1 DWT40-60 Technical Information

1·1 System

Drop height	Range 1000mm to 4200mm Resolution 1mm Accuracy ± 2mm
Drop mass	Fixed 1500kg Variable 1000Kg to 1500Kg (option) Accuracy ± 1.0%
Velocity range	4.43m/s to 9.0m/s
Energy range	14,800J to 60,750J 9,800J to 60,750J (option)
Striker	Radius of curvature 25.4mm ±0.1mm Centreline with respect to centre of anvil supports: 0mm ±1.0mm Complies with API 5L3, ASTM 436, EN 10274 Material of contact parts – H13 (BS-3BH13)
Anvil	Radius of curvature 15.0mm ±0.1mm Span 254.0mm ±1.0mm Complies with API 5L3, ASTM 436, EN 10274 Material of contact parts – H13 (BS-3BH13)
Specimen size	Width 76.0mm ±3.0mm Length 305mm±50.0mm Thickness 6mm to 38mm Weight up to 9Kg Notch depth 5.1mm±0.51mm. Notch angle 45°±2° Notch radius 0mm to 0.05mm Planarity ≤5mm Can accommodate specimens prepared according to standards API 5L3, ASTM 436, EN 10274
Overall dimensions	1520mm width 1200mm depth 8150mm height
Weight	8500kg approximately
Foundation (recommended)	Piling as required by underlying soil to suit static load of 8 metric tons, dynamic load of 100 metric tons Deep trench foundations filled with low-Q concrete Concrete topped by Imatek-supplied interface plate, levelled to 0.5 mm over 1000mm
Base	1520mm x 1200mm x 300mm solid cast steel Hole in base underneath specimen area allows retrieval of specimens (presented to front of machine)

Tower assembly	Manufactured from 3mm walled box section steel Enclosed by squared mesh panels secured to framework.
Control systems	Control for specimen autoloader Intelligent servo controller (winch) Imatek C3008 machine interface (proprietary) ImpAcqt V3 control software (on PC, impact test sequencing)
Winch	AC brushless servo motor fitted with brake, driving 4-plex chain via precision gearbox. Resolver attached to motor provides position feedback. Dual circuit mechanical limit switches to detect (a) top of travel (fixed position) (b) winch chain gone slack (any position) Secondary over-run limit switches provide back-up.
Specimen loading	By pneumatically operated pick and place system Load cycle time < 10s Placement of specimen within ± 0.5mm (X & Y axes)
Release	Release of mass by rotation of hook on bottom of catcher. Activation of both release cylinder and interlock cylinder required for release.
Safety	Safety is compliant with the European CE machinery safety directive (89/392/EEC & 91/368/EEC – machinery safety). Access to specimen area protected by solenoid-locked doors when the catcher or impact mass are in an unsafe position. Winch drive and release mechanism electrically isolated when access doors are open. Emergency stop function electrically isolates winch drive and release. All safety systems dual circuit and fail-safe. No unsafe release of the impact mass possible under any of the following conditions: (a) failure of mains power supply (b) failure of compressed air supply (c) failure of control software
Instrumentation option force	Impact force measured by force load cell, mounted immediately behind hammer. Dynamic rated capacity: ±1500kN. Non-Linearity: <0.05% of rated output. Repeatability: <0.05% of rated output. Hysteresis: <0.05% of rated output. Zero balance: <1.0% of rated output (zero offset compensation by amplifier) Operating temperature range: -20°C to +80°C. Safe overload: ±125%.

Signal conditioning	By strain-gauge amplifier Bandwidth: DC - 50KHz, –3dB. Sensitivity: 100mV Linearity: <0.02% Accuracy: ±0.5% Stability: 0.02% - 12 months Auto-zero function: automatic zero of load cell output applied as part of test cycle
Data acquisition option	Sample rate: 3,000,000 samples per second. Resolution: 16 bits Data points captured per impact: 50,000 Calibrated accuracy: ±0.1% Timebase accuracy: ±0.01% Triggering: from force signal, laser/photodiode detector or external trigger
Data acquisition auxiliary channels	Three additional channels with the same specification, simultaneously sampled
Velocity measurement option	Impact velocity measured immediately prior to impact Method: time of flight of target through laser/photo-diode detector Timing resolution: 25ns Target dimensions accuracy <0.1% Overall accuracy: ±0.1%
Performance	Overall accuracy of force measurement: ±0.75% Overall accuracy of absorbed energy: ±1.5% Cycle time (specimen to specimen): < 5 min Cycle time (specimen leaving cooling bath to impact): <= 10sec Specimen placement accuracy (notch relative to hammer centreline): ±0.5mm Specimen placement accuracy (notch relative to anvil midpoint): ±0.5mm Duty cycle: 20 tests/hour
Maintenance	Replacement of contact parts every 300 tests Preventative maintenance including replacement of clamp contact parts every 12 months or 1500 tests, whichever is sooner
Supplies	Electricity: 230VAC ±10%, 32Amp, 50/60Hz ±1%, three-phase, Neutral and Protective Earth. Air: 0.7Mpa to 0.8Mpa clean lubricated air
Operating environment	Temperature: +5C to +30ºC. Humidity: 0% to 90% non-condensing. Electrical immunity: to EN 50 082 All main electrical control systems rated at, or housed in enclosures, with protection category IP65 (to EN 60 529/10.91). The system is designed for operation in dusty environments.

