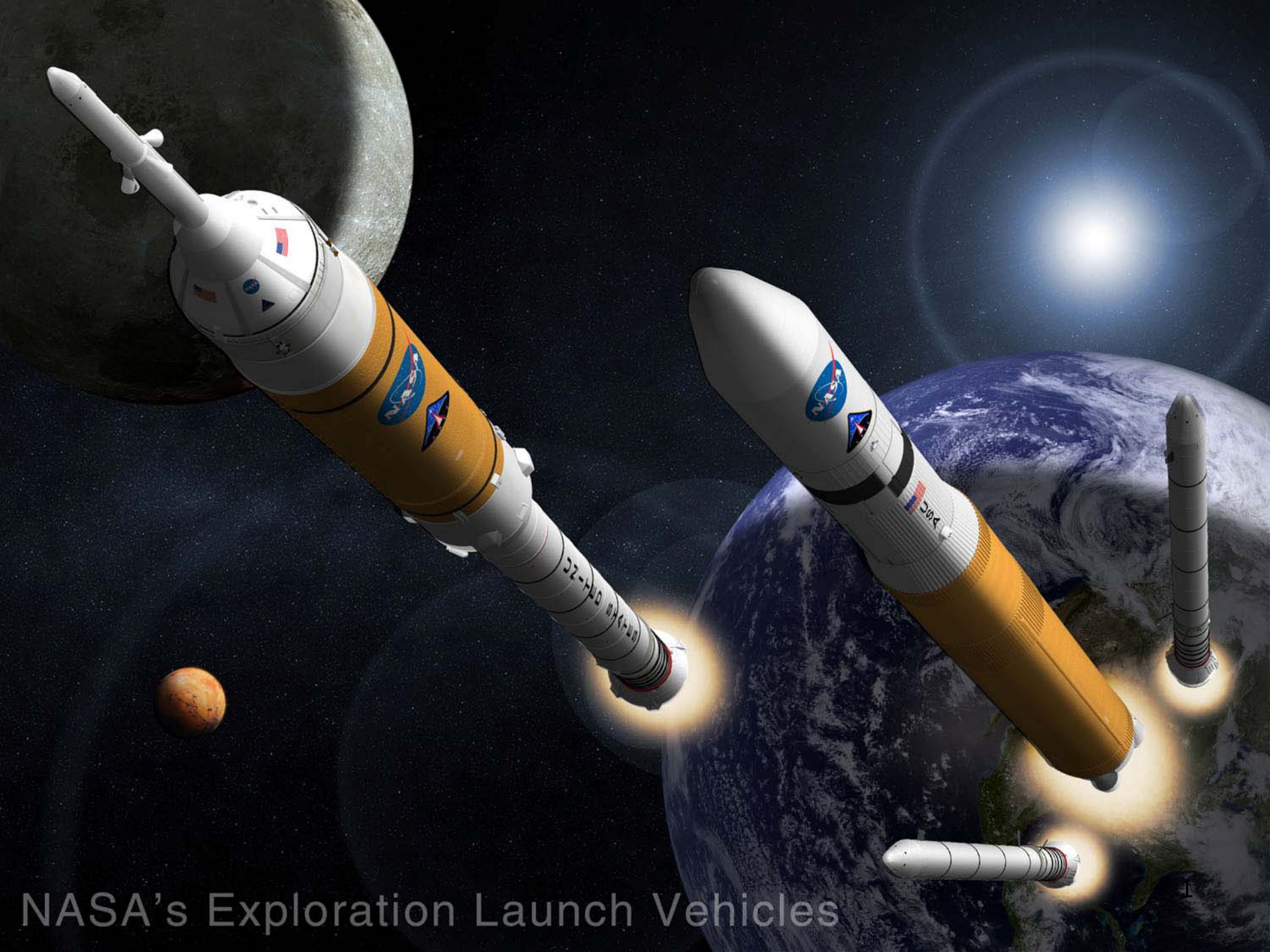


# NASA's Exploration Launch Vehicles

# NASA
# Marshall Space Flight Center

# Chilled Water Plant Savings at No Cost

*Article was published in ASHRAE Journal, July 2007*

# NASA MSFC - Central Chilled Water Plant

## Saves more than $85,000 per year with *No-Cost* Controls Logic Change

***(2009 Savings is more than $120,000)***

**The NASA Marshall space Flight Center (MSFC) Central Chilled Water Plant (CCWP) provides cooling for a majority of the 4.5 million square feet of office and laboratory space.**

