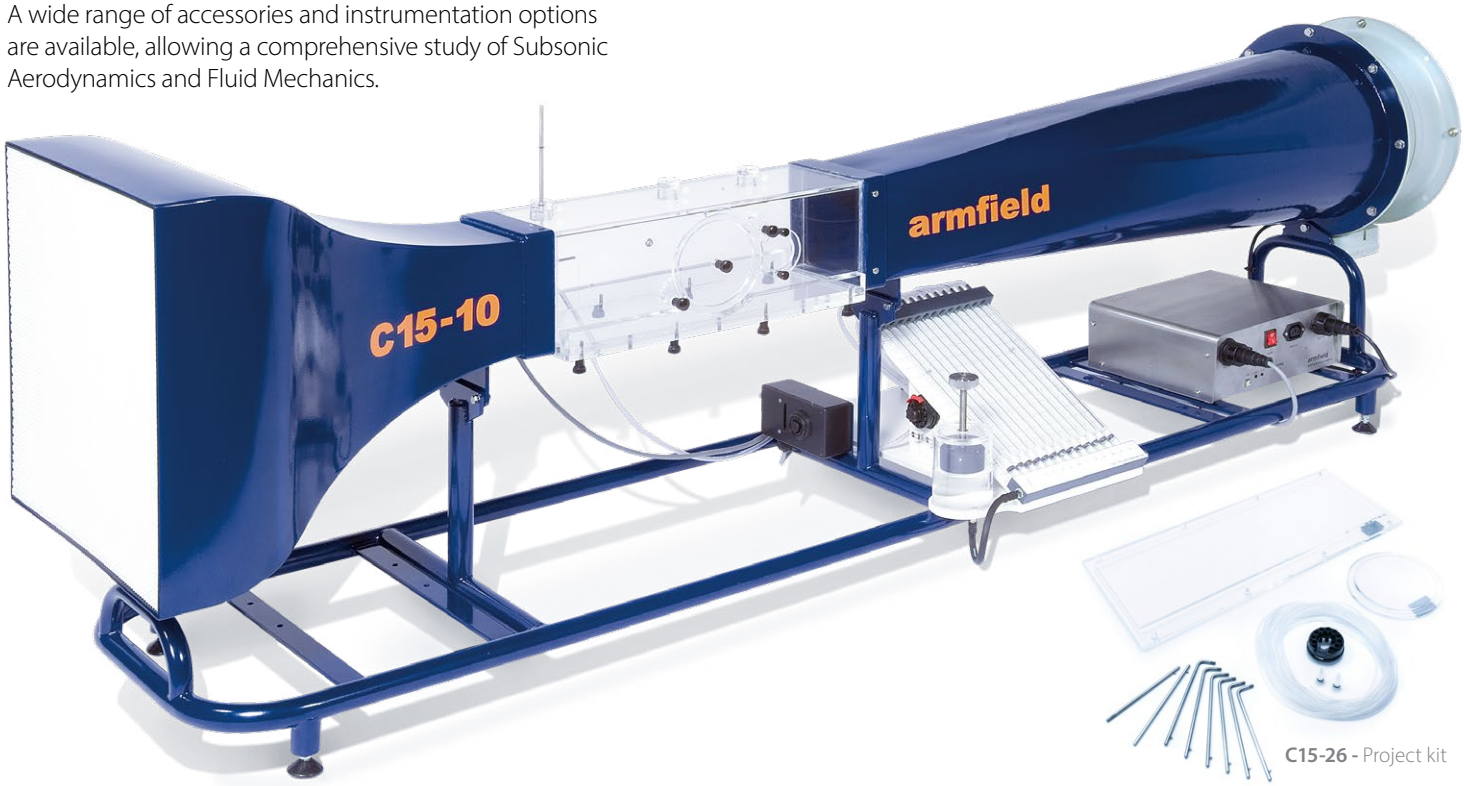
C SERIES

Computer Controlled Subsonic Wind Tunnel - C15

A compact benchtop wind tunnel, with visible working section.

A wide range of accessories and instrumentation options are available, allowing a comprehensive study of Subsonic Aerodynamics and Fluid Mechanics.

