Experiments with reducing energy use at the National Archives & Records Administration

Mark Ormsby

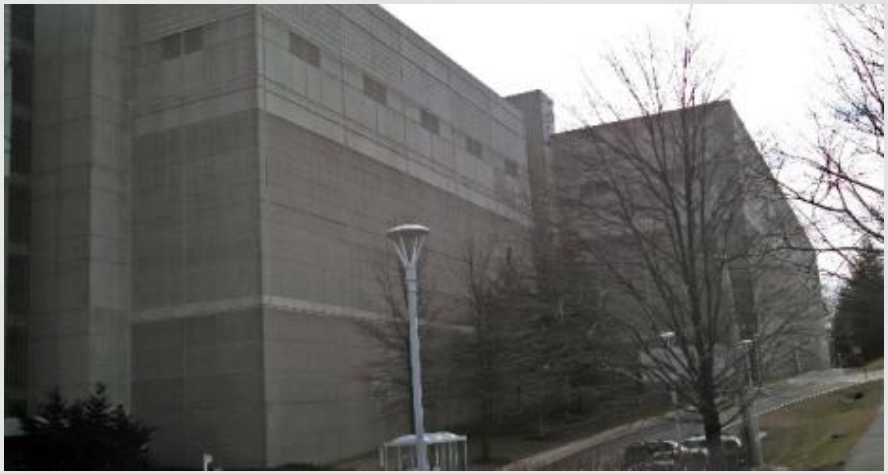
The National Archives and Records Administration (NARA) preserves, protects, and makes accessible those records deemed to have permanent, historical value

10+ billion pages of paper-based records
Photographs, audio-visual, cartographic, electronic …

Total holdings ~ 4.4 million cubic feet (125,000 cubic meters)

Archives 2 – College Park, Maryland

Constructed 1993



2,400,000 cubic feet
archival storage space

(68,000 cubic meters)

Archives 2

Constructed 1993

Yearly **electricity** cost ~1996

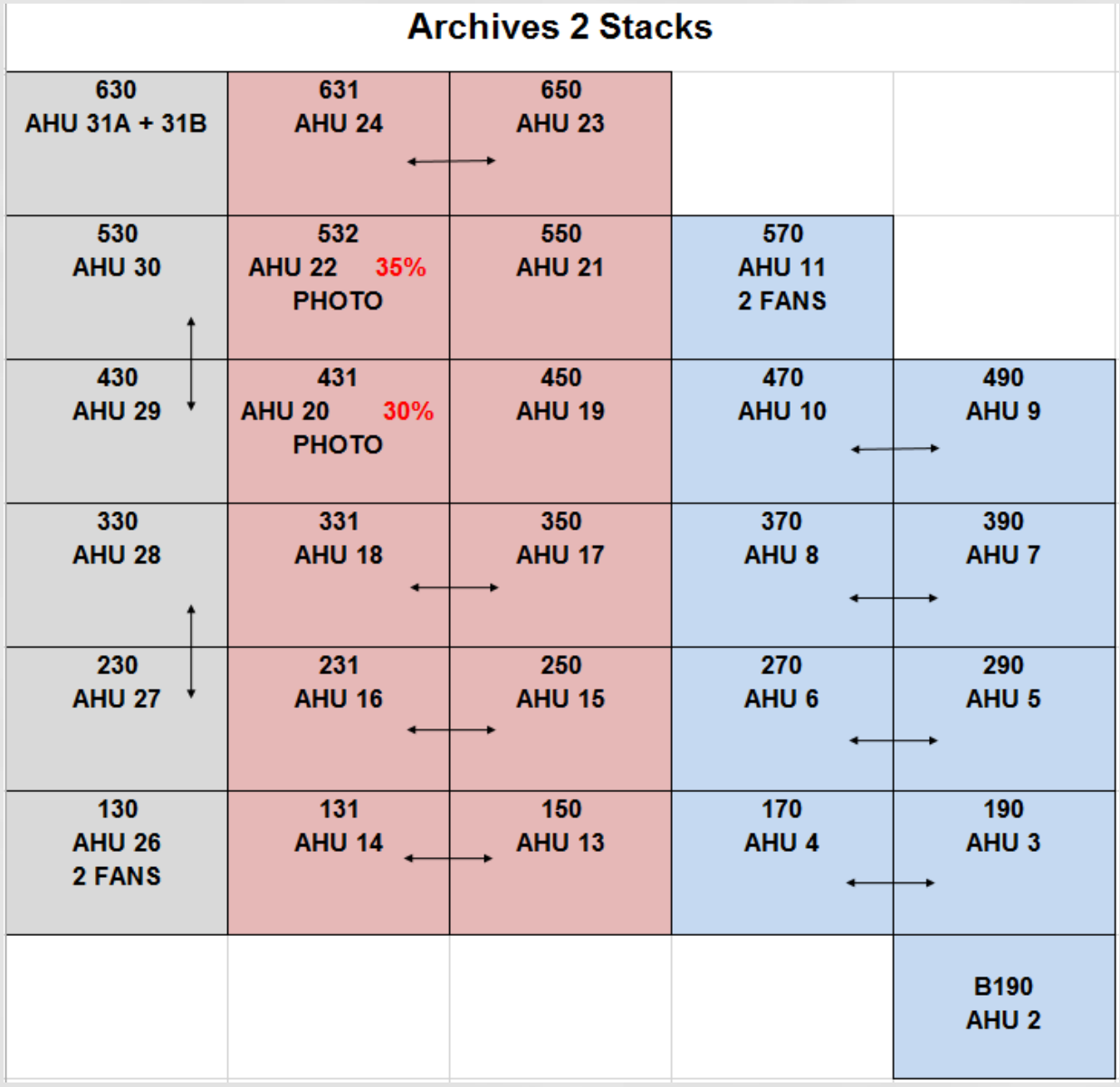
Estimated: $2 million (£ 1.4 million, € 1.8 million)

Actual: $3.1 million (£ 2.2 million, € 2.8 million)

Lighting ~ 50% of electricity use

Most of the rest consumed by air handler units (AHUs)

Stack Air Handler Unit (AHU)


Archives 2 Stacks
630
AHU 31A + 31B
631
AHU 24
650
AHU 23
530
AHU 30
532
AHU 22 35%
PHOTO
550
AHU 21
570
AHU 11
2 FANS
430
AHU 29
431
AHU 20 30%
PHOTO
450
AHU 19
470
AHU 10
490
AHU 9
330
AHU 28
331
AHU 18
350
AHU 17
370
AHU 8
390
AHU 7
230
AHU 27
231
AHU 16
250
AHU 15
270
AHU 6
290
AHU 5
130
AHU 26
2 FANS
131
AHU 14
150
AHU 13
170
AHU 4
190
AHU 3
B190
AHU 2

Summer 1995 – Redundant AHU Pairs

Use one AHU to supply two stacks
Shut down the other unit during the day

Tests of 4 stacks showed that
temperature and RH remained within specification

Expanded to shut down 12 of 28 stack AHUs during peak demand periods

December 1996

Reduced stack air exchange rate
from 6 per hour to ~ 4.8 per hour
by mechanical modifications to fans

Air exchange rate initially based
on pollutant specifications

Specifications for Air Pollutants in Storage and Exhibit Areas

SO_2	1.0 ppb	2.7 µg/m3
NO_2	2.6	5.0
Ozone	2.0	4.0
Acetic Acid	4.0	10.0
Formaldehyde	4.0	5.0

Stacks designed with 90% recirculated air
6 air changes per hour

Archives 2 Baseline – FY2003

Fiscal Year	Total Utility Cost (include water)	Electric (MWH)	Natural Gas (Thous. Cu. Ft.)	Energy Usage (KBtu)	Energy Intensity (Kbtu/Gsf)	% Energy Intensity Reduction vs FY2003
FY2003	$3,175,935	47,578	142,883	309,600,000	173	Baseline

£2,200,000
€2,900,000

2006 - Taking further advantage of redundant AHU pairs

Previously one unit off during the day
but all units on at night
to increase air exchange rate

