



Automotive Industry Action Group

CQI-15

Special Process: Welding System Assessment



ABOUT AIAG

Purpose Statement

Founded in 1982, AIAG is a globally recognized organization where OEMs and suppliers unite to address and resolve issues affecting the worldwide automotive supply chain. AIAG's goals are to reduce cost and complexity through collaboration; improve product quality, health, safety and the environment; and optimize speed to market throughout the supply chain.

AIAG Organization

AIAG is made up of a board of directors, an executive director, executives on loan from member companies, associate directors, a full-time staff, and volunteers serving on project teams. Directors, department managers, and program managers plan, direct and coordinate the association's activities under the direction of the executive director.

AIAG Projects

Volunteer committees focus on business processes or supporting technologies and methodologies. They conduct research and develop, publish, and provide training on standards, conventions, standard business practices, white papers, and guidelines in the areas of automatic identification, CAD/CAM, EDI/electronic commerce, continuous quality improvement, health focus, materials and project management, occupational health & safety, returnable containers and packaging systems, transportation/customs and truck & heavy equipment.

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CQI-15

Special Process: Welding System Assessment
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FOREWORD

Automotive Industry Action Group (AIAG) committees are made up of volunteers from member companies in the automotive industry. The work of preparing process audits is done by AIAG technical committees.

The main task of technical committees is to prepare Automotive Standards and System Requirements. Draft documents adopted by the technical committees are circulated to the Steering Committee for review and consensus approval. Publication of the documents requires approval by the Quality Steering Committee.

The Quality Steering Committee would like to acknowledge and thank the following individuals and their companies who have contributed time and effort to the development of this document.

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TABLE OF CONTENTS

ABOUT AIAG	1
FOREWORD	3
ACKNOWLEDGEMENTS	3
TABLE OF CONTENTS	4
INTRODUCTION	5
GENERAL	5
PROCESS APPROACH	5
WELDING SYSTEM ASSESSMENT GOALS	5
ASSESSMENT PROCESS	5
ASSESSOR QUALIFICATIONS	6
OTHER REQUIREMENTS	6
1 SCOPE.....	7
1.1 GENERAL	7
1.2 APPLICATION	7
1.3 REFERENCE	8
2 THE WELDING SYSTEM ASSESSMENT PROCEDURE	9
3 SPECIAL PROCESS: WELDING ASSESSMENT	10
APPENDIX A – PROCESS TABLES.....	31
GLOSSARY	49

INTRODUCTION

General

The work of preparing *CQI-15: Special Process: Welding System Assessment (WSA)* was carried out through the AIAG Welding Work Group. These welding requirements are complementary to customer and product standards.

The WSA can be used to assess an organization's ability to meet the requirements in this assessment, as well as customer, regulatory, and the organization's own requirements. The WSA can also be used between an organization and its suppliers.

In the WSA, the word "shall" indicates a requirement for purposes of the self assessment. Failure to meet the requirements results in an assessment that is either "Not Satisfactory" or "Needs Immediate Action." The word "should" indicates a recommendation. Where the term "such as" is used, any suggestions given are for guidance only.

Process Approach

The WSA supports the automotive process approach as described in ISO/TS 16949.

Welding System Assessment Goals

The goal of the WSA is the development of a welding management system that provides for continual improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain.

The WSA, coupled with an internationally recognized quality management system and applicable customer-specific requirements, defines the fundamental requirements for welding management systems.

The WSA is intended to provide a common approach to a welding management system for automotive production and service part organizations.

Assessment Process

Ongoing assessments shall be conducted annually, unless otherwise specified by the customer, to re-examine the continuing compliance with the WSA. Each assessment shall include a review of the organization's systems using the WSA. Successive Job Audits (Section 6.0 of this document) shall sample parts from different automotive component manufacturers that require compliance to the WSA document.

The assessment shall use the process approach to auditing as identified by the requirements of ISO/TS 16949.

Assessor Qualifications

Assessor(s) shall have the following specific experience to conduct the WELDING SYSTEM ASSESSMENT:

1. Be an experienced quality management system (QMS) internal auditor (for example, latest edition of ISO/TS 16949, ISO 9001)
2. Assessor shall possess welding knowledge. Evidence shall include a minimum of 5 years experience in welding or a combination of formal education in welding and welding experience totaling a minimum of 5 years
3. Assessor shall possess knowledge of and be familiar with the application of automotive quality core tools including statistical process control, measurement systems analysis, part approval, failure mode and effects analysis, and advanced quality planning.

Note: If more than one assessor is required to meet the above qualifications, the lead assessor shall be the person meeting the requirements in item #1.
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Other Requirements

The organization shall keep records as evidence of compliance to the requirements identified in the WSA, as well as all appropriate action plans to address any unsatisfactory ratings. These records shall be readily available for review by any customer requiring compliance to the requirements within this document.

1 SCOPE

1.1 General

This document specifies process requirements for an organization or its suppliers performing applicable welding, who need to:

- demonstrate ability to consistently provide product that meets customer and applicable regulatory requirements, and
- enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system.

The Welding System Assessment is applicable to sites where customer-specified parts for production and/or service are processed throughout the automotive supply chain.

1.2 Application

All requirements of the WSA are generic and are intended to be applicable to all organizations performing the welding operations addressed in this document, regardless of type, size, and product.

Note: Four Process Tables have been developed and the appropriate table(s) is to be referenced during the assessment. The Process Tables are specific to welding processes as noted below:

Process Table A - Arc Welding

Arc Stud/Fastener Welding
Flux-Cored Arc Welding
Gas Metal Arc welding
Submerged Arc Welding
Shielded Metal Arc Welding
Plasma Arc Welding
Gas Tungsten Arc Welding
Gas Metal Arc Braze Welding

Process Table B - Resistance Welding

Resistance Spot Welding
Projection Welding
Resistance Seam Welding
High-Frequency Seam Welding
Induction Seam Welding
Mash Seam Welding
Flash Welding

Process Table C - Laser Welding

Nd YAG
 CO2
 DIODE
 Wire Fed

Process Table D - Solid State Welding

Inertia Friction Welding
 Direct Drive Friction Welding
 Friction Stir Welding
 Flash Butt Welding
 Resistance Butt Welding
 Ultrasonic Welding

These Process Tables contain requirements for:

1. Management Responsibility & Quality Planning
2. Floor and Material Handling Responsibility
3. Equipment / Facilities/Controls
4. Tooling/Fixturing
5. Process Controls and Confirmation
6. Essential Variables

The Process Tables specify the tolerances of process parameters and the frequencies for checking process control parameters and parts. The Requirements and Guidance in the WSA form will notify the assessor when to refer to the Process Tables.

1.3 Reference

The following standards are used as reference material. There are other reference materials that contain more information, however, the list is not meant to be inclusive. The applicability is limited to the subject matter referenced.

Standard Number	Title	Standard's Organization
ANSI Z 49.1	Safety in Welding and Cutting	ANSI - www.ansi.org
AWS A3.0	Standard Welding Terms and Definitions	www.aws.org
AWS C7.2	Recommended Practices for Laser Beam and Welding	www.aws.org

2 THE WELDING SYSTEM ASSESSMENT PROCEDURE

1. Obtain current copy of *CQI-15 Special Process: Welding System Assessment*, from AIAG.
2. Identify all welding processes to which *CQI-15 Special Process: Welding System Assessment*, applies (see *CQI-15, 1.2*). Record these processes on the WSA.
3. Complete the WSA, determining the level of compliance. A minimum of one job audit (Section 6) shall be performed during each assessment.
4. Address each “Not Satisfactory” item and determine corrective action, including root cause analysis and implementation of the corresponding corrective action(s). The corrective action(s) shall be completed within 90 days. Records of the corrective action, including verification, shall be maintained.
5. “Needs Immediate Action” requires immediate containment of suspect product. Address each “Needs Immediate Action” item and determine corrective action(s), including root cause analysis and implementation of the corresponding corrective action(s). The corrective action(s) shall be completed within 90 days. Records of the corrective action, including verification, shall be maintained.
6. Assessments shall be conducted annually unless otherwise specified by the customer.

