ACEEE Hot Water Forum

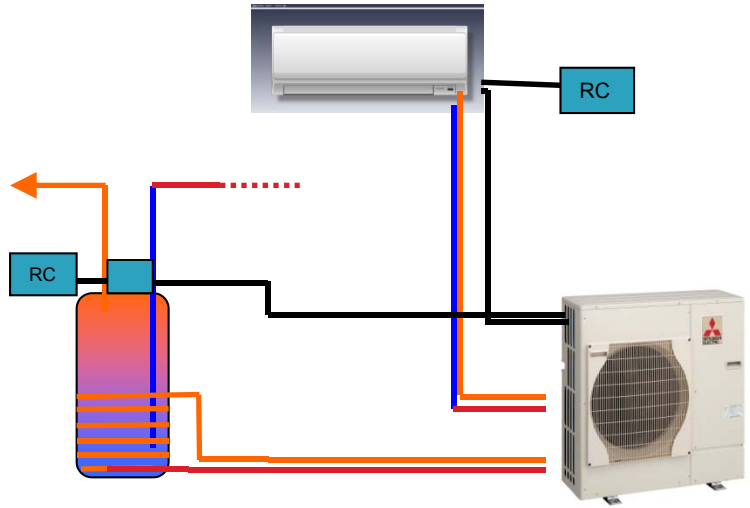
Heating Water with Multi-Purpose Residential Heat Pumps

Combi-Systems

Paul Doppel

Senior Director

Industry & Government Relations



Paul L. Doppel

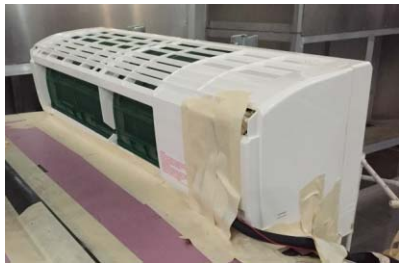
Paul Doppel has worked for Mitsubishi Electric Cooling & Heating since 2002, and was a brand manager before being promoted to his current position of Senior Director of Industry and Government Relations in 2012. A 34-year HVAC industry veteran, Doppel served as chairman of the TC 8.7 Variable Refrigerant Flow committee of ASHRAE from 2010 to 2012 and currently is the chairman, Ductless(VRF) Product Section, of the Air-Conditioning, Heating and Refrigeration Institute (AHRI).

Doppel also works with the DOE, utility companies, state governments and green building groups to enhance VRF technology education and applications. In 2009, Doppel was honored by AHRI with the Richard C. Schulze Distinguished Service Award, which is presented annually to individuals recognized for their unique contributions to the HVACR industry. He is retired from the United States Army Reserves after 30 years of service, and is a graduate of the United States Military Academy at West Point.

