Vikram Sarabhai Space Centre
Supersonic Wind Tunnel

Type of tunnel:
- High speed, Intermittent blowdown type & Horizontal

Year of establishment: 2005

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

Application:
- Aerospace & R & D

Mach number range: 1.5 to 4.0

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

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

Pressure fluctuation level (if high speed, % $C_{Prms}$): < 0.2%

Type of tests performed:
- Steady force & moment measurements
- Steady and Unsteady pressure measurements
- Schlieren flow visualization

Test control parameters:
- Ranges of Pitch (angle of attack range): -10° to 15° (continuous, pitch & pause mode) and Maximum up to 30° using bent sting
- Typical test duration: 20 seconds
- Stagnation pressure & Temperature range: 0.2 to 2.0 MPa & 300K
- Special feature: Model injection system

Instrumentation:
- Steady & unsteady pressure transducers
- 16 ports digital sensor array
- 48 ports scanivalve
- Strain gauge type force balance & Schlieren system
Data Acquisition Systems:
- PXI based 24 channels DAS (full programmable)
- SCXI signal conditioning modules with 16 bit ADC
- PXI based 8 channels high speed DAS

Customers:
- VSSC test programs including PSLV, GSLV, RLV, HSP, ABP projects

Photographs of test facility:

Photographs of typical models tested:

Top, from Left to right - 1) SRE configuration (parametric) 2) XPRESS reentry 3) R&D Jet interaction studies
Bottom, from left to right - 1) GSLV configurations 2) AGARD model 3) RLV Descent

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Vikram Sarabhai Space Centre
Open Jet Facility

Type of tunnel:
- High speed
- Intermittent blowdown type
- Horizontal

Year of establishment: 1990

Test Section size and shape: 50 mm diameter (max.)

Application:
- Aerospace
- R & D

Mach number range: 1.5 to 4.0

Type of Jet pattern: Under-expanded & Over-expanded

Type of tests performed:
- Pressure measurements
- Jet Acoustic measurements
- Schlieren flow visualization

Test control parameters:
- Different Jet exit pressure ratios

Typical test duration: 30 - 100 seconds

Instrumentation:
- Steady & unsteady pressure transducers
- Microphones for acoustic measurements
- 48 ports scanivalve
- Schlieren system

Data Acquisition Systems used:
- 8 Channels of DAS for Acoustic measurement, 3 channels for Pressure measurement
Special test rigs and test techniques developed:
- Model attitude mechanism with six degrees of freedom system, Planar Laser Induced Fluorescence

Customers:
- VSSC test programs including PSLV, GSLV, RLV, HSP, ABP projects

Photographs of test facility:

Jet impingement studies on 2nd Launch Pad

Photographs of typical models tested:

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Vikram Sarabhai Space Centre  
High Altitude Jet Simulation Facility

Type of tunnel:
- High speed
- Intermittent blowdown type
- Horizontal

Year of establishment: 2000

Application:
- Aerospace
- R & D

Mach number range: 1.5 to 4.0

Altitude simulation: upto 60km

Type of tests performed:
- Steady force & moment measurements
- Steady and Unsteady pressure measurements
- Schlieren flow visualization

Test control parameters:
- Altitude simulation up to 60KM
- Typical test duration: 30 seconds
- Stagnation pressure & Temperature range: up to 25 bar & 300K

Instrumentation:
- Steady & unsteady pressure transducers
- 16 ports digital sensor array
- 48 ports scanivalve & Schlieren system
- Strain gauge type force balance

Data Acquisition Systems used:
- NI based 16 channels (full programmable)
- SCXI signal conditioning modules with 16 bit ADC

Customers:
- VSSC test programs including PSLV, GSLV & etc.
Photographs of test facility:

Photographs of typical models tested:

_GSLV MKIII – S200 & L110 Jet interaction studies at 40 km Attitude_

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Vikram Sarabhai Space Centre
ABR Test Facility

Type of tunnel:
- High speed
- Horizontal

Year of establishment: 1995

Application:
- Aerospace
- R & D

Mach number range: 1.5 to 4.0

Maximum primary & secondary mass flow rates: 77.6 kg/s & 10 kg/s

Type of tests performed:
- Steady pressure measurements
- Flow visualization

Test control parameters:
- Typical test duration: 20 to 90 seconds
- Stagnation pressure & Temperature range: 30 bar & 300K
- Mass flow rate: 10 kg/s (max)