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3 SPECIAL PROCESS: WELDING ASSESSMENT

Cover Sheet.....	15
Section 1-5.....	18
Section 1: Management Responsibility & Quality Planning.....	18
Section 2: Floor and Material Handling Responsibility.....	24
Section 3: Equipment.....	26
Section 4: Tooling/Fixturing.....	27
Section 5: Process Controls and Confirmation.....	27

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Instructions for completing the Cover Sheet

1. Facility Name: Name of the facility being assessed.
One form shall be used for each facility. The facility may have several buildings or physical locations in the same general area. If there is a separate management team or different management system, then these locations shall be considered as separate facilities.
2. Address: The street address of the facility being assessed; P.O Box numbers may be given as additional information.
3. Phone Number: The phone number of the facility.
If there is no common phone number for the facility, the phone number of the Operations Manager or Quality Manager shall be used.
4. Fax Number: The fax number of the facility.
5. Number of Welding Employees at this Facility: The number of employees, salaried and hourly, associated with the welding operation at this facility.
6. Captive Weld Organization (Y/N): Enter "Y" if this facility welds components for their own company. Enter "N" if the company does not weld any components for their own company.
7. Commercial Weld Organization (Y/N): Enter "Y" if this facility welds components for companies other than their own company. Enter "N" if this facility does not weld any components for other companies.
8. Date of Assessment: Enter the date(s) of the assessment. An alphanumeric format shall be used to avoid confusion with different numeric formats.
Example: May 3 – 4, 2010
9. Date of Previous Assessment: List the date of the previous CQI-15 Special Process: Welding System Assessment of this facility.
10. Type(s) of Welding Processing at this Facility: Place a checkmark to designate all welding process(es) performed at this facility. This information determines the appropriate Process Table that shall be used during the assessment. Processes not listed on the cover sheet are not part of the Welding System Assessment.
11. Current Quality Certification(s): The weld organization shall list their current quality certifications, e.g., ISO/TS 16949, ISO 9001. Certifications may be from 3rd party sources or customer quality certifications. If customer quality certification is given, then the year of the last assessment by the customer shall also be given.

12. Date of Re-assessment (if necessary): If “Not Satisfactory” findings were observed from the original assessment, then the weld organization shall address each item and determine correct action, including root cause analysis and implementation of the corresponding corrective action(s).

The date of the re-assessment shall be given here, and the appropriate Question(s) from Sections 1 – 5, in the original assessment, shall be modified to reflect that the evidence, relating to the implementation of the corrective action(s), has been observed. Also, the “Number of Not Satisfactory Findings” shall be modified as appropriate.

13. Personnel Contacted: List the name(s), title(s), phone number(s), and email address(es), if available, of the principal participants from the weld organization.
14. Auditors/Assessors: List the name(s), Company(ies), phone number(s) and email address(es), if available, of the auditor/assessor(s).
15. Number of “Not Satisfactory” Findings: Enter the number of “Not Satisfactory” findings observed during the assessment.
16. Number of “Needs Immediate Action” Findings: Enter the number of “Needs Immediate Action” findings observed during the assessment.
17. Number of “Fail” Findings in the Job Audit(s): Enter the number of “Fail” findings observed from the job audit.

Special Process: Welding System Assessment			
Facility Name:			
Address:			
Phone Number:		Type(s) of Weld Processing at this Facility:	
Fax Number:		Process Table A - Arc Welding	
		Arc Stud/Fastener Welding	
Number of Welding Employees at this Facility:		Flux Cored Arc Welding	
		Gas Metal Arc Welding	
Captive Weld Organization (Y/N)		Submerged Arc Welding	
		Shielded Metal Arc Welding	
Commercial Weld Organization		Plasma Arc Welding	
		Gas Tungsten Arc Welding	
Date of Assessment:		Gas Metal Arc Braze Welding	
		Process Table B - Resistance Welding	
Date of Previous Assessment:		Resistance Spot Welding	
		Projection Welding	
		Resistance Seam Welding	
		High-frequency Seam Welding	
		Induction Seam Welding	
		Mash Seam Welding	
		Flash Welding	
		Process Table C - Laser Welding	
		Nd YAG Welding	
		CO2 Welding	
		Diode Welding	
		Wire Fed	
		Process Table D - Solid State Welding	
		Inertia Friction Welding	
		Direct Drive Friction Welding	
		Friction Stir Welding	
		Flash Butt Welding	
		Resistance Butt Welding	
		Ultrasonic Welding	
Current Quality Certification(s)			
Date of Re-assessment (if necessary):			
Personnel Contacted:			
Name	Title	Phone	Email
Auditors/Assessors			
Name	Company	Phone	Email
Number of "Not Satisfactory" Findings			
Number of "Needs Immediate Action" Findings			
Number of "Fail" Findings in the Job Audit(s)			

Instructions for completing Sections 1 – 5

Sections 1 - 5 contain questions and the requirements and guidance for each question. The Sections are:

- Section 1 – Management Responsibility & Quality Planning
- Section 2 – Floor and Material Handling Responsibility
- Section 3 – Equipment/Facilities/Control
- Section 4 – Tooling/Fixturing
- Section 5 – Process Controls and Confirmation

The assessor shall assess the weld organization compliance to Sections 1 – 5 by comparing the evidence presented by the weld organization to the requirements listed in the “Requirements and Guidance” column.

NOTE 1: In the “Requirements and Guidance” column, the word “shall” indicates a requirement and the term “such as” indicates that any suggestions given are for guidance only.

NOTE 2: The “Requirements and Guidance” column will indicate to the assessor when the Process Tables are pertinent to the Questions. When the Process Tables are pertinent to the Question, the assessor shall assess the weld organization compliance to the specified section(s) in the Process Tables.

NOTE 3: If the question is not applicable to the weld organization, then the assessor shall place a checkmark in the “N/A” Assessment column. If the observed evidence is in compliance to the question, the assessor shall note the evidence in the “Objective Evidence” column and place a check mark in the “Satisfactory” column. If the observed evidence is not in compliance to the question, then the assessor shall note the non-compliance in the “Objective Evidence” column and place a check mark in the “Not Satisfactory” column.

NOTE 4: Where nonconforming product is identified in the assessment of a given question the assessor shall place a check mark in the “Needs Immediate Action” (NIA) column. NIA requires immediate containment of suspect product.

Special Process: Welding System Assessment

Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			Needs Immediate Action
				N/A	Satisfactory	Not Satisfactory	
Section 1 - Management Responsibility & Quality Planning							
1.1	Is there a dedicated and qualified technical welding person on-site?	To ensure readily available expertise, there shall be a dedicated and qualified welding person on site. This individual shall be one of the following: Degreed Welding Engineer, or equivalent science degree, Certified Welding Inspector from approved internationally recognized body, or person agreed upon between customer and supplier. This person shall be a full-time employee and the position shall be reflected in the organization chart. A job description shall exist identifying the qualifications for the position including metallurgical and welding knowledge. The qualifications shall include a minimum of 5 years experience in welding operations or a combination of a minimum of 5 years of formal metallurgical education and welding experience.					
1.2	Is there a responsibility matrix to ensure that all key management and supervisory functions are performed by qualified personnel?	The organization shall maintain a responsibility matrix identifying all key management and supervisory functions and the qualified personnel who may perform such functions. It shall identify both primary and secondary (backup) personnel for the key functions (as defined by the organization). This matrix shall be readily available to management and customer at all times.					
1.3	Do you use only qualified welders (personnel)?	The organization shall provide employee training for all welding operations specific to their job function. All welding employees, including backup and temporary employees, shall be trained. Documented evidence shall be maintained showing the employees were trained; the evidence shall include an assessment of the effectiveness of the training, must prove knowledge of the customer's specific requirements and internal standards, and where appropriate, employee certification, such as for a manual welder. Management and customer shall define the qualification requirements for each function and ongoing or follow-up training shall also be addressed.					
1.4	How do you maintain welder certification?	Required qualification maintenance. If the welder has not welded in the specific operation in a 6 month time frame, the welder must be requalified to that operation. Based on the welder's quality performance, it must be established when retraining and requalification of the individual must be performed.					
1.5	Is set-up practice in compliance with documented work instructions?	Set-up verification to the procedures (as example: equipment settings, clamping sequence, weld sequence, direction of travel and other process controls) in compliance to documented work instructions.					

