Duke University Hospital

Critical Care Tower
Oxygen Supply Failure
December 3, 2024

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DukeHealth

Agenda

- Duke Medical Pavillion
- Hospital Oxygen Supply Overview
- Timeline of Events
- Hospital Oxygen Warning/Alarm System
- Patient Oxygen Requirements and Assessment
- Lessons Learned/EOP Plan Changes

Duke Medical Pavillion

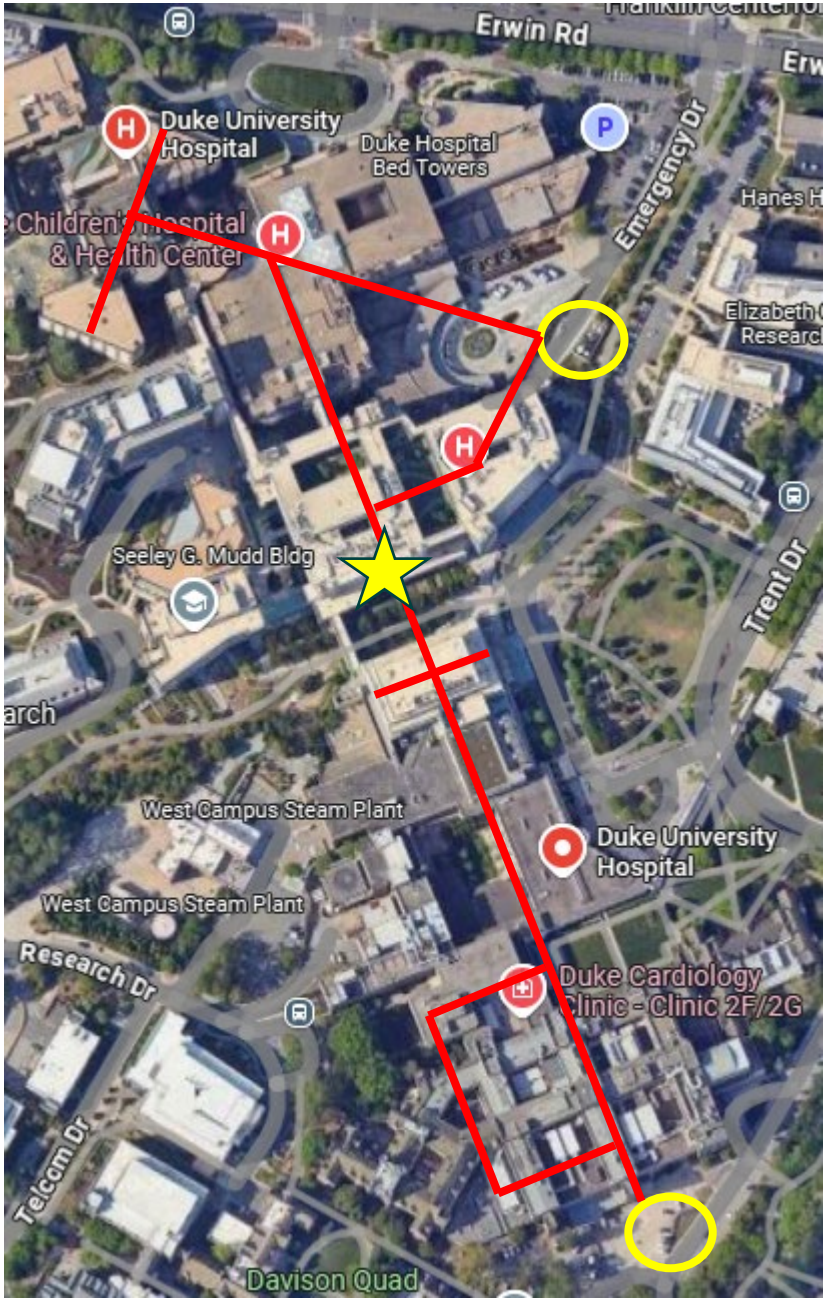
West	East
Medicine ICU	Medicine Stepdown
Cardiothoracic ICU	Cardiac Intensive Care
Surgical ICU	Cardiothoracic Stepdown
Mechanical	
Surgery	PACU
Imaging	

- 160 Critical Care Rooms
- Operating Rooms
- Cardiac MRI
- State of the art Imagine Center

