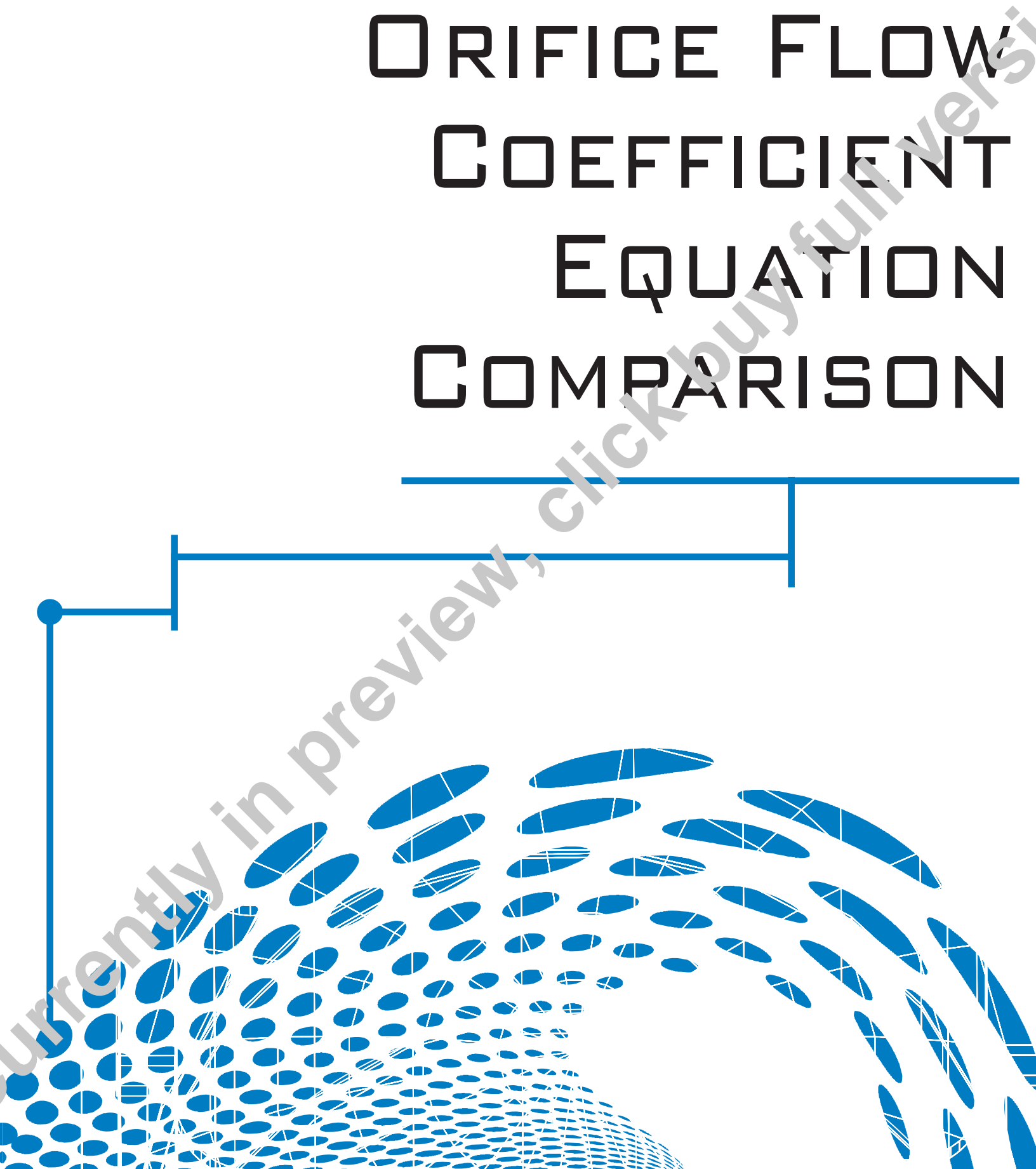


ORIFICE FLOW COEFFICIENT EQUATION COMPARISON



STP-TS-084

ORIFICE FLOW COEFFICIENT EQUATION COMPARISON

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES v

FOREWORD ix

EXECUTIVE SUMMARY x

ABBREVIATIONS AND ACRONYMS xii

1 DATABASE 1

 1.1 Flange Tap Database 1

 1.2 Meter-Run Orifice Plate Combinations 4

 1.3 Distribution of Beta Ratios 9

 1.4 Corner Tap Database 12

 1.5 Distribution of Beta Ratios 14

2 EQUATIONS 16

 2.1 Flange Tap Equations 16

 2.1.1 ASME MFC-3M 2004 (ISO-RHG) 16

 2.1.2 ISO 5167 1991 (Stoltz) 17

 2.1.3 AGA Report Number 3 1990 (AGA-RHG) 18

 2.1.4 PTC 19.5 Appendix 1 (Keyser) 19

 2.1.5 Comparison of Equations 19

 2.2 Corner Tap Equations 24

 2.2.1 ASME MFC-3M 2004 (ISO-RHG) 25

 2.2.2 ISO 5167 1991 (Stoltz) 26

 2.2.3 PTC 19.5 Appendix 1 (Keyser) 26

 2.2.4 Comparison of Equations 27

3 ANALYSIS METHODOLOGY 32

 3.1 Example of Methodology 34

4 RESULTS 36

 4.1 ASME MFC-3M 2004 (ISO-RHG) 2004 Flange Tap 36

