A RESOURCE FOR INDUSTRY

25 YEARS OF EXCELLENCE
FLUID CONTROL RESEARCH INSTITUTE
SINCE 1989

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Fluid Control Research Institute (FCRI), an autonomous R & D institute, was established in 1987 with active assistance and participation from UNDP and UNIDO, under the Ministry of Heavy Industries & Public Enterprises (Govt of India). At FCRI, we have full-fledged NABL accredited laboratories for the calibration of flow meters in water, oil and air media. The Flow Laboratories at FCRI are on par with similar laboratories in Europe, as have been proved through inter-laboratory comparison programmes with National Engineering Laboratory - UK, Delft Hydraulic Laboratory -Netherlands, NIST - USA and Denmark Tech. Institute - Denmark.

As a premier laboratory in Southeast Asia, we cater to different sectors of industries viz. refineries, power, process industries, defence, flow product manufacturers etc. Major companies viz. ONGC, BPCL, HPCL, IOCL, GAIL, Indraprastha Gas Limited, FMC Sanmar, RIL, Teltech and various Water Supply Boards have been taking advantage of our services because of the high reliability and accuracy of our systems.

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FCRI is authorised by Dept. of Weights & Measures to conduct model approval tests on flow meters and volume measuring instruments.

Besides fluid laboratories, FCRI also has the following supporting laboratories:

The Physical Standards Laboratory for calibration in the field of dimensional metrology, pressure metrology, mass, volume, density and viscosity. All our master instruments are traceable to National Physical Laboratory at New Delhi. Calibrations are carried out by established procedures in conformance with BIS specifications.

Electronics & Instrumentation Laboratory is for the calibration of electrical parameters and time.

At the Noise & Vibration Laboratory, we undertake noise evaluation of control valves, generator sets, pumps etc, vibration tests for PCBs and industrial equipments and also calibration of various sound level meters.

DAS department organises data acquisition and automation for testing, calibration and research.

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AIR FLOW LABORATORY

Air flow laboratory offers flow meter/flow product calibration & Testing/ Consultancy services to customers from a wide range of industrial sectors like automotive, aerospace, Pharmaceuticals & Health care, Gas distribution & Process industries, Flow meter manufactures, Research & Development centers, Academic institutes etc. These calibration facilities at FCRI are traceable to national and international standards.

Major facilities at Air flow Laboratory are detailed below

Primary Air Flow Laboratory (PAFL)

Primary Air flow laboratory is equipped with internationally accepted primary flow standards like Bell Provers and Piston Provers of various capacities for precise flow measurement. Calibration of flow meters at low pressure is carried out here for flow ranges up to 40 m^3/h. As per the norms stipulated by the ISO, Primary air flow lab is always maintained at controlled ambient conditions for ensuring metrological qualities of the master flow meters and thereby providing highest quality and precision in calibration of flow meters.

500 ltr capacity Bell Prover

50ltr capacity Bell Prover

Piston Prover

Secondary Air flow Laboratory (SAFL)

Secondary air flow laboratory is operating at near atmospheric pressure and has Critical flow venturi nozzles (Sonic Nozzles) as reference standard. Calibration of flow meters up to a maximum flow range of 10,000 m^3/h can be carried out here. Various types of flow meters and flow products of sizes up to 400 mm are calibrated/tested and Certified at these facilities. Critical flow venturi nozzles of different capacities designed as per ISO 9300 are used as reference flow standards. Sonic nozzles are considered as the best reference standard for Calibration of precision flow meters used for custody transfer applications.

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Secondary Air Flow Facility at FCRI

TFM Calibration in Progress at SAFL

Ultrasonic flow meter under Calibration at AFL

Industrial personnel undergoing training at AFL

Other major Calibration / testing capabilities of Air flow laboratory include:

- Model approval testing of Diaphragm gas meters as per BS EN 1359 & IS14439.
- Model approval testing of gas meters as per OIML R 137-1.
- Gas regulator (OPSO/UPSO) type approval tests as per BS EN 334, BS EN 88-1 & BS EN 88-2.
- Calibration/testing of Blower/Fan,Respirable dust samplers, High volume sampler, Leak flow calibrators, Critical flow orifices, Smooth approach orifices, Laminar flow elements, Flownozzles, Mass flow meters, Vortex Flow meters, Ultrasonic flow meters, Rotameters and Leakage and flow test on Valves, Pressure drop test on filters etc.
- Air/Gas flow measurement in large diameter ducts, Calibration of annubars, aerofoils, venturis, orifices etc. at in-situ conditions.
- Validation/Calibration of flow meters and Installation checking at site as per ISO/AGA standards.
- On the job training of Industrial personnel in the field of gas flow metering and Calibration techniques.

Major Specifications of Air Flow Calibration facilities

Testing conditions	Facility	Max. Flow rate (m^3/h)	Uncertainty in Flow rate	Max. Line Size(mm)
Near Ambient (1 bar abs)	Primary Air Flow Lab(PAFL)	0.25-40.0 m^3/h	0.10%	50
		0.05-0.25 m^3/h	0.30%	
	Secondary Air Flow Lab (SAFL)	11.25-400 m^3/h	0.15%	400
		400-10000 m^3/h	0.25%	

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OIL FLOW LABORATORY

The inherent accuracy of an oil flow measurement system is mandatory in the present day economic scenario. The profitability of any organization is directly or indirectly dependent on the efficient and economic utilization of the resources. The resources are scarce, especially the hydrocarbons / fuels / crude oil. Hence we need to control the usage of oil / fuels / hydrocarbons. The control is mainly through accurate measurement of the flow. Flow measurement is unique in comparison with other measurements because it is directly connected with expenditure/return. Oil Flow Laboratory was commissioned in 1995,and is a unique facility for calibration of custody transfer flow products in oil media.

Max. Flow Rate(m^3/h)	Max. Line Size	Uncertainty in Flow Rate (% reading)	Uncertainty in Mass (% reading)	Uncertainty in Volume (% reading)
650	250mm	Upto 100 m^3/hr : ± 0.05% 100-650m^3/hr : ± 0.075%	Upto 1.6 ton: ±0.013% 1.6ton to 8 ton: ±0.025%	Upto 1.8 m^3 : ± 0.03% 1.8m^3 to 9 m^3: ± 0.04%

Legal Metrology, Weights& Measures unit; Department of Consumer Affairs has recognized FCRI for conducting Model Approval tests on flow measuring instruments and volume measuring instruments and mainly makes use of oil flow laboratory for the purpose.

The facility makes use of static gravimetric calibration system for measurement and the calibration is performed by "Standing start and stop" method.

The principal flow medium is EXXSOL D80 with a maximum flow rate of 650 m^3/hr. NABL (National Accreditation Board for Testing and Calibration laboratories) has accredited OFL for both testing and calibration categories.

The OFL measurement uncertainty is 0.025 % in mass, 0.05 % in volume and 0.075 % in volume flow rate. The test section can handle pipes of a maximum nominal size upto 250 mm (10") NB and the minimum size it can handle is as small as 6 mm NB.

The calibration of flow products at the laboratory are carried out with reference to American Petroleum Institute (API) standards, ISO standards, ASTM standards, OIML standards, etc.

International Inter-comparison program

Oil Flow Laboratory has conducted inter laboratory comparisons with Nmi Netherlands and National Engineering Laboratory, United Kingdom and proved that the FCRI calibration results are well comparable with International systems and the system reproducibility is stable over a period of time.

Level testing facility for probes.

Calibration of composite probes used in petroleum retail outlets for level, density and temperature measurement can be carried out in this facility.

The facility can test/calibrate level measuring probes /instruments upto a height of five meters. The calibration can be done in petrol, diesel, diesel - water interface and petrol - water interface.

The budgeted uncertainty is estimated to be better than 0.1mm for level, 0.1deg.C for temperature and 0.1kg/m^3 for density at 95% confidence level

Multi viscous calibration facility

The primary calibration system works on gravimetric method. The maximum flow rate achievable in the facility is 1200 lpm. The following oils are used for calibration in the facility: Diesel, 2cst, 15cst, 32cst, 68cst, 100cst and, 220cst and 460 cst oils. The facility is also utilized for the model approval of PD meters, turbine flow meters, mass flow meters, fuel dispensers etc. as recommended in OIML R117.

The budgeted uncertainty of the system is better than ±0.05% in volume measurement.

Density calibration facility.

Measuring density with least uncertainty is critical for oil flow in pipelines which is measured largely by volume, and conversions involving density are necessary for accurate financial reporting and trade.

Density measurement is a key element of both mass and volume flow rate measurement in the oil industry, and is fundamental to the commercial operation. The most widely implemented approach for mass flow measurement is the use of a volumetric flow meter and a density meter, both of which require periodic calibration.

The facility can be exclusively utilized for the density calibration of mass flow meters and density meters of various sizes in different densities ranging from 650kg/m^3 to 1000kg/ m^3 in fluids like water(1000kg/ m^3) , Exxsol D80 (780 kg/ m^3) and ether (650kg/m^3) .The budgeted uncertainty in the determination of the density is better than 0.005% of reading at 95% confidence level.

