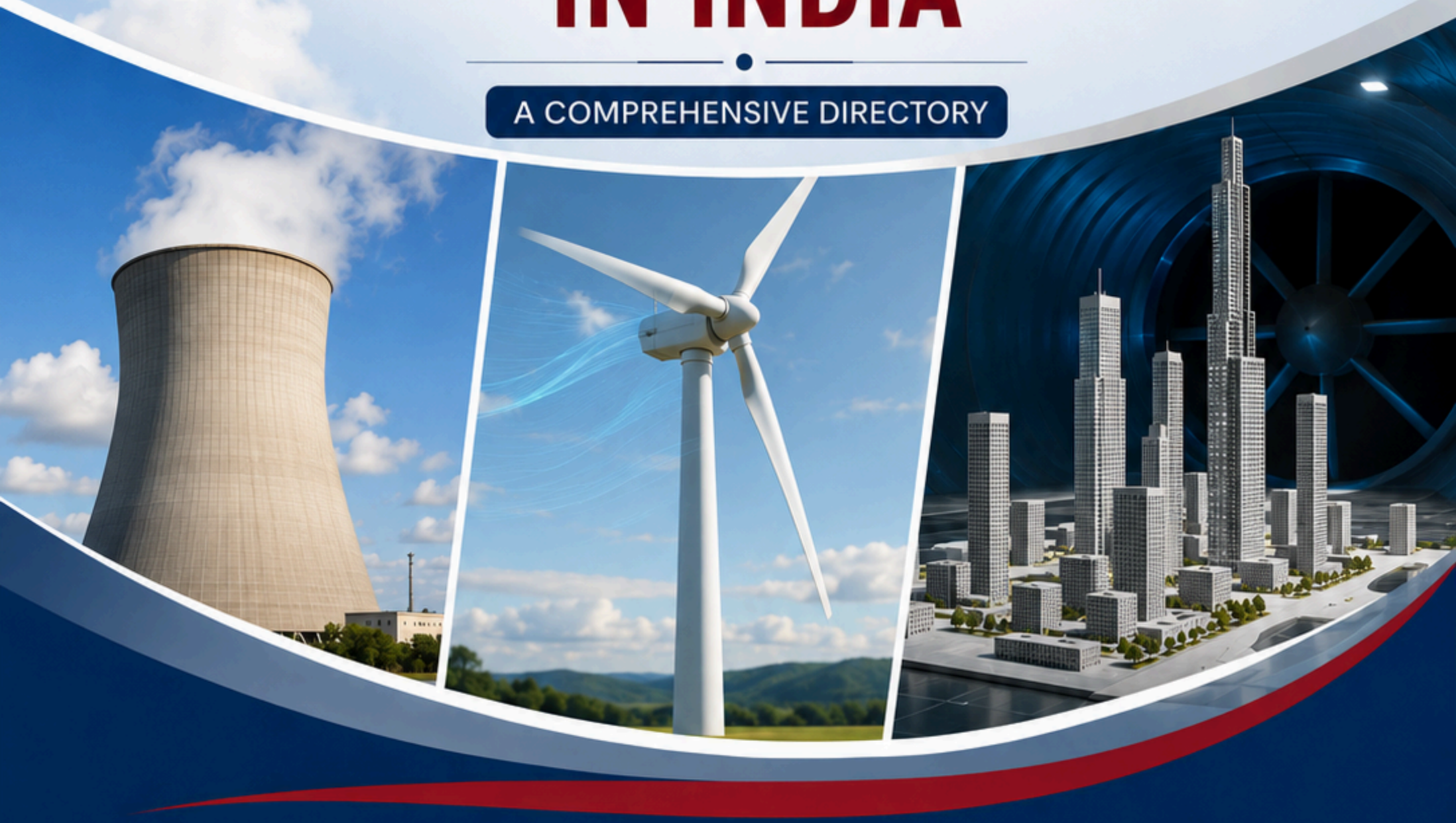
INDIAN SOCIETY FOR WIND ENGINEERING

DIRECTORY OF WIND TUNNEL FACILITIES IN INDIA

A COMPREHENSIVE DIRECTORY



Comprehensive Database

Advancing Wind Engineering

Supporting Research, Design & Safety

Building a Resilient Future

Key Institutions & Industry:

Indian Institute of Science (IISc), National Wind Tunnel Facility (NWTF, IITK), National Aerospace Laboratories (NAL), IITs (Bombay, Kharagpur, Roorkee), CSIR-SERC, DRDO, NSTL DRDL, DOAT, BIT Mesra, IIST, PEC, JUET

Birla Institute of Technology, Mesra Ranchi
Subsonic Wind Tunnel

Type of Tunnel: Subsonic wind tunnel (Continuous)

Year of Establishment: 1975

Test Section Size: 600 mm X 600 mm

Application

- Aerospace and Non-aerospace
- R&D
- Laboratory classes for students
- Project for ME students
- PhD students
- Sponsored projects

Speed range: 5 m/s - 30 m/s

Reynolds Number Range (per m): 3×10^5 to 2×10^6

FreestreamTurbulence Level: 0.5%

Type of Tests Performed

- Tuft flow visualization
- Oil flow visualization
- Static Pressure measurement
- Unsteady pressure measurement
- Force and Moment measurement

Angle of attack: 0° to 60°

Instrumentation

- Multi-tube Manometer
- Pressure transducer, pressure scanners
- Unsteady pressure Transducer (Kulite Make)
- 6 component Strain gauge balance
- Digital Camera
- Electronic speed controller
- Signal conditioners

Data Acquisition System

- PC Basses Data Acquisition Systems
- With low and high speed NI DAQ, Labview

Special test rigs and test techniques developed

- PC controlled incidence mechanism

Customers:

- Sponsored Projects from ARDB
- Sponsored Projects from CSIR

- Laboratory classes for students
- ME Students (Projects)
- PhD Students (Thesis)

Major modifications / Upgrades / Augmentations made in the last 5 years : Automation through DAS

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Indian Institute of Science, Bangalore
Department of Aerospace Engineering

Type of Tunnel: Low-Speed, Continuous, HorizontalWind Tunnel

Year of Establishment: 1959

Test Section Size and Shape: 14 ft x 9 ft(4.25mx2.75m), Octagonal

Application

- Aerospace and non-aerospace
- R&D/Industrial

Mach Number Range: 45 m/s (Max.)

Turbulence Intensity: <0.15%

Type of test Performed

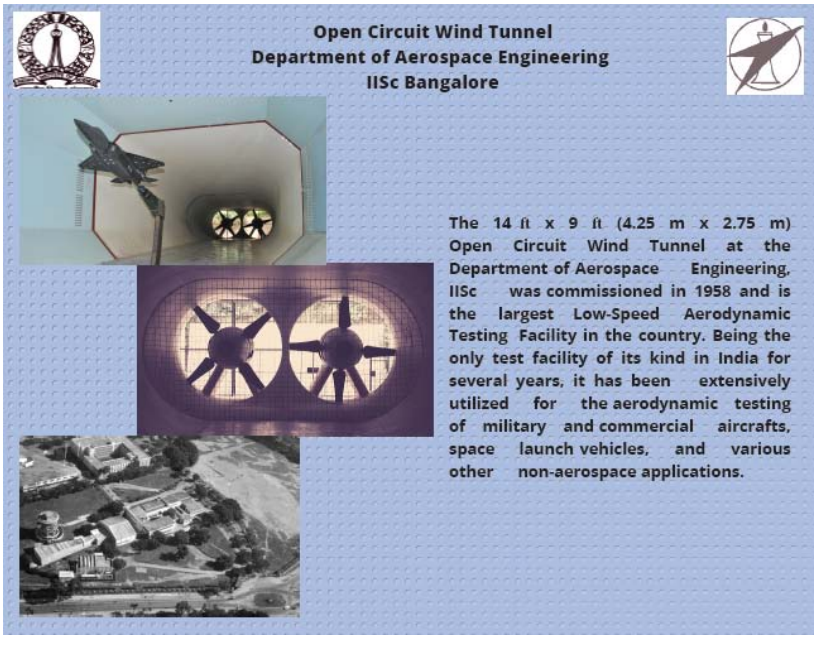
- Steady and unsteady force and moments measurements
- Steady and unsteady pressure measurements
- Wind Engineering
- Flow visualization

Test Control Parameters:

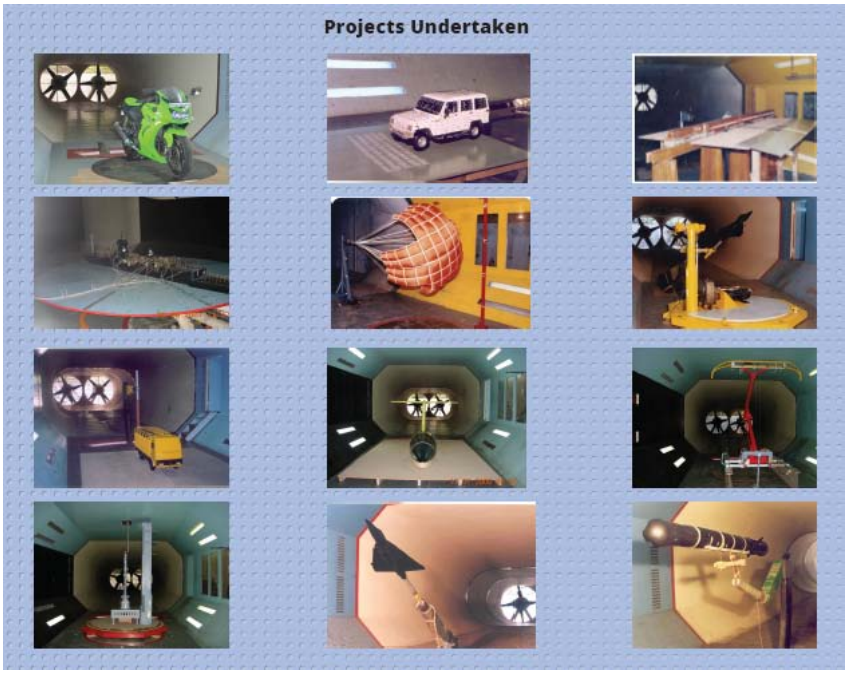
- Ranges of Pitch, Yaw, and Roll: -15° < pitch >30 °, Yaw = ±28° and Roll: Nil
- Typical Test Duration: 5 minutes

Data Acquisition System: NI Based

Customers: ADE, ADA,CABS, NAL, HAL,ISRO, etc.



