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An Introduction to: CQI-29

Special Process: Brazing System Assessment, 1st Edition

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Disclaimer:

The notes and opinions listed in this presentation are those of Abbott Furnace Company. We are not auditors and cannot guarantee the acceptance of our interpretation of this assessment for your equipment or processes.

Your company's management, engineering & quality system need to be able to defend your position and interpretation of this assessment to an auditor, “Abbott said so” will not be a valid response.

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Brazing System Assessment

- Brazing System Assessment
  - Application:
    - All organizations or its suppliers performing the brazing operations addressed in this document, regardless of type, size, and product.
    - Brazing Operations:
      - CAB Furnace Brazing
      - Vacuum Furnace Brazing
      - Flame Brazing
      - Induction Brazing
  - Use:
    - Assess an organization's ability to meet the requirements of the assessment, as well as customer, regulatory, and the organization's own requirements.
      - Can also be used between an organization and its suppliers.

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Brazing System Assessment

- Brazing System Assessment
  - Goals:
    - Develop a brazing management system that provides for continual improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain.
    - Coupled with an internationally recognized quality management system and applicable customer-specific requirements, defines the fundamental requirements for brazing management systems.
    - Provides a common approach to a brazing management system for automotive production and service part organizations.
  - Frequency
    - Annually, unless otherwise specified by the customer

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Brazing System Assessment

- The Organization Shall Keep Records:
  - as evidence of compliance
  - of appropriate action plans to address any nonconforming ratings

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CQI-29 – Summary Information Tab

- Provides organization information, brazing system percent compliance, and the job audit percent compliance.

- Color indicates compliance status:
  - Red
    - Does NOT meet the requirements, needs immediate action
  - Yellow
    - Does NOT meet the requirements, containment is in place
  - Green
    - Meets all requirements

AIAG CQI-29 Special Process: Brazing System Assessment

Company Name:			**Current Status**	**RED**	**Job Audit Summary**	
Street Address:					**CAB Furnace Overall**	**Not Completed**
Country/City/State/ZIP Code:			Brazing System % Compliance	**Not Completed**	**CAB Furnace CTQ**	0 RED CTQ Items
Site Code:					**Vacuum Furnace Overall**	**Not Completed**
Parent Code:			Job Audit % Compliance	**Not Completed**	**Vacuum Furnace CTQ**	0 RED CTQ Items
Current Quality Certification(s):					**Flame Overall**	**Not Completed**
Date of This Assessment:	February 22, 2022		Overall Total of BSA and Job Audits	**Not Completed**	**Flame CTQ**	0 RED CTQ Items
Date of Initial Assessment:					**Induction Overall**	**Not Completed**
Date of Re-Assessment (if necessary):					**Induction CTQ**	0 RED CTQ Items
Number of Brazing Employees at this Facility:					CTQ= Critical to Quality	Higher is Better
Captive Brazing Organization (Y/N):						

Review Members	Title	Email Address	Phone

Site Responsible Person	Title	Email Address	Phone

Supplier Contacts	Title	Email Address	Phone

Braze Classifications:			**Ship To Locations**	**Tier Level**	**Contact Name**	**Contact eMail**
Brazing Processes Used:						
Brazing Specifications Used:						
Commodity:	Chassis					

Part Number(s) Assessed:	Vehicle / Program	Product Information	Overall Summary Comments:

LEGEND

Red	Any CTQ RED Element Any BSA RED Element ≥67% Yellow Items on BSA or Job Audit	**Does NOT meet the requirements, needs immediate action.** Process review indicates that there is a risk of non-conforming product.
Yellow	<90% GREEN -0- RED	**Does NOT meet the requirements, containment is in place.** Process review indicates that there is sufficient containment of non-conforming product.
Green	≥90% GREEN	**Meets all requirements**

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CQI-29 – Summary Information Tab

- Color indicates compliance status:

LEGEND		
Red	Any CTQ RED Element Any BSA RED Element >33% Yellow on BSA or Job Audit	**Does NOT meet the requirements, needs immediate action.** Process review indicates that there is a risk of non-conforming product.
Yellow	<90% GREEN -0- RED	**Does NOT meet the requirements, containment is in place.** Process review indicates that there is sufficient containment of non-conforming product.
Green	≥90% GREEN	**Meets all requirements**

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CQI-29 Brazing System Assessment Tab

- Section 1 – Brazing System Process Assessment
  - Are you prepared to perform the brazing process?

