Comprehensive PV Durability Testing

The Atlas 25PLUS Testing Process

Module A

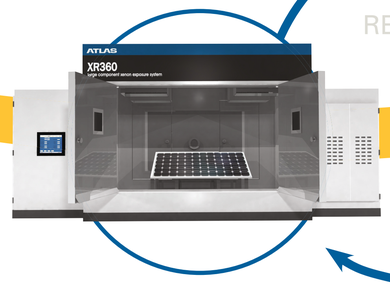
One PV module is run through the Atlas 25PLUS testing sequence over the course of 12 months.

ATLAS 25+ Comprehen ive PV Dura ility Tes ing

1 UV Conditioning

2 Salt Spray Corrosion

3 Condensing Humidity

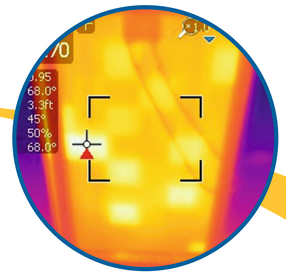


4 Solar/Thermal/ Humidity Cycle

REPEATING CYCLE

5 Solar/Thermal/ Humidity/Freeze Cycle

6 Arizona Solar Tracking including peak summer



7 Initial, final and multiple interval measurements

Visual inspections, IV curves, infrared thermographs and digital photography included.

8 Results and data

Completion of the Atlas 25PLUS program provides test data that would be otherwise unattainable with current test methods.

A report details all data, images and analyses at the end of the one year test sequence.

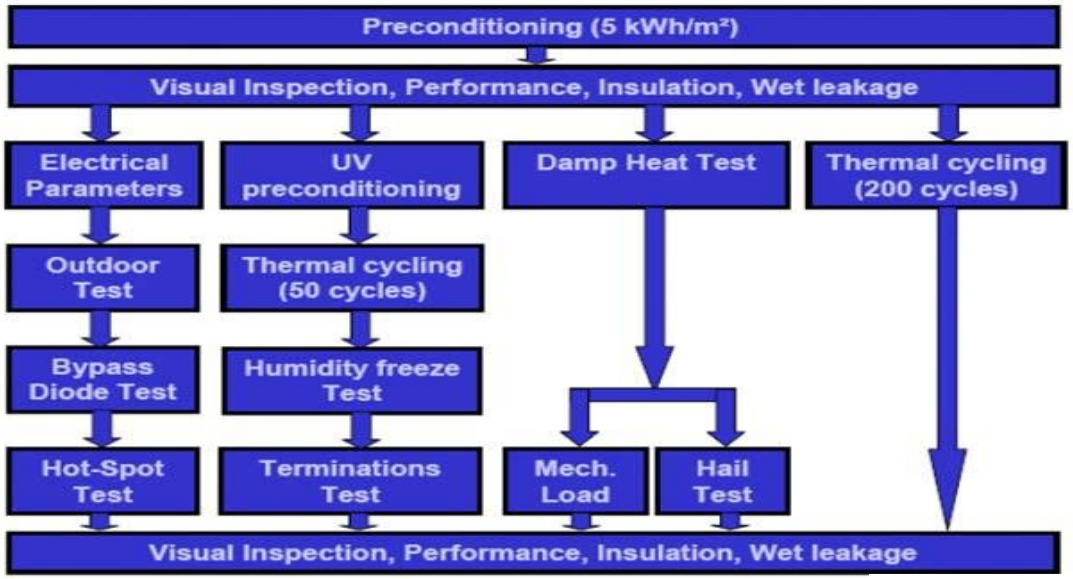
Modules B & C

Two modules provide baseline data using outdoor solar tracking in subtropical South Florida and the arid Arizona Sonoran desert for one year.

ATLAS TESTED 25+

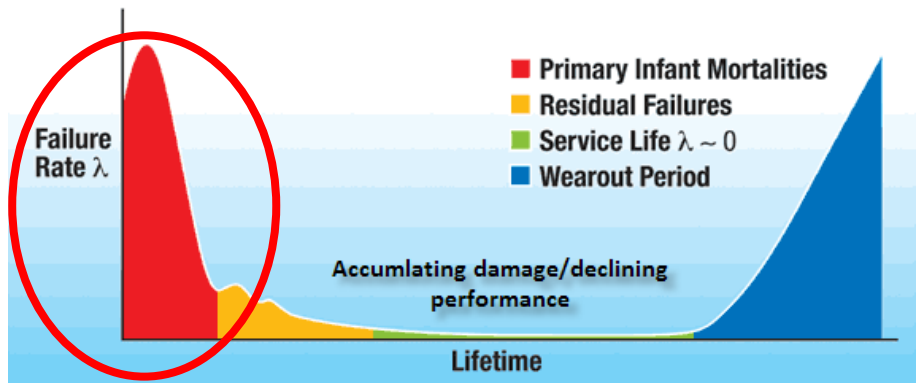
To learn more about the Atlas 25PLUS Program,
contact your local Atlas Sales Representative
or visit us online at **www.solardurability.com**