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.6	Does the welding organization perform advanced quality planning?	The organization shall incorporate a documented advance quality planning procedure. A feasibility study shall be performed and internally approved for each part. Similar parts can be grouped into part families for this effort as defined by the organization. After the part approval process is approved by the customer, no process changes are allowed unless approved by the customer. The welding organization shall contact the customer when clarification of process changes is required. This clarification of process changes shall be documented.				
1.7	Are welding FMEA's up to date and reflecting current processing?	The organization shall incorporate the use of a documented Failure Mode and Effects Analysis (FMEA) procedure and ensure the FMEA's are updated to reflect current part quality status. The FMEA shall be written for each part or part family or they may be process-specific and written for each process. In any case, they shall address all process steps from part receipt to part shipment and all key welding process parameters as defined by the organization. A cross-functional team shall be used in the development of the FMEA. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the FMEA.				
1.8	Are welding process control plans up to date and reflecting current processing?	The organization shall incorporate the use of a documented Control Plan procedure and ensure the Control Plans are updated to reflect current controls. The Control Plans shall be written for each part or part family or they may be process-specific and written for each process. They shall address all process steps from part receipt to part shipment and identify all equipment used and all essential welding process parameters as defined by the relevant individual process tables or non-essential as agreed upon between supplier and customer. A cross-functional team, including a production operator, shall be used in the development of Control Plans, which shall be consistent with all associated documentation such as work instructions, shop travelers, and FMEA's. All special characteristics, as defined by the organization and its customers, shall be identified, defined, and addressed in the Control Plans. Sample sizes and frequencies for evaluation of process and product characteristics shall also be addressed consistent with the minimum requirements listed in the Process Tables.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.9	Are all welding related and referenced specifications current and available? For example: SAE, AIAG, ASTM, ASME, AWS, ISO, General Motors, Honda, Ford, Toyota and Chrysler.	To ensure all customer requirements are both understood and satisfied, the organization shall have all specifically related welding and customer referenced standards and specifications available for use and a method to ensure that they are current. Such standards and specifications may include, but are not limited to, those relevant documents published by SAE, AIAG, ASTM, ASME, AWS, ISO, General Motors, Honda, Ford, Toyota, and Chrysler. The organization shall have a process to ensure the timely review, distribution, and implementation of all customer and industry engineering standards/specifications and changes based on customer-required schedule. Timely review should be as soon as possible and shall not exceed two working weeks. The organization shall document this process of review and implementation, and it shall address how customer and industry documents are obtained, how they are maintained within the organization, how the current status is established, and how the relevant information is cascaded to the shop floor within the two-week period. The organization shall identify who is responsible for performing these tasks.				
1.10	Is there a written process specification for all active processes?	The welding organization shall have written process specifications for all active processes and repair processes which identify all steps of the process including relevant operating parameters. Examples of operating parameters as defined by the relevant process tables. Such parameters shall not only be defined, they shall have operating tolerances as defined by the organization in order to maintain process control. These process specifications may take the form of work instructions, job card, set-up sheets, or other similar documents.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.11	Has a valid product capability study been performed initially and after process changes?	<p>The organization shall perform product capability studies for the initial validation of each process, after relocation of any process equipment, and after a major process change of any equipment or parameter. The organization and customer shall define what constitutes a major process change. Initial product capability studies shall be conducted for all welding processes per each process path defined in scope of work and in accordance with customer requirements. In the absence of customer requirements, the organization shall establish acceptable ranges for measures of capability. An action plan shall exist to address the steps to be followed in case capability indices fall outside customer requirements or established ranges.</p> <p>Each process path includes all combinations of equipment that are integrated in the performance of a welding process, e.g., weld cell with A and B side fixture feeding another weld cell with A and B side fixture or multiple machines. Capability study techniques shall include boundary sample conditions as defined by the control plan that are robust and meet all customer requirements. Example, any combination of tolerances as defined by Process Tables.</p>				
1.12	Does the welding organization monitor and analyze data over time, and react to this data?	<p>The analysis of products or processes over time can yield vital information for defect prevention efforts. The organization shall have a system to collect, analyze, and react to product or essential process data over time. Methods of analysis shall include ongoing trend or historical data analysis of product or process parameters. The organization shall determine which parameters to include in such analysis.</p>				
1.13	Is management reviewing the weld control system at a frequency determined by the control plan?	<p>Management shall review the weld process control systems. The management review shall include efforts to detect out-of-control conditions or alarm conditions. The process of reviewing the control system shall be documented and recorded in the control plan.</p>				
1.14	Are internal assessments being completed on an annual basis, at a minimum, using AIAG WSA?	<p>The organization shall conduct internal assessments on an annual basis, at a minimum, using the AIAG WSA. Concerns shall be addressed in a timely manner.</p>				
1.15	Does the Quality Department review, address, and document customer and internal concerns?	<p>The quality management system shall include a process for documenting, reviewing, and addressing customer concerns and any other concerns internal to the organization. A disciplined problem-solving approach shall be used.</p>				

Special Process: Welding System Assessment							
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment			Needs Immediate Action
				N/A	Satisfactory	Not Satisfactory	
1.16	Is there a continual improvement plan applicable to each process defined in the scope of the assessment?	The welding organization shall define a process for continual improvement for their welding processes identified in the scope of the WSA. The continual improvement process shall be designed to bring about improvements in quality and productivity. Identified actions shall be prioritized and shall include timing (estimated completion dates). The organization shall show evidence of program effectiveness.					
1.17	Does the Quality Manager or designee authorize the disposition of material from quarantine status?	The Quality Manager or designee is responsible for authorizing and documenting the disposition of quarantined material.					
1.18	Are there procedures or work instructions available to the welding personnel that define the welding process?	There shall be procedures or work instructions available to welding personnel covering the welding process. These procedures or work instructions shall include methods of addressing potential emergencies (such as power failure), equipment start-up, equipment shut-down, product segregation (See 2.8), product inspection, safety, house-keeping, and general operating procedures. These procedures or work instructions shall be accessible to shop floor personnel.					
1.19	Is there a preventive maintenance program? Is maintenance data being utilized to form a predictive maintenance program?	The organization shall have a documented preventive maintenance program for process equipment (as identified by the Process Tables). The program shall be a closed-loop process that tracks maintenance efforts from request to completion to assessment of effectiveness. Equipment operators shall have the opportunity to report problems, and problems shall also be handled in a closed-loop manner. Company data, e.g., downtime, quality rejects, first-time-through capability, recurring maintenance work orders, and operator-reported problems, shall be used to improve the preventive maintenance program. Maintenance data shall be collected and analyzed as part of a predictive maintenance program.					