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PHYSICAL STANDARDS LABORATORY

Fluid Control Research Institute (FCRI) has been accredited by National Accreditation Board for Testing and calibration Laboratories (NABL) as per ISO/IEC 17025, under the category of Mechanical Measurement' also. The mechanical measurement / metrology laboratory i.e., the PHYSICAL STANDARDS LABORATORY- of FCRI provides calibration services to Industries and Laboratories, in the field of Dimensional Metrology, Pressure, Mass, Volume, Density and Viscosity measurements. The laboratory is occupied with the most reliable and sophisticated reference instruments, operated under controlled environmental conditions. All master equipments are traceable to National Physical Laboratory at New Delhi. The laboratory is also equipped with reference instruments for Force and Torque. Calibration activities are carried out with established procedures in conformance with BIS/OIML/ISO/BS/ASTM standard specifications.

MASTER INSTRUMENTS AVAILABLE FOR CALIBRATION

Para meter	Equipment	Range	Accuracy
Length	Slip gauges	0.5 to 100mm	00 grade
	Gauge blocks	125 to 500mm	0 grade
	Slip gauge calibrator (PC interfaceable)	0 - 100mm	< 0.1 micron
	Universal length measuring machine	0 to 610 mm	0.46µm
	Surface Finish, Profile projector, Micro checker, Mu - checker, Height master, Vernier Calipers etc.		
	Standard Weights	0.001g to 50 kg	Class E1,E2,F1
Mass	Micro Balance	0 to 50 g	1 µg
	Micro Balance	0 to 210 g	0.01 mg
	Mass comparator	0 to 5 kg	0.001g
	Electronic Balance	64kg	0.001 g
	Electronic Balance	600 kg	0.1 g
Volume	Standard volume jar	5 litres/20 litres	0.02%
	Specific gravity bottle	50ml	0.02%
	Oil dead weight tester	1 to 1200 bar	0.025%
	Oil dead weight tester	1 to 600 bar	0.04%
	Air dead weight tester	-1000 to 1000mbar	0.02%
	Air dead weight tester	-1 to 7 bar	0.015%
	Absolute dead weight tester	30 mbar - 20 bar(abs)	0.025%
	Very low pressure Pneumatic dead weight tester	0.2 mbar -160 mbar	0.03%
Pressure	High Pressure Pneumatic dead weight tester	1 bar 160 bar	0.03%
	Multifunction pressure indicator	0 - 20 bar (abs)	0.025%
	Liquid column manometer, portable calibrator(400 bar), Precision pressure gauges(0.1% of span or better) etc are also available for calibration		
Force	Proving rings(tension & compression)	1000kgf, 50000kgf	Class A
Density	Hydrometer	0.6 to 1.6 g/ ml	L 50 0.5%
Viscosity	Falling ball viscometer (for transparent Newtonian liquids and gases), capillary viscometer, standard liquids etc.	0.5 to 10^5 mPas/cSt	

Following Instruments can be tested / calibrated at PSL

Length/ Dimension metrology

- Slip gauges O,I,II / Inspection grade
- Gauge blocks
- Vernier caliper (Dial, Digital & ordinary)
- Depth vernier
- Dial gauges (plunger type, lever type)
- Dial thickness gauge
- Micrometer (all types)/ Depth micrometer
- Tapes, scales & tapes
- Feeler gauges
- Radius gauges, Knife gauge
- LVDT gauge
- Test sieves
- Thickness gauges
- Mu checkers
- G.S.M scale
- Pitch gauges, Pin gauges
- Plain plug & ring gauge
- Thread plug gauges
- Bore gauge, Wire gauge, Depth gauge
- Floating carriage micrometer
- Surface table/ Surface plate
- Straight edge
- Length bar
- Height gauge/ Master
- Micro checkers (inside/ outside/ depth)
- Combination set & Bevel Protractor
- Spirit level
- Special type of Length measuring instruments

Viscosity

- Viscometers (all types including rotational)
- Visco cups Ford, B1, B2 etc.
- Viscosity of liquids

Mass & Force

- Standard Weights & Analytical Weights
- Electronic / other balances
- Load cells (static/ Dynamic)
- Proving rings (tension & compression)
- Moisture balance
- Force gauges

Volume

- Pipettes (single mark & graduated)
- Burettes
- Measuring Jars
- Measuring flask
- Specific gravity bottle/ Pyknometer
- Proving can (volume / commercial measures)
- Micropipettes

Density

- Hydrometers (density)
- Brix Hydrometers
- Lactometers
- Baume Hydrometers
- Specific gravity hydrometers
- Digital/ Analog density meters
- Density of liquid
- Mass flow meters

Pressure

- Pressure gauges (air & oil)
- Pressure transducer/ transmitter
- Dead weight tester
- Vacuum gauges
- Manometer
- Leak tester

Other services of the Laboratory

- On site calibration / Testing of instruments
- Training of personnel in calibration
- Customised Testing/calibration services for special requirements

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TRAINING PROGRAMME

Training programmes in the area of flow measurement & control, calibration, testing, Instrumentation engineering and related fields are conducted for Indian and foreign nationals by FCRI. Training programmes conducted by FCRI provide a platform for interaction between FCRI engineers and engineers from various fields outside. FCRI has successfully conducted more than 300 National training programmes and 70 International training programmes till now. The International courses come under Indian Technical & Economic Co-operation (ITEC) / Special Commonwealth African Assistance Plan (SCAAP) / TCS of Colombo Plan of Ministry of External Affairs, Govt. of India and under Self Financing Scheme.

FCRI also conducts specialized tailor made training programmes for executives / technicians in specified areas for interested organizations. Such programmes are being conducted for organizations like GAIL, ONGC, Legal Metrology Dept., RIL, BWSSB, KWA, Hindustan Zinc etc.

In addition to the above training programmes, FCRI is conducting Post Graduate Certificate Programme (PGCP) for fresh engineers twice in an year on topics - "Fluid Flow, Instrumentation Engineering & DAS in Process Industries" and "Liquid & Gas / Air Flow Measurement & Control Techniques & Standards".

More than 900 participants from 87 countries had undergone training at FCRI

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WATER FLOW LABORATORY

The Water Flow Laboratory, established in 1989, has been providing technical consultancy, research, training, testing and calibration in flow measurement for our clients across the globe. Activities of water flow laboratory are centered around calibration and testing of flow products including flow meters, valves, pumps and fire fighting equipments with water as medium of flow.

Water Flow laboratory

Static gravimetric method as per ISO 4185 is adopted here for measurement of flow rate. The Water Flow Laboratory has two divisions viz. the 600 mm Water Flow Laboratory and the 100 mm Water Flow Laboratory.

The flow meters are calibrated to the highest accuracy by weighing the quantity of water that passes through the meter during a known time interval. The laboratory is designed to handle a maximum flow rate of 4500 m^3/h and a maximum pressure of 3 bar. Pipes upto 900 mm NB diameter can be accommodated in the system. The test rig has different test line sizes up to 900 mm NB and the laboratory is capable of extending the line size upto 1200 mm. A large underground sump of 370 m^3 capacity is used to store the required water. The test rig is supplied with water at constant head from an over head tank of 50 m^3 capacity and 18 m head. During operation the constant head tank (CHT) is continuously overflowed using different low pressure pumps, which can be selected according to the requirement of the test meter. Weighing tanks of capacities 30 kg, 300 kg, 2000 kg and 20000 kg are made available for the flow measurement. Diverter systems are used to divert the flow to the weighing tank for an accurately measured time period (flying start and stop method). The mass measurement is by high precision electronic balance/load cell. Time is measured using universal counter which is triggered by a photo switch connected to the diverter system. A set of high precision differential pressure transmitters are available for the measurement of differential pressure.

Specifications of the Water Flow Laboratory (NABL)					
Max. Flow Rate (m^3/h)	Max. Size	Measurement Uncertainty			
		In Mass Flow rate	In Volume Flow rate	In Total Volume	In Total mass
4500	900mm	±0.03% (Upto 200 T/h) ±0.05% (200 to 2500 T/h)	±0.05% (Upto 600 m^3/h) ±0.10% (600 to 2500 m^3/h) ±0.15% (2500 to 4500 m^3/h)	±0.05% (Upto 20 m^3)	±0.01% (0 to 2000 kg) ±0.025% (2000 to 20000 kg)

The density of water at flowing condition is measured using an online density meter. Together with measurement of density at the moment of each diversion enables mass readings, after correction for buoyancy, to be converted into volume. The volume is divided by the respective diversion time to obtain accurate measurement of flow rate.

The laboratory has been accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) and certified by GCAS for ISO 9001.

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Special Tests at Water Flow Laboratory

Validation of Flow Nozzle assembly as per ASME PTC-6 2004

In order to conduct the turbine acceptance tests, accurate determination of primary flow is necessary to compute turbine heat rate or steam rate. All known errors must be reduced so that their individual effect is less than 0.05% of the primary flow to be measured.

