RPP-22592-FP
Revision 0

ASME AG-1 Requirement Exemption Justifications for Ventilation Systems at Nuclear Waste Storage Tanks at the Hanford Site

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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Date Published
September 2004

To Be Presented at
28th Nuclear Air Cleaning Conference

International Society for Nuclear Air Treatment Technologies (ISNATT)
Albuquerque, NM

September 27 - 30, 2004

Published in
Proceedings of the 28th Nuclear Air Cleaning Conference

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Release Approval _____ Date _____

EXECUTIVE SUMMARY

Washington State Department of Health regulations require compliance with the American Society of Mechanical Engineers (ASME) AG-1, *Code on Nuclear Air and Gas Treatment*, for all new radioactive air emission units. As a result, these requirements have been applied to systems that ventilate the radioactive waste storage tanks in the tank farm facilities on the U.S. Department of Energy's Hanford Site. ASME AG-1 is applied as a regulatory constraint to waste tank ventilation systems at the Hanford Site, even though the code was not intended for these systems. An assessment was performed to identify which requirements should be exempted for waste tank ventilation systems. The technical justifications for requirement exemptions were prepared and presented to the regulator. The technical justifications were documented so that select requirement exemptions for specific projects and systems can be sought through the regulator's permitting process. This paper presents the rationale for attempting to receive requirement exemption and presents examples of the technical justifications that form the basis for these exemptions.

LIST OF TERMS

Terms

Best Available Radionuclide Control Technology (BARCT). Technology that will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides from any proposed newly constructed or significantly modified emission units that the licensing authority determines is achievable on a case-by-case basis.

Abbreviations and Acronyms

AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASME	The American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
DOE	U.S. Department Of Energy
HEPA	High Efficiency Particulate Air
IEEE	Institute of Electrical and Electronics Engineers
UBC	Uniform Building Code
WAC	Washington Administrative Code
WDOH	Washington State Department of Health

1.0 INTRODUCTION

Washington Administrative Code WAC 246-247, "Radiation Protection - Air Emissions", establishes emission standards, requirements, and procedures for the regulation of radioactive air emissions in Washington State. The regulatory and licensing authority for this code is the Washington State Department of Health (WDOH). WAC 246-247 establishes emission standards by reference to other regulations, such as the Code of Federal Regulations, and requires new emission units and significant modifications to existing emission units to utilize best available radionuclide control technology (BARCT). As part of compliance with the BARCT requirement, design and construction of emission units must meet certain technology standards, including the American Society of Mechanical Engineers (ASME) AG-1, *Code on Nuclear Air and Gas Treatment*. ASME AG-1 is intended for use at nuclear power plants and nuclear fuel cycle facilities. However, WAC 246-247 applies the code to other nuclear facilities in Washington State, such as the U.S. Department of Energy (DOE) site at Hanford, that operate radioactive air emission units.

The process of demonstrating compliance with ASME AG-1 during design, fabrication, and installation of emission units at the Hanford Site tank farms has revealed some specific requirements that , when applied specifically to these waste tank ventilation systems, do not increase the margin of safety to human health or the environment. Therefore, exemptions from selected requirements in the technology standards or regulations required by WAC 246-247, particularly ASME AG-1, are desirable to facilitate cost-effective and efficient completion of tank farm mission objectives provided the exemptions can be justified from a technical standpoint and control of emissions is maintained within regulatory standards.

The ASME AG-1 code requirements for nuclear power plants and nuclear fuel cycle facilities are necessarily quite stringent, but may not be fully applicable to radioactive waste storage facilities, where a graded approach to their use is appropriate in consideration of other Department of Energy requirements (or industry consensus standards), which provide comparable and/or additional administrative and engineering processes and controls for these facilities. For example, waste tank ventilation systems do not need to meet post-accident operability requirements similar to those in nuclear power plants. The documented safety analysis for tank farm facilities at the Hanford Site demonstrates that waste tank ventilation systems are not required to operate continuously during or after postulated accident scenarios or a design basis seismic event to ensure performance of any nuclear safety function. Also, waste tank ventilation systems are not required to operate during or after a design basis seismic event to maintain emissions within regulatory emission standards. As a result, these systems do not need to be designed to maintain operability or structural integrity when subjected to the severe loading caused by seismic forces or the very high-energy releases expected in nuclear power plant accidents. Therefore, from a technical standpoint, waste tank ventilation systems do not need to meet all of the requirements of ASME AG-1. Compliance with

other industry consensus standards or common practices is acceptable as an alternative to certain requirements in ASME AG-1 to ensure satisfactory functional performance.

