

Liquid Nitrogen

Learning lessons the hard way

Anton de Paiva

Deputy Safety Director and BioRisk Manager

ABSA 24th October 2012

From: "XXX" <xxxx@imperial.ac.uk>

Date: 27 October 2011 11:45:22 GMT+01:00

To: "YYY" <yyyyy@imperial.ac.uk>

Subject: **body found in lab at ANHS hospital**

YYY,

ANO has just called me to say that a body has been found in a lab in our area at ANHS hospital, the deceased is a member of the hospital staff , a technician, and the lab is being treated as a crime scene.

I will get in touch with the principal investigator and offer assistance if needed

Regards

XXX

Small print

- This is still a crime scene
- I represent only Imperial College

Outline

- The incident
- Lessons learnt

Background

Imperial College London

Top 10 globally ranked University

Science only (teaching and research)

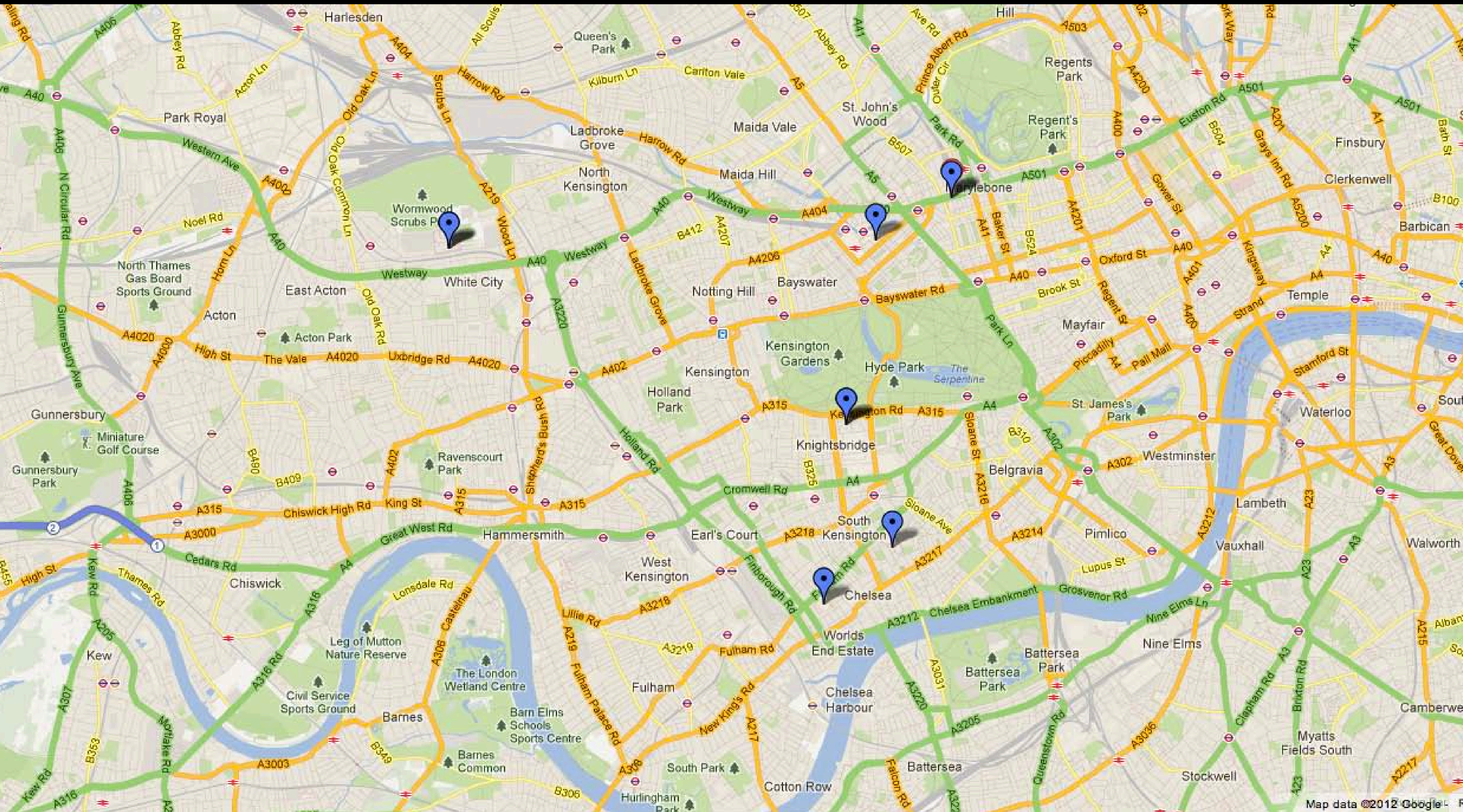
5-10% of the UK's capacity for BSL3 laboratories