IEC design type qualification tests



IEC 61215 environmental tests

IEC 61646 environmental tests are similar



IEC and weathering methods

Design Qualification environmental tests	Atlas module weathering tests
Intent: Accelerated tests to screen for major materials design and manufacturing flaws which result in premature (infant mortality) failures.	**Intent: Accelerated environmental durability tests to reproduce likely field failures and estimate service life. Tests target failures resulting for the accumulated damage of long term outdoor exposure.**
Climate Stresses: E.g. Temperature-only cycling; UV-only exposure; Humidity-Freeze cycling; Damp-Heat. Most tests delivered to separate modules.	**Climate Stresses (comprehensive): Alternating cycles of SolarSim-Temperature-Humidity and SolarSim-Temperature-Humidity-Freeze; additional UV, salt spray, condensing humidity and outdoor solar tracking (AZ,FL). Modules under solar operate at max power point.**
Stress levels and delivery not representative of end-use: No module goes through all tests; limited to 1 or 2 stresses, e.g., thermal cycling, damp heat, humidity-freeze.	**Stress levels based on climate-derived conditions: Multiple simultaneous stresses delivered in short and long term cycles and at levels more representative of nature.** **"Global Composite" climate condition standard; alternative Hot Arid Desert, Tropical/Subtropical or Northern Temperate climate conditions available.** **Optional test modifiers: Coastal/Marine; Alpine/Snow Load; Urban Industrial; Agricultural Chemicals, Dust-Dirt, Acid Rain, Mildew effects.**

ATLAS
MATERIAL TESTING SOLUTIONS

IEC and weathering methods

Design Qualification environmental tests	Atlas module weathering tests
Corrosion Testing: **Limited to Damp-Heat test**	**Salt Spray and Condensing Humidity tests and outdoor exposures included.**
No long term outdoor exposure. **IEC cautions about shortness of test; most tests are chamber-based with limited stresses.**	**Uses combination of lab accelerated and outdoor solar tracking exposures with additional outdoor reference modules on one-year exposure in Arizona and Florida.**
Few cycles but under harsh conditions: **Designed to stress for infant mortality failures; may induce failures which will not occur in service**	**Higher number of cycles (diurnal >1500) under climate derived conditions designed to stress to longer term environmental effects.**
Modules exposed non-operational **Only short outdoor test is electrically active under load.**	**Modules exposed during solar load (lab and outdoor) operated under resistive load at maximum power point.**
Solar Load: **No solar load in chamber tests – modules at chamber temperature**	**Modules primarily under full spectrum solar load (natural or SolarSim) for differential heating and solar load effects.** **Max module temperature typically < 90°C**

ATLAS
MATERIAL TESTING SOLUTIONS

Weathering cycle

Atlas 25*Plus* "global composite" environmental test cycle
(other climates available)

1 module

- UV conditioning
- Salt spray corrosion
- Condensing humidity
- Solar – Thermal – Humidity Cycle
- Solar – Thermal – Humidity/Freeze Cycle
- Arizona solar tracking including peak summer