Instrumentation:
- Steady pressure transducers

Data Acquisition Systems used:
- 4 channels for pressure measurement, PC based with ADC

Customers:
- VSSC test programs like ABP Project
Photographs of test facility:

Photographs of typical models tested:

*DMRJ Mixing Studies*

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Vikram Sarabhai Space Centre
Heat Transfer Facility

Type of tunnel:
- High speed
- Wind (Combustion products of Air & Kerosene)
- Intermittent blowdown type
- Horizontal

Year of establishment: 1981
Test Section size and shape: 0.15 m diameter – Enclosed jet
Application:
- Aerospace
- R &D

Speed range / Mach number range: 2 to 4
Reynolds number range (per m): 1 to 7 millions
Type of tests performed:
- Heat transfer measurements

Test control parameters:
- Typical test duration – 2 min (max)
- Stagnation pressure (3 to 20bar & Temperature range 1000K)

Instrumentation:
- Thermocouples, Pressure transducers, 8 channels of data acquisition, Video camera

Customers:
- VSSC test program – PSLV, GSLV, SRE, RLV, ABP projects

Milestones achieved:
- Thermal Protection System qualification studies on ASLV, PSLV, GSLV, SRE & air intake configurations (DMRJ).
Photograph of the facility:

Photographs of typical models tested:

Specimen
Flow
Specimen holder

Thermal Protection System qualification Studies on Air Intake Configuration (DMRJ)

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Vikram Sarabhai Space Centre
Hypersonic Wind Tunnel (being developed)

Type of tunnel:
- High speed
- Intermittent blowdown type
- Horizontal

Year of establishment: To be established in 2009

Test Section size and shape: 1.0 m diameter – Enclosed free jet

Application:
- Aerospace
- Industrial

Speed range / Mach number range: 6 to 12

Reynolds number range (per m): 0.2 millions to 80 millions

Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and Unsteady pressure measurements
- Aero-elastic tests
- Flow visualization
- Special tests: PLIF, Pressure Sensitive Paint Techniques

Test control parameters:
- Ranges of Pitch (-10 to 50 deg), Roll (0 to 360 deg) and Yaw (- 0 to +10 deg)
- Typical test duration - 20 to 50 sec
- Stagnation pressure (10 to 100 bar) & Temperature range (500 to 1400 K)

Instrumentation:
- NI PXI based DAS (Lab View RTOS), Strain gage balances, Steady & Unsteady Pressure transducers, thermocouples, IR camera & High speed camera

Special Test Rigs & Techniques developed:
- Model injection Mechanism and Incidence Mechanism in Pitch & Yaw orientation
Customers:
- VSSC test programs including RLV, HSP, ABP projects

Milestones achieved:
- Development of cored brick heater, hot shut-off valves capable of handling high pressure and temperature conditions, procurement of reciprocating compressor which can be of charged upto 300bars, Installation of vacuum vessel of 6600m³ volume

Schematic of test facility:

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Vikram Sarabhai Space Centre
Hypersonic Shock Tunnel (being developed)

Type of tunnel:
- High speed, Intermittent blowdown type, Horizontal

Year of establishment: To be established in 2009

Test Section size and shape: 1.0 m diameter – Enclosed jet

Application:
- Aerospace
- Industrial

Speed range / Mach number range: 6 to 12

Total Enthalpy range: 8 MJ/kg

Type of tests performed:
- Heat transfer measurements

Test control parameters:
- Typical test duration – 6 ms (max)
- Stagnation pressure (300 bar) & Temperature range (5000 K)

Instrumentation:
- Fast response transducers, heat flux gauges, IR camera, High speed camera & accelerometer based balance system

Customers:
- VSSC test program – SRE, RLV projects

Milestones achieved:
- Development of recoil system to handle high pressure and thermal loads in short duration.

