

**Oxygen Consumption Monitoring within the
University Hospitals of Leicester NHS Trust to proactively manage the
oxygen delivery system – COVID 19**



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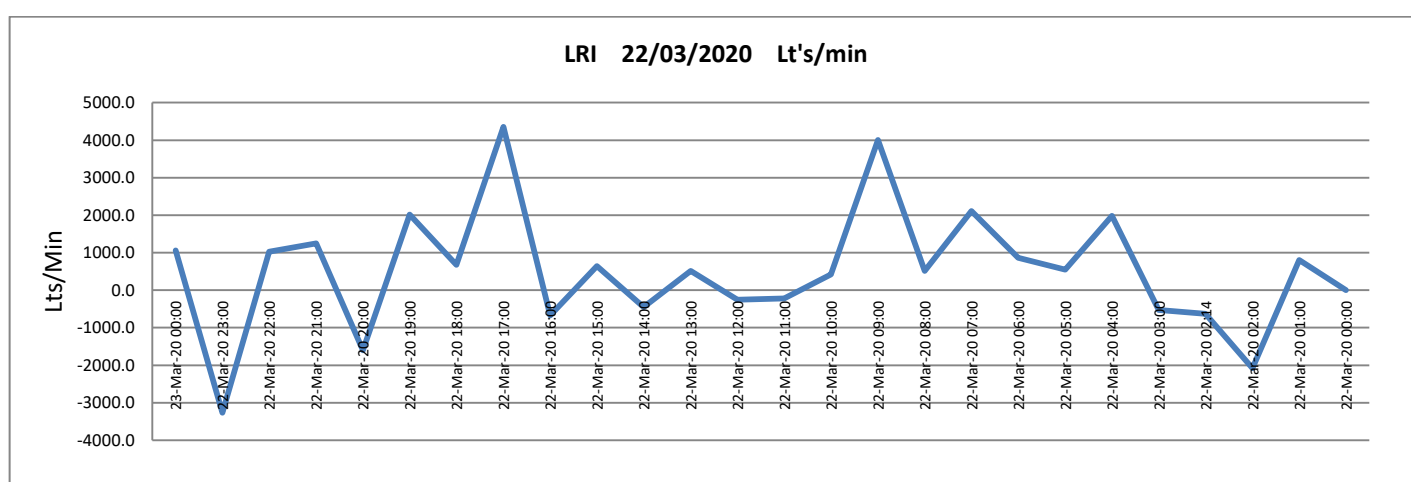
The University Hospitals of Leicester NHS Trust being one of the largest and busiest teaching hospitals having a bed capacity at the Leicester Royal Infirmary (LRI) 942, Leicester General Hospital (LGH) 471 and the Glenfield Hospital (GH) 524, realised the important role it would be asked to take as a major health care provider in the region.

As a result of the general issues and subsequent NHSE/I – 2020/001 alert relating to the Adequacy, Continuity and Quality of oxygen through the Piped Medical Gas System the trust's approach was to achieve actual measurement rather than a theoretical pipe flow methodology.

Having the initial oxygen delivery system data as below

Site	LRI	GH	LGH	
	VIE 281-17	VIE 191-17	VIE 134	
VIE Primary Capacity	22482	16100	11320	M3
VIE Primary Evaporators	250	300	220	M3
VIE Primary Regulator Max Flow Rate	3000 - 4.2 barg	3000 - 4.3 barg	3000 - 4.1 barg	lts
VIE Back up Regulator Max Flow Rate	3000 - 3.7 barg	3000 - 3.7 barg	3000 - 3.7 barg	lts
	VIE 16 - 17	VIE18	VIE 25	
VIE Secondary Capacity	4865	1527	2122	M3
VIE secondary Evaporators	51 @24hr – 71 @8hr	300	220	M3
VIE Secondary Regulator Max Flow Rate	2000 - 8.5 bar	2000 - 8.5 bar	2000 - 8.5 bar	lts
High Alarm	4.90	4.90	4.90	barg
Low alarm	3.75	3.75	3.75	barg

The next stage was to review the BOC telemetry data. As this data is intended to advise when the systems need to be refilled and not for real time consumption analysis the frequency reading is every hour; and uploaded to the online portal mid-morning for the previous day. On close review it was implying high consumption spikes in flowrate and negative spikes of a fill – which were not occurring – to which BOC CCS team confirmed there was no issue. They advised that the sites have what is deemed a bad trace.

