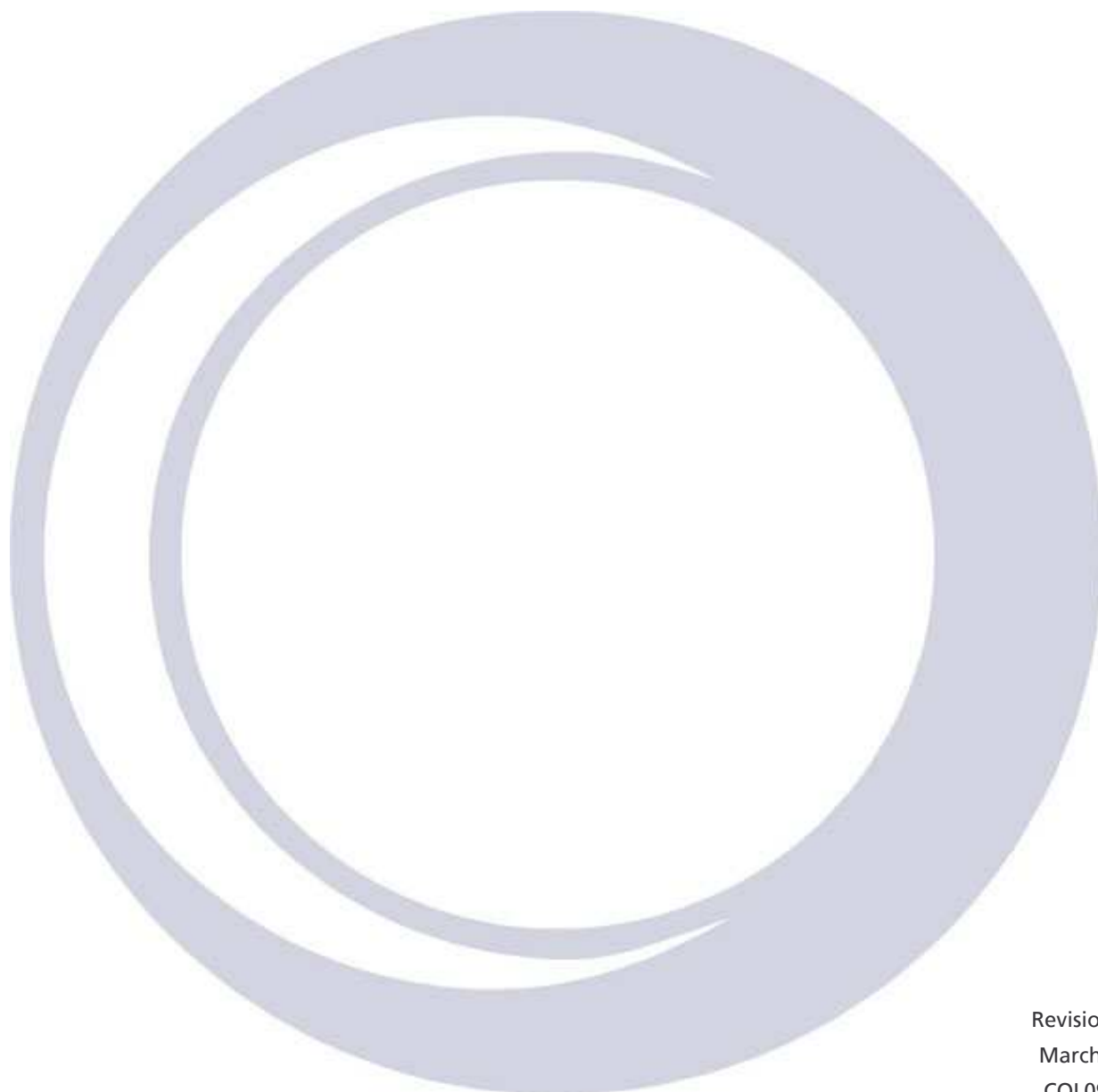


ITC601

Temperature Controller



Revision 4
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CQL0999

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Warnings

Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.

