

The first Passivhaus Archive in the UK

HARC Hereford

Presented at:

The 20th International Passivhaus Conference Darmstadt

AECB Annual Conference Norwich July 2016

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ARCHITYPE





Architect: Architype Ltd, Contractor: Kier Construction, M&E Consultants: E3, Cost Consultants: Arcadis, Energy & Environment: Alan Clarke and Nick Grant, Structural Engineers: Eastwood and Partners, Certifier: WARM, Client: Herefordshire Council.

Image Nick Grant

Many considerations:

- Security
- Fire
- Logistics
- Quarantine
- Daylight
- Public access, attractive
- Multifunction
- Future expansion
- etc etc etc . . .

I will just consider
temperature and RH!

Repository: Photo store:
13-20° C 12° C
35-60% RH 30% RH

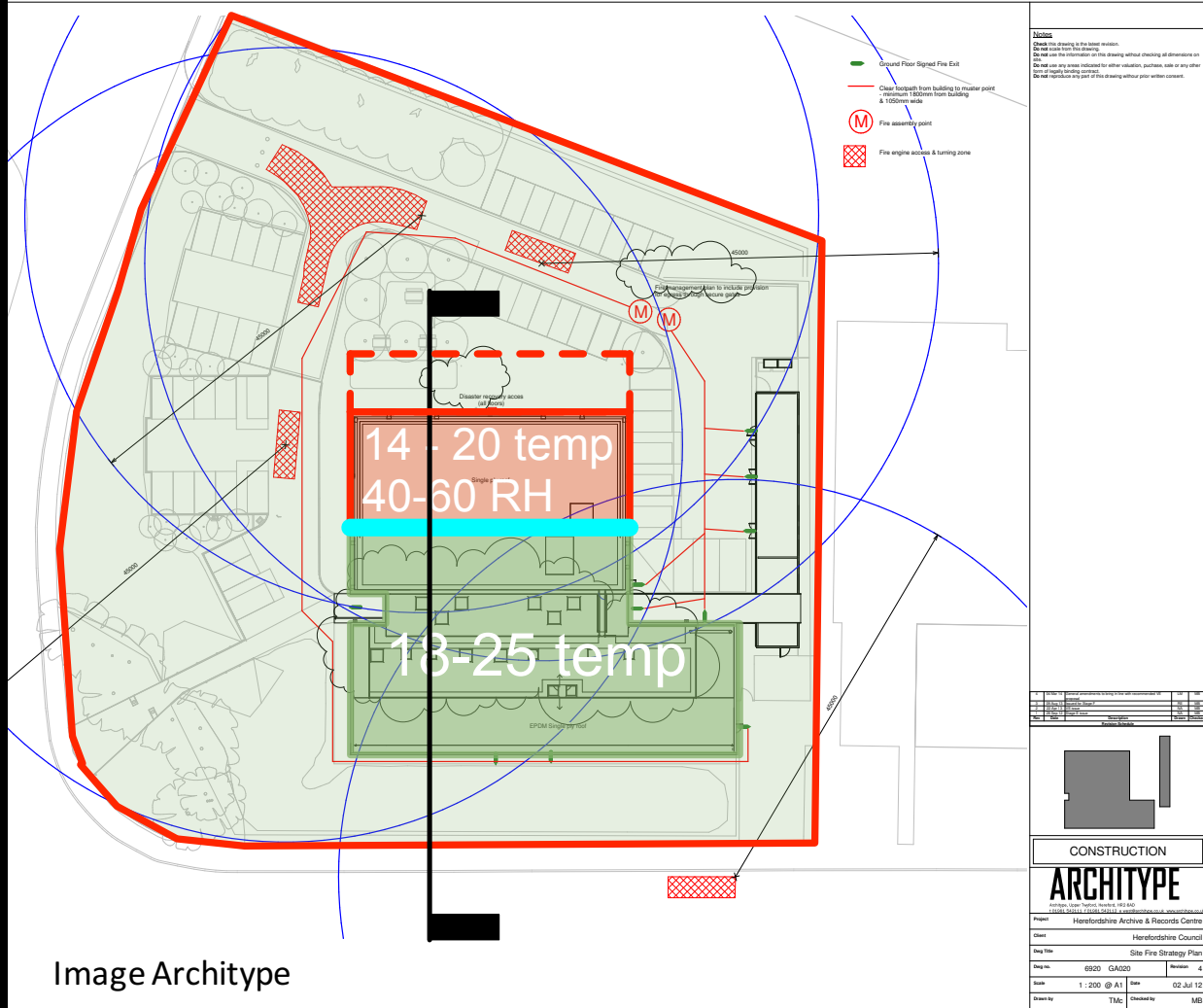
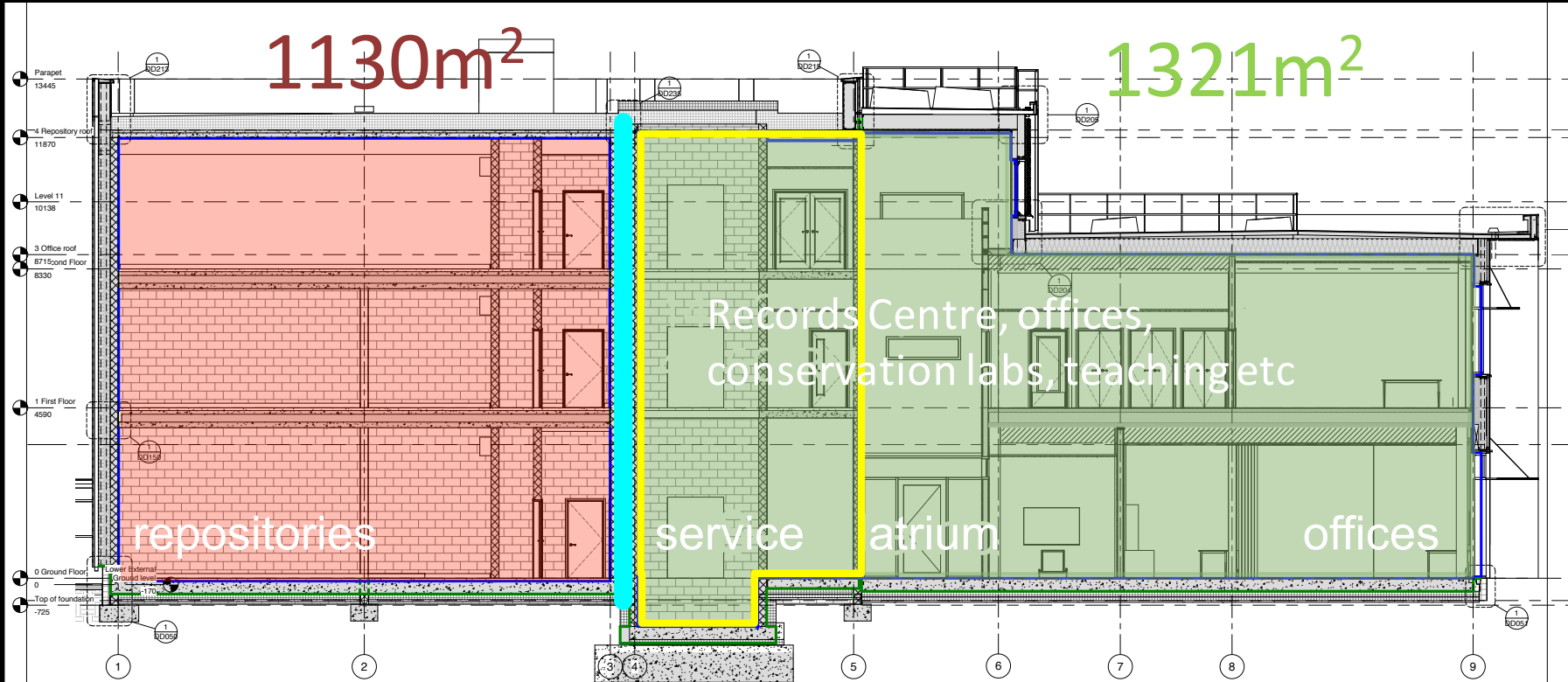