YEAR THREE

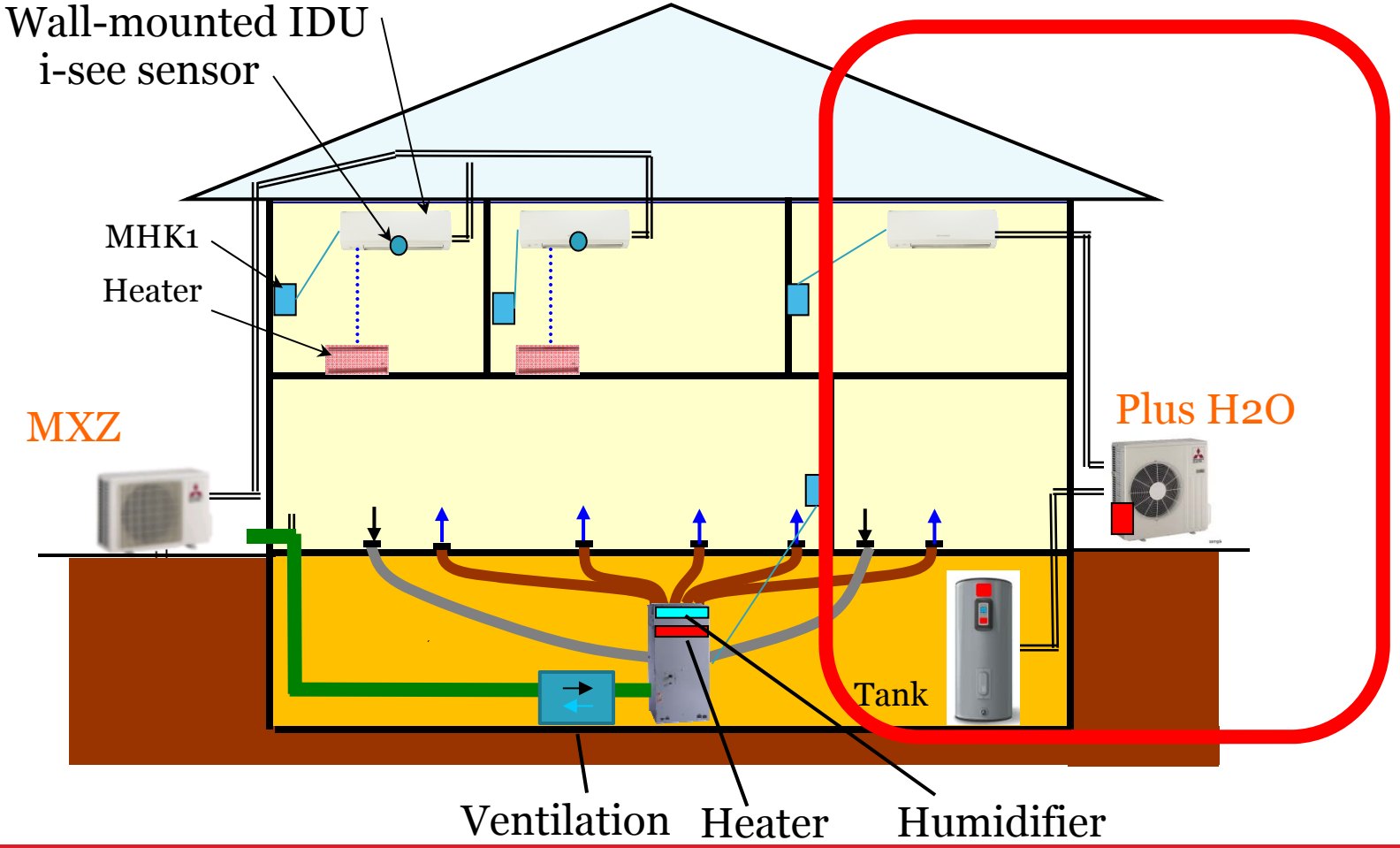
We've gone from here…

…to here



ANTIGUA: After rowing 3,000 nautical miles, the **Mitsubishi-Electric**-sponsored All Beans No Monkeys boat has arrived in Antigua. The crew of four from the UK, competing in the Tallisker Whisky Atlantic Challenge, crossed the finish line at Nelson's Dockyard English Harbour, Antigua, in the early hours of February 3. Their time of 44 days, 20 hours and 22 minutes resulted in a sixth place in the overall race, beating 19 other teams.

Whole Home Solution-
Multi-position AHU, MXZ, Plus H2O



Heating Water with Multi-Purpose Residential Heat Pumps

WHAT WE TALKED ABOUT LAST YEAR

2015

Presenter	Topic	Discussion Points
Paul Doppel	Overview and Introductions	• What we said last year • VRF & Ductless Overview • This YEAR
Tim Roller	Testing to the Standard	• Applying the 206 Standard • Testing Plans • Looking at the Results of Field Testing
Dave Kresta	Field Testing & Market Readiness	• Ductless Success in the Northwest Market • Field Applications • Market Drivers & Utility Participation
Paul Doppel	How to Measure the Performance	• What to do with Complex Systems • How do we rate these systems? • Next Steps

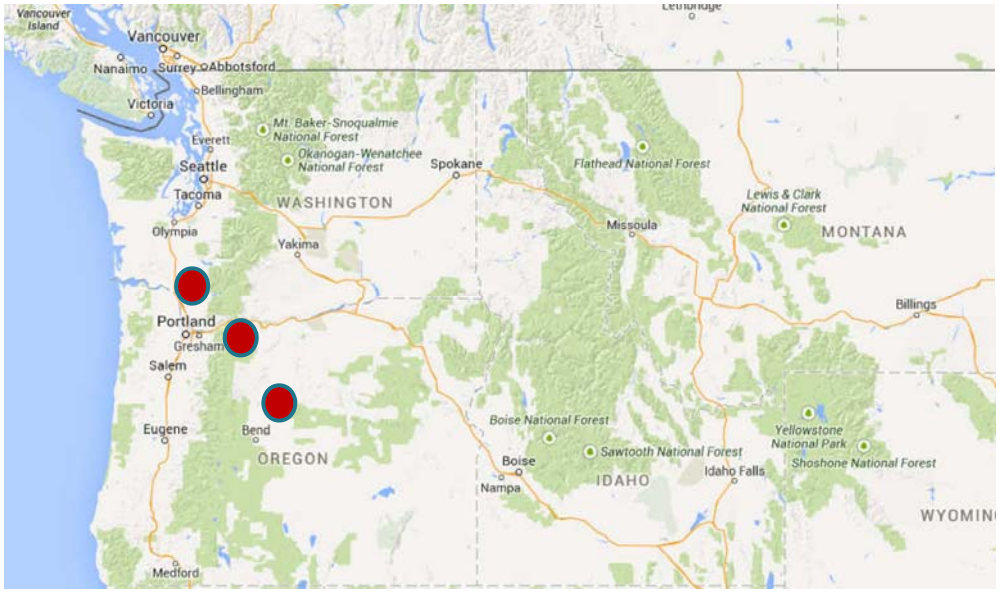
Heating Water with Multi-Purpose Residential Heat Pumps 2016

