



**RWMA TECHNICAL COMMITTEE WORKGROUP
AWS DESIGNER'S GUIDE TO RESISTANCE WELDING
October 19, 2007
San Antonio, Texas
Omni La Mansion del Rio Hotel**

Members participating:

Chair D. Uszynski, J. Dally, D. Darrah, B. DeGroot, P. Dodhia, B. Domschot, G. Doneski, T. Fick, P. Harris, R. Hirsch, R. Leibovitz, D. Maatz, R. Matteson, H. Radcliff, Jr., R. Rhodes, R. Scodeller, N. Scotchmer, M. Simmons, R. Spoth, B. White, Jr.,

Guest attending:

R. Wilson (Toyota Motor Mfg. Co.)

Minutes

I. WELCOME & INTRODUCTIONS

- Chair D. Uszynski called the meeting to order at 8:14 a.m. and affirmed that the meeting would be conducted to comply with the Committee's antitrust policy. The sign-in sheet was passed around.

II. OVERVIEW OF PROJECT

- The "Designers Guide to Resistance Welding", is being developed to provide sufficient technical detail to enable a Product Designer to apply resistance welding in basic assembly configurations. In the case where the application would become technically complex, the listed references in the guide would serve as a basis for the designer to conduct his/her own investigation to complete the design.

III. DRAFT OF DESIGNERS GUIDE TO RESISTANCE WELDING

- A current draft of the Designers Guide was supplied to all in attendance. *(copy attached)* D. Uszynski reported that the plan was to assign names to the subjects within the draft. A motion was made to make no changes to the current draft and proceed. Unanimously approved. Motion carried.
- J. Dally asked if all graphics and requirements were called out. D. Uszynski reported that the references provide all of the information that was previously discussed; however some of the information is dated and would need to be updated.
- Volunteers were requested for each chapter of the Guide. The following were the volunteers assigned:
 - ❖ Chapter 1 - **Fundamentals of Resistance Welding**
Mike Cubert and Dan Uszynski
 - ❖ Chapter 2 - **Joint Design**
Roger Hirsch, Jim Dally volunteered Gerry Doneski
 - ❖ Chapter 3 - **Weldability**
Don Maatz with Bob White, Jr. to assist
 - ❖ Chapter 4 - **Process Selection**
Bob Matteson and Jim Dally (Tom Snow will help with Portable guns)
 - ❖ Chapter 5 - **Weld Performance Requirements**
Ren Scodeller and Don Maatz
 - ❖ Chapter 6 - **Pre/post Processing**
Bill DeGroot. He will get people from his company to work on this.
 - ❖ Chapter 7 - **Equipment**
Bob White Jr., and Bryan Domschot

- ❖ Chapter 8 - **Work Handling**
Hank Radcliffe and Preston Harris
- ❖ Chapter 9 - **Safety** (*considering eliminating this section*)
Roger Hirsch and Ron Leibovitz
- ❖ Chapter 10 - **Technical Reference**

The meeting proceeded with minimal discussion as noted in the attached outline in *bold and italicized*.

IV. REVIEW OF MEETING

- A schedule of events were discussed as follows:
 - ❖ End of October - minutes sent to Committee members.
 - ❖ End of October - All reference materials would be forward to those individuals responsible for each chapter.
 - ❖ November 5 - teleconference with all committee members, questions & answers, kick-off.
 - ❖ December 5 - update
 - ❖ December 19 - update
 - ❖ January 30, 2008 - Documented sections will be returned to Dan Uszynski and Mike Cubert.
 - ❖ March 19 - Draft submitted to Committee members for review
 - ❖ April 16 - teleconference to review draft
 - ❖ D. Uszynski and Mike Cubert will compile all documentation received from the volunteers in preparation for the RWMA Spring Meeting.

V. ADJOURNMENT

The meeting adjourned at 8:45 a.m. Small groups met individually after the meeting to begin discussion of their particular chapters.

Respectfully submitted,



Susan Hopkins
RWMA Recording Secretary

Designer's Guide to Resistance Welding

OUTLINE 10/7/07

X. Forward

This document is designed to provide a level of technical detail that will allow the designer to reference this document for most applications. In the case where an application is very technically complex, the references listed will allow the designer to go to those documents to gather the information required to complete the design.

Further elaborate on resistance welding applications and uses that may not have been previously discussed

1. Fundamentals of Resistance Welding *Mike Cubert and Dan Uszynski*

- a. Designer Knowledge
 - i. Reference 2 Chapter 5 pp 126
 1. Background
 - a. Weldability of metals
 - b. Welding processes
 - c. Safety standards
 - d. Welding metallurgy
- b. The fundamentals section shall cover RW theory in brief. Descriptive figures, relevant formulas for current and heat, and a basic description of the process itself shall be covered.
- c. Discuss resistance welding as an alternative to other forms of joining (ie. bolts, rivets, togglelock, adhesive, etc.)
- d. Reference 1 Chapter 2

Reference the material to point the reader to data, but we should just tell the reader that we expect them to know about resistance welding and some ways of using it they may not have been considered.

