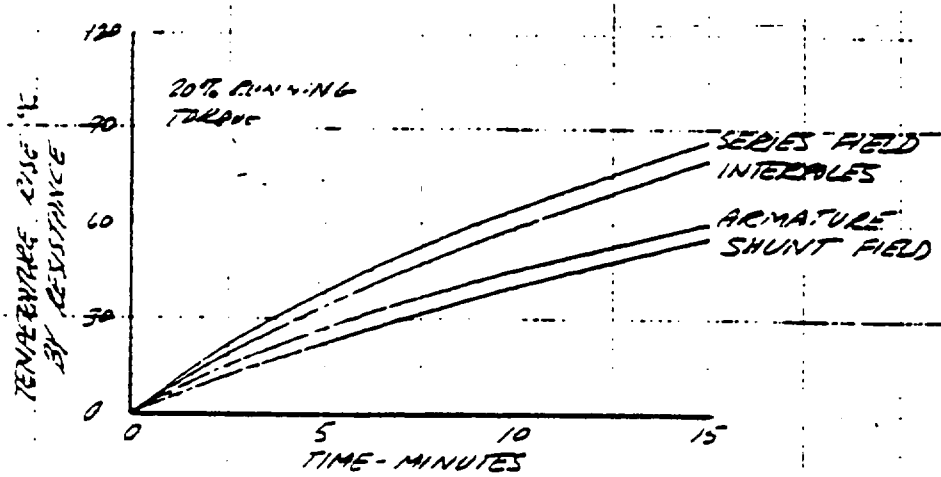


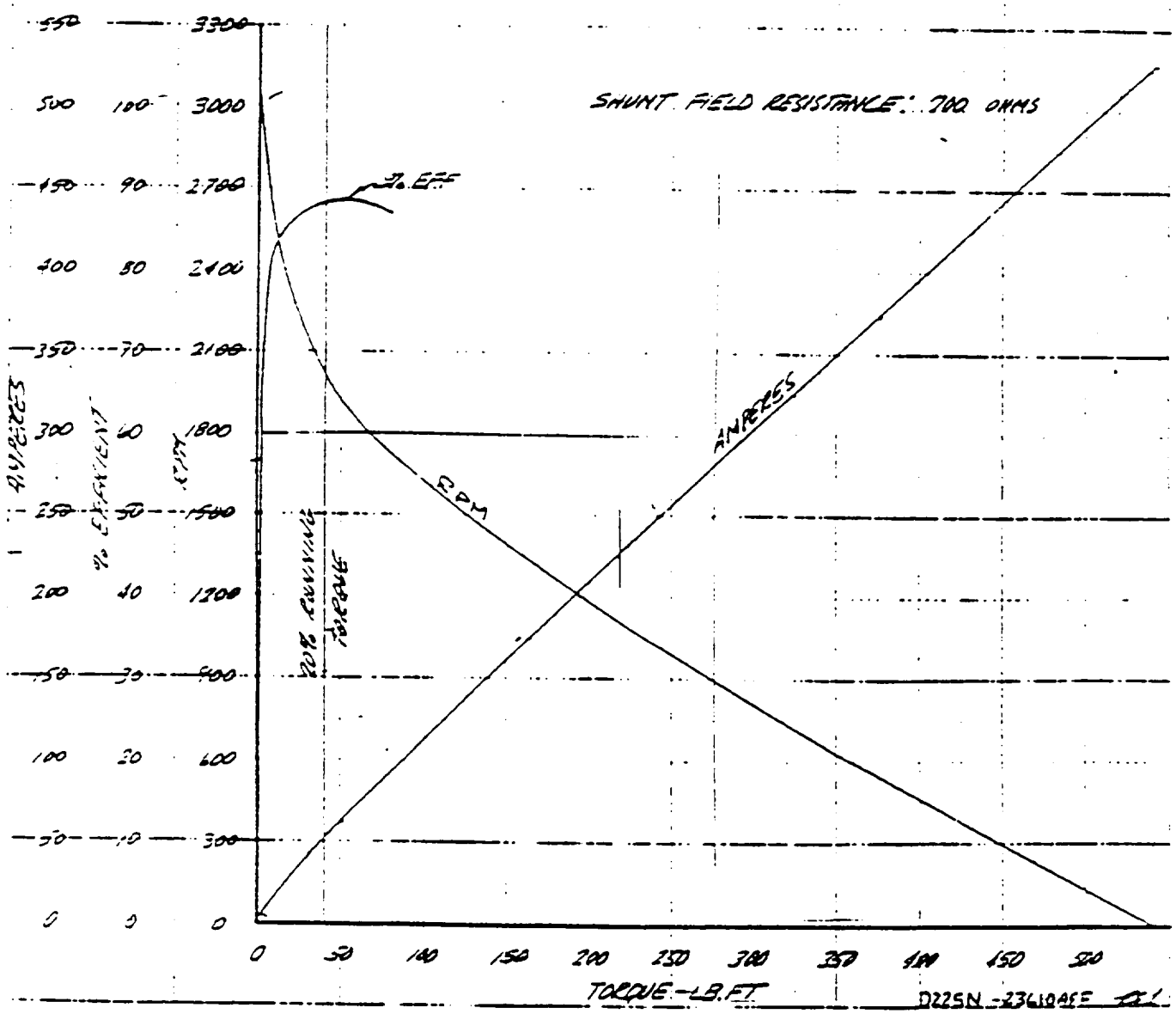

D225N - 23262 A&F

250 VOLT PERFORMANCE CURVES
COMPOUND WOUND D.C. MOTOR

H.K. PORTER COMPANY, INC.
PEERLESS ELECTRIC DIVISION
WARREN, OHIO

FRAME D225N. 200 LB. FT. LOCKED ROTOR TORQUE, 1900 R.P.M., 20% RUNNING TORQUE, S.B.




D225N-23610A5E

K-5049