WHAT WE WILL TALK ABOUT THIS YEAR

Presenter	Topic	Discussion Points
Paul Doppel	The FIELD Speaks	• Comfort Inside • How's the Water
	CHANGES	• Testing Requirements • The Tank
	Testing	• Priorities • How Extreme • Simultaneous Operation
	Market Readiness	• What to do with Complex Systems • How do we rate these systems?

Field Testing

- Three in the Northwest



- Full equipment monitoring
  - Power consumption
    - Heating
    - Cooling
    - Water Heating
  - Capacity
    - Heating
    - Cooling
    - Water Heating
  - Usage Trends
  - Energy Savings

Field Test Results Overview

The three field tests have been installed since early spring of 2014. As such, to date, we have a good amount of space cooling and water heating data to date as well as combined operation. We have seen a cooling design day, but so far, only moderate heating weather. We intend to leave the units installed until December 2014 to increase the heating mode data collection. Typically, a design heating day in this region occurs in December so we hope to observe a design heating day or close to it. Due to the ongoing nature of this study, the results reported below are strictly preliminary and expected to change at the conclusion of the study. Table 1 summarizes key energy performance data by home.

Table 1 – Energy Performance Summary by Home

Home	Cooling SEER	Heating COP	Heating HSPF**	Water Heating COP	% Water Heat Done by Elements
SW Portland	21.5	3.4	11.6	1.9	27%
Gresham	21.7	3.5	11.9	1.7	32%
Bend	19.0	3.2	10.9	1.7	10%
Average	**20.7**	**3.4**	**11.5**	**1.8**	**23%**

*Note that SEER rating has strictly defined testing procedures that can only be created in a lab environment. However, we have calculated an actual operating SEER under real world operating conditions.

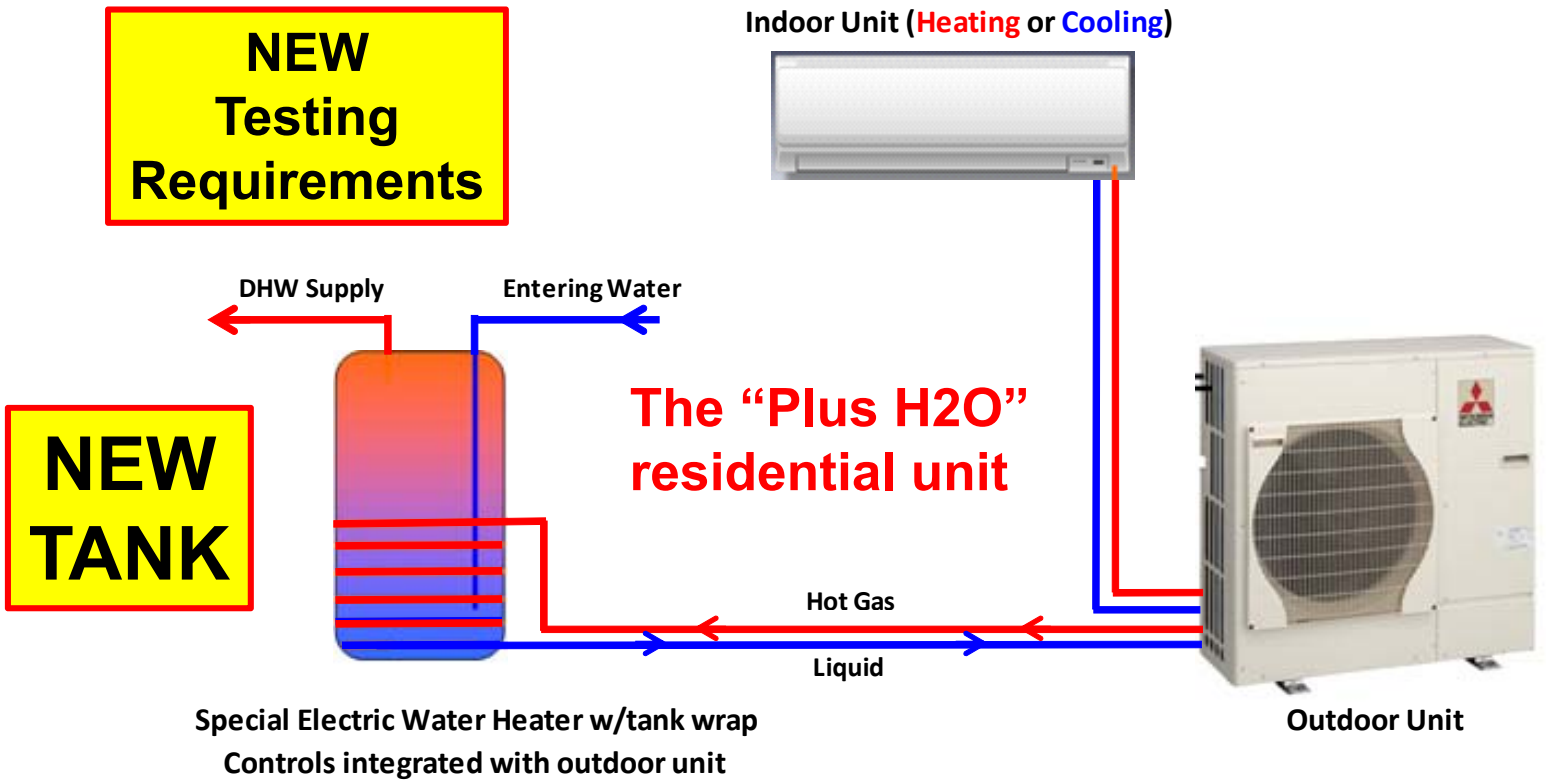
**The heating runtime captured was in milder weather. We expect that as we get into colder weather that we'll see a decrease in HSPF.

