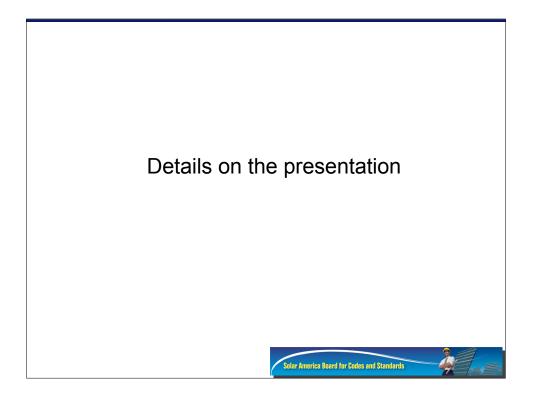


	Accele rate d	g tests of PV modu	Accele rate d
	Accelerated Qualification T esting	Comparative T esting	Life time Testing
Design Quality Confidence	Minimum *	Medium **	High ***
Objective	Minimum testing for reliability / durability of specific module design	Extended qualification testing to compare relative reliability / durability of multiple designs	Site (and configuration) specific testing or worst case site (s) testing of any specific module design
Cost and time	Low	Medium	High
Goal	Introduce the specific design in the market	Compare (to improve / purchase /invest) multiple designs	Predict lifetime and/or protect warranty
Testing protocol	Test standards exist	Tester de fine d protocol s exist but a uniform protocol is nee ded	None publicly exists, if any. Needs a comprehensive understanding on
			failu re mechanisms, failure modes and mathe matical mode k to deve bp an appropriate testing protocol
Test re quire me nt	<mark>Pass / Fail</mark> (>5% Pmax drop = Fail)	Relative power loss for a specific stress time or relative stress time for a	Identify ultimate failure mode and/or to determine / substantiate
		specific power loss	warranty period
User	Manufacturers /	Manufacture rs /	Manufacture r s
	Consumers / Investors	Consumers / Investors	
		Solar America Board for Cod	es and Standards

Current Study						
Literature	Literature	Literature	Literature search and review			
search and	search on	search and	on potential accelerated			
review on	failure modes		testing protocols to simulate			
failure		mathematical				
mechanisms		models	ultimate failure modes			
Deres	Future Work Needed					
	Develop an appropriate accelerated lifetime testing protocol Design and execution of preliminary experiments					
Develop initial mathematical models						
Validate and improve the mathematical models						
through detailed experiments						
	Develop					
"Rec	"Recommended Protocol for Accelerated Lifetime Testing"					
	Solar America Board for Codes and Standards					



Accelerated aging tests of PV modules may be classified as:

- Accelerated qualification testing (minimum design quality confidence)
- Accelerated comparative testing (medium design quality confidence)
- Accelerated lifetime testing (high design quality confidence)

Accelerated qualification testing:

- Objective: Define **minimum testing** requirements to **substantiate minimum** durability and reliability of **a specific module design**.
- Cost and time: Minimum so that the time-to-market can be reduced
- Goal: It is a test-to-pass testing to **introduce** module in the market
- Testing protocol: **Standardized** protocols defined by the test standards (Examples: IEC 61215 and IEC 61646).
- Test requirement: It is a pass / fail test with a maximum allowed limit of **5% drop** in power after accelerated stresses.
- User: Used by most manufacturers and it is a market driven requirement in Europe but it is not a requirement in the United States, except in the State of Florida.

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Accelerated comparative testing:

- Objective: Define extended / repetitive qualification testing requirements to compare the durability and reliability of different module designs.
- Cost and time: **Medium** falls between qualification testing and lifetime testing
- Goal: It is a relative testing to compare different module designs
- Testing protocol: Currently, tester defined relative / comparative testing is used by the industry (Examples: BP Solar, NREL and ESTI protocols). A uniform protocol could be developed and adopted by Solar ABCs and recommended to a standard committee.
- Test requirement: It is a relative testing with a maximum allowed **limit** (limit the time and identify relative power loss OR limit the power loss and identify relative time; former is preferred) **defined by the tester**.
- User: It could be used by the **manufacturers** (or consumers / investors) to **improve** their module designs and/or to **compare** with competitors' module designs.

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Accelerated lifetime testing:

- Objective:
 - Define site (and configuration) specific testing requirements to predict site specific lifetime of any module design.

OR

- Define worst case sites (and configuration) testing requirements to predict the worst case lifetime of any module design.
- Cost and time: **Maximum** so that the warranty period can be substantiated or determined
- Goal: It is an ultimate failure testing to **predict** lifetime and/or to protect warranty.
- Testing protocol: Currently, **none is publicly available [if any]**. Based on the field failure mechanisms, failure modes and physical / statistical models, a unique consensus testing protocol needs to be developed. It may be developed by Solar ABCs and recommended to a standard committee. As a first step, a **comprehensive literature search will be conducted** on the field failure mechanisms, life-limiting failure modes, potential accelerated testing methods and mathematical models.
- Test requirement: It is a testing to determine **ultimate failure mode** or to a maximum allowed power loss **limit dictated by the manufacturer warranty** (20% or 25%). A consensus definition for the term "ultimate failure" needs to be developed.
- User: It could be used by the individual manufacturers to determine / substantiate their warranty.

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