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1 Warnings

- 1. Before you attempt to install or operate this equipment for the first time, please make sure that you are aware of the precautions that you must take to ensure your own safety.***
- 2. High Voltage Hazard. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable.***
- 3. The AC electrical supply is considered to be the disconnect device for the equipment. Access to this must not be restricted at any time. The external AC electrical supply cable must remain accessible for disconnection of the equipment.***
- 4. Maintenance: Only qualified and authorised persons should carry out servicing and repair work on this equipment.***
- 5. High Voltage Hazard: High voltages are present inside this equipment. Isolate this equipment by switching off the external AC electrical supply, disconnecting and removing the external supply cable before any covers are removed.***
- 6. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.***
- 7. The equipment is not suitable for use with explosive or flammable gases. The equipment is not suitable for use in explosive, flammable or hazardous environments.***
- 8. The equipment does not provide protection against the ingress of water. The equipment should be positioned so that it will not be exposed to water ingress.***

2 Cautions

- 1 **If you change set-up data and want it to be retained after power down, the data must be deliberately STORED as described in section 7.6**
- 2 **ELECTROSTATIC HAZARD: This equipment contains Electrostatic Sensitive Devices (ESSD). ESSD protective procedures in accordance with BS CECC00015 Part 1 and American National Standard EIA-541-1988 must be applied when installing or maintaining this product. Refer to guidelines in the preliminary pages.**
- 3 **COOLING HAZARD. Internal components are air-cooled. Ensure the front lower ventilation space is not obstructed.**

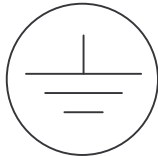
Explanation of symbols used in the Instrument



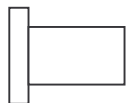
Attention; please refer to the manual



Functional earth



Protective earth



OFF



ON

3 Introduction

3.1 Use of this Manual

This manual provides complete operating information for the Oxford Instruments Intelligent Temperature Controller model ITC601, and includes the following:

- a) Installation.
- b) Operation of the temperature controller from the front panel.
- c) Use of the sweep facility.
- d) A trouble-shooting guide.

Note that a Technical Handbook is also supplied with the ITC601 which gives details of the 'test mode', communication between the ITC and a computer, a guide to the theory of control, and supplies the complete specification and circuit diagrams for the instrument.

3.2 Description of ITC601

ITC601 is a laboratory temperature controller, intended for use in general and cryogenic applications. In its most common application ITC601 will be used to control the temperature of some "sample", the properties of which are being investigated as a function of temperature. In this manual the term "sample" will be used to refer to any object being controlled and the term "system" will be used to refer to the complete assembly.

The ITC601 includes a single input channel for a single sensor. At the factory, the ITC601 will be configured for a particular temperature sensor type. The output can provide up to 40 W of heating power.

Manual operation of the controller is by means of front panel push buttons and the associated knob. Remote computer control and monitoring is possible by means of a built-in RS232 (Serial) interface, and appropriate software such as Oxford Instruments ObjectBench.

Sensor calibration data and many of the controller operating parameters are held in a non-volatile memory, which is retained when the controller is switched off.

Control is achieved through three control parameters (known as PID values). The ITC601 can automatically select appropriate values of these control parameters. Furthermore, if the instrument is operated in conjunction with the Oxford Instruments ObjectBench software, it can "learn" the optimum parameter values for a particular system.

3.3 Safety

The following general safety precautions must be observed during the operation, service and repair of this instrument.

3.3.1 Protective Ground

To minimise shock hazard the instrument must be connected to an electrical ground. The ground wire (green/yellow) in the instrument power cable must be connected to the installation electrical ground system. Do not use extension cords without a protective earth conductor. Do not disconnect the protective ground inside or outside the instrument. Do not have external circuits connected to the instrument when its protective ground is disconnected.

3.3.2 Repair and Adjustment

Ensure that the instrument is disconnected from the AC power supply (switching off the rear panel switch is not sufficient) before the covers are removed or the fuse is replaced, otherwise dangerous voltages are accessible. Capacitors inside the instrument and power connector filter, if fitted, may remain charged after removal of AC power. These should be discharged before starting work.