Schematic of test facility:
DRDL
Hypersonic Shock Tunnel

Type of tunnel:
- High speed, Wind, Intermittent, Horizontal

Year of establishment: 2008

Test Section size and shape: 1m diameter nozzle exit – enclosed free jet

Application:
- Aerospace
- R & D / Industrial

Speed range / Mach number range: 6, 6.5, 7, 8, 9 & 10

Reynolds number range (per m): 3 - 10 million maximum

Type of tests performed:
- Steady and Unsteady pressure measurements
- Flow visualization
- Special tests - Heat transfer measurement

Test control parameters:
- Ranges of Pitch, Roll and Yaw : Discrete
- Typical test duration : 1 milli sec
- Stagnation pressure & Temperature range : 5 – 85 bar & Temperature range 500- 4000 k

Instrumentation:
- Tools used : unsteady pressure transducers & thin film heat transfer gauges

Data Acquisition Systems used:
- PXI based embedded controller and simultaneous sampling ADC cards

Special test rigs and test techniques developed:
- Heat transfer measurement

Customers: DRDO
**Milestones achieved:**
- Tunnel calibration Dec 08

**Photographs of test facility:**

![Test Facility Image]

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DRDL
Aero Ballistic Range

Type of tunnel:
  ● High speed, Wind, free flight, Horizontal

Year of establishment: 1987

Test Section size and shape:
  ● Flight corridor 0.5mx0.5 mx 100 m
  ● Model diameter 20-50 mm
  ● Model length 400 mm (max)

Application:
  ● Aerospace
  ● R & D and Industrial

Speed range / Mach number range: 1.7 to 4.0
Reynolds number range (per m): 34 - 93 million

Type of tests performed:
  ● Flow visualization - Trajectory extraction from film

Test control parameters:
  ● Stagnation pressure & Temperature range : sea level free stream conditions will be experienced by the model

Instrumentation:
  ● Tools used : high speed photography with timer

Data Acquisition Systems used:
  ● Film will be read under a film reader to extract trajectory

Customers:
  ● DRDO

Photographs of test facility:

*Camera Stations - ABR*
Photographs of typical models tested:

AGNI Payload Model and Sabot  Model Shadowgraph

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DRDL
High Speed Tunnel

Type of tunnel:
- High speed, Wind

Year of establishment: 1980

Test Section size and shape:
- 300mm x 300mm solid wall test section
- 340mm dia. Enclosed free jet test section

Application:
- Aerospace / Non-aerospace
- R & D / Industrial

Speed range / Mach number range: Mach 1.4 to 4.0
Reynolds number range (per m): 0.3x10^8 to 3x10^8

Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and Unsteady pressure measurements
- Flow visualization
- Special tests (other than those listed above)
  i) Air intake tests for starting characteristics
  ii) Inter-stage tests for characterizing the flow between stages
  iii) Full scale fin opening tests to study the fin opening dynamics
  iv) Jet vane testing for force and moments

Test control parameters:
- Ranges of Pitch, Roll and Yaw: Pitch(-15° to 15°)
- Typical test duration: 100 seconds
- Stagnation pressure & Temperature range: 20 bar, 300 K

Instrumentation:
- Lab view platform

Data Acquisition Systems used:
- NI based system

Special test rigs and test techniques developed:
- Side wall mounted model testing
Customers: D R D O

Milestones achieved:

- Generation of aerodynamic design inputs for missile projects

Major modifications / Upgrades / augmentations made in the last 5 years:
- Parallel linkage model incidence mechanism

Photographs of test facility

![340 mm Axi-symmetric tunnel (Enclosed free jet)](image)

![300 mm x 300 mm 2-Dimensional tunnel](image)

Photographs of typical models tested:

Inter stage model testing

![Inter stage model testing](image)

Fin opening tests and Fin mounting at tunnel exhaust

![Fin opening tests and Fin mounting at tunnel exhaust](image)

Four jet vane model

![Four jet vane model](image)

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Type of tunnel:
- Closed circuit, closed jet, continuous flow subsonic wind tunnel

Year of establishment: 1968

Test Section size and shape: 2.74m X 1.83m, octagonal

Application:
- Primarily for indigenous development testing
- Testing requirements of R&D organizations and other industries for both aeronautical & non aeronautical applications.

Speed range / Mach number range:
- 10 – 55 m/s

Reynolds number range (per m):
- 0.63 – 3.46 millions

Free stream turbulence level (if low speed tunnel):
- 2%

Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and fluctuating pressure measurements
- Wind engineering
- Flow visualization
- Flow diagnostic tests

Special tests, viz:
- Ground effect tests
- Component loads measurements
- Efflux trails for ship models
- Stores release (gravity drop)

Test control parameters:
- Pitch angle (normal testing) - -18° to +42°
- Yaw angle (normal testing) - -28° to +28°
- Typical test duration - 15min
- High angle of attack testing up to 135°
Data Acquisition Systems used:
- Industrial PC based DAS making use of NI simultaneous sampling 16bit ADC.
- N2DAQ and LabView platform for Acquisition.
- In house developed soft ware for acquisition, processing and presentation.