Changed to 3-day cycles
with one unit serving both stacks at all times

2006 - Taking further advantage of redundant AHU pairs

Acetic acid and formaldehyde
measured in 5 stacks
before and 5 months after
3-day shutdown cycles started

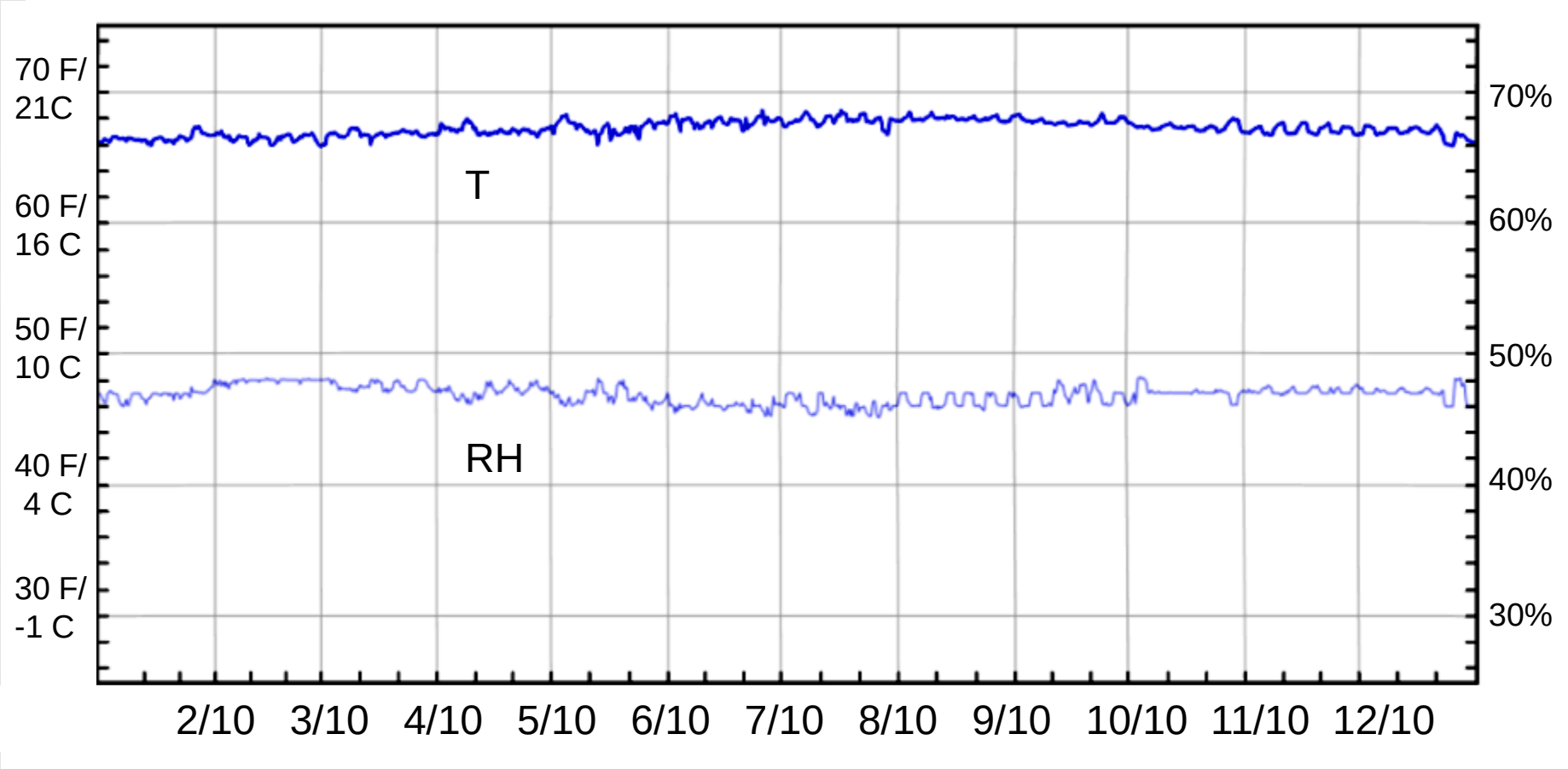
Conclusion: running two stacks on one AHU
caused no significant difference in pollutant levels
or temperature and RH control

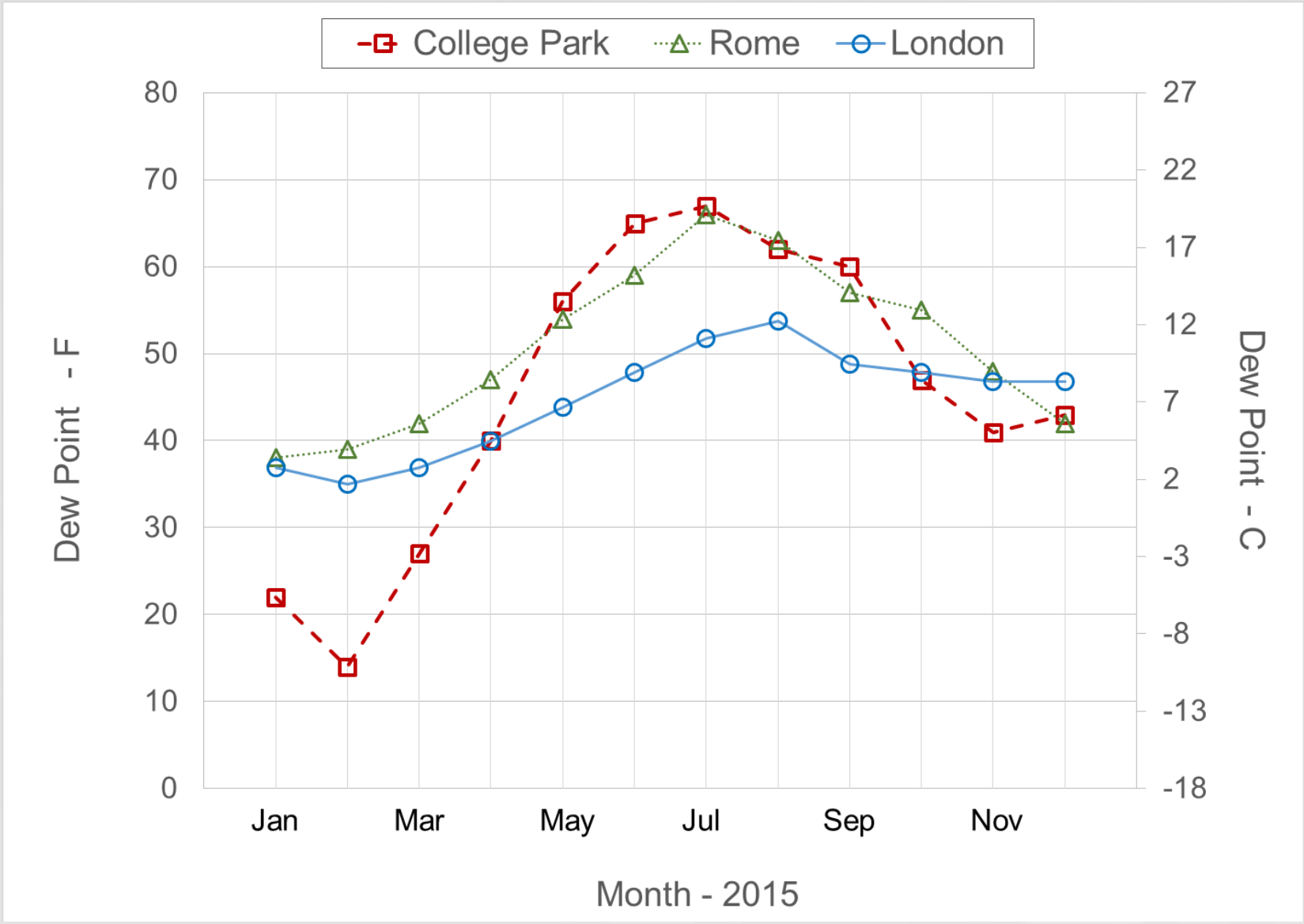
Archives II Energy and Greenhouse Gas (GHG) Consumption and Savings