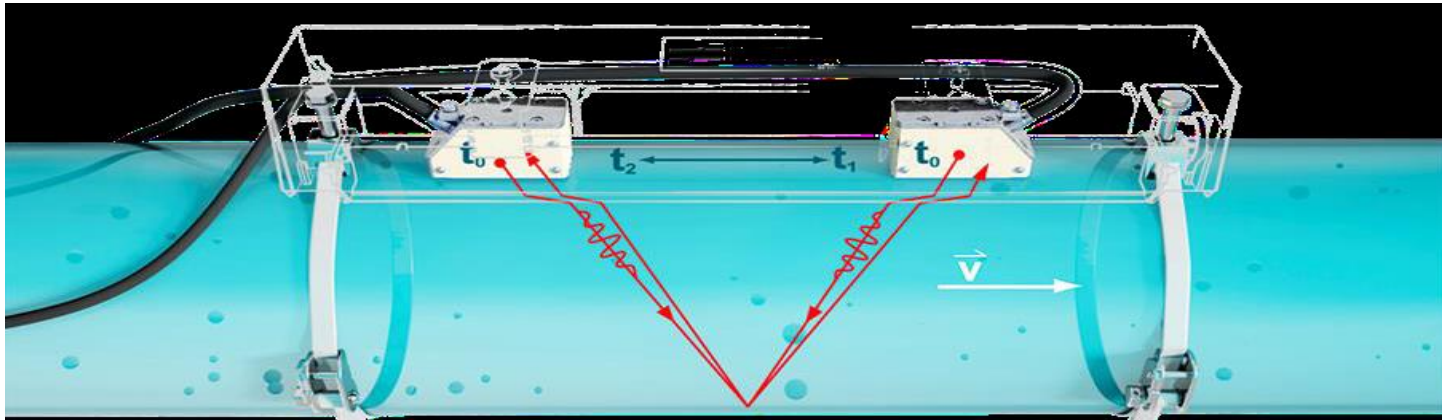


The above was not acceptable to manage the oxygen demand with any certainty.

After a few days of searching the internet a company was selected to carry out on site tests on the various sized pipework. This proved to be successful, purchase orders were raised for 4 units.

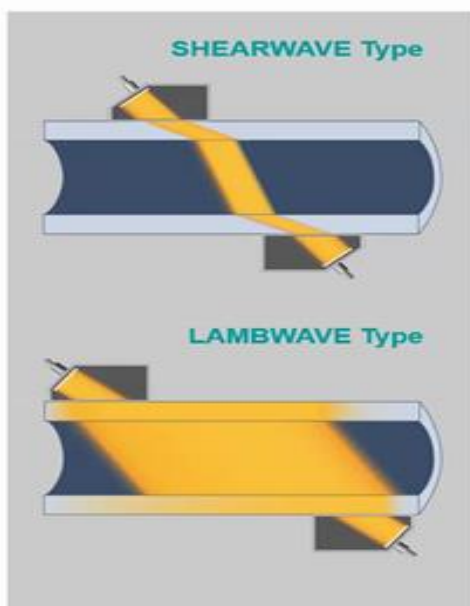
These were then installed and the initial data and assurance was attained, so additional units were requested. The data is collected from the metering via BACnet to the Building Management System where the latest version of the online real time dashboard.

The technology being used is Non-invasive ultra-sonic, which utilises a calibrated gas compatible dual matched and factory calibrated transducer pairs and transmitters for highest zero point stability.



Ultrasonic signals are emitted with and against the direction of flow of the gas. The gas flow slows one signal and accelerates the other one. This creates a difference in time flight, which is proportional to the flow velocity. Which is then used for calculation of the volume flow with a fixed temperature and pressure.

The transducers are available in Shearwave or Lambwave to account for most size, type of pipe and medium being measured.



Pipe Materials

- Copper
- Steel, Stainless Steel
- PVC, PE, PP
- Composite pipes

Media

- Compressed Air / Medical Air
- Oxygen
- Nitrogen / N₂O

two transducer types to master all applications & conditions

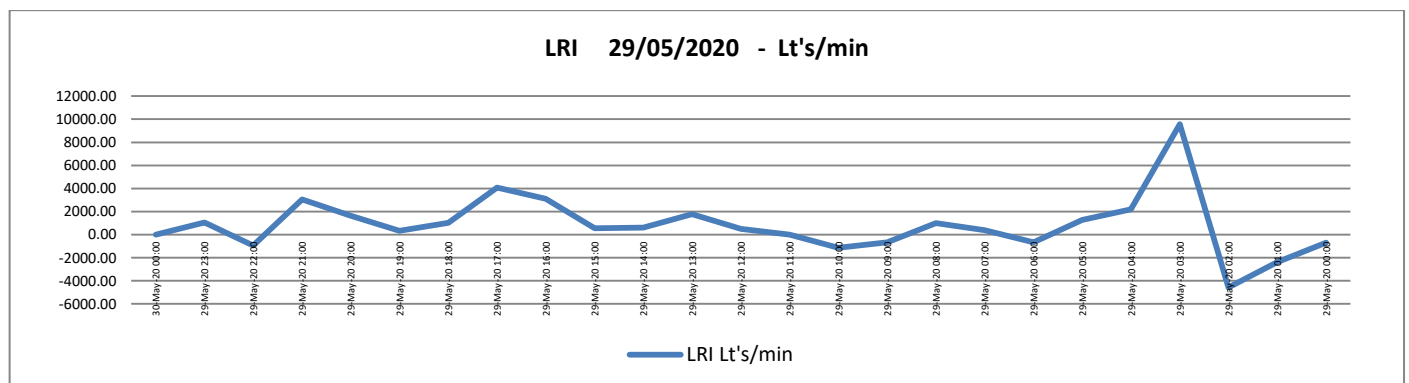
Standard setting algorithms and advanced digital signal processing ensure highly accurate and reliable measurement data. With signals evaluated every 10 ms, the unit captures quickly changing flow regimes. With temperature (Pt100) and pressure (4-20mA) compensation input devices or at a fixed value if actual input is not available the density and mass flow rate may be calculated to a given accuracy. Enabled to be installed without pipe modifications, breakins or system isolations. Parameters required, Pipe size external diameter, wall thickness, pipe material, lined or unlined, nominated pressure, temperature and type of gas.