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
1.20	Has the welding organization developed a critical spare part list and are the parts available to minimize production disruptions?	The welding organization shall develop and maintain a critical spare parts list and shall ensure the availability of such parts to minimize production disruptions.				
1.21	How does the organization document and respond to quality spills, nonconformance, customer concerns?	Reaction plans are to be followed per the control plan and PFMEA or, in the case of newly identified issues PFMEA and control plan must be updated to reflect the new failure mode and reaction steps taken.				
1.22	What is the process deviation requirements of your customer?	If there are to be changes in process outside of the current control plan and last agreed upon process and parts sign off, do you know what your customer requirements are, have you notified your customer, and do you have customer approval prior to making the change?				
1.23	Is there a system in place to authorize reprocessing and repair? Is it documented?	The quality management system shall include a documented process for reprocessing and repair that shall include authorization from a customer designated individual. The process shall describe product characteristics for which reprocessing is allowed as well as those characteristics for which reprocessing is not permissible. Any reprocessing activity shall require a new processing control sheet issued by qualified technical personnel denoting the necessary welding modifications. Records shall clearly indicate when and how any material has been reprocessed. The Quality Manager or a designee shall authorize the release of reprocessed product.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
Section 2 - Floor and Material Handling Responsibility						
2.1	Does the facility ensure that the data entered in the receiving system matches the information on the customer's shipping documents?	It is critical that all customer requirements and lot identification be adequately transferred to internal welding documents. The facility shall ensure that the data entered in the receiving system match the information on the customer's shipping documents. Documented processes and evidence of compliance shall exist, e.g., shop travelers, work orders, etc. Sometimes the material received does not precisely correspond to customer shipping documents. The facility shall have a detailed process in place to resolve receiving discrepancies. The requirements stated above also apply to captive welding departments. This process refers to receiving and shipping the parts in and out of the welding department.				
2.2	Is product clearly identified and staged throughout the welding process?	Procedures for part and container identification help to avoid incorrect processing or mixing of lots. Appropriate location and staging within the facility also help to ensure that orders are not shipped until all required operations are performed. Customer product shall be clearly identified and staged throughout the welding process. Non-welded, in-process, and finished product shall be properly segregated and identified. All material shall be staged in a dedicated and clearly defined area.				
2.3	Is lot traceability and integrity maintained throughout all processes?	Out-going lot(s) shall be traceable to the incoming lot(s). The discipline of precisely identifying lots and linking all pertinent information to them enhances the ability to do root cause analysis and continual improvement.				
2.4	Are procedures adequate to prevent movement of non-conforming product into the production system?	The control of suspect or non-conforming product is required to prevent inadvertent shipment or contamination of other lots. Procedures shall be adequate to prevent movement of non-conforming product into the production system. Procedures shall exist addressing proper disposition, product identification, and tracking of material flow in and out of the hold area. A non-conforming hold area shall be clearly designated to maintain segregation of such material.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
2.5	Are containers free of inappropriate material and contaminants?	Containers handling customer product shall be free of inappropriate material and contaminants. After emptying and before re-using containers, containers shall be inspected to ensure that all parts and inappropriate material have been removed. The source of inappropriate material shall be identified and addressed. This is to ensure that no nonconforming welded parts or inappropriate material contaminate the finished lot.				
2.6	Is part loading specified, documented and controlled?	Loading parameters shall be specified, documented, and controlled. Examples include part load sequence and clamp sequence.				
2.7	Is there a containment reaction plan and are operators trained in the process?	Operators shall be trained in material handling, containment action, and product segregation in the event of an equipment emergency including power failure. Training shall be documented. Work instructions specifically addressing potential types of equipment emergencies and failures shall be accessible to and understood by equipment operators. These instructions shall address containment/reaction plans related to all elements of the welding process. Evidence shall exist showing disposition and traceability of affected product. Unplanned or emergency downtime greatly raises the risk of improper processing.				
2.8	Is the handling, storage and packaging adequate to preserve product quality?	The welder's loading system, in-process handling, and shipping process shall be assessed for risk of part damage or other quality concerns. Other practices such as stacking of overloaded containers can also increase the risk of part damage.				
2.9	Are plant cleanliness, housekeeping, environmental and working conditions conducive to control and improved quality?	Plant cleanliness, housekeeping, environmental, and working conditions shall be conducive to controlling and improving quality. The welding 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.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
Section 3 - Equipment / Facilities/Controls						
2.10	Are parts free from contaminants that would be detrimental to the quality of the welding processes, subsequent processes, or the product?	Parts shall be free from contaminants that are detrimental to the quality of the welding processes, subsequent processes, or the product. If applicable, pre-wash and post-wash parameters shall be monitored and documented.				
3.1	Are the facilities sufficient for the welding operation?	This could include but is not limited to, facilities capabilities such as safety, environmental regulations/practice, sufficient incoming power (balance and loading), air (sizing, filtering and cleanliness), water, power supply grounding per OEM and regulatory specifications, gas mixing system (equipment and sizing), ventilation, and adequate lighting.				
3.2	Are the power supplies sufficiently sized?	The power supply should be adequate for the manufacturing process with consideration not limited to output energy, duty cycle, cooling, flow rates and grounding.				
3.3	Are process equipment calibrations and/or verification certified, documented, available, and current?	The calibration and certification of the process equipment shall be checked at regular specified intervals. Refer to the applicable Process Tables.				
3.4	Has a preventative maintenance program been established and documented?	Supplier shall have a preventative maintenance program that is documented and implemented. Refer to Section 1.19 and the applicable Process Tables.				
3.5	Have the necessary replacement parts and process consumables been identified and made readily available?	The replacement parts and process consumables shall be identified, maintained in the appropriate volumes and proper storage. Consumables must be on the customer's approved source list (if applicable). Refer to the applicable Process Tables, Section 2.0 and Section 1.19. This shall be captured in tools such as the set up procedure, PFMEA and Control Plans. It should be included in the layered process audit or other similar type quality review process.				
3.6	Are the process, equipment, and safety alarm checks being tested at the required frequency or after any repair or rebuild?	The welding operation shall have a list of welding process, equipment, and safety alarms. These alarms shall be individually tested at the required frequency as listed in the control plan, and after any repair, process change or rebuild. These checks shall be documented.				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
Section 4 - TOOLING/FIXTURING						
4.1	Is there a record of the design and set-up of the fixture?	Supplier shall have documentation of the fixture design, that are stored properly and accessible. Proper identification and revision level on the fixture or related to the fixture. Documented fixture set-up (i.e., clamps, pins, locating devices)				
4.2	Is the positioning of each part being controlled?	A method to detect proper fixture and part position is required for each part, such as the use of proximity switches, optical sensors, mechanical probes, part presence or poke yokes, etc.				
4.3	Has fixturing/tooling preventative maintenance program been established?	Supplier shall have a preventative maintenance program that is documented and implemented. Refer to Section 1.18 and the applicable Process Tables. Examples: cleaning, degreasing, and fixturing integrity.				
4.4	Are the fixture components robust?	Gas, air, sensors, control cables, etc. are adequately protected for the process environment.				
4.5	Are the tooling components designed for the welding process?	Fixturing/tooling was developed considering movement, reach, accessibility, tool center point, maintenance, and ergonomics (manual, automatic, and robotics)				
Section 5 - PROCESS CONTROLS AND CONFIRMATION						
5.1	Does welding operation include the following?	Identify the process control equipment necessary to monitor, control and provide feedback on all essential process variables as listed below and in the applicable Process Tables.				
5.1.1		Logic has been established to effectively identify and address process or equipment faults.				
5.1.2		With over rides or resets, logs must be maintained.				
5.1.3		Weld faults audible, visible and line shut down.				
5.1.4		At weld cycle interrupt, part must not be removed or passed until dispositioned by appropriate personnel.				
5.1.5		Calibration of meters and system controls.				
5.1.6		Inter-locking of previous operations have occurred and quality of parts has been verified before the next operation begins.				
5.1.7		Secure backups of all programs and procedures (electronic preferred).				
5.1.8		High/Low limit alarms established by actual data.				
5.1.9		Process variables have been defined and developed by data and shown to be statistically capable.				
5.1.10		Acceptable traceability (sequence/date coding)				