	Section 1 - Brazing System Process Assessment	
1.1	Are internal assessments being completed on an annual basis, at a minimum, using AIAG Brazing System Assessment (BSA)?	The organization shall conduct internal assessments on an annual basis, at a minimum, unless otherwise specified by the customer, using the AIAG BSA. Concerns shall be addressed in a timely manner.
1.2	Is there a dedicated and qualified technical brazing person on-site?	To ensure readily available expertise, there shall be a dedicated, qualified and full time brazing person on site. This individual shall be one of the following: 1. Degreed brazing/joining/metallurgical/materials engineer, or equivalent science degree. 2. Certified Brazing Inspector from approved internationally recognized organization. 3. A minimum of 5 years experience in brazing operations or a combination of a minimum of 5 years of formal brazing education and brazing experience. 4. A qualified person agreed upon between customer and supplier with documentation approval.
1.3	Are the facilities sufficient for the brazing operation?	Facilities: could include but is not limited to, capabilities such as safety, environmental regulations/practices, air (sizing, filtering and cleanliness), gas mixing system (equipment and sizing), ventilation, and adequate lighting. Utilities: sufficient incoming power (balance and loading) and water. Gas quality and percent mixture requirements are known.
1.4	Are the power supplies sufficiently sized and protected?	The power supply should be adequate for the induction brazing process with consideration not limited to output energy, duty cycle, cooling, flow rates and grounding. Power supply grounding per OEM and regulatory specifications. Surge protection and power fluctuation/regulation.
1.5	Is the incoming part quality, handling, storage and packaging adequate to preserve cleanliness of inventory?	The Brazer's loading system, in-process handling, and shipping process shall be assessed for risk of part damage and contamination or other quality concerns. Other practices such as stacking of overloaded containers can also increase the risk of part damage and contamination.
1.6	Are plant cleanliness, housekeeping, environmental and working conditions conducive to quality?	Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to quality. The brazing organization shall evaluate such conditions and their effect on quality. A housekeeping policy shall be clearly defined and executed. The facility shall be reviewed for conditions that are detrimental to quality processing such as loose parts on floor, contaminants, oil, inadequate plant lighting, fumes, etc.
1.7	Is there a preventive maintenance program specific to the brazing process? Is the maintenance data being utilized to verify the effectiveness?	The organization shall have a documented preventive maintenance program for brazing process equipment. The program shall track maintenance schedules. Maintenance data shall be collected and analyzed as part of a preventive maintenance program.

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CQI-29 Brazing System Assessment Tab

- Section 2 – Documentation
  - Do you have a documented quality system?
- Section 3 – Preplanning / Quality Documentation
  - Do you have mechanisms in place to identify quality issues?
- Section 4 – Production Process Monitoring / Documentation
  - Are there mechanisms and procedures in place to be sure that the process is being performed as planned?
  - What process variables are being checked?
  - How are they being checked?
  - How often are the checked?

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CQI-29 Brazing System Assessment Tab

- Section 5 – Fixturing and Tooling
  - Is the fixturing and tooling included in the quality plan?
  - Note: Geometry of braze gap must be set! It cannot be a gravity influenced gap.
- Section 6 – Rework or Scrap Procedures and Reports
  - Are you following an acceptable plan for rework?
  - Are you tracing rework?
- Section 7 – Process and Test Equipment Requirements
  - Do you have the devices to monitor the process and the process variables?