Special test rigs and test techniques developed:
- High angles of attack rig
- Smoke trials at very low speeds
- Gravity release technique
- Oil dot technique
- Streamers technique
- Ejector developments

Customers:
- ADA, ADE, HAL, IISc, NAL, DND & DRDL

Milestones achieved:
- More than 30 projects and 45 models tested since inceptions.
- Completed all the low speed test requirements for major projects like ALH, IJT, LCA, LCH, P-17 & P-28.

Major modifications / Upgrades / augmentations made in the last 5 years:
- Development of high angle of attack sting
- Induction of ESP system.

Photographs of test facility
Photographs of typical models tested

- Continuous upgrading of DAS. For the present LabView is being utilized for complete DAS.
- Limited test setup for ejector studies.
- Efflux studies test setup.

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Type of tunnel:
- Low speed, Wind, Open Circuit, Blower type Boundary layer wind tunnel

Year of establishment: 1995

Test Section size and shape:
- 1.8m (H) x 2.5m (W) x 18.0 m (L) – Rectangular
- Overall Length of Tunnel: 52 m

Application:
- Non-aerospace
- R & D and Industrial

Speed range / Mach number range: 0.5 m/s to 55.0 m/s
Reynolds number range (per m): 3.3 x10^4 to 3.6 x 10^6

Freestream turbulence level (if low speed tunnel):
- Typically around 10% at a height of about 90cm 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, is essential for every experiment for terrain simulation

Types of Structures widely being investigated (Includes R&D and Consultancy/ Sponsored Studies)
- Low-rise buildings
- Industrial Structures such as Coal Sheds; Umbilical tower; Prill tower, etc.
- Power plant Structures such as tall chimneys; Cooling Towers
- Wind-induced interference studies on group of structures in Power plants
- Multi-storey commercial and residential building Complexes
- Static and Dynamic Section models of bridge decks
Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and Unsteady pressure measurements
- Aeroelastic tests
- Flutter and Divergence studies
- Wind engineering
- Flow visualization (using PIV system)
- Flow diagnostic tests
- Special tests (other than those listed above)
  - Tests on wire mesh of antenna dish
  - Tests on interference between a group of Lattice towers

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 & Temperature range: Ambient temperature
- Special features (other than those listed above):
  - Velocity measurements using HWA
  - Long Test Section
  - Ability to simulate Atmospheric Turbulence
  - Adjustable ceiling of test section roof

Instrumentation:
- Tools used HWA; Standard Pilot Tube; Pressure Sensors; Force balance, PIV system; Strain gauge and Accelerometers along with signal conditioners.

Data Acquisition Systems used:
- Global Lab., DT Foundry System; PSI / Scanivalve Pressure Measurement Systems

Special test rigs and test techniques developed:
- Dynamic Test rigs for testing of bridge deck models.

Customers:
- Govt. / PSUs / Private Sectors such as ISRO / NLC / BHEL / L&T / Reliance / TATA / BGR / Fitchner / RVUNL
Milestones achieved:
- The SERC BLWT is highly sought for in the industry for wind tunnel testing.

Major modifications / Upgrades / Augmentations made in the last 5 years:
- Procurement of PIV System
- Upgradation of pressure measurement system

Photographs of typical models tested:

* A view of the isolated chimney model in the wind tunnel

* A view of the chimney model with interfering structures in the wind tunnel

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Type of tunnel:
- Closed-return, continuous, atmospheric wind tunnel

Year of establishment: 1999

Test Section size and shape: 2.25m (high)x3m (width)x8.75m(long)

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

Speed range: Up to 80 m/sec

Reynolds number range (per m): 0 to 5 million per metre

Free-stream turbulence level (if low speed):
- $u'/_U < 0.08\%$, $v'/_U < 0.15\%$

Type of tests performed:
- Steady force & moment measurements
- Steady and Unsteady pressure measurements
- Aeroelastic Tests
- Ground effect simulation studies
- Wind effect on structures including interference effect
- Low Reynolds number airfoils studies
- Low speed air-intake studies

