Open Safety

iBREATHE MkIV

Respiratory Simulator

RESPIRATORY SIMULATOR

iBREATHE MkIV

FEATURES & BENEFITS

- Performs ALL respiratory measurements on SCUBA, avionic and medical breathing equipment.
- From submerged, hyperbaric 1000m to full vacuum.
- WOB, Tidal Volume, Breathing Resistance, CO2, O2
- Full CNC control: no manual changes required, apart from mannequin head change.
- Tidal volumes 0.1 to 6.0 litres
- Breathing rates from 0.1 to 60 bpm
- Maximum RMV at 3.0L of 180 lpm
- CE-EN TV / BR / RMV rates are pre-programmed
- USB 2.0, or RS 485 I/O options
- Sine, Human, & Trapezoidal waveforms
- Real time results and Lissajous, breath by breath.
- Breath by breath logging
- Quick swappable mannequin heads

APPLICATIONS

- Avionic testing for Hypoxic Flight Equipment
- SCUBA and SSUBA rebreather testing
- Saturation bibs testing
- Medical Breathing Equipment testing & validation

DESCRIPTION

The iBreathe Respiratory Simulator MkIV provides the fastest test environment for respiratory testing of breathing equipment, including PPO2 control, WOB and resistance. It runs test sequences in minutes or hours that hitherto have taken days and weeks on first generation machines such as ANSTI and mechanical linkage machines. The time savings come from complete automation, allowing the user to do all tests in a single chamber run, without having to surface each time to change tidal volumes. The final report document is generated in real time, and saved on demand.

This 4th Generation machine provides larger tidal volumes and supports higher RMVs than older 2nd Generation breathing machines: tidal volumes to 6 litres, and RMVs to 180 lpm. The breathing machine may be immersed in water in test chambers, with the hyperbaric option, for pressure testing from full vacuum to depths of 1000m (3300ft). The entire simulator is portable.

The respiratory simulator comprises a full 4 Quadrant CNC controlled breathing machine that offers all combinations of breathing rate, stroke, waveform (sine, trapezoidal and human breathing patterns), and temperature, with real time display of results via an easy-to-use LabView graphical user interface. The simulator is fully CE certified, calibrated and generates reports automatically into Word or PDF formats that can achieve an ISO 17025 test traceability, meeting the requirements of even the most stringent of audits and Notified Bodies.

