Calibration and use of Sho-Rate Flowmeter Brooks Instrument Division S/N 8507136038/10

Fournier, M.; Bird, J. W.; Mulligan, M. F.

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6 April 1998

Canada

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Fournier, N.		LM-ST-822
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SUBJECT: Calibration and Use of Sho-Rate Flowmeter
Brooks Instrument Division S/N 8507136038/10

PREPARED BY: Fournier, M., Bird, J., Mulligan, M.

ISSUED TO: Hydro Québec

PROJECT NO.: L2704

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ABSTRACT

A SHO-RATE flowmeter, made by Brooks instrument division, Model 355XB1C1AA Serial Number 8507136038/10, has been calibrated for Hydro-Quebec. Besides the flowmeter calibration results for two fluids, with some comments, the report contains a brief description of the calibration facility, and a delineation of expected uncertainties, based on NRC and external calibrations.

RÉSUMÉ

Le débitmetre sho-rate, modèle 355XB1C1AA, portant le numéro de série 8507136038/10, fabriqué par la société Brooks instrument division, a été étalonné pour le compte de la société Hydro-Quebec. Le présent rapport renferme, outre les résultats de l'étalonnage pour deux liquides et certaines observations, une description de l'installation utilisée pour l'étalonnage et les marges d'erreur prévues se fondant sur des étalonnages effectués au CNRC et par un organisme indépendant.

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CALIBRATION OF THE SHO-RATE FLOWMETER BROOKS INSTRUMENT DIVISION, S/N 8507136038/10

1.0 INTRODUCTION

The Propulsion Laboratory, Institute for Aerospace Research, is the custodian of an Omnitrak ballistic calibrator, designed specifically for the calibration of turbine-type flowmeters. After a period of several years, in which the calibrator had been exclusively used for NRC meter calibrations, the service is now extended to include outside clients. A high degree of accuracy is ensured by periodic internal calibrations, traceable to Canadian standards, and by participation in calibration programs, such as the one carried out by the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), Gaithersburg, MD.

This report contains a description of the calibration facility, the expected uncertainty, with traceability, and the test procedure. The test results for this manually-read client's flowmeter are presented in tabular form, with flows determined by a reference turbine flowmeter.

2.0 DESCRIPTION OF CALIBRATOR

The flowmeter has been calibrated on an Omnitrak calibrator system, Model OT-150, S/N 83110022, manufactured by Flow Technology Inc., Phoenix, AZ. It is a precision volumetric calibration device, a detailed description of which can be found in the supplier's manual (FTI 1982). To facilitate electronic data storage, custom print-outs, plotting, and some further data reduction, the output was interfaced to a Digital Equipment Corporation MicroVAX computer.

A summary of pertinent specifications is:

· Flow Range(nominal):	0.15 to 150 USGPM or 0.0095 to 9.5 l/s (approximately 60 to 60,000 lbm/h of aviation fuel).
· Flowmeter Size Range:	1/2" to 1½" (13 to 38 mm).
· Flowmeter Assembly	Maximum length: 48" (1219 mm) Fittings: 1½", 37° flared tube fittings.

Although various fluids may be used, it was decided to perform all calibrations with the widely accepted calibrating fluid for aircraft fuel system components, MIL-C-7024C, Type II. Its specified viscosity is 1.17 ±0.05 cSt (1.17 ±0.05 $*10^{-6}$ m^2/s) at 25°C.

3.0 CALIBRATION UNCERTAINTY

When considering the uncertainty of a calibration, the whole system must be taken into account including the meter itself. As the basis for this calibration, it must be assumed that the test specimen is functioning to specifications.

The Omnitrak calibrator was factory-calibrated when bought. The volumetric resolution, or K-Factor, for this model, was specified as approximately 62,200 pulses per US gallon (PPG). Prior to delivery, the actual calibration constant for this particular calibrator was established by the manufacturer as 62,202 PPG. A careful recalibration by the Propulsion Laboratory yielded an Omnitrak K-Factor of 62,213 PPG (Grabe and Carvish 1988). In two calibration tests, each consisting of eight water draws, the averaged K-Factors, reduced to standard conditions, came to within 0.5 PPG, or $\pm 0.0008\%$, of each other. A check revealed that the K-Factor increased systematically along the draw tube of the calibrator by 0.08%, well within the manufacturer's specified limit of 0.1%.