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CQI-29 Brazing System Assessment Tab

- Section 8 – Thermal Management
  - If you are following CQI-29, there is no need to follow CQI-9. The Management Section of CQI-29 mirrors CQI-9

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Thermal Management Reference Tab

Table P3.1.1 – Calibration and Replacement Requirements for Thermocouples Used for Control, Monitoring and Recording

THERMOCOUPLE TYPE (1)	OPERATING TEMPERATURE	CALIBRATION / REPLACEMENT INTERVAL	CALIBRATED AGAINST	INITIAL CALIBRATION ACCURACY REQUIRED
Base Metal Types (K, N, J, E)	≥ 760ºC (1400ºF)	Calibrate before first use. Replace Annually **(2,3,5)**	Primary or Secondary Standard	± 1.1ºC (± 2.0ºF) or ± 0.4% of reading whichever is greater
Base Metal Types (K, J, N, E, T)	< 760ºC (1400ºF)	Calibrate before first use. Replace every two years **(2,3,5)**	Primary or Secondary Standard	± 1.1ºC (± 2.0ºF) or ± 0.4% of reading whichever is greater
Noble Metal Types (B,R,S, and RTDs)	All Temps	Calibrate before first use. Replace every two years **(2,4,5)**	Primary or Secondary Standard	± 1.1ºC (± 2.0ºF) or ± 0.4% of reading whichever is greater

Note 1. Non-Expendable

Note 2. Thermocouples shall be replaced whenever needed (e.g., failed SAT or damaged thermocouple); however, thermocouples shall be replaced minimally as stated above.

Note 3. Base metal thermocouples shall not be recalibrated.

Note 4. Noble metal thermocouples Type B, R, S and RTDs (Resistance Temperature Detectors see glossary) may be recalibrated in lieu of replacement.

Note 5. Applies to resident thermocouples used for Comparative Method SAT. Does not apply to Load Sensing Thermocouples. See Tables P3.1.4 and P3.1.5

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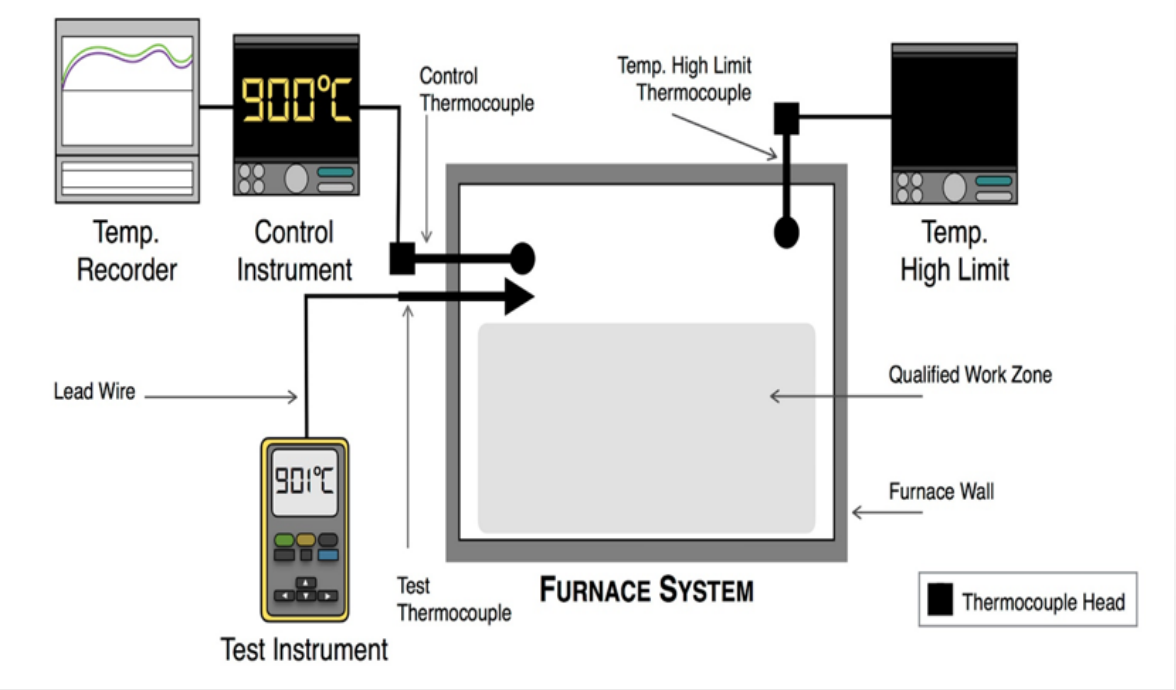
Thermal Management Reference Tab