The open-circuit wind tunnel in the old Aerospace Engineering building



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Indian Institute of Science, Bangalore
Department of Aerospace Engineering

Type of Tunnel: Low-speed, Low Turbulence Wind tunnel (LT-1)

Test Section Size:0.5m x 0.5m (c/s) x 3m (length)

Motor Power: 5 kW (6.7hp)

Contraction Ratio:13

Turbulence intensity: 0.1 %

Maximum Wind Speed: 22 m/s

Inlet Area: 1.82m x 1.82m

Type of Test Performed

- Fluctuating velocity and pressure measurements
- Wall shear stress measurements

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry
- Piezo-resistive transducers
- NI data acquisition system

Application

- Fundamental and applied fluid dynamics research: transitional and turbulent boundary layers

Low Turbulence Wind tunnel 1 (LT-1)

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Indian Institute of Science, Bangalore
Department of Aerospace Engineering

Type of Tunnel: Low-speed, Low Turbulence Wind Tunnel (LT-2)

Test Section Size: 0.6m x 0.6m (c/s) x 2.5m (length)

Motor Power: 15 kW (20hp)

Contraction Ratio:9

Turbulence intensity: < 0.2 %

Maximum Wind Speed: 45 m/s

Inlet Area:1.82m x 1.82m

Type of Test Performed

- Fluctuating velocity and pressure measurements
- Wall shear stress measurements

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry
- Piezo-resistive transducers
- NI data acquisition system

Application

- Fundamental and applied fluid dynamics research: transitional and turbulent boundary layers

Low Turbulence Wind Tunnel 2 (LT-2)

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Type of Tunnel: Closed circuit Low Speed Wind Tunnel

Test Section Size: 1m x 1m (c/s) x 3.5m (length)

Motor Power: 18 kW (25hp)

Contraction Ratio:7.84

Turbulence intensity: <0.1 %

Maximum Wind Speed: 25 m/s

Type of Test Performed

- Fluctuating velocity measurements
- pressure measurements
- wall shear stress measurements
- Load measurements
- Flow visualization

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry(1khz)
- High-speed camera
- IR camera
- Force measurements using Strain gauge balance

Application

- Airfoil model testing: Post-stall studies, Laminar separation bubbles

Closed circuit Low Speed Wind Tunnel (WT-1)

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Department of Aerospace Engineering

Type of Tunnel: Suction type Low Speed Wind Tunnel

Test Section Size: 1foot x 1foot (c/s) x 3m (length)

Motor Power: 7.5 kW (10hp)

Contraction Ratio:11.11

Turbulence intensity: 0.2 %

Maximum Wind Speed: 20 m/s

Suction Inlet Area:1.0 m x 1.0 m

Type of Test Performed

- Fluctuating velocity measurements
- pressure measurements
- wall shear stress measurements
- Load measurements
- Flow visualization

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry(15 hz)
- High-speed camera
- Force measurements using Strain gauge balance

Application

- Flat plate turbulent boundary layer flow with pressure gradients induced by top-wall contours

Suction type Low Speed Wind Tunnel (WT-2)

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Type of Tunnel: Closed Circuit Low SpeedWind Tunnel (WT-03)

Test Section Size :680mmx460mm (c/s) x 1.5m (length)

Motor Power :22 kW (30hp)

Contraction Ratio:3.58

Turbulence intensity :0.2 %

Maximum Wind Speed :20 m/s

Blower Inlet Area :0.8 m x 0.5 m

Type of Test Performed

- Fluctuating velocity measurements
- pressure measurements
- wall shear stress measurements
- Load measurements
- Flow visualization

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry(15 hz)
- High-speed camera
- IR camera
- Force measurements using Strain gauge balance

Application

- Scaled-down model testing, Flat plate turbulent boundary layer flow with pressure gradients induced by top-wall contours

Closed circuit Low Speed Wind Tunnel (WT-03)

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Indian Institute of Science, Bangalore
Department of Aerospace Engineering

Type of Tunnel: Low-speed, Cascade Wind Tunnel (WT-04)

Test Section Size :765mmx305mm (c/s)

Motor Power :37 kW (50hp)

Contraction Ratio:9

Turbulence intensity :0.2 %

Maximum Wind Speed :20 m/s

Blower Inlet Area :0.49 m x 0.37 m

Type of Test Performed

- Fluctuating velocity measurements
- pressure measurements
- wall shear stress measurements
- Flow visualization

Instrumentations

- Hotwire anemometry
- Particle Image Velocimetry(15 hz)
- High-speed camera
- IR camera

Application: Turbomachinery blade model testing

Cascade Wind Tunnel (WT-04)

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Indian Institute of Space Science & Technology,Thiruvananthapuram
Department of Aerospace Engineering

Subsonic Wind Tunnel - 1

Test Section Size: 250 x 500 x 600 mm

Maximum Speed: 25 m/s

Fan: Axial flow fan (dia. 900 mm)

Motor power: 3 HP with speed control drive

Maximum motor speed: 1400 rpm

Subsonic Wind Tunnel - 2

Test Section Size: 300 x 300 x 2000 mm

Maximum Speed: 40 m/s

Fan: Axial flow fan (dia. 900 mm)

Motor power: 5 Hp with speed control drive

Maximum motor speed: 1400 rpm

Flow Visualization Wind Tunnel

Test Section size: 200 x 100 x 300mm

Maximum Speed: 5 m/s

Fan: Axial flow fan (dia. 300 mm)

Motor power: 1 HP with speed control drive

Maximum motor speed: 1400 rpm

Shock Tube Facility

Driver: Cold gas

Tube Size: 6.4 m long driver/driven, 60 mm lD

Pressure rating: 200 bar

Enthalpy range: < 3 MJ/Kg

Steady flow duration: 4 ms (in tailored interface operation)

Customer: Students

Contact Person

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Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Low-Speed Wind Tunnel (WT-1)

Test Section Size: 2 x 2 feet (610 x 610 mm)

Application

- Aerospace and non-aerospace
- R&D
- Academic lab

Speed Range: 1 m/s – 25 m/s

Type of test Performed

- Flow visualization
- Static pressure measurements

Instrumentation

- Digital micro manometer
- Pressure scanners.
- Pitot tubes.
- Smoke generators

Customers: Students for laboratory classes, research scholars, industrial consultancyprojects.

Photographs of Low speed wind tunnel

Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Low-Speed Wind Tunnel (WT-2)

Test Section Size: 450 mm x 450 mm

Application: Laboratory classes for students

Speed Range: 1 m/s to 25 m/s

Type of test Performed

- Flow visualization
- Static pressure measurements
- Aerodynamic force measurements

Instrumentation

- Digital micro manometer
- Pitot tubes
- Force balance
- Traversing mechanism

Customers: Students for laboratory Classes

Photograph of the test facility (WT-2)

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Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Closed Circuit Wind Tunnel (WT-3)

Test Section Size: 2 x 2 feet (610 x 610 mm)

Application

- Aerospace and non-aerospace.
- R&D

Speed Range: 1 m/s – 20 m/s

Type of test Performed

- Tuft flow visualization
- Oil flow visualization
- Smoke visualization
- Static pressure measurements

Instrumentation

- Digital micro manometer
- Pressure scanners
- Pitot tubes
- Smoke generators
- Laser sheet flow visualization

Customers: Research scholars, industrial consultancy projects.

Photograph of the test facility (WT-3)

Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Open Jet Wind Tunnel

Test Section Size: 16 x16 inch (406.4 x 406.4 mm)

Application

- Aerospace and non-aerospace
- R&D
- Academic lab

Speed Range: 1 m/s – 25 m/s

Type of test Performed

- Flow visualization
- Static pressure measurements
- Hot-wire anemometry of boundary layer
- Calibration of flow measurement equipment like pitot probes and anemometers

Instrumentation:

- Digital micro manometer
- Pressure scanners
- Pitot tubes
- Smoke generators
- Hot-wire anemometer

Customers: Students for laboratory classes, research scholars, industrial consultancy projects.

Photographs of Low speed wind tunnel

Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Flight DynamicsWind Tunnel

Test Section Size: 3 x 3 feet (914 x 914 mm)

Application:

- Aerospace and non-aerospace
- R&D
- Industrial consultancy projects

Speed Range: 1 m/s – 25 m/s

Type of test Performed

- Tuft flow visualization
- Oil flow visualization
- Smoke visualization
- Static pressure measurements

Instrumentation

- Digital micro manometer
- Pressure scanners
- Pitot tubes
- Smoke generators
- Laser sheet flow visualization

Customers: Research scholars, industrial consultancy projects

Photograph of the test facility

Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Vertical Wind Tunnel with Axial Flow Fan

Test Section Size: 90 mm x 90 mm (exit section)

Application: Laboratory classes for students

Speed Range: 1 m/s to 25 m/s

Type of test Performed: Students experiments for calibrating hot-wire anemometer

Instrumentation

- Digital micro manometer
- Pitot tubes
- Traversing mechanism
- Hot-wire anemometer

Customers: Students for laboratory Classes.

Photograph of the test facility

Department of Aerospace Engineering
Aerodynamics Lab, IIT Bombay

Type of Tunnel: Planar Jet Facility

Test Section Size: 435 mm x 18 mm

Application: Laboratory classes for students

Speed Range: 1 m/s to 70m/s

Type of test Performed

- Flow study
- Instrumentation
- Digital micro manometer
- Pitot tubes
- Traversing mechanism

Customers: Students for laboratory classes

Photograph of the test facility

Contact Person for all the aboveIIT Bombay Tunnels

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Indian Institute of Technology Kanpur
National Wind Tunnel Facility (NWTF)

Type of Tunnel: Closed-Return, Continuous, Atmospheric wind Tunnel

Year of Establishment: 1999

Test Section Size: 2.25 m (height) x 3 m (width) x 8.75 m (length)

Important Features of NWTF:

- High Reynolds number Simulation
- Reynolds number: Up to 5 million/m
- Wind Speed Range: Up to 80 m/s
- Very Low Turbulence (u'/U< 0.08%)
- High Productivity
- Interchangeable Mobile Test Sections for faster setup change
- Fully Automatic Measurement and Control Systems

Special Systems and Equipment:

- Sting Type Model Support System with Five Independent Motions
- Turntables systems for aeronautical and non-aeronautical applications
- 3 D Stereoscopic PIV system

Special Test Rigs and Techniques:

- Full-model testing with sting support system
- Half-model testing with external balance
- Two-dimensional model testing using turntables
- Gust and cross-wind simulation
- ABL simulation for non-aerospace applications
- Aero-acoustic testing

Control Parameters:

- On model Pitch, Roll, and Yaw Sensors
- Roll, Pitch, Yaw (0.01deg.) Motion
- Y & Z Motions (~ 0.1mm)
- Preset and Continuous Movements

Instrumentation:

- Flex- motion Eight-axis closed loop Control System
- 32 Port ESP Scanners (±10" & ±20" WC, ±2.5, ±5.0 & ±10 PSI range with 0.05% accuracy)
- Strain Gage based Load Cells and 6-Component Balances
- Dantec Streamline CTA System
- B & K Microphone Sensors and Noise Measurement System
- RTD and Thermocouple Sensor Based Temperature Measurement

Data Acquisition Systems

- Industry Standard PXI System with Real Time Controller
- LabVIEW based Integrated Data Acquisition System
- Standard DAQ and Motion Control Hardware
- Separation of Data Acquisition and User Work Stations

Applications:

- Aerospace and Non-aerospace
- R&D and Industrial

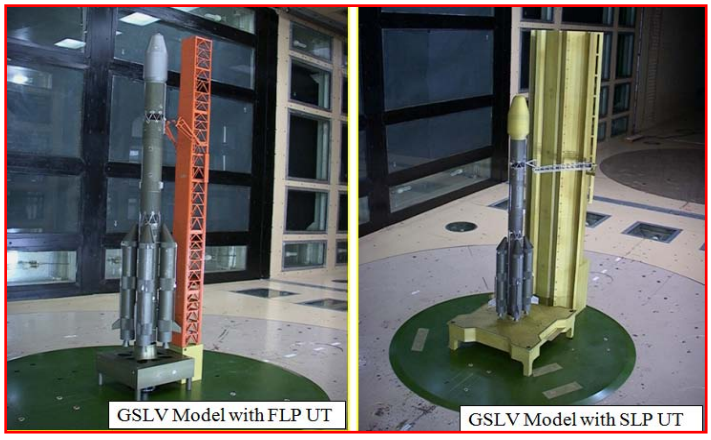
Major Customers of NWTF:

- ADA Bangalore, ADE Bangalore, NAL Bangalore, ADRDE Agra, ARDE Pune, DRDL Hyderabad, VSSC Thiruvananthapuram, Boeing USA, HAL Lucknow, RDSO Lucknow and various industries such as BHEL, L&T, TATA Motors, Ashoka Towers, Gammon India, Thermax Ltd., LANCO Infratech Ltd., Lodha and Shreepati Groups, etc.