Medical School

Terminology

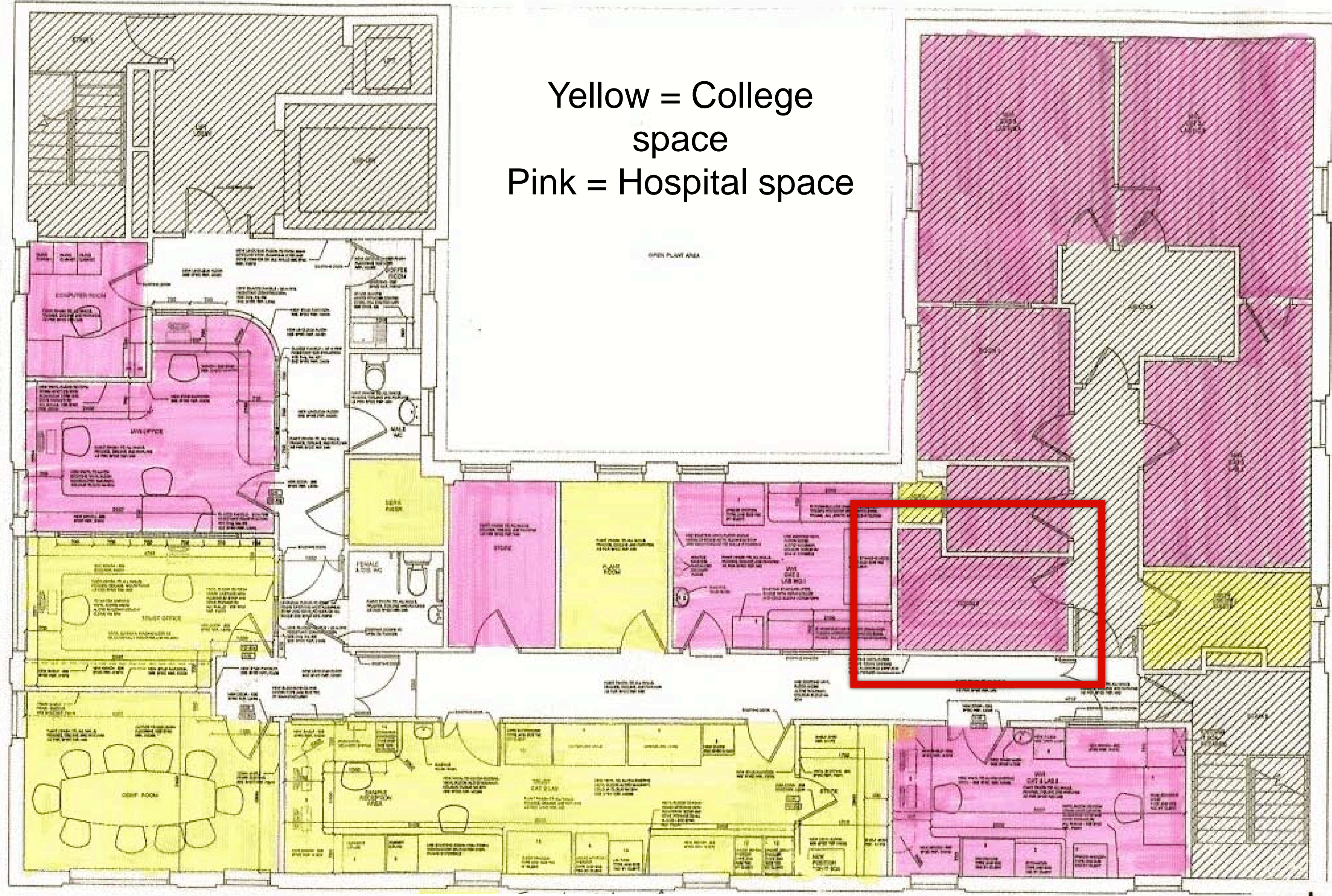
'Hospital or Trust' = National Health Service (NHS) Hospital Trust

'College' = Imperial College London





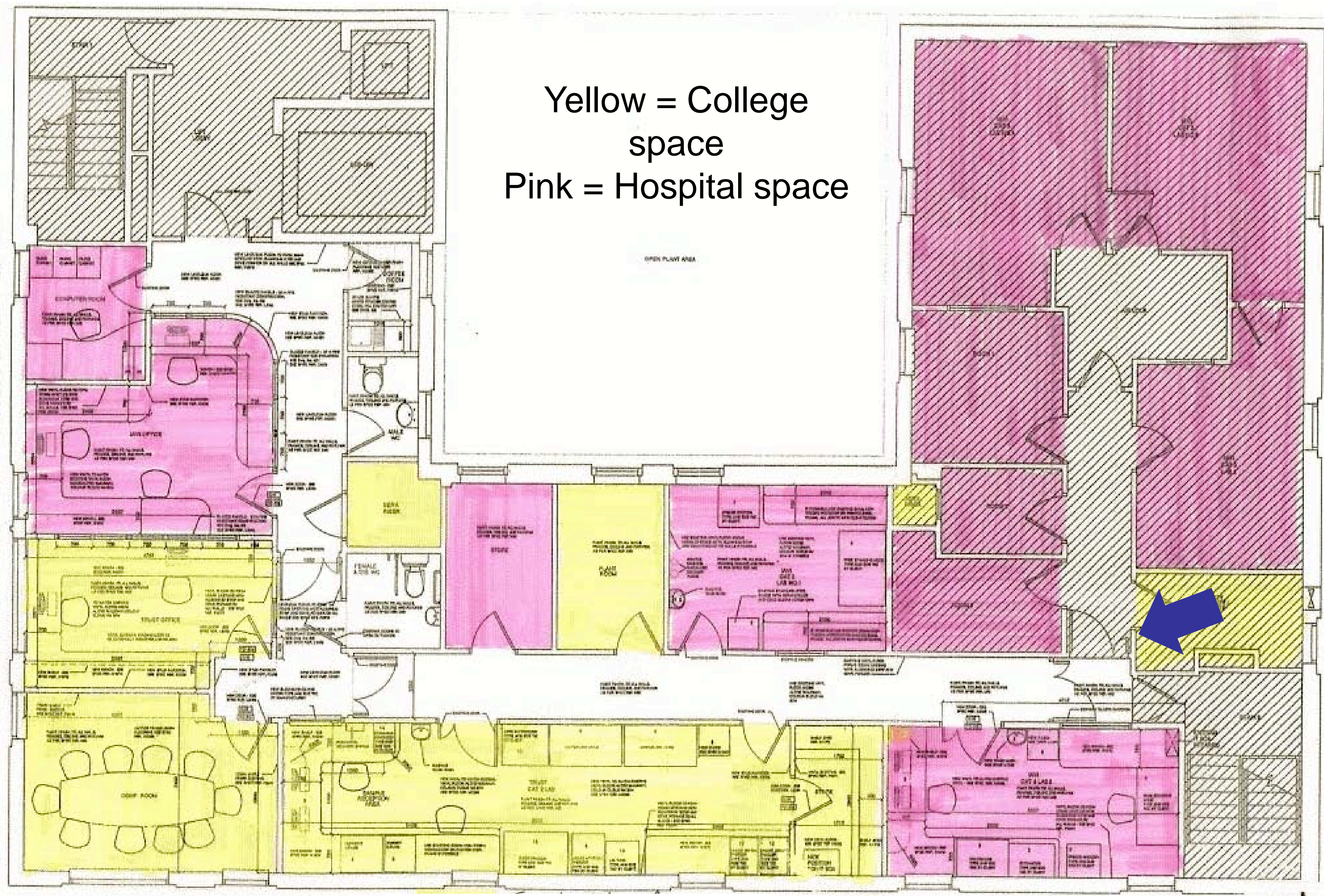
Yellow = College
space
Pink = Hospital space