Fiscal Year	Total Utility Cost (include water)	Electric (MWH)	Natural Gas (Thous. Cu. Ft.)	Energy Usage (KBtu)	Energy Intensity (Kbtu/Gsf)	% Energy Intensity Reduction vs FY2003	GHG (Metric Ton CO2)	GHG Savings vs FY2008 (Ton)
FY2003	$3,175,935	47,578	142,883	309,600,000	173	Baseline		
FY2008	$5,400,230	36,401	96,631	223,800,000	125	-28%	25,171	Baseline

£3,900,000
€4,900,000

Stack 190

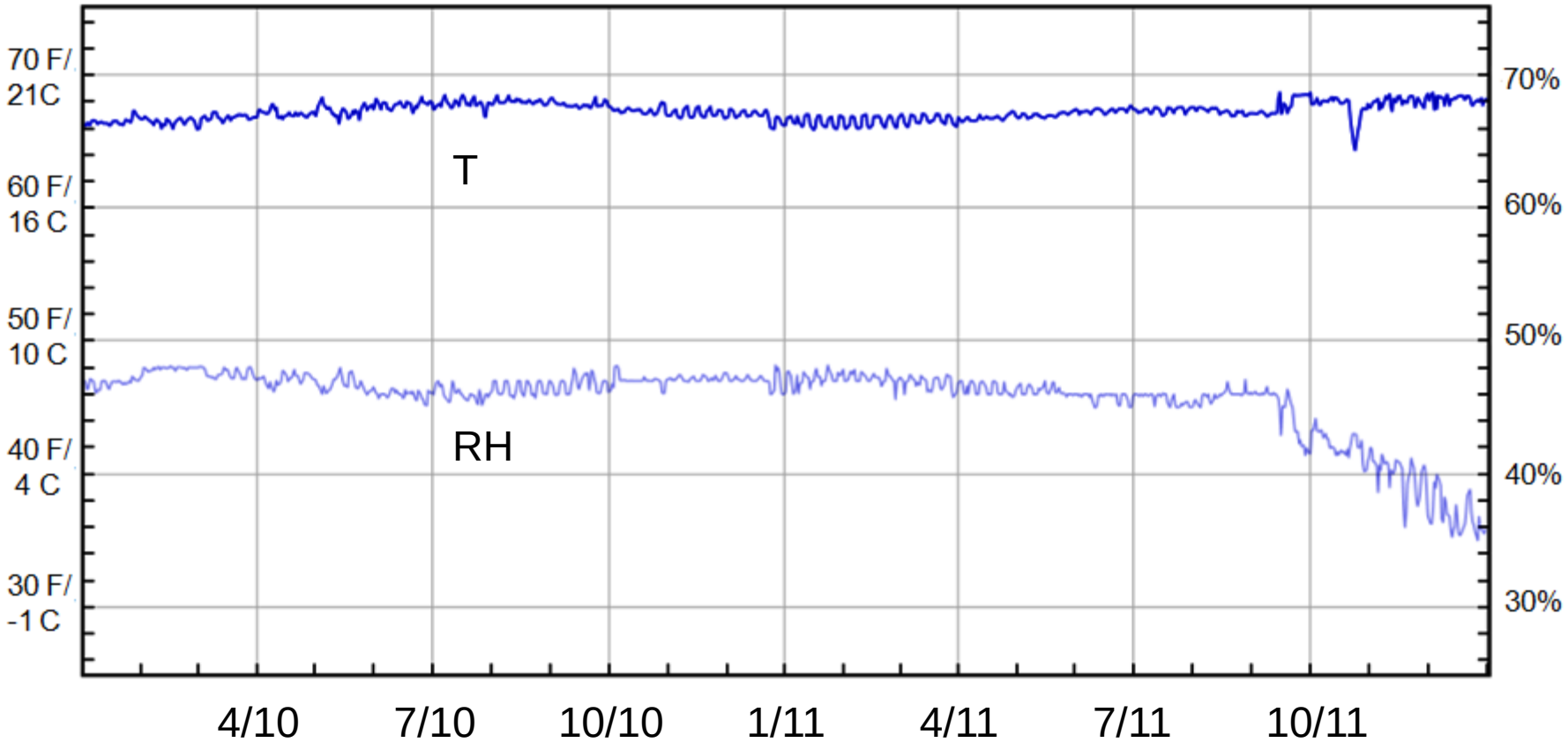

70 F/
21C
60 F/
16 C
50 F/
10 C
40 F/
4 C
30 F/
-1 C
70%
60%
50%
40%
30%
T
RH
2/10
3/10
4/10
5/10
6/10
7/10
8/10
9/10
10/10
11/10
12/10

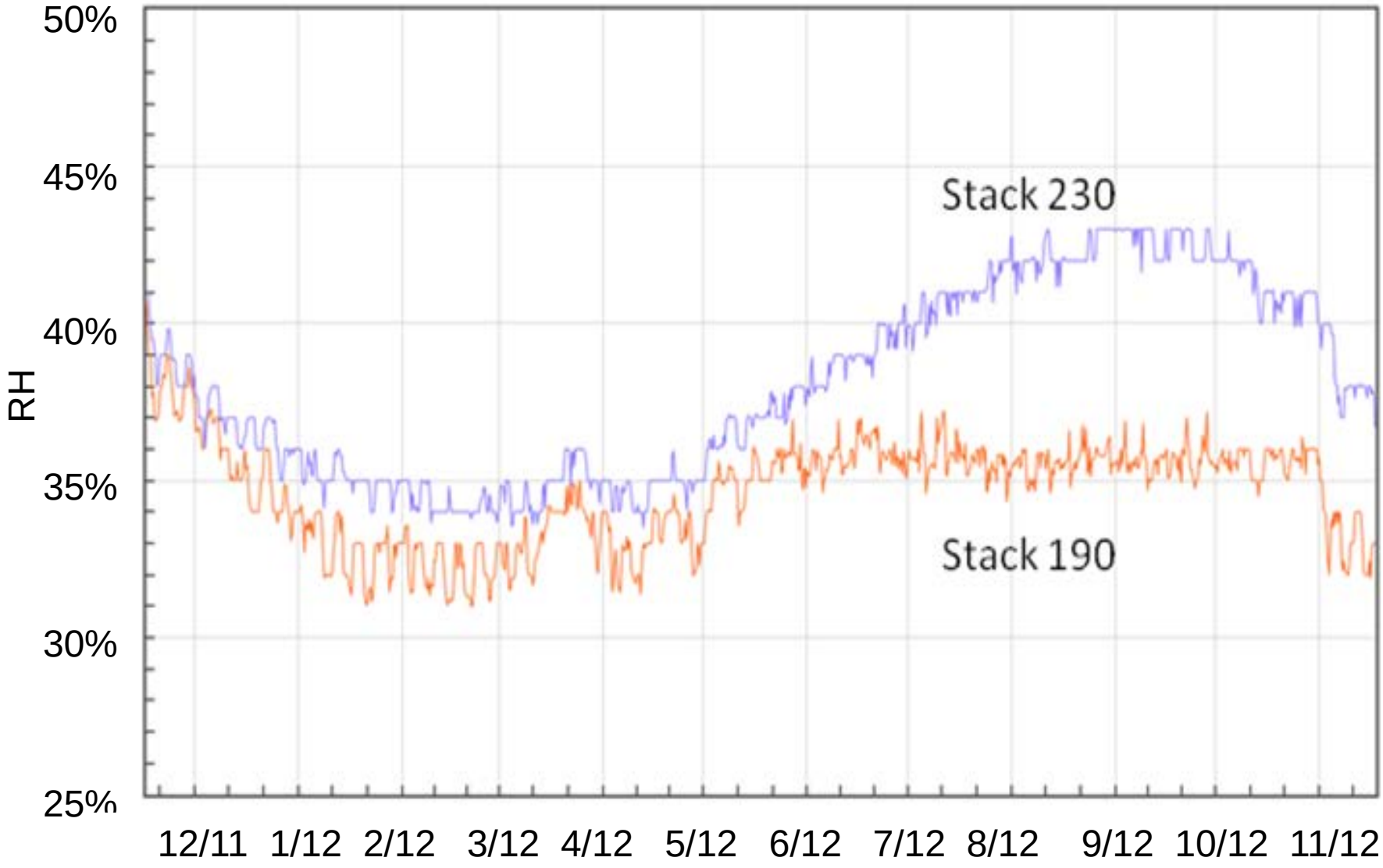

College Park
Rome
London
Dew Point - F
Dew Point - C
80
70
60
50
40
30
20
10
0
27
22
17
12
7
2
-3
-8
-13
-18
Jan
Mar
May
Jul
Sep
Nov
Month - 2015