Over the course of some 150 calibrations, on 20 in-house turbine flowmeters, the manufacturer's claimed repeatability of $\pm 0.05\%$ was confirmed, i.e., with few exceptions, calibration points fell within $\pm 0.05\%$ of a best-fit curve.

Finally, the Propulsion Laboratory participated in a round-robin calibration program conducted by the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards, Gaithersburg, MD. This program was primarily in response to requests by the Department of Defence (US), industrial users, and manufacturers. The data were evaluated by NIST by means of Youden plots (Mattingly 1988). At the high flow point, which yielded more consistent results all around, NRC had a bias, or systematic, error of 0.18% with respect to the median of all calibrators. When compared only with calibrators of the same principle as the Omnitrak, i.e. pulse counts related to volume displacement, the bias error was 0.05%. The precision error was less than 0.05% in either case. This good agreement with the median of 12 other major North American calibrators, including two from NIST, was considered to be a confirmation of the accuracy of NRC's calibration equipment and procedures. It is the intention of NRC to maintain the established link with NIST and continually test the accuracy of its flowmeter calibrator by participation in future calibration programs.

On the basis of the above described uncertainty analyses, the bias error of the calibration, relative to the true value, is expected to be within $\pm 0.18\%$, with a precision error of $\pm 0.05\%$, yielding an overall uncertainty of $\pm 0.28\%$.[1]

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[1] The uncertainty establishment and terminology follows Abernethy, R.B., et al., 1973.

4.0 FLOWMETER CALIBRATION

Two separate calibration runs were completed to try to quantify repeatability for the manually read client meter. Information pertinent to the calibration is:

Job No.: 98-08, 98-09

Calibration Date: 26/02/98, 03/03/98

Customer: Hydro-Quebec

Flowmeter and Test Data

Make/Model: Brooks Instrument Division Sho-Rate 355XB1C1AA , Rotameter-type
Size: 1/4"
Serial No.: 8507136038/10
Pickoff Type: None
Pickoff Part No: n/a
Bearing Type: None
Calibration Fluid: MIL-C-7024C, Type II
Relative Density (15.56/15.56°C): 0.7780
Fluid Temperature (avg) °C: 22.8 and 19.9 (two calibrations)
Room Temperature (avg) °C: 24.0,23.0 (two calibrations)
Operating Pressure psig: 80.0 kPa: 552
Reference Meter: Turbine meter, R/F pick-off
Flow Technology size 1/2 inch
S/N 84012790, Pick-off type 31199-101

The client meter was visually inspected for any possible damage and installed in the calibrator with NRC supplied tubing. Since the client meter is read only visually, it was installed in series with a reference turbine flowmeter with an electronic read-out coupled to the calibrator system.

Flow conditions were set using the nominal flow rate of the client meter (full scale of 150 mm = 1.35 l/min). The flow rate was then fine tuned with the needle valve of the client meter to set flows corresponding to the requested client meter points: 20, 40, 60, 80, 100, 120 and 150 mm. The client meter was read by using the centre of the indicator ball.

To provide a good definition of the calibration curve, a total of 8 points were taken. One point at 135 mm was added to better define the curve. The calibration proceeded from the lowest flow to the highest. Two separate calibration runs were completed, Runs 98-08 and 98-09.

The temperatures of the room and the fluid were recorded for each point. An averaged room temperature was used for each run. Both temperatures appear in the correction of the K-Factor to standard conditions. In addition, the actual fluid temperature was used for the calculation of the calibration fluid viscosity at each calibration point. The results of each calibration point were displayed to provide a visual assessment of the data during the calibration. Finally, the data were tabulated to provide:

- Reference flow results from NRC turbine meter for the two calibration runs;
- Client format: all test points, flow rate averaged for the two runs

These results are included in Appendices 1 and 2, respectively.

4.1 Reference Flow Meter Results

For the two calibration runs, the results of the turbine meter flow outputs are provided in Appendix 1. These data are the volumetric flow (of calibrating fluid) corresponding to the individual set points desired by the client.

The reference volumetric flow calibration factor (K-Factor), K_{cor}, has been corrected from the pressures and temperatures, present at calibration, to standard day conditions. As a visual aid in assessing the repeatability and linearity of the reference flow, the K-Factor has been plotted against frequency divided by the average viscosity of the calibration fluid (Appendix 1). This plot is commonly referred to as the universal viscosity curve. The results show good repeatability for the two runs. The contribution of this observed variation to the calibration uncertainty is discussed in section 4.3.

