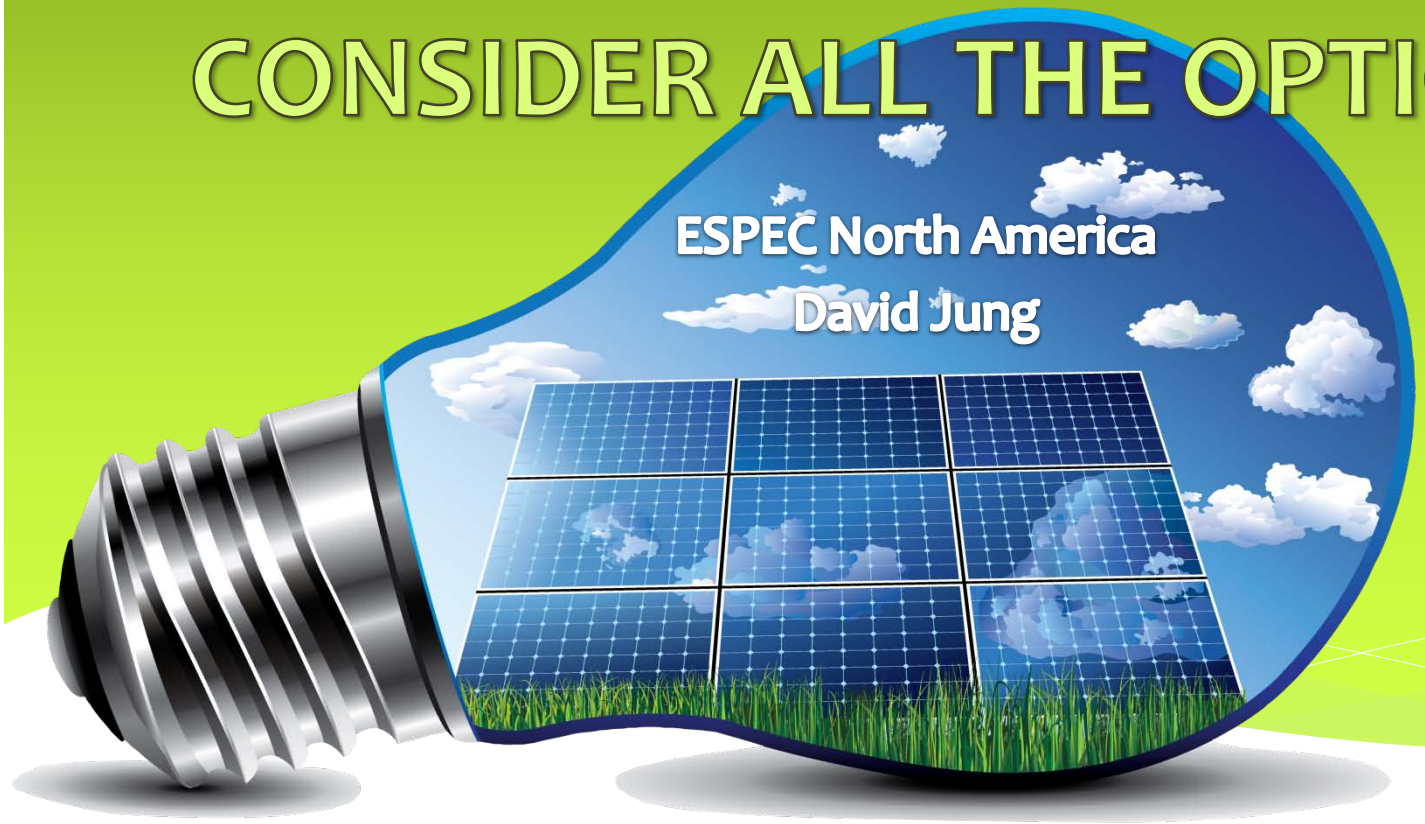
Test Chamber Brainstorming

CONSIDER ALL THE OPTIONS



ESPEC North America

David Jung

VOTE FOR YOUR FAVORITES

* Which test expansions are most worth consideration?
* And/or which test "issues" are most worth addressing?
* **Why? What benefits?**
* Have more details, add a Post-it!