2.0 TYPICAL TANK FARM VENTILATION SYSTEM DESCRIPTION

This description is intended to generally include all components that are typically installed in waste tank ventilation systems. It does not detail a specific system, but provides a general description of the systems, components, and their functions. Tank farm ventilation systems include permanently installed and temporary, portable units. These systems are typically installed to perform some or all of the following functions.

- Maintain the concentration of flammable gases from steady-state releases below the lower flammability limit in a waste storage tank headspace.
- Confine stored materials by maintaining negative pressure conditions within, and air flow through, the tank headspace, and directing the tank exhaust air through a filtration system.
- Maintain radioactive air emissions within regulatory standards and sample and monitor the emissions.
- Remove heat to maintain waste tanks below applicable temperature limits.
- Remove moisture from the double-shell tank annulus space and minimize the potential for condensation to form on the tanks, thus reducing the potential for corrosion on the outer primary tank wall and the secondary steel tank liner.
- Remove fog and aerosolized particulate to help view in-tank work activities remotely through the use of in-tank video cameras.

Air typically enters the tank through various air infiltration pathways, a filtered inlet station, or a combination of both. Tank exhaust air ductwork is connected to an emission unit that includes multiple stages of high-efficiency particulate air (HEPA) filtration, in series, as the primary abatement control for radioactive particulate emissions. A typical exhaust filter train contains a moisture separator, an air stream heater, a prefilter, and two stages of HEPA filters. One system currently in operation on site also contains adsorber cells, but these are not typically required. The fan is downstream of the filter train. The exhaust stack is sampled for radioactive particulates and monitored continuously for radioactive emissions.

Portable exhausters consist of an exhaust filter train, fan, exhaust stack, and stack sampling and monitoring systems mounted on a skid. These portable exhausters can be transported and installed to support short term, finite life projects, such as waste sampling, waste retrieval, and tank closure projects for those tanks that do not have permanently installed active ventilation systems.

3.0 APPROACH

Multiple new installations of waste tank ventilation systems are expected in the foreseeable future to support waste retrieval and tank closure activities. Therefore, a requirement reduction effort was performed to identify ASME AG-1 requirements that are both overly conservative and do not increase the margin of safety to human health and the environment. Working sessions involving individuals with detailed system and code knowledge were held to perform a line-by-line assessment of all applicable sections of ASME AG-1. Requirements were selected for which a justifiable technical argument could be made for exemption based on the overly stringent nature of the requirement when applied to waste tank ventilation systems. Bi-weekly meetings were held with WDOH engineers to keep the regulator advised of the types of exemptions that were being sought and to achieve joint understanding of the supporting justifications. The results were compiled into a supporting document (RPP-19233, 2004, *General WAC 246-247 Technology Standards Exemption Justifications for Waste Tank Ventilation Systems*) and distributed to WDOH for information and future referral. Approval of the specific exemptions from these requirements that are applicable to each individual system would then be pursued separately during the permitting process for those systems, with the supporting document providing the technical justification for exemption.

HEPA filters are the primary abatement control for radioactive particulate emissions and, therefore, strict code compliance is appropriate for HEPA filters, housings, and frames. HEPA filters are specifically defined as BARCT, so most of the exemptions identified for Section AA of ASME AG-1 are explicitly not applicable to these components based on their importance for control of radioactive emissions. Very few other exemptions were identified from these HEPA filter related component sections.

4.0 CONCLUSION

ASME AG-1 is applied as a regulatory constraint to waste tank ventilation systems at the Hanford Site, even though the code was not intended for such systems. However, obtaining requirements exemption by providing sound technical arguments is achievable. Continuous inclusion of regulators in the process was found to be very important to develop joint understanding of, and ultimately gain ultimate approval for, requirement exemptions. Care must be taken to ensure that other regulatory requirements are not compromised, such as emission standards and sampling requirements. After the initial exemption identification process is complete, continuing experience with system design and installation can reveal additional requirements for which exemption would be reasonable and beneficial. The initial effort has established the framework and scope of future exemptions for which technical arguments are reasonable and approval is reasonably assured.

