International Quality Assurance Forum

“Manufacturing Quality Assurance Guidelines”
Table 4. Elements of a QA guideline or “System”

• **Guideline element / Parts of review**

• **QA system**: Company-wide QA system/program including responsibility of each organization, document control, and Warranty return program

• **Materials qualification**: List of materials used in module fabrication; qualification program, process, criteria (properties tracked), and records for each of these materials

• **Process control**: Statistical process control and/or other process control system including: Calibration of sensors, change control, and log of data collected to support traceability

• **In-line testing**: List of measurements completed, frequency of these measurements, log of data collected
Table 4. Elements of a QA guideline or “System”

- **Traceability**: Documentation from ingot to module shipment; maintenance of records to trace future failures, ID marking of modules

- **Retest schedule**: Frequency of qualification or other module-level testing, log of data

- **Warranty return program**: Documentation of number of returns, identified failures, and corrective actions

- **Factory inspection procedure**: Frequency of inspection, fraction of manufacturing lines inspected, and evaluation criteria

- **Audit**: Internal/external audit program including factory audit procedures and retest of qualified product.
Additional Quality Management System “Elements”

- **Quality Policy:** Establish a Company “**Quality Policy**”, what the company stands for, values, etc.
- **Quality Manual:** Establish a “**Quality Manual**” that Describes;
  - How the company works / organized
  - Documentation system
    - Document control / configuration control
    - Design control, release system
  - Calibration control
    - From “hand tools” to final test simulators
  - Training / qualification of employees
    - Who is qualified to do what task?
“The Creation of a Solar Module”

Concept / Design
- Get samples
- Graphics
- Sketches

Prototype
- Drawings
- Material bids
- Eng. Build
- Test

Pre-release
- Establish BOM’s and Drawings
- Establish Tooling
- Make small runs or lots
- Test, send samples to Labs for Certification

Production
- Formal release all drawings, parts, etc.
- Make changes as required
- Achieve certs.
- Qualification / Performance
- Safety
- Manufacture the module!
Example of Process Control
“The MFG Journey of a Solar Module”

Purchased Materials
• Specifications required to buy
• Establish incoming Monitoring Techniques
• Establish Supplier Agreements

Warehouse / Staging
• Protect the incoming supplies
• Storage temperatures
• Inventory “turns” & Shelf Life

Production Processes
• Establish Work Instructions, SOP’s
• Assemble Strings of Cells
• “Lay up” glass, EVA, Strings, Buss bars, EVA, Back Sheets & Laminate
• Attach Junction Box /Cap, Frame, continuity / Hi Pot

Test and Shipping
• Flash Test,
• Label
• Packaging
• Ship
Example of Process Capability
Where do we focus?

• Approximately 95% of a Module’s costs is in purchased materials
• Variation in the incoming materials significantly affect Reliability and mfg. efficiency
• “Variation Costs you Money”
Purchased Materials

- Specifications needed to buy
- Establish Supplier Agreements
  - Process Capability
  - Notification of changes
  - Packaging,
  - Automation compatibility
  - “Shelf life”
- Establish incoming Monitoring Techniques
  - Sampling, Testing, “Certification of Compliance” etc.
Purchased Materials

- Cells
- Glass
- Junction Box / Cap, cables
- Frames
- EVA
- Backsheet
- Interconnect Ribbon
- Buss Bars
- Solder, Flux, Paste, etc.
- RTV
- Tape

- All of these materials over my 17 years of solar Module manufacturing have stopped production or caused serious reliability or performance risks!
• Warehousing task is to:
  – Receive, store & distribute materials & consumables
  – Maintain First In, First Out, FIFO
  – Protect materials from harm, moisture, dust, heat etc.
  – Assure Date Codes are current and consumable

• Staging Task is to:
  – Break down shipments and stage for the daily / weekly / monthly / demand
Production Process

- Glass Wash & Dry
- Lay up EVA
- Place Cell Strings
- Connect Buss Bars
- Inspect & Rework
- Lay up EVA
- Periodic Test
  - Elongation
  - Gel or DSC

- Stage Cells
- String Cells
- Inspect & Rework
- Inspect ?
- Attach J Box / Cap
- Attach Frames
- Lamination
- To Test
- Attach Frames
- Periodic Test
  - Elongation
  - Gel or DSC
Test & Shipping

From Inspection or J Box Assembly

Test for Hi pot & insulation resistance

Apply Label

Test Calibration module

Flash Test & record performance data

Final inspect

Packaging + Documents

Ship
Addition Monitoring / Reliability Testing

• Ongoing test and evaluation system
  – Continuously test samples of outgoing product
  – Frequently test samples of incoming material & / or proposed new material
  – Constantly monitor customer returns & feedback for clues

• Establishment of warranty reserves based on field data.
How does the “Manufacturing Quality Assurance Methods or Guidelines” apply?

✓ Check the Quality System;
  ✓ Quality Policy
    ✓ Statement of Company Commitment, beliefs, goals etc.
  ✓ Quality manual
    ✓ Organization relationships
    ✓ Documentation system, release requirements, etc.
    ✓ Registration, ISO?, IECEE? Etc.
    ✓ Calibration
    ✓ Critical task Training
    ✓ Supplier management

✓ Check Warranty behaviors
  ✓ Reserves
  ✓ How to use, etc.
  ✓ Details and caveats
How does the “Manufacturing Quality Assurance Methods or Guidelines” apply?

✔ Control of Suppliers
  ✔ Notification requirements of changes to their product
  ✔ Procurement Specifications
  ✔ Supplier for their supplier agreements
  ✔ Establishment of “Certification of compliance” usage
How does the “Manufacturing Quality Assurance Methods or Guidelines” apply?

✓ Control of Processes (examples)
  ✓ EVA in lamination process, elongation test, Gel test, DFC “calorimetry”
  ✓ Glass in handling, storage, and consistency, transmissivity
  ✓ Backsheet integrity for protection, safety etc.
  ✓ Junction Boxes or connection schemes for connectivity, welds, solder, etc.
  ✓ Preventative Maintenance system,
    ✓ tracking, periods between actions
    ✓ frequency of replacement of consumables, i.e. tips, suction cups, “pogo pins” etc.
• In Summary;
  – The Industry as a whole needs to recognize the whole system (Quality / Business System) and educate the public.
  – The Consumers (Big or Small) need to Demand the publication of lists of “certified companies” that supply under the ISO and IEC requirements etc. (IEC 61215, IEC 61730 1&2, “Quality Management system” ISO 9000-2008)
  – For it is the Total Quality System that Consistently delivers the “Goods”.
Thank you for your attention and patience.

Questions?