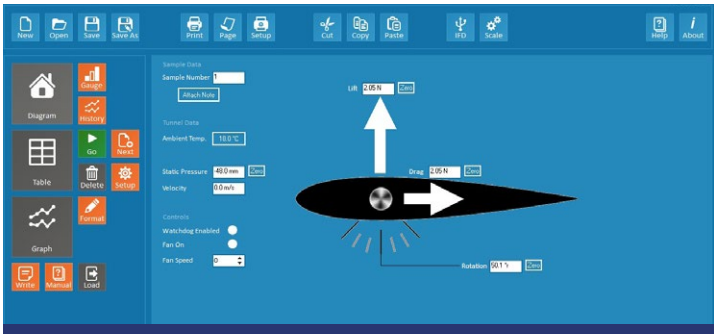
COMPUTER CONTROL & DATA CAPTURE AS STANDARD



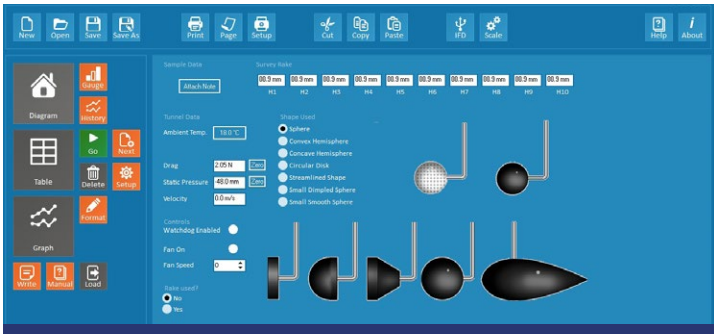
C15-26 - Project kit

Experimental content

- To convert a head measurement using a manometer to an equivalent pressure reading
- To demonstrate the use of a static pressure reading to determine tunnel air velocity
- To convert head and pressure readings to alternative engineering units
- To demonstrate the difference between Static pressure, Dynamic pressure and Total pressure and how Dynamic pressure can be used to determine air velocity
- To show how velocity varies in the test section because of the velocity profile
- To investigate the variation in Static Head resulting from a change in cross-sectional area
- To investigate the Bernoulli equation
- The visualisation of flow around a bluff body at different velocities
- The measurement of pressure distribution around a circular cylinder at different velocities
- Comparison of drag for shapes of equal equatorial diameter
- Visualisation of flow around different body shapes
- Measurement of the wake profile behind different shapes
- To investigate the pressure distribution around a symmetrical aerofoil at different angles
- To investigate the pressure distribution across the wake behind the wing
- To measure the depth of the boundary layer on smooth and rough flat plates
- To evaluate models or instruments of the students own design and/or manufacture



C15 software screen (Lift and drag on an aerofoil)

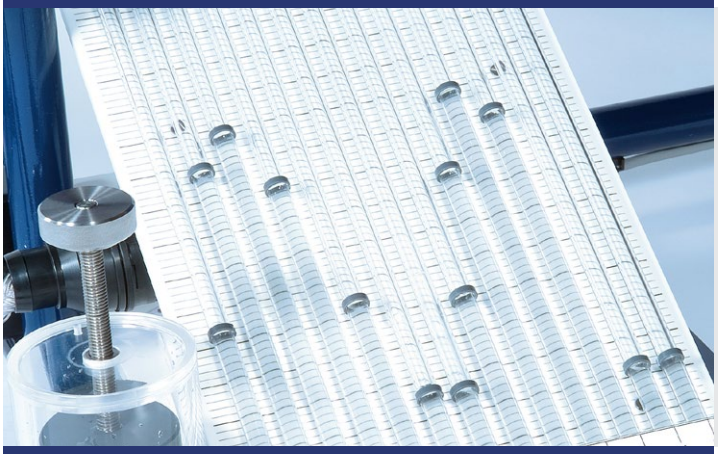


C15 software screen (Drag forces on buff and streamlined bodies)

UK office - email: sales@armfield.co.uk tel: +44 (0) 1425 478781 (for ROW)
USA office - email: info@armfield.inc tel: +1 (609) 208-2800 (USA only)

Issue: 2
URL: http://www.armfield.co.uk/c15
Applications
ChE ME CE IP

C15-11: Inclined Manometer Bank



The bank of 13 transparent tubes inclined at 30° to measure small pressure differences (0–160mm H2O).

It includes a water reservoir with screw operated displacer to allow rapid adjustment of the datum level in the manometer, and is fitted with quick release connectors for rapid connection to models and instruments.