Control Parameters:
- On model pitch, roll and yaw sensors
- Roll, Pitch and Yaw ($0.01^\circ$) and Y & Z motion (-0.1mm)
- Preset and continuous movements

Instrumentation:
- Flex-motion eight axis closed loop control system
- PSI scanners (11 Nos, 32 port each)
- 10, 20 and 70 inch WC with 0.05% accuracy
- Internal Strain gauge force balances, load cells
- DANTAC streamline CTA system for velocity measurements
● Hot-wire probes and calibrator
● RTD, SS sensors and thermocouples for temperature
● B&K microphone sensors and amplifier for noise measurements
● 3D Stereoscopic PIV system
● Light sheet generation using 6W Ar-Ion Laser Image monitoring and recording system

Data Acquisition Systems:
● Industry standard PXI system with real time embedded controller
● Virtual Instrumentation (LabVIEW)
● Separation of console and user stations
● Standard DAQ, Motion control Hardware

Special test rigs and test techniques developed:
1. Full-model testing with sting support system
2. Half-model testing with external balance
3. Turntables system for aeronautical and non-aeronautical applications
4. Moving belt ground plane for ground effect simulation.
5. Gust and cross wind simulation
6. Aero-acoustic testing
7. Laser light sheet generation system for flow visualization
8. 3D Stereoscopic PIV system

Customers:
● VSSC, ADA, NAL, ADRDE, ADE and Various industries

Photographs of test facility:

Aerospace applications
Photographs of typical models tested:

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IIT Kharagpur (Wind Tunnel No. 1)

Type of tunnel:
  ● High speed (Supersonic)
  ● Wind
  ● Intermittent
  ● Horizontal

Year of establishment : 1980
Test Section size and shape : 5 cm X 10 cm (Rectangular c/s)
Application:
  ● Aerospace
  ● R & D

Mach number range: 1.5 - 3
Type of tests performed:
  ● Steady and Unsteady pressure measurements
  ● Flow visualization

Test control parameters:
  ● Typical test duration : 10 Sec

Instrumentation:
  ● Digital manometer & anemometer
  ● Scanning valve

Data Acquisition Systems used:
  ● LabVIEW software

Photographs of test facility:
  ● Refer fig. 1 and fig. 2

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Type of tunnel:
- Low speed
- Wind
- Continuous
- Horizontal

Year of establishment: 1975

Test Section size and shape: 50 cm X 50 cm (Square c/s)

Application:
- Both Aerospace & Non-aerospace
- R & D

Speed range:
- 15 m/s – 35 m/s

Freestream turbulence level (if low speed tunnel):
- 0.5% - 1.0%

Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and Unsteady pressure measurements
- Flow visualization

Test control parameters:
- Ranges of Pitch: -100 to +350

Instrumentation:
- Digital manometer & anemometer
- Scanning valve

Data Acquisition Systems used:
- LabVIEW software

Photographs of test facility:
- Refer fig. 3 and fig. 4

Photographs of typical models tested:
- Refer fig. 8
Department of Aerospace Engineering  
IIT Kharagpur (Wind Tunnel No.3)

Type of tunnel:
- Low speed
- Wind
- Continuous
- Horizontal

Year of establishment: 1990
Test Section size and shape: 60 cm X 90 cm (Rectangular c/s)
Application:
- Aerospace
- R & D

Speed range:
- 15 m/s – 30 m/s

Freestream turbulence level (if low speed tunnel): 0.8 %

Type of tests performed:
- Steady and Unsteady force & moment measurements
- Steady and Unsteady pressure measurements

Test control parameters:
- Special features: Sinusoidal gust can be generated

Instrumentation:
- Digital manometer & anemometer
- Scanning valve

Data Acquisition Systems used:
- LabVIEW software

Photographs of test facility:
- Refer fig. 5
Department of Aerospace Engineering
IIT Kharagpur (Wind Tunnel No.4)

Type of tunnel:
- Low speed
- Wind
- Continuous
- Horizontal

Year of establishment: 1992

Test Section size and shape: 225 cm X 150 cm (Rectangular c/s)

Application:
- Both Aerospace & Non-aerospace
- Both R & D and Industrial

Speed range:
- 12 m/s

Type of tests performed:
- Steady pressure measurements
- Wind engineering

Augmentations in the last 5 years:
- Augmented with additional motor to enhance the max. speed from 8 m/s to 12 m/s

