

Special Process Validation and Control Methods

- I. Purpose: Define Special Processes at Spectrum Control including validation and control requirements.

- II. Scope: Processes where the resulting output cannot be verified by subsequent monitoring or measurement, these processes shall include the following as applicable:
 - a. Definition of criteria for review & approval of the processes
 - b. Determination of conditions to maintain approval
 - c. Approval of facilities and equipment
 - d. Qualification of operators
 - e. Use of specific methods and procedures to implement and monitor the processes
 - f. Requirements for documented information to be retained

- III. Required Information :
 - a. Internal
 - i. Method for review and monitoring of process
 - ii. Qualification of Operator
 - iii. Qualification of Facility, Equipment and Process
 - b. Supplier
 - i. Method for review and monitoring of process
 - ii. Qualification of Operator
 - iii. Qualification of Facility, Equipment and Process

- IV. Special Process Qualification:
 - a. Spectrum Control will define a qualification methodology for each special process, operator, facility and equipment.
 - b. For equipment in operation prior to the implementation of this document, operating instructions and prior historical preventative maintenance will constitute qualification for the equipment. The special process qualification may require additional testing (i.e. endurance, thermal shock, power handling, metallurgical analysis)
 - c. Any outside suppliers / contractors will not change special process parameters (including facility & equipment) without notification and approval of Spectrum Control.

| Process | SCI Process | Supplier Process | Supplier Approval |
|------------------|-------------|------------------|----------------------------|
| Solder | X | | In accordance with QMS060B |
| Weld | X | X | |
| Braze | X | | |
| Paint | X | X | |
| Plating | X | X | |
| Potting | X | | |
| Conformal Coat | X | X | |
| X-Ray Inspection | X | X | |

Special Process Validation and Control Methods

V. Approval of Process and Monitoring

Spectrum Control will define the monitoring criteria by special process. Examples of process and monitoring controls are listed below but are not limited to the following:

i. Material Controls:

1. Material Certificate of Conformance (C of C)
2. Raw material lot number for traceability
3. Key material properties (i.e. viscosity, hardness, cleanliness, purity, chemical composition, shelf life, expiration date)

ii. Process Controls:

1. Process documents and records (in accordance with defined procedure)
2. Process parameters in accordance with work instructions

iii. Equipment Controls:

1. Equipment asset number
2. Equipment calibration
3. Equipment preventive maintenance
4. Equipment settings in accordance with work instructions

iv. Test and Validation Records

1. Equipment asset number
2. Equipment calibration record
3. Process output data
4. Applicable qualification records for process and operator
5. Record retention per QMS 160A

v. Process control and monitor requirements *examples* as defined below:

| Process | SCI Process Controls and Monitors [Examples] |
|------------------|---|
| Solder | Material controls for solder, flux / pull test |
| Weld | Equipment controls / weld coupon |
| Braze | Equipment controls / 1 st piece inspection |
| Paint | Material controls for paint, equipment controls / adhesion tape test, visual inspection to acceptance criteria and/or comparative paint sample to “gold” standard |
| Plating | Material controls for chemicals, bath temperatures, pH, equipment controls/ plating thickness, solderability |
| Potting | Material controls for potting compounds, equipment controls/ durometer, electrical test, visual inspection to acceptance criteria |
| Conformal Coat | Material controls for coating, visual inspection to acceptance criteria |
| X-Ray Inspection | Equipment controls / penetrometer evaluation |

Special Process Validation and Control Methods

VI. Qualification of Operators

- a. SCI will provide verification protocols for training and validation of the operator qualification process
- b. Operator qualification requirement *examples* are defined below:

| Process | SCI Operator Qualification Test [examples] |
|----------------|---|
| Solder | Peer training/pull test/visual/SEM validation |
| Weld | Peer training, initial weld coupon - revalidation yearly – all alloys produced |
| Braze | Peer training, visual inspection |
| Paint | Adhesion tape test/ visual inspection to acceptance criteria and/or comparative paint sample to “gold” standard |
| Plating | Training Lot - Plating thickness, solderability |
| Potting | Peer training, Durometer, electrical test, visual |
| Conformal Coat | UV light, visual qualification to acceptance criteria |
| X-Ray | Peer training /Penetrometer evaluation |

VII. Supplier Requirements:

- a. Supplier to meet SCI requirements for special process monitoring and qualification in accordance with AT35-3027
- b. Shipment validation, documentation, and data in accordance with purchase order clauses and requirements
- c. Supplier may choose to do alternate qualification, guidelines including:
 - i. Operators are certified to Industry/Agency special process standards, or internal training programs
 - ii. Operator is qualified to SCI approved supplier program
 - iii. Process and Equipment are qualified
 - iv. A requalification process must be used if process is shut down for maintenance, move or out of tolerance conditions

VIII. Process Monitoring Details:

Location Key: FV = Fairview, SC = State College, MX = Mexico, ML = Marlborough
 DE = Delmar, PH = Philadelphia



Spectrum Control Inc.