2. Joint Design *Roger Hirsch and Jim Dally volunteered Gerry Doneski*

- a. Joint design itself should first include
 - i. Types of joints under separate sub-headings (ie. spot, upset, upset/flash, projection, seam, percussion, thermal brazing, etc.) include diagrams
- b. Information on weld location positioning, dimensional control, effect of performance requirements and the related design procedures for addressing them. Joint design with regard to the process(es) under consideration should be addressed.
 - i. Figures
- c. Reference 1 Chapter 7
- d. Reference 1 Chapter 9 pp 164
- e. Reference 1 Chapter 11 pp 230
- f. Reference 2 Chapter 5 pp 134-149
- g. In diagrams, have good/better/best notes, as in the old document.
- h. Electrode Design *Priyesh Doshia*
- i. Add note: The welder is NOT a stamping device. Detrimental and unpredictable effects can result from improperly formed parts.

3. Weldability *Don Maatz with Bob White, Jr. to help*

- a. The weldability section will outline the different materials, their properties, and the processes that typically employ them. The methods of employment (which material is best for the application given the performance requirements and its weldability) should be focused here, with a detailed explanation of how it relates to joint design.
- b. Material Selection
 - i. Reference 1 Chapter 8
 - ii. Reference 4 Section 2
- c. Properties of metals
 - i. Reference 2 Chapter 5 pp 127-133
- d. Common RW materials
 1. Low Carbon Steels

2. HCLA Steels
 3. HSLA Steels
 4. Stainless and High Alloy Steels
 5. Coated and Plated Steels
 6. Aluminum and Alloys
 7. Magnesium and Alloys
 8. Copper and Alloys
 9. Nickel and Alloys
 10. Misc and Dissimilar Metals
 11. Advanced HS Steels (Automotive)
- e. Stackup and layering

As with before, weldability can be addressed by the way the joints are grouped. Perhaps in a group (or individual joint), the optimal materials to be used on it could be listed, along with pros/cons you would use one over another.

4. Process Selection *Bob Matteson and Jim Dally (Tom helping with Portable guns)*
- a. The process selection section will relate the information given in the previous sections to the process that is best suited for the application of the designer. Advantages, disadvantages, machine design considerations, capital costs as well as labor and material costs, and machine configuration to facilitate the weldment design. Information such as electrode configurations and positioning, electrode types and geometries, electrode materials, and best practices for implementing the part and machine design relative to the desired process.
 - b. Reference 1 Chapter 16
 - c. Introduction
 - ii. Reference 1 Chapter 3
 - d. Economy/Productivity
 - iii. Reference 1 Chapter 3 pp 33
 - e. Spot
 - iv. Reference 1 Chapter 9
 - v. Reference 1 Chapter 15 pp 299
 - vi. Add series
 - vii. Add indirect
 - viii. Reference 6 Section 4
 - ix. Reference 9
 - x. Reference 11 (I am assuming that we would put the flange welding reference here?)
 - f. Seam
 - xi. Reference 1 Chapter 11
 - xii. Reference 6 Section 4
 - g. Projection
 - xiii. Reference 1 Chapter 10
 - xiv. Weld nuts, studs Reference 12
 1. Lots of detail here! Get data studies, etc.
 2. Add weld gun studies
 - xv. Cross wire welding
 - xvi. Reference 6 Section 5
 - h. Flash
 - xvii. Reference 1 Chapter 12
 - xviii. Reference 6 Section 6
 - i. Etc
 - j. Compare and contrast processes.

As stated before, we could split the groups of joints into process sections that make sense. Economy/productivity could be addressed individually at each joint or group.

5. Weld Performance Requirements *Ren Scodeller and Don Maatz*

- a. The weld performance section will cover information on the effect of the welding process on the welded part, and how to optimize the design to achieve the best possible weld performance. Detailed information on strength, torsion, shear, fatigue, etc will be covered here. Considerations for special materials (refractory metals, dissimilar metals, etc.) should be addressed, as well as how each process suits the requirements.
- b. Reference 1 Chapter 13
- c. Strength
- d. Torsion
- e. Fatigue
- f. Etc.
- g. Add refs 7 AMS 6858, D8.1, D17.2
- h. Charts with weldability
- i. Reference 9 Section 5

Again, this could be covered on an individual basis per joint or group.