 4.2 ISO 5167 1991 (Stoltz) Flange Tap 41

 4.3 AGA Report Number 3 1990 (AGA-RHG) Flange Tap 44

 4.4 PTC 19.5 Appendix 1 (Keyser) Equation Flange Tap 48

 4.5 ASME MFC-3M 2004 (ISO-RHG) 2004 Corner Tap 52

 4.6 ISO 5167 1991 (Stoltz) Corner Tap 56

 4.7 PTC 19.5 Appendix 1 (Keyser) Equation Corner Tap 60

5 EXTRAPOLATION TESTING 64

 5.1 Methodology 64

 5.2 Flange Tap Equation Extrapolation 65

 5.2.1 6-inch 0.35-0.40 Beta Ratio 65

 5.2.2 10-inch 0.35-0.40 Beta Ratio 66

 5.2.3 6-inch 0.45-0.50 Beta Ratio 67

 5.2.4 10-inch 0.45-0.50 Beta Ratio 68

 5.2.5 6-inch 0.55-0.60 Beta Ratio 69

 5.2.6 10-inch 0.55-0.60 Beta Ratio 70

 5.2.7 6-inch 0.65-0.70 Beta Ratio 71

 5.2.8 10-inch 0.65-0.70 Beta Ratio 72

 5.3 Corner Tap Equation Extrapolation 73

 5.3.1 6-inch 0.35-0.40 Beta Ratio 73

5.3.2	10-inch 0.45-0.50 Beta Ratio	74
5.3.3	10-inch 0.55-0.60 Beta Ratio	75
5.3.4	10-inch 0.65-0.70 Beta Ratio	76
6	SUMMARY AND CONCLUSIONS	78
6.1	Flange Tap Equations	78
6.2	Corner Tap Equations	79

