Water Flow Laboratory

COMMERCIAL - IN - CONFIDENCE

CERTIFICATE OF CALIBRATION

on

ONE ULTRASONIC FLOWMETER

of size 2" NB from

M/s. KRISTNAM TECHNOLOGY

INDIAN INSTITUTE OF TECHNOLOGY

CERTIFICATE NUMBER

FCRI/WFL/C/2019/1226

ULR-CC239519400001570F

एफ.सी.आर.आई

फ्लूइड कंट्रोल रिसर्च इंस्टिट्यूट, पालक्काड

FLUID CONTROL RESEARCH INSTITUTE, PALAKKAD

An Autonomous R&D Organisation under Ministry of Heavy Industries & Public Enterprises, Govt. of India.

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एफ.सी.आर.आई.

CERTIFICATE OF CALIBRATION

OF ONE ULTRASONIC FLOWMETER
of size 2" NB from
M/s. KRISTNAM TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY

ilac-MRA

Certificate No:
CC-2395

ULR-CC239519400001570F

Water Flow Laboratory

Date of Receipt	Date of Calibration	Date of issue
16.12.2019	31.12.2019	13.01.2020

CERTIFICATE NUMBER : FCRI/WFL/C/2019/1226

J C - 2019/2133

Approved Signatory

K. SURESH
SENIOR RESEARCH ENGINEER

SUMMARY

Test Meter	ULTRASONIC FLOWMETER
Standards Referred	ISO 4185-1980: "Measurements of Liquid flow in closed conduits using weighing method"
Laboratory	Water Flow Laboratory (WFL)
Calibration Results	The results of calibration is given in Table 1, the calibration chart is given in Fig. 2 and summary of result in Section 3.
Traceability	All the instruments /Reference flow meters used are traceable to national standards through reference standards and their calibrations are valid. NABL symbol on this certificate implies traceability of calibration data reported (Note 1, clause 5.6.2.1.1 of ISO 17025:2005).

Calibrated by	Prepared by	Checked by
K.G Jayesh Amal Suresh	Fathima K A	K Suresh, SRE

एफ.सी.आर.आई

फ्लूइड कंट्रोल रिसर्च इंस्टिट्यूट, पालक्काड

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO
CC - 2395

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CERTIFICATE NUMBER : FCRI/WFL/C/2019/1226

1. Method of Calibration

The meter to be calibrated was installed in a standard test line of water flow laboratory as shown in figure 1, Schematic of Calibration Setup. The line was flooded and entrapped air cleared using circuit air bleeds. Constant Head Tank / Direct pumping was the flow source for the calibration. Flow rate was adjusted using the downstream control valve. When flow conditions had stabilised, the flow rate was determined by collecting water for a measured time interval in the weighing system. The method used was flying-start-and-finish technique where the flow was diverted in to the weighing system and diverted back at the end of test.

The time of collection was determined by a high precision timer, which was triggered by a photo switch-timer blade arrangement attached to the diverter. The temperature of water was determined using on-line RTD's and density using an on-line Densitymeter. The actual flow rate and percentage error with respect to flowrate obtained from current output were then computed. This procedure was repeated for the other flow rates also.

2. Specification of Reference Instruments used

Instrument	*Range*	*unit*	*Uncertainty*	*Calibration Due*
Weighing System	2000	kg	1.00E-01 kg	30.12.2020
Timer	1000	sec	9.18E-04 sec	23.05.2020
Diverter System	1000	sec	6.28E-03 sec	04.04.2021
Densitymeter	3000	kg/m^3	2.20E-02 kg/m^3	06.09.2020
Data Acquisition Sysytem	4-20	mA	1.02E-02 mA	27.04.2020