Experience shows that the coefficient of discharge for a particular flow section cannot be satisfactorily predicted to meet PTC Code uncertainty objectives, and, therefore, it is necessary to calibrate each flow section. At FCRI, calibration can be undertaken with a similar Reynolds number to those in the actual installation. The physical construction of the piping in the calibrating setup can be assembled similar to that in the test setup immediately upstream and downstream of the flow-measuring section. Reynolds number in the range of 4 million can be achieved at our facility.

Many Indian and overseas customers are utilizing FCRI facilities for the calibration of their PTC -6 flow nozzles as part of qualification tests.

Laboratory Proving of Compact Provers

Water draw calibration of Compact Prover, Pycnometry and meter proving can be conducted, as per API MPMS at the laboratory. It is essential to determine the base volume of the Compact Prover. Here the signal from the detector switches are used to start and stop the flow from the prover outlet, which will be collected in a volume vessel or a weigh tank. By determining the density of the collected water, we can establish the base volume. At FCRI we can provide direct traceable volume measurement to the minimum uncertainty level. Base volume certification of Pipe Provers at site is also handled by FCRI.

Fitness for purpose requirements and appropriate verification tests at FCRI

At Fluid Control Research Institute (FCRI) exclusive test facilities for the testing of the valves against BS EN 1074 – "Valves for water supply – Fitness for purpose requirements and appropriate verifications tests" are available. Valves like Gate valves, Butterfly valves, Pressure Relief valves used in the drinking water pipe works are tested against this standard. Many Indian customers are utilizing our facility before exporting their valves to European countries.

Testing of Pressure Relief Devices as per ASME PTC 25 - 2008

The blow down capacity, lift at set pressure, over pressure and reseating pressure can be experimentally determined at the Water Flow facility. The experiment can be conducted at a pressure of 16 bar and at a flow rate of 100 m^3/hr.

The purpose of the testing is to determine the functional and operational characteristics of the pressure relief valves used in high pressure applications. The experiment can be conducted with different internals to attain the required set pressure and flow rate.

International Inter-comparisons

Water Flow Laboratory has conducted inter laboratory comparisons with International laboratories like Delft Hydraulics - Netherlands, National Engineering Laboratory - United Kingdom and proved that the FCRI results are well comparable with International flow measurement systems.

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LARGE WATER FLOW LAB

The Largest and Unique Water flow Calibration/ Testing laboratory in India was established at FCRI in the year 2012, in order to meet the demands of Manufacturer/user industries in connection with calibration/testing of large sized flow meters/ control valves with high accuracy. The laboratory is designed for a maximum pipe diameter of 2000mm with a maximum flow rate of 15000 m^3/ hr. This laboratory is accredited by NABL for testing and calibration as per ISO 17025.

Major sectors/plants availing the laboratory facility are

- Water treatment & desalination plant
- Irrigation and hydrology departments
- Power plant
- Sewage plant
- Integrated urban water management
- Drinking water and sanitation authority
- Petrochemical industries and refineries
- Manufacturing / user industries of flow meters and control valves

Apart from flow meters calibration and valve testing, the laboratory can also take up performance testing of pumps and turbines.

The laboratory consists of an underground water sump of capacity 3000 m^3 on which 5 Vertical Turbine pumps are erected. The Pumps are of rating 110 kw, 200 kw, 295 kw, 395 kw & 485 kw and are used in combinations to meet the wide flow range requirements. Four Electromagnetic flow meters are operated parallely as reference flow meters.

The major specifications of this facility are as under:

1. Flow Medium : Water
2. Maximum flow rate : 15000 m^3/hr
3. Head : 20m of Water Column
4. Pipe Line Size (Max.) : 2000mm (Design)
5. Sump Dimensions : 50m long x 8m wide x 7.5m deep
6. Type of Flow : Direct Pumping
7. Pumps Type : Vertical turbine
8. Type of Drive : Electrical Motor
9. Power Source : DG Sets, 1250 KVA (2 Nos.)
10. Uncertainty : ± 0.5%

Recently carried out Calibrations/Testings:

Sl.No.	Description of Test meter/valve	Client
1)	Wafer Check Valve 500 mm & 600 mm	M/s. Crane Process Flow Technologies (I) Ltd., Pune
2)	Electromagnetic flow meter 750 mm	M/s. Emerson Process Management (I) Pvt. Ltd., Navi Mumbai
3)	Electromagnetic flow meter 900mm	M/s. Chennai Water desalination ltd., Chennai
4)	Venturi flow meter 750mm	M/s.Hydropneumatics Pvt.Ltd, Goa
5)	Ultrasonic flow meter 1200mm & 2000mm	M/s. Indian Institute of Technology, Roorkee
6)	Pump Cavitation Test	M/s. Grundfos Pumps India Pvt.Ltd. Chennai
7)	Ultrasonic flow meter 900mm	M/s. General Electricals Pvt.ltd, Pune
8)	Electro Magnetic flow meter 1400mm	M/s. Endress + Hauser Pvt.Ltd, Mumbai
9)	Risonic Multipath Ultrasonic flow meter 2000mm	In connection with field efficiency testing at KHEP
10)	Testing of Gates 450mm & 900mm	M/s. KBJNL, Karnataka

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Calibration of 1000mm venturi meter

Calibration of Risonic Multipath Ultrasonic flow meter 2000mm

Calibration of electromagnetic flow meter 1400mm

Calibration of 750mm Venturi meter

600 mm Wafer Check Valve under test

Pump Cavitation test

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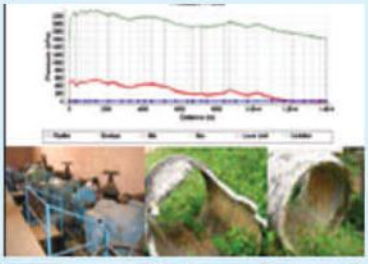
CENTRE FOR WATER MANAGEMENT

Centre for water management (CWM), a state of the art test lab for flow products, mainly domestic and bulk water meters, offer different kinds of services like flow product assessment, in-situ measurement/calibrations, analysis, design and consultancy service related to flow problems especially in water distribution networks, surge etc.

In this facility, accurate measurement of flow in terms of volume is determined by gravimetric system. Flow range up to 300 m^3/h in line size of 150 mm pipeline can be achieved in the laboratory with overall uncertainty in volume better than 0.03 %. Around 3000 water meters of various sizes are tested in CWM every year. The test facility is accredited by NABL and recognized by Bureau of Indian Standards. Testing of water meters of all sizes are conducted as per Indian and International standards.

Assistance is being offered to different water Utilities during bulk purchase of water meters. A Model approval program is launched to help the manufacturers to improve the quality of their meters.



Consultancy services offered

- Analysis, simulation and design of drinking water distribution systems
- Performance evaluation and augmentation of networks for firefighting systems
- Surge analysis of transmission systems for major cities
- Root cause analysis of pipe breaks and implementation of remedial measures
- Setting-up of test facility for water meters and other flow products
- Assessment of flow product test facilities for various flow product manufacturers and water boards
- Bulk procurement of water meters by various water boards

In-situ flow measurement & calibration done

- Flow measurement in large dia. pipes up to 3000 mm
- Field efficiency Test of hydro-electric turbines up to 250 MW
- Surge pressure measurement in transmission mains
- Flow measurement using non-conventional techniques like tracer dilution method, Gibson method etc.
- Performance evaluation of cooling water systems
- Measurement in open channels

Other Services

- Assessment of calibration and testing facilities for flow products
- Development of various Indian and International standards
- Training for professionals from water boards, consultants and manufacturers

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250 BAR COMPRESSED NATURAL GAS LABORATORY

Highlights

- Quality and Reliability Evaluation of Coriolis Mass Flow Meters
- Model approval of CNG meters and dispensers
- High Pressure calibration of Industrial Custody Transfer meters

Auto and Natural Gas Scenario in India

Increased concern on the environmental pollution caused by conventional diesel/petrol fuels has caused the emergence of Compressed Natural Gas (CNG), as an environmental friendly and clean fuel. Auto fuel Policy introduced by MoPNG aims to address the issues of vehicle emission, vehicle technology and auto fuel quality. The use of CNG and LPG would be increased in pollution affected cities and there is a continuous growth of CNG filling stations in India.

Cost of Metering Errors

The cost of the fuel is charged based on mass measurements made by Coriolis mass flow meters. OIML R139 recommendations stipulate an error limit of 1.5% on the dispensed quantity, which is in the range 2 - 100 kg. An error of about 1.5% could produce a revenue loss or gain of 1.5 % of total transactions.

Model Approval as per OIML R139

CNG dispensers used for dispensing the fuel to the automobiles should be type approved for their performance as per OIML139 norms. The constituent elements of a measuring system and the subsystems for e.g meter, transducer, electronic calculator (including the indicating device), ancillary devices providing or memorizing measurements results, self-service device shall undergo separate model approval as required.

1. Accuracy Tests at Constant Flow rates

Constant flow rates and vessel volume to be used for testing are defined in OIML R139. Each test is repeated 3 times and accuracies are determined.

2. Banking Accuracy Tests

These tests are performed at various pressured banks.