1 module FL 1 module AZ

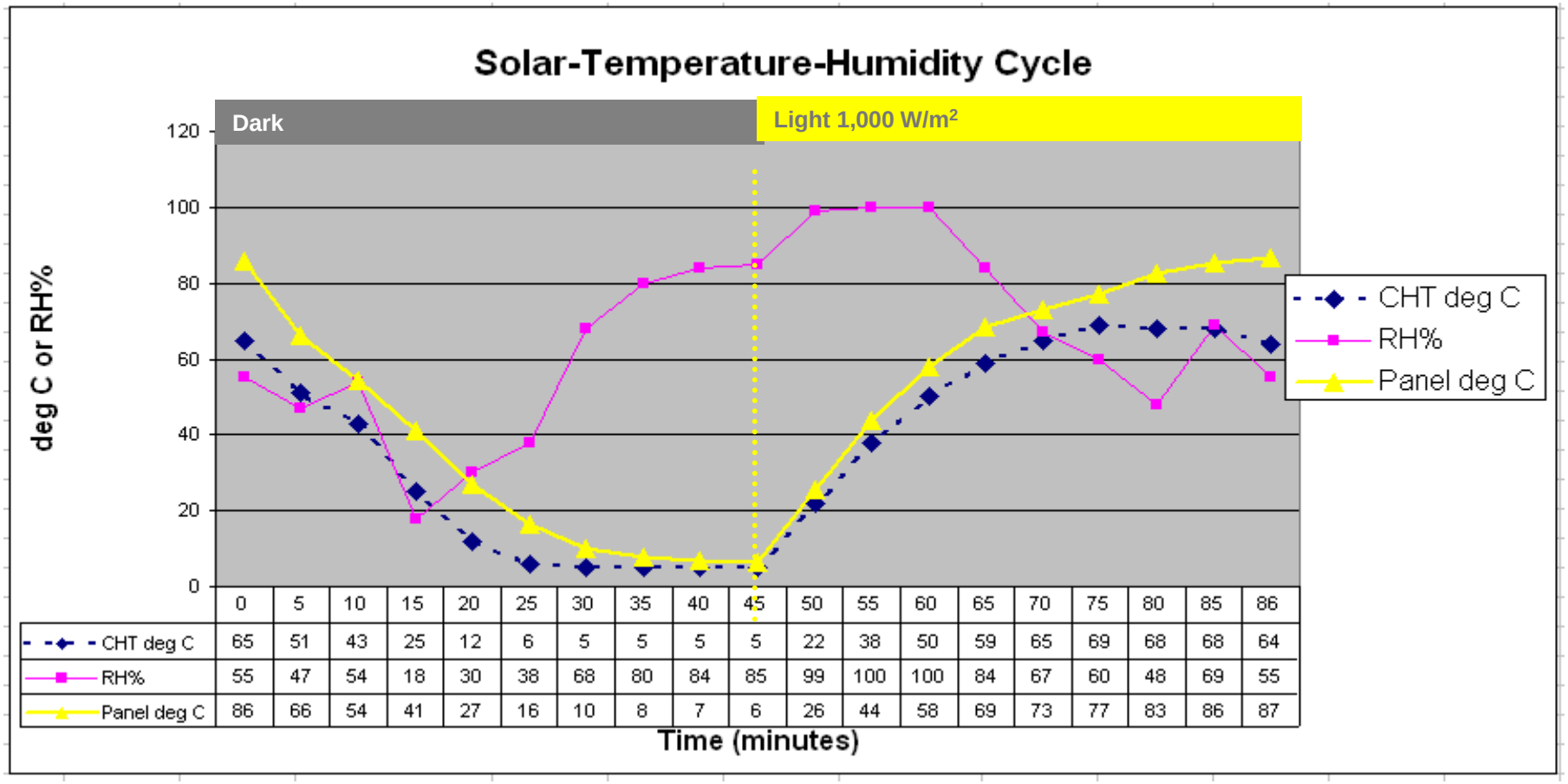
1-year solar tracking South Florida & Arizona