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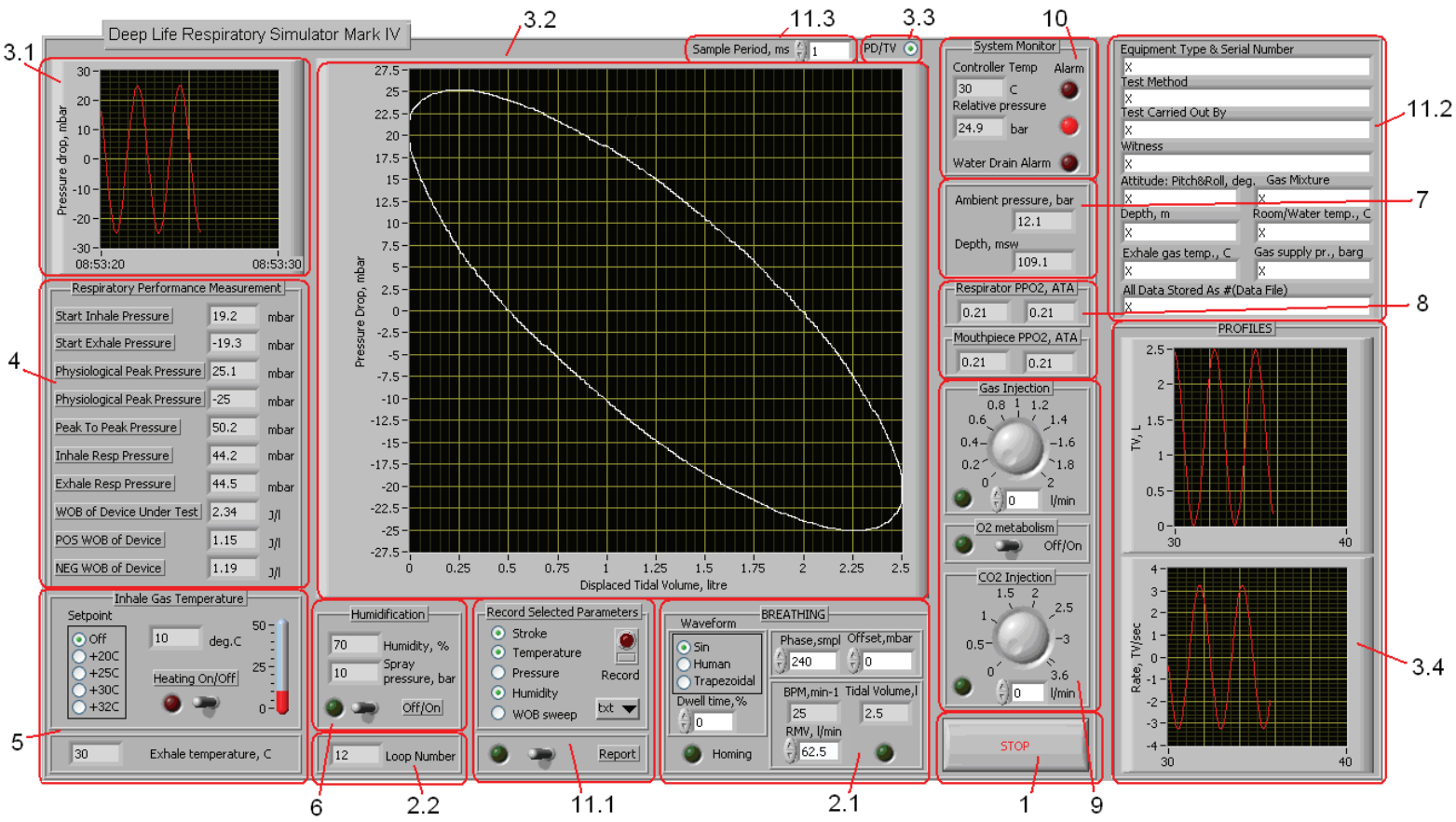
GRAPHICAL USER INTERFACE

A Windows 10 Pro laptop computer supplied with the equipment runs a LabView compiled script offering control and real time display of test parameters and results.



The user interface includes the following sections, labeled in red above:

1. Start/Stop control: stop button
2. Breathing control parameters and waveforms set
2.1. Setting of Breathing parameters and waveforms: CE and NORSOK tables pre-programmed
2.2. Count of the number of breathing cycles in the current test
3. Respiratory charts
3.1. Real time pressure plots
3.2. Real time Lissajous plot of respiratory pressures
3.3. Selector of actual and simulated pressure drop signals to compare measured with expected
3.4. Profile charts of the tidal volume and the tidal volume rate
4. Respiratory parameter monitoring, with CE results displayed in real time
5. Breathing Gas temperature control
6. Humidification measurement and control
7. Ambient pressure monitor
8. PPO2 monitor, for use with mass spectrometer
9. CO2 Gas injection, for direct control of mass flow controllers
10. System monitor
11. Data record and storage
11.1. Record selected parameters and report generation into Microsoft Excel and Word
11.2. Manual input to report generator to identify the test, witnesses etc
11.3. Setting of the data capture sample period for report and storage.

The script source is provided, allowing customers to develop their own entirely new tests. However, the standard script covers all CEN EN 250, EN 14143 and NORSOK U-101 respiratory tests. Tidal volume tests above 3 litres requires an optional fixture: a maximum tidal volume of 6 litres can be tested.

The ability to fully integrate the simulator with gas measurement, provides the means for true in-mouth, breath by breath testing of CO2, PPO2 and other gases.

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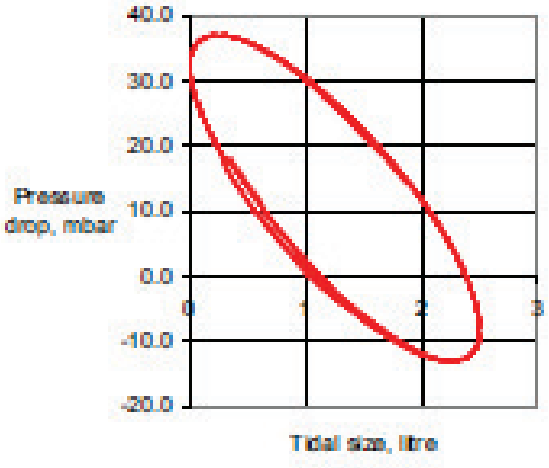
REPORT GENERATION