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LIST OF TABLES AND FIGURES

Table 1-1: Contribution of Each Testing Facility to the Flange Tap Database.....	2
Table 1-2: Fluids in the Flange Tap Database	2
Table 1-3: Location of Meter-Run Testing	3
Table 1-4: 2-inch Meter-Run Plate Combinations.....	4
Table 1-5: 3-inch Meter-Run Plate Combination	5
Table 1-6: 4-inch Meter-Run Plate Combinations.....	6
Table 1-7: 6-inch Meter-Run Plate Combinations.....	7
Table 1-8: 10-inch Meter-Run Plate Combinations.....	8
Table 1-9: 24-inch Meter-Run Plate Combinations.....	8
Figure 1-1: Beta Ratio Distribution of all Data	9
Figure 1-2: 2-inch Line Size Distribution of Beta Ratio.....	9
Figure 1-3: 3-inch Line Size Distribution of Beta Ratio.....	10
Figure 1-4: 4-inch Line Size Distribution of Beta Ratio.....	10
Figure 1-5: 6-inch Line Size Distribution of Beta Ratio.....	11
Figure 1-6: 10-inch Line Size Distribution of Beta Ratio.....	11
Figure 1-7: 24-inch Line Size Distribution of Beta Ratio.....	12
Table 1-10: Contribution of Each Testing Facility to the Corner Tap Database	13
Table 1-11: Fluids in the Corner Tap Database.....	13
Figure 1-8: Beta Ratio Distribution of all Data	14
Figure 1-9: 4-inch Line Size Distribution of Beta Ratio.....	14
Figure 1-10: 10-inch Line Size Distribution of Beta Ratio.....	15
Figure 2-1: Equation 1, ASME MFC-3M 2004 (ISO-RHG) Discharge Coefficient Equation.....	16
Figure 2-2: Equation 2, ISO 5167 1991 (Stoltz) Discharge Coefficient Equation for $D \geq 2.3$ Inches.....	17
Figure 2-3: Equation 3, ISO 5167 1991 (Stoltz) Discharge Coefficient Equation for $D < 2.3$ Inches.....	17
Figure 2-4: Equation 4, AGA Report Number 3 1990 (AGA-RHG) Discharge Coefficient Equation	18
Figure 2-5: Equation 5, PTC 19.5 Appendix 1 (Keyser) Discharge Coefficient Equation	19
Figure 2-6: Flange Tap Equations for 2-inch Line Size 0.10 Beta Ratio.....	20
Figure 2-7: Flange Tap Equations for 2-inch Line Size 0.40 Beta Ratio.....	20
Figure 2-8: Flange Tap Equations for 2-inch Line Size 0.70 Beta Ratio.....	21
Figure 2-9: Flange Tap Equations for 2-inch Line Size 0.45 Beta Ratio.....	21
Figure 2-10: Flange Tap Equations for 3-inch Line Size 0.45 Beta Ratio.....	22
Figure 2-11: Flange Tap Equations for 4-inch Line Size 0.45 Beta Ratio.....	22
Figure 2-12: Flange Tap Equations for 6-inch Line Size 0.45 Beta Ratio.....	23
Figure 2-13: Flange Tap Equations for 10-inch Line Size 0.45 Beta Ratio.....	23
Figure 2-14: Flange Tap Equations for 24-inch Line Size 0.45 Beta Ratio.....	24
Figure 2-15: Equation 6, ASME MFC-3M 2004 (ISO-RHG) Discharge Coefficient Equation.....	25
Figure 2-16: Equation 7, ISO 5167 1991 (Stoltz) Discharge Coefficient Equation.....	26
Figure 2-17: Equation 8, PTC 19.5 Appendix 1 (Keyser) Discharge Coefficient Equation.....	26
Figure 2-18: Corner Tap Equations for 2-inch Line Size 0.10 Beta Ratio.....	27
Figure 2-19: Corner Tap Equations for 2-inch Line Size 0.40 Beta Ratio.....	27
Figure 2-20: Corner Tap Equations for 2-inch Line Size 0.70 Beta Ratio.....	28
Figure 2-21: Corner Tap Equations for 2-inch Line Size 0.45 Beta Ratio.....	29
Figure 2-22: Corner Tap Equations for 3-inch Line Size 0.45 Beta Ratio.....	29
Figure 2-23: Corner Tap Equations for 4-inch Line Size 0.45 Beta Ratio.....	30
Figure 2-24: Corner Tap Equations for 6-inch Line Size 0.45 Beta Ratio.....	30
Figure 2-25: Corner Tap Equations for 10-inch Line Size 0.45 Beta Ratio.....	31