5.0 EXAMPLES

The following excerpts from the supporting document (RPP-19233) demonstrate the general approach of the technical arguments supporting the exemptions. Typically, a general argument was presented for each component that would support several of the individual requirement exemptions. These individual exemptions, specific to articles in ASME AG-1, were then presented in matrix format. A total of 177 exemptions from applicable sections of ASME AG-1 were identified. Some of these included justifications for all requirements from higher-level articles, clarifications or interpretations of applicability, or references to other requirements. The examples shown here are for emission unit system fans. Table 1 demonstrates the format for the matrix in the supporting document, using fans as the component example.
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5.1 EXAMPLE: GENERAL EXEMPTION JUSTIFICATION FOR FANS

Fans used in waste tank ventilation systems are common industrial equipment. No custom designs are used and no complex or unusual performance or operational requirements are necessary. The performance, reliability, and structural integrity of these standard industrial fans have been demonstrated in industries with far more demanding process conditions than waste tank ventilation systems. This includes industrial process off-gas systems in the paper, pollution control, hazardous waste treatment, and petrochemical industries. Air stream properties in these industrial applications may include abrasives, corrosives, fumes, and high temperatures. This successful operating history provides generic field qualification of these standard industrial components at more demanding process conditions and demonstrates the adequacy, reliability, and structural integrity of common industrial ventilation fans for use in waste tank ventilation systems.

Temporary fan shutdown for waste tank ventilation systems would not significantly increase emissions. Maintenance of vacuum conditions within the tank is most important from an emission control standpoint during ongoing waste disturbing activities within the tanks, such as waste transfers or waste retrieval activities, to prevent escape of waste aerosols through unfiltered pathways. In accordance with operating procedures, ventilation system shutdown caused by fan failure will initiate operational cessation of waste-disturbing activities to ensure that the waste is in a quiescent state when vacuum conditions cannot be maintained. Therefore, any minor additional risk of fan failure because of exemption from some of the more stringent requirements of ASME AG-1 does not result in a significant additional risk of increased radioactive emissions. Also, the additional risk of fan failure is very small because of the reliability that is demonstrated by the successful operating history of the standard, high-quality, industrial fans that are used in waste tank ventilation systems.

TABLE 1. EXAMPLE: MATRIX PRESENTATION FOR REQUIREMENT EXEMPTION JUSTIFICATIONS

Requirement Text	Chosen Alternative	Exemption Justification
AA-4200, Design Criteria (entire section): This subarticle contains the load, stress, deflection, and other criteria for the design of equipment. Verification of equipment design shall be based on calculations or tests, or a combination of both.	Manufacturers' or tank farm contractor's design criteria shall be used. Additional alternative criteria shall be identified in the design specification for specific applications. Design verification shall be in accordance with manufacturers' or tank farm contractor's procedures. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames.	The loading criteria, load combinations, and service levels defined in ASME AG-1 that are associated with nuclear power plant accident scenarios are not applicable to waste tank ventilation systems. No credible mechanism exists to create loading comparable to accident conditions at a nuclear reactor. Only Service Level A loads and stress criteria are applicable and are comparable to criteria used in most engineering design processes. Reevaluation to the specific criteria of ASME AG-1 adds little value. Manufacturers' consideration of deflection criteria as it affects normal component function is adequate for these ventilation systems. For components constructed on the Hanford Site, TFC-ENG-STD-06, "Design Loads for Tank Farm Facilities," is adequate for defining structural design criteria and includes references to requirements in such industry standards as ASCE-7, *Minimum Design Loads for Buildings and Other Structures*, and the Uniform Building Code (UBC).
AA-4300, Design of Equipment Systems and Their Supporting Elements (entire section): AA-4310, General Requirements: (Defines allowable stresses, type of analysis, and terms related to design by analysis.) AA-4320, Design Verification Of Plate- And Shell-Type Components And Their Supporting Elements: (Defines stress analysis, stress limits, and buckling stress criteria) AA- 4330, Design Verification Of Linear-Type Systems By Analysis: (Defines stress analysis and stress limits.)	Manufacturers' or tank farm contractor's design processes shall be used. Additional alternative processes shall be identified in the design specification, as necessary, for specific applications. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames.	Waste tank ventilation systems have no unusual loading or design geometry that requires application of the rigorous structural analysis of ASME AG-1. Manufacturers' analysis procedures are acceptable for the typical industrial components that are selected for these ventilation systems. Additional design analysis to the requirements of ASME AG-1 adds substantial cost with little benefit. The extensive operating history of these industrial components essentially provides field design qualification testing for components of similar design and demonstrates the adequacy of the manufacturers' design processes.