3. Endurance Test

Endurance Test shall involve at least 5000 deliveries performed in less than six months preferably at site. The measured volume for each delivery shall be 20 times the minimum measured quantity at least and the deliveries may be simulated. After the endurance cycles, tests are performed at least 3 times, and mean initial/final intrinsic errors are calculated. The deviation shall remain within specified limit.

4. Testing the Gas Influence Factors

Tests should be carried out at the limits of the meter's field of operation, i.e. at the limits of possible pressure, temperature and density for the gas for 3 times each..

Table below gives the limits of errors for flow rate performance tests.

Metrological performance requirements for CNG meters and dispensers

	Parameter	Maximum Permissible Error
1	Type Approval - Meter alone	<1%
2	Type Approval - Dispenser	<1.5 %
3	Initial Verification or subsequent verification, Meter (Lab)	<1%
4	Initial Verification or subsequent verification, System (Lab)	<1.5 %
5	Initial Verification or subsequent verification, System ,site	2%
6	Minimum Measured Quantity	Twice Type Approval
7	Repeatability Error	<0.6%
8	Error shift after endurance test	< 1 %

5. Influence and disturbance performance tests for type approval of CNG dispensers

For undertaking Model Approval / Pattern Approval Testing of CNG meters/Dispensers as per the norms specified under OIML, extensive tests need to be carried out for accuracy and performance verification. A series of Environmental tests are mandatory as per OIML to assess the performance of the system under influence and disturbance factors

FCRI services to CNG Automobile Industry

A typical CNG dispensing station and dispenser calibration is shown in the schematic (Fig.1). It consists of low pressure gas supply, multistage compressor, CNG storage cascades and dispenser. Depending on the banking of the dispensers, flow rate will vary over a wide range. Mass flow meter of the dispenser must have the capability to ensure sufficient accuracy over the flow rate range it experiences.

FCRI carries out accuracy testing of CNG dispenser using the existing installation set up with master mass meter. Master prover has a calibrated coriolis mass flow meter modified as portable proving unit. Site verification is conducted by filling 8-10 buses/autos/cars. Amount of gas filled depends on the initial pressure of the cylinder of the vehicle.

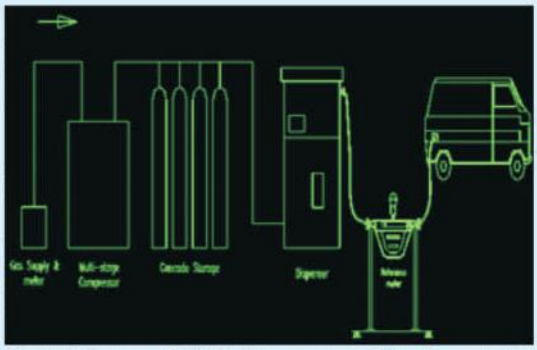

Fig.1 Scheme of CNG dispenser calibration at site

250 bar Compressed Natural Gas Laboratory

The new 250 bar facility is capable of evaluating and testing metering technologies for high pressure compressed natural gas applications, type test dispensers and mass flow meters. The facility consists of major components such as booster compressor, piping components, control components, storage cascades, weigh and buffer tanks and precision electronic mass comparator.

Specifications of the facility

Medium	:	Compressed Natural Gas	Test Line Size	:	Up to 1 1/2"
Pressure	:	Upto 200 bar	Flow rate	:	4500 kg/h
Reference System	:	Gravimetric	Uncertainty	:	0.1%
Storage Volume	:	18 m^3	Weigh Vessel	:	1 m^3 approx.

Clean dry CNG stored in cascades is used as test media. Gas drawn from Weigh/buffer tanks (pressure variation 200-25 bar) by booster type reciprocating compressor is compressed to the storage pressure of 250 bar and stored in cascades. The pressure to the test loop can be regulated to the required levels either in cascades or with multiple sets of pressure regulators while testing 2-3 bank dispensers. Mass flow rates are monitored using coriolis meters and a set of 7 critical flow venturi nozzles of different capacities control the mass flow rates through the loop. Actual mass flow rates are determined using electronic balance. Pressures /Temperatures are measured at upstream/downstream of nozzles and also at the inlet of the compressor. The facility is extensively instrumented and remotely operated valves are controlled by an online real time PC based GE Fanuc SCADA System

Fig. 2 shows the scheme of lab test of dispensers. The errors so determined must lie within the specified limits of the system. Master meters are calibrated at FCRI, prior to the site testing .Performance of the meter should be within the specified levels.

Fig.2 CNG dispenser under test in laboratory

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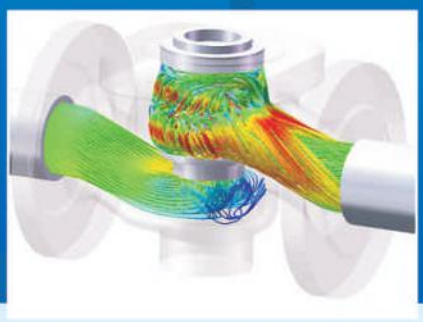
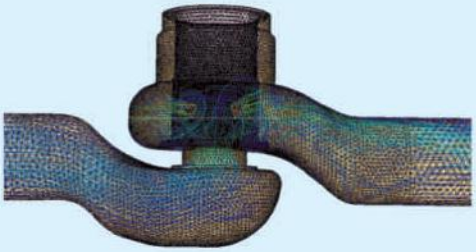
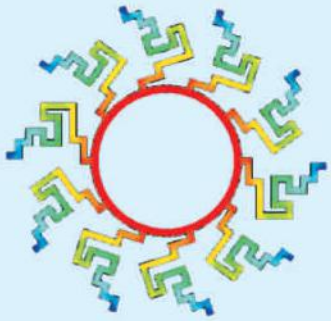
COMPUTATIONAL FLUID DYNAMICS (CFD)







Computational Fluid Dynamics (CFD) is the branch of science and technology, dealing with simulation of fluid flow with heat and mass transfer in and around various engineering and natural objects. Fluid flow plays the key role in the working process of many engineering devices. Designing of such devices for the required operational parameters is impossible without reliable prediction of characteristics of these flows. CFD plays a vital role in modeling and design optimization of many flow devices. CFD simulations also enable flow solutions at the true scale of the engineering systems with the actual operating conditions. Using CFD analysis, lead time in design and development can be significantly reduced and can simulate flow conditions not reproducible in experimental model tests. Results of CFD provide more detailed and comprehensive information of the flow field.

CFD Projects in FCRI

The attempt at using Computational Fluid Dynamics to solve practical Fluid dynamics problems began in FCRI as early as 1991. The initial attempt was to develop Fortran Codes for solution of standard fluid dynamic problems as commercial codes were too costly or were not available. Towards this a number of FORTRAN codes were developed and problems were solved. Typical solution of a simple problem would take about a week in the 486 machine available with the Institute at that time.

As commercial codes were becoming more available and computing resources were becoming cheaper, the Institute obtained the General purpose CFD Software FLUENT. The software was used to primarily optimize the choice of testing or experiment to be done on fluid flow and thermal problems that were taken up by the Institute and then for validation. The software was updated with latest versions so that the Institute had the capability to address new problems in compressible, incompressible & multiphase fluid flows, cavitation, etc.

FCRI has undertaken many sponsored/internal CFD projects in the area of Design optimization, modeling, simulation, design validation, etc. for various industries and other scientific and technical organizations. CFD modeling of flow system and simulations are carried out using FLUENT, a finite volume method based software package. The Institute has the latest version of ANSYS software. The following are the major areas covered.

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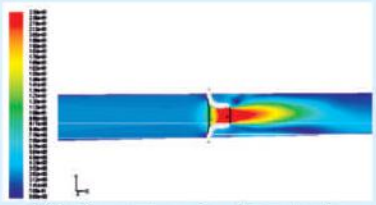
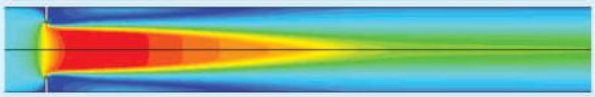
- Flow simulation through different types of flow meters like venturi meters, orifice meters, thermal mass flow meters, cone flow meters, vortex shedding flow meters, pitot tubes, etc



Velocity contours in a flow nozzle

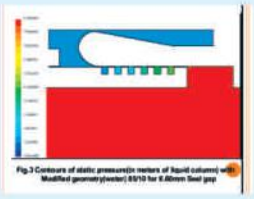


Velocity contours of flow through orifice plate

- Flow simulation through different types of valves , piping configurations, bends, diffusers, pump intakes, flow nozzles, static mixer, etc

Contours of vapour fraction in a cage valve

- Modeling and simulation of fluid flow through Intermediate heat exchangers, air inlet silencers, leakage through IHX Seals & Labyrinth seals etc.

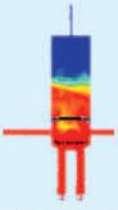


Pressure contours in Labyrinth seals

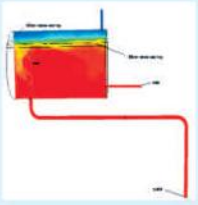
Velocity contours in an Intermediate heat exchanger

Flow velocity contours in a section of rectangular duct air inlet silencer

- Flow simulation and design optimization study of Surge tank of nuclear reactor, Snout weir, etc
- Installation effects study on Flow meters.
- Flow simulation and design optimization of different types of strainers, etc.