- Some of the sickest patients in the state

Duke University Hospital

Oxygen Supply Map

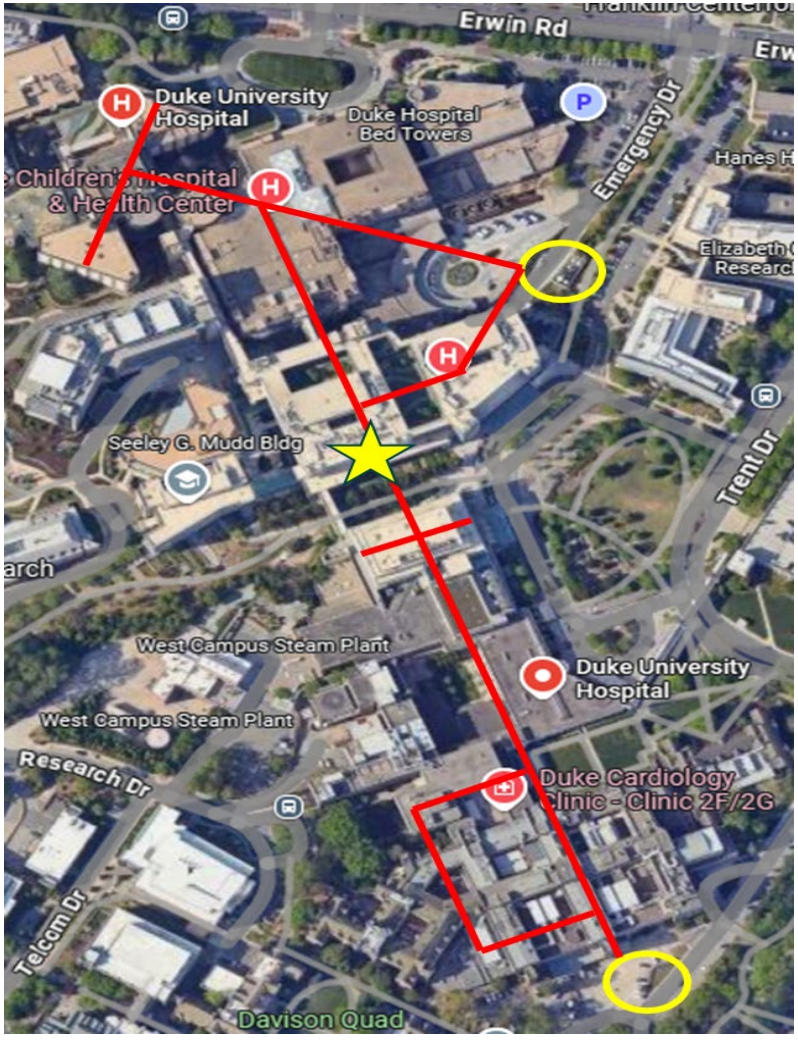


Oxygen Outage Timeline of Events

December 3, 2024

Time	Event Detail
00:07	DMP low oxygen alarm in Building Automation Room
00:10	Engineering site mechanics assessing the system
00:15	Emergency Management received call from Operations Administrator
00:20	ICU Charge RNs reporting pressure dropping and alarms sounding on floors
00:22	Page sent to all staff requesting to bring portable O2 tanks to command center
00:25	Hospital wide utility disruption plan initiated
00:30	Respiratory leader assessing and moving tanks to most critical patients
00:43	Emergency management received notification that O2 is not flowing in DMP
00:50	Emergency management onsite- confirmed O2 outage, continued deployment of O2 resources and command center coordination
01:15	Oxygen Maintenance Foreman onsite
01:25	Oxygen restored to the Duke Medical Pavilion
02:00	Patient rounding and physician led medical assessments