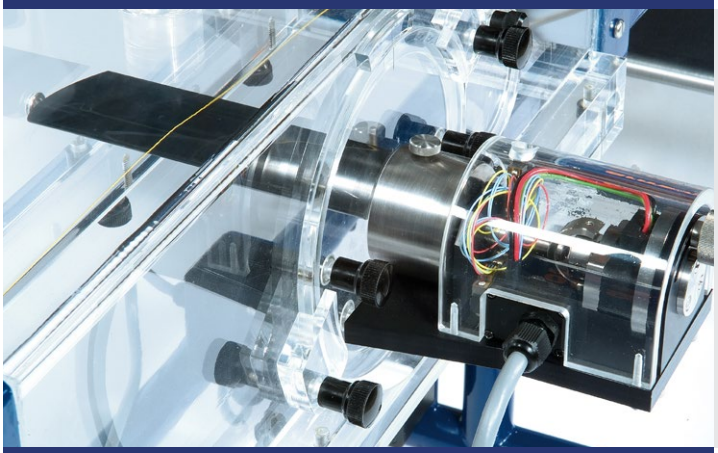
Water is used as the manometer fluid for safety and convenience in use.

C15-12: Electronic Manometer Bank

An electronic console incorporating 16 differential pressure sensors, each with a range of 0-178mm H2O. (It connects to the control PC using a second USB port, and the readings are fully integrated with the wind tunnel control software.)

A common tapping allows all sensors to be referenced to atmospheric pressure. Quick release connectors allow for rapid connection to models and instruments.

C15-13-FC : Lift and Drag Balance (requires C15-20 or C15-22)



A 2-component, electronic balance used to measure the lift and drag on appropriate models. The lift and drag models connect to the balance using a simple fixing that ensures correct orientation of the model.

Electronic sensors are used to measure the lift and drag forces, the drag being measured directly, and the lift by a reduction in the model weight. The model being tested can also be rotated on the mounting and the angle of rotation measured electronically. The readings from the lift and drag sensors and the rotation sensor are displayed on the control software screen running on the PC, and are available for data logging.

***Factory fit**

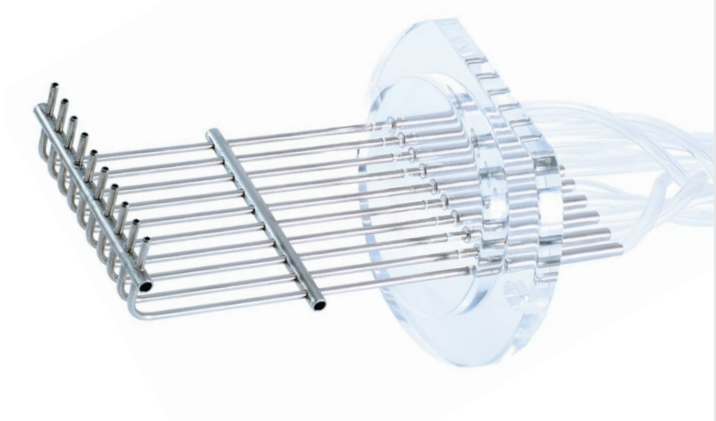
Must be fitted and calibrated during assembly; please order in advance.

C15-14: Pitot Static Tube (requires C15-11 or C15-12)

A miniature Pitot Static Tube mounted in a support plug that can be located in the roof of the working section at three alternative positions, i.e. the start of the working section and upstream and downstream of the model mounting position.

The support plug incorporates an 'O' ring to retain the Pitot Tube where it is positioned and allows the tube to traverse over the full height of the working section to measure the velocity profile inside the working section of the tunnel.

C15-15: Wake Survey Rake (requires C15-11 or C15-12)

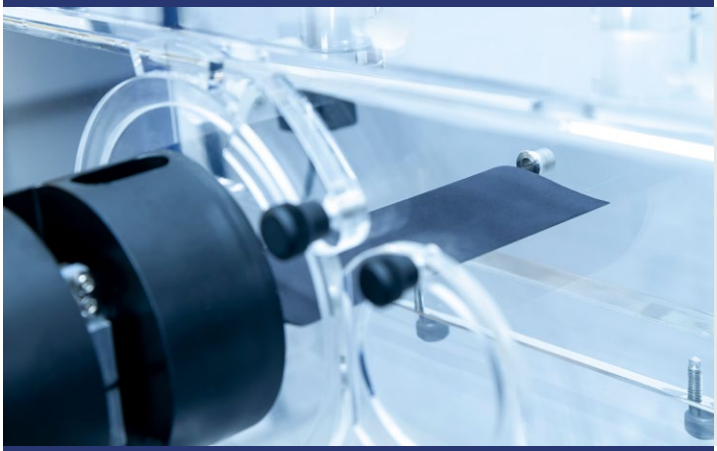


The rake consists of 10 tubes positioned vertically in a row and pointing towards the airflow. The rake is mounted downstream of the model being used.

