RANDOM EXAMINATION

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Prepared by

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RANDOM EXAMINATION

Expectations, Guidelines and Methodology

1. Scope

1.1. Codes and specifications often require that welds be subjected to spot or random radiography, ultrasonic or other examination methods. The purpose of this standard is to:

1.1.1. Present the expectations, effectiveness, and limitations of random examinations.

1.1.2. Identify common industry practices and methods for specifying random examinations.

1.1.3. Provide guidance in establishing and defining the makeup of a lot to be subjected to random examination, focusing on the ASME B31.3 use of the term "designated lot".

2. Definitions

2.1. Commonly used extent of examination are defined as follows:

2.1.1. **Random examination**: the complete examination of a specified percentage of welds selected randomly from a designated lot of piping.

2.1.2. **Spot examination**: the examination of a limited length of a weld (e.g. 1 six inch spot in each 50 feet of weld)

2.1.3. To avoid repetition of the inspection methods, this standard uses the term" random examination" to represent all examination methods including but not limited to radiography and ultrasonic methods.

3. Expectations, effectiveness, and limitations of random examination

3.1. Random or spot examination of welds in a piping system will not ensure that all the welds in that system will be of the same quality level as the welds that were examined. For example, if 10 welds in a piping system containing 100 welds are examined and accepted using random radiography, the remaining 90 welds may contain rejectable flaws that would have been disclosed if additional welds had been radiographed. If all rejectable weld flaws must be eliminated from a given piping system, then 100% of all the welds in that system must examined[1]. Simply put, to ensure that all the welds are free of rejectable flaws, 100% of those welds must be examined, repaired as necessary and reexamined.

3.2. Random examination of welds is an effective quality control tool when properly implemented.

3.2.1. When random examination is used to check the quality of the welder's work, the welder shall have no knowledge of which welds will be selected for examination. The examination provides feedback to the welder showing that the work is or is not satisfactory. If the work is not satisfactory, the welder and the welding supervisor can take corrective steps to improve weld quality in subsequent work; such steps can include the full range of changes from tighter control of fit-up, to better interpass cleaning and grinding, to better welding techniques to replacement of the welder.

3.2.2. For this process to work effectively, it is critical that examinations be made contemporaneously with the work being done to provide meaningful and timely feedback to the welder. The sooner welders learn that their welds require repair, the sooner they can take corrective action; this impacts cost and schedule positively by reducing the number of repairs and additional examinations that have to be made.

3.2.3. Accordingly, random examination may be performed before completion of all the welds in a lot.

4. Specifying Random Examination

4.1. The method, extent of examination and acceptance criteria to be applied must be clearly defined in the standard or specification and be agreed upon prior to the start of work. Prior agreement on the method, extent and acceptance criteria is standard industry practice that is well established in various welding

[1] See ASME B31.3 para. 341.4.1(b) and ASME section VIII Div 1, UW-52 footnote.

standards such as the ASME B31 Code for Pressure Piping, ASME Section VIII, Unfired Pressure Vessels, and the AWS D1.1, Structural Welding Code - Steel. For example, ASME B31.1, paragraph 136.3.1, specifies:

"The degree of examination and the acceptance standards beyond the requirements of this Code shall be a matter of prior agreement between the manufacturer, fabricator or erector and the Owner."

4.2. When performing random examination, the method of examination (e.g., radiography in accordance with ASME Section V, Article 2) and the acceptance criteria (e.g., ASME B31.1, paragraph 136.4.5) are straightforward and simple to define in the contract documents.

4.3. When random examination is specified, the extent of random examination must be clearly defined in the contract documents. Random examination can be applied to:

4.3.1. Circumferential butt and miter welds on a project.

4.3.2. Circumferential butt and miter welds within specific line classes or systems on a project,

4.3.3. Circumferential butt and miter welds within particular parts of systems (e.g., high- pressure parts of a steam system)

4.3.4. Circumferential butt and miter welds in specific locations (e.g., piping inside buildings)

4.3.5. Other schemes that satisfy the Owner or the Owners Engineer.

4.3.6. Volumetric examination is not normally applied to nozzle or branch connection welds or to fillet welds.

4.4. When the purchaser wishes to impose random examination of welds and the applicable code does not specify random examination, the following is recommended for inclusion in the purchaser's specification:

"Random examination and acceptance criteria shall be in accordance with the requirements of ASME B31.3, paragraph 341.4.1(b).
Acceptance criteria shall be in accordance with Table 341.3.2, Normal Fluid Service, with progressive sampling in accordance with paragraph 341.3.4."

5. Defining Random Examination when ASME B31.3 is applicable.

5.1. The following are important points to recognize when ASME B31.3, *Process Piping*, is the applicable Code.

5.1.1. For Normal Fluid Service piping, Paragraph 341.4.1(b) requires that not less than 5% of circumferential butt and miter groove welds be examined fully by random radiography or by random ultrasonic examination. Normal Fluid Service is the default fluid service category unless another Fluid Service Category (e.g., Category D, Category M, Severe cyclic, etc.) is specified, or a greater extent of examination is specified in the contract documents.

5.1.1.1. Random Examination is to be performed on a lot basis. Once the percentage of welds in a lot are examined and accepted and the welds representing the work of each welder in that lot have been examined and accepted, all remaining welds in that lot (i.e., those that were not examined) are Code-acceptable provided they are visually acceptable. See paragraph 341.3.1.