Yellow = College space
Pink = Hospital space





Initial findings

Victim was removing small amount
of LN for snap freezing of biopsy
tissue

No formal agreement allowing
entry by Hospital staff into this room

Lone working/out of hours

Was wearing PPE
(not sure precisely what)





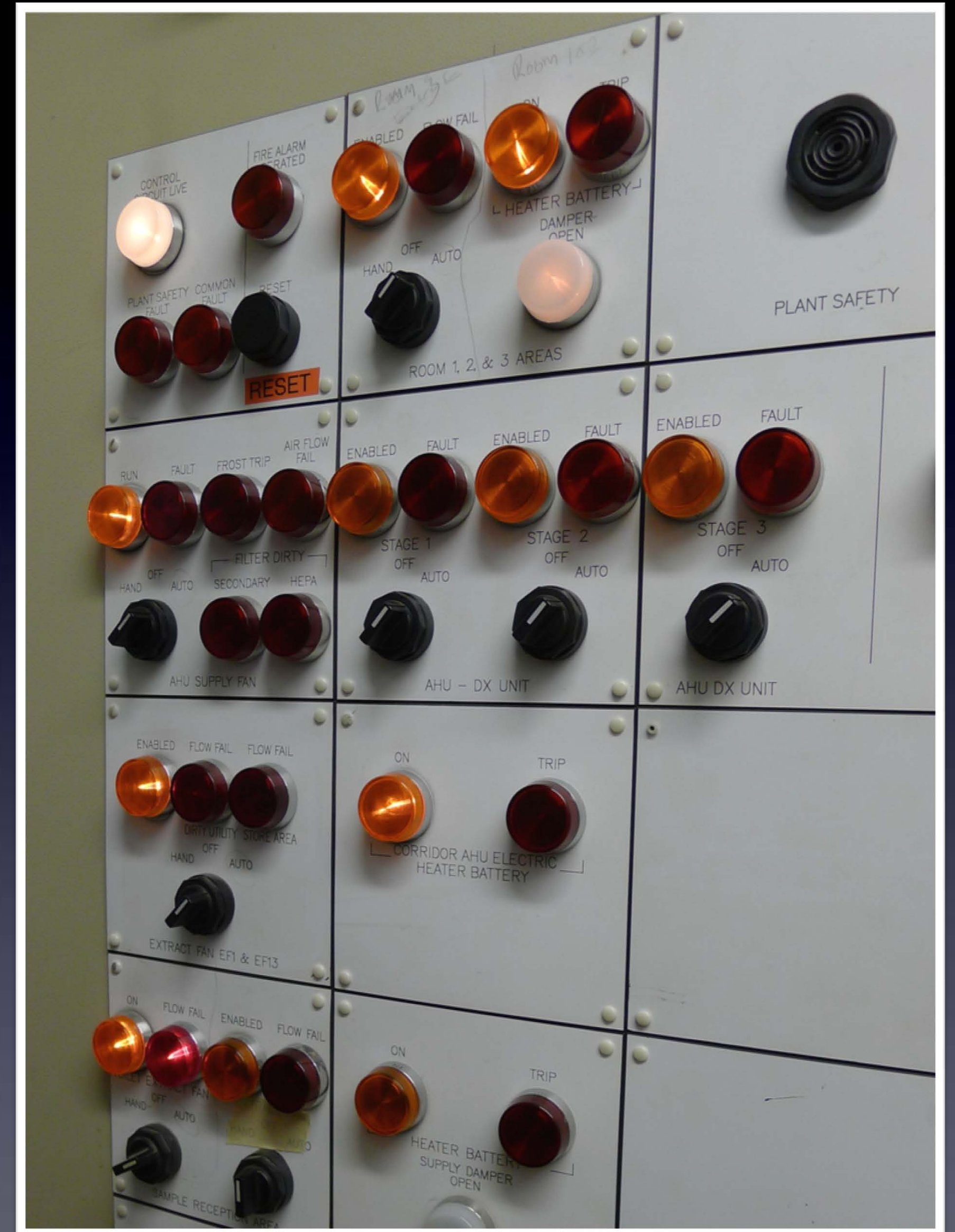
Room was ventilated (>25ACH) albeit high level extract with low level supply



There was a visual indicator of ventilation performance

but....

