



# Insurability, Bankability, Investability

Dr. Edward Hsi



# Swiss Re's Solar Panel Code of Practice



## Solar Panel Code of Practice

International guideline on the risk management and sustainability of solar panel warranty insurance



### Acknowledgements

The research we present herein draws extensively on the work of and/or discussions with many reputable institutions and individuals. In particular, we would like to acknowledge the following for their contributions to the advancing of PV reliability and/or this research.

- National Renewable Energy Laboratory (NREL) – Dr. Sarah Kurtz, Dr. John Wohlgemuth, Dr. Ingrid Repins, Dr. Peter Hacke, Dr. Nick Bosco
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- Telecom Technology Center Green Communications Laboratory (TTC) – Dr. M. H. Weng, Ryan Chiu, Christina Chang, Talo Wang
- PVGuider – Dr. Jay Lin

### Authors



**Jay Li, Director, Head of Engineering China, Swiss Re**

Jay is Head of Engineering, China and a Level 4 (top-tier) underwriter of Global Engineering, Swiss Re. Jay has extensive underwriting and hands-on risk management experience in various industries and has been a key contributor to international risk management best practice on Renewable Energies (PV and Off-shore Wind) and Underground Metro. Jay has a Bachelor of Science Degree in Mechanical Engineering and is also an MBA.



**Edward Hsi, Senior Consultant, Swiss Re**

Dr. Hsi has worked for Swiss Re for over 20 years in different roles including Senior Consultant, Global Chief Engineer, Greater China and Japan Underwriting Manager, Portfolio Manager and more. He has co-authored PV reliability papers (with NREL, UL, EU JRC, AIST, and Wells Fargo) for IEEE PVSC and European PVSEC and is a regular reviewer for IEEE Transactions on Smart Grid, Power System, and Power Delivery. He has a PhD in Electrical Engineering and is also a Chartered Financial Analyst (CFA).

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About Swiss Re

# This is Swiss Re – RE100 Cofounder, 2014



<https://www.ekoenergy.org/buying-100-renewable-energy-is-becoming-the-new-normal/>

# This is Swiss Re

June, 2017, NY's largest solar array



Source: <https://www.pv-tech.org/news/us-round-up-weschesters-largest-solar-array-community-solar-in-ma-michigan>

# World's Top 20 Reinsurance by Net Written Prem

## Top 10 World's Largest Reinsurance Groups, Ranked by Unaffiliated Gross Premium Written in 2018

EXCERPT

(USD millions)

Ranking	Company Name	Reinsurance Premiums Written				Total Shareholders Funds	Ratios		
		Life & Non-Life		Non-Life Only			Loss	Expense	Combined
		Gross	Net	Gross	Net				
1	Swiss Re Ltd.	36,406	34,042	20,864	20,220	28,727	74.2	32.4	106.6
2	Munich Reinsurance Company	35,814	34,515	23,395	22,570	30,336	65.2	34.2	99.4
3	Hannover Rück SE	21,952	19,791	13,709	12,368	10,923	66.9	29.5	96.4
4	SCOR S.E.	17,466	15,773	7,069	6,115	6,672	66.5	32.8	99.3
5	Berkshire Hathaway Inc.	15,376	15,376	9,930	9,930	352,500	88.6	21.9	110.4
6	Lloyd's	14,064	9,926	14,064	9,926	34,846	72.2	33.8	106.0
7	China Reinsurance (Group) Corporation	11,564	10,681	3,942	3,809	12,689	58.0	40.9	98.8
8	Reinsurance Group of America Inc.	11,341	10,544	N/A	N/A	8,451	N/A	N/A	N/A
9	Great West Lifeco	7,737	7,647	N/A	N/A	20,096	N/A	N/A	N/A
10	Korean Reinsurance Company	6,803	4,786	5,972	4,058	2,014	83.7	17.8	101.5