AT 35-3027

Special Process Validation and Control Methods

Welding (Tig) Process Monitoring SC

| Attribute | Detail | Process Document | Record |
|--------------------------|------------------------|------------------|------------|
| Material Control | PN Traceability | 039-10094 | KBM router |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Product requirement | 039-10094 | N/A |
| Process Check | Visual Weld Inspection | 039-10094 | KBM router |

Laser Weld Process Monitoring ML

| Attribute | Detail | Process Document | Record |
|--------------------------|------------------------|-------------------|------------|
| Material Control | PN Traceability | IT 38-0184 | KBM router |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Product requirement | Equip/Process doc | N/A |
| Process Check | Visual Weld Inspection | Equip/Process doc | KBM router |

Laser Weld Process Monitoring DE

| Attribute | Detail | Process Document | Record |
|--------------------------|------------------------|------------------|---------------------------|
| Material Control | PN Traceability | QMS Doc's, MT's | KBM router, C of C, MOP's |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Product requirement | AM01-19 | KBM router, Traveler |
| Process Check | Visual Weld Inspection | AM01-19 | KBM router, Traveler |

Special Process Validation and Control Methods

Brazing Process Monitoring SC

| Attribute | Detail | Process Document | Record |
|--------------------------|-------------------------|------------------|------------|
| Material Control | PN Traceability | 039-10119 | KBM router |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Product requirement | 039-10119 | N/A |
| Process Check | Visual Braze Inspection | 039-10119 | KBM router |

Soldering Process Monitoring FV, SC, ML, DE

| Attribute | Detail | Process Document | Record |
|----------------------------------|--------------------------------|---|---|
| Material Control | PN Traceability | FV: QMS Doc's, MT's, SC: Purchase Specs DE: QMS Docs and associated docs | N/A KBM |
| Shelf Life Control | Expiration date | FV: IT38-0184 SC: Doc's DE: QMS docs and associated docs | KBM KBM + shelf-life log |
| Reflow Ovens | Model / Serial | SAM | SAM |
| Reflow Oven Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Defined Recipe | FV: OMS Doc's, SC: WS Doc's | FV: SPC Charts SC: SMP Profile Form |
| Process Check | Solder Joint Visual Inspection | FV: OMS Doc's, Sales Dwg SC: WS Doc's DE: IPC J-STD-001, QMS docs and associated docs | FV: BOM SC: Traveler DE: Traveler and/or router |
| Solder Pots Purity & Maintenance | Solder Coupons | IPC J-STD-001 | SAM |

Special Process Validation and Control Methods

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| Painting Process Monitoring MX |
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| Attribute | Detail | Process Document | Record |
|--------------------------|-------------------|------------------|------------------|
| Material Control | PN Traceability | QMS Doc's, MT's | KBM |
| Shelf Life Control | Expiration date | IT38-0184 | KBM |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Equipment Doc | OT 34-0749 | N/A |
| Process Check | Adhesion Test | IT 38-0546 | 34-1091 Logsheet |

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| Painting Process Monitoring DE |
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| Attribute | Detail | Process Document | Record |
|--------------------------|-------------------|--------------------|----------------------|
| Material Control | PN Traceability | QMS Doc's, MT's | KBM, C of C, MOP's |
| Shelf Life Control | Expiration date | IT38-0184, Q001-21 | KBM, Shelf-Life Log |
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Equipment Doc | CP001-09 | KBM router, Traveler |
| Process Check | Adhesion Test | CP001-09 | KBM router, Traveler |

Special Process Validation and Control Methods

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| Plating Process Monitoring SC |
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| Attribute | Detail | Process Document | Record |
|----------------------------------|--------------------|-------------------------------------|--------------------|
| Material Control | PN Traceability | Purchase Spec WS-56-0014 | KBM |
| Shelf Life Control | Expiration date | Purchase Spec WS-56-0014 | KBM |
| Pot Life Control (EN only) | Bath Life | Plating Analytical Doc WS-54-0061-2 | Plating Logsheets |
| Plating Equip't Control | Model / Serial | SAM | SAM |
| Plating Equip't Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Defined Conditions | Work Instructions | N/A |
| Process Check | Chemistry checks | Plating Analytical Doc WS-54-0061-2 | Plating Log sheets |
| Process Check | Thickness coupons | XRF WS 31-0439 | Traveler |
| Process Check | Solderability test | WS 55-0168-1 | Traveler |