Image Architype

Easily isolated zones





Key design strategy:
Office isolated from repository

20—22° C
this side all
year

13-18° C
this side
is ideal

Airtight details developed with contractor
– their first Passivhaus

<0.04 ach @ 100Pa with doors sealed

(Final test 0.4 ach included doors to office – air leakage route)



Cost effective construction – concrete blocks and planks – no frame
Larsen trusses and blown cellulose.
Arts Council suggest £3,500/m²
HARC was £1,980/m² (turnkey).



Image Nick Grant



Image Nick Grant

Records Centre - timber frame.
Same details as developed for the earlier schools.
(glass area is for architecture not Passivhaus)



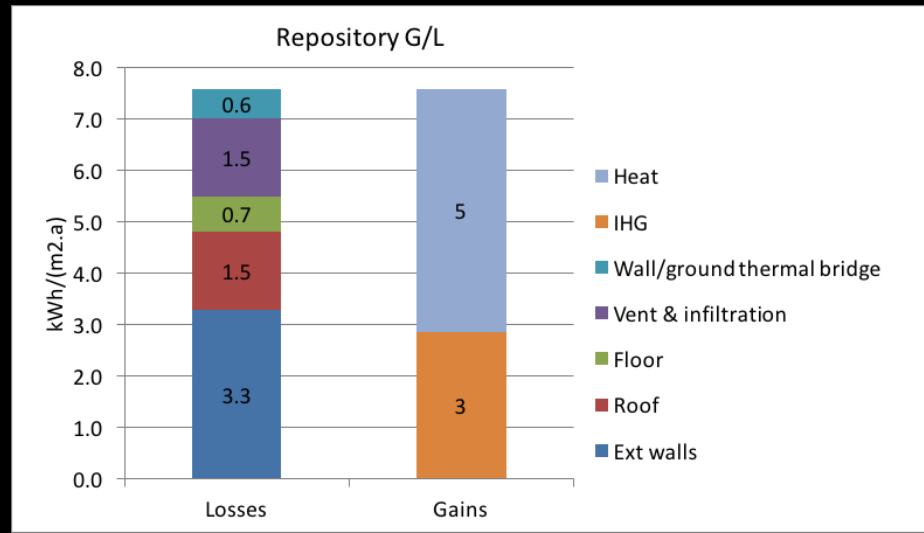
Atrium exhibition area between
repositories and offices

Repository energy balance

- Simplest form
- Low IHGs 0.6W/m^2
- c.a. 1 air change/day supply air vent
- No HRV
- Temp $13\text{-}20^\circ\text{C}$
- No cooling (except photo store)
- Inspired by Tim Padfield & Danish archives

www.conservationphysics.org

PHPP 7

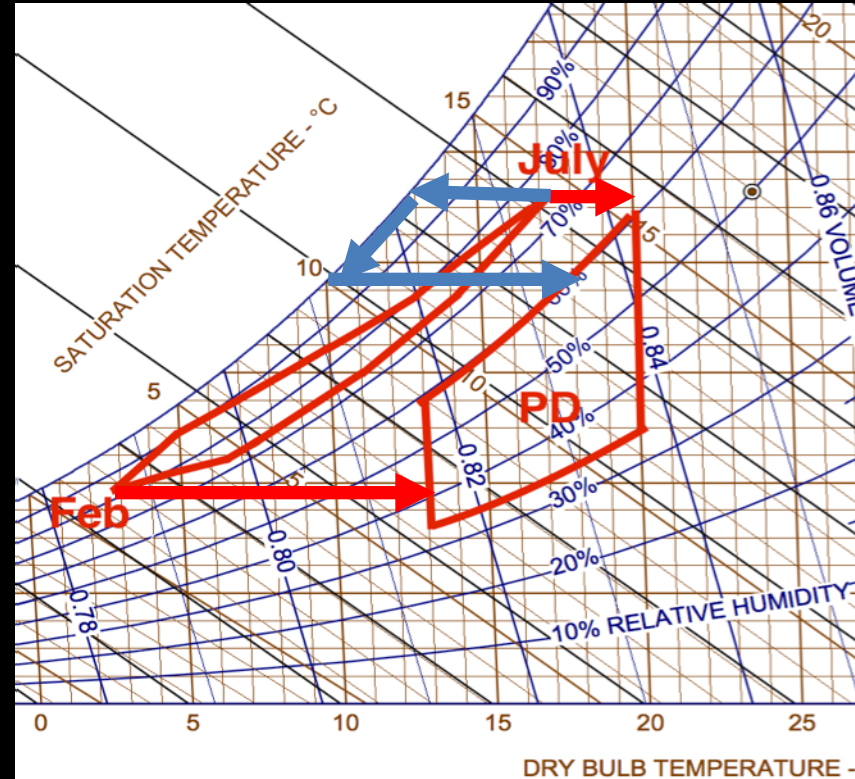


Moisture balance - monthly model

Annual average humidity is about right +/- depending on English weather.

Options:

1. Close control air conditioning
2. Passive buffering
3. Control vent on psychrometrics
4. Trim supply air humidity in summer ($100\text{m}^3/\text{h}$, $< 10\text{-}15$ litres $\text{H}_2\text{O}/\text{day}$)



Buffering (roughly)

Max vent air H₂O imbalance:
≈ +/-10 kg/day

EMC @ 40% RH ≈ 6.5%

EMC @ 60% RH ≈ 8%

= 13 %RH/% EMC change

c.a. 150,000* kg of paper etc.

10kg H₂O x 30 days = 0.2% change in EMC

= 2.6% change in RH

(* Half of archivist's estimate and ignoring building fabric moisture capacity)