Changes for the Mitsubishi Residential System for Conditioning Space and Heating Water

Active Water Heating System **-** Can provide water heating

Air Source Variable Speed

NEW Testing Requirements



NEW TESTING REQUIREMENTS

Updated First-Hour-Rating Test

NEW Testing Requirements

- Water temperature measured at delivery
- Set point temperature reduced to 125 °F
- Result determines procedure for energy factor test

NEW Testing Requirements

Updated Simulated-Usage Test

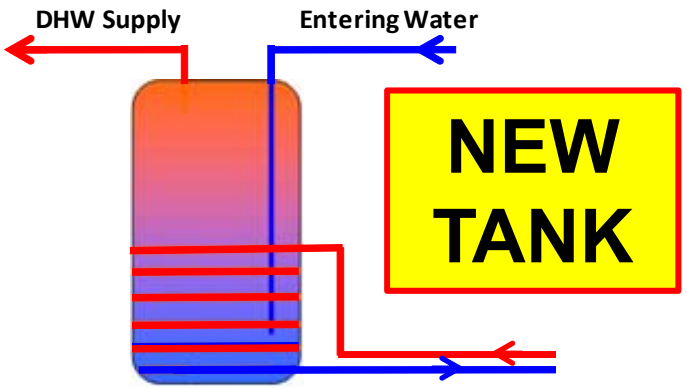
NEW Testing Requirements

- Previous Energy Factor (EF) replaced with Uniform Energy Factor (UEF)
- Draw pattern dependent on First-Hour-Rating test result
- Draws vary in length, flow rate, and quantity

NEW TANK

Active Water Heating System - Can provide water heating anytime

How can we make it better?



Special Electric Water Heater w/tank wrap
Controls integrated with outdoor unit

ADVANTAGES of New Tank

- Sized right to fit old tank's space
- More efficient materials
- Better testing results
- No "cold blow" inside
- Going into a closet not a problem