Room ventilation was
switched off



RE ALARM
OPERATED



RESET



RESET

Room 102

ENABLED



FLOW FAIL



Room 102

ON



TRIP



HEATER BATTERY

OFF

HAND

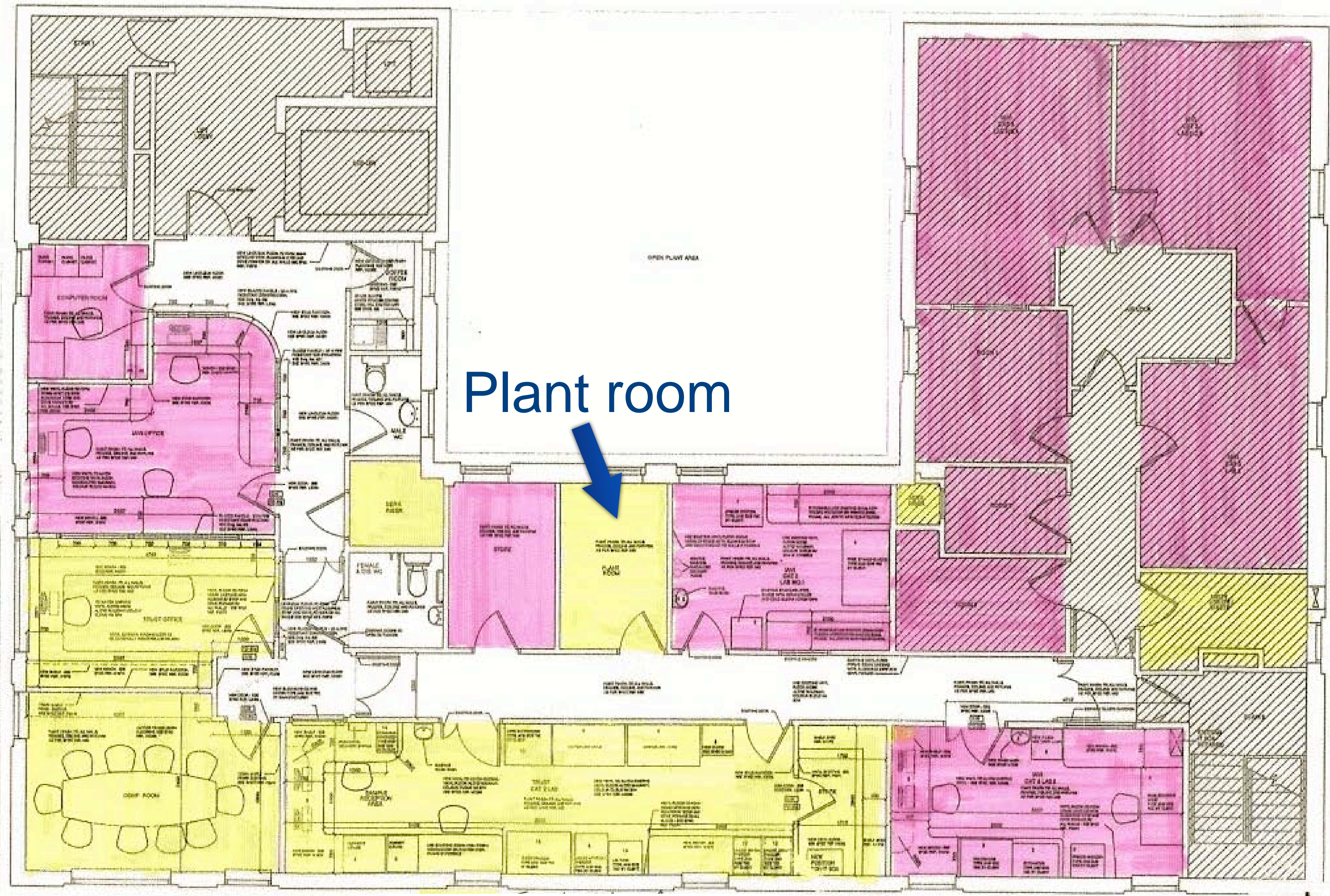
AUTO



DAMPER
OPEN



ROOM 1, 2, & 3 AREAS



Plant room



Gas detection





DANGER
Transport of gas



NO ENTRY
Temporary use

Taylor-



Sensor and alarm were battery operated and no repeater outside of the room



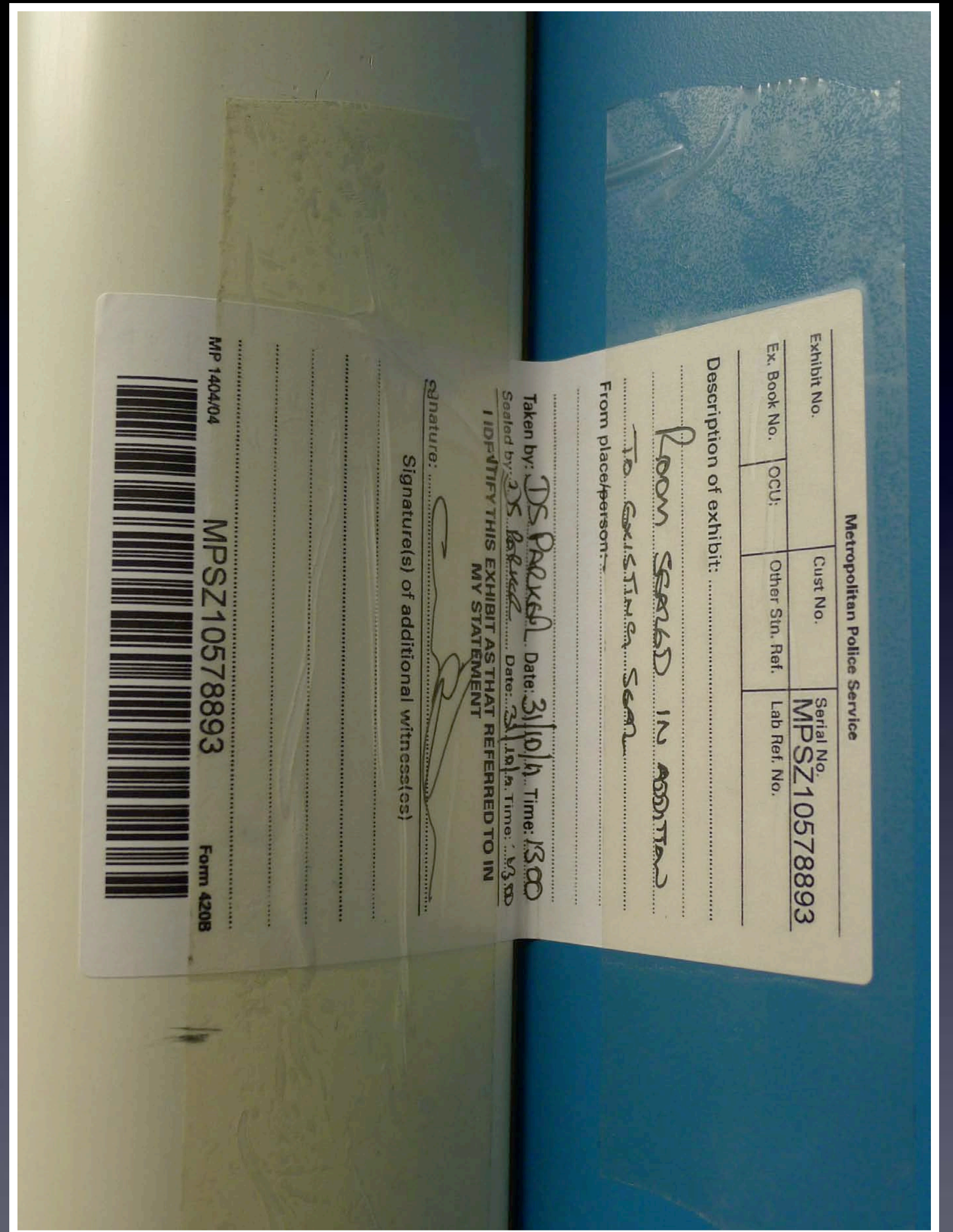
Action by regulator

Room sealed (by the police)

Direction to leave undisturbed
issued

Prohibition Notice served

Improvement Notice served



So what then?

- Immediate re-training for staff involved
- Immediate training and 'PR' for Trust staff
- Re-assess the College's use of liquid nitrogen
- Review policy and Codes of Practice

Review of 'policy'

Key questions:

- O₂ sensors - type, location and repeaters
- warning systems for ventilation performance
- risk assessment methodologies (calculations used)
- lone working procedures
- Critical plant identification
- plus usage, substitution, etc etc

Imperial College
London



Code of Practice
Liquid nitrogen - storage, use and
transportation within College
premises