For fault finding and calibration, the AC Power supply may require reconnection. This work may only be carried out by skilled personnel who are aware of the hazard involved.

3.4 Disposal and Recycling

Before disposing of this equipment, it is important to check with the appropriate local organisations to obtain advice on local rules and regulations about disposal and recycling.

You **must** contact Oxford Instruments NanoScience Customer Support (giving full product details) before any disposal begins.

4 Installation

4.1 Supply Connections



Before applying power to the instrument, ensure that the voltage selectors on the rear of the equipment are correctly set for the intended supply voltage. The selectors cover four voltage options 100 V, 115 V, 200 V and 230 V. Selectors should be set to the same value nearest to the nominal local Mains AC voltage.

If necessary, open the voltage selector panel using the slot provided, withdraw the voltage selector and replace it in the correct orientation for the intended voltage. Check that the correct fuses are fitted, then close the voltage selector panel.

Fuse ratings are:

~100/115 V T2.0AH 250 V Type T (Slow Blow)

~200/230 V T0.8AH 250 V Type T (Slow Blow)

4.2 Heater and Sensor Connections

Connections to the heater and sensor are by means of a 9 way D-socket, at the back of the unit, accessible from below.

Pin connections are:

1	Input High
2	Input Low for Normal Applications
3	Input GND (Linked to pin 2)
4	Current Source +ve
5	Current Source -ve
6	Heater Output +ve
7	Heater Output -ve
8	Input Low (Linked to pin 2)
9	Chassis Ground

The input connections are electrically isolated from the chassis ground. The Heater Output connections are electrically isolated from the input ground and the chassis ground.

4.3 RS232 Serial Data Line Connections

The serial data link from the computer is connected via a 25 way D-socket, at the back of the unit, accessible from below. By using an Oxford Instruments ISOBUS the ITC601 and other Oxford Instruments products can be connected to a single RS232 computer port simultaneously and each instrument controlled independently. For full details of the RS232 connection and the Oxford Instruments ISOBUS, refer to the technical handbook.

5 Local Operation

5.1 On / Off Switch

The main on/off switch is mounted at the back of the instrument. The main display will be illuminated whenever the instrument is switched on.

About one second after switching on, the display will show a code that indicates what sensor type the ITC601 is set for. For example, the code for Rhodium Iron resistors is **RF52**. The display then changes to the word **PASS**. This indicates that the ITC601 has completed its self test and initialisation.

After a further pause the internal safety relay will close. This links the heater to the controller output. At the same time, the display will show the measured temperature. The ITC601 will now be under local control (from the front panel), with the heater in manual mode and the heater voltage at zero.

5.2 Front Panel Controls

The front panel controls are described below.

5.2.1 The Display

The main display normally indicates the measured temperature (in kelvin).

5.2.2 The Knob

The large circular knob in the middle of the unit is connected to a 'rotary encoder', and is used to adjust any parameter. To change the value of a parameter, press the associated button to display the present value, turn the knob and the value will be seen to change. The knob should be turned clockwise to increase, or anti-clockwise to decrease the value. When the knob is turned slowly, the value will change by 1 least significant digit for each 'click', as the knob is turned faster the rate of change of the parameter increases rapidly.

5.2.3 The Buttons

Each front panel button (and associated lamp) is described below.

REMOTE

Control of the instrument may either be local from the front panel, or remote via the RS232 interface. The REMOTE button may be used to switch between Local and Remote, and an associated lamp indicates the REMOTE state. At power up, ITC601 is in local control, since at that time the instrument has no way of "knowing" whether there is a computer connected to the RS232 interface. The first command for the instrument to change from local to remote must be from the computer.

When ITC601 is in REMOTE, many of the front panel controls are disabled. Those controls which only affect the display will still work, but those which could change the operation of the instrument will not.

SWEEP

The ITC601 incorporates a programmable sweep facility. The sweep is controlled from the front panel by the SWEEP button. Sweep is described in detail in section 6.