Mitsubishi Residential System for Conditioning Space and Heating Water

Available Modes

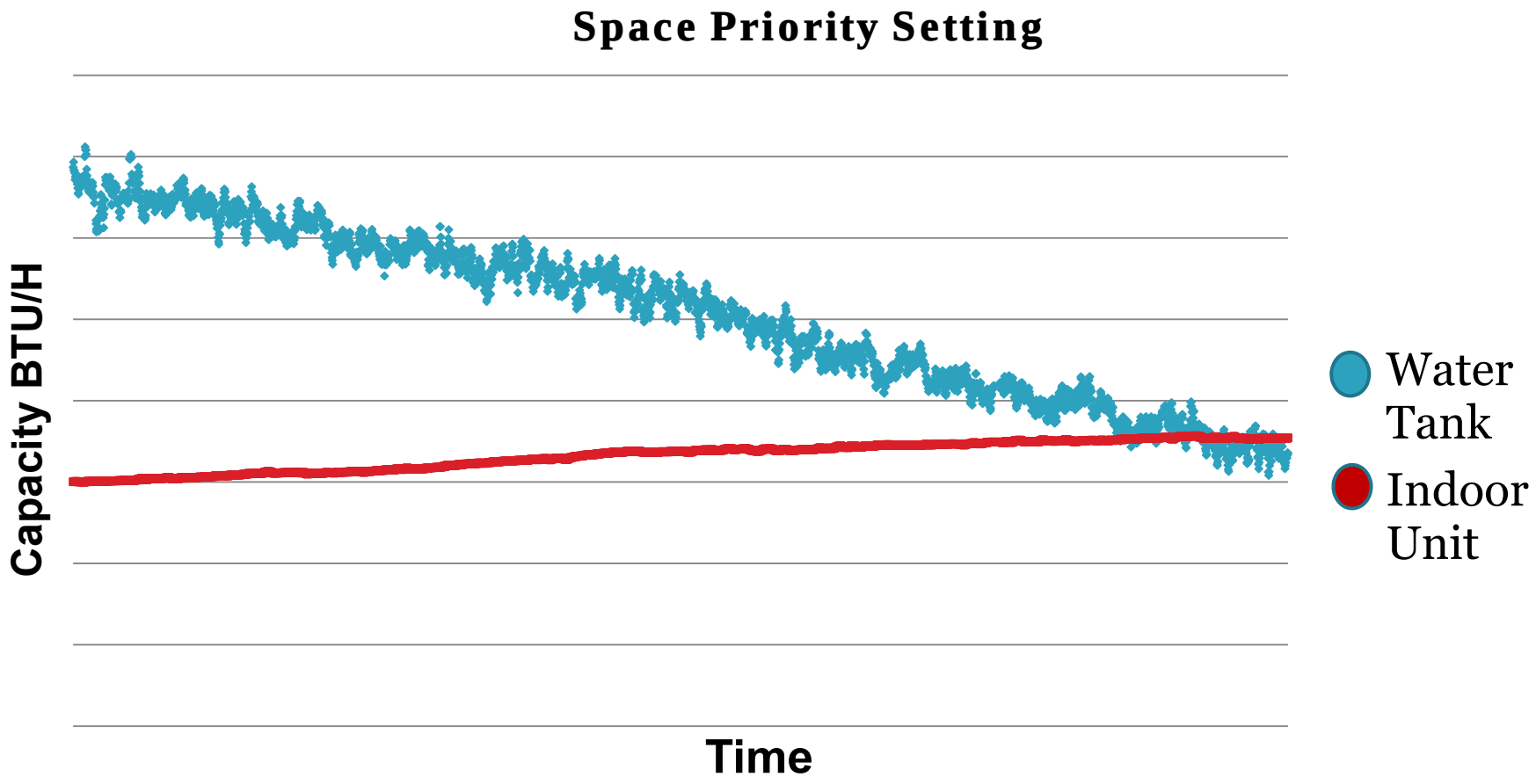
- Heating Space
- Cooling Space
- Heating Space + DHW
- Cooling Space + DHW (Heat Recovery)