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| Potting Process Monitoring FV, SC |
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| Attribute | Detail | Process Document | Record |
|--|-----------------------------|---|-------------------------------------|
| Material Control | PN Traceability | FV: QMS Doc's, MT's SC: Purchase Specs | N/A |
| Shelf Life Control | Expiration date | FV: IT38-0184 SC: Doc's | KBM |
| Potting Robots Control | Model / Serial | SAM | SAM |
| Cure Oven (where applicable) Calibration | Schedule | SAM | SAM |
| Potting Robots Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | Defined Recipes | FV: OMS Docs SC: Work Instruction | FV: BOM sign off SC: PN Cure Log |
| Process Check | Post cure visual inspection | FV: OMS Doc's, Sales Dwg SC: WS Doc's | FV: BOM SC: Traveler |

Special Process Validation and Control Methods

Potting Process Monitoring DE

| Attribute | Detail | Process Document | Record |
|--|-----------------------------|--------------------|----------------------|
| Material Control | PN Traceability | QMS Doc's, MT's | KBM, C of C, MOP's |
| Shelf Life Control | Expiration date | IT38-0184, Q001-21 | KBM, Shelf-Life Log |
| Cure Oven (where applicable) Calibration | Schedule | SAM | SAM |
| Equipment Settings | Defined Recipes | T001-25 | KBM router, Traveler |
| Process Check | Post cure visual inspection | T001-25 | KBM router, Traveler |

Conformal Coating Process Monitoring FV

| Attribute | Detail | Process Document | Record |
|--------------------|-----------------|---------------------|-----------|
| Material Control | PN Traceability | FV: QMS Doc's, MT's | N/A |
| Shelf Life Control | Expiration date | FV: IT38-0184 | KBM |
| Process Check | Viscosity Test | MT Docs, traveler | Log Sheet |

Conformal Coating Process Monitoring DE

| Attribute | Detail | Process Document | Record |
|--------------------|-----------------|------------------|----------------------|
| Material Control | PN Traceability | QMS Doc's, MT's | KBM, C of C, MOP's |
| Shelf Life Control | Expiration date | IT38-0184 | KBM, Shelf-Life Log |
| Process Check | Coverage Test | AM01-35 | KBM router, Traveler |

X-Ray Process Monitoring FV

| Attribute | Detail | Process Document | Record |
|--------------------------|--------------------|------------------------|-----------|
| Asset Control | Model / Serial | SAM | SAM |
| Asset Location Control | Production Layout | Floor Plan | N/A |
| Calibration | Schedule | SAM | SAM |
| Preventative Maintenance | Schedule | SAM | SAM |
| Equipment Settings | X-Ray Imaging | OT 34-0649, OT 34-0736 | N/A |
| Process Check | X-Ray Penetrometer | IT 38-0004 | Test Plan |
| Equipment Function | Radiation Badge | AT 35-2017 | UKG |

Special Process Validation and Control Methods

I. Operator / Process / Equipment Qualification:

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| Weld (Tig) Qualification SC |
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| Attribute | Detail | Document | Record |
|---------------------|---|-----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen - initial weld coupon - revalidation yearly – all alloys produced /Optical or Metallurgical Inspection - | 039-10094 | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

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| Weld (Laser) Qualification ML, DE |
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| Attribute | Detail | Document | Record |
|---------------------|---|--------------------------------|--------|
| Operator | Skills Training Record | UKG/Historical training record | UKG |
| Operator / Process | Qualification Specimen- initial weld coupon - revalidation yearly/ Inspection | 1 st Piece | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

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| Brazing Qualification SC |
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| Attribute | Detail | Document | Record |
|---------------------|---|-----------------------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen/ Optical Inspection | 1 st Piece | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Special Process Validation and Control Methods

Solder Process Qualification FV, SC, MX, DE

| Attribute | Detail | Document | Record |
|---------------------|---|-----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen (First Article unit) | Test Plan | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Painting Process Qualification MX

| Attribute | Detail | Document | Record |
|---------------------|---|------------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen (Adhesion test) | IT 38-0615 | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Painting Process Qualification DE

| Attribute | Detail | Document | Record |
|---------------------|---|------------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen (Adhesion test) | IT 38-0615 | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Plating Process Qualification SC

| Attribute | Detail | Document | Record |
|---------------------|---|----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen | WS docs | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Potting Process Qualification FV, DE

| Attribute | Detail | Document | Record |
|---------------------|---|-----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen (First Article unit) | Test Plan | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

Special Process Validation and Control Methods

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| Conformal Coat Process Qualification FV, DE |
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| Attribute | Detail | Document | Record |
|---------------------|---|-----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen (Black light unit) | Test Plan | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |

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| X-Ray Process Qualification FV |
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| Attribute | Detail | Document | Record |
|---------------------|---|-----------|--------|
| Operator | Skills Training Record | UKG | UKG |
| Operator / Process | Qualification Specimen | Test Plan | N/A |
| Process / Equipment | Qualification Test Plan (for new processes) | N/A | EAR |