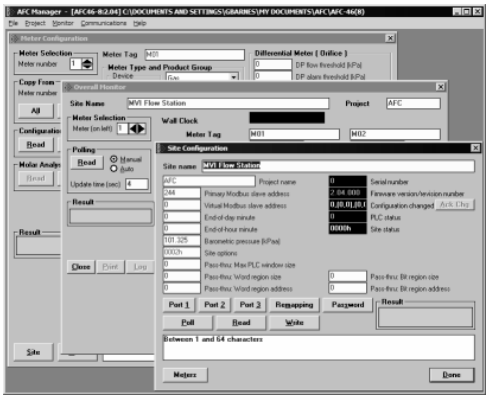
inRAx



MVI71-AFC

PLC Platform

Gas and Liquid Flow Computer

Calculation Test Report (EUB Test Cases)

December 13, 2005

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Contents

1 Introduction

In This Chapter

This document provides the MVI71-AFC test procedures and results in order to verify the MVI71-AFC AGA calculation results. The Alberta Energy and Utilities Board (EUB) uses the test cases presented in this document. The test cases are listed in the EUB Production Audit Handbook Guide 46, section 3.2 (January 2003).

1.1 Test Assumptions

The Alberta Energy and Utilities Board (EUB) used the AGA3 (1990) test procedure for Orifice Calculation (using metric units) and the compressibility factors calculated using AGA8 (1992). Although the MVI71-AFC uses the AGA3 report (1992) the results are not affected, since the values are calculated in the same way in both reports.

The orifice plate was assumed to be made of 316 SS

The ideal gas relative density was converted to the real gas relative density.

The calculated values were rounded to four decimal places, since the theoretical values are given using the same format (EUB Guide 46).

The MVI71-AFC variables that are not mentioned in this document were not changed during the tests. These variables had the default value when a new AFC project is created with the AFC Manager.

1.2 Test Procedure

The tests consisted on reading the output values generated by the MVI71-AFC module through the AFC manager software and comparing the calculated results with the EUB expected results. Each meter was configured using the AFC Manager software and the input variables (Temperature, Pressure and Differential Pressure) were entered through the ladder logic. Each meter was used to test a different test case:

Meter Number	Test Case
1	1
2	2
3	3
4	4
5	5
6	6

Follows below the configuration used during the tests:

Firmware version	2.02.000
AFC Manager Software version	2.02.000
PLC processor	PLC5/11

2 Test Cases

In This Chapter

In order to verify the MVI71-AFC calculation program the EUB uses 6 test cases that are described in this section. This section shows all input parameters and calculated results for each test case.

2.1 Test Case Number 1

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0184
CO_2	0,0000
H_2S	0,0260
C_1	0,7068
C_2	0,1414
C_3	0,0674
iC_4	0,0081
nC_4	0,0190
iC_5	0,0038
nC_5	0,0043
C_6	0,0026
C_7	0,0022

Ideal Gas relative density = 0,7792

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 52,3700mm

Orifice I.D. = 9,5250mm

Flow Data (24Hrs)

Static Pressure = 2716.765 kPag

Differential Pressure = 10.2000 kPa

Flowing Temperature = 57.0000 oC

Test Result

The results calculated by the module are listed below:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.5990	0.5990	0.0000	0.1000	PASS
Y_1	0.9989	0.9989	0.0000	0.0100	PASS*
Ev	1.0006	1.0005	0.0100	0.0100	PASS
Zb	0.9959	0.9959	0.0000	0.1000	PASS
Zf	0.9277	0.9277	0.0000	0.2000	PASS
Q	2.7532	2.7532	0.0000	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