Figure 2-26: Corner Tap Equations for 24-inch Line Size 0.45 Beta Ratio.....	31
Table 3-1: Limits for Data Compiling in Example.....	34
Table 3-2: First 6 Rows of Results in Example.....	34
Table 3-3: Results of Analysis of Points that Met Criteria in Example.....	34
Figure 3-1: Graphical Representation of the Data in the Example Analysis.....	35
Table 4-1: Number of Points Meeting ASME MFC-3M 2004 (ISO-RHG) Flange Tap Criteria.....	36
Table 4-2: Average Deviation Results for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	37
Figure 4-1: 2-inch 0.55-0.60 Beta Ratio Results for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	38
Figure 4-2: 4-inch 0.40-0.45 Beta Ratio Results for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	38
Table 4-3: Average Deviation from Database Value Regardless of Beta Ratio for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	39
Table 4-4: Average Deviation from Database Value Regardless of Line Size for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	39
Table 4-5: Number of Standard Deviations between Average Deviation and Equation for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	40
Figure 4-3: 4-inch 0.50-0.55 Beta Ratio Results for ASME MFC-3M 2004 (ISO-RHG) Flange Tap Equation.....	40
Table 4-6: Number of Points Meeting ISO 5167 1991 (Stoltz) Flange Tap Criteria.....	41
Table 4-7: Average Deviation Results for ISO 5167 1991 (Stoltz) Flange Tap Equation.....	41
Table 4-8: Average Deviation from Database Value Regardless of Beta Ratio for ISO 5167 1991 (Stoltz) Flange Tap Equation.....	42
Table 4-9: Average Deviation from Database Value Regardless of Line Size for ISO 5167 1991 (Stoltz) Flange Tap Equation.....	42
Table 4-10: Number of Standard Deviations between Average Deviation and Equation for ISO 5167 1991 (Stoltz) Flange Tap Equation.....	43
Table 4-11: Number of Points Meeting AGA Report Number 3 1990 (AGA-RHG) Flange Tap Criteria.....	44
Table 4-12: Average Deviation Results for AGA Report Number 3 1990 (AGA-RHG) Flange Tap Equation.....	45
Table 4-13: Average Deviation from Database Value Regardless of Beta Ratio for AGA Report Number 3 1990 (AGA-RHG) Flange Tap Equation.....	46
Table 4-14: Average Deviation from Database Value Regardless of Line Size for AGA Report Number 3 1990 (AGA-RHG) Flange Tap Equation.....	46
Table 4-15: Number of Standard Deviations between Average Deviation and Equation for AGA Report Number 3 1990 (AGA-RHG) Flange Tap Equation.....	47
Table 4-16: Number of Points Meeting PTC 19.5 Appendix 1 (Keyser) Flange Tap Criteria.....	48
Table 4-17: Average Deviation Results for PTC 19.5 Appendix 1 (Keyser) Flange Tap Equation.....	49
Table 4-18: Average Deviation from Database Value Regardless of Beta Ratio for PTC 19.5 Appendix 1 (Keyser) Flange Tap Equation.....	50
Table 4-19: Average Deviation from Database Value Regardless of Line Size for PTC 19.5 Appendix 1 (Keyser) Tap Equation.....	50
Table 4-20: Number of Standard Deviations between Average Deviation and Equation for PTC 19.5 Appendix 1.....	51
Table 4-21: Number of Points Meeting ASME MFC-3M 2004 (ISO-RHG) Corner Tap Criteria.....	52
Table 4-22: Average Deviation Results for ASME MFC-3M 2004 (ISO-RHG) Corner Tap Equation.....	53
Figure 4-4: 4-inch 0.15-0.20 Beta Ratio Results for ASME MFC-3M 2004 (ISO-RHG) Corner Tap Equation.....	53
Table 4-23: Average Deviation from Database Value Regardless of Beta Ratio for ASME MFC-3M 2004 (ISO-RHG) Corner Tap Equation.....	54