TAYLOR-WHARTON
LABS-40K

TAYLOR-WHARTON
LABS-40K

TAYLOR-WHARTON
LABS-40K

MEDICAL SAMPLES





CryoPanel

CE



20.8%

Oxygen Level

20.8%

Oxygen Level

20.7%

Oxygen Level



Fan
Stopped

Quantum Production
01844 339993



Valve
Open





Cryojet Controller

NITROGEN
Westinghouse Cryogenics
PV-120
NITROGEN
No. 120
wt. 51%
150°C
17.5m

Xcalibur 3

KRYOJET

KRYOJET



CRITICAL PLANT
DO NOT TURN OFF



55 00 201

SEE MOTOR LABEL FOR
ELECTRICAL DATA

55 00 201

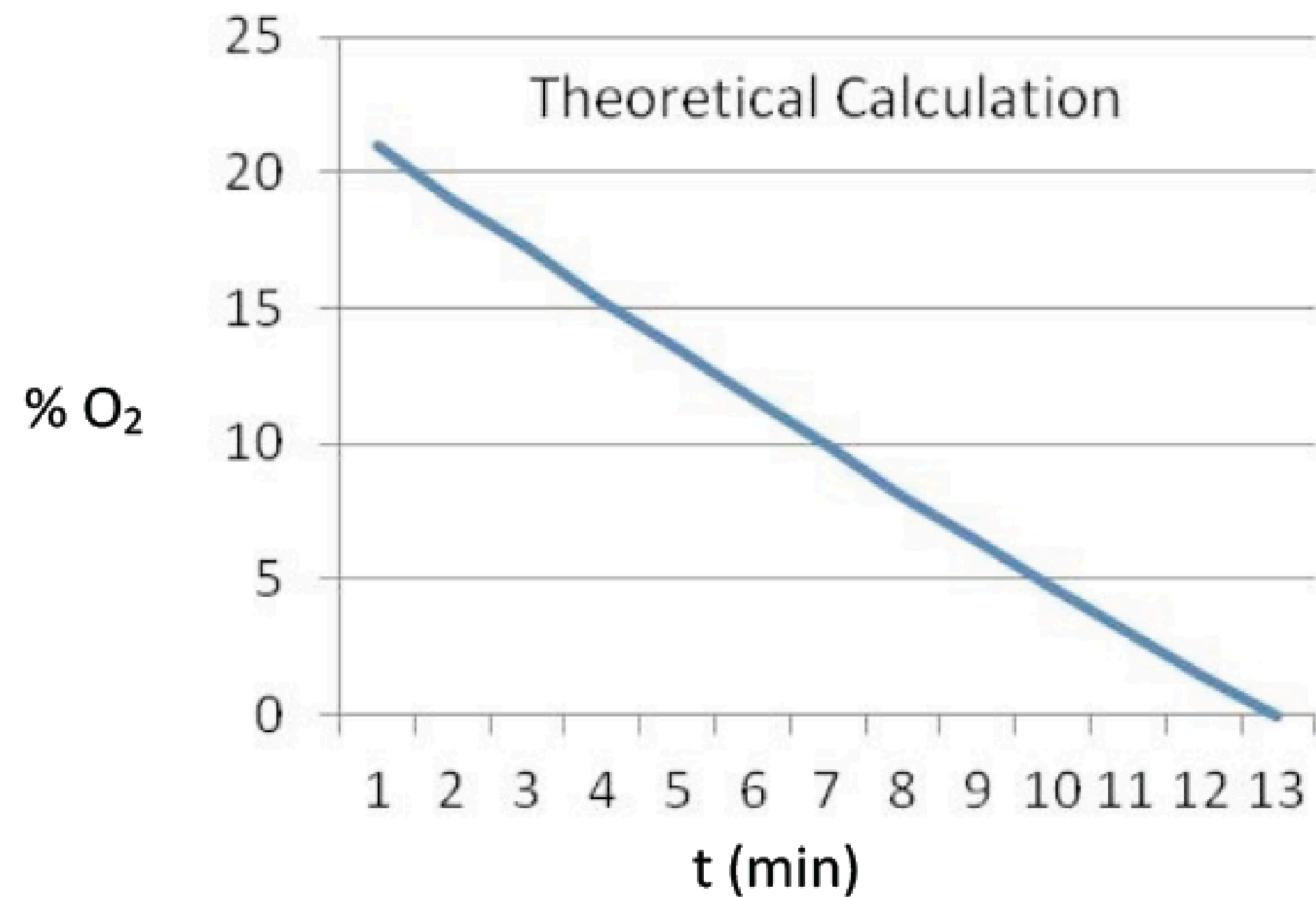
What really did happen?



TABLE 1:

Effects and symptoms at differing breathable O₂ levels (Source: BOC - Cryogenic Gas Risks)

O₂ content (% vol)	Effects and symptoms
11-14%	Physical and intellectual performance diminishes without the person being aware.
8-11%	Possibility of fainting without prior warning.
6-8%	Fainting within a few minutes - resuscitation possible if carried out immediately.
0-6%	Fainting almost immediate, death ensues, brain damage even if resuscitated.

**GRAPH 9:**

Theoretical calculation for comparison (source: BCGA GN11 Reduced Oxygen Atmospheres).

Assumptions:

1 air change per hour in room.