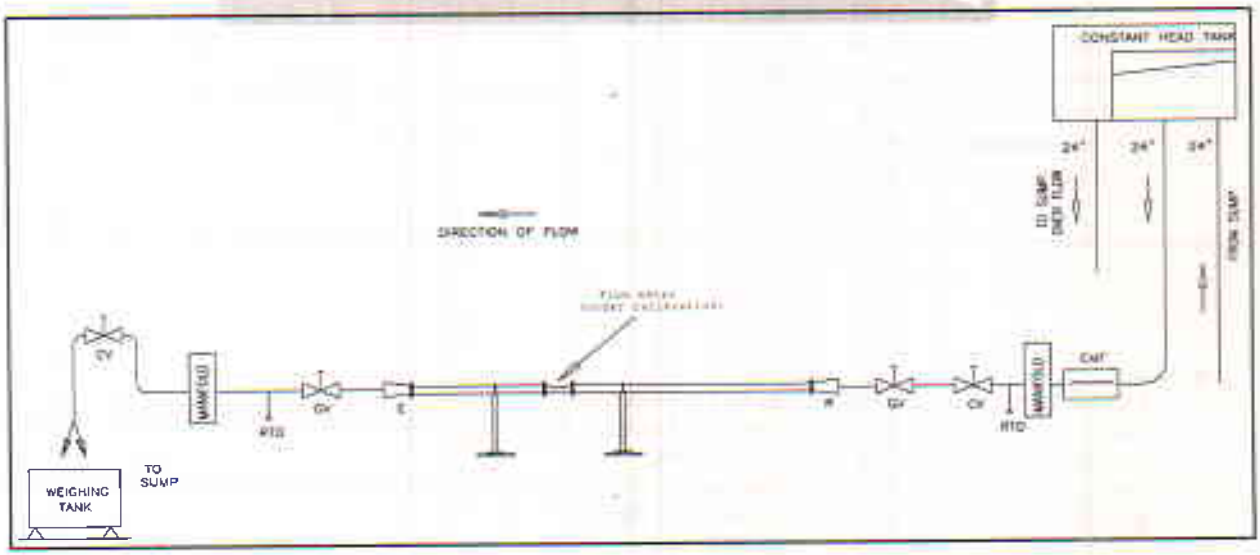

Fig 1. Schematic of Calibration Set-up

Checked

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Table. 1

FLOW ELEMENT : ULTRASONIC FLOWMETER
SIZE : 2" NB
MODEL NO : WFUBO2L0001
FLOW RANGE : 10 lps
CALIBRATING FLUID : WATER
DATE OF CALIBRATION : 31.12.2019

Sl. No	Pup bar	W_1 kg	W_2 kg	t sec	T deg C	ρ kg/m³	Qa m3/h	Qa lps	Qi lps	Error %
1	2.00	1172.35	1684.45	98.696278	29.57	995.80	18.778	5.216	7.710	47.813
2	2.00	290.95	868.40	57.894741	30.03	995.67	36.101	10.028	14.820	47.784
3	2.00	112.70	1207.90	87.419053	30.17	995.63	45.347	12.596	18.780	49.089
4	2.00	69.25	603.550	396.60505	30.80	995.47	4.677	1.355	2.06	52.058
5	2.00	603.55	773.05	125.985126	30.85	995.46	4.671	1.353	2.06	52.258
6	2.00	43.80	145.40	105.068676	31.00	995.43	3.501	0.972	0.968	-0.458
7	2.00	145.40	247.05	106.634729	31.01	995.42	3.451	0.959	0.952	-0.694
8	2.00	247.05	507.10	126.999552	31.02	995.42	7.413	2.059	2.065	0.279
9	2.00	507.10	710.10	99.225856	31.03	995.42	7.407	2.057	2.077	0.951
10	2.00	710.10	1231.90	177.051054	31.05	995.41	10.670	2.964	2.965	0.037
11	2.00	1231.90	1728.40	168.499189	31.07	995.41	10.668	2.963	2.966	0.090
12	2.00	175.20	603.05	107.102694	31.12	995.40	14.463	4.017	4.020	0.063
13	2.00	603.05	1115.45	102.257102	31.14	995.40	18.142	5.039	4.995	-0.881
14	2.00	1115.45	1608.65	82.148241	31.15	995.40	21.737	6.038	5.980	-0.959
15	2.00	229.7	673.40	63.443989	31.15	995.40	25.323	7.034	6.935	-1.409
16	2.00	673.40	1329.25	83.141811	31.16	995.40	28.559	7.933	7.870	-0.796
17	2.00	1329.35	1953.10	69.483035	31.17	995.40	32.501	9.028	8.980	-0.532
18	2.00	394.70	1076.40	68.741462	31.17	995.40	35.904	9.973	9.980	0.068
19	2.00	713	1226.10	73.619781	31.18	995.40	25.253	7.015	6.97	-0.637
							Repeatability (%)	=		0.244

Pup - Pressure at the upstream of the test meter
W_1 - Initial mass of the weigh tank
W_2 - Final mass of the weigh tank
B - Buoyancy correction factor = 1.00106
T - Online temperature of water
t - Time of collection of water
ρ - Density of water at line temperature

Qi - Indicated flowrate

Qa, Actual flowrate = $\frac{(W_2 - W_1) \times 1.00106 \times 1000}{t \times \rho}$ lps

% Dev in Qc = $\frac{(Qi - Qa)}{Qa} \times 100$ %

3. RESULT

i. The results are tabulated in Table 1 and shown graphically in fig. 2.
ii. The expanded uncertainty in flowrate, taking into account the uncertainty of curve fit equation in Fig.2, is estimated to be better than **0.037 lps**
iii. The expanded uncertainty quoted are standard uncertainty multiplied by a coverage factor k = 2 at a level of confidance of approximately 95 %.