Major Projects Executed at NWTF:

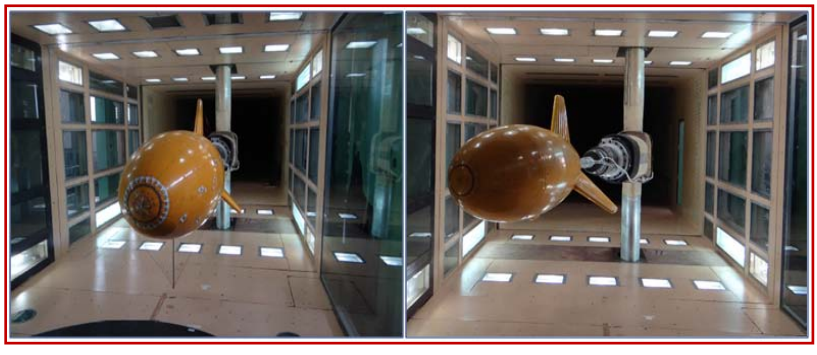
- Fundamental Study on Bluff Body Flows, Aerodynamic studies on Reusable Launch Vehicles and Space Recovery Capsules, Lift-off Study for GSLV and PSLV, Aerodynamic Studies on Light Transport and Fighter Aircrafts, Air-intake studies on fighter aircrafts and Missiles, Deployment Studies on Parachutes with different Shapes and Configurations, Aerodynamic optimization study on Ram-air Parachute Models, Aerodynamic studies on Automobiles and Automotives, Wind Tunnel Study on Pantographs for Locomotives, Wind Tunnel Studies on High-rise Buildings, Wind Tunnel Studies on Thermal Plant Structures (including Aeroelastic Testing of Chimneys and NDCTs), Wind Tunnel Studies and Flow Visualization on TELCO Passenger Car

Aircraft model mounted on Robotic Arm for aerodynamic study

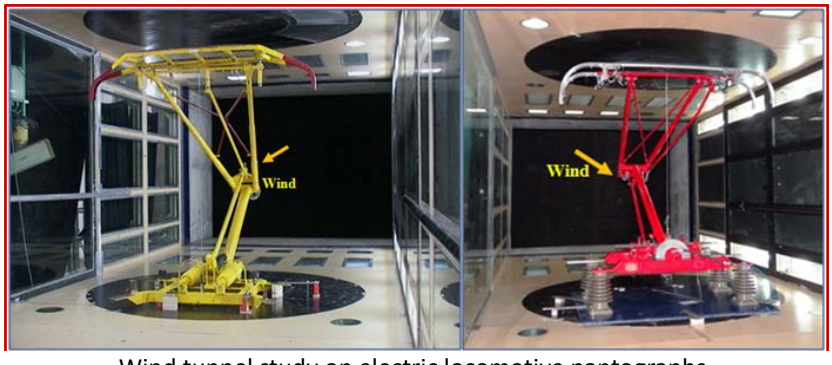


Ground effect study on launch vehicle models

Air intake studies at NWTF



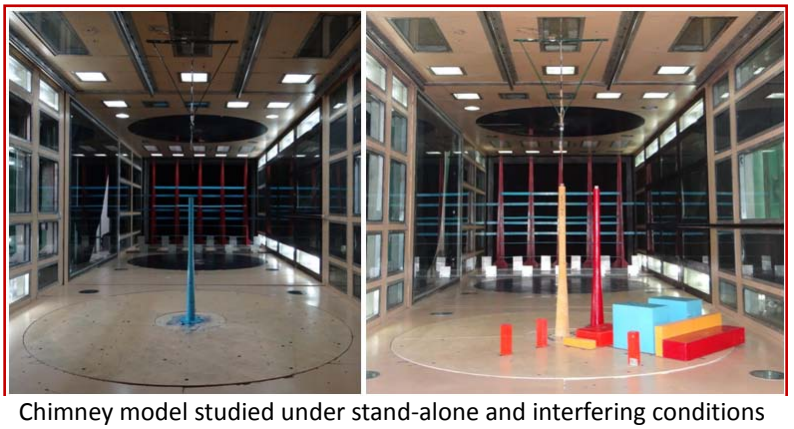
Force and Pressure measurement on aerostat model



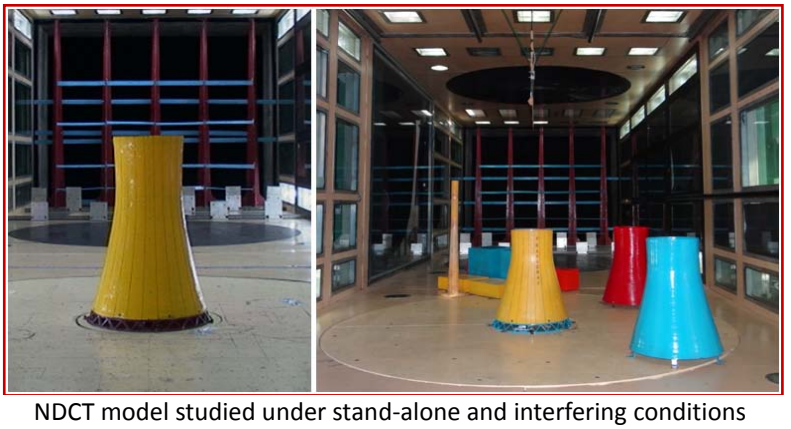
Wind tunnel study on electric locomotive pantographs

Wind tunnel study on motor cycle

Drag reduction study on a truck model

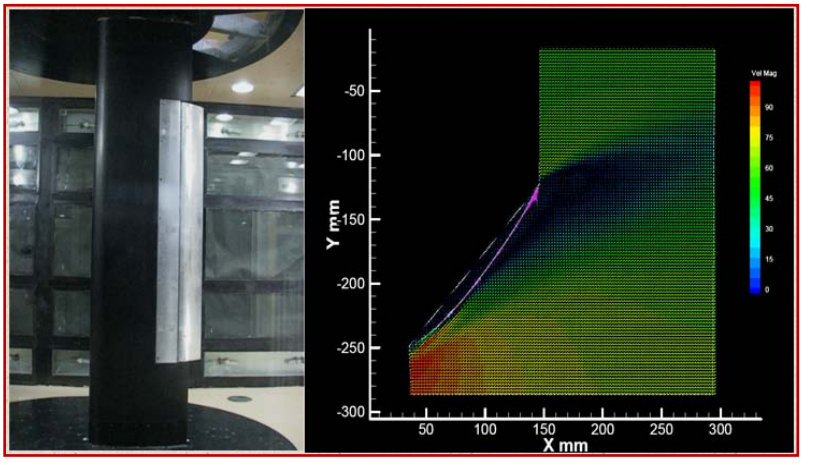


Chimney model studied under stand-alone and interfering conditions



NDCT model studied under stand-alone and interfering conditions

High-rise building models studied under simulated flow condition



PIV measurement on multi-element wing model for flow field studies

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Indian Institute of Technology Kharagpur
Department of Aerospace Engineering

Type of Tunnel: Continuous, Horizontal, suction type, open loopWind Tunnel (WT-1)

Test Section Size: 60 cm X 60 cm (Square)

Year of establishment: Around 1967

Application

- Aerospace and non-aerospace
- R&D

Speed Range: 17 - 35 m/s

Free Stream Turbulence Level: 0.5% -1%

Type of Test Performed

- Steady and unsteady force and moment measurements
- Steady and unsteady pressure measurements
- Flow visualization

Instrumentation

- Pitot probes & anemometer
- Pressure transducers (DSA and ZOC)
- Sting balance (6 component)
- ATI load cell
- PIV (2D and stereo)

Data Acquisition Systems used: LabVIEW Software

Photograph of Low speed wind tunnel (WT-1)

Indian Institute of Technology Kharagpur
Department of Aerospace Engineering

Type of Tunnel: Continuous, Horizontal, Blow down, open circuit Wind Tunnel (WT-2)

Test Section Size: 250 cm X 150 cm X 9m long

Year of establishment: 1987

Application

- Aerospace and non-aerospace
- R&D
- Industrial

Speed Range: Upto 12 m/s

Free Stream Turbulence Level: < 1%

Type of Test Performed

- Steady pressure measurements
- Wind engineering
- Flow visualization
- Force measurement

Test control Parameters

- Special features: provision to generate Atmospheric Boundary Layer
- Turn table

Instrumentation

- Pitot probes & anemometer
- pressure transducers

Data Acquisition Systems used: LabVIEW Software

Model mounted in Low speedWind Tunnel (WT-2)

Indian Institute of Technology Kharagpur
Department of Aerospace Engineering

Type of Tunnel: Low speed, Wind, Continuous, Vertical gust

Test Section Size: 60 cm X 90 cm (Rectangular)

Year of Establishment: 1985

Application

- Aerospace and non-aerospace
- R&D

Speed Range: 5 m/s - 45 m/s

Free Stream Turbulence Level: 0.8%

Type of test Performed

- Steady and unsteady force and moment measurements
- Steady and unsteady pressure measurement
- Spectrum analyser

Instrumentation

- Pitot probes & anemometer
- Pressure transducers

Data Acquisition Systems used: LabVIEW Software

Low speed Wind Tunnel (Vertical gust)

Indian Institute of Technology Kharagpur
Department of Aerospace Engineering

Type of Tunnel: Low speed Suction Type Wind Tunnel

Test Section Size: 45 cm X 45 cm (Square c/s)

Year of Establishment: 2007

Application

- Aerospace and non-aerospace
- R&D

Speed Range

- 3 m/s - 30 m/s

Free Stream Turbulence Level: 0.5% -1%

Type of test Performed

- Steady and unsteady force and moment measurements
- Steady and unsteady pressure measurements
- Flow visualization

Test control Parameters: Ranges of pitch: -20^0 to $+30^0$

Instrumentation

- Pitot probes & anemometer
- pressure transducers

Data Acquisition Systems used: LabVIEWSoftware

Low speed Suction TypeWind Tunnel

Contact Person for all Tunnels
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Indian Institute of TechnologyRoorkee
Department of Civil Engineering

Type of Tunnel: Low speed, Continuous, Horizontal, Open Circuit Wind Tunnel

Test Section Size: 2 m x 1.85 m X 15m (W x H x L)

Speed Range: 25m/s

Application

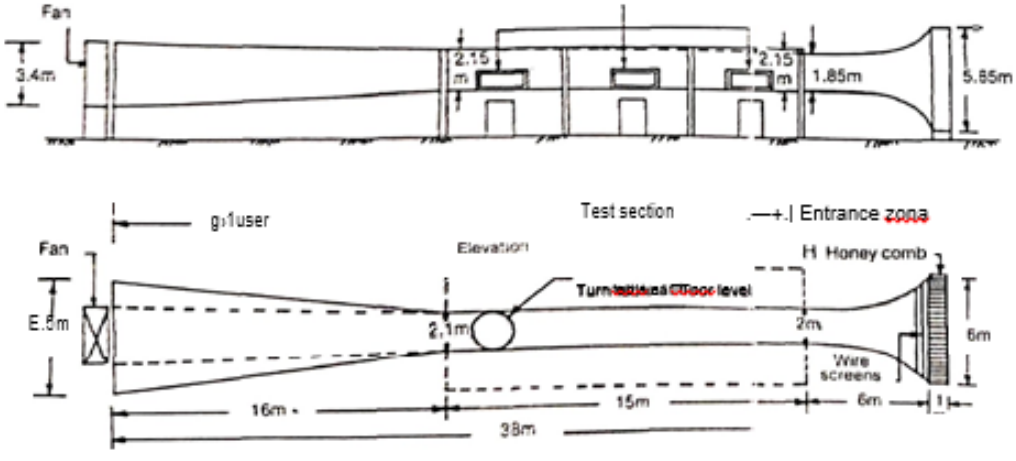
- Civil Engg.
- R&D
- Industrial

Type of Test Performed

- Chimney & Latticed Towers
- Cooling Towers
- LOw or High Rise Buildings
- Antenna Dishes
- Cylindrical & Hyper Shell Roofs

Instrumentation

- Velocity profile
- Force reactions & moments
- Turbulence characteristics
- Displacements
- Pressures
- Accelerations



Wind Tunnel Facility Line Diagram

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Jaypee Wind Engineering Application Centre
(JP-WINCENTRE), JUET, Guna, MP

Type of tunnel: Closed circuit, low speed, boundary layer wind tunnel

Year of establishment: 2019

Test Section size: 3.5 m (W) X 3.0 m (H) X 22.0 m(L) – Rectangular

Application

- Non-aeronautical and primarily for Civil Engg applications
- Industrial and R&D

Speed Range: 0.5-40 m/s

Reynolds number range (per m): 3.3×10^4 to 2.67×10^6

Reynolds number range (per m)

- Typically around 7% at a height of about 90 cm under simulated open terrain condition

Terrain Simulation

- Simulation of atmospheric boundary layer including profiles of mean velocity, turbulence intensity and spectrum of horizontal wind speed

Type of structures/ studies envisaged for wind tunnel investigation

- Tall buildings - for industrial applications-rigid and aero elastic model studies
- Power plant structures such as tall chimneys and cooling towers
- Interference effects due to surrounding buildings/ structures
- Studies on pedestrian level wind effects
- Studies on human comforts, based on wind induced oscillation

Instrumentation

- Hot-wire anemometry system: (normal and XY - wire probes)
- Multi-channel high scan dynamic pressure system (512 channels; 2 Initiums; 16 Scanners with DTC)
- Standard Pitot tube
- Six -component base balance
- Strain gauges and accelerometers
- Special arrangements for control of turn-table position; 3D-traverse system and fan speed.