**The CCWP, with a peak connected capacity of 10,000 tons, was constructed in 1999, and was designed to serve MSFC with 8 nominal 1,250-ton chillers and a 9th chiller as back-up. The CCWP was built to consolidate many small, distributed chillers that were in operation throughout MSFC.**

**The CCWP reduced the peak connected capacity from 17,000 tons to 10,000 tons, a connected capacity reduction of 41 percent.**

**To optimize operational efficiency MSFC looked for ways to incorporate no-cost operational efficiencies on all large energy using systems. The CCWP proved to be a very good candidate because it was experiencing Low Delta Temperature ($\Delta T$) Syndrome at its primary / secondary designed during off-peak conditions.**

NASA

# How Does Low ΔT Syndrome Affect CCWP Operation?

**The plant is designed to operate at a ΔT of 11ºF. But, in off-peak month the plant was experiencing a ΔT of 7ºF.**

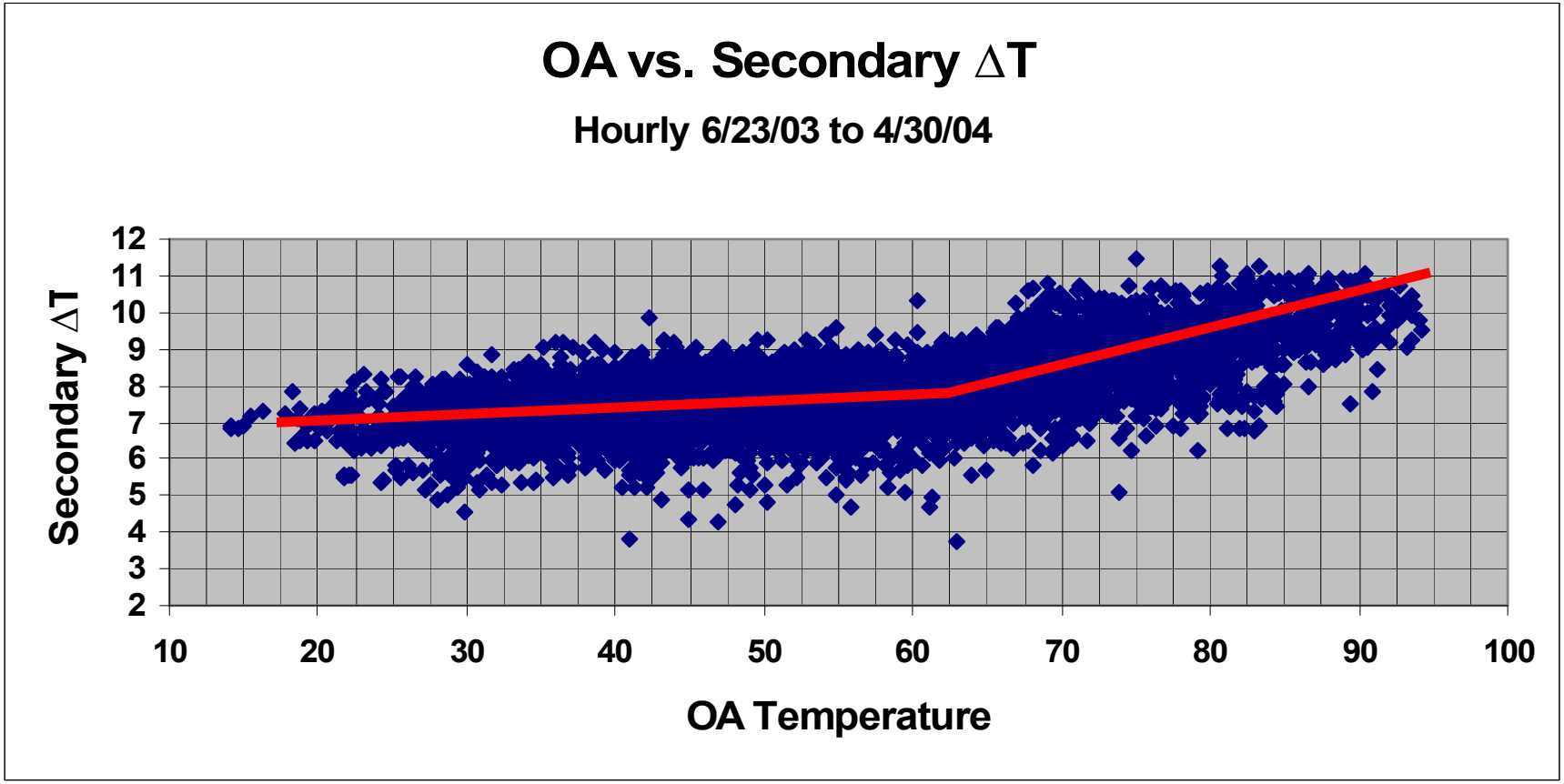
**As flow in the secondary increases and no action is taken to start another chiller, the mixing of water flows will change from the lower intersection of the decoupler to the upper intersection. The Secondary ΔT is 7ºF, but to reach full load the ΔT should be 11ºF. When this condition occur the mixture of water is at a different temperature than the actual setpoint. Thus, operators usually call for the next chiller to be started.**