Checked

एफ.सी.आर.आई

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FLUID CONTROL RESEARCH INSTITUTE, PALAKKAD

CERTIFICATE OF CALIBRATION

CERTIFICATE NO CC - 2395

ULR-CC239519400001570F

CERTIFICATE NUMBER : FCRI/WFL/C/2019/1226

CALIBRATION CURVE OF ULTRASONIC FLOWMETER
MODEL NO : WFUBO2L0001

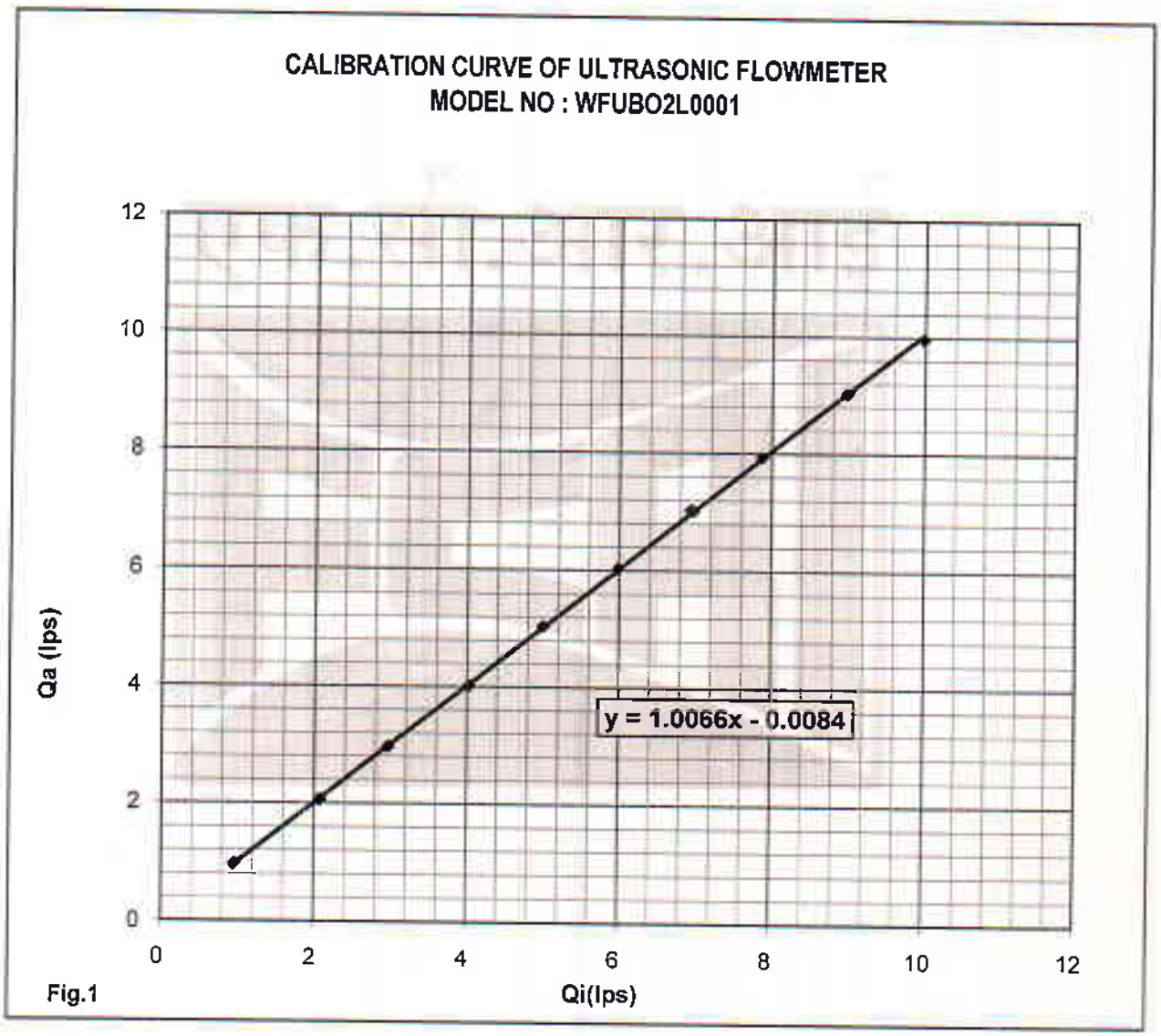

Fig.1

Checked

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Water Flow Laboratory

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CERTIFICATE OF CALIBRATION

on

ONE ULTRASONIC FLOWMETER

of size 4" NB from

M/s. KRISTNAM TECHNOLOGY

INDIAN INSTITUTE OF TECHNOLOGY

CERTIFICATE NUMBER

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FCRI

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FCRI

CERTIFICATE OF CALIBRATION

OF ONE ULTRASONIC FLOWMETER
of size 4" NB from
M/s. KRISTNAM TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY

ilac-MRA

Certificate No: CC-2395

ULR-CC239519400001571F

Water Flow Laboratory

Date of Receipt	Date of Calibration	Date of issue
16.12.2019	24.12.2019	13.01.2020