Sept. 2011 – RH setpoints for stacks with paper-based records

Adjusted from 45 +/- 5 % to 30 – 50%
with no daily maximum change

Stack 190

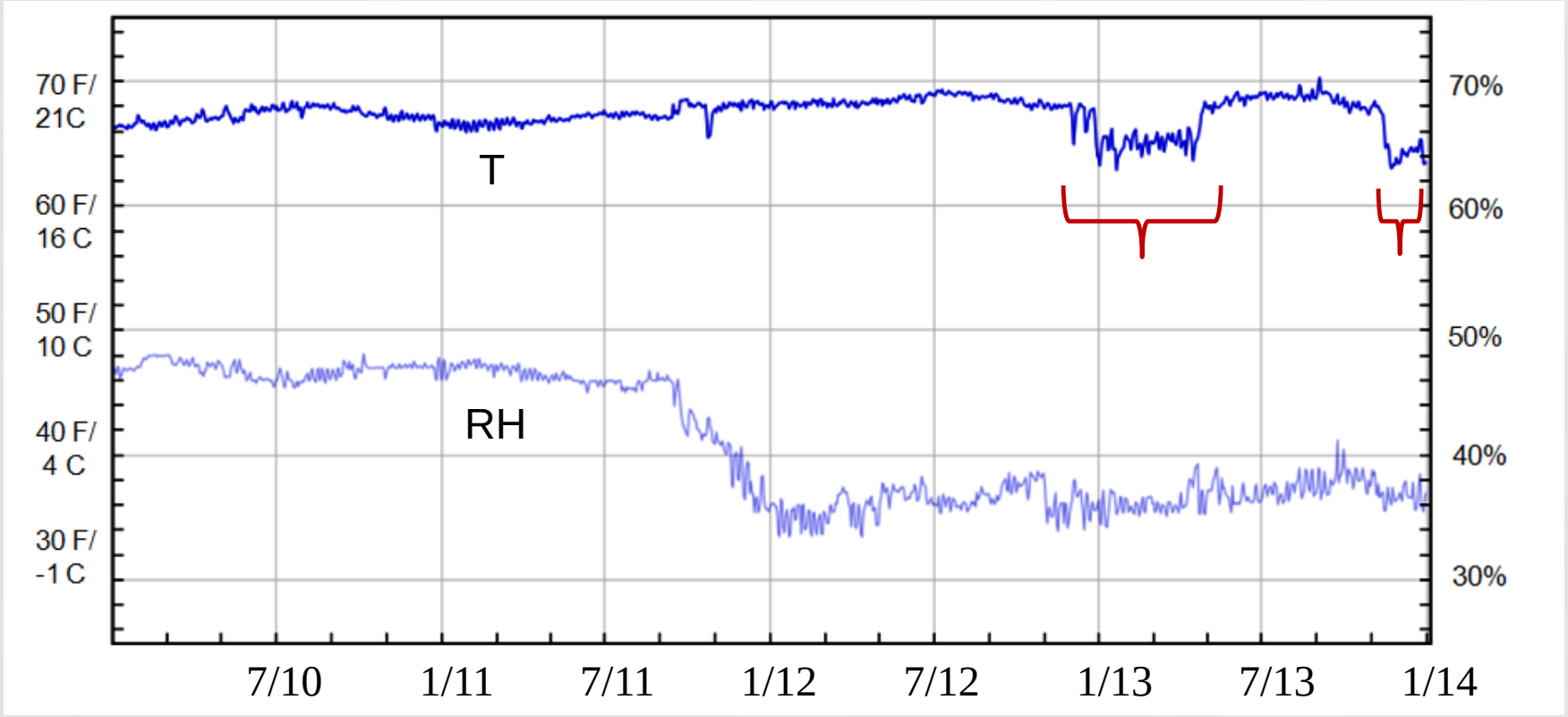

70 F/
21C
60 F/
16 C
50 F/
10 C
40 F/
4 C
30 F/
-1 C
70%
60%
50%
40%
30%
T
RH
4/10
7/10
10/10
1/11
4/11
7/11
10/11


50%
45%
40%
35%
30%
25%
RH
Stack 230
Stack 190
12/11
1/12
2/12
3/12
4/12
5/12
6/12
7/12
8/12
9/12
10/12
11/12

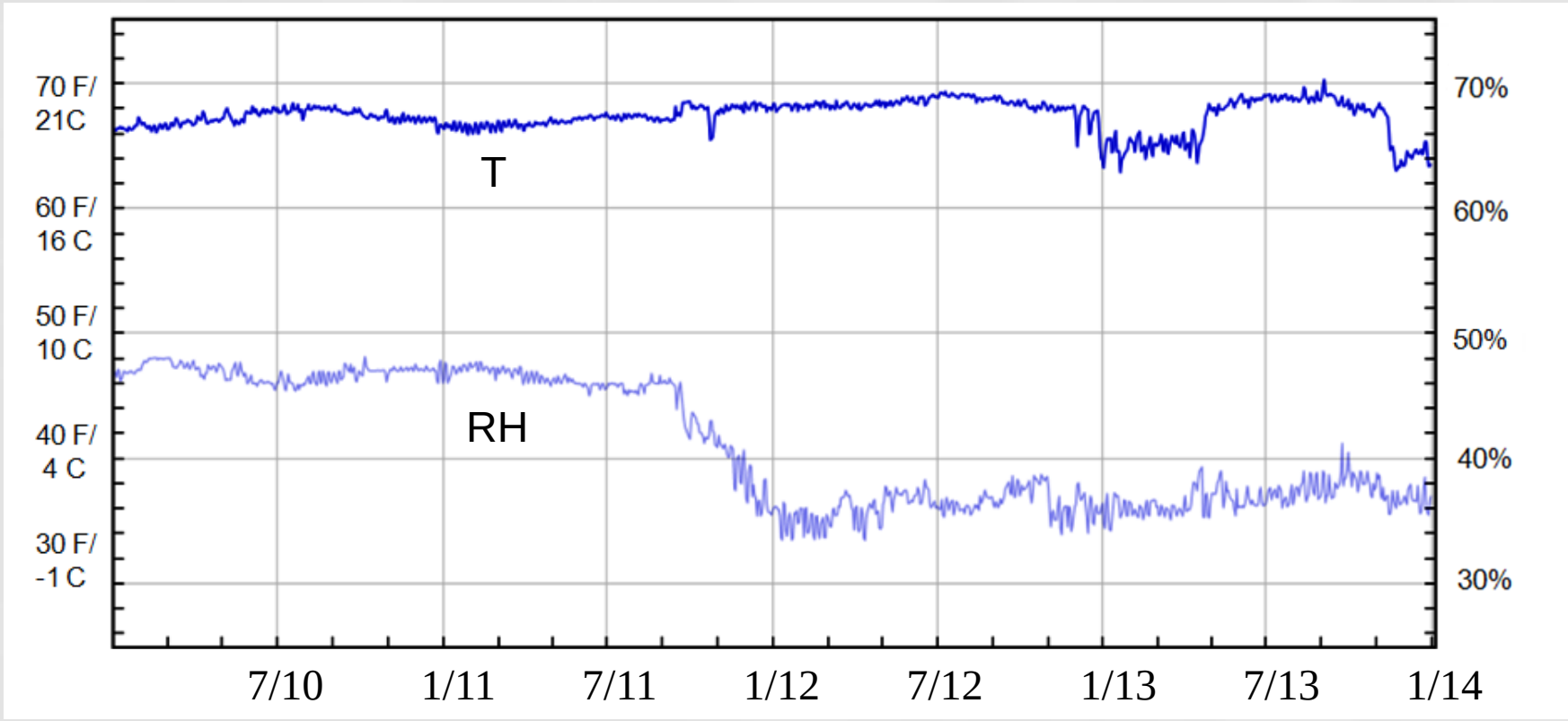
Jan – Feb 2011 : Tests with winter mode

Temperature: 68 +/- 2 F (20 C) lowered to 65 F (18 C)
Energy and chilled water use monitored

