



Chickering School classroom AC

Why are we here?

Culmination of over nine
years of work

Agenda

- Background & history
- Research on heat & humidity in classrooms
- Data gathering & results for heat & humidity
- What work has been done up to now
- AC options considered
- Solution selected
- Thanks to the team



Chickering – a History of the Building

- The school was built in 2001
- No classroom mechanical cooling/AC was installed - despite the building structure being initially designed for AC!
- Rooftop AC exists in the computer lab room, music classrooms, the library and the central admin offices only
- Since 2003 complaints from students, parents & teachers of excessive heat. This has worsened annually, with heatstroke vomiting not uncommon in some classrooms



The Chickering School Building

- Zero cooling capacity in the building - air **exchange** only
- The air exchange ducts cannot support classroom AC
- No ducts were designed or built for AC when the building was constructed in 2001 (confirmed by original architect & recent engineer visits)
- The windows do not open sufficiently for cross breeze



The Chickering School Building (2)

- At night the school building does not cool down
- Positive pressure in the building does not allow air in
- The air exchange system & recovery wheels only lower temperature by $<5^{\circ}\text{F}$ at night, even when outside night temperatures drop to 20-25 degrees below the building temperature
- 15 years ago, school never started before Labor Day- now this is the norm



Why care about heat & humidity in a school classroom ?

- Protect Dover's many investments in a student's learning environment at Chickering
- Duty of care for the town's young children
- Responsibility to the educators and staff
- Scientific research has found that high heat and high relative humidity is unhealthy and unhelpful to learning
- Our school community is calling for a change



What is the right temperature?

- Scientific research indicates 68°F is ideal and that over 77°F is harmful to learning
- Our need and focus is not to get to 68°F but to get below **78°F!**



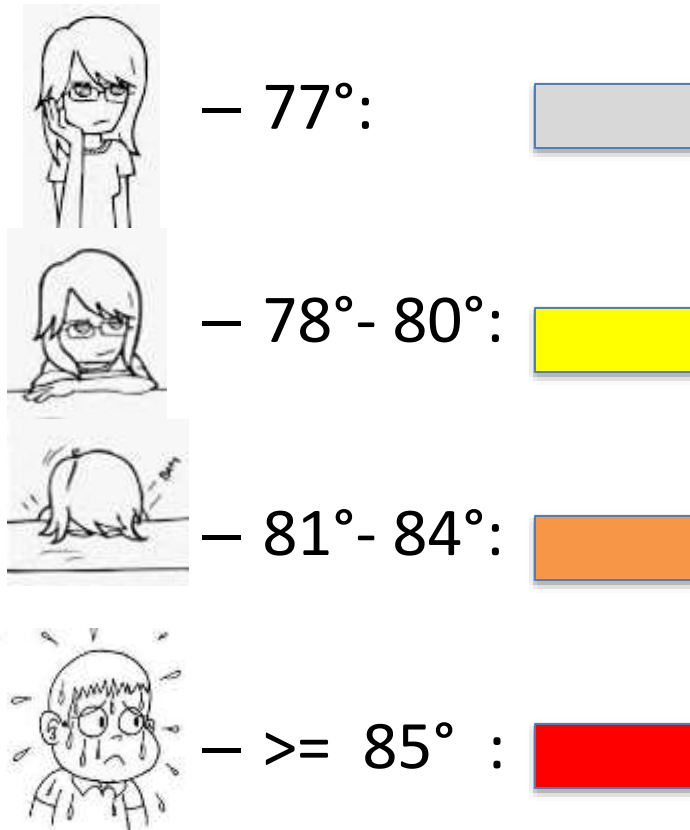
What is the Chickering indoor air temperature?

- Temperature is recorded hourly in each Chickering classroom
- We analyzed data for 2015, focusing on:
 - May, June, Week 4 August, September
 - School Hours, 8 AM – 3 PM
- Omitted data with glitches in data capture (if temp constant >4 hours)



2015 Chickering Temperature Reports

We color-coded the data by temperature (°F):



Temp (F)	1050	1065	1084	1099	2085	2099
09/09/15						
3:00 PM	82	82	83	80	87	85
2:00 PM	82	81	83	79	87	84
1:00 PM	81	81	82	79	86	83
12:00 PM	80	81	81	79	85	83
11:00 AM	80	80	80	78	84	82
10:00 AM	80	80	79	78	83	82
9:00 AM	79	79	79	77	82	81
8:00 AM	78	79	79	75	82	80
09/08/15						
3:00 PM	82	81	84	81	86	82
2:00 PM	81	81	84	80	86	82
1:00 PM	81	80	82	79	85	81
12:00 PM	81	79	81	78	83	80
11:00 AM	80	79	80	78	82	80
10:00 AM	79	79	78	76	81	79
9:00 AM	77	78	77	75	80	78

For example...