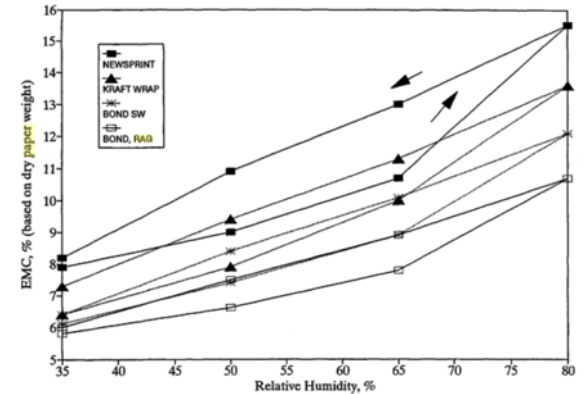
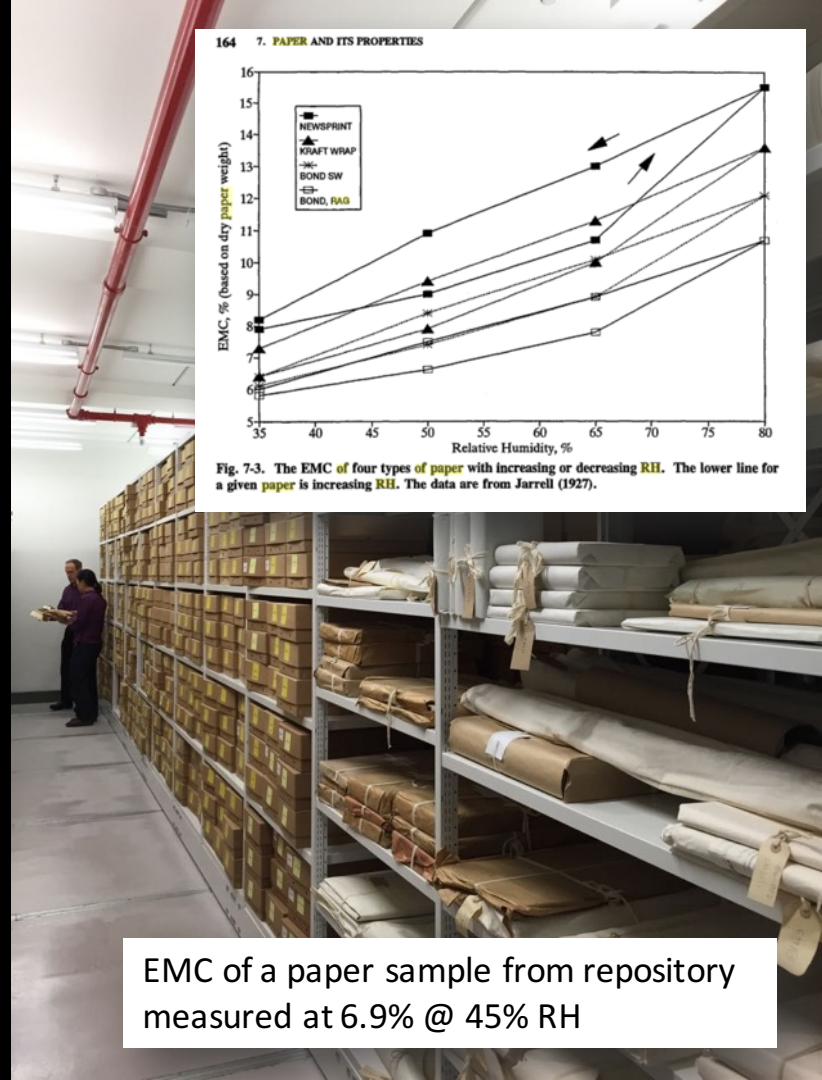


Fig. 7-3. The EMC of four types of paper with increasing or decreasing RH. The lower line for a given paper is increasing RH. The data are from Jarrell (1927).



EMC of a paper sample from repository
measured at 6.9% @ 45% RH

How long to dry 1,800 t of concrete??



September 2014
Image Nick Grant



Alan Clarke
working the
antique
chemistry
balance



March 2016

Home brew test kit

They said it wouldn't work:

Sceptical client in design meeting:

“The Titanic was said to be unsinkable”

Alan Clarke's reply:

“We are designing the iceberg”

Compromise: an iceberg with a BMS controlled heating system . . .

Titanic Versus Iceberg

4 sensors/store, alarms,
duplex boilers, duplex
pumps etc. . .

An airtight concrete box
wrapped in old newspaper. . .

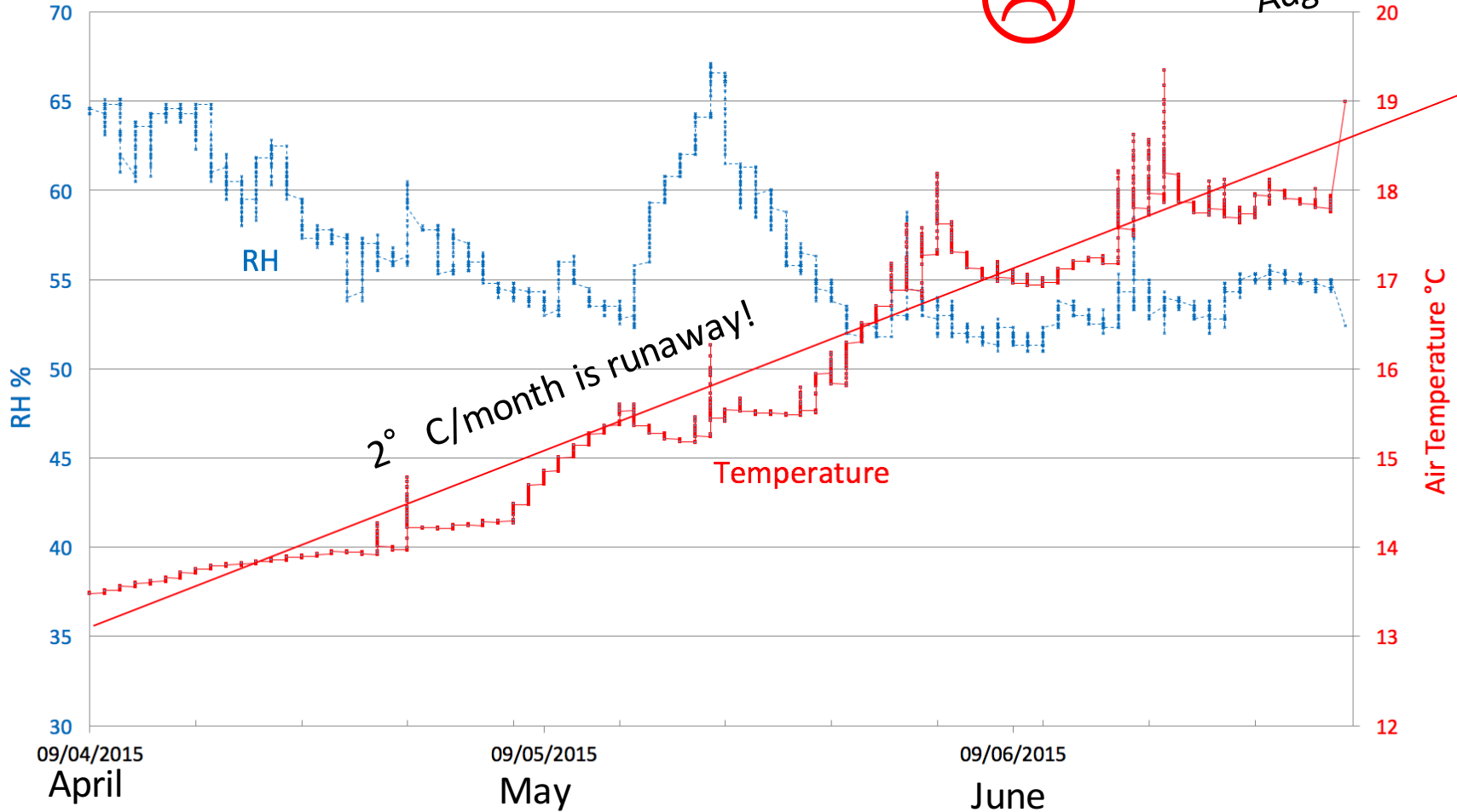


Image Nick Grant

First floor repository store



August 24° ??