Why brainstorming?

* As a chamber manufacturer, we want you to explore the possibilities and limitations of what our chambers can do for PV testing.
* The existing tests have problems that may be impeding success.
* Many of these items may have been addressed in individual R&D or situations, but should also be considered for reliability benefits.

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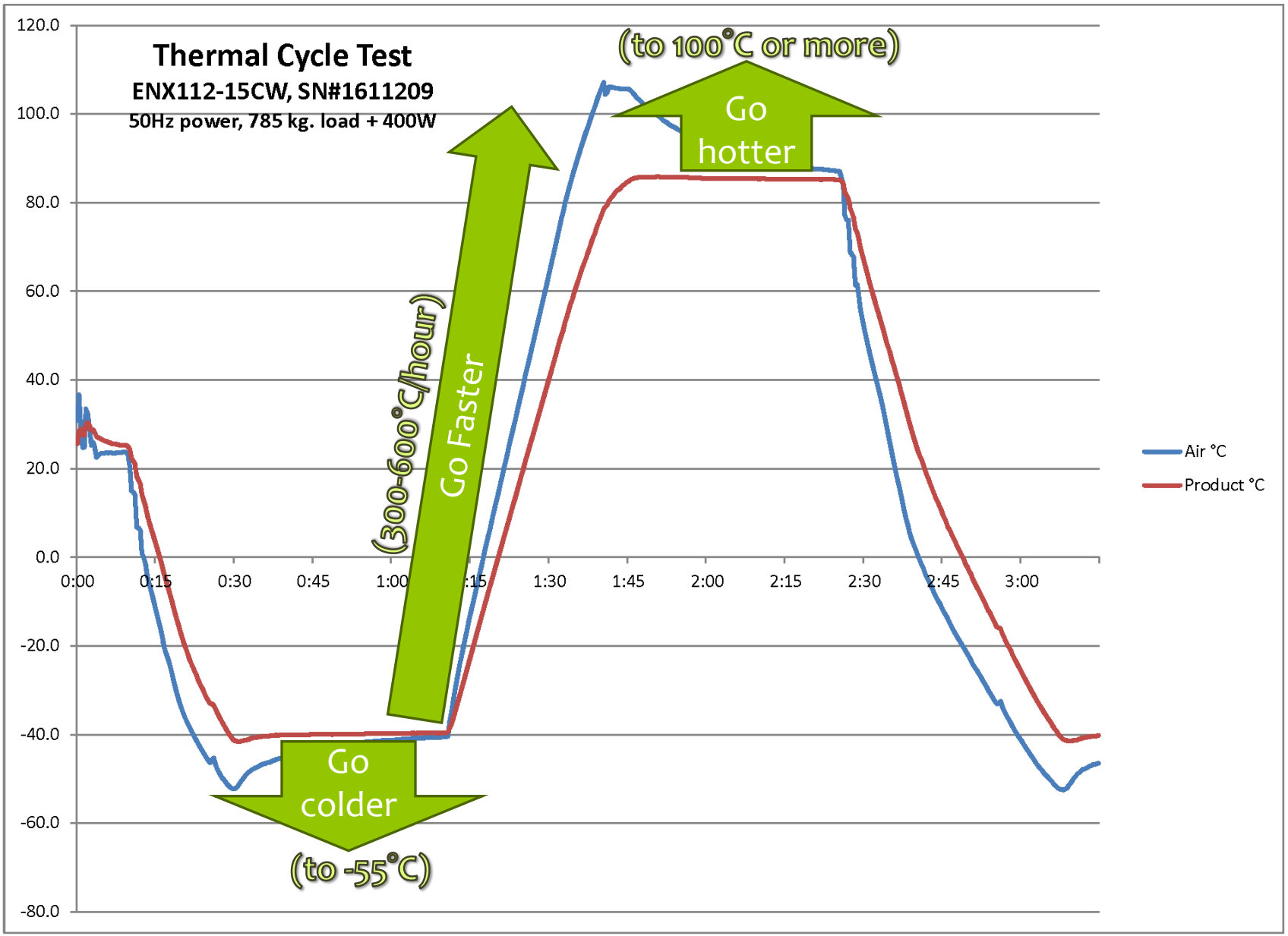
Temperature Cycling