EXAMPLE of Probe Method "A"



EXAMPLE of a Probe Method "A" System Accuracy Test (SAT) Performed on the Temperature Control System

CONTROL INSTRUMENT TEMPERATURE INDICATION (A)	CONTROL INSTRUMENT TUS OFFSET (B)	ADJUSTED CONTROL INSTRUMENT TEMPERATURE (C)=(A)-(B)	TEST INSTRUMENT TEMPERATURE INDICATION (D)	TEST THERMOCOUPLE CORRECTION FACTOR (E)	TEST INSTRUMENT CORRECTION FACTOR (F)	CORRECTED TEST INSTRUMENT TEMPERATURE READING (G)=(D)+(E)+(F)	CALCULATED SAT DIFFERENCE (C) – (G)
900°C (1652°F)	0°C (0°F)	900°C (1652°F)	901°C (1654°F)	+ 0.3°C (+ 0.5°F)	+ 0.1°C (+ 0.2°F)	901.4°C (1654.7°F)	- 1.4°C (- 2.7°F)

Illustration P3.3.1

Thermal Management Reference Tab

System Accuracy Test (SAT)

- Comparative Method
  - is a comparison between the uncorrected reading of the control instrument and the uncorrected reading of any other permanently installed monitoring system in the same work zone, such as an over temperature control system

When using the comparative method you must define the delta between both thermocouples and once the delta is defined it should not vary more than ±2º F

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Thermal Management Reference Tab

TABLE P3.3.1 SYSTEM ACCURACY TEST REQUIREMENTS

METHOD	SAT SENSOR TYPE	REQUIRED SAT TESTING FREQUENCY	MAXIMUM SAT DIFFERENCE ALLOWED
Probe Method	Types B, R and S Noble Metal Types K, N, J and E Base Metal	Quarterly	± 5.0ºC (± 10.0ºF) **(1,3)**
Comparative Method	Types B, R and S Noble Metal Types K, N, J and E Base Metal	Monthly	± 1.0ºC (± 2.0ºF) **(2,3)**

Note 1. Maximum value of the Calculated SAT difference (see P3.3.4.1.3 and P3.3.4.2.5).

Note 2. Maximum deviation from initial delta (see P3.3.4.3.3)

Note 3. Total offset/bias assigned to the correction of an SAT error shall not exceed 3.0ºC (5.0ºF). This permissible offset/bias is separate from offset/bias assignable to a Calibration error or TUS.

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Thermal Management Reference Tab

	Qualified work zone height	
Qualified work zone width	**≤ 300 mm (1 ft)** see Note 1	**> 300 mm (1 ft)** see Note 2
< 0.3 m (1 ft.)	2	4
0.3 m to 0.75 m (1 ft. – 2.5 ft.)	3	5
0.75 m to 1.5 m (2.5 ft. – 5 ft.)	3	7
1.5 m to 2.4 m (5 ft. – 8 ft.)	3	8
> 2.4 m (8 ft.)	Add one thermocouple for each 0.6 m (2 ft.) of additional width	8

Table P3.4.2 - Number and Location of the TUS Thermocouples (PLANE METHOD)

Note 1. For qualified work zone widths greater than 0.3 m (1 ft.), two TUS thermocouple locations shall be within 50 mm (2 inches) of the work zone corners or edge and one TUS thermocouple location shall be at the center. Additional TUS thermocouples shall be uniformly distributed throughout a plane perpendicular to the conveyance direction.

Note 2. For qualified work zone widths greater than 0.3 m (1 ft.), two TUS thermocouple locations shall be within 50 mm (2 inches) of the work zone corners or edge and one TUS thermocouple location shall be at the center. Additional TUS thermocouples shall be uniformly distributed throughout a plane perpendicular to the conveyance direction.