CERTIFICATE NUMBER : FCRI/WFL/C/2019/1227

J C - 2019/2133

Approved Signatory

SUMMARY

Test Meter	ULTRASONIC FLOWMETER
Standards Referred	ISO 4185-1980: "Measurements of Liquid flow in closed conduits using weighing method"
Laboratory	Water Flow Laboratory (WFL)
Calibration Results	The results of calibration is given in Table 1, the calibration chart is given in Fig. 2 and summary of result in Section 3.
Traceability	All the instruments /Reference flow meters used are traceable to national standards through reference standards and their calibrations are valid. NABL symbol on this certificate implies traceability of calibration data reported (Note 1, clause 5.6.2.1.1 of ISO 17025:2005).

Calibrated by	Prepared by	Checked by
K.G Jayesh Amal Suresh	Fathima K A	K.Suresh, SRE

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1. Method of Calibration

The meter to be calibrated was installed in a standard test line of water flow laboratory as shown in figure 1, Schematic of Calibration Setup. The line was flooded and entrapped air cleared using circuit air bleeds. Constant Head Tank / Direct pumping was the flow source for the calibration. Flow rate was adjusted using the downstream control valve. When flow conditions had stabilised, the flow rate was determined by collecting water for a measured time interval in the weighing system. The method used was flying-start-and-finish technique where the flow was diverted in to the weighing system and diverted back at the end of test.

The time of collection was determined by a high precision timer, which was triggered by a photo switch-timer blade arrangement attached to the diverter. The temperature of water was determined using on-line RTD's and density using an on-line Densitymeter. The actual flow rate and percentage error with respect to flowrate obtained from current output were then computed. This procedure was repeated for the other flow rates also.

2. Specification of Reference Instruments used

Instrument	*Range*	*unit*	*Uncertainty*	*Calibration Due*
Weighing System	20000	kg	2.90E+00 kg	02.12.2020
Timer	1000	sec	9.02E-03 sec	21.05.2020
Diverter System	1000	sec	8.10E-03 sec	11.08.2020
Densitymeter	3000	kg/m^3	2.60E-02 kg/m^3	06.09.2020
Data Acquisition Sysytem	4-20	mA	1.02E-02 mA	27.04.2020

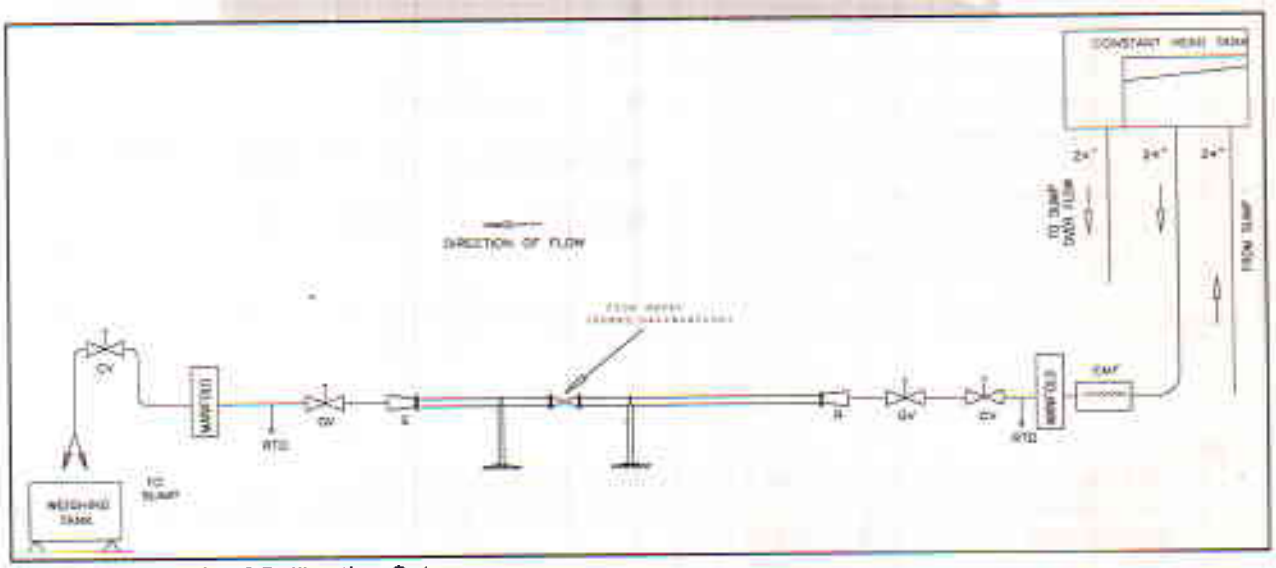

Fig 1. Schematic of Calibration Set-up

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FLUID CONTROL RESEARCH INSTITUTE, PALAKKAD

CERTIFICATE OF CALIBRATION

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CERTIFICATE NO CC - 2395

Table. 1

FLOW ELEMENT : ULTRASONIC FLOWMETER
SIZE : 4" NB
MODEL NO : WFUBO4L0001
FLOW RANGE : 100 lps
CALIBRATING FLUID : WATER
DATE OF CALIBRATION : 24.12.2019