1·2 Software

Platform	PC running Microsoft Windows XP Pro/Vista. Supplied system minimum specification of 2GB RAM, 120GB hard drive, CD-RW, 21" display.
Environment	Compatible with MS Office 2003/XP (supports export in native Excel format files, and Windows MetaFiles for graphics).
Purpose	Control of impact testing sequence and analysis of impact data.
Access control	Three, password protected levels: (a) limited access, to perform pre-defined DWTT tests. (b) supervisor access, to control the type of test performed and the required documentation information etc. (c) engineering access, for sensitive configuration and calibration functions.
Language	The DWTT system has a Human Machine Interface that is easy to use and works in UK language only.
Data security	All calibration and configuration information is held as data files on the hard drive of the control PC. Password protection of the configuration mechanism provides protection from accidental or malicious modification. Standard operating system features provide integrity checking (CRC checksum).

1·3 Temperature soak bath (option)

External construction	Zinc-coated mild steel sheet. External surfaces finished in stoved epoxy paint.
Internal construction	Bath and guides from 304 grade stainless steel.
Capacity	Sufficient to accommodate up to 10 specimens of thickness up to 50mm with minimum 26mm gap between each specimen.
Chamber access	Top loading, via pneumatically operated access door. Heaters provided around door seal to prevent freezing. Cooling inhibited while door open.
Temperature range	-80°C to +20°C.
Temperature accuracy (displayed versus actual)	± 1°C
Temperature stability (at set-point)	± 2°C
Cooling method	Injection of liquid nitrogen via cryogenic valves.
Cooling medium	Hydrofluoropolyether e.g. Galden ZT130 manufactured by Solvay Solexis. Imatek recommends the use of Galden for the cooling medium due to safety concerns regarding ethanol's flashpoint (13°C). Galden is an inert substance, non-flammable, non-toxic and environmentally friendly.
Temperature sensor	Mineral insulated metal-sheathed type K thermocouples.
Temperature control	By industry-standard temperature controller ("Eurotherm")

System control	Via control software; input of set point; soak time, ramp rate. Sounds alarm when complete
Temperature indication	By local display on bath and PC monitor.
Protection	Isolation of cooling via safety contactor triggered by industry-standard temperature monitor. Requires manual re-set when tripped. Pressure relief valves fitted to prevent build-up of excess pressure in nitrogen pipework.
Liquid nitrogen consumption (estimated)	80 litres of liquid nitrogen, based on reducing full load of specimens to –80°C and holding for 2 hours

1·4 Specimen notching apparatus (option)

Function	For pressed notching of DWTT specimens. Complies with the requirements of standards EN10274, API 5L3 and AST E436.
Construction	Hydraulically operated, consisting of a rigid H-frame with a T-slotted bed on which the specimen is supported and clamped while the notch is pressed into it.
Safety	Two-handed operation with guarding and safety interlocks prevents unconditional access to moving parts.
Frame strength	250KN
Maximum notching force	100KN
Maximum specimen thickness	30mm
Maximum specimen yield strength	500MPa

2 Functional Specification

2·1 Operator functions

Note – assumes DWTT system is fitted with instrumentation, cooling bath and automated loading options