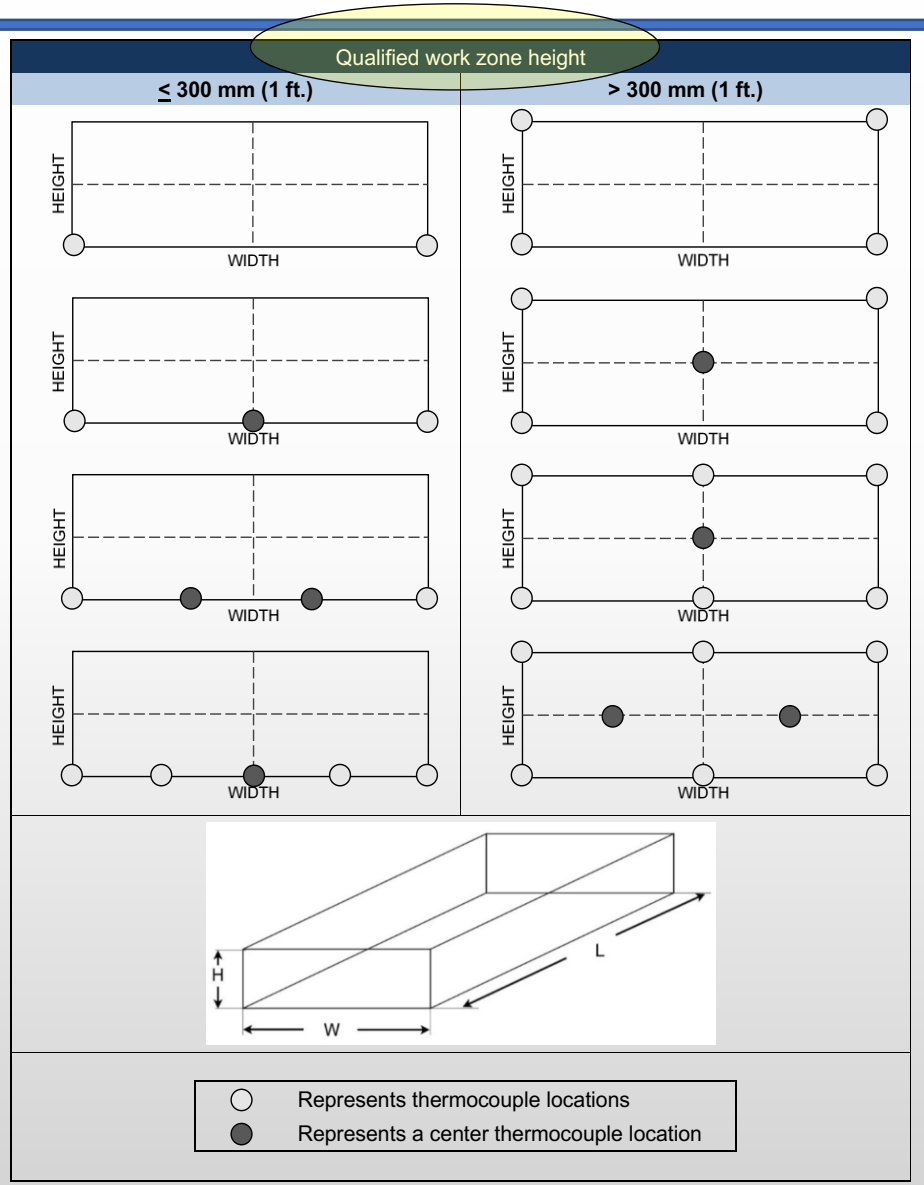

Figure P3.4.2 – Plane Method TUS Test Thermocouple Locations

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CQI-29 Brazing System Assessment Tab

- Section 9 – Process Control
  - Defines the types of quality checks and frequencies.