Special features of the tunnel

- Twin- turn table facility
- Blockage tolerant roof for accommodating large size models
- Large size settling chamber (7.5 m X 8.4 m)
- 3-D traverse system
- Ability to simulate atmospheric turbulence for different terrain conditions.

Data acquisition system/software

- LabVIEW, Matlab; PSI pressure measurement systems

Target beneficiaries: Construction and Power Industries /Central and State Govts./ PSUs like BHEL /NTPC/ NLC/ BGR /Private structural consultants etc.,

Photographs of the test facility

Photograph of the test facility

Contact Person

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National Aerospace Laboratories
1.5m Low speed wind tunnel

Type of Tunnel: Low speed, Continuous, Horizontal,Open circuit, suction type

Test Section Size: 1.5m X 1.5m square, 6.5m long

Year of Establishment: 1992

Application

- Aerospace and non-aerospace
- R&D

Speed Range: 8 m/s - 50 m/s

Free Stream Turbulence Level: ≤ 0.11%

Typical Test Duration: 40 minutes (max.), Continuous

Conventional Measurement Capability

- Digital manometer
- Scanivalve
- ESP scanner
- Hotwire and hot-film anemometer

Flow Visualization

- Surface oil flow
- Tuft flow
- Smoke wire
- Laser sheet
- Chemical sublimation

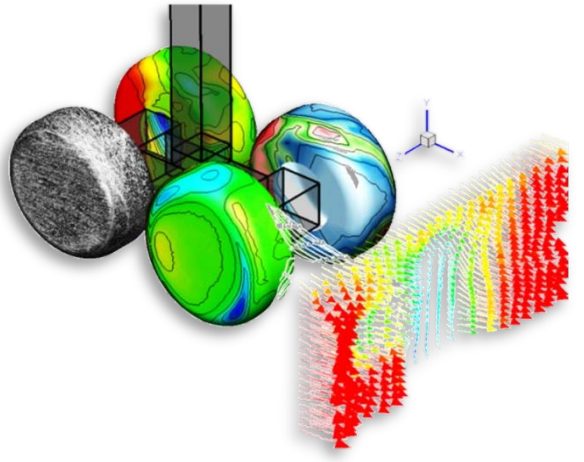
Flow Diagnostics

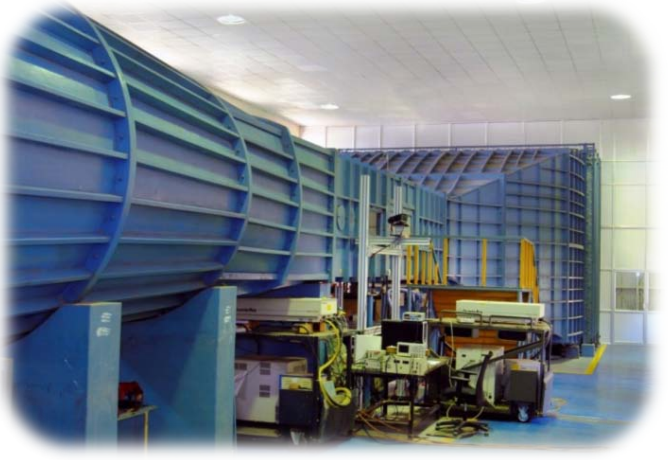
- LDV
- PIV

Customers: VSSC/DRDL/AR&DB/ADA/AR&DB/BoeingUSA

Milestone Achieved

- 2D relaminarization studies on convex surfaces
- Relaminarization studies in leading edge region of swept wing
- Powered propeller measurements on SARAS aircraft model
- Side force control on slender cones at high angles of attack
- PIV measurements on SARAS wing-flap studying slot flow
- Cross-flow transition studies on lower surface of 2D swept wing
- Drag reduction studies on KSRTC bus models
- Studies on Saras wing Flap optimization, winglet, Gurney flaps





Photographs of the test facility

Contact Person
Head
Experimental Aerodynamics Division
National Aerospace Laboratory, Bangalore - 560017
Phone: 91-80-25051570

National Aerospace Laboratories
0.55m Low speed wind tunnel

Type of Tunnel: Low speed, Open circuit, suction type

Test Section Size: Rectangular, 1.9m X 0.55m

Year of Establishment: ...

Application

- Aerospace and non-aerospace
- R&D

Speed Range: 1 m/s - 45 m/s

Flow angularity: Less than 0.5°

Free Stream Turbulence Intensity:

- < 0.12 %, up to 25m/s
- < 0.22%, up to 45m/s

Typical Test Duration: 40 minutes (max.), Continuous

Measurement Capability

- Conventional Digital Micro manometer
- Setra (Differential Pressure Transducer)
- Constant temperature hot wire anemometer
- Electronic Scanned Pressure (ESP)

Flow Visualization

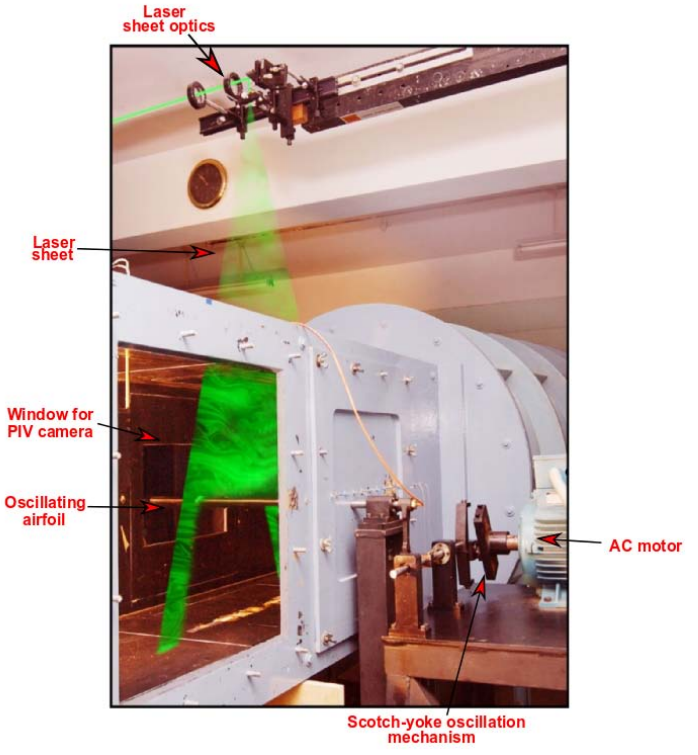
- Smoke wire, oil flow, tuft flow.

Flow Diagnostics

- Laser Doppler velocimetry (LDV)
- Phase Doppler Particle Analyzer (PDPA)
- Particle image Velocimetry (PIV)

Major studies

- Study of low Reynolds number flows
- Flow control with smart materials
- Study of separated flows
- Vortex flow investigations
- Drag reduction studies



Photographs of the test facility

Contact Person

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Naval Science and Technological Laboratory (NSTL)
Visakhapatnam, Andhra Pradesh
Low Speed Open Circuit Wind Tunnel

NSTL has a Low Speed Open Circuit Wind Tunnel designed for preliminary hydrodynamic studies of underwater bodies and model testing of high-speed marine crafts. The facility is used for large-scale search for suitable shape and propulsor configuration prior to final testing in hydrodynamic test facilities. Determination of tentative shapes, location of appendages, propulsors, and identification of most advantageous configuration is feasible with this facility. It is an ideal facility for detailed studies of vehicle hydrodynamics, vehicle-propulsor interaction, propulsor development etc, where detailed flow measurement is required. Optimization of cowl shapes for the propulsors is most conveniently done in the wind tunnel.

Test Section size

- 1.5m (W) X 1.5m (H) X 4m (L)

Speed Control

- By Thyristor Control Panel - Operates a DC Motor of 125kW capacity to rotate upto 750rpm

Tests Performed at NSTL Wind Tunnel

- Measurement of Pressure distribution over the body and control surfaces
- Detailed explorations of velocity at boundary layer
- Shear stress measurement
- Measurement of forces and moments
- Detailed study of flow patterns on the surface, boundary layer and wake of the model

Speed Range: Max. 55m/s

Instrumentation

- Differential Pressure Transducers
- Multi Port Electronic Pressure Scanners
- Hot Wire Anemometer
- 3D Velocity Probes
- Shear Stress sensors
- 3 and 5 component Dynamometers
- Wake Traverse Mechanisms

Contact Person

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Photographs of the NSTL Test Facility

CSIR - Structural Engineering Research Centre (SERC) , Chennai
Low Speed Wind Tunnel

Type of tunnel: Low Speed, Open Circuit, Blower Type Boundary Layer Wind Tunnel

Year of establishment: 1995

Test section size and shape: 1.8 m(H) x 2.5 m(W) x 18 m(L); Overall length of tunnel: 52 m

Applications:

- Non-aerospace (wind engineering)
- R & D
- Industrial

Speed range: 0.5 m/s to 55.0 m/s

Reynolds number range (per m): 3.3×10^4 to 3.6×10^6

Free stream turbulence level: Typically around 10% at a height of about 1.2 m under simulated open terrain conditions

Terrain simulation: Simulation of atmospheric boundary layer including profiles of mean velocity, turbulence intensity and spectrum of horizontal wind speed – essential for every investigation under different terrain simulations

Types of structures widely being investigated (including R & D and consultancy / sponsored studies):

- Power plant structures such as tall RC chimneys and cooling towers
- Tall/high-rise buildings and low-rise buildings
- Long span industrial structures with pitched/curved roof
- Static and dynamic sectional models of cable stayed bridge decks
- Ground mounted solar panels.

Types of tests performed:

- Steady and unsteady force
- Moment and pressure measurement on rigid models of buildings/structures
- Aeroelastic model studies on power plant structures, viz. RC chimneys, steel chimneys, etc.
- Flutter and divergence studies on dynamic sectional models of cable stayed bridge decks
- Wind-induced interference studies on group of structures (group of tall buildings, steel chimneys, RC chimneys, cooling towers, static sectional models of cable stayed bridge decks, etc.)