Temp (F)																Outside Max T°	Outside Min T°
	1095	1098	1099	1102	2022	2081	2084	2085	2088	2089	2092	2095	2098	2099	2102		
09/10/15																	
3:00 PM	77	78	79	79	79	82	83	82	83	83	84	82	82	82	83	75	64
2:00 PM	77	78	79	80	79	83	83	82	83	83	84	81	82	82	83		
1:00 PM	78	77	79	80	80	84	84	82	84	83	84	82	83	83	82		
12:00 PM	78	78	79	79	80	84	84	83	84	84	85	83	83	83	83		
11:00 AM	78	78	78	79	80	84	84	82	84	84	84	83	83	82	83		
10:00 AM	78	77	78	79	80	84	84	82	84	85	84	82	83	82	83		
9:00 AM	77	77	78	78	80	83	83	82	83	84	84	83	83	82	83		
8:00 AM	77	76	76	77	80	83	82	82	83	83	84	82	82	81	82		
09/09/15																	
3:00 PM	79	79	80	80	84	88	88	87	88	88	87	85	85	85	85	91	69
2:00 PM	79	79	79	80	84	88	87	87	87	88	87	85	85	84	84		
1:00 PM	79	78	79	80	84	87	86	86	86	86	86	84	84	83	84		
12:00 PM	78	79	79	79	82	86	85	85	85	86	86	83	84	83	83		
11:00 AM	78	78	78	78	81	86	84	84	84	85	85	82	84	82	83		
10:00 AM	77	77	78	78	80	85	83	83	83	84	84	82	82	82	82		
9:00 AM	76	76	77	77	80	84	82	82	82	83	84	81	81	81	82		
8:00 AM	76	75	75	76	80	83	82	82	82	82	83	80	80	80	80		
09/08/15																	
3:00 PM	79	79	81	81	85	89	87	86	87	86	85	83	83	82	84	96	66
2:00 PM	79	78	80	80	84	88	86	86	86	86	85	83	83	82	83		
1:00 PM	78	77	79	79	83	88	86	85	85	85	84	82	82	81	82		
12:00 PM	78	77	78	78	81	86	84	83	83	84	83	80	81	80	82		
11:00 AM	77	76	78	78	80	85	83	82	82	83	82	80	80	80	80		
10:00 AM	76	75	76	77	79	83	82	81	81	82	81	79	79	79	79		
9:00 AM	75	74	75	75	77	81	80	80	79	81	80	78	79	78	79		



2015: 8/31-9/4

First Week of School – not once 68!

Temperatures During School Hours All Days (8AM to 3PM)

Temp (F)																											Outside Max T°	Outside Min T°			
	1049	1050	1054	1055	1064	1065	1068	1069	1081	1084	1088	1089	1092	1095	1098	1099	1102	2022	2081	2084	2085	2088	2089	2092	2095	2098	2099	2102			
09/04/15																															
3:00 PM	77	79	77	78	80	79	79	80	78	78	79	79	79	77	77	78	78	78	81	82	81	82	82	82	81	79	79	80	73	50	
2:00 PM	77	79	77	78	80	79	78	79	78	78	79	78	78	76	76	78	78	78	81	82	81	81	82	83	81	80	79	81			
1:00 PM	77	79	77	78	79	79	78	79	77	77	78	79	78	76	75	77	77	78	81	81	81	81	81	82	81	80	79	79			
12:00 PM	77	78	77	77	78	78	77	78	77	77	78	78	78	77	76	76	76	77	81	81	81	81	82	82	81	80	79	80			
11:00 AM	77	78	77	77	79	78	78	79	77	77	78	79	78	77	75	76	75	77	81	81	81	81	82	82	80	79	79	79			
10:00 AM	76	78	76	76	78	77	77	78	76	76	77	78	78	76	75	76	76	76	80	81	80	81	81	82	79	79	79	79			
9:00 AM	75	77	76	76	78	77	77	78	75	75	77	77	77	75	74	74	75	76	80	80	80	80	81	82	79	79	79	79			
8:00 AM	74	76	76	75	78	76	76	78	75	75	76	77	77	75	73	73	74	76	80	80	80	80	81	82	78	78	78	79			
09/03/15																															
3:00 PM	81	82	79	82	82	80	82	83	81	83	82	83	84	79	78	79	80	82	85	84	84	85	86	85	83	84	82	83	87	57	
2:00 PM	80	80	79	81	82	80	81	82	81	82	82	82	83	79	78	79	79	81	85	84	84	84	85	85	83	83	82	82			
1:00 PM	79	80	78	80	82	79	80	81	81	81	81	83	81	77	77	78	78	81	84	83	83	83	84	84	82	82	82	82			
12:00 PM	79	80	78	79	80	78	79	80	80	80	79	80	82	81	77	77	78	79	83	82	83	83	84	84	81	82	81	81			
11:00 AM	79	79	78	79	81	78	79	80	80	79	79	79	81	80	77	76	77	77	82	81	81	81	82	83	80	81	80	81			
10:00 AM	78	78	77	78	80	77	78	79	78	78	78	79	80	76	75	76	76	77	82	81	81	80	81	82	80	80	80	80			
9:00 AM	76	77	76	77	79	77	77	78	77	76	77	78	78	74	74	75	75	76	81	80	80	79	80	82	79	80	79	80			
8:00 AM	75	75	76	76	78	77	76	77	76	76	76	76	76	74	73	74	74	76	80	79	79	78	79	81	79	79	78	78			
09/02/15																															
3:00 PM	79	80	79	81	82	80	82	82	81	81	81	83	82	78	78	79	78	83	84	86	84	85	85	85	82	84	82	82	89	55	
2:00 PM	78	80	79	80	81	79	81	81	81	80	82	83	82	77	77	78	78	82	83	85	83	84	84	84	82	82	81	82			
1:00 PM	78	79	78	79	80	78	80	81	80	79	80	82	81	77	76	77	77	80	83	83	82	83	84	83	82	82	81	80			
12:00 PM	78	79	77	78	79	77	79	80	79	78	79	81	80	76	75	76	77	79	82	82	81	82	83	83	82	82	80	80			
11:00 AM	77	79	76	78	79	77	79	79	78	77	78	80	80	76	75	76	76	78	81	81	80	80	82	82	81	80	80	80			
10:00 AM	76	78	75	77	78	76	78	78	76	76	77	78	78	75	74	75	75	76	80	79	79	79	80	81	79	79	78	79			
9:00 AM	75	76	74	76	77	76	77	77	75	76	76	77	77	74	73	74	75	75	79	78	78	78	79	80	78	78	77	78			
8:00 AM	74	74	74	74	76	76	76	76	75	75	75	76	75	73	72	73	73	75	79	77	77	77	78	80	77	77	76	77			
09/01/15																															
3:00 PM	78	77	79	79	79	79	79	78	80	79	79	80	79	75	75	76	77	80	82	82	80	80	81	82	80	79	79	80	84	55	
2:00 PM	77	77	78	78	78	79	78	78	80	79	79	80	79	75	74	75	76	79	82	80	80	80	81	81	79	79	79	79			
1:00 PM	76	76	77	77	77	78	77	77	80	78	78	79	78	74	74	75	76	78	81	80	79	79	81	81	79	79	79	79			
12:00 PM	75	76	76	76	77	78	76	77	79	77	77	78	77	74	74	74	76	77	80	79	79	79	80	80	78	78	78	78			
11:00 AM	75	75	76	76	76	77	76	77	78	76	76	76	77	76	74	73	74	75	77	80	79	79	78	80	80	78	78	78			78
10:00 AM	74	75	76	76	76	76	75	76	77	76	75	77	76	73	73	74	75	76	79	78	78	78	79	80	78	77	78	77			
9:00 AM	74	74	75	75	76	76	75	76	75	75	75	76	75	73	73	73	74	75	79	78	78	77	79	80	77	77	77	77			
8:00 AM	74	74	75	74	76	75	75	76	75	75	75	75	75	73	72	73	74	75	79	78	78	77	78	79	77	77	77	77			
08/31/15																															
3:00 PM	78	78	79	80	80	79	80	80	80	79	79	80	79	76	75	77	77	82	83	81	81	80	80	81	81	81	79	80	88	62	
2:00 PM	77	77	79	79	79	79	79	79	81	78	79	80	79	75	76	76	76	81	82	81	80	80	80	81	80	80	79	79			
1:00 PM	76	77	78	79	77	78	78	78	80	78	78	79	78	75	74	75	76	80	81	80	80	79	79	81	79	79	78	78			
12:00 PM	76	76	77	78	77	77	77	77	80	78	78	79	77	74	74	74	75	79	80	79	79	78	79	80	78	78	77	77			
11:00 AM	75	76	77	77	77	77	76	77	79	77	77	78	77	74	73	74	74	78	79	78	78	78	78	80	77	78	77	77			
10:00 AM	75	76	77	77	77	77	76	77	78	76	76	77	76	74	73	73	73	77	79	78	78	77	78	79	77	77	76	76			
9:00 AM	74	75	77	76	76	76	76	77	76	75	76	76	75	73	73	73	73	76	78	77	77	77	77	79	77	77	76	76			
8:00 AM	74	75	77	75	76	76	76	76	76	75	75	75	75	73	72	73	73	76	78	77	77	76	77	78	77	76	76	76			