* Current: Testing to -40 to 85°C, ramping at 44-100°C/hr

* EASY: Wider temp range = more stress
* MEDIUM: Faster ramping = more stress, time savings
  * Most modern chambers can go faster than 100C/hr
  * Faster rate is inversely proportional to # panels tested
* **PROBLEM: How is "max" ramping defined and controlled?**

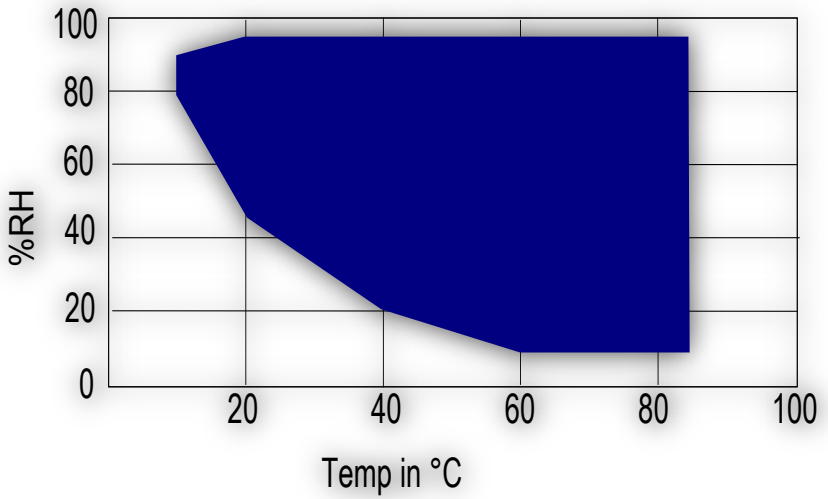

Thermal Cycle Test
ENX112-15CW, SN#1611209
50Hz power, 785 kg. load + 400W
(to 100°C or more)
Go hotter
Go Faster
(300-600°C/hour)
Go colder
(to -55°C)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
0:00
0:15
0:30
0:45
1:00
1:30
1:45
2:00
2:15
2:30
2:45
3:00
Air °C
Product °C

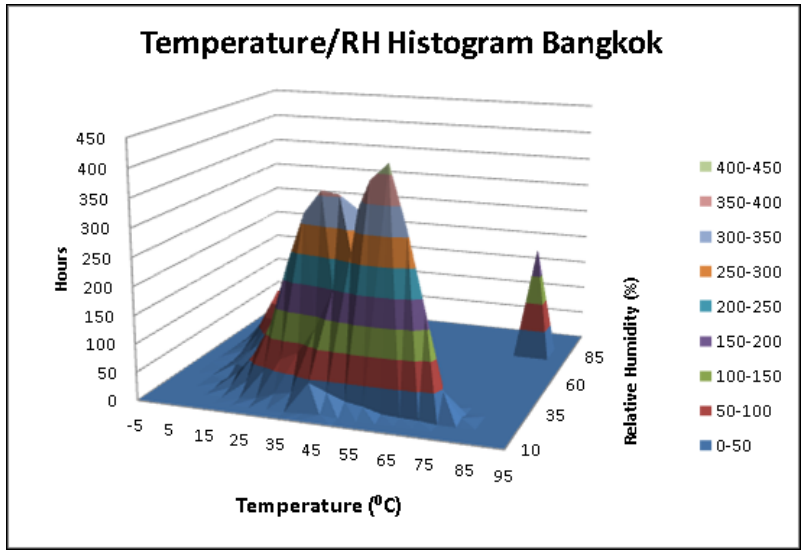
Damp Heat

* Current: Damp heat 85°C/85%

* EASY: 85°C/95% with existing chambers
* HARD: Higher than 85°C with humidity
* NEW:
  * Lower humidity? Or dry?
  * HAST: 120°C / 85-100%
  * Drop in favor of HF (like UL 1701)