Special experiments (other than those listed above)

- Studies on wire mesh of antenna dish
- Studies on models for interference between a group of lattice towers and on model of umblical tower
- Studies on models of commercial vehicles

Test control parameters:

- Ranges of pitch, roll and yaw: Turn table facility available for yaw direction (least count = 0.5deg)
- Typical test duration: Varies with test objectives and number of test cases required
- Stagnation pressure and temperature range: Ambient temperature

Special features (other than those listed above):

- Long test section, ability to simulate atmospheric turbulence, adjustable ceiling of test section roof

Instrumentation:

- Pressure scanners/sensors
- Force balances, Strain-gauges and miniature accelerometers
- Strain gauge amplifier, universal amplifier
- Particle image velocimetry system
- Hot wire anemometry System
- Multi-hole velocity probes (Cobra probes) and Standard pilot tube

Data acquisition systems used:

- Dedicated data acquisition systems for pressure, velocity, force/moment and response measurements

Special test rigs and test techniques developed:

- Dynamic test rigs for testing bridge deck sectional models

Customers:

- Government Departments and Public / Private sector undertakings such as ISRO, NTPC, BHEL, L&T, RELIANCE POWER, MITSUBISHI, TAQA Power, SANDS Infra, DILIP BUILDCON, ESSAR POWER, MAHINDRA etc.

Milestones achieved:

- The CSIR-SERC BLWT is one of the highly sought for industrial problems. More than 100 Industrial (Sponsored/Consultancy) projects were completed.

Major modifications / upgrades / augmentations made in the last five years:

- Procurement of force balances
- Procurement of DTC-Initium Pressure Scanning System
- Upgradation of DC motor fan control drive
- Procurement of multi-hole velocity probes
- Procurement of laser cutting machine
- Procurement of DAQ system for strain gauges measurement and Voltage measurements

Contact person:

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Photographs of typical models tested in SERC wind Tunnel

Sectional models of bridge decks

Model of an umbilical tower

Aeroelastic model of a tall building

Model of industrial curved roof

Models of power plant structures (chimneys and cooling towers)

Department of Aerospace Engineering
Punjab Engineering College

Type of tunnel: Low speed subsonic wind tunnel [Continuous operation]

Year of establishment: established more than 30 years ago

Test Section size: 1 m X 0.5 m

Application

- Aerospace and non-aerospace
- R&D
- Laboratory classes for students

Speed Range: 1 m/s – 30 m/s

Reynolds number range: 7×10^5 to 7×10^6

Type of test Performed

- Tuft/oil flow visualization
- Static pressure measurements

Instrumentation

- Multi-tube Manometer
- Pressure transducers
- Digital Camera

Customers: Students for laboratory classes

Photograph of the test facility

Contact Person:
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National Aerospace Laboratories
1.2m Trisonic Wind Tunnel Facility

Type of Tunnel: 1.2m Trisonic wind tunnel

Test Section Size: 1.22m x 1.22m

Year of Establishment: 1967

Operation: Intermittent blow down type

Mach number Range: 0.2 – 4.0

Reynolds number range: 8 x 10^6 to 60 x 10^6 / meter

PressureFluctuation:< 2% (C PRMS)

Test Control Parameters:

- Model incidence range: -15° to 27° continuous and step mode
- Model side slip range: -10° to 10°
- Model roll orientation: 0° to 360°
- Typical test duration: 40 seconds
- Stagnation pressure range: 1.5 to 8.0 bar
- transonic mach number control

Type of test Performed

- Steady and unsteady force and moment measurements
- Steady and unsteady pressure measurements
- Flow visualization
- Aeroelastic tests

Instrumentation

- Computer based tunnel control system
- Steady and unsteady pressure transducers
- Internal strain gauge force balances
- Schlieren system
- High speed photron camera
- ESP Scanners

Data Acquisition System: NI based data acquisition system

Customers: DRDO, VSSC, ADA, HAL, NAL

Photographs of the test facility

National Aerospace Laboratories
0.6m Trisonic Wind Tunnel Facility

Type of Tunnel: 0.6m Trisonicwindtunnel

Test Section Size: 0.6m x 0.6m

Year of Establishment: 1989

Operation : Intermittent blow down type

Mach number Range: 0.4 – 4.0

Reynolds number range: 8 x 10^6 to 60 x 10^6 / meter

PressureFluctuation:< 2% (C PRMS)

Model Incidence: -15° to 25° continuous and step mode

Model Roll: 0° to 360°

Test Duration: Operation :60 seconds(typical)

Special controls: Transonic Mach number control, Transonic Mach number and pressure sweep.

Special feature: Automatic nozzle contour for supersonic Mach numbers using VMFN

Type of test Performed

- Steady and unsteady force and moment measurements
- Steady and unsteady pressure measurements
- Flow visualization

Test control Parameters: Ranges of pitch: -20^0 to +30^0

Instrumentation

- Computer based tunnel control system
- Steady and unsteady pressure transducers
- Internal strain gauge force balances
- NI based data acquisition system

Customers: DRDO, VSSC, ADA, HAL, NAL

Photographs of the test facility

National Aerospace Laboratories
0.3m Trisonic Wind Tunnel Facility

Type of Tunnel: 0.3m Trisonic

Test Section Size:

- Transonic speed – 0.381 x 0.3 m
- Supersonic speed – 0.3 x 0.3 m

Year of Establishment: ...

Mach number Range: 0.2 – 4.0

Flow angularity

- Less than 0.5 deg

Free Stream Turbulence Intensity:

- < 0.12 %, up to 25m/s
- < 0.22%, up to 45m/s

Operation : Intermittent blow down type

Reynolds number range: 8×10^6 to 60×10^6 / meter

Model support: Sting, Wall mounted

Flow Diagnostics

- Pressure Sensitive paint (Steady & Unsteady)
- Schlieren
- Background Oriented Schlieren (BOS)
- Particle Image Velocimetry (PIV)

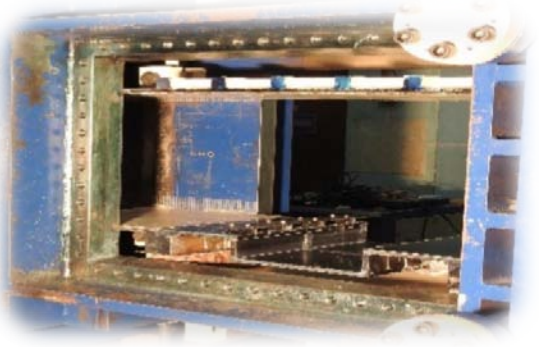
Research activities

- Intake studies
- PSP
- Delta wing studies
- Aerofoil
- Cavity flow control

Capabilities of New test Section

- Optical Access from four sides
- Increased model sizes (up to 4 times)
- Best suited for studies on weapon bay and SBLI

Customers: ADA/ADE/AR&DB/Bell/DRDL



Photographs of 0.3m Trisonic wind tunneltest facility

Contact Person

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Phone: 91-80-25051570

Birla Institute of Technology, Mesra Ranchi
Supersonic Wind Tunnel (0204)

Type of Tunnel: Supersonic wind tunnel

Year of establishment

- 1972

Test Section size

- 50 mm X 100 mm

Application

- Aerospace and Non-aerospace
- R&D
- Laboratory classes for students
- Project for ME Students
- PhD Students
- Sponsored Projects

Mach number range

- 1.5 – 3

Reynolds number range (per m)

- 2 x 107 to 10 x 107

Pressure fluctuation level

- % Cp_{rms}=0.01, at M=2.0

Type of tests Performed

- Schlieren flow visualization
- Oil flow visualization
- Static Pressure measurement
- Unsteady Pressure Measurement
- Force and Moment Measurement

Test Control Parameters

- Angle of attack : 0 to 5
- Test duration : 20 sec
- Stagnation pressure & temperature range: 8 bar, 300K

Instruments

- Multi-tube mercury manometer
- Pressure transducer,
- Electronic Pressure scanners
- Unsteady Pressure transducer (Kulite Make)
- 3 component Strain gauge balance
- Schlieren system, Digital Camera
- Signal conditioners
- NI Cards

Data Acquisition Systems

- PC Based Data Acquisition systems with low and high speed NI DAQ
- Labview

Customers:

- Sponsored Projects from ARDB
- Sponsored Projects from DRDL
- Sponsored Projects from ISRO
- Laboratory classes for students
- ME Students (Projects)
- PhD Students (Thesis)

Birla Institute of Technology, Mesra Ranchi
Supersonic Wind Tunnel (0406)

Type of Tunnel: Supersonic wind tunnel

Year of establishment: 2013

Test Section size: 100 mm X 150 mm

Application

- Aerospace and Non-aerospace
- R&D
- Laboratory classes for students
- Project for ME Students
- PhD Students
- Sponsored Projects

Mach number range: 2-3.5

Reynolds number range (per m): $2x10^7$ to 10^8

Type of tests performed: Calibration in Progress

Test Control Parameters

- Angle of attack : 0 to 5
- Test duration : 20 sec
- Stagnation pressure & temperature range: 8 bar, 300 K

Instruments

- Multi-tube mercury manometer
- Pressure transducer,
- Electronic Pressure scanners
- Unsteady Pressure transducer (Kulite Make)
- 3 component Strain gauge balance
- Schlieren system, Digital Camera
- Signal conditioners
- NI Cards

Data Acquisition Systems:

- PC Based Data Acquisition systems with low and high speed NI DAQ
- Labview

Customers:

- Sponsored Projects from ARDB
- Sponsored Projects from DRDL
- Sponsored Projects from ISRO
- Laboratory classes for students
- ME Students (Projects)
- PhD Students (Thesis)

Contact Person

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Test Facilities at Directorate of Aerodynamic Testing (DOAT)
DRDL, Hyderabad

Type of Tunnel: Axis symmetric supersonic wind tunnel (SSWT)

Test Section Size: 2.25 m (height) x 3 m (width) x 8.75 m (length)

Year of Establishment: 1978

Application: Facility is used for simulating supersonic flow over a scaled missile model for validation of aerodynamic performance. Estimation of performance of supersonic intakes, inter-stage separation and base flow

Key Specifications:

- Mach number range: 1.4, 1.7, 2.3, 2.9, 3.5, and 4.0
- Angle of Attack: -10 to 10 degrees
- Test diameter: 340 mm
- Test Duration: 60 sec (max.)

Measurements:

- Sting Type Model Support System with Five Independent Motions
- Turntables systems for aeronautical and non-aeronautical applications
- 3 D Stereoscopic PIV system

Special Test Rigs and Techniques:

- Full-model testing with sting support system
- Half-model testing with external balance
- Two-dimensional model testing using turntables
- Gust and cross-wind simulation
- ABL simulation for non-aerospace applications
- Aero-acoustic testing

Control Parameters:

- On model Pitch, Roll, and Yaw Sensors
- Roll, Pitch, Yaw (0.01deg.) motion
- Y & Z motions (~ 0.1mm)
- Preset and Continuous Movements

Instrumentation:

- Flex- motion Eight-axis closed loop Control System
- 32 Port ESP Scanners (±10” & ±20” WC, ±2.5, ±5.0 & ±10 PSI range with 0.05% accuracy)
- Strain Gage based Load Cells and 6-Component Balances
- Dantec Streamline CTA System
- B & K Microphone Sensors and Noise Measurement System
- RTD and Thermocouple Sensor Based Temperature Measurement

Axis symmetric supersonic wind tunnel (SSWT)

Contact person(s):

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Indian Institute of Science, Bangalore
Supersonic Jet Facility (SJF)

Type of Tunnel: Super Jet Facility (SJF)

Year of establishment: 2009

Working Section: Maximum test section cross-section: 50 mm x 40 mm

Operation: Long duration intermittent blowdown

Test duration:~5 seconds (typical)

Mach number range: Up to 4

Stagnation pressure: Up to 10 bar (abs)

Special Rigs

- Free jet test rig
- Supersonic ejector test rig
- Compressible mixing layer test rig
- Nozzle-isolator test rig

Major test capabilities

- Unsteady and Steady pressure measurements
- High-speed schlieren
- Planar laser Mie-scattering
- Particle image velocimetry
- Planar laser induced fluorescence

Application:

- Aerospace Research
- Energy Research
- R&D/ Industrial / Both

Customers: Tata Motors, DRDO, VSSC

Milestones achieved:

- Ejector configurations for fuel recirculation in hydrogen fuel cells designed and tested with helium as working gas for Tata motors.
- Novel supersonic nozzles - Elliptic Sharp Tipped Shallow Lobed Nozzle for mixing enhancement in supersonic flows developed and tested for ejector applications.
- Fundamental studies on supersonic-supersonic mixing relevant to high speed propulsion application are being carried out.
- Fundamental studies on nozzle-isolator interactions relevant to high speed propulsion application are being carried out.
- Several graduate students have carried out research for their thesis.