2015: 9/8 - 9/4

Week 2 of School

Temperatures During School Hours All Days (8AM to 3PM)																																		
Temp (F)																																		
	1049	1050	1054	1055	1064	1065	1068	1069	1081	1084	1088	1089	1092	1095	1098	1099	1102	2022	2081	2084	2085	2088	2089	2092	2095	2098	2099	2102	Outside Max T° Min T°					
09/11/15																																		
3:00 PM	76	77	73	76	77	76	78	78	75	78	78	77	79	76	76	76	76	75	78	79	79	79	78	79	79	79	77	77						
2:00 PM	75	76	72	75	76	76	77	78	75	77	78	76	78	76	75	76	76	74	78	78	78	79	78	79	78	79	77	77	73	55				
1:00 PM	74	76	72	75	75	75	77	78	74	76	76	77	77	75	75	75	76	74	79	78	78	78	78	79	78	78	76	76						
12:00 PM	73	76	72	75	75	75	76	77	74	75	76	76	77	75	76	75	76	74	79	78	78	78	79	79	78	78	76	75						
11:00 AM	75	76	72	74	76	75	76	77	73	76	76	76	76	75	75	75	75	73	79	77	77	77	78	79	77	78	76	75						
10:00 AM	75	76	73	74	76	75	76	77	73	75	76	76	77	74	74	75	76	73	78	77	77	77	78	78	77	77	76	75						
9:00 AM	74	75	74	74	75	75	75	76	74	74	75	76	76	73	74	74	74	73	78	77	77	77	78	78	77	76	75							
09/10/15																																		
3:00 PM	78	79	79	79	80	79	80	82	78	79	79	79	81	77	78	79	79	79	82	83	82	83	83	84	82	82	82	83	75	64				
2:00 PM	77	78	79	79	81	79	80	81	79	79	80	79	81	77	78	79	80	79	83	83	82	83	83	84	81	82	82	83						
1:00 PM	79	79	79	79	80	79	80	82	79	79	80	80	80	78	77	79	80	80	84	84	82	84	83	84	82	83	82	83						
12:00 PM	79	79	79	79	80	79	80	81	78	79	80	80	81	78	78	79	79	80	84	84	83	84	84	85	83	83	83	83						
11:00 AM	79	80	79	78	81	80	81	82	78	79	80	80	80	78	78	78	79	80	84	84	82	84	84	84	83	83	82	83						
10:00 AM	79	79	79	79	81	80	80	81	78	79	80	80	81	78	77	78	79	80	84	84	82	84	85	84	82	83	82	83						
9:00 AM	78	78	80	78	80	80	79	80	78	79	79	80	80	77	77	78	78	80	83	83	82	83	84	84	83	83	82	83						
8:00 AM	77	78	80	78	80	79	79	80	78	78	78	79	79	77	76	76	77	80	83	82	82	83	83	84	82	82	81	82						
09/09/15																																		
3:00 PM	81	82	81	81	82	82	82	83	83	83	84	85	84	79	79	80	80	84	88	88	87	88	88	87	85	85	85	85	91	69				
2:00 PM	81	82	81	81	82	81	82	83	83	83	84	85	85	79	79	79	80	84	88	87	87	87	88	87	85	85	84	84						
1:00 PM	81	81	81	81	81	81	81	82	83	82	84	84	83	79	78	79	80	84	87	86	86	86	86	86	84	84	83	84						
12:00 PM	80	80	80	80	81	81	81	81	82	81	83	83	83	78	79	79	79	82	86	85	85	85	86	86	83	84	83	83						
11:00 AM	80	80	80	79	81	80	81	81	80	80	81	83	82	78	78	78	78	81	86	84	84	84	85	85	82	84	82	83						
10:00 AM	78	80	80	79	80	80	80	81	79	79	81	81	80	77	77	78	78	80	85	83	83	83	84	84	82	82	82	82						
9:00 AM	78	79	80	78	80	79	79	80	78	79	79	80	79	76	76	77	77	80	84	82	82	82	83	84	81	81	81	82						
8:00 AM	77	78	80	78	79	79	79	79	78	79	78	79	78	76	75	75	76	80	83	82	82	82	82	83	80	80	80	80						
09/08/15																																		
3:00 PM	81	82	83	81	82	81	82	83	84	84	83	84	84	79	79	81	81	85	89	87	86	87	86	85	83	83	82	84	96	66				
2:00 PM	80	81	82	80	82	81	81	82	83	84	83	84	84	79	78	80	80	84	88	86	86	86	86	85	83	83	82	83						
1:00 PM	80	81	81	80	81	80	81	82	83	82	82	83	82	78	77	79	79	83	88	86	85	85	85	84	82	82	81	82						
12:00 PM	79	81	80	79	80	79	80	81	80	81	80	82	81	78	77	78	78	81	86	84	83	83	84	83	80	81	80	82						
11:00 AM	79	80	80	79	80	79	79	81	79	80	80	81	80	77	76	78	78	80	85	83	82	82	83	82	80	80	80	80						
10:00 AM	78	79	79	79	79	79	79	80	78	78	79	80	79	76	75	76	77	79	83	82	81	81	82	81	79	79	79	79						
9:00 AM	76	77	77	77	79	78	77	78	77	77	77	78	78	75	74	75	75	77	81	80	80	79	81	80	78	79	78	79						