TABLE 1. EXAMPLE: MATRIX PRESENTATION FOR REQUIREMENT EXEMPTION JUSTIFICATIONS

Requirement Text	Chosen Alternative	Exemption Justification
AA-4340, Functionability Requirements (entire section): The stress limits specified by this Code do not assure that the equipment will be able to perform their required safety function. Functionability is assured by following the rules stipulated below.	Additional functionability verification shall not be required. This alternative is applicable to all components except HEPA filters, HEPA filter housings, and HEPA filter frames.	The stress limits applied to these components assure that the waste tank ventilation systems will be able to perform their required emission control function by maintaining structural integrity under normal operating conditions. No additional functionability verification is required.
AA-4350, Design Verification by Testing (entire section): Design verification by testing shall be in accordance with the rules of this subarticle. Seismic tests are to be performed by subjecting the equipment to vibratory motion that conservatively simulates that postulated at the equipment mounting during the OBE and an SSE. In addition, other loads that may occur concurrently with the seismic event shall be accounted for (see AA-4212). The rules of this subarticle are consistent with and complementary to ANSI/IEEE 344.	Seismic testing shall not be required. This exemption is applicable to all components.	The seismic testing of this section is intended to verify satisfactory operability of safety systems at nuclear power plants during design basis seismic events. Neither nuclear safety requirements nor the control of emissions within regulatory standards require waste tank ventilation systems to operate during or after a seismic event. Therefore, the testing of this section is not applicable.
BA-3400, Certification of Materials: The Manufacturer shall make available, as a minimum, certified test reports of chemical and physical properties of material and hardware used for all stress components of fans and related accessories, including fan wheel components, fan shafts, and driver support plate, but excluding fan drivers, drives, and bearings. Fan components, listed in BA-3410 and BA-3420, shall be provided with a Manufacturer's Certificate of Compliance covering the ASME or ASTM material specification, grade, and class.	Fan materials shall be in conformance with the allowable materials of ASME AG-1, Table BA-3100. Substitute materials shall be allowed as identified in BA-3100. Manufacturer's Certificates of Compliance with the ASME or ASTM designations of Table BA-3100 shall be provided. Certified test reports shall not be required.	Certified test reports are documented verification of compliance of material properties with ASTM or ASME standards. They do not add significant benefit for waste tank ventilation systems because this application does not require such rigorous material testing. These ventilation systems are not subjected to excessively corrosive or damaging process conditions that would warrant such rigorous verification of physical and chemical properties. Compliance with the allowable or substitute materials of ASME AG-1 and manufacturer's Certificates of Compliance with ASME or ASTM standards provide adequate verification of the physical properties of materials. The extensive successful operating history of these standard industrial fans demonstrates the acceptability of the materials used.