TUNE

The ITC601 incorporates an automatic tune facility. The process can be started (or stopped) from the front panel by the TUNE button.

Tuning will derive optimum values for the PID coefficients at the present SET POINT temperature. The tuning process will stop automatically once suitable values have been found, this will typically take no more than 10 "time constants".

When ITC601 is in TUNE, many of the front panel controls are disabled. Those controls which only affect the display will still work, but those which could change the operation of the instrument will not.

SET UP

The ITC601 has many parameters that do not need to be viewed or adjusted very often. These may be set from the 'test mode' which is entered by pressing the SET UP button. The test mode is used to test and calibrate the instrument, to set limits, to program the sweep facility, to set the automatic PID values, etc. It is described in detail in the technical handbook.

SET POINT

Pressing the Set Point button switches the display to indicate the set point temperature. Use the knob to adjust this value.

PROP

Pressing the Prop button switches the display to indicate the proportional temperature span. Use the knob to adjust this value.

INT

Pressing the INT button switches the display to indicate the integral time (the units are minutes). Use the knob to adjust this value.

DERIV

Pressing the DERIV button switches the display to indicate the derivative action time (the units are minutes). Use the knob to adjust this value.

MAN HEATER

AUTO HEATER

The normal way in which the ITC601 controls is by applying power to a heater. In MAN control the heater voltage may be varied by rotating the knob. In AUTO control the heater voltage is varied in response to the difference between the measured temperature and a set-point. Pressing AUTO or MAN switches between the manual and automatic states. In either case, whilst the button is pressed the main display gives an approximate indication of the output voltage (note that this is not a calibrated parameter). A 10 segment bar-graph is provided to give a continuous indication of heater operation. The bar-graph display will automatically be scaled so that an output equal to the limit will light all 10 bars

AUTO PID

When ITC601 is controlling a system, the Proportional, Integral and Derivative settings may either be set manually or selected automatically from the learnt characteristics of a particular system by means of the AUTO PID button. The AUTO PID lamp illuminates when auto PID settings are in use. Learning the characteristics of the system may be done with the help of the TUNE button. It is not possible to select auto PID if no learnt data has been loaded.

5.3 Controlling at a set Temperature

To control the sample at a set temperature proceed as follows:

- Press and hold SET POINT and use the knob to enter the desired set temperature.
- Set appropriate PID values. For instance, to set the integral action time, hold down the INT button and rotate the knob to set the desired value.
- Press AUTO HEATER and the temperature controller will automatically bring the sample to the set temperature.

5.4 Limiting maximum heater output

To ensure the safety of the system being controlled it may be necessary to place an upper limiting value on the heater output. This is achieved via the 'test mode' as follows:

- Press SET UP. The display will show **tESt** followed by **t 00**.
- Rotate the knob through one click anticlockwise so that the display reads **t 09**. Press SET UP again so that the display reads **Lit**.
- Press and hold MAN HEATER. The display will show **H.toP** followed by the current value of the maximum heater output, in volts. Use the knob to adjust this value.
- Press SET UP, rotate the knob one click clockwise so that the display reads **t 00** and press SET UP again to return to the normal display.

6 Sweep

6.1 Purpose of Sweep

The sweep facility allows the set point to be programmed to follow a fixed temperature/time profile. The profile consists of a series of constant temperature steps joined by linear ramps.

The Auto-PID facility may be used in conjunction with the sweep facility to provide optimum control over a wide temperature range. To avoid the risk of discontinuities during a sweep, it may be helpful to ensure that the start and end temperatures for the sweep ramps coincide with the Auto-PID segments.

6.2 Programming a Sweep

By entering a sweep program the ITC601 can automatically control a particular temperature/time profile. A sweep program may consist of up to 16 program steps. Each program step consists of

- A set temperature, i.e. the temperature to which the sample will be brought before the program moves on to the next step
- A sweep time, i.e. the time that the controller is to take to bring the sample to the set temperature
- A hold time, i.e. the time for which the sample will be held at the set temperature.