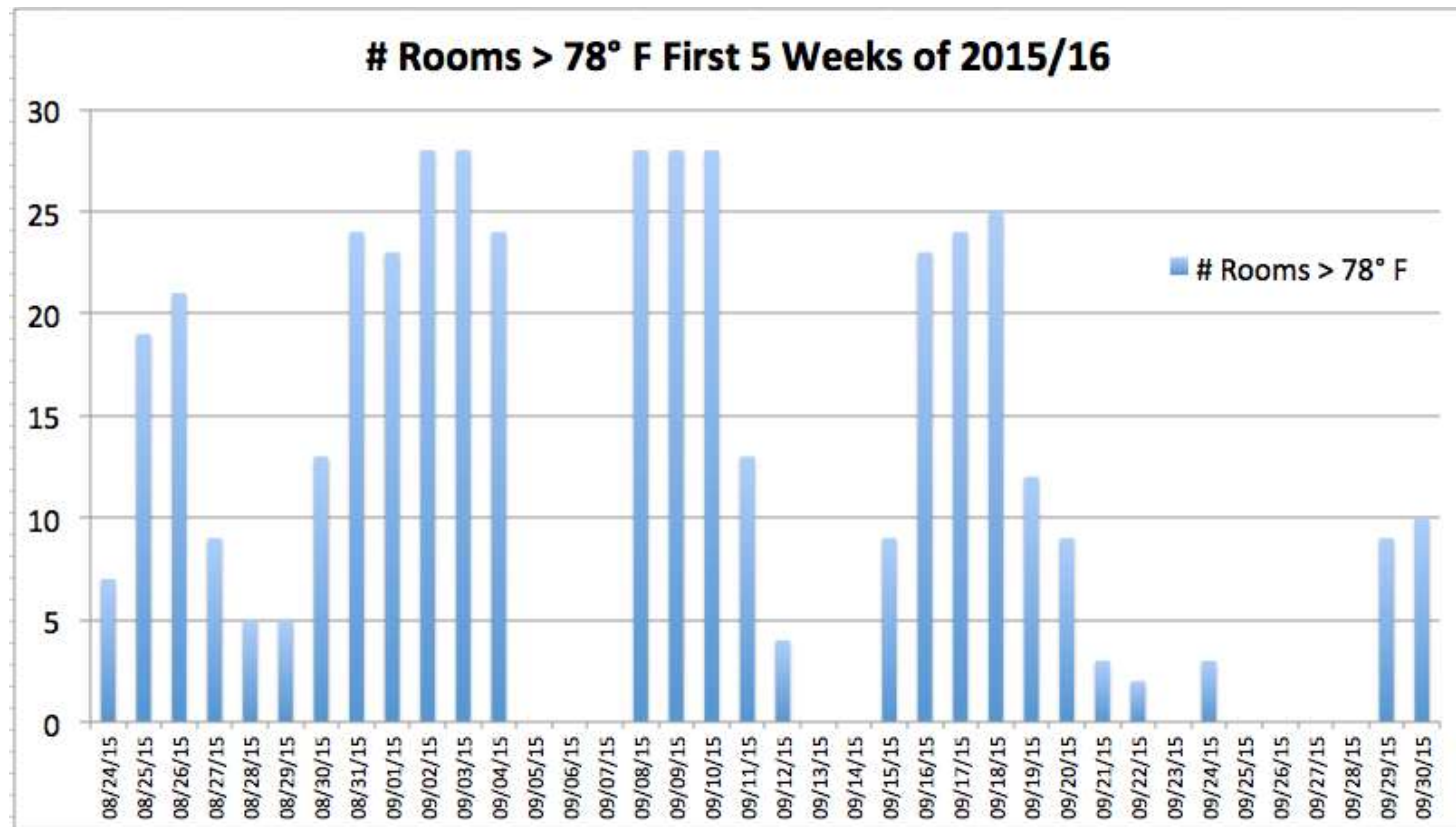


Zoom in Week 2 of School

Temp (F)												Outside Max T°	Outside Min T°
	2022	2081	2084	2085	2088	2089	2092	2095	2098	2099	2102		
09/09/15													
3:00 PM	84	88	88	87	88	88	87	85	85	85	85	91	69
2:00 PM	84	88	87	87	87	88	87	85	85	84	84		
1:00 PM	84	87	86	86	86	86	86	84	84	83	84		
12:00 PM	82	86	85	85	85	86	86	83	84	83	83		
11:00 AM	81	86	84	84	84	85	85	82	84	82	83		
10:00 AM	80	85	83	83	83	84	84	82	82	82	82		
9:00 AM	80	84	82	82	82	83	84	81	81	81	82		
8:00 AM	80	83	82	82	82	82	83	80	80	80	80		
09/08/15													
3:00 PM	85	89	87	86	87	86	85	83	83	82	84	96	66
2:00 PM	84	88	86	86	86	86	85	83	83	82	83		
1:00 PM	83	88	86	85	85	85	84	82	82	81	82		
12:00 PM	81	86	84	83	83	84	83	80	81	80	82		
11:00 AM	80	85	83	82	82	83	82	80	80	80	80		
10:00 AM	79	83	82	81	81	82	81	79	79	79	79		
9:00 AM	77	81	80	80	79	81	80	78	79	78	79		



How many rooms were hotter than 78°F the First 5 weeks of 2015/16?



What is the right relative **humidity** level?

- Scientific research says within a range of 30% to 50%
- In excess of 50%, research confirms greater health concerns for students and teachers

(IAOEH, Gaetz, Richardson, Marshall, and Hernandez, January 2016)



Humidity

- Humidity sensors exist in Chickering – these are not in classrooms but near the air handlers
- In 2016 we measured a six week period of early Fall, every six hours
- **In this study, 69% of readings were over RH 50% and 39% were at a very high level of over RH 70%**
- This is unhealthy for all



Humidity data (first six weeks of Fall)

10/14/2016 7:00	77.24	10/5/2016 7:00	89.15	9/26/2016 7:00	81.64	9/17/2016 7:00	52.65	9/8/2016 7:00	99.32
10/14/2016 1:00	55.88	10/5/2016 1:00	55.05	9/26/2016 1:00	43.65	9/17/2016 1:00	52.78	9/8/2016 1:00	76.92
10/13/2016 19:00	63.31	10/4/2016 19:00	55.8	9/25/2016 19:00	33.79	9/16/2016 19:00	41.69	9/7/2016 19:00	72.31
10/13/2016 13:00	63.36	10/4/2016 13:00	63.08	9/25/2016 13:00	35.1	9/16/2016 13:00	51.21	9/7/2016 13:00	76.35
10/13/2016 7:00	92.18	10/4/2016 7:00	95.2	9/25/2016 7:00	49.28	9/16/2016 7:00	84.3	9/7/2016 7:00	98.12
10/13/2016 1:00	53.01	10/4/2016 1:00	71.86	9/25/2016 1:00	50.46	9/16/2016 1:00	47.43	9/7/2016 1:00	83.44
10/12/2016 19:00	51.29	10/3/2016 19:00	67.25	9/24/2016 19:00	40.81	9/15/2016 19:00	46.05	9/6/2016 19:00	88.03
10/12/2016 13:00	50.4	10/3/2016 13:00	62.63	9/24/2016 13:00	38.8	9/15/2016 13:00	53.3	9/6/2016 13:00	98.38
10/12/2016 7:00	88.42	10/3/2016 7:00	96.14	9/24/2016 7:00	61.46	9/15/2016 7:00	79.45	9/6/2016 7:00	95.85
10/12/2016 1:00	47.77	10/3/2016 1:00	70.69	9/24/2016 1:00	61.04	9/15/2016 1:00	47.3	9/6/2016 1:00	81.85