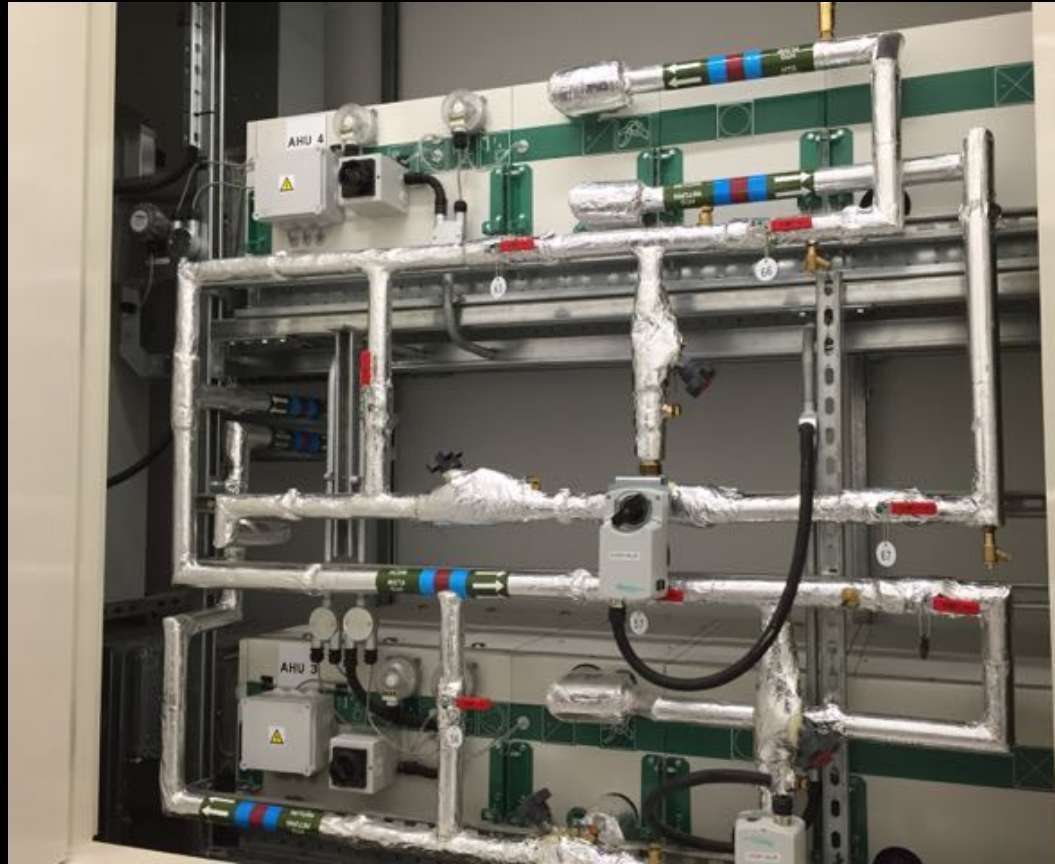
Troubleshooting 1

Unwanted hot water running through repository pipework.

Losses from insulated pipe was enough to heat the building!

- Fix - valves shut manually

(Large fan coils to meet 1kW peak heat load/floor!)



Troubleshooting 2

Photostore dehumidifier installed backwards so running inefficiently and generating unwanted heat in the service core. Fixed in June 2015



Troubleshooting 3

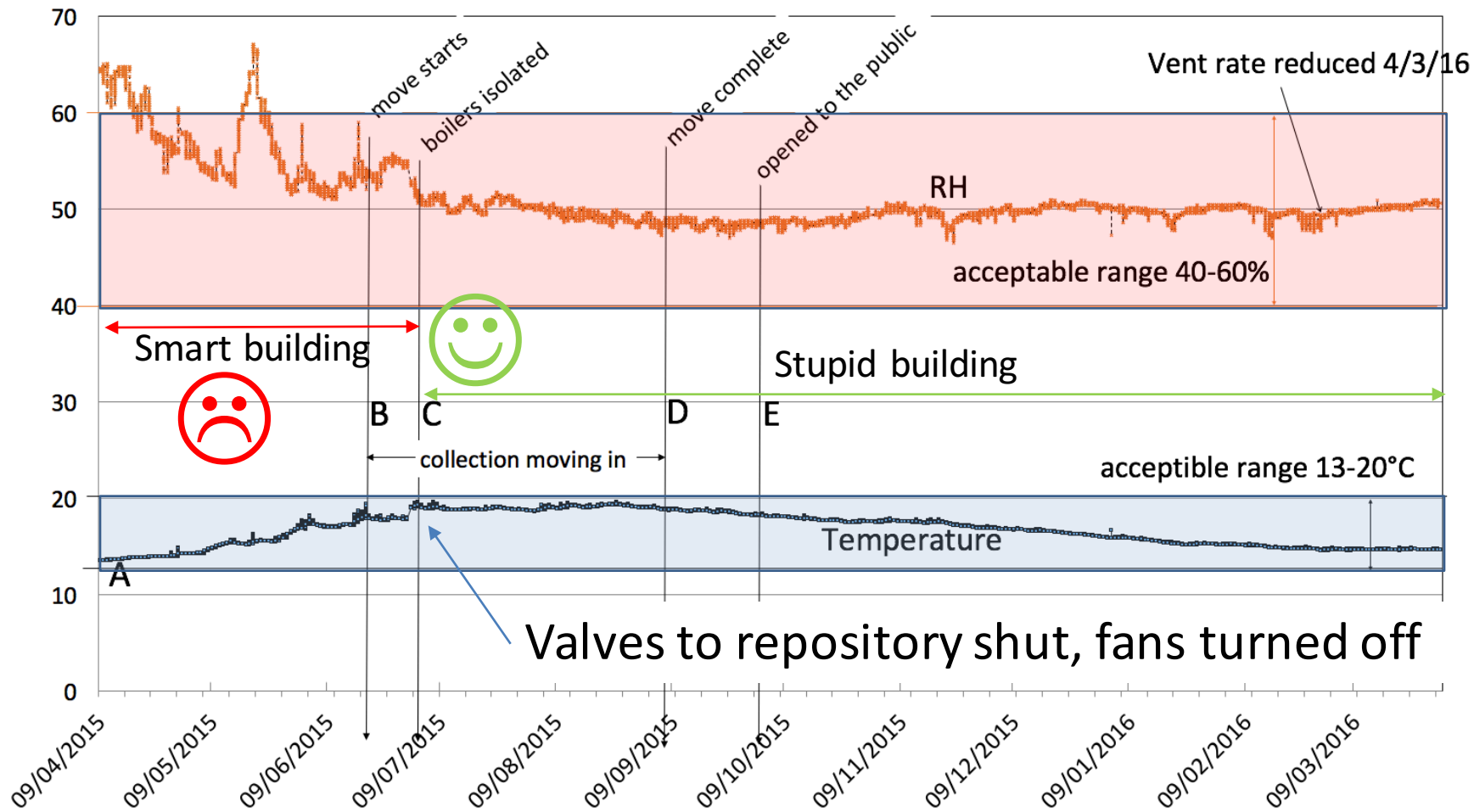
Faulty sensor wiring made the heating come on when already above set-point.

A year to fix but heating isolated so not a problem for now.