Contact faculty members:

Dr Srisha Rao MV, LHSR
Prof. G. Jagadeesh, LHSR
Department of Aerospace Engineering
Indian Institute of Science, Bangalore - 12

Indian Institute of Technology Kharagpur
Department of Aerospace Engineering

Type of Tunnel: High speed (supersonic), Wind, Intermittent, Horizontal

Test Section Size: 5 cm X 10 cm (Rectangular c/s)

Year of establishment: Around 1970

Application

- Aerospace and non-aerospace
- R&D

Mach Number Range:2.2 – 2.4

Type of test Performed

- Steady and unsteady pressure measurement
- Flow visualization
- Drag measurement

Test Control Parameters: Typical test duration: 20 Sec

Instrumentation

- Pressure transducers (Honeywell transducers &Scanivalve ZOC 15 Psid)
- Schlieren system
- Drag balance

Data Acquisition Systems used: LabVIEW Software

High speed (supersonic) Wind Tunnel

Contact Person for all Tunnels

Head

Aerospace Engineering Department, IIT Kharagpur.

VikramSarabhai Space Centre, Thiruvananthapuram
0.3 m Supersonic Wind Tunnel

Type of tunnel: High Speed, Intermittent blow down type, Horizontal

Year of establishment: 2005

Test section size and shape: 0.3m x 0.3m (square)

Application

- Aerospace
- Research &development

Speed range / Mach number range: 1.5 to 4

Reynolds number range (per m): 20 to 70 million

Free stream turbulence level (if low speed tunnel): < 0.1%

Run time & enthalpy: 1- 6 ms& 12 MJ/kg (max)

Type of tests performed

- Steady and Unsteady Pressure measurement
- Force and moment measurements
- Steady Schlieren flow visualization

Test control parameters

- Ranges of pitch (angle of attack range) :- 10˚ to 15˚ (continuous, Pich and pause mode) and maximum up to 30˚ using bent sting
- Typical test duration : 20 seconds
- Stagnation pressure and temperature range : 0.2 to 2.0 Mpa& 300 K
- Special feature : Model injection system

Instrumentation & Control system

- Steady and unsteady pressure transducers
- 32 port ESP & 16 port ESP
- Srain gauge type force balance &Schlieren system

Data Acquisition system

- PXI based 24 channels DAS (full programmable)
- SCXI signal conditioning modules with 16 bit ADC
- PXI based 8 channel high speed DAS

Customers: VSSC test programme – PSLV, GSLV, SRE, RLV, AABP projects

Milestone achieved: Aerodynamic characterization studies on PSLV, GSLV, SRE, Reusable Launch Vehicle (RLV) configurations & Air Breathing intake configurations (ERJV & DMRJ)

Photograph of .3 m Supersonic wind tunnel test facility

Contact person:
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Project Director, Trisonic Wind Tunnel project
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Vikram Sarabhai Space Centre, Thiruvananthapuram
High Altitude Jet Simulation Facility

Type of tunnel

- High Speed
- Intermittent blowdown type
- Horizontal

Year of establishment

- 2004

Test section size and shape

- Enclosed free jet

Application

- Aerospace
- Base flow limitations of launch vehicles
- Research& development

Speed range / Mach number range

- The Facility is capable of simulating high altitude conditions upto 42 Km.

Type of tests performed

- Steady and Unsteady Pressure measurement
- Schlieren flow visualization

Test control parameters

- Typical test duration : 20 seconds (typical)
- Stagnation pressure and temperature

Instrumentation & Control system

- Steady and unsteady transducers
- 32 port ESP

Data Acquisition system

- PXI based 18 bit ,8 channel programmable DAS
- SCXI signal conditioning modules

Special test rigs and test techniques developed:

- Stepper motor drive far cowl opening in 125 ms for air intake characterization studies (DMRJ)
- Stage separation test rig

Customers

- R&D

Milestone achieved: Studies on multijet interaction on base of launch vehicles

Photograph of the test facility

Contact Person:
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Project Director, Trisonic Wind Tunnel project
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Vikram Sarabhai Space Centre, Thiruvananthapuram
Heat Transfer Facility

Type of tunnel: High Speed, Wind (Combustion products of Air & Kerosene), Intermittentblowdown type, Horizontal

Year of establishment: 1981

Test section size and shape: 0.15 m diameter - Enclosed free jet

Application

- Aerospace
- Research& development

Speed range / Mach number range: 3

Reynolds number range (per m): 1 to 7 million

Run time & enthalpy: 1- 6 ms& 12 MJ/kg (max)

Type of tests performed: Heat Transfer measure

Test control parameters

- Typical test duration : 60-120 seconds
- Stagnation pressure (8 bars) and temperature (530 K)

Instrumentation & Control system

- Thermocouples
- Pressure transducers
- 8 channels of data acquisition
- Video camera

Customers: VSSC test programme – PSLV, GSLV, SRE, RLV, AABP projects

Milestone achieved: Thermal; Protection System qualification studies on ASLV, PSLV, GSLV, SRE & air intake configurations (DMRJ).

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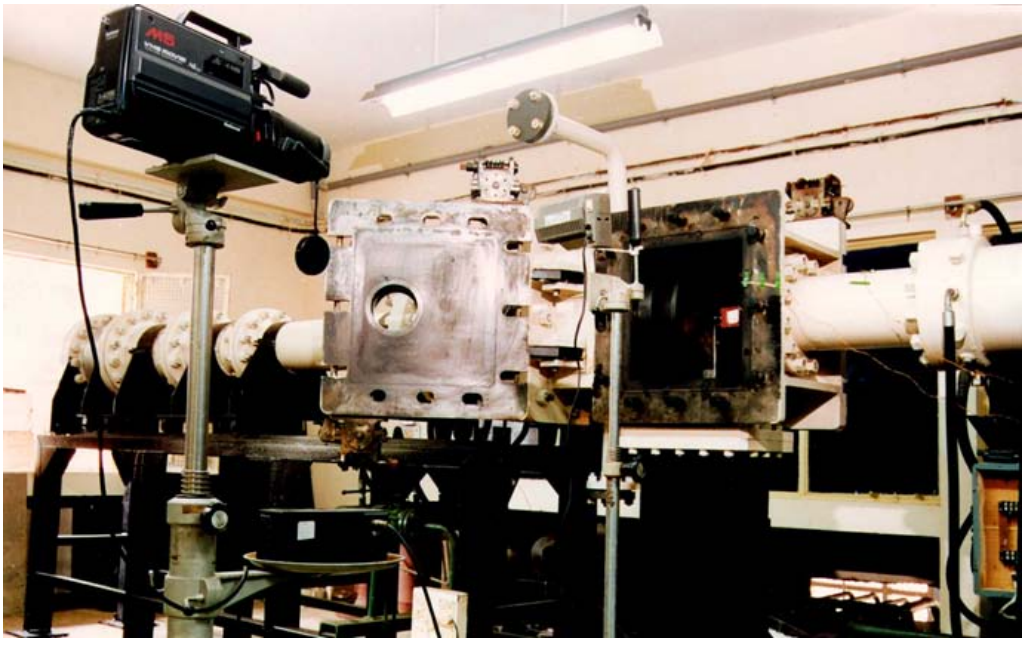

Photograph of Heat Transfer Facility

Department of Aerospace Engineering
Punjab Engineering College
Open Jet Supersonic Wind Tunnel with DAQ System

Type of tunnel

- Open jet Supersonic wind tunnel

Year of establishment

- 2012

Test Section size

- Open Jet

Application

- Aerospace and non-aerospace
- R&D
- Laboratory classes for students

Speed Range

- 2 Mach

Type of test Performed

- Pressure measurement
- Model testing
- Schliern experiment

Instrumentation

- Data Acquisition System
- Pressure transducers
- Digital Camera
- Schliern apparatus
- 3-DOF traverse system with model holding mechanism

Customers: Students for laboratory classes, Consultancy, Sponsored Projects

Photographs of the test facility

Open Jet Supersonic Wind Tunnel

Control Room

Compressed Air Vessel

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Indian Institute of Science, Bangalore
Hypersonic Shock Tunnel (HST2)

Type of Tunnel: Hypersonic Shock Tunnel (HST2)

Year of Establishment: 1999

Working section: 300 mm x 300 mm x 450 mm (length)

Operation: Intermittent blowdown

Test duration: 1-2 milliseconds (typical)

Mach number range: 6 to 12.2 and flow speed up to 3 km/s with specific enthalpy of about 3 MJ/kg

Stagnation pressure: Up to 30 bar

Reynolds number: $1x10^6$ to $2x10^6$ per meter

Model incidence: -12° to +12° and step mode

Special rigs: top and bottom strut support system

Major test capabilities

- Force and moment measurements
- Unsteady and Steady pressure measurements
- Air-intake tests
- Flow visualization using electric discharge and schlieren techniques

Application:

- Aerospace Research
- R&D/ Industrial / Both

Special techniques developed:

- Aerodynamic force balances (accelerometer balance) and heat transfer gauges (platinum thin film)

Customers: DRDO, DRDL, VSSC

Milestones achieved:

- Many research students work has been carried out and various configurations of ISRO and DRDL have been tested.

Contact faculty member:

Name: Prof. G. Jagadeesh, LHSR
Address:Department of Aerospace Engineering
Indian Institute of Science, Bangalore - 12

Indian Institute of Science, Bangalore
Free Piston Driven Hypersonic Shock Tunnel (HST3)

Type of Tunnel: Hypersonic Shock Tunnel (HST3)

Year of Establishment: 2003

Working section: 300 mm diameter flow enters a 2.5 m long cylindrical tank of 1m dia.

Operation: Intermittent blowdown

Test duration: ~1 milliseconds (typical)

Mach number range: 6 to 12 and flow speed up to 7 km/s with specific enthalpy of about 25 MJ/kg

Stagnation pressure: Up to 100 bar

Reynolds number: $1x10^6$ to $5x10^6$ per meter

Model incidence: -12° to +12° and step mode

Special rigs: top and bottom strut support system

Major test capabilities

- Force and moment measurements
- Unsteady and Steady pressure measurements
- Air-intake tests
- Flow visualization using electric discharge and schlieren techniques

Application:

- Aerospace Research
- R&D/ Industrial / Both

Special techniques developed:

- Aerodynamic force balances (accelerometer balance) and heat transfer gauges (platinum thin film)

Customers: DRDO, DRDL, VSSC

Milestones achieved:

- Many research students work has been carried out and various configurations of ISRO and DRDL have been tested.

Contact Person:

Prof. G. Jagadeesh, LHSR
Department of Aerospace Engineering
Indian Institute of Science, Bangalore - 12

Indian Institute of Science, Bangalore
Hypersonic shock Tunnel (HST4)

Type of Tunnel: Hypersonic Shock Tunnel (HST4)

Year of Establishment: 2003-2004

Working section: 1m diameter flow enters a 2.5 m long cylindrical tank of 1m dia.