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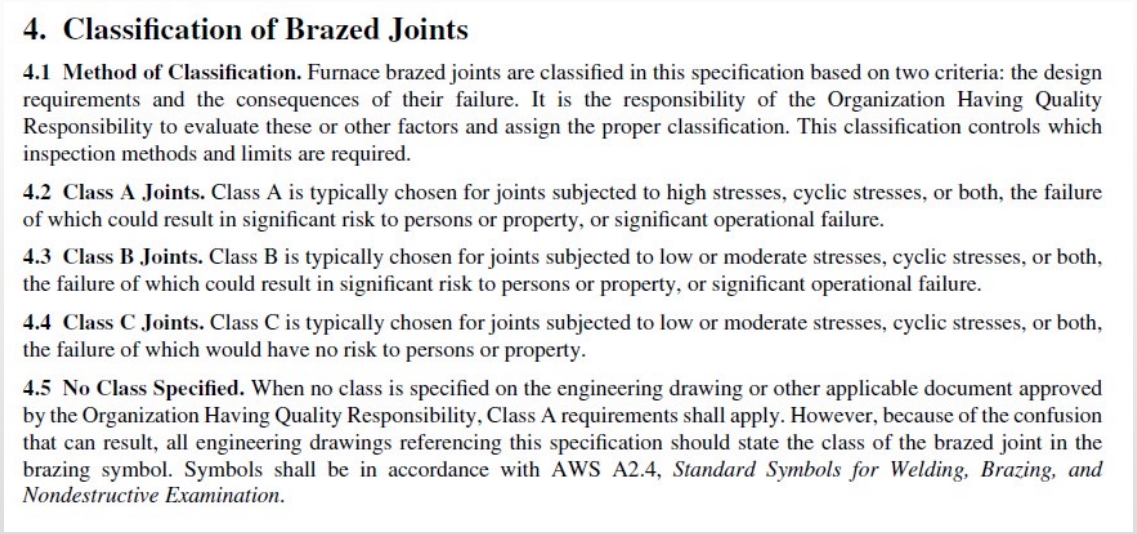
CQI-29 CAB Furnace Job Audit Tab

- 1 – Part Print
  - Braze Specifications – What do you follow?
  - Braze Identification – Numbering and tracking on print?
  - Braze Symbol Callout - Print must contain the information about each joint.
  - Braze Classification – YOU NEED TO HAVE THIS ON THE PRINT!



4. Classification of Brazed Joints

4.1 Method of Classification. Furnace brazed joints are classified in this specification based on two criteria: the design requirements and the consequences of their failure. It is the responsibility of the Organization Having Quality Responsibility to evaluate these or other factors and assign the proper classification. This classification controls which inspection methods and limits are required.

4.2 Class A Joints. Class A is typically chosen for joints subjected to high stresses, cyclic stresses, or both, the failure of which could result in significant risk to persons or property, or significant operational failure.

4.3 Class B Joints. Class B is typically chosen for joints subjected to low or moderate stresses, cyclic stresses, or both, the failure of which could result in significant risk to persons or property, or significant operational failure.

4.4 Class C Joints. Class C is typically chosen for joints subjected to low or moderate stresses, cyclic stresses, or both, the failure of which would have no risk to persons or property.

4.5 No Class Specified. When no class is specified on the engineering drawing or other applicable document approved by the Organization Having Quality Responsibility, Class A requirements shall apply. However, because of the confusion that can result, all engineering drawings referencing this specification should state the class of the brazed joint in the brazing symbol. Symbols shall be in accordance with AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*.

- Book of Knowledge – Do you have a record of how to make a good part?

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CQI-29 CAB Furnace Job Audit Tab

- 1 – Part Print (cont'd)
  - Book of Knowledge –
    - Do you have a record of how to make a good part?