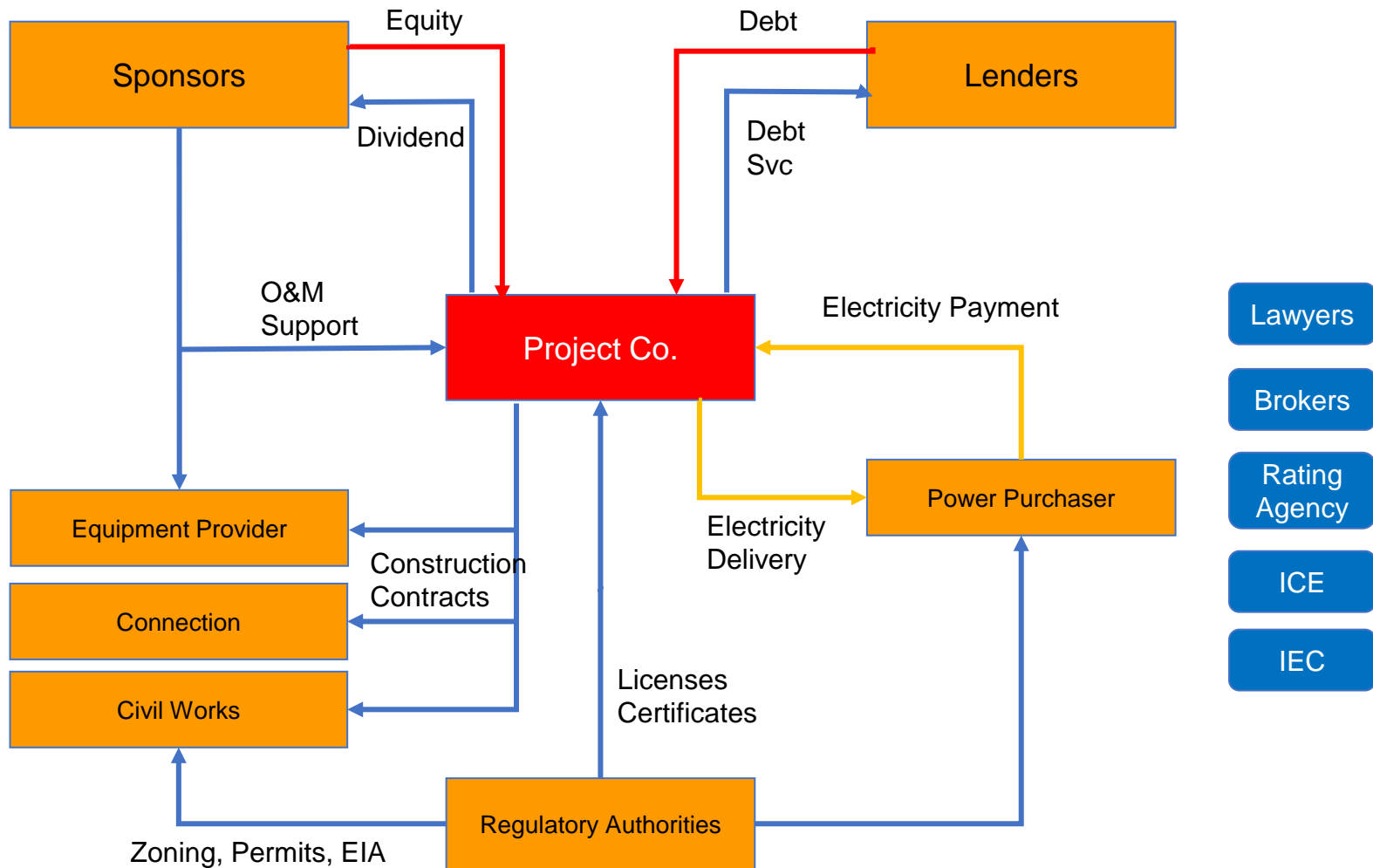
Source: AMBest





# Insurability, Bankability, and Investability

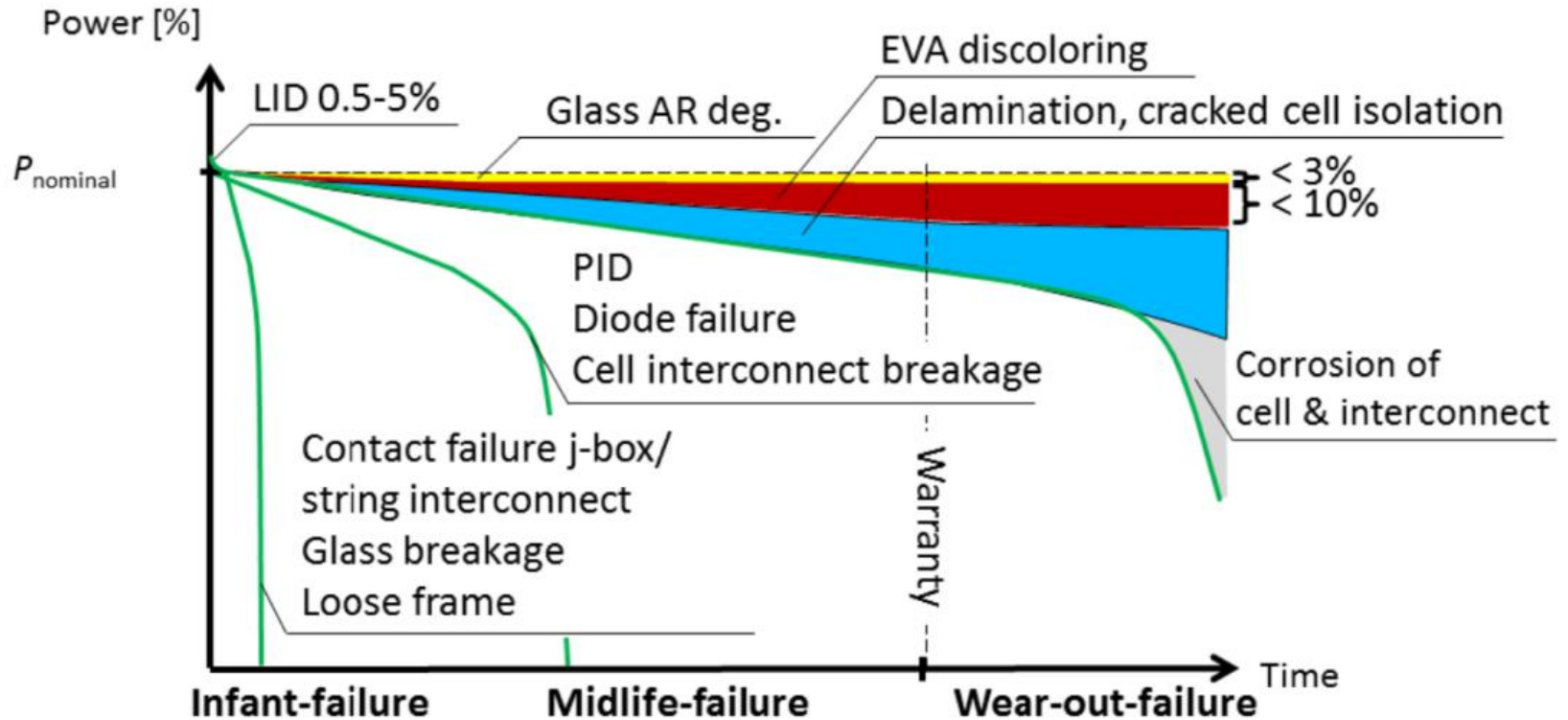
# The Stakeholders



A panoramic photograph of a town with a blue sky and white clouds. The town is visible in the lower portion of the image, with various buildings and greenery. The sky is a clear, vibrant blue with scattered white clouds. The text "Achieving Credibility - Risk Adjusted Testing" is overlaid in white on the image.