Humidity Options



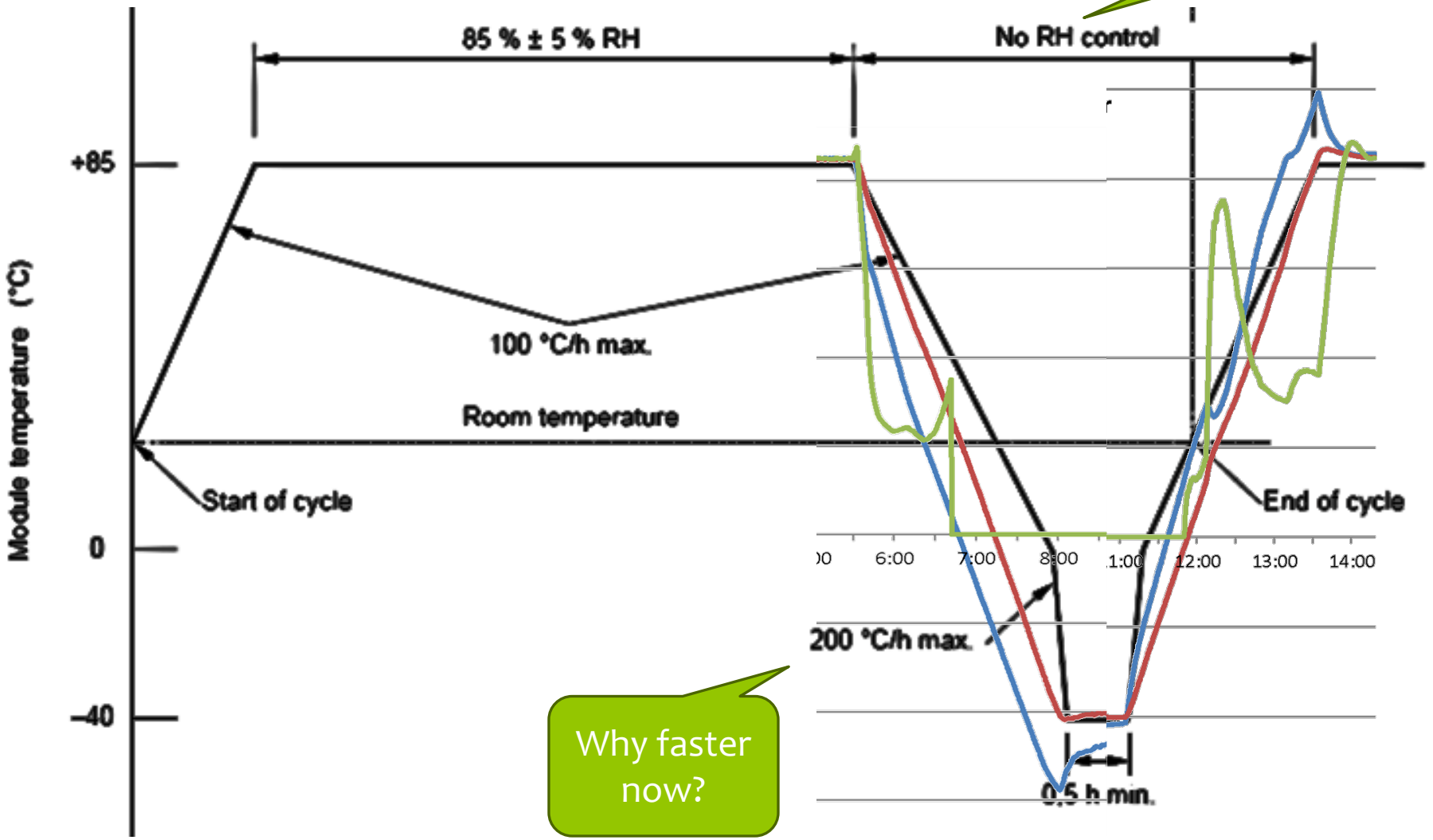


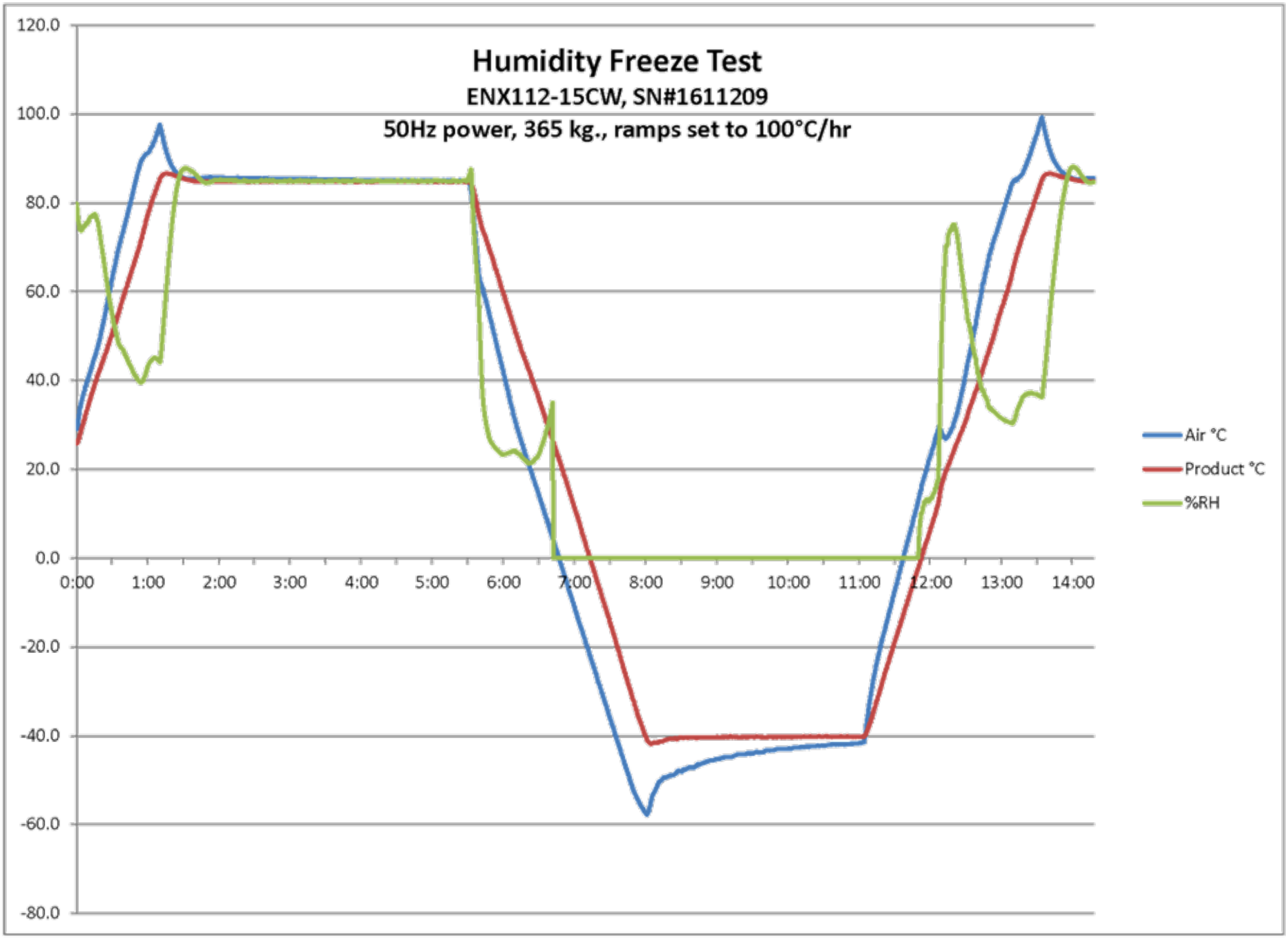
* Typical test chamber capability * Real-world humidity exposure

Humidity Freeze

* CURRENT: Cycle between -40 and 85/85, then soak for 20 hours
  * Any real ways to improve this test?
  * Is sequential DH and TC tests better?
* ISSUES:
  * Start/stop of humidity is highly variable by chamber and operator, not defined in IEC.
  * 61646 & 61215 define RH start/stop differently
  * Ramp rate restricted to 100, then 200°C/hr. Why?
  * Definition of 'max' ramp rate needed: linear or average?
  * Should moisture condense (or not) during ramping?