A complete description of the application of the K-Factor, and other factors in fuel flow measurement by a turbine flowmeter, has been given by Grabe (1988). That report also includes an uncertainty analysis for a complete fuel flow measuring system. Depending on a series of conditions, it has been demonstrated that an overall system uncertainty of $\pm 1.0\%$ of corrected flow is achievable, taking into consideration uncertainties in specific gravity and lower heating value, among other factors.

4.2 Client Meter Flow Results

Recall that the calibration of the client meter was to be provided by flowing calibration fluid through the reference turbine meter and then through the client meter. The automated turbine meter readout was then correlated to the visual reading of the client meter.

The reference volumetric flow of calibrating fluid (nominal viscosity of 1.17 cSt and relative density of 0.7779) for the NRC reference turbine meter (Appendix 1) has been tabulated, for the desired set-points, in Appendix 2, Table 2.1, column 2. Table 2.1, column 3 shows the percentage difference between the calibrator flow and the nominal meter flow (150 mm = 1.35 l/min with water). A comparison of this difference with the

the manufacturer's specifications, i.e. 5% of full scale (column 4),shows the meter meets this specification for the desired settings of 20 to 120 mm. However, the differences are probably attributable to the viscosity differences between the two fluids. NRC does not change fluids for this type of calibration.

Use of this calibration with other fluids would require empirical corrections to compensate for buoyancy effects from different fluid relative density but especially for the Reynolds number effects from different viscosity - relative density ratio. This type of meter is known to be sensitive to viscosity(Miller, 1989). Estimates of these corrections were available from the manufacturer (Appendix 2, Table 2.2).

An adjusted calibration table (Table 1) has been prepared to estimate the equivalent water flow for this calibration by :

a) *Converting the calibrating fluid flow to an equivalent water flow*: what is needed is the ratio of water flow to calibrating fluid flow for the client meter at each setting. The numerator is the client meter's nominal (water) flow rate (a linear relationship is assumed with 1.35 l/min = 150 mm) and the denominator is the corresponding calibrating fluid flow from Appendix 2, Table 2.2. This conversion ratio is shown in column 3, Table 1.

b) *Estimating the equivalent water flow (column 4)*: The water flow rate equivalent to the calibrating fluid flow is the product of the calibrating fluid flow (column 2) and the conversion ratio in column 3.

Table 1: Adjusted Calibration Data

Nominal Scale[1] [mm]	Calibrating Fluid Flow[2] [USG/min]	Ratio of Water to Cal. Fluid Flow [3]	Estimated Equivalent Water Flow [4] [USG/min]	Difference Cal. Flow to Nom. Meter Flow (Cal. Fluid) [5] [%]
20	0.0338	1.4286	0.0482	1.4
40	0.0828	1.1538	0.0955	0.5
60	0.1337	1.0547	0.1410	-1.2
80	0.1875	1.0112	0.1896	-0.3
100	0.2433	0.9626	0.2342	-1.5
120	0.3005	0.9247	0.2779	-2.7
135	0.3458	0.8980	0.3105	-3.3
150	0.3920	0.8615	0.3377	-5.3

Notes by Column:

1. Nominal scale on client meter: 0 to 150 mm.
2. Calibration results with calibrating fluid- average of two runs from Appendix 1.

3. Nominal flow rate data for water (1.35 l/min = 150 mm) divided by manufacturer supplied data (Appendix 2, Table 2.2) for flow of calibration fluid (viscosity of 1.17 cSt and relative density of 0.78) through a Brooks meter. (1 Litre= 0.26417 USG).
4. Column 2 x Column 3.
5. The calibration fluid flows of column 2 divided by the nominal calibration fluid flow for the client meter (Appendix 2, Table 2.2), converted to a percentage difference.

As a check on this estimation process, the NRC calibration results have been compared to the manufacturer's data for calibration fluid flow in the client meter. The results in column 5 of Table 1 show that the calibrator and meter nominal flows are well within 3% of reading over the range of 20 to 120 mm. At higher ranges, the error is within 6%.

Consequently, the results of this calibration may be summarized in Table 2.