The advanced diagnostics offer support to the user in understanding quickly the changing flows to allow pro-active management action before there is any related issue to patient care or the oxygen supply network.

- easy to retrofit clamp-on mounting
- no shut down
- no risk of leakage



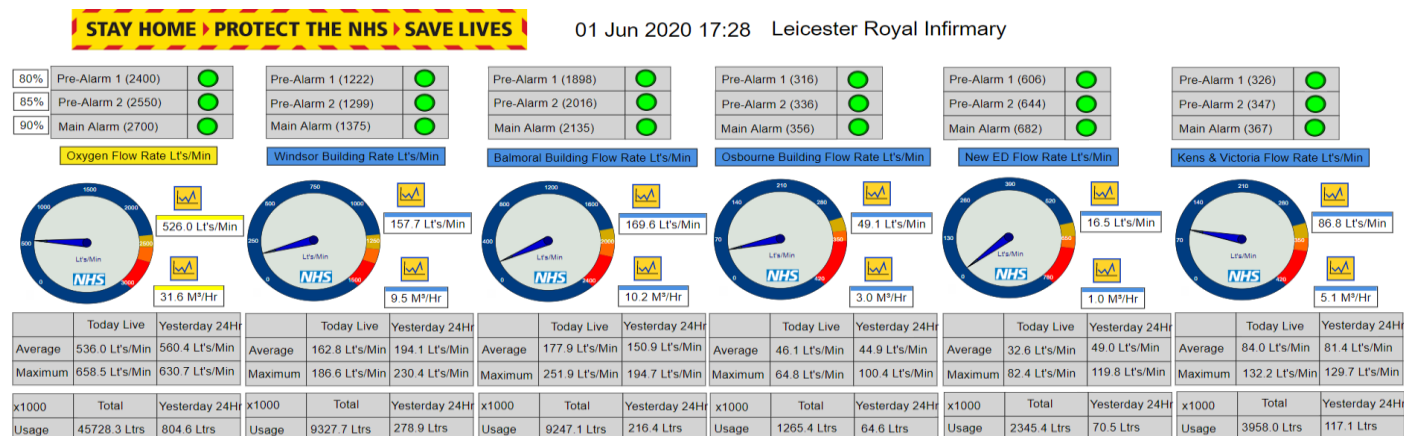
As it can be seen the use of the BOC data is still peaking and has a high demand immediately after a fill, which distorts the data which has been confirmed as acceptable by BOC. The constant metering by consumption does not show the high spikes in excess of 8000 Lts/minute. The data has given the confidence that with the constant monitoring and real time status will alert the teams if an individual line or system capacity, stability and supply are at risk.



The first graphic below are the front dashboards for the LRI, the subsequent are the auto-generated graphs which are available by just clicking the graph icon for various time periods. They are available 24/7 and give an instant update in real time with a 60 second refresh.

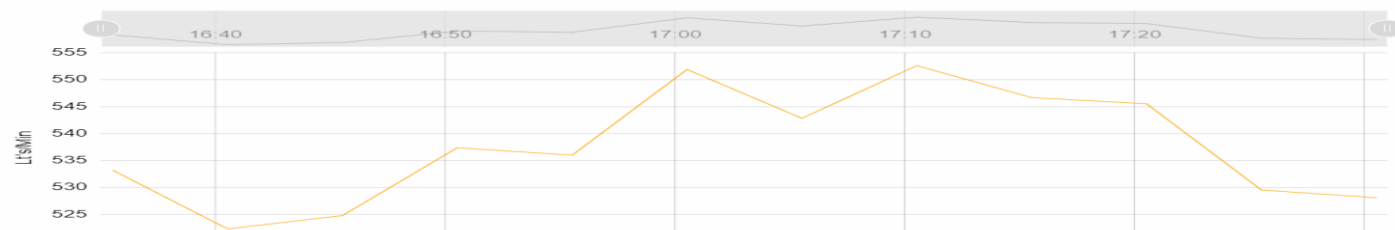
The alarms have the pre-determined levels as calculated by pipe design and industrial copper pipe capacity flow rates and HTM guidance to pressure drop.