HF Complications




Humidity Freeze Test
ENX112-15CW, SN#1611209
50Hz power, 365 kg., ramps set to 100°C/hr
120.0
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
Air °C
Product °C
%RH

Dew/Condensation
A REAL-LIFE STRESS

* PROBLEM: Humidity-freeze not designed to create dew

* MEDIUM (modification or new chamber):
  * Slower airflow to ensure dew creation
  * Faster heat-up to ensure greater air/module temp delta
    * Make heat-up NOT panel-temperature controlled
* HARD (test definition change):
  * Find best timing and settings to create dew and standardize
  * See GR-CORE 326 method 4.4.2.4

* Benefit: Up to 50% of real-world exposure involves dew/moisture

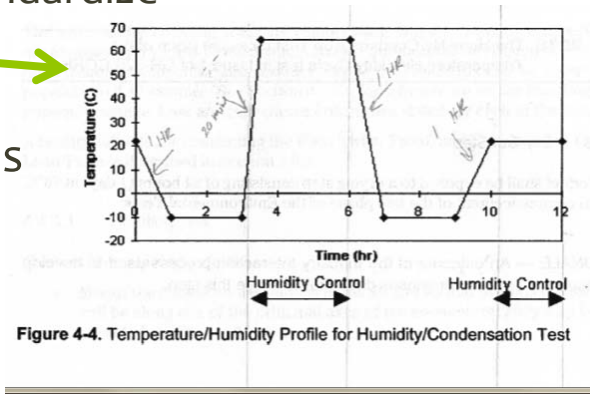


Figure 4-4. Temperature/Humidity Profile for Humidity/Condensation Test

Rain

EASY TO ADD SPRAY. ANY VALUE?

* Current: None
* MEDIUM (Special chamber feature):
  * Atomizing spray for near 100% humidity
  * Misting spray on panels
  * Water and chamber can be at different temps.
* Benefits: Simulate real-world; create dew during high humidity; overcome radiant UV heating to maintain humidity

Lighting (UV/Sun/IR)
CAN THIS BE MADE REASONABLE?

* Current: UV as preconditioning (sequential test)
* MEDIUM (Specialized equipment):
  * Combined UV with temp/humidity chamber
* Benefits: UV increases stress with humidity
* Issues: Large, expensive chamber, low thru-put, lamp heat

Radiant Radiation
HOW ABOUT A PANEL TOASTER?

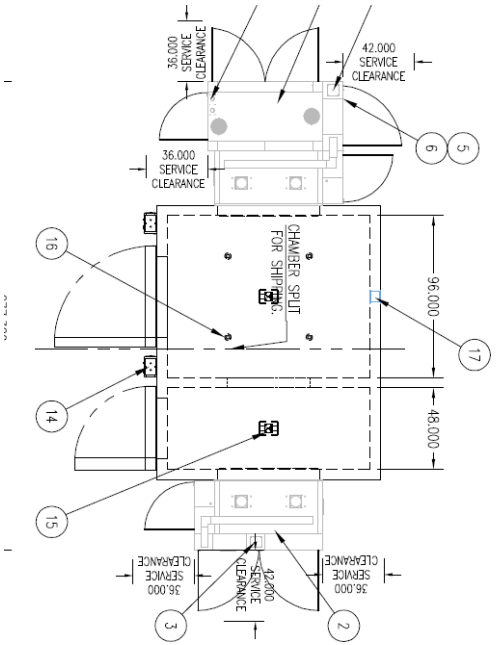
* Current: None
* PROBLEM: Chambers are designed with convection heat/cool (blowing air), but PV experience radiant heat

* HARD (New test & chamber type)
  * Imagine a ‘solar panel toaster’
  * Can wire heaters stand-in for solar radiation?

* Benefit: Simulate real-world stress; skip complexity of UV
* Risk: Unproven shortcut

Front/back Dissimilarities
TESTING VERSUS REAL-WORLD

* Current: None
* MEDIUM:
  * Two section chamber, with different temperatures on each side
  * T/H/UV chambers do this intrinsically
* BENEFIT: Real-world thermal stress because of dissimilar temperatures



Added variables
Can be added to chambers

* Ammonia
* Salt
* Vibration
* Vacuum or Pressure
* Electrical loading stress to panels