Gas release rate = 185m³/hour

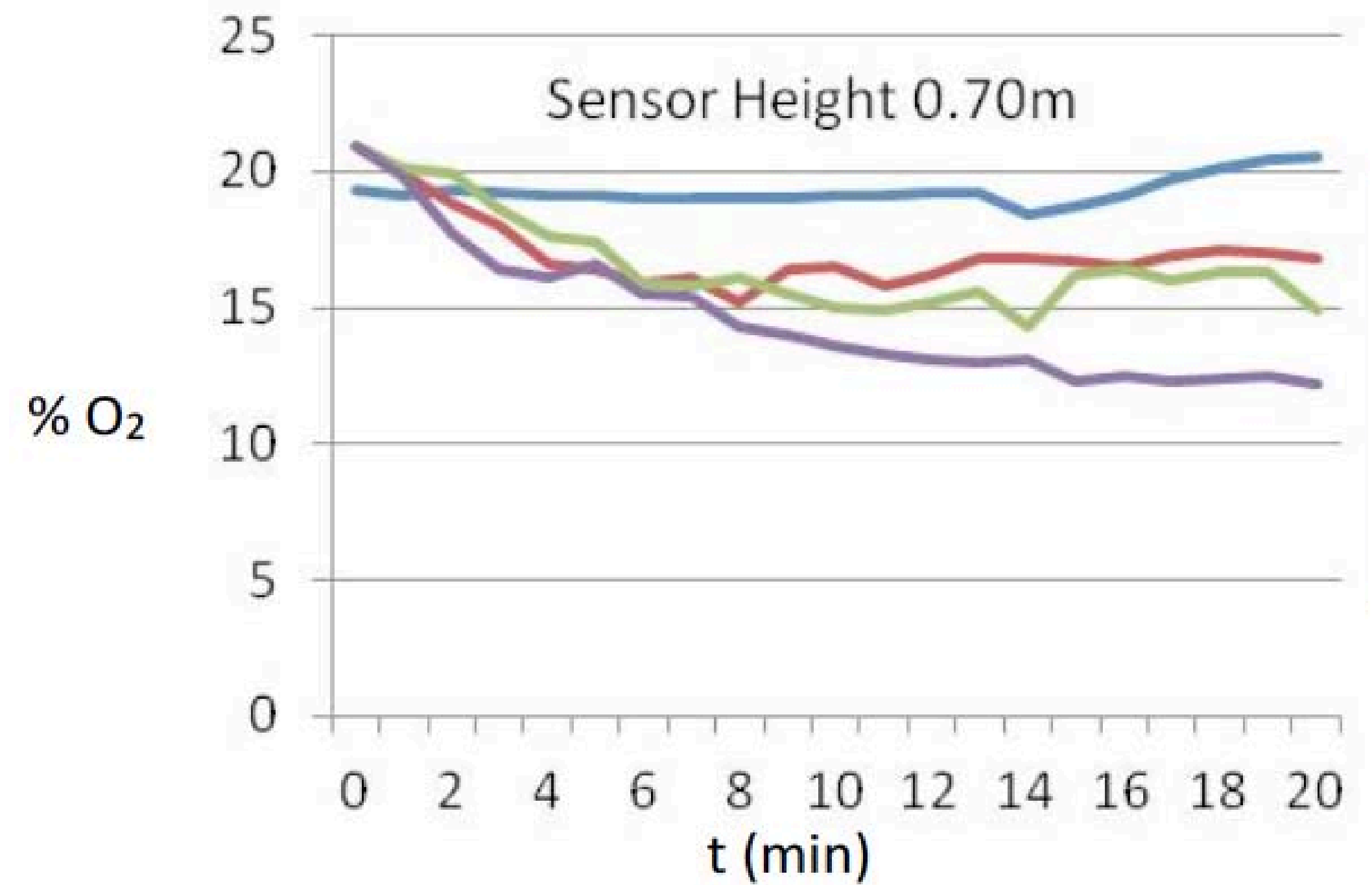
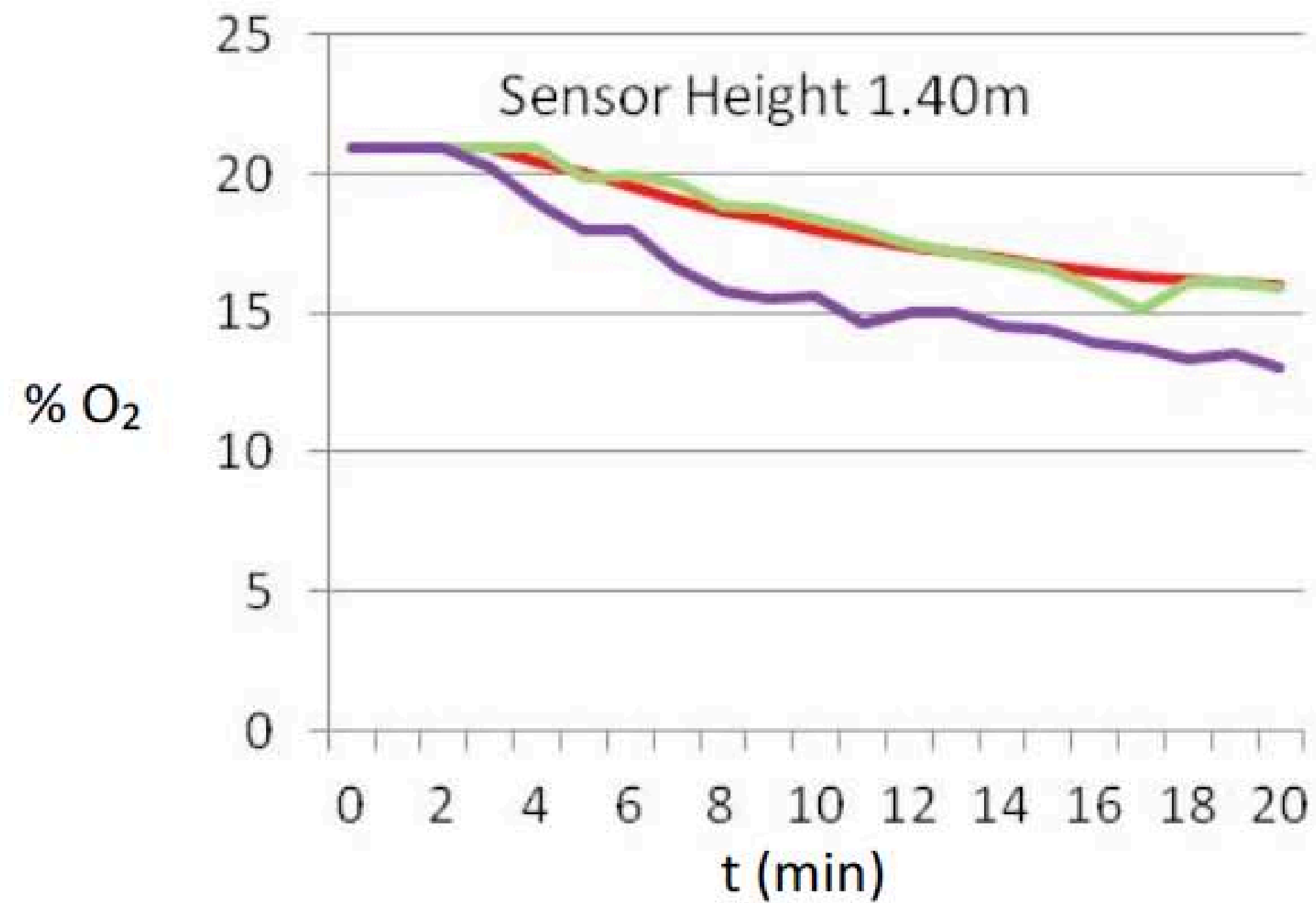
$$C_i = 0.21 + \left[\frac{0.21n - 0.21}{L + n} \right] \left[1 - e^{-t/m} \right]$$

