Laser Welding: Equipment and Process Validation

Learn how to validate your laser and your laser welding process in compliance with AWS and ISO technical standards

- Learn how to produce repeatable weld performance
- Gain theoretical and practical knowledge on how to measure and control the laser parameters to produce good welds
- Increase your knowledge of materials selection and weld joint design
- Learn to identify, analyze, and eliminate weld defects
- Bring YOUR samples for analysis and discussion

January 31–February 3, 2011
Lake Buena Vista, Florida
Course Objectives
This course provides the practical methodology and theoretical understanding for producing good, repeatable laser welds under production conditions. You will:
- Learn proven methods for validating the performance of your laser and your laser welding process
- Gain a solid understanding of the laser welding equipment and procedures to validate its performance
- Focus on the process variables involved in achieving good laser welds, including:
  - setting and calibrating the correct laser beam parameters
  - setting up the tooling, the proper shield gas, and focus
  - monitoring weld quality
  - inspecting completed laser welds
  - analyzing weld defects
  - controlling documentation

Increase Your Understanding
You will learn:
- Practical methods for approaching laser welding documentation control
- Methods to validate your laser and your laser welding process
- Step-by-step procedures for accomplishing this validation
You will examine:
- Welding of dissimilar metals
- Weld geometries
- Shield gases
- Proper tooling
- Part inspection
- Engineering specifications
- Validation procedures

Attend and Benefit
Course discussions will focus on practical information that you can apply directly to solve laser validation and laser welding problems at your facility. The “mystery” of reproducible laser welding and its many variables will be reduced to a level understandable by engineers and production personnel alike.

Those who will benefit include:
- Manufacturing engineers
- Production engineers
- Mechanical engineers
- Design engineers
- R&D engineers
- Production, maintenance and set-up personnel
- Laser operators
- Quality assurance engineers
- Purchasing agents
- Corporate standards engineers
- Laser equipment builders
- Laser service personnel
You will receive a course notebook containing numerous graphs and charts to help you choose the correct process variables and the proper laser and beam delivery system at your site. You will also receive copies of step-by-step procedures for validating your laser equipment and laser process.

Your Instructor
Simon L. Engel is president of HDE Technologies, Inc., a consulting company specializing in industrial laser applications. Prior to starting HDE Technologies, Inc. in 1998, Simon was the owner and director of HDE Systems, Inc., a contract shop providing R&D and production services in laser-assisted materials processing and abrasive waterjet machining. Simon brings to this course many years of consulting experience in laser welding. His understanding of the process, the associated documentation, and the training of personnel is gained from many successfully completed assignments for major corporations. Simon received his B.A.Sc. degree in mechanical engineering from the University of British Columbia, Canada. A member of SME, LIA, and AWS, he holds eight patents and has written numerous articles on laser application techniques. Simon is a member of the AWS Laser Welding Subcommittee and a contributing author of AWS C7.4/C7.4M:2008 Process Specification and Operator Qualification for Laser Beam Welding. Simon also serves as the technical director for the University of Wisconsin's Laser Welding Certificate Program.

Past Participating Organizations
ATK Tactical Propulsion
Babcock and Wilcox
Boston Scientific Corporation, Inc.
BWXT Pantex
Carpenter Technology
Conmed Linvatec
Dentsply Professional
EV 3 Inc.
Federal-Mogul Corporation
General Dynamics
General Electric
Goodrich SIS
GreatBatch
Gyrus ACMI
Honeywell FM&T
ITT Electronics Systems
Johnson Controls, Inc.
L-3
Lockheed Martin
Los Alamos National Laboratory
Medtronic Inc.
Milwaukee Electric Tool
Northrop Grumman Inc.
Pall Aeropower Corporation
Pratt & Whitney
Saft America
Takata Restraint Systems Inc.
The Lee Company
W.L. Gore & Associates
Westinghouse Electric Company

Bring Your Samples for Discussion
We encourage you to bring parts containing weld defects for review and analysis by the course instructor. To make the session more successful, please bring all relevant documentation and metallurgical cross-sections. Discover that the concepts taught can be directly related to eliminating weld defects and improving your laser welding operations!