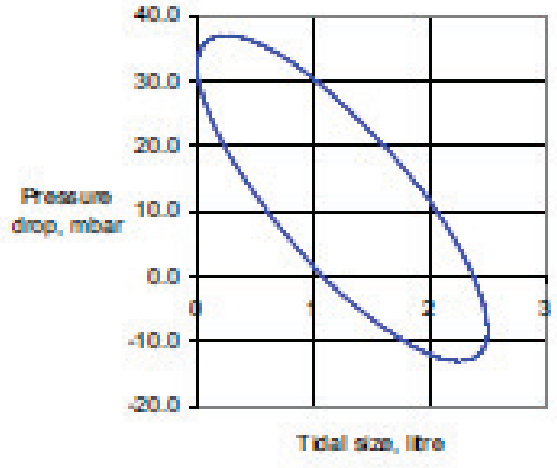
RESPIRATORY WORK AND RESISTANCE MEASUREMENT

EQUIPMENT TYPE & SERIAL NUMBER	:	Xaaa
TEST METHOD	:	Xbob
DATE AND TIME	:	2/1/2013 1:11 PM
TEST CARRIED OUT BY Xccc	WITNESS:	Xddd 9
CONDITIONS OF TEST		
ATTITUDE: PITCH & ROLL	:	X1111 Deg.
GAS MIXTURE	:	X2222
DEPTH	:	X3333 m
ROOM / WATER TEMPERATURE	:	X4444/4444 deg. C
EXHALE GAS TEMPERATURE	:	X5555 deg. C
GAS SUPPLY PRESSURE	:	X6666 barg
TIDAL VOLUME / RESP RATE / RMV	:	2.5L / 25.0 bpm / 62.5 lpm metric
RESULTS		
PRESSURE@START INHALE / EXHALE	=	32.1 / -8.0 mbar
PHYSIOLOGICAL PEAK PRESSURES	=	-13.0 / 37.0 mbar
PEAK TO PEAK PRESSURE	=	50.0 mbar
EN14143 RELATIVE PEAK PRESSURES	=	45.1 / 45.0 mbar
TOTAL POS / NEG WORK	=	1.16L/ 1.14 J/l
TOTAL WORK OF BREATHING (WOB)	=	2.3 J/l
ALL DATA STORED AS #(DATA FILE):		X777-7777

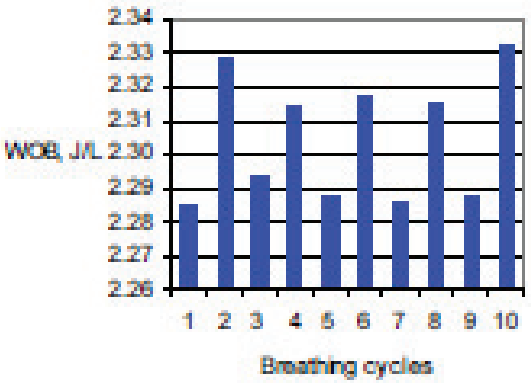
Overlaid Lissajous



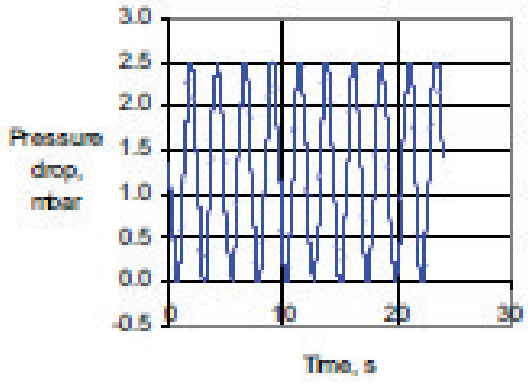
Average Lissajous



WOB with swept loop volume



Resistance with swept volume



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Reports are generated in MS Word at a press of a button. Subsequent reports can be appended to the same file, automatically.
A selection of user editable templates are provided: an example report is shown.