- 6. Pre/post Processing *Bill DeGroot (he will get people from his company)*
 - a. The section on pre- and post-processing should include the designer's concerns regarding requirements for material preparation (cleaning, edge preparation, forming, etc.), testing, inspection, etc. Testing methods for proving of performance requirements will be covered, including periodic destructive testing, in-process testing (displacement, current monitoring, etc.), and examples of mil-spec testing procedures and requirements.
 - b. Reference 1 Chapter 13 pp 288
 - c. Edge Prep
 - i. Reference 1 Chapter 12 pp 245
 - d. Cleaning
 - e. Testing
 - ii. Pull, shear, radiographic, etc.
 - iii. Reference 1 Chapter 13
 - iv. Reference 3 Chapter 21
 - f. Inspection
 - v. Reference 3 Chapter 21
 - g. D8.1, D17.2
- 7. Equipment *Bob White, Jr. and Bryan Domschot*
 - a. The equipment section will describe the machinery used in the different processes, including automation machinery such as robotics and automatic and special machines. It will also describe how machine design affects the performance of the weldment, and how it may be optimized for cost vs. performance (electrode maintenance, etc.). An example of this is to incorporate universal heads on a seam welder, platens on a projection welder, replaceable jaws on a butt welder, etc. Information such as machine stiffness, secondary circuit throat length and conductivity/inductance shall be made to illustrate how these affect the weldment performance. Power delivery should be outlined in this section also. AC, DC, stored energy, MFDC, and other power delivery methods should be outlined, and compared and contrasted. How this affects the weld performance should be the focus here. Basic information on control technology should be covered here. The capability of PLC controls versus standard welding timers should be given in order for the designer to decide the effect of cost on the overall design.
 - b. Reference 1 Chapter 15
 - c. Reference 1 Chapter 16
 - d. Equipment
 - vi. Reference 1 Chapters 4-6
 - vii. Reference 1 Chapter 10
 - viii. Reference 1 Chapter 14 pp 269
 - e. Controls
 - f. Automation
 - g. STICK TO THE BASICS HERE
 - h. Use of the machines with their relevant properties

This part could go in the back, and help the designer to specify equipment based on the joint he has chosen to use.

8. Work Handling *Hank Radcliff and Preston Harris.*
 - a. The work handling section shall cover fixture design as it applies to the weldment and its design, cost analysis to determine the part handling methods (automatic versus manual, etc.), tooling requirements and designing weldments with ease of tooling in mind, part location, tooling and fixture material considerations (ferrous, plastics, phenolics, etc) and basic design for manufacturing techniques.
 - b. Fixturing, Tooling, etc.
 - ix. Reference 1 Chapter 9 pp 201
 - x. Reference 1 Chapter 14
 - xi. Reference 3 Chapter 19
9. Safety (consider eliminating this section) *Roger Hirsh and Ron Leibovitz*
 - a. The safety section will cover personal protective equipment, worker safety (guarding, shielding, ergonomics, etc.), environmental (fumes, waste, noise, light, etc.).
 - b. Keep safety to a minimum! Add the Z49 document and then reference local and company policies only!!
 - c. Reference 10 Section 12

Even though Dan tried to keep from discussing content, this section spurred a discussion. This came, because in brackets it said, consider eliminating. The group left it to Roger to make a decision on this. There is a consensus that some safety reference needs to be in the document. Roger decided this section is out and some input will be given for sections 7 and 8.

10. Technical Reference
 - a. The technical reference section shall include all the necessary codes and standards that are used by the designer such as safety regulations, symbols, terms and definitions, testing specifications, and any reference charts or tables.
 - b. Charts
 - c. Formulas
 - d. Symbols
 - i. Reference 3 Chapter 20
 - e. Terms and Defs.
 - i. Reference 3 Appendix A
 - f. Etc.

References:

1. Resistance Welding - Design, Tooling, and Applications Wallace A. Stanley
2. AWS Welding Handbook, Eighth Ed., Volume 1
3. Welding Engineering, Boniface Rocci 1954
4. AWS Resistance Welding Manual, 4th Ed.
5. Welding Journal article
6. AWS C1.1M/C1.1:2000 Recommended Practices for Resistance Welding
7. AMS 6858, D8.1, D17.2
8. Bulletin No.27 Production Processes design for Resistance Welding, 1959
9. AWS D8.1M:200X, Specification for Automotive Weld Quality - Resistance - Spot Welding of Steel - Draft 2006
10. AWS ANSI Z49.1:2005 Safety in Welding, Cutting And Allied Process
11. Weld Flange Widths - Aluminum and Steel
12. Resistance Welding of Forged Weld Nuts - Establishment of Standard Welding Schedules