The alarms when triggered will be e-mailed and texted to the relevant personnel inclusive of the appropriate Medical Gas Authorised Persons.



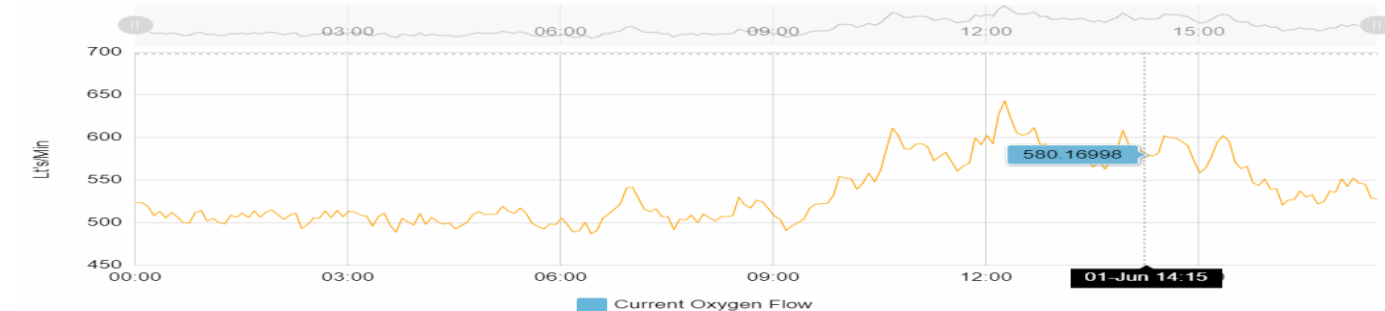
Date/Time Selection

Previous Hour



Date/Time Selection

Today



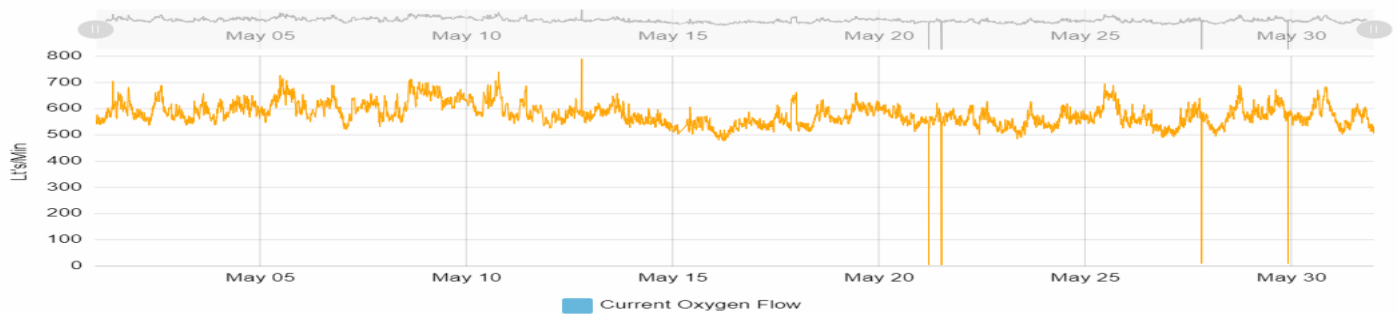
Date/Time Selection

This Week



Date/Time Selection

Last Month



Additionally there has now been implemented a daily status report @ 06:00 Hr's to co-inside with the Bed management meetings and handovers thought out UHL. It is emailed the various relevant staff members to give the latest and past 7 days update. This provides the ability to manage the wards consumption, patient base and what capacity each ward, department and leg of each of the network. To which one of the summary page is shown below.

Live Flow
498.1 Lt's/Min
29.9 M³/Hr

Leicester Royal Infirmary latest 24 Hr Oxygen Report
01 June 2020 05:59
Total of all Oxygen Lines

Latest 24 Hr usage
x1000 804.6 Ltrs
804.6 M³

Main Alarm - Normal

Pre-Alarm 1 - Normal

Pre-Alarm 2 - Normal

Latest 24 Hr Max Value 630.7 Lt's/Min
Latest 24 Hr Average Value 560.4 Lt's/Min



This monitoring of the oxygen system will be further extended to the 3rd acute site and the installation of the new VIE and ring to enhance the system which initially was an estates tool to manage the capacity issues of COVID 19 has now become a valuable clinical management asset to maintain a high level of assurance of the oxygen delivery network and system of UHL.