Overview of IEC TS 62941 Guideline for Manufacturing Quality Assurance

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Table of Contents

- PV QMS Standard timeline
- PV QMS Requirements –
  - Brief review of key requirements Vs ISO 9001
- PV QMS- Future possibilities
- Appendix
PV QMS Standard Development Timeline

- **Dec 2010**: METI approaches DOE toward international PV QA effort.
- **July 2011**: International PV Module QA Forum in San Francisco.
- **July 2011**: Highlighted the need to strengthen the QM program used by the PV module manufacturer, conclusion was to adopt the two primary goals and form the five Task Groups.
- **Sep 2011**: The International PV Module Quality Assurance Task Force was formed – 5 Task groups formed, Task Group 1- Responsible for PV QMS.
- **Oct 2011**: Task Group #1 began to write a PV-specific version of ISO 9001 supplementary requirements.
- **Oct 2013**: Submission of CD Comments to IEC.
- **Oct 2014**: National members Comments.
- **Dec 2014**: Responding to National Comments completed.
- **Feb 2015**: National Committees of IEC TC82 WG2 as the New Work Item Proposal 82/800/NP.
Supplementary requirements to ISO 9001:2008
PV QMS Key Requirements

- PV module’s design to align the expected lifetime
- Product realization that includes appropriate certification, qualification, including both type approval and safety testing
- Product traceability through the entire supply and delivery chain
- Ongoing, periodic monitoring program to ensure consistency of aspects of manufacturing
- Special Process controls
- Power rating tolerance
- Resource Management
- Closed loop learning from field information
- Supplier Management
- Manufacturing and testing
- Process auditing
- Use Statistical methods, sampling
PV QMS Requirement – Design Controls

• Focus on the organization’s control of the PV module’s design to align the expected lifetime with its relationship to the organization’s warranty

• Controls:
  – Design related records retention policy to support warranty serving
  – Design Failure Mode Effects Analysis (FMEA)
  – Reliability testing, periodic testing, Long term outdoor testing, etc.
  – Lessons learned from previous designs (Closed loop learning)
  – Customer communication- Application notes detailing specific attention and/or care needed
PV QMS Requirements – Process Controls

• Use of appropriate statistical tools and statistically significant sample sizes to make decisions that affect quality of process and products at all stages of the lifecycle

• Use of appropriate quality engineering tools to build PV modules with consistent quality and reliability

• Controls:
  – Measurement System Analysis (MSA) e.g. Gauge Repeatability & Reproducibility (GR &R) and more
  – Process FMEA
  – Poke Yoke (error proofing)
  – Control Plan
  – Statistical Process Control (SPC)
  – 8D methodology for problem solving
PV QMS – Special Processes

- Control of Special Processes* (e.g. soldering, lamination)
- Control of processes for ESD protection
- ESD- Electrostatic Discharge (ESD) safe environment at the raw material storage, processing, assembly areas, as appropriate
- Controls:
  - Process qualification, critical controls identification, operator qualifications
  - Software validation
  - ESD Program audit
  - Certification and periodic recertification process for qualified personnel

*“Where the resulting output cannot be verified by subsequent monitoring or measurement and, as a consequence, deficiencies become apparent only after the product is in use or the service has been delivered” – ISO 9001:2008.
PV QMS Requirements – Supplier Controls

- Receiving inspection and/or testing such as statistical sampling based on performance.
- Supplier notify and seek approval when there is any change of products, process, manufacturing location or significant process excursion that may affect form, fit, function, reliability or performance.

