# ASME-BPE Standard Leads to Expansion of Orbital Welding

## Selection of Automatic Welding System Is Critical to Meeting Codes

**Ernest A. Benway**

Automatic orbital welding is becoming a focal point in the bioprocessing, pharmaceutical, and personal care product industries as a result of a rigid American Society of Mechanical Engineers-Bioprocessing Equipment (ASME-BPE) standard that was reissued in 2002. Although orbital welding has been the most popular and accepted method for joining 316L stainless steel tubing in the US bioprocessing and pharmaceutical sectors for decades, the new ASME-BPE standard is leading to an expansion of orbital welding into other industries and geographical locations.

As use expands, selection of an orbital welding system can often become a critical decision for contractors and end users, both of whom must find the best way to comply with the standard welding requirements. Not all welding systems are alike, but understanding equipment capabilities can aid in selecting one that will help you meet the needs of the ASME-BPE welding standard.

**PRODUCT FOCUS:** ALL PRODUCTS MADE IN GMP FACILITIES

**PROCESS FOCUS:** FACILITY DESIGN AND CONSTRUCTION, MANUFACTURING SCALE-UP

**WHO SHOULD READ:** PROJECT MANAGERS, ENGINEERS

**KEYWORDS:** ORBITAL WELDING, PIPES AND FITTING, FACILITIES, COMPLIANCE

**LEVEL:** INTERMEDIATE

### STANDARD APPLIES GLOBALLY

The current ASME-BPE standard was issued in 2002 to replace the ASME-BPE 1997 standard, which established guidelines and protocols for designing, constructing, using, and validating equipment, components, assemblies, and other systems. The 1997 standard essentially served as a guideline for the United States and thus was not followed globally, which meant that other countries worked out their own set of standards or had no standard at all. The 2002 standard, however, is quickly becoming international in scope. Today, the new ASME-BPE standard has been applied to construction projects in more than 25 countries, and it is expected that its use will extend to other countries in the future. Companies that were not required to use automatic welding now have to comply with more stringent welding techniques as well as face documentation and validation concerns.

The new standard is rife with references to orbital welding and in many cases specifically requires its use in joining materials. Section MJ-3.2, "Welds Used in the As-Welded Condition," specifically states that "every effort shall be made to use an automatic or machine welding process" for welding pressure vessels, tanks, and piping and tubing systems. Section SD-3.7.1, "Design for Sterility and Cleanability," requires equipment to be designed to minimize the number of connections, calling for welded connections "wherever practical." Clearly, as the requirements for

**Picture 1:** Orbital welders that use microprocessor technology minimize recording errors and reduce the time involved in documenting welds.

orbital welding expand, so does the need to select a system that will pay dividends in more ways than one. The capabilities of orbital welding systems vary widely. It is critical to study what each system has to offer.

## Documentation Can Be Simplified

Documentation is a critical requirement throughout the ASME-BPE standard. Section SD-6, "Design Documentation," requires technical documentation to support the design of equipment and verify conformance with sterility and cleanability criteria. Owners are required to maintain their documentation for at least three years. Section MJ-10, "Material Joining," requires documenting welding procedures, from weld specifications to individual operator qualifications.

Using manual methods, the amount of time and effort required to meet documentation requirements can be staggering. The documentation process for welding easily can account for 30% of total welding construction labor hours on a project. A significant number of those hours are spent tracking, accumulating, and compiling the supporting data to verify every welded connection.

Throughout the construction project, welding operators must keep a daily weld log. Each weld is inspected and identified with a unique identification number that traces it to the log. At the end of the day, weld logs are collected from all operators and submitted to a quality control administrator, who inputs the data into a computer spreadsheet. At that point, the weld data report is in the proper installation qualification format and ready for official submission.

However, some orbital welding equipment uses microprocessor technology to monitor the welds in progress, capturing and compiling real-time data and electronically transferring it to a computer, where it can be formatted and stored for documentation and statistical analysis. In short, the microprocessor minimizes recording errors and reduces the time involved in documenting welds.