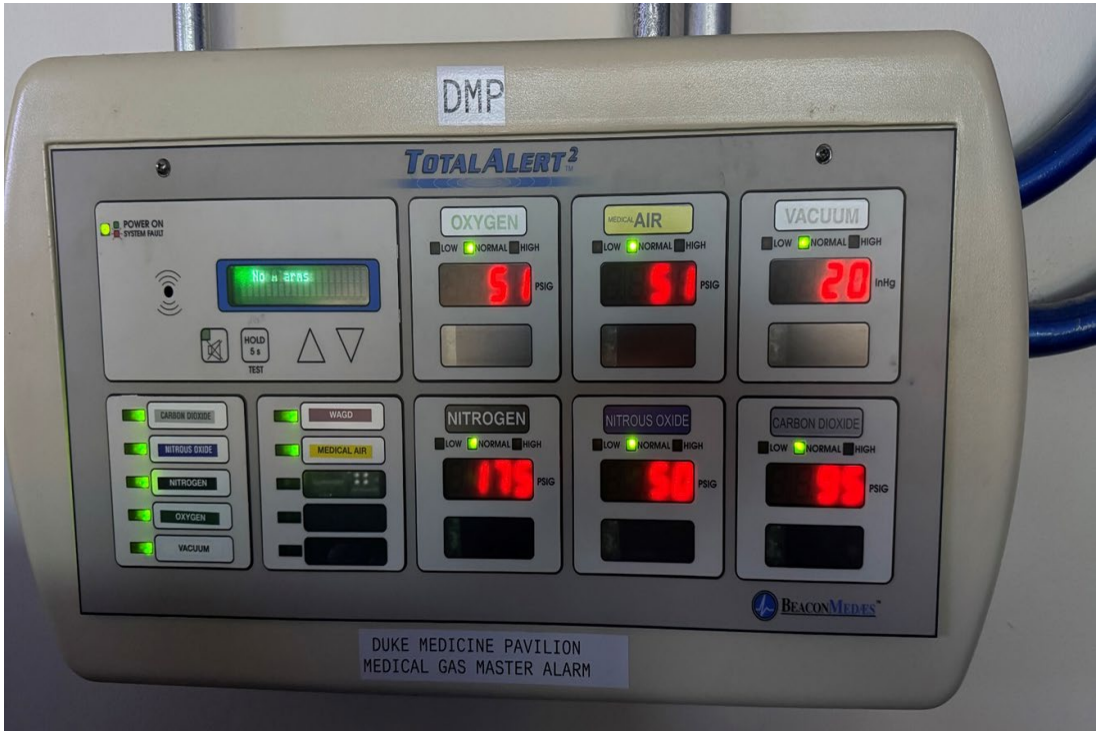
Oxygen Supply System



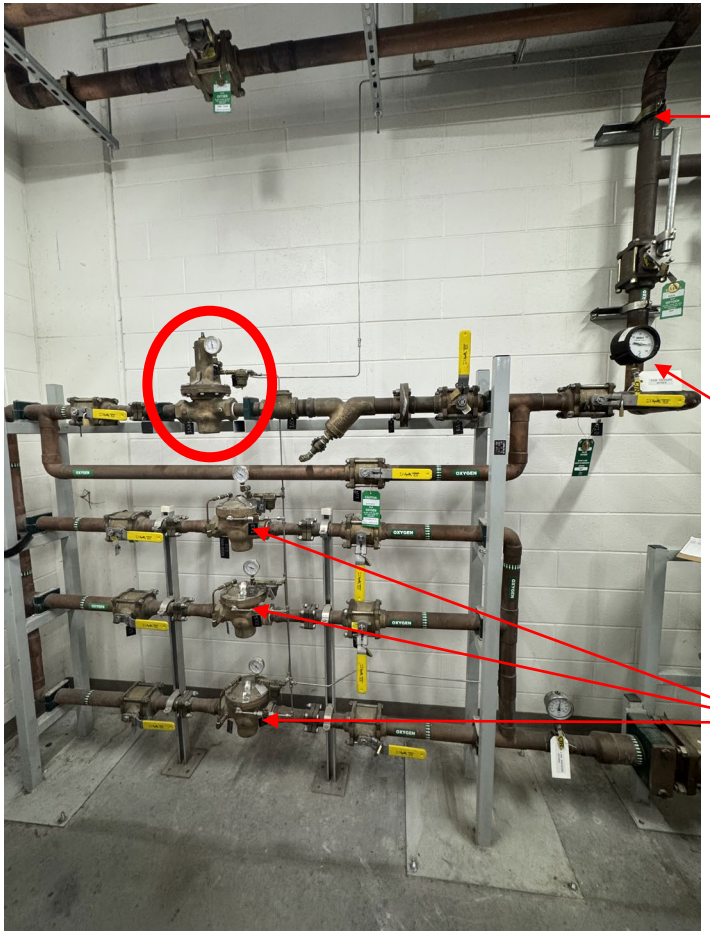
DMP Medical Gas Master Alarm Panel

DMP O2 Main Supply Line
- Normal Operating Pressure: 50psi

Alarms:
- High Pressure: 60psi
- Low Pressure: 40psi



DMP Medical Gas



Oxygen supply to DMP from the Duke Clinic Bulk Tank (Note we also have an Oxygen feed from the DHN Bulk tank)

Pressure to regulator manifold was normal PSI no issues with incoming Oxygen pressure from Duke Clinic

Output gauges to DMP were all at zero PSI.