Table 4-24: Average Deviation from Database Value Regardless of Line Size for ASME MFC-3M 2004 (ISO-RHG) Corner Tap Equation.....	54
Table 4-25: Number of Standard Deviations between Average Deviation and Equation for ASME MFC-3M 2004 (ISO- RHG) Corner Tap Equation.....	55
Table 4-26: Number of Points Meeting ISO 5167 1991 (Stoltz) Corner Tap Criteria.....	56
Figure 4-27: Average Deviation Results for ISO 5167 1991 (Stoltz) Corner Tap Equation.....	57
Figure 4-28: Average Deviation from Database Value Regardless of Beta Ratio for ISO 5167 1991 (Stoltz) Corner Tap Equation.....	58
Figure 4-29: Average Deviation from Database Value Regardless of Line Size for ISO 5167 1991 (Stoltz) Corner Tap Equation.....	58
Figure 4-30: Number of Standard Deviations between Average Deviation and Equation for ISO 5167 1991 (Stoltz) Corner Tap Equation.....	59
Table 4-31: Number of Points Meeting PTC 19.5 Appendix 1 (Keyser) Corner Tap Criteria.....	60
Figure 4-32: Average Deviation Results for PTC 19.5 Appendix 1 (Keyser) Corner Tap Equation.....	61
Figure 4-33: Average Deviation from Database Value Regardless of Beta Ratio for PTC 19.5 Appendix 1 (Keyser) Corner Tap Equation.....	62
Figure 4-34: Average Deviation from Database Value Regardless of Line Size for PTC 19.5 Appendix 1 (Keyser) Corner Tap Equation.....	62
Figure 4-35: Number of Standard Deviations between Average Deviation and Equation for PTC 19.5 Appendix 1 (Keyser) Corner Tap Equation.....	63
Figure 5-1: Example of Extrapolation Comparison.....	64
Figure 5-2: Extrapolation Analysis for 6-inch 0.35-0.40 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	65
Figure 5-3: Extrapolation Analysis for 6-inch 0.35-0.40 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	65
Figure 5-4: Extrapolation Analysis for 10-inch 0.35-0.40 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	66
Figure 5-5: Extrapolation Analysis for 10-inch 0.35-0.40 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	66
Figure 5-6: Extrapolation Analysis for 6-inch 0.45-0.50 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	67
Figure 5-7: Extrapolation Analysis for 6-inch 0.45-0.50 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	67
Figure 5-8: Extrapolation Analysis for 10-inch 0.45-0.50 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	68
Figure 5-9: Extrapolation Analysis for 10-inch 0.45-0.50 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	68
Figure 5-10: Extrapolation Analysis for 6-inch 0.55-0.60 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	69
Figure 5-11: Extrapolation Analysis for 6-inch 0.55-0.60 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	69
Figure 5-12: Extrapolation Analysis for 10-inch 0.55-0.60 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	70
Figure 5-13: Extrapolation Analysis for 10-inch 0.55-0.60 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	70
Figure 5-14: Extrapolation Analysis for 6-inch 0.65-0.70 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	71
Figure 5-15: Extrapolation Analysis for 6-inch 0.65-0.70 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	71
Figure 5-16: Extrapolation Analysis for 10-inch 0.65-0.70 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	72

Figure 5-17: Extrapolation Analysis for 10-inch 0.65-0.70 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	72
Figure 5-18: Extrapolation Analysis for 10-inch 0.35-0.40 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	73
Figure 5-19: Extrapolation Analysis for 10-inch 0.35-0.40 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	74
Figure 5-20: Extrapolation Analysis for 10-inch 0.45-0.50 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	74
Figure 5-21: Extrapolation Analysis for 10-inch 0.45-0.50 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	75
Figure 5-22: Extrapolation Analysis for 10-inch 0.55-0.60 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	75
Figure 5-23: Extrapolation Analysis for 10-inch 0.55-0.60 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	76
Figure 5-24: Extrapolation Analysis for 10-inch 0.65-0.70 Beta Ratio PTC 19.5 Appendix 1 (Keyser) Equation.....	76
Figure 5-25: Extrapolation Analysis for 10-inch 0.65-0.70 Beta Ratio ASME MFC-3M 2004 (ISO-RHG) Equation.....	77