The tubes are mounted at a fixed pitch of 5mm but the assembly can be displaced 2.5mm allowing measurements at intervals of 2.5mm by interlacing two sets of readings.

The tubes are connected via flexible tubing to a multi-way quick release connector.

C15-16-Asoft-FC: 3-Component Balance



A 3-component balance used to measure Lift, drag and moment forces on appropriate models.The models connect to the balance using a simple fixing that ensures correct orientation of the model.

The system is designed to work with a series of Armfield models and also enables the user to manufacture and test their own 3D printed or fabricated wings to test and evaluate for project work.

Integrated Electronic sensors are used to measure the lift, drag and moment forces. The model being tested can also be rotated on the mounting and the angle of rotation measured electronically. The readings from the lift, drag, moment sensors and the rotation sensor are displayed on the control software screen running on the PC, and are available for data logging.

Factory fit

Must be fitted and calibrated during assembly; please order in advance.

C15-17-Asoft-FC: 3-Component Driven Balance (Requires C15-19)

A PC controlled Driven 3 component balance incorporates a closed loop stepper drive for precise driven rotation angles particularly beneficial for remote operation/ remote learning activities and repetitious test and development.

Factory fit

Must be fitted and calibrated during assembly; please order in advance.

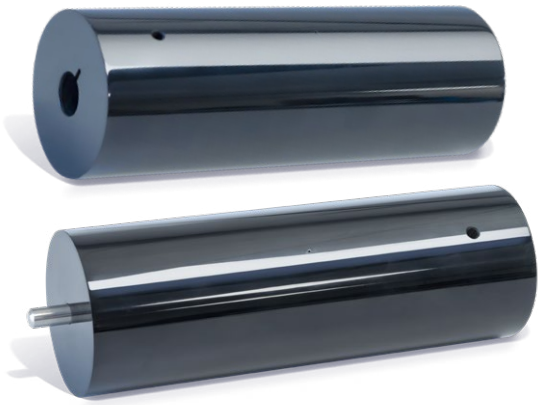
C15-18-FC: Driven 360° Model Unit (Requires C15-19)

A PC controlled driven 360-degree model interface with single pressure tapping take off to allow test models to be fitted with incorporated pressure tapping. Suitable for use with C30-18-01 pressure cylinder or for users to manufacture and test their own 3D printed or fabricated samples to test and evaluate for project work. particularly beneficial for remote operation/ remote learning activities and repetitious test and development.

Factory fit

Must be fitted and calibrated during assembly; please order in advance.

C15-18-01: Cylinder with pressure tapping for 360° drive



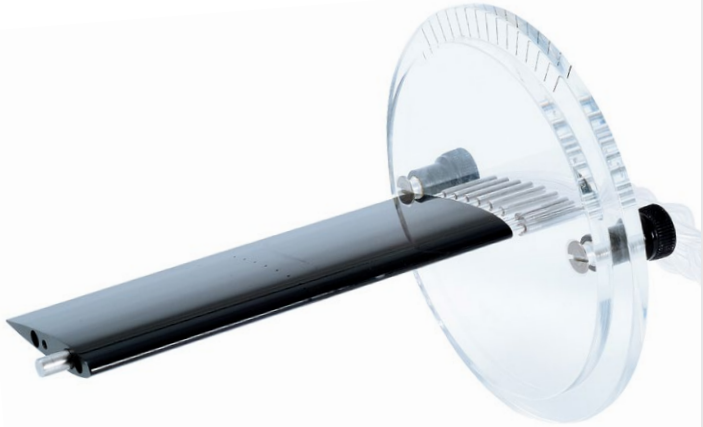
Cylinder with single pressure tapping to interface with the driven 360 degree model unit enabling the study of pressure acting on a cylinder at various velocities and angular positions.