Book of Knowledge Template

						Joint Configuration Critically Recommended Inspection Frequency					Recommended Destructive Testing Frequency - Pre-Launch		Recommended Destructive Testing Frequency - Production (After Sustainability)			
ISO Process ID	Joint Type	Joint Configuration	Insert Joint Cross-section Illustration (Pre-Brazed)	Product KPIV's (Examples Only)	Product Tolerance	YC	YS	Process KPIV's/Tolerances	Do the Process - Transition from Product to Process Characteristics	Process KPOV's	YC	YS	YC	YS	Potential Evaluation Methods	Process KPOV Tolerance - Per Specification (Potential Sources of Tolerancing)
Furnace Brazing (CAB)	Insertion	Tube to Block		ID/OD	+/- Xmm	Daily	Every 2 days	See CAB-Process Job Audit Tab		Braze Depth	Per Shift	Per Shift	Daily	Every 2 days	Visual	Supplier Joining Specification
921				Bore Depth	+/- Xmm	Daily	Every 2 days	See CAB-Process Job Audit Tab		Fillet Presence	Per Shift	Per Shift	Daily	Every 2 days	Cut and Etch	Insustry Standard
				Champfer Angle/Depth	+/- Xdegrees	Daily	Every 2 days	See CAB-Process Job Audit Tab		Porosity	Per Shift	Per Shift	Daily	Every 2 days	Bend	Customer Joining Specificaiton
				Tube Wall Thickness	+/- Xmm	Daily	Every 2 days	See CAB-Process Job Audit Tab		Alloying	Per Shift	Per Shift	Daily	Every 2 days	Transverse Hardness	
				Tube Ovality	+ Xmm	Daily	Every 2 days	See CAB-Process Job Audit Tab		Inertion Depth	Per Shift	Per Shift	Daily	Every 2 days	Leak Testing	
				Block Ovality	+ Xmm	Daily	Every 2 days	See CAB-Process Job Audit Tab								
Vaucm Brazing																
922																
Flame Brazing																
912																
Induction Brazing																
916																

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CQI-29 CAB Furnace Job Audit Tab

- 2 – Control Plan - What are you checking on the parts?

	2. CONTROL PLAN		
1.	Inline Visual Inspection	Braze shall be inspected for presence and appearance per visual acceptance criteria.	
2.	Component Quality Expectation	Identify key product characteristics to demonstrate process capabilities.	Yes
3.	Braze Quality Inspection	Understand your key process input / output variables.	Yes
4.	Cut and Etch	Performed per the braze specification and braze classification.	Yes
5.	Microstructure Evaluation	Microstructure evaluation documented per braze specification and engineering specification.	
6.	Destructive Testing	Performed based off of the braze classification.	
7.	Supplemental Peel Test	Performed based off of braze engineering specification.	
8.	Nondestructive Testing	Performed based off of the braze classification and engineering specification.	
9.	Braze Diffusion Confirmation	Micro transverse measurement of alloying from parent material through braze checks shall be performed.	Yes
10.	Braze Identification in Control Plan	Brazing Special Characteristic Identification: brazes shall be identified by braze number in the control plan per the Design Records/DFMEA/PFMEA.	Yes
11.	Braze Lot Containment	All braze validation testing shall be performed prior to shipping components with critical (CC) brazes (Batch & Hold).	Yes
12.	Control of Changes and Unplanned Events	An event matrix shall be followed for events not listed in the control plan OR if changes are made.	Yes
13.	Production Part Traceability	Traceability to brazing build date and braze stream, and placement.	
14.	Setup Part Identification	Setup parts shall be pre-marked prior to joining process for easy identification to prevent further processing or shipping.	

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CQI-29 CAB Furnace Job Audit Tab

- 3 – Braze Quality Inspection & Reports
- 4 – Parameter Documentation
  - You need to document the process and part quality variables and changes.
- 5 – Maintenance Records
  - You need to have documentation that you are maintaining your equipment, fixtures, and tools.

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CQI-29 CAB Furnace Job Audit Tab

- 6 – Sustainability
  - Are you maintaining good quality?
  - Your quality system should show that you are still making good parts!
- 7 – Process Monitoring
  - Do you control the temperature in the critical brazing zone of the process?
- 8 – Fixturing and Tooling
  - Will the fixtures and tooling provide the control needed to make a good part repeatedly?

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Thank You !

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