Table 2: Final Calibration Results

Nominal scale [mm]	Calibrating Fluid Flow [USG/min]	Estimated Equivalent Water Flow Rate [USG/min]
20	0.0338	0.0482
40	0.0828	0.0955
60	0.1337	0.1410
80	0.1875	0.1896
100	0.2433	0.2342
120	0.3005	0.2779
135	0.3458	0.3105
150	0.3920	0.3377

4.3 Client Meter Calibration Uncertainty

The overall uncertainty in this calibration of the client meter for volumetric flow measurements is made up of three contributions according to the calibration hierarchy.

a) Calibrator uncertainty: As in section 3.0, the bias is 0.18 % and the precision is 0.05.

b) Uncertainty in the output of the reference flowmeter: Based on the average of two runs, this contribution is a bias of 0.9% below 40 mm readings and at most 0.2% at 40 mm and above. These estimates are based on the differences between the two runs on the two calibration outputs for the NRC reference meter SN 84001270, provided in Appendix 1.

c) Uncertainty in visually reading the Brooks meter during the calibration process: It is assumed that the client meter can be read to the nearest gradation on the scale.

This resolution contribution to uncertainty is considered as a precision of 0.3 mm (Abernethy et al, 1980).

To obtain an overall estimate for the calibration uncertainty, the bias (b) and precision (s) contributions are combined separately in a root-sum-square method. The total calibration uncertainty is then estimated with the additive error model, b+2s. The estimated calibration uncertainty for calibrating fluid at each requested flow level is given in Table 3.

Not included are any uncertainty contributions for the corrections for the viscosity and relative density differences between water and the calibrating fluid. The manufacturer stated that these contributions being based on empirical data would still allow the meter to meet the stated specifications, i.e. those shown in column 4 of Table 2.1 in Appendix 2, and reproduced in Table 3. This last row of Table 3 contains the uncertainties to be used with the water flow rates in the last column of table 2.

Table 3: Estimated Calibration Uncertainty for Calibration and Water Flows

Calibration Uncertainty Analysis	Flow level on Brooks meter [mm]							
	20	40	60	80	100	120	135	150
Uncertainty with calibrating fluid [%]	3.9	1.9	1.3	1.1	1	1	0.7	0.7
Uncertainty with water [%]	37.5	18.8	12.5	9.4	7.5	6.3	5.6	5

To estimate the uncertainty of measurements made by a user, this calibration uncertainty would be combined with a resolution contribution (similar to that in section 4.3 point c)).

5.0 COMMENTS

The following comments can be made about the calibration of the Brooks instrument division Sho-Rate rotameter, S/N 8507136038/10, owned by Hydro-Quebec:

a. Most of the client-supplied fittings were found to be leaking. Two stainless steel swage-lock 1/4" fittings were installed.
b. An NRC reference meter which provided volumetric flow measurement gave repeatable results for the two calibration runs.

c. Visual reading of the Brooks meter was done using the centre of the indicating ball.
d. Comparison of the calibration fluid flows with the flowmeter's nominal flow with water showed some significant biases although the differences were within the specification of 5% of full scale.
e. Corrections based on manufacturer's data were applied to the calibration fluid flow to estimate corresponding water flow. With these corrections, improvements were observed in agreement between the nominal flow expected for the client meter and the calibrator flows measured by the NRC reference turbine meter.
f. Uncertainty estimates have been prepared for the calibration process only. With the empirical corrections for the calibration fluid, the uncertainty is expected to be within the manufacturer's specification. The actual uncertainty for client measurements will be greater.
g. For measurement of flow of fluids other than water, the manufacturer must be consulted to obtain empirical correction factors.

6.0 REFERENCES

Abernethy, R.B., et al., Thompson, J.W., Jr. 1973. Revised 1980. Handbook, Uncertainty in Gas Turbine Measurements. Engine Test Facility, Arnold Engineering Development Center, Air Force Systems Command, Arnold AFS, TN.