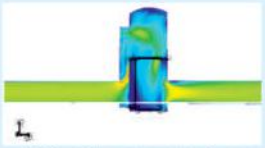


Two phase flow in surge tank of Nuclear reactor

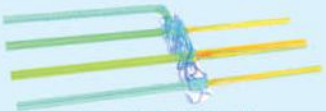


Contours of volume fraction of water in a Snout level controller

A basic training course on "Basics of Computational Fluid Dynamics and Software" is conducted annually for two days during the month of July.



Velocity contours in a Basket strainer



Flow in a manifold

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20 BAR AIR FLOW LABORATORY

a. Open Loop / Blow Down Air Test Facility

This facility is used for testing of different types of Control & other Valves, Filters, Regulators, Small size flow meters, Venting devices etc. The facility is also used for Aerodynamic noise studies for valve trims and Silencers.

This facility operates in Open loop / Blow down mode. Four interconnected pressure vessels of 11 m^3 water capacity store air at maximum of 20 bar. The three reciprocating compressors together deliver 4000 lpm FAD. The air treatment system purifies air to -60 °C tpd dew point, less than 5 ppm oil carry over and 5μ particle size

Safety valve testing for CCI-USA

Other testing capabilities

- Model approval / Capacity test of Safety relief valve.
- Model approval / Capacity test of breather valve.
- Model approval / Capacity test of Regulator & Gas safety equipment.
- Noise level measurement of valves, stacks and control devices, automobile air vents.

Air Reservoirs

b. Closed Loop Air Test Facility (CLATF)

Loop essentially has an encapsulated blower, chilled water temperature control system, filters and metering lines. Cleaned, dried, filtered compressed air is filled in the closed loop at required static pressure. The 35 kW blower maintains the flow circulation in the loop and makes up for pressure losses. Frequency control speed drive controls the flow rates through the system. A 16 TR chilled water package system maintains and controls the air temperature within ± 1°C during the period of calibration. A group of 2" and 3" turbine meters calibrated with primary / transfer standards serve as references with traceability to National Standards.

CLATF

Specifications

Medium	:	Compressed air
Operating pressure	:	2 – 20 bar (g)
Flow rate (max)	:	400 m^3/h (actual)
Temperature	:	25 ± 1°C
Reference meter	:	Turbine meters
Uncertainty	:	0.3%

c. Primary Standard Gravimetric System (PSGS)

Primary Standard Gravimetric System enables calibration of meters up to 50 mm for maximum flow rate up to 50 m^3/h (actual). The operating pressure ranges from 1.3 to 20 bar. The overall system uncertainty is 0.1%. The facility is accredited by NABL and approved by NMi for ISO 17025 criteria. The facility also uses for calibration of Coriolis type mass flow meters upto 1000 kg/h. This facility is the only Primary Standard in India for gas calibration.

The electronic precision mass comparator provides accurate measurement with 1g sensitivity in its capacity of 1200 kg. The precision dome loaded pressure regulator maintains the pressure in the test set up. The critical flow venturi nozzles with different throat diameters controls the flow rate through the set up.

PSGS

Intercomparison program

Traceability of basic quantities such as mass, length, time or derived quantities like pressure, viscosity, density etc. established to the relevant National Standards alone is not sufficient for overall uncertainty assessment due to lack of absolute knowledge of all sources of errors associated with flow measurement and further, the quantity is a time integration of instantaneous flow rate. Upstream Pipe configuration, type of compressor/pump and quality of fluid etc. influence the measurement. Hence to validate the complete calibration system, equipment and personnel, two or more laboratories should perform the same tests on selected meter. FCRI successfully participated in such exercises.

NMi Certification

Netherlands Measurements Institute(NMi), the Netherlands, certified the Closed Loop Air Test Facility (CLATF) and Primary Standard Gravimetric System (PSGS) as back as November 2002. In addition to NABL accreditation, this loop got international acclaim through Round Robin tests.

NMi officials at FCRI

General Specification

Testing conditions	Facility	Max. Flow rate (m^3/h)	Max. Line Size (mm)	Uncertainty in Flow rate
20 Bar pressure	CLATF	400	100	0.30 %
	PSGS	50	50	0.10 %
	Blow down	-	300	1-2%

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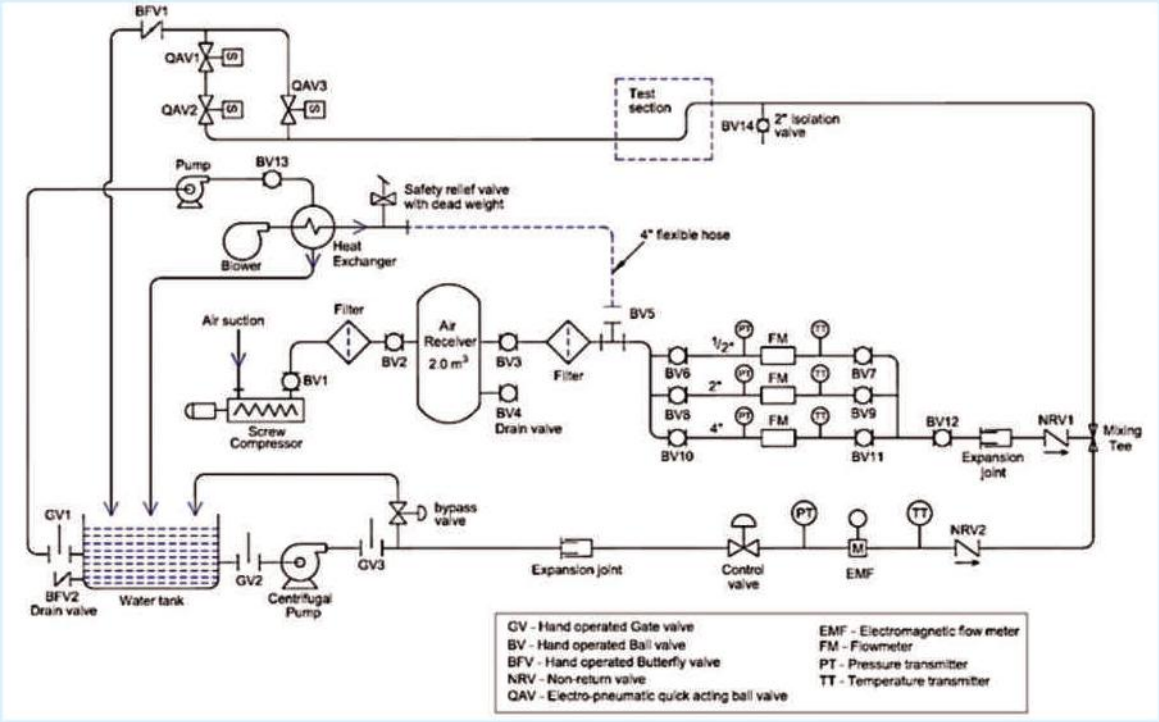
MULTIPHASE FLOW FACILITY

It is an established fact that Multi-phase flows have been posing measurement challenges regarding bringing down measurement uncertainties to acceptable orders when conventional single-phase flow meters are used. Multiphase flows, very common to upstream oil and gas sectors and power industry, are characterized by extreme variations in viscosity, density and velocity between phases. The phase distribution in multiphase flow vary both spatially as well as with reference to time besides being affected by conditions such as geometry, orientation, etc. of pipe and piping elements in flow conduit.

During the past more than a decade, FCRI has executed a number of projects in the area of two-phase and multiphase flows for many clients in India and abroad pertaining to applications such as characterization of automotive engine-oil under aeration conditions, Scale down experimental studies on Gas Entrainment in surge-tanks, related assemblies/ auxiliaries of power stations, Computational Fluid Dynamics simulation/ modeling for homogenizer/ mixer assemblies for multiphase flow, Computational Fluid Dynamics simulation/ modeling for Gas entrainment behaviour in power-station sub-assemblies such as surge-tanks, Wet gas flow studies and performance of venturies and differential pressure flowmeters under oscillating flow conditions, Design, development, performance testing of Capacitance-based phase-fraction meter for two-phase measurements.



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With support from Industry and allied agencies, FCRI has undertaken research studies towards development of custom two-phase flowmeter systems for steady-state and high-response applications such as heat-exchanger safety related monitoring in power plants. Towards research and development activities a Multiphase Flow Facility has been established at FCRI for basic measurements in two-phase air-water mixtures. The outcome of research has been multiphase flowmeters for measurements in steady-state and transient state for high temperature high pressure conditions such as steam-water mixture flows.

The unique feature about the latest flowmeter system developed for transient measurements is its collimated multi-beam gamma-ray scheme that permits inline non-intrusive tomography/visualization. The system also has its high response of the order of 5 to 20 milliseconds permitting usage for transient gas-liquid flows such as steam-water break flows in heat exchanger systems of power plants. The system has been designed for handling high flow velocities at process conditions of up to 340 °C temperature and 170 bar pressure.