Test control parameters:
- Special features: Provision to generate Atmospheric Boundary Layer

Instrumentation:
- Digital manometer and anemometer
- Scanning valve

Data Acquisition Systems used:
- LabVIEW software

Photographs of test facility:
- Refer fig. 6

Photographs of typical models tested:
- Refer fig. 7
Fig. 1. Supersonic wind tunnel with schlieren system

Fig. 2. Schlieren system

Fig. 3. Low speed wind tunnel

Fig. 4. Low speed wind tunnel

Fig. 5. Low speed wind tunnel

Fig. 6. Low speed industrial wind tunnel
Fig. 7. Car model

Fig. 8. Propeller model

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IIT Madras (Wind Tunnel No.1)

Type of tunnel:
- Continuously run Rarefied Gas Dynamics Facility
- Low Density Wind Tunnel

Year of establishment: 1979

Test Section size and shape:
- Cylindrical Vacuum Vessel of 1.0m diameter, 4.5m long

Application:
- Aerospace / Non-aerospace / Both
- R & D / Industrial / Both

Speed range / Mach number range:
- Low speeds to Hypersonic to simulate
- High Knudsen number flows

Reynolds number range (per m):
- Very low Re from Tens to Thousands

Type of tests performed:
- Steady and Unsteady pressure measurements
- Flow visualization using Glow Discharge

Rarefied gas dynamics facility
• Shear force measurements using non intrusive laser based methods
• Heat transfer measurements

Instrumentation:
• Fully instrumented with low pressure, temperature and mass flow measurements.

Customers:
• ISRO

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IIT Madras (Shock Tunnel No.2)

Type of tunnel:
- Combustion driven shock tube/shock tunnel

Year of establishment: 1980

Test Section size and shape:
- Shock tube is rectangular 40mm x 80mm
- Shock tunnel is circular nozzle exit of 300mm
  - enclosed free jet type

Application:
- Aerospace
- R & D / Industrial

Speed range / Mach number range:
- Speed in the shock tube typical 3500m/s

Shock Tunnel

Instrumented models
Mach number range:
- Mach number 5.5 in the Straight through mode
- Mach number up to 13 in the Reflected mode

Enthalpy level in the shock tunnel:
- Upto 6.0MJ /kg

Type of tests performed:
- Steady and Unsteady pressure measurements
- Flow diagnostic tests
- Heat transfer measurements

Instrumentation:
- Fully instrumented for pressure and heat transfer measurements

Customers:
- ISRO, DRDL

Contact person:
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Department of Space Engineering and Rocketry
B.I.T. Mesra, Ranchi (Wind Tunnel No.1)

Type of Tunnel:
- Low Speed
- Wind
- Continuous
- Horizontal

Year of establishment: 1965
Test Section size and shape: 150mm X 300mm

Application:
- Aerospace and Non-aerospace
- R & D

Speed range / Mach number range:
- 1 m/s – 10 m/s

Reynolds number range (per m):
- 7 x 10^5 to 7 x 10^6

Freestream turbulence level (If Low speed tunnel):
- 0.5 %

Type of tests performed:
- Static Pressures
- Wind engineering
- Flow visualization

Test control parameters:
- Ranges of Pitch, Roll and Yaw: + 300 Pitch
- Typical test duration: Continuous

Instrumentation:
- Multi-tube Manometer, Pressure pickups, Smoke generator, Digital Camera
Photographs of test facility

Infinite aerofoil

Circular Cylinder of different diameters

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Type of Tunnel:
- High Speed
- Wind
- Intermittent
- Horizontal

Year of establishment: **1972**

Test Section size and shape: 50mmx100mm (Rectangular)

Application:
- Aerospace
- R & D

Speed range / Mach number range:
- 1.5 – 3.0 Mach Number

Reynolds number range (per m):
- $2.5 \times 10^7 – 10^8$
- $2 \times 10^7 – 4 \times 10^7$

Pressure fluctuation level (if high speed, % Cprms):
- 0.01 at $M=2.0$

Type of tests performed:
- Steady & Unsteady Pressures
- Flow visualization

Test control parameters:
- Ranges of Pitch, Roll and Yaw: $+7.50$ Pitch
- Typical test duration: (15 – 30) sec
- Stagnation pressure & Temperature range: $2 – 8.2 \times 10^5 \text{ N/m}^2$, 283 -300 K

Instrumentation:
- Compressors, Air Drier, Multi-tube mercury manometer
- Pressure pickups, Unsteady pressure pickups (Kulite Make)
- B & W Schlieren system, Digital Camera, NI Cards
Data Acquisition Systems used:
  ● NI DAQ - Labview

Customers:
  ● Sponsored projects of ARDB, ISRO, DRDL, etc.