Total test program duration: 12 months

ATLAS MATERIAL TESTING SOLUTIONS

	Arid Desert	Tropical / Subtropical	Northern Temperate	"Global"
Corrosion	N/A (optional)	ISO 9227, ASTM B117 200 hours; 5% NaCl pH 6.5-7.2, 35°C, 1.0 to 2.5ml/80cm²/hour "Neutral Salt Spray Test"	ISO 9227, ASTM B117 400 hours; 5% NaCl pH 6.5-7.2, 35°C, 1.0 to 2.5ml/80cm²/hour "Neutral Salt Spray Test"	ISO 9227, ASTM B117 400 hours; 5% NaCl pH 6.5-7.2, 35°C, 1.0 to 2.5ml/80cm²/hour "Neutral Salt Spray Test"
Condensing Humidity	ASTM D2247, 125 hours @38°C or ISO 6270 40 °C	ASTM D2247, 125 hours @38°C or ISO 6270 40 °C	ASTM D2247, 125 hours @38°C or ISO 6270 40 °C	ASTM D2247, 125 hours @38°C or ISO 6270 40 °C
UV preconditioning	IEC 61215 to 30 kWh/m² (~28 days) UVA/UVB	IEC 61215 to 30 kWh/m² (~28 days) UVA/UVB	IEC 61215 to 30 kWh/m² (~28 days) UVA/UVB	IEC 61215 to 30 kWh/m² (~28 days) UVA/UVB
Humidity Cycle with simultaneous Solar SC 2000 or Enviromental Chamber w/Solar	control off at 40°C) and 65°C →5 °C (dark) in 25 min, hold 20 min, ramp up (light 1100 W/m²) 21 minutes, hold 20 min; repeat Cycle time 86 minutes 16.7cycles per day repeat 9.5 days (158 cycles)	control off at 40°C) and 65°C →15 °C (dark) in 25 min, hold 20 min, ramp up (light 1100 W/m²) 21 minutes, hold 20 min; repeat Cycle time 86 minutes 16.7cycles per day repeat 7 days (117 cycles	control off at 40°C) and 65°C →5 °C (dark) in 25 min, hold 20 min, ramp up (light 1100 W/m²) 21 minutes, hold 20 min; repeat Cycle time 86 minutes 16.7cycles per day repeat 7 days (117 cycles	control off at 40°C) and 65°C →5 °C (dark) in 25 min, hold 20 min, ramp up (light 1100 W/m²) 21 minutes, hold 20 min; repeat Cycle time 86 minutes 16.7cycles per day repeat 7 days (117 cycles)
Temperature-Humidity Freeze Cycle with Solar	55% RH (turn RH% control off at 40°C) and 65°C →-10 °C (dark) in 40 min), hold 20 min, ramp up (light 1100 W/m²) 25 minutes, hold 20 min; 105 minute cycle, 13.7 cycles/day, repeat 0.5 day (7 cycles) [4% of total 10 day cycles are freeze]	N/A 55% RH (turn RH% control off at 40°C) and 65°C →-+5 °C (dark) in 40 min), hold 20 min, ramp up (light 1100 W/m²) 25 minutes, hold 20 min; 105 minute cycle, 13.7 cycles/day, repeat 3 days (44 cycles) *No freeze in tropics*	55% RH (turn RH% control off at 40°C) and 65°C →-10 °C (dark) in 40 min), hold 20 min, ramp up (light 1100 W/m²) 25 minutes, hold 20 min; 105 minute cycle, 13.7 cycles/day, repeat 3 days (44 cycles) [27% of total 10 day cycles are freeze]	55% RH (turn RH% control off at 40°C) and 65°C →-10 °C (dark) in 40 min), hold 20 min, ramp up (light 1100 W/m²) 25 minutes, hold 20 min; 105 minute cycle, 13.7 cycles/day, repeat 3 days (44 cycles) [27% of total 10 day cycles are freeze]