With new Multiphase Flow capabilities being added in a phased manner over the past few years, FCRI infrastructure has been providing contractual support for testing and research experimental work for end-users and product developers for their two-phase and three-phase equipment such as phase-homogenisers and static mixers, phase-separators, piping components and custom devices used in multiphase. Besides, the facilities are being used by Industry for pressure drop analysis of components in two-phase gas-liquid flow regimes, experimental evaluation of two-phase flowmeter prototype models, experimental validation exercises for computation components with prototype models, etc.

FCRI welcomes both short-term and long-term research ventures from industry in two-phase and three-phase flow including gas-liquid, liquid-liquid, liquid-solid and gas-solid flows. FCRI has also developed methodologies for undertaking low flow wet-gas experiments in air-water and gas-oil flows.

Vertical Test -section for Air-water loop, with transparent pipe for visualizing air-water regime during experiments

Quick-acting Valve Setup for Phase - fraction measurement, with transparent vertical pipe section .

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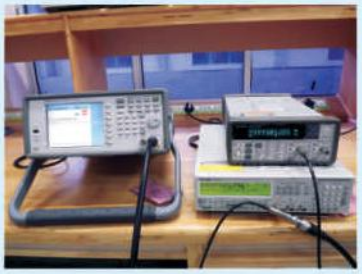
ELECTRO TECHNICAL LABORATORY (ETL)

The state of the art electro technical calibration facilities includes Electronic Voltage reference standards, Standard Resistors, Multifunction Transfer Standard, Multifunction Calibrators, CRO calibrator, Transconductance standards, AC/DC Current Shunts, LF Power Standard, RLC Standard , Cesium and Rubidium Frequency Standard, LF & RF Standard Sources etc. .



THERMAL CALIBRATION LAB

Thermal Calibration lab has facility for Fixed point calibration of SPRTs, HTPRTs and standard thermocouples probe and comparison calibration of all types of laboratory and industrial grade temperature measuring devices as per ITS-90 .

ITS-90 Fixed Point Calibration (-38.8344°C to 961.78°C)

The state of the art primary calibration facility includes, DC Bridge, Standard resistors, DMM-8½ digit, Multichannel scanner, Quartz sheathed SPRTs & HTSPRTs, TPW cell, Large sealed Fixed point cells(Mercury point to Silver Point) with dedicated maintenance baths and furnaces, PC with dedicated software for the generation of calibration reports wth temperature table.

Comparison Calibration (-70°C to 1200°C)

The comparison calibration facility of thermal lab is well equipped with a range reference SPRTs, PRTs, TCs and dedicated digital temperature indicators. A range of highly stable heat sources like LN2 comparison bath, Stirred alcohol & oil baths, dry block calibrators, thermocouple calibration furnace, Zero point well etc. can cover the temperature range from Boiling point of LN2 to 1200°C.

RH Calibration (10% to 95% & 5°C to 70°C)

The self contained relative humidity generator that measures and controls humidity with high accuracy based on "two pressure " generation principle have a large working volume to accommodate most of the humidity probes, chart recorders, humidity-loggers/transmitters and higrometers commercially available in industry for calibration.

ETL has well established quality system complying with ISO/IEC 17025. The laboratory is accredited by the National Accreditation Board for Testing & Calibration Laboratories (NABL), Department of Science and techniology, Govt. of India. The reference standards maintained in the laboratory are traceable to national standards.

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- State-of-the-art calibration standards are used by highly experienced calibration technicians.
- We provide extensive, accurate and timely calibration services at extremely competitive prices.
- Our Electro Technical & Temperature calibration services can be performed at your site or in our state-of-the-art laboratories.

This laboratory is capable of calibrating industrial and laboratory grade sourcing and measuring instruments for Electrical & Thermal parameters.

Calibration Capability - Source & Measure

ELECTRO TECHNICAL CALIBRATION		TEMPERATURE & RH CALIBRATION	
Parameters	**Range**	**Fixed point method**	**CMC**
DC Voltage	100 uV to 1000 V	-38.8344 C	6.6 m C
DC current with coil	100 μA to 1000A	0.01 C	2.9 m C
Resistance	1 uΩ to10GΩ	29.7646 C	4.2 m C
AC voltage	1 mV to 1000V	156.5985 C	5.4 m C
AC current with coil	1 mA to 1000A	231.928 C	4.9 m C
Frequency	1 Hz to 1.0GHz	419.527 C	6.6 m C
Time	1s to 5400 s	660.323 C	8.2 m C
AC Power, 50Hz , Single phase	1W to 8.8kW(upf)	961.78 C	19.7 m C
Capacitance @ 1kHz	0.19nF to 50mF	COMPARISON CALIBRATION	
Inductance @ 1kHz	100μH to 1H	Boiling Point of LN2	0.07 C
Oscilloscope Calibration	Band width up to 600MHz	-70 C to 300 C	0.020 C
		300 C to 660 C	0.053 C
Temperature Simulator/indicator Thermocouple Types B , C, E, J, K, N, R, S, T	-250°C to 2316°C	600 C to 1200 C	1.3 °C
Pt-100 RTD	-200°C to 800°C	10%-95% RH @ 25 C	0.51% RH
Pt-1000 RTD	-200 to 630°C	5 C to70 C @50% RH	0.12 °C

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SPECIAL ASSIGNMENTS & PROJECTS FACILITY

Apart from Hydraulic Performance tests and calibrations, FCRI is involved in evaluating and certifying Flow Products in Special Purpose Test Facilities. Here the performances of the flow products are checked for severe operating conditions as per design to evaluate its life in line with international and national standards. This facility also provide special tests for specific industries like Nuclear and Hydro Power industry, Water distribution systems, Automobile and aerospace industries.

The industry specific test facilities include

- High Pressure & High Temperature Testing,
- Fugitive Emission Testing
- LOCA/MSLB Test
- Product validation of swing check valve and air release valve
- Flow visualization schemes (PIV / High speed videography)
- Endurance / Life cycle Test facility
- Environmental Qualification Testing
- Cavitation Testing
- Cyclic Testing
- Cryogenic Testing
- Fire Testing
- Thermal Cyclic Testing

High Pressure and High Temperature Facility:

The high pressure high temperature loop has an operating pressure of 200 bar and temperature of 325°C with super cooled water as test medium. Pressure and temperature is attained with the help of a high pressure pump, heat exchangers and electrical heaters. Valves and flow elements with severe operating conditions can be tested in the high pressure high temperature endurance test loop for evaluating the life and performance. During test the required working pressure and temperature will be maintained on the upstream side when the valve is fully closed. Valve can be operated manually or with actuator against the set pressure. At the end of required mechanical cycles, the valve will be subjected to seat leakage test by applying the requisite pressure and temperature at the upstream side with downstream side open to atmosphere. Valve operation with rated differential pressure across the valve can also be performed in this loop. This facility is ideal for Endurance, Life cycle and Thermal cycling on valves and other flow devices.

Brief specification of the loop is

- Standards Followed : ANSI B 16.104
- Temperature : 0-350°C
- Ramp rate : 150°C/ hr. (max)
- Pressure rating: 0-200 bar
- Test Fluid : Water

Fugitive Emission Test / Type Approval Test / Elevated Temperature Test:

Here fugitive emission from control valves, isolation valves and other flow elements can be tested as per ISO 15848 or ISA 93.1 standard. Helium is used as the test fluid and Helium mass spectrometer is employed to measure the leak. Both vacuum and sniffing method can be employed for leakage measurement. During the test, valve will be subjected to the required mechanical and thermal cycles. The valve will be pressurised to a pressure corresponding to its pressure rating at the temperature set during the test. Number of mechanical and thermal cycles to be applied on the valve depends on the standard being followed. Valves upto 1500 class pressure rating and sizes upto 16" can be tested in this facility. The test temperature can vary from -196°C to +400°C.

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Type approval test as per SHELL specification (77-300) can also be performed in this facility. Two Helium mass spectrometer (ASM 142 & ASM 320) forms the heart of this facility.

Standards Followed : ISO 15848 Part I & II, ASME SEC V, ISA/ANSI 93.01, MESC SPE 77-300;77-312

Temperature : -196 to +400° C

Pressure rating : Up to ANSI 1500 Class

Minimum detectable leak rate for He : Sniffing: 1×10^{-7} mbar l/s Vacuum : 1×10^{-11} mbar l/s

LOCA/MSLB Testing for Nuclear valves:

Test facility for Steam Event Simulation for Loss of Coolant Accident and Main Stream Line Break (LOCA/MSLB) testing services meets the requirements of IEEE 323. This will enable testing of various components for the new, advanced reactor designs. MSLB/LOCA chamber simulates the harsh environment resulting due to LOCA/MSLB failure modes of Nuclear Reactors. The ability of the equipment to perform its required safety function while being subjected to the pressure, temperature, and humidity effects associated with the environment of a design basis accident. The required temperature, pressure and humidity profile will be generated in the chamber during testing. Provisions are made in the chamber to conduct actual operation of the device under test during LOCA / MSLB test environments.