- Dedicated Water Heating Only

BONUS!!!
Set System Priorities

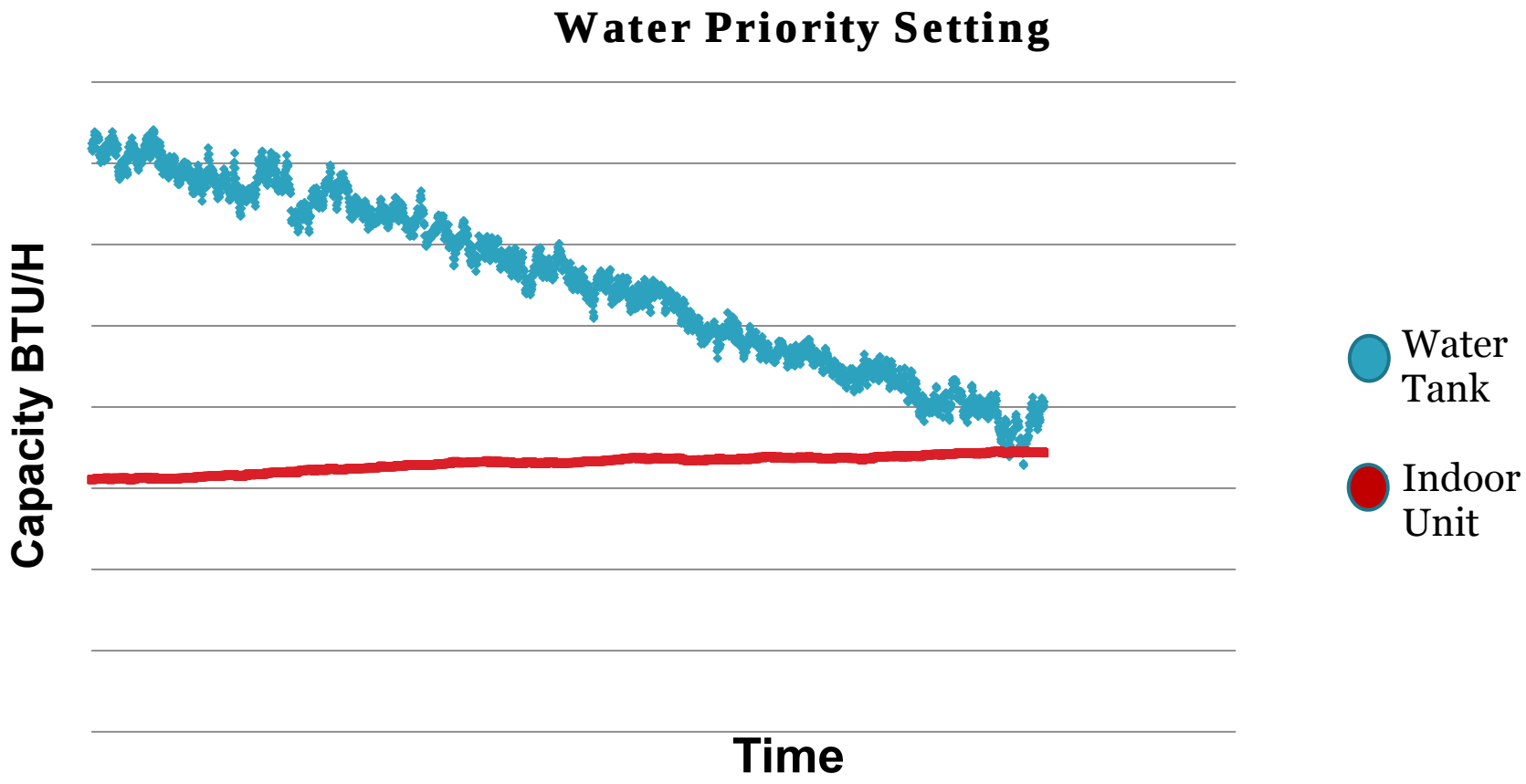
Compressor operates from 20 – 110 Hz. Depending on Mode, Demand and Outdoor Ambient