10/11/2016 19:00	45.58	10/2/2016 19:00	71.63	9/23/2016 19:00	55.02	9/14/2016 19:00	47.8	9/5/2016 19:00	46.57
10/11/2016 13:00	41.75	10/2/2016 13:00	71.79	9/23/2016 13:00	53.46	9/14/2016 13:00	47.43	9/5/2016 13:00	46.75
10/11/2016 7:00	84.93	10/2/2016 7:00	72.78	9/23/2016 7:00	76.66	9/14/2016 7:00	84.85	9/5/2016 7:00	82.95
10/11/2016 1:00	48.21	10/2/2016 1:00	75.83	9/23/2016 1:00	46.78	9/14/2016 1:00	47.61	9/5/2016 1:00	53.09
10/10/2016 19:00	43.81	10/1/2016 19:00	78.1	9/22/2016 19:00	44.98	9/13/2016 19:00	42.87	9/4/2016 19:00	44.77
10/10/2016 13:00	48.71	10/1/2016 13:00	85.35	9/22/2016 13:00	41.72	9/13/2016 13:00	41.77	9/4/2016 13:00	35.38
10/10/2016 7:00	79.04	10/1/2016 7:00	83.49	9/22/2016 7:00	88.4	9/13/2016 7:00	89.15	9/4/2016 7:00	56.45
10/10/2016 1:00	62.16	10/1/2016 1:00	81.49	9/22/2016 1:00	55.2	9/13/2016 1:00	46.41	9/4/2016 1:00	54.03
10/9/2016 19:00	65.71	9/30/2016 19:00	73.79	9/21/2016 19:00	51.29	9/12/2016 19:00	36.98	9/3/2016 19:00	44.9
10/9/2016 13:00	65.58	9/30/2016 13:00	72.75	9/21/2016 13:00	43.6	9/12/2016 13:00	37.76	9/3/2016 13:00	45.24
10/9/2016 7:00	69.36	9/30/2016 7:00	82.22	9/21/2016 7:00	96.35	9/12/2016 7:00	84.2	9/3/2016 7:00	62.61
10/9/2016 1:00	71.76	9/30/2016 1:00	65.22	9/21/2016 1:00	74.71	9/12/2016 1:00	52.57	9/3/2016 1:00	59.66
10/8/2016 19:00	66.86	9/29/2016 19:00	59.9	9/20/2016 19:00	71.53	9/11/2016 19:00	51.68	9/2/2016 19:00	50.46
10/8/2016 13:00	58.07	9/29/2016 13:00	68.79	9/20/2016 13:00	83.86	9/11/2016 13:00	56.82	9/2/2016 13:00	54.37
10/8/2016 7:00	51.47	9/29/2016 7:00	80.89	9/20/2016 7:00	100	9/11/2016 7:00	67.25	9/2/2016 7:00	87.25
10/8/2016 1:00	53.32	9/29/2016 1:00	70.2	9/20/2016 1:00	86.65	9/11/2016 1:00	60.18	9/2/2016 1:00	64.2
10/7/2016 19:00	54.34	9/28/2016 19:00	71.97	9/19/2016 19:00	90.09	9/10/2016 19:00	54.34	9/1/2016 19:00	77.37
10/7/2016 13:00	46.13	9/28/2016 13:00	87.56	9/19/2016 13:00	99.87	9/10/2016 13:00	57.65	9/1/2016 13:00	96.32
10/7/2016 7:00	87.95	9/28/2016 7:00	80.03	9/19/2016 7:00	93.14	9/10/2016 7:00	66.23	9/1/2016 7:00	93.27
10/7/2016 1:00	52.83	9/28/2016 1:00	66.18	9/19/2016 1:00	67.59	9/10/2016 1:00	58.98	9/1/2016 1:00	62.82
10/6/2016 19:00	49.49	9/27/2016 19:00	67.74	9/18/2016 19:00	66.47	9/9/2016 19:00	51.66	8/31/2016 19:00	56.84
10/6/2016 13:00	43.81	9/27/2016 13:00	84.2	9/18/2016 13:00	66.47	9/9/2016 13:00	59.58	8/31/2016 13:00	63.73
10/6/2016 7:00	91.08	9/27/2016 7:00	92.46	9/18/2016 7:00	58.93	9/9/2016 7:00	94.08	8/31/2016 7:00	87.54
10/6/2016 1:00	52.13	9/27/2016 1:00	44.3	9/18/2016 1:00	52.52	9/9/2016 1:00	66.02	8/31/2016 1:00	48.11
10/5/2016 19:00	55.83	9/26/2016 19:00	40.42	9/17/2016 19:00	46.81	9/8/2016 19:00	65.74		
10/5/2016 13:00	55.28	9/26/2016 13:00	38.44	9/17/2016 13:00	41.49	9/8/2016 13:00	79.37		