Brief Specification of the LOCA/MSLB test facility is as under

- Overall Dimension of chamber : 1000 mm dia and 1 meter depth
- Inside dimension of Chamber : 950mm dia and 1 meter depth
- Chamber environment : To suite LOCA / MSLB conditions

Test facility for Water Transmission & supply systems (Sluice, Butterfly, Non-return, Air release valve ….)

Product validation of Sluice, Butterfly, Non-return, Air release valve has been carried out as Per BS EN 1074, BS EN 12266 - Part 1 & 2, ANSI/ISA-S75.02 suitable for water applications. The purpose of this test facility is the validation test requirements of the prototype products developed by the valve manufacturer. Swing Check Valve (SCV), Non-return Valve (NRV), Sluice Valve, Butterfly Valve and Air Release Valve (ARV) for use in pipe work can be tested in this facility. If any deviation outside normal design parameters is found the details shall be recorded in the test report. The test is accomplished by cycling the pump on and off and allowing the pressure to dissipate prior to the start of the next cycle and completing the required mechanical cycles. The following test such as Shell Test, Hi-pressure Seat / Closure Low-pressure Seat /Closure Test, Obturator (Disc / Wedge) Strength Test, Resistance of Valves to Bending Resistance of Valves to Operating Load (Max Torque - Min Strength), Valve Kv (Coefficient of Flow) was measured on the valve before the start of cyclic test and after the completion of cyclic test.

Standards Followed : BS EN 1074, BS EN 12266 - Part 1 & 2, ANSI/ISA-S75.02

Temperature : Ambient

Fire Testing Of Valves :

In this test facility Testing of valves -specification for fire type testing as per BS6755 Part-2 & Fire testing of valves as per API 607 is carried out and Test fluid is water. Test valve is mounted in the test setup in normal operating direction. Upstream side of the valve is mounted with water pump as per the schematic. Downstream side of the valve is connected to collecting tank to measure the valve seat leakage. Calorimeter and thermocouples are located at proper location of the test bench. Initial valve seat

leakage will be conducted at Room temperature and recorded. The valve temperature can be elevated upto 960° C by using fuel gas. During the test the valve seat leakage will be measured and the calorimeter temperature also will be recorded. After completion of the test the leakage rate is compared with allowable value.

- Standards Followed : API 607, API 6FA, ISO 10497:2010,
- Temperature : Upto 960°C
- Pressure rating : Upto ANSI 150 Class

Endurance Test Facility:

In this facility the test was conducted as a part of proof of design test for the valve .The valve will be tested for required numbers of mechanical cycles under the test pressure as per national and international standards. The test valve is mounted on the test fixture arrangement and both sides of the valve body will be covered by cylindrical flanged test head. Upstream side of the valve was connected to pump outlet arrangement with bypass connection. Downstream side was connected to the reservoir tank. Pressure gauge and pressure switch were provided in the upstream side and downstream side of the valve. The actuator was connected to control center with pre on/off setting time. The number of ON/OFF operation of the valve was counted by an electro-mechanical counter. Before the commencement of the cyclic test the valve was subjected to the following tests Performance test, Shell Test, Disc Strength Test, Seat leakage Test, Cyclic Test. The valve was subjected to a cyclic Opening/Closing test with required time interval. Each cycle consists of applying the rated differential Pressure to the disc in the closed position, then opening the valve to the wide open position and then closing the disc. After completion of the required cycles of operation the valve was subjected to seat leakage test as per the design proof testing. After completion of the cycle test, the valve was subjected to seat leakage test and strip test.

- Standards Followed : AWWA C 504, POD Test
- Temperature : Ambient. Pressure: PN 10
- Size upto : 48 inch

Environmental Test Facility:

FCRI has environmental test facility to perform Long term thermal aging testing to monitor degradation of the Test component using qualified test facilities which enable testing for the new, advanced designs. Thermal degradation refers to the change in chemical and physical properties of a material that occur at elevated temperatures. Increased temperature accelerates most of the degradation processes. It involves aging the proposed component at three or more elevated temperatures. After each heat cycle, samples are also subjected to a repeated series of environmental exposures, such as cold shock, mechanical stress and humidity Thermocouples and electronic temperature controllers are used to the test facility to maintain the specified thermal aging temperature. Temperatures are maintained within ±1°C of the specified thermal aging temperature. Redundant Controllers are used to prevent overheating of the test samples in the event of a malfunction of the main controller.

Brief Specification of the Thermal Ageing Test Facility

Thermal Ageing Test Facility-I	Thermal Ageing Test Facility-II
Chamber Size:32"×32"×32"	Chamber Size:33"×29"×35"
Temperature range: Ambient to 700°C	Temperature range:-75 to 180°C

Cryogenic Test:

FCRI is equipped with all infrastructure required for Cryogenic Testing of valves as pre national/international standards.

The test valve is mounted on the test fixture arrangement and the line is to be flooded and entrapped air to be cleared using circuit air bleeds. Both side of the valve body was covered by blind flange. The test valve was pressurized in one direction in closed position and seat performance is checked for required time duration. During the test, one side of the valve is subjected to rated pressure. Liquid nitrogen was filled in the container and the temperature of the valve body and bonnet are measured and recorded. Once the rated temperature reached, valve seat leakage is measured and recorded. After completion of the test, the valve opening torque can be measured and recorded. Condition of the valve was visually observed for any damages. Other hydraulic components such as wire mesh hoses and braided hoses etc are also tested for their performance in this facility.

Standards Followed	:	BS 6364
Temperature	:	Upto -196^{0} C
Pressure rating	:	Upto ANSI 150 Class

Hydraulic Impulse Testing:

To ensure the long life and trouble free performance of hydraulic components Hydraulic impulse testing is being used for qualification and performance evaluation of hydraulic system components.

The hydraulic power unit (HPU) is the mechanical source of high-pressure hydraulic fluid required to operate the test components. A motor drives a hydraulic pump which Test fluid shall be water/oil. Test valve is mounted in the test setup in normal operating direction. Upstream side of the valve draws hydraulic fluid from a reservoir and pressurizes it upto 140 bar. The pressurized fluid is made available to the hydraulic test components. The HPU can produce low and high pressure output and low and high flow output. When proof pressure tests are used to determine leakage of hoses or hose assemblies, the specified proof pressure in accordance with the product standard is applied and the test components are examined during this period for evidence of leakage, cracking, abrupt changes in the dimensions of the component. The online data was logged to the Data Acquisition system continuously.

Operating pressure	:	0 to 140 bar
Size	:	3/8 Inch
Flow	:	0-40 LPM
Standards followed	:	DS/EN ISO 1402
Temperature	:	Ambient

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ENVIRONMENTAL QUALIFICATION LABORATORY

Noise & Vibration laboratory of FCRI is well equipped in the area of Calibration & Testing activities. It has the capability to handle various site assignments, including on board ships, Power plant, process plants etc. The calibration facility of FCRI is accredited by NABL for calibration of acoustic and vibration parameters. This is one of the higher level calibration facility in India. It has well experienced team of engineers to handle calibration and site assignments.

NABL accreditation details

Sl. No.	Parameter/Measurement quantity		Range(s) of measurement	Best measurement capability
1	**Acoustic Pressure**			
	Sound pressure level (Calibration of Sound level Meter)-single point		94dB & 114dB @ 1kHz,124 dB at 250Hz	0.3dB
	Sound pressure level (Calibration of Sound level Meter)-Multi point		94, 104, 114 dB at 31.5 Hz to 16kHz Octave band centre frequency	0.3dB
	Sound pressure level (Calibration of Sound level calibrator/ Acoustic calibrator)		94dB, 104dB & 114dB@ 31.5Hz to 16kHz Octave band centre frequency	1.2dB
2	**Acoustic Pressure**			
	Sound source(ISO3745)		125Hz to 16kHz	2dB
	(ISO3744)		125Hz to 16kHz	3dB
3	**Vibration amplitude**			
	Multi point calibration of vibration meter/analyzer	Acceleration	0.1 g to 10 g (RMS) Frequency range 5Hz to 5kHz	2.4%
		Velocity	1 mm/sec to 1000 mm/sec (RMS) Frequency range 5Hz to 5kHz	2.4%
		Displacement	0.01 mm to 10mm (pk) Frequency range 5Hz to 1kHz	2.4%
	Single point calibration of vibration meter	Acceleration	9.81 m/sec2 @ 159.2 Hz	2.5%
		Velocity	9.81 mm/sec @ 159.2Hz	2.5%
		Displacement	9.81 microns @159.2 Hz	2.5%
4	**Vibration exciter**		0.1g to 10g @ 5Hz to 5kHz	2.1%
5	**Speed**			
	Non contact tachometer, speed sensors		60 to 10000rpm	1.0 rpm
			10000 to 50000rpm	2.0 rpm
			50000 to 100000rpm	3.5 rpm
	Contact type tachometer, stroboscope, speed indicator		100 to 10000 rpm	1.7 rpm
	Laboratory centrifuge/ MST apparatus (single spindle speed)		100 to 10000 rpm	1.0 rpm
			10000 to 20000rpm	2.0 rpm

6	Vibration Sensor / Accelerometer		
	Accelerometer / vibration sensor up to 300 gram	Reference sensitivity 1 g & 10g @ 100 Hz & 160 Hz	1.7%
		Frequency response	
		2 to 5Hz	2.0%
		5 to 20Hz	2.0%
		21 to 99Hz	2.0%
		100 to 160 Hz	1.7%
		161Hz to 1 kHz	1.5%
		>1kHz to 5kHz	1.7%
		>5kHz to 10kHz	2.0%
		10kHz to 15kHz	--
		Linearity upto 20g	1.7%

Instruments that can be calibrated at this facility with NABL accreditation are

- Sound level meter/ analyzer
- Acoustic / Sound level calibrator
- Piston phone
- Vibration analyzer
- Vibration sensors such as accelerometer, velocity pick ups
- Accelerometer calibrator
- Signal conditioner
- Contact and Non contact type tachometer
- Stroboscope
- Laboratory centrifuge/ MST apparatus etc.