# Low Delta Temperature ($\Delta$T) Syndrome

**Under a low $\Delta$T condition, the secondary water flow would tend to increase to meet building loads, and the excess flow in the secondary system would mix with primary water leaving the plant. The increased secondary supply temperature causes the secondary return temperature to rise, effectively increasing the $\Delta$T across the chiller to match design. Indications to the plant operator would be that the operating chillers are at full capacity - but that chilled water leaving the plant was warmer than it should be, and an additional chiller should be brought online.**

# Scatter Plot

**The following slide shows a scatter plot of OA *(outside air)* vs. secondary ΔT using collected trend data. The chart below shows that, MSFC suffers from Low ΔT Syndrome during off-peak conditions - as does most similar facilities.**


OA vs. Secondary ΔT
Hourly 6/23/03 to 4/30/04
Secondary ΔT
12
11
10
9
8
7
6
5
4
3
2
10
20
30
40
50
60
70
80
90
100
OA Temperature

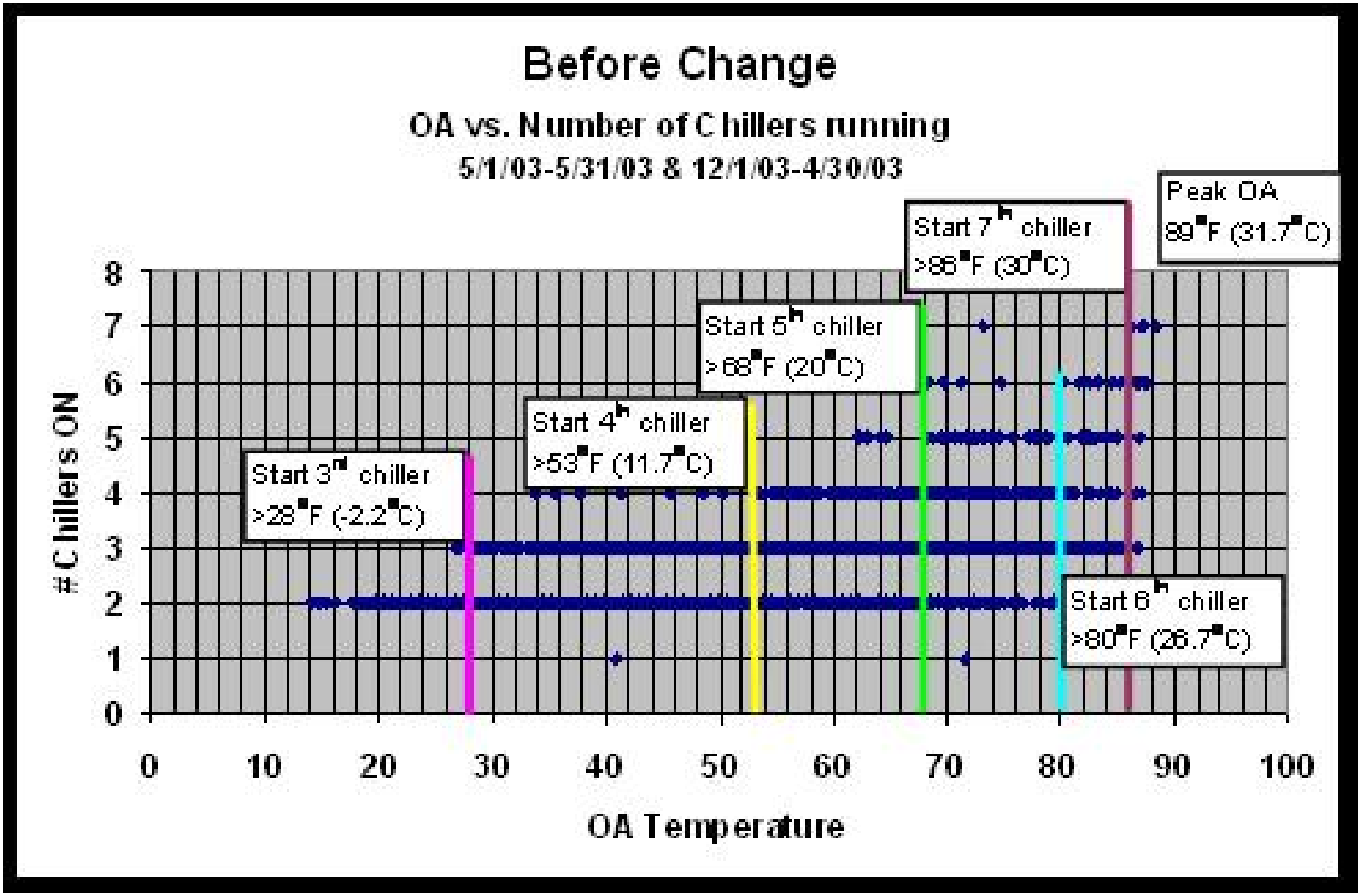
# Original Controls Logic

- Start the next chiller when the decoupler temperature stays more than 3ºF above the primary for 10 minutes
- At 7ºF ΔT Secondary, the next Chiller would start running when the machine was 64% loaded – with the average load at the start for all machines being 57.7%

# New Controls Logic

- **The plan was to enable chillers to control the secondary temperature yet load to 100% despite the impact of Low ΔT Syndrome**
- **Temperature sensors were installed on the secondary loop to detect temperature increases and modulate the chiller discharge temperature setpoint to maintain the desired mixed-water temperature in the secondary**
- **With the new controls logic, the average percent load of a chiller, before starting the next chiller, was 86.4%** *(as compared to 57.7% using the old controls logic)*