FOREWORD

This report analyzes four flange tap equations and three corner tap equations for the discharge coefficient for orifice plates. All of the equations analyzed are functions of Beta Ratios, Reynolds Number, and Line Size, and all data points were evaluated against each of the seven orifice flow coefficient equations described in more detail herein. The goals of the study were to review the data available to determine where any weak regions of the database may be, to provide a methodology for comparing the equations over a range of Reynolds Numbers, Line Sizes, and Beta Ratios, and to determine the performance of each equation in relationship to the appropriate available database of calibration data.

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EXECUTIVE SUMMARY

CEESI Measurement Solutions, Inc. (CMSI) was contracted by ASME ST-LLC to perform analysis of the performance of the equations for the discharge coefficient for orifice plates. Each equation was compared to the appropriate available database of calibration data. The goals of the study were to:

- (a) Review the data available to determine where any weak regions of the database may be;
- (b) Provide a methodology for comparing the equations over a range of Reynolds Numbers, Line Sizes, and Beta Ratios; and
- (c) Determine the performance of each equation in relationship to the database data.

Flange Tap Equations

CMSI performed a rigorous evaluation of the dataset in comparison to the equations, and found the following main conclusions in regard to the Flange Tap Equations:

- (a) Following the analysis methodology described in Section 3 herein, the average deviation of the database data from each equation was:
 - (1) ASME MFC-3M 2004 (ISO-RHG): +0.06 percent
 - (2) ISO 5167 1991 (Stoltz): -0.13 percent
 - (3) AGA Report Number 3 1990 (AGA-RHG): 0.00 percent
 - (4) PTC 19.5 Appendix 1 (Keyser): -0.12 percent
- (b) The number of regions with Average Deviations further than two standard deviations from Equation Values were determined to be:
 - (1) ASME MFC-3M 2004 (ISO-RHG): one of forty-one regions outside
 - (2) ISO 5167 1991 (Stoltz): two of thirty-nine regions outside
 - (3) AGA Report Number 3 1990 (AGA-RHG): zero of forty-one regions outside
 - (4) PTC 19.5 Appendix 1 (Keyser): three of thirty-six regions outside
- (c) Over most of the range of the equation, the ASME MFC-3M 2004 (ISO-RHG), ISO 5167 1991 (Stoltz), and AGA Report Number 3 1990 (AGA-RHG) equations are within the uncertainties of the equations. The exception to this is in the 2-inch Line Size.
- (d) In the 2-inch Line Size, where there is the largest difference between equations, the ASME MFC-3M 2004 (ISO-RHG) equation fits the database better than the other equations.
- (e) It is not clear which of the data from this database were used in the regression, but it is clear that three of the equations show very good agreement with the database.
- (f) The PTC 19.5 Appendix 1 (Keyser) Equation deviates from the other equations and the calibration data at low Reynolds Numbers; therefore, the PTC 19.5 Appendix 1 (Keyser) Equation should not be used for extrapolation with calibration data at low Reynolds Numbers. Due to the slope of the PTC 19.5 Appendix 1 (Keyser) Equation, it is not the best equation to use for extrapolation. The point at which the PTC 19.5 Appendix 1 (Keyser) Equation could be used is as a function of Line Size and Beta Ratio, and this should be taken into consideration before performing any extrapolation with the PTC 19.5 Appendix 1 (Keyser) Equation.

Therefore, when utilizing a flange tap orifice plate, CMSI recommends utilizing the ASME MFC-3M 2004 (ISO-RHG) Equation, as it fits the entire database well, and specifically covers the 2-inch Line Size very well. The AGA Report Number 3 1990 (AGA-RHG) equation is statistically equal to the ASME MFC-3M 2004 (ISO-RHG) over almost all of the regions of applicability of the two equations.