WHAT ABOUT OTHER SYSTEMS???

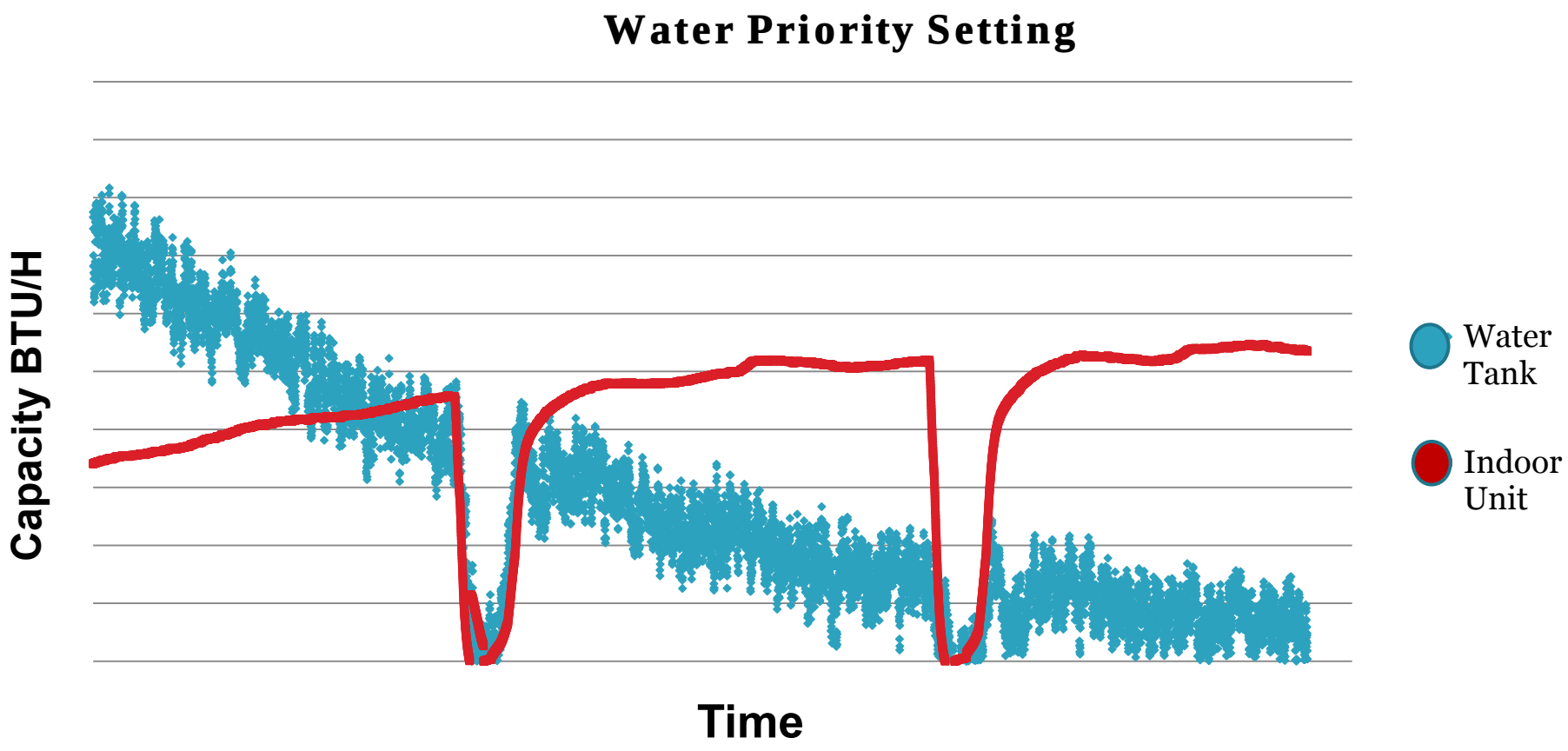
System Priorities - - Space



System Priorities - - Water



How Extreme? How about -4F



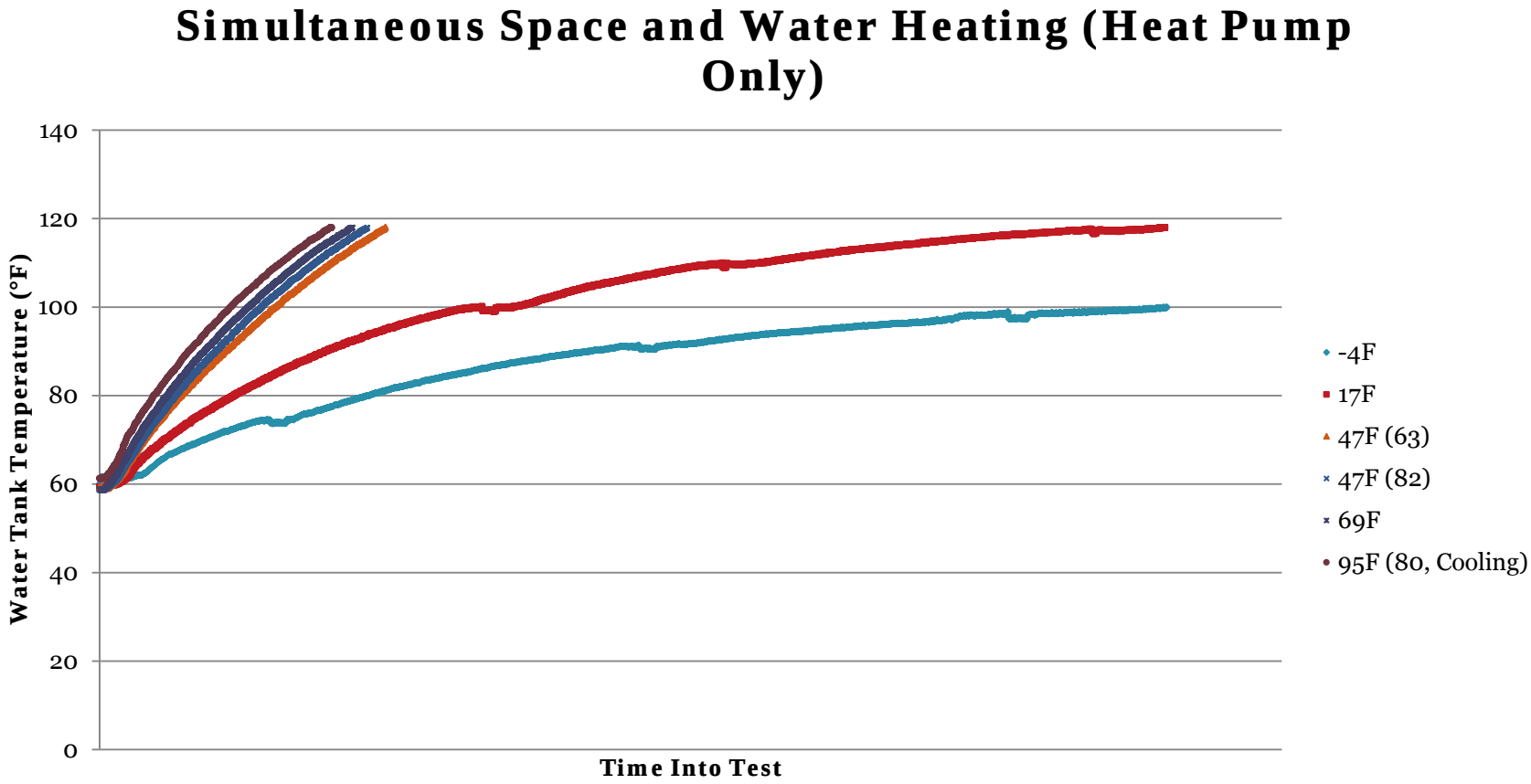
RANDOM QUESTION???