A sweep program is entered via the 'test mode'. To enter this mode press SET UP - the display will show **tESt** followed by **t 00**. Rotate the knob until the display reads **t 06** and then press SET UP again. The display will show **Pro** followed by **P 01** indicating that the data for the first program step is to be entered. Do this as follows:

- a) Press and hold SET POINT and rotate the knob until the display shows the required set temperature for the first step.
- b) Press and hold SWEEP. The display briefly shows **SEEP** followed by the sweep time for the first program step. Use the knob to bring the sweep time to the desired value. Note that the time is shown in minutes with a resolution of 6 seconds and may be adjusted between zero and 1439.9 minutes (24 hours).
- c) Press and hold SWEEP a second time. The display will briefly show **HOLD** followed by the hold time (in minutes) for the first program step. Use the knob to bring the hold time to the desired value.
- d) If any of these settings require further modification, the above steps can be repeated.

To move to the second program step rotate the knob so that the display reads **P 02**. The parameters for the second step can then be entered in the same way as above. All 16 steps may be programmed in this way.

The sweep and hold times for any unused steps should be set to zero so that these steps are automatically bypassed. The set temperature of step **P 16** is the temperature at which the set point will remain when the sweep is completed and should be set accordingly.

To escape from the sweep programming mode press SET UP, rotate the knob so that the display reads **t 00** and press SET UP again.

6.3 Starting a Sweep

Press the SWEEP button and the display will show **P 00**. Hold the button for 2 seconds and the display will change to **run**. If the temperature controller has been programmed with any sweep data the sweep will now start. If the button is released before the display changes or if there is no program, then the sweep will not start.

At the start of a sweep, the SWEEP lamp will flash and the set point will start to ramp towards the value selected for the first program step. When the first sweep time is complete, the temperature will have reached its programmed set point. The SWEEP lamp will light continuously for the hold time of the first step. This sequence will be repeated for each of the programmed steps.

Remember that the sweep facility programs the temperature controller's set point. The measured temperature will tend to lag behind the set point by an amount dependant upon the response time of the system. Remember also that the controller must be set to AUTO HEATER if the actual temperature is to be varied!

6.4 Monitoring the Progress of a Sweep

At any time during a sweep, the set point is being ramped while the SWEEPING lamp is flashing, and the set point is being held if the lamp is on continuously.

The SET POINT button may be pressed at any time to indicate the current value of the set point.

If SWEEP is pressed briefly, whilst the sweep is running, the display will indicate **P nn** where nn is the current program step number in the range 1 to 16. Do not hold SWEEP too long, or the sweep will be terminated, (see below).

6.5 Stopping a Sweep

If left uninterrupted, a sweep program will continue until all steps have been completed. If required it can be terminated before it is complete by pressing SWEEP, and holding it for 2 seconds until the display changes to **End**. The sweep program will be aborted and the set point will be left at the value it had reached when the sweep was terminated.

7 In Case of Difficulty

This section indicates some of the more common pitfalls and operator errors.

Display always shows "Hot 1"

Sensor not connected, or faulty.

Sensor limit inadvertently set to zero. In this case it will be necessary to reset the limit, but since the display will always show the "Hot" message, this must be done without the aid of the display. The procedure shown below should be used. This is the same procedure normally used to change a limit, but the absence of a display can be disconcerting!

- Switch on
- Press SET UP; brief display of **t 00**
- Rotate knob anti-clockwise one click; brief display of **t 09**
- Press SET UP; intermittent display of **Li**t
- Press and hold AUTO HEATER
- Rotate knob several turns clockwise
- Release AUTO HEATER, the display should read **Li**t
- Exit test mode in the usual way, press SET UP, select **t 00**, press SET UP.

All should now be well, with the LIMIT set to maximum.

No Heater Output

The heater limit has been set close to zero (see section 3.4).

The knob appears not to work

Controller is set to REMOTE.

The temperature controller appears to control with a large offset

INT time has been set to a very large value.

The temperature controller only moves very slowly towards set point

DERIV time has been set to a very large value.

Nothing happens when AUTO PID is pressed

No data is present in the Auto-PID table, or it has been disabled by writing a zero to the upper limit for the first entry in the table.