Sl No	Pup bar	W_1 kg	W_2 kg	t sec	T deg C	ρ kg/m^3	Qa m3/h	Qa lps	Qi lps	Error %
1	2.00	6190	7492	143.575845	29.96	996.17	32.806	9.113	9.057	-0.613
2	2.00	7492	8468	107.797590	29.96	996.17	32.754	9.098	9.048	-0.554
3	2.00	8466	12354	63.052990	30.06	996.14	223.081	61.967	61.678	-0.466
4	2.00	10456	13678	50.943375	29.97	996.17	228.806	63.557	63.603	0.072
5	2.00	4420	10582	155.156959	30.14	995.84	143.722	39.923	39.692	-0.578
6	2.00	10582	16802	156.676221	30.14	995.84	143.668	39.908	39.659	-0.623
7	2.00	5118	11244	103.541969	30.19	995.82	214.113	59.476	59.277	-0.334
8	2.00	11244	17420	104.328027	30.19	995.82	214.234	59.509	59.331	-0.300
9	2.00	4464	10326	98.983806	30.23	995.77	214.331	59.536	59.653	0.196
10	2.00	10326	15442	86.444734	30.23	995.77	214.188	59.497	59.325	-0.289
11	2.00	11228	16880	95.477467	30.26	995.71	214.255	59.515	59.331	-0.310
12	2.00	4536	9848	100.489380	30.26	995.71	191.323	53.145	53.003	-0.268
13	2.00	9848	14844	94.532697	30.29	995.68	191.286	53.135	53.240	0.198
14	2.00	5580	10520	106.566138	30.29	995.68	167.784	46.607	46.711	0.224
15	2.00	10520	15446	106.349531	30.33	995.64	167.656	46.571	46.494	-0.166
16	2.00	5488	10222	143.222782	30.33	995.64	119.640	33.233	33.072	-0.485
17	2.00	10222	14780	137.999059	30.38	995.60	119.557	33.210	32.997	-0.642
18	2.00	14780	18322	134.285736	30.38	995.60	95.476	26.521	26.337	-0.695
19	2.00	10238	13886	138.596735	30.42	995.57	95.278	26.466	26.549	0.313
20	2.00	13886	16244	116.269953	30.42	995.57	73.412	20.392	20.254	-0.678
21	2.00	16244	18808	126.195264	30.46	995.53	73.550	20.431	20.475	0.217
22	2.00	10334	13434	231.109779	30.46	995.53	48.557	13.488	13.384	-0.771
23	2.00	13434	16880	256.326492	30.49	995.50	48.668	13.519	13.552	0.245

Linearity (%) = 0.542
Repeatability (%) = 0.091

Pup - Pressure at the upstream of the test meter
W_1 - Initial mass of the weigh tank
W_2 - Final mass of the weigh tank
B - Buoyancy correction factor = 1.00106
T - Online temperature of water
t - Time of collection of water
ρ - Density of water at line temperature

Qi - Indicated flowrate

Qa, Actual flowrate = $\frac{(W_2 - W_1) \times 1.00106 \times 1000}{t \times \rho}$ lps

% Dev in Qc = $\frac{(Qi - Qa)}{Qa} \times 100$ %

3. RESULT

i. The results are tabulated in Table 1 and shown graphically in fig. 2.
ii. The expanded uncertainty in flowrate, taking into account the uncertainty of curve fit equation in Fig.2, is estimated to be better than **0.210 lps**
iii. The expanded uncertainty quoted are standard uncertainty multiplied by a coverage factor k = 2 at a level of confidance of approximately 95 %.