How fast/automatic does heating response need to be?



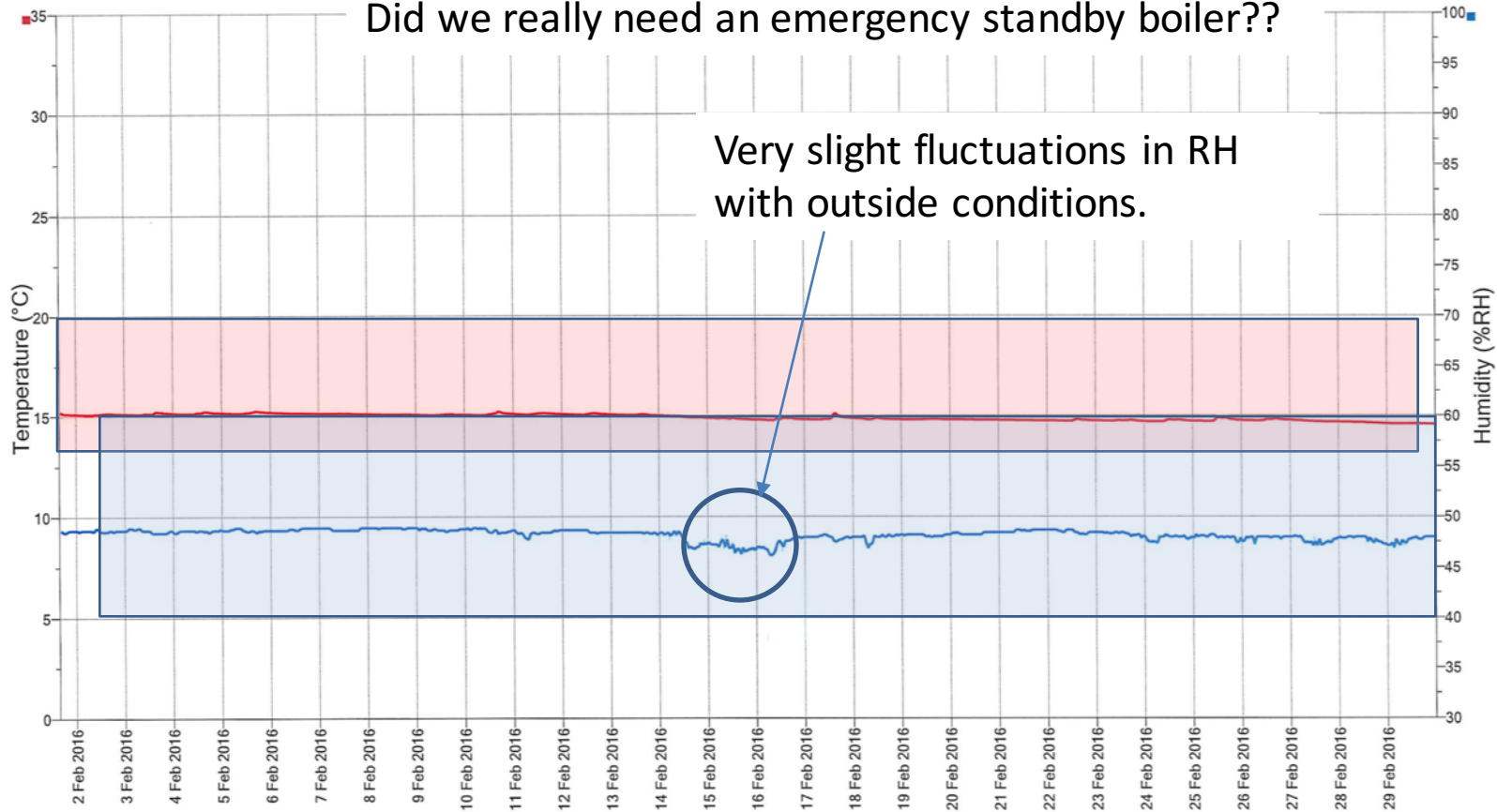
Hereford Archive first floor repository store to April 1st 2016



- 391944 Temperature Middle Floor right
- 391944 Humidity Middle Floor right

February 2016 (no heating since June)

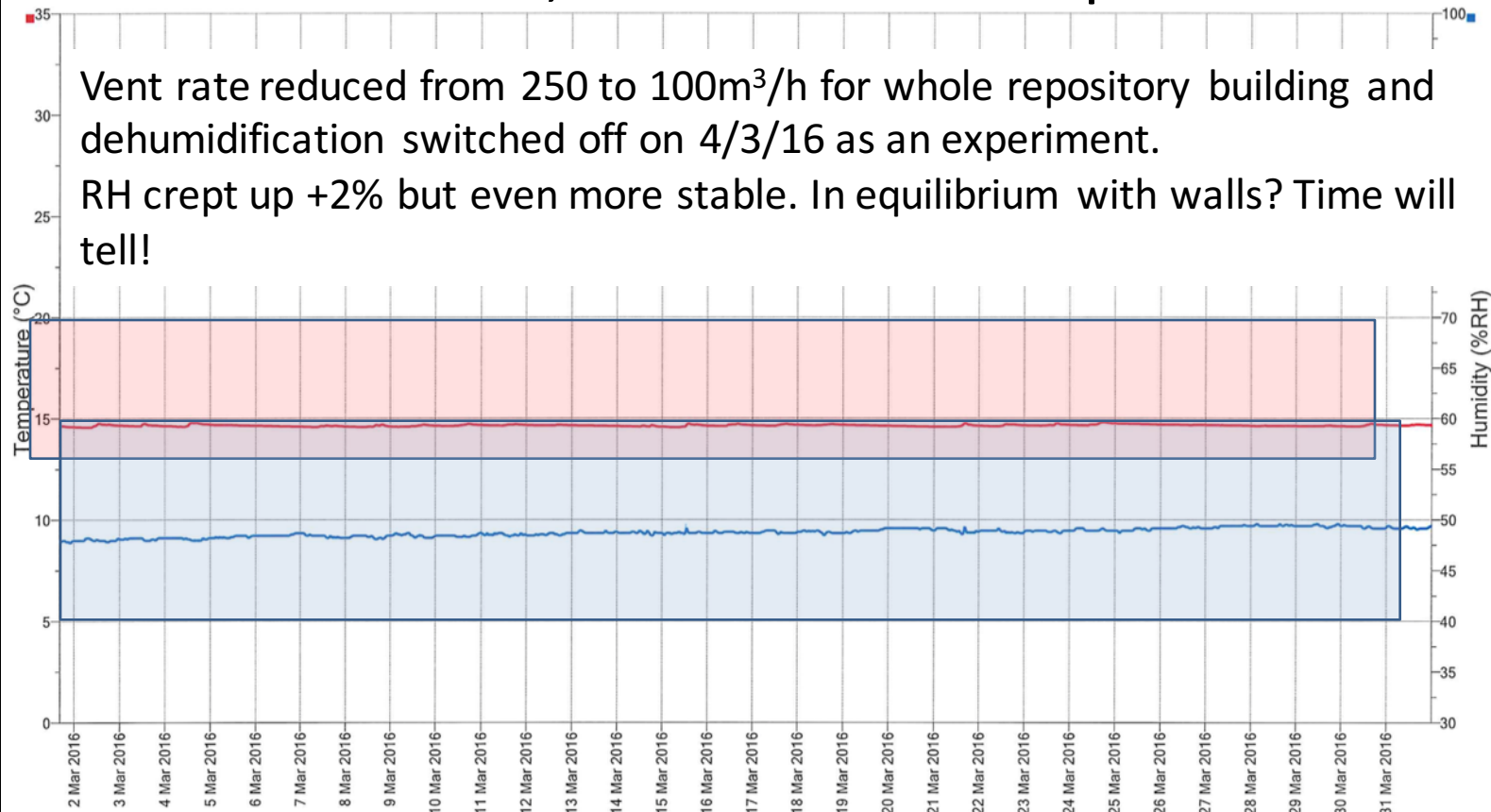
Did we really need an emergency standby boiler???