# Achieving Credibility - Risk Adjusted Testing

# Failure Modes – Technical View

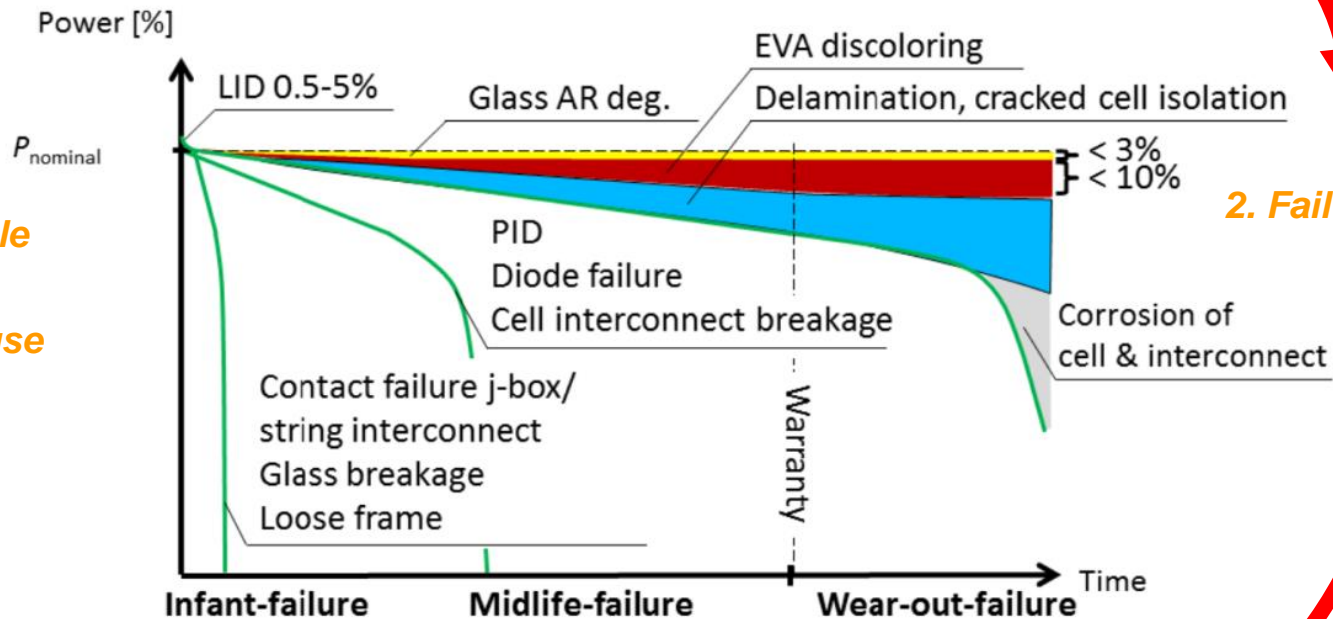


Source: IEA 2014

# Failure Modes – Underwriting View

6. If New Failure Mode...

1. Failure Mode



2. Failure Consequence

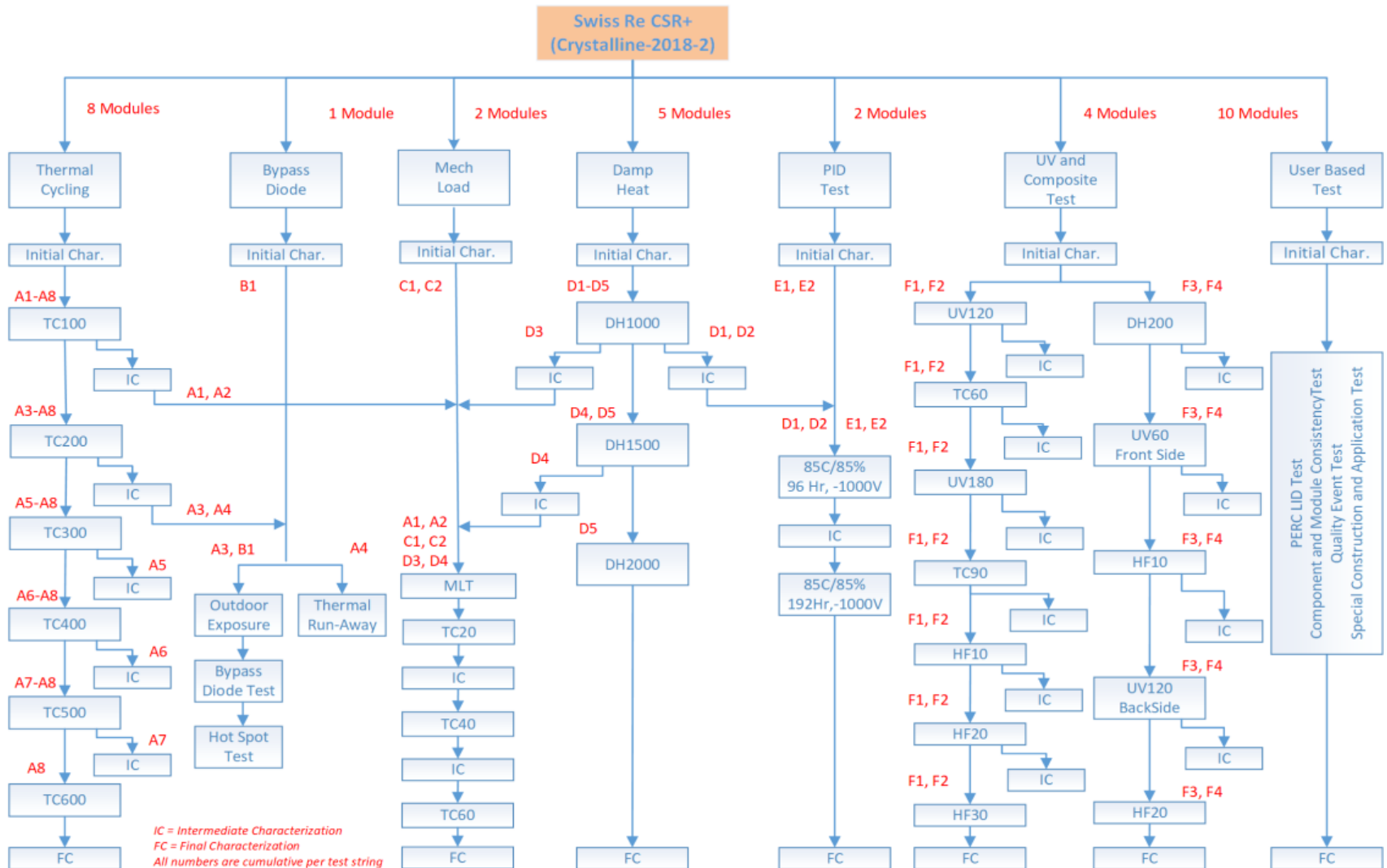
5. Failure Scale

4. Failure Cause

3. Failure Timing

Source: IEA 2014

# Risk Adjusted Testing Chart



# Feedback Loop

		Operation Management		Equipment Management		Quality Management								
No	Process Name	Tasks/Items	SOP/SIP	Equipment	Equipm't Calibration Frequency	Quality Characteristics	Spec (Figure for Illustration Purpose Only and Are Intentionally Distorted)	Inspection Tools	Inspection Frequency (Production)	Inspection Frequency (IPQC)	Records	Corrective Reaction		
17	Framing	Edge Trimming Tape Sealing Framing	Framing Instruction Manual	Trimming Tool Framing Mach	Per Shift Per Shift	Edge Condition Tape Overlap Tape Symmetry Top/Down Completion Time Frame Length Appearance	Smooth and Uniform Edge Tape Overlap Self by 7-12mm Symmetric Frame Work Complete in 25 sec No Gap, No Level Difference Corner Appearance, Parallelism	Visual	100%	5 Pcs/hour	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
18	Junction Box Install	Material Confirmation Adhesion Terminal Insertion Diode Test Potting Appearance Check	J-Box Installation Instruction Manual	Dispenser Diode Tester Caliper Potting Mach	Per Shift Per Shift Per Year Per Shift	BOM Confirmation J-Box Position Silicon Application Terminal Insertion Diode Test Potting Potting Curing Time Appearance	Per Work Order Displacement < 1.7 mm Excess Silicon 1.7~2.7 mm > 12.7 mm 0.7-0.9V Fixed Quantity and Fill Condition Per Recipe Dimension, Position	Visual/Tools	100%	15 Pcs/hour	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
19	Testing	Reference Module Mgm Serial Number Runcard Product Output Test Insulation Resistance Hi-POT Test	Ref Module Management Guidbook Solar Simulator Instruction Manual IV Curve Abnormality Decision Guide Hi-POT Test Abnormality Decision Guide	Ref Module Solar Simulator HiPOT Tester	Per Month Per Shift Per Shift	Reference Module Mgm Bar Code Consistency Apply Parameters Insulation Resistance Hi-POT Test	Ref Module Storage, Calibration Bar Code Consistency Temp 25±1° C, Scan Time/Speed > 100MOhm 3000V, Leak Current< 0.05mA	Solar Simulator	100%	10 Pcs/hour	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