Dec 2012 - Implemented in stacks with paper-based records



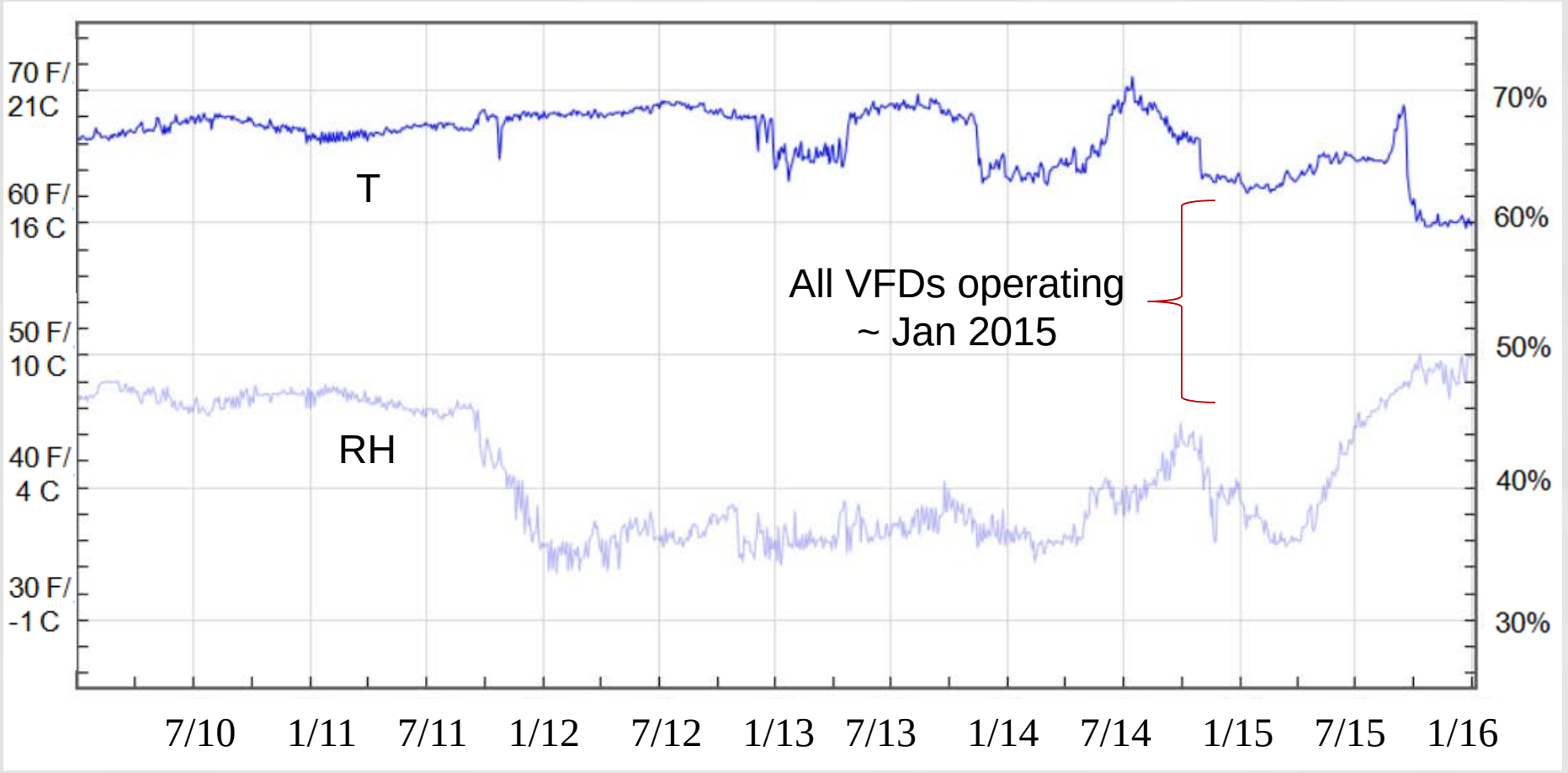
2013 : Nighttime and weekend shutdown of AHUs



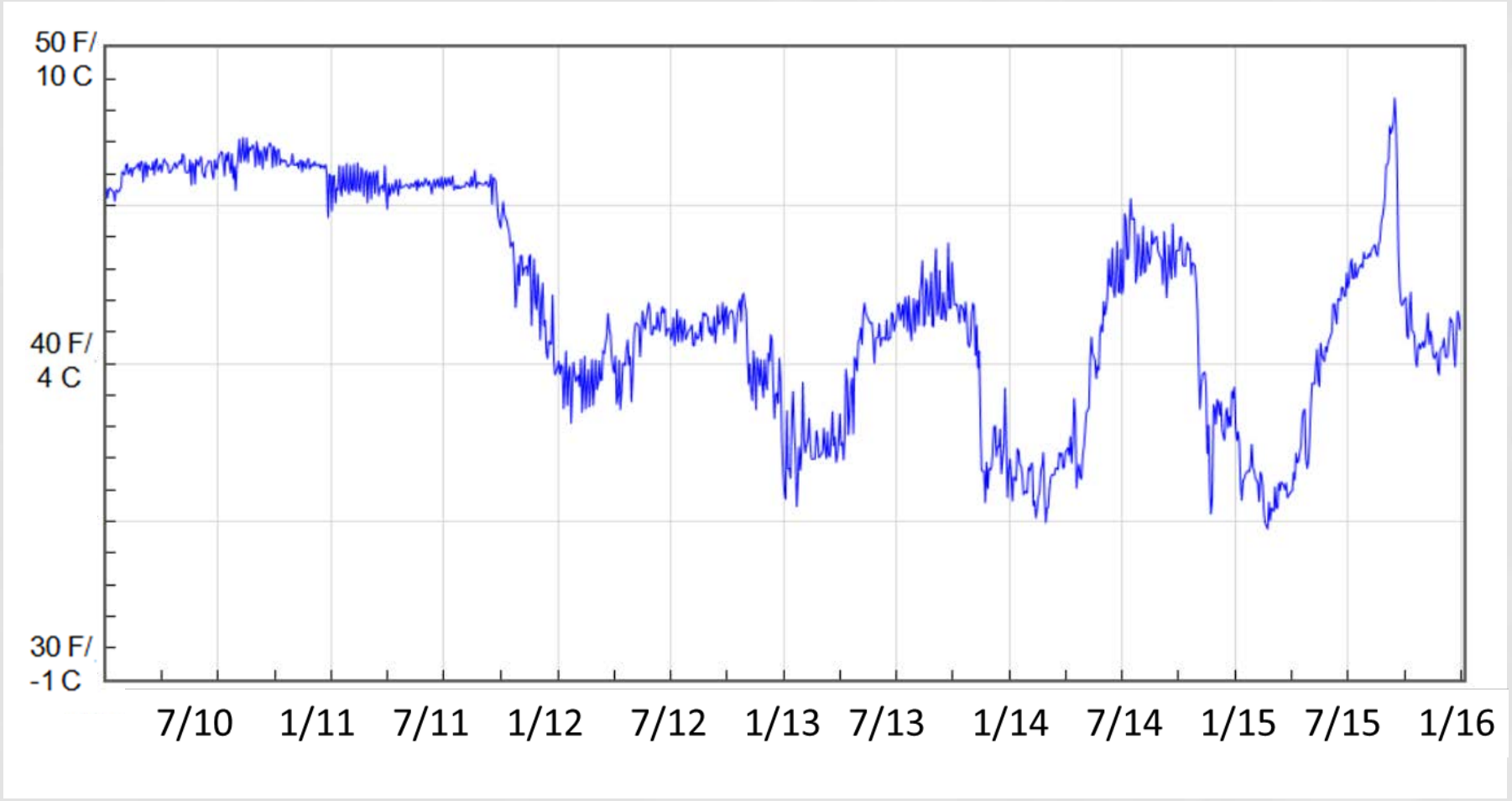
2014: Major upgrades to stack HVAC systems as part of energy savings performance contract