When SWEEP is used, the lamp lights but the temperature does not change

Not switched to AUTO HEATER.

Set Point changes without pressing SET POINT

SWEEP pressed.

"PASS" message appears during operation

Low mains voltage, the temperature controller is resetting. It will switch to manual heater with output at zero. Check the mains voltage setting is correct.

Cannot get SPAN & ZERO calibration correct together

The calibration points chosen are not sufficiently near the ends of the range, so the temperature controller is unable to adjust the points as a pair of "high" and "low" temperatures (the display will show the same message, either "Hi" or "Lo" at both points). See the technical handbook for details on calibration

The PID settings are lost after Power Down

The Store operation has not been performed. Enter and exit test mode via **t 00**.

No Display or Abnormal Display (for example Multiple Decimal Points)

This probably indicates a hardware defect but can occasionally be due to corruption of the non-volatile RAM content. The first action should be to switch the temperature controller off and on again. This will reload the RAM from the EEPROM which should cure the problem.

8 Quick Reference Guide

8.1 Front Panel Controls

REMOTE	Toggle local (front panel) and remote (computer) control.
SWEEP	Start and stop an automatic temperature sweep.
TUNE	Start and stop the Automatic Tune process
SET UP	Enter Test Mode (see below).
SET POINT	Adjust the set point temperature.
PROP	Adjust the Proportional term.
INT	Adjust the Integral term.
DERIV	Adjust the Derivative term.
MAN HEATER	Switch to manual heater control (and adjust).
AUTO HEATER	Switch to automatic heater control.
AUTO PID	Automatically set PID values from internal look-up table.

8.2 Test Mode

See the technical handbook for more details.

t 00	Exit and store.		Display
t 01	Test front panel display and lamps.		Stor
t 02	Test front panel buttons.		-----
t 03	(not used)		
t 04	Select " F " menu to set front panel display		
t 05	Select " L " menu to set PID values		Pid
	SET POINT, PROP, INT, DERIV buttons		
t 06	Select " P " menu, set sweep program values		Pro
	SET POINT button	Set target temperature	
	SWEEP button, 1st. time	Set sweep time	SEEP
	SWEEP button, 2nd. time	Set hold time	HOLD
t 07	Select sensor, factory set.	LOAD	
t 08	Calibrate the sensor	CAL	
	SET POINT button	Hi or Lo	
t 09	Set limits	Lit	
	SET POINT button	Limit user set point	SEt.P
	MAN HEATER button	Limit heater output	H.toP
	AUTO HEATER button	High temp	H.oFF
		Auto shut down	

9 Restriction of certain Hazardous Substances Statement

European Union

Under the provisions of the Restriction of certain Hazardous Substances (RoHS Under 2002/95/EC) Directive, as applied to products manufactured and sold in the UK and Europe by Oxford Instruments NanoScience (OINS). OINS has been advised that the product(s) to which this manual relates is exempt under category 6 of the RoHS Directive because it is, or will form part of, a large-scale stationary industrial tool.

China

The Chinese regulations on RoHS require that the product manual has a table stating whether the product and its sub-assemblies contain any of the restricted materials. The table below is included to meet this requirement.

TABLE LISTING RESTRICTED SUBSTANCES /受限物质列表

Product ITC 601	Toxic Hazardous Substances and Elements 有害物质及元素						
Part Name 部件名	Description 描述	Pb 铅	Hg 汞	Cd 镉	Cr(VI) 六价铬	PBB 多溴联苯	PBDE 多溴联苯醚
59-CQL1200	MAIN PCB 主电路板	X	O	X	O	O	X
59-CQL1201	ITC601 PCB ITC601板	X	O	X	O	O	X
59-CQL1401	BASE PLATE 背板	O	O	O	O	O	O
59-CQL1301	CASTING 铸件	O	O	O	O	O	O

Key: X = substance present (含此物质)
O = substance NOT present (不含此物质)

Rest of World

There are currently no other countries or communities mandating compliance with any RoHS legislation.