We also surveyed our community

- Two surveys sent out by email
- Teacher survey – 37 replies, 14 comments
- Family survey – 119 replies, 68 comments
- **Overwhelming** support for AC
- Some very moving comments shared...



What has the School Committee done so far?

- We explored non AC solutions
 - Planted trees to block sunshine
 - Dark films tested on windows; ineffective, removed
 - Pilot tested lower and larger fans; ineffective
 - Recommissioned the air exchange system & reconfirmed the handlers and air recovery wheels work properly; insignificant results
 - Ruled out portable or window AC units



Sought expert engineering advice...

- TMP (2008)
- Crowley (2016)
- MAC (ongoing)
- BG Risk (2016)
- Garcia Galuska, DeSousa (2017)



What about window AC units?

- The windows at Chickering are too weak and would not support window AC units



What about portable AC units?

- The School Committee team from the Middle School researched this option in 2011
- It was found they were too noisy and unsuitable for a learning environment



Dover Town Meeting 2017 - Dover School
Committee presentation on Air
Conditioning for Chickering School



What type of mechanical cooling solution is best for Chickering?

- Engineer reports and visits occurred in 2008, 2015, and 2017 to the school
- Four choices were considered:
 - Fully ducted, central AC
 - Hydronic chilled water system
 - A Direct Expansion (DX) split system with refrigerant units in the air exchange ducts near the air handlers
 - A Variable Flow (VRF) mini-split system, with condensers outside the building and refrigerant units at the classroom



The best choice for Chickering

- A Variable Refrigerant Flow (VRF) split system, with condensers outside the building and refrigerant units at the classroom
 - Most efficient – less energy loss as the cooling units are located at the classrooms
 - Low piping installed costs due to refrigerant piping system only
 - Relatively quiet operation
 - Reasonable cost compared to central, fully ducted AC & chilled water system
 - 15-20 year life
 - Recommended by professional engineers & installed in MA schools (Brookline HS, Newburyport MS)



VRF mini split system



Process

- An engineering design study has been commissioned and has provided a firm cost estimate
- This design study has already been approved & funded by the Dover School Committee from building rental funds and unrestricted gift funds
- After this design study, the installation project will be put out to public bid. The lowest responsible bid will be chosen. If final cost is lower than the approved monies, unused monies are returned to the Town



Timeline

- Two stages; engineering design study, then installation project
- RFQ circulated 2/20/17 for engineering design study
- Proposals were in hand 3/9/17, study awarded 3/16/17
- Design study development stage complete, scrubbed costing by 4/29/17
- Installation project bid out by 3/15/17
- Summer vacation break 2017 installation



Costing

- The cost in the Warrant Article is \$675,000 (reduced from the initial \$1m placeholder)
- (NB: this is less than the \$852,395 that was approved for the DS Middle School AC)



Summary

- We have worked over many years to research the need and the solution
- Non AC solutions have not been effective
- We ask for funds for our Elementary age students and teachers to have classroom cooling, in line with their Middle and Upper School peers



Appendix 1

Community Surveys



We also surveyed our community

- Two surveys sent out by email
- Teacher survey – 37 replies, 14 comments
- Family survey – 119 replies, 68 comments
- **Overwhelming** support for AC



Chickering Teacher Survey

Which symptoms, if any, have you experienced on high heat days?