Major modifications made in the last 5 years:
  ● Subsonic diffuser

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Air Receiver  Compressors and Air Drier  Supersonic Tunnel

Air-Intake  Re-entry Capsules  Apollo Capsule  Blunt Protrusions  Cylindrical Protrusions

Trapezoidal protrusions Typical Hypersonic Research Vehicle
Department of Space Engineering and Rocketry
B.I.T. Mesra, Ranchi (Wind Tunnel No.3)

Type of Tunnel:
- Supersonic Free Jet
- Wind
- Intermittent
- Horizontal

Year of establishment: 2007
Test Section size and shape: 2" Conical

Application:
- Aerospace
- R & D

Speed range / Mach number range:
- 1.0 – 2.0 Mach Number

Reynolds number range (per m):
- $2.5 \times 10^7 – 10^8$
- $2 \times 10^7 – 4 \times 10^7$

Type of tests performed:
- Total and Static Pressures
- Flow visualization

Test control parameters:
- Typical test duration: (15 – 30) sec
- Stagnation pressure & Temperature range: $1 – 7 \times 10^5$ N/m$^2$, 283 -300 K

Instrumentation:
Compressors, Air Drier, Pressure pickups, Static pressure probe
Total Probe, B & W Schlieren system, Digital Camera
Contact person

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MIT, Anna University, Chennai
Large Size Wind Tunnel Facility

Type of tunnel:
- Low speed continuous horizontal wind tunnel

Year of establishment: 1964

Test Section size and shape: 1x1.2x2 m Rectangular Cross-section

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

Speed range: Up to 50 m/sec

Reynolds number range (per m): Up to 3.437 million per metre

Free-stream turbulence level (if low speed): Excellent

Type of tests performed:
- Steady force & moment measurements
- Steady pressure measurements

Instrumentation:
- Multi-channel pressure scanner
- Manometers
- Strain measurements (Spidpak 3013 E- Pro package)
- Miniature Quartz Pressure Transducer
- Wind tunnel balance
- Digital storage Oscilloscope

Data Acquisition Systems:
- Electronic Data Acquisition System – 16 channels also suitable for strain measurements, sampling rate 9600 samples per sec/channel
- Thermocouple model (ITB 05E) make M/S Hottinger Baldwin – Germany.

Customers:
- AICTE, DRDO labs and Universities
Major Modification/ Upgrades/ Augmentation made in last 5 yrs:
- Model mounting and attitude changing mechanism is in progress

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Medium Size Wind Tunnel Facility

Type of tunnel:
  ● Low speed continuous horizontal wind tunnel

Year of establishment: 1985

Test Section size and shape:
  ● 0.6 x 0.6 x 2/4/6 m Rectangular Cross-section

Application:
  ● Aerospace & Non-aerospace
  ● R&D and Industrial

Speed range: Up to 30 m/sec

Reynolds number range (per m): Up to 4.125 million per metre

Free-stream turbulence level (if low speed): Good

Type of tests performed:
  ● Boundary layer flow studies

Instrumentation:
  ● Multi-channel pressure scanner
  ● Manometers
  ● Strain measurements (Spidpak 3013 E- Pro package)
  ● Miniature Quartz Pressure Transducer
  ● Wind tunnel balance
  ● Digital storage Oscilloscope

Data Acquisition Systems:
  ● Electronic Data Acquisition System – 16 channels also suitable for strain measurements, sampling rate 9600 samples per sec/channel
  ● Thermocouple model (ITB 05E) make M/S Hottinger Baldwin – Germany.