Fields starting with X in the example on the left are entered by the user into the Labview graphics interface at the start of the test sequence and may be any text string.
All data is also stored in MS Excel format, with up to 65,535 entries per file (the maximum size allowed in MS Excel).

CALIBRATION

A full calibration report is provided on delivery, demonstrating compliance to CE and NORSOK requirements for respiratory simulators, and a certificate of conformance. A calibration kit comprising NEDU and CE calibration orifices and fixtures is supplied with each system.

TRAINING

A full user manual is provided in English. Example test processes for all CE EN14143 and EN250 respiratory tests are also provided, including operational checklists.
One day of on-site training is provided, and application support is available at a standard rate.

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MANNEQUINE HEADS

A range of interchangeable mannequin heads is available in the sizes below.
The mannequin head can be rotated or unplugged. A semi-rigid hose is available to mount the head remotely.
All mannequin heads are 3D printed in Nylon,and are ftted with a breathing port in the mouth to connect with the device under test, or the calibration orifce, and a reference port in the left eye pupil.

Mannequin Heads	Sizes Available
European Male	XS, S, M, L, XL, XXL
European Female	XS, S, M
European Child (age 10)	M
Chinese Male	XS, S, M, L, XL, XXL
African Male	M, L, XL
All heads fitted with Orifice Port, reference port (on left eye pupil)	

GENERATION COMPARISON

Breathing Machine Generations	Characteristics
1st Generation	• Sine wave only • External to test chamber • Tidal volume changed by changing linkages • Maximum tidal volume 3L or less • No self-calibration or self-test • Depends on Scotch Union for accuracy
2nd Generation – iBreathe MkII	• All waveforms • Internal to test chamber • Tidal volume changed by changing linkages • Maximum tidal volume 3L • Closed loop Scotch Union drive
3rd Generation – iBreathe MkIII	• All waveforms • Internal l to test chamber • Tidal volume under CNC - no linkage changes • Max tidal volume 3L • 4 quadrant closed loop Scotch Union drive
4th Generation – iBreathe MkIV	• All waveforms • Internal to test chamber • Tidal volume under CNC - no linkage changes • Max tidal volume 6L • Direct drive with 4 quadrant control • Continuous self check and calibration

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TECHNICAL SPECIFICATION

Parameter	Min	Max	Units
Supply Voltage	24VDC@10A	36VDC@10A	VDC
External Power Supply	100V	240V	VAC
Max Supply Power		400	W
Weight	25.8 (hyperbaric)/21.5 (non-hyperbaric)		kg
Size	33.4 diameter x 47.6cm high		
Environment	Hyperbaric configuration can be operated in gas or liquid, including full submersion – all electrical connectors are wet mateable. Non-hyperbaric configuration is gas only.		
Storage temperature range	-40	+85	°C
Operating temperature	0.1	+40	°C
Operating ambient absolute pressure	0	101	bar
Operating environment		Vacuum, In Water (including Hyperbaric), Air, Heliox, Pure oxygen (O2 clean)	
RMV	10	90	lpm
Stroke	0.1	6.0	litre
Respiratory Rate	0	36	bpm
Respiratory Waveform		Sine Human Trapezoid 0% to 95%	
Resolution		14 bit, +/-700mbar. Noise <0.25mbar peak to peak. 1000 samples per second.	
Communications	RS485 115,200baud, or USB 2.0 12Mbps		
Gas ports	Optional OPV and ALV fixture		
Data display	Real time		
Lissajous	Real time, including Work Of Breathing		
Humidity control option	To 100% humidity with high speed piezo humidifier within mannequin head. Water trap within head.		
Exhale temperature control option	To +36C, 1KW heater head.		
CO2 Monitoring Option (NMIR)	20 samples per second		
O2 Monitoring Option	Solid state, 10 samples per second		
Mass Spectrometer Gas Monitoring Option	20 samples per second, all gases measured simultaneously.		