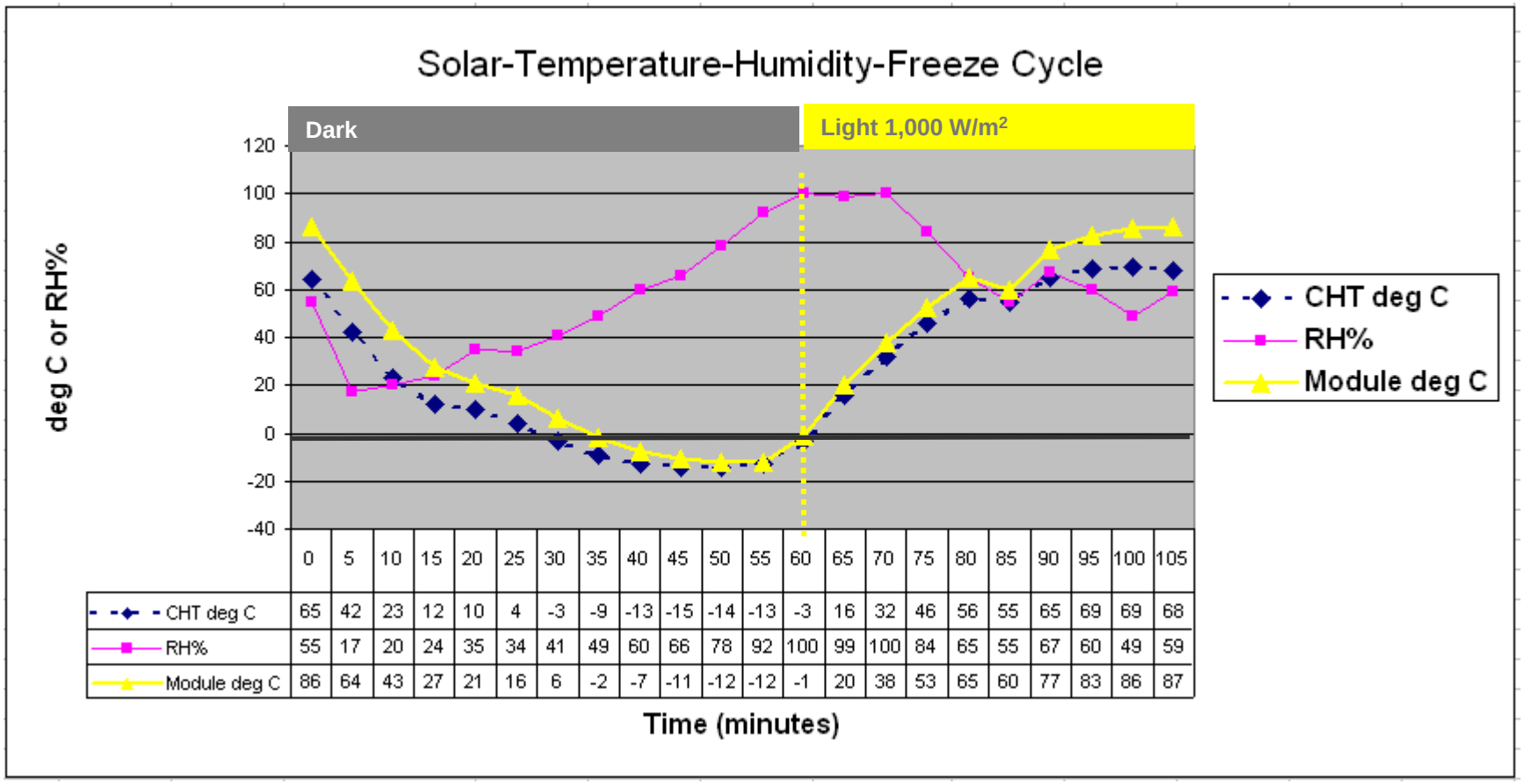
Module temperature tracking



	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	86
CHT deg C	65	51	43	25	12	6	5	5	5	5	22	38	50	59	65	69	68	68	64
RH%	55	47	54	18	30	38	68	80	84	85	99	100	100	84	67	60	48	69	55
Panel deg C	86	66	54	41	27	16	10	8	7	6	26	44	58	69	73	77	83	86	87

ATLAS
MATERIAL TESTING SOLUTIONS

Module temperature tracking

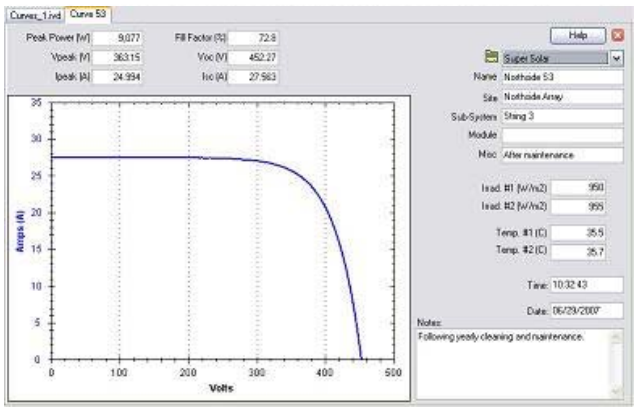


	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
CHT deg C	65	42	23	12	10	4	-3	-9	-13	-15	-14	-13	-3	16	32	46	56	55	65	69	69	68
RH%	55	17	20	24	35	34	41	49	60	66	78	92	100	99	100	84	65	55	67	60	49	59
Module deg C	86	64	43	27	21	16	6	-2	-7	-11	-12	-12	-1	20	38	53	65	60	77	83	86	87

ATLAS
MATERIAL TESTING SOLUTIONS

Monitoring


info
setup


Curves_1.ivd
Curve 53
Peak Power (W) 9.077
Fill Factor (%) 72.8
Vpeak (V) 363.15
Voc (V) 452.27
Ipeak (A) 24.994
Isc (A) 27.983
Help
Super Solar
Name Northside 53
Site Northside Array
Sub-System String 3
Module
Misc After maintenance
Insol. #1 (W/m2) 950
Insol. #2 (W/m2) 955
Temp. #1 (C) 35.5
Temp. #2 (C) 35.7
Time: 10:32:43
Date: 06/23/2007
Notes:
Following yearly cleaning and maintenance.
Amps (A)
Volts
0
5
10
15
20
25
30
35
100
200
300
400
500


Area
Max. 170
°F
ε 0.95
Refl. T 68.0°
Dist 3.3ft
FOV 45°
Rel. H 50%
Atm. T 68.0°
172
11.9
FLIR
08/24/09
14:37