  Controls:
  - Periodic supplier audits
  - Performance monitoring
  - Traceability requirements
  - Process Change management
PV QMS Requirements - Reliability

• An ongoing, periodic monitoring program to ensure consistency of aspects of manufacturing that may affect safety, performance, and reliability

• Controls:
  – Reliability test plan
  – Design and development change control
  – Supplier material change control
  – Control Plan (Manufacturing impact on reliability)
  – Statistically adequate sampling plan
  – Reliability Monitoring Program (RMP)
PV QMS Requirements - Traceability

- Requirement to improve product traceability through the entire supply and delivery chain to enact positive control of the product for recalls and warranty claims

- Controls:
  - Traceability to requirements arising from all previous failure information, customer complaints, competitive analysis, supplier feedback
  - Traceability to design and development changes
  - Traceability at supplier’s end for changes made
  - Constituent key materials and components
  - Lot/batch level
  - Traceable to supplier, date, Mfg. location
  - Traceable to Internal processes, process conditions, equipment
  - Traceable to operators (manual processes)
  - Reworked/repaired products
  - Product traceability information outside of packaging
PV QMS – Resource Management

- Resources needed to maintain the product warranty system, product reliability measurements, provision of after-sales service
- Succession planning for key functions that affect customer, quality reliability, safety and performance
- Controls:
  - Product warranty database management system
  - Technical support resources
  - Succession planning, periodic review
PV QMS Requirements - Certification'

- A product realization that includes appropriate certification (e.g. IEC qualification, including both type approval and safety testing), a design lifetime that enables alignment with warranty

- **Controls:**
  - Design FMEA/ Risk assessment
  - Internal/external qualifications
  - External Certification (e.g. IEC/TS 62915)
  - Design Changes that may require certification/recertification
  - Any applicable supplier certifications
  - Reference modules certified/traceable to recognized certification body
  - Warranty modeling
  - Customer return Failure Analysis
PV QMS Requirements – Manufacturing and Testing

- Manufacturing feasibility at the necessary scale, including risk analysis during contract review
- Out of control process - containment of product and 100% inspection (as appropriate)
- Tests performed on 100% of the products for validation of performance and safety
- Control plan for solar simulators and how they are used in the performance rating of modules
- Controls:
  - Process FMEA
  - Control Plan
  - Measurement System Analysis – uncertainty calculations
PV QMS Requirements - Inputs

- Information incorporated into the requirements of the QMS
- Inputs:
  - Previous failure information database management
  - Customer complaints
  - Competitive analysis
  - Supplier feedback
  - Closed loop learning
PV QMS – Power Rating

• Assignment of PV module power rating with allowed tolerance including measurement uncertainty

• Controls:
  - Nameplate power of a module with an allowed tolerance at standard test condition
  - Statement of the tolerance of power measurement in the label of the produced module-IEC61215, IEC61646, or IEC 62108
  - Communication with customer – Power Warranty
  - Control program IEC 60891 and IEC 60904 – Power measurement
  - Determine parameter sets for the acceptance tolerance
  - Determine measurement uncertainty
PV QMS future Possibilities (Brainstorm ideas)'

- Expansion of IEC 62941 audit checklist by asking more rigorous questions (e.g. Special processes)
- PV design, manufacturing and service metrics periodic submission to a vetted third party for analysis and publication of Best in class, top decile, median values (with anonymity - double blind process) for industry benchmarking
- PV QMS extended to suppliers of “key materials” (Similar to PPAP from Automotive industry)
- PV QMS transition to PV IMS “Integrated Management system” to include Environmental, occupation health and safety requirements for PV manufacturing
- Graded approach to PV QMS audit outcome based on maturity levels. Audits go beyond compliance
- Exchange of epidemic failure information by PV technology
- Benchmark QMS practices with other well established industry sectors (e.g. Automotive, Telecom, Aerospace)
References, Bibliography & Acknowledgements

- **References:**
  - ISO 9001:2008 Quality Management System requirements
  - IEC TS 62941 - Guideline for increased confidence in PV module design qualification and type approval (Draft)
  - JIS Q 8901:2012 - Terrestrial photovoltaic (PV) modules -- Requirement for reliability assurance system (design, production and product warranty)

- **Bibliography:**
  - ISO 19011:2011 Guidelines for auditing management systems
  - ISO 9001:2015 Quality Management System requirement (Draft standard)

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  - Ms. Sarah Kurtz, Reliability Group Manager, Principal Scientist, PhD, National Renewable Energy Laboratory, Golden, CO 80401
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