Operation: Intermittent blowdown

Test duration: 1-2 milliseconds (typical)

Mach number range: 5 to of 8 and flow speed up to 3 km/s with specific enthalpy about 3 MJ/kg

Stagnation pressure: Up to 20 bar

Reynolds number: $1x10^6$ to $2x10^6$ per meter

Model incidence: -20° to +20° and step mode

Special rigs: top and bottom strut support system

Major test capabilities

- Force and moment measurements
- Unsteady and Steady pressure measurements
- Air-intake tests
- Flow visualization using electric discharge and schlieren techniques

Application:

- Aerospace Research
- R&D/ Industrial / Both

Special techniques developed:

- Aerodynamic force balances (accelerometer balance) and heat transfer gauges (platinum thin film)

Customers: DRDO, DRDL, VSSC

Milestones achieved:

- Many research students work has been carried out and various configurations of ISRO and DRDL have been tested.

Contact Person:

Prof. G. Jagadeesh, LHSR
Department of Aerospace Engineering
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Indian Institute of Science, Bangalore
Combustion driven Hypersonic shock Tunnel (HST5)

Type of Tunnel: Hypersonic Shock Tunnel (HST5)

Year of Establishment: 2008

Working section: 300 mm diameter flow enters a 1.5 m long cylindrical tank of 1m dia.

Operation: Intermittent blowdown (combustion driven)

Test duration: 1-2 milliseconds (typical)

Mach number range: 6 and flow speed up to 4 km/s with specific enthalpy of about 6 MJ/kg

Stagnation pressure: Up to 6bar

Reynolds number: $1x10^6$ to $3x10^6$ per meter

Model incidence: -12° to +12° and step mode

Special rigs: top and bottom strut support system

Major test capabilities

- Force and moment measurements
- Unsteady and Steady pressure measurements
- Air-intake tests
- Flow visualization using electric discharge and schlieren techniques

Application:

- Aerospace Research
- R&D/ Industrial / Both

Special techniques developed:

- Aerodynamic force balances (accelerometer balance) and heat transfer gauges (platinum thin film)

Customers: DRDO, DRDL, VSSC

Milestones achieved:

- Many research students work has been carried out and various configurations of ISRO and DRDL have been tested.

Contact Person:

Prof. G. Jagadeesh, LHSR
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Vikram Sarabhai Space Centre, Thiruvananthapuram
1m Hypersonic wind tunnel

Type of tunnel: Intermittent, pressure-vacuum driven, blowdown tunnel

Year of establishment: 2012

Test section size and shape: 1 m diameter - enclosed free jet

Application

- Aerospace
- Research & Development

Mach No :6, 8, 10 & 12

Reynolds number: 80 million / metre (max)

Run time: 40 secs. (max)

Type of tests performed

- Force measurements
- Steady and unsteady pressure measurements
- Heat transfer measurements
- Flow visualization

Instrumentation & Control system

- Strain gauge balances
- Electronic pressure scanners
- Unsteady pressure sensors
- Infrared thermography
- PLC based tunnel operation & control system (prime /redundant hot standby)
- PXI based Data Acquisition System (prime / redundant mode)
- 30 channels for force measurements, 16 high speed channels for unsteady pressures

Customers: ISRO launch vehicle programs - Gaganyaan, HAVA, ORV, GSLV-Mk III

Milestones achieved

- Mach 6 leg commissioned in 2012
- Mach 12 leg commissioned in 2017
- Facility is fully utilized for ISRO programs

Contact person:

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Photograph of 1m Hypersonic wind tunnelfacility

Vikram Sarabhai Space Centre, Thiruvananthapuram
1m Sock Tunnel

Type of tunnel: Combustion driven, Short duration, High enthalpy, Blowdown Tunnel

Year of establishment: 2012

Test section size and shape: 1m& 0.65m exit diameter conical nozzles – enclosed free jet

Application

- Aerospace
- Research & development

Velocity range: 4.5 km/s (max)

Reynolds number: 12 million/m (max)

Run time & enthalpy: 1- 6 ms& 12 MJ/kg (max)

Type of tests performed

- Scramjet combustion experiments with H_2 Fuel
- Heat flux measurements on GaganyaanReentry Crew Module Models, Scramjet Modelsand Apollo model etc.
- Force measurements
- Flow visualization

Instrumentation & Control system

- Coaxial thermocouples
- Thin film gauges
- Unsteady pressure sensors (piezo-electric&piezo-resistive)
- Infrared thermography
- Accelerometers
- PLC based tunnel operation & control system (prime /redundant hot standby)
- PXI based Data Acquisition System (prime / redundant)
- 56 high speed channels @ 300 kHz BW

Customers: ISRO launch vehicle programs –Gaganyaan, ABPP, RLV, SSTO, TSTO

Milestones achieved: Facility is fully operational and used for ISRO programs.

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Photograph of the test facility

Vikram Sarabhai Space Centre, Thiruvananthapuram
0.25 m Hypersonic Wind Tunnel

Type of tunnel: High Speed, Intermittent blowdown type, Horizontal

Year of establishment: 1980

Test section size and shape: 0.25 m diameter - Enclosed free jet

Application

- Aerospace
- Research & development

Speed range / Mach number range: 4,5,6& 8

Reynolds number range (per m): 4 to 10 million

Free stream turbulence level (if low speed tunnel): < 0.1%

Type of tests performed

- Steady force and moment measurements
- Steady and Unsteady Pressure measurement
- Schlieren& air flow visualization

Test control parameters

- Typical test duration : 20 seconds (typical)
- Stagnation pressure (15 bars) and temperature (700 K)

Instrumentation & Control system: Strain gauge balance, Steady and Unsteady pressure transducers

Data Acquisition system

- PXI based 16 channel (full programmable)
- SCXI signal conditioning modules with 16 bit ADC
- PXI based 8 channel high speed DAS

Special test rigs and test techniques developed:

- Stepper motor drive far cowl opening in 125 ms for air intake characterization studies (DMRJ)
- Stage separation test rig

Customers: VSSC test programme – PSLV, GSLV, SRE, RLV, AABP projects

Contact person:

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Photograph of 0.25 m Hypersonic Wind Tunnel

Department of Aerospace Engineering
Punjab Engineering College
Reddy's Hypersonic Shock Tunnel

Type of tunnel: Reddy's Hypersonic Shock tunnel

Year of establishment: 2018

Application: Laboratory classes for students

Speed Range: 6 Mach

Type of test Performed

- Pressure measurement
- Model testing
- Schliern experiment

Photograph of the test facility

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Indian Institute of Science, Bangalore
Vertical Shock Tube (VST)

Type of Tunnel: Vertical Shock Tube (VST)

Year of Establishment: 2014

Test Specimen Diameter: 136 mm

Operation: Single loading (diaphragm type) and pulsed loading (using diaphragmless valve)

Decay Time Duration: 2-20 milliseconds (typical)

Reflected Pressure range: 0.5 MPa to 8 MPa

Major test capabilities

- Dynamic pressure measurements of the input load
- 2D Digital image correlation

Application:

- Blast mitigation research
- Shock loading of specimens

Special techniques developed:

- Single pulse shock/blast wave with a uniform loading (~5% variation in spatial pressure) on the test sample
- Shortest decay time for non-combustive and non-explosive blast testing with a regular shock tube (2 ms)

Customers:DRDO, Delseal India

Milestones achieved:

- Research work for PhD and graduate students at IISc have been successfully carried out using this facility. Blast testing of MCT for Delseal India Pvt Ltd.

Contact Person:

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Department of Aerospace Engineering
Indian Institute of Science, Bangalore - 12

Indian Institute of Science, Bangalore
Chemical Shock Tube(CST1)

Type of Tunnel: Chemical Shock Tube (CST1)

Year of Establishment: 1999

Working Section:ID-50 mm, length-5 m

Operation: Single pulse shock tube mode

Test Duration: 1.3-1.5 milliseconds (typical)

Shock Mach number range: 1.5 to 2.5

Stagnation pressure: Up to 20 bar

Stagnation temperature: 1000-1600 K

Major test capabilities

- Combustion studies of fuel
- Oxidation studies of fuel
- Ignition delay studies of fuel

Application:

- Chemical kinetics Research

Special techniques developed:

- Tuneable Diode Laser Absorption Spectroscopy (TDLAS)

Milestones achieved:

- Many research students work has been carried out

Contact Person:

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Indian Institute of Science, Bangalore
Chemical Shock Tube(CST3)

Type of Tunnel: Chemical Shock Tube (CST3)

Year of Establishment: 2011

Working Section:ID-54 mm, length-7 m

Operation: Single pulse shock tube mode

Test Duration: 1.3-1.5 milliseconds (typical)

Shock Mach number range:1.5 to 3

Stagnation pressure: Up to 30 bar

Stagnation temperature:1000-1900 K

Major test capabilities

- Combustion studies of fuel
- Oxidation studies of fuel
- Ignition delay studies of fuel

Application:

- Chemical kinetics Research

Special techniques developed:

- Driver insert

Milestones achieved:

- Many research students work has been carried out

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Indian Institute of Science, Bangalore
Department of Aerospace Engineering

Type of Tunnel: Closed circuitWater Tunnel

Test Section Size: 500mmx500mm (c/s) x 1.5m (length)

Motor Power: 37 kW (50hp)

Contraction Ratio:12.3

Turbulence intensity: <0.1 %

Maximum Wind Speed: 1.5 m/s

Type of Test Performed

- Fluctuating velocity measurements
- pressure measurements
- wall shear stress measurements
- Load measurements
- Flow visualization

Instrumentations

- Hotwire anemometry(Hot film)
- Force measurements using Strain gauge balance
- Dye flow visualization

Application

- Scaled-down model testing

Water Tunnel

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Department of Aerospace Engineering
Indian Institute of Technology Kharagpur

Type of Tunnel: Recirculatingopen surface water tunnel

Test Section Size: 1.5m x 0.4m x 0.4m

Year of establishment: 2019

Application: Low Re Aerodynamics study

Speed Range: Upto 0.2 m/s

Free stream turbulence level: < 5%

Type of test Performed: Flow visualization

Test control Parameters: Variable flow speed control

Instrumentation: NA

Data Acquisition Systems used: LabVIEW Software

Recirculating, Open Surface, Low-speed Water Tunnel

Contact Person for all Tunnels
Head
Aerospace Engineering Department, IIT Kharagpur.