What is the average water temperature for a shower?

We heat the water to 125˚F

ANSWER = 105 to 106˚F

Simultaneous



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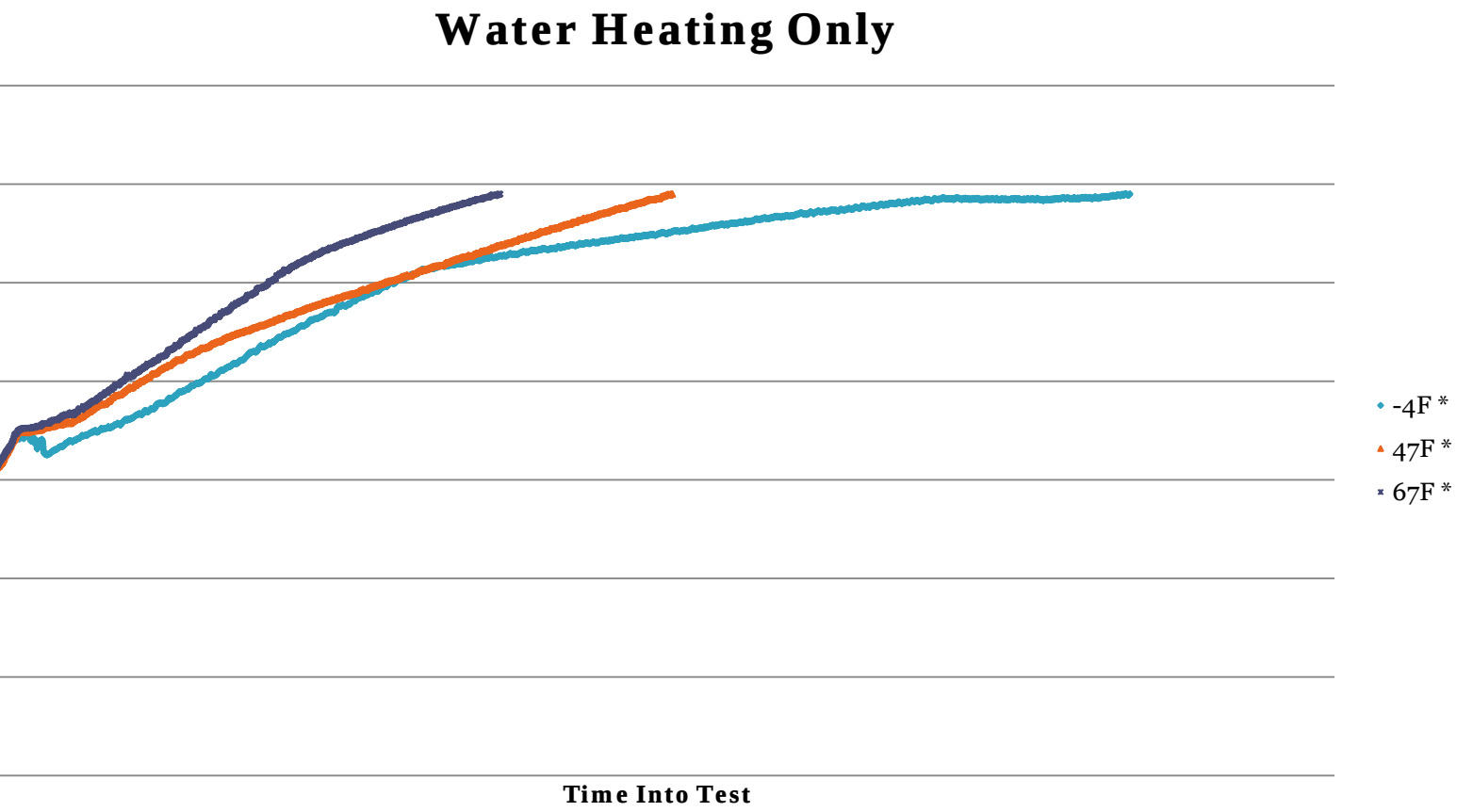

SURVEY

dentifying Test Results

system may operate is several modes:

- Space Conditioning
  - Space cooling → **SEER**
  - Space Heating → **HSPF**
- Water Heating → **EF** → **UEF**
- Space heating and water heating **Most Challenging**
- Space cooling and water he **st EFFICIENT**

otential Target Markets

Single-family (electric space + electric water)

- **95% baseboard heated homes – 478k homes**
- **100% eFAF homes – 224k homes**

SF new construction (low load homes)

Manufactured homes (new and retrofit)

Multi-family?

The MARKET is there!

The NEED is there!

Meeting CUSTOMER expectations…

A BETTER System

At the RIGHT price

Or with a little help from our friends

At the RIGHT…

energy savings