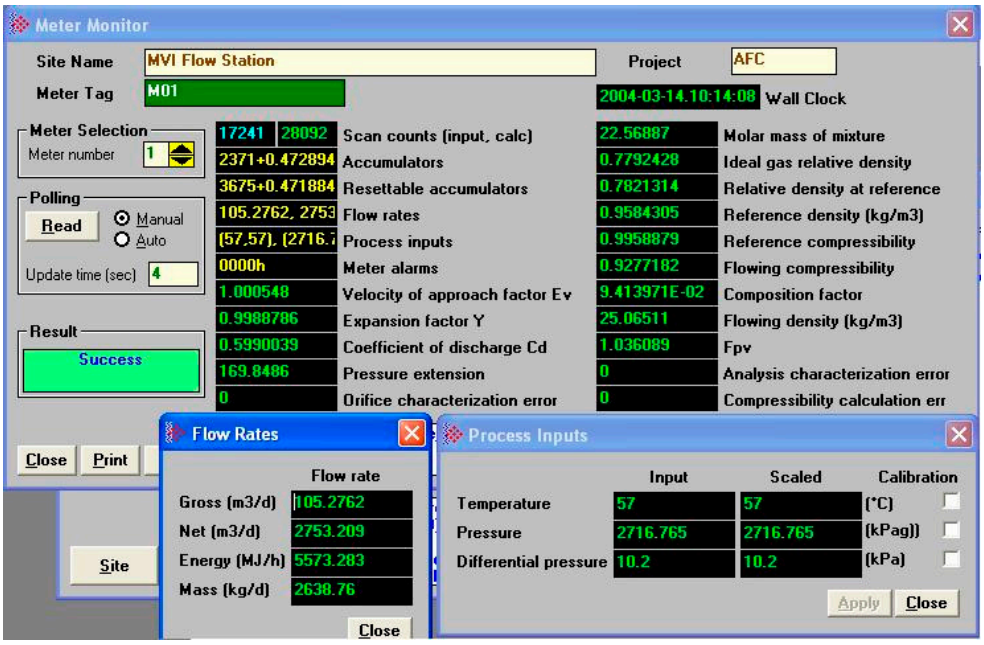
Zb = Reference Compressibility

Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1 result is usually a value less than 1.0000, the result is considered valid if the difference between the calculated and the theoretical values is less or equal than 0.0001.

Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:



2.2 Test Case Number 2

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0156
CO_2	0,0216
H_2S	0,1166
C_1	0,7334
C_2	0,0697
C_3	0,0228
iC_4	0,0044
nC_4	0,0075
iC_5	0,0028
nC_5	0,0024
C_6	0,0017
C_7	0,0015

Ideal Gas relative density = 0,7456

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 102,26mm

Orifice I.D. = 47,625mm

Flow Data (24Hrs)

Static Pressure = 8999,615 kPag

Differential Pressure = 11,0000 kPa

Flowing Temperature = 50.0000 oC

Test Result

The result calculated by the module:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.6019	0.6019	0.0000	0.1000	PASS
Y_1	0.9996	0.9996	0.0000	0.0100	PASS*
Ev	1.0244	1.0244	0.0000	0.0100	PASS
Zb	0.9967	0.9967	0.0000	0.1000	PASS
Zf	0.8097	0.8097	0.0000	0.2000	PASS
Q	146.1876	146.1800	0.0052	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

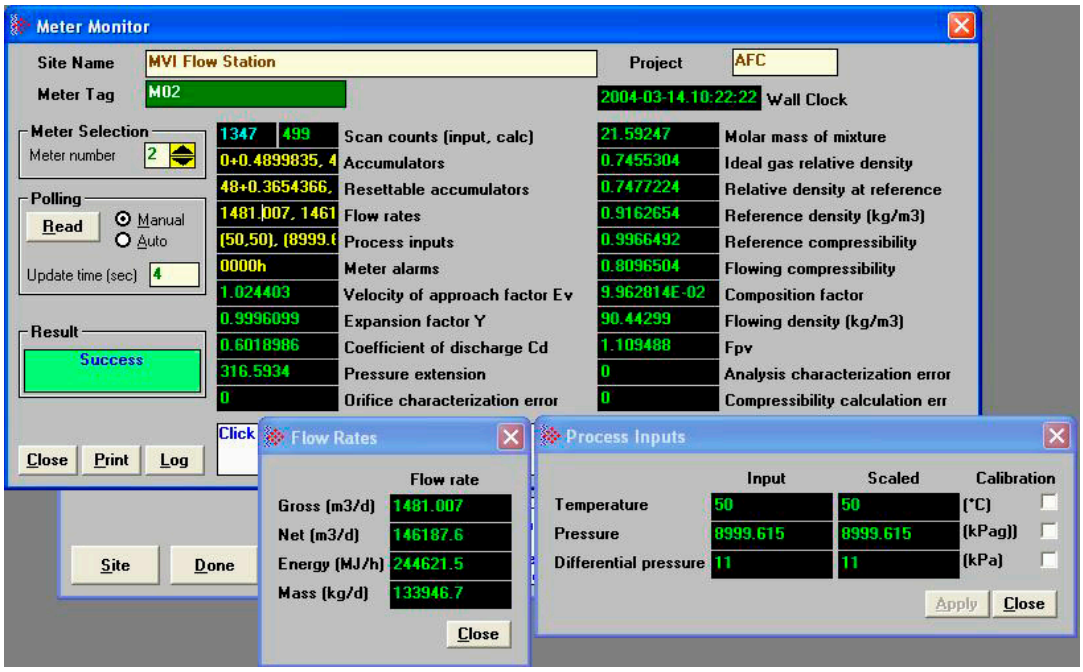
Zb = Reference Compressibility

Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1 result is usually a value less than 1.0000, the result is considered valid if the difference between the calculated and the theoretical values is less or equal than 0.0001.

Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:



2.3 Test Case Number 3

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0500
CO_2	0,1000
H_2S	0,2000
C_1	0,6000
C_2	0,0500
C_3	0,0000
iC_4	0,0000
nC_4	0,0000
iC_5	0,0000
nC_5	0,0000
C_6	0,0000

Element	Concentration
C_7	0,0000

Ideal Gas relative density = 0,8199

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 590,55mm

Orifice I.D. = 304,80mm

Flow Data (24Hrs)

Static Pressure = 10240,815 kPag

Differential Pressure = 22,1600 kPa

Flowing Temperature = 60.0000 oC

Test Result

The result calculated by the module:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.6029	0.6029	0.0000	0.1000	PASS
Y_1	0.9993	0.9993	0.0000	0.0100	PASS*
Ev	1.0375	1.0375	0.0000	0.0100	PASS
Zb	0.9968	0.9968	0.0000	0.1000	PASS
Zf	0.8213	0.8213	0.0000	0.2000	PASS
Q	8575.6480	8575.6000	0.0006	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

Zb = Reference Compressibility

Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1 result is usually a value less than 1.0000, the result is considered valid if the

difference between the calculated and the theoretical values is less or equal than 0.0001.

Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:

2.4 Test Case Number 4

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0029
CO_2	0,0258
H_2S	0,0000
C_1	0,9709
C_2	0,0003
C_3	0,0001
iC_4	0,0000
nC_4	0,0000
iC_5	0,0000
nC_5	0,0000

Element	Concentration
C_6	0,0000
C_7	0,0000

Ideal Gas relative density = 0,5803

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 146,36mm

Orifice I.D. = 88,9000mm

Flow Data (24Hrs)

Static Pressure = 9738,665 kPag

Differential Pressure = 6,6130 kPa

Flowing Temperature = 22,3500 oC

Test Result

The result calculated by the module:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.6047	0.6047	0.0000	0.1000	PASS
Y_1	0.9998	0.9998	0.0000	0.0100	PASS*
Ev	1.0759	1.0759	0.0000	0.0100	PASS
Zb	0.9980	0.9980	0.0000	0.1000	PASS
Zf	0.8425	0.8425	0.0000	0.2000	PASS
Q	503.6474	503.6500	0.0005	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

Zb = Reference Compressibility

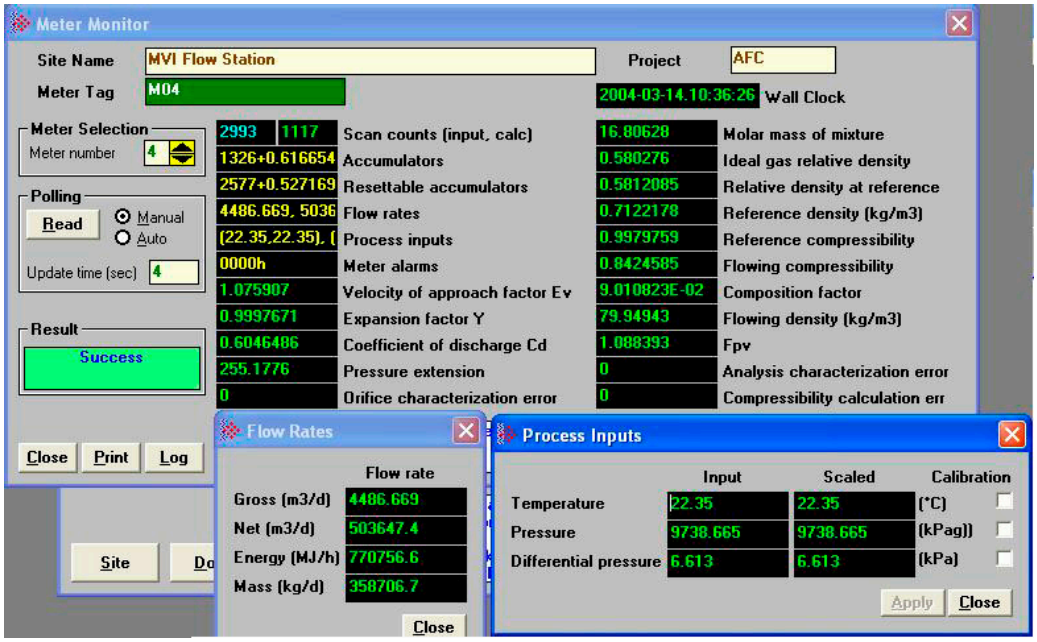
Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1