Enroll online today! epd.engr.wisc.edu/laserprocess
Laser Welding: Equipment and Process Validation
January 31–February 3, 2011 in Lake Buena Vista, Florida

Course Outline
Welcome and Introduction
Elaine M. Bower
Program Director
Department of Engineering Professional Development
University of Wisconsin–Madison

Basic Concepts
• Absorption of laser energy
• Classification of materials
• Processing laminates, composites, and alloys

Control of Power Density
• Temporal profiles to weld
  – Class I, II and III materials
• Spatial profiles to perform
  – conduction welding
  – keyhole welding
  – dissimilar materials

Temporal and Spatial Characteristics of Industrial Lasers
• CO₂ lasers
  – axial flow
  – transverse flow
  – RF excited
• Nd:YAG lasers – lamp pumped
• Diode Pumped Lasers (DPLs)
• Direct Diode Lasers (DDLs)
• Fiber lasers

Beam Delivery Systems
• Beam enhancing components
• Beam steering components
• Fiber optic delivery
• Performance analysis of the whole system

Beam Diagnostic Methods and Devices
• Spatial profilers
• Temporal profilers
• Energy meters
• Power meters
• Interpretation of the readings

Cost Analysis
• Operating costs for typical industrial laser systems

Pulsed (Power) Laser Welding
• Characteristics of conduction welds
• Process limits
• Relationship between weld penetration and
  – energy per pulse
  – power density
  – temporal profile
  – pulse width
  – rate of travel
• Optimization of parameters
• Typical examples of pulsed power welded assemblies

CW (Continuous Power) Laser Welding
• Characterization of conduction and keyhole welds
• Process limits
• Relationship between penetration and
  – average power
  – spatial profile
  – power density
  – rate of travel
• Optimization of weld quality
• Typical examples of continuous power welded assemblies

Welding of Dissimilar Metals
• Power density requirements
• Compatibility of transition temperatures
• Metallurgical considerations for
  – dispersion hardenable metals
  – transformation hardenable metals
  – free-machining metals
• Carbon and Ni/Cr equivalencies
• Use and selection of filler metals

Shield Gases
• Selection of gases and gas delivery systems
  – protecting the optics
  – best metallurgical results
  – best weld penetration
  – plasma control
• Proper gas control
  – flow rate
  – direction

Weld Joint Geometry
• Weld bead geometry—definitions
• Design criteria and fit-up tolerances for
  – butt weld joints
  – lap weld joints
  – fillet weld joints
  – self-aligning weld geometry

Tooling for Laser Welding
• Clamping requirements
• Heat sinking requirements
• Gas shield requirements

Weld Defects and Their Sources
• Laser and optics-related defects
• Materials-related defects
• Weld joint geometry-related defects
• Weld joint tooling-related defects
• Shield gas-related defects
• Criteria for re-weldability

Inspection of Laser Welds
• In-process inspection
• Non-destructive methods
• Destructive methods

Daily Schedule
Registration will begin at 8:00 a.m. on Monday, January 31, 2011 at the Doubletree Guest Suites, in the Walt Disney World Resort. The course will meet from 8:15 a.m. until 4:30 p.m. on Monday, 8:00 a.m. until 4:30 p.m. on Tuesday and Wednesday, and 8:00 a.m. until noon on Thursday. The daily schedule will include midmorning and midafternoon refreshment breaks and lunch at noon on Monday through Wednesday.

Documentation Control
• ISO technical standards
  – ISO 13919-1
  – ISO 15609-4
  – ISO 15616-1
  – ISO 22826
  – ISO 22827-1
• AWS C7.4/C7.4M:2008
• Engineering weld specifications
• Equipment validation
  – procedures
  – documentation
• Process validation
  – procedures
  – documentation
• Operator validation
  – procedures
  – documentation

Sample Analysis
• Discussion of participant-submitted samples

Please bring a calculator for use during the problem-solving sessions.