National Aerospace Laboratories
Jet AeroAcoustics Research Facility

Type of Tunnel: AeroAcoustics Research Facility

Year of Establishment: 2009

Jet rig:

- Mach number Range: 0.1 to 2.0
- Temperature Range: 800K at 2.5kg/s
- Nozzle Diameter: Up to 50 mm (2")

Anechoic Chamber

- Chamber dimensions: 3.6m x 3.6m x 4.2m (12'' x 12'' x 14'')
- Anechoic wedges (L,B,H): 0.203m x 0.609m x 0.304m (8" x 24" x 12")
- Exhaust: Treated catcher and duct
- Noise measurements from 500 Hz – 100kHz

Application

- Understand the sources of jet noise
- Study mixing noise in high subsonic hot and cold jets
- Effect of nozzle exit modification on noise generation
- Supersonic jet noise in C-D and aerospike nozzles
- Link flow field and noise field measurements

Measurement capability

- Far-field acoustic measurements
- Arc measurements
- Array measurements
- Flow field measurements
- PIV – velocity field mapping
- BOS –density field mapping

Customers

- ISRO, NAL

Contact Person

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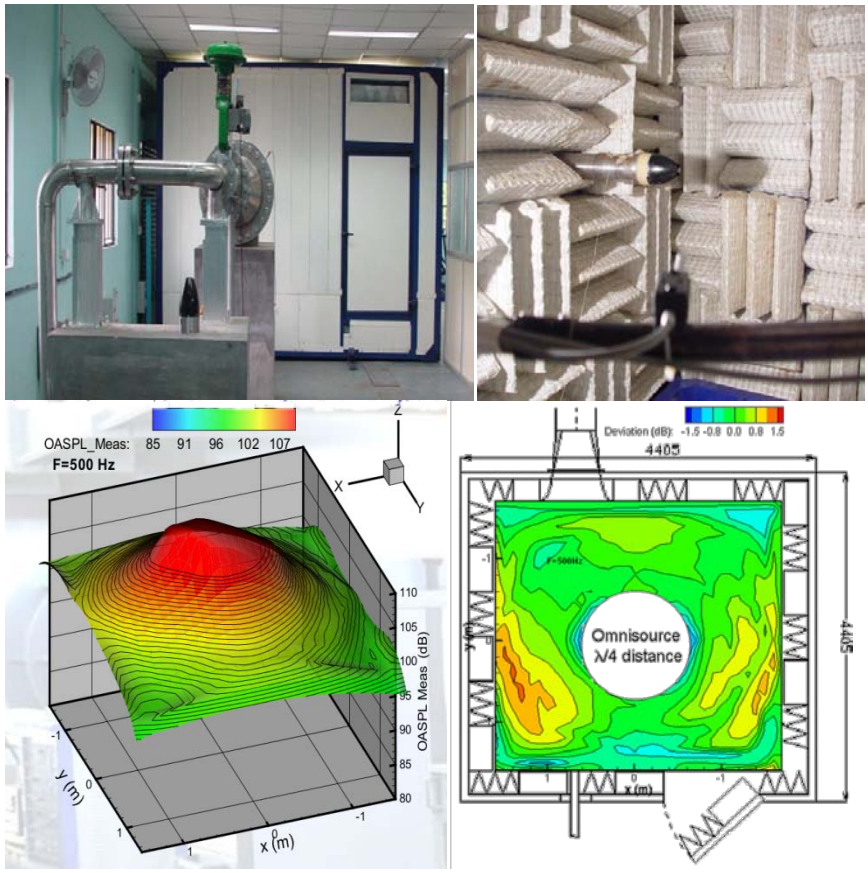

Photographs of Jet AeroAcoustics Research Facility

National Aerospace Laboratories
0.5m Base flow wind tunnel

Type of Tunnel: Base Flow Wind Tunnel

Year of Establishment: 2009

Test section size: 524 mm dia

Nozzle : Variable geometry

Operation: Intermittent Blow down type

Freestream Mach number:0.5 to 4.0

Jet nozzle flow: upto 150psi

Reynolds number range: 10-50 million/m

Model support: Nozzle inner body, 127 mm dia

Test duration: 30-40 sec

Controls/Data acquisition

- PC based controls and Lab view based data acquisition system

Flow Diagnostics

- Particle Image Velocimetry (PIV)
- Schlieren
- Background Oriented Schlieren (BOS)

Research activities

- Afterbody studies of single & twin jet nozzle
- Launch Vehicle and Missile afterbodies
- Air-intake configurations
- Aerospike nozzle

Customers

- VSSC
- DRDL
- AR&DB

Contact Person

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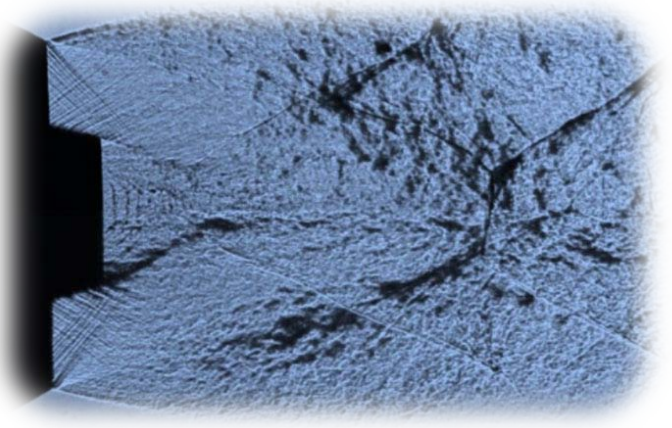

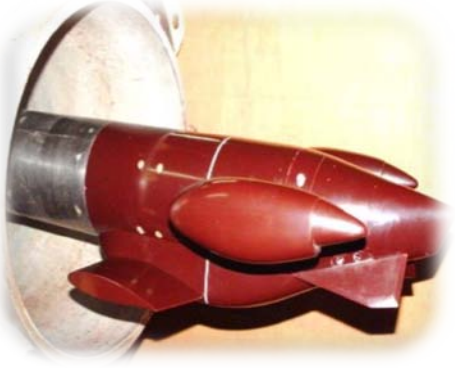

Photographs of the 0.5m Base flow test facility

National Aerospace Laboratories

Co-flow jet-facility

Type of Tunnel: Co-flow Jet Facility

Test Section:0.3m X 0.3m square, 1m high

Speed: Low speed to high subsonic

Top-Hat exit profile and low exit turbulence level

Provision for Active Forcing

- Supersonic capability
- Heterogeneous Flows

Instrumentation: Virtual Instrumentation based controls and automated data acquisition system for pressure and velocity survey

Flow diagnostics

- Laser sheet
- PIV
- LDV
- Hot wire techniques

Salient Features

- Large range of Area ratio, Velocity ratio
- Inter changeable inner nozzles – Circular, Elliptic.

Areas of Applications

- Basic Research (Mixing, Flow structures, Flow control and Acoustics)
- Combustion Chambers
- High Bypass Engines
- Cooling Systems
- Mixing Tanks
- Premixed burners
- Jet pumps

Contact Person

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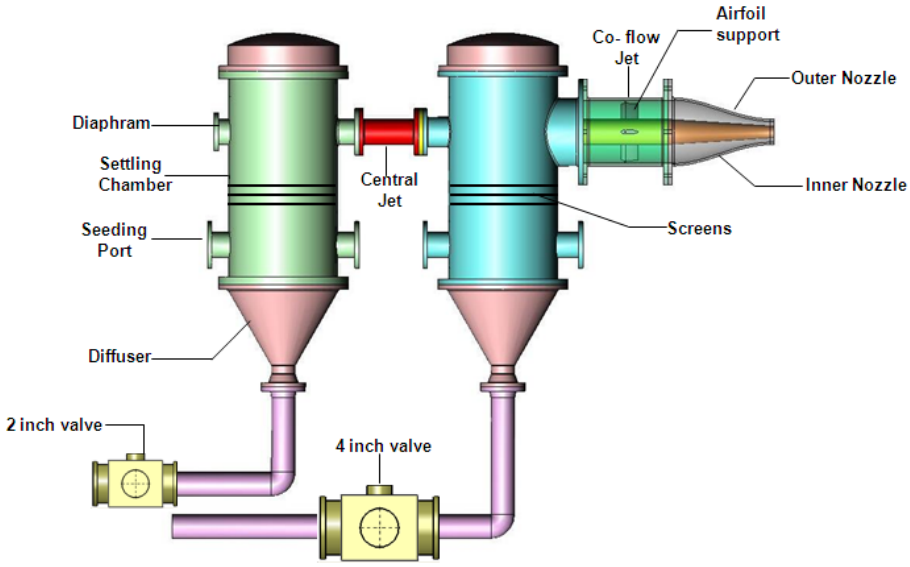
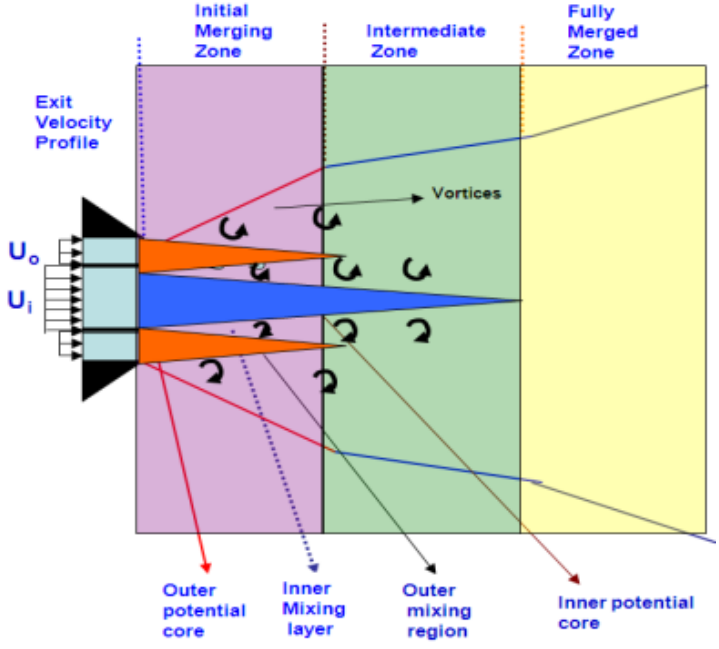
Schematic of the Co-flow jet-facility





National Aerospace Laboratories
0.3m Water tunnel

Type of Tunnel: 0.3m Water tunnel (Gravity driven, Open circuit)

Test Section:0.3m X 0.3m square, 1m high

Velocity Range: Range 2 to 7.4 cm/sec

Water storage tank :1.6m x 1.6m square, 2.1 m high of capacity $6m^3$

Flow conditioning: Honey comb (Al tubes) followed by four wire-mesh screens and a 16:1 contraction

Reynolds number: 2.5×10^3 to 10×10^3 (chord = 0.15m)

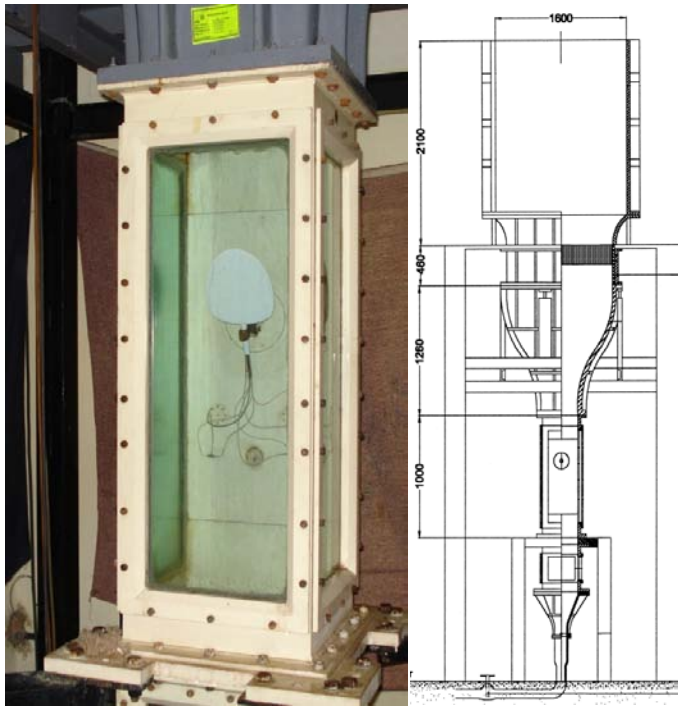
Model: Typical chord of 0.1 to 0.2m

Flow Visualization capability

- Dye flow visualization using ink (up to 5 colours)
- Hydrogen bubble (Being implemented)

Past models Visualized

- Cones
- Delta and double delta wings
- Delta wing aircraft
- Zimmermann Planform for Micro-Aerial Vehicle



Inverse Zimmermann planform in water tunnel and schematic of the test facility

Contact Person

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Department of Aerospace Engineering
Punjab Engineering College

Type of tunnel: Smoke tunnel, [Continuous operation]

Year of establishment: established more than 30 years ago

Test Section size: 10 cm (Width) X 20 cm (Height)

Application: Laboratory classes for students

Speed Range: 1 m/s - 15 m/s

Type of test Performed: Flow visualization

Photograph of the test facility

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