**Technology Aids Compliance:** With microprocessor technology, weld programs can be automatically created and stored by the welding power supply. Weld logs are maintained electronically on a PC data card and imported directly to a computer, where they can be formatted for installation qualification.

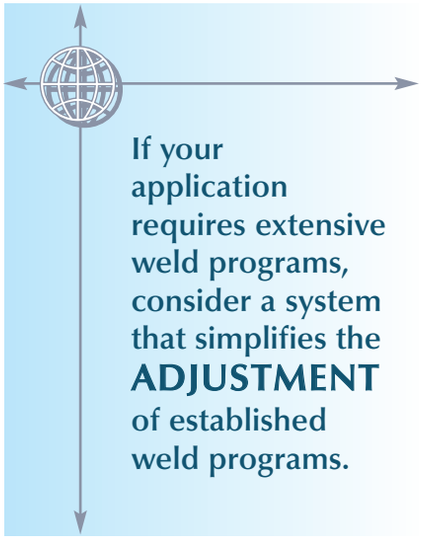
The amount of information available from an electronic weld log is significantly greater than what is kept in a manual log. Additional information is a valuable asset to documentation. Here are a few examples of information that may be found on an electronic weld log:

- Date and time of weld
- Procedure and operator identification
- Project identification
- Weld joint description and material type
- Material heats
- Tube wall thickness
- Shielding and purge gas certification numbers
- Flow rates for shielding and purge gas
- Electrode identification
- Date of last calibration.

In addition to documentation benefits, microprocessor technology can streamline a weld project's process. Programs can be developed, stored, and adjusted to accommodate variations in material heats, for example. If your application at any time requires extensive weld programs, consider a system with technology that simplifies the adjustment of established weld programs. A user-friendly system can enable programs to be built consistently and accurately through autogeneration. Such capability can reduce human error and save 30–90 minutes of the time devoted to building individual weld programs.

## Material Joining Issues

The material joining section of the ASME-BPE standard establishes criteria for weld procedures, weld joint design and preparation, and weld acceptance. Within the standard are tolerances for acceptable and unacceptable welds and requirements for weld bead widths, tube fit-ups and mismatches, and weld penetration.

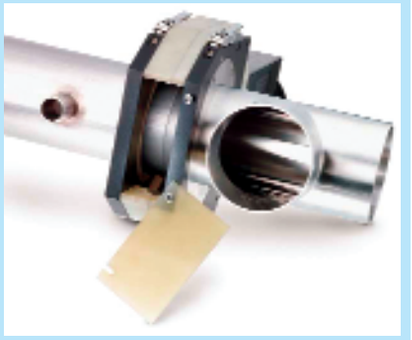


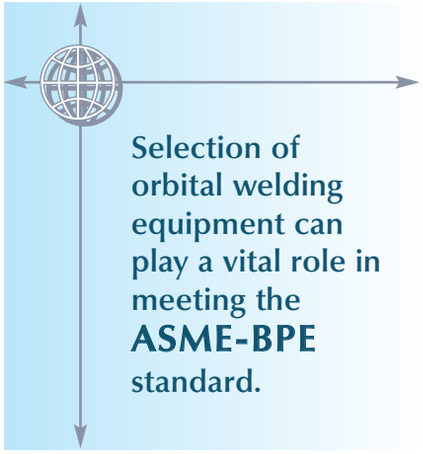

To ensure compliance, contractors and owner-operators should consider a weld system that allows users to control a weld process from fit-up to completion while providing the flexibility for quick setup changes. Flexibility is important because many different weld combinations must often be made on the same project: connecting tube to tube, tube to valves, and so on. Some weld systems come with fixtures that can be taken apart easily and reconfigured to accommodate a range of weld set-ups.