Customers:
  ● AICTE, DRDO labs and Universities
Major Modification/ Upgrades/ Augmentation made in last 5 yrs:
- Test section modified to facilitate Boundary layer studies

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Table Top Wind Tunnel Facility

Type of tunnel:
- Low speed table top continuous horizontal wind tunnel

Year of establishment: 1985

Test Section size and shape:
- 0.18 x 0.24 x 0.6 m Rectangular Cross-section

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

Speed range: Up to 80 m/sec

Reynolds number range (per m): Up to 5.5 million per metre

Free-stream turbulence level (if low speed): Good

Type of tests performed:
- Steady pressure measurements
- Flow visualization studies on 2D and 3D models

Instrumentation:
- Multi-channel pressure scanner,
- Manometers
- Strain measurements (Spidpak 3013 E- Pro package)
- Miniature Quartz Pressure Transducer
- Wind tunnel balance
- Digital storage Oscilloscope

Data Acquisition Systems:
- Electronic Data Acquisition System – 16 channels also suitable for strain measurements, sampling rate 9600 samples per sec/channel
- Thermocouple model (ITB 05E) make M/S Hottinger Baldwin – Germany.

Customers:
- AICTE, DRDO labs and Universities
Major Modification/ Upgrades/ Augmentation made in last 5 yrs:

- Internal aluminum sheet provided to make the flow uniform and to minimize the friction.

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Hydrodynamic Test Facilities

High Speed Towing Tank (HSTT)

It is a hydrodynamic test facility recognized by International Towing Tank Conference (ITTC). The tank is fitted with a high speed towing carriage which runs at a maximum speed of 20 m/sec and runs on parallel rails which are fitted to have a tolerance of 0.2 mm over 100 m length and it follow the earth’s curvature. It is fitted with a wave generator at one end to simulate random and irregular sea conditions while testing the models. It is also equipped with a model making workshop to make the scale down models of ships and submarines to carry out the model tests for determining the performance characteristics and evaluation of the power plant requirements, etc. The other features of High Speed Towing Tank (HSTT) are given below:

**Tank Dimension, m**
- 500 x 8 x 8

**Carriage Speed, m/s**
- Ahead 20 (max), Astern 3 (max) With accuracy of 0.1% of set speed

**Wave Generator**
- Dual flap type capable of generating regular and irregular waves (unidirectional) up to wave height of 0.5 m.

**Speed Control**
- By Ward Leonard System feeding power through current conductors to 8 in number 129 kW DC drive motors.

The facility is equipped with a Large Amplitude Horizontal Planar Motion Mechanism (LAHPMM) for carrying out planar motion studies of
manoeuvring characteristics of surface ships and submerged vehicles in surface condition.

**Tests Performed in HSTT**
- Resistance and self propulsion tests to assess speed power characteristics
- Flow visualization to identify flow separation, if any
- Open water test to obtain propeller characteristics
- Wake survey to determine flow velocities
- Sea-keeping tests for head sea only
- Dynamic tests for high speed vessels, such as, planning, multi-hulls, hydro-foil, SES, etc. Hydrodynamic performance evaluation of 7m long heavy weight torpedo with PJP through Vertical Planar Motion Mechanism (VPMM) tests.
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Preface

I am pleased to note that the Organizing Committee of the National Conference on Wind Tunnel Testing, being organized jointly by the National Trisonic Aerodynamic Facilities Division of NAL and the Department of Aerospace Engineering of IISc is bringing out a Directory of Wind Tunnels in India. Over the last few decades, several wind tunnel test facilities useful for civil and military aerospace and non-aerospace programmes have been established in various R & D centers, national laboratories and academic institutions. A directory of these wind tunnels, which contains their essential features is useful for several purposes, in particular for utilization by national aerospace agencies for their R & D and mission mode programmes, planning of test logistics, use by student community, etc. This also would help in bringing the like-minded professionals under a common forum to exchange ideas, professional experience and test techniques, standardization, etc. I am sure that the national aerospace agencies, professionals and the academia would welcome publication of the Directory.

Efforts were made to contact all the sources for details of test facilities from water tunnels to hypervelocity wind tunnels. The owners of these facilities were extremely supportive in giving out the details sought. I am thankful to them for this gesture. The responses received from all the facilities, including the information available from public domain are included in this Directory. It is felt that if details of any test facility have been inadvertently omitted, the same could be included in the next edition of the Directory.

I compliment the Organizers on their initiative.

A R Upadhya
Chairman
National Advisory Committee
National Conference on Wind Tunnel Testing.
NCWT-02

Directory of
Wind Tunnel Test Facilities in India

Released on the occasion of the
National Conference on Wind Tunnel Testing

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