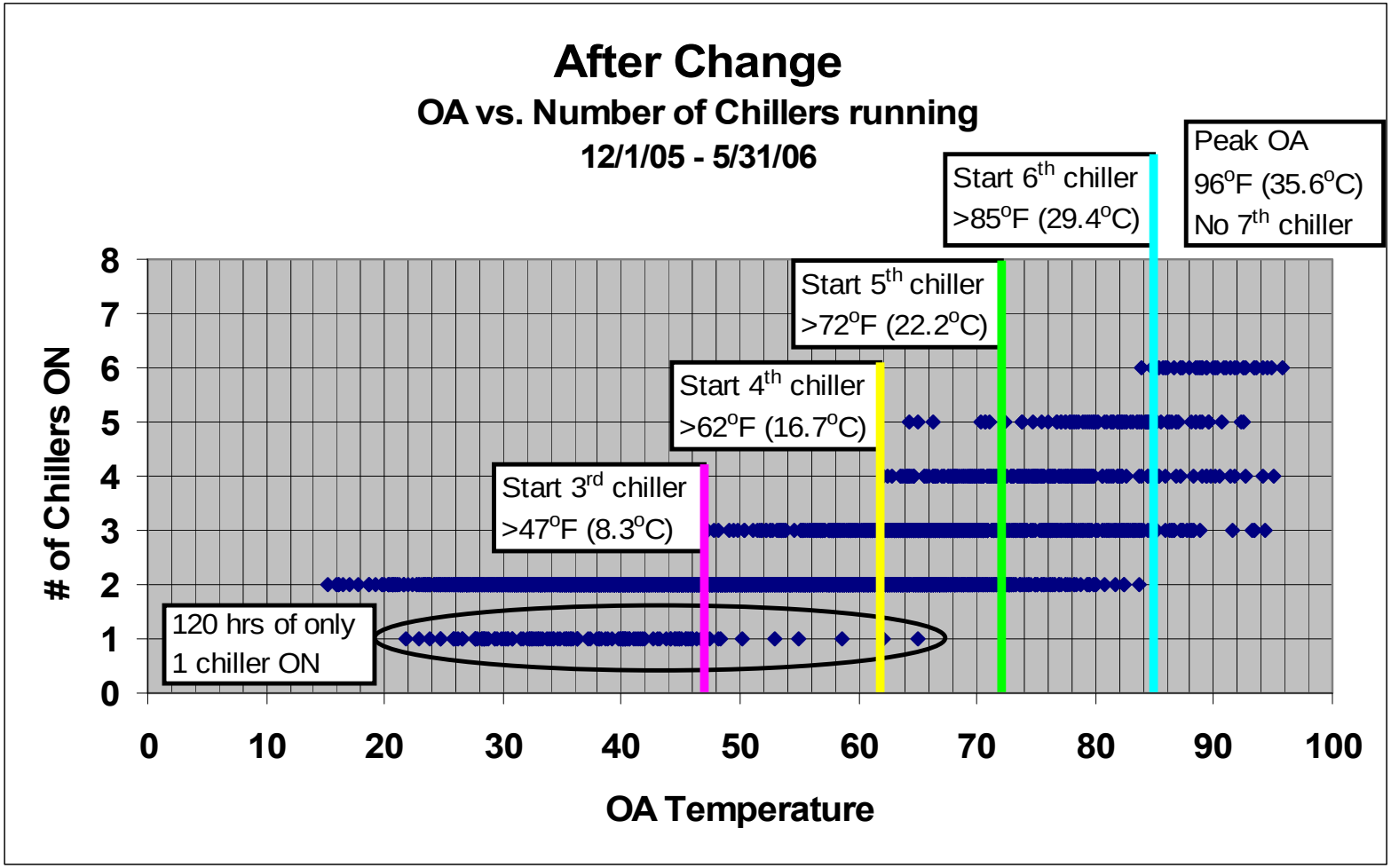
# Old Controls Logic



# Old Controls Logic

- During off-peak months the minimum site load was below 1,000 tons and even as low as 500 tons
- Yet, at least two chillers operated all but two (1-hour) events
- A third chiller was started at 28ºF
- A 7th chiller was needed at 89ºF

# New Controls Logic



# New Controls Logic

- **During off-peak months the minimum site load was below 1,000 tons and even as low as 500 tons** *(same as before)*
- **One chiller maintained the load for 120 (1-hour) events**
- **With the new controls logic a third chiller was needed at 48ºF** *(instead of the 28ºF using the old controls logic)*
- **The temperature reached 95ºF, yet a 7th chiller was never needed**

# Savings

- The engineering model projected a $50,000 savings per year
- The average measured energy savings for 2006 as compared to 2005 was 4.5%
- The actual $ savings, based on energy costs was $88,850 for 2006 & $121, 000 for 2009 base on the present electricity rate

# Conclusion

- The results of this study are applicable to any facility operating a chilled water plant with multiple chillers arranged in a primary-secondary pumping configuration
- No capital investment was required to achieve the savings, only computerized logic controls changes
- Other energy savings devices are being added at this plant but will require capital investment

# Q&A