5.1.1.2. Since B31.3 places responsibility for performing examination on the Fabricator or Contractor who is doing the welding, lot selection is the prerogative of the Fabricator or Contractor unless otherwise specified in the engineering design. Since lot selection and sampling can be a source of dispute, it is recommended that Fabricators have a written program describing their definition(s) of designated lot(s) and how welds are randomly selected to ensure that welders do not know which of their welds will be examined . See Section 6 for some methods of defining a lot.

5.1.1.3. The welds to be examined must include the work product of each welder whose welds are part of a designated lot, but B31.3 does not require that the given percentage of each welder's work within a lot be examined.

5.1.2. When a weld is rejected, B31.3 paragraph 341.3.4 requires "progressive sampling" of additional welds made by the welder who made the defective weld. Welds made by other welders within the lot that have been examined and accepted or have not been examined are not subject to additional examinations.

5.2. Should the purchaser or his representative demand additional nondestructive examination within a lot after

that lot of welds has been accepted, such additional examination is outside the provisions of B31.3. The cost of an engineering evaluation of flaws in those welds and the cost of repair welding and re-examination shall be the responsibility of the organization requiring the additional examination.

6. Establishing a Lot

6.1. The basis for establishing lots and for selection of welds to be examined should be established in writing by the Fabricator. If the purchaser will be responsible for selection of random welds in a lot, the purchaser's representative will need to be readily available to avoid impeding workflow. The process of selection of specific welds in a designate lot should also be defined in writing, (e.g., select from the list of welds in a lot, select the weld(s) after visual examination, etc.).

6.2. The welds in a lot do not need to be of the same material, thickness or size or welded with the same process. Butt welds and miter welds do not need to be segregated into different lots, and more than one welding process may be included in a lot.

6.3. In defining a lot, the fabricator/contractor should consider the following:

6.3.1. The lots should be of a size that can be easily managed. Small lots may result in increased cost because the total number of welds examined on the project will increase beyond the percentage required, but smaller lots may allow work to proceed more expeditiously. Large lots, on the other hand, lead to increased risk of additional examinations due to rejections when progressive sampling is required.

6.3.2. Welds should be examined and the results presented to the welder soon after the welds have been made in order to obtain the desired effect on the quality of the work.

6.3.3. It is acceptable to examine welds in a designated lot prior to completing the welding of that lot to provide timely feedback to the welders.

6.3.4. The results obtained in examination of one lot are not to be considered in the evaluation or extent of examination applied to any other lot.

6.3.5. A tracking method that clearly documents welds in each lot should be established.

6.3.6. Welds selected for each lot must fall into the same method and percentage of examination.

6.4. Some lot definitions are shown below.

6.4.1. **Daily:** All the welds completed by all welders and have been accepted by visual examination on any day or shift shall be considered a lot. The number of welds to be examined shall be calculated based on the number of welds made that day or shift and the percentage of welds that are required to be examined.

6.4.2. **Daily Multiple lots:** All the welds completed by all welders and accepted by visual examination on any day shall be broken up into separate lots and each lot examined individually (e.g., 65 welds are completed in a day; if the lot size is 20, those 65 welds shall be separated into 4 lots of a convenient sizes of 20 or fewer and the welds to be examined shall be selected from each lot). If the required number of welds to achieve the required lot size has not been obtained, the welds that have been completed each day shall be considered a lot.

6.4.3. **By Welder:** Only the welds of a single welder are included in the lot. When the welds made by a welder achieve the required lot size, that group of welds shall be considered a lot. Since more than one welder may make a weld, that weld shall be included only in one welder's lot.

6.4.4. **Truck Load:** All welds on all of the assemblies to be loaded on a single truck shipment may be considered a lot. Acceptance of the whole lot should be completed prior to loading the truck.

6.4.5. **All Welds on a Job:** All the welds on a job may be considered a lot. This option should not be selected unless the project is very small.

6.4.6. **Spool Grouping:** Each project shall be subdivided into "lots" as required for convenience and flow of work through the shop. The "lot" may consist of different piping systems that have the same percentage requirements for random examination.

6.4.7. **All the Welds in a Piping System or Line:** When drawings identify the customer's piping system, all welds in each system can be considered a lot. Another alternative is to choose lots by line or group of lines. This option is generally only suitable for field welding. In a shop environment, this method is discouraged

because it impedes workflow, adds material handling time and delays delivery.

6.4.8. **All Welds in a Room or other Easily defined Space:** Field work only.

6.4.9. **Welds along a run until the required number is reached.** Field work only. Not suitable for sizes and wall thicknesses where achieving a lot of a particular size takes an extended period of time.

6.5. **Shipping of Lots:** For shop fabrication, no item in a lot shall be shipped before the required examination of that lot is completed and that lot has been accepted.

7. Documentation of Sampling

7.1. Welds making up lots should be documented concurrently with the progress of fabrication. Welds should be logged as final visual inspection is completed for each spool piece or as field welds are made. Any form of tracking and documenting lots is acceptable provided:

7.1.1. The welds which make up the lot are clearly identified.

7.1.2. The number of welds from each welder is clearly identified.

7.1.3. The weld(s) selected for examination are clearly identified.

7.1.4. All the requirements for initial selection and progressive sampling have been met.