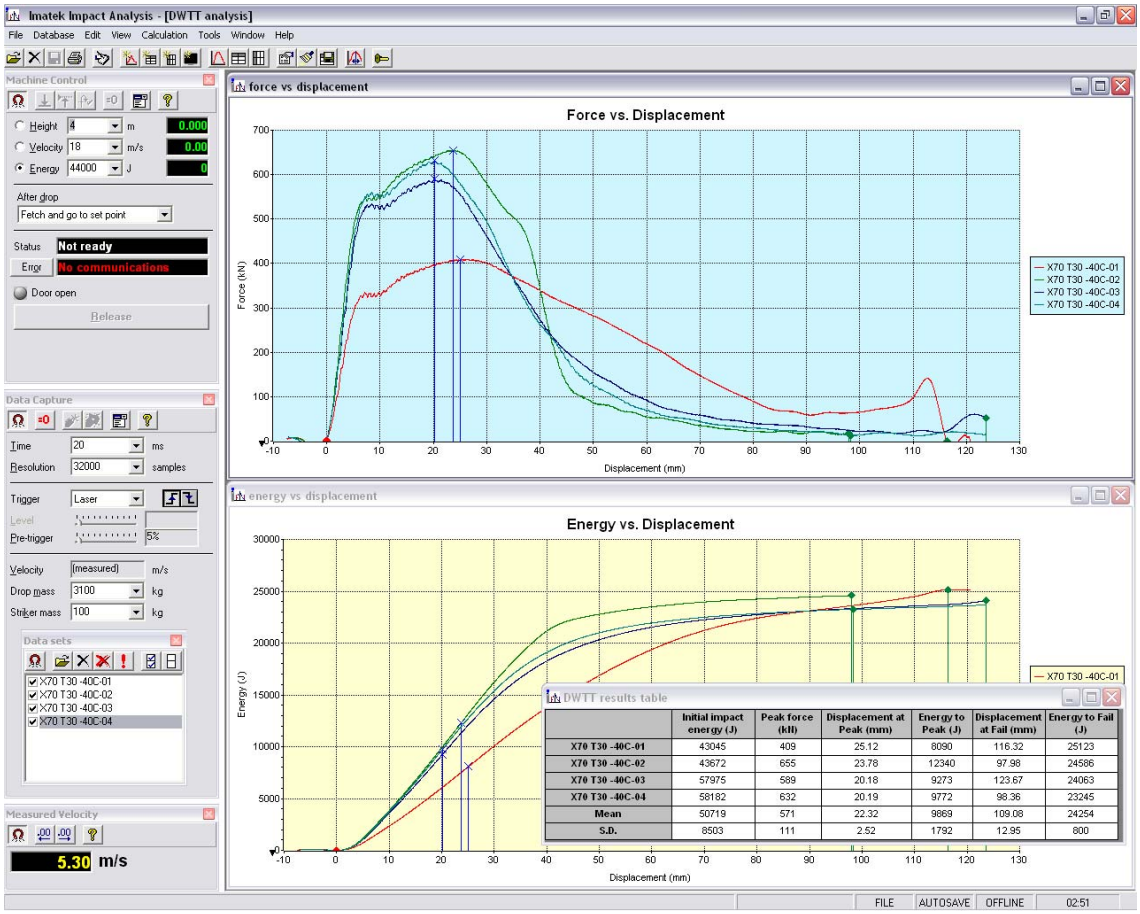
Winch pendant	Manual winch control: up, down. Multi-stage speed control
Machine panel	Laser trigger position set Specimen door unlock Access door unlock Emergency stop
Software – impact control	Set release height Set release velocity Set release energy Arm release system Set action after impact (none, fetch, fetch & go to release height)
Software – data acquisition	Set acquisition time Set acquisition resolution

	Set trigger source
	Set trigger level
	Set pre-trigger length
Software – temperature	Set soak temperature
	Set ramp speed
	Set ramp time
	Set soak time

Specimen loading

- The operator starts the release sequence via the software.
- The operator opens the specimen door.
- The operator takes a specimen from the cooling bath and places it on the alignment table.
- The operator closes the specimen door.
- The rest of the sequence is automatic: the autoloader picks the specimen up, places it on the anvil, the clamp is applied and the autoloader returns to the home position. The drop mass is then released and the broken pieces of the specimen ejected to the front of the machine.

2·2 Graphical user interface



	Initial impact energy (J)	Peak force (kN)	Displacement at Peak (mm)	Energy to Peak (J)	Displacement at Fail (mm)	Energy to Fail (J)
X70 T30 -40C-01	43045	409	25.12	8090	116.32	25123
X70 T30 -40C-02	43672	655	23.78	12340	97.98	24586
X70 T30 -40C-03	57975	589	20.18	9273	123.67	24063
X70 T30 -40C-04	58182	632	20.19	9772	98.36	23245
Mean	50719	571	22.32	9869	109.08	24254
S.D.	8503	111	2.52	1792	12.95	800

The GUI runs under Microsoft Windows. It provides both control of the impact test (drop parameters and data acquisition parameters) and analysis of the resulting data.

Control	Temperature conditioning bath set-point Impact parameter (height, velocity or energy) Data acquisition parameters (sample rate, sweep length) Impact sequence
Indication	Machine status Temperature conditioning bath actual Current impact mass position (height, velocity, energy)
Data capture	Force vs time Initial impact velocity
Calculations	Acceleration Velocity Displacement Energy User-defined curves User-defined numerical results
Units	Fully configurable units for any requirements Default units: SI, cgs and US
Markers	Configurable system of markers to identify specific points on curve, including: start of impact yield load maximum load initiation of crack propagation end of crack propagation
Data presentation	Graphs of any standard calculated or measured quantity against any other, including user-defined curves. Appearance of graphs very flexible Tables of numerical results and documentation information Hard copy of graphs and tables User-definable report layout
Other features	Test results database Automatic save of test results Three configurable levels of user access User-configurable documentation fields Frequency analysis of captured data (FFT) and very flexible filtering (Butterworth, Bessel and FFT filter types) Configuration back-up restore mechanism for securing apparatus configuration and calibration information Configurable screen layout Export of test data to Microsoft Excel, Windows Metafile and “comma separated value” file.

2·3 System limits

The apparatus is designed to operate with specimen sizes specified above.

Specimens with dimensions outside these limits are not testable.

The apparatus is designed for a maximum force of 1500KN. There is 25% over-capacity in the load cell and supporting structures. Forces above 1875KN will cause damage.

The apparatus is designed for impact energies between 9,800 J and 61,000J. It has sufficient capacity to arrest the falling mass when the impact energy is 61,000J even if the specimen absorbs no energy.

The system is designed for a minimum cycle time of 3 minutes. Cycle times under 3 minutes with very low energy absorption might result in over heating of the shock absorbers, and consequently to damage.