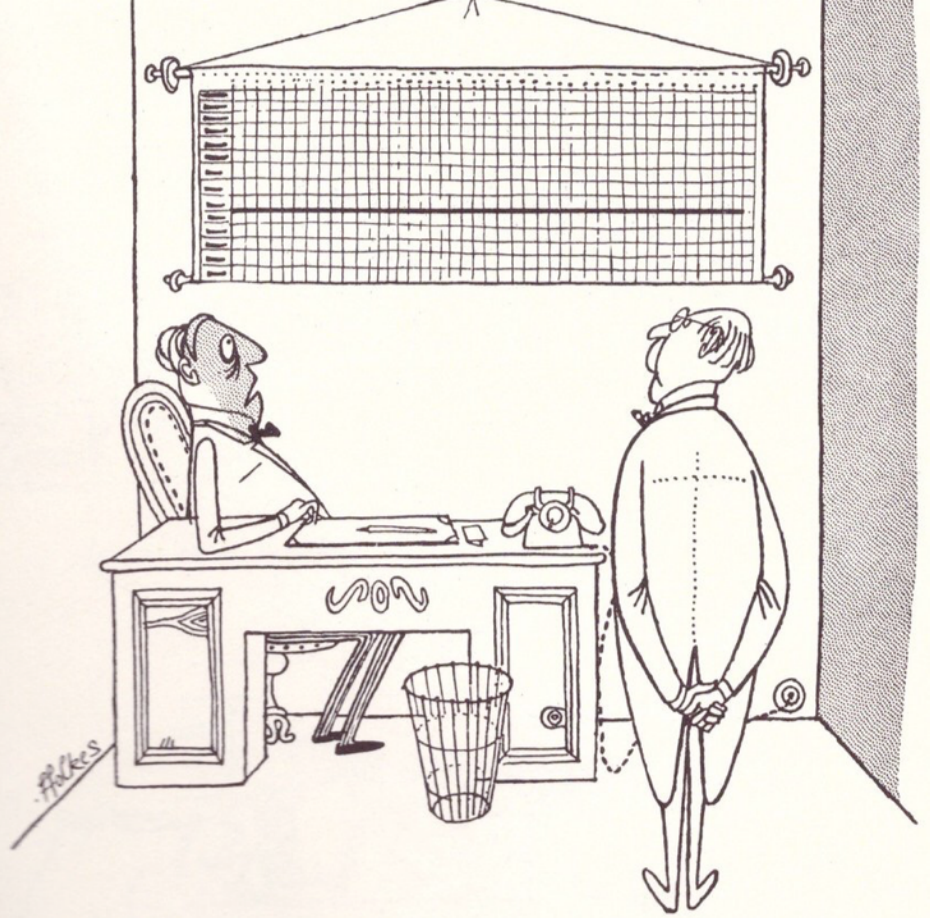


March 2016, vent reduction experiment

Vent rate reduced from 250 to 100m³/h for whole repository building and dehumidification switched off on 4/3/16 as an experiment.

RH crept up +2% but even more stable. In equilibrium with walls? Time will tell!





"Sometimes I think it will drive me mad."



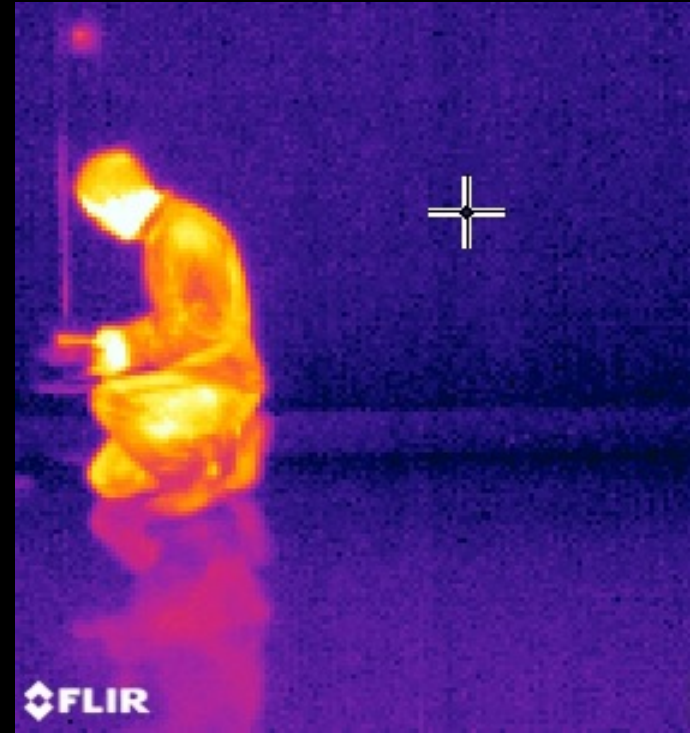
Punch thanks to Lloyd Alter

Very even conditions

Original M&E consultants argued for circulating fans, standard practice to avoid “cold spots”.

Would have required cooling for the fan gains.

Ground floor	17.00° C	50% RH
First floor	17.86° C	46% RH
Top floor	17.87° C	49% RH