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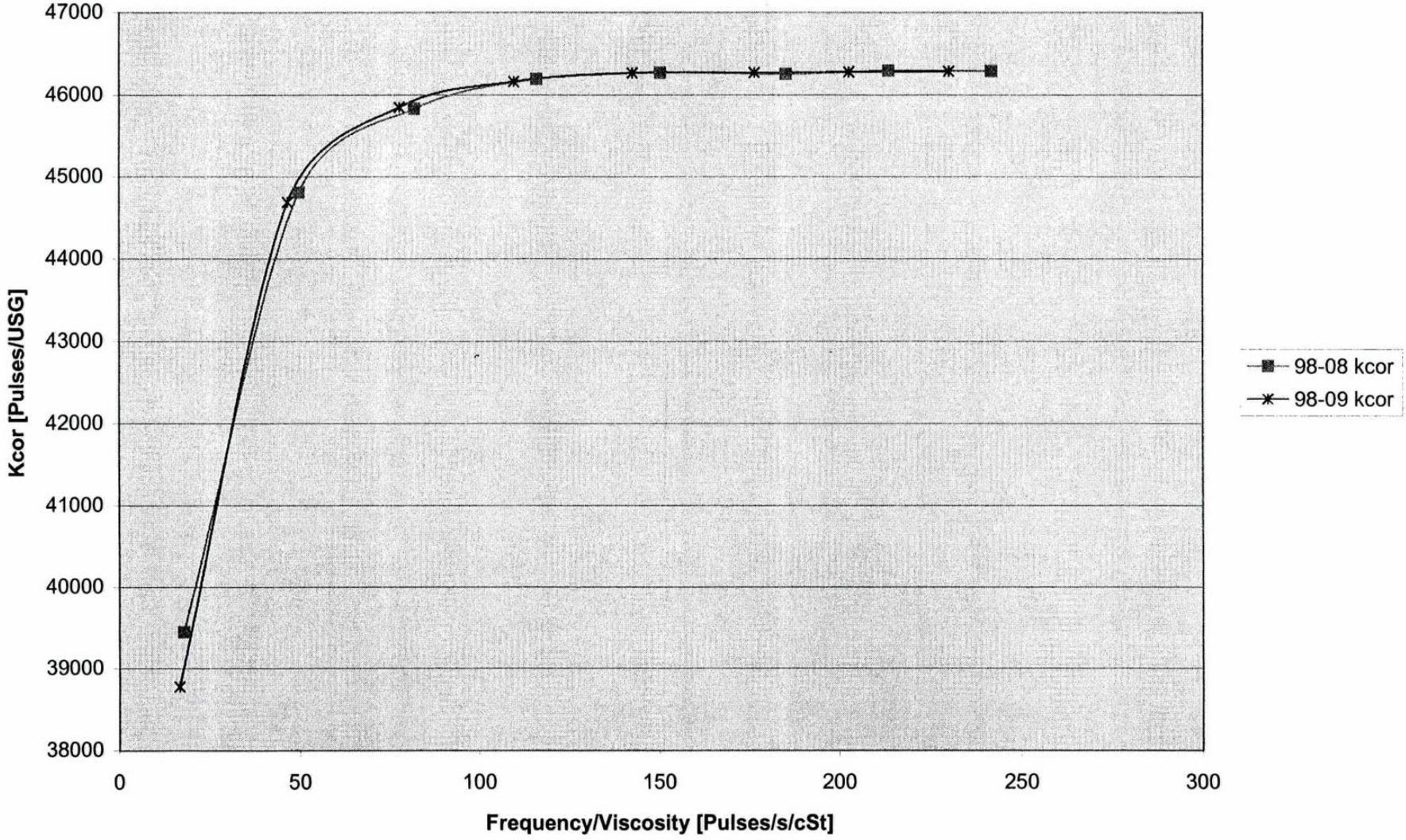
Installation, Operation and Maintenance Manual Omnitrak. October 1982. Flow Technology, Inc., 4250 East Broadway Road, Phoenix, AZ 85040.

Mattingly, G.E. 1988. A Round Robin Measurement Testing Program Using Hydrocarbon Liquids: Results for First Phase Testing. US Department of Commerce, National Institute of Standards and Technology (formerly National Bureau of Standards), National Engineering Laboratory, Center for Chemical Engineering, Fluid Flow Group, Chemical Process Metrology Division, Gaithersburg, MD 20899, NISTIR 88-4013.