20	EL Test	EL Testing	In-Line EL Testing Instruction Manual EL Test Passing Guideline	EL Tester	Per Day	EL Photo/Cracks	Per EL Test Passing Guideline	EL Tester	100%	10 Pcs/hour	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
21	Final QC Check	Module Classification Protective Paper Angle Appearance Check	Final QC Check Guidline			Power Classification Output Variability Color Classification Protective Paper Cap Appearance	Class A: Power > xxx Watt Variability < 1% Color Consistency Paper Cap on 4 Corners Front/Back/Integrity Check	Visual	100%	10 Pcs/hour	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
22	Packaging	Package Material Barcode Scan Package Content List Packaging Package Belted Carton Label Film Coated Package Appearance	Packaging Instruction Manual	Packaging Tool	Per Shift	Package Material Package Content Packaging Appearance	Per Work Order Per Work Order Packaging Instruction Manual Integrity Check	Visual	100%	1 time /shift	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
23	Outgoing QC	Inventory Management Sampling Reference Module Mgm Power Output Test Insulation Resistance Hi-POT Test Product Name & Qty Appearance	Outgoing QC Instruction Manual	Ref Module Solar Simulator HiPOT Tester	Per Month Per Shift Per Shift	Inventory Management Reference Module Mgm Apply Parameters Insulation Resistance Hi-POT Test	First In - First Out Ref Module Storage, Calibration Temp 25±1° C, Scan Time/Speed > 100MOhm 3000V, Leak Current< 0.05mA	Visual	ISO2859	1 time /shift	Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up		
SS	Specialized PVT	Product Verification Test	PVT Instruction Manual	Autonomous extended test scope to reconfirm mass-produced module performance particularly after recipe change, material supplier change, equipment change, and/or operation staff change.									Check Record IPQC Audit Record	1. Isolation 2. Report to Manager 3. Root Cause Analysis 4. Improvement Measure 5. Follow-up

**Thank You!**