SYMPTOM	% RESPONSE
Inability to concentrate/sluggishness	78%
Excessive sweating	76%
Dizziness/lightheadedness	73%
Excessive thirst	62%
Nausea	41%
Other: "I fainted in September due to the heat in my classroom", "headaches, dehydration", "swelling of body parts", "It is an oppressive work environment"	

Distributed 1/30/17

37 responses = response rate 62%



Which symptoms, if any, have any of *your students* experienced on high heat days?

SYMPTOM	% RESPONSE
Inability to concentrate/sluggishness	97%
Excessive thirst	84%
Dizziness/lightheadedness	68%
Excessive sweating	68%
Nausea	42%
Vomiting through heatstroke	3%
Other: “They are VERY hot and the fans do little to cool down our room”, “Irritability, headaches, dehydration”, “Students complain about the heat all the time”, “Sluggishness on the part of students has been excessive”	



Educators try to mitigate the heat and humidity

- 75% have had to limit classroom activity
- 75% have had to change lesson plans
- 58% have had to change rooms during the day
- Many teachers:
 - buy/bring multiple fans from home (not effective, noisy and disruptive, blows papers around)
 - leave lights off during the class day/close shades (contributes to student lethargy, youngest students can be afraid)
 - bring water for their students/spray water on students (with permission)



Representative Teacher Comments

- “I bought a small fridge so I can keep ice packs in the freezer and use many ice packs throughout the day (under skirt, under both feet, back of my neck and under my shirt while sitting in a chair to try and cool body down; I walk barefoot on the floor throughout the day to try and bring body temp down by walking on tiles.”
- “The heat in the classroom limits the amount of work I can expect my student to complete. Their little faces are so red and they are so hot that I encourage them to take the ice packs out of their lunchboxes to use on their bodies to keep cool. The excessive heat is dangerous.”



Representative Teacher Comments (2)

- “The conditions are so brutal during those weeks that they are essentially lost weeks. And typically, those weeks at the beginning of the school year are much too valuable to lose. They can set a tone for your entire year, and if the tone is sluggishness and work avoidance, the carry over is detrimental to the class environment.”
- “It's extremely difficult for students to get through the day when it's so hot. They are not good at regulating themselves and often come in from recess or gym --- overheated, this combined with the classroom heat is double hit and kids are spent. Students are exhausted, hot, and not able to concentrate. Teachers are exhausted...I think that you'd find many students are sent home early on days that the building runs hot. Adding air conditioning could help decrease student sick dismissals and possibly student and teacher absences.”



Chickering Parent/ Student Survey

Which symptoms, if any, has your child experienced on high heat days?

SYMPTOM	% RESPONSE
Inability to concentrate/sluggishness	77%
Excessive sweating	59%
Excessive thirst	53%
Dizziness/Lightheadedness	25%
Nausea	13%
Vomiting through heatstroke	1%

Distributed 1/30/17
118 total responses
5 respondents reported no heat related symptoms



Representative Parent Comments (1)

- “The school is so uncomfortable during major programming- arts night/concert and back to school night, I am inclined not to attend. I can't even imagine how hot my children are during the day with such limited access to fresh air--- since the windows don't open!”
- “Please get AC! I didn't know how bad it was I took I had 4th grader and it was 80+ degrees in the classroom at parent night. Kids and teachers alike are suffering not only from physical discomfort but the difficulty in focusing on their studies.”
- “Mornings when the day will be hot she did not want to go to school, afternoons of a hot day I heard all about how hot it was, even some days how the entire class would take breaks to go cool down.”
- I feel the main problem is that is not a conducive learning environment. But equal, if not larger, it is not a conducive workplace environment. How many would tolerate going to an office that exceeded 80 degrees, where they could not leave to escape?”



Representative Parent Comments (2)

- “Please provide A/C for the students and teachers at Chickering school. As a health care provider, it is important for the health of everyone in the school to be in temperate air. It will provide for a more comfortable work/learning environment. In addition, if someone is affected by the heat, and is trying to get to the nurse, I am nervous they might fall down the stairwell if they are coming from the second floor and are faint/dizzy due to the heat stress. It should also be noted that people with certain diseases (MS for example) can be severely and even mortally affected by extreme temperatures, we need to accommodate for those suffering from illnesses and provide them with a comfortable/safe work environment.”
- “I completely support the addition of air conditioning to Chickering. The classrooms are known to get especially warm during the summer months and I worry about my children on hot days. In addition to health concerns, I cannot imagine that an uncomfortable classroom can be conducive to productive learning.”
- “It has been an unsafe environment for our children...My daughter comes home after hot days and collapses because it's too many continuous hours in extreme heat with no break.”
- “I’m not sure how it is legal for teachers and students. There isn't adequate ventilation for the rooms to air out in the cooler evenings and so the problem compounds. We expect high levels of learning and test scores, yet I don't believe the classroom is conducive when it is so hot. Our spring and fall temps have been higher than ever with global warming. This is only going to get worse.”
- “My kids come home in the early fall and late spring with wet hair and zero energy after spending their day in a sweltering classroom”
- “Please add air conditioning! Both students and teachers are suffering through 2+ months of extraordinary heat in the current situation. Not acceptable!”