Constant volume units replaced with variable frequency drive (VFD) fans

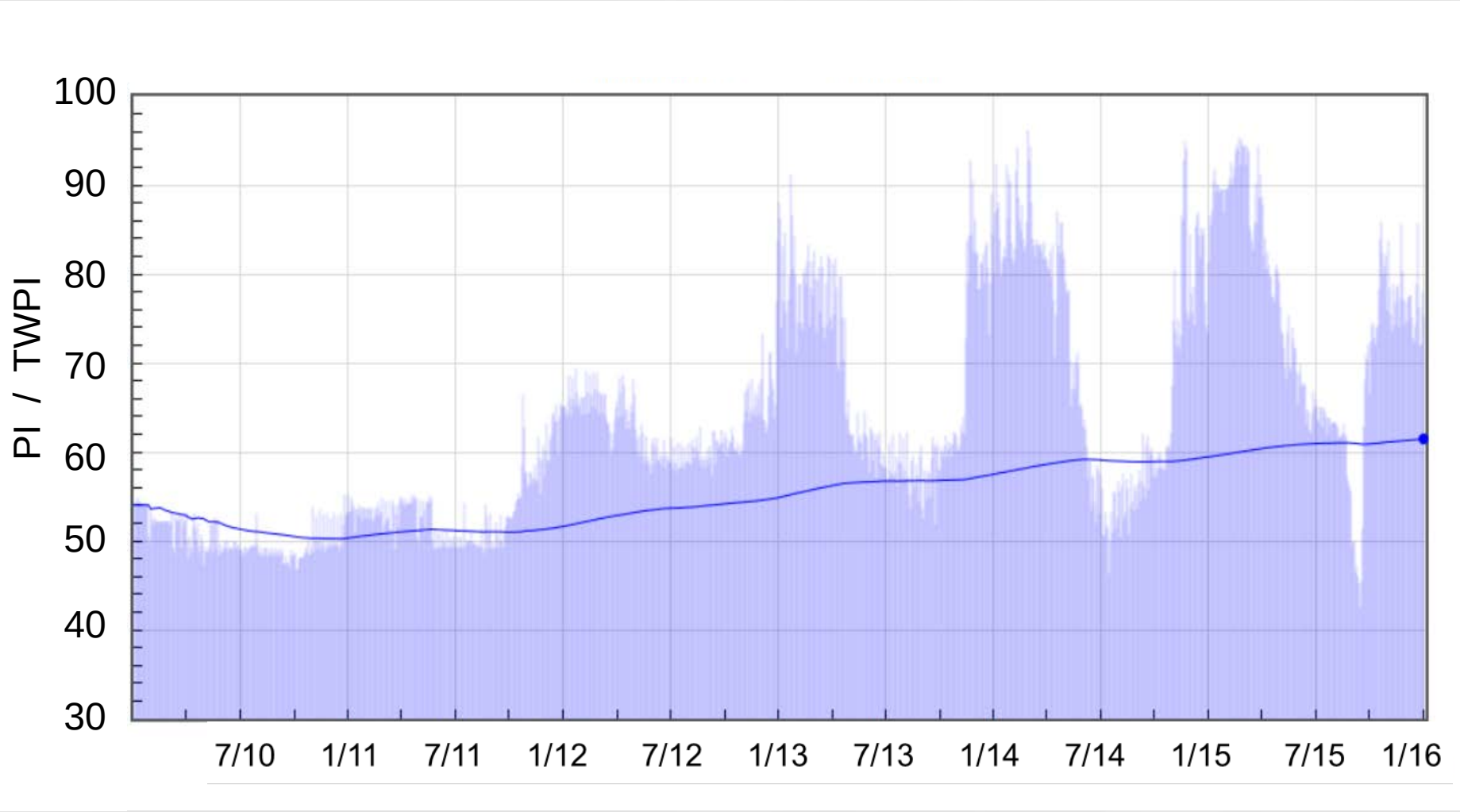
Temperature, RH, and pressure sensors installed in stacks, not return ducts


70 F/
21C
60 F/
16 C
50 F/
10 C
40 F/
4 C
30 F/
-1 C
70%
60%
50%
40%
30%
T
RH
All VFDs operating
~ Jan 2015
7/10
1/11
7/11
1/12
7/12
1/13
7/13
1/14
7/14
1/15
7/15
1/16

Dew Point in Stack 190



Time-Weighted Preservation Index



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FY2008	$5,400,230	36,401	96,631	223,800,000	125	-28%	25,171	Baseline
FY2015	$2,935,264	26,478	73,658	166,300,000	93	-46%	17,520	-30%