C15-20: Lift & Drag Aerofoil (requires C15-13)

A plain symmetrical aerofoil to NACA 0015 profile, incorporating a mounting rod that allows it to be installed on the C15-13 Lift & Drag Balance, thus allowing the lift and drag to be measured with the aerofoil at different angles of attack.

The aerofoil has the same section as the C15-21 to allow direct comparison of lift characteristics with the pressure distribution.

C15-21: Pressure Wing (requires C15-11 or C15-12)



A symmetrical aerofoil incorporating 10 tapping points distributed along the wing profile on one side, which allows the pressure distribution to be measured from the leading edge to the trailing edge.

The pressure distribution on the upper and lower surface can be obtained by inclining the aerofoil at positive and negative angles of attack. Machined to NACA 0015 profile, the aerofoil has the same section as the C15-20 to allow direct comparison of pressure distribution with the lift characteristics.

The tapping points are all flush with the surface of the aerofoil and connected via flexible tubing to a multi-way quick release connector.

C15-22 Drag Models (requires C15-13)

Seven different models are provided for use with the C15-13 Lift and Drag Balance for investigations into the influence of shape on the drag forces.

Five models are supplied with a common equatorial diameter of 50mm, thus all presenting the same cross section to the airflow:
Sphere - Hemisphere, convex to airflow - Hemisphere, concave to airflow - Circular disk - Streamlined shape.

Additionally a dimpled golf ball and plain sphere demonstrate the difference in drag force due to the dimples.

C15-23: Pressure Cylinder (requires C15-11 or C15-12)

A plain cylinder, 30mm diameter, incorporating 10 equi-spaced tapping points around half of the circumference that allow the pressure distribution around the cylinder to be measured.

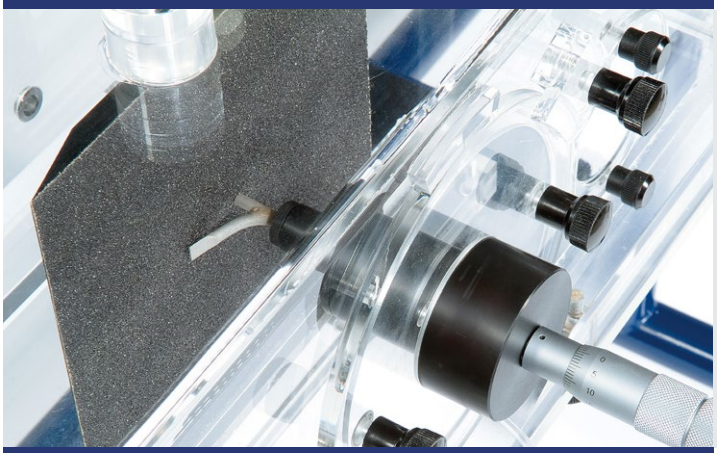
The cylinder can be rotated through 180° to plot the pressure distribution over the whole circumference.

C15-24: Bernoulli Apparatus (requires C15-11 or C15-12)

A Venturi profile that is installed in the working section of the tunnel via the removable floor. The Venturi incorporates 11 pressure tappings in the floor, connected via flexible tubing to quick release connectors.

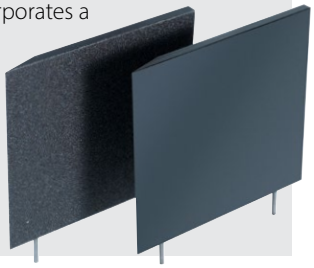
The Venturi occupies the full height of the working section and the width varies from 150mm (full width of the working section) at the inlet and outlet to 100mm at the throat. It is manufactured from clear acrylic for full visualisation.

C15-25: Boundary Layer Plate (requires C15-11 or C15-12)



A flat plate, with a bevelled leading edge, that is mounted vertically in the working section via the removable floor. A flattened Pitot tube, mounted on a traversing micrometer, allows the air velocity to be measured at different distances from the surface of the plate.