Representative Parent Comments (3)

- “As our older daughter went through Chickering, it was unbearable on hot days. I believe it is inappropriate that the town has not gone forward and upgraded the system. If it is necessary for the older children, shouldn't it be for the younger children as well? On very hot days, which we have had in recent years, I am afraid to send my child to school.”
- “A/C is a wonderful idea! I've attended several meetings and events at Chickering during hotter months and I found it to be nearly unbearable for the short time I was there. I can't imagine spending an entire day in that heat, not to mention trying to concentrate & learn! Marvelous that this is in the works!”
- “Our daughter has difficulties regulating her temperature due to premature birth and as she's sitting in a wheelchair it gets really uncomfortable for her in a overly hot classroom.”



Representative Parent Comments (4)

- “It is very concerning how hot the classrooms get. My son came home red in the face, profusely sweating and lethargic during the hot months. This temperature is unacceptable and it not conducive to a successful learning environment.”
- “My children all suffer from asthma. It is well know that hot, humid air can trigger asthma symptoms and my children have suffered such symptoms while at Chickering. The school nurse has always been fantastic about administering treatment, but a reduction in the heat/humidity will also reduce the mold spores that trigger asthma attacks.”
- “High classroom temperatures introduce a significant distraction from classroom learning. This distraction can be so easily addressed and removed by installing AC that I don't understand why the Town has not dealt with this issue before, or during prior school renovations / construction. When you further consider health and safety issues, this is really not a difficult decision. Dover property values are high in part because the public schools are rated highly in state. This is a simple long term investment in the Town that should continue or improve that trend.”



Representative Student Comments

- “I am so hot in school, I have trouble thinking straight. Then I go outside to play and take a break and I come back in and I can't stop sweating. Then I get in trouble because I can't sit still because I can't cool off. It's a bad circle. It's really really hot.”
- My child said the heat makes him very tired and it's uncomfortable and hard to focus on the teacher
- I asked my son and he dreaded going to school on hot days. The kids shouldn't have to or be expected to learn in a sweat box.
- My child told me that when it gets too hot, no one can concentrate or do anything, and that is when the bad behavior also starts because the kids cannot learn and are uncomfortable and so they start acting out. He also wanted me to mention that one of his good friends fainted this past fall because he got too hot.



Representative Student Comments (2)

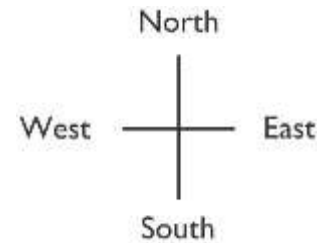
- My daughter suffers from chronic headaches and the heat and associated dehydration cause those headaches to be worse and more common making it hard for her to concentrate
 - “It is so hot and I sweat. The fan doesn't help at all. I had to go to the nurse once because I thought I was going to pass out.”
 - “I hate it. It's really really hot in there. It feels very hot and I start to sweat and fidget. Our fan is horrendous and doesn't work. It's hard to learn. You pay attention to the heat and not the lesson.”
 - “It gets way too hot and it's hard to breathe.”
- "I need to bring an extra shirt to change I get so sweaty."



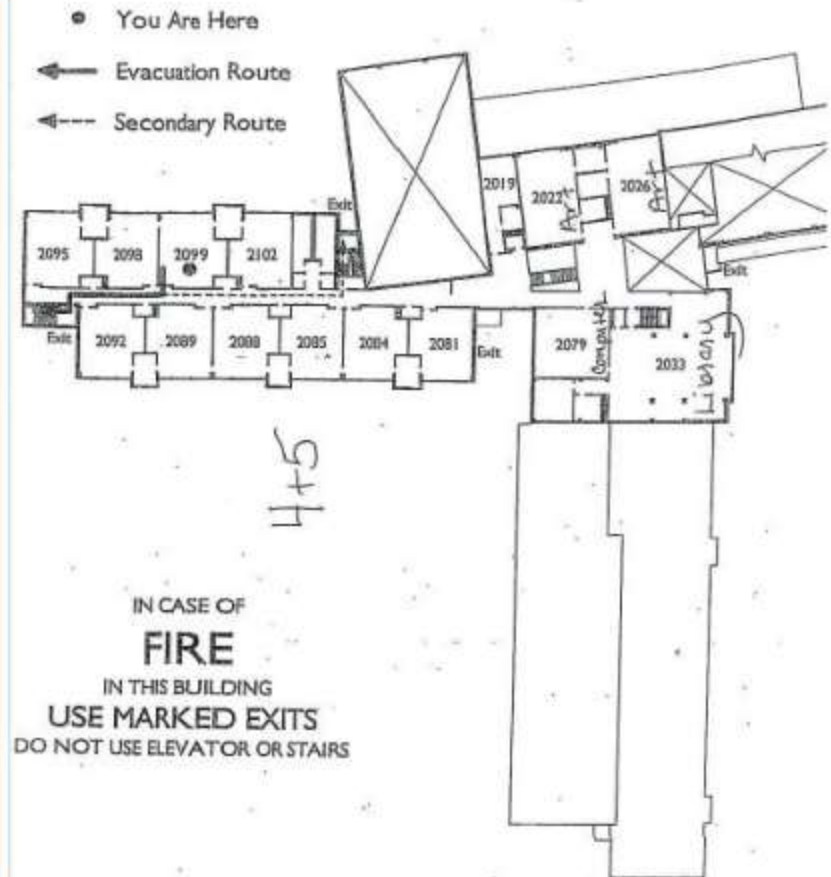
Appendix 2 (miscellaneous)



Building Floor plan



First Floor



Second Floor



Other considerations...

- We have confirmed that the electrical supply in the school **is adequate** for addition of mechanical cooling to the classrooms
- The School Committee investigated State Grant Programs but the most relevant one sadly expired in 2011.