result is usually a value less than 1.0000, the result is considered valid if the difference between the calculated and the theoretical values is less or equal than 0.0001.

Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:



2.5 Test Case Number 5

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0235
CO_2	0,0082
H_2S	0,0021
C_1	0,7358
C_2	0,1296
C_3	0,0664
iC_4	0,0088
nC_4	0,0169
iC_5	0,0035

Element	Concentration
nC_5	0,0031
C_6	0,0014
C_7	0,0007

Ideal Gas relative density = 0,7555

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 154,05mm

Orifice I.D. = 95,250mm

Flow Data (24Hrs)

Static Pressure = 2398,575 kPag

Differential Pressure = 75,000 kPa

Flowing Temperature = 34,0 oC

Test Result

The result calculated by the module:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.6041	0.6042	0.0166	0.1000	PASS
Y_1	0.9898	0.9897	0.0101	0.0100	PASS*
Ev	1.0822	1.0822	0.0000	0.0100	PASS
Zb	0.9962	0.9962	0.0000	0.1000	PASS
Zf	0.9217	0.9217	0.0000	0.2000	PASS
Q	813.1285	813.0000	0.0158	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

Zb = Reference Compressibility

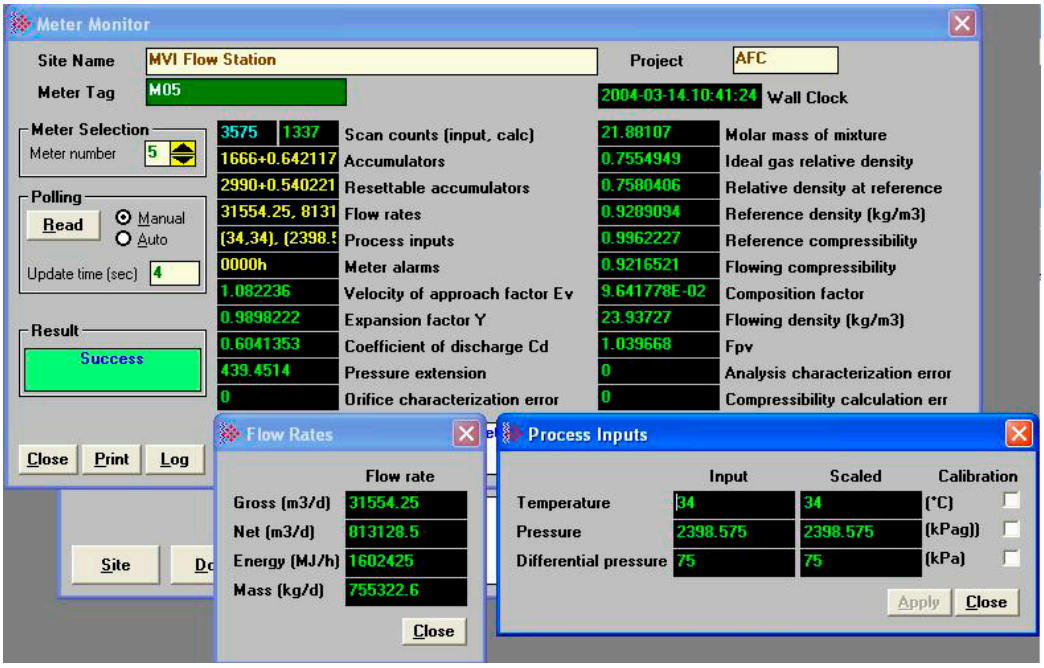
Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1

result is usually a value less than 1.0000, the result is considered valid if the difference between the calculated and the theoretical values is less or equal than 0.0001.

Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:



2.6 Test Case Number 6

Input Parameters

The following input parameters were used:

Gas Analysis

Element	Concentration
N_2	0,0268
CO_2	0,0030
H_2S	0,0000
C_1	0,6668
C_2	0,1434
C_3	0,1023
iC_4	0,0123
nC_4	0,0274

Element	Concentration
iC_5	0,0000
nC_5	0,0000
C_6	0,0180
C_7	0,0000

Ideal Gas relative density = 0,8377

Meter Data (Downstream Flange Taps)

Meter Run I.D. = 52,500mm

Orifice I.D. = 19,050mm

Flow Data (24Hrs)

Static Pressure = 2405,005 kPag

Differential Pressure = 17,0500 kPa

Flowing Temperature = 7,200 oC

Test Result

The result calculated by the module:

	Calculated Result	Theoretical Result	Actual Difference (percentage)	Actual Difference (percentage)	Result
Cd	0.6005	0.6005	0.0000	0.1000	PASS
Y_1	0.9979	0.9978	0.0100	0.0100	PASS*
Ev	1.0088	1.0088	0.0000	0.0100	PASS
Zb	0.9951	0.9951	0.0000	0.1000	PASS
Zf	0.8578	0.8578	0.0000	0.2000	PASS
Q	14.7468	14.7460	0.0054	0.2500	PASS

Where:

Cd = Orifice coefficient

Y1 = Expansion Factor

Ev = Velocity of Approach

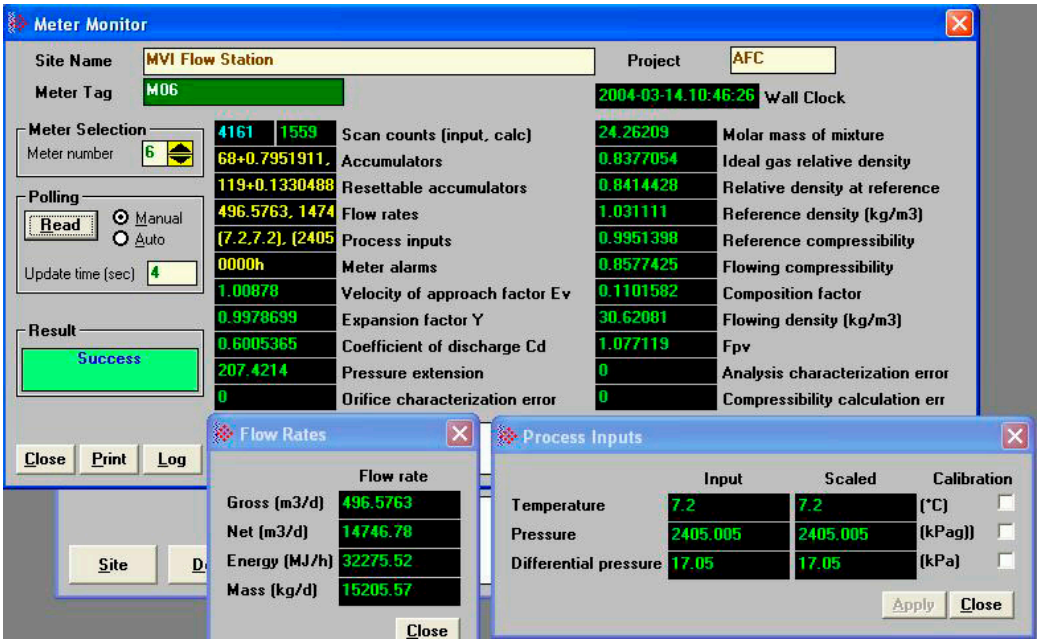
Zb = Reference Compressibility

Zf = Flowing Compressibility

Q = Flow Rate (103m3/24hours)

* Since the result is rounded to four decimal places, a maximum tolerance of 0.01% is interpreted as the maximum absolute deviation of 0.0001. Since the Y1 result is usually a value less than 1.0000, the result is considered valid if the difference between the calculated and the theoretical values is less or equal than 0.0001.

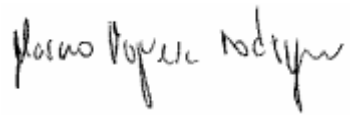
Follows below a screen shot of the AFC Manager Meter Monitor window which shows the data results for this test:



3 Conclusion

The tests demonstrated that the MVI71-AFC correctly calculates the AGA results listed in this document considering the accuracy according to Guide 46 document from the Alberta Energy and Utilities Board (EUB).

These tests were conducted by Eng Marcio N Rodrigues and were concluded on March 15th, 2004.



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