Checked

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CERTIFICATE NO CC - 2395

CALIBRATION CURVE OF ULTRASONIC FLOWMETER
MODEL NO: WFUBO4L0001

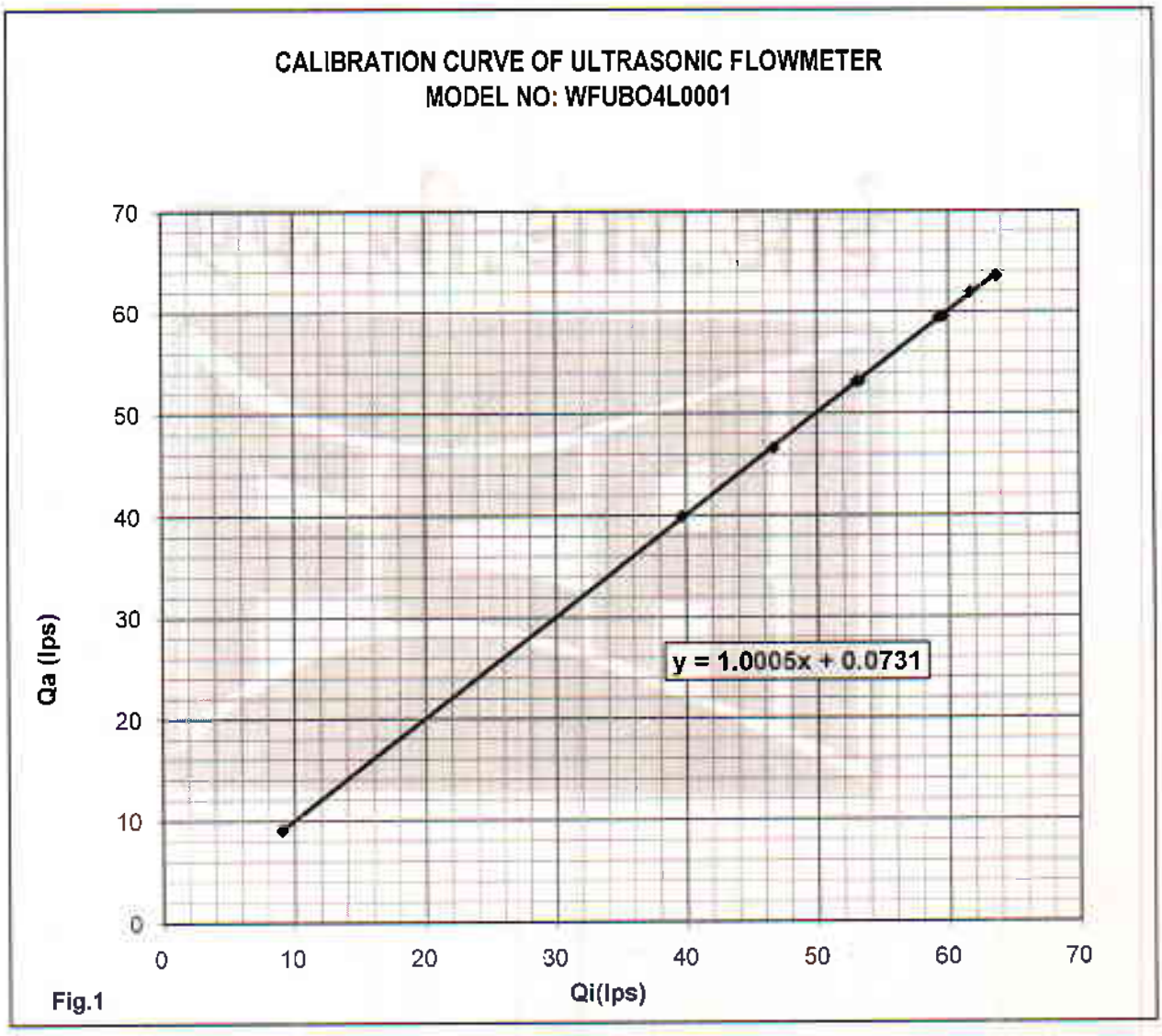

Fig.1

Checked

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Water Flow Laboratory

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ONE ULTRASONIC FLOW METER

of size 6" NB from

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Water Flow Laboratory

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K SURESH
SENIOR RESEARCH ENGINEER

Calibrated by	Prepared by	Checked by
K.G Jayesh Amal Suresh	Fathima K A	K Suresh, SRE

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Timer	1000	sec	9.02E-03 sec	21.05.2020
Diverter System	1000	sec	8.10E-03 sec	11.08.2020
Densitymeter	3000	kg/m^3	2.60E-02 kg/m^3	06.09.2020
Data Acquisition Sysytem	4-20	mA	1.02E-02 mA	27.04.2020