For consistent proper weld alignment, your weld system should include fixtures that minimize misalignment of the tubing, which is a top reason for weld rejections. Fixtures should provide solid alignment and hold tubes in place during welding. A solid collet can help secure a tube and ensure alignment throughout the weld. In addition, a fixture that is separate from the weld head will provide your welder with a full 360-degree view of the weld joint for inspection before welding (Picture 2).

Similarly, each weld joint must be positioned in its fixture so that it is

**Picture 2:** This fixture provides a 360-degree view of the weld joint.






aligned with the welding system electrode. A shift of just a few thousandths of an inch in the joint position can result in a weld with incomplete penetration or fusion at the joint and, ultimately, a weld defect. Simple gauge blocks supplied with fixtures provide a means to position the joints in the center of the fixture every time.

Gauges can also improve the likelihood that the arc gap is set in the right position during setup and in the same position every time it is changed, which will go a long way toward ensuring proper weld penetration. Failure to establish a proper arc gap can compromise the quality of a weld, rendering penetration incomplete or drastically altering bead width. An arc gap gauge that sets the electrode in the same place consistently is the best tool to minimize human error.

Equipment suppliers provide additional gauges for positioning the welding electrode. Such gauges are set to a specific position and then locked in place. Whenever the electrode is changed, the gauge is used to reposition it to exactly the same place it was on the initial setup.

Finally, preparation of tube ends is critical to complying with the new standard. Section DT-9, "Welding Ends," requires automatic weld ends to be square cut and free from burrs and breaks. Tube-cutting and facing tools can ensure that all tube ends are prepared to specification.

## Consider Mobility

Contractors and owner-operators often need a weld system that provides mobility to weld in hard-to-reach places. Section MJ-4.4, "Tubing," states that "welding on tubing shall be done using automatic (or machine) welding techniques (such as orbital tube welding or lathe welding), except where size or space will not permit."

The portability and accessibility of some systems provide more options for orbital welding, enabling it to be conducted in spaces or locations where it traditionally may have been prohibitive. For instance, power supplies can weigh less than 50 pounds. The lighter-weight models allow operators to move their welding systems quickly and easily from one job to another. Remote controls and detachable fixtures allow joints to be prepositioned, thus enabling orbital welding to be conducted in tight places.

## Service and Training

Service and training programs can be as important as the orbital welding equipment itself. If something should go awry, a lack of responsiveness from the manufacturer or service provider can result in significant construction downtime. Some companies use a network of local service providers, facilitating access to maintenance service and replacement equipment. Such networks operate nationally and worldwide. Other companies have service centers assigned to different regions. Either way, the value of service should not be underestimated.

Training is an important consideration because it can improve orbital welding protocols and thus play a role in achieving weld consistency. Training programs from equipment suppliers can vary. Some focus on using the controls of a particular type of equipment, whereas others provide genuine orbital welding courses. Many manufacturers provide training on their systems, sometimes in partnership with existing training institutions and organizations. The United Association of Pipefitters, for example, has worked closely with our company in providing qualified orbital welding courses. Equipment suppliers may supply training on their systems through distance learning techniques (compact disc programs, for example). It is worth noting that some systems require less training than others because their technology simplifies setup and operation, resulting in shorter learning curves.

The new ASME-BPE standard puts an even greater emphasis on orbital welding on the international scale and in more industry sectors than ever before. Selection of orbital welding equipment can play a vital role in meeting the standard and have a direct effect on whether compliance is achieved in the most cost-effective, efficient, and productive manner.

## References

1 ASME BPE-2002, Bioprocessing Equipment (ASME International, New York, NY); www.asme.org/codes/newsletter/72003.html#3.

***Ernest A. Benway*** *is a training specialist with Swagelok Company and a member of the ASME Bioprocessing Equipment Committee (serving on the main committee and chairing the subcommittee on general requirements and editorial review), 31500 Aurora Road, Solon, OH 44139, 1-440-349-5934 ext. 4057, fax 1-440-349-5843, ernest.benway@swagelock.com, www.swagelock.com.*