Special Process: Welding System Assessment						
Question Number	Question	Requirements and Guidance	Objective Evidence	Assessment		
				N/A	Satisfactory	Not Satisfactory
5.1.11		All tooling and process changes are documented.				
5.1.12		Documented welding procedures for each weld location and each process variable.				
5.1.13		Change over procedure (filler material, fixtures)				
5.1.14		Must have documented start-up and shut-down procedure.				
5.2	Are process control parameters monitored at established frequencies?	Process control parameters shall be monitored per frequencies established in the control plan. An appropriate person shall verify the process control parameters. Management review is required per Question 1.13.				
5.3	How does the organization review and react to out of control/specification parameters?	Are there documented reaction plans with appropriate levels of containment for both out of control and out of tolerance process parameters? Is there documented evidence that reaction plans are followed?				
5.4	How does the organization handle changes to process control parameters after initial customer approval?	There shall be a hierarchy established for making and approving process changes. Each process should be acted on according to the level of change. Review process changes with your customer.				
5.5	Are In-Process and Final Tests performed at established frequencies?	In-Process and Final Tests shall be performed per frequencies in the control plan as agreed upon between the supplier and the customer.				
5.6	Are weld quality requirements clearly defined per customer specifications?	Weld quality requirements per internal and customer specifications, such as but not limited to the following testing methodology: Cut and etch				
5.6.1		Part location, warping, gap, and dimensional requirements				
5.6.2		Correct number of welds				
5.6.3		Weld length/size				
5.6.4		Weld location				
5.6.5		Non Destructive Testing (NDT)				
5.6.6		Spatter, undercut, porosity, discontinuities..				
5.6.7		Weld direction confirmation				
5.6.8		Destructive testing				
5.6.9		Additional testing				
5.6.10						

Instructions for completing the Job Audit

The organization is to complete a minimum of one welding part job audit during each assessment. This should be done preferably on a part identified for one of the customers requiring compliance to this document. More part job audits may be done if time permits. Preferably, safety or critical parts should be audited. This may not be easily determined with fasteners, especially if the fastener manufacturer does not identify the end customer (auto manufacturer, tier one, etc.). It is recommended that the job audit be performed at the end of the welding system assessment.

- The job audit is not the only or main focus of the WSA. The other five sections on Management Responsibility and Quality Planning, Floor and Material Handling Responsibility, and Equipment/Facilities/Control, Tooling/Fixturing, and Process Controls and Confirmation are equally if not even more important. The job audit of one part, one weld process, is not sufficient to use as a basis to complete the other sections of the complete WSA.

The job audit is a compliance type audit/review of a specific part and its related paperwork and processing, including welding equipment and processing records for that job from the beginning receipt of a part through processing in the welding operation and inspection to packaging. Parts shall be taken from the shipping area at the dock or the end of the welding operation. If an automotive manufacturer's part is not available or identifiable, then parts from other customers requiring compliance with this document shall be used for the assessment.

The part checked shall represent a major weld operation such as an individual operation, cell, or assembly line. In subsequent welding system assessments, different parts and welding processes shall be checked.

The specific welding processing parameters (applies to 6.1 and 6.13 in the Job Audit) that are required in the job audit shall be added to the job audit form. This can be done by reviewing the customer specification(s), the Control Plan, the FMEA, and the floor work/job order. Each processing step shall be reviewed for proper production records/compliance/inspection. These steps can be compared to those in the Welding System Assessment for the actual job/welding process being reviewed for compliance. The welding records for the actual time frame/shift etc. that the job was processed shall also be checked. The actual welding equipment and instrumentation certification shall be verified as being in compliance to the appropriate equipment requirements in the equipment section.

Section 6 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Base Metal Specifications: _____
Filler Metal Specification (if required): _____
Welding Process(es): _____

Question #	Job Audit Question	Related WSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
6.1	Has the welding operation identified the process control equipment necessary to monitor, control and provide feedback on all essential process variables as listed in the applicable Process Tables?	1.8 5.1 5.2				
6.2	Has the logic been established to effectively identify and address process or equipment faults?	5.1				
6.3	Are over rides or resets logs maintained?	5.1.2				
6.4	Are weld faults audible, visible and does the line shut down?	5.1.3				
6.5	If the weld cycle is interrupted, is the part controlled or contained until dispositioned by appropriate personnel?	2.7 5.1.4				
6.6	Are the meters and feed back controls calibrated per established frequencies?	5.1.5 3.3				
6.7	If applicable, is there an inter-locking of the previous operation and has the quality of parts been verified?	5.1.6				

Section 6 - Job Audit

Job Identity:
 Customer: _____
 Shop Order Number: _____
 Part Number: _____
 Part Description: _____
 Base Metal Specifications: _____
 Filler Metal Specification (if required): _____
 Welding Process(es): _____

Question #	Job Audit Question	Related WSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
6.8	Are there secure backups of all programs and procedures (electronic preferred)?	5.1.7				
6.9	Are high/low limit alarms established by actual data.	5.1.8 5.1.1				
6.10	Have process variables been defined and developed by data and shown to be statistically capable?	5.1.9				
6.11	Is there acceptable traceability (sequence/date coding)?	5.1.10 5.1.11 2.3 2.7				
6.12	Is there traceability of all process and tooling changes?	4.1 5.1.11 5.4				
6.13	Are there documented welding procedures for each weld location and each process variable?	5.1.12 1.5 1.10				
6.14	Is there a documented change over procedure (filler material, fixtures)?	1.5 5.1.13 3.6				
6.15	Is there a documented start-up and shut-down procedure?	1.5 1.10 5.1.14				
6.16	Are process control parameters monitored at established frequencies?	5.2				

Section 6 - Job Audit

Job Identity: _____
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Base Metal Specifications: _____
Filler Metal Specification (if required): _____
Welding Process(es): _____

Question #	Job Audit Question	Related WSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
6.17	Are there documented reaction plans with appropriate levels of containment to both out of control and out of tolerance process parameters and provide documented evidence that reaction plans are followed?	5.3 1.21 5.6 1.8 2.7				
6.18	How does the organization handle changes to process control parameters after initial customer approval and how do you notify your customer?	1.6 5.4 1.22 1.16				
6.19	Are In-Process and Final Tests performed at established frequencies?	1.8 5.5				
6.20	Are weld quality requirements clearly defined per customer specifications?	1.9 5.6	Each part may have one or more requirements determined by the welding specification. Parts must meet each requirement. List requirements below and validate.			
6.20.1	Test Type:					
	Test Method:					
	Test Frequency and Quantity:					
	Specification:					
6.20.2	Test Type:					
	Test Method:					
	Test Frequency and Quantity:					
	Specification:					

Section 6 - Job Audit

Job Identity:
Customer: _____
Shop Order Number: _____
Part Number: _____
Part Description: _____
Base Metal Specifications: _____
Filler Metal Specification (if required): _____
Welding Process(es): _____

Question #	Job Audit Question	Related WSA Question #	Customer or Internal Requirement	Job (Shop) Order or Reference Documentation Requirement	Actual Condition (Objective Evidence)	Pass / Fail / N/A
6.20.3	Test Type:					
	Test Method:					
	Test Frequency and Quantity:					
	Specification:					
6.20.4	Test Type:					
	Test Method:					
	Test Frequency and Quantity:					
	Specification:					

APPENDIX A – PROCESS TABLES

Process Table A: Arc Stud/Fastener Welding, Flux-Cored Arc Welding, Gas Metal Arc Welding, Submerged Arc Welding, Shielded Metal Arc Welding, Plasma Arc Welding, Gas Tungsten Arc Welding, and Gas Metal Arc Braze Welding 32