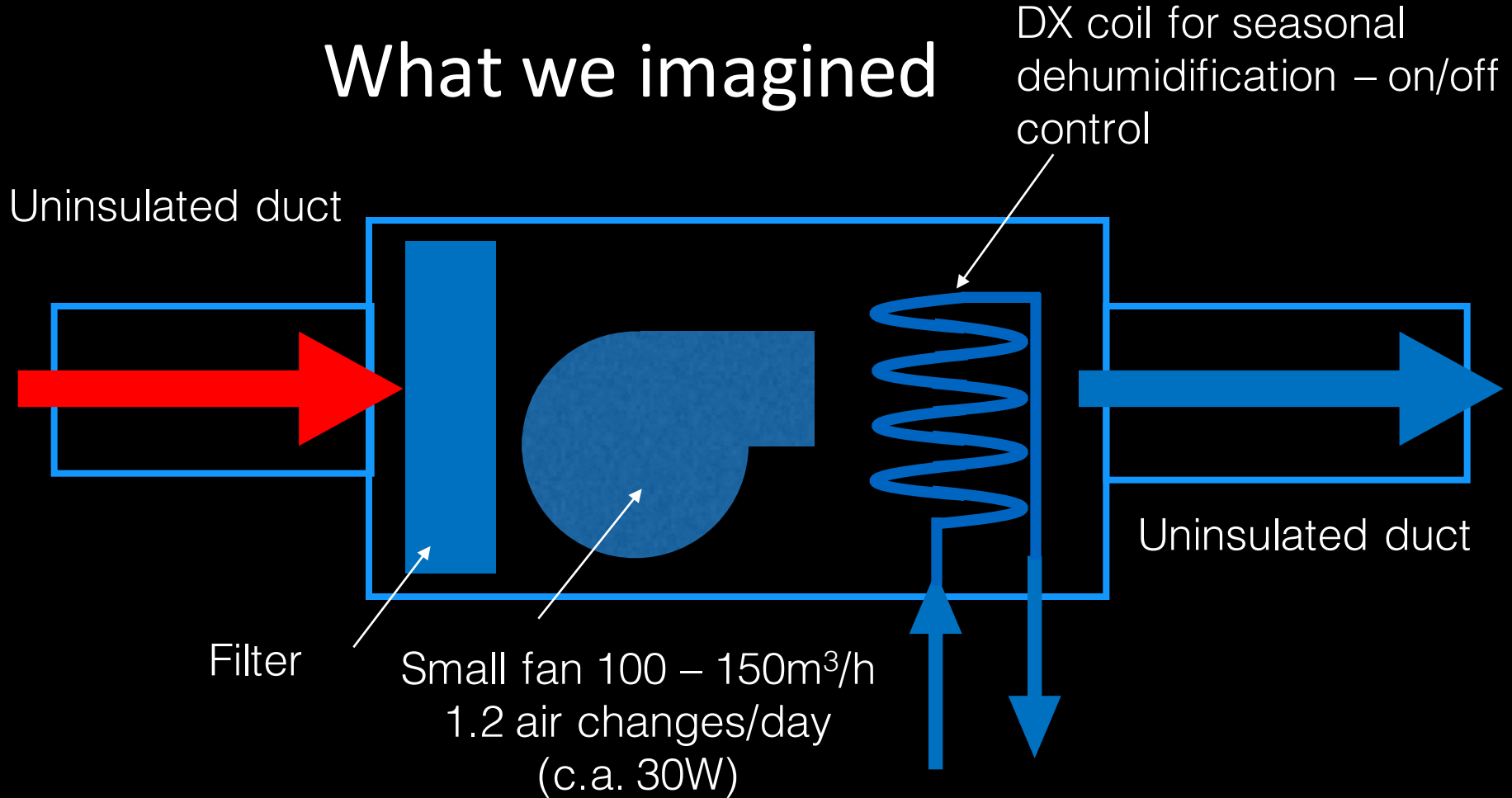
Supply air Dehumidification

(if needed)

- Ventilation is the main source of H₂O
- So make building as tight as possible
- Supply c.a. 1 air-change per day
- Trim supply air when outside air humidity is 'high'
- Don't try and control on room RH.



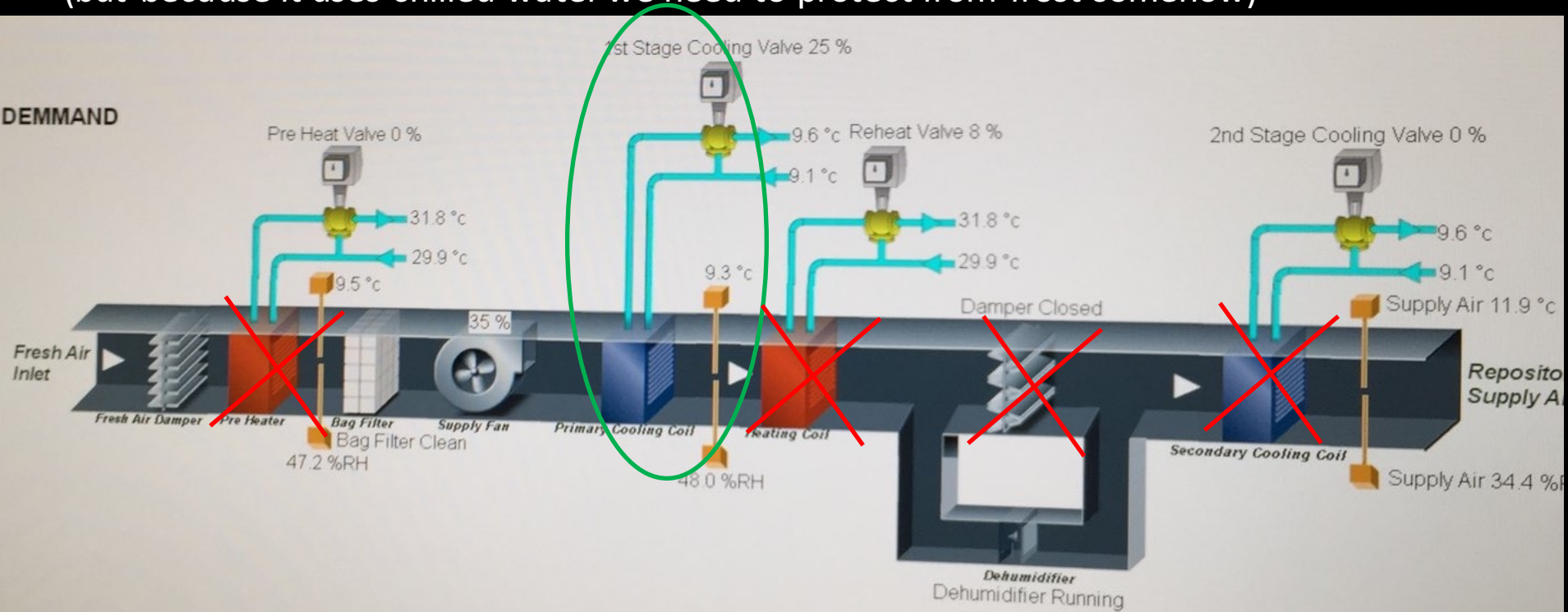
What we imagined



What we got

Now we know it works we can just use the cooling coil.

(but because it uses chilled water we need to protect from frost somehow)



Energy use – inc' labs & offices

TFA:

Records Centre	1321m ²
<u>Repository</u>	<u>1130m²</u>
<u>Total</u>	<u>2451m²</u>

June 2014 – March 2016 - whole building

Gas	11kWh/(m².a)	c.a. £1,000/a
Electricity	34kWh/(m².a)	c.a. £11,000/a
PE	≈ 100 kWh/(m².a)	

Hopefully electricity use will decrease as building dries out and lighting and other controls are sorted??