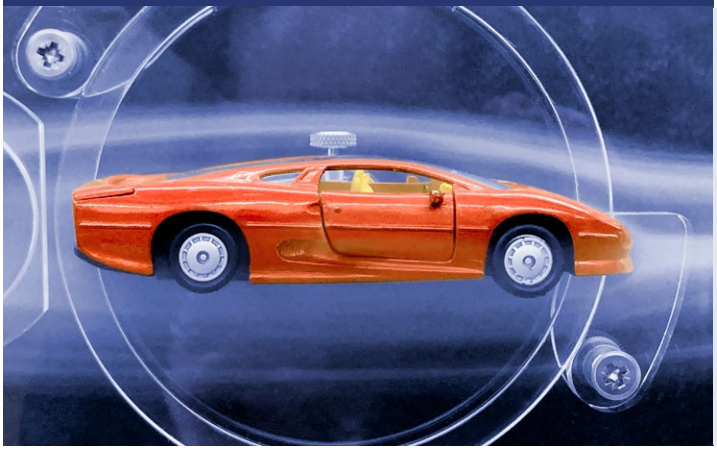
A smooth plate and artificially roughened plate (above) are included to show the difference between laminar and turbulent boundary layers. The flexible tubing from the Pitot tube incorporates a quick release connector.



C15-26: Project Kit

A selection of components that allow alternative models to be constructed by the user. Includes a floor panel, a circular hatch and a set of connectors with appropriate flexible tubing.

C-Smoke: Probe smoke Generator



The probe smoke generator allows for easy visualisation of the air flow. Available in 2 voltage variants.

C15-30-01: C15 Wing model type 1 Gottingen 535
(requires C15-13 or C15-16)

Wing model designed with a Gottingen 535 Air foil profile, as used on a slingsby T21b glider. The high camber profile is designed into an air foil to maximize its lift coefficient.

C15-30-02: C15 Wing model type 2 NACA 633-618
(requires C15-13 or C15-16)

Wing model designed with a NACA 633-618 profile, as used on the Schleicher Ka6b Glider. The profile is Less cambered than the Gottingen 535 allowing direct comparison.

C15-30-03: C15 Wing model type 3 NACA 64-212
(requires C15-13 or C15-16)

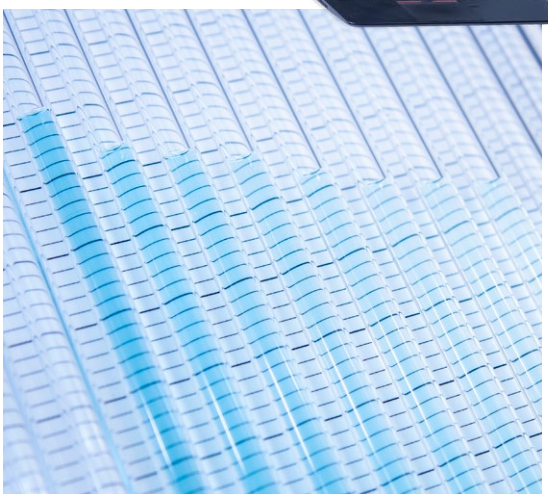
Wing model designed with a NACA 64-212 profile, as used on the MDM-1 Fox aerobatic glider. The profile is almost symmetrical and cuts through the air evenly.

C15-30-04: C15 Wing model type 4-Fauvel F2
(requires C15-13 or C15-16)

Wing model designed with a Fauvel F2 as used on the FV-36 Flying Wing. The profile a reflexed camber air foil where the camber line curves back up near the trailing edge. Such an air foil is useful in certain situations, such as with tailless aircraft.

Ordering specification

C15-10-A	Computer Controlled Wind Tunnel
C15-10-G	Computer Controlled Wind Tunnel
C15-11	Inclined Manometer Bank
C15-12	Electronic Manometer Bank
C15-13-FC	Lift and Drag Balance (requires C15-20 or C15-22)
C15-14	Pitot Static Tube (requires C15-11 or C15-12)
C15-15	Wake Survey Rake (requires C15-11 or C15-12)
C15-16-Asoft-FC	3-Component Balance
C15-17-Asoft-FC	3-Component Driven Balance - Armsoft (requires C15-19-FC)
C15-18-FC	Driven 360 degree model unit (requires C15-19-FC)
C15-18-01	C15 pressure cylinder for 360 drive unit
C15-19-FC	Wind Tunnel Accessory PSU
C15-20	Lift & Drag Aerofoil (requires C15-13)
C15-21	Pressure Wing (requires C15-11 or C15-12)
C15-22	Drag Models (requires C15-13)
C15-23	Pressure Cylinder (requires C15-11 or C15-12)
C15-24	Bernoulli Apparatus (requires C15-11 or C15-12)
C15-25	Boundary Layer Plate (requires C15-11 or C15-12)
C15-26	Project Kit
C15-30-01	C15 Wing model type 1 Gottingen 535
C15-30-02	C15 Wing model type 2 NACA 633-618
C15-30-03	C15 Wing model type 3 NACA 64-212
C15-30-04	C15 Wing model type 4-Fauvel F2



Description

The C15-10 is a computer controlled compact wind tunnel designed for benchtop operation. Air is drawn through the working section by a variable speed fan at the discharge end of the tunnel providing up to 34m/s air velocity.