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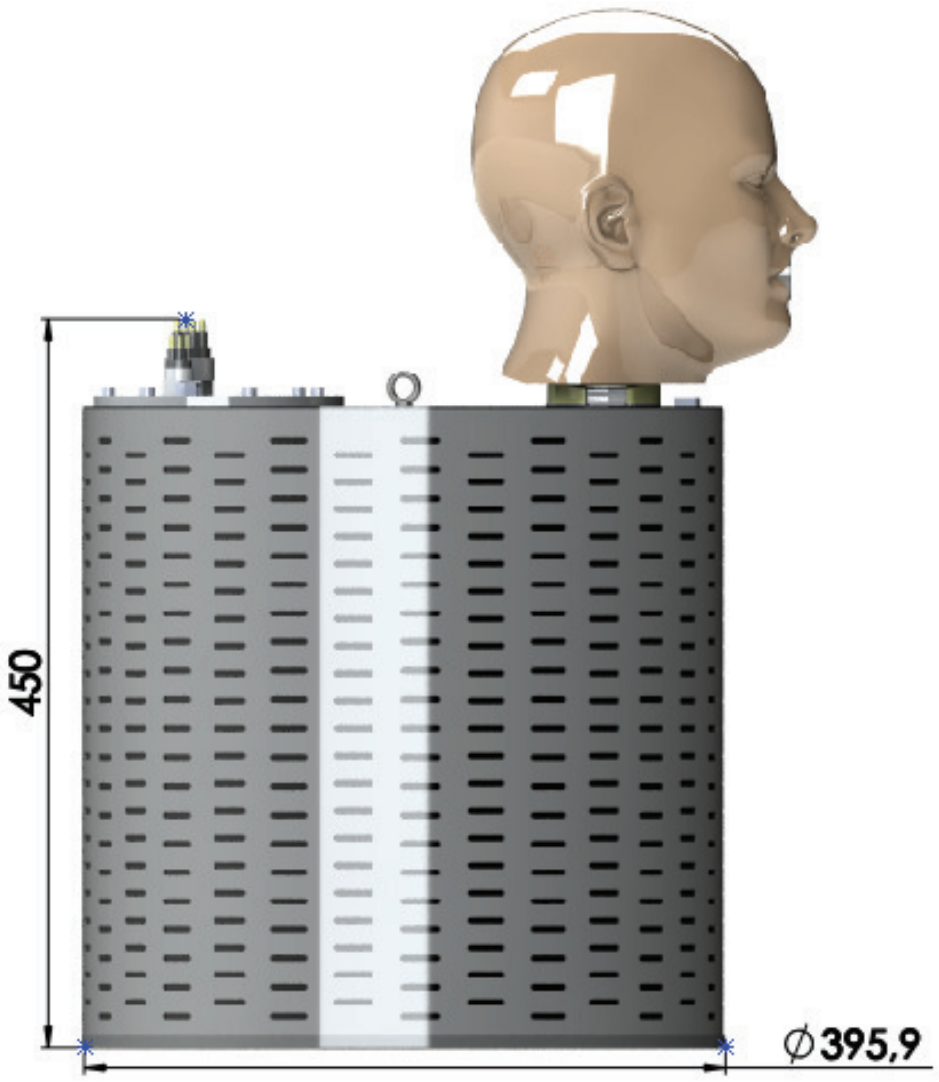

DIMENSIONS & Weight

Size of machine (Head excluded):
450mm height by diameter 395.9mm

Weight of the breathing machine varies:

- 25.8kg in hyperbaric version
- 21.5kg in non-hyperbaric version

ORDERING INFORMATION

Product Number	Description
iBreathe4-R/U(H)	Respiratory Simulator MkIV, - R designates an RS485 interface, -U designates USB 2.0 - H designates hyperbaric capability
Optional Products	
iBreathe-GHH	Piezo Humidifier and Gas Heater
iBreathe-O2M	CO2 Monitor (Breath by Breath)
iBreathe-O2M	O2 Monitor for measuring Oxygen between PPO2 0 to PPO2 4.0
iBreathe-RMS	Respiratory Mass Spectrometer
Calibration Orifices	
ORF-NEDU	US Orifices for calibration at 1 bar absolute
ORF-CE	European Orifices for calibration at 6 bar absolute
Mannequin Heads – please specify size(s) (Optional)	
Head-EM-(size)	European Male (sizes available – XS,S,M,L,XL,XXL)
Head-EF-(size)	European Female (sizes available – XS,XS,M)
Head-EC-(size)	European Child (size M)
Head-CM-(size)	Chinese Male (sizes available – XS,S,M,L,XL,XXL)
Head-AF-(size)	African Male (sizes available – M,L,XL)

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Manufactured in the UK by
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