Appendix 1: Reference Turbine Meter Results: Runs 98-08, 98-09

Appendix 1: NRC Reference Meter Results: Kcor



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TURBINE FLOWMETER CALIBRATION

Customer: Hydro-Quebec
Date: 26-FEB-98 Job #: 98-08

CALIBRATOR DATA

Make: Flow Technology Omnitrak Calibrator System Model: OT-150 S/N: 83110022
Microtrak Constant: 62215 Volume Unit: U.S. Gallon
Calibration Fluid: MIL-C-7024C, Type 2
Specific Gravity(15.56/15.56 Deg.C): 0.7779
Room Temperature (Average)[Deg. C]: 24.00 Operating Pressure [Psig]: 80.00

FLOWMETER DATA

Make/Model : Flow-technology
S/N : 84012790
Pickoff P/N: 31199-101
Size : 1/2 inch
Pickoff Type: Carrier
Bearing Type: Ball

****

RUN	T VOL	T FMP	# FMP	VOL	FREQ	F RATE	Kcor	FREQ/VISC
1	176.66	176.67	3946.0	0.1	22.335	0.33964E-01	39451.	17.806
2	71.774	71.764	4481.0	0.1	62.441	0.83596E-01	44808.	49.779
3	44.667	44.658	4583.0	0.1	102.62	0.13433	45831.	81.815
4	31.800	31.804	4621.0	0.1	145.30	0.18868	46196.	115.83
5	24.531	24.531	4628.0	0.1	188.66	0.24459	46272.	150.40
6	19.900	19.902	4627.0	0.1	232.49	0.30151	46257.	185.35
7	17.269	17.271	4631.0	0.1	268.14	0.34744	46296.	213.77
8	15.258	15.258	4630.0	0.1	303.45	0.39324	46292.	241.92

T VOL=Time for Displaced Volume [S]
T FMP=Time for Flowmeter Pulses [S]
# FMP=Number of Flowmeter Pulses [ ]
VOL=Volume of Fluid Displaced [U.S. Gal.]
FREQ=Frequency of the Flowmeter [Pulses/S]
F RATE=Flowrate [U.S. Gal./Min.]
Kcor=K-Factor of the Flowmeter Corrected to Standard Conditions [Pulses/U.S. Gal.]
FREQ/VISC=Frequency Divided by the Viscosity of the Fluid at the Temperature of the Run [Pulses/S*cSt]

Calibrated by: Certified by:

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TURBINE FLOWMETER CALIBRATION

Customer: Hydro-Quebec
Date: 3-MAR-98 Job #: 98-09

CALIBRATOR DATA

Make: Flow Technology Omnitrak Calibrator System Model: OT-150 S/N: 83110022
Microtrak Constant: 62215 Volume Unit: U.S. Gallon
Calibration Fluid: MIL-C-7024C, Type 2
Specific Gravity(15.56/15.56 Deg.C): 0.7779
Room Temperature (Average)[Deg. C]: 29.10 Operating Pressure [Psig]: 80.00

FLOWMETER DATA

Make/Model : Flow-technology
S/N : 84012790
Pickoff P/N: 31199-101
Size : 1/2 inch
Pickoff Type: Carrier
Bearing Type: Ball

****

RUN	T VOL	T FMP	# FMP	VOL	FREQ	F RATE	Kcor	FREQ/VISC
1	178.88	178.90	3879.0	0.1	21.683	0.33542E-01	38781.	16.624
2	73.155	73.148	4469.0	0.1	61.095	0.82018E-01	44689.	46.705
3	45.088	45.084	4585.0	0.1	101.70	0.13307	45849.	77.745
4	32.214	32.215	4617.0	0.1	143.32	0.18625	46163.	109.56
5	24.799	24.802	4628.0	0.1	186.60	0.24195	46269.	142.65
6	20.033	20.036	4629.0	0.1	231.03	0.29951	46277.	176.62
7	17.438	17.439	4629.0	0.1	265.44	0.34408	46282.	202.92
8	15.358	15.359	4630.0	0.1	301.45	0.39068	46291.	230.45

T VOL=Time for Displaced Volume [S]
T FMP=Time for Flowmeter Pulses [S]
# FMP=Number of Flowmeter Pulses [ ]
VOL=Volume of Fluid Displaced [U.S. Gal.]
FREQ=Frequency of the Flowmeter [Pulses/S]
F RATE=Flowrate [U.S. Gal./Min.]
Kcor=K-Factor of the Flowmeter Corrected to Standard Conditions [Pulses/U.S. Gal.]
FREQ/VISC=Frequency Divided by the Viscosity of the Fluid at the Temperature of the Run [Pulses/S*cSt]