Process Table B: Resistance Spot Welding, Projection Welding, Resistance Seam Welding, High-Frequency Seam Welding, Induction Seam Welding, Mash Seam Welding, and Flash Welding..... 34

Process Table C: Nd YAG, CO2, DIODE, and Wire Fed..... 36

Process Table D: Inertia Friction Welding, Direct Drive Friction Welding, Friction Stir Welding, Flash Butt Welding, Resistance Butt Welding and Ultrasonic Welding 40

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PROCESS TABLE A- Arc Welding Processes

Item #	Related WSA Question #	Category/Process Steps	Arc Stud/ Fastener Welding (SW)	Flux- Cored Arc Welding (FCAW)	Gas Metal Arc Welding (GMAW)	Submerged Arc Welding (SAW)	Shielded Metal Arc Welding (SMAW)	Plasma Arc Welding (PAW)	Gas Tungsten Arc Welding (GTAW)	Gas Metal Arc Braze Welding
1.0	1.7, 1.8	Arc welding specific essential variables which shall be addressed in the FMEA, control plan and welding procedures								
A1.1		Arc voltage		x	x	x		x	x	x
A1.2		Amperage	x	x	x	x	x	x	x	x
A1.3		Current type (AC/DCEN/DCEP)	x	x	x	x	x	x	x	x
A1.4		Wire feed speed		x	x	x		x ¹	x ¹	x
A1.5		Pulse setting variables specific to the OEM of the welding equipment must be documented and controlled.			x			x	x	x
A1.6		Stud gun/torch position work angle, travel angle	x	x	x	x	x	x	x	x
A1.7		Contact tip-to-work distance		x	x	x				x
A1.8		Electrode-to-work distance					✓	x	x	
A1.9		Lift height of stud	x							
A1.10		Fastener coating (determines current type)	x							
A1.11		Plunge control mode force or position	x							
A1.12		Flux classification and depth				x				
A1.13		Flux removal and reclamation plan				x				
A1.14		Gas flow pre-flow, post-flow, rate and type(s)	x ²	x ²	x			x	x	x
A1.15		Electrode and/or filler metal type, diameter, and classification	x						x	x
A1.16		Travel speed		x	x	x	✓	x ¹	x	x
A1.17		Gas nozzle size and type	x ²	x ²	x			x	x	x
A1.18		Arc starting parameters		x	x	x	✓	x	x	x
A1.19		Arc end parameters		x	x	x		x	x	x

All control of variables given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.

Dashes below indicate "not applicable".

X indicates an essential variable which shall be documented and controlled.

✓ indicates that procedure should be reviewed and documented when necessary.

PROCESS TABLE A- Arc Welding Processes

Item #	Related WSA Question #	Category/Process Steps	Arc Stud/ Fastener Welding (SW)	Flux- Cored Arc Welding (FCAW)	Gas Metal Arc Welding (GMAW)	Submerged Arc Welding (SAW)	Shielded Metal Arc Welding (SMAW)	Plasma Arc Welding (PAW)	Gas Tungsten Arc Welding (GTAW)	Gas Metal Arc Braze Welding
A1.20		Wire burnback settings		x	x	x				x
A1.21		Plunge depth	x							
A1.22		Arc time	x	x ³	x ³			x ³	x ³	
A1.23		Fastener geometry per material type	x							
A1.24	What are your procedures for:	Nozzle cleaning and cleaners, replacement		✓	✓	✓		✓	✓	✓
A1.25		Tip changes		✓	✓	✓		✓	✓	✓
A1.26		Wire liners/conduits cleaning and replacing		✓	✓	✓				✓
A1.27		Drive roll changes		✓	✓	✓				✓
A1.28		Wire guide tube change		✓	✓	✓				✓
A1.29		Antispatter Application (spray/dip and equipment)		✓	✓	✓			✓	✓
A1.30		Electrode and stud collet change	✓						✓	✓
A1.31		O rings in gas system maintenance	✓		✓			✓	✓	✓
A1.32		Gas delivery and mixing system	x ²	x ²	x	✓		x	x	x
A1.33		Flux delivery systems maintenance				✓				
A1.34		Flux removal (screens size and magnetic separators)				✓			✓	
A1.35		Electrode sharpening						✓		
A1.36		Slag removal				x				x
A1.37		Wire dereelers maintenance		✓	✓	✓				✓
A1.38		Wire brake adjustment		✓	✓	✓				✓
A1.39		Integrity of ground system	✓	✓	✓	✓		✓	✓	✓

x¹: Processes can be used both with and without filler metal.
 x²: These welding processes are designated for either gas shielded, self shielded or gasless.
 x³: Arc Spot welding applications only.

PROCESS TABLE B- Resistance Welding Processes

All control of variables given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.

Dashes below indicate "not applicable".
 X indicates an essential variable which shall be documented and controlled.
 ✓ indicates that procedure should be reviewed and documented when necessary.

Item #	Related WSA Question #	Category/Process Steps	Resistance Spot Welding (RSW)	Projection Welding (PW)	Resistance Seam Welding (RSEW)	High-Frequency Seam Welding (RSEW-HF)	Induction Seam Welding (RSEW-I)	Mash Seam Welding (RSEW-MS)	Flash Welding* (FW)
2.0	1.7, 1.8	Resistance welding specific essential variables which shall be addressed in the FMEA, control plan and welding procedures							
B2.1		Weld force	X	X	X			X	X
B2.2		Clamp force			✓			✓	✓
B2.3		Forge force	✓	✓		✓			
B2.4		Forge delay	✓	✓					
B2.5		Amperage	X	X	X			X	
B2.6		Voltage	X	X	X			X	✓
B2.7		Power				✓	✓		
B2.8		Frequency	X	X	X	X	X	X	X
B2.9		Pulsation	X	X	X			X	
B2.10		Squeeze time/cycles	X	X	X			X	
B2.11		Weld time/cycles	X	X	X			X	X
B2.12		Hold time/cycles	X	X	X			X	X
B2.13		Quench time/cycles	✓	✓	✓	✓	✓	✓	✓
B2.14		Temper time	✓	✓	✓	✓	✓	✓	✓
B2.15		Cool time/cycles	X	X	X			X	
B2.16		Upslope time/cycles	X	X	X	X	X	X	X

PROCESS TABLE B- Resistance Welding Processes

Item #	Related WSA Question #	Category/Process Steps	Resistance Spot Welding (RSW)	Projection Welding (PW)	Resistance Seam Welding (RSEW)	High-Frequency Seam Welding (RSEW-HF)	Induction Seam Welding (RSEW-I)	Mash Seam Welding (RSEW-MS)	Flash Welding* (FW)
B2.17		Stepper programs	X						
B2.18		Tip/electrode/wheel dressing	X	X	X	X		X	X
B2.19		Weld travel speed			X		X	X	
B2.20		Adequate electrode follow up in weld force / distance	X	X					X
B2.21		System cooling-transformers, electrodes, etc.	X	X	X	X	X	X	X
B2.22		Tip/electrode/wheel/coil change frequency	X	X	X	X	X	X	X
B2.23		Tip/electrode/wheel/coil alignment	X	X	X	X	X	X	X
B2.24	What are your procedures for:	Electrode selection/type (material type etc.)	✓	✓	✓	✓		✓	✓
B2.25		Electrode geometry	✓	✓	✓	✓		✓	✓
B2.26		Induction coil geometry					✓		
B2.27		Secondary loop electrical conductors (cables, leaf shunts, etc.) and mechanical joints maintenance	✓	✓	✓	✓	✓	✓	✓
B2.28		Projection weld geometry and size		✓					

All control of variables given below are subordinate to customer specific requirements.
 The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.