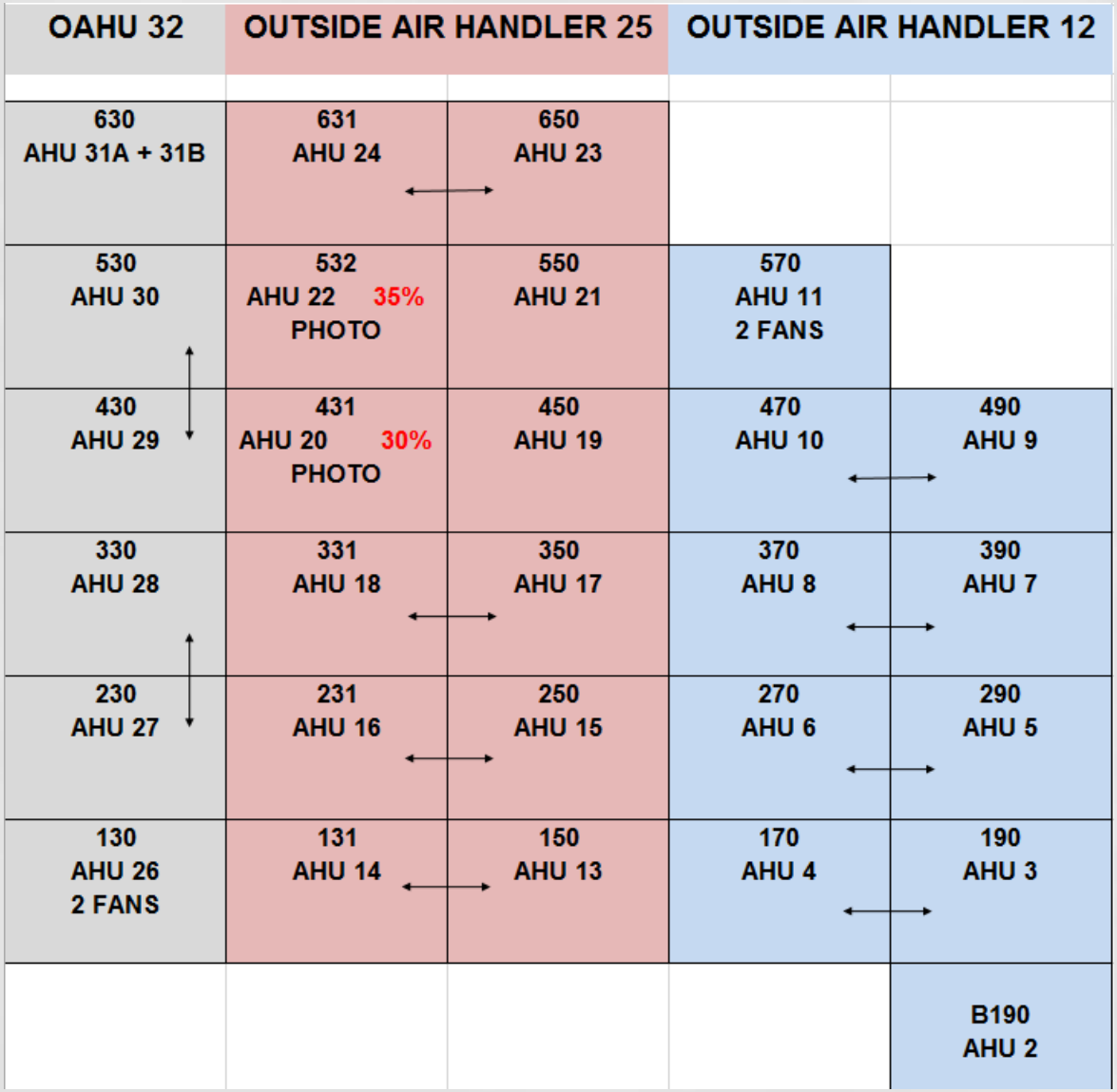
Similar Storage Environment Projects

Federal Records Centers

Presidential Libraries

Specifications for Air Pollutants in Storage and Exhibit Areas

SO_2	1.0 ppb	2.7 µg/m3
NO_2	2.6	5.0
Ozone	2.0	4.0
Acetic Acid	4.0	10.0
Formaldehyde	4.0	5.0


OAHU 32
OUTSIDE AIR HANDLER 25
OUTSIDE AIR HANDLER 12
630
AHU 31A + 31B
631
AHU 24
650
AHU 23
530
AHU 30
532
AHU 22 35%
PHOTO
550
AHU 21
570
AHU 11
2 FANS
430
AHU 29
431
AHU 20 30%
PHOTO
450
AHU 19
470
AHU 10
490
AHU 9
330
AHU 28
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370
AHU 8
390
AHU 7
230
AHU 27
231
AHU 16
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270
AHU 6
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AHU 5
130
AHU 26
2 FANS
131
AHU 14
150
AHU 13
170
AHU 4
190
AHU 3
B190
AHU 2

Measurements 1994 - 2016

Outdoor AHUs effectively filter NO2, SO2 and ozone

NO2 highest

Below specification in stacks

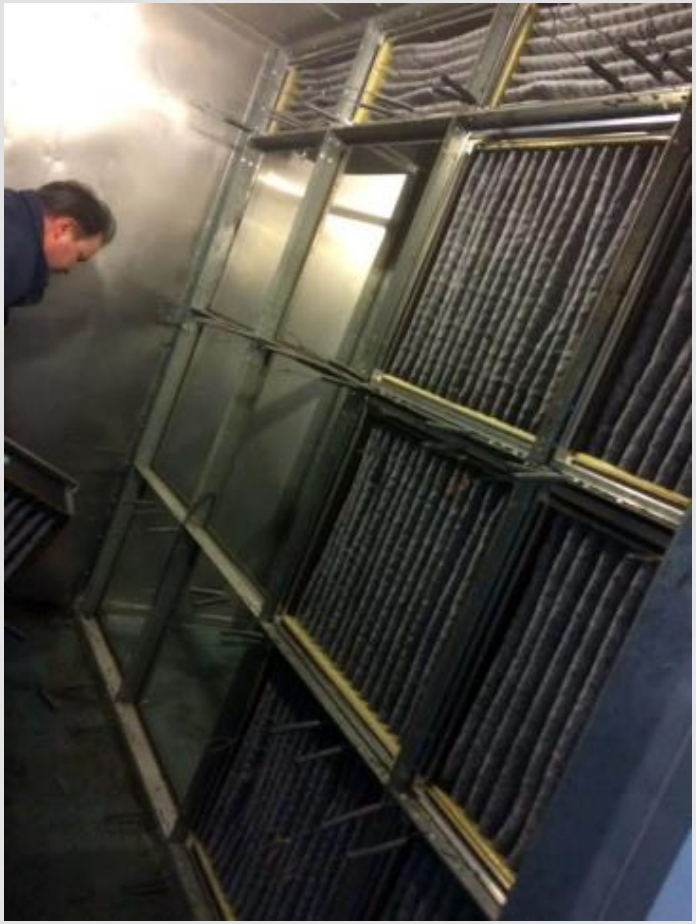
Archives 2 Stacks				
OAHU 32	OUTSIDE AIR HANDLER 25		OUTSIDE AIR HANDLER 12	
630 CLASSIFIED AHU 31A + 31B	631 CLASSIFIED AHU 24	650 AHU 23		
530 AHU 30	532 AHU 22 35%	550 AHU 21	570 AHU 11	
430 AHU 29	431 AHU 20 30%	450 AHU 19	470 AHU 10	490 CLASSIFIED AHU 9
330 AHU 28	331 AHU 18	350 AHU 17	370 AHU 8	390 AHU 7
230 AHU 27	231 AHU 16	250 AHU 15	270 AHU 6	290 AHU 5
130 AHU 26	131 AHU 14	150 AHU 13	170 AHU 4	190 AHU 3
				B190 AHU 2

Specifications for Air Pollutants in Storage and Exhibit Areas

Acetic Acid	4.0 ppb	10.0 µg/m3
Formaldehyde	4.0	5.0

Homepage of IAP
Indoor Air Pollution Working Group

Pilot Project February 2016



NO2 greater risk to paper records than acetic acid

Added benefit of lower RH

Gaseous pollutant filters removed from three stack AHUs

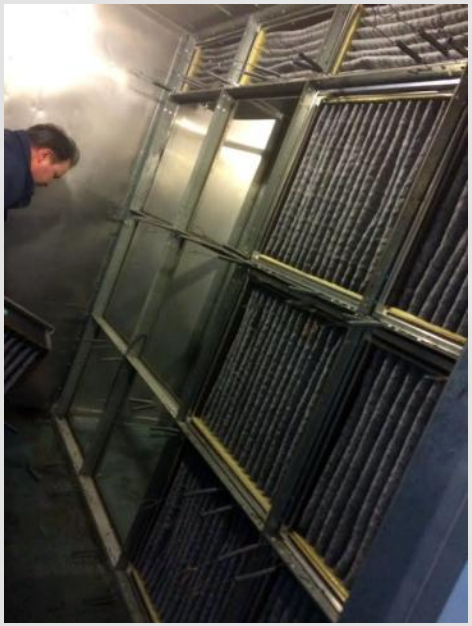
Rely on outside AHUs to filter NO2

Only stacks with paper-based records

Pilot Project February 2016

Potential energy savings:
removing filters reduced static pressure
by 1” water (250 Pascals)