Acoustic test facility

Acoustic test Facility of FCRI is well equipped with latest Sound level analyzers, Hemi - anechoic chamber, Sound source and free field test area.

These test facilities are used by

- Flow product manufacturers for noise evaluation
- Automobile sector for noise testing of products and accessories
- Engineering manufacturing sector for noise reduction purposes
- Process and power plant operators for noise survey
- Ship builders for occupational noise and vibration measurement
- Medical & computer parts manufactures for noise evaluation

FCRI is one of the approved test agency notified by Central Pollution Control Board of India for Noise certification of DG sets.

Valve noise measurement

DG set - site testing

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Vibration test facility

FCRI's vibration test facility comprises of latest vibration analyzers, accelerometer, Electro dynamic shakers. Major activities of vibration test facility are

- Vibration measurement of ship board, power plant and process plant equipments at site
- Vibration measurement of control valve as per MIL-STD-740-2(SH)-1987 "Structure borne vibratory acceleration measurements and acceptance criteria of shipboard equipment"
- Resonance search test by impact hammer method and exploratory vibration method
- Fatigue testing of specimens
- Static and dynamic strain measurement

Specifications of the Vibration test facility

Specification	2T shaker	6T Shaker
Make	Unholtz - Dickie Corporation, USA	LDS Test & Measurement, UK
Force rating	Sine 2040 kgf Random 2040 kgf (rms) Shock 4080 kgf (pk)	Sine 6000 kgf Random 6000 kgf (rms) Shock 18000 kgf (pk)
Frequency range	5 Hz to 2500Hz	5 Hz to 2500Hz
Profile capability	Sine sweep, Random, shock, track and dwell	Sine sweep, random, shock, sine on random, random on random
Number of monitoring channel	4	8
Vibration amplitude limit	Acceleration : 95g pk Velocity (Sine) : 1.8 m/sec (pk) Velocity (shock): 2.4 m/sec (pk) Displacement: 51 mm pk-pk	Acceleration : 140g pk Velocity (Sine) : 1.8 m/sec (pk) Velocity (shock): 2.4 m/sec (pk) Displacement: 63 mm pk-pk
Vertical table size	610 mm x 610 mm	1200 mm x 1200 mm
Horizontal table size	915mm x 915 mm	1500 mm x 1500 mm

Test capabilities of the system are given below

- Environmental test on electrical & electronic items on vibration as per the standard IS 9000 (part VIII)
- Seismic qualification test as per the standard IEEE 344
- Vibration test as per OIML R 185/1993
- Exploratory vibration test as per ANSI B16.41
- Shock testing as per IS 9001 Part 17 Sec 1/1985
- Vibration testing as per QM - 333 and QM 351
- Vibration testing as per JSS 55555
- Vibration testing of automobile parts as per JIS D1601/1995
- Vibration testing as per various standards and as per customer's requirement.

VIBRATION TEST FACILITY

Major Calibration & Testing Facilities at FCRI

Laboratory Fluid Flow NABL C026 / T027	Max. Flow Rate (m^3/h)	Max. Line Size	Uncertainty in Flow Rate (% reading)	Uncertainty in Volume (% reading)
Water Flow	4500 15000	900mm 2000mm	Upto 600 m^3/h : ±0.05% 600 to 2500 m^3/h : ±0.10% 2500 to 4500 m^3/h : ±0.15% 5000-15000 m^3/h : ±0.5%	20m^3 : ± 0.05%
Air Flow At Ambient conditions	10000	400mm	0-40m^3/hr : ± 0.1% >40m^3/hr : ± 0.25%	0-0.5 m^3: ± 0.1% 2 m^3 : ± 0.1%
Closed loop Air Test Facility (20 Bar) * Calibration Loop * Gravimetric Loop	 400 50	 100mm 50mm	 ± 0.3% ± 0.1%	
Oil Flow	650	250mm	0-100m^3/hr : ± 0.05% 100-650m^3/hr : ± 0.075%	Upto 1.8 m^3 : ± 0.03% 1.8m^3 to 9 m^3:± 0.04%
Compressed Natural Gas	4500 Kg/hr	1.5"	± 0.1%*	*under-Accreditation

	Parameters	Range	CMC Calibrations & Measurement Capability	Parameters	Range	Calibration & Measurement Capability
Mechanical Calibration Metrological, Pressure, Noise, Vibration etc. NABL C 056	**MASS**-Standards Weights	1mg and upto 500kg	0.00204 mg to 3 g	PRESSURE Pressure transducers	6-60 kg/cm^2 60-1200 kg/cm^2	±0.02% of rdg ±0.015% of rdg
	MASS-Weighing Balance & Mass Comparator	Various ranges from 0-2 g and upto 0-600 kg 0-20000 kg	0.001mg/g to 40 mg/kg 189 mg/kg	**PRESSURE**-Gauge pressure transducers (Pneumatic)	30 mbar to 2000 mbar abs 0.25 bar to 20 bar abs	±0.02% of rdg ±0.02%of rdg
	VOLUME –Specific Gravity bottle, Pipettes, Burettes measuring flasks	0.05 ml - 5000 ml	±0.01% of rdg	**PRESSURE** –Low Pressure Gauge & Differential	0.2 mbar to 3.2 mbar 3.2 mbar to 9.5 mbar 10mbar to 160 mbar	±0.2% of rdg ±0.16% of rdg ±0.023% of rdg
	DENSITY - Hydrometers	0.64g/cc - 1.98 g/cc	±0.0005g/cc	**PRESSURE** – Gauge Pressure Transducer (Pneumatic)	30 mbar to 2000 mbar g 1 bar g to 140 barg	±0.02% of rdg ±0.02% of rdg
	VISCOSITY- Liquids & Viscometers	1 to 60000 mPas/cSt	+/- 1% rdg	**PRESSURE**– Vacuum (Gauge)	-15 to -980 mbar g	±0.03% of rdg
				LENGTH-Slip Gauges(steel)	0.5 – 100 mm	0.05 µm to 0.16 µm
	Acoustic Pressure	94 dB @ 1 Khz 114 dB @ 1 Khz 124 dB @ 250 Hz	0.3 dB	Acceleration	10 to 100 m/s^2 (1 to 10g)	2.4% (5 Hz to 5 Khz)
	Sound Power	30 dB to 130 dB 31.5 Hz to 16 KHz	1.2 dB	Vibration Sensor	2 HZ to 15 Khz	2.5%
	Speed (Contact)	100 to 10000rpm	1.6 rpm	Vibration Sensor Sensitivity Check	100 - 160 Hz	1.30%
	Speed (Non Contact)	50 to 10000 rpm 10000 to 50000 rpm 50000 to 100000 rpm	1.0 rpm 2.0 rpm 3.5 rpm			
Electro Technical Calibration NABL C 0254	DC Voltage Source Measure	±100µV to ±1000V ±0.1mV to ±1000V	0.60% to 0.001% 0.12% to 0.0012%	DC Current Source Measure	±100µA to ±900A ±100µA to ±10A	0.014% to 2.0% 0.013% to 0.005%
	AC Voltage Source Measure	1mV to 1000V 100mV to 1000V	0.4% to 0.014% 0.04% to 0.03%	AC Current Source Measure	100µA to 700A 100µA to 10A	0.04% to 1% 0.06% to 0.035%
	Resistance Source Measure	10µΩ 10G Ω 100µΩ 1G Ω	0.6% to 0.02% 0.42% to 0.5%	Function Generator	1 Hz to 15 MHz	0.3% to 0.0025%
	Time	1 Sec - 5400 Sec	0.2µSec to 6.3µSec	Frequency	1 Hz to 600 MHz	1.0µHz to 1.2 Hz
Temperature Calibration NABL C 0255	Temperature	-70°C to +1200°C	±0.07°C to 1.3°C	Fixed Point cells	-38.8344°C to 961.78°C	6.3m°C to 24m°C
	*Temperature & Humidity Chamber	- 70°C to 180°C 10% to 95% RH		*IP Tests – Dust	IP 5X & IP 6X	
				*IP Tests – Water	IP X3 to IP X8	

* Not in NABL Scope

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