Dashes below indicate "not applicable".
 X indicates an essential variable which shall be documented and controlled.
 ✓ indicates that procedure should be reviewed and documented when necessary.

*Flash Welding is a Solid State process, however, the process controls most resemble a resistance weld process. Refer to Table D for other requirements on Flash Welding

PROCESS TABLE C- Laser Welding Processes

All control of variables given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.

Dashes below indicate "not applicable".
 X indicates an essential variable which shall be documented and controlled.
 ✓ indicates that procedure should be reviewed and documented when necessary.

Item #	Related WSA Question #	Category/Process Steps	Nd YAG (LBW)	CO2 (LBW)	DIODE (LBW)	With Wire Feed System
3.0	1.7, 1.8	Welding specific essential variables which shall be addressed in the FMEA, control plan and welding procedures				
		Equipment				
C3.1		Beam quality	X	X	X	X
C3.2		Optic cleanliness	X	X	X	X
C3.3		Cross jet or laser knife	X	X	X	X
C3.4		Beam configuration (split, single)	X	X	X	X
C3.5		Focal length	X	X	X	X
C3.6		Beam spot size	X	X	X	X
C3.7		Gas tube angle/arrangement	X	X	X	X
C3.8		Optics purge gas (flow and quality)	X	X	X	X
C3.9		Mirror cleanliness	X	X	X	X
C3.10		Mirror degradation	X	X	X	X
C3.11		Beam sharing	X	X	X	X
C3.12		Split beam	X	X	X	X
C3.13		Tip changes				X
C3.14		O rings in gas system				X

PROCESS TABLE C- Laser Welding Processes

Item #	Related WSA Question #	Category/Process Steps	Nd YAG (LBW)	CO2 (LBW)	DIODE (LBW)	With Wire Feed System
C3.15		Gas nozzle				X
C3.16		Torch angles				X
C3.17		Chillers (internal - external)	X	X	X	X
C3.18		- Flow rate	X	X	X	X
C3.19		- Water quality	X	X	X	X
C3.20		- Type of coolant	X	X	X	X
C3.21		- Additive concentration	X	X	X	X
C3.22		- Temperature control (rate of change and range)	X	X	X	X
C3.23		Wire feed system				X
C3.24		- Wire feed speed				X
C3.25		- Wire liners/conduits cleaning and replacing				X
C3.26		- Drive roll changes				X
C3.27		- Wire guide tube				X
C3.28		- Wire derealers				X
C3.29		- Wire brake adjustment				X
C3.30		- Wire cleaners/wipers				X
C3.31		- Contact tip to work distance				X
C3.32		- Wire position to laser focal point				X

All control of variables given below are subordinate to customer specific requirements.
 The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.
 Dashes below indicate "not applicable".
 X indicates an essential variable which shall be documented and controlled.
 ✓ indicates that procedure should be reviewed and documented when necessary.

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PROCESS TABLE C- Laser Welding Processes

All control of variables given below are subordinate to customer specific requirements.

The customer may have additional requirements, e.g., inspection testing, greater frequencies, etc. When performing the job audit, the auditor shall verify welding is conforming to the customer's requirements.

Dashes below indicate "not applicable".
 X indicates an essential variable which shall be documented and controlled.
 ✓ indicates that procedure should be reviewed and documented when necessary.

Item #	Related WSA Question #	Category/Process Steps	Nd YAG (LBW)	CO2 (LBW)	DIODE (LBW)	With Wire Feed System
		Beam Delivery				
C3.33		Direct			X	X
C3.34		Fiber	X		X	X
C3.35		- Fiber diameter	X		X	X
C3.36		- Fiber lengths	X		X	X
C3.37		- Bend radius	X		X	X
C3.38		- Condition of fiber	X		X	X
C3.39		- Fiber ends (condition of fiber ends)	X		X	X
C3.40		- Fiber end cooling	X		X	X
C3.41		Mirror		X		X
C3.42		- Power loss through the delivery system		X		X
C3.43		- Alignment		X		X
C3.44		- Cleanliness		X		X
C3.45		- Coatings of mirror		X		X
C3.46		- Mirror type		X		X
C3.47		- Optic and mirror cooling		X		X
		Process Variables				
C3.48		Shielding gas type - flow rate	X	X	X	X
C3.49		Weld travel speed control (rate of change, and velocity control)	X	X	X	X
C3.50		Power Output Control	X	X	X	X
C3.51		Power ramping/program (start, weld, end)	X	X	X	X
C3.52		Power at the work piece	X	X	X	X

PROCESS TABLE C- Laser Welding Processes

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Item #	Related WSA Question #	Category/Process Steps	Nd YAG (LBW)	CO2 (LBW)	DIODE (LBW)	With Wire Feed System
C3.53		Offset of beam to joint	X	X	X	X
C3.54		Continuous wave	X	X	X	X
C3.55		Pulsation	X	X	X	X
C3.56		Angle of Incidence	X	X	X	X
C3.57		Focus point	X	X	X	X
C3.58		Direction of welding (trailing or lead)	X	X	X	X
C3.59		Beam quality burn-in	X	X	X	X
C3.60		Power output control calibration	X	X	X	X
C3.61		Plasma suppression		X		X
C3.62		- Monitoring Back scatter for control process	✓	✓	✓	✓
		Fixtures/Part				
C3.63		- Stability and/or vibration isolation	X	X	X	X
C3.64		- Articulation system (smoothness of motion and accuracy)	X	X	X	X
C3.65	What are your procedures for controlling:	Part fit up	✓	✓	✓	✓
C3.66		Seam tracking	✓	✓	✓	✓
C3.67		Edge condition	✓	✓	✓	✓
C3.68		Coatings	✓	✓	✓	✓

PROCESS TABLE D - Solid State Welding Processes

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Item #	Related WSA Question #	Category/Process Steps	Inertia Friction Welding (FRW-I)	Direct Drive Friction Welding (FRW-DD)	Friction Stir Welding (FSW)	Flash Butt Welding (FW)	Resistance Butt Welding (UW)	Ultrasonic Welding
4.0	1.7, 1.8	Welding specific essential variables which shall be addressed in the FMEA, control plan and welding procedures						
D4.1		Tolerances on axial alignment	X	X	X			
D4.2		Faying surface area	X	X	X			
D4.3		Faying surface cleanliness	X	X	X			
D4.4		Initial spindal speed	X	X	X			
D4.5		Welding spindal speed			X			
D4.6		Spindal torque - to not damage equipment	X	X	X			
D4.7		Flywheels; total moment of inertia	X					
D4.8		Spindle clamp pressure	X	X	X			
D4.9		Fixture clamp pressure	X	X	X			
D4.10		Part stickout	X	X				
		Preheat (First friction phase) if needed						
D4.11		-Projection on faying surface	X ¹	X ¹				
D4.12		-Preheat force	X ¹	X ¹				
D4.13		-Preheat time or RPM	X ¹	X ¹				
D4.14		Preheat burnoff length-amount of dimension loss during preheat		X ¹		X	X	
		Weld Heat (Second friction phase)						
D4.15		-Friction weld force	X	X				
D4.16		-Friction speed at which forging begins	X	X				

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		Forging Stage						
D4.17		-Forging speed	X	X				
D4.18		-Forge force	X	X				
D4.19		-Forge time		X				
D4.20		-Forge length if limited upset is used		X				
D4.21		-Forge delay		X				
D4.22		-Upset distance		X				
D4.23		-Upset removal / management	X	X				
D4.24		-Upset hold time	X	X				
D4.25		-Upset rate	X	X				
D4.26		-Friction upset distance and time		X				
D4.27		Brake setting or stopping time dimensions and tolerances		X				
D4.28		Brake force		X				
D4.29		Brake delay prior to upset		X				
D4.30		Final position		X				
D4.31		Postweld heat treatment if needed based on materials joined	✓	✓	✓			
D4.32		Protective atmosphere if necessary for the base material	✓					
D4.33		Total burnoff-amount of dimension loss during total process		X		X		