Calibrated by: Marcel Tremblay Certified by: _____

Appendix 2: Calibration Data for SHO-RATE Rotameter

Table 2.1 Calibrating Fluid Flow Results

Scale Setting [1] [mm]	Calibrating Fluid Flow[2] [USG/min]	Difference of Calibrating Fluid Flow and Nominal Water Flow [3] [%]	Specified Accuracy [4] [%]
20	0.03375	-29.0	37.5
40	0.08281	-12.9	18.8
60	0.1337	-6.3	12.5
80	0.1875	-1.4	9.4
100	0.2433	2.3	7.5
120	0.3005	5.3	6.3
135	0.3458	7.7	5.6
150	0.3920	9.9	5.0

Notes by Column:

1. Nominal scale on client meter: 0 to 150 mm.
2. Average of F RATE data from the reference turbine meter from runs 98-08 and 98-09 (Appendix 1). Values have been rounded to 4 significant figures in line with the 0.05% repeatability of the calibrator.
3. Flow from column 2 of this table divided by nominal water flow rate (scale setting from column 1 x 1.35 l/min/150 mm x 0.26417 USG/litre), expressed as a percentage (of reading) difference.
4. Manufacturer-specified accuracy of 5% of full scale (150 mm) has been converted to a percentage of reading for each scale setting.

Table 2.2 Brooks Meter Manufacturer's Data for Calibrating Fluid Flow

NRC CH1

1567 22 STD.CU.CM./MIN. 03-13-1998

14.7 PSI
70.0 DEG.F
0.0 PSIG
0.78000 SP.GR.(LIQ)
8.04000 GMS/CC
1.00000 GMS/CC
1.17000 cS

R-615-B
Spherical
316 SS
1 ATMOS. & 70°F
8.

To: Mike Mulligan
at NRC
Fax # 613 957-3281

150.0	1567	110.0	1048	70.0	611	30.0	225
149.0	1552	109.0	1036	69.0	602	29.0	215
148.0	1537	108.0	1024	68.0	592	28.0	205
147.0	1522	107.0	1012	67.0	582	27.0	195
146.0	1508	106.0	1001	66.0	573	26.0	185
145.0	1493	105.0	990	65.0	563	25.0	175
144.0	1479	104.0	979	64.0	553	24.0	165
143.0	1464	103.0	968	63.0	543	23.0	155
142.0	1450	102.0	957	62.0	533	22.0	145
141.0	1435	101.0	946	61.0	522	21.0	135
140.0	1421	100.0	935	60.0	512	20.0	126
139.0	1407	99.0	924	59.0	501	19.0	117
138.0	1393	98.0	913	58.0	490	18.0	109
137.0	1380	97.0	902	57.0	479	17.0	100
136.0	1366	96.0	891	56.0	468	16.0	92
135.0	1353	95.0	880	55.0	457	15.0	85
134.0	1340	94.0	869	54.0	446	14.0	78
133.0	1327	93.0	858	53.0	435	13.0	72
132.0	1315	92.0	847	52.0	424	12.0	65
131.0	1303	91.0	836	51.0	414	11.0	59
130.0	1290	90.0	824	50.0	403	10.0	53
129.0	1278	89.0	813	49.0	393	9.0	47
128.0	1266	88.0	802	48.0	383	8.0	41
127.0	1254	87.0	790	47.0	373	7.0	34
126.0	1241	86.0	779	46.0	363	6.0	28
125.0	1229	85.0	768	45.0	354	5.0	22
124.0	1217	84.0	756	44.0	346		
123.0	1205	83.0	745	43.0	337		
122.0	1192	82.0	734	42.0	329		
121.0	1180	81.0	723	41.0	320		
120.0	1168	80.0	712	40.0	312		
119.0	1156	79.0	701	39.0	304		
118.0	1144	78.0	690	38.0	296		
117.0	1131	77.0	680	37.0	287		
116.0	1119	76.0	669	36.0	279		
115.0	1107	75.0	659	35.0	270		
114.0	1095	74.0	649	34.0	262		
113.0	1083	73.0	640	33.0	253		
112.0	1071	72.0	630	32.0	244		
111.0	1059	71.0	621	31.0	234		