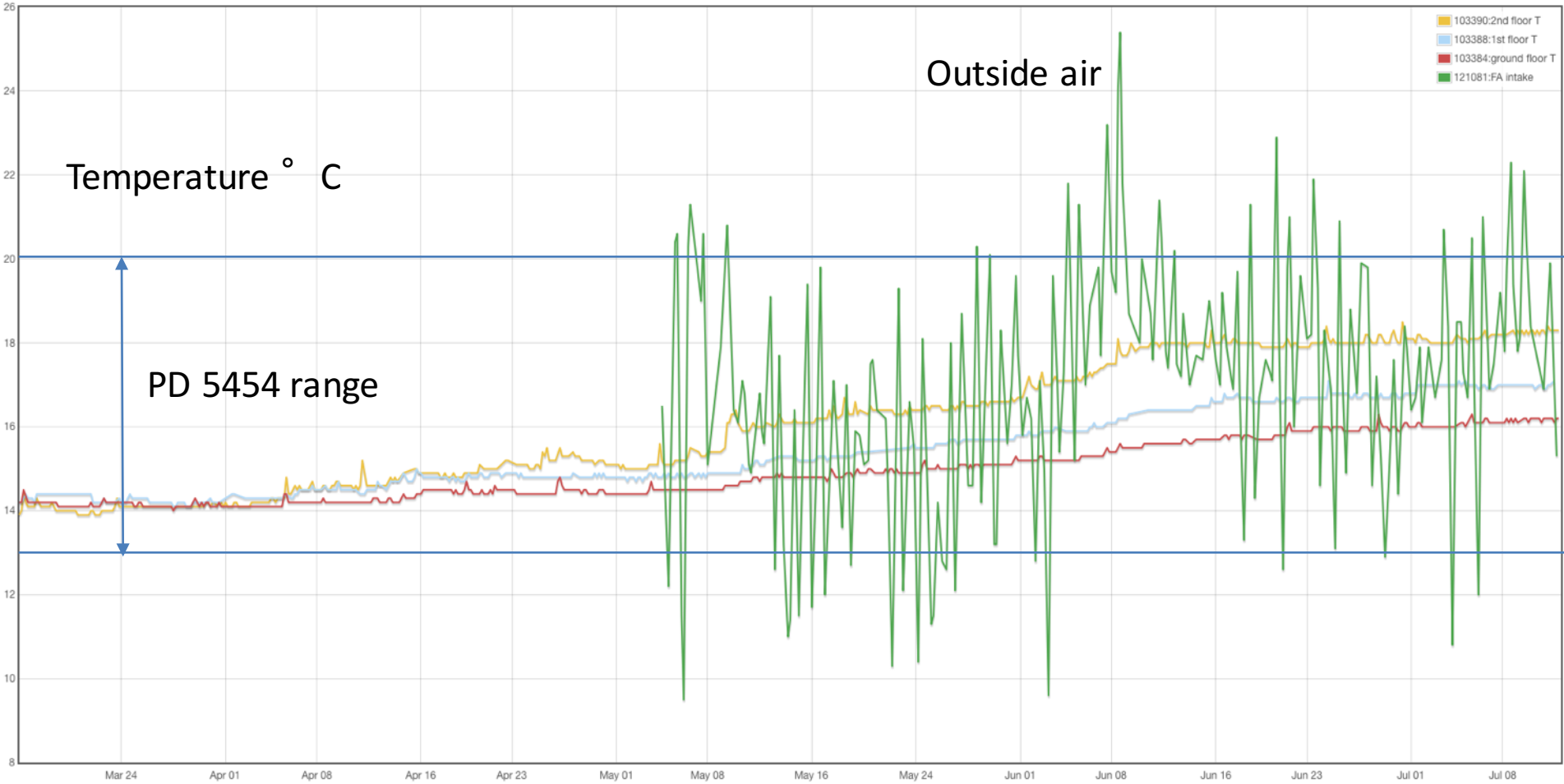
Lessons

Reducing ventilation, heat, cooling and dehumidification load to a very low level allows radically simplified control strategies – a gentle nudge.

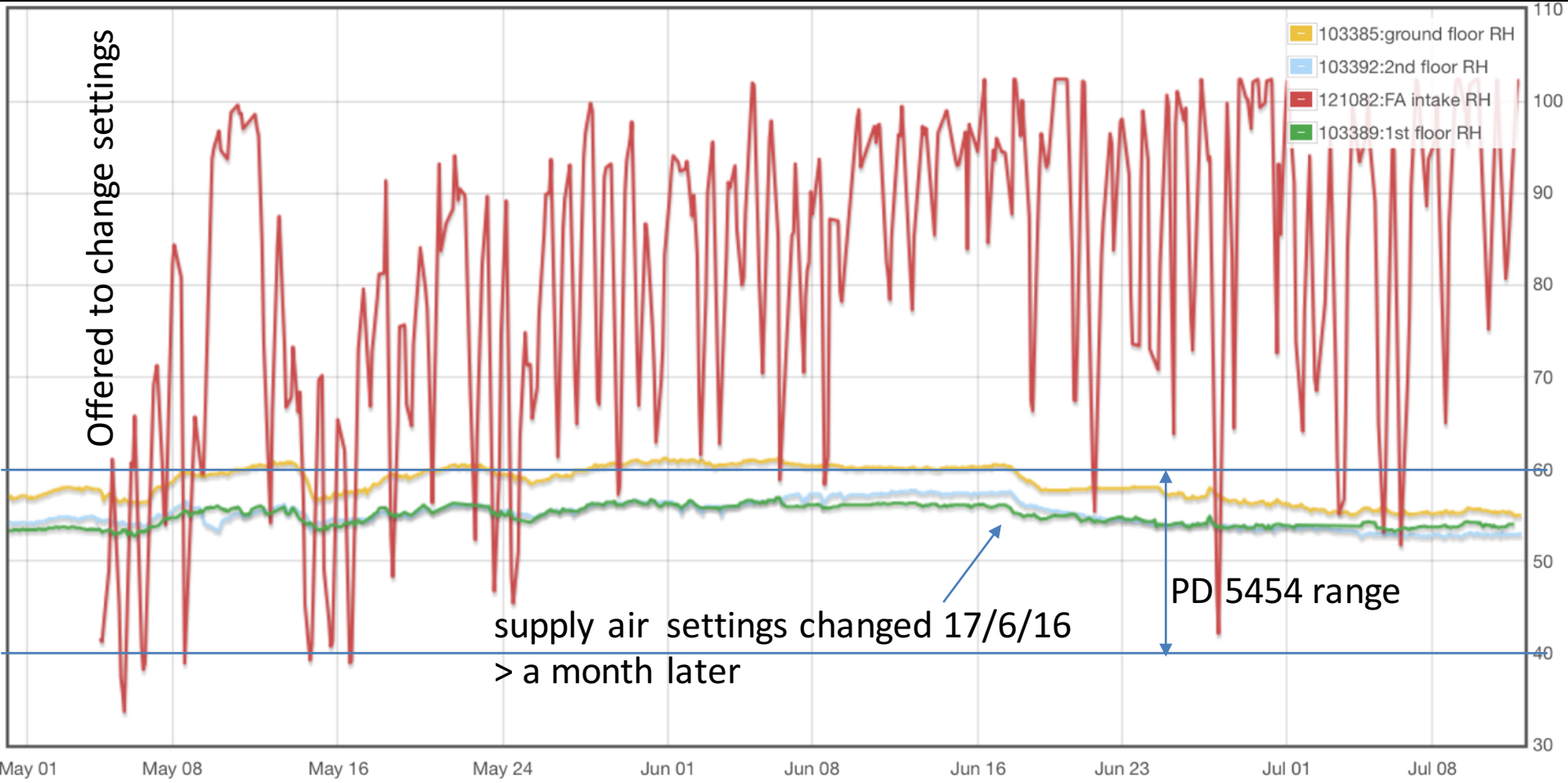
Supply air dehumidification @ about 2 air changes/day successfully stabilised RH before the building was fully dry.

Simple is really hard to get built!

Open Energy Monitor remote access by Alan Clarke



Open Energy Monitor remote access by Alan Clarke



Next time

- No BMS – save money and improve reliability
- Simpler dehumidification of air supply
- No frost coil (uninsulated ducts, turn fan off in extreme)
- Apply lessons learnt to the cooled photo-store
- Simpler heating – electric panel heaters?



Questions?