PROCESS TABLE D - Solid State Welding Processes

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		FSW						
D4.34		Primary control (position or force)			X			
D4.35		Tool to weld joint alignment during length of travel			X			
		Tool						
D4.36		-Pin to shoulder ratio			X			
D4.37		-Pin length			X			
D4.38		-Included angle for pin			X			
D4.39		-Included angle for shoulder			X			
D4.40		-Thread on pin surface			X			
D4.41		-Pin material			X			
		Plunge Practice						
D4.42		-Speed of plunge			X			
D4.43		-Spindal speed during plunge			X			
D4.44		-Preheat dwell time after plunge			X			
D4.45		-Plunge force			X			
		Weld						
D4.46		-Weld force			X			
D4.47		-Travel speed			X			
D4.48		-Tool tilt angle			X			
D4.49		-Weld spindal speed			X			
		Weld termination						
D4.50		-Exit motion of tool such as tilt angle rotation			X			
D4.51		-Spindal speed at tool extraction			X			
D4.52		-Dwell at end of travel			X			

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		FBW RBW						
D4.53		Electrode design-eliminate die burns				X	X	
D4.54		Electrode/Die cleanliness				X	X	
D4.55		Electrode/Die clamping pressure				X	X	
D4.56		Part cleanliness and scale removal				X	X	
D4.57		Part alignment				X	X	
D4.58		Joint geometry preparation				X	X	
D4.59		Initial material stickout or extension beyond electrodes				X	X	
		Preheat						
D4.60		-Preheat force				X	X	
D4.61		-Tap selection				X	X	
D4.62		-Percent heat				X	X	
D4.63		-Off time during initial die opening				X		
		Initial Flashing						
D4.64		-Initial die opening				X		
D4.65		-Initial flashing rate				X		
D4.66		-Type of platten movement (linear or parabolic)				X		
D4.67		-Voltage				X		
D4.68		-Initial flashing distance or time				X		
D4.69		-Percent heat				X		
D4.70		-Tap selection				X		

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D4.71		Flashing						
D4.72		-Flashing rate			X			
D4.73		-Type of platten movement (linear or parabolic)			X			
D4.74		-Voltage			X			
D4.75		-Flashing distance or time			X			
D4.76		-Percent heat			X			
		-Tap selection			X			
		Weld Stage 1						
D4.77		-Percent heat					X	
D4.78		-Tap selection voltage					X	
D4.79		-Force					X	
D4.80		-Pulsation (on, off and number of pulses)					X	
D4.81		-Off time before stage change					X	
		Weld Stage 2 (can be multiple stages with different parameters)						
D4.82		-Percent heat					X	
D4.83		-Tap selection voltage					X	
D4.84		-Force					X	
D4.85		-Pulsation (on, off and number of pulses)					X	

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D4.86		Forge/Upset						
D4.87		-Forge rate				X	X	
D4.88		-Forge force				X	X	
D4.89		-Forge distance / total upset				X	X	
D4.90		-Upset time				X	X	
D4.91		-Upset current				X	X	
D4.92		-Flashing voltage cut off				X		
		-Flashing removal / management				X	X	
		Post weld heat treatment if needed						
D4.93		-Heat treatment clamping distance				✓	✓	
D4.94		-Quench time				✓	✓	
D4.95		-Tap selection				✓	✓	
D4.96		-Precent heat				✓	✓	
D4.97		-Temper time				✓	✓	
D4.98		Final die opening				✓	✓	
		Ultrasonic Metal weld				X	X	
D4.99		Tap selection / design of ribbon structure						✓
D4.100		Frequency of power supply for application (40/30/20kHz)						✓
D4.101		Fixture & part design with max dimension deviation and material specs						✓

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		Upset and Monitoring (windowing)						
D4.102		Welding-Energy						X
D4.103		Welding-Time						X
D4.104		Welding-Amplitude						X
D4.105		Welding-Force						X
D4.106		Welding-Current						X
D4.107		Welding pre Height and travel (compaction)						X
D4.108		Energy with height compensation						X
D4.109		Weld Head Cooling						✓
D4.110		Environmental conditions control (i.e., temperature, humidity, dust, etc.)						✓
D4.111		TAP/Die cleanliness						✓
D4.112		TAP/Die clamping pressure						✓
D4.113		Part cleanliness and scale removal						✓
D4.114		Part alignment						✓

¹: If required to achieve heat balance. Example thin part to thick part or various hardnesses.

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		Upset and Monitoring (windowing)						
D4.113		Welding-Energy						X
D4.114		Welding-Time						X
D4.115		Welding-Amplitude						X
D4.116		Welding-Force						X
D4.117		Welding-Current						X
D4.118		Welding pre Height and travel (compaction)						X
D4.119		Energy with height compensation						X
D4.120		Weld Head Cooling						✓
D4.121		Environmental conditions control (i.e., temperature, humidity, dust, etc.)						✓
D4.122		TAP/Die cleanliness						✓
D4.123		TAP/Die clamping pressure						✓
D4.124		Part cleanliness and scale removal						✓
D4.125		Part alignment						✓

x¹: If required to achieve heat balance. Example thin part to thick part or various hardnesses.

CQI-15

Special Process: Welding System Assessment

Version 1 Issued 3/10



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GLOSSARY

See also **AWS A3.0: welding terms and definitions**

AIAG – Automotive Industry Action Group

AWS American Welding Society

ANSI American National Standard Institute

Capability – The total range of inherent variation in a stable process.

Control Plans – Written descriptions of the system for controlling processes for production of parts or bulk materials. Control Plans are written by organizations to address the important characteristics and engineering requirements of the product. Each part must have a Control Plan, but in many cases, “family” Control Plans can apply to a number of parts produced using a common process.

Critical Spare Parts List – A list of service parts critical for the operation of equipment. Extended delay in obtaining spare parts would result in unacceptable delays in the welding operation.

Cross-Functional Team – A team of employees that represent the different functions within an organization. The team will typically consist of an operator, line supervision, process engineer, metallurgist, and quality personnel.

Customer – The recipient of the organization's or supplier's product or service.

Customer Requirements – This term refers to the requirements or specifications from the original equipment manufacturer (typically the automobile company). These may be identified in the contract or purchase order, in engineering standards, part specifications, etc.

Inter-Lock – A method of preventing missed steps within the operations by putting controls on how an operation can be performed in order to force the correct completion of the operation.

Nonconforming Product – Product that does not conform to the customer requirements.

Process Tables – Tables in the WSA that list the required process controls for the welding processes covered. These tables contain minimum requirements.

Reprocessing – Any process that is performed on nonconforming product so that it will meet the specified requirements.

Responsibility Matrix – A responsibility matrix defines the designated personnel for all key functions. This matrix includes the primary and secondary designees.

Robust – A stable predictive outcome regardless of variation within operating window; able to withstand its environment, not prone to failure.

SAE International – Society of Automotive Engineers International

Shop Traveler – A document usually created in the receiving department for each batch or lot of parts received. The document defines the process routing of the parts.

Special Characteristics – are product characteristics or manufacturing process parameters which can affect safety or compliance with regulations, fit, function, performance or subsequent processing of product. Refer to customer-specific requirements.

WSA - Welding System Assessment

CQI-15

Special Process: Welding System Assessment

Version 1 Issued 3/10



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Work Instructions – Instructions that describe work conducted in one function in a company, e.g., setup, inspection, welding operation, process parameter tolerances, etc. The term “work instructions” is synonymous with the term “job instructions.”

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