A honeycomb flow straightener is incorporated at the inlet, and a 9:4:1 contraction ratio which ensures a uniform airflow through the working section.

The working section is fabricated from clear acrylic to provide optimum visibility of the models and appropriate model connection points are included in the side wall and roof of the working section to provide ease of use.

The wind tunnel is supplied as standard with an in-depth software interface providing control of the fan speed and additionally display important parameters such as static pressure and air velocity.

The Armfield C15-10 can be optionally supplied with two variants of manometry banks, a 13 tube water manometer used to simultaneously display differential pressure or a sixteen channel electronic manometer allowing direct integration into the supplied software.

The wind tunnel can be supplied with a range of optional accessories including drag bodies, lift bodies, pressure distribution, boundary layers studies and measuring instruments.

The optional models are mounted through a circular hatch using quick release clamps (120mm diameter). The placement of the optional models has been designed to minimise the disturbance to air flow and reduction in flow rate, whilst incorporating an angular scale allowing the model to be manually rotated to known angles.

The working section incorporates an innovative technique for flow visualisation around any of the optional models avoiding the need for either smoke or dry ice. A lightweight twine follows the flow contour around the model and shows if and where boundary layer separation (breakaway) occurs.

Technical Details

- Motor Rating: 0.51 kW 3 phase, 220VΔ (maximum speed 50 Hz through inverter)
- Working Section: 150mm x 150mm x 455mm
- Air Velocity: variable 0 to 34m/s
- Profiled Inlet: 9:4:1 (nominal) Contraction ratio
- Flow Visualization: Lightweight twine

Requirements

PC | USB

Scale

Electrical supply:

- C15-10-A: 220-240V/1/Phase, 50Hz, 10Amps
- C15-10-G: 220-240V/1/Phase, 60Hz, 10Amps

G version has optional 1.5kVA transformer available to accommodate 120V/1Ph/60Hz supply

The user must have a PC with a USB port, running Windows 7 above. An additional USB port will be required when using the optional C15-12

Overall dimensions

Length	2.250m
Width	0.700m
Height	0.460m
Packed and crated shipping specifications	
Volume	1.5m^3
Gross weight	220Kg

Ordering codes

C15-10-A	Computer Controlled Wind Tunnel
C15-10-G	Computer Controlled Wind Tunnel
C15-11	Inclined Manometer Bank
C15-12	Electronic Manometer Bank
C15-13-FC	Lift and Drag Balance (requires C15-20 or C15-22)
C15-14	Pitot Static Tube (requires C15-11 or C15-12)
C15-15	Wake Survey Rake (requires C15-11 or C15-12)
C15-16-Asoft-FC	3-Component Balance
C15-17-Asoft-FC	3-Component Driven Balance - Armsoft (requires C15-19-FC)
C15-18-FC	Driven 360 degree model unit (requires C15-19-FC)
C15-18-01	C15 pressure cylinder for 360 drive unit
C15-19-FC	Wind Tunnel Accessory PSU
C15-20	Lift & Drag Aerofoil (requires C15-13)
C15-21	Pressure Wing (requires C15-11 or C15-12)
C15-22	Drag Models (requires C15-13)
C15-23	Pressure Cylinder (requires C15-11 or C15-12)
C15-24	Bernoulli Apparatus (requires C15-11 or C15-12)
C15-25	Boundary Layer Plate (requires C15-11 or C15-12)
C15-26	Project Kit
C15-30-01	C15 Wing model type 1 Gottingen 535
C15-30-02	C15 Wing model type 2 NACA 633-618
C15-30-03	C15 Wing model type 3 NACA 64-212
C15-30-04	C15 Wing model type 4-Fauvel F2
C-Smoke - A or B	Probe smoke generator

Armfield standard warranty applies with this product