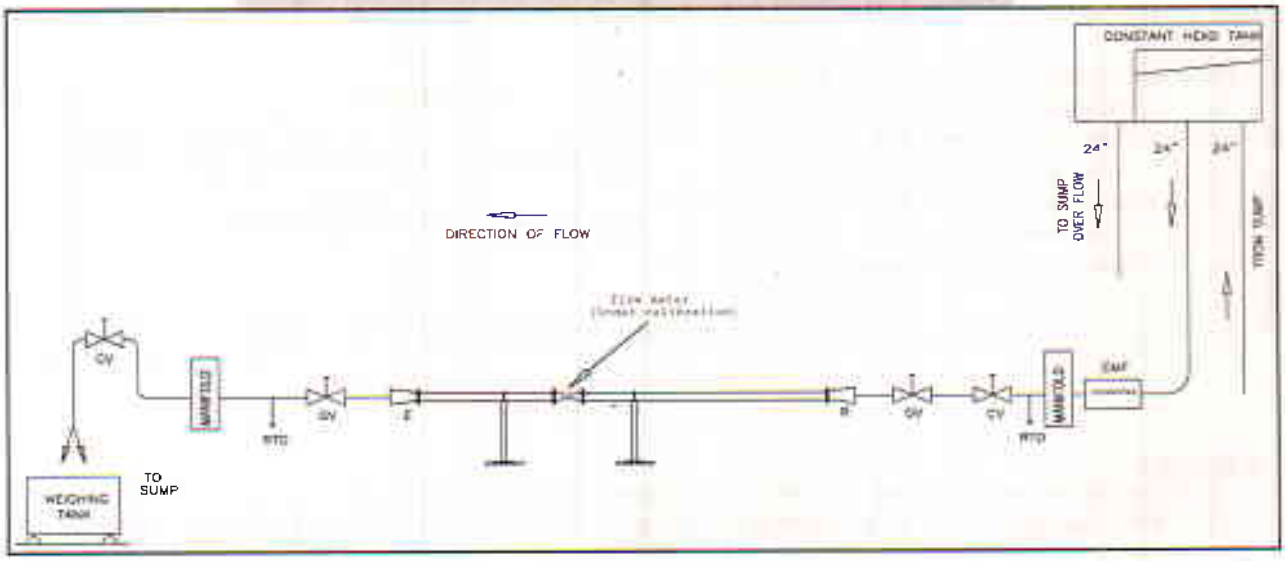

Fig 1. Schematic of Calibration Set-up

Checked

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CERTIFICATE OF CALIBRATION

ULR-CC239519400001572F

CERTIFICATE NO CC - 2395

Table. 1

FLOW ELEMENT	: ULTRASONIC FLOW METER
SIZE	: 6" NB
MODEL NO	: WFUBO6L0001
FLOW RANGE	: 100 lps
CALIBRATING FLUID	: WATER
DATE OF CALIBRATION	: 13.12.2019

Sl. No	Pup bar	W_1 kg	W_2 kg	t sec	T deg C	ρ kg/m^3	Qa m3/h	Qa lps	Qi lps	Error %
1	2.00	1368	10000	96.104514	29.58	996.56	324.808	90.224	90.79	0.627
2	2.00	10000	17444	82.929516	29.58	996.56	324.606	90.168	90.74	0.634
3	2.00	2982	9568	81.965097	29.59	996.55	290.574	80.715	81.20	0.603
4	2.00	9566	16134	81.738767	29.59	996.55	290.582	80.717	81.22	0.623
5	2.00	1910	8234	90.130024	29.62	996.54	253.741	70.484	70.62	0.187
6	2.00	8232	14512	89.580094	29.65	996.54	253.522	70.423	70.87	0.635
7	2.00	2084	7166	85.824647	29.67	996.53	214.139	59.483	59.86	0.632
8	2.00	7164	13534	107.643292	29.68	996.53	214.005	59.446	59.84	0.668
9	2.00	9548	15976	162.126585	29.70	996.52	143.383	39.829	40.03	0.499
10	2.00	1824	7198	135.511713	29.71	996.52	143.416	39.838	40.05	0.539
11	2.00	7196	11238	417.985891	29.76	996.51	34.972	9.714	9.70	-0.158
12	2.00	11236	15140	404.296772	29.79	996.51	34.921	9.700	9.65	-0.519
13	2.00	2538	9156	67.116319	29.82	996.49	356.606	99.057	99.765	0.714
14	2.00	9152	19006	99.990047	29.84	996.49	356.406	99.0018	99.75	0.756
15	2.00	5080	11030	118.073711	29.34	996.62	182.220	50.617	50.850	0.461
16	2.00	11028	16664	111.849814	29.35	996.62	182.209	50.613	50.890	0.546
17	2.00	2476	8690	122.787070	29.85	996.48	183.026	50.8405	51.18	0.658
18	2.00	8690	15112	126.969125	29.85	996.48	182.922	50.8117	51.07	0.508
19	2.00	2058	8340	206.367380	29.86	996.48	110.091	30.5808	30.75	0.553
20	2.00	8338	14292	195.756822	29.87	996.48	109.998	30.5551	30.71	0.507
21	2.00	3644	7064	171.311927	29.88	996.48	72.199	20.0553	20.15	0.472
22	2.00	7064	11062	200.176605	29.89	996.47	72.232	20.0644	20.09	0.128
23	2.00	4042	10430	128.718892	29.90	996.47	179.482	49.8561	50.01	0.317
								Linearity (%)	=	0.637
								Repeatability (%)	=	0.042

Pup - Pressure at the upstream of the test meter
W_1 - Initial mass of the weigh tank
W_2 - Final mass of the weigh tank
B - Buoyancy correction factor = 1.00106
T - Online temperature of water
t - Time of collection of water
ρ - Density of water at line temperature

Qi - Indicated flowrate

Qa, Actual flowrate $= \frac{(W_2 - W_1) \times 1.00106 \times 1000}{t \times \rho}$ lps

% Dev in Qc $= \frac{(Qi - Qa)}{Qa} \times 100$ %

3. RESULT

i. The results are tabulated in Table 1 and shown graphically in fig. 2.
ii. The expanded uncertainty in flowrate, taking into account the uncertainty of curve fit equation in Fig.2, is estimated to be better than **0.119 lps**
iii. The expanded uncertainty quoted are standard uncertainty multiplied by a coverage factor k = 2 at a level of confidance of approximately 95 %.