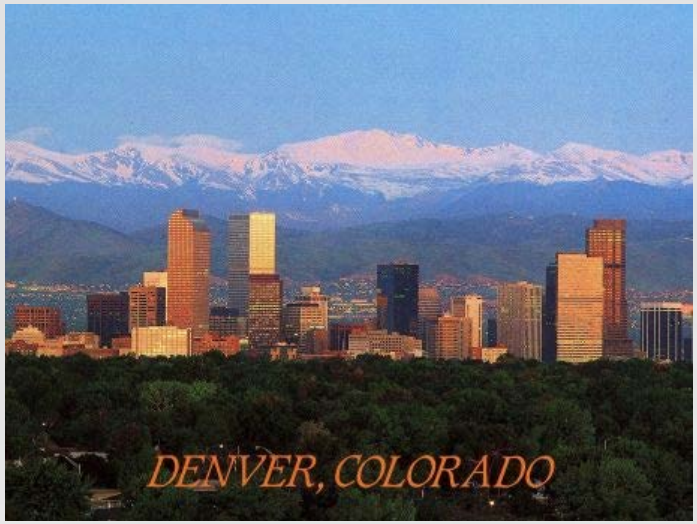
Filter media cost



National Archives Building
Washington, DC

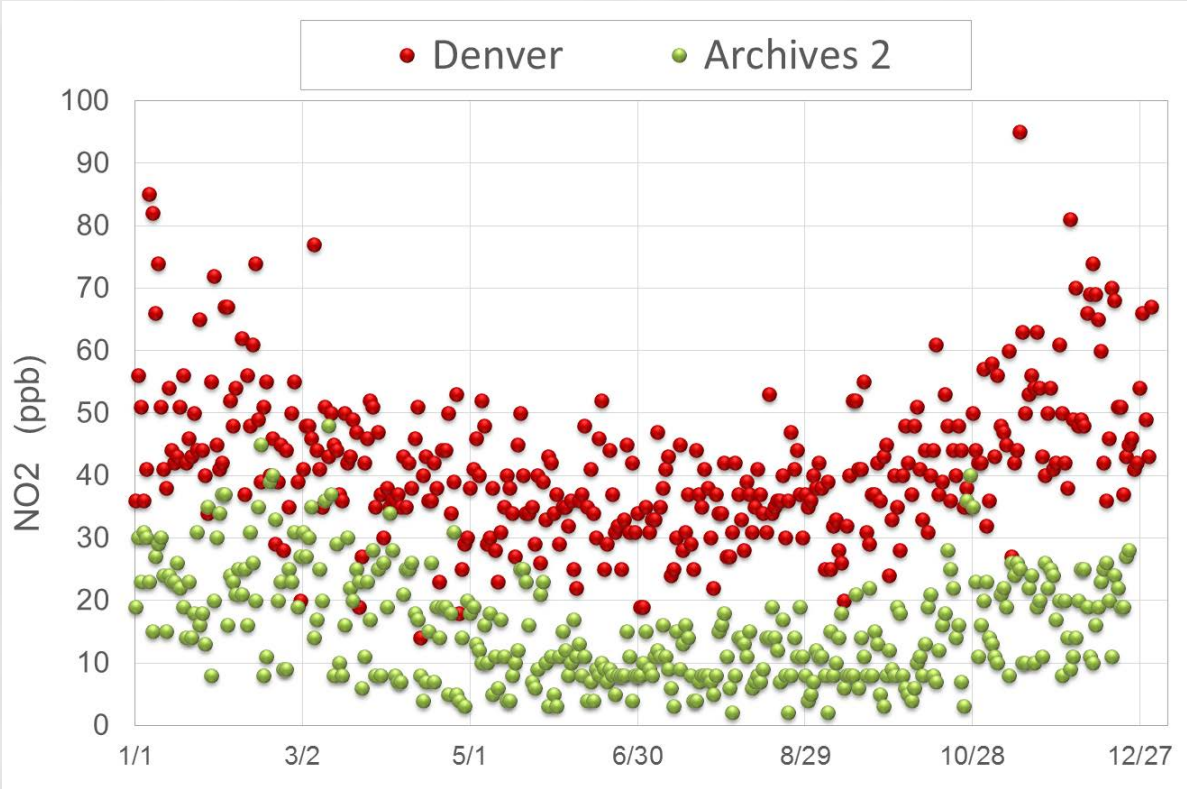
Constructed 1937

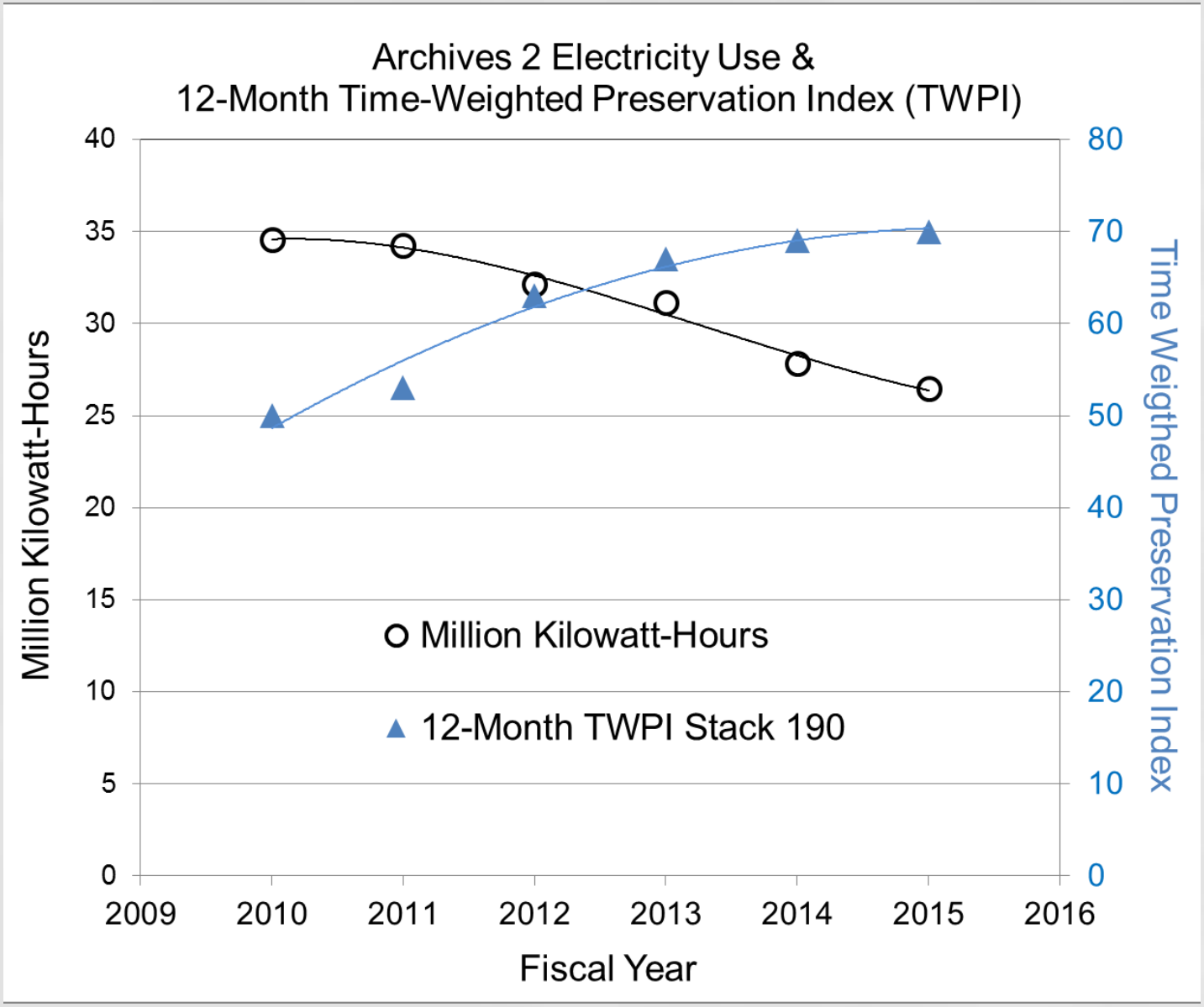
Major renovation and
HVAC upgrade ~2003



Federal Records Center
Denver, Colorado
Constructed 2012

Outdoor NO2 Levels - 2015




Archives 2 Electricity Use &
12-Month Time-Weighted Preservation Index (TWPI)
Million Kilowatt-Hours
Time Weigthed Preservation Index
40
35
30
25
20
15
10
5
0
80
70
60
50
40
30
20
10
0
2009
2010
2011
2012
2013
2014
2015
2016
Fiscal Year
Million Kilowatt-Hours
12-Month TWPI Stack 190

Acknowledgements

Preservation Programs Division, NARA

Facility & Property Management Division, NARA

LB&B Associates

Indoor Air Pollution Working Group