Related Laser Course
For information about the following course, contact Elaine Bower, program director, at 800-462-0876 or bower@engr.wisc.edu

March 7–10, 2011, Las Vegas, NV

Course #M46

This advanced course will focus on the technology and techniques available to profile, analyze, and diagnose your laser beam. You will learn methods to measure, troubleshoot, and validate your laser beam and your beam delivery systems.
Four Easy Ways to Enroll

Internet:  
http://epd.engr.wisc.edu/laserprocss

Phone:  
800-462-0876 or  
608-262-1299 (TDD 265-2370)

Mail to:  
Engineering Registration  
The Pyle Center, Dept. 107  
702 Langdon Street  
Madison, Wisconsin 53706

Fax:  
800-442-4214 or  
608-265-3448

Getting Started

Course Information

☐ Please enroll me in Laser Welding: Equipment and Process Validation  
Course #M530 January 31–February 3, 2011 in Lake Buena Vista, Florida  Fee: $2095
Team Discount: $1900 per person when two or more enroll from the same organization

Limited Enrollment

Personal Information  (Please print clearly.)

Name ________________________________  
Title ________________________________

Company ____________________________________________________________

Address ______________________________________________________________

City/State/Zip ________________________________

Phone ( ) __________________ Fax ( ) ________________

E-mail ________________________________

Additional Enrollees

Name ________________________________________________________________

Title ________________________________

E-mail ________________________________

Company ____________________________________________________________

Address ______________________________________________________________

City/State/Zip ________________________________

Phone ( ) __________________ Fax ( ) ________________

E-mail ________________________________

Billing Information

☐ Bill my company  ☐ P.O. or check enclosed (Payable in U.S. funds to UW-Madison)

Card No. ______________________________________________________________

Cardholder’s Name ________________________________

UW# ________________________________

Expiration ________________________________

Need to Know More?

Call toll free 800-462-0876 and ask for

Program Director: Elaine M. Bower 
bower@engr.wisc.edu

Program Associate: Theresa Rodger  
rodger@epd.engr.wisc.edu

or e-mail custserv@epd.engr.wisc.edu

General Information

Fee of $2095 Covers Course notebook, break refreshments, lunches, and certificate. Course materials are distributed only to participants.

Cancellation If you cannot attend, please notify us by January 24, and we will refund your fee. Because this course has limited enrollment, cancellations received after this date and no-shows are subject to the full course fee of $2095. You may enroll a substitute at any time before the course starts.

Location and Accommodations This course will be held at the DoubleTree Guest Suites, in the Walt Disney World Resort, 2305 Hotel Plaza Boulevard, Lake Buena Vista, Florida 32830. We have reserved a block of sleeping rooms ($139/single or double) for course participants at the DoubleTree Guest Suites, in the Walt Disney World Resort. To reserve a room, call 407-842-1051 by January 10, 2011 and indicate that you will be attending the University of Wisconsin course group code LAS. The group rate is also available three days prior to and three days following the main course dates.

Earn Continuing Education Credits By participating in this course, you will earn 2.6 Continuing Education Units (CEU) or 26 Professional Development Hours (PDH).

Earn a UW-Madison Laser Welding Certificate

The University of Wisconsin–Madison, Department of Engineering Professional Development offers individuals the opportunity to gain marketable recognition for their laser welding knowledge and expertise through two certificates:

LWP℠–Accredited Laser Welding Professional  
This certificate acknowledges an applicant who is the primary technical professional involved in the design, engineering, and/or management of laser welding parts, assemblies, or operations.

LWTSP℠–Accredited Laser Welding Process Technical Support Provider  
This certificate acknowledges an applicant who is the technical support provider responsible for the hands-on set-up, calibration, and operation of the laser welding process.

Both certificates require the applicant to:

- Complete the University of Wisconsin–Madison course,  
Laser Welding: Equipment and Process Validation
- Complete the University of Wisconsin–Madison course,  
Laser Beam Diagnostics and Process Monitoring
- Complete the certification examination with a score of 80 or higher. The two courses must be completed before taking the exam.
- Submit a complete application form, with supporting requirements, as required by each certificate.

For information about the Laser Welding Certificate Program, contact Elaine Bower, program director, at 800-462-0876, or e-mail her at bower@engr.wisc.edu.