TABLE 1. EXAMPLE: MATRIX PRESENTATION FOR REQUIREMENT EXEMPTION JUSTIFICATIONS

Requirement Text	Chosen Alternative	Exemption Justification
BA-4122, Aging: The aging mechanisms listed in BA-4123 shall be applied to the equipment and components, Design qualification shall be specified in accordance with ANSI/IEEE 627. A list of recommended spare parts and their expected life shall be provided for the equipment and components that are not expected to last for the life of the plant under specific environmental conditions.	This section shall be required except that design qualification in accordance with ANSI/IEEE 627 shall not be required. Design qualification shall be in accordance with the manufacturer's and tank farm contractor's procedures.	ANSI/IEEE 627, *Standard for Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations*, contains extensive qualification processes that are intended to ensure adequate functional performance of safety systems at nuclear power plants. The stated purpose of this standard is "to confirm the adequacy of the equipment design to perform its safety functions over the expected range of normal, abnormal, design-basis event, post design-basis event, and in-service test conditions." The rigor associated with this standard is not necessary for fans in waste tank ventilation systems, because continuous operation of these fans during normal, abnormal, or design-basis events is not necessary to perform its safety function or to meet regulatory emission standards. Manufacturer's and tank farm contractor's procedures for design qualification are acceptable. The successful operating history of these standard industrial fans provides significant field qualification of the design.
BA-4160, Vibration: BA-4161, General: Fan wheels shall be dynamically balanced prior to fan assembly. Final balancing shall be performed on the completed assembly. All test results shall be documented. After installation, fans shall be checked and rebalanced, if necessary, to correct changes due to handling, shipping, and final support structure conditions. BA-4162, Centrifugal Fans: The double amplitude radial displacement measured on the bearing caps at the designated fan speed shall not exceed the values listed in Table BA-4162, measured with a meter filtered to the fan rotational speed. BA-4163, Axial Fans: The double amplitude radial displacement measured on the fan housing at both the inlet and discharge locations at the designated speed shall not exceed 1.0 mil (0.025 mm), measured with a meter filtered to the fan rotational speed.	"After installation" for skid-mounted portable exhausters is interpreted to mean after mounting of the fan on the support skid, but before field installation of the entire exhauster. The vibration testing procedures and criteria of AMCA 204-96 shall be used for in-situ vibration testing for fans on skid-mounted portable exhausters after field installation.	The portable exhausters are not firmly mounted to a concrete base, but simply rest on the ground. The ASME AG-1 vibration criteria are impractical to meet for this type of field application. The more stringent ASME AG-1 vibration criteria is intended to minimize maintenance and increase reliability, but adds no benefit for abatement of radioactive air emissions when these fans are accessible for routine maintenance and are not required to operate under post-accident conditions. The accepted industry vibration standard of AMCA 204-96, *Balance Quality and Vibration Levels for Fans*, establishes criteria that are adequate to ensure the required reliability of waste tank ventilation systems. The ASME AG-1 criteria are equivalent to the most stringent criteria of AMCA 204-96 (2.5 mm/s peak velocity), which is intended for computer chip manufacturer clean room applications. The less stringent criteria for low horsepower, industrial process or petrochemical applications (6.4 mm/s peak velocity) are more appropriate for waste tank ventilation systems.

TABLE 1. EXAMPLE: MATRIX PRESENTATION FOR REQUIREMENT EXEMPTION JUSTIFICATIONS

Requirement Text	Chosen Alternative	Exemption Justification
BA-8200 Quality Assurance for Drivers: Each driver shall be manufactured under a quality assurance program that conforms to ASME NQA-2 as applied to fan drivers. Each driver shall be qualified in accordance with ANSI/IEEE 323 Class 1E qualification standards.	The manufacturer's quality assurance program shall meet the basic requirements of ASME NQA-1 or shall be based on other accepted industry standards. The tank farm contractor shall evaluate it for acceptability. Qualification in accordance with ANSI/IEEE 323 shall not be required.	See the justification for exemption from the quality assurance requirements of AA-8110 in Table C-1. ANSI/IEEE 308 defines Class 1E as, "The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment." The fan prevents leakage of waste particles by maintaining vacuum conditions within the tanks; however, it is not essential in preventing significant release or in maintaining emissions below regulatory standards. Therefore, Class 1E standards are not applicable to waste tank ventilation systems and the cost and rigor associated with compliance with Class 1E standards adds little value for control of emissions. Driver qualification in accordance with the manufacturer's design processes is acceptable.

7.0 REFERENCES

ASME AG-1, 2003, *Code on Nuclear Air and Gas Treatment,* American Society of Mechanical Engineers, New York, New York.

RPP-19233, 2004, *General WAC 246-247 Technology Standards Exemption Justifications for Waste Tank Ventilation Systems*, Rev. 0, CH2M Hill Hanford Group, Inc.

WAC 246-247, "Radiation Protection - Air Emissions," *Washington Administrative Code*, as amended.