(see footnote below)

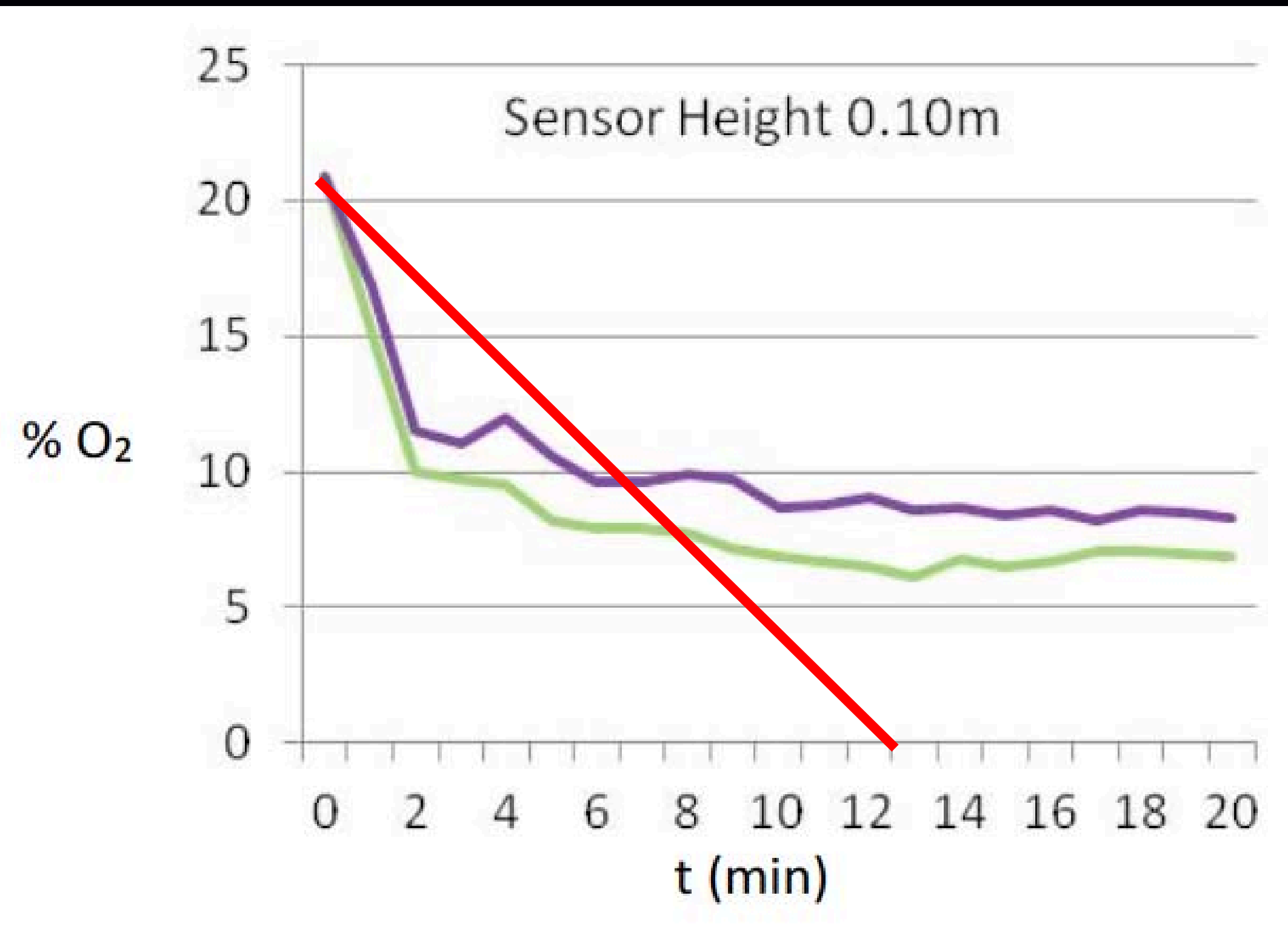








— Expt 1: Discharge to metal tray — Expt 2: Discharge to vinyl floor — Expt 3: Discharge to vinyl floor — Expt 4: Deployment of fans





So what happened?

Does it matter?

Would this have happened if...

- He had not been working alone?
- He was not using 'borrowed' space and equipment?
- The ventilation was on?
- He had checked that the ventilation was on?
- He had paid attention to the O₂ alarm

How could this have been prevented?

Control lone working

- Know what people are doing
- And what to do in the event of problems

How could this have been prevented?

Formal site partner arrangement

- Covering the use of shared space and equipment
- Plant rooms and labs

How could this have been prevented?

Critical plant

- Do you know where this all is?
- Who has access to the controls?
- And what about shared sites?

How could this have been prevented?

Control access to hazardous areas

- Think about specific rooms in shared spaces
- Think about the culture at the shared site

How could this have been prevented?

Training

- Use of liquid nitrogen
- Ventilation monitoring
- Gas alarms
- Lone working

Any questions?