ASME PTB-15-2023

Full Matrix Capture Training Manual

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PTB-15-2023

FULL MATRIX CAPTURE TRAINING MANUAL

Date of Issuance: June 28, 2023

This publication was prepared by ASME Standards Technology, LLC ("ASME ST-LLC") and sponsored by The American Society of Mechanical Engineers ("ASME"), Pressure Technology Codes & Standards.

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The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990
ISBN No. 978-0-7918-7623-7

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ACKNOWLEDGEMENTS

Upon the publication of the 2019 Edition of the ASME BPVC Section V, rules were established for Full Matrix Capture (FMC) in Article 4, Mandatory Appendix XI. This took an exceptional group of volunteers who came together and were able to dedicate time and establish processes which would allow us to finish an exceedingly challenging task in less than half the normal time.

Recognizing that we had provided a great service to industry for an emerging technology, we understood that to be truly successful, more was needed. It was obvious that there was strong interest for FMC. However, apprehension also took hold. Besides having a set of rules in the Code, a better understanding of the technology would further promote its use, and most importantly prevent a repeat of some of the mistakes of the past.

While some of us moved on after the publication of the Code rules, others remained, and soon, others would join us in the endeavor to bring this training manual to light. It cannot go without being said that only through the expertise of volunteers, and selfless sacrifice, being that of a great deal of time and dedication, would this work even be possible. The expense, let alone assembling this much talent, for the purpose of publishing a training manual such as this would otherwise have been impossible. Indeed, this was truly an exceptional group of individuals.

We also recognize that by writing this training manual, a precedent was set for ASME BPVC Section V. We would like to thank ASME for this opportunity, and hope that others will follow. Education is paramount.

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FOREWORD

Established in 1880, ASME is a professional not-for-profit organization with more than 100,000 members promoting the art, science, and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and ASME provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit www.asme.org for more information.

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1 HISTORY

1.1 ASME History

ASME has been around for more than 140 years, starting with the first meeting in the spring of 1880 in New York. As ASME was born during the industrial revolution, the meeting was largely attended by prominent industrialists of the time. The intention was to provide a forum for discussion and collaboration to better serve the needs of engineers and designers. The history of ASME cannot be appreciated without mentioning some of the consequences from the industrial revolution, two of which are boiler explosions and the need for standardization. Safety and standardization are still the main vision and mission for ASME.

The industrial revolution was made possible by the application of steam power as an energy source. In fact, the advent of steam power quickly became the industrializing nations' dominant power source. For example, the use of steam power increased from just 5% to 80% of the total power in the United States over a 20-year span in the mid-1800's. Today, steam energy (i.e., steam-driven turbines) still supplies 80% of the world's electricity.

When water converts to steam it expands ~1600 times in volume, which can generate enormous pressures. The use of steam to drive machinery was discovered to be a vast improvement over existing water mills, windmills, and even beast-of-burden power. However, early boilers from this period commonly suffered from catastrophic failures (i.e., explosions), mainly due to poor materials, poor design, and poor maintenance.

The earliest boilers were made of small wrought iron plates that were riveted together, but other materials such as copper were also commonly used. Quality improved with the use of rolled steel plates, but construction consisted of gusseted or slip-joint designs with rivets (see Figure 1-1). Acetylene was not discovered until 1836, and "conventional welding," as it is presently known, was not developed until 1881. Repairs made to boilers were left up to "best practice," which meant there were no standards of methods or quality.

Figure 1-1: Period Repair Work on a Riveted Seam

Image Courtesy of Sinewave Solutions