Checked

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CERTIFICATE NUMBER : FCRI/WFL/C/2019/1228

CALIBRATION CURVE OF ULTRASONIC FLOW METER
MODEL NO: WFUBO6L0001

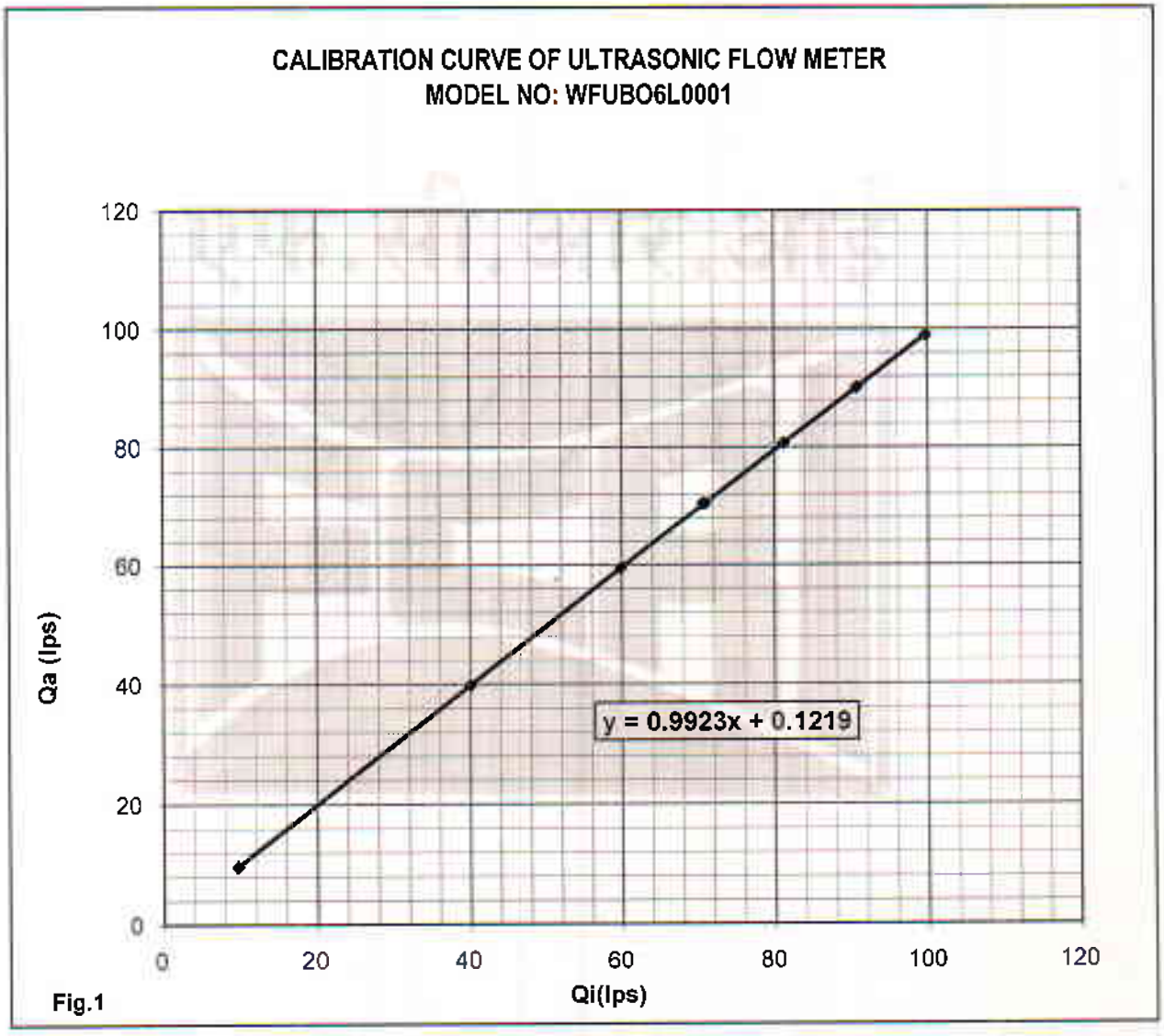

Fig.1

Checked

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