Patient O2 Assessment vs Supply

- Column A: Unit & Patient Type
- Column B: Rate
- Column C: Number of patients w/orders for rate
- Column D: Calculation of how many minutes per E tank at the rate in column B
- Column E: How many tanks would be needed per 3 hours
- Column F: How many cylinders would be needed to take care of current patient census for 3 hours
- Columns G-H: same calculations but for 24 hours

6W	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	14	280	0.6	14.0	5.1	72
	15		37	4.9		38.9	0
Vent/NI Devices	15	11	30	6.0	66.0		
High Flow	30		18	10.0		80.0	0
High Flow	45	3	12	15.0	45.0	120.0	360
High Flow	60		9	20.0		160.0	0

6E	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	2	280	0.6	2.0	5.1	10
NI Devices	15	5	37	4.9	24.3	38.9	195
High Flow	30		18	10.0		80.0	0
High Flow	45	1	12	15.0	15.0	120.0	120
High Flow	60		9	20.0		160.0	0

7W	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	23	280	0.6	23.0	5.1	118
	15		37	4.9		38.9	0
Vent/NI Devices	15	15	30	6.0	90.0		
High Flow	30		18	10.0		80.0	0
High Flow	45	3	12	15.0	45.0	120.0	360
High Flow	60		9	20.0		160.0	0

7E	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	9	280	0.6	9.0	5.1	46
NI Devices	15	2	37	4.9	9.7	38.9	78
High Flow	30		18	10.0		80.0	0
High Flow	45	1	12	15.0	15.0	120.0	120
High Flow	60		9	20.0		160.0	0

8W	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	23	280	0.6	23.0	5.1	118
	15		37	4.9		38.9	0
Vent/NI Device	15	12	30	6.0	72.0		
High Flow	30		18	10.0		80.0	0
High Flow	45	6	12	15.0	90.0	120.0	720
High Flow	60		9	20.0		160.0	0

8E	Rate(L)	Patients	Number of Minutes/ E Tank	# Tanks Needed 3hr per pt	Total Count E Cylinders / pt	# Tanks Needed 24hr per pt	Total count E Cylinders
	2	17	280	0.6	17.0	5.1	87
NI Devices	15	4	37	4.9	19.5	38.9	156
High Flow	30		18	10.0		80.0	0
High Flow	45	2	12	15.0	30.0	120.0	240
High Flow	60		9	20.0		160.0	0

- DMP Building 0xygen depleted in 40 minutes post low pressure alarm
- Portable O2 tank supply would last 6 hours

https://opencriticalcare.org/oxygen-cylinder-duration-calculator/

Lessons Learned

Areas of Strength:

- Quick notification to clinical and operational stakeholders ensured awareness and preparedness for potential impacts **(EM 12.02.01)**
- Clinical teams showed readiness to respond to potential impacts on patient care **(EM.12.02.03)**
- Respiratory therapy responded quickly, assumed SME leadership and deployed resources quickly **(EM. 12.02.03)**
- Rapid restoration of oxygen pressure prevented harm to patients, demonstrating effective mitigation efforts **(EM.12.02.05)**
- Clinical teams maintained patient safety and continuity of care during the incident **(EM.12.02.05)**
- Engineering staff efficiently utilized existing resources to bypass the faulty regulator and restore service **(EM.12.02.11)**

NO REPORTED ADVERSE PATIENT EFFECTS BY THE DMP OXYEGN OUTGAE (EM Plans Work)

Lessons Learned

Areas of Opportunity:

- Develop and disseminate role-specific training on oxygen system vulnerabilities and response protocols for clinical, engineering, and administrative staff **(EM.12.02.05)**
- Clarify and document staff roles in utility failure incidents, ensuring alignment across departments **(EM.12.02.05)**
- On a three-year interval, the existing regulator will be removed and replaced with the new spare regulator **(EM.12.02.11)**
- E&O plans to implement preventative maintenance program for the oxygen system main line regulators **(EM.12.02.11)**
- Conduct a comprehensive risk assessment of oxygen delivery systems to identify potential safety vulnerabilities **(EM.12.02.07)**
- Enhance monitoring and alert systems to detect and communicate oxygen delivery issues before pressure losses occur **(EM.12.02.07)**
- Ensure safety protocols address scenarios involving simultaneous system failures and patient evacuations if required **(EM.12.02.07)**

Immediate Changes to Emergency Operations Plan:

- Dispatch oxygen supply truck immediately following low pressure alarm
- Rapid staff recall process to create resource pool
- Assessment of oxygen supply cages and increase on hand large cylinders
- Alert local EMS and Critical Care Transport Teams

Drills/Exercise

- Conduct drills simulating worst-case oxygen system failures, including a total outage, to test staff readiness and the effectiveness of contingency plans
- Include multidisciplinary participation (clinical, engineering, emergency management, leadership) to enhance collaboration

Questions?

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