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: +5°C to +30°C.
- 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
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 61,000 J. It has sufficient capacity to arrest the falling mass when the impact energy is 61,000 J 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.